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National Measurement Institute

Proficiency Test Final Report AQA 25-01 Metals, Nutrients and Exchangeable Bases in Soil

June 2025

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SUMMARY

This report presents the results of the proficiency test AQA 25-01 Metals, Nutrients and Exchangeable Bases in Soil. The study focused on the measurement of the following acid extractable elements: Ag, Al, As, B, Ba, Be, Bi, Ca, Cd, Co, Cr, Cs, Cu, Fe, Ga, Hg, K, La, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Rb, S, Sb, Se, Sn, Sr, Th, Tl, U, V and Zn. Measurement of total P, P buffer index (with Colwell P)- PBI_{+ColP}, calcium chloride-extractable B, total carbon (TC), total organic carbon (TOC), total nitrogen (TN), Colwell K, Colwell P, EC, pH of 1:5 soil / 0.01 M $CaCl_2$ extract, exchangeable bases (Ca^{2+}, K^+, Mg^{2+}, Na^+) - 1M NH_4Cl extract and moisture content was also included in the program.

The sample set consisted of one dried soil sample, one sludge sample and one dried agricultural soil sample. The assigned values were the robust average of participants' results. The associated uncertainties were evaluated from the robust standard deviation of the participants' results.

Twenty-seven laboratories enrolled and 26 reported results. The outcomes of the study were assessed against the aims as follows, to:

i. assess laboratory capabilities in measuring metals, nutrients and exchangeable bases in soil.

Laboratory performance was assessed using both z-scores and E_n-scores.

Of 813 z-scores, 736 (91%) returned an acceptable score of $|z| \leq 2.0$.

Of 813 E_n-scores, 633 (78%) were acceptable with $|E_n| < 1.0$.

No laboratory reported results for all 52 tests for which a z-score was calculated.

Laboratory 2 returned the highest number of acceptable z-scores (48 out of 49 reported).

Laboratory 11 returned the highest number of acceptable E_n-scores (46 out of 47 reported).

ii. evaluate the laboratories' methods used in determination of inorganic analytes.

All participants used both HNO_3 and HCl as extraction reagents and most used a digestion temperature of 90°C to 100°C.

Participating laboratories were challenged by the process of subsampling a representative test portion from the sludge sample S2 and reporting results for this sample corrected for moisture content.

Some participants reported results for TC and TOC in wrong units.

iii. compare the performance of participant laboratories with their past performance.

Despite different matrices, analytes, and analyte concentrations, on average participants' performance remained consistent.

iv. develop the practical application of measurement uncertainty and provide participants with information that will be useful in evaluating their uncertainties.

Of 939 numerical results, 918 (98%) were reported with an expanded measurement uncertainty. The magnitude of these expanded uncertainties was within the range 0.82% to 1016% of the reported value.

v. produce materials that can be used in method validation and as control samples.

The test samples of this study were checked for homogeneity and are well characterised, both by in-house testing and from the results of the proficiency round. Surplus of these test samples is available for purchase from NMI.

1 INTRODUCTION

1.1 NMI Proficiency Testing Program

The National Measurement Institute (NMI) is responsible for Australia's national measurement infrastructure providing a wide range of services, including a chemical proficiency testing program.

Proficiency testing (PT) "is evaluation of participant performance against pre-established criteria by means of interlaboratory comparison."[1] NMI PT studies target chemical testing in areas of high public significance such as trade, environment, and food safety. NMI offers studies in:

- inorganic analytes in soil, water, food, filters and paint;
- pesticide residues in soil, water, fruit, vegetables, and herbs;
- hydrocarbons, phenols and other organic compounds in soil and water;
- per- and polyfluoroalkyl substances in soil, biosolid, water, biota, and food;
- chlorophyll a in water; and
- controlled drug assay, drugs in wipes, and clandestine laboratory.

AQA 25-01 is the 36th NMI proficiency study of inorganic analytes in soil.

1.2 Study Aims

The aims of the study were to:

- assess laboratory capability in measuring metals, nutrients and exchangeable bases in soil;
- evaluate the laboratories' methods used in determination of inorganic analytes;
- compare the performance of participant laboratories with their past performance;
- develop the practical application of measurement uncertainty and provide participants with information that will be useful in evaluating their uncertainties; and
- produce materials that can be used in method validation and as control samples.

1.3 Study Conduct

The conduct of NMI proficiency tests is described in the NMI Chemical Proficiency Testing Study Protocol.[2] The statistical methods used are described in the NMI Chemical Proficiency Statistical Manual.[3] These documents have been prepared with reference to ISO Standard 17043[1] and The International Harmonized Protocol for Proficiency Testing of (Chemical) Analytical Laboratories.[4]

NMI is accredited by National Association of Testing Authorities, Australia (NATA) to ISO/IEC 17043: 2023 as a provider of proficiency testing schemes. This study is within the scope of NMI's accreditation.

The choice of the test method was left to the participating laboratories.

2 STUDY INFORMATION

2.1 Selection of Matrices and Inorganic Analytes

The 66 tests over the three samples were selected from those for which an investigation level is published in the Guidelines on the Investigation Levels for Soil and Groundwater, promulgated by the National Environmental Protection Council (NEPC), [5] and from analytes commonly measured in soil.

2.2 Participation

27 laboratories participated and 26 submitted results.

The timetable of the study was:

Invitations issued:	03 March 2025
Samples dispatched:	24 March 2025
Results due:	11 April 2025
Interim report issued:	23 April 2025
Preliminary report issued	28 April 2025

2.3 Test Material Specification

Three samples were provided for analysis:

Sample S1 was 30 g of dried soil (clay).

Sample S2 was 60 g of moist sludge.

Sample S3 was 75 g of dried agricultural soil.

2.4 Laboratory Code

All participant laboratories were assigned a confidential code number.

2.5 Sample Preparation, Analysis and Homogeneity Testing

Test samples from previous studies have been demonstrated to be sufficiently homogeneous for the evaluation of participants' performance. As the same preparation procedure was followed as in the previous studies only a partial homogeneity test was conducted for samples S1 and S3, with the exception of Al and Sb in Sample S1, and of the agricultural tests in S3. A full homogeneity test of the sludge Sample S2 was conducted for all acid extractable elements and the moisture content except for La, Rb, and Tl.

The results of the partial homogeneity testing and full homogeneity testing for these samples are reported in the present study as the homogeneity value. The preparation, analysis and homogeneity testing of the study samples are described in Appendix 1.

2.6 Stability of Analytes

No stability study was carried out for the present study. Stability studies conducted for the previous proficiency tests of inorganic analytes in soil and sediment found no significant changes in any of the analytes' concentration.

2.7 Sample Storage, Dispatch and Receipt

Sample S2, the sludge sample, was stored refrigerated prior to dispatch, whilst all other test samples were stored at ambient temperature.

The samples were dispatched by courier on 24 March 2025.

The following items were packaged with the samples:

- a covering letter which included a description of the test samples and instructions for participants; and
- a form to confirm the receipt and condition of the samples.

An Excel spreadsheet for the electronic reporting of the results was emailed to participants.

2.8 Instructions to Participants

Participants were instructed as follows:

- Quantitatively analyse the samples using your normal test method.
- Please store samples S1 and S3 at room temperature.
- Sample S2, the moist sample, should be thoroughly mixed before removing a test portion. To avoid loss of moisture, do not leave the sample uncovered; store this sample refrigerated.
- For Sample S3 for determination of calcium chloride – extractable B, exchangeable bases (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}) - 1M NH_4Cl extract and of P buffer index (with Colwell P)- PBI $_{+ColP}$, participants are asked to use the methods defined by Rayment, G.E. and David, J. L in "Soil Chemical Methods-Australasia".
- These samples are an attempt to mime the real samples encountered by a laboratory in its routine activities. Please use appropriate Good Laboratory Practice when handling them, including safety aspects.
- For S1 report results for acid extractable elements on as received basis in units of mg/kg.
- For S2 report results for moisture content in % (g/100g). For acid extractable elements in S2 results are to be reported on dry weight basis (corrected for moisture content) and in units of mg/kg.
- For S3 report results on as received basis in units of cmol(+)/kg for exchangeable bases (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}) - 1M NH_4Cl extract. For all other tests, except for pH and EC (µS/cm), report results on as received basis in units of mg/kg.

SAMPLE S1		**SAMPLE S2**		**SAMPLE S3**	
Test acid extractable	**Approximate Conc. Range *(as received basis)* mg/kg**	**Test acid extractable**	**Approximate Conc. Range *(dry weight basis)* mg/kg**	**Test**	**Approximate Conc. Range *(as received basis)* mg/kg**
Ag	0.5-20	Al	1000-40000	Ca (acid extractable)	250-10000
Al	1000-40000	As	0.5-20	Calcium chloride –extractable B[1]	Not available
As	0.5-20	B	0.5-20	Colwell P	Not available
B	5-200	Ba	5-200	Colwell K	Not available
Bi	0.05-2	Be	0.05-2	EC	Not available
Cd	0.05-2	Cd	0.05-2	Exchangeable Ca-1MNH4Cl extract[2]	Not available
Co	0.5-20	Cr	5-200	Exchangeable Mg-1MNH4Cl extract[2]	Not available
Cr	5-200	Cu	5-200	Exchangeable Na-1MNH4Cl extract[2]	Not available
Cs	0.5-20	Hg	0.05-2	Exchangeable K-1MNH4Cl extract[2]	Not available
Cu	5-200	La	0.5-20	Fe (acid extractable)	1000-40000
Fe	1000-40000	Mn	20-800	K (acid extractable)	250-10000
Ga	0.5-20	Mo	5-200	Mg (acid extractable)	250-10000
Hg	0.05-2	Na	5-200	Na (acid extractable)	5-200
Li	5-200	P	20-800	P (acid extractable)	250-10000
Mn	20-800	Pb	5-200	P buffer index (with Colwell P)- PBI +ColP[3]	Not available
Ni	5-200	Rb	0.5-20	pH of 1:5soil/0.01MCaCl2 extract	Not available
Pb	5-200	Se	0.5-20	S (acid extractable)	20-800
Sb	5-200	Sn	5-200	Sr (acid extractable)	5-200
Se	0.5-20	Tl	0.5-20	Total Carbon	3000-120000
Th	0.5-20	V	5-200	Total Organic Carbon	3000-120000
U	0.5-20	Zn	5-200	Total Nitrogen	1000-40000
Zn	20-800	Moisture	20-80%	Total P	Not available

[1]Method 12C, [2]Method 15A1, [3]Method 9I2 as defined by Rayment, G.E. and David, J. L in "Soil Chemical Methods-Australasia".

- Report results using the electronic results sheet emailed to you:
- Report results as you would report to a client. For each analyte, report the expanded measurement uncertainty.
- Please send us all the requested details regarding the test method.

- Return the completed results sheet by email (proficiency@measurement.gov.au), by 11 April 2025.

2.9 Interim and Preliminary Reports

An Interim Report was emailed to participants on 23 April 2025.

A Preliminary Report was issued on 28 April 2025. This report included: a summary of the results reported by laboratories, assigned values, performance coefficient of variations, z-scores and En-scores for each analyte tested by participants.

The partial homogeneity values for the acid extractable elements in Sample S3 were included in this report.

A partial homogeneity test was conducted for sample S2 before dispatch and were provided as the homogeneity value in the Preliminary Report. The results of this data gave no reason to question the homogeneity of the sample. However, due to one laboratory's comments that the sample may not be homogeneous, a full homogeneity test was subsequently conducted on this sample for all acid extractable elements and the moisture content, except for La, Rb, and Tl. The complete data from homogeneity testing for sample S2 is provided in Appendix 1. Table 1 below shows the updated values.

Table 1 Updated Homogeneity Values for Samples S2 and S3

Sample	Analyte	Partial Homogeneity Value / Preliminary Report Value (mg/kg)	Full Homogeneity Value / Final Report Value (mg/kg)
S2	Al	6680 ± 800	5790 ± 690
S2	As	3.82 ± 0.46	3.89 ± 0.47
S2	B	7.05 ± 0.85	7.44 ± 0.89
S2	Ba	52.7 ± 6.3	55.5 ± 6.7
S2	Be	0.734 ± 0.088	0.738 ± 0.089
S2	Cd	0.763 ± 0.092	0.735 ± 0.088
S2	Cr	29.4 ± 3.5	29.0 ± 3.5
S2	Cu	27.1 ± 3.3	28.2 ± 3.4
S2	Hg	0.317 ± 0.038	0.325 ± 0.065
S2	Mn	378 ± 45	362 ± 72
S2	Mo	12.9 ± 1.5	12.7 ± 1.5
S2	Na	49.2 ± 5.9	47.1 ± 5.7
S2	P	176 ± 21	175 ± 21
S2	Pb	21.3 ± 2.6	21.3 ± 2.6
S2	Se	2.50 ± 0.30	2.48 ± 0.30
S2	Sn	12.1 ± 1.5	12.2 ± 1.5
S2	Tl	1.45 ± 0.17	NA
S2	V	20.9 ± 2.5	21.1 ± 2.5
S2	Zn	64.7 ± 7.8	65 ± 13
S2	Moisture Content	39.6 ± 0.8 %	39.3 ± 2.0 %
S3	Ca	NA	2370 ± 280
S3	Fe	NA	13500 ± 1600
S3	K	NA	2950 ± 350
S3	Mg	NA	1290 ± 160
S3	Na	NA	38.9 ± 4.7
S3	P	NA	1220 ± 150
S3	S	NA	580 ± 70
S3	Sr	NA	16.0 ± 1.9

3 PARTICIPANT LABORATORY INFORMATION

3.1 Test Method Summaries

Summaries of test methods are transcribed in Tables 2 to 10. The instruments and settings reported by participants are presented in Appendix 5.

Table 2 Methodology for Acid Extractable Elements

Lab. Code	Method Reference	Staggered Digestion	Sample Mass (g)	Temp. (°C)	Time (min)	Vol. HNO_3 (mL)	Vol. HCl (mL)	Vol. HNO_3 (1:1) (mL)	Vol. HCl (1:1) (mL)	Vol. H_2O_2 (mL)	Other
1	AS4479; USEPA 3050; 200.8; 200.7, 6010, 6020	Yes	1	95-100	120	3	3				
2	In House – referencing APHA 3125	No	0.4	120	60	2.5	7.5				
3	6020B	No	1	90	120	9	3				
4	US EPA 6010C		1	98	150	5	5				
5*	EPA 200.2 Ref 2.8 1994 / EPA 200.7 Rev 4.4 1994 / EPA 3051A Rev 1 Feb 2007	No	1	90	120			4	10		
6	US EPA 200.2	NA	1	95	50	2	2				10 (H_2O)
8*	In-house method	Yes	0.5	95	120	1	3				
10*	USEPA Method 3050	Yes	3	95	120	10	5	10		6	
11	USEPA Method 6010c, USEPA Methods 7471B, 7470A, 7471B	No	1	90-98	90	3	3				
12	AOAC 990.08	NA	0.5	100	240	5	5				
13	USEPA 3010		2	95-105	60	4	12				
14	AOAC 900.08	No	0.5	100	240	5	5				
15	US EPA 200.2	No	0.5	95	30	1	1				5 (H_2O)
16	In House, US EPA 6020B		2	95	60	4	12				4 (H_2O)
17	Acid Digestion of sediment, sludges and soil-USEPA 3050		1	95	90	3	3				
18			2.5	95	90	4	12			2	
19	USEPA 3010		2	100	60	4	12				4 (H_2O)
20	USEPA 3050B		0.5	95	120	3	3				
22	USEPA Method 6010c, USEPA Methods 7471B, 7470A, 7471B	No	1	90 - 98	90	3	3				
24	USEPA 3051A	No	0.5	180	30	9ml	3ml				
25	US EPA METHOD 3010	No	2	90-95	60	4	12				4 (H_2O)
26	EPA (Environmental Protection Agency) 1994 Method 200.8		2	109	60	800	400				
27			1	95	120	2	1				

*Additional information in Table 11

Table 3 Methodology for Total Carbon

Lab. Code	Method Reference	Total Carbon Test Method	Total Carbon Measurement Technique
1		High Temperature Oxidation	
2	In house	High Temperature Oxidation	Combustion Analyser
4		High Temperature Oxidation	
11		Combustion	Infra-Red Detectors
17		Combustion	Infra-Red Detectors
19	In House	High Temperature Oxidation	IR
20	Inhouse	High Temperature Oxidation	Infrared Gas Analysis
21	In House	High Temperature Oxidation	Combustion Analyser
25	In House	High Temperature Oxidation	Combustion infrared detection

Table 4 Methodology for Total Organic Carbon

Lab. Code	Method Reference	Total Organic Carbon Test Method	Total Organic Carbon Measurement Technique	Additional Information
1		High Temperature Oxidation		
2		High Temperature Oxidation	Combustion Analyser	TOC - sample digested with sulfurous acid prior to analysis
4		High Temperature Oxidation		
5	NTC-5403 B - 2021-05-19		Volumetric Chemical Oxidation with $K_2Cr_2O_7/H_2SO_4$	The result is corrected with the % of Humidity
10	6B1	Dichromate/H2SO4 digestion	DA (Wavelength)	
11		Combustion	Infra-Red Detectors	
17		Combustion	Infra-Red Detectors	
19	In House		Calculation (TC - IC)	
20	Inhouse	High Temperature Oxidation	Infrared Gas Analysis	
21	6B3	High Temperature Oxidation	Combustion Analyser	
22	AS1289-4.1.1 2019	Chemical Oxidation (Ag2SO4 added)	Titration	
25	In House	High Temperature Oxidation	Combustion infrared detection	

Table 5 Methodology for Colwell P and Colwell K

Lab. Code	Method Reference	Sample Mass (g)	Extraction Solution 0.5 M $NaHCO_3$ Volume (mL)	Shake time (hours)	Final Dilution Factor (Colwell K)	Final Dilution Factor (Colwell P)	Measurement Technique (Colwell K)	Measurement Technique (Colwell P)	Additional Information
2	Colwell P 9B2, Colwell K 18A1	0.4	40	16	3280	328	ICPMS	FIA (wavelength)	
4	Method 9B1: George E. Rayment and David J. Lyons	1.2	120	16					
10	9B1	1	100	16		100		DA (wavelength)	
11	9B1						ICP-OES-AV-buffer (wavelength)	DA (wavelength)	
21	9B2	1	100	17				FIA (wavelength)	880nm
27		1		16		1/100		DA (wavelength)	

Table 6 Methodology for P Buffer Index – PBI_{+ColP}

Lab. Code	Method Reference*	Sample Mass (g)	Extraction Solution (P equilibrating Solution) Volume (mL)	Shake time (hours)	Instrument	Final Dilution Factor	Wavelength (nm) / Absorbance (nm)
2	9I2	2	20	16	ICP-OES	10	213.617
4	9I2	2	20	17	ICP-OES	100	213.617
11	9B2				DA		

*9I2 as defined by Rayment, G.E. and David, J. L. in “Soil Chemical Methods-Australasia”.

Table 7 Methodology for Total P

Lab. Code	Method
5	EPA 200.2 Ref 2.8 1994 / EPA 200.7 Rev 4.4 1994 / EPA 3051A Rev 1 Feb 2007
10	Total P by Kjeldahl digestion and DA
20	Total P by Kjeldahl digestion and FIA

Table 8 Methodology for Calcium Chloride Extractable B

Lab. Code	Method Reference*	Sample Mass (g)	Extraction Solution (0.01 M $CaCl_2$) Volume (mL)	Reflux Time (min)	Instrument	Final Dilution Factor	Wavelength (nm) / Absorbance (nm)
2	12C	10	20	10	ICP-OES	2	208.889
4	12C	2	20	0.167	ICP-OES	100	249.68

*12C as defined by Rayment, G.E. and David, J. L. in “Soil Chemical Methods-Australasia”.

Table 9 Methodology for Total Nitrogen

Lab. Code	Method Reference (eg USEPA No.)	Test Method	TN = TKN	TN = TKN + NOx	Measurement Method	Instrument
1		Digestion and Distillation	No	Yes	Titrimetric method	Manual Analysis
2	In house - Dumas combustion	Combustion			Dumas -High temperature combustion	Combustion Analyser
4		Combustion			Dumas -High temperature combustion	Combustion Analyser
10	APHA Method 4500-N Org D	Block digestion	No	No	Colorimetric - salicylate method	DA
11	APHA, 4500-Norg D	Digestion	No	Yes	Colorimetric - salicylate method	DA
17	--	Combustion	No	No	Dumas -High temperature combustion	Combustion Analyser
20	Inhouse	Digestion	Yes	No	Colorimetric - phenate method	FIA
21	7A5	High Temperature Combustion			Dumas -High temperature combustion	Combustion Analyser
22	APHA, 4500-Norg D	Digestion	No	Yes	Colorimetric - salicylate method	DA
27				Yes		

Table 10 Methodology for Exchangeable Bases

Lab. Code	Method Reference	Sample Mass (g)	Shake Time (hours)	Extraction Solution	Extraction Solution Volume (mL)	Additional Information
2	15A1	1	1	1M NH4Cl	20	
3	15A1	5	1	1M NH4Cl	100	
4	15A1	2	1	1M NH4Cl	10	
5	NTC 5349 2016-09-29 / EPA 200.7 Rev 4.4. 1994	5	12 hour	1M NH4Cl	50	The result is corrected with the % of Humidity
10	15A1	2	1	1M NH4Cl	40	
11	15A1	2.5	1	1M NH4Cl	50	
17	15A1	2.5	1	1M NH4Cl	50	
19	15A1	5	2.5	1M NH4Cl	100	
21	15A1	2	1	1M NH4Cl	40	
22	15A1	2.5	1	1M NH4Cl	50	
25	15A1	5	1	1M NH4Cl	100	
27	15A1			1M NH4Cl		

*15A1 as defined by Rayment, G.E. and David, J. L. in “Soil Chemical Methods-Australasia”.

3.2 Additional Information

Participants had the option to report additional information for each sample analysed. These are transcribed in Table 11.

Table 11 Additional information

Lab. Code	Additional Information
5	Other Method EC: NTC 5596:2022-04-20 – Method B. Other Method pH: NTC 5264:2023-09-08 Other Method TOC: NTC-5403 2021-05-19 – Method B.
8	S1 was analysed as received without drying. S2 was dried at 40°C , then analysed. For Moisture content analysis, 105°C was used.
10	S3: pH of CaCl2 extract 1:5 reported.

3.3 Basis of Participants' Measurement Uncertainty Evaluation

Participants were requested to provide information about the basis of their uncertainty evaluation (Tables 12 and 13).

Table 12 Basis of Uncertainty Evaluation

Lab. Code	Approach to Evaluating MU	Information Sources for MU Evaluation[a]		Guide Document for Evaluation MU
		Precision	Method Bias	
1	Top Down - precision and estimates of the method and laboratory bias k = 2	Control Samples Duplicate Analysis	CRM	Nordtest Report TR537
2	Top Down - precision and estimates of the method and laboratory bias Coverage factor not reported	Control Samples - Reference Material / Ex PT Sample Duplicate Analysis	Instrument Calibration	Nordtest Report TR537
3	Standard deviation of replicate analyses multiplied by 2 or 3 k = 2	Control Samples	Recoveries of SS	ISO/GUM
4	Top Down - reproducibility (standard deviation) from PT studies used directly Coverage factor not reported	Standard deviation from PT studies only		Eurachem/CITAC Guide
		Control Samples Duplicate Analysis	CRM Laboratory Bias from PT Studies	
5	Standard deviation of replicate analyses multiplied by 2 or 3 k = 2	Standard deviation from PT studies only		Eurachem/CITAC Guide
		Control Samples - SS Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Variation in Sample Moisture Content Laboratory Bias from PT Studies Recoveries of SS Standard Purity	
6	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Control Samples - CRM Duplicate Analysis	Instrument Calibration Laboratory Bias from PT Studies	Eurachem/CITAC Guide
8	Standard deviation of replicate analyses multiplied by 2 or 3 k = 2	Control Samples - Reference Material / Ex PT Sample Duplicate Analysis	CRM Laboratory Bias from PT Studies	Eurachem/CITAC Guide
9	Standard deviation of replicate analyses multiplied by 2 or 3 k = 2		Instrument Calibration	Nordtest Report TR537
10	Top Down - precision and estimates of the method and laboratory bias Coverage factor not reported	Control Samples - SS Duplicate Analysis Instrument Calibration	Instrument Calibration Laboratory Bias from PT Studies Recoveries of SS	Calculated from in-house QA/QC plan
11	Top Down - precision and estimates of the method and laboratory bias k = 2	Control Samples - SS		Eurachem/CITAC Guide
12	Top Down - precision and estimates of the method and laboratory bias Coverage factor not reported	Control Samples - CRM Duplicate Analysis		NATA - General

Lab. Code	Approach to Evaluating MU	Information Sources for MU Evaluation[a]		Guide Document for Evaluation MU
		Precision	Method Bias	
13	Bottom Up (ISO/GUM, fish bone/ cause and effect diagram) Coverage factor not reported	Control Samples - CRM Instrument Calibration	CRM Instrument Calibration	ISO/GUM
14	Standard deviation of replicate analyses multiplied by 2 or 3 k = 2	Control Samples - CRM Duplicate Analysis	CRM Recoveries of SS	
15	Top Down - precision and estimates of the method and laboratory bias Coverage factor not reported	Control Samples Duplicate Analysis	Laboratory Bias from PT Studies	other”
16	Top Down - precision and estimates of the method and laboratory bias Coverage factor not reported	Control Samples	Recoveries of SS	ISO/GUM
17	Top Down - precision and estimates of the method and laboratory bias k = 2	Control Samples	Recoveries of SS	Eurachem/CITAC Guide
18	Top Down - precision and estimates of the method and laboratory bias k = 2	Control Samples - CRM Duplicate Analysis Instrument Calibration	CRM	ISO/GUM
19	Top Down - precision and estimates of the method and laboratory bias k = 2	Control Samples - CRM Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Laboratory Bias from PT Studies Recoveries of SS	ASTM E2554-13
20	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Control Samples Duplicate Analysis		
21	Top Down - reproducibility (standard deviation) from PT studies used directly Coverage factor not reported	Control Samples - Reference Material / Ex PT Sample Duplicate Analysis Instrument Calibration	CRM	NMI Uncertainty Course
22	Top Down - precision and estimates of the method and laboratory bias k = 2	Duplicate Analysis	Recoveries of SS	Eurachem/CITAC Guide
23	Top Down - precision and estimates of the method and laboratory bias k = 2	Control Samples Duplicate Analysis	CRM Instrument Calibration	ISO/GUM
24	Top Down - precision and estimates of the method and laboratory bias k = 2	Control Samples - SS Duplicate Analysis	Recoveries of SS	ISO/GUM
25	See ‘Additional Information’ section below Coverage factor not reported	Control samples - CRM Instrument Calibration	CRM	See 'Additional Information' section below
26	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Duplicate Analysis	Instrument Calibration Recoveries of SS	Eurachem/CITAC Guide

Lab. Code	Approach to Evaluating MU	Information Sources for MU Evaluation[a]		Guide Document for Evaluation MU
		Precision	Method Bias	
27	Top Down - precision and estimates of the method and laboratory bias k = 2	Control Samples - SS Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Recoveries of SS	Eurachem/CITAC Guide

*Additional information in Table 12. [a] RM = Reference Material, CRM = Certified Reference Material, SS =Spiked samples.

Table 13 Additional Information for Basis of Uncertainty Evaluation

Lab Code	Additional Information
25	Estimation of MU from within-laboratory data on bias and precision has been calculated by using the procedures outlined in ASTM E2554-13 Standard Practice for Estimating and Monitoring the Uncertainty of Test Results of a Test Method Using Control Chart Techniques

3.4 Participant Comments on this PT Study or Suggestions for Future Studies

The study co-ordinator welcomes comments or suggestions from participants about this study or possible future studies. Such feedback may be useful in improving future studies. Participants' comments are presented in Table 14, along with the study coordinator's response where appropriate.

Table 14 Participants' Comments

Lab. Code	Sample	Participant's Comments	Study Coordinator's Response
15	S2	We struggled to get consistent results for this sample. Results from re-digests weren't consistent with the other digests (or even following a trend that could be explained by different moisture content results). This suggests that the sample isn't particularly homogenous.	The aim of this study was to provide laboratories feedback on both their subsampling and extraction procedure. In the instruction letter, participants were advised to mix Sample S2 thoroughly before subsampling. An incorrect subsampling procedure, when the sample taken for analysis is not representative of the entire sample, could explain why the results from different digests were not in good agreement with each other even when assessed in the context of the moisture content results from repeated analysis. The weak digestion regime used may also explain the variability of the results and the low recovery of most acid extractable elements in both samples S1 and S2 (Figure 68). A full homogeneity test was conducted on Sample S2 for all acid extractable elements and for the moisture content, except for La, Rb, and Tl. The data is provided in Appendix 1.

4 PRESENTATION OF RESULTS AND STATISTICAL ANALYSIS

4.1 Results Summary

Participant results are listed in Tables 15 to 80 with resultant summary statistics: robust average, median, mean, number of numeric results, maximum, minimum, robust standard deviation (SD_{rob}) and robust coefficient of variation (CV_{rob}). Bar charts of results and performance scores are presented in Figures 2 to 67. An example chart with interpretation guide is shown in Figure 1.

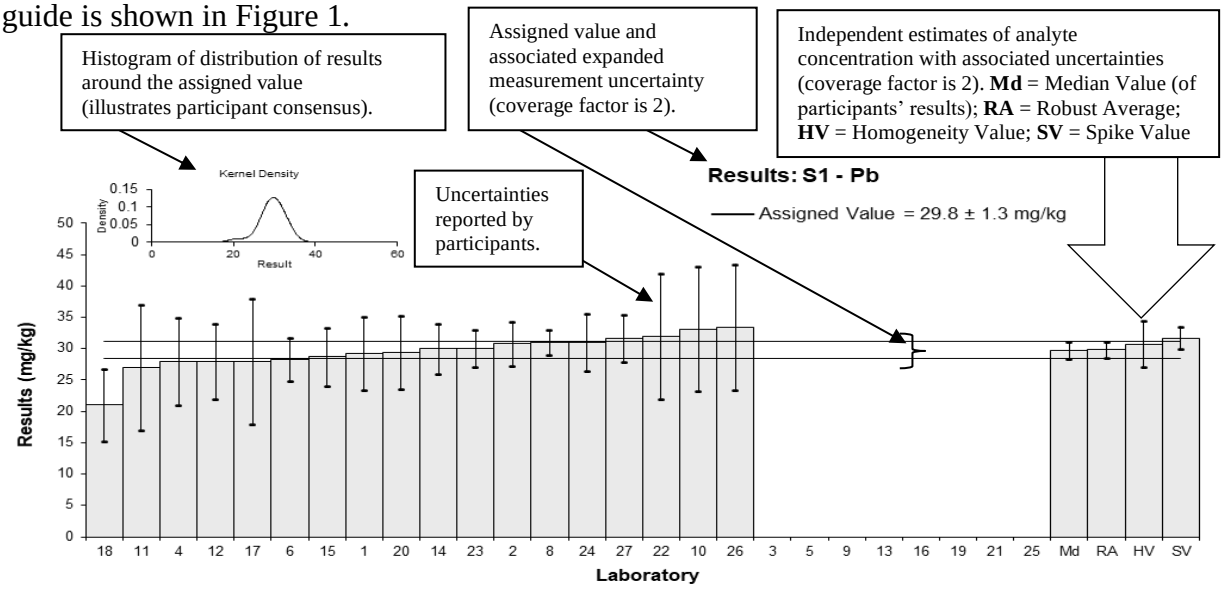


Figure 1 Guide to Presentation of Results

4.2 Outliers and Extreme Outliers

Outliers were results less than 50% and greater than 150% of the robust average and were removed before assigned value calculation. Extreme outliers (gross errors) were obvious blunders, such as those with incorrect units, decimal errors, or results from a different proficiency test item and were removed for calculation of summary statistics.[3, 4]

4.3 Assigned Value

An example of the assigned value calculation using data from the present study is given in Appendix 2. The assigned value is defined as: 'the value attributed to a particular property of a proficiency test item.'[1] In this PT study, the property is the mass fraction of analyte. Assigned values were the robust average of participants' results, outliers and extreme outliers removed; the expanded uncertainties were evaluated from the associated robust standard deviations.[4, 6]

4.4 Robust Average and Robust Between-Laboratory Coefficient of Variation

The robust averages and associated expanded measurement uncertainties were calculated using the procedure described in 'Statistical methods for use in proficiency testing by interlaboratory comparisons, ISO13528.'[6] The robust between-laboratory coefficient of variation (robust CV) is a measure of the variability of participants' results and was calculated using the procedure described in ISO13528.[6]

4.5 Target Standard Deviation for Proficiency Assessment

The target standard deviation for proficiency assessment (σ) is the product of the assigned value *(X)* and the performance coefficient of variation (PCV). This value is used for calculation of participant z-score and provides scaling for laboratory deviation from the assigned value.

$\sigma = X * \text{PCV}$ Equation 1

It is important to note that the PCV is a fixed value and is not the standard deviation of participants' results. The fixed value set for PCV is based on the existing regulation, the acceptance criteria indicated by the methods, the matrix, the concentration level of analyte and on experience from previous studies. It is backed up by mathematical models such as the Thompson/Horwitz equation.[7]

4.6 z-Score

An example of z-score calculation using data from the present study is given in Appendix 2. For each participant's result a z-score is calculated according to Equation 2 below:

$$z = \frac{(\chi - X)}{\sigma} \qquad \text{Equation 2}$$

Where:

z is z-score;
χ is participant's result;
X is the assigned value;
σ is the target standard deviation.

A z-score with absolute value (|z|):

- $|z| \leq 2.0$ is acceptable;
- $2.0 < |z| < 3.0$ is questionable;
- $|z| \geq 3.0$ is unacceptable.

4.7 E_n-Score

An example of E_n-score calculation using data from the present study is given in Appendix 2. The E_n-score is complementary to the z-score in assessing laboratory performance. E_n-score includes measurement uncertainty and is calculated according to Equation 3 below:

$$E_n = \frac{(\chi - X)}{\sqrt{U_\chi^2 + U_X^2}} \qquad \text{Equation 3}$$

Where:

E_n is E_n-score;
χ is a participants' result;
X is the assigned value;
U_χ is the expanded uncertainty of the participants' result;
U_X is the expanded uncertainty of the assigned value.

An E_n-score with absolute value ($|E_n|$):

- $|E_n| < 1.0$ is acceptable;
- $|E_n| \geq 1.0$ is unacceptable.

The acceptance criteria for E_n-score has been changed from an acceptable $|E_n|$ score of ≤ 1 to an acceptable $|E_n|$ score of < 1.0 as per new IS0/IEC 17043:2023 requirements.[1]

4.8 Traceability and Measurement Uncertainty

Laboratories accredited to ISO/IEC Standard 17025 must establish and demonstrate the traceability and measurement uncertainty associated with their test results.[8] Guidelines for quantifying uncertainty in analytical measurement are described in the Eurachem/CITAC Guide.[9]

5 TABLES AND FIGURES

Table 15

Sample Details

Sample No.	S1
Matrix	Soil (clay)
Analyte	Ag
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	3.0	0.6	-0.22	-0.16
2	3.49	0.4	0.84	0.88
3	NT	NT		
4	NR	NR		
5	NT	NT		
6	3.17	0.75	0.15	0.09
8	2.84	0.25	-0.56	-0.83
9	NT	NT		
10	3.2	0.96	0.22	0.10
11	3	1	-0.22	-0.10
12	4.4	1	2.80	1.28
13	NT	NT		
14	3.6	1.1	1.08	0.45
15	3.00	0.48	-0.22	-0.19
16	NT	NT		
17	3	1	-0.22	-0.10
18	NT	NT		
19	NT	NT		
20	3.07	0.95	-0.06	-0.03
21	NT	NT		
22	3	1	-0.22	-0.10
23	2.8	0.56	-0.65	-0.51
24	2.7	0.54	-0.86	-0.70
25	NT	NT		
26	3.15	0.945	0.11	0.05
27	<5	NR		

Statistics

Assigned Value	3.10	0.19
Spike Value	3.24	0.16
Homogeneity Value	3.02	0.36
Robust Average	3.10	0.19
Median	3.00	0.15
Mean	3.16	
N	15	
Max	4.4	
Min	2.7	
Robust SD	0.29	
Robust CV	9.3%	

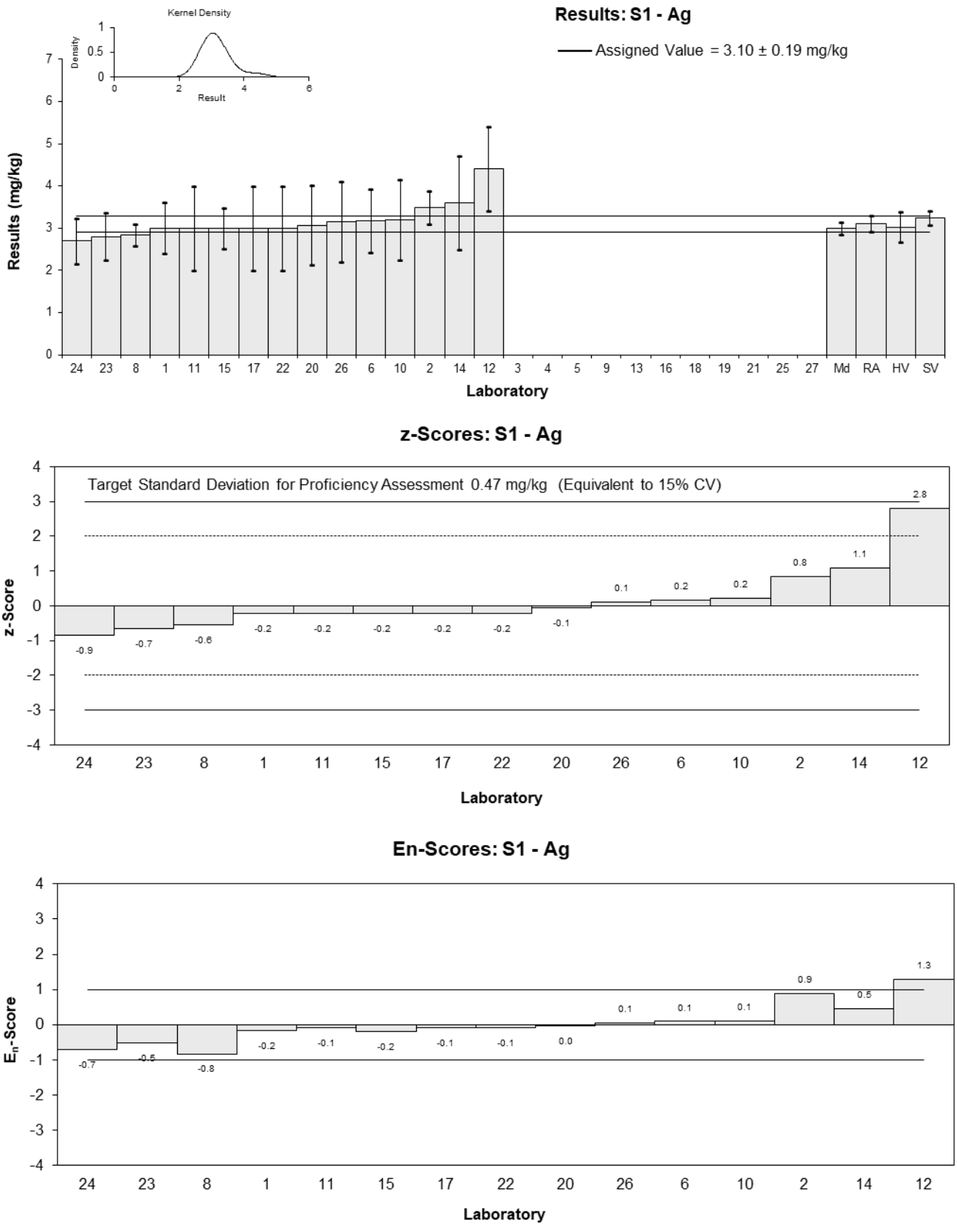

Results: S1 - Ag
Assigned Value = 3.10 ± 0.19 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
24 23 8 1 11 15 17 22 20 26 6 10 2 14 12 3 4 5 9 13 16 18 19 21 25 27 Md RA HV SV
z-Scores: S1 - Ag
Target Standard Deviation for Proficiency Assessment 0.47 mg/kg (Equivalent to 15% CV)
z-Score
-0.9 -0.7 -0.6 -0.2 -0.2 -0.2 -0.2 -0.2 -0.1 0.1 0.2 0.2 0.8 1.1 2.8
Laboratory
24 23 8 1 11 15 17 22 20 26 6 10 2 14 12
En-Scores: S1 - Ag
En-Score
-0.7 -0.5 -0.8 -0.2 -0.1 -0.2 -0.1 -0.1 0.0 0.1 0.1 0.1 0.9 0.5 1.3
Laboratory
24 23 8 1 11 15 17 22 20 26 6 10 2 14 12

Figure 2

Table 16

Sample Details

Sample No.	S1
Matrix	Soil (clay)
Analyte	Al
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	22300	4470	0.52	0.40
2	21600	2200	0.35	0.39
3	NT	NT		
4	20400	3060	0.05	0.05
5	NT	NT		
6	17900	2200	-0.57	-0.65
8	21500	1400	0.32	0.42
9	NT	NT		
10	14364.3	4309.29	-1.44	-1.14
11	19000	5000	-0.30	-0.21
12	24038	4800	0.95	0.69
13	NT	NT		
14	23900	1730	0.92	1.12
15*	10500	2300	-2.40	-2.68
16	NT	NT		
17	14000	3000	-1.53	-1.51
18	NT	NT		
19	NT	NT		
20	19400	3900	-0.20	-0.17
21	NT	NT		
22	16000	5000	-1.04	-0.73
23*	34000	15300	3.42	0.89
24*	39000	5460	4.65	3.06
25	NT	NT		
26	22200	6660	0.50	0.28
27	28700	6027	2.10	1.28

* Outlier, see Section 4.2

Statistics

Assigned Value	20200	2800
Spike Value	Not Spiked	
Robust Average	21000	3700
Median	21500	2300
Mean	21700	
N	17	
Max	39000	
Min	10500	
Robust SD	6200	
Robust CV	29%	

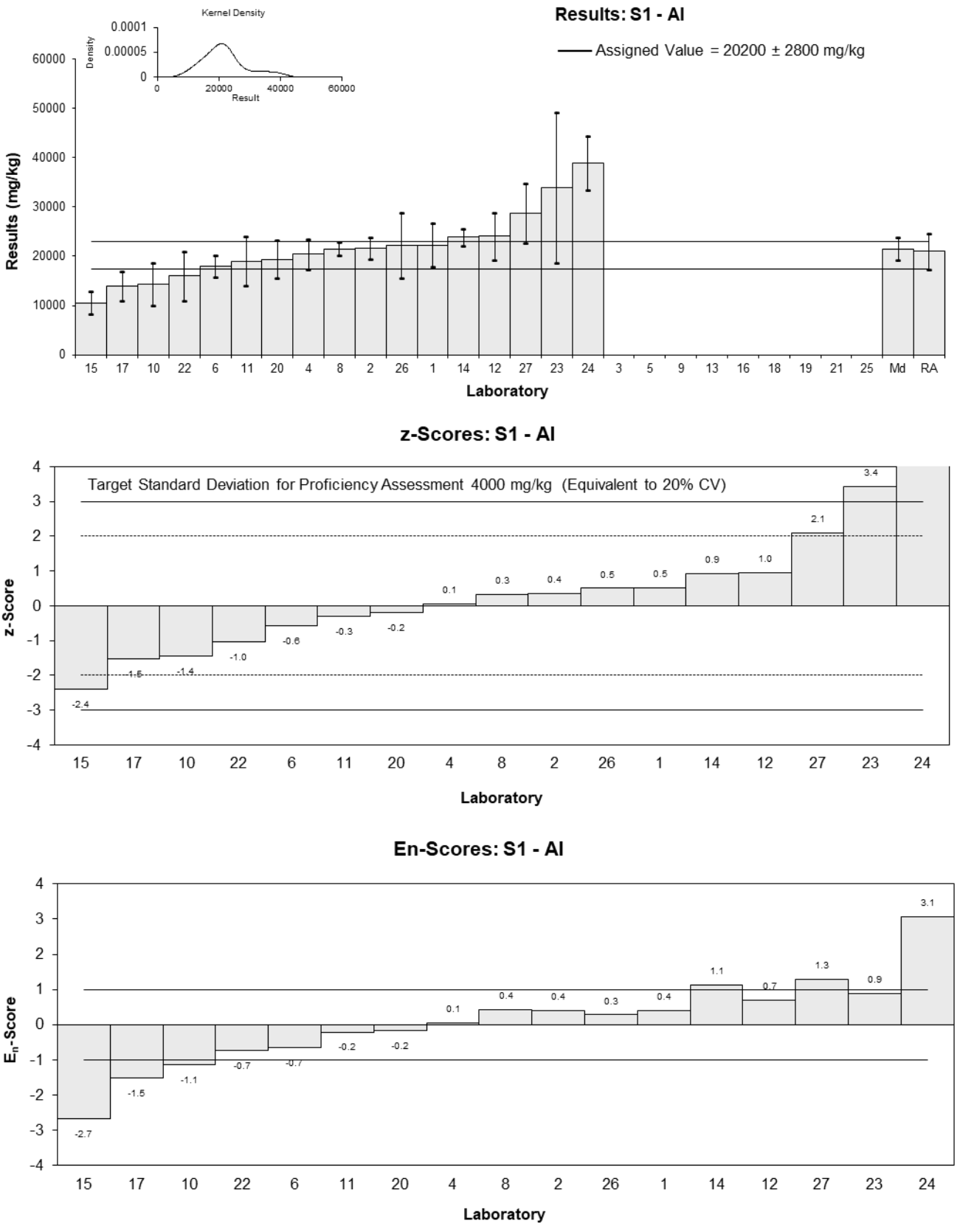

Kernel Density
Density
Result
Results: S1 - Al
Assigned Value = 20200 ± 2800 mg/kg
Results (mg/kg)
Laboratory
z-Scores: S1 - Al
Target Standard Deviation for Proficiency Assessment 4000 mg/kg (Equivalent to 20% CV)
z-Score
Laboratory
En-Scores: S1 - Al
En-Score
Laboratory

Figure 3

Table 17

Sample Details

Sample No.	S1
Matrix	Soil (clay)
Analyte	As
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	3.3	0.66	-0.27	-0.19
2	4.93	0.5	2.06	1.61
3	NT	NT		
4	<15	NR		
5	NT	NT		
6	2.61	0.30	-1.26	-1.10
8	2.95	0.15	-0.77	-0.72
9	NT	NT		
10	5.07	1.521	2.26	0.93
11	<4	NR		
12	2.3	0.4	-1.70	-1.41
13	NT	NT		
14	3.9	0.6	0.59	0.43
15	2.70	2.4	-1.13	-0.31
16	NT	NT		
17	<4	NR		
18	3.2	1.0	-0.42	-0.23
19	NT	NT		
20	3.42	0.72	-0.10	-0.07
21	NT	NT		
22	<4	NR		
23	<5	1.2		
24	4.5	0.45	1.45	1.17
25	NT	NT		
26	3.05	0.915	-0.63	-0.37
27	<5	NR		

Statistics

Assigned Value	3.49	0.74
Spike Value	Not Spiked	
Homogeneity Value	3.99	0.48
Robust Average	3.49	0.74
Median	3.25	0.64
Mean	3.49	
N	12	
Max	5.07	
Min	2.3	
Robust SD	1.0	
Robust CV	29%	

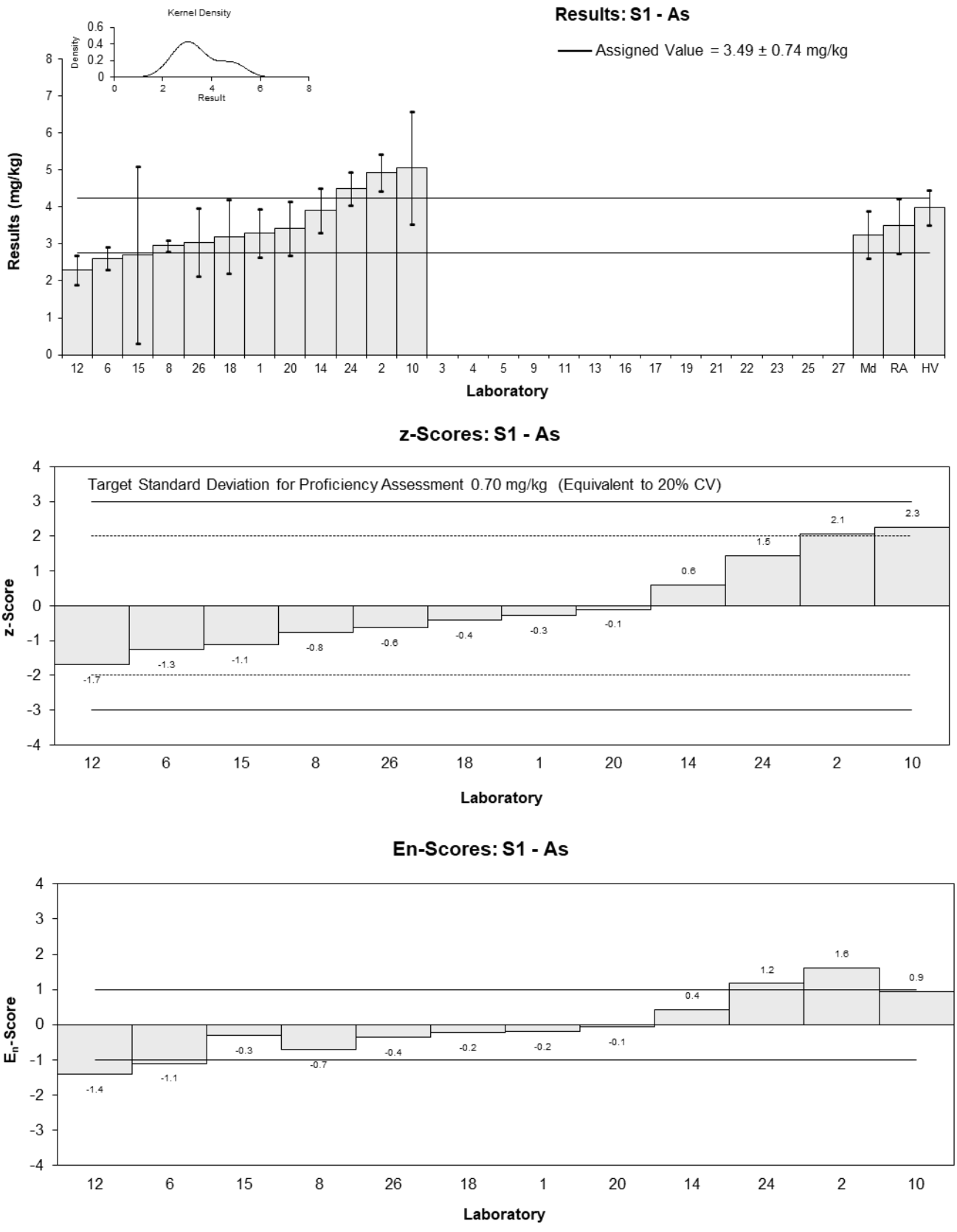

Results: S1 - As
Assigned Value = 3.49 ± 0.74 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
12 6 15 8 26 18 1 20 14 24 2 10 3 4 5 9 11 13 16 17 19 21 22 23 25 27 Md RA HV
z-Scores: S1 - As
Target Standard Deviation for Proficiency Assessment 0.70 mg/kg (Equivalent to 20% CV)
z-Score
-1.7 -1.3 -1.1 -0.8 -0.6 -0.4 -0.3 -0.1 0.6 1.5 2.1 2.3
12 6 15 8 26 18 1 20 14 24 2 10
Laboratory
En-Scores: S1 - As
En-Score
-1.4 -1.1 -0.3 -0.7 -0.4 -0.2 -0.2 -0.1 0.4 1.2 1.6 0.9
12 6 15 8 26 18 1 20 14 24 2 10
Laboratory

Figure 4

Table 18

Sample Details

Sample No.	S1
Matrix	Soil (clay)
Analyte	B
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	22.5	4.5
2	33	3.5
3	NT	NT
4	25	5
5	NT	NT
6	24.0	3.6
8	20.6	2.1
9	NT	NT
10	9.97	2.991
11	17	6
12	14.2	3
13	NT	NT
14	34	2
15	17.3	2.6
16	NT	NT
17	20	6
18	NT	NT
19	NT	NT
20	21.2	6.3
21	NT	NT
22	21	8
23	35	7
24	36	5.4
25	NT	NT
26	21	6.3
27	27.5	3.9

Statistics

Assigned Value	Not Set	
Spike Value	35.3	1.7
Homogeneity Value	32.7	3.9
Robust Average	23.5	5.1
Median	21.2	3.5
Mean	23.5	
N	17	
Max	36	
Min	9.97	
Robust SD	8.4	
Robust CV	36%	

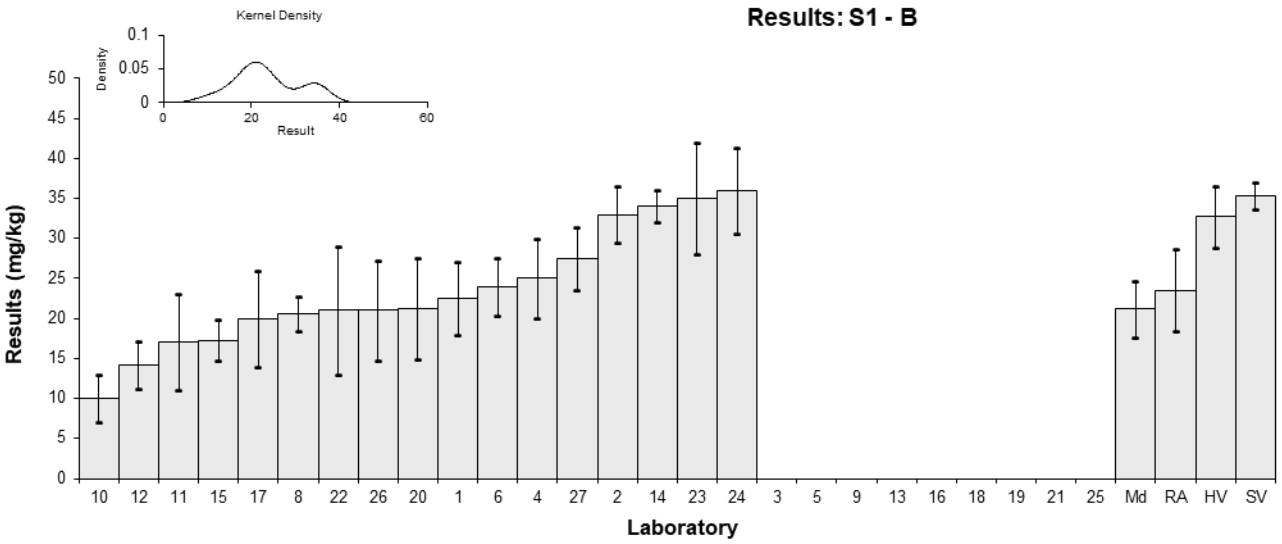

Results: S1 - B
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
10 12 11 15 17 8 22 26 20 1 6 4 27 2 14 23 24 3 5 9 13 16 18 19 21 25 Md RA HV SV

Figure 5

Table 19

Sample Details

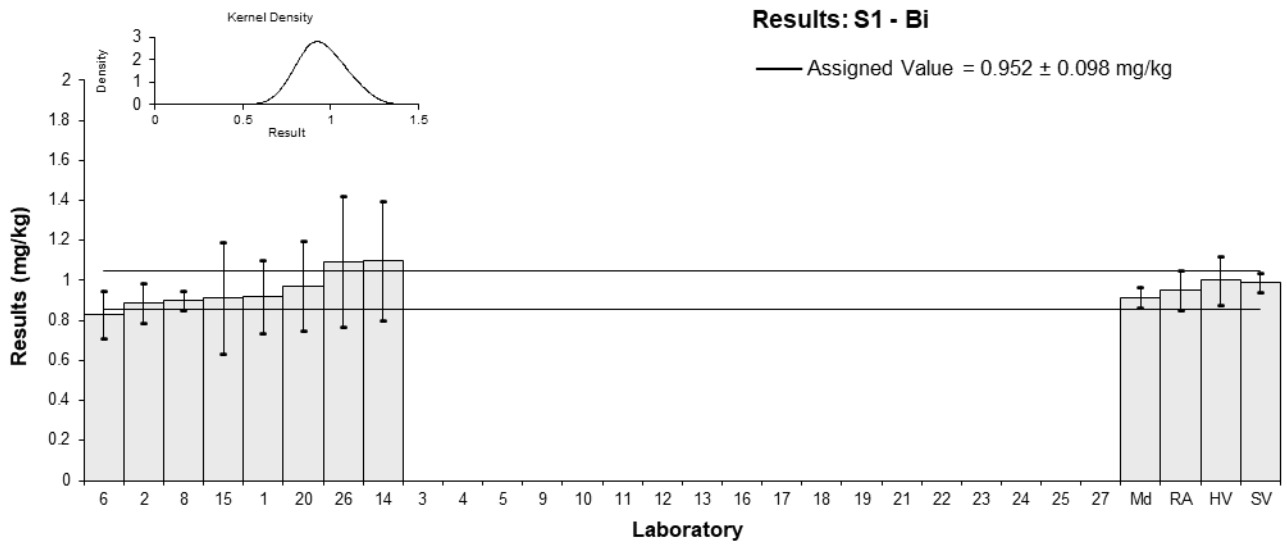
Sample No.	S1
Matrix	Soil (clay)
Analyte	Bi
Unit	mg/kg

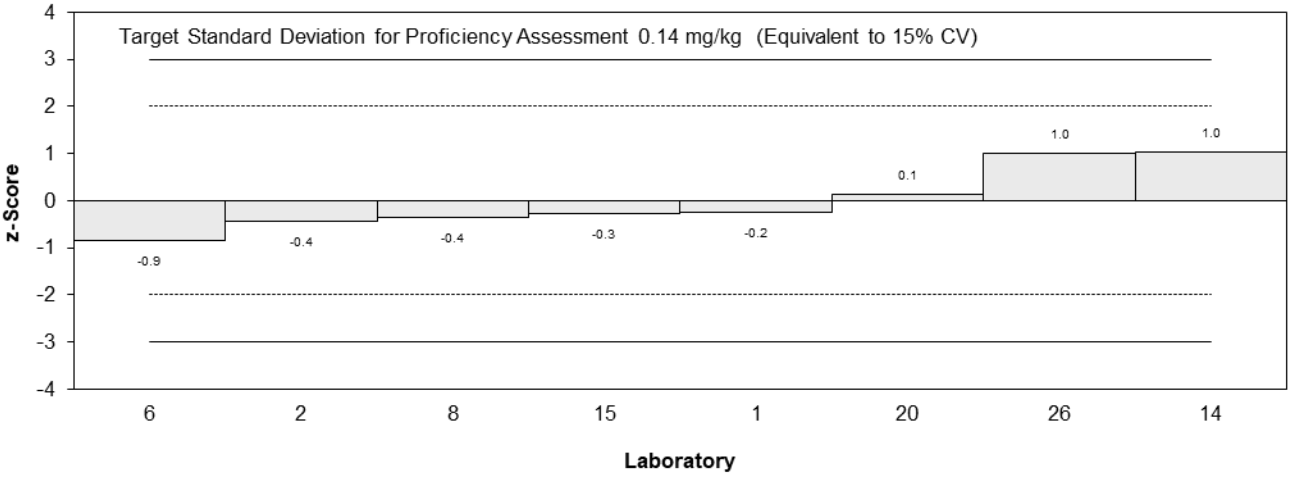
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.918	0.184	-0.24	-0.16
2	0.89	0.1	-0.43	-0.44
3	NT	NT		
4	NR	NR		
5	NT	NT		
6	0.83	0.12	-0.85	-0.79
8	0.90	0.05	-0.36	-0.47
9	NT	NT		
10	< 3	< 3		
11	<1	NR		
12	NT	NT		
13	NT	NT		
14	1.1	0.3	1.04	0.47
15	0.914	0.280	-0.27	-0.13
16	NT	NT		
17	<1	NR		
18	NT	NT		
19	NT	NT		
20	0.972	0.224	0.14	0.08
21	NT	NT		
22	<1	NR		
23	NT	NT		
24	< 2	NR		
25	NT	NT		
26	1.095	0.3285	1.00	0.42
27	NR	NR		

Statistics

Assigned Value	0.952	0.098
Spike Value	0.992	0.047
Homogeneity Value	1.00	0.12
Robust Average	0.952	0.098
Median	0.916	0.054
Mean	0.952	
N	8	
Max	1.1	
Min	0.83	
Robust SD	0.11	
Robust CV	12%	


Kernel Density
Density
Result
Results: S1 - Bi
Assigned Value = 0.952 ± 0.098 mg/kg
Results (mg/kg)
Laboratory
6 2 8 15 1 20 26 14 3 4 5 9 10 11 12 13 16 17 18 19 21 22 23 24 25 27 Md RA HV SV


z-Scores: S1 - Bi
Target Standard Deviation for Proficiency Assessment 0.14 mg/kg (Equivalent to 15% CV)
z-Score
-0.9 -0.4 -0.4 -0.3 -0.2 0.1 1.0 1.0
Laboratory
6 2 8 15 1 20 26 14

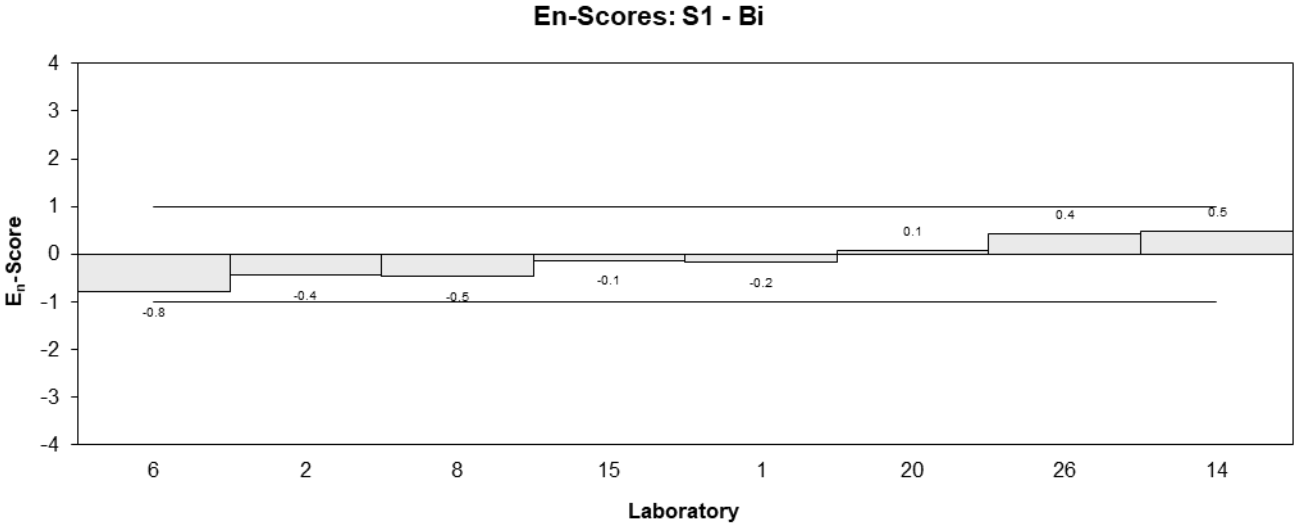

En-Scores: S1 - Bi
En-Score
-0.8 -0.4 -0.5 -0.1 -0.2 0.1 0.4 0.5
Laboratory
6 2 8 15 1 20 26 14

Figure 6

Table 20

Sample Details

Sample No.	S1
Matrix	Soil (clay)
Analyte	Cd
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.567	0.113	-0.71	-0.57
2	0.76	0.1	1.31	1.16
3	NT	NT		
4*	2.25	0.45	16.96	3.58
5	NT	NT		
6	0.630	0.076	-0.05	-0.06
8	0.65	0.04	0.16	0.27
9	NT	NT		
10	0.73	0.219	1.00	0.43
11	0.6	0.2	-0.37	-0.17
12	0.67	0.1	0.37	0.33
13	NT	NT		
14	0.66	0.06	0.26	0.35
15	0.593	0.120	-0.44	-0.33
16	NT	NT		
17	0.6	0.4	-0.37	-0.09
18	0.6	0.1	-0.37	-0.33
19	NT	NT		
20	0.620	0.167	-0.16	-0.09
21	NT	NT		
22	0.6	0.2	-0.37	-0.17
23	<1	0.3		
24	0.62	0.056	-0.16	-0.22
25	NT	NT		
26	0.7345	0.22035	1.04	0.44
27	0.56	0.06	-0.79	-1.05

* Outlier, see Section 4.2

Statistics

Assigned Value	0.635	0.039
Spike Value	0.666	0.033
Homogeneity Value	0.627	0.075
Robust Average	0.643	0.044
Median	0.620	0.027
Mean	0.73	
N	17	
Max	2.25	
Min	0.56	
Robust SD	0.072	
Robust CV	11%	

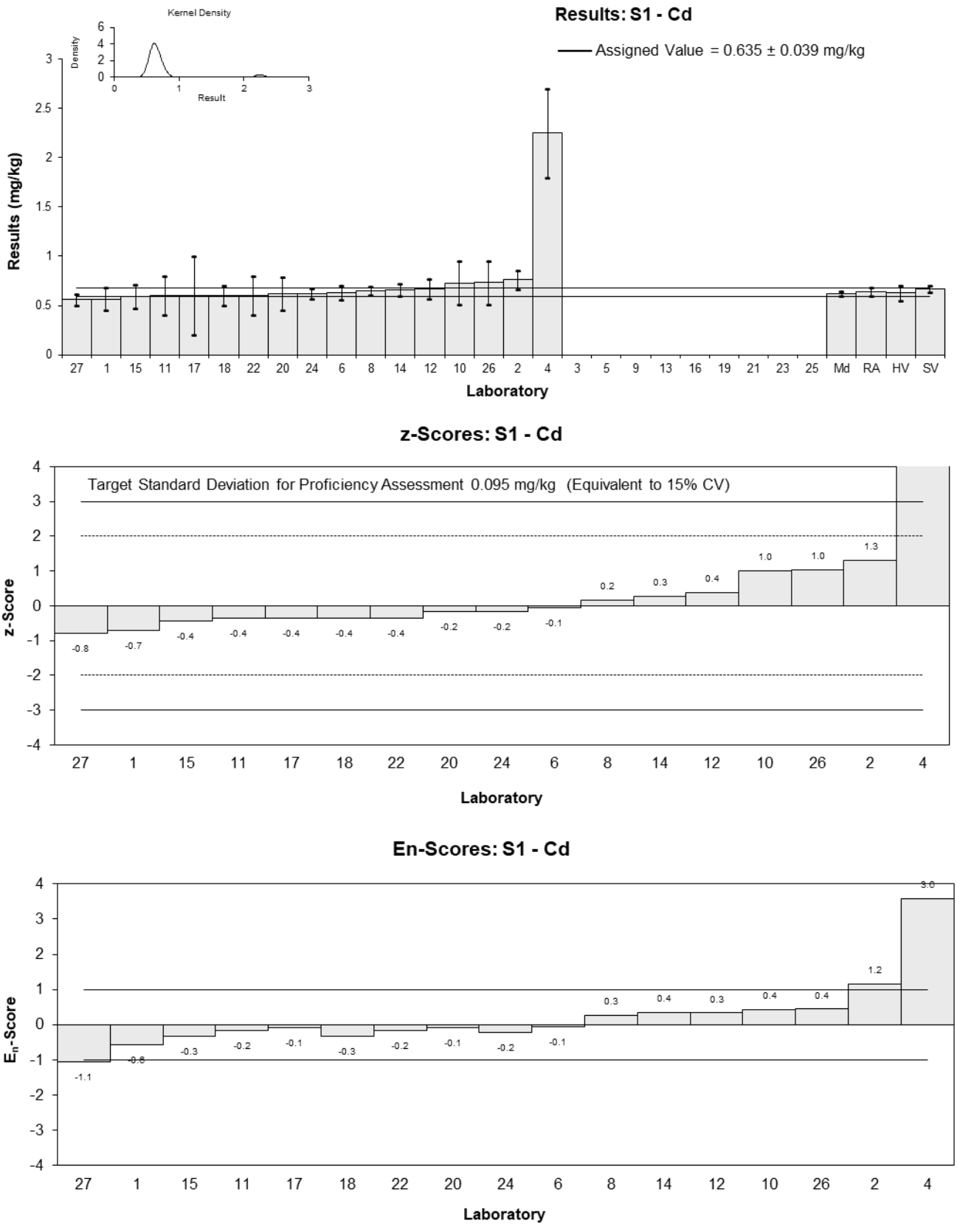

Results: S1 - Cd
Assigned Value = 0.635 ± 0.039 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
27 1 15 11 17 18 22 20 24 6 8 14 12 10 26 2 4 3 5 9 13 16 19 21 23 25 Md RA HV SV
z-Scores: S1 - Cd
Target Standard Deviation for Proficiency Assessment 0.095 mg/kg (Equivalent to 15% CV)
z-Score
-0.8 -0.7 -0.4 -0.4 -0.4 -0.4 -0.4 -0.2 -0.2 -0.1 0.2 0.3 0.4 1.0 1.0 1.3
Laboratory
27 1 15 11 17 18 22 20 24 6 8 14 12 10 26 2 4
En-Scores: S1 - Cd
En-Score
-1.1 -0.6 -0.3 -0.2 -0.1 -0.3 -0.2 -0.1 -0.2 -0.1 0.3 0.4 0.3 0.4 0.4 1.2 3.6
Laboratory
27 1 15 11 17 18 22 20 24 6 8 14 12 10 26 2 4

Figure 7

Table 21

Sample Details

Sample No.	S1
Matrix	Soil (clay)
Analyte	Co
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	11.4	2.28	-0.34	-0.17
2	13	1.5	1.02	0.71
3	NT	NT		
4	11	2.2	-0.68	-0.34
5	NT	NT		
6	11.49	0.92	-0.26	-0.25
8	12.9	0.7	0.93	1.03
9	NT	NT		
10	12.21	3.663	0.35	0.11
11	12	4	0.17	0.05
12	6.9	2	-4.15	-2.27
13	NT	NT		
14	14	1	1.86	1.72
15	10.78	1.6	-0.86	-0.57
16	NT	NT		
17	10	4	-1.53	-0.44
18	NT	NT		
19	NT	NT		
20	11.7	2.3	-0.08	-0.04
21	NT	NT		
22	12	4	0.17	0.05
23	13	1.95	1.02	0.57
24	11	1.65	-0.68	-0.44
25	NT	NT		
26	13.25	3.975	1.23	0.36
27	10.9	1.7	-0.76	-0.48

Statistics

Assigned Value	11.8	0.8
Spike Value	Not Spiked	
Homogeneity Value	13.1	1.6
Robust Average	11.8	0.8
Median	11.7	0.7
Mean	11.6	
N	17	
Max	14	
Min	6.9	
Robust SD	1.3	
Robust CV	11%	

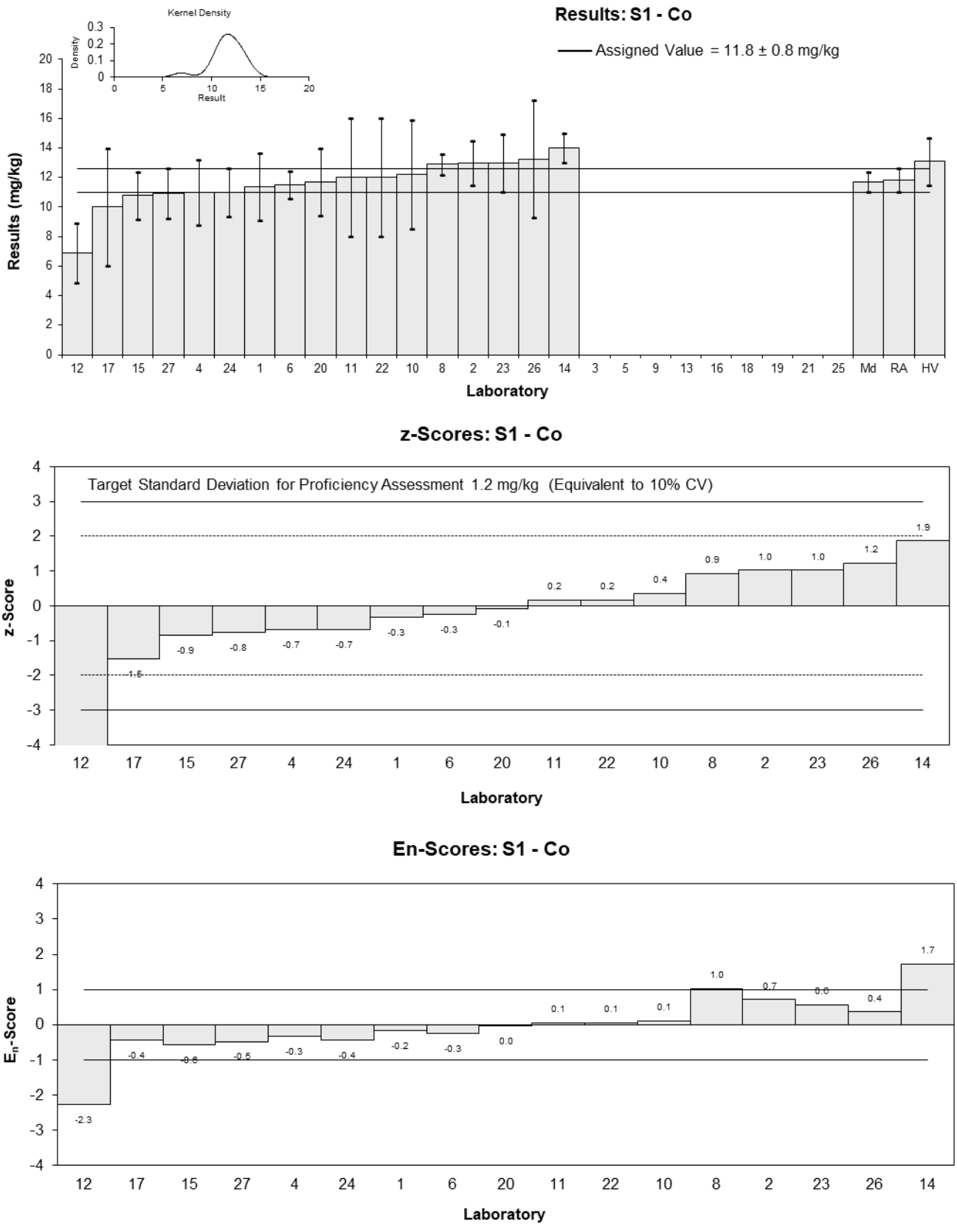

Kernel Density
Density
Result
Results: S1 - Co
Assigned Value = 11.8 ± 0.8 mg/kg
Results (mg/kg)
Laboratory
12 17 15 27 4 24 1 6 20 11 22 10 8 2 23 26 14 3 5 9 13 16 18 19 21 25 Md RA HV
z-Scores: S1 - Co
Target Standard Deviation for Proficiency Assessment 1.2 mg/kg (Equivalent to 10% CV)
z-Score
-1.5 -0.9 -0.8 -0.7 -0.7 -0.3 -0.3 -0.1 0.2 0.2 0.4 0.9 1.0 1.0 1.2 1.9
Laboratory
12 17 15 27 4 24 1 6 20 11 22 10 8 2 23 26 14
En-Scores: S1 - Co
En-Score
-2.3 -0.4 -0.6 -0.5 -0.3 -0.4 -0.2 -0.3 0.0 0.1 0.1 0.1 1.0 0.7 0.6 0.4 1.7
Laboratory
12 17 15 27 4 24 1 6 20 11 22 10 8 2 23 26 14

Figure 8

Table 22

Sample Details

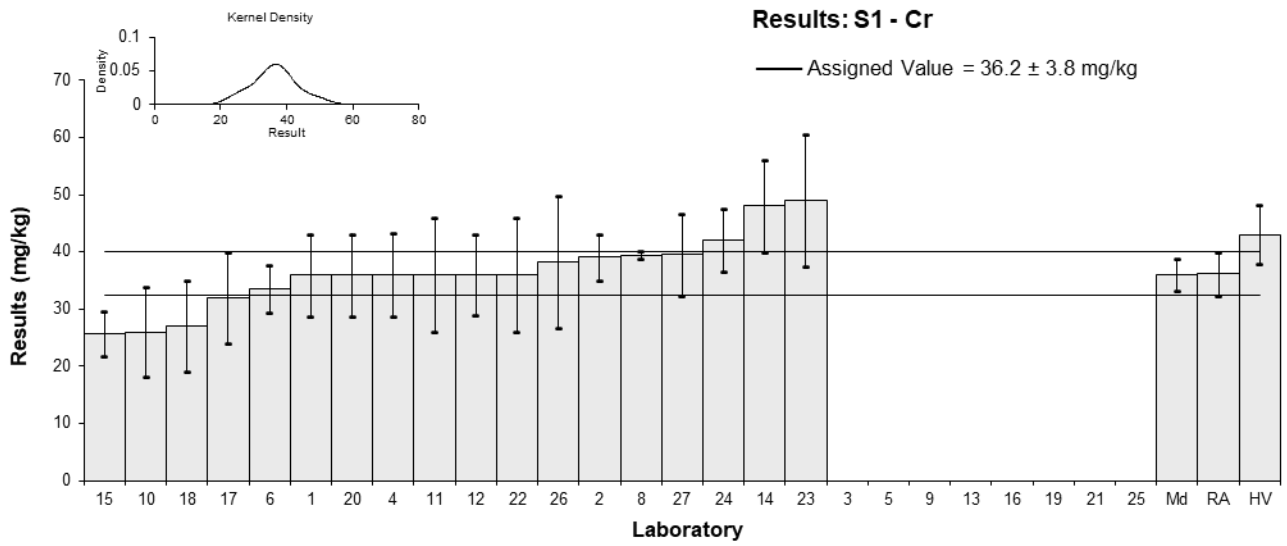
Sample No.	S1
Matrix	Soil (clay)
Analyte	Cr
Unit	mg/kg

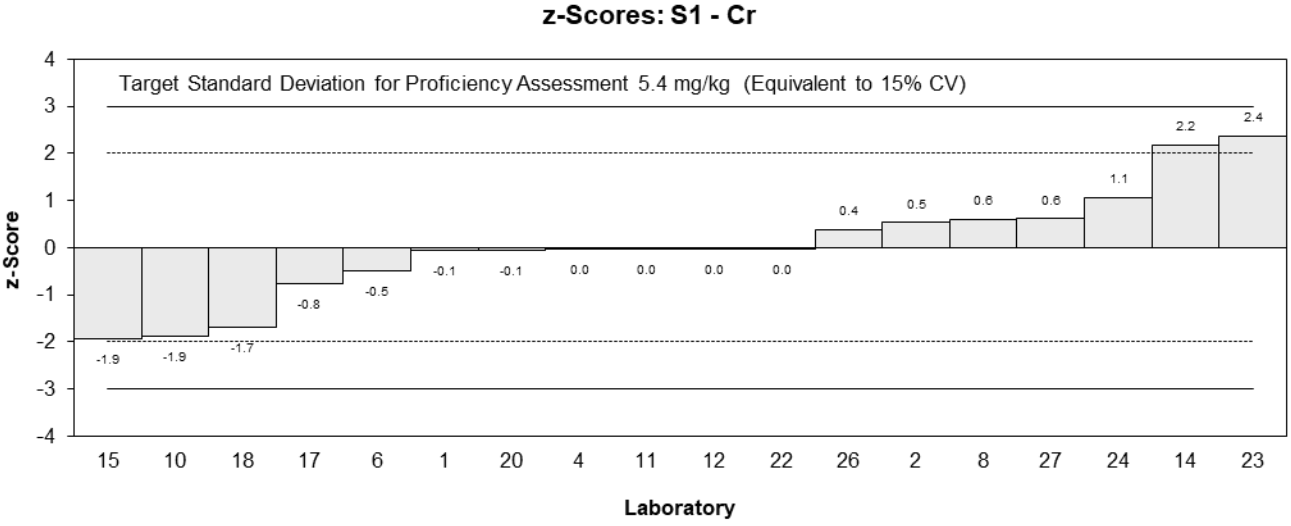
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	35.9	7.18	-0.06	-0.04
2	39.1	4.0	0.53	0.53
3	NT	NT		
4	36	7.2	-0.04	-0.02
5	NT	NT		
6	33.5	4.1	-0.50	-0.48
8	39.4	0.7	0.59	0.83
9	NT	NT		
10	26.01	7.803	-1.88	-1.17
11	36	10	-0.04	-0.02
12	36	7	-0.04	-0.03
13	NT	NT		
14	48	8	2.17	1.33
15	25.7	3.9	-1.93	-1.93
16	NT	NT		
17	32	8	-0.77	-0.47
18	27	7.9	-1.69	-1.05
19	NT	NT		
20	35.9	7.2	-0.06	-0.04
21	NT	NT		
22	36	10	-0.04	-0.02
23	49	11.5	2.36	1.06
24	42	5.46	1.07	0.87
25	NT	NT		
26	38.25	11.475	0.38	0.17
27	39.5	7.1	0.61	0.41

Statistics

Assigned Value	36.2	3.8
Spike Value	Not Spiked	
Homogeneity Value	43.0	5.2
Robust Average	36.2	3.8
Median	36.0	2.8
Mean	36.4	
N	18	
Max	49	
Min	25.7	
Robust SD	6.5	
Robust CV	18%	


Results: S1 - Cr
Assigned Value = 36.2 ± 3.8 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
15 10 18 17 6 1 20 4 11 12 22 26 2 8 27 24 14 23 3 5 9 13 16 19 21 25 Md RA HV


z-Scores: S1 - Cr
Target Standard Deviation for Proficiency Assessment 5.4 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
15 10 18 17 6 1 20 4 11 12 22 26 2 8 27 24 14 23
-1.9 -1.9 -1.7 -0.8 -0.5 -0.1 -0.1 0.0 0.0 0.0 0.0 0.4 0.5 0.6 0.6 1.1 2.2 2.4

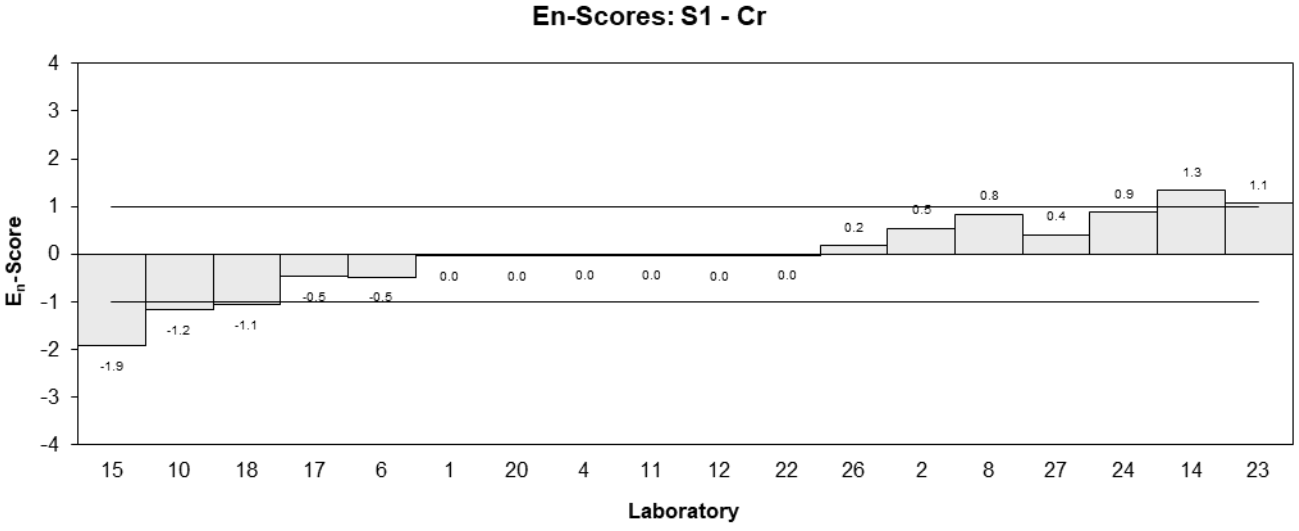

En-Scores: S1 - Cr
En-Score
Laboratory
15 10 18 17 6 1 20 4 11 12 22 26 2 8 27 24 14 23
-1.9 -1.2 -1.1 -0.5 -0.5 0.0 0.0 0.0 0.0 0.0 0.0 0.2 0.5 0.8 0.4 0.9 1.3 1.1

Figure 9

Table 23

Sample Details

Sample No.	S1
Matrix	Soil (clay)
Analyte	Cs
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	2.96	0.591
2	NT	NT
3	NT	NT
4	NR	NR
5	NT	NT
6	2.00	0.25
8	NT	NT
9	NT	NT
10	NT	NT
11	2	2
12	NT	NT
13	NT	NT
14	NR	NR
15	0.750	0.15
16	NT	NT
17	1.5	1
18	NT	NT
19	NT	NT
20	NT	NT
21	NT	NT
22	<1	NR
23	NT	NT
24	4.0	0.6
25	NT	NT
26	2.3	0.69
27	NR	NR

Statistics

Assigned Value	Not Set	
Spike Value*	1.11	0.06
Homogeneity Value	3.33	0.40
Robust Average	2.2	1.1
Median	2.00	0.70
Mean	2.22	
N	7	
Max	4	
Min	0.75	
Robust SD	1.2	
Robust CV	53%	

*Incurred value not included

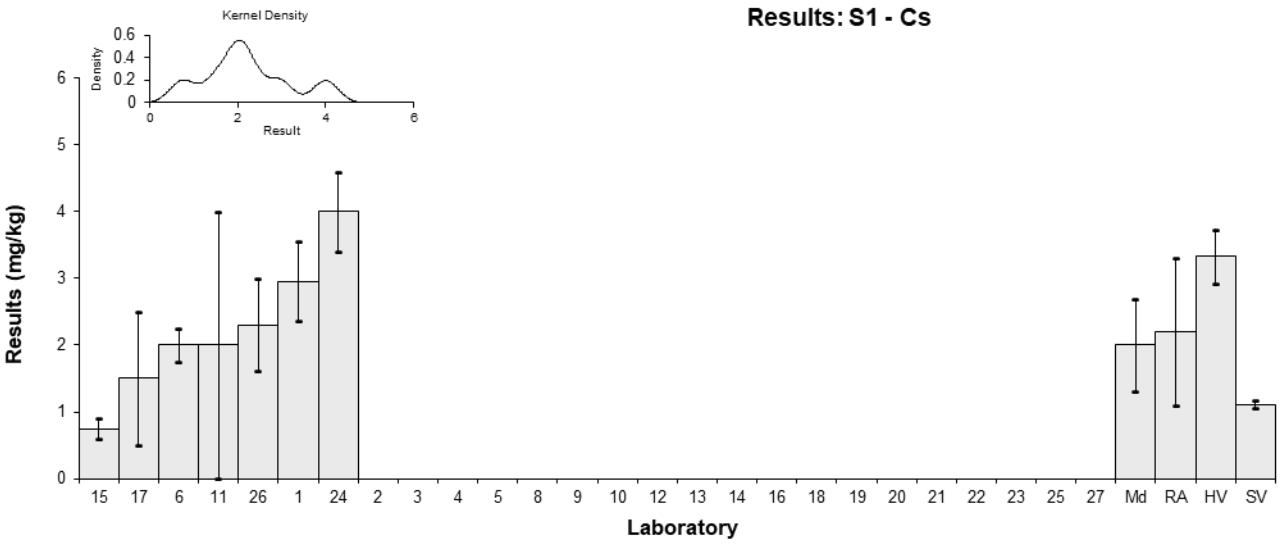

Results: S1 - Cs
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
15 17 6 11 26 1 24 2 3 4 5 8 9 10 12 13 14 16 18 19 20 21 22 23 25 27 Md RA HV SV

Figure 10

Table 24

Sample Details

Sample No.	S1
Matrix	Soil (clay)
Analyte	Cu
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	14.2	2.85	-0.21	-0.10
2	16	2.0	1.03	0.67
3	NT	NT		
4	14.5	2.9	0.00	0.00
5	NT	NT		
6	13.7	2.0	-0.55	-0.36
8	15.5	0.8	0.69	0.78
9	NT	NT		
10	12.21	3.663	-1.58	-0.60
11	14	5	-0.34	-0.10
12	NT	NT		
13	NT	NT		
14	21	1	4.48	4.60
15	11.6	1.7	-2.00	-1.47
16	NT	NT		
17	14	4	-0.34	-0.12
18	14	2.7	-0.34	-0.17
19	NT	NT		
20	14.8	3.1	0.21	0.09
21	NT	NT		
22	14	4	-0.34	-0.12
23	20	4	3.79	1.33
24	14	2.1	-0.34	-0.21
25	NT	NT		
26	16.6	4.98	1.45	0.41
27	13.5	2.2	-0.69	-0.41

Statistics

Assigned Value	14.5	1.0
Spike Value	Not Spiked	
Homogeneity Value	15.7	1.9
Robust Average	14.5	1.0
Median	14.0	0.4
Mean	14.9	
N	17	
Max	21	
Min	11.6	
Robust SD	1.7	
Robust CV	12%	

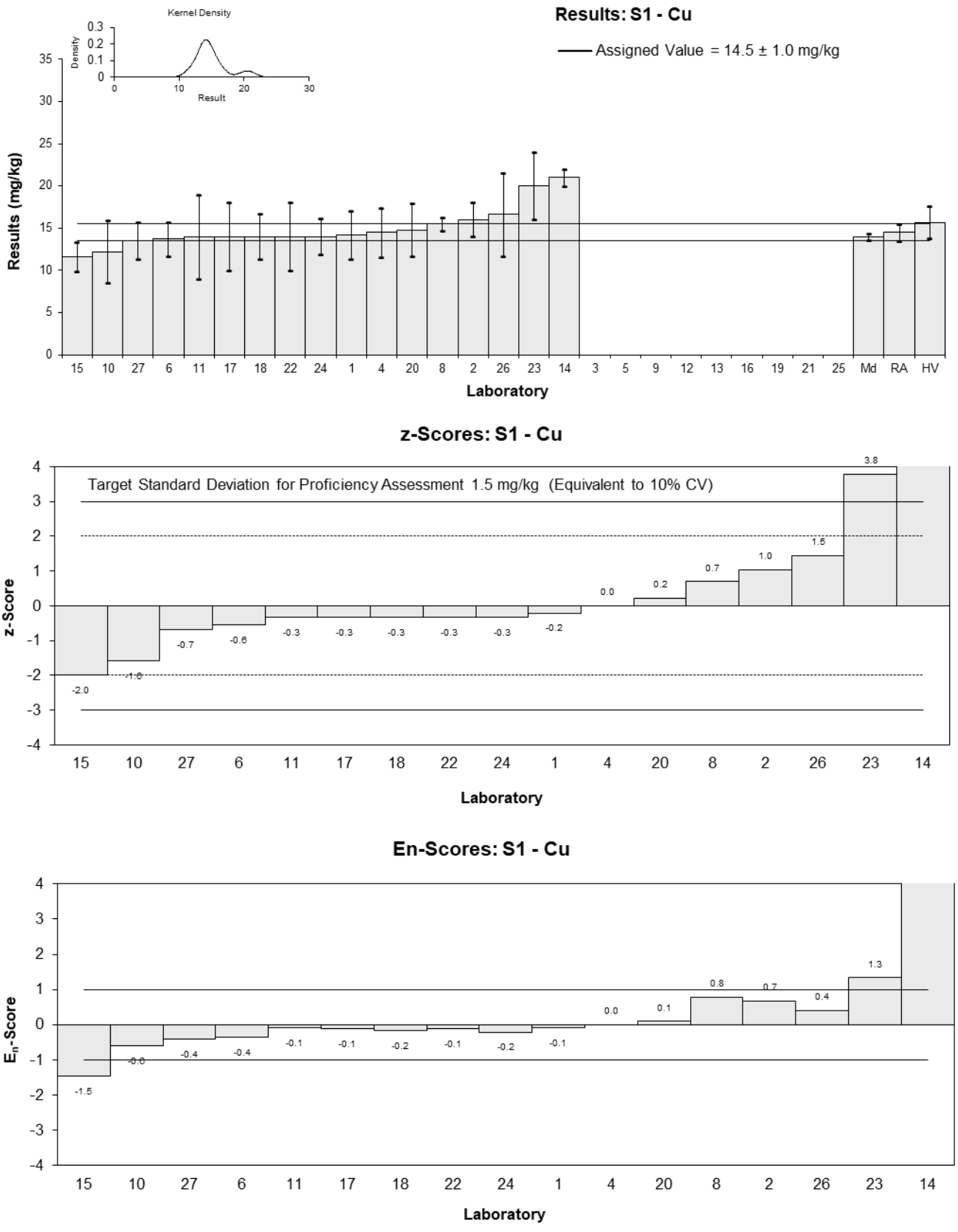

Kernel Density
Density
Result
Results: S1 - Cu
Assigned Value = 14.5 ± 1.0 mg/kg
Results (mg/kg)
Laboratory
15 10 27 6 11 17 18 22 24 1 4 20 8 2 26 23 14 3 5 9 12 13 16 19 21 25 Md RA HV
z-Scores: S1 - Cu
Target Standard Deviation for Proficiency Assessment 1.5 mg/kg (Equivalent to 10% CV)
z-Score
-2.0 -1.6 -0.7 -0.6 -0.3 -0.3 -0.3 -0.3 -0.3 -0.2 0.0 0.2 0.7 1.0 1.5 3.8
Laboratory
15 10 27 6 11 17 18 22 24 1 4 20 8 2 26 23 14
En-Scores: S1 - Cu
En-Score
-1.5 -0.6 -0.4 -0.4 -0.1 -0.1 -0.2 -0.1 -0.2 -0.1 0.0 0.1 0.8 0.7 0.4 1.3
Laboratory
15 10 27 6 11 17 18 22 24 1 4 20 8 2 26 23 14

Figure 11

Table 25

Sample Details

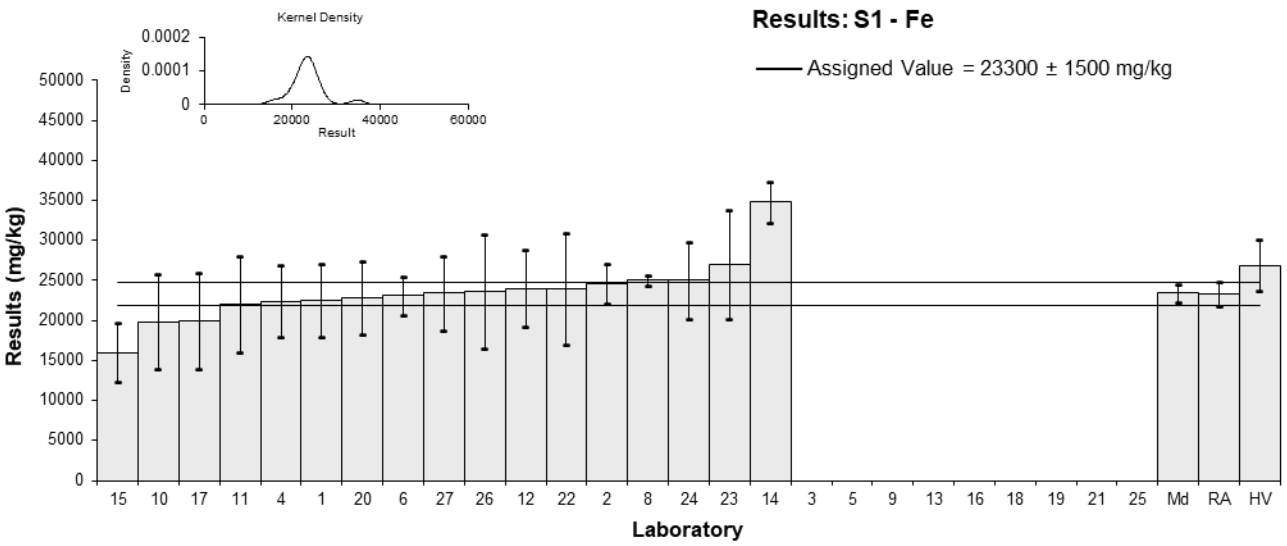
Sample No.	S1
Matrix	Soil (clay)
Analyte	Fe
Unit	mg/kg

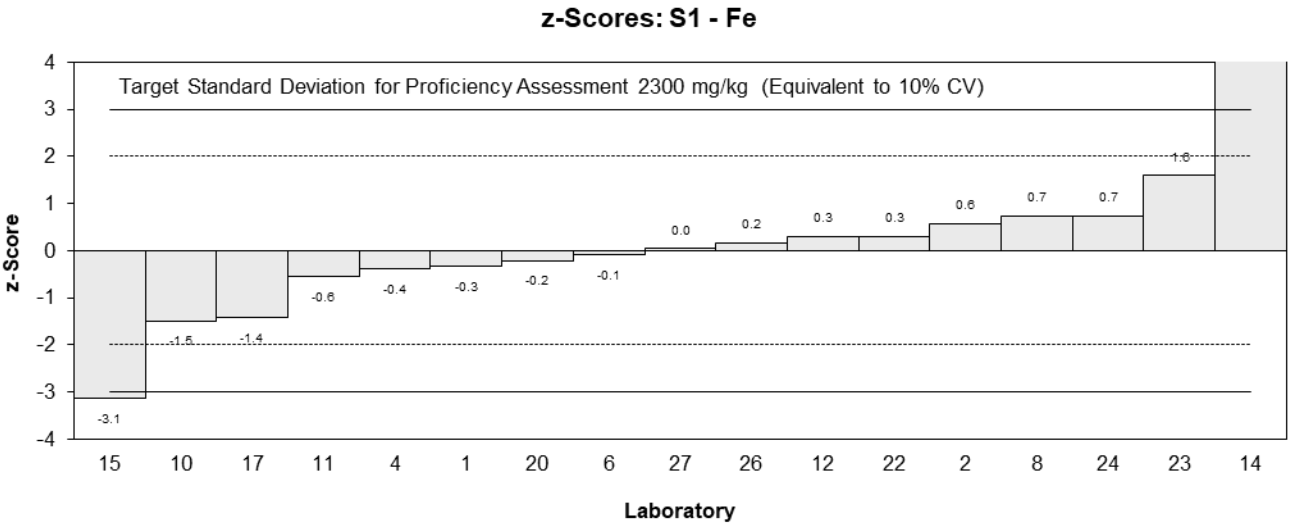
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	22500	4500	-0.34	-0.17
2	24600	2500	0.56	0.45
3	NT	NT		
4	22400	4480	-0.39	-0.19
5	NT	NT		
6	23100	2400	-0.09	-0.07
8	25000	700	0.73	1.03
9	NT	NT		
10	19825.5	5947.65	-1.49	-0.57
11	22000	6000	-0.56	-0.21
12	24000	4800	0.30	0.14
13	NT	NT		
14	34800	2520	4.94	3.92
15	16000	3700	-3.13	-1.83
16	NT	NT		
17	20000	6000	-1.42	-0.53
18	NT	NT		
19	NT	NT		
20	22800	4600	-0.21	-0.10
21	NT	NT		
22	24000	7000	0.30	0.10
23	27000	6750	1.59	0.54
24	25000	4750	0.73	0.34
25	NT	NT		
26	23650	7095	0.15	0.05
27	23400	4680	0.04	0.02

Statistics

Assigned Value	23300	1500
Spike Value	Not Spiked	
Homogeneity Value	26900	3200
Robust Average	23300	1500
Median	23400	1100
Mean	23500	
N	17	
Max	34800	
Min	16000	
Robust SD	2500	
Robust CV	11%	


Results: S1 - Fe
Assigned Value = 23300 ± 1500 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
15 10 17 11 4 1 20 6 27 26 12 22 2 8 24 23 14 3 5 9 13 16 18 19 21 25 Md RA HV


z-Scores: S1 - Fe
Target Standard Deviation for Proficiency Assessment 2300 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
15 10 17 11 4 1 20 6 27 26 12 22 2 8 24 23 14

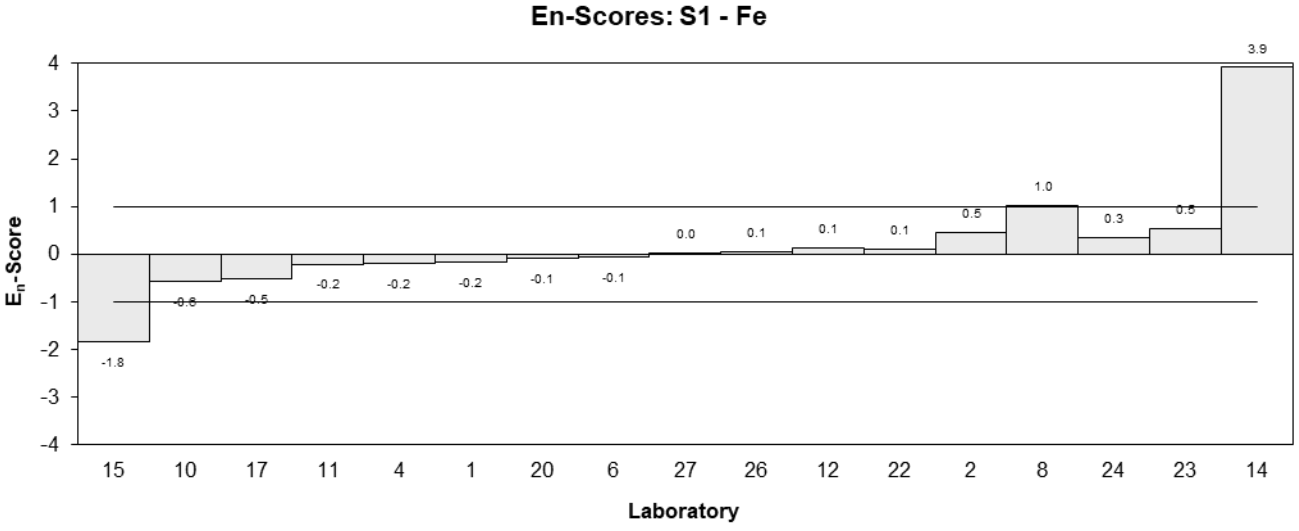

En-Scores: S1 - Fe
En-Score
Laboratory
15 10 17 11 4 1 20 6 27 26 12 22 2 8 24 23 14

Figure 12

Table 26

Sample Details

Sample No.	S1
Matrix	Soil (clay)
Analyte	Ga
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	8.78	1.76
2	NT	NT
3	NT	NT
4	NR	NR
5	NT	NT
6	NT	NT
8	NT	NT
9	NT	NT
10	NT	NT
11	8	4
12	NT	NT
13	NT	NT
14	NR	NR
15	NT	NT
16	NT	NT
17	8	4
18	NT	NT
19	NT	NT
20	NT	NT
21	NT	NT
22	8	2
23	NT	NT
24	12	1.8
25	NT	NT
26	NR	NR
27	NR	NR

Statistics

Assigned Value	Not Set	
Spike Value	Not Spiked	
Homogeneity Value	10.8	1.3
Robust Average	NA (N<6)	
Median	8.0	
Mean	9.0	
N	5	
Max	12	
Min	8	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

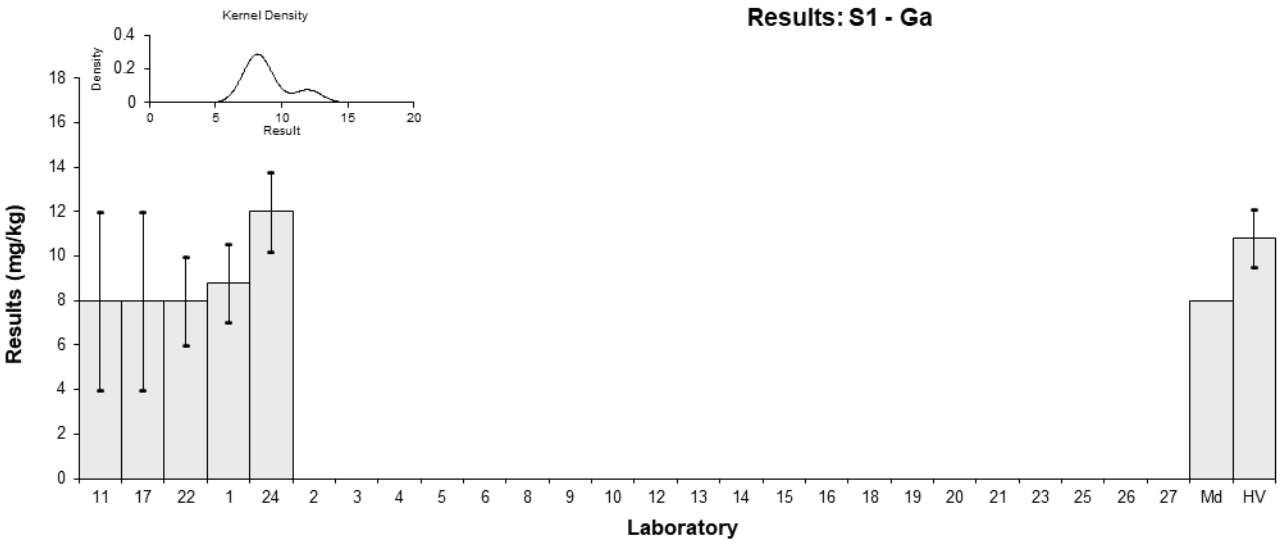

Results: S1 - Ga
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
11 17 22 1 24 2 3 4 5 6 8 9 10 12 13 14 15 16 18 19 20 21 23 25 26 27 Md HV

Figure 13

Table 27

Sample Details

Sample No.	S1
Matrix	Soil (clay)
Analyte	Hg
Unit	mg/kg

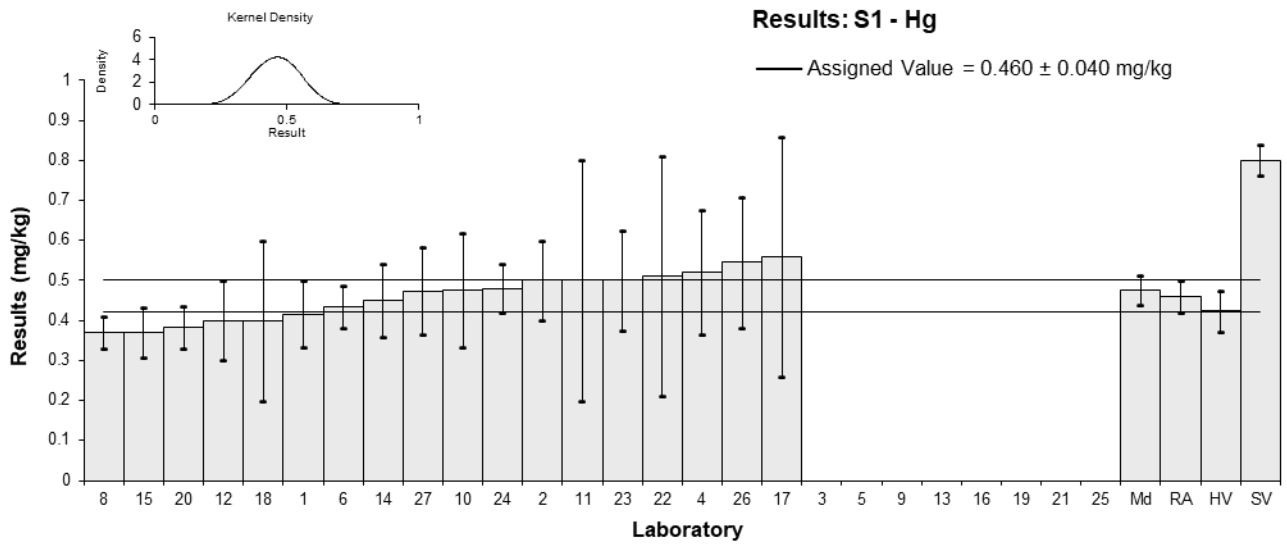
Participant Results

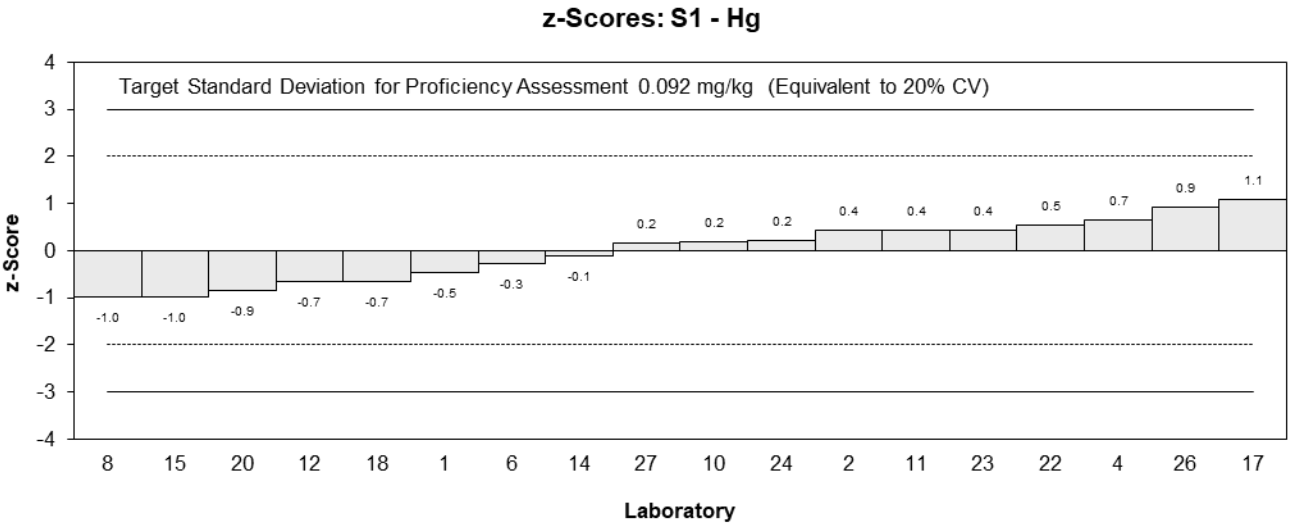
Lab. Code	Result	Uncertainty	z	E_n
1	0.416	0.083	-0.48	-0.48
2	0.50	0.1	0.43	0.37
3	NT	NT		
4	0.52	0.156	0.65	0.37
5	NT	NT		
6	0.433	0.053	-0.29	-0.41
8	0.37	0.04	-0.98	-1.59
9	NT	NT		
10	0.477	0.143	0.18	0.11
11	0.5	0.3	0.43	0.13
12	0.4	0.1	-0.65	-0.56
13	NT	NT		
14	0.45	0.09	-0.11	-0.10
15	0.37	.063	-0.98	-1.21
16	NT	NT		
17	0.56	0.3	1.09	0.33
18	0.4	0.2	-0.65	-0.29
19	NT	NT		
20	0.382	0.053	-0.85	-1.17
21	NT	NT		
22	0.51	0.3	0.54	0.17
23	0.5	0.125	0.43	0.30
24	0.48	0.06	0.22	0.28
25	NT	NT		
26	0.545	0.1635	0.92	0.50
27	0.474	0.11	0.15	0.12

Statistics

Assigned Value	0.460	0.040
Spike Value*	0.800	0.038
Homogeneity Value	0.424	0.051
Robust Average	0.460	0.040
Median	0.476	0.038
Mean	0.460	
N	18	
Max	0.56	
Min	0.37	
Robust SD	0.068	
Robust CV	15%	

*Loses during preparation may explain the difference between Spike Value and Assigned Value


Kernel Density
Density
Result
Results: S1 - Hg
Assigned Value = 0.460 ± 0.040 mg/kg
Results (mg/kg)
Laboratory
8 15 20 12 18 1 6 14 27 10 24 2 11 23 22 4 26 17 3 5 9 13 16 19 21 25 Md RA HV SV


z-Scores: S1 - Hg
Target Standard Deviation for Proficiency Assessment 0.092 mg/kg (Equivalent to 20% CV)
z-Score
-1.0 -1.0 -0.9 -0.7 -0.7 -0.5 -0.3 -0.1 0.2 0.2 0.2 0.4 0.4 0.4 0.5 0.7 0.9 1.1
Laboratory
8 15 20 12 18 1 6 14 27 10 24 2 11 23 22 4 26 17

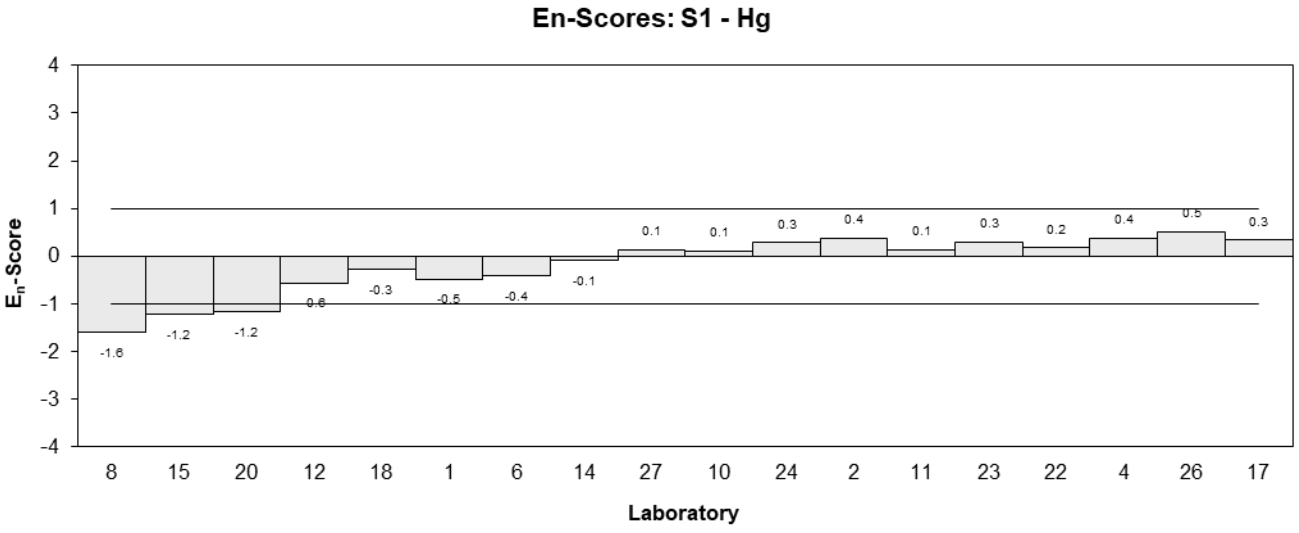

En-Scores: S1 - Hg
En-Score
-1.6 -1.2 -1.2 -0.6 -0.3 -0.5 -0.4 -0.1 0.1 0.1 0.3 0.4 0.1 0.3 0.2 0.4 0.5 0.3
Laboratory
8 15 20 12 18 1 6 14 27 10 24 2 11 23 22 4 26 17

Figure 14

Table 28

Sample Details

Sample No.	S1
Matrix	Soil (clay)
Analyte	Li
Unit	mg/kg

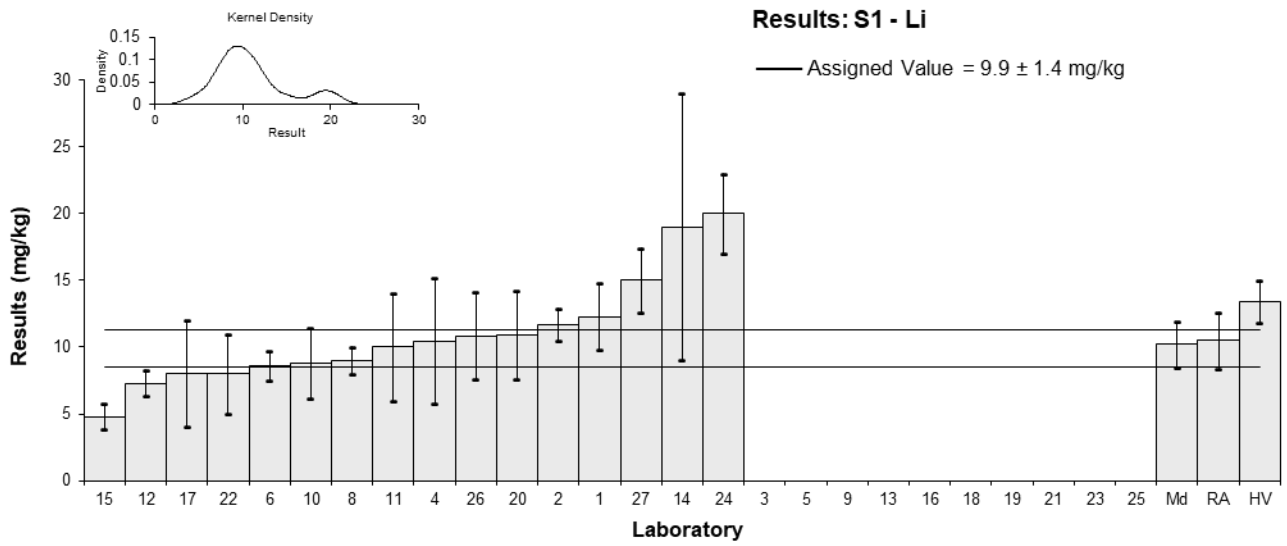
Participant Results

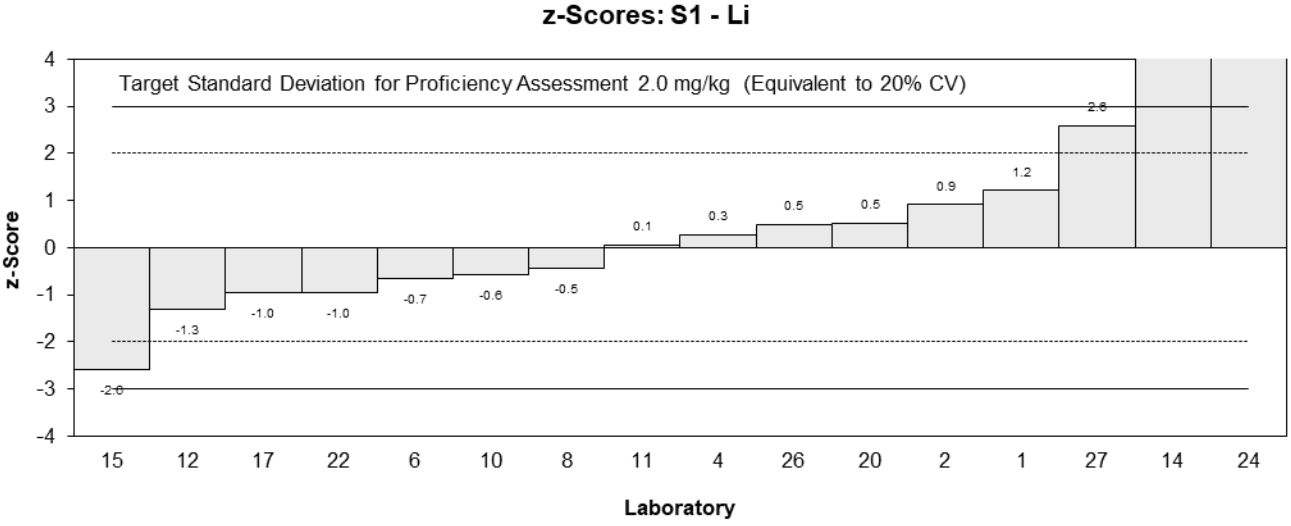
Lab. Code	Result	Uncertainty	z	E_n
1	12.3	2.47	1.21	0.85
2	11.7	1.2	0.91	0.98
3	NT	NT		
4	10.45	4.70	0.28	0.11
5	NT	NT		
6	8.6	1.1	-0.66	-0.73
8	9.0	1.0	-0.45	-0.52
9	NT	NT		
10	8.77	2.631	-0.57	-0.38
11	10	4	0.05	0.02
12	7.3	1	-1.31	-1.51
13	NT	NT		
14*	19	10	4.60	0.90
15*	4.80	0.960	-2.58	-3.00
16	NT	NT		
17	8	4	-0.96	-0.45
18	NT	NT		
19	NT	NT		
20	10.9	3.3	0.51	0.28
21	NT	NT		
22	8	3	-0.96	-0.57
23	NT	NT		
24*	20	3	5.10	3.05
25	NT	NT		
26	10.85	3.255	0.48	0.27
27	15.0	2.4	2.58	1.84

* Outlier, see Section 4.2

Statistics

Assigned Value	9.9	1.4
Spike Value	Not Spiked	
Homogeneity Value	13.4	1.6
Robust Average	10.5	2.1
Median	10.2	1.7
Mean	10.9	
N	16	
Max	20	
Min	4.8	
Robust SD	3.4	
Robust CV	32%	


Kernel Density
Density
Result
Results: S1 - Li
Assigned Value = 9.9 ± 1.4 mg/kg
Results (mg/kg)
Laboratory
15 12 17 22 6 10 8 11 4 26 20 2 1 27 14 24 3 5 9 13 16 18 19 21 23 25 Md RA HV


z-Scores: S1 - Li
Target Standard Deviation for Proficiency Assessment 2.0 mg/kg (Equivalent to 20% CV)
z-Score
Laboratory
15 12 17 22 6 10 8 11 4 26 20 2 1 27 14 24
-2.6 -1.3 -1.0 -1.0 -0.7 -0.6 -0.5 0.1 0.3 0.5 0.5 0.9 1.2 2.6

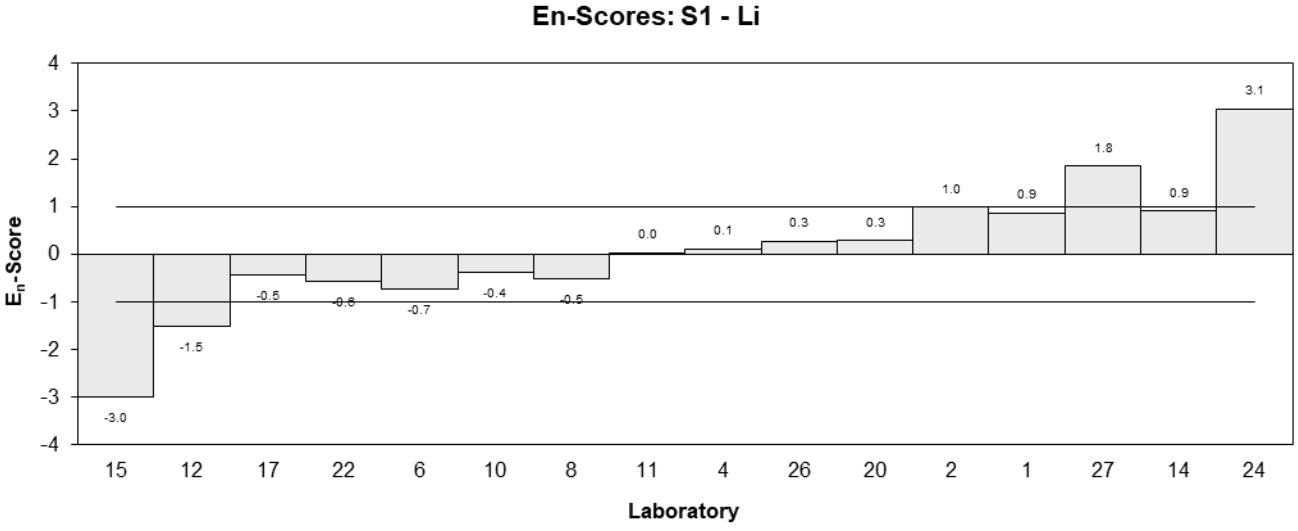

En-Scores: S1 - Li
En-Score
Laboratory
15 12 17 22 6 10 8 11 4 26 20 2 1 27 14 24
-3.0 -1.5 -0.5 -0.6 -0.7 -0.4 -0.5 0.0 0.1 0.3 0.3 1.0 0.9 1.8 0.9 3.1

Figure 15

Table 29

Sample Details

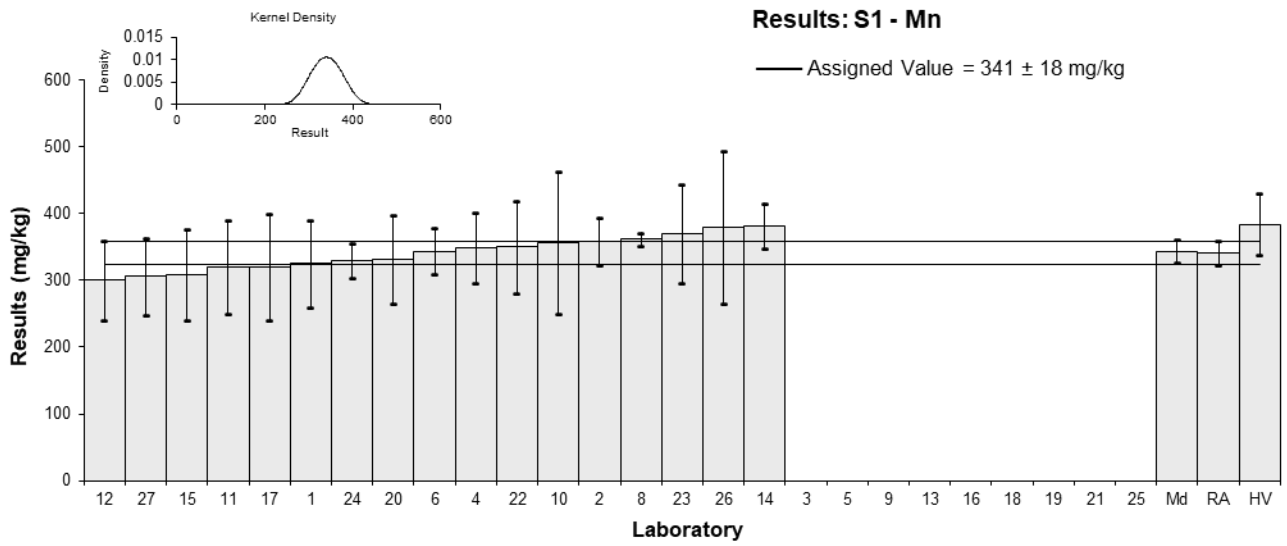
Sample No.	S1
Matrix	Soil (clay)
Analyte	Mn
Unit	mg/kg

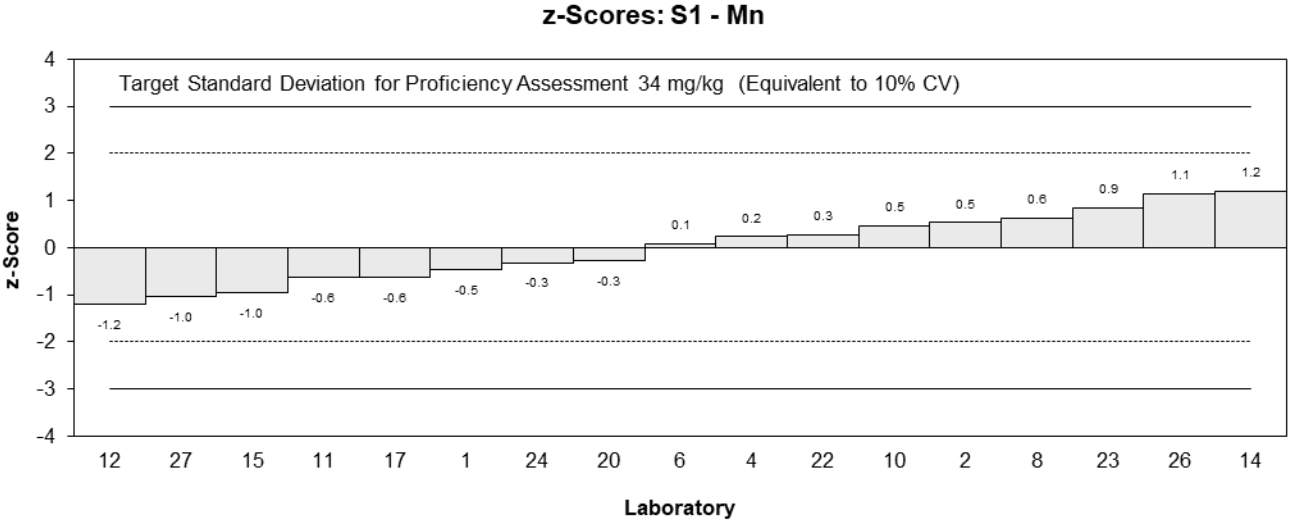
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	325	65	-0.47	-0.24
2	359	36	0.53	0.45
3	NT	NT		
4	349	52.4	0.23	0.14
5	NT	NT		
6	344	35	0.09	0.08
8	362	10	0.62	1.02
9	NT	NT		
10	356.23	106.869	0.45	0.14
11	320	70	-0.62	-0.29
12	300	60	-1.20	-0.65
13	NT	NT		
14	382	34	1.20	1.07
15	308	68	-0.97	-0.47
16	NT	NT		
17	320	80	-0.62	-0.26
18	NT	NT		
19	NT	NT		
20	331	66	-0.29	-0.15
21	NT	NT		
22	350	70	0.26	0.12
23	370	74	0.85	0.38
24	330	25.7	-0.32	-0.35
25	NT	NT		
26	379.5	113.85	1.13	0.33
27	306	58.1	-1.03	-0.58

Statistics

Assigned Value	341	18
Spike Value	Not Spiked	
Homogeneity Value	384	46
Robust Average	341	18
Median	344	17
Mean	341	
N	17	
Max	382	
Min	300	
Robust SD	29	
Robust CV	8.5%	


Results: S1 - Mn
Kernel Density
Density
Result
Assigned Value = 341 ± 18 mg/kg
Results (mg/kg)
Laboratory
12 27 15 11 17 1 24 20 6 4 22 10 2 8 23 26 14 3 5 9 13 16 18 19 21 25 Md RA HV


z-Scores: S1 - Mn
Target Standard Deviation for Proficiency Assessment 34 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
12 27 15 11 17 1 24 20 6 4 22 10 2 8 23 26 14

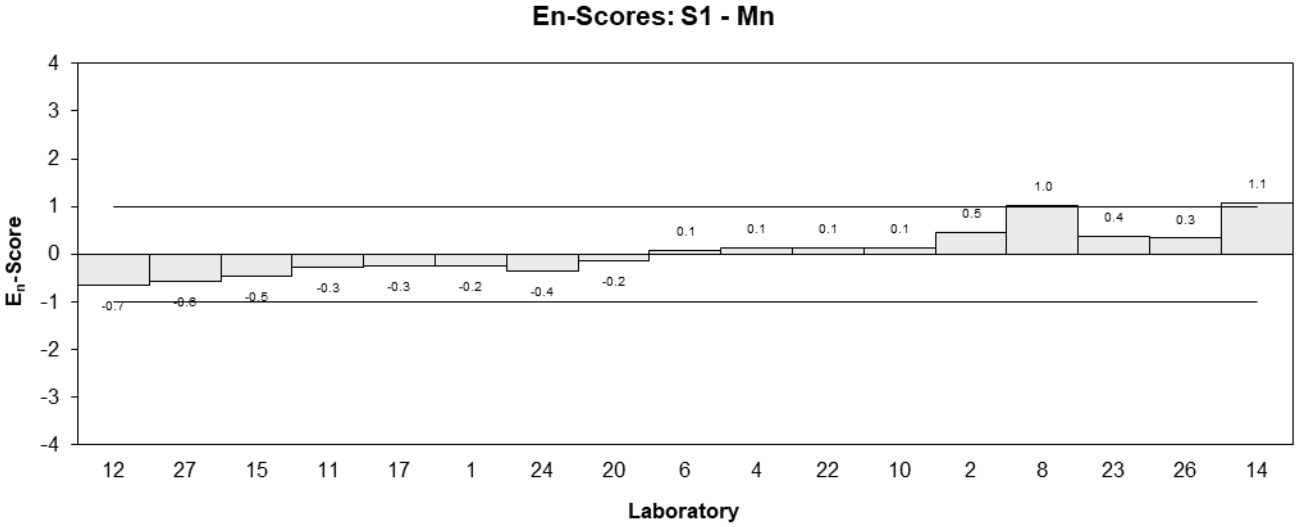

En-Scores: S1 - Mn
En-Score
Laboratory
12 27 15 11 17 1 24 20 6 4 22 10 2 8 23 26 14

Figure 16

Table 30

Sample Details

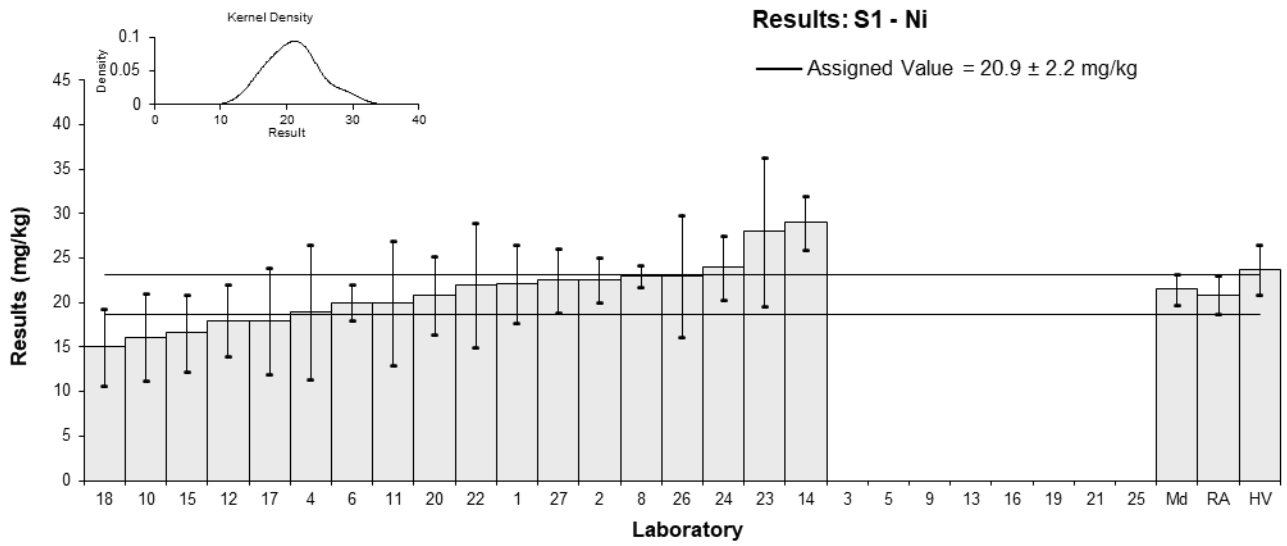
Sample No.	S1
Matrix	Soil (clay)
Analyte	Ni
Unit	mg/kg

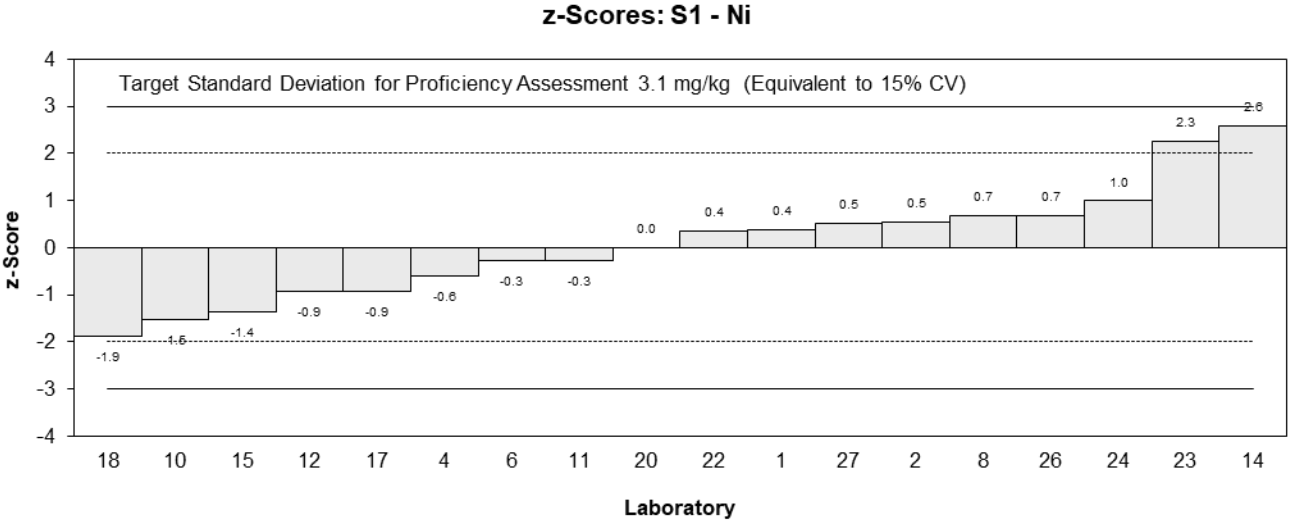
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	22.1	4.41	0.38	0.24
2	22.6	2.5	0.54	0.51
3	NT	NT		
4	19	7.6	-0.61	-0.24
5	NT	NT		
6	20.0	2.0	-0.29	-0.30
8	23.0	1.2	0.67	0.84
9	NT	NT		
10	16.14	4.842	-1.52	-0.90
11	20	7	-0.29	-0.12
12	18	4	-0.93	-0.64
13	NT	NT		
14	29	3	2.58	2.18
15	16.6	4.3	-1.37	-0.89
16	NT	NT		
17	18	6	-0.93	-0.45
18	15	4.3	-1.88	-1.22
19	NT	NT		
20	20.9	4.4	0.00	0.00
21	NT	NT		
22	22	7	0.35	0.15
23	28	8.4	2.26	0.82
24	24	3.6	0.99	0.73
25	NT	NT		
26	23	6.9	0.67	0.29
27	22.5	3.6	0.51	0.38

Statistics

Assigned Value	20.9	2.2
Spike Value	Not Spiked	
Homogeneity Value	23.7	2.8
Robust Average	20.9	2.2
Median	21.5	1.7
Mean	21.1	
N	18	
Max	29	
Min	15	
Robust SD	3.7	
Robust CV	18%	


Kernel Density
Density
Result
Results: S1 - Ni
Assigned Value = 20.9 ± 2.2 mg/kg
Results (mg/kg)
Laboratory
18 10 15 12 17 4 6 11 20 22 1 27 2 8 26 24 23 14 3 5 9 13 16 19 21 25 Md RA HV


z-Scores: S1 - Ni
Target Standard Deviation for Proficiency Assessment 3.1 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
18 10 15 12 17 4 6 11 20 22 1 27 2 8 26 24 23 14

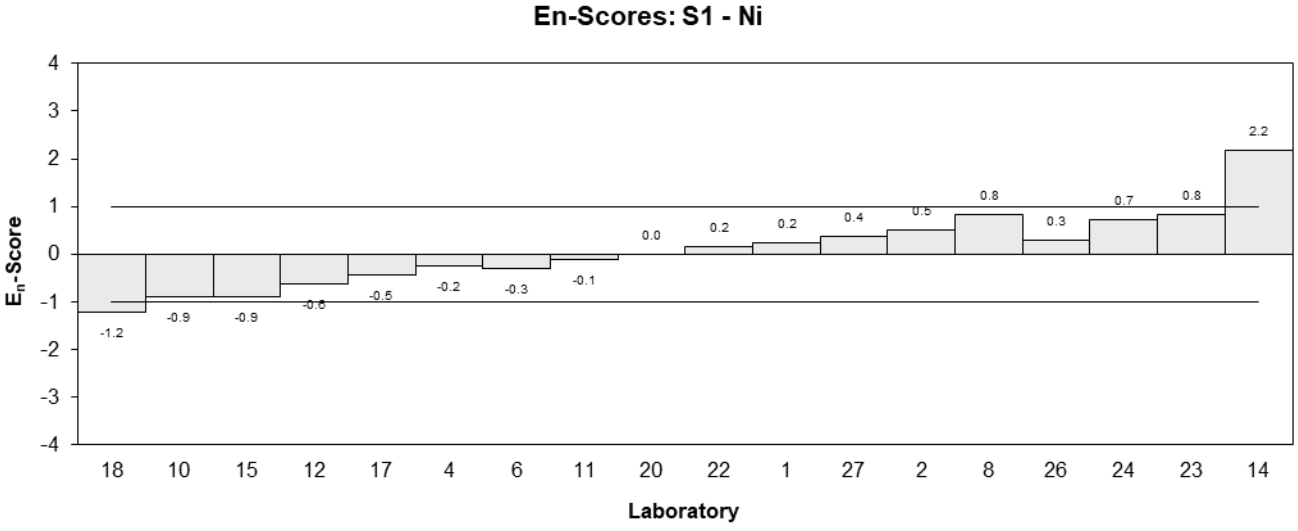

En-Scores: S1 - Ni
En-Score
Laboratory
18 10 15 12 17 4 6 11 20 22 1 27 2 8 26 24 23 14

Figure 17

Table 31

Sample Details

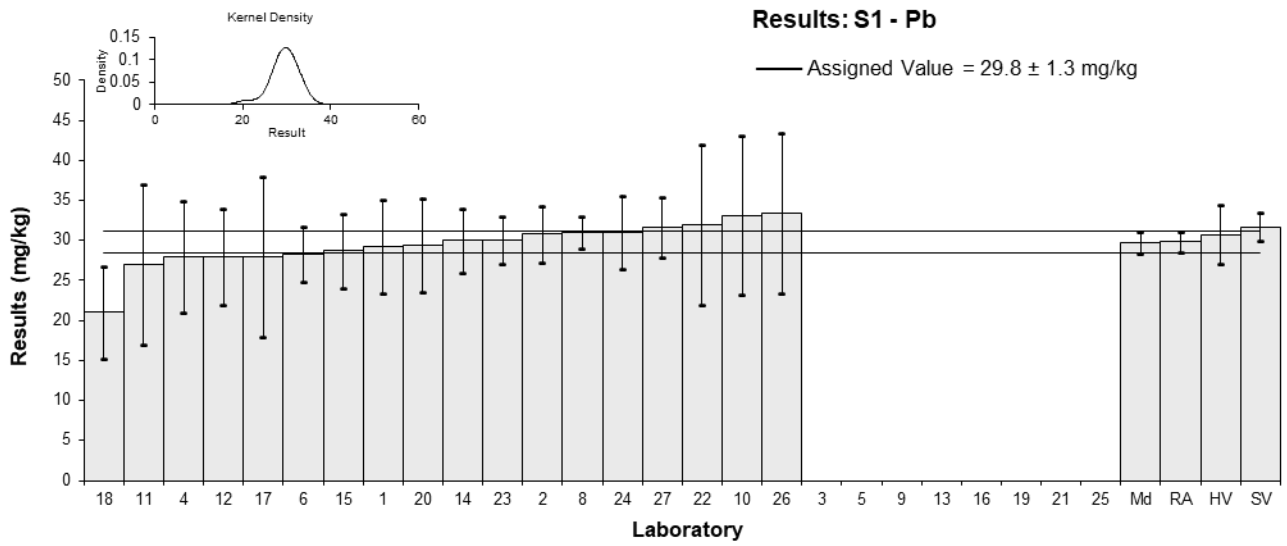
Sample No.	S1
Matrix	Soil (clay)
Analyte	Pb
Unit	mg/kg

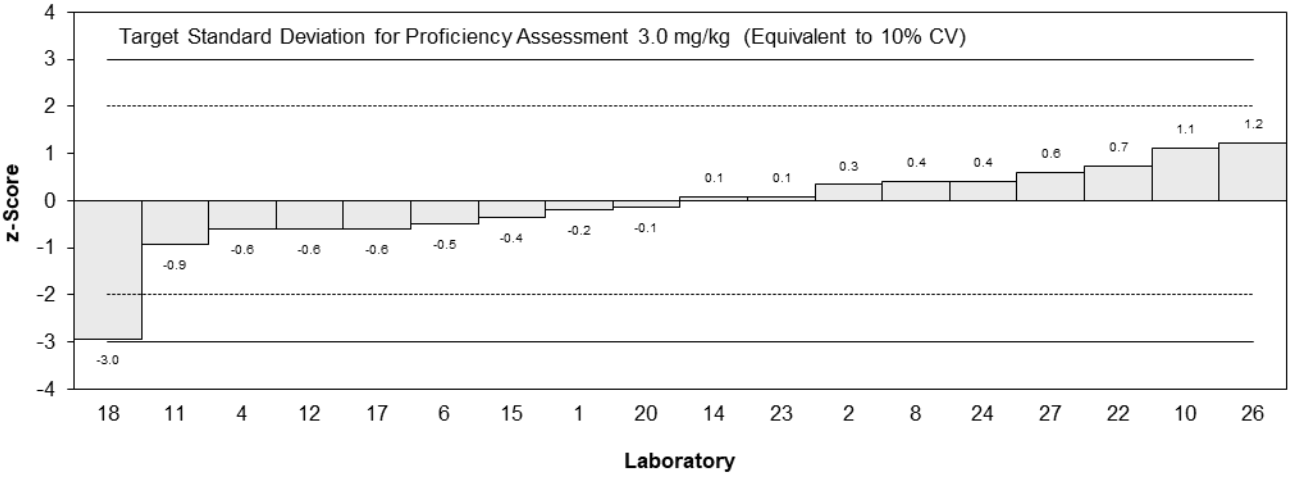
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	29.2	5.84	-0.20	-0.10
2	30.8	3.5	0.34	0.27
3	NT	NT		
4	28	7	-0.60	-0.25
5	NT	NT		
6	28.3	3.5	-0.50	-0.40
8	31.0	2.0	0.40	0.50
9	NT	NT		
10	33.1	9.93	1.11	0.33
11	27	10	-0.94	-0.28
12	28	6	-0.60	-0.29
13	NT	NT		
14	30	4	0.07	0.05
15	28.7	4.6	-0.37	-0.23
16	NT	NT		
17	28	10	-0.60	-0.18
18	21	5.7	-2.95	-1.51
19	NT	NT		
20	29.4	5.9	-0.13	-0.07
21	NT	NT		
22	32	10	0.74	0.22
23	30	3	0.07	0.06
24	31	4.59	0.40	0.25
25	NT	NT		
26	33.45	10.035	1.22	0.36
27	31.6	3.8	0.60	0.45

Statistics

Assigned Value	29.8	1.3
Spike Value	31.7	1.8
Homogeneity Value	30.7	3.7
Robust Average	29.8	1.3
Median	29.7	1.4
Mean	29.5	
N	18	
Max	33.45	
Min	21	
Robust SD	2.3	
Robust CV	7.6%	


Results: S1 - Pb
Assigned Value = 29.8 ± 1.3 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
18 11 4 12 17 6 15 1 20 14 23 2 8 24 27 22 10 26 3 5 9 13 16 19 21 25 Md RA HV SV


z-Scores: S1 - Pb
Target Standard Deviation for Proficiency Assessment 3.0 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
18 11 4 12 17 6 15 1 20 14 23 2 8 24 27 22 10 26
-3.0 -0.9 -0.6 -0.6 -0.6 -0.5 -0.4 -0.2 -0.1 0.1 0.1 0.3 0.4 0.4 0.6 0.7 1.1 1.2

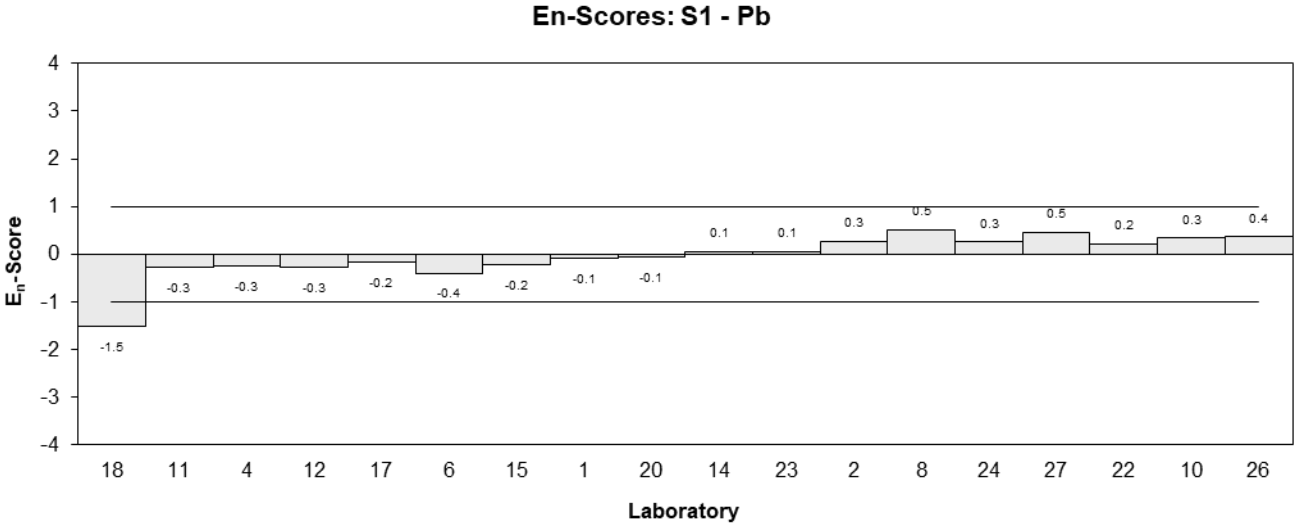

En-Scores: S1 - Pb
En-Score
Laboratory
18 11 4 12 17 6 15 1 20 14 23 2 8 24 27 22 10 26
-1.5 -0.3 -0.3 -0.3 -0.2 -0.4 -0.2 -0.1 -0.1 0.1 0.1 0.3 0.5 0.3 0.5 0.2 0.3 0.4

Figure 18

Table 32

Sample Details

Sample No.	S1
Matrix	Soil (clay)
Analyte	Sb
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	40	20
2	113	12
3	NT	NT
4	<100	NR
5	NT	NT
6	31.9	6.4
8	86	4.0
9	NT	NT
10	7.75	2.325
11	57	20
12	NT	NT
13	NT	NT
14	NR	NR
15	8.10	2.6
16	NT	NT
17	48	20
18	NT	NT
19	NT	NT
20	78.8	32.3
21	NT	NT
22	42	20
23	62	12.4
24	76	10.6
25	NT	NT
26	48.85	14.655
27	28.7	4.6

Statistics

Assigned Value	Not Set	
Spike Value	101	5
Robust Average	51	21
Median	48	18
Mean	52	
N	14	
Max	113	
Min	7.75	
Robust SD	31	
Robust CV	61%	

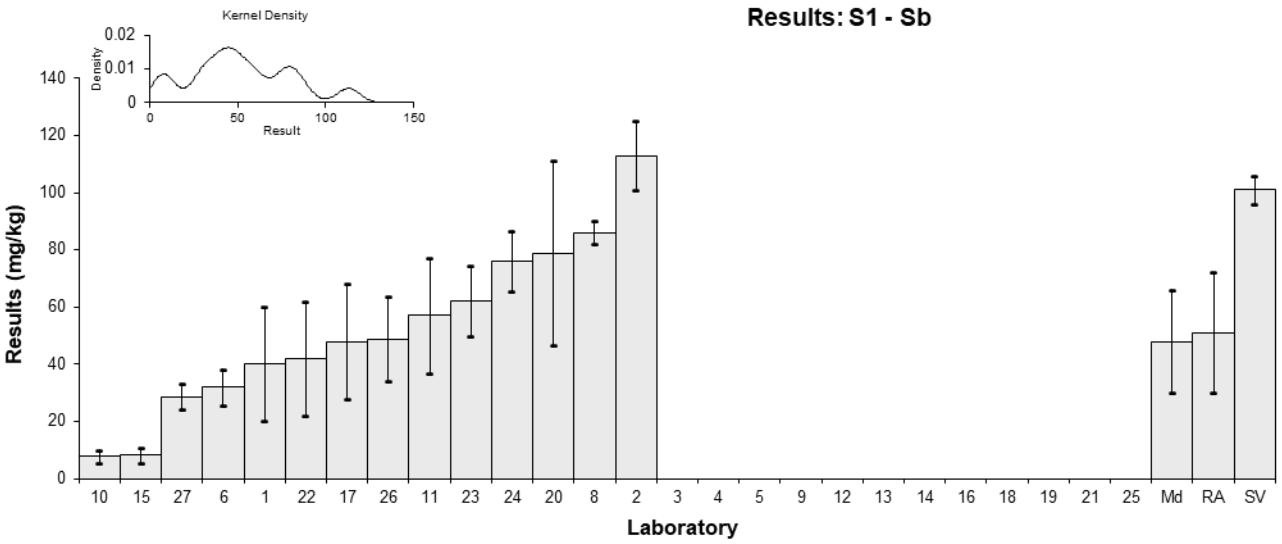

Results: S1 - Sb
Kernel Density
Density
0.02
0.01
0
0
50
100
150
Result
Results (mg/kg)
140
120
100
80
60
40
20
0
10 15 27 6 1 22 17 26 11 23 24 20 8 2 3 4 5 9 12 13 14 16 18 19 21 25 Md RA SV
Laboratory

Figure 19

Table 33

Sample Details

Sample No.	S1
Matrix	Soil (clay)
Analyte	Se
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	1.57	0.313
2	1.56	0.2
3	NT	NT
4	<100	NR
5	NT	NT
6	1.3	1.4
8	0.85	0.08
9	NT	NT
10	< 2	< 2
11	<2	NR
12	2.4	0.5
13	NT	NT
14	NR	NR
15	0.884	0.130
16	NT	NT
17	<2	NR
18	NT	NT
19	NT	NT
20	1.25	0.44
21	NT	NT
22	<2	NR
23	<5	2.25
24	2.5	0.25
25	NT	NT
26	2.2	0.66
27	<3	NR

Statistics

Assigned Value	Not Set	
Spike Value	1.78	0.09
Homogeneity Value	1.92	0.23
Robust Average	1.61	0.59
Median	1.56	0.79
Mean	1.61	
N	9	
Max	2.5	
Min	0.85	
Robust SD	0.71	
Robust CV	44%	

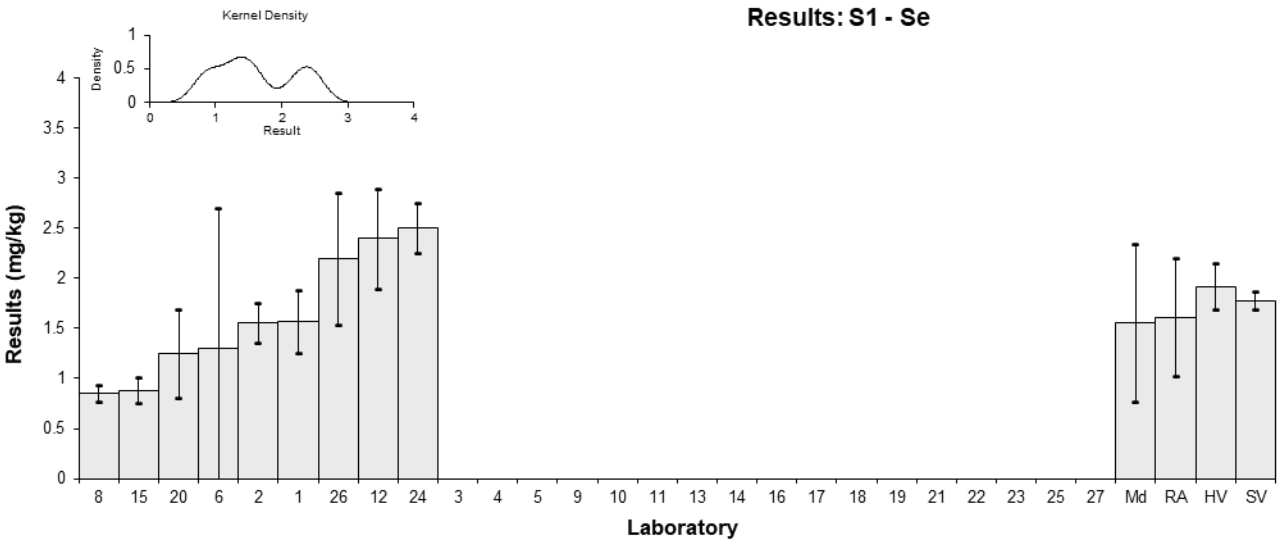

Results: S1 - Se
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
8 15 20 6 2 1 26 12 24 3 4 5 9 10 11 13 14 16 17 18 19 21 22 23 25 27 Md RA HV SV

Figure 20

Table 34

Sample Details

Sample No.	S1
Matrix	Soil (clay)
Analyte	Th
Unit	mg/kg

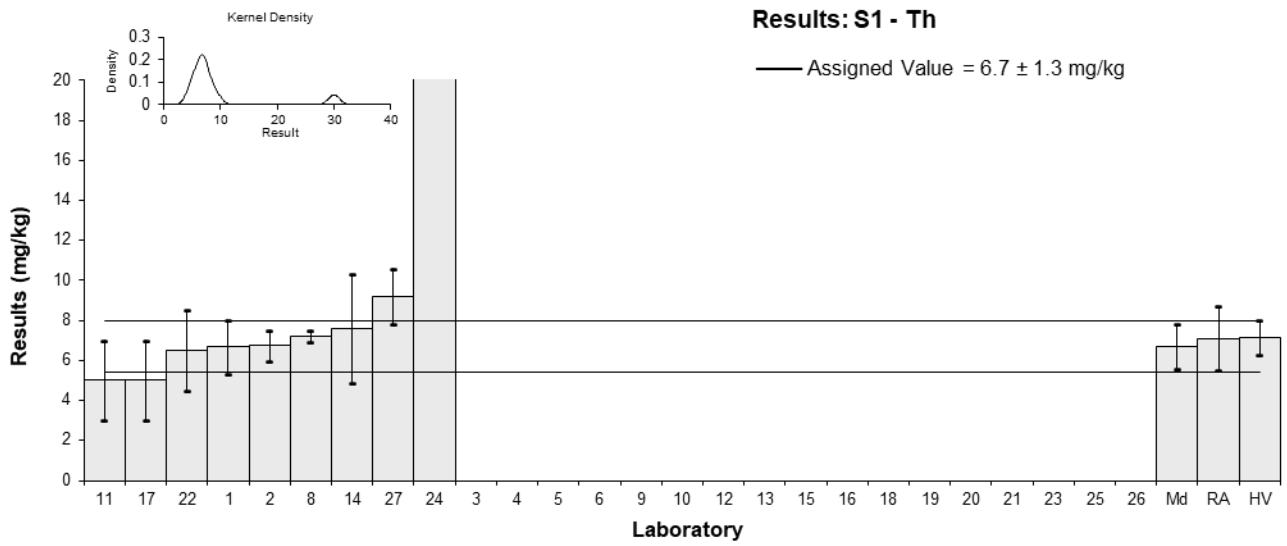
Participant Results

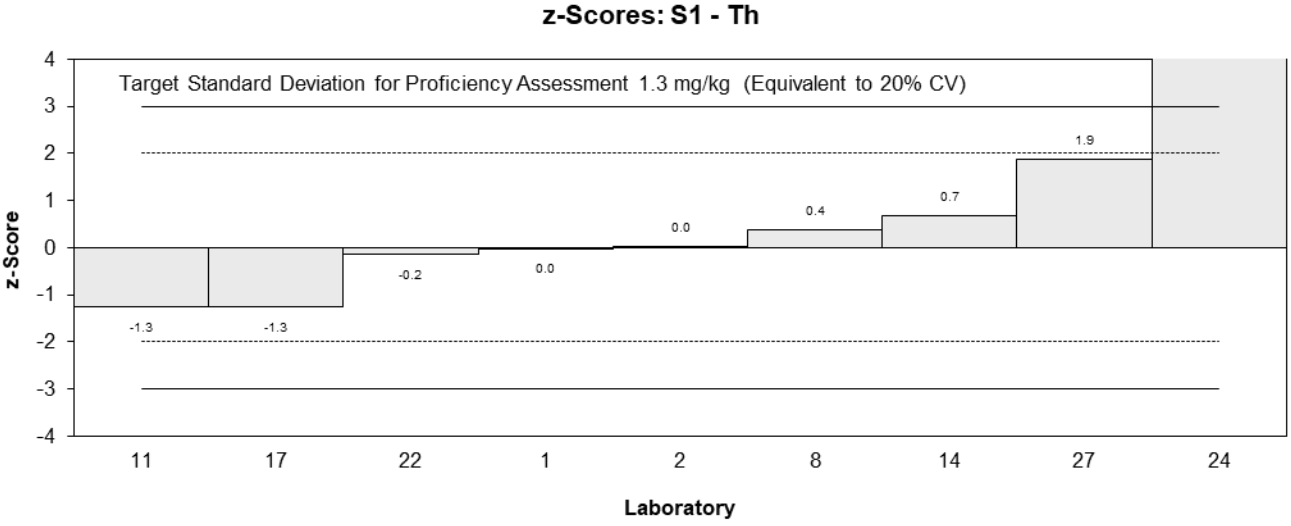
Lab. Code	Result	Uncertainty	z	E_n
1	6.69	1.34	-0.01	-0.01
2	6.73	0.8	0.02	0.02
3	NT	NT		
4	NR	NR		
5	NT	NT		
6	NT	NT		
8	7.2	0.3	0.37	0.37
9	NT	NT		
10	NT	NT		
11	5	2	-1.27	-0.71
12	NT	NT		
13	NT	NT		
14	7.6	2.7	0.67	0.30
15	NT	NT		
16	NT	NT		
17	5	2	-1.27	-0.71
18	NT	NT		
19	NT	NT		
20	NT	NT		
21	NT	NT		
22	6.5	2	-0.15	-0.08
23	NT	NT		
24*	30	4.5	17.39	4.97
25	NT	NT		
26	NR	NR		
27	9.2	1.4	1.87	1.31

* Outlier, see Section 4.2

Statistics

Assigned Value	6.7	1.3
Spike Value	Not Spiked	
Homogeneity Value	7.15	0.86
Robust Average	7.1	1.6
Median	6.7	1.1
Mean	9.3	
N	9	
Max	30	
Min	5	
Robust SD	1.9	
Robust CV	27%	


Results: S1 - Th
Assigned Value = 6.7 ± 1.3 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
11 17 22 1 2 8 14 27 24 3 4 5 6 9 10 12 13 15 16 18 19 20 21 23 25 26 Md RA HV


z-Scores: S1 - Th
Target Standard Deviation for Proficiency Assessment 1.3 mg/kg (Equivalent to 20% CV)
z-Score
Laboratory
11 17 22 1 2 8 14 27 24
-1.3 -1.3 -0.2 0.0 0.0 0.4 0.7 1.9

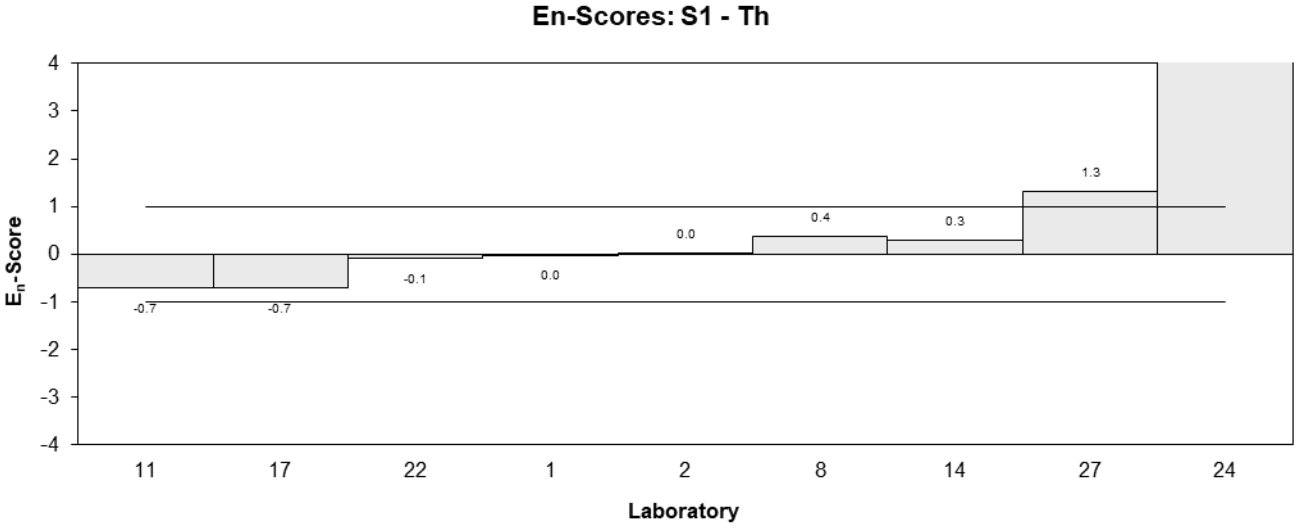

En-Scores: S1 - Th
En-Score
Laboratory
11 17 22 1 2 8 14 27 24
-0.7 -0.7 -0.1 0.0 0.0 0.4 0.3 1.3

Figure 21

Table 35

Sample Details

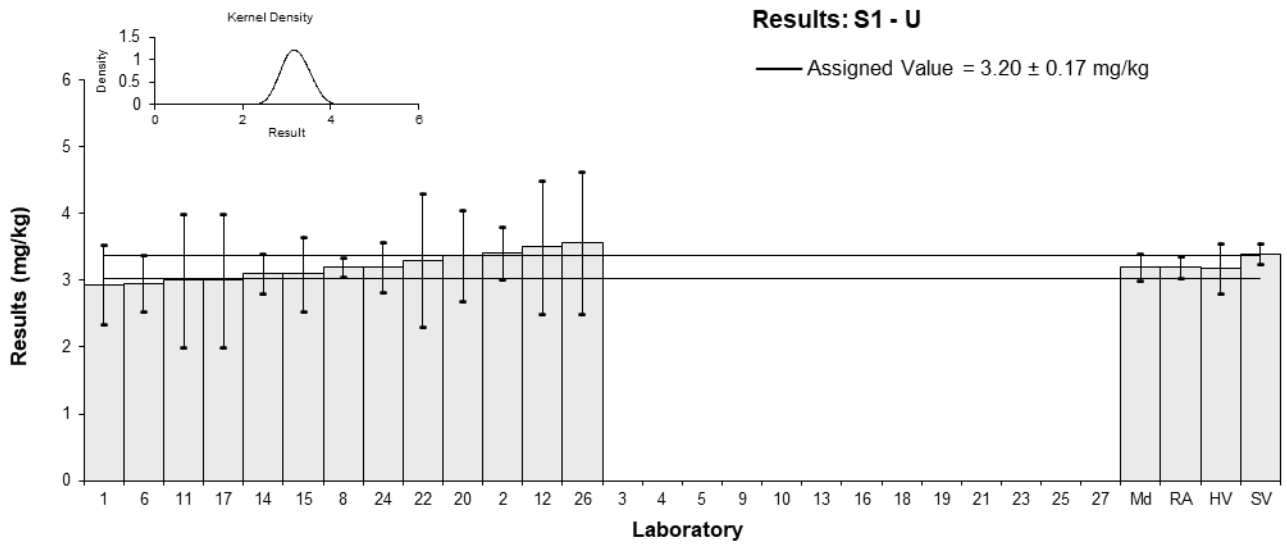
Sample No.	S1
Matrix	Soil (clay)
Analyte	U
Unit	mg/kg

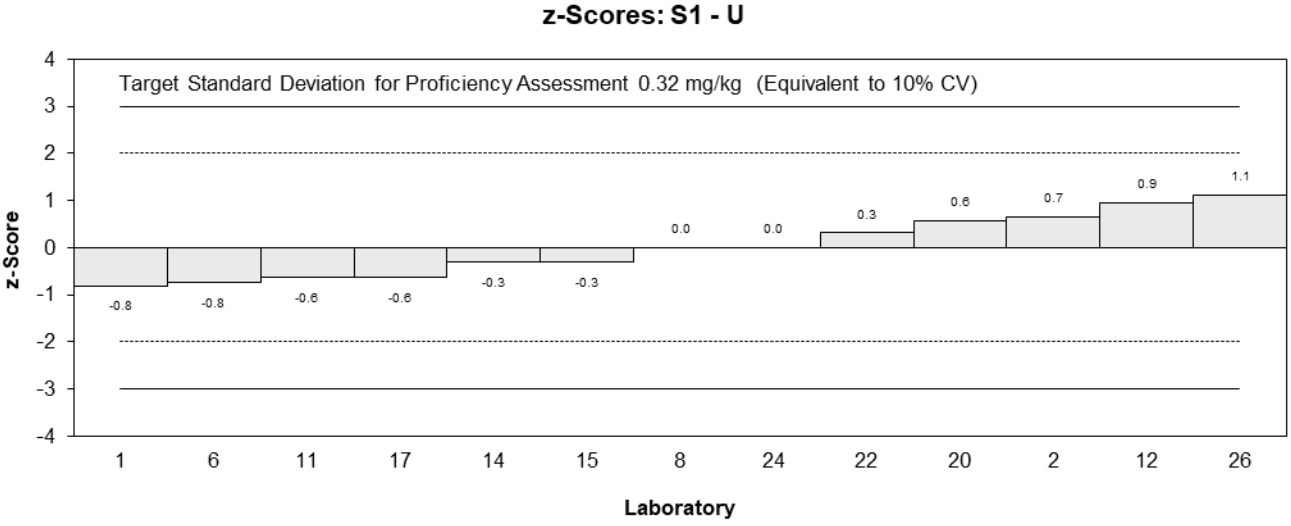
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	2.94	0.589	-0.81	-0.42
2	3.41	0.4	0.66	0.48
3	NT	NT		
4	NR	NR		
5	NT	NT		
6	2.96	0.42	-0.75	-0.53
8	3.20	0.14	0.00	0.00
9	NT	NT		
10	NT	NT		
11	3	1	-0.63	-0.20
12	3.5	1	0.94	0.30
13	NT	NT		
14	3.1	0.3	-0.31	-0.29
15	3.10	0.56	-0.31	-0.17
16	NT	NT		
17	3	1	-0.63	-0.20
18	NT	NT		
19	NT	NT		
20	3.38	0.68	0.56	0.26
21	NT	NT		
22	3.3	1	0.31	0.10
23	NT	NT		
24	3.2	0.38	0.00	0.00
25	NT	NT		
26	3.56	1.068	1.12	0.33
27	<5	NR		

Statistics

Assigned Value	3.20	0.17
Spike Value	3.40	0.16
Homogeneity Value	3.18	0.38
Robust Average	3.20	0.17
Median	3.20	0.21
Mean	3.20	
N	13	
Max	3.56	
Min	2.94	
Robust SD	0.24	
Robust CV	7.4%	


Kernel Density
Density
Result
Results: S1 - U
Assigned Value = 3.20 ± 0.17 mg/kg
Results (mg/kg)
Laboratory
1 6 11 17 14 15 8 24 22 20 2 12 26 3 4 5 9 10 13 16 18 19 21 23 25 27 Md RA HV SV


z-Scores: S1 - U
Target Standard Deviation for Proficiency Assessment 0.32 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
1 6 11 17 14 15 8 24 22 20 2 12 26
-0.8 -0.8 -0.6 -0.6 -0.3 -0.3 0.0 0.0 0.3 0.6 0.7 0.9 1.1

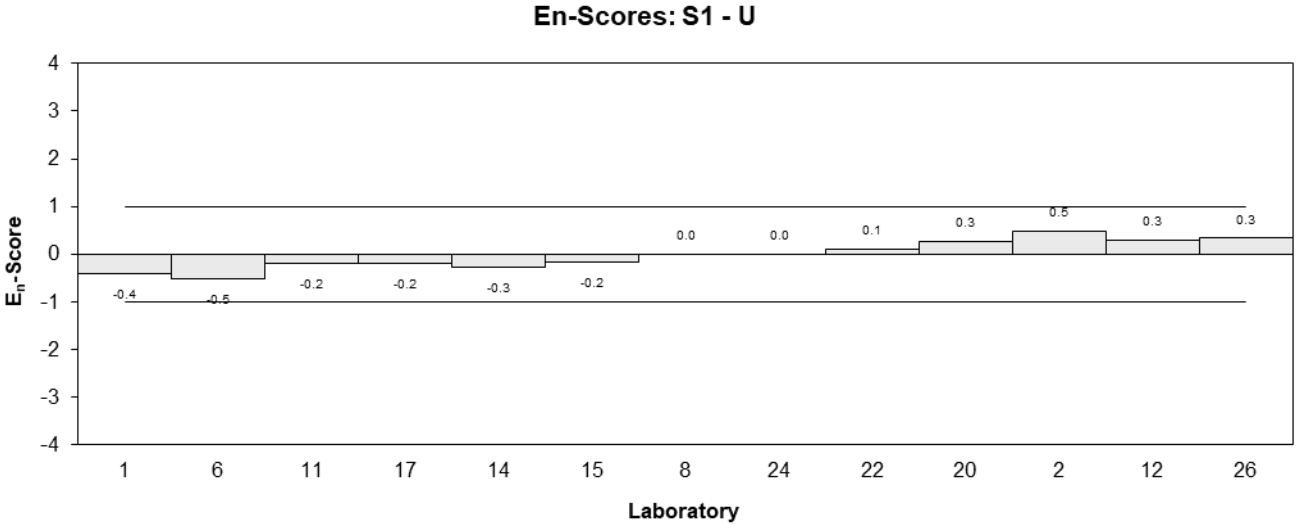

En-Scores: S1 - U
En-Score
Laboratory
1 6 11 17 14 15 8 24 22 20 2 12 26
-0.4 -0.5 -0.2 -0.2 -0.3 -0.2 0.0 0.0 0.1 0.3 0.5 0.3 0.3

Figure 22

Table 36

Sample Details

Sample No.	S1
Matrix	Soil (clay)
Analyte	Zn
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	153	30.5	-0.38	-0.19
2	180	18	1.32	1.04
3	NT	NT		
4	161.5	32.3	0.16	0.07
5	NT	NT		
6	165	27	0.38	0.21
8	170	5.0	0.69	1.07
9	NT	NT		
10	161.52	48.456	0.16	0.05
11	150	50	-0.57	-0.18
12	147	29	-0.75	-0.40
13	NT	NT		
14	155	13	-0.25	-0.25
15	160	42	0.06	0.02
16	NT	NT		
17	150	50	-0.57	-0.18
18	130	35	-1.82	-0.80
19	NT	NT		
20	163	34	0.25	0.11
21	NT	NT		
22	170	50	0.69	0.22
23	170	25.5	0.69	0.41
24	140	14	-1.19	-1.14
25	NT	NT		
26	182.5	54.75	1.48	0.42
27	143	31.5	-1.01	-0.49

Statistics

Assigned Value	159	9
Spike Value	175	8
Homogeneity Value	175	21
Robust Average	159	9
Median	161	8
Mean	158	
N	18	
Max	182.5	
Min	130	
Robust SD	15	
Robust CV	9.2%	

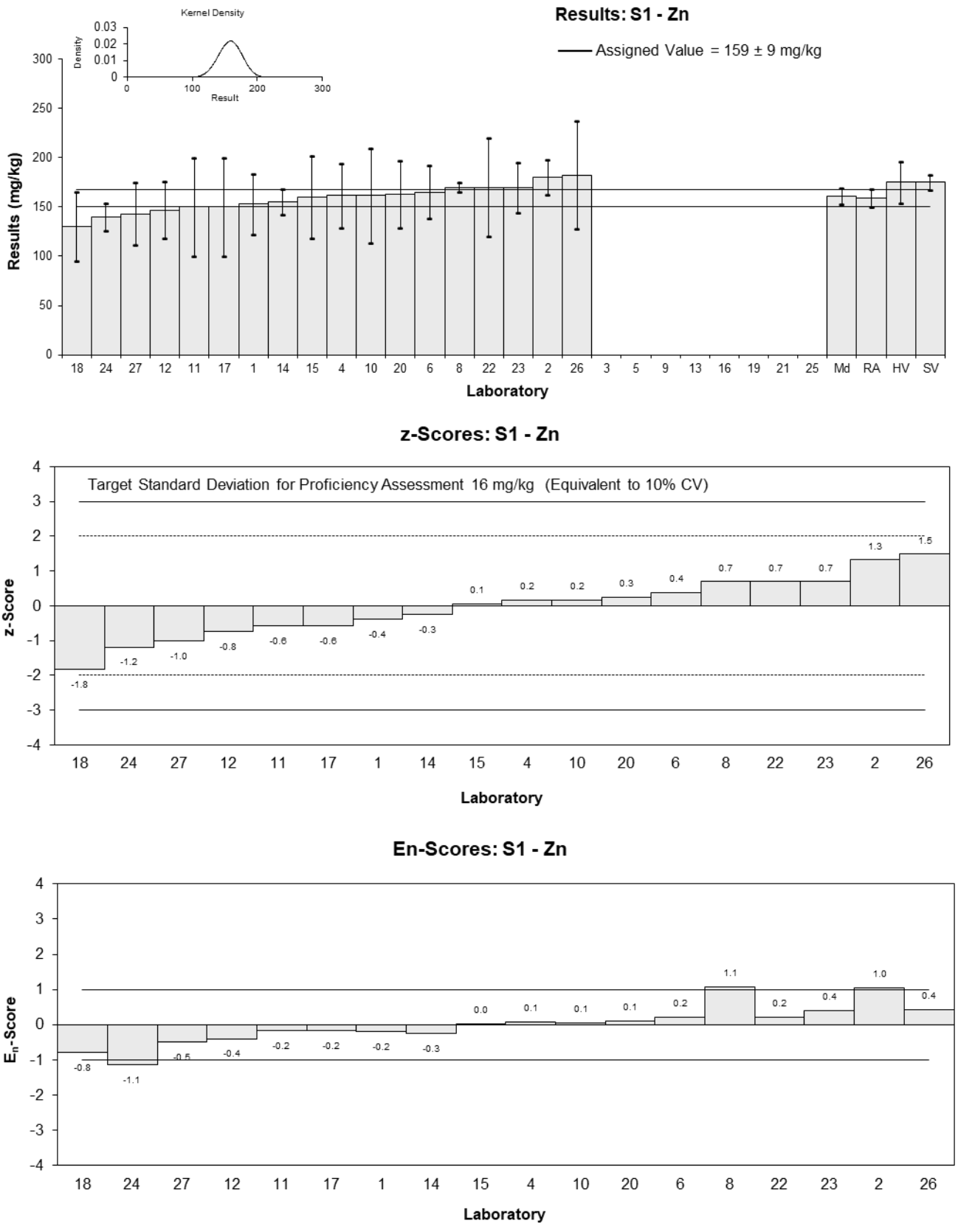

Results: S1 - Zn
Kernel Density
Density
Result
Assigned Value = 159 ± 9 mg/kg
Results (mg/kg)
Laboratory
18 24 27 12 11 17 1 14 15 4 10 20 6 8 22 23 2 26 3 5 9 13 16 19 21 25 Md RA HV SV
z-Scores: S1 - Zn
Target Standard Deviation for Proficiency Assessment 16 mg/kg (Equivalent to 10% CV)
z-Score
-1.8 -1.2 -1.0 -0.8 -0.6 -0.6 -0.4 -0.3 0.1 0.2 0.2 0.3 0.4 0.7 0.7 0.7 1.3 1.5
Laboratory
18 24 27 12 11 17 1 14 15 4 10 20 6 8 22 23 2 26
En-Scores: S1 - Zn
En-Score
-0.8 -1.1 -0.5 -0.4 -0.2 -0.2 -0.2 -0.3 0.0 0.1 0.1 0.1 0.2 1.1 0.2 0.4 1.0 0.4
Laboratory
18 24 27 12 11 17 1 14 15 4 10 20 6 8 22 23 2 26

Figure 23

Table 37

Sample Details

Sample No.	S2
Matrix	Sludge
Analyte	Al
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	6800	1360	0.85	0.68
2	6670	670	0.74	1.01
3	6430	867	0.53	0.61
4	5525	828.8	-0.25	-0.29
5	NT	NT		
6	4920	600	-0.77	-1.12
8	7000	400	1.02	1.81
9	NT	NT		
10**	12034.5	3610.35	5.36	1.71
11	4700	1500	-0.96	-0.70
12	5560	1100	-0.22	-0.21
13	5400	1080	-0.35	-0.34
14	5100	372	-0.61	-1.11
15	4810	1100	-0.86	-0.82
16	6790	1360	0.84	0.67
17	4800	2000	-0.87	-0.49
18	NT	NT		
19	6100	1530	0.25	0.18
20	NT	NT		
21	NT	NT		
22	5000	1000	-0.70	-0.72
23	6000	2700	0.16	0.07
24*	13000	1820	6.19	3.80
25	6500	1037	0.59	0.59
26	5555	1666.5	-0.22	-0.15
27	6770	1083.2	0.83	0.80

* Outlier, ** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	5810	520
Spike Value	Not Spiked	
Homogeneity Value	5790	690
Robust Average	5890	540
Median	5780	680
Mean	6170	
N	20	
Max	13000	
Min	4700	
Robust SD	970	
Robust CV	16%	

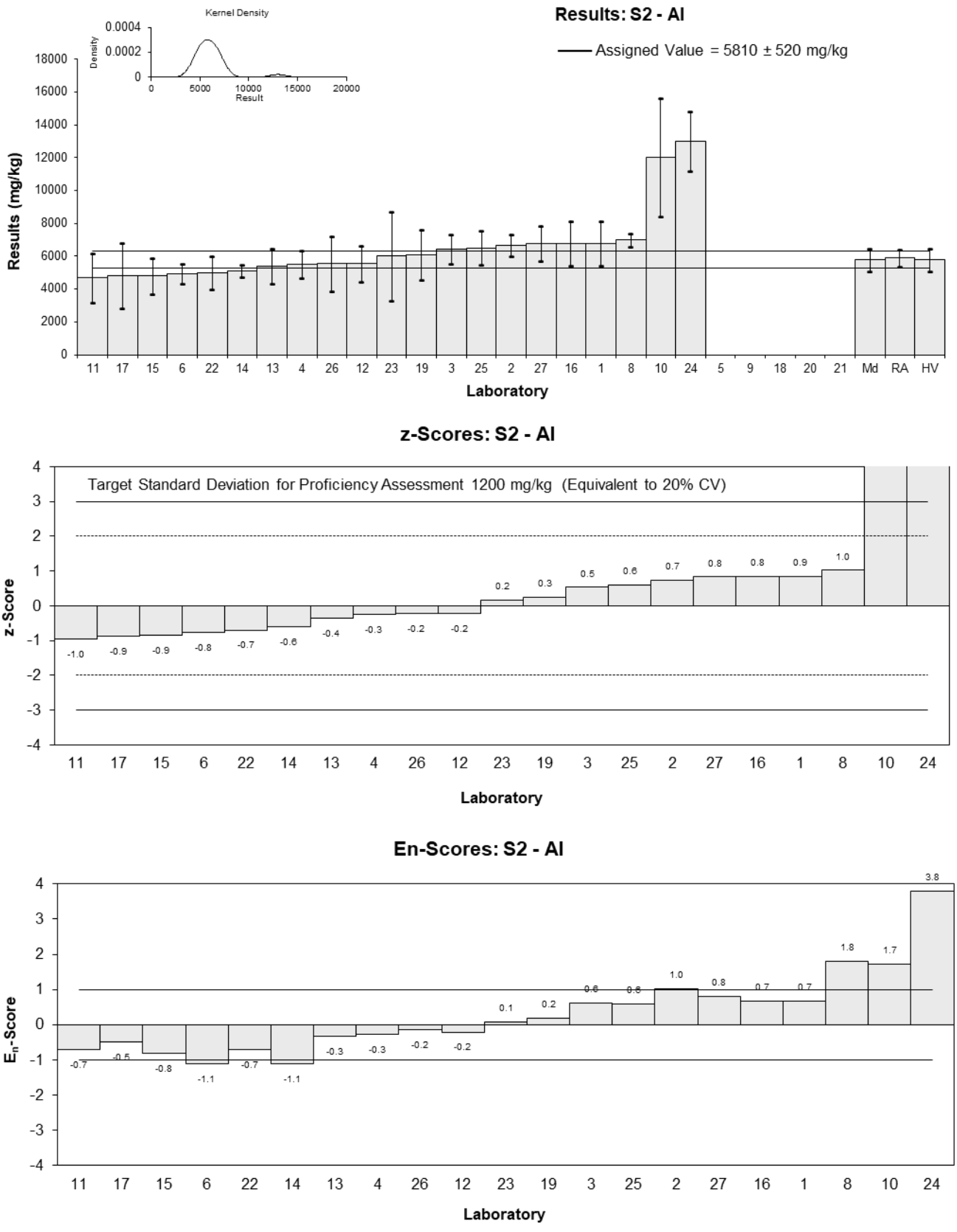

Kernel Density
Density
Result
Results: S2 - Al
Assigned Value = 5810 ± 520 mg/kg
Results (mg/kg)
Laboratory
z-Scores: S2 - Al
Target Standard Deviation for Proficiency Assessment 1200 mg/kg (Equivalent to 20% CV)
z-Score
Laboratory
En-Scores: S2 - Al
En-Score
Laboratory

Figure 24

Table 38

Sample Details

Sample No.	S2
Matrix	Sludge
Analyte	As
Unit	mg/kg

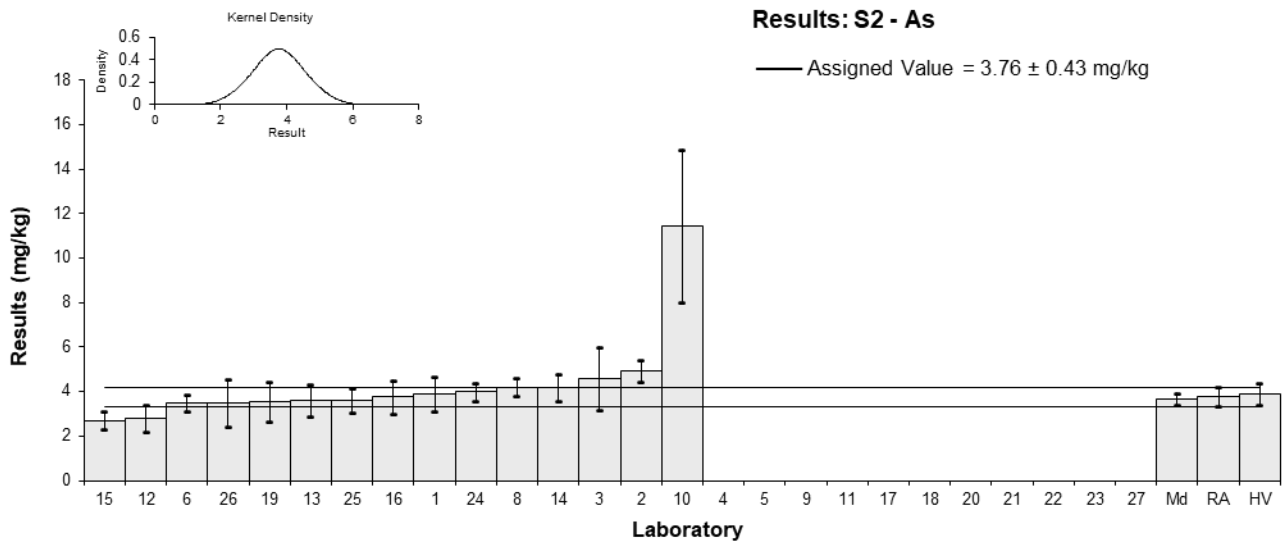
Participant Results

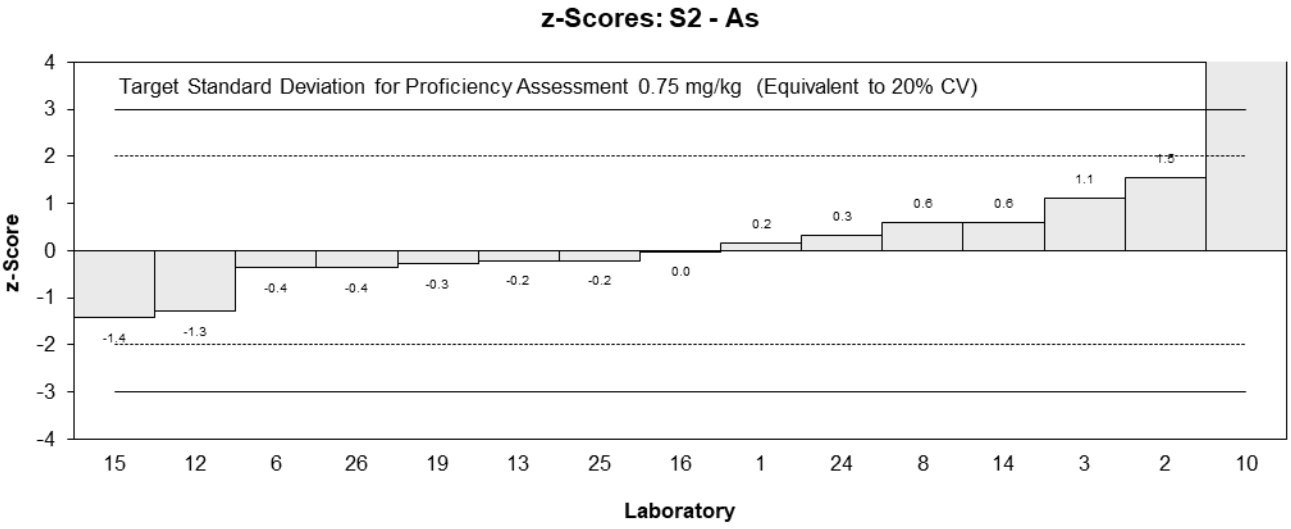
Lab. Code	Result	Uncertainty	z	E_n
1	3.89	0.779	0.17	0.15
2	4.92	0.5	1.54	1.76
3	4.6	1.4	1.12	0.57
4	<15	NR		
5	NT	NT		
6	3.48	0.38	-0.37	-0.49
8	4.2	0.4	0.59	0.75
9	NT	NT		
10**	11.46	3.438	10.24	2.22
11	<4	NR		
12	2.8	0.6	-1.28	-1.30
13	3.6	0.72	-0.21	-0.19
14	4.2	0.6	0.59	0.60
15	2.70	0.40	-1.41	-1.80
16	3.75	0.751	-0.01	-0.01
17	<4	NR		
18	NT	NT		
19	3.55	0.888	-0.28	-0.21
20	NT	NT		
21	NT	NT		
22	<4	NR		
23	NT	NT		
24	4.0	0.4	0.32	0.41
25	3.6	0.53	-0.21	-0.23
26	3.5	1.05	-0.35	-0.23
27	<5	NR		

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	3.76	0.43
Spike Value	Not Spiked	
Homogeneity Value	3.89	0.47
Robust Average	3.76	0.43
Median	3.68	0.27
Mean	3.77	
N	14	
Max	4.92	
Min	2.7	
Robust SD	0.64	
Robust CV	17%	


Results: S2 - As
Assigned Value = 3.76 ± 0.43 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
15 12 6 26 19 13 25 16 1 24 8 14 3 2 10 4 5 9 11 17 18 20 21 22 23 27 Md RA HV


z-Scores: S2 - As
Target Standard Deviation for Proficiency Assessment 0.75 mg/kg (Equivalent to 20% CV)
z-Score
Laboratory
15 12 6 26 19 13 25 16 1 24 8 14 3 2 10
-1.4 -1.3 -0.4 -0.4 -0.3 -0.2 -0.2 0.0 0.2 0.3 0.6 0.6 1.1 1.5

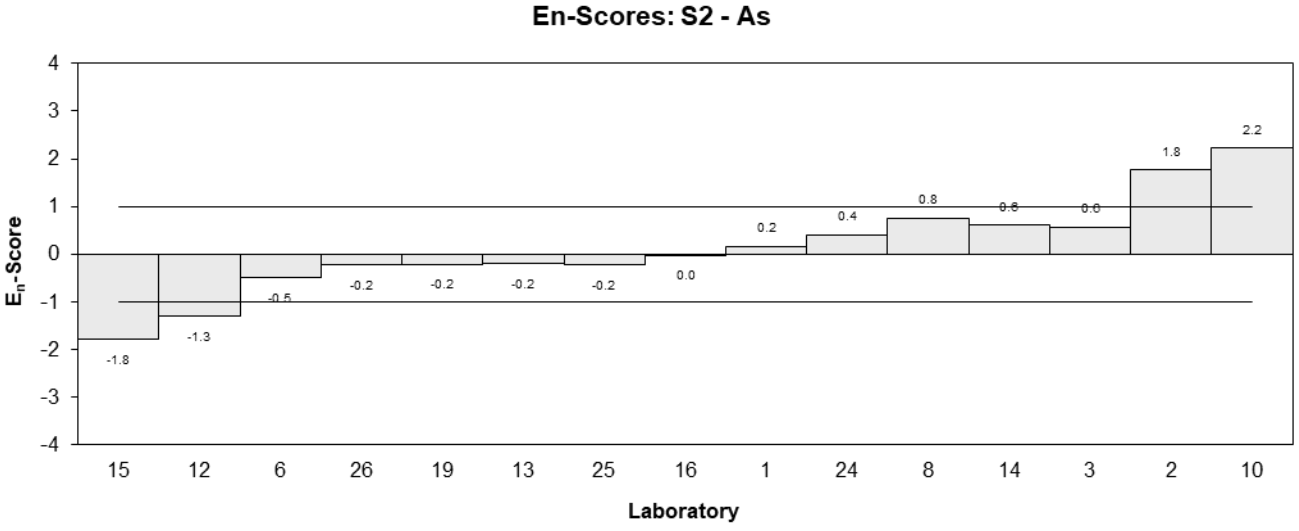

En-Scores: S2 - As
En-Score
Laboratory
15 12 6 26 19 13 25 16 1 24 8 14 3 2 10
-1.8 -1.3 -0.5 -0.2 -0.2 -0.2 -0.2 0.0 0.2 0.4 0.8 0.6 0.6 1.8 2.2

Figure 25

Table 39

Sample Details

Sample No.	S2
Matrix	Sludge
Analyte	B
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	6.76	1.35
2	8.5	1.0
3	7.4	2.2
4	<5	NR
5	NT	NT
6	5.3	1.6
8	4.7	0.4
9	NT	NT
10**	8.09	2.427
11	<10	NR
12	3.3	0.7
13	< 10	NR
14	8.8	0.6
15	5.19	0.780
16	<10	NT
17	5	3
18	NT	NT
19	< 10	NR
20	NT	NT
21	NT	NT
22	<10	NR
23	NT	NT
24	13	1.95
25	< 10	NR
26	4.6	1.38
27	<10	NR

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	Not Set	
Spike Value	Not Spiked	
Homogeneity Value	7.44	0.89
Robust Average	6.3	1.8
Median	5.3	1.6
Mean	6.6	
N	11	
Max	13	
Min	3.3	
Robust SD	2.4	
Robust CV	37%	

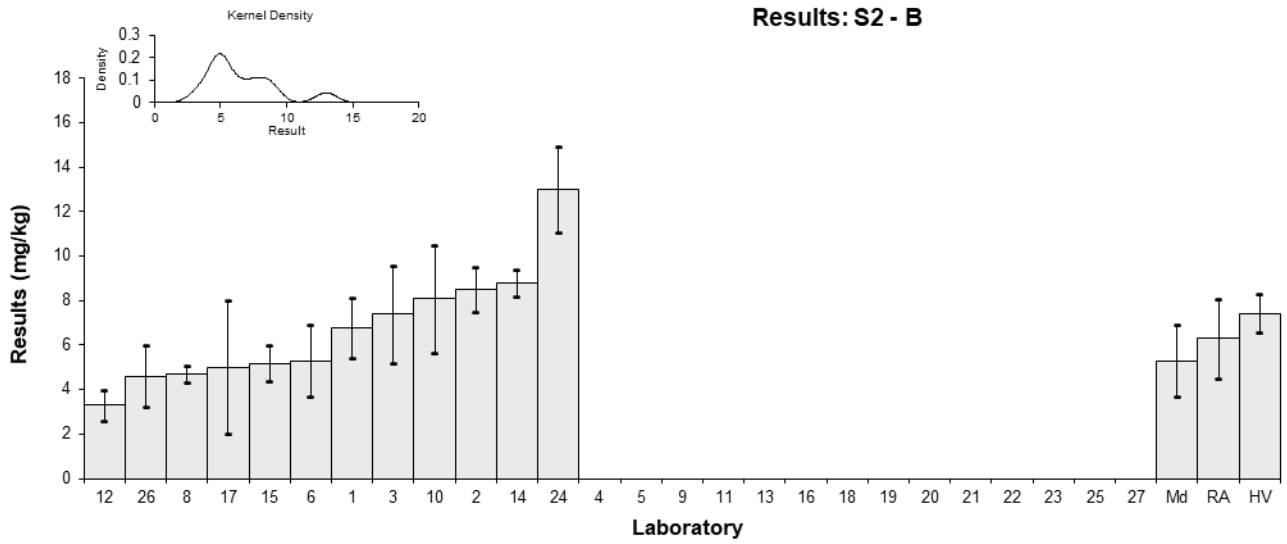

Results: S2 - B
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
12 26 8 17 15 6 1 3 10 2 14 24 4 5 9 11 13 16 18 19 20 21 22 23 25 27 Md RA HV

Figure 26

Table 40

Sample Details

Sample No.	S2
Matrix	Sludge
Analyte	Ba
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	51.2	10.2	0.98	0.74
2	59.8	6.0	1.99	2.19
3	54.5	20.1	1.37	0.57
4	40.5	18.2	-0.27	-0.12
5	NT	NT		
6	33.8	5.5	-1.05	-1.22
8	54.3	3.0	1.34	2.00
9	NT	NT		
10**	89.42	26.826	5.45	1.71
11	42	10	-0.09	-0.07
12	38.3	8	-0.53	-0.48
13	45	9	0.26	0.21
14	48.7	1.3	0.69	1.16
15	32.6	7.80	-1.19	-1.11
16	43.9	8.77	0.13	0.11
17	36	8	-0.79	-0.72
18	NT	NT		
19	41.2	10.3	-0.19	-0.14
20	NT	NT		
21	NT	NT		
22	39	10	-0.44	-0.34
23	NT	NT		
24*	74	7.4	3.64	3.52
25	41	4.9	-0.21	-0.26
26	39.85	11.955	-0.34	-0.23
27	33.6	4.8	-1.07	-1.34

* Outlier, ** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	42.8	4.9
Spike Value	Not Spiked	
Homogeneity Value	55.5	6.7
Robust Average	43.7	5.2
Median	41.2	4.4
Mean	44.7	
N	19	
Max	74	
Min	32.6	
Robust SD	9.1	
Robust CV	21%	

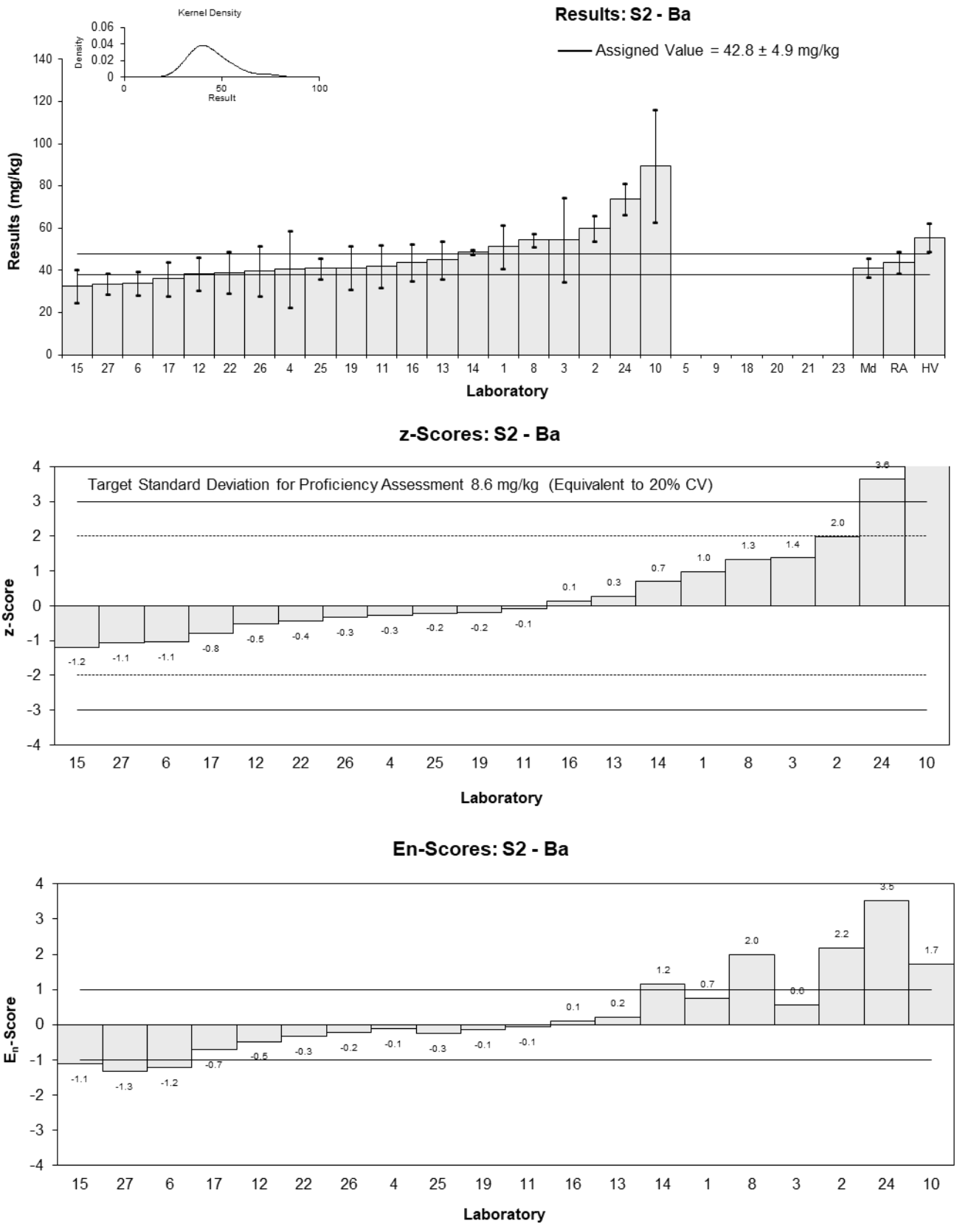

Kernel Density
Density
Result
Results: S2 - Ba
Assigned Value = 42.8 ± 4.9 mg/kg
Results (mg/kg)
Laboratory
15 27 6 17 12 22 26 4 25 19 11 16 13 14 1 8 3 2 24 10 5 9 18 20 21 23 Md RA HV
z-Scores: S2 - Ba
Target Standard Deviation for Proficiency Assessment 8.6 mg/kg (Equivalent to 20% CV)
z-Score
-1.2 -1.1 -1.1 -0.8 -0.5 -0.4 -0.3 -0.3 -0.2 -0.2 -0.1 0.1 0.3 0.7 1.0 1.3 1.4 2.0 3.6
Laboratory
15 27 6 17 12 22 26 4 25 19 11 16 13 14 1 8 3 2 24 10
En-Scores: S2 - Ba
En-Score
-1.1 -1.3 -1.2 -0.7 -0.5 -0.3 -0.2 -0.1 -0.3 -0.1 -0.1 0.1 0.2 1.2 0.7 2.0 0.6 2.2 3.5 1.7
Laboratory
15 27 6 17 12 22 26 4 25 19 11 16 13 14 1 8 3 2 24 10

Figure 27

Table 41

Sample Details

Sample No.	S2
Matrix	Sludge
Analyte	Be
Unit	mg/kg

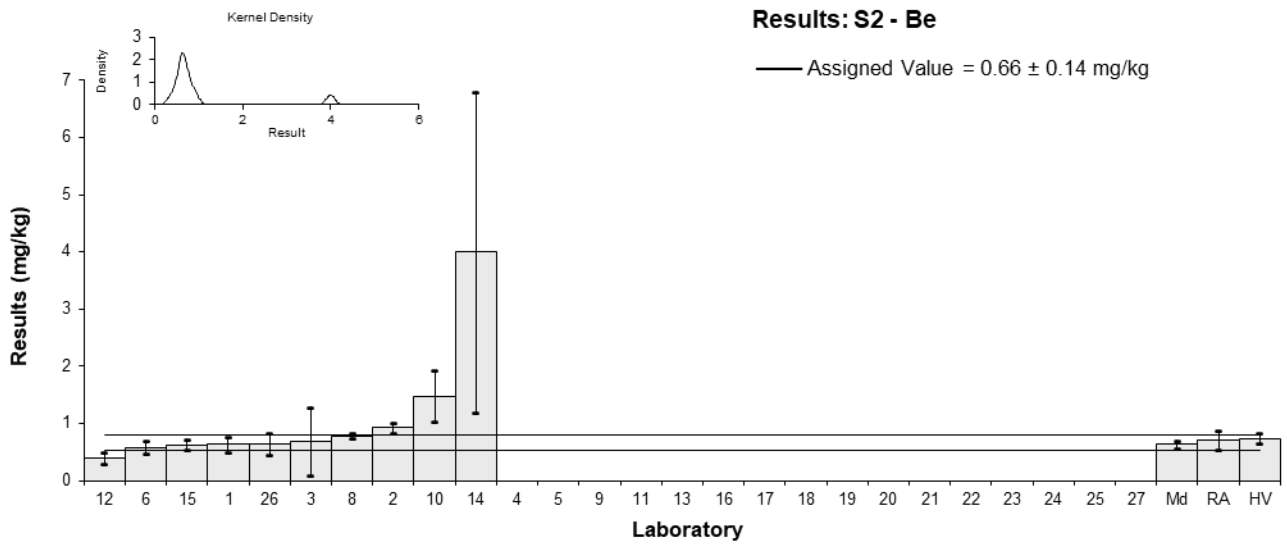
Participant Results

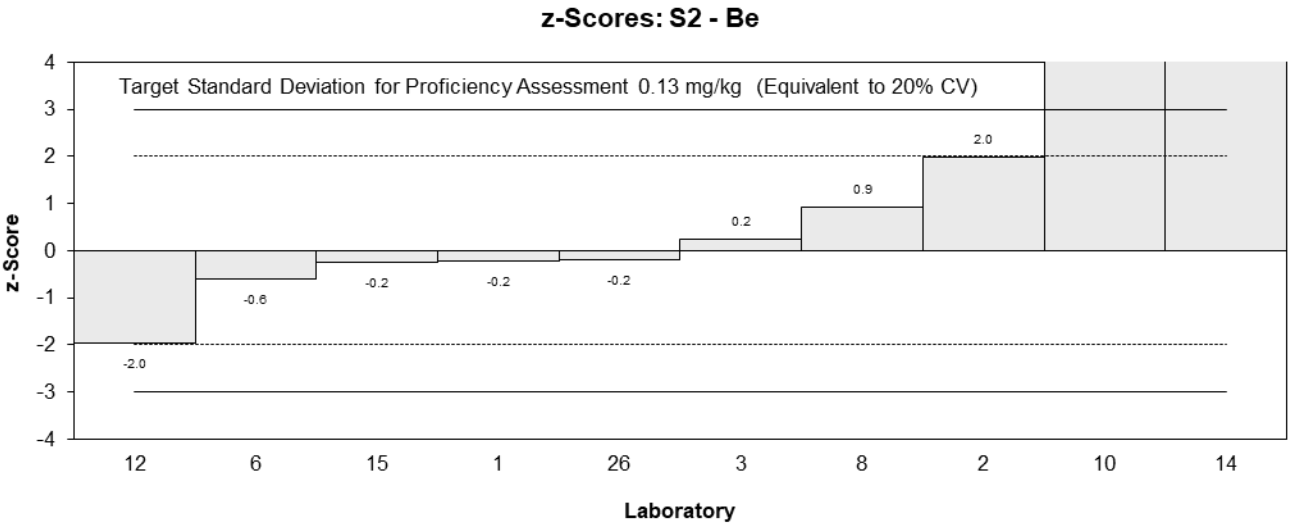
Lab. Code	Result	Uncertainty	z	E_n
1	0.629	0.126	-0.23	-0.16
2	0.92	0.1	1.97	1.51
3	0.69	0.59	0.23	0.05
4	<1	NR		
5	NT	NT		
6	0.58	0.11	-0.61	-0.45
8	0.78	0.05	0.91	0.81
9	NT	NT		
10**	1.48	0.444	6.21	1.76
11	<1	NR		
12	0.4	0.1	-1.97	-1.51
13	< 2	NR		
14*	4.0	2.8	25.30	1.19
15	0.628	0.094	-0.24	-0.19
16	<2	NT		
17	<1	1		
18	NT	NT		
19	< 2	NR		
20	NT	NT		
21	NT	NT		
22	<1	NR		
23	<0.6	0.12		
24	< 2	NR		
25	< 2	NR		
26	0.635	0.1905	-0.19	-0.11
27	<5	NR		

* Outlier, ** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	0.66	0.14
Spike Value	Not Spiked	
Homogeneity Value	0.738	0.089
Robust Average	0.70	0.17
Median	0.635	0.068
Mean	1.03	
N	9	
Max	4	
Min	0.4	
Robust SD	0.21	
Robust CV	30%	


Kernel Density
Density
Result
Results: S2 - Be
Assigned Value = 0.66 ± 0.14 mg/kg
Results (mg/kg)
Laboratory
12 6 15 1 26 3 8 2 10 14 4 5 9 11 13 16 17 18 19 20 21 22 23 24 25 27 Md RA HV


z-Scores: S2 - Be
Target Standard Deviation for Proficiency Assessment 0.13 mg/kg (Equivalent to 20% CV)
z-Score
-2.0
-0.6
-0.2
-0.2
-0.2
0.2
0.9
2.0
Laboratory
12 6 15 1 26 3 8 2 10 14

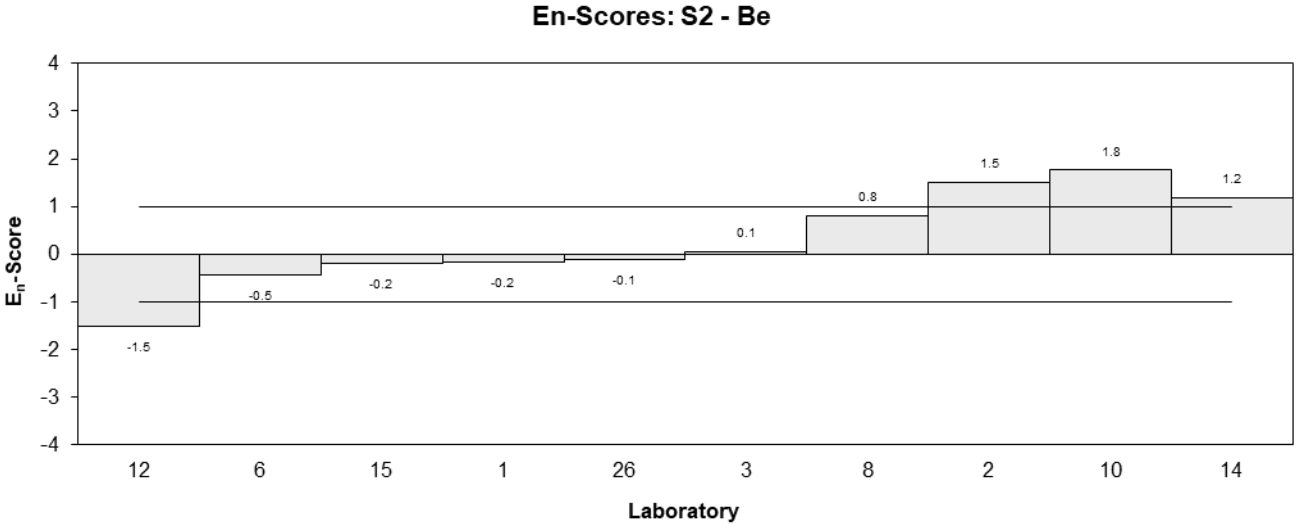

En-Scores: S2 - Be
En-Score
-1.5
-0.5
-0.2
-0.2
-0.1
0.1
0.8
1.5
1.8
1.2
Laboratory
12 6 15 1 26 3 8 2 10 14

Figure 28

Table 42

Sample Details

Sample No.	S2
Matrix	Sludge
Analyte	Cd
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	0.538	0.108
2	0.90	0.1
3	0.96	0.06
4	1.5	0.3
5	NT	NT
6	0.468	0.057
8	0.80	0.06
9	NT	NT
10**	1.36	0.408
11	0.4	0.4
12	0.4	0.1
13	0.7	0.2
14	0.58	0.06
15	0.538	0.11
16	<0.4	NT
17	0.4	0.2
18	NT	NT
19	0.445	0.111
20	NT	NT
21	NT	NT
22	0.5	0.3
23	<1	0.3
24	0.68	0.06
25	0.6	0.09
26	0.5405	0.16215
27	0.81	0.10

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	Not Set	
Spike Value	Not Spiked	
Homogeneity Value	0.735	0.088
Robust Average	0.62	0.13
Median	0.56	0.11
Mean	0.65	
N	18	
Max	1.5	
Min	0.4	
Robust SD	0.21	
Robust CV	34%	

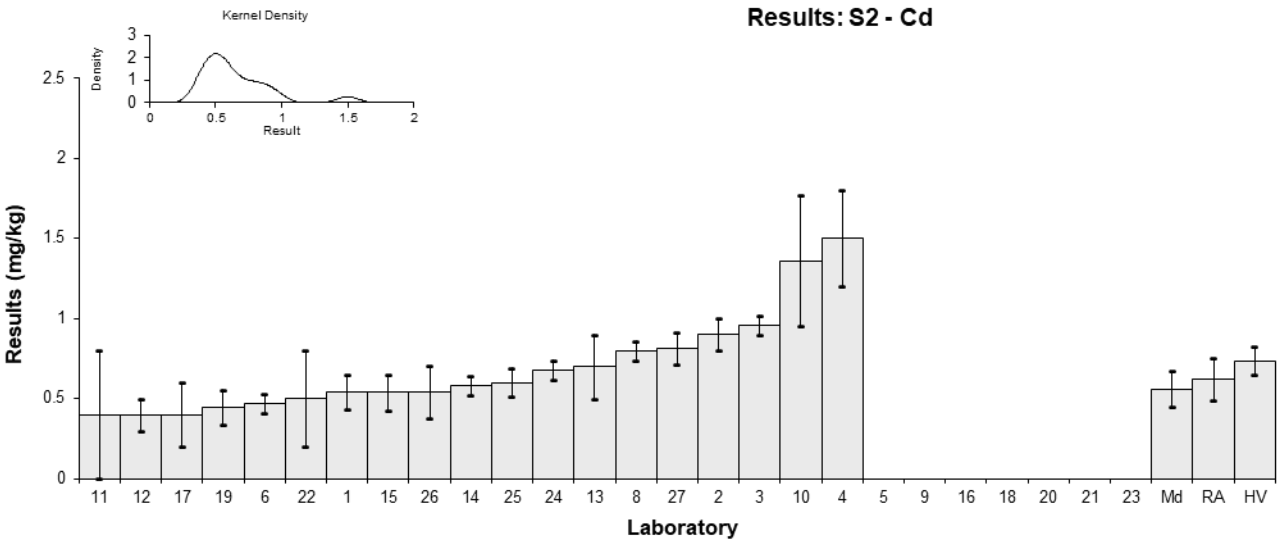

Results: S2 - Cd
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
11 12 17 19 6 22 1 15 26 14 25 24 13 8 27 2 3 10 4 5 9 16 18 20 21 23 Md RA HV

Figure 29

Table 43

Sample Details

Sample No.	S2
Matrix	Sludge
Analyte	Cr
Unit	mg/kg

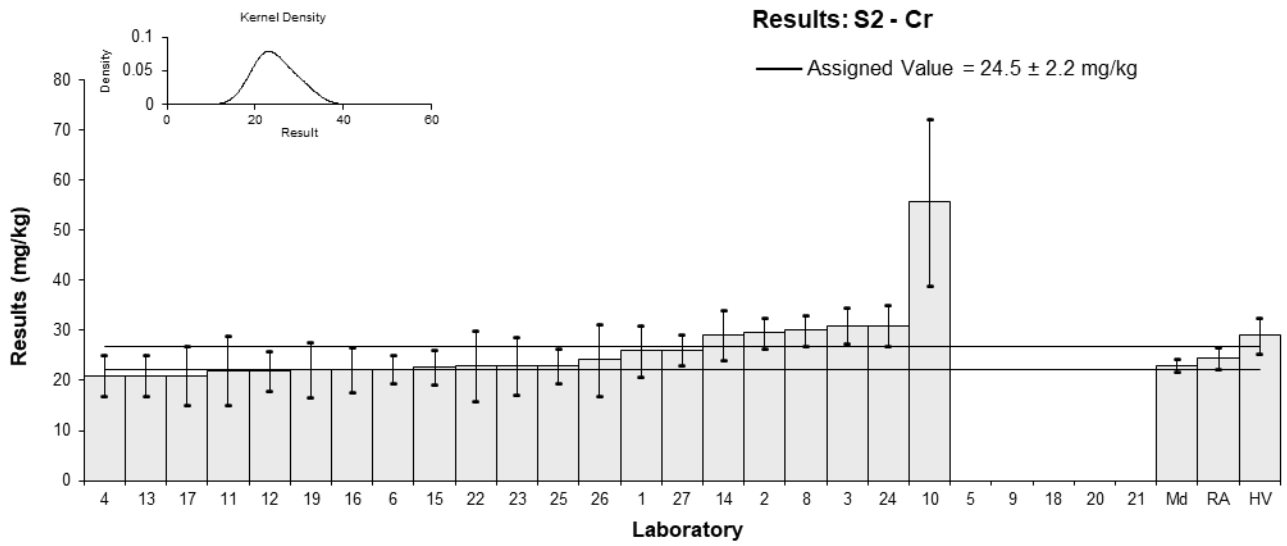
Participant Results

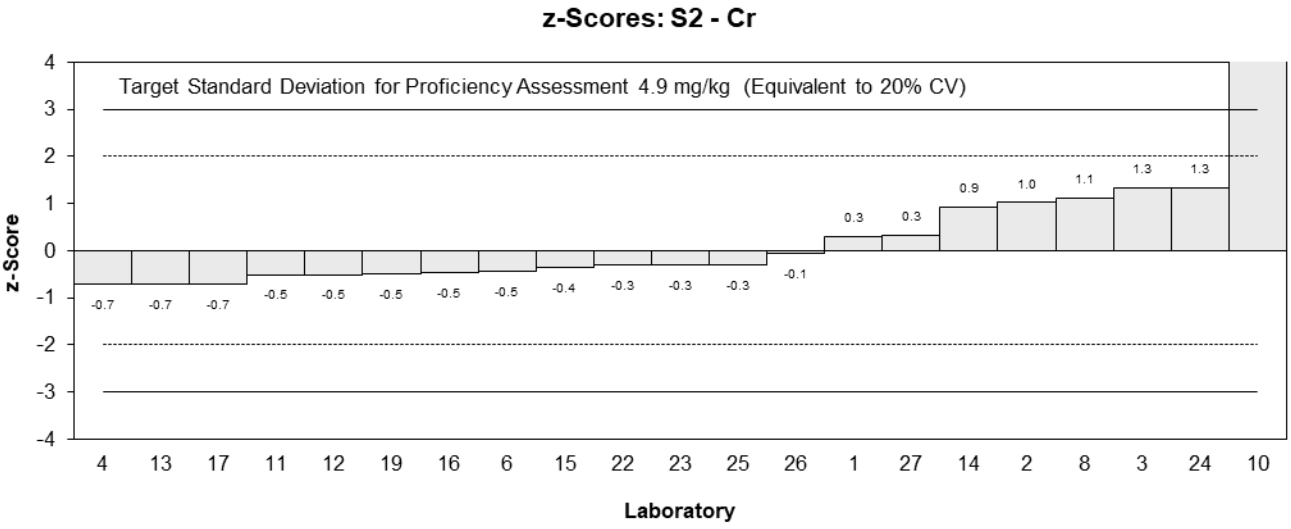
Lab. Code	Result	Uncertainty	z	E_n
1	25.9	5.18	0.29	0.25
2	29.5	3.0	1.02	1.34
3	31	3.5	1.33	1.57
4	21	4.2	-0.71	-0.74
5	NT	NT		
6	22.3	2.7	-0.45	-0.63
8	30.0	3.0	1.12	1.48
9	NT	NT		
10**	55.69	16.707	6.37	1.85
11	22	7	-0.51	-0.34
12	22	4	-0.51	-0.55
13	21	4.2	-0.71	-0.74
14	29	5	0.92	0.82
15	22.7	3.40	-0.37	-0.44
16	22.2	4.44	-0.47	-0.46
17	21	6	-0.71	-0.55
18	NT	NT		
19	22.1	5.53	-0.49	-0.40
20	NT	NT		
21	NT	NT		
22	23	7	-0.31	-0.20
23	23	5.75	-0.31	-0.24
24	31	4.03	1.33	1.42
25	23	3.4	-0.31	-0.37
26	24.15	7.245	-0.07	-0.05
27	26.1	3.1	0.33	0.42

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	24.5	2.2
Spike Value	Not Spiked	
Homogeneity Value	29.0	3.5
Robust Average	24.5	2.2
Median	23.0	1.3
Mean	24.6	
N	20	
Max	31	
Min	21	
Robust SD	3.9	
Robust CV	16%	


Kernel Density
Density
Result
Results: S2 - Cr
Assigned Value = 24.5 ± 2.2 mg/kg
Results (mg/kg)
Laboratory
4 13 17 11 12 19 16 6 15 22 23 25 26 1 27 14 2 8 3 24 10 5 9 18 20 21 Md RA HV


z-Scores: S2 - Cr
Target Standard Deviation for Proficiency Assessment 4.9 mg/kg (Equivalent to 20% CV)
z-Score
Laboratory
4 13 17 11 12 19 16 6 15 22 23 25 26 1 27 14 2 8 3 24 10

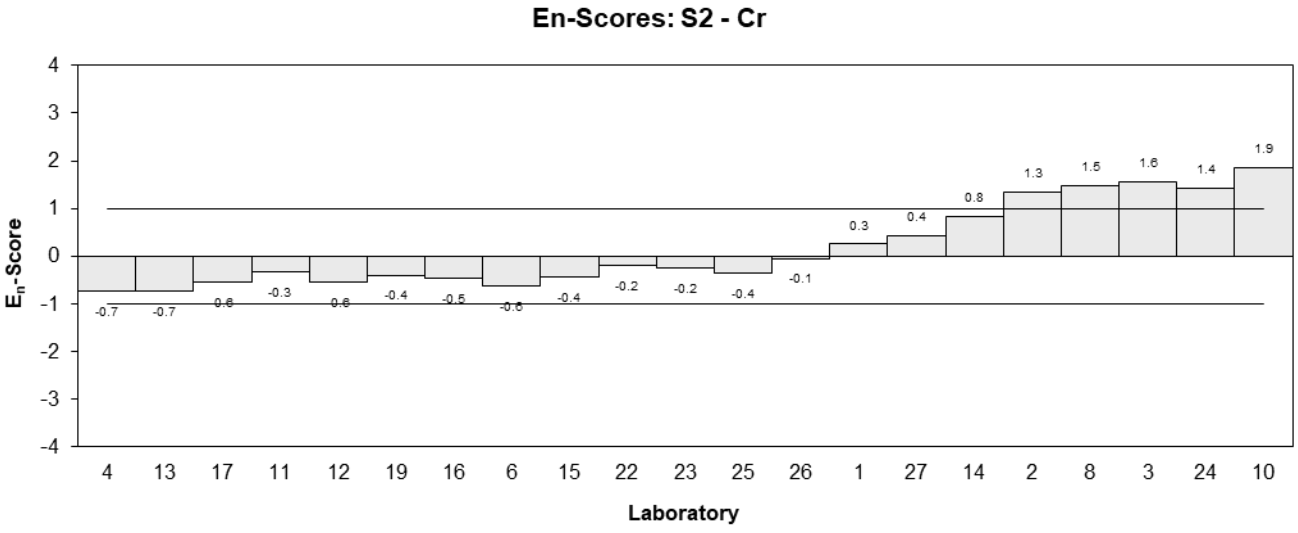

En-Scores: S2 - Cr
En-Score
Laboratory
4 13 17 11 12 19 16 6 15 22 23 25 26 1 27 14 2 8 3 24 10

Figure 30

Table 44

Sample Details

Sample No.	S2
Matrix	Sludge
Analyte	Cu
Unit	mg/kg

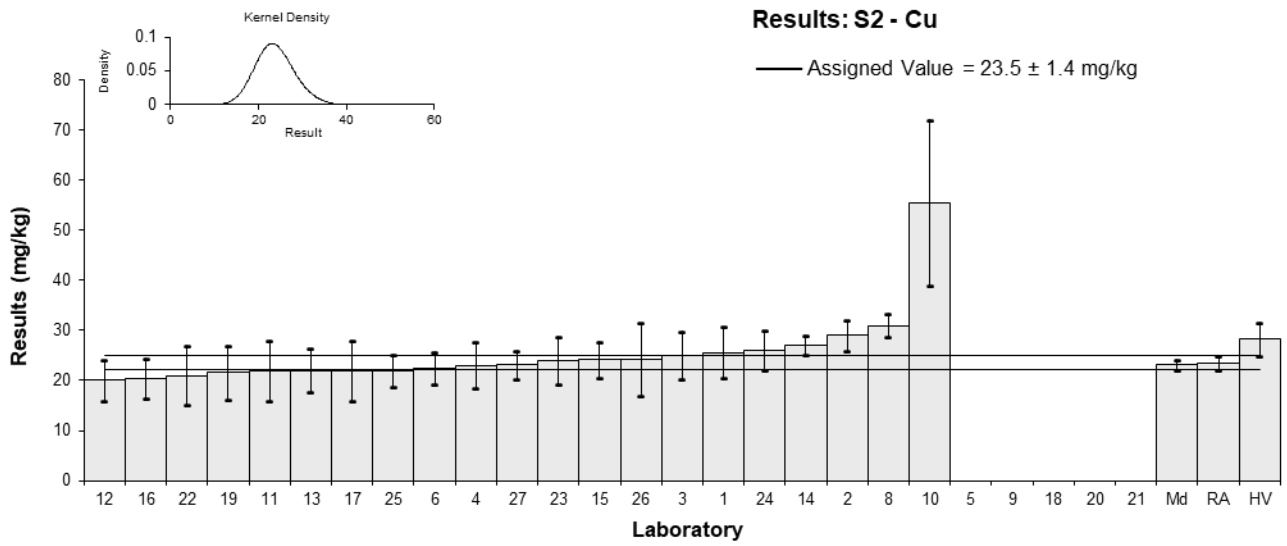
Participant Results

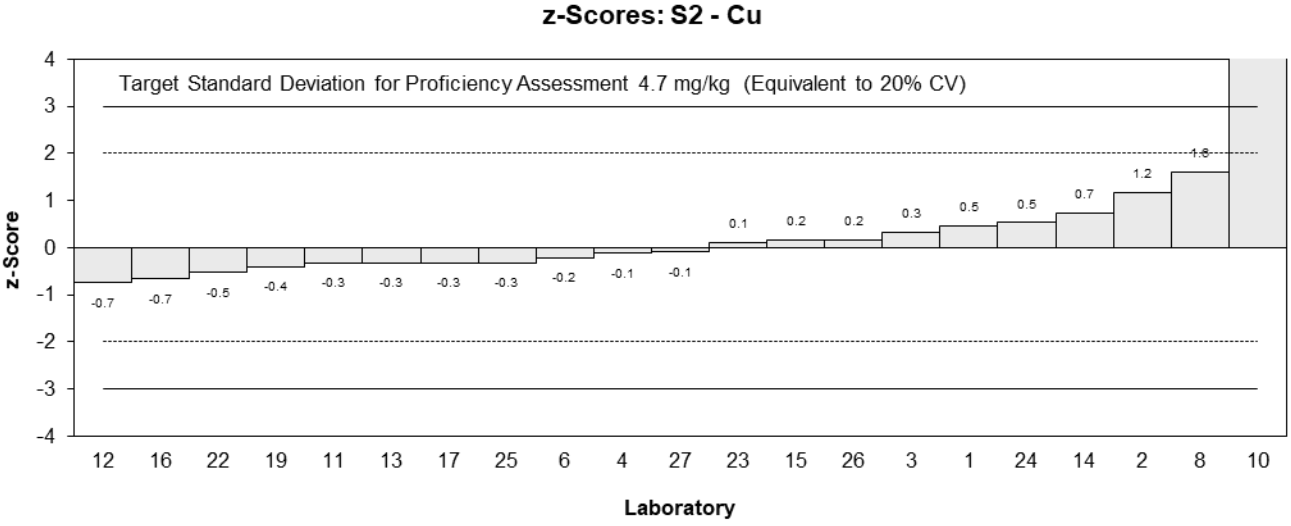
Lab. Code	Result	Uncertainty	z	E_n
1	25.6	5.11	0.45	0.40
2	29	3.0	1.17	1.66
3	25	4.8	0.32	0.30
4	23	4.6	-0.11	-0.10
5	NT	NT		
6	22.5	3.2	-0.21	-0.29
8	31.0	2.4	1.60	2.70
9	NT	NT		
10**	55.5	16.65	6.81	1.92
11	22	6	-0.32	-0.24
12	20	4	-0.74	-0.83
13	22	4.4	-0.32	-0.32
14	27	2	0.74	1.43
15	24.2	3.60	0.15	0.18
16	20.4	4.08	-0.66	-0.72
17	22	6	-0.32	-0.24
18	NT	NT		
19	21.6	5.4	-0.40	-0.34
20	NT	NT		
21	NT	NT		
22	21	6	-0.53	-0.41
23	24	4.8	0.11	0.10
24	26	3.9	0.53	0.60
25	22	3.2	-0.32	-0.43
26	24.2	7.26	0.15	0.09
27	23.1	2.8	-0.09	-0.13

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	23.5	1.4
Spike Value	Not Spiked	
Homogeneity Value	28.2	3.4
Robust Average	23.5	1.4
Median	23.1	1.1
Mean	23.8	
N	20	
Max	31	
Min	20	
Robust SD	2.6	
Robust CV	11%	


Kernel Density
Density
Result
Results: S2 - Cu
Assigned Value = 23.5 ± 1.4 mg/kg
Results (mg/kg)
Laboratory
12 16 22 19 11 13 17 25 6 4 27 23 15 26 3 1 24 14 2 8 10 5 9 18 20 21 Md RA HV


z-Scores: S2 - Cu
Target Standard Deviation for Proficiency Assessment 4.7 mg/kg (Equivalent to 20% CV)
z-Score
Laboratory
12 16 22 19 11 13 17 25 6 4 27 23 15 26 3 1 24 14 2 8 10
-0.7 -0.7 -0.5 -0.4 -0.3 -0.3 -0.3 -0.3 -0.2 -0.1 -0.1 0.1 0.2 0.2 0.3 0.5 0.5 0.7 1.2 1.6

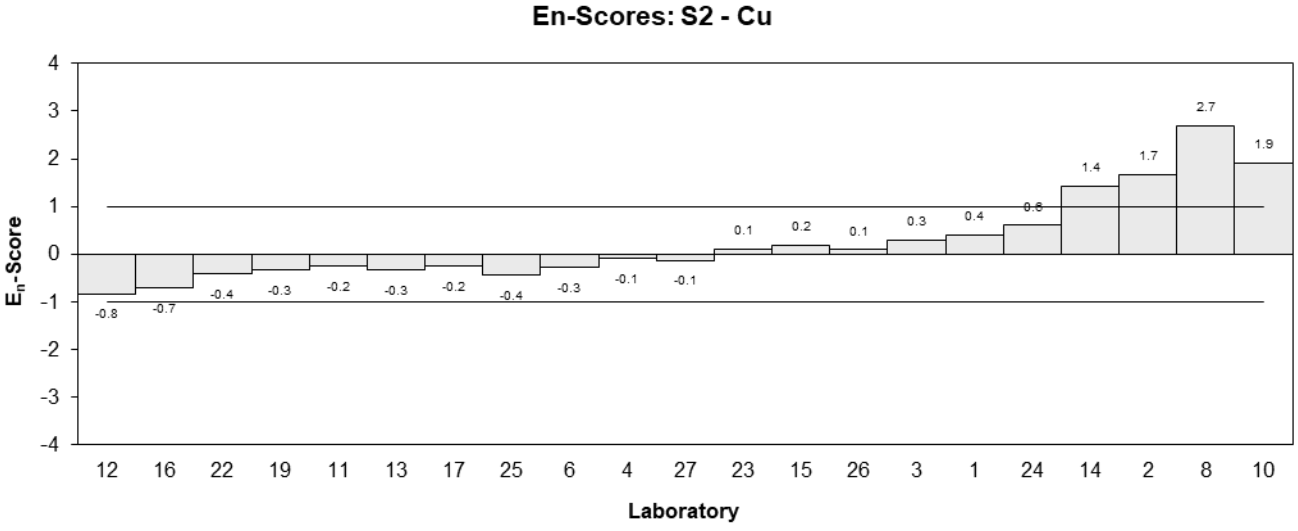

En-Scores: S2 - Cu
En-Score
Laboratory
12 16 22 19 11 13 17 25 6 4 27 23 15 26 3 1 24 14 2 8 10
-0.8 -0.7 -0.4 -0.3 -0.2 -0.3 -0.2 -0.4 -0.3 -0.1 -0.1 0.1 0.2 0.1 0.3 0.4 0.6 1.4 1.7 2.7 1.9

Figure 31

Table 45

Sample Details

Sample No.	S2
Matrix	Sludge
Analyte	Hg
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	0.34	0.08	2.00	1.12
3*	0.4	0.027	3.23	3.68
4	0.24	0.07	-0.06	-0.04
5	NT	NT		
6	0.169	0.022	-1.52	-1.87
8	0.25	0.02	0.14	0.18
9	NT	NT		
10**	0.619	0.1857	7.74	1.99
11	0.2	0.2	-0.88	-0.21
12	<0.2	0.1		
13	0.29	0.06	0.97	0.69
14	0.23	0.05	-0.27	-0.22
15	0.20	0.033	-0.88	-0.92
16	0.254	0.051	0.23	0.18
17	0.2	0.2	-0.88	-0.21
18	NT	NT		
19	0.286	0.0715	0.88	0.55
20	NT	NT		
21	NT	NT		
22	0.2	0.07	-0.88	-0.56
23	0.2	0.05	-0.88	-0.72
24	0.34	0.04	2.00	1.87
25	0.3	0.04	1.17	1.10
26	0.21	0.063	-0.68	-0.46
27	0.257	0.05	0.29	0.23

* Outlier, ** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	0.243	0.033
Spike Value	Not Spiked	
Homogeneity Value	0.325	0.065
Robust Average	0.251	0.037
Median	0.245	0.039
Mean	0.254	
N	18	
Max	0.4	
Min	0.169	
Robust SD	0.063	
Robust CV	25%	

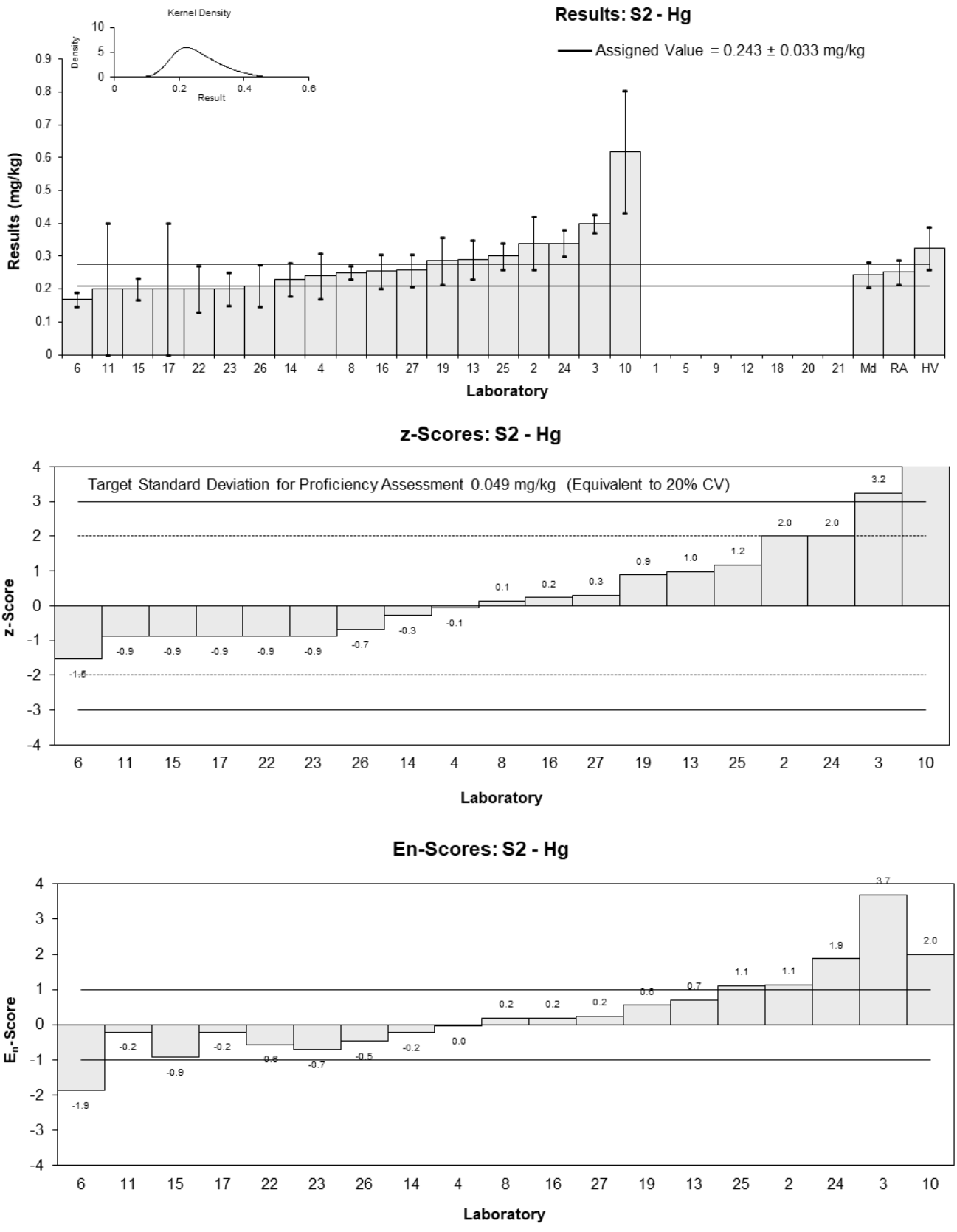

Results: S2 - Hg
Assigned Value = 0.243 ± 0.033 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
6 11 15 17 22 23 26 14 4 8 16 27 19 13 25 2 24 3 10 1 5 9 12 18 20 21 Md RA HV
z-Scores: S2 - Hg
Target Standard Deviation for Proficiency Assessment 0.049 mg/kg (Equivalent to 20% CV)
z-Score
-1.5 -0.9 -0.9 -0.9 -0.9 -0.9 -0.7 -0.3 -0.1 0.1 0.2 0.3 0.9 1.0 1.2 2.0 2.0 3.2
Laboratory
6 11 15 17 22 23 26 14 4 8 16 27 19 13 25 2 24 3 10
En-Scores: S2 - Hg
En-Score
-1.9 -0.2 -0.9 -0.2 -0.6 -0.7 -0.5 -0.2 0.0 0.2 0.2 0.2 0.6 0.7 1.1 1.1 1.9 3.7 2.0
Laboratory
6 11 15 17 22 23 26 14 4 8 16 27 19 13 25 2 24 3 10

Figure 32

Table 46

Sample Details

Sample No.	S2
Matrix	Sludge
Analyte	La
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1*	8.45	1.69	5.67	2.59
2	NT	NT		
3	NT	NT		
4	NR	NR		
5	NT	NT		
6	3.85	0.54	-0.14	-0.16
8	NT	NT		
9	NT	NT		
10	NT	NT		
11	4	2	0.05	0.02
12	NT	NT		
13	NT	NT		
14	NR	NR		
15	3.48	0.52	-0.61	-0.73
16	NT	NT		
17	4	2	0.05	0.02
18	NT	NT		
19	NT	NT		
20	NT	NT		
21	NT	NT		
22	3.9	2	-0.08	-0.03
23	NT	NT		
24*	16	2.4	15.20	4.95
25	NT	NT		
26	4.795	1.4385	1.05	0.56
27	<5	NR		

* Outlier, see Section 4.2

Statistics

Assigned Value	3.96	0.40
Spike Value	Not Spiked	
Robust Average	5.2	2.2
Median	4.00	0.44
Mean	6.1	
N	8	
Max	16	
Min	3.48	
Robust SD	2.5	
Robust CV	48%	

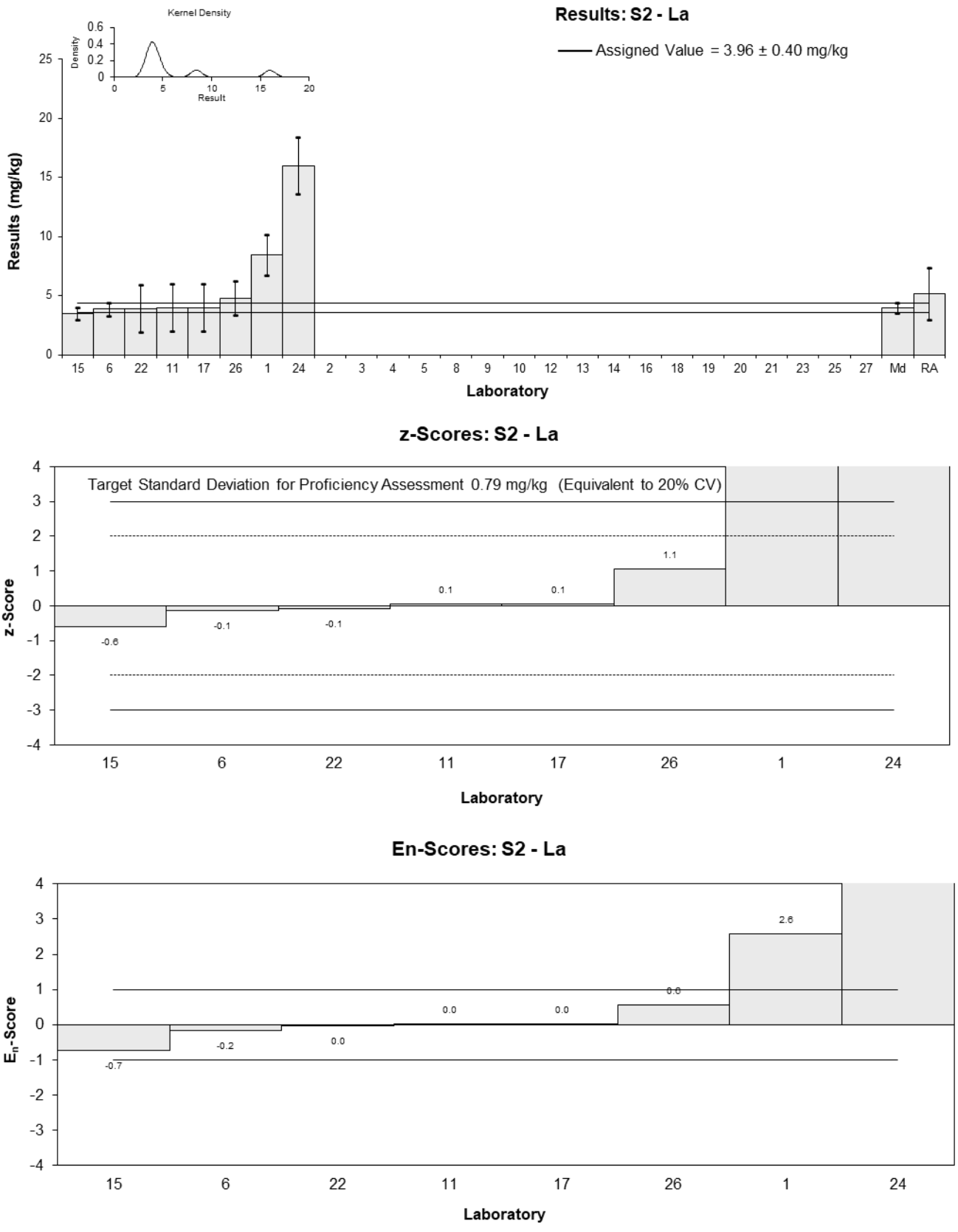

Kernel Density
Density
Result
Results: S2 - La
Assigned Value = 3.96 ± 0.40 mg/kg
Results (mg/kg)
Laboratory
15 6 22 11 17 26 1 24 2 3 4 5 8 9 10 12 13 14 16 18 19 20 21 23 25 27 Md RA
z-Scores: S2 - La
Target Standard Deviation for Proficiency Assessment 0.79 mg/kg (Equivalent to 20% CV)
z-Score
-0.6 -0.1 -0.1 0.1 0.1 1.1
15 6 22 11 17 26 1 24
Laboratory
En-Scores: S2 - La
En-Score
-0.7 -0.2 0.0 0.0 0.0 0.6 2.6
15 6 22 11 17 26 1 24
Laboratory

Figure 33

Table 47

Sample Details

Sample No.	S2
Matrix	Sludge
Analyte	Mn
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	297	59.3	0.32	0.28
2	366	37	1.56	2.02
3	407	35	2.29	3.10
4	273.5	41	-0.10	-0.12
5	NT	NT		
6	247	25	-0.57	-0.96
8	380	20	1.81	3.40
9	NT	NT		
10**	661.36	198.408	6.85	1.92
11	220	60	-1.06	-0.92
12	280	56	0.02	0.02
13	310	62	0.56	0.47
14	260	23	-0.34	-0.60
15	260	57	-0.34	-0.31
16	238	47.6	-0.73	-0.78
17	240	60	-0.70	-0.61
18	NT	NT		
19	273	68.3	-0.11	-0.08
20	NT	NT		
21	NT	NT		
22	280	100	0.02	0.01
23	240	48	-0.70	-0.74
24	320	25	0.73	1.23
25	270	32	-0.16	-0.23
26	272	81.6	-0.13	-0.08
27	277	30.5	-0.04	-0.05

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	279	22
Spike Value	Not Spiked	
Homogeneity Value	362	72
Robust Average	279	22
Median	273	21
Mean	286	
N	20	
Max	407	
Min	220	
Robust SD	40	
Robust CV	14%	

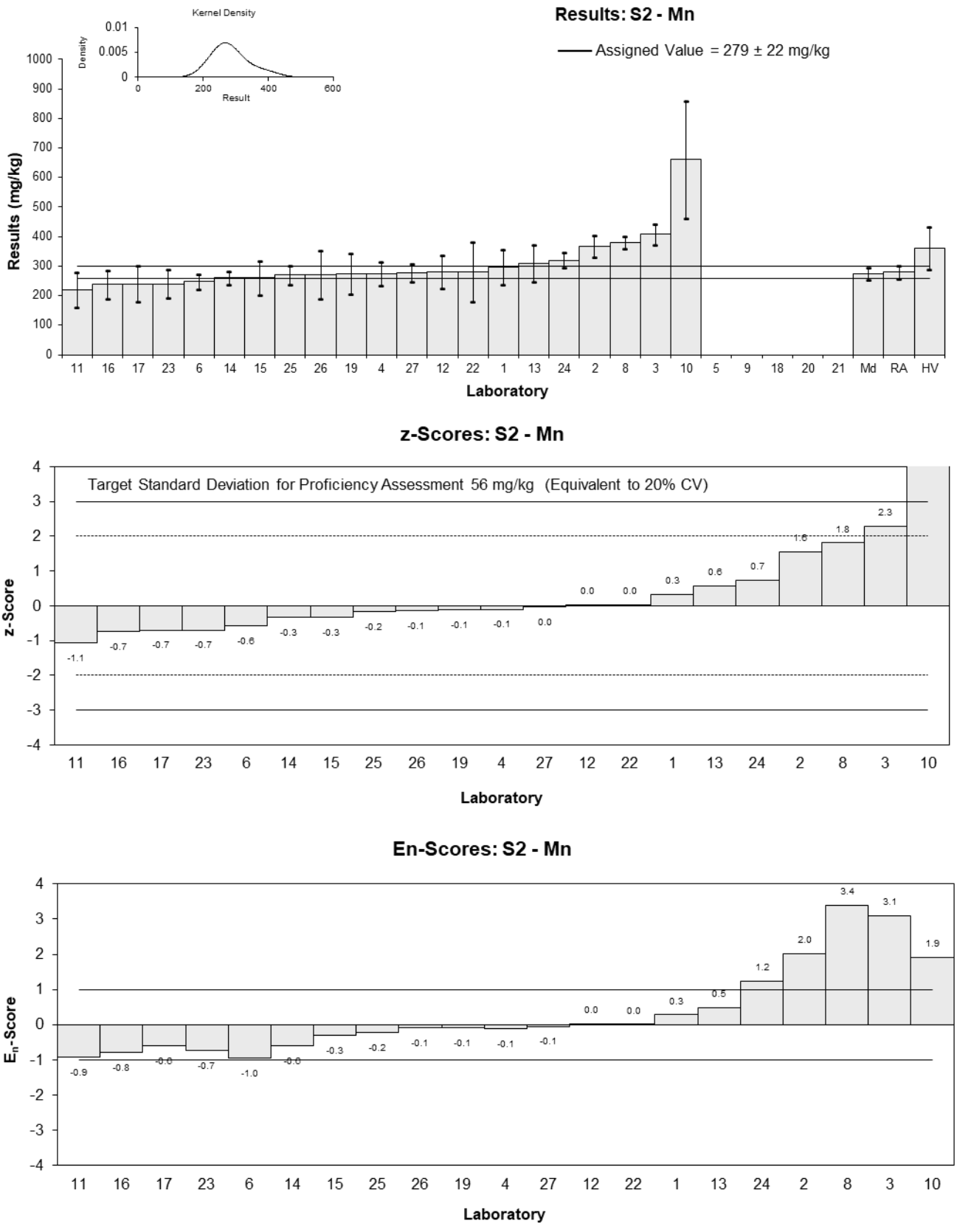

Kernel Density
Density
Result
Results: S2 - Mn
Assigned Value = 279 ± 22 mg/kg
Results (mg/kg)
Laboratory
z-Scores: S2 - Mn
Target Standard Deviation for Proficiency Assessment 56 mg/kg (Equivalent to 20% CV)
z-Score
Laboratory
En-Scores: S2 - Mn
En-Score
Laboratory

Figure 34

Table 48

Sample Details

Sample No.	S2
Matrix	Sludge
Analyte	Mo
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	11.7	2.34	0.00	0.00
2	15	1.5	1.41	1.66
3	15	1.20	1.41	1.87
4	9.85	3.4	-0.79	-0.51
5	NT	NT		
6	10.6	1.5	-0.47	-0.55
8	15.5	1.4	1.62	1.99
9	NT	NT		
10**	29.58	8.874	7.64	1.99
11	12	4	0.13	0.07
12	NT	NT		
13	11	2.2	-0.30	-0.27
14	11.5	1.2	-0.09	-0.11
15	7.50	1.10	-1.79	-2.47
16	10.0	2.00	-0.73	-0.71
17	10	4	-0.73	-0.40
18	NT	NT		
19	10.7	2.68	-0.43	-0.34
20	NT	NT		
21	NT	NT		
22	11	3	-0.30	-0.21
23	9.7	3.395	-0.85	-0.55
24	14	0.98	0.98	1.41
25	12	1.7	0.13	0.14
26	11	3.3	-0.30	-0.20
27	13.3	1.73	0.68	0.74

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	11.7	1.3
Spike Value	Not Spiked	
Homogeneity Value	12.7	1.5
Robust Average	11.7	1.3
Median	11.0	0.9
Mean	11.7	
N	19	
Max	15.5	
Min	7.5	
Robust SD	2.2	
Robust CV	19%	

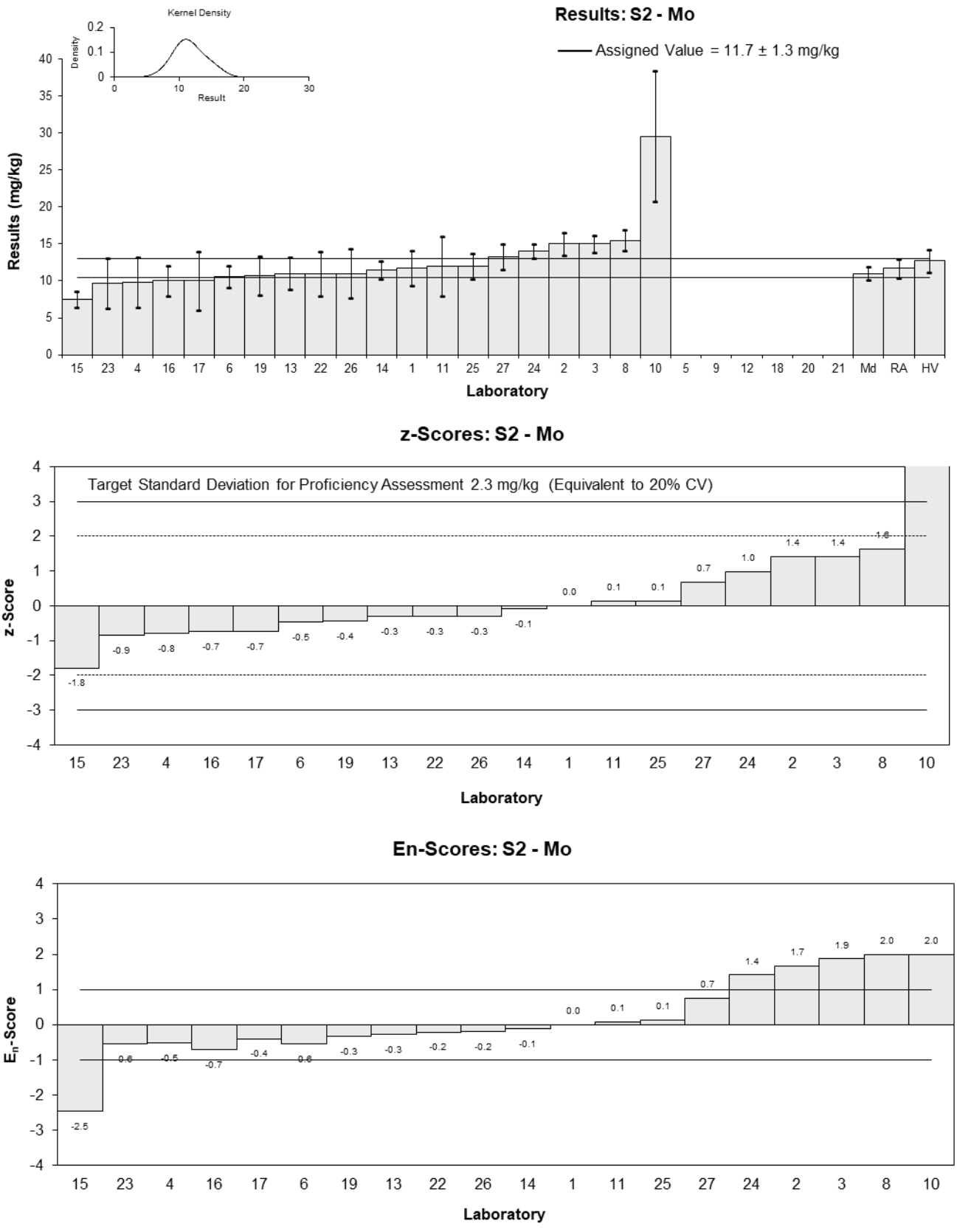

Kernel Density
Density
Result
Results: S2 - Mo
Assigned Value = 11.7 ± 1.3 mg/kg
Results (mg/kg)
Laboratory
z-Scores: S2 - Mo
Target Standard Deviation for Proficiency Assessment 2.3 mg/kg (Equivalent to 20% CV)
z-Score
Laboratory
En-Scores: S2 - Mo
En-Score
Laboratory

Figure 35

Table 49

Sample Details

Sample No.	S2
Matrix	Sludge
Analyte	Na
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	<50	NR
3	38	6.4
4	<50	NR
5	NT	NT
6	<40	27
8	51.3	5.2
9	NT	NT
10**	74	22.2
11	23	10
12	NT	NT
13	16	3.2
14**	930	57
15	<43	NR
16	34.3	6.85
17	35	10
18	NT	NT
19	33.3	8.33
20	NT	NT
21	NT	NT
22	11	6
23**	400	120
24	< 100	NR
25	33	6.4
26	NR	NR
27	<50	NR

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	Not Set	
Spike Value	Not Spiked	
Homogeneity Value	47.1	5.7
Robust Average	31	11
Median	33.3	5.8
Mean	30.5	
N	9	
Max	51.3	
Min	11	
Robust SD	14	
Robust CV	45%	

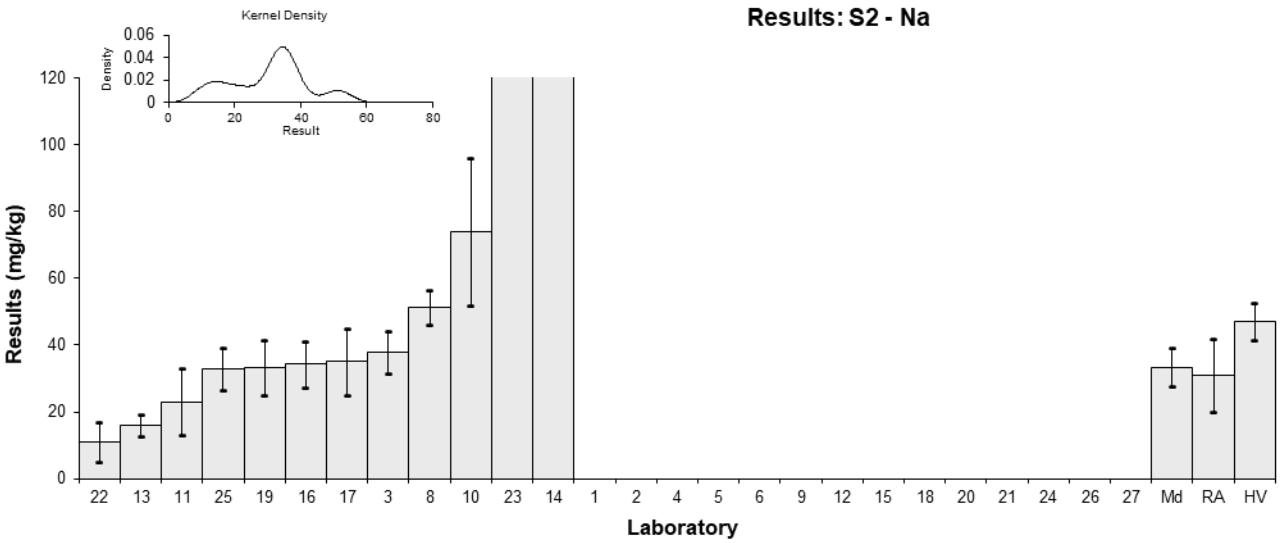

Results: S2 - Na
Kernel Density
Density
0.06
0.04
0.02
0
0
20
40
60
80
Result
Results (mg/kg)
120
100
80
60
40
20
0
22
13
11
25
19
16
17
3
8
10
23
14
1
2
4
5
6
9
12
15
18
20
21
24
26
27
Md
RA
HV
Laboratory

Figure 36

Table 50

Sample Details

Sample No.	S2
Matrix	Sludge
Analyte	P
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	166	33.1	0.29	0.26
2	183	20	0.83	1.14
3	165	46	0.25	0.17
4	157.5	31.5	0.02	0.01
5	NT	NT		
6	147	31	-0.32	-0.30
8	174	8.5	0.54	1.22
9	NT	NT		
10**	379.165	113.7495	7.08	1.94
11	130	40	-0.86	-0.65
12	150	30	-0.22	-0.22
13	140	35	-0.54	-0.46
14	180	10	0.73	1.55
15	150	20	-0.22	-0.31
16	139	27.7	-0.57	-0.60
17	135	40	-0.70	-0.53
18	NT	NT		
19	157	39.2	0.00	0.00
20	NT	NT		
21	NT	NT		
22	150	50	-0.22	-0.14
23	NT	NT		
24	180	27	0.73	0.79
25	150	20	-0.22	-0.31
26	150	45	-0.22	-0.15
27	182	29.1	0.80	0.80

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	157	11
Spike Value	Not Spiked	
Homogeneity Value	175	21
Robust Average	157	11
Median	150	9
Mean	157	
N	19	
Max	183	
Min	130	
Robust SD	19	
Robust CV	12%	

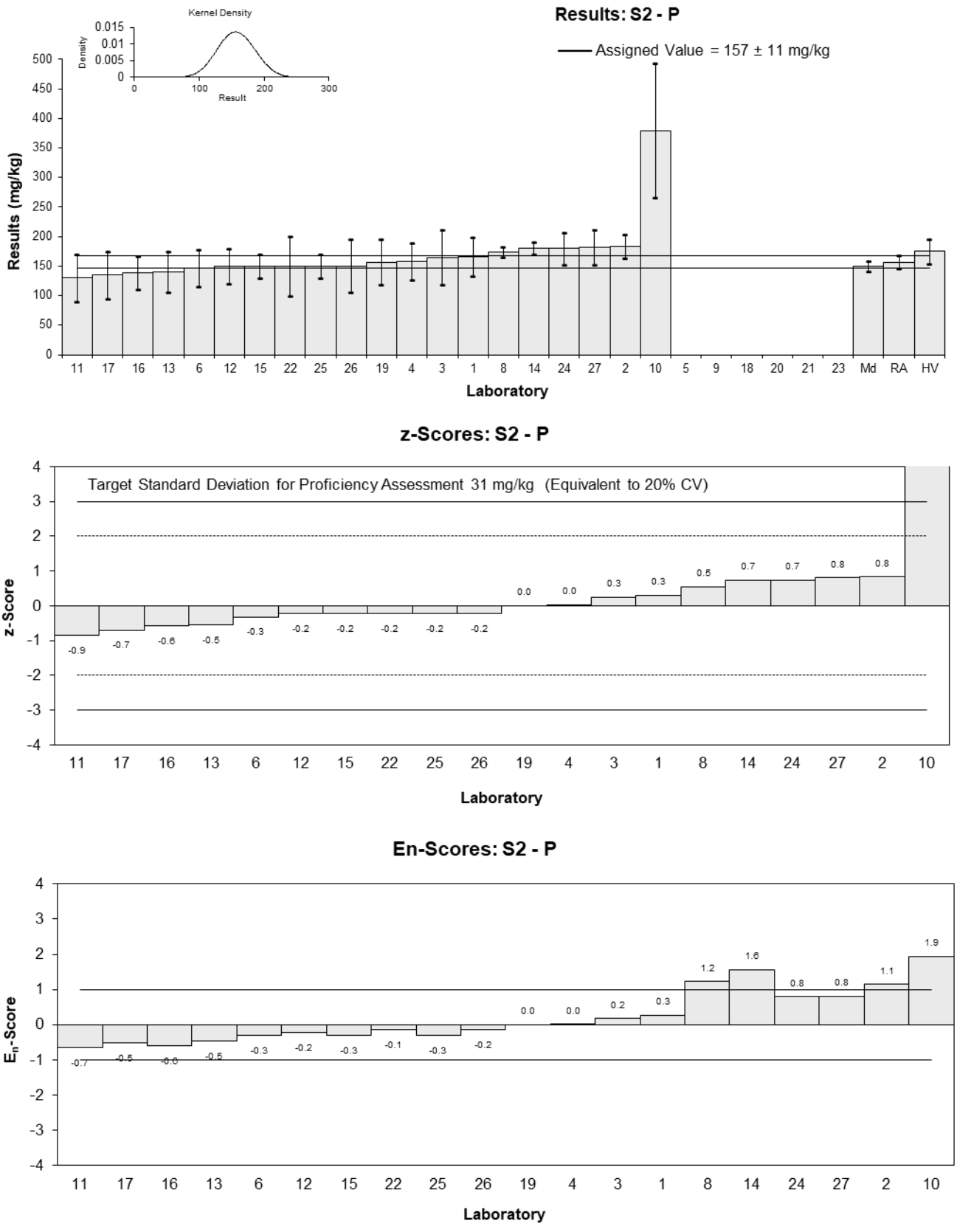

Kernel Density
Density
Result
Results: S2 - P
Assigned Value = 157 ± 11 mg/kg
Results (mg/kg)
Laboratory
11 17 16 13 6 12 15 22 25 26 19 4 3 1 8 14 24 27 2 10 5 9 18 20 21 23 Md RA HV
z-Scores: S2 - P
Target Standard Deviation for Proficiency Assessment 31 mg/kg (Equivalent to 20% CV)
z-Score
-0.9 -0.7 -0.6 -0.5 -0.3 -0.2 -0.2 -0.2 -0.2 -0.2 0.0 0.0 0.3 0.3 0.5 0.7 0.7 0.8 0.8
11 17 16 13 6 12 15 22 25 26 19 4 3 1 8 14 24 27 2 10
Laboratory
En-Scores: S2 - P
En-Score
-0.7 -0.5 -0.6 -0.5 -0.3 -0.2 -0.3 -0.1 -0.3 -0.2 0.0 0.0 0.2 0.3 1.2 1.6 0.8 0.8 1.1 1.9
11 17 16 13 6 12 15 22 25 26 19 4 3 1 8 14 24 27 2 10
Laboratory

Figure 37

Table 51

Sample Details

Sample No.	S2
Matrix	Sludge
Analyte	Pb
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	20.1	4.02	0.32	0.28
2	22.5	2.5	0.95	1.21
3	21	1.1	0.56	1.08
4	<25	NR		
5	NT	NT		
6	17.0	2.1	-0.50	-0.72
8	23.6	1.2	1.24	2.35
9	NT	NT		
10**	48.4	14.52	7.80	2.02
11	17	5	-0.50	-0.36
12	17	3	-0.50	-0.56
13	17	3.4	-0.50	-0.51
14	NR	NR		
15	19.1	3	0.05	0.06
16	16.5	3.30	-0.63	-0.65
17	17	7	-0.50	-0.26
18	NT	NT		
19	17.0	4.25	-0.50	-0.42
20	NT	NT		
21	NT	NT		
22	17	5	-0.50	-0.36
23	17	1.7	-0.50	-0.81
24	23	4.37	1.08	0.88
25	17	2.4	-0.50	-0.66
26	19.2	5.76	0.08	0.05
27	22.3	2.9	0.90	1.03

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	18.9	1.6
Spike Value	Not Spiked	
Homogeneity Value	21.3	2.6
Robust Average	18.9	1.6
Median	17.0	0.2
Mean	18.9	
N	18	
Max	23.6	
Min	16.5	
Robust SD	2.8	
Robust CV	15%	

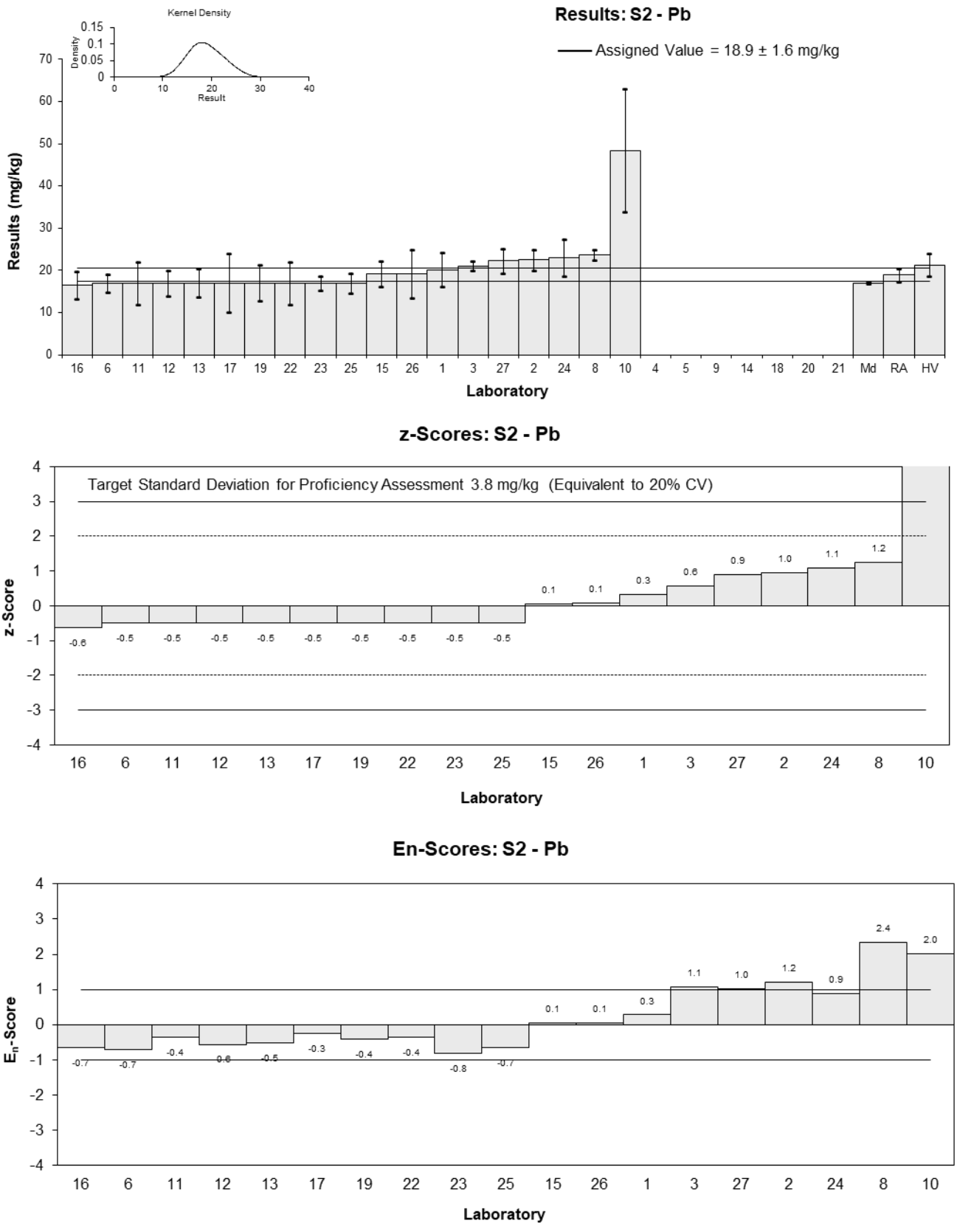

Results: S2 - Pb
Kernel Density
Density
Result
Assigned Value = 18.9 ± 1.6 mg/kg
Results (mg/kg)
Laboratory
16 6 11 12 13 17 19 22 23 25 15 26 1 3 27 2 24 8 10 4 5 9 14 18 20 21 Md RA HV
z-Scores: S2 - Pb
Target Standard Deviation for Proficiency Assessment 3.8 mg/kg (Equivalent to 20% CV)
z-Score
-0.6 -0.5 -0.5 -0.5 -0.5 -0.5 -0.5 -0.5 -0.5 -0.5 0.1 0.1 0.3 0.6 0.9 1.0 1.1 1.2
Laboratory
16 6 11 12 13 17 19 22 23 25 15 26 1 3 27 2 24 8 10
En-Scores: S2 - Pb
En-Score
-0.7 -0.7 -0.4 -0.6 -0.5 -0.3 -0.4 -0.4 -0.8 -0.7 0.1 0.1 0.3 1.1 1.0 1.2 0.9 2.4 2.0
Laboratory
16 6 11 12 13 17 19 22 23 25 15 26 1 3 27 2 24 8 10

Figure 38

Table 52

Sample Details

Sample No.	S2
Matrix	Sludge
Analyte	Rb
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1*	9.35	1.87	4.35	2.05
2	NT	NT		
3	NT	NT		
4	NR	NR		
5	NT	NT		
6	5.4	1.1	0.40	0.27
8	NT	NT		
9	NT	NT		
10	NT	NT		
11	6	2	1.00	0.45
12	NT	NT		
13	NT	NT		
14	NR	NR		
15	4.29	1.40	-0.71	-0.41
16	NT	NT		
17	5	3	0.00	0.00
18	NT	NT		
19	NT	NT		
20	NT	NT		
21	NT	NT		
22	3.6	1	-1.40	-0.99
23	NT	NT		
24*	12	1.8	7.00	3.40
25	NT	NT		
26	5.575	1.6725	0.58	0.30
27	NR	NR		

* Outlier, see Section 4.2

Statistics

Assigned Value	5.0	1.0
Spike Value	Not Spiked	
Robust Average	6.2	2.3
Median	5.5	1.1
Mean	6.4	
N	8	
Max	12	
Min	3.6	
Robust SD	2.7	
Robust CV	43%	

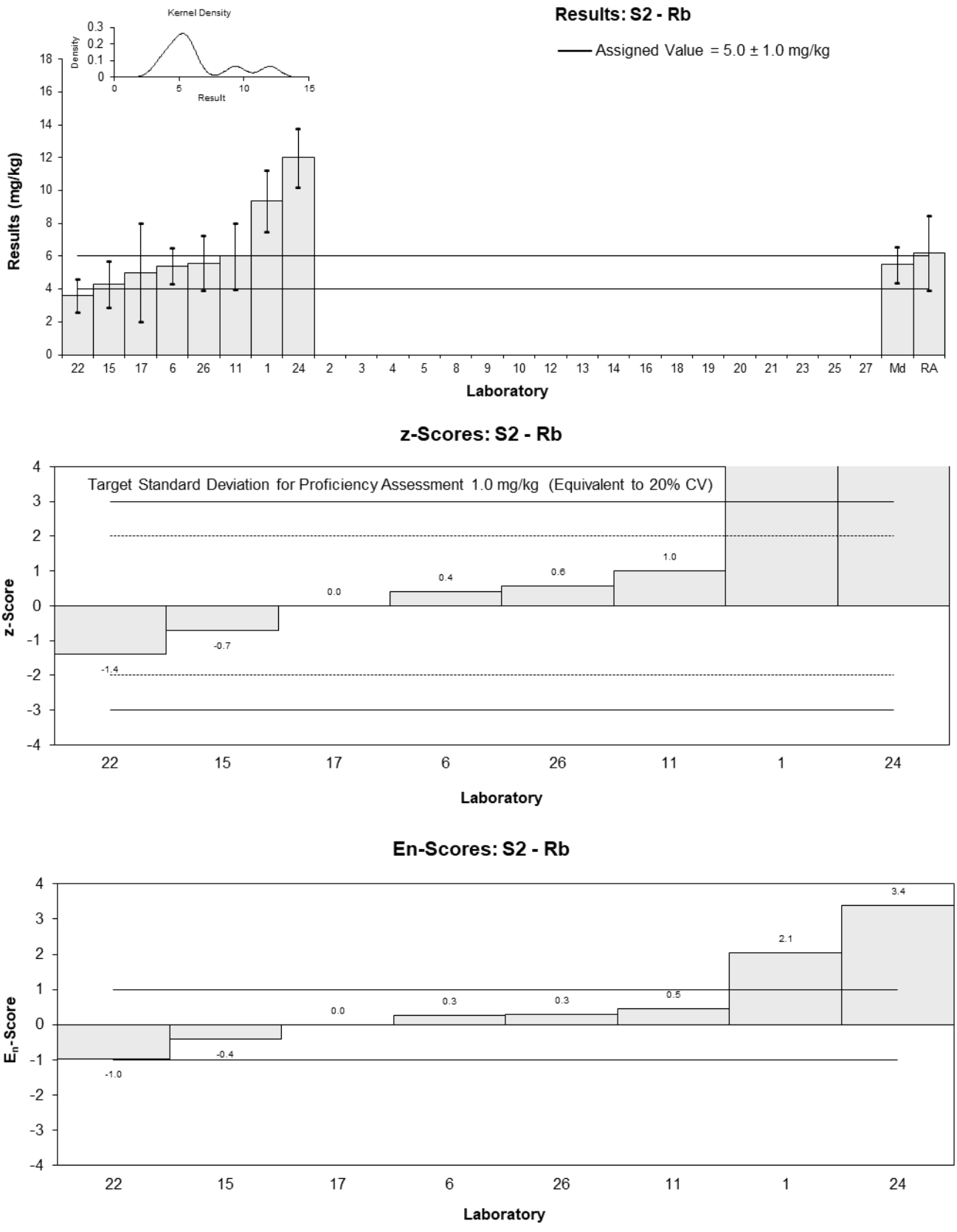

Results: S2 - Rb
Assigned Value = 5.0 ± 1.0 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
22 15 17 6 26 11 1 24 2 3 4 5 8 9 10 12 13 14 16 18 19 20 21 23 25 27 Md RA
z-Scores: S2 - Rb
Target Standard Deviation for Proficiency Assessment 1.0 mg/kg (Equivalent to 20% CV)
z-Score
-1.4
-0.7
0.0
0.4
0.6
1.0
Laboratory
22 15 17 6 26 11 1 24
En-Scores: S2 - Rb
En-Score
-1.0
-0.4
0.0
0.3
0.3
0.5
2.1
3.4
Laboratory
22 15 17 6 26 11 1 24

Figure 39

Table 53

Sample Details

Sample No.	S2
Matrix	Sludge
Analyte	Se
Unit	mg/kg

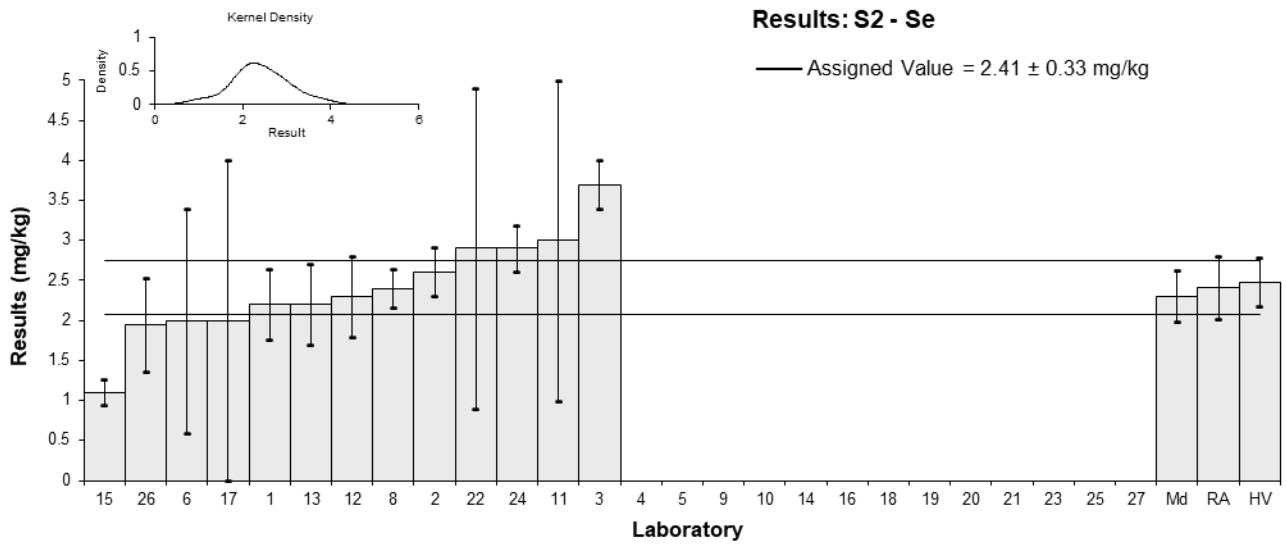
Participant Results

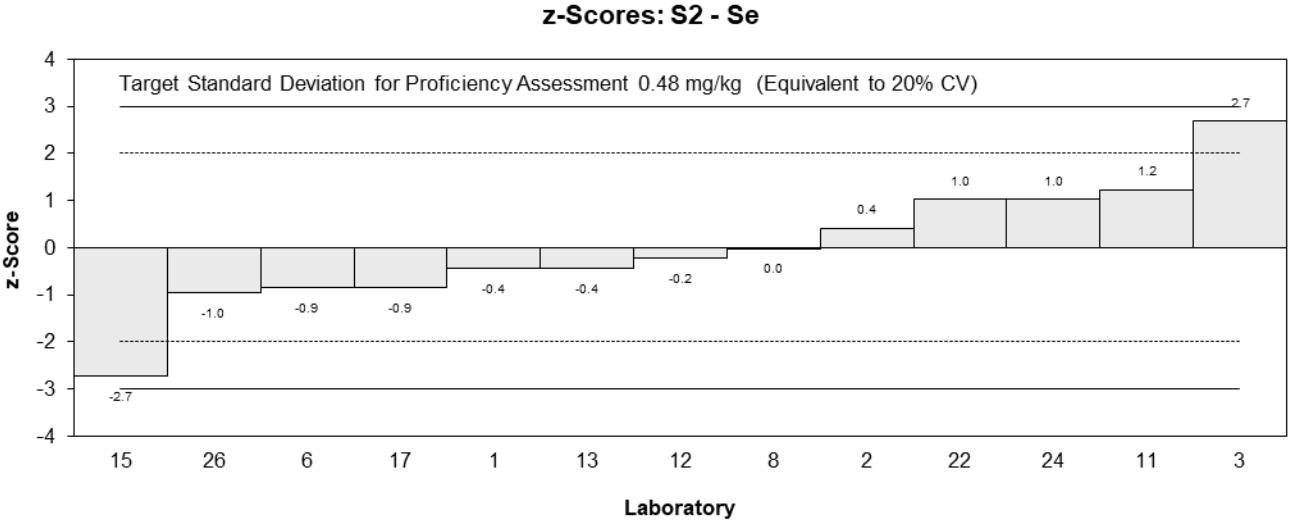
Lab. Code	Result	Uncertainty	z	E_n
1	2.2	0.44	-0.44	-0.38
2	2.61	0.3	0.41	0.45
3*	3.7	0.3	2.68	2.89
4	<100	NR		
5	NT	NT		
6	2.0	1.4	-0.85	-0.29
8	2.4	0.24	-0.02	-0.02
9	NT	NT		
10	< 2	< 2		
11	3	2	1.22	0.29
12	2.3	0.5	-0.23	-0.18
13	2.2	0.5	-0.44	-0.35
14	NR	NR		
15*	1.10	0.160	-2.72	-3.57
16	<2	NT		
17	2	2	-0.85	-0.20
18	NT	NT		
19	< 2	NR		
20	NT	NT		
21	NT	NT		
22	2.9	2	1.02	0.24
23	<5	2.25		
24	2.9	0.29	1.02	1.12
25	< 2	NR		
26	1.95	0.585	-0.95	-0.68
27	<3	NR		

* Outlier, see Section 4.2

Statistics

Assigned Value	2.41	0.33
Spike Value	Not Spiked	
Homogeneity Value	2.48	0.30
Robust Average	2.41	0.39
Median	2.30	0.32
Mean	2.40	
N	13	
Max	3.7	
Min	1.1	
Robust SD	0.56	
Robust CV	23%	


Results: S2 - Se
Assigned Value = 2.41 ± 0.33 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
15 26 6 17 1 13 12 8 2 22 24 11 3 4 5 9 10 14 16 18 19 20 21 23 25 27 Md RA HV


z-Scores: S2 - Se
Target Standard Deviation for Proficiency Assessment 0.48 mg/kg (Equivalent to 20% CV)
z-Score
Laboratory
15 26 6 17 1 13 12 8 2 22 24 11 3
-2.7 -1.0 -0.9 -0.9 -0.4 -0.4 -0.2 0.0 0.4 1.0 1.0 1.2 2.7

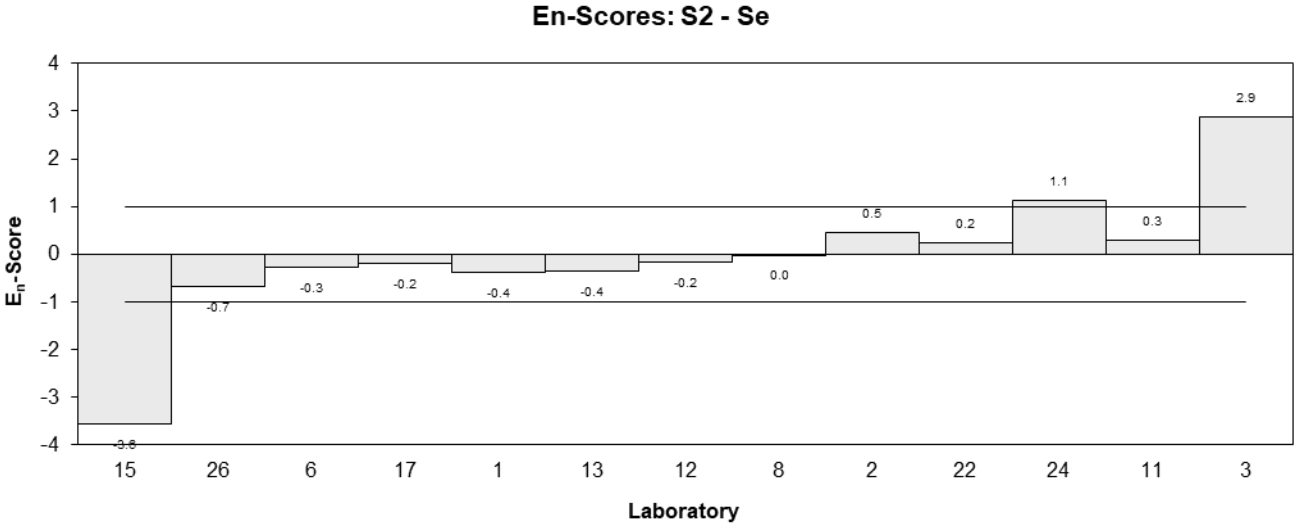

En-Scores: S2 - Se
En-Score
Laboratory
15 26 6 17 1 13 12 8 2 22 24 11 3
-3.6 -0.7 -0.3 -0.2 -0.4 -0.4 -0.2 0.0 0.5 0.2 1.1 0.3 2.9

Figure 40

Table 54

Sample Details

Sample No.	S2
Matrix	Sludge
Analyte	Sn
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	10.8	2.17	-0.09	-0.08
2	13	1.5	0.91	1.11
3	13	1.2	0.91	1.28
4	<50	NR		
5	NT	NT		
6	10.2	1.5	-0.36	-0.44
8	14.5	1.1	1.59	2.35
9	NT	NT		
10**	23.44	7.032	5.65	1.75
11	10	3	-0.45	-0.32
12	NT	NT		
13	11	2.2	0.00	0.00
14	11	2	0.00	0.00
15	9.1	2.60	-0.86	-0.68
16	<10	NT		
17	9	4	-0.91	-0.49
18	NT	NT		
19	< 10	NR		
20	NT	NT		
21	NT	NT		
22	10	3	-0.45	-0.32
23	10	1	-0.45	-0.71
24	14	1.26	1.36	1.86
25	10	1.3	-0.45	-0.61
26	10.5	3.15	-0.23	-0.15
27	10.8	1.4	-0.09	-0.12

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	11.0	1.0
Spike Value	Not Spiked	
Homogeneity Value	12.2	1.5
Robust Average	11.0	1.0
Median	10.7	0.6
Mean	11.1	
N	16	
Max	14.5	
Min	9	
Robust SD	1.7	
Robust CV	15%	

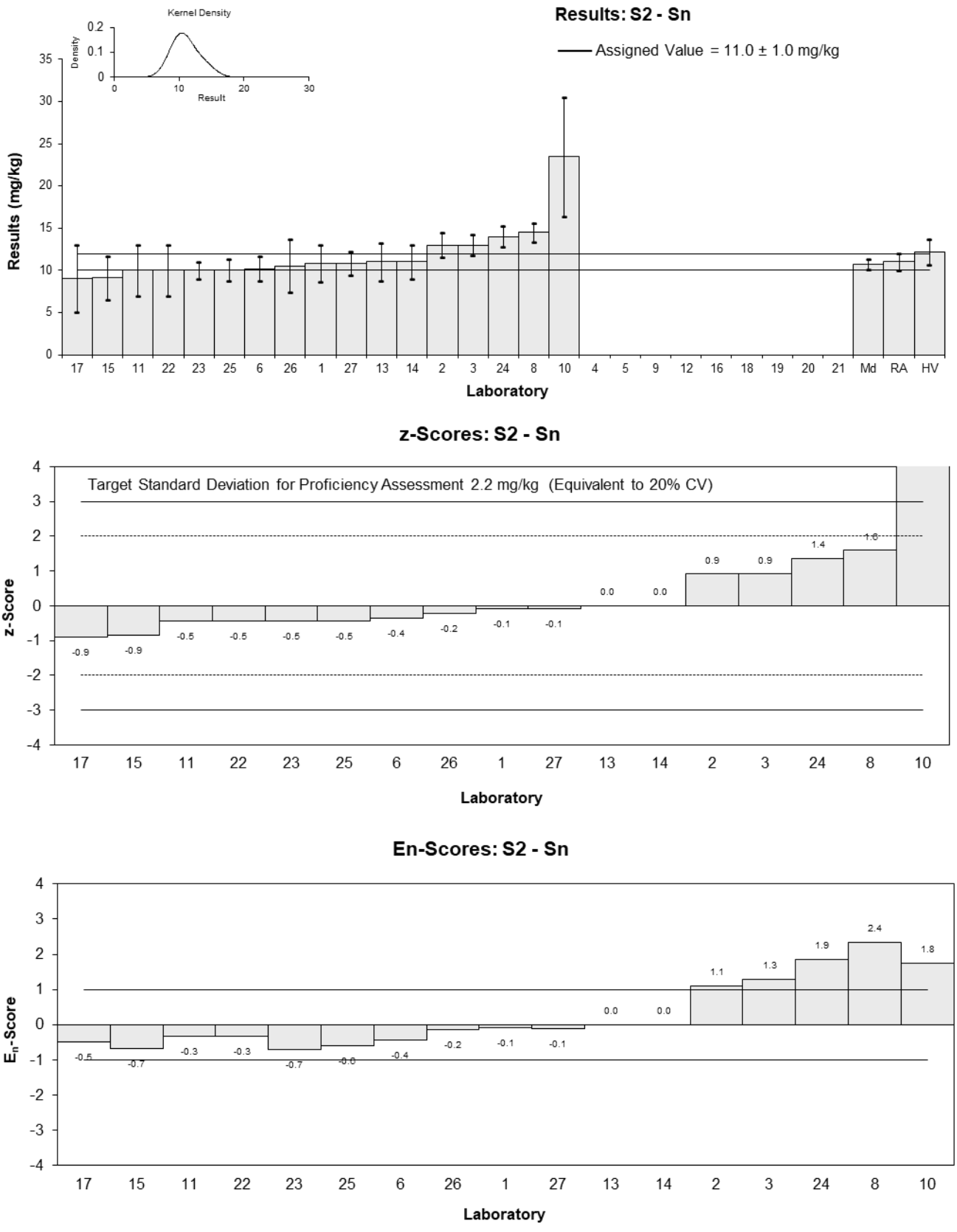

Kernel Density
Density
Result
Results: S2 - Sn
Assigned Value = 11.0 ± 1.0 mg/kg
Results (mg/kg)
Laboratory
17 15 11 22 23 25 6 26 1 27 13 14 2 3 24 8 10 4 5 9 12 16 18 19 20 21 Md RA HV
z-Scores: S2 - Sn
Target Standard Deviation for Proficiency Assessment 2.2 mg/kg (Equivalent to 20% CV)
z-Score
-0.9 -0.9 -0.5 -0.5 -0.5 -0.5 -0.4 -0.2 -0.1 -0.1 0.0 0.0 0.9 0.9 1.4 1.6
Laboratory
17 15 11 22 23 25 6 26 1 27 13 14 2 3 24 8 10
En-Scores: S2 - Sn
En-Score
-0.5 -0.7 -0.3 -0.3 -0.7 -0.6 -0.4 -0.2 -0.1 -0.1 0.0 0.0 1.1 1.3 1.9 2.4 1.8
Laboratory
17 15 11 22 23 25 6 26 1 27 13 14 2 3 24 8 10

Figure 41

Table 55

Sample Details

Sample No.	S2
Matrix	Sludge
Analyte	Tl
Unit	mg/kg

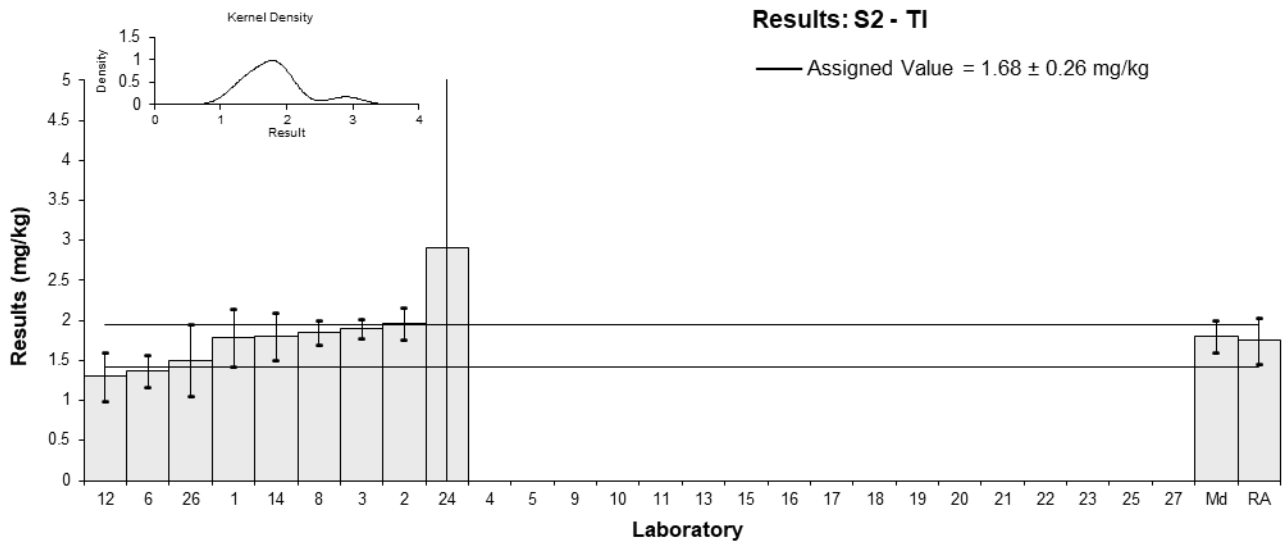
Participant Results

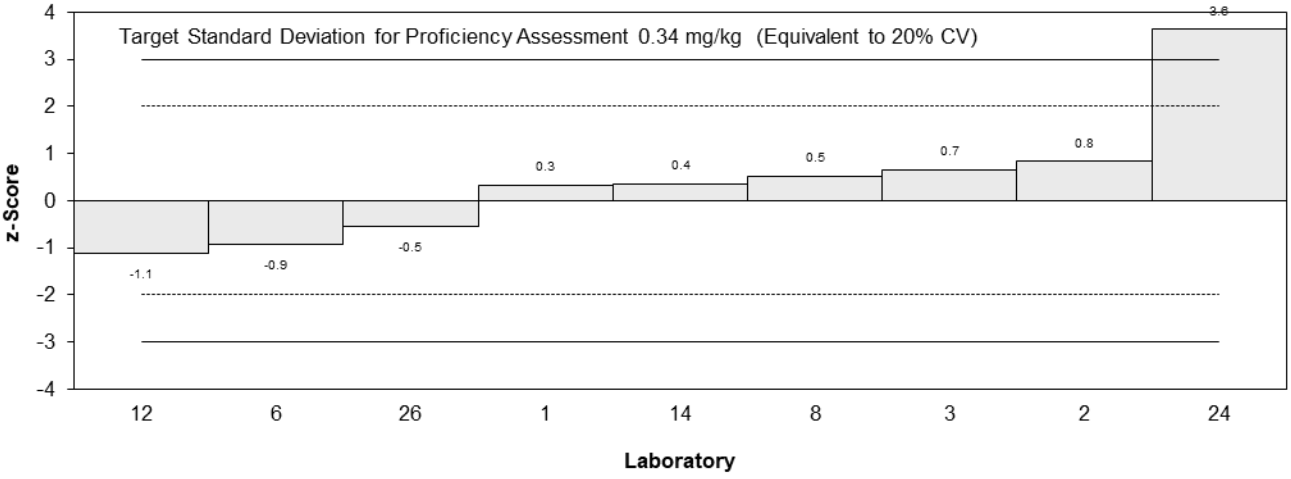
Lab. Code	Result	Uncertainty	z	E_n
1	1.79	0.358	0.33	0.25
2	1.96	0.2	0.83	0.85
3	1.90	0.12	0.65	0.77
4	<2	NR		
5	NT	NT		
6	1.37	0.20	-0.92	-0.95
8	1.85	0.15	0.51	0.57
9	NT	NT		
10	NT	NT		
11	<2	NR		
12	1.3	0.3	-1.13	-0.96
13	< 10	NR		
14	1.8	0.3	0.36	0.30
15	<1.60	NR		
16	<10	NT		
17	<2	2		
18	NT	NT		
19	< 10	NR		
20	NT	NT		
21	NT	NT		
22	<2	NR		
23	NT	NT		
24*	2.9	19.3	3.63	0.06
25	< 10	NR		
26	1.5	0.45	-0.54	-0.35
27	<5	NR		

* Outlier, see Section 4.2

Statistics

Assigned Value	1.68	0.26
Spike Value	Not Spiked	
Robust Average	1.75	0.29
Median	1.80	0.20
Mean	1.82	
N	9	
Max	2.9	
Min	1.3	
Robust SD	0.35	
Robust CV	20%	


Kernel Density
Density
Result
Results: S2 - Tl
Assigned Value = 1.68 ± 0.26 mg/kg
Results (mg/kg)
12 6 26 1 14 8 3 2 24 4 5 9 10 11 13 15 16 17 18 19 20 21 22 23 25 27 Md RA
Laboratory


z-Scores: S2 - Tl
Target Standard Deviation for Proficiency Assessment 0.34 mg/kg (Equivalent to 20% CV)
z-Score
-1.1 -0.9 -0.5 0.3 0.4 0.5 0.7 0.8 3.6
12 6 26 1 14 8 3 2 24
Laboratory

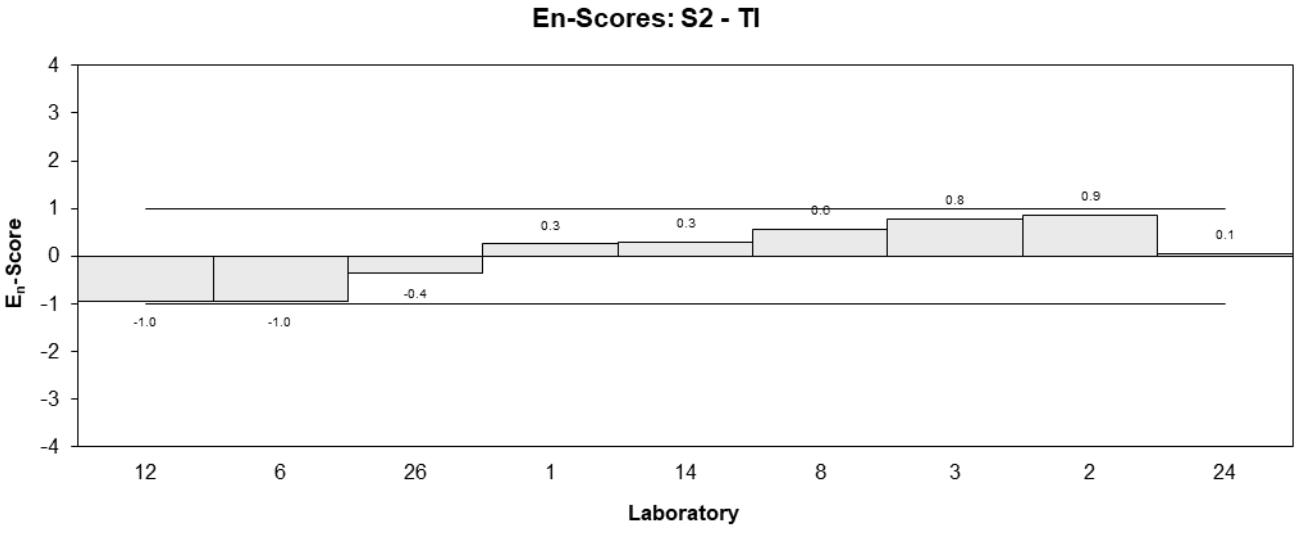

En-Scores: S2 - Tl
En-Score
-1.0 -1.0 -0.4 0.3 0.3 0.6 0.8 0.9 0.1
12 6 26 1 14 8 3 2 24
Laboratory

Figure 42

Table 56

Sample Details

Sample No.	S2
Matrix	Sludge
Analyte	V
Unit	mg/kg

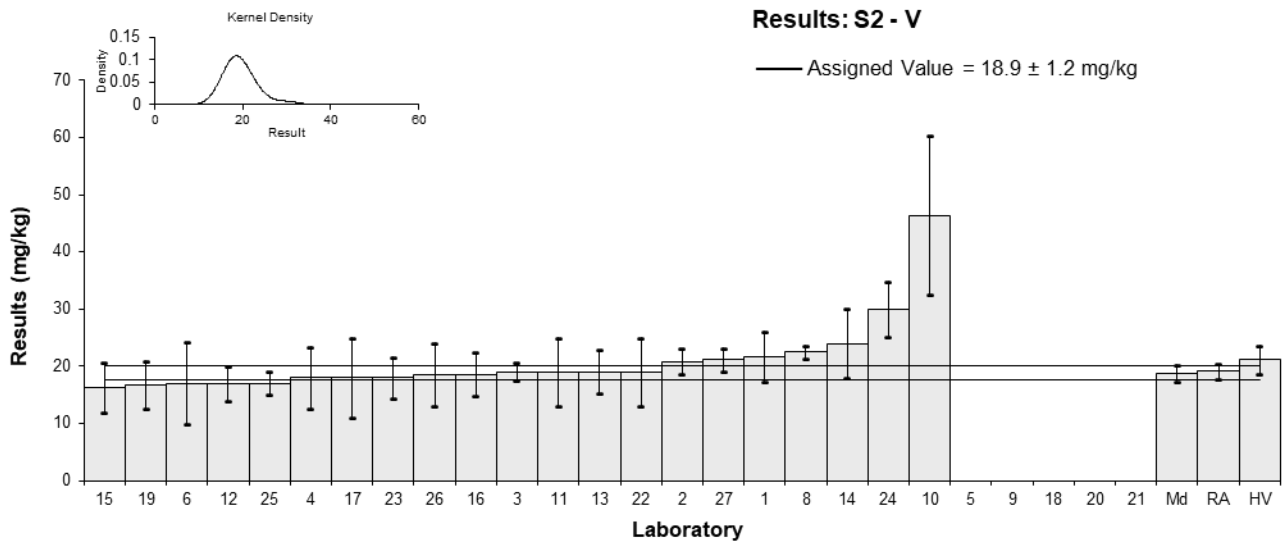
Participant Results

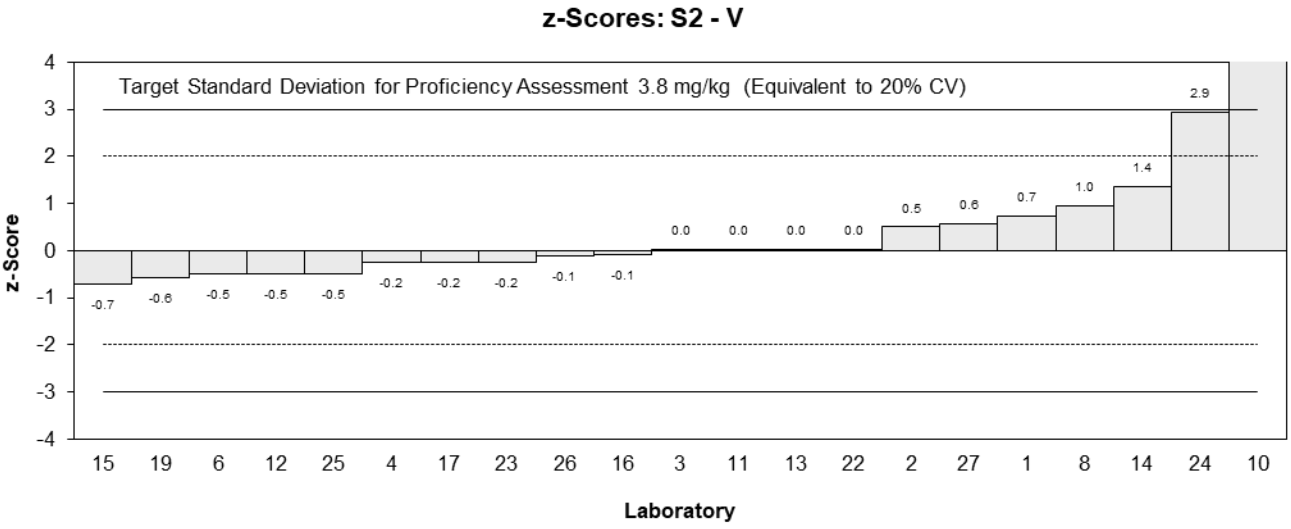
Lab. Code	Result	Uncertainty	z	E_n
1	21.7	4.34	0.74	0.62
2	20.8	2.2	0.50	0.76
3	19	1.6	0.03	0.05
4	18	5.4	-0.24	-0.16
5	NT	NT		
6	17.0	7.2	-0.50	-0.26
8	22.5	1.1	0.95	2.21
9	NT	NT		
10**	46.38	13.914	7.27	1.97
11	19	6	0.03	0.02
12	17	3	-0.50	-0.59
13	19	3.8	0.03	0.03
14	24	6	1.35	0.83
15	16.2	4.4	-0.71	-0.59
16	18.6	3.72	-0.08	-0.08
17	18	7	-0.24	-0.13
18	NT	NT		
19	16.7	4.18	-0.58	-0.51
20	NT	NT		
21	NT	NT		
22	19	6	0.03	0.02
23	18	3.6	-0.24	-0.24
24*	30	4.8	2.94	2.24
25	17	2.0	-0.50	-0.81
26	18.5	5.55	-0.11	-0.07
27	21.1	2.1	0.58	0.91

* Outlier, ** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	18.9	1.2
Spike Value	Not Spiked	
Homogeneity Value	21.1	2.5
Robust Average	19.1	1.3
Median	18.8	1.5
Mean	19.6	
N	20	
Max	30	
Min	16.2	
Robust SD	2.4	
Robust CV	12%	


Kernel Density
Density
Result
Results: S2 - V
Assigned Value = 18.9 ± 1.2 mg/kg
Results (mg/kg)
Laboratory
15 19 6 12 25 4 17 23 26 16 3 11 13 22 2 27 1 8 14 24 10 5 9 18 20 21 Md RA HV


z-Scores: S2 - V
Target Standard Deviation for Proficiency Assessment 3.8 mg/kg (Equivalent to 20% CV)
z-Score
Laboratory
15 19 6 12 25 4 17 23 26 16 3 11 13 22 2 27 1 8 14 24 10

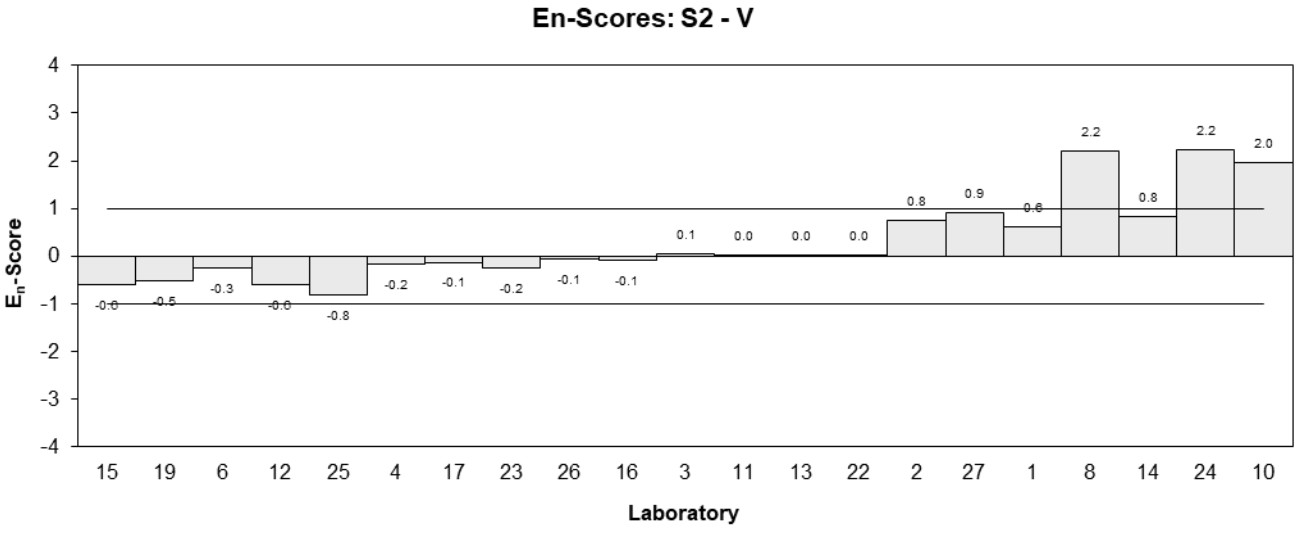

En-Scores: S2 - V
En-Score
Laboratory
15 19 6 12 25 4 17 23 26 16 3 11 13 22 2 27 1 8 14 24 10

Figure 43

Table 57

Sample Details

Sample No.	S2
Matrix	Sludge
Analyte	Zn
Unit	mg/kg

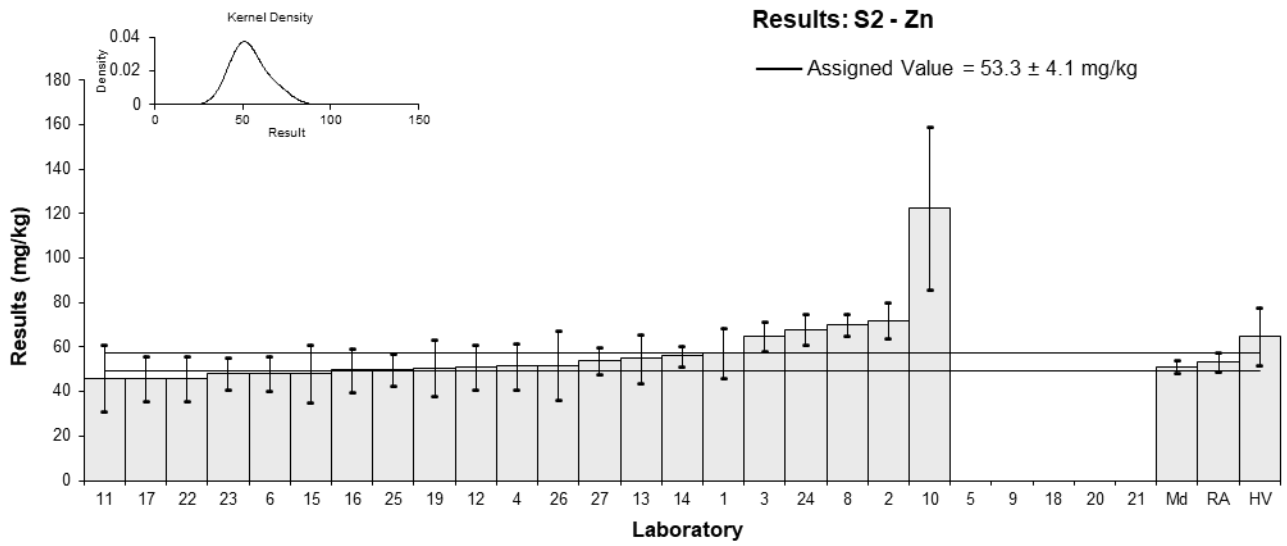
Participant Results

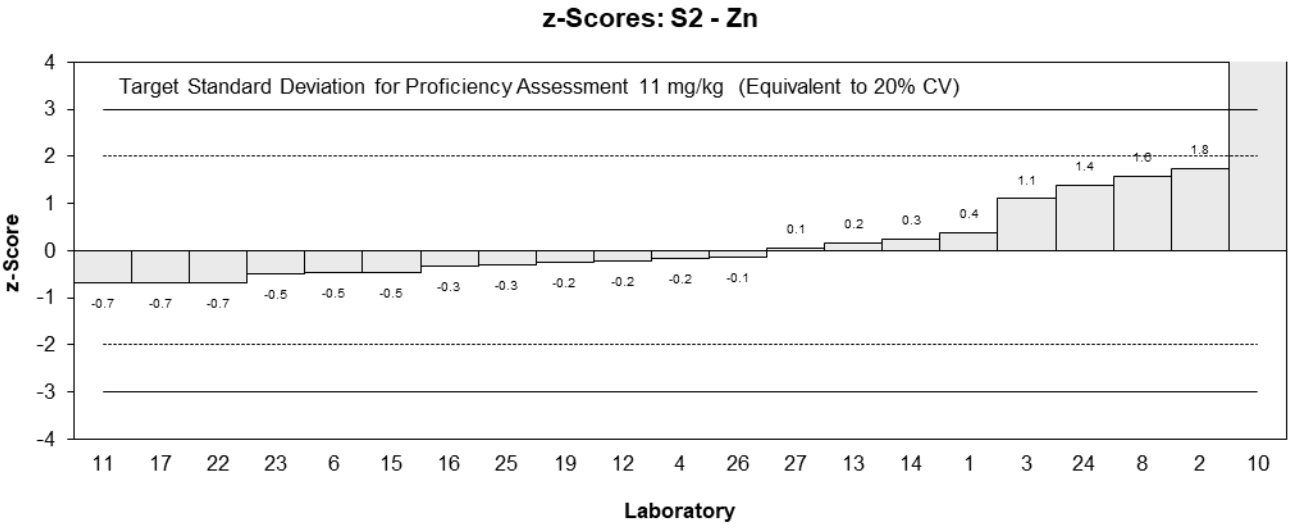
Lab. Code	Result	Uncertainty	z	E_n
1	57.4	11.5	0.38	0.34
2	72	8.0	1.75	2.08
3	65	6.5	1.10	1.52
4	51.5	10.3	-0.17	-0.16
5	NT	NT		
6	48.2	7.8	-0.48	-0.58
8	70.0	5.0	1.57	2.58
9	NT	NT		
10**	122.42	36.726	6.48	1.87
11	46	15	-0.68	-0.47
12	51	10	-0.22	-0.21
13	55	11	0.16	0.14
14	56	4.8	0.25	0.43
15	48.2	13	-0.48	-0.37
16	49.7	9.93	-0.34	-0.34
17	46	10	-0.68	-0.68
18	NT	NT		
19	50.7	12.7	-0.24	-0.19
20	NT	NT		
21	NT	NT		
22	46	10	-0.68	-0.68
23	48	7.2	-0.50	-0.64
24	68	6.8	1.38	1.85
25	50	7.3	-0.31	-0.39
26	51.9	15.57	-0.13	-0.09
27	53.9	5.9	0.06	0.08

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	53.3	4.1
Spike Value	Not Spiked	
Homogeneity Value	65	13
Robust Average	53.3	4.1
Median	51.3	2.9
Mean	54.2	
N	20	
Max	72	
Min	46	
Robust SD	7.3	
Robust CV	14%	


Kernel Density
Density
Result
Results: S2 - Zn
Assigned Value = 53.3 ± 4.1 mg/kg
Results (mg/kg)
Laboratory
11 17 22 23 6 15 16 25 19 12 4 26 27 13 14 1 3 24 8 2 10 5 9 18 20 21 Md RA HV


z-Scores: S2 - Zn
Target Standard Deviation for Proficiency Assessment 11 mg/kg (Equivalent to 20% CV)
z-Score
Laboratory
11 17 22 23 6 15 16 25 19 12 4 26 27 13 14 1 3 24 8 2 10

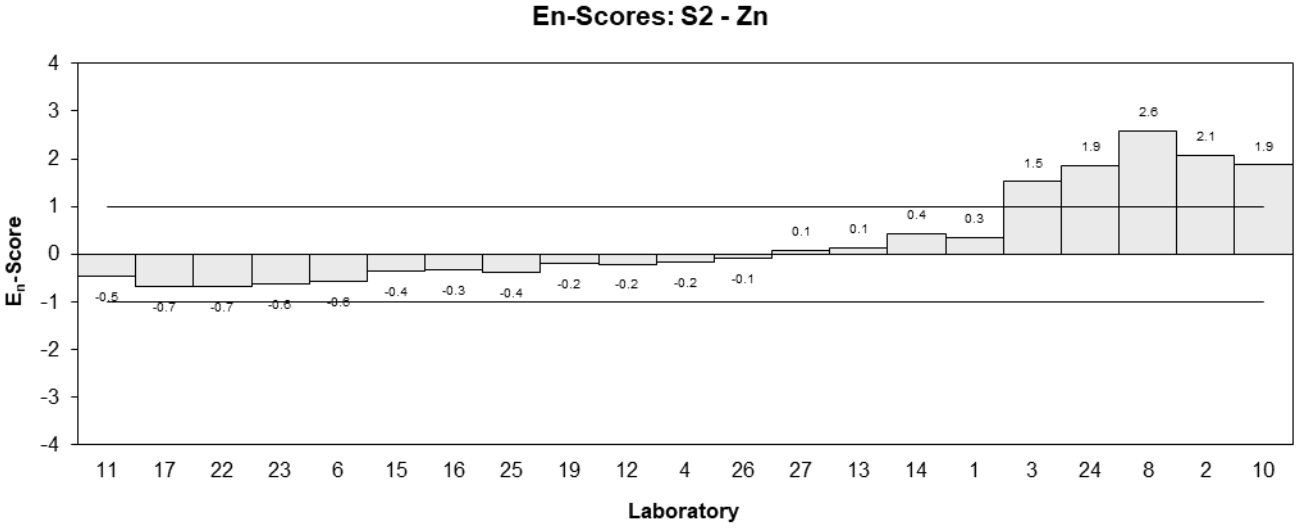

En-Scores: S2 - Zn
En-Score
Laboratory
11 17 22 23 6 15 16 25 19 12 4 26 27 13 14 1 3 24 8 2 10

Figure 44

Table 58

Sample Details

Sample No.	S2
Matrix	Sludge
Analyte	Moisture Content
Unit	%

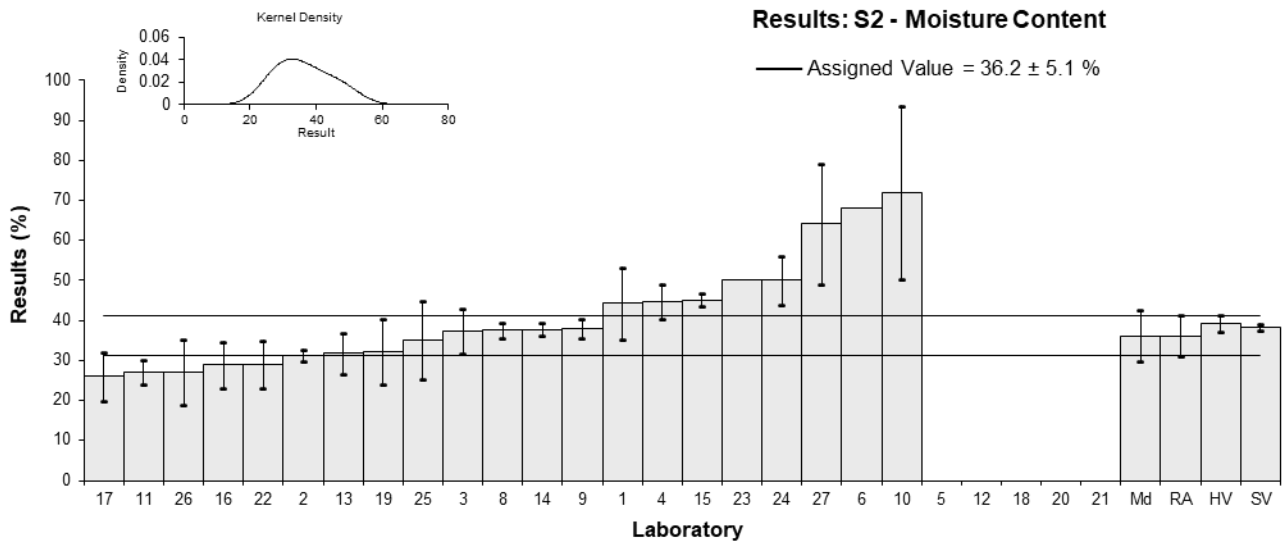
Participant Results

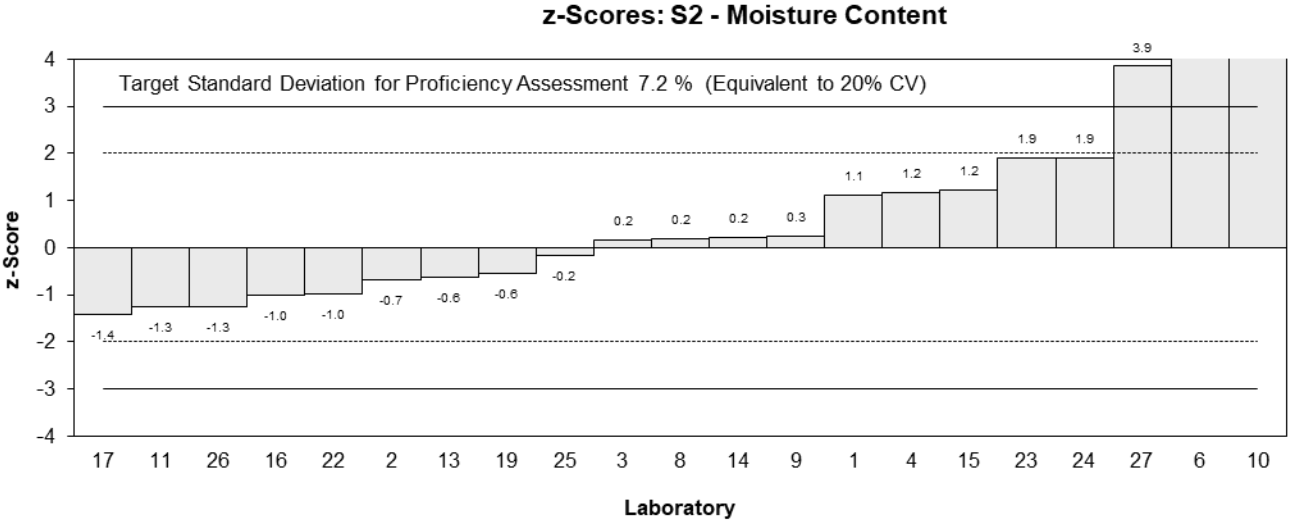
Lab. Code	Result	Uncertainty	z	E_n
1	44.3	8.9	1.12	0.79
2	31.3	1.5	-0.68	-0.92
3	37.3	5.5	0.15	0.15
4	44.7	4.47	1.17	1.25
5	NT	NT		
6**	68	NR	4.39	6.24
8	37.5	2.0	0.18	0.24
9	38.0	2.3	0.25	0.32
10**	72	21.6	4.94	1.61
11	27	3	-1.27	-1.55
12	NR	NR		
13	31.74	5	-0.62	-0.62
14	37.8	1.6	0.22	0.30
15	45.1	1.6	1.23	1.67
16	28.9	5.78	-1.01	-0.95
17	26	6	-1.41	-1.30
18	NT	NT		
19	32.2	8.05	-0.55	-0.42
20	NT	NT		
21	NT	NT		
22	29	6	-0.99	-0.91
23	50	NR	1.91	2.71
24	50	6	1.91	1.75
25	35.0	9.8	-0.17	-0.11
26	27	8.1	-1.27	-0.96
27**	64.1	15	3.85	1.76

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	36.2	5.1
Spike Value	38.3	0.9
Homogeneity Value	39.3	2.0
Robust Average	36.2	5.1
Median	36.2	6.3
Mean	36.3	
N	18	
Max	50	
Min	26	
Robust SD	8.7	
Robust CV	24%	


Kernel Density
Density
Result
Results: S2 - Moisture Content
Assigned Value = 36.2 ± 5.1 %
Results (%)
Laboratory
17 11 26 16 22 2 13 19 25 3 8 14 9 1 4 15 23 24 27 6 10 5 12 18 20 21 Md RA HV SV


z-Scores: S2 - Moisture Content
Target Standard Deviation for Proficiency Assessment 7.2 % (Equivalent to 20% CV)
z-Score
Laboratory
17 11 26 16 22 2 13 19 25 3 8 14 9 1 4 15 23 24 27 6 10

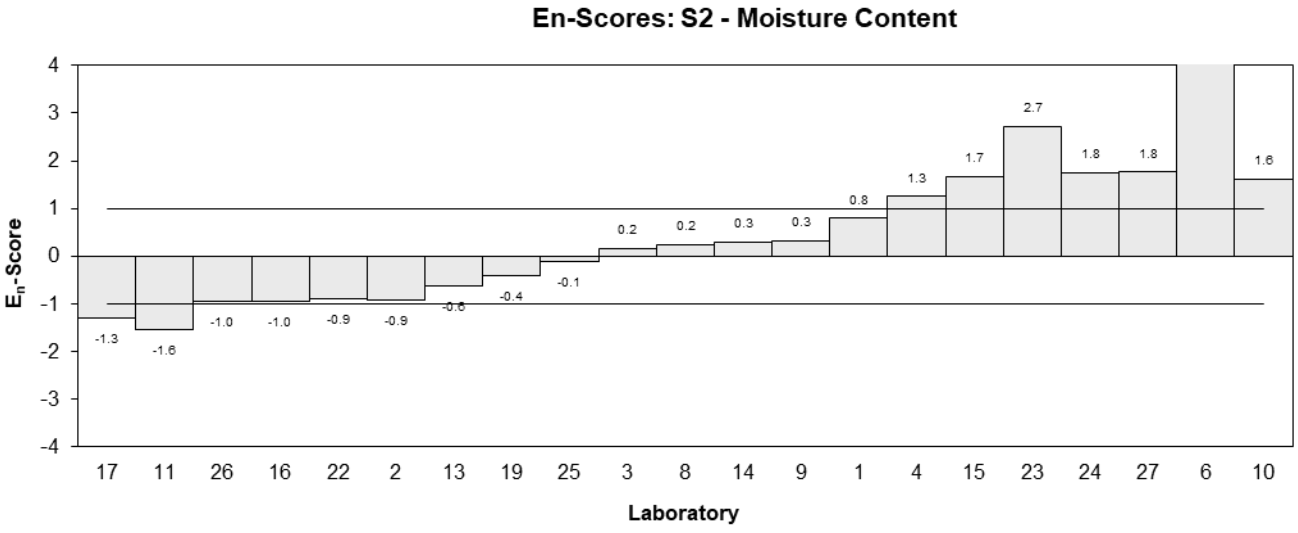

En-Scores: S2 - Moisture Content
En-Score
Laboratory
17 11 26 16 22 2 13 19 25 3 8 14 9 1 4 15 23 24 27 6 10

Figure 45

Table 59

Sample Details

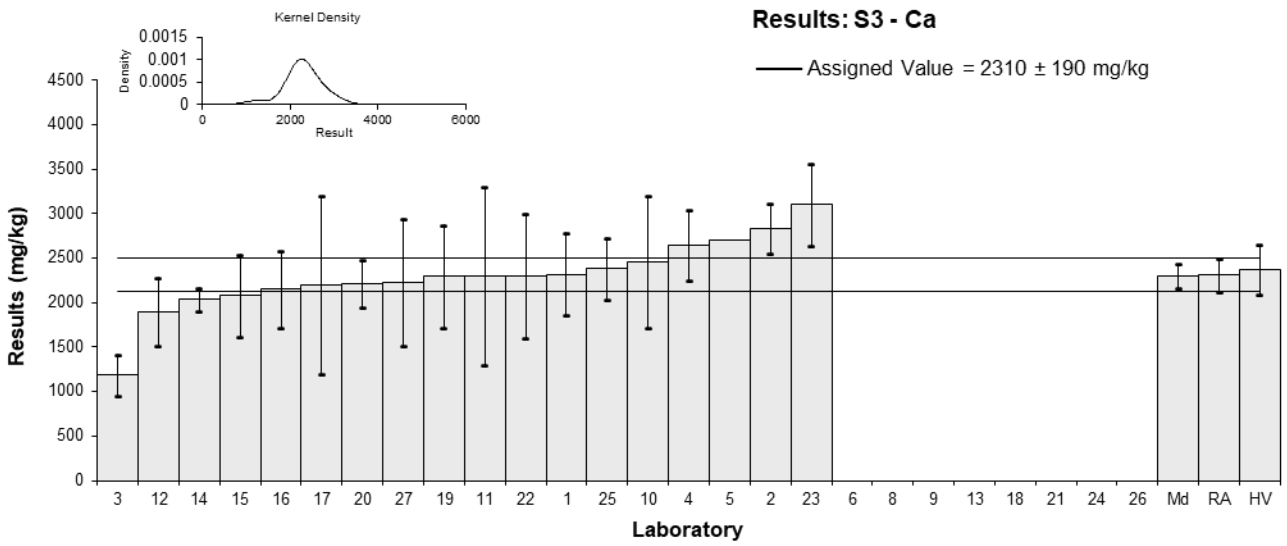
Sample No.	S3
Matrix	Soil
Analyte	Ca
Unit	mg/kg

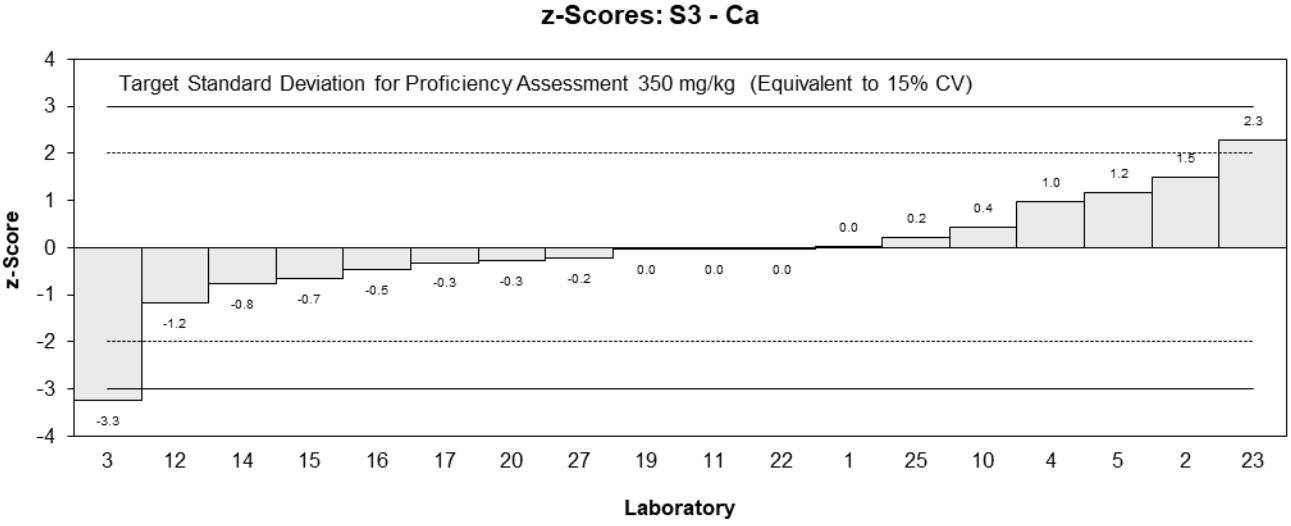
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	2320	464	0.03	0.02
2	2830	280	1.50	1.54
3	1184	230	-3.25	-3.77
4	2645	396.8	0.97	0.76
5	2710.28	NR	1.16	2.11
6	NT	NT		
8	NT	NT		
9	NT	NT		
10	2457.67	737.301	0.43	0.19
11	2300	1000	-0.03	-0.01
12	1900	380	-1.18	-0.97
13	NT	NT		
14	2040	130	-0.78	-1.17
15	2080	460	-0.66	-0.46
16	2150	429	-0.46	-0.34
17	2200	1000	-0.32	-0.11
18	NT	NT		
19	2297	574	-0.04	-0.02
20	2210	270	-0.29	-0.30
21	NR	NR		
22	2300	700	-0.03	-0.01
23	3100	465	2.28	1.57
24	NT	NT		
25	2382	346	0.21	0.18
26	NT	NT		
27	2230	714	-0.23	-0.11

Statistics

Assigned Value	2310	190
Spike Value	Not Spiked	
Homogeneity Value	2370	280
Robust Average	2310	190
Median	2300	130
Mean	2300	
N	18	
Max	3100	
Min	1184	
Robust SD	320	
Robust CV	14%	


Results: S3 - Ca
Assigned Value = 2310 ± 190 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
3 12 14 15 16 17 20 27 19 11 22 1 25 10 4 5 2 23 6 8 9 13 18 21 24 26 Md RA HV


z-Scores: S3 - Ca
Target Standard Deviation for Proficiency Assessment 350 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
3 12 14 15 16 17 20 27 19 11 22 1 25 10 4 5 2 23
-3.3 -1.2 -0.8 -0.7 -0.5 -0.3 -0.3 -0.2 0.0 0.0 0.0 0.0 0.2 0.4 1.0 1.2 1.5 2.3

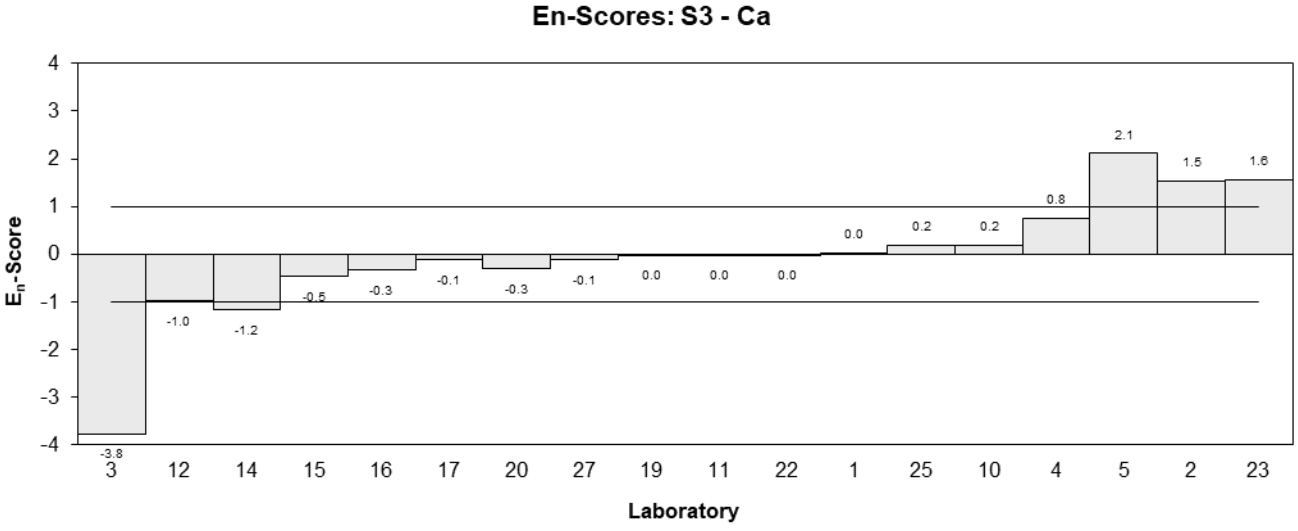

En-Scores: S3 - Ca
En-Score
Laboratory
3 12 14 15 16 17 20 27 19 11 22 1 25 10 4 5 2 23
-3.8 -1.0 -1.2 -0.5 -0.3 -0.1 -0.3 -0.1 0.0 0.0 0.0 0.0 0.2 0.2 0.8 2.1 1.5 1.6

Figure 46

Table 60

Sample Details

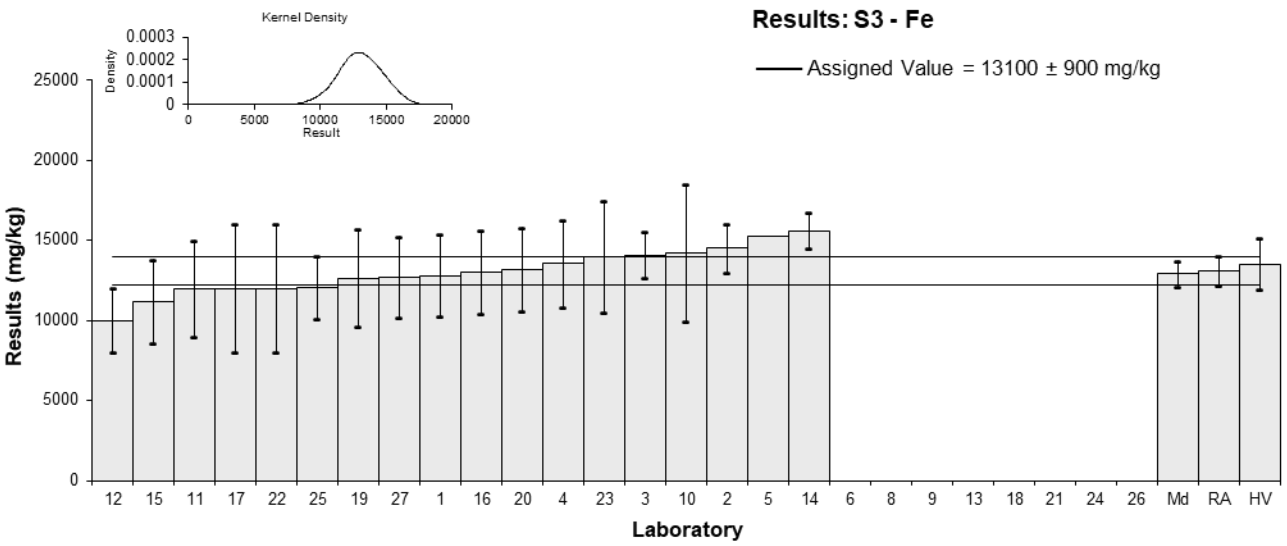
Sample No.	S3
Matrix	Soil
Analyte	Fe
Unit	mg/kg

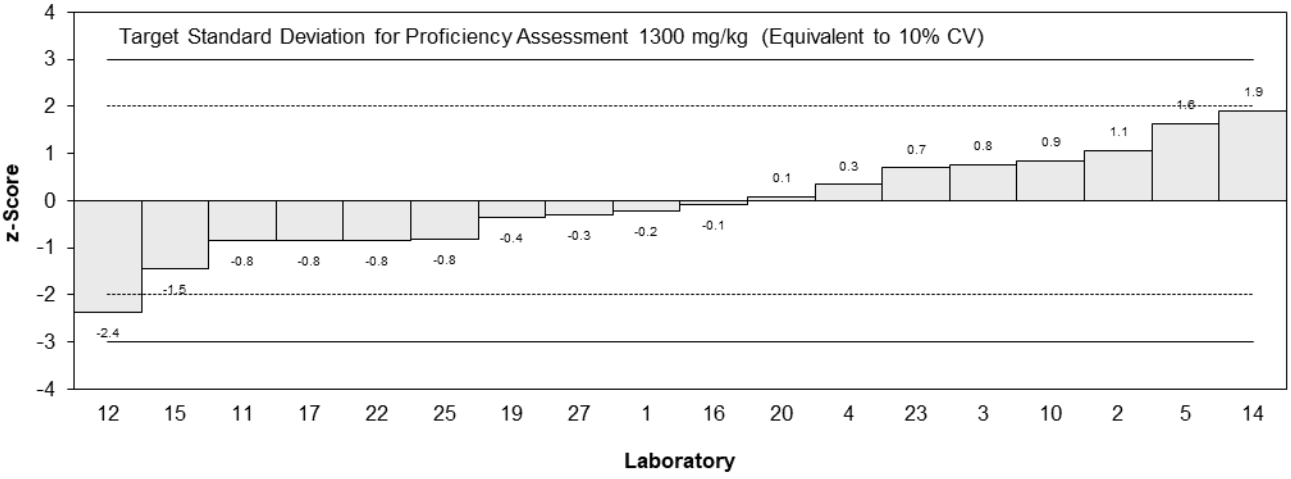
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	12800	2570	-0.23	-0.11
2	14500	1500	1.07	0.80
3	14089	1412	0.75	0.59
4	13550	2710	0.34	0.16
5	15236.17	NR	1.63	2.37
6	NT	NT		
8	NT	NT		
9	NT	NT		
10	14209.63	4262.889	0.85	0.25
11	12000	3000	-0.84	-0.35
12	10000	2000	-2.37	-1.41
13	NT	NT		
14	15600	1130	1.91	1.73
15	11200	2600	-1.45	-0.69
16	13000	2600	-0.08	-0.04
17	12000	4000	-0.84	-0.27
18	NT	NT		
19	12648	3029	-0.35	-0.14
20	13200	2600	0.08	0.04
21	NR	NR		
22	12000	4000	-0.84	-0.27
23	14000	3500	0.69	0.25
24	NT	NT		
25	12031	1960	-0.82	-0.50
26	NT	NT		
27	12700	2540	-0.31	-0.15

Statistics

Assigned Value	13100	900
Spike Value	Not Spiked	
Homogeneity Value	13500	1600
Robust Average	13100	900
Median	12900	800
Mean	13000	
N	18	
Max	15600	
Min	10000	
Robust SD	1500	
Robust CV	11%	


Results: S3 - Fe
Assigned Value = 13100 ± 900 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
12 15 11 17 22 25 19 27 1 16 20 4 23 3 10 2 5 14 6 8 9 13 18 21 24 26 Md RA HV


z-Scores: S3 - Fe
Target Standard Deviation for Proficiency Assessment 1300 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
12 15 11 17 22 25 19 27 1 16 20 4 23 3 10 2 5 14
-2.4 -1.5 -0.8 -0.8 -0.8 -0.8 -0.4 -0.3 -0.2 -0.1 0.1 0.3 0.7 0.8 0.9 1.1 1.6 1.9

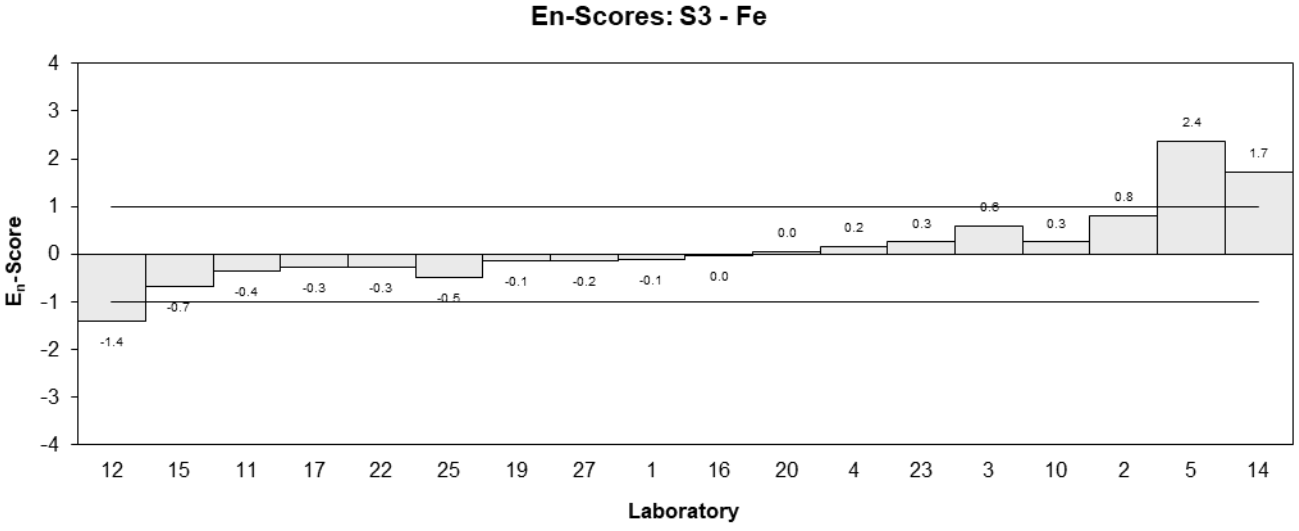

En-Scores: S3 - Fe
En-Score
Laboratory
12 15 11 17 22 25 19 27 1 16 20 4 23 3 10 2 5 14
-1.4 -0.7 -0.4 -0.3 -0.3 -0.5 -0.1 -0.2 -0.1 0.0 0.0 0.2 0.3 0.6 0.3 0.8 2.4 1.7

Figure 47

Table 61

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	K
Unit	mg/kg

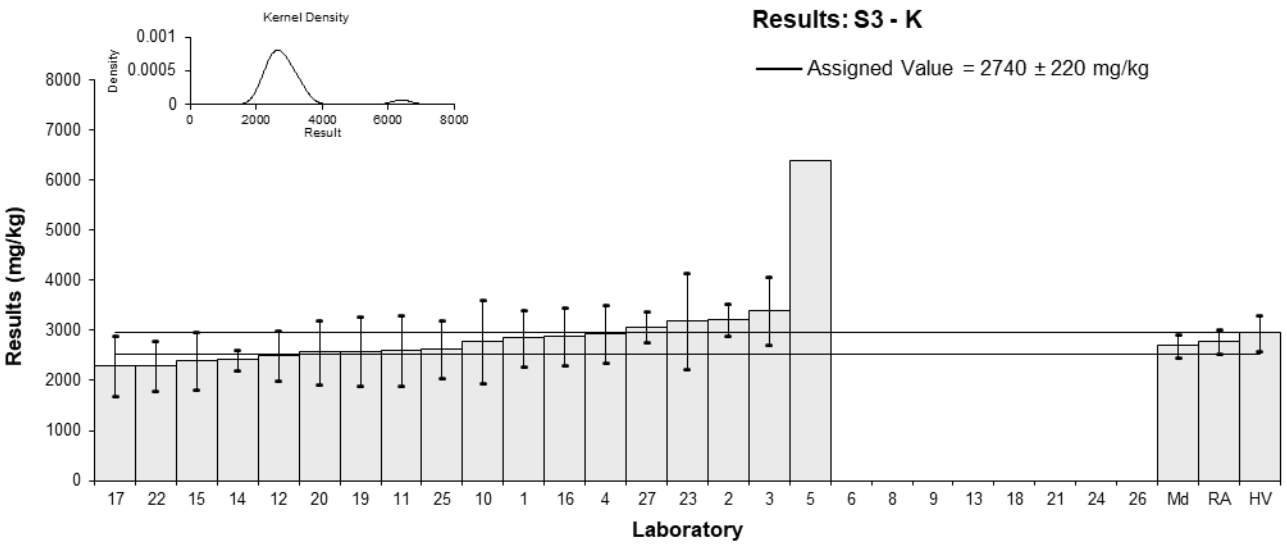
Participant Results

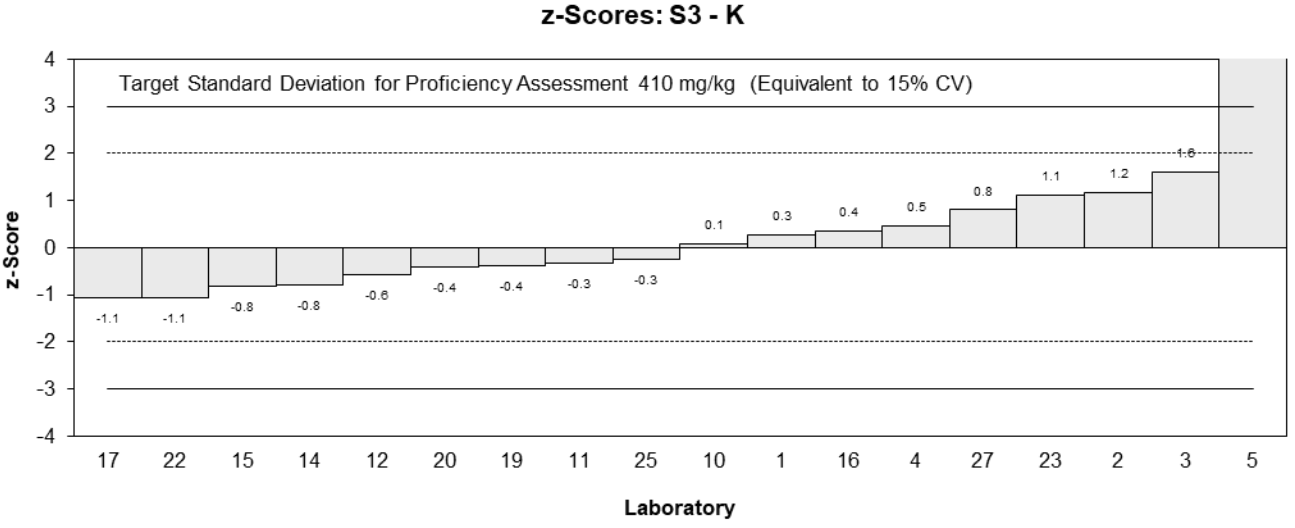
Lab. Code	Result	Uncertainty	z	E_n
1	2850	570	0.27	0.18
2	3220	320	1.17	1.24
3	3401	675.6	1.61	0.93
4	2935	587	0.47	0.31
5*	6389.31	NR	8.88	16.59
6	NT	NT		
8	NT	NT		
9	NT	NT		
10	2773.2	831.96	0.08	0.04
11	2600	700	-0.34	-0.19
12	2500	500	-0.58	-0.44
13	NT	NT		
14	2410	200	-0.80	-1.11
15	2400	570	-0.83	-0.56
16	2890	578	0.36	0.24
17	2300	600	-1.07	-0.69
18	NT	NT		
19	2580	691	-0.39	-0.22
20	2570	640	-0.41	-0.25
21	NR	NR		
22	2300	500	-1.07	-0.81
23	3200	960	1.12	0.47
24	NT	NT		
25	2636	575	-0.25	-0.17
26	NT	NT		
27	3070	307	0.80	0.87

* Outlier, see Section 4.2

Statistics

Assigned Value	2740	220
Spike Value	Not Spiked	
Homogeneity Value	2950	350
Robust Average	2780	240
Median	2700	230
Mean	2950	
N	18	
Max	6389.31	
Min	2300	
Robust SD	410	
Robust CV	15%	


Kernel Density
Density
0.001
0.0005
0
0
2000
4000
6000
8000
Result
Results: S3 - K
Assigned Value = 2740 ± 220 mg/kg
Results (mg/kg)
8000
7000
6000
5000
4000
3000
2000
1000
0
17 22 15 14 12 20 19 11 25 10 1 16 4 27 23 2 3 5 6 8 9 13 18 21 24 26 Md RA HV
Laboratory


z-Scores: S3 - K
Target Standard Deviation for Proficiency Assessment 410 mg/kg (Equivalent to 15% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-1.1 -1.1 -0.8 -0.8 -0.6 -0.4 -0.4 -0.3 -0.3 0.1 0.3 0.4 0.5 0.8 1.1 1.2 1.6
17 22 15 14 12 20 19 11 25 10 1 16 4 27 23 2 3 5
Laboratory

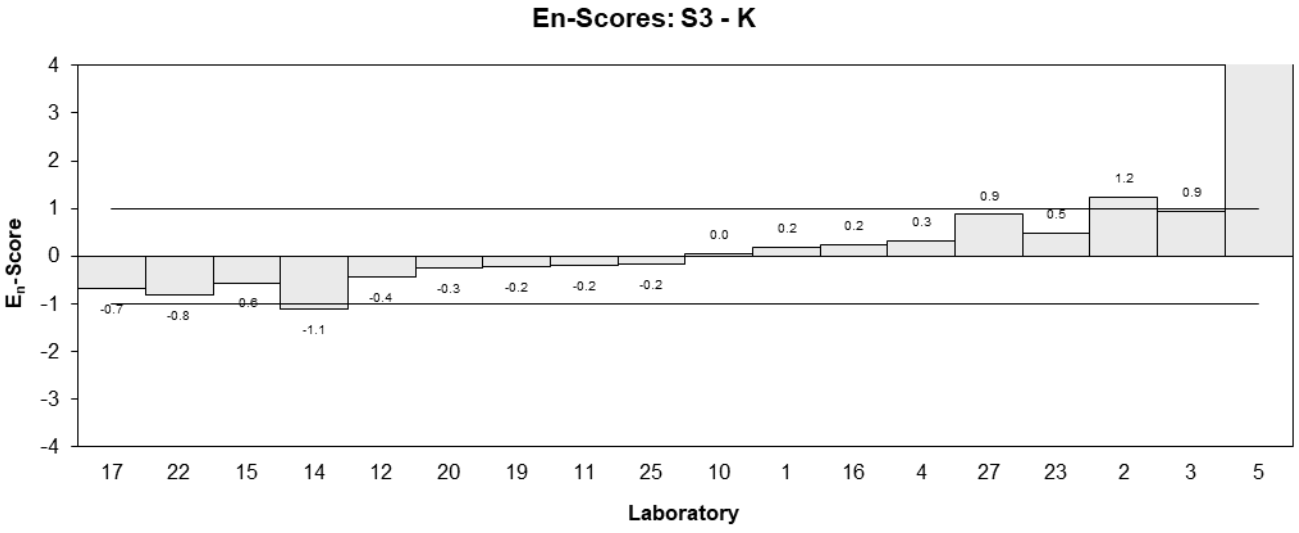

En-Scores: S3 - K
En-Score
4
3
2
1
0
-1
-2
-3
-4
-0.7 -0.8 -0.6 -1.1 -0.4 -0.3 -0.2 -0.2 -0.2 0.0 0.2 0.2 0.3 0.9 0.5 1.2 0.9
17 22 15 14 12 20 19 11 25 10 1 16 4 27 23 2 3 5
Laboratory

Figure 48

Table 62

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	Mg
Unit	mg/kg

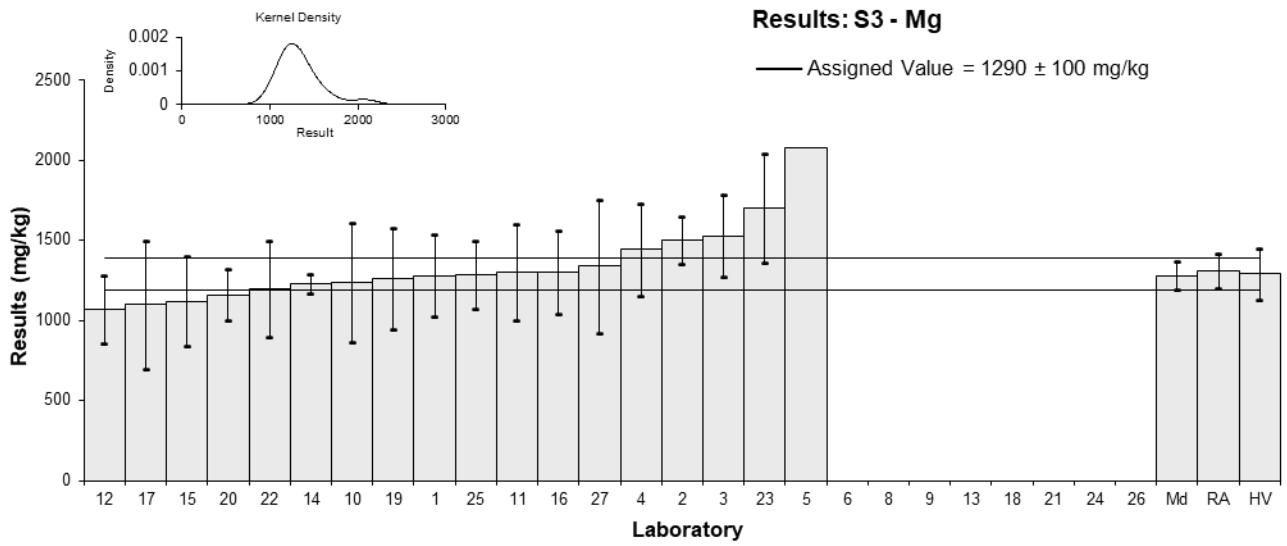
Participant Results

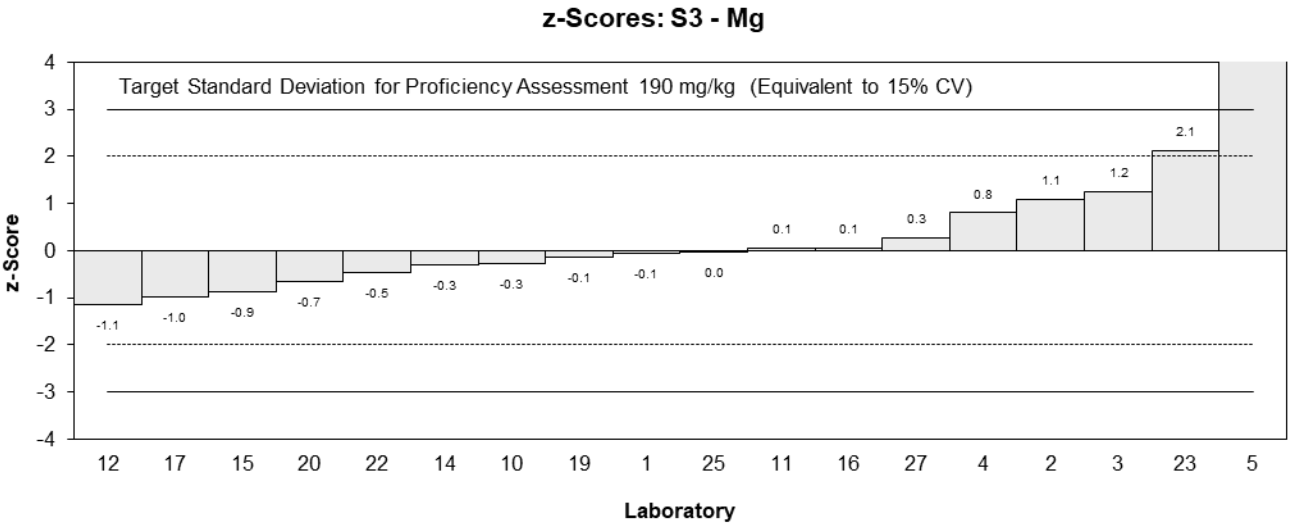
Lab. Code	Result	Uncertainty	z	E_n
1	1280	255	-0.05	-0.04
2	1500	150	1.09	1.16
3	1529	258	1.24	0.86
4	1445	289	0.80	0.51
5*	2079.12	NR	4.08	7.89
6	NT	NT		
8	NT	NT		
9	NT	NT		
10	1237.6	371.28	-0.27	-0.14
11	1300	300	0.05	0.03
12	1070	210	-1.14	-0.95
13	NT	NT		
14	1230	62	-0.31	-0.51
15	1120	280	-0.88	-0.57
16	1300	261	0.05	0.04
17	1100	400	-0.98	-0.46
18	NT	NT		
19	1262	316	-0.14	-0.08
20	1160	160	-0.67	-0.69
21	NR	NR		
22	1200	300	-0.47	-0.28
23	1700	340	2.12	1.16
24	NT	NT		
25	1285	212	-0.03	-0.02
26	NT	NT		
27	1340	415	0.26	0.12

* Outlier, see Section 4.2

Statistics

Assigned Value	1290	100
Spike Value	Not Spiked	
Homogeneity Value	1290	160
Robust Average	1310	110
Median	1280	90
Mean	1340	
N	18	
Max	2079.12	
Min	1070	
Robust SD	180	
Robust CV	14%	


Kernel Density
Density
0.002
0.001
0
0
1000
2000
3000
Result
Results: S3 - Mg
Assigned Value = 1290 ± 100 mg/kg
Results (mg/kg)
2500
2000
1500
1000
500
0
12 17 15 20 22 14 10 19 1 25 11 16 27 4 2 3 23 5 6 8 9 13 18 21 24 26 Md RA HV
Laboratory


z-Scores: S3 - Mg
Target Standard Deviation for Proficiency Assessment 190 mg/kg (Equivalent to 15% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-1.1 -1.0 -0.9 -0.7 -0.5 -0.3 -0.3 -0.1 -0.1 0.0 0.1 0.1 0.3 0.8 1.1 1.2 2.1
12 17 15 20 22 14 10 19 1 25 11 16 27 4 2 3 23 5
Laboratory

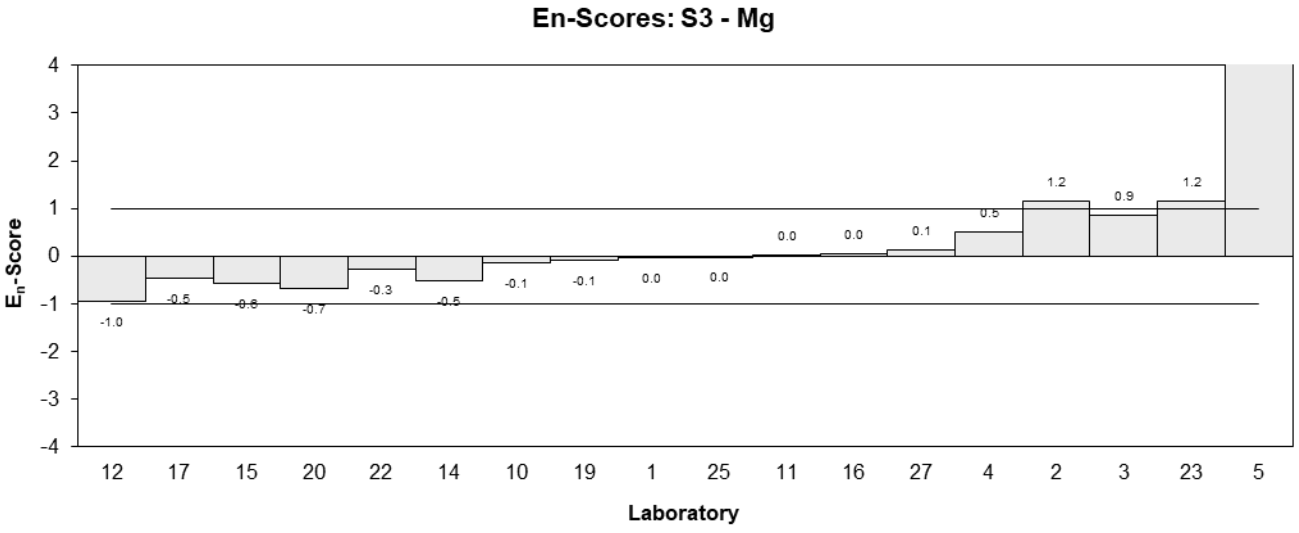

En-Scores: S3 - Mg
En-Score
4
3
2
1
0
-1
-2
-3
-4
-1.0 -0.5 -0.6 -0.7 -0.3 -0.5 -0.1 -0.1 0.0 0.0 0.0 0.0 0.1 0.5 1.2 0.9 1.2
12 17 15 20 22 14 10 19 1 25 11 16 27 4 2 3 23 5
Laboratory

Figure 49

Table 63

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	Na
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	<50	NR		
3	31	6.4	-0.91	-0.64
4	<50	NR		
5*	169.57	NR	24.82	31.09
6	NT	NT		
8	NT	NT		
9	NT	NT		
10	42.3	12.69	1.19	0.48
11	33	20	-0.54	-0.14
12	45	9	1.69	0.91
13	NT	NT		
14**	2160	133	394.45	15.96
15	<29.6	NR		
16	37.3	7.46	0.26	0.16
17	36	10	0.02	0.01
18	NT	NT		
19	30.39	7.6	-1.02	-0.63
20	36.7	7.7	0.15	0.09
21	NR	NR		
22	38	5	0.39	0.32
23**	480	144	82.47	3.08
24	NT	NT		
25	30.7	6.0	-0.97	-0.70
26	NT	NT		
27	<50	NR		

* Outlier, ** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	35.9	4.3
Spike Value	Not Spiked	
Homogeneity Value	38.9	4.7
Robust Average	37.0	4.9
Median	36.7	6.3
Mean	48	
N	11	
Max	169.57	
Min	30.39	
Robust SD	6.4	
Robust CV	17%	

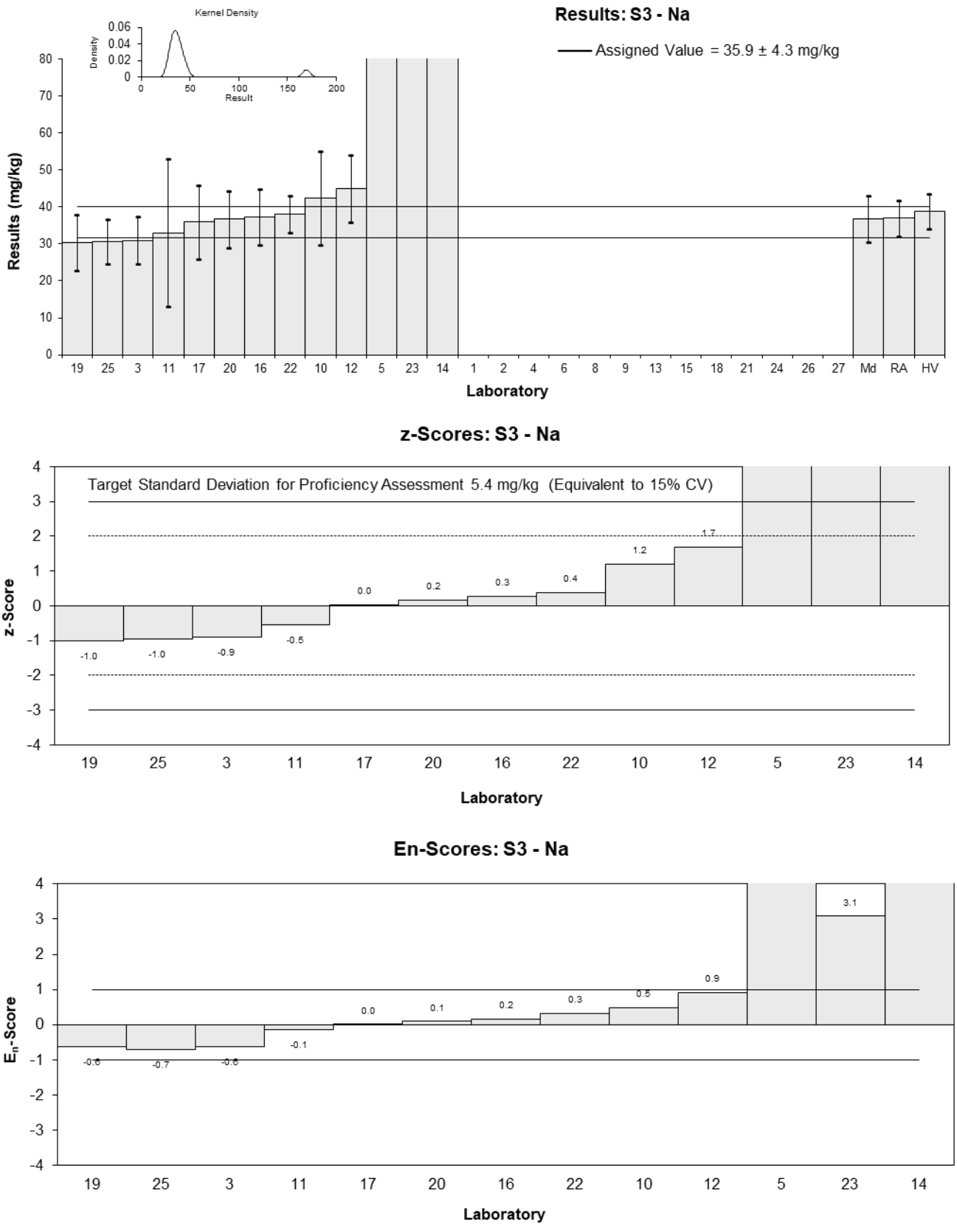

Results: S3 - Na
Assigned Value = 35.9 ± 4.3 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
19 25 3 11 17 20 16 22 10 12 5 23 14 1 2 4 6 8 9 13 15 18 21 24 26 27 Md RA HV
z-Scores: S3 - Na
Target Standard Deviation for Proficiency Assessment 5.4 mg/kg (Equivalent to 15% CV)
z-Score
-1.0 -1.0 -0.9 -0.5 0.0 0.2 0.3 0.4 1.2 1.7
Laboratory
19 25 3 11 17 20 16 22 10 12 5 23 14
En-Scores: S3 - Na
En-Score
-0.6 -0.7 -0.6 -0.1 0.0 0.1 0.2 0.3 0.5 0.9 3.1
Laboratory
19 25 3 11 17 20 16 22 10 12 5 23 14

Figure 50

Table 64

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	P
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	1140	229	-0.06	-0.04
2	1440	145	1.68	1.75
3	1486	14	1.95	4.14
4	1195	239	0.26	0.18
5**	25.95	NR	-6.52	-14.05
6	NT	NT		
8	NT	NT		
9	NT	NT		
10	1270.667	381.20	0.70	0.31
11	1100	300	-0.29	-0.16
12	950	190	-1.16	-0.97
13	NT	NT		
14	1080	60	-0.41	-0.70
15	1030	150	-0.70	-0.71
16	1200	242	0.29	0.20
17	1000	300	-0.87	-0.48
18	NT	NT		
19	1174	294	0.14	0.08
20	1120	100	-0.17	-0.23
21	NR	NR		
22	1100	400	-0.29	-0.12
23	NT	NT		
24	NT	NT		
25	1149	150	-0.01	-0.01
26	NT	NT		
27	1210	157	0.35	0.34

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	1150	80
Spike Value	Not Spiked	
Homogeneity Value	1220	150
Robust Average	1150	80
Median	1140	60
Mean	1170	
N	16	
Max	1486	
Min	950	
Robust SD	120	
Robust CV	10%	

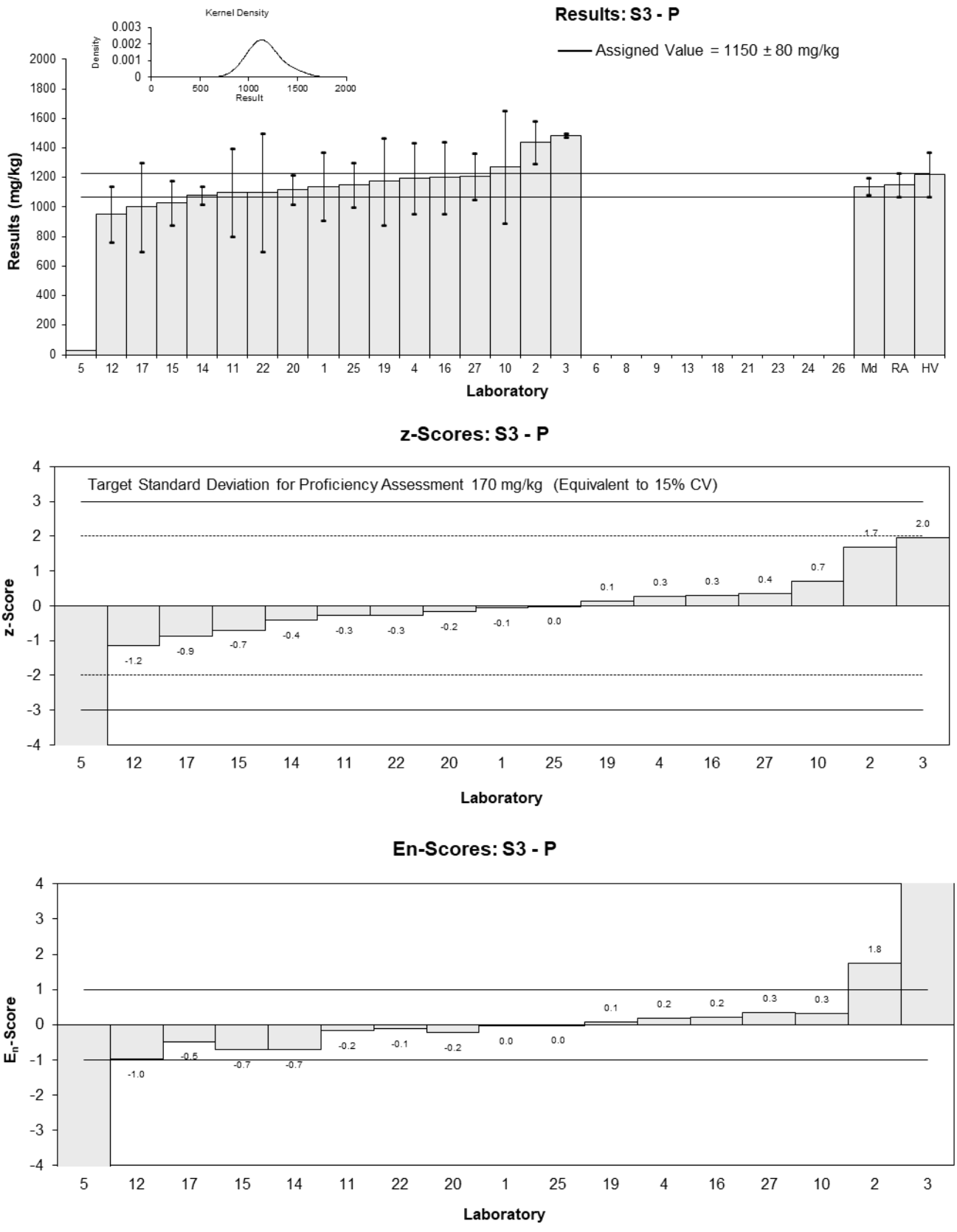

Results: S3 - P
Kernel Density
Density
Result
Assigned Value = 1150 ± 80 mg/kg
Results (mg/kg)
Laboratory
5 12 17 15 14 11 22 20 1 25 19 4 16 27 10 2 3 6 8 9 13 18 21 23 24 26 Md RA HV
z-Scores: S3 - P
Target Standard Deviation for Proficiency Assessment 170 mg/kg (Equivalent to 15% CV)
z-Score
-1.2 -0.9 -0.7 -0.4 -0.3 -0.3 -0.2 -0.1 0.0 0.1 0.3 0.3 0.4 0.7 1.7 2.0
5 12 17 15 14 11 22 20 1 25 19 4 16 27 10 2 3
Laboratory
En-Scores: S3 - P
En-Score
-1.0 -0.5 -0.7 -0.7 -0.2 -0.1 -0.2 0.0 0.0 0.1 0.2 0.2 0.3 0.3 1.8
5 12 17 15 14 11 22 20 1 25 19 4 16 27 10 2 3
Laboratory

Figure 51

Table 65

Sample Details

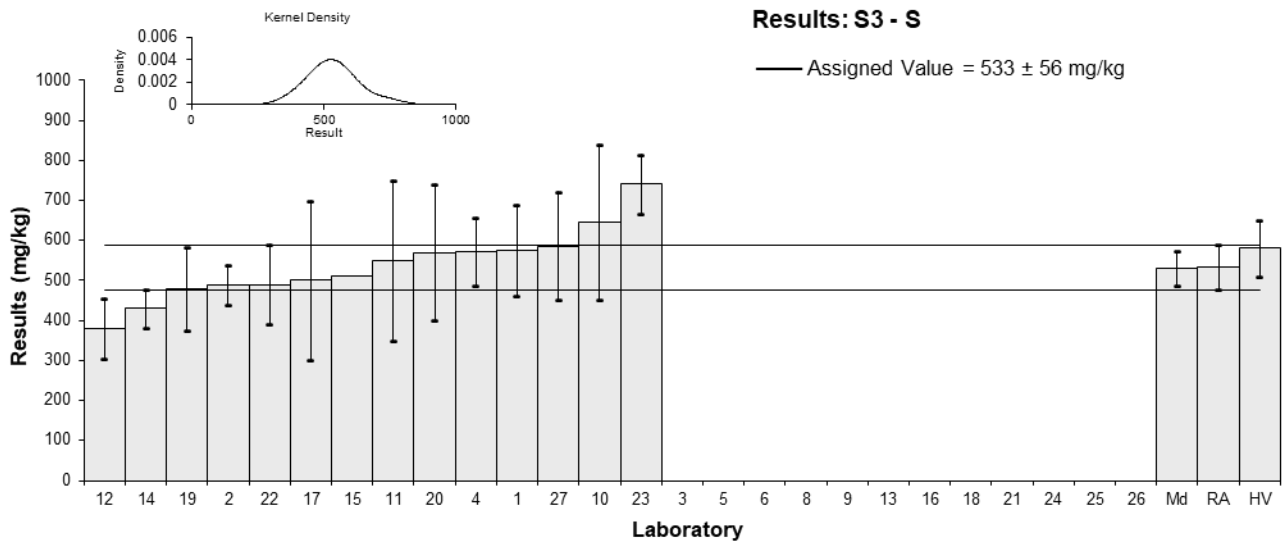
Sample No.	S3
Matrix	Soil
Analyte	S
Unit	mg/kg

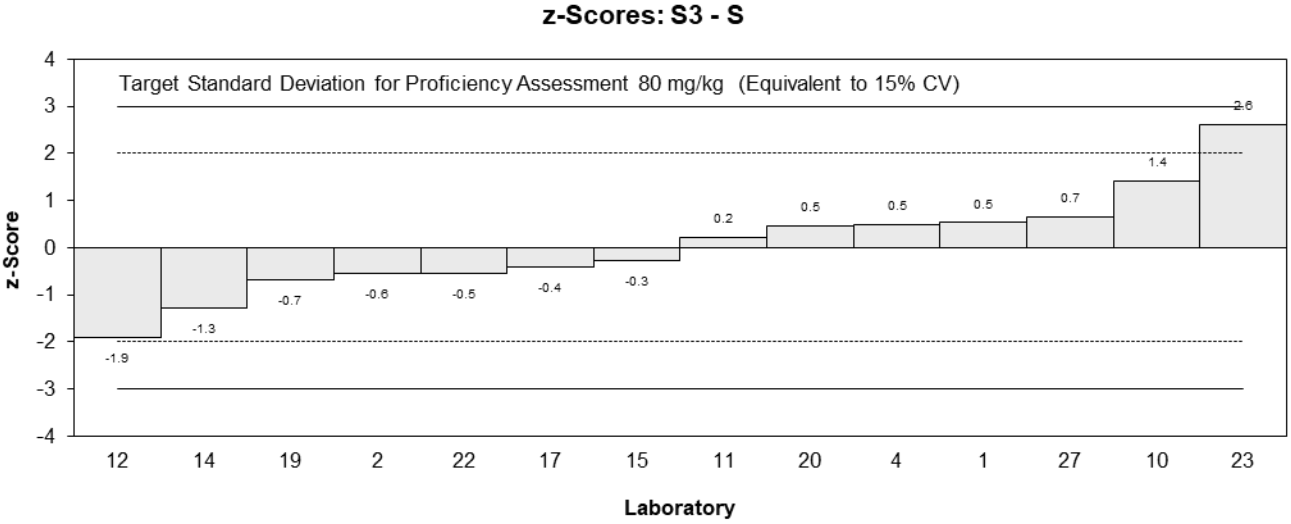
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	575	115	0.53	0.33
2	489	50	-0.55	-0.59
3	NT	NT		
4	571.5	85.73	0.48	0.38
5	NR	NR		
6	NT	NT		
8	NT	NT		
9	NT	NT		
10	646.6	193.98	1.42	0.56
11	550	200	0.21	0.08
12	380	76	-1.91	-1.62
13	NT	NT		
14	430	48	-1.29	-1.40
15	510	NR	-0.29	-0.41
16	NT	NT		
17	500	200	-0.41	-0.16
18	NT	NT		
19	478	104	-0.69	-0.47
20	570	171	0.46	0.21
21	NR	NR		
22	490	100	-0.54	-0.38
23	741	74.1	2.60	2.24
24	NT	NT		
25	NT	NT		
26	NT	NT		
27	586	135	0.66	0.36

Statistics

Assigned Value	533	56
Spike Value	Not Spiked	
Homogeneity Value	580	70
Robust Average	533	56
Median	530	43
Mean	537	
N	14	
Max	741	
Min	380	
Robust SD	84	
Robust CV	16%	


Results: S3 - S
Assigned Value = 533 ± 56 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
12 14 19 2 22 17 15 11 20 4 1 27 10 23 3 5 6 8 9 13 16 18 21 24 25 26 Md RA HV


z-Scores: S3 - S
Target Standard Deviation for Proficiency Assessment 80 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
12 14 19 2 22 17 15 11 20 4 1 27 10 23
-1.9 -1.3 -0.7 -0.6 -0.5 -0.4 -0.3 0.2 0.5 0.5 0.5 0.7 1.4 2.6

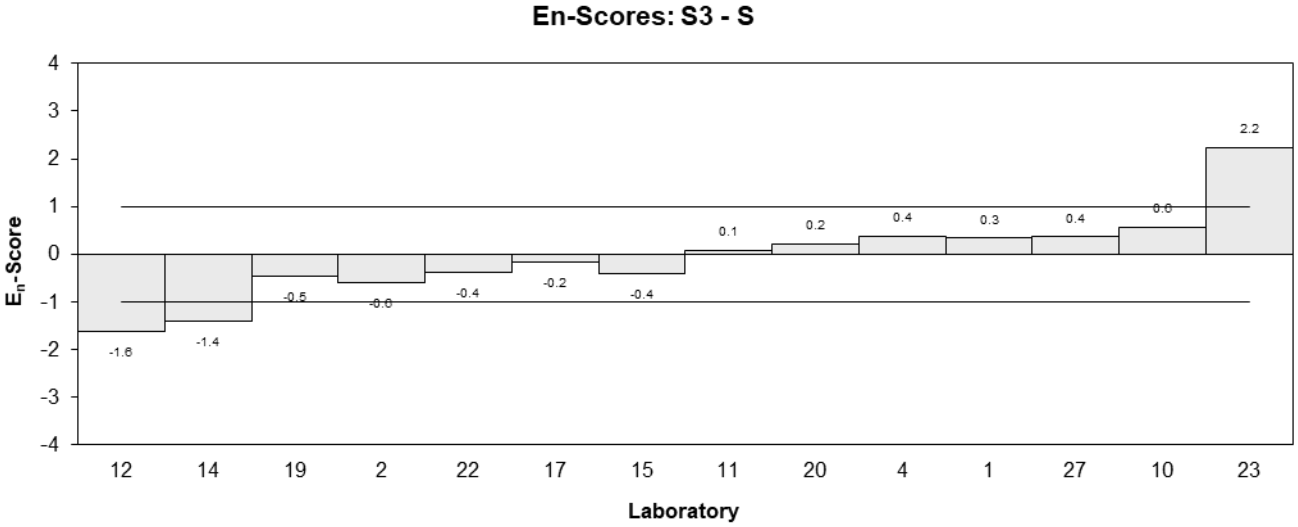

En-Scores: S3 - S
En-Score
Laboratory
12 14 19 2 22 17 15 11 20 4 1 27 10 23
-1.6 -1.4 -0.5 -0.6 -0.4 -0.2 -0.4 0.1 0.2 0.4 0.3 0.4 0.6 2.2

Figure 52

Table 66

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	Sr
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	21.9	4.39	1.58	0.89
2	20.2	2.5	0.94	0.81
3	23	3.5	2.00	1.35
4	19	3.8	0.49	0.31
5	25.68	NR	3.01	4.43
6	NT	NT		
8	NT	NT		
9	NT	NT		
10	18.65	5.595	0.36	0.16
11	16	6	-0.64	-0.27
12	16	3	-0.64	-0.49
13	NT	NT		
14	15	1	-1.02	-1.31
15	14	2.5	-1.39	-1.20
16	17.3	3.5	-0.15	-0.10
17	16	5	-0.64	-0.32
18	NT	NT		
19	17.43	3.91	-0.10	-0.06
20	17.3	2.1	-0.15	-0.14
21	NR	NR		
22	14	4	-1.39	-0.84
23*	39	7.8	8.02	2.66
24	NT	NT		
25	16.2	2.3	-0.56	-0.51
26	NT	NT		
27	17.1	2.6	-0.23	-0.19

* Outlier, see Section 4.2

Statistics

Assigned Value	17.7	1.8
Spike Value	Not Spiked	
Homogeneity Value	16.0	1.9
Robust Average	18.1	2.1
Median	17.3	1.3
Mean	19.1	
N	18	
Max	39	
Min	14	
Robust SD	3.5	
Robust CV	19%	

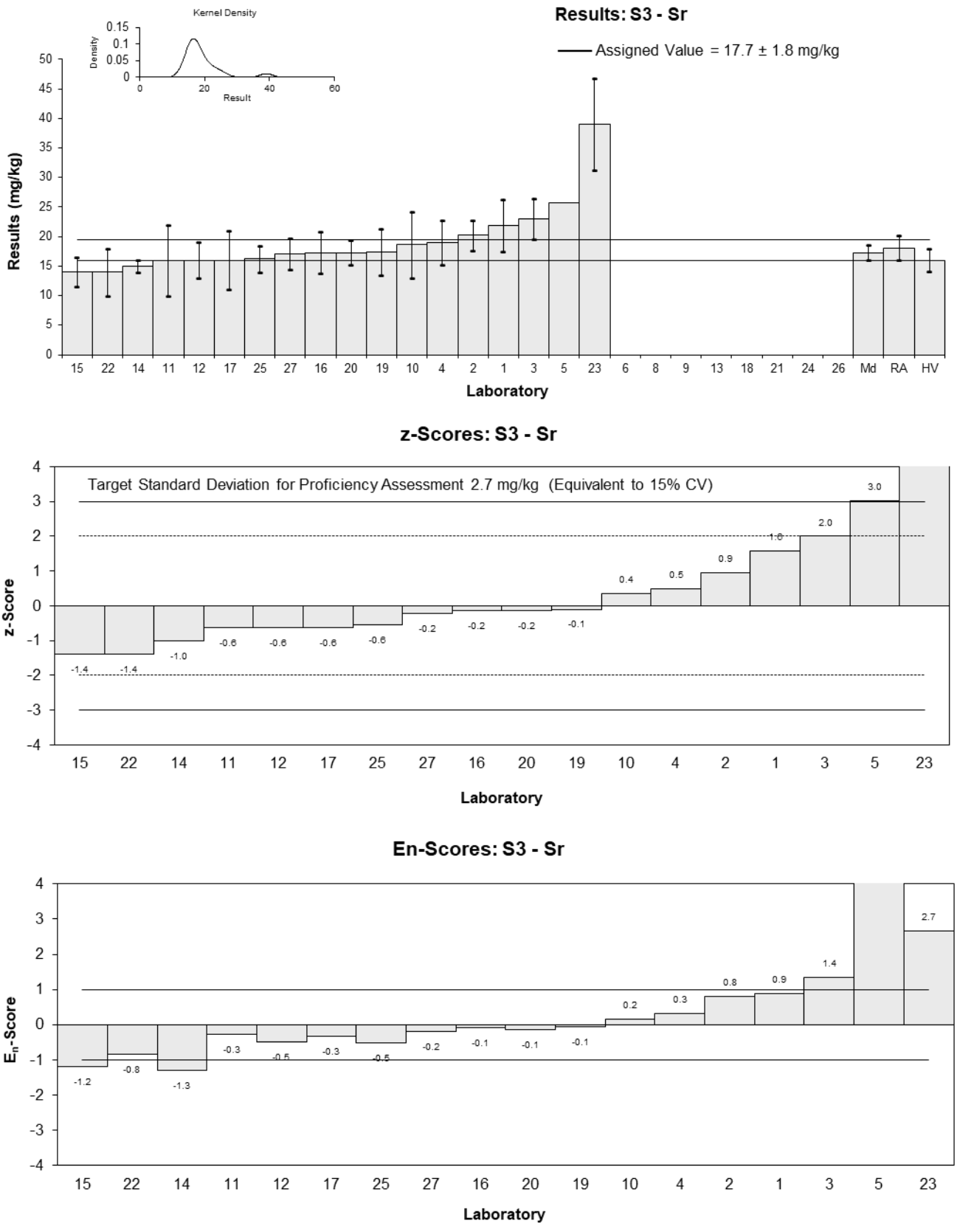

Results: S3 - Sr
Kernel Density
Density
Result
Assigned Value = 17.7 ± 1.8 mg/kg
Results (mg/kg)
Laboratory
15 22 14 11 12 17 25 27 16 20 19 10 4 2 1 3 5 23 6 8 9 13 18 21 24 26 Md RA HV
z-Scores: S3 - Sr
Target Standard Deviation for Proficiency Assessment 2.7 mg/kg (Equivalent to 15% CV)
z-Score
-1.4 -1.4 -1.0 -0.6 -0.6 -0.6 -0.6 -0.2 -0.2 -0.2 -0.1 0.4 0.5 0.9 1.6 2.0 3.0
Laboratory
15 22 14 11 12 17 25 27 16 20 19 10 4 2 1 3 5 23
En-Scores: S3 - Sr
En-Score
-1.2 -0.8 -1.3 -0.3 -0.5 -0.3 -0.5 -0.2 -0.1 -0.1 -0.1 0.2 0.3 0.8 0.9 1.4 2.7
Laboratory
15 22 14 11 12 17 25 27 16 20 19 10 4 2 1 3 5 23

Figure 53

Table 67

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	Colwell K
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	1140	110
3	NT	NT
4	NR	NR
5	NR	NR
6	NT	NT
8	NT	NT
9	NT	NT
10	NT	NT
11	1300	500
12	NT	NT
13	NT	NT
14	NR	NR
15	NT	NT
16	NT	NT
17	NR	NR
18	NT	NT
19	NT	NT
20	NT	NT
21	NR	NR
22	NT	NT
23	NT	NT
24	NT	NT
25	NT	NT
26	NT	NT
27	NR	NR

Statistics

Assigned Value	Not Set	
Spike Value	Not Spiked	
Robust Average	NA (N<6)	
Median	NA (N<3)	
Mean	1220	
N	2	
Max	1300	
Min	1140	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

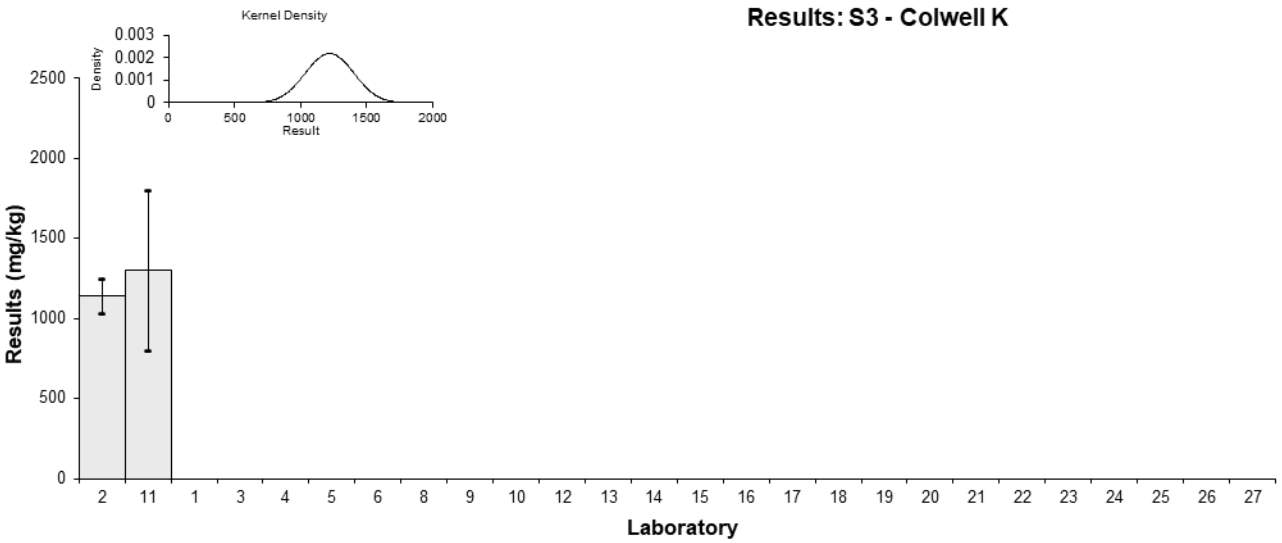

Results: S3 - Colwell K
Kernel Density
Density
0.003
0.002
0.001
0
0
500
1000
1500
2000
Result
Results (mg/kg)
2500
2000
1500
1000
500
0
2
11
1
3
4
5
6
8
9
10
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
Laboratory

Figure 54

Table 68

Sample Details

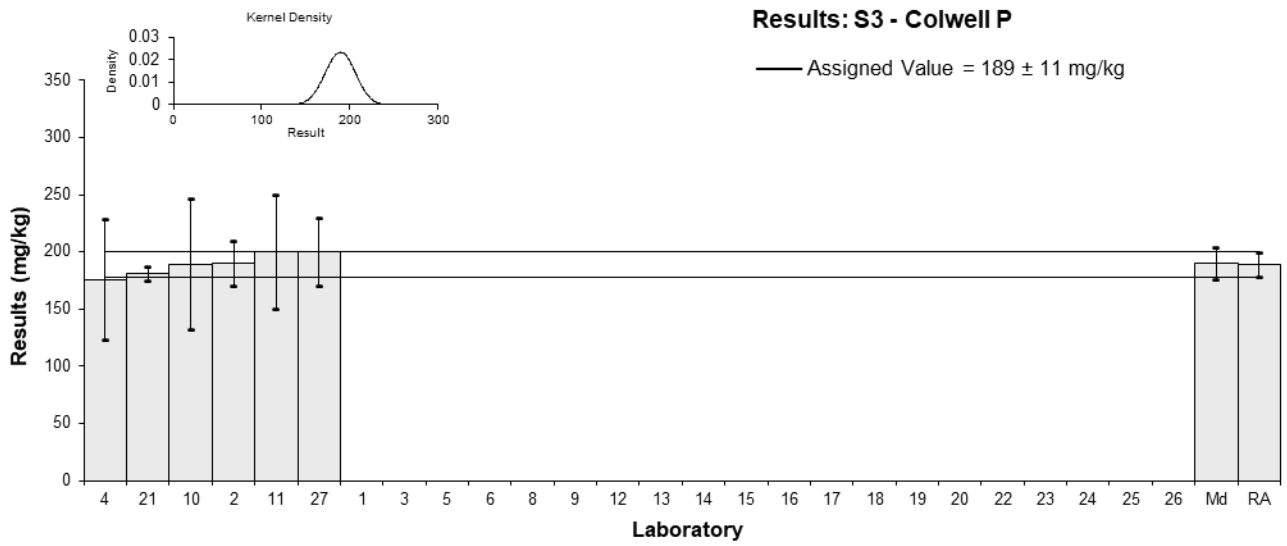
Sample No.	S3
Matrix	Soil
Analyte	Colwell P
Unit	mg/kg

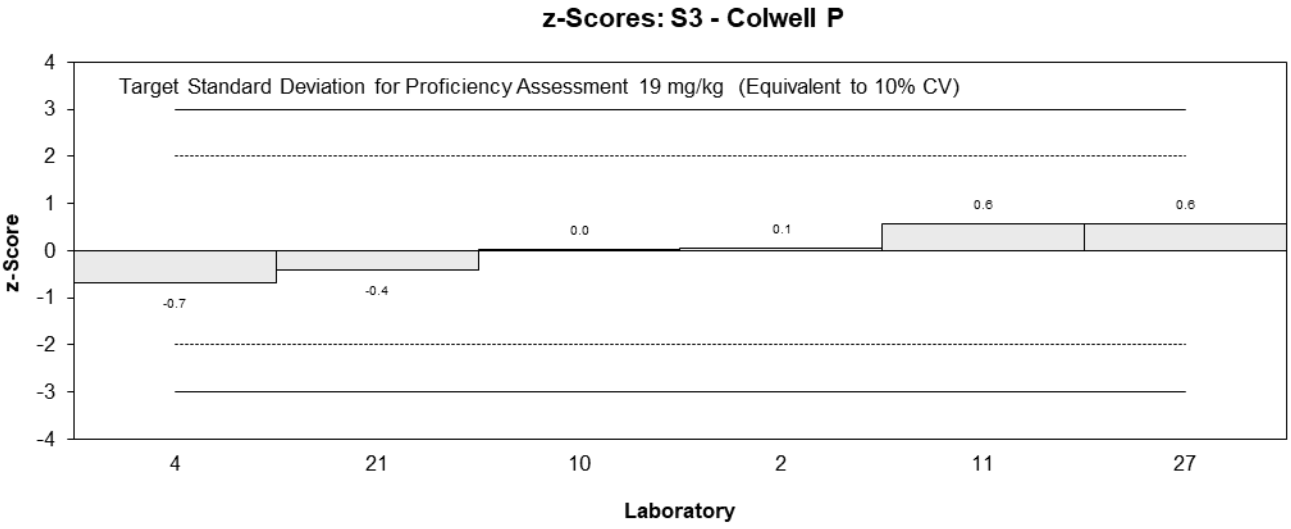
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	190	20	0.05	0.04
3	NT	NT		
4	176	52.8	-0.69	-0.24
5	NR	NR		
6	NT	NT		
8	NT	NT		
9	NT	NT		
10	189.5	56.85	0.03	0.01
11	200	50	0.58	0.21
12	NT	NT		
13	NT	NT		
14	NR	NR		
15	NT	NT		
16	NT	NT		
17	NR	NR		
18	NT	NT		
19	NT	NT		
20	NT	NT		
21	181	6.0	-0.42	-0.64
22	NT	NT		
23	NT	NT		
24	NT	NT		
25	NT	NT		
26	NT	NT		
27	200	30	0.58	0.34

Statistics

Assigned Value	189	11
Spike Value	Not Spiked	
Robust Average	189	11
Median	190	14
Mean	189	
N	6	
Max	200	
Min	176	
Robust SD	11	
Robust CV	5.8%	


Kernel Density
Density
Result
Results: S3 - Colwell P
Assigned Value = 189 ± 11 mg/kg
Results (mg/kg)
Laboratory
4 21 10 2 11 27 1 3 5 6 8 9 12 13 14 15 16 17 18 19 20 22 23 24 25 26 Md RA


z-Scores: S3 - Colwell P
Target Standard Deviation for Proficiency Assessment 19 mg/kg (Equivalent to 10% CV)
z-Score
-0.7
-0.4
0.0
0.1
0.6
0.6
Laboratory
4 21 10 2 11 27

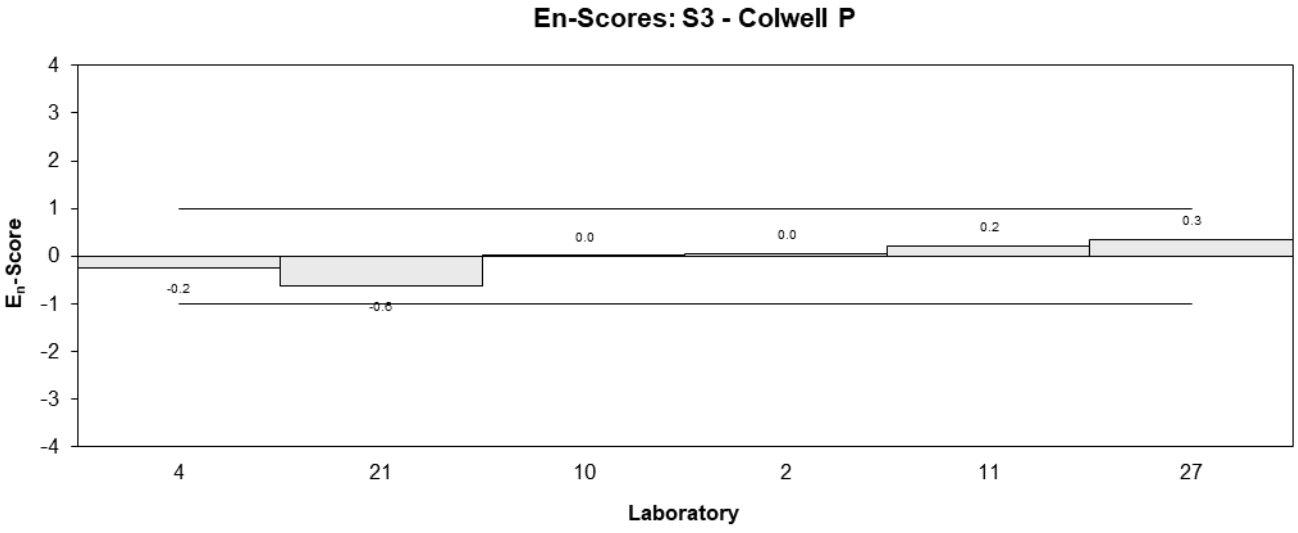

En-Scores: S3 - Colwell P
En-Score
-0.2
-0.6
0.0
0.0
0.2
0.3
Laboratory
4 21 10 2 11 27

Figure 55

Table 69

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	EC
Unit	µS/cm

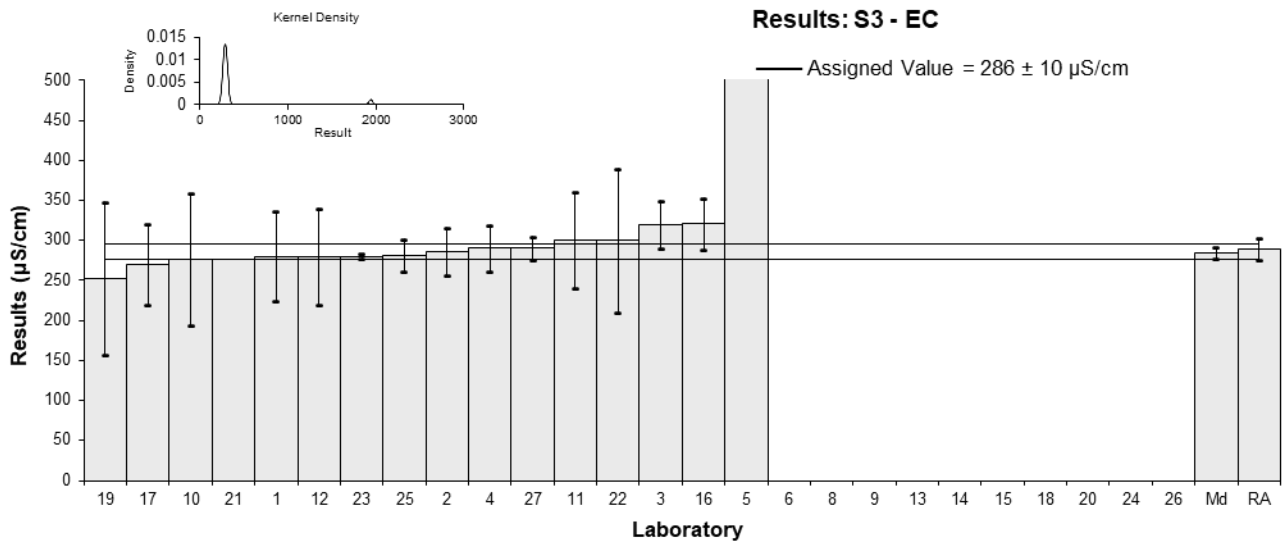
Participant Results

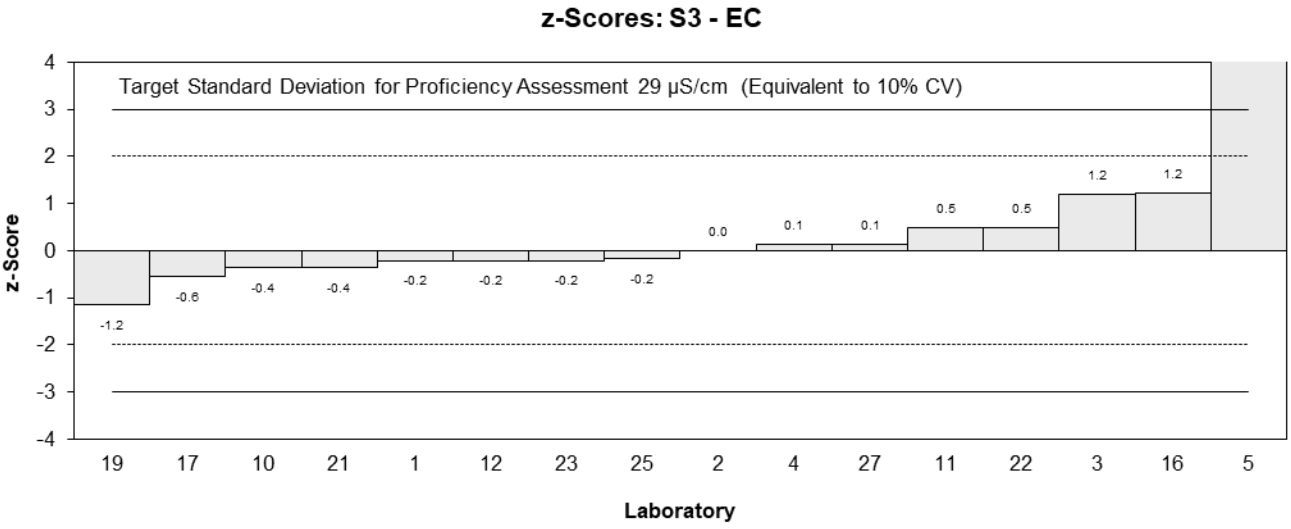
Lab. Code	Result	Uncertainty	z	E_n
1	280	56	-0.21	-0.11
2	286	30	0.00	0.00
3	320	30	1.19	1.08
4	290	29	0.14	0.13
5*	1944.51	NR	57.99	165.85
6	NT	NT		
8	NT	NT		
9	NT	NT		
10	276	82.8	-0.35	-0.12
11	300	60	0.49	0.23
12	280	60	-0.21	-0.10
13	NT	NT		
14	NR	NR		
15	NT	NT		
16	321	32.1	1.22	1.04
17	270	50	-0.56	-0.31
18	NT	NT		
19	252.8	95	-1.16	-0.35
20	NT	NT		
21	276	NR	-0.35	-1.00
22	300	90	0.49	0.15
23	280	2.8	-0.21	-0.58
24	NT	NT		
25	281.37	19.83	-0.16	-0.21
26	NT	NT		
27	290	14.5	0.14	0.23

* Outlier, see Section 4.2

Statistics

Assigned Value	286	10
Spike Value	Not Spiked	
Robust Average	289	13
Median	284	7
Mean	390	
N	16	
Max	1944.51	
Min	252.8	
Robust SD	21	
Robust CV	7.3%	


Results: S3 - EC
Kernel Density
Density
Result
Assigned Value = 286 ± 10 µS/cm
Results (µS/cm)
Laboratory
19 17 10 21 1 12 23 25 2 4 27 11 22 3 16 5 6 8 9 13 14 15 18 20 24 26 Md RA


z-Scores: S3 - EC
Target Standard Deviation for Proficiency Assessment 29 µS/cm (Equivalent to 10% CV)
z-Score
Laboratory
19 17 10 21 1 12 23 25 2 4 27 11 22 3 16 5

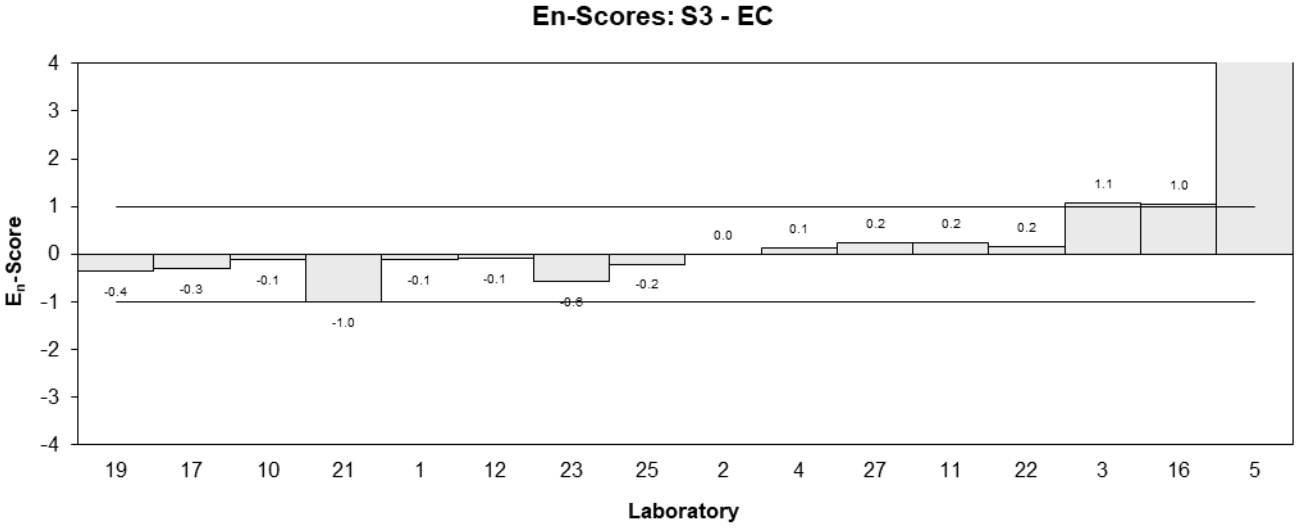

En-Scores: S3 - EC
En-Score
Laboratory
19 17 10 21 1 12 23 25 2 4 27 11 22 3 16 5

Figure 56

Table 70

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	Exchangeable Ca
Unit	cmol(+)/kg

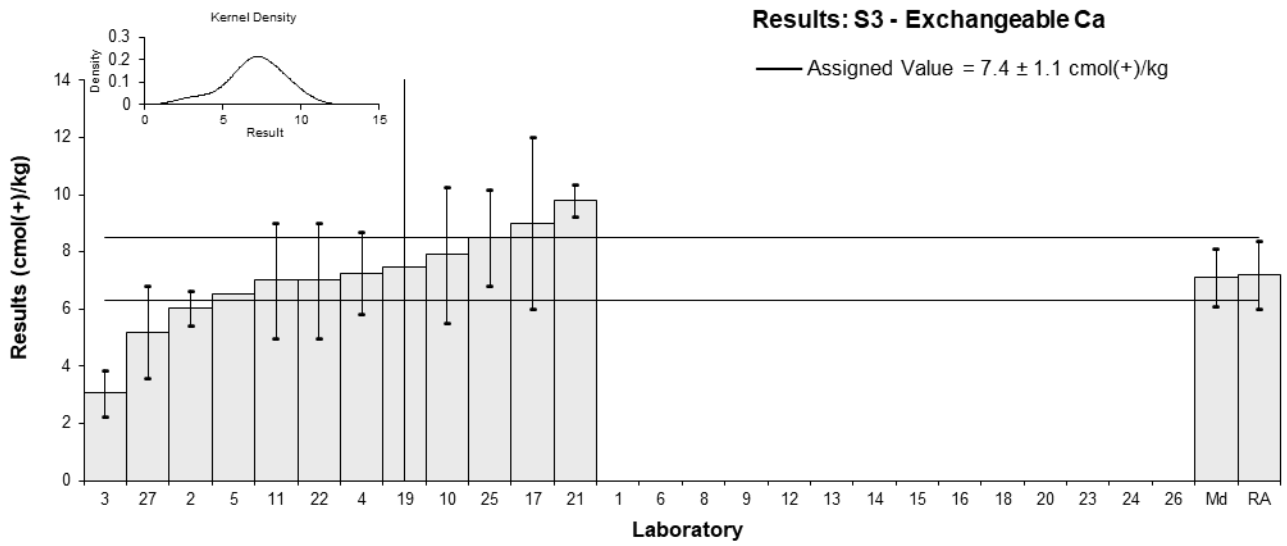
Participant Results

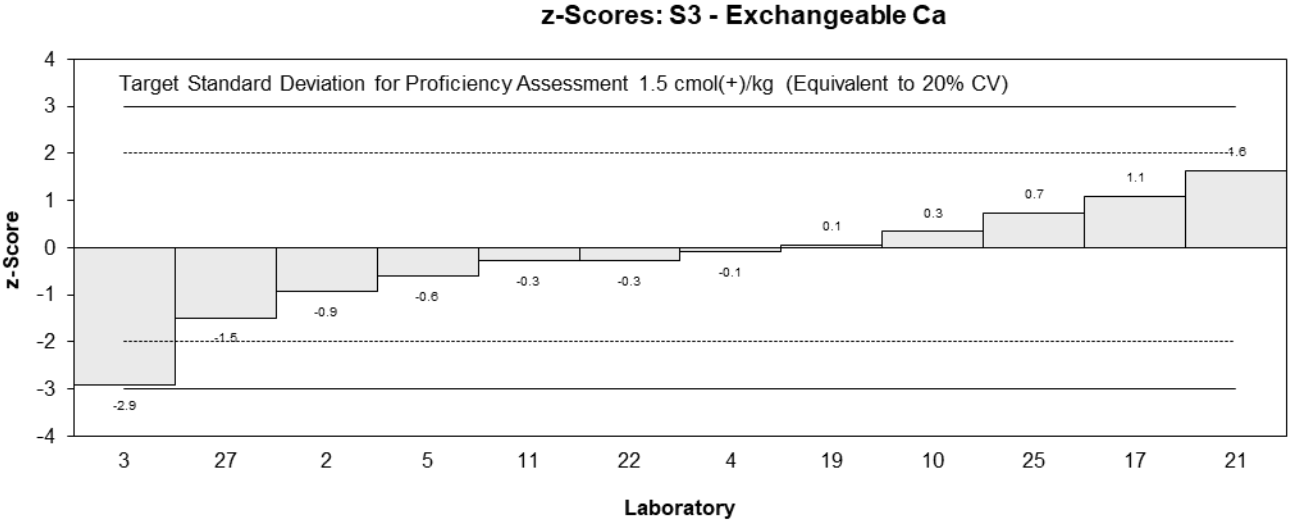
Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	6.04	0.6	-0.92	-1.09
3*	3.06	0.8	-2.93	-3.19
4	7.26	1.45	-0.09	-0.08
5	6.51	NR	-0.60	-0.81
6	NT	NT		
8	NT	NT		
9	NT	NT		
10	7.902	2.371	0.34	0.19
11	7	2	-0.27	-0.18
12	NT	NT		
13	NT	NT		
14	NR	NR		
15	NT	NT		
16	NT	NT		
17	9	3	1.08	0.50
18	NT	NT		
19	7.48	76	0.05	0.00
20	NT	NT		
21	9.8	0.56	1.62	1.94
22	7	2	-0.27	-0.18
23	NT	NT		
24	NT	NT		
25	8.5	1.7	0.74	0.54
26	NT	NT		
27	5.2	1.6	-1.49	-1.13

* Outlier, see Section 4.2

Statistics

Assigned Value	7.4	1.1
Spike Value	Not Spiked	
Robust Average	7.2	1.2
Median	7.1	1.0
Mean	7.1	
N	12	
Max	9.8	
Min	3.06	
Robust SD	1.7	
Robust CV	23%	


Results: S3 - Exchangeable Ca
Assigned Value = 7.4 ± 1.1 cmol(+)/kg
Kernel Density
Density
Result
Results (cmol(+)/kg)
Laboratory
3 27 2 5 11 22 4 19 10 25 17 21 1 6 8 9 12 13 14 15 16 18 20 23 24 26 Md RA


z-Scores: S3 - Exchangeable Ca
Target Standard Deviation for Proficiency Assessment 1.5 cmol(+)/kg (Equivalent to 20% CV)
z-Score
Laboratory
3 27 2 5 11 22 4 19 10 25 17 21
-2.9 -1.5 -0.9 -0.6 -0.3 -0.3 -0.1 0.1 0.3 0.7 1.1 1.6

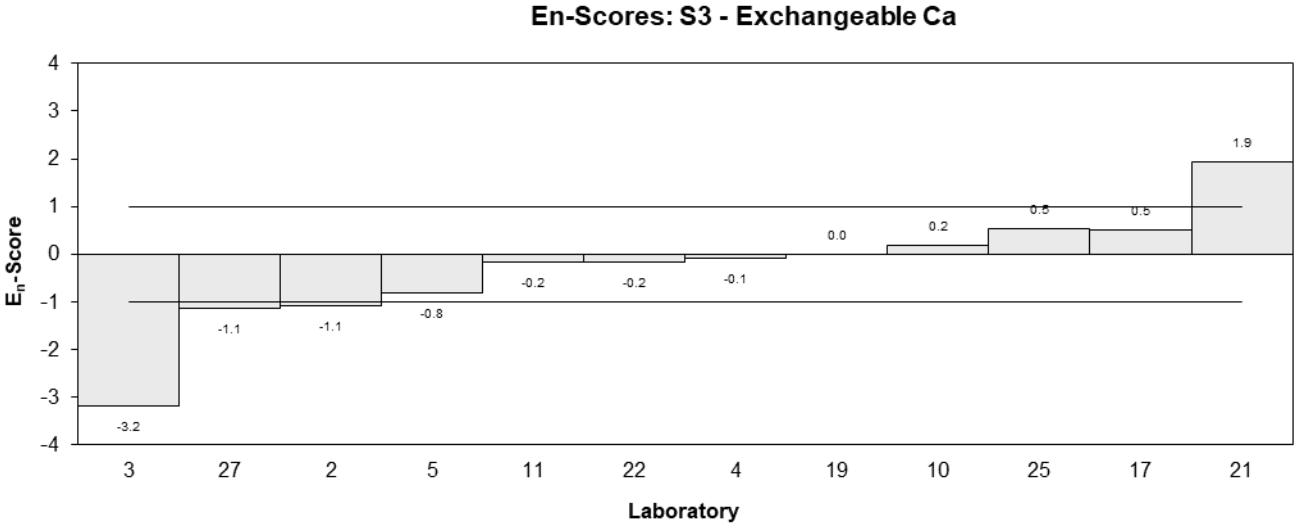

En-Scores: S3 - Exchangeable Ca
En-Score
Laboratory
3 27 2 5 11 22 4 19 10 25 17 21
-3.2 -1.1 -1.1 -0.8 -0.2 -0.2 -0.1 0.0 0.2 0.5 0.5 1.9

Figure 57

Table 71

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	Exchangeable K
Unit	cmol(+)/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	2.95	0.3	-0.39	-0.48
3	3.9	0.5	1.09	1.07
4	3.5	0.7	0.47	0.37
5	2.44	NR	-1.19	-1.81
6	NT	NT		
8	NT	NT		
9	NT	NT		
10	3.321	0.996	0.19	0.11
11	4	2	1.25	0.39
12	NT	NT		
13	NT	NT		
14	NR	NR		
15	NT	NT		
16	NT	NT		
17	3	2	-0.31	-0.10
18	NT	NT		
19	2.52	0.504	-1.06	-1.04
20	NT	NT		
21	3.6	0.07	0.62	0.94
22	3	1	-0.31	-0.18
23	NT	NT		
24	NT	NT		
25	3.5	0.7	0.47	0.37
26	NT	NT		
27	2.7	0.6	-0.78	-0.68

Statistics

Assigned Value	3.20	0.42
Spike Value	Not Spiked	
Robust Average	3.20	0.42
Median	3.16	0.42
Mean	3.20	
N	12	
Max	4	
Min	2.44	
Robust SD	0.58	
Robust CV	18%	

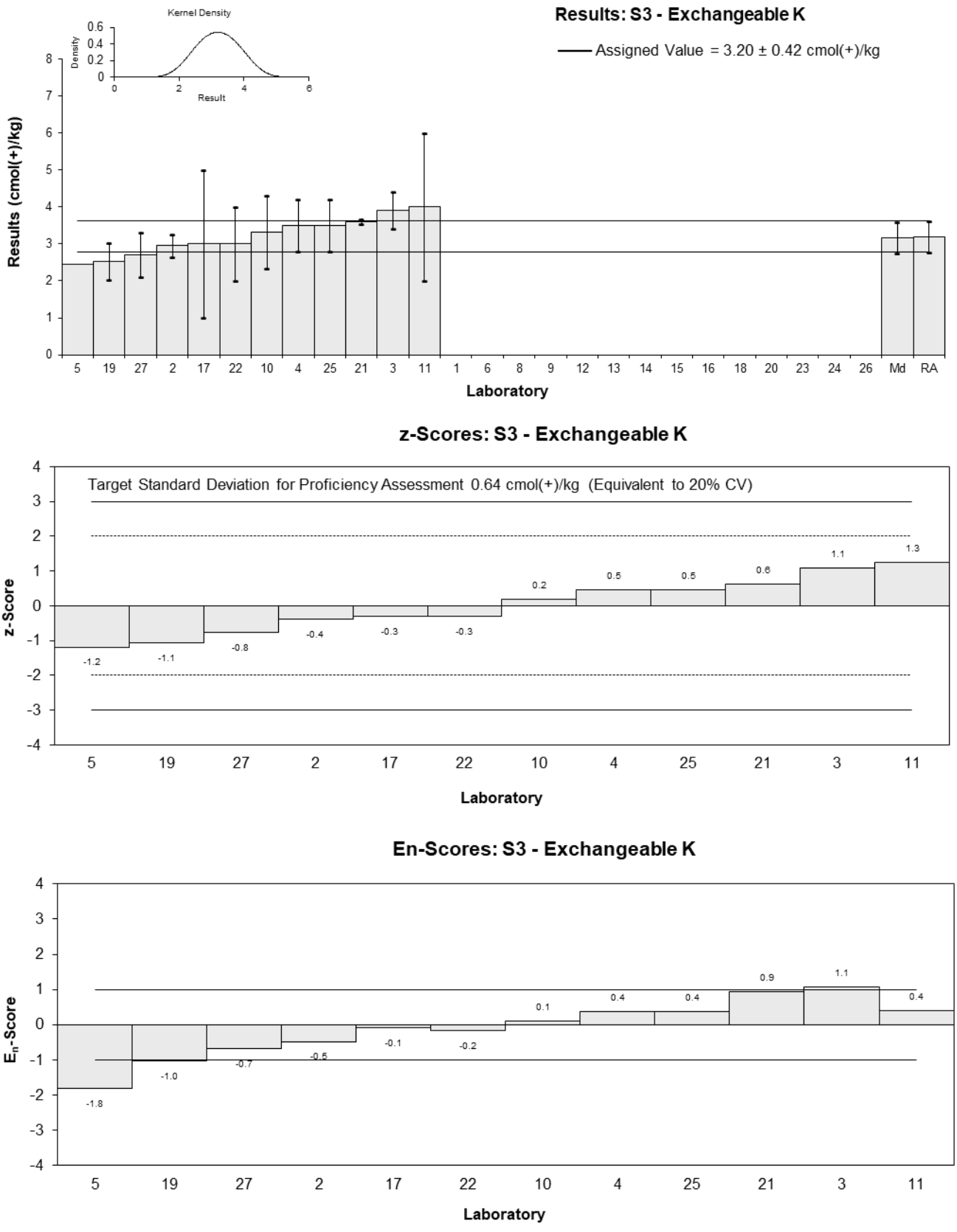

Results: S3 - Exchangeable K
Assigned Value = 3.20 ± 0.42 cmol(+)/kg
Kernel Density
Density
Result
Results (cmol(+)/kg)
Laboratory
5 19 27 2 17 22 10 4 25 21 3 11 1 6 8 9 12 13 14 15 16 18 20 23 24 26 Md RA
z-Scores: S3 - Exchangeable K
Target Standard Deviation for Proficiency Assessment 0.64 cmol(+)/kg (Equivalent to 20% CV)
z-Score
-1.2 -1.1 -0.8 -0.4 -0.3 -0.3 0.2 0.5 0.5 0.6 1.1 1.3
5 19 27 2 17 22 10 4 25 21 3 11
Laboratory
En-Scores: S3 - Exchangeable K
En-Score
-1.8 -1.0 -0.7 -0.5 -0.1 -0.2 0.1 0.4 0.4 0.9 1.1 0.4
5 19 27 2 17 22 10 4 25 21 3 11
Laboratory

Figure 58

Table 72

Sample Details

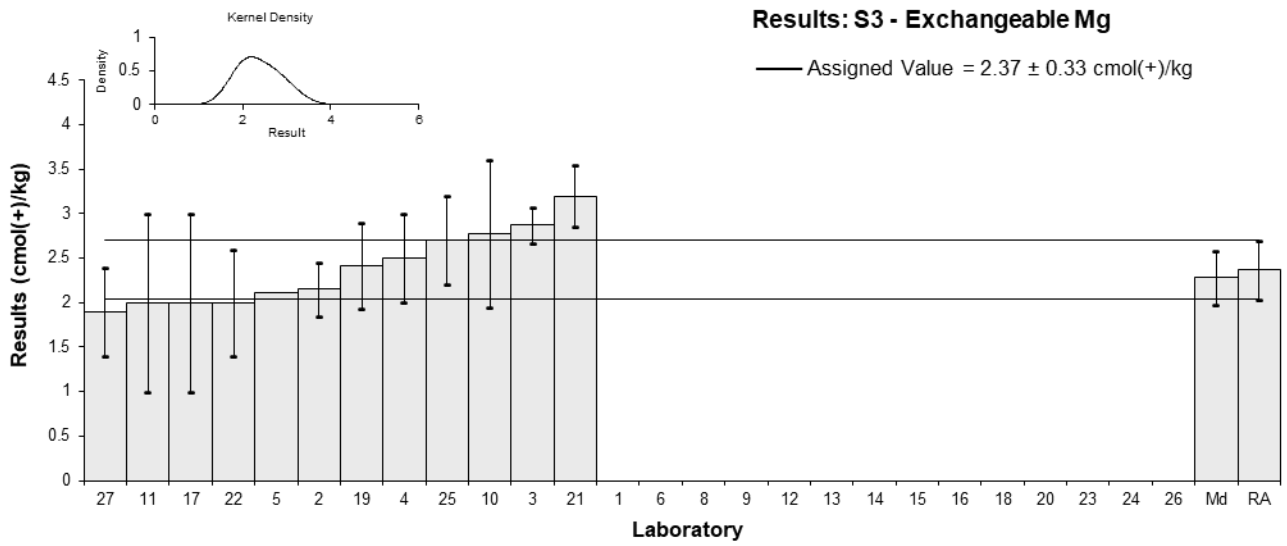
Sample No.	S3
Matrix	Soil
Analyte	Exchangeable Mg
Unit	cmol(+)/kg

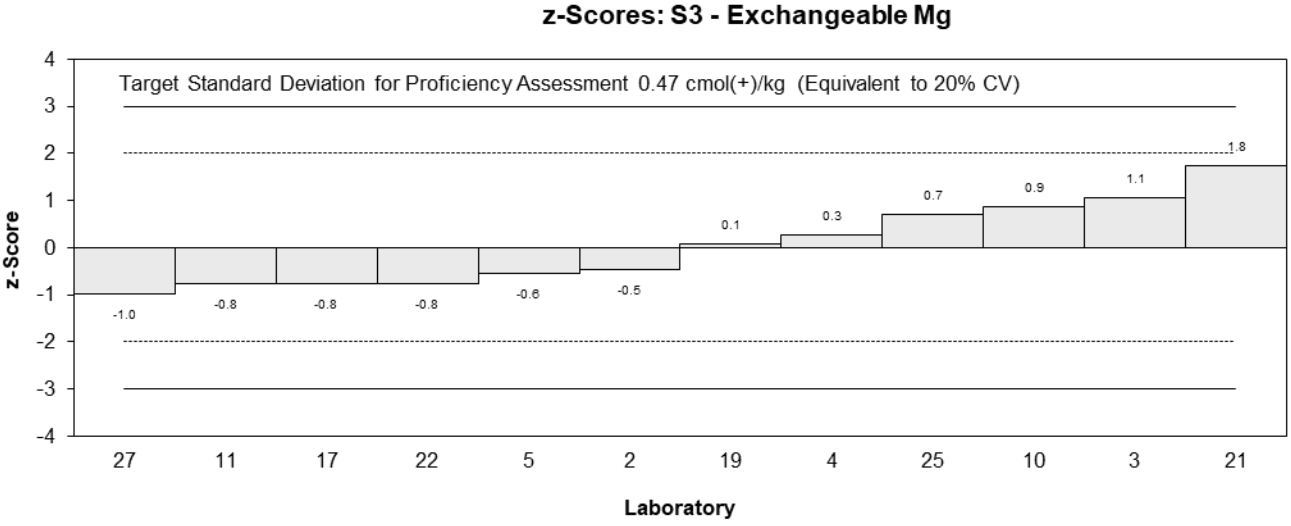
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	2.15	0.3	-0.46	-0.49
3	2.87	0.2	1.05	1.30
4	2.5	0.5	0.27	0.22
5	2.11	NR	-0.55	-0.79
6	NT	NT		
8	NT	NT		
9	NT	NT		
10	2.777	0.833	0.86	0.45
11	2	1	-0.78	-0.35
12	NT	NT		
13	NT	NT		
14	NR	NR		
15	NT	NT		
16	NT	NT		
17	2	1	-0.78	-0.35
18	NT	NT		
19	2.41	0.482	0.08	0.07
20	NT	NT		
21	3.2	0.34	1.75	1.75
22	2	0.6	-0.78	-0.54
23	NT	NT		
24	NT	NT		
25	2.7	0.5	0.70	0.55
26	NT	NT		
27	1.9	0.5	-0.99	-0.78

Statistics

Assigned Value	2.37	0.33
Spike Value	Not Spiked	
Robust Average	2.37	0.33
Median	2.28	0.30
Mean	2.38	
N	12	
Max	3.2	
Min	1.9	
Robust SD	0.45	
Robust CV	19%	


Results: S3 - Exchangeable Mg
Assigned Value = 2.37 ± 0.33 cmol(+)/kg
Kernel Density
Density
Result
Results (cmol(+)/kg)
Laboratory
27 11 17 22 5 2 19 4 25 10 3 21 1 6 8 9 12 13 14 15 16 18 20 23 24 26 Md RA


z-Scores: S3 - Exchangeable Mg
Target Standard Deviation for Proficiency Assessment 0.47 cmol(+)/kg (Equivalent to 20% CV)
z-Score
-1.0 -0.8 -0.8 -0.8 -0.6 -0.5 0.1 0.3 0.7 0.9 1.1 1.8
Laboratory
27 11 17 22 5 2 19 4 25 10 3 21

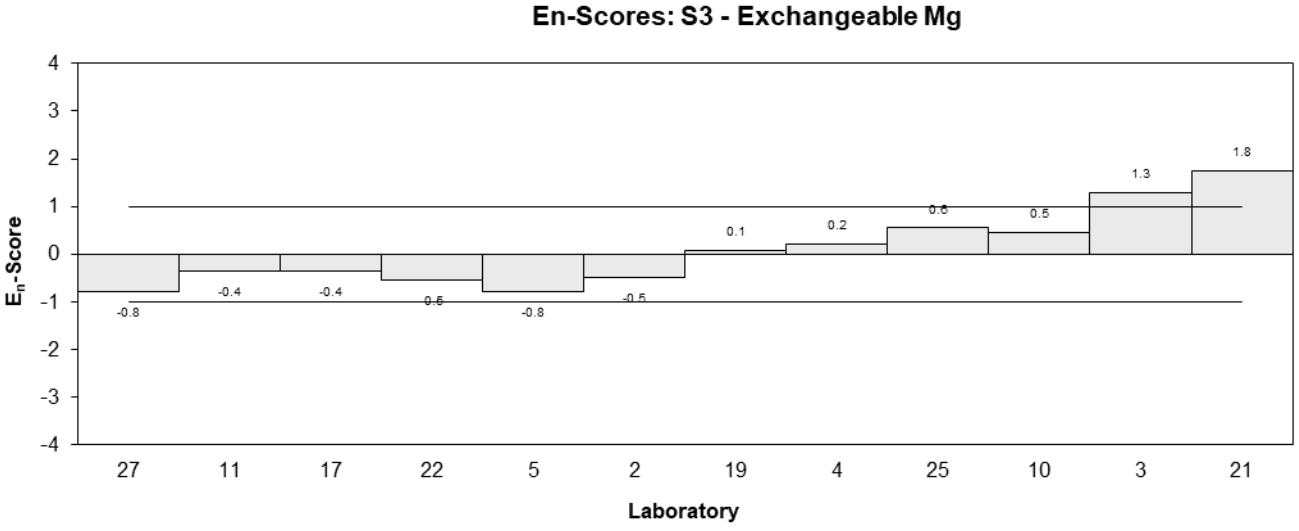

En-Scores: S3 - Exchangeable Mg
En-Score
-0.8 -0.4 -0.4 -0.6 -0.8 -0.5 0.1 0.2 0.6 0.5 1.3 1.8
Laboratory
27 11 17 22 5 2 19 4 25 10 3 21

Figure 59

Table 73

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	Exchangeable Na
Unit	cmol(+)/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	0.07	0.01
3	0.24	0.05
4	<0.1	NR
5	0.06	NR
6	NT	NT
8	NT	NT
9	NT	NT
10	0.0815	0.0245
11	<0.2	NR
12	NT	NT
13	NT	NT
14	NR	NR
15	NT	NT
16	NT	NT
17	<1	NR
18	NT	NT
19	<0.15	NR
20	NT	NT
21	0.1	0.18
22	<0.1	NR
23	NT	NT
24	NT	NT
25	< 0.1	NR
26	NT	NT
27	0.066	0.015

Statistics

Assigned Value	Not Set	
Spike Value	Not Spiked	
Robust Average	0.084	0.029
Median	0.076	0.019
Mean	0.103	
N	6	
Max	0.24	
Min	0.06	
Robust SD	0.029	
Robust CV	34%	

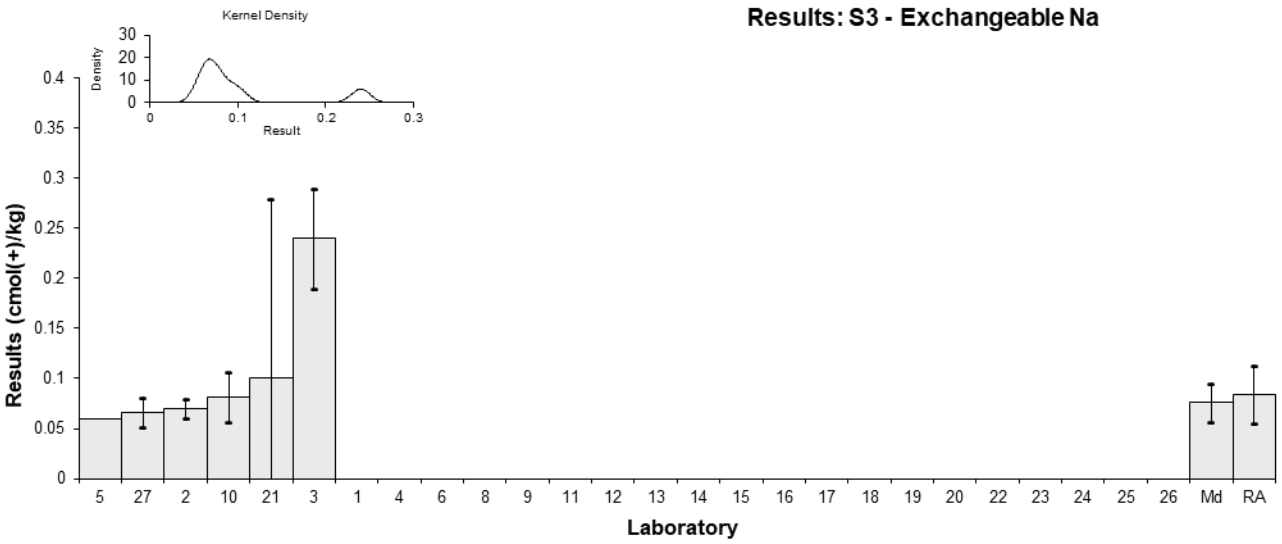

Results: S3 - Exchangeable Na
Kernel Density
Density
Result
Results (cmol(+)/kg)
Laboratory
5 27 2 10 21 3 1 4 6 8 9 11 12 13 14 15 16 17 18 19 20 22 23 24 25 26 Md RA

Figure 60

Table 74

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	Extractable B
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	0.45	0.05
3	NT	NT
4	1.04	0.33
5	83.35	NR
6	NT	NT
8	NT	NT
9	NT	NT
10	NT	NT
11	NR	NR
12	NT	NT
13	NT	NT
14	NR	NR
15	NT	NT
16	NT	NT
17	NR	NR
18	NT	NT
19	NT	NT
20	NT	NT
21	NR	NR
22	NT	NT
23	NT	NT
24	NT	NT
25	NT	NT
26	NT	NT
27	NR	NR

Statistics

Assigned Value	Not Set	
Spike Value	Not Spiked	
Robust Average	NA (N<6)	
Mean	28	
N	3	
Max	83.35	
Min	0.45	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

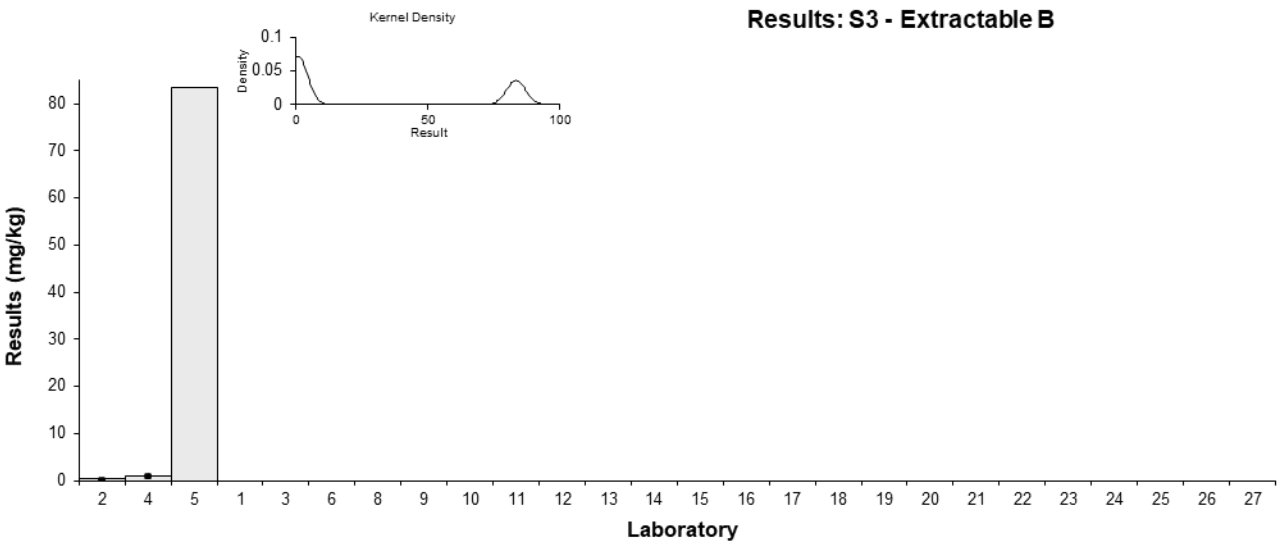

Results: S3 - Extractable B
Kernel Density
Density
0.1
0.05
0
0
50
100
Result
Results (mg/kg)
80
70
60
50
40
30
20
10
0
2
4
5
1
3
6
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
Laboratory

Figure 61

Table 75

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	PBI
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	98	10
3	NT	NT
4	98	29.4
5	NR	NR
6	NT	NT
8	NT	NT
9	NT	NT
10	NT	NT
11	NR	NR
12	NT	NT
13	NT	NT
14	NR	NR
15	NT	NT
16	NT	NT
17	NR	NR
18	NT	NT
19	NT	NT
20	NT	NT
21	NR	NR
22	NT	NT
23	NT	NT
24	NT	NT
25	NT	NT
26	NT	NT
27	NR	NR

Statistics

Assigned Value	Not Set	
Spike Value	Not Spiked	
Robust Average	NA (N<6)	
Median	NA (N<3)	
Mean	98	
N	2	
Max	98	
Min	98	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

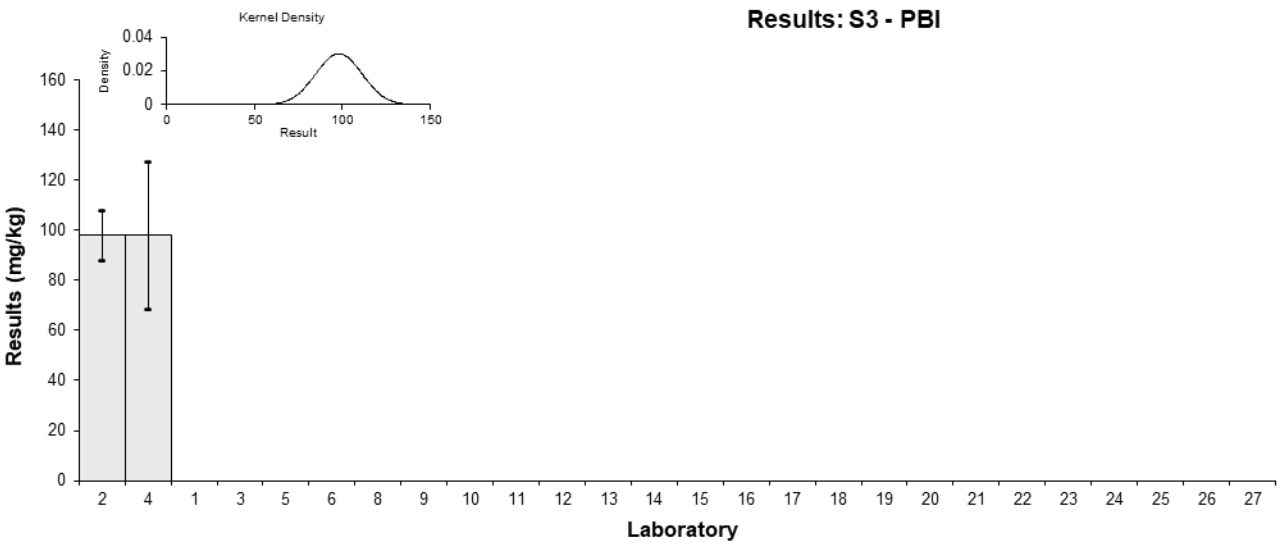

Results: S3 - PBI
Kernel Density
Density
0.04
0.02
0
0
50
100
150
Result
Results (mg/kg)
160
140
120
100
80
60
40
20
0
2
4
1
3
5
6
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
Laboratory

Figure 62

Table 76

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	pH

Participant Results

Lab. Code	Result	Uncertainty
1	5.3	1.1
2	5.63	0.2
3	6.12	0.05
4	5.89	0.59
5	6.16	NR
6	NT	NT
8	NT	NT
9	NT	NT
10	5.32	0.2
11	6.1	NR
12	6.5	1
13	NT	NT
14	NR	NR
15	NT	NT
16	5.27	0.3
17	6.1	0.2
18	NT	NT
19	5.38	0.2
20	NT	NT
21	6.02	0.08
22	6.2	0.2
23	NT	NT
24	NT	NT
25	5.48	0.76
26	NT	NT
27	5.7	0.3

Statistics

Assigned Value	Not Set	
Spike Value	Not Spiked	
Robust Average	5.81	0.29
Median	5.89	0.26
Mean	5.81	
N	15	
Max	6.5	
Min	5.27	
Robust SD	0.45	
Robust CV	7.7%	

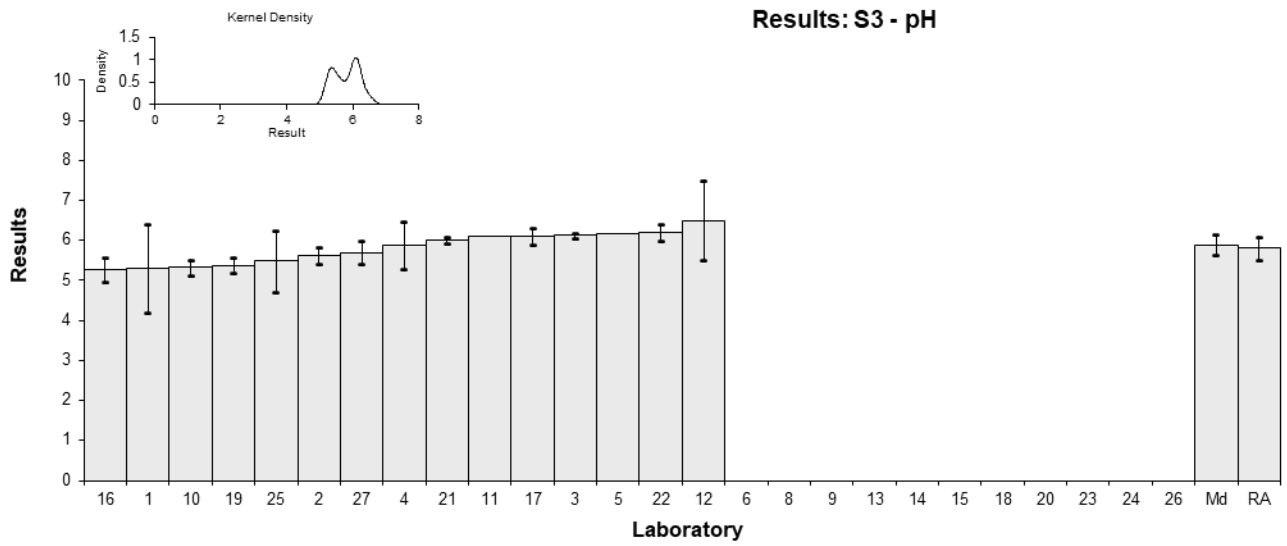

Results: S3 - pH
Kernel Density
Density
Result
Results
Laboratory
16 1 10 19 25 2 27 4 21 11 17 3 5 22 12 6 8 9 13 14 15 18 20 23 24 26 Md RA

Figure 63

Table 77

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	TC
Unit	mg/kg

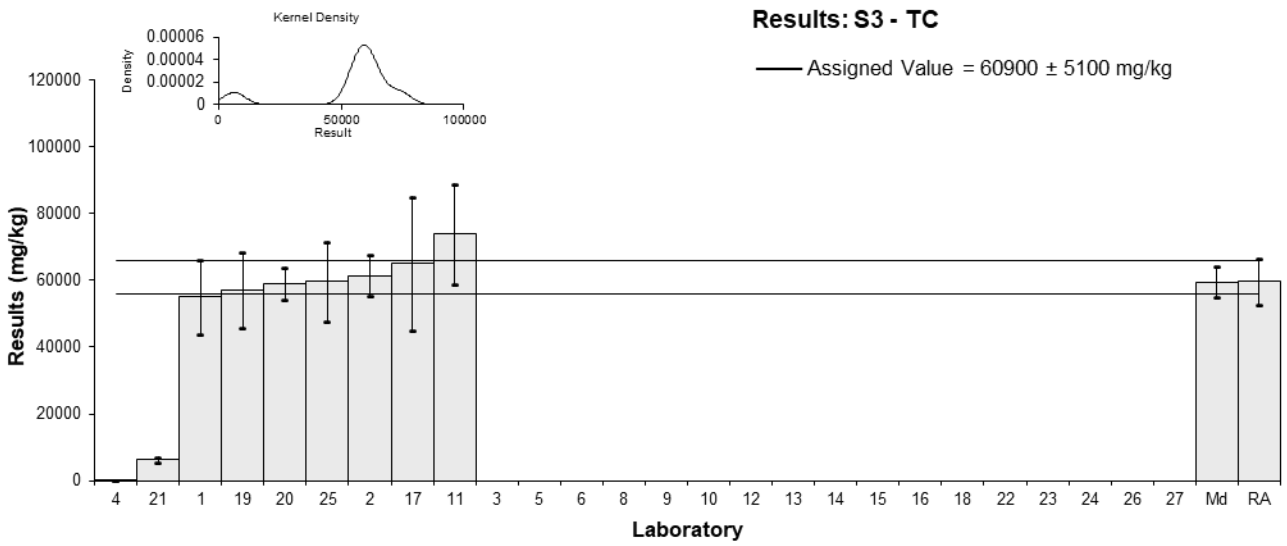
Participant Results

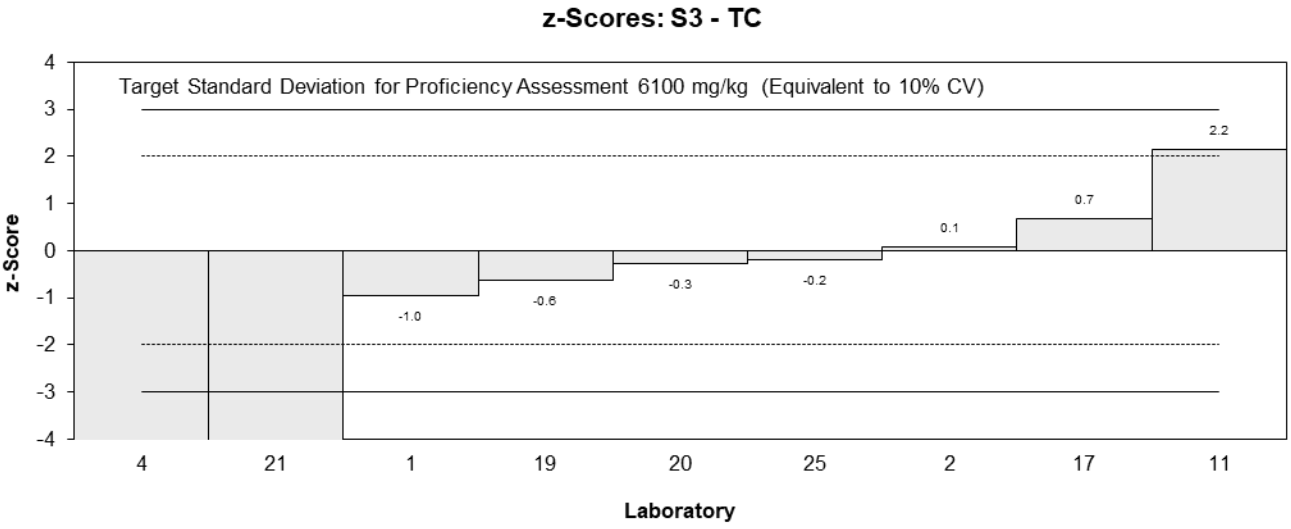
Lab. Code	Result	Uncertainty	z	E_n
1	55000	11000	-0.97	-0.49
2	61400	6140	0.08	0.06
3	NT	NT		
4**	5.94	0.59	-10.00	-11.94
5	NR	NR		
6	NT	NT		
8	NT	NT		
9	NT	NT		
10	NT	NT		
11	74000	15000	2.15	0.83
12	NT	NT		
13	NT	NT		
14	NR	NR		
15	NT	NT		
16	NT	NT		
17	65000	20000	0.67	0.20
18	NT	NT		
19	57000	11400	-0.64	-0.31
20	59200	4800	-0.28	-0.24
21*	6300	800	-8.97	-10.58
22	NT	NT		
23	NT	NT		
24	NT	NT		
25	59750	11950	-0.19	-0.09
26	NT	NT		
27	NR	NR		

* Outlier, ** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	60900	5100
Spike Value	Not Spiked	
Robust Average	59600	7100
Median	59500	4600
Mean	55000	
N	8	
Max	74000	
Min	6300	
Robust SD	8000	
Robust CV	13%	


Results: S3 - TC
Assigned Value = 60900 ± 5100 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
4 21 1 19 20 25 2 17 11 3 5 6 8 9 10 12 13 14 15 16 18 22 23 24 26 27 Md RA


z-Scores: S3 - TC
Target Standard Deviation for Proficiency Assessment 6100 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
4 21 1 19 20 25 2 17 11
-1.0
-0.6
-0.3
-0.2
0.1
0.7
2.2

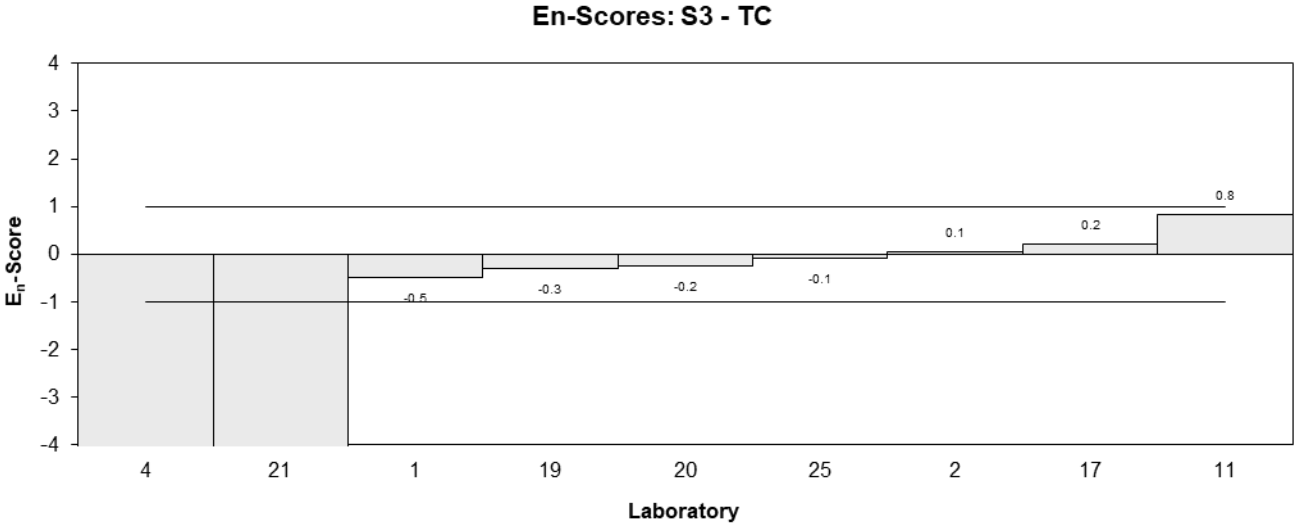

En-Scores: S3 - TC
En-Score
Laboratory
4 21 1 19 20 25 2 17 11
-0.5
-0.3
-0.2
-0.1
0.1
0.2
0.8

Figure 64

Table 78

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	TN
Unit	mg/kg

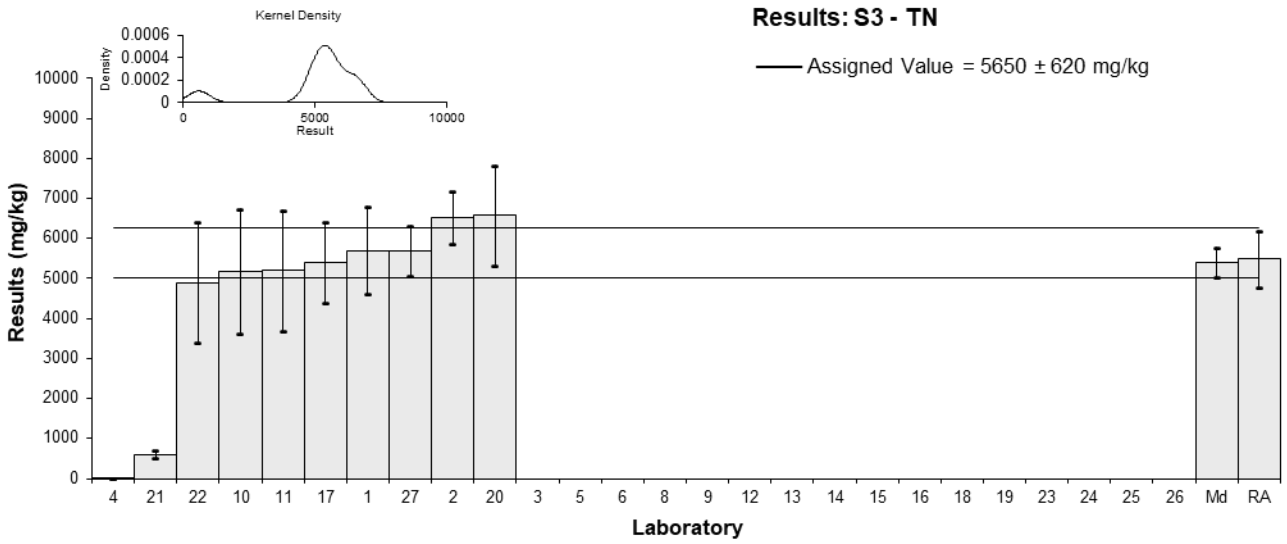
Participant Results

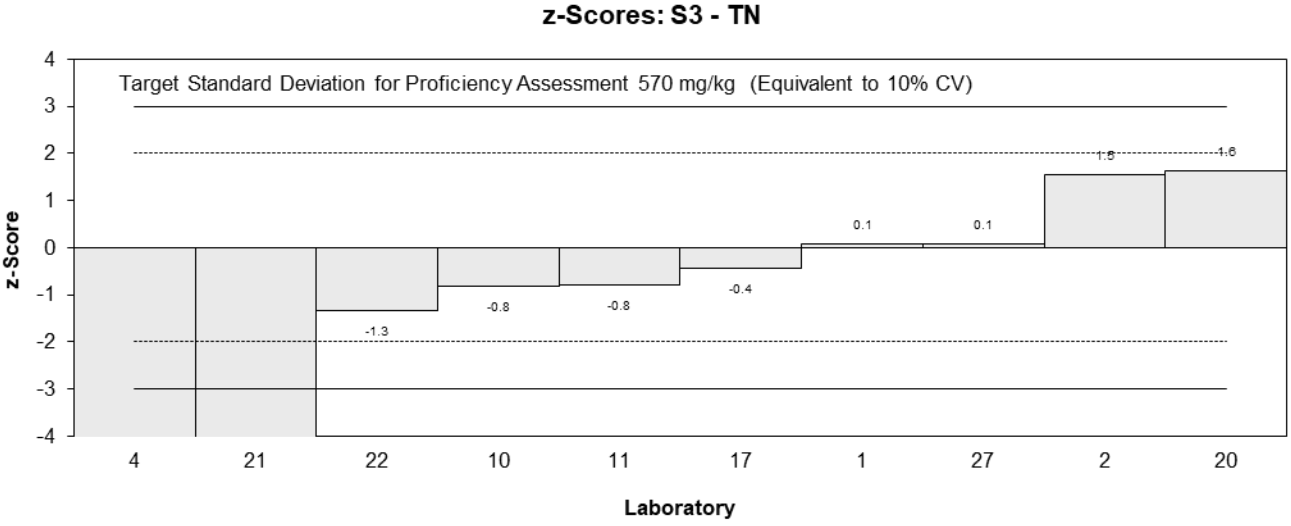
Lab. Code	Result	Uncertainty	z	E_n
1	5700	1100	0.09	0.04
2	6520	650	1.54	0.97
3	NT	NT		
4**	0.80	0.08	-10.00	-9.11
5	NR	NR		
6	NT	NT		
8	NT	NT		
9	NT	NT		
10	5183.3	1554.99	-0.83	-0.28
11	5200	1500	-0.80	-0.28
12	NT	NT		
13	NT	NT		
14	NR	NR		
15	NT	NT		
16	NT	NT		
17	5400	1000	-0.44	-0.21
18	NT	NT		
19	NT	NT		
20	6570	1250	1.63	0.66
21*	600	100	-8.94	-8.04
22	4900	1500	-1.33	-0.46
23	NT	NT		
24	NT	NT		
25	NT	NT		
26	NT	NT		
27	5700	627	0.09	0.06

* Outlier, ** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	5650	620
Spike Value	Not Spiked	
Robust Average	5490	710
Median	5400	370
Mean	5100	
N	9	
Max	6570	
Min	600	
Robust SD	850	
Robust CV	15%	


Results: S3 - TN
Assigned Value = 5650 ± 620 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
4 21 22 10 11 17 1 27 2 20 3 5 6 8 9 12 13 14 15 16 18 19 23 24 25 26 Md RA


z-Scores: S3 - TN
Target Standard Deviation for Proficiency Assessment 570 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
4 21 22 10 11 17 1 27 2 20
-1.3
-0.8
-0.8
-0.4
0.1
0.1
1.5
1.6

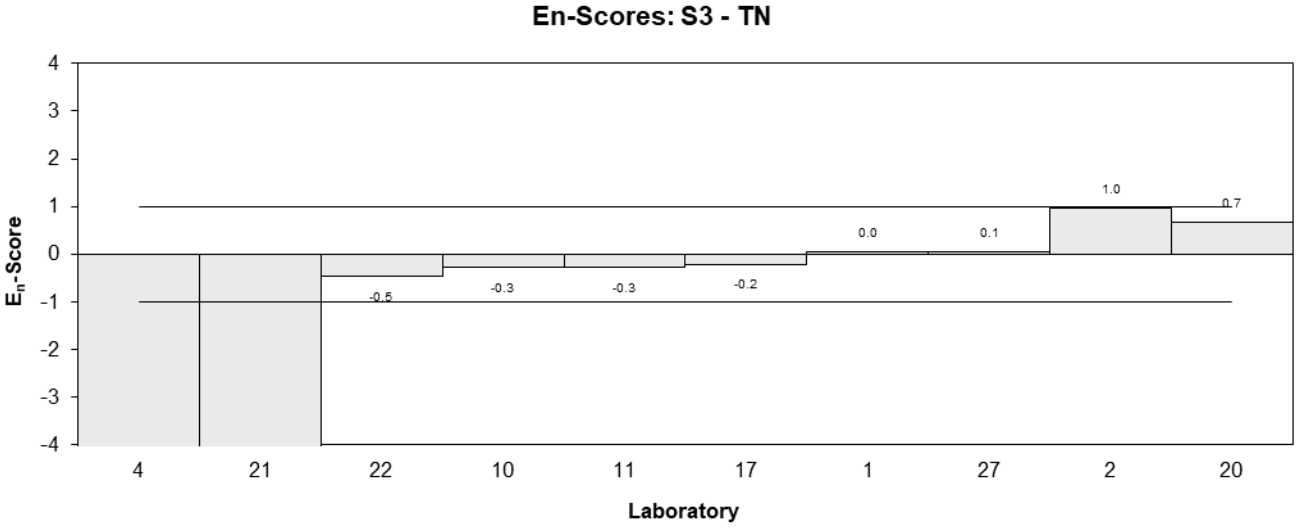

En-Scores: S3 - TN
En-Score
Laboratory
4 21 22 10 11 17 1 27 2 20
-0.5
-0.3
-0.3
-0.2
0.0
0.1
1.0
0.7

Figure 65

Table 79

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	TOC
Unit	mg/kg

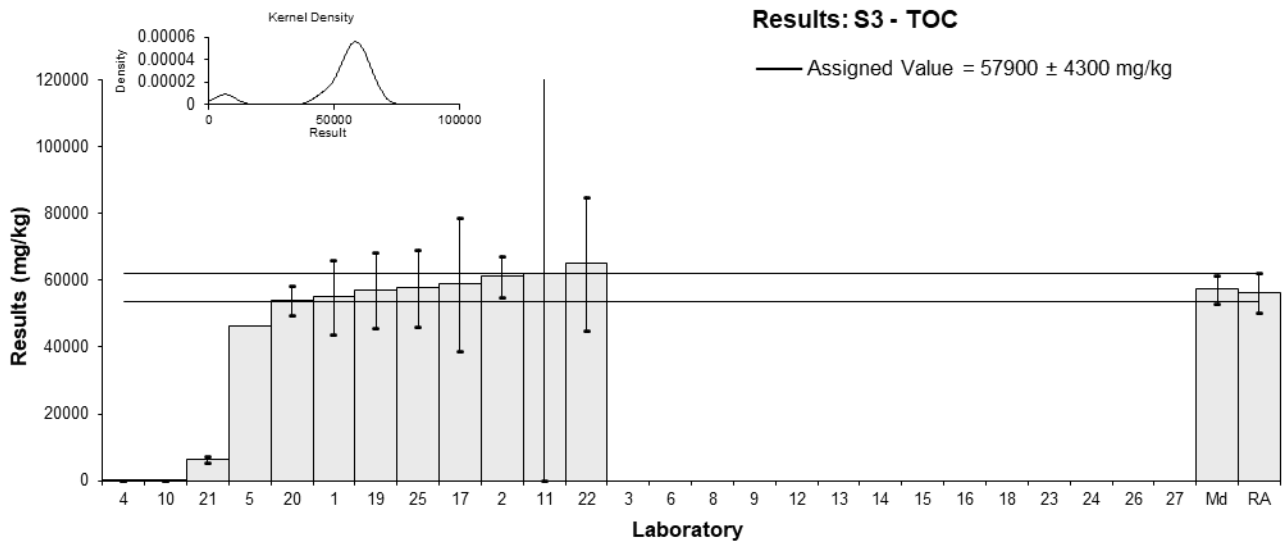
Participant Results

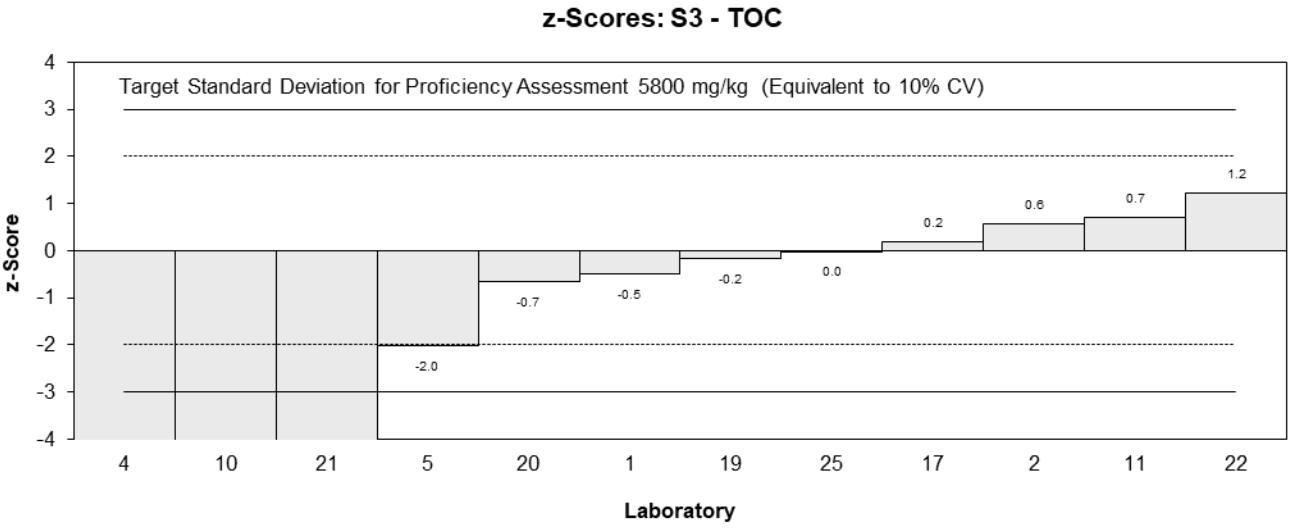
Lab. Code	Result	Uncertainty	z	E_n
1	55000	11000	-0.50	-0.25
2	61200	6120	0.57	0.44
3	NT	NT		
4**	5.96	1.19	-10.00	-13.46
5	46241.68	NR	-2.01	-2.71
6	NT	NT		
8	NT	NT		
9	NT	NT		
10**	101.08	30.32	-9.98	-13.44
11	62000	62000	0.71	0.07
12	NT	NT		
13	NT	NT		
14	NR	NR		
15	NT	NT		
16	NT	NT		
17	59000	20000	0.19	0.05
18	NT	NT		
19	57000	11400	-0.16	-0.07
20	54000	4400	-0.67	-0.63
21*	6300	853	-8.91	-11.77
22	65000	20000	1.23	0.35
23	NT	NT		
24	NT	NT		
25	57820	11564	-0.01	-0.01
26	NT	NT		
27	NR	NR		

* Outlier, ** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	57900	4300
Spike Value	Not Spiked	
Robust Average	56300	5800
Median	57400	4200
Mean	52000	
N	10	
Max	65000	
Min	6300	
Robust SD	7300	
Robust CV	13%	


Results: S3 - TOC
Assigned Value = 57900 ± 4300 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
4 10 21 5 20 1 19 25 17 2 11 22 3 6 8 9 12 13 14 15 16 18 23 24 26 27 Md RA


z-Scores: S3 - TOC
Target Standard Deviation for Proficiency Assessment 5800 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
4 10 21 5 20 1 19 25 17 2 11 22
-2.0 -0.7 -0.5 -0.2 0.0 0.2 0.6 0.7 1.2

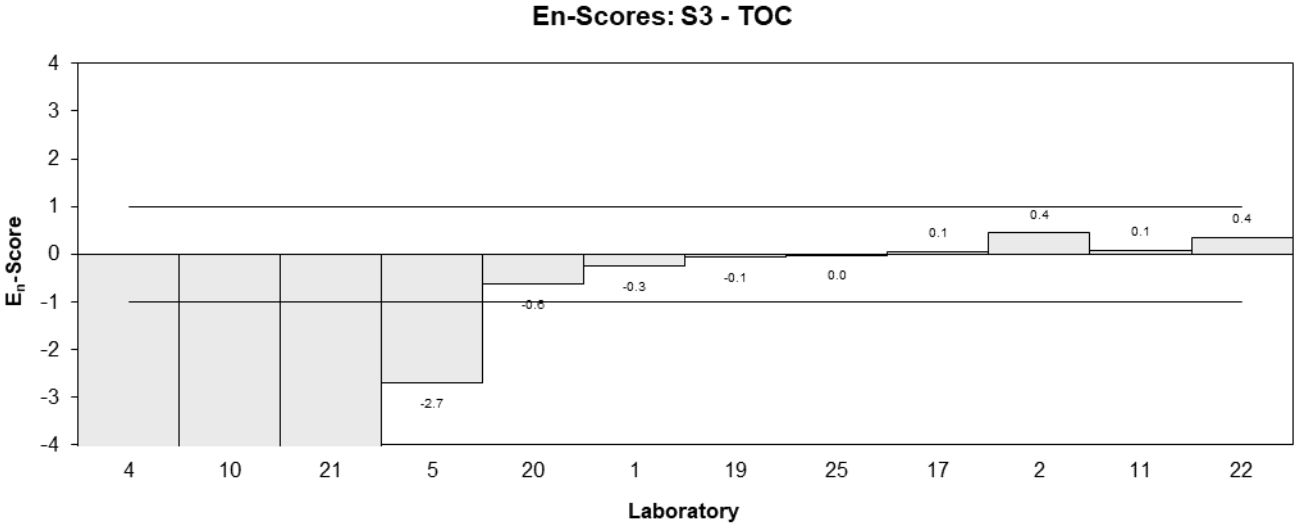

En-Scores: S3 - TOC
En-Score
Laboratory
4 10 21 5 20 1 19 25 17 2 11 22
-2.7 -0.6 -0.3 -0.1 0.0 0.1 0.4 0.1 0.4

Figure 66

Table 80

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	Total P
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	NR	NR
3	NT	NT
4	NR	NR
5	25.95	NR
6	NT	NT
8	NT	NT
9	NT	NT
10	1146.06	343.82
11	NR	NR
12	NT	NT
13	NT	NT
14	NR	NR
15	NT	NT
16	NT	NT
17	NR	NR
18	NT	NT
19	NT	NT
20	1270	360
21	NR	NR
22	NT	NT
23	NT	NT
24	NT	NT
25	NT	NT
26	NT	NT
27	NR	NR

Statistics

Assigned Value	Not Set	
Spike Value	Not Spiked	
Robust Average	NA (N<6)	
Median	1150	270
Mean	810	
N	3	
Max	1270	
Min	25.95	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

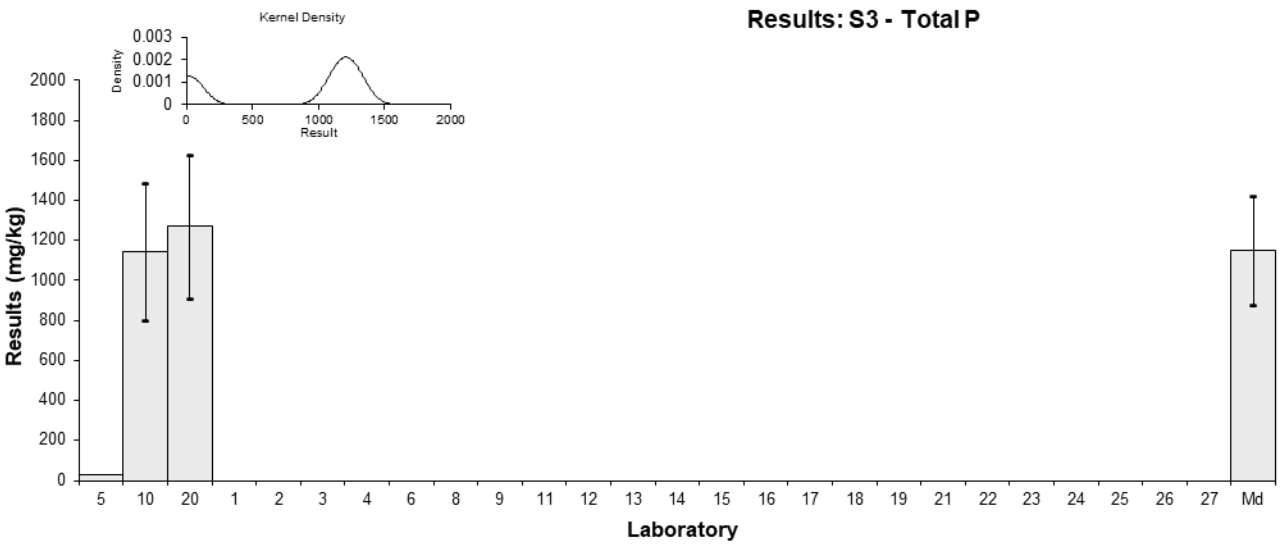

Results: S3 - Total P
Kernel Density
Density
0.003
0.002
0.001
0
0
500
1000
1500
2000
Result
Results (mg/kg)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
5
10
20
1
2
3
4
6
8
9
11
12
13
14
15
16
17
18
19
21
22
23
24
25
26
27
Md
Laboratory

Figure 67

6 DISCUSSION OF RESULTS

6.1 Assigned Value

Sample S1 was a dried soil material (clay). Participants were asked to report results for Sample S1 on an as-received basis.

Sample S2 was the same soil material as that used in the preparation of Sample S1 of PT study AQA 23-02, to which a known amount of water was added. Participants were asked to use their normal analytical method but to report results corrected for moisture content.[6]

Sample S3 was dried agricultural soil.

Assigned values for the 52 tests in the three study samples were calculated as the robust averages of participants' results. The robust averages and their associated expanded uncertainties were calculated using the procedures described in ISO 13528. [6] Extreme outliers and results less than 50% or more than 150% of the robust average were excluded prior to the calculation of each assigned value (see subchapters 4.2 and 4.3). Appendix 2 sets out the calculation of the robust average of Cu in Sample S1 and its associated uncertainty.

Laboratories 6, 10, and 27 may have reported results for solid content in S2 rather than the moisture content. To avoid bias in the calculation of the assigned value and unfair scoring, these results were excluded from the robust average calculation of the moisture content and from the calculation of all summary statistics.

Laboratory 10 may have also reported corrected results for solid content rather than moisture content in Sample S2 as all results were higher than the assigned value by approximately same factor (about 2, 72% divided by 36.2%). To avoid bias in the calculation of the assigned value and ensure fair scoring, Laboratory 10's results were excluded from the robust average calculation for all analytes of Sample S2. They were also excluded from the calculation of all summary statistics for Sample S2.

No assigned values were set for B, Cs, Ga, Sb and Se in S1, B, Cd and Na in S2 and Colwell K, exchangeable Na^+, extractable B, PBI, pH and Total P in S3 because the results were too few or too variable. However, participants may still compare their reported results for some of these elements with the robust average of participants' results and/or the homogeneity value. Descriptive statistics for these elements are presented in Section 5.

Losses during the drying process may explain the discrepancies between the spike value and the assigned value for Hg in S1.

Traceability The assigned values are not traceable to any external reference; they are traceable to the consensus of participants' results derived from a variety of measurement methods and (presumably) a variety of calibrators. So, although expressed in SI units, the metrological traceability of the assigned values has not been established.

6.2 Measurement Uncertainty Reported by Participants

Participants were asked to report an evaluation of the expanded measurement uncertainty associated with their results. Of 939 numerical results, 918 (98%) were reported with an expanded measurement uncertainty. The magnitude of these expanded uncertainties was within the range 0.82% to 1016% of the reported value. The participants used a wide variety of procedures to evaluate the expanded measurement uncertainty. These are presented in Tables 12 and 13.

Approaches to evaluating measurement uncertainty include standard deviation of replicate analysis, Horwitz formula, long term reproducibility, professional judgement, bottom-up approach, top-down approach using precision and estimates of method and laboratory bias, and top-down approach using only the reproducibility from inter-laboratory comparison studies.[9 – 15]

Participation in proficiency testing programs allows participants to check how reasonable their evaluations of uncertainty are. Results and the expanded MU are presented in the bar charts for each analyte (Figure 2 to 67). As a simple rule of thumb, when the uncertainty evaluation is smaller than the uncertainty of the assigned value, or larger than the uncertainty of the assigned value plus twice the target standard deviation, then this should be reviewed as suspect. For example, 18 laboratories reported results for Mg in S3. The uncertainty of the assigned value evaluated from the robust standard deviation of the 18 laboratories' results is 100 mg/kg or 7.8% (see equation 4, Appendix 2). Laboratory 14 may have under-estimated their expanded measurement uncertainty for Mg in S3, as their reported uncertainty evaluation was 5.0% of their reported concentration. An uncertainty evaluated from one measurement cannot be smaller than the uncertainty evaluated from 18 measurements. Alternatively, evaluations of uncertainties for Se in S2 larger than 1.3 mg/kg or 54% (the uncertainty of the assigned value of 0.33 mg/kg plus the allowable variation from the assigned value, the target standard deviation of 0.48 mg/kg, multiplied by 2, the coverage factor for a confidence interval of 95%), should also be viewed as suspect. For example, the expanded measurement uncertainties reported by Laboratories 6, 11 and 22 for Se in S2 of 1.4 mg/kg (70%), 2 mg/kg (67%) and 2 mg/kg (69%) respectively may have been over-estimated.

Laboratory 8 should review their procedure for evaluating measurement uncertainty as several of their evaluated uncertainties may be under-estimated. Laboratory 11 should also review their measurement uncertainty evaluation procedure, as several of their results may have been over-estimated.

When a laboratory has successfully participated in at least 6 proficiency testing studies, the standard deviation from proficiency testing studies only can also be used to evaluate the uncertainty of their measurement results. [10] An example of evaluating measurement uncertainty using proficiency testing data only is given in Appendix 3.

Laboratories 6, 12, 17 and 23 attached evaluations of the expanded measurement uncertainty to results reported as less than their limit of detection. An evaluation of uncertainty expressed as a value cannot be attached to a result expressed as a range.[9]

Laboratories 6, 19, 21 and 24 reported an evaluation of expanded uncertainty for some measurement results larger than the results themselves.

In some cases, the results were reported with an inappropriate number of significant figures. The recommended format is to write uncertainty to no more than two significant figures and then to write the result with the corresponding number of decimal places. For example, instead of 1146.06 ± 343.82 mg/kg, it is better to report 1150 ± 340 mg/kg or instead of 0.62 ± 0.167 mg/kg, it is better to report 0.62 ± 0.17 mg/kg.[9]

6.3 z-Score

The z-score compares a participant's deviation from the assigned value with the target standard deviation set for proficiency assessment.

The target standard deviation defines acceptable performance in a proficiency test. Target standard deviations equivalent to 10% to 20% PCV were used to calculate z-scores. Unlike the standard deviation based on between-laboratory CV, setting the target standard deviation as a realistic, set value enables z-scores to be used as a fixed reference value point for assessment of laboratory performance, independent of group performance.

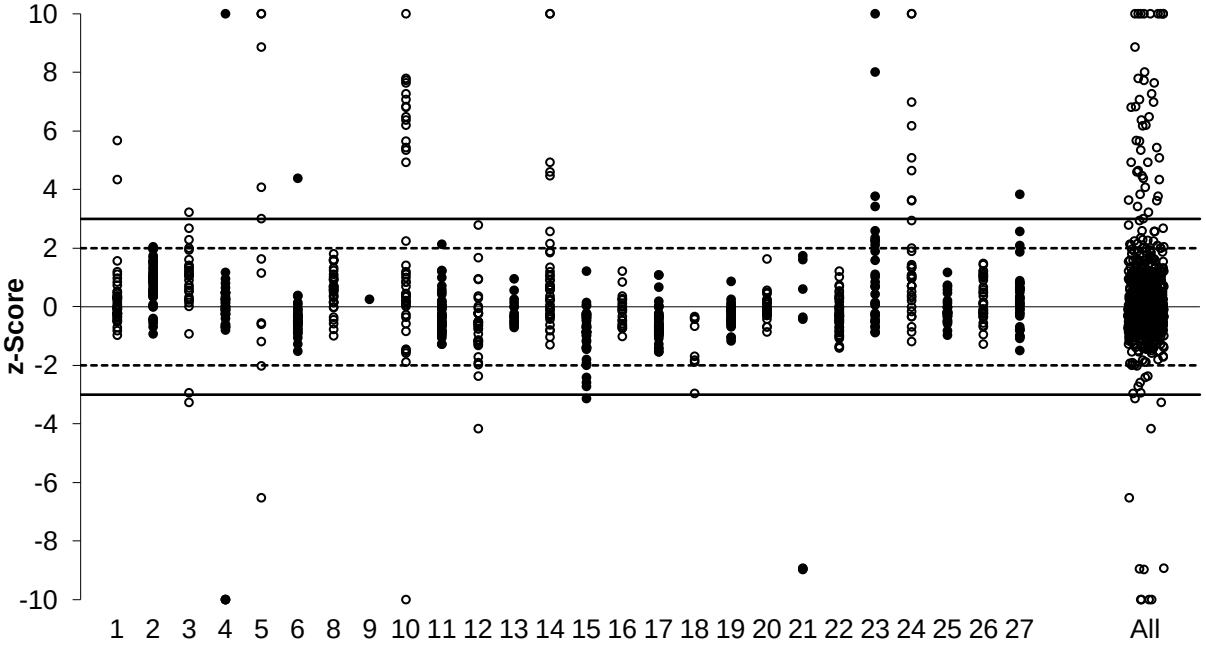
The between-laboratory coefficient of variation predicted by the Thompson-Horwitz equation[8] and the between-laboratory coefficient of variation from reported results in this study are presented for comparison in Table 81. The dispersal of participants' z-scores is presented in Figure 68 (by laboratory code) and in Figure 70 (by test). Of 813 results for which z-scores were calculated, 736 (91%) returned an acceptable score of $|z| \leq 2.0$ and 23

(3%) were questionable at 2.0 < |z| < 3.0. Participants with multiple z-scores larger than 2.0 or smaller than -2.0 should check for laboratory bias.

A summary of participants' performance is presented in Figure 71**.** No laboratory reported results for all 52 tests for which a z-score was calculated.

Laboratory 2 returned the highest number of acceptable z-scores (48 out of 49 reported).

All results reported by Laboratories **17** (46), **22** (45), **26** (35), **8** (34), **19** (27), **20** (27), **25** (27), **16** (21), **13** (15) and **9** (1) returned acceptable z-scores.



Scores of >10 or <-10 have been plotted as 10 or -10.

Figure 68 z-Score Dispersal by Laboratory

Table 81 Between-Laboratory CV of this Study, Thompson/Horwitz CV, and Set Target CV

Sample	Test	Assigned Value (mg/kg)	Between-Laboratory CV* (%)	Thompson/ Horwitz CV (%)	Target SD (as PCV) (%)
S1	Ag	3.10	9.3	13	15
S1	Al	20200	21	3.6	20
S1	As	3.49	29	13	20
S1	B	Not Set	36	NA	Not Set
S1	Bi	0.952	12	16	15
S1	Cd	0.635	9.9	17	15
S1	Co	11.8	11	11	10
S1	Cr	36.2	18	9.3	15
S1	Cs	Not Set	53	NA	Not Set
S1	Cu	14.5	12	11	10
S1	Fe	23300	11	3.5	10
S1	Ga	Not Set	NA	NA	Not Set
S1	Hg	0.460	15	18	20
S1	Li	9.9	20	11	20
S1	Mn	341	8.5	6.7	10
S1	Ni	20.9	18	10	15
S1	Pb	29.8	7.6	9.6	10
S1	Sb	Not Set	61	NA	Not Set
S1	Se	Not Set	44	NA	Not Set
S1	Th	6.7	22	12	20
S1	U	3.20	7.4	13	10

Sample	Test	Assigned Value (mg/kg)	Between-Laboratory CV* (%)	Thompson/ Horwitz CV (%)	Target SD (as PCV) (%)
S1	Zn	159	9.2	7.5	10
S2	Al	5810	16	4.3	20
S2	As	3.76	17	13	20
S2	B	Not Set	37	NA	Not Set
S2	Ba	42.8	19	9.1	20
S2	Be	0.66	24	17	20
S2	Cd	Not Set	34	NA	Not Set
S2	Cr	24.5	16	9.9	20
S2	Cu	23.5	11	9.9	20
S2	Hg	0.243	22	20	20
S2	La	3.96	9.9	13	20
S2	Mn	279	14	6.9	20
S2	Mo	11.7	19	11	20
S2	Na	Not Set	45	9.5	Not Set
S2	P	157	12	7.5	20
S2	Pb	18.9	15	10	20
S2	Rb	5.0	20	13	20
S2	Se	2.41	18	14	20
S2	Sn	11.0	15	11	20
S2	Tl	1.68	17	15	20
S2	V	18.9	11	10	20
S2	Zn	53.3	14	8.8	20
S2	Moisture Content	36.2%	24	Not applicable	20
S3	Ca	2310	14	5	15
S3	Fe	13100	11	3.8	10
S3	K	2740	13	4.9	15
S3	Mg	1290	13	5.4	15
S3	Na	35.9	15	9.3	15
S3	P	1150	10	5.5	15
S3	S	533	16	6.2	15
S3	Sr	17.7	17	10	15
S3	Colwell K	Not Set	NA	NA	Not Set
S3	Colwell P	189	5.8	7.3	10
S3	EC	286 µS/cm	5.4	6.8	10
S3	Exchangeable Ca	7.4 cmol(+)/kg	20	12	20
S3	Exchangeable K	3.20 cmol(+)/kg	18	13	20
S3	Exchangeable Mg	2.37 cmol(+)/kg	19	14	20
S3	Exchangeable Na	Not Set	34	NA	Not Set
S3	Extractable B	Not Set	NA	NA	Not Set
S3	PBI	Not Set	NA	NA	Not Set
S3	pH	Not Set	7.7	NA	Not Set
S3	TC	60900	8.9	3	10
S3	TN	5650	12	4.4	10
S3	TOC	57900	8.8	3.1	10
S3	Total P	Not Set	NA	NA	Not Set

*Robust between-laboratory CV with outliers removed. NA = Not Applicable.

6.4 E_n-score

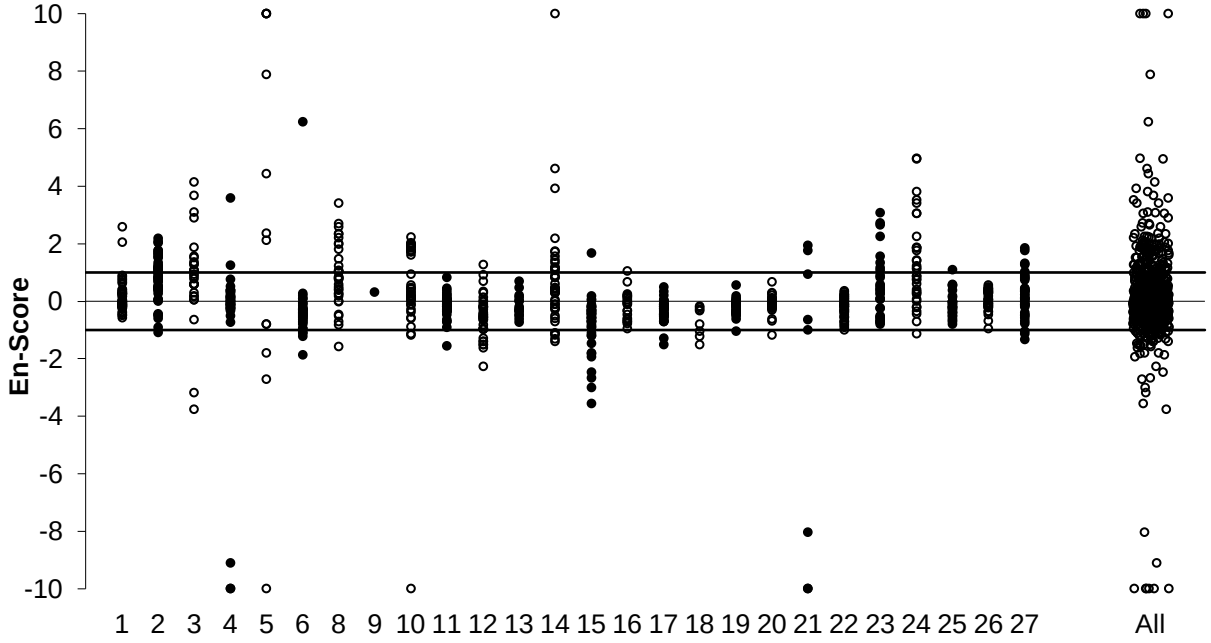
E_n-scores can be interpreted in conjunction with z-scores. The E_n-score indicates how closely a result agrees with the assigned value considering the respective uncertainties. An unacceptable E_n score for an analyte can either be caused by an inappropriate measurement, an inappropriate evaluation of measurement uncertainty, or both.

The dispersal of participants' E_n-scores is graphically presented in Figure 69. Where a laboratory did not report an expanded uncertainty with a result, an expanded uncertainty of zero (0) was used to calculate the E_n-score.

Of 813 results for which E_n-scores were calculated, 633 (78%) returned an acceptable score of $|E_n| < 1$ indicating agreement of the participants' results with the assigned values within their respective expanded measurement uncertainties.

Laboratory 11 had the highest number of acceptable E_n-scores at 46 out of 47 reported.

All results reported by Laboratories **22** (45), **26** (35), **13** (15) and **9** (1) returned acceptable En-scores.



Scores of >10 or < -10 have been plotted as 10 or -10.

Figure 69 E_n-Score Dispersal by Laboratory

6.5 Participants' Results and Analytical Methods for Acid Extractable Elements

Sample S1 was dried soil while Sample S2 was moist sludge which required a good preparation procedure to subsample a representative test portion. An appropriate calculation/reporting procedure was also required for this sample as participants were asked to report results corrected for moisture content.

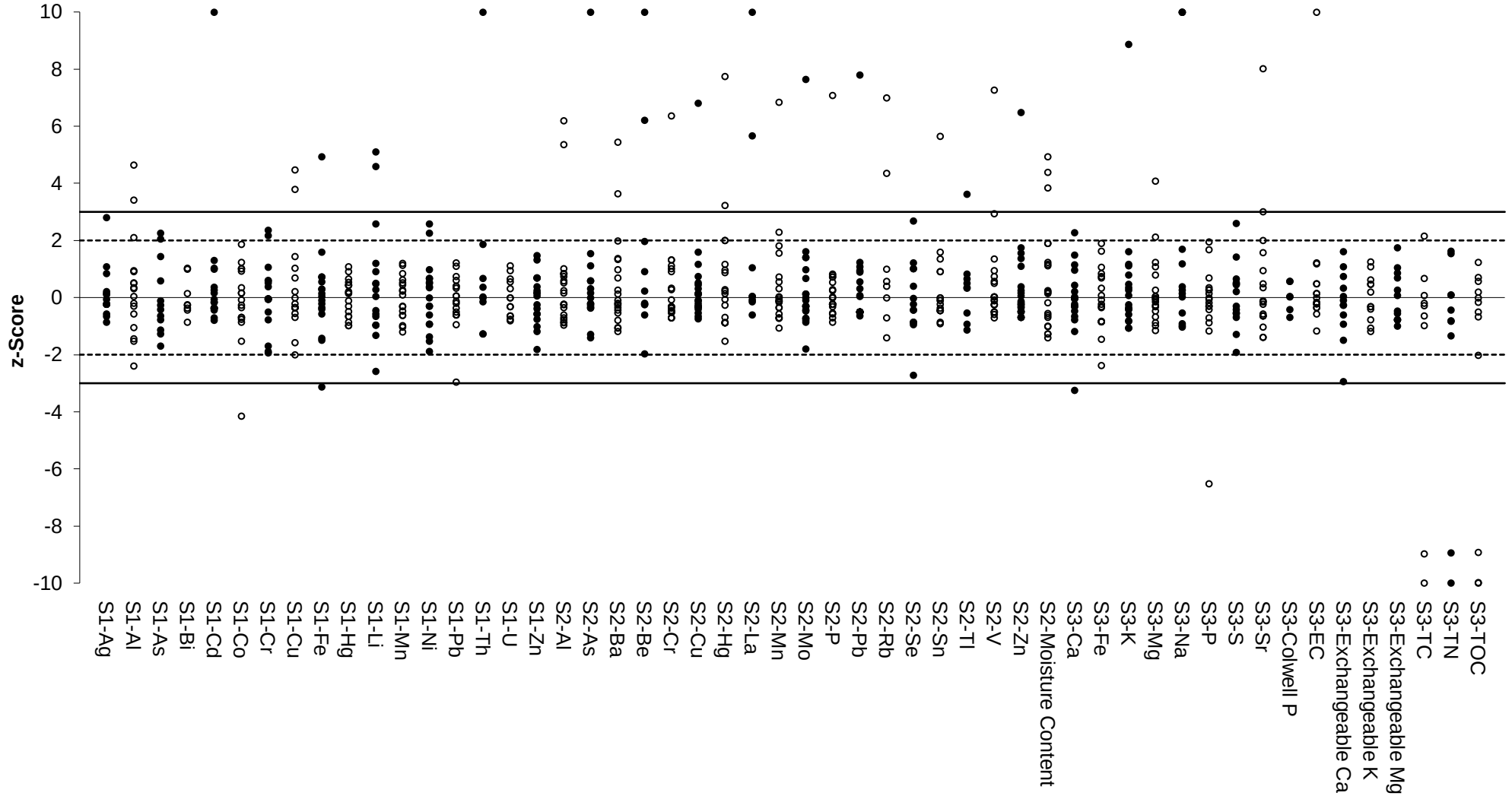
A summary of participants' results, and performance is presented in Tables 82 to 84 and in Figures 68 to 71.

Boron in S1 and S2, Cs, Sb and Se in S1 and Cd and Na in S2 challenged participants' analytical technics. No agreement was found between results reported by participants for these elements.

Subsampling a representative test portion from sludge Sample S2 and reporting results corrected for moisture content, proved challenging for some of the participating laboratories.

The results reported by laboratory 10 in Sample S2 were consistently higher than the assigned value by the same factor of approximately 2. These results were not included in statistical calculation and in the analysis of the extraction methods and instrumental techniques employed by participants.

The method descriptions provided by participants are presented in Tables 2 and 11 while the instrumental conditions are presented in Appendix 5.



Scores of >10 or <-10 have been plotted as 10 or -10.

Figure 70 z-Score Dispersal by Test

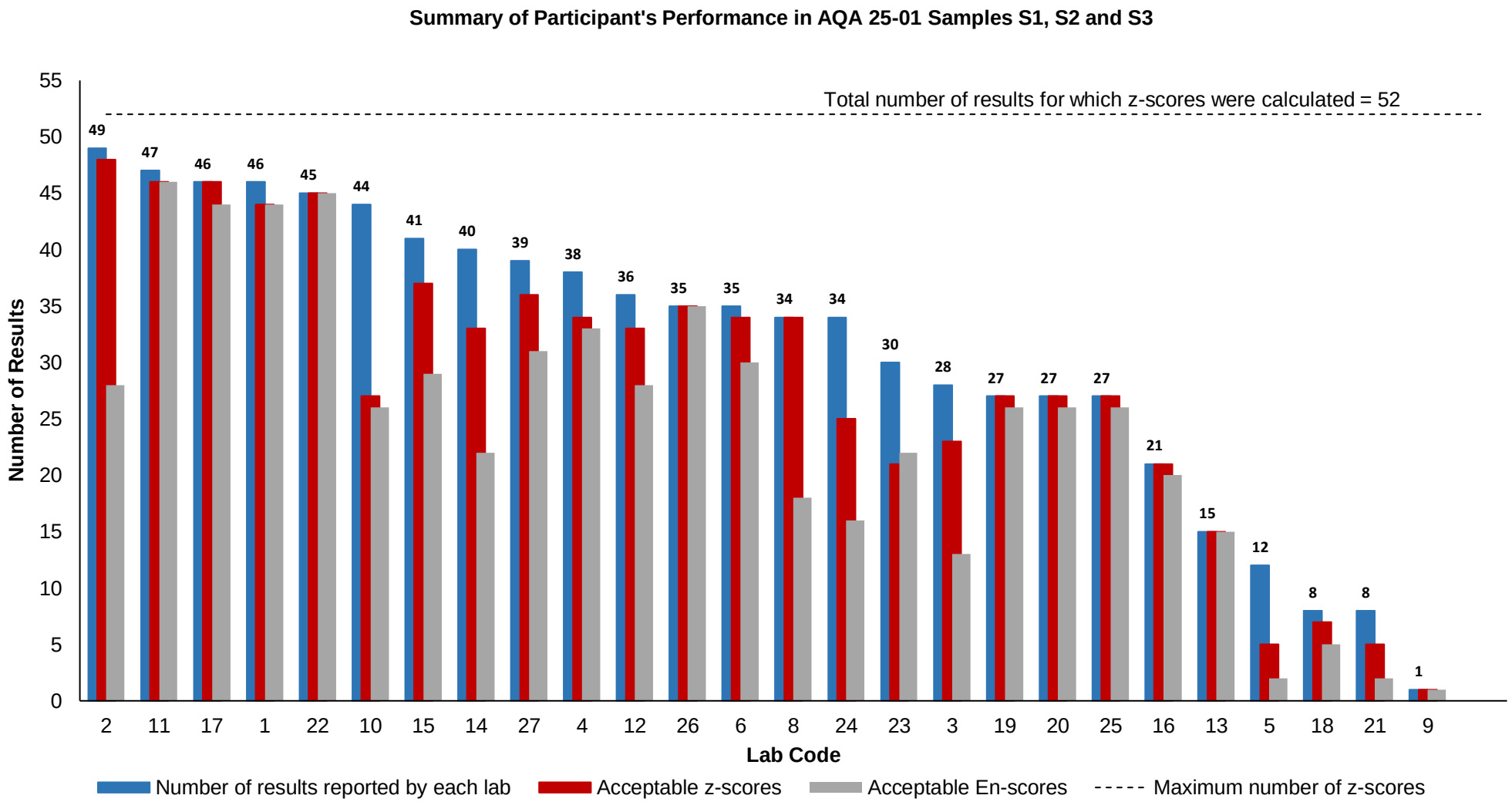


Figure 71 Summary of Participants' Performance in AQA 25-01

Table 82 Summary of Participants' Results and Performance for Sample S1

Lab Code	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	B (mg/kg)	Bi (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cs (mg/kg)	Cu (mg/kg)	Fe (mg/kg)
AV	3.10	20200	3.49	Not Set	0.952	0.635	11.8	36.2	Not Set	14.5	23300
HV	3.02	NA	3.99	32.7	1.00	0.627	13.1	43.0	3.33	15.7	26900
1	3.0	22300	3.3	22.5	0.918	0.567	11.4	35.9	2.96	14.2	22500
2	3.49	21600	4.93	33	0.89	0.76	13	39.1	NT	16	24600
3	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
4	NR	20400	<15	25	NR	2.25	11	36	NR	14.5	22400
5	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
6	3.17	17900	2.61	24.0	0.83	0.630	11.49	33.5	2.00	13.7	23100
8	2.84	21500	2.95	20.6	0.90	0.65	12.9	39.4	NT	15.5	25000
9	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
10	3.2	14364.3	5.07	9.97	< 3	0.73	12.21	26.01	NT	12.21	19825.5
11	3	19000	<4	17	<1	0.6	12	36	2	14	22000
12	4.4	24038	2.3	14.2	NT	0.67	6.9	36	NT	NT	24000
13	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
14	3.6	23900	3.9	34	1.1	0.66	14	48	NR	21	34800
15	3.00	10500	2.70	17.3	0.914	0.593	10.78	25.7	0.750	11.6	16000
16	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
17	3	14000	<4	20	<1	0.6	10	32	1.5	14	20000
18	NT	NT	3.2	NT	NT	0.6	NT	27	NT	14	NT
19	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
20	3.07	19400	3.42	21.2	0.972	0.620	11.7	35.9	NT	14.8	22800
21	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
22	3	16000	<4	21	<1	0.6	12	36	<1	14	24000
23	2.8	34000	<5	35	NT	<1	13	49	NT	20	27000
24	2.7	39000	4.5	36	< 2	0.62	11	42	4.0	14	25000
25	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
26	3.15	22200	3.05	21	1.095	0.7345	13.25	38.25	2.3	16.6	23650
27	<5	28700	<5	27.5	NR	0.56	10.9	39.5	NR	13.5	23400

Shaded cells are results which returned a questionable or unacceptable z-score. AV = Assigned Value, HV = Homogeneity Value; NA = Not Available, NT = Not Tested, NR = Not Reported.

Table 82 Summary of Participants' Results and Performance for Sample S1 (continued)

Lab Code	Ga (mg/kg)	Hg (mg/kg)	Li (mg/kg)	Mn (mg/kg)	Ni (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Th (mg/kg)	U (mg/kg)	Zn (mg/kg)
AV	Not Set	0.460	9.9	341	20.9	29.8	Not Set	Not Set	6.7	3.20	159
HV	10.8	0.424	13.4	384	23.7	30.7	Not Set	1.92	7.15	3.18	175
1	8.78	0.416	12.3	325	22.1	29.2	40	1.57	6.69	2.94	153
2	NT	0.50	11.7	359	22.6	30.8	113	1.56	6.73	3.41	180
3	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
4	NR	0.52	10.45	349	19	28	<100	<100	NR	NR	161.5
5	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
6	NT	0.433	8.6	344	20.0	28.3	31.9	1.3	NT	2.96	165
8	NT	0.37	9.0	362	23.0	31.0	86	0.85	7.2	3.20	170
9	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
10	NT	0.477	8.77	356.23	16.14	33.1	7.75	< 2	NT	NT	161.52
11	8	0.5	10	320	20	27	57	<2	5	3	150
12	NT	0.4	7.3	300	18	28	NT	2.4	NT	3.5	147
13	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
14	NR	0.45	19	382	29	30	NR	NR	7.6	3.1	155
15	NT	0.37	4.80	308	16.6	28.7	8.10	0.884	NT	3.10	160
16	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
17	8	0.56	8	320	18	28	48	<2	5	3	150
18	NT	0.4	NT	NT	15	21	NT	NT	NT	NT	130
19	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
20	NT	0.382	10.9	331	20.9	29.4	78.8	1.25	NT	3.38	163
21	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
22	8	0.51	8	350	22	32	42	<2	6.5	3.3	170
23	NT	0.5	NT	370	28	30	62	<5	NT	NT	170
24	12	0.48	20	330	24	31	76	2.5	30	3.2	140
25	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
26	NR	0.545	10.85	379.5	23	33.45	48.85	2.2	NR	3.56	182.5
27	NR	0.474	15.0	306	22.5	31.6	28.7	<3	9.2	<5	143

Shaded cells are results which returned a questionable or unacceptable z-score. AV = Assigned Value, HV = Homogeneity Value; NT = Not Tested, NR = Not Reported.

Table 83 Summary of Participants' Results and Performance for Sample S2

Lab Code	Al (mg/kg)	As (mg/kg)	B (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Cd (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Hg (mg/kg)	La (mg/kg)	Mn (mg/kg)
AV	5810	3.76	Not Set	42.8	0.66	Not Set	24.5	23.5	0.243	3.96	279
HV	5790	3.89	7.44	55.5	0.738	0.735	29.0	28.2	0.325	NA	362
1	6800	3.89	6.76	51.2	0.629	0.538	25.9	25.6	NR	8.45	297
2	6670	4.92	8.5	59.8	0.92	0.90	29.5	29	0.34	NT	366
3	6430	4.6	7.4	54.5	0.69	0.96	31	25	0.4	NT	407
4	5525	<15	<5	40.5	<1	1.5	21	23	0.24	NR	273.5
5	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
6	4920	3.48	5.3	33.8	0.58	0.468	22.3	22.5	0.169	3.85	247
8	7000	4.2	4.7	54.3	0.78	0.80	30.0	31.0	0.25	NT	380
9	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
10	12034.5	11.46	8.09	89.42	1.48	1.36	55.69	55.5	0.619	NT	661.36
11	4700	<4	<10	42	<1	0.4	22	22	0.2	4	220
12	5560	2.8	3.3	38.3	0.4	0.4	22	20	<0.2	NT	280
13	5400	3.6	< 10	45	< 2	0.7	21	22	0.29	NT	310
14	5100	4.2	8.8	48.7	4.0	0.58	29	27	0.23	NR	260
15	4810	2.70	5.19	32.6	0.628	0.538	22.7	24.2	0.20	3.48	260
16	6790	3.75	<10	43.9	<2	<0.4	22.2	20.4	0.254	NT	238
17	4800	<4	5	36	<1	0.4	21	22	0.2	4	240
18	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
19	6100	3.55	< 10	41.2	< 2	0.445	22.1	21.6	0.286	NT	273
20	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
21	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
22	5000	<4	<10	39	<1	0.5	23	21	0.2	3.9	280
23	6000	NT	NT	NT	<0.6	<1	23	24	0.2	NT	240
24	13000	4.0	13	74	< 2	0.68	31	26	0.34	16	320
25	6500	3.6	< 10	41	< 2	0.6	23	22	0.3	NT	270
26	5555	3.5	4.6	39.85	0.635	0.5405	24.15	24.2	0.21	4.795	272
27	6770	<5	<10	33.6	<5	0.81	26.1	23.1	0.257	<5	277

Shaded cells are results which returned a questionable or unacceptable z-score. AV = Assigned Value, HV = Homogeneity Value; NA = Not Available, NT = Not Tested, NR = Not Reported.

Table 83 Summary of Participants' Results and Performance for Sample S2 (continued)

Lab Code	Mo (mg/kg)	Na (mg/kg)	P (mg/kg)	Pb (mg/kg)	Rb (mg/kg)	Se (mg/kg)	Sn (mg/kg)	Tl (mg/kg)	V (mg/kg)	Zn (mg/kg)	Moisture Content (%)
AV	11.7	Not Set	157	18.9	5.0	2.41	11.0	1.68	18.9	53.3	36.2
HV	12.7	47.1	175	21.3	NA	2.48	12.2	NA	21.1	65	39.3
1	11.7	NR	166	20.1	9.35	2.2	10.8	1.79	21.7	57.4	44.3
2	15	<50	183	22.5	NT	2.61	13	1.96	20.8	72	31.3
3	15	38	165	21	NT	3.7	13	1.90	19	65	37.3
4	9.85	<50	157.5	<25	NR	<100	<50	<2	18	51.5	44.7
5	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
6	10.6	<40	147	17.0	5.4	2.0	10.2	1.37	17.0	48.2	68
8	15.5	51.3	174	23.6	NT	2.4	14.5	1.85	22.5	70.0	37.5
9	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	38.0
10	29.58	74	379.165	48.4	NT	< 2	23.44	NT	46.38	122.42	72
11	12	23	130	17	6	3	10	<2	19	46	27
12	NT	NT	150	17	NT	2.3	NT	1.3	17	51	NR
13	11	16	140	17	NT	2.2	11	< 10	19	55	31.74
14	11.5	930	180	NR	NR	NR	11	1.8	24	56	37.8
15	7.50	<43	150	19.1	4.29	1.10	9.1	<1.60	16.2	48.2	45.1
16	10.0	34.3	139	16.5	NT	<2	<10	<10	18.6	49.7	28.9
17	10	35	135	17	5	2	9	<2	18	46	26
18	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
19	10.7	33.3	157	17.0	NT	< 2	< 10	< 10	16.7	50.7	32.2
20	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
21	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
22	11	11	150	17	3.6	2.9	10	<2	19	46	29
23	9.7	400	NT	17	NT	<5	10	NT	18	48	50
24	14	< 100	180	23	12	2.9	14	2.9	30	68	50
25	12	33	150	17	NT	< 2	10	< 10	17	50	35.0
26	11	NR	150	19.2	5.575	1.95	10.5	1.5	18.5	51.9	27
27	13.3	<50	182	22.3	NR	<3	10.8	<5	21.1	53.9	64.1

Shaded cells are results which returned a questionable or unacceptable z-score. AV = Assigned Value, HV = Homogeneity Value; NT = Not Tested, NR = Not Reported.

Table 84 Summary of Participants' Results and Performance for Sample S3

Lab Code	Ca (mg/kg)	Fe (mg/kg)	K (mg/kg)	Mg (mg/kg)	Na (mg/kg)	P (mg/kg)	S (mg/kg)	Sr (mg/kg)	Colwell K (mg/kg)	Colwell P (mg/kg)	EC (µS/cm)
AV	2310	13100	2740	1290	35.9	1150	533	17.7	Not Set	189	286
HV	2370	13500	2950	1290	38.9	1220	580	16.0	NA	NA	NA
1	2320	12800	2850	1280	NR	1140	575	21.9	NR	NR	280
2	2830	14500	3220	1500	<50	1440	489	20.2	1140	190	286
3	1184	14089	3401	1529	31	1486	NT	23	NT	NT	320
4	2645	13550	2935	1445	<50	1195	571.5	19	NR	176	290
5	2710.28	15236.17	6389.31	2079.12	169.57	25.95	NR	25.68	NR	NR	1944.51
6	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
8	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
9	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
10	2457.67	14209.63	2773.2	1237.6	42.3	1270.667	646.6	18.65	NT	189.5	276
11	2300	12000	2600	1300	33	1100	550	16	1300	200	300
12	1900	10000	2500	1070	45	950	380	16	NT	NT	280
13	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
14	2040	15600	2410	1230	2160	1080	430	15	NR	NR	NR
15	2080	11200	2400	1120	<29.6	1030	510	14	NT	NT	NT
16	2150	13000	2890	1300	37.3	1200	NT	17.3	NT	NT	321
17	2200	12000	2300	1100	36	1000	500	16	NR	NR	270
18	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
19	2297	12648	2580	1262	30.39	1174	478	17.43	NT	NT	252.8
20	2210	13200	2570	1160	36.7	1120	570	17.3	NT	NT	NT
21	NR	NR	NR	NR	NR	NR	NR	NR	NR	181	276
22	2300	12000	2300	1200	38	1100	490	14	NT	NT	300
23	3100	14000	3200	1700	480	NT	741	39	NT	NT	280
24	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
25	2382	12031	2636	1285	30.7	1149	NT	16.2	NT	NT	281.37
26	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
27	2230	12700	3070	1340	<50	1210	586	17.1	NR	200	290

Shaded cells are results which returned a questionable or unacceptable z-score. AV = Assigned Value, HV = Homogeneity Value; NA = Not Available, NT = Not Tested, NR = Not Reported.

Table 84 Summary of Participants' Results and Performance for Sample S3 (continued)

Lab Code	Exchangeable Ca (cmol(+)/kg)	Exchangeable K (cmol(+)/kg)	Exchangeable Mg (cmol(+)/kg)	Exchangeable Na (cmol(+)/kg)	Extractable B (mg/kg)	PBI+ColP (mg/kg)	pH	TC (mg/kg)	TN (mg/kg)	TOC (mg/kg)	Total P (mg/kg)
AV	7.4	3.20	2.37	Not Set	Not Set	Not Set	Not Set	60900	5650	57900	Not Set
HV	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	NR	NR	NR	NR	NR	NR	5.3	55000	5700	55000	NR
2	6.04	2.95	2.15	0.07	0.45	98	5.63	61400	6520	61200	NR
3	3.06	3.9	2.87	0.24	NT	NT	6.12	NT	NT	NT	NT
4	7.26	3.5	2.5	<0.1	1.04	98	5.89	5.94	0.80	5.96	NR
5	6.51	2.44	2.11	0.06	83.35	NR	6.16	NR	NR	46241.68	25.95
6	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
8	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
9	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
10	7.902	3.321	2.777	0.0815	NT	NT	5.32	NT	5183.3	101.08	1146.06
11	7	4	2	<0.2	NR	NR	6.1	74000	5200	62000	NR
12	NT	NT	NT	NT	NT	NT	6.5	NT	NT	NT	NT
13	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
15	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
16	NT	NT	NT	NT	NT	NT	5.27	NT	NT	NT	NT
17	9	3	2	<1	NR	NR	6.1	65000	5400	59000	NR
18	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
19	7.48	2.52	2.41	<0.15	NT	NT	5.38	57000	NT	57000	NT
20	NT	NT	NT	NT	NT	NT	NT	59200	6570	54000	1270
21	9.8	3.6	3.2	0.1	NR	NR	6.02	6300	600	6300	NR
22	7	3	2	<0.1	NT	NT	6.2	NT	4900	65000	NT
23	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
24	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
25	8.5	3.5	2.7	< 0.1	NT	NT	5.48	59750	NT	57820	NT
26	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
27	5.2	2.7	1.9	0.066	NR	NR	5.7	NR	5700	NR	NR

Shaded cells are results which returned a questionable or unacceptable z-score. AV = Assigned Value, HV = Homogeneity Value; NA = Not Available, NT = Not Tested, NR = Not Reported.

Moisture Content and Reporting Results on a Dry Weight Basis (Corrected for Moisture Content).

There was large number of laboratories whose reported results in S2 were biased low or high, although not significantly. These laboratories are advised to review the subsampling procedure as this pattern was noticed for their results reported in Sample S2 only.

Laboratories 6, 10, and 27 may have reported results for solid content (fraction dry mass) rather than the moisture content (loss on evaporation).

Laboratory 10 may have also reported corrected results for solid content rather than moisture content in Sample S2 as all results were higher than the assigned value by approximately same factor (about 2, 72% divided by 36.2%).

The mass fraction of elements in the sample is calculated by multiplying the concentration of analyte in the final solution by the dilution factor and further dividing by the amount of sample taken for analyses. If the sample is analysed as received, then to correct for moisture content the result is divided by the percentage of solid content in the sample multiplied by 100. If analysis was conducted upon an already dried sample, then correction for moisture content is no longer required.

Extraction Methods

The request was for acid extractable elements; NMI PT studies of metals in soil focus on 'pseudo-total' analyses of elements in soil rather than on true total metal content because when an assessment of the anthropogenic impact of the metal content in a soil sample is made, aggressive digestion regimes (HF, high digestion temperature, high ratio acid to sample size) can lead to misleading conclusions since metals can be extracted from the fraction naturally present in the soil matrix.[5, 16-19] While an aggressive digestion regime can produce high, misleading results, weak digestion regimes (low digestion temperature, reduced digestion time, diluted acids and/or a low ratio of acid to sample size) may extract just a fraction of the contaminants from the soil.

In the present study the majority of participating laboratories used a sample size of between 0.5 g to 1 g, an extraction temperature of 90ºC to 100ºC, an extraction time of between 60 min to 120 min and a ratio HCl to HNO_3 of 1:1 or 3:1.

All participants used both HNO_3 and HCl as extraction agents. Laboratory 5 used dilute acids and only reported results for acid extractable elements in S3.

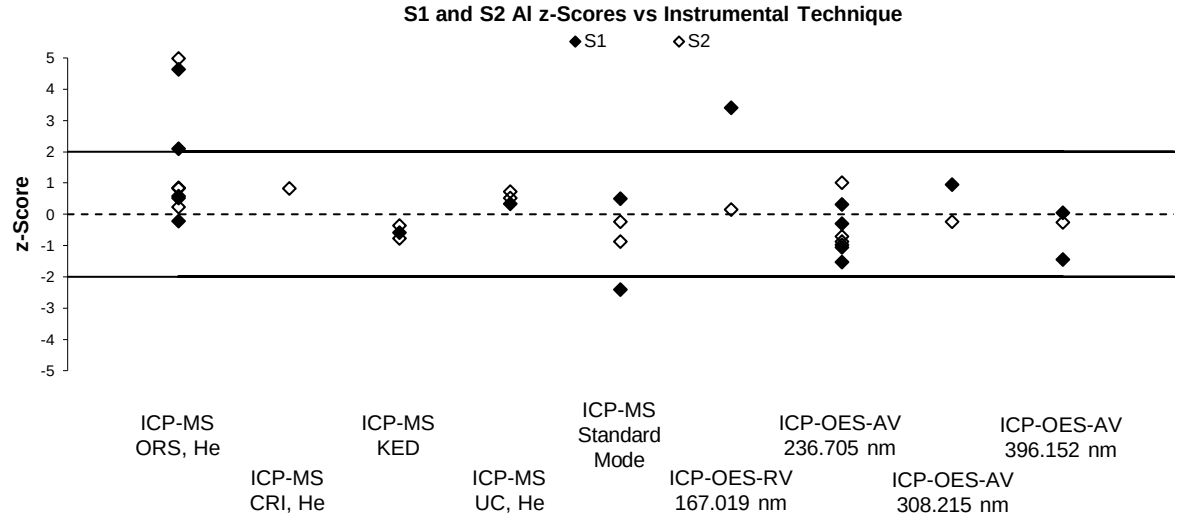
While most laboratories used a ratio of acid to sample size from 6:1 to 12:1, Laboratories 2 and 24 used a high ratio of acid to sample size, of 25:1 and 24:1 respectively. Most of the results reported by them were higher than the assigned value and spike value where applicable (Figure 68). Aggressive digestion regime may favour metal extraction from silica lattice.

Laboratories 6 and 15 digested their sample for 50 min and 30 min respectively. They also use a low ratio of acid to sample size of only 4:1. The results reported by them in both samples S1 and S2 were biased low.

Individual Element Commentary

Aluminium Dilution/calculation problems may explain the unacceptable Al results reported by Laboratory 24 in S1 and S2. Both results were higher than the assigned value by almost the same factor of 2.

Plots of results for Al versus instrumental technique used by participants are presented in Figure 72.



z-score of 6.19 has been plotted as 5.

Figure 72 S1 and S2 Al Results vs. Instrumental Technique

Antimony spike value in S1 was 101 mg/kg. No assigned value could be set for this test because the results were too variable (between 7.75 mg/kg to 113 mg/kg).

The results reported by Laboratories 2, 8, 20, 24 and 23 were in relatively good agreement with the spike value (Figure 73).

Laboratory 2 recovered 112% of the spiked Sb in the soil sample S1. Their digestion regime involved a digestion temperature of 120ºC over 60 min, no water addition, and a ratio of concentrated acid (HNO_3+HCl) to sample size of 25 to 1.

Laboratories who recovered 56% of the spike value or less used a ratio sample size to total amount of acid of between 3 to 6. Weak digestion regime may explain the poor recovery.

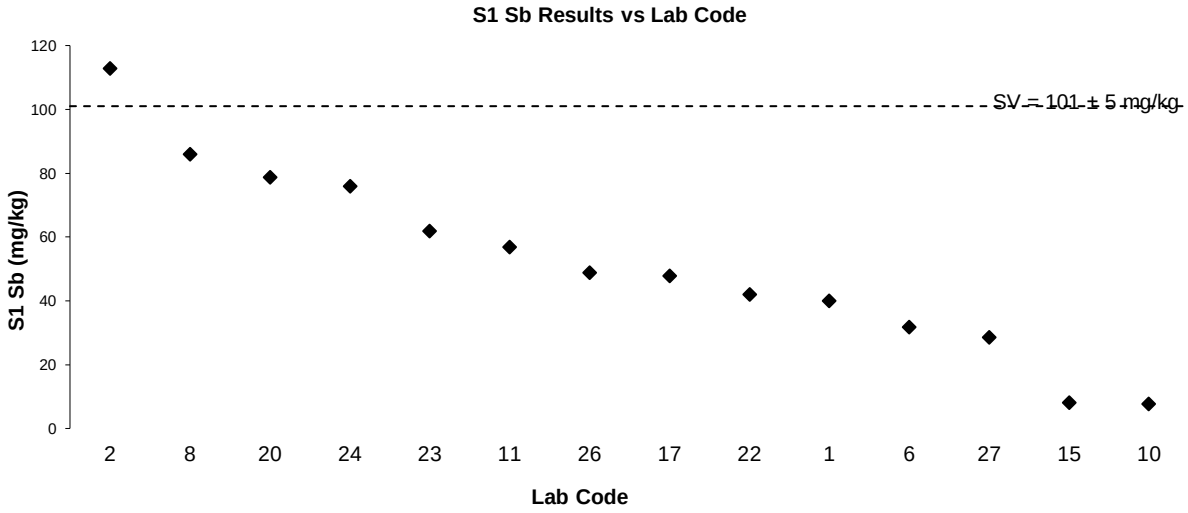


Figure 73 S1 Sb Results vs. Laboratory Code Number

Plots of participants' results versus instrumental technique are presented in Figure 74. There was no evident relationship between participants' results for Sb and the instrumental technique used.

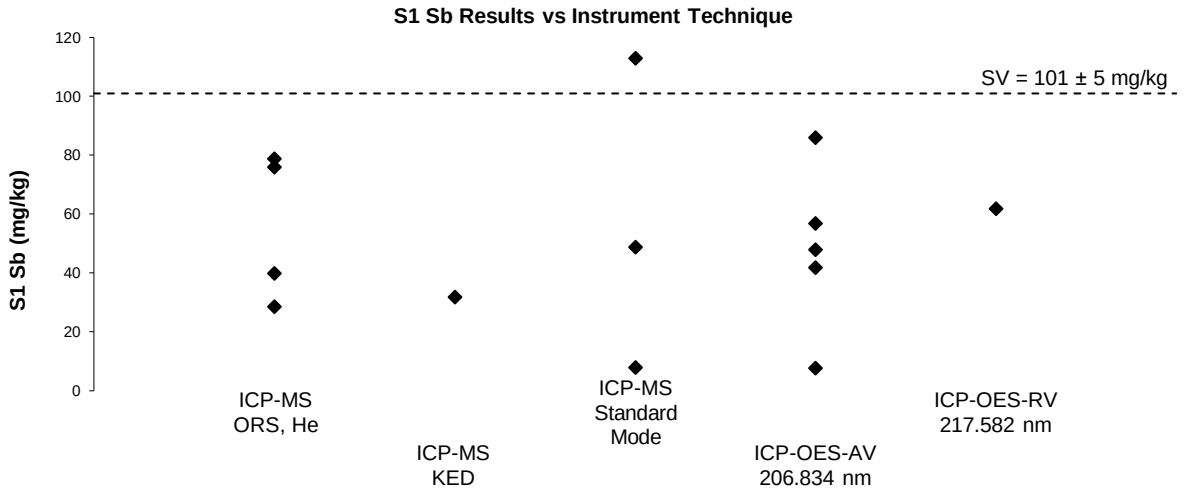


Figure 74 S1 Sb Results vs. Instrumental Technique

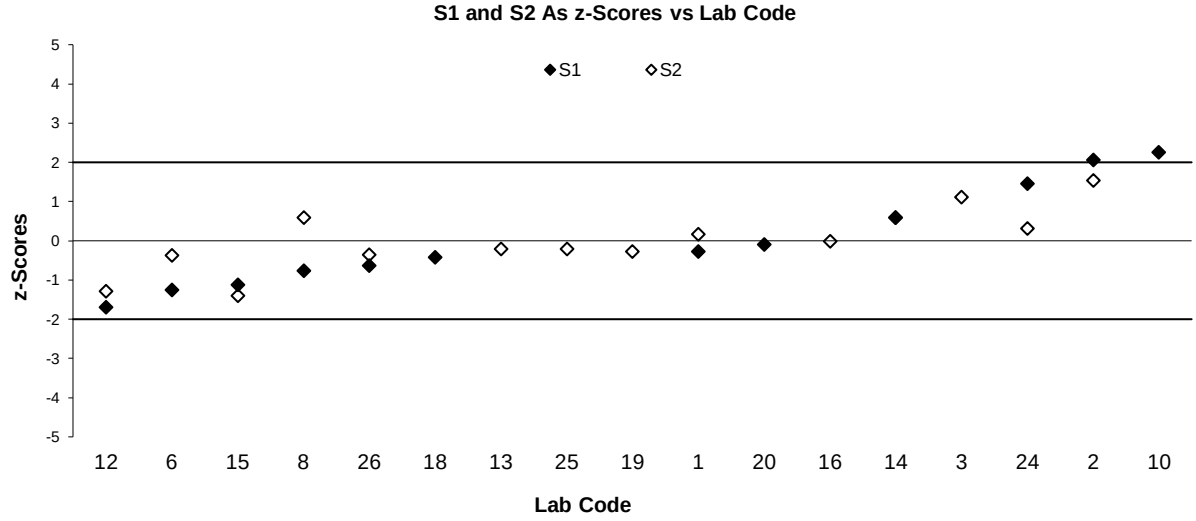


Figure 75 S1 and S2 As z-Scores vs. Laboratory Code Number

Arsenic All results reported for As in S1 and S2 returned acceptable z-scores but two.

Laboratory 2 reported high As results in both study samples (Figure 75). The result reported by them in S2 had an acceptable z-score but an unacceptable E_n-score. Similarly, the results reported by Laboratory 12 were both lower than the assigned value, and both returned acceptable z-scores but not acceptable E_n-scores.

These laboratories should assess their method and laboratory bias and if significant to correct for it.[10]

Figure 76 presents plots of participants' z-scores versus the instrumental technique used. Participants used ICP-MS in collision mode, ICP-MS/MS in reaction mode with O_2 or ICP-OES with a wavelength of 188 nm.

Boron was one of the analytes that challenged most participants' analytical techniques. This may be due to the boron level in the two study samples S1 and S2 being relatively low. The results reported by participants were variable and no assigned value could be set. Plots of participants' results in the two study samples versus instrumental techniques used are presented in Figures 77 and 78.

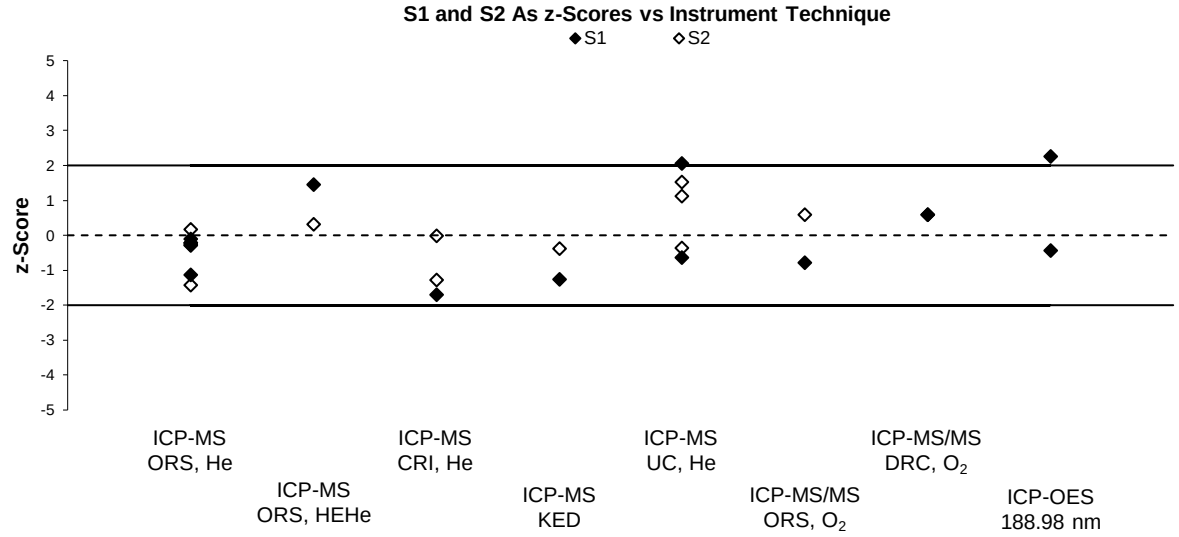


Figure 76 As z-Scores in S1 and S2 vs. Instrumental Technique

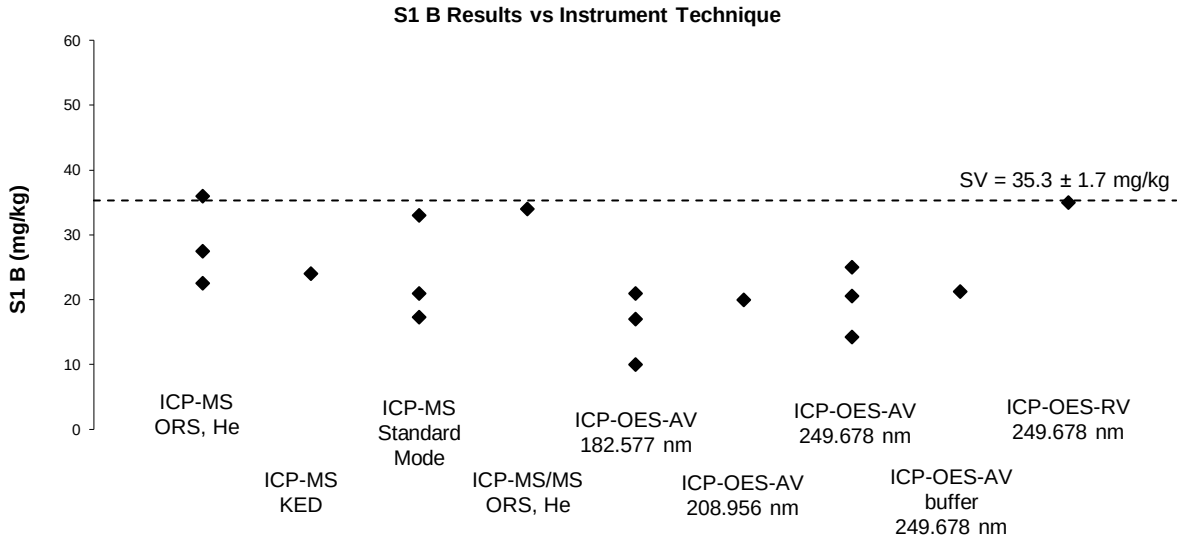


Figure 77 B Results in S1 vs. Instrumental Technique

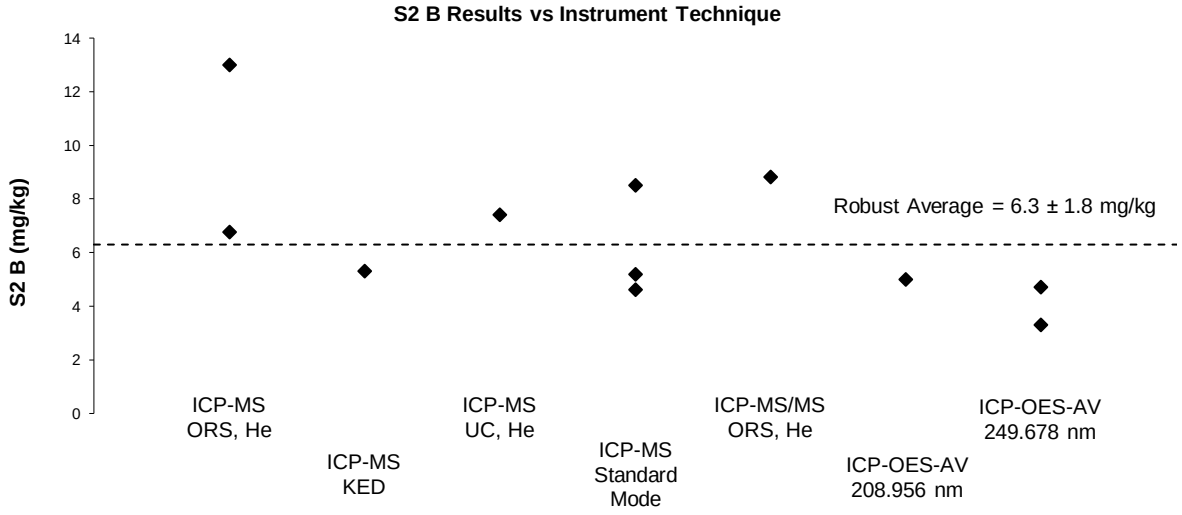


Figure 78 B Results in S2 vs. Instrumental Technique

Of 17 results reported for B in S1, 9 were in relatively good agreement with spike value (35.3 mg/kg) and the homogeneity value (32.7 mg/kg), see Figure 79.

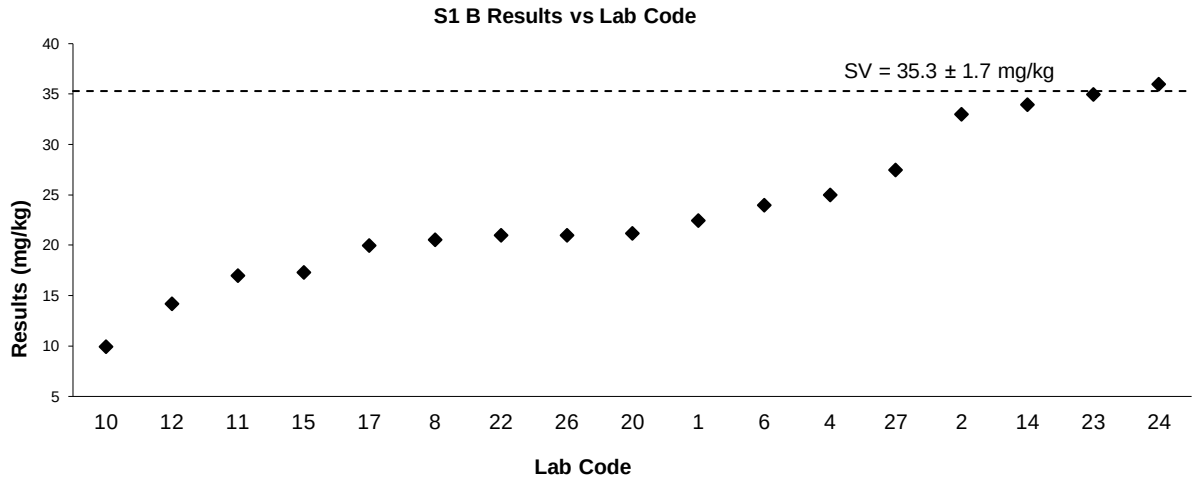
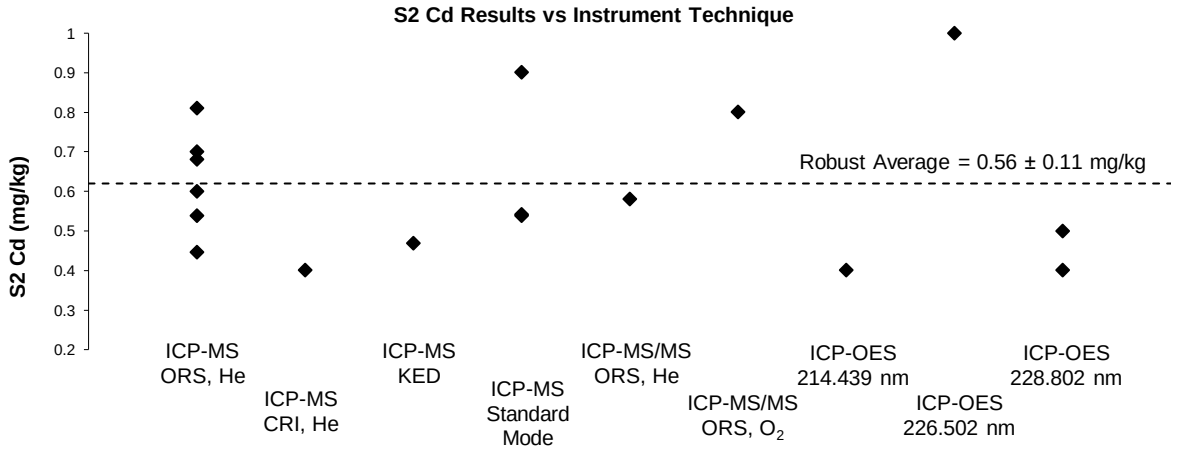


Figure 79 B Results in S1 vs. Laboratory Code Number

Cadmium level in S2 was low. The robust average of participants' results was 0.62 mg/kg and the homogeneity value was 0.735 mg/kg. The reported results varied from 0.4 mg/kg to 1.5 mg/kg; no assigned value was set for this test. Figure 80 presents plots of participants' results versus instrumental technique used.



*Laboratory 4 result of 1.5 mg/kg has been plotted as 1 mg/kg.

Figure 80 S2 Cd Results vs. Instrumental Technique

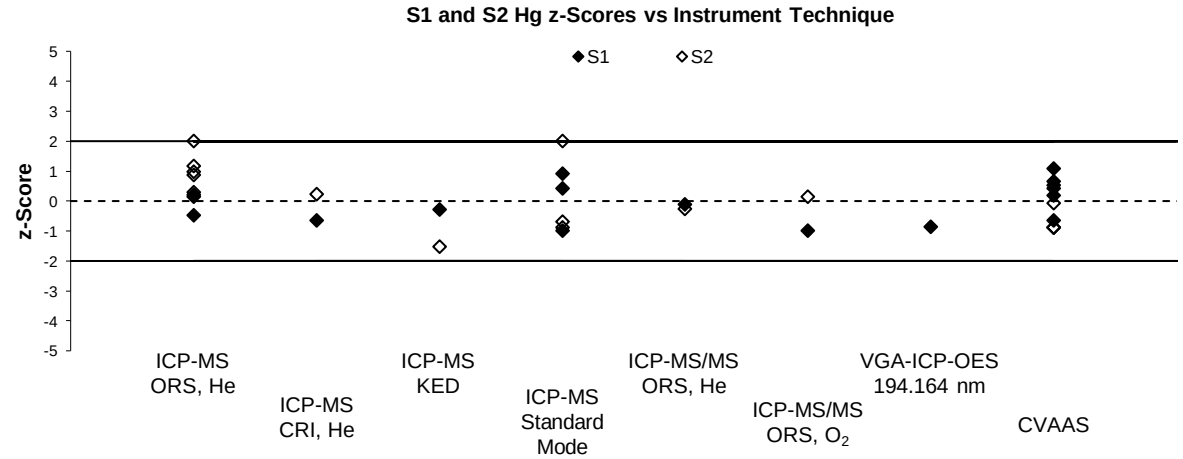


Figure 81 S1 and S2 Hg Results vs. Instrumental Technique

Mercury Participants used a wide variety of analytical techniques for Hg measurements, where ICP-MS in collision mode and CVAAS were the preferred techniques (Figure 81).

Chromium, Iron and Nickel are three elements which are strongly dependent on the digestion regime. Participants' performance for these elements in the three study samples are presented in Figures 82 to 84. Participants whose z-scores were all on the same side of zero line may need to review their extraction regime.

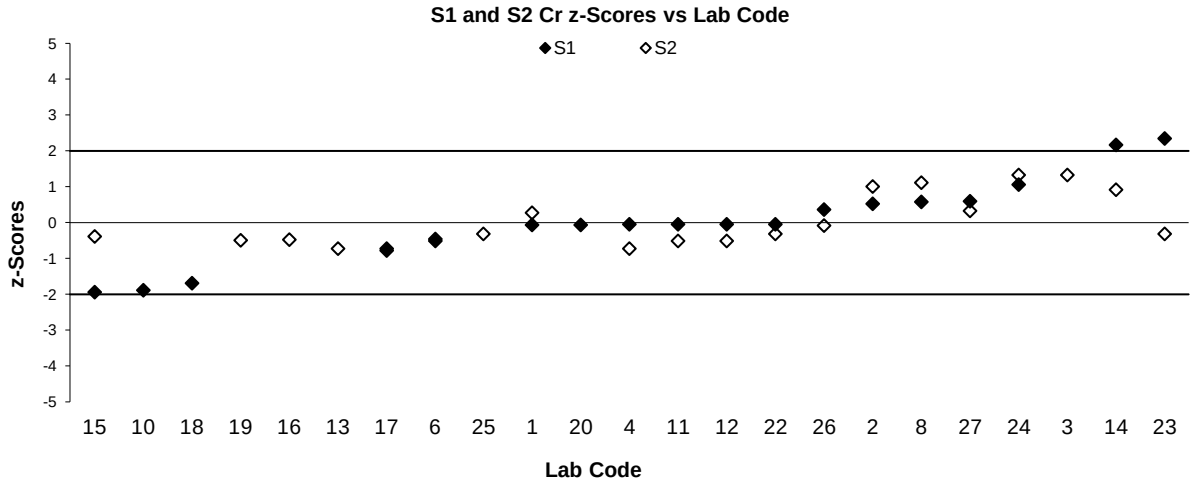


Figure 82 S1 and S2 Cr z-Scores vs. Laboratory Code Number

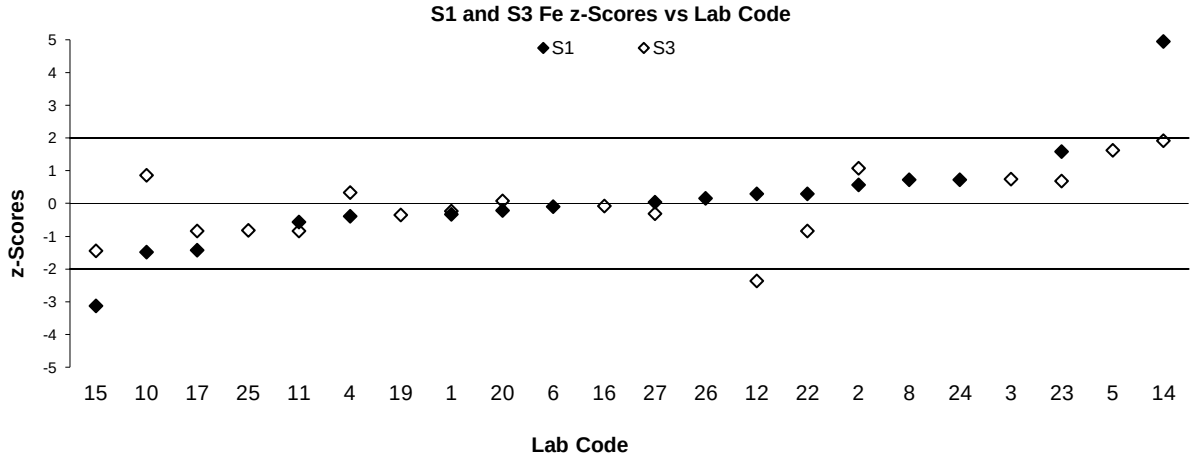


Figure 83 S1 and S3 Fe z-Scores vs. Laboratory Code Number

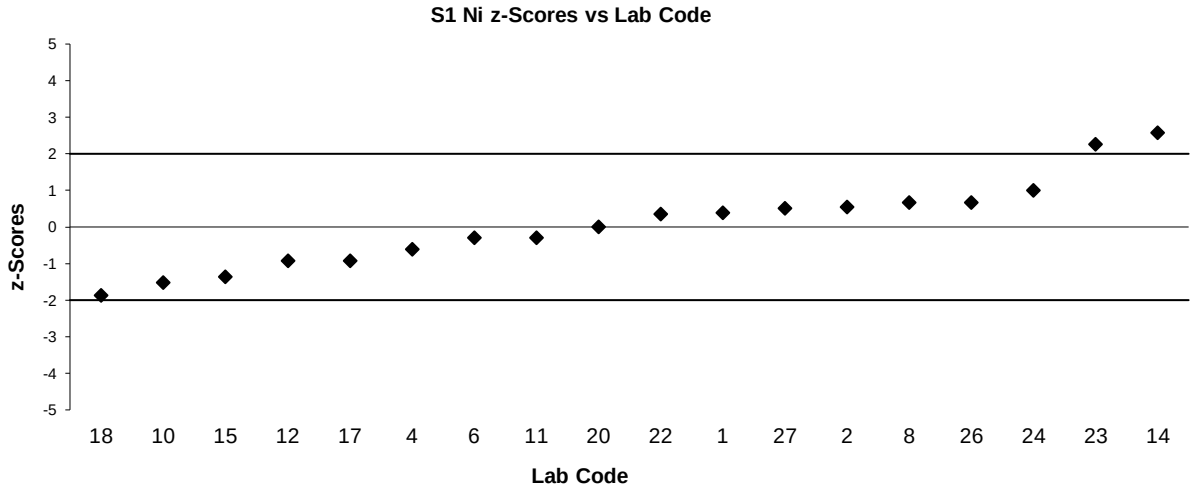


Figure 84 S1 Ni z-Scores vs. Laboratory Code Number

Selenium analysis is challenging due to there being multiple sources of significant interference. This is especially problematic at low levels where any unresolved interference can have a more significant effect on results.

Only 9 laboratories reported results for Se in S1; results were too variable, and hence no assigned value could be set.

Plots of participants' results versus instrumental technique used are presented in Figure 85. Laboratories used 4 different instrumental techniques: ICP-MS in collision mode with He, ICP-MS in collision mode with high energy He, ICP-MS in reaction mode with H_2 and ICP-MS/MS with O_2.

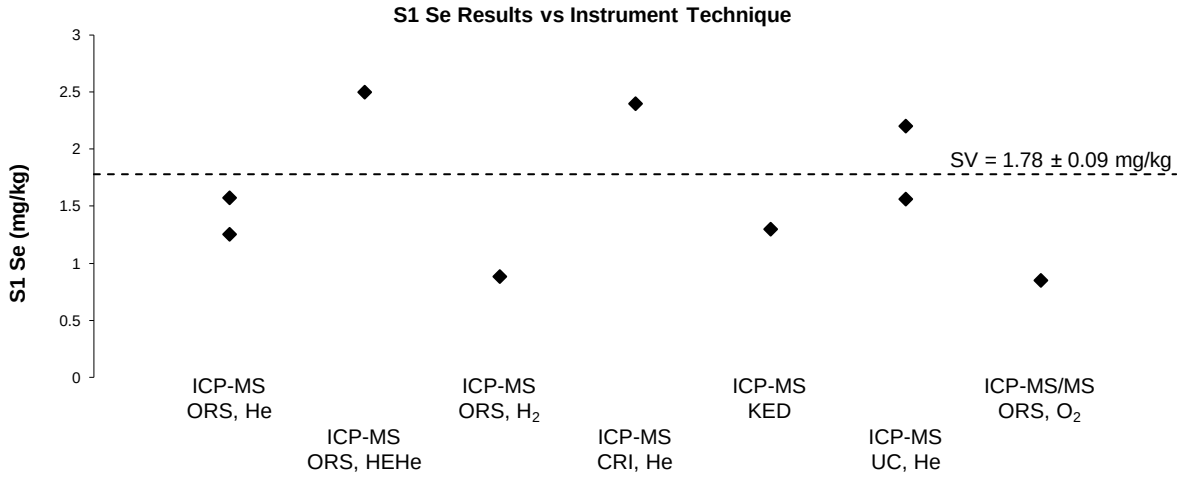
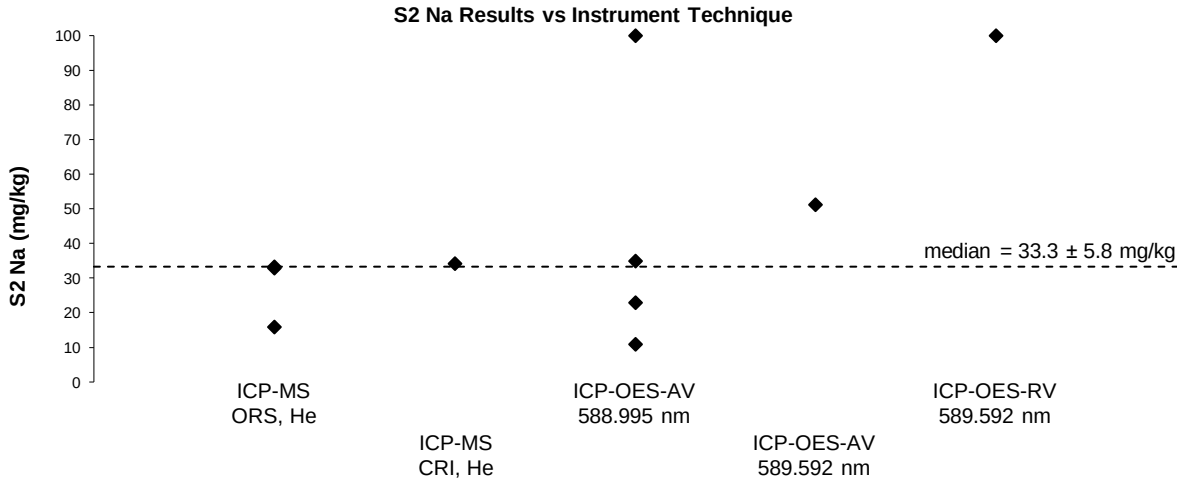


Figure 85 Se Results in S1 vs. Instrumental Technique

Sodium level in S2 was low which may have challenged participants' analytical techniques. The between-laboratory CV was large (45%) 5 times higher than the CV predicted by Thompson and Horwitz (9.5%).

Results for Na versus instrumental technique used are presented in Figure 86. Participants used a wide variety of instrumental techniques, including ICP-MS in collision mode, ICP-OES with axial view or ICP-OES with radial view.



Laboratories 14 and 23 results >100 mg/kg have been plotted as 100 mg/kg.

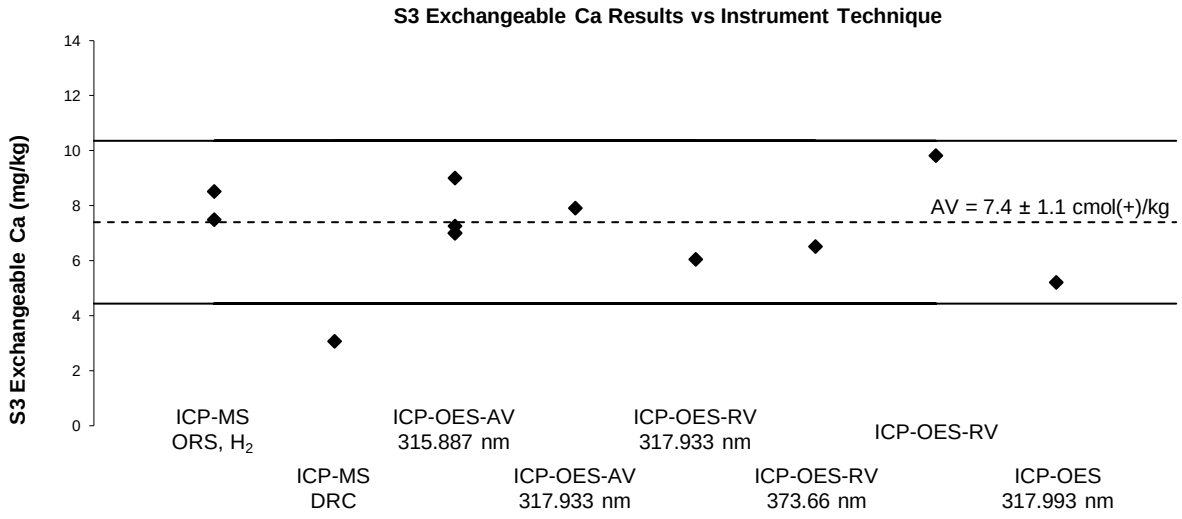
Figure 86 S2-Na Results vs. Instrumental Technique

6.6 Participants' Results and Analytical Methods for Exchangeable Bases

Measurement of exchangeable bases in soil is an empirical measurement – where the method of extraction defines the measurand. The participating laboratories were asked to analyse the sample using their normal measurement technique but to use the same preparation procedure Method 15A1 as defined by Rayment, G.E. and David, J. L in "Soil Chemical Methods-Australasia".[20]

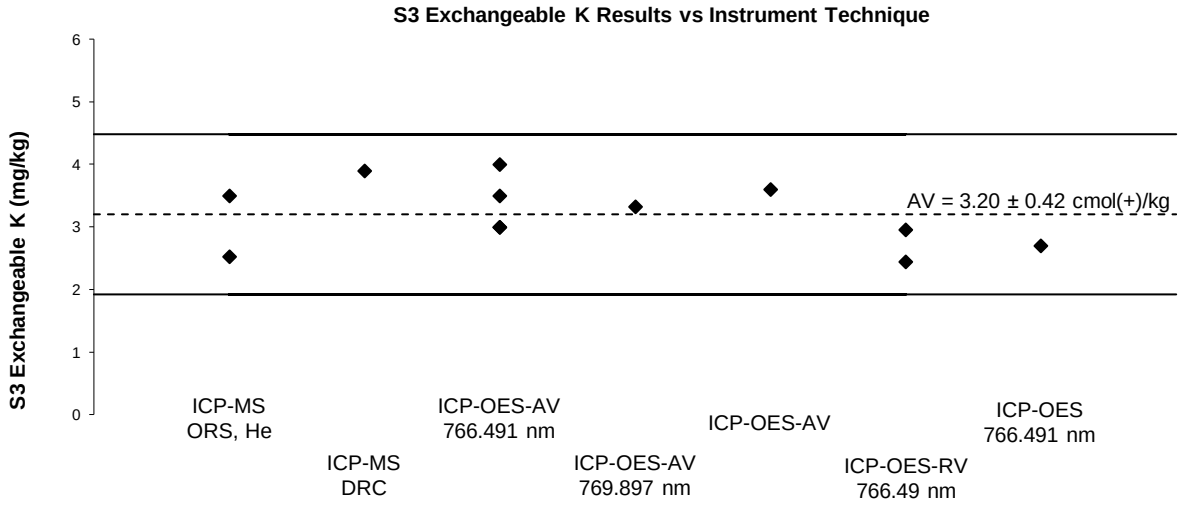
The method descriptions provided by participants are presented in Table 10. With two exceptions, all participants used a ratio sample mass/extraction solution of 1 to 20 and shook their sample for 1 to 2.5 hours. Laboratory 5 used a ratio of 1:10 for sample mass/extraction solution and shook their sample for 12 hours. No significant differences were noticed between the results reported by this participant and the results reported by participants who used a ratio of 1:20. Plots of participants' results versus the analytical methods used for the exchangeable bases measurement are presented in Figures 87 to 90.

No assigned value was set for Exchangeable Na in S3 because the reported results were too few and too variable.



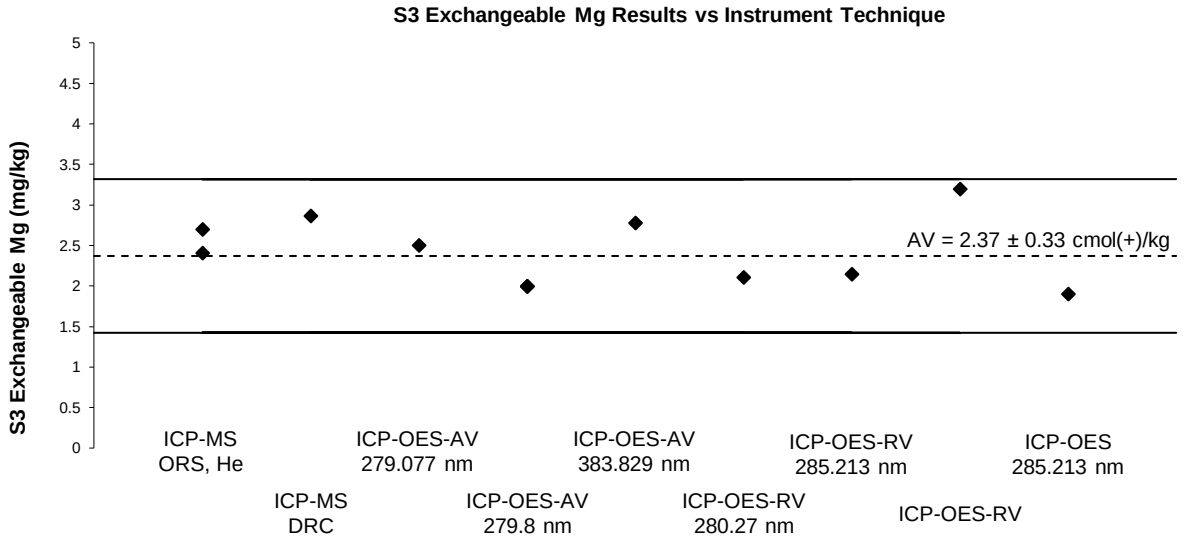
Horizontal lines on charts are the results corresponding to z-scores of 2 and -2

Figure 87 Exchangeable Ca^{2+} Results vs. Instrumental Techniques



Horizontal lines on charts are the results corresponding to z-scores of 2 and -2

Figure 88 Exchangeable K^{+} Results vs. Instrumental Techniques



Horizontal lines on charts are the results corresponding to z-scores of 2 and -2

Figure 89 Exchangeable Mg^{2+} Results vs. Instrumental Techniques

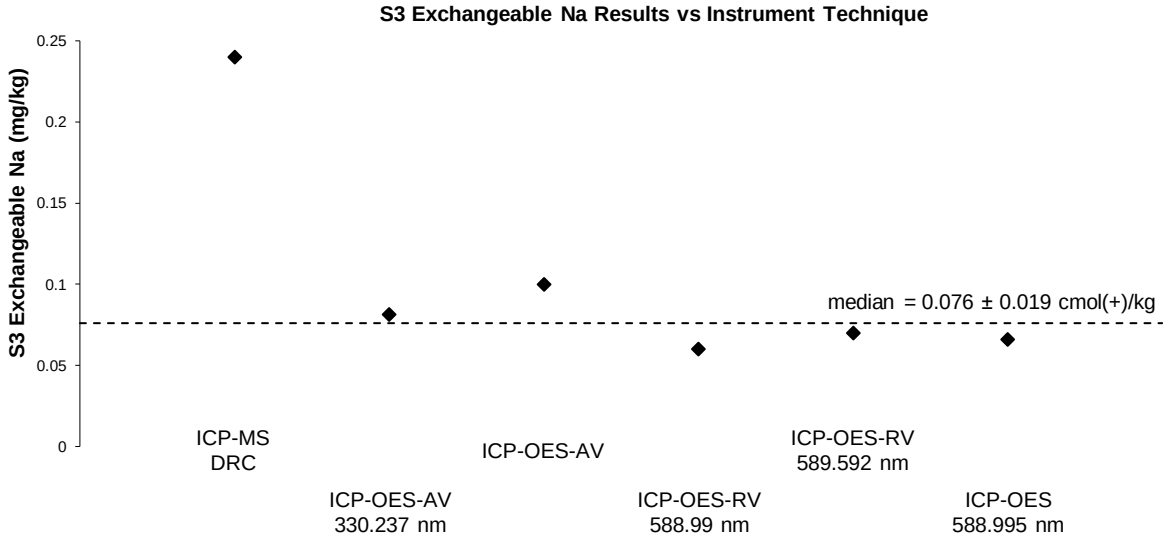


Figure 90 Exchangeable Na^{+} Results vs. Instrumental Techniques

6.7 Participants' Results and Analytical Methods for Colwell P and Colwell K

The participating laboratories were asked to follow the preparation procedure described in Method 9B1 as defined by Rayment, G.E. and David, J. L in "Soil Chemical Methods-Australasia".[20] All participants shook the sample for 16 or 17 hours and used a ratio of 1:100 sample mass/extraction solution (Table 5).

Colwell K Only 2 participants extracted K in S3 using 0.5 M $NaHCO_3$ and reported results for this test. One used ICP-OES to measure Colwell K and one used ICP-MS. The 2 results were in good agreement with each other, (Figure 91).

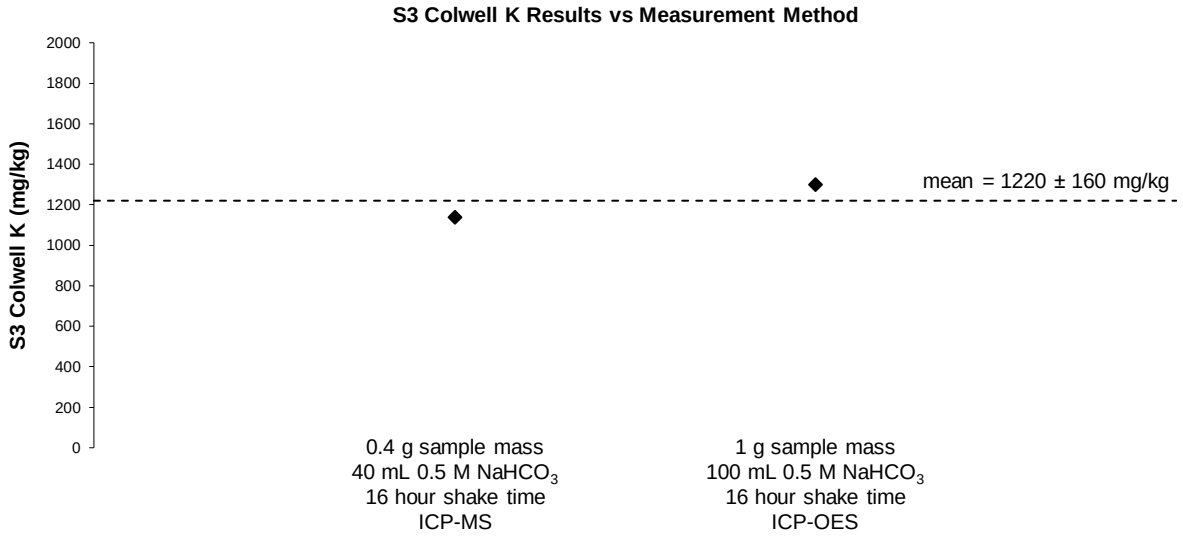
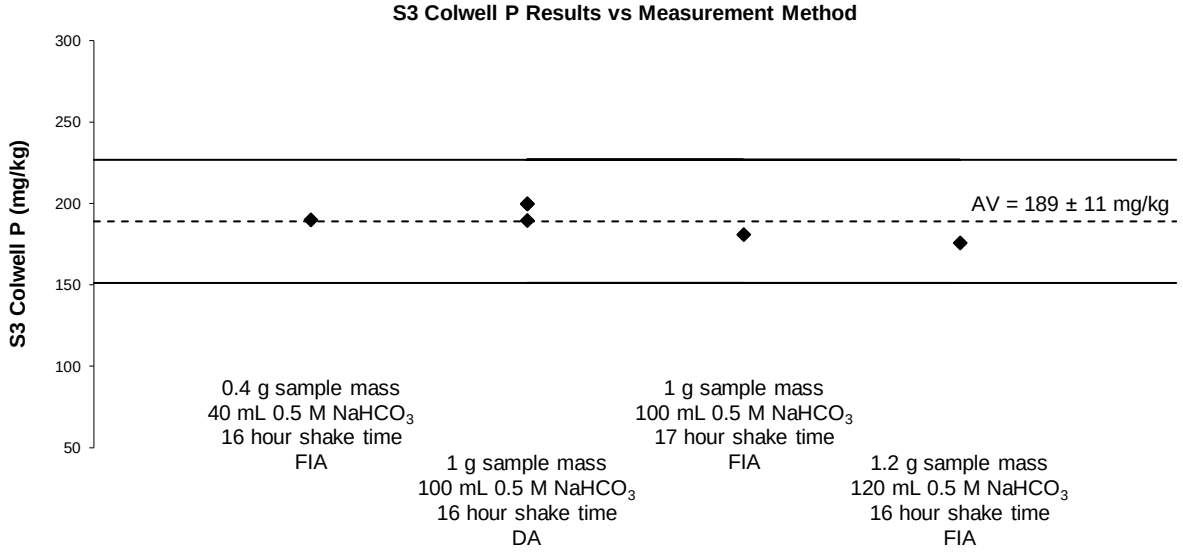


Figure 91 Colwell K Results vs. Method

Colwell P Six results were reported for Colwell P in S3 and all were compatible with each other and with the assigned value of 189 mg/kg. Plots of participants' results versus the method used are presented in Figure 92.



Horizontal lines on charts are the results corresponding to z-scores of 2 and -2

Figure 92 Colwell P Results vs. Method

6.8 Participants' Results and Analytical Methods for Phosphorus Buffer Index-PBI$_{+ColP}$

P Buffer Index-PBI$_{+ColP}$ gives an indication of the soil's ability to fix P and make it unavailable to plant uptake.

Two laboratories reported results for this test and both used a similar method: 2 g of sample, 20 mL P equilibrating solution, and 16 to 17 hours shake time and ICP-OES as instrumental technique. The results were in good agreement with each other.

6.9 pH

The results reported for pH had a bimodal distribution indicating possible method dependency and so no assigned value was set for this test (Figure 93).

Some laboratories may have not reported results for pH of $CaCl_2$ extract 1:5.

Participants will have the option to report the method used for pH determination in the next study.

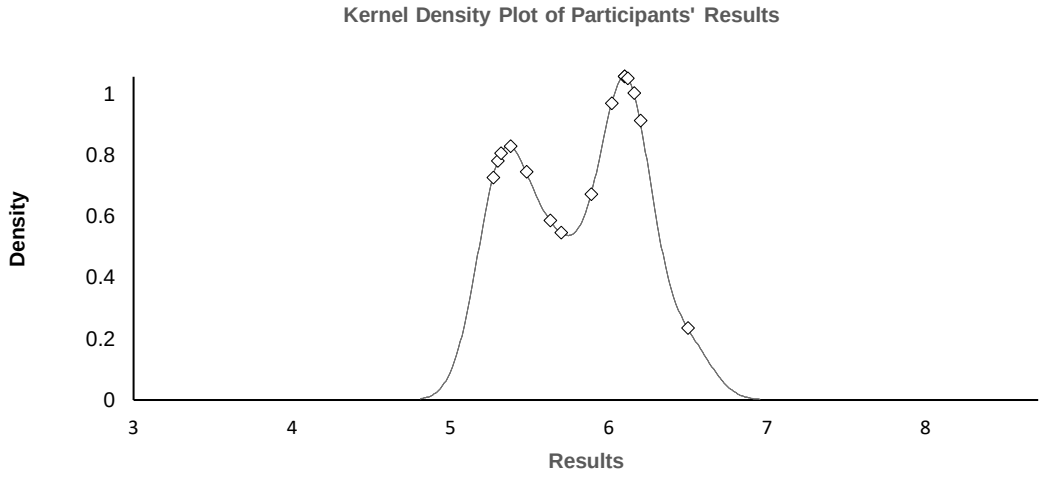


Figure 93 Kernel Density Plot of pH Results

6.10 Participants' Results and Analytical Methods for Total P

Total P Three participants reported results for total P in S3: two results were from colorimetric determination and one from mass spectrometry determination Figure 94.

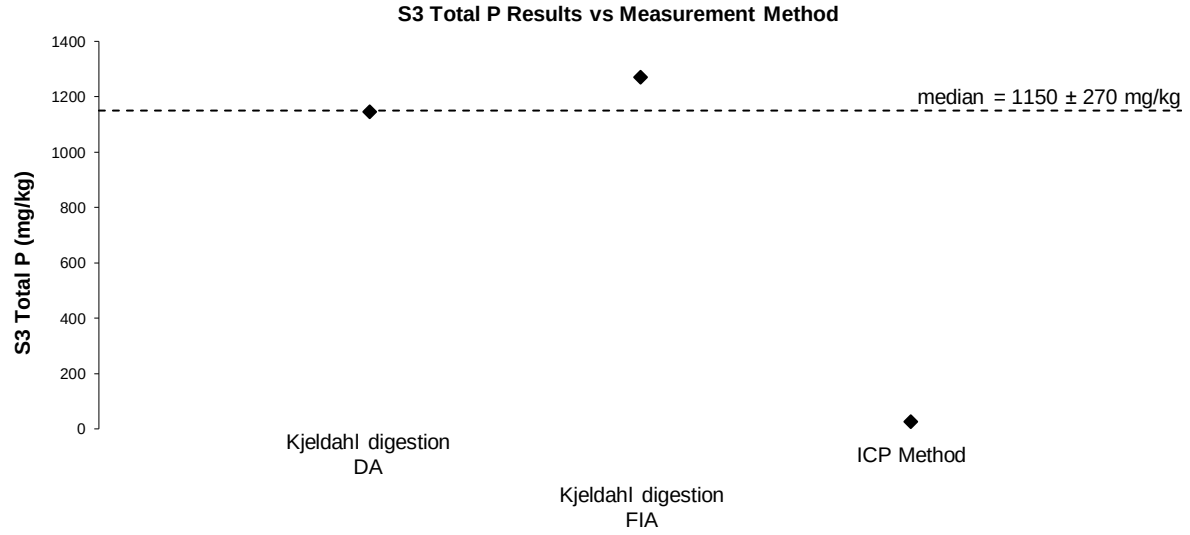
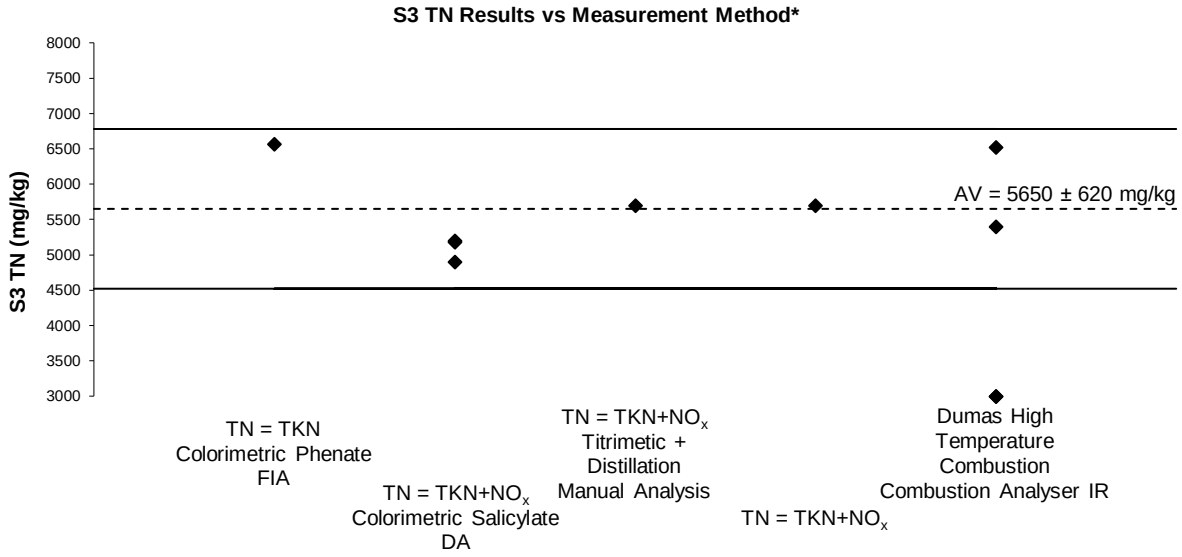


Figure 94 TP Results vs. Analytical Method

6.11 Participants' Results and Analytical Methods for Total Nitrogen

As in previous studies significant difference was found between TN results from combustion and those results calculated from TKN and NO_x. The method descriptions as provided by participants are presented in Table 9 and in Figure 95.



Horizontal lines on charts are the results corresponding to z-scores of 2 and -2. Results <3000 mg/kg have been plotted as 3000 mg/kg.

Figure 95 TN Results vs. Analytical Method

6.12 Participants' Results and Analytical Methods for Total Carbon and Total Organic Carbon

Participants were free to choose an appropriate method and were given no guidance apart from the instruction to: "Quantitatively analyse the samples using your normal test method." The method descriptions provided by participants for TC and TOC analyses are presented in Tables 3 and 4.

Total Carbon Except for 3 all reported results for TC in S3 returned acceptable z-scores.

Some laboratories may have reported the results for TC in the wrong units.

All participants reported using the high temperature oxidation method for TC measurement.

Total Organic Carbon Total organic carbon (TOC) measurements should involve the measurement of both volatile organic carbon (VOC) and of non–purgeable organic carbon (NPOC). As the loss of VOC is considered negligible when compared to the content of NPOC in a soil sample, all the NPOC reported results in Sample S3 have been considered as TOC.[20-23]

Some laboratories may have reported the results for TOC in the wrong units.

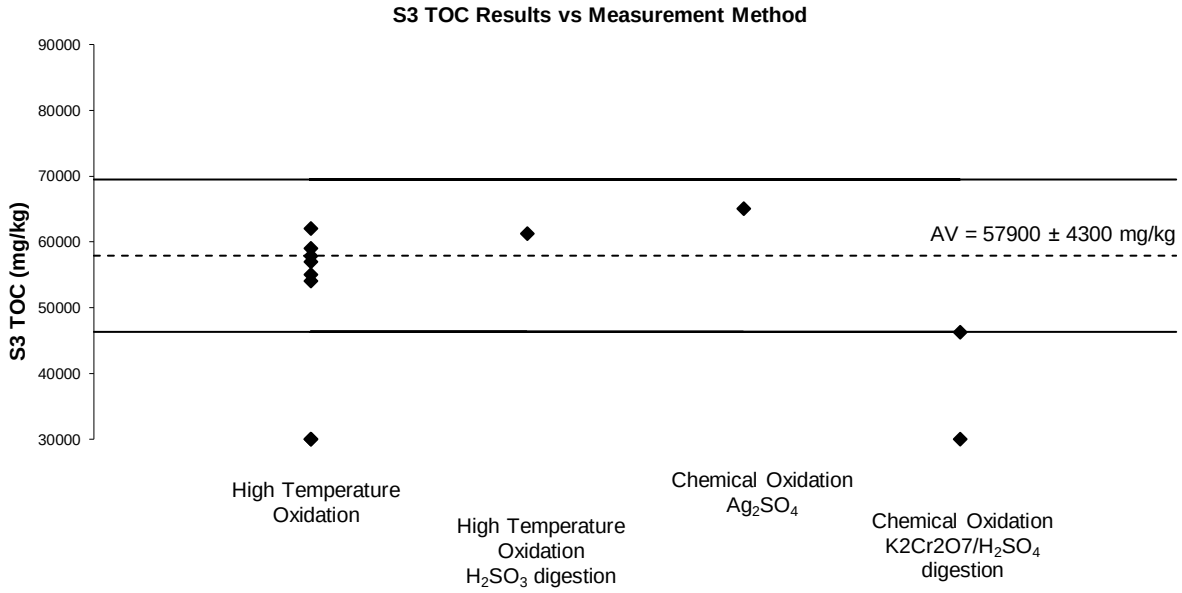
One laboratory reported adding silver sulfate to remove chloride interference .

Most participants used the high temperature oxidation method (Figure 96).

The high temperature oxidation method for organic carbon determination can be rapid and reliable when inorganic carbon is removed prior to combustion. The separation of organic carbon from inorganic carbon can be achieved by ashing or acid treatment. One participant reported predigesting the sample with H_2SO_3 before the high temperature oxidation treatment.

When ashing is used, good knowledge of the nature of soil is required to choose the right ashing temperature. The major problem when acid treatment is used is uncertainty about the completeness of inorganic carbon removal. Introduction of a pretesting step to establish the right amount of the sample to be taken for analysis and the right type and concentration of acid to be used can help avoid these problems.[23, 24]

Comparison studies on the efficiency of TOC methods found that the most appropriate method for soil TOC analyses is the automated dry combustion technique after pre-testing and pre-treatment for IC removal.[24, 25]



* Laboratory 4 result of 5.95 mg/kg, Laboratory 10 result of 101.08 mg/kg and Laboratory 21 result of 6300 mg/kg were plotted as 30000 mg/kg. Horizontal lines on charts are the results corresponding to z-scores of 2 and -2

Figure 96 TOC Result vs. Analytical Method

6.13 Comparison with Previous NMI Proficiency Tests of Metals in Soil

AQA 25-01 is the 36th NMI proficiency study of inorganic analytes in soil.

Participants' performance in measurement of metals in soil over the last thirteen years is presented in Figure 97. Despite different matrices, analytes, and analyte concentrations, on average participants' performance remained consistent.

Individual performance history reports are emailed to each participant at the end of the study; the consideration of z-scores for an analyte over time provides much more useful information than a single z-score. Over time, laboratories should expect at least 95% of their scores to lie within the range $|z| \leq 2.0$. Scores in the range $2.0 < |z| < 3.0$ can occasionally occur, however these should be interpreted in conjunction with the other scores obtained by that laboratory. For example, a trend of z-scores on one side of the zero line is an indication of method or laboratory bias.

6.14 Reference Materials and Certified Reference Materials

Participants reported whether control samples (spiked samples, certified reference materials-CRMs or matrix specific reference materials-RMs) had been used (Table 85).

Table 85 Control Samples Used by Participants

Lab. Code	Description of Control Samples
1	RM/Ex PT Sample – Agal10 and Agal12
2	RM/Ex PT Sample – Agal12 (metals) In house AG reference
3	SS
4	ASPAC CRM - QC-13950; RM/Ex PT Sample – Agal12; LOAM B
5	SS
6	CRM

8	RM/Ex PT Sample
10	SS
11	SS
12	CRM – CRM016 Trace Metals – Fresh Water Sediment 3
13	CRM
14	CRM
16	SS
17	SS
18	CRM – ERA A Waters Company 540
19	CRM – Agal12, Multi CRM components
20	AQA, In House
21	RM/Ex PT Sample – Aspac 13957, Aspac 12905, Aspac 13959, Aspac 7098, Aspac 9104, Aspac 9105
22	SS
23	CRM
24	SS – Supelco CRM052
25	CRM - QCS-01-05 ICP Quality Control Standard #1; High Purity Standards CCV-1 Solution A; High Purity Standards CCV-1 Solution B; NMI AGAL-12 Biosoil; Australian Chemical Reagents Multi Element Standard; Australian Chemical Reagents Mixed Anion Standard; ERA Mercury
26	SS
27	SS

Some laboratories reported using certified reference materials. These materials may not meet the internationally recognised definition of a Certified Reference Material:

> ***' a reference material****, accompanied by documentation issued by an authoritative body and providing one or more specified property values with associated uncertainties and traceabilities, using valid procedures'*[26]

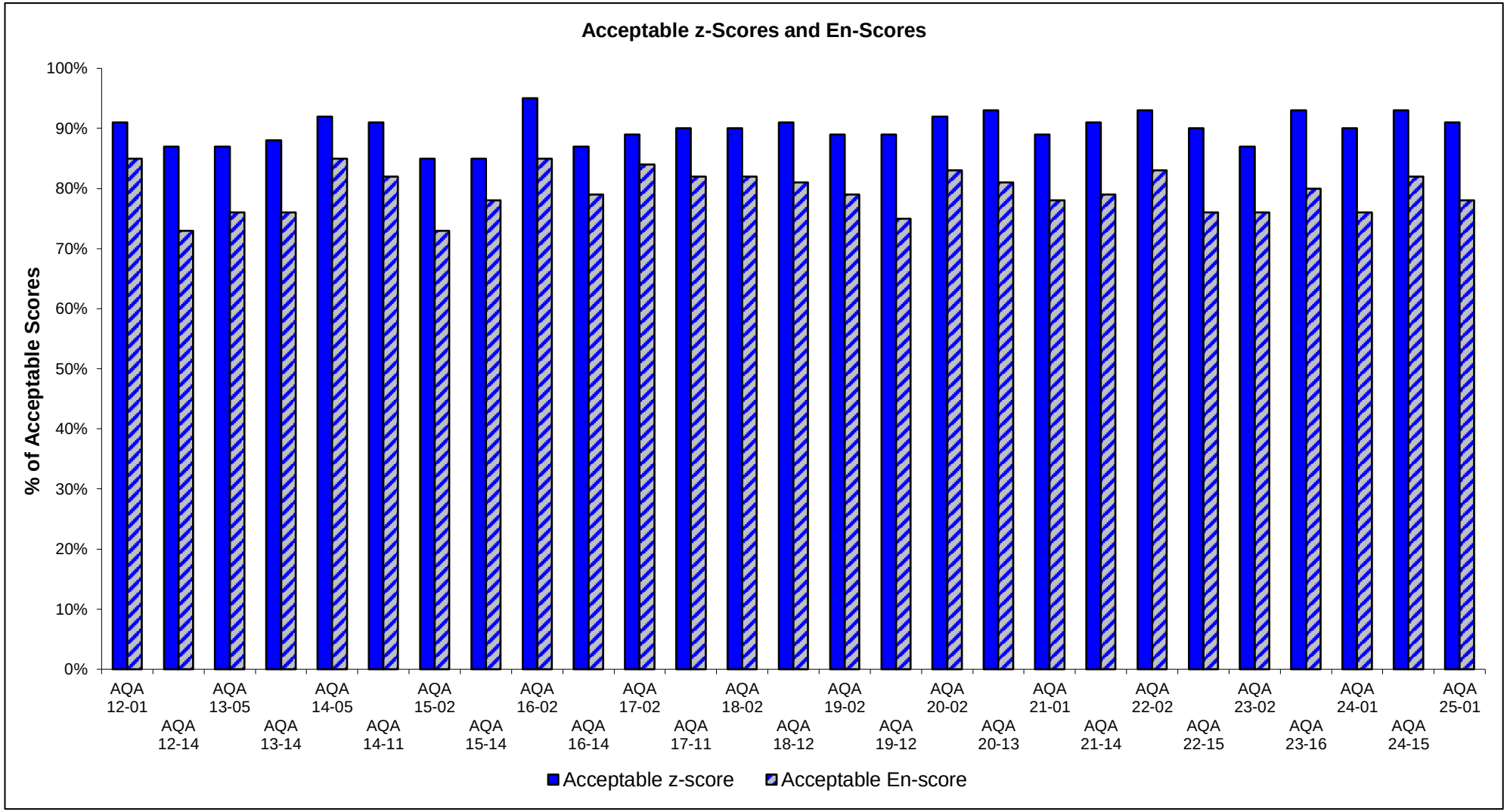


Figure 97 Participants' Performance over Time (2012-2025)

7 REFERENCES

Note: For all undated references, the latest edition of the referenced document (including any amendments) applies.

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APPENDIX 1 - SAMPLE PREPARATION, ANALYSIS AND HOMOGENEITY TESTING

Sample Preparation

Sample S1 was a clay soil material fortified for 11 elements, dried, ground and sieved prior to being divided into portions of approximately 30 g each.

Sample S2 was the same soil material as that used in the preparation of Sample S1 of PT study AQA 23-02, to which a known amount of water was added.[28]

Sample S3 was an agricultural soil material that was ground, sieved, mixed and divided into portions of 75 g each.

Sample Analysis and Homogeneity Testing

The same procedure was followed for the preparation of Samples S1, S2 and S3 as in previous NMI PT studies. Therefore, only a partial homogeneity test was conducted for elements of interest in Sample S1, except for Al and Sb, and the acid extractable elements in Sample S3. Three bottles were analysed in duplicate, and the average of the results was reported as the homogeneity value. Measurements were made under repeatability conditions in random order.

A full homogeneity test was conducted for Sample S2 for all analytes except for La, Rb, and Tl. Few participants reported results for these analytes and gave no reason to question homogeneity. Homogeneity testing for this sample was based on that described by Thompson and Fearn,[27] which is also the procedure as described in the International Harmonised Protocol for Proficiency Testing.[4] A minimum of 6 bottles from S2 were selected at random. Duplicate test-portions were taken from each bottle and the concentration of all targeted analytes measured. Measurements were made under repeatability conditions in random order. The data for the full homogeneity testing of sample S1 can be found below in Tables 86 – 104.

Table 86 Sample S2 Al Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
1	5740	5620
2	6190	5930
3	5480	6040
4	5790	5690
5	5480	5750
6	5700	6120
7	5840	5750
Mean	5790	
CV	7.5%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.47	0.73	**Pass**
s_{an}/σ	0.19	0.50	**Pass**
s^2_{sam}	0.00001	320000	**Pass**

Table 87 Sample S2 As Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
1	3.87	3.74
2	3.94	3.77
3	3.67	3.92
4	3.86	3.96
5	3.79	3.98
6	3.90	4.12
7	3.90	4.02
Mean	3.89	
CV	6.4%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.27	0.73	**Pass**
s_{an}/σ	0.16	0.50	**Pass**
s^2_{sam}	0.00001	0.14	**Pass**

Table 88 Sample S2 B Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
1	7.16	6.71
2	7.52	6.48
3	6.98	7.48
4	8.13	7.74
5	6.97	7.49
6	7.69	8.38
7	7.89	7.59
Mean	7.44	
CV	11%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.42	0.73	**Pass**
s_{an}/σ	0.28	0.50	**Pass**
s^2_{sam}	0.11	0.68	**Pass**

Table 89 Sample S2 Ba Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
1	52.1	49.1
2	54.7	53.0
3	51.0	56.0
4	57.9	59.4
5	52.4	56.0
6	56.6	62.1
7	59.4	57.6
Mean	55.5	
CV	8.9%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.35	0.73	**Pass**
s_{an}/σ	0.22	0.50	**Pass**
s^2_{sam}	7.9	32	**Pass**

Table 90 Sample S2 Be Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
1	0.731	0.713
2	0.755	0.741
3	0.699	0.766
4	0.759	0.748
5	0.668	0.733
6	0.741	0.786
7	0.765	0.728
Mean	0.738	
CV	8.1%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.35	0.73	**Pass**
s_{an}/σ	0.20	0.50	**Pass**
s^2_{sam}	0.00001	0.0054	**Pass**

Table 91 Sample S2 Cd Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
1	0.779	0.682
2	0.756	0.767
3	0.756	0.840
4	0.738	0.743
5	0.567	0.677
6	0.733	0.749
7	0.768	0.730
Mean	0.735	
CV	13%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.39	0.73	**Pass**
s_{an}/σ	0.32	0.50	**Pass**
s^2_{sam}	0.0019	0.0072	**Pass**

Table 92 Sample S2 Cr Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
1	29.8	28.7
2	29.3	29.5
3	28.1	31.0
4	28.5	28.6
5	26.3	28.5
6	28.4	29.8
7	29.4	29.5
Mean	29.0	
CV	7.5%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.50	0.73	**Pass**
s_{an}/σ	0.19	0.50	**Pass**
s^2_{sam}	0.00001	8.0	**Pass**

Table 93 Sample S2 Cu Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
1	27.6	26.3
2	27.3	27.1
3	25.8	28.5
4	29.2	29.2
5	26.4	28.8
6	28.9	30.4
7	29.8	29.9
Mean	28.2	
CV	7.7%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.45	0.73	**Pass**
s_{an}/σ	0.19	0.50	**Pass**
s^2_{sam}	1.0	7.7	**Pass**

Table 94 Sample S2 Hg Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
1	0.300	0.278
2	0.324	0.340
3	0.317	0.346
4	0.365	0.331
5	0.264	0.305
6	0.324	0.346
7	0.360	0.344
Mean	0.325	
CV	12%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.33	0.73	**Pass**
s_{an}/σ	0.30	0.50	**Pass**
s^2_{sam}	0.00054	0.0013	**Pass**

Table 95 Sample S2 Mn Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
1	389	354
2	369	377
3	369	407
4	360	360
5	300	342
6	351	360
7	368	361
Mean	362	
CV	10%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.38	0.73	**Pass**
s_{an}/σ	0.25	0.50	**Pass**
s^2_{sam}	270	1500	**Pass**

Table 96 Sample S2 Mo Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
1	13.2	12.1
2	13.1	12.7
3	12.6	13.7
4	12.9	12.9
5	10.7	12.2
6	12.8	13.1
7	13.1	12.8
Mean	12.7	
CV	9.3%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.42	0.73	**Pass**
s_{an}/σ	0.23	0.50	**Pass**
s^2_{sam}	0.16	1.7	**Pass**

Table 97 Sample S2 Na Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
1	52.2	45.6
2	47.3	49.6
3	46.6	54.1
4	48.3	45.6
5	36.7	43.3
6	46.6	45.4
7	48.7	49.2
Mean	47.1	
CV	14%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.36	0.73	**Pass**
s_{an}/σ	0.35	0.50	**Pass**
s^2_{sam}	6.2	33	**Pass**

Table 98 Sample S2 P Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
1	179	176
2	184	172
3	166	180
4	171	176
5	175	173
6	171	186
7	169	176
Mean	175	
CV	7.7%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.34	0.73	**Pass**
s_{an}/σ	0.19	0.50	**Pass**
s^2_{sam}	0.00001	300	**Pass**

Table 99 Sample S2 Pb Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
1	21.4	20.5
2	22.0	21.3
3	20.8	22.2
4	21.2	21.7
5	19.7	20.9
6	21.0	22.6
7	21.6	21.7
Mean	21.3	
CV	6.9%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.34	0.73	**Pass**
s_{an}/σ	0.17	0.50	**Pass**
s^2_{sam}	0.017	4.2	**Pass**

Table 100 Sample S2 Se Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
1	2.54	2.39
2	2.53	2.46
3	2.38	2.67
4	2.50	2.53
5	2.22	2.39
6	2.49	2.61
7	2.52	2.51
Mean	2.48	
CV	8.5%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.53	0.73	**Pass**
s_{an}/σ	0.21	0.50	**Pass**
s^2_{sam}	0.0011	0.062	**Pass**

Table 101 Sample S2 Sn Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
1	12.2	11.4
2	12.1	12.5
3	11.6	12.8
4	12.3	12.6
5	11.0	12.0
6	12.6	12.9
7	12.7	12.6
Mean	12.2	
CV	8.3%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.39	0.73	**Pass**
s_{an}/σ	0.21	0.50	**Pass**
s^2_{sam}	0.080	1.5	**Pass**

Table 102 Sample S2 V Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
1	21.0	21.5
2	21.6	20.7
3	19.4	20.9
4	20.4	20.4
5	22.0	21.9
6	20.7	22.3
7	20.5	21.7
Mean	21.1	
CV	7.0%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.33	0.73	**Pass**
s_{an}/σ	0.17	0.50	**Pass**
s^2_{sam}	0.13	4.1	**Pass**

Table 103 Sample S2 Zn Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
1	69	66
2	68	69
3	67	73
4	63	63
5	56	61
6	62	65
7	64	65
Mean	65	
CV	7.5%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.49	0.73	**Pass**
s_{an}/σ	0.19	0.50	**Pass**
s^2_{sam}	12	44	**Pass**

Table 104 Sample S2 Moisture Content Homogeneity Testing

Container Number	Result (%)	
	Replicate 1	Replicate 2
1	38.5	42.0
2	41.3	40.3
3	36.3	39.2
4	36.3	38.8
5	41.4	41.1
6	38.7	42.1
7	36.8	37.3
Mean	39.3	
CV	8.6%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.31	0.73	**Pass**
s_{an}/σ	0.21	0.50	**Pass**
s^2_{sam}	1.7	16	**Pass**

Sample Analysis for Acid Extractable Elements

Measurements for acid extractable elements involved solubilisation of metals and metal complexes using a mixture of nitric acid and hydrochloric acid. Metals were then measured using ICP-MS or ICP-OES.

The analysis for homogeneity were conducted by CRV section of NMI as per method NT2.49. [29] A test portion of approximately 0.7 g of soil for S1 and 0.5 g for S3 was weighed into a 50 mL graduated polypropylene centrifuge tube. The sample was digested using 3 mL of concentrated nitric acid and 3 mL of concentrated hydrochloric acid on a hot block at 95°C ± 5°C. After digestion, each sample was diluted to 40 mL with Milli-Q water and then further diluted as necessary.

The measurement instrument was calibrated using external standards for targeted analytes. A set of quality control samples consisting of blanks, blank matrix spike, matrix matched reference materials, duplicates and sample matrix spikes, was carried through the same set of procedures and analysed at the same time as the samples. A summary of the instrument conditions used, and the ion/wavelength monitored for each analyte is given in Table 105.

Table 105 Instrumental Technique used for Acid Extractable Elements

Analyte	Instrument	Internal Standard	Reaction/ Collision Cell (if applicable)	Cell Mode/Gas (if applicable)	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Ion (m/z) / Wavelength (nm)
Ag	ICP-MS	Rh	ORS	He	800	NA	107 m/z
Al	ICP-MS	Rh	NA	NA	NA	800	27 m/z
As	ICP-MS	Rh	ORS	He	800	800	75 m/z
B	ICP-MS	Rh	NA	NA	800	800	11 m/z
Ba	ICP-MS	Rh	ORS	He	NA	800	137 m/z
Be	ICP-MS	Rh	NA	NA	NA	800	9 m/z
Bi	ICP-MS	Ir	ORS	He	800	NA	209 m/z
Ca	ICP-OES	Y	NA	NA	800	NA	317.993 nm
Cd	ICP-MS	Rh	ORS	He	800	800	111 m/z
Co	ICP-MS	Rh	ORS	He	800	NA	59 m/z
Cr	ICP-MS	Rh	ORS	He	800	800	52 m/z
Cs	ICP-MS	Rh	ORS	He	800	NA	133 m/z
Cu	ICP-MS	Rh	ORS	He	800	800	63 m/z
Fe (S1)	ICP-MS	Rh	ORS	He	800	NA	56 m/z
Fe (S3)	ICP-OES	Y	NA	NA	800	NA	238.204 nm
Ga	ICP-MS	Rh	ORS	He	800	NA	71 m/z
Hg	ICP-MS	Rh	ORS	He	800	800	201 m/z
K	ICP-OES	Y	NA	NA	800	NA	766.491 nm
Li	ICP-MS	Rh	ORS	He	800	NA	7 m/z
Mg	ICP-OES	Y	NA	NA	800	NA	285.213 nm
Mn	ICP-MS	Rh	ORS	He	800	800	55 m/z
Mo	ICP-MS	Rh	ORS	He	NA	800	95 m/z
Na (S1)	ICP-MS	Rh	ORS	He	NA	800	23 m/z
Na (S3)	ICP-OES	Y	NA	NA	800	NA	588.995 nm
Ni	ICP-MS	Rh	ORS	He	800	NA	60 m/z
P (S1)	ICP-MS	Rh	ORS	He	NA	800	31 m/z
P (S3)	ICP-OES	Y	NA	NA	800	NA	177.434 nm
Pb	ICP-MS	Ir	ORS	He	800	800	206 m/z
S	ICP-OES	Y	NA	NA	800	NA	181.972 nm
Se	ICP-MS	Rh	ORS	HEHe	800	800	78 m/z
Sn	ICP-MS	Rh	ORS	He	NA	800	118 m/z

Sr	ICP-OES	Y	NA	NA	800	NA	421.552 nm
Th	ICP-MS	Rh	ORS	He	800	NA	232 m/z
U	ICP-MS	Ir	ORS	He	800	NA	238 m/z
V	ICP-MS	Rh	ORS	He	NA	800	51 m/z
Zn	ICP-MS	Rh	ORS	He	800	800	64 m/z

APPENDIX 2 - ASSIGNED VALUE, Z-SCORE AND E_N SCORE CALCULATION

The assigned value was calculated as the robust average using the procedure described in 'ISO 13258'[6]; the uncertainty was evaluated as:

$$u_{rob\ av} = 1.25 * S_{rob\ av} / \sqrt{p} \qquad \text{Equation 4}$$

where:

$u_{rob\ av}$ robust average standard uncertainty
$S_{rob\ mean}$ robust average standard deviation
p number of results

The expanded uncertainty ($U_{rob\ av}$) is the standard uncertainty multiplied by a coverage factor of 2 at approximately 95% confidence level.

A worked example is set out below in Table 106.

Table 106 Uncertainty of Assigned Value for Cu in Sample S1

No. results (p)	17
Robust Average	14.5 mg/kg
$S_{rob\ av}$	1.7
$u_{rob\ av}$	0.52 mg/kg
k	2
$U_{rob\ av}$	1.0 mg/kg

The assigned value for **Cu** in Sample S1 is **14.5 ± 1.0 mg/kg**

z-Score and E_n-score

For each participant's result z-score and E_n-score are calculated according to Equation 2 and Equation 3 respectively (see page 15).

A worked example is set out below in Table 107.

Table 107 z-Score and E_n-score for Cu result reported by Laboratory 20 in S1

As Result mg/kg	Assigned Value mg/kg	Set Target Standard Deviation	z-Score	E_n-Score
14.8 ± 3.1	14.5 ± 1.0	10% as PCV or 0.10 x 14.5= = 1.45 mg/kg	$z = \frac{(14.8 - 14.5)}{1.45}$ z = 0.21	$En = \frac{(14.8 - 14.5)}{\sqrt{3.1^2 + 1.^2}}$ E_n= 0.09

APPENDIX 3 - USING PT DATA FOR UNCERTAINTY EVALUATION

When a laboratory has successfully participated in at least 6 proficiency testing studies (e.g. is demonstrating control of bias and verification of repeatability), the standard deviation from proficiency testing studies (the reproducibility between-laboratory variation) can also be used to evaluate the uncertainty of their measurement results.[11, 13] An example is given.

Between 2009 and 2025 NMI carried out 31 proficiency tests of metals in soil. These studies involved analyses of acid-extractable elements at low and high levels in dried soil, moist soil, biosolid, clay, compost, sediment and sludge.

Laboratory X submitted results for As in all of these PTs. Most reported results returned acceptable z-scores. This data can be separated into two ranges of results: 1 to 10 mg/kg and 10 to 100 mg/kg (Tables 108 and 109). The pooled standard deviation of the robust CV over these PT samples for each concentration range gives evaluations of the relative standard uncertainty of 13% and 9.6% respectively. Using a coverage factor of two gives relative expanded uncertainties of 26% and 20% respectively, at a level of confidence of approximately 95%.

Table 108 Laboratory X Reported Results for As at 1 to 10 mg/kg Level.

Study No.	Sample	Laboratory result mg/kg	Assigned value mg/kg	Number of laboratories	Robust CV of all results (%)
AQA 09-13	S1 – Biosolid	4.091	3.64	11	16
	S2 – Soil	4.29	4.57	12	15
AQA 11-01	S1 – Biosolid	3.54	3.57	18	20
AQA 13-05	S1 – Soil	9.22	9.21	22	14
AQA 14-11	S1 – Sediment	7.91	7.37	21	12
AQA 15-02	S1 – Moist Sludge	8.29	7.02	22	13
	S2 – Moist Sludge	7.42	7.02	17	11
AQA 15-14	S1 – Sediment	10	9.95	17	6.7
	S2 – Soil	4.53	4.47	14	6.4
AQA 16-02	S2 – Clay	2.67	2.11	20	14
AQA 16-14	S1 – Soil	6.03	5.61	17	20
AQA 17-02	S1 – Soil	3.71	3.76	13	10
	S2 – Soil	2.92	3.01	13	4
AQA 18-02	S1 – Compost	2.22	2.73	17	11
AQA 19-02	S1 – Soil	2.83	2.65	24	11
AQA 19-12	S1 – Soil	2.32	2.12	16	16
AQA 20-13	S1 – Biosolid	2.85	3.29	17	11
AQA 21-01	S1 – Sediment	7.02	6.26	18	6.9
	S2 – Moist Sludge	3.99	3.58	13	13
AQA 22-02	S1 – Sediment	4.32	4.02	15	9.5
	S2 – Moist Soil	3.57	3.56	13	6.2
AQA 22-15	S2 – Clay	4.29	3.63	19	17
AQA 23-02	S1 – Soil	4.41	4.12	16	5.9
	S2 – Sludge	4.43	4.8	8	24
AQA 24-15	S2 - Biosolid	3.70	3.83	20	10
AQA 25-01	S2 - Sludge	4.92	3.76	14	17
				Average	12%*
$\boldsymbol{pooled\ s\%} = \sqrt{\frac{((\mathbf{11}-\mathbf{1})\times\mathbf{16^2}+(\mathbf{12}-\mathbf{1})\times\mathbf{15^2}+\cdots\cdots+(\mathbf{14}-\mathbf{1})\times\mathbf{17^2})}{\mathbf{427}-\mathbf{26}}}$					**13%**

* The pooled standard deviation was used.

Table 109 Laboratory X Reported Results for As at 10 to 100 mg/kg Level.

Study No.	Sample	Laboratory result mg/kg	Assigned value mg/kg	Number of Laboratories	Robust CV of all results (%)
AQA 10-12	S1 – Soil	16.6	14.4	19	8.5
AQA 11-12	S1 – Moist Sludge	25	21.6	13	15
AQA 12-01	S1 – Sediment	18.4	17.3	21	8.1
AQA 12-14	S2 – Soil	16.6	14.8	20	11
AQA 13-14	S1 – Sandy Soil	16.6	15.1	21	10
AQA 14-05	S1 – Soil	13.2	12.3	25	7.8
AQA 17-11	S1 – Sediment	18.1	17.4	22	11
AQA 18-12	S2 – Soil	10.4	9.6	20	8
AQA 19-12	S2 – Sediment	21	19.9	19	9
AQA 20-02	S1 – Soil	18.8	21.6	23	8.8
	S2 – Moist Soil	16.5	17.8	24	6.7
AQA 21-14	S1 – Sediment	19.5	20.9	21	8.9
AQA 22-15	S2 – Sediment	58.6	56.8	22	7.8
AQA 23-16	S1 – Soil	10.9	12.3	18	9.7
	S2 – Soil	12.4	12.3	17	9.4
AQA 24-01	S1 – Soil	35.9	35.2	20	10
	S2 – Moist Soil	11.8	12.5	16	13
				Average	9.6%*
$\boldsymbol{pooled\ s\%} = \sqrt{\frac{((\mathbf{19}-\mathbf{1})\times \mathbf{8.5^2} + (\mathbf{13}-\mathbf{1})\times \mathbf{15^2} + \cdots\cdots + (\mathbf{16}-\mathbf{1})\times \mathbf{13^2})}{\mathbf{341}-\mathbf{17}}}$					**9.6%**

* The pooled standard deviation was used

Table 110 sets out the expanded uncertainty for results of the measurement of As in soil, biosolid, clay, sediment, sludge, sandy soil, moist soil, compost and agricultural soil over the ranges 1 to 10 mg/kg and 10 to 100 mg/kg.

Table 110 Uncertainty of As Results Evaluated Using PT Data.

Results mg/kg	Uncertainty mg/kg
1.00	0.26
5.0	1.3
10.0	2.6
20.0	4.0
75	15
100	20

The evaluations of 26% and 20% relative passes the test of being reasonable, and the analysis of the 43 different PT samples over seventeen years can be assumed to include all the relevant uncertainty components (different matrices, operators, reagents, calibrators etc.), and so complies with ISO 17025 requirements.[9]

APPENDIX 4 - ACRONYMS AND ABBREVIATIONS

AOAC	Association of Official Analytical Chemists
APHA	American Public Health Association
AV	Assigned Value
CITAC	Cooperation on International Traceability in Analytical Chemistry
CRI	Collision Reaction Interface
CRM	Certified Reference Material
CV	Coefficient of Variation
CVAAS	Cold Vapour Atomic Absorption Spectroscopy
CV_{rob}	Robust Coefficient of Variation
DA	Discreet Analyser
FIA	Flow Injection Analyser
GUM	Guide to the Expression of Uncertainty in Measurement
HEHe	High energy He mode
HV	Homogeneity Value
ICP-MS	Quadrupole - Inductively Coupled Plasma - Mass Spectrometry
ICP-OES-AV	Inductively Coupled Plasma - Optical Emission Spectrometry- axial view
ICP-OES-AV-buffer	Inductively Coupled Plasma - Optical Emission Spectrometry- axial view with buffer
ICP-OES-RV	Inductively Coupled Plasma - Optical Emission Spectrometry- radial view
IC	Ion chromatograph
IR	Infrared Detector
ISO/IEC	International Organisation for Standardisation / International Electrotechnical Commission
KED	Kinetic Energy Discrimination
Max	Maximum value in a set of results
Md	Median
Min	Minimum value in a set of results
MU	Measurement Uncertainty
M.V.	Median Value
N	Number of Participants
NATA	National Association of Testing Authorities
NMI	National Measurement Institute (of Australia)
NR	Not Reported
NT	Not Tested
ORS	Octopole Reaction System
PCV	Performance Coefficient of Variation
PT	Proficiency Test
RA	Robust Average
RM	Reference Material
CV_{rob}	Robust Coefficient of Variation
SD_{rob}	Robust Standard Deviation
SV	Spiked value or formulated concentration of a PT sample
SS	Spiked sample
SI	The International System of Units
s^2_{sam}	Sampling variance
s_{an}/σ	Analytical standard deviation divided by the target standard deviation

SRM	Standard Reference Material (Trademark of NIST)
Target SD	Target standard deviation
σ	Target standard deviation
UC	Universal Cell
USEPA	United States Environmental Protection Agency
UV-Vis	Ultraviolet and Visible Spectroscopy

APPENDIX 5 - INSTRUMENT DETAILS

Table 111 Instrument Conditions Ag

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	NA	107
2	ICP-MS	Rh	NA	NA	625	NA	109
6	ICP-MS	Rh	KED	He	1000	NA	109
8	ICP-MS/MS	Rh 103	ORS	O2	80	80	107 m/z
10	ICP-OES-AV	Lu			83	NA	328.068
11	ICP-OES-AV	Lu	NA	NA	50	NA	328.289
12	ICP-MS	Rh	CRI	He	100	NA	107
14	ICP-MS					NA	
15	ICP-MS	103	ORS	He	1000	N/A	107
17	ICP-OES-AV	Lutetium	NA	NA	50	NA	328.068nm
20	ICP-MS		ORS	He	100	NA	107
22	ICP-OES-AV	Lu	NA	NA	50	NA	328.289
23	ICP-OES-RV					NA	
24	ICP-MS	Rh	ORS	He	1000	NA	107
26	ICP-MS	Rh	NA		250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	107

Table 112 Instrument Conditions Al

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	800	27
2	ICP-MS	Sc	UC	He	625	625	27
3	ICP-MS		DRC	He	100		
4	ICP-OES-AV						
6	ICP-MS	Sc	KED	He	1000	1000	27
8	ICP-OES-AV	Bi 223.061			80	80	237.312
10	ICP-OES-AV	Lu			83	NA	396.152
11	ICP-OES-AV	Lu	NA	NA	50	NA	236.705
12	ICP-OES-AV	Te			100	NA	308.215
13	ICP-MS	Sc		He	NA		
14	ICP-OES-AV						
15	ICP-MS	72	ORS	Standard Mode	5000	1000	27
16	ICP-MS	Sc	CRI	He	NA	500	27
17	ICP-OES-AV	Lutetium	NA	NA	50	50	236.705nm
19	ICP-MS	Scandium	ORS	He	NA	20	27
20	ICP-MS		ORS	He	100	NA	27
22	ICP-OES-AV	Lu	NA	NA	50	NA	236.705
23	ICP-OES-RV						
24	ICP-MS	Sc	ORS	He	50000	50000	27
25	ICP-MS	Sc	ORS	He	NA	500	27 (m/z)
26	ICP-MS	Sc	NA		250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	500	27

Table 113 Instrument Conditions As

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	800	75
2	ICP-MS	Rh	UC	He	625	625	75
3	ICP-MS		DRC	He	100		
4	ICP-OES-AV						
6	ICP-MS	Te	KED	He	400	400	75
8	ICP-MS/MS	Rh 103	ORS	O2	80	80	91 m/z
10	ICP-OES-AV	Lu			83	83	188.98
11	ICP-OES-AV	Lu	NA	NA	50	NA	188.98
12	ICP-MS	Ge	CRI	He	100	NA	75
13	ICP-MS	Rh		He	NA		
14	ICP-MS						
15	ICP-MS	72	ORS	He	1000	1000	75
16	ICP-MS	Rh	CRI	He	NA	500	75
17	ICP-OES-AV	Lutetium	NA	NA	50	50	188.980nm
18	ICP-OES-AV	NA	NA			NA	
19	ICP-MS	Scandium	ORS	He	NA	20	75
20	ICP-MS		ORS	He	100	NA	75
22	ICP-OES-AV	Lu	NA	NA	50	NA	188.98
23	ICP-OES-RV						
24	ICP-MS	Rh	ORS	HEHe	1000	1000	75
25	ICP-MS	Rh	ORS	He	NA	500	75 (m/z)
26	ICP-MS	Rh	UC	He	250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	500	75

Table 114 Instrument Conditions B

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	800	11
2	ICP-MS	Sc	NA	NA	625	625	10
3	ICP-MS		DRC	He	100		
4	ICP-OES-AV						
5	ICP-OES-RV	NA	NA	NA	NA	NA	249.77 nm
6	ICP-MS	Sc	KED	He	400	400	10
8	ICP-OES-AV	Bi 223.061			80	80	249.678
10	ICP-OES-AV	Lu			83	83	182.577
11	ICP-OES-AV	Lu	NA	NA	50	NA	182.577
12	ICP-OES-AV	Te			100	NA	249
13	ICP-MS	Sc		He	NA		
14	ICP-MS						
15	ICP-MS	89	ORS	Standard Mode	1000	1000	11
16	ICP-MS	Sc	CRI	No Gas	NA	500	11
17	ICP-OES-AV	Lutetium	NA	NA	50	50	208.956nm
19	ICP-MS	Scandium	NA	NA	NA	20	11
20	ICP-OES-AV-buffer	Lu			100	NA	249.678
22	ICP-OES-AV	Lu	NA	NA	50	NA	182.577
23	ICP-OES-RV						
24	ICP-MS	Sc	ORS	He	1000	1000	11
25	ICP-MS	Sc	ORS	He	NA	500	11 (m/z)
26	ICP-MS	Sc	NA		250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	500	11

Table 115 Instrument Conditions Ba

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	NA	800	134
2	ICP-MS	Rh	NA	NA	NA	625	138
3	ICP-MS				NA		
4	ICP-OES-AV				NA		
6	ICP-MS	Tb	KED	He	NA	400	137
8	ICP-OES-AV	Eu 397.197			NA	80	455.403
10	ICP-OES-AV	Lu			NA	83	493.408
11	ICP-OES-AV	Lu	NA	NA	50	NA	230.424
12	ICP-MS	Rh	CRI	He	100	NA	137
13	ICP-MS	Rh		He	NA		
14	ICP-MS				NA		
15	ICP-MS	159	ORS	He	NA	1000	137
16	ICP-MS	Rh	CRI	He	NA	500	135
17	ICP-OES-AV	Lutetium	NA	NA	50	50	230.424nm
19	ICP-MS	Rhodium	ORS	He	NA	20	137
22	ICP-OES-AV	Lu	NA	NA	50	NA	230.424
23	ICP-OES-RV				NA		
24	ICP-MS	Rh	ORS	He	NA	1000	137
25	ICP-MS	Rh	ORS	He	NA	500	135 (m/z)
26	ICP-MS	In	NA		250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	NA	500	137

Table 116 Instrument Conditions Be

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	NA	800	9
2	ICP-MS	Sc	NA	NA	NA	625	9
3	ICP-MS				NA		
4	ICP-OES-AV				NA		
6	ICP-MS	Sc	KED	He	NA	400	9
8	ICP-OES-AV	Lu 307.760			NA	80	313.107
10	ICP-OES-AV	Lu			NA	83	313.042
11	ICP-OES-AV	Lu	NA	NA	50	NA	313.107
12	ICP-MS	Ge	CRI	He	100	NA	9
13	ICP-MS	Sc		Standard Mode	NA		
14	ICP-MS				NA		
15	ICP-MS	72	ORS	Standard Mode	NA	1000	9
16	ICP-MS	Sc	CRI	He	NA	500	9
17	ICP-OES-AV	Lutetium	NA	NA	50	50	313.042nm
19	ICP-MS	Scandium	NA	NA	NA	20	9
22	ICP-OES-AV	Lu	NA	NA	50	NA	313.107
23	ICP-OES-RV				NA		
24	ICP-MS	Sc	ORS	He	NA	1000	9
25	ICP-MS	Sc	ORS	Standard Mode	NA	500	9 (m/z)
26	ICP-MS	Sc	NA		250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	NA	500	9

Table 117 Instrument Conditions Bi

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir	ORS	He	800	NA	209
2	ICP-MS	Ir	NA	NA	625	NA	209
6	ICP-MS	Tb	KED	He	400	NA	209
8	ICP-MS/MS	Ir 193	ORS	O2	80	NA	209 m/z
10	ICP-OES-AV	Lu			83	NA	223.061
11	ICP-MS	Lu	ORS	standard mode	1000	NA	209
12	ICP-OES-AV	Te			100	NA	223.061
14	ICP-MS					NA	
15	ICP-MS	159	ORS	Standard Mode	1000	NA	209
17	ICP-MS	Lutetium	ORS	No Gas	1000	NA	m/z 209
19	NA	NA	NA	NA	NA	20	NA
20	ICP-MS		ORS	He	100	NA	209
22	ICP-MS	Lu	ORS	standard mode	1000	NA	209
24	ICP-MS	Ir	ORS	He	1000	NA	209
26	ICP-MS	Ir	NA		250	NA	
27	NA	NA	NA	NA	500	NA	NA

Table 118 Instrument Conditions Ca

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	NA	43
2	ICP-MS	Sc	UC	He	625	NA	44
4	ICP-OES-AV					NA	
5	ICP-OES-RV	NA	NA	Other	NA	NA	373.69 nm
10	ICP-OES-AV	Lu			83	NA	317.933
11	ICP-OES-AV	Lu	NA	NA	NA	1000	315.887
12	ICP-OES-AV	Y			NA	100	317.933
14	ICP-OES-AV					NA	
15	ICP-MS	45	ORS	H2	1000	NA	40
16	ICP-MS	Sc	CRI	He	500	NA	40
17	ICP-OES-AV	Lutetium	NA	NA	50	NA	315.887nm
19	ICP-MS	Scandium	ORS	H2	100	NA	40
20	ICP-OES-AV-buffer	Lu			100	NA	430.253
22	ICP-OES-AV	Lu	NA	NA	NA	1000	315.887
23	ICP-OES-RV					NA	
25	ICP-MS	Sc	ORS	H2	100	NA	40 (m/z)
27	ICP-OES	Cs,Y	NA	NA	500	NA	317.993

Table 119 Instrument Conditions Cd

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	800	111
2	ICP-MS	Rh	NA	NA	625	625	111
4	ICP-OES-AV						
6	ICP-MS	Rh	KED	He	400	400	111
8	ICP-MS/MS	Rh 103	ORS	O2	80	80	111 m/z
10	ICP-OES-AV	Lu			83	83	214.439
11	ICP-OES-AV	Lu	NA	NA	50	NA	228.802
12	ICP-MS	Rh	CRI	He	100	NA	111
13	ICP-MS	Rh		He	NA		
14	ICP-MS						
15	ICP-MS	103	ORS	Standard Mode	1000	1000	111
16	ICP-MS	Rh	CRI	He	NA	500	111
17	ICP-OES-AV	Lutetium	NA	NA	50	50	214.439nm
18	ICP-OES-AV					NA	
19	ICP-MS	Rhodium	ORS	He	NA	20	114
20	ICP-MS		ORS	He	100	NA	114
22	ICP-OES-AV	Lu	NA	NA	50	NA	228.802
23	ICP-OES-RV						
24	ICP-MS	Rh	ORS	He	1000	1000	111
25	ICP-MS	Rh	ORS	He	NA	500	111 (m/z)
26	ICP-MS	Rh	NA		250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	500	111

Table 120 Instrument Conditions Co

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	NA	59
2	ICP-MS	Ge	UC	He	625	NA	59
4	ICP-OES-AV					NA	
6	ICP-MS	Ga	KED	He	400	NA	59
8	ICP-OES-AV	Lu 219.556			80	NA	228.615
10	ICP-OES-AV	Lu			83	NA	230.786
11	ICP-OES-AV	Lu	NA	NA	50	NA	228.615
12	ICP-MS	Ge	CRI	He	100	NA	59
14	ICP-MS					NA	
15	ICP-MS	103	ORS	He	1000	NA	59
17	ICP-OES-AV	Lutetium	NA	NA	50	50	231.160nm
20	ICP-MS		ORS	He	100	NA	59
22	ICP-OES-AV	Lu	NA	NA	50	NA	228.615
23	ICP-OES-RV					NA	
24	ICP-MS	Sc	ORS	He	1000	NA	59
26	ICP-MS	Rh	UC	He	250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	59

Table 121 Instrument Conditions Cr

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	800	52
2	ICP-MS	Sc	UC	He	625	625	52
4	ICP-OES-AV						
6	ICP-MS	Sc	KED	He	400	400	52
8	ICP-OES-AV	Lu 219.556			80	80	205.56
10	ICP-OES-AV	Lu			83	83	267.716
11	ICP-OES-AV	Lu	NA	NA	50	NA	205.56
12	ICP-MS	Ge	CRI	He	100	NA	52
13	ICP-MS	Sc		He	NA		
14	ICP-MS						
15	ICP-MS	72	ORS	He	1000	1000	52
16	ICP-MS	Sc	CRI	He	NA	500	63
17	ICP-OES-AV	Lutetium	NA	NA	50	50	205.560nm
18	ICP-OES-AV					NA	
19	ICP-MS	Scandium	ORS	He	NA	20	52
20	ICP-MS		ORS	He	100	NA	52
22	ICP-OES-AV	Lu	NA	NA	50	NA	205.56
23	ICP-OES-RV						
24	ICP-MS	Sc	ORS	He	1000	1000	52
25	ICP-MS	Sc	ORS	He	NA	500	52 (m/z)
26	ICP-MS	Sc	UC	He	250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	500	52

Table 122 Instrument Conditions Cs

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	NA	133
6	ICP-MS	Tb	KED	He	400	NA	133
11	ICP-MS	Ge	NA	NA	50	NA	107.846
15	ICP-MS	159	ORS	He	1000	NA	133
17	ICP-MS	Lutetium	ORS	No Gas	1000	NA	m/z 133
22	ICP-MS	Ge	NA	NA	50	NA	107.846
24	ICP-MS	Bi	ORS	He	1000	NA	133
26	ICP-MS	Rh	NA	He	250	NA	
27	NA	NA	NA	NA	500	NA	NA

Table 123 Instrument Conditions Cu

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	800	63
2	ICP-MS	Ge	UC	He	625	625	63
4	ICP-OES-AV						
6	ICP-MS	Ga	KED	He	400	400	63
8	ICP-OES-AV	In 303.936			80	80	327.395
10	ICP-OES-AV	Lu			83	83	327.395
11	ICP-OES-AV	Lu	NA	NA	50	NA	324.754
12	ICP-OES-AV	Te			100	NA	217.895
13	ICP-MS	Sc		He	NA		
14	ICP-MS						
15	ICP-MS	103	ORS	He	1000	1000	63
16	ICP-MS	Sc	CRI	He	NA	500	63
17	ICP-OES-AV	Lutetium	NA	NA	50	50	324.754nm
18	ICP-OES-AV					NA	
19	ICP-MS	Rhodium	ORS	He	NA	20	63
20	ICP-MS		ORS	He	100	NA	65
22	ICP-OES-AV	Lu	NA	NA	50	NA	324.754
23	ICP-OES-RV						
24	ICP-MS	Sc	ORS	He	1000	1000	63
25	ICP-MS	Sc	ORS	He	NA	500	63 (m/z)
26	ICP-MS	Ga	UC	He	250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	500	63

Table 124 Instrument Conditions Fe

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	NA	56
2	ICP-MS	Sc	UC	He	625	NA	56
4	ICP-OES-AV					NA	
5	ICP-OES-RV	NA	NA	Other	NA	NA	261.19 nm
6	ICP-MS	Sc	KED	He	1000	NA	56
8	ICP-OES-RV	Eu 271.700			80	NA	238.204
10	ICP-OES-AV	Lu			83	NA	238.204
11	ICP-OES-AV	Lu	NA	NA	5000	5000	261.382
12	ICP-OES-AV	Y			1000	1000	240.489
14	ICP-OES-AV					NA	
15	ICP-MS	103	ORS	H2	5000	NA	56
16	ICP-MS	Sc	CRI	He	500	NA	56
17	ICP-OES-AV	Lutetium	NA	NA	50-1000	NA	234.350nm
19	ICP-MS	Rhodium	ORS	He	20	NA	56
20	ICP-MS		ORS	He	100	NA	56
22	ICP-OES-AV	Lu	NA	NA	5000	5000	261.382
23	ICP-OES-RV					NA	
24	ICP-MS	Sc	ORS	He	50000	NA	56
25	ICP-MS	Sc	ORS	He	500	NA	56 (m/z)
26	ICP-MS	Ga	NA	He	250	NA	
27	ICP-OES	Cs,Y	NA	NA	500	NA	56

Table 125 Instrument Conditions Ga

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	NA	71
6	KED	He	400	NA	59		
11	ICP-MS/MS	Ge	ORS	standard mode	50	NA	71
12	ICP-MS	Ir	CRI	He	100	NA	202
17	ICP-MS	Indium	ORS	He	1000	NA	m/z 71
22	ICP-MS/MS	Ge	ORS	standard mode	50	NA	71
24	ICP-MS	Sc	ORS	He	1000	NA	69
26	UC	He	250	NA			
27	NA	NA	NA	NA	500	NA	NA

Table 1264 Instrument Conditions Hg

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir	ORS	He	800	800	202
2	ICP-MS	Ir	NA	NA	625	625	201
4	CVAAS						
6	ICP-MS	Tb	KED	He	400	400	201
8	ICP-MS/MS	Ir 193	ORS	O2	80	80	202 m/z
10	CVAAS				83	83	253.7
11	CVAAS	NA	NA	NA	500	NA	253.7
12	ICP-MS	Ir	CRI	He	100	NA	202
13	ICP-MS	Lu		He	NA		
14	ICP-MS						
15	ICP-MS	193	ORS	Standard Mode	1000	1000	201
16	ICP-MS	Lu	CRI	He	NA	500	202
17	CVAAS	NA	NA	NA	500	500	253.7nm
18	CVAAS					NA	
19	ICP-MS	Rhodium	ORS	He	NA	20	202
20	VGA-ICP-OES					NA	194.164
22	CVAAS	NA	NA	NA	500	NA	253.7
24	ICP-MS	Ir	ORS	He	1000	1000	202
25	ICP-MS	Lu	ORS	He	NA	500	202 (m/z)
26	ICP-MS	Ir	NA		250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	500	201

Table 1275 Instrument Conditions K

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	NA	39
2	ICP-MS	Sc	UC	He	625	NA	39
4	ICP-OES-AV					NA	
5	ICP-OES-RV	NA	NA	Other	NA	NA	766.49 nm
10	ICP-OES-AV	Lu			83	NA	769.897
11	ICP-OES-AV	Lu	NA	NA	NA	1000	766.491
12	ICP-OES-RV	Te			NA	100	766.491
14	ICP-OES-AV					NA	
15	ICP-MS	45	ORS	He	5000	NA	39
16	ICP-MS	Sc	CRI	He	500	NA	39
17	ICP-OES-AV	Lutetium	NA	NA	50	NA	766.491nm
19	ICP-MS	Scandium	ORS	He	100	NA	39
20	ICP-OES-AV-buffer	Lu			100	NA	766.491
22	ICP-OES-AV	Lu	NA	NA	NA	1000	766.491
23	ICP-OES-RV					NA	
25	ICP-MS	Rh	ORS	He	100	NA	39 (m/z)
27	ICP-OES	Cs,Y	NA	NA	500	NA	766.491

Table 1286 Instrument Conditions La

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	NA	800	139
6	ICP-MS	Tb	KED	He	NA	400	139
11	ICP-MS/MS	Ge	ORS	standard mode	NA	50	139
12	ICP-MS	Ge	CRI	He	100	NA	139
15	ICP-MS	159	ORS	He	NA	1000	139
17	ICP-MS	Lutetium	ORS	No Gas	NA	1000	m/z 139
22	ICP-MS/MS	Ge	ORS	standard mode	NA	50	139
24	ICP-MS	Rh	ORS	He	NA	1000	139
26	ICP-MS	In	NA		250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	NA	500	139

Table 1297 Instrument Conditions Li

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	NA	7
2	ICP-MS	Sc	NA	NA	625	NA	7
4	ICP-OES-AV					NA	
6	ICP-MS	Sc	KED	He	1000	NA	7
8	ICP-OES-AV	In 410.176			80	NA	670.783
10	ICP-OES-AV	Lu			83	NA	670.783
11	ICP-OES-AV	Lu	NA	NA	50	NA	670.783
12	ICP-MS	Ge	CRI	He	100	NA	7
14	ICP-MS					NA	
15	ICP-MS	45	ORS	H2	1000	NA	7
17	ICP-OES-AV	Lutetium	NA	NA	50	NA	670.783nm
20	ICP-OES-AV-buffer	Lu			100	NA	670.783
22	ICP-OES-AV	Lu	NA	NA	50	NA	670.783
24	ICP-MS	Sc	ORS	He	1000	NA	7
26	ICP-MS	Sc	NA		250	NA	
27	ICP-OES	Cs,Y	NA	NA	500	NA	670.783

Table 1308 Instrument Conditions Mg

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	NA	24
2	ICP-MS	Sc	UC	He	625	NA	25
4	ICP-OES-AV					NA	
5	ICP-OES-RV	NA	NA	Other	NA	NA	280.27 nm
10	ICP-OES-AV	Lu			83	NA	383.829
11	ICP-OES-AV	Lu	NA	NA	NA	1000	279.8
12	ICP-OES-AV	Y			NA	100	279.553
14	ICP-OES-AV					NA	
15	ICP-MS	45	ORS	H2	5000	NA	24
16	ICP-MS	Sc	CRI	He	500	NA	24
17	ICP-OES-AV	Lutetium	NA	NA	50	NA	279.800nm
19	ICP-MS	Scandium	ORS	He	100	NA	24
20	ICP-OES-AV-buffer	Lu			100	NA	279.078
22	ICP-OES-AV	Lu	NA	NA	NA	1000	279.8
23	ICP-OES-RV					NA	
25	ICP-MS	Sc	ORS	He	100	NA	24 (m/z)
27	ICP-OES	Cs,Y	NA	NA	500	NA	285.213

Table 13109 Instrument Conditions Mn

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	800	55
2	ICP-MS	Sc	UC	He	625	625	55
4	ICP-OES-AV						
6	ICP-MS	Sc	KED	He	1000	1000	55
8	ICP-OES-AV	Eu 271.700			80	80	257.61
10	ICP-OES-AV	Lu			83	83	260.568
11	ICP-OES-AV	Lu	NA	NA	50	NA	257.61
12	ICP-OES-AV	Y			100	NA	257.61
13	ICP-MS	Sc		He	NA		
14	ICP-MS						
15	ICP-MS	103	ORS	Standard Mode	1000	1000	55
16	ICP-MS	Sc	CRI	He	NA	500	55
17	ICP-OES-AV	Lutetium	NA	NA	50	50	257.610nm
19	ICP-MS	Rhodium	ORS	He	NA	20	55
20	ICP-MS		ORS	He	100	NA	55
22	ICP-OES-AV	Lu	NA	NA	50	NA	257.61
23	ICP-OES-RV						
24	ICP-MS	Sc	ORS	He	50000	50000	55
25	ICP-MS	Sc	ORS	He	NA	500	55 (m/z)
26	ICP-MS	Rh	UC	He	250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	500	55

Table 1320 Instrument Conditions Mo

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	NA	800	95
2	ICP-MS	Rh	NA	NA	NA	625	95
4	ICP-OES-AV				NA		
6	ICP-MS	Rh	KED	He	NA	400	98
8	ICP-OES-AV	Lu 219.556			NA	80	202.032
10	ICP-OES-AV	Lu			NA	83	202.568
11	ICP-OES-AV	Lu	NA	NA	50	NA	202.032
12	ICP-MS	Rh	CRI	He	100	NA	95
13	ICP-MS	Rh		He	NA		
14	ICP-MS				NA		
15	ICP-MS	89	ORS	He	NA	1000	95
16	ICP-MS	Rh	CRI	He	NA	500	95
17	ICP-OES-AV	Lutetium	NA	NA	50	50	202.032nm
19	ICP-MS	Rhodium	ORS	He	NA	20	95
22	ICP-OES-AV	Lu	NA	NA	50	NA	202.032
23	ICP-OES-RV				NA		
24	ICP-MS	Rh	ORS	He	NA	1000	95
25	ICP-MS	Rh	ORS	He	NA	500	95 (m/z)
26	ICP-MS	Rh	UC	He	250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	NA	500	95

Table 1331 Instrument Conditions Na

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-OES-AV	Y	NA	NA	800	800	588.995
2	ICP-MS	Sc	UC	He	625	625	23
4	ICP-OES-AV						
5	ICP-OES-RV	NA	NA	Other	NA	NA	588.99 nm
6	ICP-MS	Sc	KED	He	NA	1000	23
8	ICP-OES-AV	In 410.176			NA	80	589.592
10	ICP-OES-AV	Lu			83	83	330.237
11	ICP-OES-AV	Lu	NA	NA	1000	1000	588.995
12	ICP-OES-RV	Te			100	100	589.592
13	ICP-MS	Sc		He	NA		
14	ICP-OES-AV						
15	ICP-MS	45	ORS	H2	1000	5000	23
16	ICP-MS	Sc	CRI	He	500	500	23
17	ICP-OES-AV	Lutetium	NA	NA	50	50	588.995nm
19	ICP-MS	Scandium	ORS	He	100	100	23
20	ICP-OES-AV-buffer	Lu			100	NA	589.592
22	ICP-OES-AV	Lu	NA	NA	1000	1000	588.995
23	ICP-OES-RV						
24	ICP-MS	Sc	ORS	He	NA	1000	23
25	ICP-MS	Sc	ORS	He	100	100	23 (m/z)
27	ICP-OES	Cs,Y	NA	NA	500	500	588.995

Table 1342 Instrument Conditions Ni

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	NA	60
2	ICP-MS	Ge	UC	He	625	NA	60
4	ICP-OES-AV					NA	
6	ICP-MS	Ga	KED	He	400	NA	60
8	ICP-OES-AV	Lu 219.556			80	NA	231.604
10	ICP-OES-AV	Lu			83	NA	231.604
11	ICP-OES-AV	Lu	NA	NA	50	NA	231.604
12	ICP-OES-AV	Y			100	NA	216.555
14	ICP-MS					NA	
15	ICP-MS	103	ORS	He	1000	NA	60
17	ICP-OES-AV	Lutetium	NA	NA	50	NA	231.604nm
18	ICP-OES-AV					NA	
20	ICP-MS		ORS	He	100	NA	60
22	ICP-OES-AV	Lu	NA	NA	50	NA	231.604
23	ICP-OES-RV					NA	
24	ICP-MS	Sc	ORS	He	1000	NA	60
26	ICP-MS	Rh	UC	He	250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	60

Table 1353 Instrument Conditions P

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	800	31
2	ICP-MS	Sc	UC	He	625	625	31
4	ICP-OES-AV						
5	ICP-OES-RV	NA	NA	Other	NA	NA	213.62 nm
6	ICP-MS	Sc	KED	He	NA	1000	31
8	ICP-OES-AV	Bi 223.061			NA	80	185.878
10	ICP-OES-AV	Lu			83	83	213.618
11	ICP-OES-AV	Lu	NA	NA	NA	1000	182.143
12	ICP-OES-RV	Te			NA	100	177.434
13	ICP-OES-AV	Sc		NA	NA		
14	ICP-OES-AV						
15	ICP-MS	72	ORS	He	1000	1000	31
16	ICP-MS	Sc	CRI	He	500	500	31
17	ICP-OES-AV	Lutetium	NA	NA	50	50	213.618nm
19	ICP-MS	Scandium	ORS	He	100	100	31
20	ICP-OES-AV-buffer	Lu			100	NA	213.618
22	ICP-OES-AV	Lu	NA	NA	NA	1000	182.143
24	ICP-MS	Sc	ORS	He	NA	1000	31
25	ICP-MS	Sc	ORS	He	500	500	31 (m/z)
27	ICP-OES	Cs,Y	NA	NA	500	500	213.618

Table 1364 Instrument Conditions Pb

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir	ORS	He	800	800	208
2	ICP-MS	Ir	NA	NA	625	625	206+207+208
4	ICP-OES-AV						
6	ICP-MS	Tb	KED	He	400	400	206+207+208
8	ICP-OES-AV	Lu 219.556			80	80	220.353
10	ICP-OES-AV	Lu			83	83	220.353
11	ICP-OES-AV	Lu	NA	NA	50	NA	220.353
12	ICP-OES-AV	Te			100	NA	217
13	ICP-MS	Lu		He	NA		
14	ICP-MS						
15	ICP-MS	159	ORS	Standard Mode	1000	1000	206+207+208
16	ICP-MS	Lu	CRI	He	NA	500	208
17	ICP-OES-AV	Lutetium	NA	NA	50	50	220.353nm
18	ICP-OES-AV					NA	
19	ICP-MS	Lutetium	ORS	He	NA	20	208
20	ICP-MS		ORS	He	100	NA	208
22	ICP-OES-AV	Lu	NA	NA	50	NA	220.353
23	ICP-OES-RV						
24	ICP-MS	Ir	ORS	He	1000	1000	206 + 207 + 208
25	ICP-MS	Lu	ORS	He	NA	500	208 (m/z)
26	ICP-MS	Ir	NA		250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	500	208

Table 1375 Instrument Conditions Rb

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	NA	800	85
6	ICP-MS	Rh	KED	He	NA	400	85
11	ICP-MS	Ge	ORS	standard mode	1000	NA	85
15	ICP-MS	89	ORS	He	NA	1000	85
17	ICP-MS	Rhodium	ORS	He	NA	1000	m/z 85
22	ICP-MS	Ge	ORS	standard mode	1000	NA	85
24	ICP-MS	Rh	ORS	He	NA	1000	85
26	ICP-MS	Rh	NA		250	NA	
27	NA	NA	NA	NA	NA	500	NA

Table 1386 Instrument Conditions S

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-OES-AV	Y	NA	NA	800	NA	181.972
2	ICP-OES-AV	Lu	NA	NA	62.5	NA	181.975
4	ICP-OES-AV					NA	
10	ICP-OES-AV	Lu			83	NA	181.972
11	ICP-OES-AV	Lu	NA	NA	NA	1000	181.972
12	ICP-OES-AV	Te			NA	100	181.972
14	ICP-OES-AV					NA	
15	ICP-MS/MS	103	ORS	O2	1000	NA	48
17	ICP-OES-AV	Lutetium	NA	NA	50	NA	181.972nm
19	ICP-MS	Scandium	ORS	H2	100	NA	33
20	ICP-OES-AV-buffer	Lu			100	NA	181.972
22	ICP-OES-AV	Lu	NA	NA	NA	1000	181.972
23	ICP-OES-RV					NA	
27	ICP-OES	Cs,Y	NA	NA	500	NA	181.972

Table 1397 Instrument Conditions Sb

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	NA	121
2	ICP-MS	Rh	NA	NA	625	NA	121
4	ICP-OES-AV					NA	
6	ICP-MS	Rh	KED	He	400	NA	121
8	ICP-OES-AV	Bi 223.061			80	NA	206.834
10	ICP-OES-AV	Lu			83	NA	206.834
11	ICP-OES-AV	Lu	NA	NA	50	NA	206.834
12	ICP-MS	Rh	CRI	He	100	NA	121
15	ICP-MS	193	ORS	Standard Mode	1000	NA	121
17	ICP-OES-AV	Lutetium	NA	NA	50	NA	206.834nm
20	ICP-MS		ORS	He	100	NA	121
22	ICP-OES-AV	Lu	NA	NA	50	NA	206.834
23	ICP-OES-RV					NA	
24	ICP-MS	Rh	ORS	He	1000	NA	121
26	ICP-MS	Rh	NA		250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	121

Table 1408 Instrument Conditions Se

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	800	78
2	ICP-MS	Rh	UC	He	625	625	82
4	ICP-OES-AV						
6	ICP-MS	Te	KED	He	400	400	82
8	ICP-MS/MS	Rh 103	ORS	O2	80	80	94 m/z
10	ICP-OES-AV	Lu			83	83	196.026
11	ICP-OES-AV	Lu	NA	NA	50	NA	196.026
12	ICP-MS	Rh	CRI	He	100	NA	78
13	ICP-MS	Rh		H2	NA		
15	ICP-MS	72	ORS	H2	1000	1000	78
16	ICP-MS	Rh	CRI	H2	NA	500	78
17	ICP-OES-AV	Lutetium	NA	NA	50	50	196.026nm
19	ICP-MS	Rhodium	ORS	HEHe	NA	20	78
20	ICP-MS		ORS	He	100	NA	78
22	ICP-OES-AV	Lu	NA	NA	50	NA	196.026
23	ICP-OES-RV						
24	ICP-MS	Rh	ORS	HEHe	1000	1000	78
25	ICP-MS	Rh	ORS	H2	NA	500	78 (m/z)
26	ICP-MS	Rh	UC	He	250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	500	78

Table 1410 Instrument Conditions Sn

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	NA	800	118
2	ICP-MS	Rh	NA	NA	NA	625	118
4	ICP-OES-AV				NA		
6	ICP-MS	Rh	KED	He	NA	400	120
8	ICP-MS/MS	Rh 103	ORS	O2	NA	80	134 m/z
10	ICP-OES-AV	Lu			NA	83	189.925
11	ICP-OES-AV	Lu	NA	NA	50	NA	189.925
12	ICP-MS	Rh	CRI	He	100	NA	118
13	ICP-MS	Rh		He	NA		
14	ICP-MS				NA		
15	ICP-MS	103	ORS	He	NA	1000	118
16	ICP-MS	Rh	CRI	He	NA	500	118
17	ICP-OES-AV	Lutetium	NA	NA	NA	50	189.925nm
19	ICP-MS	Lutetium	ORS	He	NA	20	118
22	ICP-OES-AV	Lu	NA	NA	50	NA	189.925
23	ICP-OES-RV				NA		
24	ICP-MS	Rh	ORS	He	NA	1000	118
25	ICP-MS	Rh	ORS	He	NA	500	118 (m/z)
26	ICP-MS	Rh	NA		250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	NA	500	118

Table 1421 Instrument Conditions Sr

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	NA	88
2	ICP-MS	Rh	NA	NA	625	NA	88
4	ICP-OES-AV					NA	
5	ICP-OES-RV	NA	NA	Other	NA	NA	407.77 nm
10	ICP-OES-AV	Lu			83	NA	407.771
11	ICP-OES-AV	Lu	NA	NA	50	NA	421.552
12	ICP-MS	Rh	CRI	He	100	NA	88
14	ICP-OES-AV					NA	
15	ICP-MS	103	ORS	He	1000	NA	88
16	ICP-MS	Rh	CRI	He	500	NA	88
17	ICP-OES-AV	Lutetium	NA	NA	50	NA	407.771nm
19	ICP-MS	Lutetium	ORS	He	20	NA	88
20	ICP-OES-AV-buffer	Lu			100	NA	407.771
22	ICP-OES-AV	Lu	NA	NA	50	NA	421.552
23	ICP-OES-RV					NA	
25	ICP-MS	Rh	ORS	He	500	NA	88 (m/z)
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	88

Table 1432 Instrument Conditions Th

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir	ORS	He	800	NA	232
2	ICP-MS	Ir	NA	NA	625	NA	232
8	ICP-MS/MS	Ir 193	ORS	He	80	NA	232 m/z
11	ICP-MS/MS	Ge	ORS	Standard Mode	50	NA	232
12	ICP-MS	Ir	CRI	He	100	NA	232
14	ICP-MS					NA	
17	ICP-MS	Lutetium	NA	NA	1000	NA	m/z 232
22	ICP-MS/MS	Ge	ORS	Standard Mode	50	NA	232
24	ICP-MS	Ir	ORS	He	1000	NA	232
26	ICP-MS	NA	NA	NA	250	NA	NA
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	232

Table 1443 Instrument Conditions Tl

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir	ORS	He	NA	800	205
2	ICP-MS	Ir	NA	NA	NA	625	205
6	ICP-MS	Tb	KED	He	NA	400	205
8	ICP-MS/MS	Ir 193	ORS	O2	NA	80	205 m/z
11	ICP-OES-AV	Lu	NA	NA	NA	50	190.794
12	ICP-MS	Ge	CRI	He	100	NA	205
13	ICP-MS	Lu		He	NA		
14	ICP-MS				NA		
15	ICP-MS	159	ORS	Standard Mode	NA	1000	205
16	ICP-MS	Lu	CRI	He	NA	500	205
17	ICP-OES-AV	Lutetium	NA	NA	50	NA	190.794nm
19	ICP-MS	Lutetium	ORS	He	NA	20	205
22	ICP-OES-AV	Lu	NA	NA	NA	50	190.794
24	ICP-MS	Ir	ORS	He	NA	1000	205
25	ICP-MS	Lu	ORS	He	NA	500	205 (m/z)
26	ICP-MS	Ir	NA		250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	NA	500	205

Table 1454 Instrument Conditions U

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir	ORS	He	800	NA	238
2	ICP-MS	Ir	NA	NA	625	NA	238
6	ICP-MS	Tb	KED	He	400	NA	238
8	ICP-MS/MS	Ir 193	ORS	He	80	NA	238 m/z
11	ICP-MS	Lu	ORS	standard mode	1000	NA	238
12	ICP-MS	Ir	CRI	He	100	NA	238
14	ICP-MS					NA	
15	ICP-MS	159	ORS	Standard Mode	1000	NA	238
17	ICP-MS	Lutetium	ORS	No Gas	1000	NA	m/z 238
20	ICP-MS		ORS	He	100	NA	238
22	ICP-MS	Lu	ORS	standard mode	1000	NA	238
24	ICP-MS	Ir	ORS	He	1000	NA	238
26	ICP-MS	Ir	NA		250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	238

Table 1465 Instrument Conditions V

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	NA	800	51
2	ICP-MS	Sc	UC	He	NA	625	51
4	ICP-OES-AV				NA		
6	ICP-MS	Sc	KED	He	NA	400	51
8	ICP-OES-AV	Eu 271.700			NA	80	292.401
10	ICP-OES-AV	Lu			NA	83	292.401
11	ICP-OES-AV	Lu	NA	NA	50	NA	292.401
12	ICP-MS	Ge	CRI	He	100	NA	51
13	ICP-MS	Sc		He	NA		
14	ICP-MS				NA		
15	ICP-MS	72	ORS	He	NA	1000	51
16	ICP-MS	Sc	CRI	He	NA	500	51
17	ICP-OES-AV	Lutetium	NA	NA	NA	50	292.401nm
19	ICP-MS	Scandium	ORS	He	NA	20	51
22	ICP-OES-AV	Lu	NA	NA	50	NA	292.401
23	ICP-OES-RV				NA		
24	ICP-MS	Sc	ORS	He	NA	1000	51
25	ICP-MS	Sc	ORS	He	NA	500	51 (m/z)
26	ICP-MS	Sc	UC	He	250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	NA	500	51

Table 1476 Instrument Conditions Zn

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	800	64
2	ICP-MS	Ge	UC	He	625	625	66
3	ICP-MS				NA		
4	ICP-OES-AV						
6	ICP-MS	Ga	KED	He	400	400	66
8	ICP-OES-AV	Bi 223.061			80	80	206.2
10	ICP-OES-AV	Lu			83	83	213.857
11	ICP-OES-AV	Lu	NA	NA	50	NA	206.2
12	ICP-OES-AV	Te			100	NA	334.502
13	ICP-MS	Sc		He	NA		
14	ICP-MS						
15	ICP-MS	103	ORS	He	1000	1000	66
16	ICP-MS	Sc	CRI	He	NA	500	66
17	ICP-OES-AV	Lutetium	NA	NA	50	50	206.200nm
18	ICP-OES-AV					NA	
19	ICP-MS	Scandium	ORS	He	NA	20	66
20	ICP-MS		ORS	He	100	NA	66
22	ICP-OES-AV	Lu	NA	NA	50	NA	206.2
23	ICP-OES-RV						
24	ICP-MS	Sc	ORS	He	1000	1000	66
25	ICP-MS	Sc	ORS	He	NA	500	66 (m/z)
26	ICP-MS	Rh	UC	He	250	NA	
27	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	500	66

Table 148 Instrument Conditions Exchangeable Ca^{2+}

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	Final Dilution Factor	Wavelength (nm) /Ion(m/z)/ Absorbance(nm)
2	ICP-OES-RV	Y	NA		20	317.933
3	ICP-MS		DRC		100	
4	ICP-OES-AV	Yittrium			50	315.887
5	ICP-OES-RV	NA	NA	Other	NA	373.66 nm
10	ICP-OES-AV	Lu			20	317.933
11	ICP-OES-AV	Lu	NA	NA	25	315.887
17	ICP-OES-AV	Lu	NA	NA	25	315.887
19	ICP-MS	Scandium	ORS	H2	200	40
21	ICP-OES-RV					
22	ICP-OES-AV	Lu	NA	NA	25	315.887
25	ICP-MS	Sc	ORS	H2	20	40 (m/z)

Table 149 Instrument Conditions Exchangeable K^{+}

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	Final Dilution Factor	Wavelength (nm) /Ion(m/z)/ Absorbance(nm)
2	ICP-OES-RV	Y	NA		20	766.49
3	ICP-MS		DRC		100	
4	ICP-OES-AV	Yittrium			50	279.077
5	ICP-OES-RV	NA	NA	Other	NA	766.49 nm
10	ICP-OES-AV	Lu			20	769.897
11	ICP-OES-AV	Lu	NA	NA	25	766.491
17	ICP-OES-AV	Lu	NA	NA	25	766.491
19	ICP-MS	Scandium	ORS	He	200	39
21	ICP-OES-AV					
22	ICP-OES-AV	Lu	NA	NA	25	766.491
25	ICP-MS	Sc	ORS	He	20	39 (m/z)

Table 150 Instrument Conditions Exchangeable Mg^{2+}

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	Final Dilution Factor	Wavelength (nm) /Ion(m/z)/ Absorbance(nm)
2	ICP-OES-RV	Y	NA		20	285.213
3	ICP-MS		DRC		100	
4	ICP-OES-AV	Yittrium			50	589.592
5	ICP-OES-RV	NA	NA	Other	NA	280.27 nm
10	ICP-OES-AV	Lu			20	383.829
11	ICP-OES-AV	Lu	NA	NA	25	279.8
17	ICP-OES-AV	Lu	NA	NA	25	279.8
19	ICP-MS	Scandium	ORS	He	200	24
21	ICP-OES-RV					
22	ICP-OES-AV	Lu	NA	NA	25	279.8
25	ICP-MS	Sc	ORS	He	20	24 (m/z)

Table 151 Instrument Conditions Exchangeable Na^{+}

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	Final Dilution Factor	Wavelength (nm) /Ion(m/z)/ Absorbance(nm)
2	ICP-OES-RV	Y	NA		20	589.592
3	ICP-MS		DRC		100	
4	ICP-OES-AV	Yittrium			50	766.49
5	ICP-OES-RV	NA	NA	Other	NA	588.99 nm
10	ICP-OES-AV	Lu			20	330.237
11	ICP-OES-AV	Lu	NA	NA	25	588.995
17	ICP-OES-AV	Lu	NA	NA	25	588.995
19	ICP-MS	Scandium	ORS	He	200	23
21	ICP-OES-AV					
22	ICP-OES-AV	Lu	NA	NA	25	588.995
25	ICP-MS	Sc	ORS	He	20	23 (m/z)

END OF REPORT