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PROJECT WM-10

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MEMORANDUM FOR: Hubert J. Miller, Chief
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THRU: Philip S. Justus, Section Leader
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Development Branch
Division of Waste Management

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FROM: Mark Logsdon
High-Level Waste Technical
Development Branch
Division of Waste Management

SUBJECT: HYDROGEOLOGY MODELING MEETING WITH TECHNICAL ASSISTANCE CONTRACTORS, MARCH 7-8, 1983

Attached are the meeting notes for the meeting of March 7-8, 1983 between NRC's hydrogeology review team and technical assistance contractors from Geotrans, Golder Associates, and Williams and Associates. The meeting was called (1) to discuss the results of efforts to benchmark the SWIFT code against the results of the PORFLO code given in the BWIP SCR and (2) to develop advice on a strategy for hydrologic modeling in support of on-going BWIP assessments. The details of technical discussion between modelers from WMHL, Golder Associates and Geotrans on assumptions, data and modifications for SWIFT are given in a memorandum from Matthew Gordon and Michael Weber to Malcolm Knapp of WMHL.

The principal results and recommendations of the meeting are the following:

- o Both GAI and WMHL have matched the PORFLO results, given the uncertainties in RHO input data.

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- o GAI and WMHL should agree on a common grid and a common set of input parameters after DOE has responded to WMHL questions needed to define unknown inputs. A final transient simulation to refine the benchmarking should be run, probably by WMHL only.

- o NRC modeling resources should be concentrated on 3-dimensional and 2-dimensional flow modeling. Overall performance assessment (flow and transport) should be done with a 1-dimensional model applied along a flow path determined by multi-dimensional modeling. Regional-scale modeling should be the NRC's lowest priority.

The NRC hydrogeology team, including section leaders, should consider the recommendations of this meeting in developing modeling strategy for BWIP assessments at least through finalization of the NRC review of DOE's BWIP Site Characterization Plan. The staff and contractors who participated in this meeting urge that an NRC modeling strategy for BWIP be formalized within approximately four weeks.

"ORIGINAL SIGNED BY"

Mark Logsdon
High-Level Waste Technical
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DATE	03/17/83	03/17/83	03/ /83			

Meeting Notes

Meeting: NRC - Golder Associates - Williams and Associates - Geotrans
Hydrologic Modeling at BWIP

Date: March 7-8, 1983

Place: United States Nuclear Regulatory Commission
7915 Eastern Ave.
Silver Spring, MD 20910

PRESENT: Mark Logsdon, WMHT, Chairman
Matthew Gordon, WMHL
Michael Weber, WMHL
Timothy McCartin, TMBR
Robert Poggioli, TMBR
Jerry Rowe, GAI
Eileen Poeter, GAI
Roy Williams, Williams and Associates
Charles Faust, Geotrans
Barry Lester, Geotrans
Mark Reeves, Geotrans

I. Introduction

A. Logsdon reviewed the recently modified BWIP schedule (see Attachment A), emphasizing the need to have a coherent modeling strategy as a tool for licensing assessments and for providing support to NRC guidance to DOE.

B. Logsdon stated the objectives of the meeting:

1) Review the status of short term modeling in support of the DSCA to date. Resolve the status of the attempt to benchmark SWIFT against PORFLO, including joint documentation by WMHL and GAI of assumptions, data and code modifications.

2) Solicit recommendations to the NRC on modeling strategy to support on-going BWIP assessment. Topics to be considered include the relative emphasis to be given to three-dimensional flow modeling, two-dimensional flow modeling and one-dimensional sensitivity studies (including transport) at scales from near-field to regional.

II. SWIFT - 2D

A. GAI briefed the meeting on the 2-D analytical model that is the basis for DSCA Appendix D. The group agreed that the method is a technically valid approach to testing the sensitivity of pre-placement travel-time calculations as long as the assumptions are clearly stated.

B. GAI presented the results of their task to duplicate the PORFLO results of the SCR using SWIFT.

1) Poeter: GAI has made several modifications to SWIFT. These modifications will be discussed in detail with WMHL staff on 3/8/83.

2) Poeter/Rowe: Despite assumptions and code differences (described below), travel times agree with DOE results to within approximately 10-30%. Flow paths are qualitatively similar, though the GAI flow paths from the "left-hand" wing of the repository go higher in the stratigraphic section than do the DOE flow paths.

a. Assumptions and Limitations that may be affecting results:

- o Hydraulic conductivities: Hydraulic conductivities are given for a reference temperature and pressure and are adjusted for ambient conditions by the code. Hydraulic conductivity (K) depends on the density and viscosity of the fluid; over the temperature range observed, temperature effects on hydraulic conductivity could increase K by 50 to 100% if K is treated as given for a reference temperature. Because DOE may not be treating hydraulic conductivities in the same manner as GAI, flow paths and travel time calculations may differ.

- o The hydraulic gradient below the Umtanum: GAI uses a value of 5 x 10 for the vertical hydraulic grandient below the Umtanum. This is an initial condition in solving the flow equation. A different choice of initial condition would yield different flow paths and travel times.

- o The way in which thermal loading is calculated: GAI assumed that the volumetric heat term provided by DOE should be treated as applying to the volume of the repository including the shaft

and pillars. The volume apparently used in the SCR (also the volume chosen by WMHL) is based on the volume of the panel area only. GAI's thermal loading factor may be 30% higher than the value actually used by DOE. The increased heat source would lead to increased hydraulic gradients, which would affect the flow paths and travel times.

- o Differences in gridding and numerical methods: Because the numerical model approximates a solution to a partial differential equation, differences in the approximation schemes can lead to different solutions.

3) Poeter/Rowe: The "convection cells" seen in the Umtanum Flow Top (UFT) in early runs may be a numerical artifact related to rounding errors in pressure calculations.

   a. GAI eliminated the cells by reducing the number of elements used to represent the UFT. Apparently, no numerical criteria were violated.

   b. Faust/Reeves/Gordon: Coarsening the grid needs to be looked at very closely. In most cases, coarsening the grid introduces errors, rather than eliminates them.

C. WMHL presented the results of their effort to duplicate PORFLO results using SWIFT.

1) Gordon/Weber: Differences between WMHL-GAI:

   a. Grid - WMHL grid does not go as far below Umtanum nor as high above the Vantage, but does extend further laterally than GAI's

   b. Hydraulic Gradient - WMHL uses a gradient below the Umtanum that is a factor of 2 higher than GAI's

   c. Thermal Loading - WMHL uses a heat source that is about 30% lower than GAI's

2) Results are very close to GAI's - within about 10-30% of PORFLO travel times, except that the "convective cells" are present in the UFT between the two wings of the repository.

D. General Discussion of SWIFT results

1) Faust, Lester, Reeves: Both GAI and WMHL have matched the PORFLO results given the uncertainties in RHO input data.

a. This is the unanimous judgment of the meeting.

2) Faust, Gordon: The two groups should agree on a common grid and a common set of input parameters after DOE has responded to WMHL questions needed to define unknown inputs. A final transient simulation to refine the benchmarking should be run.

a. Reeves, Gordon: Only one final run (by NRC) is necessary.

III. Modeling Strategy in Support of On-going BWIP Assessments

A. Regional Modeling

1) Logsdon discussed the option that NRC should not actively model at the regional scale considering resource restrictions. NRC should:

- o remain cognizant of methods and results of groups who are doing regional-scale modeling (RHO, PNL, USGS)
- o remain cognizant of field test data that can confirm or refute proposed boundary conditions
- o exercise alternative boundary conditions on Pasco-Basin-scale 3-D model.

2) Weber discussed the option that NRC should consider doing our own regional-scale modeling to be able to support our assumed boundary conditions.

3) Rowe discussed considering modeling priorities - smaller scale modeling should have a higher priority than regional-scale modeling.

a. group generally agreed.

4) Reeves indicated that regional-scale modeling does not have to be too difficult because NRC could adopt the PNL model:

- o the PNL model is a finite-differences code;

- o history-matching (calibration) of the model is already done;
- o for both these reasons, the PNL model should be relatively easy to implement.

B. 3-Dimensional Modeling

1) Logsdon asked the group whether it is now timely for 3-D modeling of BWIP to be brought into the assessment program

   a. Faust, Lester: 3-D modeling is needed to test range of validity of 2-D modeling.

   b. Reeves: 3-D modeling is needed to test several important scenarios, (e.g., pumping, artificial recharge).

2) Rowe suggested that NRC

   a. use a true 3-D model near repository;

   b. use a quasi-3-D model (i.e., 2-D flow in multiple layers) for "far-field";

   c. use a small-scale 3-D model to analyze results of cluster tests.

3) Logsdon asked whether there is sufficient new data to justify updating Lehman/Quinn 3-D model.

   a. SCR data are not very different from ST-5 data.

   b. Williams: There are new data, but NRC doesn't have them; NRC needs another workshop to receive data on RRL-2, RRL-14, DC-16 and others.

   c. Rowe: Given continued reliance on small-scale tests, these new data are not likely to be a significant advance over data in ST-5.

C. 2-Dimensional Modeling

1) Lester: NRC needs to finalize benchmarking SWIFT against PORFLO (see point B, 4, b, above)

2) Faust: NRC needs to evaluate the model simulated in this study for boundary effects, using SWIFT-2 to extend boundary conditions. SWIFT-2 can use a 1-dimensional array of points to extend the 2-dimensional grid for

temperature, which should decrease boundary effects on temperature within the modeled section. Sandia National Laboratory proposes to extend this modification to include pressure as well as temperature.

3) Rowe recommended

   a. Using SWIFT in steady-state to perform pre-placement sensitivity studies, as in the analytical model

   b. Using 2-D modeling to test how sensitive results are to compositing of modeling units

   c. Analyzing the effects of the fixed upper boundary conditions

      i) Reeves: SWIFT-2 can handle a free water surface.

      ii) The group generally supports the idea of testing the effects of the fixed upper boundary condition as important.

   d. Using alternative meshing schemes to test the importance of the "convective cells" and to resolve the question of whether coarsening the mesh leads to unsuspected violations of numerical criteria.

4) Faust, Poggioli: NRC modelers could uncouple heat and flow, use a coarse grid to determine heat effects, and re-introduce that data as input for flow model. This would be time consuming but would save money.

5) Williams: NRC needs to use statistical evaluation of data to justify inputs to any base case for sensitivity studies.

   a. The group generally supported the use of statistics to justify inputs.

D. 1-Dimensional Overall Sensitivity Studies

1) General Concensus: At this stage in site characterization, overall performance assessment modeling (i.e., flow and transport) should be done with a 1-D model applied along a flow path determined by multi-dimensional modeling.

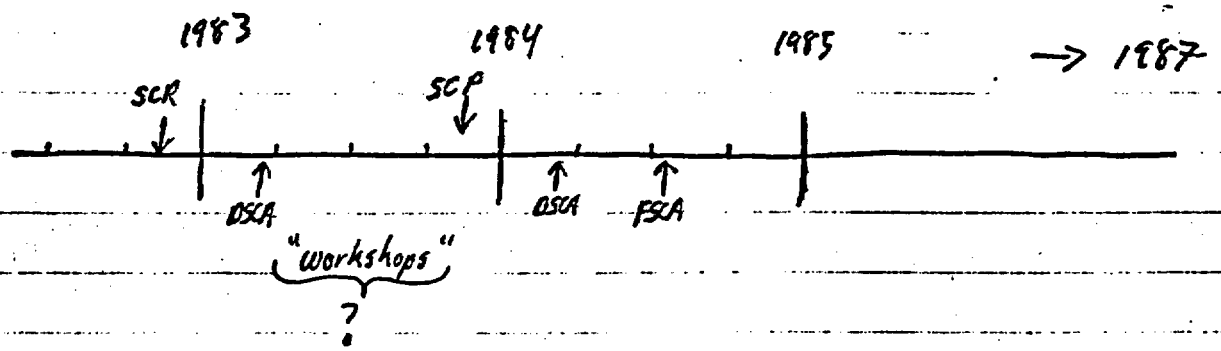
   a. Reeves: Generalized NWFT/DVM is a quasi- 3-D model suitable for this purpose.

   b. Logsdon: But as of now, it does not include LHS.

c. Reeves: No, but LHS could be accommodated in the generalized NWFT/DVM.

Attachment A

Modified BWIP Schedule



Modeling

Short Term

1-D Sensitivity (OVM)

2-D Analytical Sensitivity (Golder)

2-D Numerical (SWIFT)

Long Term

Regional

3-D: Basin Scale

2-D

1-D Sensitivity

Resolve

Plan:

1. Strategy – emphasis to receipt of SCP?
   during SCP review?
   during continuing assessments?
2. Resources – Regional??
   Codes, esp. w/ transport