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HYDRO-24-08 Progress Report for Investigation of Culebra Pore Size Distribution

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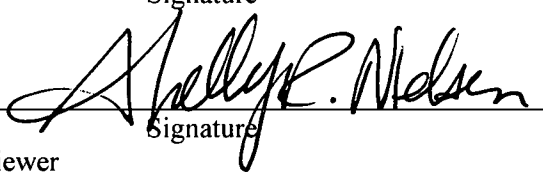
Reviewed by:	Shelly Nielsen		9-24-2024
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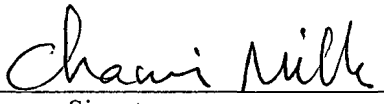
Approved by:	Chammi Miller		09/24/2024
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I. Introduction

Release through the Culebra Member of the Rustler Formation is an identified pathway for migration of actinides to the accessible environment in the Waste Isolation Pilot Plant (WIPP) Performance Assessment (PA). The model, 'Transport of Colloidal Actinides in the Culebra' conceptualizes that mineral fragment and microbial colloids are excluded from the diffusive porosity on basis of size and are effectively attenuated from advective porosity by sorption and filtration (Hansen, 2021). In their Compliance Application Review Document (CARD) for the CRA-2019, the EPA identified the Feature, Event, and Process (FEP) N71 as meriting updated evaluation with respect to microbial colloids. The EPA commented that:

> The role of microbes in facilitating radionuclide transport is a potentially important feature of the Culebra release pathway. The DOE conclusion that microbes are rapidly filtered out in the Culebra is inadequately supported and needs to be reevaluated for the CRA-2024 PA. (U.S. EPA 2022, p. 49)

The concern serving as the impetus for updated evaluation of FEP N71 was directed toward the Compliance Certification Application (CCA) era experiments supporting the conceptualization of microbial colloid filtration in the Culebra. Specifically, that the crushed dolomite medium utilized in the experiments (Yelton et al., 1999) does not adequately simulate the natural fractures and vugs of the Culebra (U.S. EPA, 2022). To address the EPA concern, Sandia has begun an investigation into the pore size distribution of the Culebra from intact hand samples collected during the mining of WIPP intake shaft 5. The primary and diagenetic porosity of the samples will be preserved through the use of drilled core plugs for analyses, rather than mechanically disaggregated Culebra dolomite. Establishing the porosity and pore throat geometry of unaltered Culebra is a critical first step to precede any future experiments observing the filtration of colloids during transport.

II. Culebra Pore Size Distribution

The Culebra samples are being analyzed utilizing a combination of nuclear magnetic resonance (NMR) and mercury intrusion capillary pressure (MICP) on 1" diameter core plugs drilled from hand sample to

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determine the porosity distribution, pore throat geometry, and dominant porosity classes present in typical Culebra. Specific sample identification is listed below in Table 1. These analyses are being conducted at the University of Texas-Austin (UT) under a contractual relationship with Sandia National Laboratories department 8882 established in April 2024. Samples were remanded to the custody of Hugh Daigle, Professor of Petroleum Engineering, at UT on May 1st. Chain of custody forms are documented in WIPP-PoreSize-1 Binder-1. Measurements are estimated to be completed September 2024.

As detailed in Test Plan TP-23-01 Revision 0: Culebra Pore Size Distribution Characterization (Foli, 2023), supporting analyses for bulk mineralogy will be conducted at Sandia National Laboratories following completion of the NMR and MICP measurements. Test Plan TP 23-01 contains a brief description of NMR and MCIP methods. Determination of the petrophysical properties of the Culebra as they relate to groundwater flow characteristics and particle transport will serve as the groundwork for future experiments examining active filtration and sorptive removal of microbes from advective flow to address the EPA concern for reevaluation of FEP N71 for future Compliance Recertification Applications.

Details concerning data processing and analysis utilizing percolation theory (Daigle, 2016; Daigle & Johnson, 2016) for determination of Culebra porosity and pore throat geometry will be detailed in an Analysis Plan in the forthcoming fiscal year along with an Analysis Report supplying the combined NMR, MICP, and mineralogical measurements.

Table 1. Culebra hand sample identification and depth information

Sample ID	Collection Depth AMSL (ft.)/Below Collar (ft.)
S5 2701-1	2701 / 700.5
S5 2703-1 (A)	2703 / 685.5
S5 2703-2 (B)	2703 / 698.5
S5 2708-1	2708 / 693.5
S5 2710-1	2710 / 691.5
S5 2711-1	2711 / 690.5
S5 2712-1	2712 / 689.5
S5 2713-1	2713 / 688.5
S5 2714-1	2714 / 687.5
S5 2715-1	2715 / 686.5
S5 2715.5-1	2715.5 / 686
S5 2716-1 (A)	2716 / 685.5
S5 2716-2 (B)	2716 / 685.5
S5 2718-1	2718 / 683.5
S5 2720-1	2720 / 681.5
S5 2721-1 (1)	2720 / 680.5
S5 2721-1 (2)	2721 / 680.5
S5 2723-1	2723 / 678.5

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III. References

Foli, I. D., 2023. Test Plan TP 23-01, Revision 0, Culebra Pore Size Distribution Characterization. Carlsbad, NM: Sandia National Laboratories ERMS # 580930.

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U.S. Department of Energy (DOE). 1996. Title 40 CFR Part 191 Compliance Certification Application for the Waste Isolation Pilot Plant (October). 21 vols. Carlsbad, NM: Carlsbad Area Office. DOE/CAO-1994-2184

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Yelton, W.G., Behl, Y.L., Kelly, J.W., Dunn, M., Gillow, J.B., Francis, A.J., & Papenguth H.W. 1999. Laboratory Evaluation of Colloidal Actinide Transport at the Waste Isolation Pilot Plant (WIPP): 1. Crushed-Dolomite Column Flow Experiments. Albuquerque, NM: Sandia National Laboratories SAND96-2894C.

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