Sustainable Water Management Using Analytical Tools and Dynamic Reservoir Operations

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WRRC Brown Bag Seminar

University of Arizona

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Advancing the Management of Water Resources

HYDROLOGICS

www.hydrologics.net

HydroLogics (www.hydrologics.net)

Small Firm, Big Reach

← Sacramento & San Joaquin Rive...

name

Sacramento & San Joaquin River Basins

description

For the Bureau of Reclamation in the late 1980s, HydroLogics developed a surface water operation simulation model (PROSIM) of the California State Water Project (SWP) and the Bureau's Central Valley Project (CVP). The model explicitly treated the CVP and SWP as a hydrologically integrated system. The monthly time step model included the Sacramento and San Joaquin Rivers and their tributaries, the Sacramento-San Joaquin Delta, the Delta-Mendota Canal and the California Aqueduct.

A module was included to track groundwater use and storages, thus allowing conjunctive use schemes to be modeled. The purpose of the model was to allow the Bureau and other users to analyze how new operating policies and/or facilities would affect the use of the resource. The model addressed recreation, hydropower, fish and wildlife, navigation, water supply for industrial, commercial, domestic and agricultural users, conjunctive use of ground water and surface water supplies, and water quality in streams, reservoirs and estuaries. An integral part of the project was training the Bureau staff to use and modify the model for their own

What's a Model, and What's a Model Good For Anyway

- An abstraction of some reality
- You can test the "goodness" of the abstraction by comparing it to the real world (research models)
- You can attempt to predict the future (or discover the past) using the abstraction (management models)

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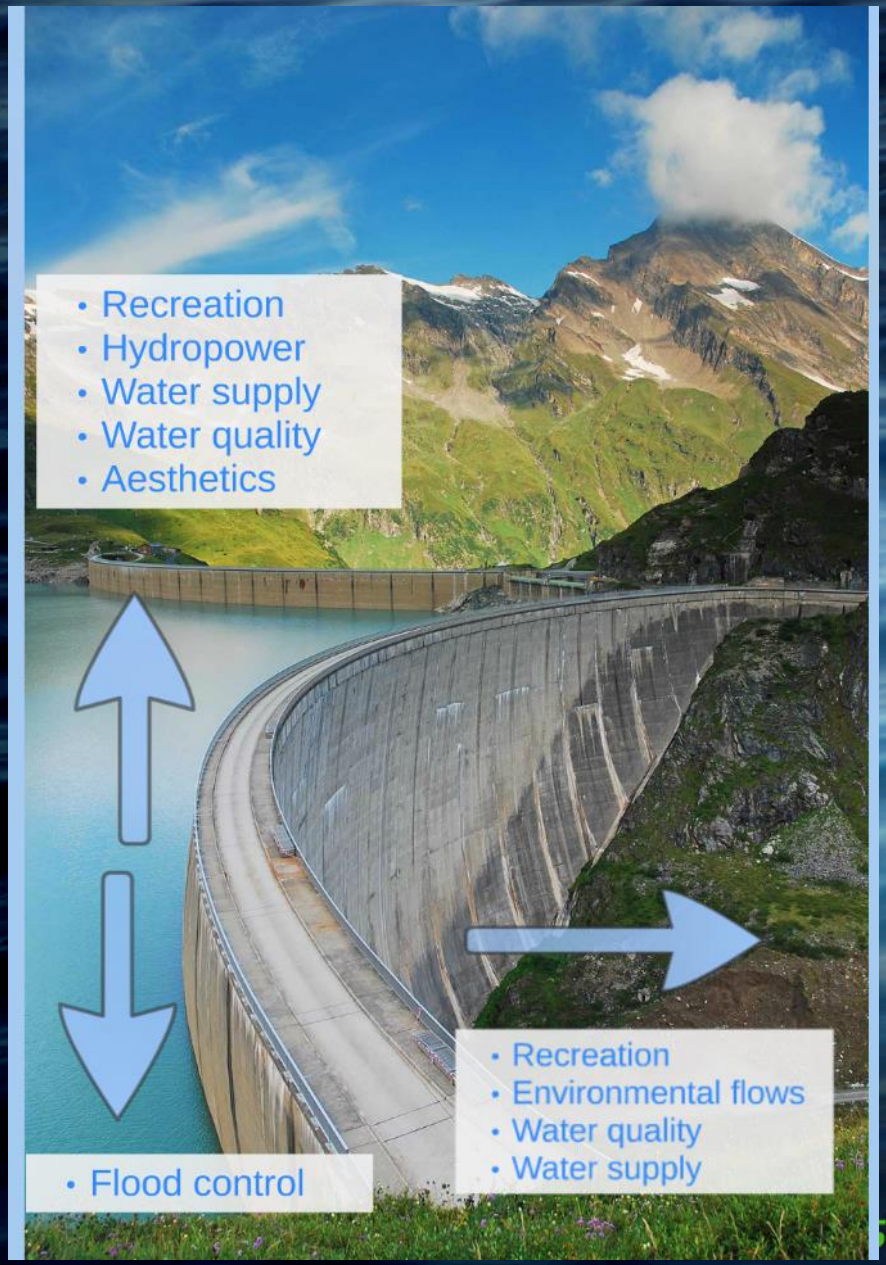
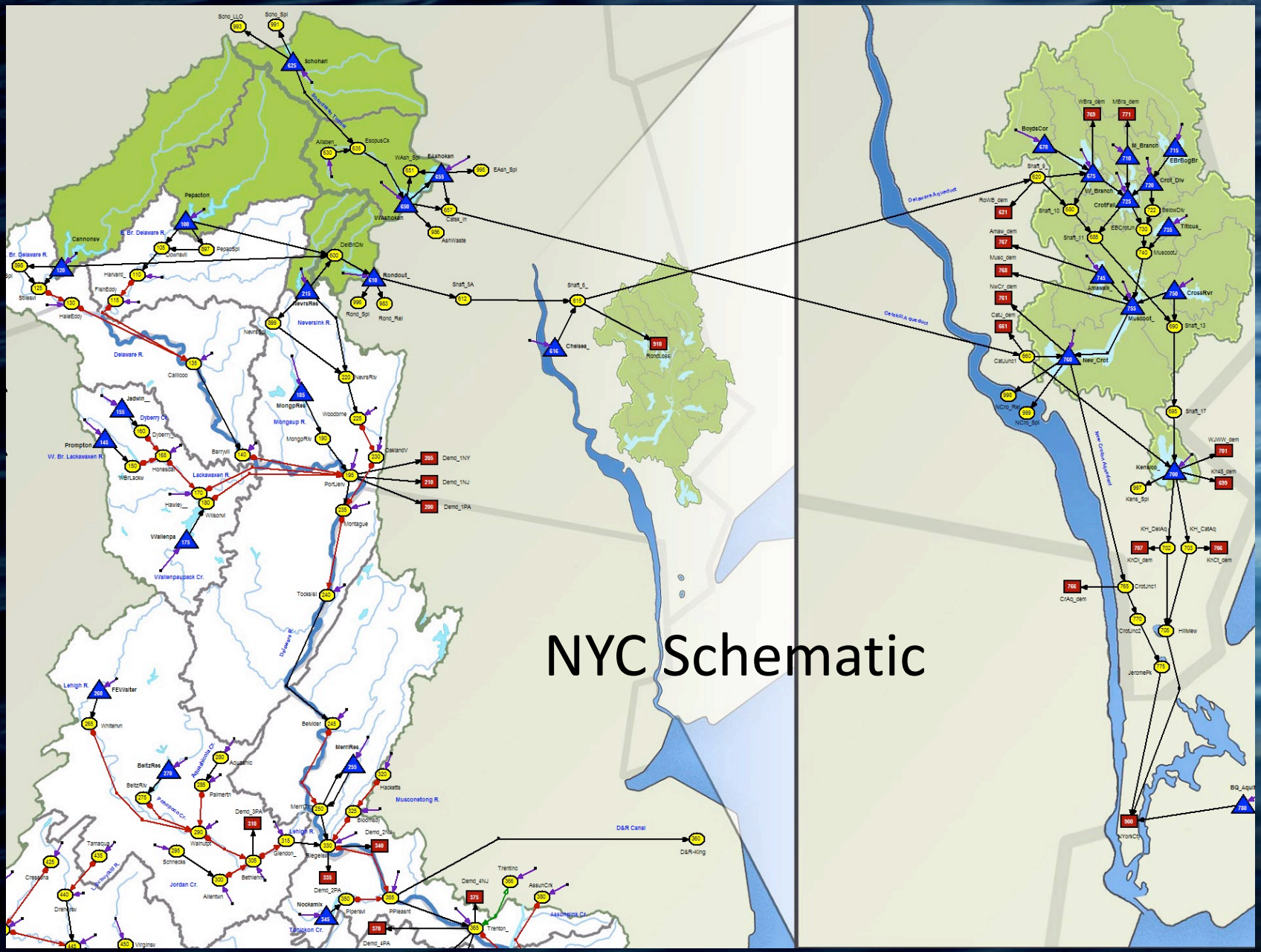
Types of Models

- Empirical (e.g. regression or neural network models)
- Mathematical cause and effect models (e.g. hydrodynamic models) - physical models
- Structural models (e.g. the USACE SF Bay Model, AI models - sometimes)
- Human behavior models (e.g. economic models and OASIS)

Competing Needs




NYC Schematic

You Must Know What Matters

- Simulation models don't tell you what matters
- You need metrics – performance measures
- Displays that allow quantitative or qualitative comparisons between alternatives

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Metrics Allow You to Explore the Nexus

- Energy
- Food
- Water
  - Value Added
  - Supply reliability
  - Flood Control
  - Recreation
  - Power
  - Food
- Getting the metrics right is most of the battle

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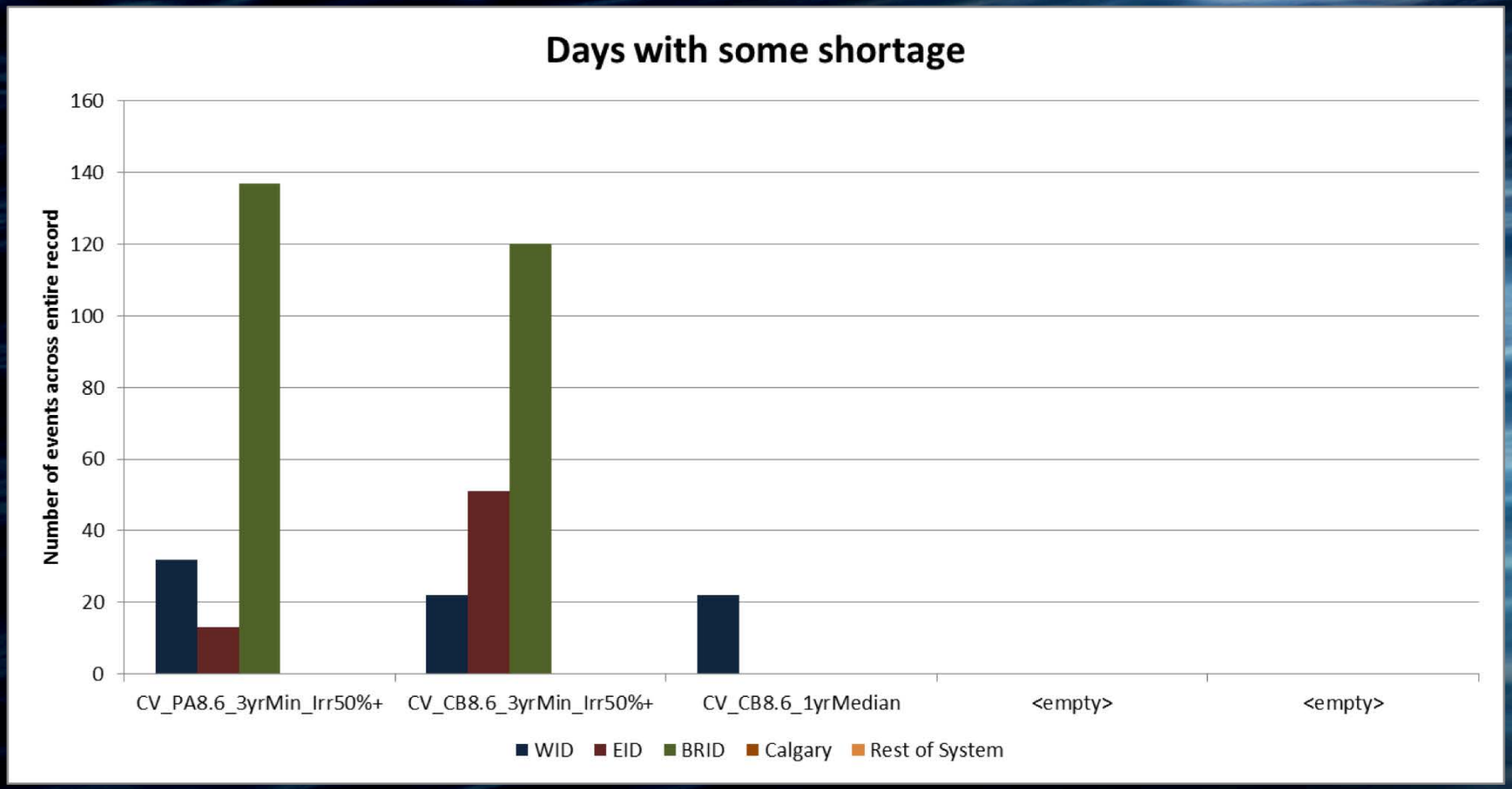
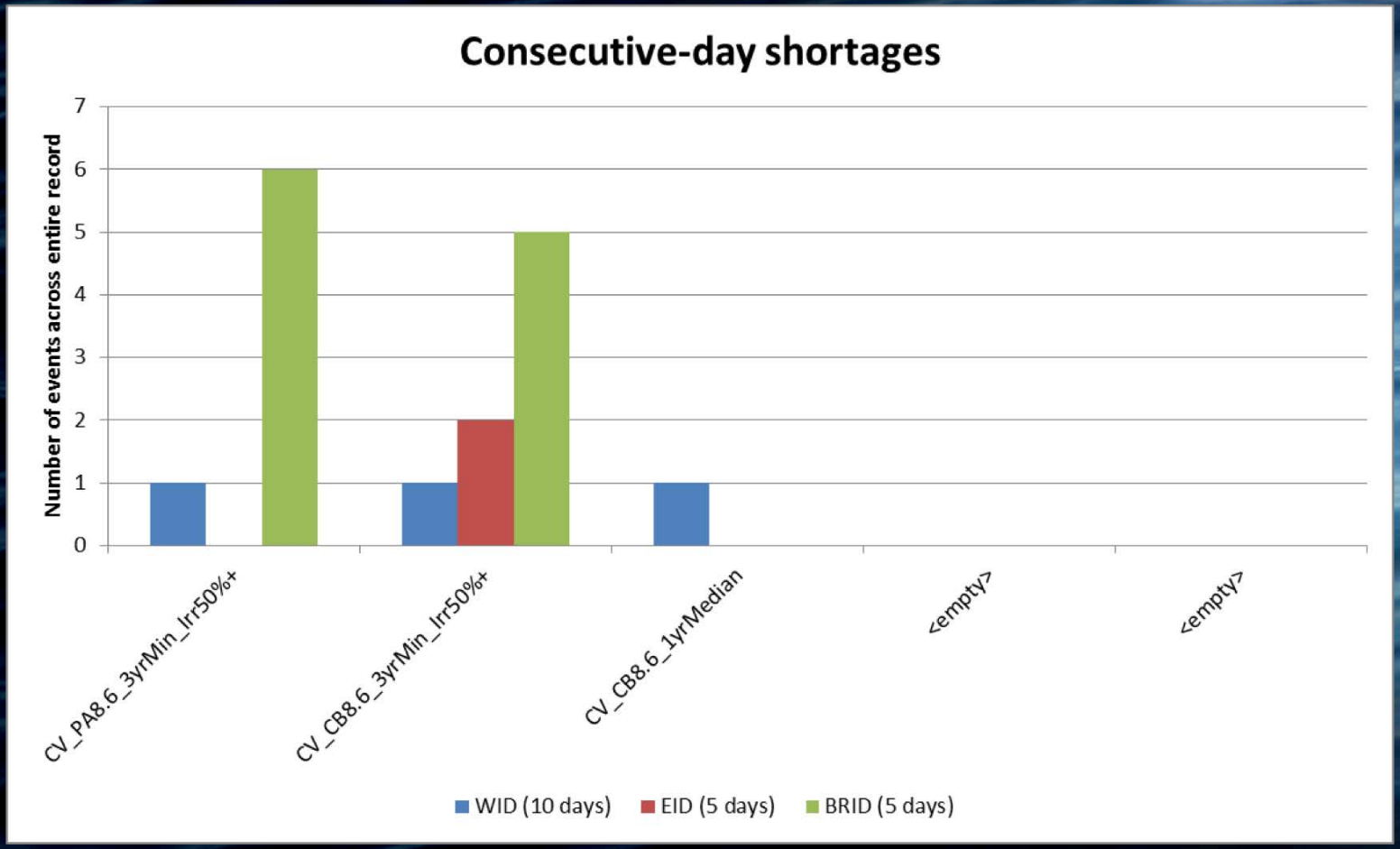
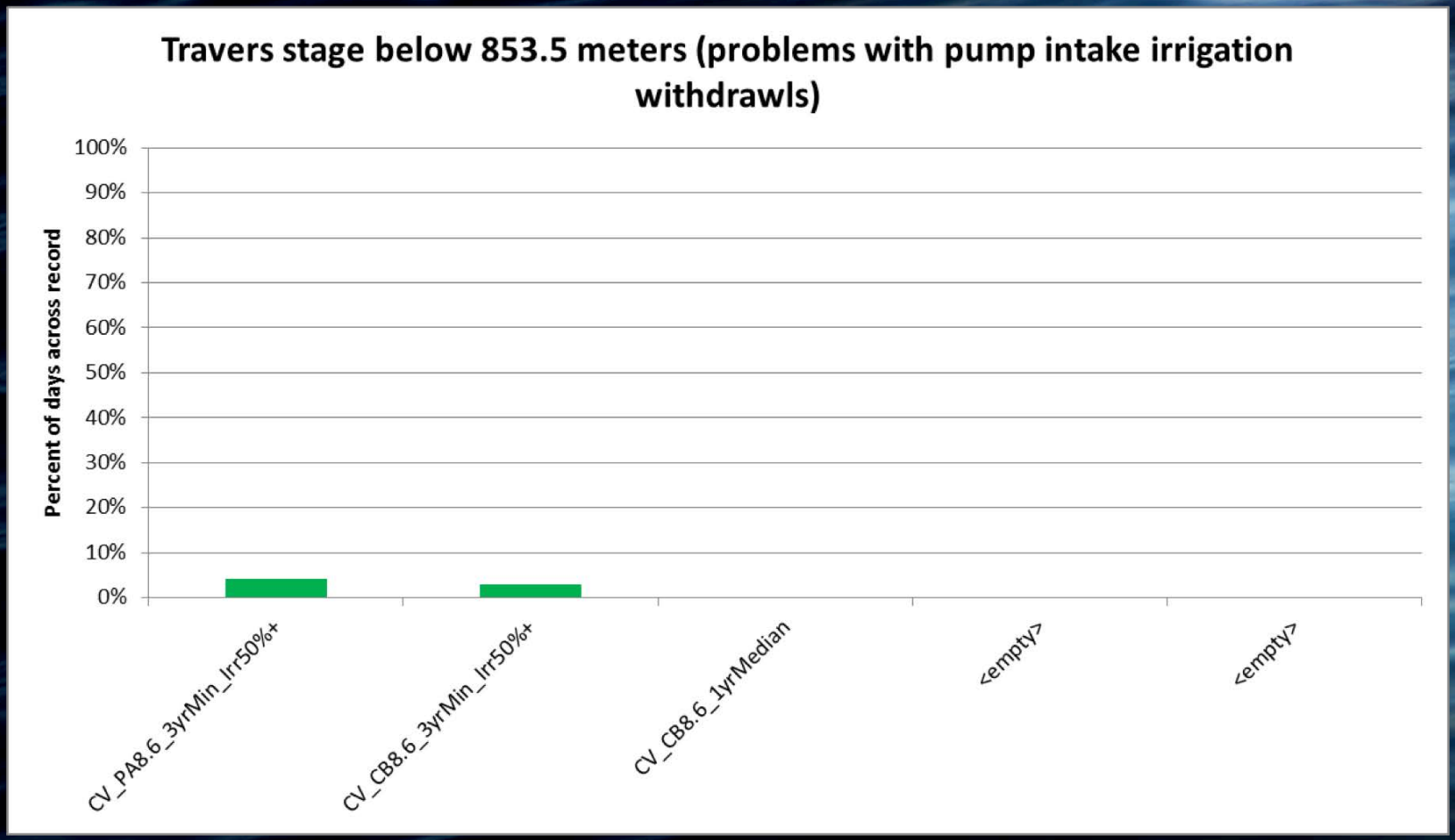
Irrigation Shortages



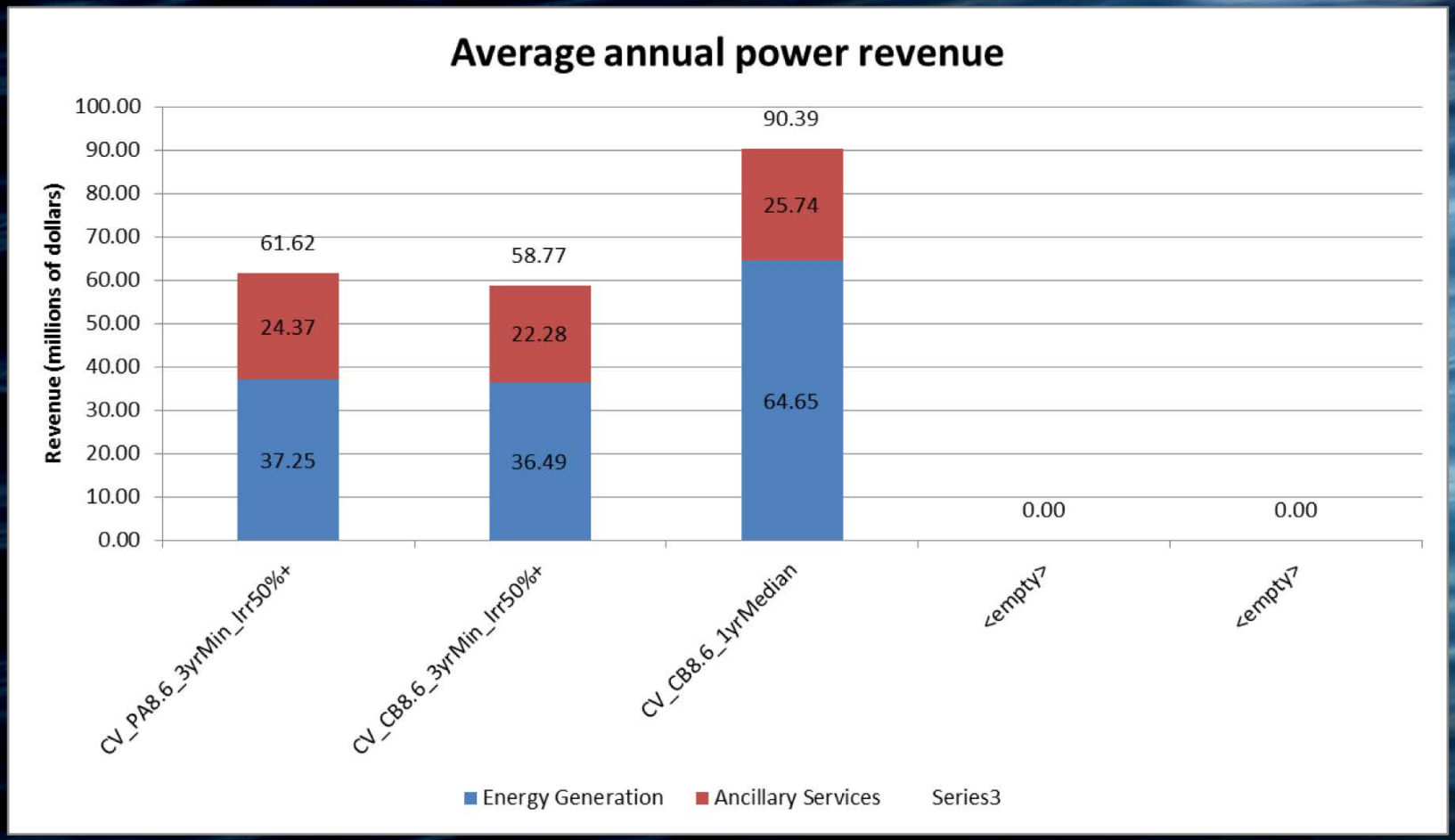
Crop Failure



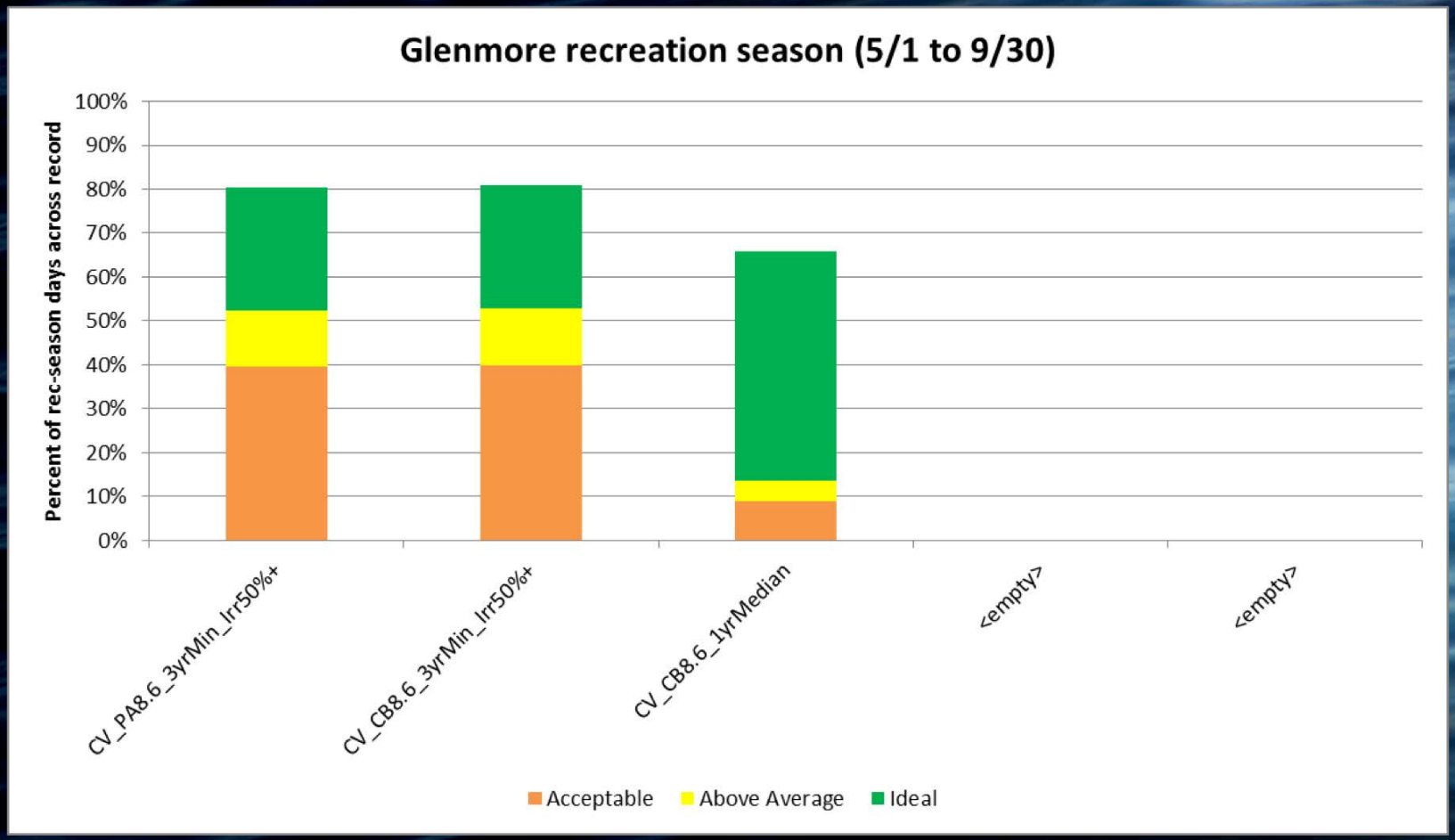
Induced Shortage



Hydropower – It's more than KWH



Recreation


Glenmore recreation season (5/1 to 9/30)
Percent of rec-season days across record
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
CV_PA8.6_3yrMin_Irr50%+
CV_CB8.6_3yrMin_Irr50%+
CV_CB8.6_1yrMedian
<empty>
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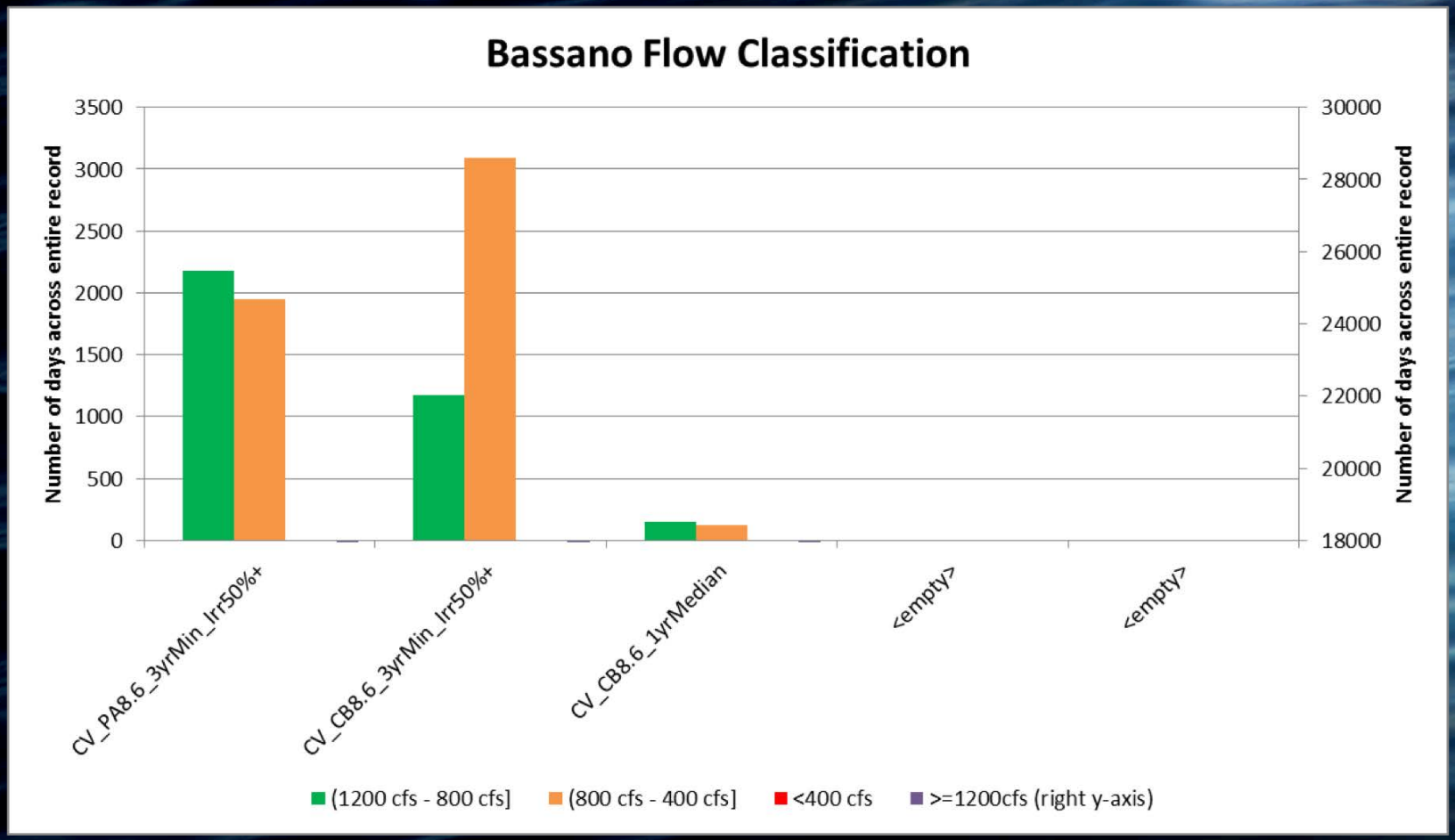
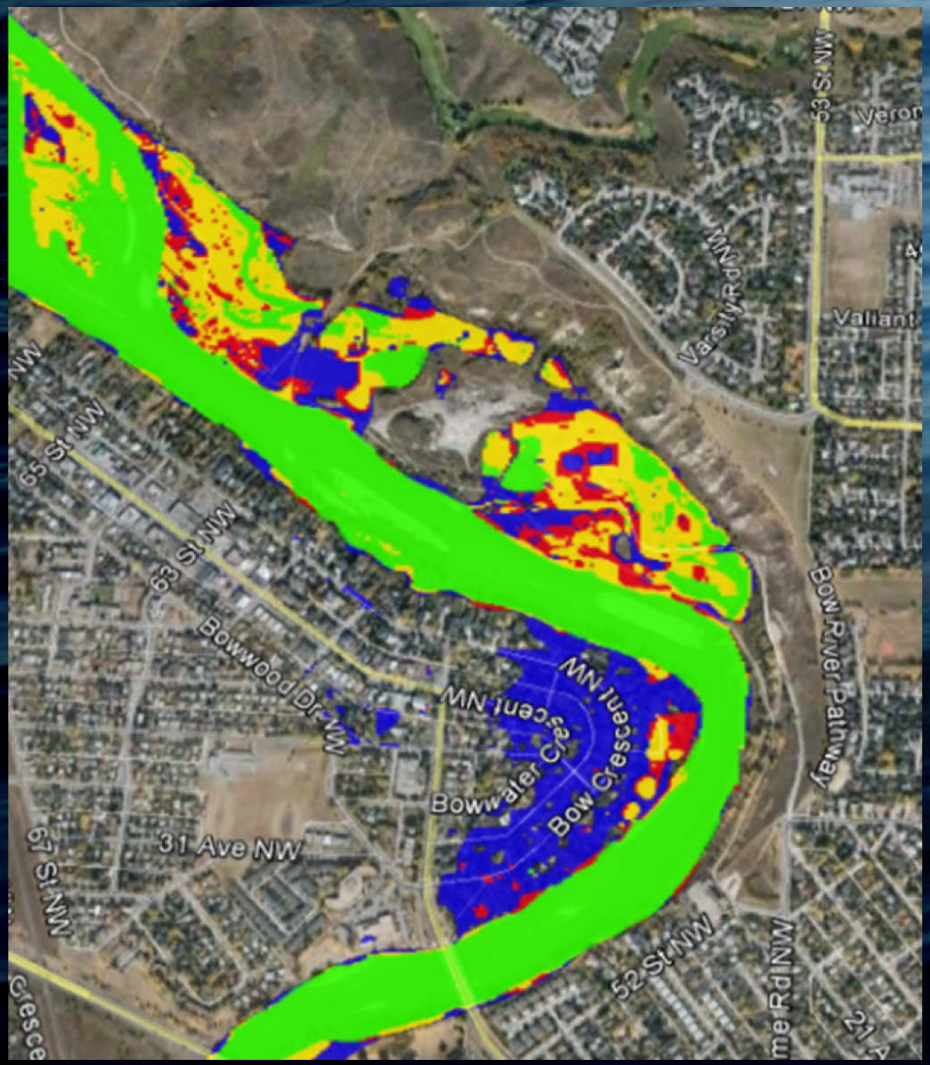
Acceptable
Above Average
Ideal

Environment



Calgary Forecast Seasonal Flood Risk



Simulation Models and Dispute Resolution

- It's a process
- Performance metrics are the key
  - Encourages stakeholders to think about what they want
  - Helps stakeholders understand each other's needs
  - Builds a basis for communications
- Build credible tools
  - Vet data, science, and assumptions, educate participants
  - Involve stakeholders directly
- Provide a common and equally available method for evaluation
  - Level the playing field
- Encourage collaboration


Google

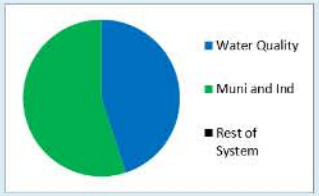
Drought Tournaments

Existing Storage

Approximate Total Expansion Cost: $0

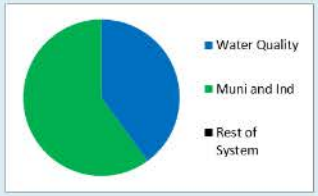
	Muni and Ind Pool (%)	Water Quality Pool (%)	Rest-of-System Pool (%)
Wildcat	55 (Base: 55%)	45 (Base: 45%)	0 (Base: 0%)

Storage Expansion: Pool Rise (%) 0
Max Expansion: 15%
Base: 81,000 AF
New: 81,000 AF
Cost: $0



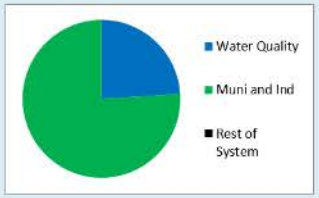
	Muni and Ind Pool (%)	Water Quality Pool (%)	Rest-of-System Pool (%)
Jayhawk	60 (Base: 60%)	40 (Base: 40%)	0 (Base: 0%)

Storage Expansion: Pool Rise (%) 0
Max Expansion: 10%
Base: 44,000 AF
New: 44,000 AF
Cost: $0



	Muni and Ind Pool (%)	Water Quality Pool (%)	Rest-of-System Pool (%)
Shocker	76 (Base: 76%)	24 (Base: 24%)	0 (Base: 0%)

Storage Expansion: Pool Rise (%) 0
Max Expansion: 20%
Base: 62,000 AF
New: 62,000 AF
Cost: $0



No Pools

Check to Turn Off Pools ☐

Turning off pools has the effect of treating stored water as available for call by any user.

New

Approximate Total Cost: $85M

New Mainstem On-stream Reservoir
Haskell Lake

Check to Enable ☐

New Tributary On-stream Reservoir
Baker Lake

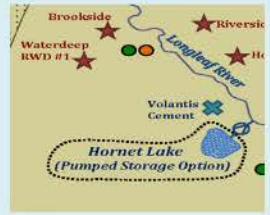
Check to Enable ☑

Operations: Support Municipal Demands

Size (AF): 30000
Min Size: 2,000 AF
Max Size: 60,000
Cost: $85M

New Pumped Storage Reservoir
Hornet Lake

Check to Enable ☐



Conservation

Approximate Total Cost: $0

	Demand Reduction (%)	Description
Municipal	0	No demand reduction.
Industrial	0	No demand reductions

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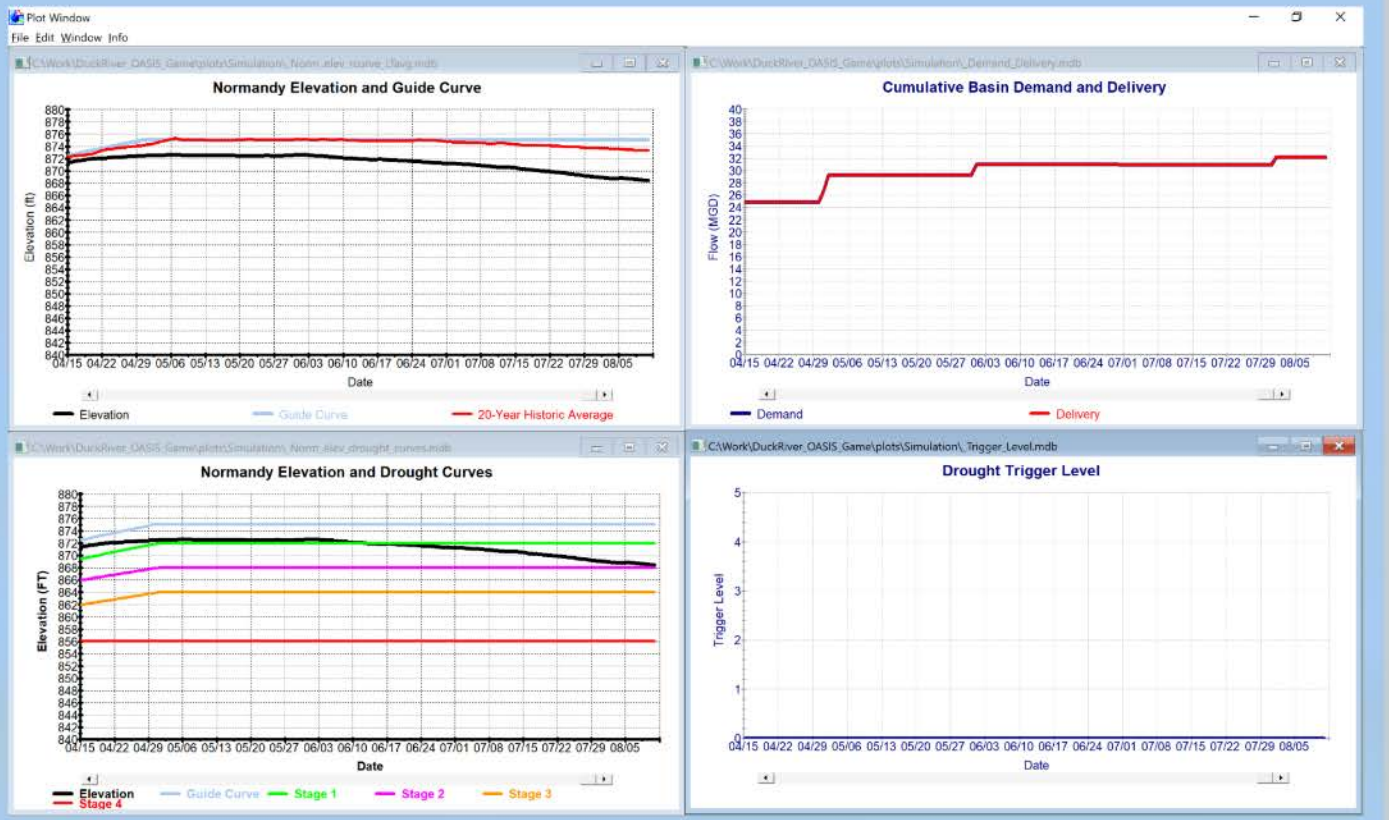
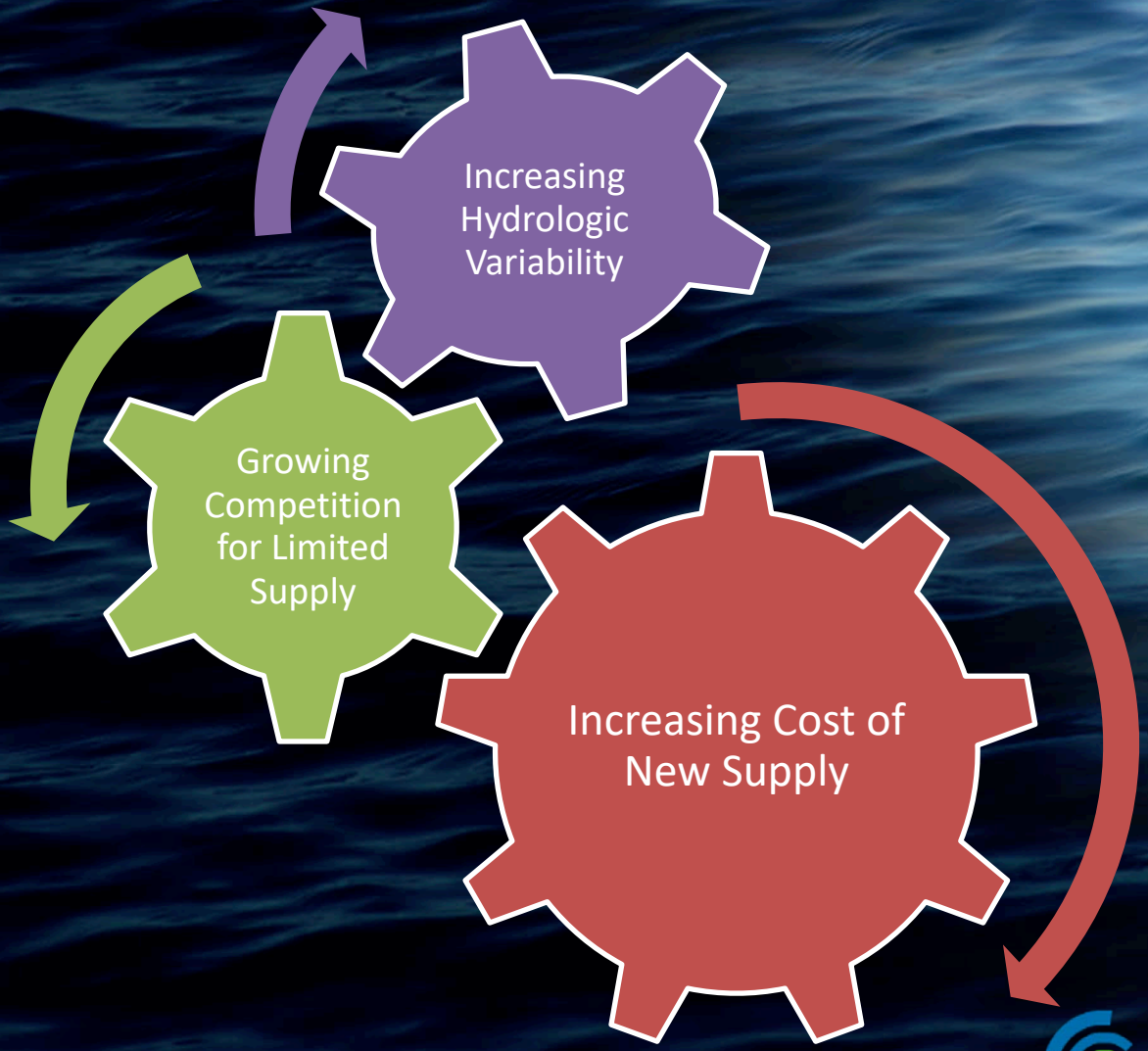
Drought Exercises

Output Information



The New Normal



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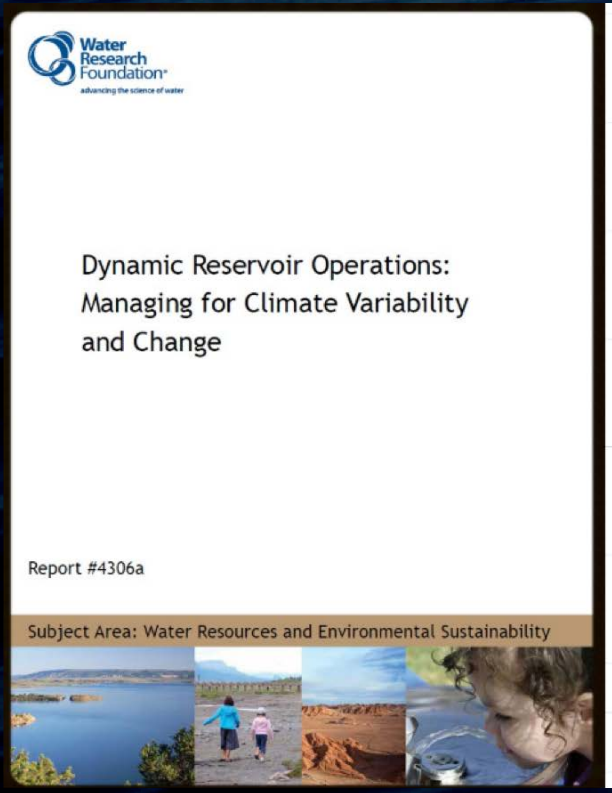
DRO: Dynamic Reservoir Operations



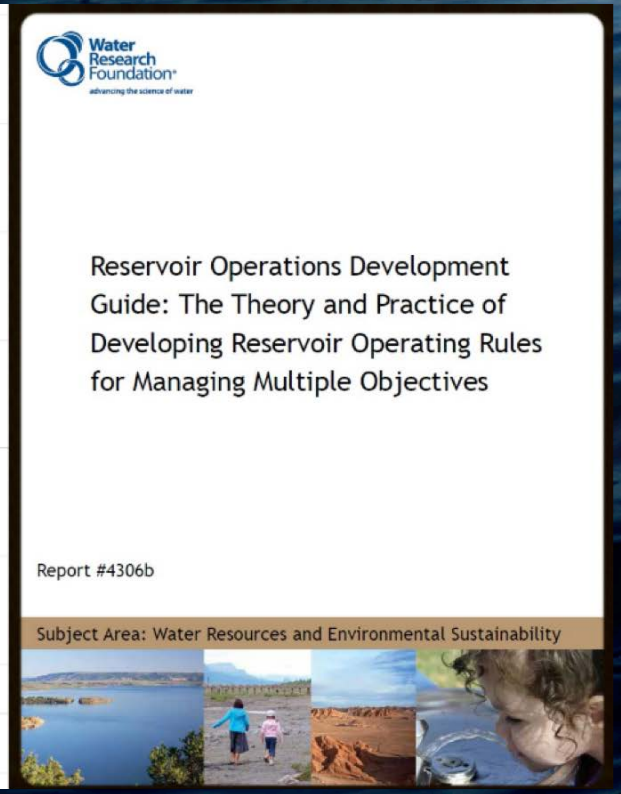


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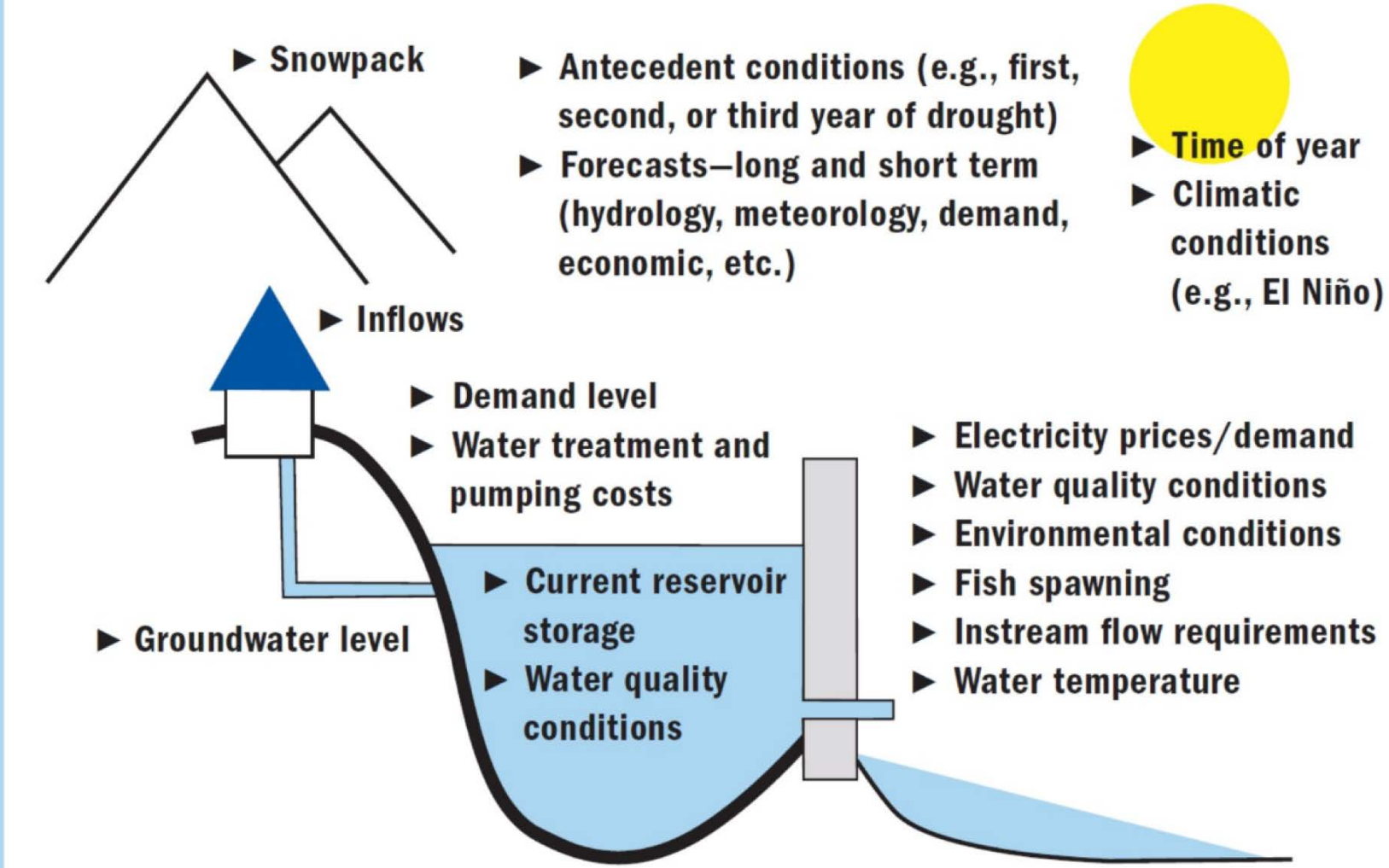
Figure 1. DRO Information

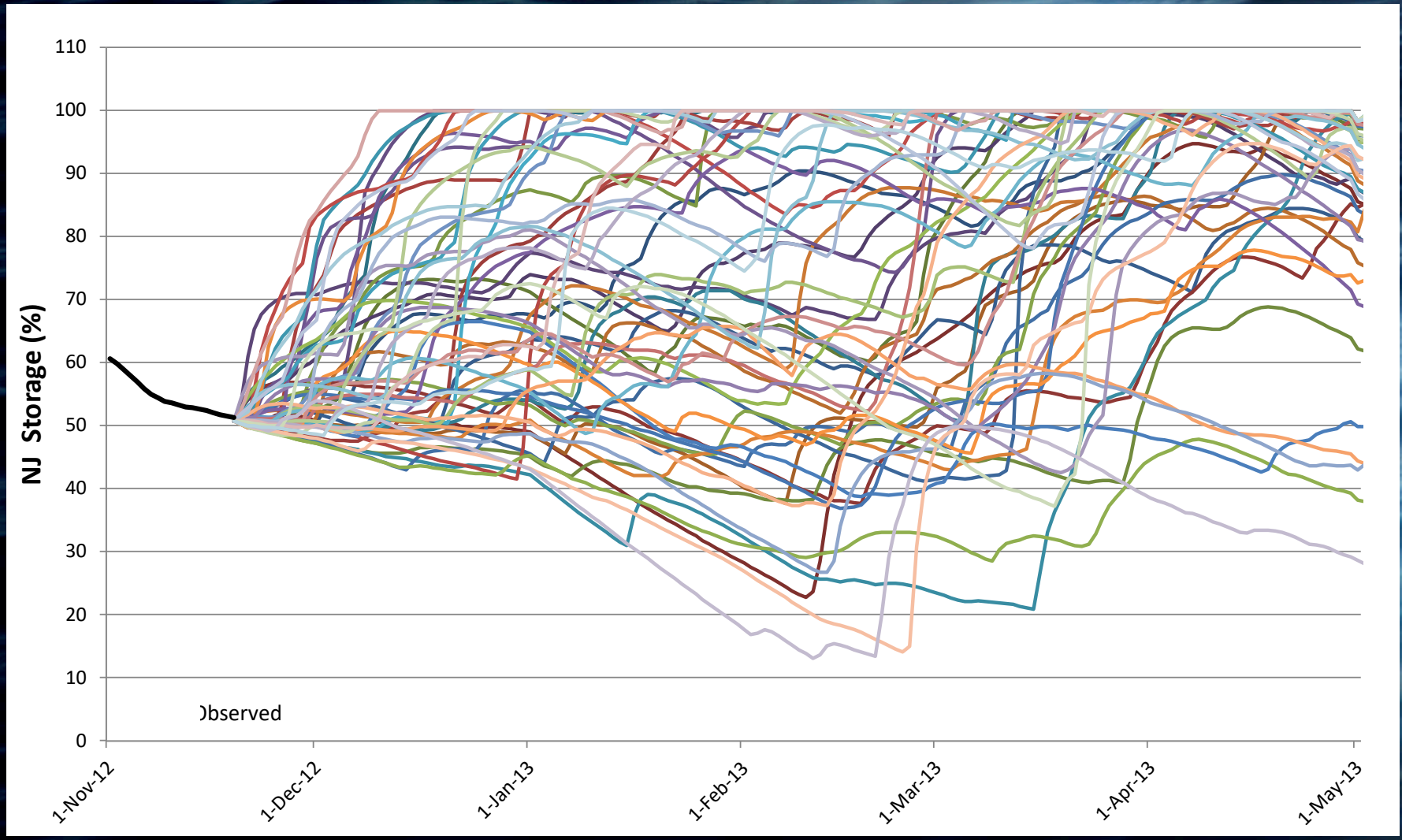
A variety of information is used to meet a utility's DRO objectives.



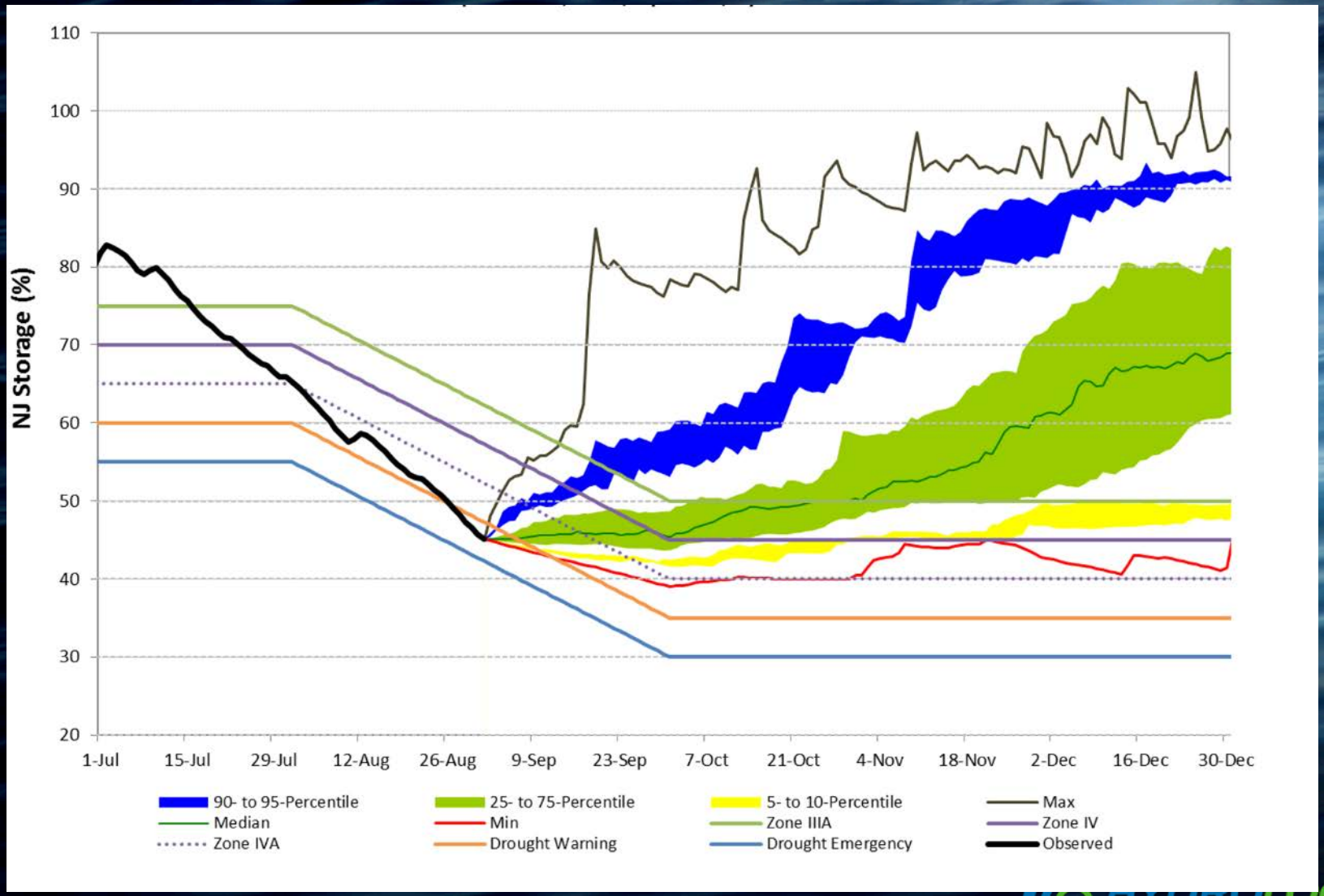
From AWWA *Opflow* magazine, March 2016

Limits of Static Rules

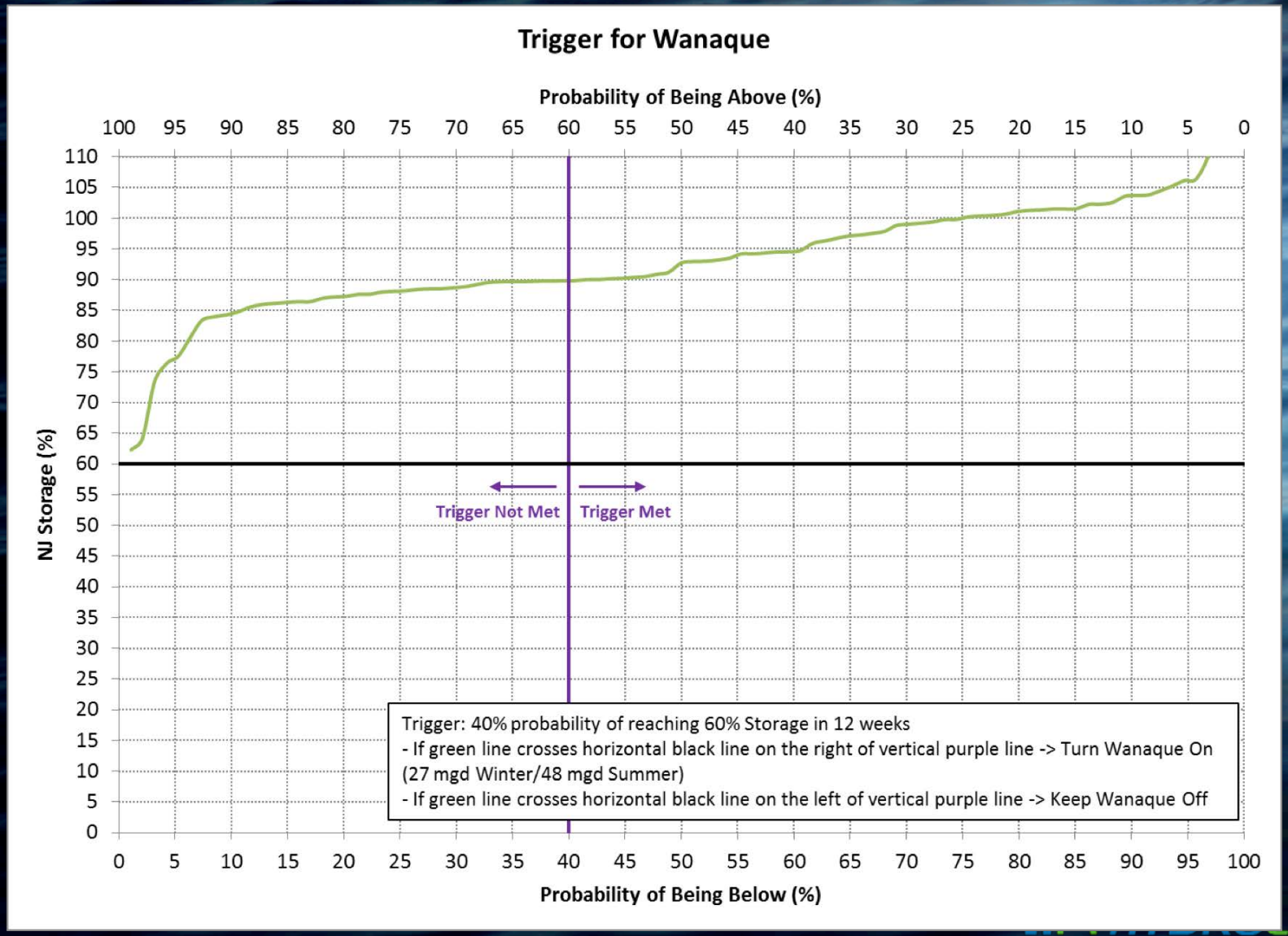
Sample Forecasts



Sample Forecasts



Dynamic Rules Based on the Forecasts



Implementation of Dynamic Rules

NYC DEPARTMENT OF ENVIRONMENTAL PROTECTION

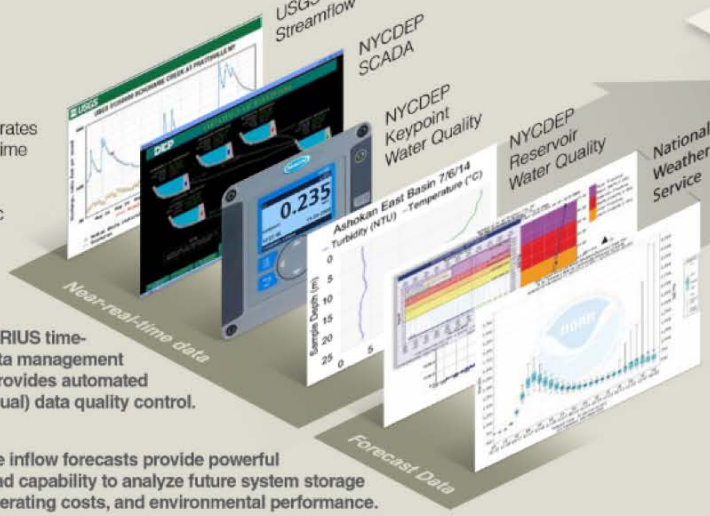
Operations Support Tool

Hazen and Sawyer led development of the Operations Support Tool (OST) to help NYCDEP meet the challenges of operating its 19-reservoir water supply system. OST is a data and modeling system that integrates near-real time data and ensemble inflow forecasts with reservoir operating rules and simulation modeling. NYCDEP uses OST to guide reservoir system operations decisions that reliably deliver 1.1 billion gallons of high quality water daily to over 9 million people.

How it works

1 Data feeds

OST integrates near-real time data and ensemble hydrologic forecasts.



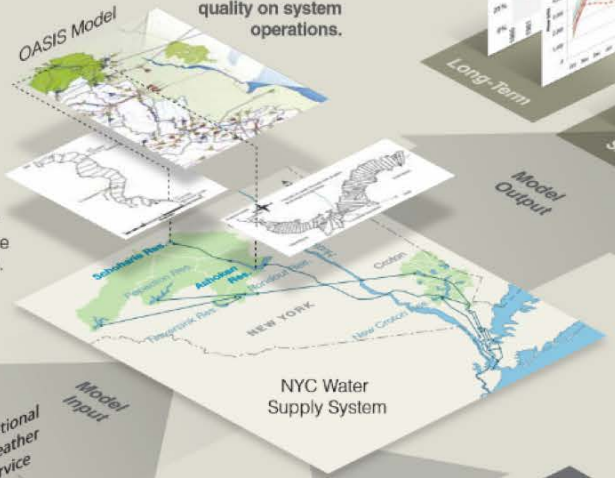
An AQUARIUS time-series data management system provides automated (and manual) data quality control.

Ensemble inflow forecasts provide powerful look-ahead capability to analyze future system storage levels, operating costs, and environmental performance.

2 Operations Model

The core of OST is an OASIS model of New York City's water supply system and the Delaware River Basin.

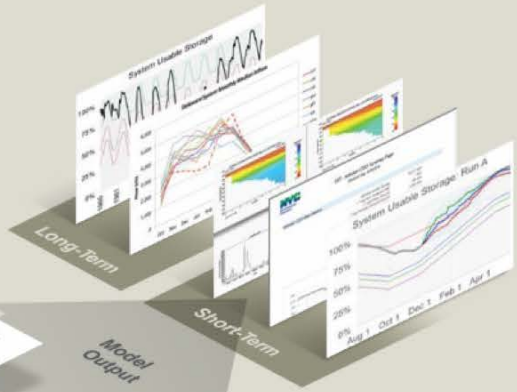
OASIS is dynamically linked to CE-QUAL-W2 models of key reservoirs to capture the impact of water quality on system operations.



The OASIS-W2 model simulates daily reservoir operations and water quality. Operators run what-if scenarios to select operations that best meet reliability, quality, environmental, and cost objectives.

3 Planning, Operations Support

Create short-term ensemble simulations for operational guidance, or long-term runs for capital planning, rule testing, and climate change assessment.



At the helm

Multiple users can access the system concurrently to review data inputs, create simulations, and analyze results through a user-friendly interface and interactive dashboard.