TECHNICAL REVIEW OF ENVIRONMENTAL MONITORING REPORTS PREPARED BY DOE FOR TANK FARMS

Date:

Reviewers: Cynthia S Barr, U.S. Nuclear Regulatory Commission

Monitoring Documents Reviewed:

1. ML17164A270, *2016 Annual Groundwater Monitoring Report for the F/H Area Radioactive Liquid Waste Tank Farms (U)*, SRNS-RP-2017-00073, Rev. 0, March 2017
2. ML18037A773, *2015 Annual Groundwater Monitoring Report for the F/H Area Radioactive Liquid Waste Tank Farms (U)*, SRNS-RP-2016-00179, Revision 0, March 2016.
3. ML15093A205, *2014 Annual Groundwater Monitoring Report For the F- and H-Area Radioactive Liquid Waste Tank Farms (U)*, SRNS-RP-2015-00069, Revision 0, March 2015.
4. ML18036A072, *Scoping Summary for the General Separations Area Eastern Groundwater Operable Unit (U)*, WSRC-RP-2000-4134, October 2016.
5. ML18036A087, *Scoping Summary for the General Separations Area Eastern Groundwater Operable Unit (U)*, WSRC-RP-2000-4134, October 2017.
6. ML18036A092, *Scoping Summary for the General Separations Area Western Groundwater Operable Unit (U)*, ERD-EN-2005-0127, October 2016.
7. ML18036A106, *Scoping Summary for the General Separations Area Western Groundwater Operable Unit (U)*, ERD-EN-2005-0127, October 2017.

<u>Summary of Review Documents</u>

SRNS-RP-2017-00073, Rev. 0 (2016 Annual Report)

The Environmental Protection Agency (EPA) and the South Carolina Department of Health and Environmental Control (SCDHEC) approved Sampling and Analysis Plan (SAPs) for FTF (SRNS-RP-2012-00287, Rev. 1) and for HTF (SRNS-RP-2012-00146, Rev. 1). SRNS-RP-2017-00073, Rev. 0 notes that during scoping of the monitoring strategy and development of the sampling plans, the United States Department of Energy (USDOE), USEPA, and SCDHEC identified gaps in the existing well coverage. Subsequently, new wells were installed at agreed upon locations at both the FTF and HTF to fill as many data gaps as possible. The report also noted that placement of additional future wells is limited by existing active utilities and operating facilities and additional well installation will not be possible until closure of the FTF and HTF.

The groundwater monitoring plan for the FTF includes sampling twice per year at a network of thirteen monitoring wells consisting of six existing wells and seven newer wells installed in 2012. In 2016, SRS sampled FTF monitoring wells in the first and third calendar quarters[1]: seven wells are screened in the Upper Aquifer Zone (UAZ) of the Upper Three Runs Aquifer (UTR), four wells are screened in the Lower Aquifer Zone (LAZ), and two background wells

[1] DOE SRS was successful at sampling all of the FTF wells as scheduled except for well FBG 1D, the background well in the UAZ. The water table was stated as being thin in the area of FBG 1D and even though the well screen is located at the bottom of the aquifer, not enough water was present to collect for sampling in either quarter after repeated attempts (SRNS-RP-2017-00073, Rev. 0).

are included in the network with one background each in the UAZ and LAZ[2]. The network of thirteen wells are intended to provide coverage to detect any releases that may occur at the FTF. Figure 2 shows the monitoring locations.

The groundwater monitoring plan for the HTF includes sampling twice per year at a network of 46 monitoring wells consisting of 36 existing wells and 10 newer wells (HAA 17 through HAA 21) installed in 2012. In 2016, all 46 HTF monitoring wells, including background wells HAA 1 A/C/D, were sampled in the first and third calendar quarters: 17 wells are screened in the UAZ, 28 wells are screened in the LAZ, and one well is screened in the Gordon Aquifer Unit (GAU)[3]. Figure 3 provides the HTF groundwater monitoring well locations.

As required by the SAPs, samples were analyzed for gross alpha, nonvolatile beta, tritium, nitrate-nitrite, cadmium, chromium, manganese, and sodium. Technetium-99 was also analyzed at both FTF and HTF. As provided in the SAP, SRS performs contingent analyses for specific radionuclides if screening results for gross alpha or nonvolatile beta exceed trigger levels of 15 picocuries per liter (pCi/L) and 50 pCi/L, respectively. In 2016, wells FTF 28, FTF 12R, and HAA 8D[4] exceeded a screening trigger level (nonvolatile beta) and contingency analyses were performed.

Overall, the 2016 sample results were similar to those from previous years. Analytical results indicated low concentrations of nitrate-nitrite and tritium in most wells at FTF and HTF (and also nonvolatile beta at FTF), and the concentrations are consistent with past results. Sampling also detected manganese and sodium, which are naturally-occurring in aquifer sediments at SRS.

Tritium was detectable (or tentatively identified[5]) in every well at the FTF. The maximum tritium concentration occurred at well FTF 30D at 42.8 pCi/ml in September 2016. Upgradient of FTF 30D tritium concentrations are stated to be very low. Manganese concentrations have increased in well FTF 9R. FTF 9R is located immediately adjacent to the F-Area Inactive Process Sewer Line (FIPSL), a vitrified clay pipeline which formerly transported low-level radioactive wastewater from the separation facilities to disposal basins, located south of the FTF. Past releases of acidic water from the FIPSL are thought to have caused manganese to be leached from aquifer sediments into groundwater. FTF 28 and FTF 12R had detection of nonvolatile beta above screening levels (above 50 pCi/L). The 2016 results indicate the existence of a nonvolatile beta plume in the LAZ downgradient of the FTF in the LAZ. The plume extends from FTF 28/12R to FTF 11C approximately 3000 feet (900 m) to the southwest. The plume is monitored by the Western Groundwater Operable Unit.

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[2] A cross-section of the regional model which includes FTF and HTF is found in Figure 1. The thickness of the TCCZ which separates the UAZ and LAZ is approximately 7-15 ft (2.1 to 4.5 m) east to west at HTF (SRNL-STI-2010-00148, Rev 0) and is 6-15 ft (1.8 to 4.5 m) thick from the southeast to the northwest corner of FTF (WSRC-TR-2007-00283).
[3] The background wells are screened in the GAU, the LAZ and the UAZ.
[4] The HAA 8D nonvolatile beta was thought to be anomalous.
[5] Tentatively identified or qualified “J” means that the constituent was below the sample quantitation limit (SQL) and thus cannot be accurately quantified.

Tritium was detectable in HTF wells but was below the MCL in every well but one. Well HAA 12C measured tritium greater than the MCL (20 pCi/mL) with a maximum result of 60.8 pCi/mL. The HTF SAP reported a maximum tritium concentration of 355 pCi/mL at well HTF 12 in 1986. Well cluster HAA 12 is down-gradient of the HTF and has a history of elevated tritium. The source of the tritium at the HAA 12 well cluster is thought to be from the Off-Site Fuels Receiving Basin facility, the numerous process sewer lines in the area, and/or the nearby H-Area Inactive Process Sewer Line (HIPSL) that transported low-level radioactive wastewater from the separations facilities to the H-Area Seepage Basins. The downgradient extent of the tritium plume is delineated and monitored by the General Separations Area Eastern Groundwater Operable Unit.

SRNS-RP-2016-00179, Rev. 0 (2015 Annual Report)

Similar to 2016 results, sampling results in 2015 were stated to be similar to those reported in previous years. In 2015, no results exceeded the screening levels for gross alpha or nonvolatile beta at HTF. Because gross alpha exceeded the screening level in well HAA 4D in 2014, isotopic speciation was performed in 2015 and reported in SRNS-RP-2016-00179. The isotopic analysis results showed no detectable concentrations of targeted radionuclides (Americium(Am)-241, Plutonium(Pu)-238 and 239/240, and Uranium(U)-238) and DOE indicated the results support the conclusion that HAA 4D alpha emitters are likely naturally occurring and not sourced by HTF.

Of note, SRS recorded 56.7 inches (144 cm) of precipitation at the H-Area weather station in 2015. This amount is greater than the 30-year average (47.2 inches per year [120 cm]) and is considered above normal rainfall for SRS. At the FTF average groundwater elevations for the Upper Aquifer Zone (UAZ) and Lower Aquifer Zone (LAZ) were approximately 220 ft (66 m) and 209 ft (63 m) above mean sea level (msl), respectively. In 2015, FTF UAZ elevations were close to normal levels and LAZ elevations were nearly 3 feet (0.9 m) above normal. At the HTF average groundwater elevations for the UAZ and LAZ were approximately 270 and 250 ft (81 and 75 m) above msl, respectively. In 2015, HTF UAZ and LAZ elevations were within 1 foot (0.3 m) of normal levels.

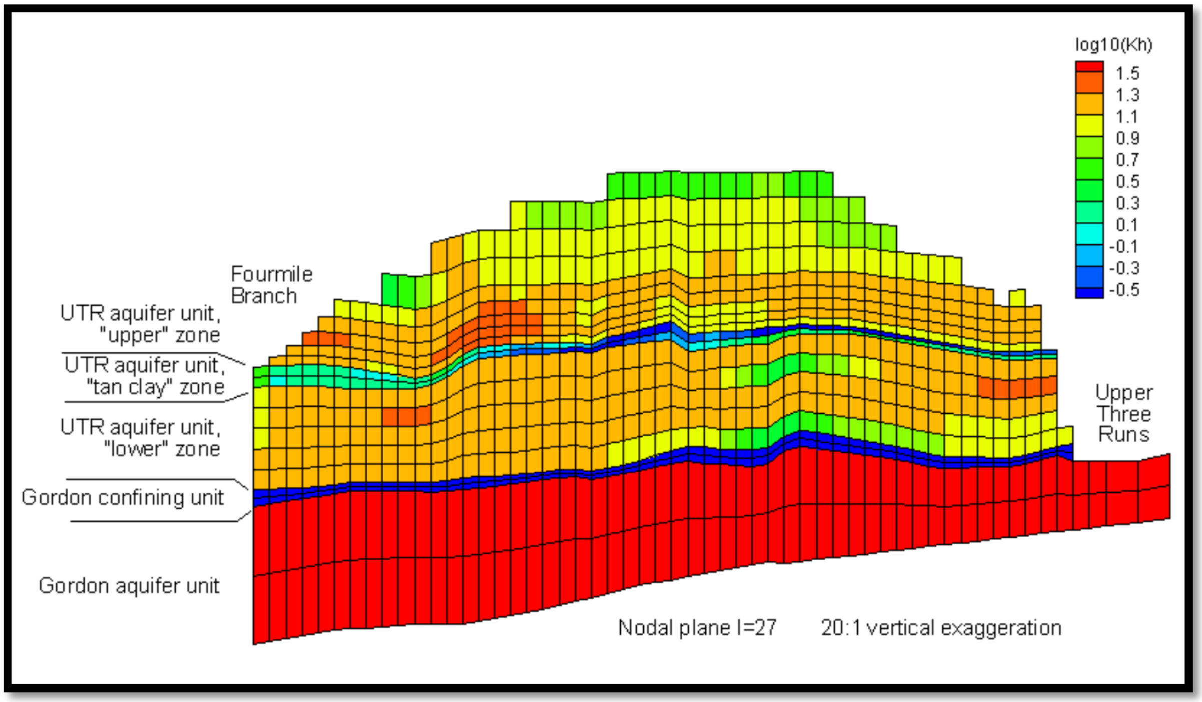

Figure 1 Cross-Section of the Upper Three Runs and Gordon Aquifer Units at the General Separations Area

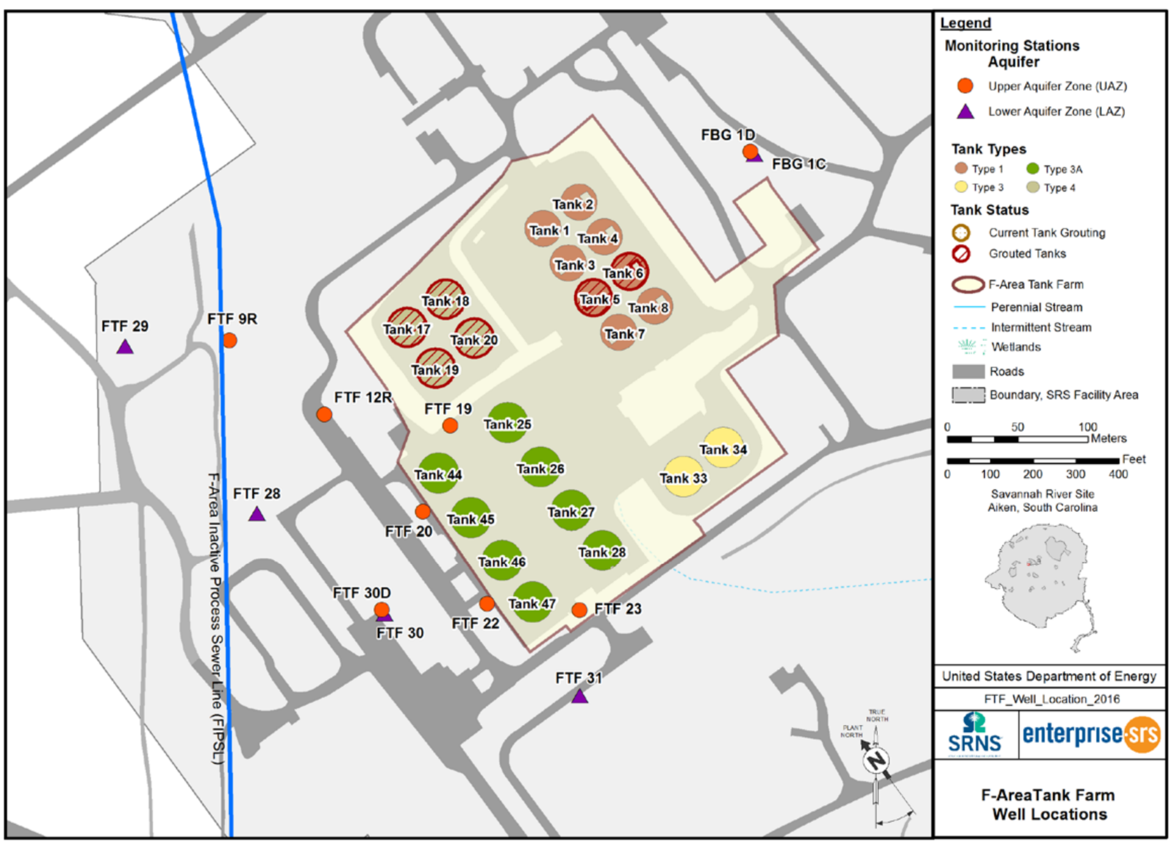

Figure 2 FTF Monitoring Well Locations (Image Credit: SRNS-RP-2017-00073, Rev. 0, Figure 4)

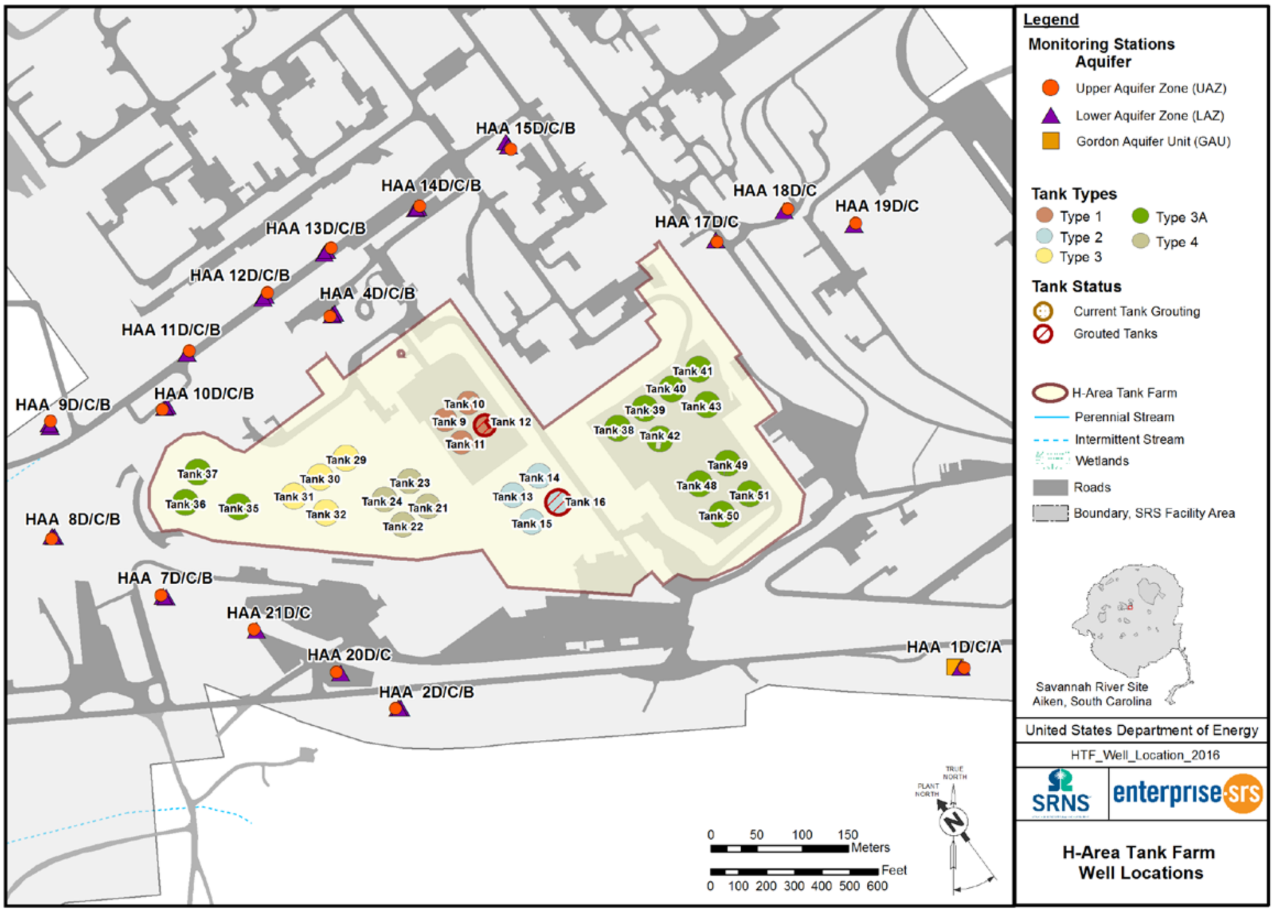

Figure 3 HTF Monitoring Well Locations (Image Credit: SRNS-RP-2017-00073, Rev. 0, Figure 4)

SRNS-RP-2015-00069, Rev. 0 (2014 Annual Report)

Similar to what was stated in the 2015 and 2016 reports, sampling results in 2014 were stated to be similar to those reported in previous years. Of note, the screening level for gross alpha (15 pCi/L) was exceeded in well HAA 4D (15.5 pCi/L), and also the maximum concentration of nitrate-nitrite was measured at HAA 4D (8.5 mg/L). Isotopic speciation was performed for specific radionuclides and all isotopes (Am-241, Pu-238 and Pu-239/240, and U-238) were non-detect. Sodium levels were the highest at wells FTF 30D and FTF 20. The maximum sodium concentration (14,300 µg/L at FTF 30D) was significantly lower than 2013 levels.

SRS recorded 48.9 inches of precipitation in 2014, which is similar to the 30-year average of 47.2 inches (120 cm) per year. The groundwater elevations were similar to those reported in 2015 discussed in the previous section.

ERD-EN-2005-0127 (2016 and 2017 Scoping Summaries)

The General Separations Area Western Groundwater Operable Unit includes sources in F-Area, which may complicate interpretation of groundwater data obtained from FTF monitoring wells (e.g., FTF 28 is included in both the Generations Separations Area Western Groundwater Operable Unit and the FTF monitoring well network). NRC staff focused on review of data for the South Plume (see Figure 4) in the Western Groundwater Operable Unit which overlaps the FTF monitoring well network. The South Plume (Figure 4) covers an area of approximately 55 acres in both the lower and upper zones of the UTR on the south west corner of F-Area. Groundwater monitoring for nitrates, gross alpha, nonvolatile beta, tritium, iodine(I)-129, radium(Ra)-226, strontium(Sr)-90, and uranium(U)-233/234, uranium(U)-238, and technetium(Tc)-99 (Tc-99 was recently added to the list) is conducted at 13 wells including a well (FTF-28), which is sampled under the FTF Sampling and Analysis Plan. SRS thinks that the South Plume is sourced by the F-Area Inactive Process Sewer Line (FIPSL), and could be associated with a collapsed section of the vitrified clay pipe down gradient of the Tank Farm. In 2015 and 2016, nonvolatile beta was the most widespread contaminant detected and was present at levels greater than the 50 pCi/L screening level at 5 of 13 wells. Concentrations ranged from 67 to 620 pCi/L at FTF-28. The highest concentrations have been detected in the area of FTF-28 and FSL-5D near the FIPSL, and also at downgradient well FGW-12C.

WSRC-RP-2000-4134 (2016 and 2017 Scoping Summaries)

The General Separations Area Eastern Groundwater Operable Unit includes sources in H-Area, which may complicate interpretation of groundwater data at HTF monitoring wells. HTF monitoring wells include HAA-5D, HAA-9D, HAA-11D, HAA-12D, HAA-13D, HAA-14D, and HAA-15D. Tritium has been detected in the groundwater of the General Separations Area Eastern Groundwater Operable Unit since monitoring began in 2002. The maximum tritium concentration at well HAA-12D screened in the Upper Aquifer Zone of the UTRA, occurred in 2002 at a value of almost 140 pCi/ml[6]. More recently, tritium levels at HAA-12D have declined to levels just below the MCL of 20 pCi/ml (see Figure 5). Of note, tritium concentrations in the deeper Gordon Aquifer well HAA-12A have been around 20 pCi/ml in recent sampling (see Figure 6). DOE explained that the presence of tritium in the Gordon Aquifer may be due to downward leakage along the well bore from the overlying Upper Aquifer Zone. Potential sources of tritium include the Off-Site Fuels Receiving Basin Facility, numerous process sewer lines, and the nearby H-Area Inactive Process Sewer Line (HIPSL).

[6] Note that only data since 2002 were reported in WSRC-RP-2000-4134 (2017). However, SRNS-RP-2017-00073 presents data since 1999 and the maximum tritium concentration at well HAA-12C and -12D were reported at around 150 pCi/mL.

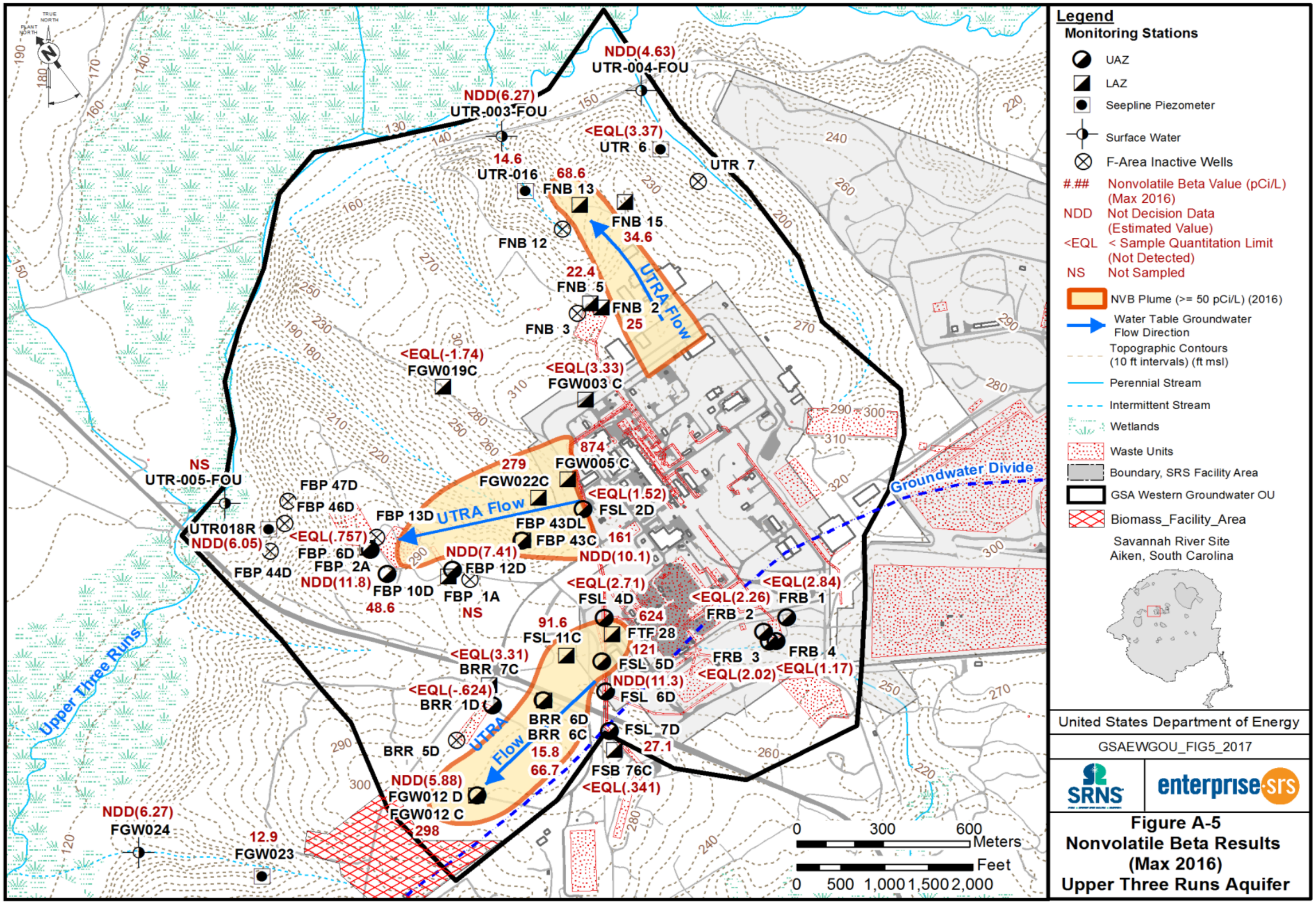

Figure 4 Western Groundwater Operable Unit Monitoring Well Network and Plumes. Image Credit: Figure A-5 in ERD-EN-2005-0127 (2017).

In 2016, nonvolatile beta was less than the screening level of 50 pCi/L at all wells. However, in 2017 nonvolatile beta was measured above the screening level in Gordon Aquifer wells HAA-12A, HAA-13A, HAA-15A. The pH has been elevated at these three wells for many years usually ranging from 10 to 13.7. In 2014, specific isotopes were analyzed and naturally occurring lead(Pb)-214 and bismuth(Bi)-214 were determined to be the primary contributors to nonvolatile beta. The high pH at these three wells was stated to be the likely cause of naturally occurring Ra-226 to be soluble in the groundwater resulting in the nonvolatile beta activity (parent to Radon(Rn)-222, Pb-214, and Bi-214). No information was provided to support the statement regarding Ra solubility versus pH. In 2014, gross alpha was also detected in two wells (HAA-15A and HCB-2) above the screening level of 15 pCi/L, although gross alpha was below the screening level in all wells in 2016.

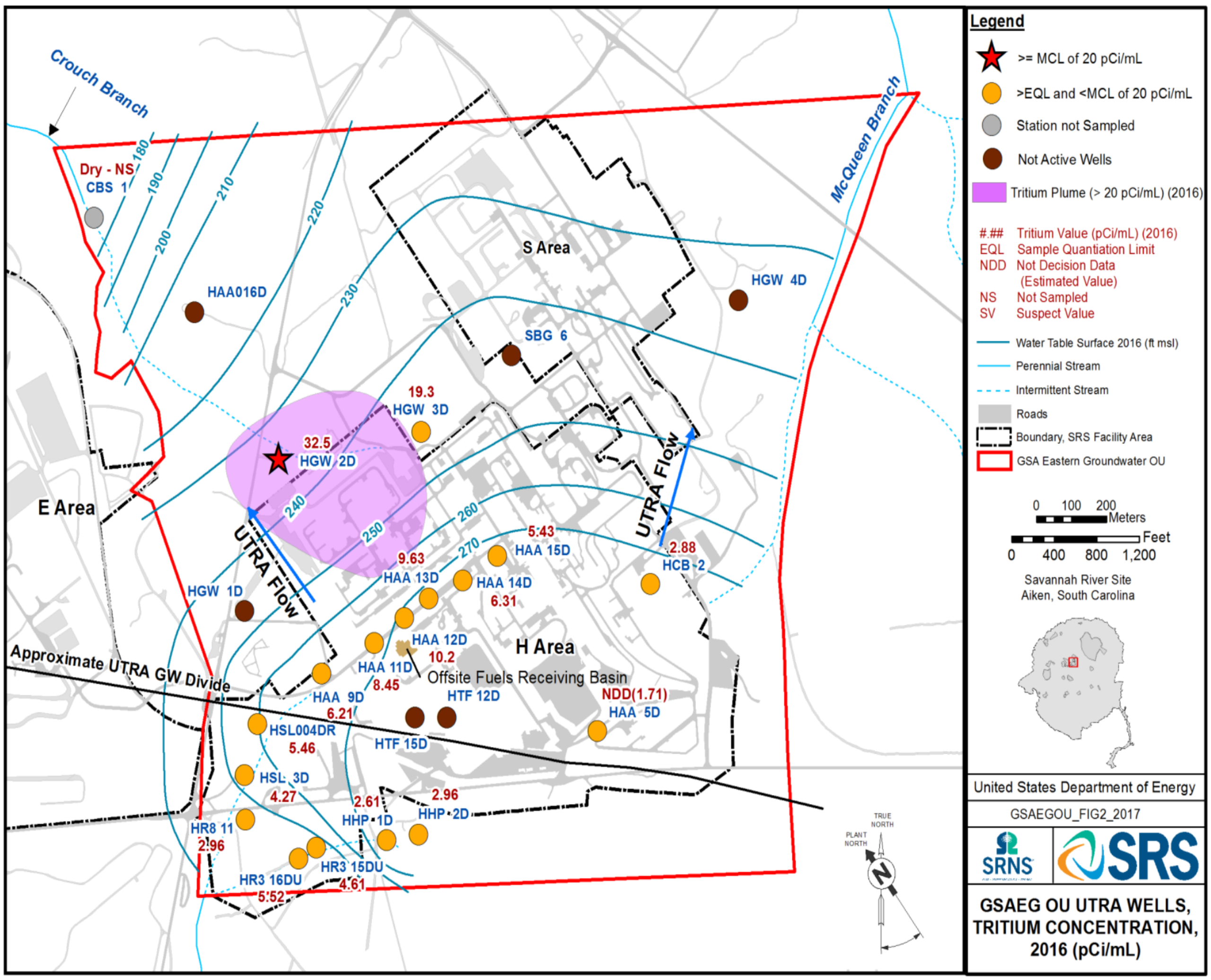

Figure 5 Eastern Groundwater Operable Unit Groundwater Monitoring Wells and Tritium Plume in the Upper Three Runs Aquifer. Image Credit: Figure 2, WSRC-RP-2000-4134, October 2017.

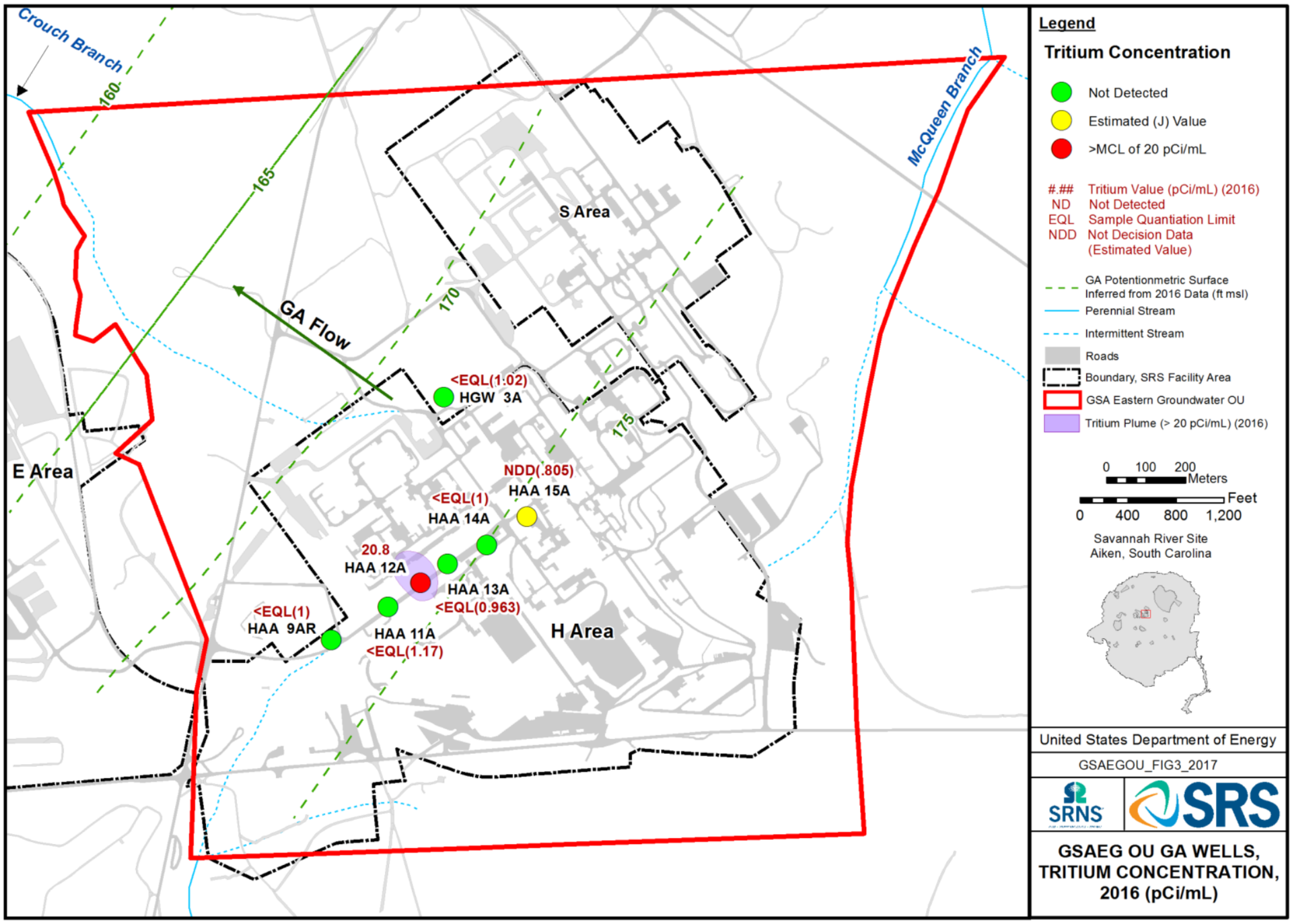

Figure 6 Eastern Groundwater Operable Unit Groundwater Monitoring Wells and Tritium Plume in the Gordon Aquifer. Image Credit: Figure 3, WSRC-RP-2000-4134, October 2017.

NRC Evaluation

Review of FTF Environmental Monitoring Reports

As stated in the previous technical review report evaluating tank farm monitoring (ML12272A124), NRC staff thinks that additional information is needed to support the conclusion that the elevated non-volatile beta and Tc-99 concentrations observed in well FTF 28 downgradient of the FTF is primarily associated with the FIPSL. FTF 28 is screened in the lower aquifer zone of the UTRA at an elevation of 151-161 ft (45-48 m). Nearby well FSL 5D, also depicted in Figure 4, is also thought to be impacted by the FIPSL; however, FSL 5D is located approximately 50 ft (15 m) higher in the upper aquifer zone of the UTRA. Although wastewater released from the FIPSL could have migrated towards FTF 28 in the vadose zone, it is more difficult to explain the vertical migration of the radioactivity to the lower aquifer zone of the UTRA (to well FTF 28) in such a short lateral distance from the source.

SRNS-RP-2017-00073, Revision 0, relies partially on depressed pH measurements to support its hypothesis that FTF 28 is impacted by acidic waste water suspected to have leaked from the FIPSL into the underlying subsurface. However, data for only a handful of wells (five) screened in the lower aquifer zone of the UTRA are presented for comparison. Well FTF 31 has a similar if not slightly higher average hydrogen ion concentration (lower pH) compared to FTF 28, and FTF 31 does not have elevated Tc-99. Furthermore, well FTF 12R (see Figure 2) screened in the upper aquifer zone of the UTRA is also impacted by elevated Tc-99 (250 pCi/L); however, this well has one of the highest pHs (pH of 6 and 6.5 in two sampling events) of the handful of wells (seven wells) where both pH and Tc-99 data are available in SRNS-RP-2017-00073. No explicit explanation for the source of Tc-99 at FTF 12R is provided. DOE should clarify the expected source of Tc-99 at FTF 12R.

As stated in the previous technical review report (ML12272A124), contamination of the lower aquifer zone of the UTRA at FTF 28 could have occurred during FTF 28 well construction due to leakage of Tc-99 from the overlying aquifer. Leakage from an overlying aquifer could provide a plausible explanation for the depth of contamination at this well. The release of Tc-99 from another source located further upgradient of the FIPSL is also another plausible explanation for the vertical extent of the Tc-99 plume near the FIPSL. Based on NRC staff's review of more recent data provided by DOE since the last technical review report, NRC staff continue to think that stronger support for the source of the plume at FTF 28 is needed. Additionally, there is no evidence that Tc-99 activity at well FTF 12R is sourced by the FIPSL. While FTF 12R may also be impacted by naturally occurring radionuclides (most of the nonvolatile beta activity observed at FTF 12R is attributable to Pb-214 and Bi-214), the presence of Tc-99 was not explicitly addressed in SRNS-RP-2017-00073. Backward particle tracking could help determine the potential source of Tc-99 at FTF 12R, and provide support for the source of the Tc-99 present at well FTF 28.

The maximum tritium concentration occurred at well FTF 30D at a value of 42.8 pCi/ml in September 2016. Upgradient of FTF 30D tritium concentrations were stated to be very low suggesting that the tritium at FTF 30D was not sourced by the Tank Farm. The screen depth of FTF 30D is 213 to 223 ft (64 to 70 m) and is expected to be higher than the centerline of any plume released from the F-Area tanks based on modeling (see Table A-1 and ML12272A124). Nonetheless, DOE does not present any information to explain the source of the tritium at this well. DOE should provide additional information regarding the source of the tritium at FTF 30D. Backward particle tracking could help determine the potential source for the tritium at well FTF 30D.

Background well FBG 1D has been dry and unable to be sampled in recent monitoring events. While water levels are considered close to their average long-term values, the inability to sample groundwater from well FBG 1D during close to average groundwater level years limits its utility as a background well. DOE should consider construction of a new background well(s) in the future to ensure quality data are able to be collected in the future.

Review of HTF Environmental Monitoring Reports

As reported in the 2016 monitoring report, tritium was detected in HTF wells but was below the MCL of 20 pCi/ml in every well except for well HAA 12C, which had a maximum result of 60.8 pCi/mL[7]. DOE proposes the source of the tritium at HAA 12 is from the Off-Site Fuels Receiving Basin facility, the numerous process sewer lines in the area, and/or the nearby H-Area Inactive Process Sewer Line (HIPSL) that transported low-level radioactive wastewater from the separations facilities to the H-Area Seepage Basins. All other wells surrounding the HAA well cluster do not appear to be impacted. Backward particle tracking could improve support for the source of the tritium plume at HAA 12 wells.

In 2016, nonvolatile beta was less than the screening level of 50 pCi/L at all wells. However, in 2017 nonvolatile beta was measured above the screening level in Gordon Aquifer wells HAA-12A, HAA-13A, HAA-15A. The pH has been elevated at these three wells for many years usually ranging from 10 to 13.7. In 2014, specific isotopes were analyzed and naturally occurring Pb-214 and Bi-214 were determined to be the primary contributors to nonvolatile beta. The high pH at these three wells was stated to be the likely cause of naturally occurring Ra-226 to be soluble in the groundwater resulting in the nonvolatile beta activity (parent to Rn-222, and Pb-214, and Bi-214). No information was provided to support the assumption that elevated pH caused Ra-226 to be more soluble in groundwater. Although the nonvolatile beta activity may have been associated with naturally occurring radioactivity, DOE did not explain the source of the elevated pH in these wells. Elevated pH could also be an indication that the groundwater has been impacted by cementitious materials. While this could be caused by poor well construction or development, DOE should explain the cause of the elevated pH in these wells and establish key chemical signatures for contamination emanating from the tank farm facility.

In an effort to evaluate the efficacy of the FTF monitoring well network for detecting future releases of radioactivity from the FTF, NRC staff previously analyzed DOE's FTF Performance Assessment (SRS-REG-2007-00002, Rev. 1) calculations and ran DOE's saturated zone transport model created using the PORFLOW finite element code. The results of the evaluation are presented in ML12272A124 and summarized in Appendix A. A similar approach was taken to evaluate the HTF monitoring well network in this technical review report.

First, NRC staff matched tank farm features on a map that utilized the Universal Transverse Mercator (UTM) coordinate system to the map shown on Figure 4.4-55 in the HTF PA (SRR-CWDA-2010-00128, Rev. 1), which depicts the HTF local saturated zone transport model grid. This was necessary because only UTM coordinates were available for HTF wells (see SRNS-RP-2017-00073, Table 1), and these wells needed to be referenced to the local saturated zone transport model grid to create observation points in the local model at each HTF well location from the water table surface to the bottom of the Gordon Aquifer. Once the

[7] The historical maximum tritium result occurred in 1986 at well HTF 12 at a value of 355 pCi/mL (SRNS-RP-2012-00146, Revision 1).

observation points were created in the local model, the HTF PORFLOW model was run using the same Tc-99 release profile (i.e., the Tc-99 release profile was similar to the Tank 16 mass flux release profile) for each HTF tank. Tc-99 was chosen for the simulations because it is fairly mobile and long-lived (i.e., acts like a conservative tracer that would produce a fully developed plume in shorter simulation periods). After the model was run, concentrations were extracted from the model from the water table surface, vertically downward to the bottom of the model domain at each HTF well location and for every year. The output data file was sorted and analyzed to identify the time and vertical location of the point of maximum concentration (the concentration output file included the minimum and maximum concentration; and location of the minimum and maximum concentration for each year). Data on the peak concentration over time was used to identify the center-line of the plume and thus, the optimal well screen depth and elevation for detecting releases from the tank farm from various sources.

Based on NRC staff's evaluation, and similar to the NRC staff's findings for the FTF, NRC staff concludes that the HTF monitoring well network could be further optimized to help ensure releases from the HTF facility are detected. Table 1 lists each HTF well and provides an assessment of whether the well is screened at an appropriate depth in the aquifer to best detect releases from various sets of tanks (all sources, southern sources (Tanks 13-16, and Tanks 48-51), central sources (Tanks 21-24), and northern sources (Tanks 35-37, Tanks 29-32, Tanks 9-12, and Tanks 38-43)). The basis for placement of the HTF well screen intervals is unclear, as they do not always appear to be screened at the most appropriate depth based on the Performance Assessment (PORFLOW) saturated zone flow and transport model results when considering releases from tank sources (consideration of other FTF sources, hydrogeological, or other considerations may have influenced well screen placement). However, in general, NRC staff finds that many of the HTF wells are screened too high in the aquifer to detect HTF tank releases should they occur in the future, most notably for tank sources located to the south which travel a much further distance to the wells (plumes would typically be expected to be significantly lower than the HTF wells are screened in many cases). In the case of northern sources, some of the wells may be screened too deep. With regard to lateral placement of HTF wells, NRC staff also notes that there appears to be an area between HAA 15 and HAA 17 well series which may not have adequate coverage to pick up releases from certain eastern tank sources based on particle tracks depicted in Figure 7, which was reproduced from the HTF PA.

NRC staff suggests that when the monitoring well network is evaluated in the future, DOE contractors perform an evaluation using the HTF Performance Assessment (PORFLOW) model and provide input on the horizontal and vertical distribution of wells in the HTF monitoring network to DOE and its subcontractors. This effort should be focused on identifying well locations that would maximize the ability to detect HTF releases and minimize false negative monitoring well results. Adequate groundwater monitoring data could help provide support for Performance Assessment models and results, as well as provide direct evidence that the tank farm facilities are operating as intended. NRC staff will continue to monitor the basis for and adequacy of the HTF monitoring well network and field and chemical data collected, as tank farm closure progresses.

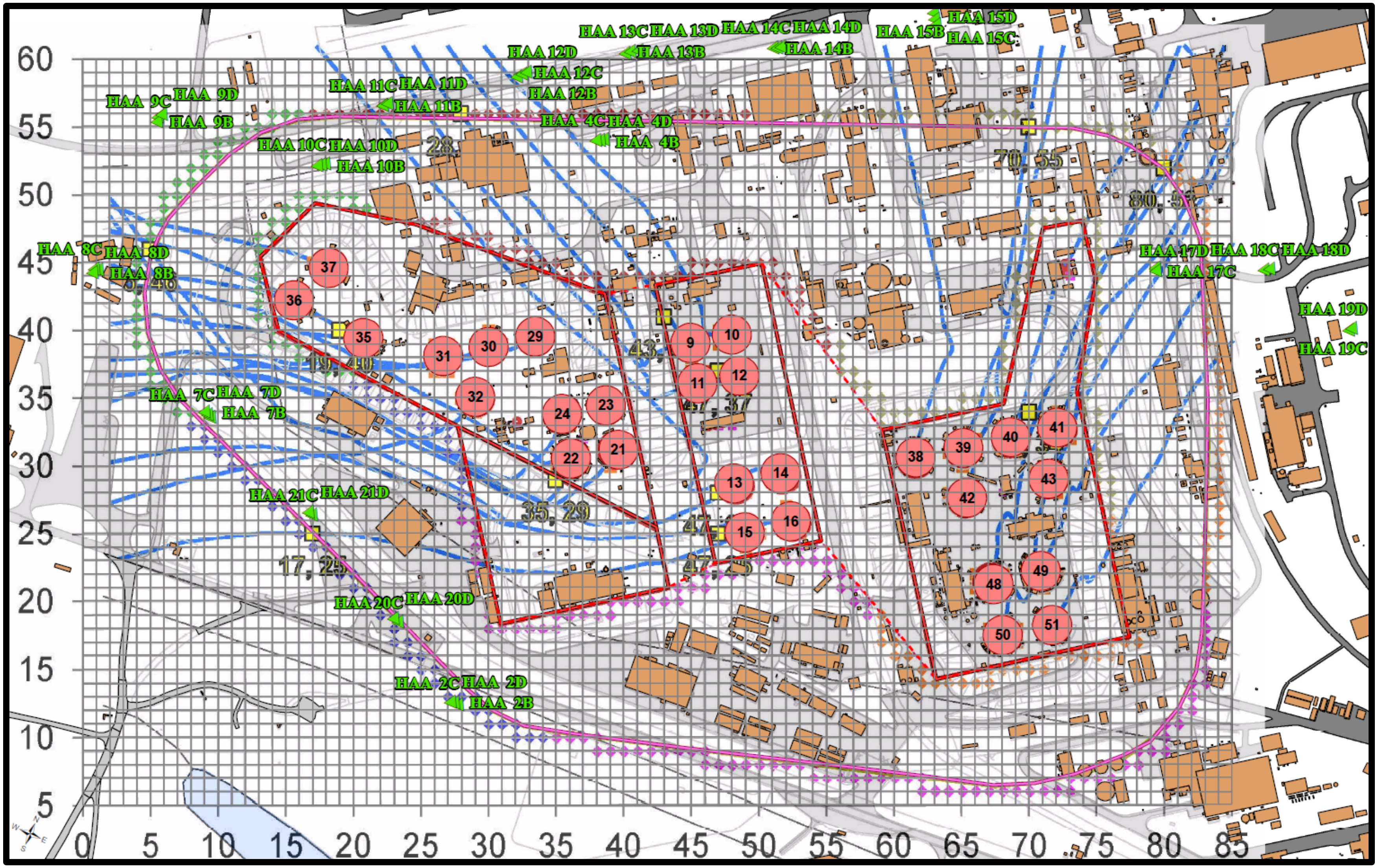

Figure 7 HTF Monitoring Well Locations in Relation to Stream Traces from HTF Tanks Illustrated in the HTF Performance Assessment Figure 4.4-55. Adapted from Figure 4.4-55 in SRR-CWDA-2010-00128, Rev. 1.

Table 1 NRC Staff's Evaluation of the Vertical Placement of HTF Monitoring Wells

Well ID	Ground Elev	X Coord	Y Coord	Screen Top	Screen Bottom	All Sources	Southern Sources	Central Sources	Nothern Sources
HAA 1A	290.9	0	0	104.9	94.9	ND	ND	ND	ND
HAA 1C	291.4	0	0	156.9	146.9	ND	ND	ND	ND
HAA 1D	291.8	0	0	280.9	260.9	ND	ND	ND	ND
HAA 2B	291.2	28	13	136.9	126.9	128	127	NA	NA
HAA 2C	290.9	28	13	181.9	171.9	128	127	174	NA
HAA 2D	290.8	28	13	280.5	260.4	128	127	174	NA
HAA 4B	298.9	39	55	127	116.5	149	128	174	150
HAA 4C	298.8	39	55	160.4	150.4	149	128	NA	150
HAA 4D	298.7	39	55	267.9	247.9	149	128	NA	150
HAA 7B	287.32	9	34	148.9	138.89	162	125	150	175
HAA 7C	287.17	9	34	190.9	180.9	162	125	150	175
HAA 7D	287.06	9	35	275.9	255.87	162	125	150	175
HAA 8B	287.14	2	45	147.9	137.9	137	127	NA	164
HAA 8C	287.05	2	45	185.9	175.9	137	127	NA	164
HAA 8D	287.07	1	45	275.9	255.9	ND	ND	ND	ND
HAA 9B	281.36	6	56	157.9	147.91	129	129	NA	139
HAA 9C	281.53	6	56	190.9	181.8	129	129	NA	139
HAA 9D	281.76	7	57	276.9	256.87	130	130	NA	139
HAA 10B	286.79	19	53	147.9	137.85	143	131	NA	149
HAA 10C	286.53	18	53	181.9	171.88	143	131	NA	149
HAA 10D	286.57	18	53	277.36	257.35	143	131	NA	149
HAA 11B	290.37	23	57	149.9	139.9	145	133	NA	151
HAA 11C	290.65	23	57	180.9	170.9	145	133	NA	151
HAA 11D	290.84	23	57	274.9	254.9	145	133	NA	151
HAA 12B	299.23	33	59	135.9	125.92	150	130	NA	150
HAA 12C	299.51	33	60	170.9	160.93	150	130	NA	150
HAA 12D	299.65	34	60	255.9	235.92	150	130	NA	150
HAA 13B	303.51	41	61	131	121.6	129	129	NA	150
HAA 13C	303.59	41	61	163.9	154.5	129	129	NA	150
HAA 13D	303.59	42	61	265.9	246.7	129	129	NA	150
HAA 14B	305.04	52	61	130.9	120.9	137	128	NA	137
HAA 14C	305.07	52	61	156.9	146.9	137	128	NA	137
HAA 14D	305.22	52	62	258.7	238.7	ND	ND	ND	ND
HAA 15B	308.33	64	64	121.9	111.89	ND	ND	ND	ND
HAA 15C	308.28	64	63	153.9	143.9	ND	ND	ND	ND
HAA 15D	308.16	64	63	258.65	238.63	ND	ND	ND	ND
HAA 17C	302.63	80	45	143.9	133.9	135	130	NA	147
HAA 17D	302.52	80	45	238.9	218.9	135	130	NA	147
HAA 18C	291.56	0	0	155.9	145.9	ND	ND	ND	ND
HAA 18D	291.37	0	0	249.9	229.9	ND	ND	ND	ND
HAA 19C	287.81	0	0	157.9	147.9	ND	ND	ND	ND
HAA 19D	287.58	0	0	264.9	249.9	ND	ND	ND	ND
HAA 20C	290.31	24	19	165.9	155.9	126	126	171	195
HAA 20D	290.16	24	19	246.9	226.9	126	126	171	195
HAA 21C	288.9	18	27	185.9	175.9	124	124	165	193
HAA 21D	288.88	17	27	256.9	236.9	125	125	164	193

Note: ND indicates that no data is available for the well because the well is not located in the local model domain. NA indicates that the well is not important to the source because it is laterally too distant from the source to be of primary importance. Blue colored cells signify that the well is screened high relative to the centerline of a plume which might emanate from the tank source listed should a release occur in the future, green colored cells signify that the well screen is optimally placed to detect releases from the tanks (yellow colored cells are very close to being optimally placed), and red colored cells signify that the well is screened low relative to the centerline of a plume which might emanate from the tank source listed should a release occur in the future. To determine the centerline of the plume, observation points were created at each well location from the water table down to the bottom of the model, and the location of the maximum concentration over time at each well location identified for each model run (for each set of tank sources).

Cross-Cutting Issues

DOE focuses on comparisons against MCLs in its tank farm monitoring reports, while MCLs are not relevant to providing support with respect to tank farm facility compliance with performance objectives in 10 CFR Part 61. Because the tank farm monitoring well network is being leveraged to provide early warning related to potential tank farm facility component releases, it would be prudent for DOE to establish action levels which would trigger further investigation based on the FTF and HTF Performance Assessments. Ideally, these action levels would consider information provided in the FTF and HTF Performance Assessments regarding chemical signatures which would signify potential tank farm facility component releases or provide information regarding performance of barriers to waste release (e.g., pH, Eh, analytical data on mobile radiological and chemical constituents). Performance assessment modeling could also be very valuable with respect to optimizing the monitoring well network and for performing particle tracking should elevated levels of key constituents be identified in groundwater. Finally, while DOE reports concentration results for comparison against MCLs, DOE should consider providing information about the dose (e.g., could provide pathway dose conversion factors [PDCFs] for various constituents of concern to provide information about the level of risk per unit concentration in groundwater). PDCFs could be used to establish trigger levels for key radionuclides of concern from FTF and HTF closure.

Teleconference or Meeting

None.

Follow-up Actions

Many of the technical issues discussed in this technical review report are similar to technical issues previously discussed in the technical report issued in 2015 which focused on evaluation of the FTF monitoring well network (ML12272A124). As indicated in ML12272A14, NRC staff will continue to monitor DOE's groundwater monitoring well network and groundwater monitoring well results to help provide support that the performance objectives in 10 CFR Part 61, Subpart C can be met for the FTF and HTF.

Open Issues

None.

Conclusions

The U.S. Nuclear Regulatory Commission (NRC) staff has performed technical reviews of environmental monitoring reports prepared by the U.S. Department of Energy (DOE) to support F-Area and H-Area Tank Farm Facilities (FTF and HTF) closure at Savannah River Site. This technical review report is related to Monitoring Factor 4.3, "Environmental Monitoring," listed in NRC staff's Monitoring Plan for the Tank Farm Facilities (Agencywide Documents Access and Management System Accession No. ML15238A761). The NRC staff concludes the following:

1. DOE has performed environmental monitoring that provides useful information on the hydrogeological systems at FTF and HTF. This information can also be used to better understand contaminant flow and transport at the tank farm facilities (TFFs) and

provide support for DOE Performance Assessment models.

2. Uncertainty exists in the source of contaminant plumes detected via the FTF and HTF monitoring well networks. A better understanding of contaminant flow and transport processes at the TFFs, and more extensive data analysis and interpretation could help reduce this uncertainty.

3. Performance assessment modeling and analysis should be better integrated with the groundwater monitoring program at the TFFs. For example, FTF and HTF monitoring well placement could be better optimized to detect releases from the TFFs should releases occur in the future. PORFLOW groundwater transport models are currently available but do not appear to be fully utilized to establish the monitoring well network, particularly to inform vertical placement of wells. Performance assessment modeling assumptions and results could be used to determine key constituents and field monitoring data which would provide the most useful information to evaluating performance of and detect early releases from the TFFs.

References

ML12272A124, *Technical Review of Environmental Monitoring and Site-Specific Distribution Coefficient Reports*, Memorandum to G.F. Suber, from C.S. Barr, and Thru C.A. McKenney, March 31, 2015.

SRNS-RP-2012-00146, Revision 1, *H-Area Tank Farm Groundwater Monitoring Plan and Sampling and Analysis Plan (U)*, ML15051A324, Prepared by: Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC 29808, November 2012.

SRNS-RP-2012-00287, Rev. 1, *F-Area Tank Farm Groundwater Sampling and Analysis Plan (U)*, ML15051A327, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC 29808, November 2012.

SRR-CWDA-2010-00128, Rev. 1, *Performance Assessment for the H-Area Tank Farm at the Savannah River Site*, ML111290317, Savannah River Remediation, LLC, Aiken, South Carolina, November 2012.

SRS-REG-2007-00002 Rev 1, *Performance Assessment for the F-Tank Farm at the Savannah River Site*, ML102850339, Savannah River Remediation, LLC, Aiken, SC, March 31, 2010.

Appendix A

Table A-1 provides results of NRC staff's evaluation of the FTF monitoring well network documented in ML12272A124. Table A-1 indicates, based on PORFLOW modeling whether FTF wells are optimally placed to detect releases from "western sources" at the FTF (i.e., Tanks 17, 18, 19, 20, 25, 26, 27, 28, 44, 45, 46, and 47) and "eastern sources" at the FTF (i.e., Tanks 1, 2, 3, 4, 5, 6, 7, and 8). Figure A-2 illustrates FTF monitoring wells in relation to stream traces from FTF tanks taken from Performance Assessment modeling, which provides information to evaluate the lateral placement of FTF wells to detect releases from the FTF tanks.

FTF Well	Screen Interval	Western Sources	Eastern Sources	Assessment of Well Location and Screen Depth
FTF 9R	203-212	--	Tanks 1 and 2	Screen depth high for eastern sources.
FTF 12R	195-205	Tanks 19 and 20	Tanks 3 and 4	Screen depth okay for western sources. Screen depth high for eastern sources.
FTF 19	198-228	Tank 44	Tanks 5 and 6	Not aligned well, but screen depth okay for western sources. Screen depth high for eastern sources.
FTF 20	198-228	Tanks 25 and 44	Tanks 7 and 8	Screen depth little high but okay for western sources. Screen depth high for eastern sources.
FTF 22	212-242	Tanks 27 and 46	--	Screen depth high for western sources.
FTF 23	201-231	Tank 47	Tanks 33 and 34	Screen depth okay but a little high for western sources. Screen depth okay but a little high for eastern sources.
FTF 28	151-161	--	Tanks 5 and 6	Screen depth high for eastern sources.
FTF 29	157-177	--	Tank 1 and 2	Screen depth high for eastern sources.
FTF 30	183-193	Tanks 26 and 45	--	Screen depth little low for western sources.
FTF 30D	213-223	Tanks 26 and 45	--	Screen depth high for western sources.
FTF 31	186-196[4]	--	Tanks 33 and 34	Screen depth okay for eastern sources.

Table A-1: Assessment of FTF Monitoring Well Network Based on Figure 3 in ML12272A124 and PORFLOW Model Simulations.

[4] Note that SRNS-RP-2014-00226 indicates that the screen depth for FTF 31 is 76-106 ft. This is different than the screen depth reported in a data report with FTF well construction details provided as a follow-up action item from the September 26-27, 2012, Onsite Observation (ML12299A188) of 96-106 ft.

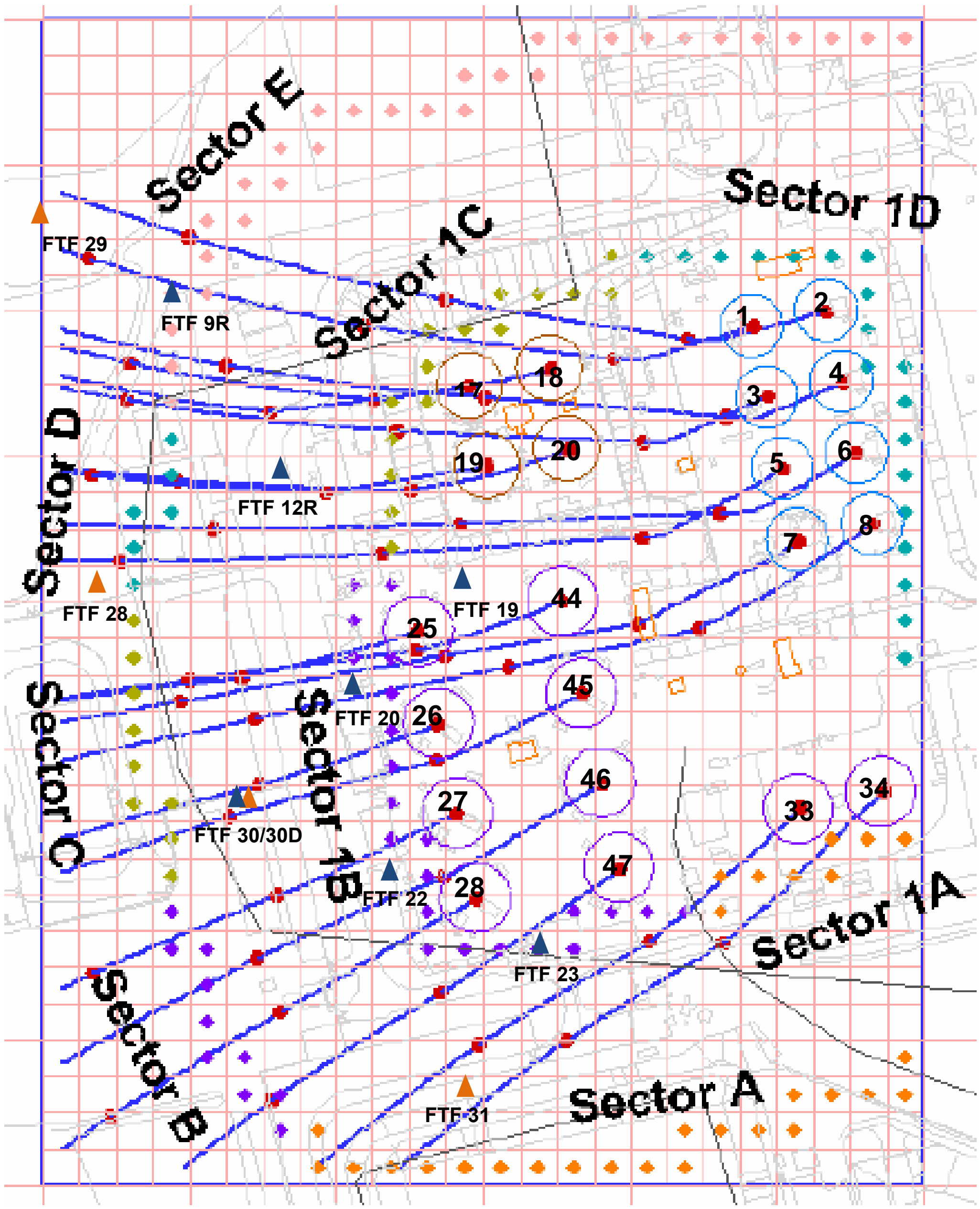

Figure A-1: Stream Traces from FTF Tanks, FTF Local Model Grid, and FTF Well Locations Assigned to Model Cells. Adapted from Figure 5.2-5, SRS-REG-2007-00002, Rev. 1.