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Glen Canyon Monthly Operations Call

Basin Hydrology and Operations

September 21, 2021

Background

This briefing is being provided consistent with the provision in Section 1.1 of the LTEMP ROD which states:

“Annually, Reclamation will develop a hydrograph based on the characteristics above. Reclamation will seek consensus on the annual hydrograph through monthly operational coordination calls with governmental entities, and regular meetings of the GCDAMP Technical Working Group (TWG) and AMWG.

Reclamation will conduct monthly Glen Canyon Dam operational coordination meetings or calls with the DOI bureaus (USGS, NPS, FWS, and BIA), WAPA, and representatives from the Basin States and UCRC. The purpose of these meetings or calls is for the participants to share and seek information on Glen Canyon Dam operations. One liaison from each Basin State and from the UCRC may participate in the monthly operational coordination meetings or calls.”

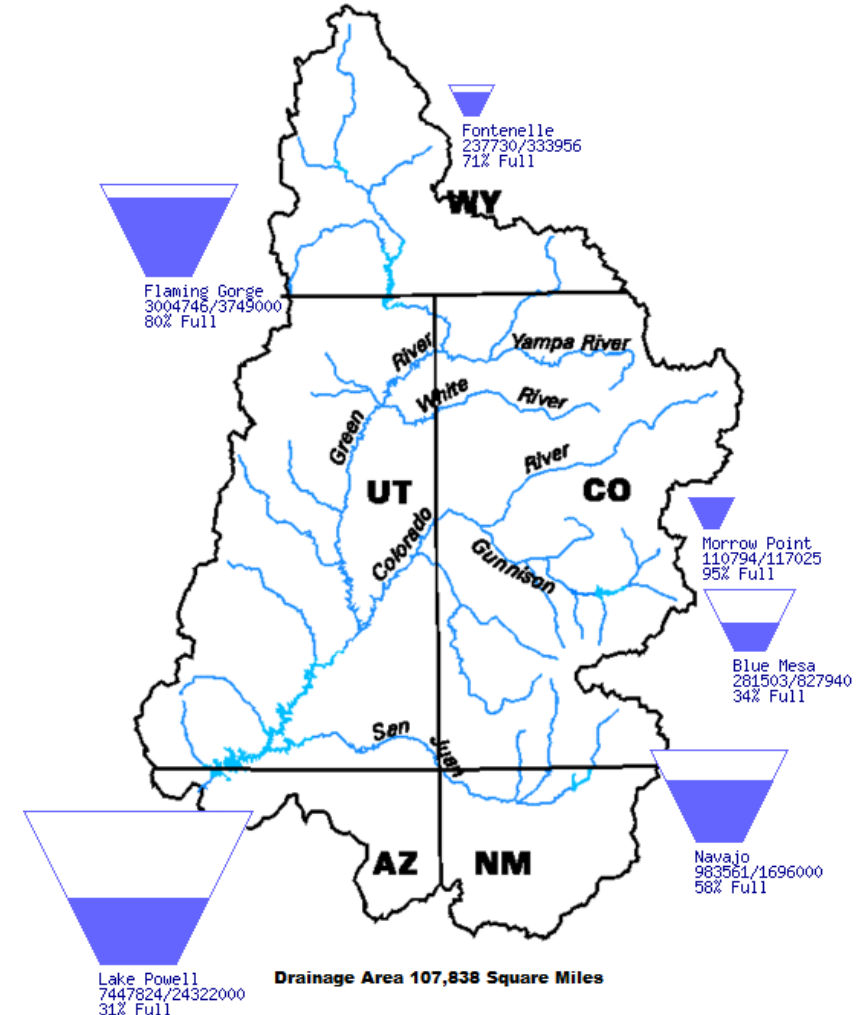


Upper Basin Storage (as of September 19, 2021)

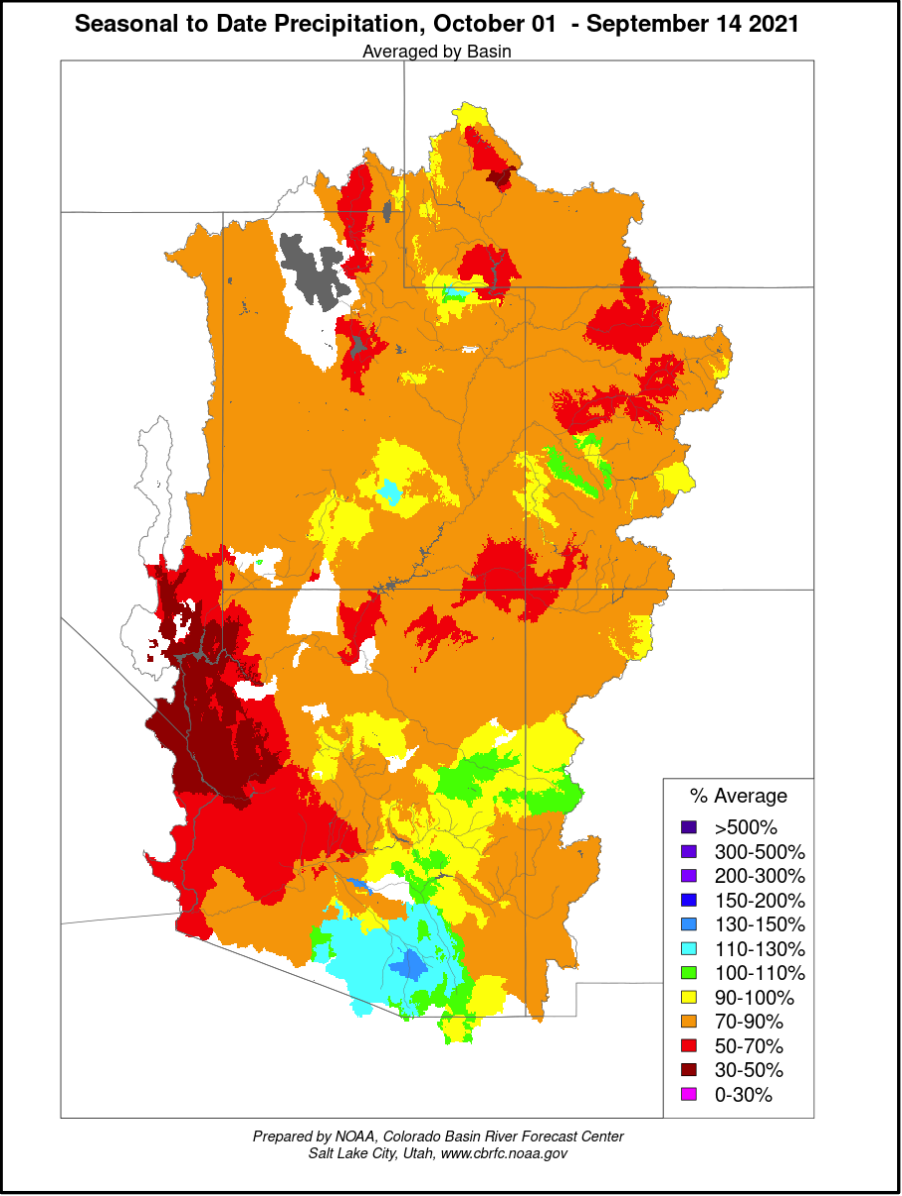
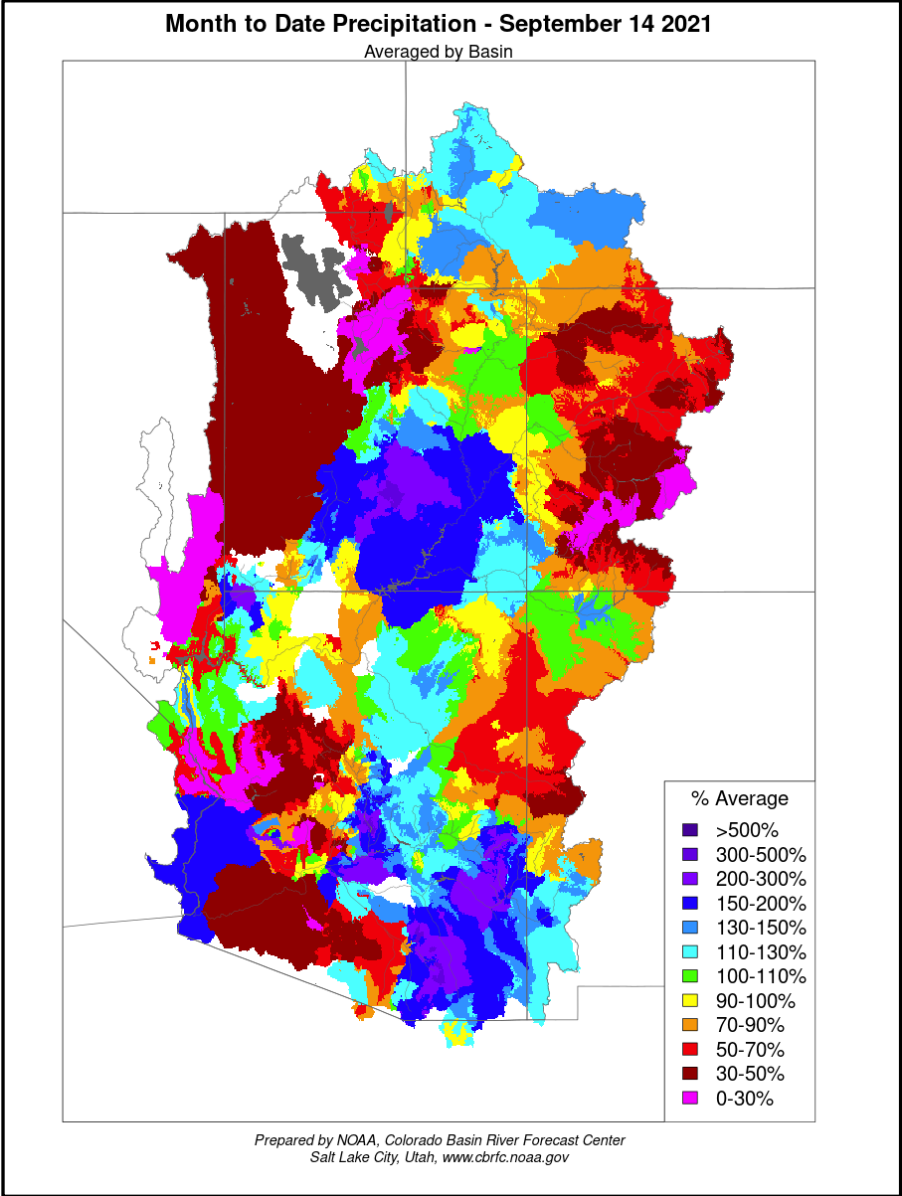
Data Current as of:
09/13/2021

Upper Colorado River Drainage Basin

Reservoir	Percent Current Live Storage	Current Live Storage (maf)	Live Storage Capacity (maf)	Elevation (feet)
Fontenelle	68	0.24	0.33	6,492.53
Flaming Gorge	79	2.99	3.75	6,020.35
Blue Mesa	32	0.27	0.83	7,442.00
Navajo	57	0.97	1.70	6,026.09
Lake Powell	30	7.38	24.32	3,547.06
UC System Storage	38	11.97	31.09	

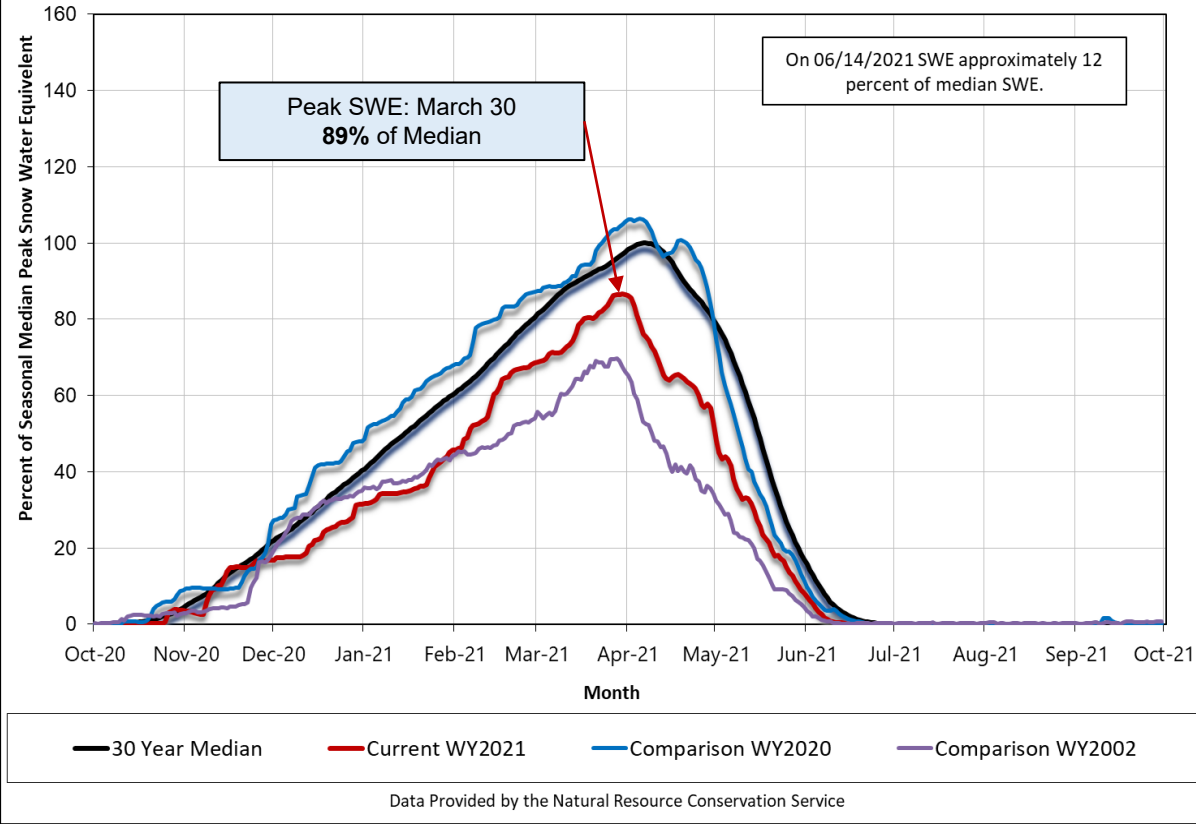


Precipitation: September and Seasonal

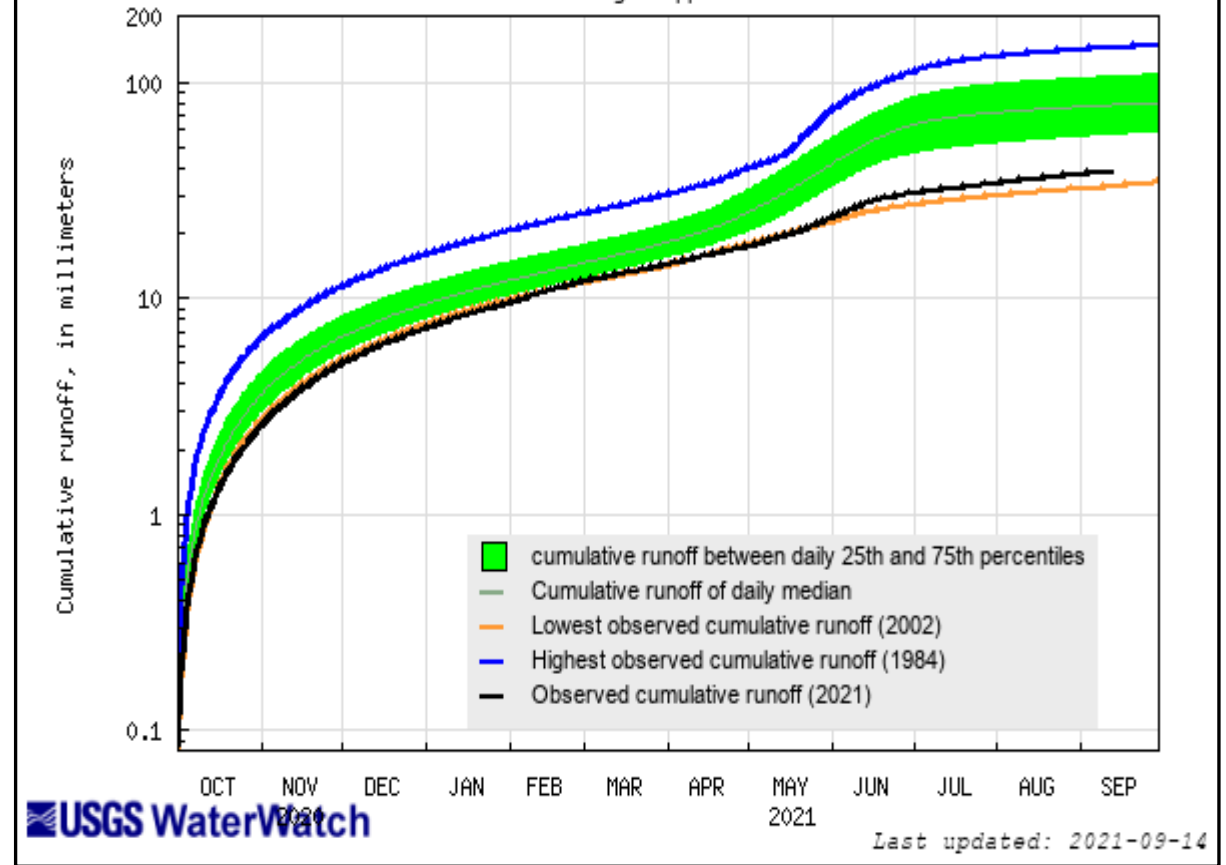


Current SWE and Observed UC Runoff

Upper Colorado River above Lake Powell Snotel Tracking



Hydrograph of cumulative 7-day average runoff for Water Resource Region Upper Colorado



Available online at: https://waterwatch.usgs.gov/index.php?id=wwdur_cumrunoff



Most Probable August Forecast Water Year 2021

April – July 2021
Observed Unregulated Inflow
as of September 1, 2021

Reservoir	Unregulated Inflow (kaf)	Percent of Average ¹
Fontenelle	318	44
Flaming Gorge	380	39
Blue Mesa	317	47
Navajo	378	51
Powell	1,850	26

Water Year 2021
Forecasted Unregulated Inflow
as of September 1, 2021

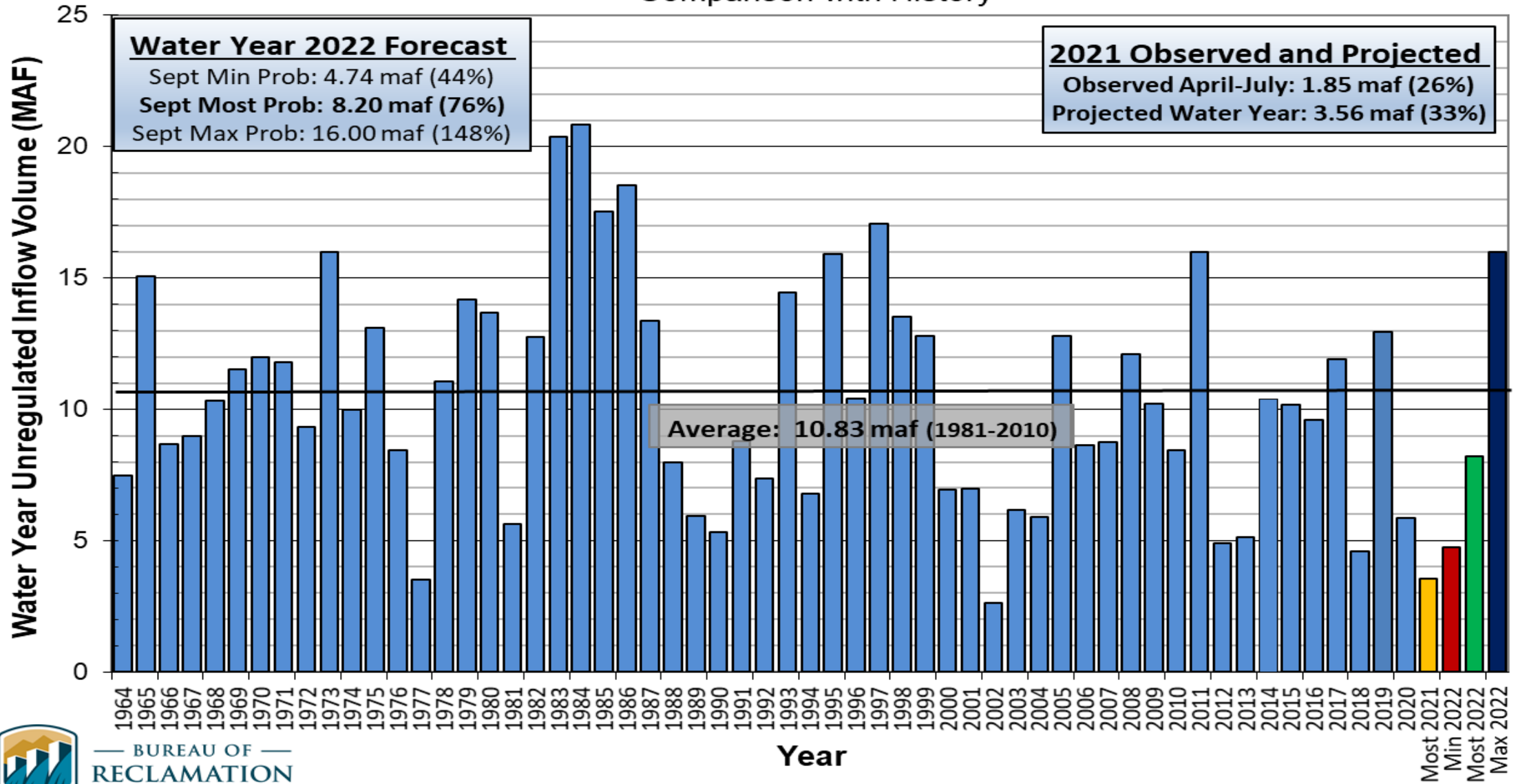
Reservoir	Unregulated Inflow (kaf)	Percent of Average ¹
Fontenelle	564	52
Flaming Gorge	676	46
Blue Mesa	526	55
Navajo	486	45
Powell	3,561	33



Lake Powell Unregulated Inflow

Water Year 2021 and 2022 Forecast *(issued September 1)*

Comparison with History



October 2021 30-Year Average Shift 1991-2020

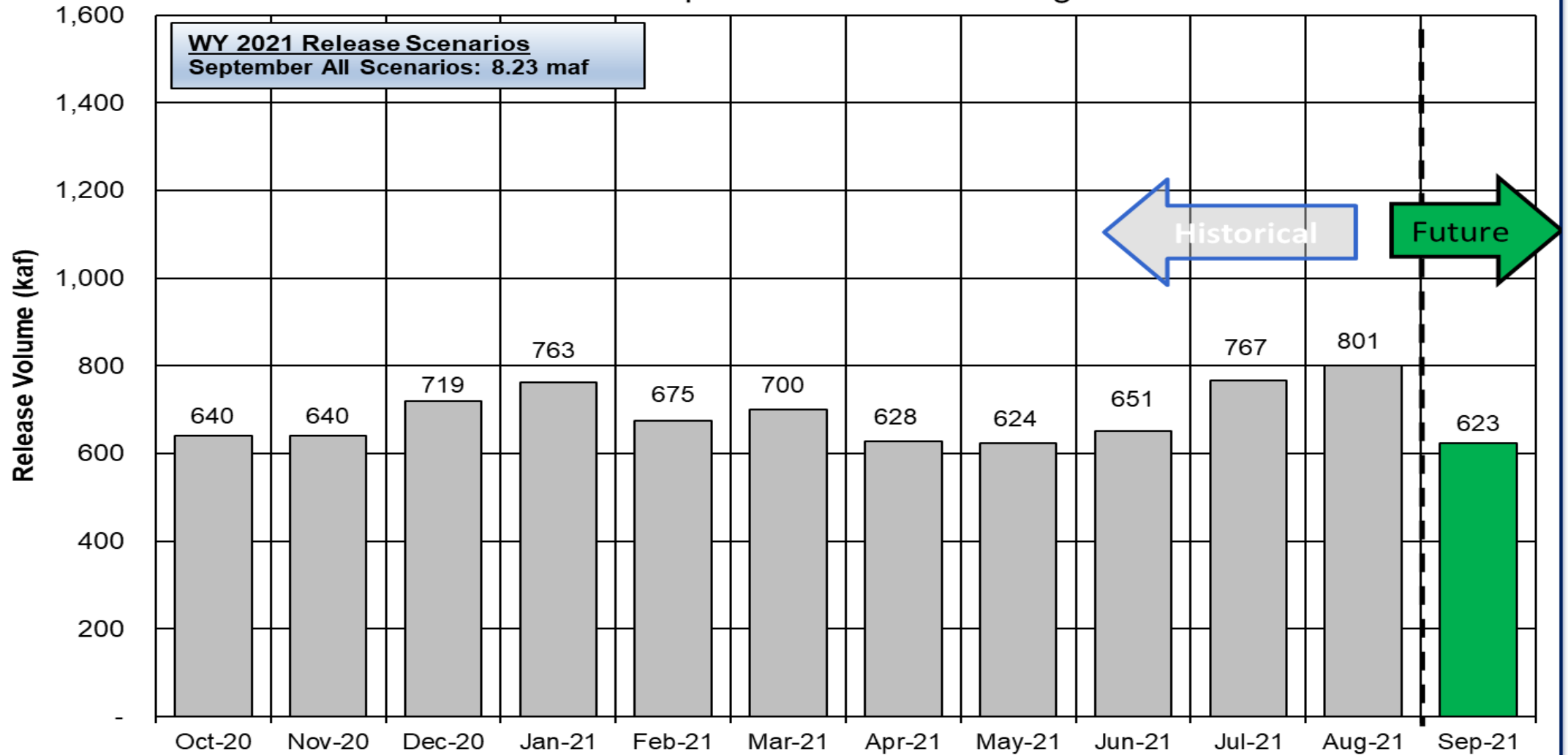
- CRSP Initial Unit facilities will continue to operate according to their Records of Decision
- Moving to the 1991-2020 statistics will provide forecasted reservoir operations that are more reflective of the dry conditions we are currently experiencing
 - The significant wet hydrology observed in the 1980s will be removed from the forecast probabilities and no longer influencing and overestimating forecasted water volumes.
 - Incorporating the last decade of record dry hydrology from 2011-2020 includes the observed higher temperatures and drier conditions that have occurred with climate change.
- Upper Green Basin least amount of change because of 2011 and 2020 wet hydrology
- San Juan has greatest shift with continued dry hydrology over last decade

Reservoirs	April-July Volumes				Water Year Volumes			
	1981-2010 April-July Avg Volume (kaf)	1991-2020 April-July Avg Volume (kaf)	April-July Volume Difference (kaf)	April-July Percent Difference	1981-2010 WY Avg Volume (kaf)	1991-2020 WY Avg Volume (kaf)	WY Volume Difference (kaf)	WY Percent Difference
Fontenelle	726	735	9	1%	1,082	1,074	(7)	-1%
Flaming Gorge	979	966	(12)	-1%	1,455	1,411	(43)	-3%
Blue Mesa	676	636	(40)	-6%	955	904	(51)	-5%
Navajo	737	628	(109)	-15%	1,075	911	(165)	-15%
Powell	7,155	6,392	(763)	-11%	10,831	9,603	(1,228)	-11%

Potential Lake Powell Monthly Release Volume Distribution

Release Scenarios for Water Year 2021

Based on September 2021 Modeling



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The Drought Response Operations Agreement (DROA) can be found here: <https://www.usbr.gov/dcp/finaldocs.html>



Upper Colorado Basin

**Projected Operations
for Water Year 2022
Based on September
2021 Modeling**



2021 DROA Timeline of Events

- **January 2021: Minimum Probable 24 Month Study run projected Powell below 3,525'**
 - Formal notification to parties
 - Enhanced monitoring and coordination
 - Monthly analysis of min/most/max
- **May 2021: Most Probable 24 Month Study run projected Powell within inches of 3,525'**
 - DROA planning formally initiated
- **July 2021: Continued declining hydrology and declining Powell**
 - Consultation and initiation of DROA releases under emergency provision of agreement



Upper Basin DROA Initial Unit Drought Response Releases that started in July 2021

- July WY2021 forecast decreased 140 kaf from the June forecast
- Continued drought conditions exacerbated already parched soil moisture conditions
- WY2022 most probable forecast decreased 1.84 maf (17%)
 - May forecast 9.97 maf (92% avg)
 - July forecast 8.13 maf (75% avg)
- Prospects of future monsoon events unknown

DROA Releases for the July 24MS Model Run

	Jul	Aug	Sep	Oct	Nov	Dec	
	(kaf)	(kaf)	(kaf)	(kaf)	(kaf)	(kaf)	Sum
Flaming Gorge	13	42	43	27	0	0	125
Blue Mesa	0	14	18	4	0	0	36
Navajo	0	0	0	0	10	10	20
Sum:	13	56	61	31	10	10	181



Lake Powell & Lake Mead Operational Table

Operating Determinations for Water Year/Calendar Year 2022

Lake Powell			Lake Mead		
Elevation (feet)	Operation According to the Interim Guidelines	Live Storage (maf) ¹	Elevation (feet)	Operation According to the Interim Guidelines	Live Storage (maf) ¹
3,700	Equalization Tier Equalize, avoid spills or release 8.23 maf	24.3	1,220	Flood Control Surplus or Quantified Surplus Condition Deliver > 7.5 maf	25.9
3,636 - 3,666 (2008-2026)	Upper Elevation Balancing Tier ³ Release 8.23 maf; if Lake Mead < 1,075 feet, balance contents with a min/max release of 7.0 and 9.0 maf	15.5 - 19.3 (2008-2026)	1,200 (approx.) ²	Domestic Surplus or ICS Surplus Condition Deliver > 7.5 maf	22.9 (approx.) ²
3,575	Mid-Elevation Release Tier Release 7.48 maf; if Lake Mead < 1,025 feet, release 8.23 maf	9.5	1,145	Normal or ICS Surplus Condition Deliver ≥ 7.5 maf	15.9
	3,535.40 ft		1,105		11.9
			1,075	1,065.85 ft	9.4
				Shortage Condition Deliver 7.167 ⁴ maf	
	Jan 1, 2022 Projection		1,050	Jan 1, 2022 Projection	7.5
3,525	Lower Elevation Balancing Tier Balance contents with a min/max release of 7.0 and 9.5 maf	5.9		Shortage Condition Deliver 7.083 ⁵ maf	5.8
3,490		4.0	1,025		5.8
3,370		0	1,000	Shortage Condition Deliver 7.0 ⁶ maf Further measures may be undertaken ⁷	4.3
			895		0

Diagram not to scale

¹ Acronym for million acre-feet

² This elevation is shown as approximate as it is determined each year by considering several factors including Lake Powell and Lake Mead storage, projected Upper Basin and Lower Basin demands, and an assumed inflow.

³ Subject to April adjustments which may result in a release according to the Equalization Tier

⁴ Of which 2.48 maf is apportioned to Arizona, 4.4 maf to California, and 0.287 maf to Nevada

⁵ Of which 2.40 maf is apportioned to Arizona, 4.4 maf to California, and 0.283 maf to Nevada

⁶ Of which 2.32 maf is apportioned to Arizona, 4.4 maf to California, and 0.280 maf to Nevada

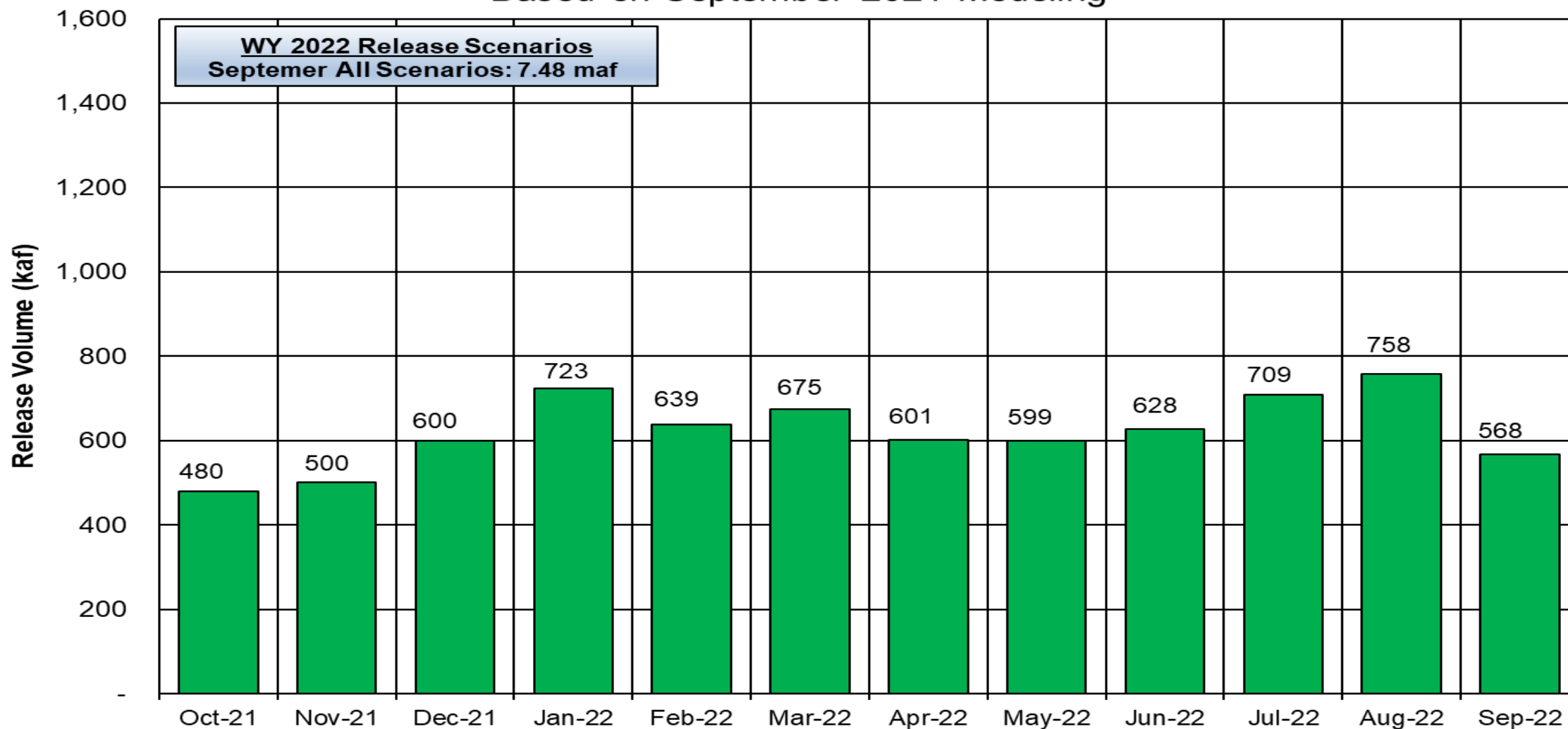
⁷ Whenever Lake Mead is below elevation 1,025 feet, the Secretary shall consider whether hydrologic conditions together with anticipated deliveries to the Lower Division States and Mexico is likely to cause the elevation at Lake Mead to fall below 1,000 feet. Such consideration, in consultation with the Basin States, may result in the undertaking of further measures, consistent with applicable Federal law.

¹ Lake Powell and Lake Mead operating determinations are based on August 2021 24-Month Study projections consistent with the 2007 Interim Guidelines and 2019 Drought Contingency Plans. These determinations will be documented in the 2022 Annual Operating Plan for Colorado River Reservoirs.

Potential Lake Powell Monthly Release Volume Distribution

Release Scenarios for Water Year 2022

Based on September 2021 Modeling

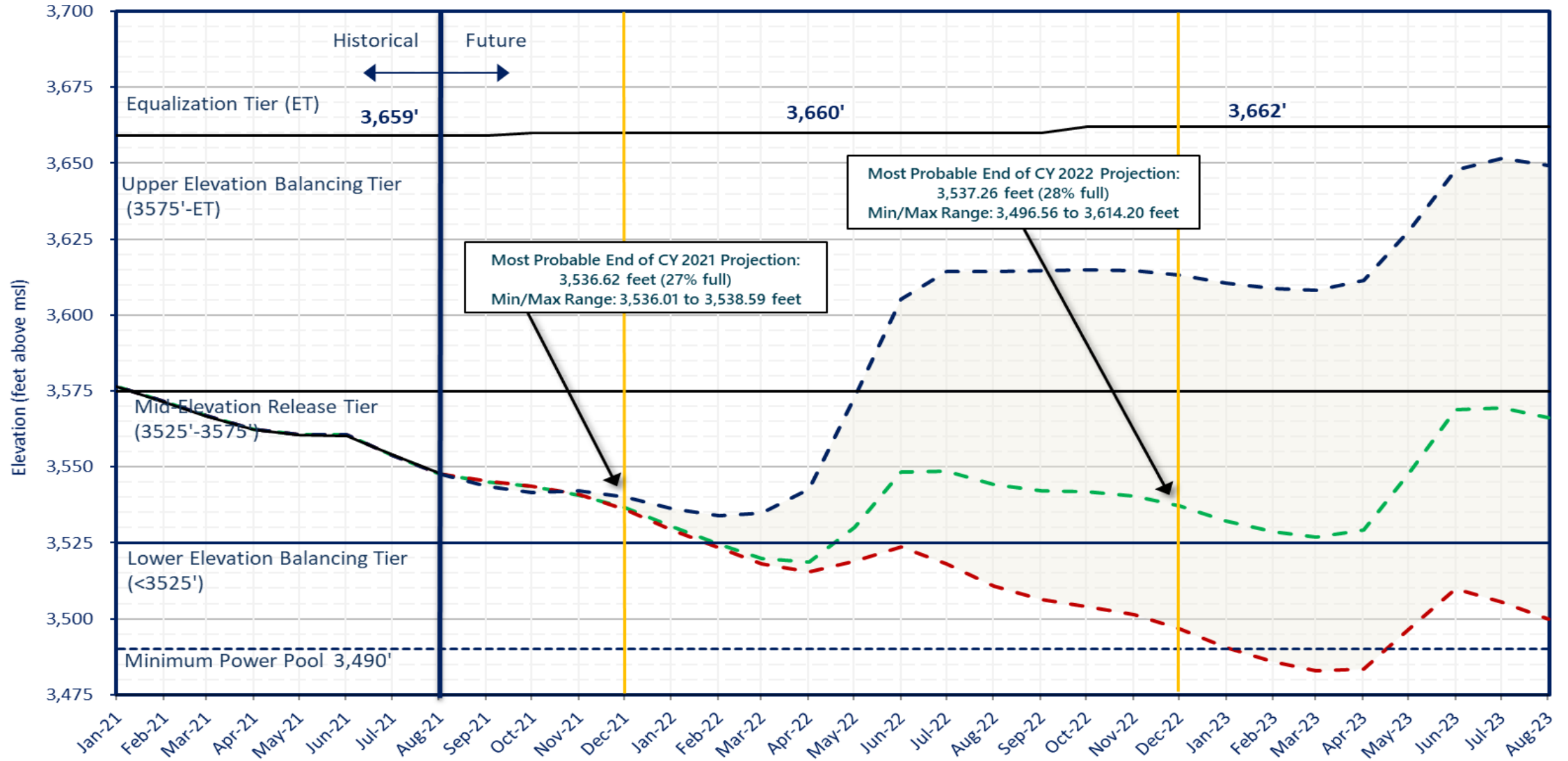


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Lake Powell End of Month Elevations

Projections from the September 2021 24-Month Study Inflow Scenarios



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- September 2021 Most Probable - Lake Powell release of 8.23 maf in WY2021 and 7.48 maf in WY2022
- September 2021 *DROA Minimum Probable - Lake Powell release of 8.23 maf in WY2021 and 7.48 maf in WY2022
- September 2021 *DROA Maximum Probable - Lake Powell release of 8.23 maf in WY2021 and 7.48 maf in WY2022
- Historical Elevations

*The Drought Response Operations Agreement (DROA) can be found here: <https://www.usbr.gov/dcp/finaldocs.html>

2007 Interim Guidelines, Minute 323, Lower Basin Drought Contingency Plan, and Binational Water Scarcity Contingency Plan Total Volumes (kaf)

Lake Mead Elevation (feet msl)	2007 Interim Guidelines Shortages		Minute 323 Delivery Reductions	Total Combined Reductions	DCP Water Savings Contributions			Binational Water Scarcity Contingency Plan Savings	Combined Volumes by Country <i>US: (2007 Interim Guidelines Shortages + DCP Contributions)</i> <i>Mexico: (Minute 323 Delivery Reductions + Binational Water Scarcity Contingency Plan Savings)</i>					Total Combined Volumes
	AZ	NV	Mexico	Lower Basin States + Mexico	AZ	NV	CA	Mexico	AZ Total	NV Total	CA Total	Lower Basin States Total	Mexico Total	Lower Basin States + Mexico
1,090 - 1,075	0	0	0	0	192	8	0	41	192	8	0	200	41	241
1,075 - 1050	320	13	50	383	192	8	0	30	512	21	0	533	80	613
1,050 - 1,045	400	17	70	487	192	8	0	34	592	25	0	617	104	721
1,045 - 1,040	400	17	70	487	240	10	200	76	640	27	200	867	146	1,013
1,040 - 1,035	400	17	70	487	240	10	250	84	640	27	250	917	154	1,071
1,035 - 1,030	400	17	70	487	240	10	300	92	640	27	300	967	162	1,129
1,030 - 1,025	400	17	70	487	240	10	350	101	640	27	350	1,017	171	1,188
<1,025	480	20	125	625	240	10	350	150	720	30	350	1,100	275	1,375

➔
2022 Reductions + Contributions

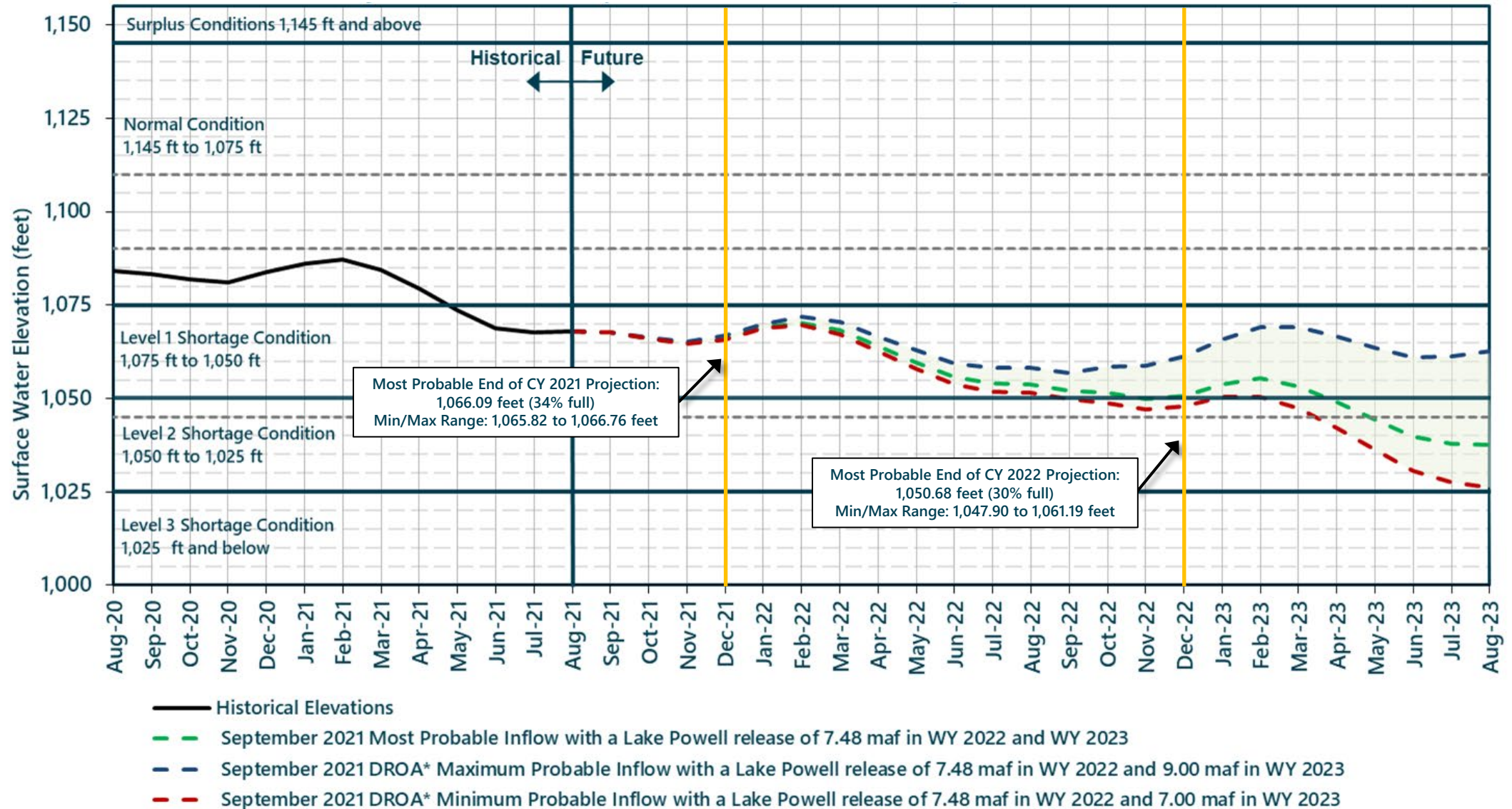
←
2022 Reductions + Contributions

The Secretary of the Interior will take affirmative actions to implement programs designed to create or conserve 100,000 acre-ft per annum or more of Colorado River System water to contribute to conservation of water supplies in Lake Mead and other Colorado River reservoirs in the lower basin. All actions taken by the United States shall be subject to applicable law, including availability of appropriations.



Lake Mead End of Month Elevations

Projections from the September 2021 24-Month Study Inflow Scenarios



*The Drought Response Operations Agreement (DROA) is available online at: <https://www.usbr.gov/dcp/finaldocs.html>.





Upper Colorado Basin

Hydropower Maintenance



Glen Canyon Dam Power Plant Unit Outage Schedule for 2021

Unit Number	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mar 2021	Apr 2021	May 2021	Jun 2021	Jul 2021	Aug 2021	Sep 2021	
1	[Outage]												[Outage]
2	[Outage]												[Outage]
3	[Outage]												
4	[Outage]												
5		[Outage]						[Outage]					
6		[Outage]											
7	[Outage]						[Outage]						
8							[Outage]						
Units Available	5	5/4	6	6	6	6/4	4	5	6	6	6	4	
Capacity (cfs)	16,400	16,400/ 12,200	19,800	19,600	19,500	19,400 (20,150) ³	19,200	15,700	19,200	19,000	18,800	11,800	
Capacity (kaf/month)	1,040	1,140	1,250	1,220	1,080	1,540	1,140	1,050	1,140	1,170	1,150	990	
Max (kaf) ¹	640	640	720	763	675	700	628	624	652	766	801	623	
Most (kaf) ¹	640	640	720	763	675	700	628	624	652	766	801	623	
Min (kaf) ¹	640	640	720	760	680	700	628	624	652	766	801	623	
											(updated 08-17-2021)		

AUG MOST²

AUG MOST

8.23 maf

8.23 maf

8.23 maf

- 1 Projected release, based on August 2021 minimum, most and maximum probable Inflow Projections and 24-Month Study model runs.
- 2 Dependent upon availability to shift contingency reserves, which will increase capacity by 30-40MW (3%) at current efficiency.
- 3 Increased capacity available from shifting contingency reserves for Spring Disturbance Flow.



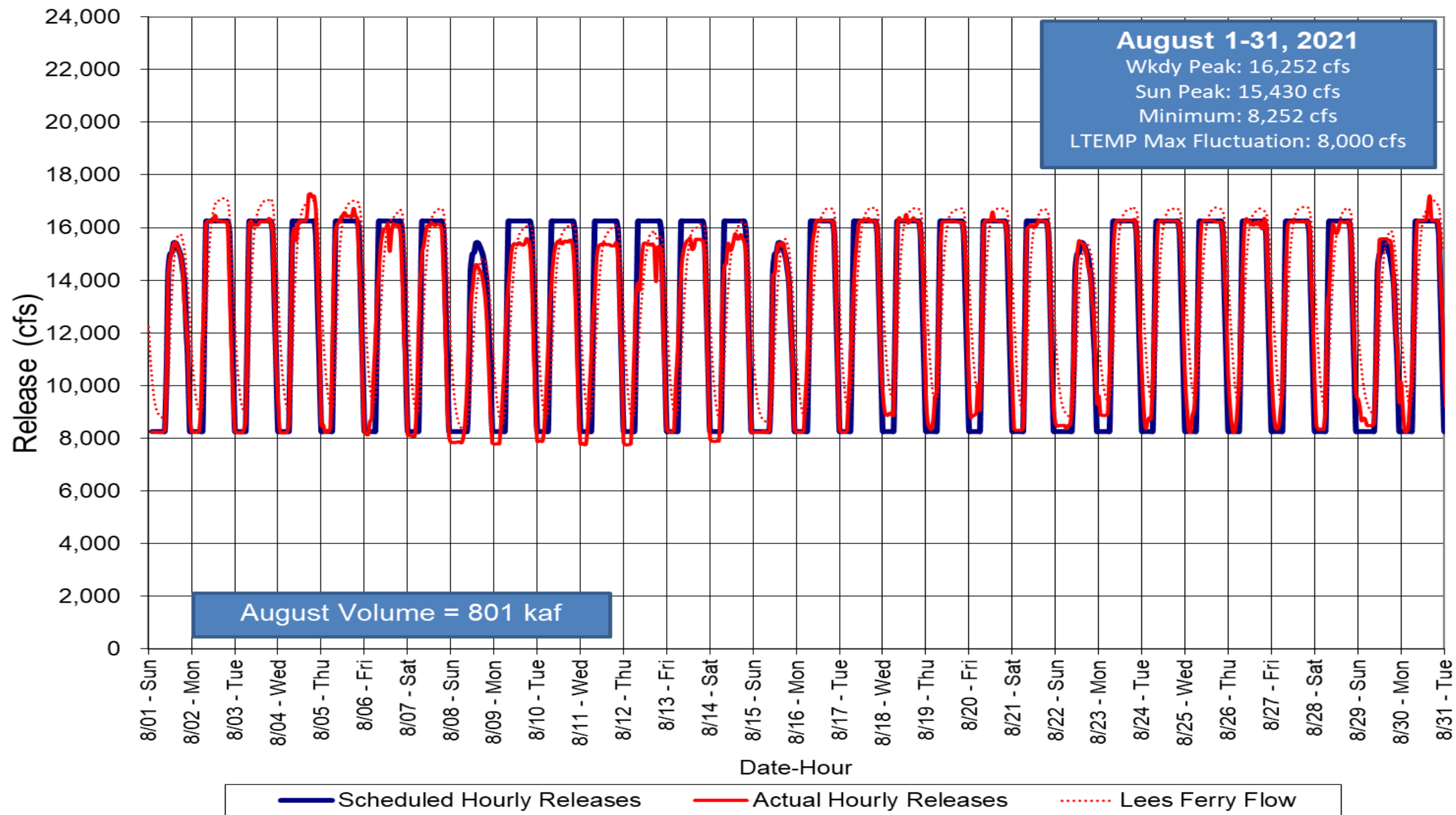
Glen Canyon Dam Power Plant Unit Outage Schedule for 2022

Unit Number	Oct 2021	Nov 2021	Dec 2021	Jan 2022	Feb 2022	Mar 2022	Apr 2022	May 2022	Jun 2022	Jul 2022	Aug 2022	Sep 2022	
1	■				■							■	
2	■				■							■	
3	■	■	■	■	■	■							
4	■	■	■	■	■	■		■					
5						■	■	■	■	■	■		
6						■	■	■	■	■	■		
7	■		■										
8	■												
Units Available	4	6/5	5	4	4	6	6	5	6	6	6	6	
Capacity (cfs)	11,700	18,500/ 15,100	15,000	11,500	11,300	17,800	17,800	14,800	18,800	18,800	18,600	18,600	AUG MOST ²
Capacity (kaf/month)	900	900	1,060	1,100	670	1,120	1,060	940	1,120	1,150	1,310	1,160	AUG MOST
Max (kaf) ¹	480	500	600	723	639	675	601	599	628	709	758	568	7.48 maf
Most (kaf) ¹	480	500	600	723	639	675	601	599	628	709	758	568	7.48 maf
Min (kaf) ¹	480	500	600	664	587	620	552	550	577	652	696	522	7.48 maf
													(updated 08-24-2021)

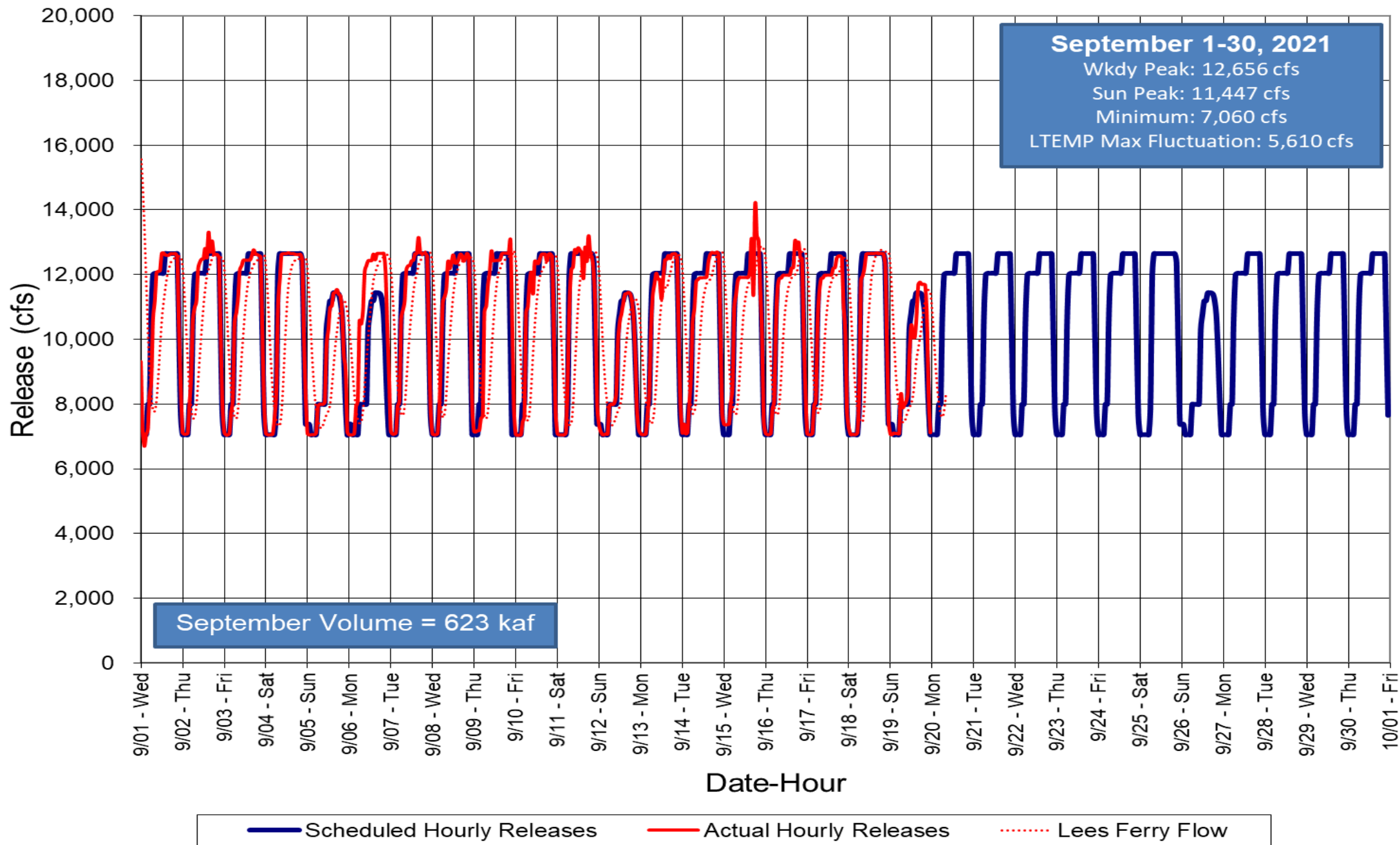
1 Projected release, based on August 2021 minimum, most and maximum probable inflow projections and 24-Month Study model runs.
 2 Dependent upon availability to shift contingency reserves, which will increase capacity by 30-40MW (3%) at current efficiency.



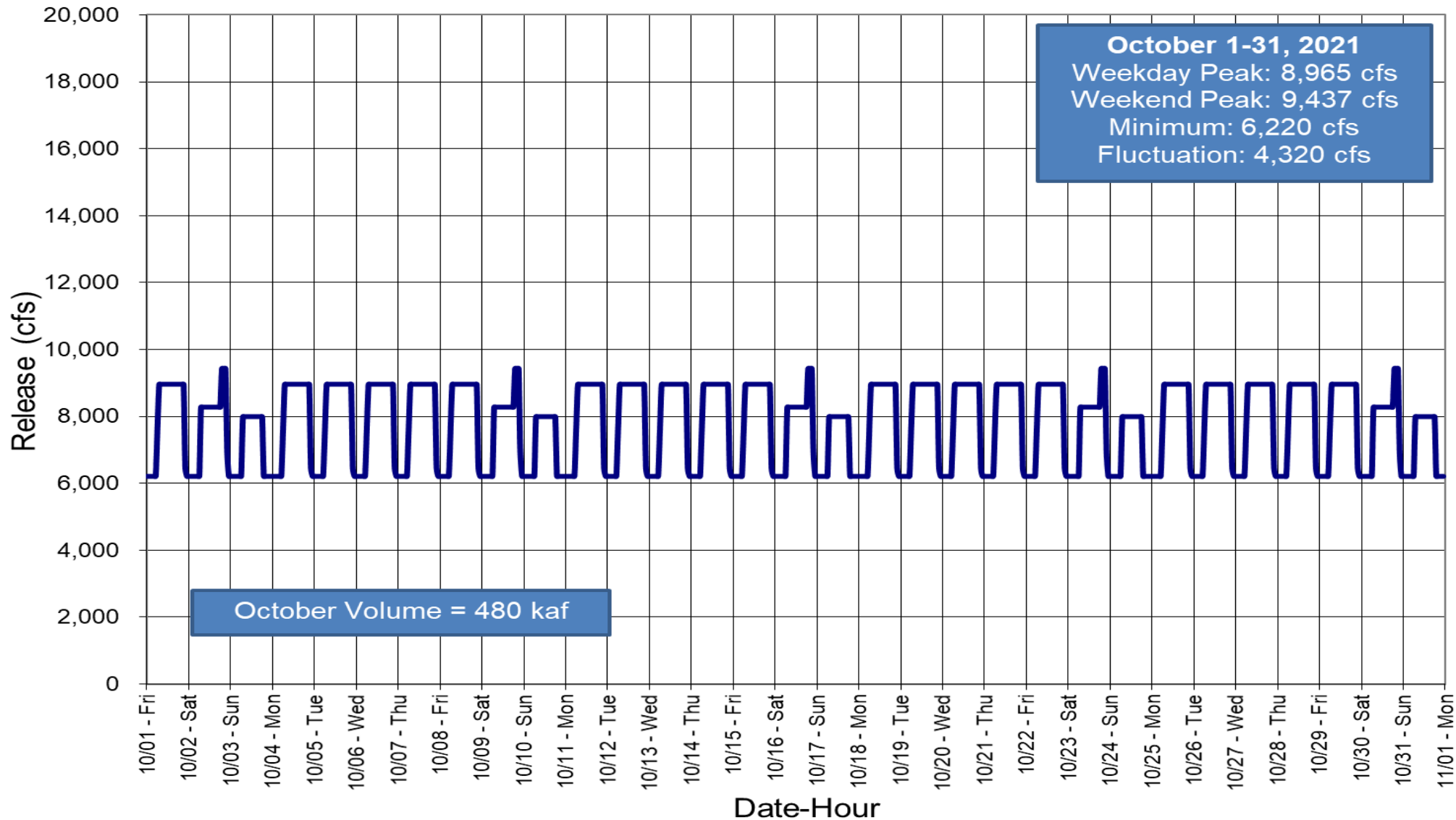
Glen Canyon Dam Hourly Release Pattern August 2021



Glen Canyon Dam Hourly Release Pattern September 2021



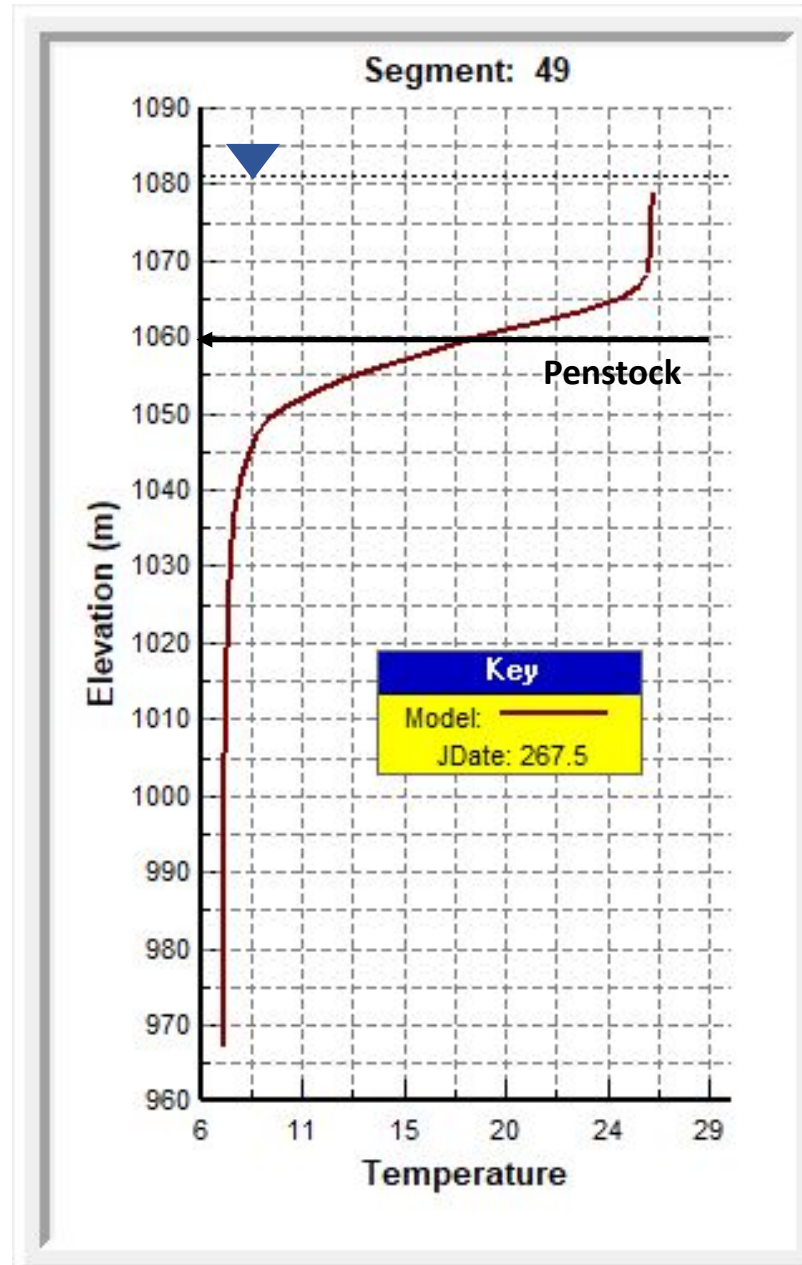
Glen Canyon Dam Hourly Release Pattern October 2021



Water Quality

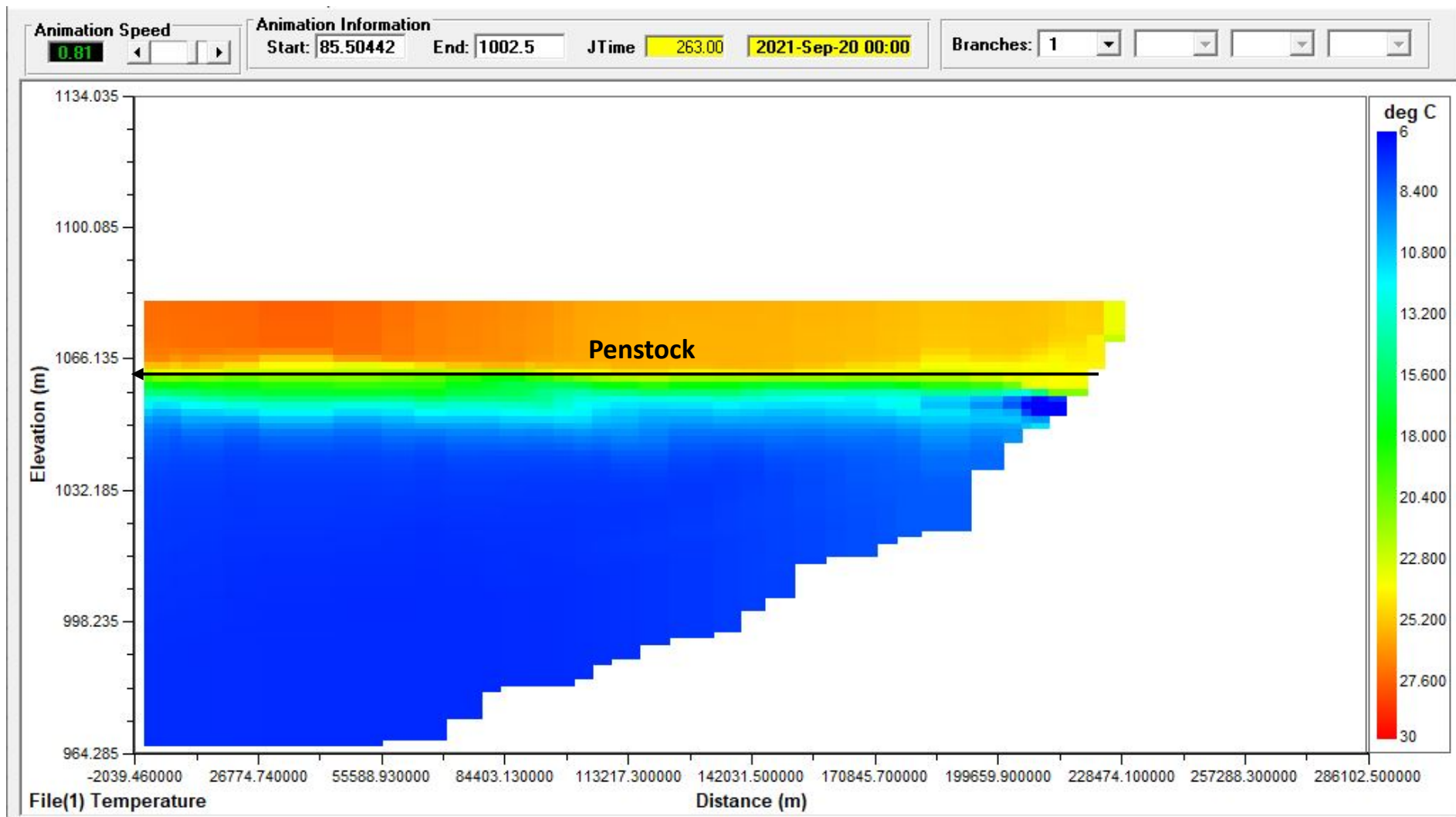


Temperature Profile of Lake Powell near Glen Canyon Dam
9/25/2021

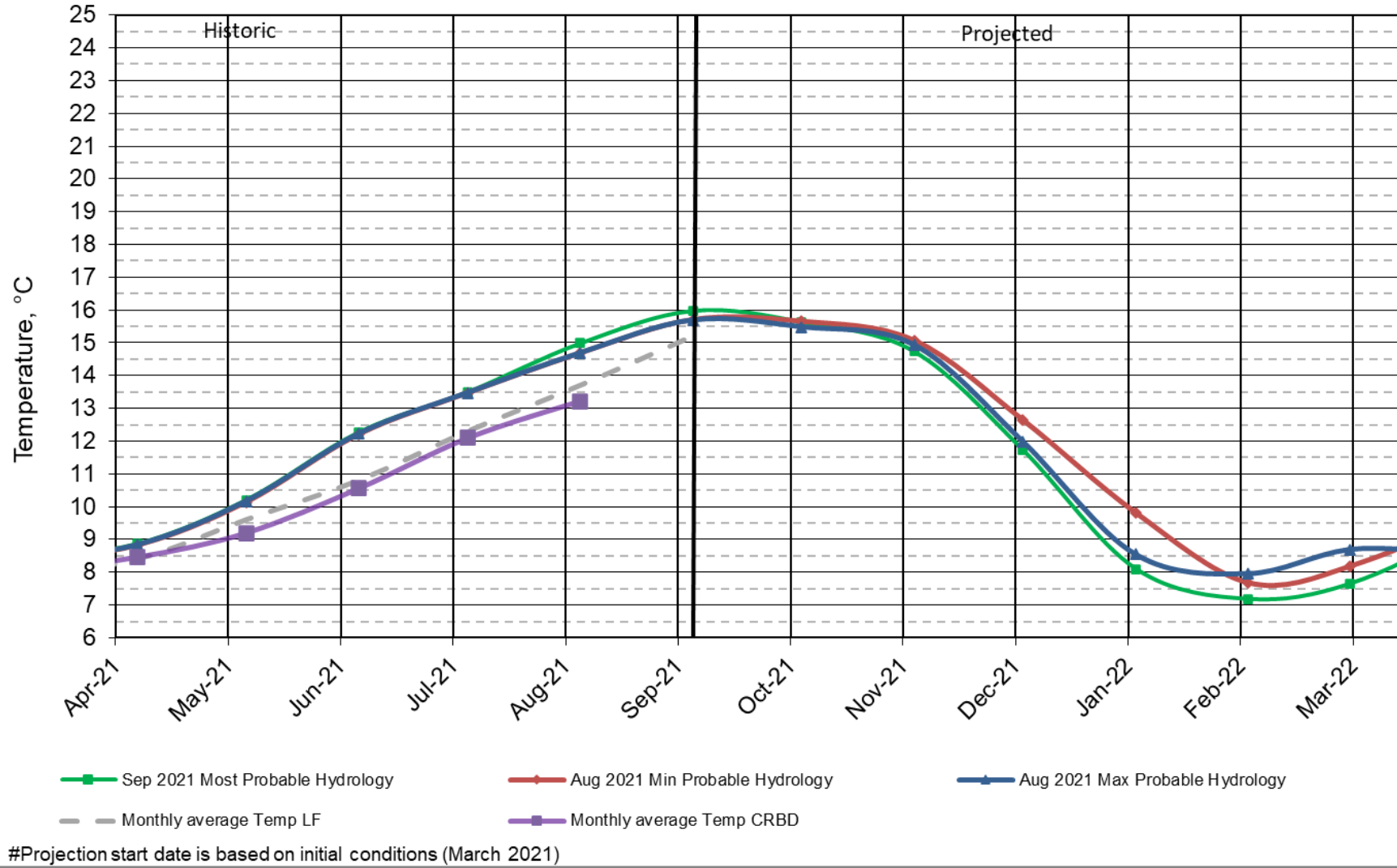


Cross Sectional Temperature Profile of Lake Powell

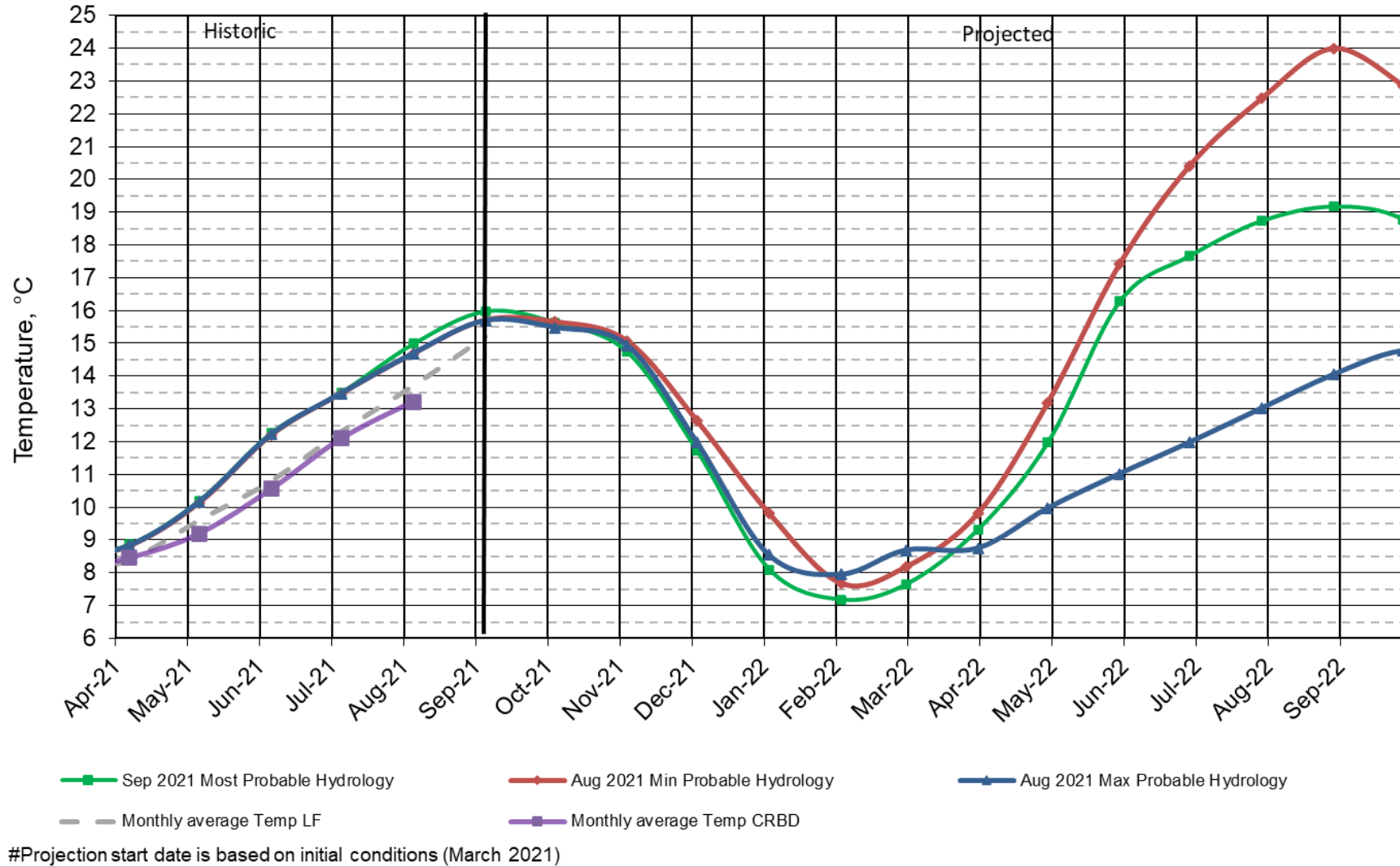
9/20/2021



Lake Powell Release Temperature Projected Temperature based on Sep 2021 Forecast

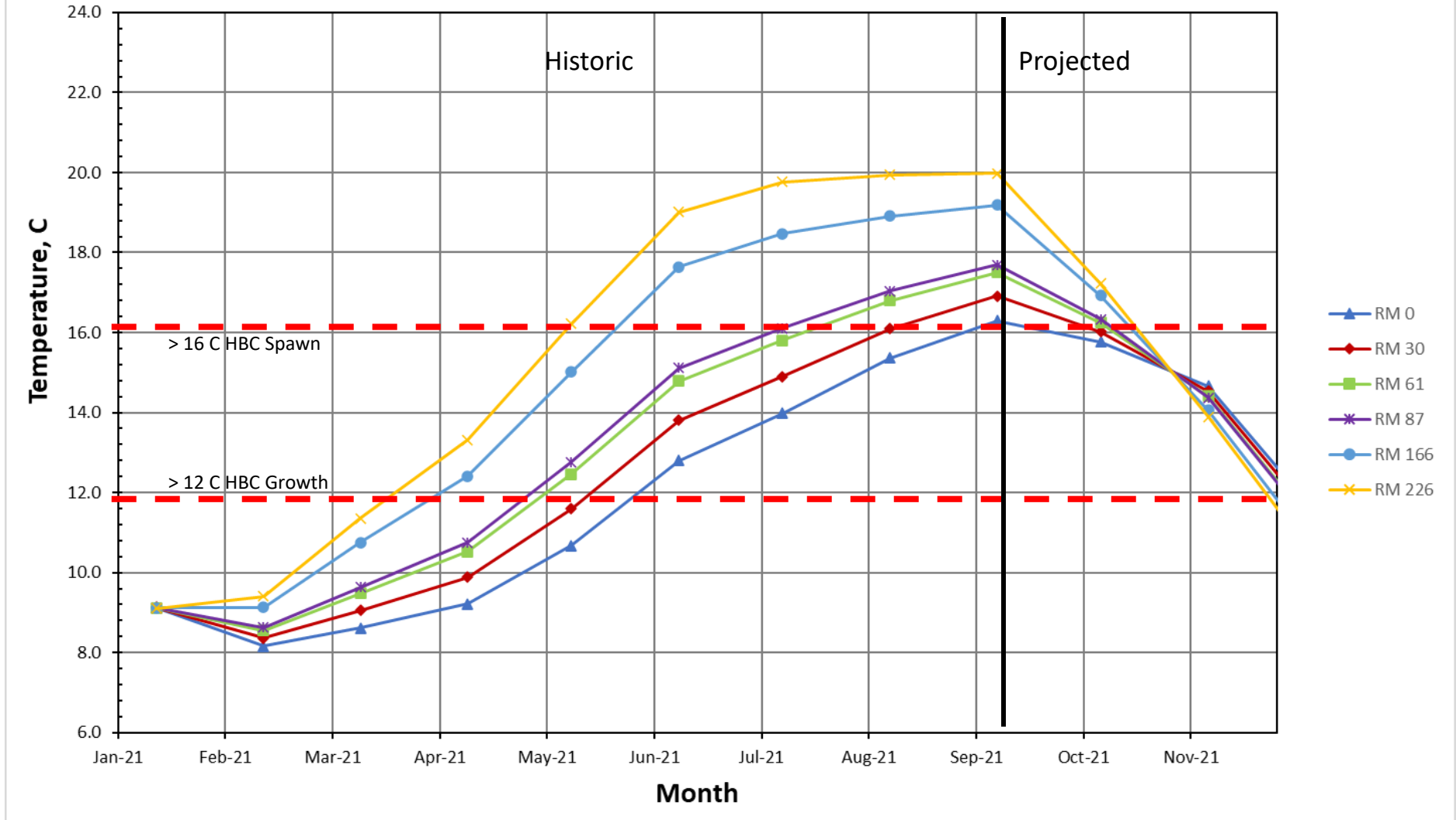


Lake Powell Release Temperature Projected Temperature based on Sep 2021 Forecast

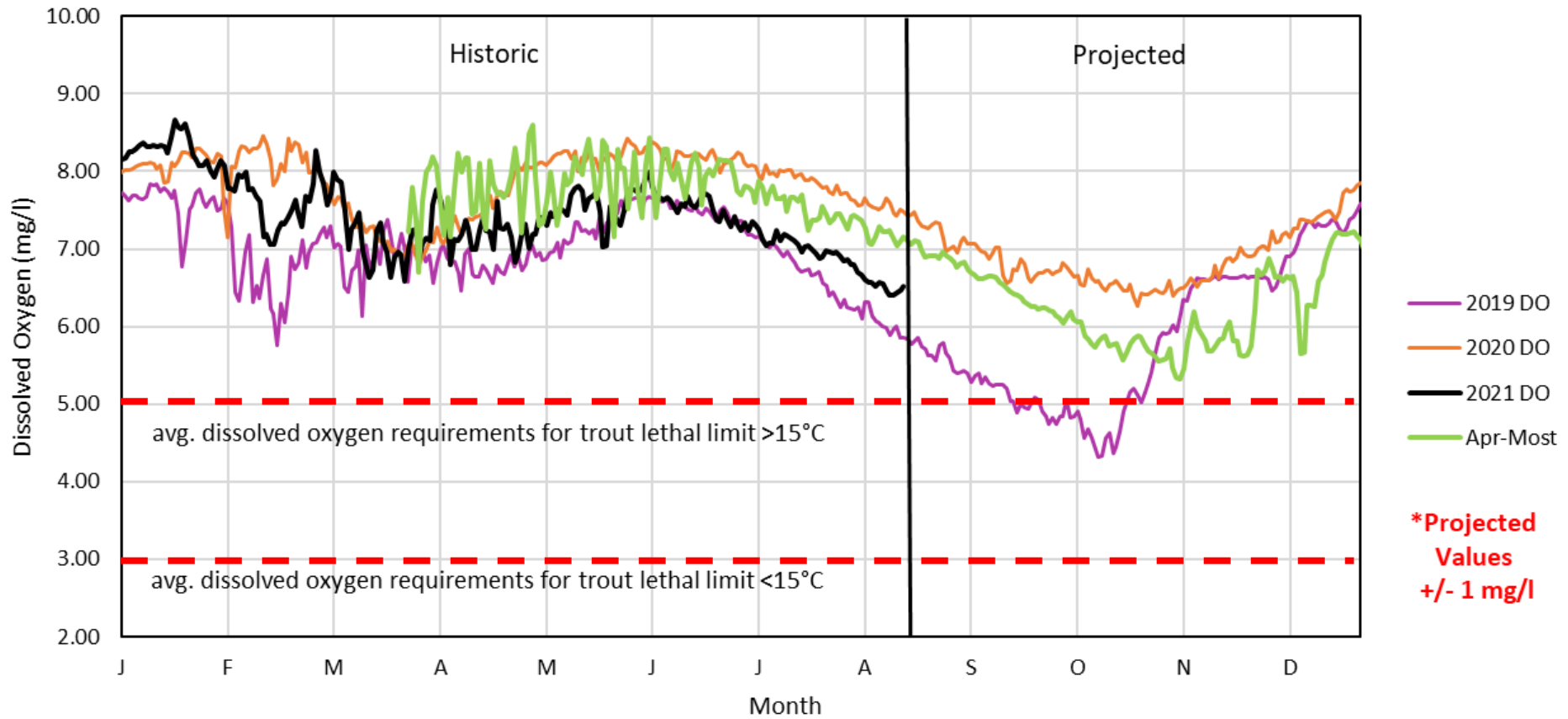


Colorado River, Grand Canyon Water Temperatures

Projections based on August 2021, Most Probable Hydrology (Dibble 2020)



DO Concentration at Glen Canyon Dam years 2019, 2020, and 2021



Questions?



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