SLIDES: Response of the System to Various Hydrological and Operational Assumptions: Reclamation Modeling Results

Terry Fulp

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Response of the System to Various Hydrological and Operational Assumptions

Reclamation Modeling Results

NRLC Conference – Boulder, CO

June 2005
Outline

- Colorado River System Operations
- Five-Year Drought
- Current Hydrology and System Status
- Drought Mitigation and Modeling
- Next Steps
Colorado River Basin Hydrology

- 16.5 million acre-feet (maf) allocated annually
- 13 to 14.5 maf of consumptive use annually
- 60 maf of storage
- 15.1 maf average annual “natural” inflow into Lake Powell over past 100 years
- Inflows are highly variable year-to-year
1996 to 2003: Provisional data, subject to change.
Operation of Lake Powell

- Three modes of governing annual releases from Lake Powell
  - Minimum objective release
  - Equalization (if Powell storage > Mead and 602(a) storage requirement is met)
  - Spill avoidance
- For 2005, minimum objective release governs the operation
Operation of Lake Mead

- Two modes of governing releases from Lake Mead
  - Flood control operations
  - Meet downstream requirements (demands)
- For 2005, meeting downstream demands governs the operation
Operation of Lake Mead
Downstream Requirements

• Downstream requirements include:
  – California  4.4 maf
  – Arizona     2.8 maf
  – Nevada      0.3 maf
  – Mexico      1.5 maf
  – Regulation of Lakes Mohave and Havasu
  – System gains and losses

• Deliveries can be larger or smaller under “surplus” or “shortage” conditions
Why is Lake Mead going down?

- Given current demands in the Lower Basin (including Mexico), and minimum objective release from Lake Powell, Lake Mead storage will continue to decline

  - **Inflow** = 9.0 maf
    (release from Powell + side inflows)
  - **Outflow** = -9.5 maf
    (LB and Mexico apportionments + downstream regulation, gains and losses)
  - **Mead evaporation loss** = -0.8 maf
  - **Balance** = -1.3 maf
Colorado River

Five Year Historic Drought

2000 - 2004

Hite Bay looking upstream
Full Pool Elevation

Lake Powell
03/09/2003
Water Year Unregulated Inflow to Lake Powell, 1999-2005

- 1999: 109% of average
- 2000: 62% of average
- 2001: 59% of average
- 2002: 25% of average
- 2003: 52% of average
- 2004: 51% of average
- 2005: 109% of average*

* based on June 2005 final inflow forecast
Mid-Term Droughts - Colorado River  
(Average 100 year natural flow 15.1 maf)

<table>
<thead>
<tr>
<th>Years</th>
<th>Duration</th>
<th>Average Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1931-1935</td>
<td>5 years</td>
<td>11.4 maf</td>
</tr>
<tr>
<td>1953-1956</td>
<td>4 years</td>
<td>10.2 maf</td>
</tr>
<tr>
<td>1959-1964</td>
<td>6 years</td>
<td>11.4 maf</td>
</tr>
<tr>
<td>1988-1992</td>
<td>5 years</td>
<td>10.9 maf</td>
</tr>
<tr>
<td>2000-2004</td>
<td>5 years</td>
<td>9.9 maf</td>
</tr>
</tbody>
</table>

* provisional data
## Colorado River Basin Storage
(as of May 31, 2005)

<table>
<thead>
<tr>
<th>Current Storage</th>
<th>Percent Full</th>
<th>1000 Ac-Ft</th>
<th>Elev. (Ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Powell</td>
<td>43%</td>
<td>10,399</td>
<td>3585.28</td>
</tr>
<tr>
<td>Lake Mead</td>
<td>60%</td>
<td>15,615</td>
<td>1142.09</td>
</tr>
<tr>
<td><strong>Total System Storage</strong></td>
<td><strong>57%</strong>*</td>
<td><strong>33,684</strong></td>
<td><strong>NA</strong></td>
</tr>
</tbody>
</table>

* Total system storage was 31,677 kaf or 53% this time last year
2005 Upper Colorado Apr–Jul Inflow based on June 2005 final inflow forecast

- Flaming Gorge – 109%
- Blue Mesa – 93%
- Navajo – 175%
- Lake Powell – 113%
Lake Powell Projected Water Surface Elevation and Storage
May 24 month Study

Water Year 2006
Assumes Unregulated Inflow of 10.85 maf
90% of 30 yr average

8.23 maf release scheduled
In WY 2005 and 2006
Minimum Power Pool 1050 ft
1142 ft 60% of Live Cap
895 ft Dead Pool Elevation
Lake Mead Capacity
1219.6 ft
25.9 maf Live Storage
1142 ft 60% of Live Cap
Active Storage 8.1 maf
1050 ft
Minimum Power Pool
1000 ft 155 ft Lower SNWA Intake
895 ft Dead Pool 2.0 maf
895 ft Dead Pool Elevation
Not to scale
May 31, 2005
RECLAMATION
Lake Mead EOM Elevation

Based on the May 2005, 24 Month Study
Lower Basin Tributary Inflows in WY 2005

- Total LB tributary inflow (October 1 through May 31)
  - approximately 2.4 maf
- Long-term average is 1.3 maf per year
- Excess flows to Mexico (October 1 through May 31)
  - approximately 123 kaf
- Lake Mead is nearly 30 feet higher now than projected in October 2004
Effect of WY 2005 Inflows

- Projected inflow into Lake Powell is 109% of average
- Unprecedented tributary inflow in the Lower Basin for WY 2005
  - Virgin River projected to be nearly 350% of average
- Projected storage* in Lakes Powell and Mead on 9/30/2005 is approximately the same as historical values from 9/30/2003
- This year has “rolled back” one year of the drought

* based on May 2005 24-mo study
Colorado River

Drought Mitigation & Modeling

RECLAMATION
Drought Mitigation and Modeling

• To date, there has never been a shortage in the Lower Basin and there are currently no shortage guidelines

• At the request of the Secretary of the Interior, the seven Basin States are discussing potential short-term and long-term drought mitigation measures
  – Short-term measures include improved system efficiencies
  – Long-term measures may include ways to decrease demands
  – Basin states technical team is investigating various operational scenarios
  – Reclamation provides technical assistance

• Secretary announced in May 2005, that the Department will initiate a public process to deal with these matters by December 2007.
Modeling Objectives

• Investigate the response of the system to:
  – a range of future inflows
  – a range of potential drought management options (which includes Lower Basin shortage)

• Determine the “side boards” for future discussions with regard to:
  – the onset of possible shortages
  – the magnitude of possible shortages
Overview of Scenarios

• Investigate the effect of “water savings” in the Lower Basin (up to 200 kaf per year)

• Investigate various shortage strategies to protect specified elevations at Lake Mead

• Investigate coordinated operation of Lakes Powell and Mead under low reservoir conditions
Modeling Approach
Protecting Specific Reservoir Elevations

- Determine when a reduction in release should occur to keep the reservoir above a specified elevation
- Determine how much reduction in release is required to keep the reservoir above a specified elevation
- Protection can be “absolute” or “probabilistic”
Modeling Assumptions
Common to All Scenarios

• Initial reservoir conditions set to January 1, 2005 levels
• Model simulates reservoir operations from 2005 through 2025
• Lake Mead is operated to meet downstream demand, except when additional releases are required to meet the ACOE flood control procedures
• Interim Surplus Guidelines in effect through 2016
Modeling Assumptions
Common to All Scenarios

- Future water use (depletion) schedules:
  - Lower Basin at 7.5 maf per year for normal years; surplus schedules in effect for surplus years\(^1\)
  - Upper Basin at 4.45 maf per year in 2005, ramping up to 4.93 MAF by 2025\(^1\)
  - Republic of Mexico at 1.5 maf per year; up to 1.7 maf per year during flood control years

\(^1\) Final Environmental Impact Statement for the Implementation Agreement, Inadvertent Overrun and Payback Policy, and Related Federal Actions; available at www.usbr.gov/lc/region
Modeling Assumptions
Common to All Scenarios

• Future inflow sequences were derived from the historical record using Reclamation’s natural flow data base, 1906 – 1995
• “Worse case” assumes the 1953 – 1973 sequence is repeated in 2005 – 2025
• All historical sequences (90 possibilities) were also studied to project the probabilities of future events
Natural Flow at Lee Ferry
17-Year Running Averages

Data synthesized from Tree Rings, Stockton and Jacoby, 1976
Data Synthesized from Observed Flows, Reclamation, 2004

17-year average = 10,465 kaf
17-year average = 11,224 kaf
17-year average (2000-2004, 1953-64) = 11,571

The year represents the first year of the 17 year average.
Modeling Scenarios Presented Today
Protect Specified Reservoir Levels

• “No Protect”
  – No protection at Powell & Mead
  – Both reservoirs can be drawn down to dead storage
    (3370 ft at Powell, 895 ft at Mead)

• “Protect Power Pools”
  – Protection for minimum power pool at Powell (3490 ft)
    & Mead (1050 ft)

• “Protect Mead 1000”
  – Protection for Mead elevation of 1000 ft only (level of
    SNWA’s lower intake structure)
Modeling Scenarios Presented Today
Coordinated Operation at Low Reservoir Levels

- **“Relaxed MOR & EQ”**
  - Powell releases 7.48 MAF annually when below 3560 ft and Mead is above 1050 ft
  - As Powell recovers, equalization releases temporarily made below 602(a) storage level (at elevation 3606 ft)
  - In effect through 2016
  - Assumes Protect 1000 for LB shortage

- **“Balance Contents”**
  - Releases made from Powell with primary objective to balance contents with Mead
  - Below 3490 ft, Powell releases 8.23 MAF annually
  - In effect through 2016
  - Assumes Protect 1000 for LB shortage
Powell EOCY Elevation
"Worse" Case

No Protect
Protect Power Pools
Protect Mead 1000
Relaxed MOR & EQ
Balance Contents

Pool Elevation (ft)
Year

Reclamation
What should we plan for?
Mead EOCY Percentile Elevations

- 90th Percentile
- 50th Percentile
- 10th Percentile

Pool Elevation (ft)

Year


No Protect
Protect Power Pools
Protect Mead 1000
Relaxed MOR & EQ
Balance Contents
Probability of Mead Elevation Below Minimum Power Pool

- No Protect
- Protect Power Pools
- Protect Mead 1000
- Relaxed MOR & EQ
- Balance Contents

Year:
- Dec-2005
- Dec-2010
- Dec-2015
- Dec-2020
- Dec-2025
Probability of Lower Basin & Mexico Shortage
Conclusions from the Modeling Results

• The earliest that the first shortage occurs in the Lower Basin is 2007; the latest the first shortage occurs in 2014
• Probability of shortage in the Lower Basin ranges between 10 and 40% over the next 20 years
• LB shortage strategies do not affect future probabilities of surplus
• The earliest Lake Powell could reach minimum power pool is 2007 and the probability of being below min. power pool in any given year is 10% or less through 2025
• Coordinated operations may be a tool to mitigate the effects of drought on Lakes Powell and Mead
• “Savings” of 200 kaf per year in the Lower Basin reduces the probability of shortage in the Lower Basin by 10-15% and can delay the onset of shortage for some operational scenarios (Not shown)