

RECLAMATION

Managing Water in the West

Basin Hydrology, Operations and 2018 Hydrograph

Glen Canyon Technical Work Group
August 30, 2017

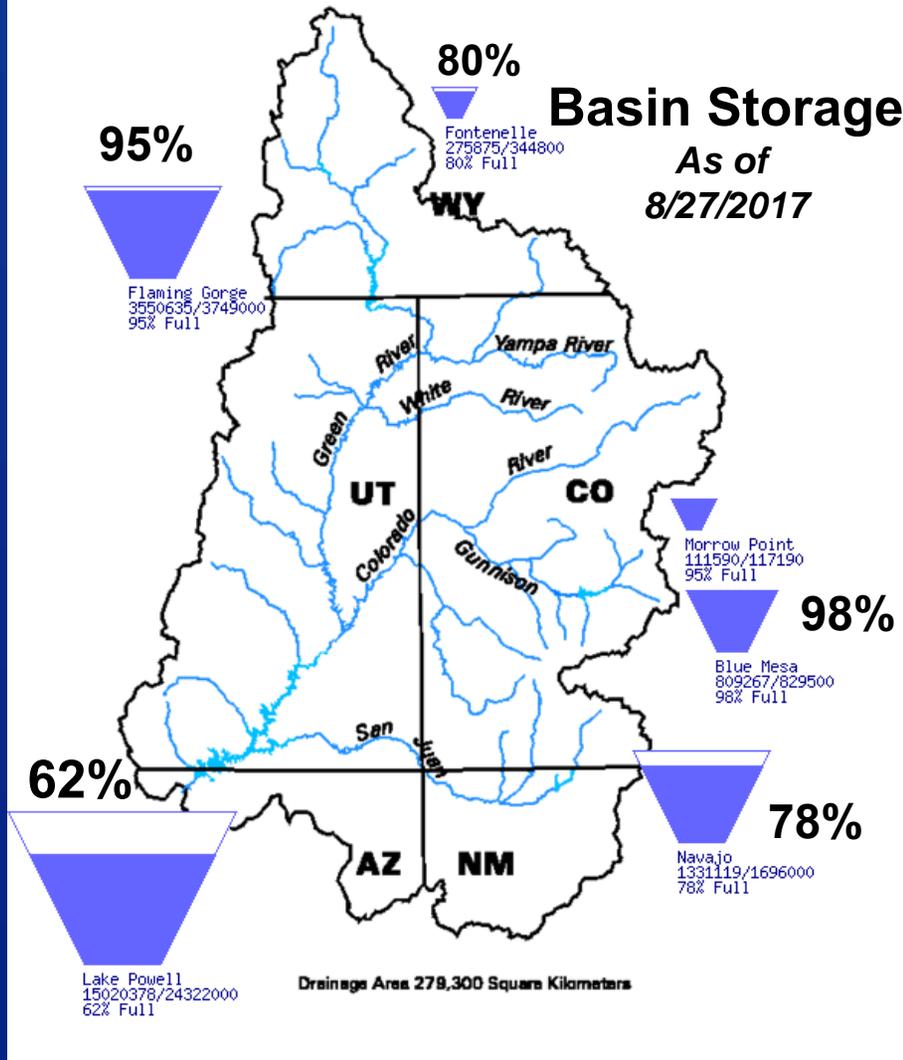


U.S. Department of the Interior
Bureau of Reclamation

Upper Basin Storage

Data Current as of:
8/27/2017

Upper Colorado River Drainage Basin



<http://www.usbr.gov/uc/water/basin/index.html>

April to July 2017 Observed Inflow

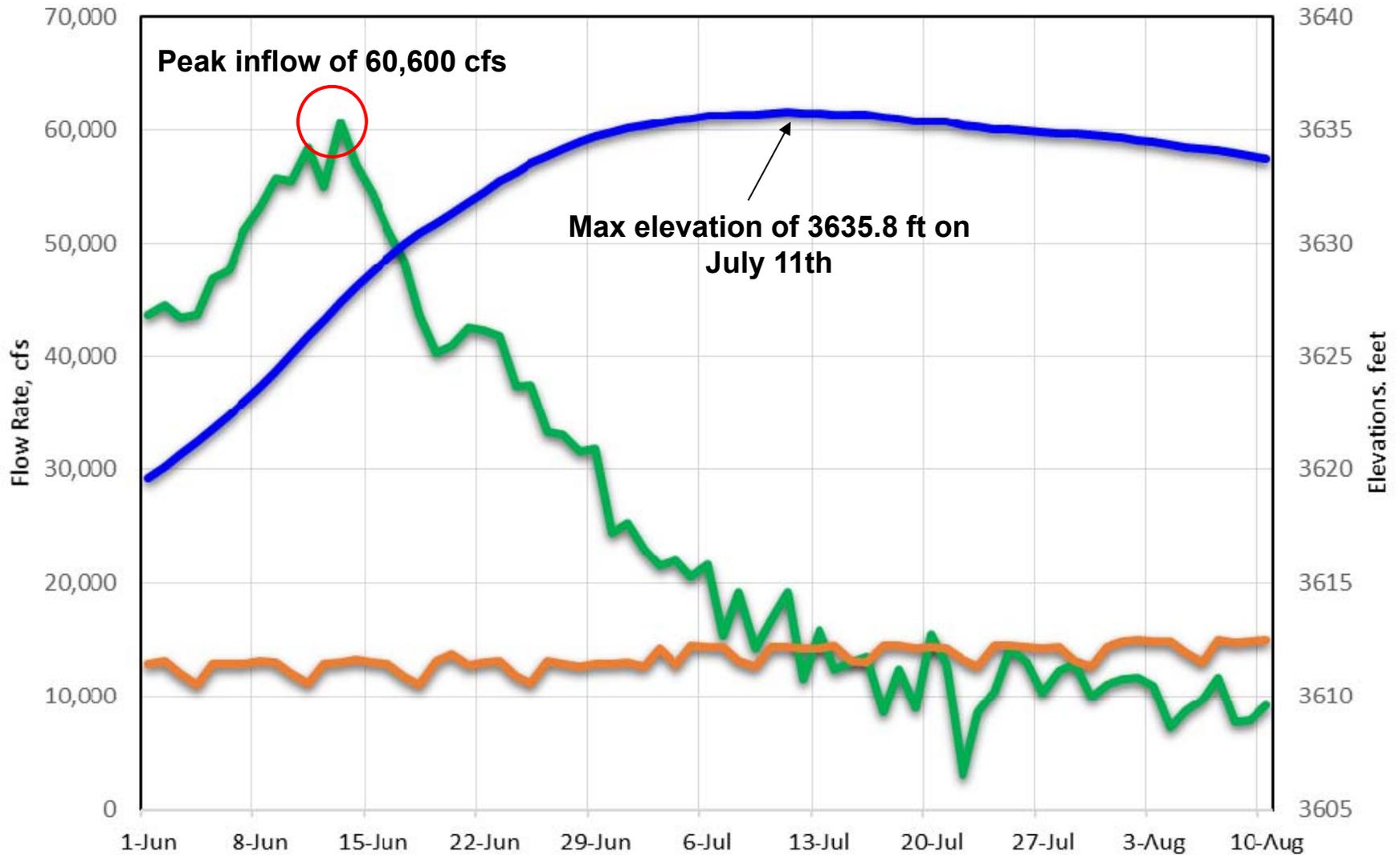
Reservoir	Apr-Jul Observed (KAF)	Percent of Average ¹
Fontenelle	1,719	237%
Flaming Gorge	2,214	226%
Blue Mesa	915	135%
Navajo	775	125%
Powell	8,174	114%

¹ percent of average based on period 1981-2010.

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Lake Powell

Inflow, cfs Total Release, cfs Elevation

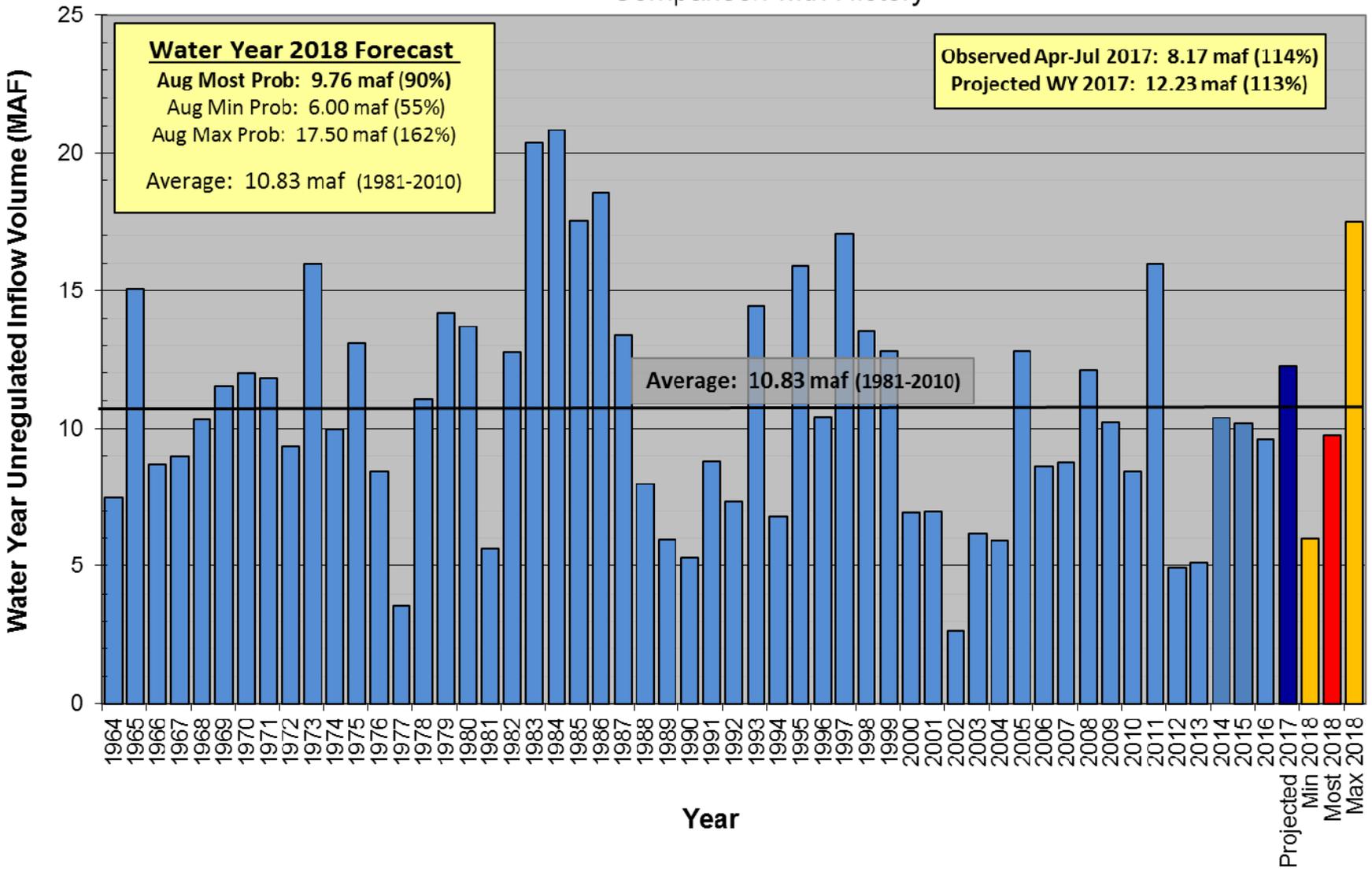


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Lake Powell Unregulated Inflow

Water Year 2018 Forecast *(issued August 1)*

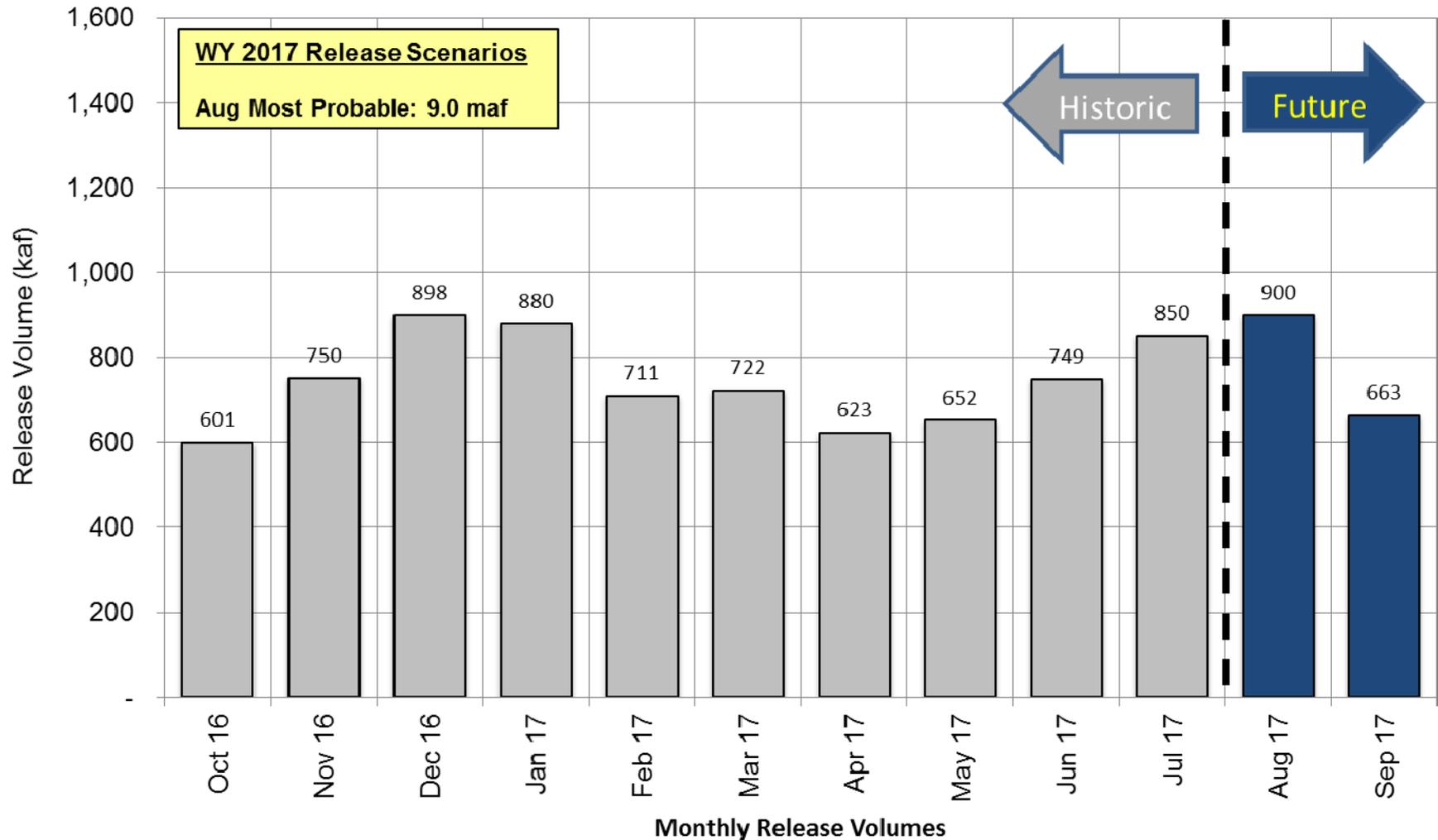
Comparison with History



Potential Lake Powell Monthly Release Volume Distribution

Release Scenarios for Water Year 2017

Updated August 2017



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Reservoir Operations for Water Year 2018

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Lake Powell 2018 Operating Tier

Upper Elevation Balancing

- Tier was set in August 2017
 - Start with 8.23 maf release
- Use April 24-Month Study projections of end of water year storage to potentially adjust
 1. Stay with 8.23 maf
 2. Balancing: 8.23 - 9.0 maf
 3. Equalization: > 8.23 maf

Lake Powell		
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
3,636 - 3,666 (2008-2026)	Upper Elevation Balancing Tier³ 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)
3,575	Mid-Elevation Release Tier Release 7.48 maf; if Lake Mead < 1,025 feet, release 8.23 maf	9.5
3,525	Lower Elevation Balancing Tier Balance contents with a min/max release of 7.0 and 9.5 maf	5.9
3,490		4.0
3,370		0

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Water Year 2018 Operating Tier

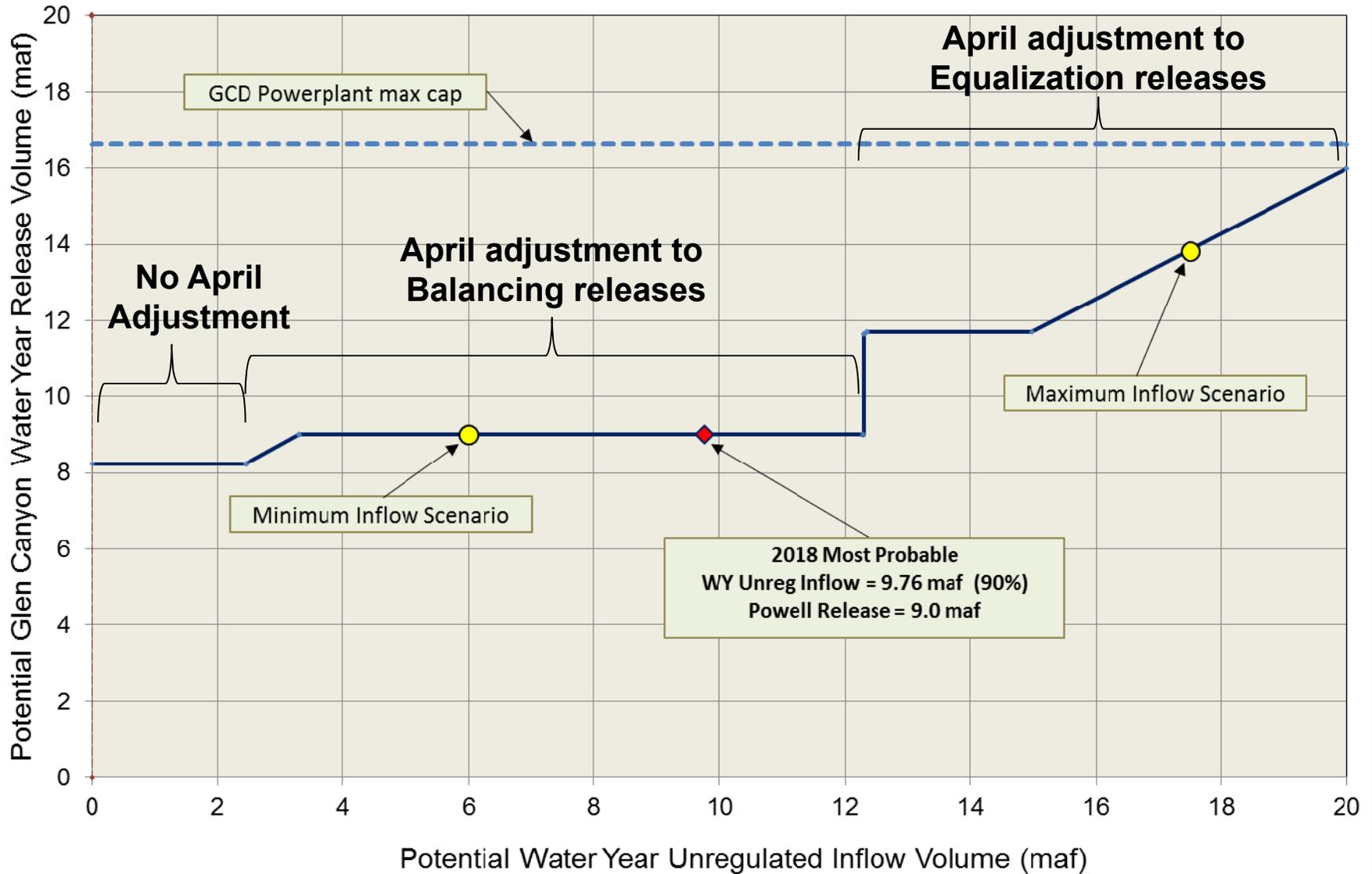
Operating Tier determined with the August 2017 24-Month Study

Powell Inflow Scenario	WY 2018 Release Projection
Probable Minimum	Upper Elevation Balancing Tier w/ Projected April shift to Balancing 9.0 maf release
Most Probable	Upper Elevation Balancing Tier w/ Projected April shift to Balancing 9.0 maf release
Probable Maximum	Upper Elevation Balancing Tier w/ Projected April shift to Equalization 13.8 maf release

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Potential Lake Powell Release Scenarios

Water Year 2018 Release Volume as a Function of Unregulated Inflow Volume
based on August 2017 24-Month Study Conditions



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**End of CY 2017 Projection:
3627.34 feet**

**End of CY 2018 Projection:
3630.17 feet
(Range 3,597 to 3,654 feet)**

Water Year 2018 projections
Most: 9.0 maf release
Max: 13.8 maf release
Min: 9.0 maf release

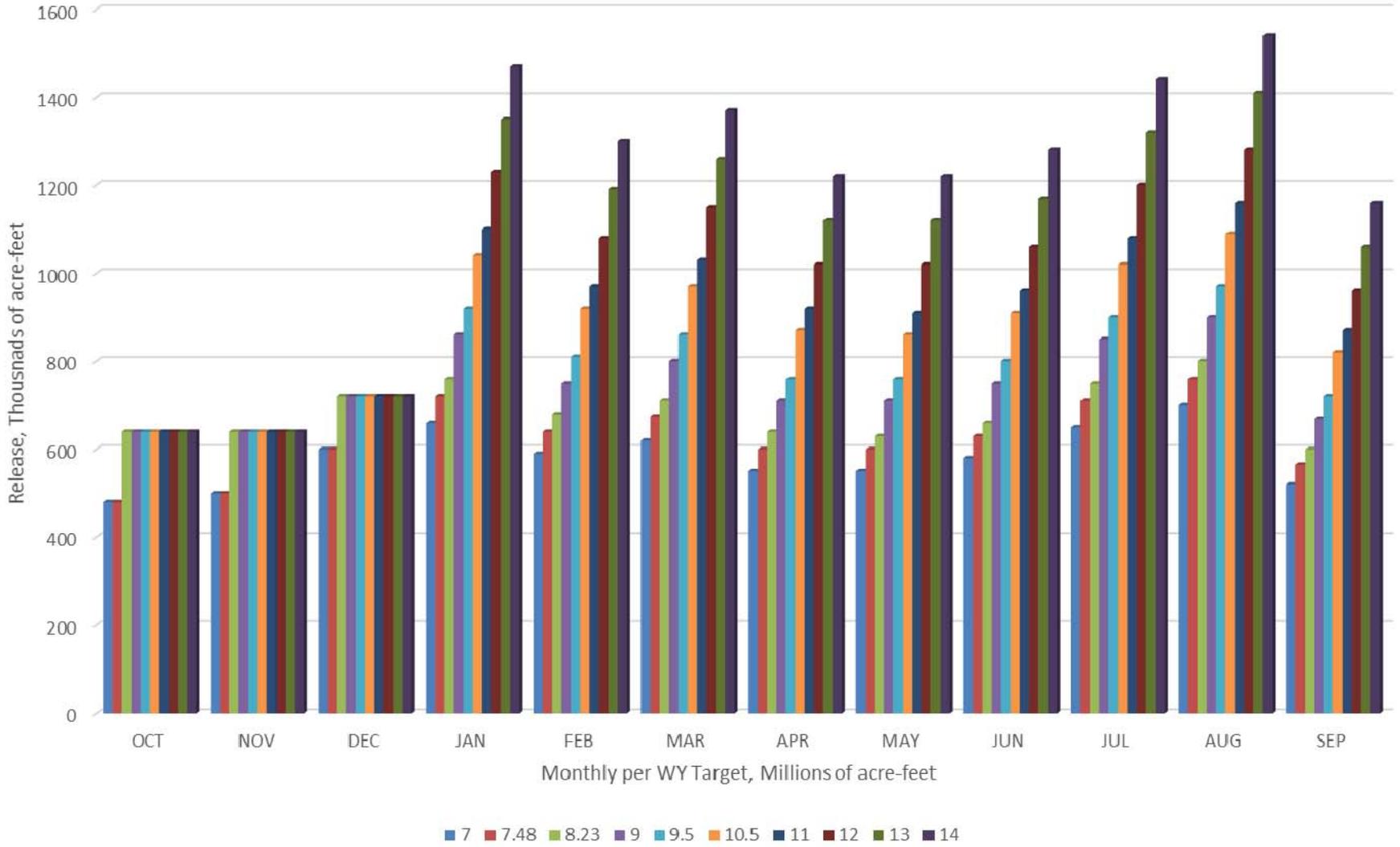
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End of CY 2017 Projection:
1,083.5 feet (39% full)
Range: 1,083.2 to 1,083.7 feet

End of CY 2018 Projection:
1,079.5 feet (38% full)
Range: 1,076 to 1,131 feet

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LTEMP Monthly Release Volumes



LTEMP Monthly Release Volumes 2018

Month	7.00	7.48	8.23	9.00	9.50	10.50	11.00	12.00	13.00	14.00
OCT	480	480	640	640	640	640	640	640	640	640
NOV	500	500	640	640	640	640	640	640	640	640
DEC	600	600	720	720	720	720	720	720	720	720
JAN	660	720	760	860	920	1040	1100	1230	1350	1470
FEB	590	640	680	750	810	920	970	1080	1190	1300
MAR	620	675	710	800	860	970	1030	1150	1260	1370
APR	550	600	640	710	760	870	920	1020	1120	1220
MAY	550	600	630	710	760	860	910	1020	1120	1220
JUN	580	630	660	750	800	910	960	1060	1170	1280
JUL	650	710	750	850	900	1020	1080	1200	1320	1440
AUG	700	760	800	900	970	1090	1160	1280	1410	1540
SEP	520	565	600	670	720	820	870	960	1060	1160

MIN & MOST

MAX

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2018 Hydrograph

Month	LTEMP Release Volume, (kaf)	Operational Considerations Release Volume, (kaf)*	LTEMP Daily Fluctuations (cfs)**
OCT	640	630	5,700
NOV	640	630	5,700
DEC	720	740	6,700
JAN	860	860	7,700
FEB	750	750	6,800
MAR	800	800	7,200
APR	710	700	6,300
MAY	710	700	6,300
JUN	750	760	7,600
JUL	850	860	8,000
AUG	900	900	8,000
SEP	670	670	6,000

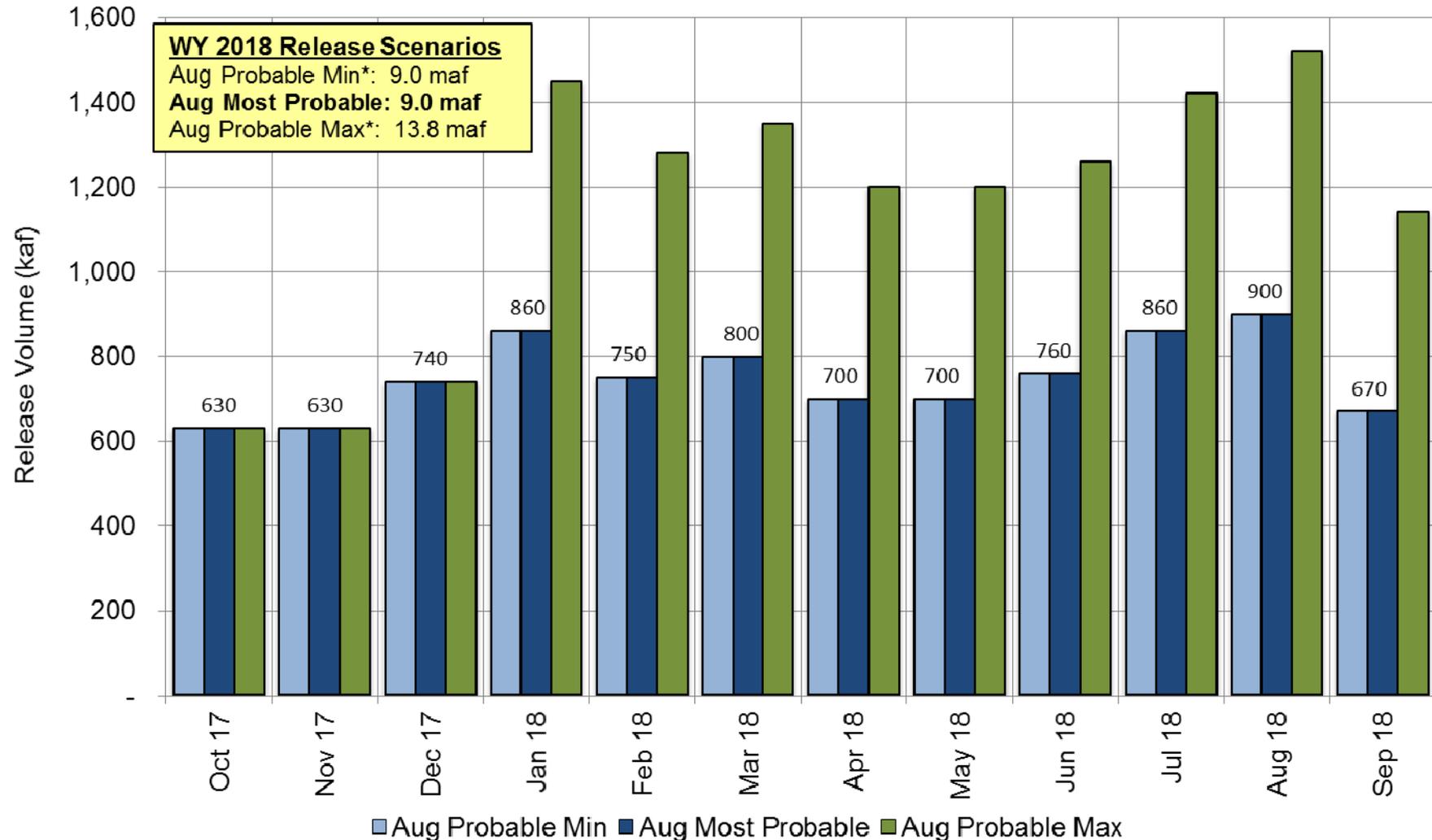
- *Modifications of monthly volumes reached between Reclamation and WAPA
- **LTEMP Daily fluctuations determined by, 9 x monthly vol (Sep – May), and 10 x monthly vol (Jun – Aug)
- LTEMP Down ramp rates, 2,500 cfs/hr (all months)
- Up-ramp rates, 4,000 cfs/hr (all months)

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Potential Lake Powell Monthly Release Volume Distribution

Release Scenarios for Water Year 2018

Based on August 2017 modeling



* Probable Min and Max annual release volume is based on August Min and Max inflow forecasts

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Glen Canyon Power Plant Planned Unit Outage Schedule for Water Year 2018

Unit Number	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018	Jun 2018	Jul 2018	Aug 2018	Sep 2018	
1													
2													
3													
4													
5													
6													
7													
8													
Units Available	5	5	7	5	5	5	5	6/8	8	8	8	7	
Capacity (cfs)	17,200	17,200	17,200	17,200	17,200	17,200	17,200	21,600	28,700	28,700	30,300	24,800	
Capacity (kaf/month)	1,270	1,140	1,410	1,240	1,120	1,060	1,010	1,610	1,710	1,760	1,760	1,560	
Max (kaf) ¹	630	630	740	1,450	1,280	1,350	1,200	1,200	1,260	1,420	1,520	1,141	13.80
Most (kaf) ²	630	630	740	860	750	800	700	700	760	860	900	670	9.0
Min (kaf) ¹	630	630	740	860	750	800	700	700	760	860	900	670	9.0

Possible HFE

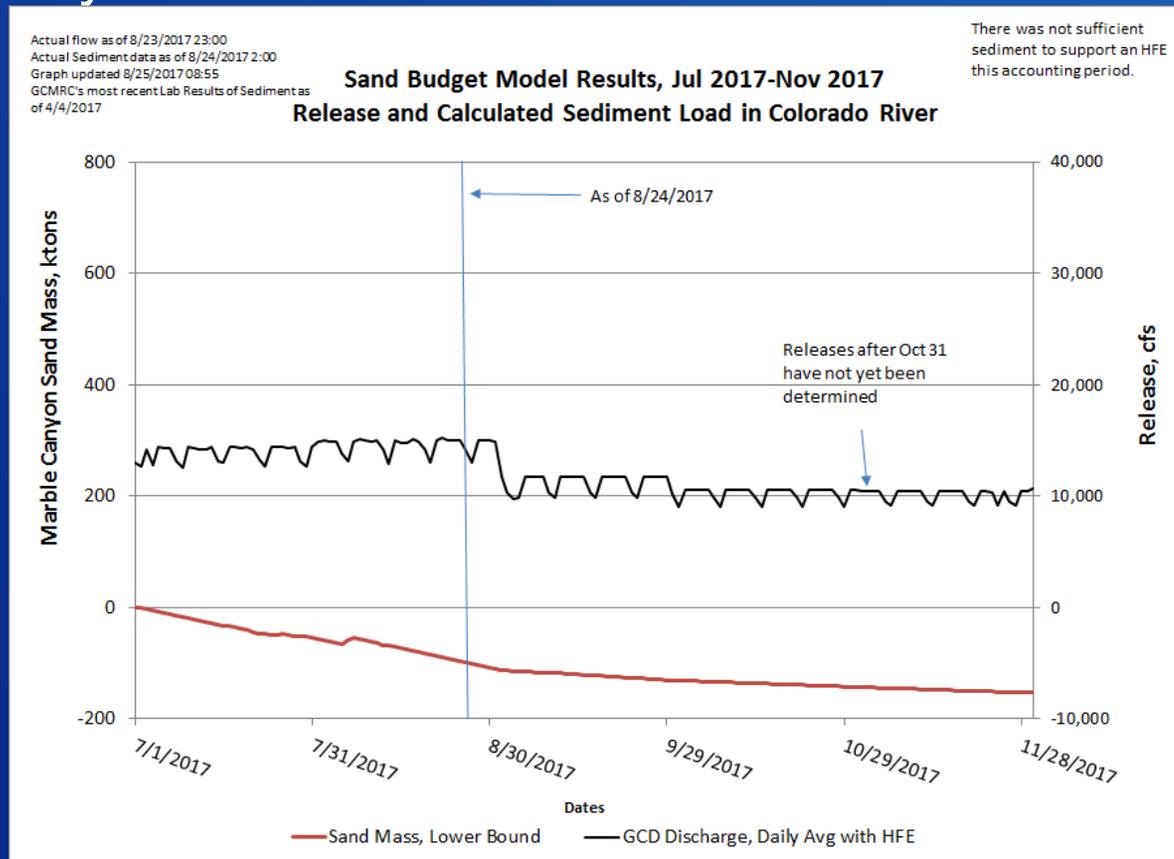
1 Projected release, based on Aug 2017 Min and Max Probable Inflow Projections and 24-Month Study model runs
 2 Projected release, based on Aug 2017 Most Probable Inflow Projections and 24-Month Study model runs

(updated 8-14-2017)



Sand Budget Model Results

- As of 8-24-2017, not enough sediment input to trigger a fall 2017 HFE
- Still early in the season



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Percent of Traces with Event or System Condition

Results from August 2017 CRSS^{1,2,3,4} (values in percent)

	Event or System Condition	2018	2019	2020	2021	2022
Upper Basin – Lake Powell	Equalization Tier	20	29	27	29	31
	<i>Equalization annual release > 8.23 maf</i>	20	29	27	28	30
	<i>Equalization annual release = 8.23 maf</i>	0	0	0	1	1
	Upper Elevation Balancing Tier	80	68	55	52	52
	<i>Upper Elevation Balancing annual release > 8.23 maf</i>	75	52	41	35	37
	<i>Upper Elevation Balancing annual release = 8.23 maf</i>	5	15	15	17	14
	<i>Upper Elevation Balancing annual release < 8.23 maf</i>	0	1	0	0	1
	Mid-Elevation Release Tier	0	3	17	15	12
	<i>Mid-Elevation Release – annual release > 8.23 maf</i>	0	0	0	0	2
	<i>Mid-Elevation Release – annual release < 8.23 maf</i>	0	3	17	15	10
Lower Elevation Balancing Tier	0	0	0	4	5	
Lower Basin – Lake Mead	Shortage Condition any amount (Mead ≤ 1,075 ft)	0	15	42	45	52
	<i>Shortage – 1st level (Mead ≤ 1,075 and ≥ 1,050)</i>	0	15	40	35	33
	<i>Shortage – 2nd level (Mead < 1,050 and ≥ 1,025)</i>	0	0	2	10	15
	<i>Shortage – 3rd level (Mead < 1,025)</i>	0	0	0	1	5
	Surplus Condition any amount (Mead ≥ 1,145 ft)	0	0	7	12	17
	<i>Surplus – Flood Control</i>	0	0	1	2	3
	Normal or ICS Surplus Condition	100	85	51	43	31

¹ Reservoir initial conditions based on results from the August 2017 most-probable 24-Month Study.

² Percentages computed from 110 hydrologic inflow sequences based on resampling of the observed natural flow record from 1906-2015 for a total of 110 traces analyzed.

³ Percentages shown may not sum to 100% due to rounding to the nearest percent.

⁴ Percentages shown may not be representative of the full range of future possibilities that could occur with different modeling assumptions.

Questions?

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Reclamation, Upper Colorado Region
Resource Management Division
Water Resources Group

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**August
determination**

**April
determination**

B. Upper Elevation Balancing Tier

1. In Water Years when the projected January 1 Lake Powell elevation is below the elevation stated in the Lake Powell Equalization Elevation Table and at or above 3,575 feet, the Secretary shall release 8.23 maf from Lake Powell if the projected January 1 Lake Mead elevation is at or above 1,075 feet.
2. If the projected January 1 Lake Powell elevation is below the elevation stated in the Lake Powell Equalization Elevation Table and at or above 3,575 feet and the projected January 1 Lake Mead elevation is below 1,075 feet, the Secretary shall balance the contents of Lake Mead and Lake Powell, but shall release not more than 9.0 maf and not less than 7.0 maf from Lake Powell in the Water Year.
3. When operating in the Upper Elevation Balancing Tier, if the April 24-Month Study projects the September 30 Lake Powell elevation to be greater than the elevation in the Lake Powell Equalization Elevation Table, the Equalization Tier will govern the operation of Lake Powell for the remainder of the Water Year (through September).
4. When operating under Section 6.B.1, if the April 24-Month Study projects the September 30 Lake Mead elevation to be below 1,075 feet and the September 30 Lake Powell elevation to be at or above 3,575 feet, the Secretary shall balance the contents of Lake Mead and Lake Powell, but shall release not more than 9.0 maf and not less than 8.23 maf from Lake Powell in the Water Year.
5. When Lake Powell is projected to be operating under Section 6.B.2. and more than 8.23 maf is projected to be released from Lake Powell during the upcoming Water Year, the Secretary shall recalculate the August 24-Month Study projection of the January 1 Lake Mead elevation to include releases above 8.23 maf that are scheduled to be released from Lake Powell during the months of October, November, and December of the upcoming Water Year, for the purposes of determining Normal or Shortage conditions pursuant to Sections 2.A. or 2.D. of these Guidelines.

Water Year 2017 Operations: April 2017 24-Month Study Upper Elevation Balancing

April 2017 24-Month Study EXHIBIT run

Timestep	Day	Powell Unreg Inflow 1,000 acre-ft/month	Powell Outflow 1,000 acre-ft/mor	Powell Pool Elevation ft	Mead Pool Elevation ft
4/30/16	Sat	813.93	665.22	3,592.12	1,076.13
5/31/16	Tue	2,294.36	700.24	3,603.87	1,073.80
6/30/16	Thu	2,907.14	799.93	3,620.01	1,071.64
7/31/16	Sun	594.51	950.23	3,618.22	1,072.75
8/31/16	Wed	253.34	899.57	3,613.55	1,075.17
9/30/16	Fri	280.81	698.89	3,610.93	1,075.23
10/31/16	Mon	381.00	600.53	3,609.48	1,076.34
11/30/16	Wed	382.75	750.41	3,605.81	1,076.55
12/31/16	Sat	300.42	898.34	3,600.49	1,080.82
1/31/17	Tue	359.01	880.30	3,595.86	1,086.08
2/28/17	Tue	555.29	710.69	3,594.33	1,089.78
3/31/17	Fri	1,109.53	720.21	3,595.91	1,088.26
4/30/17	Sun	1,600.00	600.00	3,604.11	1,084.09
5/31/17	Wed	3,000.00	600.00	3,625.41	1,080.23
6/30/17	Fri	3,350.00	600.00	3,644.54	1,076.83
7/31/17	Mon	1,350.00	600.00	3,647.98	1,074.40
8/31/17	Thu	630.00	669.53	3,647.58	1,074.06
9/30/17	Sat	450.00	600.00	3,646.82	1,072.07
10/31/17	Tue	547.21	640.00	3,646.28	1,072.48
11/30/17	Thu	489.06	640.00	3,645.53	1,071.08
12/31/17	Sun	362.53	720.00	3,644.19	1,071.09
1/31/18	Wed	361.18	1,260.00	3,638.20	1,078.23
2/28/18	Wed	392.99	1,100.00	3,633.22	1,083.81
3/31/18	Sat	665.38	1,170.00	3,628.87	1,085.56
4/30/18	Mon	1,055.51	1,040.00	3,627.74	1,085.35
5/31/18	Thu	2,342.99	1,040.00	3,636.82	1,086.19
6/30/18	Sat	2,666.05	1,080.00	3,646.31	1,087.45
7/31/18	Tue	1,090.84	1,230.00	3,643.96	1,091.75
8/31/18	Fri	499.88	1,310.00	3,637.99	1,098.00
9/30/18	Sun	408.21	981.00	3,634.00	1,101.71

Powell.Outflow -- Volume: 8.23000 [1,000,000 acre-ft]
12 values: Sum 8,230.00 -- Ave 685.83 -- Med 635.03 -- Min 600.00 -- Max 8,230.00 -- Range 298.00

With an 8.23maf release pattern for WY2017, September 30, 2017 projected elevations are:

Powell: 3646.82 (i.e, above 3575 ft)
Mead: 1072.07 (i.e, below 1075 ft)

Therefore, Powell's April adjustment is to Balancing, with releases not more than 9.0 maf and not less than 8.23 maf in the Water Year.

* Modification of monthly volumes reached between Reclamation and WAPA

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Glen Canyon Power Plant Planned Unit Outage Schedule for Water Year 2018

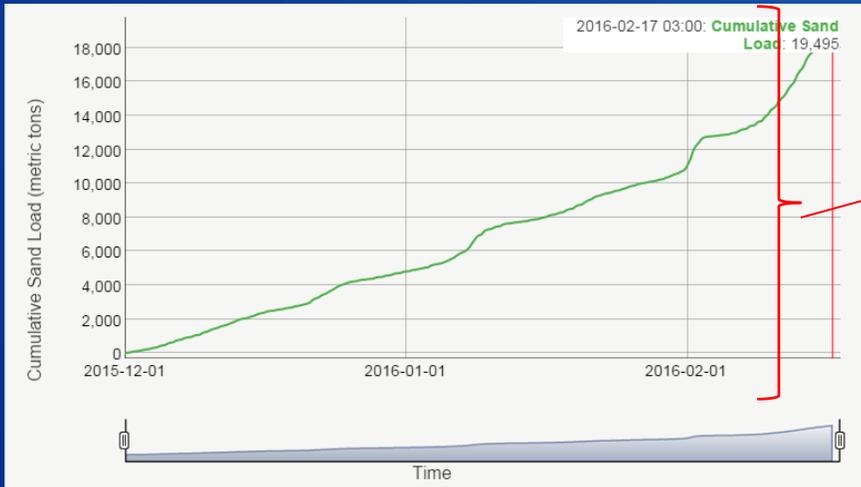
Unit Number	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018	Jun 2018	Jul 2018	Aug 2018	Sep 2018	
1		Possible HFE			[Red Bar]							[Red Bar]	
2					[Red Bar]								
3	[Red Bar]		[Red Bar]										
4								[Red Bar]					
5	[Red Bar]												
6	[Red Bar]												
7					[Red Bar]								
8					[Red Bar]								
Units Available	5	7	7	7	5	5	5	6/8	8	8	8	7	
Capacity (cfs)	16,100	23,400	23,400	23,400	16,200	16,000	16,000	27,000	27,000	27,000	27,000	23,500	
Capacity (kaf/month)	1,060	1,390	1,440	1,290	920	980	1,040	1,520	1,610	1,660	1,660	1,470	
Max (kaf) ¹	640	640	720	1,520	1,340	1,420	1,260	1,260	1,320	1,490	1,590	1,197	14.40
Most (kaf) ²	640	640	720	1,160	1,020	1,080	966	956	1,000	1,140	1,220	915	11.48
Min (kaf) ¹	640	640	720	860	750	800	710	710	750	850	900	670	9.0

- 1 Projected release, based on Apr 2017 Min and Max Probable Inflow Projections and 24-Month Study model runs
- 2 Projected release, based on Apr 2017 Most Probable Inflow Projections and 24-Month Study model runs

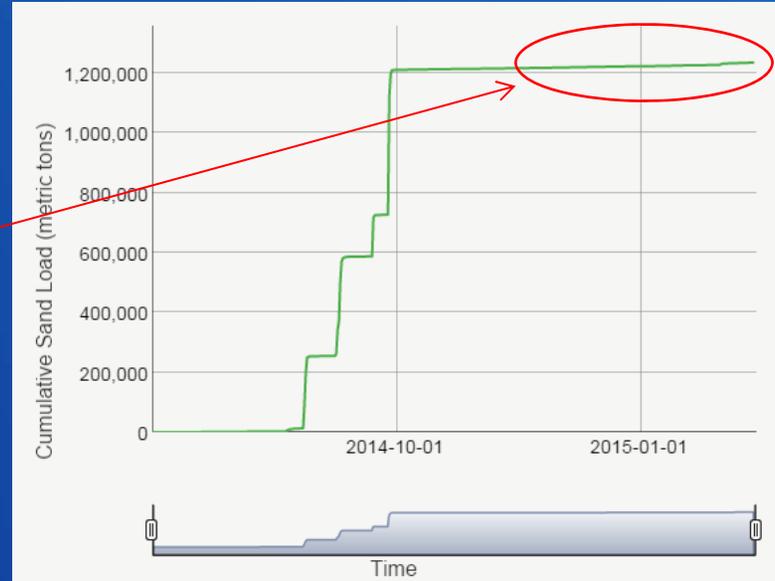
(updated 4-17-2017)

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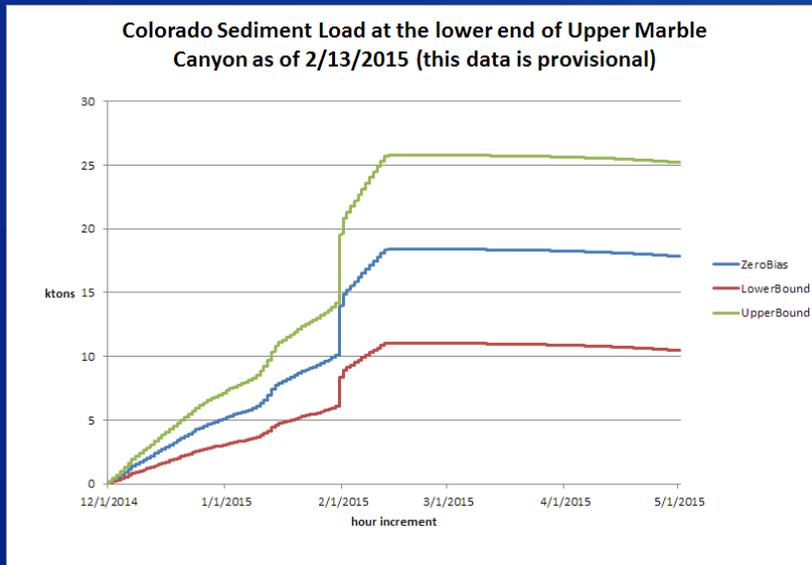
Sediment Conditions *As of 2-13-2015*



Paria Sand Load Dec 1 though Feb 13



Paria Sand Load July 1 though Feb 13



Sediment Model Results

As of 2-13-2015

Have: ~18 ktons

Need: several hundred ktons
(for the smallest HFE)

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If we end up with a 8.23 maf release instead of 9.0 maf, we will need to reduce the remaining months by 770kaf

	Typical pattern (9.0 maf)	Proposed 2016 Hydrograph (9.0 maf)	<i>Possible monthlies after maintenence considerations and discussions with Western (maintaining 2016 Hydrograph)</i>					
			9.0 maf	96 hr HFE 9.0 maf	spring HFE 9.0	8.23 maf	96 hr HFE 8.23 maf	spring HFE 8.23
October	600	600	600	600	600	600	600	600
November	600	600	600	770	600	600	770	600
December	800	900	900	900	900	900	900	900
January	800	900	900	900	900	900	900	900
February	650	700	700	665	700	700	665	700
March	650	650	650	615	650	650	615	650
April	600	600	600	600	770	540	540	710
May	650	700	700	600	600	540	500	500
June	800	800	800	800	800	600	600	500
July	1000	950	950	950	950	800	800	800
August	1050	900	900	900	900	800	800	800
September	800	700	700	700	630	600	540	570
	9000	9000	9000	9000	9000	8230	8230	8230

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