Regional Water Management Responses using IRPSIM

Technical Workshop: Water Management Responses to an Uncertain Future

October 8, 2009

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Metropolitan Water District of Southern California

Overview

- Metropolitan and the IRP at a Glance
- Introduction to IRPSIM
- Basic Application to Integrated Resources Planning
- Incorporating a New Methodology for Addressing Additional Uncertainties

Metropolitan Water District of Southern California

- Regional Water Wholesaler
- 26 Member Agencies, 6 Counties
- 37 Member Board of Directors
- 18+ million people
- Projected population growth of 220,000 people/year
- $800+ billion Regional economy
- Supply half of service area demand

Where Southern California Gets its Water

Water Banking, Exchanges, Transfers & Storage

Los Angeles Aqueduct

State Water Project

Colorado River Aqueduct

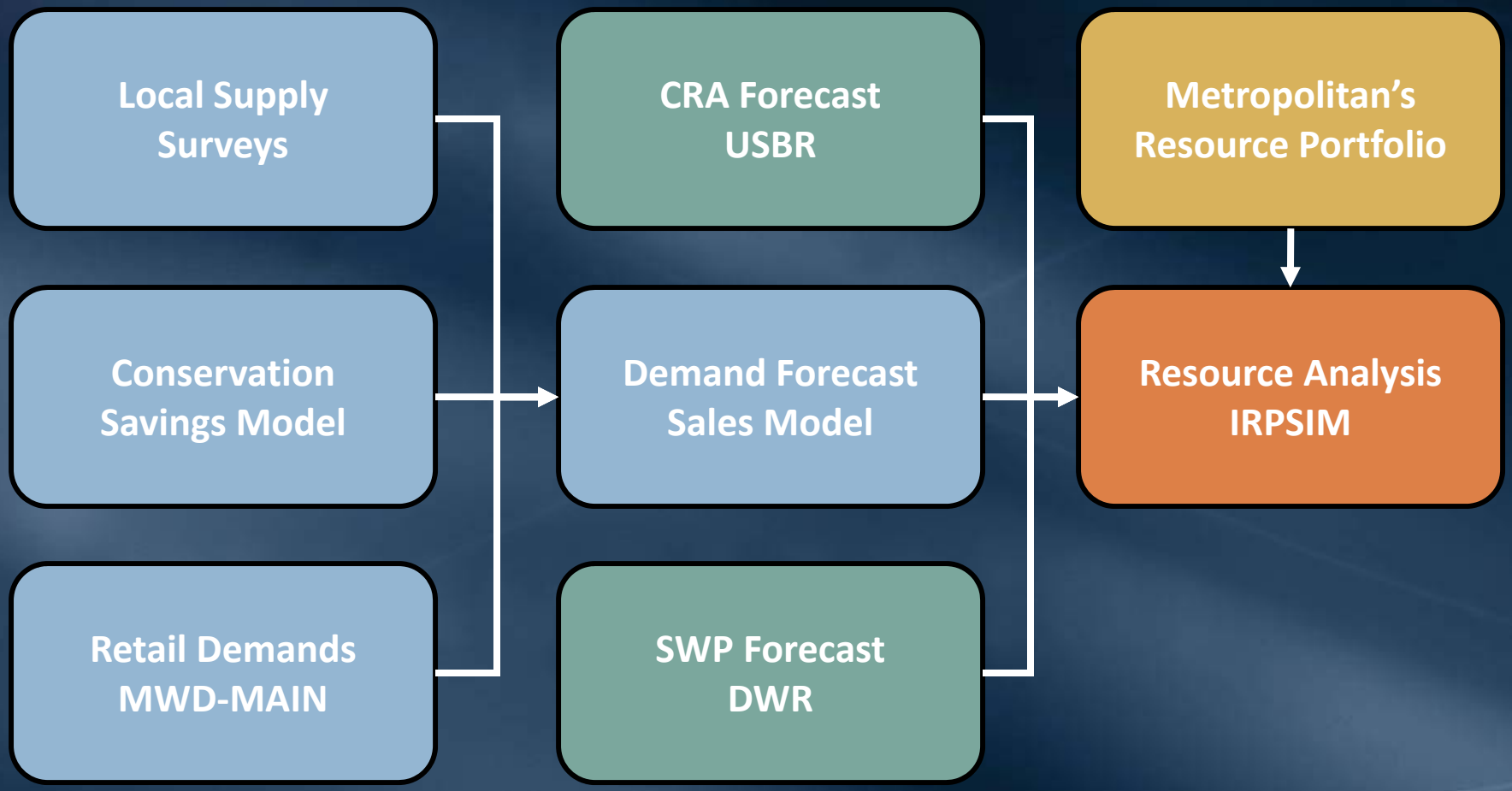
Local Supplies

Groundwater, Recycling, Conservation, Storage

Metropolitan's Integrated Water Resources Plan (IRP)

- Long-Term Water Resources Plan
- Open and Participatory Process
- Ensures
  - Diversification, Adaptability
- Recognizes Constraints
  - Environmental, Institutional
- Emphasizes
  - Reliability, Affordability, Water Quality

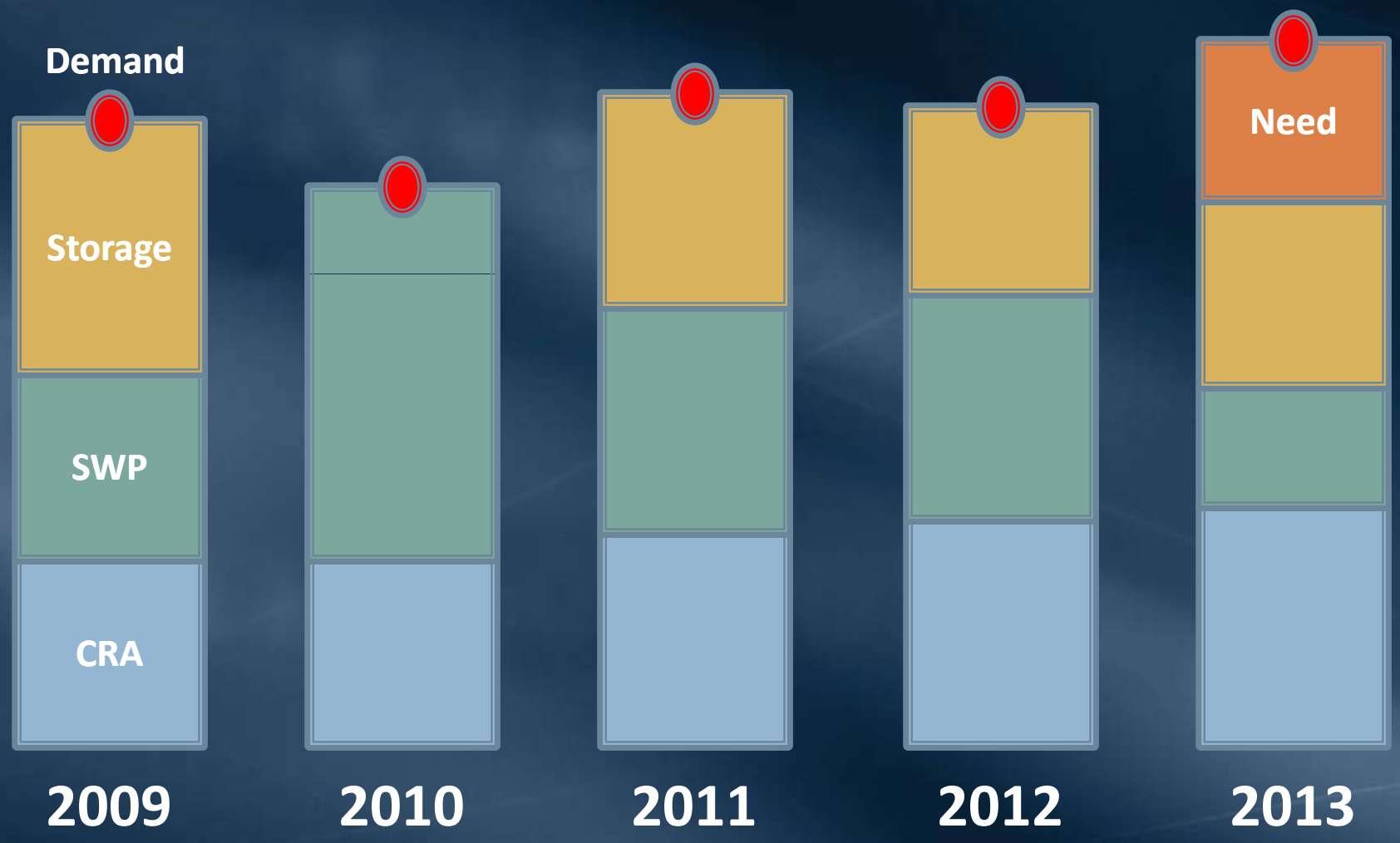
Resource Modeling Framework



Introduction to IRPSIM

- Mass Balance Water Resource Simulation Model
- Uses a Sequentially Indexed Methodology
  - Applies Hydrologic and Climatic Variation to Water Resources
- Produces Probabilistic Rather than Deterministic Information

Simulation Example



Sequential Indexing

- Links Hydrologies for Supplies, Demands, and Storage Devices
- Creates Multiple “Traces” of Hydrologic Occurrences
- Preserves the Independence of Separate Hydrologies
  - CRA, SWP, Local Supplies and Demands
- Preserves the Sequence of Hydrologic History
  - 1923 Follows 1922 etc.

IRPSIM Hydrologies

Forecast	2010	2011	2012	2013	2014	2015
1	1922	1923	1924	1925	1926	1927
2	1923	1924	1925	1926	1927	1928
3	1924	1925	1926	1927	1928	1929
4	1925	1926	1927	1928	1929	1930
. . .						
83	2004	1922	1923	1924	1925	1926

Trial

What is IRPSIM Good for?

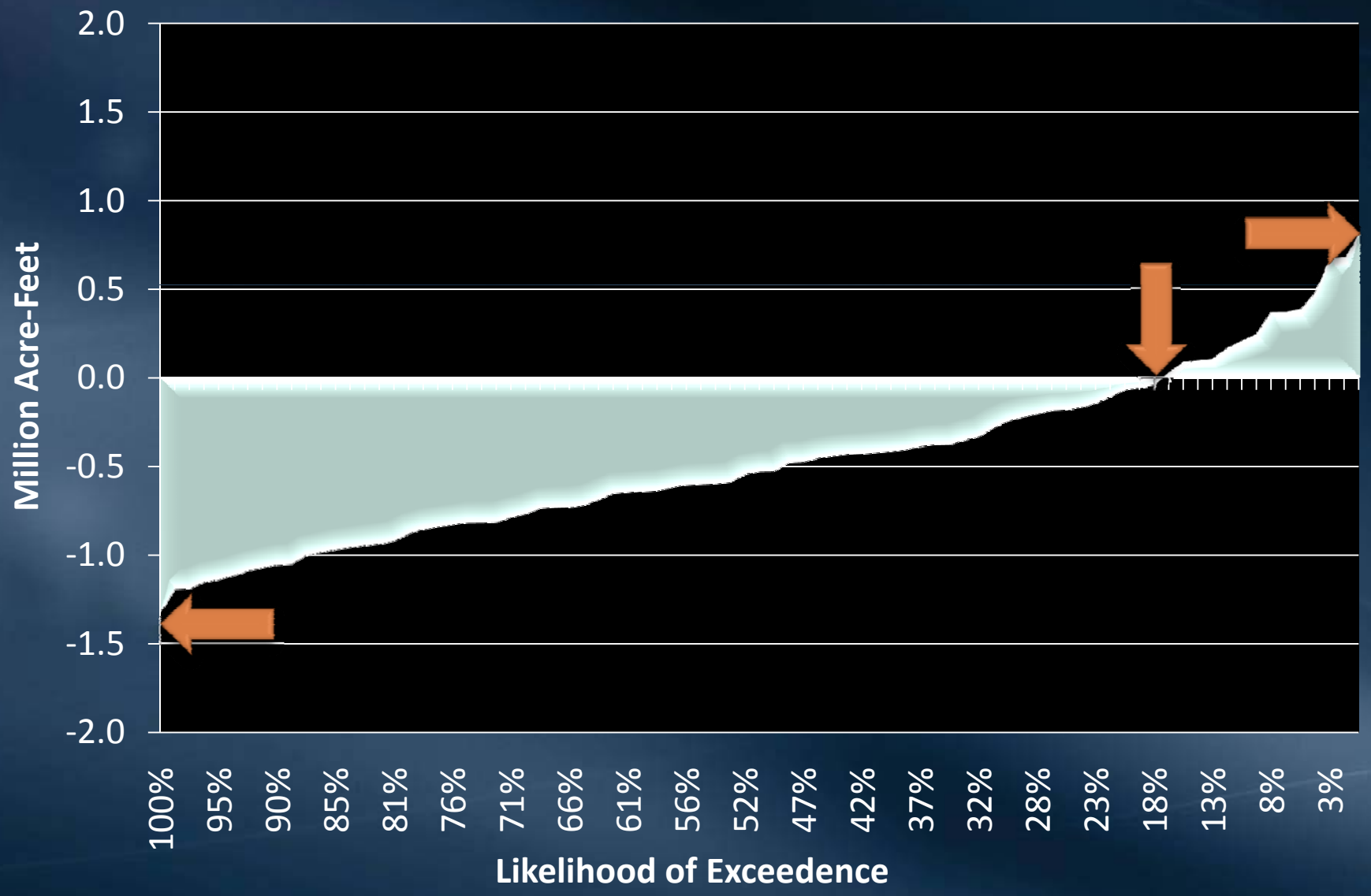
- Estimating the Effectiveness of a Water Resource Mix
- Estimating the Benefits of New Resources
- Estimating the Benefits of Storage
- Determining the Effects of Changes in Demands
- Applying Ranges of Uncertainty to Forecasted Variables

Application of IRPSIM

- IRP Strategic Policy Review - Building the "Nominal Case"

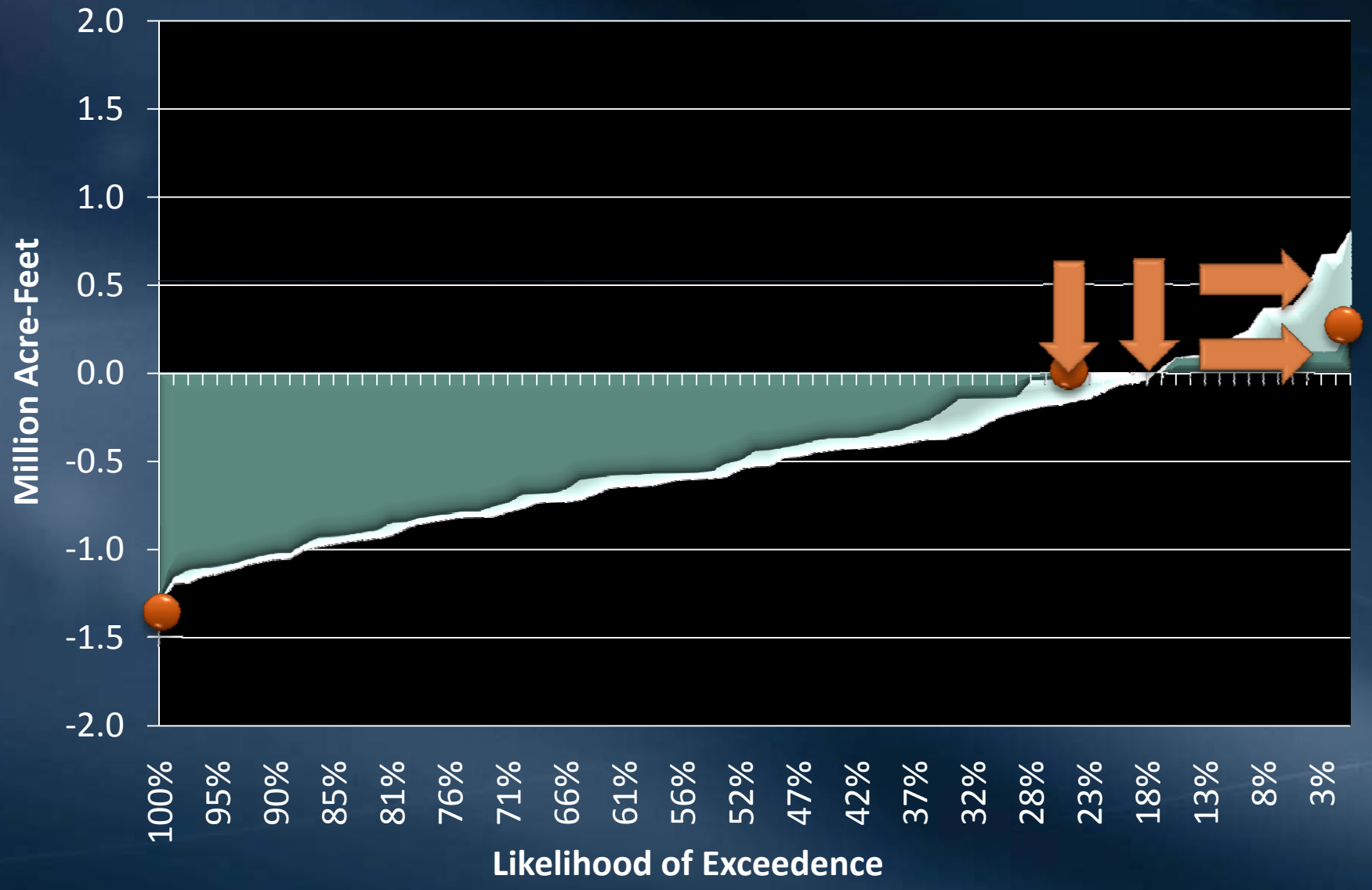
2015 Reliability Before and After Storage

Common Base Assumptions Case



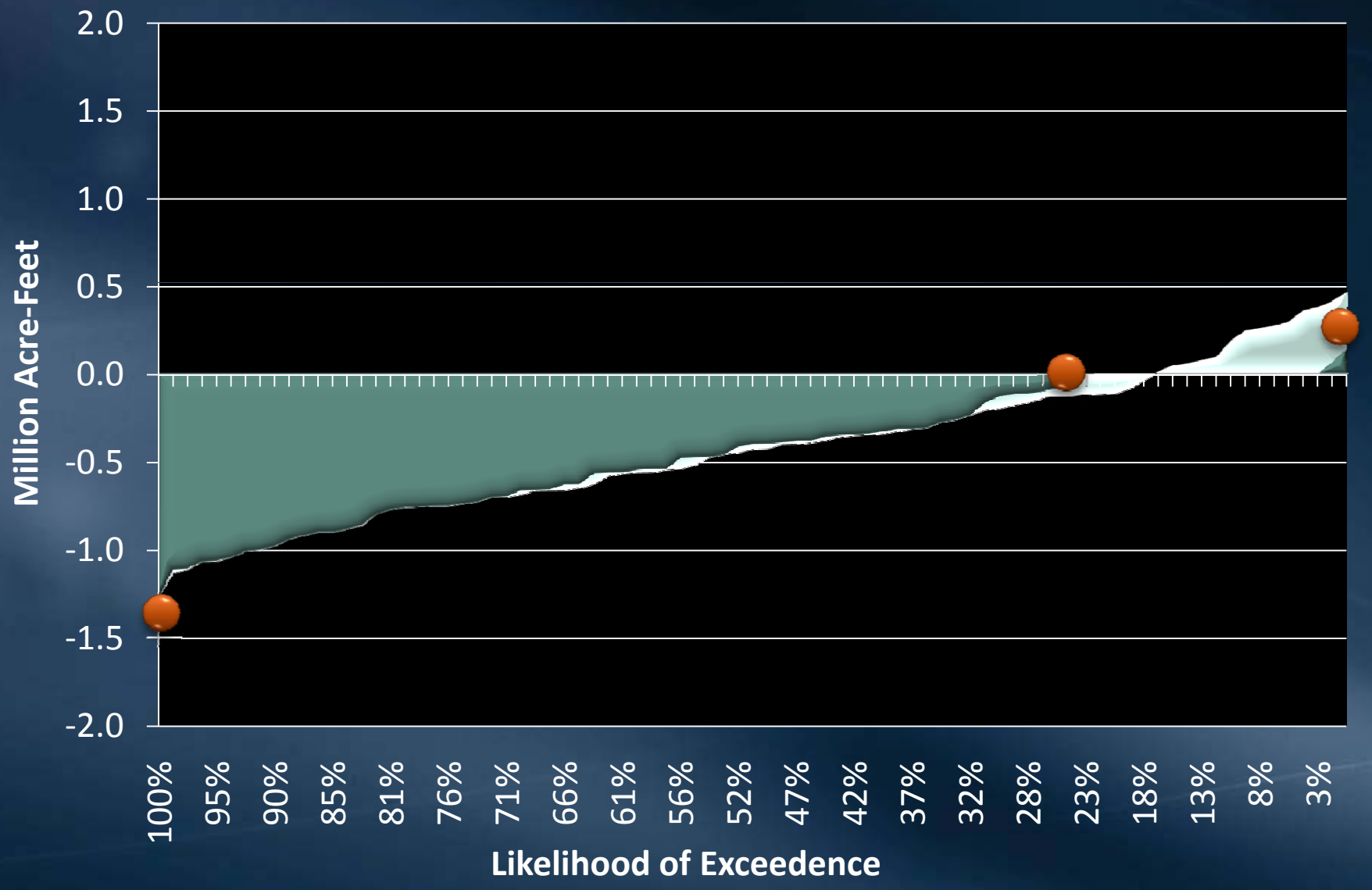
2015 Reliability Before and After Storage

Common Base Assumptions Case



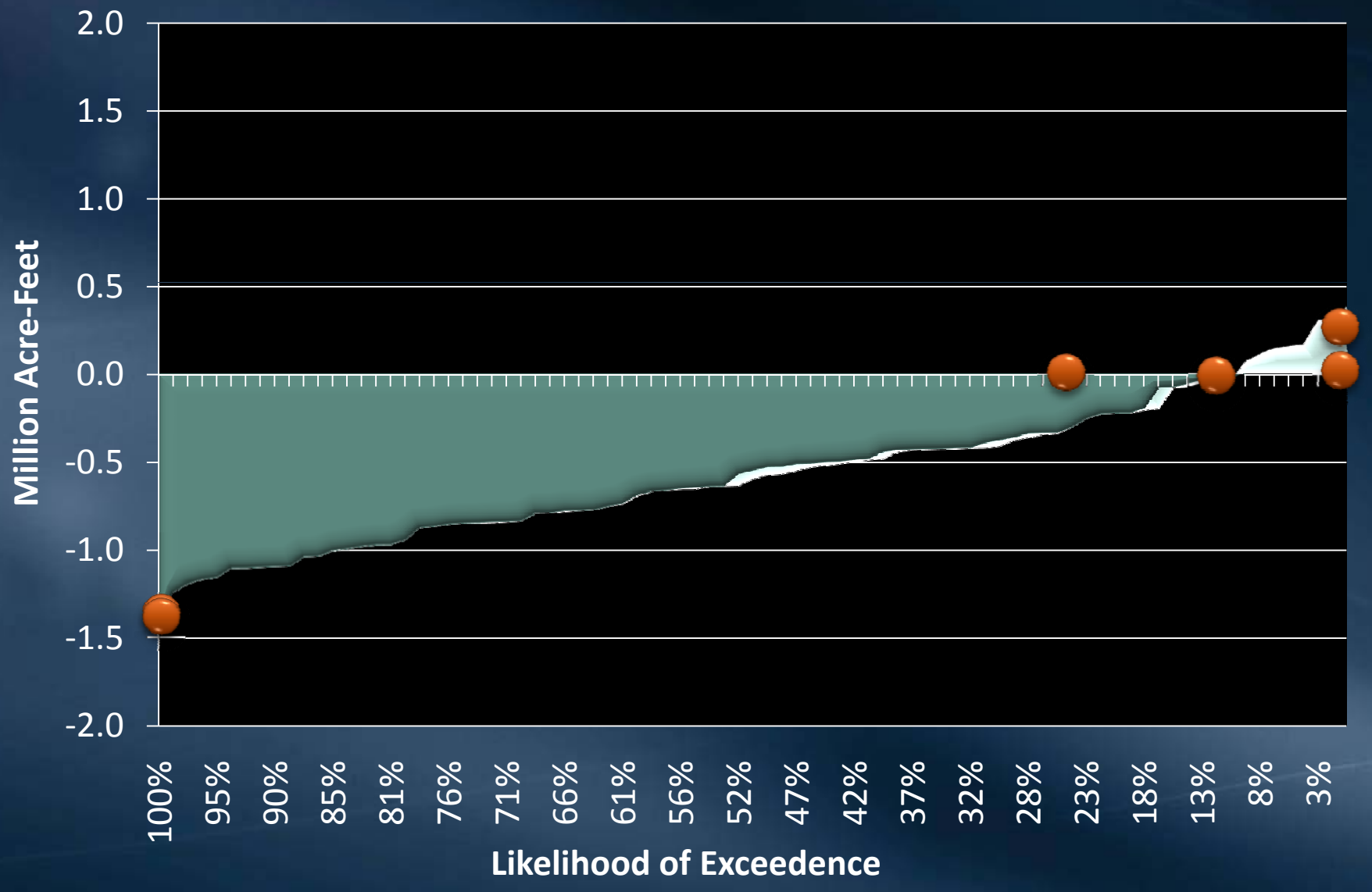
2025 Reliability Before and After Storage

Common Base Assumptions Case



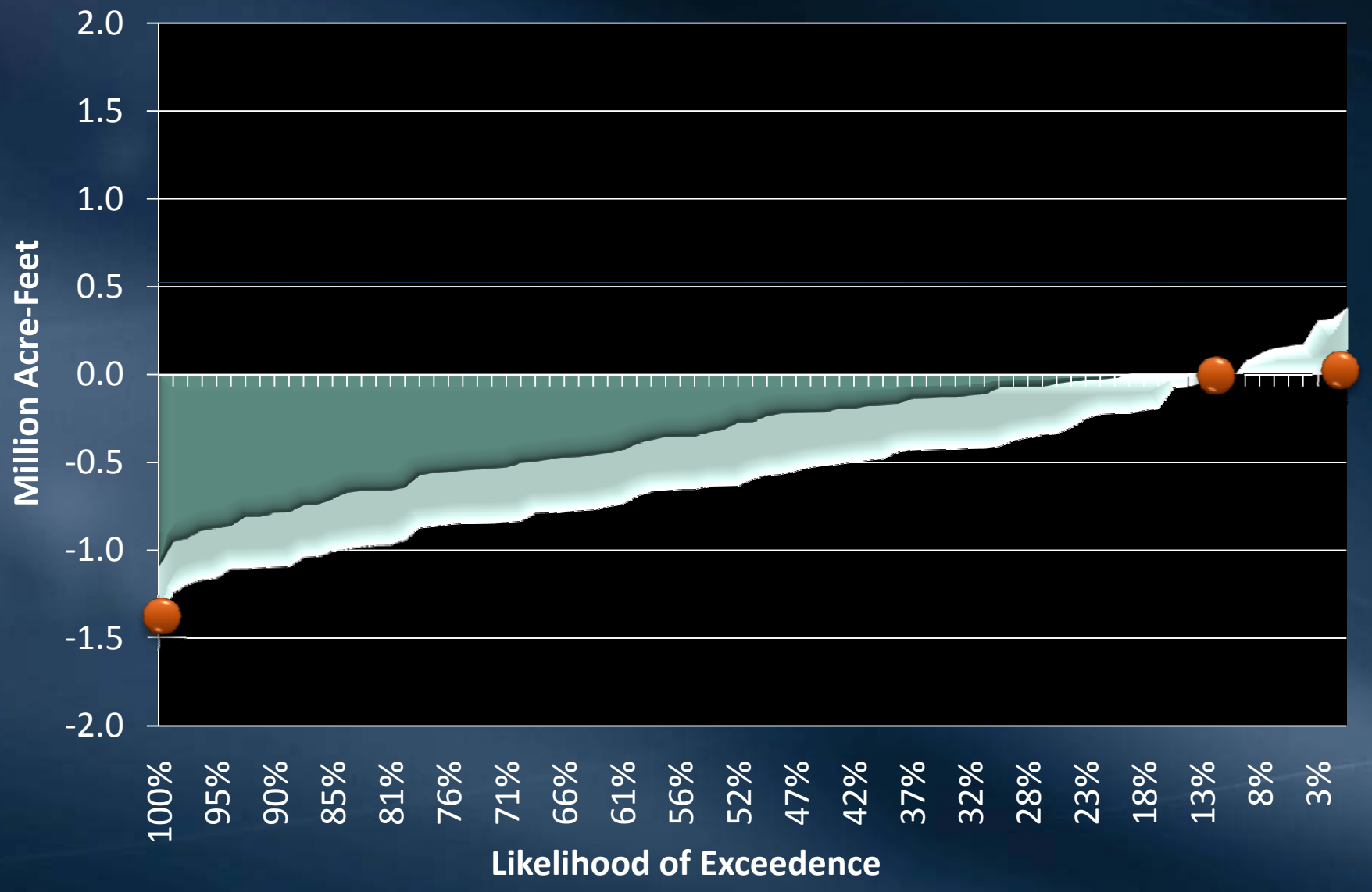
2035 Reliability Before and After Storage

Common Base Assumptions Case



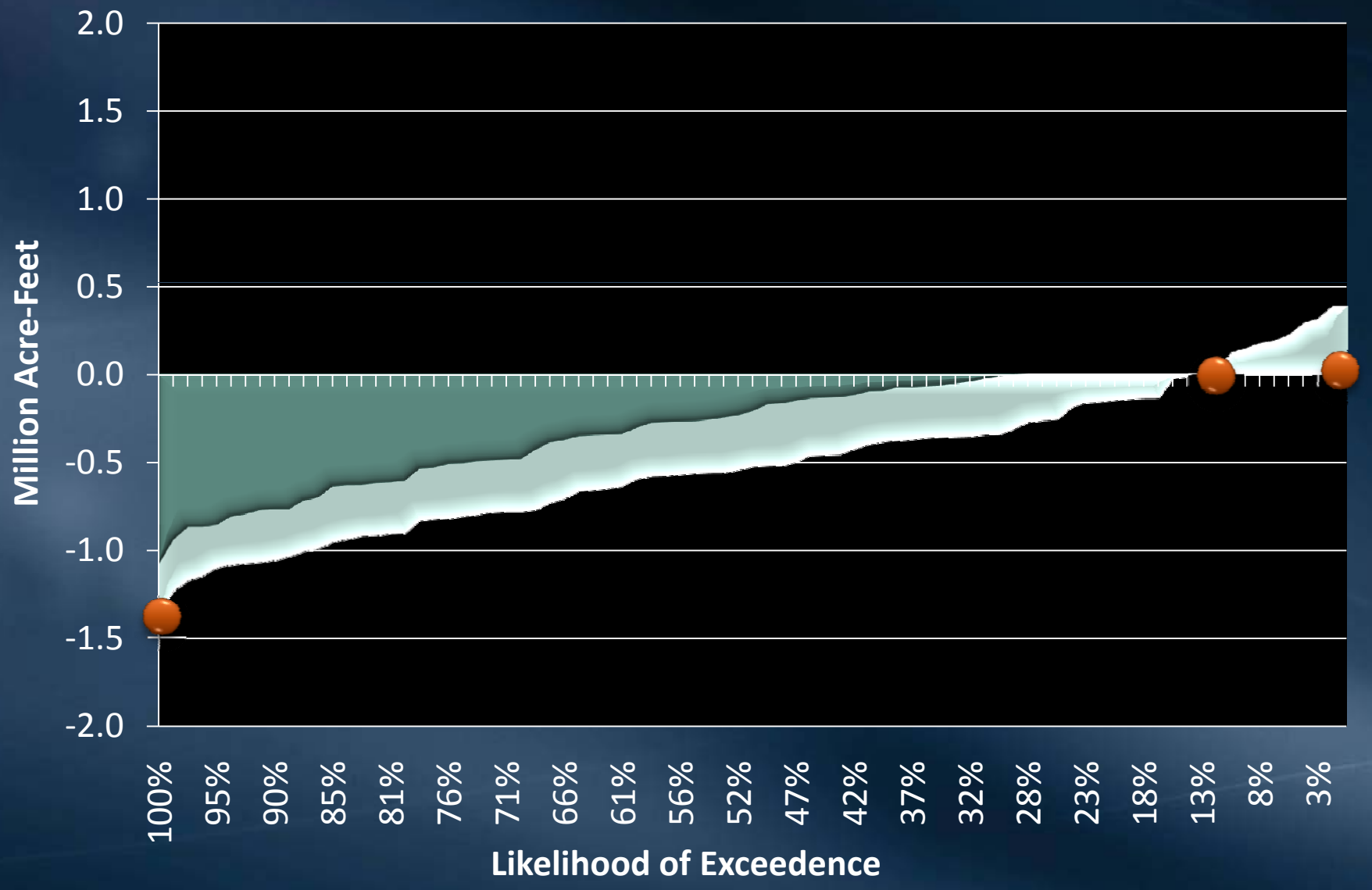
2035 Reliability Before and After Storage

Colorado River Transfers Case



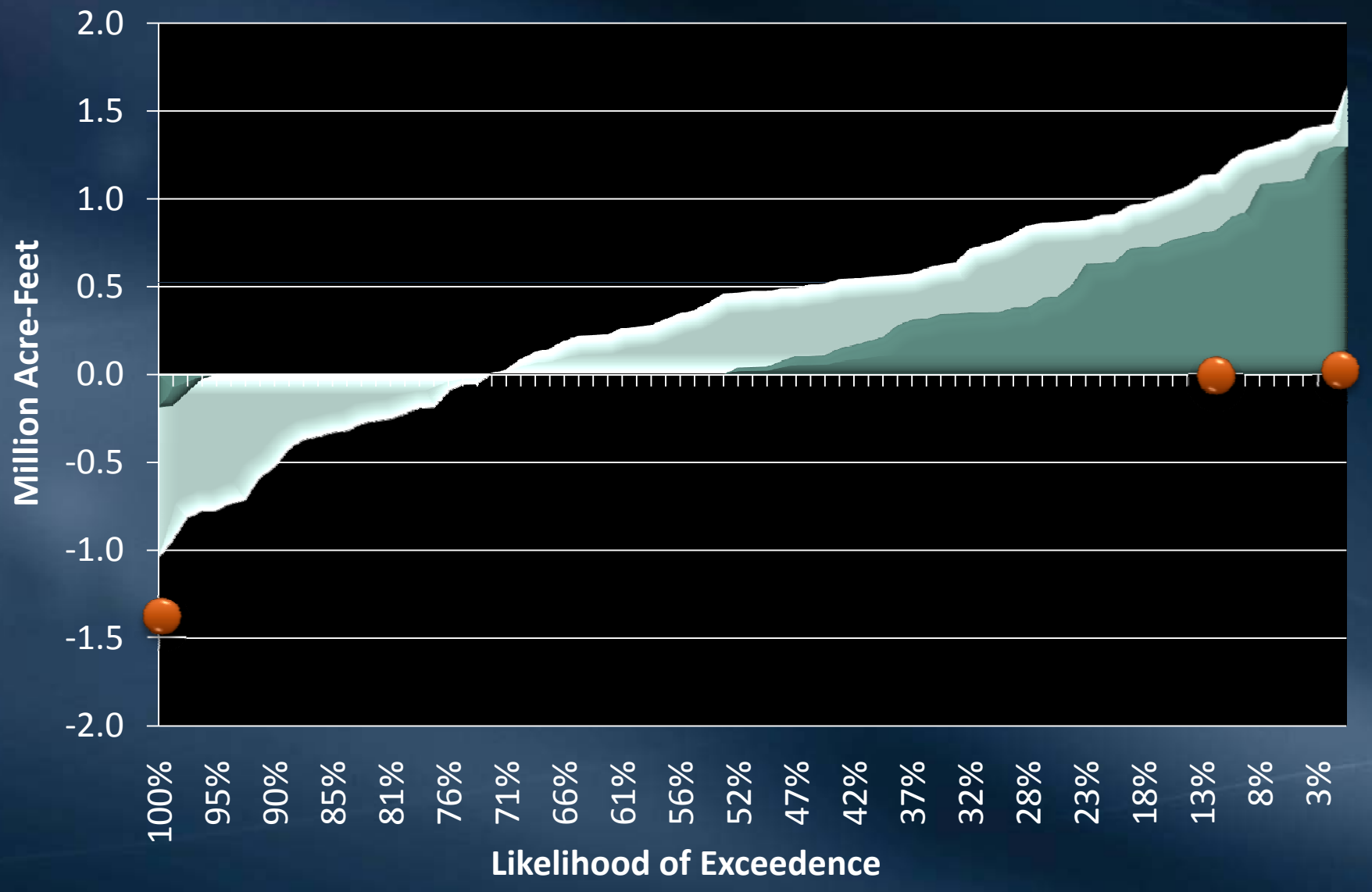
2035 Reliability Before and After Storage

Colorado River Transfers with Interim Delta Case



2035 Reliability Before and After Storage

Colorado River Transfers with Delta Solution Case



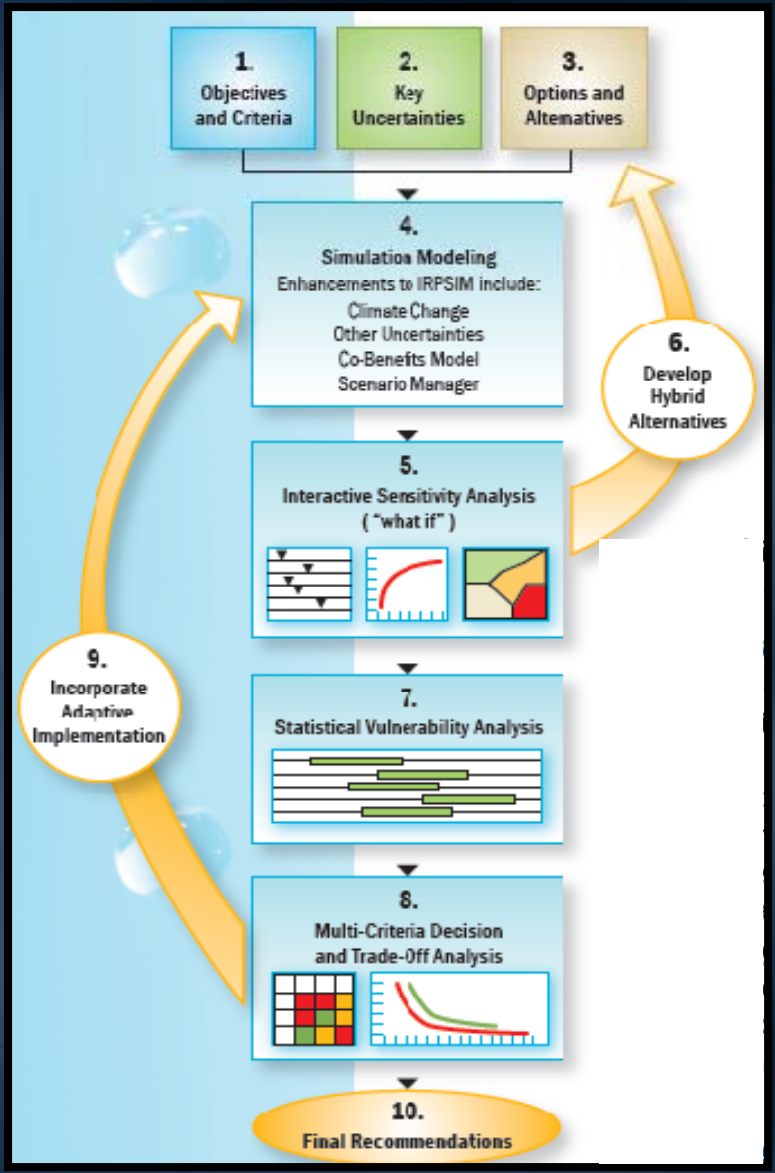
Addressing Additional Uncertainties

- Future Hydrologic Conditions Under Non-Stationary Climate
- Demographic and Economic Growth
- Energy and Implementation Costs
- New Regulation and Restrictions on Supplies

Expanding Upon Previous Methodology

- Rand Corp. "Robust Decision Making"
  - Explicitly Evaluates Strategies Against a Large Number of Scenarios
  - Analytically Identifies *Robust* Strategies
- Multi-Criteria Decision Analysis
  - Enables More Consistent Treatment of IRP Objectives
  - Reveals Tradeoffs Across Objectives

Iterative Methodology to Address Uncertainties and Multiple Objectives



Configure IRPSIM Modeling to Reflect the "Nominal Plan"

- Update "Preferred Resource Mix"
  - Reflect Most Recent Projections
  - Extend Time Period to 2035
- Expanded Development of Identified Resources
  - e.g. modest new
    efficiency, recycling, groundwater use

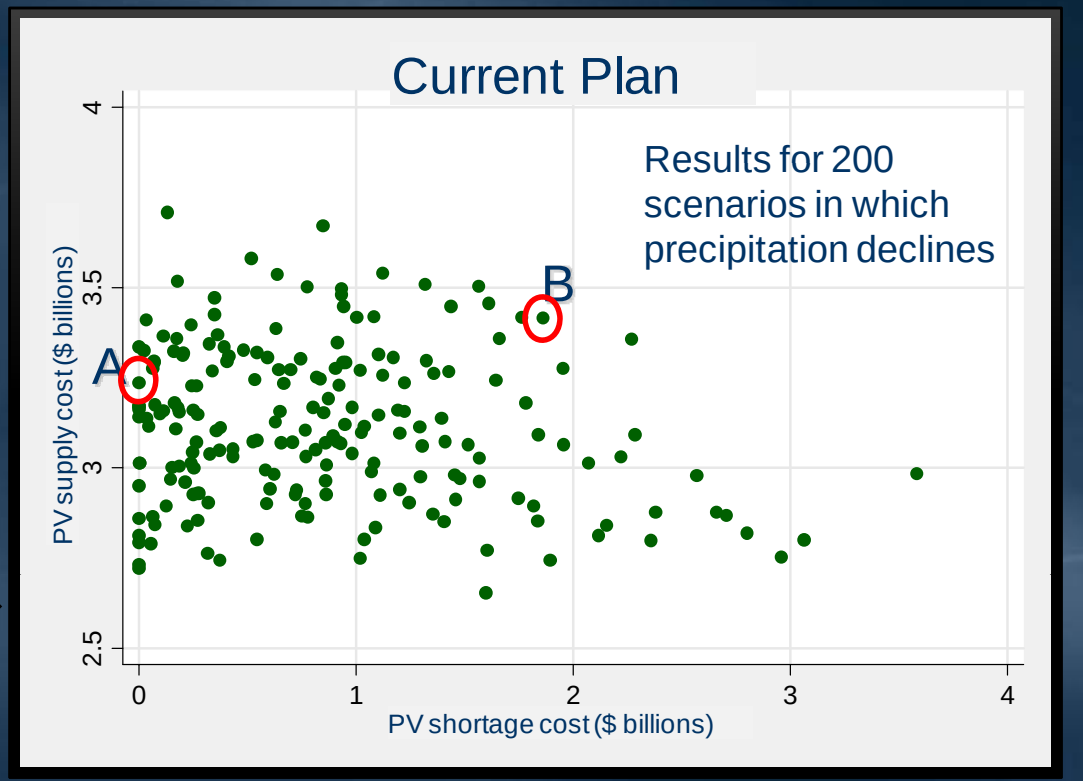
Evaluate "Nominal Plan" Against a Large Ensemble of Scenarios

- Experimental Design
  - Span plausible conditions
  - Not a statement of likelihood
- Plan Performance
  - Calculate a score for "Nominal Plan" for each scenario and performance metric

Example

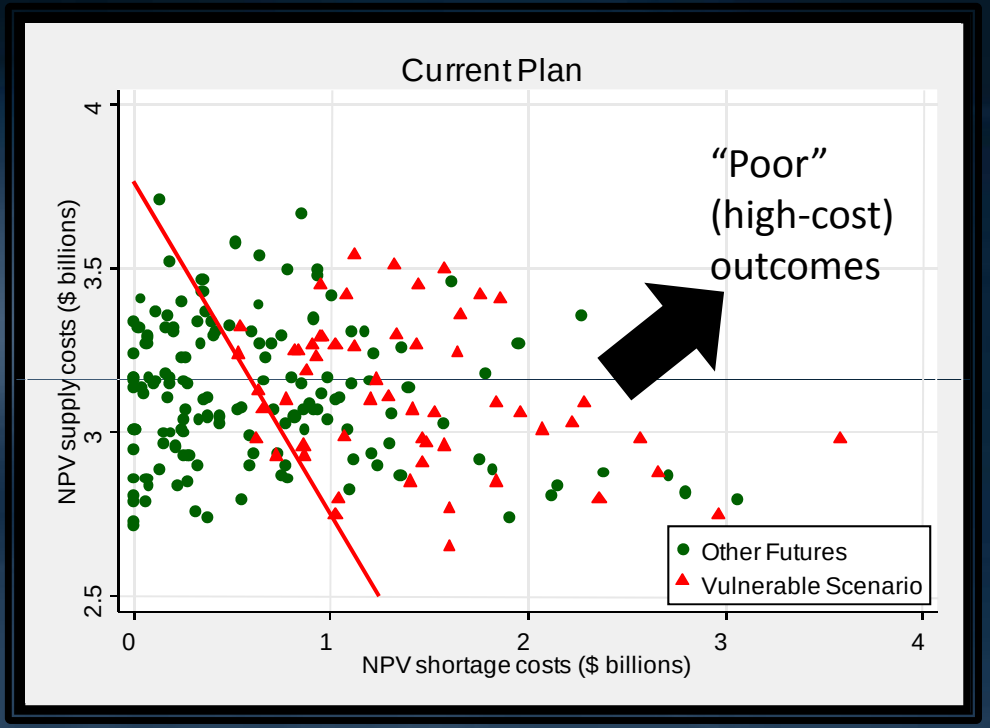
Scenario uncertainty:
- Future climate
- Changes in groundwater
- Development of recycling
- Groundwater replenishment
- Reliability of imports
- Costs of imported supplies
- Costs of water use
- Costs of efficiency

Performance of "Current Plan" based on two cost metrics evaluated against 200 scenarios



Identify and Characterize Key Vulnerabilities

- Performance Thresholds Define Outcomes "Good Enough"
- Statistical Tools Characterize Scenarios that Lead to "Poor" Outcomes
- Summarize Robustness Across Metrics
  - Counts of "Poor" Outcomes for Each Metric

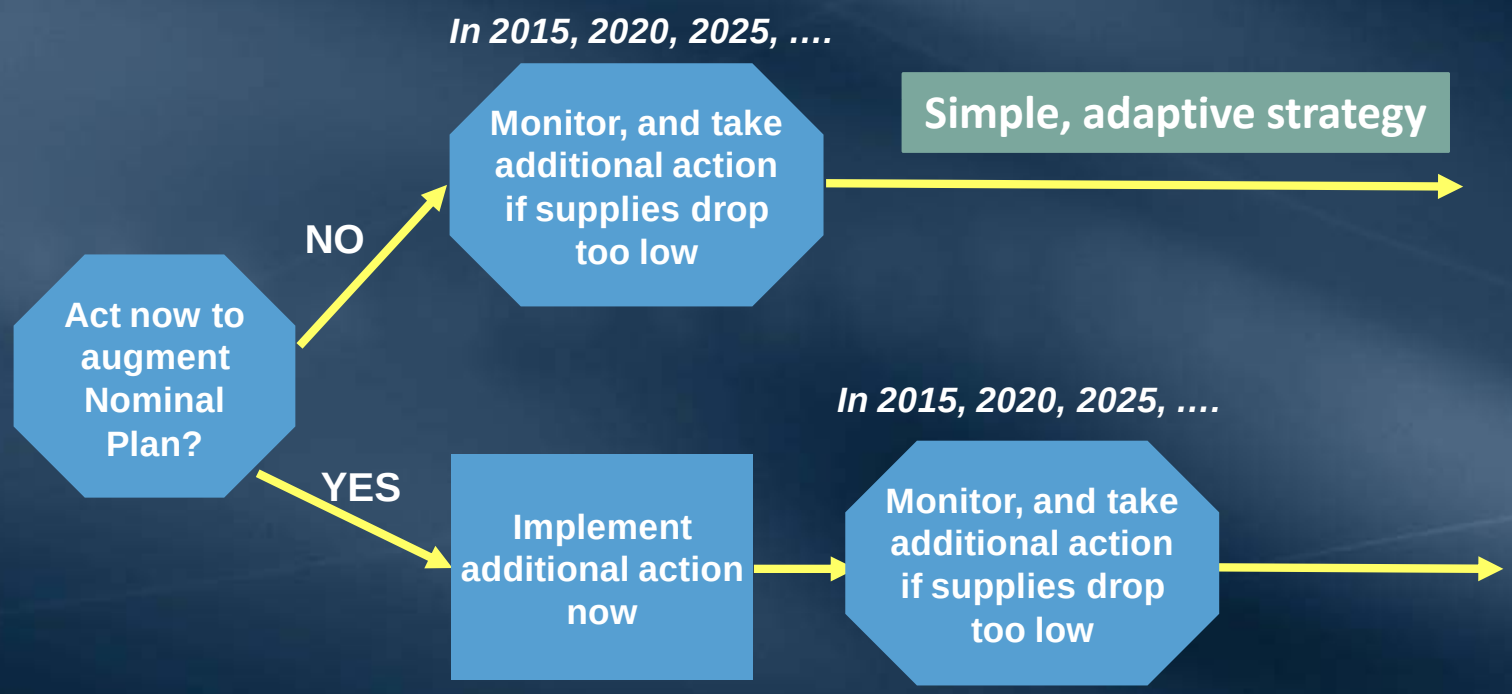


Three concurrent conditions lead to about half of poor outcomes

1. Warming and drying climate
2. Declines in groundwater perc.
3. Strong climate impacts on imports

Develop More Robust Strategies

- Vulnerabilities Reveal Key Weaknesses and Suggest Hedging Actions
- Some Weakness Occur in Out-Years and in only Some Scenarios – Suggests Adaptive Strategy

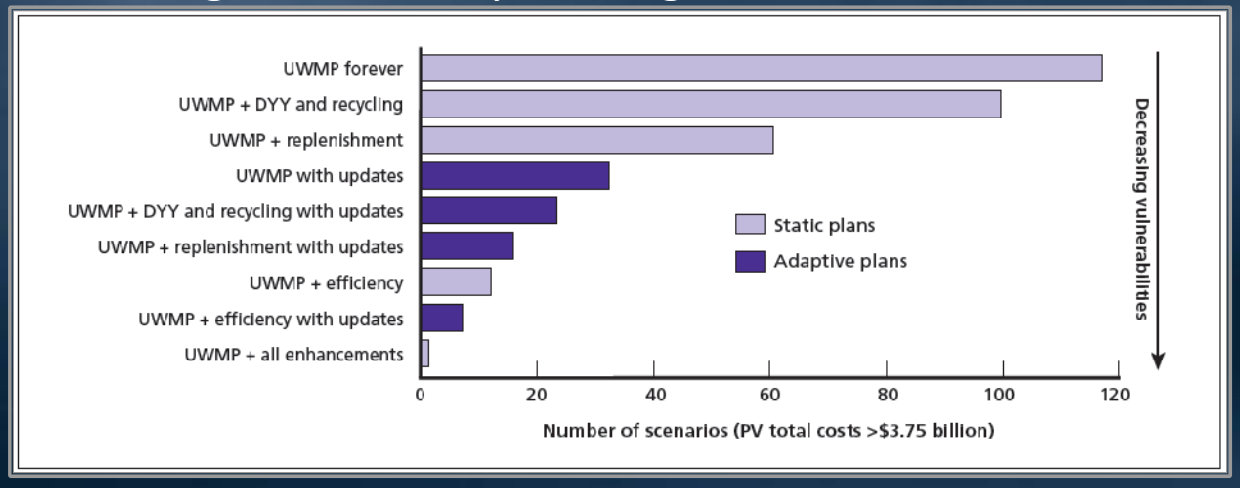


Evaluate New Strategies Against Ensemble of Scenarios

- New Strategies
  - Will have fewer and possibly different vulnerabilities
  - Will be more robust across more performance metrics

Example Output

Strategies ranked by # of high cost outcomes

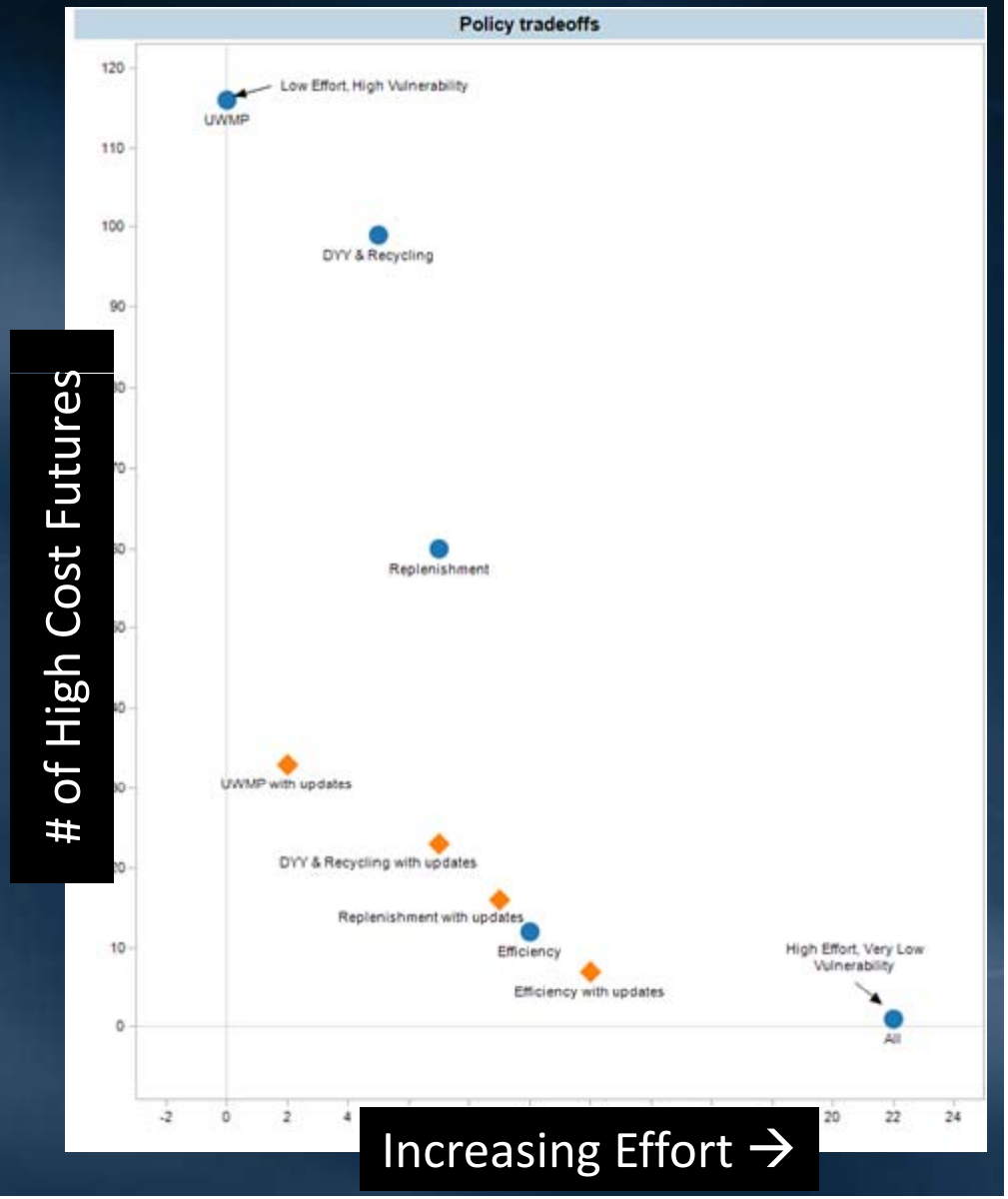


Robustness of four strategies
For three performance metrics

	M1	M2	M3
Strat 1			
Strat 2			
Strat 3			
Strat 4			

Present Key Performance Tradeoffs

- No Strategy is Perfect
  - Will Not Eliminate ALL Vulnerabilities
  - Will Not Perform Equally Well Across ALL Metrics
- Final Tradeoffs Permit MWD to Weigh Risks and Performance Across Metrics



Summary

- Metropolitan Resources are Complex and Geographically Widespread
- Metropolitan Faces Many Uncertainties in Planning for the Future
- IRPSIM is a Valuable Tool in Planning with Uncertainty
- New Methodologies are Under Development to Evaluate Additional Uncertainties
- Evolution of the IRP Process