To: Joe Youngblood

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Governor

STATE OF NEVADA

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John W. Bartlett, Director
Office of Civilian Radioactive
Waste Management
U.S. Department of Energy
Washington, D.C. 20545

Dear Dr. Bartlett:

The State of Nevada has reviewed the DOE Study Plan "Characterization of the Yucca Mountain Quaternary Regional Hydrology" (Study Plan 8.3.1.5.2.1) and its cited references, and Revision 1 to the Study Plan (received March 21, 1991), and is providing its comments in this letter and attachment. The State's comments address the adequacy, completeness, and technical accuracy of the Study Plan to meet the purposes of site characterization.

The State's primary concerns regarding the subject Study Plan are summarized as follows:

1. The Study Plan and Revision 1 do not contain a description of Activity 8.3.1.5.2.1.1 - Regional Paleoflood Evaluation, or Activity 8.3.1.5.2.1.2 - Zone Hydrochemical Analysis, and therefore a complete assessment of the Study Plan to adequately characterize the Quaternary regional hydrology cannot be accomplished. Until the State has received and reviewed the complete Study Plan, its comments must be considered preliminary.

2. The description of model linkages and parameter estimates are developed on a conceptual basis, but little discussion is provided on the practical aspects of parameter estimation and the interaction of various models. For example, serious errors with respect to the distribution of flow paths and velocities can result if proper consideration is not applied to transmissive properties in fractured systems.

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3. With respect to Activity 8.3.1.5.2.1.5 - Studies of Calcite and Opaline-Silica Vein Deposits, the Study Plan and Revision 1 do not represent a complete and current reference base of information on such vein deposits in the Yucca Mountain area and surrounding region.

4. The scientific investigation interfaces between site characterization and environmental protection required by the DOE Systems Engineering Management Plan have not been documented in this Study Plan. This concern has been identified to the Department in State comments on other study plans, but has yet to be addressed in a substantive manner.

Should you have questions, this Office is available to meet with the Department and discuss the State's comments at any time.

Sincerely,

Robert R. Loux
Executive Director

RRL:cs

Attachment

cc: Carl Gertz, YMPO
Joe Youngblood, NRC
Dade Moeller, NRC-ACNW
Don Deere, NWTRB
Dwayne Weigel, GAO
Steve Kraft, EEI

ATTACHMENT

State of Nevada comments on DOE Study Plan 8.3.1.5.2.1 "Characterization of the Yucca Mountain Quaternary Regional Hydrology."

1. Study Plan Objectives

The use of hydrologic models to predict possible future water-table elevation changes is a reasonable objective. However, it will be an extremely difficult objective to accomplish since even with the completion of all SCP studies, the information base will be sufficient only to perhaps calibrate a model of the regional hydrologic system. There will be no independent data set upon which to verify the unique model; therefore, any perturbation of such a model will only provide a very general estimate of response of the water table. A sensitivity analysis will help identify key characteristics; however, identifying all relevant boundary conditions which, in the past, influenced recharge both on site and regionally, may be impossible.

2. Study Rationale

On page 2.1-3, the emphasis of the discussion is on predicting the saturation of the repository due to change in flow regime at the repository site itself. However, if the statement on

page 1.3-10, which declares a need for maintaining 70 meters vertical distance between the repository disturbed zone and the water table is a project requirement, then equal emphasis on page 2.1-3 should be given to increases in water-table evaluation due to increased recharge up-gradient in the flow system.

On page 2.1-4, the objective of the Analog Recharge Activity (8.3.1.5.2.1.4) is misstated. The analog recharge activity is really aimed at evaluating recharge versus precipitation not infiltration. The constant use of the term infiltration or potential infiltration is inconsistent with other study plans and its common usage. The terms used throughout other study plans relate to the flux or net flux through the unsaturated zone.

On pages 2.1-14 through 2.1-17, the Study Plan discusses the logic diagrams for developing models of the unsaturated zone, saturated zone and surface waters. These three models are shown to be linked, but no equations are provided to enable an assessment of how these linkages will operate.

3. Schedule

In Section 2.2.4 - Time Required Versus Time Available, the discussion indicates a minimum record of five-year's data is

needed at each analog - recharge study site. It is quite optimistic to believe that a reliable precipitation-runoff-recharge relationship can be developed for a particular watershed based upon a record length of even twice that time period. Given the levels of precision in obtaining the measures of the water balance components, the residual error and uncertainty may mask the real recharge component. Even in areas with significantly higher precipitation than expected in these analog sites, many investigators have been unable to truly quantify recharge.

With respect to time needed for the studies, two of the studies are not discussed in the Study Plan, therefore cannot be assessed (Regional Paleo-Flood Evaluation and Quaternary Unsaturated Zone Hydrochemical Analysis). The other two studies, Evaluation of Past-Discharge Areas and Analog-Recharge Studies, are of concern because of their importance in determining potential flux through the mountain. The Study Plan indicates these studies will be carried out during a minimum of five consecutive years at each site. However, there are numerous caveats in the text which indicate these studies may require longer periods of time, since they are involve new areas of scientific research. This recharge flux information is critical, especially the analog recharge information, since all estimates of health and environmental effects are directly tied to the quantity of water contacting

the waste. If the activities take five to seven years then they will seemingly meet the current schedule for input into the EIS and License Application. If however, field work encounters unexpected conditions or many delays, then this information may not be available in time to avoid delays in the issuance of the EIS and the License Application.

4. Specific Comments on Study Plan Activities

Activity 8.3.1.5.2.1.3 Evaluation of Past-Discharge Areas

On page 3.3-1, Objective 2 of the activity is to understand the past - and present - discharge areas of the regional-hydrologic system in order to predict the future saturated-zone hydrologic system at Yucca Mountain. Even after 30 years of study of the regional flow system, there still remain significant uncertainties about the NTS-Yucca Mountain flow system with respect to interconnection and boundaries. Also, it is only optimistic to expect that in five to seven years an adequate understanding of the past regional system will be achieved.

Page 3.3-1, Objective 3 indicates that past ground water levels will be determined in carbonate caverns such as Devil's Hole. What other caverns will be investigated?

On page 3.3-3, the second paragraph indicates that elevations of paleo-spring mounds are to be used as the control to define the paleo-water table elevation. Has there been a comparison of current discharge elevations and the current carbonate potentiometric elevation to check the validity of this approach? How does the study propose to account for changing elevations through time in southern Nevada due to tectonic activity?

Section 3.3.3.1 regarding Remote Sensing (page 3.3-4) indicates that the use of remote sensing (RS) is based on the concept that the spectral analysis will provide distinct spectral signatures which can be related to specific hydrologic characteristics. Several investigations have attempted this in the past and were unsuccessful i.e., known springs at NTS were not identifiable given the resolution available from LANDSAT MSS and TM data.

The entire section on use of RS, together with other data bases, to develop a model for infiltration, assumes that there is much more hard data available than really exists. For example, climate records are few and do not give the spatial or elevation coverage needed. The only long-term records are for precipitation and temperature. To estimate what would be the response under different climatic conditions, it is first necessary to understand what is occurring under the present

day climate regime. This is extremely difficult given that the spatial and temporal distribution of precipitation is not known for most of the region.

One of the objectives of the RS analysis is to provide support data for estimating values of potential infiltration. What would be the validity of such an estimate, given that even in the wetter analog areas, the amount of water entering the soil zone and potentially available for recharge in general, is, limited by the precipitation input, rather than the soil zone characteristics that would be interpreted from the RS analysis.

On page 3.3-8 the text states that LANDSAT Thematic Mapper (TM) data were chosen for the following reasons: 1) good spatial resolution; 2) good spectral resolution; and 3) the regional nature of the study. How will the spectral signal from TM data relate to the objective of estimating infiltration or recharge?

Table 3.3.1 (page 3.3-9) identifies the data to be utilized for remote-sensing methodology development. The text does not describe the quantity or quality of the MSS and TM data available for the Yucca Mountain area. The only data description is for the Death Valley methodology development task.

Given the selection of several past LANDSAT images to be analyzed for the Death Valley "training site", how is that analysis going to be related to ground truth? For any particular location there is most likely no hard data to compare to the image. The response range between "wet" and "dry" will show up; however, this tells us little about degrees of "wet" and "dry".

In the last paragraph on page 3.3-10, a definition of "regional infiltration/recharge" is needed to avoid confusion between the two. Is the discussion directed toward the climate controlled phenomena, the physical control due to soil and vegetation characteristics, or some combination of these parameters?

The last paragraph on page 3.3-10 states that the current method for estimating recharge is based on precipitation and elevation, i.e., the Maxey-Eakin method, which provides an excellent first approximation. This method may have some validity for gross approximation of recharge in regions wetter than southern Nevada. However, proposing its use for the southern Nevada area goes well beyond its original intent, and the method has no demonstrated validity in most areas of southern Nevada.

On page 3.3-11, reference is made to available climatic data for the areas to be assessed using remote sensing. There are few long-term climate data records, other than precipitation and temperature, for the region. Only the immediate area of Yucca Mountain has a more complete climate record, which will, of necessity, have to be extrapolated with considerable uncertainty to the region.

On page 3.3-12, given the limitations on the applicability of LANDSAT data for predicting hydrologic conditions, how will the "success" of the model of infiltration be judged?

Pages 3.3-28 and 3.3-29 indicate that the center of gravity (COG) method can be used to estimate the vertical distribution of aquifer properties estimated from lithologic logs. The COG method can be a useful method for estimating parameter distribution for a number of parameters and situations. However, its use in defining certain fractured rock properties is not always appropriate. An example, where it may not be appropriate is in calculating transmissive properties of a fracture system. This is because the fracture distributions and some fracture parameter distributions determined from lithologic logs do not necessarily control actual flow channels and velocities. For instance the highest density, or the center of gravity of the fracture occurrence or fracture aperture may not be an accurate representation of the

true occurrence of, or velocity of, flow.

Activity 8.3.1.5.2.1.4 Analog-Recharge Studies

On page 3.4-8, in the second paragraph, it is stated that soil-moisture content can be estimated using thermal and reflective responses. To properly evaluate the use of this technique, some indication of its precision and accuracy needs to be provided. The difference between wet and dry can be observed, but how well can the moisture content be quantified through use of this technique?

In the section on data collection (page 3.4-8), the potential infiltration is directly related to maximum recharge for each analog site. Again, the use of "potential infiltration" is confusing. Is it intended to denote the maximum amount of water that could infiltrate over a fixed time period given certain boundary conditions?

The last paragraph on page 3.4-8 discusses a proposed comparison of packrat middens from analog sites to Yucca Mountain to establish paleoclimatic conditions. Considerable packrat midden data is already available for Yucca Mountain and surrounding areas, much of which has been collected by the Desert Research Institute under sponsorship of this Office. Was this available information taken into account in preparing

the Study Plan?

Activity 8.3.1.5.2.1.5 Studies of Calcite and Opaline-Silica Vein Deposits

During February 6-7, 1990, a DOE/NRC Workshop on hydrogenic calcite/silica deposits was held in Las Vegas, Nevada. A preponderance of "pre-characterization" data presented at this workshop provided compelling evidence that the authigenic mineralization occurring in Trench 14 is of pedogenic (soil) origin. This activity plan has not been revised to account for these findings. The study plan needs to re-focus its attention to those data needs which remain to be addressed:

1. Comprehensive age dating of the carbonate and opaline authigenics and stable isotope analyses of concurrent samples.

2. Correlative age and isotope data on authigenics from other trenches with those from Trench 14.

3. Trace element geochemistry data collection to ascertain the concentrations of key ore elements such as: Hg, Pb, Au, Ag, etc.

4. Trace element geochemistry as well as age and isotopic

data should be collected on authigenic and host rock minerals to resolve genesis issues.

5. Additional observation of Trench 14 features at increased depth.

Section 3.5.3.2 (page 3.5-8) proports to summarize the current knowledge of hydrogenic deposits in the Yucca Mountain area, with its primary focus on Trench 14. However, the section fails to acknowledge State-sponsored research or current studies by DOE Yucca Mountain Project participants. This section should be revised to include discussions of the following studies:

a. Quade and Cerling, University of Utah: This research has concluded that the Trench 14 K-horizon and vein filling carbonates were deposited as pedogenic deposits in isotopic equilibrium with C4 and C3 plant derived CO_2. Isotopic signals suggest a paleoenvironment equating to a higher altitude and a colder weather climate. See J. Quade and T. Cerling, Science, December 14, 1990, page 1549.

b. Muhs, U.S. Geological Survey: These studies of Trench 14 uranium-isotope data suggest a pedogenic formation of carbonate vein fillings. See D. Muhs, U-series

geochronology, DOE/NRC Workshop on Calcite/Silica Vein Deposits, February 6-7, 1990.

c. Vaniman, Los Alamos National Laboratory: This research suggests that the mineralogy of the Trench 14 carbonates is similar to other pedogenic deposits rather than to spring deposits. See D. Vaniman, Chemical/Mineralogic Evidence from Trench 14 Vein Deposits and Analog Sites, DOE/NRC Workshop on Calcite/Silica Vein Deposits, February 6-7, 1990.

d. Szabo and Kyser, U.S. Geological Survey. This work on drill cores from Yucca Mountain concludes that fracture- and cavity-filling calcite precipitated from downward-migrating meteoric water. See B. Szabo and T. Kyser, Geological Society of America Bulletin, Volume 102, December 1990, page 1714.

Page 3.5-14 is an index map for the State of Nevada, which shows the locations of hot springs to be sampled. It is not clear why all the hot springs to be sampled are located above 39 degrees North latitude, yet all the cold springs to be sampled are located within 36 degrees 30 minutes to 37 degrees North latitude. Hot springs exist down gradient of, and closer to Yucca Mountain than those selected. The rationale for the selection of hot springs to be sampled needs

explanation.

Section 3.5.3.10 describes the paleontological investigations proposed for this activity. Paleontological studies require comprehensive baseline data indicating environmental limitations of each species investigated. These data need to be presented in published formats for review by the scientific community. This appears to be a very ambitious study given the very limited relevant information base on aquatic and terrestrial organisms in southern Nevada.