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Managing Water in the West

Colorado River Operations: Lake Powell and Lake Mead

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Colorado River District Annual Water Seminar
September 18, 2009

U.S. Department of the Interior
Bureau of Reclamation

Colorado River Operations:
Lake Powell and Lake Mead

- Overview of the Basin
- The Current State of the System
- Interim Guidelines for Lakes Powell and Mead
- Projections of Future Reservoir Conditions
- Summary and Questions

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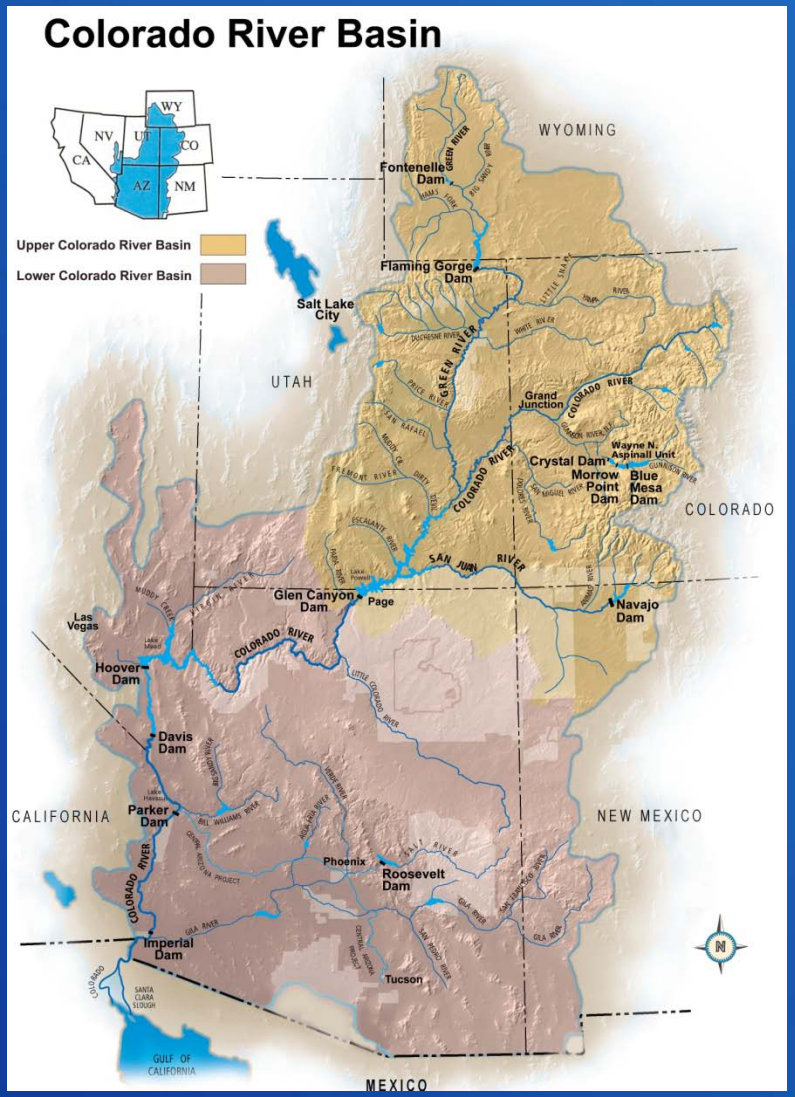
Overview of the Colorado River Basin

- Operation governed by the Law of the River
- Inflows are highly variable
- 60 million acre-feet of storage capacity
- System is over-allocated
- System operated on a tight margin, particularly in the Lower Basin



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Water Budget at Lake Mead

Given basic apportionments in the Lower Basin, the allotment to Mexico, and an 8.23 maf release from Lake Powell, Lake Mead storage declines

- Inflow = 9.0 maf
  (release from Powell + side inflows)
- Outflow = - 9.6 maf
  (AZ, CA, NV, and Mexico delivery
  + downstream regulation and gains/losses)
- Mead evaporation loss = - 0.6 maf
- Balance = - 1.2 maf

Data based on long-term averages

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Colorado River Basin Storage

(as of September 14, 2009)

Current Storage	Percent Full	MAF	Elevation (Feet)
Lake Powell	64%	15.60	3637
Lake Mead	42%	10.93	1094
Total System Storage*	58%	34.58	NA

*Total system storage includes other mainstream reservoirs and was 34.36 maf or 58% this time last year.

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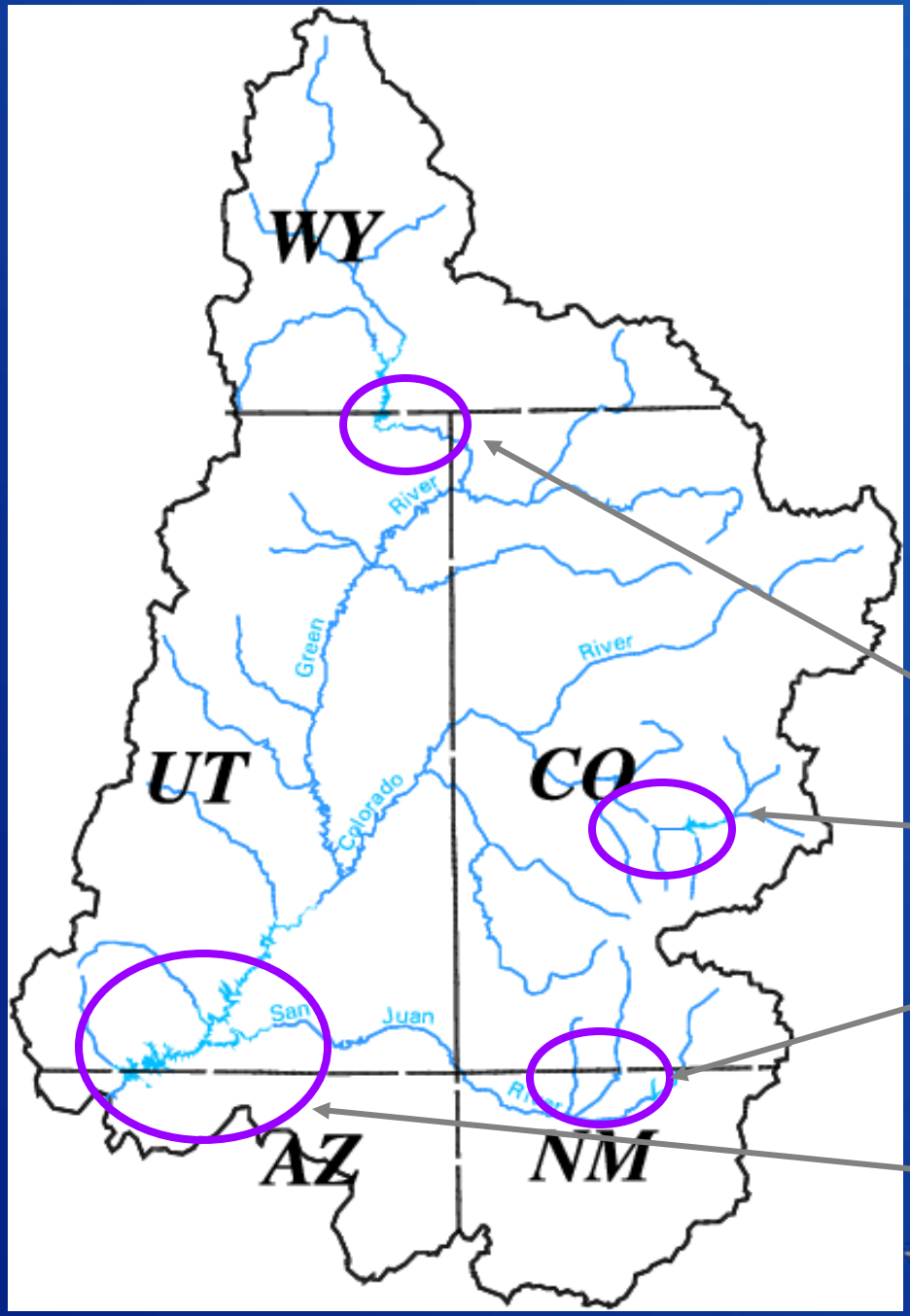

2009 Upper Colorado Observed Apr–Jul Inflow

Flaming Gorge – 101%

Blue Mesa – 107%

Navajo – 84%

Lake Powell – 99%

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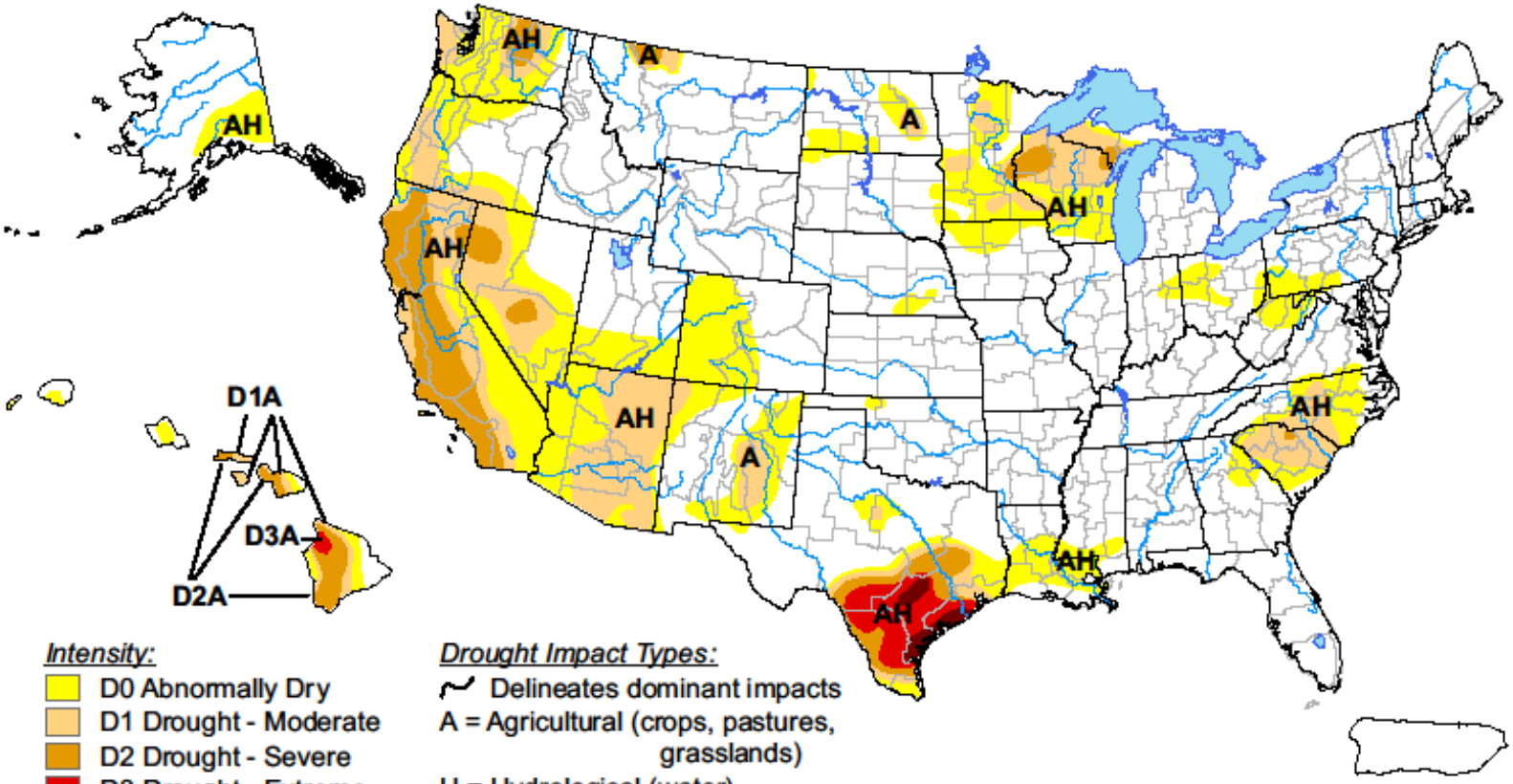
U.S. Drought Monitor

September 15, 2009
Valid 8 a.m. EDT



Intensity:
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:
- Delineates dominant impacts
- A = Agricultural (crops, pastures, grasslands)
- H = Hydrological (water)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://drought.unl.edu/dm

USDA National Drought Mitigation Center

Released Thursday, September 17, 2009
Author: Anthony Artusa, CPC/NCEP/NWS/NOAA

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State of the System (1999-2009)

WY	Unregulated inflow into Powell % of Average	Powell and Mead Storage, maf	Powell and Mead % Capacity
1999	109	47.59	95
2000	62	43.38	86
2001	59	39.01	78
2002	25	31.56	63
2003	52	27.73	55
2004	49	23.11	46
2005	105	27.16	54
2006	72	25.80	51
2007	68	24.43	49
2008	103	26.52	53
2009*	92	26.90	54

* Based on August 2009 24-Month Study.

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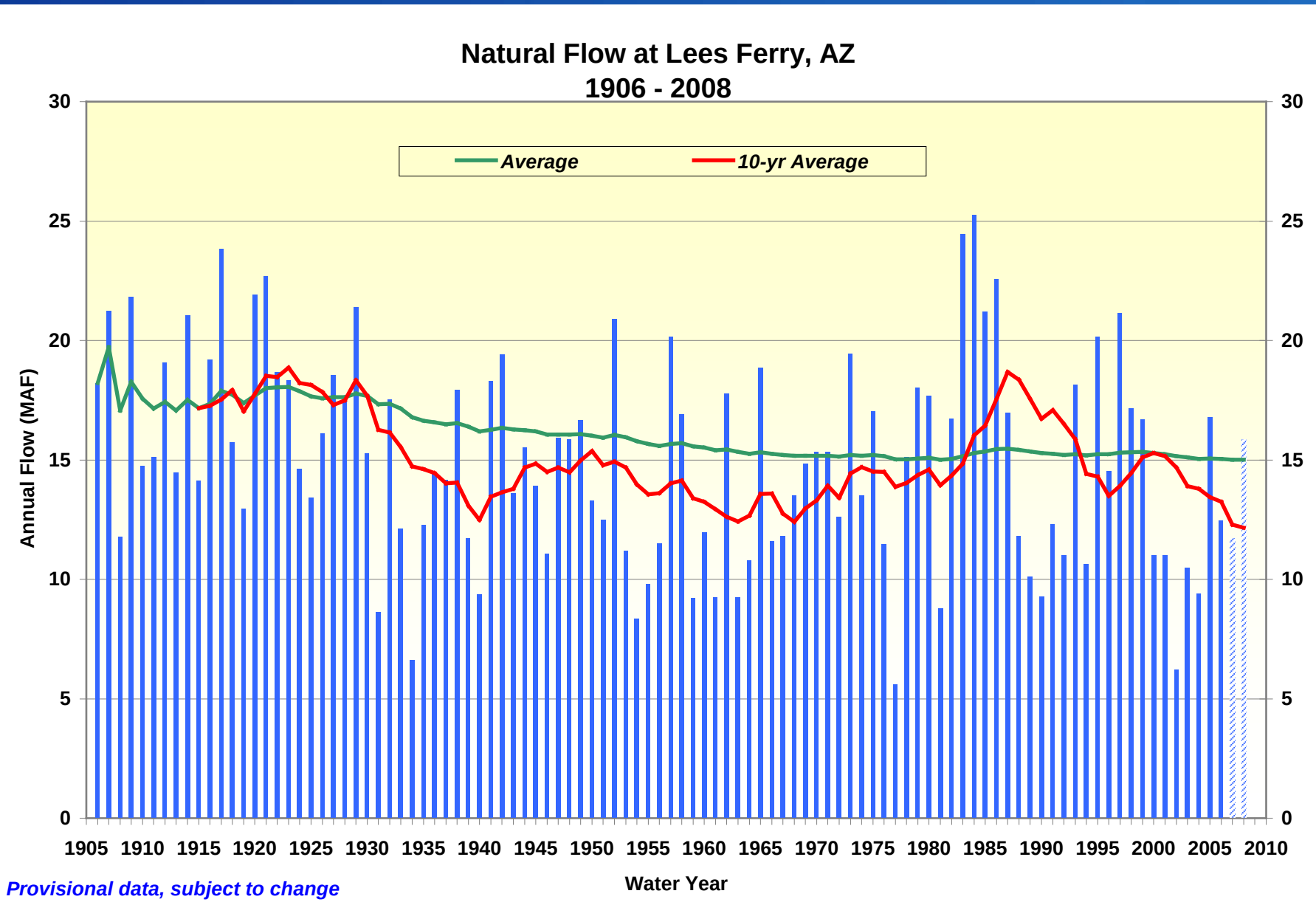

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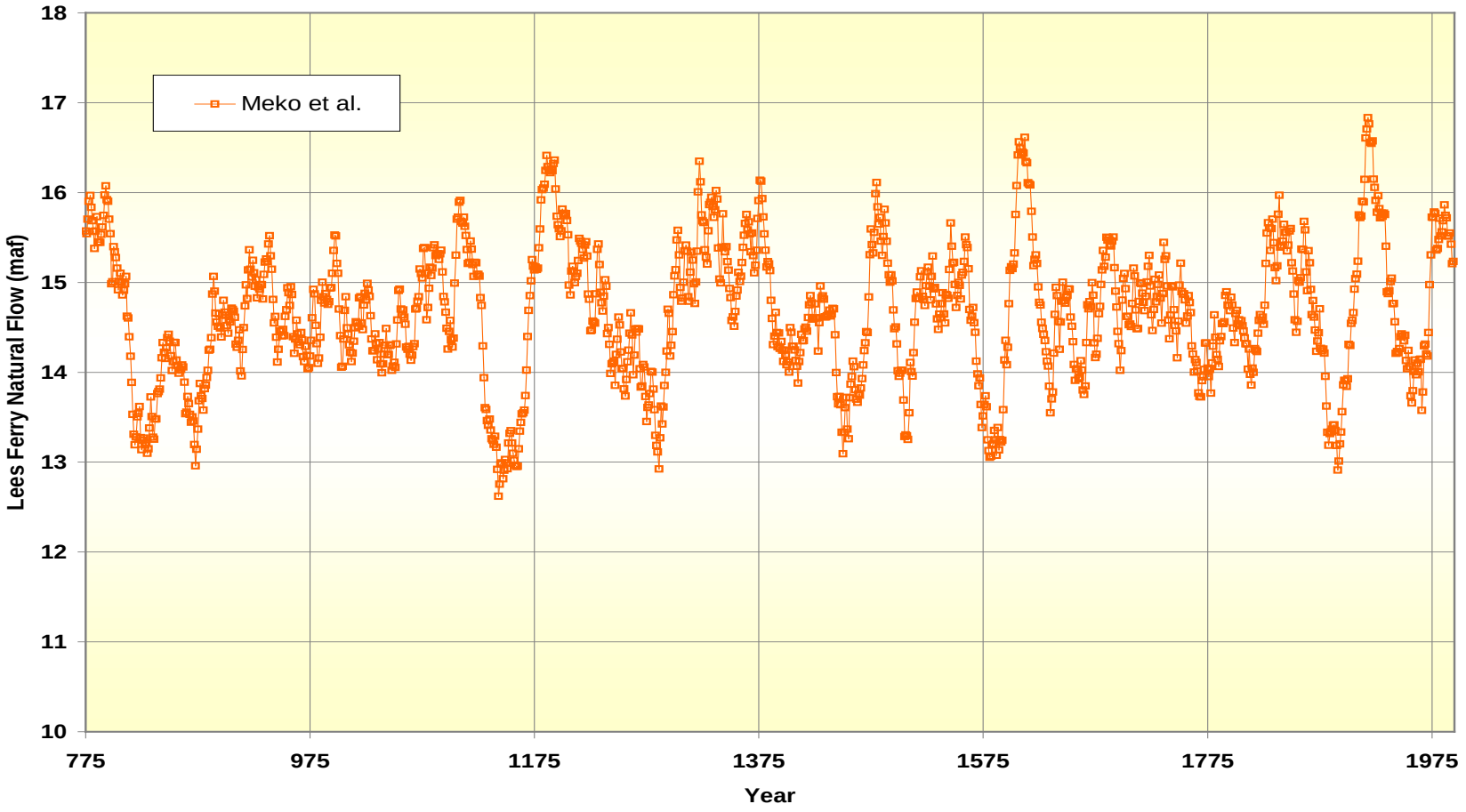
Annual Natural Flow at Lees Ferry
Tree-ring Reconstruction (Meko et al., 2007)
25-Year Running Mean



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State of the Colorado River System
Summary

- 2000 - 2009 has been the driest 10-year period in the 100-year historical record [1]
- Not unusual to have a few years of above average inflow during longer-term droughts (e.g., the 1950's)
- Tree-ring reconstructions show more severe droughts have occurred over the past 1200 years (e.g., drought in the mid 1100's)
- Approximately 34.6 maf of water in storage in the mainstream reservoirs (58% full); same as last year
- We all need to use and manage our water resources wisely

[1] Based on provisional data

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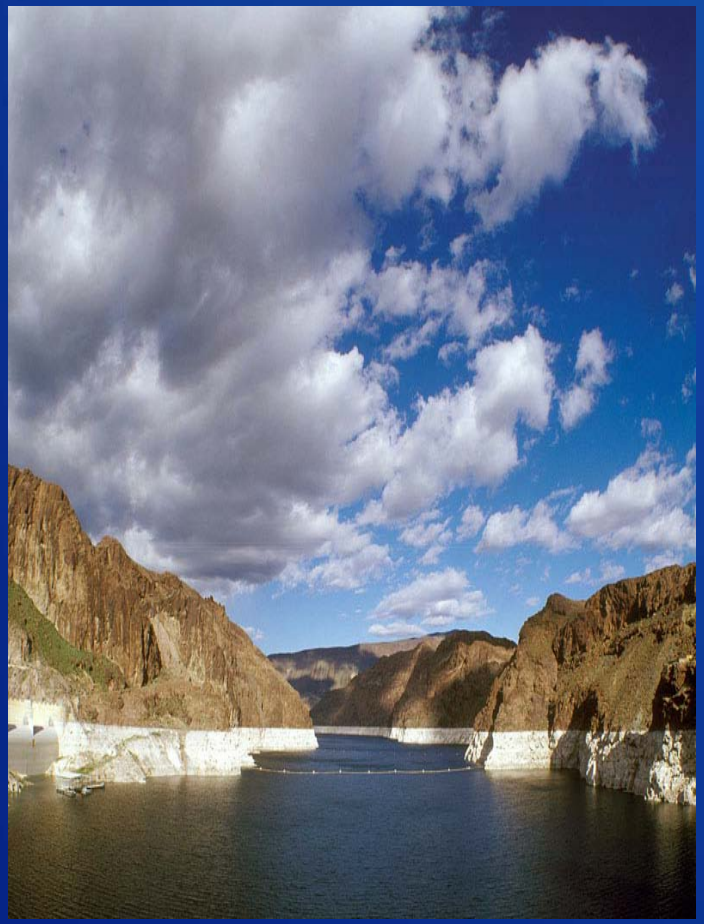
Impetus for the Interim Guidelines



- In spring of 2005, five years of unprecedented drought resulted in rapidly declining lake levels
- Demand for water projected to continually increase Basin-wide
- There were no shortage guidelines for Lower Basin users
- Operations between Lake Powell and Lake Mead were coordinated only at the higher reservoir levels (“equalization”)

Development of the Interim Guidelines[1]

- Result of a 2.5 year public process conducted pursuant to NEPA
- Guidelines are in place for an interim period (through 2026)
- Basin States agree to consult before resorting to litigation
- Key provisions of the Interim Guidelines
  - Operation for Lake Powell and Lake Mead is specified throughout the full range of operation
  - Strategy for shortages in the Lower Basin[2] is specified, including a provision for additional shortages if warranted
  - Mechanism (Intentionally Created Surplus or ICS) is established to encourage efficient and flexible water use in the Lower Basin

1. Issued in Record of Decision, dated December 13, 2007; available at http://www.usbr.gov/lc/region/programs/strategies.html
2. Mexico water deliveries are not directly affected by these guidelines

Elevation (feet)	Lake Powell Operational Diagram	Storage (maf)
3,700	**Equalization Tier** Equalize, Avoid Spills or Release 8.23 maf	24.3
3,636 - 3,666 (2008-2026)		15.5 - 19.3 (2008-2026)
3,637 *as of 9/14//09*	**Upper Elevation Balancing Tier**[1] Release 8.23 maf; if Lake Mead < 1,075 feet, balance contents with a min/max release of 7.0 and 9.0 maf	15.6 *as of 9/14/09*
3,595		11.3
3,575		9.5
3,560	**Mid-Elevation Release Tier** Release 7.48 maf; if Lake Mead < 1,025 feet, release 8.23 maf	8.3
3,525		5.9
3,490	**Lower Elevation Balancing Tier** Balance contents with a min/max release of 7.0 and 9.5 maf	4.0
3,370		0

[1] Subject to April adjustments that may result in balancing releases or releases according to the Equalization Tier.

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Elevation (feet)	Lake Mead Operational Diagram	Storage (maf)
1,220	Flood Control or 70R Surplus	25.9
1,200		22.9
	Domestic Surplus	
1,145		15.9
	Normal Operations	
1,125		13.9
1,094 as of 9/14/09		10.9 as of 9/14/09
1,075		9.4
	Shortage 333 kaf[2]	
1,050		7.5
	Shortage 417kaf[2]	
1,025		5.8
1,000	Shortage 500 kaf[2] and Consultation[3]	4.3
895		0

[1] These are amounts of shortage (i.e., reduced deliveries in the United States).

[2] If Lake Mead falls below elevation 1,025 ft msl, the Department will initiate efforts to develop additional guidelines for shortages at lower Lake Mead elevations.

Intentionally Created Surplus (ICS) in the Lower Basin

Construction of the Drop 2 Storage Reservoir

- ICS may be created through “extraordinary conservation” measures including:
  - land fallowing, canal lining, desalination, importation, system efficiency
- There is a 5% “system assessment” when ICS is created (except for system efficiency projects)
- Delivery of ICS may occur in years after creation

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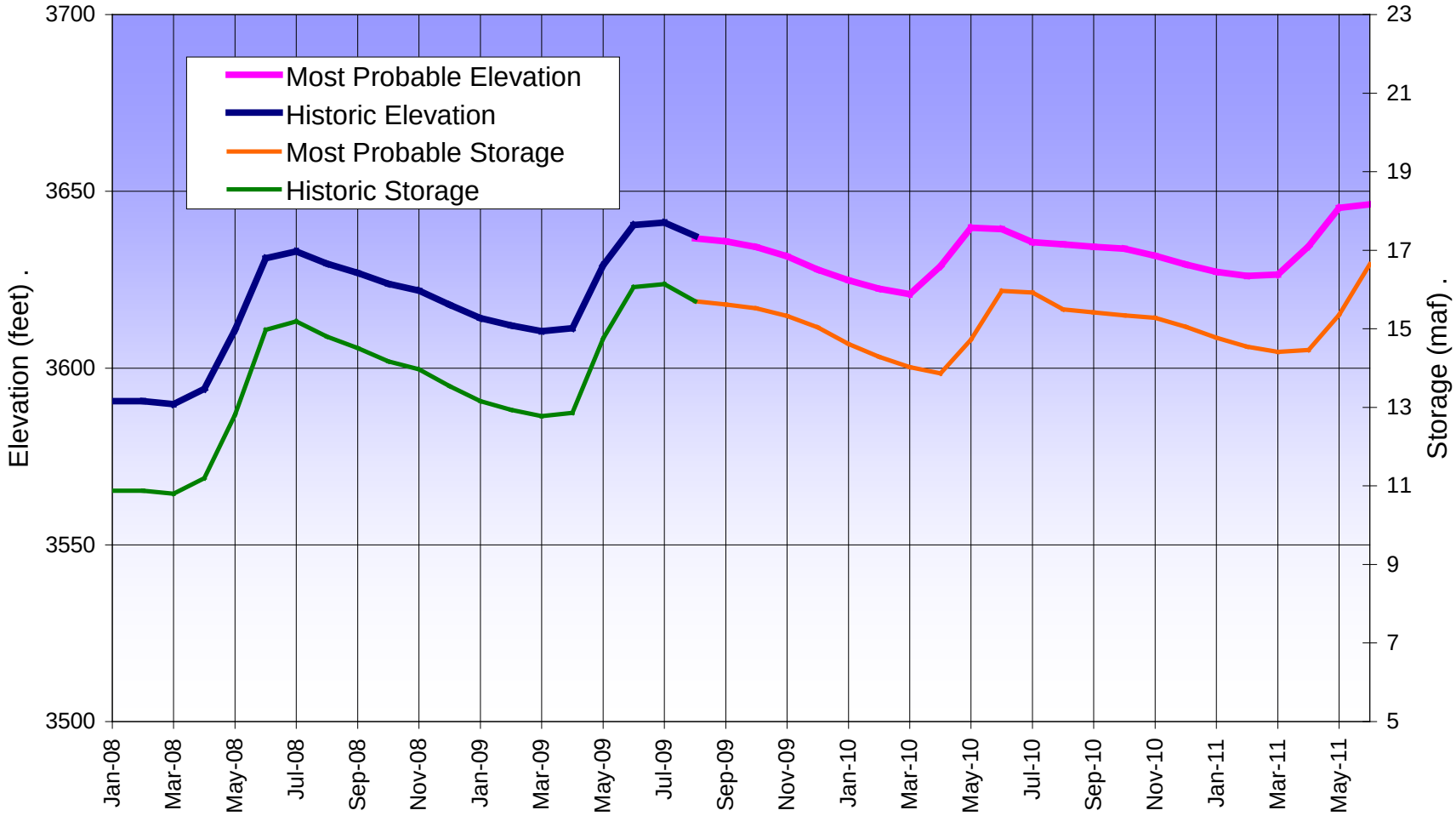
Projections of Future Reservoir Conditions

- There many sources of the uncertainty in the modeling projections including:
  - Future inflows
  - Future water demands
  - Future reservoir operations
- Future inflows are primary source of uncertainty
  - Addressed by performing multiple model runs using different inflow scenarios to generate probabilities
- How do we generate the different inflow scenarios to better estimate the probability distributions?

Lake Powell Projected EOM Water Surface Elevation and Storage
September 24-Month Study



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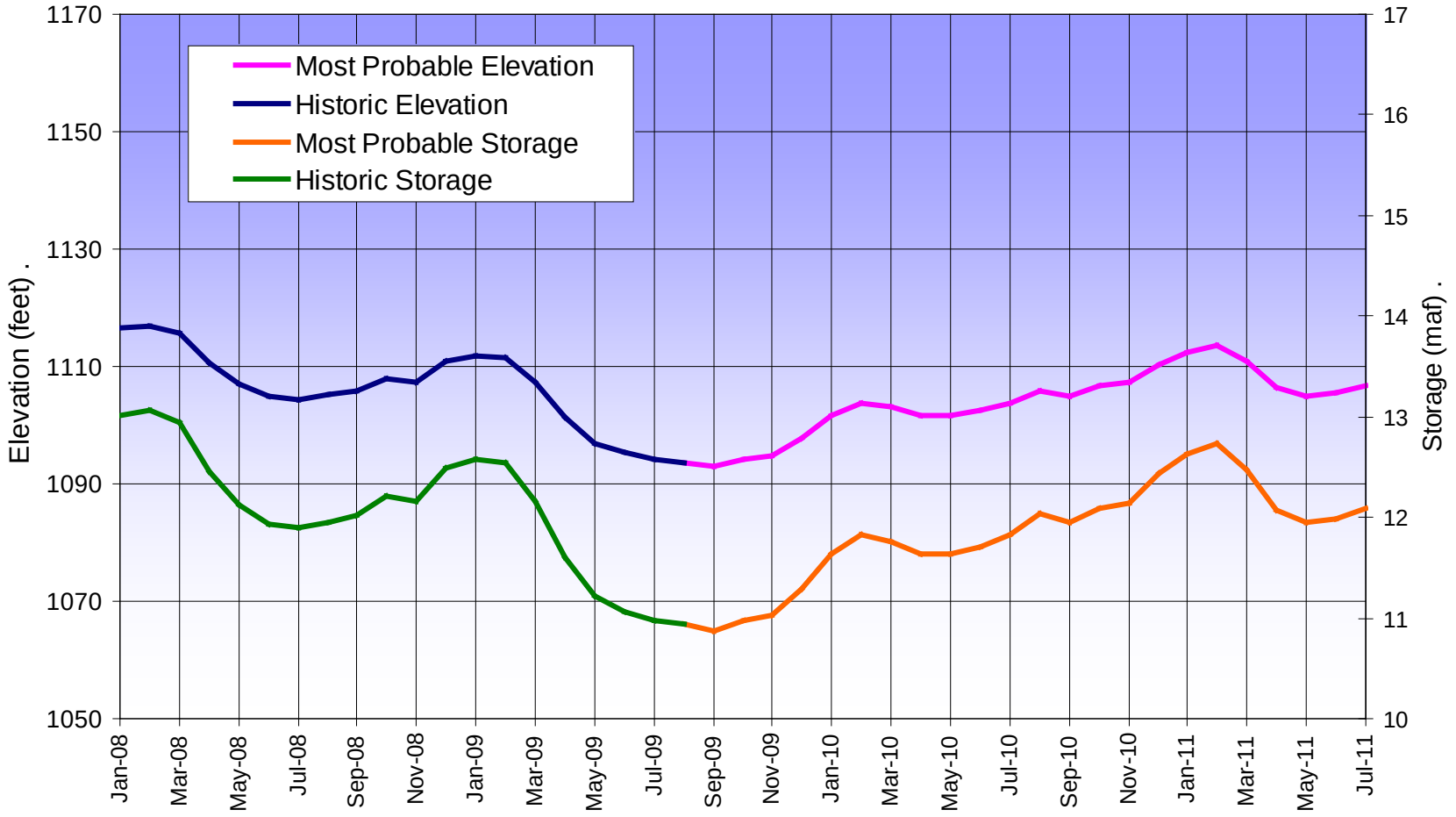

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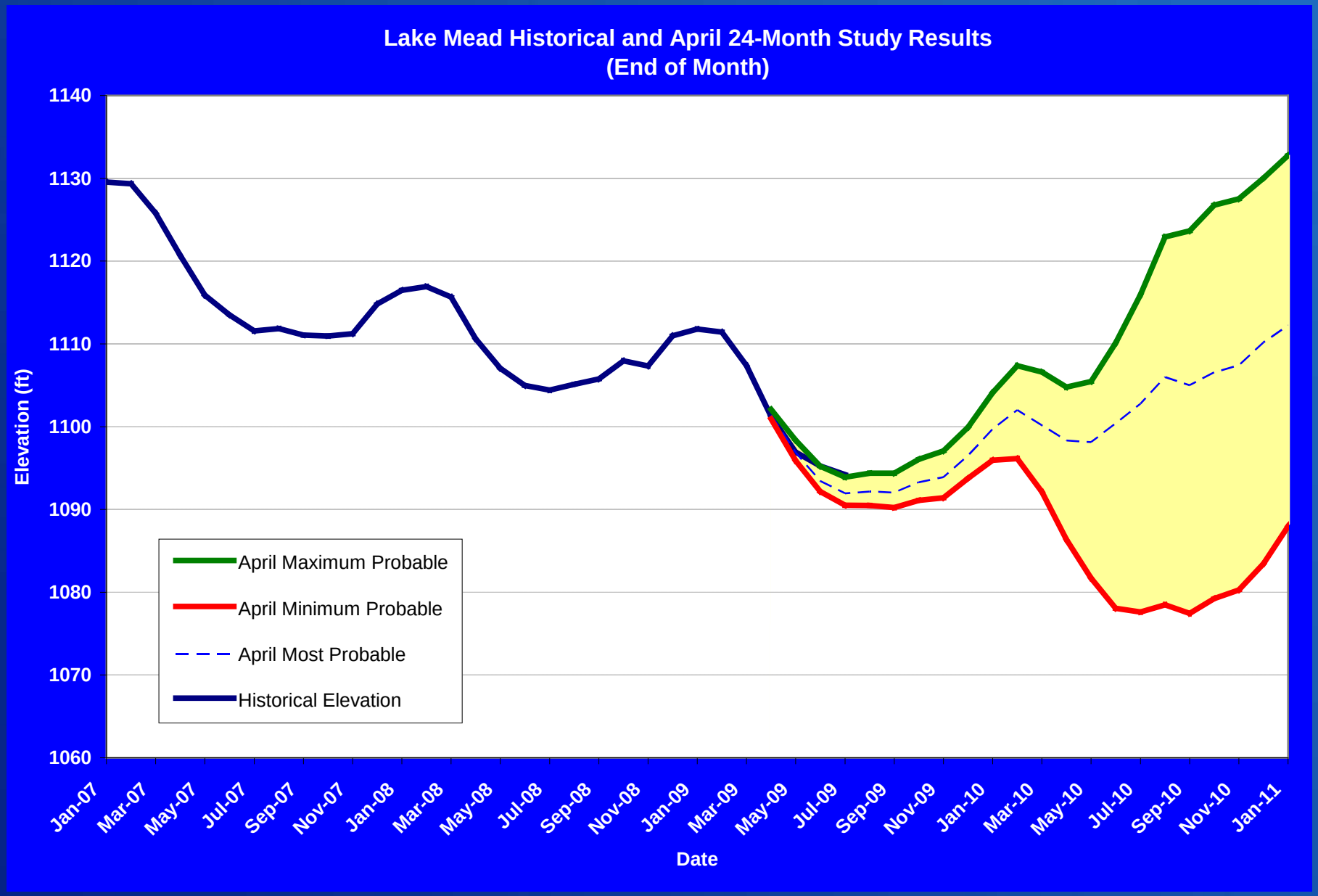

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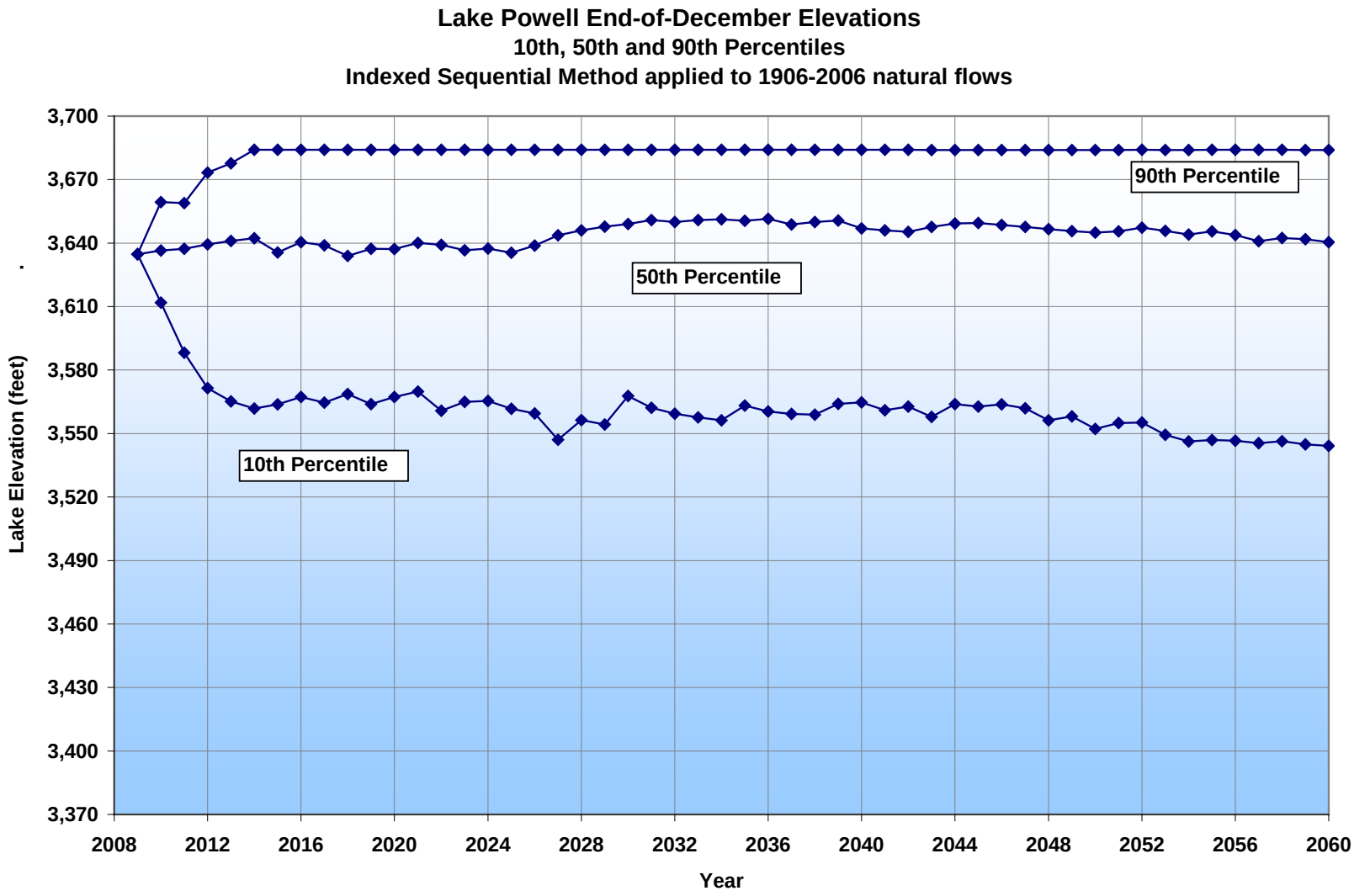
Projected Lake Powell End-of-Year Elevations
Calendar Years 2010 - 2060



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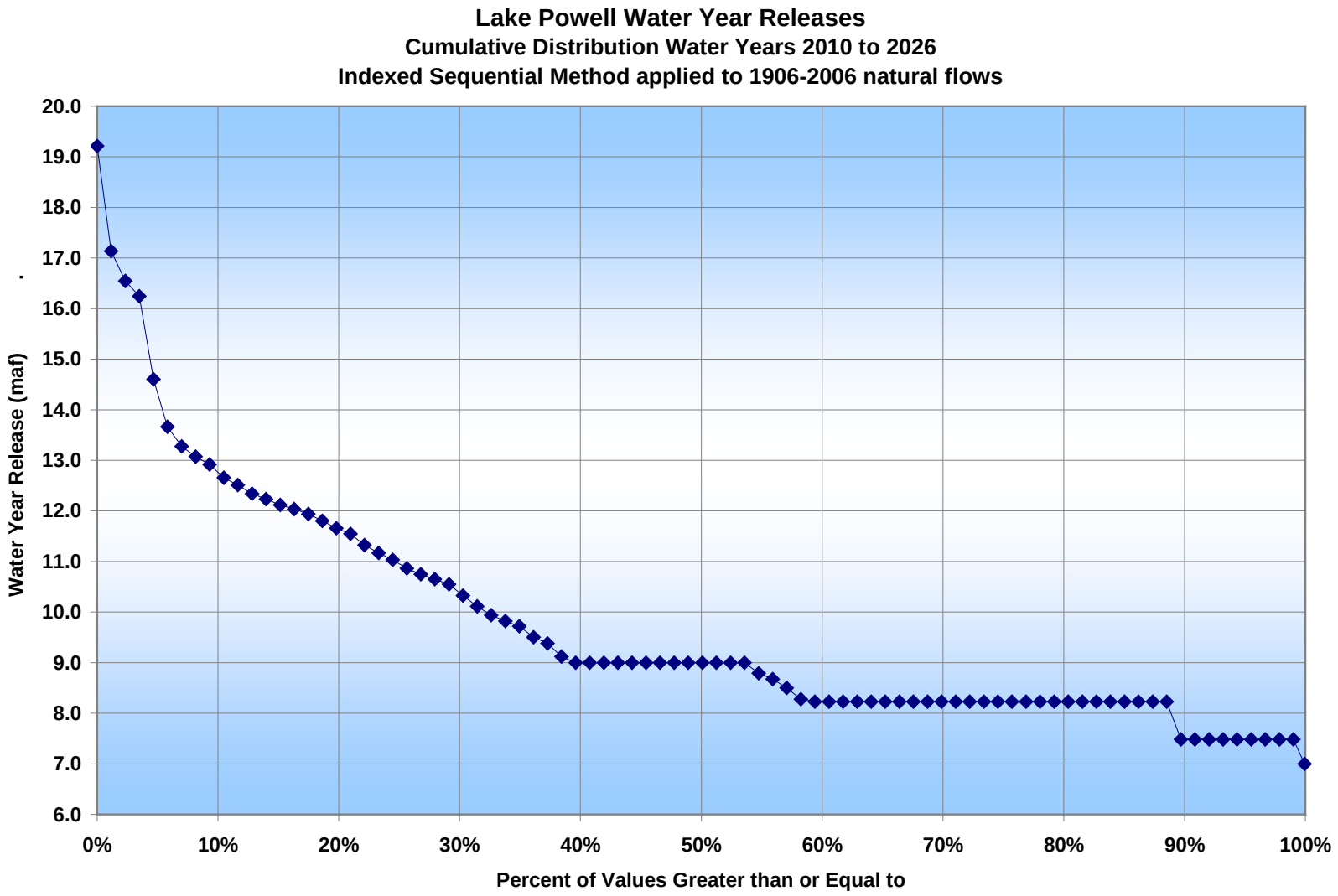
Projected Lake Powell Annual Releases
Water Years 2010 - 2026



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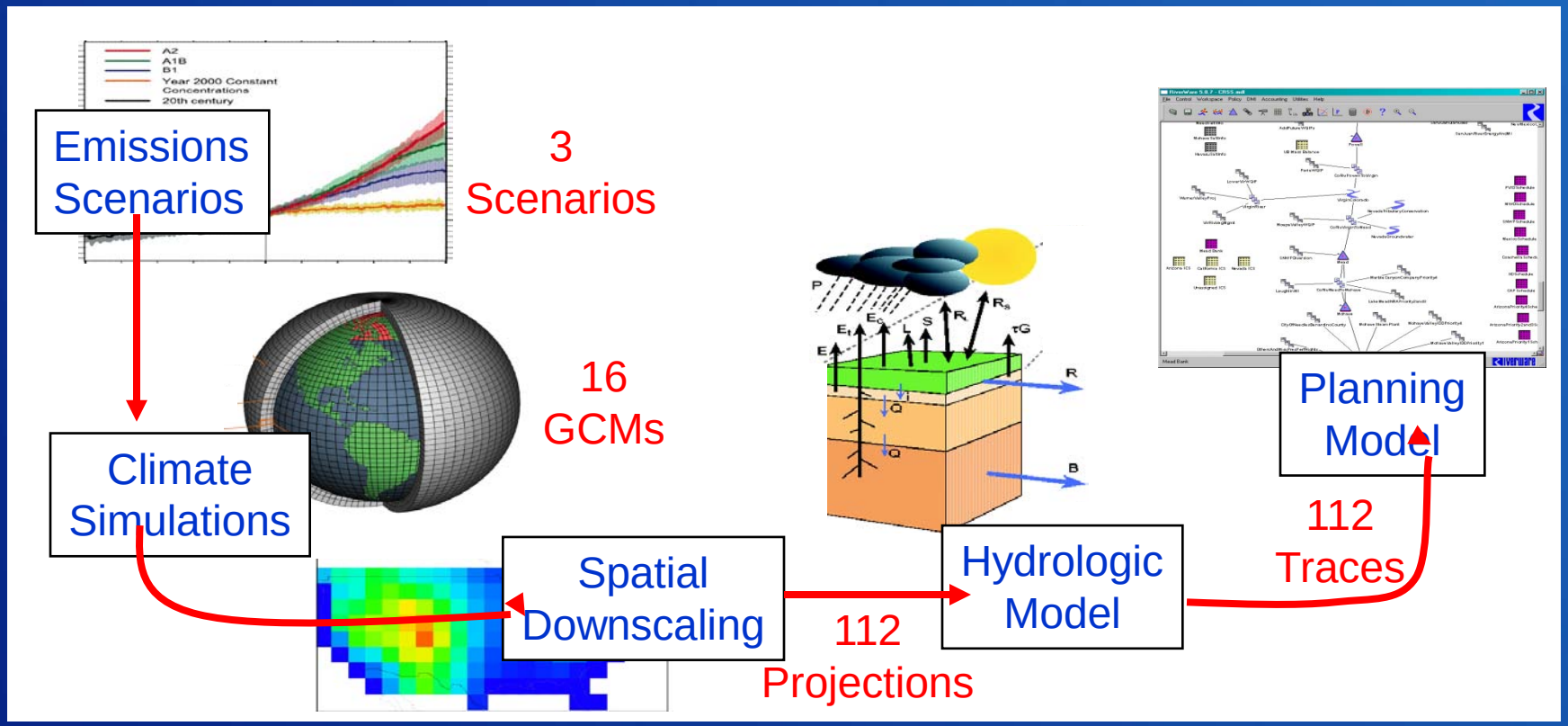
Assessing Potential Impacts of Climate Change to the Colorado River System



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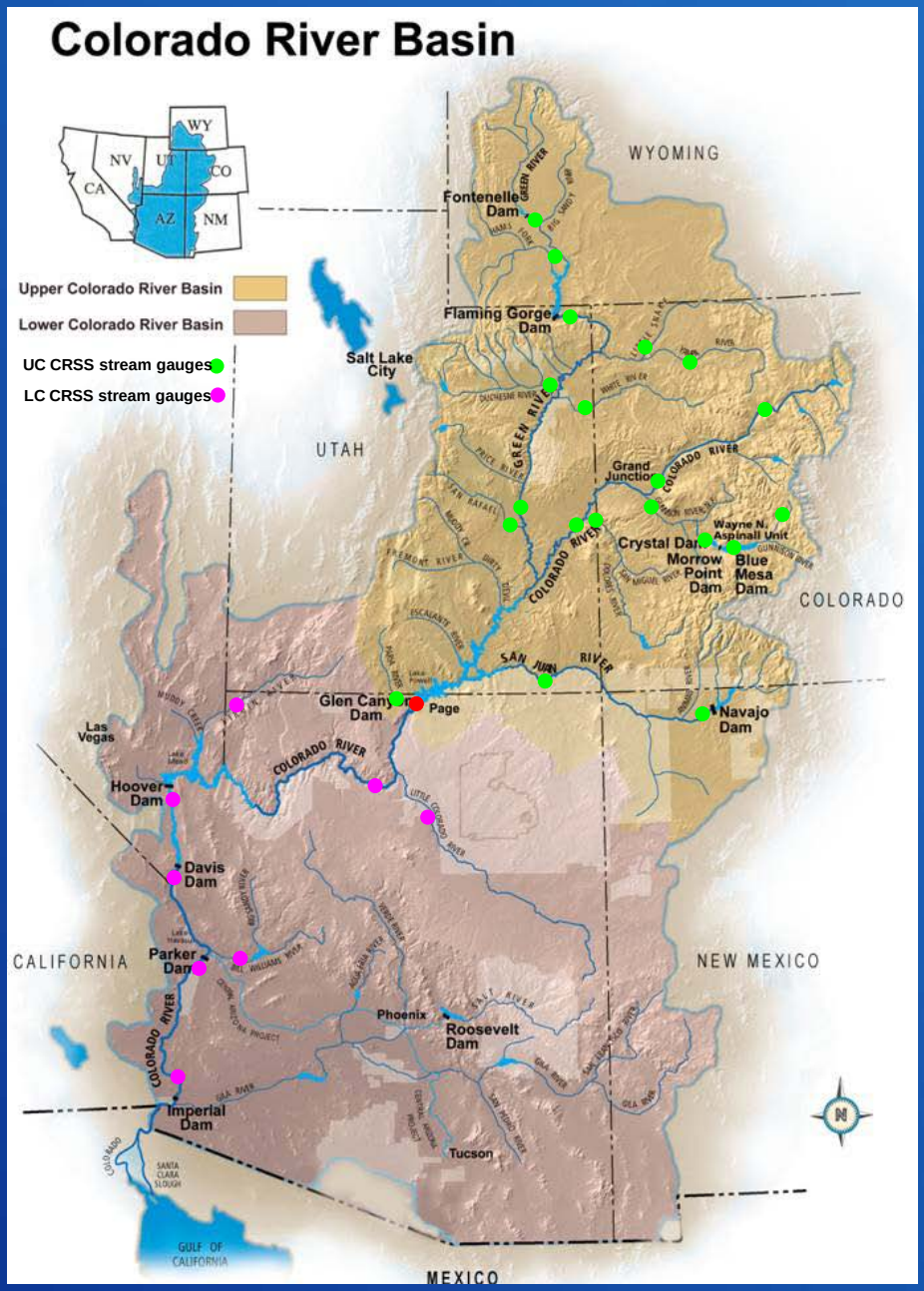
Colorado River Basin Data

- 100s of data collection points (precipitation, temperature, snowpack, stream flows, water quality)
- These data are critical to our understanding of potential impacts of climate change and variability
- These and other data collection and analysis systems need to be well-funded (e.g., PRISM)
- Example: 29 key inflow points needed for our long-term planning model



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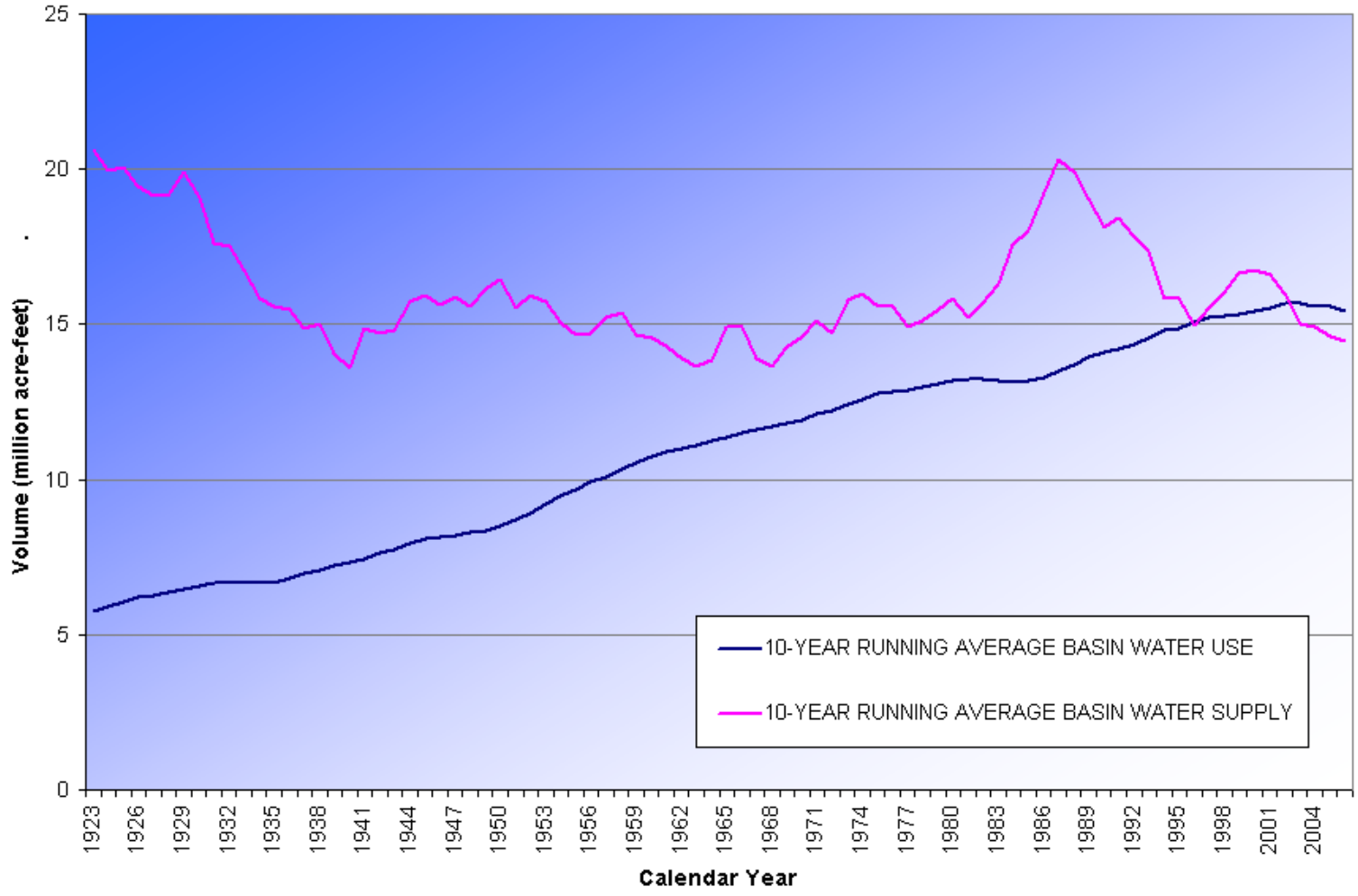
Colorado River Operations
Lake Powell and Lake Mead

- Although the solution provided by the Interim Guidelines fits within the Law of the River, agreement is for an interim period only
  - Several important issues aside through 2026
  - Too much uncertainty to “lock-in” for the long-term
- Interim Guidelines include provision that discussions must begin no later than December 31, 2020
- Much work needs to be done and is on-going in anticipation of those discussions
  - Continued research and development to better understand impacts of a changing climate
  - Continued assessment of future demands (including environmental needs)
  - Continued discussions with Mexico regarding conservation opportunities and shortage-sharing

Colorado River Basin Supply and Demand
10-year Running Average



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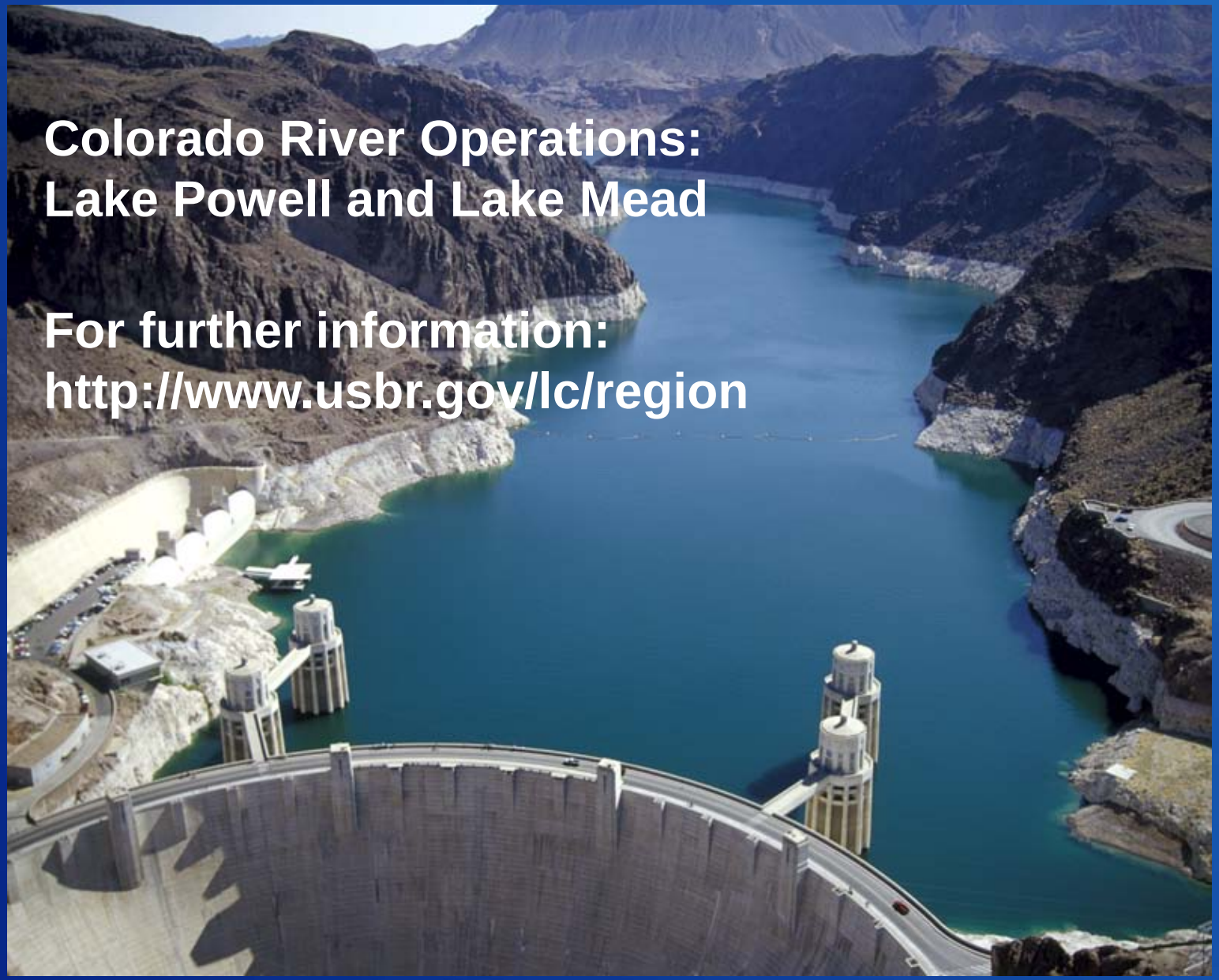

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