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U.S. Nuclear Regulatory Commission
ATTN: Mrs. Deborah A. DeMarco
Two White Flint North
11545 Rockville Pike
Mail Stop T8A23
Washington, DC 20555

Subject: Programmatic Review of Abstract

Dear Mrs. DeMarco:

The enclosed abstracts are being submitted for programmatic review. These abstracts will be submitted for presentation at the Geologic Society of America Annual Meeting to be held November 9–18, 2000, in Reno, NV. The titles of these abstracts are:

> "A Modeling Study to Assess the Validity of a Steady-State Infiltration Boundary for the Site-Scale Unsaturated Zone Flow Model of Yucca Mountain, Nevada" by J.R. Winterle
>
> "Integration of Fracture Data into Shallow Infiltration Estimates" by R.W. Fedors, D.A. Ferrill, and A. Morris

These abstracts present results of work conducted by CNWRA as part of the Unsaturated and Saturated Flow Under Isothermal Conditions Key Technical Issue. These abstracts provide summaries of recent work done to assess the validity of assumptions used by DOE in performance assessment modeling of the proposed nuclear waste repository at Yucca Mountain, Nevada. Presentation of this work in a forum such as the GSA meeting provides a valuable opportunity to exchange insights and to obtain feedback from the scientific community.

Please advise me of the results of your programmatic review. Your cooperation in this matter is appreciated.

Sincerely,

Budhi Sagar
Technical Director

/ph
Enclosures

cc:			
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A Modeling Study to Assess the Validity of a Steady-State Infiltration Boundary for the Site-Scale Unsaturated Zone Flow Model of Yucca Mountain, Nevada

James R. Winterle; Center for Nuclear Waste Regulatory Analyses, San Antonio, TX; jwinterle@swri.edu.

Submitted for presentation at the Geologic Society of America Annual Meeting, November 9–18, 2000, Reno, Nevada; Session T79, *Application of Hydrologic and Geologic Studies to the Performance of a Potential Geologic Repository at Yucca Mountain, Nevada*

Abstract

The U.S. Department of Energy (DOE) uses a site-scale unsaturated zone flow model to aid in performance assessment of a proposed geologic repository for high-level radioactive waste beneath Yucca Mountain, Nevada. A major assumption of this DOE model is that near-surface water infiltration can be treated as a steady-state flux boundary. Although infiltration events in the arid Yucca Mountain region are infrequent, highly episodic, and spatially variable, the reasonableness of this assumption is defended based on the presence of the Paintbrush nonwelded volcanic tuff (PTn) layer, which is relatively unfractured and has a high storage capacity that acts to attenuate spatial and temporal variability of deep percolation fluxes. This study presents results of a 2D, single-continuum, unsaturated flow model developed to assess the capacity of the PTn to attenuate a 50 cm infiltration pulse that reaches the PTn via a discrete fracture over a two-month period and recurs every five years. The model can be thought of as quasi-1D, as it represents vertical flow through a fracture-matrix system in a thin stratigraphic pillar with a 1 m^2 horizontal area and a vertical length of 500 m. A single column of cells is conceptualized as a continuous fracture pathway. Refined horizontal discretization of matrix cells adjacent to the fracture allows explicit consideration of capillary-pressure gradients that drive fracture-matrix mass transfer. This approach is comparable to a 1D dual-permeability model formulation but overcomes the potential biases that arise from volume averaging matrix capillary pressures. Model results are compared to those obtained using a 10 cm/yr steady-state flux boundary. It is concluded that the PTn can significantly—but not completely—attenuate the type of transient infiltration pulse considered in this study. Over the five-year cycle, predicted water flux reaching repository depths in the fracture pathway varied from about one-half to three times that predicted by the steady-state infiltration model. It is thus reasonable to expect that percolation fluxes reaching the proposed repository may exhibit transient behavior. As such, total water seepage into repository drifts may be substantially greater than that predicted by steady-state flow models. [This work, performed by CNWRA under U.S. Nuclear Regulatory Commission (NRC) contract NRC-02-97-009, does not necessarily reflect views or position of the NRC.]

INTEGRATION OF FRACTURE DATA INTO SHALLOW INFILTRATION MODELS*

FEDORS, Randall W., FERRILL, David A., both at Center for Nuclear Waste Regulatory Analyses, San Antonio, TX 78238; and MORRIS, Alan P., Division of Earth and Physical Sciences, University of Texas at San Antonio, San Antonio, Texas 78249.

Estimates of shallow infiltration in the semiarid environment at Yucca Mountain (YM), NV, are highly sensitive to the hydraulic properties of the fractured bedrock underlying the thin soil layer over the repository footprint. The conceptual model of unsaturated flow in the near-surface environment is vertical flow through the soil layer, then lateral flow over the bedrock surface until a fracture is encountered, followed by downward flow into the fracture. Near the ground surface, the fractures are generally filled with soil or caliche. Current 1-dimensional (1D) models for YM use fracture data from borehole cores to qualitatively support estimates of composite bedrock hydraulic properties. However, near-surface fracture properties can differ significantly from deep subsurface fracture properties. In addition, the schemes used for compositing bedrock matrix and fracture properties for 1D flow models for YM were based on weighted averages or on the assumption of an impermeable bedrock matrix. Published compositing (or upscaling) schemes are not valid when the permeability contrast is greater than a few orders of magnitude. The contrast in permeability between the filled-fracture and the bedrock matrix at YM ranges up to six orders of magnitude.

This study uses measured fracture data and 2-dimensional (2D) discrete feature unsaturated flow modeling to establish a basis for hydraulic property values used for 1D models of shallow infiltration. Measured fracture densities and apertures from surface exposures are directly integrated into the parameter estimation scheme for composite bedrock hydraulic properties. Fracture density and apertures are used to estimate the fracture porosity relevant for infiltration across the atmosphere/soil boundary. Different compositing schemes for 1D equivalent parameter values were evaluated using flow results from 2D discrete feature models. Results of our analyses show that where there are large contrasts in the permeability of the soil and the welded tuff bedrock matrix, the fracture porosity is a primary controlling factor in flow percolating below the reach of transpiration. In cases of smaller contrasts (two orders of magnitude) in permeability of the soil and the welded tuff bedrock matrix, the sorptivity of bedrock matrix modifies the percolating pulse significantly. Hence, the choice of compositing schemes depends on the magnitude of the contrast in hydraulic properties. The proper compositing scheme together with estimates of the fracture porosity based on field measurements significantly reduced the uncertainty in estimating equivalent hydraulic properties for 1D shallow infiltration models.

*Work was performed by CNWRA under contract NRC-02-97-009, and does not necessarily reflect views or positions of NRC.

GSA Fall 2000 Meeting abstract
for session T79 - Application of Hydrologic and Geologic Studies to the Performance of a Potential Geologic Repository at Yucca Mountain, Nevada