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Managing Water in the West

TRUCKEE BASIN STUDY

Technical Advisory Group
Indicators Workshop

July 14, 2014

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

TMWA

PCWA
water • energy • stewardship

TRUCKEE RIVER FLOOD PROJECT

TAHOE REGIONAL PLANNING AGENCY

TAG Workshop Agenda

- **Morning Briefing (9 am – 12 pm)**
  - Introductions, Purpose and Organization of Workshop
  - Progress Briefing (Supply and Demand Assessments)
  - Preview of initial results
- **Working Lunch: Adaptation Options Brainstorm**
- **Afternoon Workshop (1 – 4 pm)**
  - Indicators Workshop
  - Considerations for exploring adaptation options
  - Next Steps

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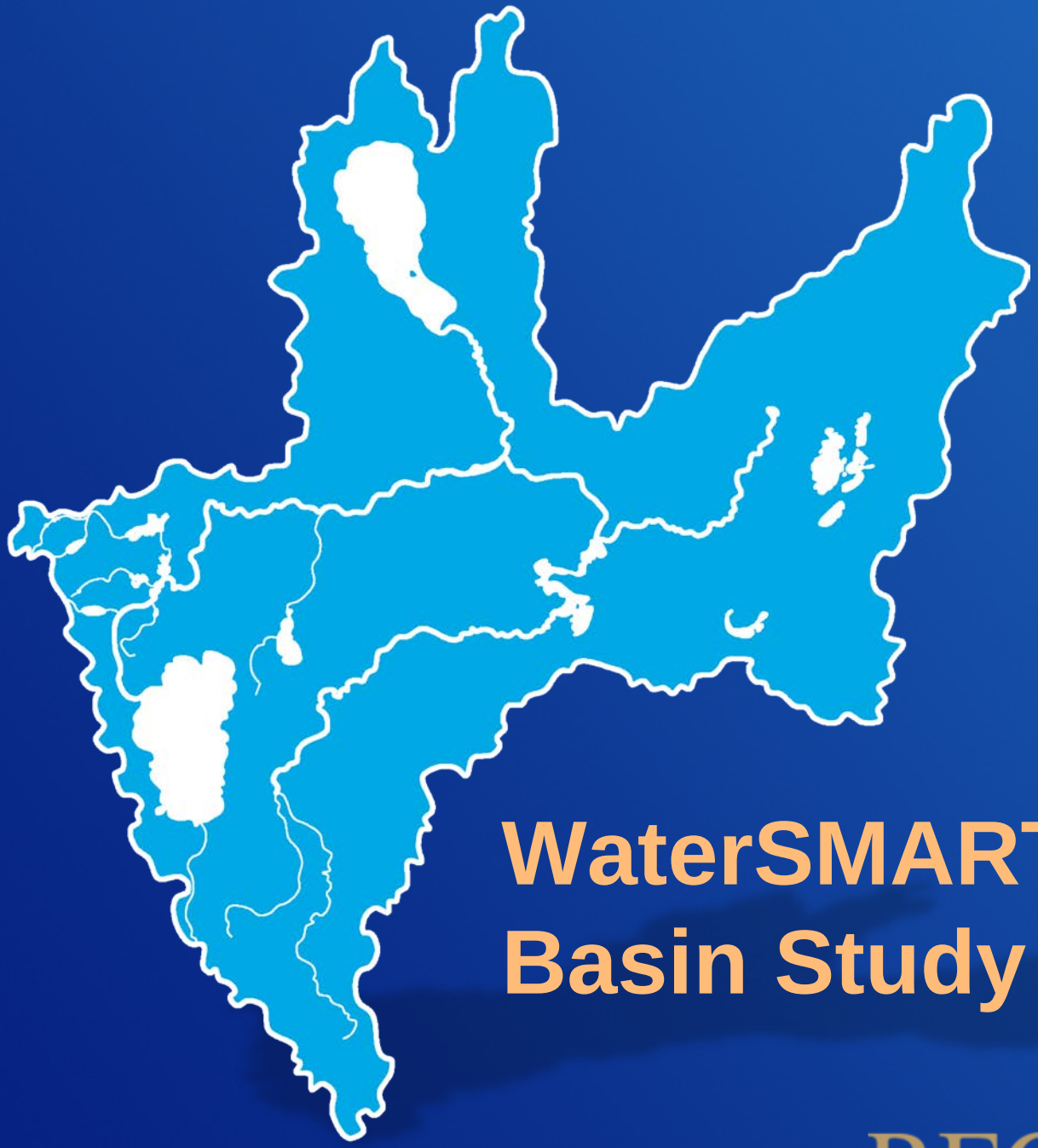

WaterSMART and the Basin Study Programs

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WaterSMART Program

- **Implements SECURE Water Act, Public Law 111-11**

- **Established in 2010 by Secretary Salazar to…**
  - **Help water resource managers make sound decisions about water use**
  - **Develop strategies to ensure sufficient water supplies for multiple uses**
  - **Develop adaptive measures to climate change**
  - **Improve water conservation**
  - **Promote sustainability**

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Basin Study Program

- **West-Wide Climate Risk Assessments**

- **Basin Studies**
  - **Basin Studies to determine imbalances**
  - **Secure Water Act authorizes the potential follow-up with Feasibility or Special studies for promising strategies**

- **Landscape Conservation Cooperatives**

West-Wide Climate Risk Assessments

- Conducted by Reclamation
- Reconnaissance-level water supply and demand analyses in eight Reclamation river basins
- Projections of climate change impacts to water supply and demand and baseline risk assessments to evaluate impacts of climate change to water uses
- Baseline for more in-depth analyses performed through Basin Studies

SECURE Water Act Section 9503(c) – Reclamation

Climate Change and Water – April 2011

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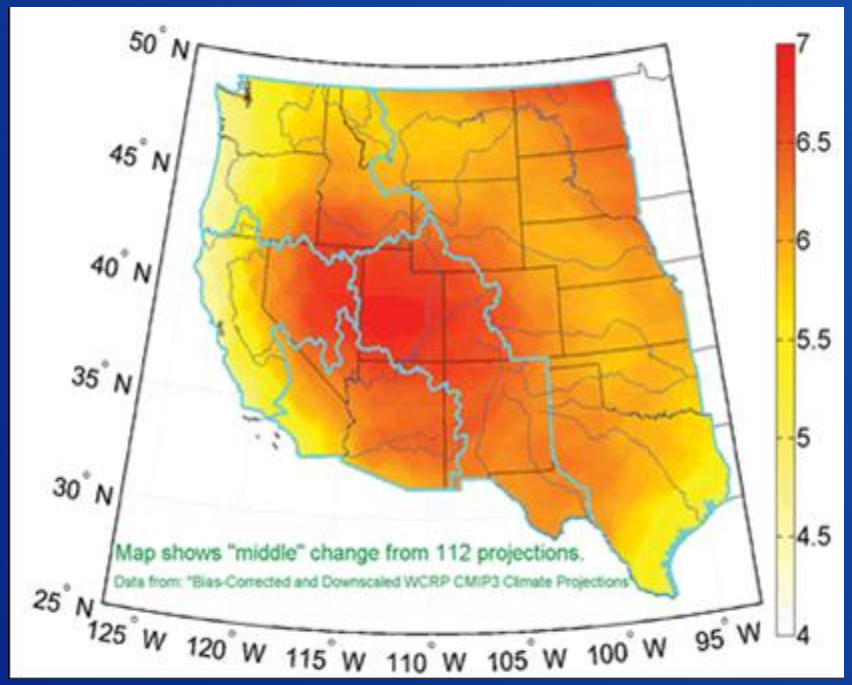
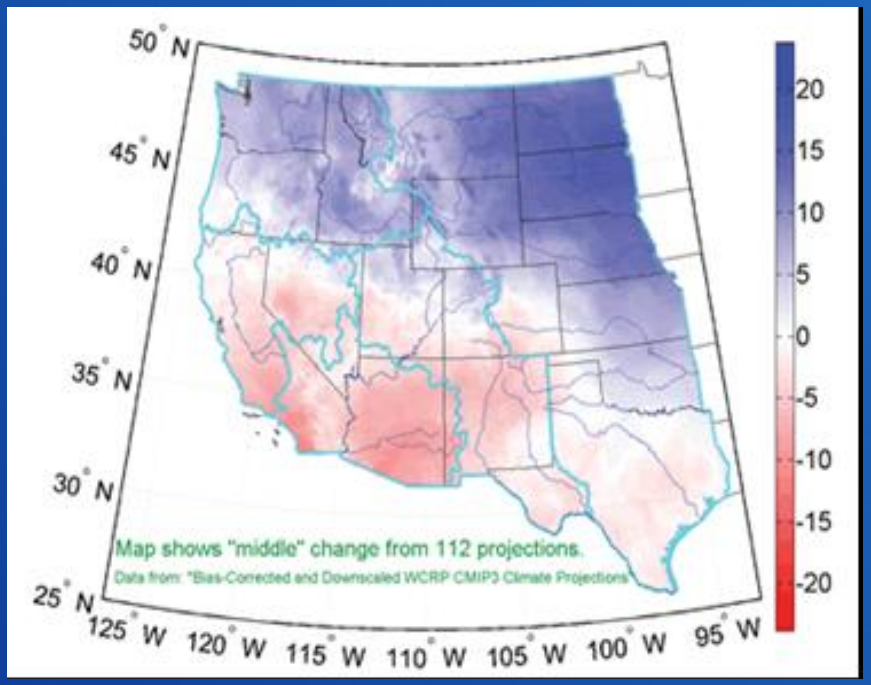
SECURE Water Act Section 9503(c) – Reclamation Climate Change and Water – April 2011





Projected median temperature (°F) and precipitation (%) changes at the end of 21st century (2070–2099) relative to historic conditions (1950–1979)

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Basin Study Partners

50-50 cost share between Reclamation and partners

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Study Management Structure

WaterSMART Basin Studies

Reclamation

Tribes

Truckee Basin Study Project Steering Team

Reclamation
Mid-Pacific

Cost-Share Partners

Executive Committee

Study Team

Technical Advisory Group

Technical Experts &
Regional Stakeholders

Workshop Topics

- Supply Scenarios
- Demand Scenarios
- Indicators and Metrics
- Options and Strategies

Public

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Basin Study Technical Approach & Purpose of Workshop

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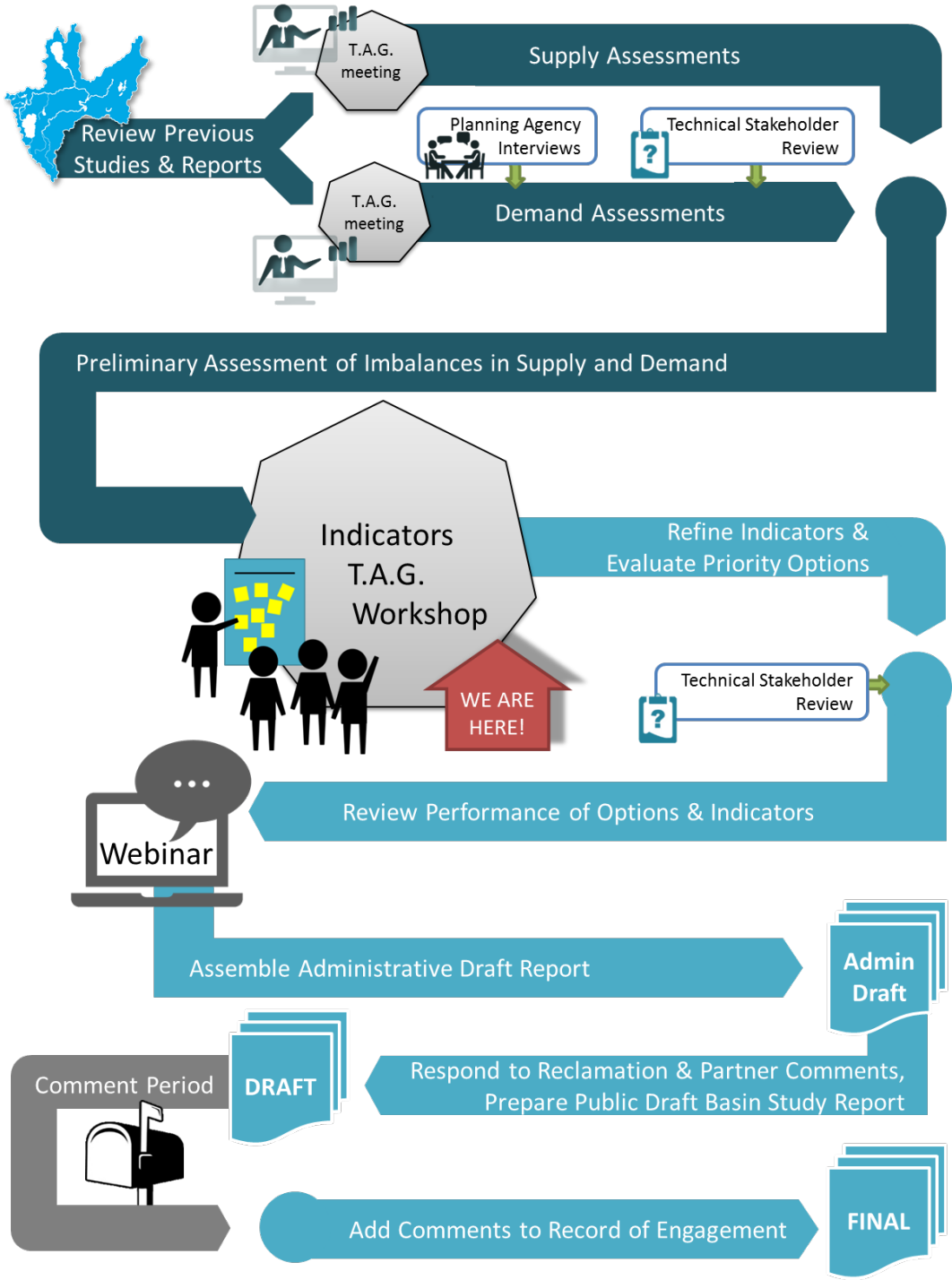
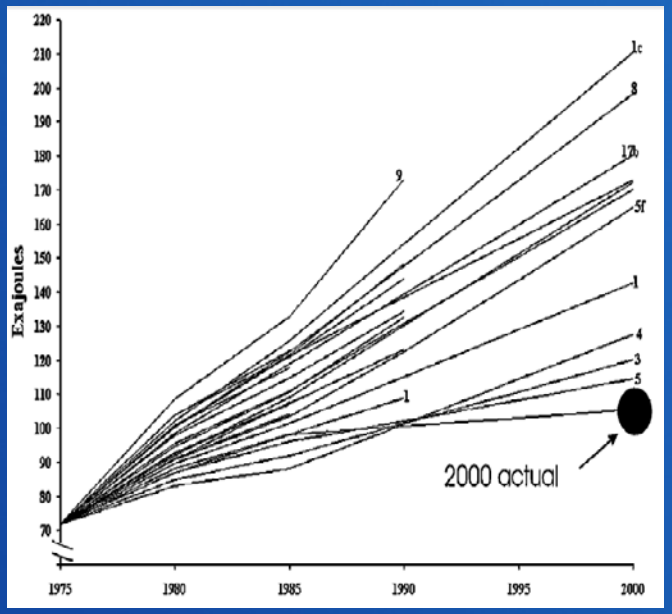
Study Process



Principal Concepts to Remember During the Morning Briefing

- **Scenarios are needed for addressing the uncertainties of the future**

- **Stakeholder/Expert input is necessary for understanding future risks and identifying responses**



Source: Craig, P.P., Gadgil, A., Koomey, J.G., 2002.

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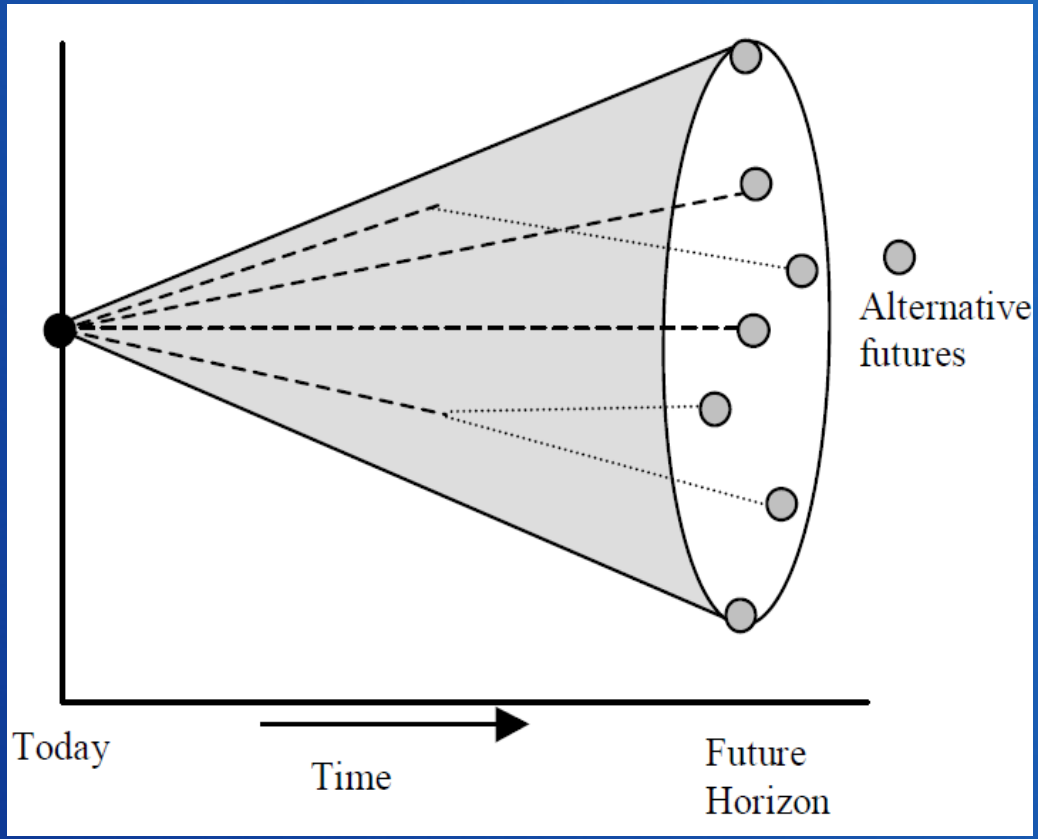
Scenario Development

- **Effective treatment of uncertainty is key to Basin Study**
- **Uncertainty is addressed through "scenarios"**



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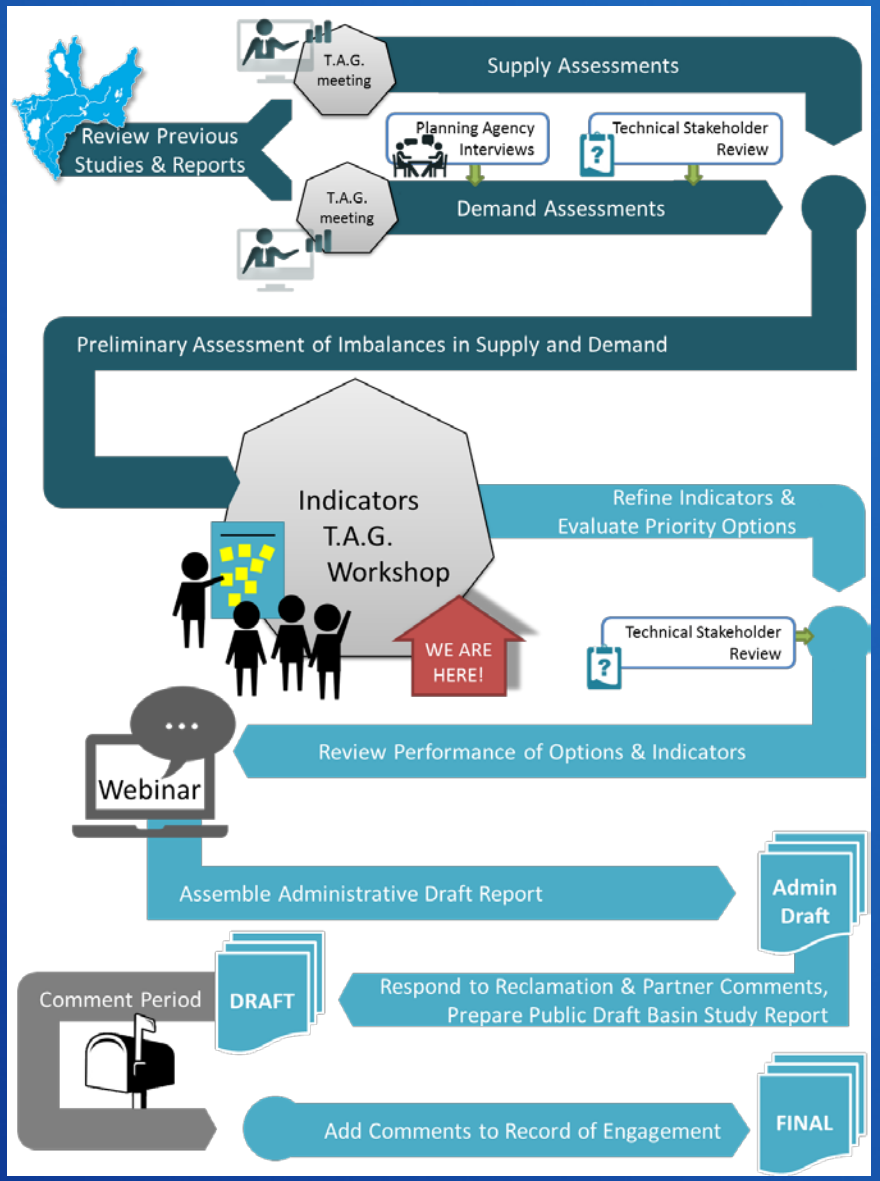
Stakeholder Input is Needed

- Identify how to represent the range of potential future demands
- Identify how to interpret risk, reliability, and sensitivity to changing conditions (indicators)
- Focus the basin study on actions that seem most effective for responding to climate change

Study Process

- **Progress To Date**
  - Refined hydrology model (DRI)
  - Completion of scenarios
  - Initial Planning Model Evaluation
- **Upcoming Activities**
  - Refinement of ‘Risk’
  - Testing Options and Strategies
- **Remaining Coordination**
  - Today’s Workshop
  - Technical review of revised indicators
  - Public Webinar to report results
  - Comment on DRAFT Report



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Methodology for Demand Assessment

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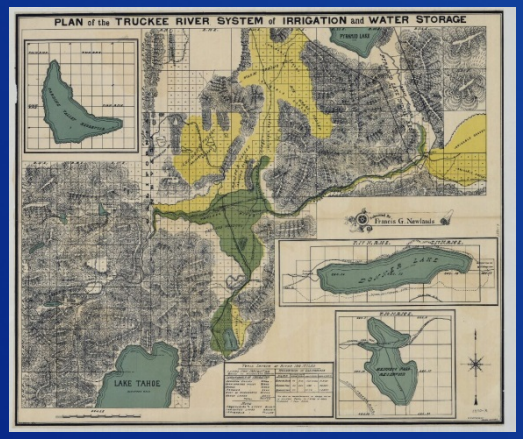
Definitions of Demand

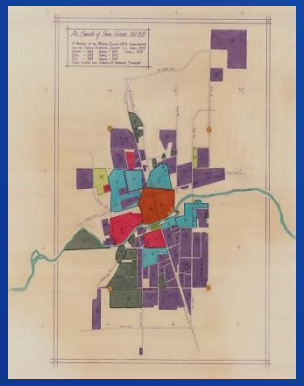
- Demands = uses
  - M&I
  - Agriculture
  - Hydropower
  - Fish/environmental flows
  - Recreation

- Consumptive and nonconsumptive diversions from the rivers that govern operations and the manner in which these diversions are sensitive to climate change.

Predicting the Current Truckee Basin

Early 1900s





Today

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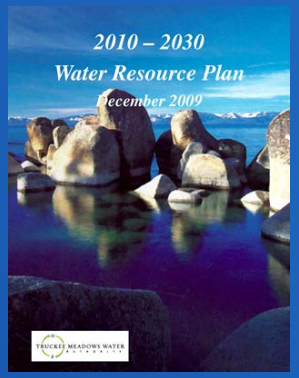
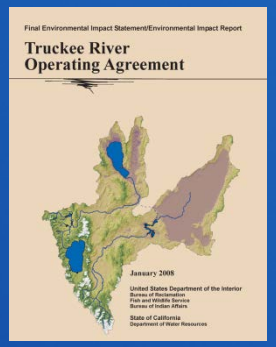
Overview of Methodology

- Review of Previous Studies and Reports
- Input from Planning Agencies on Future Growth
- Identification of Key Drivers
- Development of Future Demand Storylines
- Stakeholder Review of Demand Scenarios

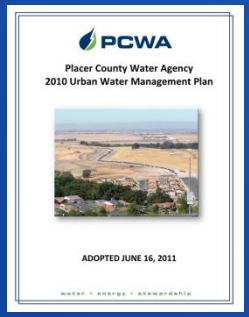
Previous Studies and Reports

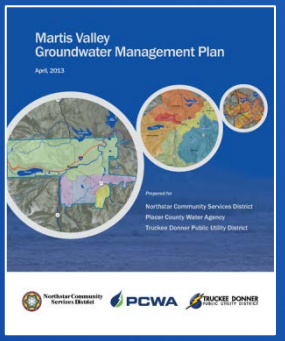
- **Planning Studies and Management Plans**
  - General plans
  - Local water resources plans
  - State demographer projections
  - Truckee River Operating Agreement EIS/EIR
  - California Water Plan





- **Environmental Studies**
  - Tahoe-focused climate change reports
  - State of the Lake reports
  - Hydrology and groundwater studies





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Input Obtained to Develop Demand Storylines

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Key Drivers in the Basin

- **Primary: Economy**

- **Secondary:**
  - **Institutional and Political Conditions**
  - **Natural Systems (environment)**
  - **Technology**
  - **Social Values and Pursuits**

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Demand Storylines

- **Robust Economy (Future Storyline)**
  - Based on late 1990s and early 2000s
  - Represents an upper bound for water use and diversions
- **Existing Trends (Future Storyline)**
  - Based on late 2000s' economic recession
  - Represents lower bound for water use and diversions
- **2012 Demands**
  - No growth
  - Serves as basis of comparison

Key Differences Between Future Demand Storylines

Robust Economy

- Urban areas reach full use of current supplies between 2040 and 2070
- Increased demand for agricultural products

Existing Trends

- Urban areas reach full use of current supplies between 2050 and 2100
- Commercial agricultural lands converted to urban use in Truckee Meadows

Sources for 2012 Demand

- **Municipal & Industrial Demands**
  - Reno area demands based upon TMWA planning estimates
  - Fernley demands based on Water Supply Master Plan
  - Tahoe demands based on TROA and area utility estimates of recent demands
- **Agriculture**
  - Newlands Project demands based upon Reclamation records of acreages under cultivation in recent years
  - Truckee Meadows agricultural demands based upon recent acreages under cultivation, per Federal Watermaster

Results of the Demand Assessment

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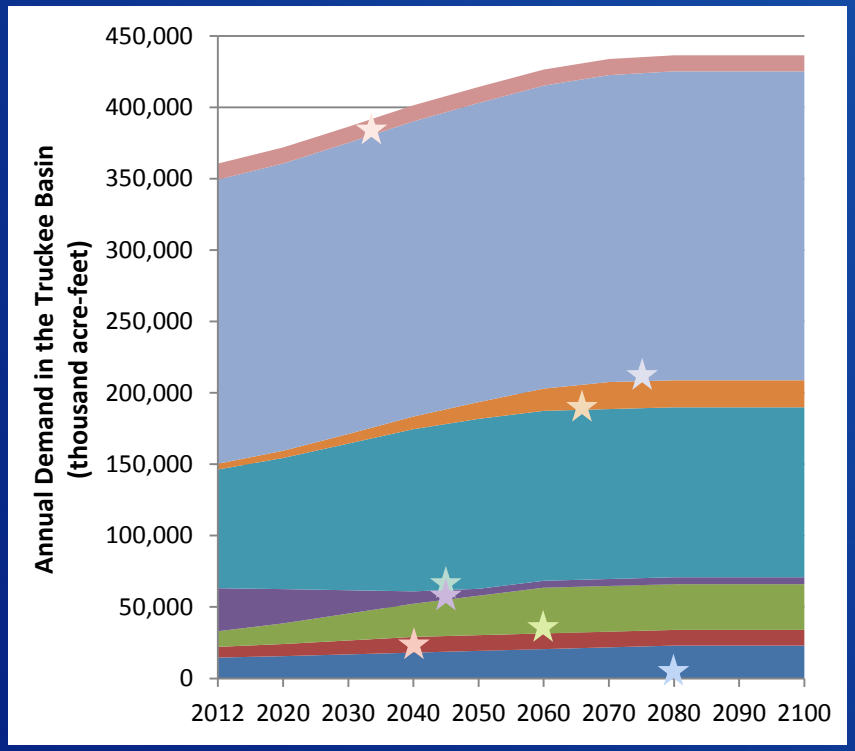
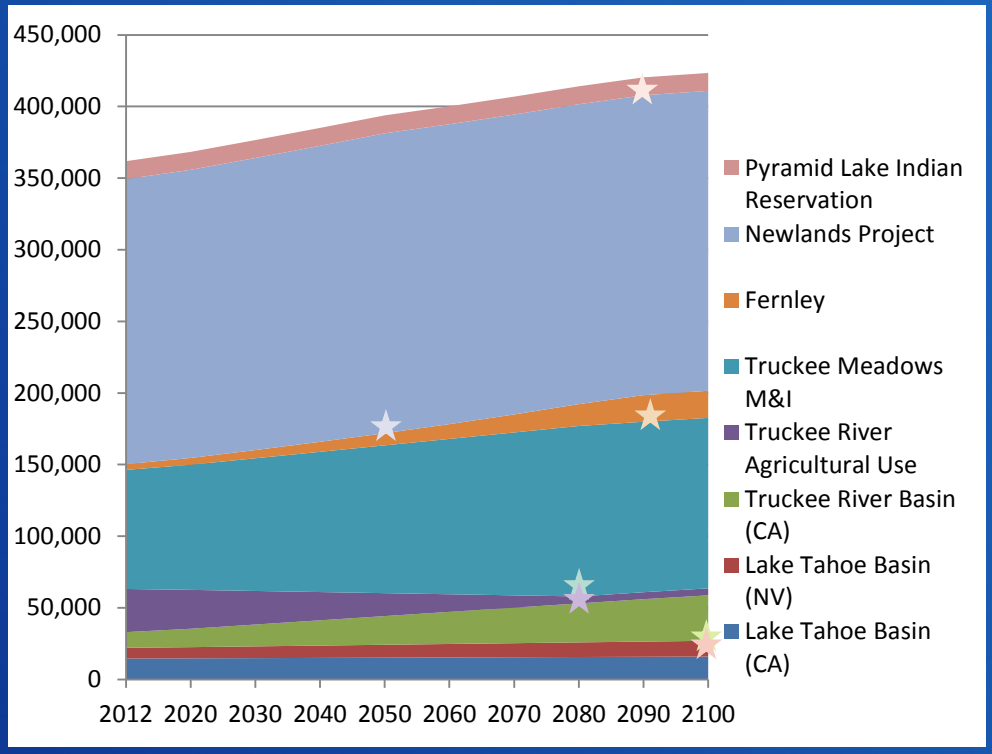
Composite Consumptive Demands

Robust Economy



Existing Trends



★ = Year in which future demand is fully reached

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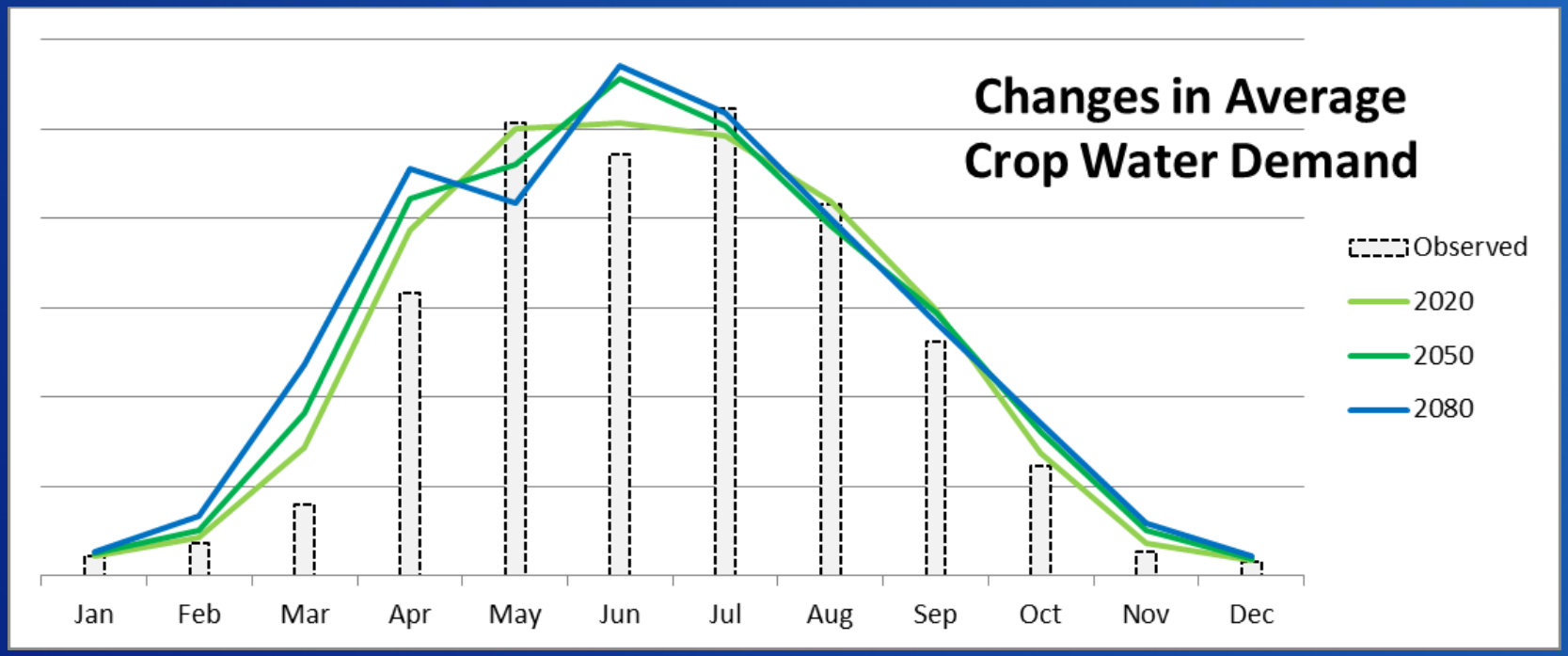
Changes in Demand due to Climate

- **Changes in evapotranspiration**
  - **Changes in crop water demand**
  - **Changes in lake evaporation**
- **Changes in ecosystem needs**

Changes in Crop Demand due to Climate



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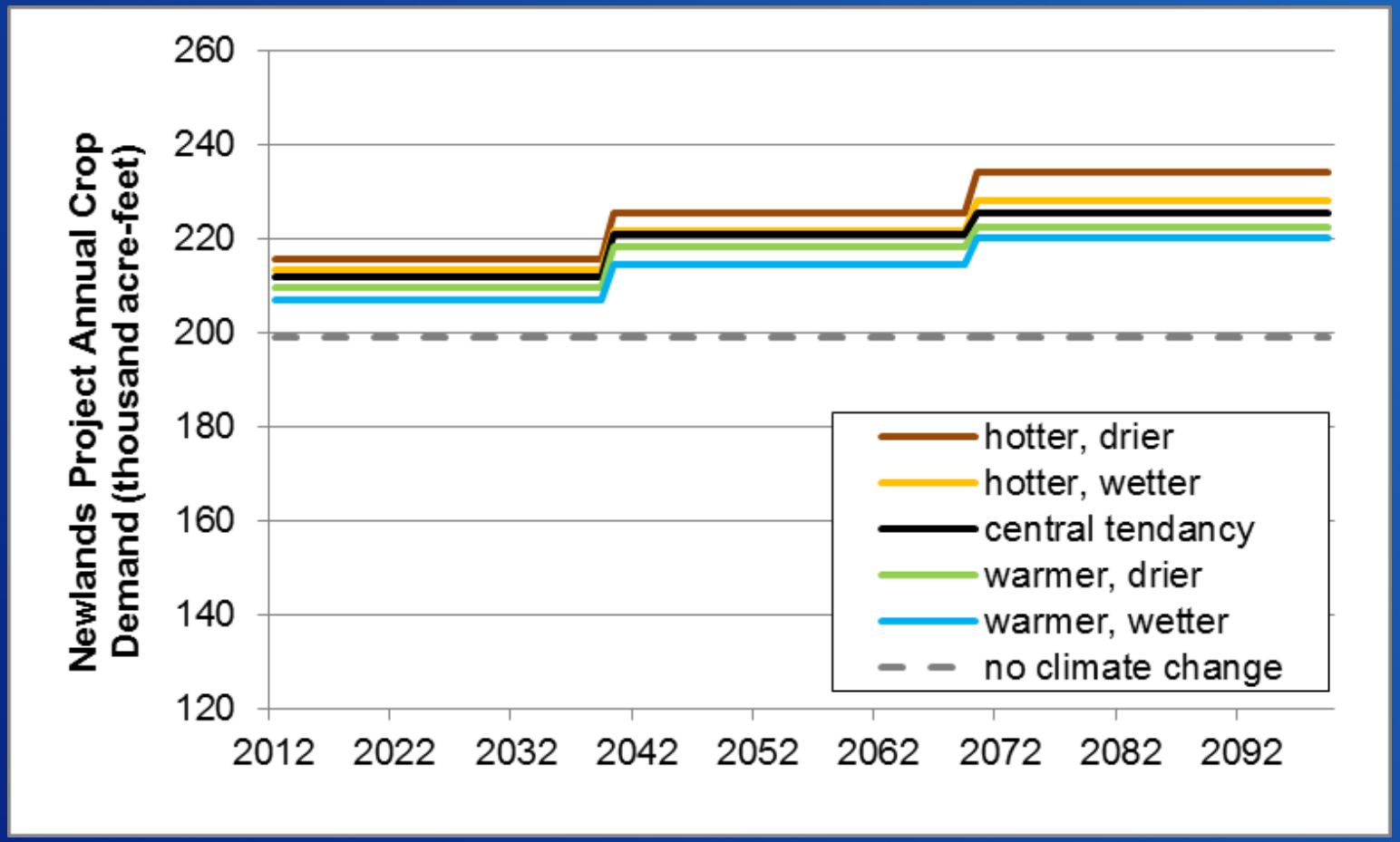
Crop Demand Under the 2012 Demand Storyline



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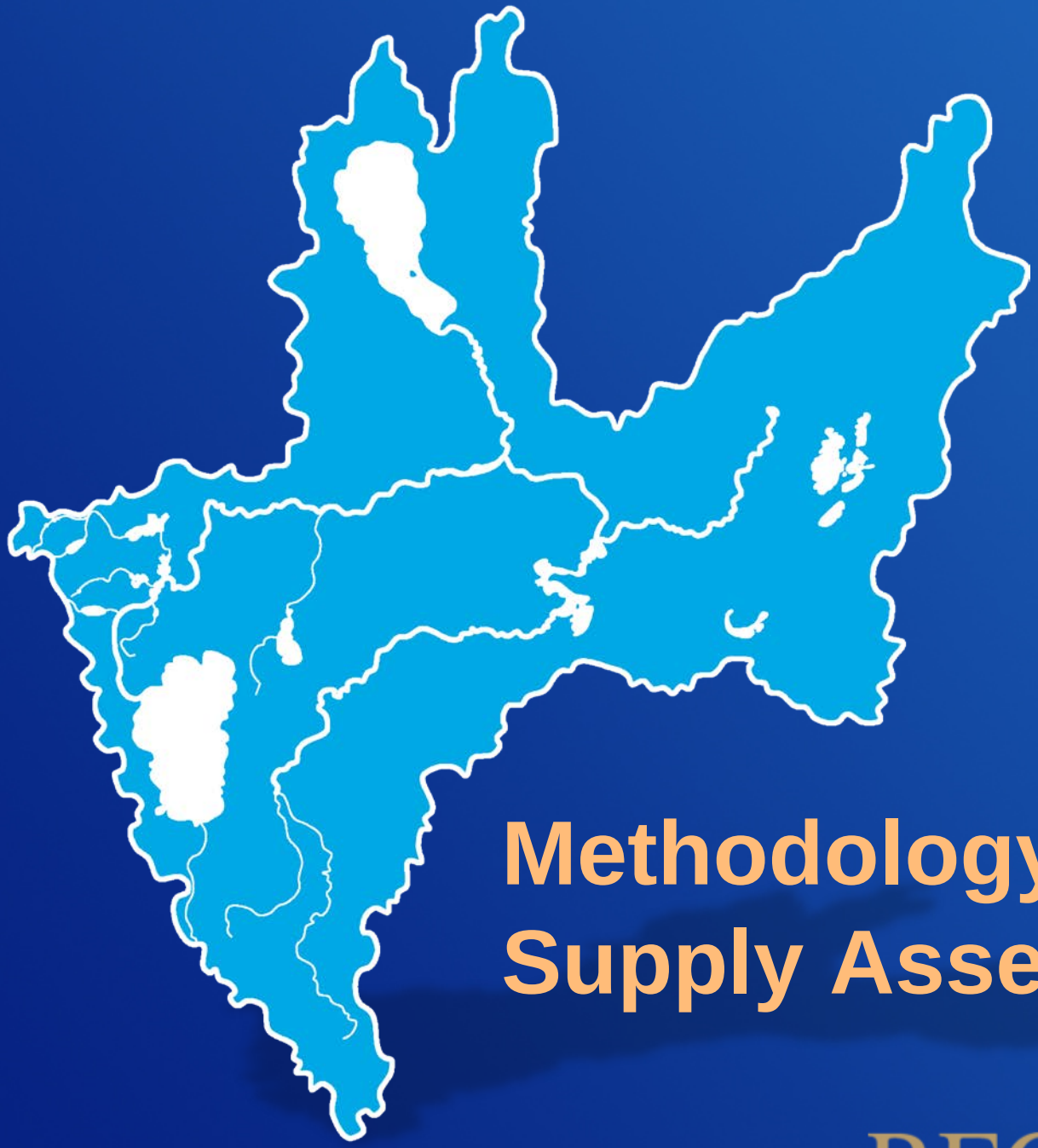
Key Features of the Approach

- Growth doesn’t occur along “straight lines”
- Changes in agricultural demand due to economic forces in combination with climate change
- Changes in ecosystem needs will be addressed through development of indicators and selection of options and strategies



Methodology of Supply Assessment

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Water Supply in the Truckee Basin Study

- Water supply is defined as water volume resulting from watershed runoff
- Water supply also includes changes in lake evaporation due to climate change

Runoff flowing in Galena Creek

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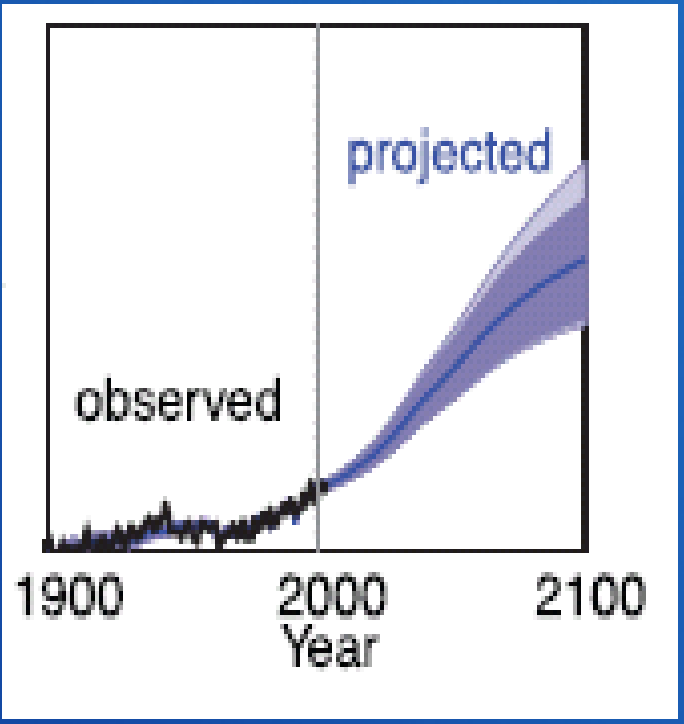
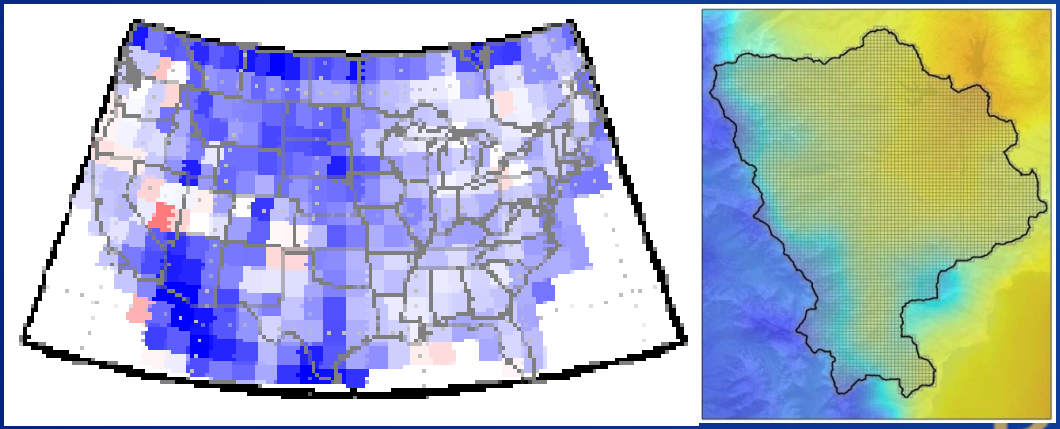
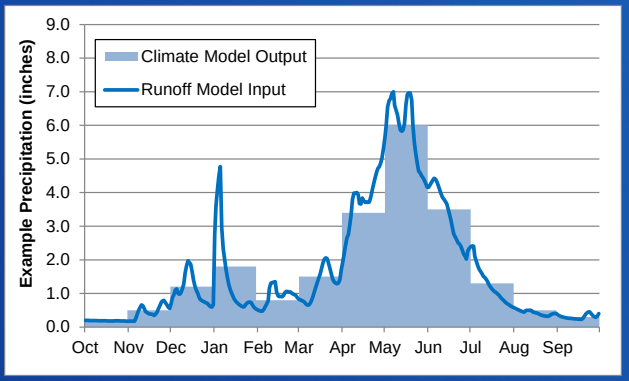
Sources of Uncertainty in Climate Change

- Imperfect gage records
- Spatial and temporal scales
- Models and assumptions

- Uncertainty influences our use of simulation results







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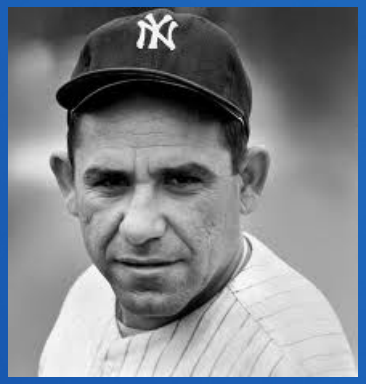
Our Baseline is not the Past

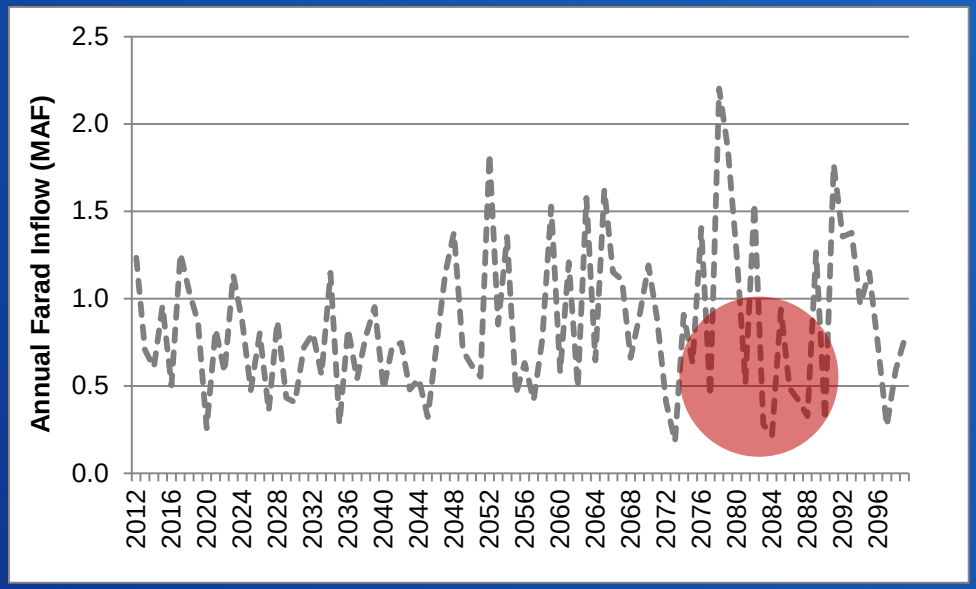
- No Climate Change scenario differs slightly from the familiar historical dataset (TCDAT)
  - Assumptions and deficiencies differ between the historical climate and TCDAT datasets
  - PRMS model calibrated to specific historical daily gage records that differ from disaggregated monthly TCDAT dataset
- No Climate Change scenario
  - Baseline condition
  - Point of comparison



"The future ain't what it used to be"

Wet/Dry Spell Timing

- **Drought of record occurs toward end of century under maximum demands**
  - **Truckee Basin Study will focus on options to address entire time period**



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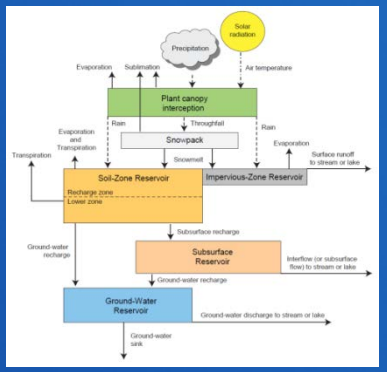
Modeling Process

Economy &
CO2 Emissions
Projections

GCMs

Precipitation
Temperature
Wind
Solar Radiation

Hydrology
Models



Surface Water
Runoff and
Evaporation

Demands &
Operations

Planning Model

Water Supply
Deliveries

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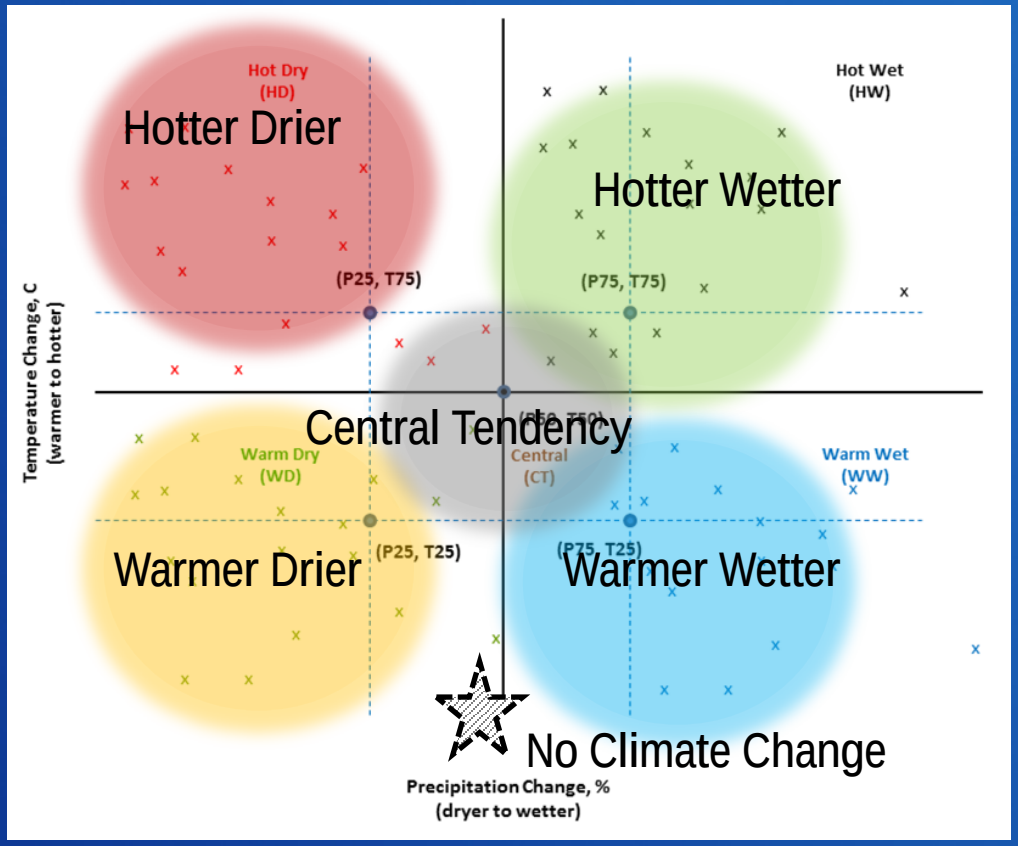
Future Supply Scenarios

- Consider the range of potential future hydrologic conditions resulting from climate change
- Based on 100 years of projected climatic conditions in the Truckee and Carson basins



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Future Water Supply Results

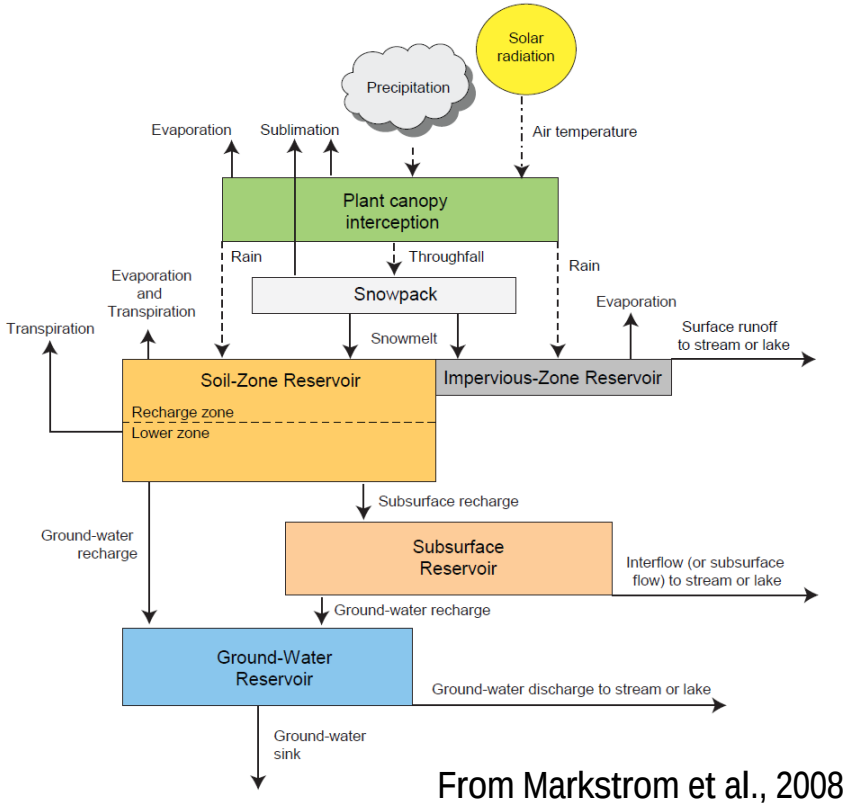

Figure 2. Schematic diagram of a watershed and its climate inputs (precipitation, air temperature, and solar radiation) simulated by PRMS (modified from Leavesley and others, 1983).

- Performed using refined hydrology model (PRMS) by Desert Research Institute
- Vast majority of flow to the Truckee River based on three basin-scale PRMS models of the Upper Truckee watershed: Lake Tahoe, Little Truckee and Martis-Donner Basins
- PRMS simulates the dominant watershed processes affecting streamflow (with the exception of groundwater discharge)

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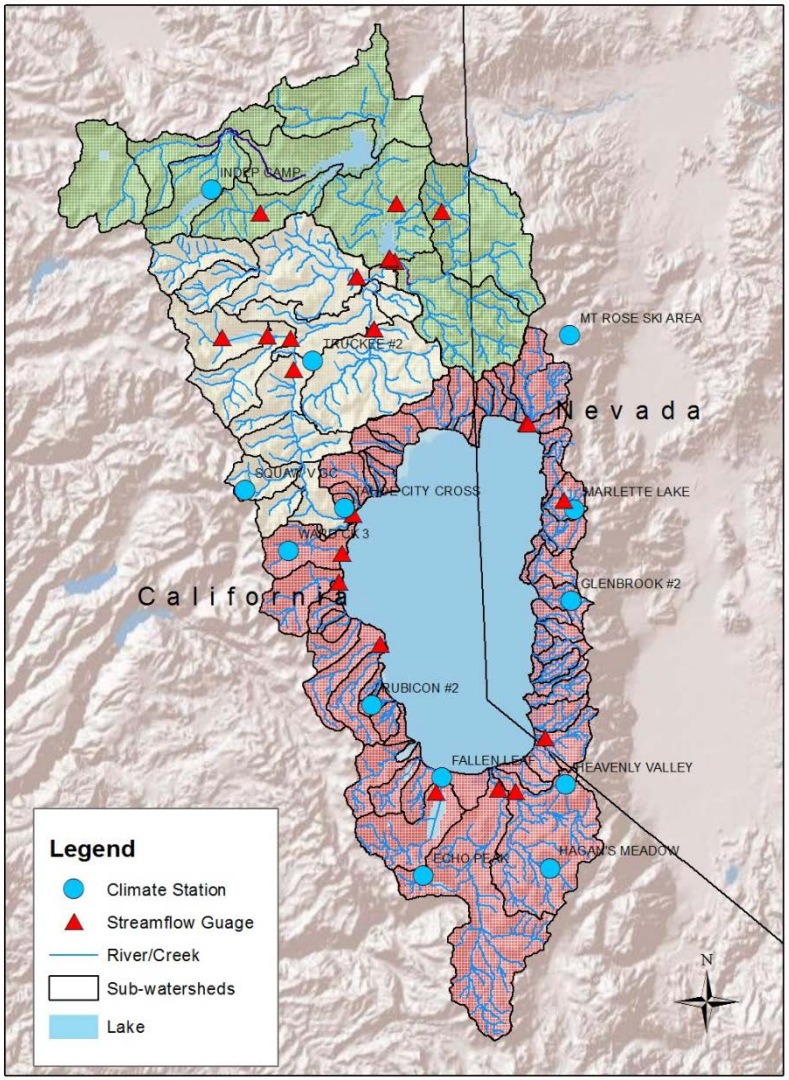
Upper Truckee Watershed



- It includes the Lake Tahoe Basin, Martis Valley Basin and Little Truckee Basin which includes
  - 82 Sub-watersheds
  - 11 Climate stations
  - 15 Streamflow stations
  - 9 Lakes

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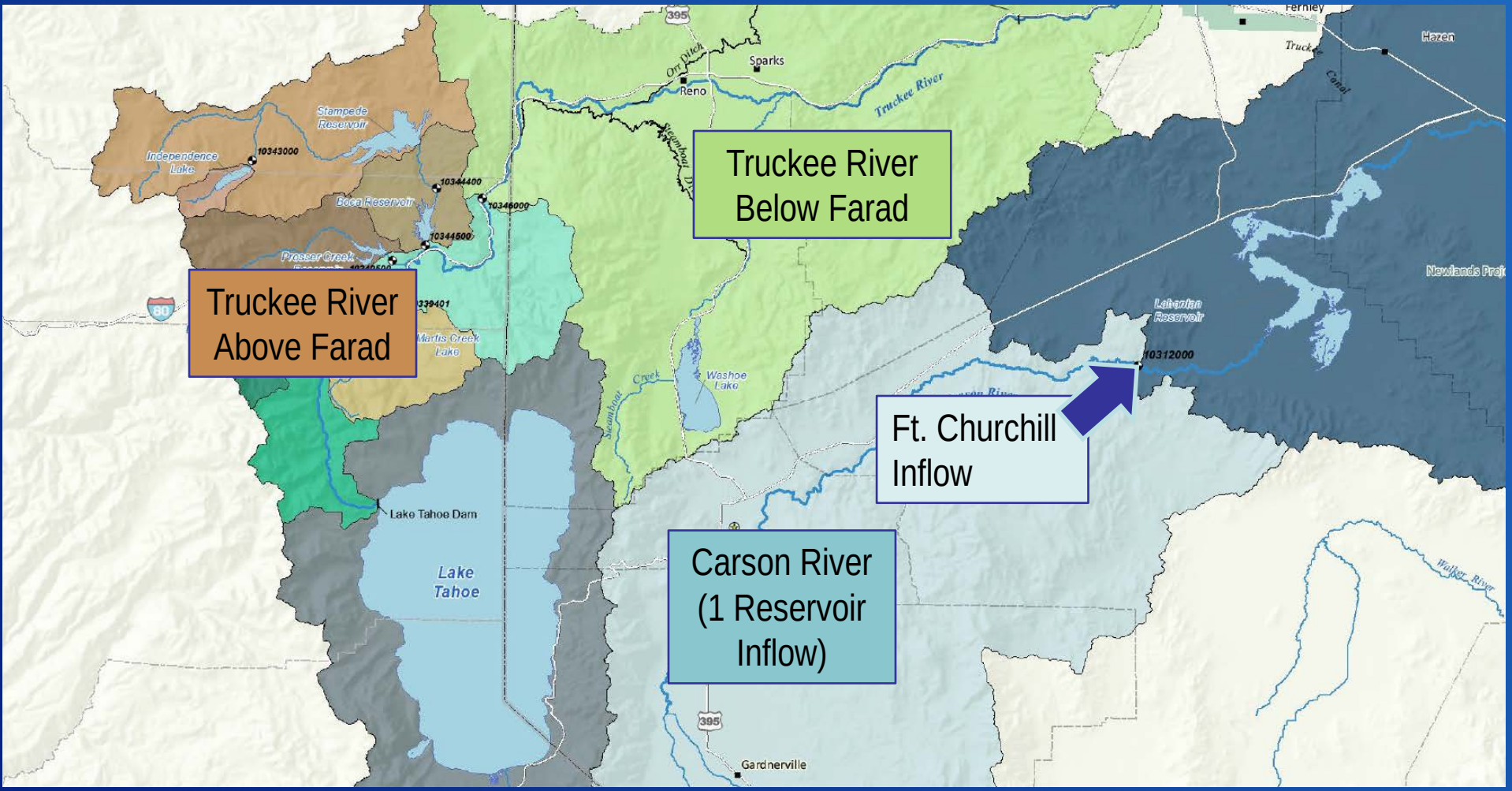
Supply in Planning Model



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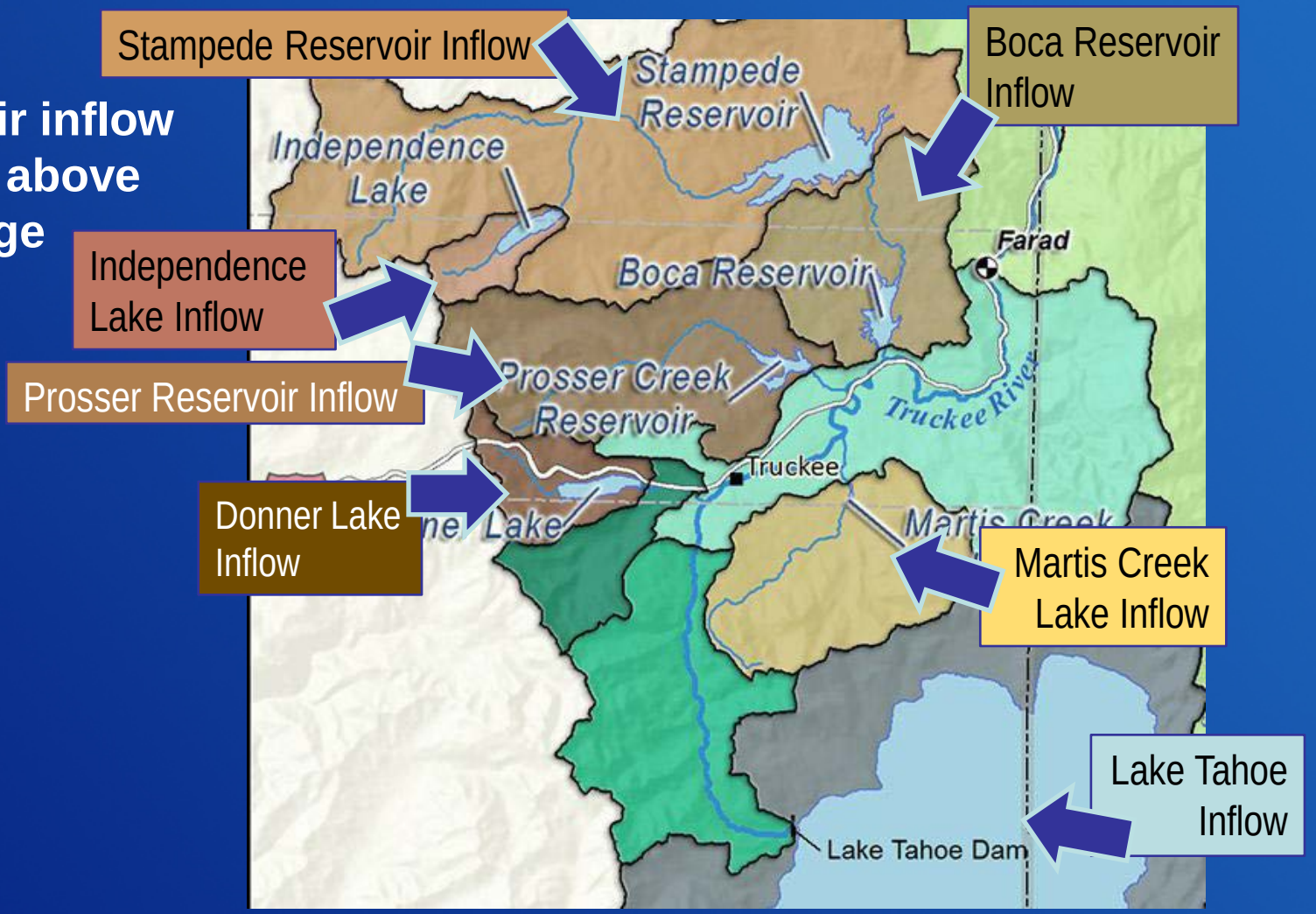
Supply in Planning Model (contd.)

- **7 reservoir inflow locations above Farad Gage**



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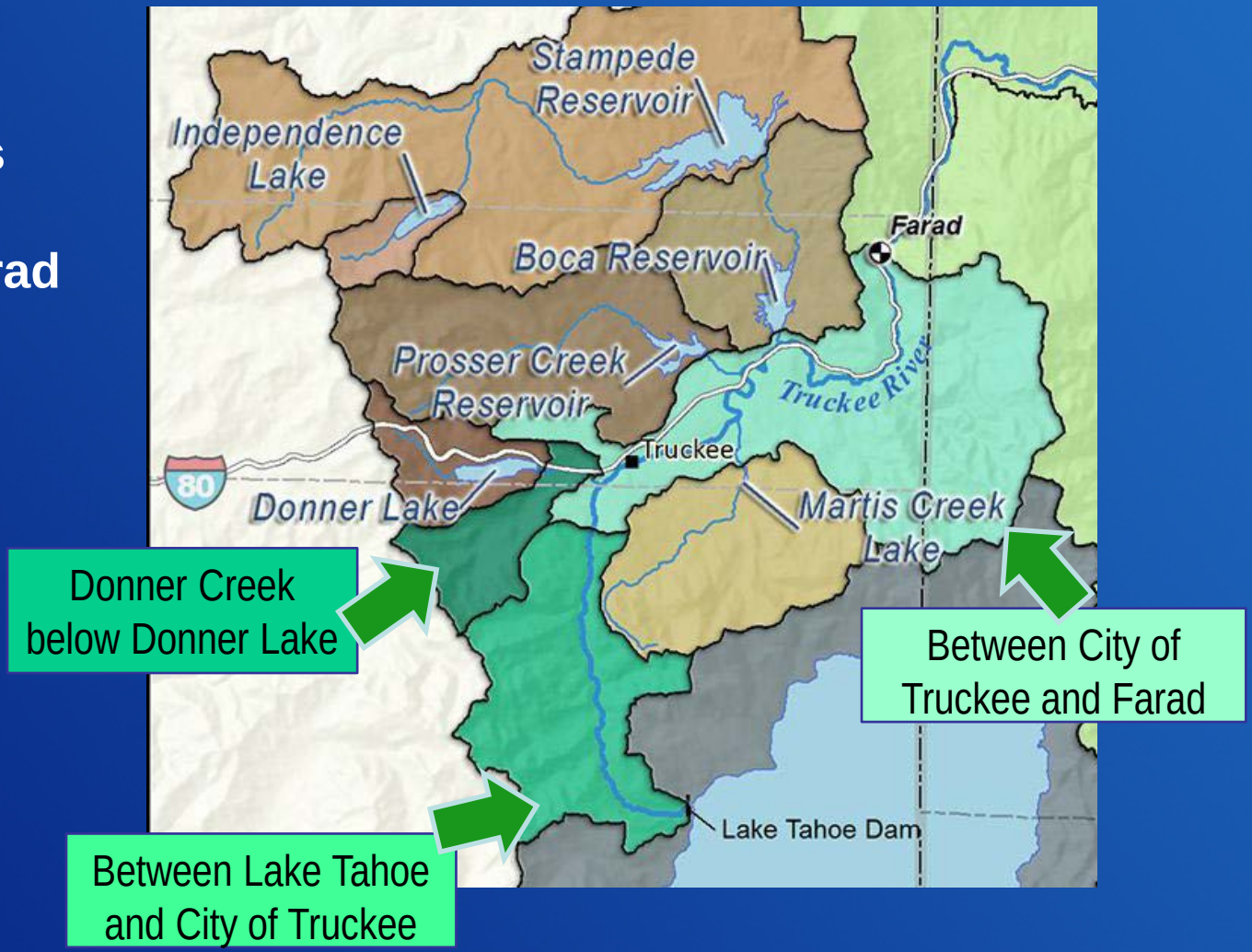
Supply in Planning Model (contd.)

- **3 unregulated inflow locations along Truckee River above Farad Gage**



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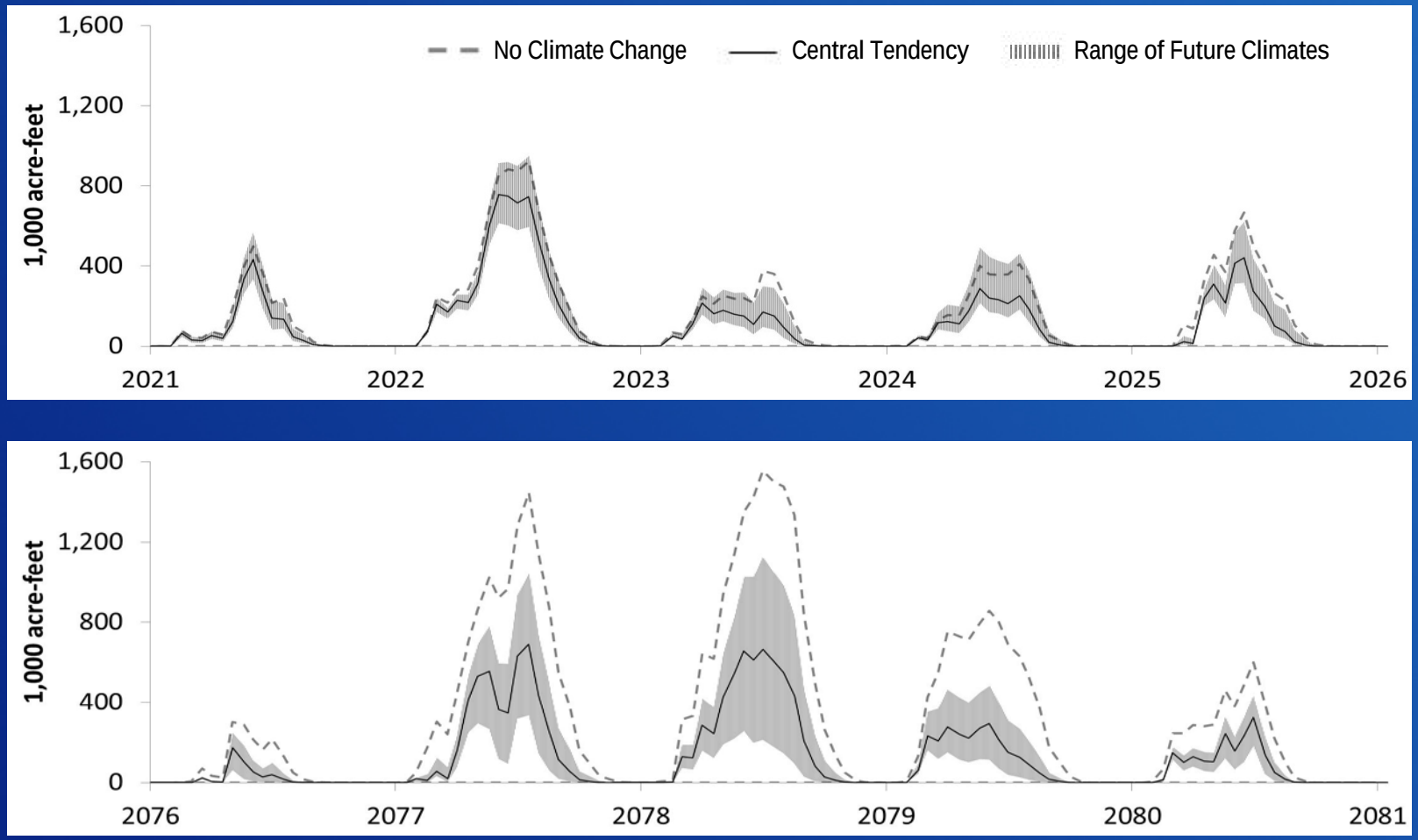
Change in Snowpack



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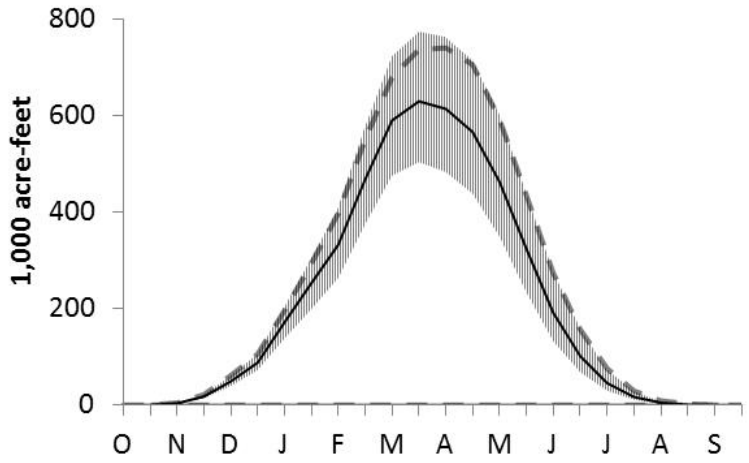
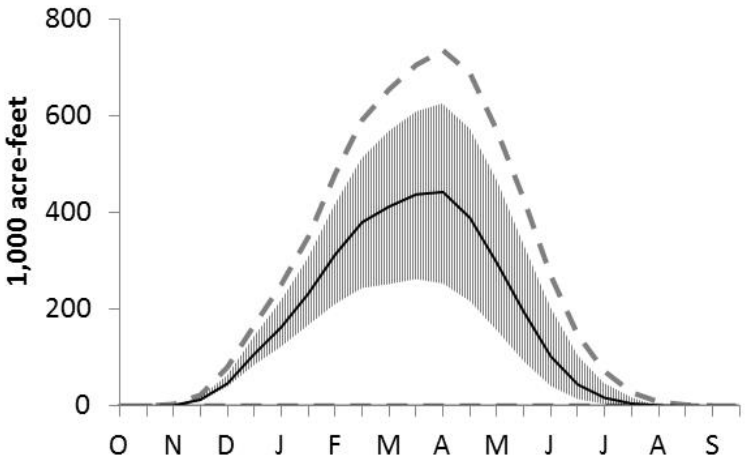
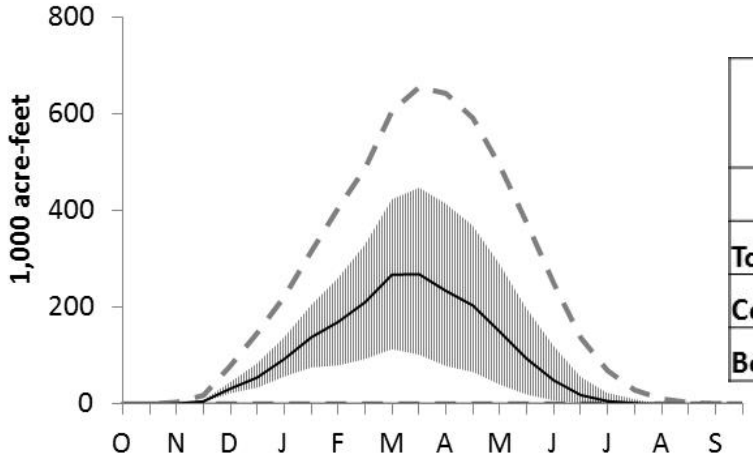
2012-2039



2040-2069



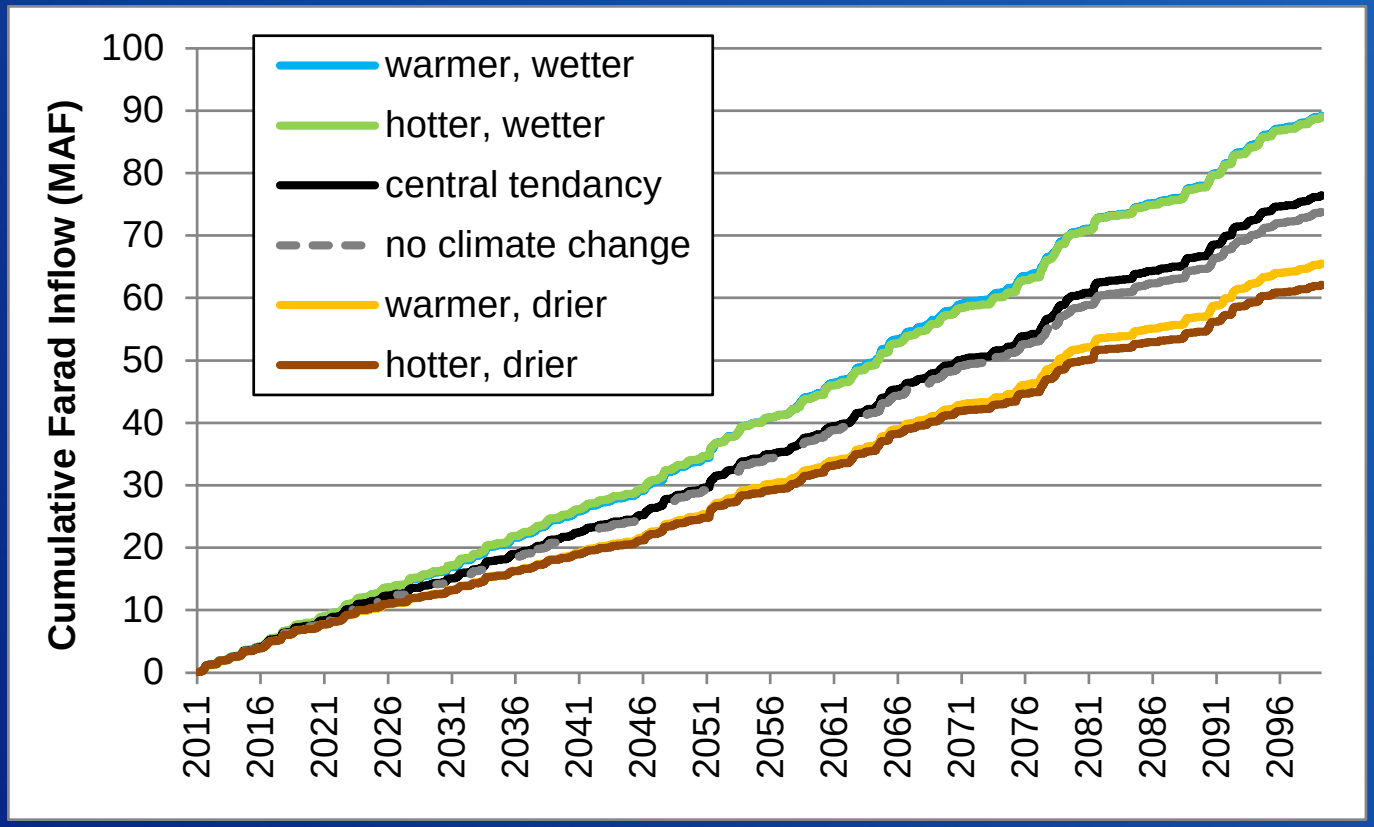
2070-2099



Comparison of Maximum Accumulation between Future Climates and No Climate Change			
	2012-2039	2040-2069	2070-2099
Top of the Range	+5%	-15%	-32%
Central Tendency	-15%	-40%	-59%
Bottom of the Range	-32%	-64%	-83%

No Climate Change — Central Tendency — Range of Future Climates

Changes in “Natural” Farad Inflows



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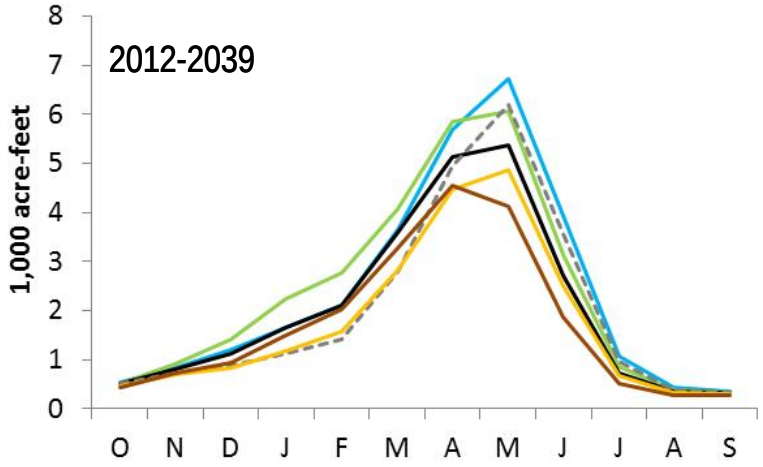
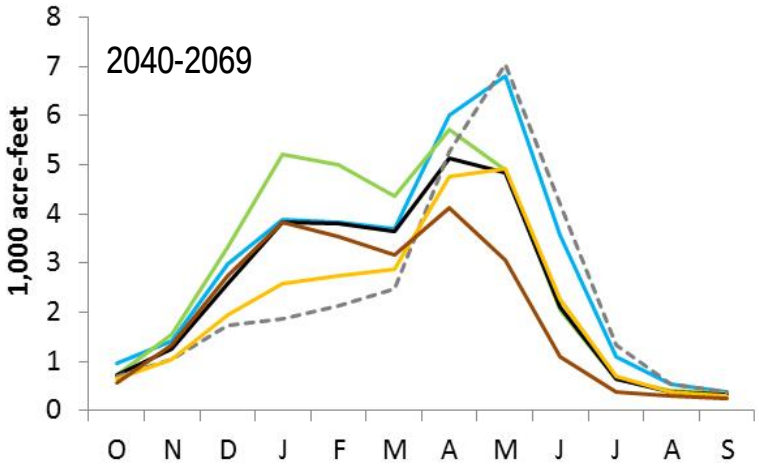
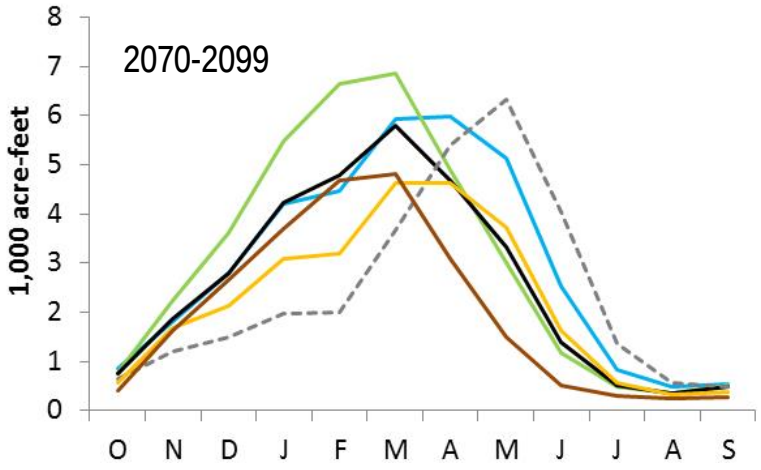
Seasonality Shifts In "Natural" Farad Inflow

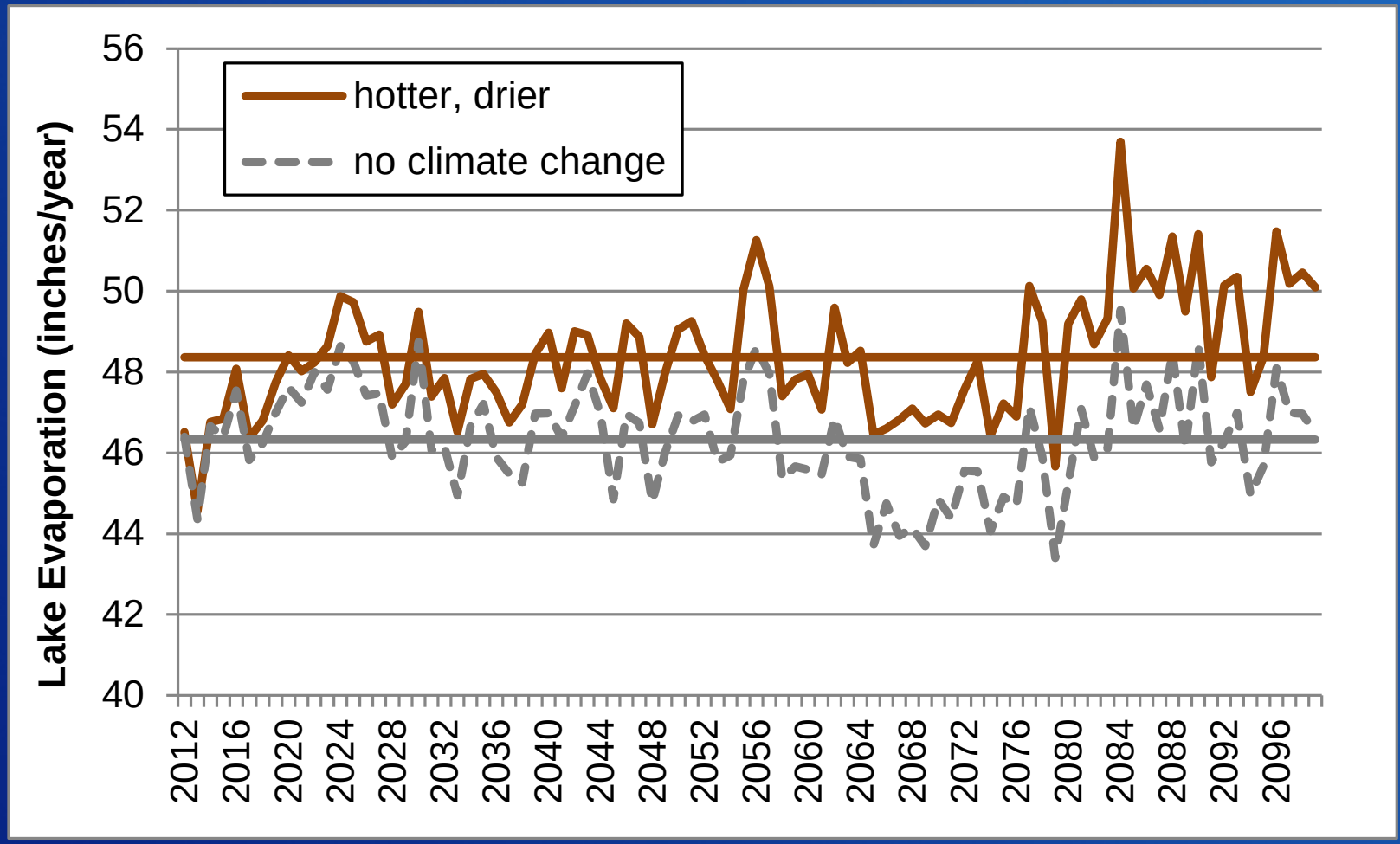


warmer, wetter
no climate change
hotter, wetter
warmer, drier
central tendency
hotter, drier





Change in Lake Tahoe Evaporation



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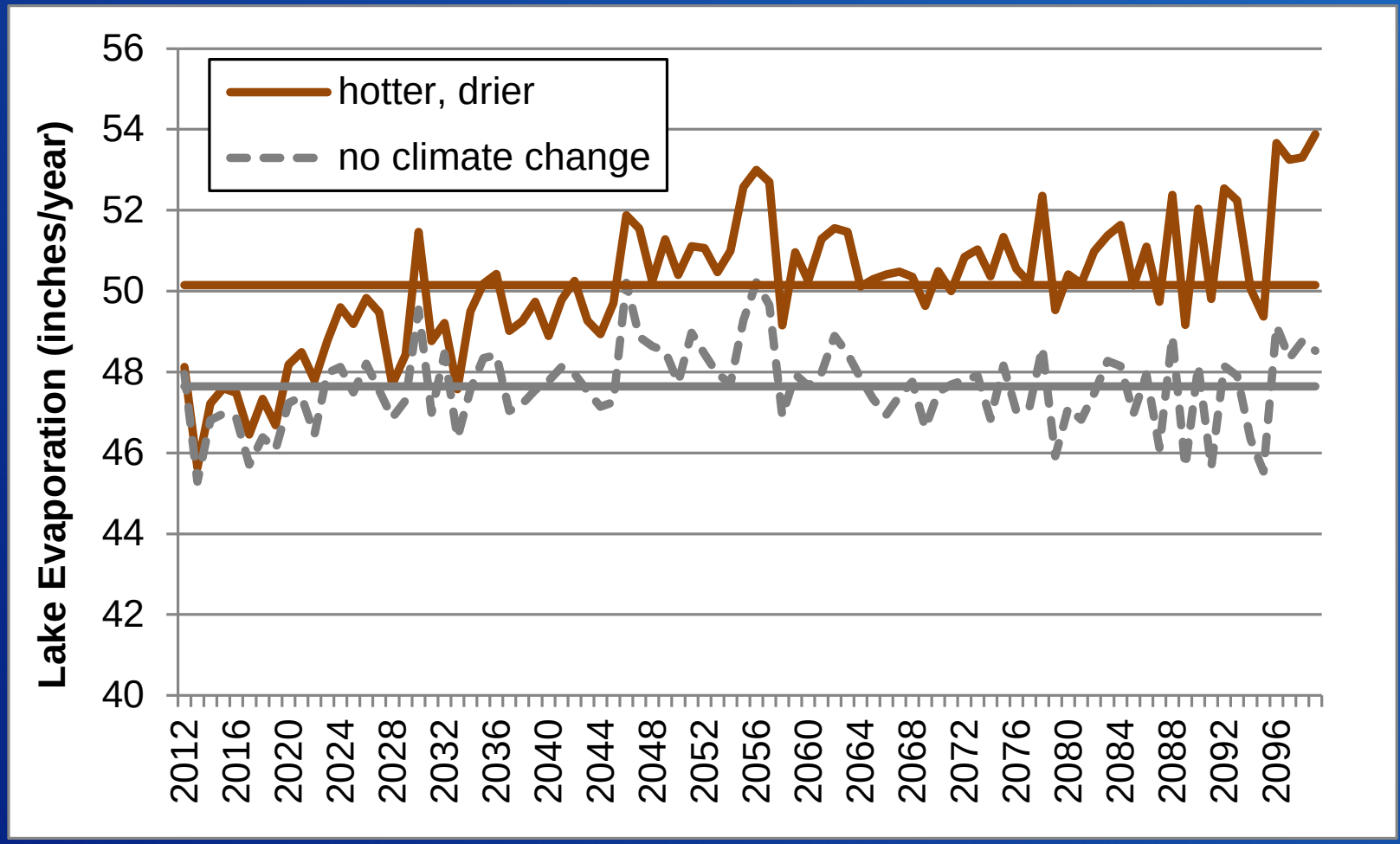
Change in Pyramid Lake Evaporation



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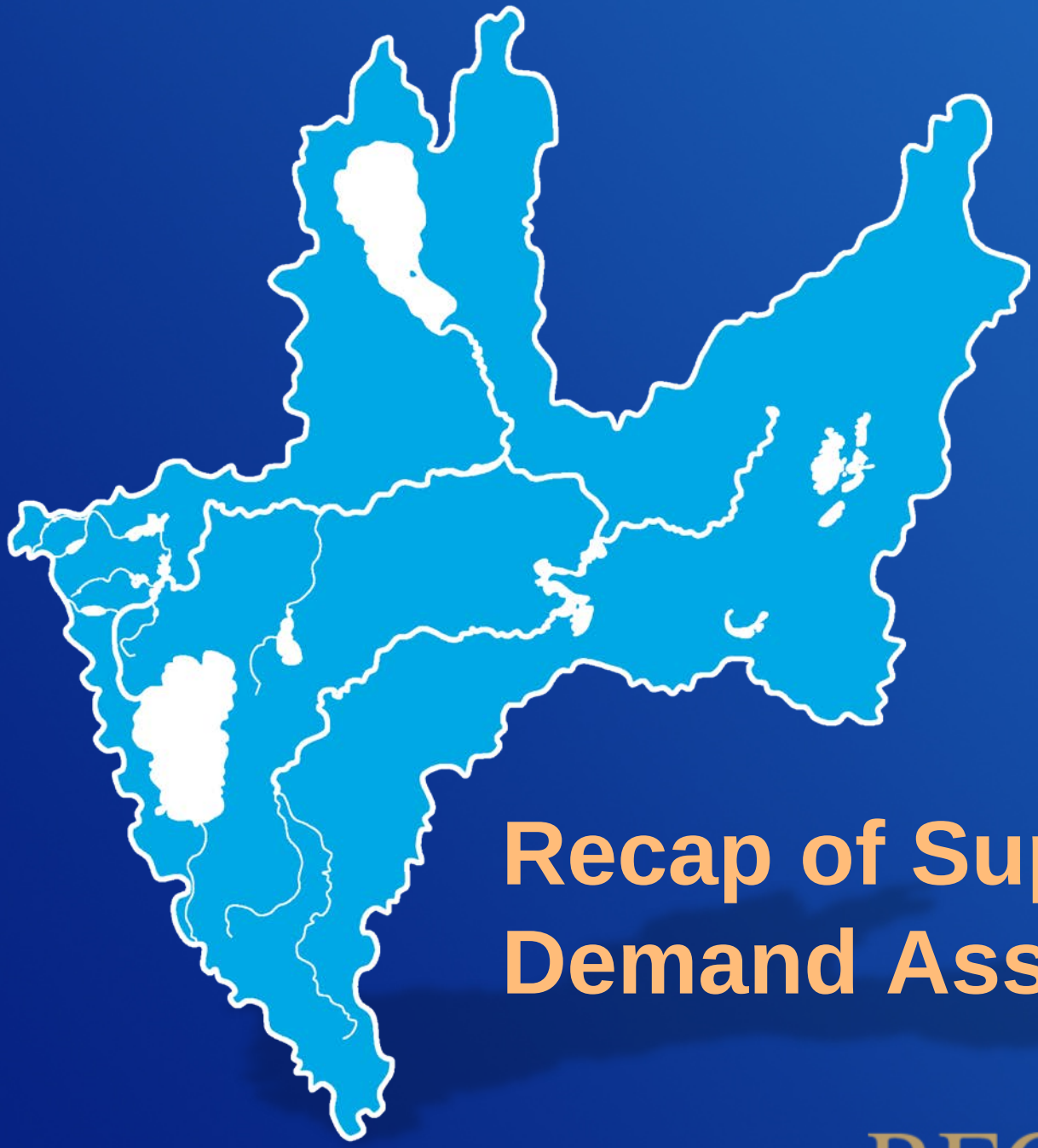
Key Features of the Approach

- Our baseline scenario will be the future No Climate Change hydrology, and may not perfectly match statistics for historical records (e.g. TCDAT)
- Some modeling outputs (e.g. daily hydrology) should be used with caution
- Our methodology produces a drought late in the century. A severe drought could occur at any time, and to be complete the Basin Study should consider the entire record of hydrology for all scenarios.

Break

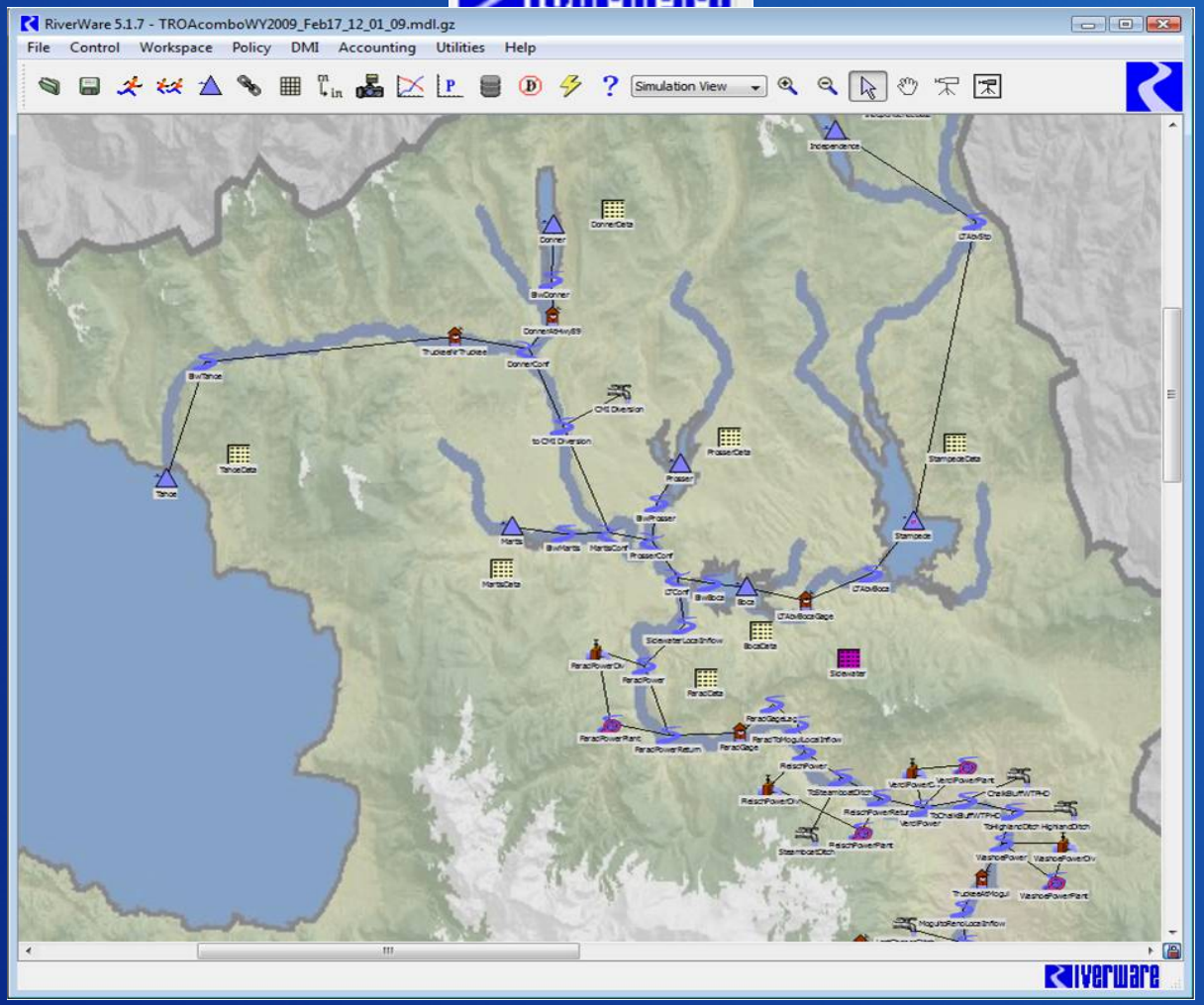
RECLAMATION



Recap of Supply and Demand Assessments

RECLAMATION

RiverWare© Basics



RECLAMATION

Truckee Carson Long-Term Planning Model Collaborative Development

- **Bureau of Reclamation (funding and oversight)**
- **Truckee Meadows Water Authority**
- **Pyramid Lake Paiute Tribe**
- **State of California (DWR)**
- **State of Nevada**
- **Federal Watermaster**

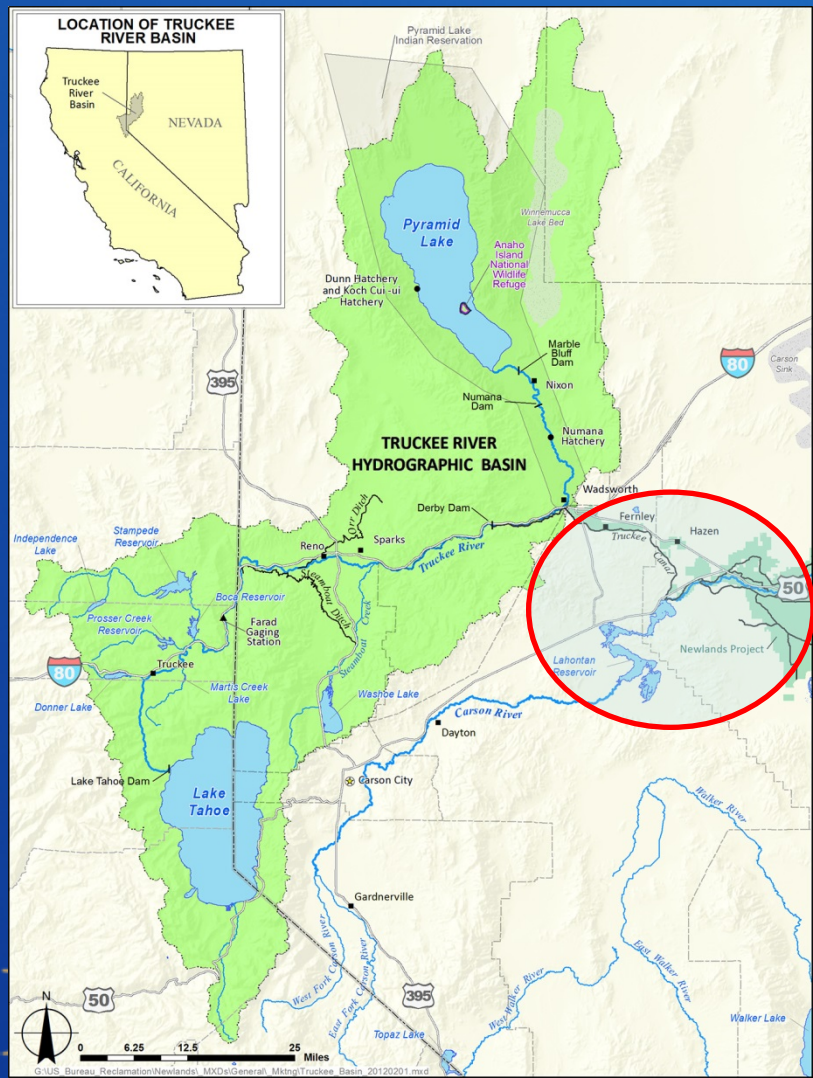
Truckee Carson TROA-Lite Planning Model Technical Details

- Daily timestep RiverWare© model
- 88-year extent (2012-2099)
- Simulates all reservoir operations and diversions/uses in the basin according to TROA policy (a few exceptions)
- Limited characterization of individual party's operational strategies within TROA
- Performs complete daily water accounting according to TROA policy

RECLAMATION

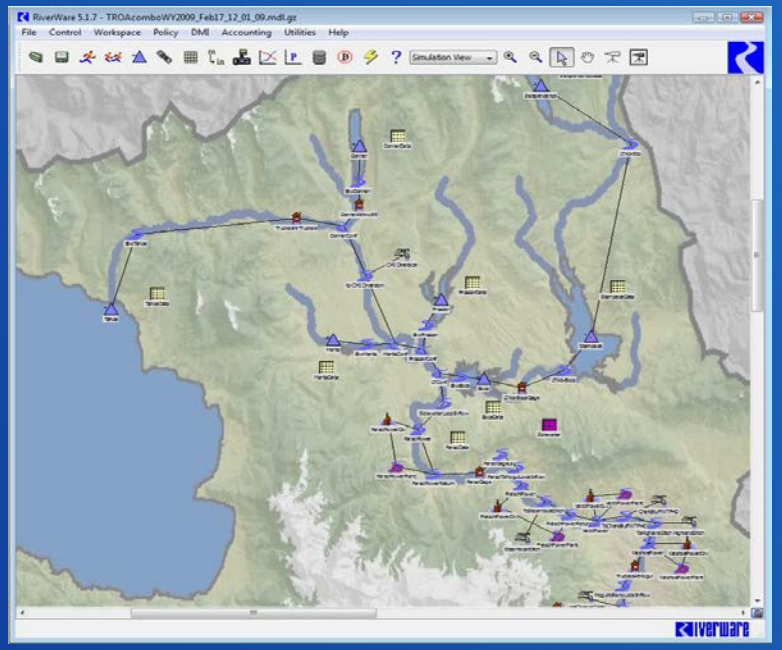
Truckee Carson TROA-Lite Planning Model Application – Newlands Project Planning Study

- In 2011, BOR awarded contract to MWH (and PWRE) to perform the Newlands Project Planning Study
- The purpose of the study was to identify alternatives for maintaining Newlands Project reliability while providing for safe operation of the Truckee Canal
- The Pre-TROA Planning Model was used to make all simulations of alternatives considered by this study
- The study was completed in 2012



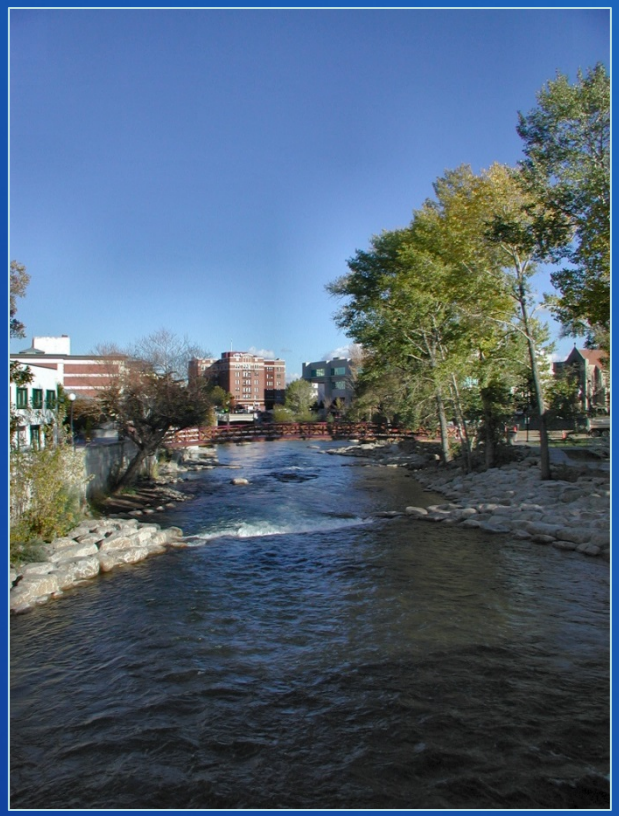
TROA-Lite Configuration

- All Pre-TROA that carries over to TROA is captured
- All mandatory TROA operations are modeled
- Some voluntary TROA operations are modeled
- Significant voluntary operations NOT included
  - California Guidelines
  - Enhanced Minimum flows
  - Joint Program Fish Credit Water
  - Others

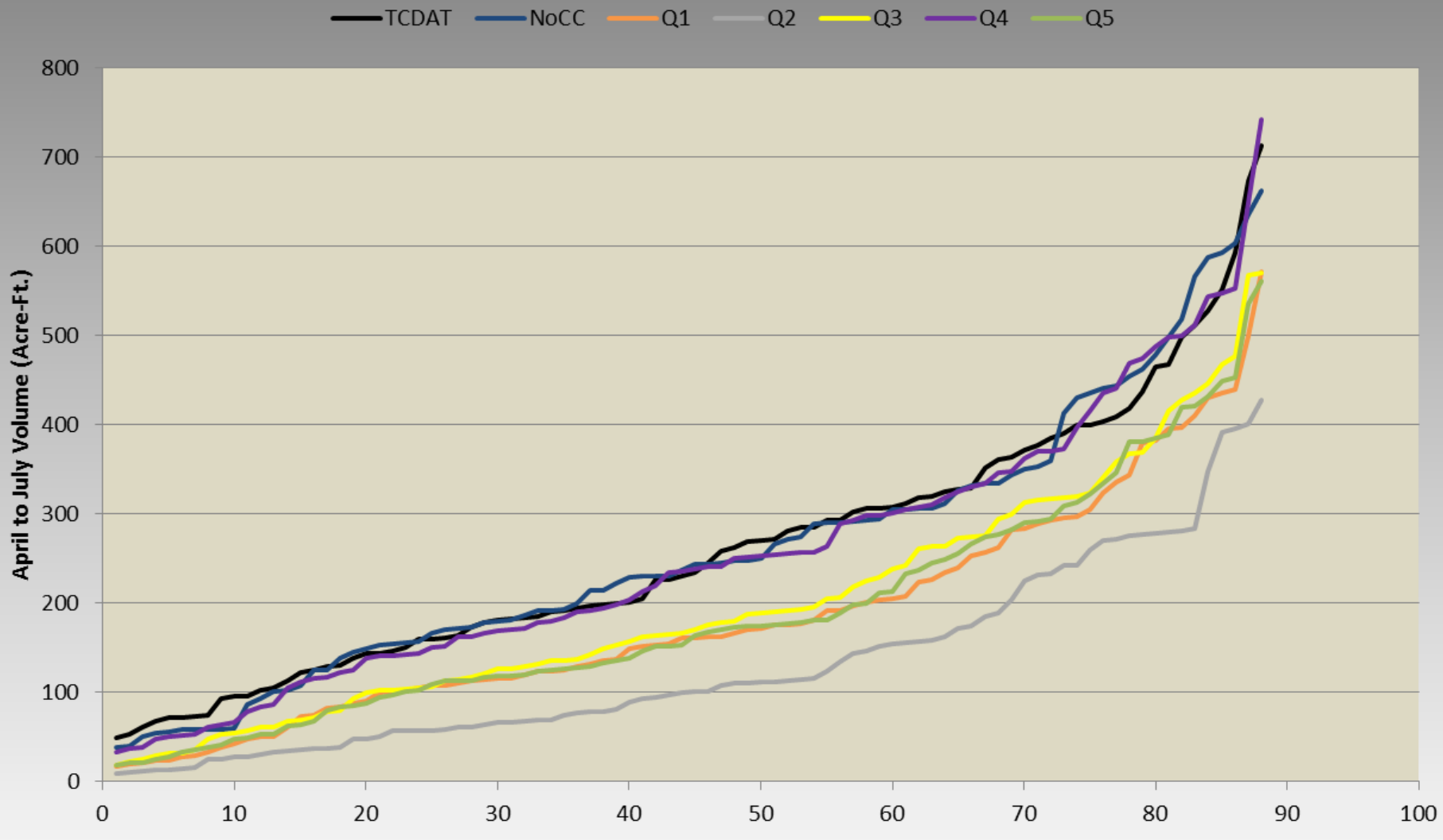


“Preliminary Runs” Configuration

- Generally the model was run with static current operational regime
- 2 minor exceptions
  - TMWA treatment capacity was increased to accommodate demand growth
  - Surface water diversions were permitted for Fernley
- Many obvious operational adaptions were not modeled which will relieve imbalances.
- These are left for the next step in the study when structural and non-structural options will be considered

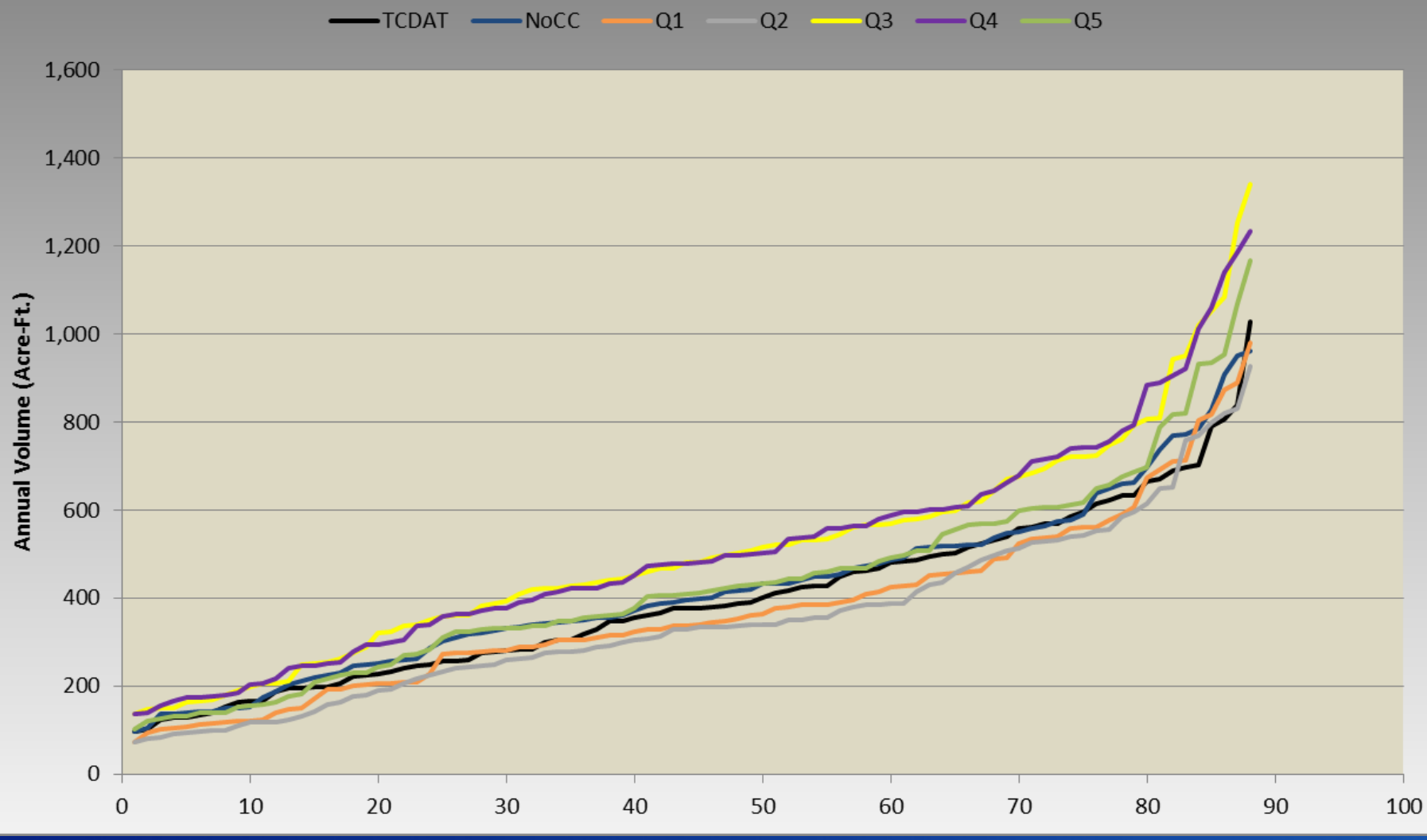


Farad April to July Volume Ranked from Lowest to Highest



RECLAMATION

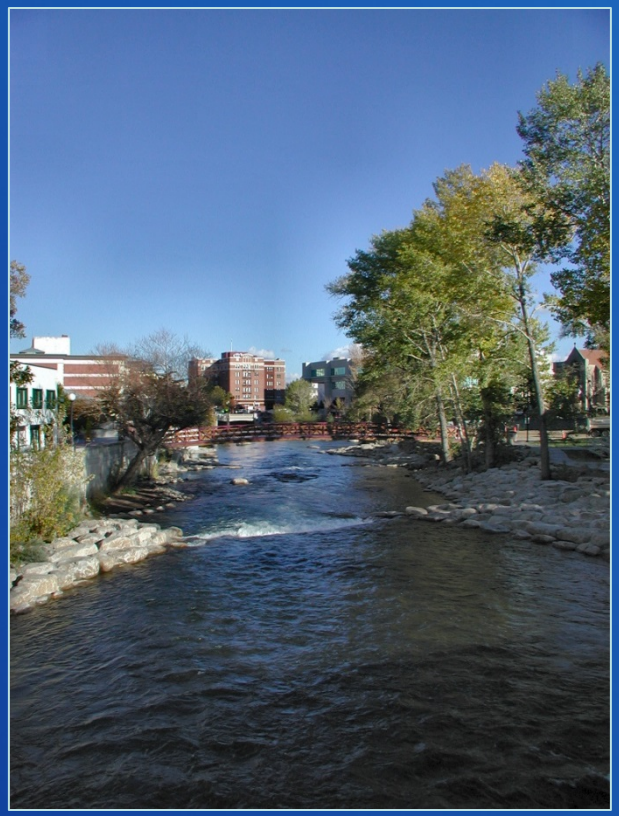
Farad Annual Volume Ranked from Lowest to Highest



RECLAMATION

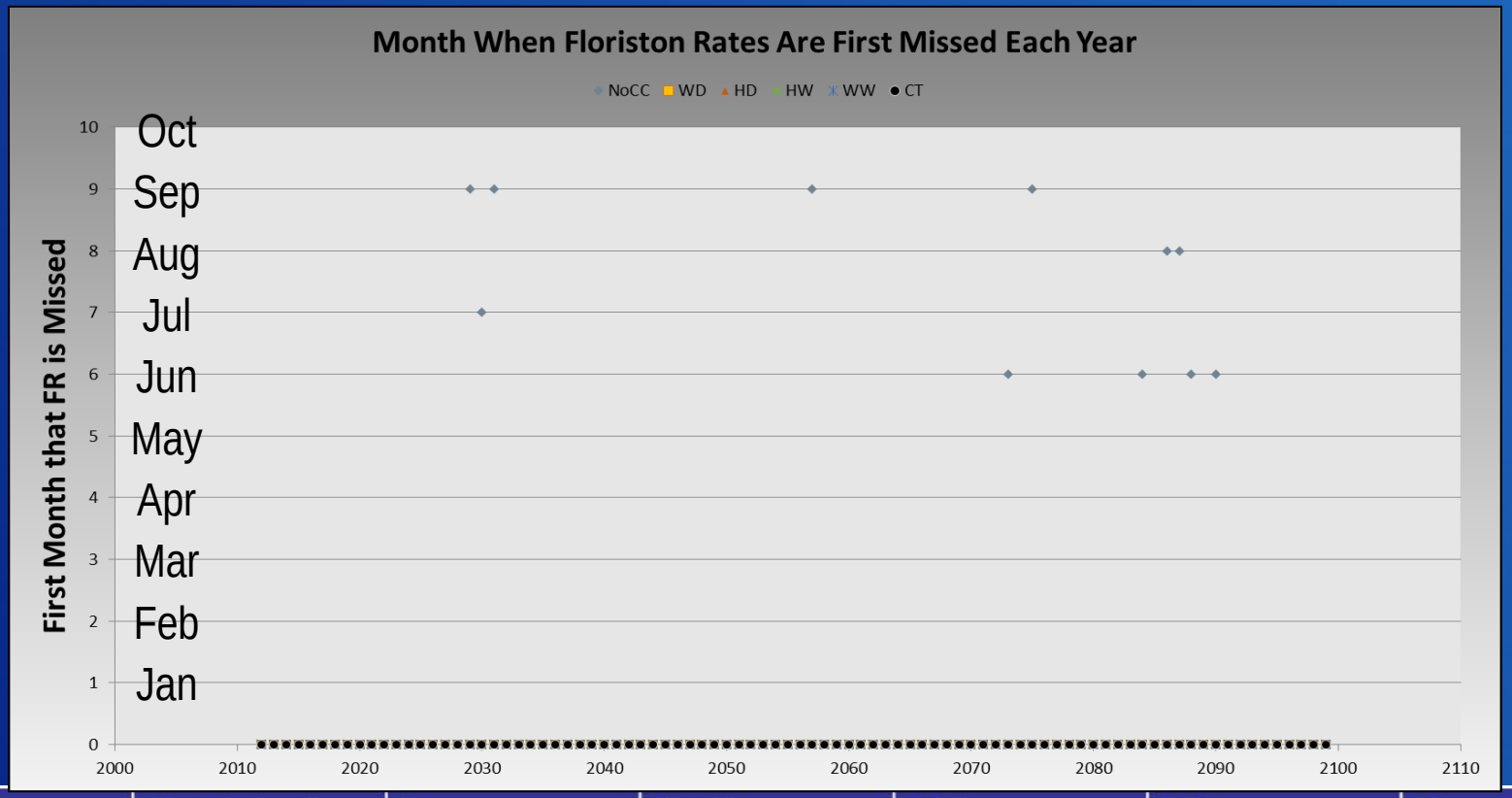
Floriston Rate Achievement

- Floriston Rate is the dominant operational criteria in the basin, even under TROA
- A prescribed rate of flow at the CA/NV state line that, when attained, meets all downstream demands
- FR not being met is one of the TROA drought criteria
- Historically, FR is met through the end of September in all but ~16% of years
- Earliest start to missing FR historically was in June of 1992



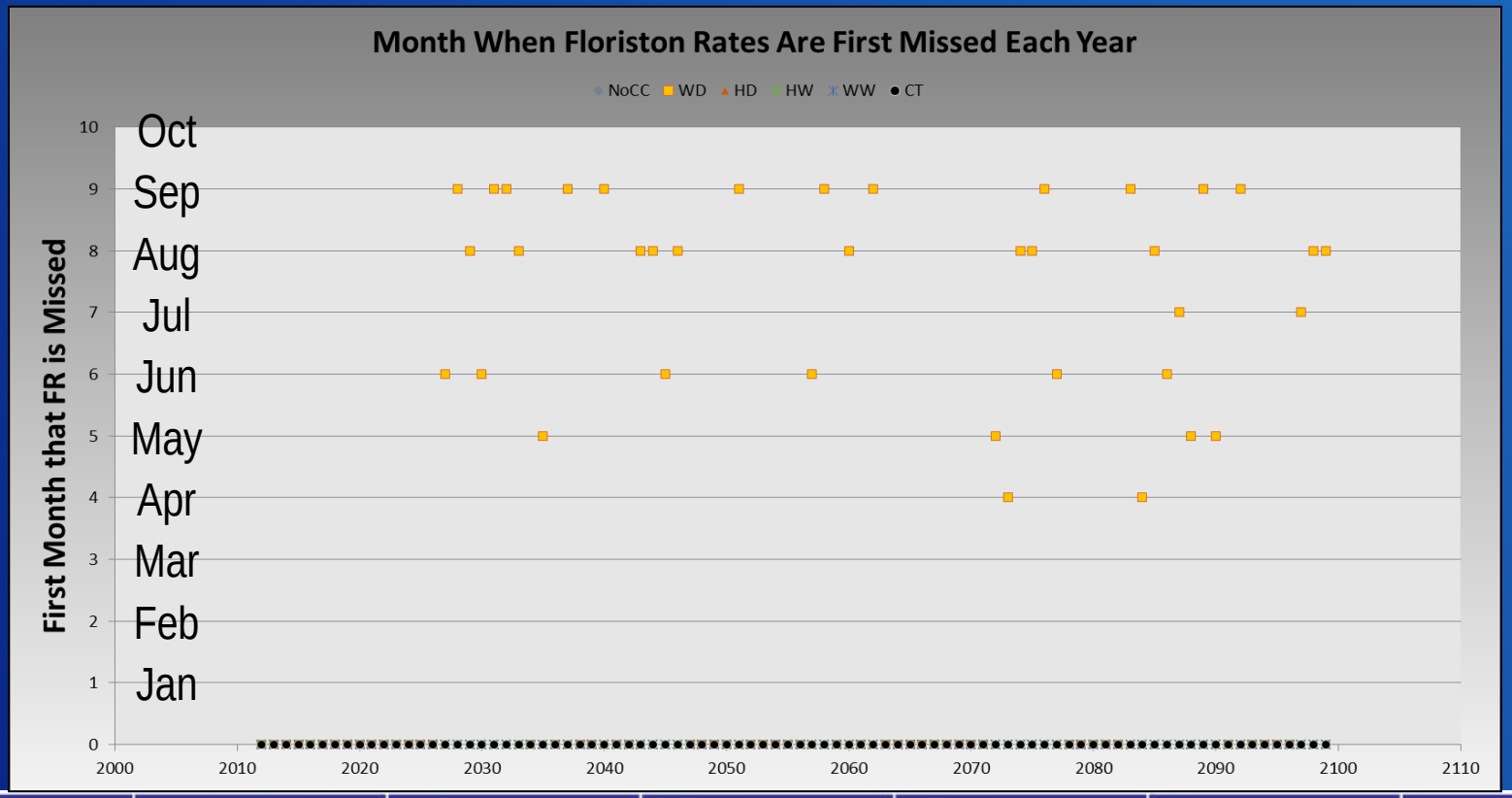
RECLAMATION

Floriston Rate Achievement – No Climate Change



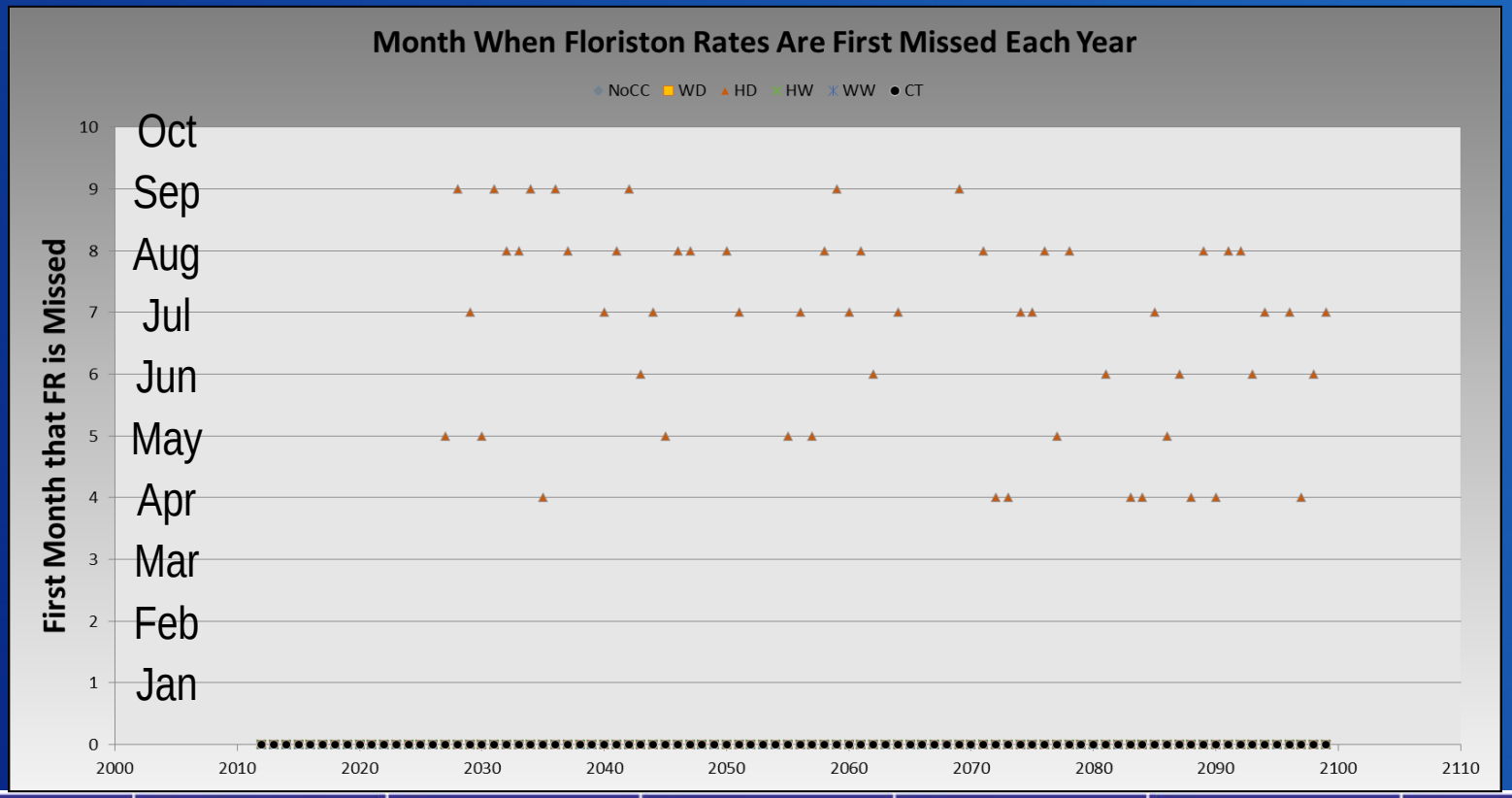
	No Climate Change	Warmer Drier	Hotter Drier	Hotter Wetter	Warmer Wetter	Central Tendency
Misses	11	37	56	15	8	20
Frequency	13%	42%	64%	17%	9%	23%
Earliest Month	Jun	Apr	Apr	May	May	May

Floriston Rate Achievement – Warmer Drier



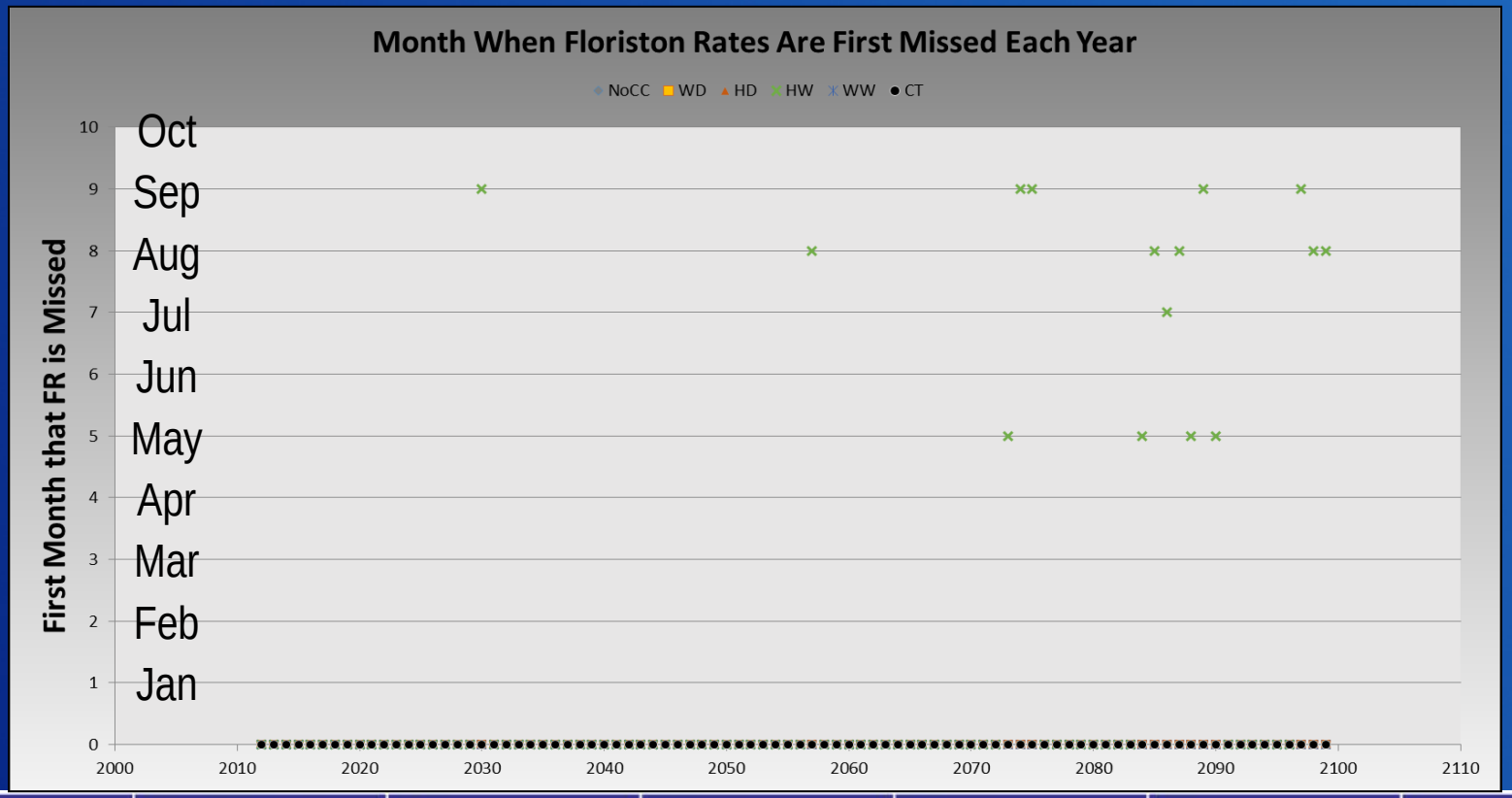
	No Climate Change	Warmer Drier	Hotter Drier	Hotter Wetter	Warmer Wetter	Central Tendency
Misses	11	37	56	15	8	20
Frequency	13%	42%	64%	17%	9%	23%
Earliest Month	Jun	Apr	Apr	May	May	May

Floriston Rate Achievement – Hotter Drier



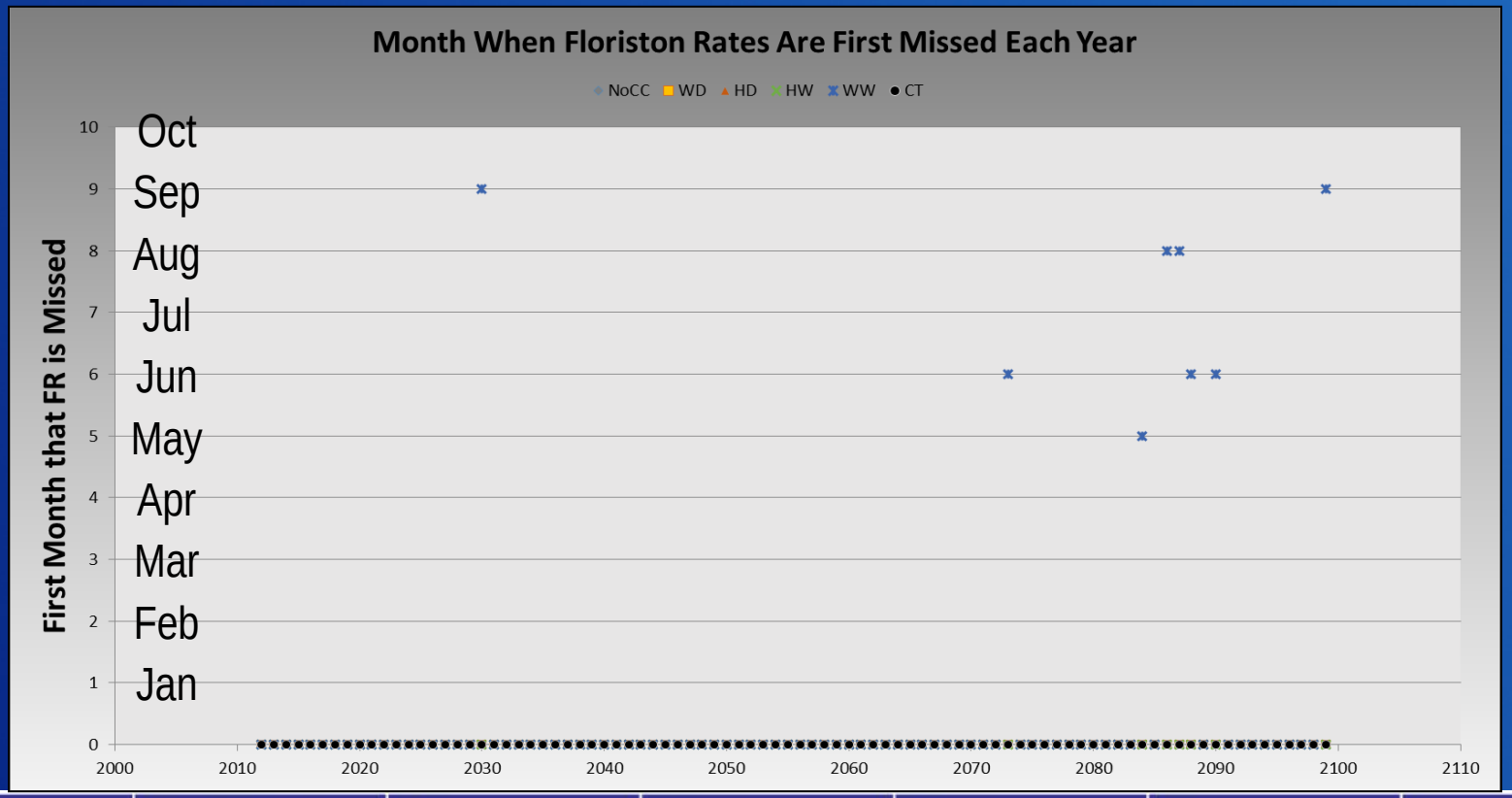
	No Climate Change	Warmer Drier	Hotter Drier	Hotter Wetter	Warmer Wetter	Central Tendency
Misses	11	37	56	15	8	20
Frequency	13%	42%	64%	17%	9%	23%
Earliest Month	Jun	Apr	Apr	May	May	May

Floriston Rate Achievement – Hotter Wetter



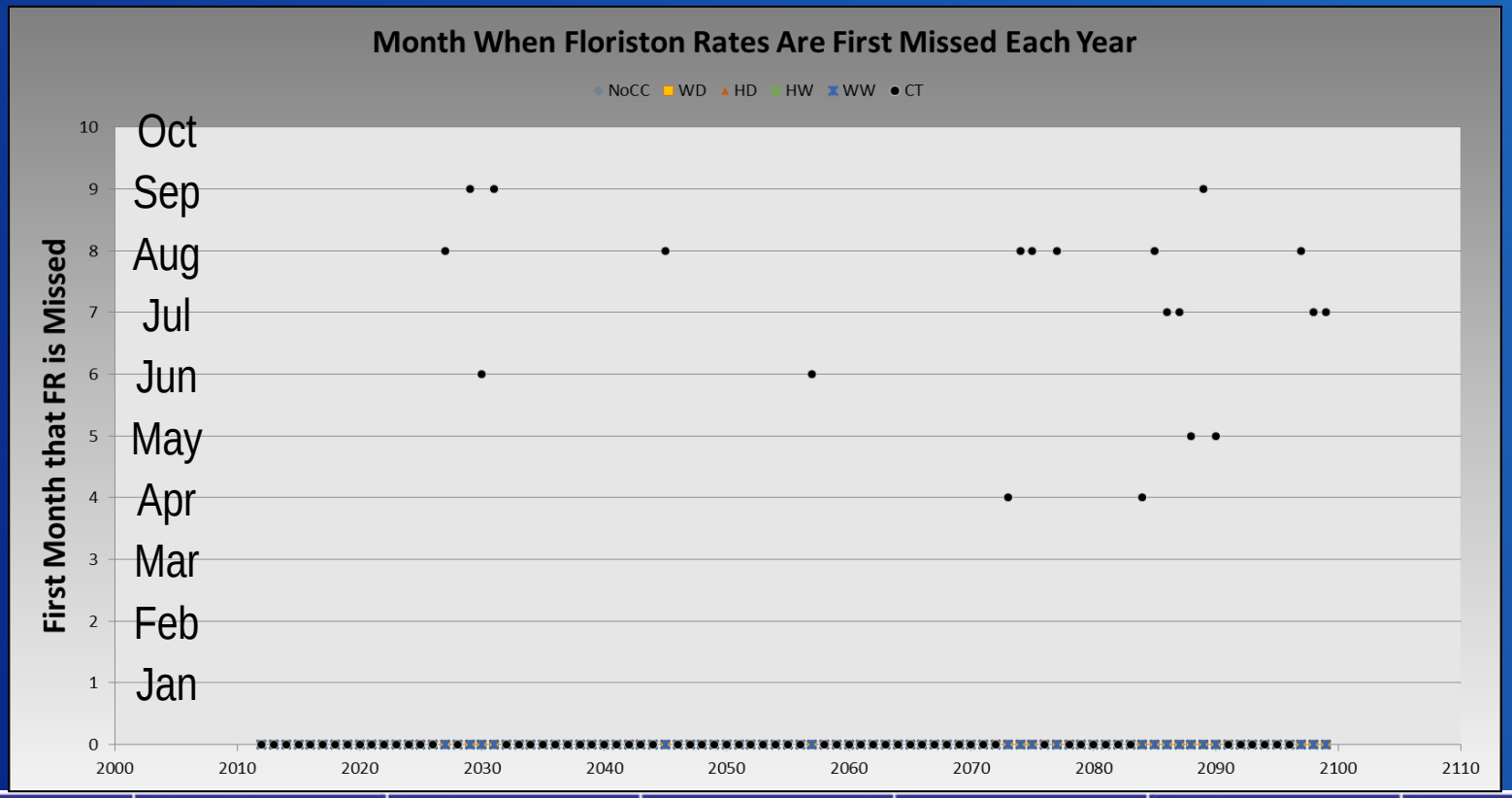
	No Climate Change	Warmer Drier	Hotter Drier	Hotter Wetter	Warmer Wetter	Central Tendency
Misses	11	37	56	15	8	20
Frequency	13%	42%	64%	17%	9%	23%
Earliest Month	Jun	Apr	Apr	May	May	May

Floriston Rate Achievement – Warmer Wetter



	No Climate Change	Warmer Drier	Hotter Drier	Hotter Wetter	Warmer Wetter	Central Tendency
Misses	11	37	56	15	8	20
Frequency	13%	42%	64%	17%	9%	23%
Earliest Month	Jun	Apr	Apr	May	May	May

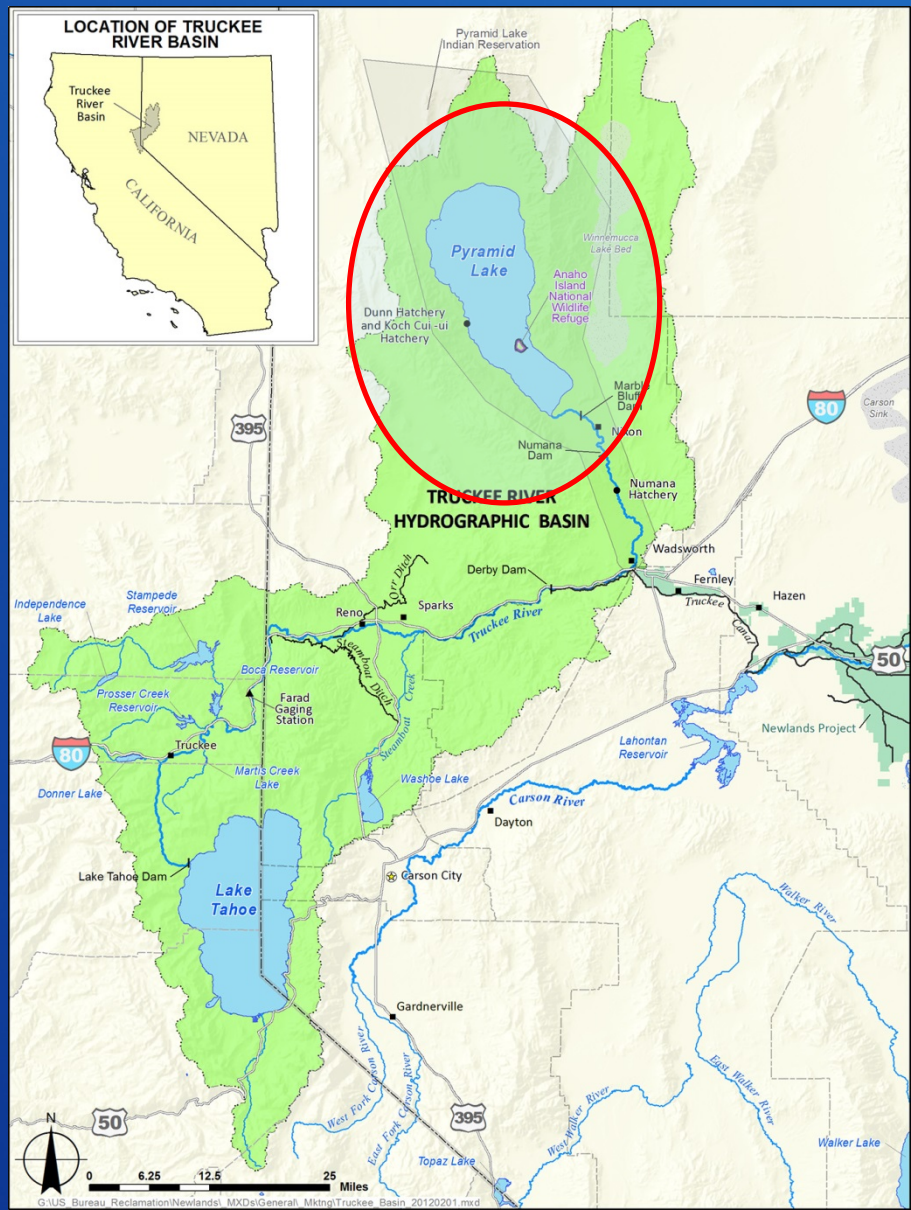
Floriston Rate Achievement – Central Tendency



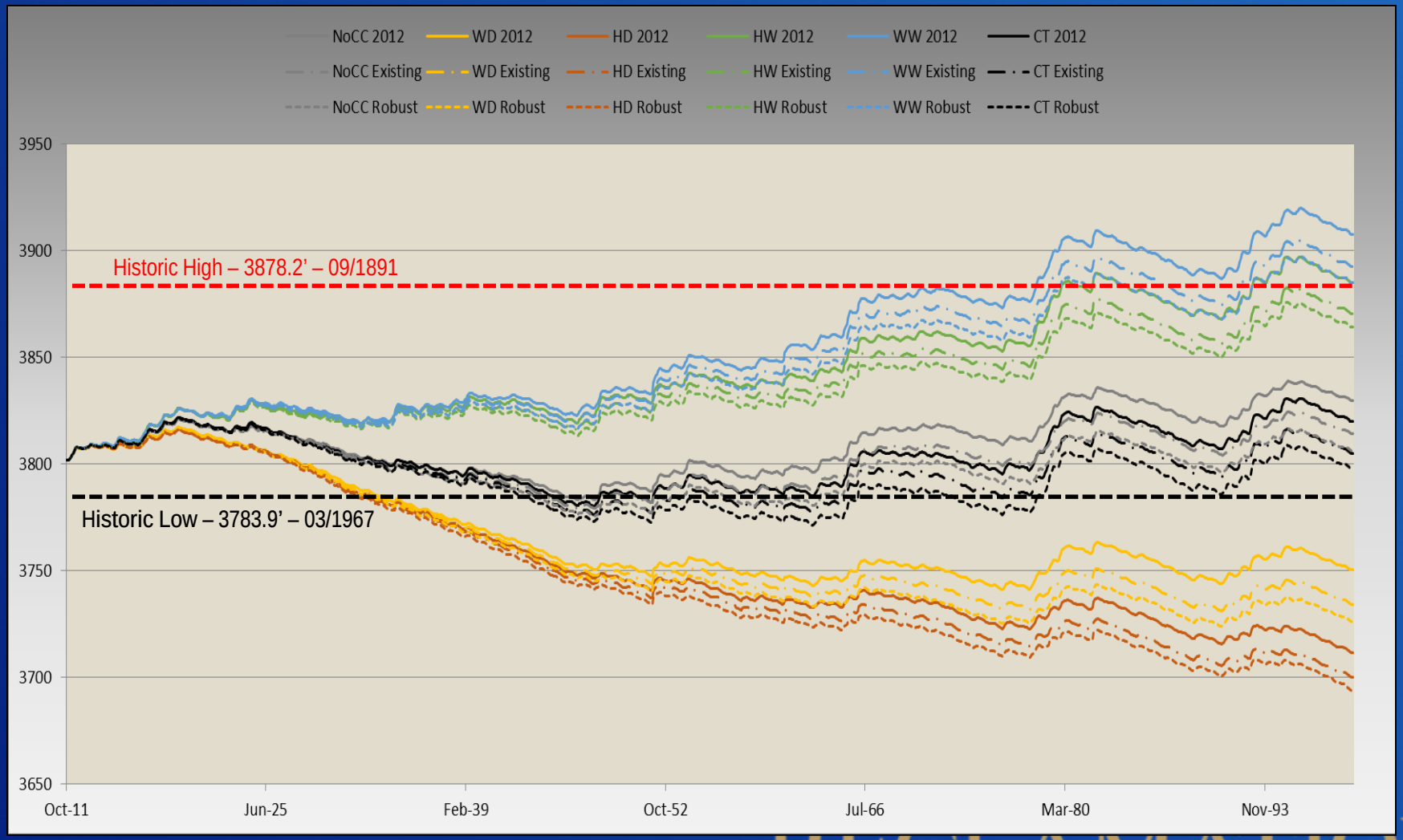
	No Climate Change	Warmer Drier	Hotter Drier	Hotter Wetter	Warmer Wetter	Central Tendency
Misses	11	37	56	15	8	20
Frequency	13%	42%	64%	17%	9%	23%
Earliest Month	Jun	Apr	Apr	May	May	May

Pyramid Lake Elevation

- Pyramid Lake is a terminal lake at the bottom of the Truckee River
- Pyramid Lake is home to the Cui-ui (endangered), and the Lahontan Cutthroat Trout (threatened)
- Historically the lake has been as high as 3878.2’ (1891)
- Has been as low as 3783.9 (1967)
- Lake is full at around 3880’ and then begins to fill Winnemucca Lake. This is not modeled
- Pyramid Lake elevation is a good indicator of long-term climate trends in the basin as year-to-year variation is dampened



Pyramid Lake Elevation (ft)



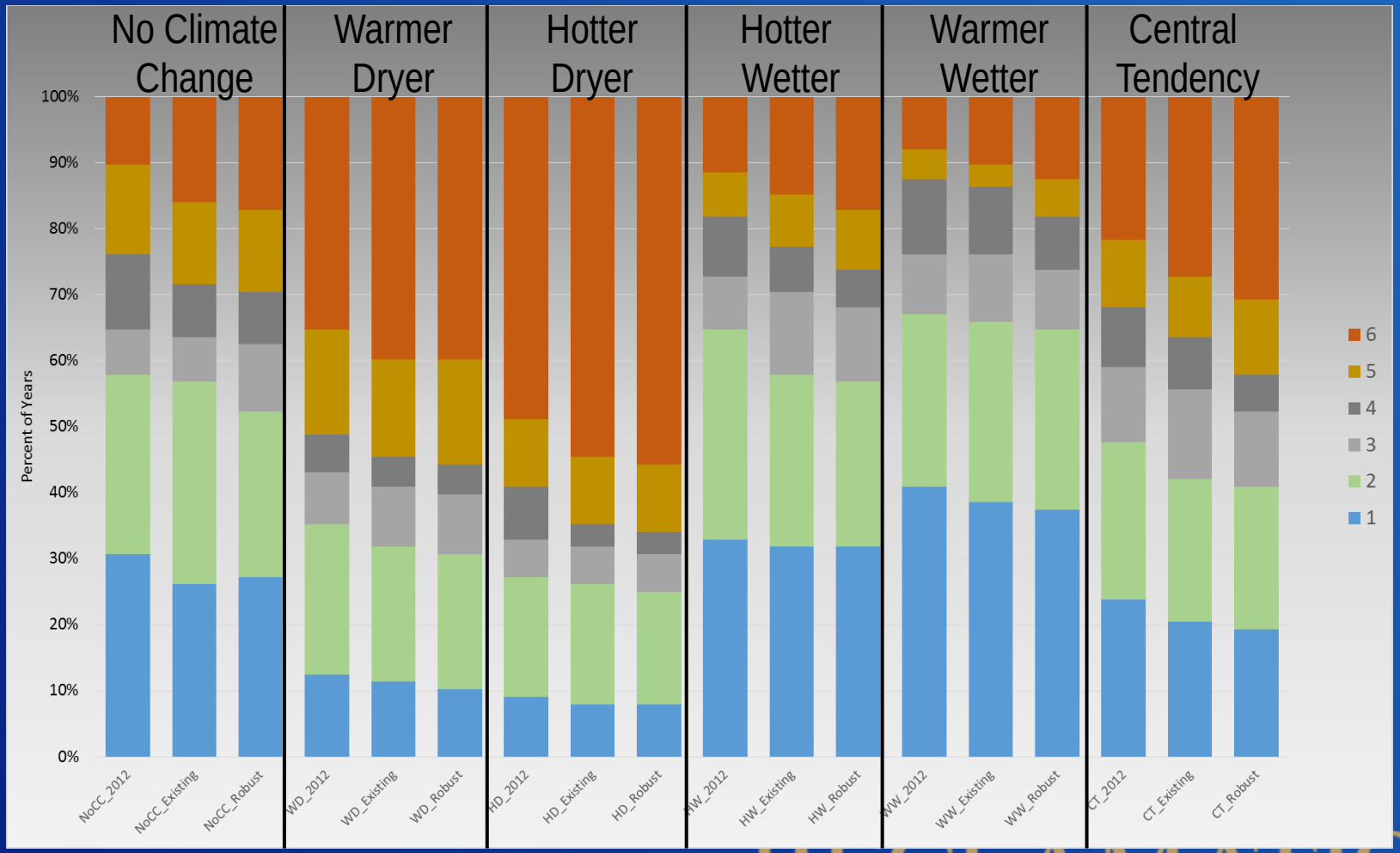
RECLAMATION

Fish Flow Regimes

- Waters in Stampede and Prosser Reservoir are designated for the Pyramid Lake Fish
- Six flow regimes, each consisting of monthly flow targets, have been established for the Lower Truckee River for the benefit of the threatened and endangered fish species
- Flow regime selection criteria is based on two factors
  - Stampede storage volume
  - Forecasted inflows into Stampede Reservoir
- PLPT adaptively manages the fishery, but the model uses the flow selection criteria exclusively

RECLAMATION

Fish Flow Regime Distribution



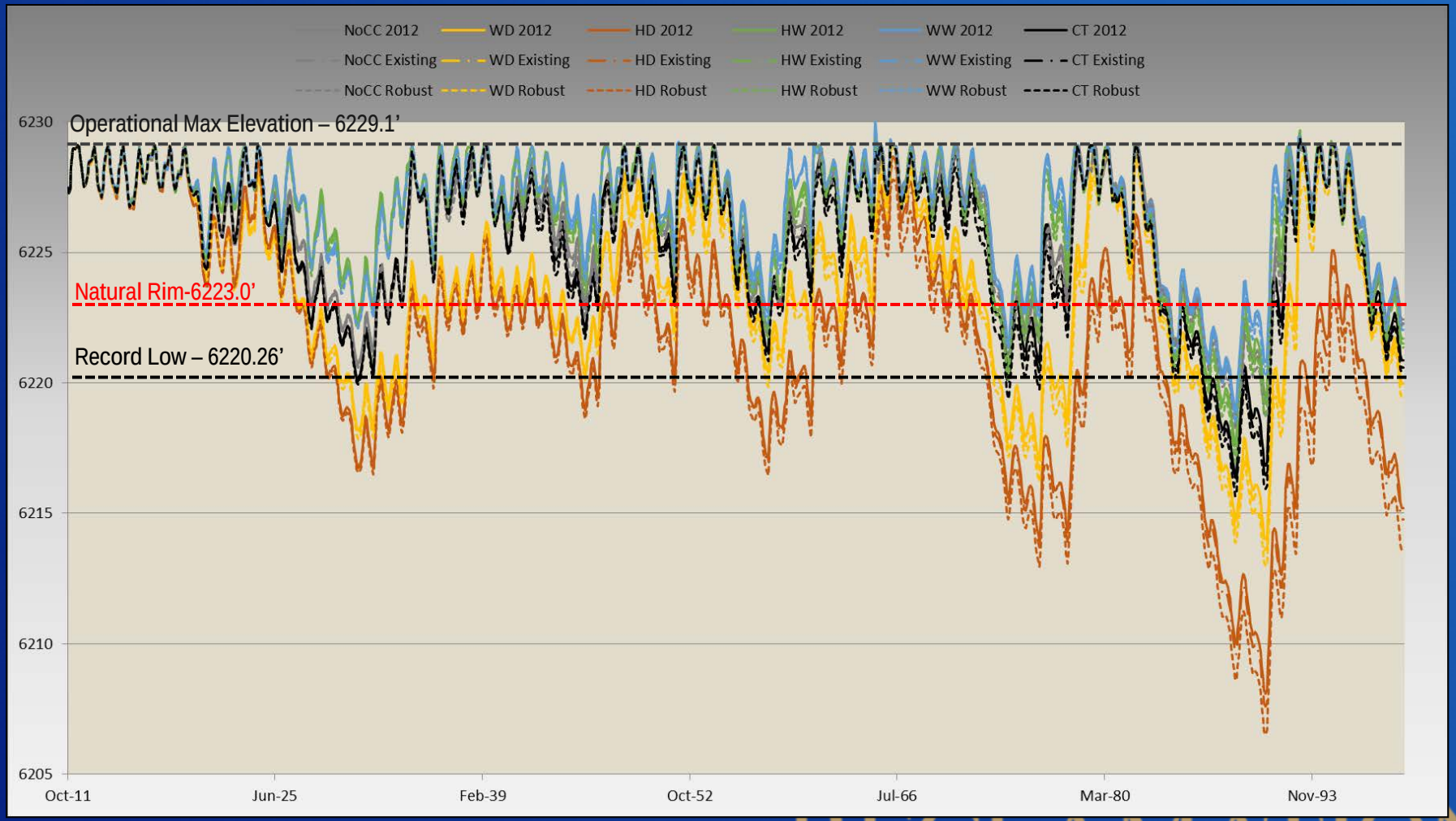
RECLAMATION

Lake Tahoe

- Truckee River starts at the Lake Tahoe dam
- The Lake Tahoe dam impounds up to 6.1 feet over the natural rim of the lake
- There is space for 744,000 acre-feet in this 6.1 feet, which is more storage than all of the other Truckee reservoirs combined
- The lake evaporates approximately 3.8’ per year (456,000 acre-ft)
- Lake Tahoe is the dominant feature from a water supply standpoint in the Truckee Basin
- When Tahoe goes below the rim, the whole system is impacted significantly

RECLAMATION

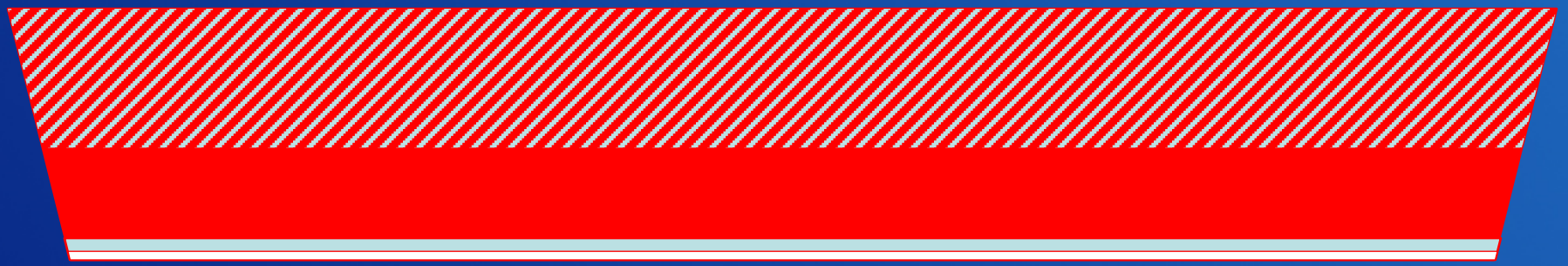
Lake Tahoe Elevation (ft)



RECLAMATION

Tahoe Total Volume and Useable Volume (to scale)

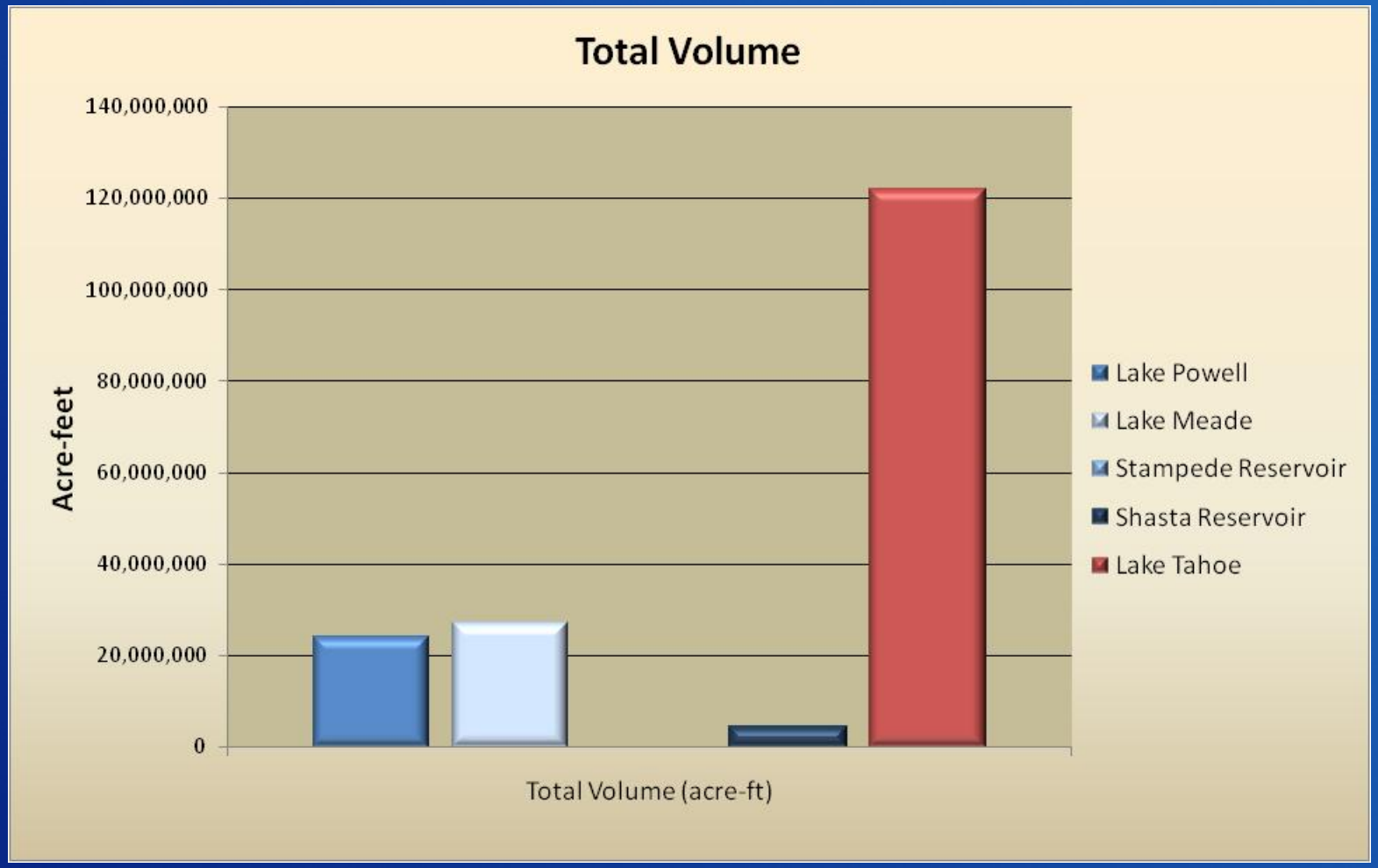
Tahoe Reservoir ?



Total Impounded Volume of Tahoe Dam……	745 taf (6.1 ft)
Average Annual Evaporation……	456 taf (3.8 ft)
Max. Controlled Summer Release (90 days @ 350 cfs)..	63 taf (0.52 ft)
Typical Release (90 days @ 70 cfs)……	13 taf (0.10 ft)

RECLAMATION

Tahoe Comparisons



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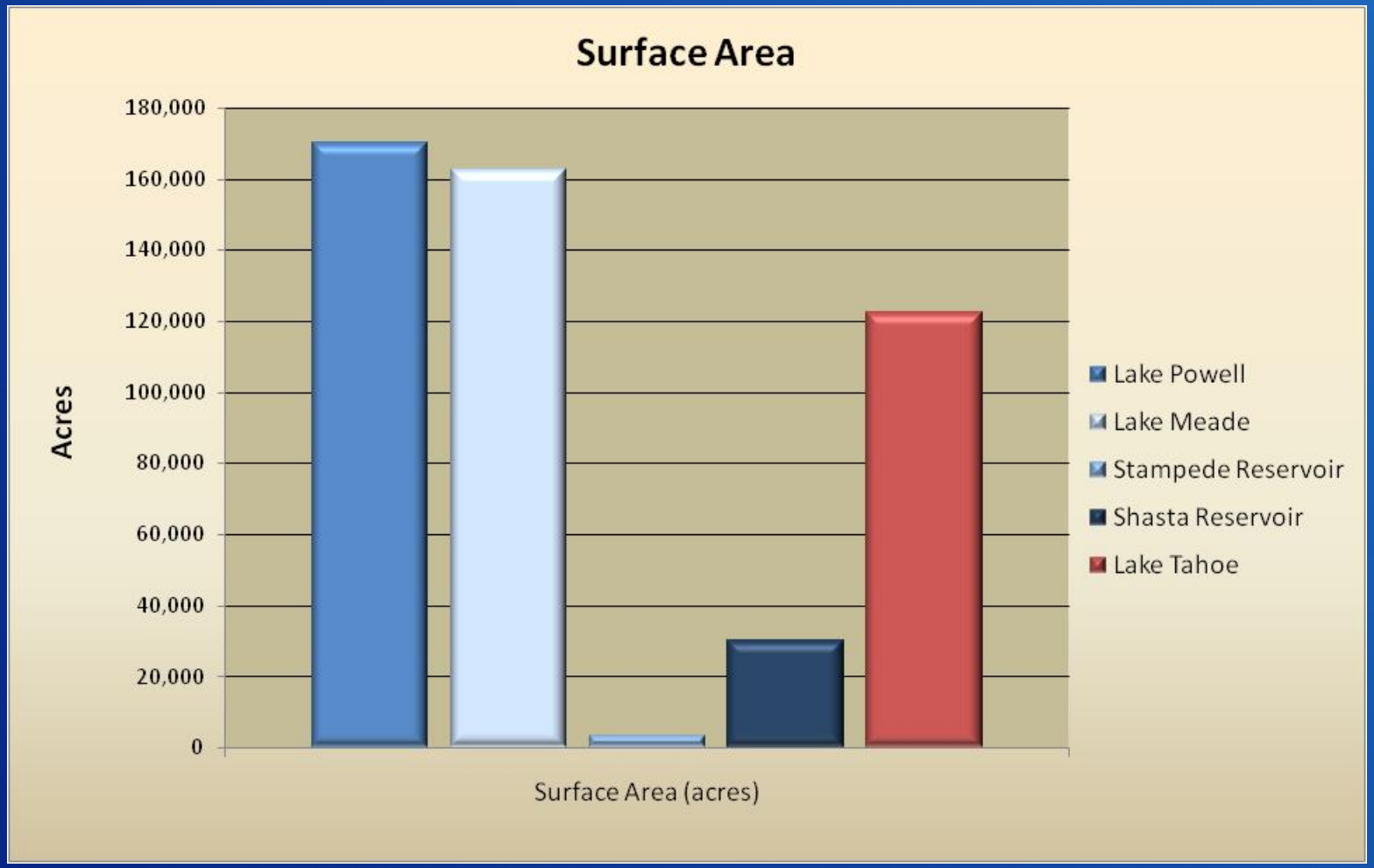
Tahoe Comparisons



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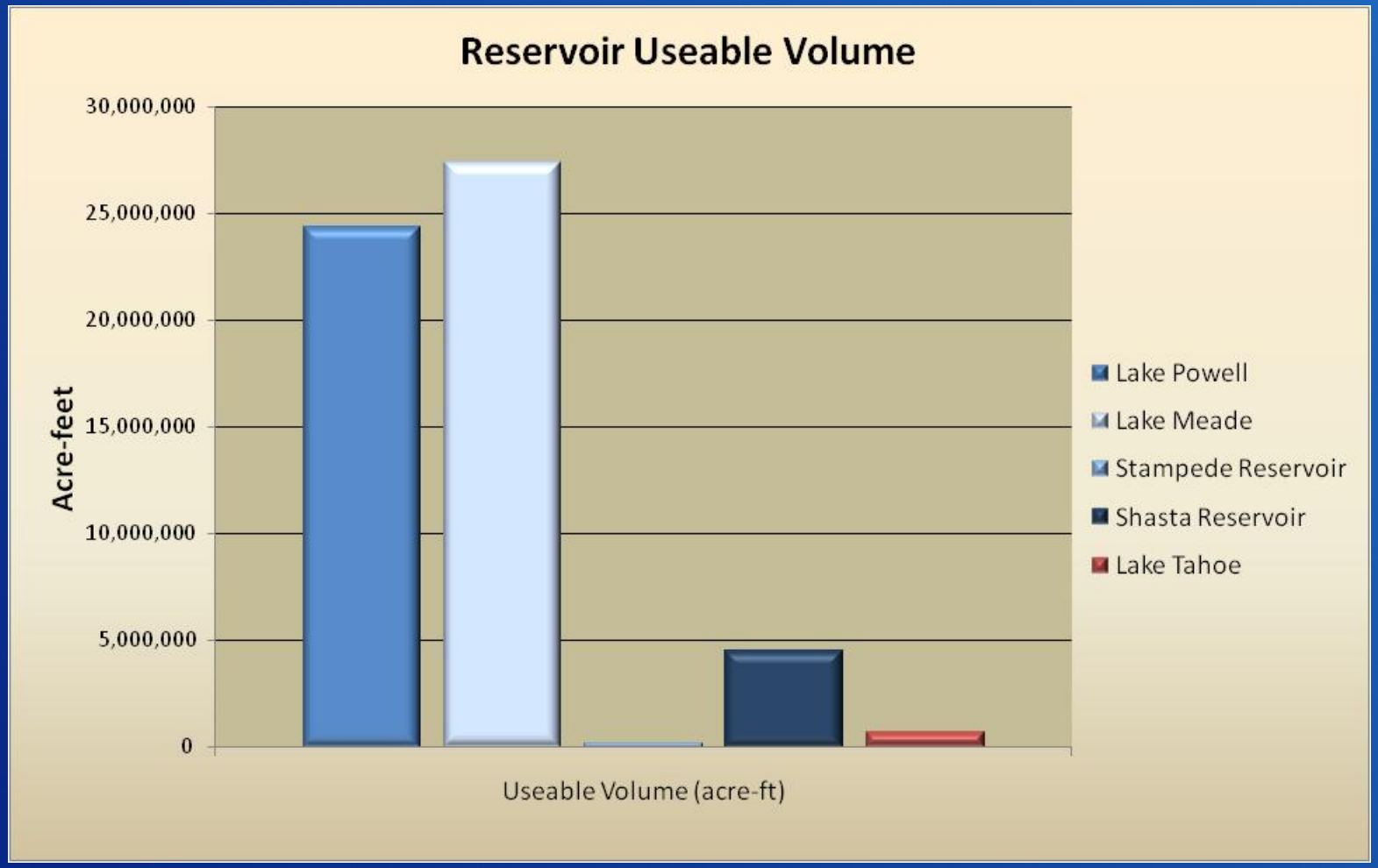
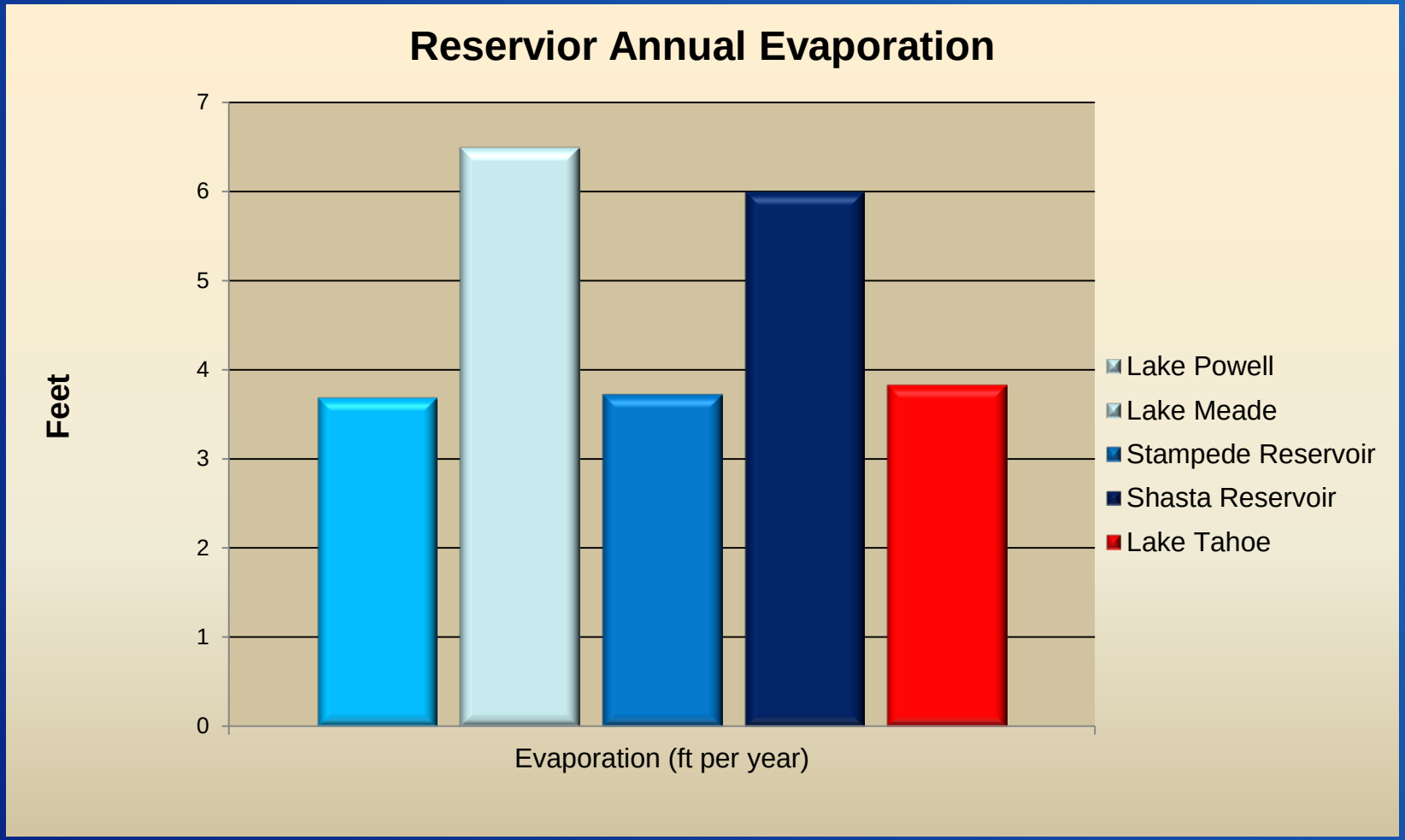
Tahoe Comparisons



RECLAMATION

Tahoe Comparisons



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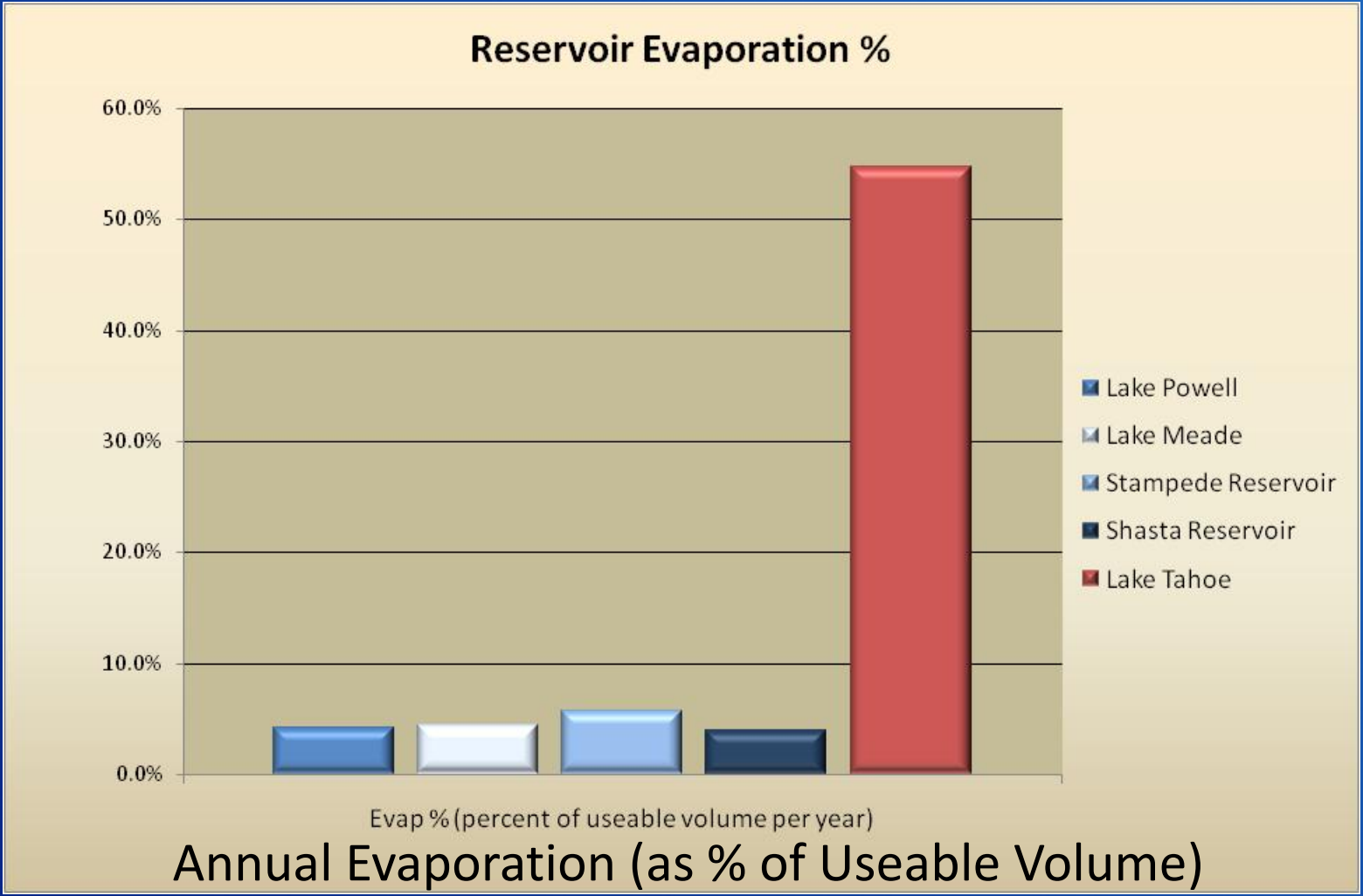
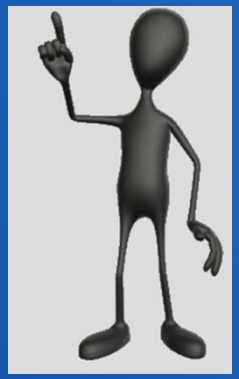
Tahoe Comparisons



Annual Evaporation (as % of Useable Volume)

RECLAMATION

Conclusions

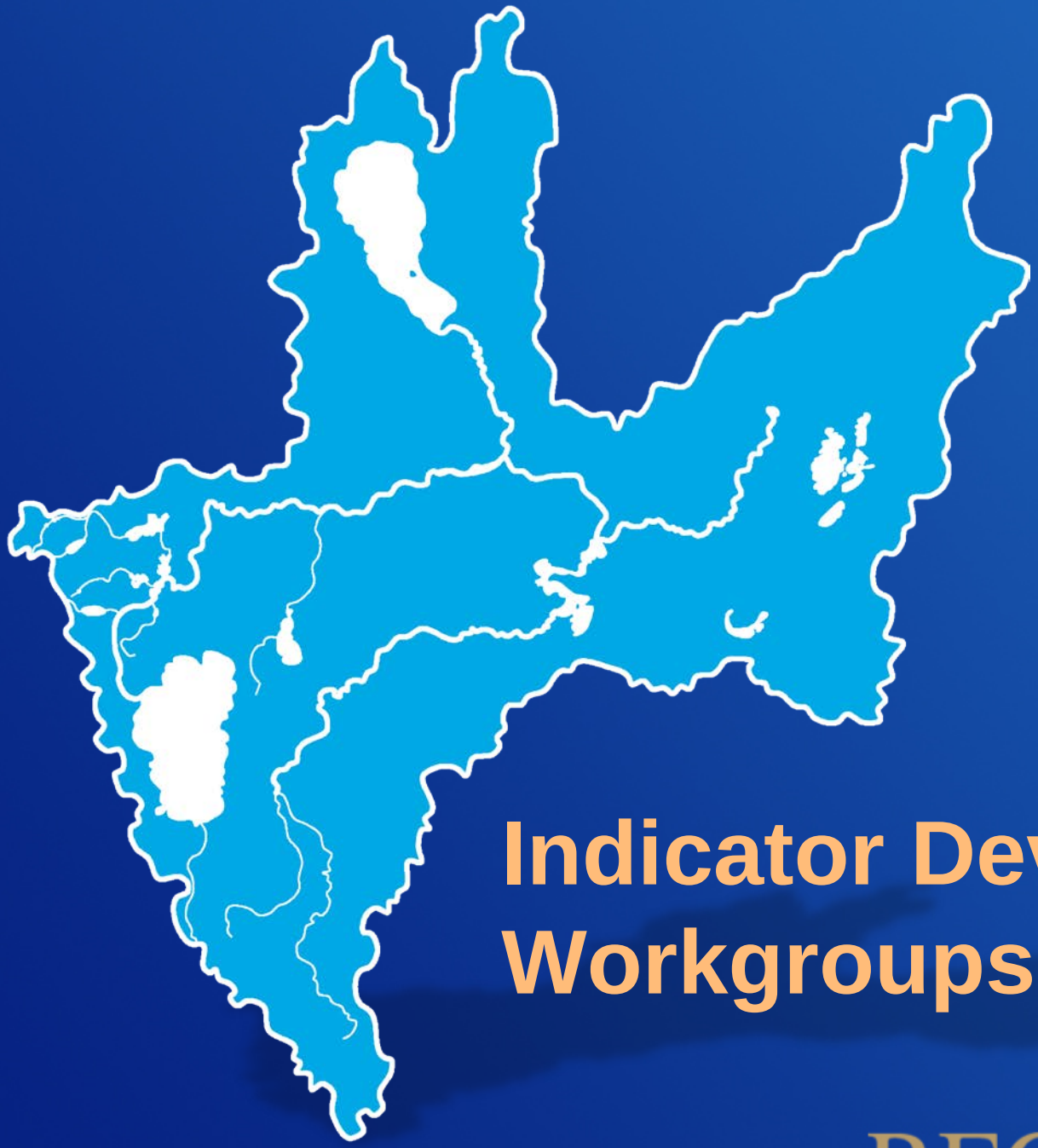


- The Truckee Basin is uniquely sensitive to climate change because of Lake Tahoe's unique water balance
- For most basins, the effects on run off from change in temperature (timing) and changes in water supply (volume) due to changing climate are largely independent, in the Truckee they are intertwined
- The uncertainty in the future climate is substantial

RECLAMATION

Working Lunch

RECLAMATION



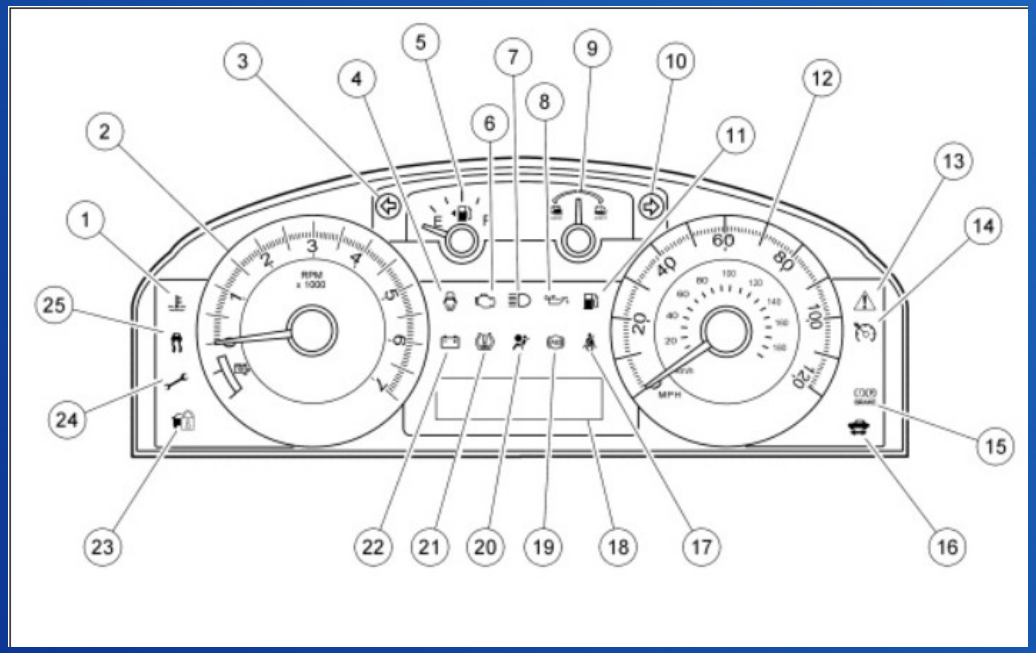
Indicator Development Workgroups

RECLAMATION

Goals for Indicator Workgroup

- **Translate model outputs (metrics) into meaningful indicators for a “Truckee Basin Dashboard”**

- **Develop a shared meaning about the Truckee Basin’s water supply risks**



RECLAMATION

Key Terms

Metrics

- Quantitative, un-interpreted, objective
- *What is measured as having happened.*

Sources of metrics:

- Climate models
- Hydrology models
- TROA Planning model

Indicators

- Requires interpretation, subjective
- *Help identify whether desired conditions been maintained, challenged, or denied.*

Sources of Indicators:

- Studies, Reports and Plans
- Expert input

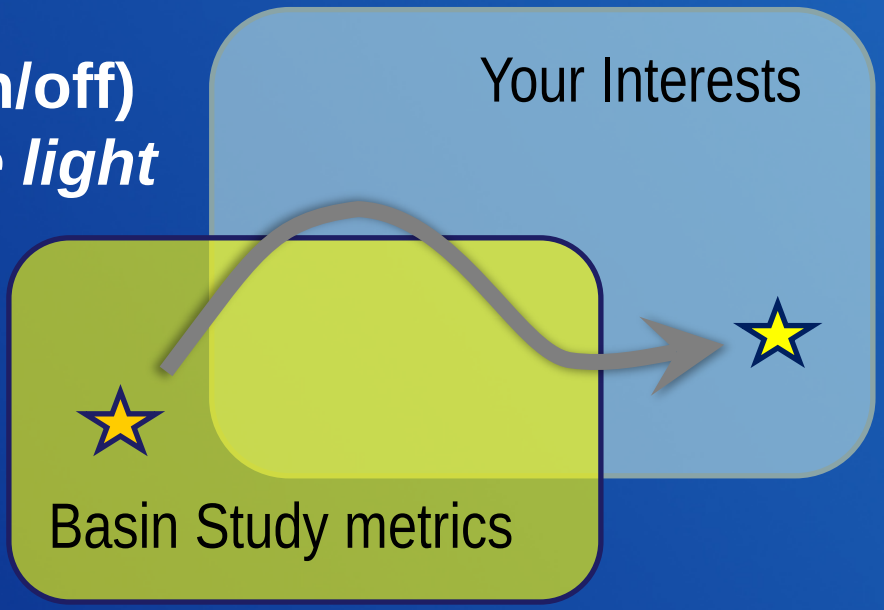
Analogy for Indicators

The Indicator		Metrics; *application to the Indicators*
Icy Conditions May Exist, Drive with Caution		Outside Temperature; *warning when temperature falls below 32˚ F.*
Fuel Status, Low Warning		Fuel Level; *warning when remaining volume is less than 1 gallon*
Something complex may require evaluation		Oxygen Sensors, Temperature Sensors, Oil Level, Odometer Reading, Time Since Last Computer Clearance; *warning when any perform outside of individually specified ranges.*

RECLAMATION

Building Meaningful Indicators

- **Keep it simple**
- **Understand the meaning within the metrics**
  - **Mismatches exist between metrics and interests**
  - **Metrics used for one purpose may be inappropriate for another**
- **Be mindful with binary (on/off) indicators (*e.g. the engine light that's always on*)**
- **Where appropriate, allow for reporting of a range**



Indicator Templates

Lights (Binary)

- Activated if a specific condition occurs (even if it only occurs once)
- Can be used when the tipping point is an average condition and/or inflexible (catastrophic)

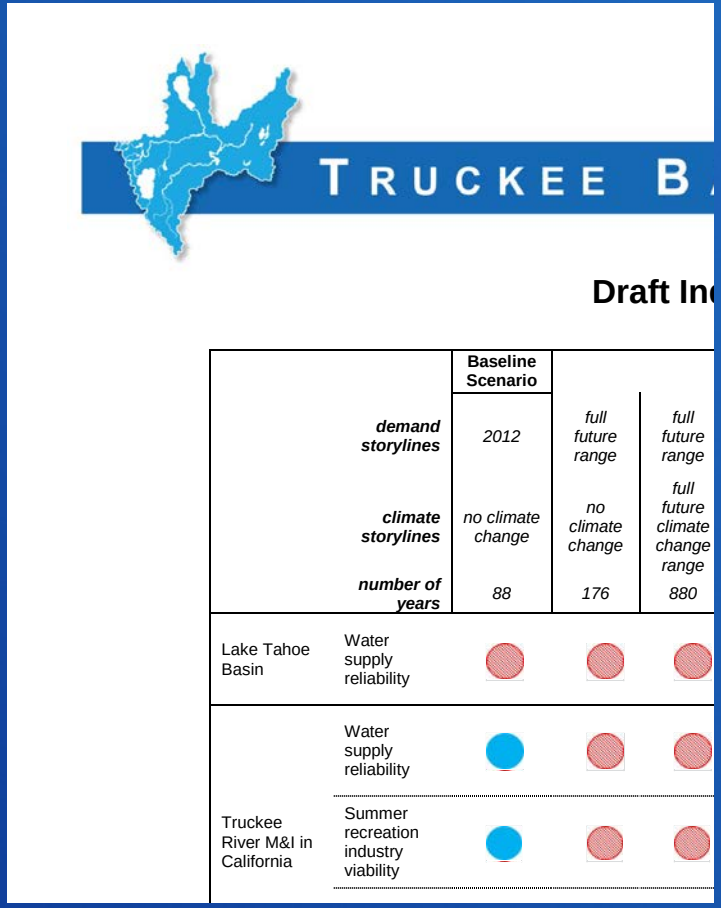
Dials (Graduated)

- Reports a range
- Can report one aspect of a complex system
- Can help diagnose problems and during the design of responses

RECLAMATION

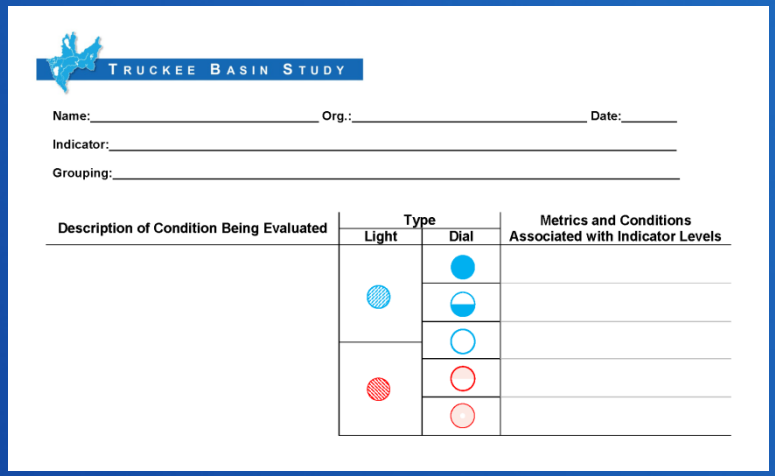
Resources for the Exercise

- Draft Dashboard & Explanation of Draft Indicators
- Plots of Selected Metrics
- List of Basin Study Metrics
- Technical Experts
  - Metrics spreadsheet
  - Indicators spreadsheet
- Blank metrics forms
- Meeting attendees



RECLAMATION

Group Exercise


TRUCKEE BASIN STUDY

Name:_____ Org.:_____ Date:_____

Indicator:_____

Grouping:_____

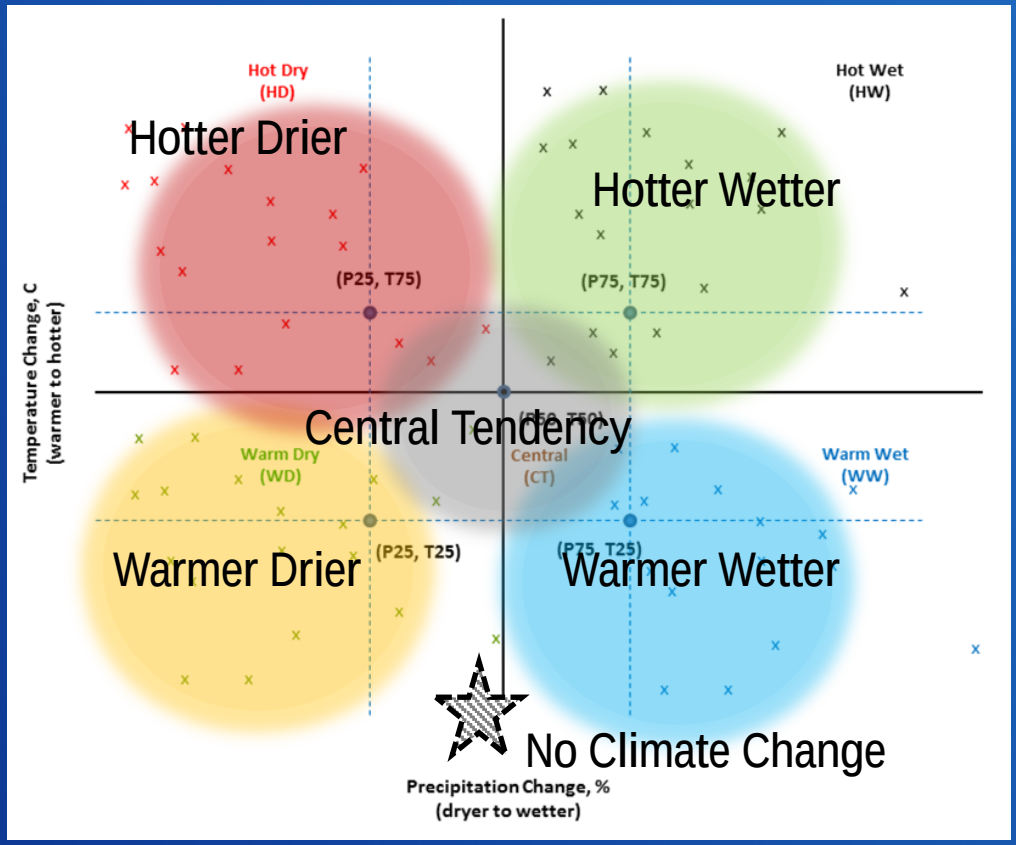
Description of Condition Being Evaluated	Type		Metrics and Conditions Associated with Indicator Levels
	Light	Dial	

- Format
  - Break into 4-5 groups
  - Diversity will help create shared meaning
- Assignment
  - Review interest/geographic groupings for completeness
  - Propose, change, or subtract indicators for each interest area
  - Pace: 10 minutes for each of the proposed groupings
- Basin Study Team Involvement
  - Recorders
  - Technical resources
  - Moderators

RECLAMATION

Groups of Scenarios on the Dashboard

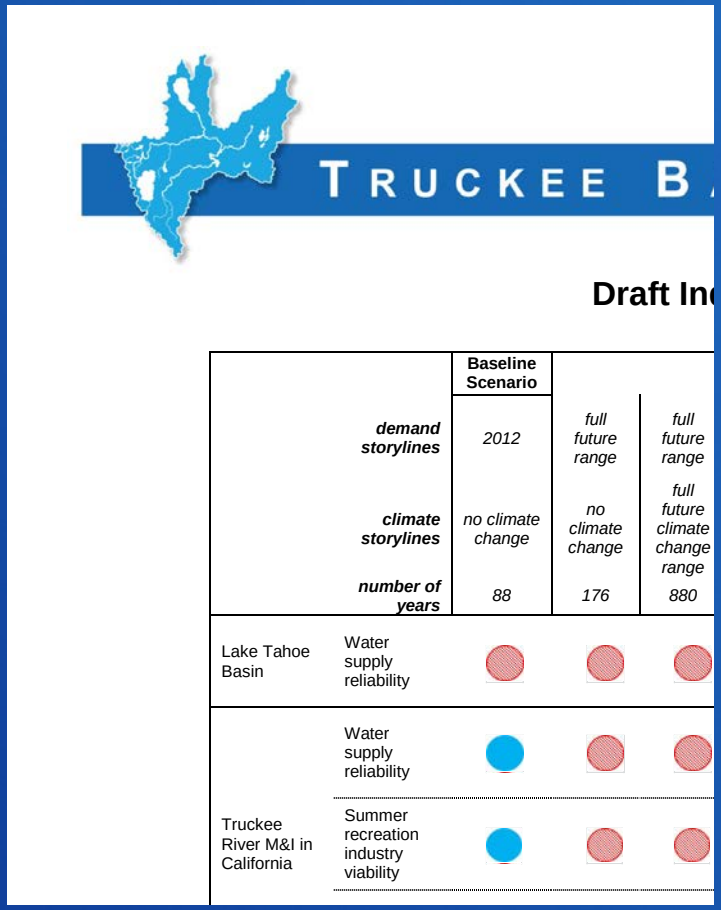
- Wetter
- Drier
- Hotter
- Warmer
- Central Tendency
- No Climate Change



RECLAMATION

Draft Indicators

- Intended to stimulate creativity, demonstrate need for updated interpretations
- Borrowed from Previous Studies and Reports
- May not be functioning well for purpose of study

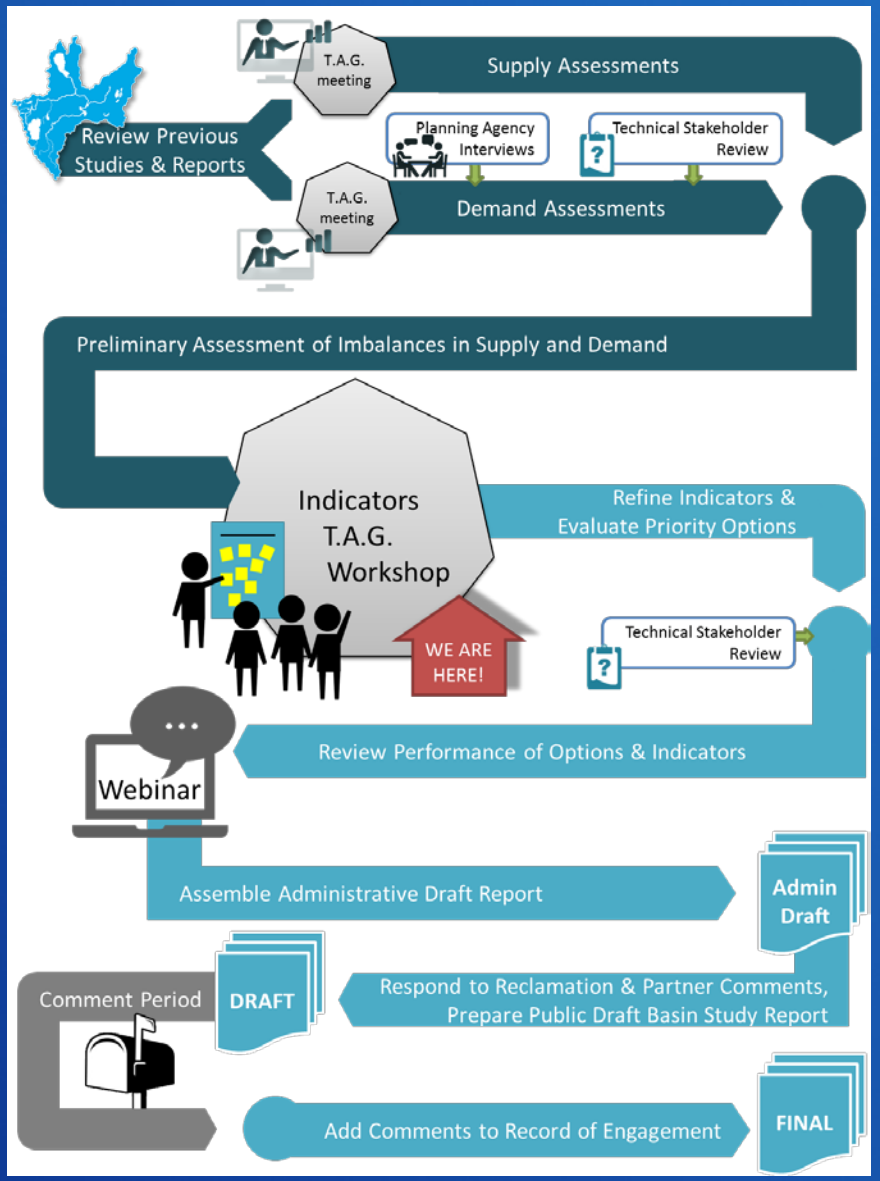


		Baseline Scenario		
	demand storylines	*2012*	*full future range*	*full future range*
	climate storylines	*no climate change*	*no climate change*	*full future climate change range*
	number of years	*88*	*176*	*880*
Lake Tahoe Basin	Water supply reliability			
Truckee River M&I in California	Water supply reliability			
	Summer recreation industry viability			

RECLAMATION

Upcoming Review and Coordination

- Information or additional metrics can be distributed after meeting
- July 21 deadline for initial metrics submission
- Dashboard will be re-distributed after options are tested



RECLAMATION