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MEMORANDUM REPORT

To: Klamath Tribal Water Quality Consortium
From: Eli Asarian, Riverbend Sciences
Date: September 20, 2021
Re: Review and comments on *Public Draft Shasta Valley Groundwater Sustainability Plan*

The public draft of the "Shasta Valley Groundwater Sustainability Plan" was circulated for public comment by the Siskiyou County Flood Control & Water Conservation District in August, 2021. To assist the member Tribes of the Klamath Tribal Water Quality Consortium in the preparation of their comments, Riverbend Sciences and subcontractors have reviewed the document and prepared the comments provided here for the Tribes' use.

A) COMMENT OVERVIEW

We have reviewed the public draft of the Shasta Valley Groundwater Sustainability Plan (GSP) and wish to provide the following comments. Our comments are arranged into three sections: A) Comment overview in which we provide a summary of our most important big-picture comments, B) comments on specific sections of the GSP chapters using the comment form provided.

A summary of our big-picture comments is provided in the following bullets, which are then discussed in the paragraphs below:

- The GSP lacks transparency
- Many GSP actions and goals sound great but are loosely defined so do not actually achieve much
- The GSP's monitoring plan is good, but without sufficient funding it cannot be implemented, and critical data gaps will remain unfilled
- The Minimum Threshold for Interconnected Surface Water should use direct measurements of springs, not a water balance that relies heavily on highly uncertain diversion estimates
- Parts of the GSP do not acknowledge the hydrologic reality of the sources of water to a well
- Even if the model will not be used for sustainable management criteria, it is still informative to look at its predictions for streamflow depletion
- The GSP does not deal appropriately with climate change

The GSP lacks transparency

Collaborative management and transparency and core tenants of SGMA. How will transparency and public access to data be incorporated into reporting and data sharing agreements? All data that is paid for with public money should be accessible to the public. All GSP reporting (i.e., annual and five-year review reports) should include electronic appendices with easily accessible data, so others could run their own analyses on the data. TC-001

We understand the political sensitivity of well metering, but how can groundwater be managed at a basinwide scale without metering? At least some subset of the wells should be mandated to be metered. Examples could include the largest wells, or new wells drilled after the passage of the SGMA legislation or after adoption of the Shasta Valley GSP. How can existing ordinances, such as the prohibition on the use of groundwater for cannabis production or the requirement for permits being needed for inter-basin transfers of groundwater, be enforced without the well metering? How can the effects of efficiency projects be verified without metering? The lack of metering requirements suggests a lack of transparency, which further suggests a lack of will to actually manage groundwater extraction. TC-002

We also have serious concerns with the lack of transparency with the current Scott Valley and Shasta Valley Watermaster District program. Watermastering should be returned to the State of California, with well-organized publicly accessible records of diversions. TC-003

Many GSP actions and goals sound great but are loosely defined so do not actually achieve much

The GSP full of things like that sound great like the "Avoiding Significant Increase of Total Net Groundwater Use from the Basin" project and management action (PMA), but when we look closely at the details we see that the wording is loosely defined so that it does not actually guarantee anything. Since all well metering is voluntary, how is it possible to verify this? TC-004

If the GSP is to actually achieve the stated objectives, it needs more things that can actually be readily verified. Examples that we recommend include:

- No additional wells for new land use or additional cropping will be permitted in the basin. Only new wells intended to replace old wells and existing crops will be permitted, and these replacement wells will be metered. The intent here is to avoid net increase in groundwater use.
- Wells intended to replace stream diversions will not be permitted, even if there will be no additional net water usage (i.e., pumped groundwater will be used to replace surface water irrigation of existing crops). The intent here is to allow the SWRCB to ascertain and regulate surface water rights and stream and spring flows. The use of groundwater wells in place of stream or spring diversions simply moves the point of diversion and lessens the ability of the SWRCB to carry out its mission.

The GSP's monitoring plan is good, but without sufficient funding it cannot be implemented, and critical data gaps will remain unfilled

We generally agree with sites and parameters proposed in Section 3.3 Monitoring Networks, but we are extremely concerned that funding will not be available to actually implement the monitoring. The GSA has a responsibility to provide the funding needed to collect these data. Without the monitoring, critical data gaps will persist and it will be impossible to understand or properly manage the intricate Shasta Valley groundwater system. TC-005

From our perspective, monitoring the flow of the springs is the most important. The output of these springs is what sustains aquatic ecosystems and agriculture in the Shasta River. In addition, the ability to predict flow in these springs is the primary endpoint upon which we will judge the performance of the Shasta Watershed Groundwater Model. We need to understand how groundwater elevations and groundwater pumping affect the flow in these springs. The monitoring plan proposes monthly monitoring of the springs, however, this is insufficient given the importance of these springs and the potential insights that high-resolution data could provide into the complex dynamics of Shasta Valley groundwater. At what time scales do the flow of these springs fluctuate (seasonal, weekly, daily, hourly, etc.) and what do these fluctuations appear to correspond with (e.g., Dwinnell reservoir levels, nearby groundwater pumps cycling on/off, flood irrigation, snowmelt, storm events, etc.)? How can we understand this without data? The two largest springs, Big Springs and Little Springs, are especially important. Other critically important springs that need continuous flow monitoring include Bridge Field Springs (on Shasta Springs Ranch, owned by Emmerson), Black Meadow Springs (on Shasta Springs Ranch, owned by Emmerson), Kettle Springs (on Shasta Springs Ranch, owned by Emmerson), and Hole in the Ground Spring. We noticed that Bridge Field Springs and Black Meadow Springs, were not included in the monitoring plan. We strongly urge that both these springs be added to the monitoring plan. TC-006

The Minimum Threshold for Interconnected Surface Water should use direct measurements of springs, not a water balance that relies heavily on highly uncertain diversion estimates

The GSP proposed a Minimum Threshold (MT) for Interconnected Surface Water (ISW) of 100 cfs groundwater contributions, based on a water balance of the Shasta River reach between Dwinnell Dam and the USGS flow gage near Montague. The estimated diversions used in the water balance are highly uncertain and unreliable, derived from private watermaster records. The bounds of uncertainty on these diversion estimates are so large as to make them nearly useless as a decision-making tool. Rather than estimating groundwater contributions based on a highly uncertain water balance, we would much rather have the MT ISW be based on the sum of measured discharges from key individual springs (i.e., Big Springs, Little Springs, Bridge Field Springs, Black Meadow Springs, Kettle Springs, and Hole in the Ground Spring). While these individual springs do not represent the entirety of the groundwater contributions (i.e., there may be some diffuse contributions as well as additional smaller springs), data on the spring flows are required anyway for management and model calibration, and should provide a more reliable relative metric of groundwater contributions than the water balance. There are not yet much data yet on these spring flows, but measurements need to begin as soon as possible. TC-007

Parts of the GSP do not acknowledge the hydrologic reality of the sources of water to a well

It is important to note that there are only three sources of water to a pumping well: 1) reductions in discharges from the system (e.g., discharges to streams and springs); 2) an increase in recharge to the system (capture of rejected recharge), and 3) change in storage (change in groundwater levels, which is only a temporary source of water and is not sustainable).

Because the Shasta work includes the entire watershed, item "2" would only result in robbing Peter to pay Paul – there is no net increase in yield when viewing the system as a whole. Item "3" is not important when looking at the long-term (sustainable) response of the system to pumping – it's only a matter of time before the impacts show up.

The point to be made here is that all groundwater pumping eventually comes at the expense of surface water systems (e.g., stream flow), the only real question is how long it will take for these depletion effects to reach the surface water systems. This delay is a function of distance from the stream and aquifer properties. It doesn't matter if the well is 10 feet or 10,000 feet from a surface water feature– the result will ultimately be impact to surface water features. This assumes that the basin does not simply go into overdraft, at which point there are no additional sources of surface water to deplete, or that they are already being depleted as rapidly as possibly given aquifer properties.

We highlight this issue because at times the GSP document seems to not acknowledge this fundamental physical reality. For example, from Chapter 3, page 46:

> As explained in the previous section, the lack of historical and high-frequency groundwater elevation data in the Basin, spatial gaps in streamflow and spring measurements, and uncertainty in the historical and current data regarding surface water diversions and groundwater does not allow the development of a reliable estimate of stream depletion due to pumping. Acknowledging these uncertainties and existing data gaps, the GSA finds it inappropriate to define the interconnected surface water SMC at this stage using modeled results of stream depletion. Instead, the GSA proposes as adaptive approach that would help improve the SMC setting in the future using newly collected data while addressing SGMA requirements…

TC-008

What other long-term source of water is there for the wells (see Theis, 1940, The Sources of Water Derived from Wells)? It is important to strike "…does not allow the development of a reliable estimate of stream depletion due to pumping." and replace with something like " …makes current model predictions of location and timing of impacts uncertain."

Even if the model will not be used for sustainable management criteria, it is still informative to look at its predictions for streamflow depletion

The GSP states that the model is not complete and therefore was not used for assessing sustainable management criteria. A primary reason given for this is lack of data. Our comment regarding this issue (Chapter 3, page 30) is:

> The text states "*The goal is to use this approach for the first 5 years of implementation, collect more data, and at the GSP update provide a stream depletion approach based on more reliable results produced by the further calibrated SWGM.*" Two fundamental questions regarding groundwater development in the Shasta Valley are "What effect has past and present groundwater

TC-009

pumping had on surface-water flow in the Shasta River, tributaries, and springs in the Valley?" "What effect will future groundwater pumping have on surface-water resources in the Shasta Valley?" From the stated text, it seems that the Shasta Watershed Groundwater Model (SWGM) will not be used to answer these questions for at least 5 years. If the groundwater part of the model can be used to calculate water budget components as has already been done, why can't it be used to calculate streamflow depletions? Conversely, if the model can't be used to reliably calculate streamflow depletions, why can it be used to calculate water-budget components? Using a groundwater model, streamflow depletion from groundwater pumping is always determined using model-calculated water budget components. At this stage of development of the groundwater model, uncertainty in computed streamflow depletion will most likely be in the timing of the depletion, rather than the relative amounts that various surface-water features are affected. In five years, there will still be uncertainty in the timing of depletion, but perhaps that uncertainty will be lower. Nonetheless, a delay of five years in tackling fundamental questions seems to be ignoring the current value of the model. If key calculations were run and re-run as the model was being improved, then the modelers would learn the sensitivity of model results to changes in parameters.

TC-009 contd.

We would add that the modeling process itself is an invaluable tool in gaining stakeholder buy-in on the local physical conditions and the model itself. This buy-in is especially important down the road when the model is used to make critical decisions. Letting stakeholders clearly see the difficulties in simplifying the system for input into the computer program and illustrating the uncertainties that arise from data gaps is invaluable as part of building trust. Unfortunately, this was not our experience on this project.

The GSP does not deal appropriately with climate change

The GSP appears to treat climate change as a check-the-box exercise rather than seriously grappling with what it will mean for groundwater management. The GSP does include model runs for future climate change, these results are not presented in a coherent way that highlights the major challenges that climate change will pose to water management. A warming climate will cause a shift in precipitation form (less snow, more rain) that will in turn shift the seasonal timing of tributary surface flows into the valley. Regardless of what happens to total precipitation or total runoff, this change in precipitation form and runoff timing is a huge issue that water management is going to need to recon with. Perhaps we missed it (and if so, we apologize), but we did not see evidence that the GSP recognizes the severity of the coming changes to climate, nor presents a coherent plan to adapt to it.

TC-010

B) COMMENTS ON SPECIFIC GSP SECTIONS USING THE COMMENT FORM PROVIDED

Chapter	Page	Section	Line/Table/ Figure #	Comment	
2	79	2.2.1.5	1500-1504	"Streamflow data from all available sources will be further assessed during hydrologic model development to identify important critical conditions. Data quantity and quality impact both selection of data to be used for calibration and interpretation of model performance during associated time periods. More weight is given to locations and time periods with higher quality data." This wording seems to suggest this work was not done as part of model calibration to date, but this appears incorrect, true? If so, it should be reworded in past tense.	TC-011
2	87-91	2.2.2.2	Figure 35-39	Based on the values this is, indeed, a depth to water map, but then it is not an "Elevation Map" as stated. It is a bit confusing as it appears to show cones of depressions in the far eastern and western areas, but as the land is sloping it is not clear how much these values reflect changes in land surface elevation versus water groundwater surface elevation. Why not present WL elevation maps and depth to water maps separately? In the latter case, it would be good to include a more detailed land surface elevation map than that provided in Figure 6 (which is in 2,000 foot increments).	TC-012
2	107	2.2.2.6	2071	This is supposed to read "south to north" not "~~north to south~~", right?	TC-013
2	108	2.2.2.6	2124-2166	We assume these measurements will continue into the future and measurements obtained throughout the year. This is important because winter periods may prove best for understanding the ultimate degree of GS/SW interaction because of the lack of nearby irrigation pumping. In addition, a year-round analysis would provide a fuller picture of this interaction.	TC-014
2	111	2.2.2.6	2128	It is coinciding, so suggest following edit: "~~potentially coinciding~~" to "coincident".	TC-015
2	133-134	2.2.2.7	2433, Figure 58	Why are these maps (Figure 58 and in Appendix 2-G) so different from Figures 35-39? Is it simply a matter of scale? Suggest replacing Figures 35-39 with these figures and including WL Elevation maps separately.	TC-016
2	136-137	2.2.2.7	2506, Figure 59	Why is this survey considered a maximum and not a minimum possible extent? There are a lot of acknowledged generalizations in this section. We would think you'd want a relatively quick field check before dismissing all the "Assumed not a GDE" areas. In addition, as noted, perched zones were not captured in the analysis. Recommend that you include something like "Representative areas currently classed as 'Assumed not a GDE' will be reviewed in the field as part of future work".	TC-017
2	138	2.2.3	Figure 60	This graph (or an additional one) should include change in storage through time.	TC-018

Chapter	Page	Section	Line/Table/ Figure #	Comment	
2	138	2.2.3	Figure 60	It is important that groundwater ET be modeled explicitly in the GSFLOW model to better understand and illustrate the changes in amount and location of potential impacts to GDEs through time in areas of shallow water tables. We assume this was done. In any case, it is easy to do in MODFLOW by adding in an ET surface corresponding to ground surface with general groundwater ET extinction point rules. We assume there is a comparable simple way to do this in GSFLOW. This needs to be reported as part of the water budgets (Figures 60-61). This would be in addition to the analysis mentioned on page 141, which we don't fully understand – given groundwater ET changes as a function of WLs, how could it be calculated ahead of time and then used as input? We realize we may misunderstand this. Clarification in the text would be very useful.	TC-019
2	138	2.2.3	2521-2531	It appears that you deem domestic and public pumping to be inconsequential. We do not necessarily disagree, but an estimate of these values needs to be provided to substantiate this position.	TC-020
2	141	2.2.3.1	2603-2609	It is important that the GSFLOW model be used to calculate groundwater ET because the water table fluctuates through time due to changing stresses. What is the benefit to calculating this outside the model and then using it as input?	TC-021
2	143	2.2.3.1	Table 15 & 16	Delete one of the "~~within the~~" in each, and in Table 16 we think you mean watershed boundary, not ~~Basin~~ boundary	TC-022
2	144	2.2.3.1	Table 18	Looks like Average and Maximum values are reversed for Agricultural Pumping, or one of the values is erroneous.	TC-023
2	145	2.2.3.4	2695	"Winter rains and winter/spring runoff ~~fill~~recharge the aquifer system between October and April (Figure 23)." Replace ~~fill~~ with recharge. If it filled there wouldn't be many of the issues we are dealing with here.	TC-024
2	146	2.2.3.4	2731-2734	"The response of the groundwater discharge to the stream system will be delayed relative to the timing of the changes in pumping or recharge – by a few days if changes occur within a few tens or hundreds of feet of a stream, by weeks to months if they occur at larger distances from the stream." This statement requires proof. Assuming delay calculations were performed for the local aquifer they should be included somewhere in the document.	TC-025
2	151	2.2.4.2	Figure 67	"Baseline" line should be removed from graph and legend because it is confusing and same color as "Wet"	TC-026

Chapter	Page	Section	Line/Table/ Figure #	Comment	
2	151	2.2.4.2	Figure 67	“Figure 67. Projected flow at the Shasta River near Yreka gage, in difference (cfs) from Baseline, for four future projected climate change scenarios” Perhaps we are mis-understanding what these scenarios are, but are extremely skeptical of any claims that the temperature-driven changes in precipitation form due to climate change (i.e., more rain and less snow) are not going to substantially decrease river flows in summer and fall, regardless of what happens to total annual amount of precipitation. The GSP should acknowledge these realities and then describe how the model predicts that this will seasonally change river flow and groundwater. The format of the graph makes it very difficult to see meaningful seasonal patterns. The y-axis scale that ranges from -2,000 to +12,000 cfs makes it impossible to see what is happening during low flows. Can you add a second panel that to graph so that the low-flow period is legible (maybe -100 to +100 cfs?)? Or maybe limit the months to just show April through October?	TC-027
2	151	2.2.5	2816-2818	Delete “~~Groundwater pumping has not caused significant and unreasonable conditions in the Basin during the last 20 years~~”. The Basin has recognized problems and is a Medium Priority to the State and its why we are doing this SGMA Plan. You can say it’s not in overdraft (continuously declining WLs), but that’s it.	TC-028
2	151	2.2.5	2827	Suggest: “…acre-feet per ~~year minus any future~~ reduction in…” to “…acre-feet per year. It may change in the future due to reduction in…”	TC-029
2	152	2.2.5	2849-2857	It appears you are saying that the sustainable yield is less than the current value of pumping. The sustainable yield needs to be defined as part of this SGMA plan and then used as the management target. As it is currently worded in the document, there is apparently no lower limit to reductions in pumping.	TC-030
3	5	3.2	114-116	The first sustainability goal listed is “Groundwater elevations and groundwater storage do not significantly decline below their historically measured range, protect the existing well infrastructure from outages, protect groundwater-dependent ecosystems, and avoid significant additional stream depletion due to groundwater pumping.” There is not definition of what “significant” means, so we suggest removing that word. Without a definition, isn’t this meaningless? It should probably either be percent (e.g., 1%) or volume?	TC-031
3	5	3.2	123	In “Groundwater will continue to provide river baseflow as interconnected surface water with no ~~significant or unreasonable~~further reduction in volume.” strike “~~significant or unreasonable~~” and replace with “further’. Without a definition, significant is too vague.	TC-032

Chapter	Page	Section	Line/Table/ Figure #	Comment	
3	6-33			We generally agree with sites and parameters proposed in Section 3.3 Monitoring Networks, but we are extremely concerned that funding will not be available to actually implement the monitoring. As described in our comments on Chapter 3, Section 3.3, pages 16-17, Table 1, we also recommend continuous flow monitoring of the springs, and adding two additional springs to the flow monitoring sites: Bridge Field Springs and Black Meadow Springs.	TC-033
3	16-17	3.3	Table 1	From our perspective, monitoring the flow of the springs is the most important. The output of these springs is what sustains aquatic ecosystems and agriculture in the Shasta River. In addition, the ability to predict flow in these springs is the primary endpoint upon which we will judge the performance of the Shasta Watershed Groundwater Model. We need to understand how groundwater elevations and groundwater pumping affect the flow in these springs. The monitoring plan proposes monthly monitoring of the springs, however, this is insufficient given the importance of these springs and the potential insights that high-resolution data could provide into the complex dynamics of Shasta Valley groundwater. At what time scales do the flow of these springs fluctuate (seasonal, weekly, daily, hourly, etc.) and what do these fluctuations appear to correspond with (e.g., Dwinnell reservoir levels, nearby groundwater pumps cycling on/off, flood irrigation, snowmelt, storm events, etc.)? How can we understand this without data? The two largest springs, Big Springs and Little Springs, are especially important. Other critically important springs that need continuous flow monitoring include Bridge Field Springs (on Shasta Springs Ranch, owned by Emmerson), Black Meadow Springs (on Shasta Springs Ranch, owned by Emmerson), Kettle Springs (on Shasta Springs Ranch, owned by Emmerson), and Hole in the Ground Spring. We noticed that Bridge Field Springs and Black Meadow Springs were not included in the monitoring plan. We strongly urge that both these springs be added to the monitoring plan.	TC-034
3	6	3.3	155	"A detailed discussion of potential data gaps, and strategies for resolving them, is included as Appendix 3-A~~Z~~"	TC-035
3	25	3.3.3.1	Table 3	Specific conductivity can readily be obtained at the wellhead using a meter. We suggest taking annually when sampling for nitrate.	TC-036
3	28	3.3.4.1	458-472	Suggest using WLs from "permanent" stilling well in stream and WLs from two nearby adjacent piezometers at different depths to track changes in gradients through time.	TC-037

Chapter	Page	Section	Line/Table/ Figure #	Comment	
3	29	3.3.4.1	Figure 6	Should "gradient near Scott River" be changed to "gradient near Shasta River?" If you did mean this to be for the Scott River, then some discussion should be added to justify using conditions in the Scott Valley for analyses in the Shasta valley. Also, not all information is given in explaining the generation of 70 cfs of baseflow for a single water-level gradient. That gradient would have to apply to some length of the river. Is the baseflow number for the entire basin? And would one water-level gradient explain that number (70 cfs)? Normally the quantity would be given as "cfs per unit length of river," or “cfs for reach X,” where reach X has some defined length.	TC-038
3	29	3.3.4.1	Figure 6 caption	This caption seems to be for a map figure, not for the schematic cross section shown.	TC-039
3	30	3.3.4.1	490-492	The text states “*The goal is to use this approach for the first 5 years of implementation, collect more data, and at the GSP update provide a stream depletion approach based on more reliable results produced by the further calibrated SWGM*.” Two fundamental questions regarding groundwater development in the Shasta Valley are “What effect has past and present groundwater pumping had on surface-water flow in the Shasta River, tributaries, and springs in the Valley?” “What effect will future groundwater pumping have on surface-water resources in the Shasta Valley?” From the stated text, it seems that the Shasta Watershed Groundwater Model (SWGM) will not be used to answer these questions for at least 5 years. If the groundwater part of the model can be used to calculate water budget components as has already been done, why can’t it be used to calculate streamflow depletions? Conversely, if the model can’t be used to reliably calculate streamflow depletions, why can it be used to calculate water-budget components? Using a groundwater model, streamflow depletion from groundwater pumping is always determined using model-calculated water budget components. At this stage of development of the groundwater model, uncertainty in computed streamflow depletion will most likely be in the timing of the depletion, rather than the relative amounts that various surface-water features are affected. In five years, there will still be uncertainty in the timing of depletion, but perhaps that uncertainty will be lower. Nonetheless, a delay of five years in tackling fundamental questions seems to be ignoring the current value of the model. If key calculations were run and re-run as the model was being improved, then the modelers would learn the sensitivity of model results to changes in parameters.	TC-040
3	30	3.3.4.2	502-511	Suggest incorporating the in-stream stilling well and adjacent vertical gradient piezometers as future improvements	TC-041
3	30	3.3.4.2	Table 5	We are confused why the “Shasta River near Yreka (SRY)” is listed in the Table 5 “Future monitoring locations for monitoring” with the Agency listed “NA”? Isn’t that a long-term flow gage that has been operated for decades by the USGS?	TC-042

Chapter	Page	Section	Line/Table/ Figure #	Comment	
3	31	3.3.4.3		"Surface diversions will be entered into the County data management system" Please describe whether or not these data will be publicly accessible. Data collected for demonstrating SGMA compliance should be publicly accessible.	TC-043
3	35	3.4.1.1	607	You appear to use Management Trigger as a formal term, but it is not in Acronym list and is only used here. If used it should be formally defined and listed in Acronyms (would conflict with Minimum Threshold)	TC-068
3	36	3.4.1.2	641-642	Suggest change "the ~~historic low~~" to "the historic smallest depth to groundwater"	TC-044
3	36-37	3.4.1.2-.3	641, Table 6, Fig 8	Why is MT set below historic low? This conflicts with previous statements of trying to reduce GW pumping and maintain or raise WLs (see Section 2.2.5)	TC-045
3	37	3.4.1.3	Table 6	"AT" is not in Acronym list.	TC-046
3	41	3.4.3.1	772-773	It is not at all clear why municipal water users are apparently de minimis. No data have been supplied to support this claim.	TC-047
3	42	3.4.3.2	787-792	"The GSA will not be using a numerical groundwater-surface water model to evaluate ISW at this time. A temporary approach based on baseflow calculation will be used." We strongly suggest using the model in parallel with the planned approach to better understand model behavior recalibration (as you note in 3.4.3.6).	TC-048
3	43	3.4.3.2	Equation, table 7	Some additional explanation would be helpful. First, mention somewhere that change in storage in the reach is assumed to be zero. We suggest changing "SRM is flow out of the USGS maintained SRM gage" to "SRM is flow at USGS maintained Shasta River near Montague (SRM) gage 11517000, located at the downstream end of the reach" A schematic with arrows for various components would help. More importantly, some sort of error analysis should be done to determine uncertainty in groundwater contributions. If an uncertainty can be estimated for each of the components of the water budgets, an analysis can be carried out to determine uncertainty in computed groundwater contributions.	TC-049

Chapter	Page	Section	Line/Table/ Figure #	Comment
3	42-44	3.4.3.2	784-832	A very important factor that does not appear to us to be mentioned in "Information and Methodology Used to Establish Minimum Thresholds and Measurable Objectives" is that there appears to be no accounting for return flows such as tailwater. If much of the irrigation along this reach of the river uses flood irrigation (i.e., in contrast to sprinklers), then isn't there a substantial quantity of tailwater that returns to the river from agricultural fields? If tailwater returns are not accounted for, then "baseflow" could be substantially overestimated in the methods described. While there are some records of tailwater quantities (i.e., from the SVRCD reports), it likely is not possible to estimate these quantities very accurately. But wouldn't it be better to at least make some educated guess about the percent of the diversions that return as tailwater (e.g., perhaps it is in the range of 10-50%) and include that in the calculation, instead of completing ignoring it? You are calling it "Groundwater Contributions" so, it should be your best estimate of groundwater. If you don't apply an adjustment for tailwater, then you should call it something else, like "Groundwater Contributions Plus Tailwater Returns," otherwise it is misleading. We do not have access to the all the reports and data sources cited in the chapter, so perhaps tailwater was indeed already accounted for and we are not aware of it, but from the descriptions provided in the GSP it appears that tailwater was ignored. TC-050
3	43	3.4.3.2	821	We suggest changing "Riparian diverters are not measured" to "Riparian diverters are not measured, despite requirements to measure and report diversions under California Senate Bill 88" TC-051
3	45	3.4.3.4	846	The proposed Minimum Threshold (MT) for Interconnected Surface Water (ISW) is 100 cfs of groundwater contributions, based on a water balance of the Shasta River reach between Dwinnell Dam and the USGS flow gage near Montague. The estimated diversions used in the water balance are highly uncertain and unreliable, derived from private watermaster records. The bounds of uncertainty on these diversion estimates are so large as to make them nearly useless as a decision-making tool. Rather than estimating groundwater contributions based on a highly uncertain water balance (i.e., not the dramatic week to week fluctuations in Table 7), we would much rather have the MT ISW be based on the sum of measured discharges from key individual springs (i.e., Big Springs, Little Springs, Bridge Field Springs, Black Meadow Springs, Kettle Springs, and Hole in the Ground Spring). While these individual springs do not represent the entirety of the groundwater contributions (i.e., there may be some diffuse contributions as well as addition smaller springs), data on the spring flows are required for anyway for management and model calibration, and should provide a more reliable relative metric of groundwater contributions than the water balance. There are not yet much data yet on these spring flows, but measurements need to begin as soon as possible. TC-052

Chapter	Page	Section	Line/Table/ Figure #	Comment	
3	46-47	3.4.3.6	906-913	What other long-term source of water is there for the wells (see Theis, 1940, The Sources of Water Derived from Wells)? It is important to strike "…~~does not allow the development of a reliable estimate of stream depletion due to pumping~~." and replace with something like " …makes current model predictions of location and timing of impacts uncertain."	TC-053
4	14	4.2	304	The "Avoiding Significant Increase of Total Net Groundwater Use from the Basin" PMA does not provide a definition of what "significant" means, so we suggest removing that word. Without a definition, isn't this PMA meaningless? It should probably either be percent (e.g., 1%) or volume? See related comment regarding Chapter 4, page 19, section 4.2, line 505-508.	TC-054
4	14	4.2	326-331	We are unable to understand exactly what the "Avoiding Significant Increase of Total Net Groundwater Use from the Basin" PMA means, especially, this excerpt: "Due to the direct relationship between net groundwater use and ET, implementation of the MA is measured by comparing the most recent five- and ten-year running averages of agricultural and urban ET over both the Basin and watershed, to the maximum value of Basin ET measured in the 2010-2020 period, within the limits of measurement uncertainty." Can it be re-stated more clearly, such as, "The goal of this MA is for X not to exceed Y by Z percent?" Can you provide information on the limits of measurement uncertainty? What is the rationale for using the maximum as the basis for the comparison? Is the purpose of the running averages to smooth out climatic variation (i.e., is ET higher in wet years than dry years)? If there is substantial variation between water year types, then should the goal be different in different water year types? What about the contribution of surface water irrigation to ET? We anticipate that climate change will cause increased reliance on groundwater because surface water flows are going to recede earlier in the irrigation season (due less snowmelt), which could result in ET staying the same but groundwater extraction will increase and flows be lower, all without violating this MA.	TC-055
4	15	4.2	341-343	"To be flexible in adjusting the limit on total net groundwater extraction if and where additional groundwater resources become available due to additional recharge dedicated to later extraction." Groundwater is already over-extracted, and there is not extra water available to use in enhancing recharge. See comments on Chapter 4, Section 4.3, page 30, line 895.	TC-056
4	19	4.2	505-508	"The permitting program would ensure that construction of new extraction wells does not significantly expand current total net groundwater use in the Basin (to the degree that such expansion may cause the occurrence of undesirable results)." How are "undesirable results" defined? Please add a definition or citation here. See related comment regarding Chapter 4, page 14, section 4.2, line 304.	TC-057

Chapter	Page	Section	Line/Table/ Figure #	Comment	
4	19	4.2	513-514	"Here are two illustrative examples of an appropriate use of well replacement…" … "Example 2: Replacement of a 1,000-gpm agricultural well that will be properly decommissioned with a new 2,000-gpm capacity agricultural well is permissible with the explicit condition that the 10-year average total net groundwater extraction within the combined area serviced by the old and the new well does not exceed the average groundwater extraction over the most recent 10-years." Since groundwater use is mostly unmetered (much less publicly accessible), how would this be tracked or enforced?	TC-058
4	23	4.2	659-667	The proposed monitoring of irrigation efficiency omits a key tool– metering of water use. Without metering, how can we know if the efficiency projects are actually working?	TC-059
4	23	4.2	659-667	The proposed monitoring of irrigation efficiency lists "Assessment of the increase in irrigation efficiency, with particular emphasis on assessing the reduction or changes in consumptive water use (evaporation, evapotranspiration) based on equipment specification, scientific literature, or field experiments." Doesn't efficiency usually not affect consumptive water use but instead just change recharge (that's how it is represented in the SVIHM, right?). What is the physical basis for thinking efficiency would affect consumptive use for crops like pasture and alfalfa that have low-lying continuous canopy cover (i.e., in contrast to orchards or row crops like tomatoes where efficient delivery systems like drip irrigation could reduce evaporation from bare soil)?	TC-060
4	25	4.2	668	"Juniper Removal: The GSA, USGS and other agencies and private stakeholders will remove excess juniper within the watershed to improve groundwater levels." While it is conceptually possible to increase water yield for some number of years following juniper removal, it is difficult to actually implement at a watershed scale and maintain it over time. Furthermore, juniper removal will not necessarily increase water yield in all climates, so local conditions should be evaluated (Niemeyer et al. 2017). Such projects should be considered within a holistic management framework that re-establishes historical fire regimes and does not focus solely on water yield. Maintenance would be needed because the benefits of one-time removal projects are likely to be short-lived (Fogarty et al. 2021). References: Fogarty, D. T., de Vries, C., Bielski, C., & Twidwell, D. (2021). Rapid Re-encroachment by Juniperus virginiana After a Single Restoration Treatment. Rangeland Ecology & Management, 78, 112–116. https://doi.org/10.1016/j.rama.2021.06.002. Niemeyer, R. J., Link, T. E., Heinse, R., & Seyfried, M. S. (2017). Climate moderates potential shifts in streamflow from changes in pinyon-juniper woodland cover across the western U.S. Hydrological Processes, 31(20), 3489–3503. https://doi.org/10.1002/hyp.11264	TC-061

Chapter	Page	Section	Line/Table/ Figure #	Comment	
4	30	4.3	895	Given that there is already a dam in place that captures winter runoff from the upper Shasta River watershed, we oppose the Managed Aquifer Recharge (MAR) or In-Lieu Recharge (ILR) PMA. Dwinnell Dam already reduces winter and spring flows enough that there are not sufficient high flows to maintain natural geomorphic processes in the Shasta River. There is no "extra" water in the Shasta River that can be used to recharge groundwater. The way to improve groundwater conditions is demand reduction.	TC-062
4	32	4.3	954	We support the Strategic Groundwater Pumping Curtailment PMA.	TC-063
App 2-E	10			We did not receive this appendix with the model documentation until September 13, so did not have time to review it in detail. Many sections of it appear to only be partially complete. We look forward to reviewing this when it is complete.	TC-064
App 2-I	8			How do the total evapotranspiration of applied water (ETaw) and precipitation (ETpr) values calculated in this report compare with previous estimates such as from CDWR Land and Water Use Estimates (https://water.ca.gov/Programs/Water-Use-And-Efficiency/Land-And-Water-Use/Agricultural-Land-And-Water-Use-Estimates), and/or the remote-sensing based Baldocchi et al. (2019)? Full citation: Baldocchi, D., Dralle, D., Jiang, C., & Ryu, Y. (2019). How Much Water Is Evaporated Across California? A Multiyear Assessment Using a Biophysical Model Forced With Satellite Remote Sensing Data. Water Resources Research, 55(4), 2722–2741. https://doi.org/10.1029/2018WR023884	TC-065
App 3-A	10		Table 2	Why are flow gages not listed in the Table 2 Data Gap Prioritization? Shouldn't measuring the flow rates of the largest springs (i.e., Big Springs, Little Springs, etc.) be the highest priority? We do not understand how it will be possible to calibrate groundwater model without having data for these springs.	TC-066
App 3-A	11		Table 2	The groundwater extraction row of Table 2 says "No strategy has been defined yet to fill this data gap. Only voluntary measures are being considered to gathered extraction data." This is disappointing. How can groundwater be effectively managed without data about how much groundwater is being pumped?	TC-067