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October 1, 2021

James Smith
Office of Nuclear Material Safety and Safeguards
Division of Decommissioning, Uranium Recovery, and Waste Programs
Nuclear Regulatory Commission
Washington, DC 20555-0001

Re: Response to DOE Comments and Additional Comments on NRC's Safety Evaluation Report of UNC License Amendment Request dated September 24, 2018
Church Rock Mill Site, Gallup, New Mexico
NRC Source Material License SUA-1475

Dear Mr. Smith:

At the Nuclear Regulatory Commission's (NRC) request, United Nuclear Corporation (UNC) is providing responses to comments on the NRC's Safety Evaluation Report (SER) received from the US Department of Energy Office of Legacy Management (DOE) in a letter dated July 21, 2021. UNC is also providing additional comments proposing minor corrections to the SER for NRC's consideration. UNC's consultants (Stantec, Cedar Creek, Dwyer Engineering and Wood) have assisted UNC with these responses and comments.

We have included DOE's comments followed by our responses in Attachment I and UNC's additional comments on the SER in Attachment II. Also, as we have discussed previously, UNC plans to submit a separate, updated License Amendment Request (LAR) that incorporates the changes in the various addendums to the LAR into a single comprehensive document. This will help clarify and simplify future compliance with license conditions related to the LAR.

Overall, while DOE's comments are helpful and may warrant including some additional details prior to issuing the Construction Drawing Set, UNC does not see the need for any significant changes to the LAR or SER based on DOE's comments.

If you have any questions or would like to discuss our response to the comments, please contact me at the telephone number provided above.

Sincerely,

Lance M. Hauer, P.E.
Legacy Site Team Leader

Attachment I – Response to DOE Office of Legacy Management's (LM) Comments on SER

DOE Comment No. 1 - Settlement

Reference: Section 3.3 Settlement, Subsection 3.3.3 Staff Review and Analysis, NRC states "The NRC staff observes that the immediate settlement in this portion of the tailing cell will range from 0.1 to 1 ft." In its evaluation, "the NRC staff concludes that the settlement calculations present information needed to demonstrate compliance with 10 CFR Part 40, Appendix A, Criterion 6(1)."

DOE Comment: LM has seen depressions form at Bluewater, Maybell West and Sherwood. And, as detailed on pg. 63 ponding is already occurring on the disposal cell. At the midpoint of a 50-foot span with a 2% grade, a one ft differential settlement occurrence could create a grade reversal. NRC should ensure the impact of ponding and differential settlement is considered in the ET cover design enough so that NRC will either accept whatever settlement occurs and accept the impacts of that settlement or require differential settlement/ponding to be repaired. The potential for additional maintenance in the future should be considered in determining the long-term surveillance fee.

UNC Response: The calculations for immediate settlement are estimates for the amount of settlement expected to occur immediately and incrementally during lifts of fill placement for construction of the repository. These estimates were prepared to evaluate impacts to the existing cover beyond the proposed Repository perimeter. The construction duration for mine waste and cover fill placement is expected to take 476 days based on the current schedule. Settlement of the surface will be monitored by survey during this time of placement and further monitored during the O&M period after the cover is completed. Areas of the cover and transitions to the existing cover where settlement occurs after construction and grades are reversed will be repaired by UNC prior to license termination.

DOE Comment No. 2 – Borrow Source

Reference: Section 3.5 Disposal Cell Cover Engineering Design, Subsection 3.5.3 Staff Review and Analysis

DOE Comment: Side slopes of 5H:1V, or 20-percent, are concerning with the new cell cover because an identical gradient also exists at the northeast side slope on the Mexican Hat disposal cell. LM recently completed a forensic geotechnical investigation to understand why the northeast side slope is eroding at Mexican Hat. At the Mexican Hat site, the cover soil is silty fine sand, with low plasticity, low cohesive strength, low bulk-density (in the 105 pounds per cubic foot range), and the cover is subject to accelerated erosion because the soil is dispersive and susceptible to piping. The NRC's standard review plan does not specifically evaluate the question of dispersive soils. Similarly, the SER does not mention anything with respect to the cover soils and their suitability to resist piping erosion. DOE acknowledges the proposed Church Rock design does not include a layered side slope, or a sodium bentonite amended radon barrier, which are also likely contributing factors to the erosion at Mexican Hat.

Upon review of LAR (2018) Appendix H, and MWH (2014) Table 3-5 Summary of Geotechnical Laboratory Data – Borrow Areas, LM suggests that additional soil dispersion testing be performed on West Borrow, North Borrow, and Dilco Hill borrow sources. Pinhole dispersion tests (ASTM D4647) were performed on a subset of samples, with the majority keying out as slight-to-moderately dispersive (ND3/ND4). Upon review of MWH (2014) appendices, no lab reports for pinhole dispersion testing were found, and further analysis of results to determine specimen performance under variable hydraulic head and flow rate, was not possible.

Most authors consider it necessary to use more than one test to ascertain the dispersity of a soil, specifically transitionally dispersive soils common to the four corners region. Sherard and Decker (1977) suggest four tests should be performed: double hydrometer (ASTM D4221), pinhole (ASTM D4647), crumb test (ASTM D6572), and chemical tests (i.e. extractable cations by saturated paste, exchangeable complex, and cation exchange capacity, using agricultural methods to account for calcium interference).

Soil sections observed in the West Borrow and North Borrow areas display low plasticity (PI ranging from 3-11) and a high percentage of soil layers have SC-SM and SM USCS classifications that are not considered suitable for disposal cell construction (NUREG 1620, Section 2.5.3). Based on limited data reported for materials in these borrow areas, materials have moderate vulnerability to erosional piping (Sherard 1953) and high to extreme internal erosion risk (ICOLD 2015; USBR 2019). Such erosion risks are further elevated under duplex soil conditions, which likely include the textural transition from mine spoils to cover soil (at ~4.5 ft from ground surface), particularly for shallower cover soil profile locations. Should these materials be used, such impacts from any cover degradation from subsurface erosion are extremely unlikely to mobilize tailings given the very thick section of low contaminant mine waste rock above the tailings. However, impacts from erosional piping and soil loss may degrade vegetation and ET cover performance which could result in unwanted percolation of meteoric water into mine waste rock and potentially the tailings below. LM's concern for piping is over the entire cover, however, our primary concern is the 20% side slopes and where there are grade changes.

Based on review of 2018 Geotechnical Data Report Church Rock Mill Site Jetty, and amendments occurring throughout 2019, the exclusive use of Jetty excavation soils (as discussed in NRC 2020 Section 3.7.3) for ET cover materials could mitigate the above concerns with borrow materials from the West Borrow, North Borrow, and Dilco Hill areas given higher plasticity and fines content of Jetty soils. Given the presence of subsurface erosion in the region, LM recommends additional characterization of borrow soils for their vulnerability to erosional piping (e.g. Sherard 1953) and internal erosion risk (e.g. ICOLD 2015; USBR 2019).

UNC Response: The exclusive use of Jetty soils is currently planned for the cover fill on the 20% slope as well as the rest of the Repository cover. Design studies have shown that there will be an adequate volume of Jetty soils for the covers. The Dilco Hill source is no longer being proposed for use and the West and North Borrow Areas are considered secondary options to the Jetty soil and are also unlikely to be used. Because of the limited relief on the existing cover over the tailings, the 20% grade on the east side is necessary to maintain the flat slopes on the majority of the cover surface and provide the disposal volume needed. The 20% slope does not receive any diverted storm flows from other areas of the cover. The only catchment for the slope area is the slope itself, which means the volume of runoff is proportionally small. The 20% slope is designed to be vegetated at the surface with an erosion protection layer comprised of 6 inches of d_{50} = 1.5-inch rock mixed at 15% by volume with the borrow soil which is generally clayey, over a 12-inch filter layer of Type II Filter Material which consists primarily of ¾-inch to 1.5-inch

gravel, with some sand and an overall maximum particle size of 3-inches. The filter would be placed over 30 inches of the compacted clayey borrow cover soil over the compacted mine waste. The rock content in the 18 inches above the cover soil is designed for the PMP surface flows, similar to the entire cover of the Repository, to provide erosion protection for the cover soil layer.

The pinhole dispersion test results are included in Appendix B1.2 to the Pre-Design Studies (PDS) Report (MWH, 2014) and attached for ease of reference. Those pinhole dispersion test results do indicate the secondary borrow sources are slightly to moderately dispersive (ND3). The materials, excluding Dilco Hill, have an average plasticity index (PI) of 12 percent and an average silt content of 34 percent. The original borrow sources West, East, North, and South were tested for extractable cations by saturated paste, exchangeable sodium, and cation exchange capacity, using agricultural methods to account for calcium interference. These results are included in the PDS Report. During evaluation of the Jetty soils for cover borrow in 2018 (Stantec, 2019), tests were performed on the proposed Jetty borrow soil that included double hydrometer (ASTM 4221) and pinhole dispersion (ASTM 4647). Consistent with the USBR (2019) reference cited in the comment which states "It is frequently suggested that at least two different tests be run to check for dispersity," two different tests were completed for the borrow sources during the PDS and during the Jetty investigation.

Plasticity from the 22 Jetty borrow samples tested indicates that the plasticity of this source is generally higher than the West and North borrow source and ranges from 11 to 44 percent. Only six of the 22 samples tested showed a *PI* less than 15, which, based on Table D-6-1 in USBR (2019) (based on Sherard (1953)), would indicate that most of the Jetty borrow material falls into the Greatest Piping Resistance Category (1). The eight double hydrometer results from the Jetty soils ranged from 0 to 17 percent, which indicates that the samples tested are *non-dispersive* based on USBR (1991).

DOE Comment No. 3 – Regulatory Requirements

Reference: Section 3.6 Construction Considerations, Subsection 3.6.1 Regulatory Requirements, NRC states "the mine waste material is not directly regulated by the NRC.".

Section 7.2 Applicable NRC Guidance states: "A concurrence and commitment from either DOE or the State to take title to the tailings impoundment after closure must be received before granting the license amendment to the 11e.(2) licensee."

DOE Comment: The statement regarding not directly regulated by NRC is not clear and needs additional clarification. Based on discussions between EPA, DOE, and NRC since the SER was provided to DOE for review, we are under the impression that all the parties agreed to view the entire cell as a system rather than having sections of cell regulated by one agency and not another. If maintenance was needed because of something that was detected during LTS&M of the site, DOE would be concerned that segmenting responsibility for portions of the disposal cell could delay action being taken.

UNC's Response: EPA's March 29, 2013, Surface Soil Operable Unit Record of Decision (ML13095A352) states as follows:

> At the UNC Site, there are two agencies with overlapping jurisdiction-EPA and NRC. As stated in the Memorandum of Understanding (MOU), dated September 30, 1988, NRC assumed the role of lead regulatory agency for the Tailings Disposal Area [TDA]

reclamation and closure activities with EPA monitoring all such activities and providing review and comments directly to NRC while EPA developed and implemented its own site action requirements for ground water contamination outside of the Tailings Disposal Area in accordance with CERCLA and the NCP. For the UNC Site Surface Soil Operable Unit, EPA is the lead agency with EPA Region 6 providing oversight. EPA is also the lead agency for the NECR site with EPA Region 9 providing oversight.

Accordingly, UNC understands that the NRC would assume the role of lead regulatory agency for the entire disposal cell—which would include both 11e.(2) material and non-11e.(2) material—because the disposal cell is located within the TDA. UNC agrees with DOE that it would be helpful for the NRC and EPA to confirm this understanding.

DOE Comment No. 4 - **Vegetation Requirements**

Reference: Section 3.7 Infiltration and Hydraulic Conductivity of the Repository and Its Cover Subsection 3.7.3 Staff Review and Analysis, NRC states "Perennial vegetation initially established on the cover was unintentionally succeeded by annual species that had a lower wilting point potential (higher water content at the wilting point), shallower roots, and a shorter period of active transpiration, thereby allowing more water to stay in the water storage layer and eventually move downwards."

Section 3.7 Infiltration and Hydraulic Conductivity of the Repository and Its Cover Subsection 3.7.4 Evaluation Findings, NRC states "Additionally, the documents in the LAR, its references, and the NRC staff's review also have provided sufficient evidence indicating that a full vegetative cover on the repository is likely to be self-sustaining in current climatic conditions."

DOE Comment: DOE would like clarification on what NRC will expect of the licensee in terms of vegetation establishment and maintenance at least prior to transfer of the site to DOE for LTS&M. Is unintentional succession anticipated to continue to occur? An evaluation of effect of climate change on vegetation and maintenance should be conducted. Maintaining vegetation on the cover for effective ET should be detailed in the scope for LTS&M and should include expected changes. The potential for additional maintenance in the future should be considered in determining the long-term surveillance fee.

UNC Response: Section 5.0 of Appendix U.2 of the LAR describes the management actions that the licensee would be expected to implement if the vegetation establishment and persistence was not in accordance with the performance criteria set forth in Section 4.2 of Appendix U.2. These management actions include interseeding, weed control, mulching, and supplemental irrigation. If needed, management actions would be deployed in response to annual vegetation monitoring findings.

Climate change considerations were addressed in Section 2.7 of Appendix U.2.

Unintentional succession is not anticipated at the Church Rock site and the site referenced by NRC where unintentional succession occurred is not comparable to the Church Rock site. The revegetation plan developed for the Church Rock site describes protocols to establish a robust, self-sustaining ecosystem to inhabit the repository cover. It is based on recent site-specific revegetation performance and establishes success criteria to ensure a well-established and diverse ecological community prior to DOE's long-term surveillance. The revegetation plan calls for a seed mix with 16 species comprised of grasses, forbs, and shrubs (Table SM of Appendix U.2) with success criteria pertaining the vegetation cover, species diversity, and shrub density.

By comparison, the referenced site was seeded with 2 perennial grasses and 1 annual grass (Smesrud 2012).

DOE Comment No. 5 – Modelling Uncertainty

Reference: Section 3.7 Infiltration and Hydraulic Conductivity of the Repository and It's Cover, Subsection 3.7.4 Evaluation findings, NRC states "Although the range of parameters assumed in the LAR for future precipitation rates, precipitation duration, snow cover, temperature and sunshine, vegetation type, root depth, and changing hydraulic conductivities due to developing soil structures will likely bound infiltration rates so that excessive seepage impacts will not be created, it cannot be excluded due to aleatory uncertainty, e.g., future meteorological phenomena may occur to drive infiltration rates higher and/or the cover may evolve in unexpected ways."

Section 3.7 Infiltration and Hydraulic Conductivity of the Repository and Its Cover Subsection 3.7.3 Staff Review and Analysis, NRC states "Unfortunately, the sensitivity runs end when the fill layer has reached a more average soil suction value, and a conceptual model of water flow after this point is unclear. Also unclear is why the fill layer in Profile B2 should become saturated as described above in a mere dozen years with an initial soil matric potential value of -2,692,958,106.4 cm, or -1,060,200,000 in, i.e., similarly dry as the fill in Profile. This lack of clarity is part of the reason the NRC staff is modifying the license condition related to ground water monitoring. This is further discussed below in Section 3.7.4."

DOE Comment: LM agrees with the uncertainties in the modeling identified by NRC. Notable uncertainties and recommendations include:

Sensitivity analysis for UNSAT-H model simulations could be performed to include absolute worst-case scenarios to determine parameter values needed to reach the threshold of net seepage into mine waste and mill tailings. Such worst-case model parameters could include:

a) The seasonality of precipitation. "less than half of the annual precipitation occurs during the summer months when PET is highest."
   i. It is unclear if antecedent soil moisture conditions from the melting of snowpack, and subsequent early spring rainfall during low PET times of year, under worst case conditions were considered in the sensitivity analysis. It does not appear that such model output was reported.
   ii. If not, LM recommends a more conservative UNSAT-H model simulation be considered, on an annual time scale, to account for incremental worst-case scenario antecedent soil moisture conditions under snowpack and spring rains when PET is low.

b) Soil condition. Ksat values from natural analogs are used for model input parameters. These values are presented in Table 13 – Table 15 in SUA 2018 Appendix H. These values range from 2.12E-04 - 3.70E-04 cm/s in the top foot of soil, and 3.40E-05 - 7.00E-05 cm/s at depths ranging from 2-4.5 ft below ground surface. Given the limited cross-sectional area of the infiltrometer used in the study, larger and more widely spaced macropores (more common at depth in semi-arid environments) may not have been adequately captured in Ksat measurements. As such the use of larger diameter block samples are suggested. Large diameter block sample tests have been conducted at UMTRCA analogs and

   i. Ksat values (at depths between 2-6ft) range from 3.69E-04 - 4.38E-04 cm/s at Bluewater, NM, 1.35E-04 – 4.06E-04 cm/s at Falls City, TX, and 3.06E-04 – 3.20E-

04 cm/s at Lakeview, OR (NUREG/CP-0312). The analog at Bluewater is most representative of Church Rock conditions. i. LM recommends that a conservative UNSAT-H model simulation consider Ksat values in the 3.0E-04 cm/s range through the depth of the ET cover profile.

ii. More conservative Van Genuchten parameters (the measured values at 1ft depth) could also be applied to all soil depths to generate the most conservative conditions.

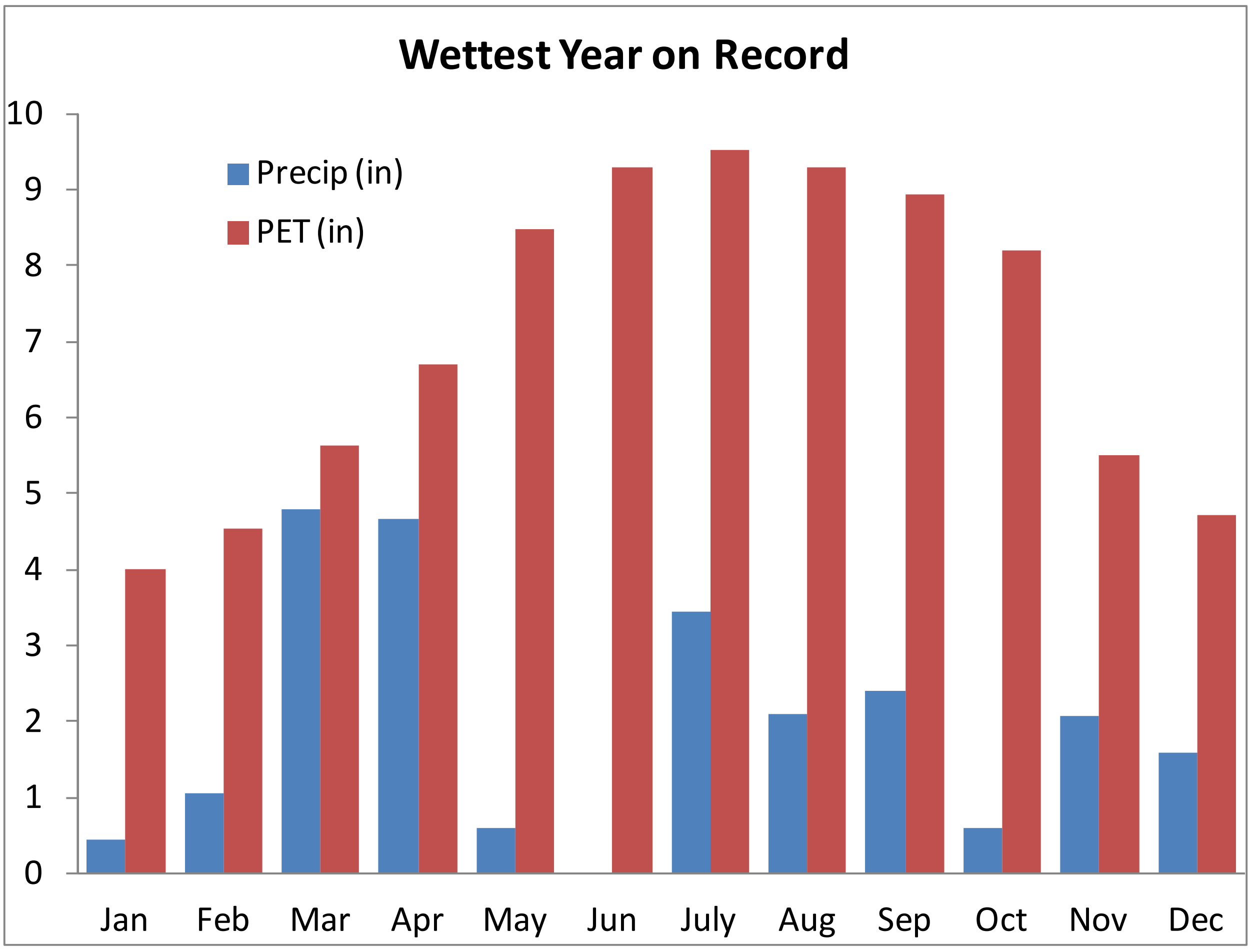
c) Vegetation condition. Given uncertainties with climate change, it is possible that PET may decrease over cover design life given vegetation shifts. i. The inclusion of a climate change analog of the cover (hotter and drier conditions) could inform longer term vegetation condition.

UNC Response: The NRC statements that DOE references indicate it is unclear in Section 3.7 what the conceptual model of water flow is after the fill layer has reached a more average soil suction value and why the fill layer in Profile B2 should become saturated as described above in a mere dozen years. To clarify, the Profile B2 does not saturate with the addition of mine spoils and ET Cover. Modeling of the B2 profile under very conservative assumptions shows that although the fill layer becomes saturated, water will not continue to migrate through the mines spoil and underlying tailings. Overall, the proposed cover will result in less infiltration than the current cover. Monitoring of groundwater levels from after the current cover system was installed indicates that groundwater elevations have been steady decreasing. Therefore, because the proposed cover system is expected to further reduce infiltration, we expect that groundwater elevations will continue to decrease, which will be evaluated through monitoring of the groundwater elevations.

UNC Response to 5a: there is no specific performance criteria associated with water balance per 40 CFR 192. Given this, the point of diminishing returns (PODR) method summarized in *Dwyer, SF, R Rager, J Hopkins. 2007. Cover System Design Guidance and Requirements Document. Los Alamos National Laboratory report LA-UR-06-4715* and *U.S. Environmental Protection Agency (USEPA), 2012. Closing Small tribal Landfills and Open Dumps. How to Design Environmentally Safe Covers Including Additional Design Guidance for Arid Regions. EPA Design Guidance EPA-909-R-11-007* was utilized. This method identifies the cover depth required to minimize flux. This method included all potential input parameters, boundary condition, and profile variability. Well over 100 sensitivity analyses were performed to evaluate potential changes in soil hydraulic properties, vegetation, and climate conditions, including antecedent soil moisture conditions from the melting of snowpack, and subsequent early spring rainfall during low PET times of year, under worst case conditions. All solutions for the vegetated ET cover system predicted no flux no matter how conservative the applied conditions. Table 1 provides a partial list of modeling sensitivity analyses performed and summarized in the *Cover System Design Report* (Dwyer, 2018). Also, there were additional analyses performed and presented in the *Consolidation and Groundwater Evaluation Report* (Dwyer, 2018)

Climate boundary conditions proved to be the most sensitive to the output. The climate was varied during the modeling simulations to include both typical and worst-case possibilities. Historical weather data for the Gallup, NM area and surrounding weather stations were evaluated from available historical data from 1897 to 2016. The average precipitation at the Gallup airport is about 11 inches per year (28 cm) per the Western Regional Climate Center (http://www.wrcc.dri.edu/). The typical model climate used an annual precipitation volume of 11.71 inches (29.74 cm). The precipitation is highest during July and August while the climate's demand for water, referred to as potential evapotranspiration (PET), is also highest during those months.

The most extreme climate year occurred in 1906 when the area received 23.8 inches (60.5 cm) of precipitation. This climate year was utilized as the most extreme weather in the computer simulations. This was not only the highest annual precipitation received on record, but the majority of the moisture came in March and April with significant moisture also received in February, November and December (see figure below). Much of this moisture came as snow or less intense rainstorms compared to the typical summer monsoons that produce high intensity storms and thus significant runoff. These months with high precipitation volume also had reduced PET due to their cooler temperatures, so this period was also the worst-case infiltration climate that the site has experienced during recorded history. To add conservatism, 1906 was modeled back-to-back in all computer simulations. This is a series of events that is beyond anything known to occur at this site. Furthermore, the precipitation was applied during the computer simulations at a rate less than the infiltration rate – essentially forcing all rainfall to infiltrate. This added additional conservatism in the modeling effort given that much of the precipitation at the site runs off before it can infiltrate into the cover system.



The beyond worst-case condition of the wettest year on record (more than double the average annual precipitation rate) two consecutive years applied with the majority of precipitation coming outside of the summer months was performed, including assuming no vegetation on the cover in multiple simulations. The precipitation was applied to allow for full infiltration and thus simulate the worst case infiltration event whether that is melting snow or a very slow and continuous precipitation event during a period when PET is reduced and transpiration is either reduced

(transpiration is reduced in the model from Julian day 63 to 170 and again from Julian day 171 to 266) or completely stopped (transpiration is ceased in the model from Julian day 0 to 63 and again form day 343 to the end of the year). Transpiration was only allowed to fully remove water from Julian day 171 to 265, less than a third of the year.

UNC Response to 5 b): Soil hydraulic properties were used from multiple potential borrow sources, including the Jetty soil, Dilco Hill source (which is no longer being proposed for use in the cover) and the West and North Borrow Areas (which are considered secondary options). These sources were carefully tested in a lab set up at the site to allow for the most accurate measurements possible. This process is adequate given the extensive borrow analyses. Remolded properties of the cover borrow soil were tested at densities representative of constructed compaction effort (as-built conditions). To account for the long-term condition of the cover soil, the tension infiltrometer measurements were made at each of the potential borrow sources that coincided with the natural analog studies of vegetation maturation. Each set of soil hydraulic properties were evaluated in the myriad of modeling sensitivity analyses. The output showed limited sensitivity of the soil properties to the output. The most sensitive condition to output as stated above was climate.

A tension infiltrometer was used because it is the most accurate method for measuring soil properties in an undisturbed setting for the soil borrow sources and vegetation potential. The base plate on the tension infiltrometer used is about the same diameter as typical block samples. The accuracy of soil hydraulic measurements using block samples of undisturbed soils is suspect at the NECR site because, based on the silty/sandy soil texture of the site soils, it is unlikely that block samples would retain their soil structure during excavation and transport to a laboratory.

UNC Response to 5c: Vegetation sensitivity was considered in the modeling sensitivity analyses. A vegetation natural analog study was performed at the site with measured vegetation input parameters specific for the model used. This was documented in *Cedar Creek Associates. 2014. Vegetation Characterization and Biointrusion Surveys Church Rock Mill Site.*

The vegetation parameter variability had limited sensitivity to the output. As stated previously, the climate was the most sensitive issue to the modeling output. The modeling performed utilized all measured vegetation parameters from reclaimed representing conditions of a recently seeded site through grassland and into shrubland communities. 'No vegetation' scenarios were also included. The water balance of the cover system is obviously improved with dry conditions.

The erosional stability of the cover system does not rely on vegetation, rather it relies on the mixture of rock into the soil to create a 'desert pavement'. This erosion analysis met the criteria established by Dwyer et al (2007) as well as NUREG 1623. The erosion analysis included no vegetation.

DOE Comment No. 6 - Pipeline Arroyo Chute

Reference: Section 4.3 Water Surface Profiles, Channel Velocities, and Shear Stress, Subsection 4.3.3, Heading 4.3.3.1 Pipeline Arroyo, NRC states "Performance concerns with the riprap jetty in the Pipeline Arroyo have been documented (NRC, 2003a). These composited aspects of the site and performance to date make the integrity of the riprap chute, and potential need for maintenance more uncertain in the long term. The NRC staff therefore cannot conclude with reasonable assurance that the proposed design will provide control of radiological hazards for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years. As discussed in more detail in SER Section 4.3.3.4, the NRC staff is therefore imposing a license condition requiring an observation period prior to license termination to verify that the design is function[al] as intended. Additionally, the observation period will allow for an informed decision related to the anticipated life span of the design and any long-term surveillance, maintenance, and funding needs for the revised approach to site stability, considering past performance and significant uncertainties discussed above. The license condition allows the licensee to demonstrate compliance using a performance-based approach."

And Heading 4.3.3.4 Stability of Riprap Chute in Pipeline Arroyo, NRC states "The NRC staff performed an independent assessment and recognizes there is uncertainty with the forces acting on the riprap in a hydraulic jump. The NRC staff considers that the erosion protection features will likely require active maintenance over the performance period because of the unique aspects of the site. The NRC staff further concludes that the licensee has not demonstrated that hydraulic design features can sustain the impact forces resulting from hydraulic jumps at the narrow outlet channel near the end of the riprap chute."

DOE Comment: Because the performance period for the design is effectiveness for 1000 years to the extent reasonably achievable, and, in any case, for at least 200 years, observing the performance for only five years may not be sufficient to identify deficiencies that would affect long term performance. Designing for the PMP requires the engineering remedy is overbuilt to withstand the forces of nature for the long term. What is the probability that a low-frequency storm event will carry a high-enough intensity to test the design over a period of five years? DOE recommends that it would be more prudent to test the design with a percent-of-PMP approach rather than a fixed period.

LM recommends considering climatic conditions during the observation period. If the NRC is unsure about the forces resulting from the hydraulic jump, shouldn't this require additional analysis then by the licensee? The potential for erosional issues and costly maintenance in the future should be considered in determining the long-term surveillance fee.

UNC Response:

NRC has proposed a monitoring period of 5 years for the Repository including the stormwater controls and the Jetty area. Defining the monitoring period based on a percent of PMP approach would lead to a completely undefined time period for monitoring. Also, while UNC is open to monitoring rainfall, relating measured rainfall to in-channel flow rates can be complicated particularly due to the isolated nature of monsoonal storm events that control local peak flows in this environment.

With regard to LM's comment on NRC comments in 4.3.3.4, the riprap chute is designed to protect the tailings embankment from migration of the arroyo channel at the location of the sandstone outcrop that narrows the arroyo and the large riprap in the chute has been designed

to resist scour from a PMP flood event. Because of the significance of the storm flows used to size the riprap, we do not anticipate that the riprap itself once placed, will require active maintenance due to storm flows through the arroyo.

The design includes riprap through the section of the arroyo where the chute is located to prevent upstream migration of the erosion that has been observed at the existing Jetty structure. Because arroyos are dynamic systems, changes in the banks and the alignment of the arroyo are expected to occur over the next 1,000 years upstream and downstream of the proposed chute. Some scour of the arroyo cross section in the unlined sections up- and down-stream of the riprap armored chute, even if caused by the hydraulic jump at the outlet, is not expected to lead to lateral arroyo migration with the potential to threaten the tailings embankment therefore, no additional analysis of the system is warranted.

DOE Comment No. 7 - Pipeline Arroyo Chute (drawings)

Reference: Northeast Church Rock Project, Revised 95% Design Submittal – July 2018, Volume 2 – Design Drawings.

DOE Comment: The following are additional comments regarding the Revised 95% Design Drawings.

a. Sheet 9-10, Mill Site Repository Area Stormwater Controls, Riprap Chute Sections: Design drawings should include a cross-section of the crest of the rundown, providing details of station location, elevations, crest width, riprap side slopes, and water surface elevation (WSE) of the PMF. As the long-term custodian, DOE can utilize this important information without having to retrieve it from electronic CAD data interpolation.
b. Sheet 9-09, Mill Site Repository Area Stormwater Controls, Riprap Chute: The area of disturbance delineated on this drawing does not realistically provide the actual area of disturbance. A constructability review will determine potential access roads, temporary staging areas, and other requirements to safely and efficiently construct the riprap chute. These constructability requirements will alter the geometry of the channel and the area of disturbance. The proposed models used to design the channel may be compromised, depending on the extent of disturbance required. A constructability review should be performed and subsequently, the design re-evaluated for applicability. In addition, access for future maintenance along the chute needs to be part of the design which may mean making "temporary" construction roads permanent.
c. Sheet 9-11, Mill Site Repository Area Stormwater Controls, Riprap Chute Details, Detail #2B, Typical Chute Riprap and Bedding Detail, and Appendix I, Attachment I.3, Filter Compatibility Calculations for Mill Site and Mine Site Stormwater Controls: There is a large gradation gap between the top filter layer and the 27-inch riprap. Our concerns are the interstitial velocities in the area of the hydraulic jump where the top filter layer could effectively become a wearing layer as particles are slowly removed. NUREG 1623 was used to design the filter at the bottom of the Pipeline Arroyo Chute. DOE does not believe that NUREG 1623 is the correct design guidance criteria for this application. DOE suggests you consider the following references as well: U.S. Department of the Interior, Bureau of Reclamation (BOR), 1987. Design of Small Dams https://www.usbr.gov/pn/programs/ea/wash/potholes/techreport-alta-attachmentK.pdf and Mishra, S.K., J.F. Ruff, 1998. Riprap Design for Overtopped Embankments. Final Report. Prepared for U.S. Bureau of Reclamation. https://www.usbr.gov/tsc/techreferences/hydraulics_lab/pubs/PAP/PAP-0809.pdf. Both could be useful.

d. All Sheets, Mill Site Repository Area Stormwater Controls: There are no details providing tie-in information of the proposed improvements to existing ground. (i.e., riprap and filter tie-in to existing ground along graded slopes and base of structures). If this is not addressed during the bidding process, it may prompt an RFI (request for information) during construction and subsequently lead to a change order. Leaving this detail to the construction contractor's discretion could potentially be problematic.
e. Sheet 9-10, Mill Site Repository Area Stormwater Controls, Riprap Chute Sections, Detail D, Section D: At Station 3+00, the armoring of the inlet apron above the crest of the rundown may need to be longer than 50 feet. The velocities shown in Appendix I, Attachment I.7 could cause significant scour.
f. Will there be specific notes or information describing how riprap should be placed in the channel? What Quality Assurance and Quality Control measures/requirements are being proposed for construction activities to ensure the riprap bedding filter layers are placed to specification?

UNC Response:

UNC Response to 7a: The 100% design (Issued for Construction [IFC]) design drawings will include the additional information requested (cross-section of the crest of the rundown, providing details of station location, elevations, crest width, riprap side slopes, and water surface elevation (WSE) of the PMF).

UNC Response to 7b: UNC will consider a Constructability Review of the design prior to preparation of the IFC Drawings. Construction means and methods will be determined by the contractor with oversight from the engineer. However, UNC does not anticipate the need for ongoing maintenance to the chute once constructed. The 5.3% alignment is expected to be accessible with tracked equipment from the short 5:1 slope located near the northeast corner of the structure. If the proposed chute geometry and/or area of disturbance is to be permanently and significantly altered to accommodate construction and maintenance access roads, then the evaluation models will be updated to estimate hydraulic conditions during flood events using the new proposed chute geometry.

UNC Response to 7c: The Stantec design document (Attachment I.3) presented an analysis of filtering capabilities between the top filter layer (Type II Filter) and the D_{50} = 24-inch riprap material using the Terzaghi method which provides if the ratio of the D_{15} of the Riprap layer (D_{15f}) and the D_{85} of the Type II Filter layer (D_{85b}) is less than 5 then there will not be sufficient void space in the riprap layer for the sub-layer to wash through. This is consistent with recommendations in USBR (1987) (see Page 218 of the manual).

Table 3 of Attachment I.3 provides the computed ratio of the proposed materials is 4.92. This value is computed using average sizes within the material gradation limits presented in Table 1 and Table 2. From analyzing the extremes of the provided gradation limits, the maximum D_{15f}/$D85_b$ that could occur within the specified gradation limits is 7.4. More recent research by J.P. Giroud (see reference below) notes the simplistic retention criteria (Terzaghi Criteria) does not account for the internal stability of the soil structure and that the actual threshold for soil stability as defined by D_{15f}/$D85_b$ is not constant but rather varies with the coefficient of uniformity of the sub-layer. This is illustrated in Fig. 13 provided below taken from Giroud, 2003 which indicates the variable retention criteria suggested by Giroud using the thick solid line and constant retention criteria suggested by Terzaghi using the thick dashed line. The specified Type II material

coefficient of uniformities (defined by D_{60}/D_{10}) that could occur within the specified gradation limits of the Type II filter material is between 7.5 and 2.9. The interpolated curve (thick solid line) from Fig. 13 suggests $D_{15f}/D85_b$ values of 7.5 or less will be stable within the range of potential Type II Filter material coefficients of uniformity. This finding by Giroud is supported by the testing completed by Mishra and Ruff (1998). This document presents results of tests on riprap materials of D_{50}=15-in, 26-in, 11-in. riprap materials placed over a filter bedding layer. The bedding materials used had a D_{50} between 1.5-in. and 1.9-in and a coefficient of uniformity of approximately 1.6. The filter compatibility between the tested riprap and bedding materials (i.e., D_{15f}/D_{85b}) is 3.5, 7.0, and 2.7 respectively. Even in the case where the D_{15f}/D_{85b} is equal to 7 (greater than 5) no washout of the bedding layer was reported in the test result findings.

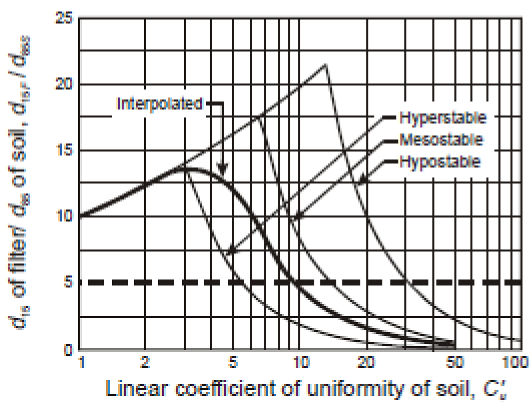


Fig. 13: Suggested value of the retention criterion for granular filters, for a dense soil, interpolated between the hyperstable and mesostable cases. (The dashed line represents the classical retention criterion for granular filters, Equation 72.)

(from Giroud, J.P., 2003)

UNC Response to 7d: Stantec will include additional details in the 100% design IFC drawings.

UNC Response to 7e: The riprap chute is designed to prevent the arroyo from head cutting around the sandstone outcrop and migrating toward the embankment, by securing the existing grades upstream and downstream of the chute, not to prevent scour that might occur in the upstream channel section during extreme flood events. The 50-foot apron length will be sufficient to maintain the ramp crest geometry.

UNC Response to 7f: The specifications provide guidance for the placement requirements of the riprap and the filters as well as the QA/QC requirements for material gradations.

DOE Comment No. 8 – Report Figures

Reference: Subsection 5.3.2 Mill Tailings Impacted Hydrogeologic Units and Subsection 5.3.4 Groundwater Monitoring Network

DOE Comment: Either referencing reports or adding figures to show potentiometric maps of Zone 1 and 3 and figures with different symbols for wells in each unit (alluvium = circle, zone 3 = triangle, zone 1 = diamond) and color code by contaminant concentration, if applicable, would help.

UNC Response:

There are figures showing potentiometric maps of the groundwater zones in the annual corrective action program review reports submitted to NRC, EPA, and other agencies which are available through NRC's Agencywide Documents Access and Management System (ADAMS). On behalf of UNC, on January 29, 2021 Wood submitted the most recent annual report: *Annual Performance Review Report/2020 Groundwater Corrective Action (ML21048A130),* which can be referenced in the SER.

DOE Comment No. 9 – Additional Groundwater Monitoring

Reference: Subsection 5.3.1 Groundwater Compliance, NRC staff observes that "the mill tailings and groundwater would not be impacted by the disposition of mine spoils at the current impoundment, but with unacceptably large uncertainties." To address the uncertainties primarily due to the parameters associated with climate, vegetation and hydraulic properties, NRC proposed additional groundwater monitoring wells be added to the current groundwater monitoring network at the site, with water level measurements along with water quality monitoring as well.

Section 5.4 Evaluation Findings, NRC requires: "that quarterly measurements of water levels and water quality sampling results from the following monitoring wells, EPA 5, 614, 515A, and 604 in Zone 1, EPA 23,509D, 802, 803, 807, and 808 in SW Alluvium, and 613, 701, and 702 in Zone 3 be used to measure any seepage resulting from the placement of the mine waste. These wells are located immediately downgradient of the mill tailings impoundment in each Zone. Wells that go dry should also continue to be checked for the reemergence of water on a quarterly basis. The findings should be included in the annual site monitoring report."

DOE Comment: NRC neither indicates how long this activity is to continue, nor whether it will be incumbent on LM to perform this activity after the license is terminated. LM requires clarification concerning NRC's objectives on this and to what extent EPA will be a partner. DOE asks NRC to discuss with EPA whether this scope will be part of and what it may require of the licensee under its CERCLA authority.

If NRC expects LM to continue quarterly monitoring in the long term, then we request that NRC require the licensee to submit forecasts that "require robust technical bases with supportive evidence to significantly reduce associated uncertainty." LM must be assured that either EPA or NRC will exercise enforcement authority and reengage the licensee if there is unacceptable performance of the groundwater remedy. LM requests EPA and NRC attorneys participate in discussions with DOE attorneys to find acceptable resolution to this unacceptable risk. Dual regulation could work if LM had a teaming arrangement with EPA, who can then reengage the licensee to cure latent defects.

In addition, LM recommends the use of transducers to monitor groundwater levels at selected locations rather than quarterly sampling. Transducers will not only provide a more complete record of long-term water level changes but also monitor short-term variations that can be missed by quarterly measurements. An example would be a flood event that could significantly raise water levels temporarily. Transducers can also be used to monitor key wells that are transitioning to permanently dry as water levels drop over the long-term. Episodic periods of saturation may be missed by quarterly measurements.

UNC Response:

UNC agrees that LM, NRC and EPA should clarify and document an agreement of their respective roles with regard to future groundwater remediation and monitoring and we are willing to participate in these discussions. Consistent with the approach used at other Title II Uranium Mill Tailings Radiation Control Act (UMTRCA) sites, responsibility for long-term monitoring and maintenance should be transferred to LM at the time LM takes title to the material and land.

UNC has monitored groundwater levels by manual measurements since the 1980s and voluntarily in certain wells with transducers since 2013. Graphs of the long-term manual monitoring results are provided in the annual corrective action reports referenced in the response to Comment 8 above. As shown in the graphs included in the 2020 Corrective Action Report, water levels have steadily decreased over time. To evaluate the potential for short-term changes in water level, UNC routinely assesses current transducer data and is willing to continue collecting manual measurements and transducer readings from up to six wells to supplement manual measurements until transfer of the site to LM.

References:

Cedar Creek Associates. 2014. Vegetation Characterization and Biointrusion Surveys Church Rock Mill Site

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MWH, Inc. (MWH), 2014. Pre-Design Studies, Northeast Church Rock Mine Site Removal Action, Church Rock Mill Site. Prepared for United Nuclear Corporation and General Electric Corporation. October 31.

Sherard J., 1953. USBR Technical Memorandum 645, Influence of Soil Properties and Construction Methods on the Performance of Homogenous Earth Dams. Chap. VI, Earth Dam Piping.

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Phytoremediation. 2012;14 Suppl 1:76-93. doi: 10.1080/15226514.2011.607871. PMID: 22574382.

Stantec, 2018. Application for Amendment of USNRC Source Material License SUA-1475. September 24.

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USBR, 2019. D6-Internal Erosion Risks for Embankments and Foundations. July.

USBR, 1991. Characteristics and Problems of Clay Soils – Technical Report. October.

USBR, 1987. Design of Small Dams Manual

Wood, 2020. Annual Performance Review Report/2020 Groundwater Corrective Action, Church Rock, New Mexico. January 29.

Table 1: Summary of Computer Simulations in the Cover Profile Sensitivity Analyses

Simulation Series	Cover Profile/Model Geometry	Input Parameters utilized in respective Sensitivity Analysis				
		Rock Size in Surface Admixture (D50)	Soil Borrow Source	Cover Soil Hydraulic Property Measurement	Vegetation Stage	Climate
Series A	14-in surface admixture over 34-in cover soil	1.5-inch	East Borrow	Remolded (EB-B6-03)	No vegetation	Typical & two consecutive years of wettest year on record
	14-in surface admixture over 34-in cover soil	1.5-inch	North Drainage Borrow	Remolded (NB-B2-04)	No vegetation	Typical & two consecutive years of wettest year on record
	14-in surface admixture over 34-in cover soil	1.5-inch	South Drainage Borrow	Remolded (SB-B4-01)	No vegetation	Typical & two consecutive years of wettest year on record
	14-in surface admixture over 34-in cover soil	1.5-inch	West Borrow	Remolded (WB-B1-06)	No vegetation	Typical & two consecutive years of wettest year on record
Series B	18-in surface admixture over 34-in cover soil	2-inch	East Borrow	Remolded (EB-B6-03)	No vegetation	Typical & two consecutive years of wettest year on record
	18-in surface admixture over 34-in cover soil	2-inch	North Drainage Borrow	Remolded (NB-B2-04)	No vegetation	Typical & two consecutive years of wettest year on record
	18-in surface admixture over 34-in cover soil	2-inch	South Drainage Borrow	Remolded (SB-B4-01)	No vegetation	Typical & two consecutive years of wettest year on record
	18-in surface admixture over 34-in cover soil	2-inch	West Borrow	Remolded (WB-B1-06)	No vegetation	Typical & two consecutive years of wettest year on record

Table 1: Summary of Computer Simulations in the Cover Profile Sensitivity Analyses

Simulation Series	Cover Profile/Model Geometry	Input Parameters utilized in respective Sensitivity Analysis				
		Rock Size in Surface Admixture (D50)	Soil Borrow Source	Cover Soil Hydraulic Property Measurement	Vegetation Stage	Climate
Series C	27-in surface admixture over 34-in cover soil	3-inch	East Borrow	Remolded (EB-B6-03)	No vegetation	Typical & two consecutive years of wettest year on record
	27-in surface admixture over 34-in cover soil	3-inch	North Drainage Borrow	Remolded (NB-B2-04)	No vegetation	Typical & two consecutive years of wettest year on record
	27-in surface admixture over 34-in cover soil	3-inch	South Drainage Borrow	Remolded (SB-B4-01)	No vegetation	Typical & two consecutive years of wettest year on record
	27-in surface admixture over 34-in cover soil	3-inch	West Borrow	Remolded (WB-B1-06)	No vegetation	Typical & two consecutive years of wettest year on record
Series D	14-in surface admixture over 34-in cover soil	1.5-inch	East Borrow	Remolded (EB-B6-03)	Reclaimed Vegetation	Typical & two consecutive years of wettest year on record
	14-in surface admixture over 34-in cover soil	1.5-inch	North Drainage Borrow	Remolded (NB-B2-04)	Reclaimed Vegetation	Typical & two consecutive years of wettest year on record
	14-in surface admixture over 34-in cover soil	1.5-inch	South Drainage Borrow	Remolded (SB-B4-01)	Reclaimed Vegetation	Typical & two consecutive years of wettest year on record
	14-in surface admixture over 34-in cover soil	1.5-inch	West Borrow	Remolded (WB-B1-06)	Reclaimed Vegetation	Typical & two consecutive years of wettest year on record

Table 1: Summary of Computer Simulations in the Cover Profile Sensitivity Analyses

Simulation Series	Cover Profile/Model Geometry	Input Parameters utilized in respective Sensitivity Analysis				
		Rock Size in Surface Admixture (D50)	Soil Borrow Source	Cover Soil Hydraulic Property Measurement	Vegetation Stage	Climate
Series E	18-in surface admixture over 34-in cover soil	2-inch	East Borrow	Remolded (EB-B6-03)	Reclaimed Vegetation	Typical & two consecutive years of wettest year on record
	18-in surface admixture over 34-in cover soil	2-inch	North Drainage Borrow	Remolded (NB-B2-04)	Reclaimed Vegetation	Typical & two consecutive years of wettest year on record
	18-in surface admixture over 34-in cover soil	2-inch	South Drainage Borrow	Remolded (SB-B4-01)	Reclaimed Vegetation	Typical & two consecutive years of wettest year on record
	18-in surface admixture over 34-in cover soil	2-inch	West Borrow	Remolded (WB-B1-06)	Reclaimed Vegetation	Typical & two consecutive years of wettest year on record
Series F	27-in surface admixture over 34-in cover soil	3-inch	East Borrow	Remolded (EB-B6-03)	Reclaimed Vegetation	Typical & two consecutive years of wettest year on record
	27-in surface admixture over 34-in cover soil	3-inch	North Drainage Borrow	Remolded (NB-B2-04)	Reclaimed Vegetation	Typical & two consecutive years of wettest year on record
	27-in surface admixture over 34-in cover soil	3-inch	South Drainage Borrow	Remolded (SB-B4-01)	Reclaimed Vegetation	Typical & two consecutive years of wettest year on record
	27-in surface admixture over 34-in cover soil	3-inch	West Borrow	Remolded (WB-B1-06)	Reclaimed Vegetation	Typical & two consecutive years of wettest year on record

Table 1: Summary of Computer Simulations in the Cover Profile Sensitivity Analyses

Simulation Series	Cover Profile/Model Geometry	Input Parameters utilized in respective Sensitivity Analysis				
		Rock Size in Surface Admixture (D50)	Soil Borrow Source	Cover Soil Hydraulic Property Measurement	Vegetation Stage	Climate
Series G	14-in surface admixture over 34-in cover soil	1.5-inch	East Borrow	Remolded (EB-B6-03)	Grassland Vegetation	Typical & two consecutive years of wettest year on record
	14-in surface admixture over 34-in cover soil	1.5-inch	North Drainage Borrow	Remolded (NB-B2-04)	Grassland Vegetation	Typical & two consecutive years of wettest year on record
	14-in surface admixture over 34-in cover soil	1.5-inch	South Drainage Borrow	Remolded (SB-B4-01)	Grassland Vegetation	Typical & two consecutive years of wettest year on record
	14-in surface admixture over 34-in cover soil	1.5-inch	West Borrow	Remolded (WB-B1-06)	Grassland Vegetation	Typical & two consecutive years of wettest year on record
Series H	18-in surface admixture over 34-in cover soil	2-inch	East Borrow	Remolded (EB-B6-03)	Grassland Vegetation	Typical & two consecutive years of wettest year on record
	18-in surface admixture over 34-in cover soil	2-inch	North Drainage Borrow	Remolded (NB-B2-04)	Grassland Vegetation	Typical & two consecutive years of wettest year on record
	18-in surface admixture over 34-in cover soil	2-inch	South Drainage Borrow	Remolded (SB-B4-01)	Grassland Vegetation	Typical & two consecutive years of wettest year on record
	18-in surface admixture over 34-in cover soil	2-inch	West Borrow	Remolded (WB-B1-06)	Grassland Vegetation	Typical & two consecutive years of wettest year on record

Table 1: Summary of Computer Simulations in the Cover Profile Sensitivity Analyses

Simulation Series	Cover Profile/Model Geometry	Input Parameters utilized in respective Sensitivity Analysis				
		Rock Size in Surface Admixture (D50)	Soil Borrow Source	Cover Soil Hydraulic Property Measurement	Vegetation Stage	Climate
Series I	27-in surface admixture over 34-in cover soil	3-inch	East Borrow	Remolded (EB-B6-03)	Grassland Vegetation	Typical & two consecutive years of wettest year on record
	27-in surface admixture over 34-in cover soil	3-inch	North Drainage Borrow	Remolded (NB-B2-04)	Grassland Vegetation	Typical & two consecutive years of wettest year on record
	27-in surface admixture over 34-in cover soil	3-inch	South Drainage Borrow	Remolded (SB-B4-01)	Grassland Vegetation	Typical & two consecutive years of wettest year on record
	27-in surface admixture over 34-in cover soil	3-inch	West Borrow	Remolded (WB-B1-06)	Reclaimed Vegetation	Typical & two consecutive years of wettest year on record
Series J	14-in surface admixture over 34-in cover soil	1.5-inch	East Borrow	Remolded (EB-B6-03)	Shrubland Vegetation	Typical & two consecutive years of wettest year on record
	14-in surface admixture over 34-in cover soil	1.5-inch	North Drainage Borrow	Remolded (NB-B2-04)	Shrubland Vegetation	Typical & two consecutive years of wettest year on record
	14-in surface admixture over 34-in cover soil	1.5-inch	South Drainage Borrow	Remolded (SB-B4-01)	Shrubland Vegetation	Typical & two consecutive years of wettest year on record
	14-in surface admixture over 34-in cover soil	1.5-inch	West Borrow	Remolded (WB-B1-06)	Shrubland Vegetation	Typical & two consecutive years of wettest year on record

Table 1: Summary of Computer Simulations in the Cover Profile Sensitivity Analyses

Simulation Series	Cover Profile/Model Geometry	Input Parameters utilized in respective Sensitivity Analysis				
		Rock Size in Surface Admixture (D50)	Soil Borrow Source	Cover Soil Hydraulic Property Measurement	Vegetation Stage	Climate
Series K	18-in surface admixture over 34-in cover soil	2-inch	East Borrow	Remolded (EB-B6-03)	Shrubland Vegetation	Typical & two consecutive years of wettest year on record
	18-in surface admixture over 34-in cover soil	2-inch	North Drainage Borrow	Remolded (NB-B2-04)	Shrubland Vegetation	Typical & two consecutive years of wettest year on record
	18-in surface admixture over 34-in cover soil	2-inch	South Drainage Borrow	Remolded (SB-B4-01)	Shrubland Vegetation	Typical & two consecutive years of wettest year on record
	18-in surface admixture over 34-in cover soil	2-inch	West Borrow	Remolded (WB-B1-06)	Shrubland Vegetation	Typical & two consecutive years of wettest year on record
Series L	27-in surface admixture over 34-in cover soil	3-inch	East Borrow	Remolded (EB-B6-03)	Shrubland Vegetation	Typical & two consecutive years of wettest year on record
	27-in surface admixture over 34-in cover soil	3-inch	North Drainage Borrow	Remolded (NB-B2-04)	Shrubland Vegetation	Typical & two consecutive years of wettest year on record
	27-in surface admixture over 34-in cover soil	3-inch	South Drainage Borrow	Remolded (SB-B4-01)	Shrubland Vegetation	Typical & two consecutive years of wettest year on record
	27-in surface admixture over 34-in cover soil	3-inch	West Borrow	Remolded (WB-B1-06)	Shrubland Vegetation	Typical & two consecutive years of wettest year on record

Table 1: Summary of Computer Simulations in the Cover Profile Sensitivity Analyses

Simulation Series	Cover Profile/Model Geometry	Input Parameters utilized in respective Sensitivity Analysis				
		Rock Size in Surface Admixture (D50)	Soil Borrow Source	Cover Soil Hydraulic Property Measurement	Vegetation Stage	Climate
Series M	14-in surface admixture over 34-in cover soil	1.5-inch	East Borrow	In Situ (Dwyer 2014)	No Vegetation	Typical & two consecutive years of wettest year on record
	14-in surface admixture over 34-in cover soil	1.5-inch	North Drainage Borrow	In Situ (Dwyer 2014)	No Vegetation	Typical & two consecutive years of wettest year on record
	14-in surface admixture over 34-in cover soil	1.5-inch	South Drainage Borrow	In Situ (Dwyer 2014)	No Vegetation	Typical & two consecutive years of wettest year on record
Series N	18-in surface admixture over 34-in cover soil	2-inch	East Borrow	In Situ (Dwyer 2014)	No Vegetation	Typical & two consecutive years of wettest year on record
	18-in surface admixture over 34-in cover soil	2-inch	North Drainage Borrow	In Situ (Dwyer 2014)	No Vegetation	Typical & two consecutive years of wettest year on record
	18-in surface admixture over 34-in cover soil	2-inch	South Drainage Borrow	In Situ (Dwyer 2014)	No Vegetation	Typical & two consecutive years of wettest year on record
Series O	27-in surface admixture over 34-in cover soil	3-inch	East Borrow	In Situ (Dwyer 2014)	No Vegetation	Typical & two consecutive years of wettest year on record
	27-in surface admixture over 34-in cover soil	3-inch	North Drainage Borrow	In Situ (Dwyer 2014)	No Vegetation	Typical & two consecutive years of wettest year on record
	27-in surface admixture over 34-in cover soil	3-inch	South Drainage Borrow	In Situ (Dwyer 2014)	No Vegetation	Typical & two consecutive years of wettest year on record

Table 1: Summary of Computer Simulations in the Cover Profile Sensitivity Analyses

Simulation Series	Cover Profile/Model Geometry	Input Parameters utilized in respective Sensitivity Analysis				
		Rock Size in Surface Admixture (D50)	Soil Borrow Source	Cover Soil Hydraulic Property Measurement	Vegetation Stage	Climate
Series P	14-in surface admixture over 34-in cover soil	1.5-inch	East Borrow	In Situ (Dwyer 2014)	Reclaimed Vegetation	Typical & two consecutive years of wettest year on record
	14-in surface admixture over 34-in cover soil	1.5-inch	North Drainage Borrow	In Situ (Dwyer 2014)	Reclaimed Vegetation	Typical & two consecutive years of wettest year on record
	14-in surface admixture over 34-in cover soil	1.5-inch	South Drainage Borrow	In Situ (Dwyer 2014)	Reclaimed Vegetation	Typical & two consecutive years of wettest year on record
Series Q	18-in surface admixture over 34-in cover soil	2-inch	East Borrow	In Situ (Dwyer 2014)	Reclaimed Vegetation	Typical & two consecutive years of wettest year on record
	18-in surface admixture over 34-in cover soil	2-inch	North Drainage Borrow	In Situ (Dwyer 2014)	Reclaimed Vegetation	Typical & two consecutive years of wettest year on record
	18-in surface admixture over 34-in cover soil	2-inch	South Drainage Borrow	In Situ (Dwyer 2014)	Reclaimed Vegetation	Typical & two consecutive years of wettest year on record
Series R	27-in surface admixture over 34-in cover soil	3-inch	East Borrow	In Situ (Dwyer 2014)	Reclaimed Vegetation	Typical & two consecutive years of wettest year on record
	27-in surface admixture over 34-in cover soil	3-inch	North Drainage Borrow	In Situ (Dwyer 2014)	Reclaimed Vegetation	Typical & two consecutive years of wettest year on record
	27-in surface admixture over 34-in cover soil	3-inch	South Drainage Borrow	In Situ (Dwyer 2014)	Reclaimed Vegetation	Typical & two consecutive years of wettest year on record

Table 1: Summary of Computer Simulations in the Cover Profile Sensitivity Analyses

Simulation Series	Cover Profile/Model Geometry	Input Parameters utilized in respective Sensitivity Analysis				
		Rock Size in Surface Admixture (D50)	Soil Borrow Source	Cover Soil Hydraulic Property Measurement	Vegetation Stage	Climate
Series S	14-in surface admixture over 34-in cover soil	1.5-inch	East Borrow	In Situ (Dwyer 2014)	Grassland Vegetation	Typical & two consecutive years of wettest year on record
	14-in surface admixture over 34-in cover soil	1.5-inch	North Drainage Borrow	In Situ (Dwyer 2014)	Grassland Vegetation	Typical & two consecutive years of wettest year on record
	14-in surface admixture over 34-in cover soil	1.5-inch	South Drainage Borrow	In Situ (Dwyer 2014)	Grassland Vegetation	Typical & two consecutive years of wettest year on record
Series T	18-in surface admixture over 34-in cover soil	2-inch	East Borrow	In Situ (Dwyer 2014)	Grassland Vegetation	Typical & two consecutive years of wettest year on record
	18-in surface admixture over 34-in cover soil	2-inch	North Drainage Borrow	In Situ (Dwyer 2014)	Grassland Vegetation	Typical & two consecutive years of wettest year on record
	18-in surface admixture over 34-in cover soil	2-inch	South Drainage Borrow	In Situ (Dwyer 2014)	Grassland Vegetation	Typical & two consecutive years of wettest year on record
Series U	27-in surface admixture over 34-in cover soil	3-inch	East Borrow	In Situ (Dwyer 2014)	Grassland Vegetation	Typical & two consecutive years of wettest year on record
	27-in surface admixture over 34-in cover soil	3-inch	North Drainage Borrow	In Situ (Dwyer 2014)	Grassland Vegetation	Typical & two consecutive years of wettest year on record
	27-in surface admixture over 34-in cover soil	3-inch	South Drainage Borrow	In Situ (Dwyer 2014)	Grassland Vegetation	Typical & two consecutive years of wettest year on record

Table 1: Summary of Computer Simulations in the Cover Profile Sensitivity Analyses

Simulation Series	Cover Profile/Model Geometry	Input Parameters utilized in respective Sensitivity Analysis				
		Rock Size in Surface Admixture (D50)	Soil Borrow Source	Cover Soil Hydraulic Property Measurement	Vegetation Stage	Climate
Series V	14-in surface admixture over 34-in cover soil	1.5-inch	East Borrow	In Situ (Dwyer 2014)	Shrubland Vegetation	Typical & two consecutive years of wettest year on record
	14-in surface admixture over 34-in cover soil	1.5-inch	North Drainage Borrow	In Situ (Dwyer 2014)	Shrubland Vegetation	Typical & two consecutive years of wettest year on record
	14-in surface admixture over 34-in cover soil	1.5-inch	South Drainage Borrow	In Situ (Dwyer 2014)	Shrubland Vegetation	Typical & two consecutive years of wettest year on record
Series W	18-in surface admixture over 34-in cover soil	2-inch	East Borrow	In Situ (Dwyer 2014)	Shrubland Vegetation	Typical & two consecutive years of wettest year on record
	18-in surface admixture over 34-in cover soil	2-inch	North Drainage Borrow	In Situ (Dwyer 2014)	Shrubland Vegetation	Typical & two consecutive years of wettest year on record
	18-in surface admixture over 34-in cover soil	2-inch	South Drainage Borrow	In Situ (Dwyer 2014)	Shrubland Vegetation	Typical & two consecutive years of wettest year on record
Series X	27-in surface admixture over 34-in cover soil	3-inch	East Borrow	In Situ (Dwyer 2014)	Shrubland Vegetation	Typical & two consecutive years of wettest year on record
	27-in surface admixture over 34-in cover soil	3-inch	North Drainage Borrow	In Situ (Dwyer 2014)	Shrubland Vegetation	Typical & two consecutive years of wettest year on record
	27-in surface admixture over 34-in cover soil	3-inch	South Drainage Borrow	In Situ (Dwyer 2014)	Shrubland Vegetation	Typical & two consecutive years of wettest year on record

Attachment Referenced in Response to DOE Comment # 2

APPENDIX B1.2 FROM PRE-DESIGN STUDIES REPORT (MWH, 2014)
GEOTECHNICAL TEST RESULTS
ADVANCED TERRA TESTING

Provided under separate cover due to file size.

Attachment II – UNC Comments on SER

1. Section 1.2 Proposed Activities, page 8, Table 1: Documents that make up the LAR: UNC recommends adding the following document to Table 1: *UNC Response to NRC Group 1 RAI Clarification* (ADAMS Package Number: ML19233A112), dated August 20, 2019. This document provides responses to NRC's comments seeking clarification of certain information. Changes made to the LAR based on these responses are provided in ML19305D526 which is listed on Table 1.

2. Section 2.3.4 Seismicity and Ground Motion Estimates, page 32, 2nd paragraph, 2nd sentence indicates: "The PGA value used in the LAR is relatively conservative as it is lower than the value used in the seismic evaluation." UNC recommends replacing "lower" with "higher" in this sentence because a conservative PGA would be a greater or higher value than that used in the previous seismic evaluation. As presented in Section 2.3.4, the previous seismic evaluation conducted in 1997 used a PGA of 0.196g and the 2018 seismic evaluation used a higher PGA of 0.3g.

3. Section 3.7.2 Regulatory Acceptance Criteria, page 60, 1st full paragraph, 2nd to last sentence indicates: "Model calculations of ET will be evaluated as will the conceptual models of water flow within the repository and disposal cells from the initial precipitation to potential seepage through the mill tailings." The model calculations have been completed, therefore we recommend changing "will be evaluated" to "have been evaluated" in this sentence.

4. Section 5.4 Evaluation Findings, pages 127 and 128: This section includes a table listing wells by the "Portion of Site" that the licensee shall monitor as part of the compliance monitoring program. Based on our review, we believe the following wells have been listed under the incorrectly:

   - Wells EPA 8, 501A, EPA 2, TWQ-142, TWQ-143, 412, 502A, and 504A are listed under Zone 3 and should be listed under Zone 1
   - Well 627 is listed under Zone 3 and should be listed under SW Alluvium.