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Managing Water in the West

Colorado River Basin Water Supply and Demand Study

Public Webinar
Overview of Final Study Report
January 25, 2013

U.S. Department of the Interior
Bureau of Reclamation

Colorado River Basin Water Supply and Demand Study

- Welcome and Introductions
- Study Overview
- Overview of Final Study Report
- Next Steps
- 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 conducted by Reclamation and the Basin States, in collaboration with stakeholders throughout the Basin
- Began in January 2010 and completed in December 2012
- A planning study – does *not* result in any decisions, but will provide the technical foundation for future activities

Cost-Share Partners
Arizona Department of Water Resources
(California) Six Agency Committee
Colorado Water Conservation Board
New Mexico Interstate Stream Commission
Southern Nevada Water Authority
Utah Division of Water Resources
Wyoming State Engineer's Office
Reclamation's Upper and Lower Colorado Regions

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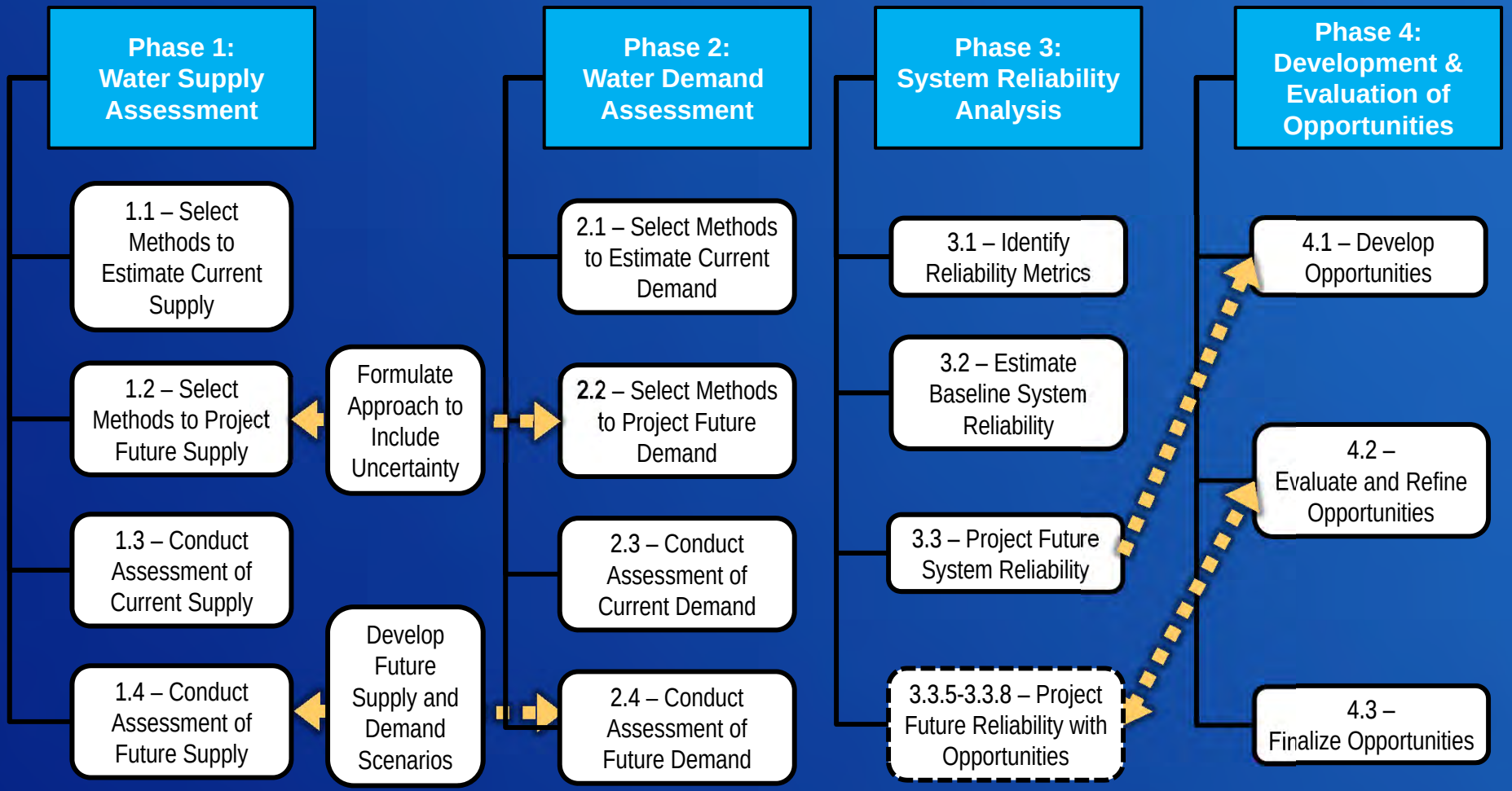
Study Phases and Tasks



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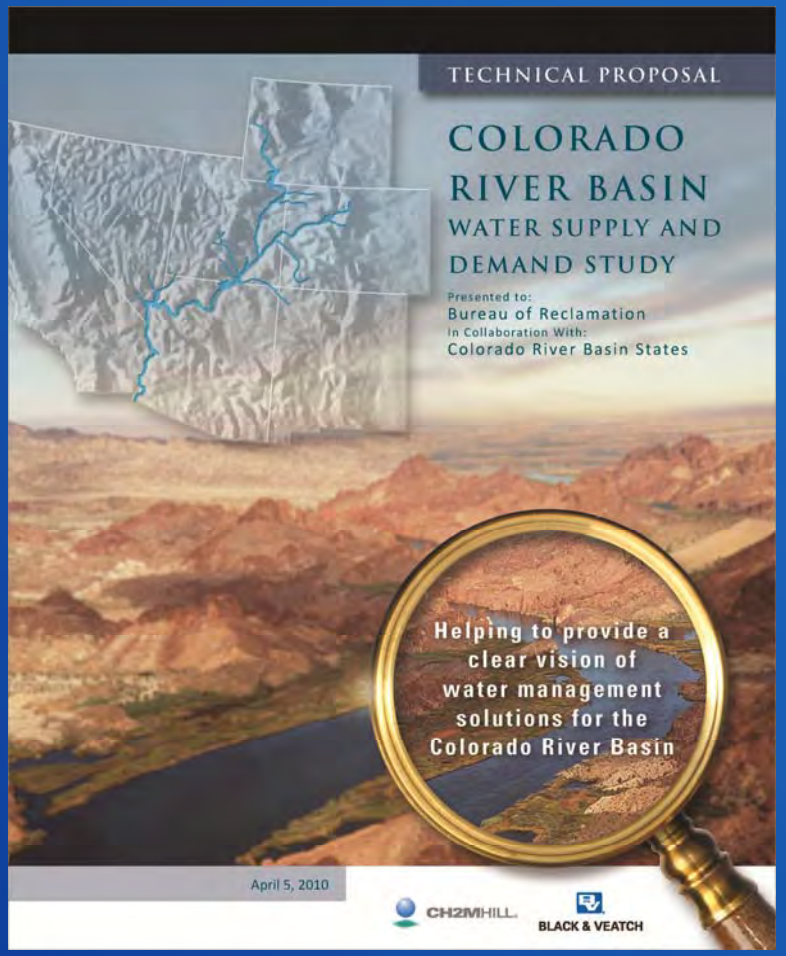
Contracted Services

- CH2M Hill and Black & Veatch were brought on in April 2010
  - Overall support for the Study
  - Water supply and demand assessment; option development and characterization; and portfolio development and evaluation
  - Technical integration and Study documentation support

- The RAND Corporation was brought on in March 2012
  - Support for system reliability analysis
  - Vulnerability assessment; portfolio development and evaluation



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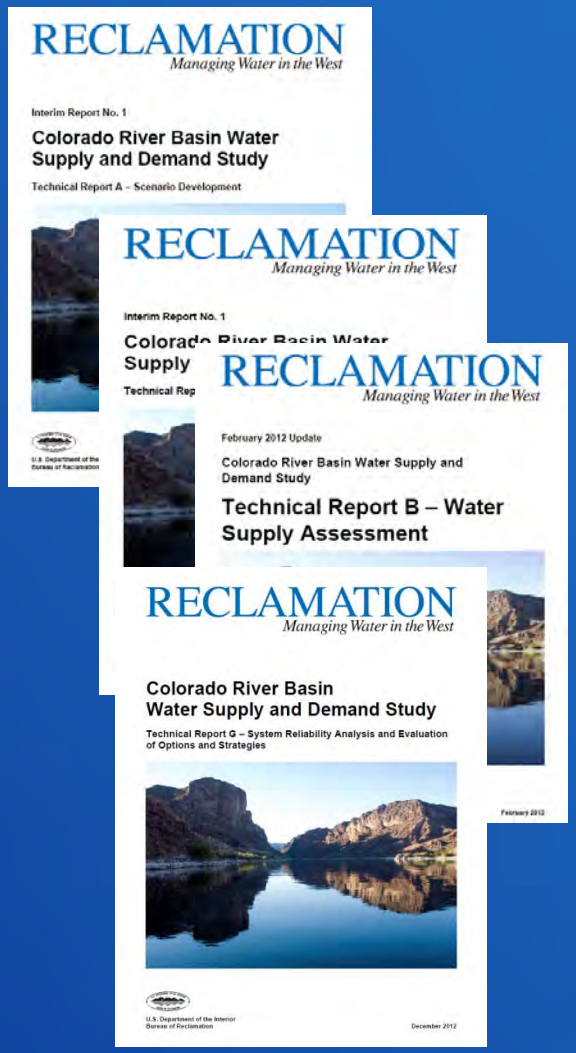
Final Study Reports

- The final Study is a collection of reports available at: http://www.usbr.gov/lc/region/programs/crbstudy/report1.html

Executive Summary
Study Report
Technical Report A – Scenario Development
Technical Report B – Water Supply Assessment
Technical Report C – Water Demand Assessment
Technical Report D – System Reliability Metrics
Technical Report E – Approach to Develop and Evaluate Opportunities to Balance Supply
Technical Report F – Development of Options and Strategies
Technical Report G – System Reliability Analysis and Evaluation of Options and Strategies



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Comments

- Should be submitted by March 14, 2013
- May be submitted in the following ways:
  - Study website at:
    http://www.usbr.gov/lc/region/programs/crbstudy.html
  - E-mail to: **ColoradoRiverBasinStudy@usbr.gov**
  - U.S. mail to:

    U.S. Bureau of Reclamation
    Attention Ms. Pam Adams, LC-2721
    PO Box 61470
    Boulder City NV 89006-1470
  - Fax to: **702-293-8418**
- Comments will be summarized, posted to the website, and considered in future Basin planning activities

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Colorado River Basin Water Supply and Demand Study

Summary of Water Supply and Demand Assessment

Technical Reports A, B, C

Presenter: Carly Jerla

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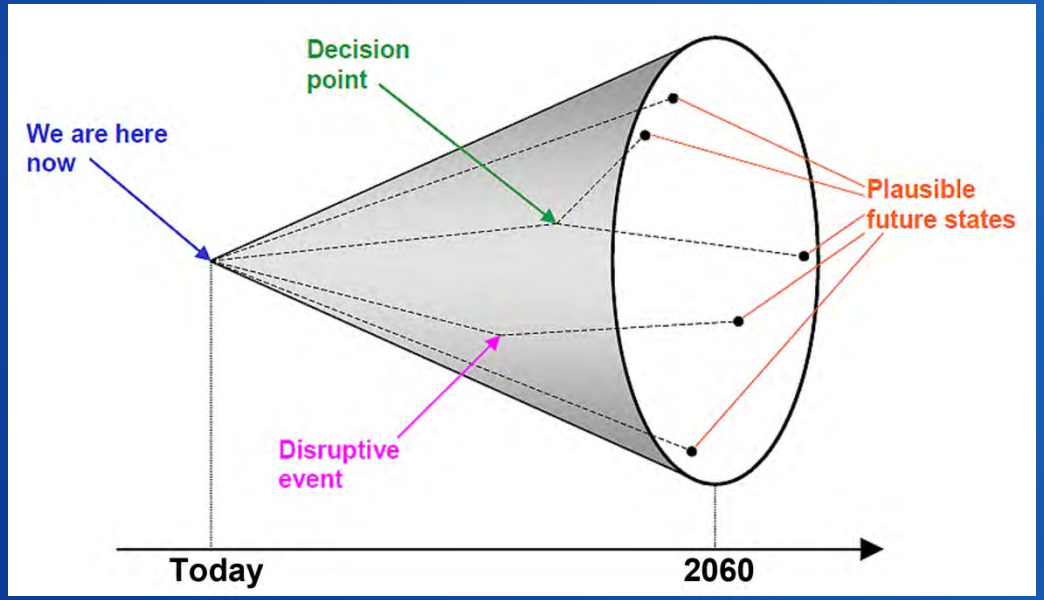
Scenario Planning: Addressing an Uncertain Future

- The path of major influences on the Colorado River system is uncertain and can not be represented by a single view

- An infinite number of plausible futures exist

- A manageable and informative number of scenarios are being developed to explore the broad range of futures



(adapted from Timpe and Scheepers, 2003)

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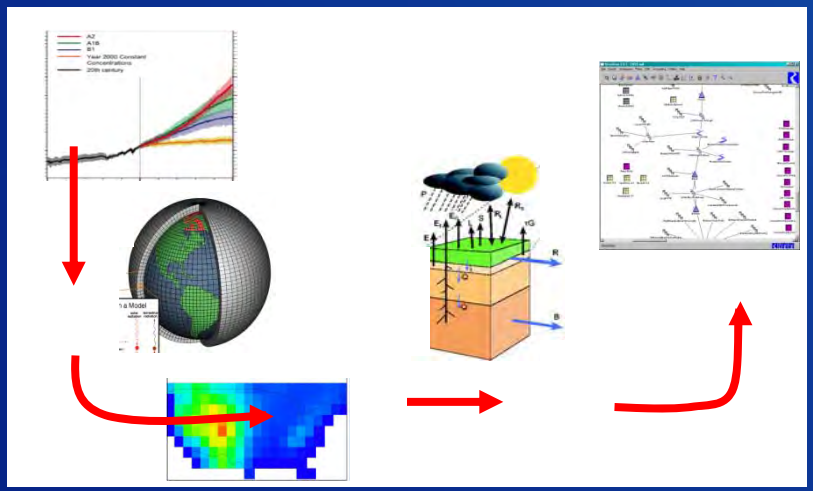
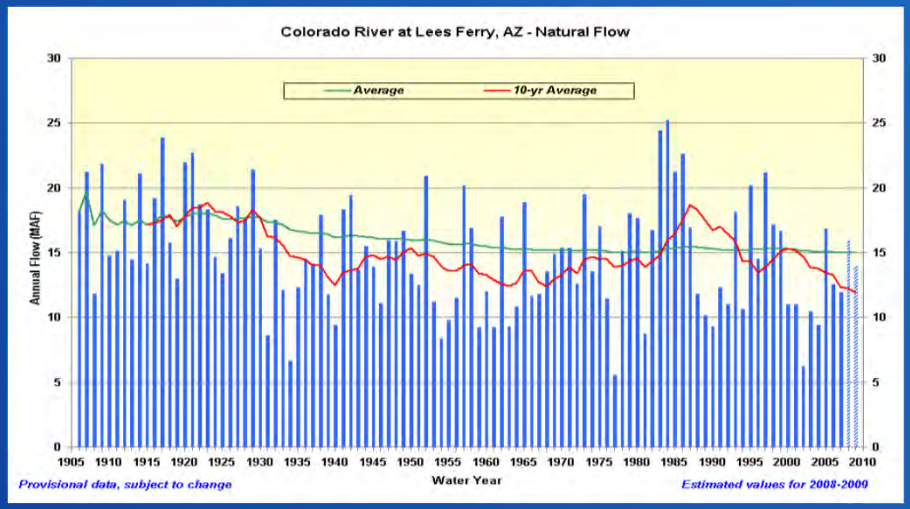
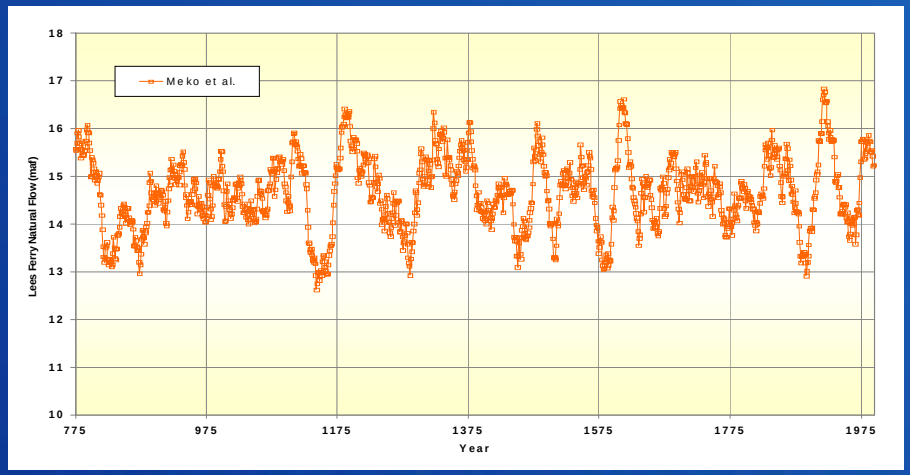
Water Supply Scenarios*

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







* Multiple realizations for each scenario

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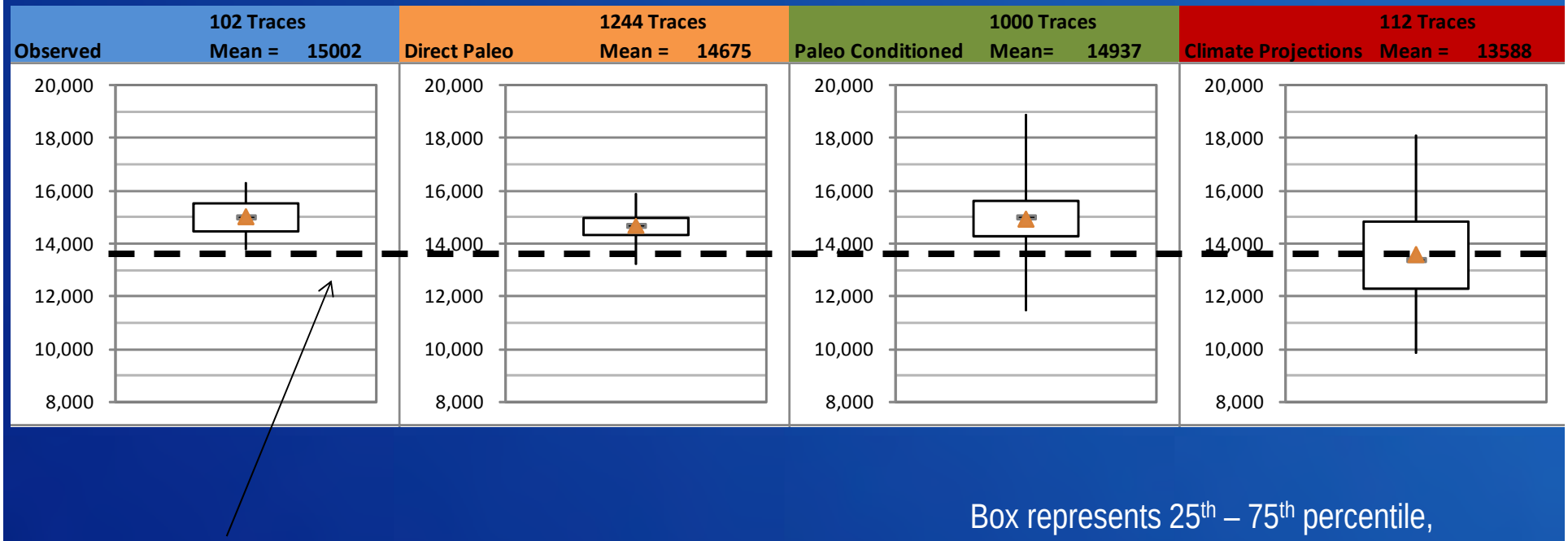
Quantification of Water Supply Scenarios

Projections of 2011-2060 Average Natural Flow at Lees Ferry



1991 – 2010 average = 13.7 MAF

Box represents 25th – 75th percentile, whiskers represent min and max, and triangle represents mean of all traces

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Water Demand Scenarios

- **Current Projected (A)**: growth, development patterns, and institutions continue along recent trends
- **Slow Growth (B):** low growth with emphasis on economic efficiency
- **Rapid Growth (C1 and C2):** economic resurgence (population and energy) and current preferences toward human and environmental values
  - C1 – slower technology adoption
  - C2 – rapid technology adoption
- **Enhanced Environment (D1 and D2):** expanded environmental awareness and stewardship with growing economy
  - D1 – with moderate population growth
  - D2 – with rapid population growth

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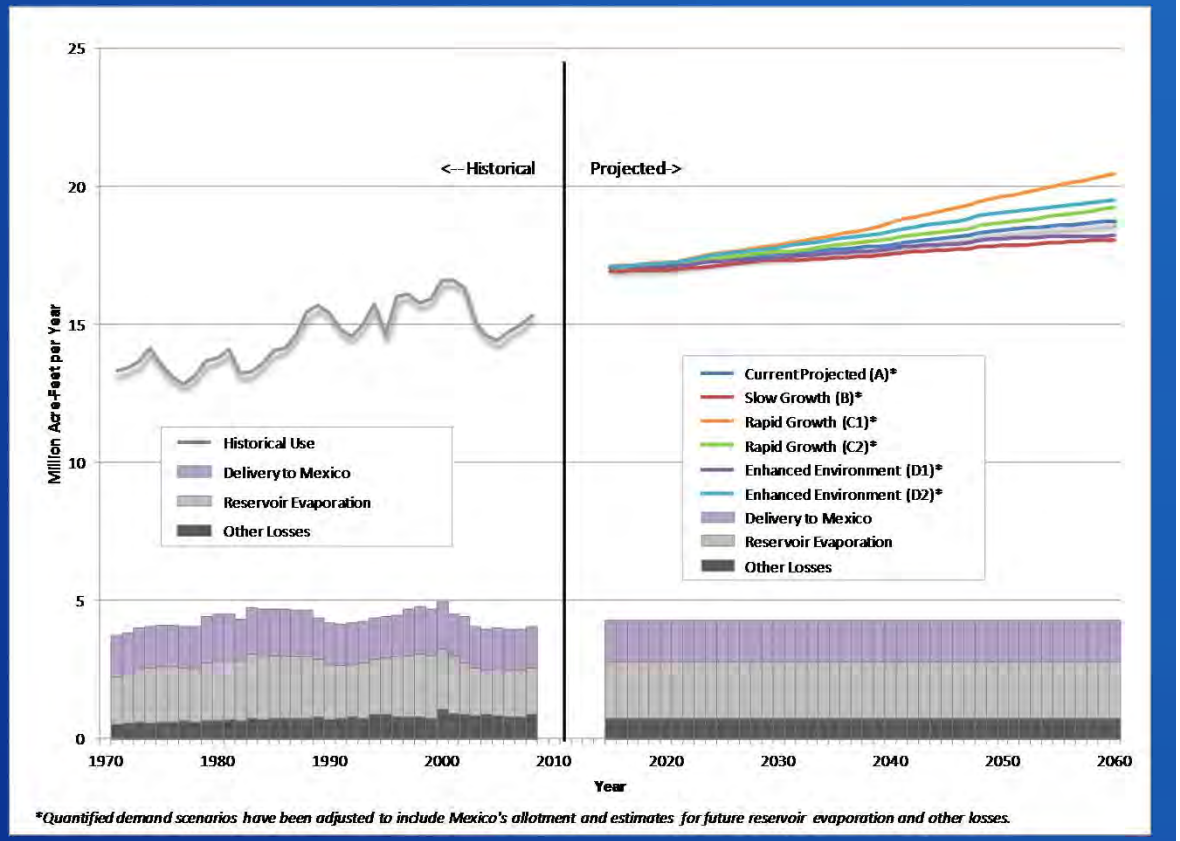
Quantification of Water Demand Scenarios

- Demand for consumptive uses ranges between 13.8 and 16.2 maf by 2060 (including Mexico and losses 18.1 and 20.4 maf by 2060)
- Approximately a 20% spread between the lowest (Slow Growth) and highest (Rapid Growth – C1) demand scenarios

Colorado River Basin Historical Use and Future Projected Demand



*Quantified demand scenarios have been adjusted to include Mexico's allotment and estimates for future reservoir evaporation and other losses.

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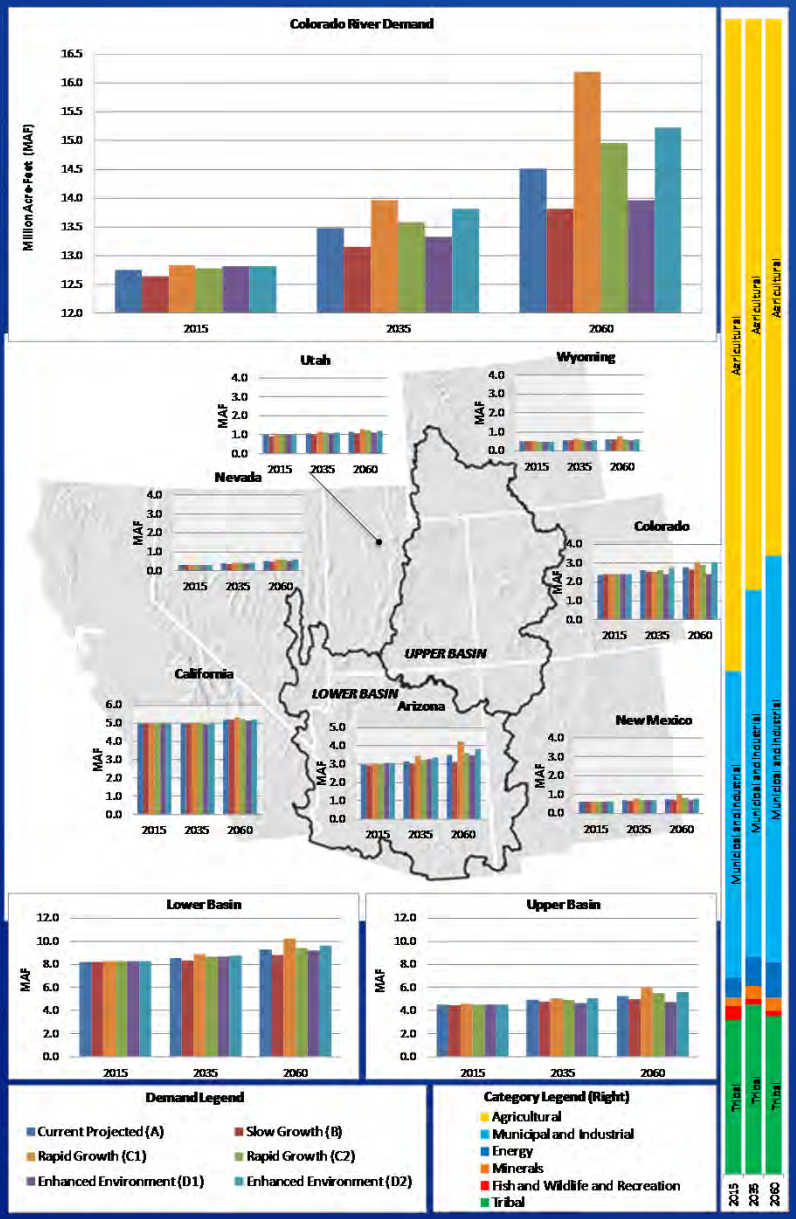
Water Demand Quantification Results



- Parameters driving demands include population, per capita water use, and irrigated acreage and are projected to change from 2015 to 2060:
  - Population increase from about 40 million people by 23% (49 million) to 91% (77 million)
  - Per capita water use decrease by 7% to 19%
  - Irrigated acreage decrease from about 5.5 million acres by 6% (5.2 million) to15% (4.6 million)

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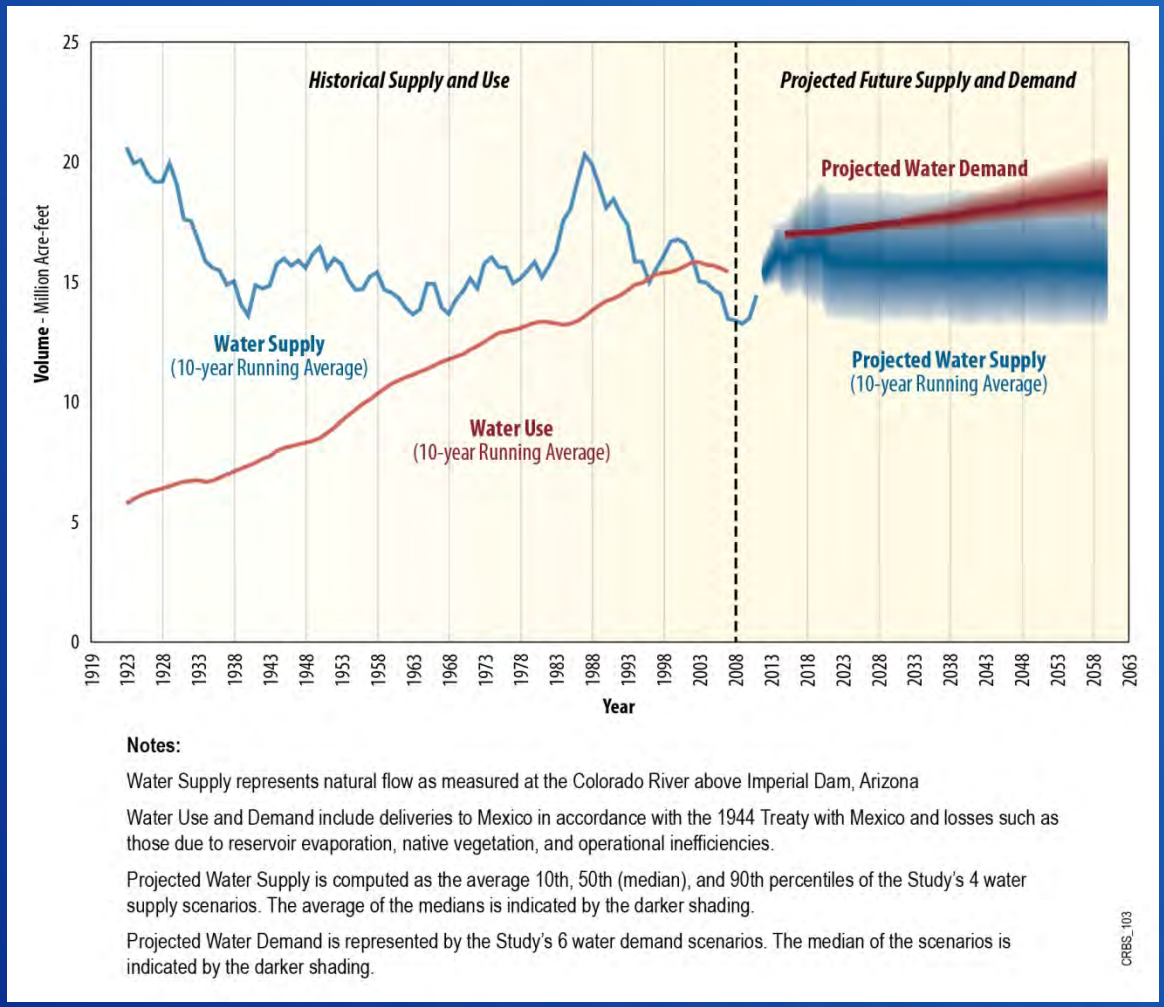
Projected Future Colorado River Basin Water Supply and Demand

- Average supply-demand imbalances by 2060 are approximately 3.2 million acre-feet
- This imbalance may be more or less depending on the nature of the particular supply and demand scenario
- Imbalances have occurred in the past and deliveries have been met due to reservoir storage



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Colorado River Basin Water Supply and Demand Study

Summary of System Reliability Analysis without Options & Strategies

Technical Reports D, G

Presenter: Ken Nowak

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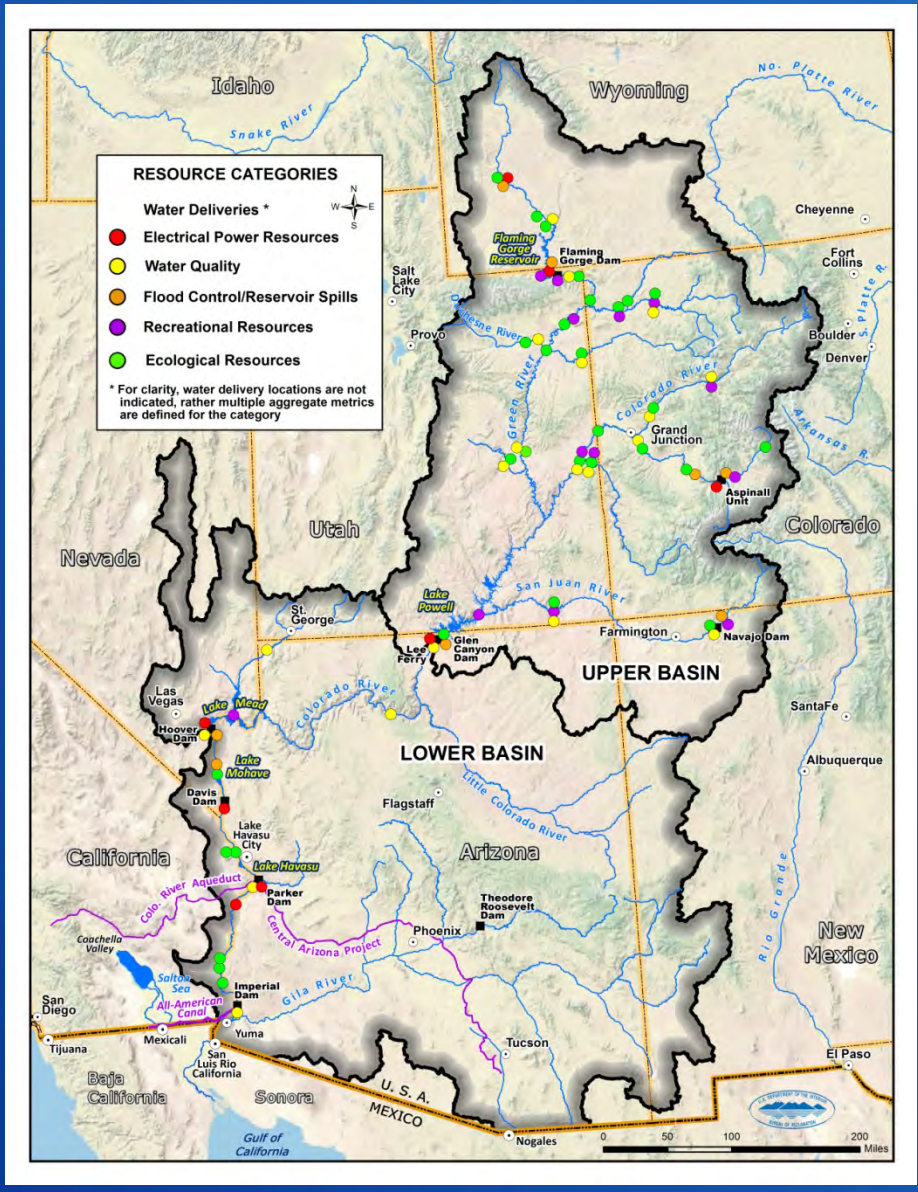
System Reliability Analysis

- Simulate the state of the system over the next 50 years for each scenario, with and without options and strategies
- Use metrics and vulnerabilities to quantify impacts to Basin resources
- **Resource Categories**
  - Water Deliveries
  - Electrical Power Resources
  - Water Quality
  - Flood Control
  - Recreational Resources
  - Ecological Resources



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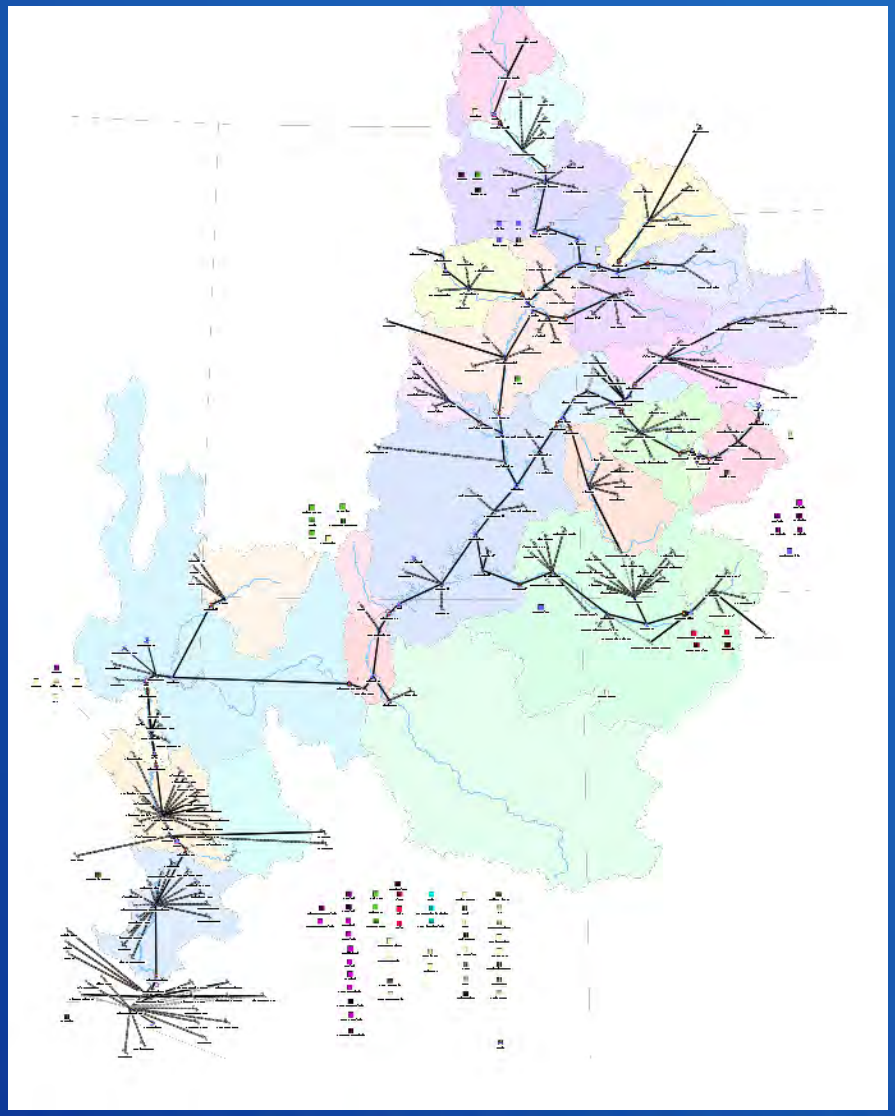
Colorado River Simulation System (CRSS)

- Reclamation's official Basin-wide long-term planning model
- Implemented in RiverWare™
- Simulates operations at 12 reservoirs and deliveries to over 500 individual 'water users' at a monthly time-step
- Model logic reflects reservoir operations
- Gives a range of potential future system conditions



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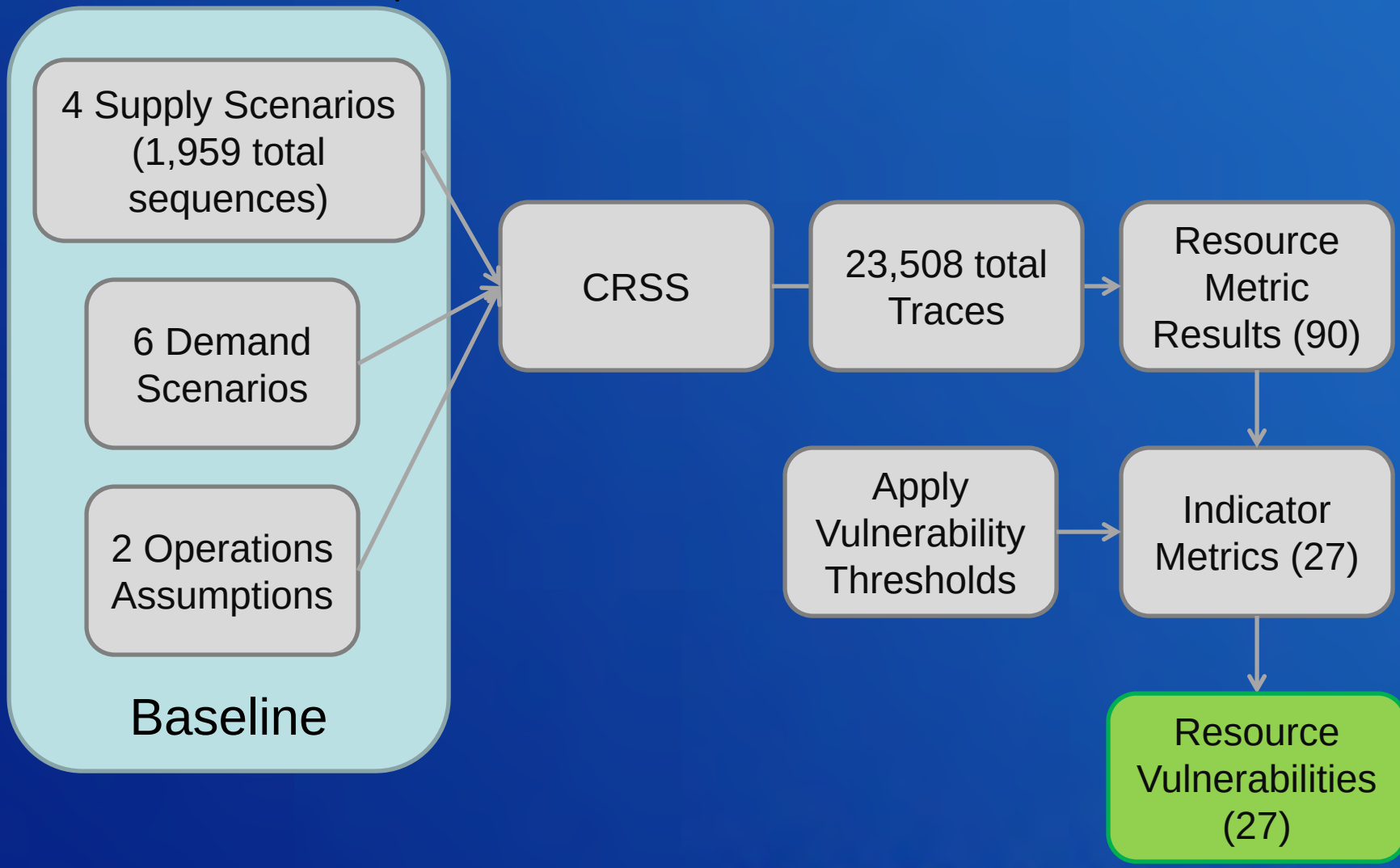
System Reliability Analysis Approach



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Example Path of Metric to Vulnerability

Resource Category	System Reliability Metric (90 total)	Indicator Metric (26 total)	Vulnerability Threshold (26 total)
Water Delivery	Lake Mead elevation < 1,000’	Lake Mead elevation < 1,000’	One occurrence in any month
Electrical Power	Upper Basin Electrical Power Generated	Upper Basin Electrical Power Generated	Generation < 4,450 GWh/yr for more than 3 consecutive years
Recreational	Boating flow days on the Yampa River at Maybell and Deerlodge; Green River at Jensen and Greendale	Total Boating Flow Days in the Green River Basin	Days less than current conditions with variable hydrology

Flood control and water quality followed path similar to water delivery; ecological followed path similar to recreational.

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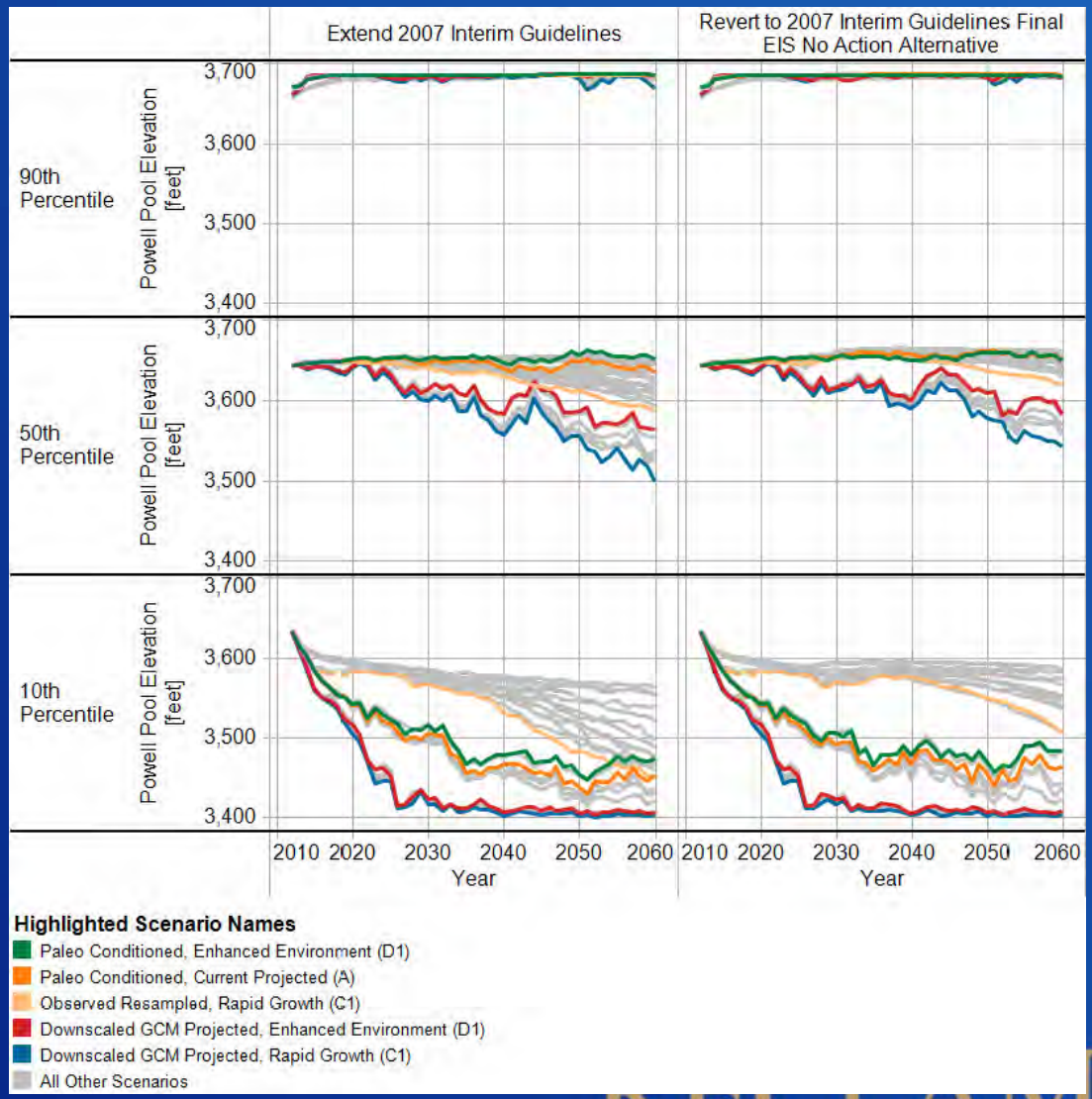
Lake Powell Pool Elevation
10th, 50th and 90th Percentiles



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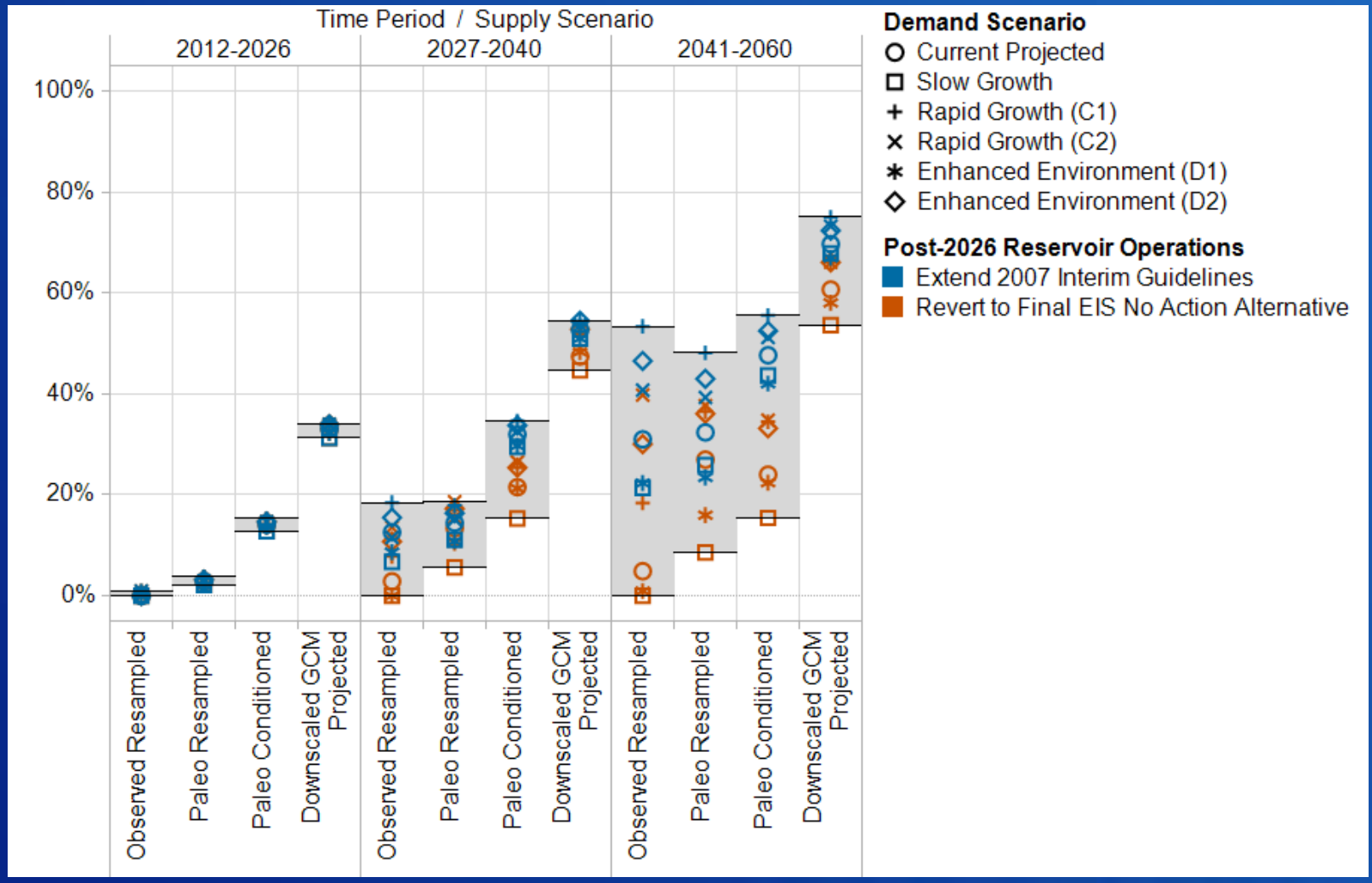
Lake Mead Pool Elevation < 1,000 feet
Percent of Traces Vulnerable



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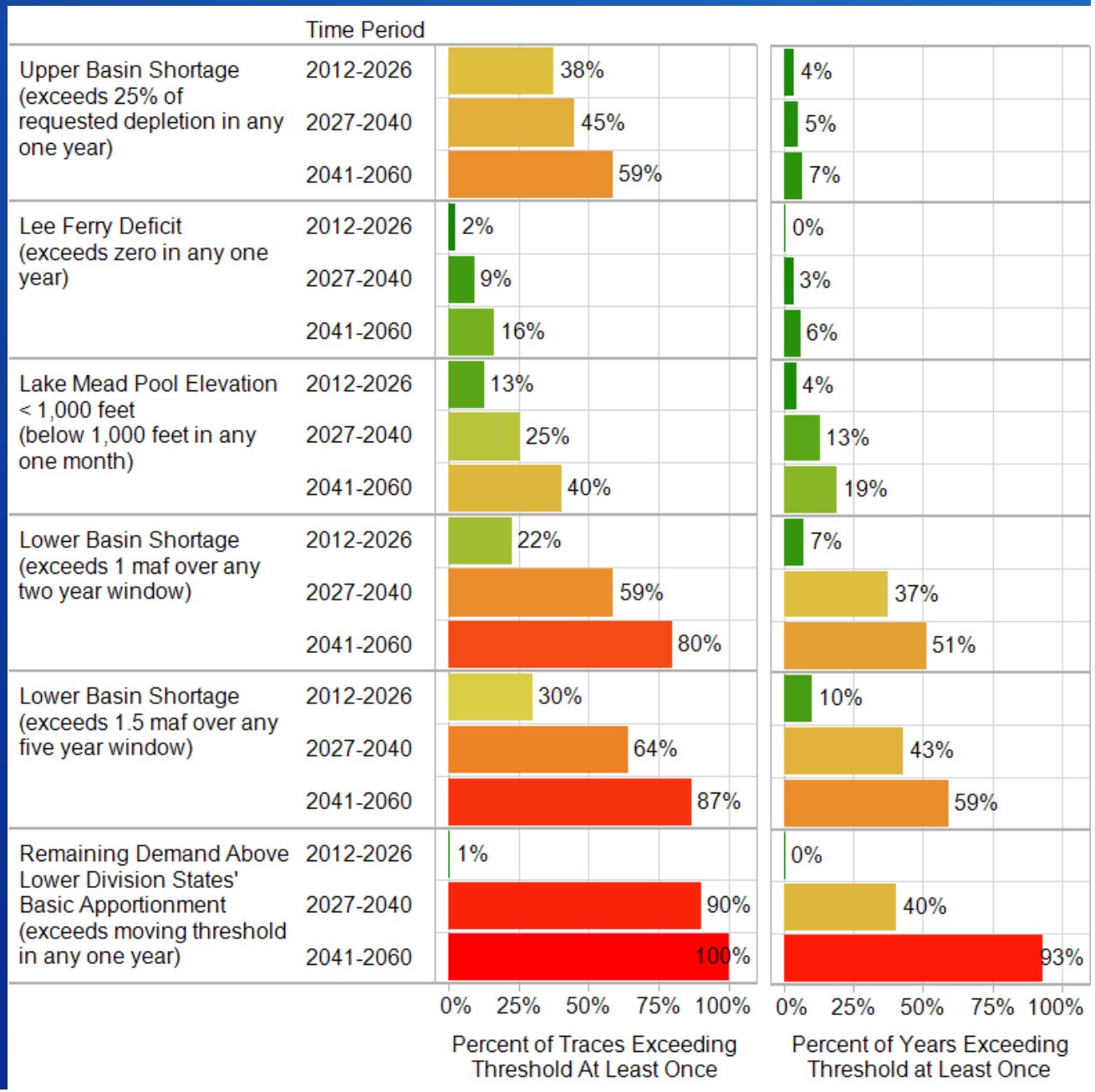
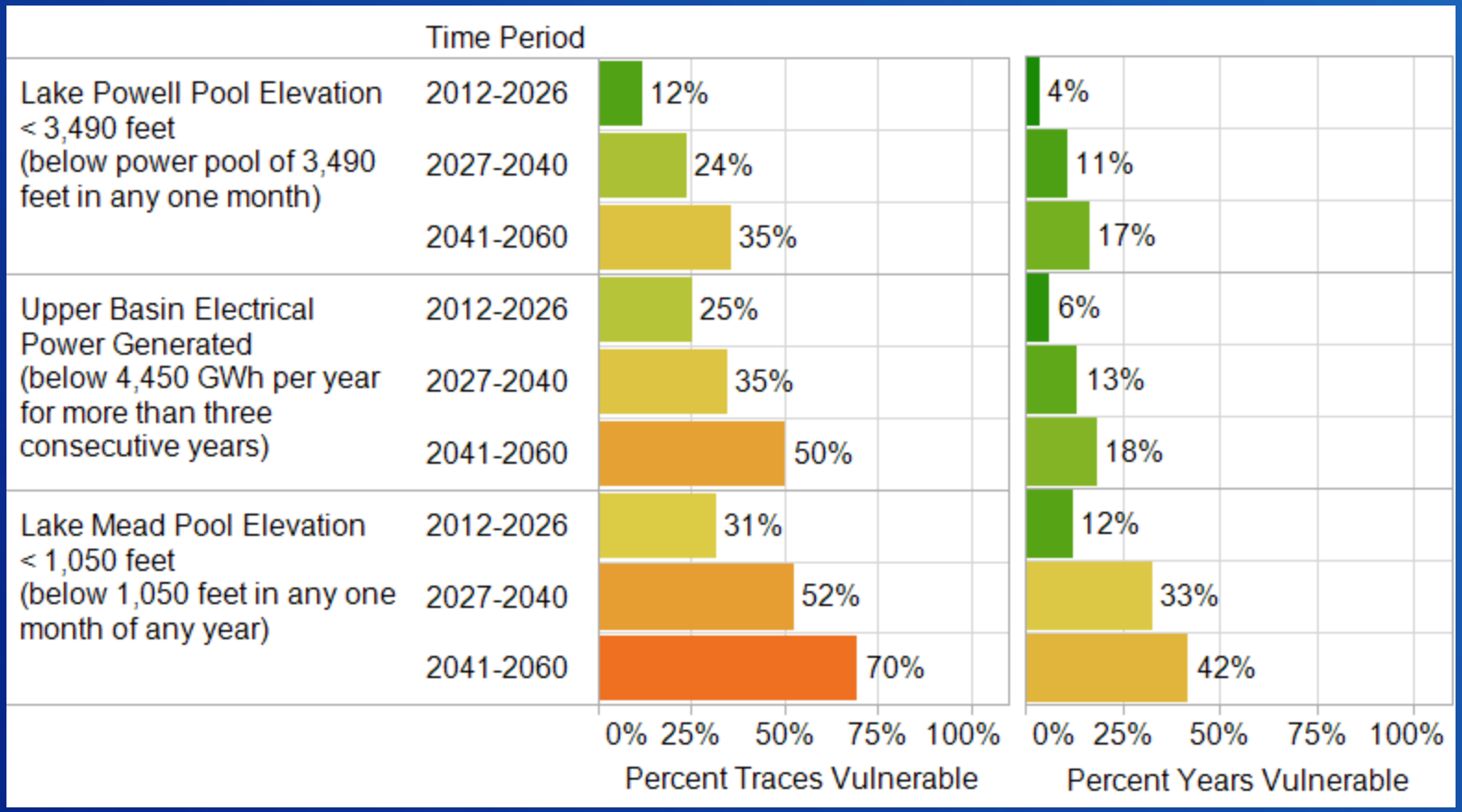
Water Deliveries *Percent of Traces and Years Vulnerable*



Electric Power Resources
Percent of Traces and Years Vulnerable



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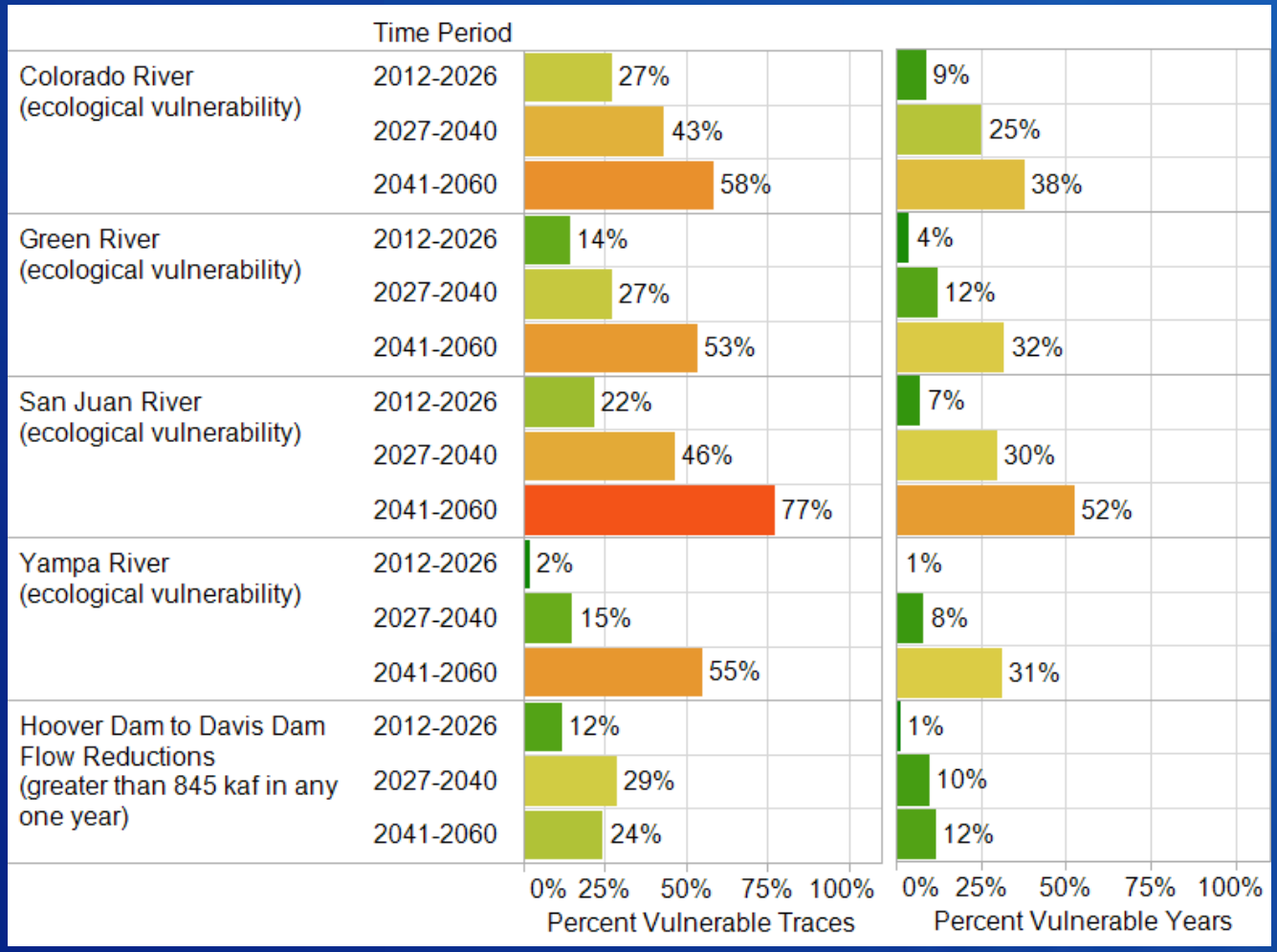
Ecological Resources
Percent of Traces and Years Vulnerable



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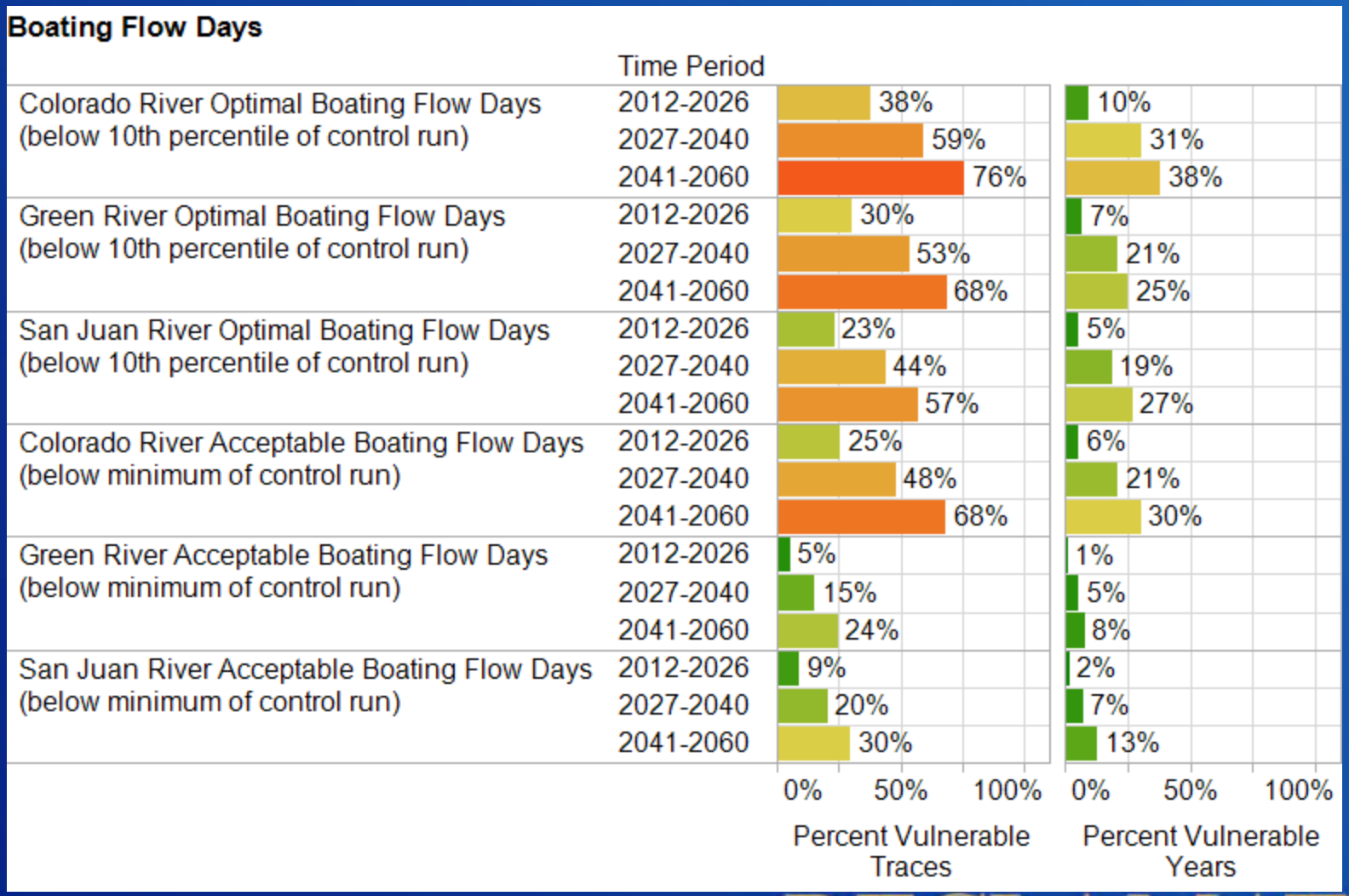
Recreational (River) Resources
Percent of Traces and Years Vulnerable



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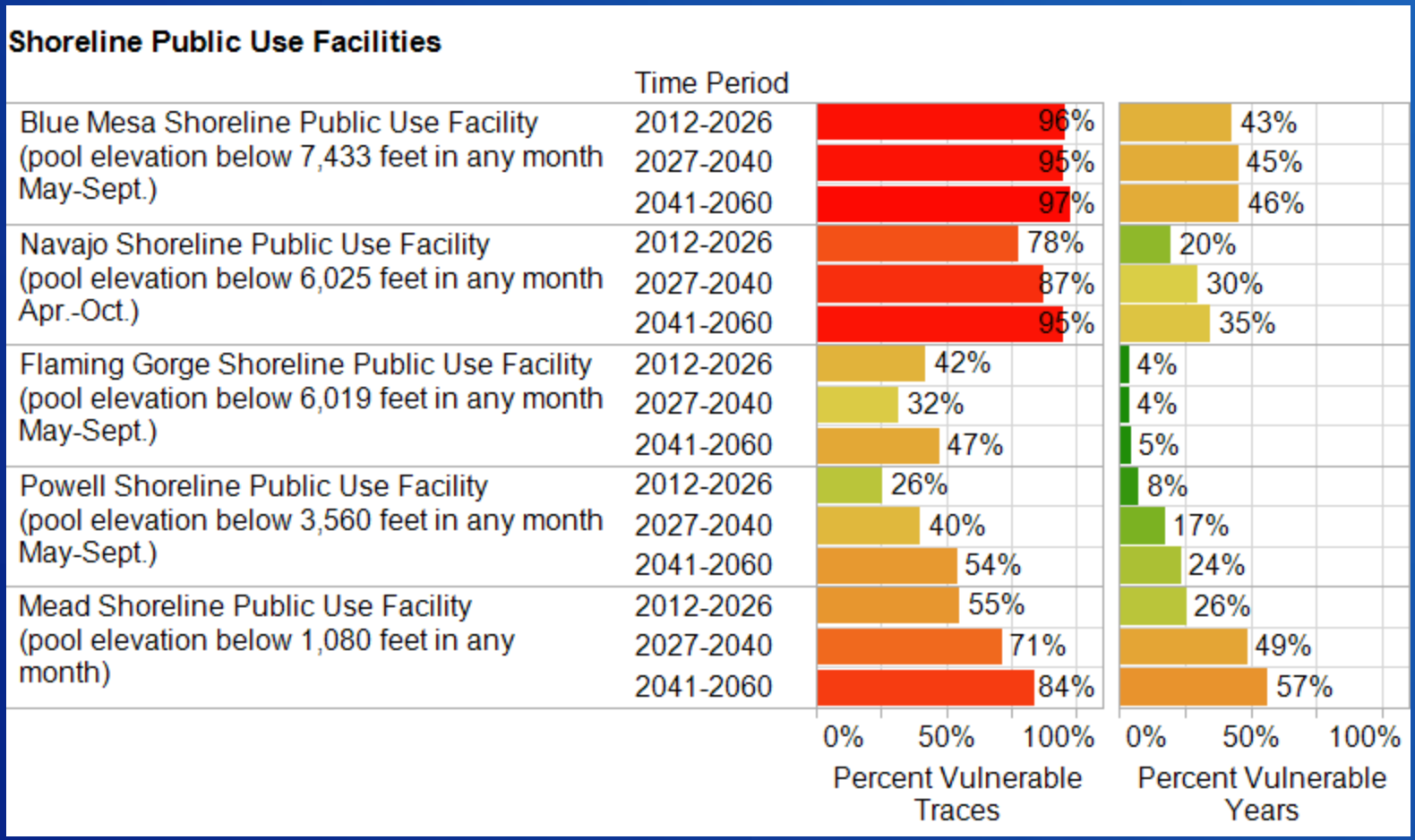
Recreational (Shoreline) Resources
Percent of Traces and Years Vulnerable

Shoreline Public Use Facilities



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Colorado River Basin Water Supply and Demand Study

Summary of the Development of Options & Strategies

Technical Report F

Presenter: Armin Munevar

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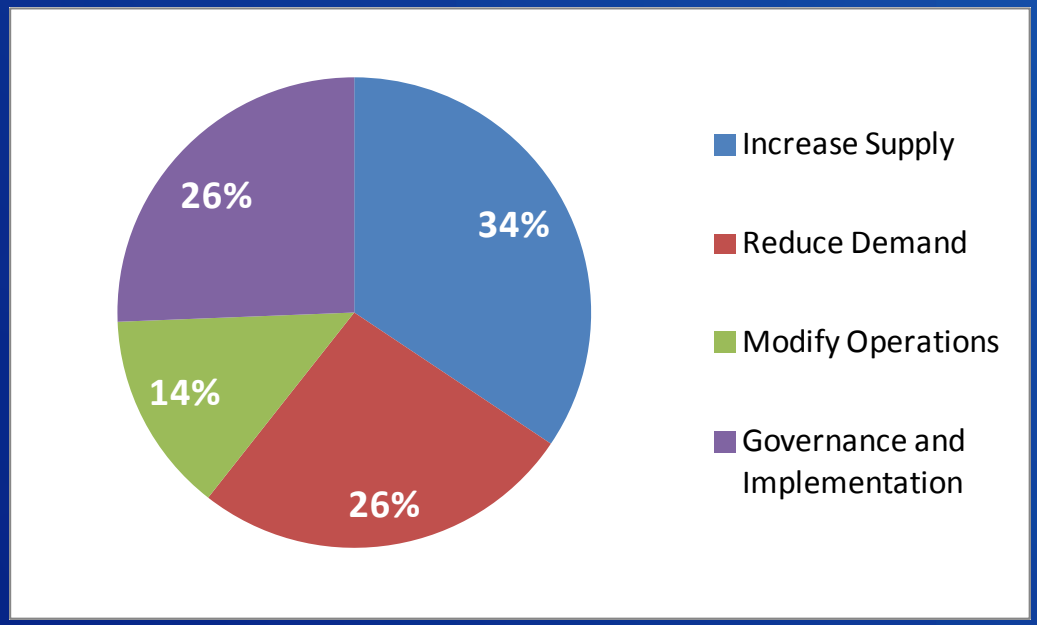
Summary of Options Submitted

- Over 150 options were submitted to the Study from Nov 2011 – Feb 2012
- All options received were included and are reflected in the Study



Increased Supply – reuse, desalination, importation, etc.

Reduced Demand – M&I and agricultural conservation, etc.

Modify Operations – transfers & exchanges, water banking, etc.

Governance & Implementation – stakeholder committees, population control, re-allocation, etc.

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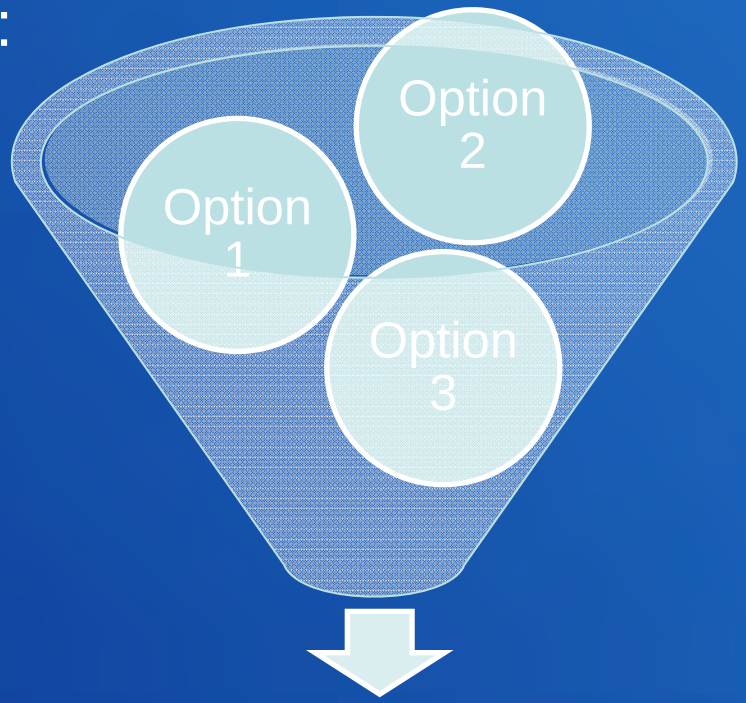
Organizing and Characterizing Options

- Characterization Criteria includes:
  - Quantity of yield
  - Timing of implementation
  - Technical feasibility
  - Energy needs
  - Cost
  - Permitting
  - Legal and policy considerations
  - Implementation risk



Importation | Desalination | Agricultural Conservation | M&I Conservation | Watershed Management | System Operations

Does not represent all option categories

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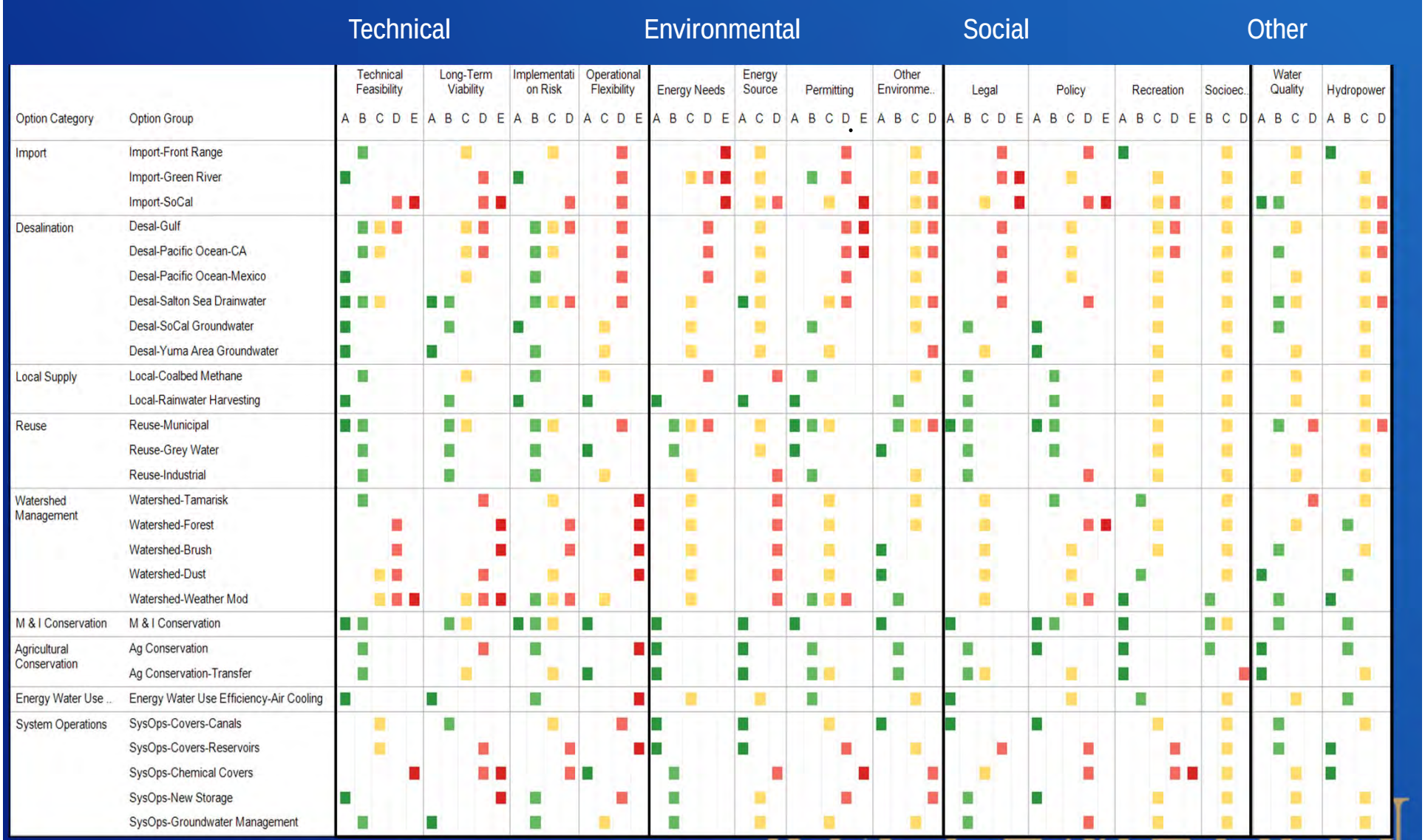
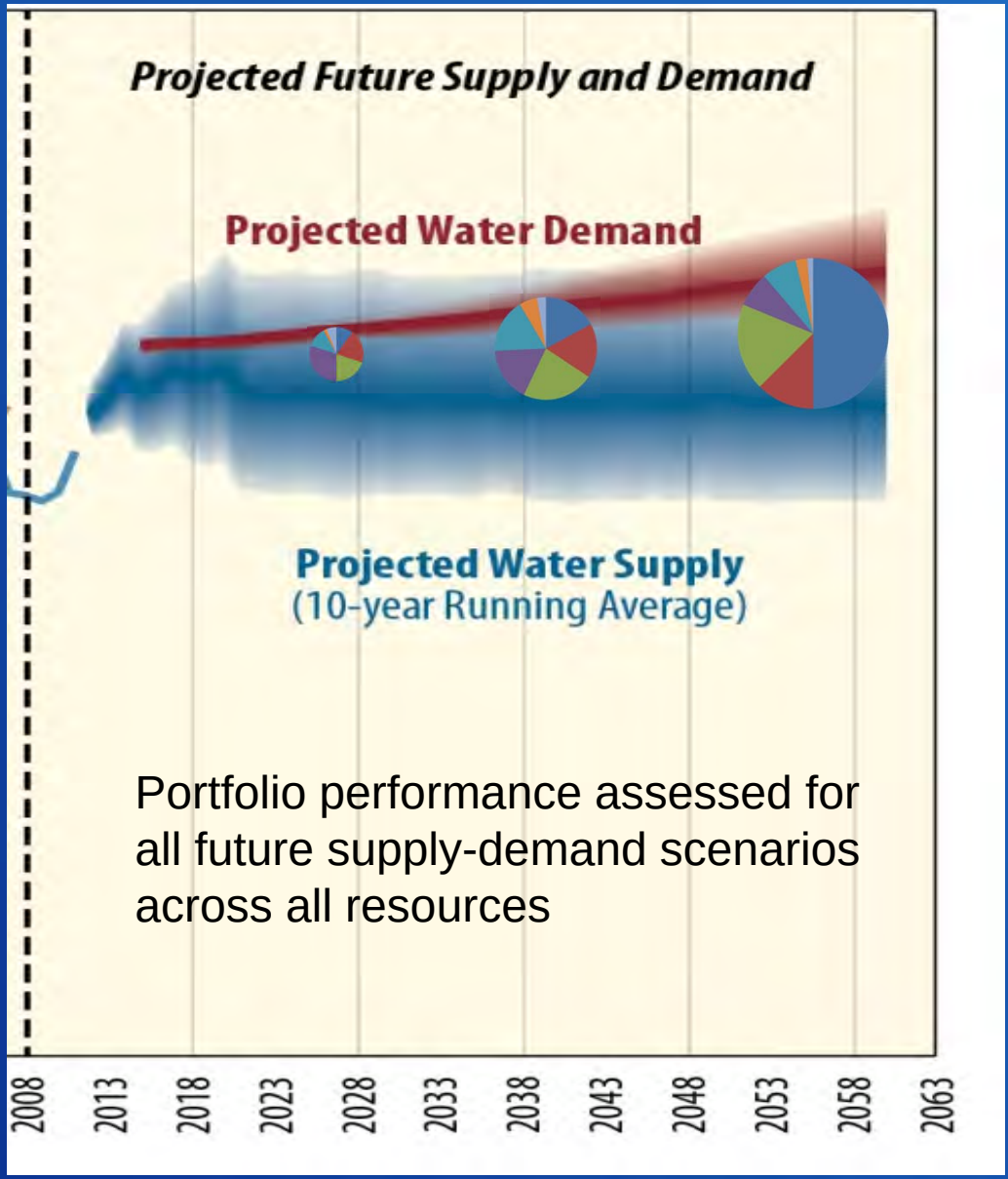
Option Characterization Results



Portfolio Development

- "Portfolios" are combinations of options that implement a particular strategy
- Strategy expressed through characterization criteria which determines how options are combined
- Four portfolios were developed to demonstrate potential ways options could be combined



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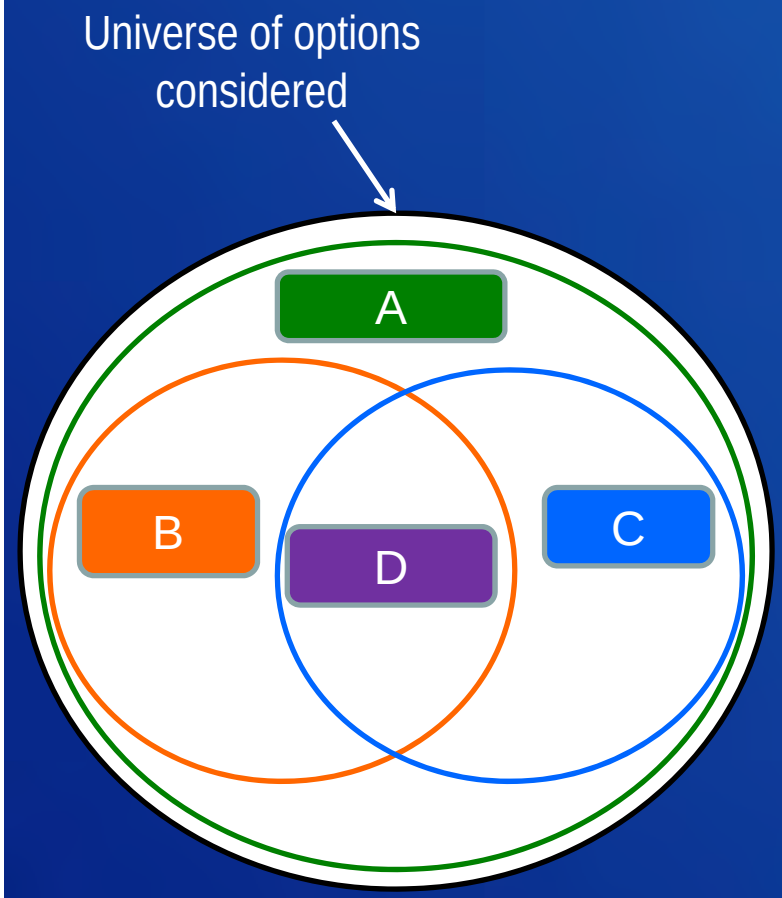
Summary of Portfolios



Option Selection
• Least restrictive resulting in a highly inclusive set of option preferences • Considers the largest set of options
• Low-risk strategy in the long-term with high reliability • High technical feasibility • Excludes options with high permitting, legal and policy risks
• Prioritizes options that have low environmental impacts and long-term flexibility • Excludes options with high permitting risk
• High technical feasibility and long-term reliability • Low energy intensity • Excludes options with high permitting, legal, and policy risk • Considers smallest set of options

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Summary of Option Inclusion Across Portfolios

Option Category	Option Group	Portfolios			
		Portfolio A	Portfolio B	Portfolio C	Portfolio D
Importation	Imports to the Colorado Front Range from the Missouri or Mississippi Rivers	X	X		
Desalination	Gulf of California	X	X		
	Pacific Ocean in California	X	X		
	Pacific Ocean in Mexico	X	X		
	Salton Sea Drainwater	X	X	X	X
	Groundwater in Southern California	X	X	X	X
	Groundwater in the Area near Yuma, Arizona	X	X	X	X
Reuse	Municipal Wastewater	X	X	X	X
	Grey Water	X		X	
	Industrial Wastewater	X	X	X	X
Local Supply	Treatment of Coal Bed Methane-Produced Water	X	X		
	Rainwater Harvesting	X		X	
Watershed Management	Dust Control	X		X	
	Tamarisk Control	X		X	
	Weather Modification	X	X	X	X
M&I Water Conservation	M&I Conservation	X	X	X	X
Agricultural Water Conservation	Agricultural Water Conservation with Transfers	X	X	X	X
Energy Water Use Efficiency	Power Plant Conversion to Air Cooling	X	X	X	X
Water Banking	Upper Basin Water Bank	X		X	

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Colorado River Basin Water Supply and Demand Study

Summary of the System Reliability Analysis with Options & Strategies

Technical Report G

Presenter: David Groves

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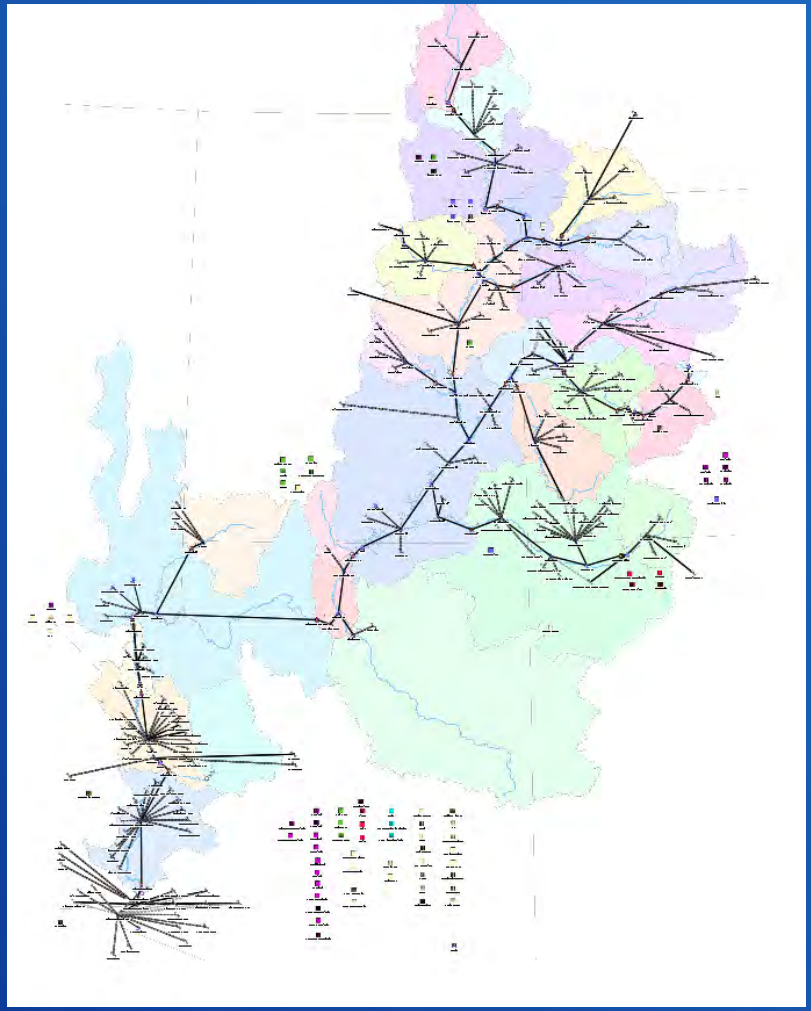
Approach to Implement and Analyze Portfolios

- Input to CRSS included option timing, yield, and cost
- Options were implemented, based on cost-effectiveness, when signposts indicated an approaching vulnerability
  - This dynamic approach avoids implementing options when not needed
  - Signposts were informed by vulnerable conditions (those conditions that frequently led to vulnerabilities)
- All portfolios were assessed across all future conditions



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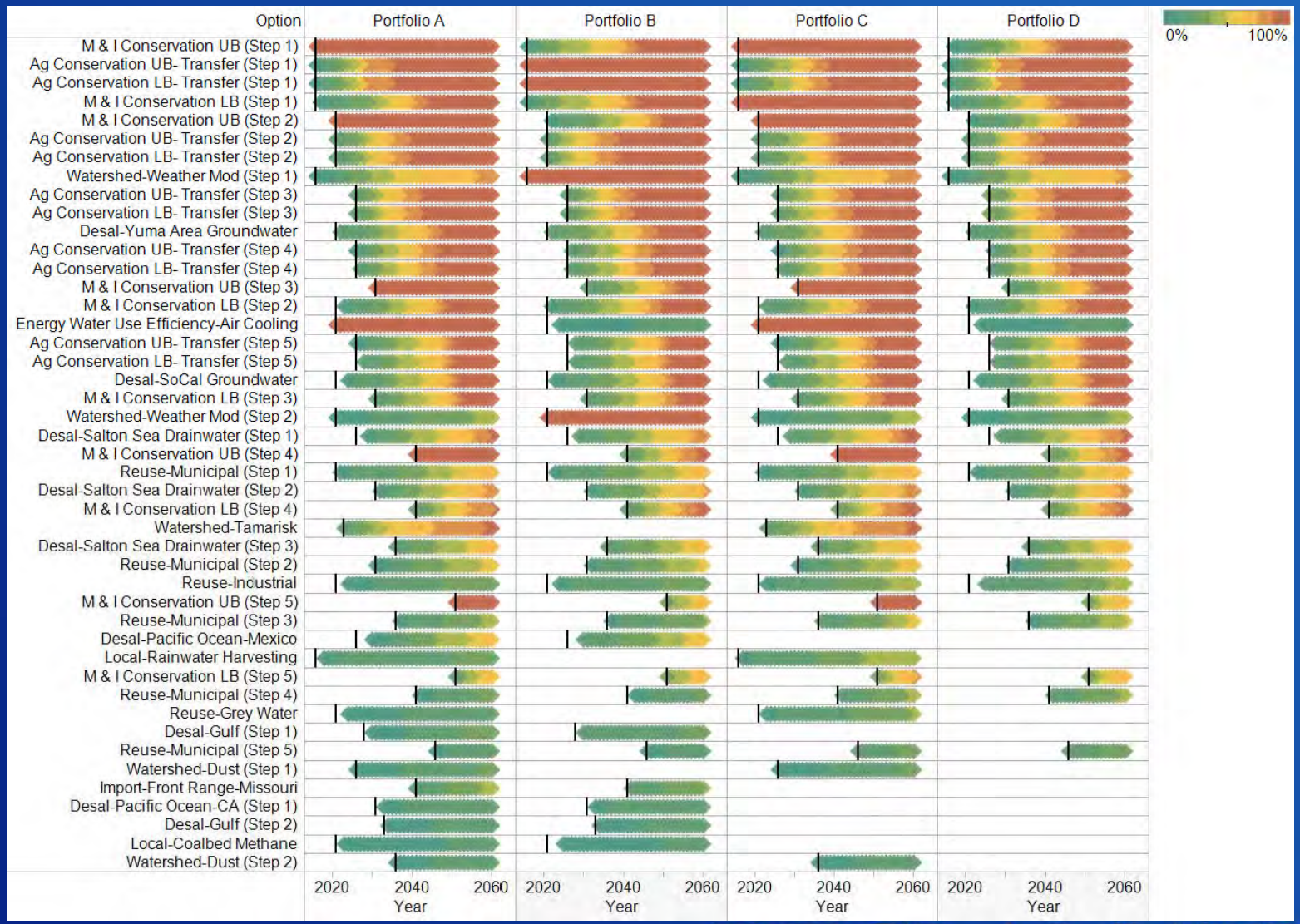
Frequency of Option Implementation



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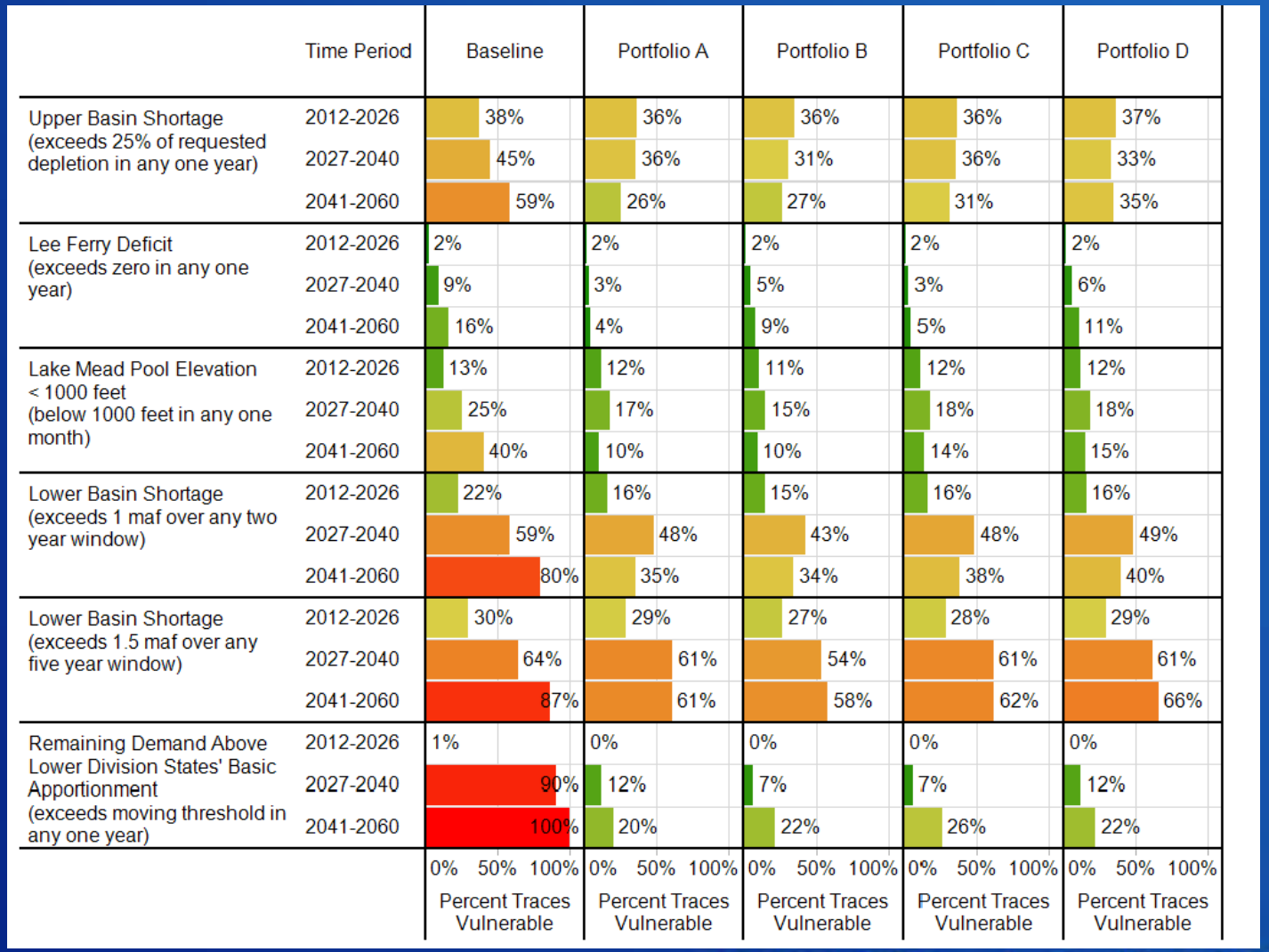
Water Deliveries
Percent of Traces Vulnerable



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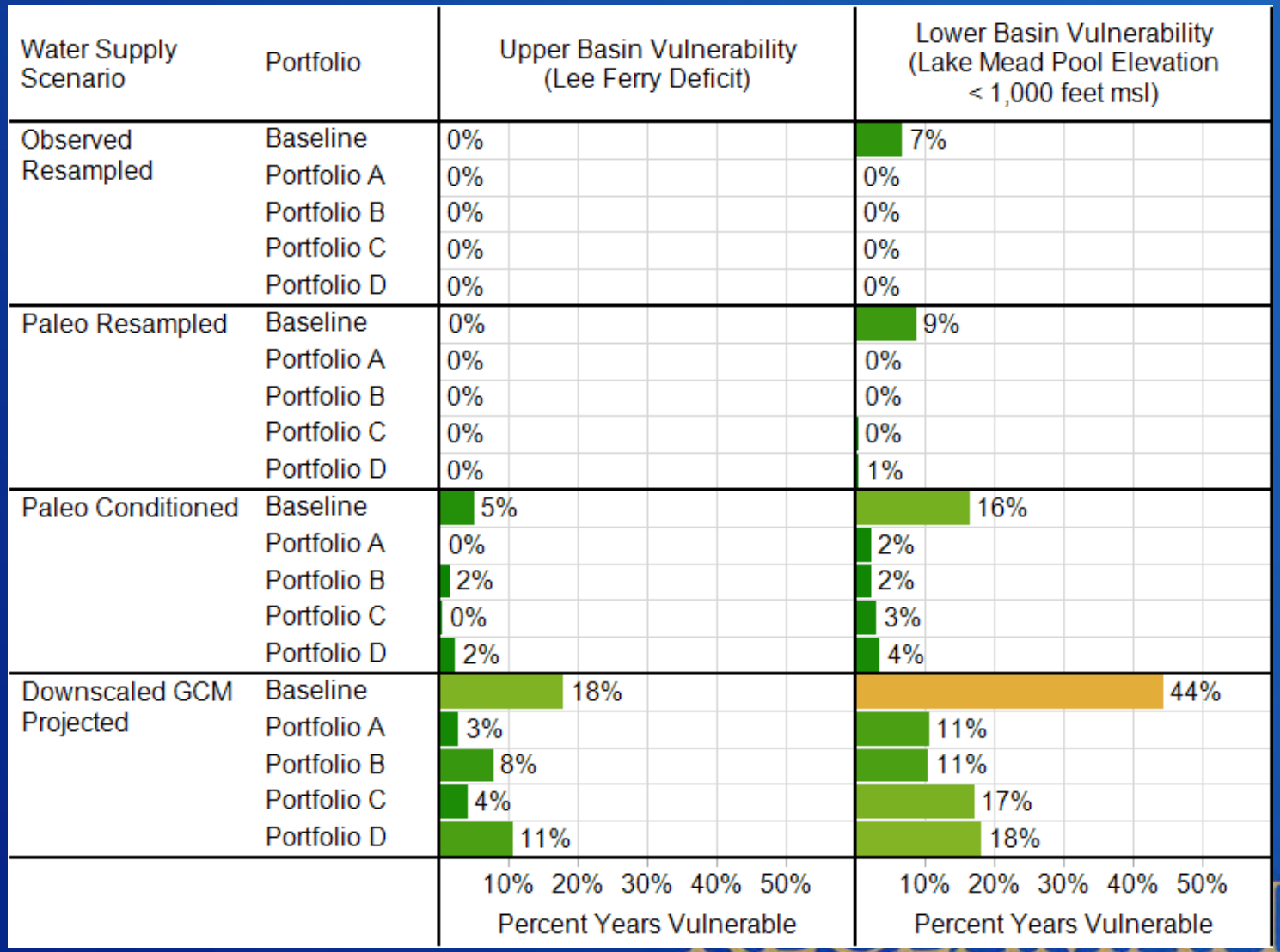
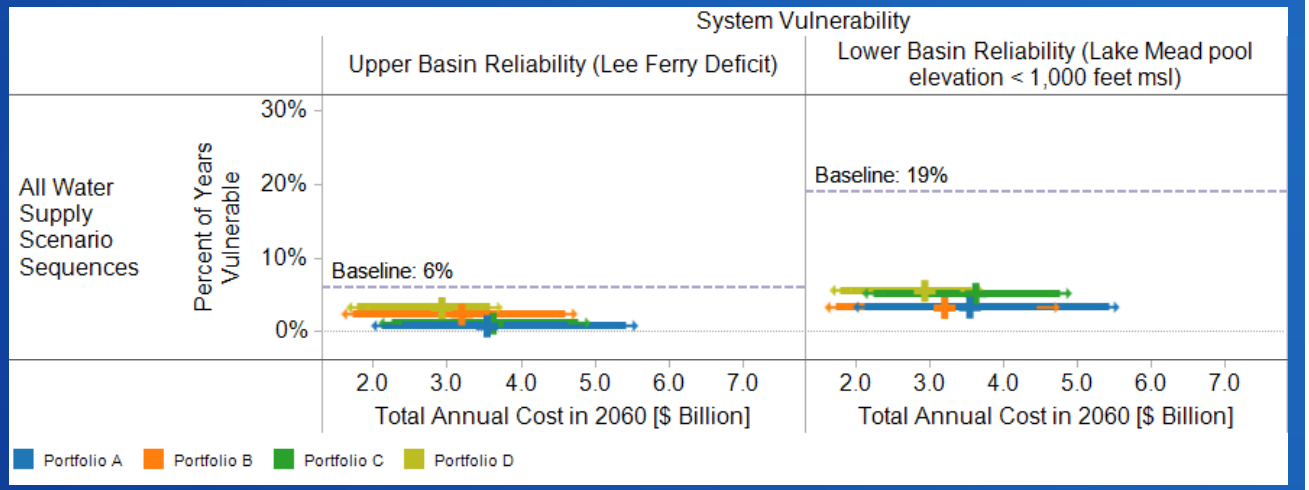
Reduction in Key Vulnerabilities by Water Supply Scenario



Tradeoffs Between Vulnerability Reduction and Costs

All Water Supply Scenario Sequences



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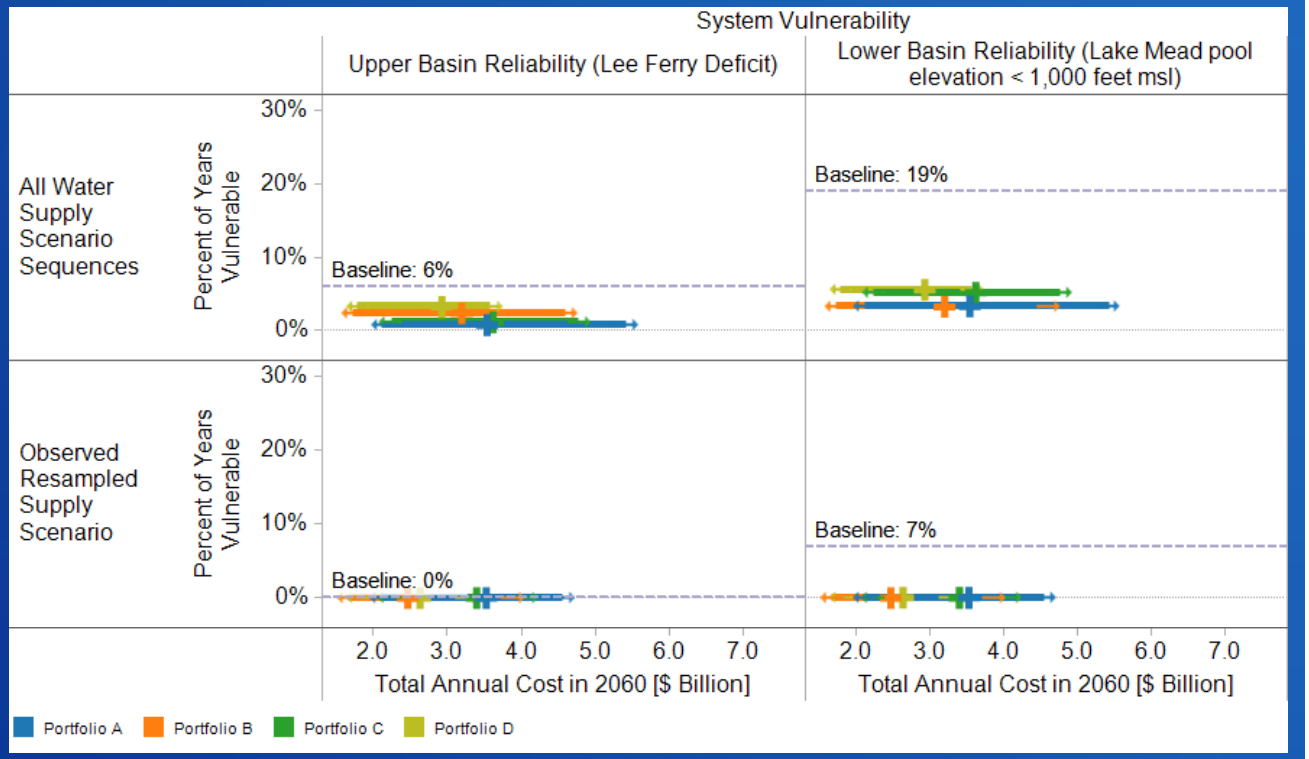
Tradeoffs Between Vulnerability Reduction and Costs

All Water Supply Scenario Sequences

Observed Resampled Scenario Sequences



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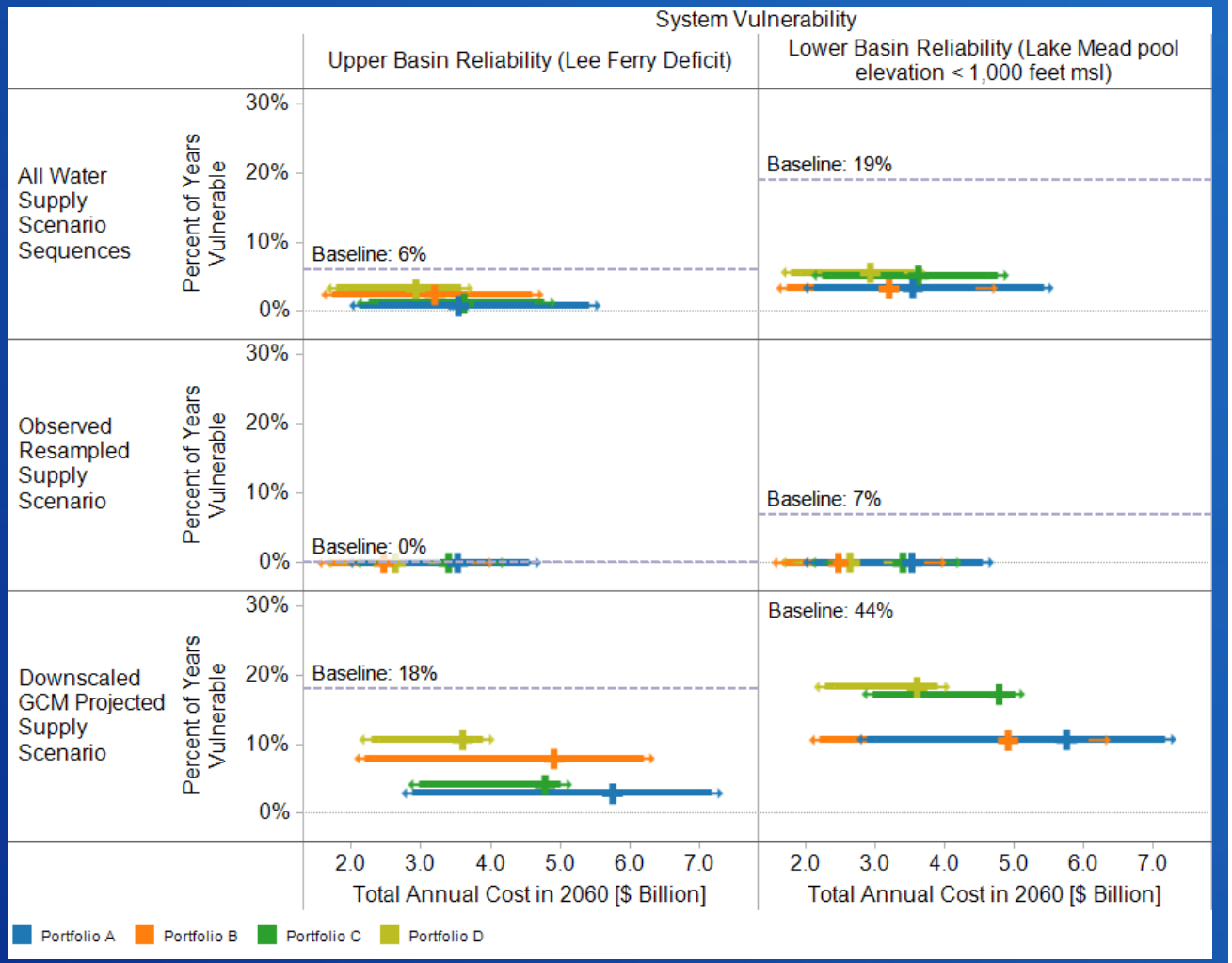
Tradeoffs Between Vulnerability Reduction and Costs

All Water Supply Scenario Sequences

Observed Resampled Scenario Sequences

Downscaled GCM Scenario Sequences



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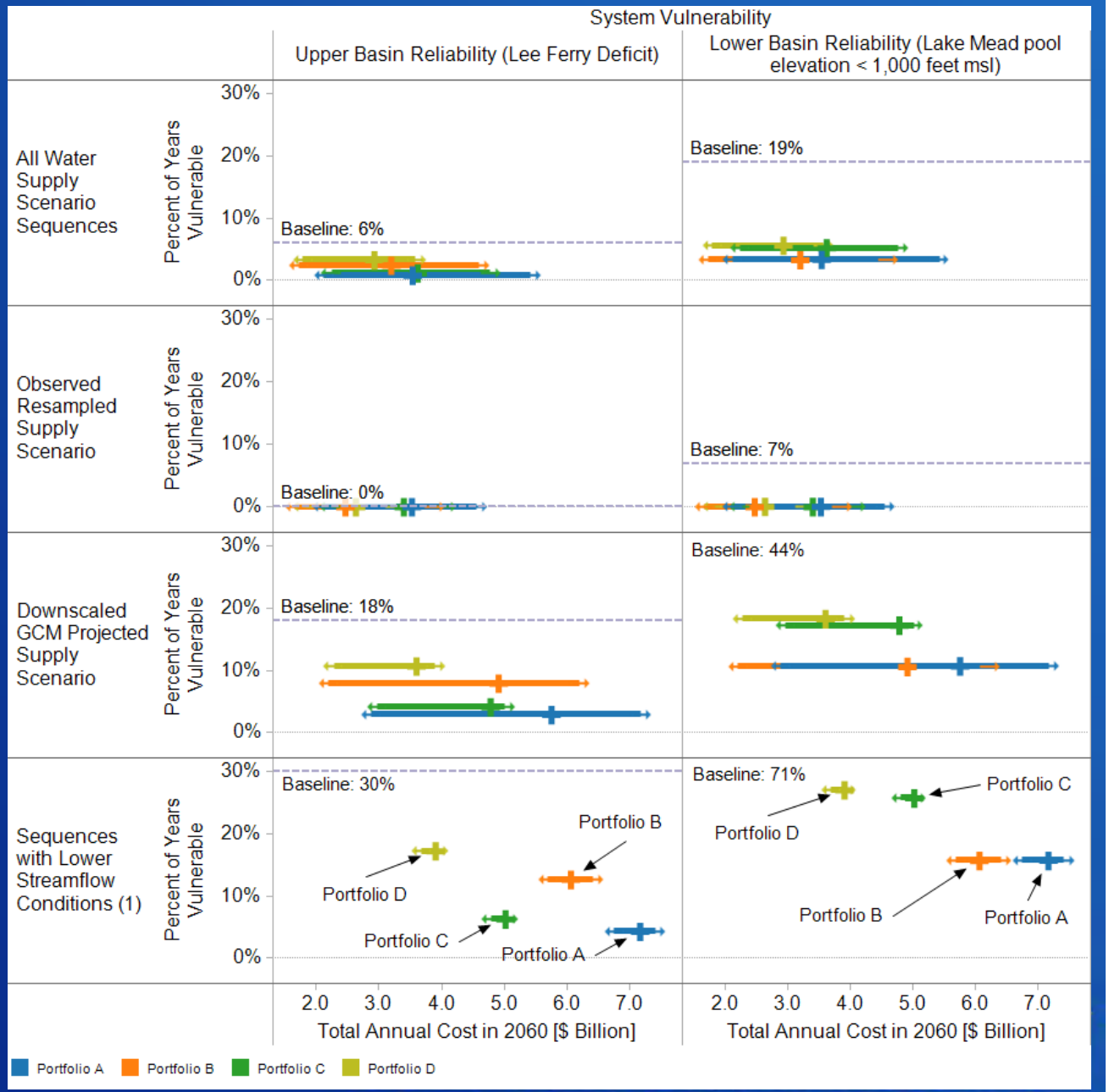
Tradeoffs Between Vulnerability Reduction and Costs

All Water Supply Scenario Sequences

Observed Resampled Scenario Sequences

Downscaled GCM Scenario Sequences

Low Streamflow Conditions



Percent of Traces in Which Options are Implemented

Option Category	Option Group	Portfolio A	Portfolio B	Portfolio C	Portfolio D
Ag. Conservation	Ag Conservation with Transfers	100%	100%	100%	100%
Desalination	Desal-Groundwater	99%	99%	99%	99%
	Desal-Gulf of California	28%	27%		
	Desal-Pacific Ocean-California	16%	17%		
	Desal-Pacific Ocean-Mexico	66%	63%		
	Desal-Salton Sea	78%	76%	85%	81%
	Desal-Yuma	100%	100%	100%	100%
Energy WUE	Energy Water Use Efficiency	100%	19%	100%	20%
Import	Import Front Range	42%	39%		
Local Supply	Local-Coalbed Methane	16%	16%		
	Local-Rain	29%		48%	
M & I Conservation	M&I Conservation	95%	93%	97%	93%
Reuse	Reuse-Grey Water	25%		39%	
	Reuse-Industrial	35%	33%	44%	42%
	Reuse-Municipal	47%	44%	54%	53%
Watershed Management	Watershed-Brush Control	89%		88%	
	Watershed-Dust Control	23%		24%	
	Watershed-Weather Mod	60%	100%	62%	59%

Implementation
0% 100%

Minimum Delay (years)
0 5 10 15 ≥ 21

Colorado River Basin Water Supply and Demand Study

Study Limitations and Next Steps

Presenter: Carly Jerla

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Study Limitations

- The detail and depth to which analyses were performed was limited by the availability of data, methods, and capability of existing models.

- Some of these limitations include:
  - Ability to assess impacts to Basin resources
  - Options characterization process
  - Consideration of options
  - Treatment of Lower Basin tributaries

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Next Steps

- The Study lists 10 areas where next steps should be taken:
  - M&I and Agricultural Water Conservation and Reuse
  - Water Banks
  - Watershed Management
  - Augmentation
  - Water Transfers
  - Tribal Water
  - Environmental Flows
  - Data and Tool Development
  - Climate Science Research
  - Partnerships
- In early 2013, Reclamation will convene interested stakeholders to conduct a workshop to review the recommended next steps and initiate actions to implement next steps

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Colorado River Basin Water Supply and Demand Study

Study Contact Information

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