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Revision 1

FY2014 Special Analysis for the Saltstone Disposal Facility at the Savannah River Site: Quality Assurance Report

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ACRONYMS

DLL	Dynamic Linked Library
K_d	Distribution Coefficient
PA	Performance Assessment
QA	Quality Assurance
SA	Special Analysis
SDF	Saltstone Disposal Facility
SDU	Saltstone Disposal Unit
SQAP	Software Quality Assurance Plan
SRNL	Savannah River National Laboratory
SRR	Savannah River Remediation LLC
SRS	Savannah River Site
WDA	Waste Disposal Authority

1.0 INTRODUCTION

The purpose of this report is to document input data verification and technical checking of model files and calculations developed in support of Revision 2 of the FY2014 Special Analysis (SA) for the Saltstone Disposal Facility (SDF) at the Savannah River Site (SRS), hereafter referred to as the FY2014 SDF SA. [SRR-CWDA-2014-00006] This report focuses on technical checking of work performed by Waste Disposal Authority (WDA) staff, as well as verification of inputs provided to WDA by organizations external to Savannah River Remediation LLC (SRR), such as the Savannah River National Laboratory (SRNL).

Section 2 describes checking and verification activities related to input development. Sections 3 and 4 describe the checking of models developed in support of the FY2014 SDF SA. Section 5 discusses checking and verification of post-processed data and model results. Section 6 provides a summary of software Quality Assurance (QA). Finally, Section 7 summarizes the results of these QA.

1.1 Scope and Method

The scope of this report focuses on input data verification and technical checking of inputs and modeling components that have changed relative to the SDF Performance Assessment (PA) and the FY2013 SDF SA. [SRR-CWDA-2009-00017; SRR-CWDA-2013-00062]

The activities documented within this report were performed according to the following documents:

- E7 Manual, *Conduct of Engineering*, Procedure 2.60, Technical Reviews [E7-2.60]
- S4 Manual, *Liquid Waste Organization Administrative Procedures*, Procedure ENG.51, *Verification and Checking of Technical Documents* (for SRR) [S4-ENG.51]
- *Technical Report Design Check Guidelines* (for SRNL) [WSRC-IM-2002-00011]
- 1Q *Quality Assurance Manual*, Procedure 20-1, *Software Quality Assurance* [1Q-20-1]

S4-ENG.51 and WSRC-IM-2002-00011 supplement E7-2.60. The objective of these documents is to ensure that inputs, calculations, and results are technically correct, accurate and complete. Sections 2 through 7 of this report describe how this objective was met for various aspects of the FY2014 SDF SA development.

Completed QA documentation associated with the FY2014 SDF SA accompanies this report as supporting files.

1.2 QA Summary

This report concludes that the FY2014 SDF SA has no outstanding issues that require resolution. Therefore, the results of the FY2014 SDF SA are technically defensible and complete. The FY2014 SDF SA modeling results are appropriate for the intended use.

2.0 SDF SA INPUT DATA VERIFICATION

The following sections provide detailed information about data verification for various datasets used as inputs to the FY2014 SDF SA. As the models from the FY2013 SDF SA (SRR-CWDA-2013-00062) were used as a starting point, the focus of data verification was those inputs that are different relative to the previous modeling.

2.1 Updated K_d Values

Upon completion of the FY2013 SDF SA, a new technical report was issued (*Radioiodine Geochemistry in the SRS Subsurface Environment*) with revised site-specific iodine K_ds in SRS soils. [SRNL-STI-2012-00518] The new values were applied for iodine. All other K_d values reflect the values used in the previous SA and were independently reviewed as documented in the *FY2013 Special Analysis for the Saltstone Disposal Facility at the Savannah River Site: Quality Assurance Report*. [SRR-CWDA-2013-00087]

2.2 Revised SDU Design and Layout

The revised layout of the SDF and the design for the 375-foot diameter Saltstone Disposal Units (SDUs) are documented in a series of design drawings and specifications. Each of these documents were prepared according to QA controls, including independent Verifiers, Checkers, and Reviewers, as appropriate.

- C-CC-Z-00039, *Z Area Saltstone Disposal Site SDU6 Tank Design Concrete Foundation Plan*
- C-CC-Z-00042, *Z Area Saltstone Disposal Site SDU6 Tank Design Concrete Wall and Column Section and Details*
- C-CC-Z-00044, *Z Area Saltstone Disposal Site SDU6 Tank Design Concrete Sections and Details*
- C-CC-Z-00049, *Saltstone Disposal Site SDU6 Tank Design Concrete Roof Embed and Nozzle Plan*
- C-CG-Z-00047, *Z Area Saltstone Disposal Site SDU 6 Site Preparation Grading and Erosion & Sediment Control Plan (Phase 2) Excavation Area*
- C-CY-Z-00005, *Z Area Saltstone Disposal Site SDU 6 Tank Design HDPE/GCL, Leakage Detection and Settlement Monitoring Plan*
- C-CY-Z-00006, *Z Area Saltstone Disposal Site SDU6 Tank Design Civil Leakage Detection System Sections and Details*
- C-SPP-Z-00008, *Saltstone Disposal Site - SDU 6 (Procurement Spec)*

Primary modeling of these features was performed by SRNL staff (for PORFLOW) and by Barry Lester (for GoldSim©). Steve Hommel independently verified that the revised design had been correctly incorporated into the PORFLOW and GoldSim© models according to guidelines provided in S4-ENG.51, and documented in *FY2014_SDF_SA_ModelDesignCheck.PDF*. Steve

Hommel prepared the FY2014 SDF SA text (Section 3.3) based on the various design drawings and David Watkins reviewed the text as documented in *Section 3.3 OSR 46-573.pdf*.

2.3 Updated SDF Inventory

The updated SDF inventory was documented in *SDF Inventory Estimates for Transport Modeling*. [SRR-CWDA-2013-00147] This document and the recommended values were reviewed by Steve Hommel as documented on the approval page of the report. Primary modeling to incorporate these values was performed by SRNL staff (for PORFLOW) and by Barry Lester (for GoldSim©). Steve Hommel independently verified that the revised SDF inventory had been correctly incorporated into the PORFLOW and GoldSim© models according to guidelines provided in S4-ENG.51, and documented in *FY2014_SDF_SA_InventoryCheck.pdf*.

2.4 Updated Cementitious Degradation Analysis

Due to the revised SDU design for future SDUs, the cementitious degradation analysis was updated to quantify degradation rates and timing. In addition, the degradation analysis of the 150-foot diameter SDUs was updated to reflect the conservative assumption that the units will be completely filled with saltstone grout, effectively removing any clean cap.

This analysis was performed according to the descriptions provided in Section 4.2 of the FY2013 SDF SA and using the approaches described in *Degradation of Cementitious Materials Associated with Saltstone Disposal Units* and *PORFLOW Modeling Supporting the FY13 Saltstone Special Analysis*. [SRR-CWDA-2013-00062; SRNL-STI-2013-00118; SRNL-STI-2013-00280] The revised calculations were performed in PORFLOW and the review of the PORFLOW modeling work is described in Section 3.0 of this report. Additional post processing of the PORFLOW result files was performed to confirm PORFLOW results and to generate figures and values for the discussion provided in Section 4.2 of the FY2014 SDF SA. This post-processing was performed within three Excel files: *FY14SA_degradation_rev2.xlsm*, *SDU 6 Degradation.xlsx*, and *SDU2 Data.xlsx*. This post-processing was performed by Richard Sheppard and checked by Steve Hommel, per E7-2.60 according to guidelines provided in S4-ENG.51, and documented in *FY2014_SDF_SA_Sect4.2.2_ExcelFileCheck.pdf*.

2.5 Revised Technetium Release Model

The technetium release model has been revised, relative to the approach used in the 2009 SDF PA and the FY2013 SDF SA. The revised model is described in *PORFLOW Modeling Supporting the FY14 Saltstone Special Analysis.* [SRNL-STI-2014-00083] Due to the complexity of the subject, an independent technical reviewer who is a subject matter expert, Marc Wood, was consulted to perform a technical review of the approach. During a teleconference on February 26, 2014, Marc Wood indicated that he found the revised release model to be appropriate for the intended purpose and an improvement over previous modeling approaches. In addition, the inputs and calculations were checked as part of the PORFLOW design checking as discussed in Section 3.0.

2.6 Updated Dose Calculation

The applicable dose calculations have been revised, relative to the approaches used in the 2009 SDF PA and the FY2013 SDF SA. The revised calculations are described in Revision 1 of the

Dose Calculation Methodology for Liquid Waste Performance Assessments at the Savannah River Site. [SRR-CWDA-2013-00058] This approach was developed and implemented by Steven Hommel. David Watkins provided technical review of the approach and Barry Lester reviewed the implementation of the calculations within the GoldSim© file. These reviews were performed per E7-2.60 according to guidelines provided in S4-ENG.51.

3.0 PORFLOW MODELING

PORFLOW modeling performed in support of the FY2014 SDF SA is pivotal to demonstrating the performance of the SDF system with respect to waste release and transport. Accordingly, the PORFLOW modeling underwent additional levels of scrutiny. The following checking and verification activities were performed to provide high confidence in the quality of the FY2014 SDF SA PORFLOW models.

3.1 Technical Review of PORFLOW

The report that documents PORFLOW modeling, *PORFLOW Modeling Supporting the FY14 Saltstone Special Analysis*, underwent technical review per E7-2.60. The report was prepared by Gregory Flach and Glen Taylor and the independent, technical review was conducted by Frank Smith III. [SRNL-STI-2014-00083]

The design check of the FY2014 SDF SA PORFLOW modeling work was independently documented within SRNL-L3200-2014-00005 and is not repeated herein.

4.0 GOLDSIM© MODELING

This section describes the checking and verification activities for the development of model files and calculations performed in support of the FY2014 SDF SA.

4.1 GoldSim© Model File Development

GoldSim© modeling within the FY2014 SDF SA serves four functions. First, a fate and transport model is used for benchmarking the results from the PORFLOW model, providing greater confidence in the modeling approaches and to use for single parameter sensitivity analyses (i.e., deterministic modeling). Second, GoldSim© facilitates uncertainty analyses by allowing uncertainty distributions as input parameters that can be sampled over multiple realizations (i.e., probabilistic modeling). Next, the GoldSim© benchmarking model can be modified to perform deterministic sensitivity analyses. Finally, a GoldSim© dose calculator converts concentration data into doses (either to hypothetical members of the public or hypothetical human intruders).

The GoldSim© models for the FY2014 SDF SA were developed using the GoldSim© software and are documented in two reports: *Saltstone Disposal Facility Stochastic Fate and Transport Model* and *Updates to the Saltstone Disposal Facility Fate and Transport Model*. [SRR-CWDA-2011-00178; SRR-CWDA-2013-00073]

4.2 GoldSim© Dose Calculations Using PORFLOW Concentrations

Doses were determined from the concentrations of several discrete PORFLOW runs in the FY2014 SDF SA. These PORFLOW doses are documented in Sections 5.5 and 5.6.7, and 6.4 of

the FY2014 SDF SA. All dose calculations used the same GoldSim© file, except that the concentrations were replaced using the desired concentrations as determined in PORFLOW. The initial GoldSim© file used was: *SRS Saltstone v5.005.gsm*. Although the final GoldSim© model file developed was *SRS Saltstone v5.006.gsm* (as described in Sections 4.3 through 4.5), no dose calculations have changed; therefore, using this model file solely for dose calculations (i.e., not for transport or probabilistic modeling) is appropriate.

Steven Hommel input the concentration data. David Watkins independently checked each of these files according to the requirements of S4-ENG.51 and documented his checking in *Section 5.5 OSR 46-573.pdf*, *Section 5.6.7 OSR 46-573.pdf*, and *Section 6.4 OSR 46-573.pdf*. This work was done prior to the revision of the dose calculation described in Section 2.6. Therefore, the work was updated (by Steve Hommel) using the revised dose calculations (per SRR-CWDA-2013-00058) and re-checked (by David Watkins) and re-documented in *FY2014_SDF_SA_Rev2_Check_DoseCalcs.pdf*.

4.3 GoldSim© Benchmark Modeling

Two GoldSim© files were developed to support the benchmark modeling described in the FY2014 SDF SA: *SRS Saltstone v5.006.gsm* and *Tc99_SDU_V1.006.gsm*. These two benchmarking models were designed to run deterministically, rather than probabilistically, and to preserve many time histories for result comparisons. These models were prepared by Barry Lester and checked by Steve Hommel and as documented in *FY2014_SDF_SA_BenchmarkingCheck.pdf*, *SRS Saltstone v5.006.gsm_chng_model_chk.pdf*. and *Tc99_SDU_V1.006_chng_model_chk.pdf*. David Watkins provided an additional review, as documented in *Section 5.6.2 OSR 46-573.pdf*.

4.4 GoldSim© Probabilistic Modeling

Two GoldSim© files were developed to probabilistically model fate and transport of contaminants in support of the FY2014 SDF SA. Barry Lester prepared the updated fate and transport calculations as described in *Updates to the Saltstone Disposal Facility Fate and Transport Model*. [SRR-CWDA-2013-00073] As described in SRR-CWDA-2013-00073, the two models were the SDF GoldSim© All-Species Model (*SRS Saltstone v5.004.gsm*) and the SDF GoldSim© Tc-99 Release Model (*Tc99_SDU_V1.005.gsm*).

Model development was an iterative process. As such, changes were tracked and checked until the final model versions were developed. Table 4.4-1 provides a summary of the checking documentation.

Table 4.4-1: Summary of GoldSim© Checking

Checked Model File	Source File	Checklist PDF	Created By	Checked By
SDF GoldSim© All-Species Model				
SRS Saltstone v4.103A.gsm	SRS Saltstone v4.102.gsm	SRS Saltstone v4.103A_chng_model_chk.pdf	Barry Lester	Steve Hommel
SRS Saltstone v5.000.gsm	SRS Saltstone v4.103A.gsm	SRS Saltstone v5.000_chng_model_chk.pdf	Barry Lester	Steve Hommel
SRS Saltstone v5.001.gsm	SRS Saltstone v5.000.gsm	SRS Saltstone v5.001_chng_model_chk.pdf	Barry Lester	Steve Hommel
SRS Saltstone v5.002.gsm	SRS Saltstone v5.001.gsm	SRS Saltstone v5.002_chng_model_chk.pdf	Barry Lester	Steve Hommel
SRS Saltstone v5.003.gsm and SRS Saltstone v5.004.gsm	SRS Saltstone v5.002.gsm	SRS Saltstone v5.004_chng_model_chk.pdf	Barry Lester	Steve Hommel
SRS Saltstone v5.005.gsm and SRS Saltstone v5.006.gsm	SRS Saltstone v5.004.gsm	SRS Saltstone v5.006_chng_model_chk.pdf	Steve Hommel	David Watkins
SDF GoldSim© Tc-99 Release Model				
Tc99_SDU_V1.000.gsm	Initial Model	Tc99_SDU_V1.000_chng_model_chk.pdf	Barry Lester	Steve Hommel
Tc99_SDU_V1.001.gsm	Tc99_SDU_V1.000.gsm	Tc99_SDU_V1.001_chng_model_chk.pdf	Barry Lester	Steve Hommel
Tc99_SDU_V1.002.gsm	Tc99_SDU_V1.001.gsm	Tc99_SDU_V1.002_chng_model_chk.pdf	Barry Lester	Steve Hommel
Tc99_SDU_V1.003.gsm	Tc99_SDU_V1.002.gsm	Tc99_SDU_V1.003_chng_model_chk.pdf	Barry Lester	Steve Hommel
Tc99_SDU_V1.004.gsm	Tc99_SDU_V1.003.gsm	Tc99_SDU_V1.004_chng_model_chk.pdf	Barry Lester	Steve Hommel
Tc99_SDU_V1.005.gsm	Tc99_SDU_V1.004.gsm	Tc99_SDU_V1.005_chng_model_chk.pdf	Barry Lester	Steve Hommel
Tc99_SDU_V1.006.gsm	Tc99_SDU_V1.005.gsm	Tc99_SDU_V1.006_chng_model_chk.pdf	Steve Hommel	David Watkins
Summary: All issues identified during checking have been resolved.				

All checking was performed according to the requirements of S4-ENG.51.

4.5 GoldSim© Deterministic Modeling

In addition to probabilistic modeling, the GoldSim© files can be modified and run deterministically to support sensitivity analyses. Three such analyses were performed for the FY2014 SDF SA: technetium solubility, technetium release using a simplified mass transfer model, and inventory stratification of the 375-foot diameter SDU. These model modifications were implemented by Barry Lester and Steve Hommel and checked by David Watkins, as documented in *Section 5.6.6 OSR 46-573.pdf* and *Section 5.6.6.3 OSR 46-573.pdf.*

5.0 OTHER CALCULATIONS AND TECHNICAL WORK

The following discusses the checking of calculations that were not discussed in the previous sections.

5.1 Sensitivity Run Radionuclide Selections

PORFLOW dose results from the evaluation case model were used to determine sensitivity run radionuclides. This determination reduced the list of radionuclides used in sensitivity analyses, focusing on only those radionuclides that offer the most risk with respect to doses. This determination was performed in the Excel file: *FY2014_SDF_SA_PORFLOW_STAT_RatioSL.xlsx*. This determination of sensitivity run radionuclides was performed by Steve Hommel and checked by David Watkins, per E7-2.60

according to guidelines provided in S4-ENG.51, and documented in *Section 5.2 OSR 46-573.pdf*. This work was done prior to the revision of the dose calculation described in Section 2.6. Therefore, the work was updated (by Steve Hommel) using the revised dose calculations (per SRR-CWDA-2013-00058) and re-checked (by David Watkins) and re-documented in *FY2014_SDF_SA_Rev2_Check_DoseCalcs.pdf*.

5.2 Peak Concentration Values

Concentration data, generated by the PORFLOW model, was evaluated for peak concentrations and provided in the Appendices of the FY2014 SDF SA. This evaluation was performed in the Excel files: *FY2014 SDF PA beta-gamma 100 meter_02-10-14.xlsx*, *FY2014 SDF PA beta-gamma 1 meter_2-19-14.xlsx*, and *FY2014 SDF PA beta-gamma intruder_2-10-14.xlsx*. This evaluation was performed by David Watkins and checked by Steve Hommel, per E7-2.60 according to guidelines provided in S4-ENG.51, and documented in *FY2014_SDF-SA_PeakConcentrations-Check.pdf*.

5.3 Uncertainty Analysis Results Tables and Figures

Section 5.6.4 and Section 6.5 of the FY2014 SDF SA provide data and figures supporting the probabilistic uncertainty analyses that were performed on multi-realization data sets. Data from the two GoldSim© model files were copied and pasted into Excel files where they were plotted (and sometimes combined) to generate figures and data in support of the uncertainty analyses described in the FY2014 SDF SA. This data was generated by Steve Hommel and checked by David Watkins, per E7-2.60 according to guidelines provided in S4-ENG.51, and documented the PDF: *Section 5.6.4 OSR 46-573.pdf* and *Section 6.5 OSR 46-573.pdf*. This work was done prior to the revision of the dose calculation described in Section 2.6. Therefore, the work was updated (by Steve Hommel) using the revised dose calculations and re-checked (by David Watkins) and re-documented in *FY2014_SDF_SA_Rev2_Check_Excel_Uncertainty.pdf*.

5.4 Probabilistic Sensitivity Analyses (MVIEW)

Section 5.6.5 and Section 6.5 of the FY2014 SDF SA provide data and figures supporting the probabilistic sensitivity analyses that were performed on multi-realization data sets. Multiple files within two subdirectories were generated and checked. The subdirectories were: *Section 5.6.5* and *Section 6.5*. This data was generated by Steve Hommel and checked by David Watkins, per E7-2.60 according to guidelines provided in S4-ENG.51, and documented the PDFs: *Section 5.6.5 OSR 46-573.pdf*, *Section 6.5 OSR 46-573.pdf*, and *FY2014_SDF_SA_Rev2_Check_GSM_01_thru_06.pdf*.

6.0 SDF SA SOFTWARE QUALITY ASSURANCE

Table 6.0-1 maps the software used in the development of the FY2014 SDF SA to the related Software Quality Assurance Plans (SQAPs) and related QA documentation.

Table 6.0-1: Summary of Software Used for the FY2014 SDF SA

Software Name	Version	Software Quality Assurance Documentation	Purpose/Use
GoldSim©	10.50 (SP3)	*Software Quality Assurance Plan for GoldSim© for the Savannah River Site's Liquid Waste Program* (B-SQP-C-00002)	Used for benchmark testing, dose calculations, probabilistic modeling, and deterministic sensitivity modeling.
GoldSimFlows	N/A	*Software Quality Assurance Plan for PORFLOW Flow-Field Extraction Tool (GoldSimFlows)* (Q-SQP-A-00008)	Used to extract PORFLOW data and format it to be read by ReadPORFLOWData.dll.
mView	4.00	*Software Quality Assurance Plan for mView* (B-SQP-C-00005)	Used for sensitivity analysis of probabilistic modeling results.
PORFLOW	6.30.2	*Software Testing and Verification of PORFLOW Versions 6.30.1 and 6.30.*2 (SRNL-TR-2010-00213)	Used for deterministic modeling of flow and contaminant transport.
ReadPORFLOWData.dll	2.0	*Software Quality Assurance Plan for ReadPORFLOWData.dll for the Savannah River Site's Liquid Waste Program (*B-SQP-C-00003)	Dynamic linked library called by GoldSim© software to read data from external files (i.e., PORFLOW result data).
TransitionTime.dll	1.0	*Software Quality Assurance Plan for TransitionTime.dll for the Savannah River Site Liquid Waste Program* (SRR-CWDA-2014-00033)	Dynamic linked library called by GoldSim© software to calculate transition times based on flows.

All of the software listed above has undergone software qualification per SRS software qualification procedures (i.e., 1Q-20-1).

7.0 CONCLUSIONS

The FY2014 SDF SA is a collection of model files and analyses that are technically correct, accurate, and complete. The results of the FY2014 SDF SA provide an appropriate technical basis for informing decisions related to compliance requirements for final closure of the SDF.

During the course of the extensive checking and verification process, all errors that were identified were corrected prior to completion of documentation.

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