Response to Comments submitted Central Valley, Regional Board

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.

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.

That is understood.

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.

Is or will not the same be true for the other studies as well?

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?

Refer to p. 14, last paragraph.

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.

Loamy sand and sand are included in the less than 20% clay suitability criterion recommended by the WI/KJ Study. Since these textures were singled out for suitability, the paragraph discusses other soil textures that also can fall within the criterion.

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?

Soil water-holding capacity may be determined by a standard procedure of summation of horizon soil texture and thickness (depth).

The commenter does not indicate what is meant by “nuisance conditions” within the context of the issue being addressed.

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.”

The studies with the most direct bearing on protection of water quality are those which investigate the ultimate fate of winery waste applied to soil. In this regard, see in particular the discussion under Issue 3. The relevance of the Harter study is limited in our context since no trials were conducted with either organic fertilizers or organic waste.

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

That fact is already clearly stated in the first paragraph of both the Results and Conclusions sections, and the reader is directed to other parts of the LR report.

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.

See the previous response. The reader is directed to the discussion under Issue 3. The LR author has a personal preference for a 10% clay minimum, but the literature reviewed supports a 5% minimum, which in any case is an improvement over the existing 0% minimum, or lack thereof. In addition, the LR recommendations combine the 5% clay minimum with a bulk density criterion as a further safeguard.

What about the Harter study needs to be reconciled? As stated above, the relevance of the Harter study is limited for our purpose since no trials were conducted with either organic fertilizers or organic waste. In any case, the LR recommendations are intended to ensure that applied winery wastewater will be retained within the biologically active soil zone until full treatment has occurred.

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.

"Good results" is in relation to soil treatment of winery wastewater and protection of water quality. Nuisance odors was not identified nor selected by the Project Team as a topic for the LR investigation.

See the subsequent discussion under this section for the derivation of the 30% clay maximum on the basis of the suitable range of soil hydraulic conductivity.

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.

The moderately high saturated hydraulic conductivity class as a suitability range is derived from the results of the Chapman study presented in detail under Issue 3. "Organic carbon reduction" and "reduction of BOD and N" are all part of the same process.

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.

The intent of this section was to provide an additional explanation for ease of comprehension. The text seems long enough, as the report is already quite lengthy. The different sections of the report are written as an interconnected whole, while trying to avoid excess repetition.

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

What is the commenter's justification?

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?

Yes, it is actually relatively easy to distinguish between the two. "Reduced" refers to wastewater applications reduced below the soil water-holding capacity, in order to

reduce the possibility of incompletely treated wastewater infiltrating out of the soil zone. One-year completes one seasonal cycle of temperature and precipitation ranges for soil re-consolidation and re-aggregation.

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"?

The values are derived by dividing 60 inches average soil depth by 72 and 120 hours as the maximum range in treatment time required. Acclimatized soils have received a previous application of winery wastewater; non-acclimatized soils have not.

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.

As stated above, the relevance of the Harter study is limited for our purpose since no trials were conducted with either organic fertilizers or organic waste.

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.

What TN level does not exceed the commenter's level of concern?

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?

Preferential flow paths are a natural (as well as induced) feature that cannot be fully "prevented". The LR recommendations would set margins of safety to ensure that wastewater treatment takes place within the zone of soil microbiological activity.

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?

No. One study found that wine lees have an average BOD:TN of 3.88 (see LR page 50).

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.

In this regard and others, a perennial cover crop would be advantageous as recommended in the LR. Applying winery wastewater with a C:N of 25-40 will ensure uptake of available N by micro-organisms in the decomposition process following application. Further, low winter temperatures will retard the release of N bound in undecomposed OM and humus. Increasing spring temperatures will increase the availability of N at the time of renewed vegetative growth.

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.

The purpose of the LR is to report on published scientific literature, not Regional Board policy. The method of land application proposed in the LR report will avoid an increase in Fe and Mn concentrations.

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.

This statement by one source is outweighed by data and statements of other sources. No information substantiating the lack of a correlation between Fe and Mn solubility and redox status was found.

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.

If by "complete" the commenter means 100%, the commenter needs to be reminded that 100% of anything is unachievable even in an engineered system let alone a natural system. The WI/KJ study did not distinguish between N removal by denitrification and N removal by microbial biomass, which is the point of the last sentence. Again, applying wastewater with C:N of 25-40 will render the uncertainty moot.

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?

The condition of 80% WFPS optimizes the balance between aerobic decomposition/ humification and denitrification, while avoiding a redox status conducive to Fe and Mn reduction.

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.

What needs to be reconciled? The LR recommendation is not the optimization of denitrification, but a balance between denitrification and humification.

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?

Yes. In "finished" compost, the growth of microbial biomass has consumed readily decomposable (and soluble) OM and completed humification. The addition of compost to the soil not only improves soil quality, but enhances the natural soil function of protecting water quality.

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.

By her own admission, the commenter did not read a single one of the hundred or more research articles distributed to the Project Team. Is it any wonder that she is "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?

C:N is the scientific standard. The answer to the question is both.

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.

The entire LR report is intended to be interconnected.

Recommendation 2.4: While I agree that soil ph (sic) 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.

The commenter’s supposition has not been substantiated. Research data indicates a soil trend towards neutral after land application of either acidic or alkaline winery waste. The LR report recommends a pre-application blending to achieve a more balanced pH before application as an additional safety factor.

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?

Per individual process water application event.

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

Additional information regarding this topic may be found under Issues #1 and #4.

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.

This literature review report proposes a method whereby maintenance of applied waste within a specified C:N ratio obviates the need for conditions conducive to denitrification to the extent of conditions also conducive to the reduction of Fe and Mn. Therefore, the proposed method could avoid the problem of having to “decide” between the unacceptable conditions of either excess nitrate or excess Fe and Mn in solution, without necessarily requiring pre-treatment to remove N.

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.

The very paragraph referenced by the commenter provides the explanation the commenter is seeking. Please read it again carefully.

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.

The focus of this literature review report is on the protection of groundwater quality. This report does not address surface runoff and nuisance odors, not because they are not of importance to the Regional Board, but because they were not identified as issues in the PR of the WI/KJ study, and were not identified as issues by the Project Team when the LR process was established. Consideration of issues pertaining to climate change is now required in any Water Board process.

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.

The conversion factor must be determined empirically. See the second full paragraph on page 50. BOD concentrations are non-standard units in scientific literature.

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?

The commenter has failed to read the textural triangle chart correctly. Please look at it again carefully.

A non-acclimatized soil is one to which winery wastewater has not been previously applied. Acclimatization begins with the first wastewater application. In the most detailed study of the effect on soil of applied winery wastewater (Chapman 1995), the non-acclimatized soil differed from the acclimatized soil by requiring an maximum of 4.8 days for complete treatment compared to a maximum of 2.6 days for the acclimatized soil. Therefore, the acclimatization process would have no impact on groundwater quality as long as the soil water-holding capacity was not exceeded, and a period of five days passes before the next application.

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.

What information is desired? Methods of measurement? C measurements are the scientific standard; BOD measurements need to be justified.

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.

The commenter has misunderstood the paragraph at the top of page 34. What has not been confirmed by direct observation is that decomposing micro-organisms out compete denitrifying organisms for available N in the land application of winery wastewater, not that C:N 25-40 and higher will lead to rapid N uptake, which is well established. Further, the primary recommendation for additional research is to determine which of many available and established methods for measuring the degree of activity of the soil microbial decomposer biomass is most applicable to land application of winery waste to California soils, not that the decomposition process itself does not occur, which again is well established. The point here is to determine the most practical direct measurement of microbial decomposer activity in order to satisfy the stringent requirements of the Regional Board for direct, near real-time (on the order of minutes to a few days depending on the method selected) quantitative monitoring of the decomposition process. See Issue #5 for a discussion and evaluation of these methods.

Temporary storage of wastewater would be necessary to adjust the C:N ratio to the optimal range. The C:N/BOD:N conversion factor is discussed in the second full paragraph on page 50.

With regard to the commenter's placement of "will likely" in quotes and reference to a reasonable level of confidence, it must be understood that 100% desired managed results cannot be achieved in even laboratory settings and completely engineered

systems, even less so can that expectation be applied to natural systems, managed or not. What does the commenter recommend for a “reasonable level of confidence”?

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.

What methods is the commenter referring to? What scientific literature can be cited to substantiate the claim that the unidentified methods may have an adverse effect on groundwater quality?

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.

The C:N ratio of 25-40 is the range that needs to be achieved only at the time of application. Therefore, there is no need or purpose to “maintain” this soil ratio through active management; the C:N ratio will naturally change to a 15-30 range, indicating completeness of soil treatment. The purpose in requiring the 25-40 ratio range initially in applied organic waste is to avoid the temporary problems of excess soluble N (for an untreated waste ratio below 25) or excess soluble C (for a ratio above 40), prior to decomposition and humification. The proposal to establish this requirement is actually intended to be over-protective of soil water quality and groundwater quality in order to meet the stringent requirements of the Regional Board.

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?

Acclimatization begins with the first winery wastewater application. Soil micro-organisms adapt quickly (within minutes to hours) to changes in organic matter inputs. Acclimatization is hastened by larger and more frequent applications. Please reread pages 29-31 to better understand the acclimatization process. A one-year time period is more than what is likely needed, and was proposed only to satisfy the excessively stringent “safety-margin” requirements of the Regional Board.

Groundwater is protected by not exceeding the soil water-holding capacity in any single wastewater application, thereby allowing time for treatment by soil micro-organisms before percolation below the microbially active soil depth (approximately five feet in most agriculturally-suitable Central Valley soils).

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.

The commenter is merely stating the obvious. BOD and N are specific in this context. Please remember the scope of work of the literature review (which did not include TDS), and refer to other sections of the report for other contaminants.

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.

The literature review did not yield any scientific basis for establishing a required depth to groundwater below the soil zone. The scope of work as established by the Project Team did not include all COCs. All natural systems have uncertainties (as do laboratory and engineered systems). If substantial rain falls on an application basin within about 0.3 to 2.6 days (for acclimatized soils) of wastewater application, untreated leachate could possibly reach groundwater. Therefore, predicted rainfall within this time period must be accounted for. The uncertainty regarding preferential pathways is obviated by managing wastewater application for retention within the soil zone. Just because grape roots may extend into fractured bedrock does not mean that the roots are in contact with the groundwater table.

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.

The determination was explained under Issue #1.

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?

"Validated" means validated by monitoring. Please note that the report recommends against relying on denitrification below the soil zone.

Recommendation 4.2: see comment above regarding hydraulic conductivity limits.

See response above regarding hydraulic conductivity limits.

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

See response 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.

The literature review revealed that purged groundwater samples will yield a false reading by preventing denitrification in the capillary zone. The issue in question is to determine the possibility of groundwater quality impact resulting from the application of winery wastewater, not regional groundwater quality or that of the "entire" aquifer. Since in this case, the EPA sample collection standard would result in a false reading, the standard in not applicable.

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.

Please refer to the explanation on pages 24-26, and the subsequent review of scientific studies on pages 26-33.

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.

How would an "overapplication" of organic matter be quantified? How would it be determined on a site-by-site basis? What scientific literature can be cited to justify the quantification? The application of organic waste with a C:N ratio within the range of 25-40 is the safety factor. In addition, the recommended limit of wastewater volume application not to exceed the soil water-holding capacity under antecedent and anticipated (weather forecast) conditions places an effective upper limit on organic matter application.

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.

The literature review has shown that it is appropriate to do otherwise in this context. See the response to the comment above on Recommendation 4.5.

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).

The LR author concurs with the commenter's second and third sentences, but not the first sentence. The prevention of future groundwater impacts at the point of land application of winery waste is the primary consideration in the LR, and its conclusions and recommendations. Groundwater quality monitoring alone is not a reliable measure of success, both due to the post-impact result, as well as uncertainties in measurement. The quantitative monitoring measures in Recommendation 5-1 are intended for the specific purpose of monitoring the safety factors that will prevent groundwater quality impacts at the point of waste application.

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.

The recommendation for additional research is specifically for use in compliance monitoring.

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).

This is understood.

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.

Please see the second full paragraph on page 50 for the definition of vinasse, the high-strength wastewater resulting from distillation. It is understood that mulch is not wastewater. The Agnew study is relevant for the effects of the biochemical decomposition of organic vineyard and winery waste and further verification of the C:N ratio.

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

"Recommended levels" in this context refers to those in effect in France. An extensive internet search was conducted to find them, but was unsuccessful.

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

See the response above.

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.

What is the regulatory basis of the distinction between wastewater and irrigation water with respect to salt? In some cases, irrigation water may have a higher salt content that wastewater. How is "straight" irrigation water defined? (For example, treated and untreated wastewater from various and multiple sources is discharged into the Bay-Delta system, the water of which is then distributed by the CVP and SWP as "straight" irrigation and drinking water.)

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.

In general, the LR author concurs with this comment. The addition of organic matter does increase the capacity of soil to retain some salts, as well as uptake by salt-tolerant plants. The commenter's statement is true with respect to any region that has inadequate drainage out of the watershed, regardless of the source of water applied (wastewater or "straight" irrigation water).

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?

The same monitoring as proposed in this LR for spreading basins should be required for cropland application. Growth of a perennial cover crop is recommended for spreading basins. Grapes in vineyards are perennial and may benefit from cover cropping in addition to the benefits to soil treatment of wastewater.

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?

The field trials reported were single applications which were not compared to multiple applications.

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

See response above regarding salt-build-up.

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.

On what basis does the commenter draw her conclusion? What scientific literature, and what alternative conclusions and recommendations based on that literature, does the commenter cite?

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.

Applying variable strength waste streams directly to soil may provide necessary treatment, but pre-application blending in temporary storage provides an additional safeguard with respect to any uncertainty.

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?

No upper limit for the concentration of C and N in solution (or in mass) was found in the scientific literature review. A higher concentration (within the suitable ratio range) could require less residence time between applications. All fertilizer amendments, commercial as well as organic, add to the salt load, as does all applications of surface water and groundwater for irrigation. Under some circumstances, even incident rainfall can add measurable salt. Chemical fertilizers constitute the highest salt addition by concentration, and possibly also by 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.

The benefits of applied compost to improvement in soil wastewater treatment capacity are detailed in the LR.

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).

Comment noted.

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.

The LR found no information to substantiate this conclusion.

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

This issue was not addressed 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.

The subject of the WI/KJ Study and the LR is the land application method of winery wastewater disposal, not the other methods referred to by the commenter. Regional Board staff have in the past claimed to have monitoring data from land application sites indicating impacts to groundwater quality. This data has never been made available and subject to the same type of peer review analysis as has the WI/KJ Study. The comment implies that this data may not even exist.

The commenter’s reasoning for the inappropriateness of using the term BMP is inexplicable.

Response to Comments Submitted by Kennedy/Jenks Consultants

General Comments

1. As previously indicated to you via email on 19 October 2007, one of our primary concerns is whether the findings and conclusions of the literature review pertain equally to two fundamentally different types of land application: (1) high-rate application in spreading basins designed for rapid infiltration, where alternate wetting and drying cycles are employed to optimize treatment; or (2) slow-rate, continuous application for crop irrigation at rates that are optimized for plant and soil agronomic capacities. Since the Wine Institute's study specifically investigated use of spreading basins, conclusions and recommendations of the literature review that relate to best practices for crop irrigation are not directly transferable to the WI's guidelines. The scope of the literature review did, however, include addressing the potential applicability of the guidelines to crop irrigation specifically under Issue 6. The WI suggests that the Literature Review Report be modified to differentiate the findings based on research related to spreading basins. This could be accomplished in the Report by consolidating the analysis and conclusions related to crop irrigation within the discussion of Issue 6.

The analysis and conclusions related to crop irrigation with wastewater are already consolidated under Issue 6. The points of difference between spreading basin rapid infiltration and crop irrigation are specified in the Issue 6 conclusions; in other respects, the two types of land application are not fundamentally different, as the report explains under this and other Issue sections.

2. The literature discusses two types of nitrogen removal that are naturally occurring in the environment: reactions where nitrogen is incorporated into soil microbial biomass, and reactions that have biogeochemical drivers (e.g., nitrification/denitrification). Although both types can contribute to nitrogen control, the WI study focused only on identifying conditions and practices to optimize nitrification/denitrification processes. As a result, the conclusions and recommendations of the literature review that are oriented toward enhancing soil aerobic microbial biomass activity would be out of context if incorporated in the guidelines. In fact, some practices and conditions intended to promote microbial activity could be detrimental to denitrification. The WI suggests that the Report be modified to separate the conclusions and recommendations that are applicable to optimizing the denitrification process from the alternative concepts developed based on the literature review.

The commenter does not identify what practices and conditions intended to promote microbial activity could be detrimental to denitrification. In contrast, the LR reports on studies that show that denitrification can occur simultaneously with aerobic OM decomposition and humification. The LR recommends a land application practice that can accomplish both objectives, while avoiding reducing conditions that could result in increased Fe and Mn solubility, as well as any possibility of incomplete denitrification, both of which are of particular concern to the Regional Board.

3. The Report provides information on some topics that are outside the intended scope of the literature review, as defined by the original 10 unresolved issues. These areas include mulching and composting of solid wastes, use of wetlands, and consideration of other treatment methods. For clarity, the WI suggests that these materials be transferred to appendices of the Report. This would ensure that useful findings are conveyed for reference, while keeping the full focus of the Report on application of process water to spreading basins.

The composting of winery waste and the use of wetland treatment are both pre-treatment methods, the material pertaining to which occurs under Issue 7, the question on whether pre-treatment should be conducted and with what methods. How is this material outside of the intended scope of Issue 7?

4. For each of the 10 issues, the Report provides the PI's analysis of the issue, literature review results, literature review conclusions, and conclusions for the WI study and guidelines (or recommendations). In some cases, it is difficult to readily discern which of the conclusions and recommendations are directly indicated by the literature, and which were inferred by the PI from the findings. The WI would welcome modification of the Report to more clearly differentiate the source of conclusions and recommendations. This could be accomplished by adding a separate section for PI comments and recommendations to the discussion of each issue.

The purpose of the four headings under each issue is to provide the distinction and separation the commenter is requesting. If the commenter wishes to avoid PI-adulterated content, please read or retain only the material under the Literature Review Results heading.

Comments by Issue

Issue 1.
Information that was gathered substantiates applicability of the guidelines to loams, silt loams, loamy sands and sandy loams, with some limitations that should be indicated in the text. However, as noted in General Comment #1 above, conclusions regarding soil texture are quite different for slow rate irrigation-style land application and the rapid infiltration practice that was the focus of the Wine Institute's study. For example, the Report indicates that finer textured soils are better for land application. Although this is accurate for irrigation-style land application, for a rapid infiltration system, the higher permeability of coarser textured soils is more desirable.

The higher permeability of coarse-textured soils is exactly the land application circumstance with the greatest potential to lead to groundwater pollution if not conducted with the utmost care. Hence, the extension of land application suitability to finer-textured soils allows for greater certainty of "rapid" infiltration wastewater treatment without groundwater pollution, with a larger management margin of error.

Issue 2.
Information that was gathered substantiates that measurement of iron and manganese can be used as an indicator of lowered redox potential conditions where denitrification will occur. Specifically, the literature review found a direct relationship between iron and manganese concentrations and the absence of nitrate in groundwater (refer to page 19, paragraph 2 of the Report). We agree with the reported finding that nitrogen removal also occurs under other conditions and through other means.

Comment noted.

Issue 3.

The literature review suggests that the upper limit of BOD proposed in the guidelines would be conservative, and concludes that there is no basis for limiting BOD mass loading. It also indicates that the Carbon to Nitrogen ratio (C:N) is a more appropriate measure if the objective is management of soil microbial biomass. The PI recommends a C:N ratio of (25-40:1) and pH (7 - 8); these criteria appear to have been selected for optimal humification of soil and carbon sequestering. However, because the WI guidance pertained to land application in spreading basins, these recommendations are not directly applicable.

The proposed C:N guideline is directly applicable to spreading basin land application as a safeguard for incomplete denitrification, or to allow the avoidance of increased soluble Fe and Mn.

Issue 4.

The literature review substantiated that this is accurate. Key parameters to assure denitrification in the vadose zone include the presence of sufficient amounts of dissolved organic carbon (or BOD) and nitrate. The PI also recommended that the upper five feet should be managed to optimize treatment activity, with particular attention to hydraulic loading, including uniformity of application to mitigate preferential flow paths.

The mitigation for preferential flow paths is retention of wastewater within the soil zone until treatment is complete, a maximum of 2.6 days for winery waste acclimated soils.

Issue 5.

Monitoring programs, as described in the guidelines for site selection and process water application management, were substantiated in the literature. Lysimeters were not found to be reliable for this application. The PI also recommended that measures of soil microbial status be incorporated. However, because soil microbial status monitoring is still considered primarily a research technique, it would not be appropriate to recommend it in the guidance.

The recommendation for soil microbial status monitoring is further research and field trials for the reason stated, not immediate implementation.

Issue 6.

The literature review supported application of the WI guidelines to irrigation, but also identified additional measures that would contribute to best management. Accordingly, some modification of the WI guidelines would be needed if this is an objective. As indicated in General Comment #1 above, evaluation of this issue led to a set of observations and recommendations that are potentially useful in designing an optimal system for irrigation with wastewater, but not relevant to the rapid infiltration practice investigated by the WI.

The commenter's statement is correct, except that the WI/KJ guidelines for spreading basin land application would not need to be modified for the Issue 6 recommendations, but would need to be modified to assimilate the other Issue recommendations.

Issue 7.

The literature review suggested that some level of pre-treatment or equalization is appropriate to address the variability in winery wastewater characteristics prior to land application for crop irrigation. For spreading basin application, the guidelines for limiting constituent analysis already indicate that there are two cases where pretreatment or alternate disposal is needed: (1) if process water pH is outside the range of 3 to 10, or (2) if the ratio of BOD:TN is less than 20. In the absence of those conditions, adherence to the guidelines will preclude the need for pretreatment.

The proposed LR guidelines are specifically intended to modify the WI/KJ guidelines, for greater certainty of groundwater quality protection in spreading basin land application.

In conclusion, the WI would like to acknowledge the beneficial contribution of the literature review to the further development of best practices for land application in the wine industry. We recommend that the Project Team meet to discuss next steps, including potential strategies for addressing the general comments presented in this letter. One approach that can be considered is a workshop-style meeting to review the Report on an issue-by-issue basis with the goal of identifying items that can be reorganized, such that changes are mutually acceptable and the final report will best accomplish the original objectives for the literature review. We look forward to continuing to collaborate with you in this effort.

Comment noted, with best wishes.