Better Precipitation Forecasting, Better Colorado River Basin Drought Contingency Planning

Jeanine Jones, CDWR
National Rank of Largest Metropolitan Areas & Irrigation Districts

United States
- Los Angeles – 2nd
- Phoenix – 6th
- San Diego – 8th
- Imperial Irrigation District – 1st (by volume)

Mexico
- Tijuana – 5th
- Mexicali – 12th
- Irrigation District #014 (Mexicali Valley) – 5th
Complex Legal & Institutional Framework (Law of the River)

• 1922 Colorado River Compact
• 1928 Boulder Canyon Project Act
• 1930 Seven-Party Agreement (Calif.)
• 1944 Mexico Treaty
• 1948 Upper Colorado River Basin Compact
• 2003 Quantification Settlement Agreement
• Consolidated Decree (547 U. S. 150 (2006))
Law of the River v. Law of Hydrology

LOR
• 7.5 MAF Upper Basin
• 7.5 MAF Lower Basin
• (Also 1.0 MAF surplus water to LB, when available)
• 1.5 MAF Mexico
• 16.5 MAF total (or 17.5 with LB surplus water)

LOH
• Long-term historical unimpaired flow at Lee Ferry -- ~15 MAF
Period from 2000 through 2017 is driest 18-year period in observed record
Upper Colorado River Drainage Basin

Drainage Area 107,838 Square Miles

Lake Powell
13024435/24322000
54% Full

Fontenelle
118935/344800
34% Full

Flaming Gorge
3185510/3749000
85% Full

Morrow Point
103859/117025
86% Full

Blue Mesa
540950/629500
65% Full

Navajo
1238888/1696000
73% Full
Data for: 03/26/2018
Flows are daily averages.
Elevations and Storage Volumes are midnight values.
Last updated on: 03/27/2018 8AM

LEGEND:
cfs: Flows in cubic feet-per-second
kaf: Storage volumes in thousand-acre-feet
ft: Elevations in feet above mean-sea-level
Reservoir Operations Framework, Some Key Points

• Managing drought/shortages
  – 2007 Interim Guidelines
  – 2012 Treaty Minute 319
  – 2017 Treaty Minute 323

• Ecosystem improvements to Colorado River Delta in Mexico
  – Minutes 319 & 323
USBR Interim Guidelines

• NEPA ROD signed in 2007 for operations beginning in 2008
• In effect for ops through 2026
• Previously, Powell & Mead operated to avoid flood control spills
• Changing the operating criteria reduced the probability & severity of shortages
Guidelines, con’t.

• Modified pre-existing Interim Surplus Guidelines
• Established trigger elevations in Powell for releases to Mead, and trigger elevations in Mead for reducing Lower Basin deliveries (shortage condition)
• Provided methodology for storing credit water (Intentionally Created Surplus) in Mead
• Review of guidelines’ effectiveness required in 2020
<table>
<thead>
<tr>
<th>Elevation (feet)</th>
<th>Lake Powell</th>
<th>Live Storage (maf)</th>
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| 3,700           | Equalization Tier  
Equalize, avoid spills or release 8.23 maf | 24.3 |
| 3,636 - 3,666 (2008-2026) | 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 | 15.5 - 19.3 (approx. 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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<th>Elevation (feet)</th>
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<th>Operation According to the Interim Guidelines</th>
<th>Live Storage (maf)</th>
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| 1,220           | Flood Control Surplus or Quantified Surplus Condition  
Deliver > 7.5 maf | 25.9 |
| 1,200 (approx.) | Domestic Surplus or ICS Surplus Condition  
Deliver > 7.5 maf | 22.9 (approx.) |
| 1,145           | Normal or ICS Surplus Condition  
Deliver ≥ 7.5 maf | 15.9 |
| 1,105           | 11.9 |
| 1,075           | Shortage Condition  
Deliver 7.167 maf | 9.4 |
| 1,050           | 7.5 |
| 1,025           | Shortage Condition  
Deliver 7.063 maf | 5.8 |
| 1,000           | Shortage Condition  
Deliver 7.00 maf  
Further measures may be undertaken | 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 and Lower 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 0.263 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 Division States and Mexico is 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.
Lake Mead End of Calendar Year Elevation

- Surplus Condition
- Adoption of 2007 Interim Guidelines
- Normal or ICS Surplus Condition
- Level 1 Shortage Condition
- IBWC Minute 318
- IBWC Minute 319
- Level 2 Shortage Condition
- Pilot System Conservation Program and Lower Basin Drought MOU
- IBWC Minute 323
- Level 3 Shortage Condition and reconsultation under the 2007 Interim Guidelines

- Actual Lake Mead End of CY 2017 Elevation

- System Conservation Water
- Mexico Deferred Delivery
- Other Voluntary Contributions
- U.S. ICS
- Hypothetical Elevation without Storage/Conservation Programs
And Why Is This Important?

- Historically, Lower Basin deliveries highly reliable
- Entering new territory relative to risk of Lower Basin shortages
- Risk management actions being taken, e.g. SNWA third intake, 2014 conservation actions
Benefits of Better Forecasting

• Lead time!
• Lead time!!
• Lead time!!!
• Basin is extremely institutionally complex, any risk management action takes time to negotiate and implement
USBR’s 24-Month Study

### OPERATION PLAN FOR COLORADO RIVER SYSTEM RESERVOIRS

**March 2018 24-Month Study**

**Lake Powell**

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* Based on the Colorado River Basin Forecast Center’s Most Probable Water Supply Forecast

Model Run ID: 3053
Processed On: 3/12/2018 10:33:36AM
Drought Contingency Planning

• Shortage risk increasing as long-term dryness persists

• Reducing the risks, e.g.
  – Upper Basin: Compact call, minimum power pool at Powell
  – Lower Basin: SNWA’s intake at 1050, third tier shortage
Risk Management Considerations

• Costs of making a wrong decision (water & monetary)
• Avoided costs and opportunity costs
• Risk tolerance
Schematic illustration of regional variations in the primary weather phenomena that lead to extreme precipitation, flooding and contribute to water supply in the Western U.S. 

- **Atmospheric Rivers** (fall and winter)
- **Southwest Monsoon** (summer & fall)
- **Great Plains Deep Convection** (spring and summer)
- **Spring Front Range Upslope** (rain/snow)

Marty Ralph et al
Better S2S Precipitation Forecasting

- What type of events provide how much of the precip in the important 15% of the Basin?
- How do we predict them?
- How do we make this happen?
So How Do We Figure This Out???