RESPONSE TO STEERING COMMITTEE MODEL UPDATE SUBCOMMITTEE AND COUNTY STAFF COMMENTS ON PASO ROBLES GROUNDWATER BASIN MODEL UPDATE
(Draft Report Issued 19-Sep-14)

Comment No.	Comment	Response (GEOSCIENCE / Todd Groundwater Team)
1	Add a change-in-water elevation map for year 2040 for both model runs, similar to what's been presented to the public in the past.	Agreed. Figures 111 and 112 will be revised to show change in groundwater elevation using similar style of "red zone" maps provided to public by others.
2	Compare estimated basin yield from this model to the previous model.	Agreed. The report will be revised to address this comment.
3	Section 5.6.3.3 provides a very detailed description of the agricultural water demand used in the model runs, but is silent on the assumptions used for municipal and rural residential demands. Some description of the assumptions used for municipal and rural residential demand should be provided. A table similar to Table 5-5 should be included in this section for municipal and rural residential demands would be helpful.	Projected growth of 1% in municipal and rural residential demand was assumed. Accordingly, pumping for these two categories was increased by 1% each year. Future increases were applied to the active rural residential coverage and municipal production well locations identified in 2011. Tables 32 and 33 provide model-simulated pumping for municipal and rural residential for model run 1 and 2, respectively.
4	The "raw" model was so far from being aligned with actual well levels that it leads one to believe there may be some fundamental flaw in the basic assumptions/approach to the model, making calibration efforts appear like a force fit. If the model was forced to converge, it will likely not meet the County's needs in analyzing alternative solutions to stabilizing groundwater levels in the Paso Basin.	For this model update, groundwater recharge was calculated from the Basin watershed model, which determines Basin inflow and associated areal distribution differently than the original model. In addition, groundwater outflow was estimated differently than the original model. As a result, the groundwater levels generated by the original model after updating the flux terms with more recent data but prior to recalibration, deviated from the observed levels because the volumes and distribution of inflow and outflow are different that the original model. As indicated in Section 5.4.1, the recalibration process followed the industry standard "history matching" technique. This technique involves adjusting aquifer parameters and rerunning the model until the relative error of the difference in observed and modeled water levels is at an acceptable level. Therefore, the updated Basin model is an appropriate tool for simulating predictive scenarios to evaluate alternative groundwater solutions.
5	Complete the executive summary	Agreed. The report will be revised to address this comment.

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6	Table 5-7 - I do think the inflow/Nacimiento needs to be clarified to specify return flow OR the total delivery - total use needs to be accounted on the inflow/outflow side. The assumptions need to be clarified in Table 5-7 - what were the model parameters?	The values shown in Table 5-7 represent total NWP water deliveries (actual and projected) to the Paso Robles, Templeton and Atascadero turnouts. For model runs 1 and 2, it was assumed these applied to groundwater recharge (inflow term) and then extracted in the future by groundwater pumping wells (outflow term).
7	It is a bit confusing to have the net and gross numbers in this table. I think my confusion is that the table refers to net losses to basin (i.e., ET by riparian), but it doesn't do that same thing for the other net outflow (i.e., ET). So it seems the terms are a bit jumbled and inconsistent.	All net annual values for each inflow and outflow term are provided in Tables 32 and 33 for model run 1 and model run 2, respectively. These tables are comprehensive, covering 6 inflow terms and 7 outflow terms over a period of 29 years. Therefore, the purpose of Table 5-7 is to summarize the average annual budgets for all inflow and outflow terms, to provide a comparison of totals, and to show how the total budgets correspond to differences in the change in groundwater storage for each model run.

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8	I am also concerned about the inflow/recharge issue from outside the boundary - it seems that for a rural basin, 50% from outside the basin is high. Even a couple of inches of rain over the basin would do more than that.	Deep percolation from precipitation falling directly on the groundwater basin, which is a semiarid region, is minimal. Researchers have estimated that deep percolation of direct precipitation ranges from zero to about 0.05 ft per year (Eychaner, 1983; Danskin and others, 1988 and 1989; Hollett and others, 1991; Hanson and others, 1994) within a semiarid groundwater basin (such as the Paso Robles Basin). For example, 3% of the total precipitation was used as the deep percolation from precipitation for the San Bernardino Basin Area (Danskin and others, 2005) and Rialto-Colton Ground Water Basin (Woolfenden and Koczot, 2001). The average annual precipitation for the Paso Robles Basin is approximately 16 inches per year, which is similar to the San Bernardino and Rialto-Colton Basins. The original model used 40,800 acre-ft/yr of deep percolation from precipitation, which accounts for 7% of the precipitation. This is significantly greater than the amount of recharge used by the above references.
9	I would also be curious to know what the problems with the calibration were.	The calibration of the updated Basin model is a complex process in that there are several model parameters which require adjusting and rerunning of the model to review the result of a specific adjustment. Since the inflow recharge terms were calculated using a watershed model, this added additional time to the calibration process.
10	I would like to understand what adjustments were made to what factors.	The process used to calibrate the update Basin Model included adjusting the recharge flux terms, horizontal and vertical hydraulic conductivity, and storativity coefficient.

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11	Please explain in the report the status of the Atascadero subbasin: Is it considered a separate basin; what is the yield of the basin. This is a very important point to understand in order to understand the yield of the main basin and how it might be most effectively managed.	The final report will indicate that based upon the available information and data the degree to which the Rinconada Fault affects groundwater movement within the confined aquifer from the Atascadero Sub-basin to the adjacent main Basin (i.e., Estrella Sub-area) could not be determined. Therefore, the updated model uses the same conceptual groundwater flow system as the original model.
12	In the final report, can the mapping be presented in an interactive fashion on the county website so that a viewer can enlarge the sections of the map and see more details. Also, it would be helpful to have a few more of the larger roadways identified on the maps.	Providing interactive maps is outside the scope of work for this model update. Additional "larger" roadways will be added to the appropriate report figures.
13	This is an opportunity to explain the 30 million acre-ft total storage capacity (Fugro) vs. 1.7 million acre-ft usable storage capacity (DWR) numbers.	Evaluation of previous estimates of groundwater basin storage capacity by Fugro and DWR is outside the scope of work for this model update.
14	Tables are before figures in the document. Revise table of contents accordingly.	The figures are intended to come before the tables. The final report will be organized in this manner.
15	Add a Glossary	Agreed. The report will be revised to address this comment.
16	Need to explain difference between streambed seepage and subsurface inflow. Is some streambed seepage included in the subsurface inflow?	Section 3.3 provides an explanation for both of these recharge terms.
17	Modeling of streambed percolation that occurs outside of the Basin as subsurface inflow through the Basin boundary is confusing. See page 38.	Agreed. The report will be revised to clarify that streambed percolation that occurs within the watershed outside of the groundwater basin was calculated by the watershed model, which was subsequently input into the groundwater model as subsurface inflow.
18	Executive Summary: - Begin with an explanation that the model is a series of mathematical equations, it is a tool for understanding the groundwater basin.	Agreed. The report will be revised to address this comment.
19	Executive Summary: Explain sub-watersheds.	Agreed. The report will be revised to address this comment.

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20	Executive Summary: Discuss Atascadero sub-basin separation and need for more detailed analysis.	Agreed. The report will be revised to address this comment.
21	Executive Summary: Present results of future scenarios and explain assumptions used in each.	Agreed. The report will be revised to address this comment.
22	Executive Summary: Summarize the perennial yield and change in storage over the timeframes analyzed. Explain those terms.	Agreed. The report will be revised to address this comment.
23	Executive Summary: Include tables of summary info.	Agreed. The report will be revised to address this comment.
24	Executive Summary: Prepare and include updated “red zone” maps, which present well level declines during the specified timeframe (1997 to 2013, as currently available and looking into the future - 1997 to 2040).	See response to comment #1.
25	Executive Summary: Write in concise, understandable terms for public and decision-makers.	Agreed. The report will be revised to address this comment.
26	Since 2011 is considered as baseline, Table 33 contains years (2012, 2013, and 2014) which have already taken place. The rainfall data for these years is obviously not represented in this table. The reader needs to either clearly understand that the weather data is not accurate for those actual years. Or the years (at least 2012, 2013, 2014) need to be labeled as “baseline +1, baseline +2, etc.”	Agreed. The report will be revised to address this comment.
27	Page 22.Wasn’t the UC study already done and available	Yes. The text in Section 3.2.1.2.3 is based on TM1 Methodology and will be revised to ensure it is consistent with later text.
28	Page 29. Mark Battany performed a more recent soil salinity study. Soil salinity and the need for leaching is much more of a concern than it was.	Yes. The text in Section 3.2.1.2.3 is based on TM1 Methodology and will be revised. Salinity study results through 2012 will be cited.
29	Page 30. Define SSURGO.	Agreed. The report will be revised to address this comment.
30	Page 35. 3.2.1.3.3. Deep Percolation of Applied Irrigation and Landscape Water	Applied irrigation water covers water applied to all outdoor land uses including ag and landscaping. The text in the first sentence will be revised to show that water applied to landscaping was considered as well.

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Comment No.	Comment	Response (GEOSCIENCE / Todd Groundwater Team)
31	Page 51, Table 3-15. In heading - Vineyard.	Agreed. The report will be revised to address this comment.
32	Page 54. Vineyard water use ranges from 1.1 to 2.6 ft per year, per Table 10. Text should match values in table.	The text currently cites the irrigation demand (i.e. consumptive use range in Table 10). Values in the comment apply to the applied water (considering irrigation efficiency). Numbers and text will be revised to clearly reflect applied water versus irrigation demand.
33	Page 54. Should note that this study is of volunteer vineyards - which are arguably better managed than those who did not volunteer.	Understood and agreed. We will determine an appropriate place to note this.
34	Page 56. Variability of water use after 1998 reflects the more refined analysis of water use by taking into account effective rainfall, etc.?	The gradual consistent downward trend prior to 1998 is due to the steady decline in ag acreage (primarily alfalfa). Variability after 1998 was due to the annual land use mapping available and the growth in vineyard acreage, for which irrigation rates are generally more sensitive to climatic conditions. The methodology used to estimate ag water demand is equally refined throughout the model simulation period (starting in 1981). Section 3.2.1.2.3, which suggests more refinement post 1998 for certain factors, will be updated to be more clear.
35	Page 56. Some ag ponds are used for irrigation management. They may never be empty, and they are over 50% full during the irrigation season. Also, 50% full results in a surface area greater than 50%.	Evaporative demand of ag ponds were simulated based on average operating conditions. Ag pond water area acreages were provided by SLO County. Given the relatively small evaporative water demand of the ponds, analysis of pond geometry was not conducted. Text will be revised to say 50% area is assumed (not 50% capacity), recognizing the 1:1 surface area to volume ratio is incorrect.

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36	Page 58. Need to include an estimate for non-metered groundwater pumping within the city/CSD limits - golf courses, pasture, vineyards, parks, landscaping etc.	Water demand of golf courses, pastures and vineyards were estimated and included whether or not they are within City/CSD limits. Water use of parks and landscaping within cities/CSDs is subsumed in metered municipal pumping and not reported separately.
37	Page 59, Table 3-20. Why the large variation for San Miguel CSD?	The reason for the variability with respect to San Miguel CSD is not evident. The values in the our tables were re-checked and are correctly presented in the table.
38	Page 60. MWP? Should be MWR?	Noted. The report will be revised and reference it as Master Water Report (MWR).
39	Page 61, Table 3-21. Are swimming pools and large ornamental ponds included within the irrigated landscaping area?	We did not observe significant numbers of either in the parcels surveyed.
40	Page 63/64, Table 13. Although the text explains the handling of the data, the table will be impossible to explain. Also, some readers will turn directly to the table and will not read the text. It would be better to adjust the dwelling units backwards through time and leave the water demand factors (AFY/unit) constant.	Noted. The table will be updated along with a note to reflect what was done in actuality.
41	Page 64. Need to include estimates for landscaping at small commercial operations - wineries, tasting rooms, event centers, bed & breakfast establishments, equestrian facilities, etc.	In some cases, for example wineries, landscaping irrigation is included in the general estimate for water demand (recognizing that some wineries have more landscaping than others). Our evaluation of highway rest stops, which include considerable landscaping, indicated that the water demand nonetheless is very low and not significant relative to basin-wide water use.
42	Page 76. Difference between deep percolation of streambed seepage and subsurface inflow through basin boundary is unclear.	See response to comment #16
43	Page 77, 5.2.1.2. "A total of 47" 5.2.1.3. "A total of 2,977"	Agreed. The report will be revised to address this comment.

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44	Page 78, 5.2.1.4. "A total of 133", 5.2.1.5 "…a total of 3,358", 5.3 The modification of the Basin boundary is unclear. 5.3.1 "…level patterns and trends"	Agreed. The report will be revised to address this comment.
45	Page 79. Since some of the simulated water levels did not match well with the observed well levels, there should be a clear explanation up front in this section that these levels and trends drove the need for recalibration of the model. So, these are not the final conclusions.	Agreed. The report will be revised to address this comment.
46	Page 81. Explain the statement ". . . the updated model was not an accurate predictor of transient flow."	Groundwater flow models are described based on the capability to simulate either "steady-state" and/or "transient" flow of water through an aquifer. In general, steady-state flow represents rate and direction of flow to be constant with time, while transient flow varies through time. A requirement of this model update was to determine the ability of the original model to simulate transient groundwater flow following the update process. If the original model was able to simulate groundwater levels which matched observed water levels to an acceptable degree after the flux terms were updated with more recent data, then it may not have been necessary to recalibrate the original model. However, the purpose of this statement is to indicate the original model was not able to accurately predict transient flow after the flux terms were updated, therefore, recalibration was recommended.
47	Page 84. Calculation of groundwater discharge to rivers is not explained.	Agreed. The report will be revised to address this comment.
48	Page 85, first sentence. "In general, the recalibrated model-calculated . . . "	Agreed. The report will be revised to address this comment.
49	Page 85, 5.4.3. Why was subsurface inflow not included?	Subsurface inflow to the Basin was calculated by the watershed model, and is not a parameter adjustment for the groundwater model calibration.

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50	Page 86, 5.5. Need to include other definitions of perennial/safe yield/sustainable yield (DWR, Sustainable Groundwater Management Act) to put this in context. Change in storage has not been defined in the document at this point. Perennial yield = groundwater pumping less change in storage?	Agreed. The report will be revised to address this comment.
51	Page 87, 5.6.2. Explain that baseline was 2011, although report was completed in 2014. So 2012, 2013 and 2014 are shown as future years with specified assumptions.	See response to Comment #26.
52	Page 93, second paragraph from bottom. Model vs. mode.	Agreed. The report will be revised to address this comment.
53	In Section 3.2.1.1.10~~1~~ they describe crop coefficient as a "dimensionless number". How about "crop coefficients have been developed by UC Scientists to accurately estimate water use by particular crops under the specific measureable conditions on the surface of the Paso Robles Basin."	Noted. The text will be updated to better define and reflect the importance of the crop coefficient values.
54	In the section discussing Frost Control and Leaching it would be good to point out that these occur at the end of the wet season and most of this water will be available for crop growth or pushed through the soil and down into the upper reaches of the basin. Also that farmers should reduce irrigation applications accordingly. Typically for basin calculations the loss to evaporation is relatively small and should be calculable.	Noted. The text will be updated to better describe the significance and timing of frost control and leaching. The daily moisture balances account for the fate of frost control water, but because it is a relatively small factor, it was not tracked and reported individually.
55	In Tables 32~~33~~ and 33~~34~~ the values for total inflow, ag pumping and the ultimate change in storage are based on the model using historical data to project typical years of higher and lower rainfall. I think you will need a note to point that fact out to the casual reader right on the Table.	A footnote will be added to the tables to address this comment.

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56	I would guess that the Table Grapes I and my neighbor farm are in the Deciduous category and may increase that acreage.	Table grapes were included with vineyards. Because of the small acreage of table grapes versus wine grapes in the study area, the slightly greater amount of applied water needed for table grapes over wine grapes (managed using RDI) is within the error of the ag analysis and was therefore not evaluated explicitly.
57	Some confusion as to the meaning of “transient” with respect to calibration, and nowhere is the word defined. Is the use of “transient” intended to identify a separate and unique phase of the calibration process or is it simply a component of the overall recalibration? Perhaps the word “transient” should simply be deleted.	Agreed. The report will be revised to address this comment. See response to Comment #46 for a definition and purpose of "transient" as it pertains to groundwater modeling.
58	The titles for Figures 93 through 98 are not the same as in the Index of Figures. The titles of all Figures and Tables should be checked against the Indices.	Agreed. The report will be revised to address this comment.
59	The Contractor should address additional uses or modifications to the Updated Basin Model in either or both of the Executive Summary and Section 7. of the Final Model Update Report.	Agreed. The report will be revised to address this comment.
60	If it is determined that SLO County Public Works is to play some role in further validation and execution of the Basin Model, then the Contractor should be tasked to provide the County with usage instructions (User's Manual) and the following model components in usable form: a) the Updated Basin Model as one or more software modules, along with the appropriate MODFLOW package; and b) the Basin Watershed Model and the Hydrologic Simulation Program (HSPF) component.	The development and submittal of a User's Manual is beyond the scope of work for this model update. In addition to a complete electronic copy of the watershed model and groundwater flow model files, HSPF and MODFLOW files will be supplied to the SLO County Public Works as stated in the General Agreement.

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61	Do their calculations of water entering the basin during heavy storms have a cap to adjust for all the runoff? Or do they take total numbers and apply them evenly to their calculations? Similarly how do they handle fall rains that often evaporate before the next rain? We see this for .75" rains some years. All the .1 to .25 rains can add up in the soil if they come together. Most years they add 2 or 4 inches to the rainfall total but 0 inches to soil moisture let alone entering the subsoil.	A "cap" was not used to adjust runoff generated during heavy storm events. The GEOSCIENCE/Todd Groundwater Team has provided the County Public Works Department proposed refinements which will reevaluate recharge events in order to improve the accuracy of the distribution of runoff occurring within the watershed.
62	Table 6 on pg. 137 lists rural residential acreage as 146,225 (low, medium and high density). Is this acreage with residences on it or does the acreage include residential zoning that is not built on yet? Also, are the values representative of land use for the entire watershed and groundwater basin?	It is not within the scope of this model update to evaluate each land use type polygon and verify the land use type assigned by others. However, it has been recognized that this type of misrepresentation may occur. For example, the majority of low density residential located outside of the urbanized areas is more representative of "Open Space." The acreage values presented in Table 6 are representative of land use for all 81 sub-watersheds (i.e., watershed and groundwater basin) as shown on Figure 30.
63	There are overlying landowners and water users where water levels have not been impacted (Shandon and San Juan sub-areas) while there are other sub-areas (Estrella sub-area) with significant impacts. There does not appear to be consideration of the fact that although it is one basin, there are aquifers within the basin that need attention, while others are not or have had very little impact. Focus might be more appropriate on the impacted areas as opposed to a one-size-fits-all evaluation.	This type of evaluation is outside the scope of work.

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64	Page 52, paragraph 2 states that bare soil conditions are assumed to cover 100% of the ground surface from April 1 through October 31. This of course is not correct as a number of vineyards have year round cover crop. Although not a large issue, this is symptomatic of model assumptions.	It is recognized that cover crop management varies from vineyard to vineyard. Due to the complexity of the calculations used to estimate irrigation demand on an annual basis with varying climatic factors and soil moisture conditions, a simplifying assumption of cover crop coverage was essential to make the estimation of irrigation demand tractable. As noted in the comment, the error associated with this simplifying assumption is a small issue.
65	Page 92, item #2, it is assumed that the RDI in 2011 will remain constant, which is probably not a correct assumption as an increasing number of vineyards are looking to produce higher quality grapes.	While economic factors may increase RDI management in the future, the degree of such future increases have not been quantified. The percentage of vineyards under RDI management is high as of 2011, and thus the degree that future irrigation demand may be underestimated (due to future underestimation of RDI use) is relatively small.
66	Page 92, item #3, it is assumed that all crops will not increase their irrigation efficiency. With the cost of irrigation continuing to increase and technology improving, it can be more correctly assumed that irrigation efficiency will improve.	Projected increases in irrigation efficiency have not been quantified for incorporation in the model update. The irrigation efficiency applied for vineyards is high as of 2011, and thus the degree by which future irrigation demand may be overestimated (due to potential underestimation of future irrigation efficiency) is relatively small. It is noted that simplifying assumptions identified in Comments #65 and #66 may possibly underestimate and overestimate irrigation demand, respectively (i.e., potential errors counteract each other).
67	The Executive Summary maps show that the most impacted water sub-area in the basin is the Estrella sub-area. This is the area surrounding the city of Paso Robles and where most of the rural residential development is located. There does not seem to be significant attention to this relationship.	Model runs 1 and 2 developed for this model update were designed to show how the basin responds to changes projected into the future based upon available data and assumptions developed by the consulting team, County and modeling subcommittee participants. An evaluation of model results for specific areas within the model area was not a part of the scope of work.

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68	Page 39 indicates that the average annual deep percolation from municipal wastewater effluent is 5,487 AFY. Table 3-20 on pg. 59 shows municipal pumping is 13,117 AFY in 2011 with an average of 11,879 AFY of pumping for the 31 years of the model. The municipal pumping has steadily increased by almost 6,000 AFY. It appears that urban areas are pumping 6,392 AFY more than they are replenishing. The city of Paso Robles is the largest pumper of water with over 6,000 AFY since 1999. Unfortunately, it does not appear that the water deficit from the urban areas is being fully addressed as a factor contributing to the basin issues.	See response to previous comment #67.
69	Tables 5-5 and 5-6 (pg. 90) show annual irrigated crop acreage increases. Unfortunately, the table does not take into consideration that alfalfa is being converted to vineyards, which will likely decrease the agricultural irrigation water use in future years.	Tables 11 and 12 provide 2011 irrigation demand and applied water for the Basin and watershed, respectively. The 2011 values, which were projected forward 29 years for Model Run 1 are significantly lower than the long-term average. Also, forecasted increases in vineyard acreages were used for Model Run 2, as discussed in Section 5.6.3.3.1 Estimation of Annual Crop Acreages from Calendar Years 2012-2040.
70	The selection of the HSPF Watershed model for estimating recharge components and a soil water balance spreadsheet model to estimate groundwater pumping for input into MODFLOW 2000 could have been improved by using GSFLOW, which is a fully linked and integrated watershed and groundwater flow model developed by the USGS.	In addition to the HSPF modeling code, GEOSCIENCE has extensive knowledge of the GSFLOW model code, having worked with the authors on modeling projects since 2009. Use of the HSPF model provided the ability to sum calculated daily recharge values and input as semi-annual values into the Basin Model (the original modelers used semi-annual stress periods for the Basin Model). The process of which GSFLOW uses to link a surface water/watershed model with a groundwater model requires that both models use the same stress period.

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71	Examination of the calibration results show the Watershed model simulating considerably more streamflow in the Salinas River during low flows than what historically has occurred.	Agreed. Calibration scatter plots indicate the Watershed model tends to over-estimate streamflow less than 100 cubic ft per second. This condition suggests the overall Basin recharge estimate may be reasonable but the temporal and areal distribution of that recharge is different than simulated. The GEOSCIENCE/Todd Groundwater Team has provided the County Public Works Department proposed refinements which will improve the ability of the Watershed model to simulate low streamflow.
72	The amount of subsurface inflow from outside the basin as a source of recharge appears to be high when compared to other sources of recharge.	Agreed. The GEOSCIENCE/Todd Groundwater Team has provided County Department of Public Works proposed refinements which will reevaluate the fate of water from the watershed entering the Basin.
73	There are instances during which the amount of subsurface inflow increases (or decreases) by a factor of over 50 from one year to the next which seems extreme. An explanation for the wide variations in the annual subsurface inflow from year to year is not provided.	See response to previous comment #72.
74	The actual pumping and recharge which was output in the groundwater model may be considerably different than what is reported in the water budget in Table 26. The extent to which this was an issue or the amount which these values differ from the modeled inputs is not documented.	The values provided in Table 26 were generated by the updated and recalibrated Basin Model.
75	Since it appears as if the inflow and outflow values in Table 26 are not representative of groundwater model output results, the reported ‘Change in Groundwater Storage’ in Table 26 may not be reliable and the estimated perennial yield (which is based on the recharge, discharge, and change in storage values) is likely inaccurate.	See response to previous comment #74.

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76	With respect to the parameter estimation using PEST, there is no mention of the initial parameter estimates, range of acceptable values, or the basis for determining the range of acceptable values. Furthermore, there is no discussion of how the estimated parameter values compare to field estimates or the conceptual model (i.e. depositional processes and hydrofacies).	Agreed. The report will be revised to address this comment.
77	Normally, it is common to adjust recharge and discharge terms or to adjust aquifer properties during model calibration but not to do both. In this case it appears as if Geoscience did both which is unconventional and could result in a model that does not represent the conceptual model.	The recharge (i.e., inflow) values input into the Basin Model are calculated by the watershed model. Therefore, the iterative process of calibrating the Basin Model includes making adjustments not only to the aquifer parameters, but also to the recharge values from the watershed model. As stated before, the recharge budget components estimated by the watershed model are representative of the conceptual model.
78	The numerical groundwater flow model represents stream-aquifer interactions using two separate processes, which is unusual. Geoscience utilizes the Recharge package and the Streamflow Routing package to represent exchanges between groundwater and surface water.	Actually, the process used included Recharge package and Stream package (STR); not the Streamflow-Routing (SFR) package. However, the GEOSCIENCE/Todd Groundwater Team recognized the limitations of this process and has provided the County Department of Public Works proposed refinements to the Basin Model which includes replacing the combined packages with the Streamflow-Routing (SFR) package.
79	Documentation in the report was limited with respect to how the Streamflow Routing (SFR) package was set up. Important information regarding headwater streamflows, channel geometry, streambed conductance, or the Mannings roughness coefficient is not described, making it difficult to evaluate whether the input values are representative of the conceptual model.	See response to previous comment #78.

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80	The description of both the sensitivity analysis/model uncertainty does not include important details or a thorough analysis of the results. Among the reported goals of the study is to evaluate model uncertainty. It would seem important to quantify how the uncertainty in the parameter estimates affects the model outcome. The role parameter uncertainty plays in the estimates of perennial yield and in evaluating the results from the future scenarios is likely important and should be reflected in the results.	The results of the sensitivity analysis indicated that the Basin Model is most sensitivie to changes in groundwater pumping and recharge from streambed percolation. The Basin Model has been improved (from this update) through an extensive evaluation of agricultural groundwater pumping, which is known to be the largest basin outflow, but with considerable uncertainty. The uncertainty associated with recharge from streambed percolation was recognized by the modeling team, and has been proposed to be mitigated through future model refinements (as discussed in the response to Comment #71).
81	Figures 71 through 81 are very difficult to review.	Noted. The Basin is divided into seven sub-areas and one sub-basin, and there are four model layers. In order to provide representative hydrographs per sub-area/sub-basin for each model layer per figure, it was necessary to reduce the scale of the hydrographs. Standard shapes and colors were used (e.g., blue triangle = observed water level) appropriately in each figure to provide the reader with the ability to differentiate and therefore review the analyses.
82	It would also be helpful to include charts to accompany many of the larger tables to increase the readability of the results.	The summary report includes over 30 tables that provide adequate data and results; many include categories which can be located on corresponding figures included in the summary report. The GEOSCIENCE/Todd Groundwater Team consider the combined tables and figures provided to be adequate for analysis of results.

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Comment No.	Comment	Response (GEOSCIENCE / Todd Groundwater Team)
83	The discussion of the development of assumptions and inputs for "Model Run 2" is incomplete. The rate of growth for vineyards seems high compared to the 0.8% growth experienced from 2004 through 2011. There is not any discussion regarding urban growth or what land use vineyard growth will replace (native vegetation or other crops) and how that was incorporated in the model run. In addition, there is no mention of how the current moratorium on new development of groundwater supplies (if it is extended for two years through 2015) is accounted for in the model run or how that may negate the 2.9% growth rate in vineyards between 2012 and 2017 and the 11% growth rate in vineyards between 2016 and 2017.	The rates of vineyard growth from 2012 to 2017 incorporate detailed analysis by the SLO County Agricultural Commissioner's Office (ACO) of future vineyard growth, identifying parcels projected to be converted to vineyards. A one percent growth rate for vineyards is assumed from 2018 onward; groundwater production and applied water associated with the 1 percent growth rate from 2018 onward is applied to the vineyard parcel coverage in 2018.
84	The report does not address how crop water demands outside the basin in the watershed are met. It is not documented whether they are ~~they~~ met with groundwater exported from the basin to the watershed or from groundwater pumping in the watershed or a combination of the two. The report also does not address how subsurface inflows are affected by growth in crop water demands in the watershed.	For the model update, crop irrigation demand is assumed to be met by groundwater. The location of groundwater withdrawal is assumed to occur at the centroid of each individual crop field (or group of adjacent fields under the same ownership). The effect of crop water demand in the watershed areas on subsurface inflows to the basin are accounted for by the watershed model.
85	The simulation of an increase in groundwater discharge to rivers in Model Run 2 compared to Model Run 1 seems counterintuitive since groundwater pumping is higher and groundwater levels in the Bradley area are much lower in Model Run 2 compared to Model Run 1.	Recharge from Nacimiento Water Project supplies and wastewater were projected to increase under Model Run 2 conditions. The purpose of the comparison was to determine increases of groundwater discharge to rivers in response to the increased recharge.

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86	In the section describing how the streams were set up in the Watershed model, the criteria for selecting outlet locations is unclear as is the metric for evaluating "channel type" and "geography." The FTABLE and how it works is poorly defined (FTABLE is used to relate discharge with stream stage, volume, surface area). There is no mention of which FTABLE was used and how this was determined.	Agreed. The report will be revised to address this comment.
87	The use of average monthly ETo from the CIMIS ETo map [Figure 48] for a model that is set up with daily rather than monthly stress periods. Grids of daily ETo are available from CIMIS as well as daily data from CIMIS stations. Although there is some evidence to suggest that the ETo map is a reasonable estimate of the actual daily ETo, the correlation coefficient should not be the only measure of fit used to compare these datasets as it does not account for bias or effectively quantify the error. In looking at these data [Table 9], there are cases where the correlation coefficient is excellent, but there is substantial residual error between measured and predicted ETo. It would be useful to see the Root Mean Square Error and ideally some additional fit statistics.	As shown on Figure 48, there is one CIMIS station and six Western Weather Group stations located within the watershed area. A daily ETo 2-km grid map (CIMIS Spatial) is available for the watershed; however, the accuracy of these grids can be significantly affected by factors which characterize the watershed (weather station density, topography and cloud/fog cover). The daily data for the period 2005-2011 from the WWG stations was input to the Basin Watershed Model. Regression analysis, as described in Section 3.2.1.2.8 of the report, was used to generate the daily input for the period where daily ETo data was not available. As shown in Table 9, the results of the analysis indicated a very strong correlation between measured daily (compiled as monthly) data and CIMIS reference ETo rates, which we feel was sufficient for model input.

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88	Vegetable crop coefficients (Kc) do not vary with crop maturity. There should be substantially lower Kc for younger plants (see Snyder, 2000) suggesting ETc is likely overestimated in these areas in the spring. The Watershed Model uses an unreasonably high Kc from October through December (1.00) considering the assumption that vegetables are grown from May to September (perhaps table [Table 3-5] needs to be updated). Also, the value assumed for bare soil Kc is not included.	Monthly Kc values for vegetables were taken directly from the 2012 Water Master Report, which were adapted from DWR 113-3 (DWR, 1974), UC Leaflet 21427, and UC Leaflet 21428. Possible overestimation of vegetable Kc values from October through December are likely to have a relatively minor impact on overall groundwater demand, as the vegetable acreage in the Basin and surrounding watershed and daily reference ET values from October through December are relatively small. Bare soil Kc values are variable and thus are not included in the Kc table. As explained in Section 3.4.1.2 <u>Cover Crop ET and Bare Soil Evapotranspiration in Soil Moisture Water Balances</u>, the Kc value of bare soil was assumed to equal 1.0 on a day when rainfall or irrigation for frost prevention occurs, 0.9 one day following the last rainfall or frost irrigation day, and 0.8 two days after the last rainfall or frost irrigation. The Kc value of bare soil was assumed to decline from after day two by 0.2 each day until reaching 0.0 six days after the last rainfall or frost irrigation day.
89	An explanation is not provided for the 20%, 60%, 80%, and 100% ETc adjustments in vines based on the year. This adjustment should be made based on the growth stage of the vine and it is not clear whether the assumptions were made from published information.	The final estimation of vineyard irrigation demand did not consider the growth stage of vineyards. Due to the complexity of the calculations used to estimate vineyard irrigation demand on an annual basis with varying climatic factors and soil conditions, vineyards were simulated using ETc values for mature vines only. According to Mark Battany, while immature vines may require less irrigation than mature vines (under the same irrigation management strategy), immature vines are less likely to be subject to RDI. Thus, the likely error associated with the assumption of Kc values for mature vines only in the model update is relatively small.

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90	An explanation is not provided as to why irrigation methods are the only factor in determining irrigation efficiency. Conveyance losses, deficit irrigation, etc. should also be considered.	Discussion on how irrigation efficiencies were determined is provided in Section 3.2.1.2.3 Determining Types of Applied Water and Section 3.4.1.2 Estimation of Annual Crop Consumptive Use from Water Years 1981-2011.
91	Irrigation methods for Forage/Pasture/Alfalfa for San Luis Obispo County in Table 3-7 does not add to 100%.	Agreed. The report will be revised to address this comment.
92	There does not appear to be any explanation for the methodology in estimating the precipitation adjustment factor. It would be beneficial to view statistics on how well this methodology performs and if the distribution of annual precipitation is a good predictor of the daily distribution of precipitation.	Section 3.2.1.2.5 Determining Average Daily Precipitation provides a complete explanation for the methodology used to develop precipitation adjustment factors. As indicated, the adjustment factors were based on long-term average annual precipitation data. Daily precipitation station data for which to evaluate the distribution of annual precipitation are not available.
93	It does not appear as if the amount of recharge from precipitation and return flow from irrigation was accurately captured. It appears as if this value is underestimated especially during the 1981-1997 period.	Agreed. This issues has been identified and the GEOSCIENCE/Todd Groundwater Team has provided the County Public Works Department proposed refinements to reevaluate deep percolation of direct precipitation and agricultural return flows in the Basin.
94	There does not seem to be much difference in recharge from precipitation/return flows over time to account for the conversion of alfalfa to vineyards and native vegetation/ranching/dry farming to vineyards and the introduction of more efficient irrigation practices.	Recharge from precipitation/return flows over time take into account the increased irrigation efficiency, changing crop acreages, and variable climatic conditions over time.

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95	It seems like the subsurface inflow component is high compared to other recharge components. This seems unreasonable given that the majority of the area not included in the groundwater model contributing to this inflow component is bedrock which could arguably be treated as a no-flow boundary.	See response to comment #72.
96	The description of the calibration process for the Watershed Model is somewhat vague and the results are poorly presented. It is unclear which parameters in the Watershed Model were adjusted during calibration and a table containing the final parameter values is not included. There also does not appear to be a sensitivity analysis or any discussion of the model uncertainty which was originally listed in the scope of work. Results from only four stream gages were presented when there are data from 13 gages available. Even if hydrographs from only four gages are presented, all the useful measurements should be included in some calculation of overall model fit.	The report will be revised to include the model parameters adjusted during the calibration process; a sensitivity analysis of the watershed model was not included in the scope of work. Final parameter values of the calibrated watershed model can be obtained from the model files provided to the County. The report will also be revised to clarify why 4 of the 13 gaging stations were used to evaluate the quality of model calibration.
97	The reliance on using the correlation coefficient to judge the adequacy of watershed model calibration is not recommended. The correlation coefficient is generally a weak measure of model fit as it does not adequately quantify model error and model bias. Other fit statistics should be included.	The process used to calibrate the Basin (HSPF) watershed model included both graphical and statistical techniques that are recommended by the authors of HSPF. This technique is commonly used by the GEOSCIENCE/Todd Team and the modeling community for calibration of HSPF models.

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98	The irrigation scheduling is essentially the same for all crops which does not seem to be consistent with actual irrigation practices.	A set of daily water balances was developed for seven irrigated crop groups and used to develop the reference crop irrigation demand rates. A detailed overview of the technical approach is provided as Section 3.4.1.2 Estimation of Annual Crop Consumptive Use from Water Years 1981-2011. Estimated annual irrigation demands per crop type and applied rates are provided in Table 10.
99	In Table 3-15, the Vegetable Kc does not match values in Table 3-5 used in the Watershed Model.	Agreed. The report will be revised to address this comment.
100	It is assumed that rainfall and irrigation for frost protection from March 16 through April 15 are subject to bare soil ETc when these fields are assumed to have a cover crop through March 31.	As stated in Section 3.4.1.2 Estimation of Annual Crop Consumptive Use from Water Years 1981-2011, frost protection results mostly in return flow and ET consumption is limited to short-term evaporation from wet soil.
101	The rationale for utilizing semi-annual stress periods when the Watershed Model can provide data on daily and monthly stress periods is not presented. It may be useful to include an evaluation (even qualitative) of the temporal discretization in the discussion of the model calibration evaluation and whether using shorter stress periods may produce better results.	Agreed. The report will be revised to address this comment.
102	In Section 5.6, the predictive scenarios are run on monthly stress periods while the calibrated model is discretized on a semi-annual basis. Stress period length should be consistent between the calibrated model and the predictive scenarios.	Agreed. The report will be revised to address this comment.

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103	Each stress period should be broken up into multiple time steps to avoid introducing numerical errors (Anderson and Woessner, 1991). Also, the maximum mass balance error in any model time step as a percentage of the average of inflows and outflows (percent error) should be included in the discussion of model calibration results for the numerical groundwater flow model.	Each stress period was divided into 15 time steps, and the percent error was verified to be within 1% for each model run.
104	It would be useful to indicate whether PEST converged on parameter values which produce some locally minimized error, what the upper and lower parameter bounds are, and what information was used to determine the upper and lower bounds.	Agreed. The report will be revised to address this comment.
105	It would be helpful to include a map or table to compare the parameter estimates from before (trial and error calibrated) and after the automated [PEST] calibration.	The parameter adjustments (i.e., values) used during the automated calibration process are not representative of the final calibrated model; therefore, it is not appropriate to include in the report.
106	The results from the future scenarios show that in Scenario 2 there is increased groundwater pumping and a considerable annual storage deficit (20,000 afy versus 5,000 afy). However, results from this model show a comparable amount of subsurface outflow and increased discharge to rivers. There is not a clear explanation of why this is the case.	Average annual outflow is comparable between both model runs. The increase in discharge to rivers under Model Scenario 2 is a result of increased recharge from Nacimiento Project Water and treated wastewater.

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107	The summary of the water budget states that the agricultural pumping is slightly less than the assumption, but the amount is not quantified. It is unknown whether the input value or the actual pumping value from the model is presented in the water budget table.	All inflow and outflow water budget components presented in Tables 32 and 33 are from the Basin Model. During the simulation period, a groundwater flow model calculates the water level for each active model cell and for every stress period based on all of the inflow/outflow components. When an assumed value (e.g., agricultural pumping) exceeds the amount of available groundwater within a model cell, it causes the cell to go "dry." The cell remains dry until the water level returns at a later time (stress period). Therefore, simulated values can vary from the input values as a function of dry cells occuring throughout the simulation period. Simulated values can also differ from the input due to the convergence error, which is inherent to all numerical models. The agricultural pumping values simulated for Model Run 2 differ because the assumed water demands were high enough (i.e., higher than for Model Run 1) to result in dry cells in various areas and during various time throughout the simulation period. However, the difference is marginal, and the convergence errors of the Basin Model is within an acceptable range.
108	Given the changes in the water table, it seems reasonable that riparian vegetation would be impacted. This would be better represented using the EVT package which simulates the ET rate as a function of the water table elevation instead of fixing the ET using the WEL package.	Either method can be used to represent any impacts to riparian vegetation associated with changing groundwater elevations. However, the WEL package was used for the following reasons: (1) ET is minimal [3% of total average annual outflow]; (2) observed water level changes within model layer 1 are minimal; and (3) there was potential for significant rounding error using the EVT package as a byproduct of assigned ET extinction depth, water level, and total thickness of model layer 1.