

Glen Canyon Dam Adaptive Management Work Group
Agenda Item Form
August 24-25, 2016

Agenda Item

Basin Hydrology and Water Year (WY) 2017 Hydrograph

Purpose of Agenda Item

To send a recommended WY 2017 Glen Canyon Dam hydrograph to the Secretary of the Interior.

Action Requested

Motion requested. The motion (see page 2) is recommended by TWG. However, no motion is officially made unless and until an AMWG member makes the motion in accordance with the AMWG Operating Procedures.

Presenters

Paul Davidson, Hydraulic Engineer, Bureau of Reclamation, Upper Colorado Region
Vineetha Kartha, State of Arizona AMWG Alternate and Technical Work Group Chair

Previous Action Taken

- ✓ **June 14, 2016:** TWG passed the WY 2017 Hydrograph motion by consensus.
- ✓ **August 27, 2015:** At its August 2015 meeting, the AMWG passed a motion to recommend to the Secretary of the Interior her approval of the DOI-DOE Proposed Hydrograph for WY 2016. Previous year hydrographs (water years 2012, 2013, 2014 and 2015) were also recommended by the TWG and the AMWG and approved by the Secretary of the Interior

Relevant Science

The TWG has been presented with a proposal for the WY 2017 Hydrograph and operational scenarios based on the range of current projected hydrology. The anticipated range of conditions and objectives for 2017 remain similar to previous years, therefore, the targeted approach adopted as the 2012, 2013, 2014, 2015, and 2016 Hydrographs is recommended again for the WY 2017 Hydrograph.

Summary of Presentation and Background Information

Basin Hydrology

The first portion of the presentation is intended to provide pertinent information to AMWG members on current water supply and forecasted hydrologic conditions within the Upper Colorado River Basin. The presentation will focus on projected reservoir conditions and operations at Lake Powell/Glen Canyon Dam for the remainder of WY 2016 and provide an outlook for WY 2017.

WY 2016 Hydrograph

The second portion of the presentation will cover the potential range of annual release volumes from Lake Powell in WY 2017 and the proposed WY 2017 Hydrograph, which is unchanged from that which was recommended and approved for WY 2016. Vineetha Kartha, TWG Chair, will provide a brief summary of the TWG deliberation and motion.

Motion requested: The following proposed motion is based on the recommendation from the TWG. However, no motion is presumed to be made unless and until an AMWG member makes the motion in accordance with the AMWG Operating Procedures.

AMWG recommends to the Secretary of the Interior for her approval the following Water Year 2017 Hydrograph for Glen Canyon Dam.

- Annual Release Volumes will be determined by the 2007 Interim Guidelines and shall be reviewed and adopted through the normal annual operating plan process (in consultation with the Basin States as appropriate).
- Monthly Release Volumes are anticipated to shift depending upon: (1) the projected Annual Release Volume, (2) power plant capacity, and (3) the magnitude of a potential High Flow Experiment.
- Monthly Release Volumes may vary within the targets identified below. Any remaining monthly operational flexibility will be used for existing power production operations under the Modified Low Fluctuating Flow (MLFF) alternative selected by the 1996 ROD and contained in the 1995 FEIS and in compliance with all applicable NEPA compliance documents (HFE EA, NNFC EA, 2007 Interim Guidelines). Monthly release volumes proposed in this hydrograph will not affect operating tier determinations for Lakes Powell and Mead under the 2007 Interim Guidelines.
- Release objective for June is:
 - 600 to 650 kaf for annual releases below 9.0 maf
 - 800 kaf for annual releases of 9.0 maf to less than 9.5 maf
 - 900 kaf for annual releases of 9.5 maf to less than 10 maf
 - Greater than 900 kaf for annual releases 10 maf and greater
- Release objective for August is:
 - 800 kaf for annual release below 9.0 maf
 - 900 kaf for annual releases of 9.0 maf to less than 10 maf
 - Greater than 900 kaf for annual releases 10 maf and greater
- Release objective for September is:
 - 600 kaf for annual releases below 9.0 maf
 - 700 kaf for annual releases of 9.0 maf to less than 10.0 maf
 - 800 kaf or greater for annual releases of 10.0 maf or greater; up to power plant capacity for high equalization releases
- Monthly Release Volumes will generally strive to maintain 600 kaf levels in the shoulder months (spring and fall) and 800 kaf in the December/January and July/August timeframe.

Additionally, the Bureau of Reclamation will continue to apply best professional judgment in conducting actual operations and in response to changing conditions throughout the water year. Such efforts will continue to be undertaken in coordination with the DOI/DOE agencies and in consultation with the Basin States as appropriate, to consider changing conditions and adjust projected operations in a manner consistent with the objectives of these parameters as stated above and pursuant to the Law of the River.

RECLAMATION

Managing Water in the West

Basin Hydrology, Operations and 2017 Hydrograph

Adaptive Management Work Group
August 24, 2016



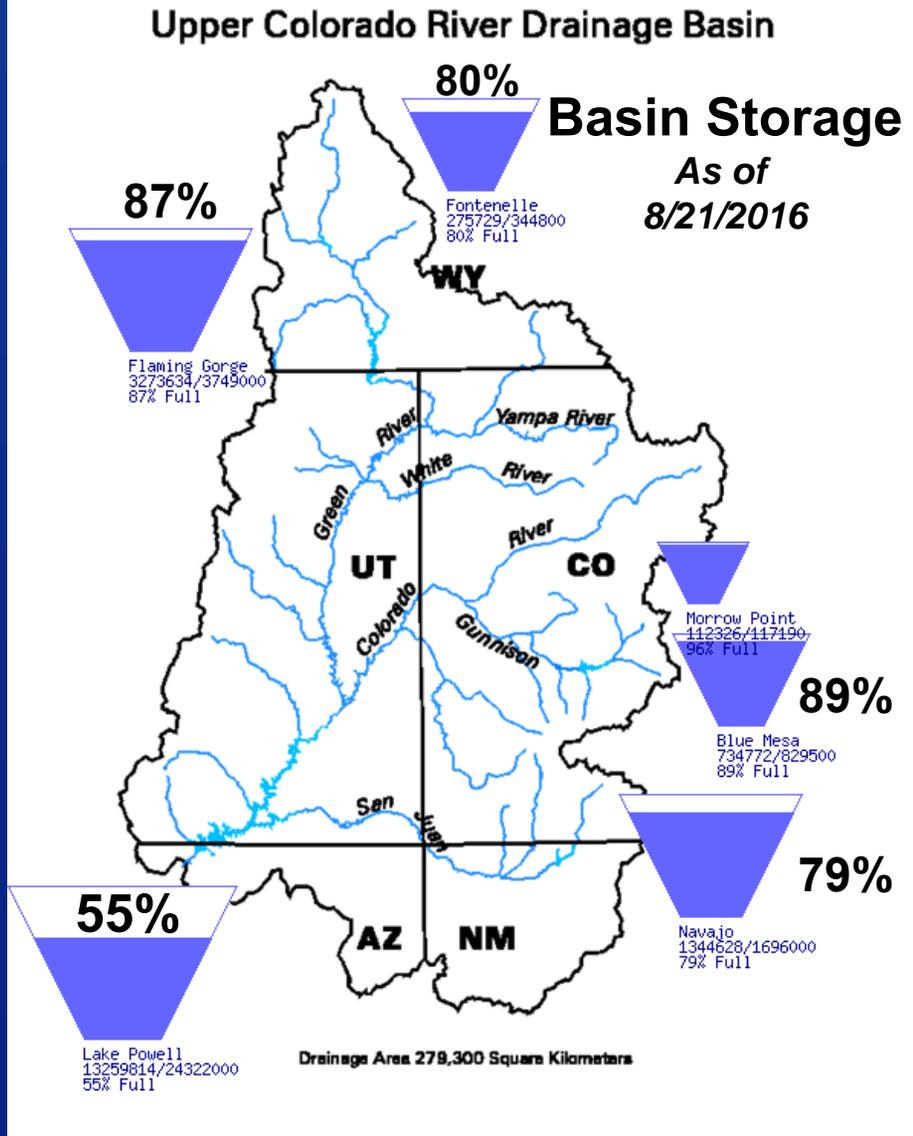
U.S. Department of the Interior
Bureau of Reclamation

Presentation Overview

- Hydrology and Operations
- 2017 Hydrograph

Upper Basin Storage

Data Current as of:
08/21/2016



Water Year 2017 Forecasted Inflow

Reservoir	Apr-Jul Observed (KAF)	Percent of Average ¹
Fontenelle	945	87%
Flaming Gorge	1,290	89%
Blue Mesa	840	88%
Navajo	915	93%
Powell	9,630	89%

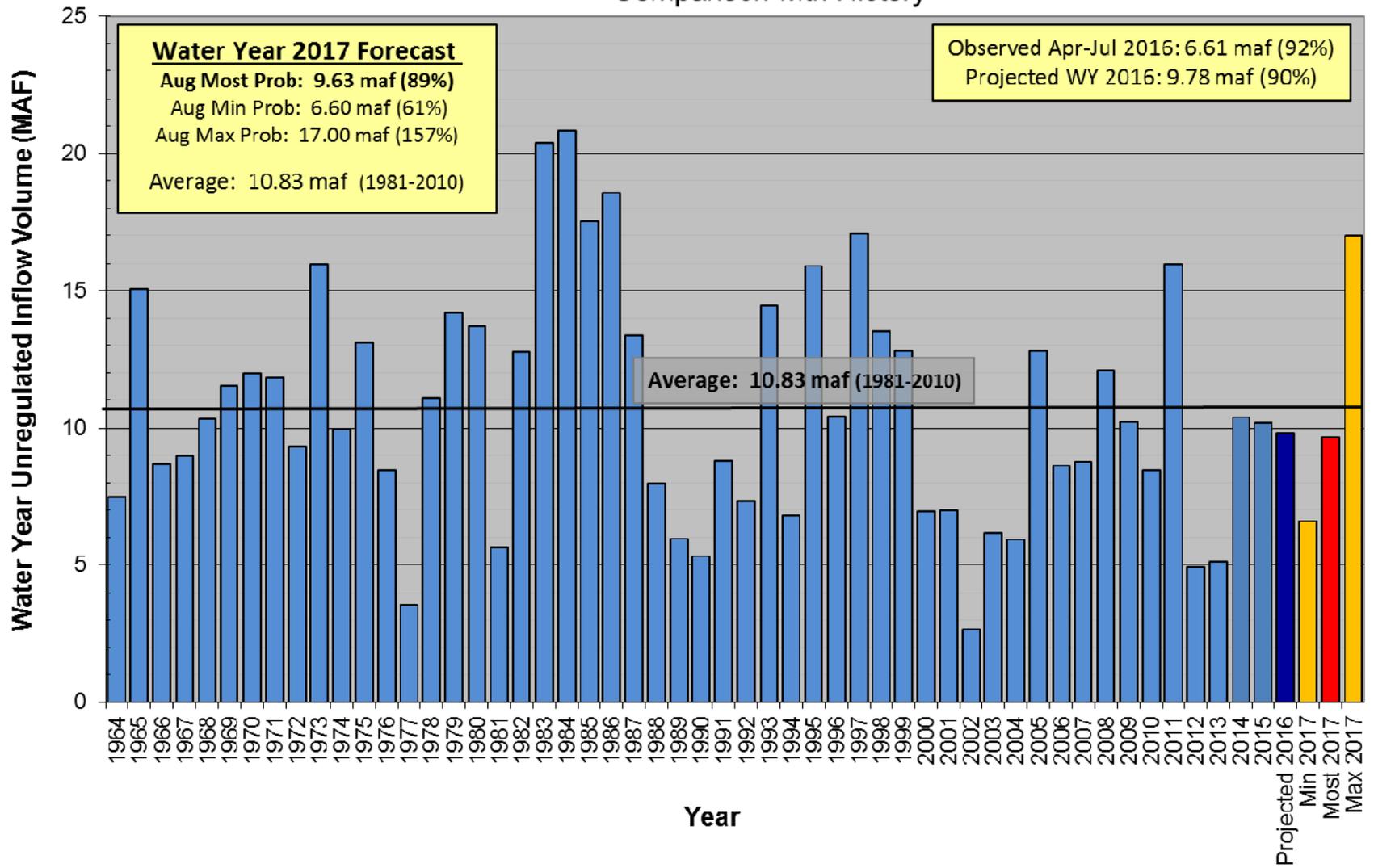
¹ percent of average based on period 1981-2010.

http://www.usbr.gov/uc/water/basin/tc_cr.html

Lake Powell Unregulated Inflow

Water Year 2017 Forecast *(issued August 1)*

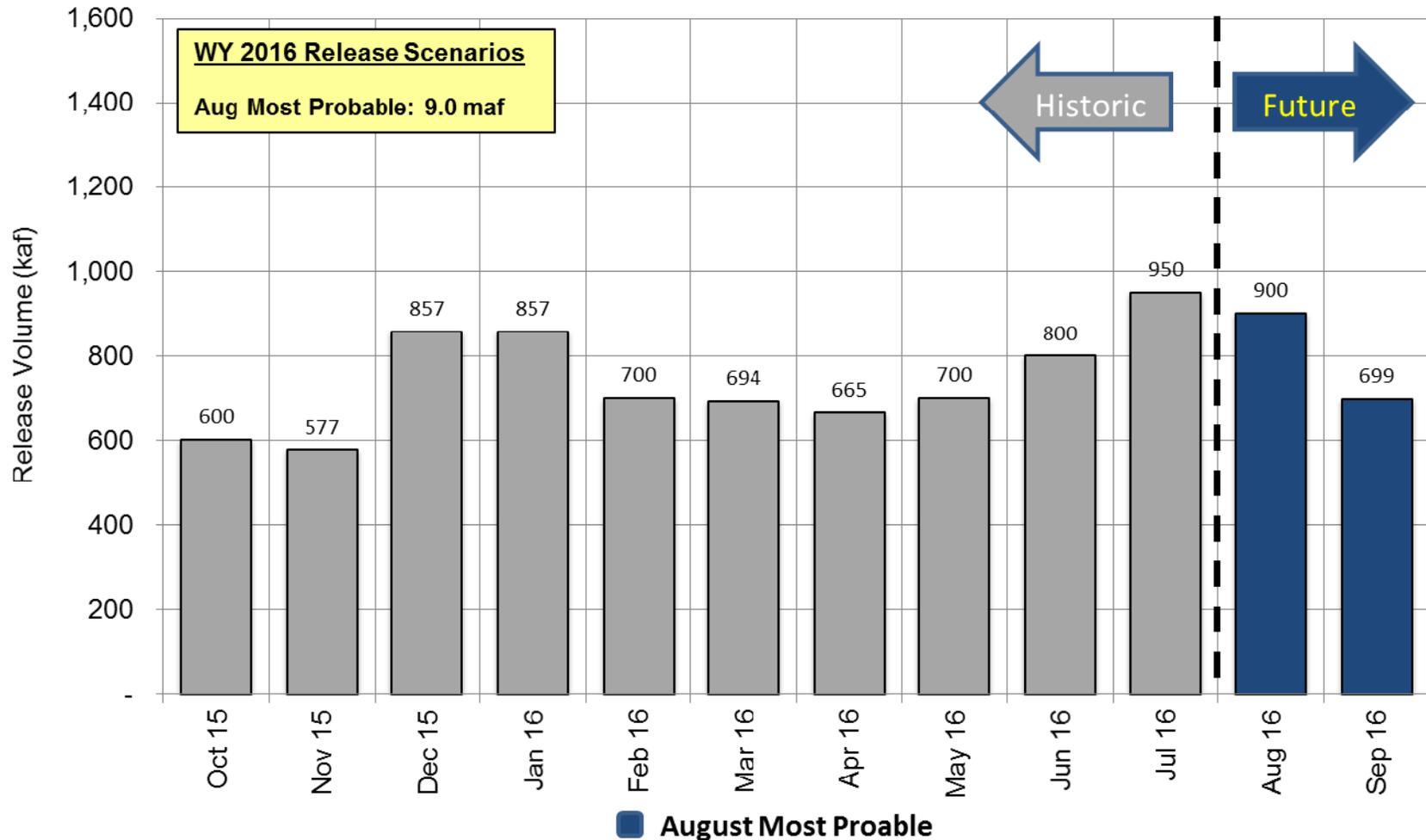
Comparison with History



Projected Lake Powell Monthly Release Volume Distribution

Release Scenarios for Water Year 2016

Updated August 2016



Lake Powell 2017 Operating Tier

Upper Elevation Balancing

- Tier was set using the August 2016
- April Adjustment to Balancing
- Goal: balance contents of Lake Powell and Lake Mead by end of water year
 - release 8.23 maf - 9.0 maf
 - Currently projecting 9.0 maf release

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

Lake Powell 2017 Operating Tier Scenarios

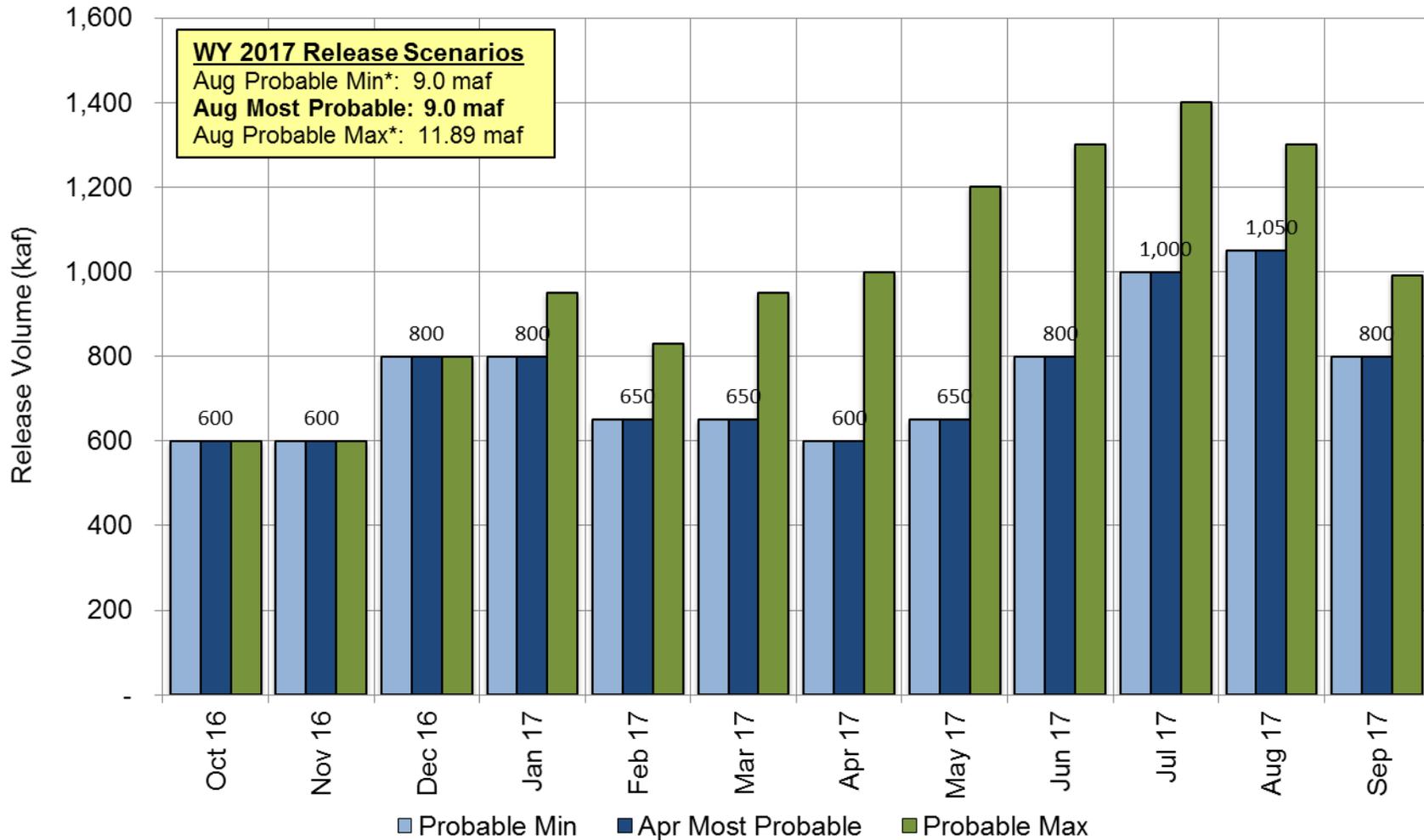
Based on August 2016 modeling

Inflow Scenario	Operating Tier Release Volume
Minimum Probable	Upper Elevation Balancing 9.0 maf
Most Probable	Upper Elevation Balancing 9.0 maf
Maximum Probable	Upper Elevation Balancing 11.9 maf

Potential Lake Powell Monthly Release Volume Distribution

Release Scenarios for Water Year 2017

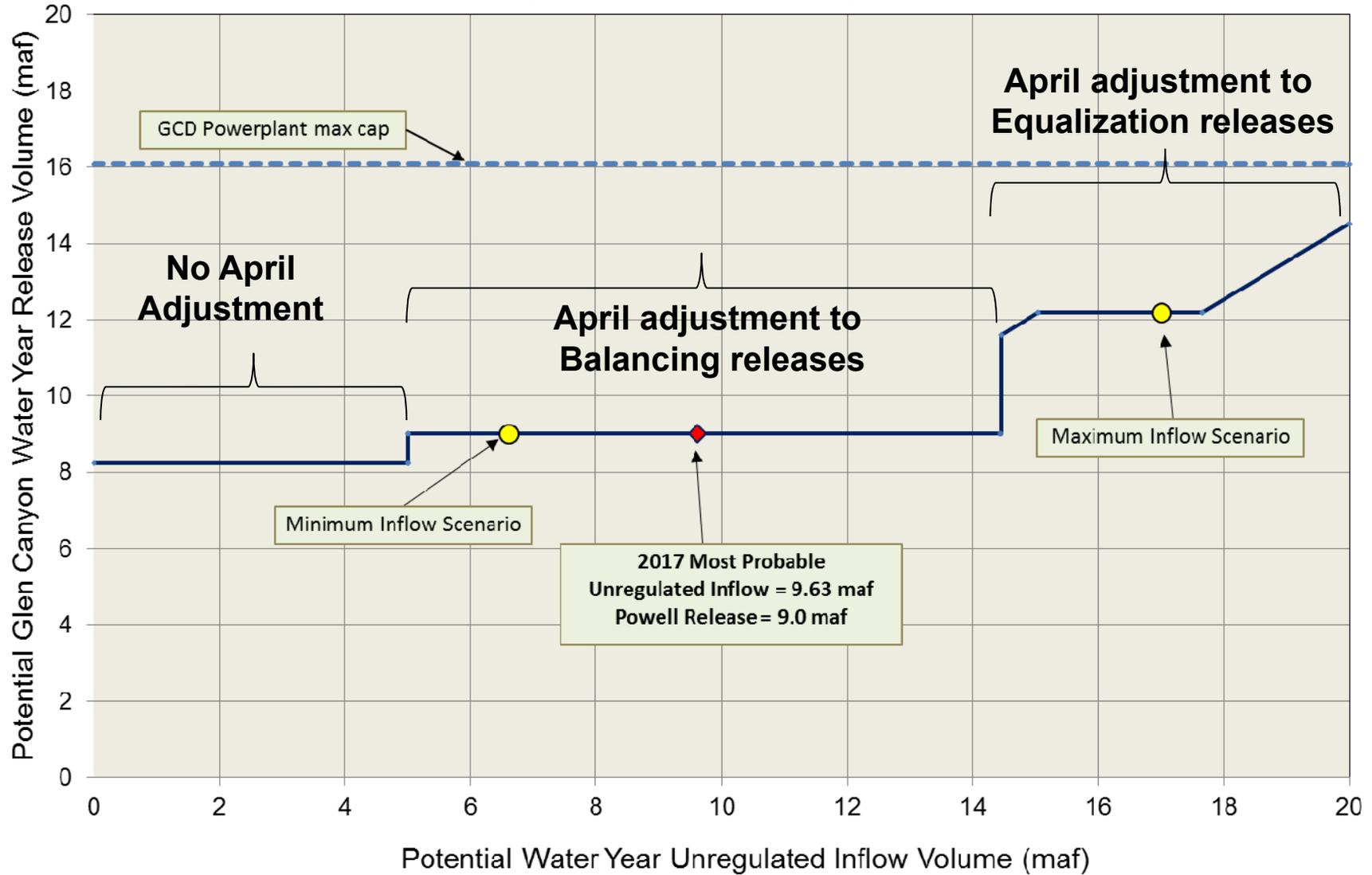
Updated August 2016



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

Potential Lake Powell Release Scenarios

Water Year 2017 Release Volume as a Function of Unregulated Inflow Volume
based on August 2016 24-Month Study Conditions



Percent of Traces with Event or System Condition

Results from August 2016 CRSS^{1,2,3} (values in percent)

	Event or System Condition	2017	2018	2019	2020	2021
Upper Basin – Lake Powell	Equalization Tier	7	21	21	28	31
	<i>Equalization – annual release > 8.23 maf</i>	7	21	21	27	30
	<i>Equalization – annual release = 8.23 maf</i>	0	0	0	1	1
	Upper Elevation Balancing Tier	93	57	57	53	45
	<i>Upper Elevation Balancing – annual release > 8.23 maf</i>	89	48	43	41	35
	<i>Upper Elevation Balancing – annual release = 8.23 maf</i>	4	8	13	10	10
	<i>Upper Elevation Balancing – annual release < 8.23 maf</i>	0	1	1	2	0
	Mid-Elevation Release Tier	0	21	20	10	16
	<i>Mid-Elevation Release – annual release = 8.23 maf</i>	0	0	0	1	1
	<i>Mid-Elevation Release – annual release = 7.48 maf</i>	0	21	20	9	15
Lower Elevation Balancing Tier	0	0	2	9	8	
Lower Basin – Lake Mead	Shortage Condition – any amount (Mead ≤ 1,075 ft)	0	48	60	60	56
	<i>Shortage – 1st level (Mead ≤ 1,075 and ≥ 1,050)</i>	0	48	50	41	33
	<i>Shortage – 2nd level (Mead < 1,050 and ≥ 1,025)</i>	0	0	10	16	16
	<i>Shortage – 3rd level (Mead < 1,025)</i>	0	0	0	3	7
	Surplus Condition – any amount (Mead ≥ 1,145 ft)	0	0	5	8	14
	<i>Surplus – Flood Control</i>	0	0	0	1	2
	Normal or ICS Surplus Condition	100	52	35	32	30

¹ Reservoir initial conditions based on December 31, 2016 conditions from the August 2016 24-Month Study.

² Percentages computed from 107 hydrologic inflow sequences based on resampling of the observed natural flow record from 1906-2012 for a total of 107 traces analyzed.

³ Percentages shown may not be representative of the full range of future possibilities that could occur with different modeling assumptions.

CRSS Results

August 2016

Description of model analyzed

<i>Natural Flow Input</i>	<i>Description</i>
Direct Natural Flow (DNF)	Indexed Sequential Method (ISM) on observed natural flow record (1906-2012) to create 107 traces

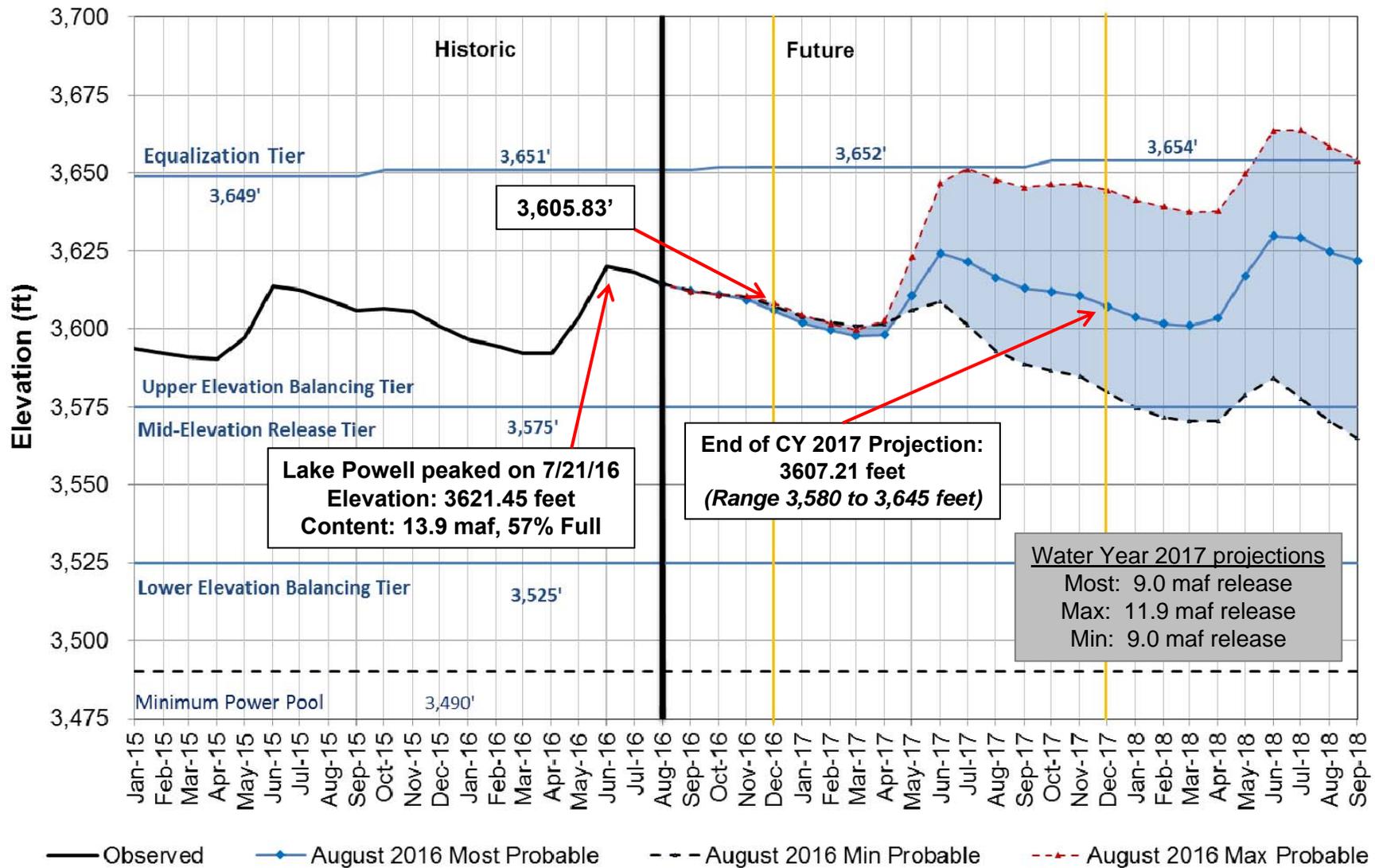
Key Modeling Assumptions Common to All Runs

1. Reservoir initial conditions based on the most probable August 24-month Study projected levels for December 31, 2015.
2. Lake Powell and Lake Mead operations according to Interim Guidelines with an ICS limit of 2.1 MAF
3. All other modeling assumptions are documented in Appendix A of the Shortage/Coordinated Operations FEIS and Appendix G2 of the Colorado River Basin Water Supply and Demand Study.
4. Upper Basin demand schedules updated to 2007 UCRC schedules in December 2009
5. Lower Basin ICS schedules updated by the Lower Basin States in December 2009; SNWA revised ICS assumptions August 2016.

RECLAMATION

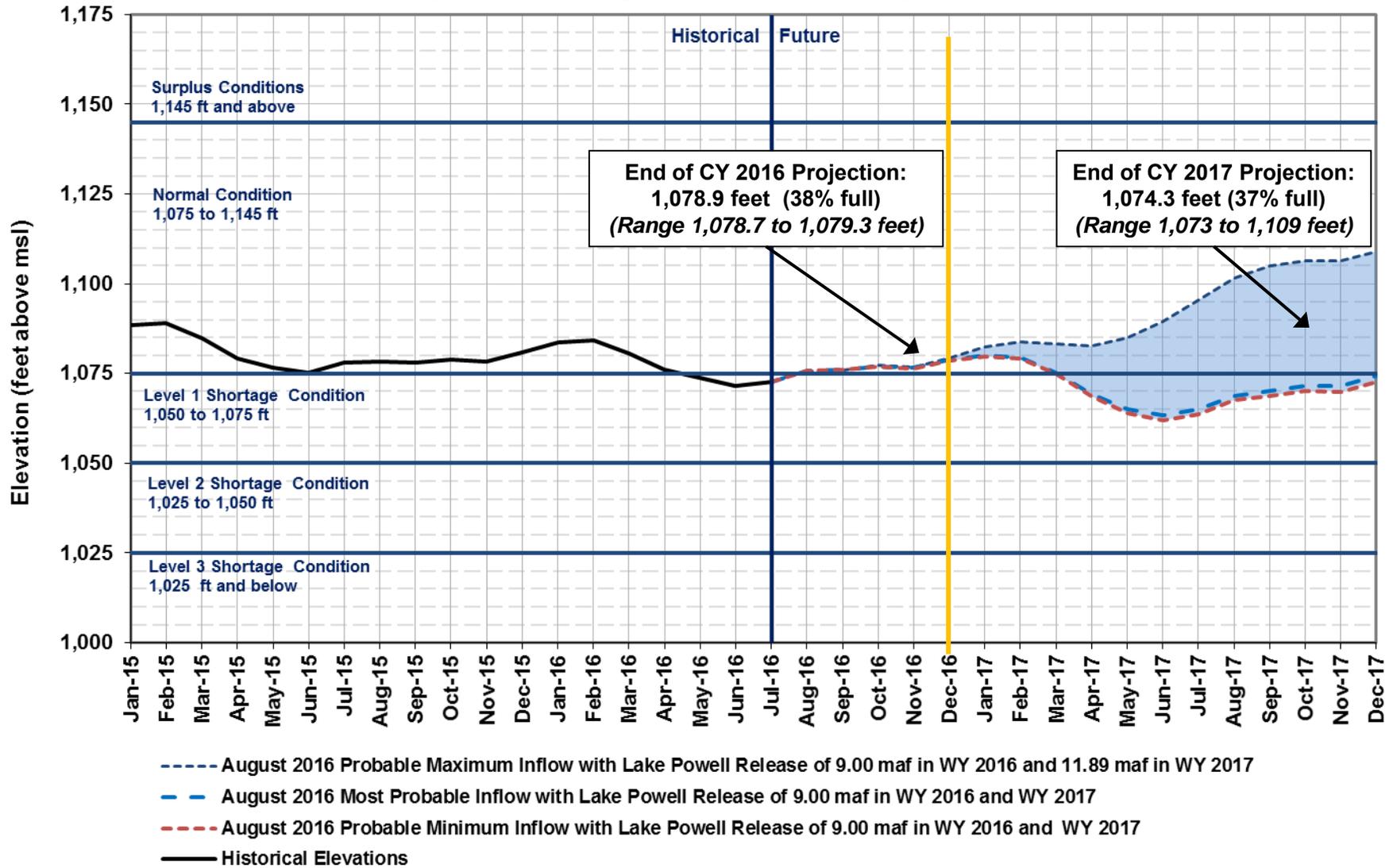
Lake Powell End of Month Elevations

Historic and Projected based on August 2016 Modeling



Lake Mead End of Month Elevations

Projections from August 2016 24-Month Study Inflow Scenarios



Glen Canyon Power Plant Planned Unit Outage Schedule for Water Year 2017

Unit Number	Oct 2016	Nov 2016	Dec 2016	Jan 2017	Feb 2017	Mar 2017	Apr 2017	May 2017	Jun 2017	Jul 2017	Aug 2017	Sep 2017
1	■							■	■	■	■	■
2	■											■
3			■	■	■	■	■	■				
4						■						
5	■	■	■									
6												
7					■							
8					■							
Units Available	5	7	7	7	5	6	7	7	7	7	7	6
Capacity (cfs)	16,100	23,500	23,500	23,500	16,200	20,100	23,600	23,600	23,600	23,600	23,600	19,900
Capacity (kaf/month)	1,080	1,400	1,460	1,420	950	1,280	1,400	1,460	1,400	1,450	1,450	1,220
Max (kaf) ¹	600	600	800	950	800	950	1000	1200	1300	1400	1300	992
Most (kaf) ²	600	600	800	800	650	650	600	650	800	1000	1050	800
Min (kaf) ¹	600	600	800	800	650	650	600	650	800	1000	1050	800

11.89
9.0
9.0

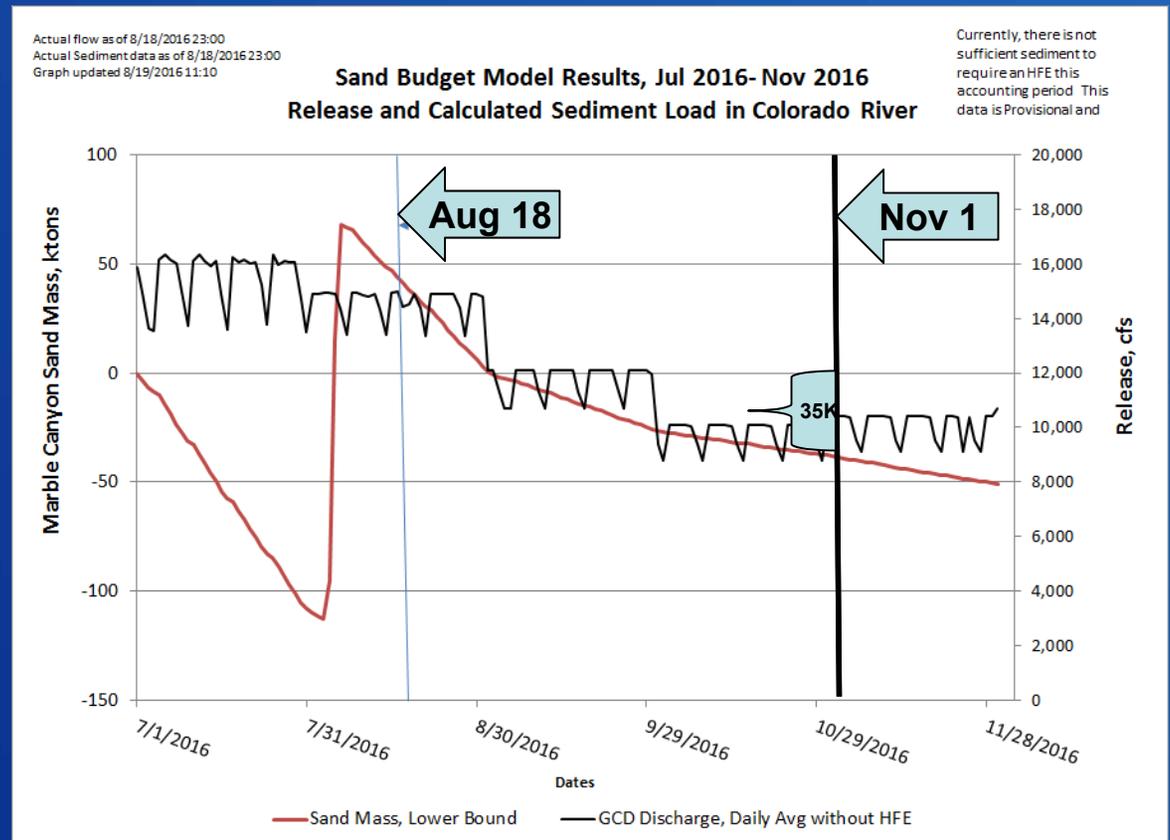
(updated 8-12-2016)

- 1 Projected release, based on Aug 2016 Min and Max Probable Inflow Projections and 24-Month Study model runs
- 2 Projected release, based on Aug 2016 Most Probable Inflow Projections and 24-Month Study model runs

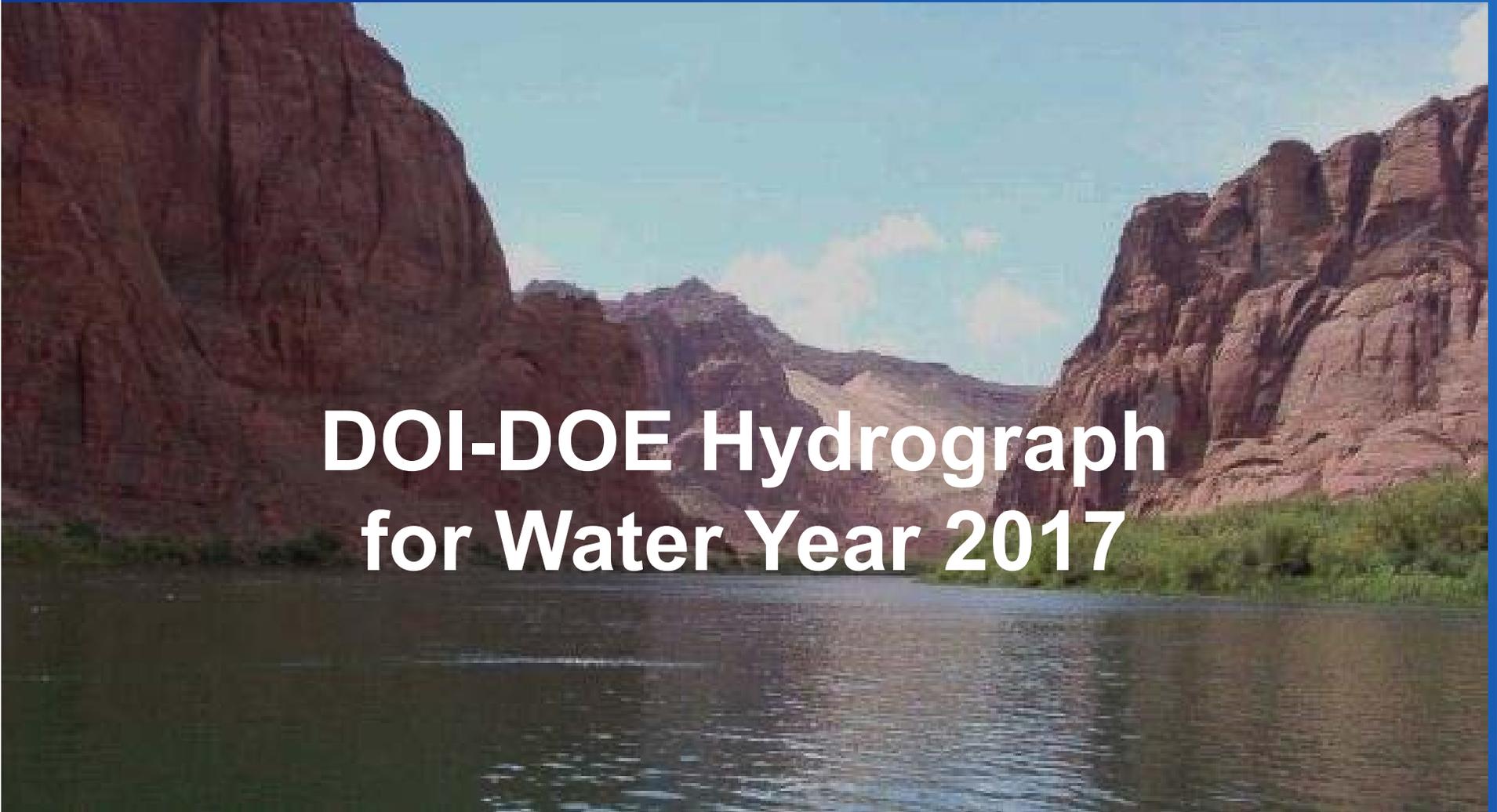
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Sand Budget Model Results

- As of 8-18-2016, not enough sediment input to trigger a fall 2016 HFE
- Still early in the season
- Green Sun Fish?



RECLAMATION



DOI-DOE Hydrograph for Water Year 2017

RECLAMATION

2017 Hydrograph Initial Thoughts

- Start with 2016 Hydrograph
 - Target lower August and September releases
 - Move water to other equal value months for hydropower (Dec/Jan)
 - Avoid shifting “extra” water to June (which cools temperatures at the mouth of the LCR)
- Consider proposed modifications

2017 Projected Annual Release

(Based on August 2016 modeling)

- **Min probable: 9.0 maf release**

(Upper Elevation Balancing Tier - with projected April adjustment to Balancing 8.23-9.0 maf release)

- **Most probable: 9.0 maf release**

(Upper Elevation Balancing Tier - with projected April adjustment to Balancing 8.23-9.0 maf release)

- **Max probable: 11.9 maf release**

(Upper Elevation Balancing Tier
with projected April adjustment to Equalization 8.23-11.9 maf release)

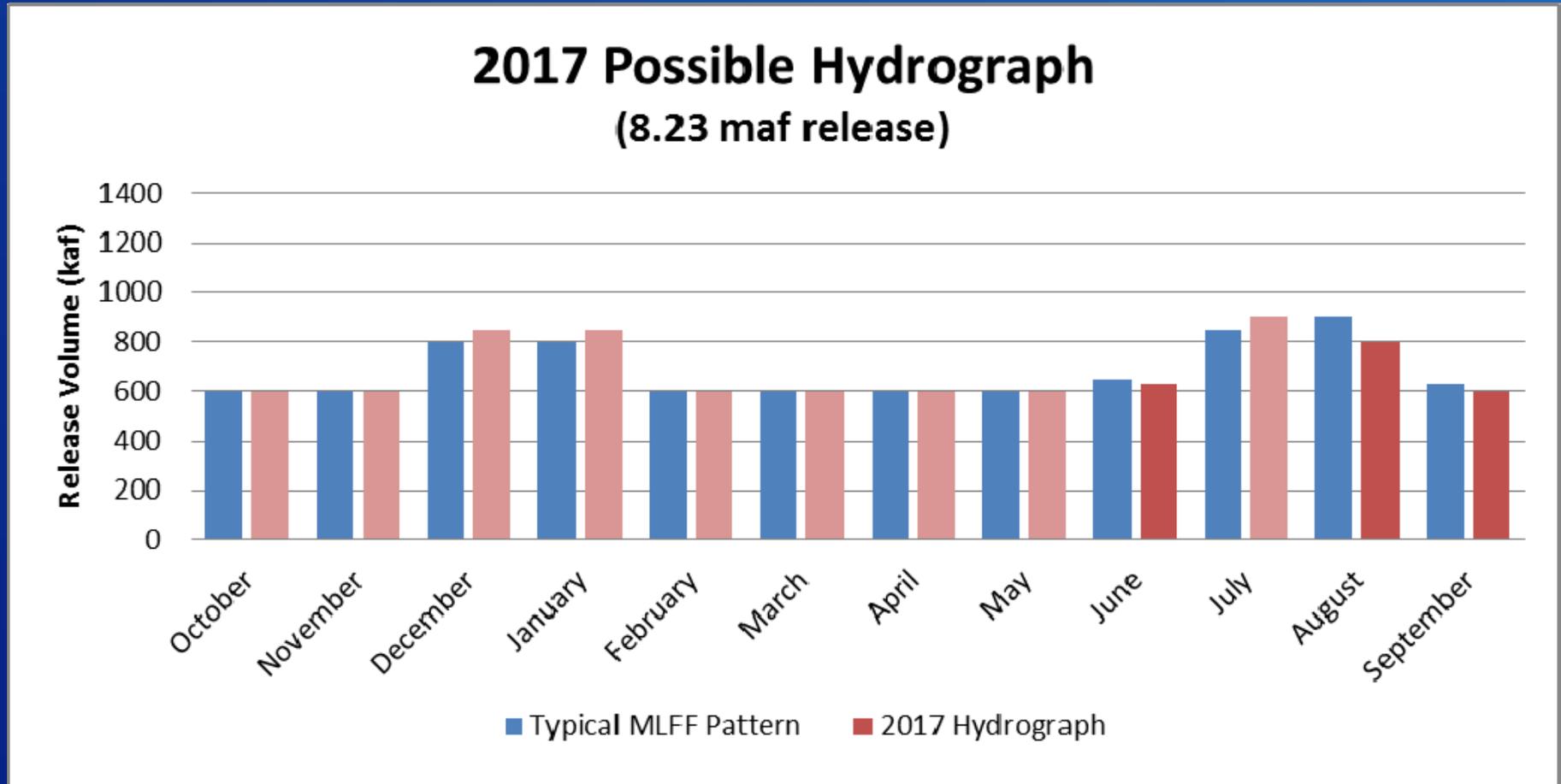
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Proposed 2017 Hydrograph

Annual Release Volume	June	August	September
less than 9.0 maf	600 kaf - 650 kaf	800 kaf	600 kaf
9.0 maf – less than 9.5 maf	800 kaf	900 kaf	700 kaf
9.5 maf – less than 10 maf	900 kaf	900 kaf	700 kaf
10 maf and greater	900 kaf or more	900 kaf or more	800 kaf or more

2017 Proposed Hydrograph

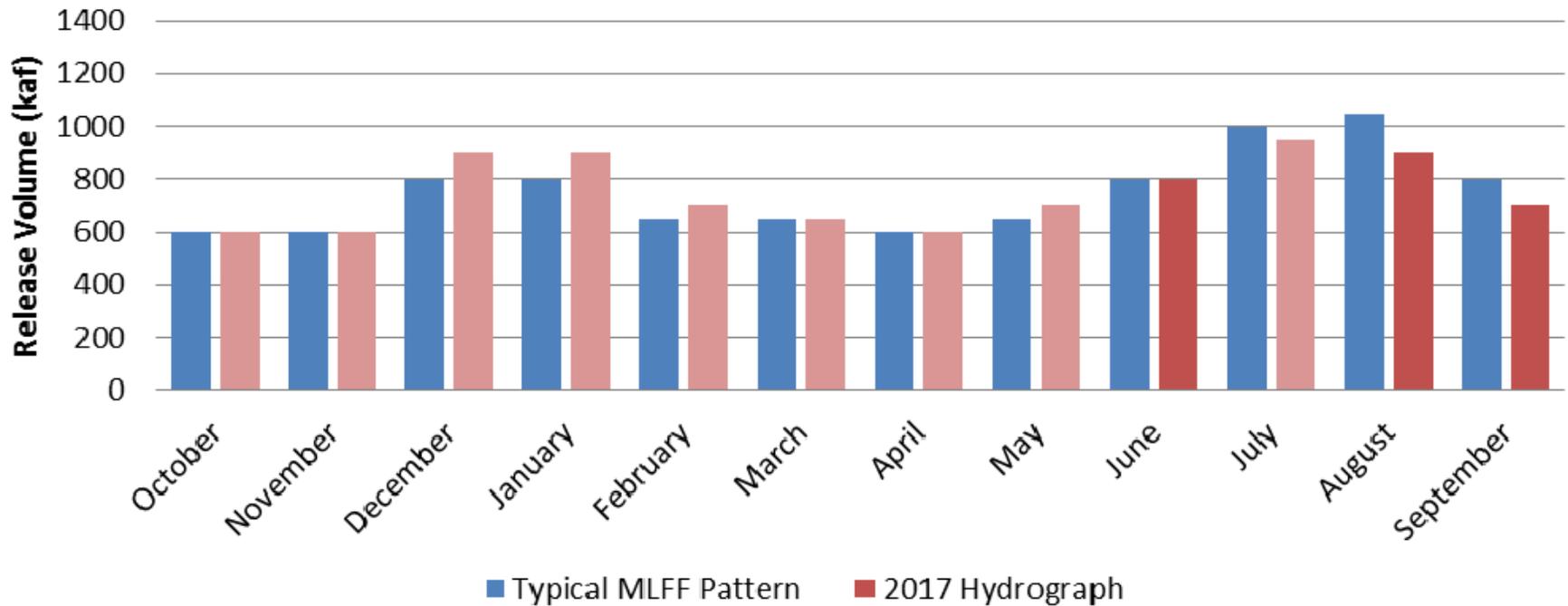
8.23 maf release



2017 Proposed Hydrograph

9.0 maf release

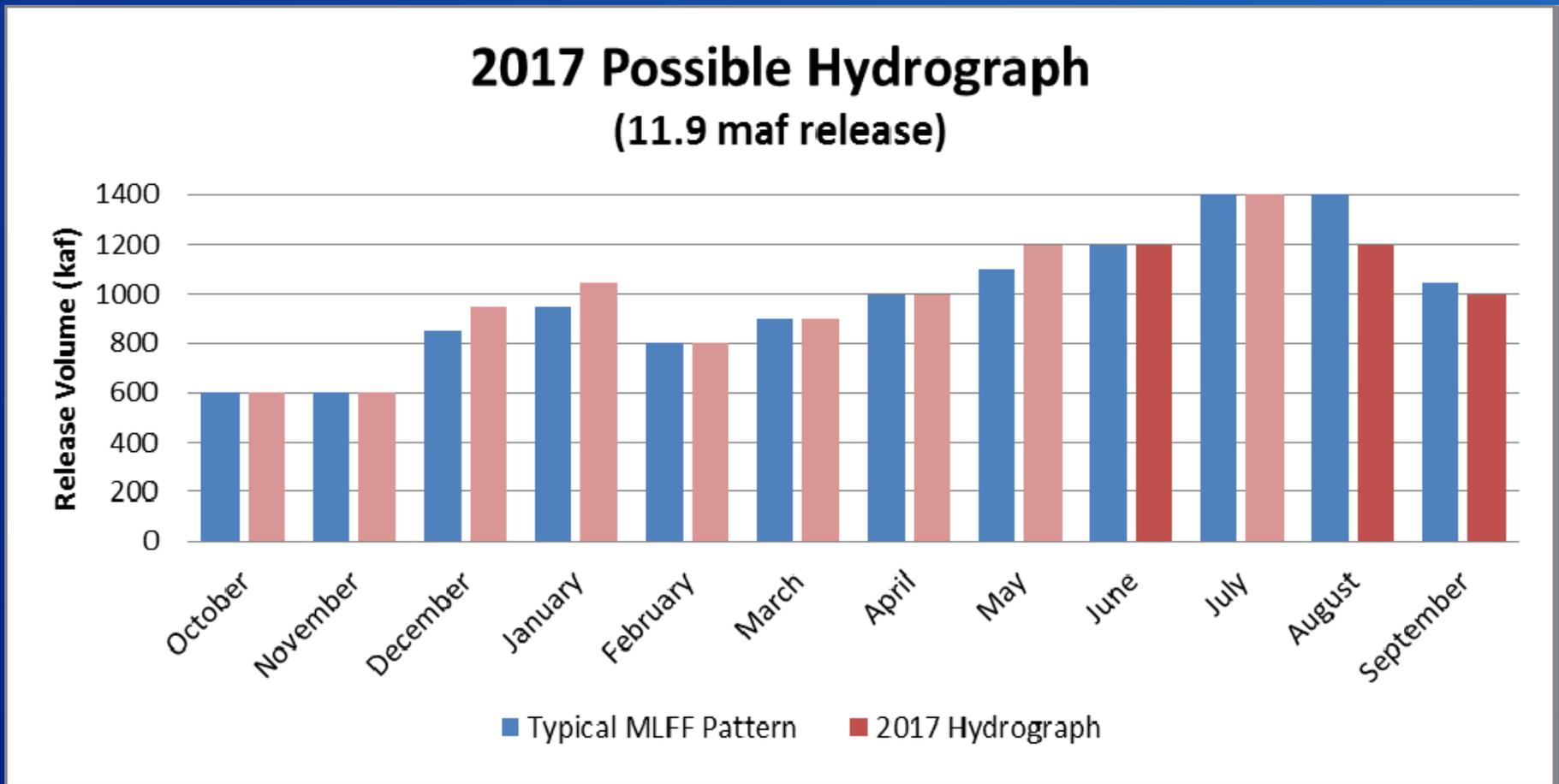
2017 Possible Hydrograph
(9.0 maf release)



2017 Proposed Hydrograph

11.9 maf release

- Lots of water to move: limited flexibility, minimal difference.



Questions?

Paul Davidson

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Hydraulic Engineer, Glen Canyon
Reclamation, Upper Colorado Region
Resource Management Division
Water Resources Group

RECLAMATION

2017 Hydrograph Motion

Previous Action Taken

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Hydrograph motion (slide 1 of 2)

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Hydrograph motion (slide 2 of 2)

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RECLAMATION