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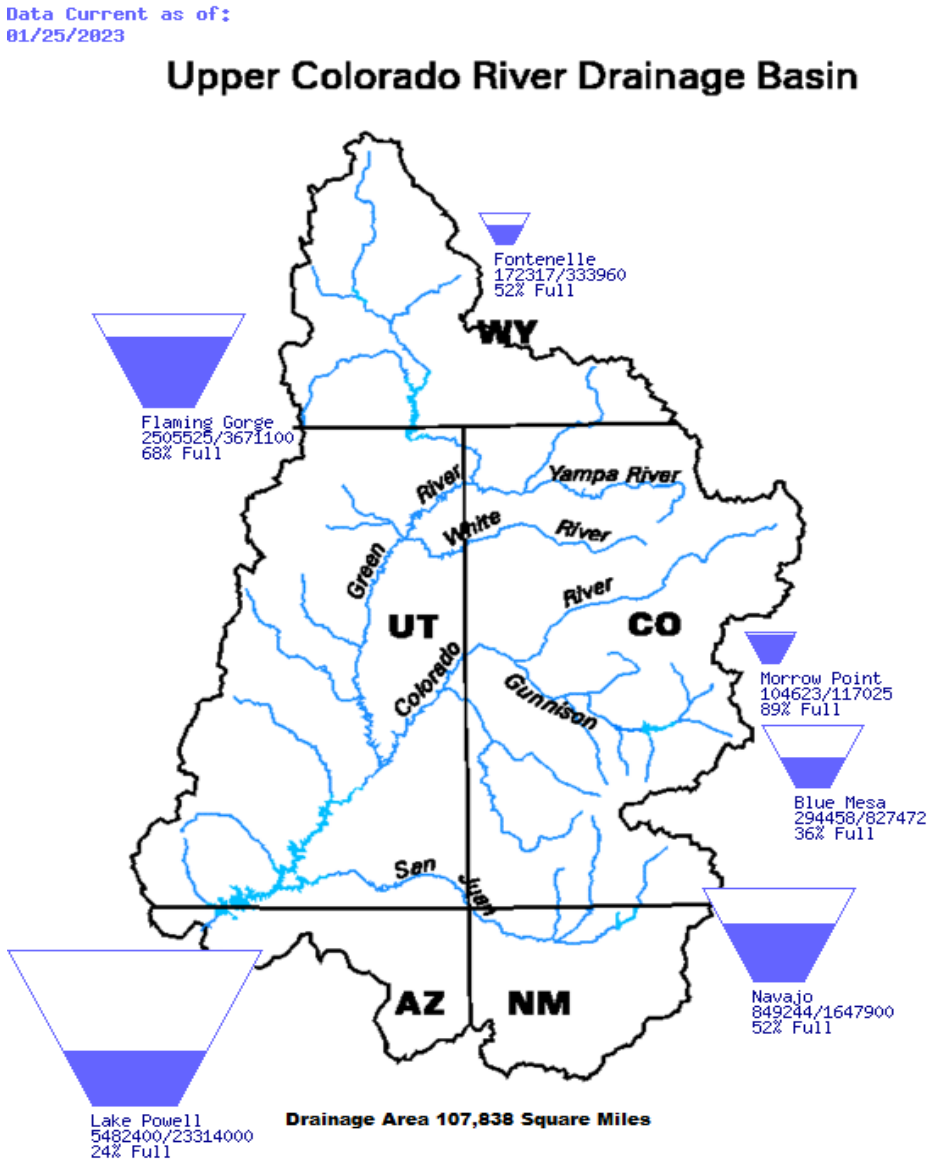
Technical Working Group Glen Canyon Operations

Basin Hydrology and Water Quality

January 26, 2023

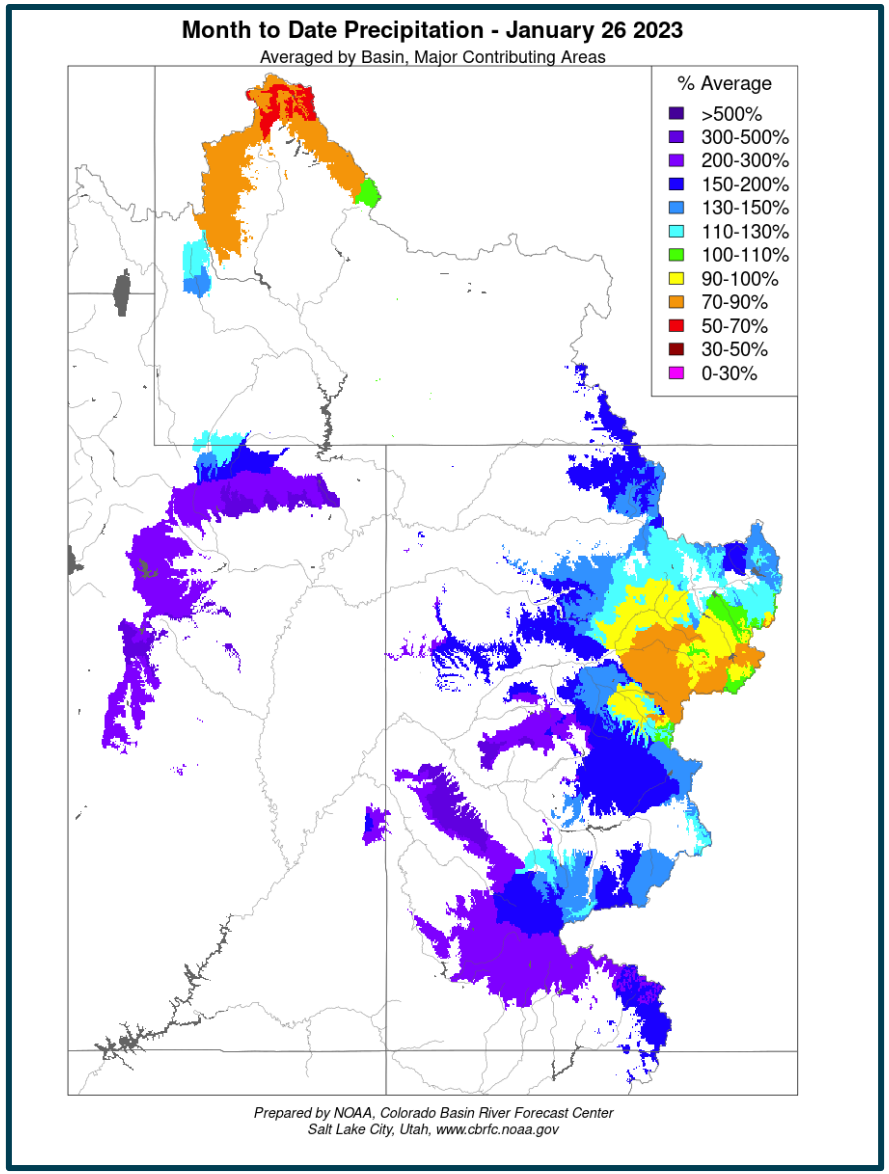
Upper Basin Storage (as of January 25, 2023)

Reservoir	Percent Current Live Storage	Current Live Storage (maf)	Live Storage Capacity (maf)	Elevation (feet)
Fontenelle	52	0.17	0.33	6,482.52
Flaming Gorge	68	2.50	3.67	6,007.47
Blue Mesa	36	0.29	0.83	7,447.25
Navajo	52	0.85	1.65	6,018.09
Lake Powell	24	5.48	23.31	3,523.91
UC System Storage	31	9.43	29.79	
Total System Storage	33	19.10	58.48	

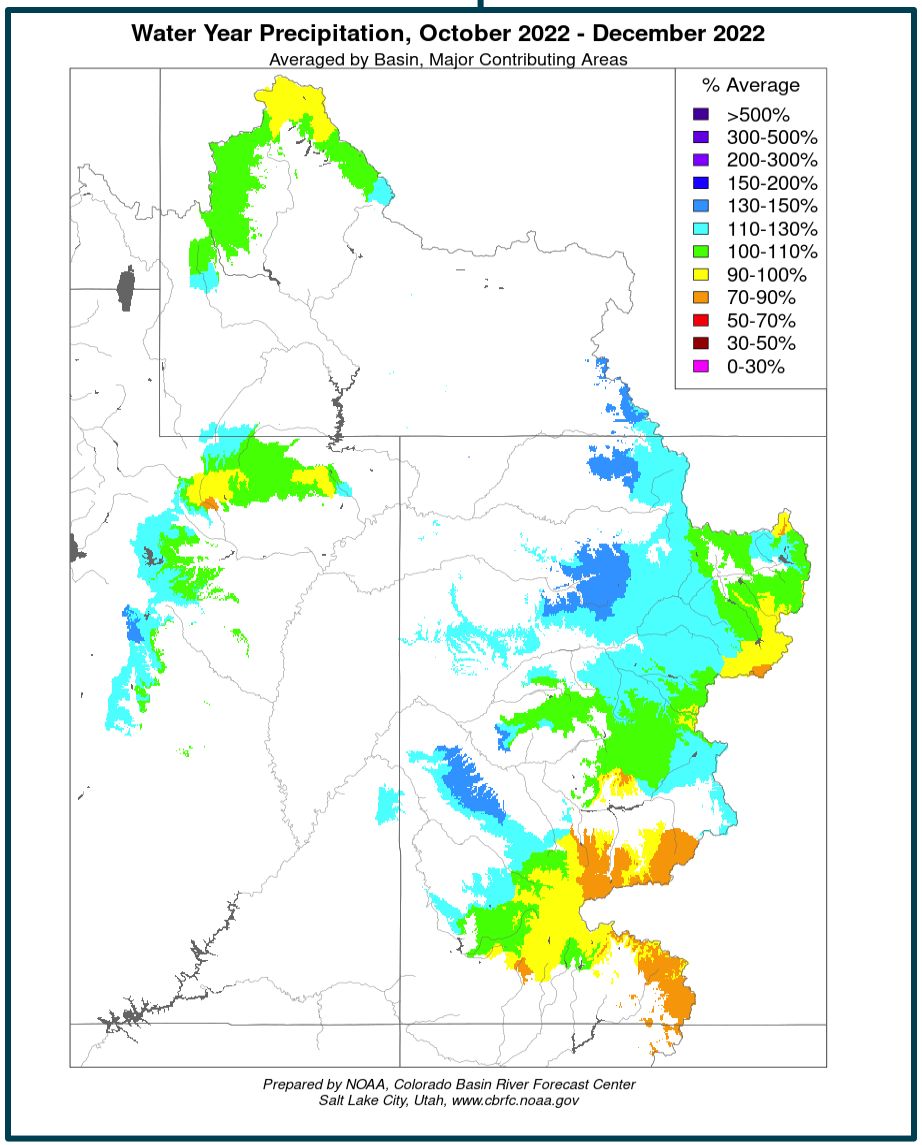


January Month and WY Precipitation

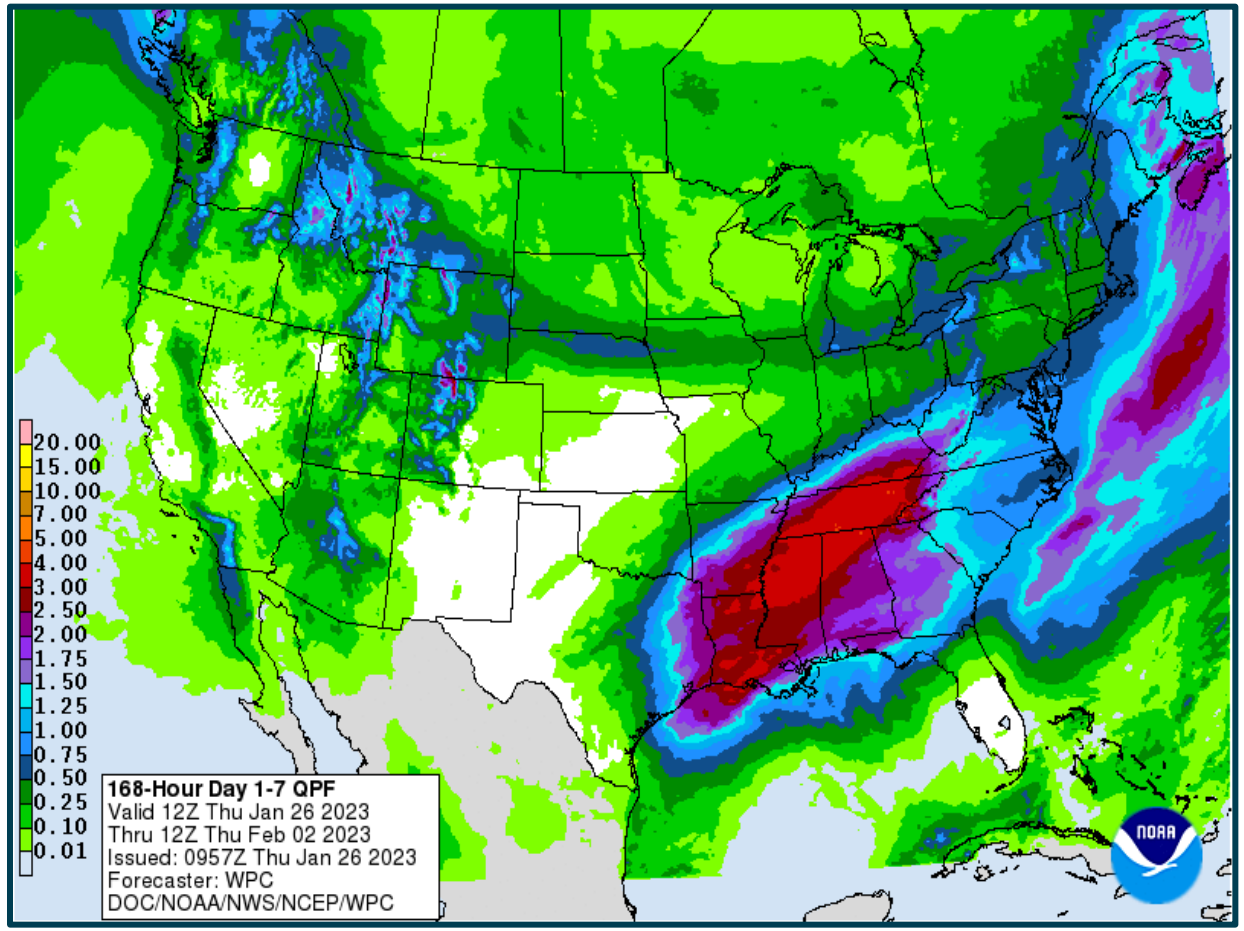
Month to Date Precipitation

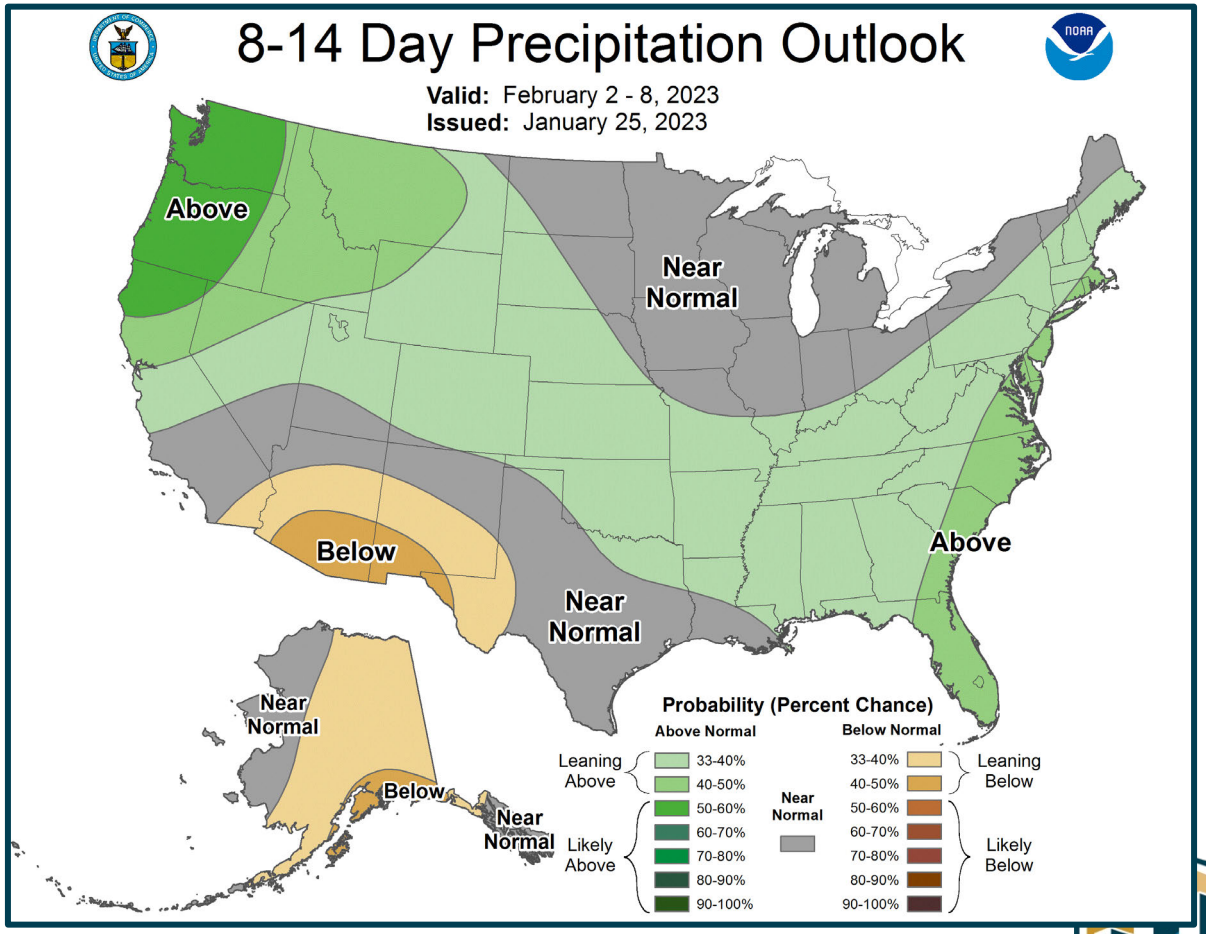


WY Precipitation

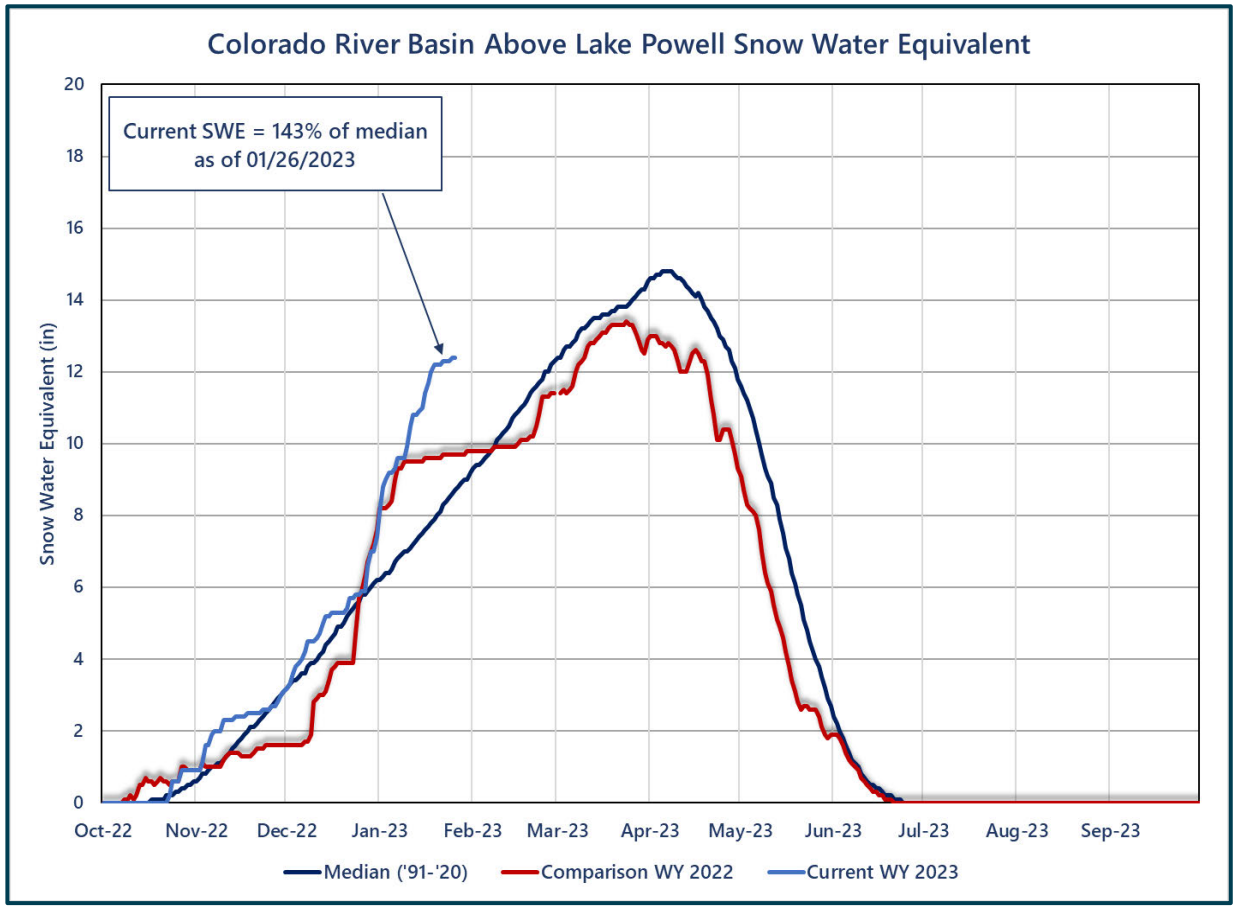


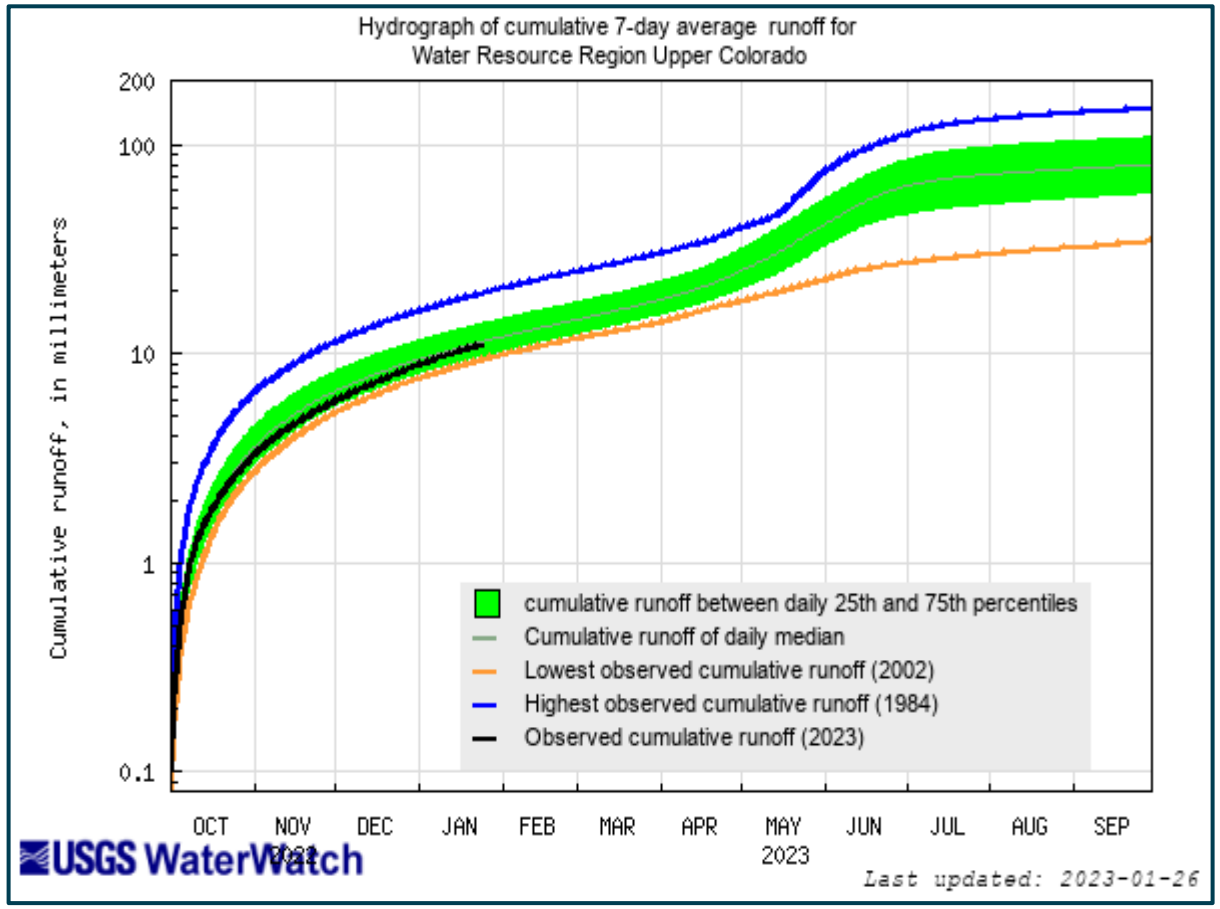
Climate Prediction Center Short-Term Precipitation Forecast



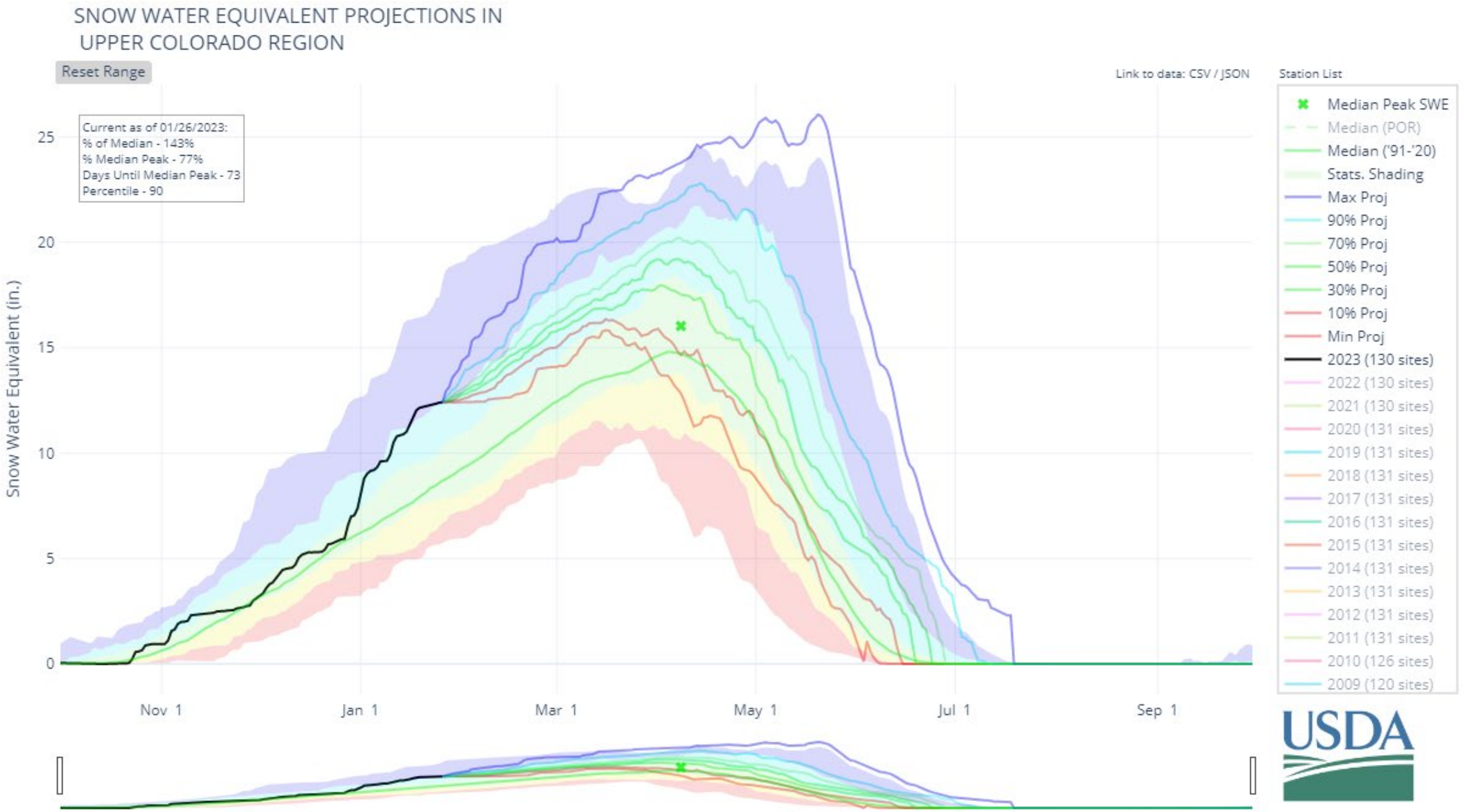


Upper Colorado SWE and Observed Inflows





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



https://www.nrcs.usda.gov/Internet/WCIS/AWS_PLOTS/basinCharts/Proj/WTEQ/stdHUC2/14_Upper_Colorado_Region.html

Most Probable January Forecast
Water Year 2023

April – July 2023
Forecasted Unregulated Inflow

as of January 5, 2023

Reservoir	Inflow (kaf)	Percent of Avg[1]
Fontenelle	700	95
Flaming Gorge	950	98
Blue Mesa	605	95
Navajo	570	91
Powell	6,700	105

Powell midmonth = 7,500 maf (117%)

Water Year 2023
Unregulated Inflow Forecast

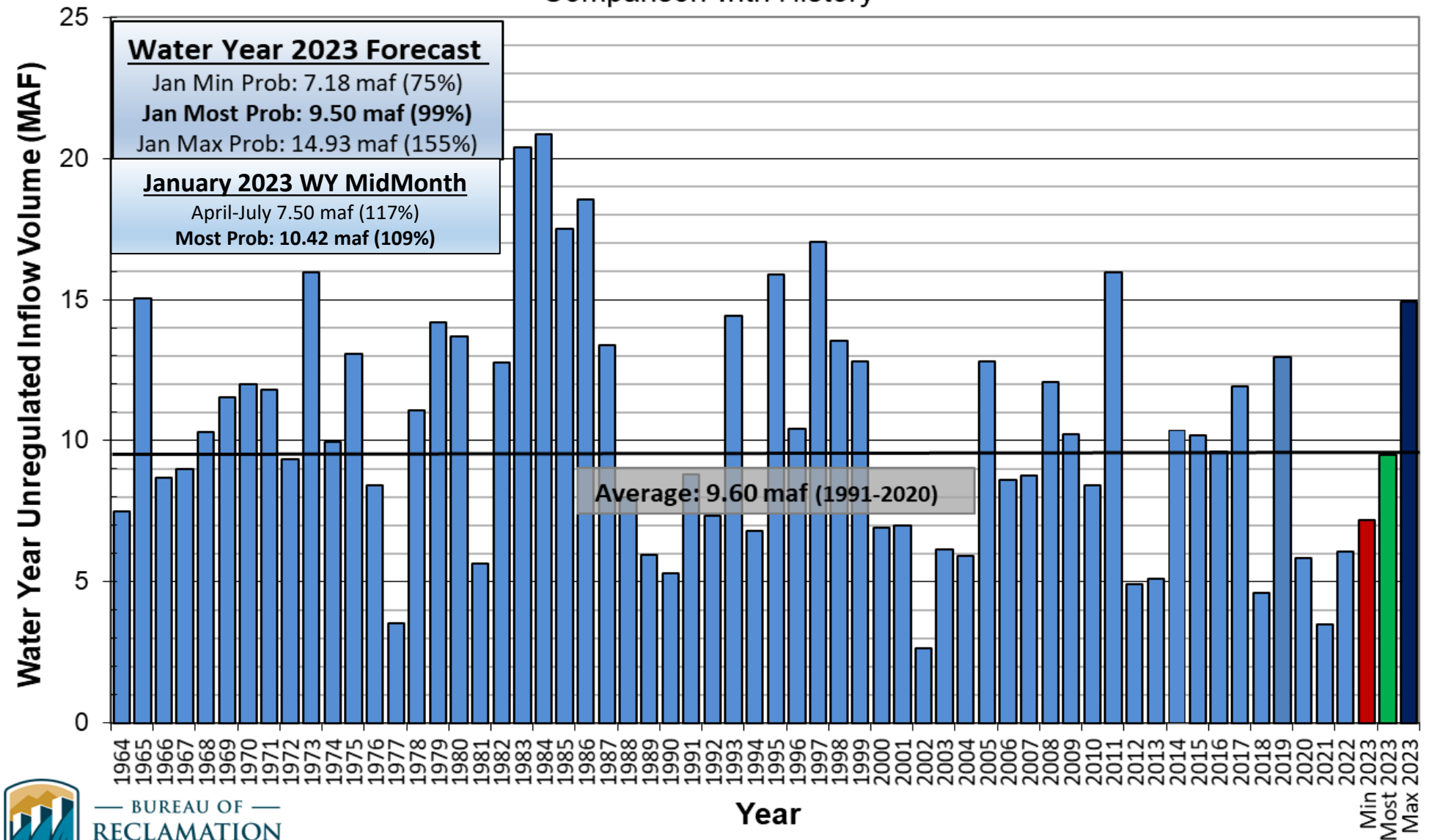
as of January 5, 2023

Reservoir	Inflow (kaf)	Percent of Avg[1]
Fontenelle	990	92
Flaming Gorge	1,323	94
Blue Mesa	838	93
Navajo	790	87
Powell	9,498	99

Powell midmonth = 10,418 maf (109%)

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

Lake Powell Unregulated Inflow
Water Year 2023 Forecast *(issued January 5)*
Comparison with History



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Upper Colorado Basin

Hydrology and Operations Projections Based on January 2023 24-Month Study

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
    - Glen Canyon Dam will hold back a total of 523 kaf during the months of December 2022 through April 2023. There are continued discussions when and how that water will be released later in the year.

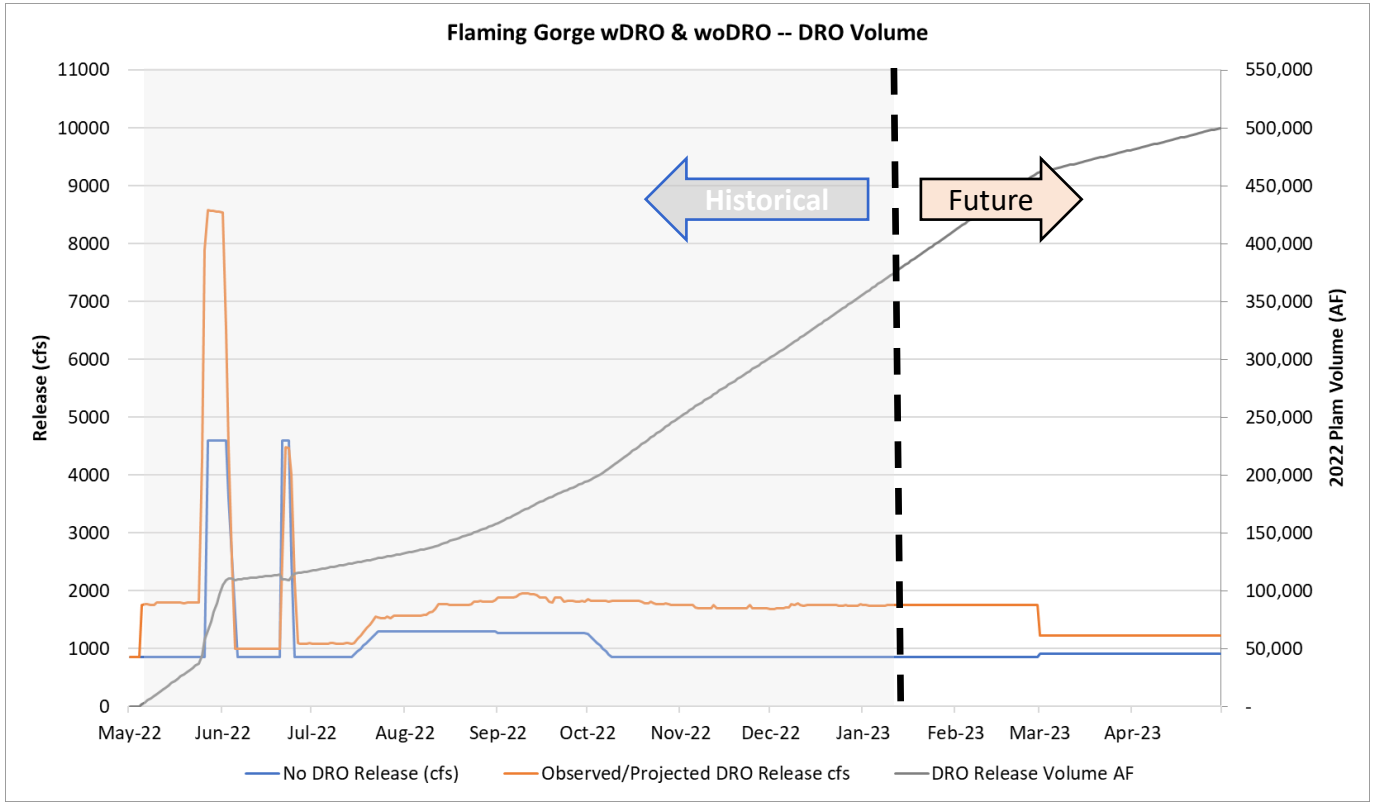
Drought Response Operations Agreement (DROA)

DROA Volumes Released[1]

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

[1]DROA operational year is from May through April.

Flaming Gorge 2022 Plan Daily Releases



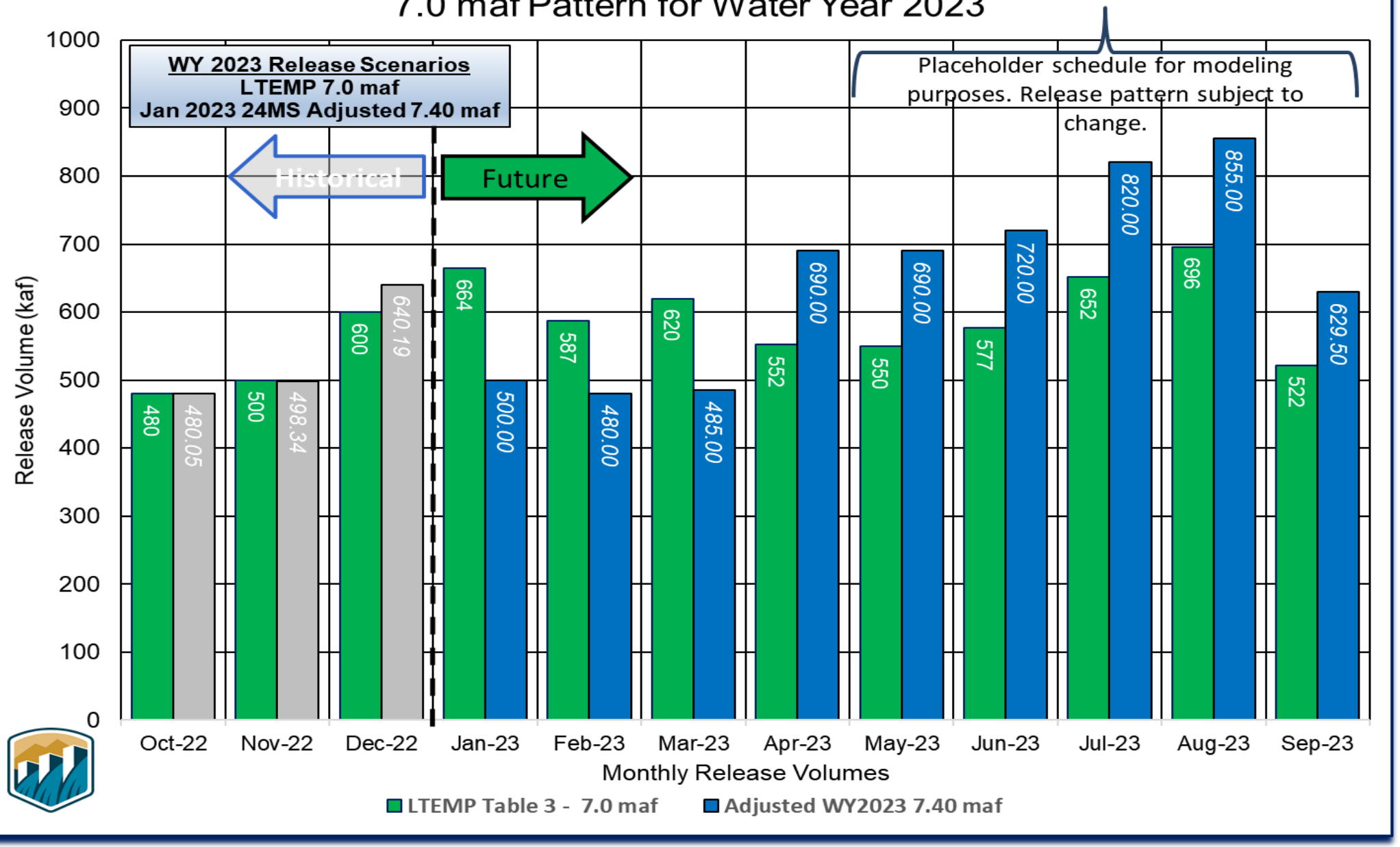
Flaming Gorge DROA release as of January 22 = 393 kaf

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 Monthly Release Volume Distribution

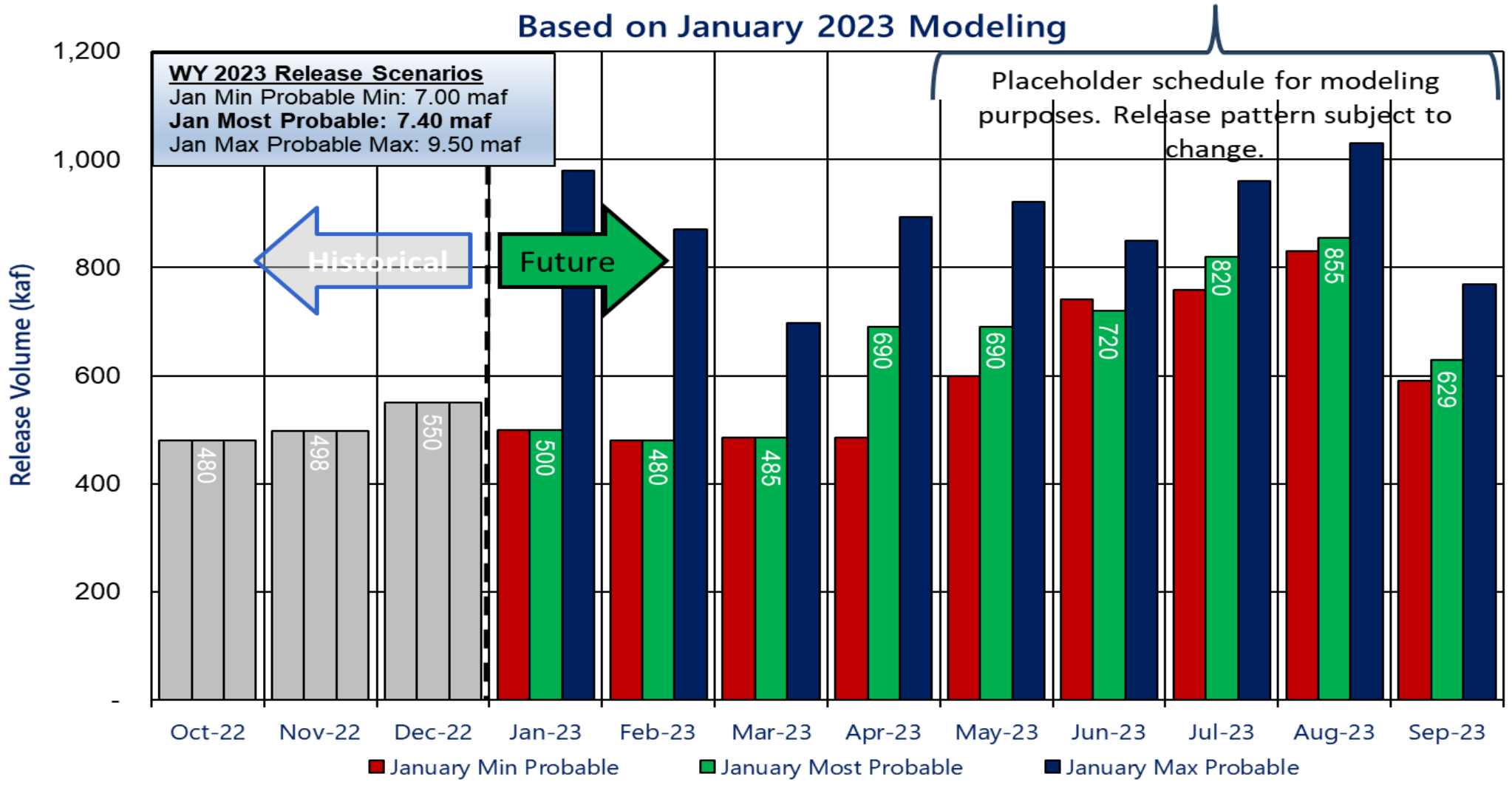
7.0 maf Pattern for Water Year 2023



Potential Lake Powell Monthly Release Volume Distribution

Release Scenarios for Water Year 2023

Based on January 2023 Modeling



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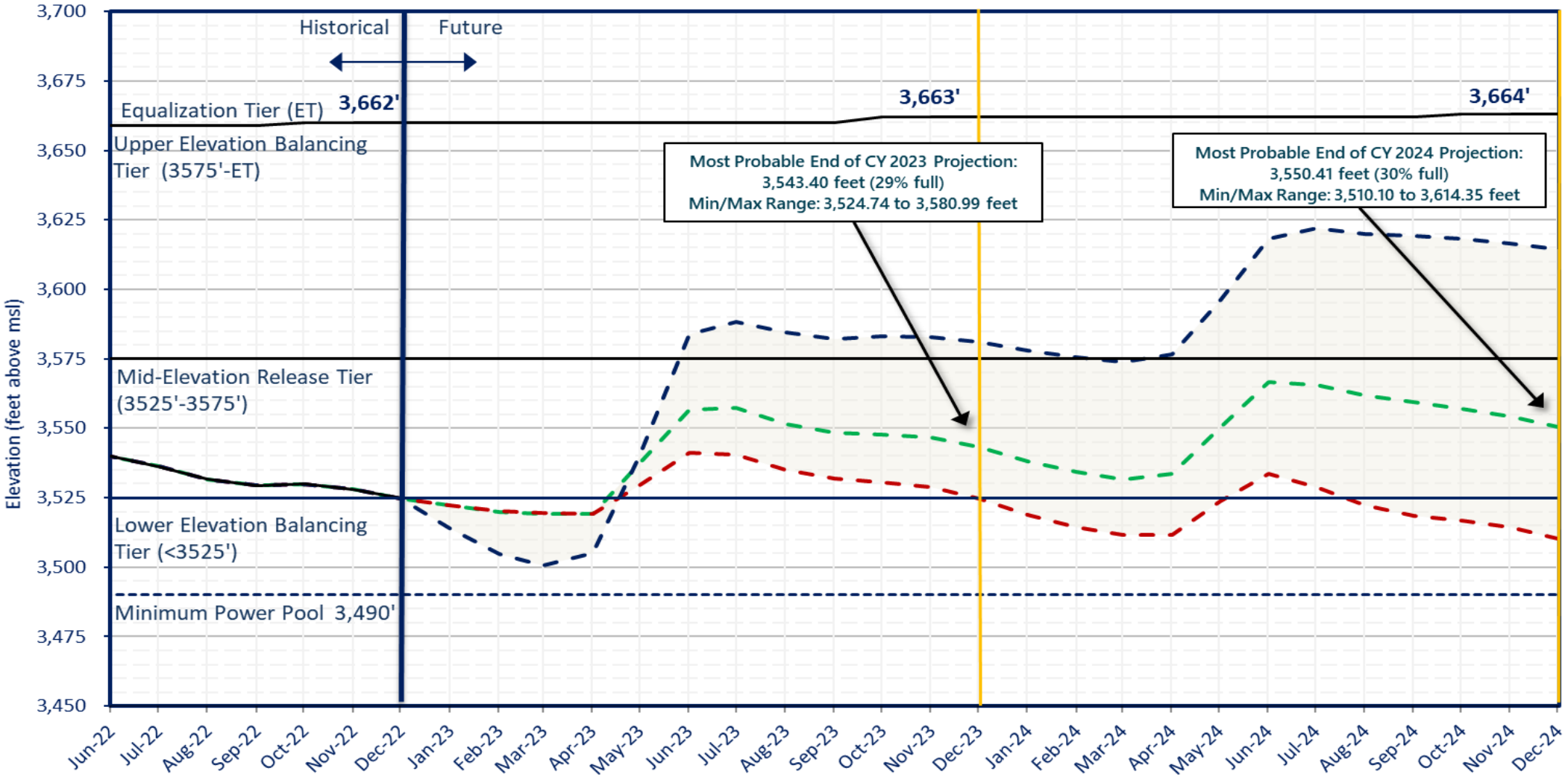
Reclamation Operational Modeling
Model Comparison

	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[1]

Projections from the January 2023 24-Month Study Inflow Scenarios

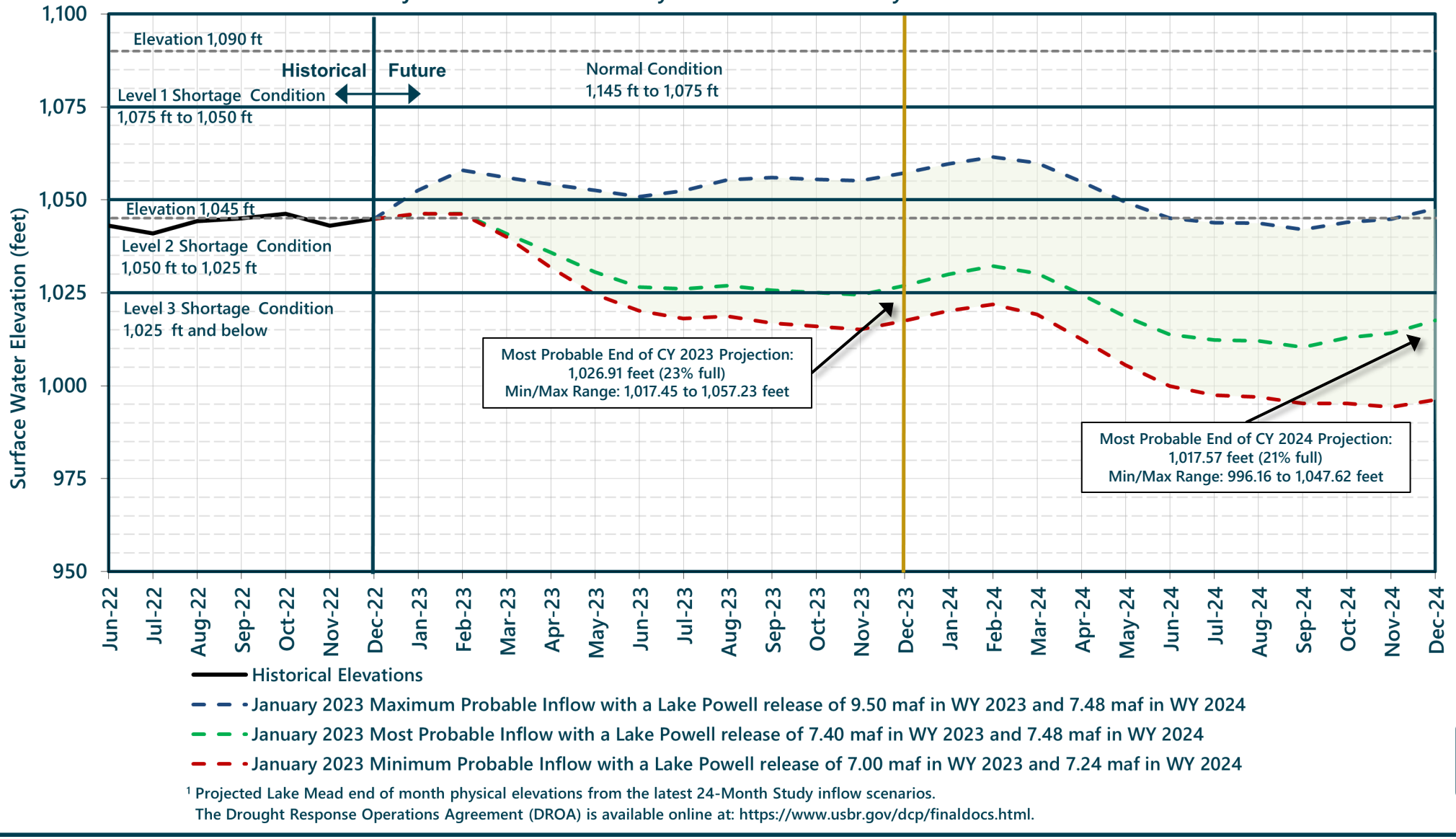


- January 2023 Most Probable Inflow - Lake Powell release of 7.40 maf in WY2023 and 7.48 maf in WY2024
- January 2023 Minimum Probable Inflow - Lake Powell release of 7.0 maf in WY2023 and 7.24 maf in WY2024
- January 2023 Maximum Probable Inflow - Lake Powell release of 9.5 maf in WY2023 and 7.48 maf in WY2024
- Historical Elevations

[1]Projected Lake Powell end-of-month physical elevations from the latest 24-Month Study inflow scenarios.
Additional information can be found here: https://www.usbr.gov/dcp/droa.html

Lake Mead End of Month Elevations[1]

Projections from the January 2023 24-Month Study Inflow Scenarios



[1] Projected Lake Mead end of month physical elevations from the latest 24-Month Study inflow scenarios.
The Drought Response Operations Agreement (DROA) is available online at: https://www.usbr.gov/dcp/finaldocs.html.

The chart above displays projected "physical" elevations for Lake Mead.

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	4	6	6	6	6	6	4	
Capacity (cfs)	18,200	18,150	18,050	18,000	17,880	11,240	17,850	18,450	19,000	19,000	18,900	11,880	JAN MOST[2]
Capacity (kaf/month)	1,120	1,080	1,110	1,110	950	760	1,060	1,130	1,130	1,170	1,160	780	JAN MOST
Max (kaf) [1]	480	498	550	980	870	698	893	921	850	960	1,030	770	9.50 maf
Most (kaf) [1]	480	498	550	500	480	485	690	690	720	820	855	630	7.40 maf
Min (kaf) [1]	480	498	550	500	480	485	485	600	741	759	831	591	7.00 maf
										(updated 01-17-2023)			

1 Projected release, based on January 2023 for the 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.

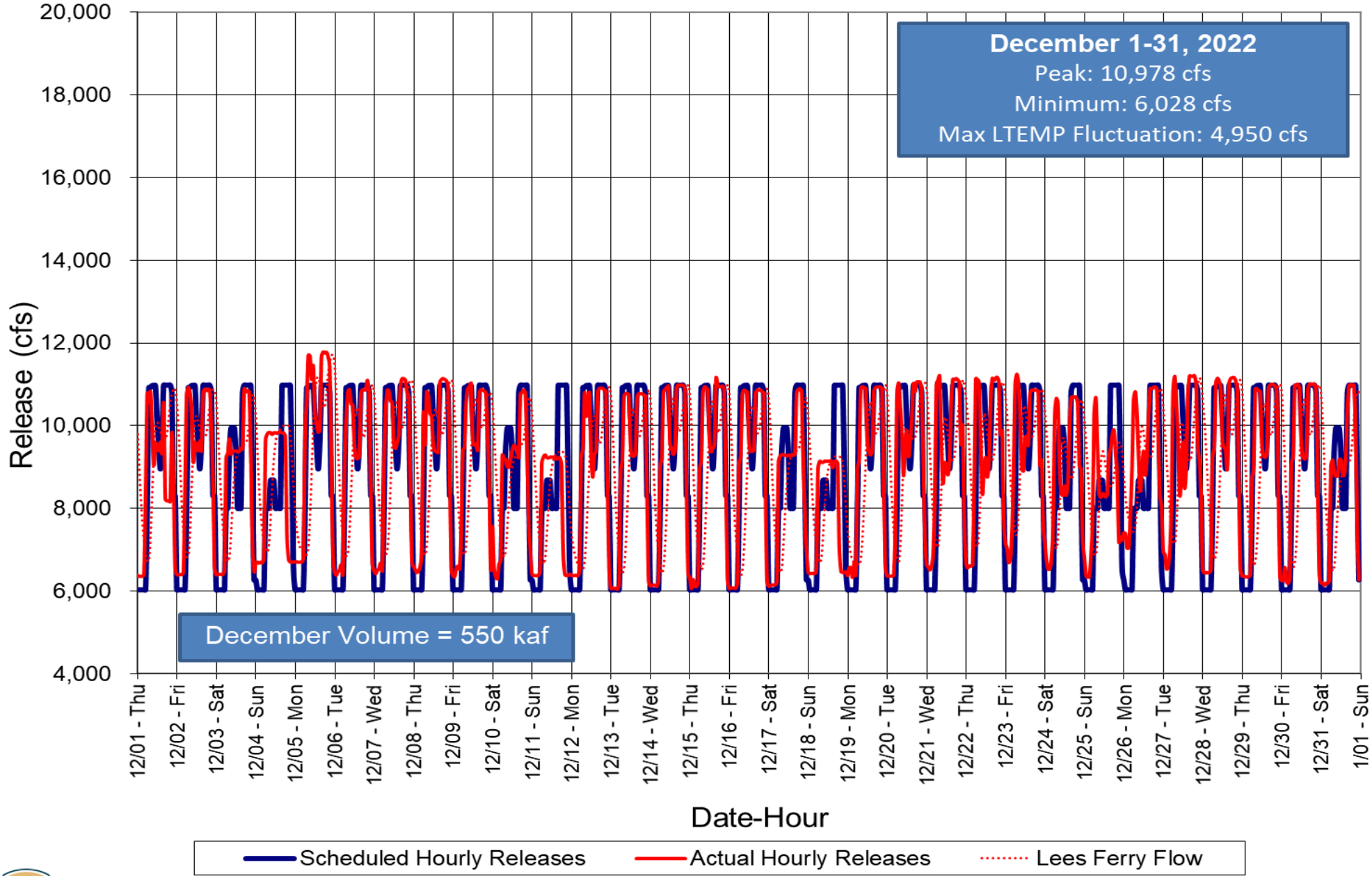
Glen Canyon Dam Power Plant Unit Outage Schedule for WY2024

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	
1													
2													
3													
4													
5													
6													
7													
8													
Units Available	6	6	7	8	6	7	5	6	6	6	6	4	
Capacity (cfs)	18,800	18,750	22,100	25,300	18,400	21,650	14,950	18,860	19,340	19,300	19,000	12,100	JAN MOST[2]
Capacity (kaf/month)	1,250	1,220	1,400	1,560	1,110	1,480	1,040	1,260	1,190	1,190	1,180	790	JAN 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	690	610	650	570	570	600	680	730	563	7.24 maf
										(updated 01-16-2023)			

1 Projected release, based on January 2023 for the 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 December 2022



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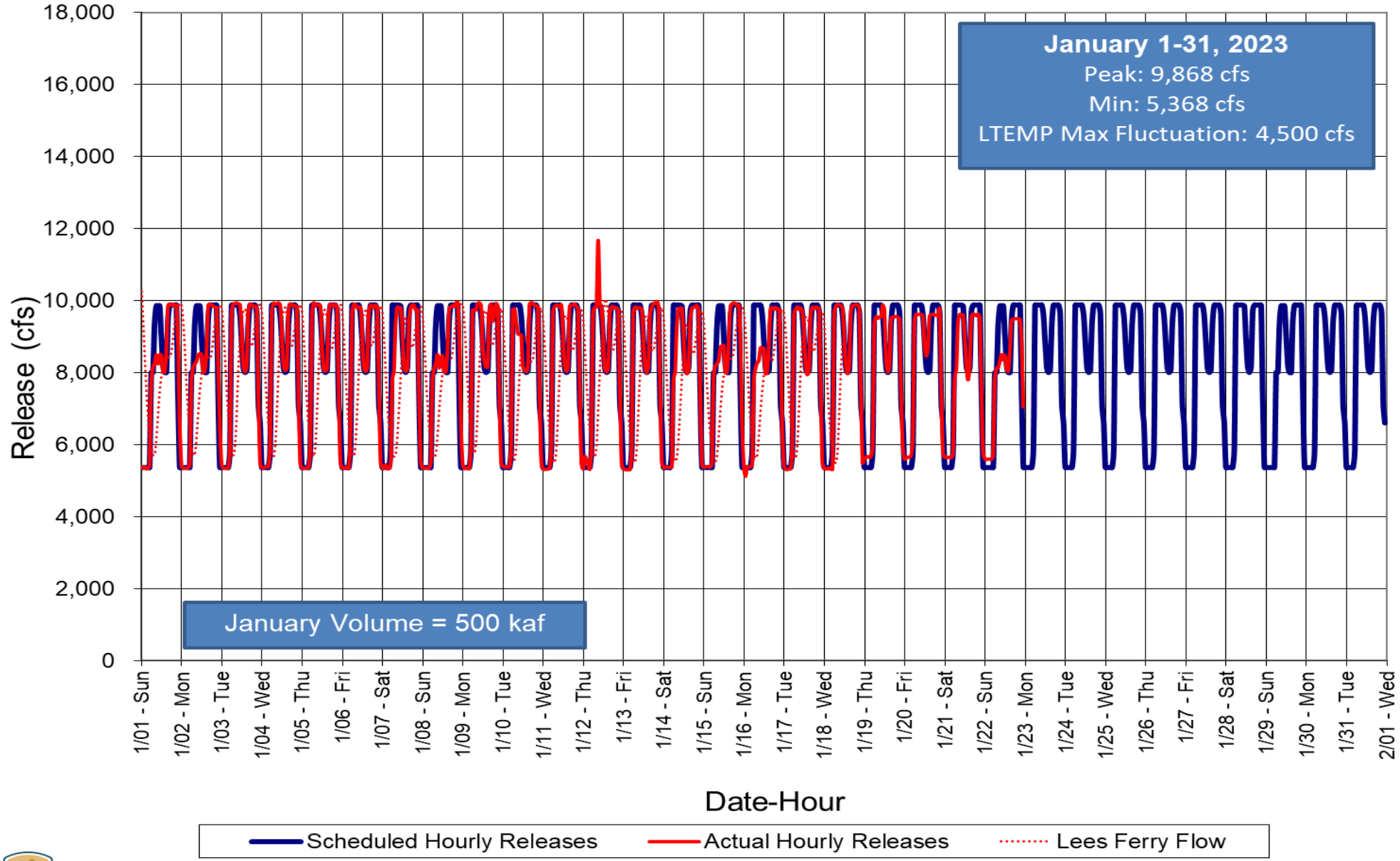
Glen Canyon Dam Hourly Release Pattern January 2023



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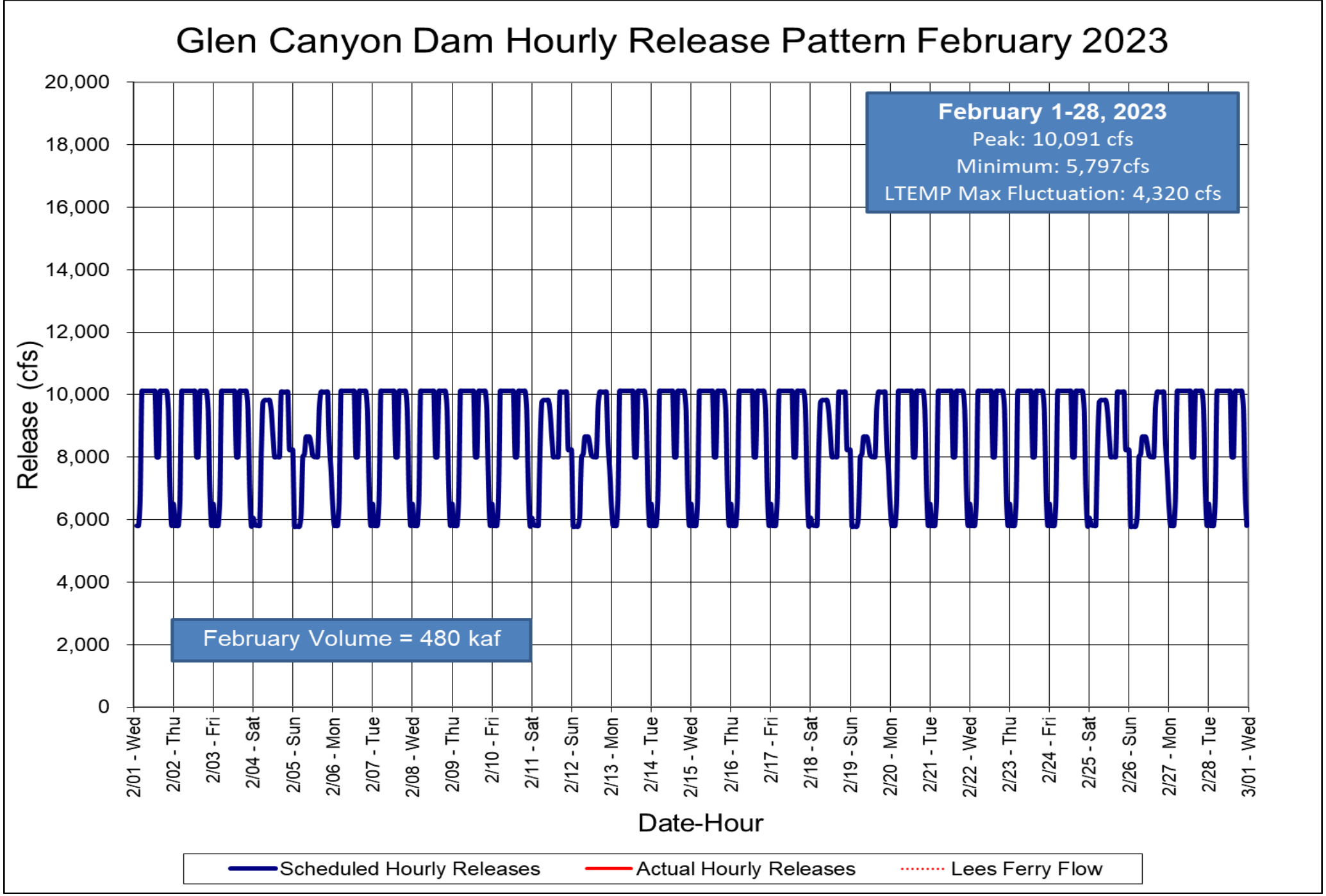
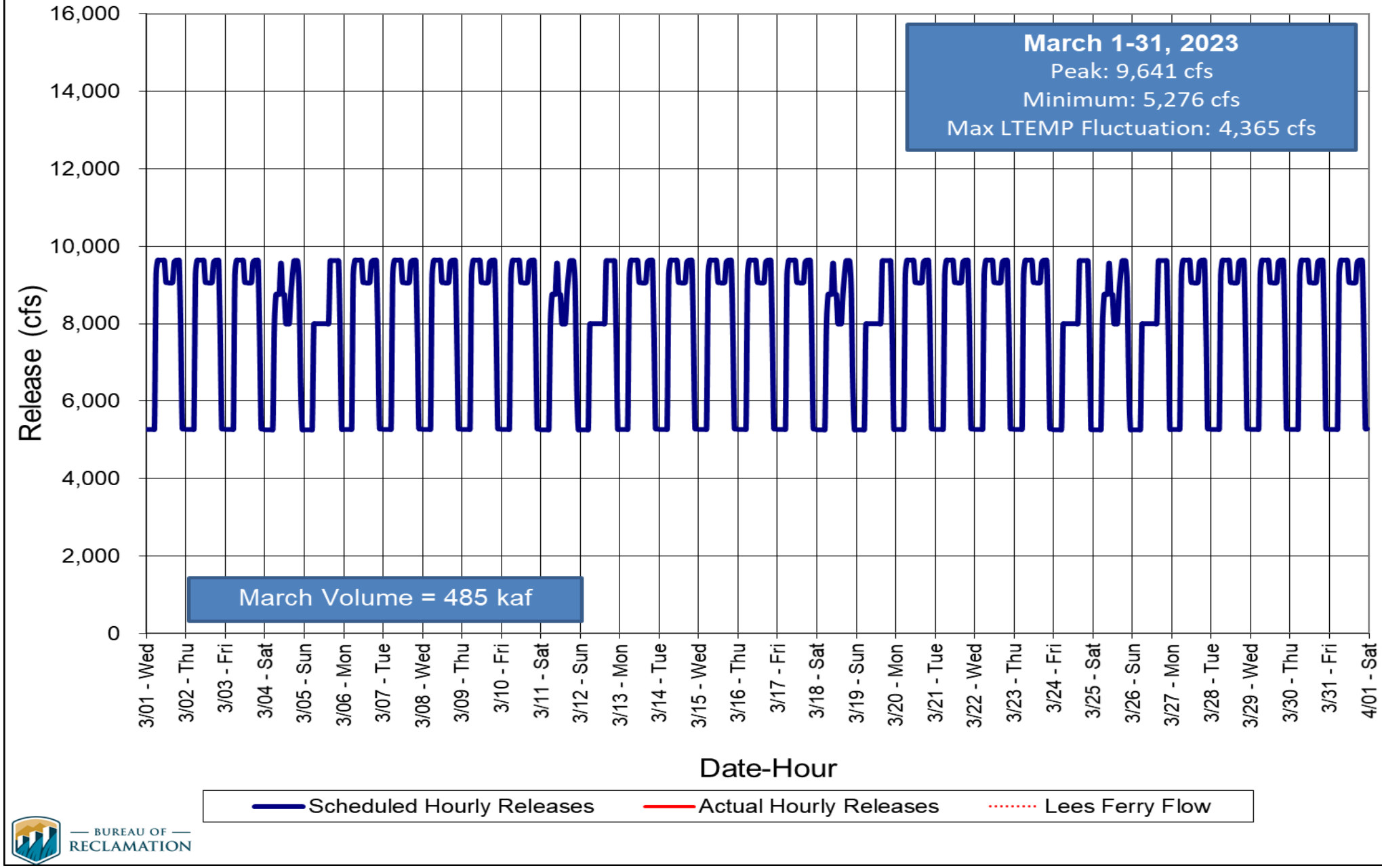

Glen Canyon Dam Hourly Release Pattern February 2023
February 1-28, 2023
Peak: 10,091 cfs
Minimum: 5,797cfs
LTEMP Max Fluctuation: 4,320 cfs
February Volume = 480 kaf
Release (cfs)
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
2/01 - Wed
2/02 - Thu
2/03 - Fri
2/04 - Sat
2/05 - Sun
2/06 - Mon
2/07 - Tue
2/08 - Wed
2/09 - Thu
2/10 - Fri
2/11 - Sat
2/12 - Sun
2/13 - Mon
2/14 - Tue
2/15 - Wed
2/16 - Thu
2/17 - Fri
2/18 - Sat
2/19 - Sun
2/20 - Mon
2/21 - Tue
2/22 - Wed
2/23 - Thu
2/24 - Fri
2/25 - Sat
2/26 - Sun
2/27 - Mon
2/28 - Tue
3/01 - Wed
Date-Hour
Scheduled Hourly Releases
Actual Hourly Releases
Lees Ferry Flow

Glen Canyon Dam Hourly Release Pattern March 2023



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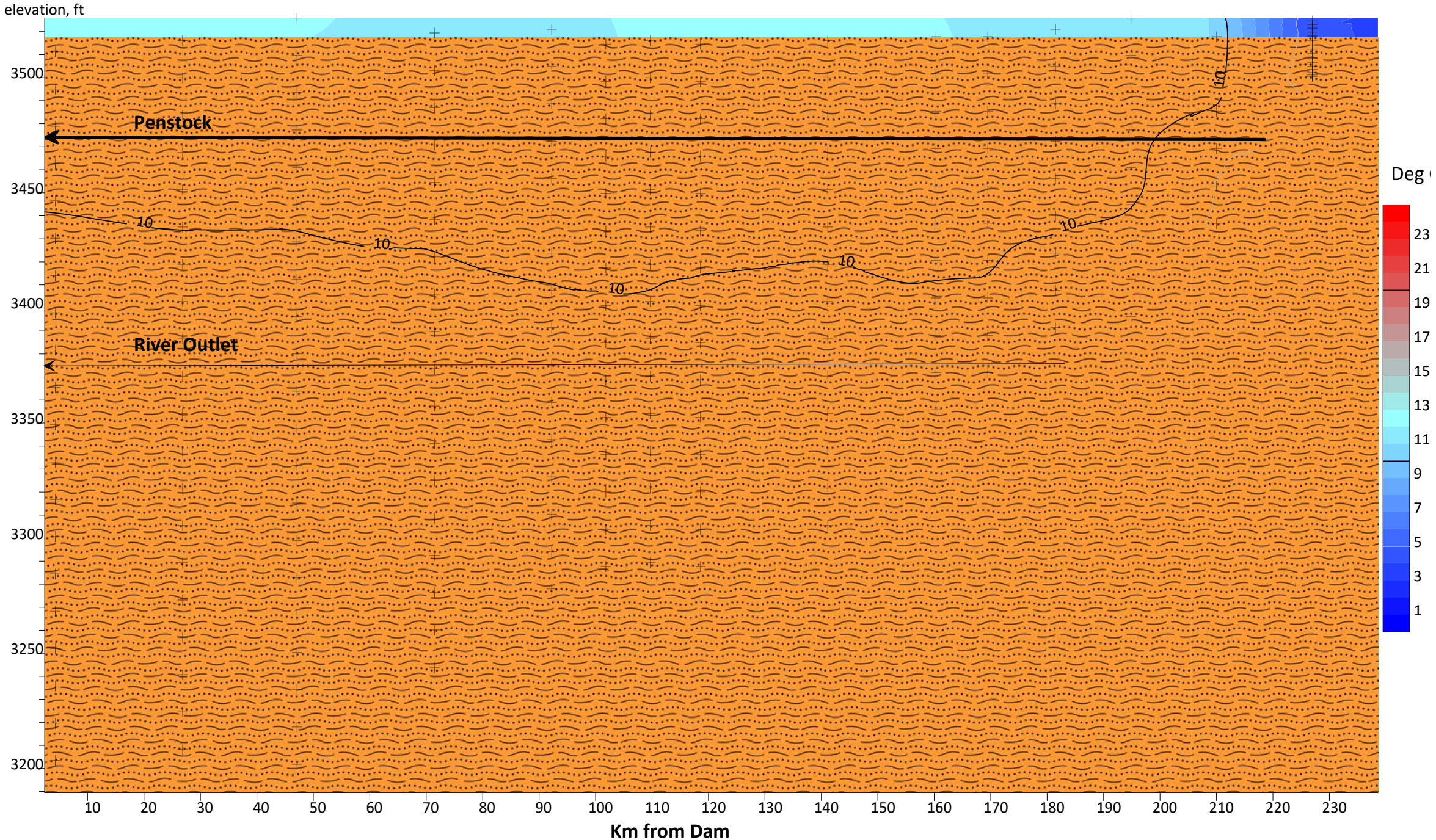
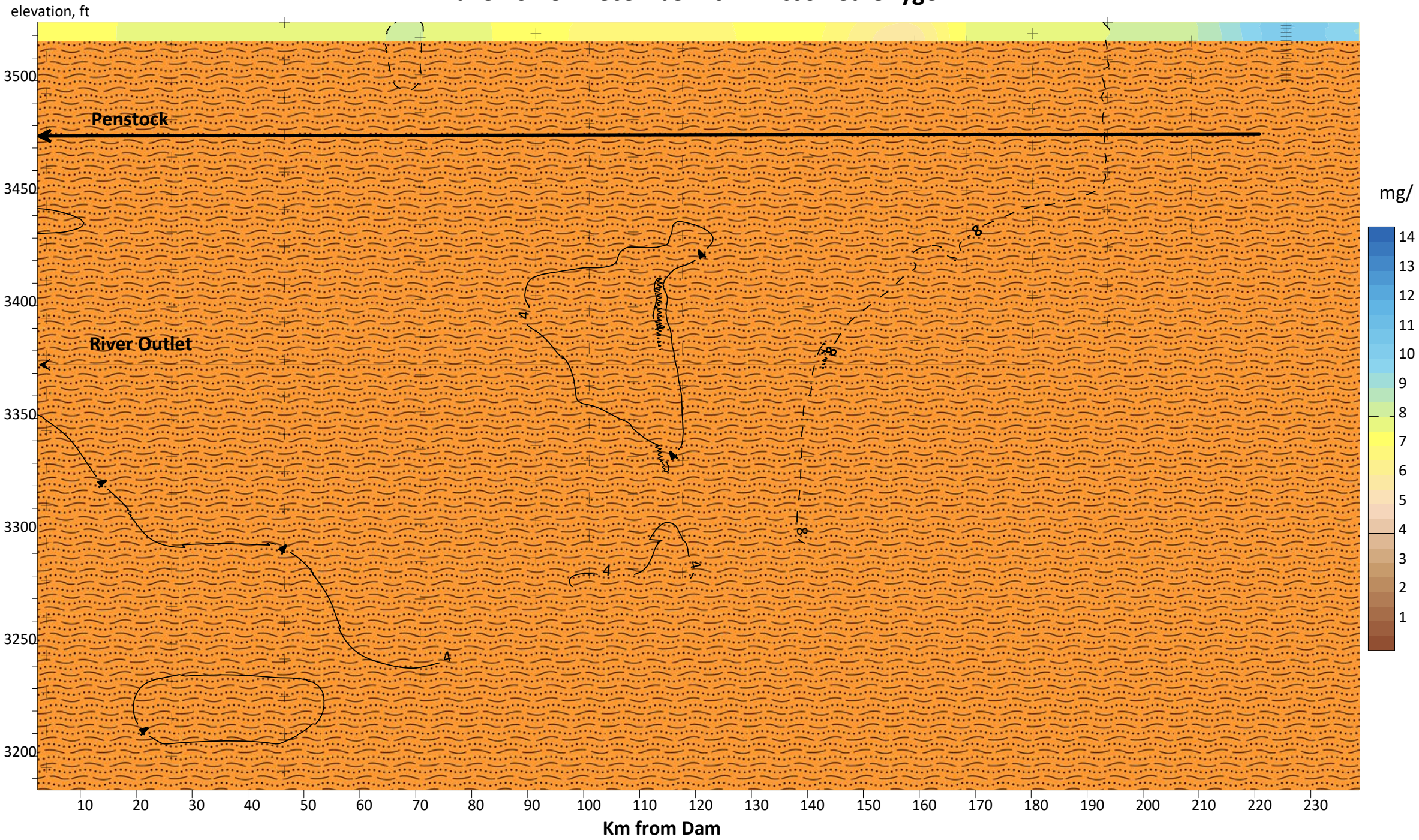
Water Quality

Lake Powell Temperature Dec 2022

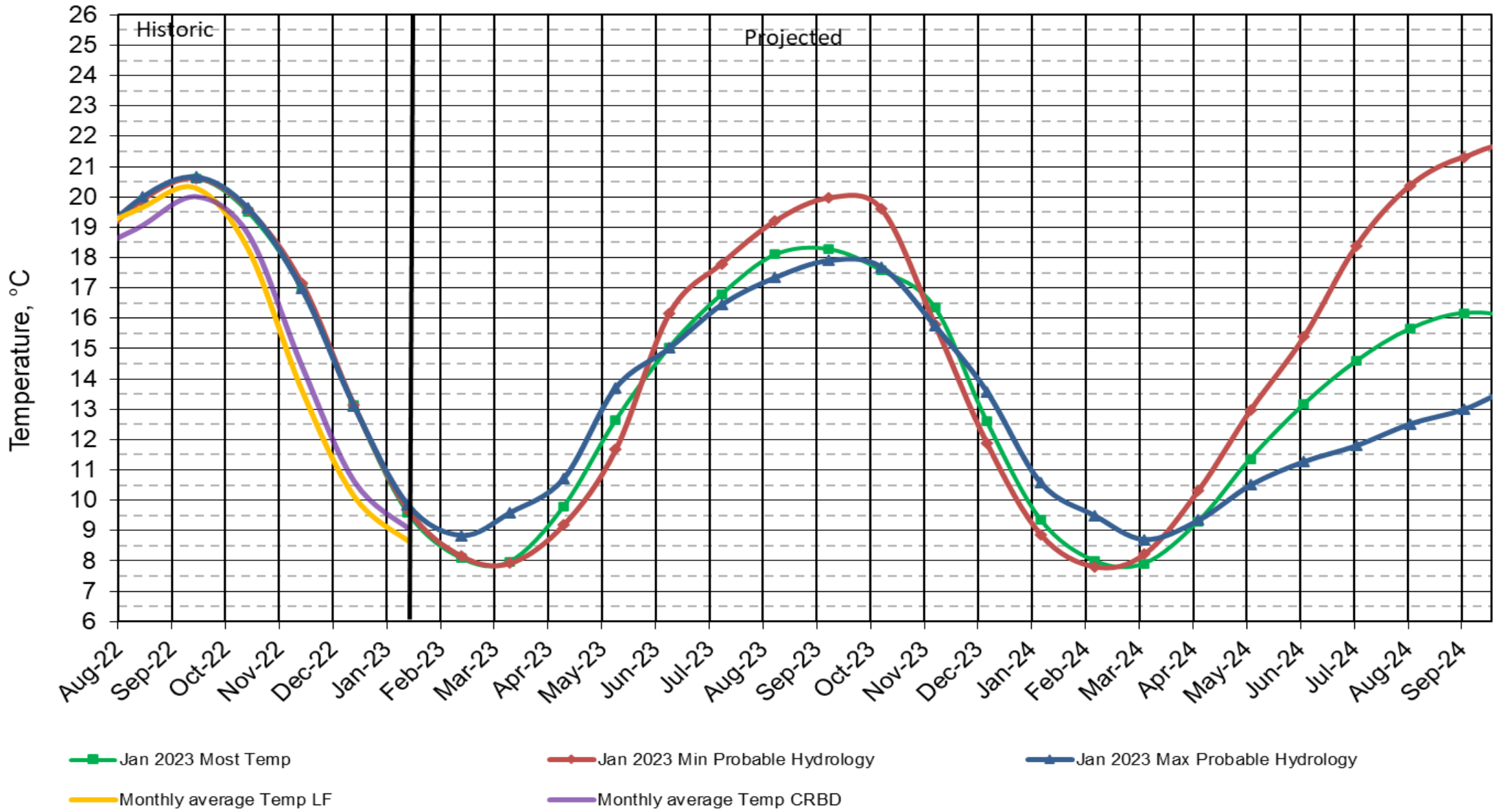


Lake Powell December 2022 Dissolved Oxygen

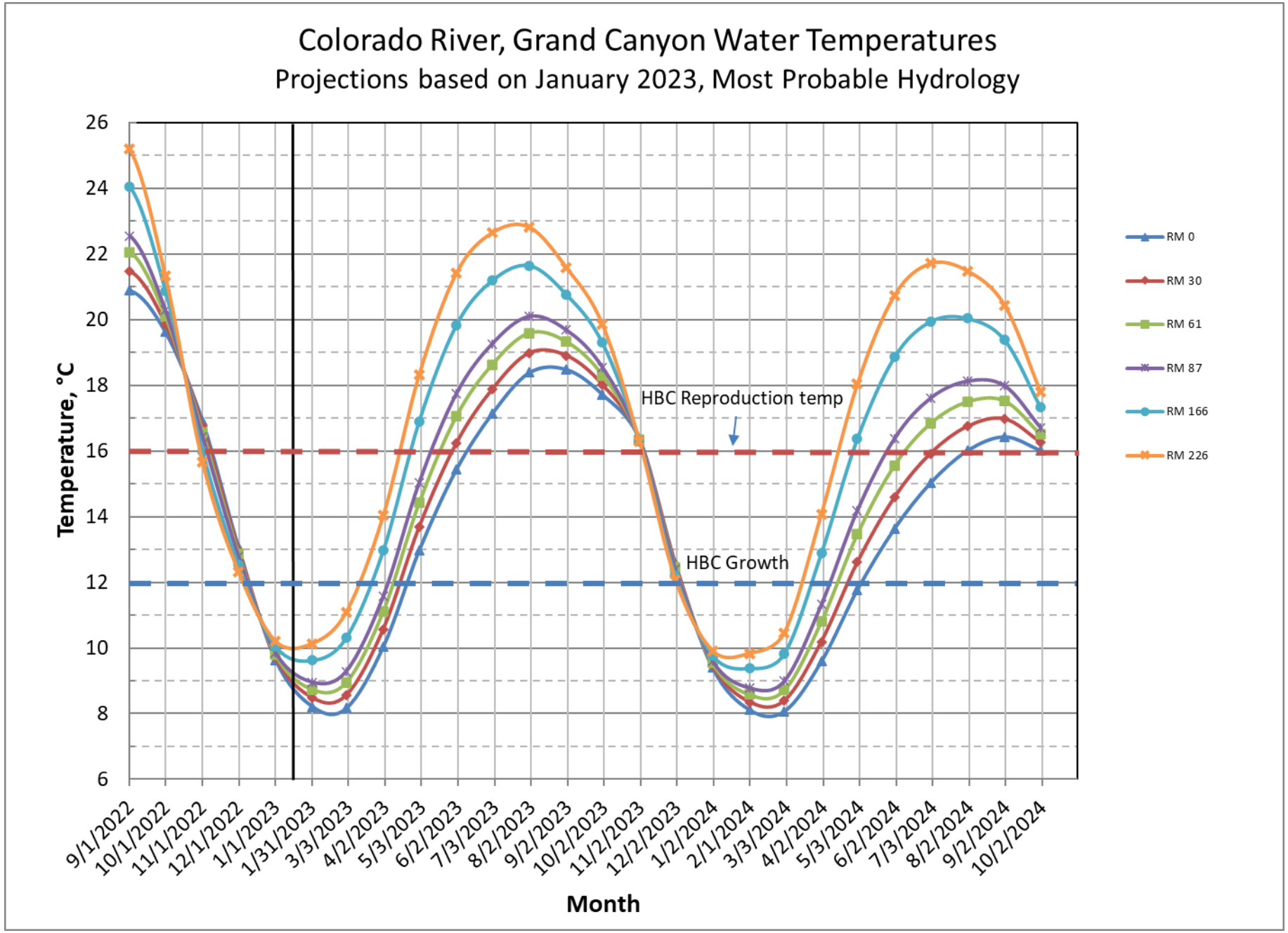


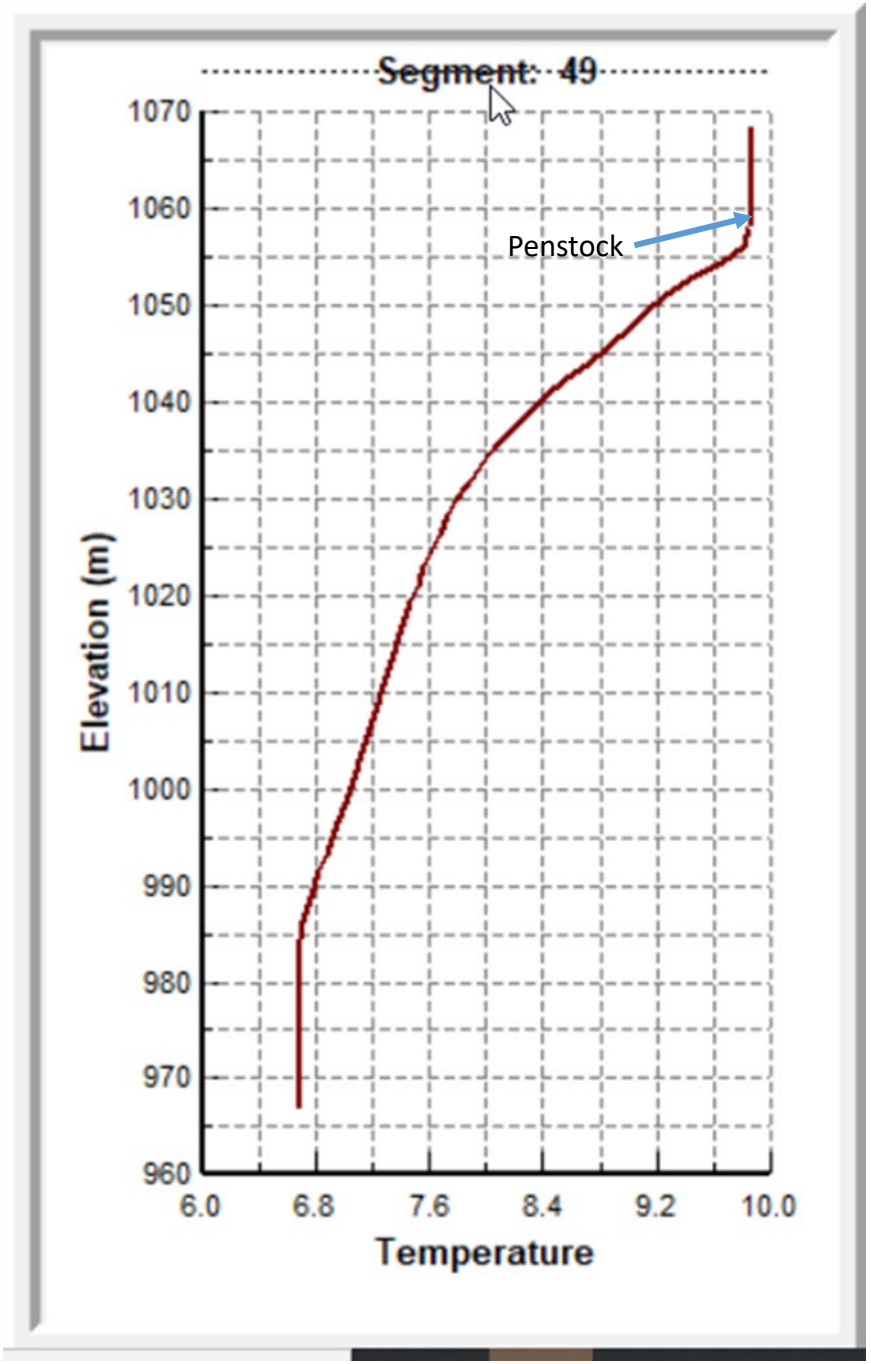
Lake Powell Release Temperature

Projected Temperature based on January 2023 Forecast



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


Colorado River, Grand Canyon Water Temperatures
Projections based on January 2023, Most Probable Hydrology
Temperature, °C
26
24
22
20
18
16
14
12
10
8
6
HBC Reproduction temp
HBC Growth
9/1/2022
10/1/2022
11/1/2022
12/1/2022
1/1/2023
1/31/2023
3/3/2023
4/2/2023
5/3/2023
6/2/2023
7/3/2023
8/2/2023
9/2/2023
10/2/2023
11/2/2023
12/2/2023
1/2/2024
2/1/2024
3/3/2024
4/2/2024
5/3/2024
6/2/2024
7/3/2024
8/2/2024
9/2/2024
10/2/2024
Month
RM 0
RM 30
RM 61
RM 87
RM 166
RM 226


Segment: 49
Penstock
Elevation (m)
1070
1060
1050
1040
1030
1020
1010
1000
990
980
970
960
6.0
6.8
7.6
8.4
9.2
10.0
Temperature

Daily Water Quality Data at Glen Canyon D..

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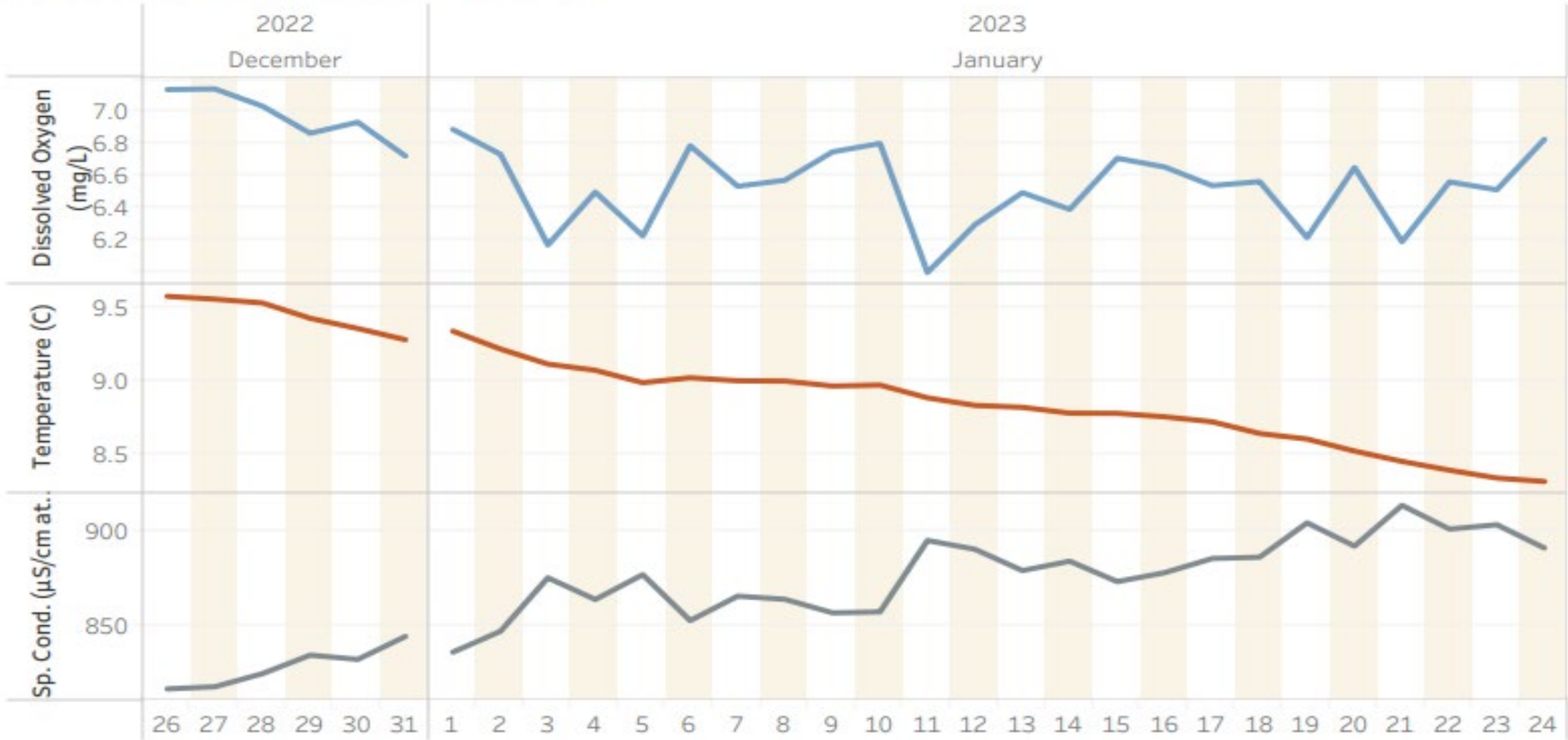
Daily Dissolved Oxygen & Temperature Values



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

Select Date Extent
12/26/2022 to 1/24/2023

These data are preliminary or provisional and are subject to revision. They are being provided to meet the need for timely best science. The data have not received final approval by the U.S. Geol..

Daily Water Quality Data at Glen Canyon Dam

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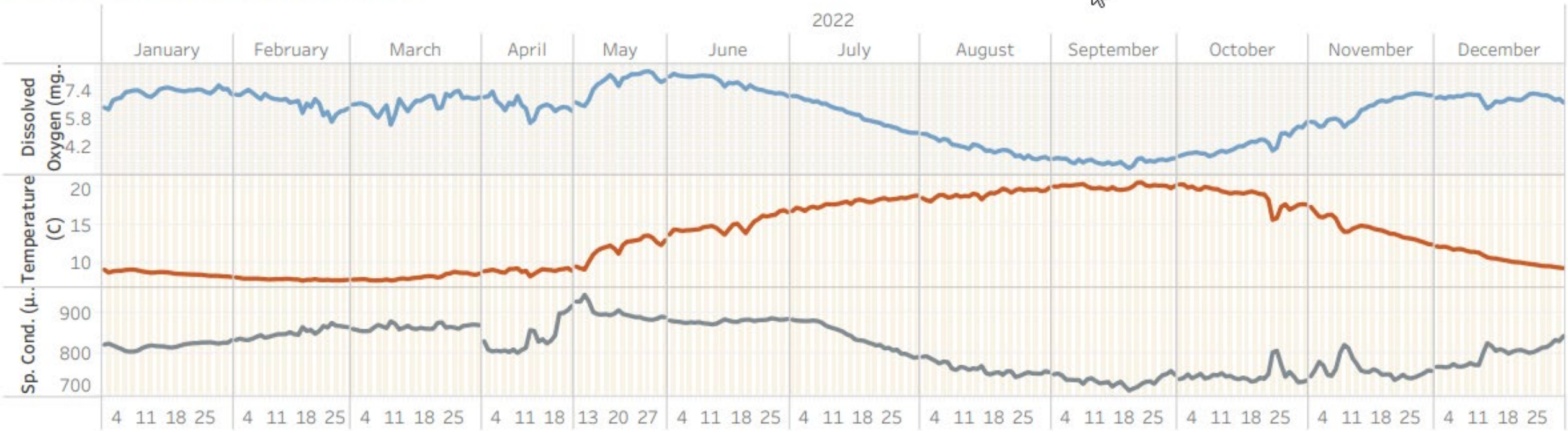
Daily Dissolved Oxygen & Temperature Values



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

Select Date.. 1/1/2022 to 12/31/2022

These data are preliminary or provisional and are subject to revision. They are being provided to meet the need for timely best science. The data have ..


Questions?
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