ORAU
OAK RIDGE ASSOCIATED UNIVERSITIES

April 18, 2013

Mr. Bryan Werner
Pennsylvania Bureau of Radiation Protection
Rachael Carson Office Building
P.O. Box 8469
Harrisburg, Pennsylvania 17105-8489

SUBJECT: INTERIM REPORT—INDEPENDENT VERIFICATION SURVEY OF SECTION 3, SURVEY UNITS 1, 4, AND 5 EXCAVATED SURFACES, WHITTAKER CORPORATION, REYNOLDS INDUSTRIAL PARK, TRANSFER, PENNSYLVANIA
DCN: 5002-SR-04-0

Dear Mr. Werner:

Oak Ridge Associated Universities (ORAU), operating under the Oak Ridge Institute for Science and Education (ORISE) contract, is pleased to provide the enclosed interim report that details the verification survey activities that were performed on the excavated surfaces of Survey Units 1, 4, and 5 in Section 3 on March 13 and 14, 2013, at the Whittaker Corporation site in Transfer, Pennsylvania. A full report will be provided at project completion.

Please contact me via my information below, Tim Vitkus at 865.576.5073, or Erika Bailey at 865.576.6659, if you have any questions.

Sincerely,

Wade C. Adams

Wade C. Adams
Project Manager/Health Physicist
Independent Environmental Assessment
and Verification Program

WCA:fr

Enclosure

Cc: File/5002

electronic distribution: E. Bailey, ORAU
S. Roberts, ORAU
T. Vitkus, ORAU

Voice: 865.576.0065 **Fax: 865.241.3497** **E-mail: Wade.Adams@orau.org**
P.O. Box 117 | Oak Ridge, TN 37831 | www.orau.org

INDEPENDENT VERIFICATION SURVEY OF SECTION 3, SURVEY UNITS 1, 4, AND 5 EXCAVATED SURFACES, WHITTAKER CORPORATION, REYNOLDS INDUSTRIAL PARK, TRANSFER, PENNSYLVANIA

INTERIM REPORT

Prepared by
Wade C. Adams
Independent Environmental Assessment and Verification Program
Oak Ridge Associated Universities

April 2013

Prepared for the
State of Pennsylvania

ORAU
OAK RIDGE ASSOCIATED UNIVERSITIES

INTERIM REPORT—INDEPENDENT VERIFICATION SURVEY OF SECTION 3, SURVEY UNITS 1, 4, AND 5 EXCAVATED SURFACES, WHITTAKER CORPORATION, REYNOLDS INDUSTRIAL PARK, TRANSFER, PENNSYLVANIA

Prepared by: Wade C. Adams Date: 4/18/2013
W. C. Adams, Project Manager/Health Physicist
Independent Environmental Assessment and
Verification Program

Reviewed by: Wade P. Ivey Date: 4/18/13
W. P. Ivey, Laboratory Group Manager
Independent Environmental Assessment and
Verification Program

Reviewed by: Paige H. Benton Date: 4/18/13
P. H. Benton, Quality Assurance Specialist
Independent Environmental Assessment and
Verification Program

Approved for release by: Timothy Vitkus Date: 4/18/2013
T. J. Vitkus, JEAV Associate Director,
Director of Survey Operations
Independent Environmental Assessment and
Verification Program

INTERIM REPORT—INDEPENDENT VERIFICATION SURVEY OF SECTION 3, SURVEY UNITS 1, 4, AND 5 EXCAVATED SURFACES, WHITTAKER CORPORATION, REYNOLDS INDUSTRIAL PARK, TRANSFER, PENNSYLVANIA

1. INTRODUCTION

The Whittaker Corporation's (Whittaker) Waste and Slag Storage Area in Transfer, Pennsylvania is in the process of being decommissioned (Fig. 1). Whittaker, as well as prior owners of the site, used source material containing licensable quantities of thorium and uranium for the extraction of rare earth metals. These source materials consisted mainly of Brazilian and Canadian Pyrochlore, a mineral found in some granitic geologic formations. These operations resulted in slag by-products containing thorium and uranium. Materials processing took place at the site from 1966 to 1974. In general, the radiological contaminants consist mostly of natural uranium and thorium and their associated daughter products in secular equilibrium. However, laboratory analyses of some of the slag samples have shown that the uranium-238 (U-238) concentrations are not always in secular equilibrium with the decay series concentrations (ESL 2012a).

Whittaker has been decommissioning the site in accordance with the commitments described in License No. SMA-1018. Decommissioning activities have included excavation of the waste slag, processing excavated material to separate the radioactive material from the soil, and shipping the radioactive material to a licensed disposal site.

The licensee's decommissioning contractor, Energy*Solutions*, LLC (ESL), is currently completing site remediation activities and associated final status surveys (FSS). Remediation is being performed in accordance with requirements of the site's decommissioning plan (ESL 2006) to satisfy the dose-based criteria of *10 CFR 20, Subpart E, Radiological Criteria for License Termination* for the release of a site to unrestricted use (CFR 2011). FSSs are being performed according to the guidance provided in the *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (NRC 2000). The FSS plan described the methods ESL used to demonstrate that residual contamination in Section 3 met the derived concentration guideline levels ($DCGL_W$s) approved by the U.S. Nuclear Regulatory Commission (NRC) as the site release criteria in the August 2005 License Renewal (NRC 2005 and 2006).

The Pennsylvania Department of Environmental Protection (PaDEP), as an agreement state with the NRC, is the regulatory authority and requested that the Independent Environmental Assessment and Verification (IEAV) Program of Oak Ridge Associated Universities (ORAU) perform verification surveys at Whittaker under the Oak Ridge Institute for Science and Education (ORISE) contract. The verification is being conducted in phases. Phase 1, the subject of this interim letter report, was the verification of the excavation surfaces (EXS) of Section 3, Survey Units (SUs) 1, 4, and 5. Phase 2 is planned to include the verification survey of various Section 3 backfill lifts. Phase 3 will be the verification survey of the final exposed surface (FES) of Section 3 after backfill completion. Figure 2 shows all five SUs within Section 3, the three SUs that are discussed in this interim letter report (SUs 1, 4, and 5), and the inaccessible areas associated with those SUs.

2. PROCEDURES

ORAU personnel conducted independent radiation surface scans and soil sampling to evaluate the radiological status of the Section 3 EXS for SUs 1, 4, and 5. Survey activities performed by ORAU personnel were conducted in accordance with the project-specific plan, the ORAU/ORISE Survey Procedures Manual, and the ORAU Quality Program Manual (ORAU/ORISE 2013a, ORAU/ORISE 2013b, and ORAU 2012). Additionally, the ESL FSS plan and Section 3 SU data packages were reviewed and comments provided to PaDEP (ORAU/ORISE 2012a and 2013c).

2.1 REFERENCE SYSTEM

ORAU referenced survey results using ESL's established coordinate system. The reference system used global positioning system (GPS) coordinates X (easting), Y (northing), based on Pennsylvania State Plane North American Datum 1983 coordinates.

2.2 SURFACE SCANS

Surface scans were performed using sodium iodide (NaI) scintillation detectors coupled to ratemeter-scalers with audible indicators. Coverage consisted of high-density scans in the Section 3 EXS. The detectors were also coupled to GPS systems that enabled real-time gamma count rate and spatial data capture. Locations of elevated direct radiation, suggesting the presence of residual

contamination, were marked and identified for further investigation. Figures 3 through 5 indicate the surface scan coverage and gamma count rates for SUs 1, 4, and 5, respectively.

2.3 SOIL SAMPLING

ORAU planned the verification activities to ensure the collection of a sufficient number of random samples within Section 3 for estimating the mean contaminant concentrations. The ESL data from the FSS data packages for each SU were used as the planning inputs when determining the number of verification measurement locations. A ranked set sampling (RSS) approach was used to design the verification sampling plan (EPA 2006). Figures 6 through 8 show the RSS locations and Figs. 9 through 11 show the random soil sampling locations.

In addition to the six random soil samples collected from each SU, a judgmental sample was also collected from within each SU. The judgmental samples were collected at locations that exhibited elevated gamma activity during the gamma walkover scans. Figures 9 through 11 also show the judgmental sampling locations.

2.4 SOIL SAMPLE COMPARISON

During the collection of RSS soil samples, ORAU collected split samples from each location with ESL personnel.

3. SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples were returned to the ORAU/ORISE laboratory in Oak Ridge, Tennessee for analysis and interpretation. Sample analyses were performed in accordance with the ORAU/ORISE Laboratory Procedures Manual (ORAU/ORISE 2012b). Soil samples were analyzed by solid-state gamma spectroscopy for gamma-emitting progeny of both the thorium-232 (Th-232) and U-238 decay series. Analytical results were reported in units of picocuries per gram dry weight basis (pCi/g). The data generated were compared with the approved $DCGL_W$s established for the Whittaker site.

4. APPLICABLE SITE GUIDELINES

The major radionuclides of concern (ROCs) at the Whittaker site are Th-232 and associated daughter products (Th-232 + C) and U-238 with (U-238 + C) and without the associated daughters. The ROCs and the associated $DCGL_W$s are displayed in Table 1.

Table 1. Applicable Radiological Soil Cleanup Criteria[a]

Radionuclides of Concern	$DCGL_W$ (pCi/g)
Th-232 + C	7
U-238	166.5
U-238 + C	9.7

[a]From ESL FSSP for Section 3, Table 2-1, Page 15

Because multiple contaminants are present, the unity rule is applied. The unity rule requires calculation of the sum-of-fractions (SOFs) in accordance with the following equation:

$$\frac{Conc._{Th-232+C}}{DCGL_{Th-232+C}} + \frac{Conc._{U-238}}{DCGL_{U-238}} + \frac{Conc._{U-238+C}}{DCGL_{U-238+C}} \leq 1$$

Because there are $DCGL_W$s for U-238 that are dependent upon whether the U-238 is from natural (unprocessed) uranium or processed uranium, the analytical data required evaluation to determine whether residual U-238 concentrations are indicative of processed uranium, unprocessed uranium, or a combination of the two. This was accomplished through the comparison of the radium-226 progeny, specifically the lead-214 (Pb-214) concentration, and the U-238 immediate daughter, Th-234.

5. FINDINGS AND RESULTS

The results of the verification survey are discussed below.

5.1 DOCUMENT REVIEW

The ORAU initial reviews of ESL's project documentation and FSS plans indicated that procedures and methods implemented were appropriate. Minor comments identified were transmitted to PaDEP via e-mail correspondence (ORAU/ORISE 2012c and 2013c).

5.2 SURFACE SCANS

The gamma scan results for Section 3, SUs 1, 4, and 5 EXS, are illustrated in Figs. 3 through 5, respectively. The gamma radiation levels for most of the survey areas were comparable to background levels (i.e., ranging from 5,000 to 16,000 counts per minute [cpm)]. One area of elevated gamma radiation (23,000 cpm; Hotspot 1) was detected along the northeast corner of SU1 (Fig. 3). This area was along the border with SU2 which had not yet been remediated. A judgmental soil sample (S0044) was collected from this location (Fig. 9). An area of elevated gamma radiation (18,000 cpm; Hotspot 2) was also detected in the southwest portion of SU4 (Fig. 4). This area was also identified by the ESL scans during the FSS activities and they performed follow-up investigations during those activities. A judgmental soil sample (S0051) was collected from this location (Fig. 10). At the midpoint of the southern portion of SU5 (Hotspot 3), along the hillside and wetlands interface, an area of elevated gamma radiation (21,000 cpm) was detected (Fig. 5). A judgmental soil sample (S0058) was collected from this location (Fig. 11). Another area of elevated gamma radiation exceeding 140,000 cpm was detected in the northwest area of SU5 (Hotspot 4). ESL personnel were notified and a small (approximately the size of a golf ball) piece of slag was removed. Further ORAU investigations of the soil surface after the slag piece was removed indicated that the soil location was at background levels.

A review of the gamma scan results also indicated that the three areas of elevated gamma radiation within Section 3, SUs 1, 4, and 5 (Figs. 3 through 5) were also identified by the ESL gamma scans in the respective FSS Data Packages (ESL 2012b, c, and d).

5.3 RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES

Table 2 provides the radionuclide concentrations data for soil samples in Section 3, EXS.

Table 2. Radionuclide Concentrations in Soil Samples Section 3, Survey Units 1, 4, and 5 Excavation Surfaces					
Sample ID	**Sample Location**	**Radionuclide Concentrations (pCi/g)**			
		Th-232[a]	**U-238[b]**	**Ra-226[c]**	**SOF[d]**
Survey Unit 1					
5002S0038	378154E, 135908N	0.95 ± 0.14[e]	0.74 ± 0.47	1.06 ± 0.08	0.24
5002S0039	378157E, 135913N	1.25 ± 0.17	1.07 ± 0.59	0.76 ± 0.06	0.26
5002S0040	378183E, 135910N	2.41 ± 0.25	1.25 ± 0.56	1.22 ± 0.09	0.47
5002S0041	378170E, 135920N	0.72 ± 0.12	1.06 ± 0.41	0.46 ± 0.05	0.15
5002S0042	378134E, 135931N	1.03 ± 0.16	0.88 ± 0.51	0.52 ± 0.07	0.20
5002S0043	378168E, 135907N	1.55 ± 0.24	1.22 ± 0.75	0.81 ± 0.09	0.31
Random Mean		*1.32*	*1.04*	*0.81*	*0.27*
Survey Unit 1 – Judgmental Sample					
5002S0044	378176E, 135937N	6.48 ± 0.62	3.01 ± 0.93	2.18 ± 0.15	1.16
Survey Unit 4					
5002S0045	378176E, 136007N	1.06 ± 0.13	0.87 ± 0.44	0.63 ± 0.06	0.22
5002S0046	378154E, 136004N	1.36 ± 0.18	0.87 ± 0.54	0.69 ± 0.07	0.27
5002S0047	378164E, 135999N	1.93 ± 0.23	1.94 ± 0.89	2.59 ± 0.17	0.54
5002S0048	378174E, 136031N	0.90 ± 0.14	1.16 ± 0.52	0.59 ± 0.06	0.19
5002S0049	378167E, 136028N	2.15 ± 0.26	2.00 ± 0.64	1.04 ± 0.09	0.42
5002S0050	378157E, 136000N	1.10 ± 0.15	0.80 ± 0.39	0.66 ± 0.06	0.23
Random Mean		*1.42*	*1.27*	*1.03*	*0.31*
Survey Unit 4 – Judgmental Sample					
5002S0051	378162E, 136000N	2.53 ± 0.27	3.34 ± 0.60	1.49 ± 0.11	0.53
Survey Unit 5					
5002S0052	378197E, 136049N	0.82 ± 0.17	1.20 ± 0.61	0.50 ± 0.08	0.17
5002S0053	378199E, 136018N	1.13 ± 0.16	1.12 ± 0.54	0.78 ± 0.07	0.24
5002S0054	378194E, 135999N	3.26 ± 0.33	1.81 ± 0.68	0.97 ± 0.08	0.57

Table 2. Radionuclide Concentrations in Soil Samples Section 3, Survey Units 1, 4, and 5 Excavation Surfaces					
Sample ID	**Sample Location**	**Radionuclide Concentrations (pCi/g)**			
		Th-232[a]	**U-238[b]**	**Ra-226[c]**	**SOF[d]**
5002S0055	378187E, 135987N	0.78 ± 0.10	0.84 ± 0.33	0.51 ± 0.05	0.17
5002S0056	378190E, 135958N	0.60 ± 0.21	2.02 ± 0.87	0.56 ± 0.11	0.15
5002S0057	378193E, 135908N	0.95 ± 0.14	0.80 ± 0.52	0.85 ± 0.07	0.22
Random Mean		***1.26***	***1.30***	***0.70***	***0.25***
Survey Units 5 – Judgmental Sample					
5002S0058	378192E, 135955N	3.70 ± 0.39	2.13 ± 0.71	1.74 ± 0.13	0.71

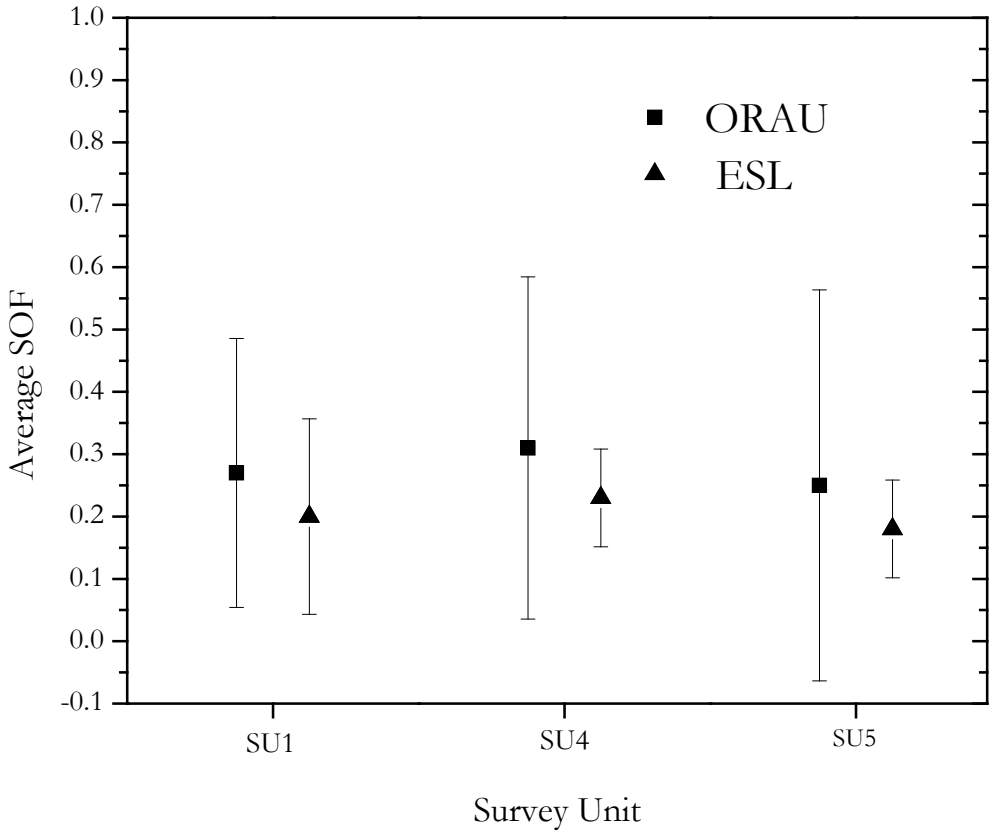
[a]Reported using Ac-228 as a surrogate.
[b]Reported using Th-234 as a surrogate.
[c]Reported using Pb-214 as a surrogate.
[d]Sum-of-Fractions (SOF) results were calculated on the most conservative basis, which assumes all ROCs are from site activities and therefore no background correction has been made. U-238+C SOF contribution was based on [Ra-226]/9.7. Processed U-238 contribution was based on ([U-238] – [Ra-226])/166.5).
[e]Uncertainties represent the 95% upper confidence level interval, based on total propagated uncertainties.

ORAU compared the verification survey results with ESL's Section 3 FSS EXS data package results for SUs 1, 4, and 5. The results of the statistical comparison are provided in Table 3. The individual SU statistical results for the ORAU verification and the ESL FSS are in good agreement.

Table 3. Section 3, Survey Units 1, 4, and 5 Statistical Comparison of Radionuclide Concentrations (pCi/g) and Sum-of-Fractions[a]								
Radionuclide	**Th-232[b]**		**U-238[c]**		**Ra-226[d]**		**SOF**	
	ORAU	**ESL**	**ORAU**	**ESL**	**ORAU**	**ESL**	**ORAU**	**ESL**
Section 3, Survey Unit 1								
Survey Unit Average	1.32	0.88	1.04	1.20	0.81	0.68	0.27	0.20
Median	1.14	0.81	1.07	1.38	0.79	0.66	0.25	0.19
Standard Deviation	0.60	0.37	0.20	0.61	0.30	0.24	0.11	0.08
Minimum	0.72	0.51	0.74	0.13	0.46	0.36	0.15	0.11
Maximum	2.41	1.77	1.25	1.77	1.22	1.27	0.47	0.39
Section 3, Survey Unit 4								
Survey Unit Average	1.42	1.03	1.27	1.40	1.03	0.70	0.31	0.23
Median	1.23	0.95	1.02	1.71	0.68	0.69	0.25	0.21
Standard Deviation	0.51	0.22	0.55	0.68	0.78	0.09	0.14	0.04
Minimum	0.90	0.76	0.80	0.17	0.59	0.59	0.19	0.18
Maximum	2.15	1.44	2.00	2.06	2.59	0.85	0.54	0.31
Section 3, Survey Unit 5								
Survey Unit Average	1.26	0.81	1.30	—[e]	0.70	0.55	0.25	0.18
Median	0.89	0.75	1.16	—	0.67	0.52	0.20	0.17
Standard Deviation	1.00	0.23	0.51	—	0.20	0.11	0.16	0.04
Minimum	0.60	0.58	0.80	—	0.50	0.43	0.15	0.13
Maximum	3.26	1.36	2.02	—	0.97	0.78	0.57	0.26

[a]ESL data values are from the data results in the ESL Section 3 FSS data packages. The ESL data in this table is from the FSS data packages and not the split sample results.
[b]Reported using Ac-228 as a surrogate.
[c]Reported using Th-234 as a surrogate for ORAU data and for ESL data for SUs 1 and 4.
[d]Reported using Pb-214 as a surrogate.
[e]For SUs 1 and 4, ESL did report U-238 values. For SU5, ESL did not report this value directly but infers that the U-238 value is equal to the Th-232 value.

A graphical comparison of the data is provided in the following chart and indicates that the mean concentrations of the verification SU sample populations overlap within the 95% confidence interval, based on the planning inputs for each SU.



5.4 ANALYTICAL COMPARISON OF SPLIT SAMPLES

During the collection of verification soil samples, ORAU collected split samples with ESL personnel. ESL performed gamma spectroscopy analyses on their portion of the split samples and provided those results to the State of Pennsylvania and ORAU (ESL 2013). Table 4 presents the comparison of the ORAU and ESL analytical results using the duplicate error ratio (DER), also known as the normalized absolute difference. A DER ≤ 3 indicates that, at a 99% confidence interval, split sample results do not differ significantly when compared to their respective one standard deviation (sigma) uncertainty (ANSI N42.22).

The following equation presents the DER calculation.

$$DER = \frac{|O - E|}{\sqrt{({U_O}^2 + {U_E}^2)}}$$

Where:

O = ORAU sample result
E = ESL sample result
U_O = ORAU sample one sigma uncertainty
U_E = ESL sample one sigma uncertainty

With the exception of Samples 5002S0041, 5002S0044, 5002S0047, and 5002S0049, the results indicate good agreement between the samples, considering these are split samples and not a reanalysis of the same physical samples.

Table 4. Comparison of Radionuclide Concentrations (pCi/g) in Split Samples with Energy*Solutions*											
Sample ID	Th-232[a] (pCi/g)		Th-232 DER[b]		U-238[c] (pCi/g)	Ra-226[d] (pCi/g)		Ra-226 DER		SOF[e]	
	ORAU[f]	ESL[g]	Value	< 3?	ORAU[f]	ORAU[f]	ESL[g]	Value	< 3?	ORAU[f]	ESL[g]
5002S0038	0.95 ± 0.14	0.97 ± 0.21	0.16	Yes	0.74 ± 0.47	1.06 ± 0.08	0.93 ± 0.17	1.40	Yes	0.24	0.24
5002S0039	1.25 ± 0.17	1.25 ± 0.20	0.00	Yes	1.07 ± 0.59	0.76 ± 0.06	0.97 ± 0.17	2.26	Yes	0.26	0.29
5002S0040	2.41 ± 0.25	2.40 ± 0.27	0.05	Yes	1.25 ± 0.56	1.22 ± 0.09	1.50 ± 0.29	1.81	Yes	0.47	0.51
5002S0041	0.72 ± 0.12	1.06 ± 0.18	3.08	No	1.06 ± 0.41	0.46 ± 0.05	0.69 ± 0.13	3.18	No	0.15	0.23
5002S0042	1.03 ± 0.16	1.12 ± 0.20	0.69	Yes	0.88 ± 0.51	0.52 ± 0.07	0.74 ± 0.15	2.55	Yes	0.20	0.24
5002S0043	1.55 ± 0.24	1.88 ± 0.27	1.79	Yes	1.22 ± 0.75	0.81 ± 0.09	0.93 ± 0.22	0.95	Yes	0.31	0.38
5002S0044[h]	*6.48* ± 0.62	*4.23* ± *0.41*	5.93	No	*3.01* ± *0.93*	*2.18* ± *0.15*	*2.33* ± *0.33*	0.81	Yes	*1.16*	*0.87*
5002S0045	1.06 ± 0.13	1.48 ± 0.25	2.92	Yes	0.87 ± 0.44	0.63 ± 0.06	0.79 ± 0.16	1.80	Yes	0.22	0.30
5002S0046	1.36 ± 0.18	1.37 ± 0.22	0.07	Yes	0.87 ± 0.54	0.69 ± 0.07	0.87 ± 0.20	1.65	Yes	0.27	0.29
5002S0047	1.93 ± 0.23	1.85 ± 0.22	0.49	Yes	1.94 ± 0.89	2.59 ± 0.17	1.89 ± 0.27	4.30	No	0.54	0.47
5002S0048	0.90 ± 0.14	1.17 ± 0.22	2.03	Yes	1.16 ± 0.52	0.59 ± 0.06	0.67 ± 0.13	1.15	Yes	0.19	0.24
5002S0049	2.15 ± 0.26	1.33 ± 0.18	5.08	No	2.00 ± 0.64	1.04 ± 0.09	0.84 ± 0.17	2.08	Yes	0.42	0.28
5002S0050	1.10 ± 0.15	0.96 ± 0.21	1.06	Yes	0.80 ± 0.39	0.66 ± 0.06	0.60 ± 0.13	0.77	Yes	0.23	0.21
5002S0051	*2.53* ± 0.27	*2.26* ± *0.27*	1.39	Yes	*3.34* ± *0.60*	*1.49* ± *0.11*	*1.48* ± *0.22*	0.08	Yes	*0.53*	*0.49*
5002S0052	0.82 ± 0.17	1.31 ± 0.39	2.26	Yes	1.20 ± 0.61	0.50 ± 0.08	0.76 ± 0.21	2.24	Yes	0.17	0.27
5002S0053	1.13 ± 0.16	1.32 ± 0.24	1.29	Yes	1.12 ± 0.54	0.78 ± 0.07	0.84 ± 0.18	0.63	Yes	0.24	0.28
5002S0054	3.26 ± 0.33	2.63 ± 0.31	2.73	Yes	1.81 ± 0.68	0.97 ± 0.08	0.83 ± 0.21	1.19	Yes	0.57	0.48

Table 4. Comparison of Radionuclide Concentrations (pCi/g) in Split Samples with Energy*Solutions*

Sample ID	Th-232[a] (pCi/g)		Th-232 DER[b]		U-238[c] (pCi/g)	Ra-226[d] (pCi/g)		Ra-226 DER		SOF[e]	
	ORAU[f]	ESL[g]	Value	< 3?	ORAU[f]	ORAU[f]	ESL[g]	Value	< 3?	ORAU[f]	ESL[g]
5002S0055	0.78 ± 0.10	0.99 ± 0.19	1.94	Yes	0.84 ± 0.33	0.51 ± 0.05	0.58 ± 0.12	1.10	Yes	0.17	0.21
5002S0056	0.60 ± 0.21	0.74 ± 0.39	0.61	Yes	2.02 ± 0.87	0.56 ± 0.11	0.76 ± 0.22	1.55	Yes	0.15	0.19
5002S0057	0.95 ± 0.14	1.07 ± 0.18	1.03	Yes	0.80 ± 0.52	0.85 ± 0.07	0.77 ± 0.19	0.74	Yes	0.22	0.24
5002S0058	*3.70 ± 0.39*	*3.89 ± 0.44*	0.63	Yes	*2.13 ± 0.71*	*1.74 ± 0.13*	*1.87 ± 0.37*	0.65	Yes	0.71	0.77

[a]Reported using Ac-228 as a surrogate.

[b]Duplicate error ratio (DER), also known as normalized absolute difference. A DER ≤ 3 indicates that, at a 99% confidence interval, split sample results do not differ significantly when compared to their respective one standard deviation (sigma) uncertainty (ANSI N42.22). Two sigma standard deviations are reported in this data table. The two sigma standard deviations were divided by 1.96 to determine a one sigma value for the DER calculations.

[c]Reported using Th-234 as a surrogate for ORAU data. ESL did not report U-238 data directly, but assumes that the U-238 concentration was equal to the Th-232 concentration. The assumed U-238 value is used in the calculation of the ESL SOF values.

[d]Reported using Pb-214 as a surrogate.

[e]ESL Sum-of-Fractions (SOF) calculated assuming U-238 concentrations are equal to the Th-232 concentrations. The following DCGL values were used: 7 pCi/g for Th-232; 166.5 pCi/g for U-238; and, 9.7 pCi/g for Ra-226

[f]ORAU data in this table is from Table 2. The ORAU uncertainties presented in the table represent the 95% upper confidence level interval, based on total propagated uncertainties.

[g]Data provided by ESL to ORAU through e-mail on April 12, 2013 (ESL 2013).

[h]Italics represents the judgmental samples that were collected based on the gamma walkover scan results.

6. COMPARISON OF RESULTS WITH GUIDELINES

The soil sample results were compared with the individual radionuclide $DCGL_W$s and the SOF values were compared with the unity $DCGL_W$ of 1. Sample results for 5002S0038 through 5002S0043 and 5002S0045 through 5002S0058 satisfied the guideline conditions. Although the individual radionuclide sample results for 5002S0044 satisfied their respective $DCGL_W$s, the SOF of 1.16 was greater than 1. The $DCGL_W$ represents the average allowable concentration within a SU. Small, localized areas of elevated radionuclide concentrations are evaluated relative to a $DCGL_{EMC}$ (elevated measurement comparison). Because each ROC concentration was less than the respective $DCGL_W$, the affected area was localized, and because the SOF exceedance was within what could be the result of background concentration variability, an elevated measurement comparison was not necessary for this location. A review of the data provided for the EXS in Section 3 indicated that the Section 3 EXS met the approved averaging for the excavation surfaces FSS activities for SUs 1, 4, and 5.

7. SUMMARY

At Pennsylvania Department of Environmental Protection's request, ORAU's IEAV program conducted verification surveys on the excavated surfaces of Section 3, SUs 1, 4, and 5 at the Whittaker site on March 13 and 14, 2013. The survey activities included visual inspections, gamma radiation surface scans, gamma activity measurements, and soil sampling activities. Verification activities also included the review and assessment of the licensee's project documentation and methodologies.

Surface scans identified four areas of elevated direct gamma radiation distinguishable from background; one area within SUs 1 and 4 and two areas within SU5. One area within SU5 was remediated by removing a golf ball size piece of slag while ORAU staff was onsite. With the exception of the golf ball size piece of slag within SU5, a review of the ESL Section 3 EXS data packages for SUs 1, 4, and 5 indicated that these locations of elevated gamma radiation were also identified by the ESL gamma scans and that ESL personnel performed additional investigations and soil sampling within these areas. The investigative results indicated that the areas met the release criteria.

With the exception of Sample 5002S0044, the verification sample results were below the respective $DCGL_W$ values for the site ROCs. However, the SOF result for Sample 5002S0044 was 1.16; which is greater than 1. Since this affected area was a small, localized area, an EMC calculation was deemed unnecessary. All verification results were below the respective $DCGL_W$ values for the site ROCs. It is also noted that the split sample comparison results, with the exception of Samples 5002S0041, 44, 47, and 49, had DER values less than 3.

Fig. 1. Whittaker Site Location, Pennsylvania

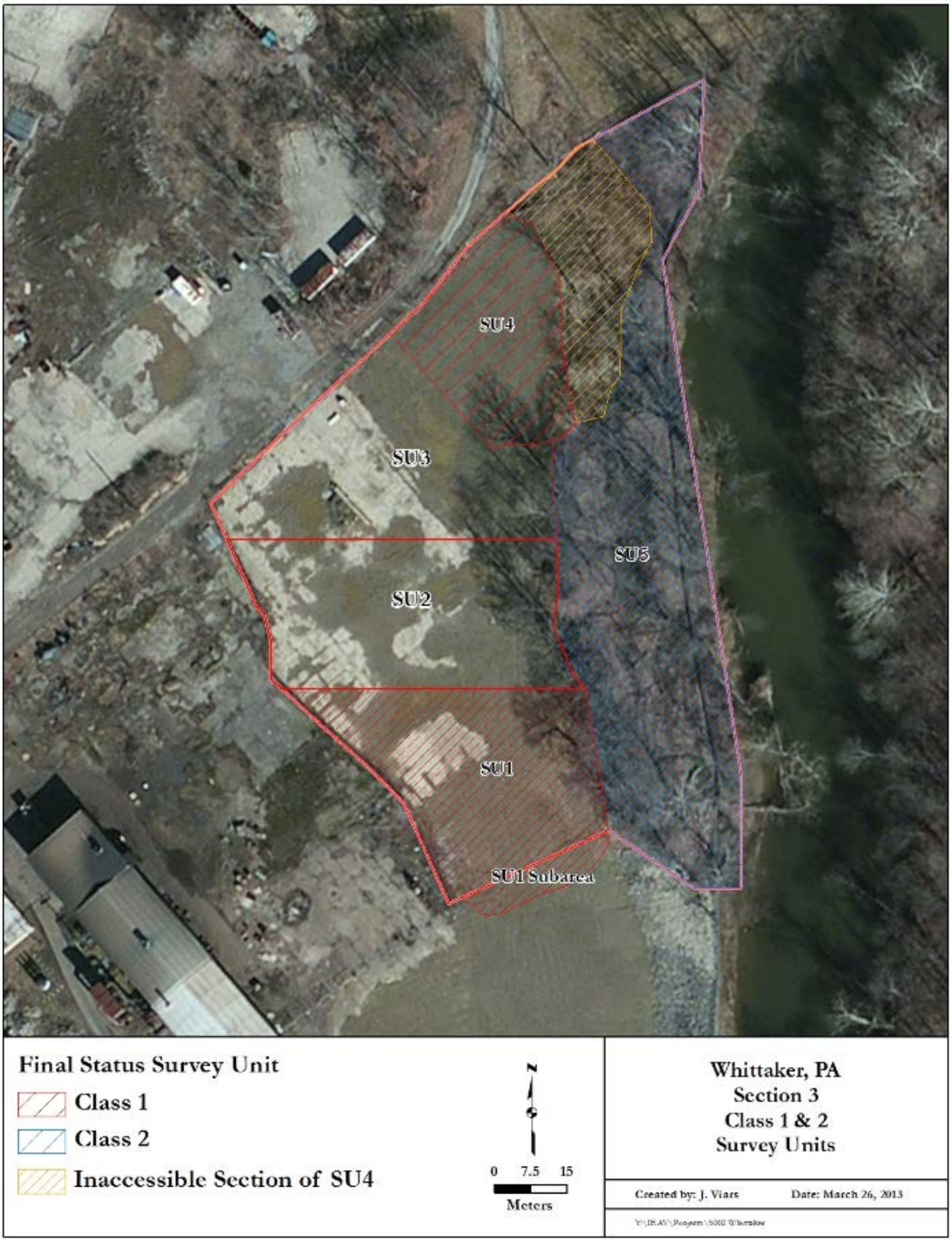


Fig. 2. Whittaker Section 3 Survey Units Indicating Inaccessible Area

Fig. 3. NaI Gamma Walkover Scan in Whittaker Section 3, Survey Unit 1—Base of Excavation Surface

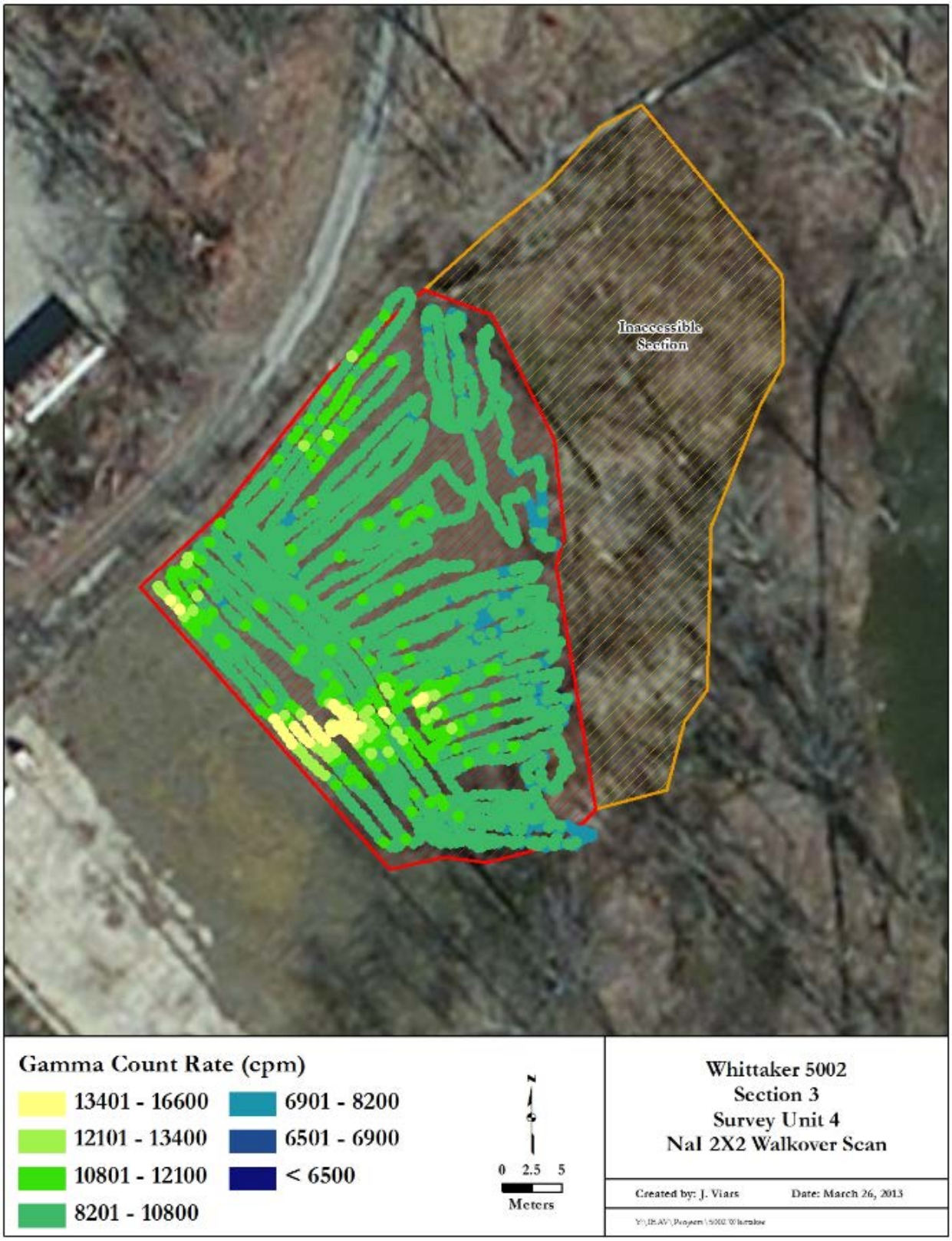


Fig. 4. NaI Gamma Walkover Scan in Whittaker Section 3, Survey Unit 4—Base of Excavation Surface

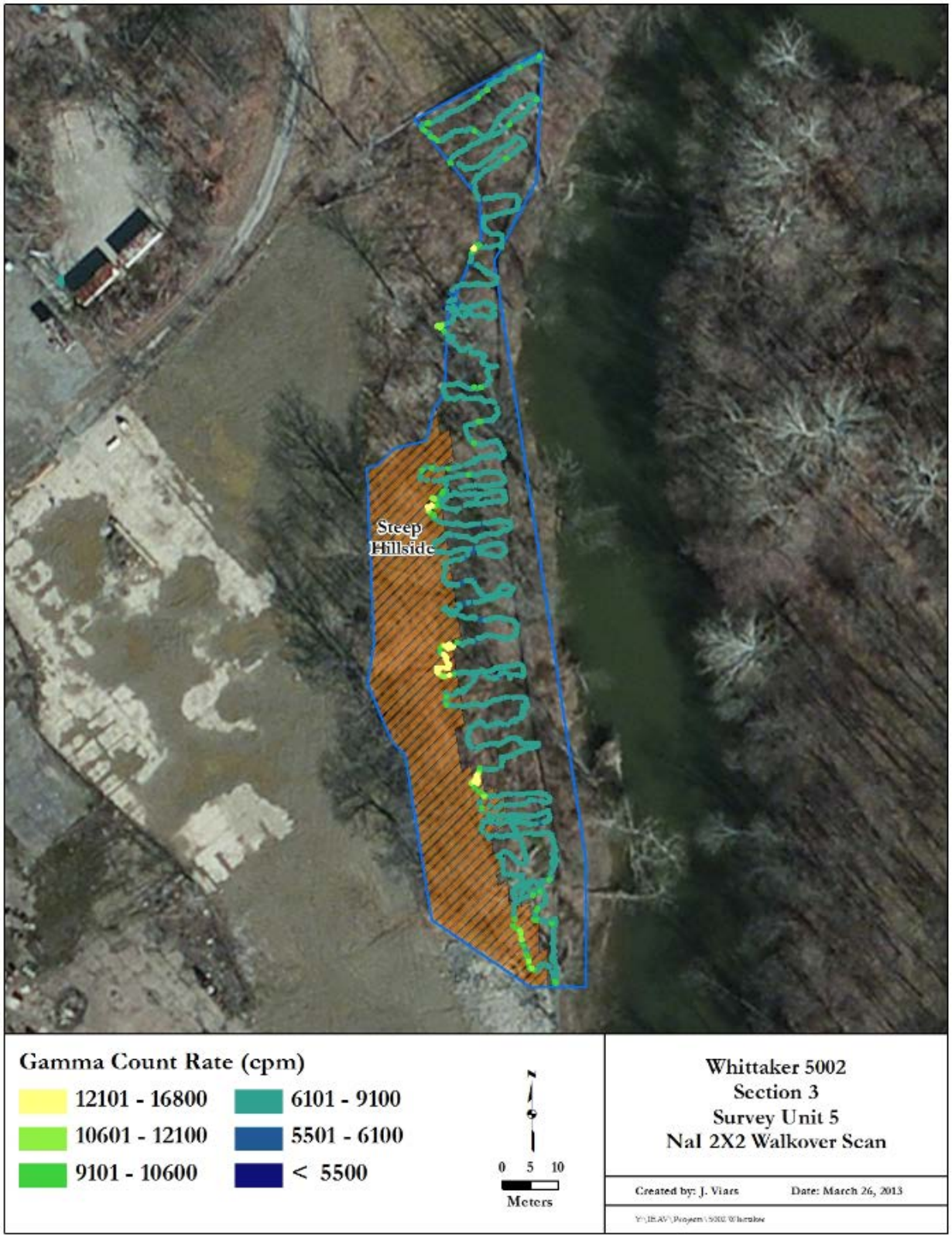


Fig. 5. NaI Gamma Walkover Scan in Whittaker Section 3, Survey Unit 5—Base of Excavation Surface

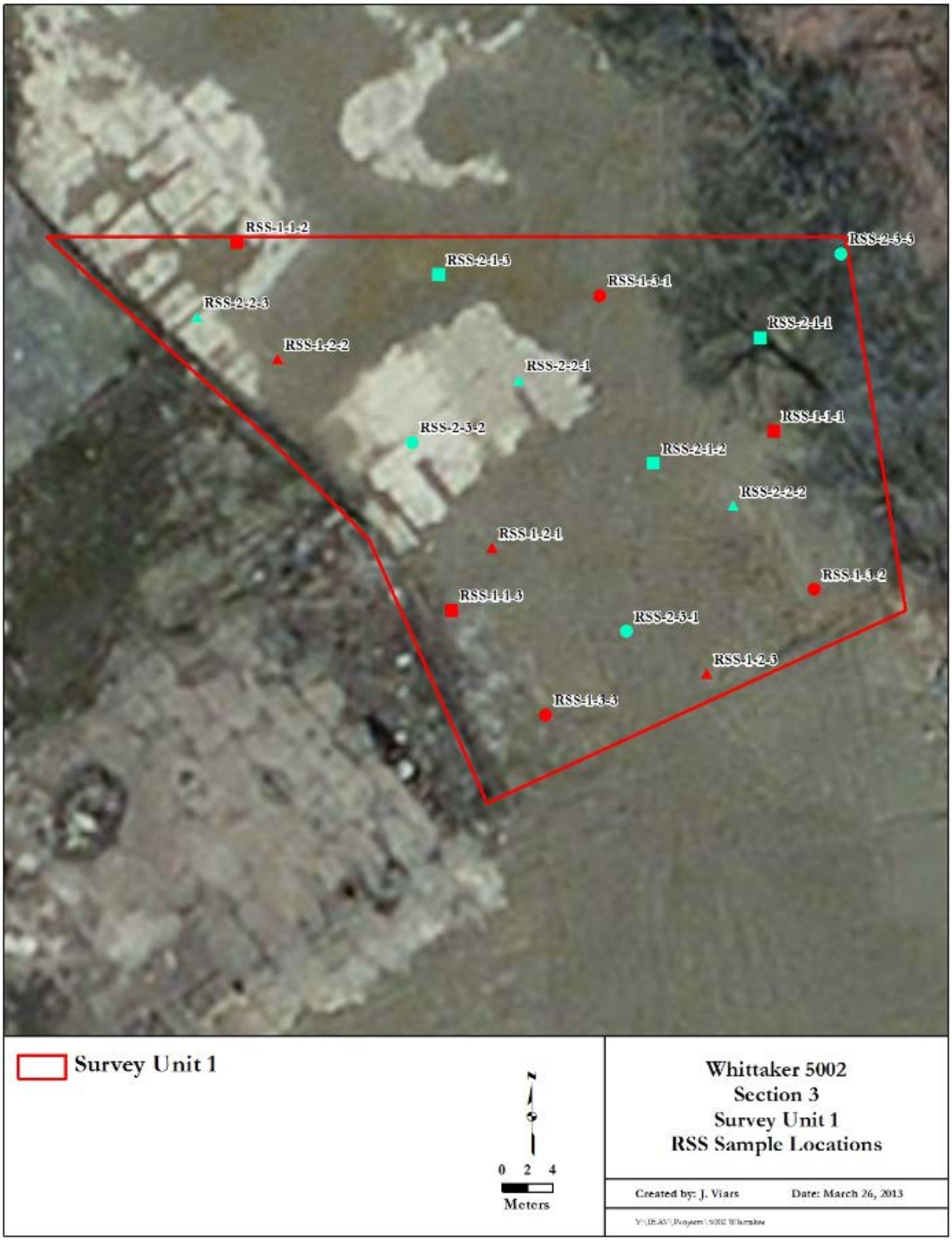


Fig. 6. Ranked Set Sample Locations in Whittaker Section 3, Survey Unit 1—Base of Excavation Surface

Fig. 7. Ranked Set Sample Locations in Whittaker Section 3, Survey Unit 4—Base of Excavation Surface

Fig. 8. Ranked Set Sample Locations in Whittaker Section 3, Survey Unit 5—Base of Excavation Surface

Fig. 9. Random and Judgmental Soil Samples in Whittaker Section 3, Survey Unit 1—Base of Excavation Surface

Fig. 10. Random and Judgmental Soil Samples in Whittaker Section 3, Survey Unit 4—Base of Excavation Surface

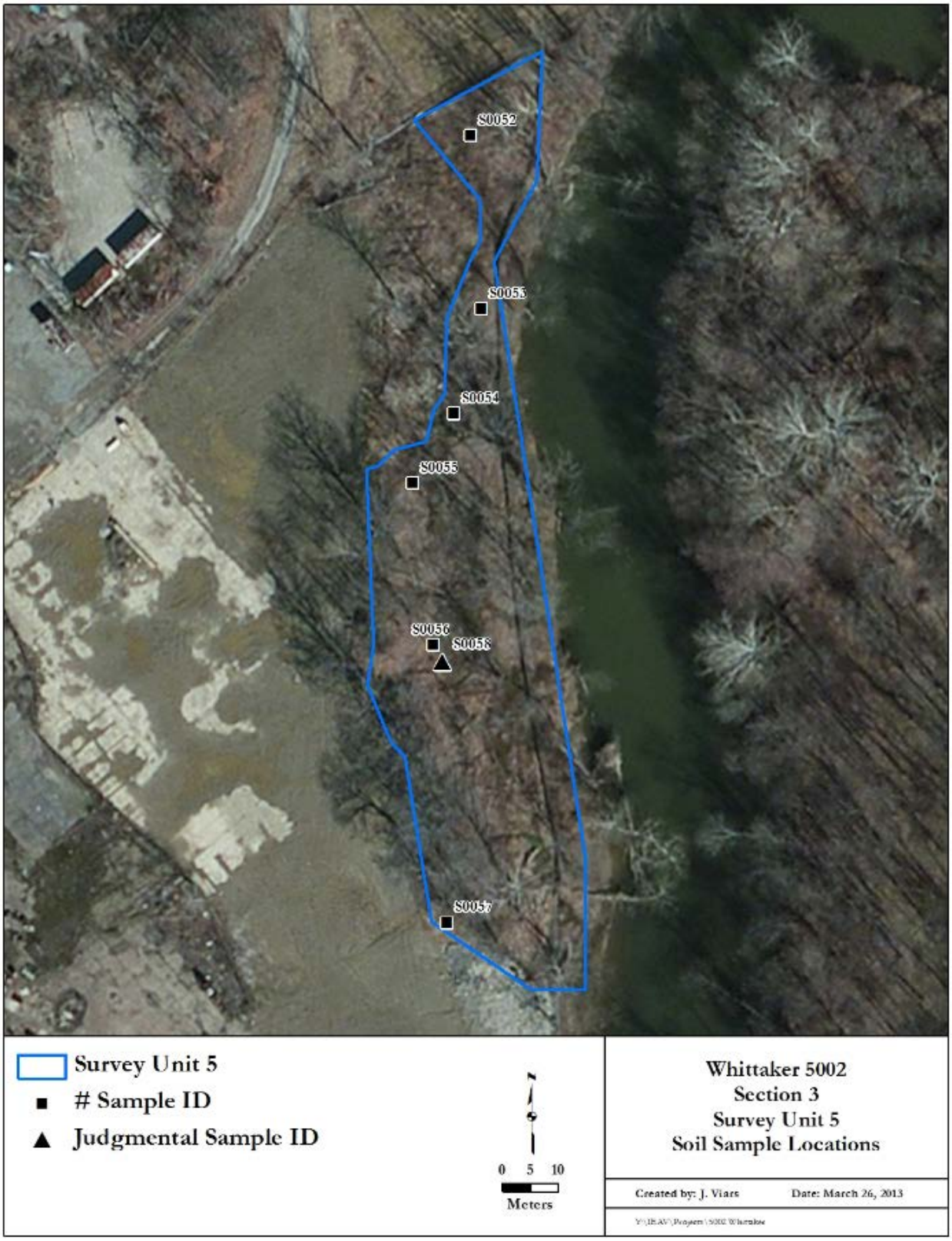


Fig. 11. Random and Judgmental Soil Samples in Whittaker Section 3, Survey Unit 5 —Base of Excavation Surface

8. REFERENCES

ANSI 1995. *Traceability of Radioactive Sources to NIST and Associated Instrument Quality Control.* American National Standards Institute. ANSI N42.22. New York, New York.

CFR 2011. *Standards for Protection Against Radiation.* 10 CFR Part 20. Code of Federal Regulations. Washington, DC. November 22.

EPA 2006. *Data QualityAssessment: Statistical Methods for Practitioners.* EPA QA/G-9S; U.S. Environmental Protection Agency. Washington, DC. February.

ESL 2006. *Decommissioning Plan, Whittaker Corporation Waste and Slag Storage Area. Document No. 82A9426, Revision 2*. Energy*Solutions*, LLC. Danbury, Connecticut. December.

ESL 2012a. *Final Status Survey Plan (FSSP), Section 3 of the Whittaker Corporation Waste and Slag Storage Area, Reynolds Industrial Park, Transfer, Pennsylvania, Revision 1, Document No. CS-OP-PN-063.* Energy*Solutions,* LLC. Danbury, Connecticut. April 6.

ESL 2012b. *Final Status Survey Data Package, Section 3, SU4. Whittaker Corporation Waste and Slag Storage Area, Reynolds Industrial Park, Transfer, Pennsylvania.* Energy*Solutions*, LLC . Danbury, Connecticut. October 3.

ESL 2012c. *Final Status Survey Data Package), Section 3, SU5. Whittaker Corporation Waste and Slag Storage Area, Reynolds Industrial Park, Transfer, Pennsylvania.* Energy*Solutions*, LLC. Danbury, Connecticut. October 5.

ESL 2012d. *Final Status Survey Data Package, Section 3, SU1. Whittaker Corporation Waste and Slag Storage Area, Reynolds Industrial Park, Transfer, Pennsylvania.* Energy*Solutions*, LLC. Danbury, Connecticut. November 29.

ESL 2013. E-mail correspondence from T. Bauer (Energy*Solutions*) to W. Adams (ORAU). Subject: SOR for Whittaker Split Samples. Energy*Solutions*, LLC. Danbury, Connecticut. April 12.

NRC 2000. *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM).* NUREG-1575; Revision 1. U.S. Nuclear Regulatory Commission. Washington, DC. August.

NRC 2005 and 2006. Whittaker NRC License Renewal. U.S. Nuclear Regulatory Commission. Washington, DC.

ORAU 2012. *Quality Program Manual for the Independent Environmental Assessment and Verification Program.* Oak Ridge Associated Universities. Oak Ridge, Tennessee. November 29.

ORAU/ORISE 2012a. *Document Review—Final Status Survey Plan, Section 3 of the Whittaker Corporation, Waste Slag Storage Area, Reynolds Industrial Park, Transfer, Pennsylvania.* DCN: 5002-DR-01-0. Oak Ridge Institute for Science and Education, managed and operated by Oak Ridge Associated Universities. Oak Ridge, Tennessee. January 26.

ORAU/ORISE 2012b. *Laboratory Procedures Manual for the Independent Environmental Assessment and Verification Program*. Oak Ridge Institute for Science and Education, managed and operated by Oak Ridge Associated Universities. Oak Ridge, Tennessee. December 13.

ORAU/ORISE 2012c. E-mail correspondence from W. Adams (ORAU/ORISE) to B. Werner (PaDEP). Subject: "2012-04-16 FSSP Section 3 Comments." Oak Ridge Institute for Science and Education, managed and operated by Oak Ridge Associated Universities. Oak Ridge, Tennessee. April 16.

ORAU/ORISE 2013a. *Project-Specific Plan for the Independent Verification of Section 3 at the Whittaker Corporation, Reynolds Industrial Park, Transfer, Pennsylvania*. DCN: 5002-PL-02-0. Oak Ridge, Tennessee. February 6.

ORAU/ORISE 2013b. *Survey Procedures Manual for the Independent Environmental Assessment and Verification Program*. Oak Ridge Institute for Science and Education, managed and operated by Oak Ridge Associated Universities. Oak Ridge, Tennessee. January 18.

ORAU/ORISE 2013c. E-mail correspondence from W. Adams (ORAU/ORISE) to B. Werner (PaDEP). Subject: "Whittaker Survey Packages Section 3, SUs 1, 4 and 5 Review." Oak Ridge, Tennessee. February 6.