California Regional Water Quality Control Board
Central Valley Region
Karl E. Longley, ScD, PE, Chair

Linda S. Adams
Secretary for Environmental Protection

Sacramento Main Office
11020 Sun Center Drive #200, Rancho Cordova, California 95670-6114
Phone (916) 464-3291 • FAX (916) 464-4645
http://www.waterboards.ca.gov/centralvalley

Arnold Schwarzenegger
Governor

TO: Wayne Verrill
Division of Water Quality
State Water Board

FROM: Wendy Wyels
Environmental Program Manager
Central Valley Regional Board

SIGNATURE: ___via e-mail_____

DATE: 19 October 2007

SUBJECT: ***REVIEW OF THE WINERY PROJECT TEAM DRAFT LITERATURE REVIEW REPORT***

Thank you for the opportunity to review the *Winery Project Team Draft Literature Review Report (15 August 2007)*. You are to be commended for completion of a very large literature review and the ability to succinctly summarize the documents.

My review of the draft document follows. I look forward to discussing my questions and concerns with the Winery Project Team members during our meeting on 24 October. If you have any questions prior to that time, I can be reached at (916) 464-4835 or by e-mail at wwyels@waterboards.ca.gov.

Study Purpose and Definition of Primary Unresolved Issues: I appreciate inclusion of the last paragraph on p. 3 which states that potential groundwater impact due to inorganic salts was not addressed in the study. However, the last paragraph on p. 1 should recognize that the results of the literature review will be only one factor in the revision of the Wine Institute's draft guidelines and the Regional Board's regulations of winery wastewater. The revised draft guidelines and our regulatory measures will also need to account for salinity issues.

Relationship to Other Ongoing and Proposed Studies: It should be recognized that both Regional Board and State Board staff provided comments on the *Manual for Good Practice for Land Application of Food Process/Rinse Water*. Some of these comments were addressed and some were not.

Issue 1: Do the draft guidelines apply to soils other than sandy loams?

Issue Analysis:
p.7, paragraph 3: How would a discharger implement the WI/KJ recommendations that "deep ripping can be prescribed but must be conducted so that excessive drainage does not result"? How would the Regional Board ensure that excessive drainage does not result?

p.8: The text discusses the textural triangle, and lists the soils, which have a clay content of less than 20%. However, neither loamy sands or sands are mentioned. Is this because WI/KJ already determined that these soils are not appropriate for direct application of winery wastewater? If this is the case, the text should say so. If this isn't the case, then it needs to be further discussed.

p.9, paragraph 3: WI/KJ states that the single-event hydraulic loading rate should not exceed the soil water-holding capacity between the surface and five-foot depth. How will this be determined? Has the issue of nuisance conditions also been considered?

Literature Review Results:
p.9-10. If I recall correctly, none of the studies summarized address the issue of groundwater quality. Instead, they were concerned with disposing of the waste or the quality of the grapes when wastewater was applied to the soil around the vines. The only study that I see has any direct bearing on this issue is Harter, which states that "vadose zone preferential flow paths are particularly dominant in sandy unsaturated sediments."

Literature Review Conclusions:
p.10, first paragraph: The conclusions in this paragraph are not supported by the text in the Literature Review Results section.

p.10, second paragraph. The Literature Review Results section does not support the statement that sandy soils were found to be "suitable mediums for soil treatment". It is premature to state that a 5% clay content is appropriate for a minimum soil criteria guideline. In addition, the statement from Harter regarding preferential flow paths needs to be reconciled.

p.10, third paragraph: "Good results" in relation to what? The Regional Board needs to see results in terms of protection of groundwater quality and prevention of nuisance odors. It is unclear why soils with 30% clay are suitable.

p. 10, last two paragraphs: I'm unclear why it is appropriate to use the USDA's full range of values for the "moderately high saturated hydraulic conductivity class". Also, I'm unclear as to why the values should be acceptable when based on the time needed for organic carbon reduction. The soils also need to reduce the BOD and total nitrogen to acceptable levels, and this needs to be factored in when determining acceptable infiltration rates.

p.11-14: This section is unclear. It appears that acceptable ranges for soil texture and bulk density ranges are being based on the USDA's "moderately high saturated hydraulic conductivity class". More explanation is needed as to why these associations are appropriate before I can make any meaningful comments.

p.14, sixth paragraph: I agree with the last sentence.

p.14, last paragraph: The Central Valley has been intensively farmed for decades. Is it possible to distinguish the need for deep ripping due to natural soil forming conditions versus due to compaction from heavy equipment? What's the basis for recommending a "reduced application of wastewater" for a one-year period for soils that have been deep ripped? What does "reduced" mean? Why one year?

p.15, second paragraph. It's unclear how the values of 0.83 in/hr and 0.5 in/hr were calculated. What is the definition of "acclimatized soils" and "non-acclimatized soils"?

WI/KJ Study and Guideline Conclusions

I cannot comment on the recommended changes to the WI's guidelines until the above comments and questions are addressed. In addition, the Harter article needs to be addressed.

Issue 2: Are iron and manganese appropriate for use as indicators of nitrogen removal? Will the soil remove enough nitrogen to protect the underlying groundwater?

Issue Analysis
p. 16, last paragraph: It is noted that WI/KJ did not collect samples lower than five feet bgs, and that while the TN may have been "substantially reduced" at that depth, I recall that the levels were still high enough to be a concern to groundwater quality.

p. 17, third and fourth paragraphs: In paragraph three, increased nitrate concentrations are attributed to deep ripping and pre-application planting of corn, which could have lead to preferential flow paths. However, paragraph four states that pre-application cropping would be beneficial in removing stored nitrogen from the soil. While I agree that cropping would probably be appropriate, how will a discharger prevent preferential flow paths?

p. 17, fifth paragraph: My understanding is that the BOD:TN concentration in winery wastewater, even during the crush, is highly variable. Does the data support WI/KJ's suggestion that the BOD:TN ratio is always higher than the 20:1 ratio needed for near-complete denitrification?

p. 17, seventh paragraph: WI/KJ's thought that a cropping program can be matched to the loading rates assumes that the remaining nitrogen will be within the rooting zone of the crop. It is also noted that due to the timing of crush, the ground would probably be fallow from mid-November until the spring. The nitrogen which is not denitrified could migrate below the rooting zone with winter rains.

p.18, first paragraph. The discussion regarding "unacceptable" levels of iron and manganese in the vadose zone percolate and the groundwater needs to reference regulatory constraints, specifically State Water Board Resolution No. 68-16 and the Central Valley Regional Board's Basin Plan. Regional Board staff cannot approve a project that does not protect groundwater in concert with these items. The discharger will need to show that the concentration of iron and manganese (and other constituents) in the groundwater beneath the disposal fields does not exceed background concentrations, or if it does, does not exceed the applicable water quality objectives only if (a) the discharger has implemented best practicable treatment and control practices, and (b) the Regional Board has determined that it is to the benefit of the people of the State to allow degradation.

Literature Review Conclusions
p. 20, last paragraph: I'm not certain the literature review substantiates the statement that analysis for Fe and Mn is a relatively accurate method for determining soil redox status. The discussion of James, 2000 (p. 19, second paragraph) includes the statement that "detailed research is needed to prove this hypothesis" that measurement of Mn and Fe would quantify electron activity in soils.

p. 21, first paragraph: I agree that WI/KJ showed a lowered redox potential in the treatment soils, but the question is whether it was enough for complete denitrification and how to prevent

the excessive release of iron and manganese. In addition, I'm not clear about the last sentence of this paragraph.

p. 21, second paragraph. The middle sentences regarding WFPS are somewhat confusing. Are you recommending 80% WFPS? If this value is appropriate for denitrification, it is also optimal for BOD reduction? What does it do to iron and manganese concentrations?

p. 21, fourth paragraph. I agree with the paragraph, but wonder how it should be reconciled with the recommendation from Issue #1 that soils only require a minimum of 5% clay.

p.22, second and third paragraphs: Are you recommending that winery compost be added to the soil in addition to the wastewater? What is "finished" organic matter?

WI/KJ Study and Guideline Conclusions
My overall comment is that I'm not certain that the literature review answered the questions posed by the project team. I'm still left with the same questions.

Recommendation 2.2: I think it would be better to express a BOD:TN ratio instead of a C:N ratio. Does "post soil treatment" mean between applications or between seasons?

Recommendation 2.3: This recommendation builds upon the conclusions of Issue #1, and I can't comment on it until my Issue #1 questions are addressed.

Recommendation 2.4: While I agree that soil ph should be maintained within a neutral range, I'm concerned that due to the wastewater disposal, a discharger may need to add additional supplements that could impact groundwater more than under a normal farming operation.

Issue 3: Is the proposed BOD limit appropriate? Is the proposed BOD:TN ratio appropriate?

Issue Analysis
p. 23, first paragraph: Are the loading rates in the first two sentences on a per-cycle or per-year basis?

p.23, third paragraph: I don't understand this paragraph.

p.24, fourth paragraph: As stated earlier, this wastewater treatment proposal must comply with Resolution 68-16 and the Basin Plan in regard to groundwater impacts. I agree with the PR that the priority is to keep the iron and manganese concentrations low enough to comply. As stated previously by WI/KJ, it may be necessary to pre-treat to remove nitrogen prior to land application.

Literature Review Results
p. 24, last paragraph: I'm unclear how we went from the issue of BOD loading rates to soil organic carbon sequestration. I need to understand this transition before I can fully appreciate the discussion on pages 25-33.

p.25, first paragraph: From a Regional Board standpoint, the “optimal objective” of the land application of winery wastewater must be the prevention of runoff to surface waters, the prevention of nuisance odors, and the protection of groundwater. Please recall that the WI/KJ study this is just one potential method of treating winery wastewater to meet these objectives. If necessary, WI/KJ could incorporate other treatment trains prior to land application.

p.29, first paragraph: It would be helpful if the carbon concentrations in the Australian wastewater could be related to the BOD concentrations that were reported during the WI/KJ study.

p.29, second paragraph: Loamy sand has 0% clay content? Not according to the textural triangle on page 8. How would one determine that a soil has become acclimatized (I assume that this means used to winery wastewater)? What happens to groundwater quality during the acclimatization process?

Literature Review Conclusions
p.33, last paragraph: I would like some more information about C measurements before agreeing that BOD should no longer be measured.

WI/KJ Study and Guideline Conclusions
Recommendation 3.2: It is recommended that the wastewater maintains a C:N ratio of 25-40, as this “will likely” result in rapid nitrogen uptake so that establishment of denitrification conditions would not be necessary. Yet the paragraph at the top of page 34 states that no study has confirmed this hypothesis. In writing WDRs, Regional Board staff must have reasonable confidence that permit conditions will protect water quality, and I’m not sure that this recommendation meets that criteria. Also, how would a winery determine this value on a real-time basis? If analytical data is needed, then would the winery need to store its wastewater in a pond until it is shown that the wastewater has the appropriate ratio? How does the proposed C:N ratio relate to a BOD:TN ratio (i.e., how does it relate to the BOD:TN ratio of the wastewater applied during the studies)? I can’t comment on the second part of this recommendation, as it again relates to my questions from earlier in the document.

Recommendation 3.3: It appears that some of the methods to enhance humification may have an adverse effect on groundwater quality, and may not mesh with other recommendations for this project.

Recommendation 3.4: Again, I’m not certain that a C:N ratio of 25-40 has been justified. Assuming it is, would this ratio need to be maintained at all times during the soil treatment cycle, or just was the wastewater is applied? In regard to a BOD loading limit, permitting issues may override the recommendations of the literature review. For example, Regional Board staff needs to show that a discharger has enough land area to treat and dispose of the waste that is generated. To do that, the discharger must provide the maximum volume and strength of the waste, and show that there is enough land area to prevent nuisance conditions, prevent run-off, and protect groundwater. Given that winery wastewater concentrations are highly variable, I’m not certain that we could write permits without loading limits, or write permits that require applications of waste to be adjusted based on observed conditions. However, the Regional Board may authorize site-specific tests for a smaller volume waste stream.

Recommendations 3.5 and 3.6: How was it determined that acclimatization can be completed in one year? How is groundwater quality protected during this process?

Issue 4: Can we assume that contaminants percolating below five feet will be transformed such that groundwater will be protected?

p. 36, sixth paragraph: This issue pertains to all contaminants of concern, not just nitrogen or BOD. For example, staff is also interested in iron, manganese, volatile dissolved solids, total dissolved solids and whether these contaminants are retained/degraded in the vadose zone or caused increased concentrations in groundwater underneath these types of land application areas.

Literature Review Conclusions
p. 39, fourth paragraph: I don't believe it is reasonable to say that there is no limit needed for the depth to groundwater. The literature cited mainly concerns nitrogen, and does not address the other COCs. In addition, there are too many uncertainties in the application of this work – for example, some reactions are faster with warm soil, yet crush wastewater is generated in the fall/early winter. What happens if rain falls on a basin already containing wastewater? Won't the water holding capacity be exceeded and leachate be generated before it is fully treated? What about preferential pathways? In addition, I believe that some foothill grapes have roots extending into the fractured bedrock.

p. 39, fifth paragraph: I still need clarification on how the 0.83 and 0.50 inches/hour hydraulic conductivity limits were determined to be appropriate.

WI/KJ Study and Guideline Conclusions (p.40)
My overall comment is that I'm not certain that the literature review answered the questions posed by the project team. I'm still left with the same questions.

Recommendation 4.1: What is meant by "validated" vadose zone and groundwater capillary fringe zone dentrification?

Recommendation 4.2: see comment above regarding hydraulic conductivity limits.

Recommendation 4.3: see comment above regarding depth to groundwater issue.

Recommendation 4.5: My understanding is that the literature review indicates that unpurged groundwater monitoring wells will have a lower nitrogen concentration that the surrounding aquifer. We need to know the water quality of the entire aquifer, not the concentration in a small area in which denitrification is enhanced. In order to obtain a representative sample, the well must be purged following EPA standards.

Issue 5: What kind of monitoring program is necessary to show compliance? Do lysimeters provide representative samples?

Literature Review Conclusions

p.43: it is not clear how soil microbial monitoring parameters relate *directly* to groundwater quality. I understand that they are an indication of the health of the soil, but at this time I don't believe there's any data to link them to changes in water quality due to application of wastewater.

p.43, fourth paragraph: While I agree that the application of organic matter to soil is beneficial, the *overapplication* of organic matter can adversely impact water quality. For this project, we need to determine, on a site-by-site basis, the point at which an impact could occur and then add a safety factor.

WI/KJ Study and Guideline Conclusions (p.44)
Recommendation 5.3: We require that dischargers follow the EPA protocol of purging groundwater monitoring wells before collecting samples. This literature review has not shown that it is appropriate to do otherwise.

Recommendation 5.4: If soil lysimeter data is too variable to use to assess whether the soil treatment system is working as assumed, then the only reliable measure of success would be groundwater monitoring. However, our job is to *prevent* groundwater impacts – we can't allow a discharge to occur until it impacts groundwater and then require it to be modified. Therefore, any permitting activity should include numerous safety factors (realizing that the application of wastewater to soils is subject to many variables, including waste strength and weather).

Recommendation 5.5: If more research is to be done about microbial soil biomass used as a monitoring tool, then I strongly recommend that it be tied to compliance monitoring. Otherwise, it could be a useful tool for a farm manager, but I don't imagine it would have much applicability from a regulatory context.

Issue 6: Could these guidelines also apply to dischargers who apply the wastewater to crops (instead of bare soil)?

Issue Analysis
Winery wastewater is also currently applied to crops that are not grown in spreading basis (i.e., directly to cropland as a supplement to irrigation water).

Literature Results
I thought that the term "vinasse" applied to solid waste, not wastewater. If so, the Tano papers don't apply to this issue. The Agnew paper doesn't apply either, as it is a study of the impact of winery waste mulches.

p. 46, fourth paragraph: What are the "recommended levels" which would prevent an impact on crop production?

Literature Review Conclusions
p. 47: see my above question about the applicability of vinasse to this issue.

p. 47, fifth paragraph: We recognize that leaching of salts is a necessary part of irrigated agriculture. However, from a regulatory context, the question is whether excess salts are

being leached due to the application of wastewater instead of straight irrigation water. At that point, the discharger must show compliance with Resolution No. 68-16.

p. 47, fifth paragraph: The last sentence states that site soils may be managed to retain some salts. This does not appear to be a sustainable concept, as there is a limit as to the amount of inorganic salt which may be retained by a soil. After that point, there will be groundwater and/or surface water impacts.

WI/KJ Study and Guideline Conclusions (p.47)
The literature review does not answer my questions about whether untreated winery wastewater, applied directly to cropland, will transform/degrade in the soil and prevent impacts to groundwater. If a discharger proposes to apply untreated wastewater to their cropland, should they be required to do the same monitoring as a discharger proposing to apply untreated wastewater to bare ground? Should any disposal of this type be required to have year-round cropping?

Recommendation 6-4: I don't believe that the literature review section discussed a single wastewater application versus multiple applications. How was this recommendation derived?

Recommendation 6-5: See comment above regarding salt buildup.

Issue 7: Should winery waste be pre-treated before application to bare soil?

Literature Review Conclusions
p. 56, second paragraph: I'm not certain that the literature review has shown that the land application of winery wastewater will result in expected water quality benefits.

p. 56, fourth paragraph: My impression is that the land application of winery wastewater must be conducted under very controlled conditions, and that this can more readily be accomplished when the wastewater is stored in a basin prior to application. Mixing different strength waste streams directly on the soil will probably not provide the desired treatment.

WI/KJ Study and Guideline Conclusions (p.57)
Recommendation 7-1: Further discussion should be given to the concepts of mixing wastewater from wineries with food processors, or mixing wastewater with urea or other high nitrogen compounds to produce the desired C:N ratio. Is there an upper limit for the concentration (not ratio) of the compounds? Would a higher concentration waste require more residence time between applications? Would urea add to the inorganic salt load?

Recommendation 7-2: I agree that winery waste should be composted (in a manner which protects surface water and groundwater) prior to land application. I'm not certain that it's appropriate to apply the compost to the same soil which is receiving the wastewater, however.

Issue 8: Does the data show that VDS is removed within the first five feet of the soil?

Issue Analysis: Upon request, Regional Board staff were provided with a full data set from the WI/KJ study, including concentrations of TDS, IDS, and VDS for each sample. Regional Board

data shows that, although variable, winery wastewater contains approximately 50% VDS and 50% IDS.

While VDS samples were “markedly lower” in the lysimeter samples, they were still high enough to cause concern for groundwater quality (as the water quality criterion is TDS, any VDS which moves into the groundwater has the potential to cause a discharger to exceed background TDS values or exceed the TDS groundwater limitation).

Literature Review Conclusions
While the PR may not have deemed this issue important, WI/KJ has stated that the Regional Board should be regulating the waste on the basis of IDS concentrations, not TDS. The rationale is that VDS will be removed in the soil column. However, Regional Board data shows that when VDS is over-applied to a land discharge area, it will be detected in the groundwater beneath the site. Therefore, Regional Board staff is reluctant to regulate based only on IDS concentrations, and in order to fully protect the groundwater, have continued to regulate based on TDS.

Issue 9: What level of confidence is needed by Regional Board staff to permit these type of treatment/disposal sites?

This issue was not address in the literature review, as it is a policy decision.

Issue 10: To what extent have existing winery waste discharge sites impacted groundwater?

WI/KJ Study and Guideline Conclusions (p.59): The WI/KJ study provided one proposed method for the treatment and disposal of winery wastewater. In addition, there are established physical treatment processes (source reduction, screening, aeration, DAF, etc) which are also available to reduce the strength of wastewater characterized by high BOD, nitrogen, and TDS. The vast majority of medium- to large-size wineries do not follow the practices studied by WI/KJ, so therefore a review of winery groundwater monitoring data would not be an indication of the success of the WI/KJ disposal method. I do not believe that the term “BMP” should be used in conjunction with this type of waste discharge, as the term implies that there are factors preventing a waste from being fully treated (i.e., stormwater). That’s not the case for winery wastewater.