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GCDAMP Technical Management Work Group

Basin Hydrology, Operations and Water Quality

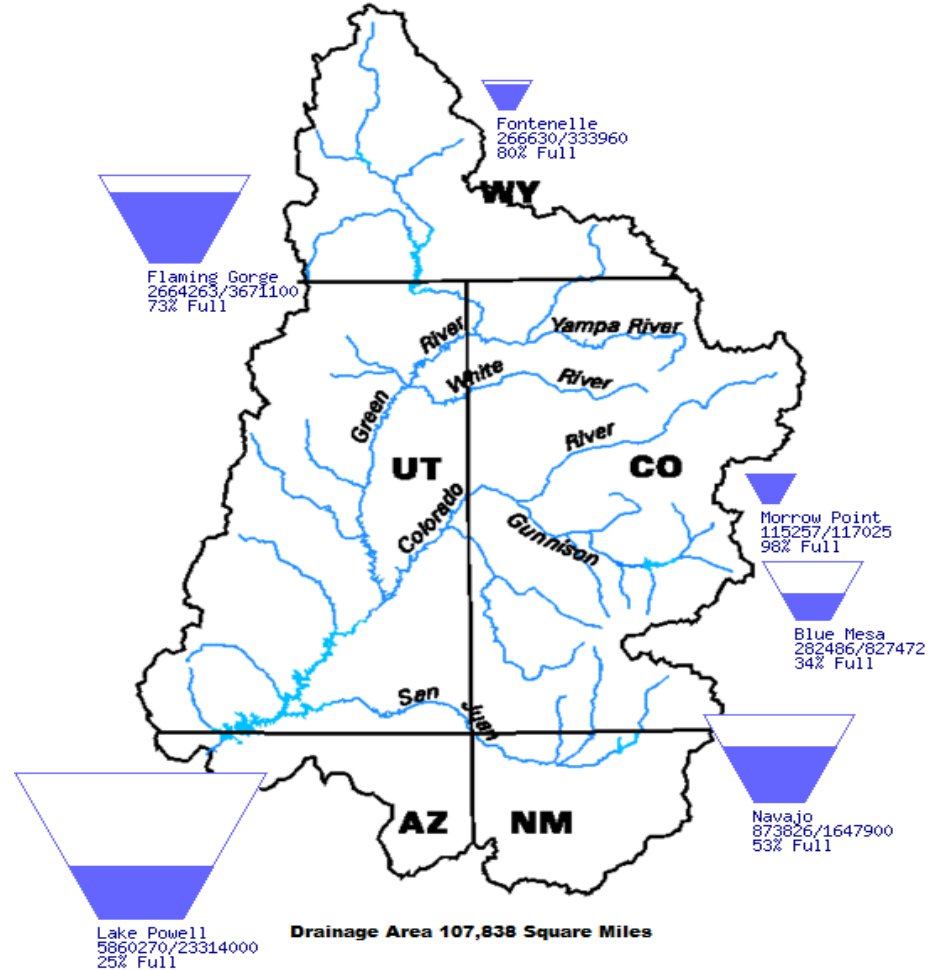
October 11, 2022

Upper Basin Storage (as of October 11, 2022)

Data Current as of:
10/10/2022

Upper Colorado River Drainage Basin

Reservoir	Percent Current Live Storage	Current Live Storage (maf)	Live Storage Capacity (maf)	Elevation (feet)
Fontenelle	81	0.27	0.33	6,497.47
Flaming Gorge	73	2.67	3.67	6,012.75
Blue Mesa	35	0.29	0.83	7,445.66
Navajo	53	0.87	1.65	6,020.85
Lake Powell	25	5.85	23.31	3,530.21
UC System Storage	34	10.08	29.79	
Total System Storage	33	19.55	58.48	



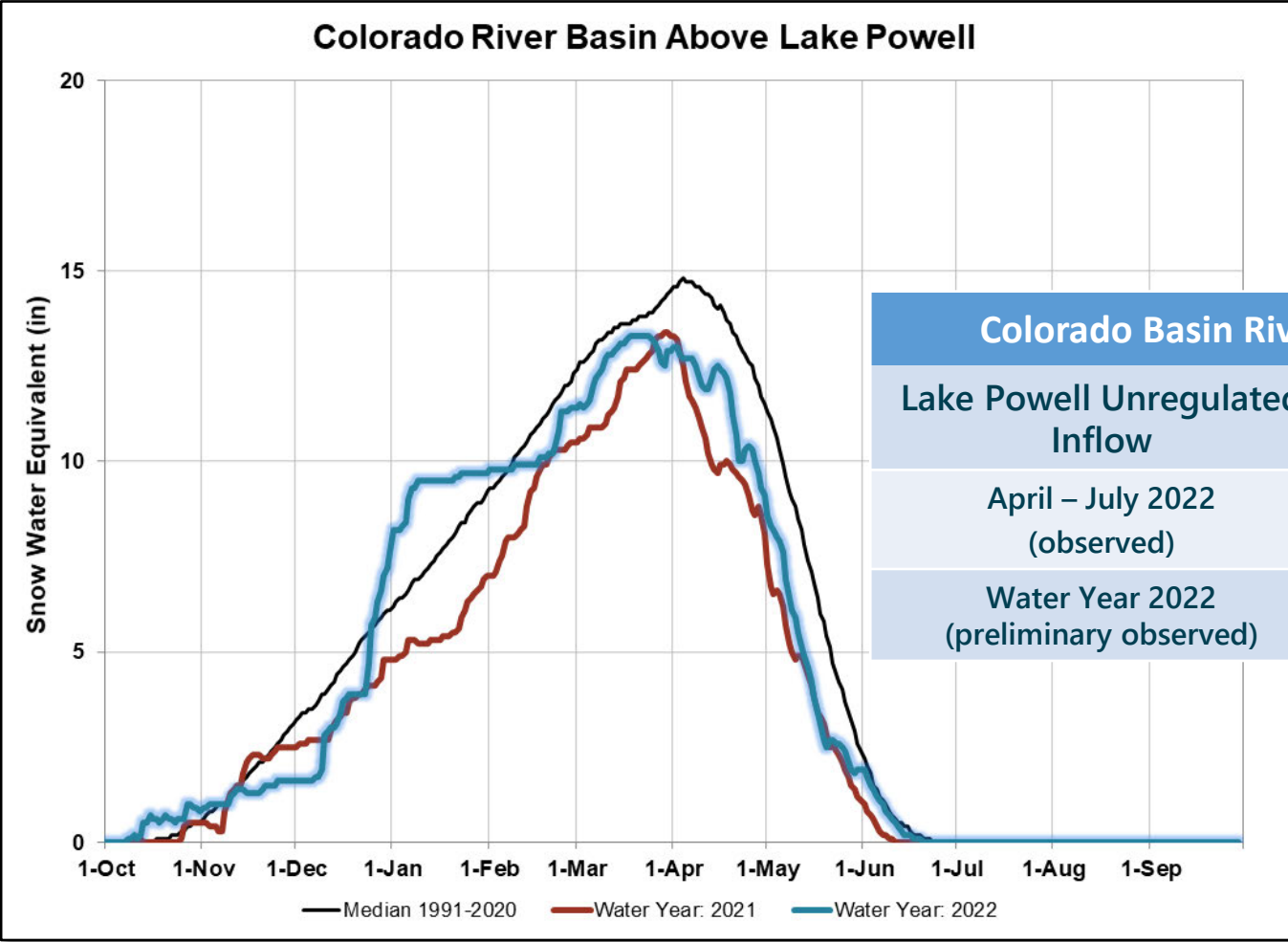
Water Year Snowpack and Precipitation^{1,2,3} as of October 11, 2022

Colorado River Basin above Lake Powell

Water Year 2022
Precipitation
(observed)
101%

Water Year 2023
Precipitation
(year-to-date)
91% of average

Current Snowpack
NA% of median



¹Percent of normal precipitation is based on an arithmetic mean, or average; percent of normal snowpack is based on the median value for a given date.

²Statistics are based on the 30-year period of record from 1991-2020.

³Precipitation values may vary significantly from week-to-week this early in the water year.



Most Probable – Observed and October Final Water Years 2022 and 2023

April – July 2022
Observed Unregulated Inflow

Reservoir	Inflow (kaf)	Percent of Avg ¹
Fontenelle	456	62
Flaming Gorge	552	57
Blue Mesa	431	68
Navajo	381	60
Powell	3,750	59

Water Year 2022
Observed Unregulated Inflow

Reservoir	Inflow (kaf)	Percent of Avg ¹
Fontenelle	744	69
Flaming Gorge	900	64
Blue Mesa	639	71
Navajo	574	63
Powell	6,084	63

Water Year 2023
Unregulated Inflow Forecast
as of October 1, 2022

Reservoir	Inflow (kaf)	Percent of Avg ¹
Fontenelle	930	87
Flaming Gorge	1,215	86
Blue Mesa	820	91
Navajo	790	87
Powell	8,100	84

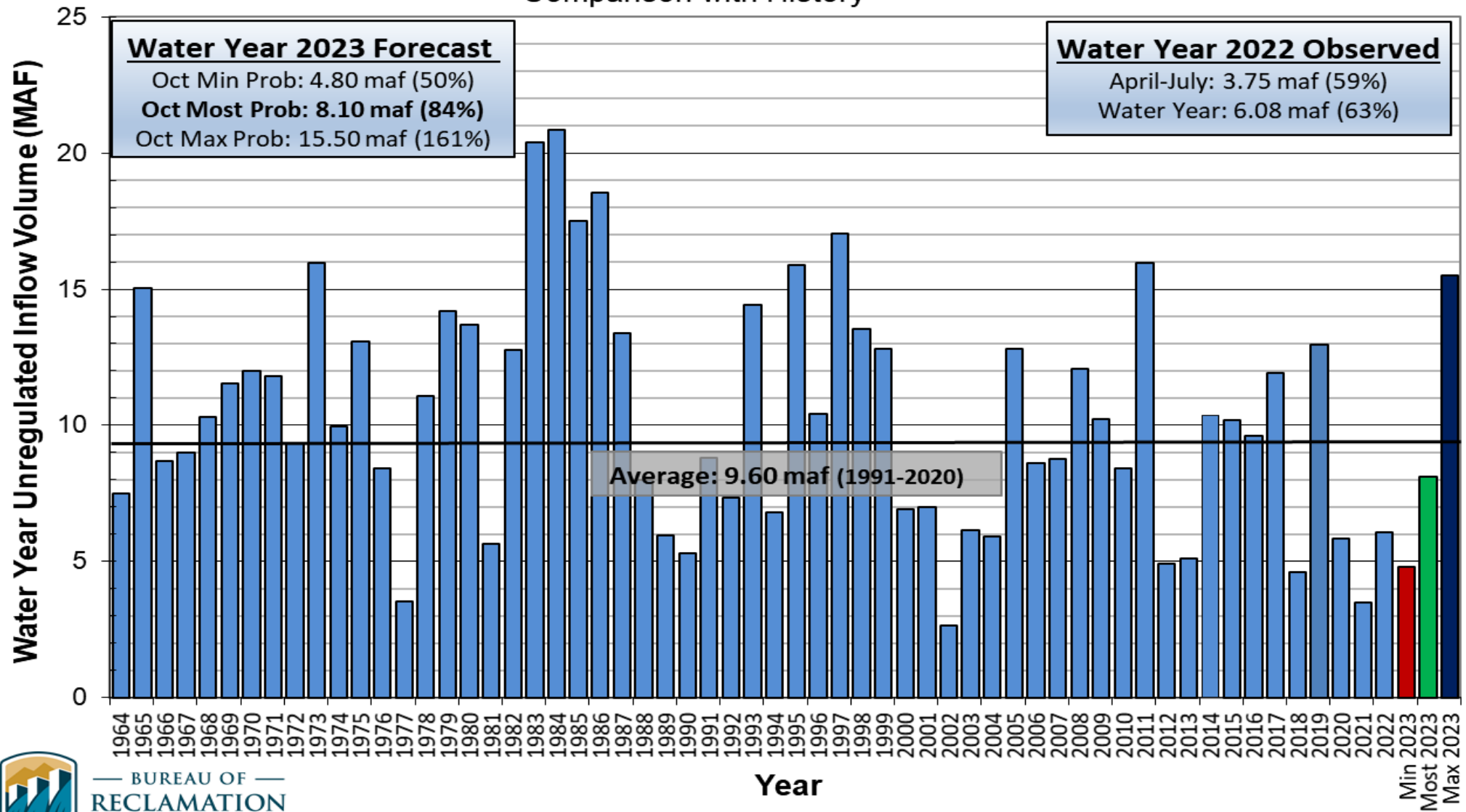
¹Averages are based on the 1991 through 2020 period of record.



Lake Powell Unregulated Inflow

Water Year 2023 Forecast (issued October 4)

Comparison with History



Upper Basin DROA Initial Unit Drought Response

Releases started in July 2021 and finished October 2021

- January 2022 minimum probable model elevations were below 3,525 feet within 24 month
- Continued drought conditions exacerbated already parched soil moisture conditions
- May 2022 most probable elevations were below 3,525 feet
- Continued below average inflows decreased available water in the San Juan Basin

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

DROA Releases for the December 24MS Model Run

	Jul	Aug	Sep	Oct	Nov	Dec	
	(kaf)	(kaf)	(kaf)	(kaf)	(kaf)	(kaf)	Sum
Flaming Gorge	12	45	44	24	0	0	125
Blue Mesa	0	17	16	3	0	0	36
Navajo	0	0	0	0	0	0	0
Sum:	12	62	60	27	0	0	161



Upper Basin Drought Response Actions

- The Bureau of Reclamation announced on May 3, 2022, two separate urgent drought response actions that will help prop up Lake Powell by nearly 1 million acre-feet (maf) of water over the next 12 months (May 2022 through April 2023). To protect Lake Powell, more water will flow into the lake from upstream reservoirs and less water will be released downstream:
 - Under a Drought Contingency Plan adopted in 2022, approximately 500 thousand acre-feet (kaf) of water will come from Flaming Gorge Reservoir, located approximately 455 river miles upstream of Lake Powell (2022 Plan).
 - For more information: <https://www.usbr.gov/uc/DocLibrary/Plans/20220429-2022DroughtResponseOperationsPlan-ApprovalMemo-508-DOI.pdf>.
 - Another 480 kaf will be left in Lake Powell by reducing Glen Canyon Dam's annual release volume from 7.48 maf to 7.00 maf (GC Operational Adjustment), in accordance with Sections 6 and 7.D of the 2007 Interim Guidelines.
 - For more information: <https://www.usbr.gov/uc/DocLibrary/Plans/20220503-2022DROA-GlenCanyonDamOperationsDecisionLetter-508-DOI.pdf>



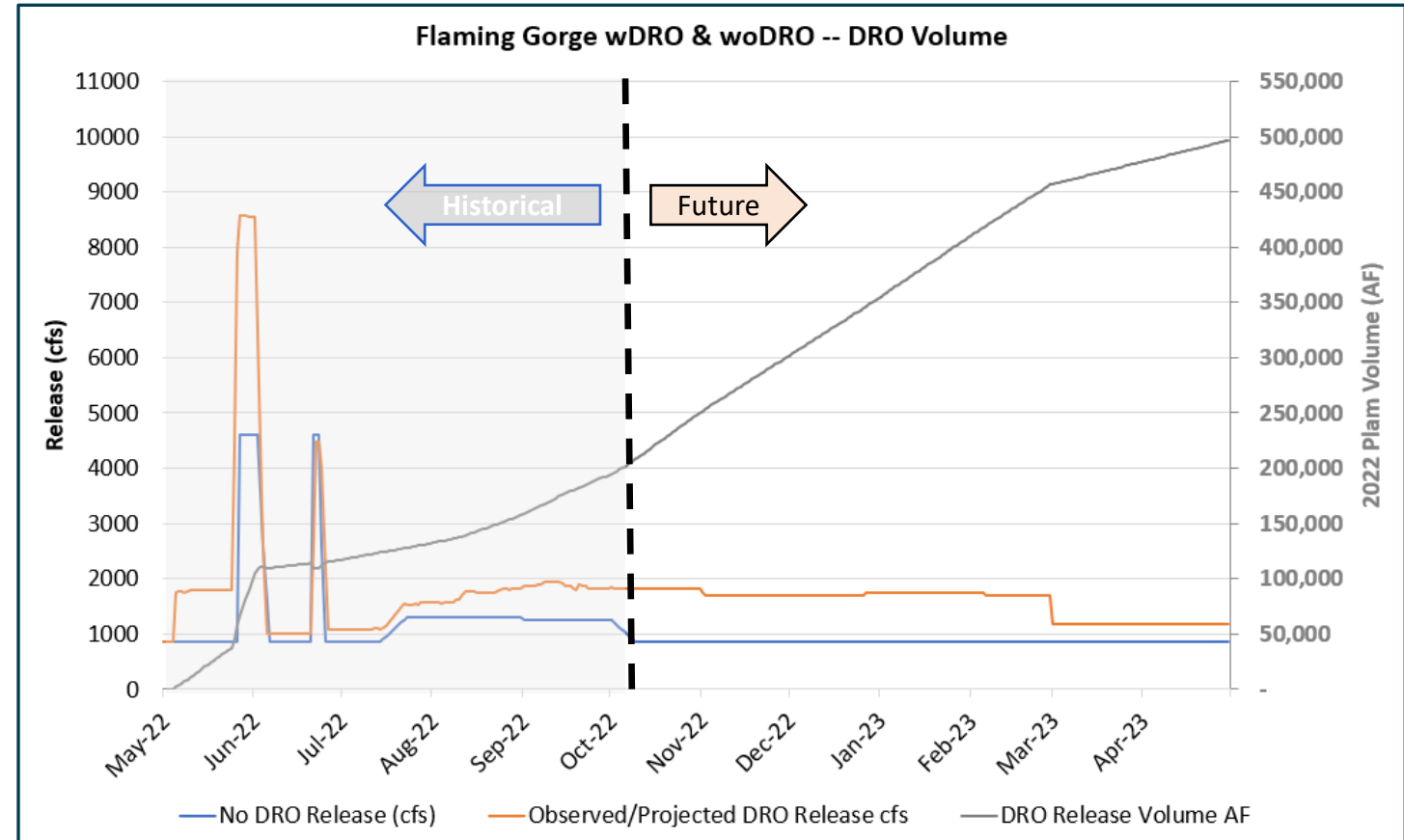
Drought Response Operations Agreement (DROA)

DROA Volumes Released¹

Reservoir	2021 DROA Volume (kaf)	2022 DROA Volume (kaf)	Total DROA Volume (kaf)
Flaming Gorge	125	500	625
Blue Mesa	36	0	36
Navajo	0	0	0
Volume in Powell	161	500	661

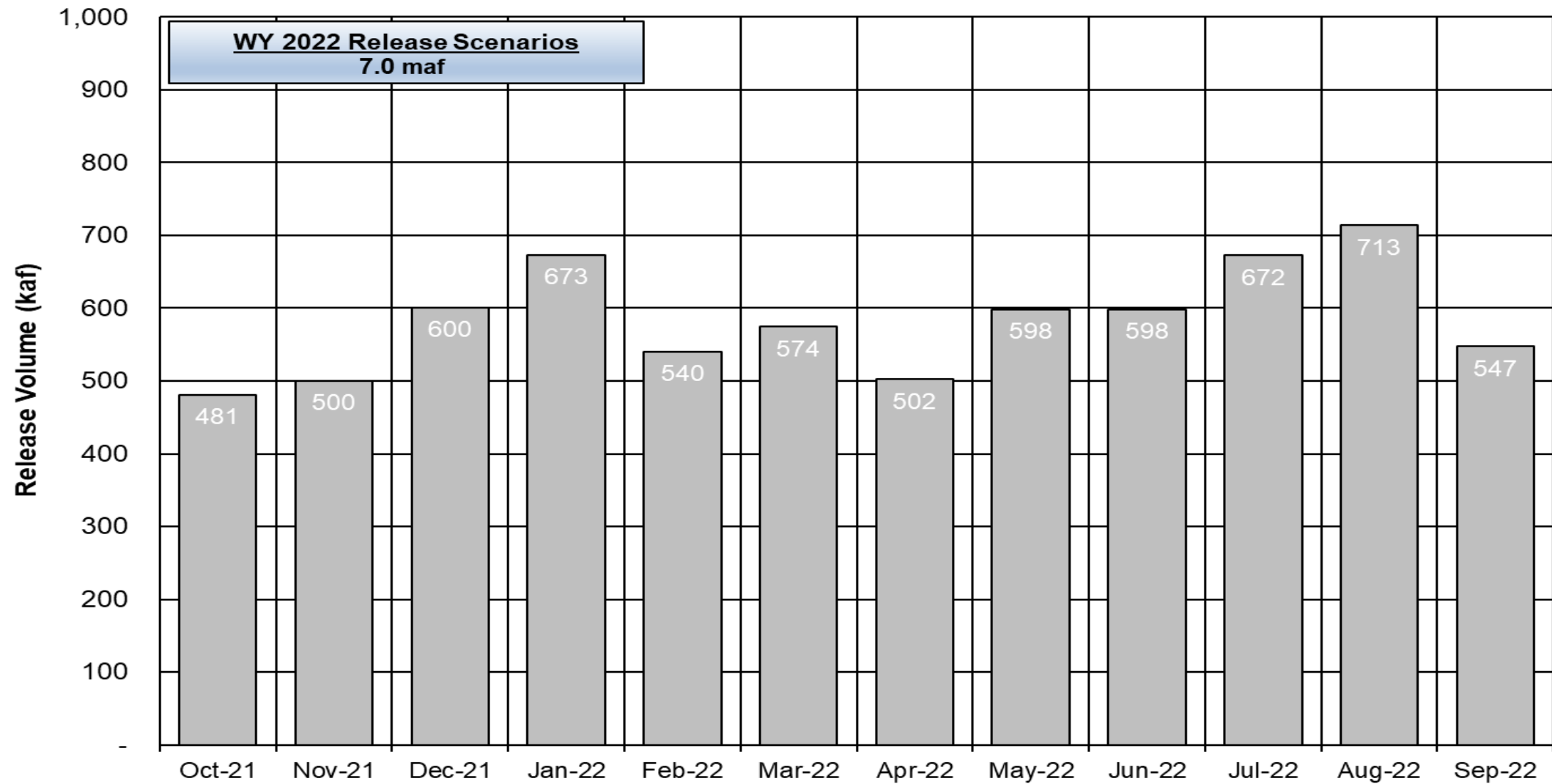
¹DROA operational year is from May through April.

Flaming Gorge 2022 Plan Daily Releases



Potential Lake Powell Monthly Release Volume Distribution

Release Scenarios for Water Year 2022



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





August and September 24- Month Study Projections

Upper Colorado Basin
Region Operations



Lake Powell & Lake Mead Operational Table

Lake Powell Operational Tier Determination Run (aka "Exhibit Run") with an 8.23 maf Release^{1,2}

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			1,145	Normal or ICS Surplus Condition Deliver ≥ 7.5 maf	15.9
	Mid-Elevation Release Tier Release 7.48 maf; if Lake Mead < 1,025 feet, release 8.23 maf	9.5	1,105		11.9
			1,075	Shortage Condition Deliver 7.167 ⁴ maf	9.4
	Lower Elevation Balancing Tier Balance contents with a min/max release of 7.0 and 9.5 maf	5.9	1,050		7.5
3,525				Shortage Condition Deliver 7.083 ⁵ maf	
		4.0	1,025	Shortage Condition Deliver 7.0 ⁶ maf Further measures may be undertaken ⁷	5.8
3,490			1,000		4.3
3,370			895		0

**3,505.66 ft
Jan 1, 2023
Projection**

**1,047.61 ft
Jan 1, 2023
Projection**

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 operational tier determinations are based on August 2021 24-Month Study projections will be documented in the draft 2023 AOP.

² The operating determination for WY 2023 is based on a projected elevation "as if" the 0.48 maf were delivered to Lake Mead with a Glen Canyon Dam release pattern of 8.23 maf.



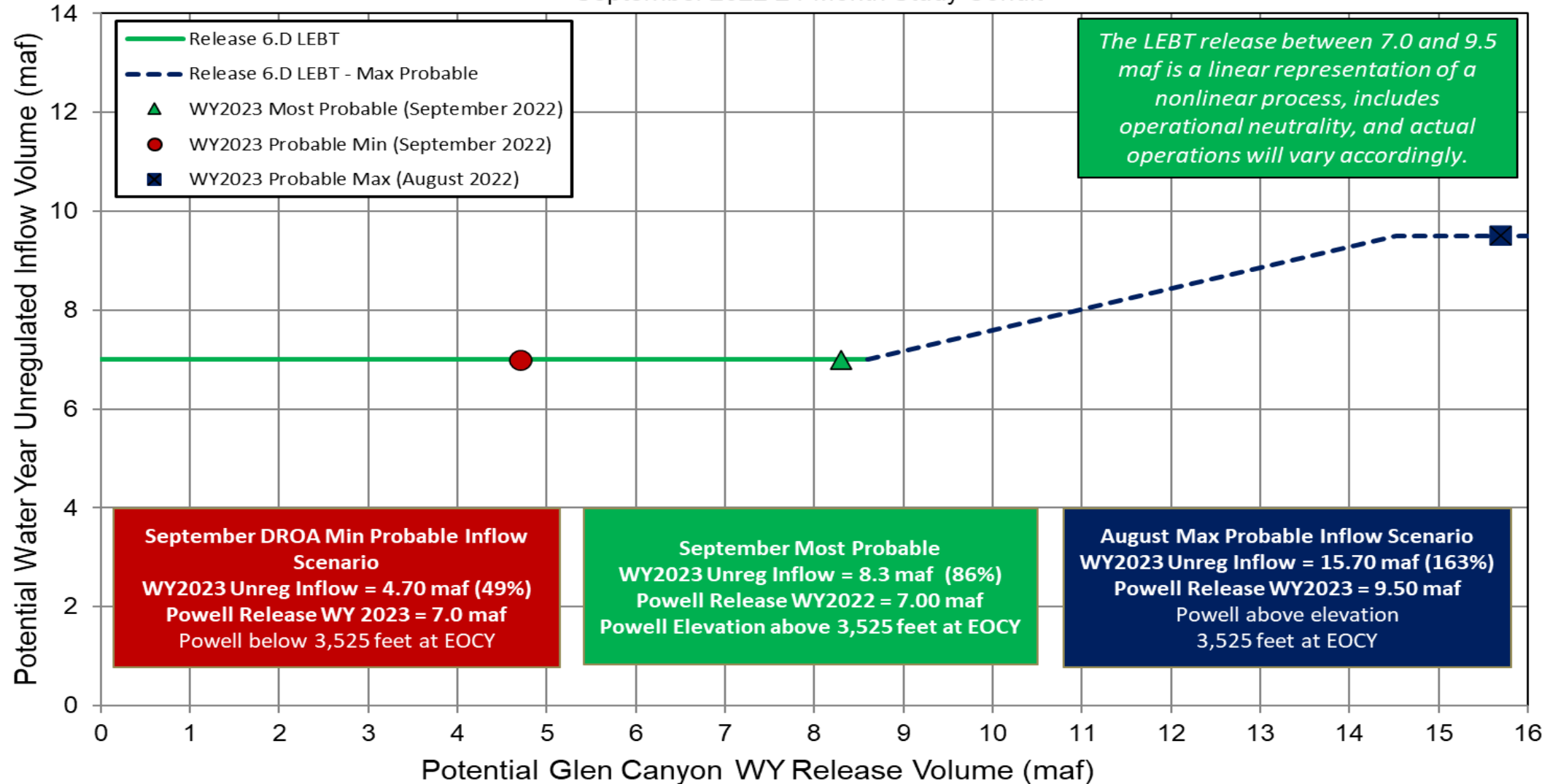
Upper Basin Reservoir Operations in Water Year 2023

- Lake Powell will be operated consistent with the 2007 Interim Guidelines, the Upper Basin Drought Response Operations Agreement and Upper Basin Records of Decision
- Lake Powell's projected end of calendar year (CY) 2022 "tier determination" elevation in the August 2022 24-Month Study determines Lake Powell's operating tier in CY 2023
 - Lake Powell will operate in the Lower Elevation Balancing Tier where Lake Powell and Lake Mead will balance contents with Glen Canyon Dam release volumes no less than 7.0 maf and no more than 9.5 maf
- Consistent with the provisions of the 2007 Interim Guidelines, and to preserve the benefits to Glen Canyon Dam facilities from 2022 Operations into 2023 and 2024, Reclamation will consult with the Basin States on monthly and annual operations. Reclamation will also ensure all appropriate consultation with Basin Tribes, the Republic of Mexico, other federal agencies, water users and non-governmental organizations with respect to implementation of these monthly and annual operations.
 - The Glen Canyon Dam annual release has initially been set to 7.00 maf, and in April 2023 Reclamation will evaluate hydrologic conditions to determine if balancing releases may be appropriate under the conditions established in the 2007 Interim Guidelines;
 - Balancing releases will be limited (with a minimum of 7.00 maf) to protect Lake Powell from declining below elevation 3,525 feet at the end of December 2023;
 - Balancing releases will take into account operational neutrality of the 0.480 maf that was retained in Lake Powell under the May 2022 action1. Any Lake Powell balancing release volume will be calculated as if the 0.480 maf had been delivered to Lake Mead in WY 2022; and
 - The modeling approach for WY 2023 will apply to 2024.



Lake Powell Release Scenarios under Section 6.D, Operational Neutrality and WY2023 Protect Powell Elevation 3,525 ft

Water Year 2023 Release Volume as a Function of the Lower Elevation Balancing Tier based on August and September 2022 24-Month Study Condit



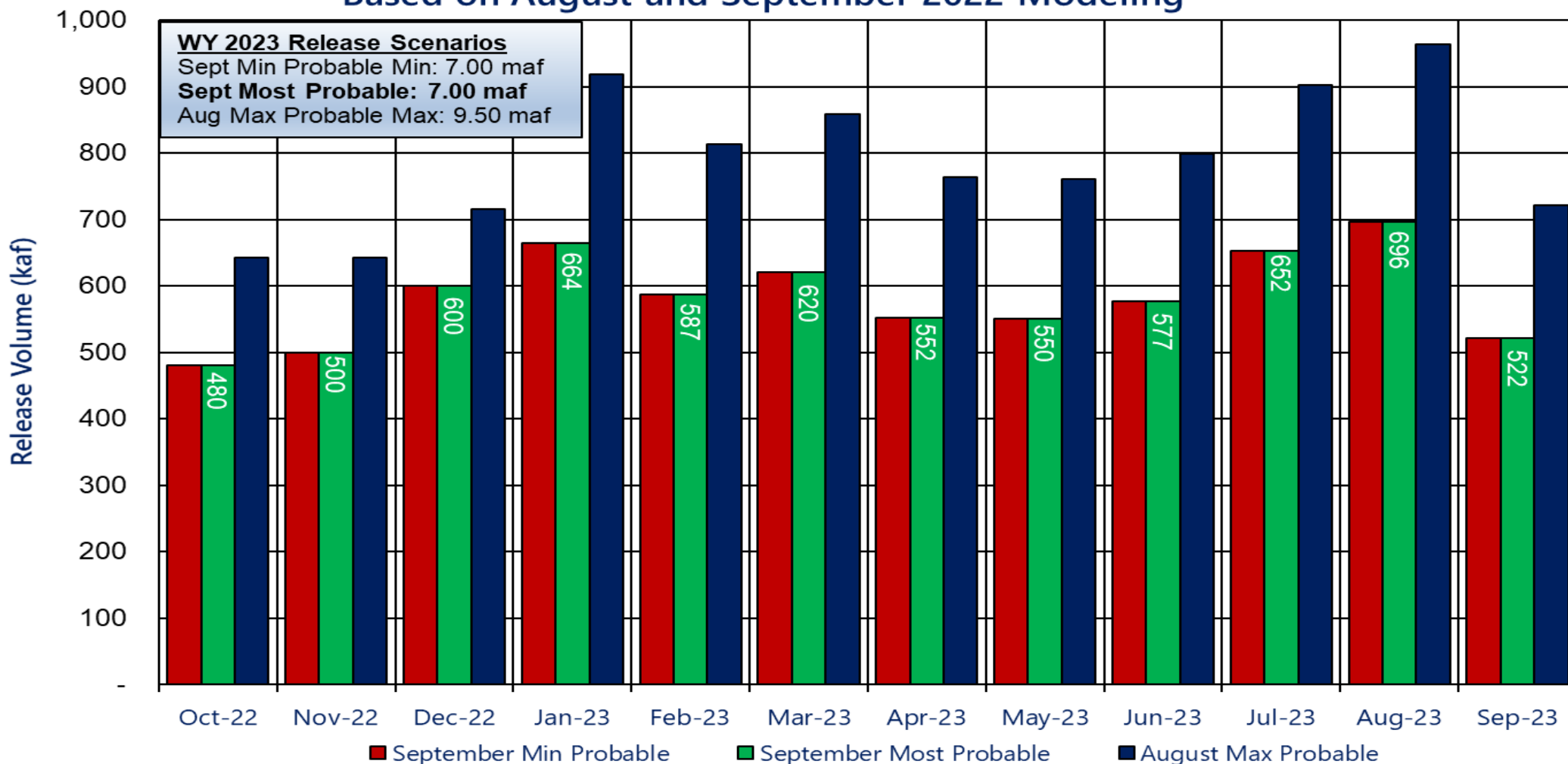
*The Drought Response Operations Agreement (DROA) can be found here: <https://www.usbr.gov/dcp/finaldocs.html>



Potential Lake Powell Monthly Release Volume Distribution

Release Scenarios for Water Year 2023

Based on August and September 2022 Modeling

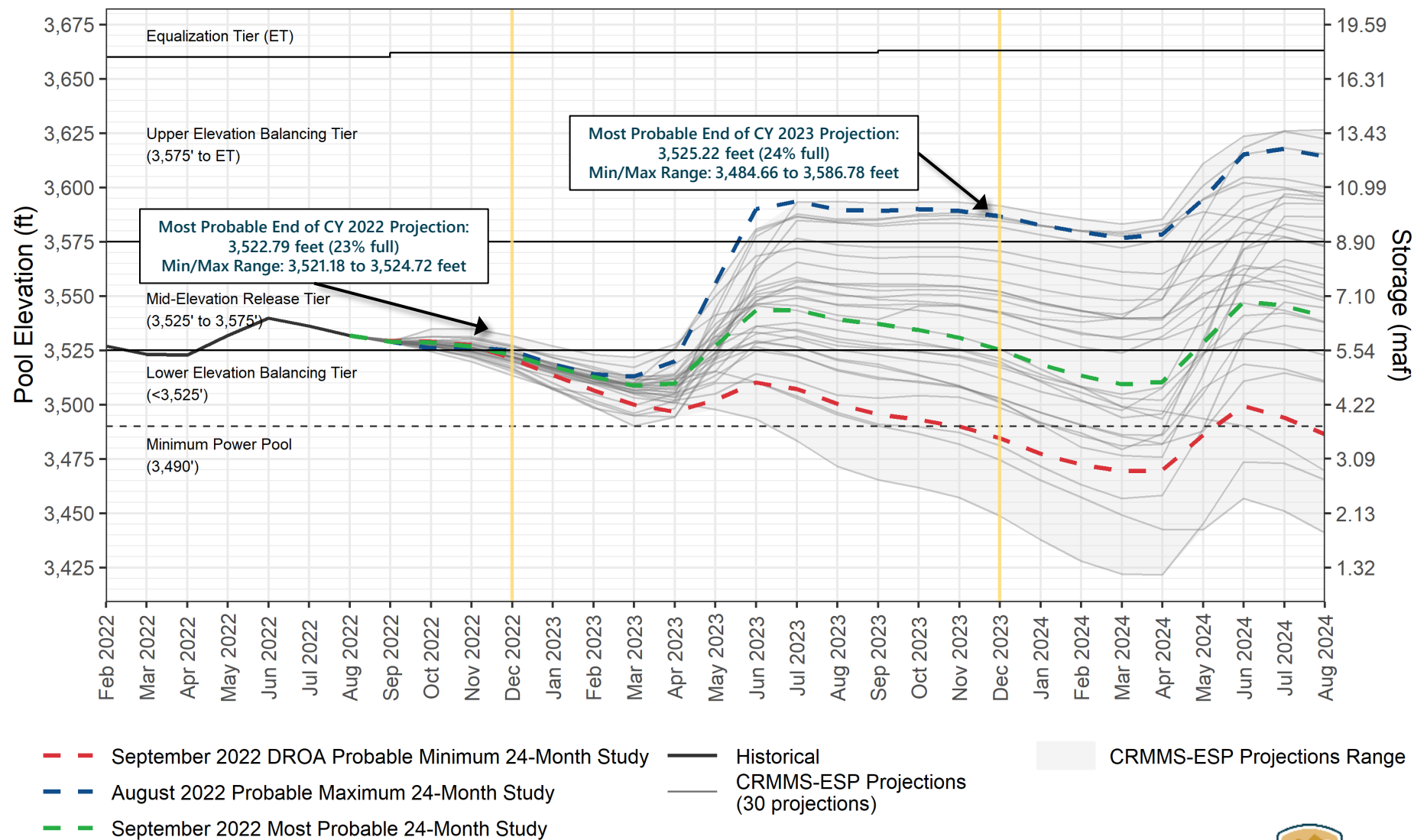


Consistent with the provisions of the 2007 Interim Guidelines, and to preserve the benefits to Glen Canyon Dam facilities from 2022 Operations into 2023 and 2024, Reclamation will consult with the Basin States on monthly and annual operations. Reclamation will also ensure all appropriate consultation with Basin Tribes, the Republic of Mexico, other federal agencies, water users and non-governmental organizations with respect to implementation of these monthly and annual operations.



Lake Powell End-of-Month Elevations¹

CRMMS Projections from August and September 2022



¹ Projected Lake Powell end-of-month physical elevations from the latest CRMMS-ESP and 24-Month Study inflow scenarios.



Comparison of Current (August 2022) and Last Published (May 2022) CRMMS-ESP 5-Year Projections

Chance of Lake Powell Falling Below Critical Reservoir Elevations in any Month of the Water Year (WY)

	Run	WY 2023	WY 2024	WY 2025	WY 2026	WY 2027 ¹
Lake Powell less than 3,525 feet	May 2022	90%	50%	37%	30%	23%
	August 2022	100%	50%	37%	30%	30%
	Difference	10%	0%	0%	0%	7%
Lake Powell less than 3,490 feet (minimum power pool)	May 2022	3%	23%	17%	23%	13%
	August 2022	10%	30%	20%	17%	13%
	Difference	7%	7%	3%	-6%	0%
Lake Powell less than 3,375 feet (dead pool = 3,370 feet)	May 2022	0%	0%	0%	0%	0%
	August 2022	0%	0%	0%	0%	0%
	Difference	0%	0%	0%	0%	0%

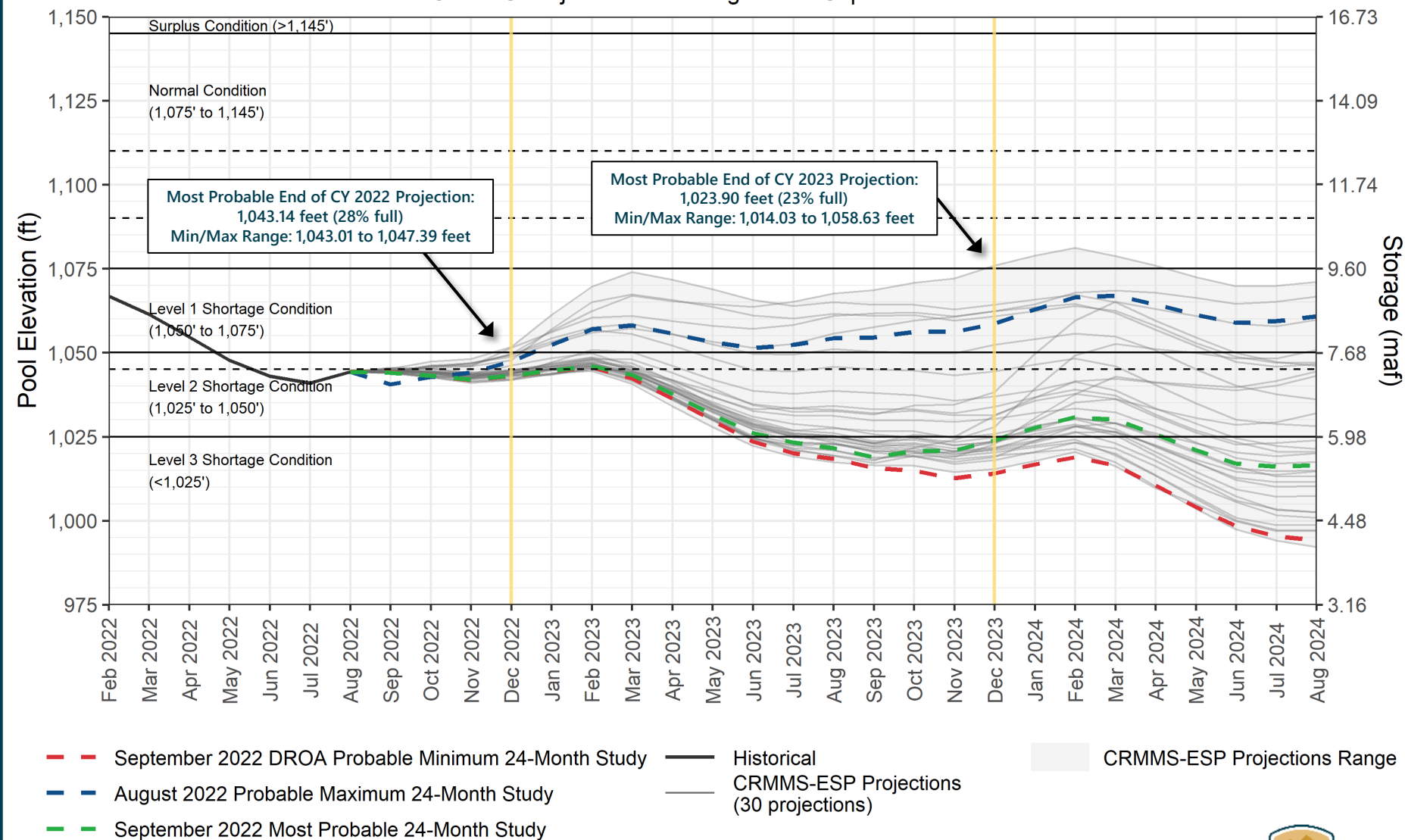
All results are computed based on projected physical elevations for Lake Powell.

¹ For modeling purposes, simulated years beyond 2026 assume a continuation of the 2007 Interim Guidelines, the 2019 Colorado River Basin Drought Contingency Plans, and Minute 323, including the Binational Water Scarcity Contingency Plan. Except for certain provisions related to ICS recovery and Upper Basin demand management, operations under these agreements are in effect through 2026. Reclamation anticipates beginning a process in early 2023 to develop operations for post-2026, and the modeling assumptions described here are subject to change for the analysis to be used in that process.



Lake Mead End-of-Month Elevations¹

CRMMS Projections from August and September 2022



¹ Projected Lake Mead end-of-month physical elevations from the latest CRMMS-ESP and 24-Month Study inflow scenarios.



Comparison of Current (August 2022) and Last Published (May 2022) CRMMS-ESP 5-Year Projections

Chance of Lake Mead Falling Below Critical Reservoir Elevations in any Month of the Calendar Year

	Run	2023	2024	2025	2026	2027 ¹
Lake Mead less than 1,020 feet	May 2022	40%	50%	47%	50%	53%
	August 2022	47%	57%	57%	60%	57%
	Difference	7%	7%	10%	10%	4%
Lake Mead less than 1,000 feet	May 2022	0%	13%	20%	20%	13%
	August 2022	0%	23%	20%	20%	17%
	Difference	0%	10%	0%	0%	4%
Lake Mead less than 950 feet (minimum power pool)	May 2022	0%	0%	0%	3%	3%
	August 2022	0%	0%	0%	7%	3%
	Difference	0%	0%	0%	4%	0%
Lake Mead less than 900 feet (dead pool = 895 feet)	May 2022	0%	0%	0%	0%	0%
	August 2022	0%	0%	0%	0%	0%
	Difference	0%	0%	0%	0%	0%

All results are computed based on projected physical elevations for Lake Mead.

¹ For modeling purposes, simulated years beyond 2026 assume a continuation of the 2007 Interim Guidelines, the 2019 Colorado River Basin Drought Contingency Plans, and Minute 323, including the Binational Water Scarcity Contingency Plan. Except for certain provisions related to ICS recovery and Upper Basin demand management, operations under these agreements are in effect through 2026. Reclamation anticipates beginning a process in early 2023 to develop operations for post-2026, and the modeling assumptions described here are subject to change for the analysis to be used in that process.





Upper Colorado Basin

Hydropower Maintenance



Glen Canyon Dam Power Plant Unit Outage Schedule for WY2023

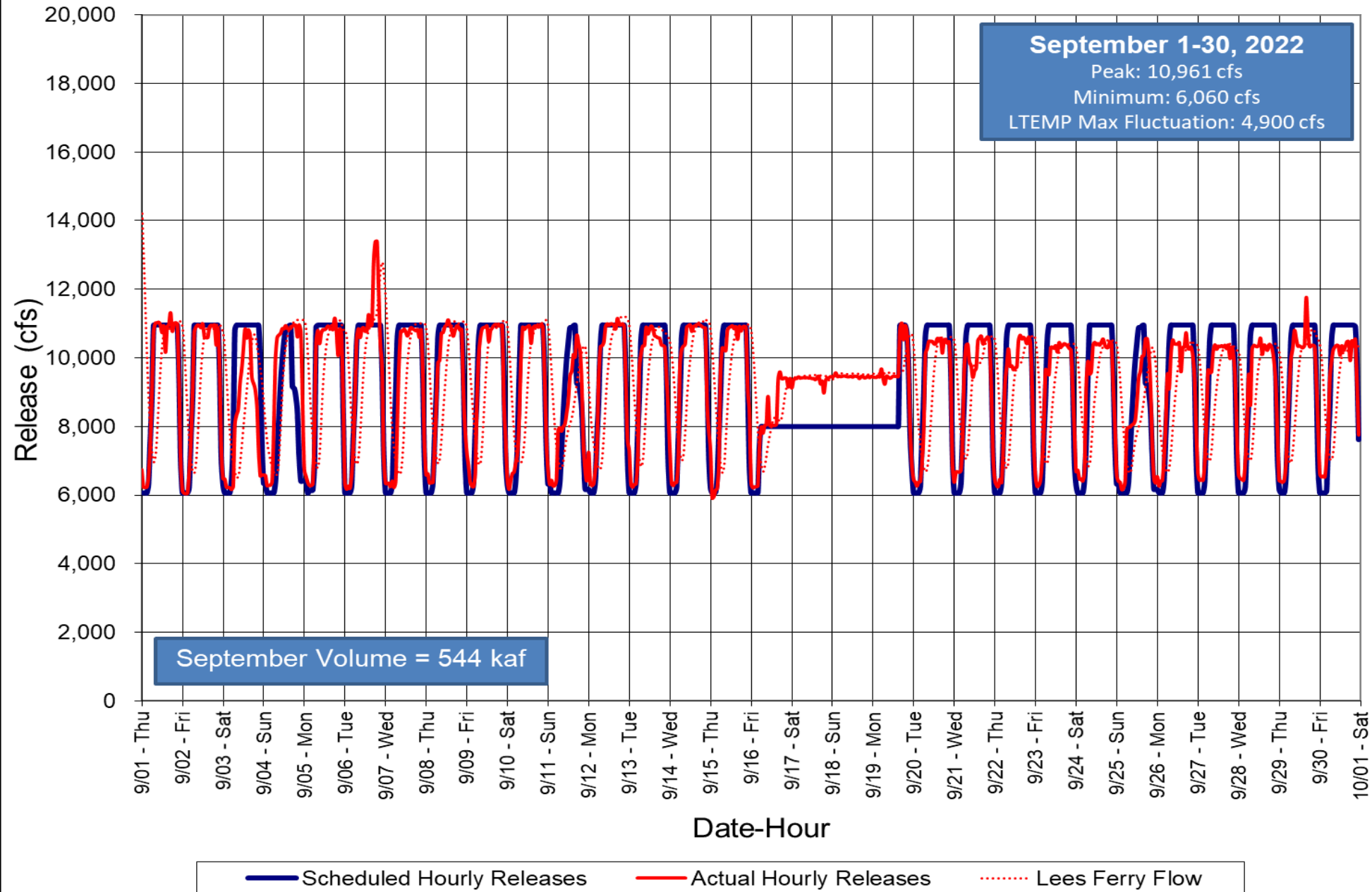
Unit Number	Oct 2022	Nov 2022	Dec 2022	Jan 2023	Feb 2023	Mar 2023	Apr 2023	May 2023	Jun 2023	Jul 2023	Aug 2023	Sep 2023	
1													
2													
3													
4													
5													
6													
7													
8													
Units Available	6	6	8	6	6	4	6	6	6	6	6	4	
Capacity (cfs)	18,200	18,100	24,600	17,800	17,600	11,000	17,500	18,100	18,650	18,650	18,500	11,600	SEP MOST ²
Capacity (kaf/month)	1,120	1,200	1,510	1,200	1,200	740	1,040	1,110	1,110	1,130	1,120	730	SEP MOST
Max (kaf) ¹	643	642	715	919	813	858	764	761	798	902	963	722	9.5 maf
Most (kaf) ¹	480	500	600	664	587	620	552	550	577	652	696	522	7.0 maf
Min (kaf) ¹	480	500	600	664	587	620	552	550	577	652	696	522	7.0 maf
										(updated 08-17-2022)			

1 Projected release, based on September 2022 minimum and most and August 2022 maximum probable Inflow Projections and 24-Month Study model runs.

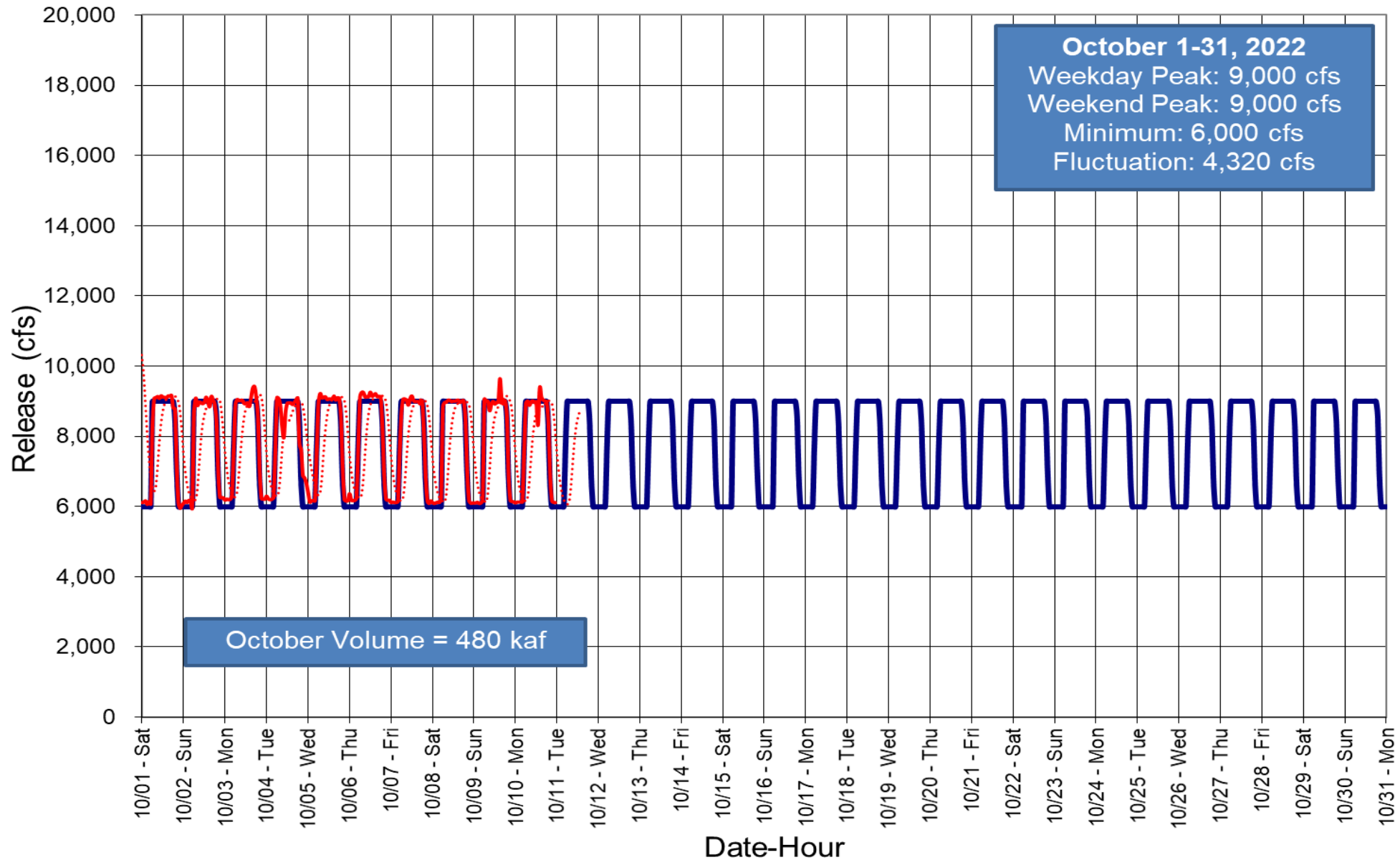
2 Dependent upon availability to shift contingency reserves, which will increase capacity by 30-40MW (3%) at current efficiency.



Glen Canyon Dam Hourly Release Pattern September 2022



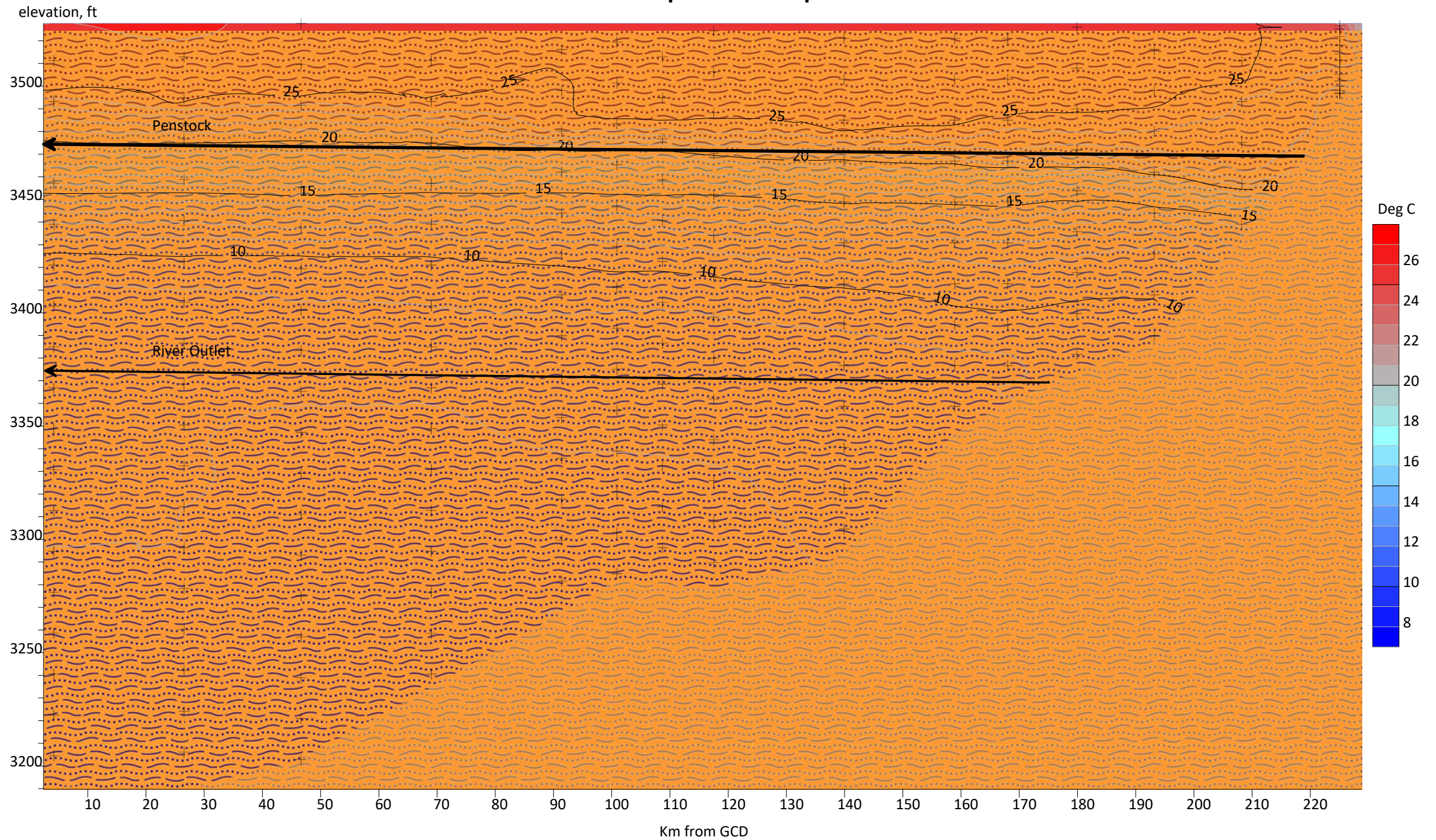
Glen Canyon Dam Hourly Release Pattern October 2022



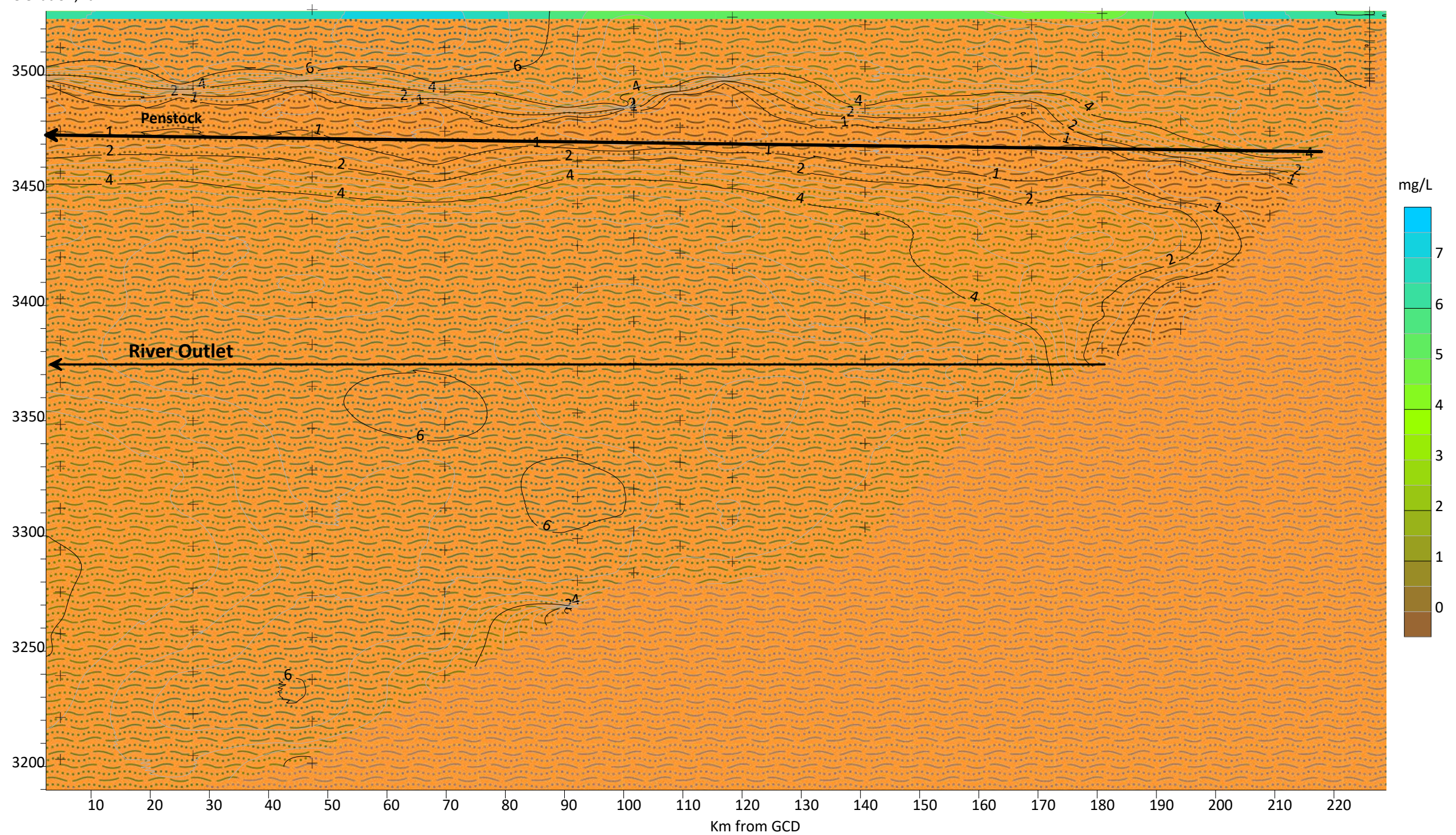
Water Quality



Lake Powell Sept 2022 Temperature



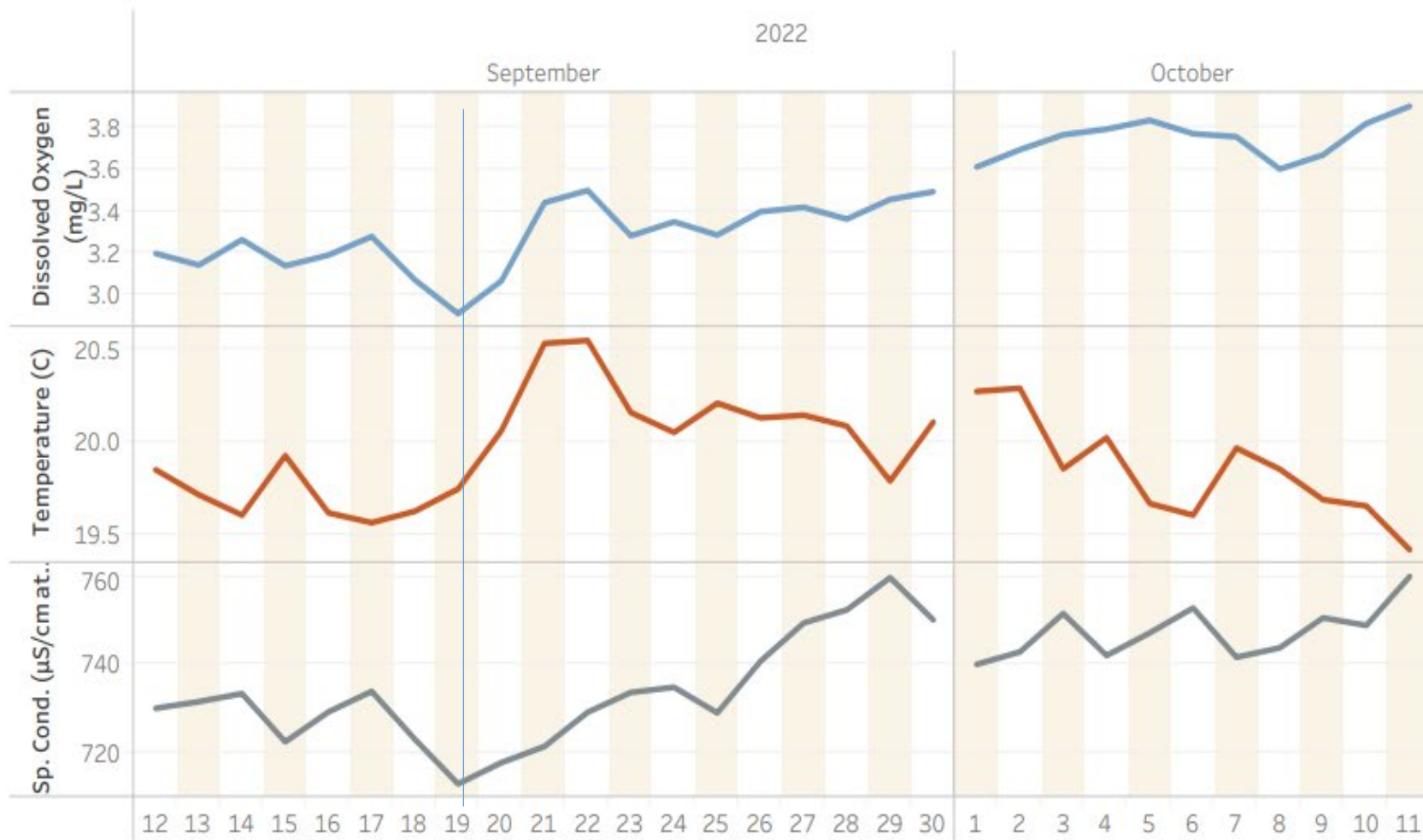
elevation, ft



Daily Water Quality Data at Glen Canyon D..

[Download PDF](#)

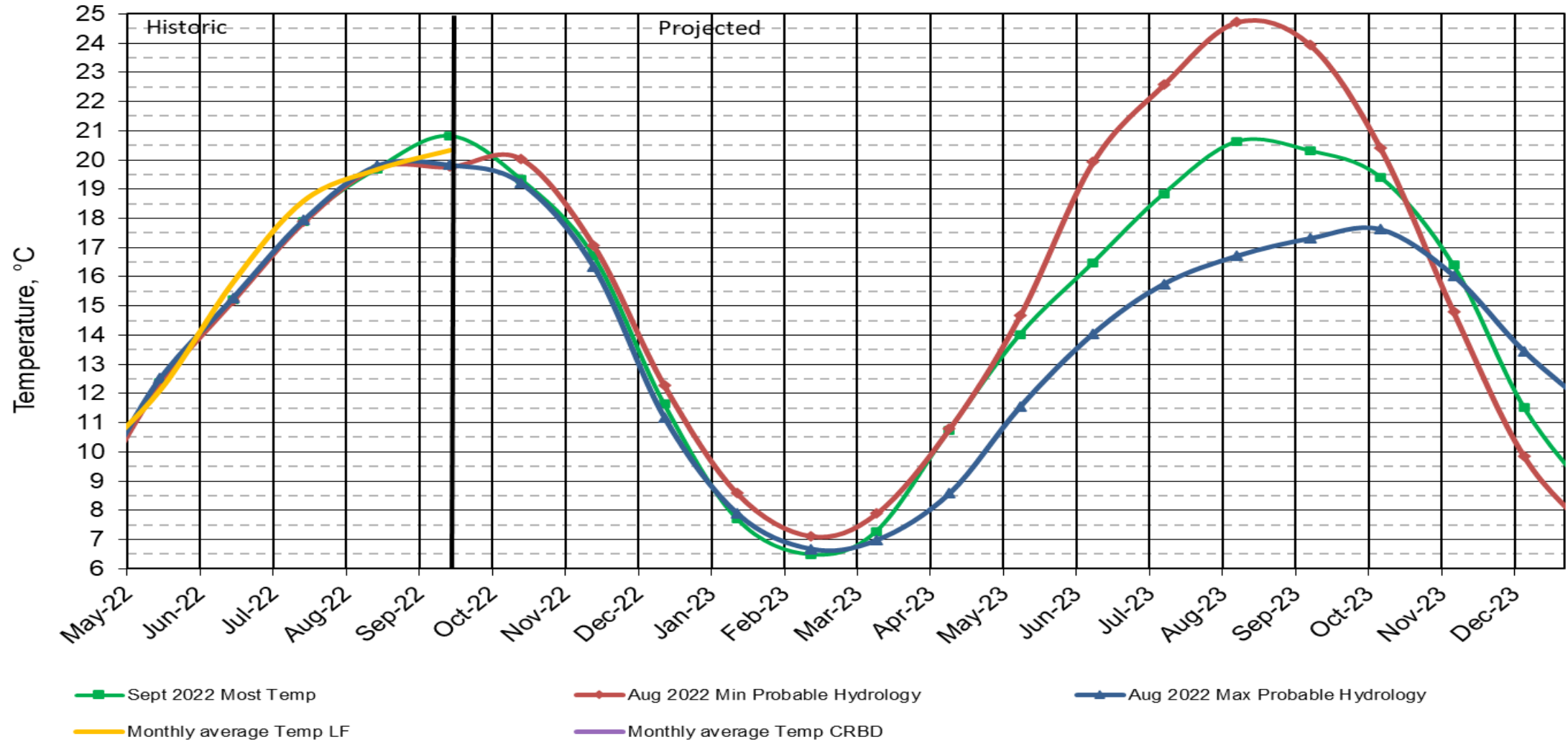
Daily Dissolved Oxygen & Temperature Values



The trends of daily average Dissolved Oxygen, Temperature and Specific Conductance shown for the past 30 days.

Lake Powell Release Temperature

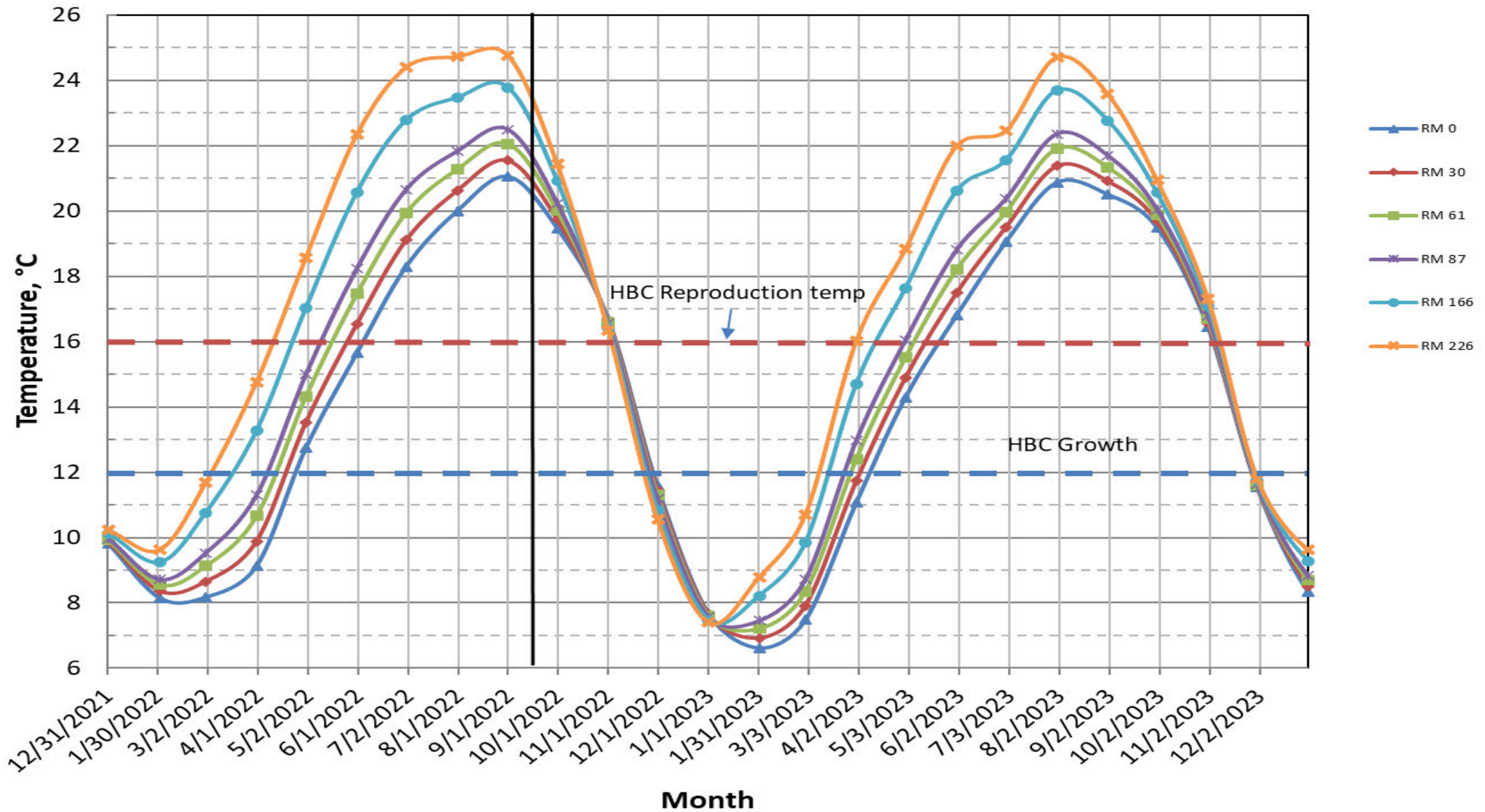
Projected Temperature based on September 2022 Forecast



#Projection start date is based on initial conditions (March 2021)

Colorado River, Grand Canyon Water Temperatures

Projections based on September 2022, Most Probable Hydrology



Questions?



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