MINUTES
CHINO BASIN WATERMASTER
APPROPRIATIVE POOL – SPECIAL MEETING
May 20, 2020

The Appropriative Pool special meeting was held via conference call on May 20, 2020.

APPROPRIATIVE POOL MEMBERS PRESENT ON CALL

John Bosler, Chair	Cucamonga Valley Water District
Cris Fealy, Vice-Chair	Fontana Water Company
Cris Fealy	Nicholson Trust
Van Jew	Monte Vista Water District
Van Jew	Monte Vista Irrigation Company
Brian Lee	San Antonio Water Company
Chris Berch	Jurupa Community Services District
Ron Craig	City of Chino Hills
Sam Gershon	Santa Ana River Water Company
Chris Diggs	City of Pomona
Scott Burton	City of Ontario
Josh Swift	Fontana Union Water Company
Dave Crosley	City of Chino

OTHERS PRESENT ON CALL

Shawnda Grady	Ellison Schneider Harris & Donlan, LLP
Katie Gienger	City of Ontario
Justin Scott-Coe	Monte Vista Water District
Courtney Jones	City of Ontario
Eric Fordham	GeoPentech
Eduardo Espinoza	Cucamonga Valley Water District
Steve Nix	City of Upland
Eric Tarango	Fontana Water Company
John Schatz	John Schatz, Attorney at Law
Eunice Ulloa	City of Chino

CALL TO ORDER
Chair Bosler called the Appropriative Pool special meeting to order at 10:00 a.m.

AGENDA – ADDITIONS/REORDER
None

I. CONFIDENTIAL SESSION
Chair Bosler called for a confidential session at 10:00 a.m. to discuss the following:

1. 2020 Safe Yield Reset
2. OBMPU/Storage Management Plan/Implementation Plan

Confidential session concluded at 12:04 p.m. with the following reportable action:

The Pool authorized the distribution of the attached Safe Yield Reset letter.

ADJOURNMENT
Chair Bosler adjourned the Appropriative Pool special meeting at 12:04 p.m.

Secretary: ________________________________

Approved: ________June 11, 2020____________

Attachment:
1. 20200520 Letter from AP to P. Kavounas re 2020 SYR Including Tech Review by T. Harder

Appropriative Pool
Chair: John Bosler
Vice-Chair: Cris Fealy

Chino Basin Watermaster
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May 20, 2020

Mr. Peter Kavounas
General Manager
9641 San Bernardino Road
Rancho Cucamonga, CA 91730

Re: 2020 Safe Yield Reset

Dear Mr. Kavounas:

Although an abbreviated review period has not afforded sufficient time for more information, subject to the scope of information provided by Watermaster the majority of the Appropriative Pool does not oppose the proposed 131,000 acre-feet per year 2020 Safe Yield Reset.

The AP, however, strongly and unanimously recommends Watermaster's consideration of the following in connection with future Safe Yield Resets, including possible interim refinements to the 2020 Safe Yield Reset. These items are intended to improve the process and outcome.

1. A predictive uncertainty analysis has become an industry standard procedure when using complex models to inform groundwater management decisions. The analysis would involve developing multiple versions (preferably hundreds) of the Chino Valley Model, each with unique parameter distributions. Further details regarding this are included in the attached April 23, 2020 Thomas Harder & Co. letter (Harder SYR Letter) submitted to Watermaster.

2. Conducting a check-in on groundwater storage for the period 2011 to 2018 using the criteria described in the attached Harder SYR Letter.

3. Compute the Safe Yield for the 2020 to 2030 time period based on a long-term projected net recharge from at least 2020 to 2050 in order to smooth out short-term hydrologic conditions such as the lingering impacts of recent historic dry conditions.

4. Use the above information to inform the Appropriative Pool with respect to redetermining the Safe Yield for the 2020 to 2030 time period.

Sincerely,

John Bosler, Chair
Chino Basin Appropriative Pool

Thomas Harder & Co.
Groundwater Consulting

April 23, 2020

Mr. John Schatz, Esq
P.O. Box 7775
Laguna Niguel, CA 92607

Re: Technical Review of the Models and Methodology Used as a Basis for the 2020 Safe Yield Reset

Dear Mr. Schatz,

As requested by the Chino Basin Watermaster Appropriative Pool (AP), I have participated in a technical review of the Chino Basin 2020 Safe Yield Reset process since July 2019. That process has included attendance and active participation at the following meetings:

- July 23, 2019 Technical Review Meeting at Wildermuth Environmental, Inc. (WEI).
- January 27, 2020 Technical Review Meeting at WEI.
- March 27, 2020 Technical Review Conference Call.
- March 31, 2020 Technical Review Conference Call.

In addition to participation in these meetings/conference calls, I reviewed WEI's documentation of the 2020 Safe Yield Reset entitled "2020 Safe Yield Recalculation Final Report," dated April 2, 2020 (WEI, 2020).[1] This letter summarizes my findings, comments, and recommendations resulting from participation in the 2020 Safe Yield Reset process.

General Observations

Compliance with Methodology to Estimate Safe Yield

The 2020 Safe Yield Reset is a Court-ordered reassignment of the Safe Yield of the Chino Basin, in accordance with the 2000 Optimum Basin Management Plan (OBMP) Implementation Plan.[2]

[1] WEI, 2020. 2020 Safe Yield Recalculation Final Report. Dated April 2, 2020.
[2] Program Element 8 Develop and Implement Groundwater Storage Management Program: Section (f)

This document requires the Safe Yield of the basin to be redetermined in 2010 and every ten years thereafter. The Court-ordered methodology for redetermining the Safe Yield is defined in the Chino Basin Watermaster (Watermaster) Rules and Regulations,[3] including Exhibit A.[4] The methodology described in WEI (2020) to estimate the Safe Yield of the Chino Basin for the period from 2021 to 2030 generally follows the methodology described in Appendix A to the Safe Yield Reset Agreement. Watermaster Rules and Regulations Section 6.5 specifies "The reset will rely upon long-term hydrology and will include data from 1921 to the date of the reset evaluation." As described in WEI (2020), the 2020 Safe Yield estimation relies on precipitation data for the period 1950 to 2011 and does not include precipitation data extending back to 1921 as was specified in the Rules and Regulations Section 6.5 (d). As such, the methodology used in the 2020 Safe Yield reset does not explicitly comply with the Chino Basin Rules and Regulations.

The Court-approved methodology to estimate the Safe Yield of the Chino Basin relies on a series of models to simulate the distribution and movement of water at the land surface, within the unsaturated zone, and within the aquifer system. While there is no explicit statement in WEI (2020) or previous Safe Yield Reset documentation that says so, it is assumed that the Watermaster considers these models appropriate to help determine the Safe Yield because they are widely-accepted, widely-tested, and/or acceptably calibrated to measured data. Indeed, the latest versions of the Chino Basin models are calibrated to an extensive dataset within what would be considered industry standards.

Uncertainty in the Model Parameters Used to Calibrate the Models

While the models used to determine the Safe Yield of the Chino Basin can be considered calibrated, there is significant uncertainty in the numerous combinations and distributions of parameters derived to achieve calibration and it is not possible that the calibration is unique. In other words, there are other combinations of parameters, all within plausible ranges, that, if assigned to the model, could result in an acceptable calibration. Each calibrated model would result in a different water budget and estimate of Safe Yield. To be clear, the magnitude of data available for developing and calibrating the Chino Basin models is extensive and it is among the best constrained models with which I have experience. Nonetheless, there is no way to directly measure all the parameters across every square inch of the basin necessary to develop a perfectly complete water budget and achieve a perfectly constrained model. A primary concern I have is that the Chino Valley Model is being presented as "accurate" and the implication is that it is the only correct model. Some model-derived data are being presented to the nearest acre-foot implying a level of accuracy that is not defensible given the uncertainty of the input parameters.

[3] Chino Basin Watermaster Rules and Regulations, Section 6.5

[4] WEI, 2015a. Reset Technical Memorandum - Methodology to Reset Safe Yield Using Long-Term Average Hydrology and Current and Projected Future Cultural Conditions. Appendix A to the Safe Yield Reset Agreement.

In reality, the model presented in the report is one of many plausible hydrogeological conceptualizations of the Chino Basin, each of which would result in a calibrated model.

There are numerous assumed or estimated parameters in the Chino Basin model, including (but not limited to):

- The configuration of model layers
- Surface water flow into the Chino Basin
- Distribution of evapotranspiration (ET) across the basin
- Storm water capture
- Managed aquifer recharge basin infiltration rates
- Initial soil moisture content
- Irrigation efficiency
- Deep infiltration lag times
- Streambed conductance
- ET extinction depth
- Subsurface inflow from adjacent basins
- Distribution and character of sediments in the subsurface
- Aquifer parameters
    - Horizontal hydraulic conductivity
    - Vertical hydraulic conductivity
    - Specific yield
    - Specific storage
- Horizontal flow barrier (i.e. fault) conductance

All these parameters, and more, are uncertain and variations in assigned values change the water budget. There is further uncertainty in the assumptions necessary to develop the future water budget that is analyzed with the model to determine the Safe Yield (projected magnitude and location of pumping, recharge, and hydrology). Depending on how the uncertainty is addressed dictates the model outcome.

Impacts of Model Uncertainty on Model Results

This uncertainty is apparent when comparing the water budgets of the previous Safe Yield reset model (WEI, 2015b)[5] with the results of the current one (WEI, 2020).[6] For example, changes in

[5] WEI, 2015b. 2013 Chino Basin Groundwater Model Update and Recalculation of Safe Yield Pursuant to the Peace Agreement. Prepared for the Chino Basin Watermaster by Wildermuth Environmental, Inc., dated October 2015.
[6] WEI, 2020. 2020 Safe Yield Recalculation Final Report. Prepared for the Chino Basin Watermaster by Wildermuth Environmental, Inc., dated April 2, 2020.

model assumptions to estimate Deep Infiltration of Precipitation and Applied Water (DIPAW) were revised between the previous model and current one that resulted in significant differences in this recharge over the previous Safe Yield estimation period from 2011 to 2020. The differences in annual DIPAW during this time period were as much as approximately 27,000 acre-ft (see Table 1). Both models were/are acceptably calibrated, but the water budgets are different. In the current model, other assumed model parameters would likely have been changed during calibration to adjust to the new recharge rates and achieve acceptable calibration. The revised DIPAW rates may be more representative than the original. However, they are still estimated and subject to change in the future as more information becomes available, as is the case for all assumed parameters in the model. If the past is any indication of the future, the next model will likely have a different set of DIPAW values, and/or other revised model input values that will likely yield different results. This type of uncertainty is inherent in all surface water and groundwater models.

Following the above observations, it is my opinion that the most significant omission from the WEI (2020) model analysis and report is an uncertainty analysis. Performance of a predictive uncertainty analysis using publicly-available software is now commonplace in the technical literature and is considered standard practice in groundwater modeling.[7] Uncertainty analysis is also a California Department of Water Resources (CDWR) best management practice for predictive model analysis in support of the Sustainable Groundwater Management Act (SGMA).[8] Such an analysis would consider multiple realizations of the models with ranges of parameter values, each constrained in such a way as to result in acceptable calibration. The estimated Safe Yield from each model realization would be plotted on a cumulative probability chart, which can be used to identify an acceptable range within which to manage the basin. This would provide the basin managers with a sense as to potential variability in the Safe Yield estimate, for use in making decisions.

Specific Comments to the 2020 Model Report

The following are my specific comments to the WEI (2020) 2020 Safe Yield Recalculation Final Report, dated April 2, 2020:

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[7] Beven, K.J. and P. Young. 2013. A Guide to Good Practice in Modeling Semantics for Authors and Referees. Water Resources Research 49 (8), 5092-5098.

Anderson, M.P., W.W. Woessner, and R.J. Hunt. 2015. Applied Groundwater Modeling Simulation of Flow and Advective Transport, 2nd ed. London, UK: Academic Press.

[8] CDWR, 2016. Best Management Practices for Sustainable Management of Groundwater – Modeling BMP. Dated December 2016.

Title

In keeping with the estimated nature of the Safe Yield and to be consistent with the language in the Safe Yield Methodology adopted by the Court, I recommend to replace the word "Recalculation" in the title of the report with "Reset" or "Redetermination." The same would apply to other areas of the report where "recalculation" is used.

Section 1

Section 1.2 pg. Listing of undesirable results: It should be noted that these undesirable results are listed as examples and that not all are specific to the Chino Basin.

Section 1.2 pg. 1-2, last paragraph: It would be helpful to clarify the relationship between net recharge and Safe Yield prior to this point.

Section 1.3 pg. 1-4: Is this long-term hydrology analogous to/defined by the base period?

…"meets other Safe Yield related criteria,…" Are these the criteria you discuss in Sections 1.3.1 through 1.3.5? If so, this isn't clear. If not, what are the criteria, per the title of this section? MPI is not discussed as a criterion as per the court approved methodology and consistent with the title of Section 1.3.

Section 1.3.1 pg. 1-4, 1st paragraph: The base period needs to be defined. What period was used and why was the selected period used. What is its significance with respect to the Chino Basin Safe Yield calculation? How is it applied? The connection is not clear.

Section 1.3.1 pg. 1-4, last paragraph: I'm not sure what you are saying here. If the historical record is not useable, what did you use? Is this only for land use or does it apply to precipitation as well?

Section 1.3.2 Storage pg. 1-4: Need to define what is meant by the term "operational storage space." Presumably "operational storage" is a subset of the total storage space; has the volume and spatial distribution required for "operational storage" been defined?

Section 1.3.3 Basin Area pg. 1-5: More explanation is needed to justify assigning the recharge and discharge terms for the hydrologic boundary to the adjudicated boundary. Are you confident that the net recharge/safe yield calculated for one area and applied to another is representative?

Section 1.3.4 Cultural Conditions, pg. 1-5: There is some confusion as to what constitutes a "cultural condition." I think a definition and examples of such would be helpful up front. For example, are groundwater production patterns, stormwater capture/recharge, storage programs, and basin re-operation considered cultural conditions? Along those lines, are the changes in drainage patterns described in Section 1.3.5 considered cultural conditions?

Section 1.4 Court Direction to Reset Safe Yield, pg. 1-6, Section 4.4, 2nd Sentence: "The reset will rely upon long-term hydrology and will include data from 1921 to the date of the reset evaluation." The methodology described in Section 7.2, using an average precipitation from 1950 to 2011, appears to contradict what was directed by the Court.

Section 1.5 Court Approved Methodology to Calculate Safe Yield pg. 1-7, No. 5: This is a critical criterion to defining safe yield, which is not mentioned in Section 1.3.

Section 1.6 Scope of Work, pg. 1-8 Task 5: This task bullet implies that multiple planning simulations would be conducted. Did this occur?

Section 1.7 Scope of the Model Update, pg. 1-8, 2nd paragraph: We need assurance that the outflow reported by Cucamonga and Six Basins is the same as the inflow to Chino. Have the changes you implemented in the Chino Basin model been implemented in the models relied on by the neighboring basins?

Section 1.8 Scope of the Planning Projection Update, pg. 1-8, 1st paragraph: The last sentence indicates future water supply and demand information was "provided by the Parties and others." Who/what are the "others"?

Section 2

Section 2.5 Aquifer Systems pg. 2-13, 2nd paragraph: Have the aquifer and aquitard layers in the Cucamonga and Six Basins areas been revised to match the new Chino Basin conceptualization or vice versa? How do the aquifers line up at the basin boundaries? Are the conceptualizations identified in WEI (2012) and WEI (2017) the latest?

Section 2.6 Aquifer Properties pg. 2-18, Equation and 1st full paragraph: While this relationship may work in a laboratory on a sample with a known grain size distribution and cementation, it has little value in interpreting general descriptions of "sand" and "clay" from driller's logs. Attached is a typical driller's log from the Chino Basin. What is the source of the equation on the top of pg. 2-18? How was the equation on the top of page 2-18 applied to the information in a driller's log such as the one attached (see Attachment A)? This equation is similar to those published by Hazen (2011) and others. It is noted that, in most cases, it is only applicable to sediments with grain size distributions in the range of 0.1 to 0.3 mm (Fetter, 2001).

Section 2.6 Aquifer Properties pg. 2-18, 2nd paragraph: It is noted that McCuen et al., 1981 addresses soil infiltration, not specific yield.

Section 2.6.1 Compilation of Existing Well Data pg. 2-18, 1st sentence: See comment above.

Section 2.6.2 Classification of Texture and Reference Hydraulic Values for Aquifer Sediments pg. 2-18, 2nd paragraph, 2nd sentence: How have data from these pumping tests been used to constrain the texture analysis? Other than this statement, there is no mention of how pumping test data, which are specifically designed and conducted to address model needs, were used to either determine initial parameter values or constrain calibrated values. Pumping tests have been conducted on all of the Chino Basin Desalter Wells, which provides critical information for constraining aquifer parameters in one of the most vital areas of the basin – where hydraulic control is achieved and maintained. It is my opinion that data obtained from controlled pumping tests are more reliable than grain size analysis for determining hydraulic conductivity and, if interference well measurements can be obtained, storage coefficients.

Section 2.6.2 Classification of Texture and Reference Hydraulic Values for Aquifer Sediments pg. 2-19, last paragraph of section: *"Using this method, specific yield, horizontal hydraulic conductivity, and vertical hydraulic conductivity values were computed for each layer at each well location."* Are the values computed using texture analysis initial values?

Section 2.6.4 Specific Yield pg. 2-20: What were the criteria for accepting a driller's log as useful for the analysis? Model estimated specific yields should be compared to values derived from pumping tests to confirm modeling results.

Section 2.6.5 Specific Yield pg. 2-20: Model estimated hydraulic conductivity or values derived from texture analysis should be compared to values derived from pumping tests to confirm modeling results. It is my understanding that a table of pumping test-derived hydraulic conductivity values will be provided in the final report.

Figures 2-10, 2-11, and 2-12. These figures need to be relabeled to make it clear that they are pre-calibrated parameter distributions.

Section 2.6.6 Vertical Hydraulic Conductivity pg. 2-21: It is not clear in this section how you determined vertical hydraulic conductivity.

Section 2.7 Land Subsidence in the Chino Basin pg. 2-21: Land subsidence is, in part, a function of the storage properties of the aquitards, which you have now included in the model as Layers 2 and 4. This section should include a discussion of why model layers 2 and 4 where included in the CVM and their relationship to future land subsidence evaluations. Have the inelastic and elastic storage properties that dictate aquitard compaction been incorporated into this model? As it appears that the land subsidence package has not been included in this model, when you calibrate land subsidence, you will need to adjust the elastic/inelastic storage properties during that process. During that process, it may be prudent to adjust the other aquifer parameters in the model to optimize calibration. This will cause changes to the model-predicted water budget.

Section 3

Section 3.1.1.1 Subsurface Inflow from Adjacent Groundwater Basins pg. 3-2, 1st paragraph: Is there no inflow from the Cucamonga Basin and Six Basins?

Section 3.1.1.4 MAR pg. 3-3: This should be spelled out in the title. Also, this is defined as "Managed Artificial Recharge" in some parts of the report and "Managed Aquifer Recharge" in others.

Section 3.1.2.1 Groundwater Pumping pg. 3-3: It should be noted that Agricultural pumping after 2004 is metered.

Section 3.2.5 Precipitation, 1st full paragraph on pg. 3-6 and Figure 3-13: Is the precipitation data presented in this section and shown on Figure 3-13 spatially averaged over the CVM or is this data for a specific location? In addition to providing general observations on the range of precipitation over the CVM for the historic period, as well as the occurrence of dry periods, a statistical evaluation of the distribution of rainfall data showing standard deviation bands about the mean should also be provided. An example of the statistical distribution of rainfall for a 75-year time period for a Riverside County station is provided as an example in the upper left graph of Attachment B. For comparison, the example precipitation data set is evaluated for a 10-year moving average (same time length used for the Safe Yield reset; lower left graph). These data are further evaluated to assess the probability for an average rainfall over a 10-year period exceeding the mean (graphs shown on the right). For the example shown, the probability that any 10-year period may exceed the mean rainfall for the period is 49.5% and may exceed the mean by 50% is about 18%. Using the 16th and 84th percentile distributions (+/-1 standard deviation) of rainfall to estimate DIPAW could provide additional useful information on the possible likely range in groundwater recharge for use in management decisions.

Section 3.2.5 Precipitation, last paragraph on pg. 3-6: What was the time period for the daily precipitation data used with the HSPF and R4 models?

Figure 3-7. It appears that the Cypress Channel is represented as being fully concrete lined. Based on City of Chino staff review of aerial photos, it appears that approximately 3,000 feet of the channel located immediately north of Kimball Avenue (within the CIM property) is unlined and the channel condition along this segment may be characterized as natural soft bottom.

Section 5

Section 5.1 Surface Water Models 2nd paragraph, 2nd sentence. This sentence implies you used HSPF to estimate MAR? Is that true?

Section 5.2.1 Model Domain and Grid 1st full paragraph on pg. 5-2. As noted on the March 27 technical conference call, these layers don't pinch out but are simulated with the same hydrologic parameters as the overlying layer.

Section 5.2.1 Model Domain and Grid 2nd paragraph on pg. 5-2. "*The Six Basins consists of three layers and the Cucamonga and Spadra Basins consist of two layers.*" How is the layering in the adjacent basins reconciled at the Chino Basin boundary with the 5-layer model in the Chino Basin?

Section 5.2.3 Hydraulic Properties and Zonation 1st full paragraph on pg. 5-3, 2nd sentence. "*The calculated parameter value for any model…*" Do you mean "cell" instead of "model"? If not, I don't understand this sentence.

Section 5.2.3 Hydraulic Properties and Zonation (last paragraph, page 5-3 and Table 5-1). Tabulation of the range of aquifer parameters for each zone/layer would be more meaningful than the zone coefficients.

Table 5-2: Add the range of parameter values assigned.

Section 5.2.4.1 Initial Condition In the Vadose Zone (last paragraph, page 5-3 and Figure 5-4): Considering lag time is a key parameter that relates the amount of time it takes for DIPAW to move through the vadose zone, it is recommended to include more control points than the few, widely distributed evaluated boreholes used in the model.

Section 5.2.4.1 Initial Condition In the Vadose Zone, pg 5-4, 2nd paragraph: The last sentence of the paragraph indicates the linear reservoir approach "was difficult to calibrate and created unrealistic volumes of water stored in the vadose zone." Despite the calibration difficulties, did it calibrate? Were the "unrealistic volumes of stored water" too little or too much? How is the volume of water stored in the vadose zone known to be unrealistic when using the linear reservoir approach?

Section 5.2.4.2 Initial Condition in the Saturated Zone, pg. 5-5. How much data was available to constrain the groundwater levels in the Cucamonga and Six Basins? Show control points on Figures 5-5a and 5-5b.

Section 5.2.5.1 Subsurface Inflow from Mountain Boundaries, pg. 5-5. The surface water inflow from the San Gabriel Mountains, which is the basis for the subsurface inflow, is highly uncertain.

Section 5.2.5.3 Recharge from San Gabriel Mountain Streams Tributary to the Santa Ana River, 1st paragraph, last sentence. The storm-water capture is estimated so, in this case, you are calibrating the model to estimated data. This introduces uncertainty to the results. More robust measurement of stormwater capture will improve the reliability of the calibration.

Section 5.2.5.4 Surface Water and Groundwater Interaction in the Santa Ana River and Its Lower Tributaries, 1st paragraph on pg. 5-7. Is there a reference document that you relied on to characterize the Santa Ana River streambed? If so, please cite.

Section 5.2.6.2 Streamflow-Routing Package (SFR2). What were the streambed hydraulic conductivities used for SFR2? What is the basis for the streambed hydraulic conductivity values? Do the streambed hydraulic conductivities vary from stream segment to stream segment? If so, what is that based on? Were streambed conductivities varied during PEST calibration?

Section 5.2.6.5 Evapotranspiration Segments Package (ETS), 2nd paragraph. What was the extinction depth that you assigned to the ETS package? What was it based on?

Section 5.2.6.5 Evapotranspiration Segments Package (ETS), 2nd paragraph, last sentence. *"When MODFLOW solves for groundwater elevations, the evapotranspiration rate of a model cell is determined by using the user defined relationship of evapotranspiration rate to the calculated depth."* What user defined relationship did you use specific to this model?

Section 5.2.6.6 Horizontal-Flow Barrier Package (HFB): How did you determine the horizontal hydraulic conductivities assigned to the horizontal flow barriers (i.e. faults)?

Section 5.2.7.2 Sensitivity Process (SEN) and Observation Process (OBS) (page 5-9): This section should be expanded to include a discussion on how "Observational Sensitivities" were used in the modeling process.

Table 5-1. While I think I understand why you constructed this table the way you did, it is not very meaningful to the average reader. These values are multipliers and not actual values assigned to zones. I'd like to see a table showing the initial parameter estimate and the range of values that the initial estimate was allowed to vary during the PEST calibration.

Section 6

Section 6 – Model Calibration, 1st sentence, pg 6-1): Model calibration does not "validate" the water budget. It results in inflow and outflow values used to "estimate" the water budget.

Section 6.2.1 Calibration to Estimated Discharge and Diversion, 1st paragraph, page 6-2: Were the HSPF and R4 models calibrated based on IEUA data for the time period 2005 to 2017? Were the IEUA data rather than model data used explicitly for stormwater MAR in the model? The time range for measured data and calibrated data used in the model is not clear from the discussion in this section and in Section 5.1.

Section 6.2.1 Calibration to Estimated Discharge and Diversions, last paragraph on pg. 6-2: Is the evapotranspiration (ET) referenced in this paragraph the Puddingstone Data? Is the ET data depth-dependent? How did you determine depth-dependent ET?

Section 6.3.2 Selection of Calibration Data, 3rd paragraph. *"To ensure that the water level measurements were distributed evenly over time, and to avoid bias toward high-frequency water level measurements, a subset of water level measurements were selected for calibration purposes and the selected water levels are at least 15-days apart."* It seems to me that if you are collecting groundwater levels at high frequency (e.g. multiple times per day or daily), selecting an average groundwater level for the month would be more representative and avoid bias or the possibility of inadvertently selecting an outlier.

Section 6.3.3 Sensitivity Analysis and Covariance Matrix, pg. 6-6, 2nd and 3rd paragraphs: Generally, parameters that are correlated either directly or inversely are tied during parameter estimation such that the parameters move together (or inversely) but not independently in order to reduce parameter estimation runs. This section indicates the correlated parameters were "excluded." Does this mean these parameters were fixed and not included in the parameter estimation process? This would be counter to the approach generally used for parameter estimation.

Section 6.3.4.2 Calibration Results, pg. 6-8, 4th paragraph. "*…indicate that the model parameterization and the water budget for the 2020 CVM are <u>accurate</u>: it would not be possible to achieve good calibration in the groundwater basin and the surface water system, as indicated by the high values for the coefficient of determination and NSE index, if the model parameterization and the water budget were not <u>accurate</u>*." The use of the term "accurate" is not appropriate for this model or any other model relying on assumptions and estimates with varying degrees of uncertainty to achieve calibration. Models are simplified representations of a natural system and there are inherent uncertainties in the parameters and necessary simplifications used to describe the system, which is very complex. Given this, models may or may not provide reasonable predictions (e.g. Oreskes et al. 1994,[9] Poeter 2007,[10] Doherty et al 2010,[11] and Rubin 2003[12]). The CVM is no different. A predictive uncertainty analysis is needed to characterize the uncertainty in the water budget and Safe Yield estimated using the CVM.

Pg. 6-7 last paragraph: Presumably meant to read "at deep wells screened in layers 3 and **<u>5</u>** of the so-called ...".

Section 6.3.5 Residual Analysis, pg. 6-9, 2nd paragraph. There is no statement in the report that says what this calibration means for estimating Safe Yield.

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[9] Oreskes, N., K. Schrader-Frechette and K. Belitz, 1994, Verification, Validation and Confirmation of Numerical Models in the Earth Sciences. Science, vol 263, February 4, pp.641-646.

[10] Poeter, E., 2007, All models are wrong: How Do We Know Which are Useful? – Looking Back at the 2006 Darcy Lecture Tour. Ground Water, vol. 45, issue 4, pp. 390-391.

[11] Doherty, J. and D. Welter, 2010, A Short Exploration of Structural Noise. Water Resources Research, 46.

[12] Rubin, Y., 2003, Applied Stochastic Hydrogeology. Oxford and New York, Oxford University Press, 391 pp.

Section 6.3.6.1.3.3 MAR, pg 6-12 and Table 6-3: Table 6-3 is for the time period 1978 through 2018, though in Section 5.1 the available data for calibration is 2005 through 2018. Please clarify which data set are used for calibration.

Section 6.3.6.3 Change in Storage. This change in storage should be checked against a change in storage using changes in hydraulic head and specific yield across the model area. We need to know if the changes in storage estimated from the model/spreadsheet are consistent with what is physically happening in the basin.

Section 6.3.6.4 Total Basin Storage, table at the top of pg. 6-15. Quantifying the storage in the basin to the nearest acre-ft suggests a level of accuracy that is not realistic. These should be rounded.

Section 6.3.7 Net Recharge, 2nd table on pg. 6-15. Same comment as for Section 6.3.6.4.

Table 6-2. Initial and Calibrated Parameter Zone Scalers: The table should include the range of actual values derived for each zone as well as the bounds that PEST was allowed to vary during calibration.

Table 6-3. Water Budget for the Chino Basin for the Calibration Period: Please identify which data are estimated (modeled) and which are measured.

Section 6 Figures: The horizontal hydraulic conductivity and specific yield parameter distribution maps from the calibrated model, as provided via email from WEI on April 15, 2020 in response to my request for information, should be included in the report (see my comments to these data starting on pg. 10 below). In addition, I'd like to see parameter distribution maps for vertical hydraulic conductivity for each layer of the model provided in the report as well. Further, aquifer parameters derived from pumping tests should be shown on the maps or provided in a table and referenced to a location on the maps. The table of "stress derived hydraulic conductivities" and calibrated model aquifer parameters provided via email on April 15, 2020 will suffice although I'd like the well locations in the table shown on the aquifer parameter maps of horizontal hydraulic conductivity.

Section 7

Section 7.2 Long-Term Historical Records Used to Estimate Net Recharge (procedures, pages 7-2 and 7-3, Table 7-2 and Figures 7-6 and 7-7). The use of the long-term average precipitation and ET_o in the HSPF and R4 simulations with DWR change factors should also include application of the 16th and 84th percentile precipitation and ET_o values to provide upper and lower bounds for estimated DIPAW. Such a range can be incorporated into an uncertainty analysis as part of an overall assessment of the potential projected range in Safe Yield of the basin.

Section 7.3 Present and Projected Future Cultural Conditions, 1st sentence. It was my understanding that land subsidence will be evaluated with a future version of the model. If that is still the case, this sentence should be modified to reflect that.

Section 7.3.1.1 Groundwater Pumping Projections, pg. 7-5, 2nd paragraph. Pumping distribution and magnitude could change the Safe Yield of the basin. Potential changes in pumping patterns should be evaluated to assess how we can optimize the basin and preserve Safe Yield.

Section 7.3.1.2 Methodology to Project Replenishment Obligations, pg. 7-7: This description indicates it was assumed that 80% of replenishment would occur via unused pumping rights and stored water. Presumably, the 80% assumption has some influence on the Safe Yield estimate. Knowing (now) that this assumption influences the calculated Safe Yield, the Appropriators may opt to modify their behavior and cause more (or less) replenishment to be satisfied from storage than 80%. This is just one example of how the model should be used as a tool for the development of the Safe Yield recalculation and not the sole predictor of Safe Yield.

Section 7.3.2 Impacts of Drought and Future Water Conservation Vadose Zone Storage Initial Conditions: While this section describes discrete periods of relatively recent drought, what would be the effect of using stored water rather than using replenishment water to augment the calculated net recharge, assuming this would become a temporary adjustment (increase) to the reset SY?

Section 7.3.2, last paragraph. All the parameters listed in this paragraph, with the possible exception of the initial groundwater levels, are estimated. These estimated values resulted in the DIPAW recharge term, which is also estimated. This comment is only to emphasize that the use of the term "accurate" in Section 6.3.4.2 is inappropriate and misrepresents the reliability of the model.

Section 7.3.3 Conservation Related Impacts of Assembly Bill 1668 and Senate Bill 606, pgs 7-9 and 7-10: While the imposed irrigation ETAF will likely result in reduced DIPAW and net recharge and Safe Yield, has the implied irrigation reductions also been accounted for in the planned water demand scenarios? One would think the conservation effort would offset the amount of water used.

Section 7.4.3 Change in Storage, pg. 7-10, 1st paragraph of section: Is the controlled overdraft of the basin accounted for in the methodology to estimate Safe Yield? If so, how?

Section 7.4.4 1st Table. For the recharge components, there are two rows that appear to represent Santa Ana River Streambed Infiltration. I believe one of them may represent streambed infiltration from Santa Ana River tributaries(?) Also, the last recharge component for Managed Artificial Recharge appears to be cut off – should be "Recycled and Imported."

Section 7.4.4, pg. 7-12, 2nd paragraph and Figure 7-7. The reduction in net recharge for the 2021 to 2030 time period resulting from carryover of the extreme dry period in the 20 years preceding the planning period is a relatively short-term phenomenon and does not represent a long-term hydrological average. The Safe Yield should be estimated by more than just 10 years into the future in order to average out relatively short-term climatic variations, such as the recent dry period.

Section 7.6 Recommended Safe Yield. In implementing the methodology for estimating Safe Yield described in Section 7.1, did you identify MPI in any of the iterative model runs to determine Safe Yield, as per No. 5 of that section? If so, at what initial Safe Yield did you determine MPI, what was the nature of the MPI, and where did it occur?

Section 7.6 Recommended Safe Yield. It appears that the Safe Yield is estimated from the average net recharge of the time period from 2020 to 2030. However, there is nothing in the Court-ordered methodology or Rules and Regulations that require Watermaster to limit the prospective time period over which the net recharge is estimated to the 10-year period over which the Safe Yield will be applied. In fact, it is contrary to relying on a long-term hydrology as a basis for the estimate.

Appendix B: The appendix includes three WEI memos, one dated 2/6/20 and two others dated 2/11/20. The 2/6 memo indicates the step 7 density analyses were performed independently by two to three persons and then those results were averaged. What was the variability in the spread of the independent analyses? One of the 2/11 memos describes the assumptions attributable to septic system contributions to groundwater recharge, and indicates the "unit" contributions decrease with time. Most existing septic systems have been in-service for decades, and if true then what explanation(s) are provided to support assumed decreasing contribution to groundwater recharge? It does not seem reasonable to assume their operational efficiencies have changed. The other 2/11 memo discusses groundwater discharged from aquitards due to land subsidence, and indicates such contribution is considered negligible. Please provide what estimated volume would be anticipated and considered negligible.

Appendix D, D-162. The message of the figure is not evident.

Comments to the Supplemental Data Provided by Wildermuth Environmental via Technical Memorandum on April 15, 2020

Following the January 27, 2020 Safe Yield Reset meeting, I prepared a Technical Memorandum, dated February 3, 2020, with additional questions and a request for additional data. WEI provided data and responses to this request in a Memorandum dated April 15, 2020. The following are my comments regarding the data provided by WEI:

Pg. 2 second to last paragraph and Table 1: WEI has stated that the stress test hydraulic conductivities that I provided for the Chino Basin Desalter wells were based on Jacob's straight-line solution for confined aquifers and that, in so doing, the values are overestimated because the aquifer is unconfined. The application of the Jacob straight line method for estimating aquifer transmissivity and hydraulic conductivity can easily be corrected by plotting and analyzing adjusted drawdown values using the following relationship:[13]

$$s' = s - \frac{s^2}{2h}$$

Where:

s' = adjusted drawdown (ft)

s = measured drawdown (ft)

h = aquifer thickness (ft)

For the stress test-derived horizontal hydraulic conductivity at Chino II-2, the value in Table 1 of the WEI response to comments is approximately 400 ft/day. When the correction is applied to the drawdown data, the adjusted hydraulic conductivity for unconfined conditions is approximately 470 ft/day. Both corrected and uncorrected values are significantly higher than the value used in the calibrated model for that location (approximately 85 ft/day). Hydraulic conductivity values derived from pumping tests are higher than model calibrated values at all of the desalter wells. Were the stress test horizontal hydraulic conductivity data summarized in Table 1, or a corrected version, used to constrain aquifer parameterization during calibration? What were the upper and lower bounds assigned to the initial hydraulic conductivity values in PEST? Was the prior information from the stress test data used to constrain the bounds assigned to PEST? Were they allowed to vary as high as the values derived from pumping tests?

Figure 3. There is a significant change in horizontal hydraulic conductivity along straight lines in multiple locations of Layers 1 and 2. These lines correlate to parameter zones described in WEI (2020). It is noted that, from a conceptual perspective, sediments would not be expected to be deposited with linear boundaries as shown on these maps. There is likely a high degree of uncertainty in how these zones are simulated in the model. It is further noted that the horizontal hydraulic conductivities shown for Layer 1 along Bellgrave Avenue and in the vicinity of Mission Boulevard and the 60 Freeway are lower than indicated from pumping test-derived data.

Page 3, Equation at the top of page. This relationship applies to horizontal flow of water in an aquifer and is representative if there isn't significant vertical flow of water in the borehole. Are

[13] Kruseman, G.P. and De Ridder, N.A., 1970. *Analysis and Evaluation of Pumping Test Data*. Bulletin 11. International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands.

there significant hydraulic head differences between aquifers in the model? If so, what are the magnitude of differences?

Page 3, last paragraph, last sentence. While the residuals at the Ayalla Park monitoring well may not impact the Safe Yield estimate significantly, future calibration for land subsidence will involve changes to the aquifer storage properties in this area, which may improve groundwater level calibration but will also change the water budget and could result in changes to the Safe Yield.

Summary and Recommendations

As mentioned earlier in this letter, the biggest omission in the 2020 Safe Yield Recalculation is a predictive uncertainty analysis. Such an analysis has become an industry standard procedure when using complex models to inform groundwater basin management decisions. The predictive uncertainty analysis would involve developing multiple versions (preferably hundreds) of the Chino Valley Model, each with unique parameter distributions. The unique model distributions can be developed automatically using PEST and its associated utility programs. Parameter bounds would be selected to be within plausible ranges based on available data. The water budgets for realizations with acceptable model calibrations would then be processed to determine the Safe Yield for each realization, resulting in a range of Safe Yield estimates for the basin. I recommend conducting this analysis prior to finalizing the Safe Yield for the next 10 years.

In addition to the predictive uncertainty analysis and prior to finalizing the Safe Yield, I recommend the following:

- Conduct a check of the change in groundwater storage for the period 2011 to 2018 using the following relationship:

  $$Vw = (Sy)(A)(\Delta h)$$

  Where:

Vw	=	the volume of groundwater storage change (acre-ft).
Sy	=	specific yield of aquifer sediments (unitless).
A	=	the surface area of the aquifer within the Chino Basin (acres).
Δh	=	the change in hydraulic head (i.e. groundwater level) (feet).

  The change in groundwater storage will be specific to the shallow aquifer (Model Layer 1). The areal distribution of specific yield should be the same as that used in the calibrated model used to estimate Safe Yield. Either model-generated or hand-drawn groundwater contours for 2011 and 2018 would be exported to/digitized in GIS software, which can then be used to calculate the change in hydraulic head across the area. The storage change estimated in this way would then be compared to the change in storage shown in Table 6-3 of the model report WEI (2020).

- Compute the Safe Yield for the 2020 to 2030 time period based on a long-term projected net recharge from at least 2020 to 2050 in order to smooth out short-term hydrologic conditions such as the lingering impacts of recent historic dry conditions.

- Use the above information to inform the AP for redetermining the Safe Yield of the Chino Basin for the 2020 to 2030 time period.

I appreciate the opportunity to provide hydrogeological consulting services to the Chino Basin Watermaster Appropriative Pool. If you have any questions, feel free to contact me at (714) 394-4449.

Sincerely,

Thomas Harder

Thomas Harder, P.G., C.HG.
Principal Hydrogeologist

Comparison of DIPAW for the Period 2011 - 2020

Yr	DIPAW in 2015 Model[1]	DIPAW in 2020 Model[2]	Difference in DIPAW Between 2015 and 2020 Models
2011	81,096	88,763	7,667
2012	91,059	84,009	-7,050
2013	90,236	80,130	-10,106
2014	91,466	78,395	-13,071
2015	91,550	75,817	-15,733
2016	95,445	73,547	-21,898
2017	96,220	72,874	-23,346
2018	96,705	69,532	-27,173
2019	95,553	68,414	-27,139
2020	94,200	70,654	-23,546
		Average 2011 - 2020	**-16,140**

* All values are in acre-ft

[1] Wildermuth Environmental, 2015. 2013 Chino Basin Groundwater Model Update and Recalculation of Safe Yield Pursuant to the Peace Agreement. Table 7-6.

[2] Wildermuth Environmental, 2020. 2020 Safe Yield Recalculation - Administrative Draft Report. Tables 6-3 and 7-2.

Yellow highlighted cells are based on model projections.

Attachment A

ORIGINAL
File with DWR

APR 30 1977

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
WATER WELL DRILLERS REPORT

Do Not Fill In

№ 107275

State Well No.
Other Well No. 02S/07W17E

(1) OWNER:

Name
Address

(2) LOCATION OF WELL:

County San Bernardino Owner's number, if any
Township, Range, and Section
Distance from cities, roads, railroads, etc. 500' East of Walker and 250' South of Schaeffer

(3) TYPE OF WORK (check):

New Well ☒ Deepening ☐ Reconditioning ☐ Destroying ☐
If destruction, describe material and procedure in Item 11.

(4) PROPOSED USE (check):

Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☒ Test Well ☐ Other ☐

(5) EQUIPMENT:

Rotary ☒
Cable ☐
Other ☐

(6) CASING INSTALLED:

STEEL: OTHER:
SINGLE ☒ DOUBLE ☐

From ft.	To ft.	Diam.	Gage or Wall	Diameter of Bore	From ft. (If gravel packed)	To ft. (If gravel packed)
0	450	16	1/4	26"	0	454

Size of shoe or well ring: Bull Nose Size of gravel: 3/8" Pea
Describe joint Butt Weld

(7) PERFORATIONS OR SCREEN:

Type of perforation or name of screen Vertical Mill Slot

From ft.	To ft.	Perf. per row	Rows per ft.	Size in. x in.
280	450	16	4	2½ X 1/8

(8) CONSTRUCTION:

Was a surface sanitary seal provided? Yes ☒ No ☐ To what depth 50 ft.
Were any strata sealed against pollution? Yes ☐ No ☒ If yes, note depth of strata
From ft. to ft.
From ft. to ft.
Method of sealing 30" Conductor Cemented in 36" Hole

(9) WATER LEVELS:

Depth at which water was first found, if known ft.
Standing level before perforating, if known ft.
Standing level after perforating and developing 149 ft.

(10) WELL TESTS:

Was pump test made? Yes ☒ No ☐ If yes, by whom? McCalla Bros.
2000 gal./min. with 88 ft. drawdown after 37 hrs.
Temperature of water Was a chemical analysis made? Yes ☐ No ☒
Was electric log made of well? Yes ☐ No ☒ If yes, attach copy

(11) WELL LOG:

Total depth 454 ft. Depth of completed well 450 ft.

Formation: *Describe by color, character, size of material, and structure*

From ft.	To ft.	Formation
0	50	Conductor
50	98	Sand and Gravel
98	136	Clay and Streaks of Gravel
136	161	Gravel
161	164	Fine and Coarse Sand
164	168	Clay
168	170	Sand and Gravel
170	175	Clay
175	190	Sand, Gravel and Clay Streaks
190	204	Sand and Gravel
204	206	Clay
206	212	Sand, Gravel and Clay Streaks
212	230	Clay
230	240	Sand and Gravel
240	249	Clay
249	255	Sand and Gravel
255	265	Clay
265	270	Sand and Gravel
270	284	Clay
284	296	Sand and Gravel
296	300	Clay
300	361	Sand, Gravel and Boulders
361	372	Clay
372	406	Sand and Gravel
406	410	Clay
410	415	Sand and Gravel
415	426	Clay
426	450	Sand and Gravel
450	454	Clay

elev 720

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850 GPM @ 190' Pump Level
1200 GPM @ 202' Pump Level
1700 GPM @ 224' Pump Level
2000 GPM @ 237' Pump Level

Work started 6-30-76 19 , Completed 10-18-76

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME McCalla Bros.
(Person, firm, or corporation) (*Typed or printed*)

Address 3819 West First Street
Santa Ana, CA 92703

[SIGNED] (signature) (*Well Driller*)

License No. 196824 Dated April 26, 1977 , 19

SKETCH LOCATION OF WELL ON REVERSE SIDE

DWR 188 (REV. 9-68)

67139-750 8-72 30M TRIP OSP

Attachment B