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AN SAB REPORT: REVIEW OF THE ASSESSMENT FRAMEWORK FOR GROUND-WATER MODEL APPLICATIONS

REVIEW OF THE OFFICE OF SOLID WASTE AND EMERGENCY RESPONSE ASSESSMENT FRAMEWORK FOR GROUND-WATER MODEL APPLICATIONS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF THE ADMINISTRATOR
SCIENCE ADVISORY BOARD

EPA-SAB-EEC-93-013

June 21, 1993

Honorable Carol M. Browner
Administrator
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Subject: Science Advisory Board Review of the OSWER Assessment Framework for Ground-Water Model Applications

Dear Ms. Browner:

The Science Advisory Board (SAB) has completed its review of the Office of Solid Waste and Emergency Response (OSWER) draft guidance, "Assessment Framework for Ground-Water Model Applications," dated October 1992 (hereafter cited as the Framework). The document was addressed at a meeting of the Modeling Project Subcommittee (MPS) of the Environmental Engineering Committee (EEC) in Arlington, VA on January 14-15, 1993. Technical presentations were given by OSWER's Information Management Staff (IMS), their contractors and consultants, and EPA Region III and V technical staff. Subcommittee member and consultant review comments were verbally conveyed to these participants at the close of the meeting.

In accordance with the "charge to the Subcommittee," the MPS review focused on the scientific underpinnings and completeness of the substance of the Framework; whether the Framework provides help from the project management perspective for managing model applications; whether the use of the Framework will serve to aid the OSWER staff in improving the management of its modeling activities; and whether there is additional information or direction which should be added to improve the Framework, especially with regard to project management requirements for the modeling team, and to the modeling code and public domain issues.

The OSWER IMS are to be commended for their thoughtful approach to the development of the Framework. The MPS strongly supports this effort and encourages the extension of this framework, or the development of other frameworks, for additional types of model applications. The Framework represents

a significant advance in OSWER's approach to the management and use of mathematical models in Superfund remediation planning and hazardous waste programs of the Office of Solid Waste (OSW).

Overall, the Framework is based on sound science and its developers have appreciated the need for a comprehensive and flexible document. The modeling philosophy represented in the Framework is reasonable and the language and level of detail are generally suitable for the intended users. In some of the sections, however, the Framework contains too much detail which may tend to reduce the general applicability of the guidance and potentially foster its misuse as a document to supplant experienced professional judgement.

The MPS believes that this Framework will be a useful tool for OSWER in the management and assessment of modeling applications. It will, in fact, assist in providing a basis for common agreement among diverse users as to which components are likely to constitute a good modeling study, and it could help to improve the level of awareness and quality of modeling applications. In this effort, OSWER has responded positively to past guidance from the SAB/EEC and is to be commended for its early involvement of Agency Regional Office personnel in the development of the Framework.

The MPS is concerned, however, that the Framework could be inappropriately formalized as a required checklist to be used as the basis for accepting or evaluating the quality or appropriateness of a <u>particular</u> modeling study. We stress that modeling is not a linear process; that it is an iterative, evolutionary approach to the refinement of our understanding of a physical system, and a tool for the application of this understanding to the prediction of system response. Clearly, no guidance document is a substitute for modeling education and experience. The Framework should not be used to promote modeling by inexperienced people, nor be relied upon to supplant experienced professional judgement or measurement. The MPS has made a number of recommendations in the report which follows to reduce the likelihood that the Framework will be misinterpreted or misused, and to enhance its value to managers as a guidance document.

While many useful EPA publications related to ground-water are contained in the Framework, it appears that a number of related documents were overlooked in its development. A number of specific documents were cited by the MPS to be consulted in the revision of the Framework and incorporated in its reference list.

The MPS was not asked to review the bound document entitled "Ground-Water Modeling Compendium," and was only able to inspect it in a cursory manner, as this document was not distributed prior to the meeting of January 14, 1993. Because the Framework represents a rather broad overview of modeling practice, it seems likely that the user-community receiving the Compendium will interpret the Framework in terms of the example model application descriptions and assessments embodied in the Compendium. It is observed by the MPS that

the modeling studies presented in the Compendium predate the Framework and may not be illustrative of its reasoned application. Therefore, to avoid any potential interpretational pitfalls, the MPS recommends the publication of a revised Framework as a separate document, and OSWER staff should be encouraged to seek out good modeling application case histories to illustrate applicable points covered in the Framework.

To avoid Framework user misconceptions about the predictive accuracy of models, the MPS recommends that the document language be refined to clarify the precise meaning of phrases, such as "required level of confidence," "performance target," "quality assurance," and "model verification."

A number of specific concerns and suggestions, along with suggested language revisions are offered by the MPS. With appropriate revisions as suggested, the MPS believes that the Framework will become a useful document for management of ground-water modeling applications within the Agency.

We appreciate the opportunity to conduct this review and look forward to your response to the scientific advice contained herein, and in particular to the items stressed in this forwarding letter to you.

Sincerely,

Raymond C. Loehr

Dr. Raymond C. Loehr, Chair
Executive Committee
Science Advisory Board

Richard A. Conway

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NOTICE

This report has been written as a part of the activities of the Science Advisory Board, a public advisory group providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The Board is structured to provide a balanced, expert assessment of scientific matters related to problems facing the Agency. This report has not been reviewed for approval by the Agency; hence, the comments of this report do not necessarily represent the views and policies of the Environmental Protection Agency or of other federal agencies. Any mention of trade names or commercial products does not constitute endorsement or recommendation for use.

ABSTRACT

The Modeling Project Subcommittee (MPS) of the Environmental Engineering Committee (EEC) of the Environmental Protection Agency's (EPA) Science Advisory Board (SAB) reviewed the Agency's Office of Solid Waste and Emergency Response (OSWER) draft guidance entitled "Assessment Framework for Ground-Water Model Applications," dated October, 1992. (hereafter cited as the Framework). The MPS met on January 14 and 15, 1993 and reviewed the Framework.

In accordance with its charge, the MPS review focused on the scientific correctness and completeness of the substance of the Framework; whether the Framework provides guidance to OSWER for managing model applications; and whether there is additional information or direction which should be added to improve the Framework.

The MPS strongly supports this effort and encourages the extension of this Famework, or the development of other frameworks, for additional types of model applications. The Framework represents a significant advance in OSWER's approach to the management and use of mathematical models in Superfund remediation planning.

In order to improve the usefulness and flexibility of the Framework and to reduce the likelihood that the Framework be used inappropriately, the MPS suggests the following: that the introduction be expanded to clarify intended users and uses; that graphic illustrations be added to emphasize feedback involved in the modeling process; that the Framework be distributed as a separate document; and that additional references be consulted in its revision. Particular language revisions are also recommended to improve clarity and comprehensiveness.

With revision, the MPS believes that the Framework will be a useful guidance document for OSWER management of ground-water model applications.

Key Words: Assessment Framework, , Assessment Framework for Ground-Water Model Application, Ground-Water Models, Hazardous Waste, Superfund

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1. EXECUTIVE SUMMARY

The Science Advisory Board (SAB) has completed its review of the Office of Solid Waste and Emergency Response (OSWER) draft guidance, entitled "Assessment Framework for Ground-Water Model Applications," dated October 1992 (hereafter cited as the Framework) (See Appendix C; Reference 6). The document was reviewed and discussed at a meeting of the Modeling Project Subcommittee (MPS) of the Environmental Engineering Committee (EEC) in Arlington, VA on January 14-15, 1993. At this meeting, technical presentations on the development and application of the Framework were given by OSWER's Information Management Staff (IMS), their contractors and consultants, and EPA Region III and V technical staff. Subcommittee member and consultant review comments were verbally conveyed to these participants at the close of the meeting in a debriefing session.

In accordance with the "charge to the Subcommittee," (See Appendix B for the complete charge) the MPS review focused on:

a) the scientific underpinnings and completeness of the substance of the Framework,

b) whether the Framework provides help from the project management perspective for managing model applications,

c) whether the use of the Framework will serve to aid the OSWER staff in improving the management of its modeling activities, and

d) whether there is additional information or direction which should be added to improve the Framework, especially with regard to project management requirements for the modeling team, and to the modeling code and public domain issues.

The OSWER Information Management Staff are to be commended for their thoughtful approach to the development of the Framework. The MPS strongly supports this effort and encourages the extension of this framework, or the development of other frameworks, for additional types of model applications. The Framework represents a significant advance in OSWER's approach to the management and use of mathematical models in Superfund remediation planning.

Overall, the Framework is based on sound science and its developers have appreciated the need for a comprehensive and flexible document. The modeling philosophy represented in the Framework is reasonable and for the most part, the language and level of detail are suitable for the intended users. In some of the sections, however, the Framework contains a level of detail which the MPS believes to be inappropriate. Here, the presence of too much detail may tend to

reduce the general applicability of the guidance and could potentially foster its misuse as a document to supplant experienced professional judgement.

The MPS believes that this Framework will be a useful tool for OSWER management and its consultants in the management and assessment of modeling applications. It will, in fact, provide a basis for common agreement among diverse users as to which components constitute a good modeling study, and it could help to improve the level of awareness and quality of modeling applications. In this effort, OSWER has responded positively to past guidance from the SAB/EEC and is to be commended for its early involvement of Agency Regional Office personnel in the development of the Framework.

The MPS is concerned, however, that the Framework could be inappropriately formalized as a required checklist to be used as the basis for accepting or evaluating the quality or appropriateness of a particular modeling study. We would like to stress that modeling is not a linear process; that it is an iterative, evolutionary approach to the refinement of our understanding of a natural system, and a tool for the application of this understanding to the prediction of system response. Clearly, no guidance document is a substitute for modeling education and experience. The Framework should not be used to promote modeling by inexperienced people, nor be relied upon to supplant experienced professional judgement or measurement. The MPS has made a number of recommendations in the report which follows to reduce the likelihood that the Framework will be misinterpreted or misused, and to enhance its value to managers as a guidance document.

While many useful EPA publications related to ground-water are referenced in the Framework, it appears that a few related documents were overlooked in its development. It is important that use be made of previously published materials which are relevant to the subject. Therefore, a number of specific documents were cited by the MPS to be incorporated in its reference list.

The MPS was not asked to review the bound document entitled "Ground-Water Modeling Compendium," and was only able to inspect it in a cursory manner, as this document was not distributed prior to the meeting of January 14, 1993. Because the Framework represents a rather broad overview of modeling practice, it seems likely that the user-community receiving the compendium will interpret the Framework in terms of the example model application descriptions and assessments embodied in the Compendium. It is observed by the MPS that the modeling studies presented in the Compendium predate the Framework and may not be illustrative of its reasoned application. Therefore, to avoid any potential interpretational pitfalls, the MPS recommends the publication of a revised Framework as a separate document. OSWER staff should be encouraged to seek out good modeling application case histories to illustrate applicable points covered in the Framework.

To avoid Framework user misconceptions about the predictive accuracy of models, the MPS recommends that the document language be refined to clarify the precise meaning of phrases, such as "required level of confidence," "performance target," "quality assurance," and "model verification."

A number of specific concerns and suggestions, along with suggested language revisions are offered by the MPS in Appendix A. With appropriate revisions as suggested, the MPS believes that the Framework will become a useful document for management of ground-water modeling applications within the Agency.

2. INTRODUCTION

The Science Advisory Board (SAB) has completed its review of the Office of Solid Waste and Emergency Response (OSWER) draft guidance entitled "Assessment Framework for Ground-Water Model Applications" dated October, 1992 (hereafter cited as the Framework) (See Appendix C; Reference 6). The document was reviewed and discussed at a meeting of the Modeling Project Subcommittee (MPS) of the Environmental Engineering Committee in Arlington, VA, on January 14-15, 1993. At this meeting, technical presentations on the development and application of the Framework were given by OSWER's Information Management Staff, their contractors and consultants, and EPA Region III and V technical staff. Subcommittee member review comments were summarized for these participants in a public session at the close of the meeting.

The Framework is a product of OSWER's Pilot Study on Model Management. This Pilot Study was designed to provide "useful information on existing modeling practices and models to EPA staff, contractors, and the regulated community." (EPA-500-B-92-006) (See Appendix C; Reference 7). The Pilot Study is part of an ongoing OSWER initiative on modeling which was motivated by the SAB's January 1989 Report, "Resolution on Use of Mathematical Models by EPA for Regulatory Assessment and Decision-Making," (See Appendix C; Reference 9). Earlier products of this OSWER initiative have been reviewed by the SAB/EEC (See, for example, EPA-SAB-EEC-91-016, see Appendix C; Reference 10).

The stated objective of the Framework is "to support the use of models as tools for aiding decision-making". The Framework is being disseminated as an integral part of a document entitled "Ground-Water Modeling Compendium: Model Fact Sheets, Descriptions, Applications, and Assessment Framework (EPA-500-B-92-006, October 1992) (See Appendix C; Reference 7) (hereafter cited as the Compendium). It is intended that use of the Compendium will "help promote the appropriate use of models and therefore sound and defensible modeling within the hazardous waste/Superfund programs."

The MPS was not asked to review the Compendium. Thus, the SAB/MPS review focused solely on the Framework. In accordance with the "charge to the Subcommittee," the MPS was asked to assess the scientific correctness and completeness of the substance of the Framework; whether the Framework provides help from the project management perspective for managing model applications; whether the use of the Framework will serve to aid the OSWER staff in improving the management of its modeling activities; and whether there is additional information or direction which should be added to improve the Framework, especially with regard to project requirements for the modeling team and to the modeling code and public domain issues. (See Appendix B for the charge to the SAB). The report which follows herein is the consensus response of the MPS to this charge.

2.1 General Assessment

The Framework represents a significant advance in OSWER's approach to the management and use of mathematical models in the waste management programs, including Superfund remediation. Overall, OSWER has done an excellent job of formulating criteria for modeling application assessment. In this effort, OSWER has responded positively to past guidance from the SAB/EEC (See Appendix A; References 8, 9, & 10) and is to be commended for its early involvement of Regional Office Personnel in the development of the Framework.

The Framework is based on sound science and its developers have appreciated the need for a comprehensive and flexible document. The MPS believes that this Framework will be a useful tool for OSWER management and consultants in the management and assessment of modeling applications. It will provide a basis for common agreement among diverse users as to which components constitute a good modeling study and it could help to improve the level of awareness and quality of models applications. This perspective on the intended use of the Framework is also shared by OSWER/IM staff.

The MPS is concerned, however, that the Framework could be inappropriately formalized as a required checklist to be used as the basis for accepting or evaluating the quality or appropriateness of a particular modeling application. Clearly, no guidance document is a substitute for modeling education and experience. The Framework should not be viewed as an endorsement for the application of models by inexperienced people nor should it be relied upon to supplant experienced professional judgment.

The following recommendations are made to reduce the likelihood that the Framework will be misinterpreted or misused and to enhance its value to managers as a guidance document. These recommendations involve six general issues:

a) Expansion of the Framework introduction,

b) Graphic representation of concepts,

c) Balance of treatment,

d) Reference to previous work,

e) Interrelationship of the Framework and its Compendium, and

f) Clarification of terminology.

Some substantive comments on particular assessment criteria are also included, in response to the charge to the Subcommittee.

In the interest of providing a concise, readable report, detailed technical comments which illustrate and elaborate upon the general recommendations are included in Appendix A. These technical comments are referenced where appropriate in the body of the report.

3. RECOMMENDATIONS

3.1 Expansion Of The Framework Introduction

Although it is recognized that a concise guidance document is desirable, the MPS strongly recommends that the introduction to the Framework be substantially expanded to clarify the objectives and intended applications of the guidance. In this revised introduction, the following points should be addressed:

a) The focus of the current Framework should be explicitly identified as pertaining to the application of groundwater flow and advective transport models,

b) The objectives of the Framework should be clearly described,

c) The intended (primary and secondary) users of the Framework should be identified,

d) The potential way in which the Framework could be employed by each of these users and the appropriate stages (timing) for its application in the modeling process should be described,

e) The intended flexibility of the guidance and its status as a "living document," subject to expansion and revision, should be emphasized, and

f) A brief discussion of the value of modeling would also be appropriate in the introduction. The Framework, in its present form, focuses almost exclusively on the use of models for prediction and evaluation of alternative remedial schemes. While prediction is often the endpoint of the modeling process, the value of modeling is not limited to this goal. The modeling process can enhance one's understanding of the natural system, help in the refinement of a conceptual model, facilitate hypothesis testing, help check consistency of data sets, help identify critical (controlling) processes, and aid in the planning of site characterization (data collection).

Points (a) through (e) above were addressed in the technical briefings presented to the MPS by OSWER personnel and consultants on January 14, 1993. OSWER is encouraged to use the viewgraph materials from these briefings to help in the expansion of the Framework introduction. Particular attention should be directed toward the viewgraph materials which consider the limitations of the document.

Particularly useful insights regarding the need for and application of the Framework were provided in a presentation by Dr. Luanne Vanderpool, EPA Region V Geologist. Dr. Vanderpool's presentation included a discussion of how the Framework is likely to be used in practice and by whom. She indicated that she is acquainted with a number of instances where ground-water models had been used to evaluate sites in a manner that was either inappropriate or difficult for EPA management to assess. The principal purpose of the Framework in this application is to provide guidance to EPA management in the review of model applications. Her presentation also included a good discussion of the stages in the modeling process at which the review criteria could be applied. These stages included the initial proposal for model use; the early application of the model; at completion of the model application; and in a post-review, after decisions based upon the model application were implemented. Dr. Vanderpool emphasized that applications of the Framework at early stages of the modeling process could be most beneficial. Her presentation also addressed how the Framework might be applied differently, depending upon the group which performs the model study (i.e., the EPA, an EPA contractor, or a consultant for the Potentially Responsible Party (PRP) and the individual(s) who performs the review). Effort should be made to incorporate the above insights into the Framework introduction.

3.2 Graphic Representation Of Concepts

Although the Framework is designed as a comprehensive and flexible document, its format creates the unfortunate impression that the intended use of this document is as a once-through checklist. This impression is conveyed specifically by the outline organization, the lack of cross-referencing to indicate important points of feedback, and the identification of individual items by boxes (□). Modeling, however, is not a linear process. It is an iterative, evolutionary

approach to the refinement of our understanding of a natural system and a tool for the application of this understanding to the prediction of system response.

Typically, model type and complexity will evolve during the course of a project as more is learned about a system. In order to emphasize this iterative nature of modeling, the MPS recommends that figures (logic flow diagrams) be added to the Framework text to represent the important stages, the interrelationships, and feedback loops in the modeling process. This use of figures would help clarify the meaning of many statements in the guidance and would help reduce the tendency to use the framework in a linear, once-through (sequential) fashion. These figures should also incorporate the ways in which modeling can be integrated into data collection and decision-making, thereby providing manager-users a broad conceptual view of the potential role of models in site assessment and in remediation planning. The boxes identifying individual sections of the Framework should be deleted.

3.3 Balance Of Treatment

Overall, the modeling philosophy represented in the Framework is reasonable and the language and level of detail are suitable to the intended users. The Framework developers have recognized the importance of maintaining comprehensiveness and flexibility in the document. It is necessary that the Framework provide sufficient detail to clarify the important concepts for all users, while, at the same time, avoiding over-prescription of model components or structure, thereby retaining a balanced, flexible, concise guidance document. Such a balance is often difficult to achieve.

In some of its sections, the Framework contains a level of detail which the MPS believes to be inappropriate to the above objectives. Here, the presence of too much detail will tend to reduce the general applicability of the guidance and potentially foster its misuse as a document to supplant experienced professional judgment. Two important sections which the MPS finds overly detailed are highlighted below, and other more minor suggestions are included, by section number, in Appendix A.

Section 24, under **"Conceptual Model Development,"** itemizes required field data. In this list, there is a marked lack of balance between the collection of flow and transport-related information, with most of the emphasis placed on flow data.

Clearly, no data list can be exhaustive, nor are all listed data equally important or relevant to a specific system or model. Thus, to increase the comprehensive and flexible use of this guidance, the MPS recommends deletion of the third and fourth order subheadings in this section. Second order subheadings should then be reorganized and reworded to reflect more balance between flow and transport data. A suggested specific format is given in Appendix A.

There is a serious omission in Section 24 which also needs to be rectified. Here the potential role which heterogeneity plays in conceptual model development is not considered. The importance of quantitative and qualitative information on the variability of properties must be acknowledged. The suggested wording in Appendix A is intended to address this issue.

The section titled, "Model Set-up and Input Estimation" contains too much detail pertaining to model structure. Here the focus is on the application of finite difference and finite element models, to the exclusion of other numerical or analytical approaches. The Framework, however, is not intended as a finite difference or finite element modeling primer. It is recommended that this entire section be rewritten to emphasize documentation of modeling decisions, rather than specific rules for model grid development and temporal discretization.

3.4 Reference To Previous Work

Although the Framework contains an extensive reference list, it appears that a number of related reports were overlooked. It is important that use be made of the major publications relevant to the subject. The reports listed below which discuss many issues pertinent to the Framework, should be consulted in the revisions of this document:

Keely, J.F. (1987). (See Appendix C; Reference 1) presents numerous useful schematics that illustrate modeling concepts and their interrelationships

U.S. Office of Technology Assessment, (1982). (See Appendix C; Reference 12) reviews the use of all models in water resources, including ground-water models.

Van der Heijde, Paul, K.M. and Richard A. Park, (1986). (See Appendix C; Reference 13).

NRC, 1990 (See Appendix C; Reference 5) is an authorative review by the NRC/NAS, sponsored in part by EPA, which summarizes the salient aspects of mathematical modeling applications for remedial assessments. This document discusses many of the same issues of importance in the Framework.

The Framework contains a useful list of EPA Publications related to ground-water modeling. In addition, footnotes direct the user to other references for more information. Some of the footnoted references, such as draft documents, however, may not be easily accessible. The MPS urges OSWER to make provisions for user access to this information part of their overall management plan. The reference list should be viewed, like the Framework, as a dynamic entity to be updated and refined with time and experience.

3.5 Interrelationship Of The Framework and Its Compendium

The Assessment Framework is being disseminated as an integral part (Section 2.0) of a bound document titled, "Ground-Water Modeling Compendium: Model Fact Sheets, Descriptions, Applications, and Assessment Framework" (EPA-500-B-92-006), October, 1992 (See Appendix C; Reference 7).

The MPS was not asked to review the Compendium and indeed, was able to inspect it only in a cursory manner, as this document was not distributed prior to the meeting on January 14, 1993. Because the Framework represents a rather broad overview of modeling practice, it seems likely that the user community receiving the Compendium will interpret the Framework in terms of the example model application descriptions and assessments embodied in the Compendium.

The MPS is concerned that the Framework has been distributed widely in this form prior to SAB review. Modeling studies presented in the Compendium predate the Framework and may not be illustrative of its reasoned application. To avoid the interpretational pitfalls described above, the MPS recommends the publication of a revised Framework as a separate document.

OSWER should be encouraged, however, to seek out good modeling application case histories to illustrate points covered in the Framework. In fact, many case histories are a part of the literature or the public record. The MPS believes that a critical analysis of selected case histories in the context of the Framework could be of substantial value to the intended users.

3.6 Clarification Of Terminology

A number of phrases used in the Framework could easily be misinterpreted by a user unfamiliar with models and their limitations. These phrases include "required level of confidence," "performance target," "quality assurance," and "model verification." Indeed, within the peer-reviewed modeling literature itself, there is substantial disagreement as to the precise meaning of these terms (See for example, Appendix C; Reference 3).

To avoid Framework user misconceptions about the predictive accuracy of models, the MPS recommends that document language be refined to clarify the meaning of such phrases. Specific concerns and some suggested language revisions are listed by section number in Appendix A.

There is a great deal of emphasis in the Framework on "model verification" and "quality assurance." While the listed modeling activities associated with these goals are entirely appropriate and consistent with good modeling practice, they cannot assure that a model reliably represents a given physical system. Certain activities are necessary to build confidence in a model application but they are insufficient to guarantee accurate predictions.

When a physical system is subject to new stresses (as during the application of a remedial strategy), errors in the conceptual model which had little impact during the calibration phase may become dominant sources of error for the prediction phase. Similarly, while use of qualified personnel, careful documentation of the modeling process, and peer review are undoubtedly important aspects of sound modeling management, they cannot assure a quality (i.e. accurate) model prediction. Because, then, a specific model of a physical system can never be completely "verified," it becomes important to identify uncertainties in model input parameters and conceptual assumptions and to explore the implications of these uncertainties on model predictions. These issues should be stressed in the Framework guidance.

For a more complete discussion, see: Konikow, Leonard F. and John D. Bredehoeft, 1992. (Appendix C; Reference 3).

3.7 Sections 14 and 39

As part of its charge, the MPS was particularly requested to provide recommendations pertaining to Sections 14 and 39 of the Framework. Section 14, listed under **"Project Management,"** focuses on the desirable qualifications of the modeling team (See Appendix C; Reference 6).

The MPS believes that this section would benefit from OSWER's review of the previously referenced USEPA Ground-Water Modeling Policy Study Group report (van der Heijde and Park, 1986, See Appendix C; Reference 13). This document discusses the types of staff required to perform groundwater modeling in a section titled, "Technology Transfer and Training to Sustain and Improve Expertise of Agency Personnel" (pp. 52-58).

Another publication (OTA, 1982. See Appendix C; Reference 12) considers specific education and training requirements for model developers, users, and managers involved in water resources modeling applications. These two reports cited above also address issues relating to the hiring and retention of qualified personnel.

The MPS recommends that the above references be used to refine the statement in Section 14 concerning required modeling team experience.

Section 39, under **"Model (Code) Selection,"** relates to the accessibility of models and suggests that a selected model should be in the "public domain." The use of proprietary vs. public domain codes is discussed in van der Heijde and Park (1986) (See Appendix C; Reference 13). In this report, it is recommended (p. 42) that a general framework of nondiscriminatory criteria should be established by the Agency to apply to all codes. The MPS agrees with this 1986 Study Group's recommendation and suggests that a set of criteria be developed to replace the existing language in Section 39 and to eliminate the need for making a distinction between public domain and proprietary models. These criteria should include:

a) Publication and peer review of the model conceptual and mathematical framework,

b) Full model documentation and visibility of underlying model assumptions,

c) Incorporation of a mass balance,

d) Testing of the code, and

e) Model availability for independent (third party) evaluation.

In the formulation of model selection criteria, it should be noted that, if ground-water models are to be relied upon to form expert opinions in litigation, the other side will be permitted access to the foundation of those opinions, including the source code. This was the ruling of the Special Master in the case of United States of America et al vs. Hooker Chemicals & Plastics Corporation et al (Love Canal) on November 30, 1989 (See Appendix C; Reference 11). At the same time, the Special Master granted a Protective Order so that the code could not be used by the opposing side for any purpose other than the trial. Thus, when selecting a ground-water model for litigation purposes, access to the source code is an important consideration.

For further information on the use of ground-water models in litigation, see: Kezsbom, A. and A.V. Goldman, 1991. (See Appendix C; Reference 2).

4. CONCLUSIONS

With appropriate revisions, as outlined above, the MPS believes that the Framework will become a useful document for management of ground-water modeling applications within the Agency. OSWER/IM staff are to be commended for their thoughtful approach to the development of this guidance. The use of experts and the early involvement of regional staff have helped to produce a comprehensive and flexible document.

The MPS strongly supports this effort and encourages the extension of this Framework (or the development of other frameworks) for additional types of model applications. While the Framework will undoubtedly help improve existing modeling management practice, it must be cautioned that this guidance cannot supplant the pressing need for the hiring and retention of qualified modeling personnel in the Agency. This point was addressed in an earlier Modeling Resolution report of the SAB/EEC (EPA-SAB-EEC-89-012) (See Appendix C - Reference 9).

To aid OSWER in its overall management of ground-water models, it is further recommended by the MPS that a repository be established to electronically

archive site-specific model application data files. A discussion of this concept is contained in National Research Council, 1992. (See Appendix C; Reference 4).

The SAB/EEC/MPS has appreciated the opportunity to review the draft Framework document and would be pleased to review future products of the OSWER Pilot Study on Model Management.

APPENDIX A - DETAILED TECHNICAL COMMENTS (By Section Number)

This represents a compilation of detailed technical comments which illustrate and elaborate upon the general recommendations contained in the body of this report. They are itemized by the corresponding section number in the Framework document (See Appendix C; Reference 6).

Modeling Application Objectives:

It is recommended that a section be added prior to number 1, relating to the establishment of a need for the modeling study.

2. The management decision objectives and the role and need for a modeling study in the pursuit of these objectives should first be established, considering applicable regulatory and policy issues.

3. It is difficult to distinguish here between model functions and modeling objectives. Perhaps function should be defined in glossary.

5. This section should be rephrased to reflect the fact that the "required" level of analysis (level of model complexity) may be revised as a better understanding of the site/problem/data is developed.

In this section, some discussion of the factors which influence model complexity might also be appropriate. These factors include:

a) The importance of the decisions which will be influenced by the model results,

b) The sensitivity of these decisions to the range of possible or likely outcomes of the modeling, and

c) The availability of time and resources for the modeling application.

7. This section is ambiguous. It is not clear how the required level of confidence can be specified in advance in a meaningful way nor how to determine whether the desired level of confidence is achieved. It is suggested that this item be deleted.

8. More clarification is needed on the meaning of the term, "performance target." If, as stated in the glossary, this means model accuracy, then this second phrase should be defined. The Framework should address the possibility that the performance target may not be obtainable.

12. It is recommended that this section be combined with section 5.

13. It is recommended that this section be combined with section 3.

Project Management:

Here one important aspect of project management is not considered, namely financial budgeting and cost control. Related areas of project management for computer modeling would include management and procurement of adequate modern computer equipment and facilities.

17. The meaning of the word, "independent," must be clarified. Does independent mean that people who provide peer review cannot work for the same contractor or agency or that they cannot have worked on the same project? Clarification must be given for the meaning of Quality Assurance (QA) in the present context. Components of QA discussed here include (a) staffing with qualified people; (b) peer review; and (c) appropriate documentation. Are other components envisioned? Caution should be exercised against the establishment of a rigid QA bureaucracy of personnel and procedures which could adversely impact project efficiency and progress.

19. This item seems rather obvious and inconsistent with the tone of the rest of the Framework, and it is suggested that it be deleted.

20. Here the need to provide enough information for reproducibility should be emphasized.

21. Parts of this section are very detailed. In this detail, there is a lack of balance between flow and transport. It is suggested that the subheadings **"Background Chemical Quality"** and **"Chemical Parameters"** be added under Conceptual Model and Ground-Water Model Construction, respectively, to improve the balance.

The subheading **"Sources and Sinks"** should be rephrased as **"Water Sources and Sinks."** The documentation should include a section highlighting assumptions, their relation to reality, and their potential impact on the solution.

The Public Domain vs. Proprietary Model subheading should be revised for consistency with Section 39, as discussed in the main body of this report.

Conceptual Model Development:

24. Here too much detail is included. It is recommended that third and fourth order subheadings be deleted and that the second order subheadings be reworded to be more inclusive of and flexible to varying model application scenarios. Acknowledgment must also be made of the potential importance of heterogeneity. A suggested revised subsection is: **"Quantification and Qualification of Field Data."**

The conceptual model should be based upon a quantification of field data as well as other qualitative data that includes information on the nature and variability of:

a) Aquifer system (Distribution and configuration of aquifer and confining formations),

b) Hydrologic boundaries,

c) Hydraulic and chemical properties of formations,

d) Fluid potential and properties,

e) Contaminant sources and properties, and

f) Fluid sources and sinks.

34. It is recommended that this section be deleted. The important aspects of it are already contained within Sections 23 and 24. Further, the wording here would seem to imply an unwarranted rigidity in the conceptual model, that parameters should not be modified during or after calibration.

Model (Code) Selection:

35. Recommended rewording: "The selected model (code) should be described with regard to its flow and contaminant transport and transformation processes".

36. This section should be clarified to indicate that it is the reliability of the generic model (code) that is being assessed here. It may be appropriate to reference the International Ground Water Modeling Center (IGWMC) Data Base here as a footnote.

Model Setup and Input Estimation:

46/47. Here the level of detail should be reduced, as discussed in the main body of the report.

58. The meaning of water budget must be clarified here. Is this the water budget of the model or the real system?

61. Although it may be desirable, it is almost never feasible in real field applications to obtain an independent set of field observations.

Overall Effectiveness:

This section should include a statement describing another measure of effectiveness, that the modeling results are consistent with most available data.

Glossary:
Calibration:

Change wording to indicate that the range of error does not have to be pre-established.

Contaminant Transformation:

Add reference to biological transformations.

Uncertainty analysis:

Replace existing entry with the following definition: process to identify uncertainties in model input parameters and conceptual assumptions, and the implications of these on the uncertainty in model predictions, including potential impacts on the decisions which will be made based on these predictions.

Verification:

See discussion in main body of this report.

References:

Two references cited in the Framework are incomplete and consequently difficult for the user to find: Bauer et al, 1984, Middleton and Hiller, 1990.

SAB's Charge

- Is the substance of the Framework scientifically correct?
- Does the Framework address ground-water model application activities with as much completeness as is acceptable and necessary?
- Does the Framework provide help from the project management perspective for managing model applications?
- Will the use of the Framework serve to aid OSWER in improving the management of its modeling activities?
- Is there additional information or direction which should be added to #14 (Project Management - requirements for modeling team) and #39 (model code in the public domain)?

APPENDIX C - REFERENCES CITED

1) Keely, J.F. 1987. The Use of Models in Managing Ground-Water Protection Programs, EPA/600/8-87/003, ORD, Ada, OK. 72p.

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3) Konikow, Leonard F. and John D. Bredehoeft,"Ground-Water Models Cannot be Validated," Advances in Water Resources 15, 75-83, 1992.

4) National Research Council, A review of ground water modeling needs for the U.S. Army, Washington, D.C., 1992.

5) National Research Council, Ground Water Models; Scientific and Regulatory Applications, National Academy Press, Washington, DC, 1990, 303 pp.

6) U.S. EPA, "Draft Assessment Framework for Ground Water Model Applications," Office of Emergency and Remedial Response, October 1992 (NOTE: This Draft Assessment Framework was sent by Richard J. Guimond, Assistant Surgeon General, USPHS and Deputy Assistant Administrator of the Office of Solid Waste and Emergency Response on October 5, 1992 to Office Directors and Regional Waste Management Division Directors, along with a proposed Policy Directive on the Use of Computerized Models in the Hazardous Waste/Superfund Programs. On October 26, 1992 Richard J. Guimond sent a formal request to Dr. Donald G. Barnes, Director of the SAB for review of the Draft Guidance "Assessment Framework for Ground Water Model Applications" in Support of an OSWER Policy on the Use of Models).

7) U.S. EPA, "Ground-Water Modeling Compendium: Model Fact Sheets, Descriptions, Applications, and Assessment Framework" (EPA-500-B-92-006), October, 1992.

8) U.S. EPA/SAB Memo from Conway, Small and Kooyoomjian of the SAB to Mr. Asa R. Frost, Jr., Director of Information Management, U.S. EPA, Office of Solid Waste and Emergency Response, Washington D.C. Pertaining to the SAB's Consultation on Review of Selection Criteria for Participation of EPA Staff on the Proposed Agency Task Force on Modeling, April 29, 1991

9) U.S. EPA/SAB Report of the Environmental Engineering Committee, entitled, "Resolution on Use of Mathematical Models by EPA for Regulatory Assessment and Decision-Making," (EPA-SAB-EEC-89-012), January, 13, 1989

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11) United States of America et al vs. Hooker Chemicals & Plastics Corporation et al (Love Canal) on November 30, 1989.

12) U.S. Office of Technology Assessment, "Use of Models for Water Resources of the United States," U.S. Government Printing Office, Washington, D. C., 1982

13) Van der Heijde, Paul, K.M. and Richard A. Park, 1986. U.S. EPA Ground Water Modeling Policy Study Group, International Ground Water Modeling Center, Holcomb Research Institute, Butler University, Indianapolis, IN

APPENDIX D - GLOSSARY OF TERMS AND ACRONYMS

EEC	Environmental Engineering Committee (SAB/EEC, also referred to as "The Committee")
EPA	U.S. Environmental Protection Agency (U.S. EPA, or "The Agency")
IGWMC	International Ground Water Modeling Center
IM	Information Management (U.S. EPA/OSWER)
IMS	Information Management Staff (U.S. EPA/OSWER)
MPS	Modeling Project Subcommittee (U.S. EPA/SAB/EEC)
NAS	National Academy of Sciences
NRC	National Research Council
OSW	Office of Solid Waste (U.S. EPA)
OSWER	Office of Solid Waste and Emergency Response (U.S. EPA)
OTA	U.S. Congressional Office of Technology Assessment
PRP	Potentially Responsible Party
QA	Quality Assurance
SAB	Science Advisory Board (U.S. EPA)
U.S.	United States
USGS	United States Geological Survey

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