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NUCLEAR WASTE CONSULTANTS INC.

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Attention: Pohle

(Return to WM, 623-SS)

009/1.1/WWL.001
RS-NMS-85-009
Communication No. 12

86 JAN 13 P12:34
January 8, 1986

U.S. Nuclear Regulatory Commission
Division of Waste Management
Geotechnical Branch
MS-623-SS
Washington, DC 20555

Attention: Mr. Jeff Pohle, Project Officer
Technical Assistance in Hydrogeology - Project B (RS-NMS-85-009)

Re: NNWSI Site Familiarization Report, Subtask 1.1

Dear Mr. Pohle:

This cover letter transmits to the NRC staff the Site Familiarization Subtask Report for NNWSI, Subtask 1.1 of Contract No. RS-NMS-85-009. This report has been prepared by the Dr. David McWhorter and Mr. Lyle Davis of the staff of Water, Waste and Land, the site team for NNWSI, under subcontract to Nuclear Waste Consultants. The report has received a management and technical review by Mark Logsdon and Adrian Brown of Nuclear Waste Consultants.

Nuclear Waste Consultants calls to your attention several specific technical matters concerning the hydrology of the site that have been raised by Water, Waste and Land in their review of the conceptual models of the hydrogeology in the NNWSI literature. These technical matters include:

1. Determination of net infiltration in the unsaturated zone.
2. The effectiveness of a capillary barrier in the fractured, unsaturated tuff.
3. The nature and importance of vapor phase flow and transport.
4. The effects of thermal loading of the repository on the hydrology of the unsaturated system.

Based on our review of the NNWSI literature and the work of other NRC consultants under previous contracts, Nuclear Waste Consultants considers that the earlier work on the geologic framework of the hydrologic system provides a useful initial step in formulating and evaluating conceptual models of the site. It is our intention that this work should be pursued under subsequent subtasks for NNWSI. However, we concur with Water, Waste and Land that there are specifically hydrologic aspects of the conceptual model as proposed to date by DOE that need to be addressed in a timely fashion, also. We consider that the matters raised by Water, Waste and Land in this report, and other, similar concerns that will continue to be raised, can be profitably analyzed starting at an early time in the program, in keeping with our understanding of the intent of the Statement of Work.

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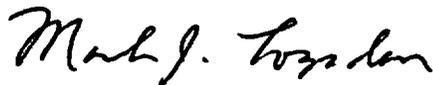
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The Statement of Work for all three tasks calls for comment on the NRC staff's hydrologic issues. Water, Waste and Land has commented briefly in this report, per the SOW. Nuclear Waste Consultants and its subcontractors will be preparing a letter report to the NRC staff concerning the proposed NNWSI Issue Hierarchy. It is our intention to broaden the scope of that letter report to address related matters that arise in the NRC's issues.

The submission of this letter report meets the contractual deliverable for Subtask 1.1 of Contract Number RS-NMS-85-009 and completes the NNWSI Site Familiarization subtask.

If you have any questions concerning this report or related matters, please contact me immediately.

Respectfully submitted,
NUCLEAR WASTE CONSULTANTS, INC.



Mark J. Logsdon, Project Manager

Att: NNWSI Site Familiarization Report, Subtask 1.1

cc: US NRC - Director, NMSS (ATTN: PSB)
DWM (ATTN: Division Director) - 2
Barry Bromberg, Contract Administrator
WMGT (ATTN: Branch Chief)

M. Galloway, TTI
R. Knowlton, DBS

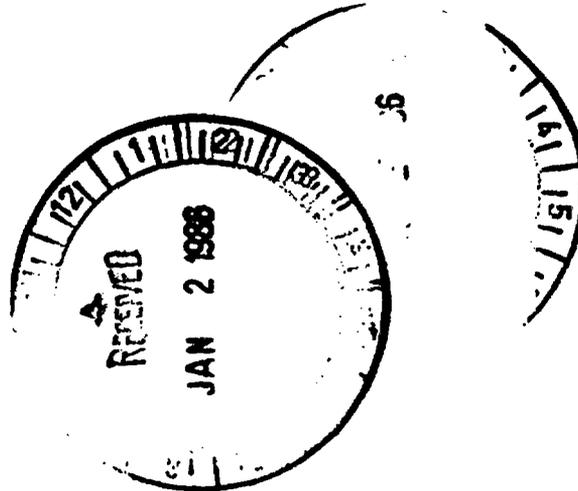
bc: L. Davis, WWL

Nuclear Waste Consultants, Inc.



Water, Waste & Land, Inc.
CONSULTING ENGINEERS & SCIENTISTS

December 31, 1985



Nuclear Waste Consultants, Inc.
8341 So. Sangre de Cristo Road
Suite 6
Littleton, CO 80127

Attention: Mr. Adrian Brown, Project Director

Re: Site Familiarization Report, Subtask 1.1

Dear Mr. Brown:

This letter serves as our report for Subtask 1.1, Site Familiarization, as required by our subcontract with Nuclear Waste Consultants. After your review of this report, please forward it to Jeff Pohle at the US Nuclear Regulatory Commission.

Background

Nuclear Waste Consultants, Inc., (NWC) was awarded NRC project RS-MNS-85-009 entitled "Technical Assistance in Hydrogeology - Project B - Analysis" on September 28, 1985. Water, Waste and Land, Inc., (WWL) is subcontracted to NWC as the group responsible for review of hydrogeologic investigations of the Nevada Nuclear Waste Storage Investigation Project (NNWSI). David McWhorter, the NNWSI Project Director for WWL, and I attended the kickoff meeting held October 22-25, 1985, at NRC offices in Silver Spring, MD. At this meeting we met with personnel from both the Geotechnical Branch and the Repository Projects Branch of the Waste Management Division of NRC as well as personnel from Williams and Associates, the contractor awarded NRC Project RS-MNS-85-008 entitled "Technical Assistance in Hydrogeology - Project A - Testing."

In addition to meeting personnel involved with the project we were able to obtain a copy of the Draft Environmental Assessment (EA) for the Yucca Mountain Site as well as NRC comments which relate to the Draft EA. We also reviewed a bibliography of documents relating to the NNWSI project and requested approximately 162 documents relating to hydrogeology of the site. To date we have received 157 of the papers requested. The following five documents were requested but have not yet been received:

DOE/NWTS-33(3), NWTS Program Criteria for Mined Geologic Disposal of Nuclear Waste, Repository Performance and Development Criteria, prepared by NWTS/Battelle for DOE, July, 1982, USNRC Log Number: 00683.

LA-9706-MS, Levy, Petrology of Samples from Drill Holes USW H-3, H-4, and H-5, Yucca Mountain, Nevada, by Los Alamos National Laboratory, No Date, USNRC Log Number: 01500.

SAND82-1977, McTigue, An Effective Stress Principle for Partially Saturated Media, by Sandia for DOE, August, 1985, USNRC Log Number: 01459.

UCRL-53574, Oversby, Reaction of Bullfrog Tuff with J-13 Well Water at 120 C, by LLL, July 18, 1984, USNRC Log Number: 01672.

83-4067, Doty, Water Table in Rocks of Cenozoic and Paleozoic Age, 1980, Yucca Flat, Nevada Test Site, Nevada, Water Resources Investigations Report by USGS, 1983, USNRC Log Number: 01484.

Document Data Base

Because of the large number of documents relating to the hydrogeology of the Yucca Mountain Site, a computerized data base was created to facilitate management of the library of available information. Figure 1 presents the form used to prepare the necessary information to be input to the data base and also outlines the general structure of the data base. At the present time 195 documents have been entered into the data base and cataloged for rapid retrieval. Currently only pertinent bibliographic information (title, author, date, document number, etc.) have been entered because only a few of the documents have actually been reviewed by our staff due to the large number of documents available and the relatively short time frame allotted for completion of this subtask. As documents are reviewed, the data base will be updated and additional documents will be entered as they become available. A listing of documents which are currently available to the NWL staff is presented as Attachment A to this report. Although not included in the listing, we have also received a number of miscellaneous documents such as letters, data tabulations, etc., which are being cataloged and filed. Included in these documents is a series of letters and miscellaneous papers relating to the Exploratory Shaft. These papers will be reviewed informally by Dr. McWhorter and myself during January.

Site Familiarization

Our current familiarization and understanding of the hydrogeology has been derived primarily from the following documents:

DOE, 1984. Draft Environmental Assessment, Yucca Mountain Site, Nevada Research and Development Area, Nevada, DOW/RQ-0012.

Montazer, P. and W. E. Wilson, 1984. Conceptual Hydrologic Model of Flow in the Unsaturated Zone, Yucca Mountain, Nevada. USGS, Water-Resources Investigations Report 84-4345.

Wang, J. S. Y. and T. N. Narasimhan, 1984. Hydrologic Mechanisms Governing Fluid Flow in Partially Saturated, Fractured, Porous Tuff at Yucca Mountain. Lawrence Berkeley Laboratory, LBL-18473.

NRC, 1985. Comments on DOE Draft Environmental Assessment for Yucca Mountain Site, March 20.

We reviewed these documents with the intent of gaining an overview perspective of the hydrogeology and some insight to the current thinking of specific hydrologic mechanisms that play key roles at the Yucca Mountain Site. In so doing we developed several impressions and concerns that will act to guide further in-depth review. These impressions and concerns are discussed very briefly below. We recognize that our review to date is rather cursory and that any or all of the impressions and concerns we raise here may turn out to be unfounded or resolved upon further study of available documents.

History

Prior to passage of Public Law 97-425, the Nuclear Waste Policy Act of 1982, several alternatives for disposing high-level radioactive wastes were investigated. In May, 1981, DOE selected disposal in mined geologic repositories as the preferred method and Congress concurred as outlined in Section 111(b)(1) of Public Law 97-425 which was passed in 1982. Preliminary screening of suitable sites began in the mid 1950's and until 1977 was limited mainly to salt sites. In 1977, the volcanic rocks of the Pasco Basin of Washington and the Southern Great Basin of Nevada were added to the list of sites considered to be acceptable for a waste repository on the basis of land use. Areas on or contiguous to the Nevada Test Site (NTS) were considered appropriate since a majority of these lands are currently under government control. Initially nine rock types and 15 locations were identified as potentially acceptable. Based on screening criteria, the Yucca Mountain Site was selected as the preferred location for a repository in the vicinity of NTS and tuff was selected as the preferred host rock. Of the four tuff rock units initially considered, the welded Topopah Spring Member of the Paintbrush Tuff was selected as the target horizon for a repository. At Yucca Mountain unsaturated conditions exist within this rock unit. In February, 1983, the Yucca Mountain Site was identified as a potentially acceptable site.

The Conceptual Model

Obviously, the salient hydrologic feature of the Yucca Mountain site with relevance to a radioactive waste repository is the very thick section of unsaturated welded and nonwelded tuff. Evidently, the quantity of water moving in this unsaturated, fractured system is flux controlled, governed by the near-surface phenomena of infiltration and subsequent evapotranspiration. Even though potential evapotranspiration greatly exceeds the estimated precipitation

(150 mm/yr), it is believe that, perhaps, as much as 3 percent of the precipitation becomes net infiltration (i.e., deep percolation).

It seems that the quantity of net infiltration is a key issue in understanding the unsaturated hydrology of the site. So far we have uncovered only indirect and, sometimes, contradictory evidence relating to the actual quantity of net infiltration. Insofar as the flux of net infiltration may be of the same order as the saturated permeability of the matrix in the Topopah Springs Member, it seems critical that the flux of net infiltration be resolved with substantial confidence.

The concept of a capillary barrier is invoked to support an argument for enhanced lateral flow at the contact between the Tiva Canyon welded unit and the underlying Paintbrush nonwelded unit. It is supposed that this has the effect of diminishing the vertical flux that passes into the Topopah Springs Member. This appears to be a second critically important aspect that remains inadequately investigated. It is not clear to us how effective such a barrier is under the circumstances at Yucca Mountain. Air entrapment below this contact is discussed as further diminishing the flux into the Paintbrush nonwelded unit. We question the effectiveness of this mechanism. It depends upon the relative permeability to air being practically zero in the overlying Tiva Canyon, a circumstance that would be very temporary if it should occur at all. Even in the fractured Tiva Canyon, it seems more likely that sporadic infiltration events will be greatly damped and practically steady state conditions will prevail at the base of the Tiva Canyon unit. In any case, this appears to be an important aspect that must be resolved.

It is our impression that the very thick, fractured, unsaturated system that exists at Yucca Mountain is one in which water vapor transport may be critical to understanding the hydrology. Ordinarily, the quantities of water moved by vapor transport are insignificant relative to those that occur by bulk liquid phase flow. While the possibility of vapor transport effects are acknowledged in the documents reviewed, essentially no investigation has been made, apparently.

Waters that eventually pass through the unsaturated zone evidently enter a saturated ground-water aquifer that is part of the Death Valley system. It was stated that waters of this system do not enter neighboring ground-water systems. While we do not dispute this contention, we note no evidence in support thereof.

Thermal Effects

Little or no discussion of the unsaturated hydrology affected by elevated temperatures around the repository was included in documents reviewed to date. It appears that this may be an important factor, given the unsaturated conditions of the site. It appears possible that a situation of counter-current flux of vapor and liquid water could occur; the liquid flux being toward the repository and the vapor flux being directed away from the repository. Vapor and liquid transport coefficients for both temperature and water content gradients are required for analysis. We note no mention of these coefficients. Overall, it appears that an analysis of combined water and heat

transfer will be required to understand the water flow during the period of elevated temperatures.

Issues

As outlined in the Request for Proposal, part of subtask 1.1 was to be directed at the review of "Hydrology Issues for Nevada Nuclear Waste Storage Investigations Project", NMWSI STP-1.0, Draft, August, 1984. We have reviewed the issues as presented in this document and currently have no additions, deletions, or modifications to the issues as presented. In general, the presented issues are broad enough to cover both the regional and site specific groundwater concerns of placing a repository at Yucca Mountain. Our concerns, as presented in the previous discussion, on the other hand, are directed at some of the specific questions that we feel need to be addressed in order to arrive at answers to the issues as presented in STP-1.0. In addition, we will be re-evaluating the NRC issue list as part of our Review of DOE Issue Hierarchy during January.

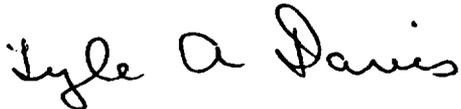
Summary

In conclusion, we have successfully completed the Site Familiarization subtask of the project. In so doing, we have gained a basic understanding of the hydrogeology of the Yucca Mountain area. We are also cognizant of the large amount of literature that is available regarding the general hydrology and geology of the Yucca Mountain vicinity and have established a library of the pertinent documents for reference during subsequent tasks to be performed as part of this project. This should allow these tasks to be performed in the most efficient manner possible.

If you have questions or if we can in any way be of assistance to you during your review of this document, do not hesitate to contact us.

Sincerely,

WATER, WASTE AND LAND, INC.



Lyle A. Davis
Project Manager

LAD:dm1

ATTACHMENT A

NEVADA NUCLEAR WASTE STORAGE INVESTIGATION

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