RECLAMATION

*Managing Water in the West*

# Technical Support to the Basin States Regarding Drought Conditions on the Colorado River

**A Joint Presentation of Reclamation with the Arizona Department of Water Resources and the Metropolitan Water District of Southern California**

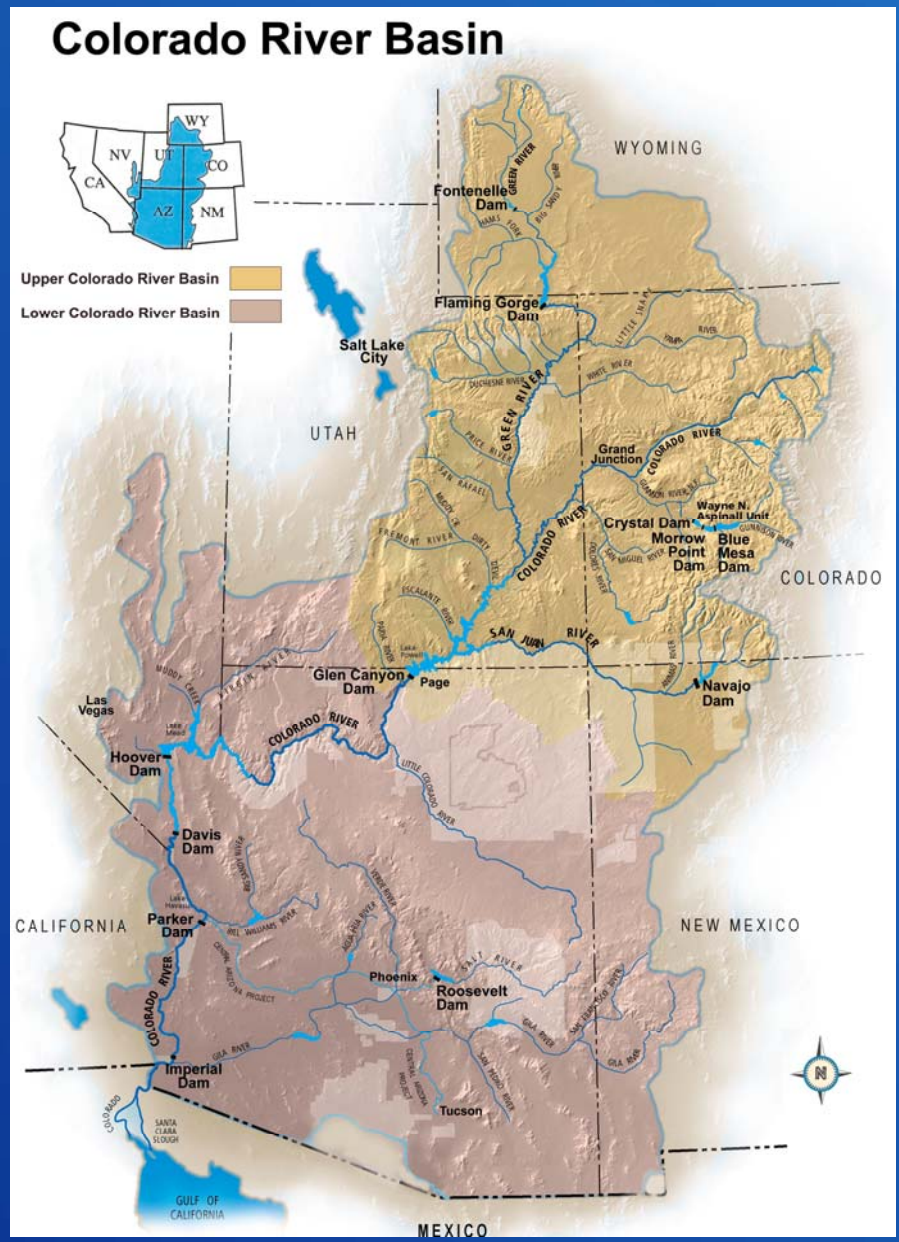
**RiverWare User Group Meeting – Boulder, CO**

**March 2006**

U.S. Department of the Interior
Bureau of Reclamation

# Agenda

- System Status
- Overview of Activities
- Use of RiverWare
  - Reclamation technical support
  - Independent modeling by the Basin States

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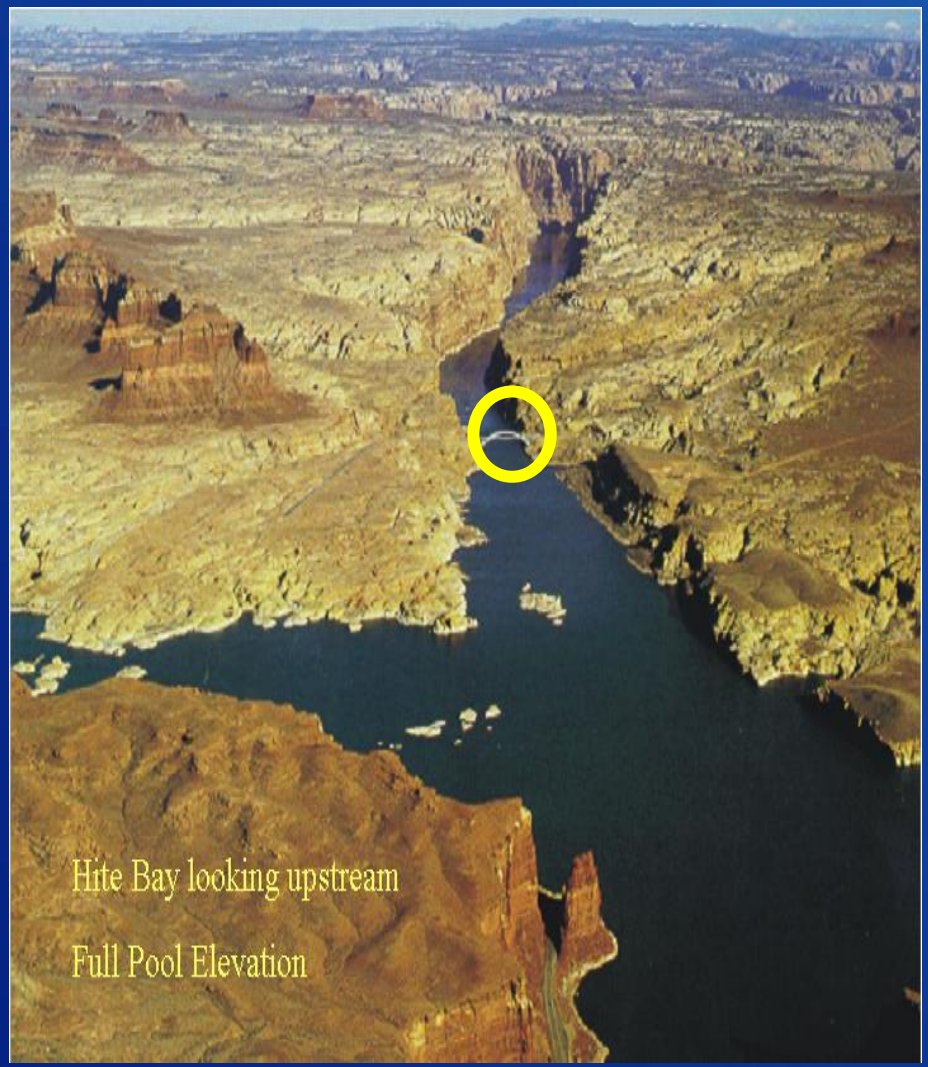
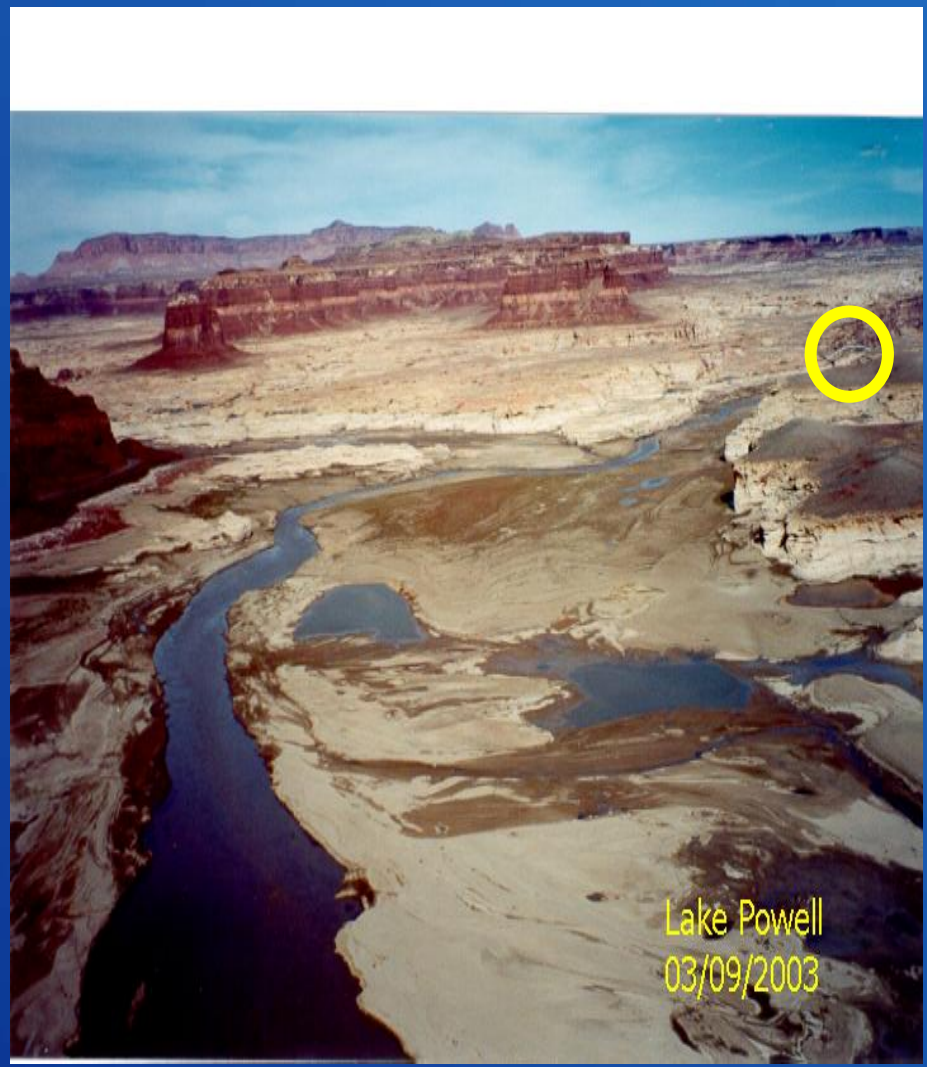
# State of the System (1999-2005)

| WY | Inflow to Powell (% of average) | Powell and Mead % Capacity |
|---|---|---|
| 1999 | 109% | 95% |
| 2000 | 62% | 86% |
| 2001 | 59% | 78% |
| 2002 | 25% | 63% |
| 2003 | 52% | 55% |
| 2004 | 51% | 46% |
| 2005 | 105% | 54% |

# Lake Powell at Hite Bay
## Circa 1999 – March 2003

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# Colorado River Basin Storage

## (as of March 1, 2006)

| Current Storage | Percent Full | Million Acre-Feet | Elevation (Feet) |
|---|---|---|---|
| Lake Powell | 44% | 10.79 | 3589 |
| Lake Mead | 60% | 15.52 | 1141 |
| Total System Storage | 57%* | 33.87 | NA |

- Total system storage was 30.98 maf or 52% this time last year

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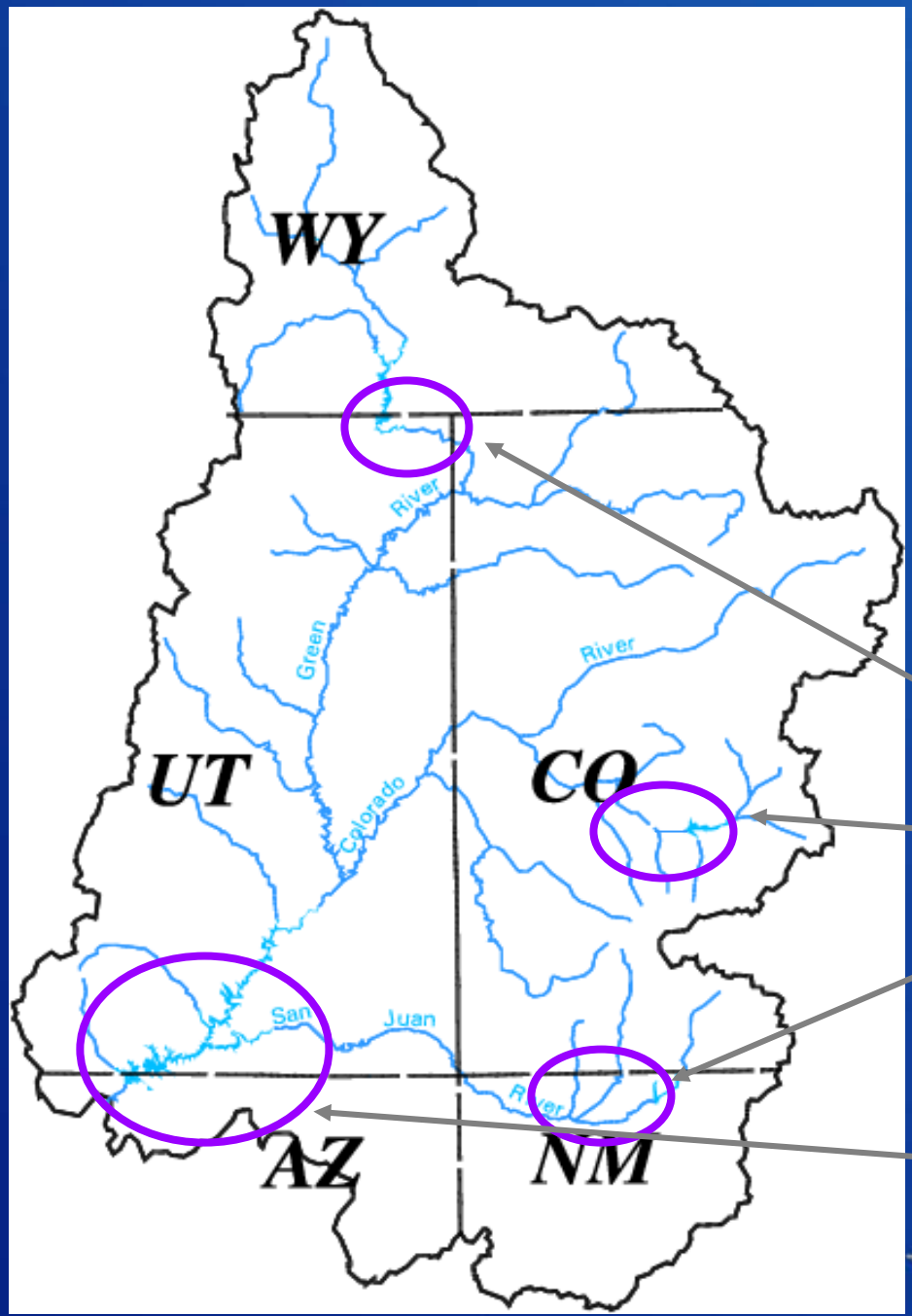
# 2006 Upper Colorado Projected Apr–Jul Inflow

based on Mar 2006
Final inflow forecast




Flaming Gorge – 105 %

Blue Mesa – 97 %

Navajo – 31 %

Lake Powell – 91 %

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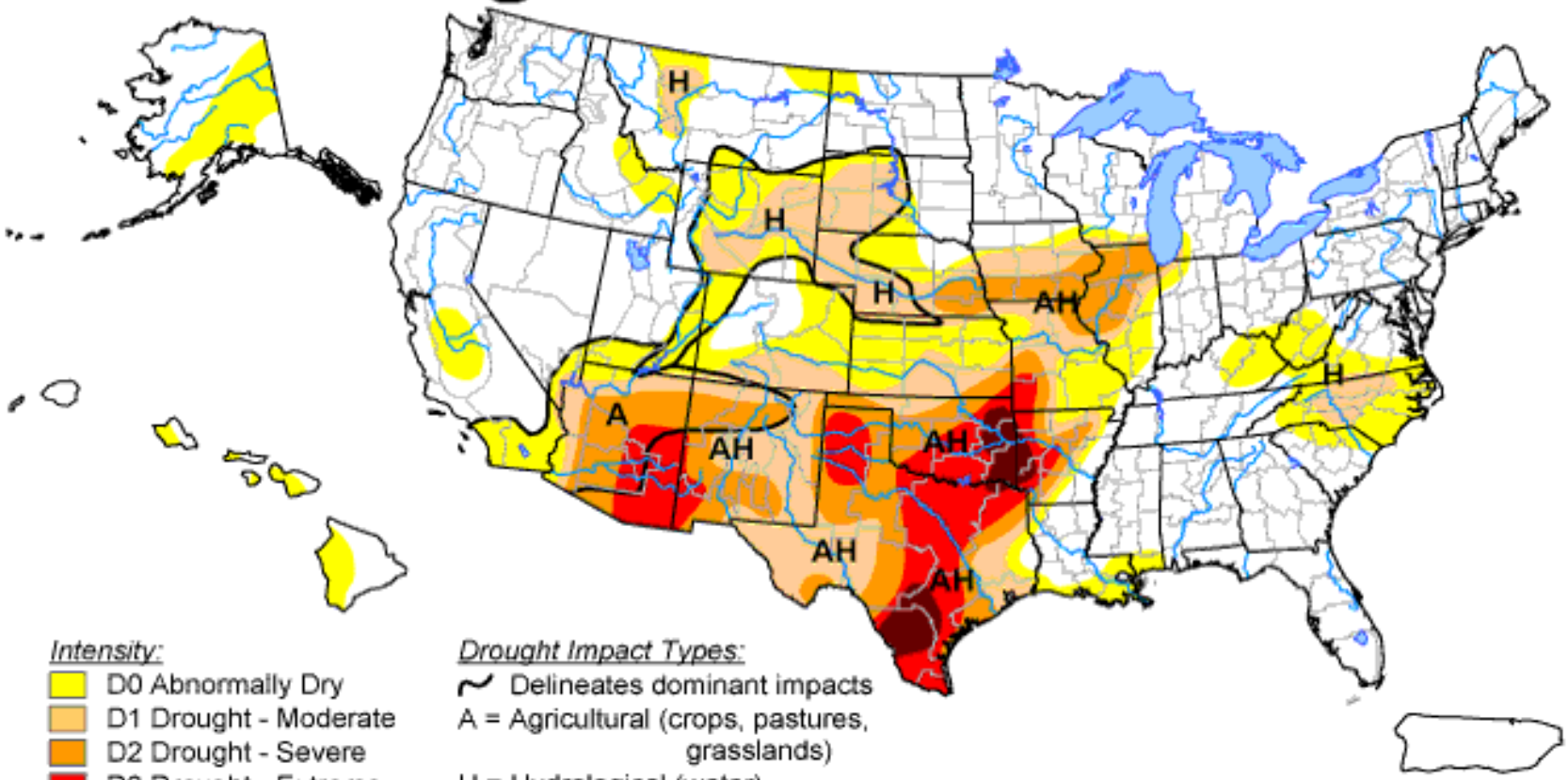
# U.S. Drought Monitor

**February 28, 2006**
Valid 7 a.m. EST




*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**

***Released Thursday, March 2, 2006***

***Author: Brian Fuchs, National Drought Mitigation Center***

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# Is the Drought Over?

- In 100 years of record keeping there has never been 6 consecutive years of below average inflow to the Colorado River
- When compared to other longer-term droughts (e.g., the 1950's), there were a couple of years of above average inflow
- Prudent water management is the wise course of action

# Prudent Water Management

- Drought conditions have impacted Colorado River system storage
- Future droughts are a certainty
- Water use continues to increase
- The Secretary as Watermaster in the Lower Basin, may declare a shortage – delivery of less than 7.5 maf
- To date, there has never been a shortage in the Lower Basin and there are currently no shortage guidelines
- Shortage guidelines will:
  - Inform the Secretary's decision
  - Provide a degree of certainty to Lower Basin water users

# Process Overview

- In 2004, the Secretary challenged the Basin States to develop a drought mitigation plan for the Colorado River Basin
- May 2004 – Basin states began studying potential operational scenarios to lessen the impacts of drought conditions using Reclamation as a technical resource
- May 2005 – the Secretary directed Reclamation to engage in a process to develop guidelines for:
  - Lower Basin shortages
  - Coordinated operation of Lakes Powell and Mead under low reservoir conditions
- February 3, 2006 – Basin States proposal submitted to Secretary

# Reclamation's Project Schedule

- Summer, 2005 – solicited public comments on content, format, mechanisms and analysis to be considered to address drought and other management challenges
- Fall, 2005 – Announced intent to initiate NEPA process and solicited public comments on scope and alternatives development
- March, 2006 – Scoping report will be made available to public
- December, 2006 – Draft EIS will be made available to public
- September, 2007 – Final EIS will be made available to public
- December, 2007 – Record of Decision issued

# Use of RiverWare in Support of the Basin States

- CRSS-Lite Model
  - Implemented in RiverWare
  - Developed by Carly Jerla of Reclamation as part of her Masters work at CADSWES
  - Mimics the operations of CRSS on an annual timestep (<0.05% diff)
  - Lake Powell and downstream only
  - Significantly shorter run time
  - User friendly and available to stakeholders

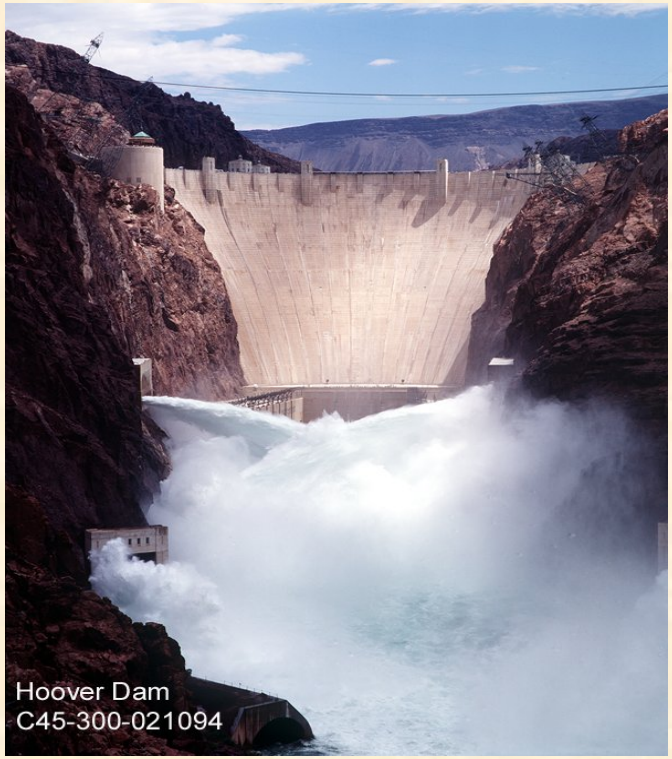

- CRSS-Lite was used exclusively as the modeling tool for this process
  - Relatively short run time allowed a multitude of operational strategies to be evaluated and compared
  - Over 50 different operational strategies modeled

# Use of RiverWare in Support of the Basin States

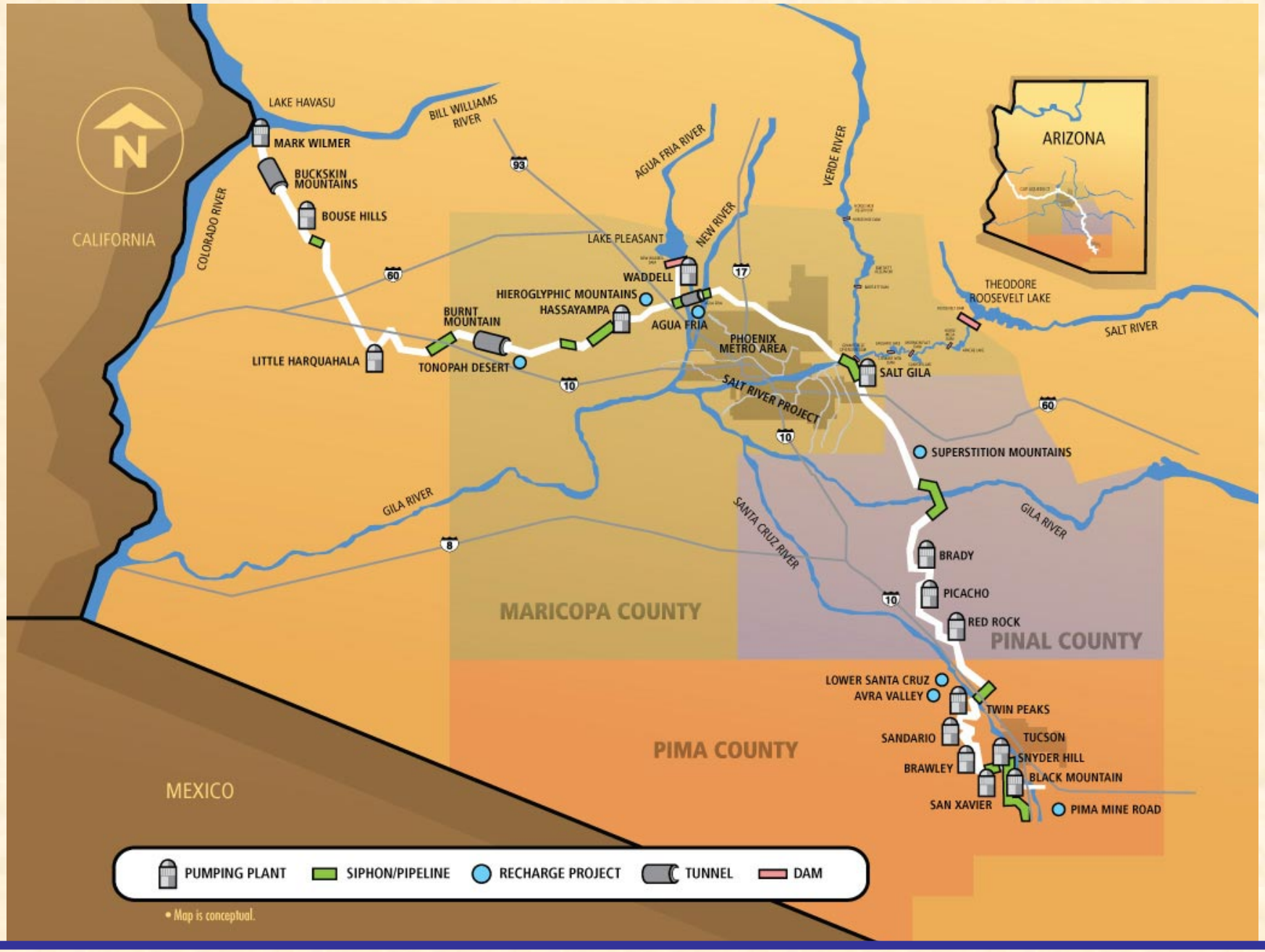
- At the request of the Basin States, several technical modeling meetings were held
- On-the-fly modeling and debugging at the technical meetings
- Internal webpage for exchange of models, rulesets, GPAT analyses
- Ease and user-friendly application promoted success


- Parallel to the external process between states, RiverWare was being used for intra-state decision support in Arizona and California
  - Don Gross from the Arizona Department of Water Resources
  - Karen Murphy from the Metropolitan Water District of Southern California

# Arizona Shortage Strategy




**Donald J. Gross, P.E. – Arizona Department of Water Resources**
**Patrick Dent, P.E. – Central Arizona Project**


N
CALIFORNIA
LAKE HAVASU
MARK WILMER
BUCKSKIN MOUNTAINS
BOUSE HILLS
COLORADO RIVER
BILL WILLIAMS RIVER
93
AGUA FRIA RIVER
VERDE RIVER
ARIZONA
LAKE PLEASANT
NEW RIVER
WADDELL
17
HIEROGLYPHIC MOUNTAINS
HASSAYAMPA
AGUA FRIA
BURNT MOUNTAIN
PHOENIX METRO AREA
THEODORE ROOSEVELT LAKE
SALT RIVER
LITTLE HARQUAHALA
TONOPAH DESERT
10
SALT GILA
SALT RIVER PROJECT
60
SUPERSTITION MOUNTAINS
GILA RIVER
SANTA CRUZ RIVER
8
BRADY
PICACHO
RED ROCK
MARICOPA COUNTY
PINAL COUNTY
LOWER SANTA CRUZ
AVRA VALLEY
TWIN PEAKS
SANDARIO
TUCSON
SNYDER HILL
BRAWLEY
BLACK MOUNTAIN
SAN XAVIER
PIMA MINE ROAD
PIMA COUNTY
MEXICO
PUMPING PLANT
SIPHON/PIPELINE
RECHARGE PROJECT
TUNNEL
DAM
• Map is conceptual.

# *Arizona Shortage Strategy*
## Work Group

- **Develop a recommendation to the Director of the Department of Water Resources regarding the appropriate volume of shortage for an interim period.**
- **Develop a recommendation to the Director regarding how shortage will be shared in Arizona between CAP and post-1968 mainstem Colorado River water users (Priority 4 Contractors)**

# *Arizona Shortage Strategy*
# Work Group Members

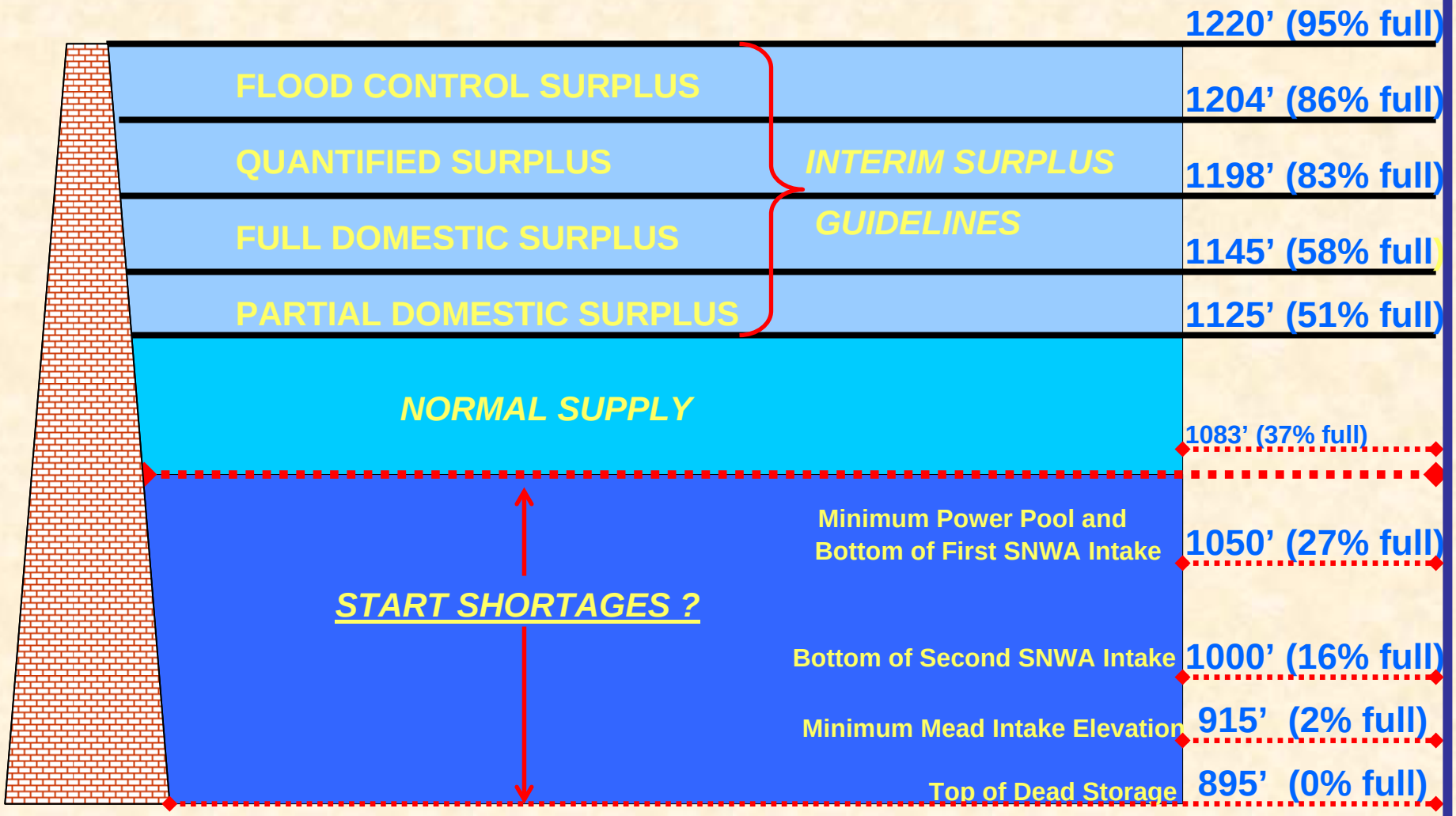
- Central Arizona Project (CAP)
- CAP Contractors
  - M&I
  - Agriculture
  - Tribal
  - Incentive Recharge
- Fourth Priority Mainstem M&I
- Fourth Priority Mainstem Agriculture
- Reclamation
- Tribal (Mainstem and Central Arizona
- Environmental
- Academia
- Municipal Water Users (AMWUA)
- Power
- Arizona Water Banking Authority (AWBA)
- Central Arizona Ground Water Replenishment District (CAGRD)
- Yuma Colorado River Water Users

# *Arizona Shortage Strategy*
## Work Group Topics

- Current Reservoir Conditions
- Factors that Affect Water Supply
- Key Reservoir Elevations
- Colorado River Priority System
- Proposed Shortage Sharing

# Arizona Shortage Strategy

## Critical Lake Mead Elevations



# *Arizona Shortage Strategy*
## Shortage Probability Factors

- Reservoir Inflow
- Upper Basin Demand
- Lower Basin Demand
- Selected Shortage Strategy

# *Arizona Shortage Strategy*
# Alternative Shortage Options

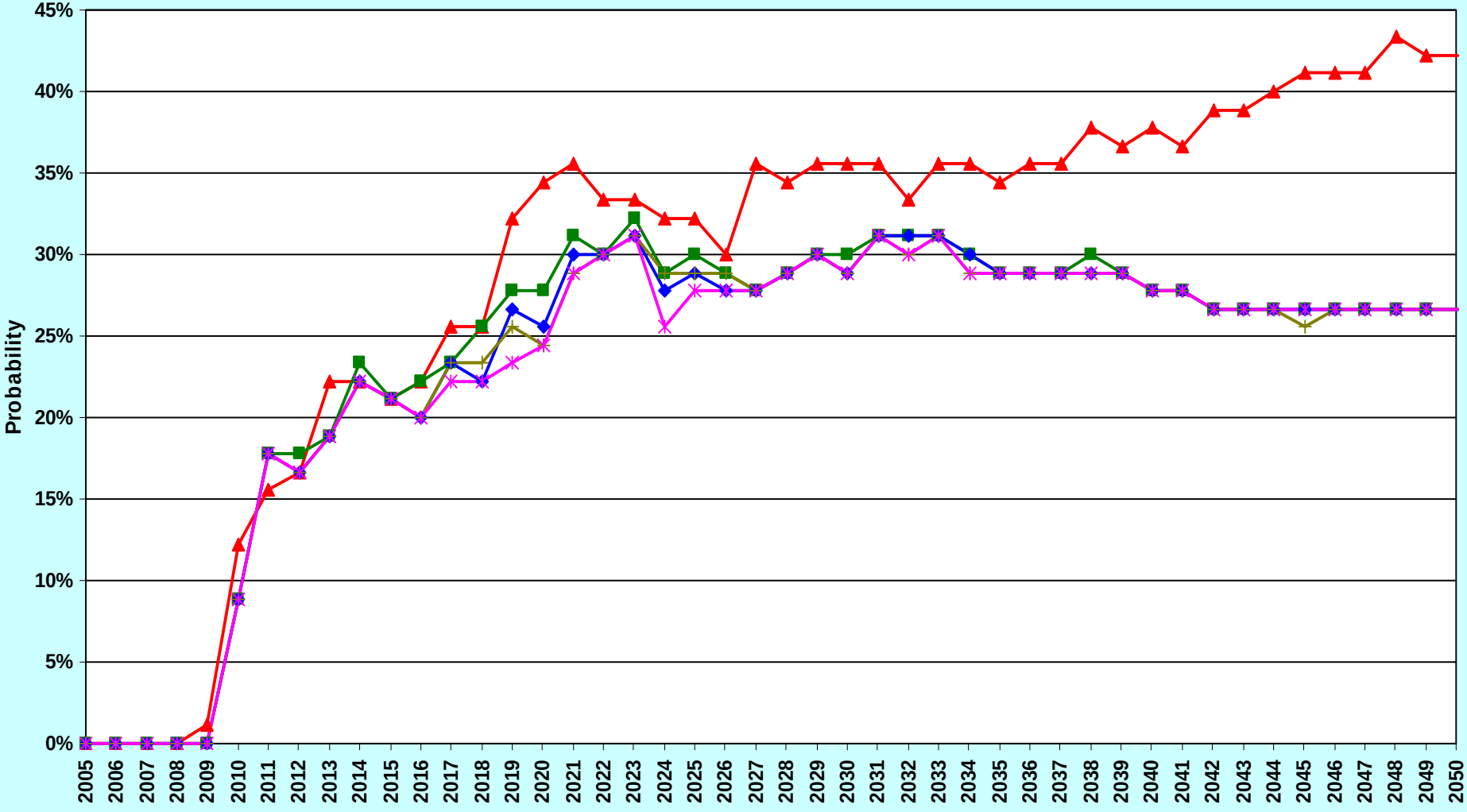
- **Probability/Volume Based Shortage Option**
  **(Used CRSS-EZ and CRSS-Lite Models)**
  1. **300,000 AF**
  2. **500,000 AF**
  3. **800,000 AF**
- **Tiered Shortage Volumes Based on Lake Mead Reservoir Elevation - either 1,100 or 1,075**
  **(Used CRSS-Lite Model)**
  1. **200,000/400,000/600,000 AF**
  2. **400,000/700,000 AF**
  3. **300,000/500,000/800,000 AF**
  4. **400,000/500,000/600,000 AF**

# *Arizona Shortage Strategy*
## Shortage Analysis

1. Probability of shortage
2. Probability of exceeding planned shortage amount
3. Average volume of exceeding planned shortage amount
4. Maximum duration of consecutive shortage years

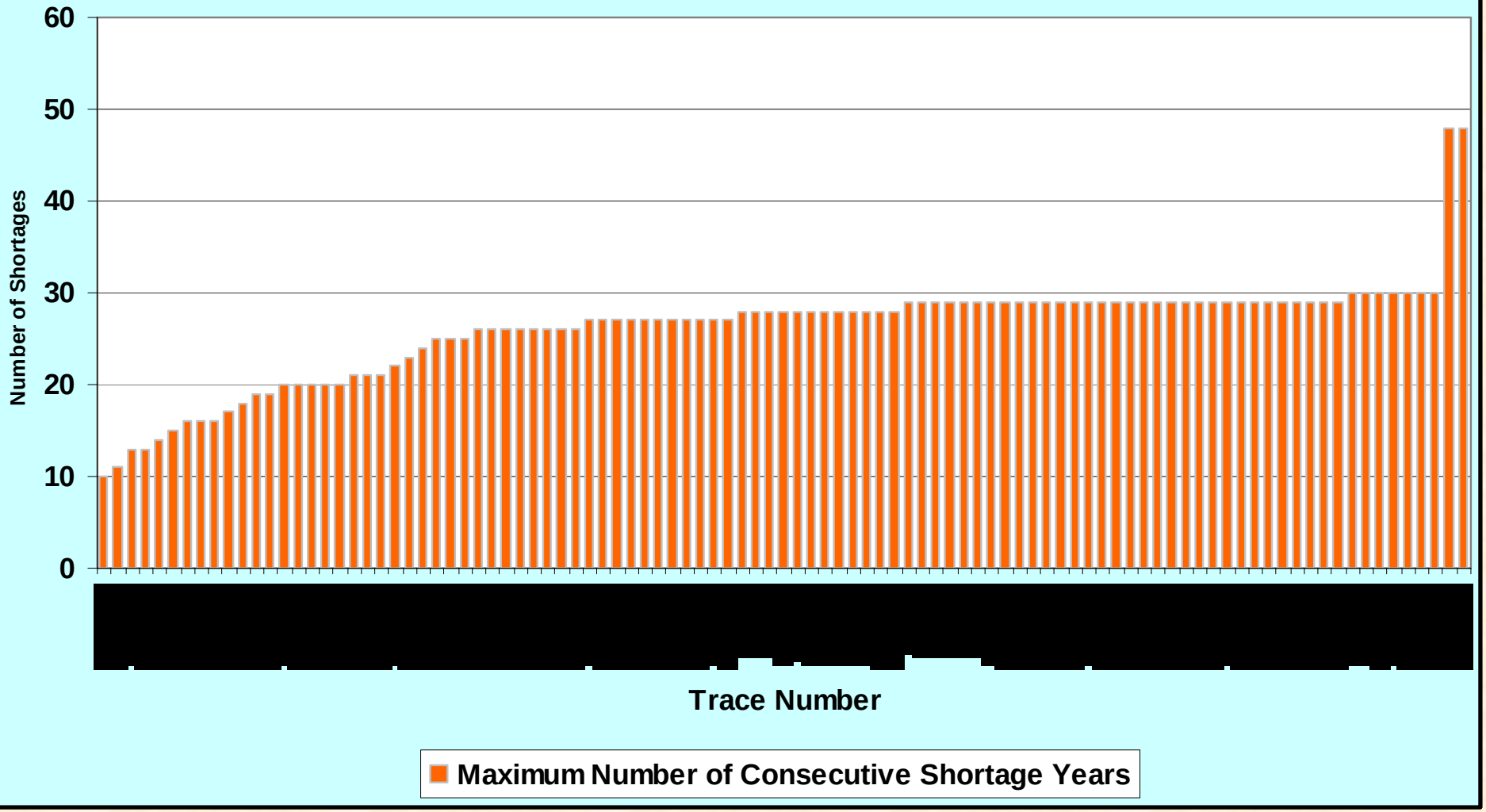
# PROBABILITY OF SHORTAGE

## *UPPER BASIN LIMITED TO 4.8 MAF - AWBA PROJECTION*




- Interim Surplus Guidelines - Ending in 2016, 80P1050 First Level Shortage, Mead Minimum Elevation - 1,000 feet, Upper Basin Limited to 4.8 MAF - AWBA Projection, YDP Starts in 2009, 500 KAF Shortage
- Interim Surplus Guidelines - Ending in 2016, Tiered Shortage Strategy - 200 KAF, 400 KAF, 600 KAF (Tier Starts at 1,075), Mead Minimum Elevation - 1,000 feet, Upper Basin Limited to 4.8 MAF - AWBA Projection, YDP Starts in 2009
- Interim Surplus Guidelines - Ending in 2016, Tiered Shortage Strategy - 300 KAF, 500 KAF, 800 KAF (Tier Starts at 1,075), Mead Minimum Elevation - 1,000 feet, Upper Basin Limited to 4.8 MAF - AWBA Projection, YDP Starts in 2009
- Interim Surplus Guidelines - Ending in 2016, Tiered Shortage Strategy - 400 KAF, 500 KAF, 600 KAF (Tier Starts at 1,075), Mead Minimum Elevation - 1,000 feet, Upper Basin Limited to 4.8 MAF - AWBA Projection, YDP Starts in 2009
- Interim Surplus Guidelines - Ending in 2016, Tiered Shortage Strategy - 400 KAF, 700 KAF (Tier Starts at 1,075), Mead Minimum Elevation - 1,000 feet, Upper Basin Limited to 4.8 MAF - AWBA Projection, YDP Starts in 2009

# MAXIMUM DURATION OF SHORTAGES
## (Based on the Following Scenario - Interim Surplus Guidelines - Ending in 2016 - 300 KAF Shortage Upper Basin Limited to 4.8 Million Acre-feet - AWBA Projection)

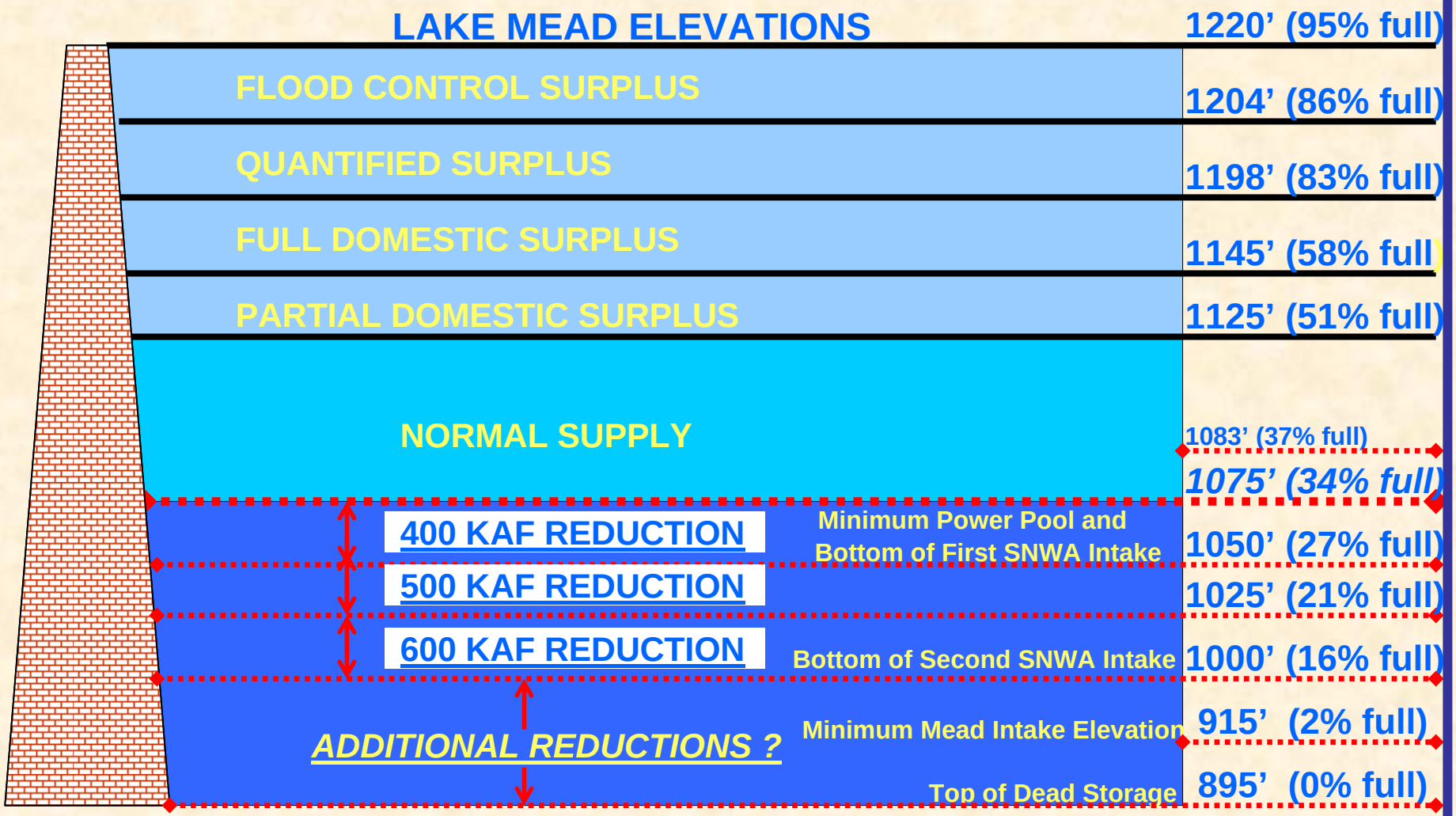


# *Arizona Shortage Strategy*
## Recommendation

- **Work Group members recommended the 400,000/500,000/600,000 acre-feet tiered shortage strategy.**
- **Strategy was incorporated in the Basin States negotiations.**

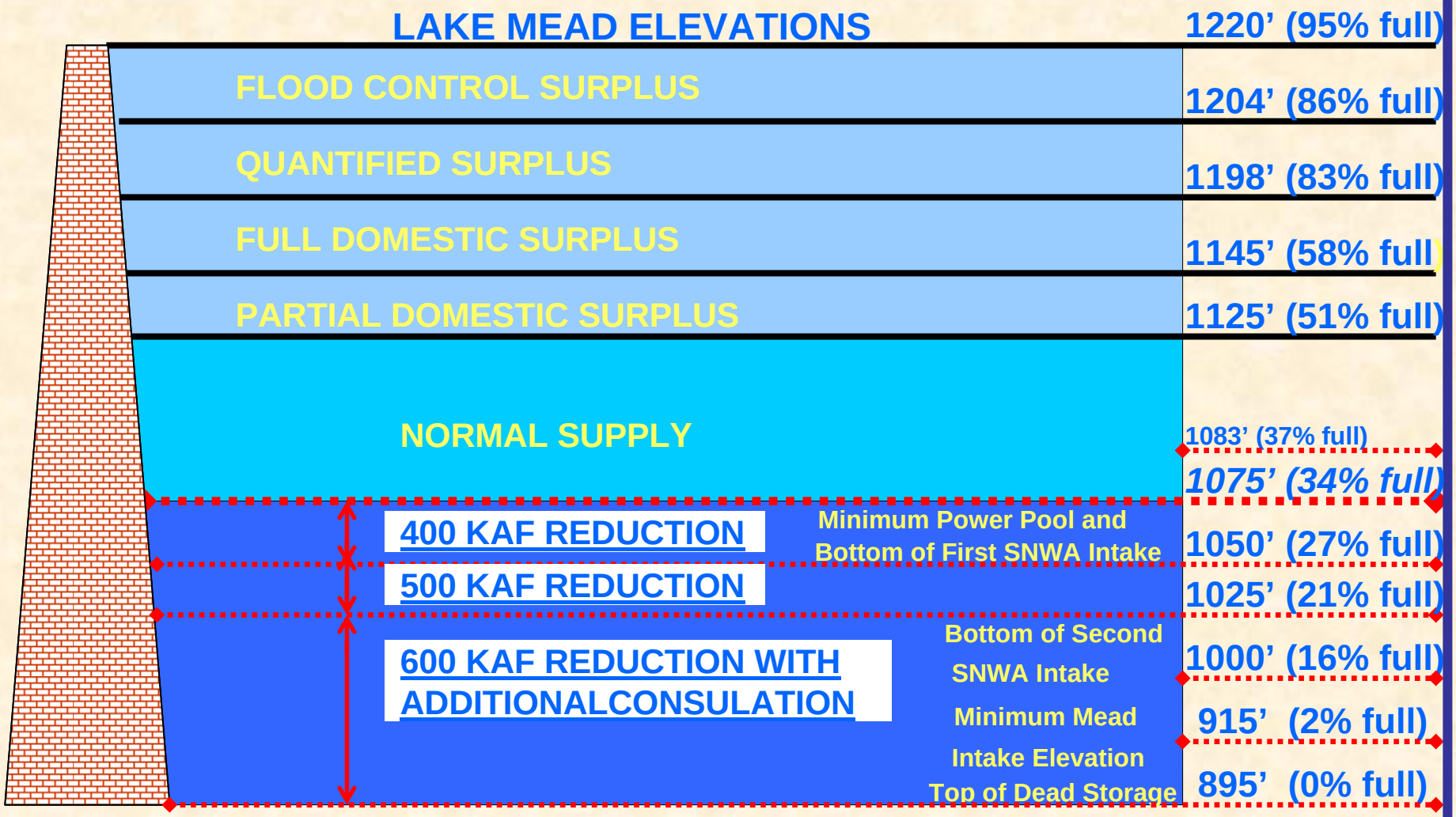
# Arizona Shortage Strategy

## Arizona Recommended Shortage Option



# Arizona Shortage Strategy

## Basin States Recommendation



# California Modeling of Shortage Criteria

- California agencies also met to discuss and evaluate shortage criteria
- Reclamation's RiverWare CRSS-Lite model was used in-state by
  - Abbas Amir-Teymoori of the Colorado River Board of California
  - Karen Murphy of the Metropolitan Water District of Southern California

# Exchanging Model Information

- Reclamation was modifying models, editing rulesets, and creating graphs from model output for use in discussions with Technical Group members
- Reclamation posted files on a Brown and Caldwell website constructed specifically for the Technical Group
- Technical Group members log onto the website to view and download information

# Working with Reclamation Models and Rulesets

- Reclamation models and rulesets were evaluated after each posting
  - Looking for what has changed in the latest files
  - Running the models to retrieve information not provided with Reclamation simulations
- Reclamation models and rulesets were modified in-house as needed.  For example:
  - Adding flags of interest to model objects and setting them within existing rules
  - Inserting original rules and objects
- Reclamation also provided models with requested changes for in-house use

# Some Issues for Consideration

- Keeping in-house models and rulesets from diverging from Reclamation models and rulesets
- Quickly determining what has been changed in a model or ruleset
- Making sure that something changed in-house does not inadvertently affect other rules
- Adequately documenting changes to models and rulesets

# Closing Thoughts

- Technical support provided to the Basin States was just one application of RiverWare in the overall project NEPA process
- Technical support provided to NGOs in development of their proposal (Conservation Before Shortage)
- Reclamation shortage guidelines/coordinated reservoir management strategies project (NEPA process)
- Final EIS decision support tool will be CRSS

# Technical Support to the Basin States Regarding Drought Conditions on the Colorado River

**Project website:**
**http://www.usbr.gov/lc/region/g4000/strategies/index.html**

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