To: Upper Santa Clara River Chloride TMDL Collaborative Process Project Steering Committee
Sam Unger, Los Angeles Regional Water Quality Board
Brian Louie, Santa Clarita Valley Sanitation District

From: Paul Downs,
Project Facilitator
Upper Santa Clara River Chloride TMDL Collaborative Process

Date: February 8, 2008

Re: Final Comments by the Co-Chairs of the Agricultural Chloride Threshold Study Technical Advisory Panel on the Technical Memorandum "Compliance Averaging Period for Chloride Threshold Guidelines in Avocado"

The purpose of this memorandum is to transmit the final comments of Drs. Ben Faber and Steve Grattan on the NewFields Averaging Period Memorandum. See Attachment A. Drs. Faber and Grattan are the Co-Chairs of Agricultural Chloride Threshold Study Technical Advisory Panel (the "AGTAP").

Background

In September 2005, the AGTAP concluded its review of the Agricultural Chloride Threshold Study Literature Review Evaluation (LRE). In September 2006, the Project Steering Team issued as supplemental request to the AGTAP Co-Chairs to obtain their input on determining an appropriate averaging period for chloride, a topic which the LRE was not intended to address. (See Attachment C.)

In September 2007, the Project Steering Committee directed NewFields Agricultural & Environmental Resources (NewFields) to conduct a study of an appropriate compliance averaging period for use in the Site Specific Objective/Anti-Degradation Analysis study of the TMDL. The Steering Committee also requested that the AGTAP Co-Chairs review the report and provide comment.

Charge

The charge issued to the AGTAP Co-Chairs is below (see also Attachment B).

> Review and provide comments on the two items below. The purpose of this review is to assess the validity of the TM recommendations, to ensure that they are supported by sound scientific methods and the relevant technical literature. The TAP Co-Chairs are being asked to review and comment on:
>
> - The December 14, 2007 Technical Memorandum (TM) titled "Compliance Averaging Period for Chloride Threshold Guidelines in Avocado" and
> - The comments provided by the Santa Clarita Valley Sanitation District and the Regional Board and NewFields' response to these comments. (Both the comments and the responses are contained in a separate technical memorandum prepared by NewFields.)
>
> The TAP Co-chairs are also being asked to provide an opinion on the applicability of the TM recommendations for other salt sensitive crops (nursery and strawberries), and if the duration of the recommended averaging period could be revised, if future controls in place provide better water quality and reduce the variability of the data, as compared to historic water quality conditions.

Attachments

Attached to this memorandum are the following:

Attachment A: AGTAP Co-Chairs Final Comments On Averaging Period

Attachment B: AGTAP Co-Chairs Charge

Attachment C: AGTAP Co-Chairs Supplemental Request and Responses

ATTACHMENT A: AGTAP CO-CHAIRS FINAL COMMENTS ON AVERAGING PERIOD

Comments on "Compliance Averaging Period for Chloride Threshold Guidelines in Avocado" and

"Comment Change Report for the Draft Technical Memorandum: Compliance Averaging Period for Chloride Threshold Guidelines in Avocado."

Ben Faber, Ph.D., and Steve Grattan, Ph.D
University of California
Co-chairs, Agricultural Chloride Threshold Study Technical Advisory Panel
January 30, 2008

As charged by the USCR Chloride TMDL Project Steering Committee to evaluate the comments and responses to the Technical Memorandum (TM) titled "Compliance Averaging Period for Chloride Threshold Guidelines in Avocado", the Ag TAP Co-chairs would like to compliment the thoroughness of the memorandum, the thoughtfulness of the comments by both the LA Regional Water Quality Control Board and the Santa Clarita Valley Sanitation District Staff and the thorough replies to the comments by NewFields. The LA Regional Water Quality Control Board and the Sanitation District bring up some interesting points, but in general the Ag TAP Co-chairs feel that all the responses to their comments by NewFields are thorough and reasonable.

There are 'critical periods' in the life cycle of the avocado and flowering is one of them. The fact that the tree can flower and set fruit in nearly every month of the year in this region means that the 'critical period' could be interpreted as the whole year. The bulk of fruit set does occur in spring and early summer, though, but it is still a long period during which the tree must sustain lots of different stresses – weather being the most critical. Irrigation is certainly the most critical operation a grower practices that affects fruit set and water quality is a major issue in irrigation. The effects of water quality are not instantaneous, but can impact the tree over a matter of weeks if quality is poor. The time it takes to adversely impact the tree is dependent upon the extent by which salinity or chloride stress exceeds the maximum tolerable limit. If the salinity or chloride is more than several times higher than the tolerance limit, injury will occur much sooner than if the concentration is only 50% higher. Rainfall mitigates the effects of poor water quality. In years of low rainfall or years with only a short duration, irrigation is practiced throughout the year, and the accumulated effects of poor water quality and insufficient leaching due to low rainfall are most noticeable. Improved water quality can not reverse damage to avocado that has already occurred from poor quality.

The question of what running averaging period to use as a threshold for chloride at the Camulos Diversion is important. The research on chloride effects on avocado is insufficient to provide a scientifically-based recommendation on an optimal averaging period. Ag TAP members feel that the averaging period is largely dependent upon the predicted variability in the chloride concentration in the irrigation water over time. The averaging period should not be so short that it becomes onerous to manage diluting waters or so long that discharge periods or spikes of high chlorides are lost in the average. For example, using a running average of 12-months could mask periods of weeks and possibly months if and when chloride concentrations could rise to potentially stressful levels. On the other hand, the three-month rolling average that NewFields proposes does seem to account for most of the fluctuations and could be useful in managing chloride levels. The Ag TAP Co-chairs are in agreement that the three-month averaging period is adequate at this time.

The Ag TAP Co-chairs were also asked if this averaging period could be extended in the future if improved techniques or technologies were developed that could stabilize the chloride concentration within the range of acceptable or safe levels. Should such a technique be developed and effectively implemented in the future, we feel that extending the averaging period is certainly reasonable.

The Ag TAP Co-chairs were further tasked to provide an opinion on the applicability of this TM on other salt sensitive crops. We know that strawberries are sensitive to salinity and chloride and there are a number nursery crops that are sensitive, as well. There are so many different nursery crops grown in the

area and the inventories keep changing over time. There is not sufficient scientifically-based information on chloride or even salt tolerance of all the likely nursery crops grown in the area. However, because of avocado's extreme sensitivity to chloride and salinity, the Ag TAP Co-chairs feel it would be difficult to find a nursery crop more sensitive than avocado. It would therefore be reasonable to assume that the chloride standard set for avocado would adequately protect the vast majority, if not all nursery crops.

ATTACHMENT B: AGTAP Co-Chairs Charge

Agricultural Averaging Period Review

Technical Advisory Panel (TAP) Co-Chair Purpose and Charge

Review Purpose

The Project Team has retained NewFields Agricultural & Environmental Resources (NewFields) to assess the appropriate averaging periods for the LRE chloride guidelines. The Regional Board will need this information to determine an appropriate compliance averaging period when considering site-specific objectives and establishing waste load allocations for chloride, associated with the Upper Santa Clara River Chloride TMDL.

Background

The Agricultural LRE Study established that "the best estimate of a chloride hazard concentration ranges from 110 to 120 mg/L" (LRE Final Report, p. vi), for which the concentration of 120 mg/L is an approximation of 117 mg/L (LRE Final Report, p. 3-12, p 3-17). The TAP majority suggested ~100 mg/L as a lower limit and 117 mg/L as a conservative upper-protective limit (TAP Critical Review Report, p. 5). However, the LRE did not determine the best existing scientific assessments of the appropriate averaging periods for the LRE chloride guidelines.

TAP Co-Chair Charge

The Co-Chairs of the Agricultural TAP are being asked to review and provide comments on the two items below. The purpose of this review is to assess the validity of the TM recommendations, to ensure that they are supported by sound scientific methods and the relevant technical literature. The TAP Co-Chairs are being asked to review and comment on:

- The December 14, 2007 Technical Memorandum (TM) titled "Compliance Averaging Period for Chloride Threshold Guidelines in Avocado" and
- The comments provided by the Santa Clarita Valley Sanitation District and the Regional Board and NewFields' response to these comments. (Both the comments and the responses are contained in a separate technical memorandum prepared by NewFields[1].)

The TAP Co-chairs are also being asked to provide an opinion on the applicability of the TM recommendations for other salt sensitive crops (nursery and strawberries), and if the duration of the recommended averaging period could be revised, if future controls in place provide better water quality and reduce the variability of the data, as compared to historic water quality conditions.

TAP Co-Chairs

Ben A. Faber, Ph.D.: Ventura County Cooperative Extension.

Dr. Faber serves as the soils/water/subtropical horticulture advisor in Ventura County. He has research experience in plant nutrition and soil management. His current research focuses on irrigation requirements of avocado and citrus, methods of controlling groundwater nitrate pollution, effects of yard waste mulches on citrus production and various methods for controlling micronutrient deficiencies in avocado. He received his Ph.D. from the University of California, Davis; an M.S. in Soil Fertility, University of California, Davis; and a B.S. Biology, University of California, Santa Cruz. He is the author

[1] December 14, 2007 Technical Memorandum with subject line "Comment Change Report for the Draft Technical Memorandum: Compliance Averaging Period for Chloride Threshold Guidelines in Avocado."

and co-author of multiple technical papers and publications, including 18 publications developed over the last six years.

Steven R. Grattan, Ph.D.

Dr. Grattan is a Professor at the University of California, Davis. He serves as the plant-water relations specialist in the Department of Land, Air, and Water Resources, Hydrologic Science Division at the University of California, Davis. His research areas include irrigation management with saline water; plant response in saline environments; uptake of nutrients and trace elements by plants in saline environments; and crop water use. He also performs international consulting work with the World Bank, USDA/OICD, and USAID. Previously, he served as a research assistant with the University of California, Riverside, and as a research plant physiologist at the USDA/ARS Salinity Laboratory. Mr. Grattan received his Ph.D. in Soil Science from the University of California, Riverside; an M.S. in Soil Science from the University of California, Riverside; and a B.S. in Soil and Water Science from the University of California, Davis. He is the author and co-author of 15 technical proceedings/presentations, 74 refereed publications, and over 100 reports.

Proposed Timeframe

If possible, the Project Team requests that Dr. Grattan and Dr. Faber provide comments associated with the TAP Co-Chair Charge by January 28, 2008.

ATTACHMENT C: AGTAP Co-Chairs Supplemental Request and Responses

Grattan's response to request (11/11/06)

Re: REQUEST TO AG TAP ON AVERAGING PERIODS

The project team needs to document the best existing scientific assessments of the appropriate averaging periods for the LRE chloride guidelines and of the potential for acute injury. The Regional Board will need this information to determine an appropriate compliance period when establishing waste load allocations and final effluent permit limits for chloride.

Background

The LRE established that "the best estimate of a chloride hazard concentration ranges from 110 to 120 mg/L." The LRE author indicated that this estimated range applies to long-term steady state water quality. The author also stated that agronomic research tends to focus on long-term, steady state water quality because, in general, water quality levels are not highly variable.

Request

Based on your professional interpretation of the existing literature, provide guidance to determine what averaging periods for variations in chloride concentrations would be protective of salt-sensitive crops. Please address the specific questions below:

1. Should the LRE guidelines be applied as a chronic threshold (i.e., an average over some specified period of time) or an acute threshold (a single sample never to be exceeded)?

   It seems appropriate to me that the LRE guidelines be applied as a chronic threshold. The 110 to 120 mg/L range for the upper limit of Cl for the irrigation of avocado assumes long-term use under steady state conditions assuming the more Cl sensitive rootstock and that rainfall is not considered significant as an annual means of leaching or partially leaching Cl from the rootzone. However, this assumes that the variation in irrigation Cl concentration is not large.

2. If the LRE guidelines are to be applied as a chronic threshold, what is the appropriate averaging period (e.g., 12-month average, 6-month average, 1-month average, etc.)?

   Because avocados are so sensitive to salinity and Cl and that they represent a long-term investment, I would tend to error on the safe side. As indicated by Ben Faber, trees may be particularly susceptible should an additional stress present itself such as Santa Ana winds. Therefore I would suggest that a shorter time interval be used (one month seems appropriate but is somewhat dependent on the extent by which Cl deviate from the mean) (see #3).

3. Is the averaging period dependent upon the magnitude by which the chloride concentration deviates from the average?

   I do believe that the extent by which Cl deviates from the mean should affect the averaging period. If deviations are in the 10-20% range, perhaps 6 month averages or longer is more appropriate. If Cl concentrations double over a short period of time, then shorter periods may be appropriate. Hopefully this is not the case because a doubling in Cl (eg 120 to 240mg/L), even for a short period of time, may be extremely detrimental to this salt-sensitive tree. Perhaps a dual chronic/acute interim limit is appropriate at this point in time. More research is needed to get a better idea on plants response averages and deviations. Such a study could readily conducted.

4. Are there growth stages for avocado, strawberry, and nursery plants that are especially susceptible to chloride hazard, i.e., if the crop is exposed to chloride at that stage, the chloride

hazard will be more than if exposed at other growth stages? If yes, how long is the sensitivity period?

This is a really good question and I don't think the research is adequate enough to adequately address this issue. We know that tolerance in most plants vary with stage of development. Many annual crops are generally sensitive during early growth and development. Tree crops can be sensitive to specific ion toxicities, particularly over long periods of time. I would defer this question to Ben since he has had more practical experience than me. This too is a researchable topic.

5. Is it possible for the chloride hazard to occur at a short period of time, but the symptoms (such as leaf injury and yield) will be shown at much later time? If it is possible, how long would the period of time that causes chloride hazard be?

   I am aware of some research that describes no ill effects of a crop until a hot, dry day comes about. Researchers describe injury at that time as being instantaneous. If the plants are sensitive at flowering, then the damage that occurs during flowering may be subtle, yet such subtle damages could translate into large yield losses later on (ie harvest).

6. Are the terms "acute" and "chronic" suitable to describe chloride hazard to plants?

   I think for salt or Cl sensitive crops, such terms are suitable.

7. If additional studies are necessary to answer the above questions, could any existing study results be used to establish an interim acute and chronic guideline for chloride hazard to avocado? Specifically, could an approach be used to establish 117 mg/L as an interim chronic guideline and 178 mg/L as an interim acute guideline to protect agricultural supply beneficial uses, based on Bingham and Finn (1966, 1968) study results or any other study evaluated as relevant within the LRE?

   This is a difficult call. If you consider the combination of uncertainties, large investment, and the trees susceptibility to multiple stresses in the field, I would not be comfortable with the acute limit being set at 178mg/L at this point in time before more research is conducted. The 178 mg/L may be appropriate, but only if all other management and environmental factors are optimal. The chronic level of 117 mg/L, based on the existing studies and the thorough LRE, seems appropriate to me.

REQUEST TO AG TAP ON AVERAGING PERIODS

Response of Dr. Faber

The project team needs to document the best existing scientific assessments of the appropriate averaging periods for the LRE chloride guidelines and of the potential for acute injury. The Regional Board will need this information to determine an appropriate compliance period when establishing waste load allocations and final effluent permit limits for chloride.

Background

The LRE established that “the best estimate of a chloride hazard concentration ranges from 110 to 120 mg/L.” The LRE author indicated that this estimated range applies to long-term steady state water quality. The author also stated that agronomic research tends to focus on long-term, steady state water quality because, in general, water quality levels are not highly variable.

Request

Based on your professional interpretation of the existing literature, provide guidance to determine what averaging periods for variations in chloride concentrations would be protective of salt-sensitive crops. Please address the specific questions below:

1. Should the LRE guidelines be applied as a chronic threshold (i.e., an average over some specified period of time) or an acute threshold (a single sample never to be exceeded)?

- I would think it should be set as a chronic threshold, since you never know when hot, dry winds might kick up. I’ve seen avocado trees show leaf burn symptoms a week after a Santa Ana condition.

2. If the LRE guidelines are to be applied as a chronic threshold, what is the appropriate averaging period (e.g., 12-month average, 6-month average, 1-month average, etc.)?

- I would think the averaging period would be the shortest period possible, since the weather is quite variable along the coast – hot in January and cold in June some years.

3. Is the averaging period dependent upon the magnitude by which the chloride concentration deviates from the average?

- Not sure what the question is? If the concentration average varies slightly, then the averaging period can be longer. If there are sharp spikes, it should probably be shorter, such as a month.

4. Are there growth stages for avocado, strawberry, and nursery plants that are especially susceptible to chloride hazard, i.e., if the crop is exposed to chloride at that stage, the chloride hazard will be more than if exposed at other growth stages? If yes, how long is the sensitivity period?

- Typically flowering and fruiting are the most sensitive periods for avo and strawberry. For nursery plants, as well, but often they are sold for the foliage condition.

5. Is it possible for the chloride hazard to occur at a short period of time, but the symptoms (such as leaf injury and yield) will be shown at much later time? If it is possible, how long would the period of time that causes chloride hazard be?

- It’s possible to have damage to have damage and not see it until a stress, such as a Santa Ana comes along. Not sure how long the hazard needs to be in place.

6. Are the terms "acute" and "chronic" suitable to describe chloride hazard to plants?

- Again not sure what length of time it takes to impact plant growth and yield.

7. If additional studies are necessary to answer the above questions, could any existing study results be used to establish an interim acute and chronic guideline for chloride hazard to avocado? Specifically, could an approach be used to establish 117 mg/L as an interim chronic guideline and 178 mg/L as an interim acute guideline to protect agricultural supply beneficial uses, based on Bingham and Finn (1966, 1968) study results or any other study evaluated as relevant within the LRE?

- This is the question, isn't it? Soil concentrations vary tremendously depending on rainfall and other weather conditions. When it's cool, the plants can probably tolerate higher levels of chloride, when hot, less. That's why the protective level was thought to be near 100 ppm for years.