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Evaluation of Potential Breach of Side Wall High Density Polyethylene (HDPE) Liner on Saltstone Disposal Unit Cell 3A

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ACRONYMS

CA	Composite Analysis
FY	Fiscal Year
GCL	Geosynthetic Clay Liner
HDPE	High Density Polyethylene
LCL	Liquid Collection Layer
MCC	Moisture Characteristic Curve
NCR	Non-Conformance Report
PA	Performance Assessment
SA	Special Analysis
SDF	Saltstone Disposal Facility
SDU	Saltstone Disposal Unit
SPF	Saltstone Production Facility
SRR	Savannah River Remediation LLC
SRS	Savannah River Site
UWMQE	Unreviewed Waste Management Question Evaluation
WD	Waste Determination

1.0 PURPOSE

The purpose of this document is to support the issuance of an Unreviewed Waste Management Question Evaluation (UWMQE) that assesses a potential breach of the High Density Polyethylene (HDPE) liner on the exterior of Saltstone Disposal Unit (SDU) Cell 3A as described in *SDU 3A Sump Rainwater Intrusion*, 2014-NCR-05-0017.

2.0 PROPOSED ACTIVITY OR NEW INFORMATION

The proposed activity is to accept a potential tear, faulty weld, or other mechanism that results in a breach to the HDPE liner on the exterior of SDU Cell 3A, and allows a small amount of water flow and air ingress through the HDPE earlier than modeled. If found to be acceptable, this evaluation would support a Non-Conformance Report (NCR) disposition of "as is".

3.0 APPLICABLE CRITERIA

Proposed activities at the Saltstone Disposal Facility (SDF) are reviewed in accordance with Savannah River Remediation LLC (SRR) Manual S4, Procedure ENG 46, to ensure that inputs, assumptions, results and conclusions of the DOE-approved Performance Assessment (PA), Waste Determination (WD), Savannah River Site (SRS) Composite Analysis (CA), and any associated Special Analyses (SAs), and UWMQEs, remain valid.

The *Unreviewed Waste Management Question Requirements Document for Saltstone Facility*, SRR-CWDA-2011-00196, defines specific criteria that must be met for processing and disposal activities. Specific criteria that could be impacted by the proposed activity are provided in Section 2.3:

- Table 2.3-1, Screening Criteria Number 2 and 6

No.	Screening Criteria	Basis
2	Structural integrity of the as-constructed SDUs is maintained which will limit contaminant release to a controlled and low rate	2009 PA, Section 4.4.2, assumes that the SDU provides an effective barrier to contaminant release with no fast flow paths that would allow infiltrating water to enter or exit the SDU prior to general SDU concrete degradation
6	SDUs design/build meet the criteria listed in Tables 2.3-2 through Tables 2.3-4 and Figure 2.3-1 of this section	Provided in the cited tables and figure

[SRR-CWDA-2011-00196]

- Table 2.3-3, HDPE-GCL Dimensional Properties Criteria

Material Zone	Critical Dimension
High Density Polyethylene (HDPE)-Geosynthethic Clay Liner (GCL)	100 mils (min) HDPE

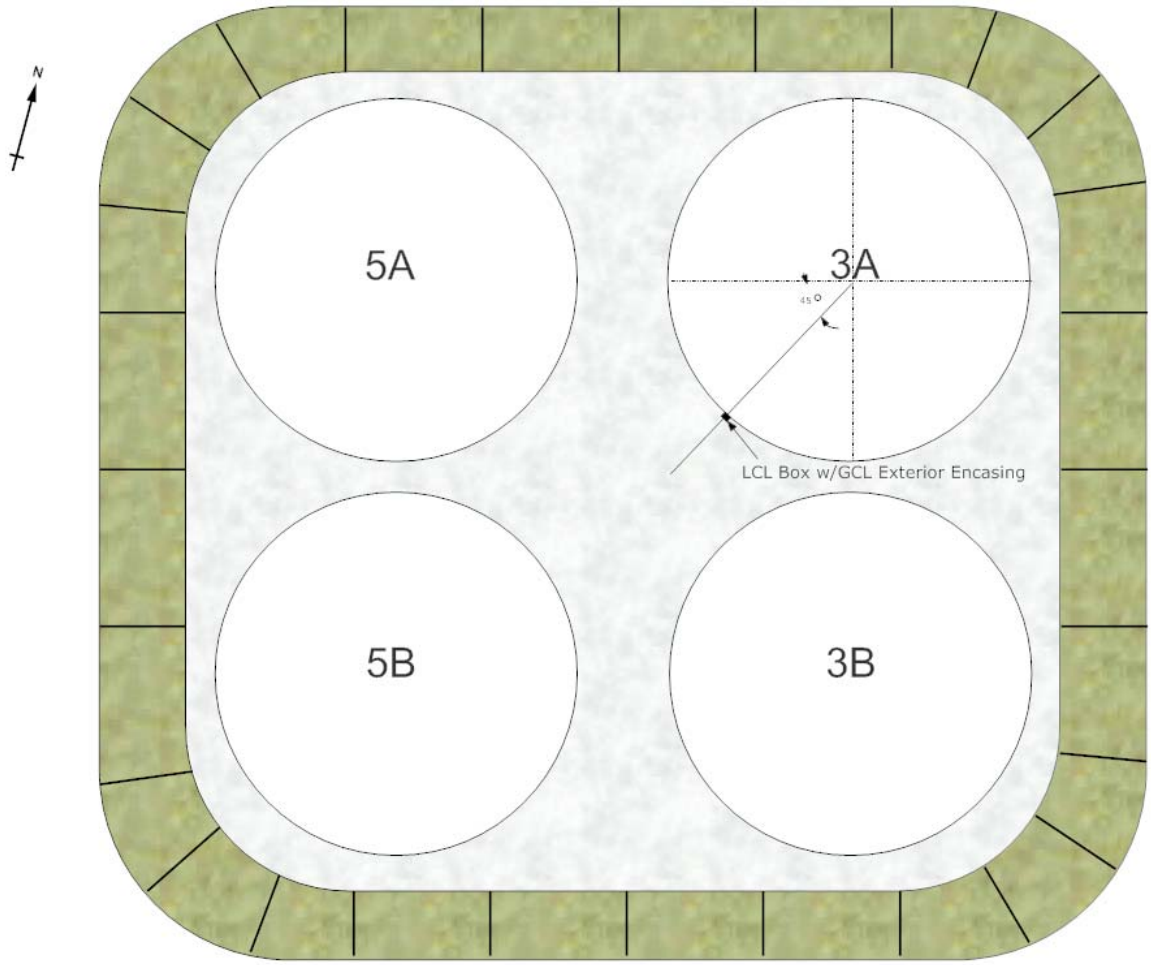
[SRR-CWDA-2011-00196]

4.0 BACKGROUND

SDU Cell 3A is currently empty and has only been used to demonstrate operability of the entire system using pig launches. Liquid has been observed in the SDU Cell 3A liquid collection box since the unit was brought online. The liquid is periodically removed but the collection box continues to recharge with water.

SDU Cell 3A contains a geonet fabric under the cell floor which drains to an HDPE collection box located on the southwest quadrant of the unit as depicted in Figure 4.0-1.

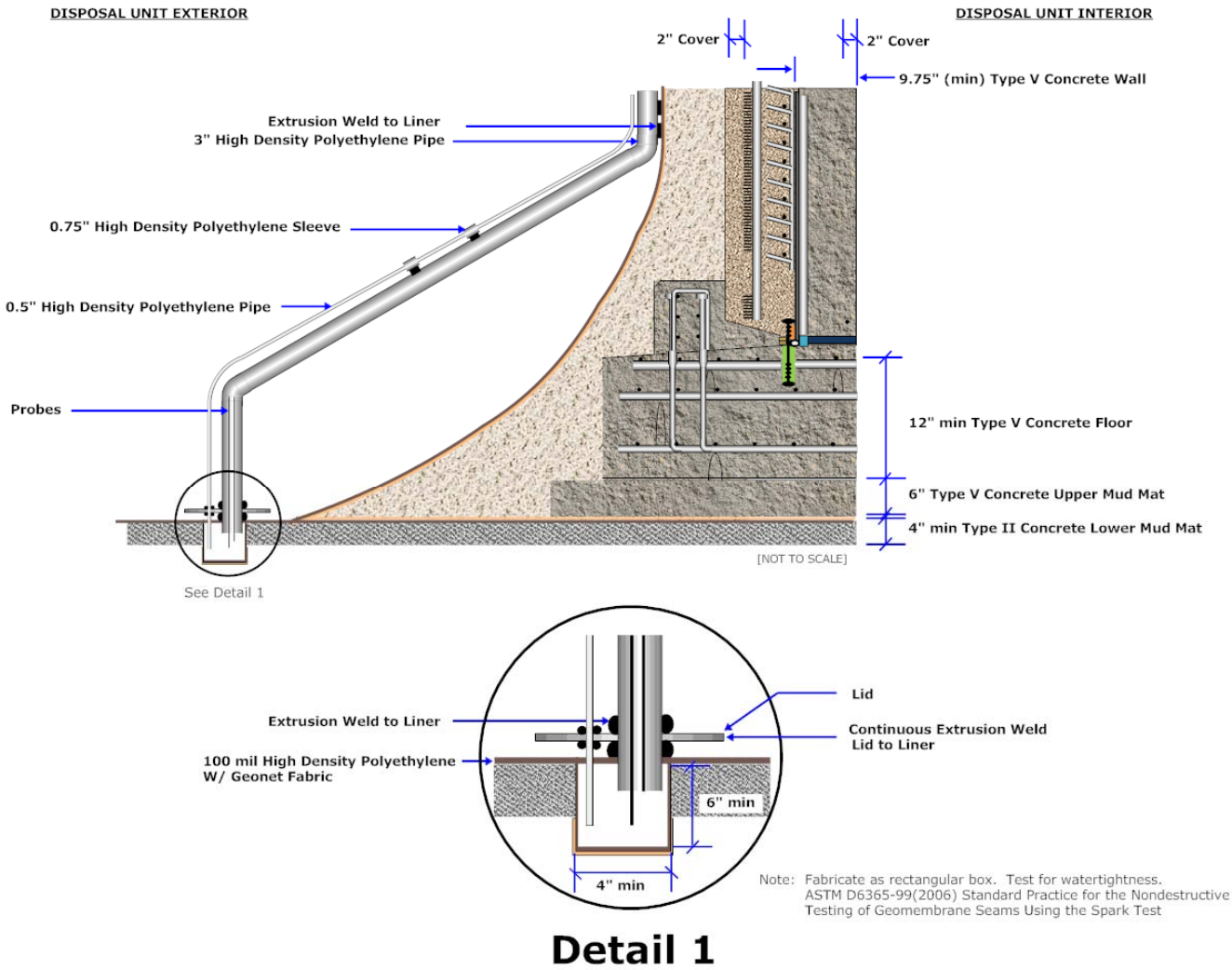
Figure 4.0-1: SDU Cell 3A Liquid Collection Box Orientation



The purpose of the geonet fabric/collection box is to provide a means to collect liquids that may exit the unit. The cell interior currently does not contain liquid, yet liquids continue to collect in the collection box. The liquids are presumed to be rainwater in the surrounding soils that has found a pathway through the HDPE and into the collection sump. The bulk of the HDPE is seam

welded. However, the SDU Cell 3A collection box is not amenable to seam welding and is, instead, extrusion welded. In addition, two (2) HDPE pipes, both of which are extrusion welded, penetrate the top of the collection box for instrumentation access and pumping capability. Figure 4.0-2 depicts the liquid collection box details.

Figure 4.0-2: Liquid Collection Box Details



[SRR0000427-027-D-MDM, SRR0000427-052-B-MDM]

The initial conditions of the PA/SA Base Case assume that the system is fully saturated but flow is essentially zero. Over time however, the model assumes that systems, structures, and components degrade resulting in flow. Conditions that allow early flow through the system, such as a breach in the HDPE, are not consistent with either the 2009 PA Base Case model or the Fiscal Year (FY) 2013 SA Evaluation Case model. [SRR-CWDA-2009-00017, SRR-CWDA-2013-00062]

5.0 PA ATTRIBUTES OF INTEREST

5.1 High Density Polyethylene

The FY2013 SA assumes that at t=0 years the HDPE provides an intact, 100-mil thick barrier and the system, including the concrete walls, are fully saturated. The HDPE barrier hydraulic conductivity is 5.87E-10 at t=0 years. Thus, at t=0 years, although the system is fully saturated, there is little, if any, flow through the system. The HDPE degrades over time such that at t=900 years the HDPE barrier hydraulic conductivity is 6.04E-8, approximately 100 times more permeable than at t=0 years. At that point the unit is experiencing the effects of groundwater flow. [SRR-CWDA-2013-00062]

5.2 Degradation Mechanisms

Degradation by sulfate attack originates from the saltstone itself and progresses from the inside wall to the exterior wall. Sulfate attack is modeled to begin immediately (i.e., t=0 years). Sulfate attack is by far the most aggressive form of degradation modeled in the 2009 PA and FY2013 SA. [SRR-CWDA-2009-00017, SRR-CWDA-2013-00062]

Degradation from carbonation occurs from the exterior of the wall towards the interior. At t=900 years the modeling of degradation via carbonation begins when the HDPE degrades. Carbonation is a relatively minor contributor to degradation. [SRR-CWDA-2013-00062]

6.0 EVALUATION OF PROPOSED ACTIVITY OR NEW INFORMATION

The proposed activity is to accept a potential tear, faulty weld, or other mechanism that resulted in a breach to the HDPE liner on the exterior of SDU Cell 3A, and allows a small amount of groundwater flow through the HDPE earlier than modeled. The effect of this activity would be to introduce groundwater flow into the system earlier than modeled and begin concrete degradation from carbonation earlier than modeled.

6.1 Impact on Degradation via Sulfate Attack

Sulfate attack originates internally to the unit. Initial flow through an imperfection in the HDPE impacts the external surfaces of the concrete, but does not impact the timing or rate of sulfate attack. Thus, sulfate attack is not impacted by the proposed activity.

6.2 Impact on Degradation via Carbonation

Degradation from carbonation is impacted by changes in the HDPE. The model assumes that carbonation is delayed due to the presence of HDPE by approximately 900 years. The proposed activity would initiate flow into the system at t=0 years. Thus, degradation from carbonation would begin earlier than modeled. This effect does little to affect the shape of the dose curve, but it could result in shifting the modeled doses to slightly (no more than 900 years) earlier in time.

6.3 Impact on K_d Values

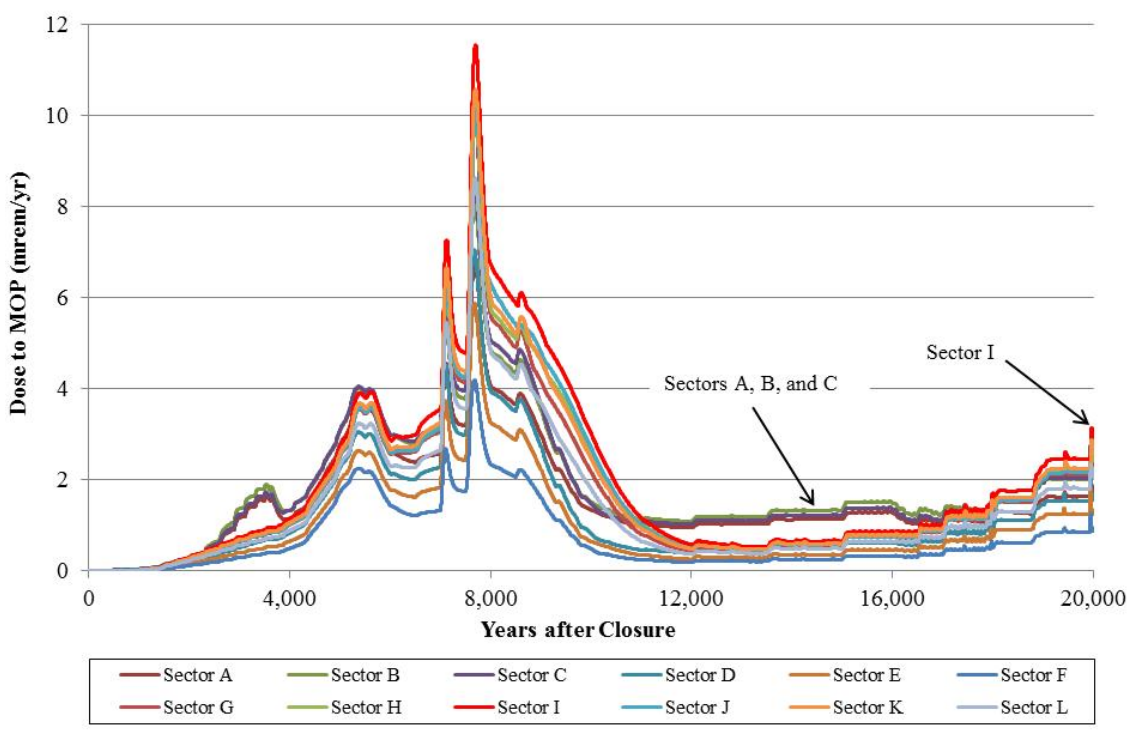
K_d values represent the contaminant concentration remaining in the solid compared the contaminant concentration in the surrounding aqueous solution when the system is at equilibrium [EPA 402-R-99-004A]. Introduction of water into the system earlier than modeled does not change the empirical value of K_d. Thus there is no adverse impact on K_d values used in the PA.

6.4 Impact on Dose

Qualitatively, the effect of initiating degradation from carbonation at t=0 years does not change the magnitude of modeled doses.

In the context of the 20,000 year dose curve, initiating flow at t=0 years is analogous to beginning the current modeling at t=900 years, when the unit sees groundwater flow. Figure 6.4-1 depicts the doses from various sectors of the entire SDF and is provided only for perspective of the magnitude of dose for the facility as a whole. SDU Cell 3A is only one contributor to the total dose curve presented in Figure 6.4-1. Thus, although assessing the entire SDF dose in this manner is conservative, the impact of the proposed activity or new information on SDU Cell 3A only would be less than is depicted in Figure 6.4-1. From a qualitative standpoint the dose curves can be used with a new period of interest starting at year 900. Looking at a new window from t=900 years to t=10,900 years, the peak dose remains unchanged.

Figure 6.4-1: Saltstone Disposal Facility Dose by Sector, 0 to 20,000 years



[SRR-CWDA-2013-00062]

Since the magnitude of the dose is not expected to change and the accelerated degradation does not affect the peak dose during the period of interest, the impact to dose will not to exceed performance objectives.

6.5 Impact on Sensitivity Cases

Sensitivity cases addressed in the PA and FY2013 SA include the following areas:

- Uncertainty Analyses
- Flow Cases
- Oxygen Sources
- Roof Slope
- Joint Zone Moisture Characteristic Curve (MCC) Sensitivity
- Technetium Solubility
- Technetium Solubility with Increased Flow

Constituent solubility, uncertainty analyses, roof slope, joint zone MCC sensitivities, and technetium solubility are not significantly affected by changing flow due to a breach of the HDPE material.

Flow cases, oxygen sources, and technetium solubility with increased flow may be impacted similarly to that described in Section 6.4. However, evaluating a new period of interest from t=900 years to t=10,900 reveals that peak doses are not expected to increase.

6.6 Impact on Inadvertent Intruder Scenarios

By way of guidance in *NRC Staff Guidance Document for Activities Related to U. S Department of Energy Waste Determinations*, NUREG 1854, the NRC uses 500 mrem/yr dose limit for evaluating impacts to an inadvertent intruder for purposes of 10 CFR 61.42. Peak doses modeled in the FY2013 SA for the period of interest do not exceed 40 mrem/year. [SRR-CWDA-2013-00062] Since a breach to the HDPE is not expected to increase doses, only to shift the timing, the dose to the inadvertent intruder should remain within 500 mrem/yr.

6.5 Impact on Air Pathways

Modeling of the air pathways dose assumes no HDPE is present. Thus, any change to the air pathways dose due to a breach of existing HDPE is bounded by the existing modeling.

7.0 CONCLUSION

The imperfections in the HDPE are not expected to increase the magnitude of anticipated doses from SDU Cell 3A. The primary impact of water flow through the HDPE is to accelerate the timing of flow and associated degradation due to carbonation. This change would effectively move the modeled dose curves to the left by no more than 900 years. Since the magnitude of the dose is not expected to adversely change, and the accelerated degradation does not affect the peak dose during the period of interest, the impact to dose is not expected to exceed 10 CFR 61 performance objectives. Therefore the activity can proceed as is.

8.0 REFERENCES

10 CFR 61, *Licensing Requirements for Land Disposal of Radioactive Waste*, U.S. Nuclear Regulatory Commission, Washington DC, December 22, 2011.

2014-NCR-05-0017, *SDU 3A Sump Rainwater Intrusion*, Savannah River Site, Aiken, SC, Rev. 0, March 5, 2014.

EPA 402-R-99-004A, *Understanding Variation in Partition Coefficient, Kd Values*, Environmental Protection Agency, August 1999.

Manual S4, ENG 46, *LW Unreviewed Waste Management Question (UWMQ)*, Savannah River Site, Aiken, SC, Rev. 2, March 23, 2012.

NUREG 1854, *NRC Staff Guidance Document for Activities Related to U. S Department of Energy Waste Determinations*, U.S. Nuclear Regulatory Commission, Washington DC, August 2007.

SRR0000427-027-D-MDM, *Tank Drawings Cell 3 and 5*, MDM Services Corporation, August 23, 2011.

SRR0000427-052-B-MDM, *LCL Desing/Installation/Details/and Layout Drawings*, MDM Services Corporation, April 13, 2011.

SRR-CWDA-2009-00017, *Performance Assessment for the Saltstone Disposal Facility at the Savannah River Site*, Savannah River Site, Aiken, SC, Rev. 0, October 29, 2009.

SRR-CWDA-2011-00196, *Unreviewed Waste Management Question Requirements Document for Saltstone Facility*, Savannah River Site, Aiken, SC, Rev. 2, April 2014.

SRR-CWDA-2013-00062, *FY2013 Special Analysis for the Saltstone Disposal Facility at the Savannah River Site*, Savannah River Site, Aiken, SC, Rev. 2, October 2013.