The NRC has reviewed the Design Work Plan for the Northeast Church Rock Mine Site Removal Action dated July 27, 2015 as a member of the Technical Design Review Team (TDRT). Three specific concerns were prevalent among the TDRT members following the meeting on August 18, 2015; 1) the decision to select a preferred repository option for the 30 percent preliminary design was premature based on the supporting information; 2) two of the three repository options were inconsistent with previous designs and requirements; and 3) the design criteria used to develop the three repository options and the selection of the preferred option appears to be subjective. The NRCs general and specific comments provided below relate to the three concerns, as well as additional concerns related to the Design Work Plan. Based on the review of the information provided in the work plan, the NRC is currently unable to make an informed decision for the selection of a repository design. This decision is based on the lack of supporting design detail such as best management practices, design calculations, assumptions, technical specifications, and consideration of the regulatory requirements. Choosing a repository option at this time is believed to be premature and possibly counterproductive since substantial time and effort may go into developing the preferred (Option 2) repository only to be confronted at a later point with information and evidence showing untenable inadequacies. However, the NRC believes that the analyses, studies, and actions proposed in the work plan, in general, will provide sufficient supporting information to develop acceptable design criteria, assuming that NRCs comments and concerns provided below are addressed and incorporated appropriately.

In addition, the NRC was under the presumption that the license amendment application, including the environmental report, would undergo Pre-Application Audits at 30, 60, and 90 percent completion. Due to the technical and regulatory complexity of the proposed action, the NRC recommends that the development of the NRC license amendment application be completed in parallel with the design and environmental reports required by the EPA. The earlier development of the license amendment application Audits of the draft application prior to submission, to identify any major acceptance or technical review issues. The Pre-Application Audits would allow NRC review of the technical and environmental analyses used to support the repository design within the context of NRC regulatory requirements.

#### **General Comments:**

- 1) The terms consolidation, settlement, and differential settlement should be clearly defined when they are discussed. Consolidation will occur to some extent in the mill tailings below the repository (both over the short term and over the long term) in contrast to the tailings outside of the new repository boundary. Settlement may also occur in the mine waste over time. If the settlement in the mine waste is uneven due to the nature of the mine spoils, e.g., larger object (debris) vs. finegrained sediments, differential settlement may occur. A settlement analysis for the mine waste and the mill tailings should be performed for profiles containing varying materials and at the boundary of the new repository.
- 2) The results, input parameters, and assumptions used in each of the design analyses should be compared to ensure that there are no contradictions between the analyses. For example, the assumptions and material properties (e.g. riprap size, etc.) used in the erosion analyses should not contradict those used in the ET cover analyses.
- 3) The models and equations proposed in the design analyses have not been determined to be acceptable for use by the NRC at this time due to the limited information provided in the work plan.

The NRC will require an evaluation of the models and equations to ensure that they are appropriate for conditions and consistent with guidance. Additionally, the final repository design must be supported by design analyses that use specifications and conditions that are consistent with the final design unless the design analysis is more conservative than elements used in the final design, e.g., the seepage estimates would be considered conservative if the overall thickness of the overlying material was reduced in the final design.

- 4) The NRC does not agree with the qualitative design criteria used in Section 8.2 to select the three repository options or the proposed option. The design process should be cyclical and initially driven by simple conservative calculations or assumptions that can be refined with complex solutions based actual conditions. The NRC understands that the proposed repository design option will be modified to conform to conclusions of the completed analyses discussed in the work plan. The repository design will also be limited by the properties and quality of the economically available materials required for construction of the repository components. Additionally, the Pre-Design Studies Report dated October 31, 2014 has already evaluated and tested potential cover and erosion protection materials available for construction of the repository. These materials should be used to develop the design criteria if acceptable or alternative sources should be proposed and tested.
- 5) A cost benefit analysis should be performed to assure that the selected design would provide maximum protection to public health and safety over the 1000-year performance period based on a design that is cost effective. NUREG-1620 states that "All site-specific licensing decisions based on Appendix A criteria or proposed alternatives will consider the risk to health and safety and the environment and the economic costs involved." Additional information and guidance can be found in NUREG-1620 Volume 1.
- 6) The existing radon barrier will be utilized as a liner and will also perform as the foundation for the proposed repository. An additional stability analysis should be performed on the foundation (previous radon barrier) to determine loading conditions and factors of safety at this interface. The foundation will be subjected to shear stresses imposed by the weight of the new repository. Many soils undergo relatively large plastic strains as the applied shear stresses approach the shear strength of the soil and should be analyzed as a potential point of failure. Regulatory Guide 3.11, Version 3 should be reviewed for additional guidance.
- 7) The Design Work Plan states that it also fulfills the requirement of the Design Criteria Report. The NRC expected at minimum, conservative design calculations and assumptions to be included in the Design Criteria Report. The design criteria used for the selection of the preferred option should be based on the results of the design analyses described in the work plan. The results of the design analyses should be presented in the 30 Percent Design Report to support the preferred repository option.
- 8) An additional "Areas of Potential Concern" from the May 16, 2013 letter [ADAMS No. ML13126A259] included perched conditions within the mine waste. An analysis demonstrating that such concerns are unfounded should be included in Design Work Plan. Additionally, the NRC staff had previously commented on "Areas of Potential Concern" in the May 16, 2013 letter and MWH had responded to these potential concerns on August 16, 2013 [ADAMS No. ML13242A118]. One potential concern related to breaks/cracks outside the repository perimeter. MWH's response stated that, "This abrupt change in loading is not planned, since the repository will be constructed with a sloping surface. The perimeter of the repository will be thin..." Two of the three designs, including the preferred option, contradict this statement and do include "abrupt changes." Therefore, NRC staff's concern is still relevant.

### **Specific Comments:**

- 9) Section 1-1 (p. 1-2) states that, "This Design Work Plan describes the process and strategy that will be used to design the remedy; it does not contain design details such as best management practices (BMPs), design calculations, assumptions, or technical specifications. These details will be developed during the actual design process and will be included in the design submittals." Although this critical information is missing from this report, Section 6.3 states that Option 2, the North Dome option, (Figure 6-2) is the preferred repository option, based on the evaluation presented in Section 6.2 and siting and conceptual design criteria summarized in Table 6-1. However, Section 6.2 does not contain an evaluation, but instead a qualitative listing of comparative characterizations relative to two other repository options, and Section 6.3 justifies the selection of Option 2 by repeating the descriptions in Section 6.2. Characteristics that seemed to have been given higher consideration for choosing Option 2 included visual impact which appears to have been synonymous with the amount of riprap included in the design. In comparison, repository features and processes relied upon to protect public health and safety, which may or may not include riprap, could not be considered when selecting the design option since this information is currently unknown. Critical information and data is missing from the report, e.g., no information is provided with regards to the ET cover, so that a selection evaluation is not possible.
- 10) Section 8.2.1.9 provides a brief description of the radon emanation analysis and states that "The cover thickness and material will prevent release of radon-220 and -222 exceeding an average release rate of 20 pCi/m2s...." To comply with 10 CFR 40, Appendix A, Criterion 6(5), near surface cover materials (i.e., within the top three meters) may not include waste or rock that contains elevated levels of radium; soils used for near surface cover must be essentially the same, as far as radioactivity is concerned, as that of surrounding surface soils. This is to ensure that surface radon exhalation is not significantly above background because of the cover material itself. Section 8.2.1.9 further states that "Soil properties for the cover materials in the RADON model will be based on the laboratory test results for the mine spoils and the borrow materials from the PDS." This statement is unclear and appears to include the mine spoils into the final cover thickness. The final cover that will be placed above the mill tailings and the mine waste must meet all the requirements in Criterion 6. Therefore, the final cover thickness must be calculated to account for radon emanation from both the mill tailings, the mine waste, and any additional material that exceeds background conditions for radioactivity. Please provide clarifying information about the final cover calculation and assumptions used.
- 11) The criteria of "Long-Term Maintenance Erosional Stability" listed in Table 6-1 is only addressed in a relative manner by classifying each of the designs as high, medium or low risk. No supporting calculations are presented. To determine a range of erosion protection designs that are compatible with an ET-type cover, screening calculations using the methods presented in NUREG-1623 should be conducted. These screening calculations could provide a range of stable slope-length configurations to inform the conceptual design.

### **Conceptual Design Criteria**

12) Limiting footprint to the existing Tailings Disposal Area (TDA):

The new repository design was limited to the footprint of the existing Tailings Disposal Area (TDA). The NRC provided comments on EPAs Engineering Evaluation and Cost Analysis (EECA) by letter dated February 23, 2009. The NRC considered co-disposal within the licensed tailing disposal cells at the UNC Church Rock Mill Site as the most viable Alternative (Alternative 5) proposed by EPA. The requirement to constrain non-11e.(2) byproduct material within the existing licensed tailings

disposal cells appeared to be based on the selected alternative rather than an NRC requirement. The DOE also supported Alternative 5A, provided that the non-byproduct material be incorporated so that it was indistinguishable from the existing NRC licensed by-product material. The NRC agrees with DOEs condition and will only consider expanding the disposal area with unilateral support from all agencies and concurrence from NRCs Office of General Council.

13) Repository cover design to minimize long-term maintenance:

A repository cover design that minimizes long-term maintenance is considered inadequate. The final repository design will need to provide permanent isolation of byproduct and non-byproduct material, and minimize the potential for dispersion by natural forces, <u>without</u> the need for active maintenance, over the 1,000-year longevity requirement. Additionally, no credit may be taken for active maintenance in the design for long-term stability.

14) Repository should limit fill thickness over tailings and minimize additional migration of residual pore water from the tailings into the underlying alluvium:

The NRC staff agrees that the repository should limit the fill thickness over fine tailings with a water content that would result in sufficient seepage to impact ground water above the NRC approved Ground Water Protection Standards (GWPS). The fill thickness limit should be guided by the estimated seepage flux predicted by modeling with UNSAT-H. However, the decision to limit fill thickness or avoid placement of fill over the thick tailings profile in the western and center portion of the Central Cell is unclear since these locations consist mainly of coarse tailings with low water content. Historic boring logs, SHB79-13 and SHB79-18, were located in tailings with the thickest profiles at these locations and consist entirely of coarse sand tailings. Figure 3-3 of the 2014 Pre-Design Studies report indicates that the eastern portion of the central cell generally contains greater thicknesses of fine-grained tailings, while the western portion of the central cell generally has fine-grained tailings thicknesses that are less than 5 ft.

The differentiation between coarse and fine tailings is relevant to the design because the potential adverse impacts (e.g. settlement and pore water migration) from fill placement over tailings may vary depending on the grain size of the tailings. This point is highlighted in the 2011 Steve Dwyer seepage and consolidation report which states that its focus is on the fine tailings, which were placed wet.

The Draft Design Work Plan does not contain any options where mine waste is placed over the western portion of the central cell. It is noted that placing mine waste in this area was presented as Alternative No. 3 of the 2014 Pre-Design Studies report (Figure 3-2). It is unclear why this option was not carried forward to the 2015 Draft Design Work Plan. The merits of placing mine waste in the western portions of the central tailings should be evaluated. Screening-level settlement calculations which encompass the areas of thicker tailings (both coarse and fine-grained) should be conducted to inform the conceptual design.

15) Repository construction should minimize the disturbance area on the existing TDA cover:

 a) The NRC staff would like further clarification why construction of the new repository should minimize disturbance on the existing TDA. This constraint appears to have limited the design of the repository, resulting in two options that are strikingly different than the alternatives previously considered. Options 2 and 3 are questionable considering the proposed 9-percent evapotranspirative top slopes and the 4 horizontal units (4h) to one vertical unit (1v) side slopes. The use of slopes steeper than 5h:1v is considered an alternative to the requirements in 10 CFR Part 40, Appendix A, Criterion 4(c). When slopes steeper than 5h:1v are proposed, a technical

justification should be offered as to why a 5h:1v or flatter slope would be impractical and compensating factors and conditions are incorporated in the slope design for assuring long-term stability. For slopes steeper than 5h:1v, an acceptable economic basis and an equivalent level of protection must be provided to justify an alternative to 10 CFR Part 40, Appendix A, Criterion 4(c) (NUREG 1620). Additionally, Criterion 4(d) requires the establishment of a full self-sustaining (emphasis added) vegetative cover or a rock cover employed to reduce wind and water erosion to negligible levels and that a rock covering of slopes may be unnecessary where impoundment slopes are very gentle (on the order of 10h:1v or less). A slope of 0.5 - 1 percent is considered generally acceptable by the NRC for top slopes with lengths greater than 500 feet and 1 - 4 percent for top slopes with lengths less than 500 feet.

b) The NRC staff does not agree with the abrupt distinction between the new cover and the existing cover. Previous design alternatives integrated the slopes of the new cover with the existing cover slopes. The necessary aprons, toes, and drainage swales proposed for the three options will be a major area of NRC review due to the potential for damaging erosive forces at these interfaces. The design objective for the repository should first consider reasonable low risk alternatives with consideration of potential environmental impacts, e.g., ground water impacts, long-term maintenance, e.g., self-sustaining vegetation, differential settlement, and erosional stability.

### Previous Comments and Concerns Relevant to the Design Work Plan

- Specific comments and concerns were emailed to EPA on January 20, 2015 [Accession Number: ML15008A104]. The following comments and concerns were not discussed in the current Design Work Plan:
  - a. The ten-year period to allow evaluation of the impacts of settlement, as well as anticipated reduction in surface infiltration due to the repository configuration and ET cover system is not expected to be sufficient to capture the peak rate of drainage resulting from consolidation of the existing tailings. The effectiveness of the cover system design must be based on long-term performance.
  - b. The NRC staff disagrees that the average climate data over a ten-year period will provide conservatism in the model. The model should be based on daily historical climate conditions. [And based on long-term performance.]
  - c. The NRC staff would expect an evaluation to be initiated once an increased rate of drainage resulted from consolidation. The level of complexity required to determine groundwater impacts should be dependent on the resulting level of increased flux. If the increased rate of flux appears to be minimal, a simplistic and highly conservative analysis may be appropriate to evaluate groundwater impacts.
  - d. The staffs from various agencies had comments and concerns with the original UNSAT H modeling that was done in 2011, and NRC staff would like an opportunity to resolve those issues before the model is run to determine the flow through the tailings impoundment. The more significant issues are listed below. NRC staff can provide more detail and specifics about these issues upon request.
    - i. It is not clear how the Terzaghi assumptions are being fulfilled, or why it is not significant if one or more of these assumptions are not being fulfilled. However, a previous UNC response did state that: "...the assumptions have been shown to be valid in similar applications..." in reference to Terzaghi's theory of consolidation.

NRC staff has long expressed interest in such documents and is interested in reviewing documentations pertaining to these similar applications which demonstrate that Terzaghi's theory (for saturated soils) has been successfully applied to partially saturated, heterogeneous/ anisotropic soils to predict consolidation. This information is necessary to demonstrate the conservatism of the simulations.

- ii. Section 3.1 in the 2011 Consolidation report stated that the first stage of consolidation is the "Immediate" stage. No further discussion was presented in the report on this stage. Technical literature suggests that immediate settlement analyses are used for all fine-grained soils including silts and clays with a degree of saturation of 90% or less, and for all coarse-grained soils, while consolidation settlement analyses are used for all saturated, or nearly saturated, fine-grained soils. If the impact from immediate settlement is not significant in comparison to the Terzaghi's primary and secondary consolidation, a technical basis should assumption should be provided.
- 17) Section 8.2.1 (p. 8-3) discusses how "The upper 12 inches of the existing 18-inch thick tailings cover (radon barrier) will then be scarified, moisture conditioned, and compacted in place, to form the repository base layer." In case the radon barrier is thinner than expected, tailings may be brought to the surface.
- 18) Section 6.1 (p. 6-2) states that, "Conceptual slopes and slope lengths of each repository option were optimized to shed water, mitigate ponding, and minimize erosion." The references for this optimization should be provided.
- 19) Section 8.2.1 (p. 8-4) states that, "Ten years was selected because preliminary analysis indicates the flux calculations approach steady-state at that time." The references for this preliminary analysis should be provided.
- 20) Section 4.3.2 (p. 4-2) states that, "During the RA, PTW will be segregated from lower activity mine waste and transported to an off-site..." The references for how for this PTW will be segregated from the lower activity mine waste should be provided.