SEPARATIONS PROCESS RESEARCH UNIT DISPOSITION PROJECT

SEPARATIONS PROCESS RESEARCH UNIT RADIOLOGICAL CLEANUP REPORT

SPRU EEC-20-002

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Summary

The radiological remediation of the Separations Process Research Unit on the Knolls Atomic Power Laboratory site has been completed under DOE Contract No: DE-AM09-05SR22414, Task Order DE-AT30-08CC60014/SP16. Verification that the remediation has achieved the required cleanup criteria has been demonstrated in a series of Final Status Survey (FSS) Reports and approved by the DOE SPRU Field Office. This Radiological Cleanup Report summarizes the remediation activities and compiles the associated FSS reports and associated independent verification reports to document completion of the overall cleanup activities.

Contents

List of Tables

List of Figures

List of Attachments

Attachment 1 ORISE Verification Report DCN 5309-SR-01-0, Lower Level

Attachment 2 ORISE Verification Report DCN 5309-LT-03-1, Administration Area

Attachment 3 ORISE Verification Report DCN 5309-SR-02-0, Upper Level

List of Appendices

SURVEY UNIT	REPORT NUMBER	Appendix	SAP NUMBER	Appendix
SU-40	SPRU-EEC-18-028	A	SPRU-SAP-SU-40	AA
SU-41	SPRU-EEC-18-009	B	SPRU-SAP-SU-41	BB
SU-42	SPRU-EEC-18-010	C	SPRU-SAP-SU-42	CC
SU-43	SPRU-EEC-18-011	D	SPRU-SAP-SU-43	DD
SU-44	SPRU-EEC-18-012	E	SPRU-SAP-SU-44	EE
SU-51	SPRU-EEC-17-008	F	SPRU-SAP-SU-51	FF
SU-52	SPRU-EEC-18-006	G	SPRU-SAP-SU-52	GG
SU-53	SPRU-EEC-18-013	H	SPRU-SAP-SU-53	HH
SU-54	SPRU-EEC-18-008	I	SPRU-SAP-SU-54	II
SU-55	SPRU-EEC-18-014	J	SPRU-SAP-SU-55	JJ
SU-56	SPRU-EEC-18-007	K	SPRU-SAP-SU-56	KK
SU-57	SPRU-EEC-18-015	L	SPRU-SAP-SU-57	LL
SU-58	SPRU-EEC-18-016	M	SPRU-SAP-SU-58	MM
SU-60	SPRU-EEC-18-017	N	SPRU-SAP-SU-60	NN
SU-63	SPRU-EEC-18-005	O	SPRU-SAP-SU-63	OO
SU-64	SPRU-EEC-18-020	P	SPRU-SAP-SU-64	PP
SU-65	SPRU-EEC-18-018	Q	SPRU-SAP-SU-65	QQ
SU-70	SPRU-EEC-18-021	R	SPRU-SAP-SU-70	RR
G1 Wall/Roof	SPRU-EEC-18-025	S	SPRU-SAP-G1 Building	SS
F Building Wall	SPRU-EEC-19-001	T		
G1 Wall	MEMO-SPRU-17-023	U		

Introduction

The objectives of the Separations Process Research Unit Disposition Project (SPRU DP) were to conduct the:

- Deactivation, demolition, and removal of the SPRU nuclear facilities;
- Cleanup and environmental restoration of the underlying and surrounding contaminated soil; and,
- Decontamination of piping tunnel connecting the SPRU facilities to other operating facilities.

The field work to accomplish these objectives was performed during the period from 2010 – 2019. The radiological cleanup of the SPRU facilities and associated environmental media was conducted to meet the clean-up criteria specified in the Task Order, as documented in a series of reports consistent with the guidance in the Multi-Agency Radiological Site Survey and Investigation Manual (MARSSIM). This Radiological Cleanup Report summarizes the activities undertaken to accomplish the cleanup as well as the associated documentation.

Survey and sampling results demonstrated that the radiological conditions on the remediated SPRU site meet the relevant cleanup criteria with the exception of some limited areas on the remaining portion of the wall that was common between the since-removed G2 Building and the remaining G1 Building. These areas have been left in place in order to avoid negatively impacting the structural integrity of the G1 Building. The radiological conditions have been quantified and the locations isolated by covering with concrete or metal plate. DOE has approved the residual conditions.

Project Description

SPRU facilities were constructed and operated from the late 1940s to the early 1950s at the Knolls Atomic Power Laboratory (KAPL) in Niskayuna, NY. SPRU consisted primarily of two Upper Level buildings, G2 and H2, to conduct research on the chemical separation of plutonium and uranium. After discontinuing operations in October 1953, SPRU was maintained in "caretaking status" until decommissioning began in 2000. The SPRU Upper Level site includes Buildings G2 and H2, surrounding asphalt and gravel roadways, and the hillside to the west as shown in the photograph in Figure 1.

DOE, using its authority under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) has pursued removal of the SPRU facilities and removal of incidental contaminated soil in the Upper Level using the non-time critical removal action process. Engineering Evaluation and Cost Analyses (EECAs) have been issued, presented to the public, and DOE has selected the preferred alternatives.

This report describes work that was conducted under Contract DE-AM09-05SR22414, Task Order DE-AT30-08CC60014/SP16. Remediation of the SPRU facilities began in 2010 with the removal of the Building H2 above-grade structure and the start of Building G2 exterior removal. After an unexpected radiological release during removal of equipment from H2, the technical approach for the project was modified. Enclosures were built around both the G2 and H2 structures to allow decontamination to proceed under controlled ventilation. Figure 2 shows the configuration at the SPRU Upper Level after construction of the enclosures. Equipment and piping were removed from the G2 and H2 facilities under the monitored ventilation, and the interior of the buildings underwent substantial radiological decontamination. G2 and H2 building structure demolition resumed in 2016 and was completed in August 2019.

Figure 1. SPRU Site Prior to Decommissioning Project

A detailed discussion of the SPRU remediation activities is provided in the *Demolition Completion Report for SPRU Facility*.

Radiological Clean-Up Criteria

Soil and Concrete Criteria

The *Radiological Characterization Report for SPRU Outside Areas* (DOE/CH2MHILL 2006) described the nature and extent of radiological contaminants in the SPRU upper level areas. Multiple radioactive materials, including source material, special nuclear material (SNM), fission products, and activation products, were identified as potential constituents of concern. The *Final Derived Concentration Guideline Levels Technical Basis* (DOE/CH2MHILL 2005) described potential future exposure pathways for residual radiological contaminants and developed dose-based cleanup levels for soil, also known as derived concentration guideline levels (DCGLs), for several future site-use scenarios. The Task Order Statement of Work specified the industrial land use scenario as appropriate for future site use and provided the applicable DCGLs for soil. Table 1 contains a list of the SPRU-DP radionuclide constituents of concern (ROCs) and the approved soil DCGLs.

During the execution of the SPRU Project, authorized limits were developed to support a remedial alternative that would allow clean or decontaminated concrete to remain in the sub-surface. Those limits were approved by DOE in letter SPRU 17-030, *Authorized Limits for Concrete Remaining at Depth at SPRU*, in April 2017. The authorization specifically identified the DCGLs for four primary nuclides, as listed in Table 1. The significant change was to reduce the DCGL for concrete to 353 pCi/g down from the soil DCGL of 4,826 pCi/g.

Based on the relative potential of Cs-137 to exceed its DCGL, and the anticipated low fraction of the DCGLs of the other ROCs, the land survey plan was based on Cs-137. This

affected the establishment of the Investigation Level (IL) and potential exceedance level (equivalent to 30 pCi/g DCGL for Cs-137) for the gamma survey in each of the survey units.

The soil DCGLs were applied to all the survey units with the exception of SU-40, the H2 Vent Stack Pad. The concrete stack pad was surveyed and sampled against the concrete DCGLs. All of the concrete samples for SU-40 were non-detects ("U" qualified) with the highest reported value of 0.353 pCi/g. Therefore, the difference in the DCGLs did not affect the evaluation of the condition of the survey unit.

Results from each sample were compared against the cleanup criteria using the Sum of the Ratios (SOR) approach, where each nuclide's concentration is divided by the corresponding DCGL and the sum of each samples ratios must be less than one in order to meet the criteria. This unity rule is expressed mathematically as:

$$\frac{C_1}{DCGL_1} + \frac{C_2}{DCGL_2} + \cdots + \frac{C_n}{DCGL_n} \leq 1$$

Where:

C_n = concentration of radionuclide n in a given sample
$DCGL_n$ = DCGL of radionuclide n

The laboratory reported concentration values, including those with "U" qualifiers, were used in the SOR with one exception. If the laboratory reported a negative concentration (e.g. -0.2 pCi/g), the value was replaced with zero to calculate the SOR.

Surface Criteria

A different type of criteria is applied to the wall surfaces being left in place on the F Buildings and the G1 Building. The western side of the F Buildings served as the east side of the SPRU site and remains in place. The G1 Building shared a common interior wall with the SPRU G2 Building. The common wall remains in place and is now the external wall of the G1 Building. Part of the G1 west wall was within the SPRU site. These remaining surfaces were evaluated for removable (loose) and fixed contamination rather than the volumetric criteria for soil and sub-surface concrete.

The criteria for residual surface contamination are derived from radiological controls, which are established by DOE in accordance with Appendix D of 10 CFR 835. The SPRU criteria for alpha emitters are based on the values associated transuranic nuclides and for the beta-gamma emitters. Specific values are established by the KAPL site, and were implemented for the remaining wall surfaces in recognition that the facility would be returned to KAPL operational control after completion of the SPRU remediation.

The KAPL criteria are set forth in units of picoCuries per 100 cm^2 (pCi/100 cm^2) for loose contamination and in units of pCi per direct probe for fixed contamination, as listed in Table 2. The fixed criteria are based on the specific instrumentation used by KAPL. Neither loose nor fixed contamination is measured directly in terms of "pCi" because the size and calibration of the measuring instrument must be considered. Table 2 shows the KAPL criteria expressed in units of disintegrations per minute ("dpm"). To allow for alternate survey instrumentation to be used, the "Direct Probe" criteria established by KAPL was converted to a more general bases of "dpm/100 cm^2", based on the standard KAPL probe area of 15.5 cm^2 for both the alpha and beta-gamma instruments. Table 2 shows the surface release criteria in both KAPL and the more general units.

Table 1. SPRU Radiological Cleanup Criteria

Derived Concentration Guidelines (DCGL) Values for Cleanup at SPRU		
Radionuclide	**Industrial Land Use DCGL (pCi/g) Upper Level**	**Concrete Located at Depth (Primary Nuclides)**
Americium-241	595	595
Cesium-137	30	30
Cobalt-60	10.3	
Europium-152	22.8	
Europium-154	21.1	
Europium-155	892	
H-3 (Tritium)	3.38E+06	
Nickel-63	5.12E+06	
Plutonium-238	818	
Plutonium-239	737	737
Plutonium-240	738	
Plutonium-241	20,060	
Promethium-147	1.63E+06	
Samarium-151	6.73E+06	
Strontium-90	4,826	353
Technetium-99	1.17E+06	
Thorium-232	9.50	
Uranium-234	767	
Uranium-235	196	
Uranium-238	896	
Zirconium-93	1.37E+06	

Table 2. SPRU Surface Contamination Release Criteria

	Loose Surface Criteria (smear)		Direct Probe (DP) Criteria*		SPRU DP Equivalent** (Static)
	pCi/100 cm^2	dpm/100cm^2	pCi/DP	dpm/DP*	dpm/100 cm^2
Alpha-Contamination (TRU present)	9	20	20	44.4	268
Beta-Gamma Contamination	450	1000	450	1000	6451
Gamma-Radiation	General Area Dose (@ 30 cm from the surface)				
	<0.06 mR/hr (<60 uR/hr)				

*Based on KAPL using beta gamma probes with an area of 15.5 cm^2, and alpha probes with an area of 15.5 cm^2.
**Direct probes in use by SPRU for contamination surveys are 100 cm^2 in surface area. The ratio of 100 cm^2 probe size to 15.5 cm^2 probe multiplied times the dpm/DP resulted in the SPRU DP Equivalent (Static) dpm/100 cm^2 values as listed in the table.

SPRU Project Activities

Demolition / Remediation

Initial decommissioning activities of the G2 and H2 buildings were started in 2010 using an open air approach for all structural demolition and remediation. After re-evaluation of the demolition approach and contamination control requirements, enclosures with filtered ventilation were constructed over both buildings in 2011–2013. Sludge from the H2 Vault tanks was processed and shipped for off-site disposal in 2013 and 2014. Equipment removal and decontamination of the G2 building interior and research cells was completed by June 2016, allowing for open air demolition of the remaining G2 structure. The first phase of the G2 demolition and remediation of the associated soil in the south end of the footprint was finished in July 2017. This area was surveyed and sampled as Survey Unit SU-51. Approval for backfill of the area was granted by DOE, and the area was backfilled in November 2017.

The H2 tanks, tank vault enclosure, and associated piping were removed in 2015 while the H2 enclosure was in place. The surfaces of the concrete vaults were decontaminated, as required for disposal, prior to demolition and removal. The internal walls of Building H2 were demolished prior to removal of the Building H2 enclosure in October 2017. Demolition of the remaining structures and excavation of contaminated soil were completed in 2018. Surveys and sampling of the footprints of H2, the H2/G2 Tunnel, and the northern part of G2 (Phase 2) were conducted, and DOE approved backfill of the Upper Level in October 2018. Backfill and restoration of the Upper Level was completed in July 2019.

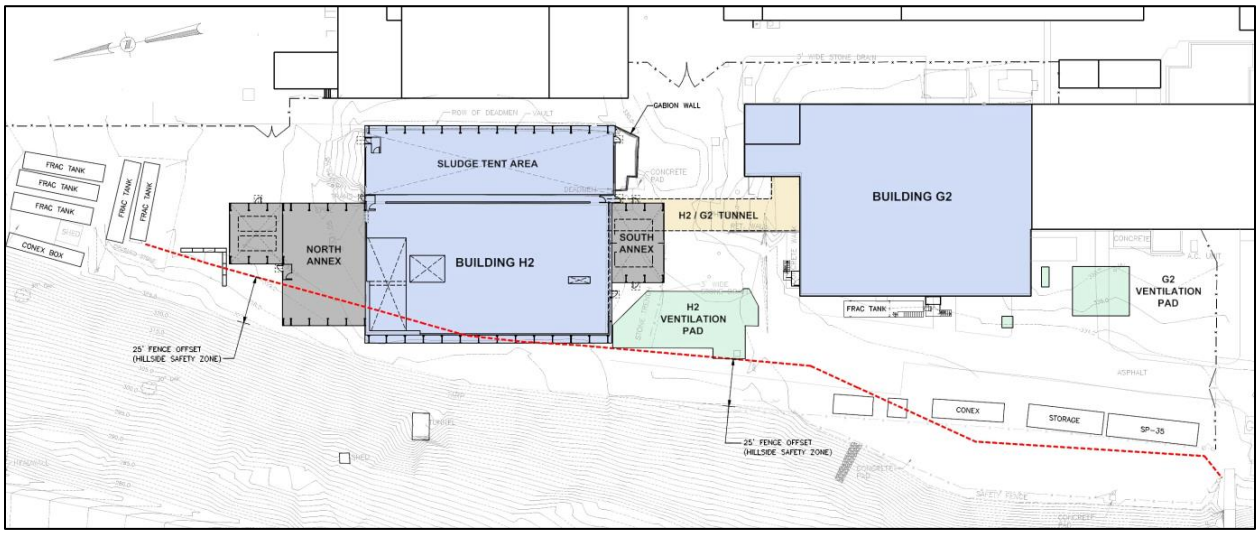

Figure 2. SPRU Upper Level Layout after Enclosure Construction

Confirmation Surveys and Sampling

Surveys and sampling of the SPRU areas were performed to verify that the residual radioactivity remaining at the SPRU-DP site is below the levels specified in the Task Order. Sampling and Analysis Plans (SAPs) were developed for each survey unit in accordance with SPRU-RC-012, *Final Status Survey and Confirmation Sampling and Analysis Plan (FSS/CSAP)*. Figure 3 shows the KAPL site with the SPRU areas shown in color. The SPRU operational areas in the northwest are shown in greater detail in Figure 4. All of the administrative area in the southeast portion of the KAPL site is covered in Survey Unit 70, and is depicted in Figure 5.

Survey and sampling results in all survey units showed that the respective units met the clean-up criteria in accordance with the Task Order requirements.

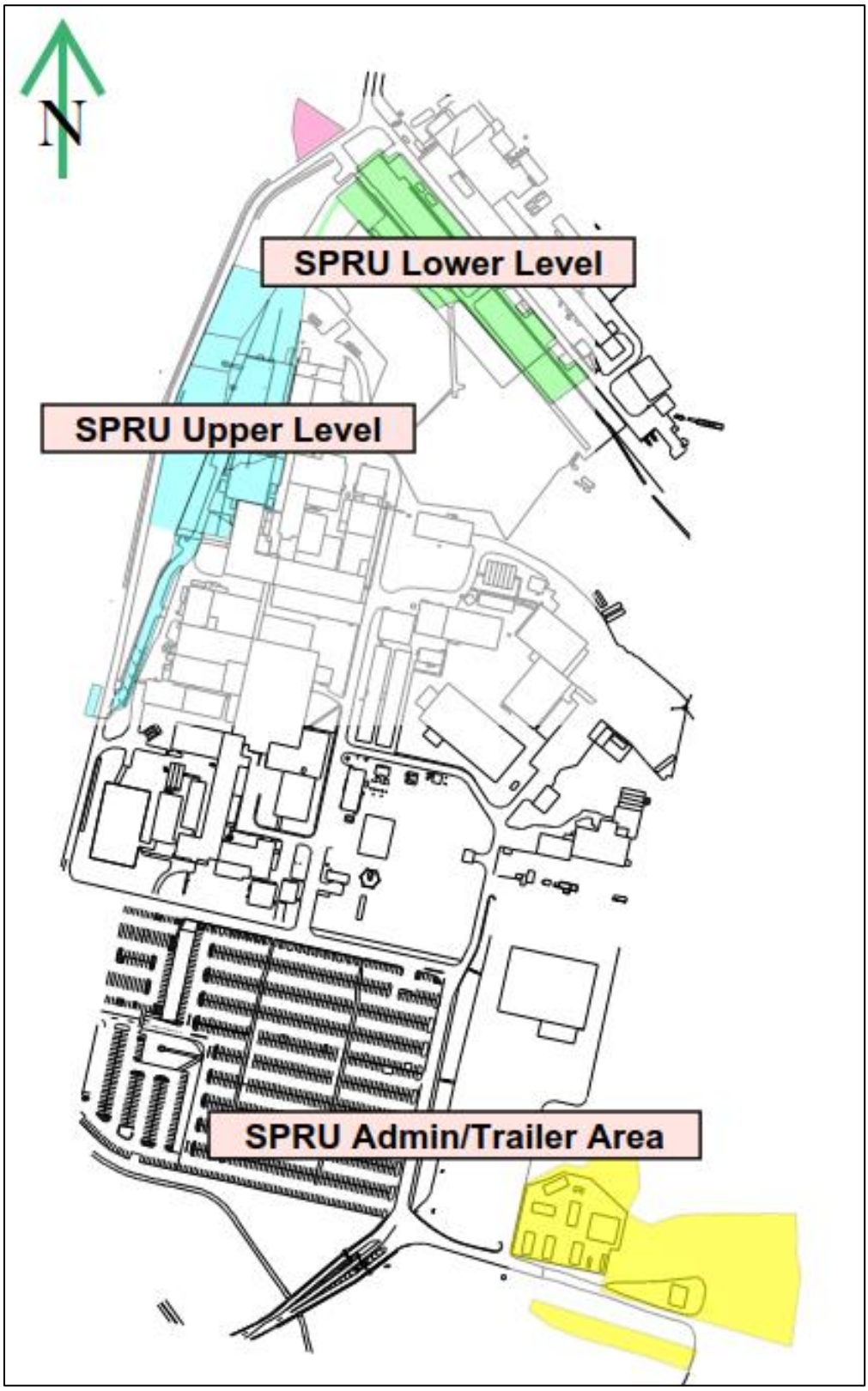

Figure 3. KAPL Site with SPRU areas in color

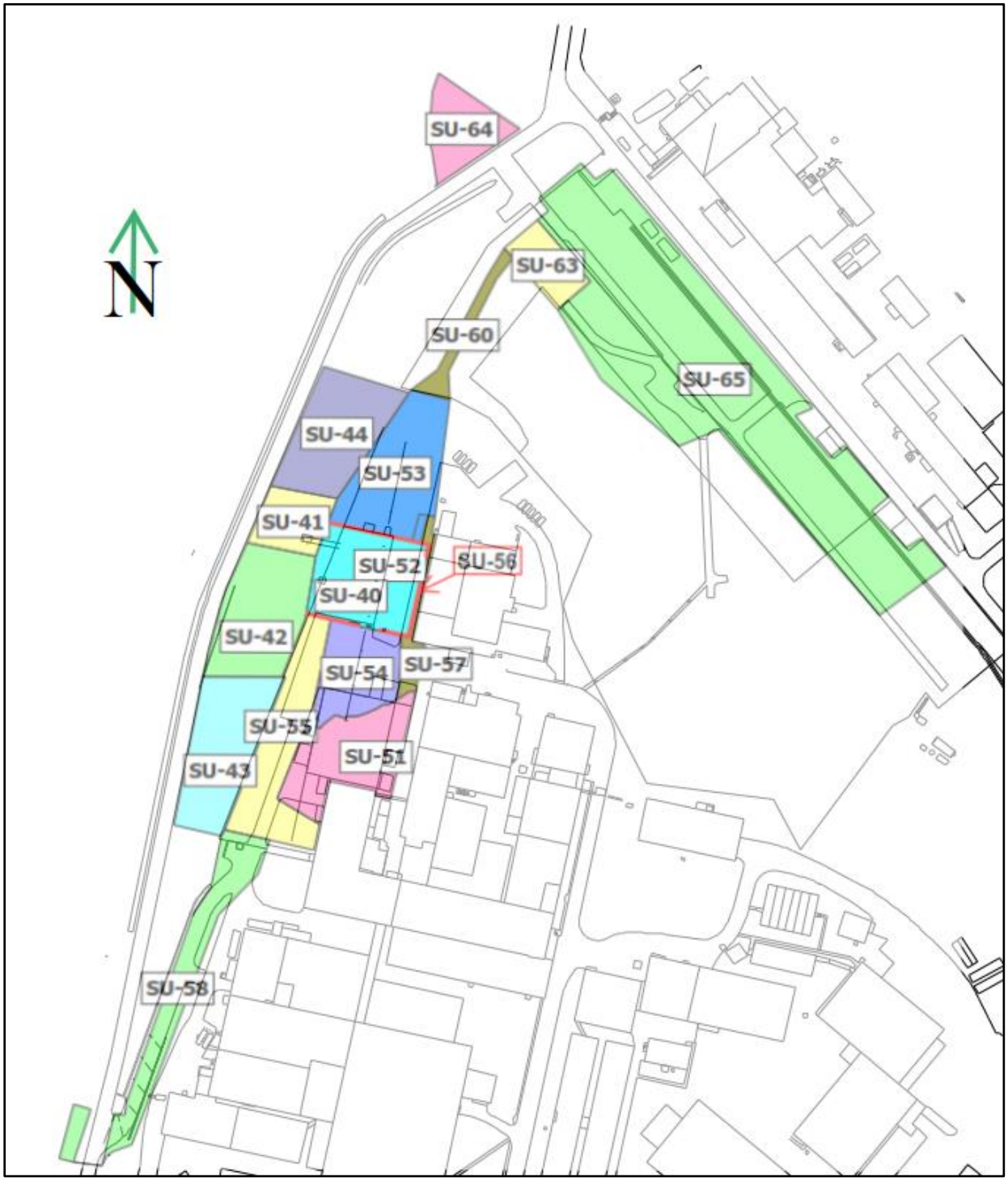

Figure 4. Survey Units in SPRU Operations Areas

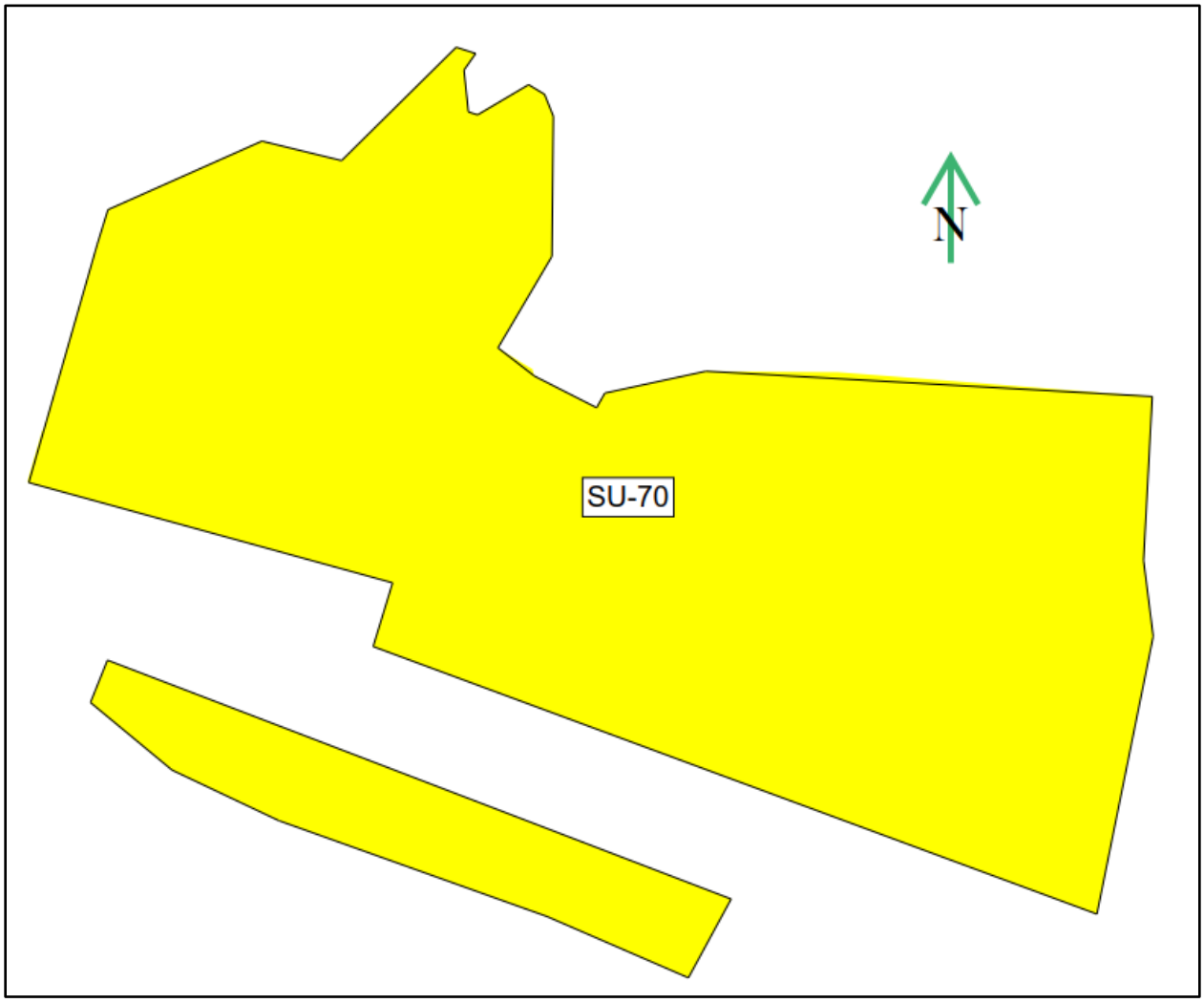

Figure 5. Survey Unit SU-70 in Administrative - Trailer Area

FSS Reports

A report was prepared for each survey unit documenting the survey and sampling results. Table 3 presents a summary of the survey unit locations and corresponding reports, along with the issue date of the report. Each report is provided as an appendix. The associated Sampling and Analysis Plans are provided as separate appendices.

Table 3. SPRU Survey Unit Final Status Survey Reports

SURVEY UNIT	LOCATION	REPORT NUMBER	DATE	Appendix
SU-40	H2 Vent Stack Pad	SPRU-EEC-18-028	3/04/2020	A
SU-41	West Hillside (Sump Area)	SPRU-EEC-18-009	12/06/2019	B
SU-42	Center Hillside Area	SPRU-EEC-18-010	3/04/2020	C
SU-43	South Hillside Area	SPRU-EEC-18-011	3/04/2020	D
SU-44	North Hillside Area	SPRU-EEC-18-012	3/04/2020	E
SU-51	G2 excavation (south area)	SPRU-EEC-17-008	1/29/2020	F
SU-52	H2 Building Footprint	SPRU-EEC-18-006	12/06/2019	G
SU-53	North Yard of H2	SPRU-EEC-18-013	10/03/2019	H
SU-54	G2 North Footprint and Tunnel	SPRU-EEC-18-008	12/10/2019	I
SU-55	Support Area	SPRU-EEC-18-014	3/04/2020	J
SU-56	H2 Excavation Sidewalls	SPRU-EEC-18-007	12/12/2019	K
SU-57	Sheet Pile Walkway	SPRU-EEC-18-015	3/04/2020	L
SU-58	Access Road Snow Plow Area	SPRU-EEC-18-016	3/04/2020	M
SU-60	LLRB Staircase Hill	SPRU-EEC-18-017	2/13/2020	N
SU-63	Frac Tank Pad	SPRU-EEC-18-005	2/13/2020	O
SU-64	Lower Level Parking Lot	SPRU-EEC-18-020	2/13/2020	P
SU-65	Lower Level Rail Bed	SPRU-EEC-18-018	2/13/2020	Q
SU-70	Admin/Trailer Area	SPRU-EEC-18-021	11/25/2019	R
G1 Wall/Roof	G1 North Wall and Roof	SPRU-EEC-18-025	12/19/2019	S
F Building Wall	F Building West Wall	SPRU-EEC-19-001	3/28/2019	T
G1 Wall	G1 Wall Below Grade	MEMO-SPRU-17-023	11/2/2017	U

Independent Verification

Under the direction of the DOE SPRU Field Office, the Oak Ridge Institute for Science and Education (ORISE) conducted independent verification of the final status survey and sampling activities. The ORISE verification reports are included as Attachments 1, 2, and 3.

References

Contract DE-AM09-05SR22414, Task Order DE-AT30-08CC60014/SP16

Demolition Completion Report for SPRU Facility, SPRU-EEC-20-003

CH2M Hill *Separations Process Research Unit Project, Final Derived Concentration Guideline Levels Technical Basis*, TBD-03, Revision 4, August 17, 2005

DOE Letter SPRU 17-030, Steven Feinberg (DOE) to Jeff Selvey (AECOM), *Authorized Limits for Concrete Remaining at Depth at SPRU*, April 10, 2017

NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM), 402-R-97-016, DOE/EH-0624

Final Status Survey and Confirmation Sampling and Analysis Plan (FSS/CSAP), SPRU-RC-012

Quality Assurance Project Plan for Radiological Confirmation Sampling (QAPjP), SPRU-RC-011,

ORISE VERIFICATION REPORTS

Attachment 1 ORISE Verification Report DCN 5309-SR-01-0, Lower Level

Attachment 2 ORISE Verification Report DCN 5309-LT-03-1, Administration Area

Attachment 3 ORISE Verification Report DCN 5309-SR-02-0, Upper Level

FINAL STATUS SURVEY REPORTS

Appendix	SURVEY UNIT	LOCATION	REPORT NUMBER
A	SU-40	H2 Vent Stack Pad	SPRU-EEC-18-028
B	SU-41	West Hillside (Sump Area)	SPRU-EEC-18-009
C	SU-42	Center Hillside Area	SPRU-EEC-18-010
D	SU-43	South Hillside Area	SPRU-EEC-18-011
E	SU-44	North Hillside Area	SPRU-EEC-18-012
F	SU-51	G2 excavation (south area)	SPRU-EEC-17-008
G	SU-52	H2 Building Footprint	SPRU-EEC-18-006
H	SU-53	North Yard of H2	SPRU-EEC-18-013
I	SU-54	G2 North Footprint and Tunnel	SPRU-EEC-18-008
J	SU-55	Support Area	SPRU-EEC-18-014
K	SU-56	H2 Excavation Sidewalls	SPRU-EEC-18-007
L	SU-57	Sheet Pile Walkway	SPRU-EEC-18-015
M	SU-58	Access Road Snow Plow Area	SPRU-EEC-18-016
N	SU-60	LLRB Staircase Hill	SPRU-EEC-18-017
O	SU-63	Frac Tank Pad	SPRU-EEC-18-005
P	SU-64	Lower Level Parking Lot	SPRU-EEC-18-020
Q	SU-65	Lower Level Rail Bed	SPRU-EEC-18-018
R	SU-70	Admin/Trailer Area	SPRU-EEC-18-021
S	G1 Wall/Roof	G1 North Wall and Roof	SPRU-EEC-18-025
T	F Building Wall	F Building West Wall	SPRU-EEC-19-001
U	G1 Wall	G1 Wall Below Grade	MEMO-SPRU-17-023

SAMPLING and ANALYSIS PLANS

Appendix	SURVEY UNIT	LOCATION	SAP NUMBER
AA	SU-40	H2 Vent Stack Pad	SPRU-SAP-SU-40
BB	SU-41	West Hillside (Sump Area)	SPRU-SAP-SU-41
CC	SU-42	Center Hillside Area	SPRU-SAP-SU-42
DD	SU-43	South Hillside Area	SPRU-SAP-SU-43
EE	SU-44	North Hillside Area	SPRU-SAP-SU-44
FF	SU-51	G2 excavation (south area)	SPRU-SAP-SU-51
GG	SU-52	H2 Building Footprint	SPRU-SAP-SU-52
HH	SU-53	North Yard of H2	SPRU-SAP-SU-53
II	SU-54	G2 North Footprint and Tunnel	SPRU-SAP-SU-54
JJ	SU-55	Support Area	SPRU-SAP-SU-55
KK	SU-56	H2 Excavation Sidewalls	SPRU-SAP-SU-56
LL	SU-57	Sheet Pile Walkway	SPRU-SAP-SU-57
MM	SU-58	Access Road Snow Plow Area	SPRU-SAP-SU-58
NN	SU-60	LLRB Staircase Hill	SPRU-SAP-SU-60
OO	SU-63	Frac Tank Pad	SPRU-SAP-SU-63
PP	SU-64	Lower Level Parking Lot	SPRU-SAP-SU-64
QQ	SU-65	Lower Level Rail Bed	SPRU-SAP-SU-65
RR	SU-70	Admin/Trailer Area	SPRU-SAP-SU-70
SS	G1 Wall/Roof	G1 North Wall and Roof	SPRU-SAP-G1 Building