



February 28, 2020

Mr. Michael Cooke
Chair West Turlock Subbasin GSA TAC
City of Turlock
156 S. Broadway, Ste. 270
Turlock, CA 95380

Mr. Kevin Kauffman
Chair East Turlock Subbasin GSA TAC
731 East Yosemite Ave, Ste. B
318
Merced CA 95340

SUBJECT: TECHNICAL REVIEW AND COMMENTS ON THE PRELIMINARY DRAFTS OF CHAPTERS 1, 2, AND 4 OF A GROUNDWATER SUSTAINABILITY PLAN FOR THE TURLOCK SUBBASIN

Dear Messrs. Cooke and Kauffman:

We provide the attached comments to the Preliminary Draft Chapters 1, 2, and 4 of the Turlock Subbasin Groundwater Sustainability Plan prepared and released by Todd Groundwater on February 25, 2019. Our understanding is that comments were requested to these early drafts in the January 23, 2020 Joint TAC Meeting. In addition it is our understanding that comments were requested on the information and presentation provided regarding a hydrologic model developed to represent the subbasin; the information came in a spreadsheet [AnnualWaterBudgets(C2VSimTM_v0.1.18).xlsx] and the presentation in a PDF file [20191212_TAC4_TurlockSubbasinCalibration.pdf]. We have reviewed these more technical materials regarding the model and have provided questions to the Todd Groundwater team to consider as they further their work on Water Budget evaluations. In our review here we have tried to look at whether there may be conflicts in the information developed.

There are three attachments to this letter. The first, Attachment A, is a copy of the cover page and table of contents from that early draft that is provided for context of what the overall outline of the document was intended to be at that time. The second, Attachment B, is the cover page to the modeling workshop presentation as a point of reference (the entire file is too large to include). The third, Attachment C, are our technical comments and suggestions to these preliminary draft Chapters/Sections to guide them toward a more ready state for public review.

The chapters were prepared early in the process as we understand it in order to keep in coordination with the adjoining subbasins in condition of Critical Overdraft, the Merced and the Delta Mendota. As a result of that early preparation many additional elements of the Turlock Subbasin GSP have now been developed but some remain to be developed. The most notable element is a series of analyses of groundwater hydraulic head conditions in Water Year 1991. That is the beginning of the GSP Study Period for the Turlock Subbasin. As such it is essential that groundwater evaluations based on data for that period of time be performed. It should also be noted that our work has identified elevation datum



Messrs. Cooke and Kauffman
ETSGSA Review Comments of the 2019
Draft GSP Sections of the Turlock Subbasin GSP
February 29, 2020

errors for wells measured by DWR and others. That will require rechecking the integrity of data to a reasonable extent. Our recommendation would be that the Todd Groundwater team discuss with DWR when they will be updating the Water Data Library to reflect corrections offered by various GSAs to the CASGEM and Water Data Library records.

Our specific comments on items in the drafts are provided in Attachment C.

Please contact me should you have any questions, comments or concerns.

Respectfully,

E-PUR, LLC

John M. Lambie, PG, CEG, PE, CWRE
Principal Geohydrologist

Attachments:

Attachment A - Todd Groundwater Table of Contents from February 25, 2019 Preliminary Draft Sections Document with Acronyms Table

Attachment B - Cover page to December 12, 2019 TAC Technical Workshop No. 4 Presentation Hydrologic Model Development, Calibration, and Preliminary Water Budgets

Attachment C - E-PUR Comments to February 25, 2019 Preliminary Draft Chapters 1, 2, and 4 of the Turlock Subbasin Groundwater Sustainability Plan

cc: Ms. Debbie Liebbersbach, Project Manager of GSP Grant Contracts, Member WTSGSA TAC
Mr. Al Rossini, Chairman ETSGSA Board

ATTACHMENT A
TABLE OF CONTENTS FROM FEBRUARY 25, 2019
PRELIMINARY DRAFT SECTIONS DOCUMENT
WITH ACRONYMS TABLE

**WTSGSA /
ETSGSA LOGO**

PRELIMINARY DRAFT
TURLOCK SUBBASIN
GROUNDWATER
SUSTAINABILITY PLAN
(GSP)

WEST TURLOCK SUBBASIN
GROUNDWATER
SUSTAINABILITY AGENCY

EAST TURLOCK SUBBASIN
GROUNDWATER
SUSTAINABILITY AGENCY

February 25, 2019



2490 Mariner Square Loop, Suite 215
Alameda, CA 94501
510.747.6920
www.toddgroundwater.com

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Appendices

APPENDIX A: Appendix Contents

Acronyms

AWMP	Agricultural Water Management Plan
bgs	Below ground surface
BMP	Best Management Practices
CASGEM	California Ambient Statewide Groundwater Elevation Monitoring Program
CCR	California Code of Regulations
CDFW	California Department of Fish and Wildlife
CIMIS	California Irrigation Management Information System
CSD	Community Services District
CVRWQCB	Regional Water Quality Control Board, Central Valley Region
DMMs	Demand Management Measures
DWR	Department of Water Resources, State of California
DBCP	Dibromochloropropane
DTSC	Department of Toxic Substances Control
ESJWQC	East San Joaquin Water Quality Coalition
ETSGSA	East Turlock Subbasin Groundwater Sustainability Agency
EWD	Eastside Water District
EWMP	Efficient Water Management Practices
FMMP	Farmland Mapping and Monitoring Program
GDE	Groundwater dependent ecosystem
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
GWMP	Groundwater Management Plan
ILRP	Irrigated Lands Regulatory Program
IWMP	Irrigation Water Master Plan
JPA	Joint Powers Agreement
M&I	Municipal & Industrial
MAR	Managed Aquifer Recharge
MID	Merced Irrigation District
NOAA	National Oceanic and Atmospheric Administration
MOU	Memorandum of Understanding

NMP	Nitrogen Management Plan
PCE	Tetrachloroethylene
PEIR	County Programmatic Environmental Impact Report
PRISM	Parameter-elevation Relationships on Independent Slopes Model
RSWSP	Regional Surface Water Supply Project (City of Turlock)
RWQCB	Regional Water Quality Control Board
SCHM	Stanislaus County Hydrologic Model
SGMA	Sustainable Groundwater Management Act
SOI	Sphere of Influence
TAC	Technical Advisory Committee
TCP	Trichloropropane
TDS	Total Dissolved Solids
TGBA	Turlock Groundwater Basin Association
TID	Turlock Irrigation District
USBR	United States Bureau of Reclamation
UWMP	Urban Water Management Plan
WCR	Well Completion Reports (available from DWR)
WDR	Waste Discharge Requirements
WTSGSA	West Turlock Subbasin Groundwater Sustainability Agency

ATTACHMENT B

COVER PAGE TO DECEMBER 12, 2019

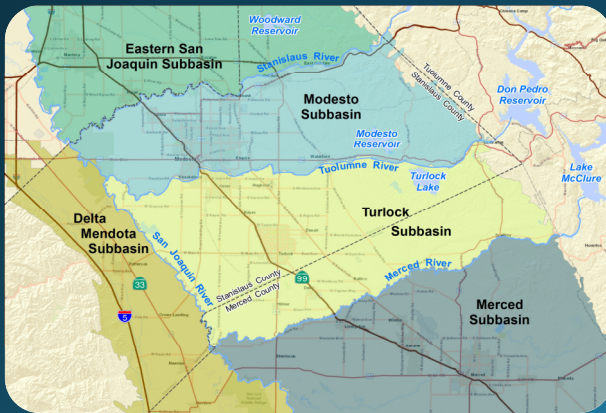
TAC TECHNICAL WORKSHOP NO. 4 PRESENTATION

HYDROLOGIC MODEL DEVELOPMENT, CALIBRATION, AND PRELIMINARY WATER BUDGETS

West Turlock Subbasin Groundwater Sustainability Agency (WTSGSA)
East Turlock Subbasin Groundwater Sustainability Agency (ETSGSA)

Turlock Subbasin Groundwater
Sustainability Plan (GSP)
Technical Workshop No. 4

Joint Technical Advisory
Committees (TACs) Meeting
December 12, 2019



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Agenda

- Background & Model Development
- Evaluation of DRAFT Model Calibration
 - Calibration Statistics- DRAFT
 - Groundwater Levels- DRAFT
 - Stream Hydrographs- DRAFT
- Review of Water Budgets
 - Land & Water Use Budgets- DRAFT
 - Groundwater Budgets- DRAFT

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ATTACHMENT C
E-PUR COMMENTS TO FEBRUARY 25, 2019
PRELIMINARY DRAFT CHAPTERS 1, 2, AND 4
OF THE TURLOCK SUBBASIN GROUNDWATER SUSTAINABILITY PLAN



Comments to February 25, 2019 Preliminary Draft Chapters 1, 2, and 4 of the Turlock Subbasin Groundwater Sustainability Plan

[Clarification to the Acronyms after the Table of Contents.](#)

The PEIR mentioned is the existing Stanislaus County PEIR for New Groundwater Extraction Wells. A new PEIR for the Turlock Subbasin Projects and Management Actions is contemplated and may eventually need to be added.

[References Section](#)

We note that there are a variety of references cited in Section 4 that are not in the preliminary draft References, Chapter 8. Prior to public release some congruity is needed as to how a public reviewer is to accept the information offered in Chapters 1, 2, and 4. It might be suitable to have references provided as a final subsection in each Chapter.

We also note that there are some essential geohydrologic references for the region that have not been noted such as California Department of Water Resources, 1979. "Water Supply and Demand in the Cooperstown and Montpelier Subareas, Eastern Stanislaus and Northern Merced Counties" Memorandum Report, June 20. This particular reference provides a good review of the geology, geohydrology and water budget estimates prior to its publication date of 1979. We will endeavor to convey this and other regional references directly to the GSP consulting team to use as they would.

[Section 2.1 on Agency Boundaries](#)

Figure 2-2 on agency boundaries will need to be updated to incorporate lands annexed into Eastside Water District. In addition it appears that there are areas within TID along the Main Canal in the eastern regions of the Turlock Subbasin that are not depicted accordingly; this produces a discrepancy between Figure 1-1 and Figure 2-2.

[Section 2.2 on Existing Land Use](#)

It may be worthwhile to update Land Use coverages beyond 2014 in future drafts of the GSP. We suggest adding language that the accompanying text, tables and figures may be updated as new information becomes available. As an aside, apart from the text of a public review draft of these chapters of the GSP, we recommend that the respective TACs select a target date or dates for inclusion of various types of data and information to the GSP. Our feeling is that such dates for one of type of information and another should be suggested, discussed, and agreed upon; a good example is land and water use as of the start of the Sustainable Groundwater Management Program (SGMP) for the Turlock Subbasin which is January 1, 2015.

The baseline conditions from which the GSP begins to manage is another subject for discussion at the TAC level prior to completion of Section 2.2.

[Section 2.3 on Water Sources and Use](#)

This section needs to describe and incorporate additional sources of surface water for the Subbasin. There are more surface water sources than are listed in the preliminary draft. Each of the local watersheds in

Comments to February 25, 2019 Preliminary Draft Chapters 1, 2, and 4 of the Turlock Subbasin Groundwater Sustainability Plan

the eastern portion of the Turlock Subbasin are used for surface water storage for agriculture and this is not currently described. The text should be revised to incorporate some of the following facts and discussions regarding local watersheds.

The largest local watershed within the Turlock Subbasin is the Dry Creek of Merced County at roughly 120 square miles (~77,000 acres) which extends into the Sierran uplands above the alluvial basin. Along the Dry Creek there are a variety of surface water impoundment and detention structures that are used principally to meet local land use water demands. Some of these structures also provide for added groundwater recharge; some coincidentally and some intentionally. EWD conducted a successful pilot study of intentional groundwater recharge via the natural stream bed in the Dry Creek in 2017-2018 using Merced ID water as a source of identifiable water due to its lighter signature of the stable isotopes of oxygen and hydrogen than those in local recharge. Projects to increase recharge via the natural streambed have been put into effect and more are likely to be instituted by the ETSGSA. Lastly, it may be useful and helpful to develop an inventory of water rights for the Dry Creek of Merced County given the existing and potential uses of surface water as a source of water to the Subbasin.

Another large local watershed is the area tributary to Rouse Lake, an effectively closed basin with no outlet. The Rouse Lake watershed has over 16 square miles (or 10,400 acres) in drainage to it. Several small impoundments exist on tributary watercourses above Rouse Lake to meet local land use water demands.

Other watersheds of importance are Mustang Creek (13,750 acres to its confluence with TID's Highline Canal), Sand Creek (13,300 acres to its confluence with TID's Main Canal), and Peaslee Creek (5,400 acres). Mustang Creek has two floodwater detention structures to prevent property damage and alleviate flood risks. Peaslee Creek has one or more impoundments within its watershed to control fugitive stormwater that might otherwise damage crops or infrastructure.

[Section 2.3.1 on supplied surface water](#)

This section should provide historic quantities of Merced ID water delivered to the Turlock Subbasin via the Northside Canal.

This subsection should also describe whether there are lands with riparian water rights alongside the Tuolumne River inside the Turlock Subbasin. The same should be discussed for land alongside the Merced River inside the Turlock Subbasin.

The pending development and use of surface water to provide municipal water supply to the City of Turlock could be mentioned here along with the following subsection given the overall context of this subsection and the subsequent discussion of groundwater use.

[Section 2.3.2 on groundwater](#)

Opening paragraph is in need of updating to describe that groundwater extraction estimates are based upon the Turlock edition of the C2VSim FG model rather than the prior SCHM.

The discussion of municipal systems might be updated to also indicate the pending change to City of Turlock's reliance upon groundwater.

Comments to February 25, 2019 Preliminary Draft Chapters 1, 2, and 4 of the Turlock Subbasin Groundwater Sustainability Plan

Further the discussion of the municipal systems use of groundwater could be expanded to indicate their overall reliance on groundwater as a percentage or as to the availability of secondary sources to meet land use demands (e.g. reclaimed water for landscape irrigation).

In the discussion of drought and domestic wells there is an unfortunate use of the term Dry Well and Dry Well Program. That term, dry well, is subsequently used in Section 2.5.4 to describe a form of groundwater recharge well.

[Section 2.6.2 on Well Permitting](#)

Section 2.6.2.2 for Merced County well permitting could be updated to include their new recharge/injection well permitting to protect water quality.¹ It may be advisable to generate this discussion of Merced County UIC permitting into its own subsection (e.g. Section 2.6.2.3) since the UIC focuses on groundwater quality as compared to the water quantity issues addressed by the Export Ordinance that are addressed well in the draft as it is.

[Section 4.1.1 on Regional Geologic and Structural Setting](#)

The discussion would be greatly improved by adding date ranges in terms such as million years ago (Mya) for geologic unit formation or geologic events rather than strictly geologic terms for them such as Cenozoic.

The structural discussion of geology would be enhanced by identifying the regional strike and dip in keeping with the USGS 2015 modeling study (Phillips, S.P., D. Rewis, and J. Traum, 2015. Hydrologic Model of the Modesto Region, California, 1960–2004. USGS Scientific Investigations Report 2015–5045). The structural orientation of the semi-consolidated formations has the strike northwest to southeast at an angle of roughly 37 degrees west of north (i.e. N37W). The dip is of course perpendicular to the strike (i.e. N 127W). The literature also describes that the angle of structural and stratigraphic dip decreases to the southwest from a high of 3 degrees in the uplifted semi-consolidated deposits of the Mehrten to lone sequence in the east, to a low of 1 degree near and beneath the City of Modesto. The land surface slope is typically about 0.5 degrees lower than the structural slope; as a result of this difference between land surface slope versus the depositional/structural slope, the geologic formations form a wedge-shaped geometry that increases in thickness to the west.

The normal faulting in the region is “reverse normal” faulting as depicted on Figures 4-18 and 4-21a. The text should describe it that way as it affects the geohydrology.

[Section 4.1.2.1 on Climate](#)

The discussion and figures are displaying different data in Figure 4-2 than is being discussed and described for the groundwater model and water budget evaluations. Care should be taken to bring these presentations to a common understanding (for example 11.5 inches per year on Slide 25 from 12/12/19 vs. the 12.0 in the text here and on Figure 4-2)

¹ RECHARGE/INJECTION WELL CONSTRUCTION AND DESTRUCTION APPLICATION/PERMIT MERCED COUNTY CODE, CHAPTER 9.28 AND 9.27

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In Section 4.1.2.1 it appears that the discussion of climate would be enhanced by incorporating the figures from the 12/12/19 Technical Workshop #4 presentation at Slides 19-25. Those figures depict and analyze the 96-year period and a variety of sub-periods for their statistical descriptors. The 27 years described on Figure 4-2 and discussed in the preliminary draft appear insufficient for a discussion of climate. We would recommend adding to the text here some of the sources and foundation for those figures. Having these figures for a basis will be essential to the subsequent discussions of Study Period and Water Budget analyses.

An additional comment is that there is a great deal of discussion in the document about a “Study Period” ahead of Section 4.3.1 where the “Study Period” is to be described in context based on the data. We would recommend adding a discussion around the GSP regulations that require this “Study Period” much further forward in the document than Section 4.3. The text here in Section 4.1.2.1 could then be more technical in nature and set up a discussion of Study Period selection in Section 4.3..1 rather than here. This would allow a climate data review to be made and discussed in context.

Section 4.1.2.2 on Topography

The text states that ground surface elevation dips to the west. However, a southwest bearing for the land surface dip describes the overall dip slope of the land surface much better. This text should be revised. Our analysis of the overall subbasin topography shows the dip of the land surface is West 37 degrees South (i.e., W37S). This explains the drainage of the Dry Creek toward the Merced River for example. This is important in the context of groundwater flow as numerous peer-reviewed studies and texts indicate the general matching of groundwater hydraulic heads with land surface contours. The text should be revised to something generally accurate whether it is this precise compass bearing or not.

Section 4.1.4 on Principal Aquifers

The text and concepts here are generally fine and allow room for subsequent evaluation of how best to evaluate, understand and manage aquifer conditions.

One notable confusing element for our reviewers is the description of the Eastern Principal Aquifer. Our understanding is that the Eastern Principal Aquifer begins at the eastern edge of the Corcoran Clay extents. Section 4.2.5.2 at page 4-28 is the clearest statement of this interpretation in the GSP and should be repeated here within Section 4.1.4. The text describing the generalities of the lateral and vertical character of the three Principal Aquifers at the top of page 4-9 should be revised to make that plain. Additionally on this subject of clarity in communicating and analyzing via the Principal Aquifers, on Figure 4-21a the current placement of the words “Eastern Principal Aquifer” and the associated bi-directional arrow provide the reader the mistaken impression that this Principal Aquifer is defined as beginning east of the GSA boundary. This is not what is described in the text with its discussion of saturation in units such as the Modesto and Riverbank. Those two relatively shallow formations are not saturated within the ETSGSA (the Riverbank outcrops in the ETSGSA but it is not saturated); the Riverbank Formation at least is saturated in the eastern portion of the area of the WTSGSA. The figure must be revised and/or the text if in the GSP consulting teams view the Modesto Formation does not become saturated or cannot become saturated in the Eastern Principal Aquifer owing to its presence at land surface and its mapped thickness of tens of feet vertically.

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Further Figure 4-21a deserves further clarification of two or more features via a Legend or via callouts directly within the figure. Specifically, in the figure there is an apparent groundwater-table line that is very helpful for an evaluation of conditions among Principal Aquifers. However, it has no date assigned to it nor designation of what it is based upon (It should be based upon hydraulic head values for wells screened at or near the phreatic surface in the aquifer). This information could be presented in a Legend or in a callout. Again specifically there are numbers above the land surface that are affixed to data locations in the subsurface but the numbers are not identified via a Legend or a general callout as to what they are. We would recommend a Legend but leave that to the GSP consultants to decide how best to identify what that information is and thereby where the data are taken from.

On page 4-9 there is a discussion that the Valley Springs and Lone Formations are consolidated. Like the Mehrten they are semi-consolidated not consolidated. This is an important distinction in relation to their geohydrologic connection to the overlying Mehrten and their prospective value as water bearing units that contribute to the fresh water supply in the Subbasin even if the units themselves do not produce large flow rates to a well. A good description of their geologic and geohydrologic properties can be found in California Department of Water Resources, 1979. "Water Supply and Demand in the Cooperstown and Montpelier Subareas, Eastern Stanislaus and Northern Merced Counties" Memorandum Report, June 20. Furthermore there are one or more places in the text where the Lone Formation is described as a marine sedimentary unit. The Lone Formation's type section and depositional framework are very well described by the USGS (<https://pubs.usgs.gov/of/2006/1378/>). The Lone Formation is principally a non-marine sedimentary deposit occurring near a moving ancestral shoreline of an inland sea many millions of years ago as it was being deposited from erosion of the younger Sierra Nevada uplands. The Lone in places is a used and useful water supply aquifer unit; notably it was not regarded that way by the DWR locally in 1979 but that does not render it inconsequential to the fresh water resources of the Turlock Subbasin. The discussions regarding the three semi-consolidated sedimentary formations beneath the Turlock Subbasin could be revised.

In this same discussion at the middle of page 4-9 there is a recommendation that "all" formations of the Eastern Principal Aquifer be managed collectively. There is also a helpful and critical statement that this can be adjusted in the future if data indicate that they be better managed with added subdivisions. This is excellent as it provides for both testing of the conceptual model and adaptive management. However, we recommend inclusion of a description of which formations constitute the "all". It appears from Figure 4-21a that the Eastern Principal Aquifer currently consists of the unconsolidated Turlock Lake Formation, and the semi-consolidated Mehrten, Valley Springs, and Lone Formations; the Modesto and Riverbank Formations do not appear to be saturated at Cross Section B-B'. But it may be that sustainable groundwater management may see one or both of those formations become saturated; conversely sustainable groundwater management analysis and planning may recommend that those or other formations be isolated in a subdividing of the conceptualized Eastern Principal Aquifer. Thus we recommend expansion of the text here to describe what is meant by the term "all".

Section 4.1.4.3 on Hydrogeologic Framework

Figures 4-14, 4-17, and 4-21a for Cross Sections along A1-A4 are difficult to understand. They may be revised for the sake of clarity. Where the three figures overlap they express things very differently as to

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faults. There is no fault or discussion of such on Figure 4-14, A1-A3 but the discussion on page 4-19 describes the importance of faults. Figure 4-17, A2-A4 depicts a significant known fault between A2 and A3 where Figure 4-14 does not. This fault location should be applied in the area of overlap on Figure 4-14 for A1-A3. This has been done for Figure 4-21a, A1-A4 and should be depicted on Figure 4-14 as well.

The text at page 4-19 needs several corrections. The text calls out as cross section A1-A4 but the figure is entitled A-A'. The text states the dip of the geologic strata and formations as westerly but like the topography the structural dip slope is southwesterly at roughly W37S. This text should be revised to state the regional orientation of geologic formations since their orientation governs a great deal of the movement of water along permeable sediment beds.

[Section 4.1.4.4 on Aquifer Properties](#)

The discussions text here on aquifer properties is in need of revision. It should include a review and discussion of Phillips, S.P., D. Rewis, and J. Traum, 2015. Hydrologic Model of the Modesto Region, California, 1960–2004. USGS Scientific Investigations Report 2015–5045. This USGS report is among the most precise geohydrologic information available for the Turlock Subbasin, and it is from a peer-reviewed authoritative source. The current text discussion provided on aquifers and their respective transmissivity appears to be too limited given the variety of information and sources available via Phillips et al.

In addition in this subsection it is very difficult to distinguish the discussion around the three Principal Aquifers. For example it is often difficult to tell if the discussion of the Mehrten Formation is being used to describe the Eastern Principal Aquifer. The text should be edited for clarity.

This subsection must be revised to include a discussion of aquifer water storage properties. The aquifer hydraulic properties of porosity, specific yield, specific storage and overall storage coefficients should be reviewed and incorporated to a revised text. It would be useful if this revised section provided water storage characteristics apart from the Turlock Subbasin model such as those from the Central Valley Hydrologic Model, the MERSTAN Model, or other literature sources such as the DWR integration method for specific yield described in their 1979 study of this region.

[Section 4.2 on Groundwater Conditions](#)

It would be helpful to initiate this discussion of conditions assessment as to how they will or will not relate to the three Principal Aquifers defined in Sections 4.1. This has been done in Subsection 4.2.5.2 and that same type of context is needed here in the introduction

[Section 4.2.2 on Water Level Trends](#)

We recommend that the evaluation of water level trends for wells be revised. The evaluation of well groups should be connected to an analysis of groundwater levels and trends in the three Principal Aquifers. This has been done in Section 4.2.5.2 on groundwater quality and should also be done here regarding hydraulic head conditions.

Figure 4-23 could begin this evaluation by depicting which wells are representative of which aquifer; however, based on the subsequent absence of construction data for some of these representative hydrographs, some of the wells on Figure 4-23 may need to be substituted for another. Figure 4-23 would

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also be improved by removing the intra basin GSA boundary line and instead describing the Western Principal Aquifers region and the Eastern Principal Aquifer region.

Figures 4-24 to 4-27 appear to be in need of revision for clarity. The boundary for the Corcoran Clay that appears to define the aquifers regions distinction should be on each. The GSA boundary line certainly could stay but may only confuse the designations of Principal Aquifers laterally...

Figure 4-24 could be revised to include only wells in the Western Upper Principal Aquifer by removing Well 3 and placing it on another figure that evaluates the water level trends in the Western Lower Principal Aquifer. The shallow wells on the figure provide a different perspective on shallow groundwater conditions both as to trend and absolute groundwater elevations. Well 3 detracts from that analysis as it behaves very differently.

We recommend that use of well hydrographs be limited to those wells for which construction information can be located. On Figure 4-25 there are well hydrographs with no apparent depth of completion (Wells 7 and 8); these well hydrographs should be replaced with wells with known construction. Also wells with semi-continuous hydrographs up to and thru the start of the SGMP should be used; Wells 7 and 8 on Figure 4-25 appear to have been discontinued as measurement locations.

On Figures 4-26 and 4-27 there are well hydrographs with no construction (12, 13, 14, 15, 16, and 17). E-PUR either has these records for construction or can suggest nearby wells with hydrographs that have known construction.

Additional figures and hydrographs may be helpful to understanding past and present groundwater conditions. For example evaluation of Water Level Trends in relation to surface water bodies may be useful in assessing patterns over time and in relation to groundwater surface-water interaction. Alignments of well evaluation groups and hydrographs from among those already identified and perhaps a few more along the three major rivers would provide that opportunity for analysis of what has and is happening as described by data. We recommend revising and augmenting each of Figures 4-24 to 4-27.

[Section 4.2.3.1 on Groundwater Elevation Contour Maps](#)

The groundwater elevation contour maps in the preliminary draft do not attempt to identify wells by their attribution to a Principal Aquifer. Groundwater elevation contour maps need to be able to describe how hydraulic heads are being compared as between the three Principal Aquifers. We recommend preparation of maps that can provide such evaluation.

If wells have unknown depths then it is best that they not be used in any of the analyses. Particular consideration must be given to whether a well intersects the phreatic surface of water in the aquifer given the importance of specific yield over specific storage in an unconfined vs. a confined aquifer. Long well screens are fine in our experience as long as the uppermost interval of the aquifer that is screened is known; this identifies whether the well exhibits unconfined or confined storage characteristics. This is true regardless of whether a well is located in the Western Upper Principal Aquifer or the Eastern Principal Aquifer where well depth is less the determinant. This vetting of the quality of well water level data may cause many data points laterally to be taken out of the process of contouring hydraulic heads; however,

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it is better that there are fewer data points to develop contours from than to accept water level data from wells of unknown construction. This is especially relevant to the Western Principal Aquifer area where the hydraulic distinctions of aquifer recharge and discharge with riverine boundaries is more subtle than in the Eastern Principal Aquifer area where it is not subtle.

Groundwater hydraulic head contour maps are needed between Principal Aquifer groups to be able to describe with data what the area wide changes in hydraulic head are. Furthermore it is likely that two or more contour maps are necessary for each period to assess groundwater heads. Creating new figures that identify wells by Principal Aquifer and then provide hydraulic head contours laterally across the region and those wells in different aquifers will aid identify relationships and assessing the hydrogeologic conceptual model. We recommend creating one series of maps that contour across unconfined to semi-confined conditions laterally as these may best reflect the change in groundwater in storage. Additionally the GSP could develop and present confined condition maps by utilizing Western Lower Principal Aquifer wells with known deeper top-of-screen interval wells in the Eastern Principal Aquifer. This series of maps could provide a great deal of insight regarding groundwater flow and inter area evaluations. A groundwater model predicated on a relatively simplistic mathematical framework cannot address these questions and issues that are vital to Subbasin sustainable groundwater management. The model is a Water Budgets tool; it cannot accurately backcast or forecast hydraulic heads and it cannot identify inter-well issues such as fault obstructions to flow. The groundwater contour maps described here can enable such an evaluation.

In addition to the types of groundwater elevation contour maps, new groundwater elevation contour maps by time interval are needed. It is essential that the beginning of the Study Period and the end of the Study Period are contoured using an appropriate method of inter-well regional comparisons via posting and contouring.

For vertical head comparisons, a sequence of areal maps that compares the difference between groundwater-elevation contours above and below the Corcoran Clay will produce what is an isopach map. Those should be created, presented and evaluated with the TAC as to the potential magnitude of vertical flow and the potential regional differences in the interconnectedness of shallow and deep well hydraulic heads and their significance regionally. Then subsequently, contouring the calculated difference between these temporal isopach maps should be done to assess what changes are occurring in vertical flow over time. This secondary analysis derived from actual hydraulic head data at different times as a set of isocontours themselves is necessary at the beginning of the Study Period and at the end of the Study Period. More work is needed here to be able to describe the Subbasin and to test the conceptual model of water movement in the Subbasin.

The nature of the discussion on page 4-23 in regard to groundwater potentially moving this way or that way based on relative hydraulic heads recommends if not requires, that directional flow arrows be added to the groundwater elevation contour figures. The intent of the text is to describe lateral and vertical flow and the graphics should support that.

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The current depictions of Spring 2017 and Spring 1998 groundwater hydraulic heads could be revised to a Principal-Aquifers-based analysis or they could be dropped altogether. They are not essential figures. That is not to say they are irrelevant or should not be included, but to the extent time or budget factors become an issue for the GSP team to revise them to something useful, then they could instead be dropped. However, their presence as alternate time periods of analysis than the Study Period in this early draft of GSP Chapters does beget the question of what the last time period of data records is going to be that the GSP intends to stop on and begin to plan from. Will groundwater elevation data from the Spring of 2020 (seasonal high condition per the GSP regulations) constitute the final assessment period of real data being used to support the GSP filing? Or some other seasonal high period such as Spring 2017?

The placeholder in grey highlighted text in the preliminary draft at page 4-24 for groundwater flow along the river boundaries is worth commenting upon now. In addition to the indicated and then pending evaluation of what the Turlock Subbasin hydrologic groundwater model suggests for surface water groundwater interaction, the evaluation on the subject of groundwater surface-water interaction should also incorporate an analysis using well groups along riverine boundaries as mentioned earlier. For examples hydrograph Wells 1, 2, and 4 align along the San Joaquin River area in the Western Upper Principal Aquifer. The nature of their responses through drought periods and non-drought periods and the differences in the magnitude and way these wells respond near the rivers may provide more substantive information about actual surface water groundwater interaction and the direction and magnitude of groundwater movement in different areas than the Water Budget model; we say this despite the models relatively well constrained framework for conditions near the three major rivers surrounding the Subbasin. Both evaluations are needed for what is an essential component to groundwater management. The Turlock Subbasin model forecasts that millions of acre-feet of groundwater exit the Western Upper Principal Aquifer over the Study Period and it is essential that this be tested by analysis of the actual data. This is a case where the water budget predictions in the model need to be supported by the inter-well comparison of real data given the poor overall hydraulic head matching that a regional groundwater model can forecast. It perhaps should be noted that the MERSTAN model (Phillips et al., 2015, USGS Scientific Investigations Report 2015–5045) produced extremely precise backcasts of groundwater surface water interaction for the Tuolumne and Merced Rivers and might be evaluated here as well on page 4-24.

[Section 4.2.4 on Changes in Groundwater in Storage](#)

This section also contains a placeholder awaiting the Turlock Subbasin model assessment. An analysis from comparative groundwater elevation contours is likely to provide a more accurate assessment of changes in groundwater storage. This is how the DWR generated storage change estimates for decadal periods in 1979 for the ETSGSA area. It is a method that was used in the Kings River Basin for the Kings East GSP.

The GSP regulations on evaluations of groundwater in storage read, §354.18(b) The water budget shall quantify the following, either through direct measurements or estimates based on data: (4) The change in the annual volume of groundwater in storage between seasonal high conditions. Data measurements will be made each year. Will a revised model run be made each year to develop an estimate or will the

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data be used? These are valuable questions to begin to address by the way in which the data underlying the GSP is developed into information that informs.

[Section 4.2.5.3.8 on 1,2,3 TCP](#)

The text states that 1,2,3 TCP (TCP) was used as a cleaning and degreasing solvent. While that may be true TCP it would be better to describe TCP as being used for both industrial and agricultural purposes. We concur with the description of its widespread presence laterally and vertically in both urban and rural areas.

[Section 4.2.8 on Groundwater Dependent Ecosystems](#)

It appears the discussion is incomplete and the analysis is not yet finished. It is not clear when or how this section will be made ready for a public review draft. We recommend that the analysis be completed to the extent necessary to release it for public review as this may be a topic of particular interest to non-governmental organizations.

[Section 4.3 Water Budgets](#)

It is our understanding that this Section may become its own Chapter. This would enable Chapter 4 to be developed to a Public Review Draft without it.

[Section 4.4 Management Areas](#)

This section appears to be a placeholder for the GSP to address the topic. It does not appear that this will soon be ready for a public review draft. Perhaps Section 4.4 could be placed into another Chapter consistent with the preceding discussion of Water Budgets. Proceeding in this way could enable a major portion of the early framework of the GSP to be made ready for public review without Sections 4.3 and 4.4.