



A center of excellence in earth sciences and engineering®

Geosciences and Engineering Division
6220 Culebra Road • San Antonio, Texas, U.S.A. 78238-5166
(210) 522-5160 • Fax (210) 522-5155

September 8, 2011
Contract No. NRC-02-07-006
Account No. 20.14002.01.441
06300001

Attn: Document Control Desk
U.S. Nuclear Regulatory Commission
Dr. King Stablein
Office of Nuclear Material Safety and Safeguards
Division of High-Level Waste Repository Safety
Mail Stop EBB-2-BO2
Washington, DC 20555

Subject: Implications for Fluid Flow From an Analysis of Faulted and Fractured Tuffs Near
Bishop, California—Final Report (IM 14002.01.441.147)

Dear Dr. Stablein:

This letter retransmits the subject report, incorporating the comments provided by the U.S. Nuclear Regulatory Commission (NRC) on the original report transmitted on June 24, 2011. Please note that the title of the report has been changed to "Hydrogeologic Heterogeneity of Faulted and Fractured Glass Mountain Bedded Tuffaceous Sediments and Ashfall Deposits: The Crucifix Site Near Bishop, California."

The Center for Nuclear Waste Regulatory Analyses (CNWRA®) received NRC comments on the original draft report in an email dated July 15, 2011. The NRC staff comments and CNWRA staff responses are documented in a table included with this letter and the document changes can be viewed in Version 3.0 (dated August 25, 2011) of the following SharePoint document:

YM Licensing Review > Knowledge Management > Knowledge Capture Reports >
Dinwiddie_Implications for Fluid Flow from Tuffs_147 > final Crucifix Manuscript_NRC
Report

The NRC staff indicated in an email dated August 30, 2011, that the revised report was acceptable. The final formatted version of the report is preserved at the SharePoint location shown above.

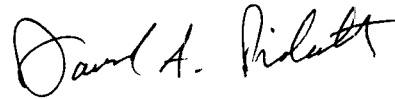


Washington Office
1801 Rockville Pike, Suite 105 • Rockville, Maryland 20852-1633

Dr. King Stablein
September 8, 2011
Page 2

Please contact Jude McMurry at (210) 522-6935 or me at (210) 522-5582 if you have any questions regarding this report.

Sincerely yours,



David Pickett
Senior Program Manager
Integrated Spent Fuel Regulatory
Program—Geologic Disposal

DP/ar
Enclosure
Attachment

cc:

NRC

D. DeMarco
R. Jackson
V. Whipple
L. Kokajko
A. Mohseni
J. Davis
J. Rubenstone
J. Guttmann
Y. Kim
T. McCartin
B. Hill
P. Hall
R. Fedors
K. Bradbury

CNWRA

W. Patrick
B. Sagar
J. McMurry
Program Managers
Group Managers
C. Dinwiddie
R. McGinnis
D. Ferrill
M. Padilla

SwRI

Record Copy B—IQS
D. Stillman

*How Cynthia responded to
NRC (Fedex) comments* *(fm)*

COMMENT RESOLUTION RECORD		PAGE 1 OF 2 PAGES
PROJECT NUMBER: 14002.01.441	DOCUMENT DATE:	DOCUMENT NUMBER:
TITLE: Hydrogeologic heterogeneity of faulted and fractured Glass Mountain bedded tuffaceous sediments and ashfall deposits: the Crucifix site near Bishop, California		
COMMENTS: NRC	RESPONSES: Authors	
1. Re-phrase last paragraph of conclusion (page 7-4 to 7-5) to better parallel wording of abstract and introduction in regard to the need to better understand the uncertainty and the quantification of the potential length scale of lateral flow diversion in nonwelded tuffs. This is a programmatic comment.	Subject sentence rephrased to "More detailed three-dimensional modeling of the nonwelded Paintbrush Tuff at the hundreds of meters scale—its lithologic properties, gradational contacts, slope interruptions and reversals, and small-displacement, fault-related deformation structures—would improve understanding of the potential length scale of lateral flow diversion within this hydrologic unit, the associated uncertainty and the effects of this uncertainty."	
2. Page 1-3. Instead of "devoted to understanding water flow through," wouldn't it be more correct that this study is "devoted to characterizing properties that affect flow through"	Subject phrase rephrased to "...relatively few field studies have been devoted to characterizing properties that affect water flow through faulted and fractured, porous and permeable deposits..."	
3. Section 2, Objectives, page 2-1. You just mention the influence on gas permeability, which implies interest at only one scale. Shouldn't the objective be to look at heterogeneity at several scales at it affects lateral flow diversion? These several scales are mentioned (and are integral to) throughout the rest of the report.	Subject sentence rephrased to "Because the hydrologic properties of bedded tuffaceous sediments and ashfall deposits are influenced by structurally induced secondary heterogeneities at several scales, we collected multiscale data from a horst-bounding normal fault, its footwall deformation zone, and the nonfaulted protolith just beyond the footwall deformation zone to assess the characteristics and distribution of deformation features as well as the potential influence they have on permeability."	
4. Section 3, Study Area, page 3-1; last sentence. There is no Figure 3a (should be Figure 3).	Figure callout corrected.	
5. Section 5.2, page 5-2, last paragraph. The use of 25-cm circles begs for a comment why 25-cm diameter circles were chosen, especially since the volume of influence for gas permeability measurements may be smaller, or at least the measurement results may be dominated by a smaller volume. Just add some clarification as to why results may/may not change if a different diameter is chosen.	<p>The following sentences were added to the Methods section: A circle was selected as the most appropriate two-dimensional shape from which to measure fractures that may intersect the averaging volume of the permeability measurement (cf. Molz et al. 2003). Permeability test holes were approximately spaced on 25-cm centers, so a 25-cm-diameter circle was selected to provide nearly complete coverage of fractures occurring within each bed, while minimizing the potential for fractures to be double-counted.</p> <p>The following sentences were added to the Results section: Had a smaller-diameter fracture-measurement circle been selected, measured areal fracture densities would likely have decreased, perhaps more in some locations than others. The degree to which correlation between areal fracture density and permeability may have improved, however, is unclear and out of scope of this analysis.</p>	

COMMENT RESOLUTION RECORD		PAGE 2 OF 2 PAGES
PROJECT NUMBER: 14002.01.441	DOCUMENT DATE:	DOCUMENT NUMBER:
TITLE: Hydrogeologic heterogeneity of faulted and fractured Glass Mountain bedded tuffaceous sediments and ashfall deposits: the Crucifix site near Bishop, California		
COMMENTS: NRC	RESPONSES: Authors	
6. Section 5.7 (all), page 5-4. This sentence is an example of complex sentences sprinkled throughout the report that are difficult to read. This forces the reader to go back and figure out the sentence, before understanding the information in the sentence. There is so much detailed descriptive geologic info, that adding complex sentences makes is difficult to get through the main body of the report.	Subject sentence has been split into two sentences: "We used a specific gravity measurement technique based upon Archimedes' principle and the assumption that the solid constituents had mineral and glass fractions equivalent to those reported by Hildreth (1979) and Wilson and Hildreth (1998) for the nonwelded Bishop Tuff [see Evans and Bradbury (2004, Appendix) for additional detail]. We used a modified jolly balance and the specific gravity technique to calculate total porosity of two representative whole rock samples from bed 1, three samples from bed 2, and four samples from the Crucifix fault core."	
7. Section 5.8, page 5-4, middle of first paragraph. How do you know that 10 cm is beyond the depth of surface weathering influence in this type of rock?	Elsewhere throughout the report, other small changes are made to improve readability. We do not know, nor did we state, this. Text modified to: "Use of this <i>in situ</i> method (i) eliminates the need to extract fragile samples for laboratory analysis and (ii) minimizes effects of weathering on the measured permeability value by sampling rock that is not directly exposed to the atmosphere (we cannot be certain we are sampling nonweathered material, however). The small-drillhole minipermeameter probe is inserted into a 10-cm-long, 1.8-cm-diameter hole..."	
8. Page 6-2. Are you really going to use the word "droughty."	Yes, droughty is an appropriate word choice. The climate is always arid; it is not always droughty as it was in 2007.	
9. One additional comment for the author to ponder is the issue of study objectives versus techniques and approaches. Over-printing by structure deformation may not be readily picked up in standard point measurements. The authors used several field approaches to directly address the focus on evaluating potential for lateral flow. Can a take-away point be made that standard measurement/ estimation of layer properties may not reflect/lead to behavior that the researcher is focusing on (lateral flow diversion in this case)?	We added the following sentences to the second to last Conclusions paragraph to capture this take-away message: "Standard point measurement techniques spanning one or two orders of magnitude in averaging volume that are used to estimate hydrologic modeling parameters are not sufficient to address questions about the potential for lateral flow disruption by structural deformation features. An integrated, multiscale approach is best adapted to reveal the potential effects of structural overprinting on fluid flow."	