



California Water and Environmental Modeling Forum

Promoting Excellence and Consensus in Water and Environmental Modeling

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CWEMF's Peer Reviews

The complexity of California water management issues has motivated the development of correspondingly complex computer models to support public decision-making. These models, along with supporting data and sufficiently detailed documentation, must be open to public scrutiny to foster confidence among water managers and stakeholders. If a proprietary model is used for public decision-making, detailed information must be provided to allow the public to assess the accuracy of model results. Critical reviews of model algorithms and input and output data by independent parties are also essential.

CWEMF, established in 1994 as a non-profit, non-partisan organization, has initiated and managed a number of impartial peer reviews to bolster confidence in the use of specific models to analyze California water management issues. Peer reviews are not intended to provide "stamps-of-approval" or to disapprove models. Rather, their purposes are to:

- Document strengths and weaknesses
- Suggest improvements
- Assess the suitability for intended applications

The main goals of peer reviews are to promote a better understanding, to facilitate acceptance of the model by the user community in some cases, and to provide constructive feedback to model developers. Peer reviews can also serve to expand public experience and expertise with the model.

In a CWEMF sponsored peer review process, an independent expert is identified to work with the Steering Committee to select one or more reviewers from academic

institutions, consulting firms, and public or government agencies. The reviewers are provided written review materials such as model data, documentation, and study reports. In some cases, the written materials are summarized in oral presentations in a public workshop. The reviewers study the materials to a sufficient level of detail and prepare a written report of their findings. More details are provided in the section titled "The Peer Review Process" below.

CWEMF has sponsored reviews of one-dimensional hydrodynamic and transport models, the integrated groundwater and surface water model IGSM, the SWP/CVP simulation model CalSim-II, and in-stream temperature models. The section titled "Conducting Peer Reviews" below discusses the lessons learned and provides some insights into these often-ardent processes.

Additional CWEMF Services

Besides initiating and managing impartial peer reviews, CWEMF also works to:

- Facilitate open, constructive discussion on physical, chemical, biological, and economic modeling
- Conduct problem solving workshops to address technical disagreements
- Organize technical training and educational workshops on a wide range of water resources and environmental issues
- Coordinate model development, refinement, and use through interagency model user groups

For more information on CWEMF and reports of previous reviews, please visit www.cwemf.org.

The Peer Review Process

In general, CWEMF's peer review process follows the eight steps outlined below:

1. Model specification – The party proposing the peer review may be a model developer, a model user, a regulatory or funding agency, or another stakeholder. The initial step is to identify the model or models for review and specify the model's purposes and explicit applications.

2. Obtain funding – The proposing party works with the CWEMF Steering Committee (Committee) to secure funding for the review.

3. Select reviewers – An independent expert is identified to work with the Committee to select one or more “peer” and “external” reviewers from academic institutions, consulting firms, and public or government agencies. To the extent possible, experts will be selected with no vested interests in the model under review. However, the selected reviewers, as a team, must have broad expertise to cover all relevant disciplines for an in-depth review of the model. The qualifications of the reviewers and, in particular, their expertise relevant to the model under review, will be provided in an appendix to the final report.

4. Define scope – The Committee works with the review panel, proposing party, and other interested parties to develop a customized work plan for the review. This work plan will include specific objectives of the review, a detailed set of guidelines for the reviewers, and a schedule. The guidelines vary depending on the model and the specific objectives of the review. The scopes of past CWEMF reviews have focused on the strengths and weaknesses of the models, proposed improvements, and identified appropriate applications. The schedule must be agreed to by all parties and be realistic. The review panel will strive to meet this schedule and notify the Committee immediately of any delay.

5. Assemble model, data, and documentation – The proposing party is

responsible for assembling the model, data, and documentation for the reviewers. It must also identify model developer(s) who would be available to the review panel to answer questions and conduct model runs (if deemed necessary) during the review process. In some cases, the computer code for the model may have to be made available to the review panel.

6. Conduct initial review – The review panel examines all of the materials provided. Workshops may be conducted to address the capabilities and limitations of the models with model developers and the user community. These workshops may include both closed and public sessions. The review panel may request specific model runs which may be performed by the review panel or, in the case of complex or platform-specific proprietary models, by the model developers. Details of these model runs will be summarized in the review report.

7. Prepare draft report – The review panel prepares a draft report as dictated by the scope of the review and provides it to the proposing party, model developers, and the Committee for review. Any comment or suggestion provided on the draft report is non-binding to the review panel. The findings of the draft report may also be presented in a public workshop and/or posted on the CWEMF web site to solicit public comments. Public comments are encouraged as they often improve the quality and acceptance of the review.

8. Prepare final report – Based on the comments received, the review panel revises the draft report at its discretion. The report may include comments received on the draft report and the review panel's responses to the comments. Dissenting views from one or more reviewers will be discussed either in the main body of the report or in an appendix. After all reviewers endorse the report, the final draft is posted on the CWEMF web site. The Committee decides on accepting the report as a CWEMF publication.

Conducting Peer Reviews

The effectiveness and usefulness of a peer review depend on a number of factors, many of which are within CWEMF's control. Whereas each review is unique and must be customized accordingly, the primary issues to consider in preparing and conducting a review are similar. Based on past experience of CWEMF and input from the California water community, the key considerations (the "nuts and bolts" of a review) are divided into a number of categories and discussed in the following paragraphs.

Prologue

What is the most important purpose of a peer review?

CWEMF believes peer review provides policy makers and management staff with an appropriate level of confidence in model results for the particular application at issue. The question then becomes how the reliability and accuracy of a model could be understood by a non-expert audience and to improve the perception and trust in accepting results from modeling analyses.

Peer review is just one of the components critical to establishing the credibility of a model. A model review can only address a few issues in depth, and peer reviewers do not have the same hands-on experience about the system as model developers and local parties. A model review cannot replace a broader and more systematic set of documentation, quality control, and testing protocols for model development and application efforts. Indeed, these efforts, many of which are described in the CWEMF document *Protocols for Water & Environmental Modeling*, are almost always essential requisites for a positive model review.

Good quality control and quality assurance procedures in model development and application that are well documented makes a peer review much more efficient. This allows reviewers to assess model compliance with quality assurance and control protocols, and hence the reliability of

modeling results and if uncertainties are properly quantified. Peer reviewers are more likely to endorse a set of model development and application protocols than the model itself.

While reviewers cannot be expected to endorse a model, their assessments on how well a model simulates the system for its intended application, both in absolute terms and in relation to the current state of scientific understanding, is information that would be most useful for an audience who are not experts in the field. Most numerical models developed to address water resources management issues involve highly complex systems, often requiring simplifying approximations and assumptions that cannot be fully justified. Peer reviews that focus on imperfections could be counter-productive.

Many peer reviews involve more than one model, be it different versions of a model or competing models serving similar applications. To ensure that the relative merits of competing models (or versions of the same model) are assessed with objectivity, specific criteria must be detailed in the scope of review so that the review panel could focus on the specific issues of concern in its assessment. Foremost of these criteria is the specific application or issue that the model is intended to address.

Sponsorship

Whereas CWEMF has successfully conducted a number of reviews in the past, it is more practical to seek joint sponsorships with other agencies that have an interest in furthering the use of sound, objective science in water management decisions. State and federal agencies such as the CALFED Science Program and the US Environmental Protection Agency have collaborated with CWEMF in the past. Partnerships with stakeholders that have vested interests are feasible if they are not involved in the administration of the review.

All partners in the review must agree to the approach and process. Administrators

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should keep a reasonable distance from technical matters of the review, and their technical comments to review findings should not be binding to the review panel.

Scope of review

Each peer review is unique. Therefore its scope must be clearly defined beforehand to focus the review panel on the key issues to be addressed in the report. Where possible, key issues to be addressed in the report should be stated in explicit terms and be focused rather than broad or general. Limitations on available resources may limit the likelihood of a definitive conclusion, and these limitations should be acknowledged beforehand. Clear, realistic expectations on what can reasonably be accomplished will help all parties to better focus the direction of the review.

Review panel

The review panel must have a sufficiently broad range of expertise in the key subject areas of the model. The panel members must be independent thinkers, critical but objective and unbiased. Where feasible, reviewers with academic and with practicing perspectives should be included. The panel members should have a good understanding of CWEMF's philosophy (as outlined in this document) and the specific purposes of the review, and agree to the approach and process.

A review panel may consist of others involved in the operations and modeling of the same system, and could include "peer" stakeholders with vested interests. Additional "external" experts with less direct knowledge and experience with the particular system, but significant practical and methodological expertise in similar systems can also be included. Because most reviews involve the modeling of complex systems, having in-depth knowledge of the local system on the panel can make the review more effective. At the same time, reviewers external to the system can bring a broader perspective to the review. The best choice could be a combination of peer and external experts,

with the mix depending on the particular model and review goals.

Model developers

Commitment from model developers to assist in the review is important. Their input on intended model applications and limitations as well as their assessments of the soundness of hypotheses, assumptions, and data, can help the review panel get up to speed, making the review process much more efficient and useful.

Documentation from model developers is perhaps the most critical material for the review panel. Documentation should be well organized and customized to the extent possible to address the core questions of the review. A summary document with links to specific details works best in most cases. In most complex systems, the accuracy of models can only be established if an adequate amount of data of sufficient accuracy is available. Model documentation must therefore include explicit discussions on the availability and quality of data (field measurements and simulated numbers).

Communication protocol between review panel and model developers

Many reviews in science and engineering are conducted in an adversarial setting, and a firewall is often set up between the review panel and model developers. Communications between the parties are limited and often restricted to formal correspondences only. This "procedural fairness" is often set up to protect the perception of fairness about the process, sponsors, and panel members.

Whereas a firewall may serve well in judicial settings, it could produce an inferior technical product because ambiguities, misunderstandings, and controversies may not be easily resolved. The review panel has to acquire sufficient knowledge in a relatively short period on a complex system that may take years to develop expertise. Objective, honest exchange allows complex issues to be addressed more effectively and makes the review process more productive and

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efficient. Allowing panel members to communicate freely is the most effective way to clarify doubts and concerns on modeling issues. Assuring that selected review panel members have integrity and are competent and committed to the peer review process as outlined in this discussion can protect procedural fairness.

Any restrictions on direct communications between panel members and model developers (or other stakeholders), if deemed necessary, must be explicitly stated and understood at the beginning of the review process.

Stakeholder involvement and public input

An open review process serves to improve the awareness and acceptance of the review. Methods for involving the public include well-publicized public workshops, direct mailing and emails, dedicated web site postings, as well as other appropriate venues. All public input through these venues should be made in form of written comments. Written comments are more precise, harder to overlook, and easier to organize and address.

Review report

The main body of the final report should be understandable to anyone with a general technical background, i.e., it should not require detailed knowledge or expertise in the specific subject area under review. However, detailed technical information should not be avoided if it is pertinent to the review, and should be included as appendices. Special attention on clarity is critical to avoid ambiguity and the likelihood of misinterpretation. The findings do not necessarily have to be consensus driven – dissenting views could stimulate further improvements if they are well supported. Specific recommendations for improvement of modeling aspects or tasks, divided into near-term and longer-term, can provide concrete guidelines to model developers. Releasing a draft report for public comments can improve the quality of the report, but the decision to incorporate comments and editing should be left to the sole discretion of

the review panel. It is a good practice to attach public comments in an appendix, along with the panel's responses to an appropriate level of detail.

A review is, by definition, critical. A review report is almost always written to focus, consciously or unconsciously, on the weaknesses in a model. A review report that only addresses model weaknesses, however, may be misconstrued, used for unintended purposes, and be counter-productive. For a fair and balanced assessment of a model, both the strengths and weaknesses of the model should be discussed. The review panel should be encouraged to identify positive model features as well as providing constructive criticisms.

A review organized by CWEMF is not meant to provide endorsement of a model. However, by discussing the model's strengths and needs for improvement, and explicit references to the appropriateness of different applications wherever possible, the report can serve to address most questions regarding the reliability of modeling results for the intended application, the critical question to most decision making processes.

Schedule and budget

The schedule for the review should be realistic and agreed to by all parties at the beginning. Sufficient resources should be secured, in collaboration with other agencies where appropriate.

Resource needs should include not only those for reviewers but also for model developers to support the review. The availability and timeliness of model developers in responding to requests by the panel must be confirmed early on in the review process. Administrator(s) of the review must also be available to address any issues expeditiously as they arise.

In some cases, provisions should be made to allow for a follow-up review on efforts to address recommendations in the final report.