Shieldalloy PEmails

From: John Hayes
Sent: Friday, November 14, 2008 11:23 AM
To: Smith, David R. (Windsor,CT-US); White, David
Cc: Steve Spayd; Jenny Goodman; Carol D. Berger; Oliva, Jean (Windsor,CT-US)
Subject: Master RAI 11142008 to SMC & NJ.doc
Attachments: Master RAI 11142008 to SMC & NJ.doc

Enclosed are the staff's draft RAIs for discussion during the Wednesday, November 19, 2008 publicly notice meeting. The purpose of the meeting is to review the draft RAIs and to ensure that the NRC has clearing identified the information that it is seeking and that SMC understands the NRC's request. It is possible, as a result of the site visit and this meeting, that additional RAIs may be added to those in the attachment to this email or that the staff may delete or revise some. The deletions or revisions may occur as a result of knowledge gained during the site visit or due to the fact that it is identified that the information that the staff is seeking is already contained in existing SMC documents which are part of this amendment request.

Please contact me if you have any questions.

Thanks,

Jack

Hearing Identifier: Shieldalloy_DP_Public_EX
Email Number: 16

Mail Envelope Properties (D841D501B2C4D244B75AB897F70C149484665ACF08)

Subject: Master RAI 11142008 to SMC & NJ.doc
Sent Date: 11/14/2008 11:22:44 AM
Received Date: 11/14/2008 11:22:42 AM
From: John Hayes

Created By: John.Hayes@nrc.gov

Recipients:
"Steve Spayd" <Steve.Spayd@dep.state.nj.us>
Tracking Status: None
"Jenny Goodman" <Jenny.Goodman@dep.state.nj.us>
Tracking Status: None
"Carol D. Berger" <CDBerger@IEM-Inc.com>
Tracking Status: None
"Oliva, Jean (Windsor,CT-US)" <JOliva@trcsolutions.com>
Tracking Status: None
"Smith, David R. (Windsor,CT-US)" <DRSmith@trcsolutions.com>
Tracking Status: None
"White, David" <dwhite@metvan.com>
Tracking Status: None

Post Office: HQCLSTR01.nrc.gov

Files	**Size**	**Date & Time**
MESSAGE	838	11/14/2008 11:22:42 AM
Master RAI 11142008 to SMC & NJ.doc		142842

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

SHIELDALLOY
REQUESTS FOR ADDITIONAL INFORMATION
SMC ENGINEERED BARRIER DESIGN DOCUMENT

General

1. **Avoid using the term "prevent" infiltration when describing the purpose of the engineered barrier or its components.**

Basis:

Many places in Section 8.3 and the Appendices use the term "prevent" in discussions of the purpose of the engineered barrier or its components. For example, on page 5, the clay barrier layer discussion states that "The clay barrier layer has been designed to prevent precipitation that percolates through the upper layers of the engineered barrier from infiltrating into the underlying consolidated materials." This use of the term "prevent" is misleading and likely unsupportable. The term prevent can give the unrealistic expectation that the clay barrier would preclude infiltration, rather than reduce to some acceptable amount together with other components. Some parts of the text use of more accurate term "inhibit" (e.g., Appendix B, p. B-12, para. 2)

Path Forward:

Consider using a more realistic term such as "reduce", "inhibit", or "minimize" wherever the term "prevent" has been used in the text and appendices.

2. **Geotechnical Characterization of Site and Borrow Materials: There is no geotechnical site subsurface or borrow material (other than rock) characterization provided with the engineered barrier design documentation.**

Basis:

All geotechnical analyses seem to have been performed based on assumptions only (see RAIs 41, 42, and 43). In order to acceptably perform geotechnical analyses related to potential degradation mechanisms, there need to be soil borings, test pits, sample testing, etc. to provide the basis for material characteristics. The NRC staff recognizes that the QA/QC Construction Plan includes statements on testing borrow source materials prior to placement. This also should be discussed in Section 8.3.1.

Path forward:

SMC needs to conduct and provide the results of a geotechnical subsurface characterization program. As an alternative to providing a new subsurface investigation, SMC could provide information from previous subsurface investigations in the immediate area of the proposed disposal cell. As an alternative to an immediate identification and assessment of borrow materials, SMC has indicated in its QA/QC Construction Plan that it will test and report on borrow material characteristics prior to their placement. However, SMC should include a statement upfront in Section 8.3.1 that it will test borrow materials once the borrow sources are identified, and provide appropriate test results to demonstrate that conservative assumptions were used in the geotechnical analyses and material specifications will be met.

3. **Conduct radiological characterization of soils during construction of the engineered barrier when existing piles of slag and baghouse dust are removed from their current location to the engineered barrier footprint.**

Basis:

Shieldalloy has collected soil samples under the edges of some of the existing slag and baghouse piles to determine if there is evidence of leaching of radionuclides over the past few decades and movement into the soil beneath the piles. Due to size of the existing piles, sampling directly beneath the large piles could not be done. However, construction of the engineered barrier would result in relocation of slag and baghouse dust material. When some of the piles of slag and baghouse dust are moved to the engineered barrier footprint, the soils beneath these moved piles would become accessible for sampling at depth and analysis for radionuclides. These tests would provide additional data regarding the absence or presence of radionuclides that could have been leached from the piles over the past decades of exposure to weathering processes.

Path Forward:

Shieldalloy should propose plans for sampling the soils under the slag and baghouse dust piles after they have been moved.

<u>Section 8.3</u>

4. **The discussion on page 2 regarding development of the design for the engineered barrier incorrectly references NRC's regulation in 10 CFR Part 61.52.**

Basis:

The NRC regulation for low level waste disposal facilities under 10 CFR Part 61.52 does not apply to the decommissioning of the Shieldalloy site.

Path Forward:

Remove the reference to 10 CFR Part 61.52 and reference the NRC decommissioning requirements for restricted use in License Termination Rule in 10 CFR 20.1403, along with the supporting guidance in NUREG-1757, Vol 2, Rev. 1, Section 3.5 on Use of Engineered Barriers.

5. **The risk-informed, graded approach used in the development of a robust engineered barrier design is not explained.**

Basis:

It is noted on page 2 that a risk-informed, graded approach was used in the development of a robust engineered barrier design. A discussion is missing of how the risk informed, graded approach was used by Shieldalloy for developing the design, determining the individual barriers and their functions, and providing a technical basis for the design that is based on compliance with 10 CFR 20.1403 of the LTR. For example, on page 3 there is a list of specific considerations that are deemed applicable to the SMC site such as providing shielding and severely limiting infiltration. These considerations could be discussed within the context of reducing risk and contributing to compliance with the dose criteria by describing the source term and related exposure pathways these barriers are designed to mitigate.

Such a discussion would provide a clearer understanding of how long-term protection would be provided and how the design contributes to compliance. It also would provide an understanding along with dose assessments and sensitivity analyses of how each component of the engineered barrier system contributes and which components are relied on for compliance.

Path Forward:

NUREG-1757 vol. 2, Rev. 1, Section 3.5 discusses the use of a risk-formed graded approach for developing the design of engineered barriers under NRC's License Termination Rule in 10 CFR 20 Subpart E. A discussion of how the risk-informed approach was used to develop the design so that it contributes to compliance with both the 25 and 100 mrem/yr dose criteria of the LTR should be provided. Also describe how the approach was graded so that more robust components of the design were incorporated in order to address the need for long-term protection for the long-lived radionuclides. For example, the design approach of the erosion protection layer used the NRC guidance in NUREG-1623 for designing the rock cover based on the PMP and PMF to provide a more robust and passive design that would not rely on active ongoing maintenance.

6. **The boundary for the restricted use area shown on Figure 18.6 is incorrect.**

Basis:

Figure 18.6 referenced on page 4 shows the new footprint of the engineered barrier falling outside of the restricted use area boundary.

Path Forward:

Revise Figure 18.6 by changing the restricted use area boundary that incorporates the new footprint of the engineered barrier or change the footprint. The revised boundary should also consider the long-term monitoring plans when revised to include the location of future groundwater monitoring wells and the need to maintain controls on these wells.

7. **The discussion on page 4 states that the thickness of the engineered barrier layer was selected so that exposure would be less than 100 mrem/yr even if no barrier maintenance takes place. This statement is unclear and incomplete.**

Basis:

It is unclear if the statement on page 4 “so that exposure would be less than 100 mrem/yr even if no barrier maintenance takes place.” is the same as the100 mrem/yr LTR dose criterion assuming failure of institutional controls.

The statement on page 4 is also incomplete because the reference to 100 mrem/yr also gives the impression that this is the only dose criterion that the engineered barrier contributes to because there is no discussion that the engineered barrier system performance must also meet the restricted use 25 mrem/yr dose criterion for when institutional control are in effect. For example, the shielding layer is critical to reducing direct exposures so that the 25 mrem/yr dose criterion can be met. Thus, the discussion does not explain that the engineered barrier system and all of its components should be designed as appropriate to contribute to compliance with both the 25 and 100 mrem/yr dose criteria.

Path Forward:

Explain that both the 25 mrem/yr and 100 mrem/yr LTR dose criteria are applicable to the engineered barrier design and how the design was developed to contribute to compliance with the applicable dose criteria. This is fundamental to the risk-informed approach.

8. It was noted on page 2 that a risk-informed approach was used for the engineered barrier design; however, the amount of reliance that would be placed on the engineered barrier toward compliance was not discussed.

Basis:

The August 21, 2008, transmittal letter for the engineered barrier report stated in the second paragraph that SMC believes that there is no evidence of slag leaching and that the engineered barrier design will add a further layer of protection to the underlying ground water quality. It is not entirely clear from this statement how much the engineered barrier overall is being relied on for meeting the dose criteria or if SMC believes that compliance can be achieved solely by the low leachability of the slag and baghouse dust. In other words, it is unclear if the engineered barrier performance is in addition to the slag performance or are allocations of performance needed from both to achieve compliance. Is the performance allocation 100 percent for the slag and 0 percent for the engineered barrier or would both the slag and engineered barrier contribute? For the first case, the engineered barrier could be considered another layer of protection, or a redundancy.

Path Forward:

After the results of the leach rate tests are available, explain how performance of the source term and overall engineered barrier is allocated for compliance with both the 25 and 100 mrem/yr dose criteria and for both the direct exposure and groundwater exposure pathways. In other words, do a sensitivity analysis with and without the engineered barrier.

9. This section identifies and discusses the Final Status Survey and the Long-Term Control Plan. A discussion of a Construction Completion Report should also be included here similar to how it is discussed in Section 4.3 of Appendix C and that it would need to be eventually prepared to document how the entire engineered barrier, including contaminated materials and cover, was constructed.

Basis:

For decommissioning a site with the use of an engineered barrier, the NRC would need a Construction Completion Report that documents how the entire engineered barrier, including contaminated materials and cover, was actually constructed. Although a Construction Completion Report is not specifically mentioned in the LTR or in NUREG-1757, this approach has been used in NRC's Uranium Recovery Program and has recently been adapted and used at one decommissioning site under the LTR, the Cabot site in Reading, Pennsylvania.

Appendix C identifies the need for such a report, but it is not identified or described in Section 8.3.

Path Forward:

A new section before Section 8.3.4 on Final Status Survey should be added to commit to developing a Construction Completion Report and submitting it to NRC together with the Final Status Survey Report and the Long Term Control Plan after completing decommissioning activities. The Completion Report for the Cabot site should be used as a recent example and has already been provided to Shieldalloy. It is noted that this example, is simpler than expected for the Shieldalloy engineered barrier because the Cabot engineered barrier was only designed for erosion protection and did not have the other barrier components that are being proposed for the Shieldalloy engineered barrier. Furthermore, the Completion Report should address construction of the entire engineered barrier including contaminated materials and cover layers. For SMC consideration, an example Completion Report contents is given below that is based on similar reports that have been submitted to NRC by uranium mill tailings licensees as well as the decommissioning of the Cabot site.

<u>Example of Completion Report Contents</u>

1. Introduction
2. Site History and Background Information
3. Overview of Construction Activities and Associated Quality Control Testing
4. Completed Site Cleanup Decommissioning Activities
5. Contaminated Material Co-Location Activities and Test Results
6. Clay Barrier Placement and Test Results
7. Biointrusion/Drainage layer Placement and Test Results
8. Geotextiles Placement and Test Results
9. Cover soil Layer Placement and Test Results
10. Bedding Layer Placement and Test Results
11. Erosion Control Layer Placement and Test Results
12. Other Decommissioning Activities
13. Summary and Conclusions
14. References

10. Cleanup goals should be developed and used as the basis for removal of contaminated surface soils adjacent to the engineered barrier footprint.

Basis:

Section 8.3.2 on page 9, paragraph 1 states that “As part of the consolidation process, surface soil screening for radiological constituents will be performed within the Storage yard to ensure soils outside of the footprint of the engineered barrier are not impacted." This statement is inconsistent with the third paragraph that states: "…those areas that are above the applicable DCGL will be placed onto the consolidated pile." Not impacted implies lack of any radiological contamination from facility operations, while removal of soil above the DCGL implies removal to the specific level. Also, the applicable DCGL is not identified in this Section; however the staff notes that DCGLs for unrestricted areas are discussed in Chapter 5 of the Decommissioning Plan.

Path Forward:

Resolve the inconsistency in discussions as identified above and provide the applicable DCGL or reference where it would be provided in the Decommissioning Plan.

11. Need to clarify the design consideration on minimizing handling to lower costs. (Page 4; 3rd Bullet from top)

Basis:

This item in the list of design considerations indicates a goal to minimize the need for handling materials to lower construction costs. Since the need for a design that meets the dose requirements is primary, this factor should include a caveat that minimizing handling to lower costs is only a consideration when there is no impact on the overall stability of the storage system.

Path forward:

SMC should indicate that the goal to minimize the need for handling materials to lower construction costs is only a consideration when there is no impact on the overall stability of the storage system.

12. Cover Soil Layer: A description of the make-up of this material (soil type, gradation requirements, etc), as has been included for the other engineered barrier layers, is absent from this section. (Page 6; 2nd Bullet)

Basis:

Although a description of the make-up of this material can be found elsewhere in the specifications section of this documentation, a brief description in this section will provide consistency on discussion of each barrier layer.

Path forward:

SMC should add a description of the cover soil layer material requirements to this section.

13. The proposed process for co-locating, handling, and placing all of the contaminated material may have a high possibility for incomplete filling of voids, subsequent movement of fines into the voids with time, and resulting differential settlement/slumping on the surface of the engineered barrier. (Page 7; Section 8.3.2 and Drawing D-1)

Basis:

This section includes a discussion of the process for co-locating, handling, and placing all of the contaminated material. The approach calls for initial placement of the largest slag, overlain by intermediate sized slag, overlain by the fine material, "filling in voids where possible." As described, this method would have a high possibility for incomplete filling of voids, subsequent movement of fines into the voids with time, and resulting differential settlement/slumping on the surface of the engineered barrier.

Path forward:

SMC needs to provide discussion of the detailed methods that would be used to ensure all voids are filled. In addition, SMC needs to provide information on the basis for selection of this approach in lieu of crushing and/or mixing the contaminated materials to form a uniform mixture that could be compacted to form a completely stable base for the engineered barrier. As an alternative, SMC could provide a different process for co-locating the contaminated materials.

14. The cost analysis associated with the Long-Term Control Plan (LTCP) should be included for review at this time. (Page 11; Section 8.3.6)

Basis:

This section indicates that the LTCP will be submitted at a later date as part of the Final Decommissioning Report, and lists information that will be included in the LTCP. The staff recognizes that this later submittal is consistent with NRC guidance in NUREG-1757. However, because this information has an impact on the cost analysis, which feeds the surety determination, the LTCP cost analysis should be included for review at this time.

Path forward:

Based on a clear understanding of what activities will be involved under the LTCP, SMC should provide the cost analysis for these activities, and factor this line item into the surety analysis.

A**<u>ppendix A</u>** (**<u>Earthwork Specifications)</u>**

15. This section (and other places throughout the documentation) repeats the proposed questionable process for placement of contaminated materials. (Section 02220-7; Part 3.2.1)

Basis:

See RAI 13 on contaminated material placement

Path forward:

SMC should consider possible revisions to the proposed process described in various sections throughout the documentation in accordance with the response to RAI 13.

16. Complications may occur when using nuclear gauges on radioactive materials. (Section 02220-9; Part 3.5.2)

Basis:

This section addresses compaction of NRC-licensed material, and testing of density and moisture content with a nuclear gauge. Complications may occur when using nuclear gauges on radioactive materials.

Path forward:

SMC should commit to pre-compaction testing of the contaminated material to ensure the nuclear gauge will work effectively in the contaminated material environment, and to enable accurate calibration of the equipment.

17. Contrary to the statement in this section that "The following test frequencies shall be consistent with paragraph 1.4.1, Part B….," they are not. (Section 02227-8; Part 3.2.2)

Basis:
To be consistent with paragraph 1.4.1, the line items for compaction, Atterberg Limits, and conductivity in the Section 3.2.2 table should specify "once for every 5000 cubic yards" rather than "Initial test (one time)."

Path forward:
SMC needs to correct this inconsistency.

18. More information is needed to properly define the riprap gradations. (Section 02228)

Basis:

Detailed gradations showing the complete gradation bands and the minimum D_{50} for each layer thickness and rock size are needed for the NRC staff to complete its review. It should be emphasized that the required D_{50} to resist erosion should represent the minimum D_{50} of the rock gradation. Guidance for providing more detailed gradations may be found in NUREG-1623, Appendix F.

Path Forward:

SMC should revise the gradations to be used for each layer thickness, provide the gradation bands, and specify the minimum D_{50} values.

19. The quality assurance requirements in Sections 02228 and 02225 for the radiological characteristics of the diabase angular stone for erosion protection and the clay barrier are inconsistent and the technical basis is not clear.

Basis:

On page 2, Section 1.3.1 B. 1, indicates radiological test results for the diabase rock shall be in conformance with Table B.1 of NUREG-1757. However, Table B.2 of NUREG-1757, vol. 1, seems more appropriate because this table contains uranium and thorium, which are found in the diabase as identified on page 7 of Appendix B, Attachment 2. However, Table B.2 values are NRC's screening values for meeting 25 mrem/yr and as such may not be appropriate levels for bringing materials onsite from offsite sources. This Table B.2 approach also appears inconsistent with page 4, Part 2 A.3. that indicates that the diabase rock should be below the background radioactive level. Furthermore, the background level is not given. Similar requirements for the clay barrier in Section 02225, page 6 states that source material (uranium and thorium) shall not exceed 50 ppm. No basis is given here for the 50 ppm value for the clay and it is not clear why a different requirement is given for the rock and the clay. Appendix B, Attachment 2, p. 7 states that the diabase rock has a total uranium and thorium activity of about 1.2 pCi/g. It is not clear how this low activity level compares to stated requirements (background, Table B.2, or 50 ppm).

Path Forward:

Resolve the inconsistencies in the radiological requirements for the clay and the rock discussed above and provide a technical basis for the value(s) selected. Consider using background as the specification for both clay and rock. If site background is not used provide a basis for the selected value and describe how a value greater than background would be considered in the dose assessment..

20. Clarify the timing of durability test results and acceptance/rejection of rock during production.

Basis:

Section 3.3.1 on page 8 indicates that durability test results would be used for acceptance or rejection of the rock. Appendix C, p 3-7 also states that testing will be done "prior to delivery and during placement". Production experience at other sites indicates that durability test results will take time to conduct and analyze before a decision about acceptance or rejection of the rock can be made. Because there would be a small amount of rock and a short time needed for placement, the rock could be prematurely placed on the engineered barrier before the analyses are completed and an acceptance decision made.

Path Forward:

It should be noted in the Section 3.3.1, Appendix C, and appropriate procedures that rock production and placement schedules would account for the rock durability testing time in order to avoid placing rock on the engineered barrier before it is accepted.

21. (Appendix B, Attachment 1) Additional information and analyses are needed to justify the design of the perimeter drainage channels.

Basis:

Staff notes that the method used to size the riprap for the perimeter drainage channels was the Connecticut Department of Transportation (CTDOT) method. Based on a check of the rock sizes using this method, the staff considers that the rock sizes may be too small, when compared with some other methods.

Path Forward:

Since NUREG-1623 provides acceptable methods for rock sizing, SMC should check the CTDOT riprap sizing method used and compare the results with NUREG-1623 methods. If necessary, the rock sizes should be revised.

22. Additional information and analyses are needed to justify the design of the perimeter drainage channels, with regard to potential large increases in shear stresses on the outside of the bends of the channels. (Attachment 1)

Basis:

The perimeter drainage channels are designed to convey flows around the disposal cell. With the large amount of channel curvature proposed, the riprap design needs to include an allowance for increased shear stresses on outside of these bends. Guidance for determining increased shear stresses and rock sizes on the outside of bends may be found in NUREG-1623.

Path Forward:

SMC should either modify the channel rock sizes at those locations where curvature occurs or should justify that the currently-proposed design is adequate.

23. Additional information and analyses are needed to justify the actual ability to construct a rock-lined channel with a very small bottom width. (Attachment 1)

Basis:

SMC proposes to construct trapezoidal perimeter drainage channels with a bottom width of two feet. Based on staff experience with the construction of rock-lined channels, it appears that it may be difficult to construct a channel with such a small bottom width, especially since the rock sizes may be larger than 12-18 inches.

Path Forward:

SMC should provide further discussion regarding their procedures for constructing the channel. SMC should also evaluate the possibility that it may be difficult to meet placement specifications and re-design the channel, if necessary.

24. Additional information and analyses are needed to justify the design of the aprons for the outlets of the perimeter drainage channels. (Attachment 1)

Basis:

Staff review of the design of the riprap for the diversion channel outlet aprons indicates that the rock size, rock volume, and overall design may not be adequate to prevent erosion, head-cutting, and gully intrusion. It is not clear that adequate consideration has been given to flow distribution across the aprons and the localized flow concentrations and flow velocities produced at the channel outlets onto the apron. Guidance for the design of aprons and channel outlets may be found in NUREG-1623.

Path Forward:

SMC should provide additional information and calculations to demonstrate how the aprons were designed. The revised calculations and design should provide: the design velocities for the riprap of the apron; the minimum flare angle (based on the velocity) of the apron as it increases in width in a downstream direction; velocities and possible scour depths at the downstream end of the aprons; and rock sizes for the apron and the toe of the apron. Additionally, SMC should provide detailed drawings of aprons. These detailed drawings should show the aprons, with particular emphasis on their location and the manner in which the diversion channel transitions from a trapezoidal channel to a horizontal rock apron.

25. The staff notes that the storm water detention area south of the disposal cell is designed for a 100-year flood event, which may not be sufficient to prevent erosion and flooding of the cell. (Attachment 1)

Basis:

It is not clear how a Probable Maximum Flood (PMF) event would affect this area and, in particular, how the detention area design will affect the design of the disposal cell. For example, the PMF could erode and damage the culvert and/or form a large gully or a preferred flow path.

Path Forward:

SMC should provide further analyses of the effects of a PMF and how the disposal cell design may be impacted by such an event.

26. A technical basis is not given for the thickness of the cover for shielding purposes.

Basis:

Appendix B provides a technical basis discussion for each of the engineered barrier components/layers, but does not discuss shielding and the basis for determining the appropriate thickness of the cover to limit direct exposure and comply with both the 25 mrem/yr and 100/500 mrem/yr. dose criteria.

Path Forward:

Add a discussion that provides the technical basis for the components of the engineered barrier that are intended to provide shielding of direct exposure.

27. Revise the reference to meeting radon release limits.

Basis:

Section 1.1 on page B-1 references performance objectives from NUREG-1623, including item #4, specifically for “meeting radon release limits.” The manner in which this performance objective is worded on page B-1, it could be inferred that the erosion barrier itself is designed to meet radon release limits. This is not the case. Instead the discussion in NUREG-1623 on page 7-8 means that erosion protection is needed to prevent gullies in the radon barrier that could expose uranium mill tailings and result in higher radon releases.

Path Forward:

Reword item 4) as follows: "preventing exposure of tailings by erosion and resulting higher radon releases."

28. Add a discussion of how a design based on the PMP and PMF conditions also reduces the need for future long-term maintenance.

Basis:

Section 1.1 on page B-1, paragraph 2 indicates that "By designing to protect against erosion under PMP and PMF conditions, protection will also be provided under less severe, more common storm events." While correct, further discussion is needed of how this design approach would minimize future long-term maintenance.

Path Forward:

Add a discussion of how the PMP and PMF design approach would also minimize future maintenance. See NUREG-1623 for discussions of various approaches.

29. Provide a technical basis for the moisture monitoring and irrigating approach and 10-year time period proposed for maintaining the moisture content of the clay layer. Discuss the potential for changes in hydraulic properties at deeper depths over long periods of time and without monitoring and maintenance (irrigation) that might be able to maintain moisture levels and minimize desiccation cracking at depth.

Basis:

In Section 1.2.2, page B-5 the depth of the clay layer is stated as sufficient to limit desiccation and that sufficient silt and clay in the cover soil would maximize moisture retention. Also, in-situ soil monitoring sensors will monitor soil moisture content of the clay barrier for 10 years and irrigation could be used to maintain acceptable moisture content of the clay layer. No references are provided as a technical basis that this approach has been demonstrated to be effective either in the short term or long term. Furthermore, discuss how the proper amount and timing of adding moisture by irrigation would be determined and how excessive irrigation would be avoided so that irrigation does not contribute to infiltration into the slag and baghouse dust.

Section 1.2 on page B-4 discusses recent ACAP studies regarding desiccation and hydraulic degradation. However, the references provided place much emphasis on short-term studies, such at the Monticello site with a design similar to SMC, that no percolation was reported over four years of monitoring. However, no discussion is provided about the uncertainty over decades or hundreds of years.

Path Forward:

Provide a technical basis for using irrigation. Also discuss how the amount and timing would be determined and excess irrigation avoided.

30. Provide the contribution to total infiltration estimates from each component of the engineered barrier system, including ET, surface runoff, storage in the soil layer, runoff through the drainage layer, and infiltration through the clay layer.

Basis:

Section 1.7, pp. B-10 to 11 notes that the analysis "conservatively neglects runoff associated with the surface layers of the engineered barrier, as well as absorption/storage in soil pores." The estimates discussed place greater emphasis on selected layers that have uncertainty in long-term performance, such as clogging of the drainage layer and degree of desiccation cracking of the clay layer. In contrast, surface runoff from the 3:1 slope of the engineered barrier should be considered a "layer" or another component of the engineered barrier system. This component might make a significant contribution to reducing infiltration even with the rock surface, but could be enhanced with a rock/soil/vegetation surface if needed. Furthermore, there may be less uncertainty about the performance of this component than with the clay layer component as well as its long term stability. In addition, long-term monitoring and maintenance would be simpler and less than that needed for other layers, such as the clay layer. While it appears to be conservative to neglect the surface component, it may be a component with many advantages and its contribution should be analyzed and its advantages and disadvantages discussed together with the other components.

Path Forward:

Based on infiltration analyses and dose modeling results (see RAIs 35 and 36), each component of the total engineered barrier system should be listed and its contribution to the infiltration estimate and dose reduction should be given, both for as designed and degraded conditions. This would provide a clear summary of the calculations and dose modeling/sensitivity analyses for each component and provide a overview of how all the components are estimated to perform by reducing infiltration and contributing to compliance. Furthermore, this approach would allow alternative total infiltration values to be estimated by removing components that might be uncertain for some reason, such as questionable performance of the clay layer over the long term. Similarly, another component could be added or modified, such as using a rock/soil/vegetative erosion protection/ET surface component that would then have a higher estimate of surface runoff and ET than the rock-only erosion protection layer. For each of these alternative designs/systems for infiltration control, the resulting alternative total infiltration values could be used to calculate dose, thereby, estimating the contribution of the alternative engineered barrier systems on compliance with both the 25 and 100/500 mrem/yr dose criteria. Such an approach would be more risk-informed by providing risk insights from alternative designs and assumptions about degradation. The advantages and disadvantages of each component should also be discussed, both from a performance standpoint but also long-term monitoring and maintenance.

31. Revise the statement of purpose for durable rock.

Basis:

Attachment 2, p. 1 states that “The main purpose of selecting a durable rock material is to sustain the forces of weathering (known as rock durability) for a period of at least 1,000 years.” Sustain is the incorrect term to use; instead, NRC guidance uses the term “withstand” the forces of weathering.

Path Forward:

Revise the term as suggested above.

32. Discuss the results of petrographic analyses that identified minor alteration of plagioclase feldspars to sericite, a mineral that is less durable than feldspar.

Basis:

The section on Absence of Adverse Minerals and Heterogeneities on p. 9 does not acknowledge or discuss the results of PENNDOT and SMC petrographic analyses that documented small amounts of sericite, a mineral that resulted from the alteration of feldspar and is less durable than feldspar. Also missing are the conclusions from the April 28, 2008, petrographic report prepare for SMC that the sericite alterations did not affect the overall integrity, density, and good quality of the rock.

Path Forward:

Add a discussion of the petrographic analyses conducted by PENNDOT and SMC that indentified small amounts of the secondary mineral sericite that resulted from the alteration of feldspars. Explain the origin of this secondary mineral, the small amounts observed, and conclusions regarding future rock durability. Include, the conclusion of the April 28, 2008, petrographic report prepared for SMC that the sericitic alterations did not affect the overall integrity, density, and good quality of the rock.

33. Clarify and add a discussion of natural analogues more relevant to New Jersey.

Basis:

In the section on Direct and Indirect Evidence for Resistance to Weathering on p. 10-11, natural analogue rocks are discussed from climates different than New Jersey. Reconsider adding some of the diabase analogues from the Cabot information provided because they are the same or similar diabase in a similar climate (New York and Pennsylvania). While the erratics from the western US and Turkey might be of general use, they are in a more arid climate than New Jersey and that is why the New York/Central Park erratics would provide a stronger example from a similar climate. However, explain that the more arid examples are useful even though they are in arid climates because of the long time period they indicate (approx. 10,000 yrs) relative to the regulatory time period of 1000 years. Furthermore, the example from Turkey indicates that the striations withstood many years of exposure. An approximate time is needed because the term “many” is unclear.

Path Forward:

Revise as suggested above.

34. The potential use of irrigation or construction of permeable zones in the cover soil is not included in the evaluation of infiltration for RESRAD dose modeling. (**Appendix B Section 1.2, page B-6, 1st paragraph)**

Basis:

SMC states it may use irrigation or construct permeable zones in the cover soil to maintain acceptable soil moisture levels. SMC does not include the potential use of irrigation or construction of permeable zones in the cover soil in its evaluation of infiltration for RESRAD dose modeling found in Section 1.7 of this document. To-date SMC has not included the use of irrigation in its dose modeling evaluations in the decommissioning plan. The use of irrigation or construction of permeable zones in the cover soil has the potential for increasing the infiltration rate.

Path forward:

SMC should include the potential use of irrigation or construction of permeable zones in the cover soil in its evaluation of infiltration for RESRAD dose modeling found in Section 1.7 of this document.

35. SMC uses potential evapotranspiration rather than actual evapotranspiration in its evaluation of infiltration and does not include a discussion of how evapotranspiration would change as the cover degrades. SMC did not include any discussion of how it determined the evapotranspiration coefficient that will be used in the RESRAD dose modeling. (**Section 1.7, page B-10, 4th paragraph and Attachment 6, page 2, 2nd paragraph)**

Basis:

SMC calculates infiltration (**I**) as precipitation ($\mathbf{P_r}$) minus evapotranspiration (**ET**) minus runoff ($\mathbf{Q_d}$). In applying this formula SMC uses a constant value for **ET** represented by the potential evapotranspiration rate. By using potential evapotranspiration rather than actual evapotranspiration SMC is overestimating the evapotranspiration and potentially underestimating infiltration. There are various environmental conditions that would cause actual ET to be less than potential ET. Additionally, there are factors related to the design of the engineered barrier that would cause actual ET to be less than potential ET. For example, the engineered barrier is not designed to include a vegetative cover, so there will be no transpiration from the cover, only evaporation, under the as-built state. In addition, SMC uses the same value for evapotranspiration under both the controls-in place and the controls-fail conditions. SMC does not discuss how degradation of the cover layers over time will impact evapotranspiration.

Both Appendix B, Section 1.7 and Attachment 6 identify the coefficient of evapotranspiration as one of the parameters required by the RESRAD dose modeling code for the calculation of infiltration. However, there is no discussion in either of these two sections of the Engineered Barrier Design document of the values or range of values that were calculated for this coefficient, or how these values will be incorporated into the dose modeling in RESRAD.

Path forward:

SMC should use the actual evapotranspiration in its infiltration analysis. The analysis should address the amount of evaporation or evapotranspiration that is estimated to occur from each component (layer) of the engineered barrier, particularly the cover soil and biointrusion/drainage layers. The estimate of actual evapotranspiration should consider how the individual layers of the barrier degrade over time under both the controls in-place and controls-fail conditions.

SMC should justify the methods used to calculate actual evapotranspiration and the assumptions used in those calculations.

SMC should provide its method for determining the values of the evapotranspiration coefficient that will be used in the RESRAD dose modeling under the controls in-place and all controls-fail conditions. SMC should discuss how these values will be used in the RESRAD dose modeling. SMC should also perform a sensitivity analysis on this parameter in the dose analysis and provide justification for the range of values used for the parameter in the sensitivity analysis.

36. SMC does not provide justification for determining the drainage from (flow through) the biointrusion/drainage layer using a method that is meant to describe runoff from a drainage basin. SMC does not provide adequate justification for the assumptions made when applying this method. SMC does not explain how the different runoff coefficients calculated for the 3 conditions of the clay barrier will be incorporated in to the RESRAD dose modeling. (Section 1.7, page B-11, 1st and 2nd paragraphs and Attachment 6, pages 3 and 4)

Basis:

The method employed by SMC for calculating runoff at the clay barrier layer is typically used for calculating runoff from a small drainage basin during rainfall events and represents in part runoff over a surface. SMC applied this method to estimate runoff at the clay barrier surface which represents flow through a porous medium (in this case the biointrusion/drainage layer of the engineered barrier).

In its discussion of the determination of the value $\mathbf{c_1}$ for use in calculating the runoff coefficient ($\mathbf{C_r} = 1 - \mathbf{c_1} - \mathbf{c_2} - \mathbf{c_3}$), SMC states that the slope of the engineered barrier along the direction of flow is approximately 90% sloped at 33% (the length of the side slope) and 10% sloped at 4% (the length of the top slope). Measuring the lengths of the slopes on the drawings included with the barrier design document shows that the length of the 33% side slope would be approximately 60-65% of the total length in the direction of flow direction and the length of the 4% top slope would be approximately 35-40% of the total length in the direction of flow. Given that the length of the 4% slope is longer than SMC stated and considering that flow at the clay barrier layer represents flow through a porous medium, not flow over the clay barrier surface, as discussed above and therefore the same runoff to slope relationships would not apply, $\mathbf{c_1}$ is likely greater than the value of zero assumed by SMC. Similarly, the value of $\mathbf{c_3}$ used in the calculation of the runoff coefficient does not represent runoff over the smooth, uniform surface of the clay barrier layer in the as-built state and over cultivated farmland when degraded, as described by SMC, but flow through the biointrusion/drainage layer in its as-built and degraded states. SMC is possibly underestimating the values of $\mathbf{c_1}$ and $\mathbf{c_3}$ used in this method. If so, they are overestimating the runoff coefficient and underestimating infiltration.

Also, SMC describes the clay barrier layer ultimately developing the overall permeability of clayey loam and assigns the corresponding value of $\mathbf{c_2}$ for the maximum infiltration case in the equation to calculate $\mathbf{C_r}$. SMC states this change will occur over a very long time period and appears to only consider it occurring under the controls-fail condition. SMC does not provide any justification for the degree of change in the permeability of the clay layer, the length of time it would take to reach this state or why it would only reach this state under the controls-fail condition.

Furthermore, SMC does not describe how the range of values calculated for the runoff coefficient under the controls in-place and all controls fail conditions will be incorporated into the RESRAD dose modeling.

Path forward:

SMC should provide justification for why the rational method for calculating runoff from small watersheds described in this section is appropriate for describing runoff at the clay barrier layer and calculating the values for the runoff coefficient that will be used in the RESRAD dose modeling. In applying this method, SMC should provide stronger justification for the assumptions made about the values used for $\mathbf{c_1}$, $\mathbf{c_2}$ and $\mathbf{c_3}$ used to calculate the runoff coefficient under the various levels of degradation. Analysis of how runoff from the barrier changes with time should include an analysis of how the biointrusion/drainage layer degrades and how that degradation affects drainage from (flow through) the layer.

Alternatively, SMC could use a different method of calculating runoff from the engineered barrier that accounts for how each layer of the barrier affects the total amount of runoff from the barrier as a whole. Included in that analysis should be a discussion of how the individual layers of the barrier degrade over time under both the controls in-place and controls-fail conditions and how that degradation affects runoff.

SMC needs to describe how the values calculated for the runoff coefficient under the controls in-place and controls fail conditions will be used in the RESRAD dose modeling. SMC should also perform a sensitivity analysis on this parameter in the dose analysis and provide justification for the range of values used for the parameter in the sensitivity analysis.

37. **In its evaluation of infiltration SMC does not account for the absence of vegetation from the rock cover in its estimation of evapotranspiration or runoff in the as-built state of the barrier. SMC also does not account for the possibility of vegetation taking root on the surface of the cover as it**

degrades over time under either the controls in-place or controls fail conditions.

Basis:

The use of values of potential evapotranspiration based on regional values for vegetated areas would overestimate evapotranspiration for the rock-only top layer of the cover and is not appropriate. The presence or absence of vegetation will have a significant affect on the evapotranspiration and runoff from the cover.

Path forward:

Analysis of evapotranspiration needs to be consistent with the state of the cover in the as-built condition (no vegetation present). Additionally, SMC should consider the presence or absence of vegetation on the surface of the engineered barrier in its evaluation of how infiltration changes as the barrier degrades over time under both the controls in-place and controls fail conditions. Depending on results of leach tests and overall performance of the engineered barrier, SMC should be aware of and possibly consider an alternative design in which the erosion control layer consists of a rock/soil matrix which either includes vegetation from the start or allows for vegetation to take root naturally over time and evaluate the infiltration that would occur from such a design.

38. **SMC does not provide adequate justification for assumptions made about the level of degradation of the clay barrier and the values used to represent that degradation in its analysis of infiltration. (Attachment 6, page 2A, 4th paragraph)**

Basis:

In describing the sensitivity analysis on the alternate method for calculating infiltration SMC varies the saturated hydraulic conductivity of the clay barrier layer by a factor of ten, but provides no basis for this being the limit of the degradation of the clay barrier layer. Some research on the performance of clay barriers indicates the hydraulic conductivity may increase by two or three orders of magnitude.

Path forward:

SMC should provide justification for assumptions made in its analysis of infiltration regarding the level of degradation of the barrier layers that occurs under both the controls in-place and controls-fail conditions. Justification should be provided for the ranges of values used in the sensitivity analysis. This justification should include examples from analog sites, field experiments, or citations from recent research, etc. SMC should explicitly describe how the results of this analysis will be utilized in the RESRAD dose modeling.

39. Assumptions related to freeze/thaw considerations need additional justification or revision. (Page B-5; 2nd paragraph)

Basis:

This section provides discussion of freeze/thaw considerations. In eliminating freeze/thaw as a concern, the 2nd paragraph includes statements that: 1) "…the SMC facility is located in an area that exhibits an extreme frost penetration of approximately 25 inches."; and 2) "…the proposed depth of the clay barrier ranges from 36 to 72 inches below the surface of the site…". Based on a selection of penetration depth from Figure 13 of Attachment 3, it would appear that the extreme penetration depth is approximately 29.5 inches. Furthermore, the assessment of frost penetration depth should consider the facts that; 1) the drainage layer is not a frost-limiting soil layer, and 2) the mounding configuration of the cell may facilitate an increase in frost penetration depth. In addition, consideration of the depth of the clay barrier below the surface of the disposal cell should not include the thickness of the rock layers on the top and sides, unless SMC proposes to change the rock to a rock/sol matrix. Eliminating consideration of the current rock layers would result in the clay barrier depth being from 33 to 69 inches on top, and 24 to 60 inches on the sides.

Path forward:

SMC needs to correct the depth of frost penetration assessment based on the observations above and modify its conclusions, or otherwise provide further justification of the original numbers given in the analysis.

40. There is no discussion of the basis for selecting a 10-year monitoring period for the soil moisture monitoring probes. (Page B-5; Section 1.2.2; 4th paragraph)

Basis:

The discussion of soil moisture monitoring in this section on desiccation indicates that probes will be used to monitor soil moisture content of the clay barrier for 10 years. There is no discussion of the basis for selecting a 10-year monitoring period.

Path forward:

SMC should include a discussion of what the determining factors are for setting the period for monitoring clay barrier moisture at 10 years, as opposed to a longer period.

41. The discussion does not make clear what engineered barrier components each of the 6 numbered materials corresponds to. Nor is there any basis provided for the material property assumptions, as discussed in RAI 2. (Page B-8; Section 1.4 and Attachment 4 Slope Stability Analysis)

Basis:

The slope stability analysis indicates that the modeling included 6 materials and provided assumptions of the properties of each of those materials. The discussion does not make clear what engineered barrier components each of the 6 numbered materials corresponds to. In addition, there is no basis provided for the material property assumptions, as discussed in RAI 2.

Path forward:

SMC needs to indicate what engineered barrier components each of the 6 numbered materials corresponds to. In addition, SMC needs to provide the basis (from investigations and material testing) for slope stability property values assigned to each of the materials used as input to the modeling, including the subsurface materials.

42. Settlement Analysis: There is insufficient basis for the settlement conclusions. (Page B-9; Section 1.5)

Basis:

The discussion includes an assumption that all the subsurface materials are sand deposits subject to small rapid settlement, and that co-locating the contaminated materials as discussed in RAI 13 will eliminate any significant settlement of these materials. Therefore, SMC concludes settlement is not an issue. Regarding the subsurface materials, there should be site borings with Standard Penetration Test blow-counts to demonstrate there are no loose sands or layers of silts and clays that would invalidate the settlement assumption. In addition, as discussed in RAI 13, there is no basis for the assumption that the contaminated material placement approach will not result in voids and future settlement.

Path forward:

SMC needs to provide a stronger basis for its settlement assumptions, including information on subsurface soils from site investigations and material testing, and information on placement of contaminated materials in response to RAI 13.

43. Liquefaction: There needs to be a stronger basis for its liquefaction assumptions. (Page B-9; Section 1.6)

Basis:

The discussion includes an assumption that the subsurface consists only of non-loose sands and silts that are not subject to liquefaction. Again, there should be borings and site information to demonstrate this.

Path forward:

SMC needs to provide a stronger basis for its liquefaction assumptions, including site information and information on subsurface soils from site investigations and material testing. SMC is referred to Regulatory Guide 3.11, Rev 3 (ML082380144) for the process of liquefaction analysis. The Regulatory Guide may also be found on the NRC's Web Site.

44. Evaluation of Individual and Cumulative Impacts on the Performance of the Engineered Barrier: Somewhere in this documentation, perhaps in this section, there needs to be a more complete tie to the dose modeling analysis. (Page B-12; Section 1.8)

Basis:

This section provides generally an assessment of certain potential degradation mechanisms on the groundwater pathway for dose modeling. Somewhere in this documentation, perhaps in this section, there needs to be a more complete tie to the dose modeling analysis, including what degradation assumptions will be made to input the dose model scenarios under both control and loss-of-control situations, and plans to identify how much degradation would have to occur to result in non-compliance under the loss-of-control situation.

Path forward:

SMC needs to include in the engineered barrier documentation a more complete tie to the dose modeling analysis, including but not limited to: 1) what degradation assumptions will be made to input the dose model scenarios under both control and loss-of-control situations, and 2) plans to identify how much degradation would have to occur to result in non-compliance under the loss-of-control situation.

Appendix C (Quality Assurance and Quality Control Construction Plan)

45. Explain that the purpose of the petrographic analyses is to confirm the absence or presence of small, insignificant amounts of potentially adverse minerals such as olivine and sericite.

Basis:

Page 3-8 states that a petrographic analysis would be completed in accordance with ASTM C-295-90. However, specific objectives of the petrographic analysis also should be identified and should include, confirming the absence or small, insignificant amounts of potentially adverse minerals such as olivine and sericite.

Path Forward:

Revise the procedure as suggested above.

Appendix D (Operation and Maintenance Plan)

46. The boundary for the restricted use area shown on Figure 2-3 is incorrect.

Basis:

Figure 2-4 on page 2-1 shows the new footprint of the engineered barrier falling outside of the restricted use area boundary.

Path Forward:

Revise Figure 2-3 by changing the restricted use area boundary that incorporates the new footprint of the engineered barrier or revise the footprint. The revised boundary of the restricted area should also consider the long-term monitoring plans when revised to include the location of future groundwater monitoring wells and the need to maintain controls on these wells.

47. Consider approaches to monitor and confirm the engineered barrier system's performance for limiting infiltration and potential leaching of the contaminated materials.

Basis:

Monitoring the soil moisture of the clay layer is the only monitoring proposed for the engineered barrier other than surveillance. No monitoring is proposed to confirm the engineered barrier total system performance for limiting infiltration, or no justification is given for not proposing this type of monitoring Ongoing results of ACAP studies (August 18, 2008, memorandum from Benson to NRC) indicate that direct measurement of percolation is the only means to accurately assess the hydrologic performance of covers and that large-scale measurements of percolation are needed because soil properties in covers are scale dependent and heterogeneous.

Furthermore, the potential need for confirmatory sampling and analyses for radionuclides in the water that has percolated through the pile was not discussed.

Path Forward:

Discuss the applicability of the results of recent ongoing studies on the effectiveness of monitoring programs to verify cover performance for reducing infiltration such as reported by Benson. Discuss long-term monitoring methods and duration for the total system or justify why such long-term monitoring is not needed.

Discuss the sampling and analysis plans for radionuclides in the water that has percolated through the pile considering the results of ongoing leach tests and sampling under the piles. If no long-term confirmatory testing is proposed, provide the justification for this decision.

48. Drainage Features: The purpose, functions, and requirements of the drainage retention basin should be discussed in more detail upfront in Section 8.3 of the Engineered Barrier Report. (Section 2.3)

Basis:

This section and Construction Drawings C-5 and C-6 indicate that there will be a drainage retention basin associated with the site design. There is no discussion of this feature elsewhere in the documentation. This feature's purpose, functions, and requirements should be discussed in more detail upfront in Section 8.3 of the Engineered Barrier Report, including its needs for a liner, and its long-term stability requirements.

Path forward:

SMC needs to include upfront in Section 8.3 a more detailed discussion of the retention basin's purpose, functions, and requirements, including its needs for a liner, and its long-term stability requirements.

49. Visual Inspections: During the first few years after construction, visual inspections should be performed more frequently than quarterly. (Section 3.1)

Basis:

This section indicates that "Inspections of the engineered barrier will be conducted on a quarterly basis…" The first few years after completion of the disposal cell are important to monitoring its acceptable performance. Therefore, during that time, visual inspections should be performed more frequently than quarterly.

Path forward:
SMC needs to consider including a commitment to perform more frequent visual inspections of the disposal cell during the first few years after its completion.