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Characterization of SDU 6 East Sump Water Samples

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EXECUTIVE SUMMARY

This report details results from characterization of the Saltstone Disposal Unit 6 (SDU 6) East Sump water samples. In March of 2022, Saltstone Radiation Protection Department (RPD) personnel reported SDU 6 East Sump beta/gamma radiation levels at ~ 33 dpm/mL (~ 15 pCi/mL) beta/gamma in excess of the water sampling limit of 16 dpm/mL (7.2 pCi/mL). Replicate samples obtained from the SDU 6 East Sump were sent to the Savannah River National Laboratory (SRNL) for analysis to include pH, limited anions, toxic metals and radionuclides. Subsequent sump samples associated with SDU 7 that has not yet been filled with any radioactive material were also analyzed at SRNL for both nitrate and nitrite.

Based on the analytical results obtained from the SDU 6 East Sump samples, the following conclusions can be made:

- Chemical analysis of the SDU 6 sump samples indicate that this water is likely associated or contaminated with the contents of radioactive saltstone made with Tank 50 Decontaminated Salt Solution (DSS)[a] in the SDU 6.
    - The measured pH values show elevation from neutral water that is presumed to be related to the caustic grout.
    - Measured nitrate and nitrite concentrations from SDU 6 sump are in the same ratio of Tank 50 DSS but only present at ~ 0.5% of the Tank 50 concentrations. Comparison of the SDU 6 nitrate and nitrite average levels of 560 mg/L and 115 mg/L, respectively, to similar analysis for SDU 7 showing no detectable nitrate and nitrite, suggests that the SDU 6 sump samples are contaminated with Tank 50 DSS constituents.
    - All Resource Conservation and Recovery Act (RCRA) metals analyzed in the samples are below detection limit except for Ba with an average value of 0.26 ± 0.14 mg/L. Thus, the aqueous SDU 6 sump samples are considered non-toxic for RCRA metals per the RCRA regulatory toxicity limits.

- Radiochemical analysis of the SDU 6 sump samples also suggest presence of SDU 6 radioactive components.
    - The combined concentrations for nonvolatile beta, Tc-99 and I-129 determined by SRNL are in the range of the preliminary water radiochemical sampling results performed by SDU RPD personnel.
    - A single detectable value for tritium of 8.8 dpm/mL (4.0 pCi/mL) was measured for the Sump 2 sample with the other tritium values being below the detection limit of <6.9 dpm/mL (<3.1 pCi/mL). Final alpha decay measurements indicate alpha concentrations of 3.0 dpm/mL ± 1.3 dpm/mL (1.4 pCi/mL ± 0.59 pCi/mL). This average alpha concentration is similar to the alpha limit for water sampling of 3 dpm/mL (1.4 pCi/mL).
    - No detectable concentrations of Sr-90 or Cs-137 radionuclides are present in the sump samples. These two prominent Tank 50 radionuclides are likely not present in the sump water due to interactions with both the saltstone and the upper concrete mud mat layer beneath the saltstone. Sr^{2+} behaves similarly to Ca^{2+}, having strong chemical binding in the cement microstructure. Cs^{+} has an increased affinity for granite aggregate and sand within the upper concrete mud mat layer beneath the SDU 6 relative to the radionuclides detected in the sump samples.

[a] Tank 50 salt solution primarily contains DSS from the Salt Waste Processing Facility and other smaller amounts of Tank Closure Cesium Removal (TCCR) effluent and Effluent Treatment Plant (ETP) aqueous transfers.

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LIST OF ABBREVIATIONS

CP&C	Chemical Process and Characterization
DMA	Direct Mercury Analyzer
ELN	Electronic Laboratory Notebook
GFPC	Gas Flow Proportional Counter
IC	Ion Chromatography
ICP-AES	Inductively Coupled Plasma Atomic Emission Spectrometry
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
LIMS	Laboratory Information Management System
PA	Performance Assessment
RCRA	Resource Conservation and Recovery Act
RPD	Radiological Protection Department
RSD	Relative Standard Deviation
SDF	Saltstone Disposal Facility
SDU	Saltstone Disposal Unit
SRNL	Savannah River National Laboratory
SRMC	Savannah River Mission Completion
SRS	Savannah River Site
SWPF	Salt Waste Production Facility
TAR	Task Assistance Request
TCCR	Tank Closure Cesium Removal
TCLP	Toxicity Characteristic Leaching Procedure

1.0 Introduction

The Savannah River National Laboratory (SRNL) recently received aqueous samples from the Saltstone Disposal Unit 6 (SDU 6) East Sump in the Saltstone Disposal Facility (SDF). These samples were produced from routine sampling of the SDU 6 East Sump in early March 2022. As described in Reference 1, the SDU sumps comprise a leak detection system that collects any liquids from beneath the SDU concrete floor. A Geosynthetic Clay Liner (GCL) Geotextile and a High-Density Polyethylene (HDPE) Geomembrane are located between the lower and upper concrete mud mats to form a composite hydraulic barrier beneath the SDU. Four liquid collection sumps are installed outside the SDU foundation perimeter, 90 degrees apart, and provide a means to sample any collected liquid for analysis of potential chemical and radiological constituents. The sumps are 1 foot deep, 16 inches in diameter, comprised of HDPE pipe filled with #57 stone to reduce the flammable vapor space in the sumps.[1]

SDF Radiological Protection Department (RPD) personnel reported initial results from the SDU 6 East Sump of 33 dpm/mL (~ 15 pCi/mL) beta-gamma in excess of the water sampling free release limit of 16 dpm/mL (7.2 pCi/mL).[2] SDF requested, through a Technical Assistance Request (TAR),[3] characterization of the sump water samples for various analytes including pH, nitrate and nitrite, Resource Conservation and Recovery Act (RCRA) toxic metals (arsenic, barium, cadmium, chromium, lead, mercury and silver). Initial radionuclide analyses included tritium, iodine-129, cesium-137 and technecium-99. Strontium-90 was also later added to the analysis list via communication between SRNL and SDF personnel. This group of analytes was determined from consideration of various species that are routinely measured in characterization of Tank 50 Salt Solution Sample Waste Acceptance Criteria (WAC)[4,5] and for the RCRA metals associated with Toxicity Characteristic Leaching Procedure (TCLP) analysis of grout produced from actual Tank 50 salt solution.[6] The radionuclides I-129, Tc-99, Cs-137, and Sr-90 are also mentioned in the Performance Assessment (PA) for the SDF as potentially the most mobile (I-129 and Tc-99) and having the highest inventories (Cs-137 and Sr-90).[7] Due to the relatively short half-lives of both Cs-137 and Sr-90 of approximately 30 years, only I-129 and Tc-99 are predicted to produce long-term dose risk within the first 1,000 to 10,000 years or more after the SDU closure cap is installed.[7]

2.0 Experimental

2.1 Visual Observation

SDU 6 Sump water samples were received at SRNL on March 15, 2022. Table 1 shows the identified radiation monitoring results provided by SDF RPD for the three sump samples obtained by pumping, and the single sample obtained by a dip-sample method. These results, which accompanied the samples upon receipt at SRNL, were obtained using the water sampling methods and represent total nonvolatile beta-gamma species since that method uses planchets that are heated to dryness before counting.[2] The relevant sample information provided by SDF for these samples, as well as other information described in this report, is recorded for permanent retention in the SRNL Electronic Laboratory Notebook (ELN) within notebook B9108-00327-21[8]

Corresponding SRNL Chemical Process & Characterization (CP&C) analytical Laboratory Information Management System (LIMS) numbers are also shown for each sample in the bottom row. All SDF RPD measured beta-gamma values are above the beta-gamma threshold limit of 16 dpm/mL (7.2 pCi/mL). Each individual sump sample was received in a 250-mL plastic bottle that was bagged with a RPD radiation label for dose rate information. Each of these four samples was packaged in its own paint can outer container and these packages were transported to SRNL E-wing radioactive sample receiving area from the SDF. Each of the samples was then placed in a SRNL analytical laboratory radiochemical hood where they were removed from the outer paint can and plastic bag packaging. The radiochemical hood used for this initial preparation is one known to be relatively free of any fixed or transferrable contamination. Figure 1 shows the three sump samples from left to right obtained by pumping and the single dip sample (before SRNL analytical labeling) on right. There are visible trace insoluble solids in the pumped samples. Per conversations with SDU personnel, these solids are thought to be associated with the carbon steel lines associated with the pump equipment. The dip sample appears to be clear and contains no observable solids. A high-purity water sample (not shown in Figure 1) obtained from a Milli-Q water purification system within SRNL with nominal >18 Mohm·cm resistivity was also included in the analyses as a control/blank sample.

Table 1. Summary SDF SDU 6 Sump Sample Identification and Data Supplied by SDF RPD

Sample 37, 1 of 2	Sample 37, 2 of 2	Sample 39	Sample 38 (Dip Sample)
Collected 3/14/2022, 17:15	Collected 3/14/2022, 17:15	Collected 3/12/2022, 16:00	Collected 3/14/2022, 17:00
47.4 dpm/mL (21.4 pCi/mL) Beta-Gamma	47.4 dpm/mL (21.4 pCi/mL) Beta-Gamma	47.4 dpm/mL (21.4 pCi/mL) Beta-Gamma	29.7 dpm/mL (13.4 pCi/mL) Beta-Gamma
pH = 9	pH = 9	pH = 9	pH = 8
Sample 1, SRNL 25882	Sample 2, SRNL 25883	Sample 3, SRNL 25884	Dip Sample, SRNL 25910

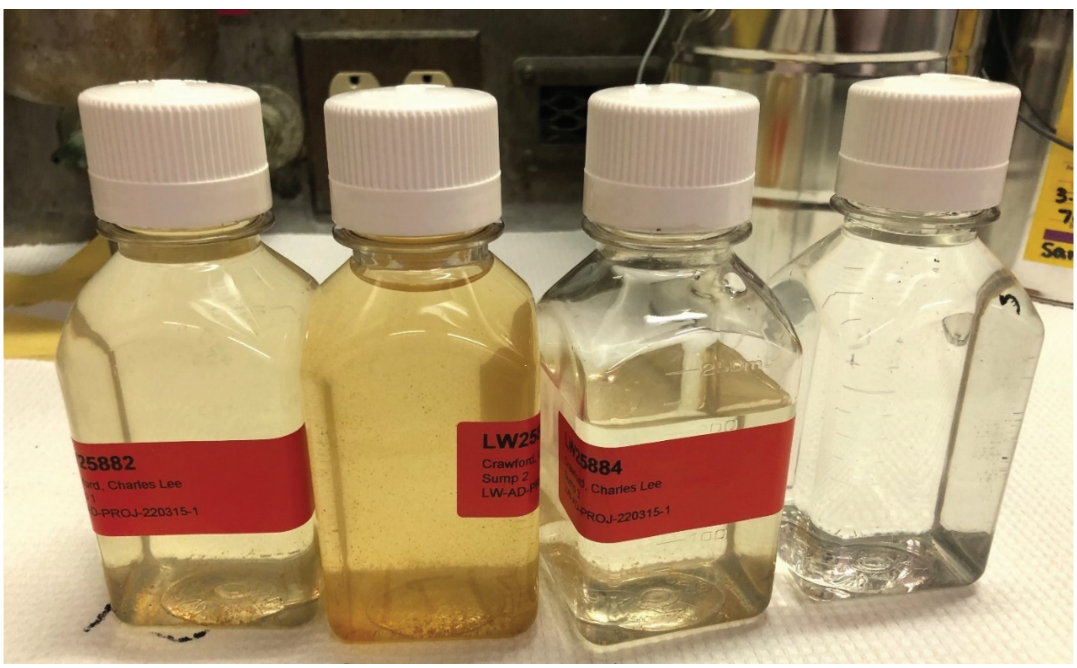

Figure 1. SDU 6 East Sump Samples. Three Samples on Left are SDU 6 Sump Pump Samples and Sample on Right is a Dip-Sample from the SDU 6 Sump.

2.2 Analysis Methods for the Sump Samples

The four aqueous sump samples and a high purity water blank were analyzed by SRNL CP&C personnel for pH using a titration method and for nitrate and nitrite anions using Ion Chromatography (IC). The RCRA metals were measured using Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES) including Direct Mercury Analysis (DMA) for mercury and Inductively Coupled Plasma- Mass Spectroscopy (ICP-MS) for arsenic and selenium. Individual radiochemical counting methods were applied for tritium, iodine-129, cesium-137, technecium-99 and strontium-90. The I-129, Tc-99 and Sr-90 involved separation steps in the radiochemical methods. Gross alpha and gross nonvolatile beta analysis were performed using Gas-Flow Proportional Counters (GFPC). GFPC involves heated planchets to take liquid aliquots to dryness before counting. Care was taken to minimize any laboratory radiochemical contamination of these sump water samples within SRNL analytical laboratories. SRNL analytical laboratories has experience working with low dose aqueous samples, for example in the ongoing radiochemical analysis of SRMC tank farm evaporator overhead samples. For these sump samples, an initial large aliquot was obtained to support all the radiochemical analyses before transferring the remainder of the samples over to other analytical labs that perform non-radiochemical counting analysis on contaminated samples, i.e., DMA, ICP-AES, ICP-MS. In this manner the initial aliquots could be uniquely handled by radiochemical analysis personnel without the possibility of cross contamination from the other non-radiochemical analysis labs that routinely handle contaminated samples.

2.3 Quality Assurance

Quality Assurance requirements for performing reviews of technical reports and the extent of review are established in manual E7 2.60.[9] SRNL documents the extent and type of review using the SRNL Technical Report Design Checklist contained in WSRC-IM-2002-00011, Rev. 2.[10] The customer requested that this work be conducted under guidance of a TAR which represents nonbaseline activities within the SDF.[3] The data described in this report is recorded for permanent retention in the Electronic Laboratory Notebook (ELN) within notebook B9108-00327-21.[8]

3.0 Results and Discussion

3.1 Chemical Analyses

Results of the pH measurements and chemical analysis for nitrate, nitrite and RCRA metals are shown in Table 2. The standard deviations shown represent the 1-sigma uncertainty in averaging all four of the sump samples. A percent Relative Standard Deviation (%RSD) is calculated by dividing the average value by the standard deviation and multiplying that result by 100. The pH values for the sump samples are measured to be average 7.76 ± 0.88 which is within agreement of the initial pH measurement range from the SDF at pH = 8 to 9. These pH values showing some elevation in caustic compared to pure water (pH = 7) or natural water in contact with air (pH = 5-7) could be indication that the sump water is associated or contaminated with the caustic grout in SDU 6. The nitrate and nitrite concentrations show a similar ratio to their concentrations in Tank 50 supernate ([nitrite]/[nitrate] = 0.2). However, these reported sump concentrations for both anions are ~ 0.5% of the levels contained in Tank 50 salt solution.[5] SDU personnel also obtained duplicate sump samples from the SDU 7 unit as a comparison to the results from SDU 6. No radioactive material has been placed in SDU 7. Initial analysis by SDU RPD personnel indicated that these SDU 7 sump samples were under the water sampling limits of 16 dpm/mL (7.2 pCi/mL) beta-gamma and 3 dpm/mL (1.4 pCi/mL) alpha. The SDU 7 samples were then transferred to SRNL with the request to analyze for nitrate and nitrite concentrations. No detectable nitrate or nitrite was found in the SDU 7 samples to the IC detection limit of 1 mg/L.

All RCRA metals shown in Table 2 are below detection limit except for Ba with an average value of 0.26 ± 0.14 mg/L. Thus the aqueous SDU 6 sump samples are considered non-toxic for RCRA metals per the RCRA regulatory toxicity limits.[6] The only measurable RCRA metals typically found in Tank 50 salt solution are Cr, Pb and Hg.[5]

Table 2. SDU 6 Sump Analyses for pH, Anions and RCRA Metals

Sample ID	SRNL LIMS Number	pH	Nitrate	Nitrite	Ba	Cd	Pb	Ag	Cr	As	Se	Hg
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Sample 1	25882	7.46	594	113	0.228	< 1.0E-03	< 5.6E-02	< 1.7E-03	< 1.0E-02	< 5.0E-03	< 5.0E-03	< 1.0E-02
Sample 2	25883	7.92	559	108	0.200	< 1.0E-03	< 5.6E-02	< 1.7E-03	< 1.0E-02	< 5.0E-03	< 5.0E-03	< 1.0E-02
Sample 3	25884	6.77	525	115	0.468	< 1.0E-03	< 5.6E-02	< 1.7E-03	< 1.0E-02	< 5.0E-03	< 5.0E-03	< 1.0E-02
Dip Sample	25910	8.87	565	125	0.154	< 1.0E-03	< 5.6E-02	< 1.7E-03	< 1.0E-02	< 5.0E-03	< 5.0E-03	< 1.0E-02
Control Blank	25885	--	<10	<10	<1.0E-03	<1.0E-03	<5.6E-02	<1.7E-03	<1.0E-02	<5.0E-03	<5.0E-03	<1.0E-02
Avg. All	--	7.76	560.75	115.25	0.26	--	--	--	--	--	--	--
St.Dev. Sump	--	0.88	28.31	7.14	0.14	--	--	--	--	--	--	--
%RSD	--	11	5	6	53	--	--	--	--	--	--	--

3.2 Radiochemical Analyses

Radiochemical analyses are presented in Table 3. No detectable Cs-137 from gamma scan counting on 50-mL aliquots was found in any of the sump samples for either the initial short 1,000 seconds counting attempt or the extended 50,000 seconds counting routine. By applying a longer gamma scan counting time, the original detection limits shown for Cs-137 in the range of <0.97 dpm/mL to <1.1 dpm/mL (<0.44 pCi/mL to <0.50 pCi/mL), were reduced to the range of <0.16 dpm/mL to <0.19 dpm/mL (<0.072 pCi/mL to <0.086 pCi/mL). A single detectable value for tritium of 8.8 dpm/mL (4.0 pCi/mL) is shown for sample 2 with the other tritium values being below the detection limit of <6.9 dpm/mL (<3.1 pCi/mL).

GFPC for alpha and beta emitters was initially performed on 3/18/2022 and these same samples were recounted later on 3/21/2022. A relatively high alpha value is shown for sample 3 of 84 dpm/mL (38 pCi/mL) compared to the others in the range of 1.9 to 3.2 dpm/mL (0.86 pCi/mL to 1.4 pCi/mL). The latter recount for alpha showed all sump sample values in the range of 1.7 dpm/mL to 4.4 dpm/mL (0.77 pCi/mL to 2.0 pCi/mL) along with the control water blank sample at <0.27 dpm/mL (<0.12 pCi/mL). The relatively large drop in alpha activity in sample 3 after the three-day delayed counting is attributed to initial presence of relatively short-lived radon. The source of the proposed radon is not known, e.g., it could have been an airborne contaminant particle or it could have been in the sample. The common radon isotopes and their half-lives are Rn-219 ($t_{1/2}$ = 4 sec), Rn-220 ($t_{1/2}$ = 56 sec) and Rn-222 ($t_{1/2}$ = 3.8 day).[11] Similar delayed GFPC recounting of nonvolatile beta indicates similar results to the initial beta counting which suggests there are no short-lived non-volatile beta emitters in the sump samples. None of the radon isotopes are measured in routine Tank 50 WAC.[4] Radium isotopes Ra-226 and Ra-228 are typically measured at less than detection for Tank 50.[5] Ra-226 is an alpha emitter with half-life of 1.6E+03 years that produces Rn-222 as a daughter decay product.[11] Ra-224, which is not analyzed in the Tank 50 WAC, is and alpha emitter with half-life of 3.66 days that produces Rn-220 as a daughter decay product.[11]

Table 3 shows that the sump samples contain average values of 0.28 ± 0.03 dpm/mL (0.13 ± 0.01 pCi/mL) for I-129 and 18.8 ± 9.2 dpm/mL (8.5 ± 4.1 pCi/mL) for Tc-99. The Sr-90 analysis involves a separation step using resins that strip out pure Sr-90 from a mixture of radionuclides. After separation of the Sr-90, the daughter radioisotope Y-90 is allowed to reach radiological equilibrium and both isotopes are then analyzed to maximize the sensitivity of the analysis. The detection limits shown in the range of <0.98 dpm/mL to <1.9 dpm/mL (<0.44 pCi/mL to <0.86 pCi/mL) could be lowered in future analyses if desired by using a larger volume of sample, using an ultra-low background liquid scintillation counter, and/or by extending the overall analysis period, i.e., ingrowth of Y-90, to greater than the period allowed in this analysis. The current analyses were performed using 10-mL aliquots with a post-separation ingrowth period of ~ 3 days (allowing only ~50% of the possible Y-90 activity to grow in).

The measured concentrations from these radiochemical methods (non-volatile beta, Tc-99 and I-129) suggest that the sump water is associated or contaminated with the radioactive contents of the SDU 6. Both Cs-137 and Sr-90 are among the highest concentrations of radionuclides present in Tank 50,[5] however they are not detectable in the sump water. Assuming from the other radiochemical analyses that the sump water does contain SDU 6 species, it could be expected that Cs-137 and/or Sr-90 might also be detectable. Preliminary discussions held between SRNL and SDU personnel have offered some possible explanations as to the lack of detectable Cs-137 and Sr-90 in the sump water. These two prominent Tank 50 radionuclides are likely not present in the sump water due to interactions with both the saltstone and the upper concrete mud mat layer beneath.[7] Sr^{2+} cation is similar to Ca^{2+} and could also be chemically bound in the saltstone matrix limiting its mobility. The role of calcium in cement is to form calcium silicate hydrates which form the interlocking chemical structure of cured cement product. The Cs^{+} cation likely sorbs to mineral components within the upper layer of Type II concrete mud mat that is directly above the 100-mil HDPE geomembrane and geosynthetic clay liner, located below the base of the SDU 6.[7] Cs^{+} has a high affinity for mineral phase within the granite aggregate[12] used in the mud mat layers while also having an increased affinity for sand relative to the radionuclides detected in the sump.[7] The sand and granite content of the mud mats are 74% by weight of the concrete mix used.[13]

Table 3. SDU 6 Sump Sample Radiochemical Analysis Results

	SRNL		Extended Count		3/18/2022	3/21/2022	3/18/2022	3/21/2022			
Sample ID	LIMS Number	Cs-137	Cs-137	Tritium	Alpha	Alpha	Non-volatile Beta	Non-volatile Beta	I-129	Tc-99	Sr-90
		dpm/mL	dpm/mL	dpm/mL	dpm/mL	dpm/mL	dpm/mL	dpm/mL	dpm/mL	dpm/mL	dpm/mL
Sample 1	25882	<1.0E+00	<1.6E-01	<6.9E+00	3.2E+00	2.3E+00	3.5E+01	3.1E+01	3.2E-01	1.2E+01	<9.8E-01
Sample 2	25883	<1.1E+00	<1.7E-01	8.8E+00	1.9E+00	1.7E+00	3.1E+01	3.1E+01	2.6E-01	1.0E+01	<1.6E+00
Sample 3	25884	<9.7E-01	<1.6E-01	<6.9E+00	8.4E+01	4.4E+00	4.0E+01	4.4E+01	2.5E-01	2.5E+01	<1.9E+00
Dip Sample	25910	<1.1E+00	<1.9E-01	<6.9E+00	2.9E+00	3.7E+00	4.6E+01	4.8E+01	2.9E-01	2.9E+01	<1.5E+00
Control Blank	25885	<9.5E-01	<1.7E-01	<6.9E+00	<1.1E+00	<2.7E-01	<1.6E+00	<1.7E+00	< 3.0E-02	<7.3E-01	<1.7E+00
Avg. All	--	--	--	8.8*	22.9	3.0	38.1	38.6	0.28	18.8	--
St.Dev. Sump	--	--	--	--	40.4	1.3	6.5	8.7	0.03	9.2	--
%RSD	--	--	--	--	177	42	17	23	10	49	--

*Only a single detectable value was determined from the four sump samples

4.0 Conclusions

Based on the analytical results obtained from the SDU 6 East Sump samples, the following conclusions can be made:

- Chemical analysis of the SDU 6 sump samples indicate that this water is likely associated or contaminated with the contents of Tank 50 material in the SDU 6.
    - The measured pH values show elevation from neutral water that is presumed to be related to the caustic grout.
    - Measured nitrate and nitrite concentrations from SDU 6 sump are in the same ratio of Tank 50 material but only present at ~ 0.5% of the Tank 50 concentrations. Comparison of the SDU 6 nitrate and nitrite average levels of 560 mg/L any 115 mg/L, respectively, to similar analysis for SDU 7 showing no detectable nitrate and nitrite, suggests that the SDU 6 sump samples are indeed contaminated with Tank 50 grout components.
    - All Resource Conservation and Recovery Act (RCRA) metals analyzed in the samples are below detection limit except for Ba with an average value of 0.26 ± 0.14 mg/L. Thus, the aqueous SDU 6 sump samples are considered non-toxic for RCRA metals per the RCRA regulatory toxicity limits.

- Radiochemical analysis of the SDU 6 sump samples also suggest presence of SDU 6 radioactive components.
    - The combined concentrations for nonvolatile beta, Tc-99 and I-129 determined by SRNL are in the range of the preliminary water radiochemical sampling results performed by SDU RPD personnel. The Tc-99 and I-129 concentrations are less than 0.03% and 0.06% of the Tank 50 concentrations for Tc-99 and I-129, respectively.
    - A single detectable value for tritium of 8.8 dpm/mL (4.0 pCi/mL) was measured for the Sump 2 sample with the other tritium values being below the detection limit of <6.9 dpm/mL (<3.1 pCi/mL). Final alpha decay measurements indicate alpha concentrations of 3.0 dpm/mL ± 1.3 dpm/mL (1.4 pCi/mL ± 0.59 pCi/mL). This average alpha concentration is similar to the alpha limit for water sampling of 3 dpm/mL (1.4 pCi/mL).
    - No detectable concentrations of Sr-90 or Cs-137 radionuclides are present in the sump samples. These two prominent Tank 50 radionuclides are likely not present in the sump water due to interactions with both the saltstone grout and concrete mud mat layers beneath. Sr^{2+} behaves similarly to Ca^{2+}, having strong chemical binding in the cement microstructure. Cs^{+} has an increased affinity for granite aggregate and sand within the concrete mud mat layers beneath the SDU 6 relative to the radionuclides detected in the sump samples.

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M. H. Doyle	J. D. Rahming
R. E. Edwards	W. G. Ramsey
P. J. Flores	J. W. Ray
C. M. Gregory	P. J. Riley
D. G. Harmon	L. B. Romanowski
S. J. Harrington	K. H. Rosenberger
B. Harris	E. T. Sadowski
E. W. Harrison	A. Samadi-Dezfouli
C. C. Herman	D. P. Skiff
K. A. Hill	F. M. Smith
P. J. Hill	A. V. Staub
R. M. Hoeppel	M. E. Stone
S. Hommel	P. C. Suggs
A. T. Hooker	L. F. Templeton
T. H. Huff	N. Travljanin
H. M. Hunter	K. R. Wells
J. F. Iaukea	B. J. Wiedenman
V. Jain	T. L. White
W. C. Jolin	M. L. Whitehead
R. C. Jolly	A. W. Wiggins
A. W. Jung	Records Administration (EDWS)
J. S. Kirk	