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Update of the Safe Yield Reset Methodology

Peer Review Meeting

July 20, 2022

Agenda

- Background and Objectives
- Summary of Draft TM #1
- Discussion of Peer Review Comments and Responses on Draft TM #1
- Discussion of Proposed Updated Safe Yield Reset Methodology (Draft TM #2)
- Next Steps and Schedule

Background

- April 28, 2017 Court Order
  - Approved current Safe Yield reset methodology
  - Included a provision to update the Safe Yield reset methodology
  - Required a peer review process

"4.4 Safe Yield Reset Methodology. […] In furtherance of the goal of maximizing the beneficial use of the waters of the Chino Basin, Watermaster, with the recommendation and advice of the Pools and Advisory Committee, may supplement the Reset Technical Memorandum's methodology to incorporate future advances in best management practices and hydrologic science as they evolve over the term of this order."

Background

- 2020 Safe Yield Reset
  - Applied Court-approved methodology to reset the Safe Yield for fiscal year 2021-2030 = 131,000 afy
  - Several peer-review comments recommended that the SY reset methodology be revised in the future to account for:
    - Model parameter uncertainty
    - Predictive uncertainty, such as:
      - Future hydrology
      - Future water demands/supply plans

Objectives and Benefits

- Produces net recharge estimates with quantified uncertainty
- Produces estimates of MPI/undesirable results with quantified uncertainty
- Improves understanding of Basin response to various potential futures
    - Climate change
    - Hydrology
    - Water demand/supply plans
- Provides planning information to guide optimal Basin management

Background

- Spring 2021 – Watermaster proposed a scope of work to update the SY Reset methodology to address uncertainty
- Appropriative Pool requested modified scope to solicit feedback early in the process
- Watermaster prepared a modified scope to address AP concerns and recommendations
  - Scope and budget approved in FY 2021/22

Background

- Watermaster prepared a TM describing uncertainty in modeling and in the CVM
- October 2021 Peer Review Meeting:
  - Discussed methods to address uncertainty
  - Expressed desire for cost-effectiveness
- Comments and responses can be found in the October 29, 2021 letter from West Yost that accompanied a scope and budget amendment for FY 2021/22

Background – October 2021 Peer Review Meeting

- May 2022: Watermaster prepared a Draft TM #1 for a proposed Safe Yield Reset methodology
- May 19, 2022 Peer Review Meeting to review Draft TM #1
- Received comments from peer reviewers
- July 2022: Watermaster prepared a Draft TM #2 for a proposed Safe Yield Reset methodology that addresses the peer-review comments

Today's Meeting Objectives

- Peer reviewers understand the proposed Safe Yield Reset methodology and responses to comments on Draft TM #1
- Gather feedback from peer review committee on the proposed Safe Yield Reset methodology

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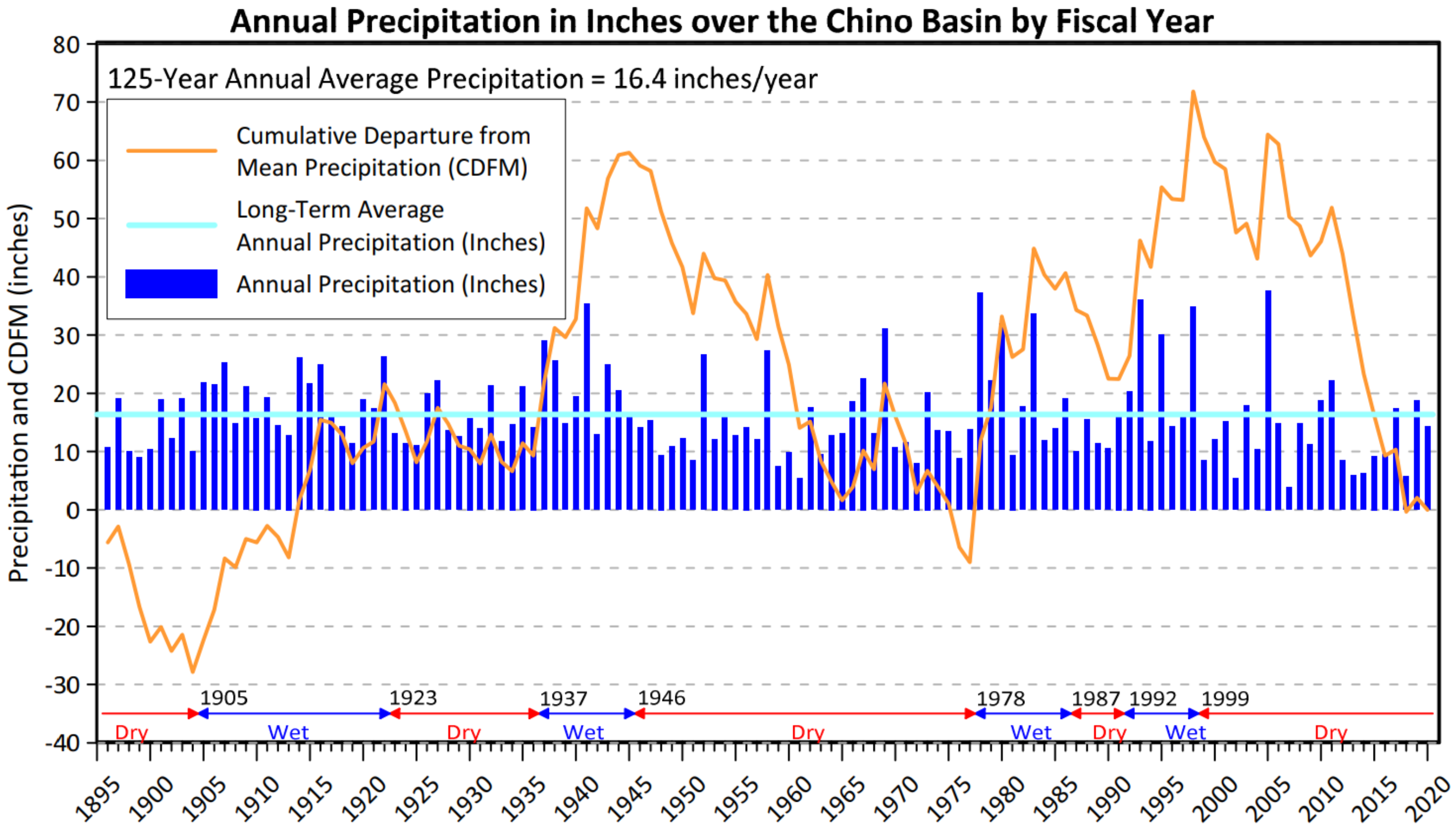
Uncertainty in Surface Water and Groundwater Modeling

- What is uncertainty?
- Sources of uncertainty in surface water and groundwater modeling:
  - Historical data
  - Surface water and groundwater model parameters
  - Demand and supply plans
  - Climate/hydrology

Addressing Uncertainty in Historical Data

- Includes directly observed data and estimated data calculated from observations
- Availability of a lot of data from varying sources
- Will honor historical data



Addressing Uncertainty in Model Parameters

Recommended Method: Iterative Ensemble Smoother (IES) with PESTPP-IES

- Relatively low computing cost to address non-uniqueness problems in model parameters.
- Computing cost does not grow with the number of parameters.
- Straightforward implementation (Attachment A of TM).

Addressing Uncertainty in Demand and Supply Plan Projections

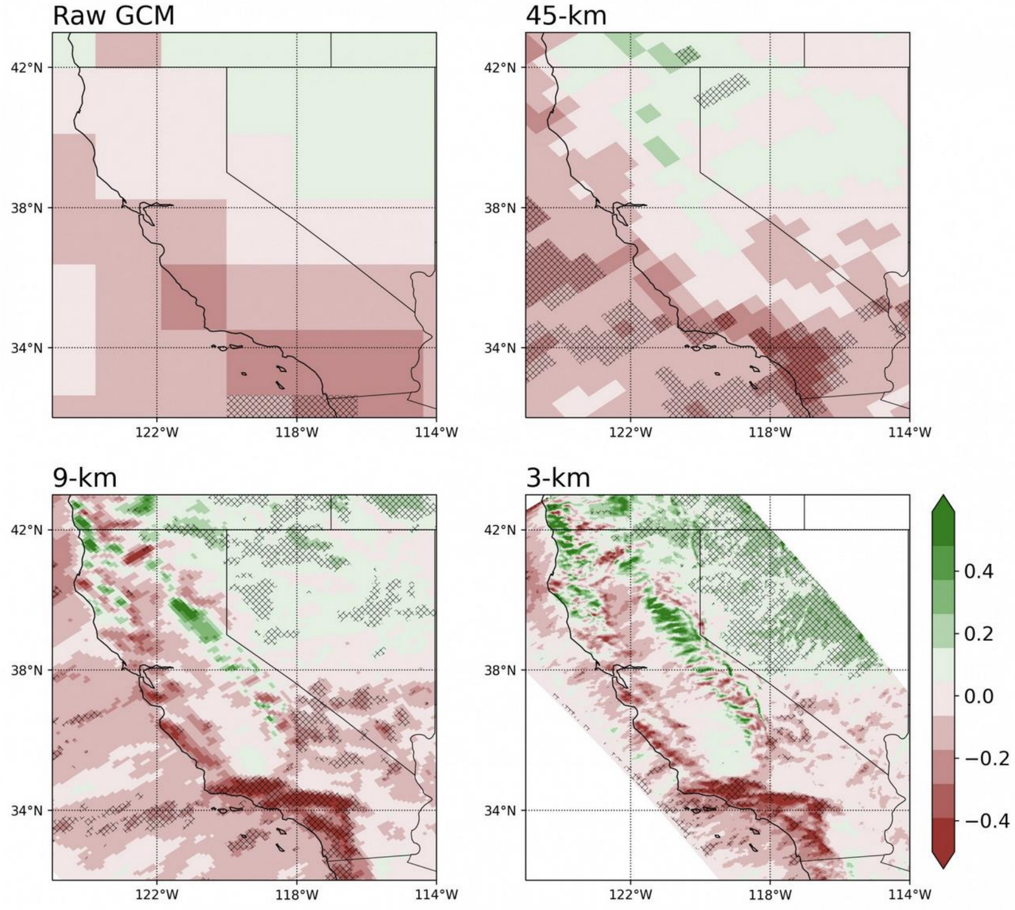
- Recommended method:

1. Identify drivers of changes in future demands and supplies (e.g., population growth, water conservation mandates, climate change)
    a. Conduct workshops with Parties and wholesale agencies
2. Develop scenarios based on combinations of drivers
3. Select a subset of scenarios in (2) to incorporate into projection realizations
4. Quantify water supply plans for selected scenarios
    a. Conduct workshops with Parties and wholesale agencies
5. Translate water supply plans into model inputs

Addressing Uncertainty in Climate/Hydrology Projections

Recommended Method:

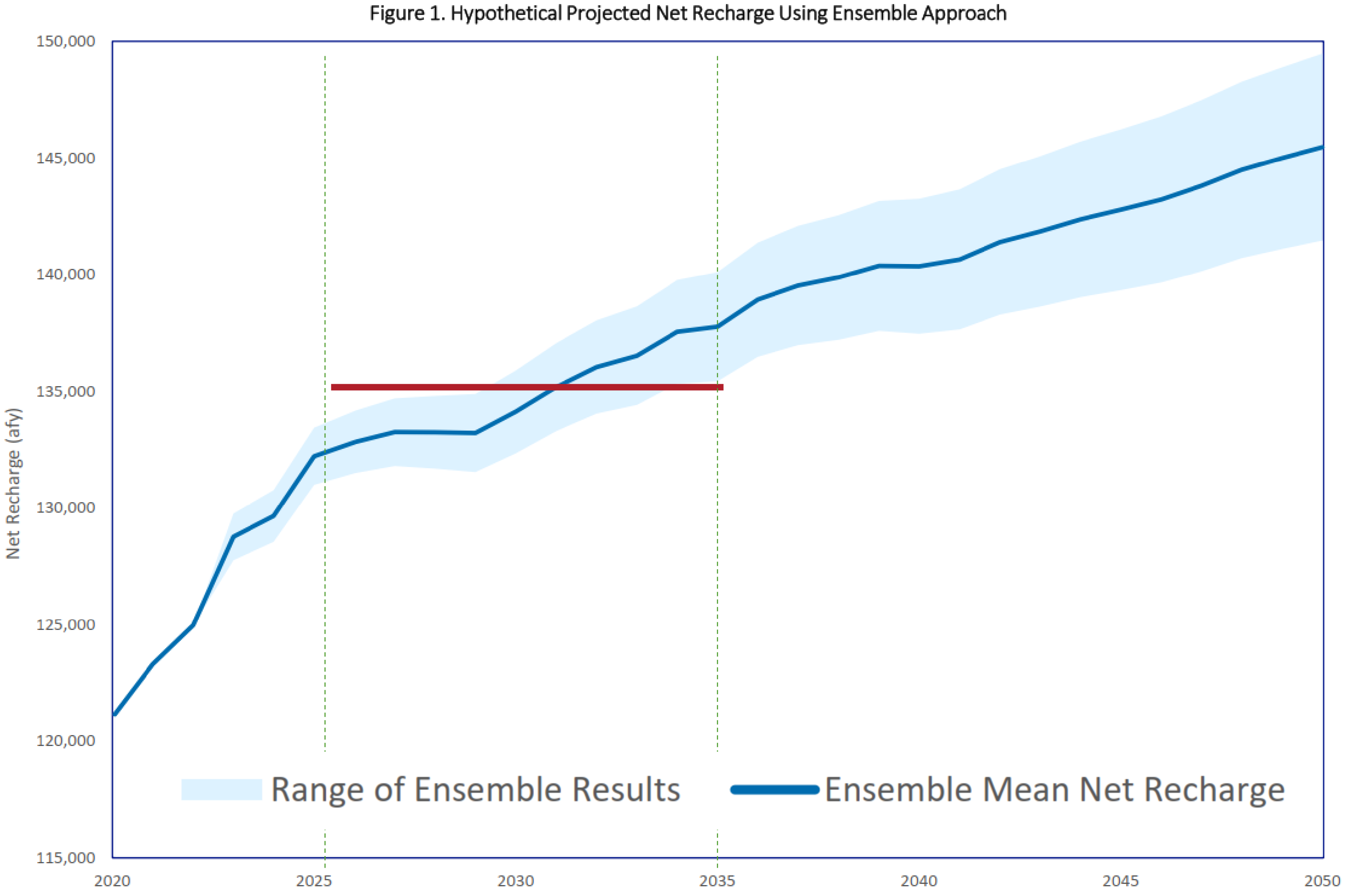
1. Review and select a subset of the available dynamically downscaled WRF-CMIP6 datasets.
2. Review and select representative future cultural conditions consistent with the water demand and supply plan scenarios.
3. Incorporate the chosen combinations of climate datasets and cultural conditions into the CVM



Future (2080-2100 average) minus historical (1980-2015 average) simulated precipitation anomalies [mm/d] from a raw GCM and from WRF downscaling grids. Hatching denotes statistical significance greater than 0.9, and cross hatching denotes significance greater than 0.99.

https://dept.atmos.ucla.edu/alexhall/downscaling-cmip6

Interpreting the Model Ensemble



Proposed Updated Methodology to Calculate the Safe Yield (1/3)

1. Update model and generate multiple calibrated groundwater model realizations (calibration realizations):
   a. Update HSPF/R4 models
   b. Update MODFLOW model for the historical period
   c. Select adjustable parameters and prepare files to include parameters in PESTPP-IES
   d. Prepare observation calibration targets
   e. Use PESTPP-IES to estimate model parameters and generate calibrated realizations

Proposed Updated Methodology to Calculate the Safe Yield (2/3)

2. Develop future scenarios of demands, water-supply plans, and climate/hydrology using the recommended approaches and methods
3. Generate projection realizations (combinations of calibrated realizations and future scenarios)
4. Simulate the ensemble of projection realizations over the planning period and quantify the water budget, net recharge, the state of Hydraulic Control, and the potential for MPI or undesirable results for each projection realization.

Proposed Updated Methodology to Calculate the Safe Yield (3/3)

5. Conduct statistical analyses of ensemble results, including:
   a. Water budget and net recharge over 50-year planning period
   b. Safe Yield = ensemble mean net recharge over prospective 10-year period
   c. Statistics of projection realizations that result in MPI or loss of hydraulic control
6. Evaluate risk for MPI and loss of hydraulic control based on statistics.

   "Identify and implement prudent measures necessary to mitigate [MPI and undesirable results], set the value of Safe Yield to ensure there is no [MPI and undesirable results], or implement a combination of mitigation measures and a changed Safe Yield."

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Comments on Draft #1

1. Model Details
   - Elements of the CVM
   - Individual model runs
2. Ensemble Implementation
3. Cost

Comments on Draft #1: Model Details

Comment (Rick Rees – Comment No. 4): *Clarify how the HSPF and R4 models will be incorporated into the uncertainty analysis.*

Response: *We do not plan to conduct an uncertainty analysis on the HSPF and R4 models. We plan to update the HSPF and R4 models and use them similar to our current methodology. It is not recommended that the HSPF or R4 models be subject to the uncertainty analysis. Rather, the HSPF/R4 estimated DIPAW and subsurface inflows to CVM will be included as adjustable parameters in PESTPP-IES.*

Comments on Draft #1: Model Details

Comment (Tom Harder – Comment No. 2): *Provided recommendations for speeding up run times and simplifying the modeling configuration:*

1) *Increase cell size*
2) *Reduce number of model layers*
3) *Discontinue use of HSPF and R4 models*
4) *Reduce time step*
5) *Change solver configuration*
6) *Implement PLPROC Kx relationship equations*
7) *Remove outlier groundwater level observations*

Comments on Draft #1: Model Details

Comment (Tom Harder – Comment No. 3; Dave Crosley/Eric Fordham – Comment No. 2): *Recommend incorporating distribution system losses (i.e., water main leaks) as a recharge component to the CVM.*

Response:

- *Any potential work to include water main leaks in the updated CVM is not necessary to finalize the SY Reset methodology*
- *Incorporating water main leaks is contingent on receiving reliable data from the Appropriative Pool Parties. We have yet to receive sufficient information to develop defensible assumptions for the location/magnitude of recharge resulting from these leaks over the calibration and planning periods.*
- *We will develop a cost estimate in FY 2022/23 to include water main leaks in the CVM during the forthcoming model update.*

Comments on Draft #1: Ensemble Implementation

Comment (Rick Rees – Comment Nos. 1,7; Dave Crosley/Eric Fordham – Comment No. 4): *Start with fewer calibration realizations and only add complexity (more calibration realizations) if necessary.*

Response: *We propose to start with a smaller subset of calibration realizations, review results, and determine whether more calibration realizations should be added. Results will be discussed with the peer review committee.*

Comments on Draft #1: Ensemble Implementation

Comment (Rick Rees – Comment Nos. 5,7): *Start with fewer demand and supply plan scenarios and only add supply plan scenarios if necessary. Consider whether the selected demand and supply plan scenarios should be weighted by likelihood.*

Response: *We agree. Like the calibration realizations, we will begin by recommending fewer scenarios and only add more if necessary. We have included a provision to assign likelihoods to the demand and supply plan scenarios in Draft #2.*

Comments on Draft #1: Ensemble Implementation

Comment (Rick Rees – Comment No. 6): *Clarify how plausibility will be determined when choosing climate scenarios. Set limit to number of recommended climate scenarios. Maintain consistency between climate scenarios chosen and the future climate conditions assumed in other studies (e.g., SNMP).*

Response:

- *We propose selecting climate scenarios and gradually increase the number of simulated projection realizations until the results of the simulated net recharge of the ensemble converge.*
- *We will present the available climate datasets and our proposed selected datasets at a peer review workshop to gather feedback before implementation.*
- *We will ensure consistency in the planning scenarios, including future climate, across other Chino Basin planning studies.*

Comments on Draft #1: Cost

Comment (Tom Harder – Comment No. 1): *Cost estimate to implement the updated Safe Yield Reset methodology is higher than anticipated.*

Response:

- *Total cost to implement the updated Safe Yield Reset methodology is estimated to be about $1.75 to $2.3 million over three years.*
- *Cost due to additional runtime of the ensemble is anticipated to be small*
- *HSPF and R4 models will not be subject to an uncertainty analysis*

Comments on Draft #1: Cost

Comment (Tom Harder – Comment No. 1): *Cost estimate to implement the updated Safe Yield Reset methodology is higher than anticipated.*

Response:

- *Primary reasons for the increase in cost compared to the 2020 Safe Yield Recalculation are the following:*

  1. Conversion of the CVM to a pilot point method of calibration to facilitate the use of PESTPP-IES
  2. Development and application of PESTPP-IES tools
  3. Development of tools to generate scenarios for projection realizations
  4. Development of tools and methods to systematically assess MPI and undesirable results for the ensemble of projection realizations
  5. Additional peer reviews
  6. Added complexity and content of reporting

Comments on Draft #1: Cost

Comment (Dave Crosley/Eric Fordham – Comment No. 5): *We recommend the consultant conduct independent research and process development to better understand the mechanics of their planned approach such that only the essential steps required for the CVM uncertainty analysis are recognized and the associated level of effort and costs can be defined.*

Response:

- *The TM documents our research and process development, as informed by the peer review process*
- *We are confident in our understanding of the implementation process, but there are inherent unknown variables in the process that warrant the range in cost estimate.*

Comments on Draft #1: Cost

Comment (Dave Crosley/Eric Fordham – Comment No. 5): *A detailed cost estimate should be prepared to conduct the CVM uncertainty analysis for the basin's safe yield that should be presented to the Chino Basin groundwater producers for their consideration.*

Response:

- *More detailed annual budgets, such as the current budget for FY 2022/23, are presented for approval by the Advisory Committee and Board in the spring prior to the new FY. We present these budgets with clear assumptions on scope, schedule, and deliverables, and we will continue to do so during the implementation of the updated Safe Yield Reset methodology.*

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Updates included in Draft TM #2

1. Use of HSPF and R4 models
2. Assignment of likelihoods to water demand and supply plan scenarios
3. Coupling water demand/supply plan scenarios and climate scenarios
4. Choosing climate scenarios
5. Incremental addition of projection realizations
6. Saving model results

Updates included in Draft TM #2

1. Use of HSPF and R4 models
   - Uncertainty analysis will not include HSPF and R4 models
   - HSPF and R4 models will still be run deterministically and may not be recalibrated from 2020 CVM
   - Outputs from HSPF and R4 models (DIPAW, boundary fluxes) will be included as adjustable parameters in PESTPP-IES.

Updates included in Draft TM #2

2. Assignment of likelihoods to water demand and supply plan scenarios
    - Parties may provide feedback to aid in the assignment of non-uniform likelihoods to the chosen water demand and supply plan scenarios (e.g., “most likely” scenario that may have a higher weight than less likely scenarios)
    - Likelihoods would be applied to ensemble to calculate Safe Yield and evaluate MPI

Updates included in Draft TM #2

3. Coupling water demand/supply plan scenarios and climate scenarios

    - Water demand/supply plan scenarios should be consistent with the climate scenarios
    - Certain combinations of water demand/supply plan scenarios and climate scenarios may not be practical and should not be considered

Updates included in Draft TM #2

4. Choosing climate scenarios
   - Data from available WRF-CMIP6 scenarios will be compared to historical PRISM (precipitation) data over the concurrent time period
   - The results of this comparison will be used to rank the WRF-CMIP6 models and select the climate scenarios for use in the CVM
   - Results and recommended climate scenarios will be discussed with the peer review committee

Updates included in Draft TM #2

5. Incremental addition of projection realizations
    - Start the model simulation with a smaller number of projection realizations.
    - Review results and determine convergence of simulated net recharge. Add projection realizations to ensemble until simulated net recharge converges or limit of projection realization is reached.
    - The upper limit of projection realizations will be discussed with peer review committee prior to implementation.

Updates included in Draft TM #2

6. Saving model results
   - Key water budget components for each calibration realization and projection realization will be saved
   - Model input files and/or the tools used to generate them will be saved to preserve the reproducibility of model results

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Next Steps and Schedule

- Summarize feedback from today's meeting
- Collect additional feedback by Friday, August 5th
- Finalize TM and distribute by Friday, September 2nd
- Prepare summary TM and run through Watermaster process in September

CHINO BASIN WATERMASTER

Partners in Basin Management

THANK YOU