

April 11, 2014

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Non-15 Permitting
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SUBJECT: CENTRAL VALLEY SALINITY ALTERNATIVES FOR LONG-TERM SUSTAINABILITY (CV-SALTS) TECHNICAL ADVISORY COMMITTEE RECOMMENDATIONS REGARDING THE CITY OF DIXON'S SITE SPECIFIC BORON STUDY AND ADDENDUM (ORDER NO. R5-2008-0136)

Dear Ms. Olson,

On September 12, 2013, the CV-SALTS Technical Advisory Committee (TAC) reviewed and discussed the *Site-Specific Boron Objective Study Work Plan* (Stantec 2013), as it related to ongoing CV-SALTS evaluations to determine appropriate salinity water quality objectives to protect agricultural supply water. A letter from the TAC, dated October 17, 2013, was submitted to you with a finding that the "TAC agreed that the Work Plan as proposed will achieve the stated objectives of the project" with the provision that "the project proponent provide the technical justification for the proposed annual average in the Study Report." Subsequent to that letter, the City of Dixon submitted a *Site Specific Boron Objective Study* (Stantec 2014a) and a *Site Specific Salinity Objective Study as an Addendum to the Boron Study* (Stantec 2014b). The TAC has reviewed the studies to determine if the objectives of the work plan were met through the completion of the studies. This consistency review follows our general technical comments below. The TAC recommendations are in italics following each general comment and the comments in the work plan consistency review. The general comments are grouped by the two studies and the analysis of the averaging period, which is applicable to both studies. Each set of comments are prioritized in order of importance.

General Comments

Site Specific Boron Objective Study

1. The site-specific objective studies generally attempt to determine the threshold concentrations in soil solution below which the crops would be protected at a 95 percent of yield basis for those crops that comprised more than 5 percent of the land use in the study area. A steady-state salinity model (Rhoades and Merrill, 1976) based on plant uptake was used to determine boron concentrations in soil solution as a function of boron concentrations in irrigation water for various crops under one or more leaching fraction/irrigation scenarios¹. *The salinity model and the results shown in Figure 2 should be explained with greater clarity to improve understanding. Dixon should consider adding a table that illustrates the steps used in the analyses in a sequential manner. Working through a specific example would be helpful. If possible, the model should be included as an electronic addendum to facilitate the review process.*
2. There are a number of assumptions and statements throughout the study that are not supported with sufficient citations from literature or with actual data to allow the reviewer to easily come to the conclusions reached in the report. As an example, the following statement² is made: "Assuming that sunflower yield responds similar to other seed and grain crops, adding 1 mg/L boron to the threshold would reduce yield by less than 5 percent; therefore, a soil solution boron

¹ Figure 2, page 2.6, Stantec 2014a

² Page 2.6 of Stantec 2014a

concentration of 1.75 mg/L is anticipated to be protective of the 95 percent yield for sunflowers.” There are two potential issues with this statement: (i) the assumption that the yield of sunflower response to boron concentration in soil solution is similar to other seed and grain crops is not supported herein by literature, and (ii) the data showing the yield response curve for other seed and grain crops is not presented. *Dixon should support all statements and assumptions in the studies with literature or with data. Note that the physiology of sunflower, a dicot, differs significantly from cereal grains, which are all monocots. The other major dicot seed crop (safflower) is grown in the cool season, whereas sunflower is grown during the warm season. It could thus be argued that these oilseeds and grains are not intuitive models for sunflower.*

3. In Section 2.2, the following statement³ is made, “The most limiting local crops based on sensitivity to boron are wheat, sunflowers, and beans. Beans were not identified as a potential crop in the City’s survey, and the most recent 2003 DWR survey reported that all beans were irrigated with a surface water supply.” During its policy discussions, CV-SALTS has recognized that when interpreting narrative AGR standards, it is essential to focus on areas that actually recharge the water supply being used to irrigate the sensitive crop in question. Beans irrigated with surface water are thus irrelevant to an AGR standard for groundwater. Even if beans were irrigated with groundwater, CV-SALTS has had technical discussions concerning the criteria for deciding which crops to evaluate in this type of analysis. One method is to only evaluate crops that are grown on more than five percent of the study area. A second method is rank-order the crops from those with the greatest land area to least. The total land area would then be summed until 95 percent of the study area is accounted for. Only these relatively common crops would be evaluated. Applying either of these methods to the Dixon area would exclude beans as a crop to be evaluated. *The TAC recommends that the methods discussed by CV-SALTS to determine sensitive crop species be used in this study; in this case, sunflower would be the crop under consideration.*
4. In Section 2.3.4, the following two statements⁴ are made: “This 95 percent threshold for a wheat-bean rotation can be achieved using an irrigation water supply with a boron concentration [of] 1.5 mg/L at both 15 and 25 percent LR. Increasing the irrigation water supply boron concentration to 1.8 mg/L is protective of 95 percent yield of snap beans and wheat rotation at both LR, and weighing all factors this value is proposed as an appropriate site specific objective (SSO) for boron.” Neither beans nor snap beans are crops that are common according to CV-SALTS criteria in the study area. *As discussed in General Comment 3, sunflower should be the sensitive crop analyzed in this study. Note that the proposed numerical, site-specific objective for boron would not be very different.*
5. Table 1⁵ has column headings for the constituents of concern that include “Potable Water,” “Raw Wastewater,” and “Proposed Discharge to Groundwater (annual average).” *Please add footnotes to the table to clarify the meaning of the column headings. Consider renaming the last column to “Estimated Concentrations in WWTF Discharge to Groundwater.” Also consider renaming the table from “Agricultural Use Protection – Constituents of Concern (mg/L)” to “Summary of Average Concentrations of Constituents of Concern inform 20XX to 20YY.”*
6. In the first paragraph of Section 2.3⁶, the following statement is made: “This model calculates the salt concentration in quarter fractions of the root zone, and the linear average of these concentrations is recommended to represent soil salinity under infrequent irrigations.” *Please provide some supporting information that this model is applicable to cropping conditions in the Dixon area. Also include an example regarding “infrequent irrigation” (e.g., weekly). Note that literature supports an exponential uptake profile. Where this condition exists, and a linear uptake model is used for analysis, calculated thresholds will be significantly lower than real thresholds.*

³ Page 2.3 of Stantec 2014a

⁴ Page 2.7 of Stantec 2014a

⁵ Page 1.2 of Stantec 2014a

⁶ Page 2.4 of Stantec 2014a

7. In the second paragraph of Section 2.4⁷, the following statement is made: “If the maximum rate of irrigation (12.3 inches) and maximum irrigation water boron concentration (1.8 mg/L) from the boron buildup modeling were applied to an acre of this soil, and all boron remained in the surface foot of soil, it would take over 11 years to apply 4 lbs of boron and achieve the equilibrium 0.7 mg/L soil solution boron concentration.” *It is not clear what is meant by the “equilibrium 0.7 mg/L soil solution boron concentration” – please clarify. Note that if leaching occurs, all boron would not remain in the surface foot of soil over the 11 year period, because some would be leached. Irrigation with a more concentrated solution over time will bring the system to a new equilibrium in which the solid phase is in equilibrium with the new hydro-chemical regime. Achieving an equilibrium within 11 years makes this irrigation scenario appear to be less than sustainable. Perhaps the underlying assumptions should be re-visited or more clearly explained.*
8. In the second paragraph of Section 3.2⁸, the following statement is made: “The Yolo County Flood Control and Water Conservation District (YCFCWD) reported the long term average boron concentration for its irrigation supply (Cache Creek at the Capay Dam) was 1.7 mg/L and average boron concentrations of groundwater in Yolo County range from 0.6 to 6.6 mg/L (YCFCWD, 2007).” *While the boron concentrations in the irrigation supply and groundwater are similar to concentrations in the Dixon study area, no data are presented that would support the argument that there was not significant yield (greater than 5 percent) reductions due to the presence of boron in irrigation supply at those concentrations. In other words, yield data for Yolo County compared with averages for other crops was not presented. It is recognized that a multitude of other factors affect yield, so drawing conclusions from this line of reasoning may not be tenable. In any case, the existence of high background B concentrations is not evidence that they do not affect crop yield.*

Site Specific Salinity Objective Study as an Addendum to the Boron Study

9. In Section 1.1⁹, the following statements are made: “The major findings of the salinity research were that osmotic stress was the primary cause of crop decline...” and “Generally, annual crops are not susceptible to sodium and chloride toxicity.” However, it is recognized that leaf burn and foliar stress can result from overhead sprinkler irrigation if it is not timed properly. *Please provide background or rationale for developing site-specific objectives for sodium and chloride. Note that crops comprising more than 5 percent of the study area – while affected by osmotic stress (electrical conductivity [EC]) – are not susceptible to sodium or chloride toxicity from root uptake. As an alternative, elevated sodium could be compared to ranges that, at varying levels of EC, can affect soil permeability. The sodium adsorption ratio (SAR) and the EC are the critical parameters for protecting AGR beneficial uses in this study area.*
10. In Section 2.1¹⁰, Table 1 provides salinity threshold and the EC value where there is less than a 95 percent yield reduction. *Please cite the reference(s) for these values. Pursuant to Comment 2, please provide references or supporting data for all assumptions and statements.* Table 1 also lists sodium and chloride concentrations supposedly associated with a less than 95 percent yield reduction for the study area crops. *However, these concentrations may not be directly related to yield reduction, because they were estimated based on ratios of these ions to a threshold EC. The threshold EC was determined in a test designed to evaluate crop yield response to salinity, not sodium or chloride. Calling these derived concentrations of sodium and chloride “objectives” implies that water at a slightly higher concentration would be deleterious to the crops in question, while the method employed does not support this conclusion. The TAC recommends that these concentrations not be reported as proposed objectives. If included in the study, they should be labeled as “concentrations of Na and Cl that would be associated with an EC threshold at the assumed molar ratios of specific ions.” Also please consider reducing the number of significant figures to two and adding “Estimated” to the table title.*

⁷ Page 2.7 of Stantec 2014a

⁸ Page 3.2 of Stantec 2014a

⁹ Page 1.1 of Stantec 2014b

¹⁰ Page 2.1 of Stantec 2014b

Averaging Period

11. The October 17, 2013 CV-SALTS letter states that the “TAC recommended that the project proponent provide the technical justification for the proposed annual average in the Study Report. In addition, the TAC recommends that the project proponent participate in future TAC discussions regarding the averaging periods.” The Site-Specific Boron Objective study states that “there is limited knowledge on boron’s role in plant nutrition as well as on the mechanisms responsible for boron toxicity.¹¹” *This should be documented with literature citations.* This study also discusses the buffering or signal-dampening response to fluctuations in boron concentration in the soil system, which is likely to occur. The salinity addendum also cites best management practices (BMPs) that can ameliorate higher salinity during stages of plant growth where there is higher sensitivity to salinity: “1) salt sensitive crops are generally planted in the spring after seasonal precipitation has leached soluble salts from the soil; 2) Pre-plant irrigations can be applied to minimize soil salinity encountered during the early growth stages.¹²” *These BMPs should be documented. Dixon has provided some discussion about how variations in boron concentrations in the discharge are buffered by soil sorption. In terms of the averaging period for discharge measurements: this depends on how the boron concentrations in the discharge vary over time. Dixon needs to demonstrate that the long-term average concentration of the discharge is represented by their proposed metric. The TAC continues to recommend that Dixon stay involved and continue to participate in the on-going discussions concerning the averaging periods.*

Work Plan Consistency Review

In reviewing these two studies, the TAC performed a consistency review between the work plan and the study – in other words, did the study achieve the work plan objectives. The work plan objectives and findings are summarized below.

1. “Additional crop types of regional significance have been compiled by the Dixon RCD and Solano County. The California Department of Water Resources (DWR) conducted land use surveys of Solano County in 1994 and 2003, which identified crops grown and irrigation methods in individual fields during those years. **These sources of information will be used to document agricultural practices in the area.**”¹³ *This work plan requirement/proposed task is substantively accomplished in the study.*
2. “Other pertinent agriculture practices which help reduce impacts from salt, and therefore boron, include artificial drainage, adjustments to leaching fraction, soil amendments, and supplemental (i.e. higher quality) irrigation water, if available. These practices are more difficult to characterize and quantify, primarily due to individual farmers experience with, and application of, these practices. Generally, the best source of this information is from discussions with local Cooperative Extension agents, resource conservation districts, and/or irrigation districts. **Therefore, the study will solicit such input from the Dixon RCD.**”¹⁴ *Difficult to tell if RCD or the UC Cooperative Extension staff was contacted for information, but agricultural practices are discussed in Section 2.3. The TAC recommends clarification regarding degree to which input was provided by Dixon RCD.*
3. “**Available SID reports and the available groundwater reports will be reviewed to identify irrigation water quality in the area. We will also obtain water quality information that may be provided by the local farmers.**”¹⁵ *A summary of irrigation and groundwater quality data is not presented. The TAC recommends that these data be presented to the extent that they were acquired.*
4. The Soil Survey of Solano County prepared by the Soil Conservation Service (NRCS) in 1977 provides the most comprehensive assessment of soils in the area and **will be used to identify soil**

¹¹ Page 3.1 of Stantec 2014a

¹² Page 3.1 of Stantec 2014b

¹³ Page 4 of Stantec 2013

¹⁴ Page 4 of Stantec 2013

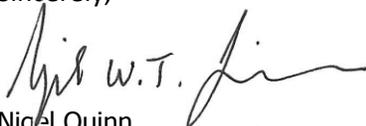
¹⁵ Page 5 of Stantec 2013

types and salinity management related aspects of those soils.¹⁶ *This work plan requirement/proposed task is substantively accomplished in the study.*

5. “Additionally, the presence of calcium, nitrogen, and potassium can affect plant uptake as well as expression of boron deficiency and toxicity symptoms. **Available literature will be reviewed to assess, at least qualitatively, the ability of area soils to buffer the concentration of boron in the soil solution and ameliorate detrimental effects on crops.**¹⁷ *This work plan requirement/proposed task appears to have been substantively accomplished in the study. However, as noted in General Comment 2, the literature needs to be sufficiently cited in the studies to demonstrate adherence to this element.*
6. “Local climatic data will be reviewed and used to assess boron loading and where applicable any discrepancies with reported tolerance studies. **Average year rainfall amounts will be used to calculate loading and/or leaching of boron.**¹⁸ *This work plan requirement/proposed task is substantively accomplished in the study. Climatic data should be provided as an attachment.*
7. “**The potential for flooding in the area will be reviewed to determine if substantial volumes of stormwater are contributing to irrigation demand and/or flushing the soils.**¹⁹ *This work plan requirement/proposed task is not discussed in the study. If flooding is thought not to occur in the study area because of the slope and drainage system, then this should be stated. For other study areas, flooding is a potentially important phenomenon in that it can flush the root zone of salts, including boron.*

In summary, the TAC appreciates having the opportunity review the findings from this study and addendum. In terms of the boron site-specific objective, the TAC recommends that the methods discussed by CV-SALTS to determine sensitive crop species be used in this study; in this case, sunflower would be the crop under consideration (General Comment 3). For the salinity addendum, the TAC recommends that the derived concentrations of sodium and chloride not be reported as proposed objectives. If included in the study, they should be labeled as “concentrations of Na and Cl that would be associated with an EC threshold at the assumed molar ratios of specific ions” (General Comment 10). Conservative assumptions in calculating sodium and chloride thresholds in this study result in threshold values that are likely lower than necessary to be protective of the AGR beneficial use and this may not be appropriate for other study areas. In addition to these two comments, the TAC believes that findings in this study can be more strongly demonstrated by addressing the other comments noted above. Many of these comments are clarifications or requests for supporting documentation all of which will result in a more robust report. Finally, the City’s proposal concerning averaging periods will be taken into consideration in the TAC’s evaluation of appropriate methodologies for temporal averaging for compliance.

Sincerely,


Nigel Quinn
Chair, CV-SALTS Technical Advisory Committee


Parry Klassen
Chair, CV-SALTS Executive Committee

Cc: Joe Leach, City Engineer/Public Works Director, City of Dixon
Robert Busby, Supervising Engineer, CVWB
Andrew Altevoigt, Assistant Executive Officer, CVWB
Jeanne Chilcott, Central Valley Regional Water Quality Control Board

¹⁶ Page 5 of Stantec 2013

¹⁷ Page 5 of Stantec 2013

¹⁸ Page 5 of Stantec 2013

¹⁹ Page 5 of Stantec 2013

References

- Rhoades, J. D. and S.D. Merrill. 1976. Assessing the suitability of water for irrigation: Theoretical and empirical approaches. In: Prognosis of Salinity and Alkalinity. Soils Bulletin 31. Food and Agriculture Organization. Rome, Italy. pp. 69-109
- Stantec. 2013. City of Dixon: Site Specific Boron Objective Work Plan. August 2, 2013. Prepared for the City of Dixon.
- Stantec. 2014a. City of Dixon WWTF: Site Specific Boron Objective Study. February 7, 2014. Prepared for the City of Dixon.
- Stantec. 2014b. City of Dixon WWTF: Site Specific Salinity Objectives Study. An Addendum to the Site Specific Boron Objective Study. February 14, 2014. Prepared for the City of Dixon.