

# RECLAMATION

*Managing Water in the West*

## **Taking RiverWare to the Extreme: the Colorado River Basin Study**

**2012 RiverWare User Group Meeting  
February 2, 2012**



U.S. Department of the Interior  
Bureau of Reclamation

# Colorado River Basin Water Supply and Demand Study

- Basin Study Overview
- Demand Input Tool
- RiverWare Modeling
- Questions



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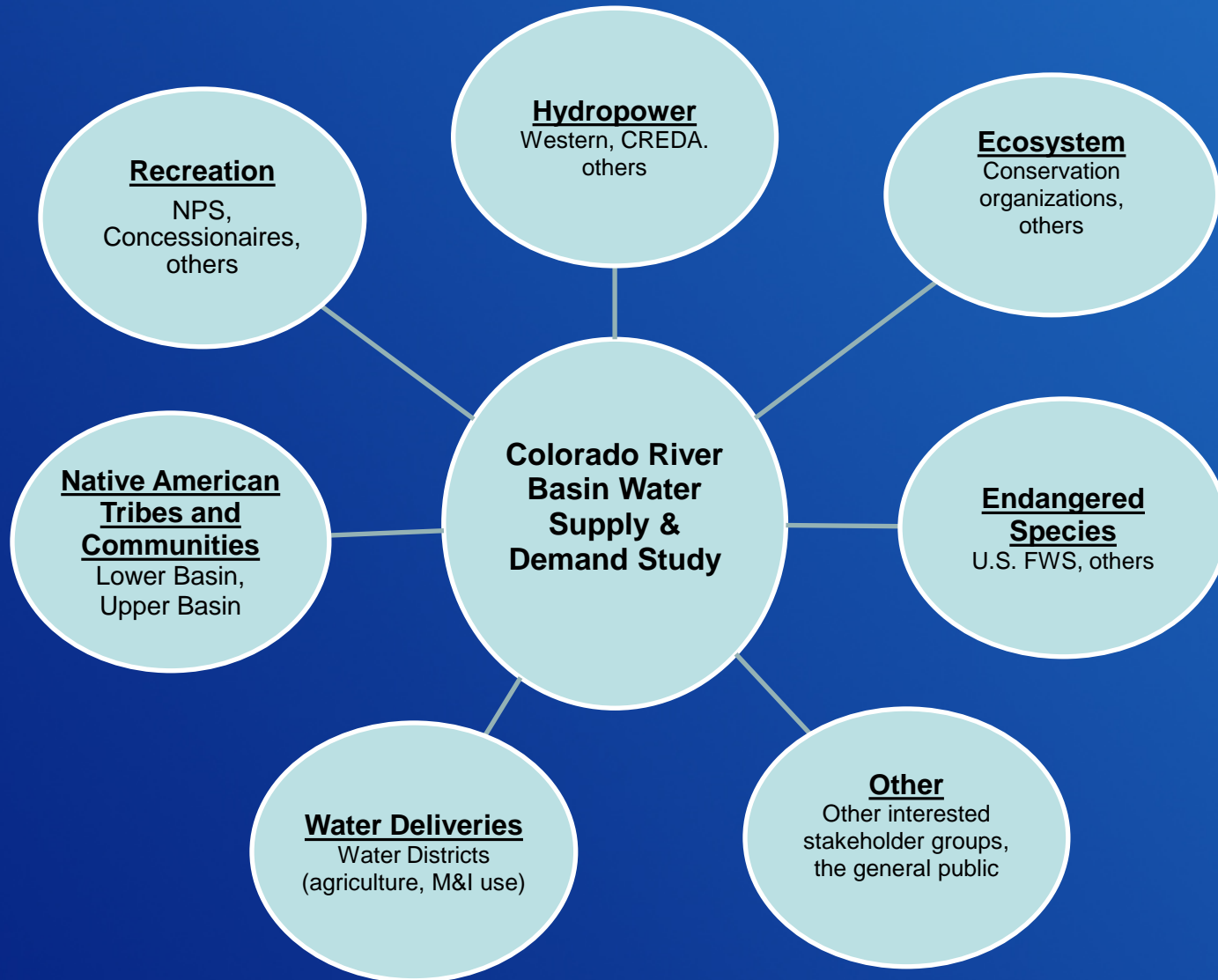
# Colorado River Basin Water Supply and Demand Study

- Study Objective
  - Assess future water supply and demand imbalances over the next 50 years
  - Develop and evaluate opportunities for resolving imbalances
- Study being conducted by Reclamation and the Basin States, in collaboration with stakeholders throughout the Basin
- Study began in January 2010 and will be completed by July 2012
- A planning study – will *not* result in any decisions, but will provide the technical foundation for future activities



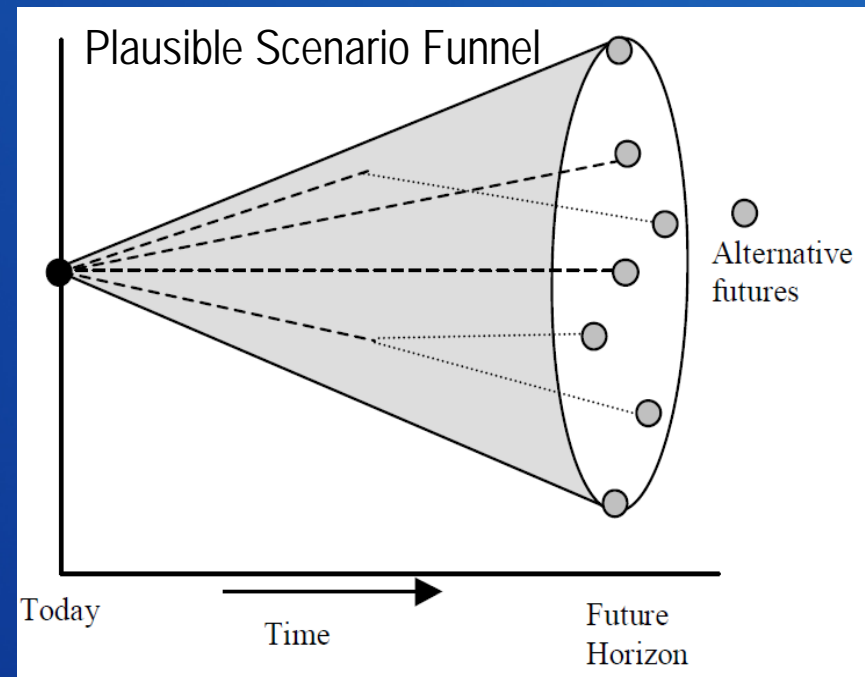
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# Study Outreach



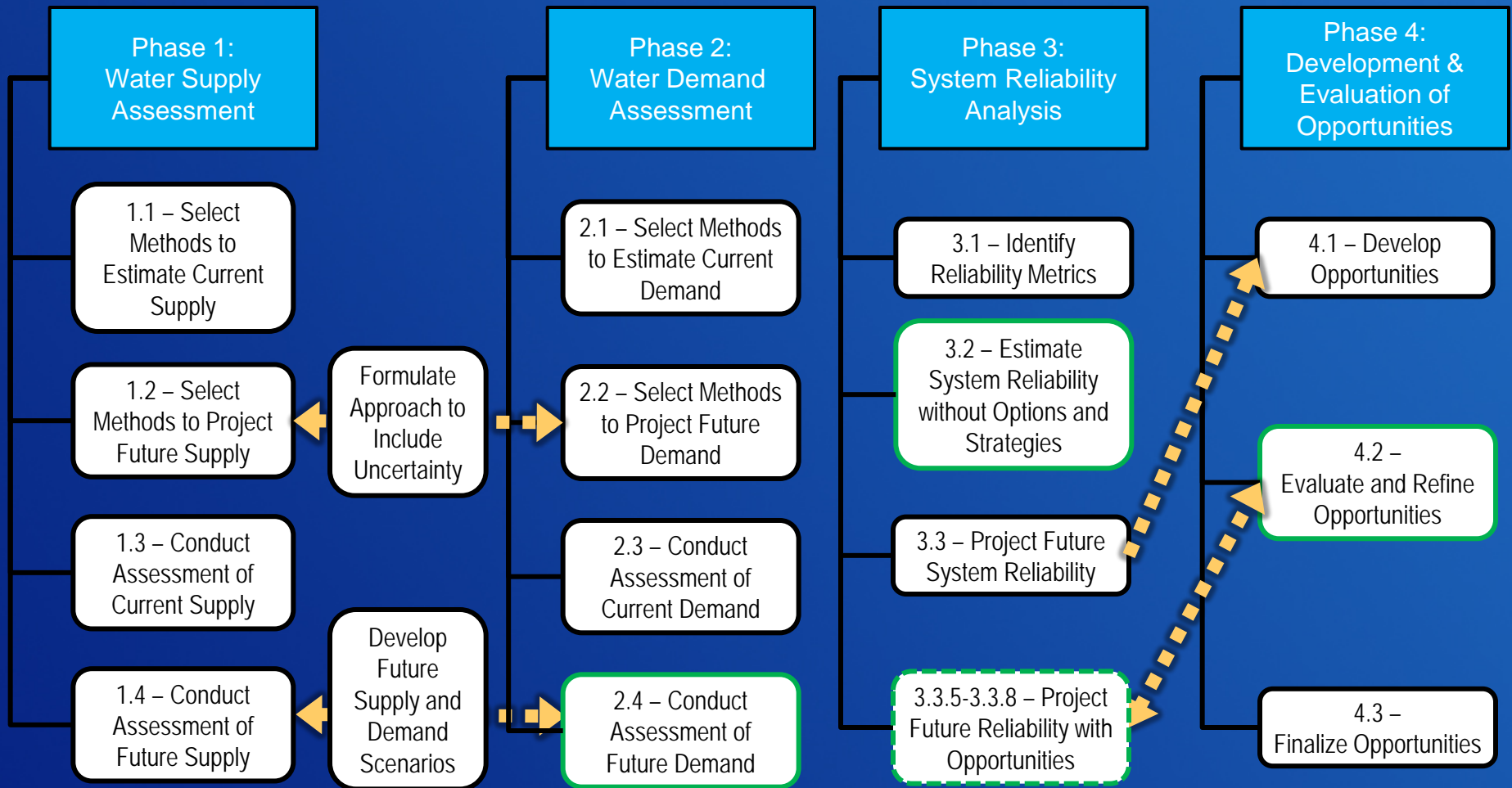
# Approach for Incorporating Uncertainty

- Effective treatment of uncertainty is key to project success
  - Trajectory of major influences on the Colorado River system is uncertain and cannot be represented by a single view
- Uncertainty is being addressed through a Scenario Approach
  - Provides structured process and common language for discussing uncertainty
  - Explores alternative views of plausible futures
  - A manageable and informative number of scenarios developed to explore the broad range of futures





# Study Phases and Tasks



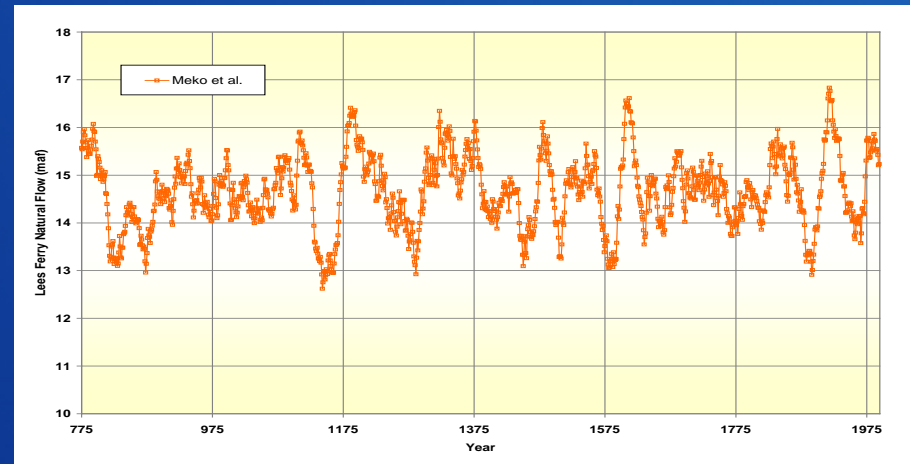
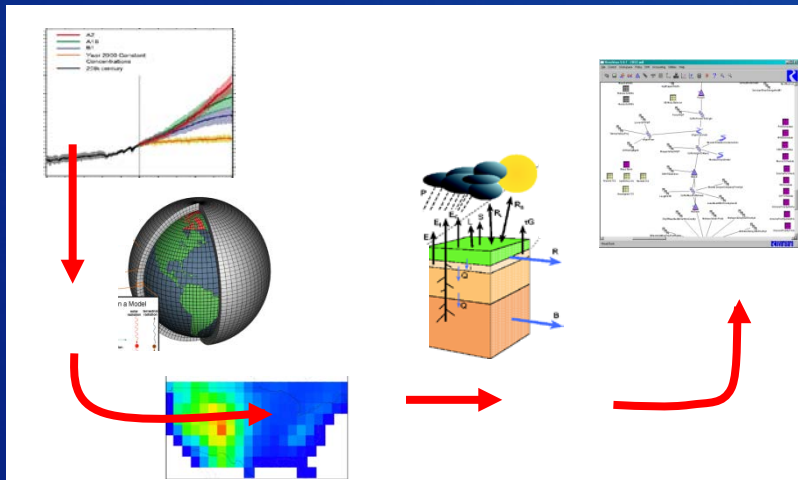
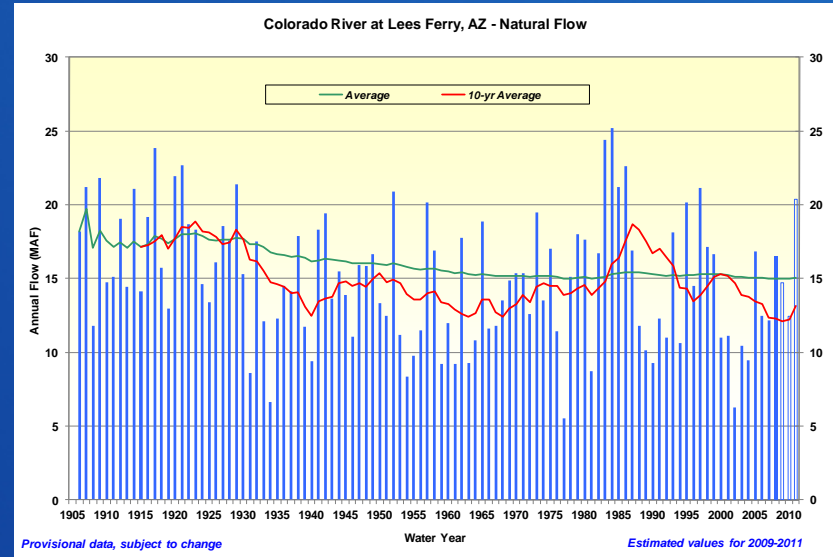
Use of RiverWare or DIT is critical

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# Phase 1: Water Supply Assessment

## Scenarios\*:

- Observed Resampled
- Paleo Resampled
- Paleo Conditioned
- Downscaled GCM Projected



\* Multiple realizations for each scenario

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# Phase 2: Water Demand Assessment

## Scenarios\*:

- **Current Projected:** growth, development patterns, and institutions continue along recent trends
- **Slow Growth:** low growth with emphasis on economic efficiency
- **Rapid Growth:** economic resurgence (population and energy) and current preferences toward human and environmental values \*\*
- **Enhanced Environment:** expanded environmental awareness and stewardship with growing economy \*\*

\* Preliminary – Scenario names subject to change

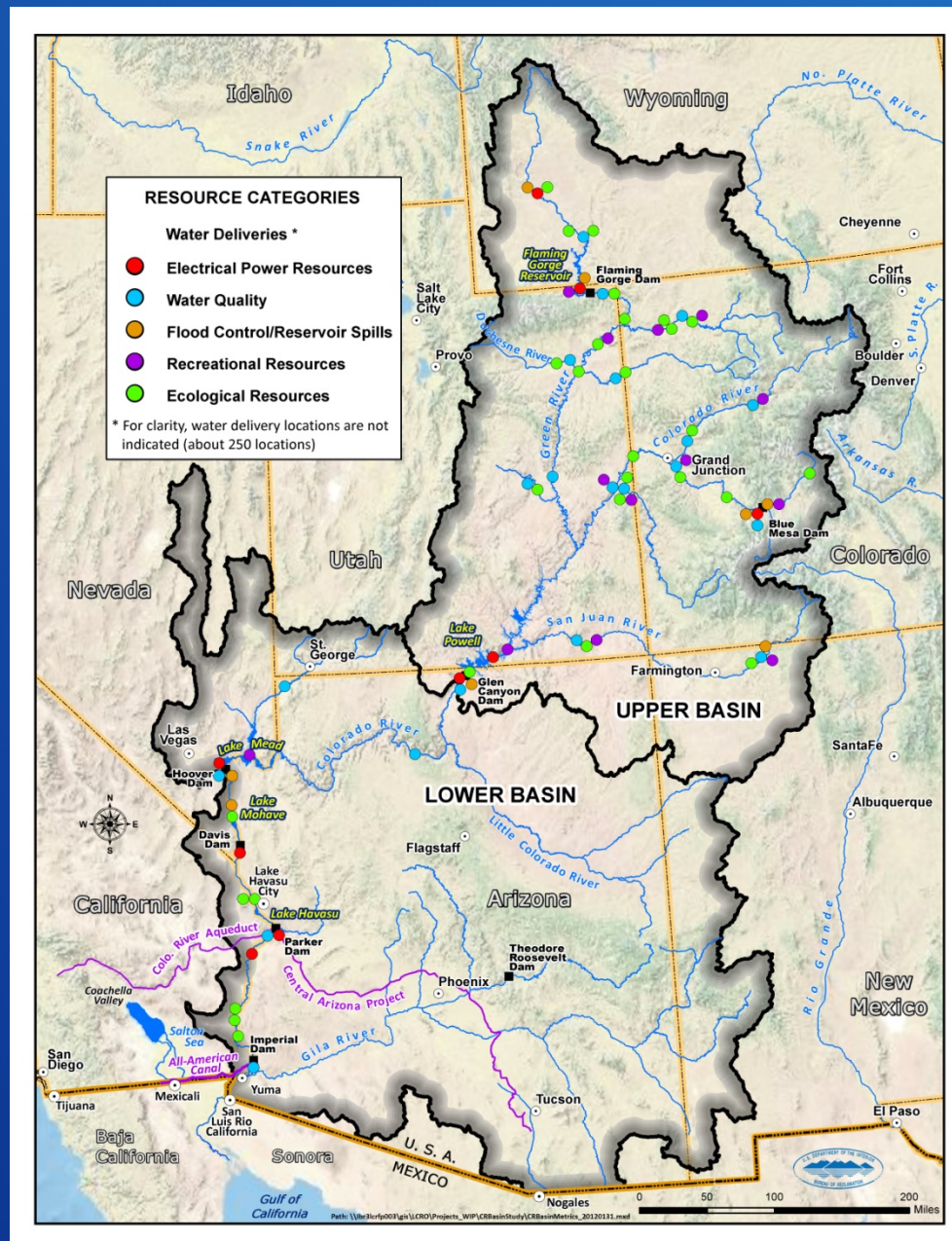
\*\* Additional “branches” possible depending upon assumed trajectory of specific socio-economic factors

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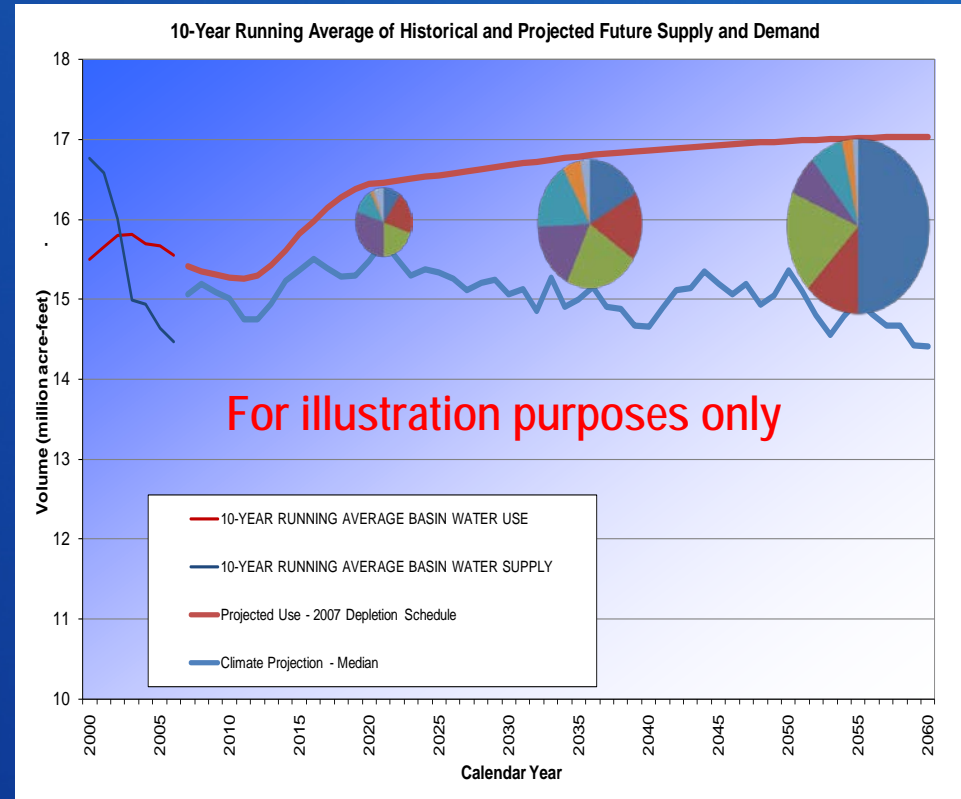
# Phase 3: System Reliability Analysis

- Simulate the state of the system on a monthly time step over the next 50 years for each scenario, with and without options and strategies
- Metrics will be used to quantify impacts to system resources
- **Resource Categories**
  - Water Deliveries
  - Electrical Power Resources
  - Water Quality
  - Flood Control
  - Recreational Resources
  - Ecological Resources



# Phase 4: Development and Evaluation of Opportunities to Balance Supply and Demand

- Consider a wide range of options and strategies
  - Representative options
- Consider “Portfolios” of unique combinations of options
- Will not result in selection or funding of a proposed project



# Demand Input Tool

- Excel based tool for specifying/modifying demands
- User specifies demands identical to the model structure
  - Aggregate diversion objects
  - Water users
- Create attributes to 'tag' each water user



# Baseline Development

## Description of Baseline:

Simulation (CRSS) model and baseline data are provided by USBR and representative organizations from each state. The basin includes the Colorado, Gunnison, Dolores, Green, Yampa, Little Snake, White, and San Juan rivers.

Tool User Name:

USBR

Creation Date:

8/3/2010

Last Modified:

10/21/2011

## Define Attributes

Aggregate Diversion Sites and Water Users

### Define Attributes

Attribute:

Applies To:

Node	Aggregate Diversion Site
Tributary	Aggregate Diversion Site
State	Water User Element
<b>Sector</b>	<b>Water User Element</b>
Online Depletion Class	Water User Element
Tribe	Water User Element
Planning Area	Water User Element

Delete Selected

Attribute Values

Agriculture  
Energy  
Exports  
Fish & Wildlife  
M & I  
Minerals  
Reservoir Evaporation  
Water Quality Improvement Projects (WQIP)  
Industrial  
Imports  
Recreation

Delete Selected

Attribute Name:

Attribute Value Name:

Applies To:

- Aggregate Diversion Site  
 Water User Element

Add Attribute

Add Attribute Value

### Time Range

Start Year: 2000

End Year: 2060

Change Time Range For The  
Baseline And All Scenarios

OK

Apply

Cancel

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# Demand Input Tool

- Quickly input demands
- Allows user to specify 'baseline' scenario
  - Specify depletion requested and efficiency ratio
    - DIT computes diversion requested
- Create scenarios based on changes to baseline
  - Relative or percent change from the baseline, or new amount
- Plotting feature

# Demand Input Tool

Water User
✕

Water User Name:

RiverWare Name:

New Users will also need to be added as Elements to the model in RiverWare with the same name

Attributes
Data

Select Water User for Default Values

Select a pre-existing Water User for its default values for Monthly Distribution Coefficient, Efficiency Ratio, and Salinity Pick-up.

Data Entry

Time Series (Year)	Diversion Requested (KAF/Yr)	Depletion Requested (KAF/Yr)	Efficiency Ratio (Depletion / Diversion)	Salinity Pick-up (mg/L/Yr)
2008				
2009				
2010	105.2	105.2	1	0
2011				
2012				
2013				
2014				
2015				
2016				
2017				

Selected Year

Depletion Requested

Efficiency Ratio

Salinity Pick-up

Water Monthly Distribution Coefficients

Water Monthly Distribution Coefficients (%)	
January	0
February	0
March	3
April	12
May	28
June	31
July	12
August	4
September	1
October	6
November	2
December	1

Total:   
 Must sum to 100

OK

Apply

Cancel

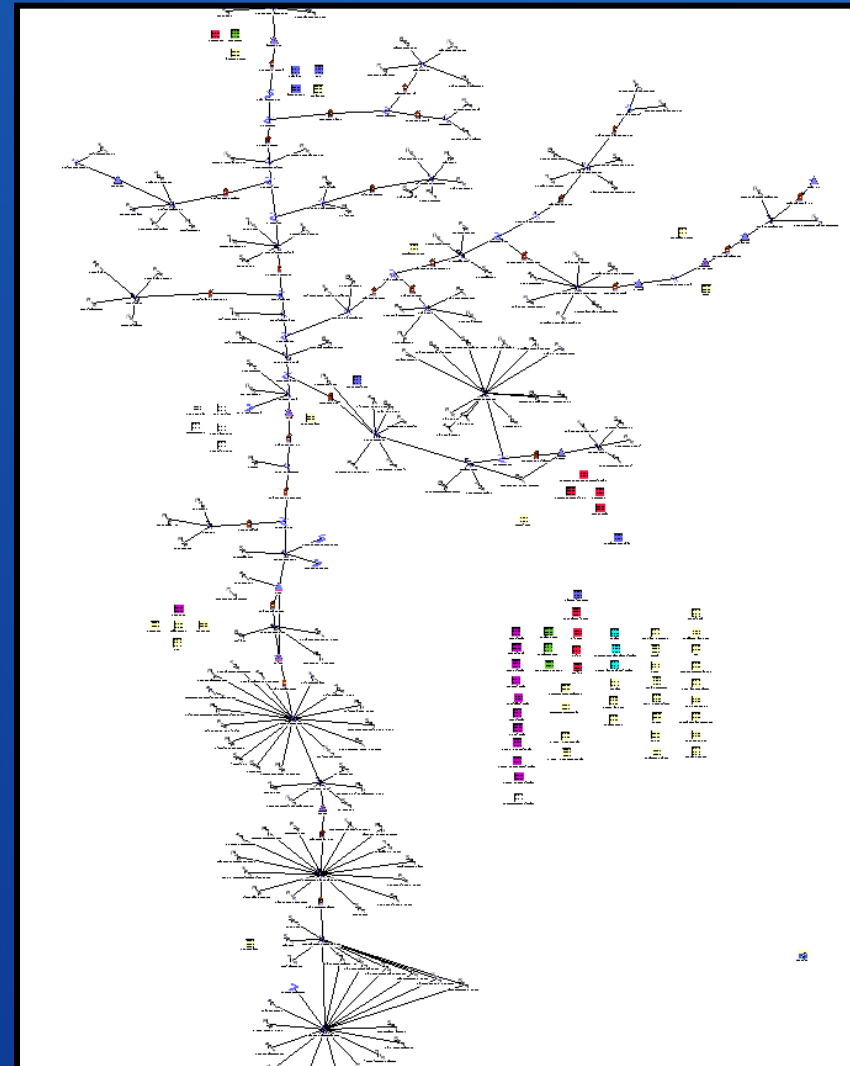


# Use of Demand Input Tool

- Worked closely with cost-share partners to develop the demand scenarios
- Input the Current Projected demand scenario as the 'baseline' scenario
  - Does not imply greater significance of this demand scenario
- Specified all other demand scenarios as changes to the 'baseline' scenario
- Can easily import to CRSS through the Excel DMI feature

# Colorado River Simulation System (CRSS)

- Monthly time step, basin-wide planning model
- Simulates operations at 12 reservoirs and deliveries to over 500 individual 'water users'
- Upper Basin reservoir rules updated to reflect recent RODs
  - Flaming Gorge
  - Navajo



# System Reliability Modeling

- **System reliability analysis without options and strategies**
- **48 different scenarios**
  - 6 demand scenarios
  - 4 supply scenarios
    - Total of 1959 traces
  - 2 policy alternatives
- **23,508 traces**
- **1,151,892 simulated years**



# Distributed MRM

- Allows multiple RiverWare instances to run at the same time
  - 1 instance for each core
- Reduces estimated computing time from 200 hours to 15 hours
  - Even more savings from increased computing power

**Configuration**

Name: owell Mead 2007 ROD Guidelines Extended

Mode: Concurrent

Policy:  Rules

Input:  Input DMIs

None

Traces

Index Seq.

Description | Output | Run Parameters | Policy | Input | Distributed Runs | Concurrent Runs

Login As: User: Password: ⚠ Not Secure [Learn More...](#)

Working Directory: \\DirtyDevil\CRSS\_TEMP\temp

Save Distributed Configuration As: \\DirtyDevil\CRSS\_TEMP\temp\CRSS.cfg

Run Post-Processor:

**Simulations**

Distribute Evenly Port: 27285 Number of Traces: 103 of 103

Host	First Trace	Last Trace	Num Traces
DirtyDevil	1	9	9
DirtyDevil	10	18	9
DirtyDevil	19	27	9
DirtyDevil	28	36	9
DirtyDevil	37	45	9
DirtyDevil	46	54	9
DirtyDevil	55	63	9

**Environment Variables**

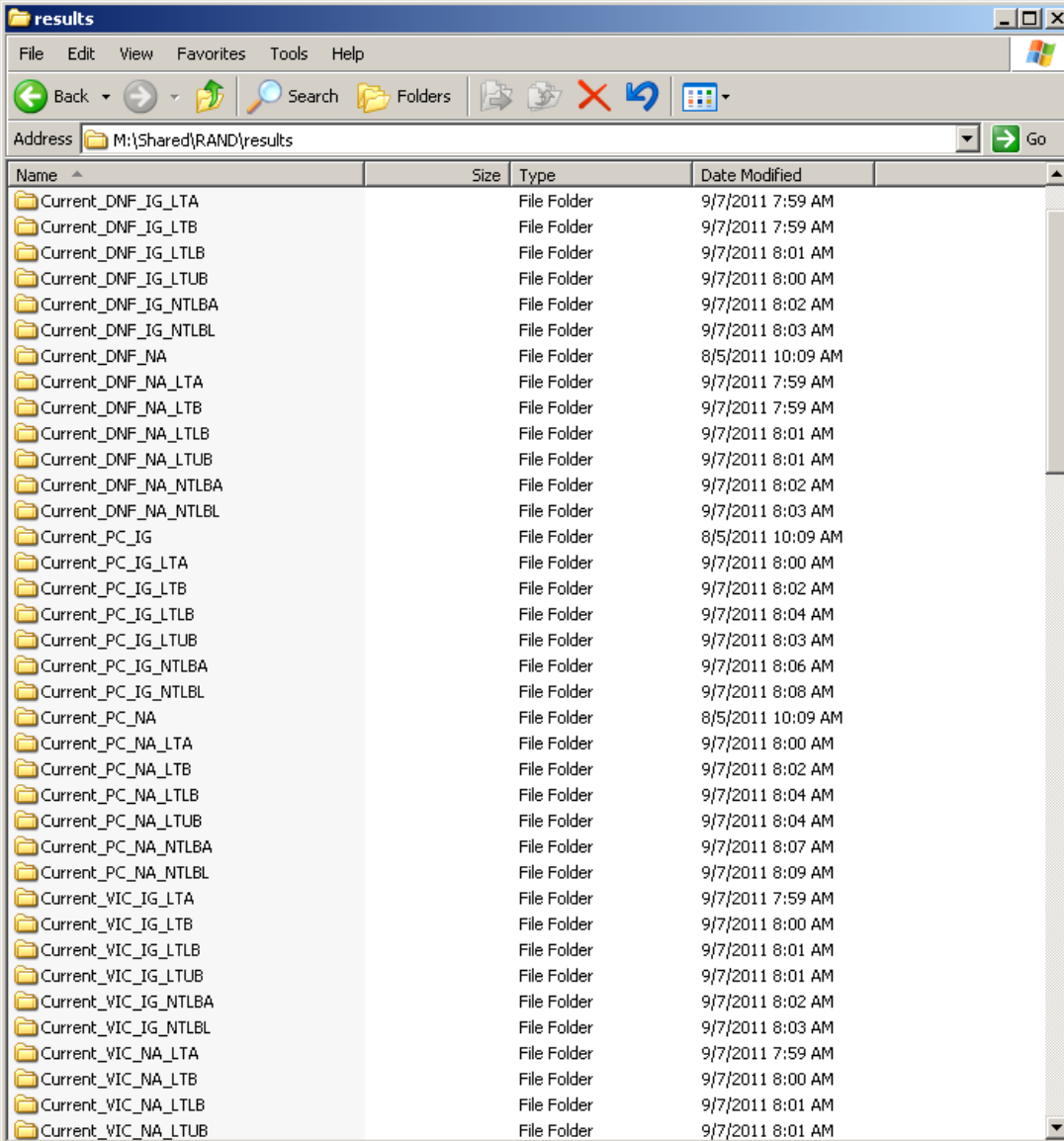
Variable	Value
CRSS_DIR	C:\model\CRSS.Jan2012

# Additional Modeling

- **System reliability with representative options and strategies**
  - About 25 representative options
  - Reducing number of scenarios in half based on system reliability analysis without options and strategies
  - Results in about 140,000 additional traces
- **System reliability with portfolios**
  - Each portfolio implements multiple representative options
    - Portfolios will have various objectives, e.g., hydropower focused
  - Anticipating between 5-8 portfolios
  - About 34,000 additional traces

# Data Management

- Overall that is over 9.6 million simulated years of data!
- Need an automated way to manage input/output data as well as configure and start simulations



The screenshot shows a Windows Explorer window titled 'results' with the address bar set to 'M:\Shared\RAND\results'. The window displays a list of folders organized into a hierarchical structure. The folders are grouped by simulation type: DNF, PC, and VIC, each with sub-folders for different simulation parameters (IG, NA, LTA, LTB, LTLB, LTLBA, LTLBL). The 'Date Modified' column shows the last modification date for each folder, ranging from 8/5/2011 to 9/7/2011.

Name	Size	Type	Date Modified
Current_DNF_IG_LTA		File Folder	9/7/2011 7:59 AM
Current_DNF_IG_LTB		File Folder	9/7/2011 7:59 AM
Current_DNF_IG_LTLB		File Folder	9/7/2011 8:01 AM
Current_DNF_IG_LTLBA		File Folder	9/7/2011 8:00 AM
Current_DNF_IG_LTLBL		File Folder	9/7/2011 8:02 AM
Current_DNF_IG_NTLBA		File Folder	9/7/2011 8:03 AM
Current_DNF_IG_NTLBL		File Folder	9/7/2011 8:03 AM
Current_DNF_NA		File Folder	8/5/2011 10:09 AM
Current_DNF_NA_LTA		File Folder	9/7/2011 7:59 AM
Current_DNF_NA_LTB		File Folder	9/7/2011 7:59 AM
Current_DNF_NA_LTLB		File Folder	9/7/2011 8:01 AM
Current_DNF_NA_LTLBA		File Folder	9/7/2011 8:01 AM
Current_DNF_NA_LTLBL		File Folder	9/7/2011 8:01 AM
Current_DNF_NA_NTLBA		File Folder	9/7/2011 8:02 AM
Current_DNF_NA_NTLBL		File Folder	9/7/2011 8:03 AM
Current_PC_IG		File Folder	8/5/2011 10:09 AM
Current_PC_IG_LTA		File Folder	9/7/2011 8:00 AM
Current_PC_IG_LTB		File Folder	9/7/2011 8:02 AM
Current_PC_IG_LTLB		File Folder	9/7/2011 8:04 AM
Current_PC_IG_LTLBA		File Folder	9/7/2011 8:03 AM
Current_PC_IG_LTLBL		File Folder	9/7/2011 8:06 AM
Current_PC_IG_NTLBA		File Folder	9/7/2011 8:08 AM
Current_PC_IG_NTLBL		File Folder	9/7/2011 8:08 AM
Current_PC_NA		File Folder	8/5/2011 10:09 AM
Current_PC_NA_LTA		File Folder	9/7/2011 8:00 AM
Current_PC_NA_LTB		File Folder	9/7/2011 8:02 AM
Current_PC_NA_LTLB		File Folder	9/7/2011 8:04 AM
Current_PC_NA_LTLBA		File Folder	9/7/2011 8:04 AM
Current_PC_NA_LTLBL		File Folder	9/7/2011 8:07 AM
Current_PC_NA_NTLBA		File Folder	9/7/2011 8:09 AM
Current_PC_NA_NTLBL		File Folder	9/7/2011 8:09 AM
Current_VIC_IG_LTA		File Folder	9/7/2011 7:59 AM
Current_VIC_IG_LTB		File Folder	9/7/2011 8:00 AM
Current_VIC_IG_LTLB		File Folder	9/7/2011 8:01 AM
Current_VIC_IG_LTLBA		File Folder	9/7/2011 8:01 AM
Current_VIC_IG_LTLBL		File Folder	9/7/2011 8:02 AM
Current_VIC_IG_NTLBA		File Folder	9/7/2011 8:03 AM
Current_VIC_IG_NTLBL		File Folder	9/7/2011 8:03 AM
Current_VIC_NA_LTA		File Folder	9/7/2011 7:59 AM
Current_VIC_NA_LTB		File Folder	9/7/2011 8:00 AM
Current_VIC_NA_LTLB		File Folder	9/7/2011 8:01 AM
Current_VIC_NA_LTLBA		File Folder	9/7/2011 8:01 AM
Current_VIC_NA_LTLBL		File Folder	9/7/2011 8:01 AM

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# Study Manager

- **Study manager helps:**
  - Organize input and output data
  - Configure scenarios
  - Automatically start MRM
    - No downtime between scenarios
    - Creates/invokes batch-mode scripts
  - Perform automatic post processing of results
    - RDF to Excel
    - RDF annualizer
    - Run other scripts
- **More about the Study Manager from CADSWES**

A wide-angle photograph of a large reservoir or dam. The water is a deep blue-green color. In the center, a small boat is visible. The surrounding hillsides are steep and rocky, with some sparse vegetation. The sky is clear and blue. The word "QUESTIONS?" is overlaid in large, bold, black letters in the center of the image.

**QUESTIONS?**

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