

RECLAMATION

Managing Water in the West

Glen Canyon Dam Operations During Equalization

*TWG Meeting
January 28, 2016*



U.S. Department of the Interior
Bureau of Reclamation

Presentation Overview

- What is equalization?
- Why hydrology matters
- Recent example of equalization operations
- How "frequently" equalization releases occur
- Back to back wet years
- Questions/Discussion

What is Equalization?

- It is an operating tier at Lake Powell

Lake Powell Operational Tiers (subject to April adjustments or mid-year review modifications)		
Lake Powell Elevation (feet)	Lake Powell Operational Tier	Lake Powell Active Storage (maf)
3,700	Equalization Tier equalize, avoid spills or release 8.23 maf	24.32
3,636 – 3,666 (see table below)	Upper Elevation Balancing Tier release 8.23 maf; if Lake Mead < 1,075 feet, balance contents with a min/max release of 7.0 and 9.0 maf	15.54 – 19.29 (2008 – 2026)
3,575	Mid-Elevation Release Tier release 7.48 maf; if Lake Mead < 1,025 feet, release 8.23 maf	9.52
3,525	Lower Elevation Balancing Tier balance contents with a min/max release of 7.0 and 9.5 maf	5.93
3,370		0

What is Equalization?

- If Powell elevation is projected to be above the equalization level → release more than 8.23 maf until at the end of the water year, such that:
 - Powell storage = Mead Storage, or
 - Mead elevation = 1,105', or
 - Powell elevation = equalization level – 20 ft, or
 - Powell elevation = equalization level
- So... what is balancing?
 - Attempt balance the contents of Powell and Mead by the end of the water year
 - BUT Powell releases UP TO 9.0 maf

How is Equalization determined?

- **August** 24-Month Study Projection of Lake Powell Jan 1 elevation \geq equalization level
OR
- **April** 24-Month Study projection of Lake Powell September 30th elevation \geq equalization level

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What is Equalization?

- Equalization level increases each year of the interim period
 - With each passing year, reservoir has to be “more full” to trigger equalization

Water Year	Elevation (feet)
2008	3,636
2009	3,639
2010	3,642
2011	3,643
2012	3,645
2013	3,646
2014	3,648
2015	3,649
2016	3,651
2017	3,652
2018	3,654
2019	3,655
2020	3,657
2021	3,659
2022	3,660
2023	3,662
2024	3,663
2025	3,664
2026	3,666

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August determination

1. In Water Years when Lake Powell elevation is projected on January 1 to be at or above the elevation stated in the Lake Powell Equalization Elevation Table, an amount of water will be released from Lake Powell to Lake Mead at a rate greater than 8.23 maf per Water Year to the extent necessary to avoid spills, or equalize storage in the two reservoirs, or otherwise to release 8.23 maf from Lake Powell. The Secretary shall release at least 8.23 maf per Water Year and shall release additional water to the extent that the additional releases will not cause Lake Powell content to be below the elevation stated in the Lake Powell Equalization Elevation Table or cause Lake Mead content to exceed that of Lake Powell; provided, however, if Lake Powell reaches the elevation stated in the Lake Powell Equalization Elevation Table for that Water Year and the September 30 projected Lake Mead elevation is below elevation 1,105 feet, the Secretary shall release additional water from Lake Powell to Lake Mead until the first of the following conditions is projected to occur on September 30: (i) the reservoirs fully equalize; (ii) Lake Mead reaches elevation 1,105 feet; or (iii) Lake Powell reaches 20 feet below the elevation in the Lake Powell Equalization Elevation Table for that year.

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April determination

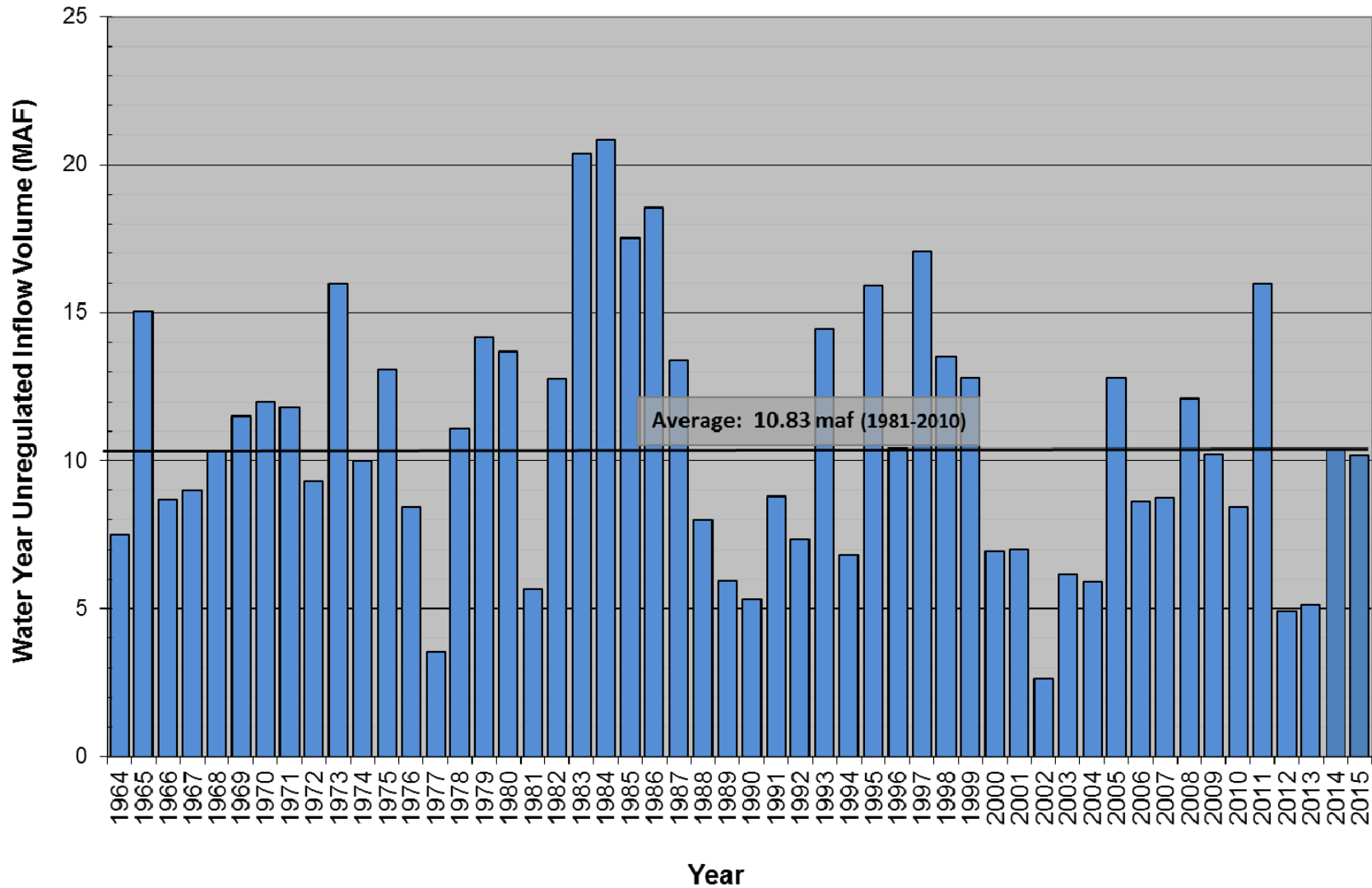
B. Upper Elevation Balancing Tier

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.

Hydrology matters!

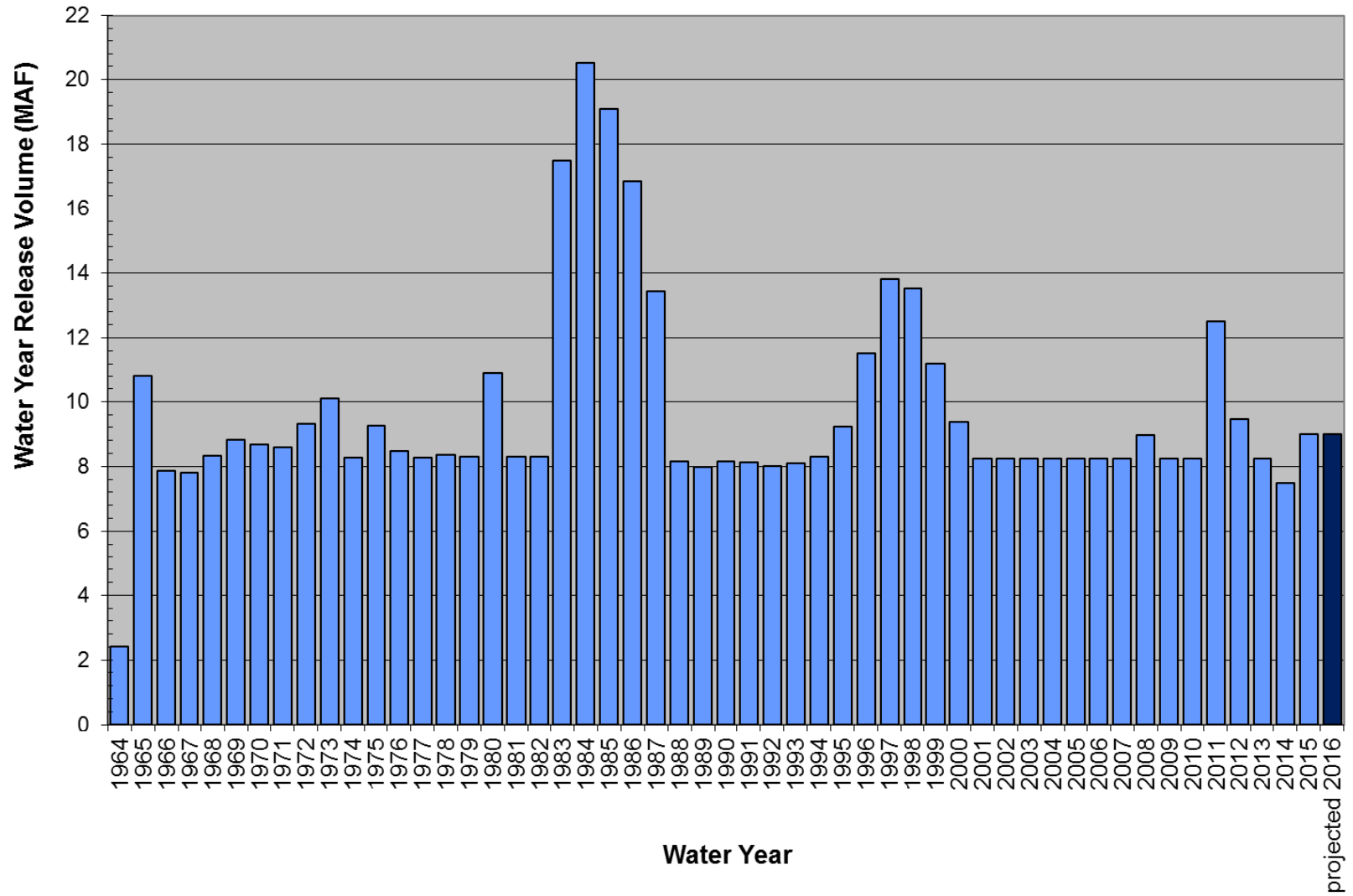
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Lake Powell Unregulated Inflow



Lake Powell Release

Water Year Volume

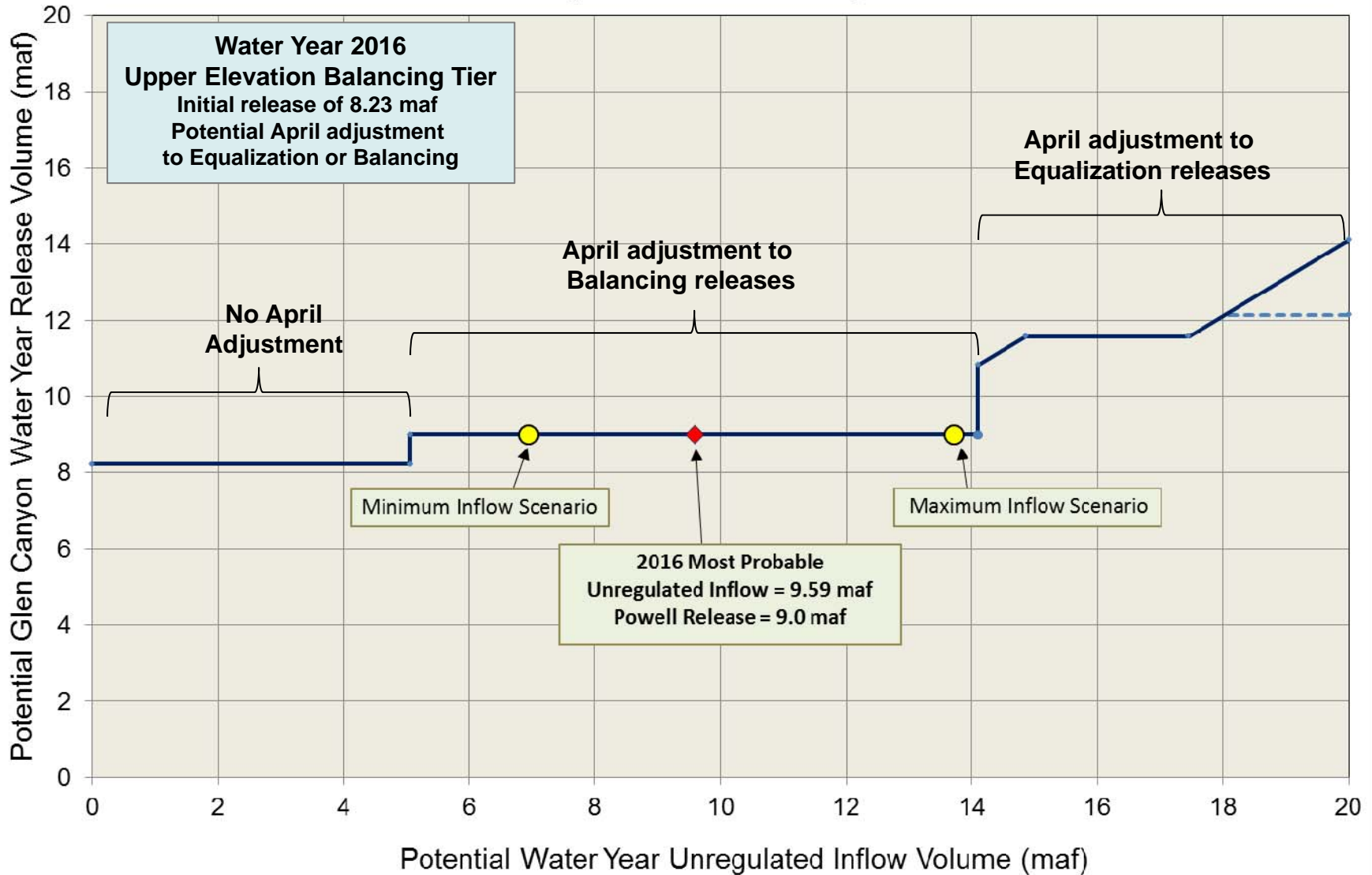


Reservoir initial conditions matter

- Powell
- Mead

Potential Lake Powell Release Scenarios

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



Glen Canyon Power Plant Provisional Unit Outage Schedule for Water Year 2016

Unit Number	Oct 2015	Nov 2015	Dec 2015	Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016	Sep 2016	
1													
2													
3													
4													
5													
6													
7													
8													
Units Available	6	7	7	7	5	5	6	6	7	7	7	5	
Capacity (cfs)	18,400	22,100	22,100	22,100	15,200	15,300	18,700	18,600	22,100	22,100	22,100	15,100	
Capacity (kaf/month)	1,150	1,130	1,280	1,300	920	990	1,140	1,140	1,310	1,330	1,310	940	
Max (kaf) ¹	--	--	--	900	700	650	666	700	800	950	900	700	9.0
Most (kaf) ²	600	577	857	900	700	650	666	700	800	950	900	700	9.0
Min (kaf) ¹	--	--	--	900	700	650	666	700	800	950	900	700	9.0

Maintenance matters

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

(updated 1-19-2016)

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Water Year 2011
Review of Operations

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Summary of Lake Powell and Lake Mead Operations

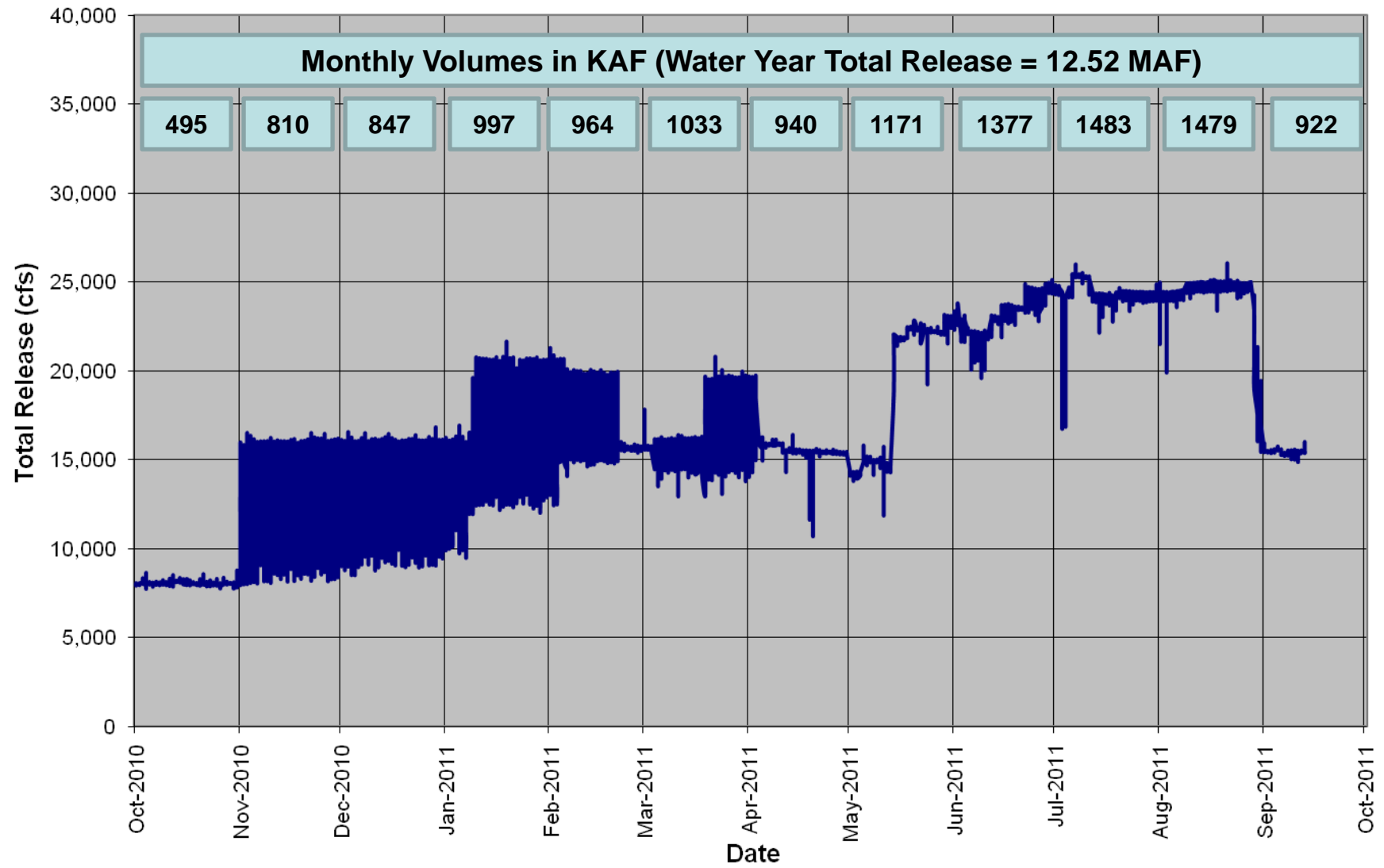
Review of 24-Month Study 2011 Water Year Projections

24-Month Study	Projected Powell WY Unreg Inflow	Projected Powell Apr- Jul Unreg Inflow	Projected Lake Powell EOWY Elevation w/ 8.23 maf Release	Projected Glen Canyon WY Release	Projected Amount of EQ Release	Projected Lake Mead EOWY Elevation	Probability of EQ
Jan 2011	110% 13.19 maf	120% 9.5 maf	3663.31 ft	11.36 maf	3.13 maf	1105.00 ft	76%
Feb 2011	105% 12.60 maf	113% 9.0 maf	3657.85 ft	11.48 maf	3.25 maf	1105.00 ft	71%
Mar 2011	105% 12.68 maf	116% 9.2 maf	3658.16 ft	11.63 maf	3.40 maf	1105.00 ft	97%
Apr 2011	109% 13.11 maf	120% 9.5 maf	3662.63 ft	11.56 maf	3.33 maf	1105.00 ft	---
Oct-1 2011	139% 16.79 maf	162% 12.89 maf	3653.01 ft	12.52 maf	4.29 maf	1116.04 ft	---

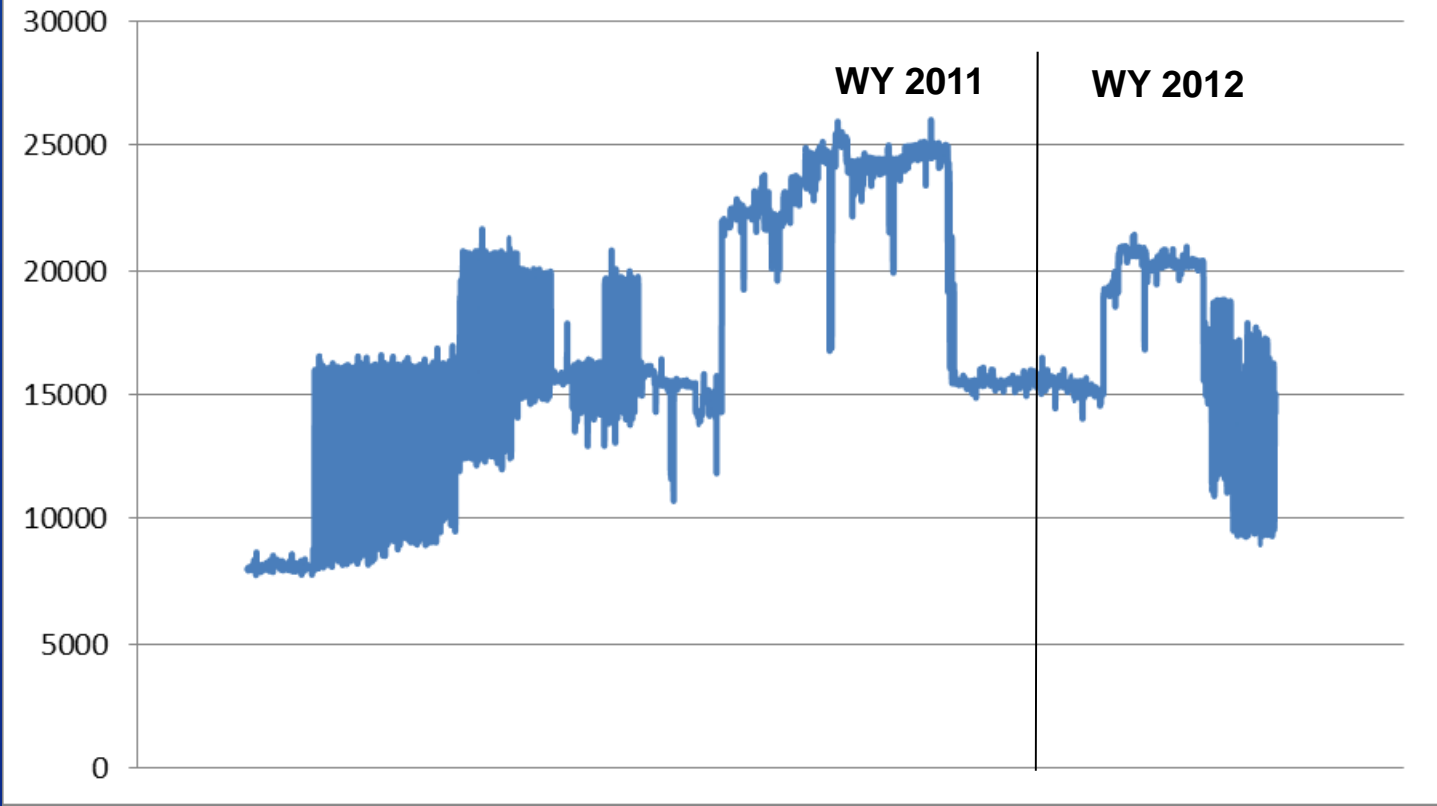
In 2011, the Equalization Elevation is 3643 ft.

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Glen Canyon Dam Hourly Average Releases WY2011

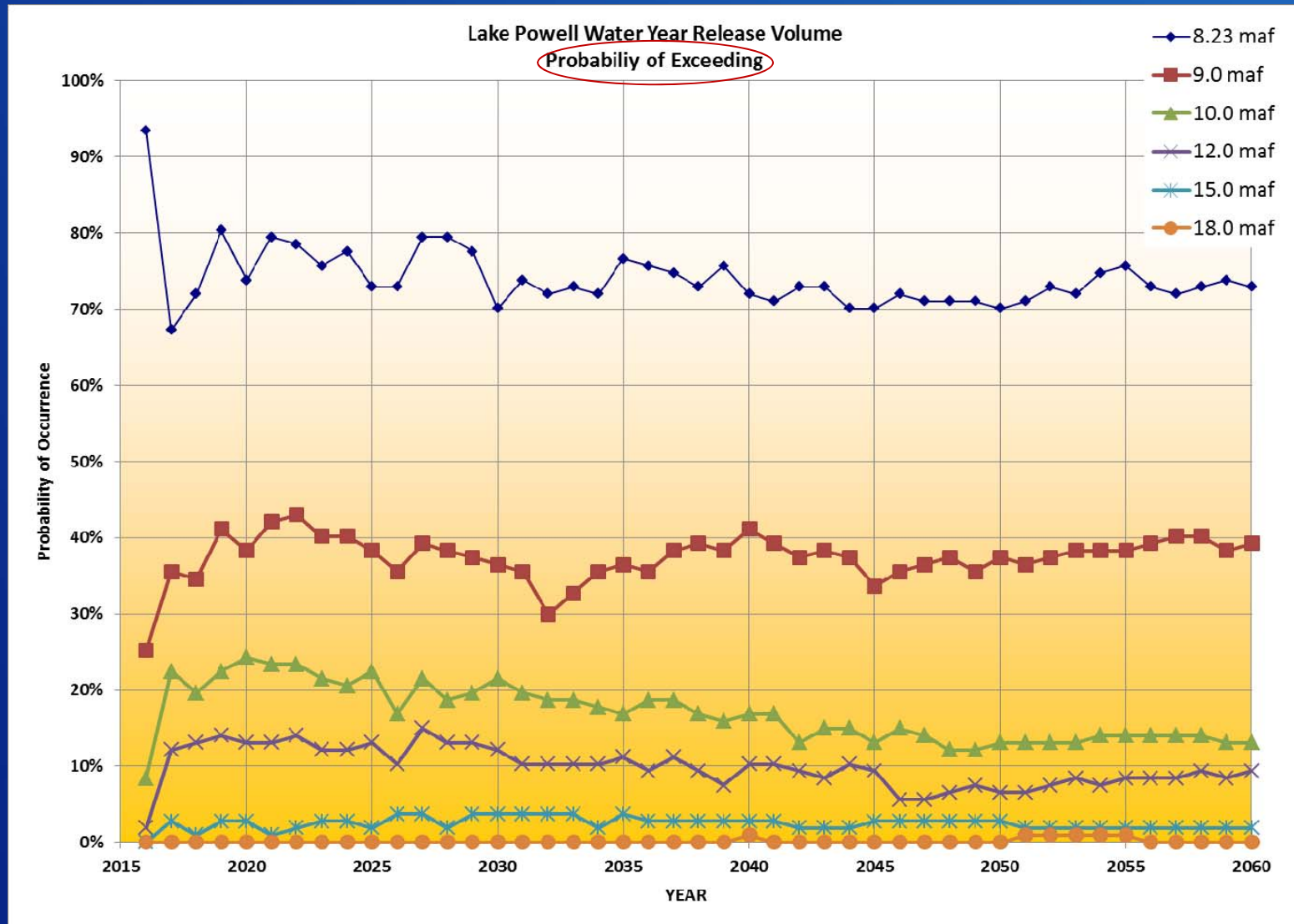


LAKE POWELL 2011 release (cfs)



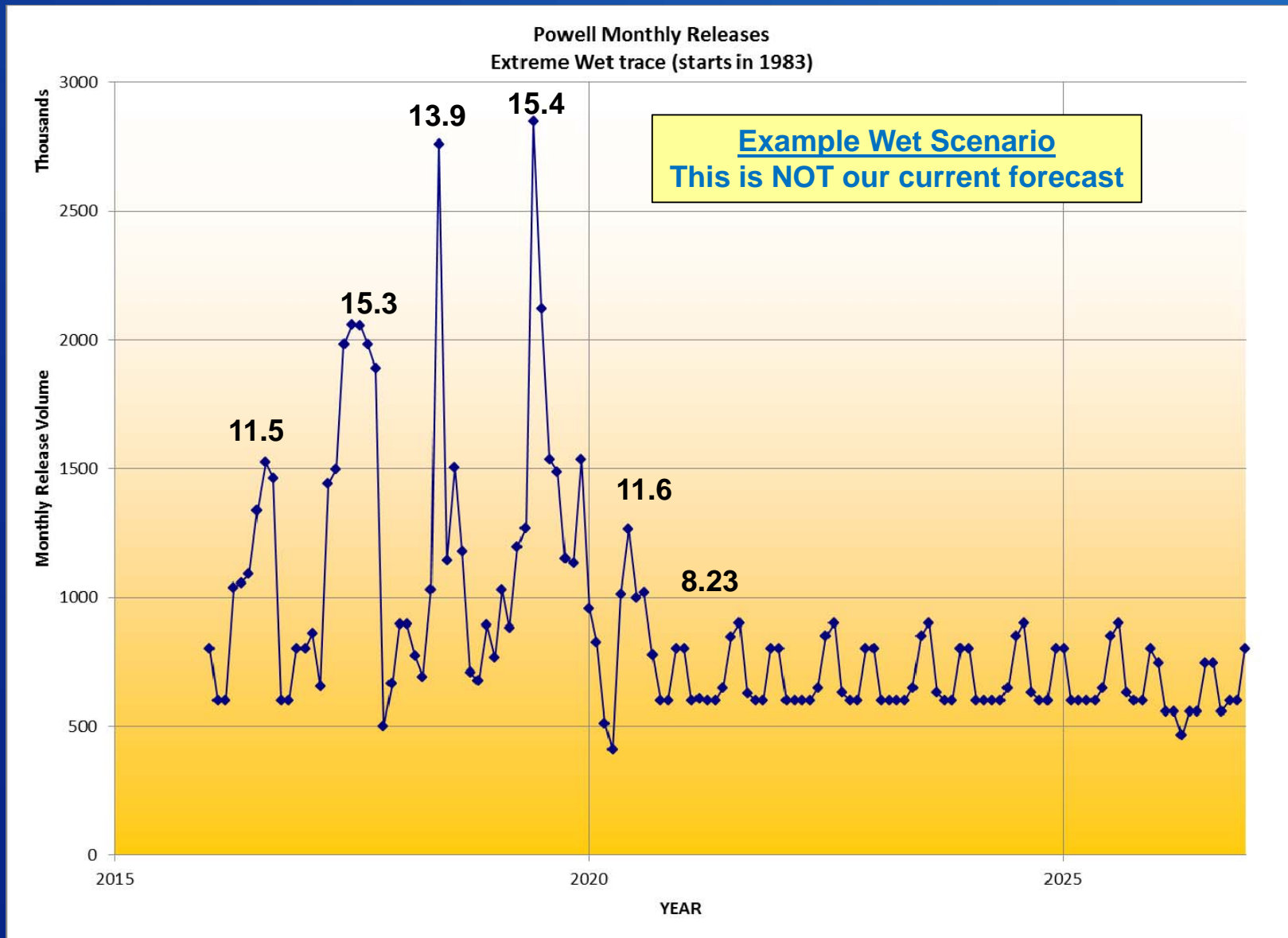
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How frequent are high annual releases?



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Back to back large annual volume releases?



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Summary

- Equalization is an operating tier under the interim guidelines
- Hydrology matters
 - Hydrology (and forecast development) determines how “spread out” the total annual volume is over the water year
- Reservoir initial elevations matter
- Maintenance matters
- Releases can be 8.23 up to 12 maf, 15 maf ... or more

Thank you!

Questions / Discussion

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Extra Slides Follow

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Equalization for 2011

	Lake Powell Elevation (ft)	Lake Powell Storage (maf)
Observed EOWY Condition	3653.01	17.593
Equalization EOWY Objective	3643.00	16.360
Difference	10.01	1.233

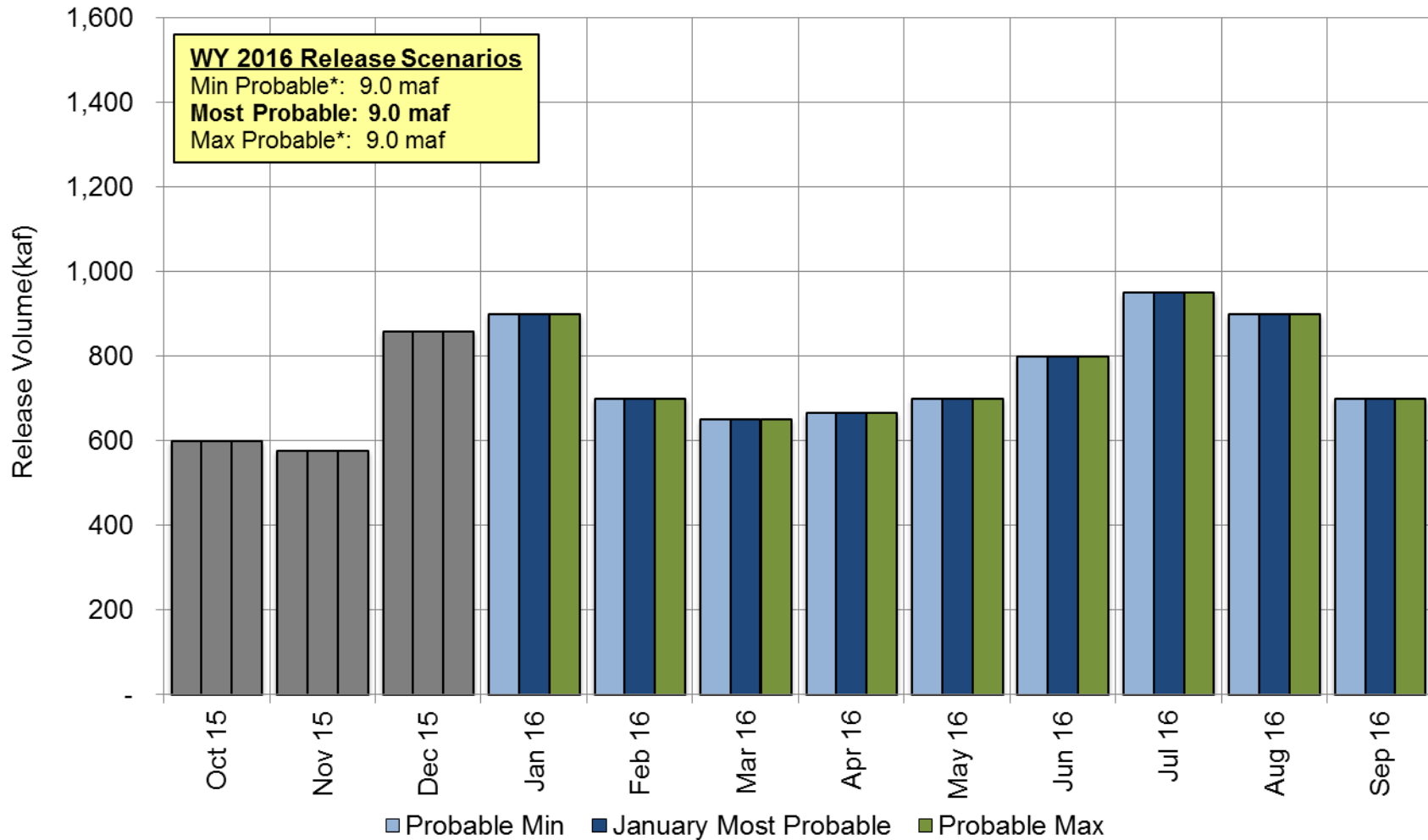
Equalization in 2011 was not achieved on September 30, 2011 due to powerplant release limitations during water year 2011. The Equalization objective in 2011 was to achieve a Lake Powell elevation on September 30, 2011 of 3643.00 feet.

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Potential Lake Powell Monthly Release Volume Distribution

Release Scenarios for Water Year 2016

Updated January 2016



* Probable min and max annual release volume is based on January probable min and max inflow forecasts

August
determination

April
determination

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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.