BUREAU OF RECLAMATION

Glen Canyon Monthly Operations Call

Basin Hydrology and Operations

September 20, 2023

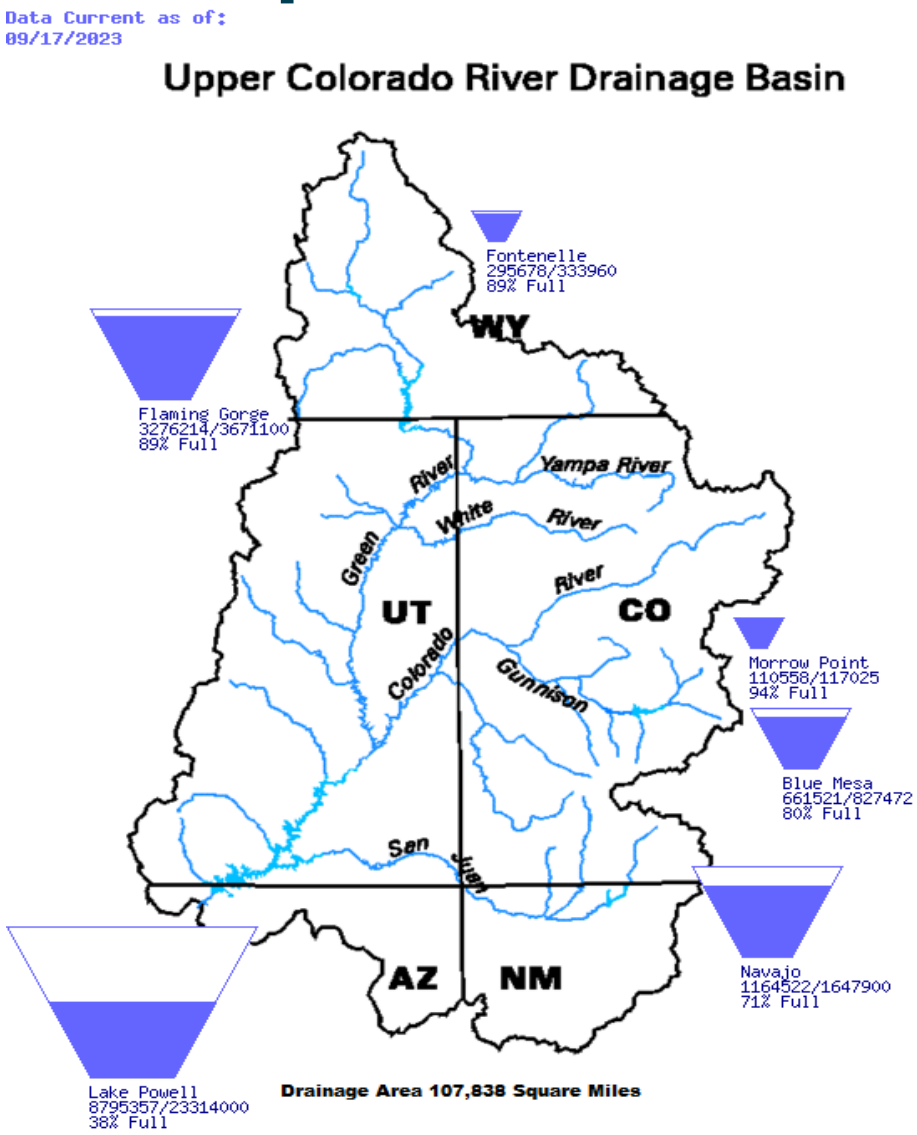
Background

This briefing is being provided consistent with the provision in Attachment B - 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."

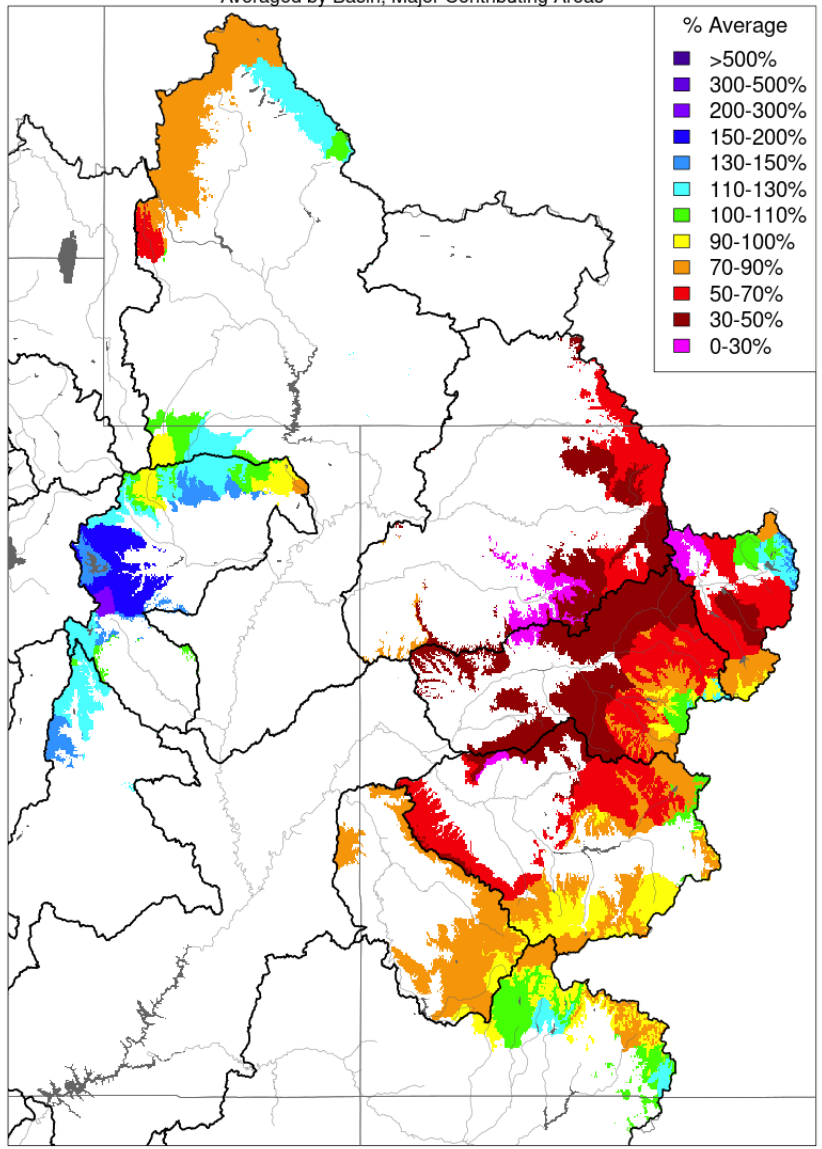
Upper Basin Storage (as of Sept 18, 2023)

Reservoir	Percent Current Live Storage	Current Live Storage (maf)	Live Storage Capacity (maf)	Elevation (feet)
Fontenelle	88	0.29	0.33	6,500.87
Flaming Gorge	89	3.27	3.67	6,030.25
Blue Mesa	80	0.66	0.83	7,500.01
Navajo	71	1.16	1.65	6,049.30
Lake Powell	38	8.79	23.31	3,573.62
UC System Storage	48	14.31	29.93	
System Storage	44	25.46	58.48	



Month to Date Precipitation - September 19 2023

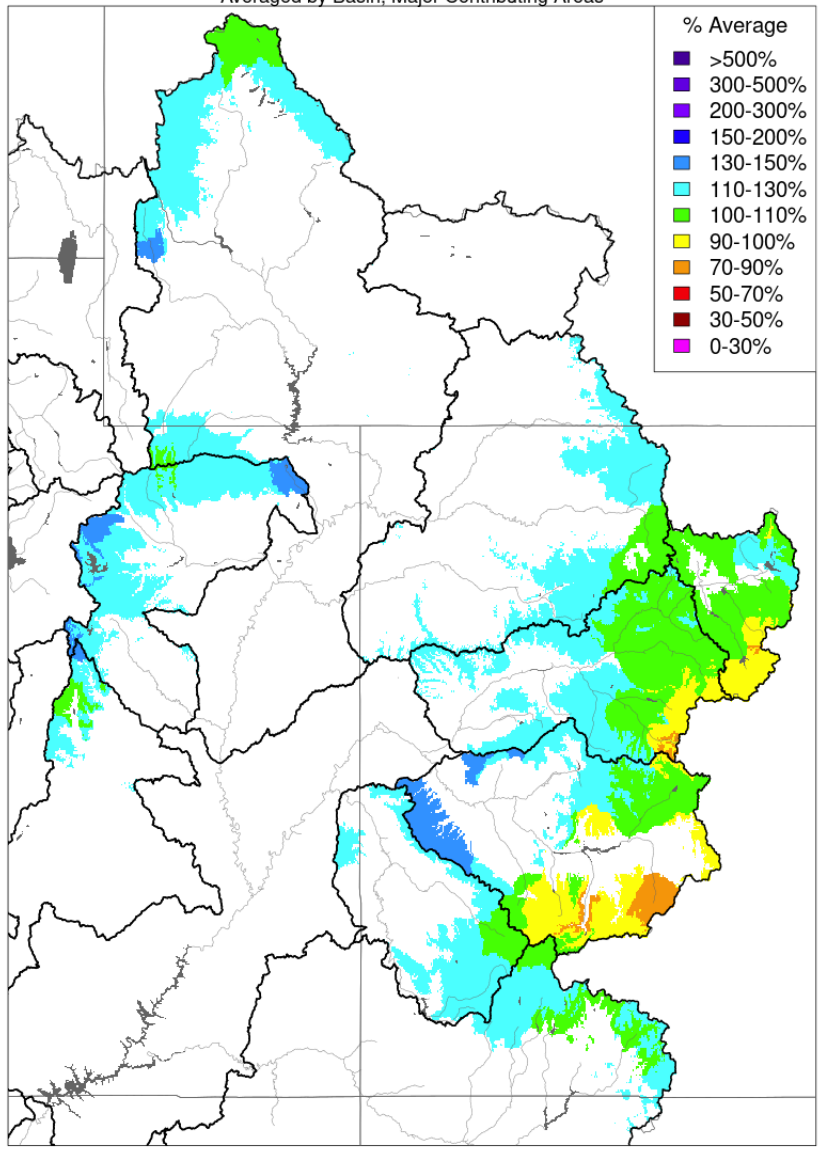
Averaged by Basin, Major Contributing Areas



Prepared by NOAA, Colorado Basin River Forecast Center
Salt Lake City, Utah, www.cbrfc.noaa.gov

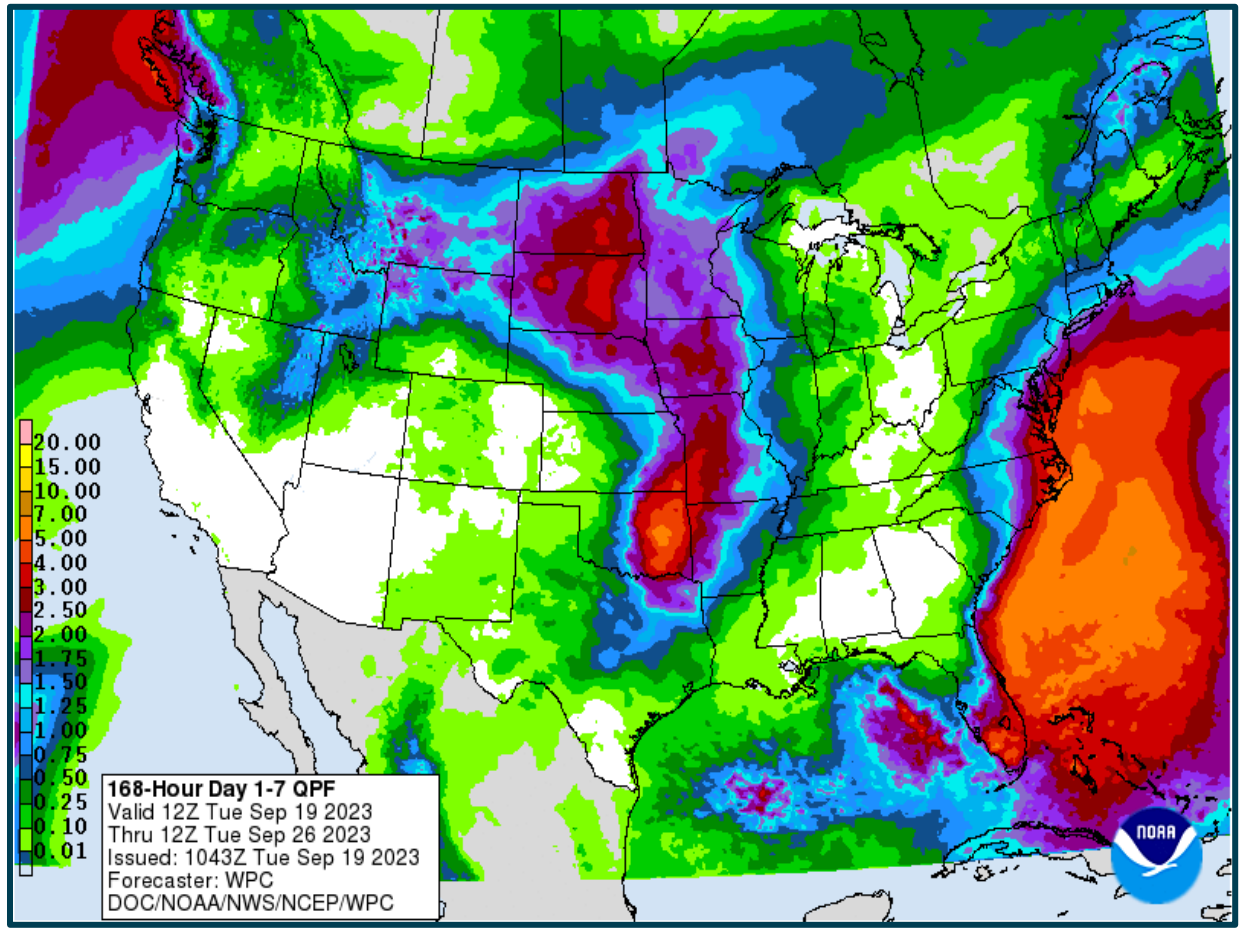
Water Year Precipitation, October 2022 - August 2023

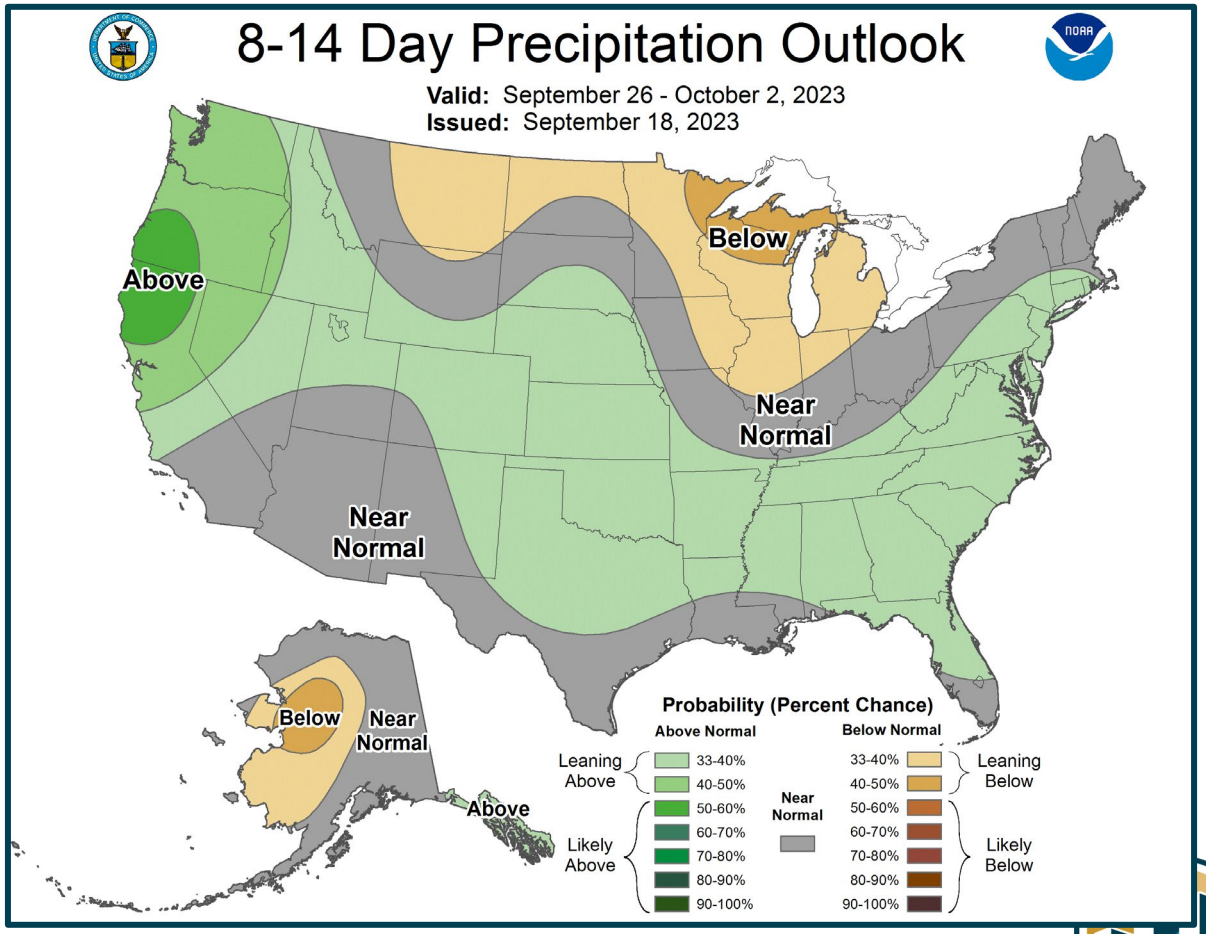
Averaged by Basin, Major Contributing Areas



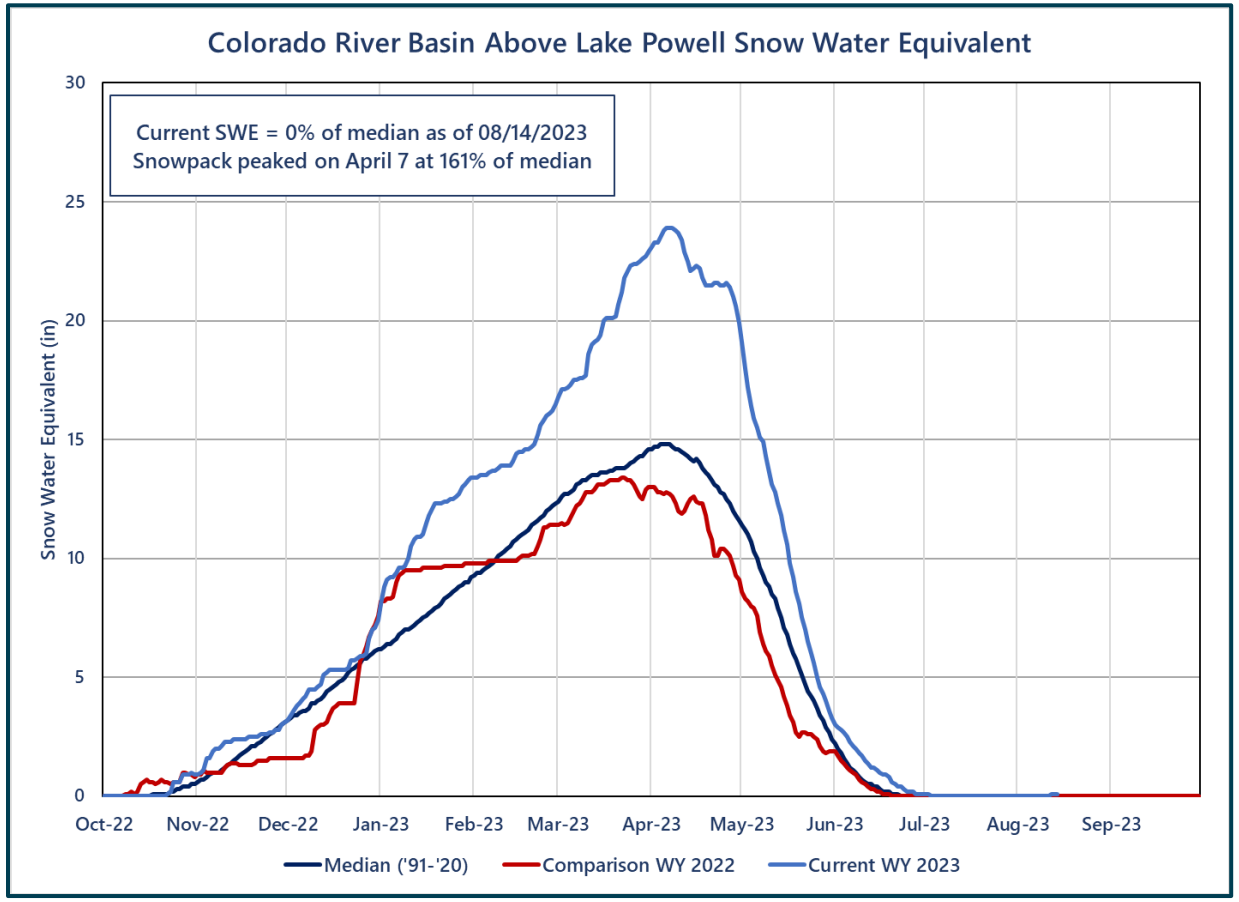
Prepared by NOAA, Colorado Basin River Forecast Center
Salt Lake City, Utah, www.cbrfc.noaa.gov

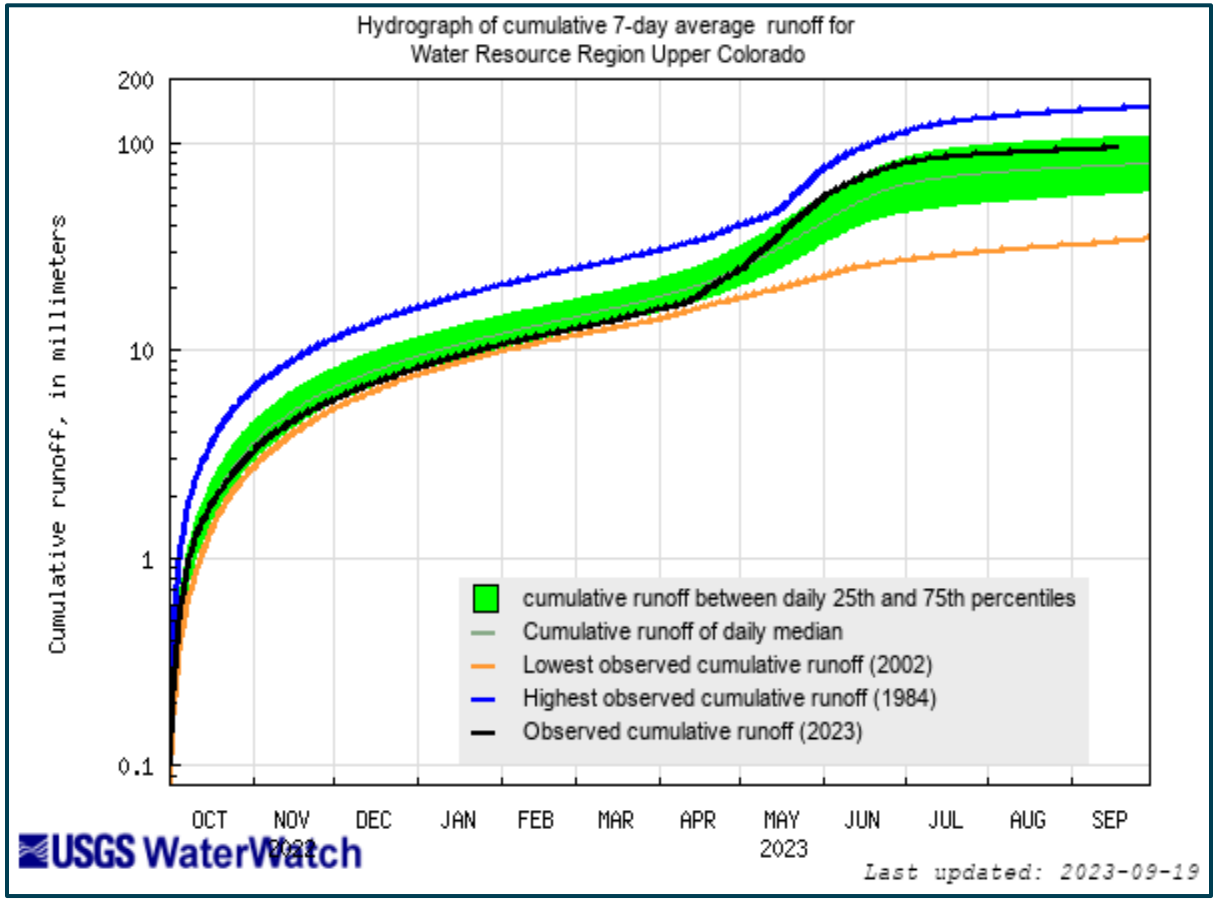
Weather Prediction Center and Climate Prediction Center Precipitation Forecasts





Upper Colorado SWE and Observed Inflows





https://waterwatch.usgs.gov/index.php

Most Probable September Observed and Forecast Water Year 2023

April – July 2023 Observed Unregulated Inflow

as of September 1, 2023

Reservoir	Inflow (kaf)	Percent of Avg[1]
Fontenelle	951	129
Flaming Gorge	1,457	151
Blue Mesa	833	131
Navajo	1,028	163
Powell	10,619	166

Water Year 2023 Unregulated Inflow Forecast

as of September 1, 2023

Reservoir	Inflow (kaf)	Percent of Avg[1]
Fontenelle	1,260	117
Flaming Gorge	1,836	130
Blue Mesa	1,073	118
Navajo	1,244	137
Powell	13,598	142

Midmonth Powell 13,479 kaf (140%)

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

Most Probable September Forecast
Water Year 2024

April – July 2024
Forecasted Unregulated Inflow

as of September 1, 2023

Reservoir	Inflow (kaf)	Percent of Avg[1]
Fontenelle	690	94
Flaming Gorge	940	97
Blue Mesa	618	97
Navajo	574	91
Powell	6,450	101

Water Year 2024
Unregulated Inflow Forecast

as of September 1, 2023

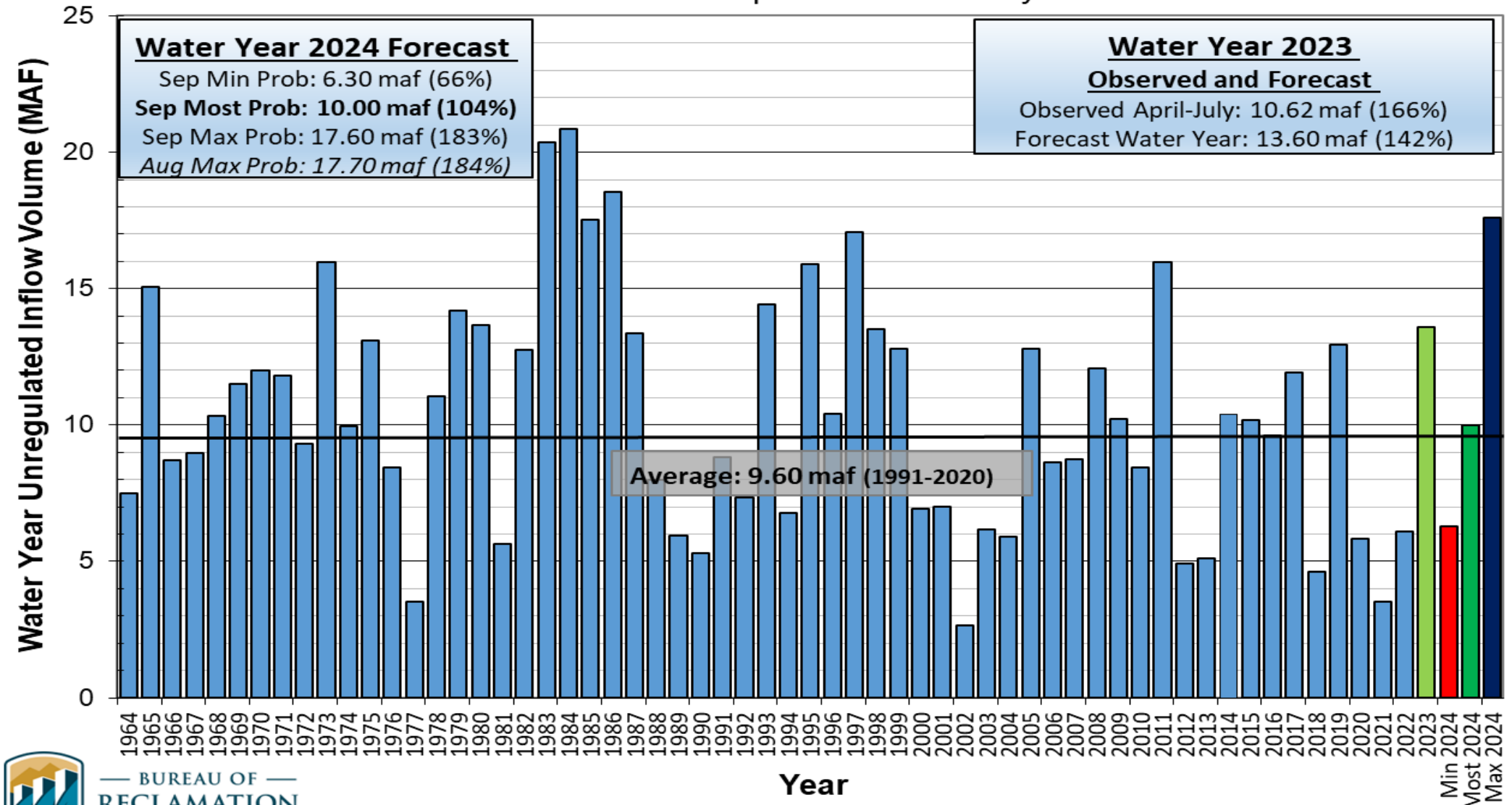
Reservoir	Inflow (kaf)	Percent of Avg[1]
Fontenelle	1,035	96
Flaming Gorge	1,405	100
Blue Mesa	890	98
Navajo	830	91
Powell	10,000	104

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

Lake Powell Unregulated Inflow

Water Year 2023 and 2024 Forecast *(issued September 1)*

Comparison with History



BUREAU OF RECLAMATION

Upper Colorado Basin

Hydrology and Operations Projections Based on August and September 2023 24-Month Study

Upper Basin Reservoir Operations
Water Years 2023 and 2024

- 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 water year (WY) 2023 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
- Lake Powell WY 2024 will operate in the Mid-Elevation Release Tier where Lake Powell will release 7.48 maf
- 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 & Lake Mead Operational Table

Lake Powell Operational Tier Determination Run (aka "Exhibit Run") with an 8.23 maf Release[1]

3,568.57 ft
Jan 1, 2024
Projection

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
3,525	**Lower Elevation Balancing Tier** Balance contents with a min/max release of 7.0 and 9.5 maf	5.9	1,105	**Shortage Condition** Deliver 7.167[4] maf	11.9
3,490		4.0	1,075	**Shortage Condition** Deliver 7.083[5] maf	9.4
3,370		0	1,050	**Shortage Condition** Deliver 7.0[6] maf Further measures may be undertaken[7]	7.5
			1,025		5.8
			1,000		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

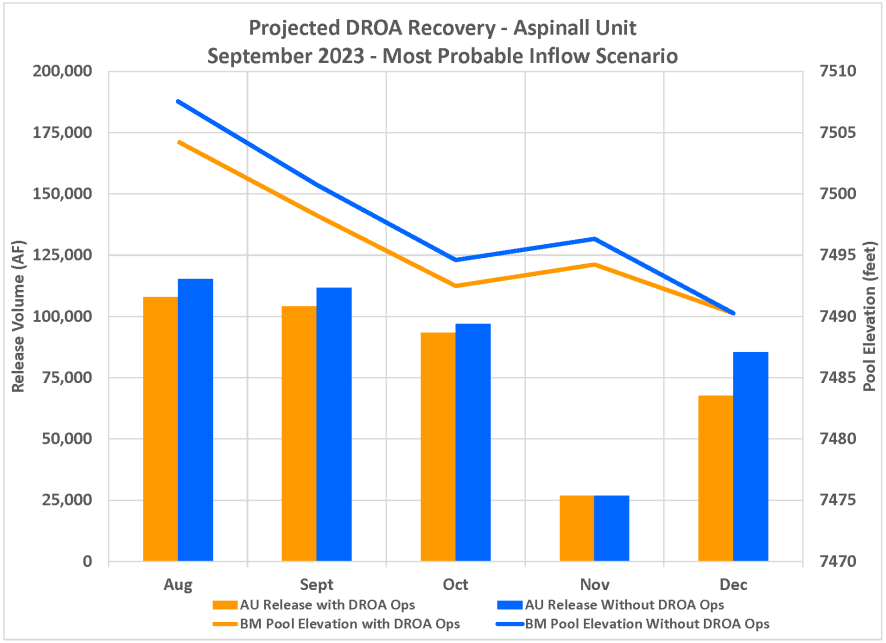
[6] Of which 2.32 maf is apportioned to Arizona, 4.4 maf to California, and 0.280 maf to Nevada

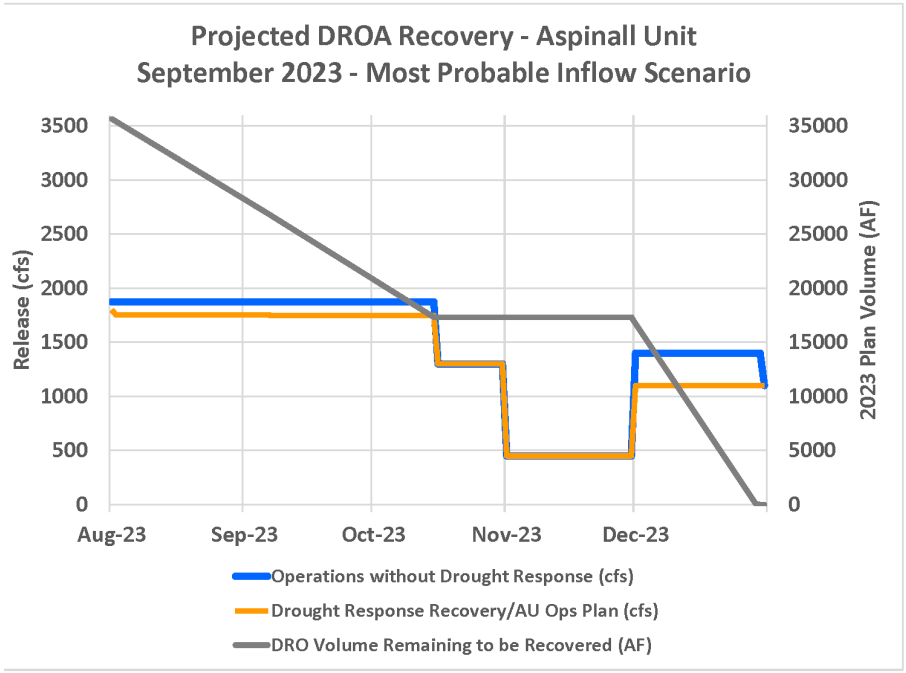
[7] Whenever Lake Mead is below elevation 1,025 feet, the Secretary shall consider whether hydrologic conditions together with anticipated deliveries to the Lower Division States and Mexico is likely to cause the elevation at Lake Mead to fall below 1,000 feet. Such consideration, in consultation with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

[1] Lake Powell and Lake Mead operational tier determinations will be documented in the draft 2024 AOP.

DROA Recovery - BM

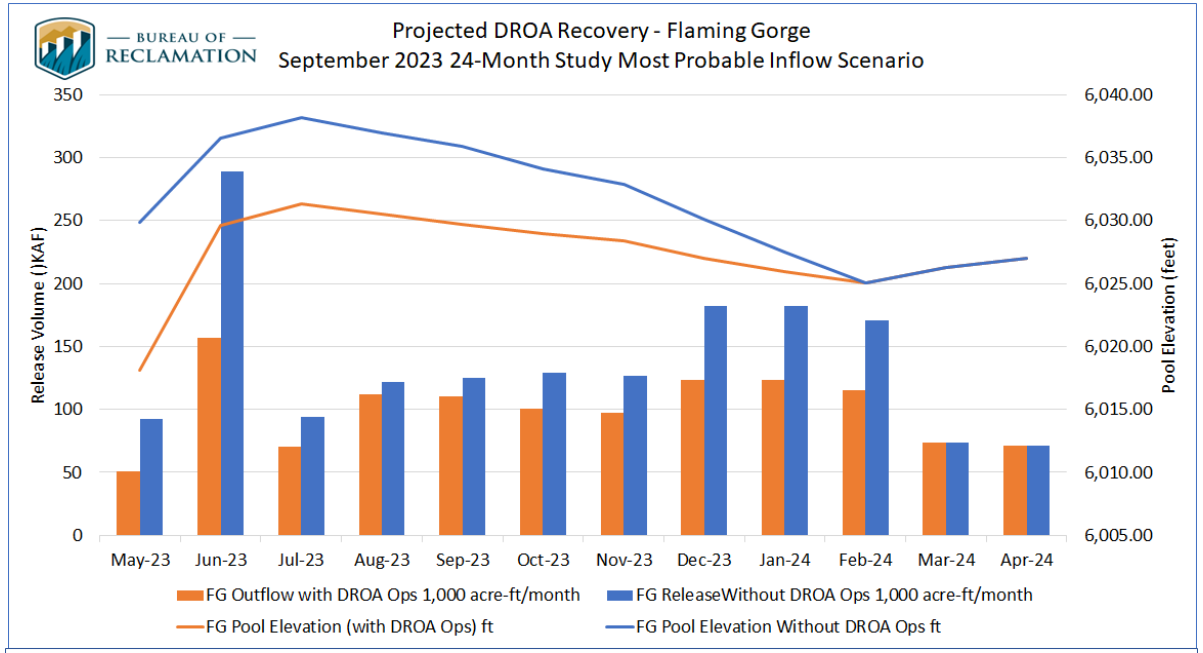
- Estimated August 2023 recovery amount around 7.4 kaf
- Projected to achieve incremental recovery and icing target by the end of Dec 23

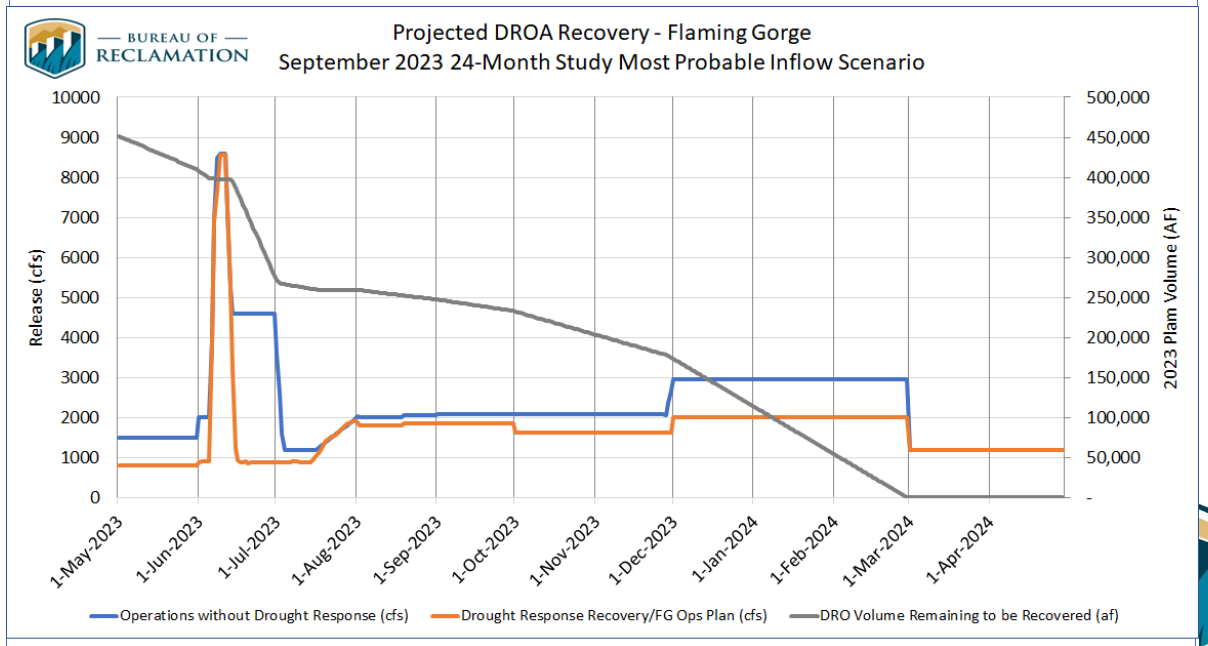




DROA Recovery - FG

- Estimated August 2023 recovery amount around 12 kaf at Flaming Gorge. Projected to achieve incremental recovery in February 2024 and the May 1 Drawdown Target of 6,027

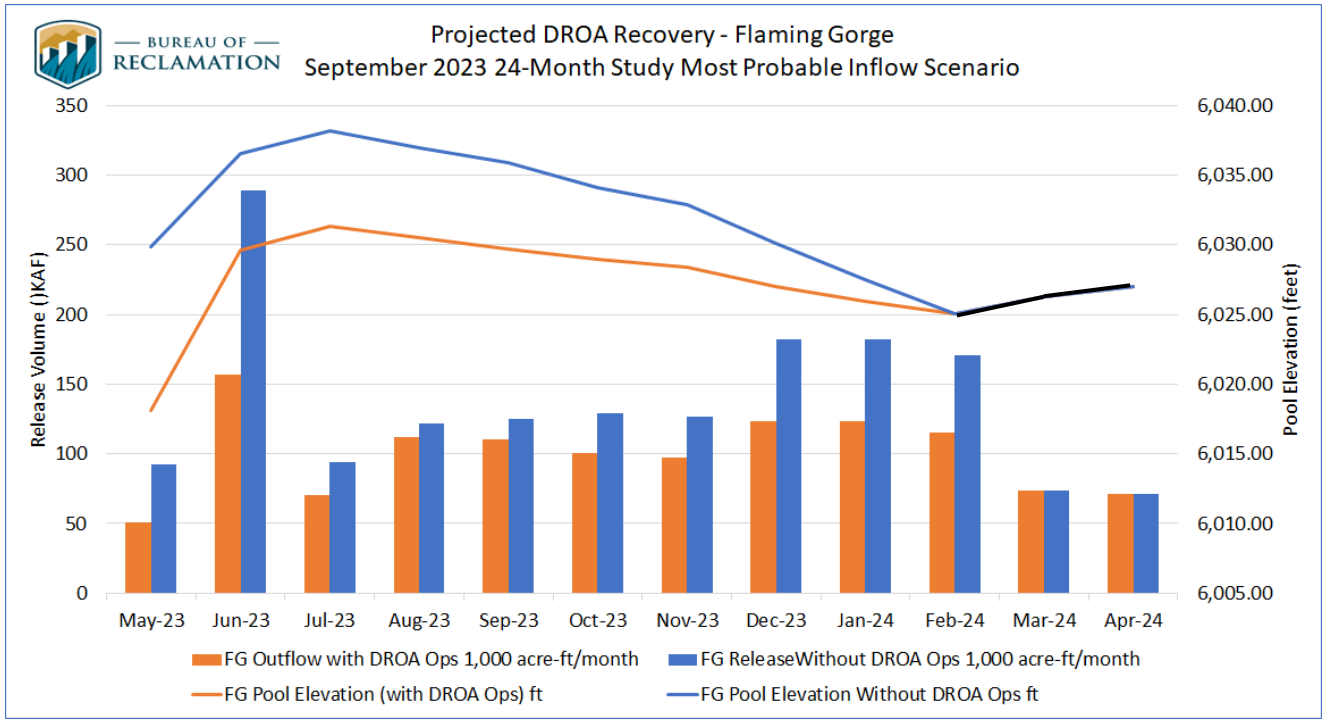




Drought Response Operations Agreement (DROA)

Completed DROA Volumes[1,2]

Reservoir	2021 DROA Volume (kaf)	2022 DROA Volume (kaf)	2023 DROA Volume (kaf)[4]	Total DROA Volume (kaf)
Flaming Gorge	125	328[3]	-205	248
Blue Mesa	36	0	-7	29
Navajo	0	0	0	0
Total DROA Volume (kaf)	161	328	-213	276

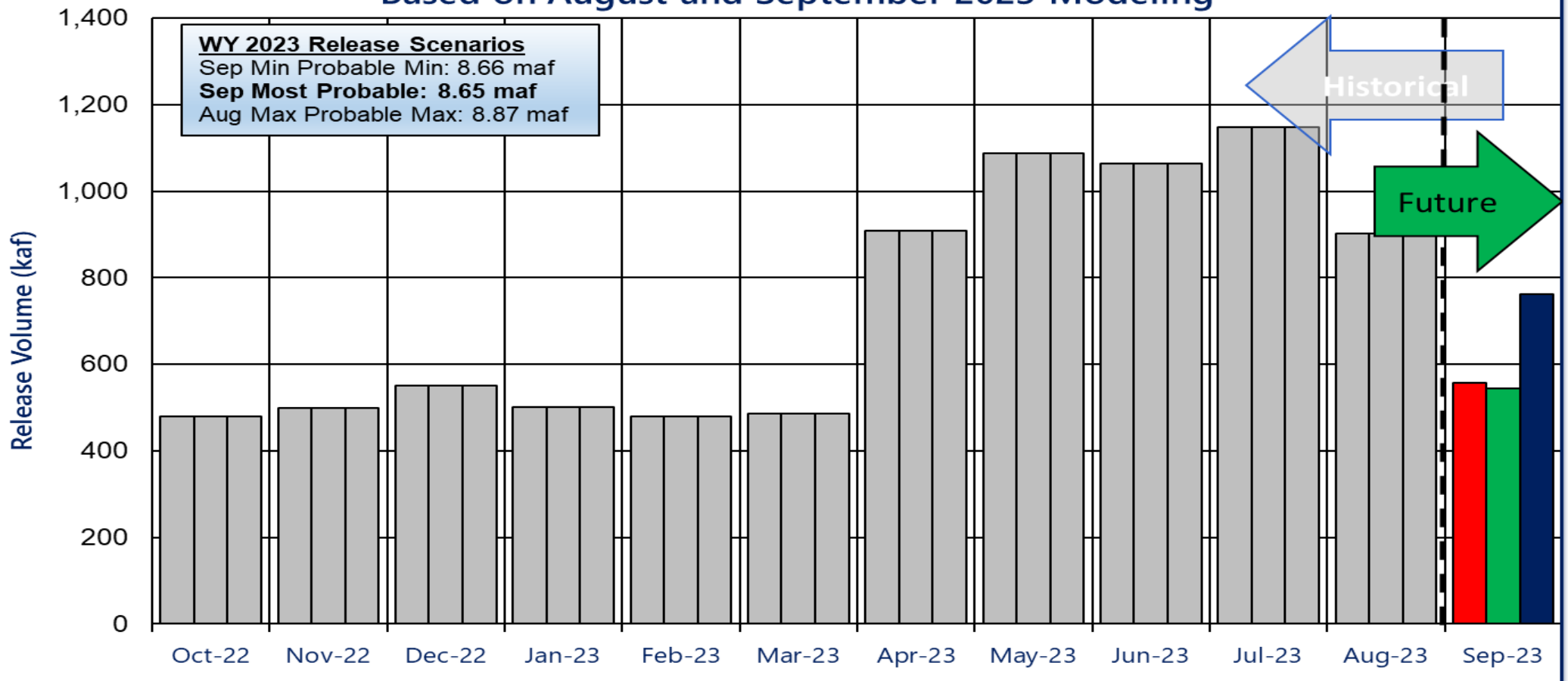


[1]DROA operational year is from May through April.
[2]Positive values indicate Drought Response Operations Releases and negative values indicate Drought Response Operations Recovery
[3] 463 kaf of DROA releases prior to DROA release suspension on March 6, 2023. -135 kaf of DROA recovery from March 7, 2023 through April 30, 2023
[4]DROA recovery through August 2023

Potential Lake Powell Monthly Release Volume Distribution

Release Scenarios for Water Year 2023

Based on August and September 2023 Modeling



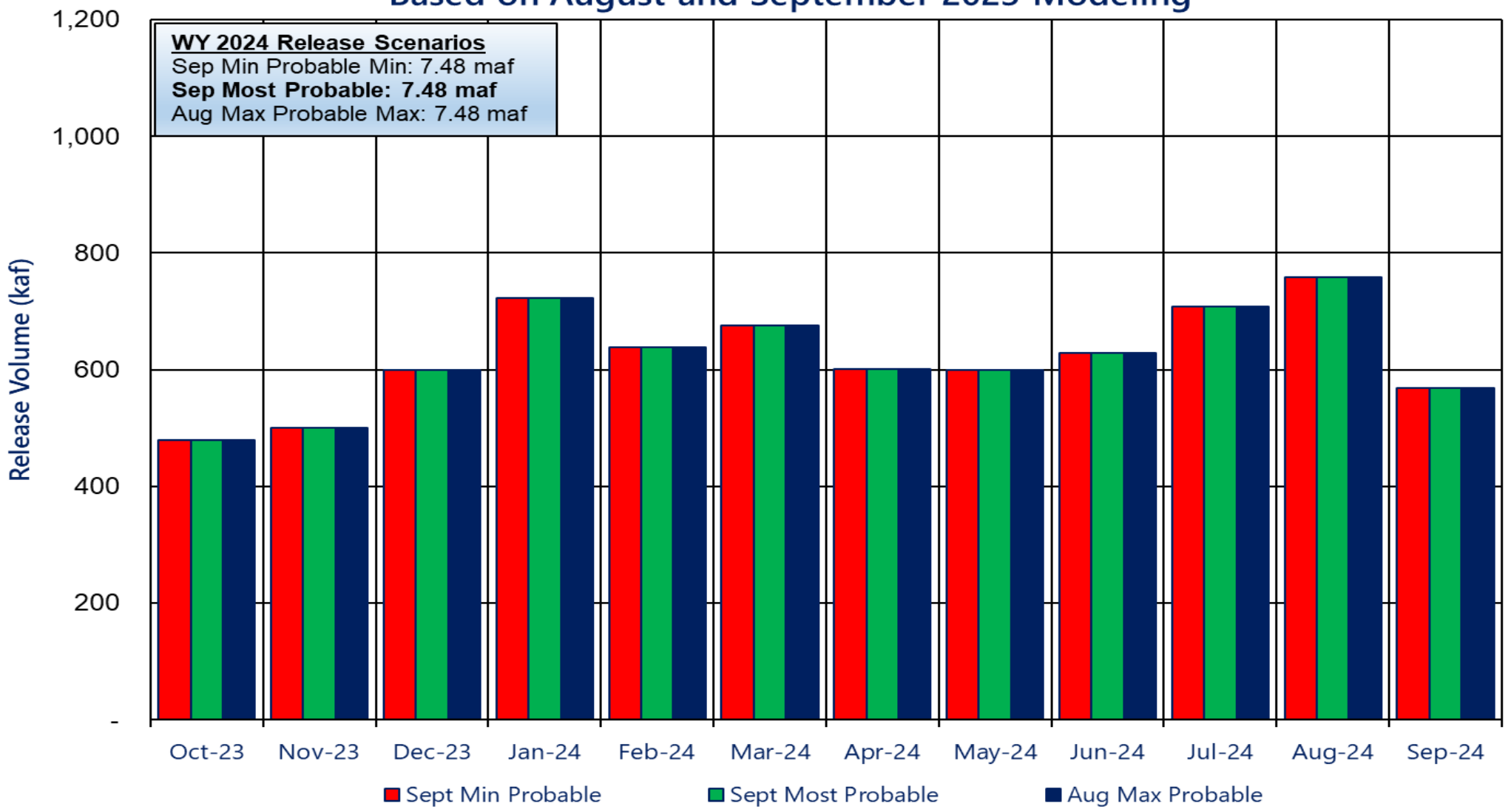
	10/1/2022	11/1/2022	12/1/2022	1/1/2023	2/1/2023	3/1/2023	4/1/2023	5/1/2023	6/1/2023	7/1/2023	8/1/2023	9/1/2023
Sept Min Probable	480.052	498.343	549.767	500.681	480.408	486.044	909.310	1,088.254	1,063.574	1,149.012	901.664	556.675
Sept Most Probable	480.052	498.343	549.767	500.681	480.408	486.044	909.310	1,088.254	1,063.574	1,149.012	901.664	543.552
Aug Max Probable	480.052	498.343	549.767	500.681	480.408	486.044	909.310	1,088.254	1,063.574	1,149.012	901.664	761.938

Reclamation will balance contents between Lakes Powell and Mead by the end of the water year, as nearly as practicable, as required under the Lower Elevation Balancing Tier, Section 6.D.1 of the 2007 Interim Guidelines

Potential Lake Powell Monthly Release Volume Distribution

Release Scenarios for Water Year 2024

Based on August and September 2023 Modeling

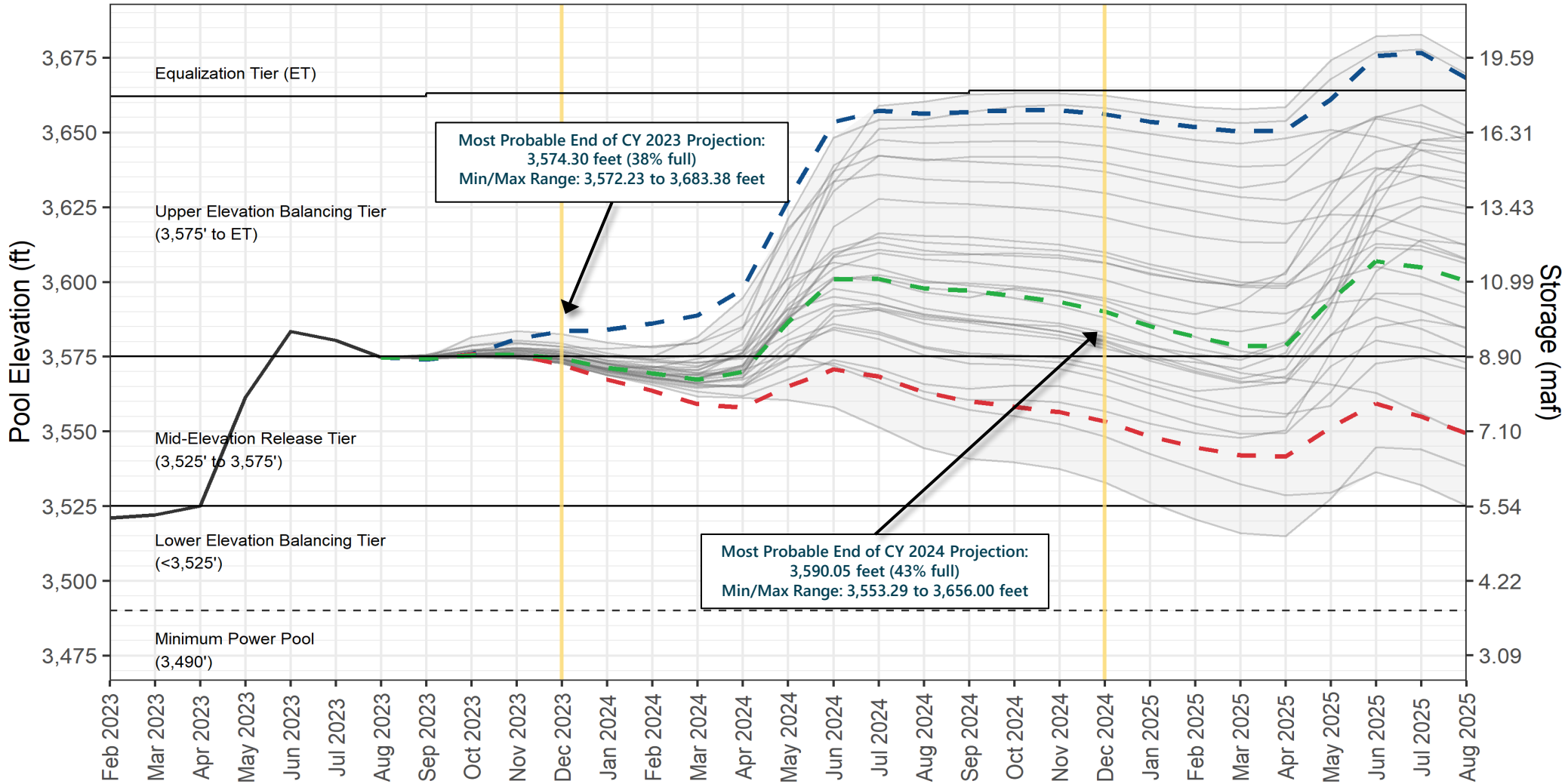


Reclamation Operational Modeling
Model Comparison

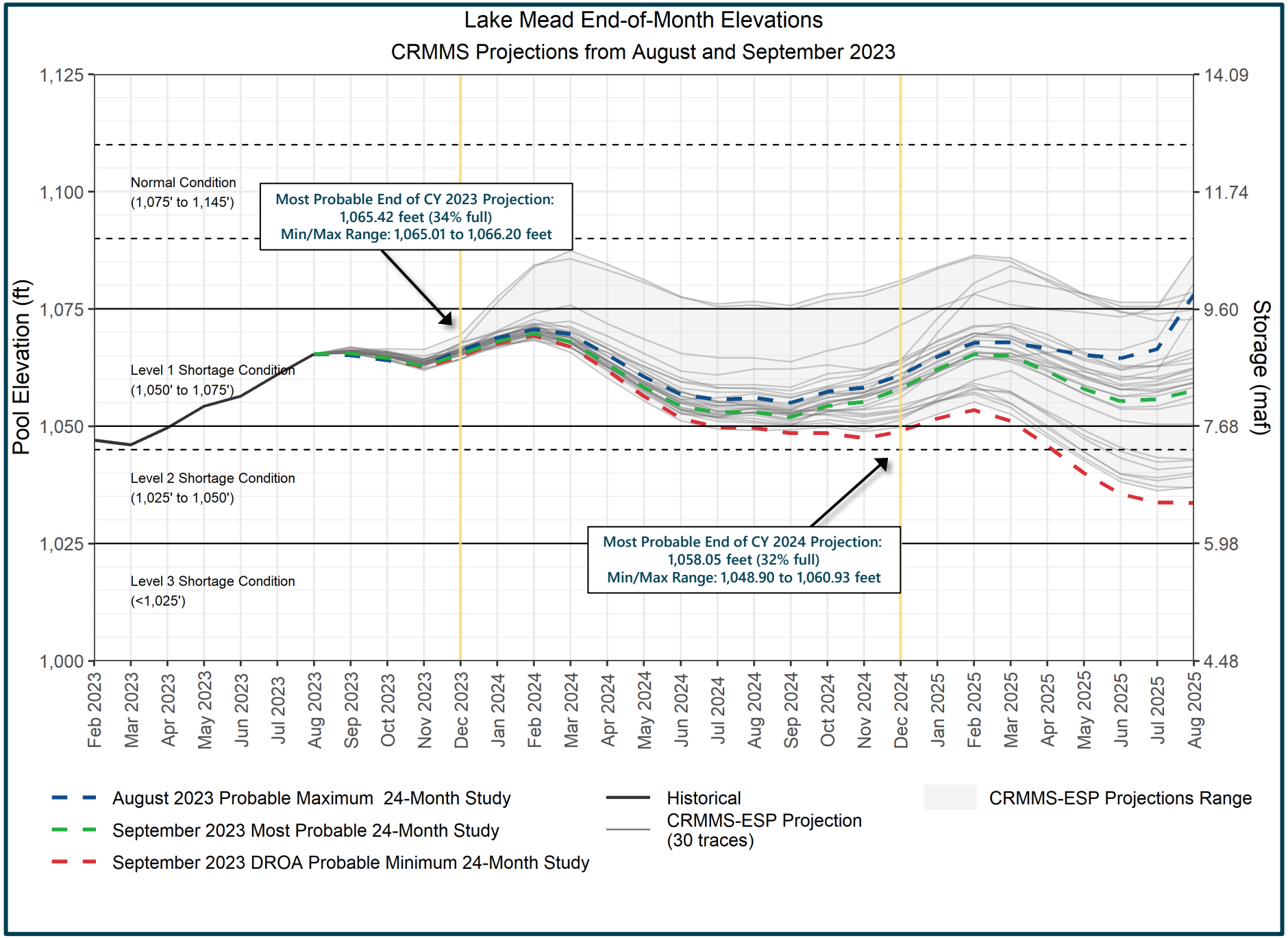
	Colorado River Mid-term Modeling System (CRMMS)		CRSS
	24-Month Study Mode (Manual Mode)	Ensemble Mode (Rule-based Mode)	
Primary Use	AOP tier determinations and projections of current conditions	Risk-based operational planning and analysis	Long-term planning, comparison of alternatives
Simulated Reservoir Operations	Operations input manually	Rule-driven operations	
Probabilistic or Deterministic	Deterministic – single hydrologic trace	Deterministic OR Probabilistic 30 (or more) hydrologic traces	Probabilistic – 100+ traces
Time Horizon (years)	1 - 2	1 - 5	1 - 50
Upper Basin Inflow	Unregulated forecast, 1 trace	Unregulated ESP forecast, 30 traces	Natural flow; historical, paleo, or climate change hydrology
Upper Basin Demands	Implicit, in unregulated inflow forecast		Explicit, 2016 UCRC assumptions
Lower Basin Demands	Official approved or operational		Developed with LB users

Lake Powell End-of-Month Elevations

CRMMS Projections from August and September 2023



Reclamation will balance contents between Lakes Powell and Mead by the end of the water year, as nearly as practicable, as required under the Lower Elevation Balancing Tier, Section 6.D.1 of the 2007 Interim Guidelines


Lake Mead End-of-Month Elevations
CRMMS Projections from August and September 2023
Pool Elevation (ft)
Storage (maf)
1,125
1,100
1,075
1,050
1,025
1,000
14.09
11.74
9.60
7.68
5.98
4.48
Normal Condition
(1,075' to 1,145')
Level 1 Shortage Condition
(1,050' to 1,075')
Level 2 Shortage Condition
(1,025' to 1,050')
Level 3 Shortage Condition
(<1,025')
Most Probable End of CY 2023 Projection:
1,065.42 feet (34% full)
Min/Max Range: 1,065.01 to 1,066.20 feet
Most Probable End of CY 2024 Projection:
1,058.05 feet (32% full)
Min/Max Range: 1,048.90 to 1,060.93 feet
Feb 2023
Mar 2023
Apr 2023
May 2023
Jun 2023
Jul 2023
Aug 2023
Sep 2023
Oct 2023
Nov 2023
Dec 2023
Jan 2024
Feb 2024
Mar 2024
Apr 2024
May 2024
Jun 2024
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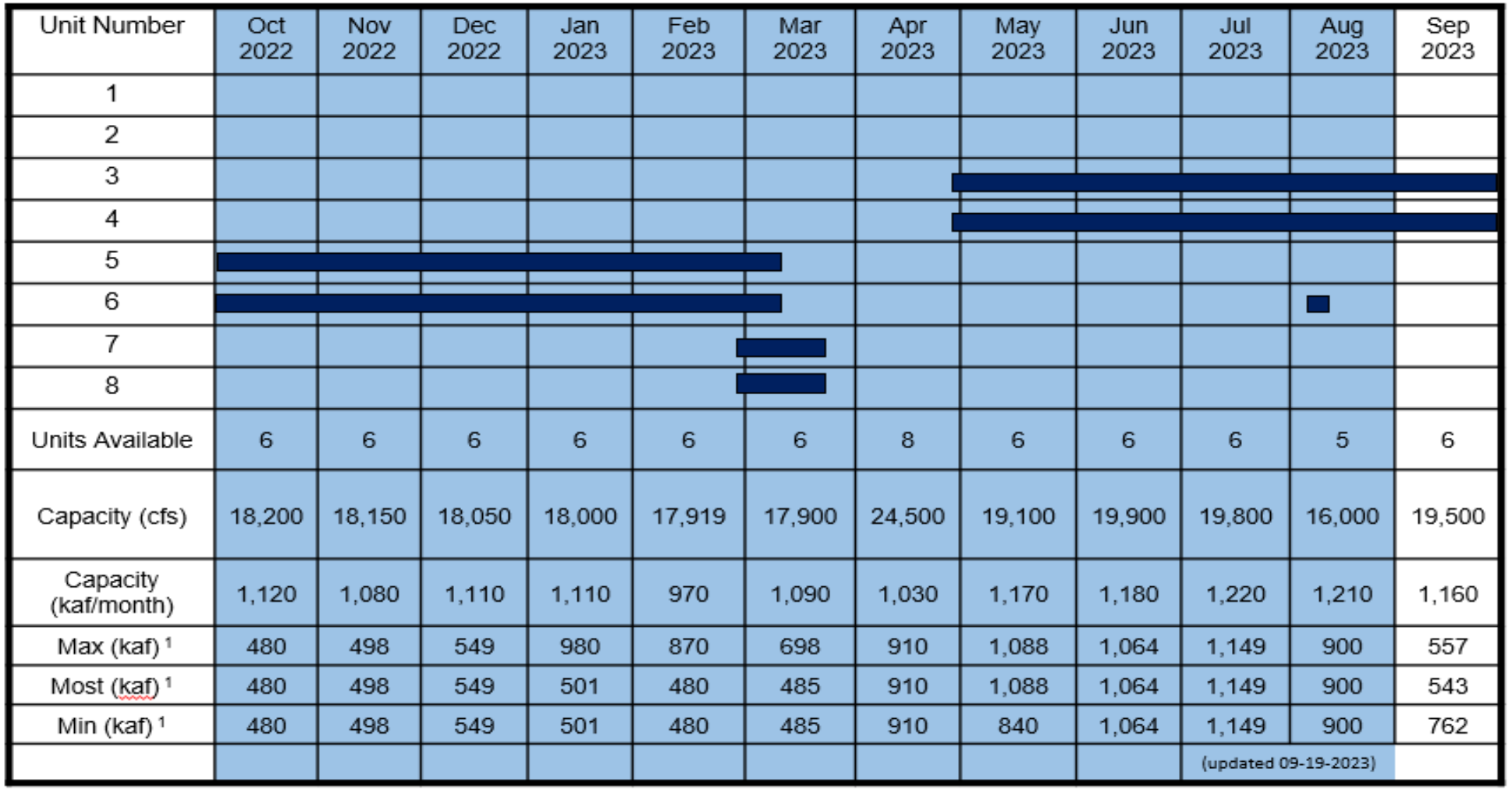
Sep 2024
Oct 2024
Nov 2024
Dec 2024
Jan 2025
Feb 2025
Mar 2025
Apr 2025
May 2025
Jun 2025
Jul 2025
Aug 2025
August 2023 Probable Maximum 24-Month Study
September 2023 Most Probable 24-Month Study
September 2023 DROA Probable Minimum 24-Month Study
Historical
CRMMS-ESP Projection
(30 traces)
CRMMS-ESP Projections Range

Upper Colorado Basin

Hydropower Maintenance

Glen Canyon Dam Power Plant Unit Outage Schedule for 2023



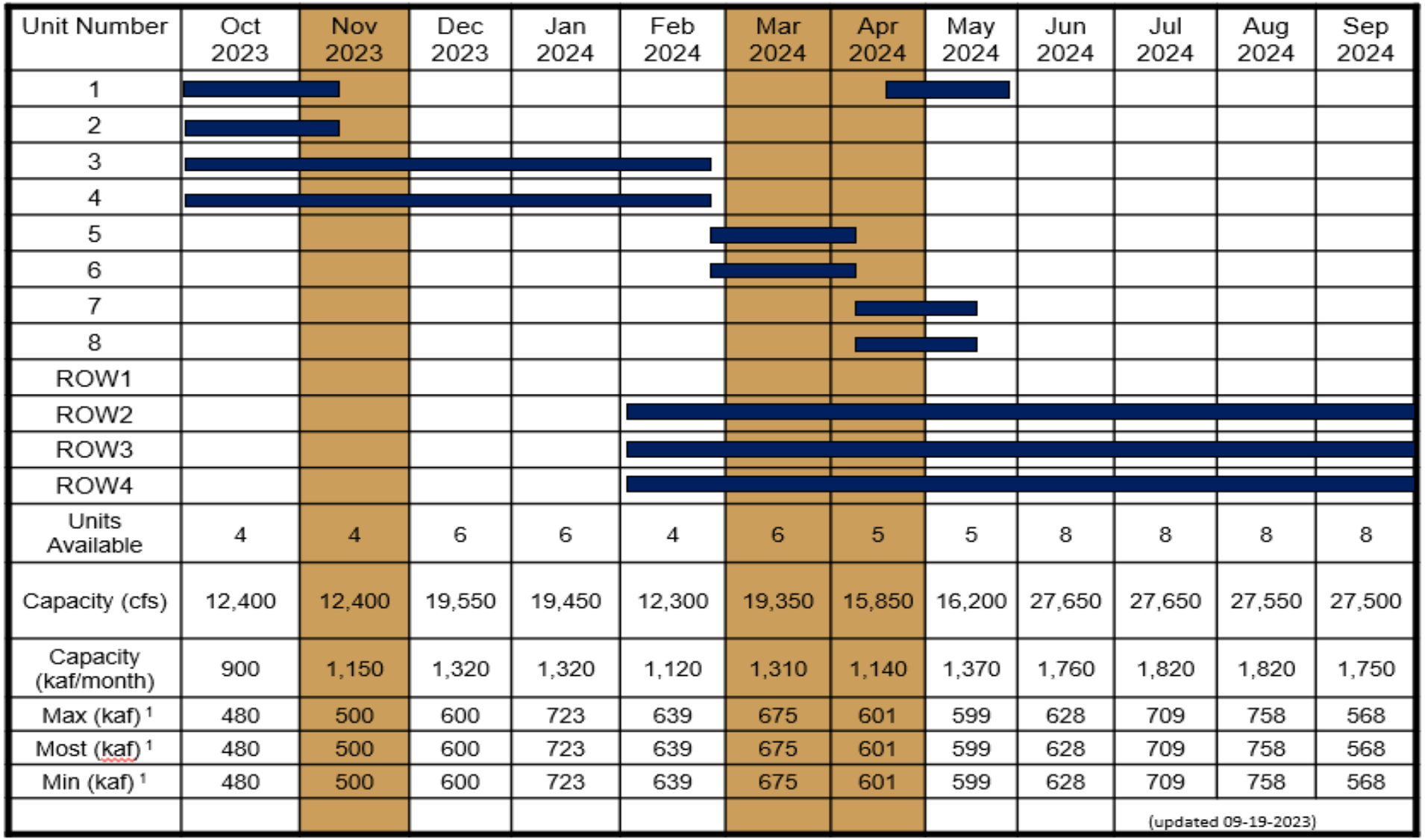
Unit Number	Oct 2022	Nov 2022	Dec 2022	Jan 2023	Feb 2023	Mar 2023	Apr 2023	May 2023	Jun 2023	Jul 2023	Aug 2023	Sep 2023	
1													
2													
3													
4													
5													
6													
7													
8													
Units Available	6	6	6	6	6	6	8	6	6	6	5	6	
Capacity (cfs)	18,200	18,150	18,050	18,000	17,919	17,900	24,500	19,100	19,900	19,800	16,000	19,500	SEP MOST[2]
Capacity (kaf/month)	1,120	1,080	1,110	1,110	970	1,090	1,030	1,170	1,180	1,220	1,210	1,160	SEP MOST
Max (kaf) [1]	480	498	549	980	870	698	910	1,088	1,064	1,149	900	557	8.66 maf
Most (kaf) [1]	480	498	549	501	480	485	910	1,088	1,064	1,149	900	543	8.65 maf
Min (kaf) [1]	480	498	549	501	480	485	910	840	1,064	1,149	900	762	8.86 maf
										(updated 09-19-2023)			

1 Projected release, based on September 2023 24MS for the minimum and most probable and August 2023 24MS inflow projections for the maximum probable and 24-Month Study model runs.

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

Reclamation will balance contents between Lakes Powell and Mead by the end of the water year, as nearly as practicable, as required under the Lower Elevation Balancing Tier, Section 6.D.1 of the 2007 Interim Guidelines

Glen Canyon Dam Power Plant Unit Outage Schedule for 2024



Unit Number	Oct 2023	Nov 2023	Dec 2023	Jan 2024	Feb 2024	Mar 2024	Apr 2024	May 2024	Jun 2024	Jul 2024	Aug 2024	Sep 2024	
Units Available	4	4	6	6	4	6	5	5	8	8	8	8	
Capacity (cfs)	12,400	12,400	19,550	19,450	12,300	19,350	15,850	16,200	27,650	27,650	27,550	27,500	SEP MOST[2]
Capacity (kaf/month)	900	1,150	1,320	1,320	1,120	1,310	1,140	1,370	1,760	1,820	1,820	1,750	SEP 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	723	639	675	601	599	628	709	758	568	7.48 maf
										(updated 09-19-2023)			

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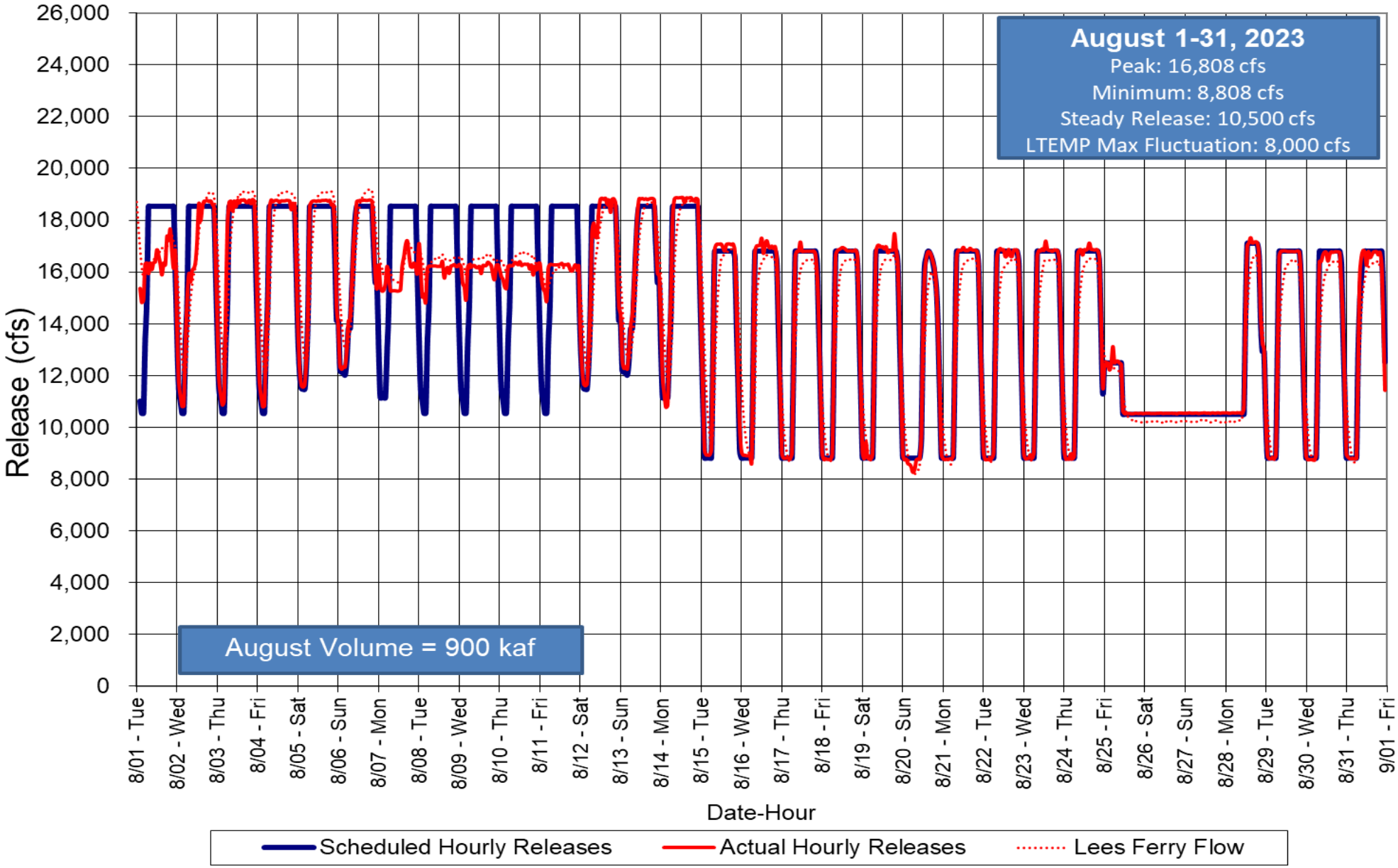
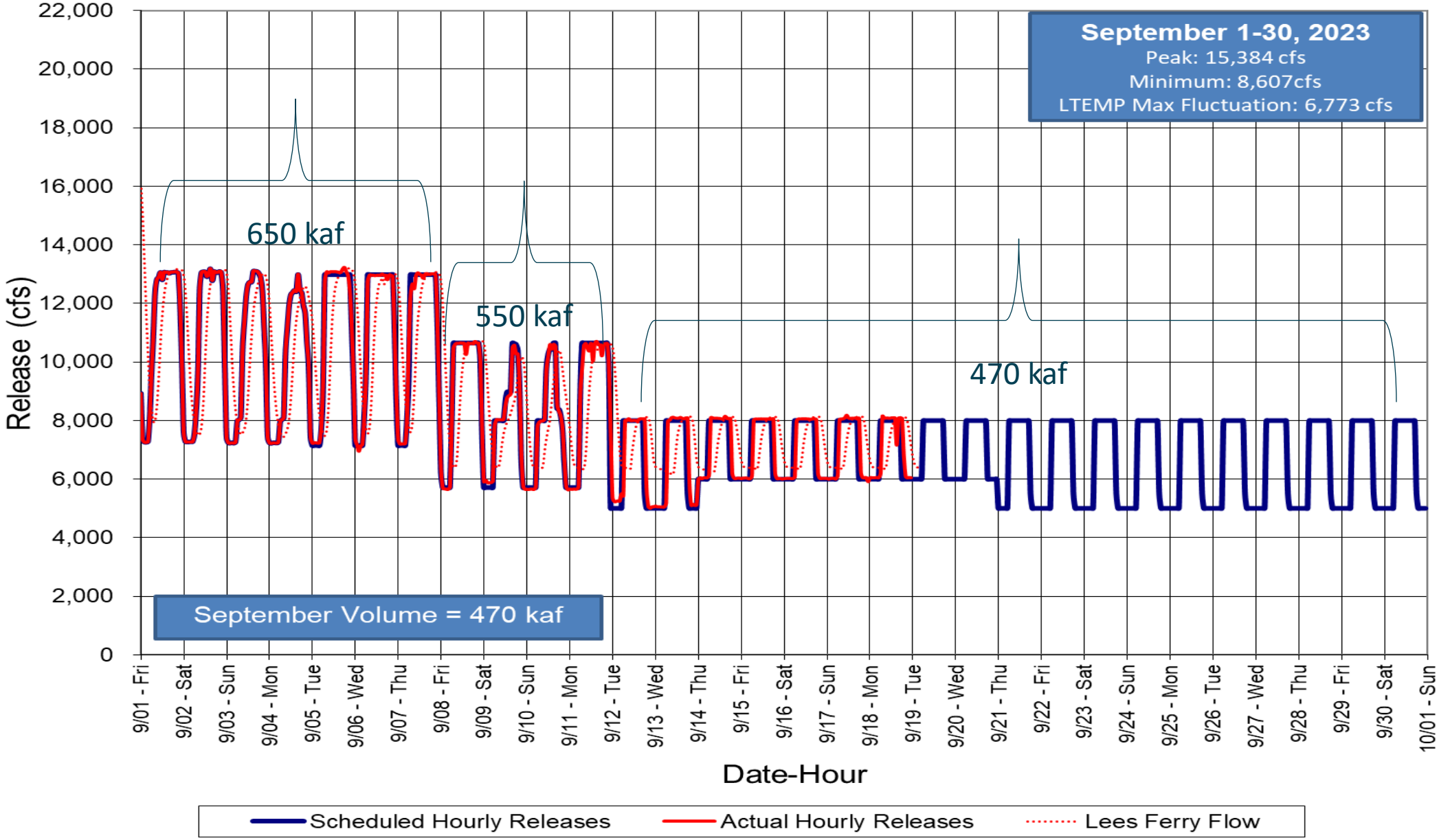
2 Dependent upon availability to shift contingency regulation, which will increase capacity by 30-40MW (3%) at current efficiency.

Glen Canyon Dam Hourly Release Pattern August 2023



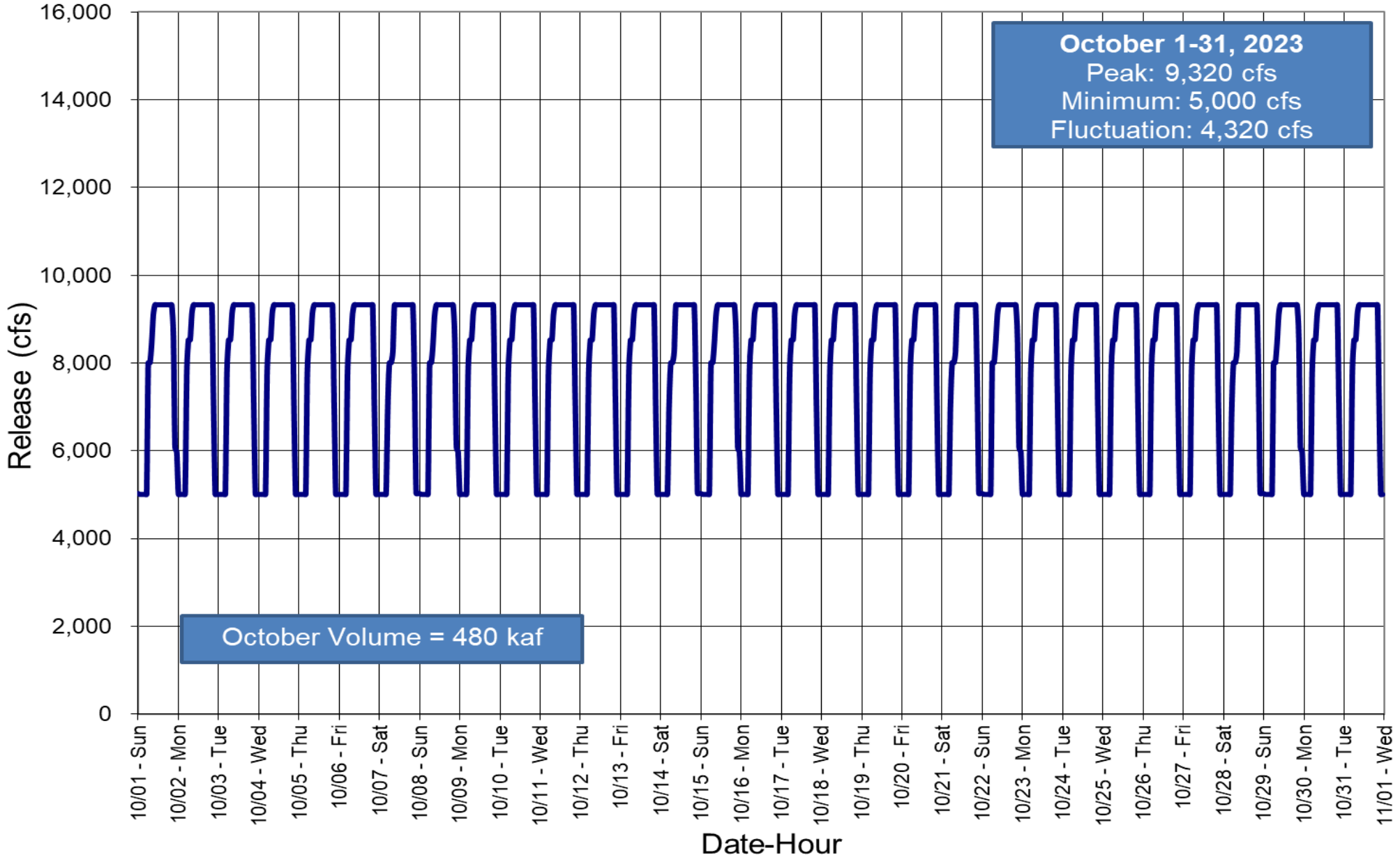
BUREAU OF RECLAMATION

Glen Canyon Dam Hourly Release Pattern September 2023



Reclamation will balance contents between Lakes Powell and Mead by the end of the water year, as nearly as practicable, as required under the Lower Elevation Balancing Tier, Section 6.D.1 of the 2007 Interim Guidelines

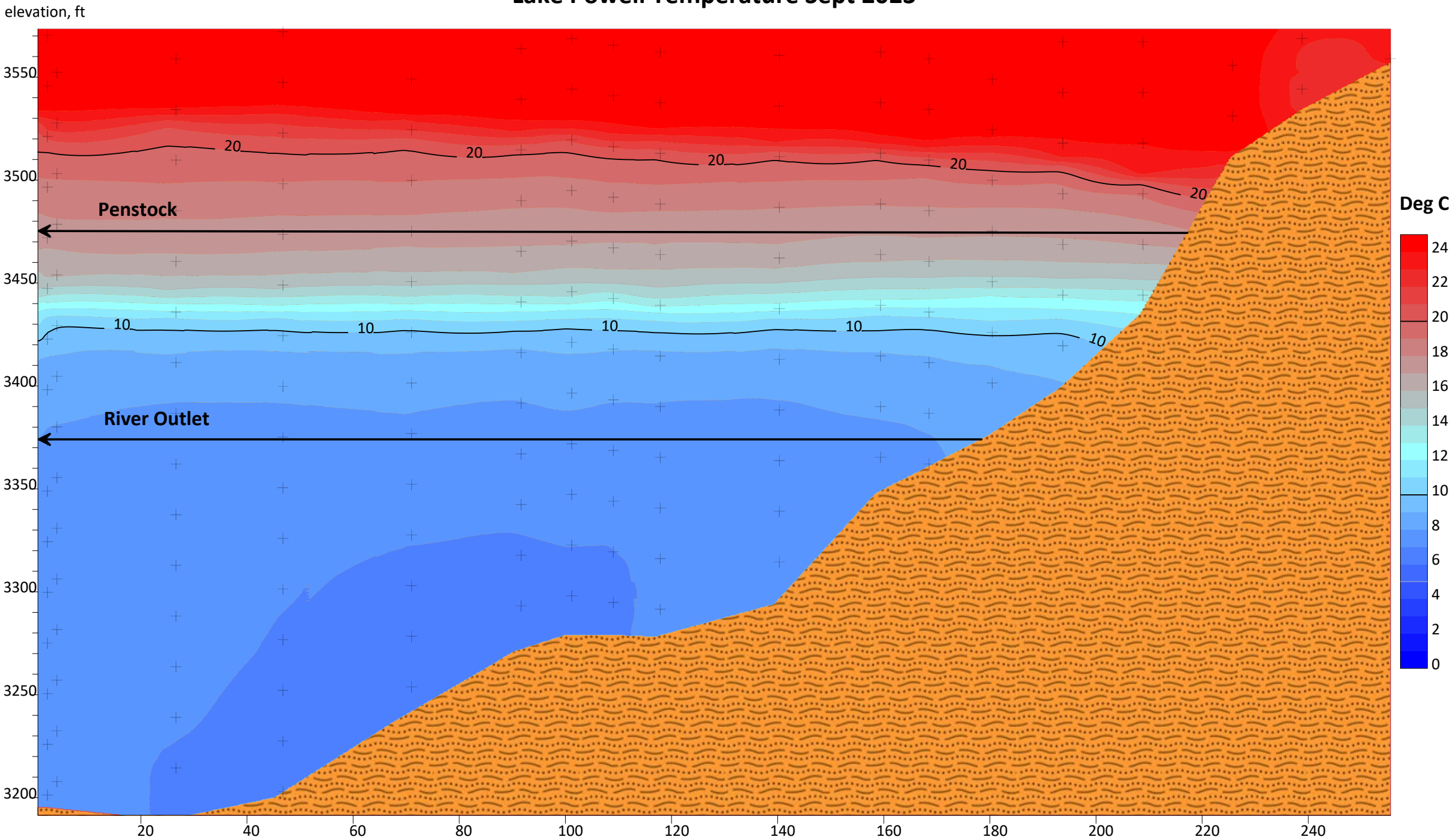
Glen Canyon Dam Hourly Release Pattern October 2023



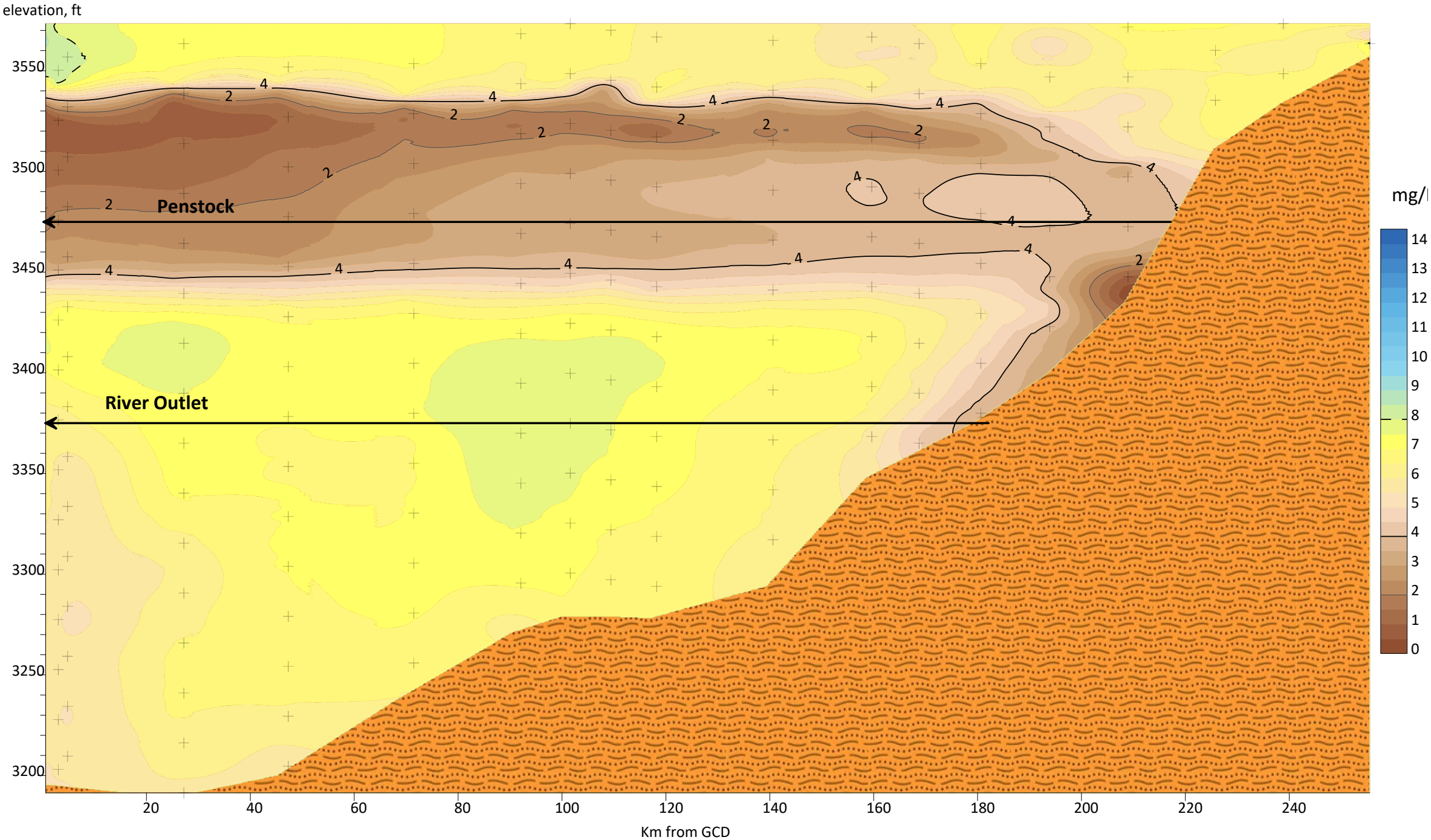
BUREAU OF RECLAMATION

Water Quality

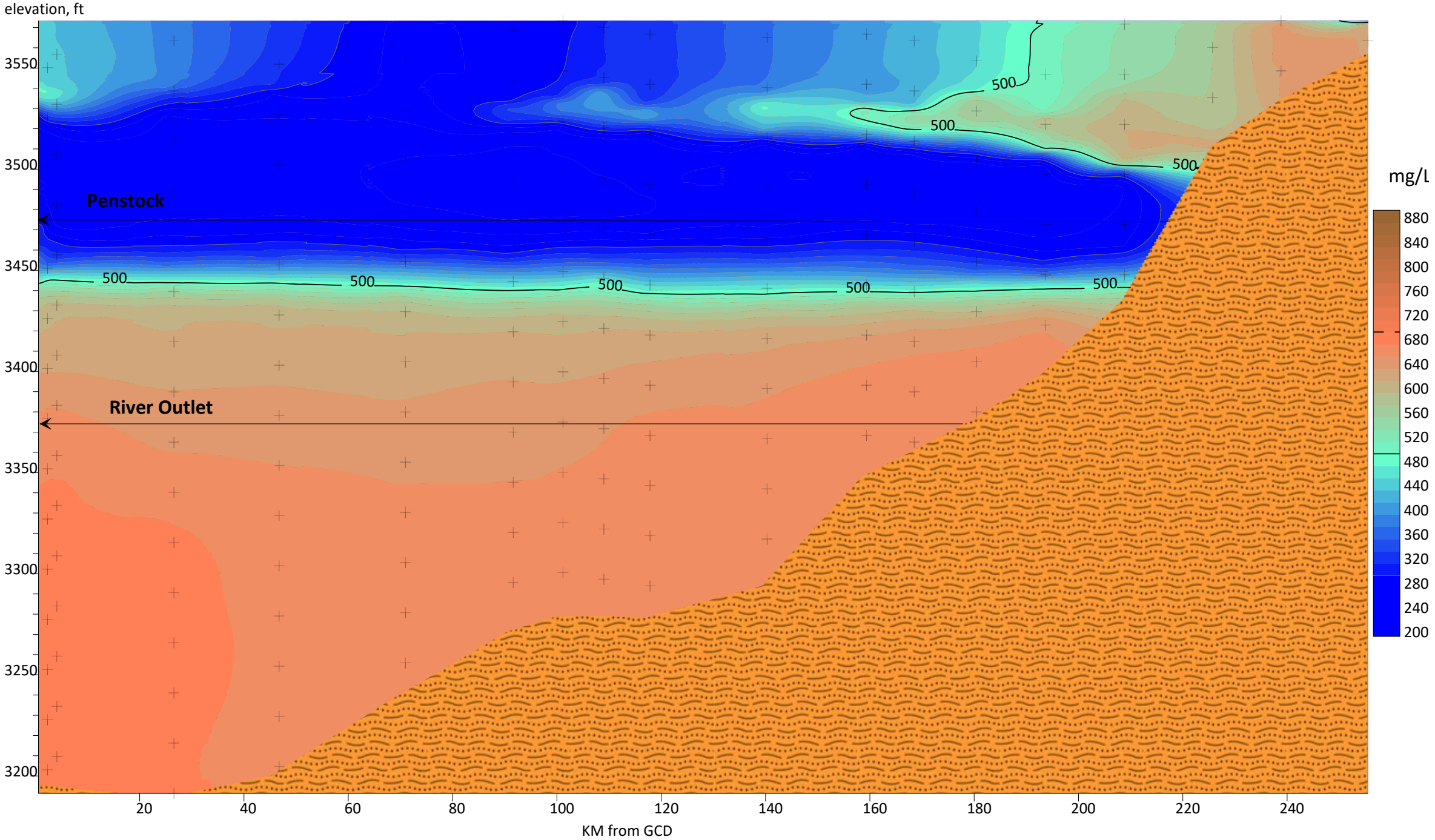
Lake Powell Temperature Sept 2023



Lake Powell Dissolved Oxygen, Sept 2023



Lake Powell TDS, Sept 2023

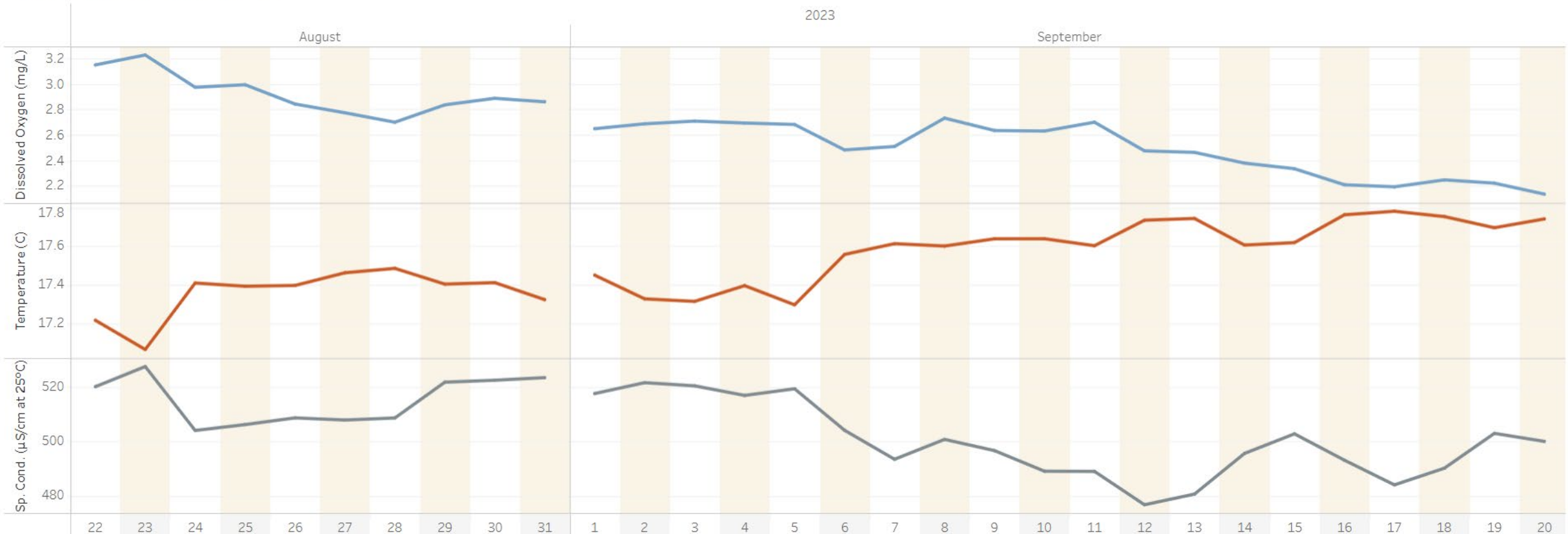


Daily Water Quality Data at Glen Canyon Dam

Download PDF

USGS science for a changing world

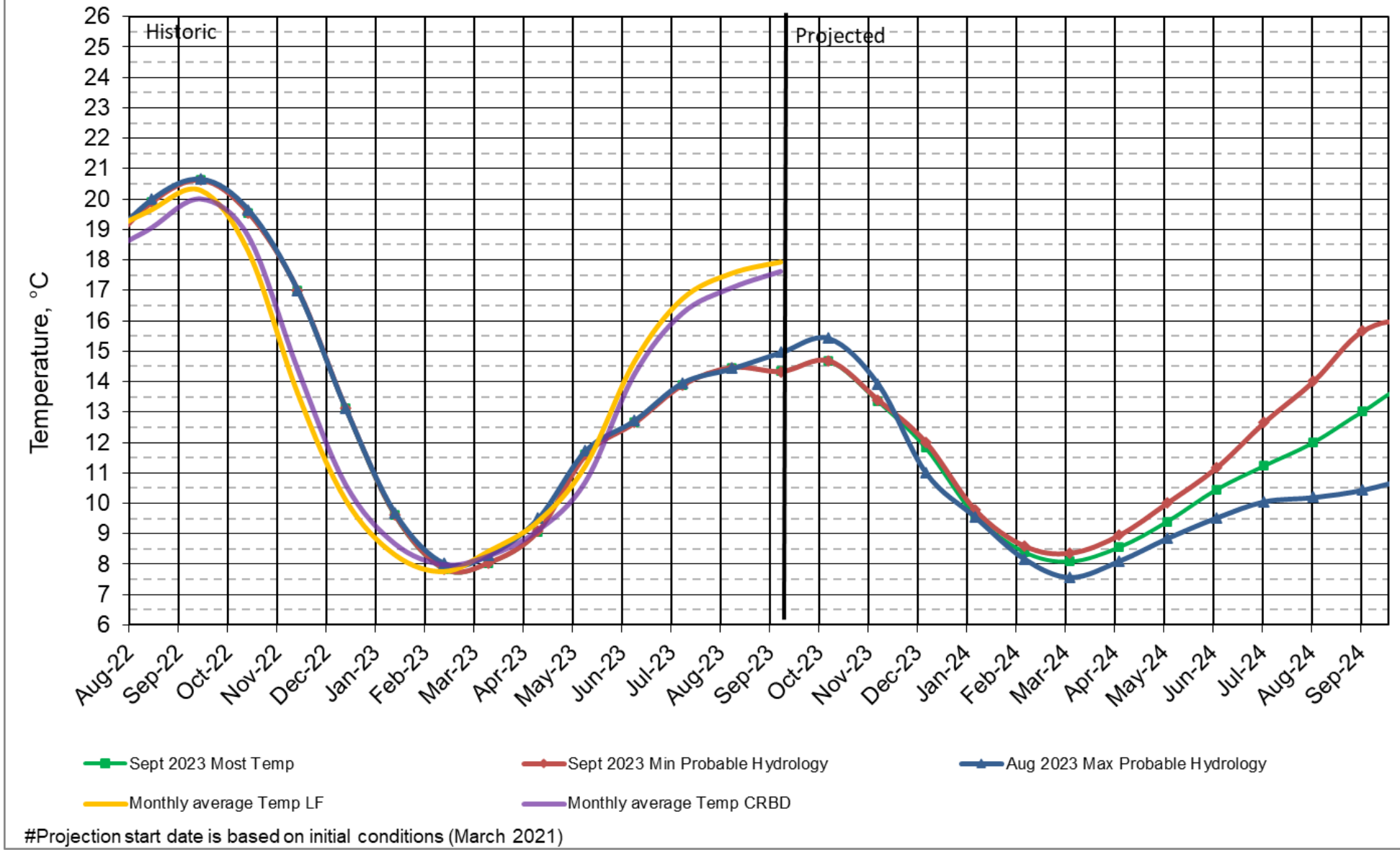
Daily Dissolved Oxygen & Temperature Values



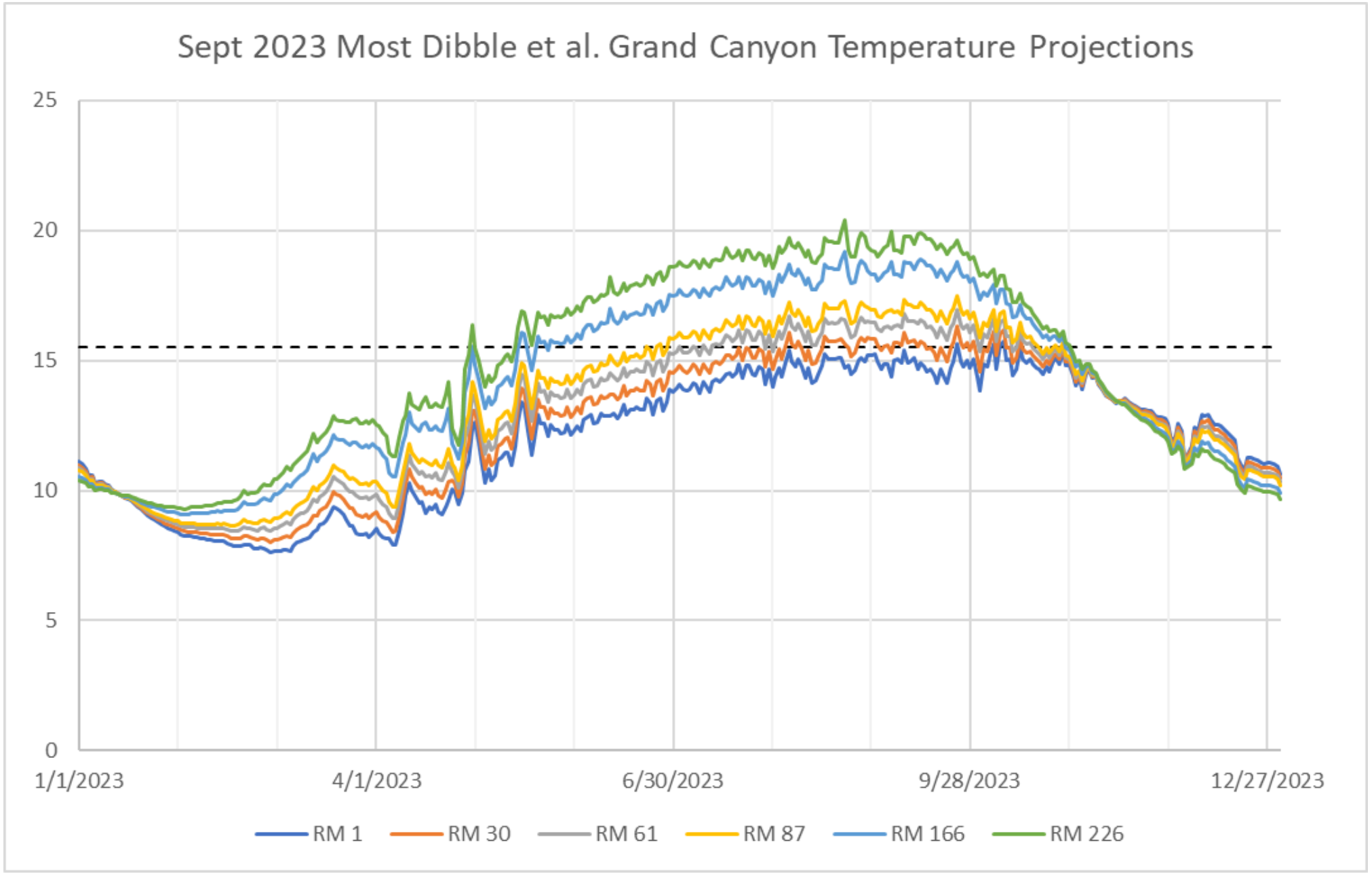
The trends of daily average Dissolved Oxygen, Temperature and Specific Conductance shown for the past 30 days.

Lake Powell Release Temperature

Projected Temperature based on August 2023 Forecast



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


Sept 2023 Most Dibble et al. Grand Canyon Temperature Projections
25
20
15
10
5
0
1/1/2023
4/1/2023
6/30/2023
9/28/2023
12/27/2023
RM 1
RM 30
RM 61
RM 87
RM 166
RM 226


Questions?
BUREAU OF
RECLAMATION