State of California
North Coast Regional Water Quality Control Board

PEER REVIEW COMMENTS & RESPONSES

FOR THE

ACTION PLAN FOR THE SCOTT RIVER SEDIMENT AND TEMPERATURE TOTAL MAXIMUM DAILY LOADS

November 22, 2005

State Water Resources Control Board
North Coast Region
5550 Skylane Boulevard, Suite A
Santa Rosa, California 95403
707-576-2220

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QUESTIONS ASKED OF PEER REVIEWERS

The statutory mandate for external scientific review (Health and Safety Code Section 57004) states that the reviewer's responsibility is to determine "whether the scientific portion of the proposed rule is based upon sound scientific knowledge, methods, and practices."

We request that the reviewer make this determination for each of the following issues that constitute the scientific portion of the proposed regulatory action. An explanatory statement is provided for each issue.

Nature of the water quality problem.

The Scott River TMDL Action Plan is based on the conclusion that beneficial uses of water in the watershed, notably salmonid habitat, have been adversely affected by increased sediment loadings and increased water temperature. This impact to beneficial uses is seen in declining salmonid populations over the last century and in-stream data obtained from the watershed. Additionally, water quality objectives have not been met. In-stream sampling data show that excess sediment and increased water temperatures within the river system are outside the range that fosters desired conditions for optimal salmonid habitat and other beneficial uses.

1. Is the method used to demonstrate the linkage between changes in sediment loading and stream temperatures, habitat changes, and impacts to beneficial uses based on sound scientific knowledge, methods, and practices?

Use of in-stream metrics to represent properly functioning conditions.

Assessments of stream and habitat conditions are based on an evaluation of a suite of in-stream indicators. These indicators were selected based, in part, on their importance to desired salmonid habitat conditions. Selection of numerical values was based on a review of existing literature throughout the Pacific Northwest regarding the needs of the salmonids and conditions that would be found in natural streams that fully support salmonid species. In-stream indices include aquatic insect assemblage, embeddedness, large woody debris, pool distribution, percent fines, thalweg profile, and V*. The in-stream indicators and target values were peer reviewed in 2004. Therefore, review should focus on whether it is appropriate to apply the indicators to the Scott River Watershed.

2. Is it scientifically sound to apply the in-stream indices selected, which were derived based on literature research, to the Scott River to represent, or assess, the quality of in-stream salmonid habitat?

Sediment Source Analysis.

Watershed-wide sediment inventories and the evaluation of sediment delivery to watercourses are the basis for estimating sediment delivery rates. Sources include roads, landslides, soil creep, and a variety of large and small erosion and mass wasting features. The inventory estimates rates of anthropogenic and natural sediment production. Desktop review is supported by fieldwork to assess a subset of the total number of sites within the watershed.

3. Are the methods used in the sediment source analysis based upon sound scientific knowledge, methods, and practices?

Sediment TMDL

For the Noyo River, the USEPA used a reference time period to calculate the TMDL for the Noyo River (EPA, 1999). The TMDL for the Noyo River was set at the estimated background sediment delivery rate for the 1940s. Because salmonid populations were robust during this time period, which was assumed to be a quiescent period between the logging of old growth at the turn of the century and logging of second growth in the middle of the 20th century, EPA postulated that there could be increases above the natural amount of sediment and still maintain healthy watershed conditions. Analysis of sediment sources during this period indicates that there was about one part human induced sediment delivery for every four parts natural sediment delivery (i.e. a 1:4 ratio, or a 25% increase). The TMDL for the Scott River is set equal to the estimated loading capacity of the river and its tributaries. Taking the EPA study of the Noyo River as the best available information relating to acceptable level of increase, the Scott River TMDL is set at 125 percent of natural sediment delivery.

4. Is the method used to calculate the TMDL based upon sound scientific knowledge, methods, and practices?

Temperature Modeling

The impact of various parameters (i.e., shade, flowrate, groundwater accretion, surface water diversion, and channel geometry) on stream temperature were evaluated using the HEAT SOURCE computer model. Results indicate that direct solar gain and groundwater accretion have significant impacts on stream temperature. Analysis of current and potential streamside shade was performed in several stream reaches using the RIPTOPO model. Results of the temperature analysis indicate that increased shade canopy would improve water temperatures in all the stream reaches evaluated. This conclusion was extrapolated to the entire watershed. Consequently, the temperature TMDL proposes to control direct solar gain. Effective shade was selected as the surrogate TMDL metric for direct solar gain to the stream.

5. Do the methods and assumptions used to predict the flow and hydraulic geometry of the modeled stream reaches result in a proper characterization of hydrodynamics?

6. Were sufficient types of stream reaches modeled to extrapolate results into the broader watershed?

7. Is the use of Manning's “n” as a model calibration parameter appropriate?

8. Does the analysis demonstrate the HEAT SOURCE computer model is sufficiently calibrated and validated to evaluate the effects of various parameters on stream temperature?

9. Does the analysis demonstrate that effective shade is a scientifically sound metric for controlling near-stream practices that affect stream temperature?

10. Does the analysis demonstrate that groundwater accretion has an influence on in-stream water temperatures?

Other Issues

Reviewers are not limited to addressing the specific issues presented above. We invite you to contemplate the following "Big Picture" questions.

11. In reading the technical reports and proposed implementation language, are there any additional scientific issues that should be part of the scientific portion of the proposed rule that are not described above? If so, please comment with respect to the statute language given above.

12. Taken as a whole, are the scientific portions of the proposed rule based upon sound scientific knowledge, methods, and practices?

Reviewers should also note that some proposed actions may rely significantly on professional judgment where available scientific data are not as extensive as desired to support the statute requirements for absolute scientific rigor. In these situations, the proposed course of action is favored over no action.

Dr. Don C. Erman's Comments

Peer Review of

Staff Report for the Action Plan for the Scott River Watershed Sediment and Temperature Total Maximum Daily Loads

By

Don C. Erman

Response to issues requested of peer reviewers

Nature of the water quality problem:

1. Is the method used to demonstrate the linkage between changes in sediment loading and stream temperatures, habitat changes, and impacts to beneficial uses based on sound scientific knowledge, methods, and practices?

The combination of literature review, site sampling and simulation has demonstrated the linkages mentioned and the approach is based on sound scientific knowledge, methods, and practice.

Use of in-stream metrics to represent properly functioning conditions:

2. Is it scientifically sound to apply the in-stream indices selected, which were derived based on literature research, to the Scott River to represent, or assess, the quality of in-stream salmonid habitat?

The indices are all standard methods now and are appropriate to the Scott River basin. The list of indicators might be expanded at least to include stream width because this variable is assumed to be out of its normal range presently, is shown to be an important factor in evaluating sediment loads and temperature and should adjust with time as conditions improve. Of importance to the assessment of conditions is not only the list of methods but also the timing and frequency and design of sampling needed to judge change at locations and over time. This aspect will be addressed after adoption of the TMDLs, as indicated in Chapter 6. Some of the indices are partially redundant or correlated (e.g., sediment size and fines, embeddedness and V*). (I believe this statement can be checked by review of the study by Knopp for coastal streams in logging areas as part of the CDF Pilot Monitoring Group.)

The conclusion by Quigley (2001) that the surveys of macroinvertebrates of a few sites with a very few samples are sufficient for a "baseline" is doubtful. Much more extensive and intensive sampling would be necessary to establish a true baseline of biotic conditions. The problem with settling on some or a few metrics for macroinvertebrate assemblages was summarized by Magurran (1988) who recommended trying many different indices to see what "works". All indices tend to emphasize certain factors of abundance and distribution and the "right" metric(s) is seldom known in advance.

<u>Sediment source analysis</u>:

3. Are the methods used in the sediment source analysis based upon sound scientific knowledge, methods, and practices?

The methods used to inventory sediment sources seem appropriate to the problem. The scale and level of detail needed is quite daunting. There has been substantial field analysis and measurement to support other methods of obtaining estimates. Nevertheless, the uneven nature of some field data collection (validation) can be worrisome for estimates that require extrapolation. For example, there has been much work (although not stratified by basin types) on problems of sediment delivered by road systems. In the final summary of source allocation, however, the far greatest contributor of sediment is the streamside small discrete features category. Efforts to assign human and non-human cause are crucial to the final load allocation. Locating small discrete features may also be sensitive to the sampling design and affect the final estimates. More work is needed to check the initial assumptions and the sensitivity of results to these considerations.

The work has been thoughtful in its stratification of sampling and the rationale for creating classes. These steps have strengthened the reliability of most estimates. In some cases, however, the Water Board staff should explicitly target locations and estimates where assumptions can be tested. A summary of some of the future needs for study is presented in Chapter 7; however, the staff might consider developing a more detailed list of "assumption checks" which they and their collaborators could address as time and resources permit.

<u>Sediment TMDL</u>:

4. Is the method used to calculate TMDL based upon sound scientific knowledge, methods, and practices?

The general approach of applying a factor (additional 25%) to natural loading seems reasonable and based upon previous work elsewhere. The various sources of sediment are well described. The combination of remote assessments, reviews, and ground checking has been impressive for a problem of this magnitude. The issue may focus on whether or not the level of natural loading has been estimated correctly. There is always a question of whether the procedures for finding and allocating sources have been given enough effort. For the scale and level of detail needed for this basin, the procedures are adequate to the problem. Improvements should come with further study along the lines I mentioned above and summarized in the draft.

A deeper problem may lie with the statements that the natural load is known to be an underestimate (thus providing a built-in safety factor). There should be more description (qualitative or quantitative) of how one can tell the estimates are lower than actual. The closest section I could identify that dealt with a method that could lead to underestimates of loading was in the section that resulted in Table 3.15. There is another section (3.2.2) that also discusses "conservative" estimates of time intervals of sediment delivery. But the later is not an allocation of natural or human source—only the time period for distribution of any sediment. The Draft should present a clearer summary of what methods and logic were used by the staff to create a condition of underestimated natural load.

I would suggest it is preferable to make any estimate as reliable and close to actual as possible. When there is uncertainty, it would also be preferable to present some way of evaluating the level of uncertainty (as done, for example, in the temperature model output evaluations) or list the rules and assumptions for critical steps in combining elements of the source allocations. This procedure may be already in the text, but it is scattered and incomplete. For example, it is clear that the estimates of human or non-human source of discrete features were not estimated for all disturbance sizes or locations. But the consequences of that procedure need evaluation. In problems of this complexity, it is an acknowledged fact that "errors" can pile up. I suggest that no methods be used that incorporate known bias; at least then the errors should be more random. In places, I thought that the estimation procedure of sediment quantity was separate from the process used to judge whether it was from human or natural causes. The estimates of all sediment loss may be underestimated but that issue is different from whether the judgment of human or non-human was biased.

If the range of uncertainty can be estimated at all, it would seem to me more transparent to incorporate "safety" as an adjustment to the multiplication factor applied to the natural loading, and make the estimate of natural loading as close to actual as possible. The interpretation may be resolved by careful reflection on what is meant by "underestimate of natural loading". I suspect that loading was underestimated but the allocation to human or non-human cause may not have been. The results of the present analysis are both a development of TMDLs and a basis for concluding that excess sediment and temperature "are outside the range that fosters desire conditions."

Temperature modeling:

5. Do the methods and assumptions used to predict the flow and hydraulic geometry of the modeled stream reaches result in proper characterization of hydrodynamics?

The Draft has used fairly standard procedures for predicting flow and geometry. Checks of assumptions have generally been good (e.g., measuring flows for possible ground water accretion zones, developing rating curves, regression). I was less confident that the assignment of large reaches of stream channel according to one or two Rosgen-type classes was valid or what the consequences of a finer scale classification would mean to the results. The text is not entirely clear on the issue of stream width. At one point, it seems that low flow channel width is estimated from an adjustment of the well-established statistical relationship of bankfull flow vs. drainage area. Later, the temperature model used actual field-based measurements of average wetted channel width. I could not determine how the draft dealt with the issue of the channel being wider than it should be under natural conditions. Thus, the model run (Fig. 4.13) with half potential width is not entirely clear. The latter point may not be relevant to modeling temperatures under existing conditions, however. The draft has apparently just concluded that unnatural width is a margin of safety. As an aside, I wondered, given the frequent field samples of channel width, why the staff did not also measure actual average depths and make their own determination of channel type.

The text is not entirely clear on how sinuosity was eventually calculated or how sensitive model results might be to this variable. Mass balance approaches for computing change in temperature from the joining of flows of different temperature are also well established methods.

6. Were sufficient types of stream reaches modeled to extrapolate results into the broader watershed?

Questions like this emerge for a whole suite of variables and the only way to know or get a feel for the answer is to collect more data specifically designed to test the assumptions. Elsewhere in the Draft the staff has conducted some evaluation of "errors" in comparing model results to measured values, and this general approach could be applied to other situations. The use of stratified random sampling for some data was an extremely valuable approach and lends support to the use of broad extrapolation.

7. Is the use of Manning's n as a model calibration parameter appropriate?

There are two issues with regard to using Manning's n. First is whether the determination in the field, based on the guide provided in the USGS publication, was made consistently by all personnel who conducted the surveys. No details were given to judge quality control. If, as likely, Water Board staff who conducted the surveys have familiarity and practice with judging n, then statements to that fact are important in the text and support the idea of consistency. The second issue, changing estimates of n until the model seems correct, is less objective. There are many variables that go into the model. There is no discussion in the text as to why Manning's n was chosen as the variable to adjust—was the choice suggested by other users of the model or did the staff use trial and error to find what worked? If the personnel who made estimates of n are confident of their ability to determine n, then were the field determinations frequent enough to provide coverage? (A single value of n, 0.225, on the mainstem Scott River from mile 1 to nearly 30, looks suspicious.) Because in some segments of the basin, the model seemed to require no adjustment of Manning's n, there is little in the Draft to allow a reader to know whether using Manning's n as a "calibration" tool makes sense. And, if n is changed, the Draft should explain how much change in n was made. In the case of complex models, it is a questionable practice to build a model based on estimates of the needed variables, but then change the values of a variable if the model doesn't "work", unless there is evidence for which variable should be changed and how to change it. The text also does not explain the variable requirements for the Model. Thus, initially I had assumed that estimates of "dominant particle size" were used somehow as a basis of estimating "roughness" (Manning's n).

8. Does the analysis demonstrate the HEAT SOURCE computer model is sufficiently calibrated and validated to evaluate the effects of various parameters on stream temperature?

The Draft provides tables for judging the adequacy of the calibration and validation of the model. In some cases (stream reaches) the model did poorly but overall, with the scale and level of detail needed, the model does reasonably well in predicting temperature. It may be pushing the limits of the model to expect it both to function well at specific sites and to predict overall trends such as gradual warming downstream or sharp changes where major ground water is added. On a river scale, the model responds in ways that fit expected connections to shade, groundwater accretion, and other factors. The Draft might be expanded somewhat by illustrating more examples of temperature simulations with variations of several factors. In particular, there could be plots that incorporate at least some combinations of shade, groundwater, surface diversions and change in channel width. The full value of the model should be to compute a prediction with a range of each variable in combination with others. The number of possible combinations is quite large but such model runs might give insight into interactions or the scope for cooling under an "ideal" combination. In particular, interactions among shade and groundwater accretion would be instructive. The suggestion of using RIPTOPO (or other models) to help organize and prioritize future actions is an important statement and stems from model capability to examine different assumptions and variations in key variables.

9. Does the analysis demonstrate that effective shade is a scientifically sound metric for controlling near-stream practices that affect stream temperature?

There is already a well-established literature that demonstrates the connection between shade and stream temperature. The analysis has demonstrated that among the variables examined that have known potential effects on stream temperature, effective shade in the Scott River system is one of the most important for improving stream conditions. The extension of the analysis to microclimate effects on stream temperature is an interesting approach and shows the value of the model for examining other conditions. The text should define "effective shade" when first used and be consistent in use of terms between text and figures.

10. Does the analysis demonstrate that groundwater accretion has an influence on in-stream water temperatures?

My assessment is similar to question 9. The influence is already well known. The analysis has demonstrated that the main stem of the Scott River in particular is quite sensitive to the influence of groundwater accretion and that measurement and simulation suggest water quality problems are associated with the groundwater system.

Other Issues

The Draft incorporates much detail and many steps in constructing the eventual TMDL for sediment and temperature. The Draft could be improved by giving the reader more forecasts in introductory sections of what is to come. For example, although the models are referenced for full examination, it would nevertheless help comprehension if a list of the critical variables were defined first and what variables/factors needed to be measured in the field. I did not understand the purpose of some sections until nearly the end of major parts of the report.

The implementation section gives an impression that most features (e.g., sediment sources or effective shade) would be addressed in parts and pieces. That is, improvements will come by changes in some factor, in some practice or in some project. The Draft also makes clear that the number and diversity of partners and collaborators in this basin are large and complex. But the TMDLs are scores for the integration of all factors on fairly large scales (river wide for sediment). Specific language even states that the TMDL for sediment will be judged on a 10-yr rolling average. I am unsure from the Draft how, when and who will be integrating the data to report whether the Scott River is meeting the overall TMDL. I suggest that the Draft discuss in chapter 6 a preliminary timeline, for example, when the Water Board will recalculate the TMDLs to gauge progress or update something like Fig. 4.28 for temperature.

The language of implementation is also purposely vague at this stage (especially given what is hoped to be a collaborative nature of achieving improvements and measuring success) and gives only broad direction for how the process might work to carry out needed improvements in the watershed. Nevertheless, in places it sounds as if the Draft is restating the need to use Best Management Practices. I would assume that BMPs have been in force in much of the basin but have either been unsuccessful or not applied.

The Water Board staff may also wish to review sections the Sierra Nevada Ecosystem Project report (e.g., Chapter 36, Vol. II; Chapter 5, Vol. III; Chapter 2, Addendum) that deal with riparian conditions and management. The approach and logic may provide ideas for the Wetland and Riparian Protection Policy under consideration.

The Draft Staff Report has taken on a huge analysis project. The demands for data are both broad and specific. There is evidence of joint problem analysis and solution that suggest future progress. The reasoning for what has been studied and how features have been addressed is generally understandable, consistent and valid. The broad framework for assessing sediment sources and allocating them among sub-basins, conditions and causes is sound. The computer models adopted for sediment and temperature seem fitted to the scope of the problem and within the capacity of the Water Board and others to provide needed data. Where assumptions and extrapolations have of necessity been made, future targeted study should help clarify their importance and fill gaps.

Peer Review of

Staff Report for the Action Plan for the Scott River Watershed Sediment and Temperature Total Maximum Daily Loads

By

Don C. Erman

Specific Editorial Notes

p. 1-2. Somewhere in this section it would be useful to give the ownership breakdown and possibly a map showing federal, state, and private land. Later places in the text talk about ownership and such distinctions as private commercial forest but the relative amount or the location is vague or given much too late.

p. 2-9. State whether the McNeil sampler was used for all the streams, not just French Creek.

p. 2-10/11, Sec. 2.2.1.7. V* Condition
Discuss the timing of restoration on French Creek with respect to the timing of sediment sampling. One cannot tell if the highest value was before, during, or after work began. If the samples were affected by the restoration (especially work on road crossings), then the high value may not reflect the trend assumed. The conclusions that may be drawn from the data (revised as per subsequent updates of the draft) as given on the last line p. 2-9 may be overstated. The highest value at the beginning may be affected by restoration and the remaining values in the time series show no clear pattern of decrease with time.

p. 2-12, first paragraph. There is no explanation up to this point of what are "point-source categories" mentioned in the inventories. Explain.

Conditions in Scott River
The section at the top of p. 2-12 suggests that not all roads have been surveyed in the entire basin. The discussion seems rather loosely connected to the (road crossings) topic in places. Is it possible to partition the miles of road in the three categories under Target (2.2.2.3)? What is the potential for decommissioning miles or making them "hydrologically maintenance free"? On p. 2-10, for example, the text suggests some problems are irreversible. A summary table of current conditions (by Target Class) and potential condition might help. What proportion of the entire watershed road system has been surveyed? Total miles are reported later but might be included here as well.

p. 2-13 Conditions in Scott River
The draft states that SHN Consulting surveyed the road system on 12 square miles and found problems. Fruit Growers Supply is said to have "agreed to develop a plan…" And the Forest Service conducted a large-scale survey of road stream crossings. These topics and the results seem to come up in later

sections. But it may still be helpful to cite either some summary statistics here or direct the reader to the fact that these points will be discussed in later sections.

On both p. 2-12 and 2-13 the discussion of data sources focuses on small-scale studies although the topic is the entire Scott River basin. I have trouble seeing the picture of the whole basin in these sections
p. 2-14, sec. 2.2.2.4. The total miles of road are reported later but could be stated here in the context of the discussion, and given by Target Category. The definition of "road adjacent to stream" comes up here but is left too much later in the draft for explanation and estimation. Either give the data here or direct the reader to the later sections where it is reported.

p. 2-15, sec. 2.2.2.6. Wildlife comes up here but again, how it is dealt with comes later. Surely, it too results in removal of vegetation sufficient to reduced rainfall interception and other soil protection functions" as stated in the text. The text either here or later should clearly explain whether fire is considered a natural or human factor in terms of consideration in the TMDL.

p. 2-23, Fig. 2.3. It is not clear whether the names on the x-axis are stations on the South Fork River or stations on the tributary itself at that location. If they are stations on the South Fork, indicate whether they are below the tributary or otherwise uninfluenced by entry of cooler water. The same issue of labeling clarity comes up in Fig. 2.4 on p. 2-24. The paragraph on p. 2-24 further confuses understanding because it refers to East Fork Scott River and its tributaries. I am unsure then, what data are being shown in Fig. 2.4.

p. 2-25. The paragraph could be written for better clarity. The text says, "many sites are suitable…" when the data in Fig. 2.5 suggest that only in some years do some sites have suitable temperatures. I assume that the horizontal dashed line is the threshold for "suitable" on this and other similar figures. In Fig. 2.5, there are 30 sites apparently but only 15 with names on the x-axis. Of these, 18 never met the threshold, 7 more only met the threshold in one year—the "good" year of 1999. Only 3 stations met the threshold (barely) but 2 were sampled once (Etna and Upper Clarks Creek).

p. 2-27, sec. 2.7.1.6. I believe the second sentence should read "The majority…have unsuitable temperatures…" I can not follow the text "with the exceptions being Mill, Kelsey and Thompkins" for Fig. 2.7. Patterson Creek is not shown on Fig. 2.7; Upper Kelsey had a temperature of 10.9, Deep Ck. had 20 degrees. Review the text and figure.

Sec. 2.7.2. Define "Effective Shade" here (the first time used?) The section begins by discussing potential shade. Rearrange paragraphs or discussion so that effective shade is defined then move on to calculations of potential.

p. 2-28. Fig. 2.8 does not appear to be a comparison of the two models or comparison of model values to measured canopy as indicated by the text in para. 1, top of page. In para. 3, Fig. 2.8 is described differently. I am unclear from the text how the "90% potential" is reflected in figures 2.8, 2.9 and 2.10. Are these figures computed for a specific time—summer solstice?

p. 3-4, 3-6, 3-7 Examples of good checking of assumptions.

p. 3-5. CWEs

This section has been revised. Generally, the new language is fine and the substitution of terms for CWE are ok, if a bit cumbersome. There is one point still troubling. . If a general discussion of CWEs (by whatever name) is included, I suggest it be a separate overarching section of the report.
This section now occurs in Chapter 3, Sediment Source Analysis. From the context then, and repeated in sec. 3.8.3, it still continues the impression that interactions of human activities in a watershed are somehow tied just to erosion. The ways interacting factors are dealt with in the chapter are also limited to the sediment processes. But the draft as a whole considers much more and comes much closer to CWE (in the non-legal sense). The staff knows, for example, that water flows, groundwater interactions, and cropping and grazing of riparian vegetation are all part of the mix, and the draft has taken some pains to put these together. What this draft shows, in fact, is that even the UC Committee had a limited view of what is "accumulated" in a basin. As the SNEP report discussed in a number of chapters, conventional approaches to dealing with watershed effects have ignored such elements as grazing and water diversion. The sections in chapter 3 only deal with (some) of the interactions that affect the sediment picture. It has not even in this case dealt entirely with the interaction of surface flow and sediment (i.e., p. 4-34).

For example, the transport of sediment is integral with flow conditions. Thus, storage and channel changes reflect both the sediment source element and the transport capacity of the stream. To the degree that the Scott River no longer has a natural transport capacity, even a natural rate of erosion would continue some degree of channel alteration from normal conditions. This point comes up on p. 4-34 in Margins of Safety for temperature. Some of the connections to surface water are discussed in the draft but correction or adjustments of surface water allocation is beyond the scope of the TMDL, and as discussed in the draft, require actions by the State Water Board and others.

p. 3-6. The text mentions the Water Board staff checked the road inventory but the result is not given until p. 3-8. Perhaps connect these sections?

Sec. 3.2.1. The extrapolation of results from the South Fork Pilot Study is important but confusing and might be reviewed for improving clarity. I'm not sure sometimes if all the subsequent references to the South Fork study are the same, for example. I am not even sure where the boundaries are for the study. The South Fork is listed on two of the seven subwatersheds; thus, I am unsure how representative the Study area was in terms of geological units. Further, the RM study was only on private land and the reader has no idea of how those lands are arranged by geologic type in the Pilot watershed.
The extrapolation of results rests on whether the Pilot Study was a statistically reliable representation of the entire basin or at least with respect to the allocation of samples by geologic type. Be specific about this context.
Am I correct that in both estimates (p. 3-6, end of section) there were estimates of roads from a model and other estimates of discrete sources? In the second estimate of road sediment, only granitic types were handled separately for the modeled portion of the road sediment other than discrete sources.

p. 3-7, sec. 3.2.2. Is the reference here to RM (2000) a reference to the same data/study mentioned in 3.2.1? If so, then is it true that Water Board staff also only surveyed the portion of sites on the timber company roads? Again, there should be discussion of the representativeness of the timber company portion of the watershed.
The discussion of the role of a 14-year recurrence interval flood is not entirely clear. Did the Water Board staff conclude that only floods of that size create erosion in the basin? Does it also conclude that

erosion features identified in the survey that are less than 14 years were still caused by the flood and that those older than 14 years were influenced as well? Or was it the fact it was a "rain-on-snow" event. Flood frequency of the same recurrence interval also occurs from non rain-on-snow runoff. There are usually two features that act to produce sediment—condition of the land and triggering mechanisms. Is the stage always set for erosion but it takes a major flood to activate? Further, I always have trouble with statements that something is "conservative" or not (e.g., paragraph 4. P. 3.7). If the staff had chosen a 30-year recurrence interval, the estimate of rate would have been even smaller than that used. How does the use of a 14 year divisor for rate calculations lead to eventual underestimates of natural load (and hence a safety factor), if the staff could have chosen a 30 year time for an even lower rate and greater underestimate or safety factor? Is the safety factor here, really the difference between actual estimates of age from the 21 features versus the use of a 14-year flood? It might be useful to at least provide the average age of the 21 features. And change the last sentence on p. 3-7 that says "assuming an average 14-year recurrence interval." The statement is unclear and confuses the meaning of recurrence intervals.

p. 3.8. The text explains how road crossings were adjusted by a factor of 2 and other adjustments. It is not clear, however, whether the data of Table 3.3 and 3.4 are the raw values from Vestra, the modified road miles from RM inventory (e.g., paragraph 3, p. 3.8) and include the 2X multiplier for crossings.

p. 3.9, para 5. Explain also if Sommarstrom et al. estimated the relative storage by categories (e.g., hillslope, upper bank, etc.). The text indicates that storage by tributary "channel bedload" was included in the TMDL approach. Does that approach then eventually account for the storage categories such as upper banks, channel margins and alluvial fans which got there at some time by being in the channel?

p. 3-10. The paragraph description of Table 3.2 seems out of place and perhaps could be moved under section 3.1.4.

p. 3-11, para 3. The explanation of Table 3.5 sounds like the details of what was first described on p. 3-6, Sec. 3.2.1. To improve understanding, I suggest the terminology used in both sections be identical. For example, use SEDMOL2 on p. 3.6 (if that is the model there) and be consistent on what is called the second estimate based in part on GSS. The text is somewhat confusing also because, I think, the draft is incorporating here the adjustments to Vestra estimates. (See my comments earlier about this point and Tables 3.3 and 3.4).
p. 3-16. It is not possible to judge the reasonableness of the conclusion in paragraph 4 that numerous small landslides do not contribute much. Perhaps the draft could use some values from the Vestra survey (areas, volume?) so that the FS survey of 182 slides less than 1 acre are unimportant. The estimates of small discrete sources elsewhere in the source analysis suggest size is inverse to relative importance. Or perhaps, the survey data shows that the small slides are at great distance from water sources. The other reasons (lack of sufficient information) for not considering the FS data might be corrected by more study.

p. 3-22. The discussion at the top of the page seems redundant with p. 3-2. Perhaps just restate the draft has used the same four geological units for this analysis.

p. 3-23, The new text for this section and the additional figures are helpful. The key point in this section is in new paragraph 3, "North coast Water Board staff used the best available information to estimate the anthropogenic portion of sediment contribution…" It is clear that the staff used information and

professional judgement to reach conclusions about human or non-human causes. Even the process used to place activities into categories of 25% was not set up to favor allocation to either human or non-human cause. Thus, the process may be in error, but it is not purposely creating a bias of human origin of sediment sources. In context, I assume that the choice of 25% category reflects the judgement that staff could only estimate/judge sources within about 12.5% as to cause. That value may be useful for judging the uncertainty of final estimates.
I suggest that a future project also test the assumption that large discrete features have the same proportion as estimated for human and non-human small discrete features.

Fig. 3.5 does not show an interpretation (of formerly called CWEs); only the location of sampling sites. The new figures are useful.
Why does Table 3.15 have cells for human activity but no estimate of contribution (e.g., M-03-03, S-01-03, and others)?
P. 3-28 to 30, and sec. 3.9.4.
The text is clear on the rationale for a loading capacity of 125% of the natural load. And it is important to suggest, as the draft does, some kind of re-evaluation of the ratio and progress toward the goals (p. 2-28). I remain troubled by the statement that a margin of safety is provided because natural loads were known to be underestimated. Partly, the trouble may be simply in wording. From the text earlier, it seems that the process for evaluating all sources (regardless of cause) would lead to underestimation of erosion rates. But the process for allocating cause (human or non-human) has no obvious logic or stated process for underestimating the role of humans. It turns out, of course, that the simple calculation of TMDL results in 125% being applied to the natural load portion. Loads of <u>all</u> types are likely <u>less</u> than stated. Surely, the Water Board staff does not believe that their estimate of non-human load was purposely overestimated. This value is also underestimated, if I understand correctly. Some discussion of this issue in the text may clarify understanding. Why would reviewer state that "loads of <u>all</u> types are likely <u>less</u> than stated," when we arrived at the opposite conclusion? I am not sure where the reviewer is getting his information. Will examine the text in light of this comment. DAC

p. 4-5. Surface Water. Add thermal mass to the processes affected.

p. 4-6/7. Sec. 4.2.2. The broad reasons for model choice are clear. Although the fine details of Heat Source can be reviewed on the Web, the draft should at least list the data/variable requirements of the model. This list will help the reader understand later why various parameters have been discussed (e.g., dominant particle size, Manning's n, etc.)

p. 4-9. It is unclear in some places of the draft how the staff is dealing with channel width. In the introductory section (p. 4-2), it is clear that human activities can/have produced a channel that is wider and shallower than "natural". But I am unable to see exactly how the draft has arrive at 1) whether the Scott River is wider and shallower, and 2) what should/could be the natural shape. Has the Rosgen (1996) width-to-depth ratio been used as the natural condition?
(The text refers to section 2.8 for discussion of channel width but I could not find it. The missing section 2.8 may have clarified these points.)
Further, it is not clear <u>why</u> the low flow channel width is always 50% of bankfull. (I understand <u>how</u> the 50% channel was estimated.) Although bankfull width (and discharge) at a station is a constant, "low flow" is not. Has the draft assumed some low flow value or does the change in width vs. Q become insignificant below some value of Q? Explain.

p. 4-10. Sinuosity. I would have expected for this exercise that known meander frequency for channel gradients would be sufficient to estimate total stream length of the straightened reaches. The process is obscure to the reader how stream lengths were eventually obtained. Is the reference (SRWC 2004) a source of how sinuosity was reconstructed? At the least, the draft should state the values of existing stream length and the "hypothetical stream channel."

Combined Factors. As I mentioned in the section in response to specific questions, I suggest a wider range of combinations be included in simulations.

p. 4-11. Sec. 4.3.1.2. In this section, width-to-depth ratios were assigned as Rosgen F or B but on p. 4-9; the draft says a Rosgen C-type ratio was used. Is this a contradiction? Explain.

p. 4-12. Was dominant particle size determined from pebble counts and therefore reflect the size class of largest percentage by weight divided by square root of 2? Fig. 4.4 does not parallel the language in the text. The reason for estimates of dominant particle size is unclear.

There appears to be a weak correlation between the dominant surface particle size (Fig. 4.4) and final values for Manning's n (Fig. 4.6). Was 'n' estimated from the dominant particle size (i.e., the roughness of the surface)? The text explains how 'n' was adjusted, so could Fig. 4.6 include the unadjusted initial estimates of 'n'? How important was sampling intensity to the final values for particle size and 'n' versus the other measured values (width, depth, etc.)?

p. 4-13, sec. 4.3.1.4. Fig. 4.9 is not especially useful for comparing modeled vs. measured shade. The "Xs" in this figure are difficult to compare with the curves. The term "effective shade" is used here. Because only 5 sites apparently have measure values of shade, perhaps a summary table in the text could be given that compares measured vs. "current modeled".

p. 4-14/15. Simple statements of "out of phase" or "under-predicts" are not in themselves completely helpful in judging adequacy of model outputs. The tables (4.4A, 4.4B) are in terms of error and bias. There needs to be more text that gives meaning to the amount of error and bias. The single sentences on p. 4-15 are not enough. In particular, if there are other studies that discusses error (item #2), this context should be developed more completely. It is also not clear from Table 4.4A&B what the units are for the various values.

Has the staff also considered the factors discussed by George Brown (of Brown and Kreiger) that affect stream heating? In particular, his early studies suggested that large pools and areas of bedrock would result in significantly different temperatures (in opposite ways) from his prediction model. Pools give a large value to area but the area does not "contribute" to heating and bedrock removes by conduction substantial heat. Perhaps these factors are incorporated in the Heat Source model. I wonder if features such as this may have affected model outputs that were "calibrated" by changes in Manning's n.

p. 4-19, Sec. 4.3.2.4. The legend and labels should parallel the terms in the text (i.e., current shade).

p. 4-21, Sec. 4.3.3.1. Missing text at end of section.

p. 4-22, Sec. 4.3.3.3. Fig. 4.20 should use terms that parallel the text. The figure legend says "Flow" and "Potential Flow".

Sec. 4.3.3.4. Fig. 4.22 only shows current shade, not potential.

p. 4-23, Sec. 4.3.3.7. The text claims much of the East Fork would have achieved temperature conditions for steelhead if potential vegetation were established. Fig. 4.23, representing “the warmest time period” still appears to have mostly warmer temperatures than the criteria on Table 2.9. Further, in sec. 4.3.3.6, the text states the model underestimates temperatures (they are warmer than modeled?). Clarify these points.
The discussion (p. 4-24) seems more correct by stating that with potential vegetation the temperature conditions could improve substantially.

p. 4-26. It is interesting that even though Houston/Cabin Meadows Creeks apparently had weaker data for many of the model parameters, the results “demonstrated that the model accurately predicts temperatures…” Does this reflect a feature of the model, perhaps that it is better at small than large scale? Or is there an expectation of model performance (i.e., both reach and basin scale) that is unreasonable? The model was also “calibrated” apparently by changing Manning’s n. Does that mean the predictions were also possibly out of phase or under–preditions as on p. 4-14/15 until ‘n’ was adjusted?

p. 4-27. I believe the figure referenced at the top of the page (Fig. 4.24), para 5, is incomplete.

p. 4-30. I suggest rewording of the statement that “all sources of stream temperature are accounted for with shade.” There are a result elsewhere to show that groundwater is important. Implications of model runs with the combinations suggested earlier should help sharpen or clarify the relative role of shade and groundwater (or surface water flow) by reach or subwatershed.

In several places, there is mention of estimates of temperature when streams are the hottest. And the models of shade are based on conditions at the summer solstice. The text might point out early that these periods are not coincident. As the early work by Brown and Kreiger discussed, maximum stream heating combines the solar flux and the surface area and volume of water. So, maximum heating is usually a month or so later than the solstice.

Implementation

Is there some expected rate of achievement of the goals/targets for sediment and temperature, or is this part of the future collaboration planned among interested parties?

DR. DOUGLAS D. PIIRTO'S COMMENTS

August 3, 2005

Mr. Ben Zabinsky, Water Resources Control Engineer
California Regional Water Quality Control Board
5550 Skylane Boulevard, Suite A
Santa Rosa, CA 95403

Subject: Review of the Scientific Basis of the Scott River TMDL Action Plan and Staff Report

File: Scott River, TMDL Development and Planning

Dear Mr. Zabinsky,

I am writing this letter to document my review comments of the scientific portions of the Scott River TMDL Action Plan and the corresponding Staff Report. I reviewed the following four documents:

1. The plain English summary of the Scott River TMDL Action Plan

2. The list of scientific issues and questions to guide focus to the review that is presented here

3. Action Plan for the Scott River Watershed Sediment and Temperature Total Maximum Daily Loads

4. Staff Report for the Action Plan for the Scott River Watershed Sediment and Temperature Total Maximum Daily Loads.

I have organized my review to be responsive to the issues and associated 11 questions shown in Enclosure 2 titled "Description of Issues to be Addressed by Peer Reviewers." First, however, to set the stage for my review, I am listing a few key characteristics of the Scott River Watershed area and providing a short summary of the purpose and need for action. I make this effort to do so as these key characteristics influence my review comments.

Scott River Watershed Key Characteristics (information as shown in the NCRWQCB 2005 Staff Report and associated documents)

1. The watershed is located in Siskiyou County. The Scott River flows north and is tributary to the Klamath River. The watershed encompasses approximately 520,184 acres.
2. Seven uniquely different sub-watershed basins exist within the Scott River watershed.
3. The Scott River has two major reaches (i.e., canyon section and valley section).
4. Precipitation in the form of rain or snow varies substantially from a low of 12-15 inches/year in the Eastside Mountains to 60-80 inches/year in the mountains to the west and south of Scott Valley.

5. Topography is quite varied from the gently graded floor of Scott valley to the rugged mountain areas with steep canyons and fast moving streams.
6. Conifer vegetation or mixed conifer and hardwood species occur on 81% of the land area within the watershed. The remaining 19% of land area is covered with agricultural crops, grassland, brush or designated as other. The vegetation forms a mosaic of varied species, densities, and seral stages across the watershed area influenced by past natural and anthropocentric disturbance events.
7. The watershed occurs in the Klamath Mountain geologic/geomorphic province. The bedrock varies substantially as does topography within each of the seven sub-watershed areas.
8. Each sub-watershed area has differing sediment sources and volumes. For example, the West Canyon area is identified as having a high landslide risk with a sediment volume of 1070 tons/sq mi-yr. of which 559 tons/sq mi-yr are from natural sources. The Scott Valley area on the other hand is shown as having no landslide activity and the lowest sediment volume (531 tons/sq mi-yr).
9. Approximately 5,800 people live in the watershed area
10. Ground water aquifers are identified as a very important source of water supply to the river system and to the local community. They also play an important role in stream temperature regulation.
11. Mining, ranching (i.e., grazing), transportation (i.e., roads), farming (e.g., hay cropping), recreation, logging, urban development are some of the past and current land uses that occur within the watershed. The extent of this anthropocentric disturbance varies within each sub-watershed basin.
12. Approximately 10.4% of the watershed is designated as wilderness and 1% as wild and scenic river area. The land is managed/owned by public agencies (e.g., Forest Service, BLM), industrial owners (e.g., Fruit Growers, Timber Products Corporation), and private citizens.

Purpose and Need

The North Coast Regional Water Quality Control Board is proposing an amendment to the Water Quality Control Plan for the North Coast Region titled the "Action Plan for the Scott River Sediment and Temperature Total Maximum Daily Loads (Scott River TMDL)." It is stated in Attachment 2 that the Scott River TMDL "is based on the conclusion that beneficial uses of water in the watershed, notably salmonid habitat, have been adversely affected by increased sediment loading and increased water temperature." It is further stated "In-stream sampling data show that excess sediment and increased water temperatures within the river system are outside the range that fosters desired conditions of optimal salmonid habitat and other beneficial uses."

Nature of the Water Quality Problem

1. Is the method used to demonstrate the linkage between changes in sediment loading and stream temperatures, habitat changes, and impacts to beneficial uses based on sound scientific knowledge, methods, and practices?

   Answer: No.

- Numerous statements occur in the Staff Report, Action Plan and Attachments that indicate that sediment load and stream temperatures are outside the normal range of conditions. However, I am very confused on what constitutes normal in the context of episodic ecosystem events that randomly occur within any given ecosystem. We are told that sediment loads and stream temperatures are presently too high. I find little information in the Staff Report that helps me determine how these levels varied through time say from the time before Euro American influence to present day. How did these levels vary in each given sub-watershed basin through time? Are past disturbance events related to the sediment loads we currently see in each sub-watershed basin? Is it appropriate to manage for an average TMDL when some sub-watershed basins have a natural sediment load that is already higher than the numbers used in the TMDL calculation formula?

- Five factors are listed on page 4-2 of the Staff Report as influencing stream temperature: stream shade, stream flow via surface diversion, stream flow via changes in groundwater accretion, channel geometry, and microclimate. Do these factors work in concert or does one variable have more of an affect on stream temperature than does another? Emphasis is placed in the Action Plan on maintaining shade. But is it possible that reduced flow from groundwater aquifer systems is having a greater influence on stream temperature? To what extent is shading needed along any given stream each?

- A greater degree of scientific review and analysis is needed to answer the following questions:

    - What extent of shade is needed along a given stream reach in relation to how vegetation mosaics develop?
    - How wide should the riparian zone be in relation to shading for the stream?
    - How dense should the vegetation be in relation to promoting conditions that will favor rapid development of large tree characteristics?
    - What proportion of a given stream reach should be in early, mid and late seral stages of vegetation development?
    - Will shading make any difference if ground water inputs are insufficient to provide cold water to begin with?

Use of In-stream Metrics to Represent Properly Functioning Conditions

2. Is it scientifically sound to apply the in-stream indices selected, which were derived based on literature research, to the Scott River to represent, or assess, the quality of in-stream salmonid habitat?

   Answer: Yes and No.

- The in-stream indicator list includes the following: aquatic insect assemblages, riffle embeddedness conditions, large wood debris (LWD), pool distribution and depth conditions, sediment substrate composition-percent fines, Thalweg profile, and V* conditions. I suspect that this in-stream indicator list is a good place to start however I have several concerns:

    - Stream discharge-flow rate (cubic feet second) is not listed as an important indicator. It would seem that flow rate would be important to both sediment load and temperature. And given that certain stream reaches actually dry out would tend to suggest that flow rate be factored into any mitigations regarding sediment load and temperature.

    - A full explanation of the natural range of variability in each sub-watershed basin comparing the pre Euro American period to present day is not provided in the Staff Report. More information is needed to define a desired future condition for each sub-watershed area.

- The watershed sediment list included such things as, stream crossings with diversion potential or significant failure potential, hydrologic connectivity, annual road inspection and correction, road location, surfacing, sidecast, activity in unstable areas, disturbed area, salmonid population, salmonid habitat, salmonid periodicity, salmonid temperature requirements. I found it difficult to specifically list the indicator that is being measured given the list I developed from what was presented in the Staff Report. In some cases, the item in my list is only a heading and not a measurable indicator. I found this section of the Staff Report very confounding. I have two specific concerns:

    - There is an old adage that "if you can't measure it, you can't manage for it." What specifically is being measured at the watershed level and what is the desired future condition for that watershed indicator?

    - What is the defined threshold of concern for each of these watershed indicators in relation to a defined natural range of variability and desired future condition given past, existing and future human use and development.

Sediment Source Analysis

3. Are the methods used in the sediment source analysis based upon sound scientific knowledge, methods, and practices?

    Answer: No

    - I have several observations regarding development of this watershed TMDL level. I do not, based on the scientific information presented in the Staff report, presently support the TMDL recommended requirement of 550 tons/sq mi-1 for the following reasons:

        - TMDL = Loading Capacity = (125%) x (440 tons/sq mi-yr) = 550 tons/sq mi-yr

- The total load for the West Canyon area is 1070 tons/sq mi-yr. of which 559 tons/sq mi-yr is from natural sources. How can a standard (i.e., 550 tons/sq mi-yr) that was developed for the entire Scott River watershed be applied to the West Canyon area that is already over the specified TMDL level from natural causes. Five of the seven sub-watershed basins already have a total load from natural causes that exceeds the 440 ton/sq mi-yr used in the above equation. I therefore must conclude that the selection of the 440 tons/sq mi-yr is more of a professional judgment decision rather than one based fully on scientific observation. It would seem that the recommended TMDL standard be specifically set for each sub-watershed basin rather than for the entire river but I would need to further debate this point with other forest scientists before specifically recommending a specific course of action. What is troublesome is that this scientific debate is not fully addressed in the text.

- I am particularly dismayed that the specific tables that help to illustrate how the average 440 tons/sq mi-yr figure was determined are not provided in the Staff Report that was sent to me. I was not able to locate for example, Tables 3.2, 3.3, 3.4 and most importantly Table 3.22. Other figures and tables are also missing as well (e.g., Tables 3.5, 3.6, 3.7 etc.). A list of Tables and Figures was not provided for the Staff Report. Tables and Figures are also missing from other chapters as well.

Temperature Modeling

4. Does the temperature source analysis demonstrate that the methods and assumptions used to predict the flow and hydraulic geometry of the modeled stream reaches result in a proper characterization of hydrodynamics?

   Answer: No

   - Pre Euro American vs. present day stream temperature ranges are not listed for each sub-watershed area. It is stated on page 2-21 of the Staff Report that "Summer temperature conditions in the main stem of Scott River do not support suitable rearing habitat for salmonids." On the surface, this sounds like a defensible scientific statement. But as I thought about what is being stated on page 2-21 for the various streams in the Scott river watershed, it occurred to me that summer temperatures varied naturally as a result of numerous episodic natural disturbance events (e.g., fire, climate changes, changes in ground water supply, etc.). And more importantly, stream temperatures are affected by various site factors. It is stated in the Staff Report (NCRWQCB 2005 page 2-21) "Stream temperatures vary considerably throughout the Scott River watershed in response to geomorphic and hydrologic characteristics." So, how do we know when a desired temperature condition is achieved for a given sub-watershed area given these varying conditions?

   - It is further stated on page 4-4 of the Staff Report (NCRWQCB 2005) "It has been reported that the Scott River went dry for long stretches in 1924, 1977, 1991, 1994, 2001, 2002, and 2004." I suspect that further study will show that the Scott River may have gone dry for various intervals in the past resulting from various natural and human disturbance events. Given this context, how do we manage stream temperature when water supply as influenced by episodic events is the more important variable to begin with?

- A major case is made in the Action Plan for making sure sufficient shade is provided to keep summer temperatures down within various streams in the watershed. But to what extent is shading needed in a given stream reach as compared to the larger context? How much of a given stream reach must be shaded to provide suitable habitat? Blanket prescriptions and associated action items rarely work given varied disturbance history, varied land use, and varied conditions that exist in each sub-watershed basin and within each stream reach.

5. Were sufficient types of stream reaches modeled to extrapolate results into the broader watershed?

   Answer: Given the amount of time I have to do this review, I am not in a position to fully answer this question. I do have a concern about the lack of temporal data to gauge how disturbance events/management actions influence sediment load and stream temperature.

6. Does the analysis demonstrate that use of Manning's "n" is an appropriate parameter to calibrate the model?

   Answer: It depends on it used per a recent conversation I had with Dr. Brian Dietterick who is a hydrology professor here at Cal Poly. Manning "n" is a channel roughness indicator.

7. Does the analysis demonstrate the HEATSOURCE computer model is sufficiently calibrated validated to evaluate the effects of various parameters on stream temperature?

   Answer: I am not convinced based on the data and information presented in the Staff Report that HEATSOURCE is sufficiently calibrated. I support this conclusion with the following points:

   - I did find good discussion that various parameters do influence stream temperature such as stream flow via surface-diversion and stream flow via changes in groundwater accretion. I found some very interesting discussion on page 4-15 of the Staff Report: "As flow increases, the rate of heating and accretion results in a reduction of river flow. As flow volume increases, the rate of heating and cooling decreases. Simply put, more water takes longer to heat. It is logical then that because the majority of Scott River summer flow originates from groundwater, the rate of groundwater accretion greatly affects total volume of the river, and thus its rate of heating and cooling. The results indicate that the temperature of Scott River is very sensitive to the amount of groundwater entering the river." <u>If this is the case, then why is so much attention being placed on shading when the real problem is water flow</u>

- I found numerous statements that the model is out-of-phase with measured temperatures, under-predicts, or over-predicts. And on page 4-15 the following statement appears: "the measures of error are similar to results of other stream temperature modeling efforts." What specifically is the error result for these other studies? What is the error result of HEATSOURCE as it was applied to various locations within the watershed? How is this error result affected when disturbance events are factored into the model?

- I am particularly troubled by the discussion that appears on pages 4-27 through 4-30 regarding the NCRWQCB evaluation of Forest Practice Rules. We are presented with information on the use of the HEATSOURCE model with four possible scenarios in the Houston Creek area. We are told that the model tells us that temperatures could increase if only the California Forest Practice Rules were followed from 0.5 degrees to 1.5 degrees Centigrade. How do we gauge this result in relation to the error rate for the HEATSOURCE model and in relation to surface diversion and groundwater accretion? I am not convinced that sufficient information is presented to conclude that current Forest Practice Rules are insufficient.

- Several tables and figures were absent from Chapter 4 in the Staff Report that was sent to me. I found review of Chapter 4 to be very difficult. Based on the points I make above, <u>I do not believe the conclusions shown on page 4-29 of the Staff Report are fully supported by the information provided</u>.

8. Does the analysis demonstrate that effective shade is a scientifically sound metric for controlling near-stream practices that affect stream temperature?

   Answer: No. Not when it is stated "the temperature of Scott River is very sensitive to the amount of groundwater entering the river." I can not gauge based on the information provided how increased shade levels will influence stream temperature if water flow is the primary factor controlling stream temperature.

9. Does the analysis demonstrate that groundwater accretion has an impact on in-stream water temperatures?

   Answer: Yes.

Other Issues

10. In reading the technical reports and proposed implementation language, are there any additional scientific issues that should be part of the scientific portion of the proposed rule that are not described above? If so comment with respect to the statute language given the above.

    Answer: Yes I see many issues some of which I have already surfaced in comments elsewhere in this report. Additionally:

- The emphasis of the Amendment seems to be more responsive/reactionary to a proposed agency/landowner action rather than to assist in the identification of a desired future condition. For example, the Staff Report clearly recognizes that different vegetation types and seral stages will exist at various locations along a stream course and also within a given stream reach. However, it is not clear how a given agency/landowner is directed to manage for these varied conditions that naturally develop within a stream course and its associated riparian zone.

11. Taken as a whole, is the scientific portion of the proposed rule based upon sound scientific knowledge, methods, and practices?

    Answer: Yes and no.

    - A lot of good data collection has occurred that provides a useful foundation for management decisions. However, the big ecosystem management picture still needs much more evaluation given current and projected human use and development needs for the Scott River watershed.

    - Numerous statements in the NCRWQCB 2005 Staff Report trouble me. For Example, on page 2-1 "Because information about habitat parameters in some areas of the watershed is not available, conservative assumptions based on professional judgment were made regarding factors that potentially limit salmonid populations in the basin." What are the conservative assumptions that guided the analysis? Are they documented in the Staff Report? I was asked to judge the scientific merits of the Staff Report and the associated Action Plan. I can not fully do this without full disclosure of all the information. There are several other areas within the Staff Report where this type of professional judgment statement is made. It is impossible for me to fully evaluate the science of professional judgment statements or margins of safety when little information is provided on exactly what information was used.

    - Very little if any discussion occurs within the Staff Report on the past occurrence of fire events and their episodic effect on sediment delivery, sediment volume, temperature, and ecological impacts (e.g., influence on salmonid populations, macro- and micro-invertebrates, amphibians, etc.).

    - I can not conclude that implementation actions listed in the Action Plan that suggest landowners refrain from cutting trees is supported by scientific information provided in the Staff Report particularly when it is stated across the board for the entire watershed. The Action Plan states: "The Regional Water Board encourages parties responsible for vegetation that provides shade to a water body in the Scott River watershed to (1) refrain from removing vegetation (e.g., cutting of trees), (2) refrain from conducting activities that might suppress the growth of new or existing vegetation (e.g., e.g., allowing cattle to eat and trample riparian vegetation), and (3) preserve and restore such vegetation." How does a manager sustainably manage the vegetation with a given stream reach if natural and human management actions are minimized? What proportion of a given stream should be in early, mid and late seral stages to match up with past vegetation conditions to insure sustainable management? The emphasis on the action item listed in Table 7 of the Action Plan is more focused on limiting management rather than to focus on what is "needed for sustainable management" in a given stream reach. Simply stating that one should refrain from cutting trees is not supported by science when sustainable management of the vegetation is considered. Having too many trees within a given stream reach may increase risk of catastrophic fire, hinder development of late seral stage characteristics, affect habitat conditions for various forms of wildlife, affect ground water availability in terms of evapotranspiration, and increase risk of bark beetle or disease development. A case in point centers on having too many hardwood trees in a given reach that may be influencing development of desired late seral confer tree development.

Thank you for giving me this opportunity to provide constructive feedback to help guide development of viable and effective sediment and temperature total maximum daily loads (TMDLs) for the Scott River watershed. Please contact me should you require further information (805-756-2968).

Respectfully

Douglas D. Piirto, Ph.D. and RPF #2179
Professor of Forestry and Natural Resources Management

cc:

- Dr. Don Erman, 43200 East Oakside Place, Davis, CA 95616
- Dr. Gerald Bowes, Department of Water Quality, State Water Resources Control Board, Box 100, Sacramento, CA 95812-0100

STAFF'S RESPONSES TO PEER REVIEWERS' COMMENTS

Nature of the water quality problem.

The Scott River TMDL Action Plan is based on the conclusion that beneficial uses of water in the watershed, notably salmonid habitat, have been adversely affected by increased sediment loadings and increased water temperature. This impact to beneficial uses is seen in declining salmonid populations over the last century and in-stream data obtained from the watershed. Additionally, water quality objectives have not been met. In-stream sampling data show that excess sediment and increased water temperatures within the river system are outside the range that fosters desired conditions for optimal salmonid habitat and other beneficial uses.

Question: Is the method used to demonstrate the linkage between changes in sediment loading and stream temperatures, habitat changes, and impacts to beneficial uses based on sound scientific knowledge, methods, and practices?

(1) Dr. Erman: "The combination of literature review, site sampling and simulation has demonstrated the linkages mentioned and the approach is based on sound scientific knowledge, methods, and practice."

RESPONSE: Regional Water Board staff concur.

(2) Dr. Piirto: "No. Numerous statements occur in the Staff Report, Action Plan and Attachments that indicate that sediment load and stream temperatures are outside the normal range of conditions. However, I am very confused on what constitutes normal in the context of episodic ecosystem events that randomly occur within any given ecosystem. We are told that sediment loads and stream temperatures are presently too high. I find little information in the Staff Report that helps me determine how these levels varied through time say from the time before Euro American influence to present day. How did these levels vary in each given sub-watershed basin through time? Are past disturbance events related to the sediment loads we currently see in each sub-watershed basin?"

RESPONSE: Data describing sediment loads, stream temperatures, and beneficial uses prior to Euro-American influences are not available. In fact, very little data related to these subjects were collected until recently. However, it is clear from the available information that the cold water fisheries flourished up until the second half of the 20th century (this information is presented Section 2.3 of the Staff Report[1]). It is also clear that salmonid species are sensitive to sediment and temperature conditions in freshwater environments. Likewise, it is clear that the factors that influence sediment loads and stream temperatures have been

[1] *Public Review Draft Staff Report for the Action Plan for the Scott River Watershed Sediment and Temperature Total Maximum Daily Loads* dated September 19, 2005.

significantly affected by human activities in a time period similar to that associated with the decline of salmonid populations .

(3) Dr. Piirto: "No. . . . Is it appropriate to manage for an average TMDL when some sub-watershed basins have a natural sediment load that is already higher than the numbers used in the TMDL calculation formula?

RESPONSE: Regional Water Board staff have determined that it is appropriate to manage for the Scott River watershed because the TMDL is based on a watershed-scale approach. Implementation and mitigation will be on a site or subwatershed basis. In the case of sediment, natural factors including geologic substrate, slope, elevation, and vegetation produce natural variations in sediment delivery between subwatersheds. The fact that some subwatersheds naturally exceed the average aimed for in the total watershed does not invalidate the average TMDL as a desired condition. (4) Dr. Piirto: "No. . . . Five factors are listed on page 4-2 of the Staff Report as influencing stream temperature: stream shade, stream flow via surface diversion, stream flow via changes in groundwater accretion, channel geometry, and microclimate. Do these factors work in concert or does one variable have more of an affect on stream temperature than does another? Emphasis is placed in the Action Plan on maintaining shade. But is it possible that reduced flow from groundwater aquifer systems is having a greater influence on stream temperature? To what extent is shading needed along any given stream each?"

RESPONSE: The results of the Scott River temperature analysis (presented in Section 4.3.1.7 of the Staff Report) indicate that groundwater is, in fact, a major driver of stream temperatures. The analysis also demonstrates that shade conditions must also be addressed in order for the temperature standard to be met. An estimate of the extent that shade is needed for attainment of the temperature standard is presented in Figure 4.31. A new figure has been added to the Staff Report depicting current and potential shade conditions on the mainstem of the Scott River.

(5) Dr. Piirto: "No. . . . A greater degree of scientific review and analysis is needed to answer the following questions: What extent of shade is needed along a given stream reach in relation to how vegetation mosaics develop?"

RESPONSE: The shade analysis is intended to be a watershed-scale analysis. Regional Water Board staff believe the extent of shade that is needed to satisfy the water quality objective for temperature is the extent of shade that has the potential to occur at a site, given natural conditions. The determination of site-potential conditions should be done on a site-by-site basis, and was not the objective of this analysis. Our analysis assumes that given enough time and proper management, the riparian areas of the Scott watershed will return to conditions that are known to have occurred.

(6) Dr. Piirto: "No. . . . A greater degree of scientific review and analysis is needed to answer the following questions: . . . How wide should the riparian zone be in relation to shading for the stream?"

RESPONSE: The topic raised is beyond the scope of the analysis. The objective of the temperature source analysis is to evaluate and quantify the impacts of human activities, and to provide an understanding of stream heating processes so that sources of the impairment can effectively be addressed. The Regional Water Board is developing a wetlands and riparian policy that will address the issue of riparian buffer widths.

(7) Dr. Piirto: "No. . . . A greater degree of scientific review and analysis is needed to answer the following questions: . . . How dense should the vegetation be in relation to promoting conditions that will favor rapid development of large tree characteristics? What proportion of a given stream reach should be in early, mid and late seral stages of vegetation development?"

RESPONSE: A conclusion of the stream temperature analysis is that site-potential shade conditions must exist for attainment of the temperature standard. The potential of a site to support riparian vegetation will determine the density and seral stage characteristics. The question posed is interesting, however the answer goes beyond the scope, and is not a necessary product of this analysis. Please see the response to Comment 6.

(8) Dr. Piirto: "No. . . . A greater degree of scientific review and analysis is needed to answer the following questions: . . . Will shading make any difference if ground water inputs are insufficient to provide cold water to begin with?"

RESPONSE: The effects of shade were evaluated for four different streams and are presented in Sections 4.3.1.7, 4.3.2.7, 4.3.3.7, and 4.3.4.7, and in Figures 4.14, 4.21, 4.28, 4.29, and 4.30 of the Staff Report. Based on the analysis results, Regional Water Board staff have concluded that site-potential shade conditions are critical for attainment of the temperature standard, regardless of groundwater conditions.

Use of in-stream metrics to represent properly functioning conditions.

Assessments of stream and habitat conditions are based on an evaluation of a suite of in-stream indicators. These indicators were selected based, in part, on their importance to desired salmonid habitat conditions. Selection of numerical values was based on a review of existing literature throughout the Pacific Northwest regarding the needs of the salmonids and conditions that would be found in natural streams that fully support salmonid species. In-stream indices include aquatic insect assemblage, embeddedness, large woody debris, pool distribution, percent fines, thalweg profile, and V*. The in-stream indicators and target values were peer reviewed in 2004. Therefore, review should focus on whether it is appropriate to apply the indicators to the Scott River Watershed.

Question: Is it scientifically sound to apply the in-stream indices selected, which were derived based on literature research, to the Scott River to represent, or assess, the quality of in-stream salmonid habitat?

(9) Dr. Erman: "The indices are all standard methods now and are appropriate to the Scott River basin."

RESPONSE: Regional Water Board staff concur.

(10) Dr. Erman: "The list of indicators might be expanded at least to include stream width because this variable is assumed to be out of its normal range presently, is shown to be an important factor in evaluating sediment loads and temperature and should adjust with time as conditions improve."

RESPONSE: Regional Water Board staff concur that there would be value in a stream width indicator. However, indicators proposed get at the issue of sediment delivery in an adequate way for the TMDL study.

(11) Dr. Erman: "The conclusion by Quigley (2001) that the surveys of macroinvertebrates of a few sites with a very few samples are sufficient for a "baseline" is doubtful. Much more extensive and intensive sampling would be necessary to establish a true baseline of biotic conditions. The problem with settling on some or a few metrics for macroinvertebrate assemblages was summarized by Magurran (1988) who recommended trying many different indices to see what 'works'. All indices tend to emphasize certain factors of abundance and distribution and the 'right' metric(s) is seldom known in advance."

RESPONSE: Regional Water Board staff concur. The term "baseline" has been changed to "background information" to add clarity.

(12) Dr. Piirto: "Yes and No. . . . I suspect that this in-stream indicator list is a good place to start however I have several concerns: Stream discharge-flow rate (cubic feet second) is not listed as an important indicator. It would seem that flow rate would be important to both sediment load and temperature. And given that certain stream reaches actually dry out would tend to suggest that flow rate be factored into any mitigations regarding sediment load and temperature."

RESPONSE: The in-stream sediment desired conditions (which were called indicators in the peer review draft) are intended to focus on water quality, rather than water quantity parameters.

(13) Dr. Piirto: "Yes and No. . . . I suspect that this in-stream indicator list is a good place to start however I have several concerns: . . . A full explanation of the natural range of variability in each sub-watershed basin comparing the pre Euro American period to present day is not provided in the Staff Report. More information is needed to define a desired future condition for each sub-watershed area."

RESPONSE: Please see the response to Comment 2.

(14) Dr. Piirto: "Yes and No. . . .[In regards to watershed sediment desired conditions,] I found it difficult to specifically list the indicator that is being measured given the list I developed from what was presented in the Staff Report. In some cases, the item in my list is only a heading and not a measurable indicator. I found this section of the Staff Report very confounding."

RESPONSE: Regional Water Board staff concur. Table 2.4, which summarizes watershed desired conditions for sediment in one location, has been added to the Staff Report. Table 2.5 summarizes available data from the Scott watershed for the instream parameters and compares these data to the desired conditions.

(15) Dr. Piirto: "Yes and No. . . . [In regard to watershed sediment desired conditions] I have two specific concerns: There is an old adage that 'if you can't measure it, you can't manage for it.' What specifically is being measured at the watershed level and what is the desired future condition for that watershed indicator?"

RESPONSE: The watershed indicators and desired conditions are spelled out in Section 2.2. Desired conditions are summarized in Section 2.4.1 and Table 2.4. The indicators are measured at multiple locations and the results extrapolated to watershed level.

As described in Table 2.4, there are six watershed indicators. While most of the indicators cite a desired condition that involves a trend as a component, they also include an endpoint that is measurable at a watershed scale. Diversion potential at individual crossings can be assessed based on engineering design considerations. Hydrologic connectivity can be calculated using road design information, GIS tools and readily available models. Road inspection and correction activities can be recorded and reported. Road location and surfacing is also amenable to inventory and reporting. Activities in unstable areas are typically addressed in the timber harvest review process. Disturbed areas is an area where more effort would be appropriate to develop a disturbance index or some similar measure. As such, the desired condition is a decrease in disturbed area. This again is subject to analysis based on comparison of past levels of disturbance to current or proposed future levels.

(16) Dr. Piirto: "Yes and No. . . . [In regard to watershed sediment desired conditions,] I have two specific concerns: . . . What is the defined threshold of concern for each of these watershed indicators in relation to a defined natural range of variability and desired future condition given past, existing and future human use and development.?"

RESPONSE: The indicators are evaluated in terms of whether they meet water quality standards and support beneficial uses.

Sediment Source Analysis.

Watershed-wide sediment inventories and the evaluation of sediment delivery to watercourses are the basis for estimating sediment delivery rates. Sources include roads, landslides, soil creep, and a variety of large and small erosion and mass wasting features. The inventory estimates rates of anthropogenic and natural sediment production. Desktop review is supported by fieldwork to assess a subset of the total number of sites within the watershed.

Question: Are the methods used in the sediment source analysis based upon sound scientific knowledge, methods, and practices?

(17) Dr. Erman: "The methods used to inventory sediment sources seem appropriate to the problem."

RESPONSE: Regional Water Board staff concur.

(18) Dr. Erman: "The scale and level of detail needed is quite daunting. There has been substantial field analysis and measurement to support other methods of obtaining estimates. Nevertheless, the uneven nature of some field data collection (validation) can be worrisome for estimates that require extrapolation. For example, there has been much work (although not stratified by basin types) on problems of sediment delivered by road systems. In the final summary of source allocation, however, the far greatest contributor of sediment is the streamside small discrete features category. Efforts to assign human and non-human cause are crucial to the final load allocation. Locating small discrete features may also be sensitive to the sampling design and affect the final estimates. More work is needed to check the initial assumptions and the sensitivity of results to these considerations."

RESPONSE: Regional Water Board staff concur that checking assumptions and integrating original data is desirable. Staff have used the best available data including what staff generated and data gathered from published and unpublished reports. The stratified random sampling was intended to maximize the data usability. Acknowledging that more detailed studies can lead to more insight, staff believe they have shown that the degree of detail used is sufficient for the aims of the TMDL study. The streamside features assessment discussion has been expanded and rewritten to provide more clarity on the methods used and the rationale for assigning quartiles to each reach.

(19) Dr. Erman: "The work has been thoughtful in its stratification of sampling and the rationale for creating classes. These steps have strengthened the reliability of most estimates."

RESPONSE: Regional Water Board staff concur.

(20) Dr. Erman: "In some cases, however, the Water Board staff should explicitly target locations and estimates where assumptions can be tested. A summary of some of the future needs for study is presented in Chapter 7 [Reassessment]; however, the staff might

consider developing a more detailed list of ‘assumption checks’ which they and their collaborators could address as time and resources permit.”

RESPONSE: The commenter’s suggestion is useful. Staff’s intent is to address this in reassessment of the sediment source analysis as noted in Table 7.1. As time and resources permit, staff will develop and refine changes that might be needed in assumptions.

(21) Dr. Piirto: “No. . . . The total load for the West Canyon area is 1070 tons/sq mi-yr. of which 559 tons/sq mi-yr is from natural sources. How can a standard (i.e., 550 tons/sq mi-yr) that was developed for the entire Scott River watershed be applied to the West Canyon area that is already over the specified TMDL level from natural causes. Five of the seven sub-watershed basins already have a total load from natural causes that exceeds the 440 ton/sq mi-yr used in the above equation [TMDL = Loading Capacity = (125%) x (440 tons/sq mi-yr) = 550 tons/sq mi-yr]. I therefore must conclude that the selection of the 440 tons/sq mi-yr is more of a professional judgment decision rather than one based fully on scientific observation. It would seem that the recommended TMDL standard be specifically set for each sub-watershed basin rather than for the entire river but I would need to further debate this point with other forest scientists before specifically recommending a specific course of action. What is troublesome is that this scientific debate is not fully addressed in the text.”

RESPONSE: The TMDL is presented as an average for the watershed. Information on delivery rates at the subwatershed scale is presented, and Regional Board staff anticipate that this information is both more reflective of subwatershed conditions, and useful for planning purposes. It is not the intent of Regional Board staff that the watershed-scale average should be applied to each subwatershed, for just the reasons noted in the comment. Doing this would lead not only to a conclusion that some subwatersheds can never meet the TMDL, but to the additional conclusion that other subwatersheds already meet the TMDL (if considered as an absolute value). Neither of these interpretations would be correct. With respect to the West Canyon in particular, Regional Water Board note that the steepest, most unstable subwatershed has a greater sediment delivery than the TMDL for the whole watershed, and that this is a demonstration of the effect of subwatershed conditions on delivery rates. This in turn supports reliance on a percentage above an estimated rate of natural sediment delivery as opposed to using an absolute value.

(22) Dr. Piirto: “No. . . . I am particularly dismayed that the specific tables that help to illustrate how the average 440 tons/sq mi-yr figure was determined are not provided in the Staff Report that was sent to me. I was not able to locate for example, Tables 3.2, 3.3, 3.4 and most importantly Table 3.22. Other figures and tables are also missing as well (e.g., Tables 3.5, 3.6, 3.7 etc.). A list of Tables and Figures was not provided for the Staff Report. Tables and Figures are also missing from other chapters as well.”

RESPONSE: Review of transmittal records for the peer review draft indicate that the entire document including the tables noted by the reviewer were included in the transmittal. Because of formatting considerations the tables were separated in the document: some were integrated into the text, while others were presented at the end of the text. Staff apologized for any confusion this may have caused and would have been happy to clarify this misunderstanding if it had been addressed prior to completion of the review.

Sediment TMDL

For the Noyo River, the USEPA used a reference time period to calculate the TMDL for the Noyo River (EPA, 1999). The TMDL for the Noyo River was set at the estimated background sediment delivery rate for the 1940s. Because salmonid populations were robust during this time period, which was assumed to be a quiescent period between the logging of old growth at the turn of the century and logging of second growth in the middle of the 20th century, EPA postulated that there could be increases above the natural amount of sediment and still maintain healthy watershed conditions. Analysis of sediment sources during this period indicates that there was about one part human induced sediment delivery for every four parts natural sediment delivery (i.e. a 1:4 ratio, or a 25% increase). The TMDL for the Scott River is set equal to the estimated loading capacity of the river and its tributaries. Taking the EPA study of the Noyo River as the best available information relating to acceptable level of increase, the Scott River TMDL is set at 125 percent of natural sediment delivery.

Question: Is the method used to calculate the TMDL based upon sound scientific knowledge, methods, and practices?

(23) Dr. Erman: "The general approach of applying a factor (additional 25%) to natural loading seems reasonable and based upon previous work elsewhere. The various sources of sediment are well described. The combination of remote assessments, reviews, and ground checking has been impressive for a problem of this magnitude."

RESPONSE: Regional Water Board staff concur.

(24) Dr. Erman: "The issue may focus on whether or not the level of natural loading has been estimated correctly. There is always a question of whether the procedures for finding and allocating sources have been given enough effort. For the scale and level of detail needed for this basin, the procedures are adequate to the problem. Improvements should come with further study along the lines I mentioned above and summarized in the draft."

RESPONSE: Regional Water Board staff concur that the procedures used to calculate the sediment TMDL are adequate for the scale and level of detail needed for the Scott River watershed. Staff also concur that improvements can be made as more data and information become available.

(25) Dr. Erman: "A deeper problem may lie with the statements that the natural load is known to be an underestimate (thus providing a built-in safety factor). There should be more description (qualitative or quantitative) of how one can tell the estimates are lower than actual. . . . The Draft should present a clearer summary of what methods and logic were used by the staff to create a condition of underestimated natural load."

RESPONSE: Regional Water Board staff concur and have revised the Staff Report to include a more thorough discussion on the margin of safety and the factors that contribute to that margin (see Section 3.5.4).

(26) Dr. Erman: "I would suggest it is preferable to make any estimate as reliable and close to actual as possible. . . . it is an acknowledged fact that "errors" can pile up. I suggest that no methods be used that incorporate known bias; at least then the errors should be more random."

RESPONSE: Because the Clean Water Act and associated regulations require a margin of safety (Section 3.5.4), and because in some cases the error cannot be determined with confidence using the best available information, staff chose to take the safe course and employ methods that assured the required conservative approach. Using this approach, staff has not then added an additional margin of safety.

(27) Dr. Erman: "When there is uncertainty, it would also be preferable to present some way of evaluating the level of uncertainty (as done, for example, in the temperature model output evaluations) or list the rules and assumptions for critical steps in combining elements of the source allocations."

RESPONSE: The sediment study is not a model in the same sense that the temperature study is. In the temperature study a computer model is applied that allows testing of sensitivity by varying one parameter and observing changes in values of other parameters. The sediment study is a calculation and summation of estimated sediment delivery from different sources without the modeling function of interaction between sources. The assumptions behind the calculations are spelled out in each section.

(28) Dr. Erman: ". . . it is clear that the estimates of human or non-human source of discrete features were not estimated for all disturbance sizes or locations. But the consequences of that procedure need evaluation."

RESPONSE: For the large sources – landslides – the inventory aimed at counting and estimating them all. For small sources a small sample was collected on a stratified random sampling basis and extrapolated to the rest of the Scott River watershed. A similar technique has been used in other TMDL analyses done by other investigators in other North Coast Region watersheds. The consequence of this procedure is that contribution from the small features watershed-wide is an estimate based on a limited sample. In subsequent studies toward implementation, more detailed local and site observations will be appropriate. The implementation plan anticipates this by encouraging submittal and consideration of site-specific information if available.

(29) Dr. Erman: "If the range of uncertainty can be estimated at all, it would seem to me more transparent to incorporate "safety" as an adjustment to the multiplication factor applied to the natural loading, and make the estimate of natural loading as close to actual as possible. The interpretation may be resolved by careful reflection on what is meant by "underestimate of natural loading". I suspect that loading was underestimated but the allocation to human or non-human cause may not have been."

RESPONSE: Further study will give further insight, but staff believe that the figures as presented give a reasonable approximation for the purposes of this TMDL study. As noted above, the margin of safety discussion has been modified in response to the reviewer's comments.

(30) Dr. Erman: "The results of the present analysis are both a development of TMDLs and a basis for concluding that excess sediment and temperature 'are outside the range that fosters desire conditions.'"

RESPONSE: Regional Water Board staff concur.

Temperature Modeling

The impact of various parameters (i.e., shade, flowrate, groundwater accretion, surface water diversion, and channel geometry) on stream temperature were evaluated using the HEAT SOURCE computer model. Results indicate that direct solar gain and groundwater accretion have significant impacts on stream temperature. Analysis of current and potential streamside shade was performed in several stream reaches using the RIPTOPO model. Results of the temperature analysis indicate that increased shade canopy would improve water temperatures in all the stream reaches evaluated. This conclusion was extrapolated to the entire watershed. Consequently, the temperature TMDL proposes to control direct solar gain. Effective shade was selected as the surrogate TMDL metric for direct solar gain to the stream.

Question: Do the methods and assumptions used to predict the flow and hydraulic geometry of the modeled stream reaches result in a proper characterization of hydrodynamics?

(31) Dr. Erman: "The Draft has used fairly standard procedures for predicting flow and geometry. Checks of assumptions have generally been good (e.g., measuring flows for possible ground water accretion zones, developing rating curves, regression)."

RESPONSE: Regional Water Board staff concur.

(32) Dr. Erman: "I was less confident that the assignment of large reaches of stream channel according to one or two Rosgen-type classes was valid or what the consequences of a finer scale classification would mean to the results."

RESPONSE: Regional Water Board staff believe the channel type assignments are reasonable and appropriate. The effect of misclassifying channel types manifests in the errors seen in tables 4.6A&B and the figures in Appendix C. Regional Water Board staff assigned Rosgen channel types based on habitat typing surveys conducted by the Siskiyou RCD (2003). The document now reflects this.

(33) Dr. Erman: "The text is not entirely clear on the issue of stream width. At one point, it seems that low flow channel width is estimated from an adjustment of the well-established statistical relationship of bankfull flow vs. drainage area. Later, the temperature model used actual field-based measurements of average wetted channel width. I could not determine how the draft dealt with the issue of the channel being wider than it should be under natural conditions. Thus, the model run (Fig. 4.13) with half potential width is not entirely clear. [This] point may not be relevant to modeling temperatures under existing conditions, however. The draft has apparently just concluded that unnatural width is a margin of safety."

RESPONSE: The following language has been added to the staff report to clarify how channel width was estimated:

"Potential channel widths were developed using the bankfull relationships described in Section 4.2.9 and a typical width-to-depth ratio for a C-type stream (24) (Rosgen, 1996). Regional Water Board staff assumed:

- The top width of the potential low flow channel of the Scott River would be half the bankfull width, based on a comparison of the wetted widths measured from imagery captured on July 25th and 26th, 2003, to the bankfull widths predicted by the relationship of bankfull width to drainage area (Figure 4.5).
- The potential channel dimensions of the Scott River upstream of the Scott River canyon correspond to a "C" type channel. The Scott River is currently an "F" type channel in this reach (Quigley, 2003).
- The wetted channel widths of July 25th and 26th, 2003, are representative of the top widths of the low-flow channel.
- The low-flow channel width-to-depth ratios are similar to the bankfull width-to-depth ratios."

(34) Dr. Erman: "As an aside, I wondered, given the frequent field samples of channel width, why the staff did not also measure actual average depths and make their own determination of channel type."

RESPONSE: Channel widths were measured using channel dimensions digitized from high-resolution aerial imagery, not field samples.

(35) Dr. Erman: "The text is not entirely clear on how sinuosity was eventually calculated or how sensitive model results might be to this variable."

RESPONSE: As discussed in section 4.2.10.4, the depiction of the pre-straightened stream channel was developed using orthophotos, along with staff's judgment and interpretation. The change in sinuosity was not calculated, as this is not a model input variable. Rather, the model uses information about the channel alignment, and gradient, to calculate hyporheic flux. Our analysis indicates the model is not sensitive to changes in channel alignment of the magnitude estimated for the Scott River. The increase in channel length due to the change in alignment has been added to the text.

(36) Dr. Erman: "Mass balance approaches for computing change in temperature from the joining of flows of different temperature are also well established methods."

RESPONSE: Regional Water Board staff concur.

(37) Dr. Piirto: "No. Pre Euro American vs. present day stream temperature ranges are not listed for each sub-watershed area."

RESPONSE: Please see the response to Comment 2.

(38) Dr. Piirto: "No. . . . summer temperatures varied naturally as a result of numerous episodic natural disturbance events (e.g., fire, climate changes, changes in ground water supply, etc.). And more importantly, stream temperatures are affected by various site factors. It is stated in the Staff Report (NCRWQCB 2005 page 2-21) 'Stream temperatures vary considerably throughout the Scott River watershed in response to geomorphic and hydrologic characteristics.' So, how do we know when a desired temperature condition is achieved for a given sub-watershed area given these varying conditions?"

RESPONSE: The temperature metrics and the temperature desired conditions (see Sections 2.5.1 and 2.5.2 of the Staff Report) are based on functioning salmonid habitat, not pre-Euro American temperature conditions, which are unknown. Additionally, Regional Water Board staff acknowledges temperature variability in time and space. The analysis demonstrates that site-potential shade conditions must be achieved in order for the temperature standard to be met. Site potential shade conditions will be achieved when the potential vegetation at a site reaches maturity.

(39) Dr. Piirto: "No. . . . how do we manage stream temperature when water supply as influenced by episodic events is the more important variable to begin with? "

RESPONSE: Regional Board Water staff acknowledge that episodic natural events, such as droughts and floods, will occur. These events determine, in part, the site-potential riparian conditions. The site-potential conditions are the management goal that will achieve the temperature standard, not a particular stream temperature. Stream shade has a significant influence on stream temperatures, regardless of the water supply conditions.

(40) Dr. Piirto: "No . . .to what extent is shading needed in a given stream reach as compared to the larger context? How much of a given stream reach must be shaded to provide suitable habitat? Blanket prescriptions and associated action items rarely work given varied disturbance history, varied land use, and varied conditions that exist in each sub-watershed basin and within each stream reach."

RESPONSE: The analysis demonstrates that site-potential effective shade conditions must be achieved in order for the temperature standard to be met. To clarify and better demonstrate this condition on the mainstem Scott River, a figure has been added to the text that compares current riparian tree height conditions to potential tree height conditions. The potential conditions are at a reach-scale, and are not intended to represent a site-specific prescription or desired condition. The implementation plan allows for and anticipates that site-specific information would be presented and considered.

Question: Were sufficient types of stream reaches modeled to extrapolate results into the broader watershed?

(41) Dr. Erman: "Questions like this emerge for a whole suite of variables and the only way to know or get a feel for the answer is to collect more data specifically designed to test the assumptions. Elsewhere in the Draft the staff has conducted some evaluation of "errors" in comparing model results to measured values, and this general approach could be applied to other situations. The use of stratified random sampling for some data was an extremely valuable approach and lends support to the use of broad extrapolation."

RESPONSE: Regional Water Board staff concur.

(42) Dr. Piirto: "I do have a concern about the lack of temporal data to gauge how disturbance events/management actions influence sediment load and stream temperature."

RESPONSE: Regional Water Board staff have determined that the available information is adequate to identify which of the potential factors are the most influential.

Question: Is the use of Manning's "n" as a model calibration parameter appropriate?

(43) Dr. Erman: "There are two issues with regard to using Manning's n. First is whether the determination in the field, based on the guide provided in the USGS publication, was made consistently by all personnel who conducted the surveys. No details were given to judge quality control. If, as likely, Water Board staff who conducted the surveys have familiarity and practice with judging n, then statements to that fact are important in the text and support the idea of consistency."

RESPONSE: Please see the response to comment 44, below.

(44) Dr. Erman: "The second issue, changing estimates of n until the model seems correct, is less objective. There are many variables that go into the model. There is no discussion in the text as to why Manning's n was chosen as the variable to adjust—was the choice suggested by other users of the model or did the staff use trial and error to find what worked? If the personnel who made estimates of n are confident of their ability to determine n, then were the field determinations frequent enough to provide coverage? (A single value of n, 0.225, on the mainstem Scott River from mile 1 to nearly 30, looks suspicious.) Because in some segments of the basin, the model seemed to require no adjustment of Manning's n, there is little in the Draft to allow a reader to know whether using Manning's n as a "calibration" tool makes sense. And, if n is changed, the Draft should explain how much change in n was made. In the case of complex models, it is a questionable practice to build a model based on estimates of the needed variables, but then change the values of a variable if the model doesn't "work", unless there is evidence for which variable should be changed and how to change it. The text also does not explain the variable requirements for the Model. Thus, initially I had assumed that estimates of "dominant particle size" were used somehow as a basis of estimating "roughness" (Manning's n)."

RESPONSE: Manning's n (Channel roughness) is routinely determined by solving for the coefficient when all the other hydraulic variables (wetted dimensions, slope, and flow) are known. Because it is not subject to direct measurement (i.e. channel roughness can't be measured, rather the effects of channel roughness are measured), and because it affects both wetted dimensions and travel time, it is a logical calibration parameter. In this analysis, the flows and wetted widths were known and some information describing velocities and depths was available, though they were not measured comprehensively. The remaining hydraulic variables, width-to-depth ratio and Manning's n, were the only missing variables required to describe the hydrodynamics of the river. Regional Water Board staff used the estimates of width-to-depth ratios suggested in the model documentation for the given channel types, for lack of better data. The remaining variable, Manning's n, was first approximated using best professional judgment so that initial model runs could be generated, then the variable was adjusted so that the modeled hydraulic conditions approached the measured hydraulic conditions. Although better results may have been possible by also adjusting the width-to-depth ratios, staff decided to limit the subjectiveness of the calibration by limiting the calibration to only one parameter. The practice is in fact a standard approach to model calibration. The text of the Staff Report has been modified to clarify these points.

Question: Does the analysis demonstrate the HEAT SOURCE computer model is sufficiently calibrated and validated to evaluate the effects of various parameters on stream temperature?

(45) Dr. Erman: "In some cases (stream reaches) the model did poorly but overall, with the scale and level of detail needed, the model does reasonably well in predicting temperature. It may be pushing the limits of the model to expect it both to function well at specific

sites and to predict overall trends such as gradual warming downstream or sharp changes where major ground water is added. On a river scale, the model responds in ways that fit expected connections to shade, groundwater accretion, and other factors."

RESPONSE: Regional Water Board staff concur with the reviewer's comments regarding the performance of the model at the river scale. Regional Water Board staff have added additional information (Appendix C) related to the performance of the models at the reach scale.

(46) Dr. Erman: "The Draft might be expanded somewhat by illustrating more examples of temperature simulations with variations of several factors. In particular, there could be plots that incorporate at least some combinations of shade, groundwater, surface diversions and change in channel width. The full value of the model should be to compute a prediction with a range of each variable in combination with others. The number of possible combinations is quite large but such model runs might give insight into interactions or the scope for cooling under an "ideal" combination. In particular, interactions among shade and groundwater accretion would be instructive."

RESPONSE: Plots incorporating combinations of shade, groundwater, surface diversions, and channel geometry have been added to the text. Plots comparing measured and modeled temperatures have also been added.

(47) Dr. Erman: "The suggestion of using RIPTOPO (or other models) to help organize and prioritize future actions is an important statement and stems from model capability to examine different assumptions and variations in key variables."

RESPONSE: Regional Water Board staff concur.

(48) Dr. Piirto: "I am not convinced based on the data and information presented in the Staff Report that HEATSOURCE is sufficiently calibrated. I support this conclusion with the following points: . . . why is so much attention being placed on shading when the real problem is water flow."

RESPONSE: The Staff Report does demonstrate that Scott River temperatures are sensitive to the amount of groundwater entering the river. The Staff Report also demonstrates that Scott River temperatures are sensitive to the amount of stream shade. Both groundwater and effective shade are important.

(49) Dr. Piirto: "I am not convinced based on the data and information presented in the Staff Report that HEATSOURCE is sufficiently calibrated. I support this conclusion with the following points: . . .I found numerous statements that the model is out-of-phase with measured temperatures, under-predicts, or over-predicts. And on page 4-15 the following statement appears: "the measures of error are similar to results of other stream temperature modeling efforts." What specifically is the error result

for these other studies? What is the error result of HEATSOURCE as it was applied to various locations within the watershed? How is this error result affected when disturbance events are factored into the model?

RESPONSE: The Staff Report has been modified to provide examples of other modeling efforts with similar results. The "error result" of the model is reported in Table 4.5B for the seventeen locations where data were available to evaluate the performance of the model. The effects of disturbance events are not relevant to calibration and validation of models.

(50) Dr. Piirto: "I am not convinced based on the data and information presented in the Staff Report that HEATSOURCE is sufficiently calibrated. I support this conclusion with the following points: . . .the model tells us that temperatures could increase if only the California Forest Practice Rules were followed from 0.5 degrees to 1.5 degrees Centigrade. How do we gauge this result in relation to the error rate for the HEATSOURCE model and in relation to surface diversion and groundwater accretion? I am not convinced that sufficient information is presented to conclude that current Forest Practice Rules are insufficient."

RESPONSE: Regional Water Board staff do not concur. The greatest utility of a model is in comparing the results of one scenario to another. While the model application may demonstrate a degree of error in comparison to measured values, the differences between model scenario results are absolute in relation to each other. The analysis demonstrates that timber harvest can be in compliance with the California Forest Practice Rules, while not in compliance with the temperature water quality standard. The text has been re-written for clarity.

(51) Dr. Piirto: "I am not convinced based on the data and information presented in the Staff Report that HEATSOURCE is sufficiently calibrated. I support this conclusion with the following points: . . . Several tables and figures were absent from Chapter 4 in the Staff Report that was sent to me. I found review of Chapter 4 to be very difficult."

RESPONSE: Please see the response to Comment 22.

(52) Dr. Piirto: "Based on the points I make above, I do not believe the conclusions shown on page 4-29 of the Staff Report are fully supported by the information provided."

RESPONSE: Regional Water Board staff do not concur. Please see the responses to Comments 48 through 51.

Question: Does the analysis demonstrate that effective shade is a scientifically sound metric for controlling near-stream practices that affect stream temperature?

(53) Dr. Erman: "There is already a well-established literature that demonstrates the connection between shade and stream temperature. The analysis has demonstrated that among the variables examined that have known potential effects on stream temperature,

effective shade in the Scott River system is one of the most important for improving stream conditions. The extension of the analysis to microclimate effects on stream temperature is an interesting approach and shows the value of the model for examining other conditions."

RESPONSE: Regional Water Board staff concur.

(54) Dr. Erman: "The text should define 'effective shade' when first used and be consistent in use of terms between text and figures."

RESPONSE: Regional Water Board staff concur and the text has been modified as suggested.

(55) Dr. Piirto: "No. Not when it is stated 'the temperature of Scott River is very sensitive to the amount of groundwater entering the river.' I can not gauge based on the information provided how increased shade levels will influence stream temperature if water flow is the primary factor controlling stream temperature."

RESPONSE: Regional Water Board staff do not concur. The analysis does not show that water flow is the primary factor affecting stream temperatures. Rather, the analysis demonstrates that in the limited areas of the watershed where groundwater interacts with surface water (in the lower gradient alluvial portions of the watershed), groundwater can have a significant effect on stream temperatures, in addition to effective shade. The effects of shade were evaluated for four different streams and are presented in Sections 4.3.1.7, 4.3.2.7, 4.3.3.7, and 4.3.4.7, and in Figures 4.14, 4.21, 4.28, 4.29, and 4.30 of the Staff Report.

Question: Does the analysis demonstrate that groundwater accretion has an influence on in-stream water temperatures?

(56) Dr. Erman: "The influence is already well known. The analysis has demonstrated that the main stem of the Scott River in particular is quite sensitive to the influence of groundwater accretion and that measurement and simulation suggest water quality problems are associated with the groundwater system."

RESPONSE: Regional Water Board staff concur.

(57) Dr. Piirto: "Yes."

RESPONSE: Regional Water Board staff concur.

General Questions & Other Issues

Reviewers are not limited to addressing the specific issues presented above. We invite contemplation of the following big picture questions.

Questions: In reading the technical reports and proposed implementation language, are they any additional scientific issues that should be part of the scientific portion of the proposed rule that are not described above? If so, please comment with respect to the statue language given above. Taken as a whole, are the scientific portions of the proposed rule based upon sound scientific knowledge, methods, and practices?

(58) Dr. Erman: "The Draft could be improved by giving the reader more forecasts in introductory sections of what is to come. For example, although the models are referenced for full examination, it would nevertheless help comprehension if a list of the critical variables were defined first and what variables/factors needed to be measured in the field. I did not understand the purpose of some sections until nearly the end of major parts of the report."

RESPONSE: Regional Water Board staff concur and have revised the Staff Report to add clarity.

(59) Dr. Erman: "I am unsure from the Draft how, when and who will be integrating the data to report whether the Scott River is meeting the overall TMDL. I suggest that the Draft discuss in chapter 6 a preliminary timeline, for example, where the Water Board will recalculate the TMDLs to gauge progress or update something like Fig. 4.28 for temperature."

RESPONSE: Regional Water Board staff concur that the TMDL Action Plan should include a discussion on how, when, and who will re-calculate the TMDLs and evaluate attainment of the TMDLs. The Reassessment Chapter (Chapter 7) of the Staff Report has been revised to include such a discussion.

(60) Dr. Erman: "The Water Board staff may also wish to review sections [of] the Sierra Nevada Ecosystem Project report (e.g., Chapter 36, Vol. II, Chapter 5, Vol. III; Chapter 2, Addendum) that deal with riparian conditions and management. The approach and logic may provide ideas for the Wetland and Riparian Protection Policy under consideration."

RESPONSE: Regional Water Board staff concur and thank Dr. Erman for this reference. Staff will take the Sierra Nevada Ecosystem Project report into consideration when developing the Wetland and Riparian Protection Policy.

(61) Dr. Erman: "There is evidence of joint problem analysis and solution that suggest future progress. The reasoning for what has been studied and how features have been addressed is generally understandable, consistent and valid. The broad framework for assessing sediment sources and allocating them among sub-basins, conditions and causes is sound. The computer models adopted for sediment and temperature seem fitted to the scope of the problem and within the capacity of the Water Board and others to provide needed data. Where assumptions and extrapolations have of necessity been made, future targeted study should help clarify their importance and fill gaps."

RESPONSE: Regional Water Board staff concur.

(62) Dr. Piirto: "The emphasis of the Amendment seems to be more responsive/reactionary to a proposed agency/landowner action rather than to assist in the identification of a desired future condition."

RESPONSE: The TMDL Action Plan identifies the desired future sediment and temperature conditions of the Scott River and its tributaries in the form of the proposed TMDLs and load allocations. The implementation actions then focus on land uses that impact sediment and temperature loads.

(63) Dr. Piirto: ". . . the Staff Report clearly recognizes that different vegetation types and seral stages will exist at various locations along a stream course and also within a given stream reach. However, it is not clear how a given agency/landowner is directed to manage for these varied conditions that naturally develop within a stream course and its associated riparian zone."

RESPONSE: In regard to managing the near-stream area to provide shade to a water body, maintenance of natural receiving water temperatures is necessary to attain the existing Water Quality Objective for temperature. Natural receiving water temperatures are the temperatures present if the watershed is not disturbed by human activities. This takes into account natural variability. In order to maintain natural receiving water temperatures, natural shade conditions provided by vegetation must also be maintained. This will vary on a site-specific scale. On a watershed scale, the proposed implementation actions describe how this is to be accomplished: through encouragement of the preservation and restoration of vegetation that provides shade to a water body, through the development of appropriate permitting and enforcement actions, and through the development of the Wetland and Riparian Protection Policy.

(64) Dr. Piirto: ". . . the big ecosystem management picture still needs much more evaluation given current and projected human use and development needs for the Scott River watershed."

RESPONSE: Regional Water Board staff concur that, in several instances, more information and analysis is necessary before specific implementation actions can be identified. For example, staff propose that the current Caltrans Storm Water Program be evaluated for effectiveness and that a groundwater and surface water study be developed and completed; both before further implementation actions are proposed.

(65) Dr. Piirto: "What are the conservative assumptions that guided the [desired conditions] analysis? Are they documented in the Staff Report? I was asked to judge the scientific merits of the Staff Report and the associated Action Plan. I can not fully do this without full disclosure of all the information. There are several other areas

within the Staff Report where this type of professional judgment statement is made. It is impossible for me to fully evaluate the science of professional judgment statements or margins of safety when little information is provided on exactly what information was used."

RESPONSE: The conservative assumptions are those that are described in the bullets in section 4.7.

(66) Dr. Piirto: "Very little if any discussion occurs within the Staff Report on the past occurrence of fire events and their episodic effect on sediment delivery, sediment volume, temperature, and ecological impacts (e.g., influence on salmonid populations, macro- and micro-invertebrates, amphibians, etc.)."

RESPONSE: This is a topic that Regional Water Board staff have not addressed. Partly this is because available data are far from complete, and partly it is because of the difficulty of assigning natural or anthropogenic cause in many cases. For the purpose of the TMDL studies, fire is assumed to be a natural phenomenon. See General Comment 19 **Wildfire**.

(67) Dr. Piirto: "I can not conclude that implementation actions listed in the Action Plan that suggest landowners refrain from cutting trees is supported by scientific information provided in the Staff Report particularly when it is stated across the board for the entire watershed."

RESPONSE: Regional Water Board staff do not concur. The shade provided to a water body by trees and other vegetation has a dramatic, beneficial impact on stream temperatures. This is demonstrated throughout Chapter 4 of the Staff Report. In the absence of topographic shade, the removal of vegetation that provides shade to a water body will increase solar radiation levels and will raise water temperatures. Therefore, one of the proposed implementation actions is to encourage landowners throughout the Scott River watershed to refrain from removing such vegetation.

(68) Dr. Piirto: "The emphasis on the action item listed in Table 7 of the Action Plan is more focused on what is 'needed for sustainable management' in a given stream reach. Simply stating that one should refrain from cutting tress is not supported by science when sustainable management of the vegetation is considered. Having too many trees within a given stream reach may increase risk of catastrophic fire, hinder development of late seral stage characteristics, affect habitat conditions for various forms of wildlife, affect ground water availability in terms of evapotranspiration, and increase risk of bark beetle or disease development."

RESPONSE: Regional Water Board staff do not concur. First, controlling the number of trees in a riparian area to protect against fire and disease and to encourage late seral stage characteristics and wildlife habitat (i.e., Dr. Piirto's definition of sustainable management) is not the purpose of the implementation action in question. The purpose of the proposed implementation action is to encourage responsible parties to minimize the removal of vegetation that provides shade to a water body. This will help to maintain and reduce water temperatures. Second, the TMDL Action Plan does not require responsible parties to refrain from cutting trees. Third, controlling the number of trees in a riparian area for the above reasons does not necessarily interfere with maintaining and increasing the amount of shade provided to a water body. In fact, encouraging late seral stage vegetation may provide more shade. Fourth, please see the response to Comment 67. Fifth, in regards to groundwater availability due to transpiration, the amount of water transpired by trees and other riparian vegetation is one of the issues that the proposed groundwater and surface water study will address, as discussed in Section 5.1.8.2 of the Staff Report.

Specific Editorial Notes

Dr. Erman included with his review several editorial comments with suggestions for additional clarification, detail, edits to figure/table titles, etc. throughout the Staff Report. Regional Water Board staff appreciate these comments and have incorporated many of these suggestions. While many of these comments do not necessitate a response by staff, there are several comments that staff have responded to in more length, as follows:

(69) Dr. Erman "p. 1-2. Somewhere in this section it would be useful to give the ownership breakdown and possibly a map showing federal, state, and private land. Later places in the text talk about ownership and such distinctions as private commercial forest but the relative amount or the location is vague or given much too late."

RESPONSE: A new section, 1.5.8, has been added with a figure to summarize ownership.

(70) Dr. Erman p. 2-9. State whether the McNeil sampler was used for all the streams, not just French Creek.

RESPONSE: McNeil samplers were used for all of these measurements. The text has been clarified.

(71) Dr. Erman "Discuss the timing of restoration on French Creek with respect to the timing of sediment sampling. One cannot tell if the highest value was before, during, or after work began."

RESPONSE: Revision made.

(72) Dr. Erman "p. 2-12, first paragraph. There is no explanation up to this point of what are "point-source categories" mentioned in the inventories. Explain."

RESPONSE: Revision made.

(73) Dr. Erman "p. 2-13 Conditions in Scott River
The draft states that SHN Consulting surveyed the road system on 12 square miles and found problems."

RESPONSE: This section has been revised and reorganized, and staff believe the questions posed have been addressed.

(74) Dr. Erman On both p. 2-12 and 2-13 the discussion of data sources focuses on small-scale studies although the topic is the entire Scott River basin. I have trouble seeing the picture of the whole basin in these sections

RESPONSE: This section has been revised to better integrate the information.

(75) Dr. Erman p. 2-14, sec. 2.2.2.4. The total miles of road are reported later but could be stated here in the context of the discussion, and given by Target Category. The definition of "road adjacent to stream" comes up here but is left too much later in the draft for explanation and estimation. Either give the data here or direct the reader to the later sections where it is reported.

RESPONSE: This section has been revised and reorganized in ways that address this comment.

(76) Dr. Erman "p. 2-15, sec. 2.2.2.6. Wildlife (sic) comes up here but again, how it is dealt with comes later. Surely, it too results in removal of vegetation sufficient to reduced rainfall interception and other soil protection functions" as stated in the text. <u>The text either here or later should clearly explain whether fire is considered a natural or human factor in terms of consideration in the TMDL</u>."

RESPONSE: Human intervention can affect both the frequency and the intensity of fires, but staff have not made an attempt here to address this complex issue. For the purpose of this study, fire is assumed to be a natural process.

(77) Dr. Erman p. 2-23, Fig. 2.3. It is not clear whether the names on the x-axis are stations <u>on</u> the South Fork River or stations on the tributary itself at that location. If they are stations on the South Fork, indicate whether they are below the tributary or otherwise uninfluenced by entry of cooler water. The same issue of labeling clarity comes up in Fig. 2.4 on p. 2-24. The paragraph on p. 2-24 further confuses understanding because it refers to East Fork Scott River <u>and</u> its tributaries. I am unsure then, what data are being shown in Fig. 2.4.

RESPONSE: The figures have been replaced with tables. Sites with "South Fork" or "East Fork" in their name are measurements made in the river, not the tributary. Other sites are tributary locations. Information describing the exact placement of these data loggers did not accompany the data submitted by cooperators.

(78) Dr. Erman p. 2-25. The paragraph could be written for better clarity. The text says, "many sites are suitable…" when the data in Fig. 2.5 suggest that only in some years do

some sites have suitable temperatures. I assume that the horizontal dashed line is the threshold for “suitable” on this and other similar figures. In Fig. 2.5, there are 30 sites apparently but only 15 with names on the x-axis. Of these, 18 never met the threshold, 7 more only met the threshold in one year—the “good” year of 1999. Only 3 stations met the threshold (barely) but 2 were sampled once (Etna and Upper Clarks Creek).

RESPONSE: Regional Water Board staff have revised the text and replaced the figures with tables.

(79) Dr. Erman p. 2-27, sec. 2.7.1.6. I believe the second sentence should read “The majority…have unsuitable temperatures…” I can not follow the text “with the exceptions being Mill, Kelsey and Thompkins” for Fig. 2.7. Patterson Creek is not shown on Fig. 2.7; Upper Kelsey had a temperature of 10.9, Deep Ck. had 20 degrees. Review the text and figure.

RESPONSE: Regional Water Board staff have revised the text and replaced the figures with tables.

(80) Dr. Erman Sec. 2.7.2. Define “Effective Shade” here (the first time used?) The section begins by discussing potential shade. Rearrange paragraphs or discussion so that effective shade is defined then move on to calculations of potential

RESPONSE: Regional Water Board staff have revised the text.

(81) Dr. Erman p. 2-28. Fig. 2.8 does not appear to be a comparison of the two models or comparison of model values to measured canopy as indicated by the text in para. 1, top of page. In para. 3, Fig. 2.8 is described differently. I am unclear from the text how the “90% potential” is reflected in figures 2.8, 2.9 and 2.10. Are these figures computed for a specific time—summer solstice?

RESPONSE: Regional Water Board staff have revised the text. The figures present shade results, based on the assumption that the vegetation height is 90% of the potential for each class. The date evaluated is July 22.

(82) Dr. Erman p. 3-4, 3-6, 3-7 Examples of good checking of assumptions.

RESPONSE: Regional Water Board staff concur.

(83) Dr. Erman p. 3-5. CWEs: This section has been revised. Generally, the new language is fine and the substitution of terms for CWE are ok, if a bit cumbersome. There is one point still troubling. . If a general discussion of CWEs (by whatever name) is included, I suggest it be a separate overarching section of the report. This section now occurs in Chapter 3, Sediment Source Analysis. From the context then, and repeated in sec. 3.8.3, it still continues the impression that interactions of human activities in a watershed are somehow tied just to erosion.

RESPONSE: Cumulative effects (now called EMIHAs) are considered specifically only in the sediment study and therefore are discussed in the sediment section. The temperature study incorporates some of the concepts but applies a different methodology.

(84) Dr. Erman "p. 3-6. The text mentions the Water Board staff checked the road inventory but the result is not given until p. 3-8. Perhaps connect these sections."

RESPONSE: Revised and connection made.

(85) Dr. Erman "I'm not sure sometimes if all the subsequent references to the South Fork study are the same, for example. I am not even sure where the boundaries are for the study. The South Fork is listed on two of the seven subwatersheds;"

RESPONSE: The text has been revised. Wording clarifies that South Fork and West Headwater Subwatershed are coincident.

(86) Dr. Erman "Further, the RM study was only on private land and the reader has no idea of how those lands are arranged by geologic type in the Pilot watershed. The extrapolation of results rests on whether the Pilot Study was a statistically reliable representation of the entire basin or at least with respect to the allocation of samples by geologic type. Be specific about this context."

RESPONSE: Revision made in Section 3.2.1, paragraph 1 to clarify text in response to comment.

(87) Dr. Erman "p. 3-7, sec. 3.2.2. Is the reference here to RM (2000) a reference to the same data/study mentioned in 3.2.1? If so, then is it true that Water Board staff also only surveyed the portion of sites on the timber company roads? Again, there should be discussion of the representativeness of the timber company portion of the watershed."

RESPONSE: Revision made in Section 3.2.1, paragraph 1, to clarify in response to comment.

(88) Dr. Erman The discussion of the role of a 14-year recurrence interval flood is not entirely clear. Did the Water Board staff conclude that only floods of that size create erosion in the basin? Does it also conclude that erosion features identified in the survey that are less than 14 years were still caused by the flood and that those older than 14 years were influenced as well? Or was it the fact it was a "rain-on-snow" event. Flood frequency of the same recurrence interval also occurs from non rain-on-snow runoff. There are usually two features that act to produce sediment—condition of the land and triggering mechanisms. Is the stage always set for erosion but it takes a major flood to activate? Further, I always have trouble with statements that something is "conservative" or not (e.g., paragraph 4. P. 3.7). If the staff had chosen

a 30-year recurrence interval, the estimate of rate would have been even smaller than that used. How does the use of a 14 year divisor for rate calculations lead to eventual underestimates of natural load (and hence a safety factor), if the staff could have chosen a 30 year time for an even lower rate and greater underestimate or safety factor? Is the safety factor here, really the difference between actual estimates of age from the 21 features versus the use of a 14-year flood? It might be useful to at least provide the average age of the 21 features. And change the last sentence on p. 3-7 that says "assuming an average 14-year recurrence interval." The statement is unclear and confuses the meaning of recurrence intervals.

RESPONSE: This section has been revised, and staff believe that the reviewer's questions have been answered.

(89) Dr. Erman p. 3.8. The text explains how road crossings were adjusted by a factor of 2 and other adjustments. It is not clear, however, whether the data of Table 3.3 and 3.4 are the raw values from Vestra, the modified road miles from RM inventory (e.g., paragraph 3, p. 3.8) and include the 2X multiplier for crossings.

RESPONSE: This approach has been superceded by a different method. See Section 3.2.2.

(90) Dr. Erman p. 3.9, para 5. Explain also if Sommarstrom et al. estimated the relative storage by categories (e.g., hillslope, upper bank, etc.). The text indicates that storage by tributary "channel bedload" was included in the TMDL approach. Does that approach then eventually account for the storage categories such as upper banks, channel margins and alluvial fans which got there at some time by being in the channel?

RESPONSE: In the TMDL study Sommarstrom's concept of different reservoirs of sediment storage was not applied. The TMDL study is concerned with delivery of sediment into the stream system.

(91) Dr. Erman p. 3-10. The paragraph description of Table 3.2 seems out of place and perhaps could be moved under section 3.1.4.

RESPONSE: Staff reviewed this suggestion and decided that while Section 3.1.4 describes the nature of the geologic units, Table 3.2, which summarizes their distribution, is better discussed under Section 3.2.4, where distribution of factors affecting road-related sediment is the topic.

(92) Dr. Erman p. 3-11, para 3. The explanation of Table 3.5 sounds like the details of what was first described on p. 3-6, Sec. 3.2.1. To improve understanding, I suggest the terminology used in both sections be identical. For example, use SEDMOL2 on p. 3.6 (if that is the model there) and be consistent on what is called the second estimate based in part on GSS. The text is somewhat confusing also because, I

think, the draft is incorporating here the adjustments to Vestra estimates. (See my comments earlier about this point and Tables 3.3 and 3.4).

RESPONSE: Revisions have been made to answer the reviewer's comments.

(94) Dr. Erman p. 3-22. The discussion at the top of the page seems redundant with p. 3-2. Perhaps just restate the draft has used the same four geological units for this analysis.

RESPONSE: Page 3.2 defines granitic bedrock for the purpose of mapping classification. Page 3.22 discusses the Granitic Sed Study of Sommarstrom and others. These are quite different topics in different contexts.

(95) Dr. Erman I suggest that a future project also test the assumption that large discrete features have the same proportion as estimated for human and non-human small discrete features.

RESPONSE: This test may well be done in future work.

(96) Dr. Erman Why does Table 3.15 have cells for human activity but no estimate of contribution (e.g., M-03-03, S-01-03, and others)?

RESPONSE: Table 3.15 has been revised, combined, and updated in ways that answer this question.

(97) Dr. Erman The text is clear on the rationale for a loading capacity of 125% of the natural load. And it is important to suggest, as the draft does, some kind of re-evaluation of the ratio and progress toward the goals (p. 2-28). I remain troubled by the statement that a margin of safety is provided because natural loads were known to be underestimated. Partly, the trouble may be simply in wording. From the text earlier, it seems that the process for evaluating all sources (regardless of cause) would lead to underestimation of erosion rates. But the process for allocating cause (human or non-human) has no obvious logic or stated process for underestimating the role of humans. It turns out, of course, that the simple calculation of TMDL results in 125% being applied to the natural load portion. Loads of <u>all</u> types are likely <u>less</u> than stated. Surely, the Water Board staff does not believe that their estimate of non-human load was purposely overestimated. This value is also underestimated, if I understand correctly. Some discussion of this issue in the text may clarify understanding

RESPONSE: The TMDL is calculated on the basis of the ratio between natural and human-caused sediment delivery. The numbers for both sources may be in error, but if they are both in error in the same direction and by the same proportion then the ratio stays the same and the TMDL calculation is not altered. Section 303(d) of the Clean Water Act requires that a TMDL include a margin of safety to take into account uncertainties in sediment estimates. Such a margin could be achieved in several ways including adding an arbitrary proportion to the estimate of human-induced sediment or subtracting an arbitrary proportion of the natural sediment estimate. In this study staff consciously underestimated one source of natural sediment, soil creep, and overestimated one source of human-induced sediment, road-associated small features:

- Ages of small roadside features tended to be estimated low. If roadside features in the South Fork Pilot Study attributed to the 1997 flood event actually were initiated before 1977, yearly rates of sediment delivery estimated for these features would be higher and are therefore conservative in the context of calculating the TMDL.
- Section 3.4.1. In estimating sediment delivery by soil creep it was recognized that the hydrography used directly affects the estimate of delivery from this source. Because no available hydrography GIS layer shows all streams, as evidenced in field studies, the delivery from this natural source is underestimated. This underestimate affects the allocation of anthropogenic sediment, as the allocation is calculated as a percentage of the natural delivery.

(98) Dr. Erman: p. 4-5. Surface Water. Add thermal mass to the processes affected.

RESPONSE: The section has been revised to include thermal mass.

(99) Dr. Erman: p. 4-6/7. Sec. 4.2.2. The broad reasons for model choice are clear. Although the fine details of Heat Source can be reviewed on the Web, the draft should at least list the data/variable requirements of the model. This list will help the reader understand later why various parameters have been discussed (e.g., dominant particle size, Manning's n, etc.)

RESPONSE: A table detailing the data requirements of the model has been added.

(100) Dr. Erman: p. 4-9. It is unclear in some places of the draft how the staff is dealing with channel width. In the introductory section (p. 4-2), it is clear that human activities can/have produced a channel that is wider and shallower than "natural". But I am unable to see exactly how the draft has arrive at 1) whether the Scott River is wider and shallower, and 2) what should/could be the natural shape. Has the Rosgen (1996) width-to-depth ratio been used as the natural condition?
(The text refers to section 2.8 for discussion of channel width but I could not find it. The missing section 2.8 may have clarified these points.)

RESPONSE: Regional Water Board staff assumed that the Scott River would exhibit attributes of a C-type channel under natural conditions. We then evaluated stream temperatures given the current F-type channel (w:d = 28), and a C-type (w:d = 24). This approach came directly from the Oregon methodology that we followed. Additional text has been added to the staff report to clarify our approach, and is included in our response to comment 33.

(101) Dr. Erman: Further, it is not clear <u>why</u> the low flow channel width is always 50% of bankfull. (I understand <u>how</u> the 50% channel was estimated.) Although bankfull width (and

discharge) at a station is a constant, "low flow" is not. Has the draft assumed some low flow value or does the change in width vs. Q become insignificant below some value of Q? Explain.

RESPONSE: Additional text has been added to the staff report to clarify our assumptions and methods. Please see response to comment 33. It seems the text was not clear about the difference between low flow channel width and low flow wetted width.

(102) Dr. Erman: p. 4-10. Sinuosity. I would have expected for this exercise that known meander frequency for channel gradients would be sufficient to estimate total stream length of the straightened reaches. The process is obscure to the reader how stream lengths were eventually obtained. Is the reference (SRWC 2004) a source of how sinuosity was reconstructed? At the least, the draft should state the values of existing stream length and the "hypothetical stream channel."

RESPONSE: Additional text has been added to the staff report. Also, please see response to comment 35.

(103) Dr. Erman: Combined Factors. As I mentioned in the section in response to specific questions, I suggest a wider range of combinations be included in simulations.

RESPONSE: Please see the response to comment 46.

(104) Dr. Erman: p. 4-11. Sec. 4.3.1.2. In this section, width-to-depth ratios were assigned as Rosgen F or B but on p. 4-9; the draft says a Rosgen C-type ratio was used. Is this a contradiction? Explain.

RESPONSE: Please see the response to comments 33 and 100.

(105) Dr. Erman: p. 4-12. Was dominant particle size determined from pebble counts and therefore reflect the size class of largest percentage by weight divided by square root of 2? Fig. 4.4 does not parallel the language in the text. The reason for estimates of dominant particle size is unclear.
There appears to be a weak correlation between the dominant surface particle size (Fig. 4.4) and final values for Manning's n (Fig. 4.6). Was 'n' estimated from the dominant particle size (i.e., the roughness of the surface)? The text explains how 'n' was adjusted, so could Fig. 4.6 include the unadjusted initial estimates of 'n'? How important was sampling intensity to the final values for particle size and 'n' versus the other measured values (width, depth, etc.)?

RESPONSE: Regional Water Board staff developed estimates of dominant particle size based on substrate information contained in habitat typing data and observations made in the field. These are ocular estimates. Language has been added in the text and in Table 4.1 to explain why the model requires these data.

The response to comment #44 addresses the topic of Manning's n values. The values presented in Figure 4.6 (now 4.7) are the final values of Manning's n. The estimates of particle size are coarse-scale estimates, thus sampling intensity was not an important factor.

(106) Dr. Erman: p. 4-13, sec. 4.3.1.4. Fig. 4.9 is not especially useful for comparing modeled vs. measured shade. The "Xs" in this figure are difficult to compare with the curves. The term "effective shade" is used here. Because only 5 sites apparently have measure values of shade, perhaps a summary table in the text could be given that compares measured vs. "current modeled".

RESPONSE: Figure 4.9 has been replaced with Table 4.4.

(107) Dr. Erman: p. 4-14/15. Simple statements of "out of phase" or "under-predicts" are not in themselves completely helpful in judging adequacy of model outputs. The tables (4.4A, 4.4B) are in terms of error and bias. There needs to be more text that gives meaning to the amount of error and bias. The single sentences on p. 4-15 are not enough. In particular, if there are other studies that discusses error (item #2), this context should be developed more completely. It is also not clear from Table 4.4A&B what the units are for the various values.
Has the staff also considered the factors discussed by George Brown (of Brown and Kreiger) that affect stream heating? In particular, his early studies suggested that large pools and areas of bedrock would result in significantly different temperatures (in opposite ways) from his prediction model. Pools give a large value to area but the area does not "contribute" to heating and bedrock removes by conduction substantial heat. Perhaps these factors are incorporated in the Heat Source model. I wonder if features such as this may have affected model outputs that were "calibrated" by changes in Manning's n.

RESPONSE: Charts of measured and modeled stream temperatures have been included for all calibration and validation periods and sites. These charts are contained in Appendix C. The charts provide the best context for interpreting the simple statements in the text. In addition, the text has been modified to reference the particular studies that the error was compared to.

The Heat Source model does, in fact, account for bed conduction and the area exposed to bed conduction versus the sun and atmosphere.

(108) Dr. Erman: p. 4-19, Sec. 4.3.2.4. The legend and labels should parallel the terms in the text (i.e., current shade).

RESPONSE: The text and figures have been revised.

(109) Dr. Erman: p. 4-21, Sec. 4.3.3.1. Missing text at end of section

RESPONSE: The missing text has been added.

(110) Dr. Erman: p. 4-22, Sec. 4.3.3.3. Fig. 4.20 should use terms that parallel the text. The figure legend says “Flow” and “Potential Flow”.

RESPONSE: The text and figures have been revised.

(111) Dr. Erman: Sec. 4.3.3.4. Fig. 4.22 only shows current shade, not potential.

RESPONSE: The text and figures have been revised.

(111) Dr. Erman: p. 4-23, Sec. 4.3.3.7. The text claims much of the East Fork would have achieved temperature conditions for steelhead if potential vegetation were established. Fig. 4.23, representing “the warmest time period” still appears to have mostly warmer temperatures than the criteria on Table 2.9. Further, in sec. 4.3.3.6, the text states the model underestimates temperatures (they are warmer than modeled?). Clarify these points.
The discussion (p. 4-24) seems more correct by stating that with potential vegetation the temperature conditions could improve substantially.

RESPONSE: The text of section 4.3.3.7 has been modified.

(112) Dr. Erman: p. 4-26. It is interesting that even though Houston/Cabin Meadows Creeks apparently had weaker data for many of the model parameters, the results “demonstrated that the model accurately predicts temperatures…” Does this reflect a feature of the model, perhaps that it is better at small than large scale? Or is there an expectation of model performance (i.e., both reach and basin scale) that is unreasonable? The model was also “calibrated” apparently by changing Manning’s n. Does that mean the predictions were also possibly out of phase or under–preditions as on p. 4-14/15 until ‘n’ was adjusted?

RESPONSE: Although the characterization of vegetation conditions was limited by the available imagery, the model calibrated well. This is most likely due to the relatively simple hydrology of the stream. The stream is mostly confined in a bedrock channel, thus groundwater accretion is not an issue. Also, the relative flow contributions of the tributaries were well described by continuously monitored temperatures above, below, and within the tributaries. These results reflect a fundamental characteristic of models that simulate dynamic transport: getting the flows correct is very important.

(113) Dr. Erman: p. 4-27. I believe the figure referenced at the top of the page (Fig. 4.24), para 5, is incomplete.

RESPONSE: Regional Water Board staff have reviewed the figure and find that it is complete. Typographic errors that referenced the incorrect figures have been corrected. We hope this correction clears up any confusion.

(114) Dr. Erman: p. 4-30. I suggest rewording of the statement that "all sources of stream temperature are accounted for with shade." There are a result elsewhere to show that groundwater is important. Implications of model runs with the combinations suggested earlier should help sharpen or clarify the relative role of shade and groundwater (or surface water flow) by reach or subwatershed.

RESPONSE: The text has been removed.

(115) Dr. Erman: In several places, there is mention of estimates of temperature when streams are the hottest. And the models of shade are based on conditions at the summer solstice. The text might point out early that these periods are not coincident. As the early work by Brown and Kreiger discussed, maximum stream heating combines the solar flux and the surface area and volume of water. So, maximum heating is usually a month or so later than the solstice.

RESPONSE: Text has been added that notes the difference in time periods.

(116) Dr. Erman: "Is there some expected rate of achievement of the goals/targets for sediment and temperature, or is this part of the future collaboration planned among interested parties?"

RESPONSE: The is no expected time frame within which Regional Water Board staff expect the sediment or temperature TMDL to be attained and the water quality objectives to be met. However, within ten years of the date the TMDL Action Plan takes effect, staff shall assess the effectiveness of the TMDL Action at meeting the TMDLs, achieving objectives, and protecting beneficial uses. This will allow for adaptive management.