CV SALTS
Central Valley Salinity Alternatives for Long-term Sustainability

CVSC
Central Valley Salinity Coalition Inc.

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Via Hand Delivery and Electronic Mail

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SUBJECT: CV-SALTS Technical Advisory Committee Responses to the Central Valley Regional Water Quality Control Board Upstream Salinity Total Maximum Daily Load Questions

Dear Ms. Montgomery and Mr. Simi;

The CV-SALTS Technical Advisory Committee (TAC) agreed at the June 17, 2009 meeting to provide you with formal technical comments to three questions you presented at the May 13, 2009 TAC. We appreciate the opportunity to work with you in developing a process for future project review by the CV-SALTS TAC that will provide substantive, timely technical information, and understanding of where those projects interact with the development of a Central Valley Salinity and Nitrate Management Plan.

On May 13th you made a presentation to the TAC on modeling tools that may be used to help the Regional Board establish site-specific salinity and boron water quality objectives in the lower San Joaquin River and Total Maximum Daily Loads (TMDLs) to implement those objectives. You submitted the following three questions to the TAC with the goal of receiving immediate feedback on the models initially identified (WARMF and CalSim II) and suggestions of other models that may need to be considered for this portion of your project:

1. Do any other models include the combination of land use and water quality features included in WARMF for the SJR watershed?

2. Do any models besides CalSim II represent California's water system accurately enough to be considered for use in this project?

3. Are 1-D flow models sufficient to represent the San Joaquin River system for the purposes of this project?

The TAC discussed that selection of appropriate models includes evaluating modeling objectives, model availability, computing requirements, technical expertise required, accuracy, applicability to the basin planning process, and pre/post processing features. A combination of models may be required to accurately represent the system where no single model is available to adequately evaluate the achievability of proposed water quality objectives. The TAC also requested further information on the Regional Board's use of models. Jay Simi provided the following response on the model uses.

> *Regional Board staff envisions a tiered modeling process with a 'system-level' model simulating reservoir operations and water supply with output being fed to a watershed level model to simulate water quality conditions at potential compliance locations on the lower San Joaquin River. Staff feels this tiered structure will allow for effective simulation of a full range of hydrology in the basin while also offering insight into the water quality impacts of proposed objectives at specific locations.*

General Comments

It is important to be clear on what problem the model is being applied to and why. A model should be employed that captures the scale and the timing of the processes that most strongly influence the problem. In some cases, a simple spreadsheet model is perfectly adequate. The TAC strongly encourages the Regional Board to consider the nature of the constituent of concern, the temporal and physical scale of its interactions with surface and ground waters, and the temporal and physical scale that the Regional Board intends to regulate for the constituent. These considerations will assist the Regional Board in identifying and applying appropriate modeling tools. Because the TAC did not receive this type of information, it can only inform the Regional Board in a more general way.

Another suggestion is to consider a simple loading analysis of current conditions based on the existing TMDL for salinity and boron at Vernalis. The resulting upstream water quality of the application of the existing load allocations would ensure that the Regional Board is not undertaking a duplicative effort, and could provide insight into modeling needs. For example, the existing TMDL treats groundwater as a static quantity and quality annually and a loading analysis could inform you as to whether this assumption is still appropriate.

Finally, it is generally believed that groundwater plays an important role in salinity in the San Joaquin River and in the management of salinity, but there is still much technical work being done to fully understand this role – especially on a temporal scale. These comments are made in light of this important fact.

1. **Do any other models include the combination of land use and water quality features included in WARMF for the SJR watershed?**

CV-SALTS has recently selected Larry Walker Associates for its Salt and Nitrate Source Work Plan and Pilot Study. Larry Walker Associates is employing the WARMF model for this work. The significant advantages of WARMF in this situation are its past employment in two of the pilot study areas and its ability to model processes significant to nitrate. In areas where surface water is not dominant it may not be the model of choice. WARMF has only sparse presence in the scientific literature (4 citations for “WARMF” in the scientific database Web of Science).

The Regional Board used the DWRSIM and SJRIO models to develop the TMDL for the salinity and boron objectives at TMDL. WARMF is a descendent of these models and contains the same data set, inputs and assumptions and is a natural replacement for SJRIO.

Need for WARMF

The WARMF model focuses on the influence of land use features on water quality. Land use features can be significant for constituents that undergo significant physical, chemical, or biological transformations in the environment or for situations where one is seeking to identify localized effects. These do not generally apply to salinity in the San Joaquin River, which can be evaluated with a more simplified mass balance approach. For the development of Upstream Salinity Objectives, model development and use should focus on surface water discharges and groundwater accretions into the river, and not on localized groundwater under different cropping or land use practices.

The WARMF Model is data intensive and includes rainfall, cropping patterns, irrigation practices, fertilization, waste-water reuse and industrial-like activities such as confined animal production and food processing. The Regional Board should evaluate whether any of these factors are controlling in meeting surface water quality objectives for salinity in surface water of the San Joaquin River before employing the WARMF model. In the San Joaquin River Basin, the controlling factor for salinity management in surface water is the concentration and timing of discharges, of both good and poor quality water, as well as groundwater accretions to the river. Land use and other factors may influence groundwater in certain areas and need to be considered in developing a groundwater strategy but they are not that important for developing a surface water management program. This is because it generally takes decades for the effects of present day land use practices to be seen in groundwater accretions to the river.

This said, groundwater is a strong influence on the quality of the river in certain reaches but the quality of the groundwater that is having this influence was established decades ago and present land use and waste disposal practices have little influence on groundwater quality in the vicinity of the river and on present water quality in the river. Because of this, a hydrologic model such as CalSim II, for which the quality of present-day groundwater accretions is time invariant, may be adequate for your purposes. Existing groundwater models that provide information on stream-aquifer fluxes will continue to provide utility to estimate the sensitivity of groundwater accretions to future climate and long-term drought sequences.

Other Surface Water Quality Models and Groundwater Simulation Models

Other surface water quality models were mentioned in the TAC discussions. The United States Geological Survey (USGS) is completing a Central Valley Groundwater Hydrologic Model (Claudia Faunt and Randy Hanson at the USGS, San Diego). The USGS model is a groundwater and surface water flow model with a land-use based preprocessor (MODFLOW FARM package) that estimates aquifer recharge based on agricultural cropping practices. The model does not include water quality. Another watershed and water quality model is the USDA Soil and Water Assessment Tool (SWAT). Similar to WARMF, the model accounts for watershed processes including climate, weather, atmospheric conditions, precipitation, runoff, evapotranspiration, soil water, and groundwater; water quality processes including fate, transport, and transformation/reaction of nitrogen, phosphorus, pesticides, bacteria, sediment; erosion processes; and main channel processes (flood routing). SWAT represents groundwater as a storage unit within the (sub-)watershed with recharge, pumping, water level changes, and groundwater-stream-discharge accounted for in its water and solute mass balance. However, it is not a multi-dimensional groundwater flow model. Dr. Minghua Zhang (mhzhang@ucdavis.edu), UC Davis, has developed a San Joaquin River SWAT model as well as a Sacramento River SWAT model to estimate pesticide loading and temporal water quality dynamics in the watershed (Y. Luo, X.

Zhang, X. Liu, D. Ficklin and M. Zhang, 2008). Dynamic modeling of organophosphate pesticide load in surface water in the northern San Joaquin Valley watershed of California has also been performed to evaluate the impact of best management practices for pesticide use, and to model impacts of climate change on water quality (Environ. Pollut. 156, pp. 1171–1181). The San Joaquin SWAT model was calibrated using stream flow and nitrogen data. Details can be found at http://www.brc.tamus.edu/swat/. The SWAT model has been extensively used and documented in the scientific literature (a search of Web of Science database yielded several hundred articles related to "SWAT and WATER").

A detailed land use simulator is available for various IWFM applications in the San Joaquin Basin. Three models C2VSIM (Dr. Dogrul, DWR), WESTSIM (Dr. Quinn, LBNL) and MERCEDSIM (Dr. Quinn, LBNL) use the land use simulator – which develops land-use based estimates of surface water hydrology including precipitation, ET, aquifer recharge and return flow for a 30 year time period. This land use simulator is somewhat more mature than the USGS MODFLOW FARM package and currently simulates typical irrigation hydrology for 17 proxy agricultural crops. In WESTSIM and MERCEDSIM the unit of analysis is the individual water district. Larger west-side water districts such as Westlands Water District and the Central California Irrigation District are divided into a number of sub-areas based on management areas recognized by each water district. This helps to provide more realistic recharge estimates and will have utility for developing accurate salt balances at a water district scale. C2VSIM is a regional surface-groundwater model application to the entire Central Valley that has been developed by the California Dept. of Water Resources. WESTSIM is a Bureau of Reclamation application that simulates the surface and groundwater hydrology of the west-side of the San Joaquin Valley between Tracy and Kettleman City. MERCEDSIM is a Lawrence Berkeley National Laboratory application that simulates the hydrology of east and west-side Merced County. None of the IWFM model applications currently include water quality. These groundwater – surface water flow models could be used with a simple advective transport and salt load accounting model to make estimates of .salt balance at a later date.

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2. Do any models besides CalSim II represent California's water system accurately enough to be considered for use in this project?

CalSim II currently provides a good representation of surface water system management in the San Joaquin Basin. CalSim III is still under development, but is expected to improve upon temporal resolution of CALSIM II – since it is more of an operations model and runs on a daily timestep as opposed to the more typical monthly timestep for CalSim II– which is, primarily, a water allocation model. These models are a rather coarse aggregation of the basin, but also take into account many constraints that dictate the allocation of water in the Basin and reservoir operating rules that govern water release from dams along each of the major tributaries.

While the groundwater component of CalSim II is not strong, it is based outputs from more rigorous groundwater models - CALSIM-II derives most groundwater accretions from C2VSIM and utilizes the nodal connectivity of WESTSIM for resolving drainage return flow paths to the San Joaquin River. The TAC recommends that the Regional Board familiarize themselves with recent USGS field and model simulation studies by Charlie Kratzer (USGS) and Randy Dahlgren (UC Davis) to develop a more complete understanding of groundwater accretions along the main stem of the San Joaquin River. If resources are available, groundwater models such as WESTSIM

or MERCEDSIM could be employed as a check on water balances. The TAC is also available to participate in such discussions.

The other advantage of using CalSim II is that the State Water Resources Control Board (State Board) is using it for their review of the South Delta flow and salinity standards. Employment of similar assumptions will allow the Regional Board to compare their results or adapt their analysis to the work of the State Board.

3. Are 1-D models sufficient to represent the San Joaquin River system for the purposes of this project?

Yes, 1-D mass balance models are perfectly adequate to represent the San Joaquin River system for the purposes of this project. This is especially true when considering the nature of the constituent being regulated.

Depending on the actual detail and reliability needed for the project a 1 D tool could be used. The initial modeling effort should be on an input and output models to define the relative importance of each of the salt inputs to the River. The focus should not be on developing a complex model involving chemical changes as salt can be considered initially as conservative. The main emphasis at first should be on developing a model that can give us the relative importance of each of the variables that control river flow and quality. The Salt and Boron TMDL gave us the relative importance of the river inputs and we should be prepared to model these under different scenarios to see how well the river responds to management and the need for additional monitoring. The TAC may be able to provide additional recommendations based on the specific sensitivity of the various inputs.

Conclusion

In conclusion we hope you find these comments and recommendations useful in developing the Upstream Vernalis TMDL, and look forward to continuing to coordinate closely through the development of that TMDL and the development of a Central Valley Salinity and Nitrate Management Plan.

Sincerely,

Nigel Quinn
Chair, Technical Advisory Committee
CV-SALTS

Mona Shulman
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