Our Region's Trusted Water Leader
San Diego County Water Authority

May 24, 2021



**VIA EMAIL AND U.S. MAIL**

Mr. Adam Wilson, Moderator
San Diego County LAFCO
(adwilson858@yahoo.com)

Re: Water Authority Comments On Dr. Hanemann Water Reliability Report

Dear Mr. Wilson:

Per San Diego LAFCO's request, this letter provides comments from the San Diego County Water Authority on Dr. Hanemann's Draft Technical Memorandum: Water Supply Reliability (the "Draft Report").

The Water Authority appreciates Dr. Hanemann's efforts, and LAFCO's attempt to sort through the various complex water supply issues in these reorganization proceedings. Dr. Hanemann always made clear that his report would be a draft, and that he was open to comments and factual updates. In that spirit the Water Authority provides the following remarks.

## Comment 1

The essential conclusion reached by Dr, Hanemann that the Water Authority has a higher comparative reliability is accurate. Indeed, the conclusion is similar to that reached by Fallbrook and Rainbow's own expert Ken Weinberg as to the reliability of SDCWA's water supply:

> "As evidenced in the last two droughts where cutbacks were initiated by MWD (2010-2011 and 2015-2016) SDCWA reliability was greater and cutbacks substantially lower than the MWD regional cutback level. Although MWD maximum cutback levels during both those droughts was 5%, SDCWA because of its more reliable supplies, provided greater reliability to its member agencies M&I customers during both shortages."[1]

[1] *See* Exhibit 9 to Water Authority's September 18, 2020, Response, Weinberg Report page 3. Ken Weinberg's reports are relied upon by both Fallbrook and Rainbow. (*See* Fallbrook LAFCO application attachments, and Rainbow's Supplemental Information for Application RMWD Final, page 16.)

> "Although MWD planning documents anticipate that it will not experience cutbacks if its assumptions on local and imported supplies are fulfilled, they have experienced two rounds of cutbacks within the last 10 years."[2]

However, the bases for the Draft Report's conclusion are actually more extensive than indicated in the report, and we believe adding further foundation will provide helpful detail to the report. Comments 2 through 4 address these additional bases that we believe should be considered and included. Then, in Comment 5, we address the issue of supply risk based on a potential earthquake on the Elsinore Fault, an important issue not covered in the Draft Report.

## Comment 2

The Water Authority concurs with Dr. Hanemann that a water reliability analysis should be based on a "stress test" so as to examine difficult circumstances to judge the availability of a water supply. In that context it is vital that key assumptions be tested.

There are two key water supply reliability assumptions stated for the report: that the Water Authority will, over the study period, retain access to its Colorado River QSA water, because it is Priority 3 water from IID; and that MWD will be able to access its 550,000 acre-feet allotment of Colorado River water. Draft Report, p.7. The first is a reasonable assumption with a solid factual base; the second is not a reasonable assumption, and does not have a factual base.

The full MWD assumption stated in the Draft Report is this: "I assume that MWD will in all circumstances receive 550,000 AF of Colorado River water. In addition to State Water Project water, it will be able to obtain sufficient water from its storage reserves and from water market purchases to meet the full net demand from Member Agencies." Draft Report Page 7. The assumption has three required elements, each of which we disagree with: (1) that MWD will always have access to its 550,000 acre-feet of Colorado River water; (2) that MWD will receive substantial volumes of State Water Project water; and (3) that substantive water market transfers and storage supplies will be sufficient and available to MWD in drought.

*Colorado River Element*: California's normal year Colorado River allotment is 4.4 million acre-feet. This water is allocated on a priority system to various California agencies. The lower an agency's priority right, the more likely it will face a cutback of its water in times of shortage.

Of the 4.4 million acre-feet of normal year allotment to California, *MWD has the lowest priority water, at Priority 4*. Its water allotment of the 4.4 maf is 550,000 acre-feet (the presumed reference in the Draft Report). As to the Water Authority's QSA water, in contrast, it is Priority 3 water by way of conserved water transfer with IID and canal lining in the Imperial Valley.[3] The Draft Report's assumption that the Water Authority will have use of this QSA water is correct and without any possible contest.

However, because MWD's 550,000 acre-feet in California's 4.4 million acre-foot entitlement is *Priority 4* water, it is subject to material reductions. So long as California is not cut back from its 4.4 million acre-foot entitlement, MWD will have access to this water; but we believe the

[2] Fallbrook Public Utility District "Plan for Providing Service December 2019," at pp.43-44 of pdf LAFCO application.

[3] *See* Exhibit B to the Federal QSA Agreement, which is in Exhibit 8 to the Water Authority's LAFCO Response of September 18, 2020.

assumption that this 550,000 acre-feet will avoid any cuts in coming years is not a reasonable assumption, and is especially not applicable in the context of a "stress test." Over the long-term horizon, the Colorado River is facing water shortages that may ultimately reach California's water entitlement. If that occurs, MWD's 550,000 acre-feet entitlement is the first water to be lost under the priority system.

Additionally, if there are shortages on the Colorado River, and they are such that California must contribute, under the Drought Contingency Plan (DCP) negotiated by MWD, then MWD must make up the shortfall for California. This would come from MWD's own Colorado River storage supplies, and thus materially reduce MWD's water storage.

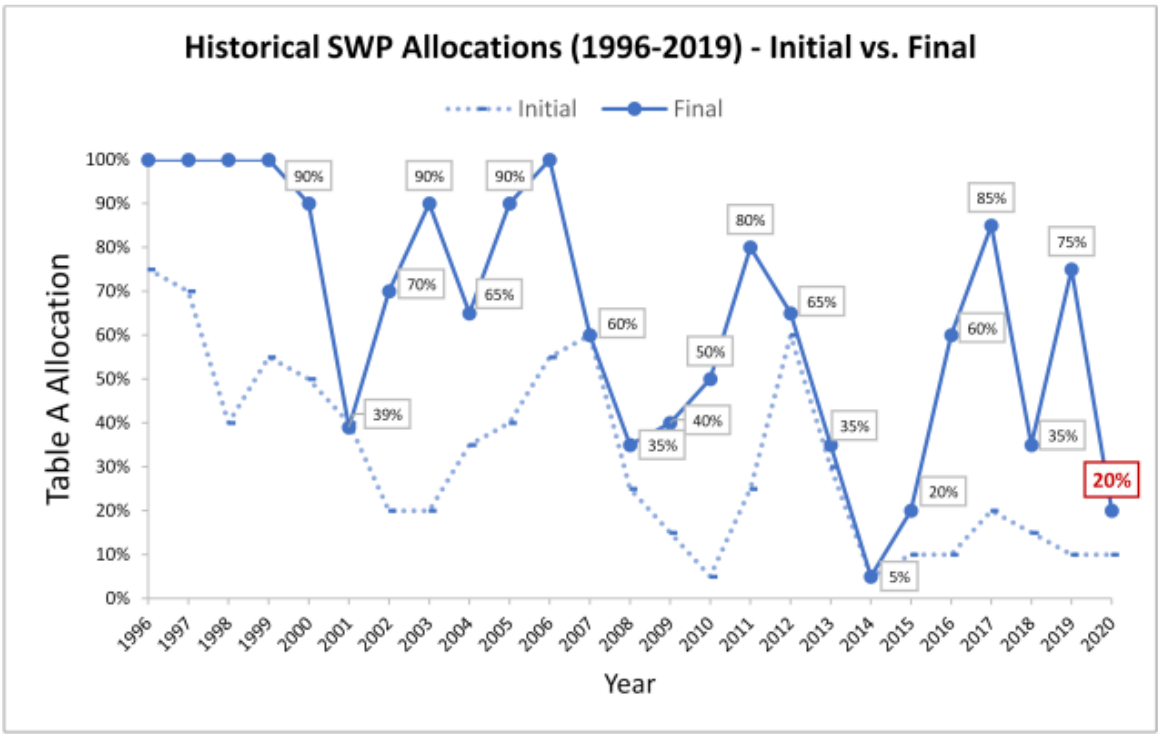
The Draft Report must address the likelihood that MWD will lose a meaningful portion of its Colorado River supplies in very dry periods to cover Colorado River shortages. Attached as Exhibit "B" are newly updated materials from the Bureau of Reclamation and its stress tests as to Colorado River water supplies. Of particular note is the table on page 22 which indicates a 53% chance that Lake Mead will fall below elevation 1,045' in both 2024 and 2025 in the Stress Test hydrology.

MWD analyzed what the DCP issue means for California in 2019 and determined that just through 2026 California's share of Colorado River DCP cutbacks in dry years would be a cumulative *1.7 million acre-feet*. *See* attached Exhibit "A," page 10 MWD stress test model. Under the DCP agreement it negotiated, MWD now bears almost full responsibility under the DCP for California's share of cutbacks, and this must be factored into the equation for the availability of its Colorado River supplies. On Exhibit "A" at slide 9 one can see the volume of California's, and thus MWD's, Colorado River water requirement of at least 200,000 AF per year under the DCP below elevation 1,045'.

Therefore, the Draft Report should re-evaluate the element of the assumption which states that MWD will always be able to access its 550,000 acre-feet of Priority 4 water.

*State Water Project Element*: In 2021, the State Water Project is expected to be able to provide contractors with only 5% of their entitlement. The percentage allotments vary by year, but the trend is steadily downward, as shown in this chart issued by the Department of Water Resources in 2020[4]:

[4] See An Introduction to State Water Project Deliveries | California WaterBlog




Indeed, since just 2013 there have been six years of very low SWP supplies: 35% (2013), 5% (2014), 20% (2015), 35% (2018), 20% (2020), and 5% (2021).

Additionally, as set out in the many exhibits submitted by the Water Authority in its Response at LAFCO, MWD is facing even more major cutbacks on the SWP due to significant environmental problems in the Bay-Delta.

Therefore, the facts actually show that the likelihood of MWD obtaining substantial volumes of water from the State Water Project is not a fair assumption, and we ask that the Draft Report re-evaluate that element in light of these facts.

*Water Transfer/Storage Element*: The final key portion of the stated assumption is that MWD will be able to acquire water from third parties to make up any shortfall in supply, or can meet all needs from storage. However, we do not believe there is a factual basis for this statement, and we offer the following facts to demonstrate why the assumptions about water transfers or storage providing adequate supply are not supportable:

- There is a history of multiple major MWD water shortages resulting in cutbacks. As noted above by Fallbrook and Rainbow's expert, "they have experienced two rounds of cutbacks within the last 10 years."[5] In these cases MWD did *not* remedy its shortfalls with third party supplies or storage, but rather forced cutbacks on member agency deliveries. It is speculative, at best, to assume that MWD would respond differently in the future.

[5] *See also* the extensive detail of MWD shortages in the Water Authority Response to LAFCO of September 18, 2020.

- The reason MWD may not be able to make up major supply shortfalls in drought is because: (a) in major droughts, many suppliers are short on water, and there are not large supplies generally available at a reasonable cost, or perhaps at any cost; (b) MWD is a huge agency. When it is short on water, the volumes are significant. Spot water transfers are often not available in the necessary volumes, especially in the driest years, to meet such demands; and (c) a meaningful portion of the potential transfer market is tied up on the State Water Project, and as time has gone on there is less and less water available from that source, particularly in the dry years being considered in a reliability "stress test."

In summary, therefore, we ask that Dr. Hanemann consider the above facts, and we suggest that the report note that MWD has faced meaningful shortages in the past, that MWD faces increased challenges as to SWP water, and that MWD faces potential cutbacks to its 550,000 acre-foot Priority 4 Colorado River entitlement due to its lower priority and DCP obligations and potential lowered Lake Mead elevations.

Rainbow and Fallbrook customers are entitled to know that the reorganization proposals will not provide for delivery of the "same water" that is equally reliable to the water supply they have now. These customers currently are guaranteed firm rights to "Priority 3" Colorado River Water by being in the Water Authority service area. The proposal would exchange these guaranteed rights for non-guaranteed rights to "Priority 4" Colorado River Water. Water Authority customers, including those in Rainbow and Fallbrook, invested in the conservation measures necessary to create the QSA precisely to gain both the reliability and cost advantage that Water Authority customers now enjoy over those who are dependent on MWD's less reliable supply.

In addition to the diminished contractual security proposed by the applicants, the plan would put Rainbow and Fallbrook customers at political risk under drought conditions by cutting them off from San Diego County. The value of regional relationships was proven when San Diego County was confronted in the past with mandated cuts in water supply. The Water Authority voted to protect a water supply for San Diego's agricultural customers, including those in Rainbow and Fallbrook, who otherwise would have lost 90% of their water. In an "all for one and one for all" spirit, this effort was broadly supported by both public and private San Diego regional interests. This is the sort of political cohesion that LAFCO was established to promote and frankly many other parts of the state seek to emulate.

## **Comment 3**

The Draft Report's calculations of Eastern's need for water in dry years, though they may be accurate, do not appear to be relevant to the issue before LAFCO, because under the current proposal *Rainbow and Fallbrook will have no ability to access any Eastern supplies other than those from MWD*. Consider the following undisputed facts:

- There is no Eastern infrastructure that connects in any manner to Fallbrook or Rainbow, nor are there plans to build any.

- The parties admit that they are solely going to be receiving MWD supplies, and nothing else. This is documented extensively in the Water Authority Response at LAFCO, and was just admitted again by Rainbow General Manager Tom Kennedy at a public Rainbow meeting in May:

> GENERAL MANAGER KENNEDY:·"Eastern's just the paper guy in between us and Metropolitan."[6]
>
> "CHAIR NELSON:· -- would we end up participating in the payment for those developments [in Eastern] -- . . . .
> GENERAL MANAGER KENNEDY:· Right. We will not. Under our agreement with them [Eastern] we are just strictly getting Metropolitan water from them."[7]

Therefore, whatever Eastern's own customers may have access to in terms of water storage or independent supplies, those water supplies and facilities will not benefit Fallbrook and Rainbow, which never paid for them, and for which there are no Eastern infrastructure connections.

Because Fallbrook and Rainbow do not propose paying for or receiving any benefits from Eastern's storage, local supplies, or water system other than MWD water, a study of Eastern's infrastructure, water storage, local supplies, and water rights is irrelevant to consideration of how reliable Fallbrook and Rainbow's water supply will be under detachment.

This key fact was not clear in the Draft Report and should be clearly stated when talking about Eastern's overall reliability and what Eastern will (and won't) provide to Fallbrook and Rainbow as wholesale customers. Fallbrook and Rainbow customers will not receive any local supply or storage benefits from Eastern in the event of an MWD cutback or allocation of MWD supplies. By contrast, they currently receive the full benefit of the Water Authority's more reliable water portfolio, which includes seawater desalination, higher-priority QSA Colorado River water, and expanded regional storage for use in dry years

**Comment 4**

The Draft Report's conclusion relies in part on what was stated orally at the recent Advisory Committee meeting: that the Water Authority's has high preferential rights at MWD. This should be included in the Draft Report. The Water Authority's high preferential rights at MWD are detailed in the March 9, 2021, letter we sent to LAFCO, and in our September 18, 2020, LAFCO Response.

One critical point that must not be forgotten is this: Rainbow and Fallbrook, if detached, are not expected to have any preferential right to MWD water. Why? Because, as confirmed by MWD General Manager Kightlinger, no portion of the Water Authority's statutory preferential rights move to Eastern, and Eastern's own preferential rights (which are less than Eastern's current actual MWD usage) are based on the history of Eastern's ratepayers paying into MWD over many years (MWD Act Section 135: "the total *accumulation* of amounts paid by such agency to the district on tax assessments and otherwise, excepting purchase of water, toward the capital cost and operating expense of the district's works . . . ." Emphasis added.) Without a further buy-in to Eastern's system, which is not being proposed or taking place ("Eastern's just the paper guy in between us and Metropolitan"), preferential rights at Eastern will not be available to

[6] Exhibit "C" Transcript, p.36(6-7) (highlighting added).

[7] *Id*. at p.39(10-17).

Fallbrook and Rainbow customers. From the standpoint of risk, this should be a fatal flaw in the reorganization applications.

## Comment 5

The Draft Report contains no mention of water supplies during an earthquake. However, a "stress test" is to consider what can happen when things go wrong. A water supply is not a luxury but a survival necessity, and thus we suggest that an earthquake analysis is critical and must be included in a supply review.[8]

Rainbow and Fallbrook expert Ken Weinberg clearly stated that Fallbrook and Rainbow would be at risk by depending on MWD water if there were an earthquake on the Elsinore Fault:

> "In a potential annexation to EMWD FPUD and RMWD M&I customers would be tied to MWD reliability and supply availability in both droughts and catastrophic emergencies. In a catastrophic emergency, such as an earthquake that cuts off imported supplies MWD has emergency storage supplies that would provide a 75% level of Service to its member agencies similar to SDCWA Emergency Storage Project (ESP). However, SDCWA would be able to provide emergency service in the event of an earthquake on the Elsinore Fault that would *disrupt Lake Skinner and other [MWD] associated facilities that serve San Diego county*. *This would result in a lower level of reliability for those customers in an annexation to EMWD compared to remaining in SDCWA*."[9] (Emphasis added.)

Following a major earthquake on the Elsinore Fault, Fallbrook and Rainbow could be without MWD imported water for an extended period of time. Such an earthquake could sever the pipelines delivering MWD water to those agencies from the north. This issue was not addressed in the Draft Report but is a critically important factor when assessing the overall comparative reliability of Eastern versus the Water Authority. The Water Authority's Emergency Storage Project (ESP) and Carryover Storage Project (CSP) were developed to address both a catastrophic (earthquake) event and extreme drought risk factors to be able to provide service to all of its member agencies in the event of an outage. MWD's and Eastern's system, both north of the fault, would not be able to deliver any water supplies in a major outage.

This is an extreme risk to both agencies, particularly Rainbow; again, one that might reasonably be considered a fatal flaw of the detachment applications. The difference in reliability levels between the two applicants also was not covered in the Draft Report. For example, Fallbrook has local groundwater supplies and is currently developing more, and could better buffer a supply cutback from MWD since Fallbrook's reliance on MWD for supplemental water will decrease over time. However, Rainbow does not currently have any local supplies, nor are any in development, nor is there storage to fall back on. Detachment would leave Fallbrook and Rainbow customers fully exposed to the risk of a complete loss of water.

[8] The fact that all parties' initial LAFCO submissions addressed earthquake water supply issues shows that it is an important issue that should not be ignored by LAFCO.

[9] *See* Exhibit 9 to Water Authority's September 18, 2020, Response, Weinberg Report page 3.

## Conclusion

The Draft Report covers certain "macro" agency supply issues, but these are not all the water supply issues relevant to the reliability analysis. Although the conclusion on reliability is accurate, we believe the analysis would benefit from additional factual support, as detailed above.

Sincerely,

Sandra L. Kerl
General Manager

cc via email:

Water Authority Board of Directors
Keene Simonds, SD LAFCO Executive Officer
Holly Whatley, SD LAFCO Commission Counsel
Tom Kennedy, General Manager, Rainbow MWD
Jack Bebee, General Manager, Fallbrook PUD
Alfred Smith, Counsel, Rainbow MWD
Paula C. P. de Sousa, Counsel, Fallbrook PUD
Nick Kanetis, Deputy General Manager, Eastern MWD
Mark Hattam, General Counsel, San Diego County Water Authority
Kristina Lawson, Special Counsel, San Diego County Water Authority

# EXHIBIT A

# Authorize participation in the Lower Basin Drought Contingency Plan on behalf of California

Water Planning and Stewardship Committee
8-1
March 11, 2019

# Recent Updates & Actions – Metropolitan Board

- Oral Report - Water Planning & Stewardship Committee – October 8, 2018
- Information Item - Water Planning & Stewardship Committee – November 6, 2018
- Metropolitan Board vote to authorize the agency to enter the Lower Basin DCP – December 11, 2018

# Status of DCP Approval in California

- Metropolitan Board authorized both Interstate and Intrastate DCP agreements: 12/11/2018
- Coachella Valley Irrigation District authorized
  - Interstate agreement: 2/12/2019
  - Intrastate agreements: 12/19/2018
- Palo Verde Irrigation District – authorized 'Documents related to Drought Contingency Planning': 12/18/2018
- Imperial Irrigation District authorized and suspended Intrastate agreements: 12/10/2018

# Imperial Irrigation District Conditions on Intrastate DCP Implementation Agreements

- Imperial Irrigation District (IID) Board voted to authorize the MWD/IID DCP Implementation agreement and California ICS Agreement Amendment No. 3, "but their implementation is suspended until the following conditions are met" at its December 2018 meeting:
  - All seven Colorado River Basin States and the United States approve the interstate DCP documents before the IID votes on the interstate agreements;
  - IID Board approves any proposed legislation submitted to Congress; and
  - *"The State of California and the United States have irrevocably committed to providing sufficient funding for the full completion of the 10 year Salton Sea Management Plan at a 1:1 federal to state funding commitment in addition to mitigating any and all future considerations as a result of the implementation of the Intra-California Agreement and the Interstate DCP Agreements."*

# Reasons for Metropolitan to Step In For California's DCP Obligations

- IID's conditions for approval are unlikely to be satisfied anytime soon
- Committing to the DCP allows operational flexibility for Metropolitan to store ICS in 2019 rather than draw ICS down
- Better than average hydrology in California and damage to Whitewater spreading have made Lake Mead storage even more important in 2019

# Reduced risks of Assuming CA's Obligation

- Risks of Metropolitan assuming California's DCP Contribution obligations are mitigated by the following:
  - Wetter than expected hydrology in the Colorado River Basin this year
  - Higher than expected 2018 ICS creation
  - Unused 2018 water

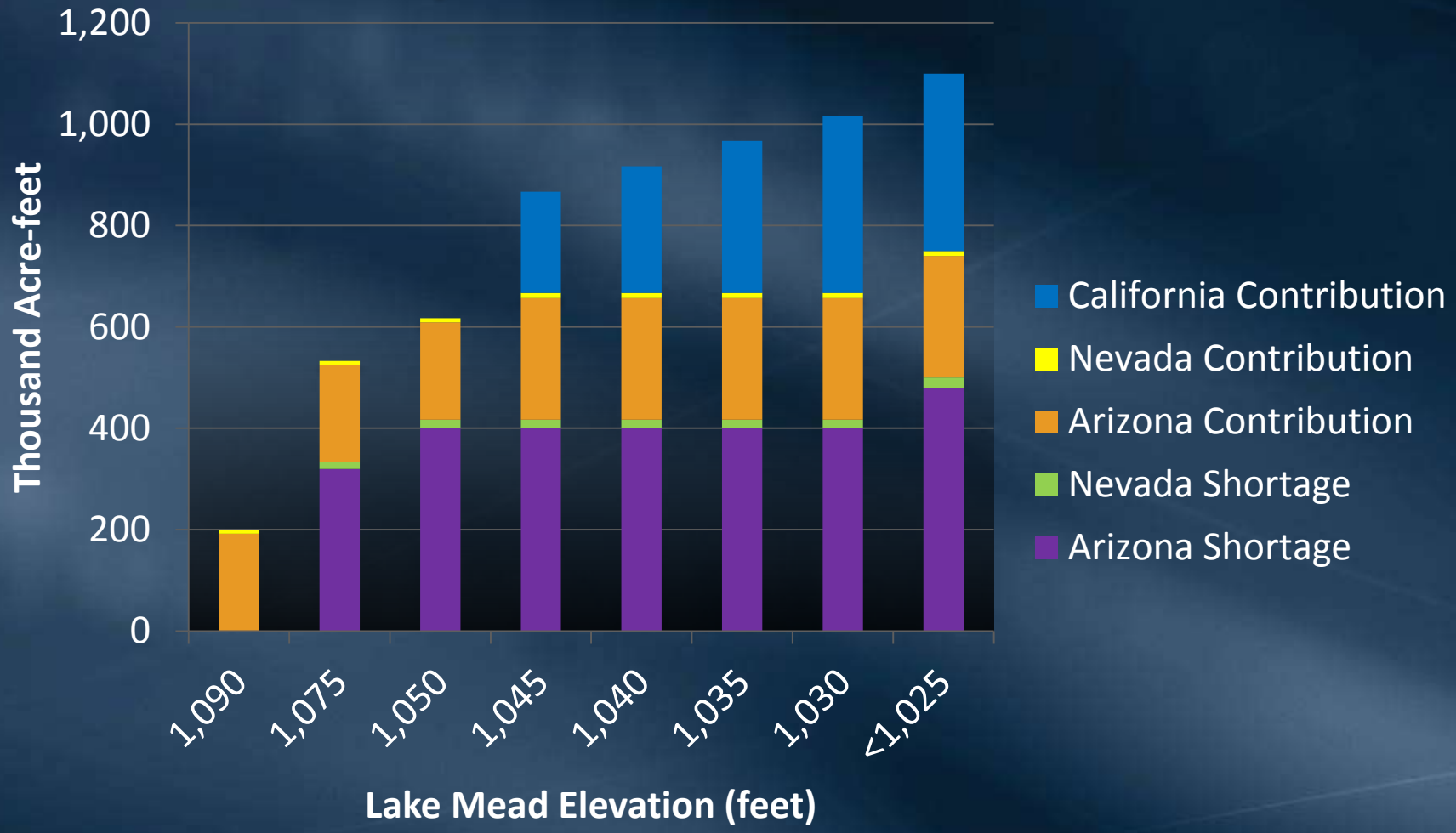
# Benefits of Lower Basin DCP (Interstate Agreement)

- *Increased Flexibility*: Enhances access to Intentionally Created Surplus (ICS) and interstate banking at lower Lake Mead elevations - available at shortage tiers
- *Lower System Assessment:* Reduces current evaporative and system charges on MWD water stored in Lake Mead
- *More ICS Storage Capacity:* Increases California's total ICS storage capacity 200 TAF – from 1.5 to 1.7 MAF

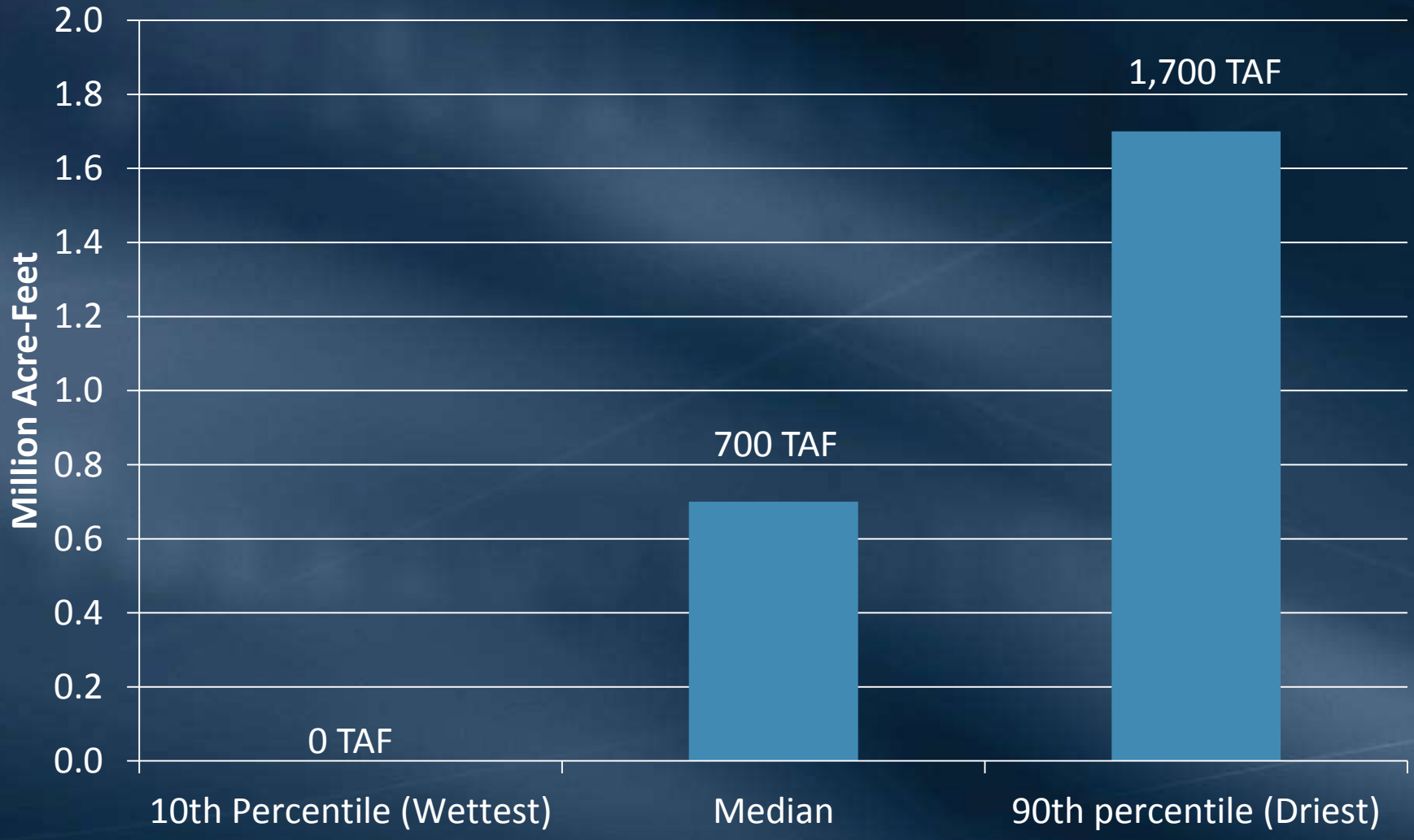
# Commitments Assumed in Lower Basin DCP (Interstate Agreements)

- *DCP Contributions* - Each Lower Division State (AZ, NV and CA) assumes the obligation to store defined volumes of water in Lake Mead, at specified reservoir elevations.
  - Each State determines how its DCP Contribution obligation through intrastate agreements

# Total Lower Basin Contributions with DCP by Elevation



# Cumulative California Contribution through 2026, Stress Test Modeling



# California's DCP Contributions

Division of California's DCP Obligations (as approved by MWD Board December, 2018)

- Imperial Irrigation District – 125,000 AF per year, for first two years of DCP Contributions. Sources: water currently stored with MWD and in Lake Mead, and existing conservation programs within IID
- Coachella Valley Water District – 7%. Source: Quantification Settlement Agreement transfers
- Palo Verde Irrigation District – 8%. Source: Existing fallowing program with Metropolitan
- Metropolitan – the remainder of CA's DCP Contribution

# Sources of Metropolitan's DCP Contributions

- Current ICS balance ~ 600 TAF
- Future ICS creation – may store up to 400 TAF annually
- DCP Contributions and ICS Accumulation Limits Sharing Agreement – up to 300 TAF

# Benefits of DCP for Metropolitan

- Creates additional certainty in Lake Mead operations through 2026
- Reduces the risk of Lake Mead declining below elevation 1,020’
- Enhances ICS storage capacity and accessibility
- Provides more favorable system assessment charges
- Protects ability to continue hydropower generation

# Board Option #1

- Authorize participation in the Lower Basin Drought Contingency Plan on behalf of California.

# Board Option #2

- Do not authorize participation in the Lower Basin Drought Contingency Plan on behalf of California.

# Staff Recommendation

- Staff recommends Option #1


THE METROPOLITAN WATER DISTRICT OF
SOUTHERN CALIFORNIA
1928

# EXHIBIT B

| | |
|---|---|
| **From:** | Butler, Robert (Alan) |
| **To:** | Adrian Cortez; Adriana Resendez; Adriana Rodriguez; Pivarnik, Alexander J; alexei.luganov@snwa.com; Witherall, Amy J; amy.ostdiek; Amy Haas; astraub@southernute-nsn.gov; Angela Rashid; angela slaughter; Anna Morales; Antonio Rascón; Ashley.Nielson@noaa.gov; Ramakrishnan, Balaji; barry.lawrence@wyo.gov; Uriona, Beau C; Bill Hasencamp; LCB Liaison, BOR WRO; Brenda.Alcorn@noaa.gov; Bret Esslin; carla.hernandez@conagua.gob.mx; Jerla, Carly; Casey Collins; charlie.ferrantelli@wyo.gov; Cutler, Christopher CRC; Christina.Noftsker@state.nm.us; Chris Harris; Chuck Cullom; Colby Pellegrino; Denham, Dan; Bunk, Daniel A; Daniel Galindo; Daniel Avila; Dave Kanzer; Deanna Ikeya; DPolyzos@mwdh2o.com; Mohamed, Dylan; Ostler, Don; EVirden@usbr.gov; Edwin Fernando Zetina Robleda; Erick Chavez; ewitkoski@crc.nv.gov; Francisco Bernal; Allan, Genevieve C; Patno, Heather E; Bon Santoyo Homey; Nguyen-DeCorse, Hong B; Prairie, James R; Beadnell, James N; jasonjohn@navajo-nsn.gov; Javier Aparicio; jweiner; Jeffrey Inwood; jeff.johnson@snwa.com; Dodds, Jeremy R.; Jerry Zimmerman; Khaya, Jessica A; jneuwerth@crb.ca.gov; jim.lochhead@denverwater.org; jdanielsen@mwdh2o.com; jshoff@iid.com; Jose Gutiérrez; juan.chompa@conagua.gob.mx; julie.gondzar@wyo.gov; Mathews, Kara; Grantz, Katrina A; Rodgers, Kelly; Velasquez, Kimberlyn; Lain.Leoniak@coag.gov; Laura Lamdin; Traynham, Lee E; Lindia Liu; laoys@mwdh2o.com; Luis Heredia; Ferreira, Marcia; mclark@mvidd.net; Bernardo, Michael A; Michelle Stokes - NOAA Federal; miguel.rodriguezt@conagua.gob.mx; MPropersi@mwdh2o.com; Mohammed Mahmoud, PhD; Todea, Nathaniel; Santos, Noe I; Orestes Morfin; Adams, Pamela S; pdent@cap-az.com; Davidson, Paul J; Paul Miller; Paul.Harms@state.nm.us; Peggy Roefer; pnelson@cvwd.org; Rabi Gyawali; Smith, Rebecca M; Clayton, Richard B; Rich Juricich; Rick.Marsicek@denverwater.org; Butler, Robert (Alan); Robert Cheng; Robert King; Snow, Robert F; rolf.schmidt@state.nm.us; Sally Spener; Eto, Sandra; sprice@crc.state.nv.us; Sara Larsen; Baker, Sarah A; Schrag-Toso, Sean C; Seth Shanahan; Tighi, Shana G; srosset@mwdh2o.com; STakeguchi@mwdh2o.com; Steve Wolff; Oxford, Talmadge L; Thomas, Terri L; Thomas Maher; Tina Shields; Thomas Buschatzke; Tom Ryan; Larsen, Tyler J; Warren Turkett; William Finn; zane.marshall@snwa.com; Jennifer Pena; Gerry Walker |
| **Cc:** | Wade, Stacy L; Pullan, Wayne G; Arend, David J; Gould, Jacklynn L; Picard, Daniel C; Grantz, Katrina A; Aaron, Patricia; Erickson, Jennifer M; Snow, Robert F; Smith, Rodney; Witherall, Amy J; Bunk, Daniel A; Cutler, Christopher CRC; Williams, Nicholas T; Callister, Kathleen E; UCBLiaison, BOR WRO; LCB Liaison, BOR WRO |
| **Subject:** | April 2021 Colorado River System Projections through 2026 |
| **Date:** | Tuesday, May 4, 2021 1:43:24 PM |
| **Attachments:** | CRSS April 2021.pdf<br>LFnatFlow1906-2021.2021.4.20.xlsx |

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Hi,

We completed the April update to the official projections through 2026, which are attached and summarized below. These results will also be available at https://www.usbr.gov/lc/region/g4000/riverops/crss-5year-projections.html and https://www.usbr.gov/lc/region/g4000/riverops/crss-alt-hydrology.html later today.

Additionally, the preliminary provisional estimates of the natural flow at Lees Ferry for CY/WY 2021 (as well 2020) are attached and available at https://www.usbr.gov/lc/region/g4000/NaturalFlow/provisional.html. The 2019 natural flows were released on April 20, 2021, and were used for this CRSS run.

***Key assumptions***

- Projections for 2021 are from the April 2021 Colorado River Mid-term Modeling System (CRMMS) in MTOM Mode, with the 2021 hydrology per the Colorado Basin River Forecast Center's April official forecast consisting of 35 future inflow sequences
- CRSS projections begin in 2022 using all 35 end-of-December 2021 projections from the April 2021 CRMMS in MTOM Mode
- Hydrology for 2022-2026 is based on resampling the 1906-2019 (Full hydrology) natural flow record and resampling the 1988-2019 (Stress Test hydrology) natural flow record
- The Upper Basin demands are per the 2016 UCRC schedule.

    - Reclamation incorporated the 2016 UCRC Demand Schedule for the Upper Colorado River Division States ("2016 Schedule") for the first time in the January 2021 CRSS official model run. The Upper Division States and UCRC assisted with the representation of this new schedule in CRSS. During this process, the need for additional refinements to the representation of Upper Colorado River Basin water use in CRSS was identified. Reclamation is currently working with the Upper Division States and UCRC on such refinements.
- Regarding Drought Contingency Plan (DCP) modeling- in the Upper Basin, only the Drought Response Operations are included. In the Lower Basin, assumptions regarding DCP Contributions, Intentionally Created Surplus, and other system conservation have been verified with each State. Mexico's Binational Water Scarcity Contingency Plan is also included.

***Key results***

- Overall, April 2021 projections are generally lower at Lake Powell and Lake Mead than the January 2021 projections. Because we added 2019, which was 121% of average, to the natural flows used in the April projections, some April 2021 outlooks are slightly better than the January outlooks for a single year; however, the overall trend is lower projections in the April results.

- At Powell, the April elevation projections are lower on average than the January projections.
    - The April-July most probable runoff forecast decreased by 600 kaf between January and April. (Note that the forecast decreased an additional 500 kaf from the beginning of April to mid-April, but because this modeling used the April 2nd forecast the additional decrease is not reflected in these results.)
        - Based on the April forecast Powell will most likely be operating in the Mid-Elevation Release Tier releasing 7.48 maf next year (91% chance – an increase of 15% since January).
            - There is a 59% chance of back-to-back (WY 2022 and 2023) 7.48 maf release years in the Stress Test hydrology and a 46% chance of back-to-back 7.48 maf release years in the Full hydrology
            - The Mid-Elevation release tier is also the most likely operating tier in 2023, where the projections show a 65% chance of operating in this tier in the Stress Test hydrology – an increase of 5% since January.
        - If this year gets even worse (like 2002) there is a chance that we end this year with Powell below 3,525' and operate in the Lower Elevation Balancing Tier in WY 2022. **However**, this ignores any drought response operations this year, as those are not modeled in MTOM.
        - Beyond 2022, Powell's chances of falling to critical levels increased by up to

4% in the Stress Test hydrology compared to the January projections and increased by 1-4% in the Full Hydrology.

- At Mead, the April elevation projections are also lower on average than the January projections.
    - The 2021 operations modeled in CRMMS in MTOM Mode include required Lower Basin DCP contributions and Mexico's Binational Water Scarcity Contingency Plan savings
    - With Powell's WY2021 release now set to 8.23 maf, the range of Mead's end-of-2021 elevations is now much more constrained
        - There is a 97% chance of shortage in CY 2022, and all projections from CRMMS in MTOM Mode show that DCP and BWSCP contributions will be required in 2022.
        - The chance of a shortage in 2023-2025 exceeds 75% in every year for both the Full and Stress Test hydrology, and there is greater than 90% chance of shortage in 2023 in both hydrology scenarios.
            - The chances of level 1 shortages increased in 2023 by 1% in the Stress Test hydrology but decreased in 2024. The decrease in level 1 shortage was due to increased probabilities of level 2 and 3 shortages.
            - The chances of level 2 and level 3 shortages increased (1-10%) in 2023-2025 in both the Full and Stress Test hydrology. The first projected level 2 shortage is in 2023, and the chance of a level 2 shortage in 2024 increased from 50% to 60% in the Stress Test hydrology.
    - Compared to the January projections, the chances of Mead falling to critical elevations in the next 5 years remained similar (+/- 1%) in the Full hydrology but increased by 2-5% in the Stress Test hydrology.
        - There is now a 36-44% chance that Lake Mead will fall below 1,025' in any month in 2024 or 2025 in the Stress Test hydrology
        - In both the Full and Stress Test hydrology there is < 4% chance of falling to 1,000 feet in any month through 2024.

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BUREAU OF RECLAMATION

# Colorado River Basin April 2021 Update of Projected Future Conditions

April 2021

# Outline

- Model Assumptions
- Comparison of January 2021 and April 2021 results
  - January 2021 vs. April 2021
  - Full hydrology (1906 – 2019) and Stress Test hydrology (1988 – 2019)
- April 2021 results that will be posted online

# Approach for Official April 2021 Probabilistic Modeling

1. Use the April Colorado River Mid-term Modeling System (CRMMS) – MTOM mode to project 2021 operations
   - 2021 hydrology per the Colorado Basin River Forecast Center's April official forecast consisting of 35 future inflow sequences
2. Initialize CRSS with all 35 CRMMS MTOM mode projections of December 2021 reservoir conditions, 2022 Lake Powell operating tier, and 2022 Lake Mead operating condition
3. Use CRSS to project 2022-2026 conditions using 114 hydrologic inflow sequences from the observed natural flow record (1906-2019), i.e., "Full Hydrology", and 32 hydrologic inflow sequences from the observed natural flow record (1988-2019), i.e., "Stress Test Hydrology"
   - Full Hydrology: 35 initial conditions x 114 hydrologic inflow sequences = 3,990 total simulations in CRSS
   - Stress Test Hydrology: 35 initial conditions x 32 hydrologic inflow sequences = 1,120 total simulations in CRSS
4. Compute probabilities across all future traces

# Key Official April 2021 Modeling Assumptions

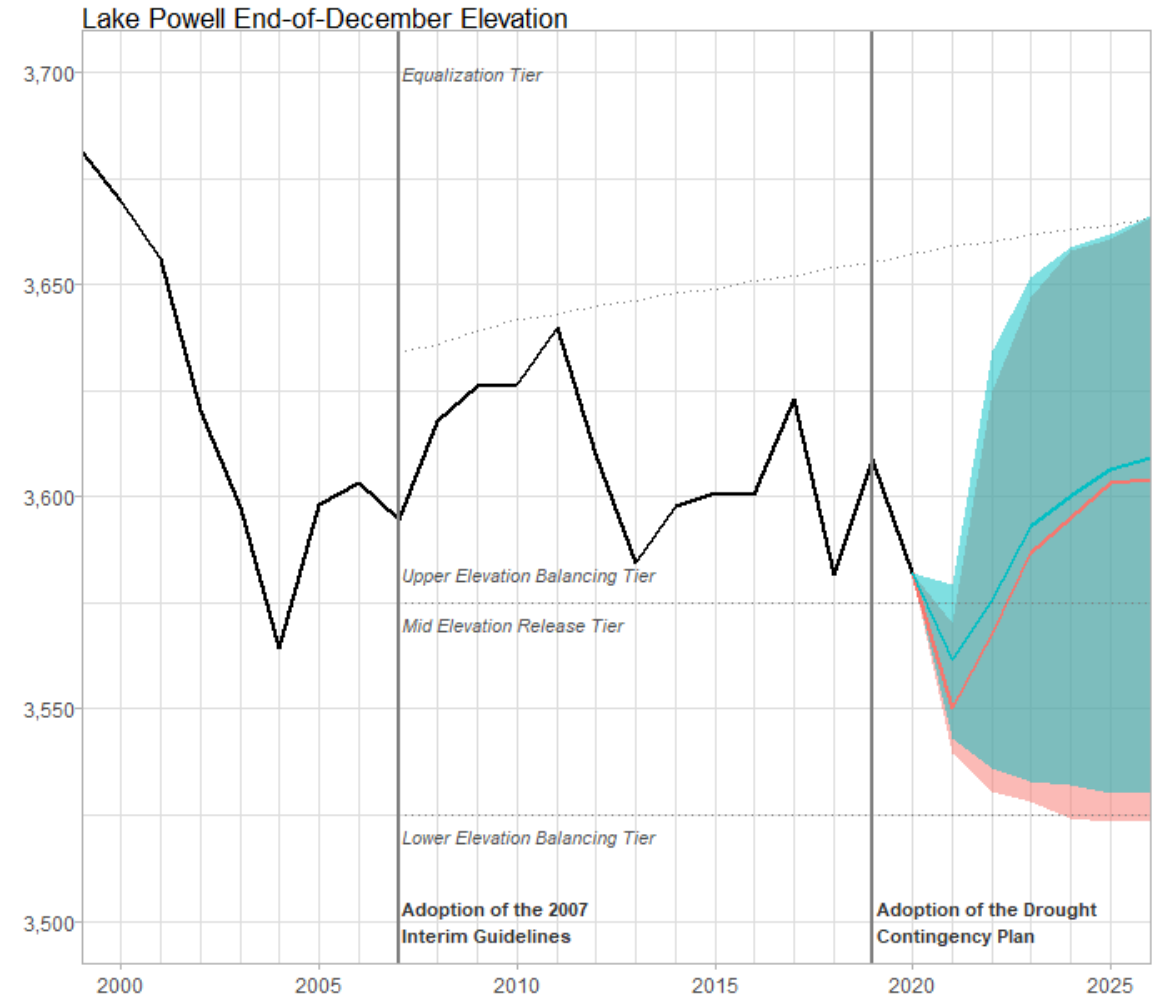
| | CRMMS MTOM Mode | CRSS |
|---|---|---|
| Primary Use | Risk-based operational planning and analysis during mid-term time period | Long-term planning studies, operational criteria development, and risk analysis |
| Simulation Start Date | April 2021 | January 2022 |
| Reservoir Initial Conditions | Based on observed March 31, 2020 reservoir elevations | Based on 35 simulations of December 31, 2021 conditions using MTOM |
| Lake Powell and Lake Mead Operations | Operations are consistent with the 2007 Record of Decision on Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations of Lake Powell and Lake Mead (2007 Interim Guidelines), the Colorado River Basin Drought Contingency Plans, and Minute 323 to the 1944 U.S-Mexico Water Treaty. | |
| Upper Basin Inflows | Ensemble of 35 unregulated inflow forecasts dated April 2, 2021, based on observed temperature and precipitation from 1981-2015, provided by Colorado Basin River Forecast Center (CBRFC) | Two hydrology scenarios are used in these projections. Each scenario is combined with all 35 initial conditions.<br>1. Resampled observed natural flows from 1906-2019 creating 114 future hydrologic sequences using the "Indexed Sequential Method"<br>2. Resampled observed natural flows from 1988-2019 creating 32 future hydrologic sequences using the "Indexed Sequential Method" |
| Lower Basin Inflows | 35 possibilities based on the 35-year (1981-2015) historical record | |
| Upper Basin Water Demand | Estimated and incorporated in the unregulated inflow forecasts provided by the CBRFC | Developed in coordination with the Upper Colorado River Commission (UCRC)[1] |
| Lower Basin Water Demand | Developed in coordination with the Lower Basin States and Mexico | |

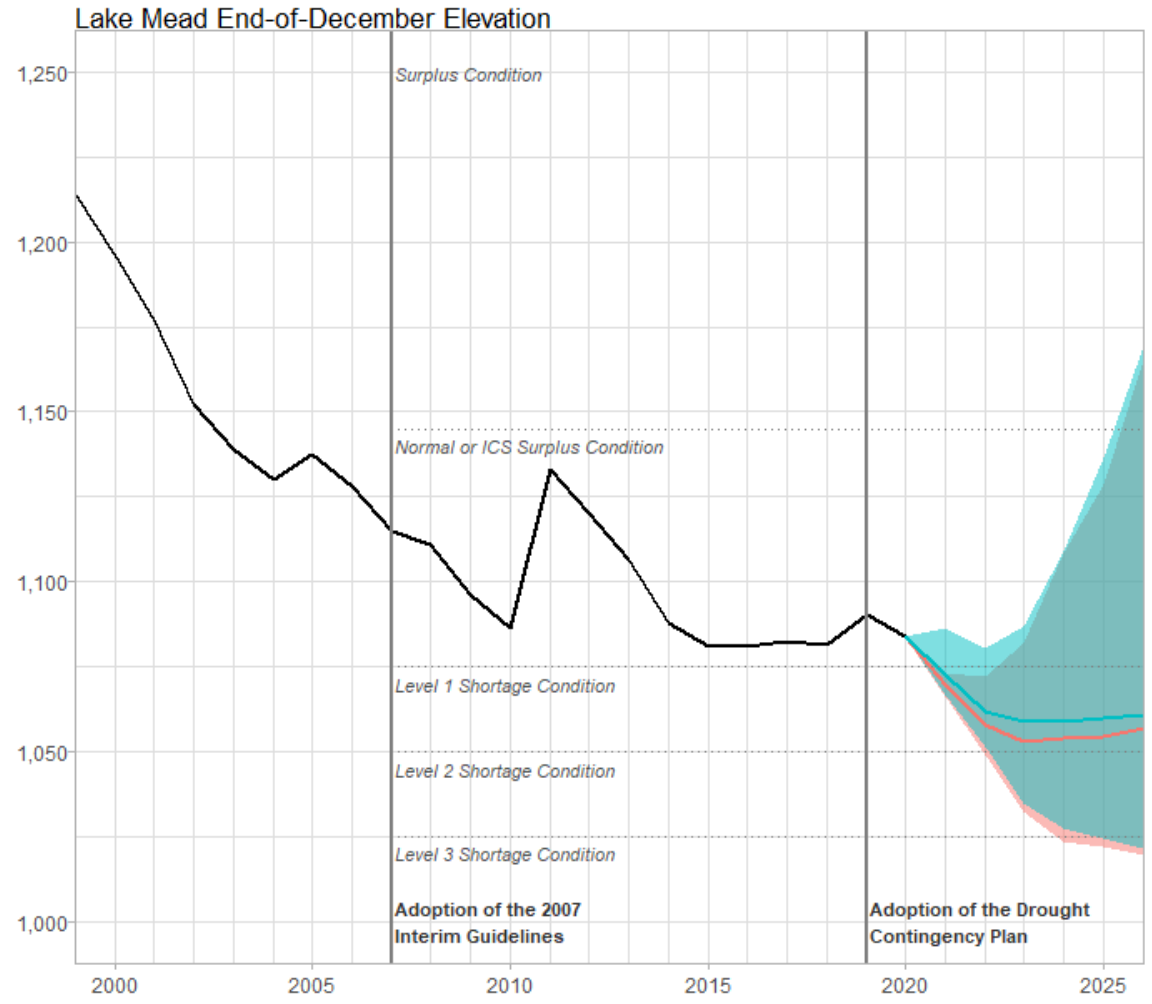
Notes:

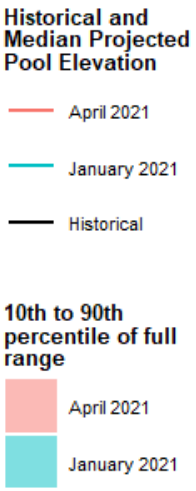
[1] Reclamation incorporated the 2016 UCRC Demand Schedule for the Upper Colorado River Division States ("2016 Schedule") for the first time in the January 2021 CRSS official model run. The Upper Division States and UCRC assisted with the representation of this new schedule in CRSS. During this process, the need for additional refinements to the representation of Upper Colorado River Basin water use in CRSS was identified. Reclamation is currently working with the Upper Division States and UCRC on such refinements.

# Comparison of January 2021 and April 2021 Results with the Full Hydrology

# January 2021 vs. April 2021
# Full Hydrology



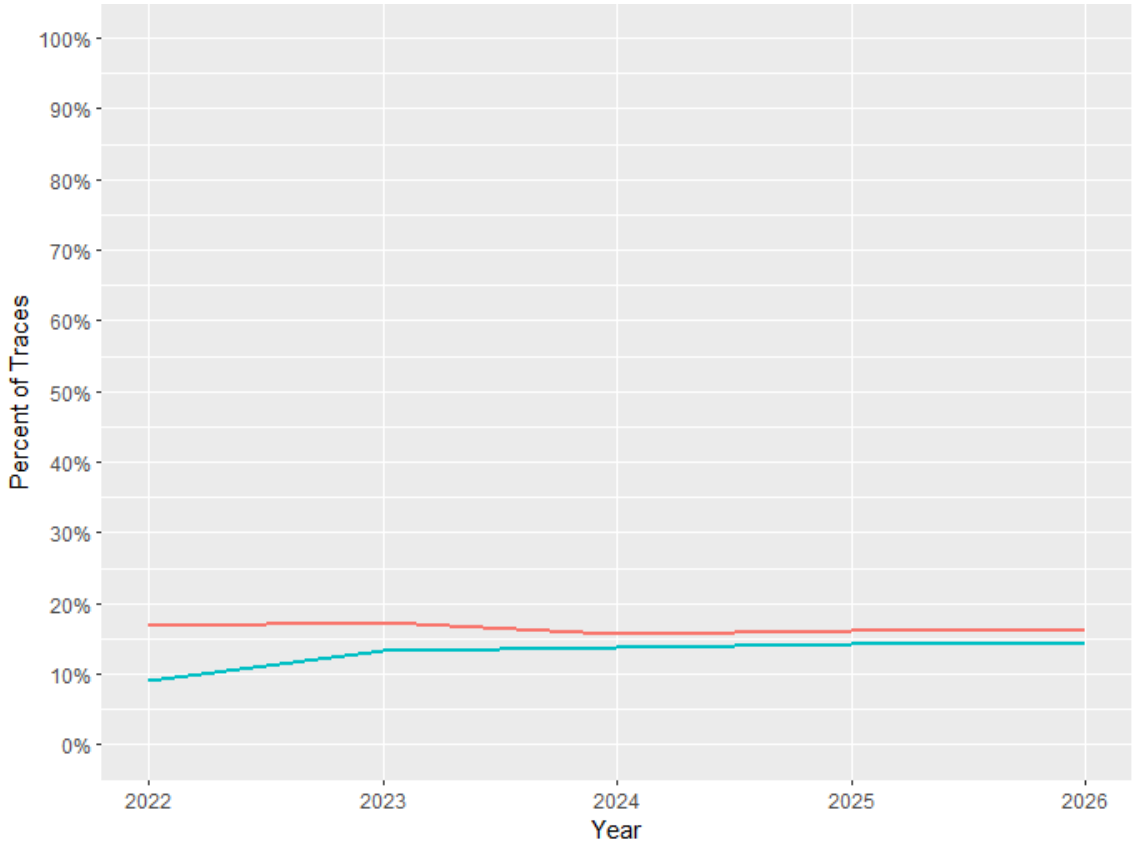



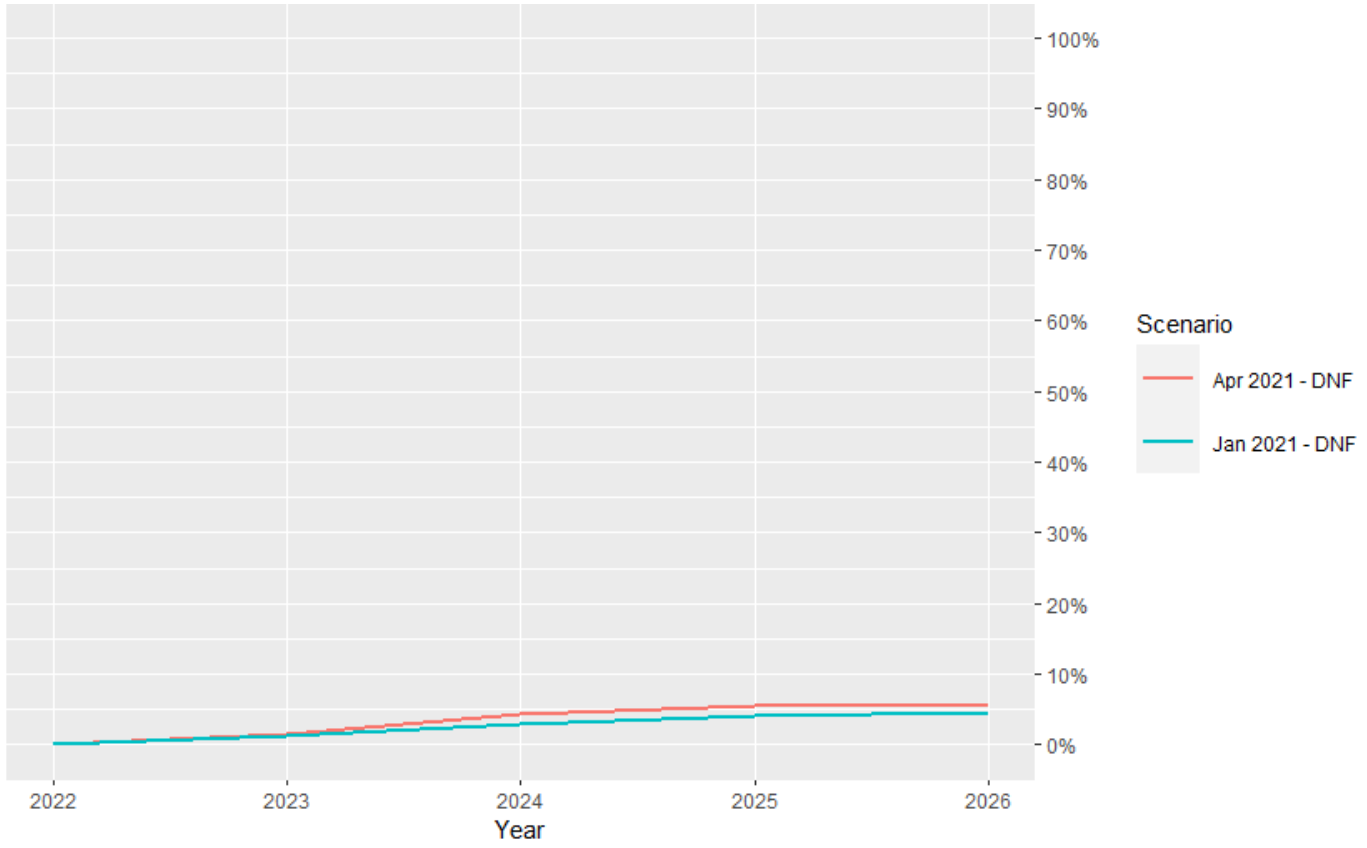
# January 2021 vs. April 2021 Full Hydrology

## Lake Powell:

Percent of traces less than elevation 3,525’ in any water year



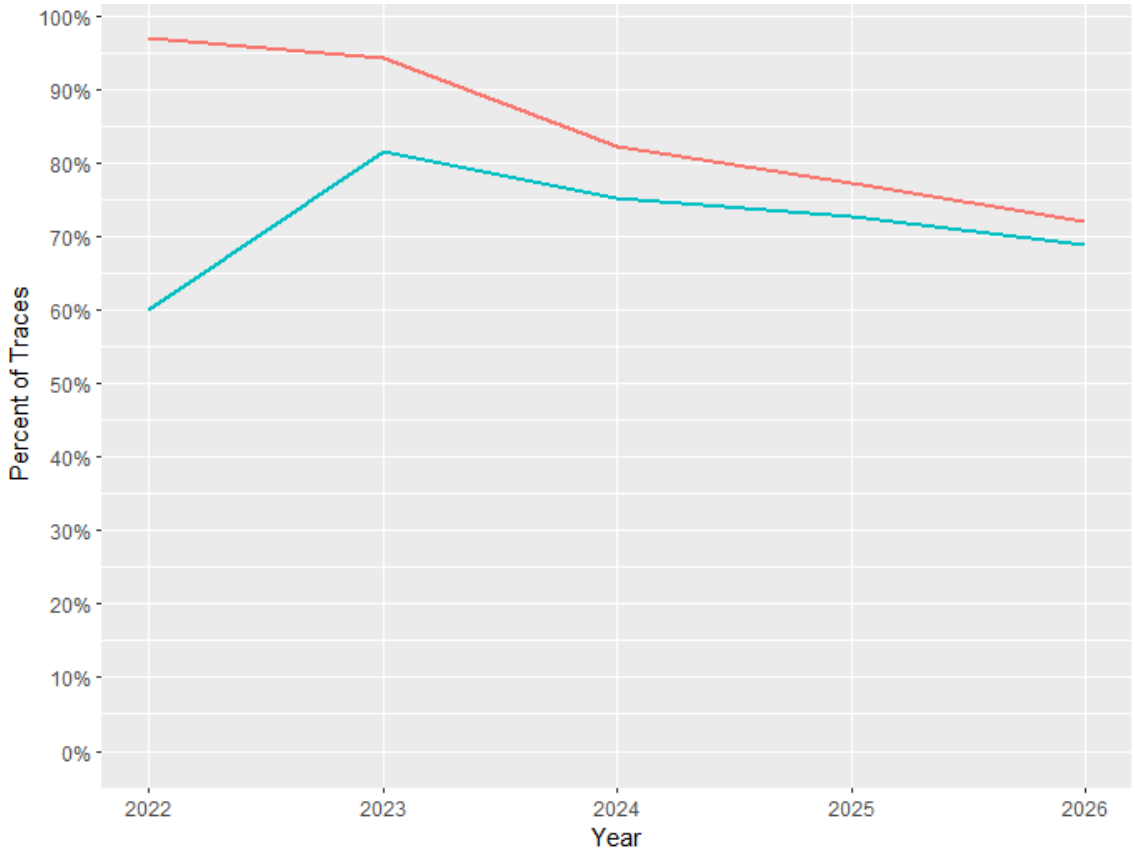

Percent of traces less than elevation 3,490’ (power pool) in any water year



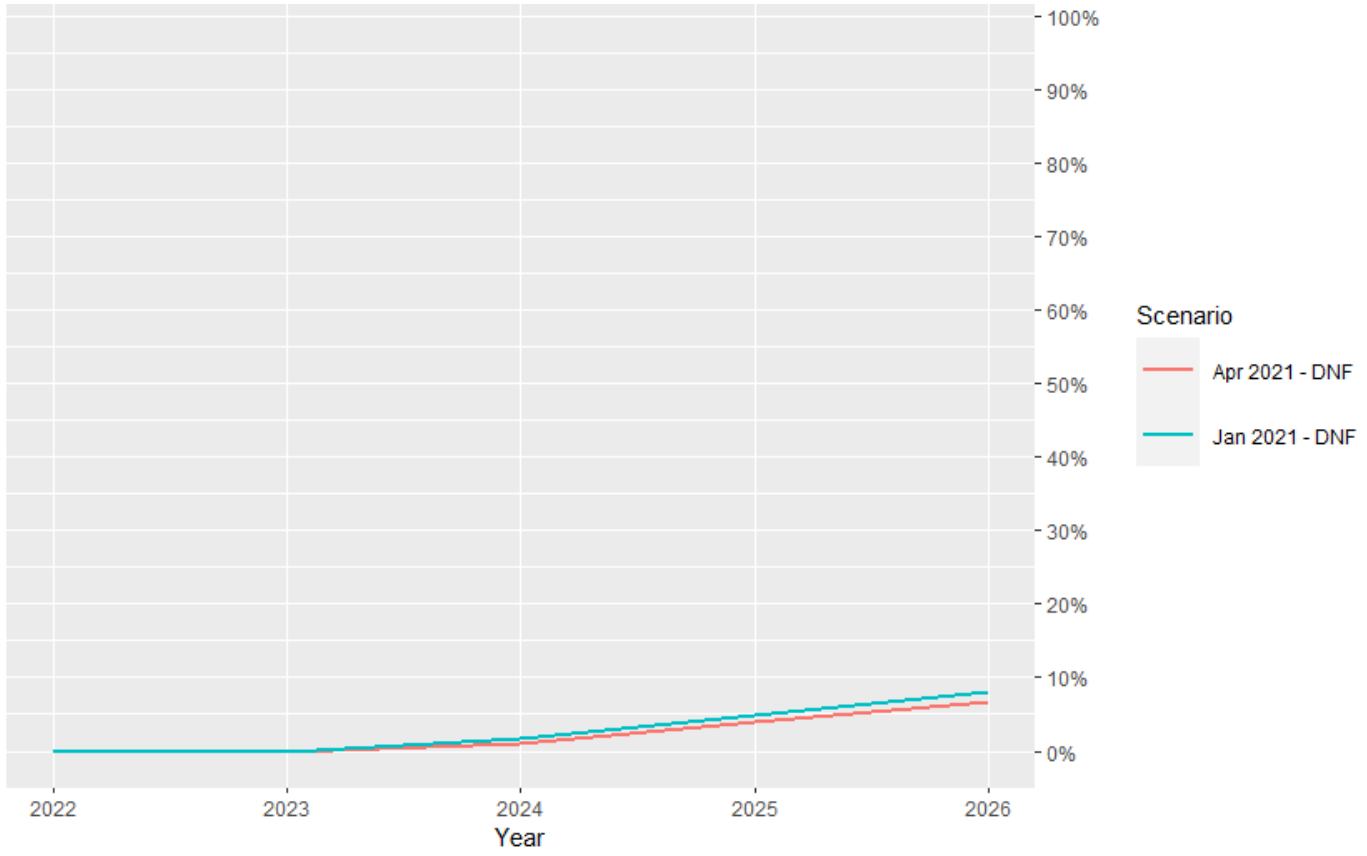
# January 2021 vs. April 2021 Full Hydrology

## Lower Basin:

Percent of traces in Shortage Conditions



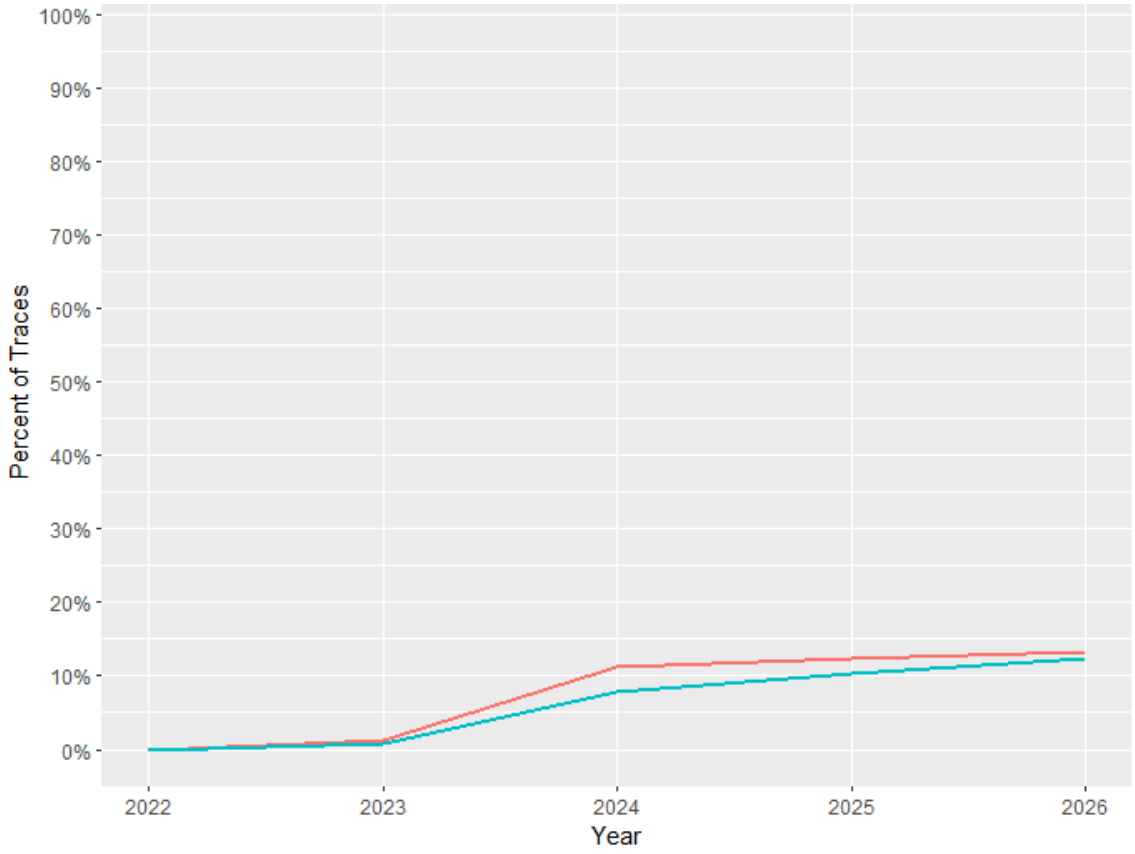

Percent of traces in Surplus Conditions



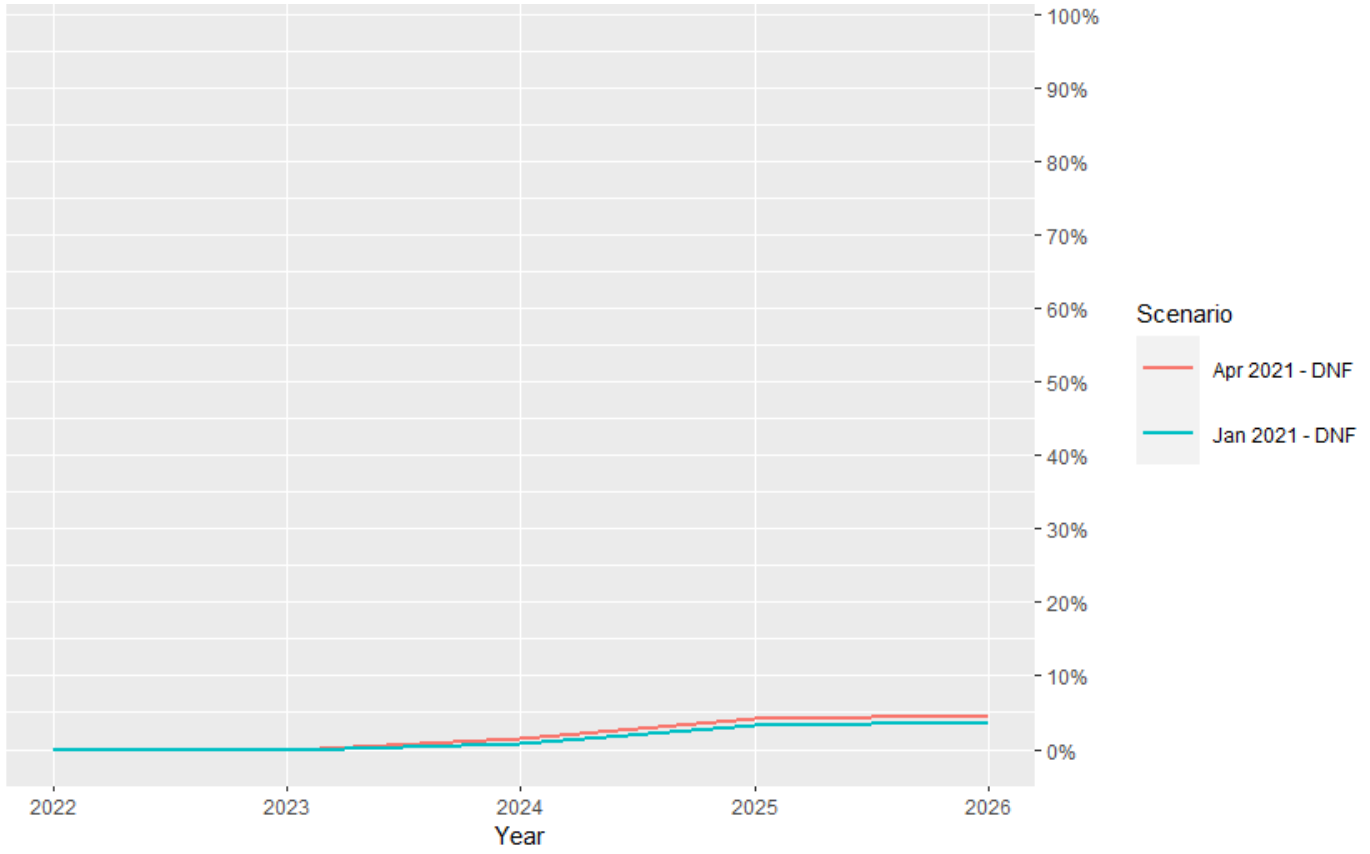
# January 2021 vs. April 2021 Full Hydrology

## Lake Mead:

Percent of traces less than elevation 1,025’ in December




Percent of traces less than elevation 1,000’ in any month



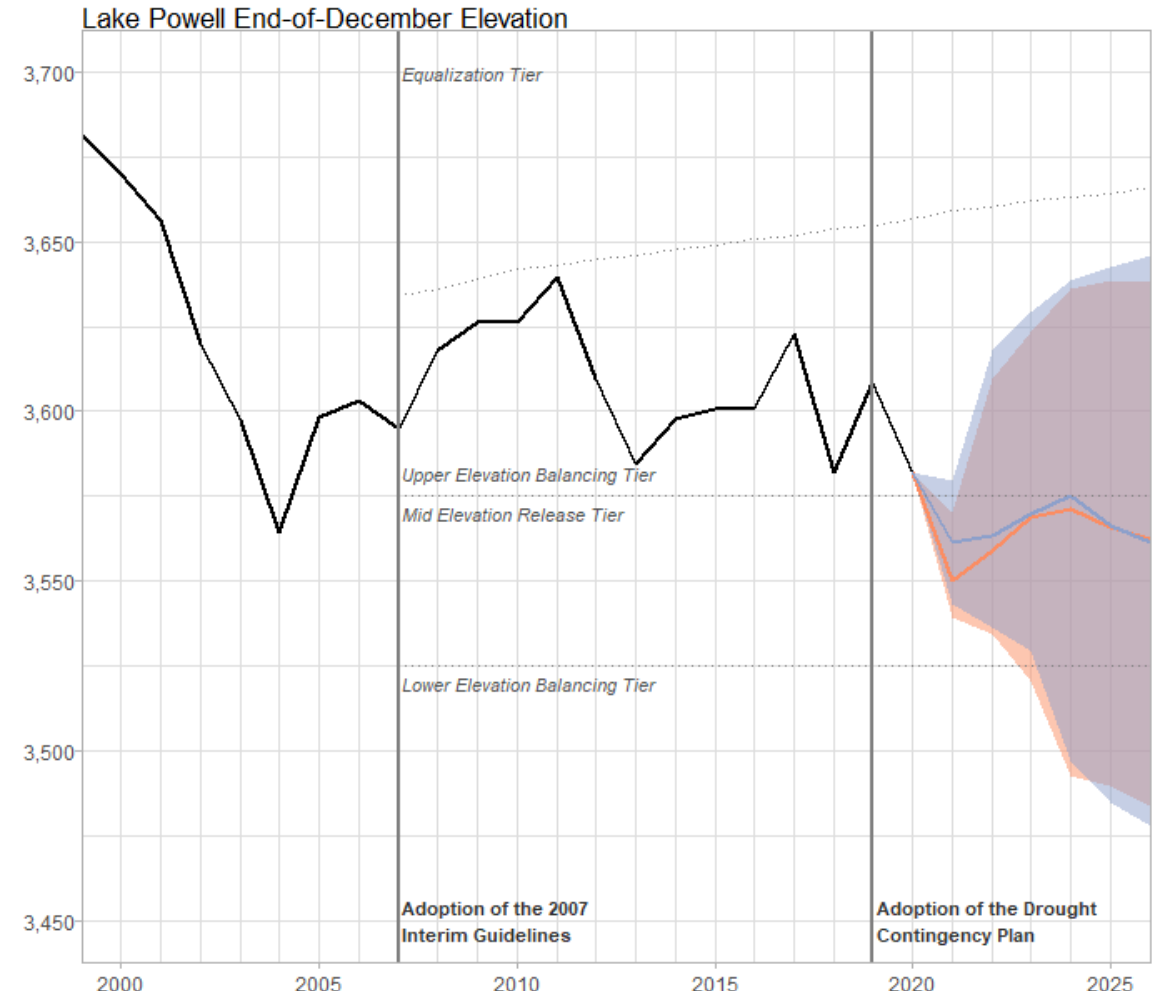
# Comparison of January 2021 and April 2021 Projections
## Chance of Reaching Critical Reservoir Elevations
## Using the Full Hydrology (1906-2019)

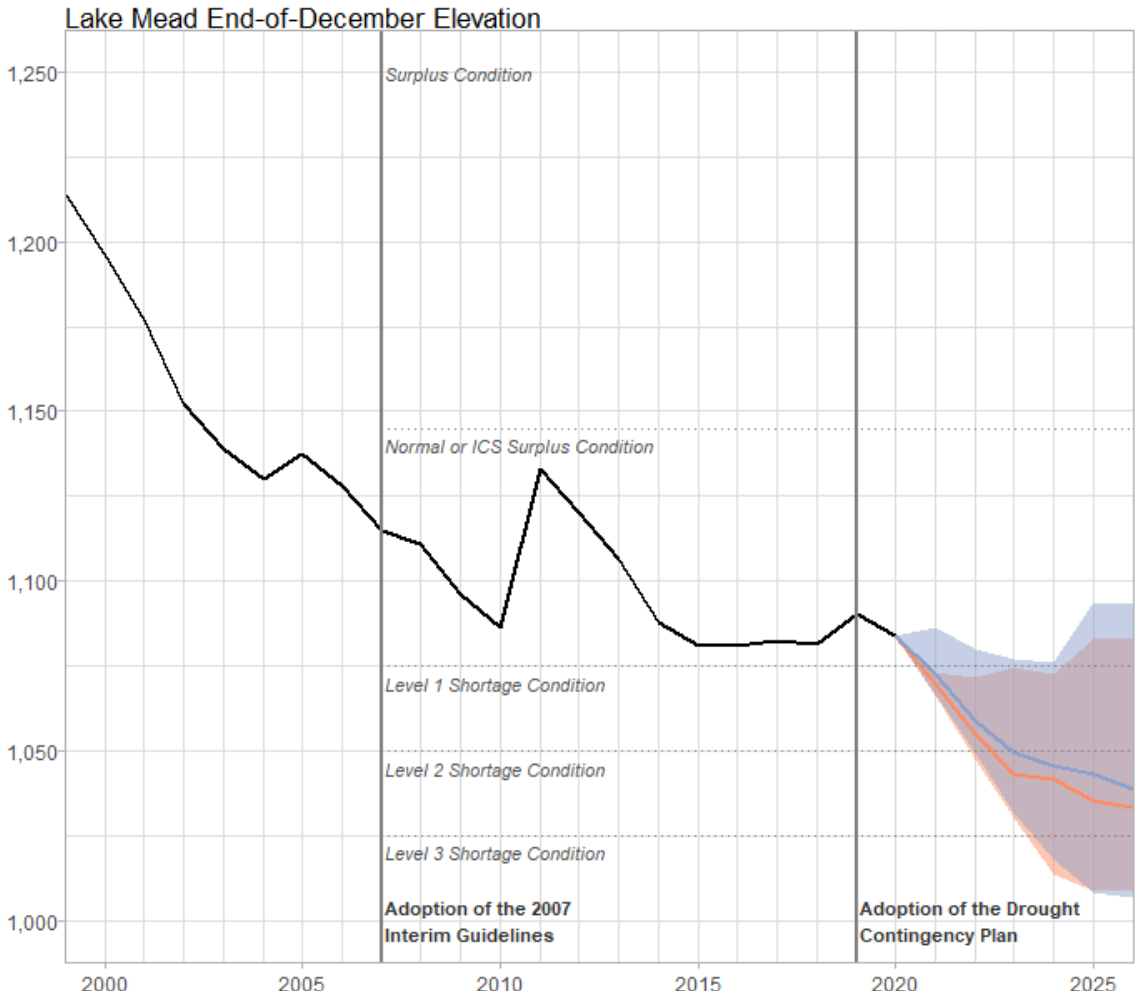
| | Run | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|
| **Lake Mead less than 1,025 feet** | January 2021 | 0% | 0% | 2% | 14% | 20% |
| | April 2021 | 0% | 0% | 1% | 15% | 19% |
| | Difference | 0% | 0% | -1% | 1% | -1% |
| **Lake Mead less than 1,000 feet** | January 2021 | 0% | 0% | 0% | <1% | 3% |
| | April 2021 | 0% | 0% | 0% | 1% | 4% |
| | Difference | 0% | 0% | 0% | <1% | 1% |
| **Lake Powell less than 3,525 feet** | January 2021 | 0% | 9% | 13% | 14% | 14% |
| | April 2021 | 0% | 17% | 17% | 16% | 16% |
| | Difference | 0% | 8% | 4% | 2% | 2% |
| **Lake Powell less than 3,490 feet** | January 2021 | 0% | <1% | 1% | 3% | 4% |
| | April 2021 | 0% | 0% | 1% | 4% | 6% |
| | Difference | 0% | <-1% | 0% | 1% | 2% |

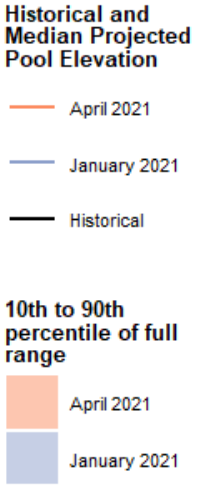
All results computed as the chance of falling below the threshold in any month in the calendar (water) year for Lake Mead (Lake Powell).

# Comparison of January 2021 and April 2021 Results with the Stress Test Hydrology

# January 2021 vs. April 2021 Stress Test Hydrology



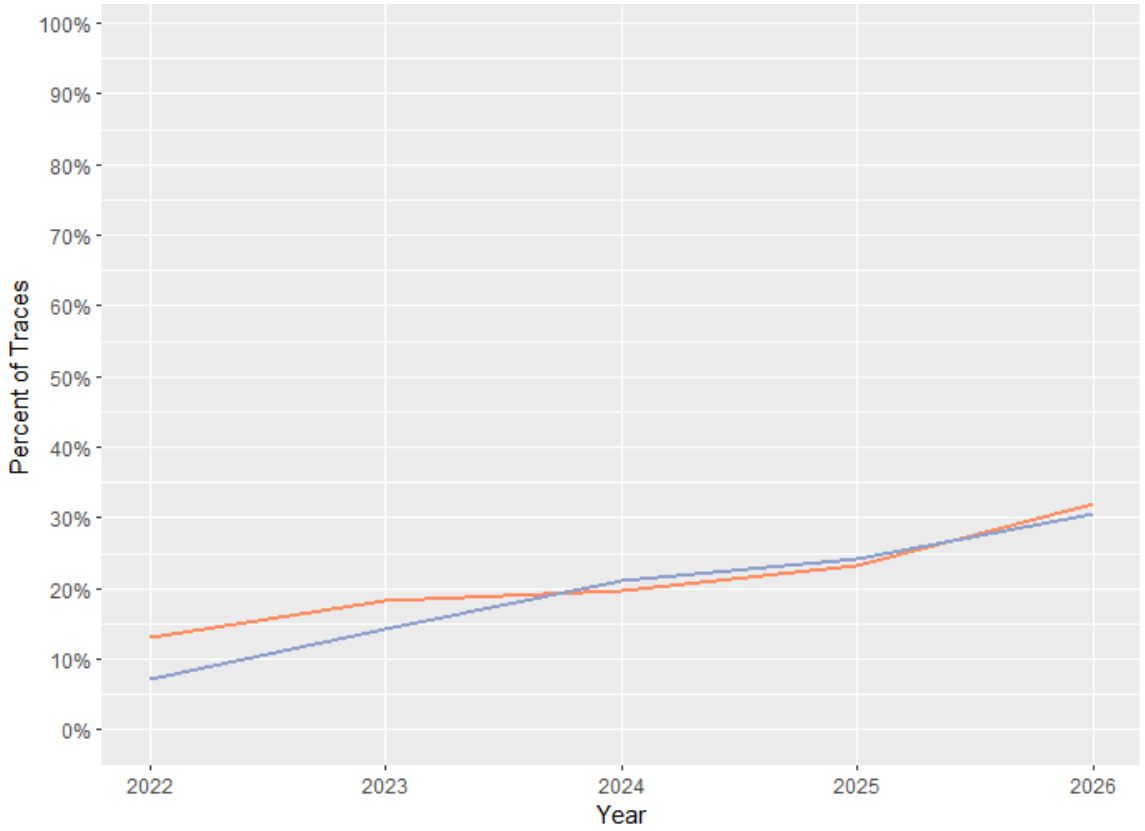



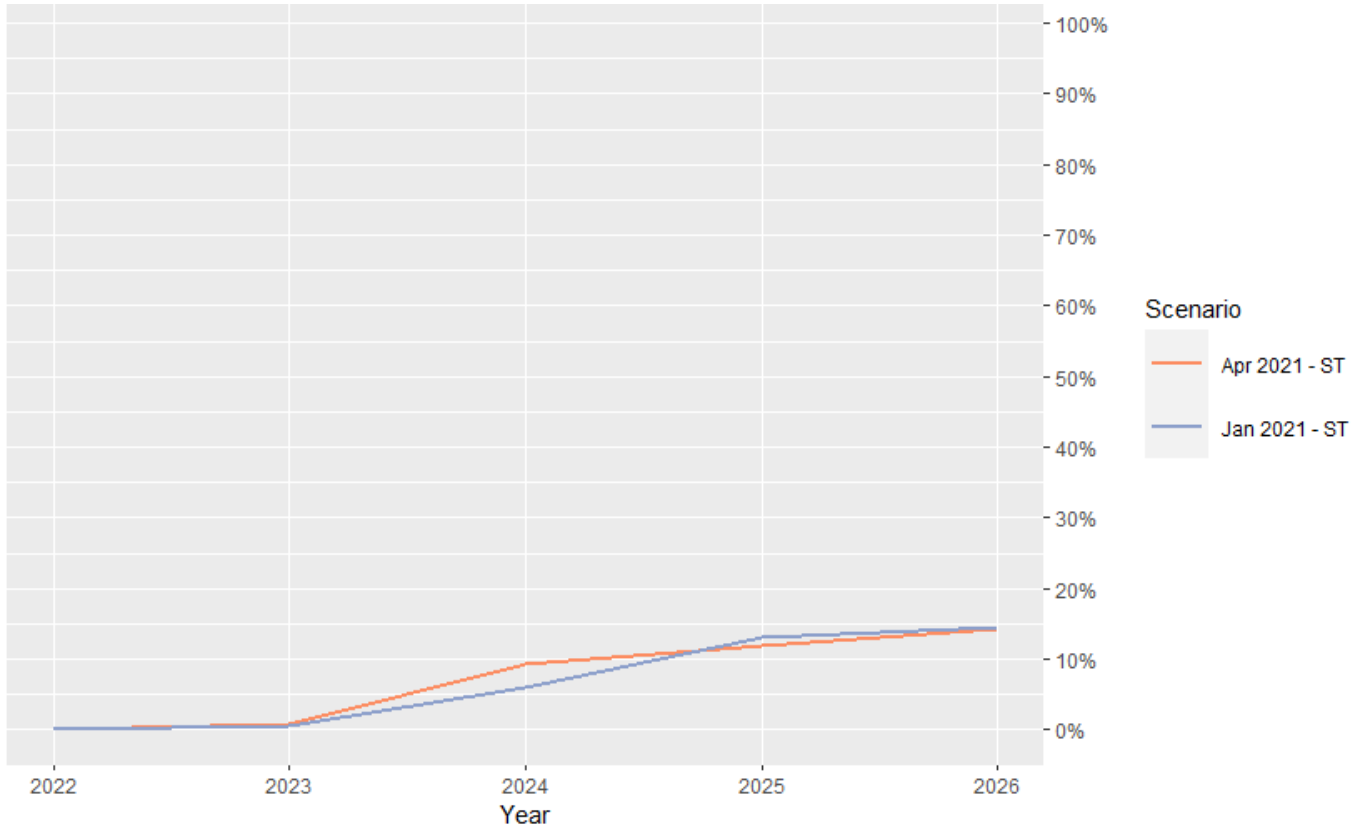
# January 2021 vs. April 2021 Stress Test Hydrology

## Lake Powell:

Percent of traces less than elevation 3,525’ in any water year



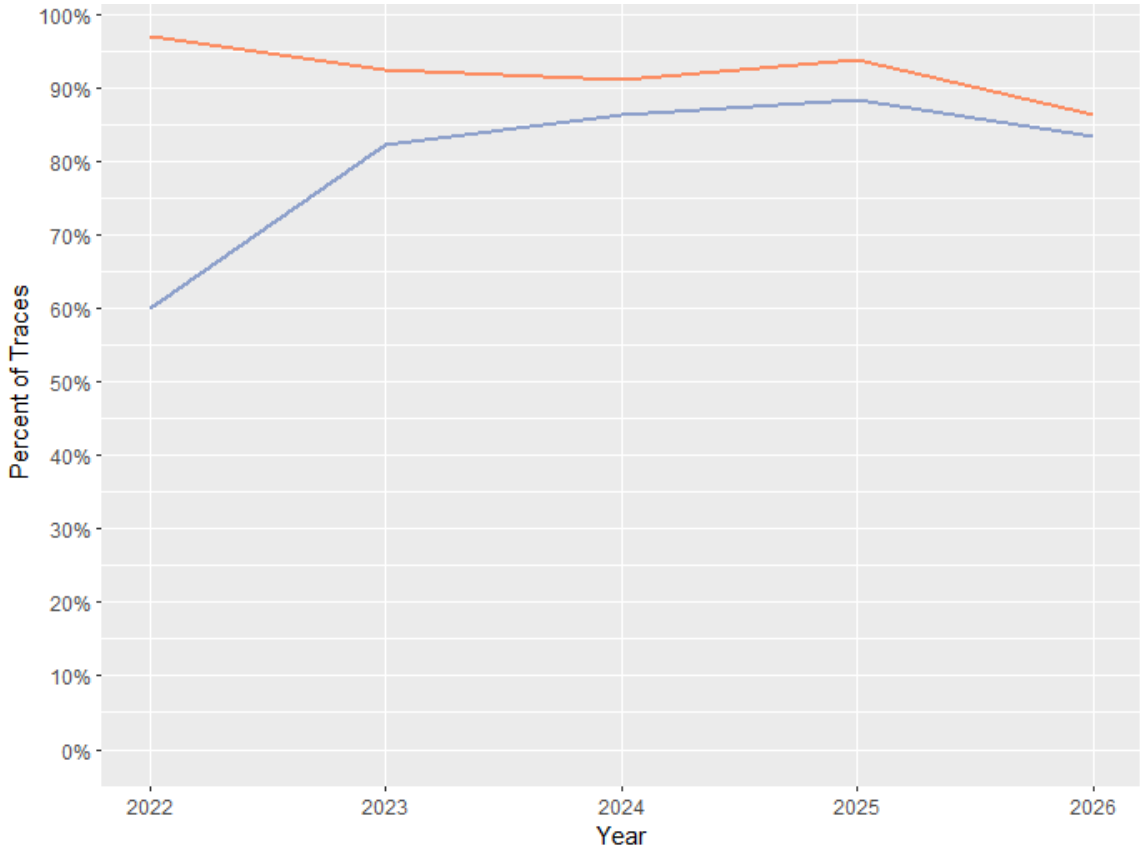

Percent of traces less than elevation 3,490’ (power pool) in any water year



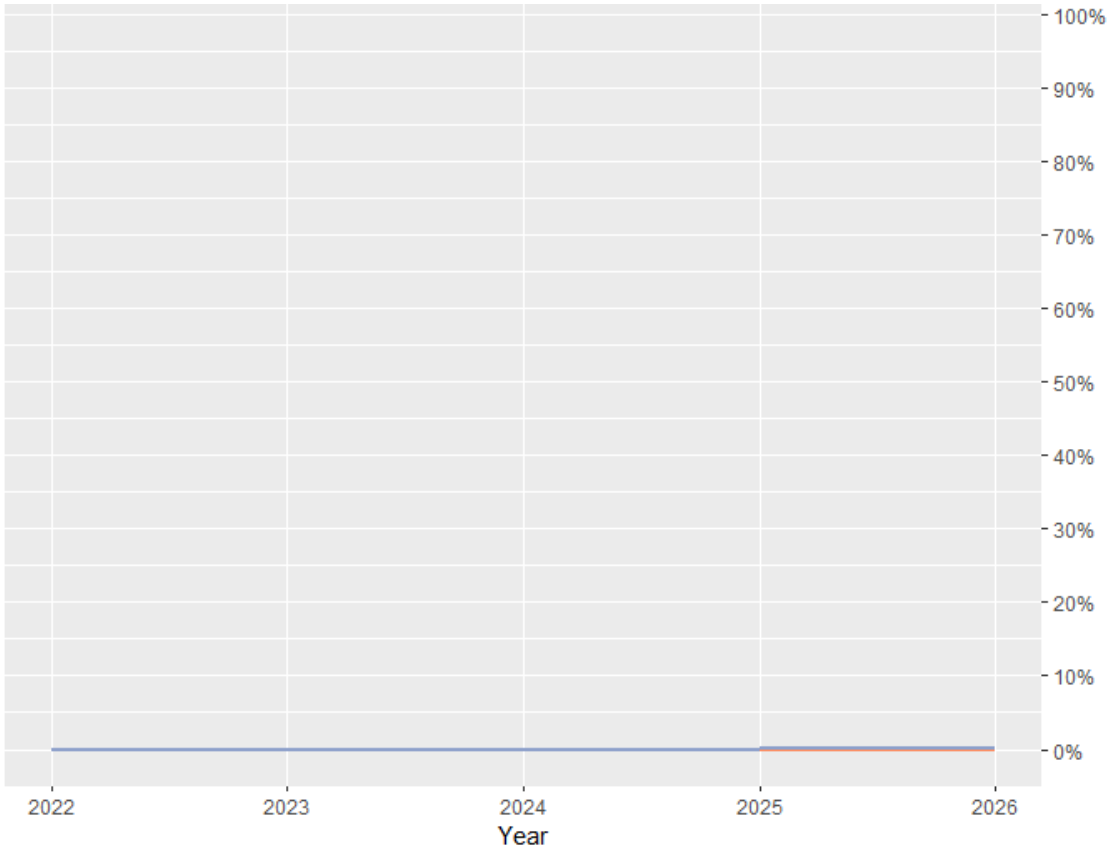
# January 2021 vs. April 2021 Stress Test Hydrology

## Lower Basin:

Percent of traces in Shortage Conditions



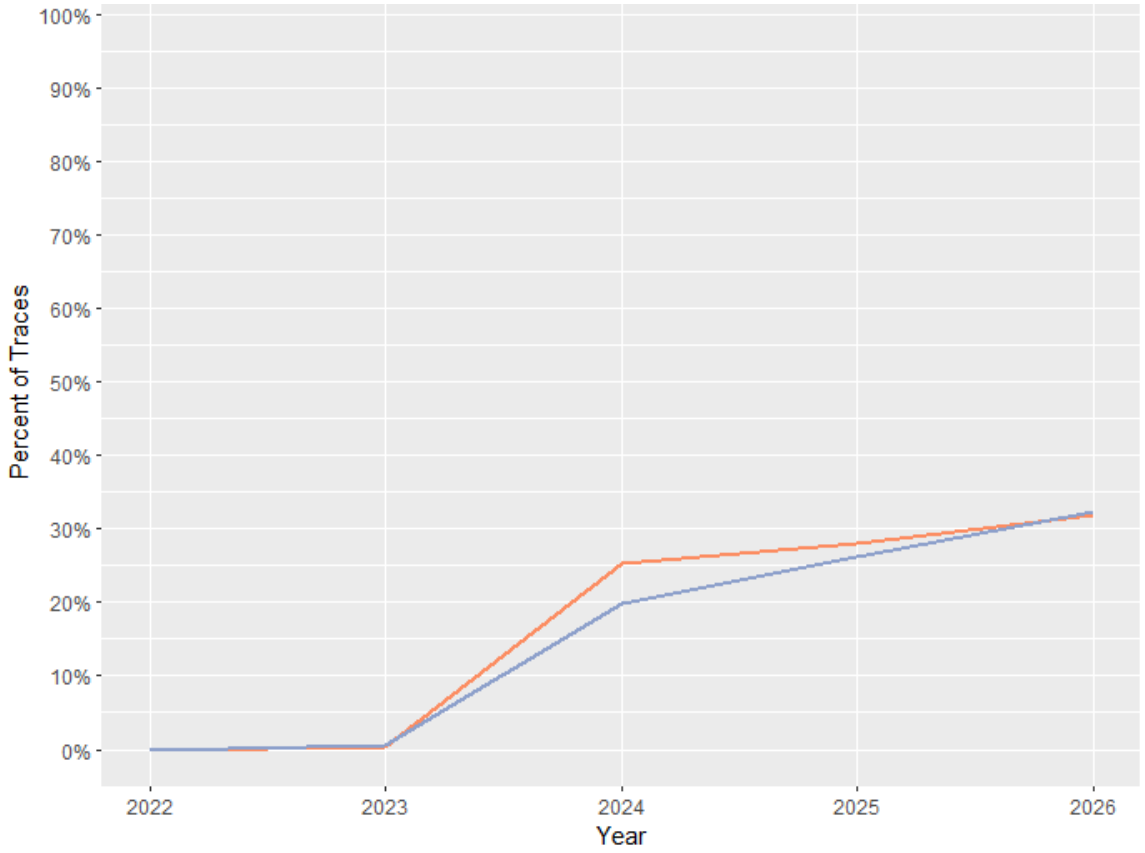

Percent of traces in Surplus Conditions



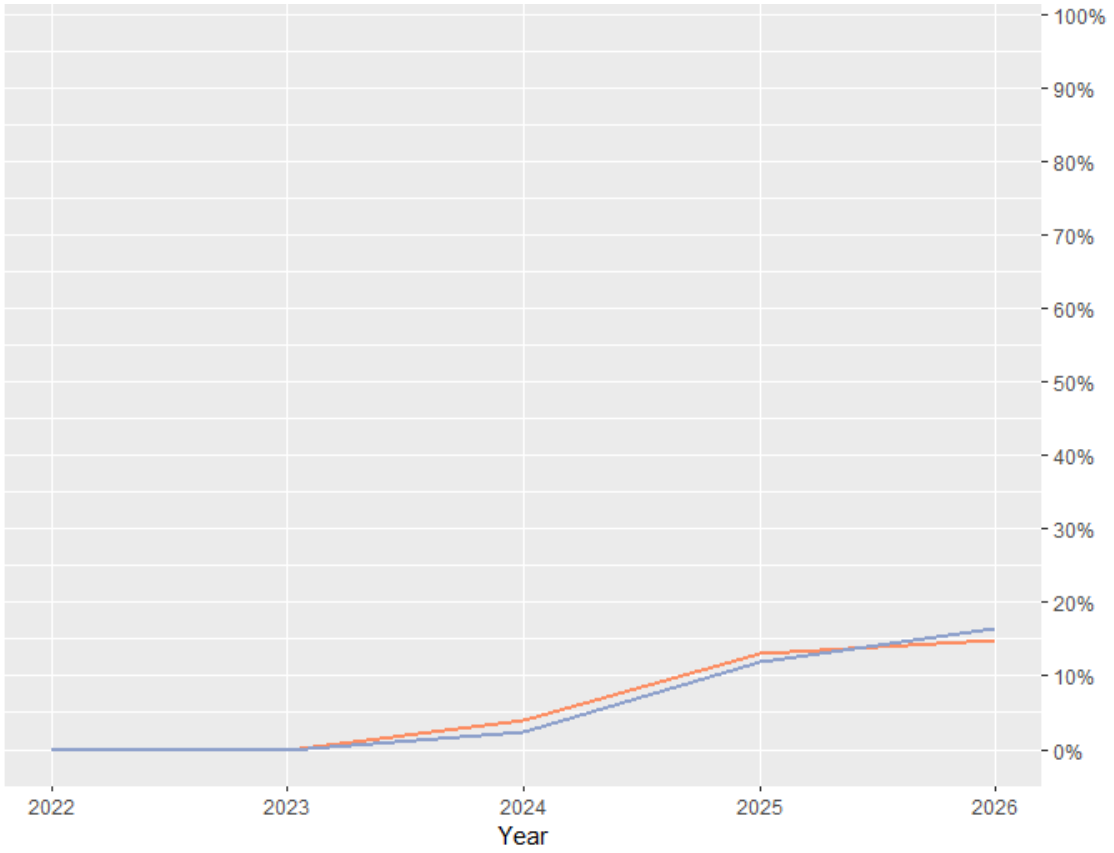

# January 2021 vs. April 2021 Stress Test Hydrology

## Lake Mead:

Percent of traces less than elevation 1,025’ in December




Percent of traces less than elevation 1,000’ in any month



# Comparison of January 2021 and April 2021 Projections
## Chance of Reaching Critical Reservoir Elevations
## Using the Stress Test Hydrology (1988-2019)

| | Run | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|
| **Lake Mead less than 1,025 feet** | January 2021 | 0% | 0% | 4% | 31% | 41% |
| | April 2021 | 0% | 0% | 8% | 36% | 44% |
| | Difference | 0% | 0% | 4% | 5% | 3% |
| **Lake Mead less than 1,000 feet** | January 2021 | 0% | 0% | 0% | 2% | 12% |
| | April 2021 | 0% | 0% | 0% | 4% | 13% |
| | Difference | 0% | 0% | 0% | 2% | 1% |
| **Lake Powell less than 3,525 feet** | January 2021 | 0% | 7% | 14% | 21% | 24% |
| | April 2021 | 0% | 13% | 18% | 20% | 23% |
| | Difference | 0% | 6% | 4% | -1% | -1% |
| **Lake Powell less than 3,490 feet** | January 2021 | 0% | 0% | <1% | 6% | 13% |
| | April 2021 | 0% | 0% | <1% | 9% | 12% |
| | Difference | 0% | 0% | 0% | 3% | -1% |

All results computed as the chance of falling below the threshold in any month in the calendar (water) year for Lake Mead (Lake Powell).

# Posted April 2021 Results

# Upper Basin – Lake Powell
# Percent of Traces with Event or System Condition
## Results from April 2021 CRMMS MTOM Mode/CRSS using the Full Hydrology and Stress Test Hydrology (values in percent)

| Event or System Condition | 2021 | 2022 | 2023 | 2024 | 2025 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Equalization Tier (Powell ≥ Equalization [EQ] Elevation)** | **0** | **0** | **6** | **12** | **17** | **0** | **0** | **0** | **3** | **7** |
| *Equalization – annual release > 8.23 maf* | *0* | *0* | *6* | *12* | *17* | *0* | *0* | *0* | *3* | *7* |
| *Equalization – annual release = 8.23 maf* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* |
| **Upper Elevation Balancing Tier (Powell < EQ Elevation and ≥ 3,575 ft)** | **100** | **3** | **36** | **49** | **50** | **100** | **3** | **31** | **41** | **39** |
| *Upper Elevation Balancing – annual release > 8.23 maf* | *0* | *2* | *35* | *45* | *44* | *0* | *2* | *30* | *39* | *36* |
| *Upper Elevation Balancing – annual release = 8.23 maf* | *100* | *<1* | *1* | *4* | *5* | *100* | *<1* | *<1* | *2* | *3* |
| *Upper Elevation Balancing – annual release < 8.23 maf* | *0* | *0* | *0* | *<1* | *0* | *0* | *0* | *0* | *<1* | *0* |
| **Mid-Elevation Release Tier (Powell < 3,575 and ≥ 3,525 ft)** | **0** | **91** | **51** | **31** | **23** | **0** | **91** | **65** | **45** | **35** |
| *Mid-Elevation Release – annual release = 8.23 maf* | *0* | *0* | *0* | *<1* | *2* | *0* | *0* | *0* | *0* | *5* |
| *Mid-Elevation Release – annual release = 7.48 maf* | *0* | *91* | *51* | *30* | *21* | *0* | *91* | *65* | *45* | *30* |
| **Lower Elevation Balancing Tier (Powell < 3,525 ft)** | **0** | **6** | **7** | **8** | **10** | **0** | **6** | **4** | **11** | **18** |
| Below Minimum Power Pool (Powell < 3,490 ft) | 0 | 0 | 1 | 4 | 6 | 0 | 0 | <1 | 9 | 12 |

Notes:
[1] Modeled operations include the 2007 Interim Guidelines, Upper Basin Drought Response Operations, Lower Basin Drought Contingency Plan, and Minute 323, including the Binational Water Scarcity Contingency Plan.
[2] Reservoir initial conditions on March 31, 2021 were simulated using the April 2021 MTOM based on the CBRFC unregulated inflow forecast ensemble dated April 2, 2021.
[3] Each of the 35 initial conditions from MTOM were coupled with 114 hydrologic inflow sequences from the Full Hydrology that resamples the observed natural flow record from 1906-2019 for a total of 3,990 traces analyzed and with 32 hydrologic inflow sequences from the Stress Test Hydrology that resamples the observed natural flow record from 1988-2019 for a total of 1,120 traces analyzed.
[4] Percentages shown in this table may not be representative of the full range of future possibilities that could occur with different modeling assumptions.
[5] Percentages shown may not sum to 100% due to rounding to the nearest percent.

# Lower Basin – Lake Mead
# Percent of Traces with Event or System Condition
## Results from April 2021 CRMMS MTOM Mode/CRSS using the Full Hydrology and Stress Test Hydrology (values in percent)

| Event or System Condition | 2021 | 2022 | 2023 | 2024 | 2025 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Surplus Condition – any amount (Mead ≥ 1,145 ft)** | **0** | **0** | **0** | **1** | **4** | **0** | **0** | **0** | **0** | **0** |
| Surplus – Flood Control | 0 | 0 | 0 | 0 | <1 | 0 | 0 | 0 | 0 | 0 |
| **Normal or ICS Surplus Condition (Mead < 1,145 and > 1,075 ft)** | **100** | **3** | **6** | **17** | **19** | **100** | **3** | **8** | **9** | **6** |
| Recovery of DCP ICS / Mexico's Water Savings (Mead >/≥ 1,110 ft) | 0 | 0 | 0 | 4 | 9 | 0 | 0 | 0 | 0 | <1 |
| DCP Contribution / Mexico's Water Savings (Mead ≤ 1,090 and > 1,075 ft) | 100 | 3 | 5 | 11 | 10 | 100 | 3 | 7 | 9 | 3 |
| **Shortage Condition – any amount (Mead ≤ 1,075 ft)** | **0** | **97** | **94** | **82** | **77** | **0** | **97** | **92** | **91** | **94** |
| *Shortage / Reduction – 1st level (Mead ≤ 1,075 and ≥ 1,050)* | *0* | *97* | *81* | *37* | *34* | *0* | *97* | *71* | *31* | *33* |
| DCP Contribution / Mexico's Water Savings (Mead ≤ 1,075 and > 1,050 ft) | 0 | 97 | 81 | 37 | 34 | 0 | 97 | 71 | 31 | 33 |
| *Shortage / Reduction – 2nd level (Mead < 1,050 and ≥ 1,025)* | *0* | *0* | *13* | *44* | *32* | *0* | *0* | *21* | *60* | *36* |
| DCP Contribution / Mexico's Water Savings (Mead ≤ 1,050 and > 1,045 ft) | *0* | *0* | *11* | *9* | *6* | *0* | *0* | *17* | *6* | *7* |
| DCP Contribution / Mexico's Water Savings (Mead ≤ 1,045 and > 1,040 ft) | 0 | 0 | 2 | 9 | 6 | 0 | 0 | 4 | 11 | 6 |
| DCP Contribution / Mexico's Water Savings (Mead ≤ 1,040 and > 1,035 ft) | 0 | 0 | <1 | 11 | 8 | 0 | 0 | 0 | 16 | 6 |
| DCP Contribution / Mexico's Water Savings (Mead ≤ 1,035 and > 1,030 ft) | 0 | 0 | 0 | 10 | 7 | 0 | 0 | 0 | 17 | 6 |
| DCP Contribution / Mexico's Water Savings (Mead ≤ 1,030 and ≥/> 1,025 ft) | 0 | 0 | 0 | 5 | 6 | 0 | 0 | 0 | 9 | 10 |
| *Shortage / Reduction – 3rd level (Mead < 1,025)* | *0* | *0* | *0* | *1* | *11* | *0* | *0* | *0* | *<1* | *25* |
| DCP Contribution / Mexico's Water Savings (Mead </≤ 1,025 ft) | 0 | 0 | 0 | 1 | 11 | 0 | 0 | 0 | <1 | 25 |

Notes:
[1] Modeled operations include the 2007 Interim Guidelines, Upper Basin Drought Response Operations, Lower Basin Drought Contingency Plan, and Minute 323, including the Binational Water Scarcity Contingency Plan.
[2] Reservoir initial conditions on March 31, 2021 were simulated using the April 2021 MTOM based on the CBRFC unregulated inflow forecast ensemble dated April 2, 2021.
[3] Each of the 35 initial conditions from MTOM were coupled with 114 hydrologic inflow sequences from the Full Hydrology that resamples the observed natural flow record from 1906-2019 for a total of 3,990 traces analyzed and with 32 hydrologic inflow sequences from the Stress Test Hydrology that resamples the observed natural flow record from 1988-2019 for a total of 1,120 traces analyzed.
[4] Percentages shown in this table may not be representative of the full range of future possibilities that could occur with different modeling assumptions.
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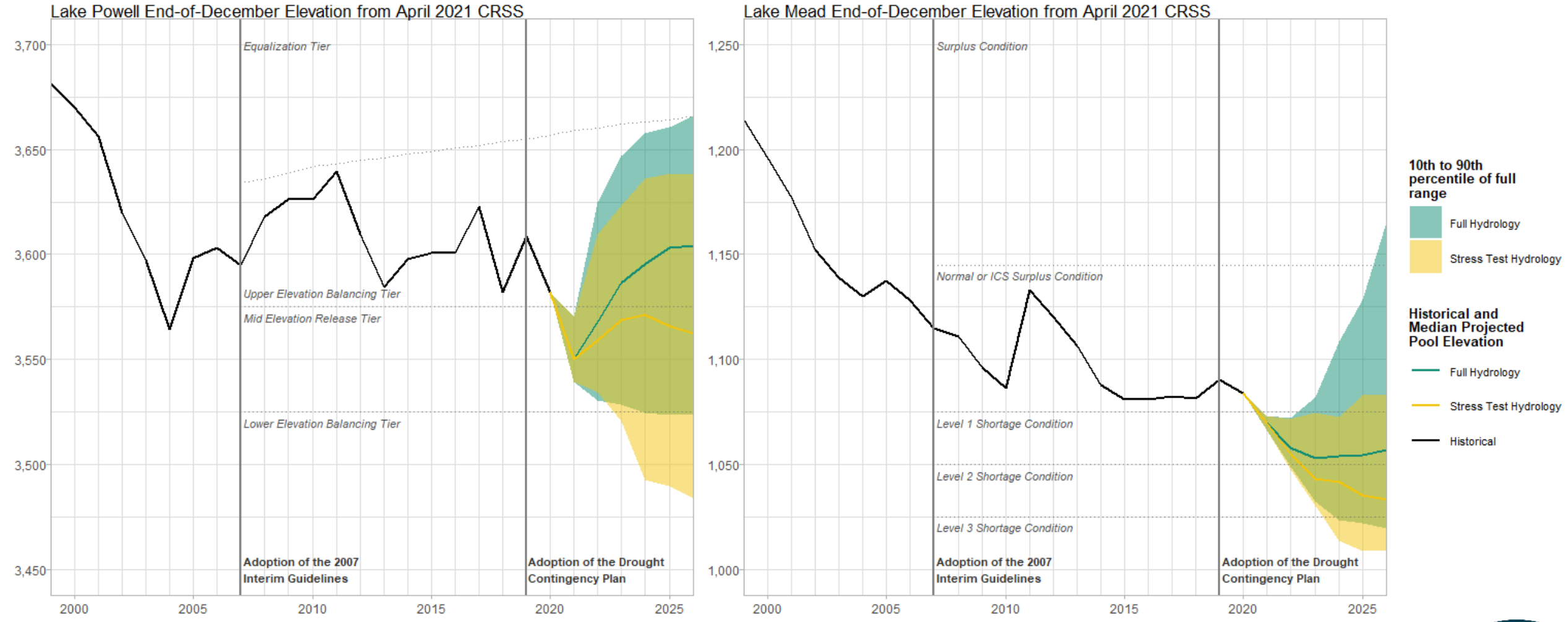
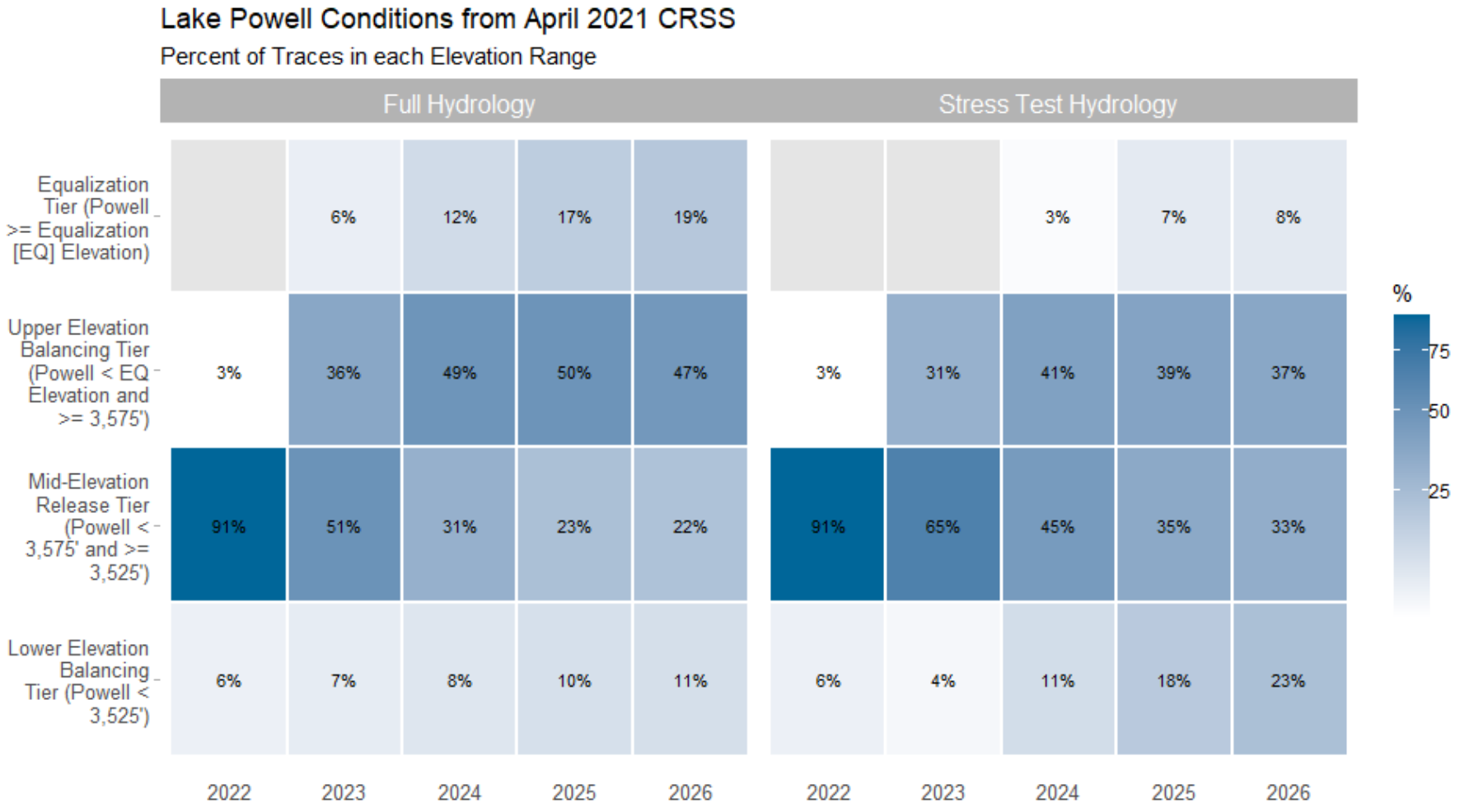
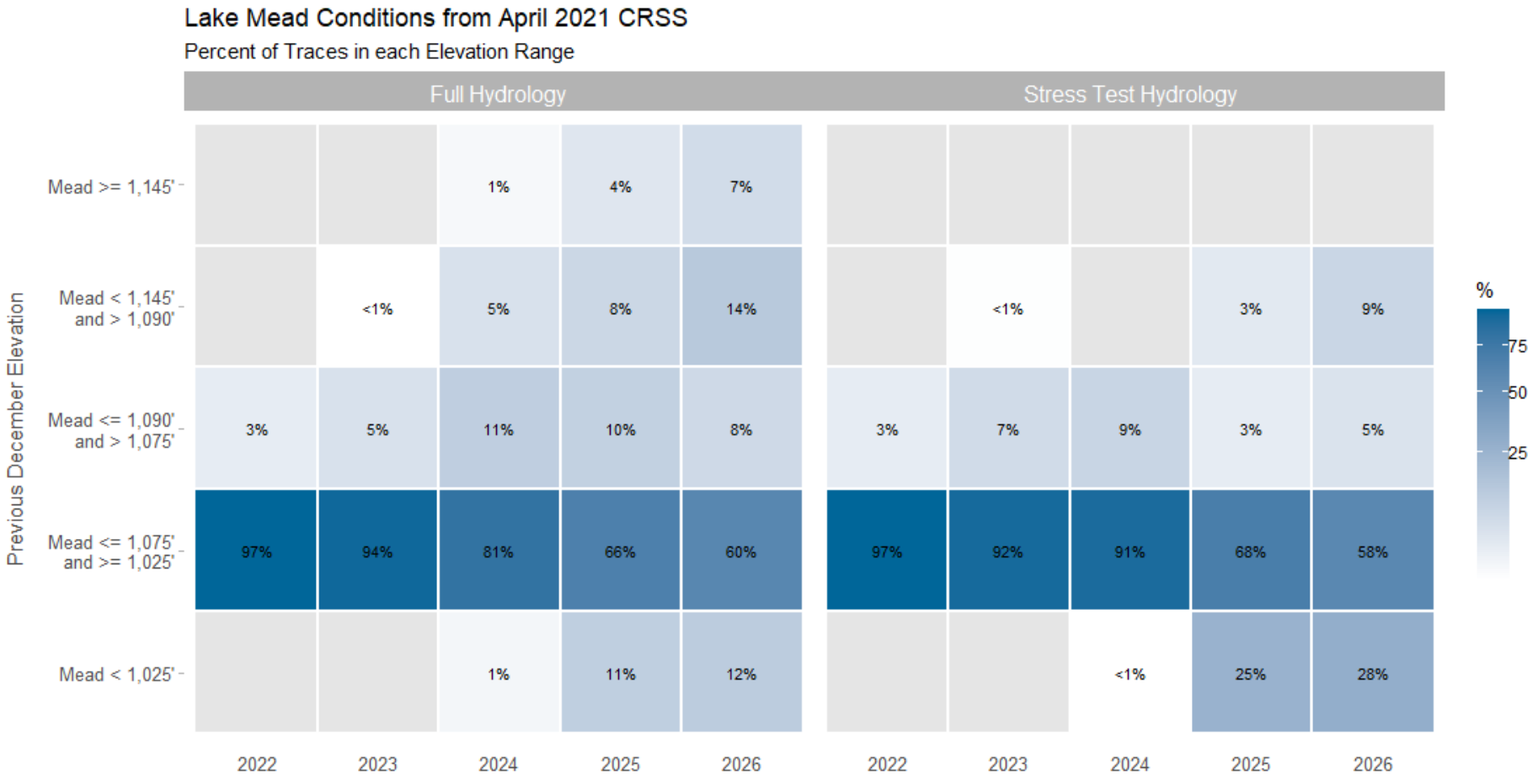
# April 2021
# Full Hydrology vs. Stress Test Hydrology



# April 2021
# Full Hydrology vs. Stress Test Hydrology

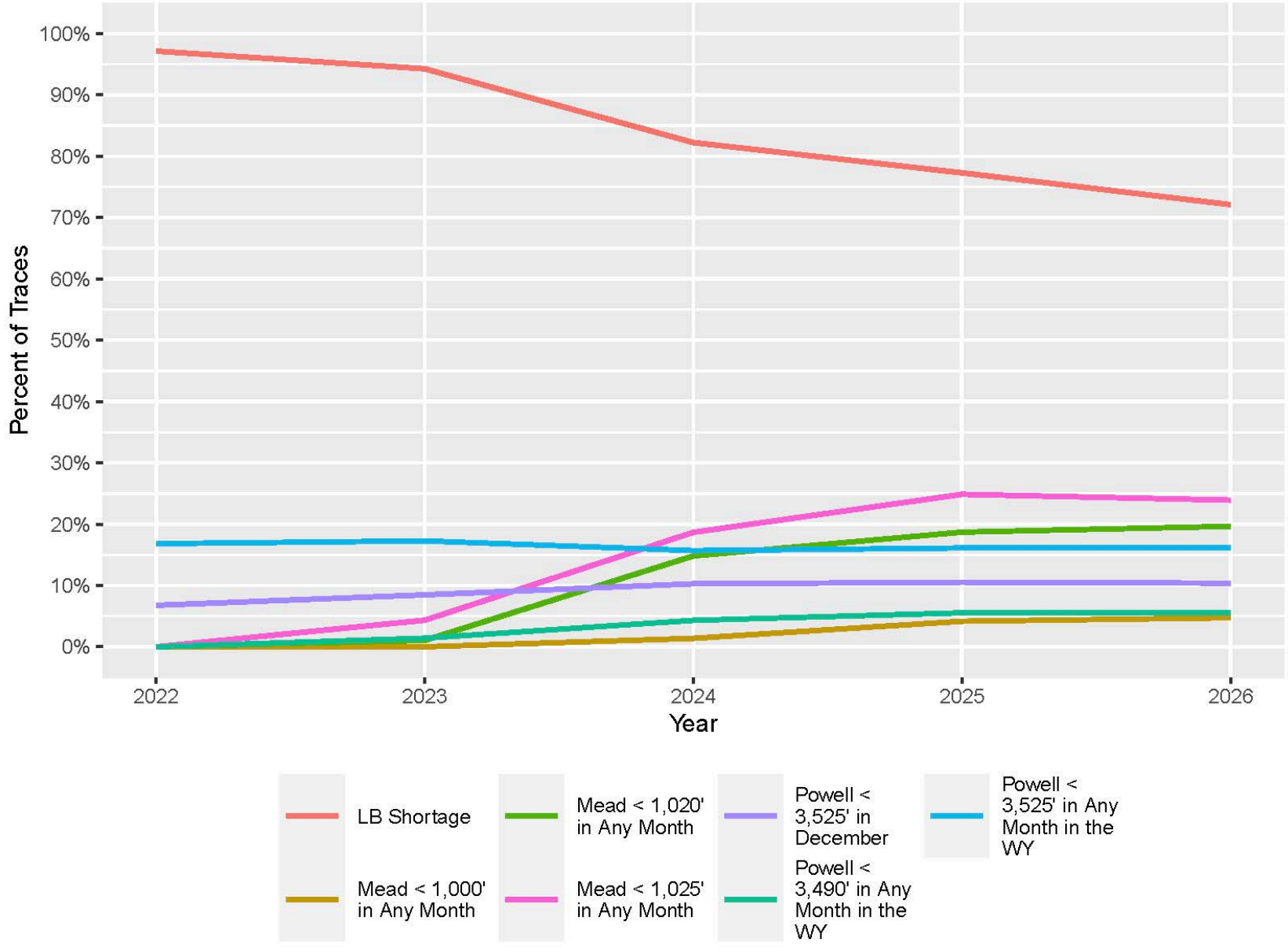


# April 2021
# Full Hydrology vs. Stress Test Hydrology

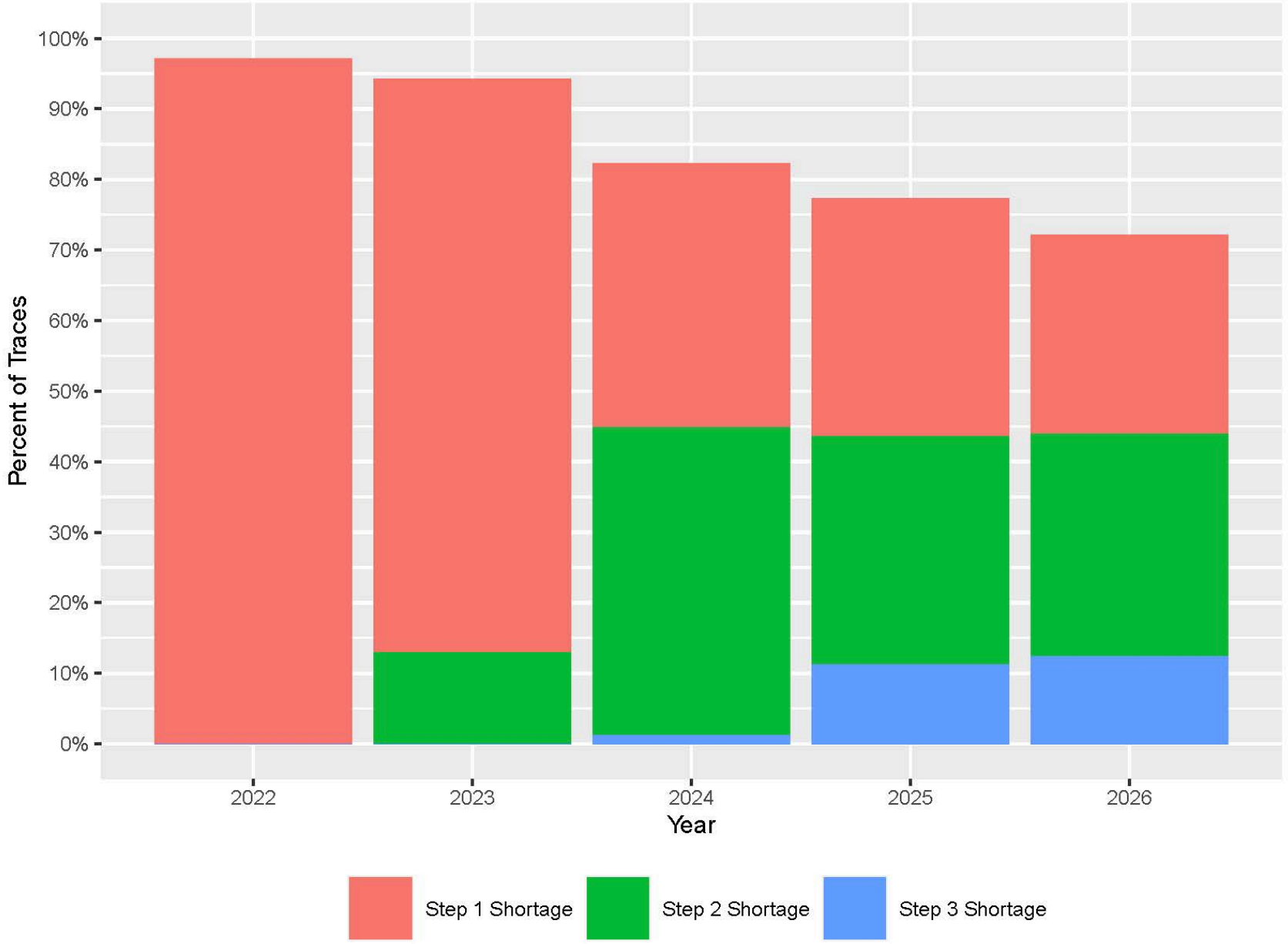


# Supplemental April 2021 Results

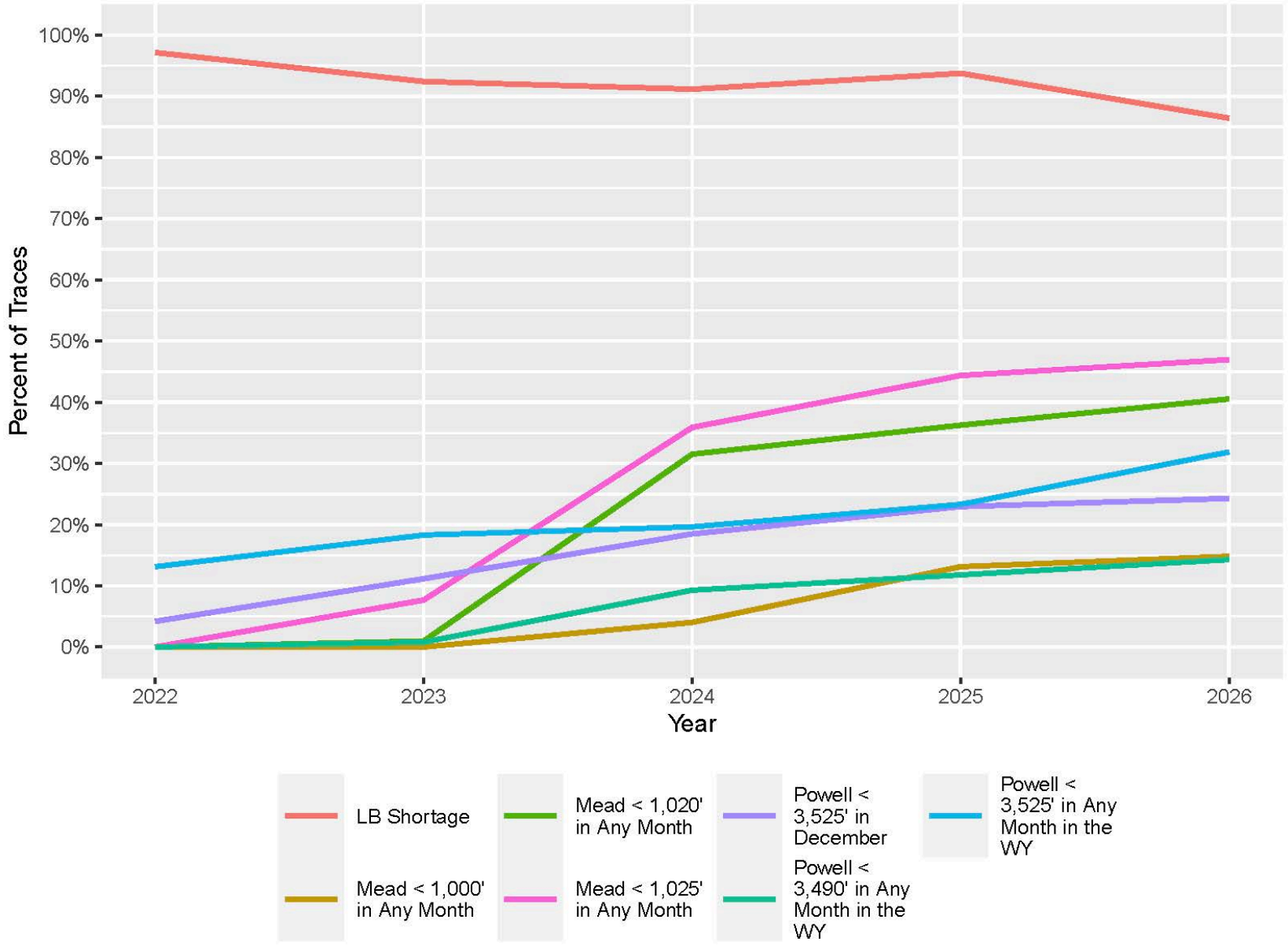
# April 2021 CRSS Results with Full Hydrology



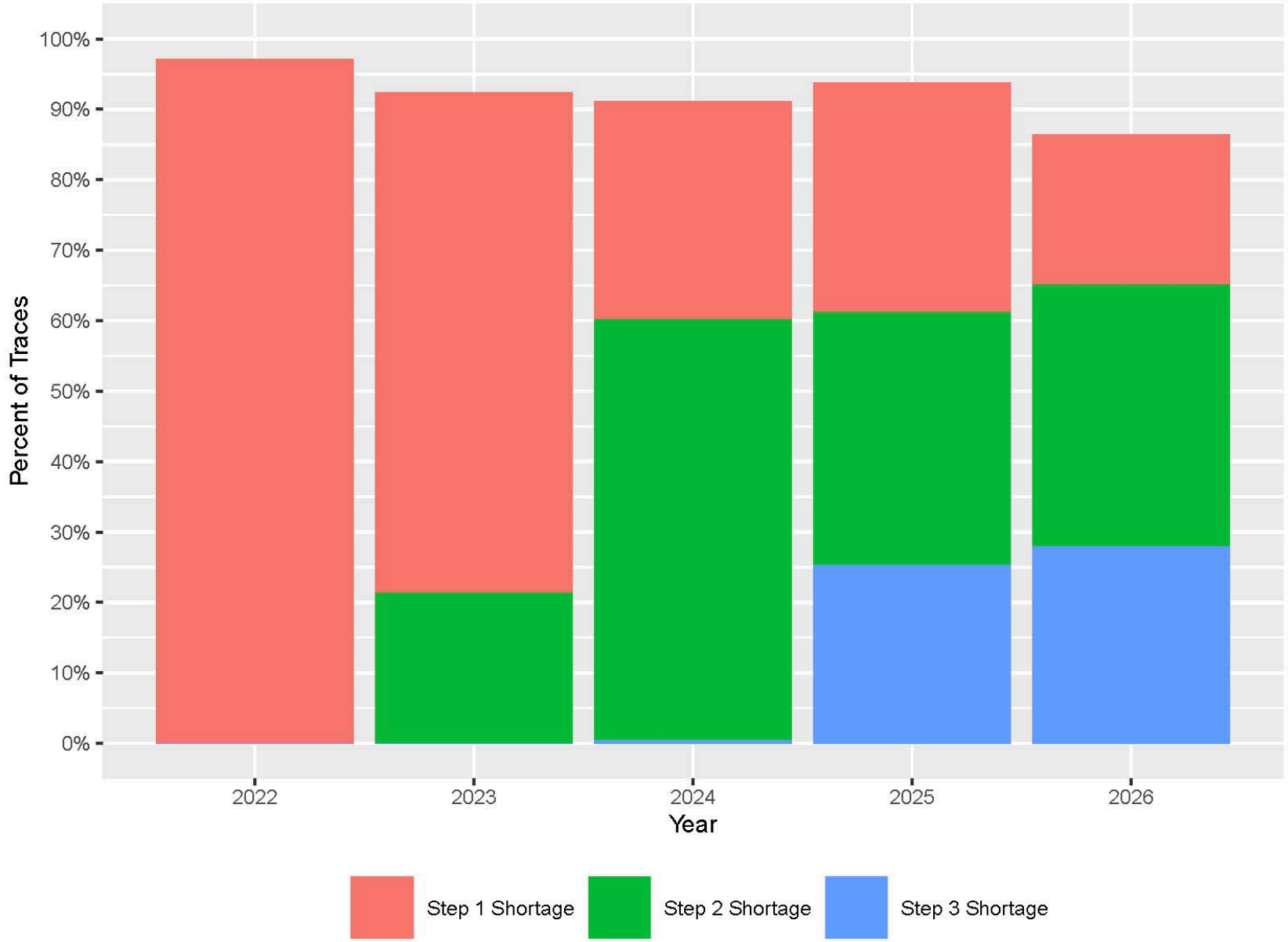
# April 2021 CRSS Results with Full Hydrology



# April 2021 CRSS Results with Stress Test Hydrology



# April 2021 CRSS Results with Stress Test Hydrology



Last Updated 4/20/2021

| | WY Lees Ferry Natural Flow (AF) |
|---|---|
| **1906** | 18,214,678 |
| **1907** | 21,234,305 |
| **1908** | 11,773,952 |
| **1909** | 21,841,427 |
| **1910** | 14,736,670 |
| **1911** | 15,125,081 |
| **1912** | 19,082,127 |
| **1913** | 14,472,192 |
| **1914** | 21,066,767 |
| **1915** | 14,137,603 |
| **1916** | 19,187,542 |
| **1917** | 23,849,259 |
| **1918** | 15,750,724 |
| **1919** | 12,951,469 |
| **1920** | 21,927,976 |
| **1921** | 22,703,070 |
| **1922** | 18,524,420 |
| **1923** | 18,327,468 |
| **1924** | 14,650,942 |
| **1925** | 13,514,438 |
| **1926** | 16,248,626 |
| **1927** | 18,689,765 |
| **1928** | 17,770,602 |
| **1929** | 21,791,156 |
| **1930** | 15,130,571 |
| **1931** | 8,868,682 |
| **1932** | 17,809,509 |
| **1933** | 12,312,744 |
| **1934** | 6,589,700 |
| **1935** | 12,248,940 |
| **1936** | 14,521,432 |
| **1937** | 14,159,154 |
| **1938** | 17,918,453 |
| **1939** | 11,699,708 |
| **1940** | 9,422,918 |
| **1941** | 18,269,619 |
| **1942** | 19,333,147 |
| **1943** | 13,613,558 |
| **1944** | 15,422,647 |
| **1945** | 14,040,218 |
| **1946** | 11,000,258 |
| **1947** | 15,851,265 |
| **1948** | 15,761,665 |
| **1949** | 16,733,517 |
| **1950** | 13,111,501 |
| **1951** | 12,445,707 |
| **1952** | 20,850,053 |
| **1953** | 11,154,855 |
| **1954** | 8,304,000 |
| **1955** | 9,709,235 |
| **1956** | 11,622,348 |
| **1957** | 20,211,418 |
| **1958** | 16,870,816 |
| **1959** | 9,245,100 |
| **1960** | 11,977,277 |
| **1961** | 9,199,061 |
| **1962** | 17,760,809 |
| **1963** | 9,115,209 |
| **1964** | 10,381,353 |

| | |
|---|---|
| **1965** | 18,358,969 |
| **1966** | 11,060,726 |
| **1967** | 11,708,544 |
| **1968** | 13,338,625 |
| **1969** | 14,452,503 |
| **1970** | 15,055,808 |
| **1971** | 14,845,450 |
| **1972** | 12,398,440 |
| **1973** | 19,271,376 |
| **1974** | 12,965,679 |
| **1975** | 16,565,941 |
| **1976** | 11,201,164 |
| **1977** | 5,435,281 |
| **1978** | 14,892,801 |
| **1979** | 17,609,595 |
| **1980** | 17,309,701 |
| **1981** | 8,638,712 |
| **1982** | 16,724,911 |
| **1983** | 23,729,841 |
| **1984** | 24,177,981 |
| **1985** | 21,044,575 |
| **1986** | 22,368,445 |
| **1987** | 16,596,465 |
| **1988** | 11,668,810 |
| **1989** | 9,552,232 |
| **1990** | 8,974,011 |
| **1991** | 12,344,601 |
| **1992** | 11,068,530 |
| **1993** | 18,697,528 |
| **1994** | 10,611,249 |
| **1995** | 19,872,761 |
| **1996** | 14,052,945 |
| **1997** | 21,184,925 |
| **1998** | 16,968,573 |
| **1999** | 16,452,831 |
| **2000** | 10,541,308 |
| **2001** | 11,023,149 |
| **2002** | 5,870,736 |
| **2003** | 10,455,249 |
| **2004** | 9,443,222 |
| **2005** | 17,117,932 |
| **2006** | 12,627,808 |
| **2007** | 12,567,529 |
| **2008** | 16,315,600 |
| **2009** | 14,306,982 |
| **2010** | 12,326,232 |
| **2011** | 20,207,163 |
| **2012** | 8,442,054 |
| **2013** | 8,973,286 |
| **2014** | 14,100,670 |
| **2015** | 13,433,124 |
| **2016** | 13,477,814 |
| **2017** | 16,476,397 |
| **2018** | 8,614,203 |
| **2019** | 17,750,093 |
| **2020** | 9,608,497 |
| **2021** | 8,601,000 |

| | |
|---|---|
| **1906-2020 average** | 14,740,159 |
| **1981-2010 average** | 14,577,522 |

Last Updated 4/20/2021

| | CY Lees Ferry Natural Flow (AF) |
|---|---|
| **1906** | 18,723,760 |
| **1907** | 20,892,589 |
| **1908** | 11,711,022 |
| **1909** | 22,198,132 |
| **1910** | 14,596,645 |
| **1911** | 15,650,022 |
| **1912** | 18,623,405 |
| **1913** | 14,536,380 |
| **1914** | 21,354,813 |
| **1915** | 13,623,272 |
| **1916** | 20,142,885 |
| **1917** | 22,942,804 |
| **1918** | 15,865,937 |
| **1919** | 12,651,367 |
| **1920** | 22,287,631 |
| **1921** | 22,514,401 |
| **1922** | 18,296,777 |
| **1923** | 18,997,638 |
| **1924** | 13,928,686 |
| **1925** | 14,505,619 |
| **1926** | 15,378,418 |
| **1927** | 19,645,777 |
| **1928** | 17,160,409 |
| **1929** | 22,218,872 |
| **1930** | 14,448,164 |
| **1931** | 8,754,890 |
| **1932** | 17,665,041 |
| **1933** | 12,361,183 |
| **1934** | 6,140,558 |
| **1935** | 12,608,227 |
| **1936** | 14,661,124 |
| **1937** | 14,303,932 |
| **1938** | 18,121,894 |
| **1939** | 11,167,271 |
| **1940** | 9,981,674 |
| **1941** | 20,018,936 |
| **1942** | 17,163,785 |
| **1943** | 13,716,241 |
| **1944** | 15,296,903 |
| **1945** | 14,258,149 |
| **1946** | 11,036,688 |
| **1947** | 16,380,601 |
| **1948** | 15,025,098 |
| **1949** | 16,972,591 |
| **1950** | 12,949,869 |
| **1951** | 12,478,879 |
| **1952** | 20,741,619 |
| **1953** | 11,123,293 |
| **1954** | 8,424,222 |
| **1955** | 9,358,169 |
| **1956** | 11,538,011 |
| **1957** | 21,512,861 |
| **1958** | 15,860,011 |
| **1959** | 9,619,893 |
| **1960** | 11,529,387 |
| **1961** | 9,950,773 |
| **1962** | 17,358,465 |
| **1963** | 8,630,540 |
| **1964** | 10,414,057 |

| | |
|---|---|
| **1965** | 19,416,659 |
| **1966** | 10,162,126 |
| **1967** | 11,505,464 |
| **1968** | 13,654,500 |
| **1969** | 14,915,964 |
| **1970** | 14,947,995 |
| **1971** | 14,985,011 |
| **1972** | 13,115,812 |
| **1973** | 18,158,448 |
| **1974** | 12,922,281 |
| **1975** | 16,535,645 |
| **1976** | 11,044,042 |
| **1977** | 5,377,608 |
| **1978** | 15,159,688 |
| **1979** | 17,440,940 |
| **1980** | 17,441,260 |
| **1981** | 8,917,125 |
| **1982** | 17,332,763 |
| **1983** | 23,574,839 |
| **1984** | 24,356,400 |
| **1985** | 21,040,944 |
| **1986** | 22,978,268 |
| **1987** | 15,334,211 |
| **1988** | 11,188,465 |
| **1989** | 9,474,177 |
| **1990** | 9,350,891 |
| **1991** | 12,322,480 |
| **1992** | 10,916,327 |
| **1993** | 18,916,054 |
| **1994** | 10,581,050 |
| **1995** | 19,987,810 |
| **1996** | 14,216,745 |
| **1997** | 21,685,974 |
| **1998** | 16,703,470 |
| **1999** | 15,874,339 |
| **2000** | 10,533,910 |
| **2001** | 10,725,899 |
| **2002** | 6,023,485 |
| **2003** | 10,538,803 |
| **2004** | 9,928,883 |
| **2005** | 17,123,054 |
| **2006** | 13,549,645 |
| **2007** | 11,416,980 |
| **2008** | 16,121,728 |
| **2009** | 14,135,539 |
| **2010** | 12,721,534 |
| **2011** | 20,302,681 |
| **2012** | 7,805,306 |
| **2013** | 9,596,660 |
| **2014** | 14,361,567 |
| **2015** | 13,049,587 |
| **2016** | 13,429,717 |
| **2017** | 16,420,731 |
| **2018** | 8,320,588 |
| **2019** | 17,846,949 |
| **2020** | 9,152,299 |
| **2021** | 9,335,000 |
| **1906-2020 average** | 14,736,188 |
| **1981-2010 average** | 14,585,726 |

# Provisional natural flow computation methods

**Colorado River at Lees Ferry, AZ (USGS gauge 09380000)**

## Overview

Natural flows for the Colorado River Basin are annually computed at 29 stations throughout the system. The data and methods required to compute these natural flows are documented in Prairie and Callejo (2005) available on the Natural Flow and Salt website. (http://www.usbr.gov/lc/region/g4000/NaturalFlow/index.html)
In addition the website hosts the current natural flows at 29 sites and natural salt at 20 sites through the Colorado River Basin. There is typically a 1 ½ -year lag from the end of the current year until natural flows are available throughout the basin for that year. For example, calendar year flows for 2015 should be available by spring 2017. This occurs because determining natural flow requires consumptive uses and losses (CUL) data, which in turn requires county agricultural statistics. County agriculture statistics are not typically available until September of the following year and then at least 6 months are required to determine CUL and then natural flow throughout the Basin.

Given this delay of at least 1 ½ years for natural flow estimates, Reclamation has devised methods to estimate natural flows at the Colorado River at Lees Ferry, AZ to provide an early estimate of natural flow for water operators and stakeholders at this key gauge location within the monitoring network.

These early estimates at Lees Ferry are found with one of two methods based on available data. The first method requires data that is typically available 3 months after the end of the year. The second method only requires a forecast of the total unregulated inflow for the given water or calendar year to estimate the annual natural flow.

## Method 1

The first method determines a "provisional" estimate of natural flow at Lees Ferry defined as:

$$\begin{aligned}&\text{provisional natural flow at Lees Ferry} = \\ &\quad \text{observed annual flow at Lees Ferry} + \\ &\quad \text{average cumsuptive use for the last 5 published years} \pm \\ &\quad \text{net change in mainstem storage} \pm \\ &\quad \text{net change in off-mainstem storage} \pm \\ &\quad \text{net change bank storage} + \\ &\quad \text{mainstem reservoir evaporation}\end{aligned} \qquad (1)$$

where the observed annual flow at Lees Ferry is the USGS gauge (09380000) value taken from the Hydrologic Data Base (HDB) for the year of interest. Specifically, we query SiteDataTypeID 1578 from the r_month table and aggregate to the water year (WY) and calendar year (CY).

The average consumptive use over the last 5 published years is taken from supporting data for the published consumptive uses and losses reports. The values from the published reports cannot be directly used because they must be adjusted to remove the effects of Paria River depletions. Though these depletions are included with Upper Basin consumptive use their impact on flows is below the Lees Ferry gauge.

The net change in mainstem storage, off-mainstem storage, bank storage, and mainstem evaporation are taken from the HDB r_month table. Table 1 lists the reservoirs included in each of these categories.

**Table 1. Reservoir included in provisional natural flow estimate under method 1.**

| Mainstem storage | Off-mainstem storage | Bank storage | Mainstem evaporation |
|---|---|---|---|
| *Blue Mesa* | Dillon | Flaming Gorge | Blue Mesa |
| *Crystal* | Fruitgrowers | Powell | Flaming Gorge |
| *Flaming Gorge* | Green Moutain | | Morrow Pont |
| *Fontenelle* | Homestake | | Powell |
| *Morrow Pont* | Jacksons Gulch | | |
| *Powell* | Joes Valley | | |
| *Navajo* | Granby | | |
| *Taylor Park* | Lemon | | |
| | McPhee | | |
| | Meeks Cabin | | |
| | Moon Lake | | |
| | Viva Naughton | | |
| | Paonia | | |
| | Reudi | | |
| | Scofield | | |
| | Shadow Mountain | | |
| | Silver Jack | | |
| | Steinaker | | |
| | Soldier Creek | | |
| | Starvation | | |
| | Strawberry | | |
| | Vallecito | | |
| | Vega | | |
| | Williams Fork | | |
| | Willow Creek | | |
| | Wolford | | |

Based on equation (1) either a WY or CY estimate of provisional natural flow can be determined. Method 1 is used to estimate the natural flow in the year beyond the last published year of current natural flow data available throughout the basin. For example, presently the last published year is 2012. Method 1 was used to estimate both WY and CY 2013 natural flows at Lees Ferry. All the required data to estimate WY and CY flows in 2014 are not yet available for Method 1; therefore, an alternate method is required.

## Method 2

The second method provides a "preliminary provisional" estimate of natural flow at Lees Ferry defined as:

$$\begin{aligned}&\text{preliminary provisional natural flow at Lees Ferry} = \\ &\text{1981 - 2010 average (Normal) natural flow at Lees Ferry} * \\ &\text{forecasted \% of Normal natural flow}\end{aligned} \qquad (2)$$

where the forecasted % of Normal natural flow is determined based on the unregulated inflow forecast into Lake Powell published in the most recent 24-Month Study. The unregulated inflow forecast into Lake Powell is translated to natural flow using a linear regression of 1981-2010 percent of Normal for unregulated inflow into Lake Powell versus natural flow at Lees Ferry. The CY linear relationship, where $y$ = natural flow % of Normal and $x$ = unregulated inflow % of Normal is defined as:

$$y = 0.7423x + 0.2577 \qquad (3)$$

The linear fit of the WY 1981-2010 data is defined as:

$$y = 0.7459x + 0.2541 \qquad (4)$$

Figure 1 shows the (a) CY and (b) WY linear regression fit along with the 1981-2010 observed data.

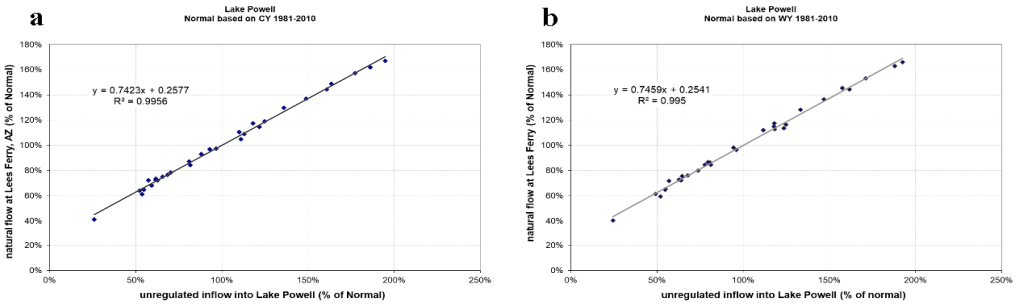



**Figure 1. Regression fit for CY and WY 1981-2010 Lake Powell data (Normal based on 1981-2010 average).**

Under Method 2 if the WY or CY of interest recently ended and data is not yet available to meet the requirements of Method 1 then the forecasted % of Normal natural flow can be replaced with the observed % of Normal natural flow for that given year.

# EXHIBIT C

CERTIFIED COPY

# AUDIO TRANSCRIPTION OF

# RAINBOW MWD

# ENGINEERING AND OPERATIONS COMMITTEE MEETING

MAY 5, 2021

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MIG GASCA
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AUDIO TRANSCRIPTION OF

RAINBOW MWD

ENGINEERING AND OPERATIONS COMMITTEE MEETING

MAY 5, 2021

CHAIR NELSON: I'm going to call this thing to order. So I'll call the meeting to order, and we'll start with the Pledge of Allegiance.

GENERAL MANAGER KENNEDY: Ready - begin.

(Pledge of Allegiance is recited)

CHAIR NELSON: Okay. I can do rollcall. Flint Nelson is here. We do not have a Vice Chair. So, Helene Brazier?

COMMITTEE MEMBER BRAZIER: Here.

CHAIR NELSON: Robert Marnett?

COMMITTEE MEMBER MARNETT: Present.

CHAIR NELSON: Mig Gasca?

COMMITTEE MEMBER GASCA: Present.

CHAIR NELSON: Okay. So we have - we have enough room to seat an alternate. So after I do the next item, we will deal with that. So these are instructions to allow public comment on agenda items from those attending this meeting via teleconference or videoconference.

If at any point anyone would like to ask a question or make a comment and have joined this

CHAIR NELSON: Can I just ask briefly - the, the little chart on the right of the Water Authority - is just more indication that they're in another alternative universe, and that we - we need to move forward with detachment. I am idly curious - what would that chart look like for the - for our planned new parent, which would be Eastern Municipal Water District? Are - what are they looking at?

GENERAL MANAGER KENNEDY: You know, I think a lot of us --

CHAIR NELSON: Because they have to do --

GENERAL MANAGER KENNEDY: Yeah.

CHAIR NELSON: -- these same studies --

GENERAL MANAGER KENNEDY: Right.

CHAIR NELSON: -- and these same things, right?

GENERAL MANAGER KENNEDY: Eastern is - in southwestern Riverside County - is experienced - high growth. There's a lot of residential, lot of growth going on in that area. So I haven't looked at their plan in, in detail. But I imagine they would show growth, because you know, that whole Inland Empire area is - they're building subdivisions like mad. So they do anticipate - but they are also one of the leaders in recycled water, and reuse. So you know, their, the, their demand on imported potable water may

stay pretty flat, because they're going to try to move all their irrigation and what on to recycled water, and they also have local supplies. And so - but they will definitely show some growth.

What Metropolitan did, being - you know, Eastern's just the - the paper guy in between us and Metropolitan - they actually did four demand scenarios, and they're working through right now, where they show, you know, you know, high demand - four quadrants, with high demand, low demand, high supply, and low supply. Right? And then mark, making - putting those together to see what the impacts are.

And obviously, having high demand and low supply being the worst, and trying to work through the probabilities of those, and what would their shortages be. And, and it - I think it's a better way to look at it holistically for planning purposes, because you have to figure out what the relative probability of each of those things occurring are, and then gauge your investments to meet extremely unlikely events.

But what we're seeing right now with Metropolitan over the last 20, 25 years, the investment they've made in Diamond Valley Lake, and then storage in Lake Mead, and several other projects, is that right now they're sitting on over two years of

supply for all of Southern California, even if there was not more, one more drop coming in from any other sources - sitting in storage in Lake Mead and other places. So what we're seeing in Southern California is that, that the trend is not as dramatic as ours, but the trend is down, but investments that were made a long time ago - we're not talking about whether we're going to have enough supply. We're worrying that we've, we're going to have too, too much supply, and your mix of take or pay water contracts makes a big difference.

And that's where the Water Authority needs to be super careful, because their Urban Water Management Plan shows in 2035, they come down and just touch the level of their contract delivery water. They don't quite go below it. Somehow, then it goes back up. And that - the reason it went down is because of San Diego Pure Water, right? They show demands going up, but Pure Water brings them down.

And - but that's not what all the member agencies' analysis looks like. It shows it going below that. And I, I think they've got about a five or seven-year window to right-size their supply portfolio so they don't end up paying for water they don't take. But - I tell them that at the Water

Authority all the time, but they don't listen.

CHAIR NELSON: So just for clarification - back to Eastern --

GENERAL MANAGER KENNEDY: Yeah.

CHAIR NELSON: If they are experiencing growth because of all the residential development pushing east, I guess --

GENERAL MANAGER KENNEDY: Yeah.

CHAIR NELSON: And of course --

MALE SPEAKER: Yes.

CHAIR NELSON: -- I guess they include Palm Springs, is that right?

GENERAL MANAGER KENNEDY: No, they, they don't --

CHAIR NELSON: Okay.

GENERAL MANAGER KENNEDY: -- include Palm Springs.

CHAIR NELSON: Okay.

GENERAL MANAGER KENNEDY: They're in with --

CHAIR NELSON: Okay. So then - but they're still --

GENERAL MANAGER KENNEDY: -- Moreno Valley --

CHAIR NELSON: -- having all this development pushing east.

GENERAL MANAGER KENNEDY: -- Perris.

MALE SPEAKER: Hemet.

CHAIR NELSON: And if they have a set of investments to make sure there is adequate long term water supply for those increasing developments out there, is there a process by which they allocate the cost recovery for those investments over the expense - the, the cost of building those investments - would we end up paying for, if, well, if we joined Eastern --

GENERAL MANAGER KENNEDY: Um-hmm.

CHAIR NELSON: -- would we end up participating in the payment for those developments --

MALE SPEAKER: Yeah.

CHAIR NELSON: -- out in areas that are not us?

GENERAL MANAGER KENNEDY: Right. We will not. Under our agreement with them, we are just strictly getting Metropolitan water from them.

CHAIR NELSON: Okay. Okay.

GENERAL MANAGER KENNEDY: In our agreement, we have the option to buy into a local supply project, should we choose to, to - if we want to --

CHAIR NELSON: Okay.

GENERAL MANAGER KENNEDY: -- increase the reliability for some reason, and then evaluate what the cost of those were - would be. And so that's on the table. And if they turned up a new groundwater

desalter plant or something, we can say, 'Hey, we want to buy 3,000 acre-feet of that production,' - it's not going to cost us $1100 an acre-foot. We know it's going to cost $1800 an acre-foot, but we want it as a hedge, right? And those are decisions we can make as those come along, but --

CHAIR NELSON: Okay. Well --

GENERAL MANAGER KENNEDY: -- the analysis we did for the application to LAFCO is that Met's supplies, you know, delivering through Eastern, meet every Urban Water Management Plan planning horizon that, that we can take --

CHAIR NELSON: Well, that's reassuring, that we are not potentially in a position to pay for that other development --

GENERAL MANAGER KENNEDY: Our, our --

CHAIR NELSON: So, thank you. Thank you.

GENERAL MANAGER KENNEDY: -- rate is $11.00 over Met's rate.

CHAIR NELSON: Thank you.

GENERAL MANAGER KENNEDY: Period, the end.

CHAIR NELSON: Thank you. That's great.

COMMITTEE MEMBER GASCA: Well, there's one thing to add to that. And, and you've got to realize that the development that takes place, like say,