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## I, Mark Wildermuth, declare as follows:

- 1. I am the founder and President of Wildermuth Environmental, Inc. ("WEI"), a water resources consulting firm. My firm consults for the Chino Basin Watermaster ("Watermaster") with respect to implementation of the Chino Basin Optimum Basin Management Program ("OBMP") and other Watermaster duties.
- 2. I am a hydrologist and a registered civil engineer and have been involved in the Chino Basin as such for approximately 34 years.
- 3. I have personal knowledge of the facts set forth in this declaration, and, if called as a witness, I could and would testify competently thereto under oath.
- 4. I have been retained as an expert consultant and testifying expert in multiple matter involving groundwater and recharge analysis. For example, I was retained by the Palmdale Water District as an expert witness in the Phase 3 trial in the adjudication of the Antelope Valley groundwater basin. I conducted research and developed a methodology to estimate natural recharge, a component of safe yield. My methodology was reviewed and accepted by other licensed professionals retained by the municipal water agencies involved in litigation. Upon completion of my work I testified on recharge and where my work was accepted by the Court and used as the basis for establishing the safe yield in the recent settlement of groundwater rights. The safe yield was based on natural recharge estimated by me from historical data including precipitation for the period 1951 through 2005 and adjusted for present cultural conditions.
- 5. As a consultant to Watermaster, I assisted in the development of Watermaster's OBMP and the OBMP Implementation Plan, and I have reviewed the Court-approved actions requiring OBMP implementation, including the Peace Agreement and the Peace II Agreement.
- 6. In conjunction with Watermaster's Motion regarding 2015 Safe Yield Reset Agreement, Amendment of Restated Judgment, Paragraph 6, I prepared a document entitled Declaration of Mark Wildermuth in Support of Motion regarding 2015 Safe Yield Reset Agreement, Amendment of Restated Judgment, Paragraph 6 ("October 2015 Declaration").

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- 7. The work done pursuant to the OBMP Implementation Plan allows for maximum beneficial use of the Basin's waters to be made, such that the Safe Yield need not be reduced due to potential undesirable results of pumping at a certain level within the Basin.
- 8. The 2013 update to the original 2003 Chino Basin Groundwater Model ("2013 Model") was developed by me and under my direction. The process of updating the model, which resulted in the 2013 Model, is documented in the 2013 Chino Basin Groundwater Model Update and Recalculation of Safe Yield Pursuant to Peace Agreements ("Model Update Report"), attached as Exhibit 1 to my October 2015 Declaration. I have re-reviewed the Model Update Report and it accurately describes the process of updating the model and the evaluation of the Basin Safe Yield that supports the conclusions in the 2015 Safe Yield Reset Agreement.
- 9. During the facilitated process led by Watermaster legal counsel pursuant to the Facilitation and Non-Disclosure Agreement (FANDA), I spoke with Mr. Robert Shibatani regarding the 2013 Model and my evaluation of the Chino Basin Safe Yield pursuant to the Court Approved Management Agreements, as that term is defined in the 2015 Safe Yield Reset Agreement.
- 10. I have reviewed the Declaration of Robert Shibatani in Support of City of Chino's Opposition to Watermaster's Motion regarding 2015 Safe Yield Reset Agreement, Amendment of Restated Judgment, Paragraph 6 ("Shibatani Declaration") and considered the suggestions therein both during the negotiations that resulted in the 2015 Safe Yield Reset Agreement and since.
- 11. The procedure to estimate Safe Yield is described in Exhibit A to the 2015 Safe Yield Reset Agreement, titled Methodology to Reset Agreement entitled Safe Yield Using Long-Term Average Hydrology and Current and Projected Future Cultural Conditions. This Methodology was drafted by me. The Methodology consists of a five-step process to estimate net recharge and Safe Yield. The first four steps deal with the estimate of net recharge. The fifth step in the process is:
  - Qualitatively evaluate whether the groundwater production at the net recharge rate estimated in [4] above will cause or threaten to cause 'undesirable results' or 'Material Physical Injury'. If groundwater production at net recharge rate estimated in [4] above will cause or threaten to cause 'undesirable results' or

'Material Physical Injury' then Watermaster will identify and implement prudent measures necessary to mitigate 'undesirable results' or 'Material Physical Injury', set the value of Safe Yield to ensure there is no 'undesirable results' or 'Material Physical Injury', or implement a combination of mitigation measures and a changed Safe Yield."

- 12. Undesirable results may be qualitatively identified from monitoring activities and qualitative assessments of modeling work. For example, the monitoring of groundwater levels (or projected groundwater elevations from a groundwater model) can be used to estimate depth to groundwater, but the determination that the depth to groundwater causes excessive pumping lift is a qualitative determination. Watermaster's groundwater model (the 2013 Model) can be used to quantitatively determine changes in groundwater management to mitigate undesirable results, including resetting Safe Yield, which is the intention of step 5 above.
- 13. Watermaster, both through its own staff and through contract with WEI, conducts extensive monitoring of the Basin and performs periodic interpretation of the monitoring data. This information is interpreted by both Watermaster staff and WEI to determine if undesirable results have or are projected to occur. These interpretations start out as qualitative interpretations and are subsequently investigated to determine the precise causes of the undesirable result and to identify means to mitigate or manage it.
- 14. Currently, there are indications of potential imminent undesirable results: the ongoing permanent land subsidence in the northwest Management Zone 1 area ("MZ1") and a groundwater production sustainability challenge in the Jurupa Community Services District (JCSD) service area. In our work for Watermaster, which I supervise, WEI detected these potential imminent undesirable results as part of monitoring ground levels in the northwest MZ1 area and through reports of lost production in the JCSD area, respectively—not from the water budget table derived from the Watermaster model. These challenges are due to groundwater elevations in those areas that are lower than necessary to not have such challenges. Both of these potential imminent undesirable results were identified through the qualitative assessment of monitoring data. Both are potential undesirable results, are being currently being investigated in the ongoing OBMP implementation, and should be considered in resetting the Safe Yield. And,

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neither of these challenges would be readily identifiable in a water budget table.

- According to the Watermaster records that I have reviewed, there are over 400,000 15. acre-ft of water in stored water accounts that may be produced from the Basin in addition to the Basin's Safe Yield. Producing the stored water could exacerbate the two challenges identified above. The Watermaster's groundwater modeling work used in the Safe Yield reset process, which I designed and supervised, projects that groundwater levels will decline in the Northwest MZ1 area and the JCSD service area in the future. Therefore, setting the Safe Yield based on net recharge plus additional mining of water in storage is not prudent and is inconsistent with my professional understanding of the Judgment definition of Safe Yield.
- 16. In his declaration, Mr. Shibatani suggests that Watermaster should have used available bias-corrected spatially downscaled (BCSD) global circulation model (GCM) projections of future precipitation instead of historical precipitation to project net recharge. I believe this to be based on the Mr. Shibatani's opinion that climate change is occurring and that the available BCSD precipitation projections from the plethora of GCMs are accurate. (Shibatani Declaration, ¶¶ 29-34.) It is my opinion that climate change is occurring and could likely impact future net recharge to the Basin. However, based on my research and the research conducted under my direction, the BCSD precipitation predictions from the various GCMs that have been used for planning in California do not accurately predict precipitation in the Santa Ana River Watershed, which includes the Chino Basin.
- 17. In 2011, I managed the development of the San Juan Basin Groundwater and Facilities Management Plan for the San Juan Basin Authority. The San Juan Basin is located in southern California, approximately 30 miles to the south of the Chino Basin. As part of that work, we obtained BCSD GCM projections for the GCMs and emission scenarios that were being investigated by the California Action Team (see http://www.waterplan.water.ca.gov/docs/cwpu2009/0310final/v4c02a12 cwp2009.pdf). We compared the historical precipitation at the Laguna Beach precipitation station to BCSD GCM projections, which demonstrated that the GCM projections failed to produce the historical wet and dry periods that occurred in the period 1950 through 2000. Since 2011, I, and WEI staff

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under my direction, have investigated the ability of various GCMs to produce accurate estimates of historical precipitation in the Santa Ana Watershed, including the Chino Basin.

- 18. Attached hereto as Exhibit 1 is a figure showing the upper Santa Ana Watershed, the Chino Basin within it, and the location of three precipitation stations: station 35, located in the Temescal Groundwater Basin; station 1021, located in the Chino Basin; and station 2146, located in San Bernardino Basin area, which has been relied upon by the Santa Ana River Watermaster in its annual reports. Exhibit 1 was prepared at my direction and I believe it to be accurate.
- 19. My staff and I downloaded the BCSD precipitation projections for two GCMs and projection scenarios that included the CCSM3 model with the a2 projection and the CCSM4 model with RCP 2.6 projection. We compared the observed data at precipitation stations 35, 1021, and 2146 to the GCM model projections for the historical period of 1950 through 2010. These comparisons were done using cumulative departure from mean precipitation (CDFM) plots to determine if the GCM projections could reproduce observed wet and dry periods and scatter plots to directly compare the accuracy of GCM estimates of annual precipitation to observed annual precipitation.
- 20. Attached hereto as Exhibits 2a, 2b, and 2c are figures, which were prepared at my direction and which I believe to be accurate, showing the CDFM plot comparisons for the CCSM3 model with the a2 projection for precipitation at stations 31, 1021, and 2146, respectively. Attached as Exhibit 2d is a figure, prepared at my direction and which I believe to be accurate, showing the CDFM comparison plots for all three precipitation stations. The CDFM plot is used to identify wet and dry periods. A positive slope (increasing value from left to right) indicates a wet period, a negative slope (decreasing value from left to right) indicates a dry period, and a flat slope indicates a period of average to near average precipitation.
- Analysis of the CDFM plots for all three precipitation stations, as shown in 21. Exhibits 2a through 2c, indicated that the GCM: failed to reproduce the dry period that ran from 1950 (actually 1946) through 1977, included a very wet period in the late 1950s through early 1960 that did not occur, included a very dry period from about 1969 through 1974 that did not occur, and tended to capture the wet period that generally ran from 1978 through 1983, but

entirely missed the 1998 El Nino southern oscillation event.

- 22. Attached hereto as Exhibits 3a, 3b, and 3c are figures, prepared at my direction and which I believe to be accurate, which show the CDFM plot comparisons for the CCSM4 model (an updated version of CCMS3) with the RCP 2.6 scenario for precipitation at stations 31, 1021, and 2146, respectively. Attached as Exhibit 3d is a figure, prepared at my direction, which shows the CDFM comparison plots for all three precipitation stations. Review of these CDFM plots illustrated in Exhibits 3a through 3c shows that the GCM predictions are slightly better than with the CCSM3 model in matching the climatic trends through the late 1960s, but thereafter, the CCSM4 model performs substantially poorer than the CCSM3 model projections, completely missing the 1978 through 1983 wet period and the 1998 El Nino southern oscillation event. In summary, the GCM's failed to duplicate wet and dry periods at these precipitation stations in the Santa Ana Watershed and the Chino Basin.
- 23. Review of Figures 2d and 3d shows: (1) the CDFM plots for precipitation observed at the precipitation stations follow very similar time trends, indicating that the three precipitation stations have identical wet and dry periods as would be expected, but they show significant differences in the range of wetness and dryness in their time histories, indicating geospatial differences in the amounts of observed precipitation; and (2) the GCM precipitation projections track each other very closely, indicating relatively little geospatial differences in precipitation, and the GCM projections fail to reproduce the geospatial variability in precipitation.
- 24. Attached hereto as Exhibits 4a, 4b, and 4c are scatter plots, prepared at my direction and which I believe to be accurate, that directly compare the annual precipitation for the GCM projections for the CCSM3 model with the a2 emission scenario to observed precipitation at stations 31, 1021, and 2146, respectively.
- 25. Attached hereto as Exhibits 5a, 5b, and 5c, are scatter plots, prepared at my direction and which I believe to be accurate, that directly compare the annual precipitation for the GCM projections for the CCSM4 model with the RCP 2.6 scenario to precipitation at stations 31, 1021, and 2146, respectively. The straight diagonal red line that emanates from the plot origin and follows a 45-degree angle represents a perfect fit: points that fall on the red line mean that the

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GCM prediction of annual precipitation is identical to the observed value. Note that, in all the scatter plots, the points that represent direct comparisons of annual observed precipitation to GCM-based precipitation estimates are well distributed throughout the plot area and do not follow the perfect-fit line, indicating that the GCMs failed to produce accurate estimates of precipitation. It is common practice to estimate the coefficient of determination when comparing observed data to model projections on scatter plots. The coefficient of determination is the amount of variance in the observed data that is explained by the model or, in this case, the GCM. The coefficient of determination for each plot is less than or equal to 0.001, indicating that the GCMs can predict 0.1 percent or less of the variance observed in the observed data.

26. Another tool related to the coefficient of determination that is used to determine how well a GCM replicates historical precipitation is the Nash-Sutcliffe efficiency (NSE) index. The NSE index is a normalized statistic that determines the relative magnitude of the residual variance ("noise") compared to the measured data variance ("information") (Nash, J. E., and J. V. Sutcliffe. 1970. River flow forecasting through conceptual models: Part 1. A discussion of principles, J. Hydrology 10(3): 282-290). Like the coefficient of determination, the NSE index indicates how well the plot of observed versus simulated data fits the "perfect-fit" line. The NSE index ranges between  $-\infty$  and 1.0, with the NSE index equal to 1.0 being the optimal value. Values less than 0.0 indicate that the mean observed value is a better predictor than the simulate value, which indicates unacceptable performance. The characterization of the calibration performance using the NSE index is reported (Moriasi, D. N., Arnold, J. G., Van Liew, M. W., Binger, r. l., Harmel, R. D., Veith, T. L. 2007. Model Evaluation Guidelines for Systematic Quantification of Accuracy in Watershed Simulations. Vol. 50(3): 885–900 2007 American Society of Agricultural and Biological Engineers ISSN 0001-2351) as follows: negative infinity to 0.5 as unsatisfactory; 0.5 to 0.65 as satisfactory; 0.65 to 0.75 as good; 0.75 to 1.0 as very good. The NSE index computed for the comparison of the historical precipitation to the BCSD GCM precipitation estimates for the Santa Ana Watershed and the Chino Basin are all negative, indicating the BCSD GCM projections do not accurately reproduce historical precipitation.

27. It is my opinion that the GCMs are not calibrated to reproduce historical

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precipitation in the Santa Ana Watershed and the Chino Basin, the expected accuracy in their projections beyond 2010 cannot be assumed to be better than in the historical period, and, therefore, contrary to Mr. Shibatani's opinion, the GCM projections of precipitation should not be used as a basis for projecting Safe Yield in the Chino Basin.

28. Though, as described above, I believe climate change to be occurring, there are three reasons why it is my opinion that it is appropriate to use historical precipitation data in the Safe Yield reset. Firstly, climate change is not just starting to occur; it likely started affecting precipitation in the mid-20<sup>th</sup> century, and thus it is included in the historical precipitation record. Secondly, climate change is occurring gradually; there is no need to rush into using GCM projections if the predictive capability of GCMs cannot be demonstrated. And, finally, GCMs and their projections will improve over time, and precipitation and temperature projections from them should be considered in future Safe Yield resets as explicitly stated in Section 4.4 of the 2015 Safe Yield Reset Agreement:

> 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 Agreement.

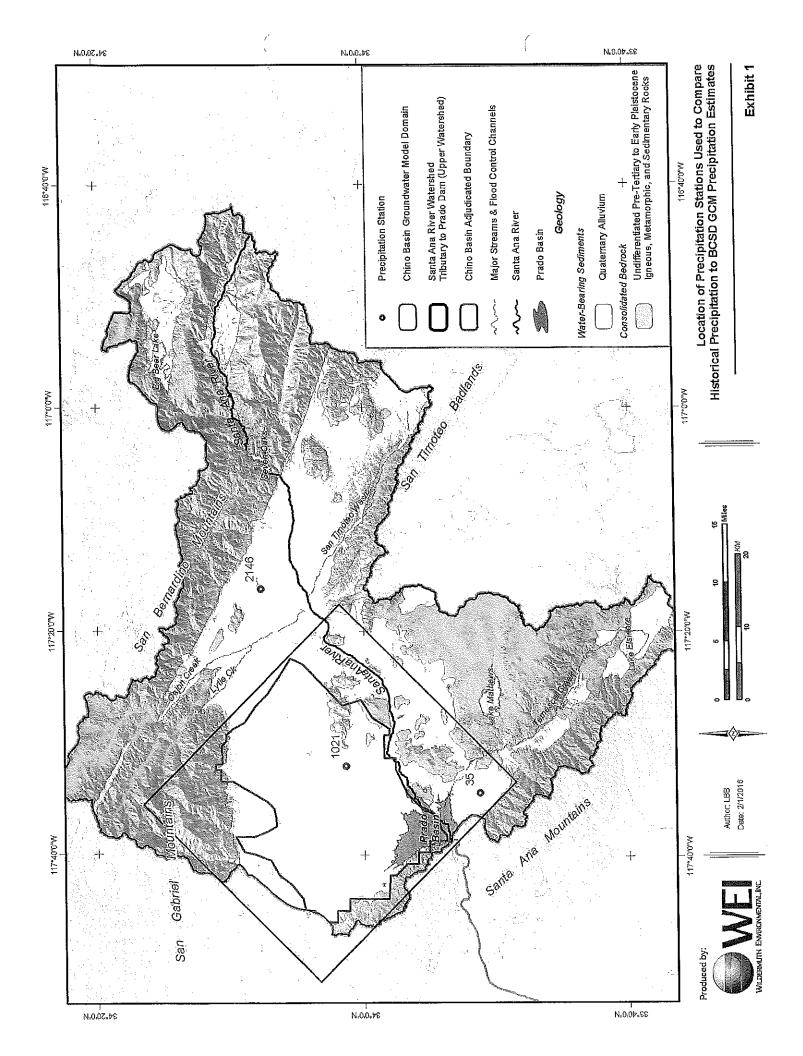
I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct to the best of my knowledge.

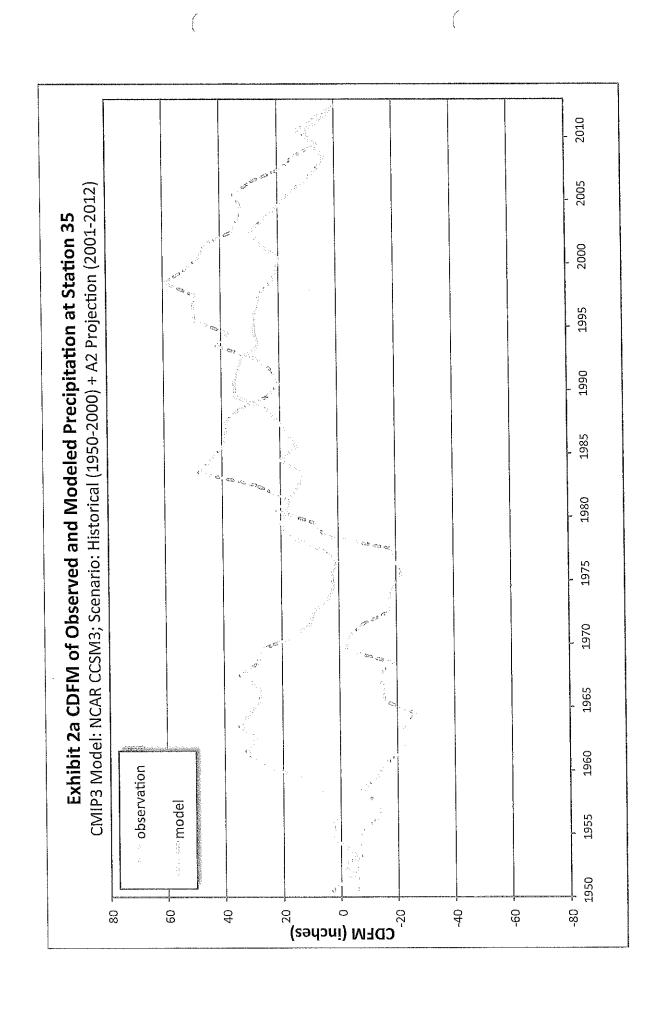
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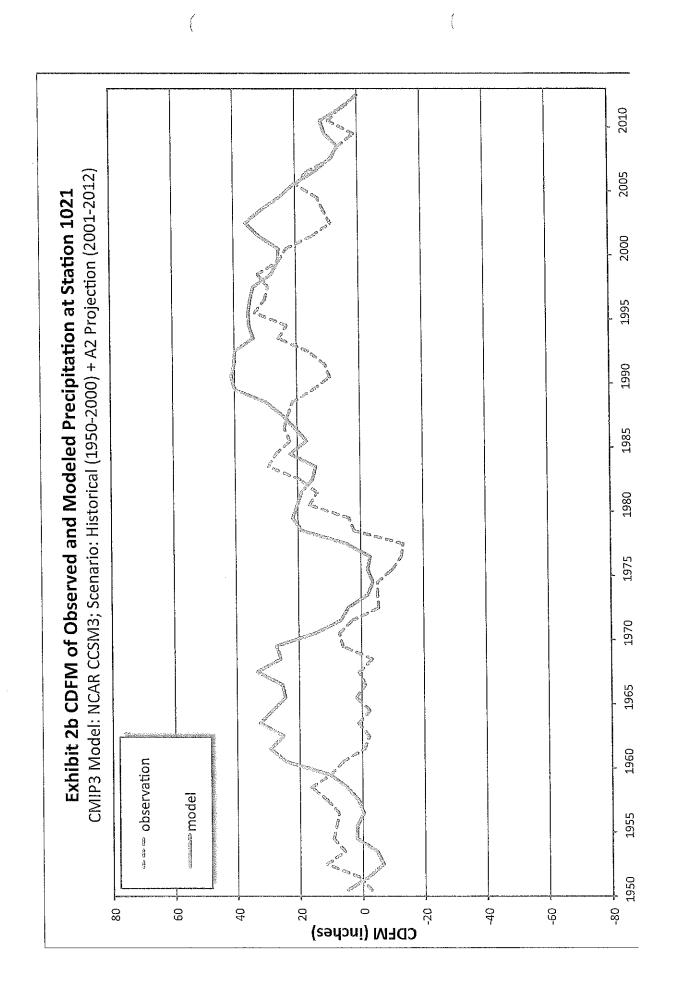
MARK WILDERMUTH

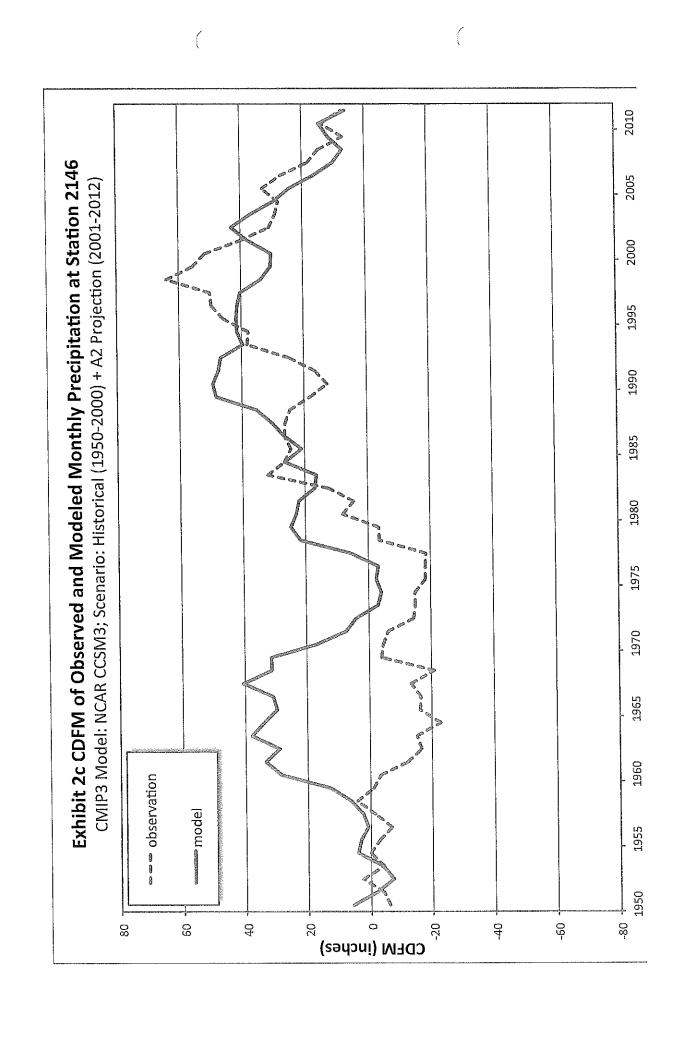
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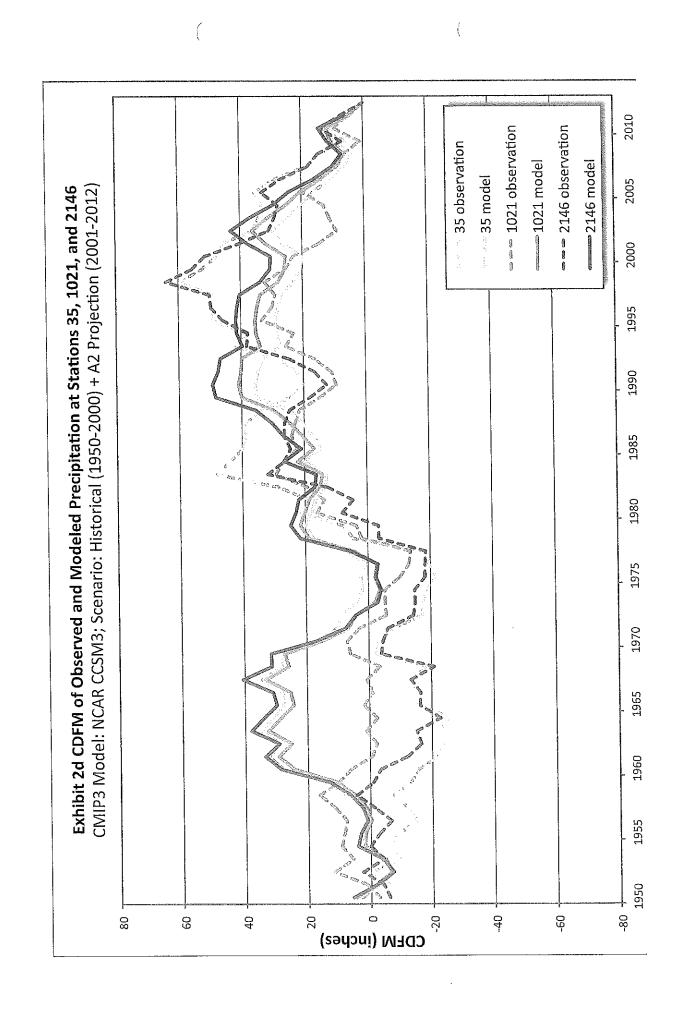
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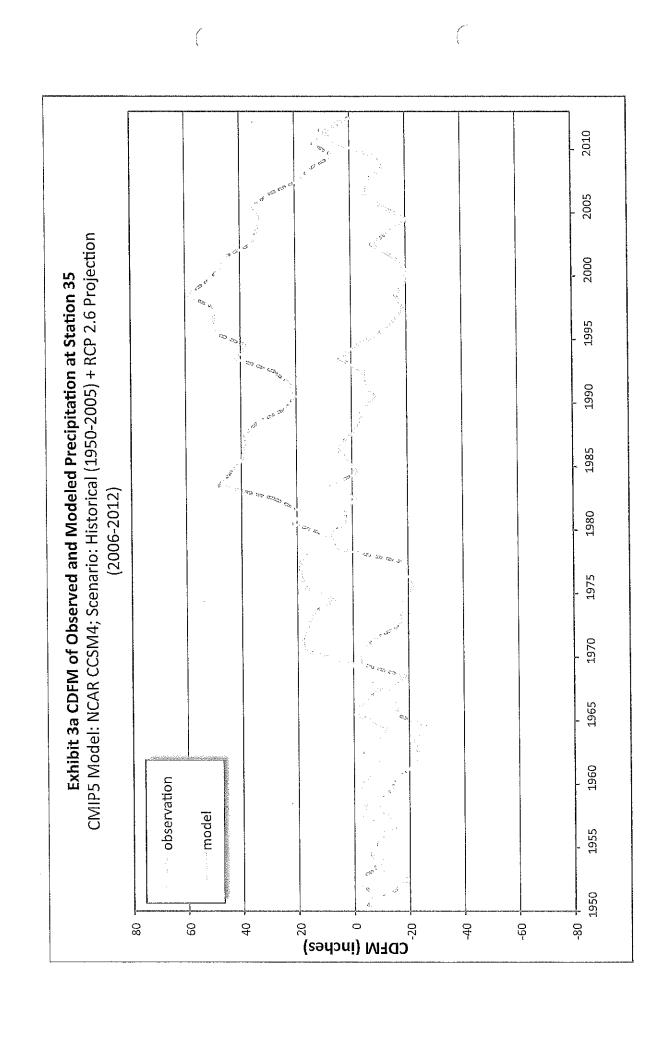


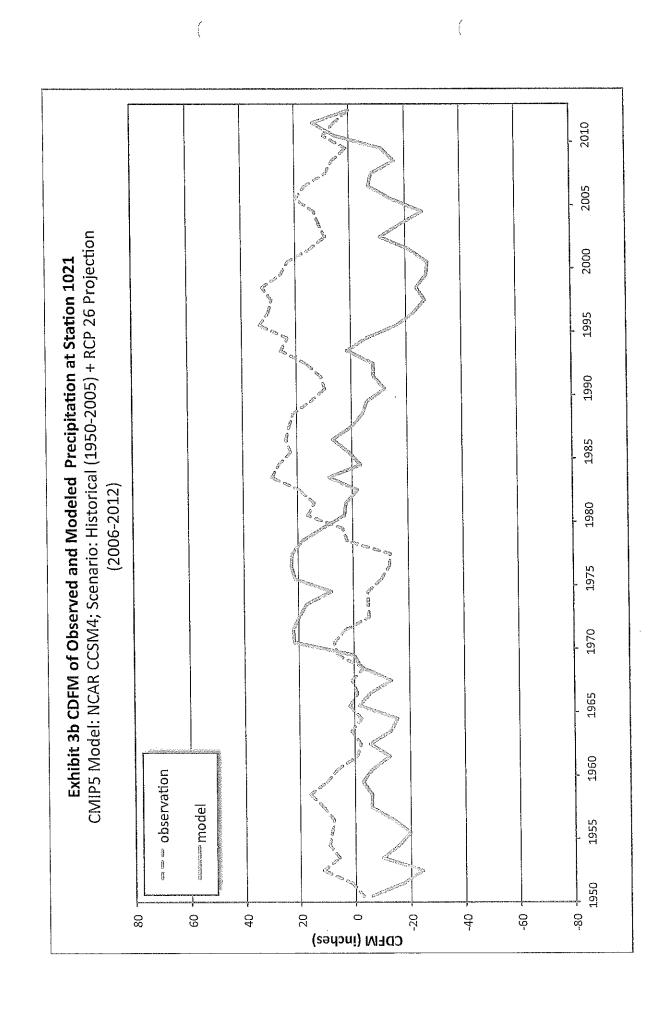


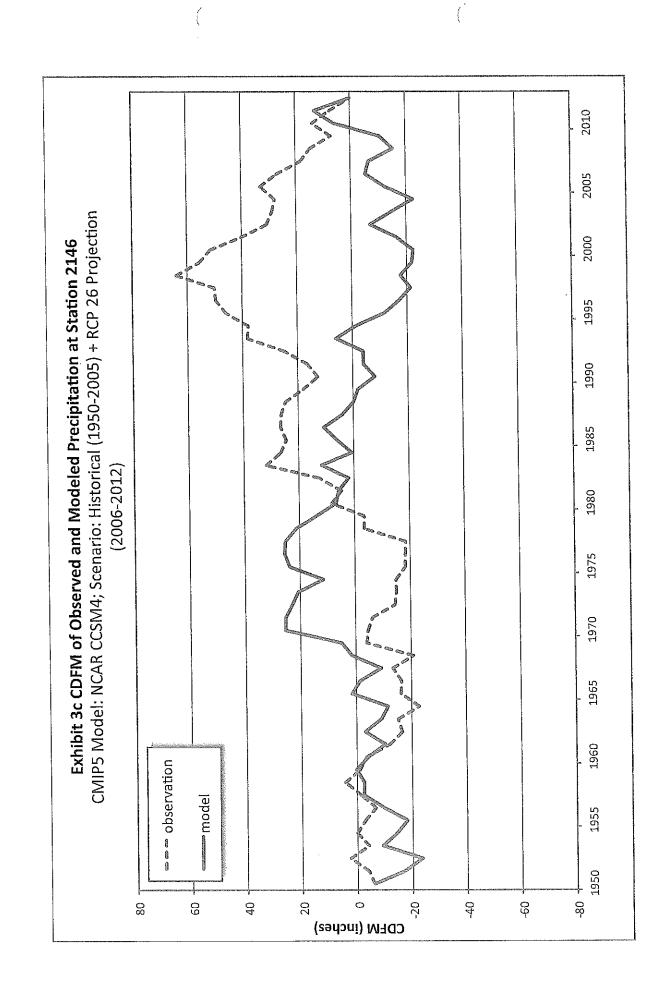


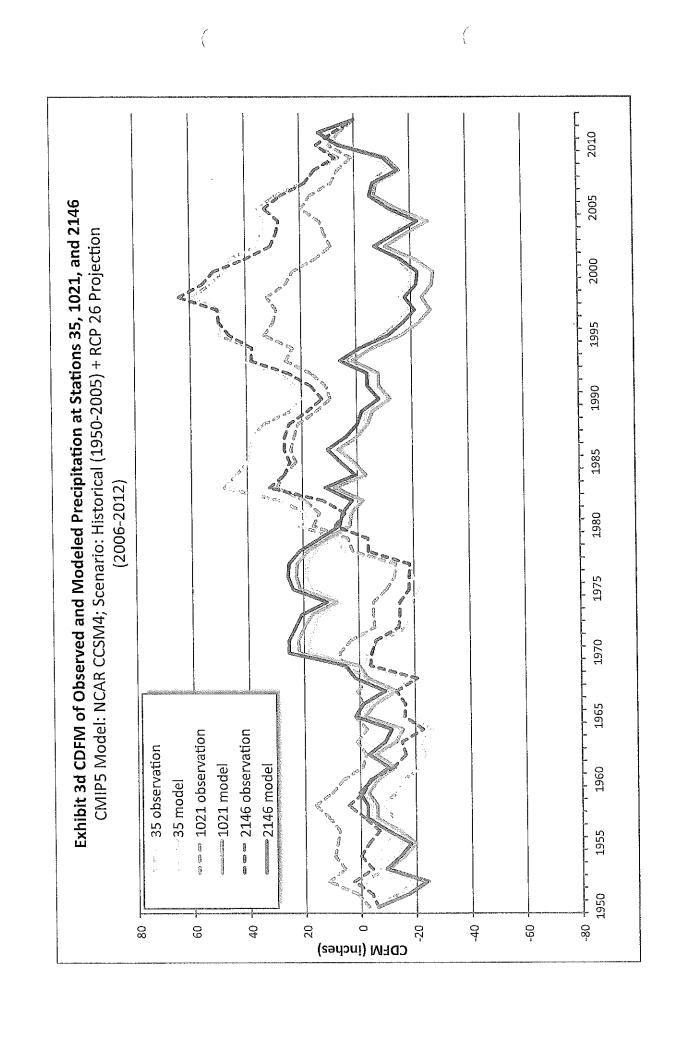


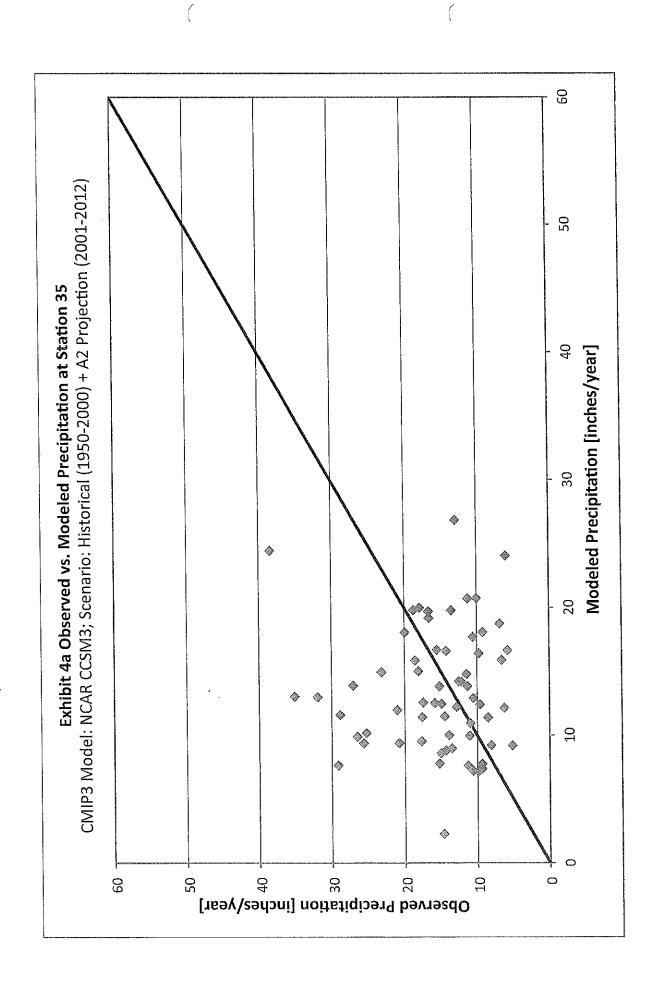


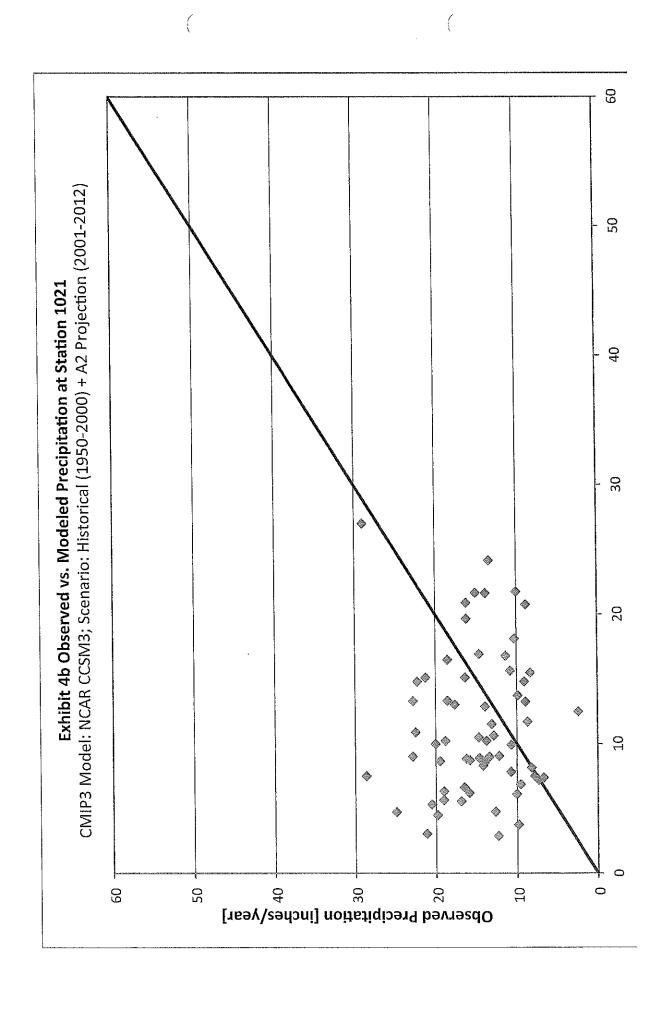


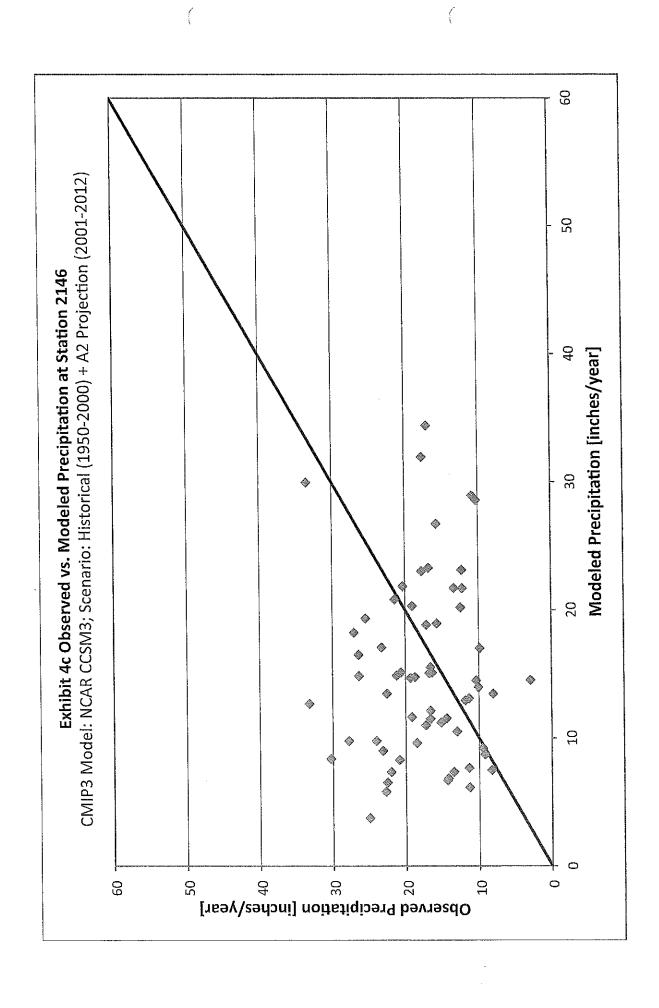


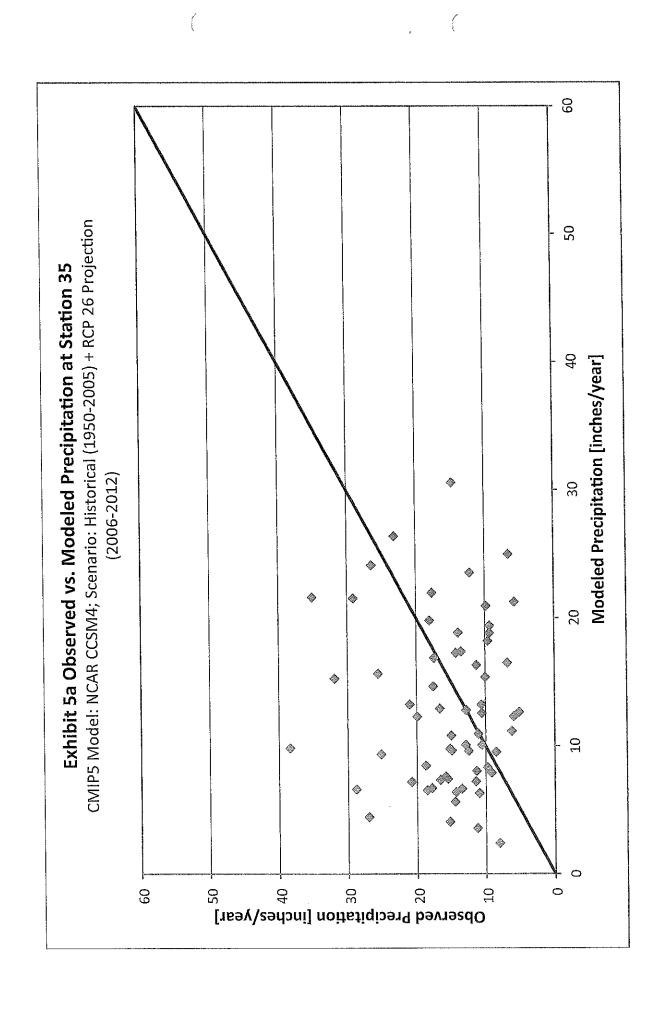


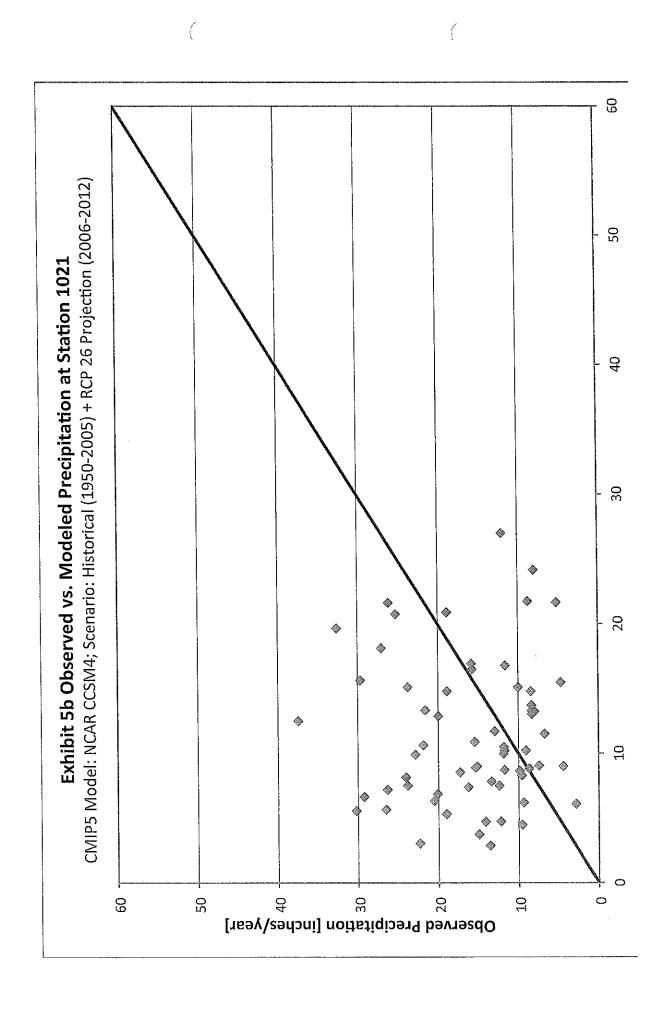


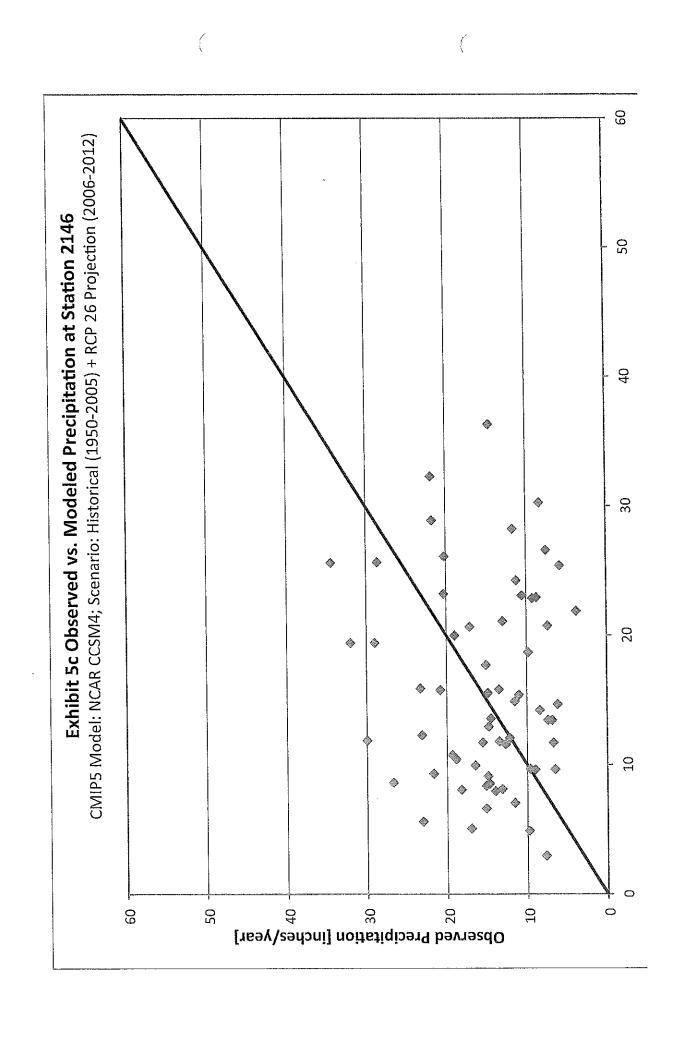












## **CHINO BASIN WATERMASTER**

## Case No. RCV 51010

## Chino Basin Municipal Water District v. The City of Chino

### **PROOF OF SERVICE**

### I declare that:

I am employed in the County of San Bernardino, California. I am over the age of 18 years and not a party to the within action. My business address is Chino Basin Watermaster, 9641 San Bernardino Road, Rancho Cucamonga, California 91730; telephone (909) 484-3888.

On February 1, 2016 I served the following:

	On February 1, 2016 I served the following.
1.	SUPPLEMENTAL DECLARATION OF MARK WILDERMUTH IN SUPPORT OF WATERMASTER'S REPLY TO OPPOSITIONS TO MOTION REGARDING 2015 SAFE YIELD RESET AGREEMENT, AMENDMENT OF RESTATED JUDGMENT, PARAGRAPH 6
<u>X</u> /	BY MAIL: in said cause, by placing a true copy thereof enclosed with postage thereon fully prepaid, for delivery by United States Postal Service mail at Rancho Cucamonga, California, addresses as follows:  See attached service list: Mailing List 1
	BY PERSONAL SERVICE: I caused such envelope to be delivered by hand to the addressee.
<u></u> /	BY FACSIMILE: I transmitted said document by fax transmission from (909) 484-3890 to the fax number(s) indicated. The transmission was reported as complete on the transmission report, which was properly issued by the transmitting fax machine.
<u>/ X _</u> /	BY ELECTRONIC MAIL: I transmitted notice of availability of electronic documents by electronic transmission to the email address indicated. The transmission was reported as complete on the transmission report, which was properly issued by the transmitting electronic mail device.
I declare under penalty of perjury under the laws of the State of California that the above is true and correct.	

Executed on February 1, 2016 in Rancho Cucamonga, California.

By: Janine Wilson

Chino Basin Watermaster

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Eric Leuze
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Frank LoGuidice
Frank Yoo
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Gailyn Watson
Gene Koopman
Geoffrey Kamansky
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