Colorado River Drought

National Dam Safety Program Technical Seminar | 2023

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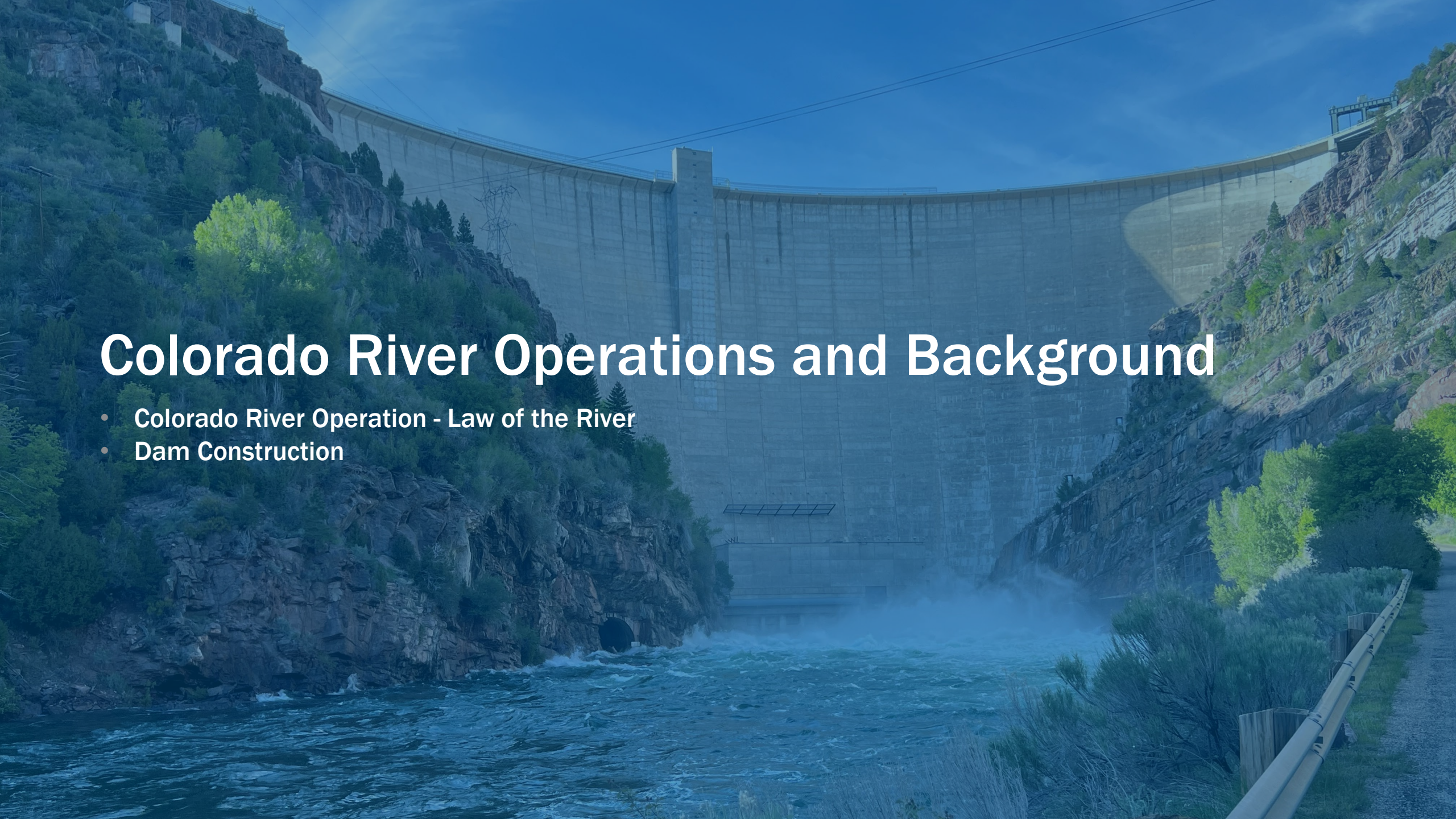
Outline

- Colorado River Operations, Background
- Facilities and Drought Status
- Impacts to facilities and Dam Safety
- Remedial actions and plans

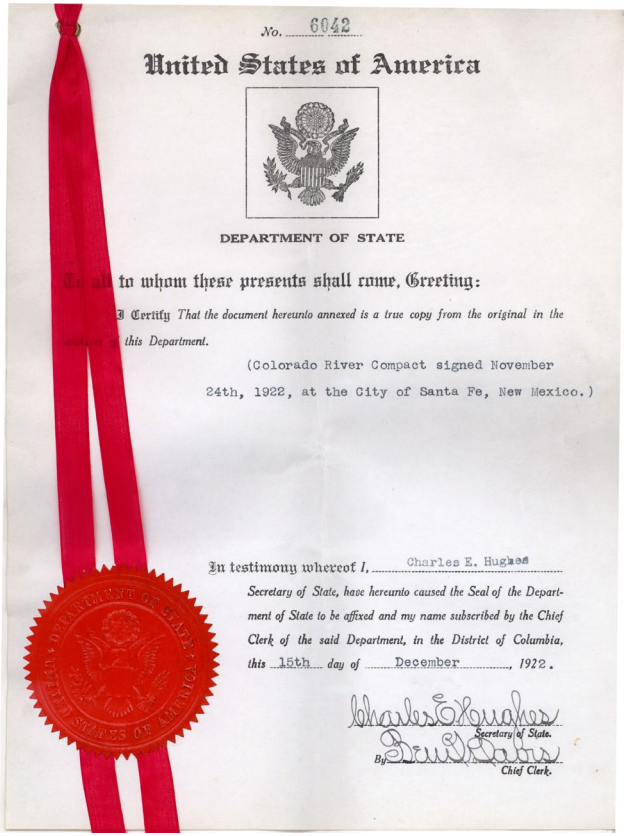


Colorado River Operations and Background

- Colorado River Operation - Law of the River
- Dam Construction

Colorado River Operation - Law of the River

1922 Colorado River Compact



No. 6042

United States of America

DEPARTMENT OF STATE

To all to whom these presents shall come, Greeting:

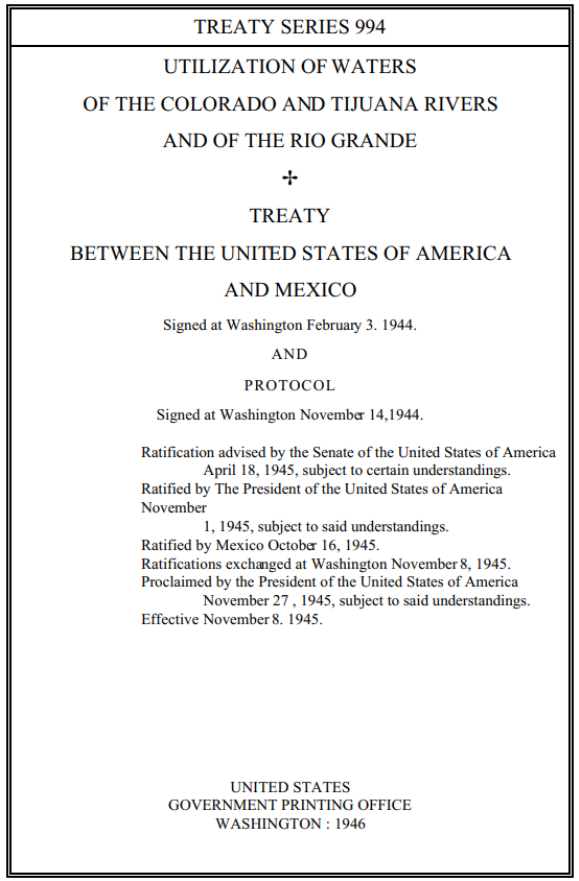
I Certify That the document hereunto annexed is a true copy from the original in the [illegible] this Department.

(Colorado River Compact signed November 24th, 1922, at the City of Santa Fe, New Mexico.)

In testimony whereof I, Charles E. Hughes Secretary of State, have hereunto caused the Seal of the Department of State to be affixed and my name subscribed by the Chief Clerk of the said Department, in the District of Columbia, this 15th day of December, 1922.

Charles E. Hughes
Secretary of State.
By [illegible]
Chief Clerk.

1944 Treaty: US and Mexico



TREATY SERIES 994

UTILIZATION OF WATERS
OF THE COLORADO AND TIJUANA RIVERS
AND OF THE RIO GRANDE

+

TREATY
BETWEEN THE UNITED STATES OF AMERICA
AND MEXICO

Signed at Washington February 3. 1944.

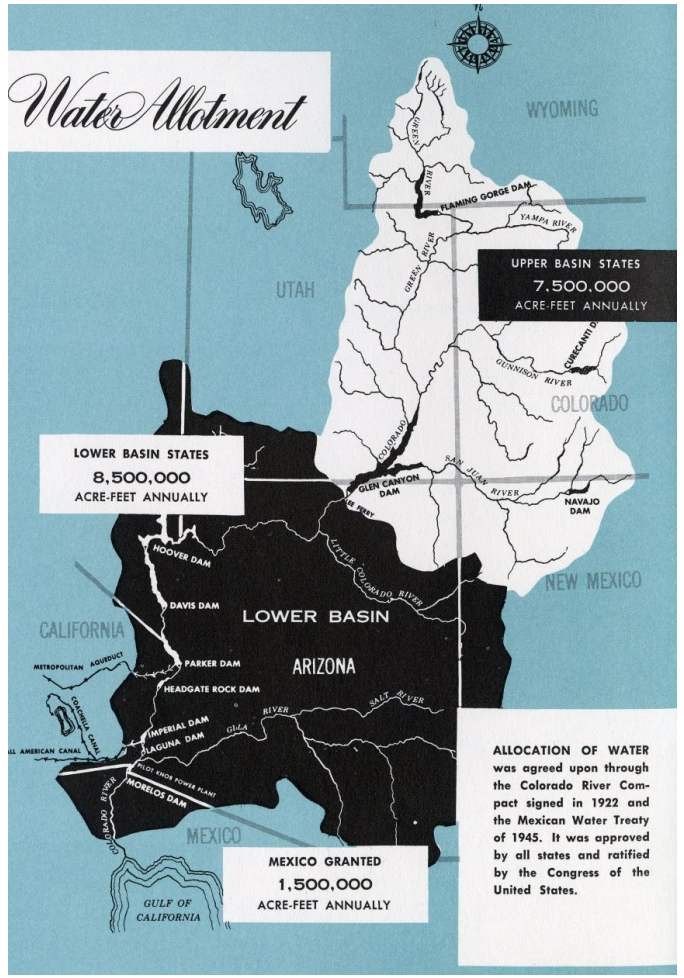
AND

PROTOCOL

Signed at Washington November 14,1944.

Ratification advised by the Senate of the United States of America April 18, 1945, subject to certain understandings.
Ratified by The President of the United States of America November 1, 1945, subject to said understandings.
Ratified by Mexico October 16, 1945.
Ratifications exchanged at Washington November 8, 1945.
Proclaimed by the President of the United States of America November 27 , 1945, subject to said understandings.
Effective November 8. 1945.

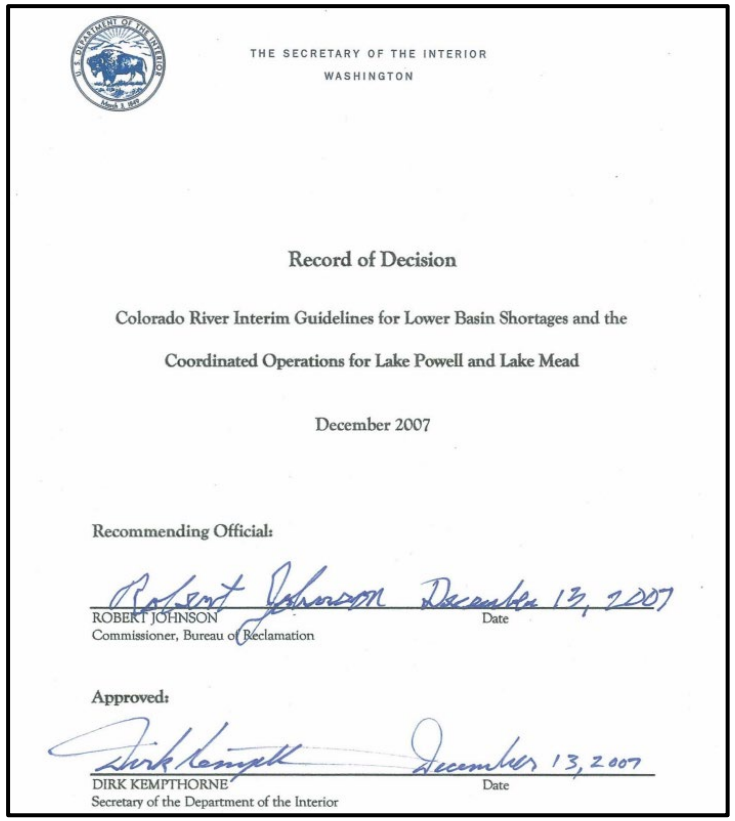
UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1946



Images from Utah Division of Archives and Records Service: https://archivesnews.utah.gov/2015/03/27/the-law-of-the-river-compact-and-development/ and Bureau of Reclamation: https://www.usbr.gov/lc/region/pao/pdfiles/mextrety.pdf

Colorado River Operation - Law of the River (cont.)

2007 Interim Guidelines



THE SECRETARY OF THE INTERIOR
WASHINGTON

Record of Decision

Colorado River Interim Guidelines for Lower Basin Shortages and the

Coordinated Operations for Lake Powell and Lake Mead

December 2007

Recommending Official:

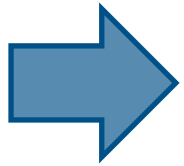
Robert Johnson December 13, 2007

ROBERT JOHNSON
Commissioner, Bureau of Reclamation
Date

Approved:

Dirk Kempthorne December 13, 2007

DIRK KEMPTHORNE
Secretary of the Department of the Interior
Date



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 Tier**[3] 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		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

Lake Mead		
Elevation (feet)	Operation According to the Interim Guidelines	Live Storage (maf)[1]
1,220	**Flood Control Surplus or Quantified Surplus Condition** Deliver > 7.5 maf	25.9
1,200 (approx.)[2]	**Domestic Surplus or ICS Surplus Condition** Deliver > 7.5 maf	22.9 (approx.)[2]
1,145	**Normal or ICS Surplus Condition** Deliver ≥ 7.5 maf	15.9
1,075	**Shortage Condition** Deliver 7.167[4] maf	9.4
1,050	**Shortage Condition** Deliver 7.083[5] maf	7.5
1,025		5.8
1,000	**Shortage Condition** Deliver 7.0[6] maf Further measures may be undertaken[7]	4.3
895		0

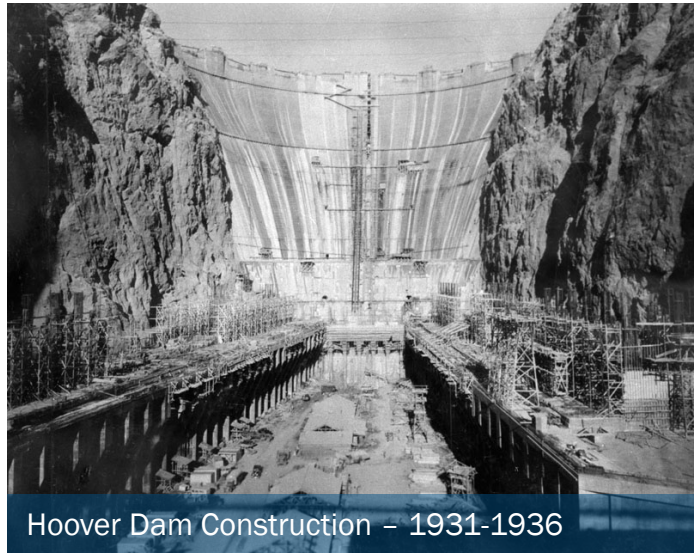
Diagram not to scale

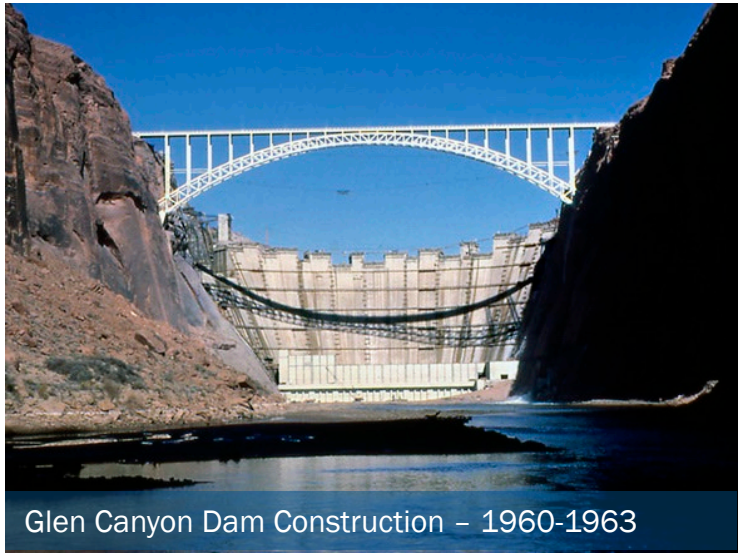
[1] Acronym for million acre-feet;
[2] This elevation is shown as approximate as it is determined each year by considering several factors including Lake Powell and Lake Mead storage, projected Upper Basin demands, and an assumed inflow; [3] Subject to April adjustments which may result in a release according to the Equalization Tier;
[4] Of which 2.48 maf is apportioned to Arizona, 4.4 maf to California, and 0.287 maf to Nevada;
[5] Of which 2.40 maf is apportioned to Arizona, 4.4 maf to California, and 0.283 maf to Nevada;
[6] Of which 2.32 maf is apportioned to Arizona, 4.4 maf to California, and 0.280 maf to Nevada;
[7] Whenever Lake Mead is below elevation 1,025 feet, the Secretary shall consider whether hydrologic conditions together with anticipated deliveries to the Lower Divison States and Mexico are likely to cause the elevation at Lake Mead to fall below 1,000 feet. Such consideration, in consultation with the Basin States, may result in the undertaking of further measures, consistent with applicable Federal law.

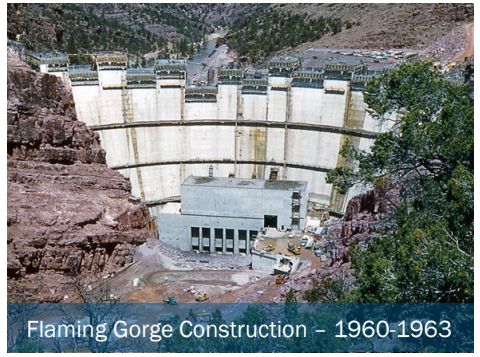
Images from Bureau of Reclamation: https://www.usbr.gov/ColoradoRiverBasin/#InterimGuidelines

Project Construction

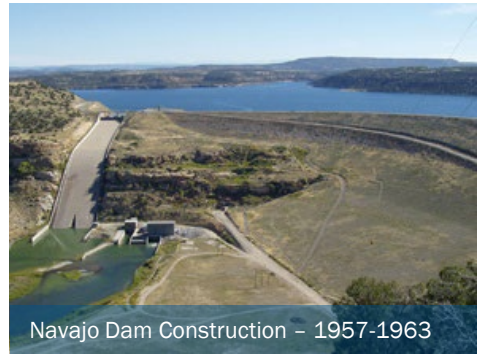
- **Boulder Canyon Project**
  - Hoover Dam (28.95 maf)
- **Colorado River Storage project**
  - Glen Canyon Dam (26.2 maf)
  - Flaming Gorge Dam (3.8 maf)
  - Aspinall Unit (1.1 maf)
  - Navajo Dam (1.0 maf)


Hoover Dam Construction – 1931-1936


Glen Canyon Dam Construction – 1960-1963


Flaming Gorge Construction – 1960-1963


Blue Mesa Construction – 1962-1966

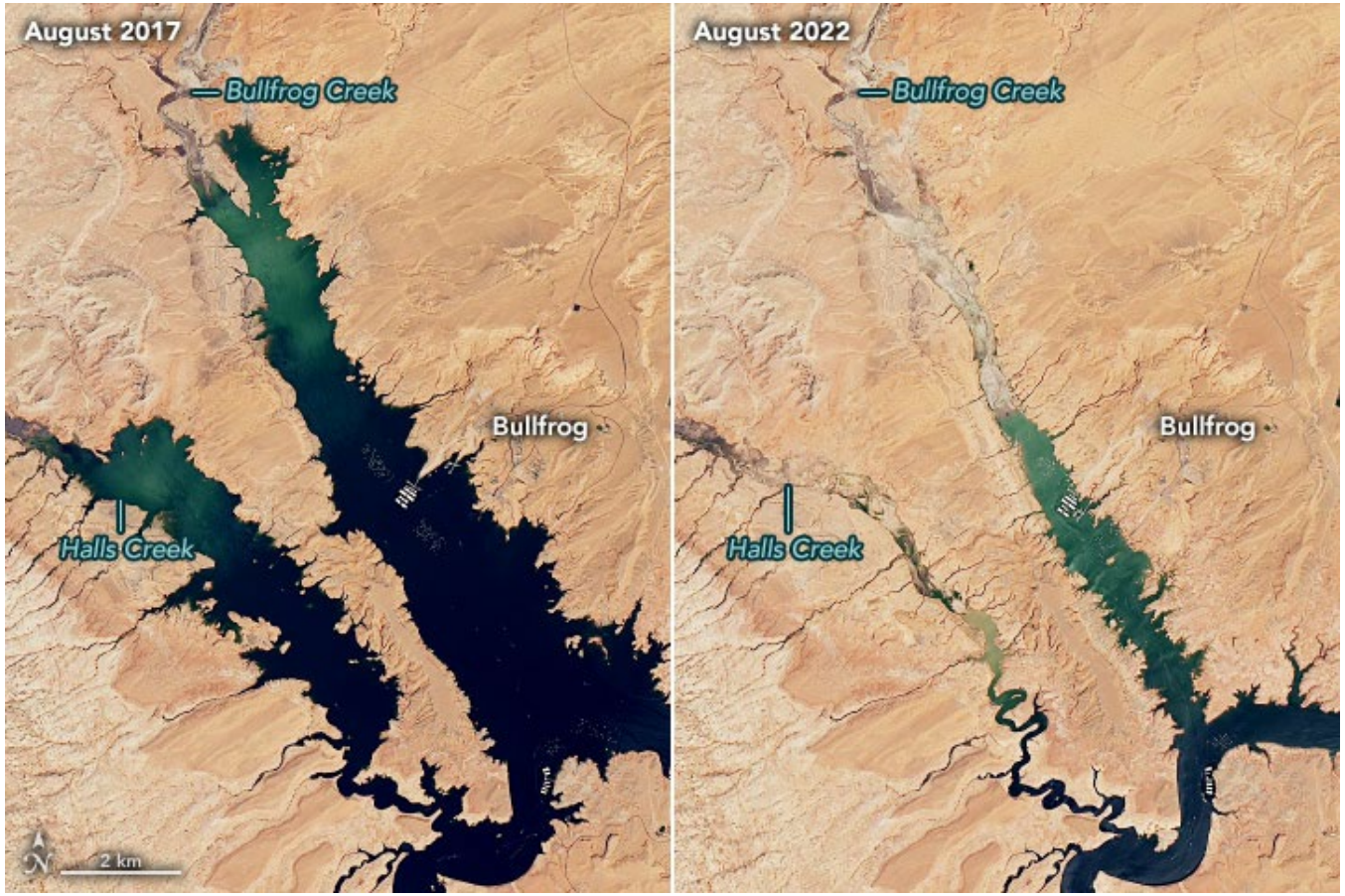

Navajo Dam Construction – 1957-1963

Facility and Drought Status

- Current Drought
- Facility Status

Lake Mead and Lake Powell Declining Water Surface Elevations

Images from Landsat Image Gallery: https://landsat.visibleearth.nasa.gov/view.php?id=148758



Images from Landsat Image Gallery: https://landsat.visibleearth.nasa.gov/view.php?id=150249

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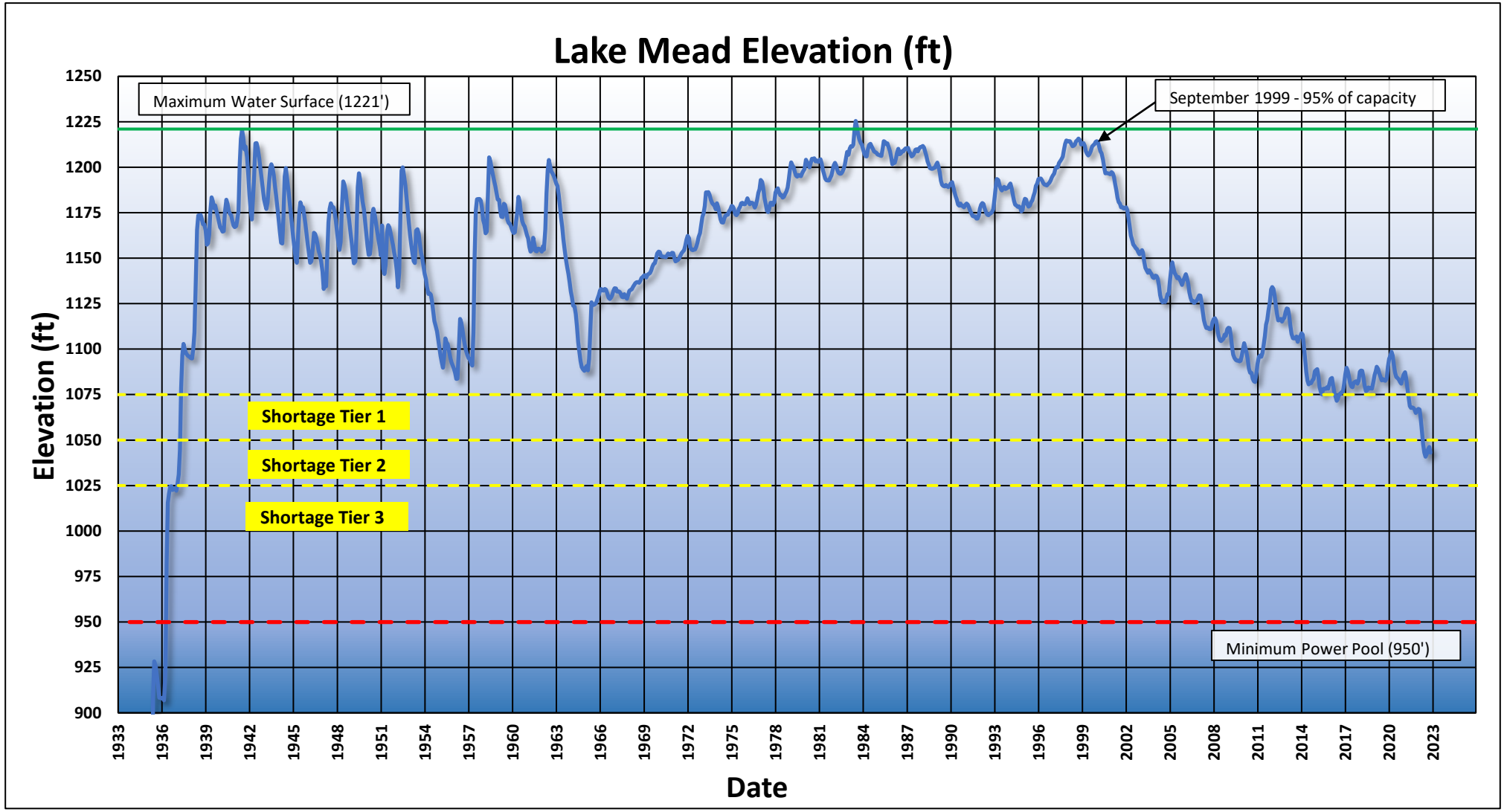
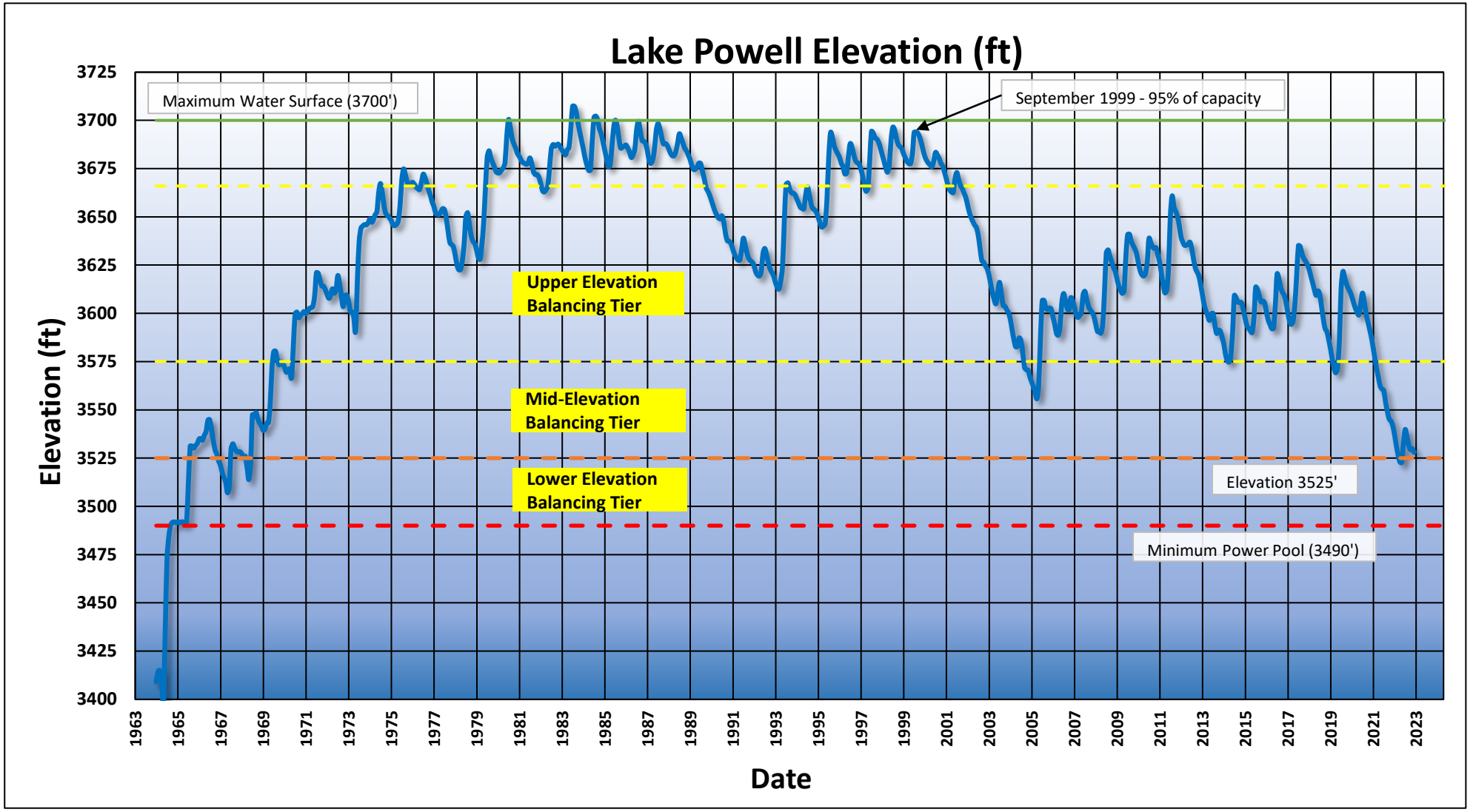
Lake Mead Elevation (1936-2022)



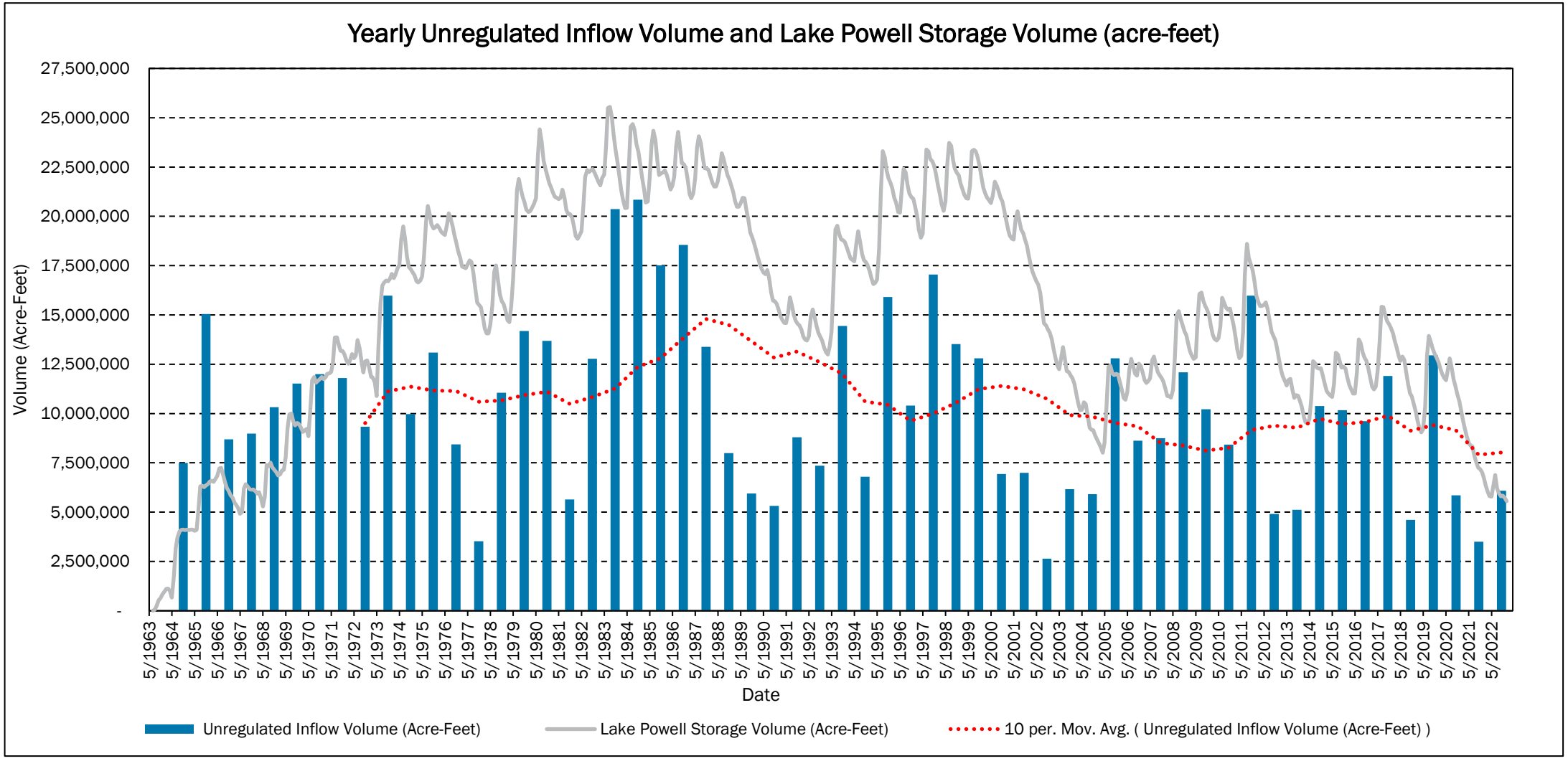
Data from Bureau of Reclamation: https://www.usbr.gov/lc/region/g4000/hourly/mead-elv.html

Lake Powell Elevation (1964-2022)



Data from Bureau of Reclamation: https://www.usbr.gov/uc/water/hydrodata/reservoir_data/919/dashboard.html#huc/

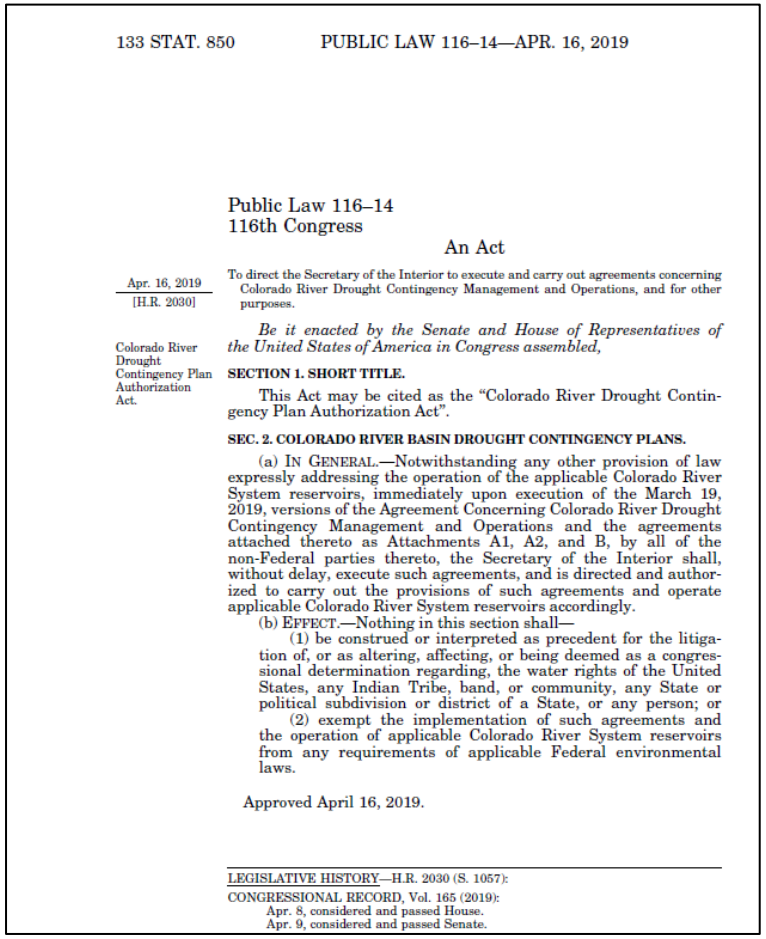
Lake Powell Unregulated Inflow (1964-2022)



Data from Bureau of Reclamation: https://www.usbr.gov/uc/water/hydrodata/reservoir_data/919/dashboard.html#huc/

2019 Drought Contingency Plan (DCP) Authorization Act

2019 DCP Authorization Act



133 STAT. 850 PUBLIC LAW 116–14—APR. 16, 2019

Public Law 116–14
116th Congress

An Act

Apr. 16, 2019
[H.R. 2030]

To direct the Secretary of the Interior to execute and carry out agreements concerning Colorado River Drought Contingency Management and Operations, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

Colorado River Drought Contingency Plan Authorization Act.

SECTION 1. SHORT TITLE.

This Act may be cited as the "Colorado River Drought Contingency Plan Authorization Act".

SEC. 2. COLORADO RIVER BASIN DROUGHT CONTINGENCY PLANS.

(a) IN GENERAL.—Notwithstanding any other provision of law expressly addressing the operation of the applicable Colorado River System reservoirs, immediately upon execution of the March 19, 2019, versions of the Agreement Concerning Colorado River Drought Contingency Management and Operations and the agreements attached thereto as Attachments A1, A2, and B, by all of the non-Federal parties thereto, the Secretary of the Interior shall, without delay, execute such agreements, and is directed and authorized to carry out the provisions of such agreements and operate applicable Colorado River System reservoirs accordingly.

(b) EFFECT.—Nothing in this section shall—

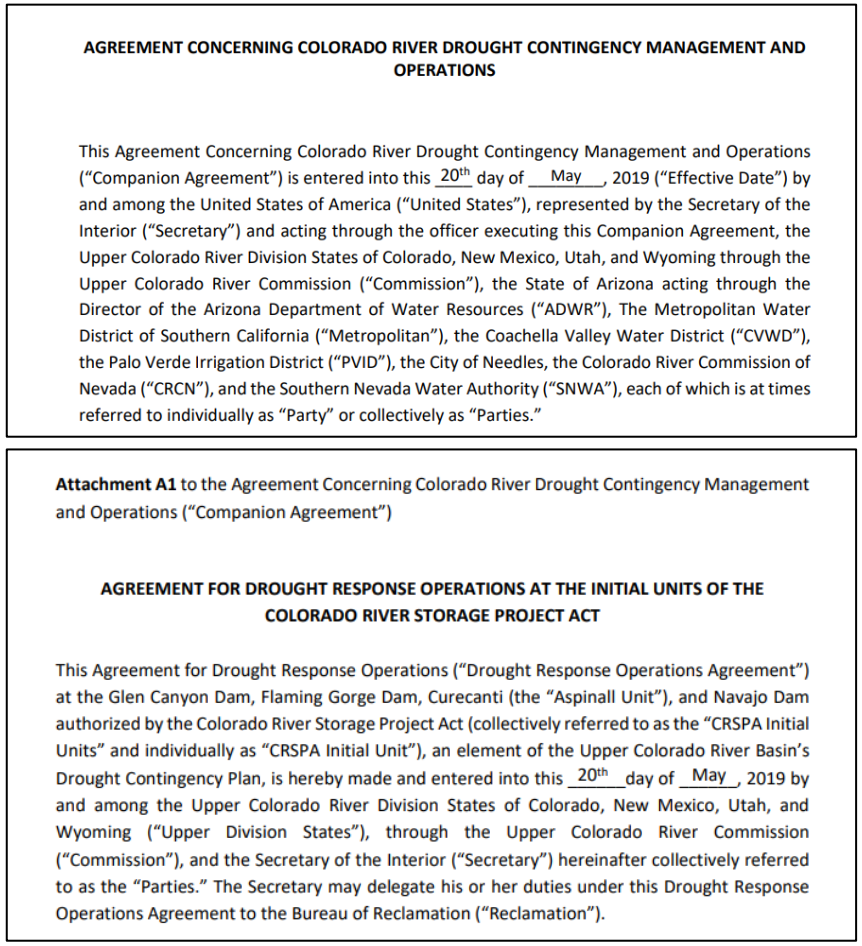
(1) be construed or interpreted as precedent for the litigation of, or as altering, affecting, or being deemed as a congressional determination regarding, the water rights of the United States, any Indian Tribe, band, or community, any State or political subdivision or district of a State, or any person; or

(2) exempt the implementation of such agreements and the operation of applicable Colorado River System reservoirs from any requirements of applicable Federal environmental laws.

Approved April 16, 2019.

LEGISLATIVE HISTORY—H.R. 2030 (S. 1057):
CONGRESSIONAL RECORD, Vol. 165 (2019):
Apr. 8, considered and passed House.
Apr. 9, considered and passed Senate.

2019 Drought Response Operations Agreement (DROA)



AGREEMENT CONCERNING COLORADO RIVER DROUGHT CONTINGENCY MANAGEMENT AND OPERATIONS

This Agreement Concerning Colorado River Drought Contingency Management and Operations ("Companion Agreement") is entered into this 20th day of May, 2019 ("Effective Date") by and among the United States of America ("United States"), represented by the Secretary of the Interior ("Secretary") and acting through the officer executing this Companion Agreement, the Upper Colorado River Division States of Colorado, New Mexico, Utah, and Wyoming through the Upper Colorado River Commission ("Commission"), the State of Arizona acting through the Director of the Arizona Department of Water Resources ("ADWR"), The Metropolitan Water District of Southern California ("Metropolitan"), the Coachella Valley Water District ("CVWD"), the Palo Verde Irrigation District ("PVID"), the City of Needles, the Colorado River Commission of Nevada ("CRCN"), and the Southern Nevada Water Authority ("SNWA"), each of which is at times referred to individually as "Party" or collectively as "Parties."

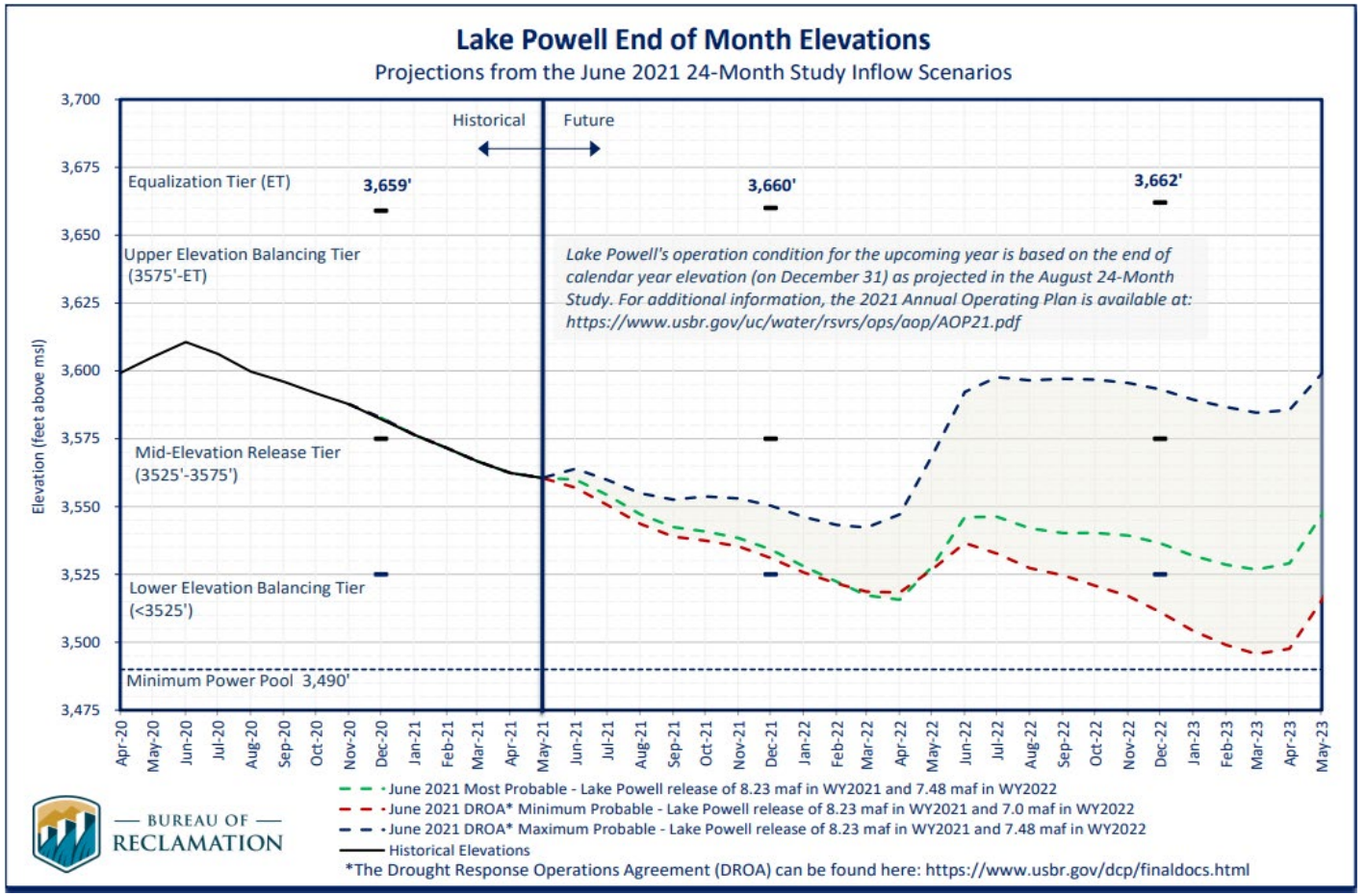
Attachment A1 to the Agreement Concerning Colorado River Drought Contingency Management and Operations ("Companion Agreement")

AGREEMENT FOR DROUGHT RESPONSE OPERATIONS AT THE INITIAL UNITS OF THE COLORADO RIVER STORAGE PROJECT ACT

This Agreement for Drought Response Operations ("Drought Response Operations Agreement") at the Glen Canyon Dam, Flaming Gorge Dam, Curecanti (the "Aspinall Unit"), and Navajo Dam authorized by the Colorado River Storage Project Act (collectively referred to as the "CRSPA Initial Units" and individually as "CRSPA Initial Unit"), an element of the Upper Colorado River Basin's Drought Contingency Plan, is hereby made and entered into this 20th day of May, 2019 by and among the Upper Colorado River Division States of Colorado, New Mexico, Utah, and Wyoming ("Upper Division States"), through the Upper Colorado River Commission ("Commission"), and the Secretary of the Interior ("Secretary") hereinafter collectively referred to as the "Parties." The Secretary may delegate his or her duties under this Drought Response Operations Agreement to the Bureau of Reclamation ("Reclamation").

Images from Bureau of Reclamation: https://www.usbr.gov/ColoradoRiverBasin/#InterimGuidelines

July 2021 – Initiation of releases according to the Drought Response Operations Agreement



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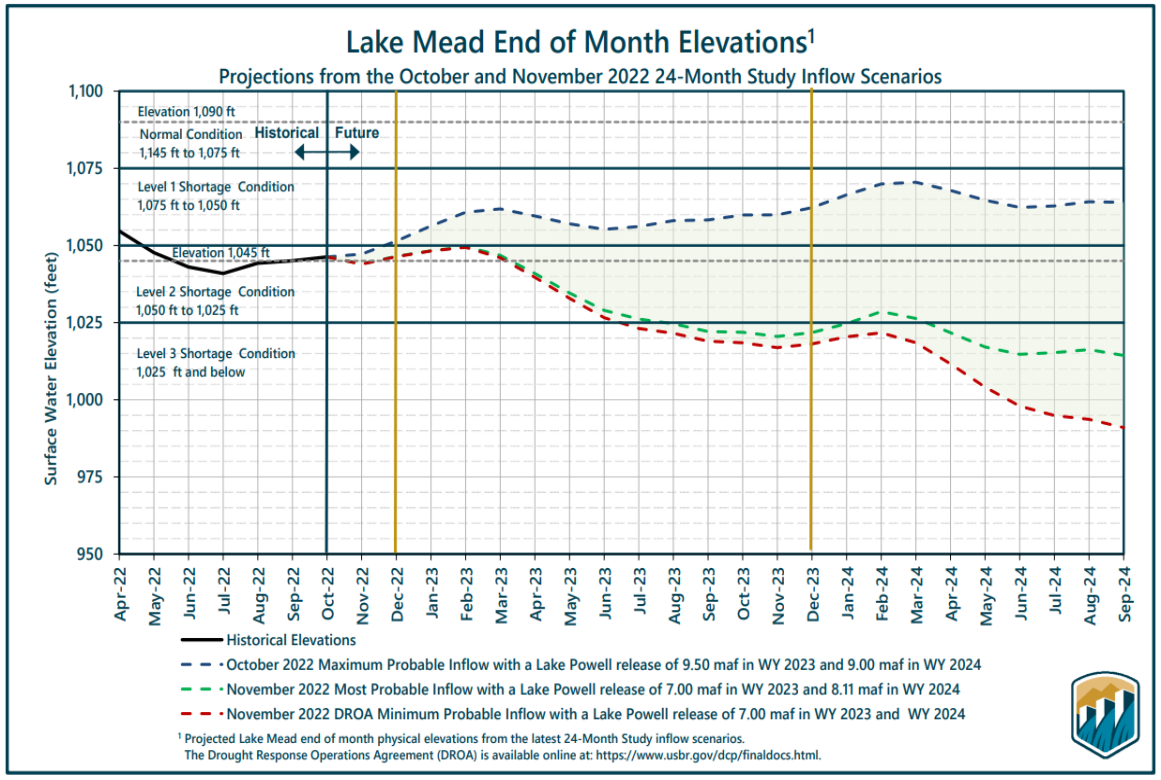
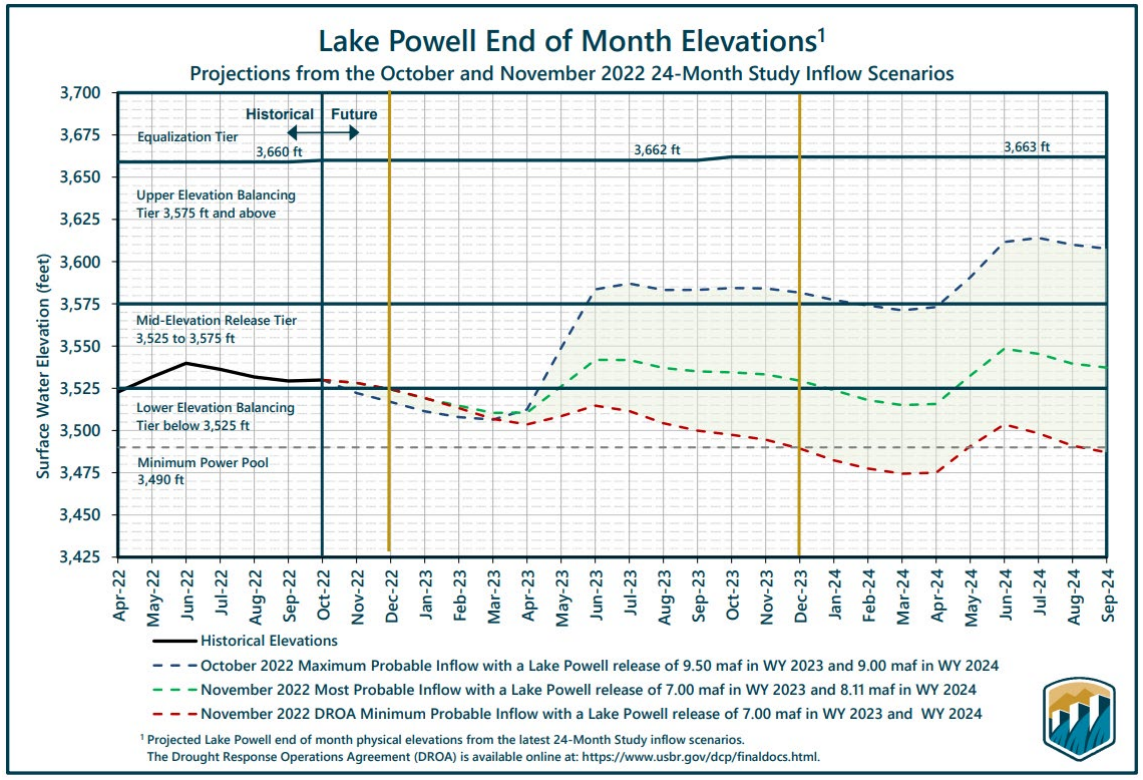
Current 24-month Study Projections





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Images from Bureau of Reclamation: https://www.usbr.gov/lc/region/g4000/24mo/2022/November-Chart.pdf

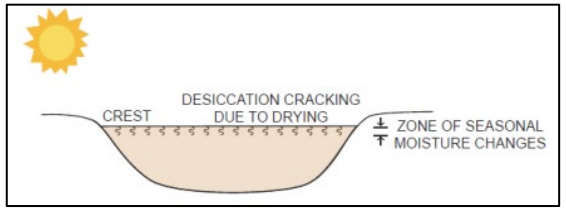
Potential Impacts to Facilities and Dam Safety

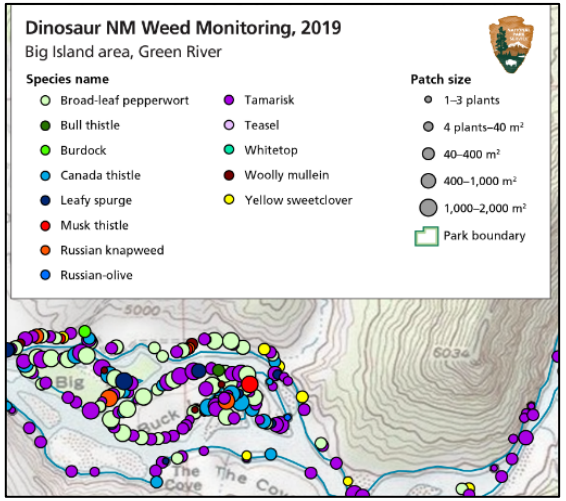
Potential Drought Impacts and concerns

- Power Generation
  - Power Generation at Glen Canyon Dam is not possible below elevation 3490, Lake Mead at elevation 950
- Water Delivery
  - Water Delivery capacity is significantly reduced as elevations decline below minimum power pool. There is a potential releases will not meet minimum release requirements according to the current Law of the River
  - 40 Million people in the basin depend on the Colorado River Flows

Additional Potential Impacts and concerns

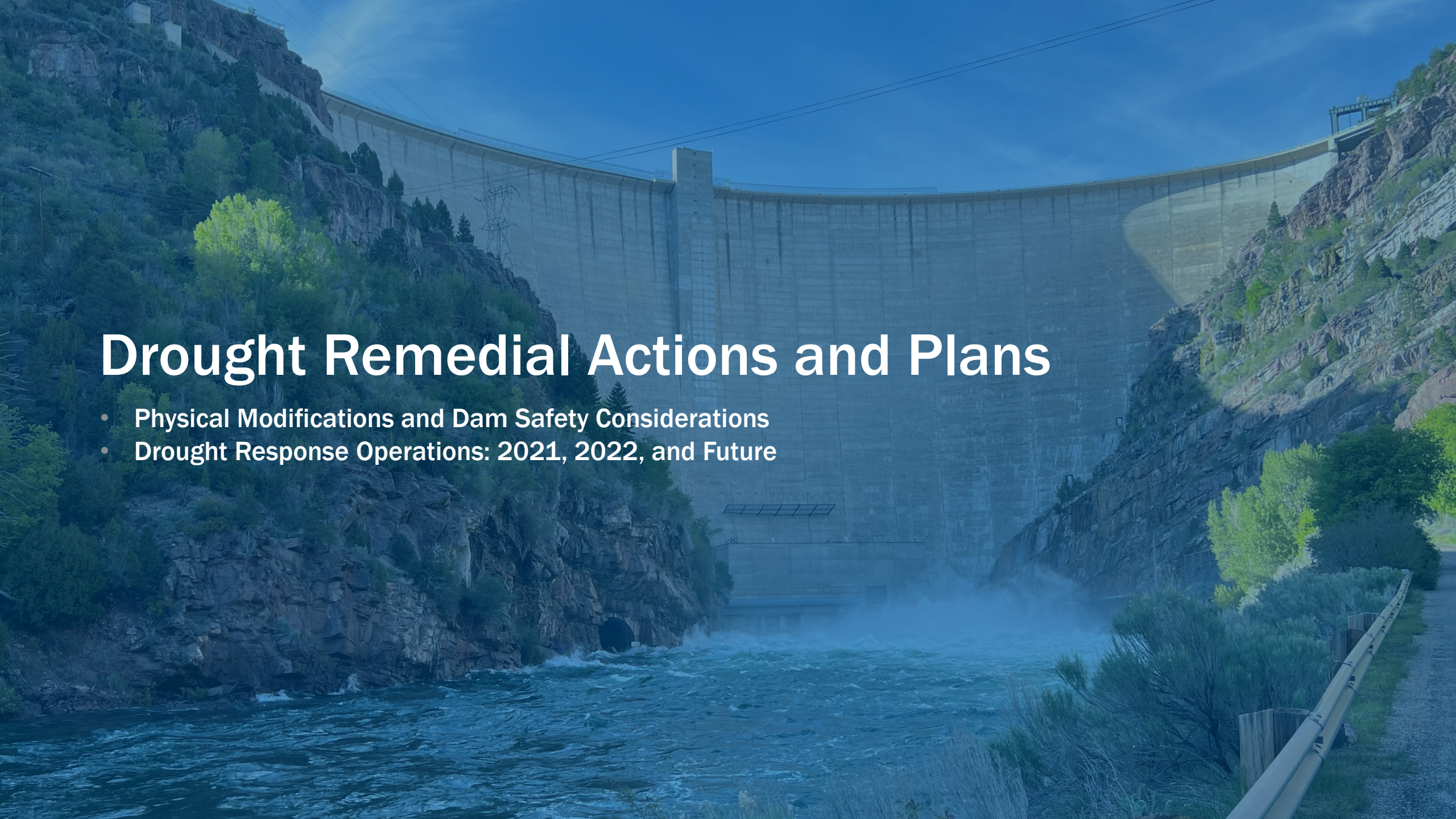
- Dam Safety concerns from extended drawdown
  - Glen Canyon and Flaming Gorge Dams –
    - Rock fall (reservoir rim) leading to seiche waves - YouTube video: Massive Lake Powell rock slide caught on camera (https://www.youtube.com/watch?v=vxmBiNpzQ9A (May 2022)
    - Freeze-Thaw issues – concrete dam exposed at much lower elevations than most of facility life
    - First Fill in recovery
    - Others?
  - Blue Mesa and Navajo (Earthen Embankment Dams)
    - Potential Desiccation Cracking from extended drawdown
    - Filling and Drawdown Rate limitations (rates of reservoir water surface change are much higher at lower water surface elevations) – Example: 2021 call for Blue Mesa reservoir release (drawdown) that exceeded limitations
    - First Fill considerations in recovery
- ESA concerns in DRO and when in recovery
  - Recovery Programs: 4 Endangered Species in the Green and Colorado Rivers
    - Increased Temperatures – advantageous for particular invasive and endangered species, bad for trout fishery
    - Decreased Releases – bad for riparian habitat, advantageous for invasive riparian plants
  - AMWG: Riparian Health below Glen Canyon
    - Decreased release potential impacts high flow events





Additional Potential Impacts and concerns (cont.)

- Stakeholders and Potential Impacts
  - States
    - Colorado River Compact Requirements
  - Cities
    - Culinary Water
  - Counties
  - Landowners
    - Irrigation
    - Flood Control
  - Recreation
    - Reservoir boating, fishing, camping
    - River rafting, fishing, camping
    - Marina Owners and operations
  - Power Generation
    - Loss of power generation impacts revenues that support environmental programs
    - Less power available for specific low-income and rural customers
  - Environmental Impacts
    - 4 Colorado River Endangered Species: Razorback Sucker, Colorado Pikeminnow, Bonytail, Humpback Chub
    - Invasive Species
    - Riparian habitat and Fluvial Geomorphology
  - Federal Agencies
    - WAPA
    - CREDA
    - NPS
    - NFS
    - FWS
    - DOI
    - Reclamation



Drought Remedial Actions and Plans

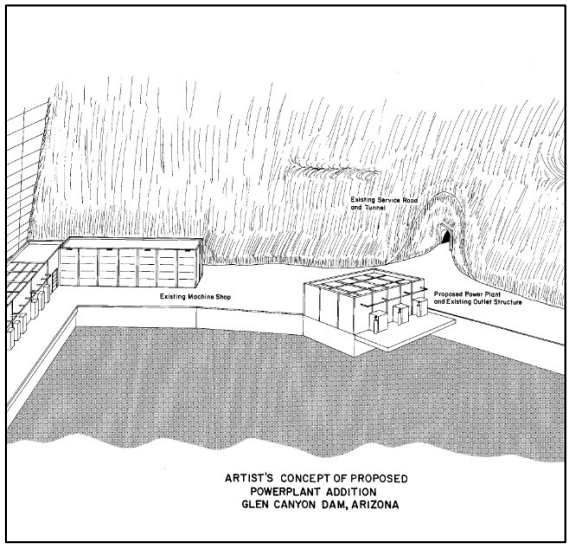
- Physical Modifications and Dam Safety Considerations
- Drought Response Operations: 2021, 2022, and Future

Physical Modifications potentially leading to a Dam Safety Review

- Culinary water connection for the City of Page, AZ and LeChee Chapter of the Navajo Nation (Complete)
  - (Possible similar modification for Flaming Gorge for the Dutch John City culinary water service)

  Bureau of Reclamation completes project at Glen Canyon Dam to protect local water supply during extremely low lake levels
  (https://www.usbr.gov/newsroom/news-release/4405)

- 2022 Value Planning Study: Glen Canyon Dam Low-Head Hydropower
  - Potential solutions to be evaluated include structural modifications that would allow for hydropower generation below minimum power pool.



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2021 DROA Actions

- Additional 2021 releases based on the Drought Response Operations Agreement

DROA Releases for the July 24MS Model Run

	Jul (kaf)	Aug (kaf)	Sep (kaf)	Oct (kaf)	Nov (kaf)	Dec (kaf)	Sum
Flaming Gorge	13	42	43	27	0	0	125
Blue Mesa	0	18	18	0	0	0	36
Navajo	0	0	0	0	~~10~~	~~10~~	~~20~~
Sum:	13	60	61	27	~~10~~	~~10~~	~~181~~

161 kaf

2022 Drought Response Actions

- Release of 500,000 acre-feet from Flaming Gorge (2022 DRO Plan).
- Reduce Glen Canyon Dam's 2022 annual release by 480,000 acre-feet from 7.48 million acre-feet to 7.00 million acre-feet (within 2007 Interim Guidelines flexibility).
- Lake Powell Monthly Release Adjustment

For more information:
Recommendation to approve 2022 Drought Response Operations Plan (https://www.usbr.gov/uc/DocLibrary/Plans/20220429-2022DroughtResponseOperationsPlan-ApprovalMemo-508-DOI.pdf)
2022 Glen Canyon Dam Operations Decision Letter (https://www.usbr.gov/uc/DocLibrary/Plans/20220503-2022DROA-GlenCanyonDamOperationsDecisionLetter-508-DOI.pdf)

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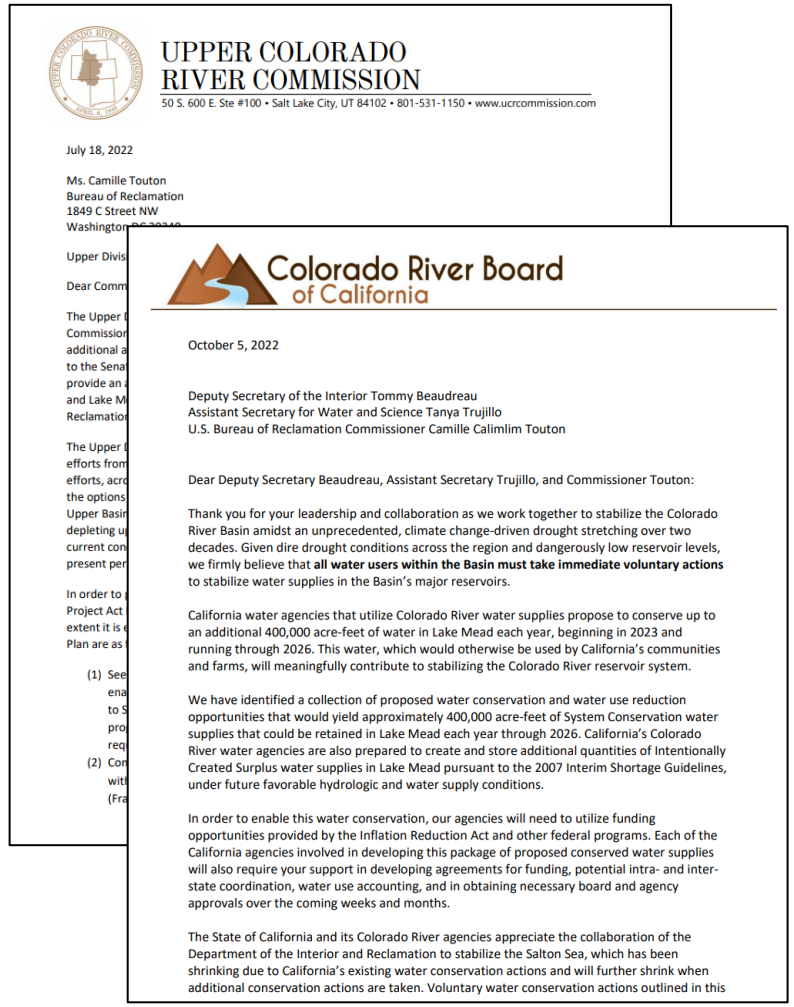
Future Basin States' Drought Response Action Proposals

- Upper Division State's 5-point plan:
  - System Conservation Pilot Project reauthorization
  - Initiate 2023 Drought Response Operations Plan development in August 2022
  - Upper Basin Demand Management program
  - Use funding from the Bipartisan Infrastructure Law to accelerate enhanced measurement, monitoring, and reporting to improve water management tools
  - Continue strict water management and administration within the available annual water supply

  Upper Colorado River Commission, Letter to Reclamation
  (http://www.ucrcommission.com/wp-content/uploads/2022/07/2022-July-18-Letter-to-Reclamation.pdf)

- Lower Division States
  - Shortage Cuts in 2022: and 2023:
    - Arizona: 18%, 512,000 acre-feet — Arizona: 21%, 592,000 acre-feet
    - Nevada: 7%, 21,000 acre-feet — Nevada: 8%, 25,000 acre-feet
    - Mexico: 5%, 80,000 acre-feet — Mexico: 7%, 104,000 acre-feet
  - California offered to cut 400,000 acre-feet in 2023

  Colorado River Board of California, Letter signed October 5, 2022
  (http://crb.ca.gov/wp-content/uploads/2022/10/California-Letter_FINAL_Signed_10052022.pdf)



UPPER COLORADO RIVER COMMISSION
50 S. 600 E. Ste #100 • Salt Lake City, UT 84102 • 801-531-1150 • www.ucrcommission.com

July 18, 2022

Ms. Camille Touton
Bureau of Reclamation
1849 C Street NW

Colorado River Board of California

October 5, 2022

Deputy Secretary of the Interior Tommy Beaudreau
Assistant Secretary for Water and Science Tanya Trujillo
U.S. Bureau of Reclamation Commissioner Camille Calimlim Touton

Dear Deputy Secretary Beaudreau, Assistant Secretary Trujillo, and Commissioner Touton:

Thank you for your leadership and collaboration as we work together to stabilize the Colorado River Basin amidst an unprecedented, climate change-driven drought stretching over two decades. Given dire drought conditions across the region and dangerously low reservoir levels, we firmly believe that **all water users within the Basin must take immediate voluntary actions** to stabilize water supplies in the Basin's major reservoirs.

California water agencies that utilize Colorado River water supplies propose to conserve up to an additional 400,000 acre-feet of water in Lake Mead each year, beginning in 2023 and running through 2026. This water, which would otherwise be used by California's communities and farms, will meaningfully contribute to stabilizing the Colorado River reservoir system.

We have identified a collection of proposed water conservation and water use reduction opportunities that would yield approximately 400,000 acre-feet of System Conservation water supplies that could be retained in Lake Mead each year through 2026. California's Colorado River water agencies are also prepared to create and store additional quantities of Intentionally Created Surplus water supplies in Lake Mead pursuant to the 2007 Interim Shortage Guidelines, under future favorable hydrologic and water supply conditions.

In order to enable this water conservation, our agencies will need to utilize funding opportunities provided by the Inflation Reduction Act and other federal programs. Each of the California agencies involved in developing this package of proposed conserved water supplies will also require your support in developing agreements for funding, potential intra- and inter-state coordination, water use accounting, and in obtaining necessary board and agency approvals over the coming weeks and months.

The State of California and its Colorado River agencies appreciate the collaboration of the Department of the Interior and Reclamation to stabilize the Salton Sea, which has been shrinking due to California's existing water conservation actions and will further shrink when additional conservation actions are taken. Voluntary water conservation actions outlined in this

Future Reclamation/DOI Drought Response Actions

- Reclamation Commissioner Touton requested the Basin States cut an additional 2 to 4 Million acre-feet
- 2023 Supplemental Environmental Impact Statement (SEIS) - https://www.doi.gov/pressreleases/interior-department-initiates-significant-action-protect-colorado-river-system (https://www.doi.gov/pressreleases/interior-department-initiates-significant-action-protect-colorado-river-system)
- 2023 Drought Response Operations Plan
- Update to 2007 interim guidelines: Post-2026 Colorado River Operational Strategies for Lake Powell and Lake Mead (https://www.usbr.gov/ColoradoRiverBasin/Post2026Ops.html) and Request for Input on Development of Post-2026 Colorado River Reservoir Operational Strategies for Lake Powell and Lake Mead Under Historically Low Reservoir Conditions (https://www.federalregister.gov/documents/2022/06/24/2022-13502/request-for-input-on-development-of-post-2026-colorado-river-reservoir-operational-strategies-for)

Conclusion

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