Unique Natural System Modeling Aspects of the H-Tank Farm at the Savannah River Site – 15271

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ABSTRACT

The U.S. Department of Energy (DOE) is in the process of closing radioactive waste storage tanks at the Savannah River Site (SRS). One of the key technical documents supporting closure and regulatory decision documents is the Performance Assessment (PA). PAs within the DOE complex are performance-based, risk-informed analyses of the fate and transport of residual contaminants, in this case any residual material remaining following cleaning and closure of the tank systems. There are two active radioactive waste storage facilities at SRS, F-Tank Farm (FTF) and H-Tank Farm (HTF), which consist of 51 carbon steel waste tanks. To date, six tanks have been emptied and closed in FTF. Activities are currently in progress to support closure of the first tanks in HTF. A PA has been developed for HTF and includes modeling that takes into account the unique aspects of the natural system associated with HTF [1]. These unique aspects include the water table elevation in relation to the tanks and the complex flow patterns of the groundwater beneath HTF.

INTRODUCTION

The SRS is a DOE site located in south-central South Carolina, approximately 161 kilometers (100 miles) from the Atlantic Coast. The major physical feature at SRS is the Savannah River, approximately 32 kilometers (20 miles) of which serves as the southwestern boundary of the site and the South Carolina-Georgia border. The SRS includes portions of Aiken, Barnwell, and Allendale Counties in South Carolina. The SRS occupies an almost circular area of approximately 803 square kilometers (310 square miles) and contains production, service, and research and development areas. The Liquid Waste facilities are located in the industrialized central portion of the site known as the General Separations Area (GSA) as depicted in Figure 1. The H-Tank Farm (HTF) consists of approximately 180,000 m^2 (45 acres) located in the southeast portion of the GSA. HTF contains 29 carbon steel underground tanks with storage capacities ranging from approximately 2840 to 4920 cubic meters (750,000 to 1,300,000 gallons) and various supporting ancillary equipment. Figure 2 presents the general layout of HTF including the storage tanks and principal ancillary equipment.

As PAs are performance-based, risk-informed analyses of the fate and transport of contaminants, modeling must utilize numerous inputs regarding the nature of the contaminants, the engineered barriers surrounding the contaminants and the natural system (see Figure 3). The unique aspects of the natural system at HTF will be explored as the performance of the natural system can impact modeling results and make interpretation of these results complicated.

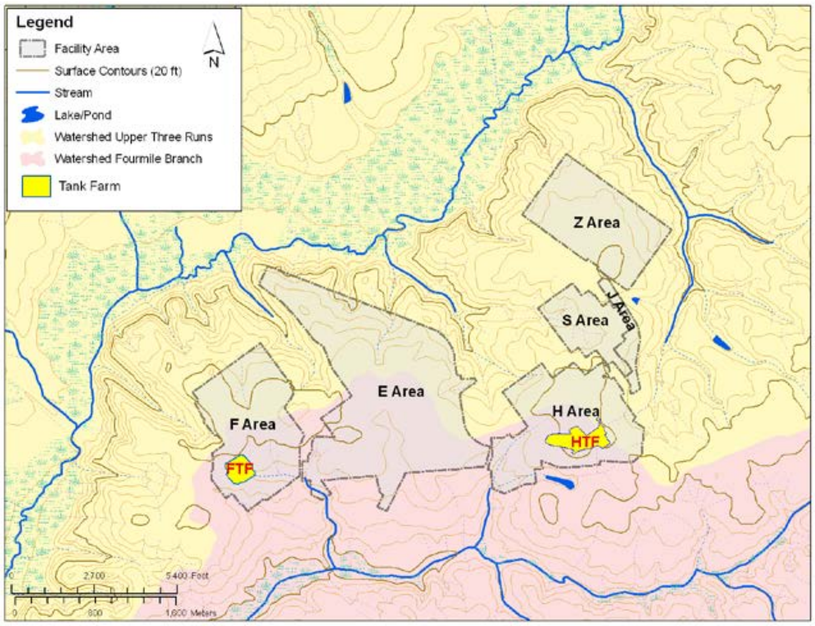

Fig. 1. SRS General Separations Area.

Fig. 2. HTF General Layout.

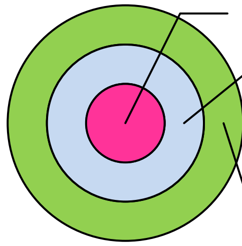

Fig. 3. Modeling Input Integration.

DISCUSSION

As stated previously, the PA developed for HTF takes into account the unique aspects of the natural system associated with HTF. The natural system surrounding HTF is different not only to conditions at other DOE sites but is also unique compared to the other facilities at SRS. The two important natural system features to the PA fate and transport modeling is the height of the water table in relation to the tanks and the groundwater flow patterns in the saturated zone.

Water Table Elevation

One aspect that is distinctly different from other SRS and DOE facilities is the fact that several HTF tanks are either completely or partially submerged in the water table or saturated zone. In most facilities, contaminants are initially located in an unsaturated vadose zone and must transport through the vadose zone before they reach the groundwater. While SRS is a more humid site and thus has a higher water table than some other DOE sites, HTF is unique compared to other SRS liquid waste facilities where the vadose zone can vary in thickness but is actually absent is some areas of HTF. For example, at FTF the vadose zone thickness varies from approximately 0.4 to 6.1 meters (1.2 to 20 feet) [2] and at the Saltstone Disposal Facility varies from approximately 10.9 to 14.6 meters (35.6 to 48 feet) [3]. At HTF there are four tanks that are typically completely submerged in the water table and four tanks that are partially submerged. For the remaining 21 tanks in HTF, the vadose zone thickness varies from approximately 2.1 to 5.5 meters (7 to 18 feet). For the oldest tanks, Tanks 9 thru 12, the tanks are typically completely submerged in the water table. Figure 4 presents a depiction of the measured water table elevation at various groundwater wells in the vicinity of the four tanks from 1975 thru 2013 in relation to the tank elevations [4]. While the water table at times has been below the top of the tank, it is always significantly above the contaminated zone (CZ) of residual material as indicated by "CZ" in the figure. For Tanks 13 thru 16, the tanks are typically only partially submerged, although the contaminated zone is often submerged as depicted in Figure 5. The water table elevation is a unique aspect to the natural system at HTF that must be taken into account in the fate and transport modeling. The impact of the small or non-existent vadose zone is that once contaminants transport from the closed system they are immediately able to travel in the groundwater to potential exposure points. In typical systems, the presence of a vadose zone can delay contaminant introduction to the groundwater for hundreds or thousands of years depending on the nature of infiltration rates and contaminant sorption in the soil. This can be extremely important to regulatory decisions and is important to the modeling for HTF.

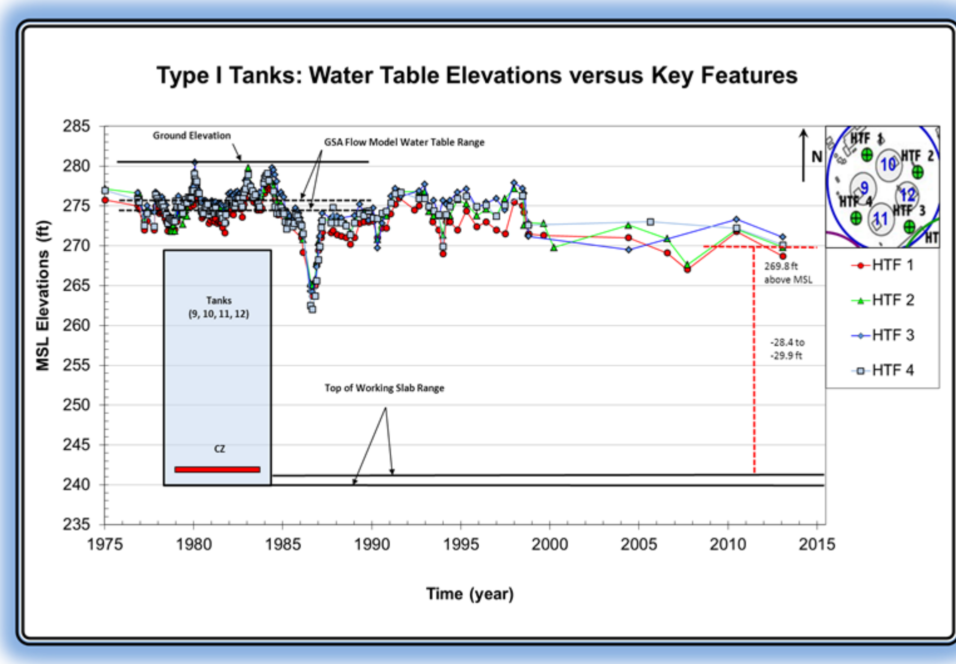

Fig. 4. Historical water table elevations near Tanks 9-12. [4]

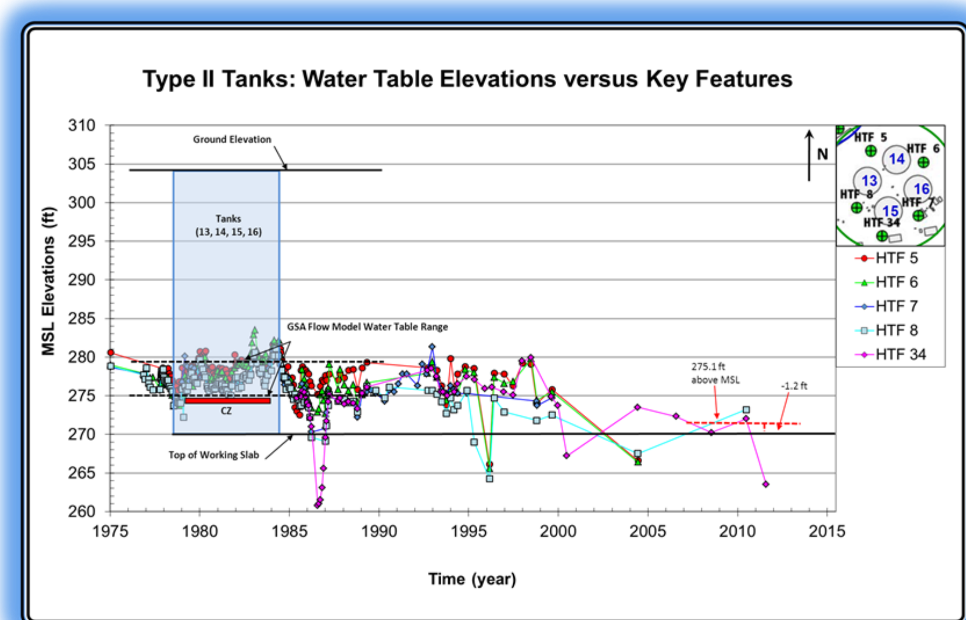

Fig. 5. Historical water table elevations near Tanks 13-16.

For comparison, the vadose zone thickness can be a significant natural barrier to contaminant movement at other DOE sites. Figure 6 indicates that at the Nevada National Security Site the vadose zone thickness beneath their low level waste disposal facility is greater than 210 meters (700 feet) [4]. At the Idaho National Laboratory, the vadose zone thickness varies from approximately 75 to 145 meters (245 to 475 feet) [5]. At the Hanford Site, the vadose zone thickness under the C-Tank Farm is approximately 76 meters (250 feet) [6]. The comparison of the HTF vadose zone thickness to that of other DOE sites further indicates the unique aspect of the water table elevation in relation to the HTF tanks under a closure condition.

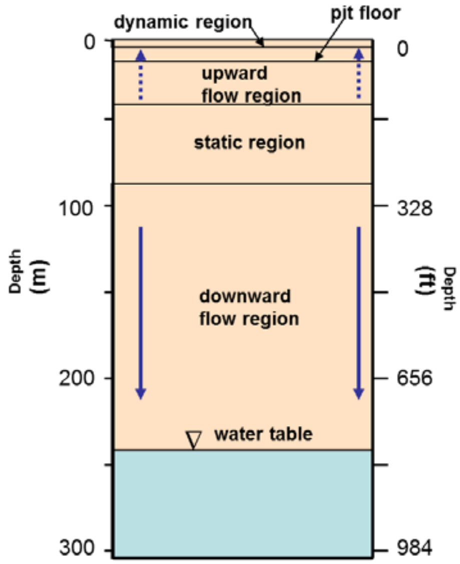

Fig. 6. Vadose zone at Nevada National Security Site. [4]

Groundwater Flow

Another distinct aspect of the HTF natural system is the groundwater flow beneath the facility. While most other liquid waste facilities at SRS have groundwater flows that emanate in a single direction of flow, certain areas of HTF are at a hydro geologic high point in which groundwater does not flow in a single direction. For comparison purposes, Figure 7 is a depiction of the centerline plume traces from individual FTF tanks and Figure 8 presents the composite plume dispersion from all contaminant sources [2]. The figures indicate that the groundwater flows in the general direction of the individual tanks and contaminant plumes can have significant interaction. Figure 9 is a depiction of the centerline plume traces from individual HTF tanks [1]. Items to note compared to Figure 7 in FTF are that some stream traces behave erratically because of the layered nature of the saturated zone and the vertical location of the tanks with little to no vadose zone thickness. Another item to note is that the traces leave the facility in many directions which can also influence dispersion. Figure 10 presents the composite plume dispersion from all contaminant sources. While this figure indicates that the plumes appear to go in the general direction of the contaminant plumes, individual tanks at the high point have a plume that does not disperse through a single flow path. Tank 16 is an example of this unique aspect of HTF and Figure 11 presents the contaminant dispersion associated with Tank 16. The unique groundwater flow results in the high dispersion of individual plumes and extensive plume interaction that makes for difficult interpretation at points of assessment.

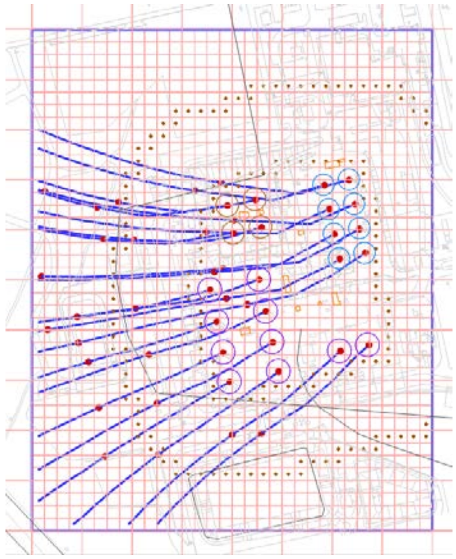

Fig. 7. Groundwater flow beneath FTF.

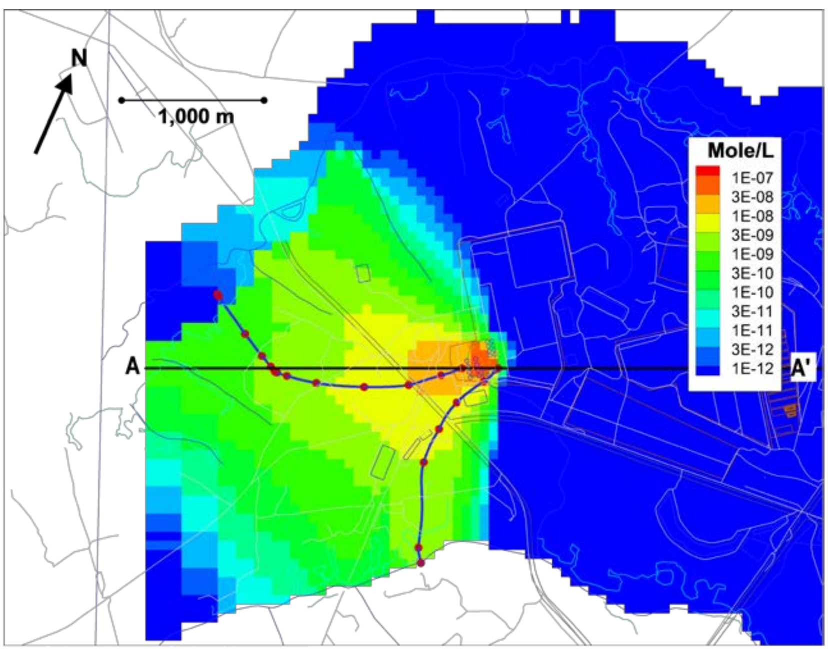

Fig. 8. Contaminant plume leaving FTF.

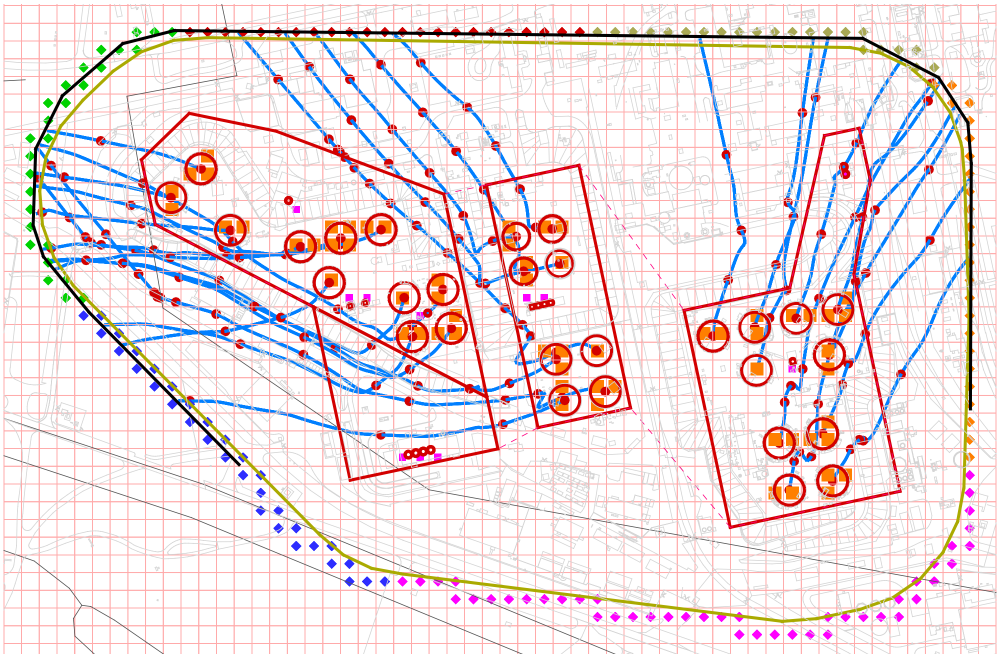

Fig. 9. Groundwater flow beneath HTF.

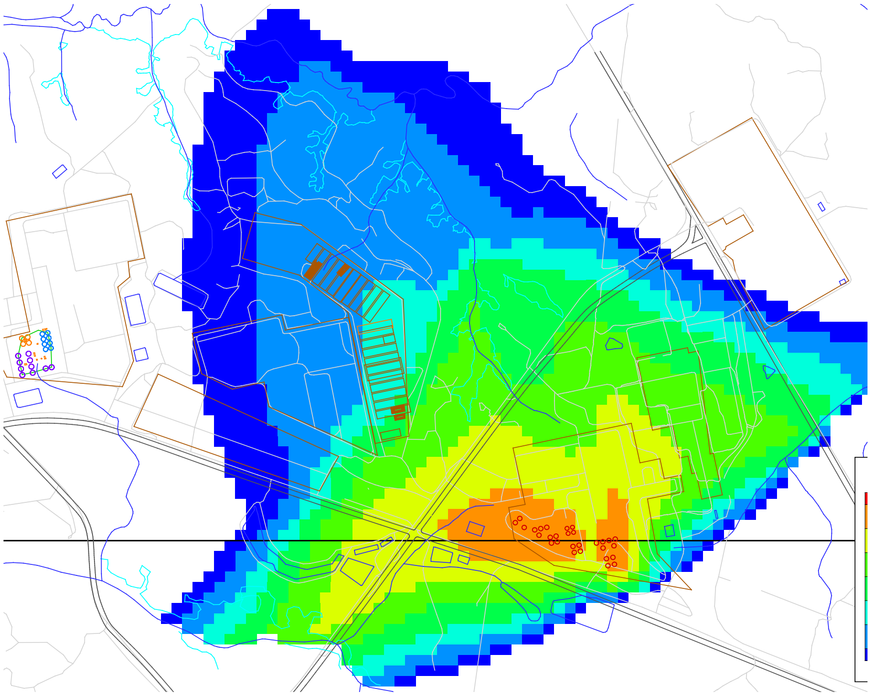

Fig. 10. Contaminant plume leaving HTF.

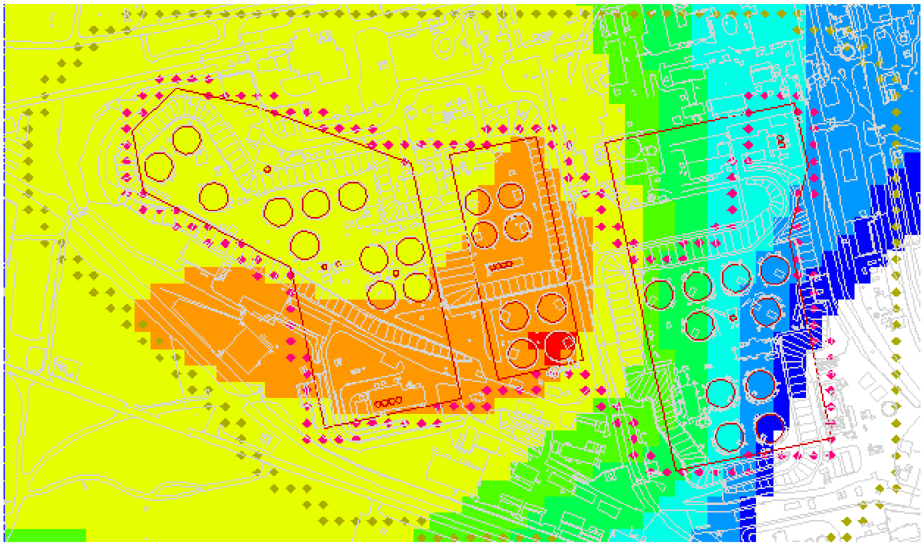

Fig. 11. Contaminant plume leaving Tank 16 only.

CONCLUSIONS

In conclusion, the unique natural system associated with HTF is different from not only the other liquid waste facilities at SRS but from other DOE sites. The natural system behavior is an important input to the PA fate and transport modeling and makes interpretation of results complicated. By evaluating the available data and evaluating individual tank behaviors one can provide a more informed interpretation of the modeling results at various points of assessment and improve the understanding of the closed system.

REFERENCES

1. SRR, *Performance Assessment for the H-Area Tank Farm at the Savannah River Site*, SRR-CWDA-2010-00128, Revision 1, Savannah River Site, Aiken, SC (2012).

2. SRR, *Performance Assessment for the F-Tank Farm at the Savannah River Site*, SRS-REG-2007-00002, Revision 1, Savannah River Site, Aiken, SC (2010).

3. SRR, *Performance Assessment for the Saltstone Disposal Facility at the Savannah River Site*, SRR-CWDA-2009-00017, Revision 0, Savannah River Site, Aiken, SC (2009).

4. NRC, Transcript of NRC Advisory Committee on Reactor Safeguards (ACRS) Radiation Protection and Nuclear Materials Subcommittee Meeting Tuesday November 19, 2013, ML13339A891, Nuclear Regulatory Commission, Rockville, MD (2013).

5. INL, *Preliminary Review of Models, Assumptions and Key Data Used in Performance Assessments and Composite Analysis at the Idaho National Laboratory*, INL/EXT-09-16417, Idaho National Laboratory, Idaho Falls, ID (2009).

6. WRPS, *Surface Geophysical Exploration of UPR-200-E-82 Near the C Tank Farm*, RPP-RPT-50052, Revision 0, Hanford Site, Richland, WA (2011).