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Proficiency Test Final Report AQA 26-16 Metals, Nutrients, and Anions in Soil and Compost

November 2026

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Summary

This report presents the results of the proficiency test AQA 26-16 Metals, Nutrients, and Anions in Soil and Compost. The study covers the measurement of acid extractable elements: Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Ga, Hg, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Rb, S, Sb, Se, Sn, Sr, U, V and Zn. Measurement of pH, electrical conductivity (EC), water soluble bromide (Br^-), chloride (Cl^-), fluoride (F^-), iodide (I^-), orthophosphate-P (PO_4^{3-}-P), and sulphate (SO_4^{2-}) and of total Kjeldahl nitrogen (TKN), 2M KCl extractable ammonium nitrogen (NH_4^+-N) and 2M KCl extractable nitrate nitrogen (NO_3^--N) were also included in the program.

The sample set consisted of one soil sample, one compost sample, and one agricultural soil sample.

Twenty-five laboratories registered to participate, and all submitted results.

The assigned values were the robust average of participants' results. The associated uncertainties were evaluated from the robust standard deviations of the participants' results.

The outcomes of the study were assessed against the aims as follows, to:

i. assess laboratory capability in measuring metals, nutrients, and anions in soil and compost;

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

Of 641 z-scores, 604 (94%) returned $|z| \leq 2.0$, indicating an acceptable performance.

Of 641 E_n-scores, 559 (87%) returned $|E_n| < 1.0$, indicating agreement of the participant's result with the assigned value within their respective expanded uncertainties.

Laboratory 15 returned acceptable z-scores for all scored analytes (45).

All scored results reported by Laboratories 1, 2, 6, 7, 9, 10, 19, and 24 returned acceptable z-scores and E_n-scores.

ii. evaluate laboratories' methods used in determination of inorganic analytes in soil and compost;

All participants used the same digestion method for all three matrices.

Cr and Ni in compost sample S2 challenged participants' analytical techniques compared with soil sample S1. While all results reported for these analytes in the soil sample returned acceptable z-scores, there was no agreement among the results reported for the compost sample.

The biased low Cr, Co and Ni results in the compost sample S2 and U in soil sample S1 were reported by laboratories that used a small volume of acid, dilute acids and/or hydrogen peroxide, which may have reduced the effective acid strength of the digestion mixture. Their digestion procedure may have extracted only a fraction of these contaminates present in the compost sample.

Caution is advised when using the colorimetric method for fluoride determination, as it is known to suffer from interference from chlorides.

Most of the sulphate results from ICP-OES and ICP-MS measurements were biased high.

iii. assess the ability of participants to determine compliance of compost sample against AS 4454;

Of 56 results assessed, 54 (96%) gave the correct compliance status with respect to AS 4454.

Some participants should also consider reviewing their laboratory reporting limit of <5 mg/kg for Se in compost as it might not be fit for purpose.

iv. compare the performance of participant laboratories with their past performance;

Over the last 30 studies of inorganic analytes in soil, the average proportion of acceptable scores was 90% for z-scores and 80% for E_n-scores.

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

Of 759 numerical results, 752 (99%) were reported with an expanded measurement uncertainty. The magnitude of the reported expanded uncertainties was within the range 0.29% to 83% of the reported value. An example of evaluating measurement uncertainty using proficiency testing data only is given in Appendix 3.

vi. 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 test samples are available for purchase from NMIA.

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1 INTRODUCTION

1.1 NMIA Proficiency Testing Program

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

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

- per- and polyfluoroalkyl substances in soil, biosolids, compost, water, biota, food, and consumer goods;
- hydrocarbons, phenols, and other organic compounds in soil and water;
- pesticide residues in soil, biosolids, compost, water, fruit, vegetables, and herbs;
- metals in soil, compost, biosolids, water, food, filters, and paint;
- nutrients, anions, and physical tests in water and soil;
- chlorophyll a in water; and
- controlled drug assay, drugs in wipes, and clandestine laboratory.

AQA 26-16 is the 39th NMIA 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 anions in soil and compost;
- evaluate laboratories' methods used in determination of inorganic analytes in soil and compost;
- assess the ability of participants to determine compliance of compost samples against AS 4454;
- 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 NMIA PT studies is described in the NMIA Study Protocol for Proficiency Testing.[2] The statistical methods used are described in the NMIA Chemical Proficiency Testing Statistical Manual.[3] These documents have been prepared with reference to ISO/IEC 17043 and The International Harmonized Protocol for the Proficiency Testing of Analytical Chemistry Laboratories.[1,4]

NMIA is accredited by the National Association of Testing Authorities, Australia (NATA) to ISO/IEC 17043 as a provider of proficiency testing schemes.[1] This study falls within the scope of NMIA's accreditation (Accreditation No. 198; Site No. 14485).

2 STUDY INFORMATION

2.1 Study Timetable

The timetable of the study was:

Invitation issued:	03 August 2026
Samples dispatched:	24 August 2026
Results due:	18 September 2026
Interim report issued:	24 September 2026
Preliminary report issued:	25 September 2026

2.2 Participation and Laboratory Code

Twenty-five laboratories participated in this study, and all submitted results. A confidential laboratory code number was assigned to each of these 25 participants.

2.3 Selection of Matrices and Inorganic Analytes

The 57 tests included across the three study samples were selected from those for which an investigation level is published in the National Environment Protection Measure (NEPM)-Schedule B1 and Australian Standard (AS) 4454 Composts, soil conditioners and mulches.[5,6]

2.4 Test Material Specification

Three samples were provided for analysis:

- Sample S1 was 30 g of dried soil;
- Sample S2 was 30 g of dried compost; and
- Sample S3 was 75 g of dried agricultural soil.

2.5 Sample Preparation, Analysis and Homogeneity Testing

All samples were prepared and packaged using a process that has been demonstrated to produce homogeneous samples in previous studies. Therefore, only a partial homogeneity test was conducted for acid extractable elements in Samples S1 and S3. Partial homogeneity analyses were also conducted for other analytes in Sample S3 except for pH, EC, and TKN. The results from the partial homogeneity tests are reported in the present study as homogeneity value.

This is the first time a compost sample has been included in a NMIA PT study. A full homogeneity test was conducted for all analytes in Sample S2.

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 in the present study. Stability studies conducted for the previous proficiency tests of inorganic analytes in soil-like matrices found no significant changes in any of the analytes' concentration.

2.7 Sample Storage, Dispatch, and Receipt

All test samples were stored at room temperature prior to dispatch by courier on 24 August 2026.

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 results was emailed to participants.

2.8 Instructions to Participants

Participants were instructed as follows:

- If samples cannot be analysed on the day of receipt, please store them at room temperature.
- Quantitatively analyse the samples using your normal test method.
- For *Sample S3* for 2M KCl Extractable (NO_3^--N) and (NH_4^+-N), participants are asked to follow the extraction procedure described below:

  "Prepare a 1:10 w/v soil/2M KCl extracting solution. For example, weigh 5 g of soil into a suitable bottle or jar and add 50 mL of 2M KCl extracting solution. Mechanically shake (end-over-end preferred), at room temperature for 1 h. Allow around 20-30 min for soil to settle and clarify and then take a known aliquot for the measurement technique employed. Further dilution of the aliquot may be required."
  - measure the analytes using a colorimetric method; and
  - report results of 1:10 soil/2M KCl extracting solution on as received basis in units of mg/kg for: 2M KCl extractable ammonium-N (NH_4^+-N) and 2M KCl extractable nitrate-N (NO_3^--N).
- Report on as received basis in units of mg/kg except for EC and pH. EC results are to be reported in units of µS/cm.

SAMPLE S1 30 g Dried Soil		**SAMPLE S2 30 g Dried Compost**		**SAMPLE S3 75 g Dried Agricultural Soil**	
Test (acid extractable)	**Estimated Value* [mg/kg]**	**Test (acid extractable)**	**Estimated Value* [mg/kg]**	**Test**	**Estimated Value* [mg/kg]**
Ag	0.5-20	Ag	0.5-20	Ca (acid extractable)	10-4000
As	0.5-20	Al	100-4000	Fe (acid extractable)	500-20000
Be	0.05-2	As	0.5-20	K (acid extractable)	100-4000
Cd	0.5-20	B	0.5-20	Mg (acid extractable)	100-4000
Cr	5-200	Ba	5-200	Na (acid extractable)	5-200
Cu	5-200	Cd	0.5-20	P (acid extractable)	100-4000
Ga	0.5-20	Co	0.5-20	S (acid extractable)	100-4000
Hg	0.5-20	Cr	5-200	Sr (acid extractable)	0.5-20
Li	0.5-20	Cu	5-200	Water Soluble Bromide (Br^-) - 1:5 soil/water extract	0.5-20
Mn	50-2000	Hg	0.5-20	Water Soluble Chloride (Cl^-) - 1:5 soil/water extract	5-200
Na	5-200	Mn	10-4000	Water Soluble Fluoride (F^-) - 1:5 soil/water extract	0.05-2
Ni	0.5-20	Mo	0.5-20	Water Soluble Iodide (I^-) - 1:5 soil/water extract	0.05-2
Pb	50-2000	Ni	5-200	Water Soluble Orthophosphate-P (PO_4^{3-}-P) - 1:5 soil/water extract	0.05-2
Rb	5-200	P	100-4000	Water Soluble Sulphate (SO_4^{2-}) - 1:5 soil/water extract	5-200
Sb	5-200	Pb	5-200	EC of 1:5 soil/water extract	NA (µS/cm)
Se	0.5-20	Se	0.5-20	pH of 1:5 soil/water suspension	NA
Sn	0.5-20	Sn	0.05-2	Kjeldahl nitrogen, total (TKN)	250-10000

SAMPLE S1 30 g Dried Soil		SAMPLE S2 30 g Dried Compost		SAMPLE S3 75 g Dried Agricultural Soil	
Test (acid extractable)	**Estimated Value* [mg/kg]**	**Test (acid extractable)**	**Estimated Value* [mg/kg]**	**Test**	**Estimated Value* [mg/kg]**
U	0.5-20	V	0.5-20	2M KCl Extractable (Ammonium-N)	5-200
Zn	50-2000	Zn	5-200	2M KCl Extractable (Nitrate-N)	5-200

*As these samples are real samples, the values given are indicative. NA = Not Available.

- 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 the requested details regarding the test method and the basis of your uncertainty evaluation.
- Please return the completed results sheet by email (proficiency@measurement.gov.au) by 18 September 2026.

2.9 Interim and Preliminary Reports

An interim report was emailed to participants on 24 September 2026.

A preliminary report was emailed to all participants on 25 September 2026. This report included: a summary of the results reported by laboratories, assigned values, performance coefficient of variations, z-scores and E_n-scores for each analyte tested by participants.

There were no changes from the Preliminary Report in this Final Report.

3 PARTICIPANT LABORATORY INFORMATION

3.1 Test Method Summaries

Summaries of test methods are transcribed in Tables 1 to 10.

Table 1 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. H_2O_2 (mL)	Other (mL)
1	USEPA 3050B		0.5	95	120	3	3			
2	In House		1	112.5	120	7.5	2.5			
3	US EPA 3050B - modified	Yes	0.5	95	120	3	4		1.5	
4	USEPA-6010C (Except Mercury by USEPA-7471B)		1	120		5	5			
5	EPA Method 3050B Acid Digestion of Sediments, Sludges and Soils	NA	0.5	85	240	5	5			
6	US EPA 1994 Method 200.8	No	2	109	60	800	400			1200 (H_2O)
7	US EPA METHOD 3010		2	95-105	60	4	12			4 (H_2O)
8*	GLOSOLAN-SOP-19, Version No.1 (2023)		0.25	180	35	6	3		2	
9	US EPA 200.2	NA	1	95	50	2	2			10 (H_2O)
10	In-House Method	No	2	105	60	0.4	1.2			
11	US EPA METHOD 3010	No	2	95-105	60	4	12			4 (H_2O)
12*	USEPA Method 3050	Yes	3	95	120	10	5	10	6	
13	EPA	Yes	0.3	95	60	3	2			
14	USEPA 200.7 and 200.8	NA	0.5	95	90	1	1.5		1	
15		Yes	1	100	120	3	3			
17	200.2 Revision 2.8	Yes	1	95 ± 5	60	2	10		2	
18	In House Method - referencing APHA 3125	No	0.4	120	60	2.5	7.5			
20*	USEPA 3050B									
21	USEPA method 200.2 Revision 2.8	Yes	1	95	60			2	2	10 (HCl 1:4)
22	USEPA 3010		2	95-105	60	4	12			
23	EPA Method 200.7	No	0.5	95	120	2mL	2mL			10mL (H_2O)
25	US EPA 200.8	Yes	0.5	105	120	3	9			

*Additional information in Table 10.

Table 2 Methodology for Total Kjeldahl Nitrogen

Lab. Code	Method Reference (eg USEPA No.)	Test Method: Digestion	Test Method: Distillation	Test Method: Other	Measurement Method	Instrument
1	Inhouse	Yes			Fluorometric	FIA
2	In house	Yes	No	Kjeldahl digestion	Colorimetric - salicylate method	DA
5	European Standard - Determination of Kjeldahl Nitrogen in soil, biowaste and sewage sludge 2005-08.	Yes	Yes		Titrimetric method	FOSS
7	inhouse	Yes	No		Colorimetric - salicylate method	FIA
8	According to EN 13342 and DIN 11261, Modified by BUCHI (2013)	Yes	Yes		Titrimetric method	Auto Titrator
12*	APHA Method 4500-N Org D	Yes	No	No	Colorimetric - salicylate method	DA
14	4500-Norg D	Yes	No		Colorimetric - salicylate method	FIA
15	APHA 4500-N B. C	Yes	Yes		Titrimetric method	FOSS
17	APHA 22nd edition 4500 Norg A & D with Jirka Modification-Jirka et al. (1976)	Yes			Colorimetric - phenate method	DA
18*					TKN = TN-NOx (Dumas)	LECO
21	APHA 4500	Yes			Colorimetric - salicylate method	DA
25*	US EPA 351.2	Yes			Colorimetric - salicylate method	SFA

*Additional information in Table 10.

Table 3 Methodology for 2M KCl Extractable Ammonium-N and Nitrate-N

Lab. Code	Method Reference		Sample Mass (g)	2M KCl Added (mL)	Shake Time (hours)	Measurement Method		Measurement Instrument	
	NH_4^+-N	NO_3^--N				NH_4^+-N	NO_3^--N	NH_4^+-N	NO_3^--N
2	In House	In House	1.5 g	15 mL	1 hour	Colorimetric - Salicylate method	Colorimetric-Sulfanilamide -NEDD Cd reduction	SFA	SFA
5	Per NMI AQA 26-16 Instruction	Per NMI AQA 26-16 Instruction	5	50	1	Colorimetric - Phenate method	Colorimetric-Sulfanilamide -NEDD Cd reduction	FIA	FIA
7	in-house	in-house	10	50	1	Colorimetric - Salicylate method	Colorimetric - Salicylate method	DA	DA
8	In-House Method	In-House Method	5	50	1	Colorimetric - Salicylate method	Colorimetric-Sulfanilamide -NEDD Cd reduction	Manual Analysis	Manual Analysis
12	Rayment and Lyons Method 7C1	NA	5	50	1	OPA method	NA	FIA	NA
14	4500-NH3 H	4500-NO3 I	3	30	1	Colorimetric - Phenate method	Colorimetric-Sulfanilamide -NEDD Cd reduction	FIA	FIA
15			10	100	30	Fluorescence	Colorimetric-Sulfanilamide -NEDD Cd reduction	SFA	SFA
18	In House	In House	2	20	1	Colorimetric - Salicylate method	Colorimetric - Vanadium III method	FIA	FIA
24	7C2b	7C2b	10	100	1	Colorimetric - Salicylate method	Colorimetric-Sulfanilamide -NEDD Cd reduction	FIA	FIA
25	APHA 4500-NH3 G	APHA 4500-NO3 F	10	100	1	Colorimetric - Phenate method	Colorimetric-Sulfanilamide -NEDD Cd reduction	DA	DA

Table 4 Methodology for Water Soluble Bromide

Lab. Code	Method Reference	Sample Mass (g)	Water Volume (mL)	Shake Time (hours)	Measurement Method	Instrument
5	APHA, Standard Methods for the Examination of Water and Wastewater, Method 4110	10	50	1	ICP-Method	ICP-MS
11	In-House Method	8	40	1	Ion Chromatographic Method	IC
12	APHA 4110 D	10	50	1	Ion Chromatographic Method	IC
15		16	80	1 hour	Ion Chromatographic Method	IC
17	APHA 4110	10	50	1 hour	Ion Chromatographic Method	IC
21	APHA 4110	10	50	1	Ion Chromatographic Method	IC
25	US EPA 300.1 Part B	10	50	1	Ion Chromatographic Method	IC

Table 5 Methodology for Water Soluble Chloride

Lab. Code	Method Reference	Sample Mass (g)	Water Volume (mL)	Shake Time (hours)	Measurement Method	Instrument
3	APHA 4110 B	15	75	1	Ion Chromatographic Method	IC
5	APHA, Standard Methods for the Examination of Water and Wastewater, Method 4110	10	50	1	Mercuric Thiocyanate	DA
7	in-house	10	50	1	Ferricyanide Colorimetric Method	DA
8	USEPA	10	50	0.5	Argentometric Titration	Titration
11	In-House Method	8	40	1	Ion Chromatographic Method	IC
12	APHA Method 4500-Cl- G	10	50	1	Mercuric Thiocyanate	DA
15		16	80	1 hour	Ion Chromatographic Method	IC
17	APHA 4500-Cl-	10	50	1 hour	Ferricyanide Colorimetric Method	DA
18		2	10	1	Mercurric Nitrate Titration	SFA
21	APHA 4500	10	50	1	Ferricyanide Colorimetric Method	DA
22	APHA-4500-Cl E	5	50	1	Ferricyanide Colorimetric Method	DA
25	APHA 4500-Cl- E	10	50	1	Ferricyanide Colorimetric Method	DA

Table 6 Methodology for Water Soluble Fluoride

Lab. Code	Method Reference	Sample Mass (g)	Water Volume (mL)	Shake Time (hours)	Measurement Method	Instrument
5	Per NMI AQA 26-16 Instructions	10	50	1	Ion Selective Electrode Method	Fluoride Selective Electrode
8	USEPA	10	50	0.5	Colorimetric Method	Spectrophotometer
12	APHA Method 4500-F- C	10	50	1	Ion Selective Electrode Method	Fluoride Selective Electrode
15		16	80	1 hour	Ion Selective Electrode Method	Fluoride Selective Electrode
17	APHA 4500-F-	10	50	1 hour	Ion Selective Electrode Method	Fluoride Selective Electrode
18		2	10	1	Ion Selective Electrode Method	Fluoride Selective Electrode
21	APHA 4500	10	50	1	Ion Selective Electrode Method	OMNIS PCT
25	APHA 4500-F- C	10	50	1	Ion Selective Electrode Method	Fluoride Selective Electrode

Table 7 Methodology for Water Soluble Iodide

Lab. Code	Method Reference	Sample Mass (g)	Water Volume (mL)	Shake Time (hours)	Measurement Method	Instrument
5	APHA, Standard Methods for the Examination of Water and Wastewater, Method 4110 Page 4-5 to 4-12	10	50	1	Determine as Iodine	ICP-MS
11	In-House Method	8	40	1	Ion Chromatographic Method	IC
12	APHA Method 4110 D	10	50	1	Ion Chromatographic Method	IC
15		16	80	1 hour	Ion Chromatographic Method	IC
17	APHA 4110	10	50	1 hour	Ion Chromatographic Method	IC
21	APHA 4110	10	50	1	Ion Chromatographic Method	IC
25	US EPA 300.1	10	50	1	Ion Chromatographic Method	IC

Table 8 Methodology for Water Soluble Orthophosphate-P

Lab. Code	Method Reference	Sample Mass (g)	Water Volume (mL)	Shake Time (hours)	Measurement Method	Instrument
5	APHA, Standard Methods for the Examination of Water and Wastewater, Method 4500-P G	10	50	1	Ascorbic Acid Colorimetric Method	FIA
7	in-house	10	50	1	Vanadomolybdophosphoric Colorimetric Method	DA
8	USEPA	10	50	0.5	Ascorbic Acid Colorimetric Method	Manual Analysis
12	APHA Method 4500-P F	10	50	1	Ascorbic Acid Colorimetric Method	DA
15		16	80	1 hour	Ion Chromatographic Method	IC
17	APHA 4500-P	10	50	1 hour	Ascorbic Acid Colorimetric Method	DA
18		2	10	1	Vanadomolybdophosphoric Colorimetric Method	FIA
21	APHA 4500	10	50	1	Ascorbic Acid Colorimetric Method	DA
22	APHA 4500-P-B-D	5	50	1	Ascorbic Acid Colorimetric Method	DA
25	APHA 4500-P G	10	50	1	Ascorbic Acid Colorimetric Method	DA

Table 9 Methodology for Water Soluble Sulphate

Lab. Code	Method Reference	Sample Mass (g)	Water Volume (mL)	Shake Time (hours)	Measurement Method	Instrument
3	APHA 4110 B	15	75	1	Ion Chromatographic Method	IC
5	APHA, Standard Methods for the Examination of Water and Wastewater, Method 4110 Page 4-5 to 4-12	10	50	1	Turbidimetric Method	DA
7	in-house	10	50	1	Turbidimetric Method	DA
8	USEPA	10	50	0.5	Turbidimetric Method	Manual Analysis
11	In-House Method	8	40	1	Ion Chromatographic Method	IC
12*	USEPA Method 6010D (2018) and APHA Method 3120	10	50	1	ICP-Method	ICP-OES
15		16	80	1 hour	Ion Chromatographic Method	IC
17	APHA 3120	10	50	1 hour	ICP-Method	ICP-OES
18		2	10	1	ICP-Method	ICP-OES
21	G.E. Rayment & D.L. Lyons	10	50	1	ICP-Method	ICP-OES
22	APHA 4500 - SO4 E	5	50	1	Turbidimetric Method	DA
25	US EPA 200.8	10	50	1	ICP-Method	ICP-MS

*Additional information in Table 10.

3.2 Instruments Used for Measurements

The instruments and settings used by participants for acid extractable elements are presented in Appendix 4.

3.3 Additional Information

Participants had the option to report additional information for each sample analysed. These are transcribed in Table 10.

Table 10 Additional Information

Lab Code	Additional Information
8	Acid Extractable Elements: 0.25g microwave digested sample was made up to 50 ml with distilled water then further diluted 10 times before measurement by Flame Atomic Spectrometer and Digital Flame Analyser.
12	Acid Extractable Elements: Instrument for Hg: Cetac Hg Analyser TKN: Block Digestion and DA Sulphate: Sulphur result from OES was converted to SO4
18	TKN: TKN = TN by LECO and Nox by FIA
20	S1, S3: Microwave digestion (not hotblock)
25	S3: The TKP result was much higher than that of the Acid Extract & ICPMS

3.4 Basis of Participants' Measurement Uncertainty Evaluations

Participants were requested to provide information about their basis of measurement uncertainty (MU) evaluations. This is presented in Tables 11 and 12.

Table 11 Basis of Uncertainty Evaluation

Lab. Code	Approach to Evaluating MU	Information Sources for MU Evaluation[a]		Guide Document for Evaluating MU
		Precision	Method Bias	
1	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Control Samples Duplicate Analysis		
2	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Control Samples Duplicate Analysis	CRM Recoveries of SS	NATA General Accreditation, Guidance, Estimating and Reporting MU (Replace TN 33)
3	Top Down - precision and evaluations of the method and laboratory bias k = 2	Control Samples - CRM Duplicate Analysis	CRM Instrument Calibration Recoveries of SS	
4	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - CRM Duplicate Analysis	CRM Instrument Calibration Recoveries of SS	NMIA Uncertainty Course
5	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples Duplicate Analysis	Laboratory Bias from PT Studies	ISO/GUM
6	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Duplicate Analysis	Recoveries of SS	
7	Top Down - precision and evaluations of the method and laboratory bias k = 2	Control Samples - CRM Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Recoveries of SS	ASTM E2554-13
8	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Control Samples - CRM Duplicate Analysis Instrument Calibration	CRM Instrument Calibration	Other
9	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Control Samples Duplicate Analysis	Instrument Calibration Laboratory Bias from PT Studies	Eurachem/CITAC Guide
10	Top Down - precision and evaluations of the method and laboratory bias k = 2	Control Samples Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Recoveries of SS	ISO/GUM
11*	Control Chart Techniques Coverage factor not reported	Control Samples - CRM Instrument Calibration	CRM	ASTM E2554-13
12	Top Down - precision and evaluations 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
13	Bottom Up (ISO/GUM, fish bone/ cause and effect diagram) k = 2	Control Samples - Reference Material / Ex PT Sample Duplicate Analysis Instrument Calibration	Laboratory Bias from PT Studies	ISO/GUM
14	Bottom Up (ISO/GUM, fish bone/ cause and effect diagram) Coverage factor not reported	Control Samples - SS Duplicate Analysis Instrument Calibration	Instrument Calibration Recoveries of SS	Eurachem/CITAC Guide
15	Top Down - precision and evaluations of the method and laboratory bias k = 2	Standard deviation from PT studies only		Nordtest Report TR537
		Control Samples Duplicate Analysis	CRM Laboratory Bias from PT Studies Recoveries of SS	

Lab. Code	Approach to Evaluating MU	Information Sources for MU Evaluation[a]		Guide Document for Evaluating MU
		Precision	Method Bias	
16	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - CRM Duplicate Analysis	CRM	Eurachem/CITAC Guide
17	Top Down - precision and evaluations of the method and laboratory bias k = 2	Control Samples - CRM Duplicate Analysis Instrument Calibration	CRM Instrument Calibration	Eurachem/CITAC Guide
18	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - Reference Material / Ex PT Sample Duplicate Analysis	Instrument Calibration Standard Purity	Nordtest Report TR537
19	Top Down - precision and evaluations of the method and laboratory bias k = 2	Control Samples - Reference Material / Ex PT Sample Duplicate Analysis	CRM	ISO/GUM
20	Top Down - precision and evaluations of the method and laboratory bias k = 2	Control Samples - CRM Duplicate Analysis	CRM Instrument Calibration	NMIA Uncertainty Course
21	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - SS Duplicate Analysis		Eurachem/CITAC Guide
22	Bottom Up (ISO/GUM, fish bone/ cause and effect diagram) Coverage factor not reported	Control Samples - CRM Duplicate Analysis Instrument Calibration	CRM Instrument Calibration	ISO/GUM
23	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - CRM	CRM	ISO/GUM
24	Top Down - reproducibility (standard deviation) from PT studies used directly Coverage factor not reported	Control Samples - CRM Duplicate Analysis Instrument Calibration		Nordtest Report TR537
25	Top Down - precision and evaluations of the method and laboratory bias k = 2	Duplicate Analysis	CRM Laboratory Bias from PT Studies	ISO/GUM

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

Table 12 Additional Information for Basis of Uncertainty Evaluation

Lab Code	Additional Information
11	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

3.5 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.

No comments were made in the current study.

4 PRESENTATION OF RESULTS AND STATISTICAL ANALYSIS

4.1 Results Summary

Participant results are listed in Tables 13 to 69 with resultant summary statistics. Bar charts of results and performance scores are presented in Figures 2 to 58. An example chart with interpretation guide is shown in Figure 1.

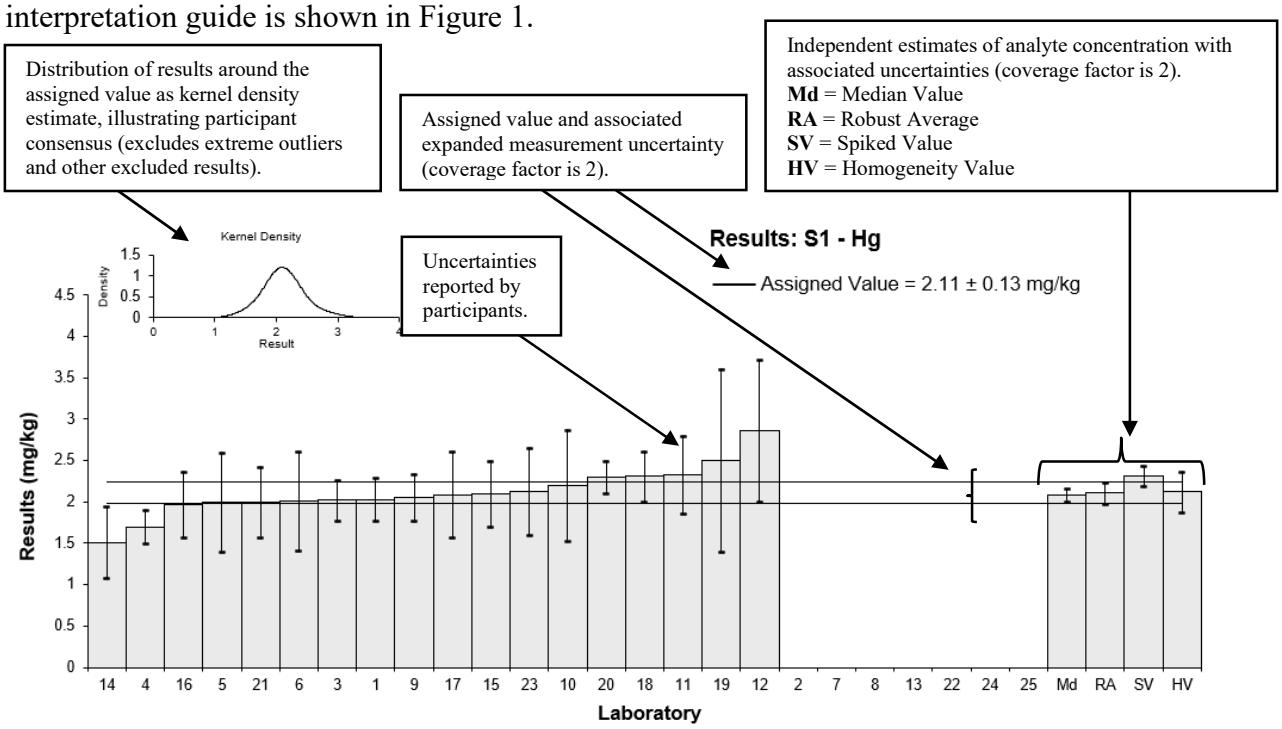


Figure 1 Guide to Presentation of Results

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 placement errors, or results from a different PT item and were removed for calculation of summary statistics.[3, 4, 7]

4.3 Assigned Value

The assigned value is defined as the 'value attributed to a particular property or characteristic of a proficiency testing item.'[1] In this study, the property is the mass fraction of analyte. Assigned values were the robust average of participants' results (after the removal of outliers) and the expanded uncertainties were evaluated from the associated robust standard deviations.[4, 7] An example of the assigned value calculation using data from the present study is given in Appendix 2.

4.4 Robust Average and Robust Between-Laboratory Coefficient of Variation

The robust averages and associated expanded measurement uncertainties, and robust CVs (a measure of the variability of participants' results) were calculated using the procedure described in ISO 13528.[7] The robust CVs as presented in the Section 5 Statistics Tables are the robust between-laboratory CVs including outliers but excluding extreme outliers. Everywhere else in the report, the robust between-laboratory CV refers to the robust CV calculated with both outliers and extreme outliers removed.

4.5 Standard Deviation for Proficiency Assessment

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

$$\sigma = (X) \times \text{PCV} \qquad \text{Equation 1}$$

It is important to note that the PCV is a set value and is not the standard deviation of participants' results. The 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.[8]

4.6 z-Score

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

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

Where:

z is z-score;
χ is a participant's result;
X is the assigned value;
σ is the SDPA from Equation 1.

A z-score with absolute value (|z|): $|z| \leq 2.0$ is acceptable, $2.0 < |z| < 3.0$ is questionable, and $|z| \geq 3.0$ is not acceptable.

4.7 E_n-Score

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. An example of E_n-score calculation using data from the present study is given in Appendix 2.

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

where:

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

For an E_n-score with the absolute value ($|E_n|$): $|E_n| < 1.0$ is acceptable; and $|E_n| \geq 1.0$ is not acceptable.

4.8 Traceability and Measurement Uncertainty

Laboratories accredited to ISO/IEC 17025 must establish and demonstrate the traceability and measurement uncertainty associated with their test results.[9] Guidelines for quantifying uncertainty in analytical measurement are described in the Eurachem/CITAC Guide.[10]

5 TABLES AND FIGURES

Table 13

Sample Details

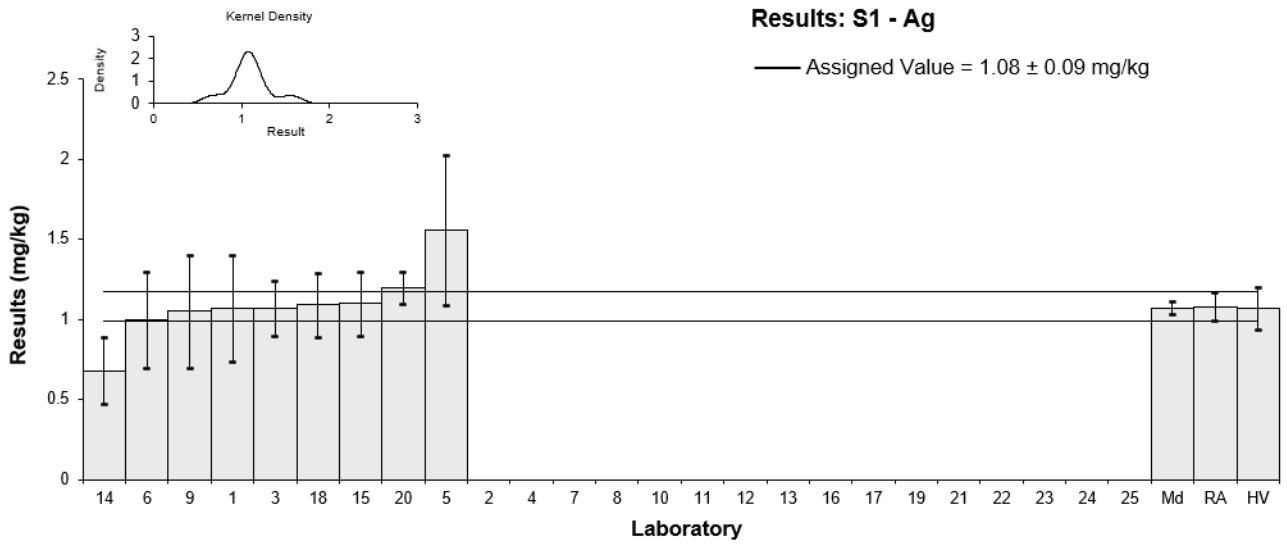
Sample No.	S1
Matrix	Soil
Analyte	Ag
Unit	mg/kg

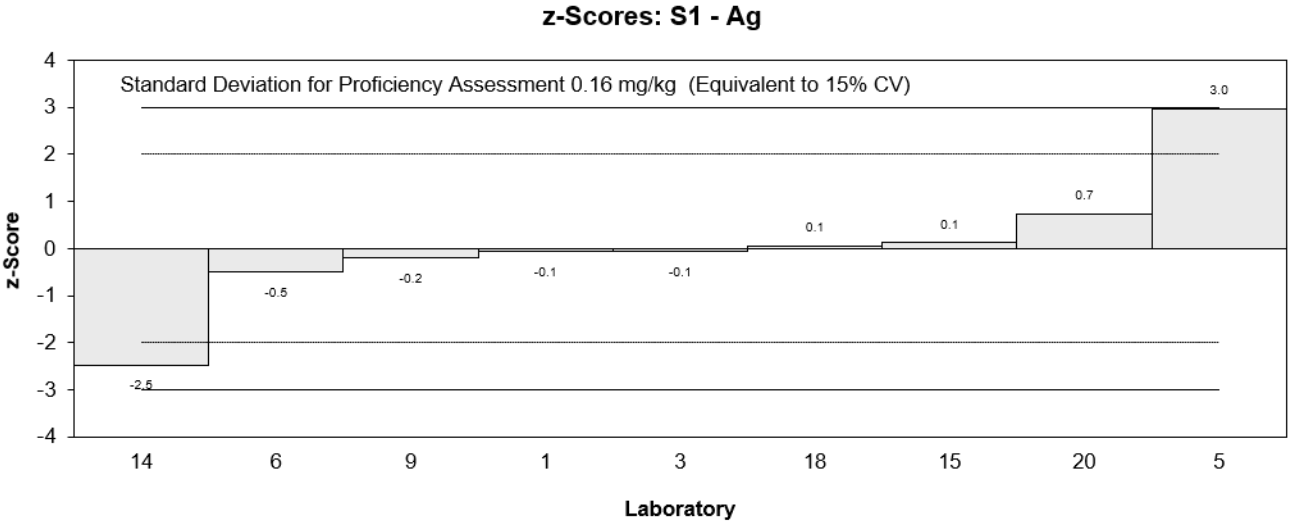
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	1.07	0.33	-0.06	-0.03
2	NT	NT		
3	1.07	0.17	-0.06	-0.05
4	NT	NT		
5	1.56	0.468	2.96	1.01
6	1	0.3	-0.49	-0.26
7	NT	NT		
8	NT	NT		
9	1.05	0.35	-0.19	-0.08
10	<5	NR		
11	< 2	NR		
12	<1	<1		
13	NT	NT		
14	0.68	0.21	-2.47	-1.75
15	1.1	0.2	0.12	0.09
16	<2	NR		
17	<2	NR		
18	1.09	0.2	0.06	0.05
19	NT	NT		
20	1.2	0.1	0.74	0.89
21	<2	NR		
22	NT	NT		
23	NT	NT		
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	1.08	0.09
Spiked Value	Not Spiked	
Homogeneity Value	1.07	0.13
Robust Average	1.08	0.09
Median	1.07	0.04
Mean	1.09	
N	9	
Max	1.56	
Min	0.68	
Robust SD	0.11	
Robust CV	10%	


Kernel Density
Density
Result
Results: S1 - Ag
Assigned Value = 1.08 ± 0.09 mg/kg
Results (mg/kg)
Laboratory
14 6 9 1 3 18 15 20 5 2 4 7 8 10 11 12 13 16 17 19 21 22 23 24 25 Md RA HV


z-Scores: S1 - Ag
Standard Deviation for Proficiency Assessment 0.16 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
14 6 9 1 3 18 15 20 5
-2.5
-0.5
-0.2
-0.1
-0.1
0.1
0.1
0.7
3.0

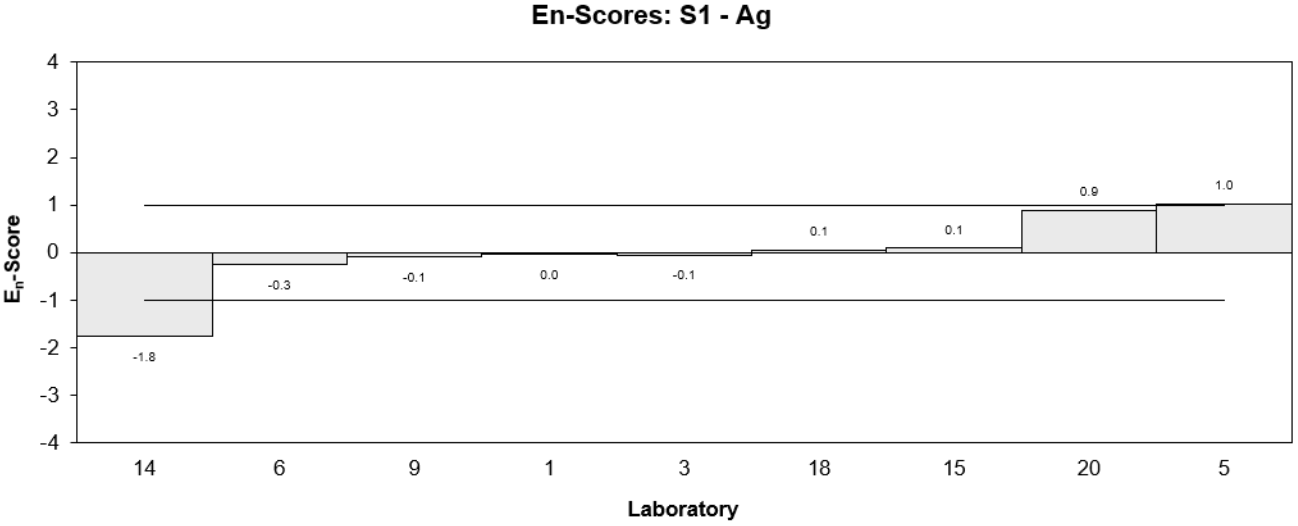

En-Scores: S1 - Ag
En-Score
Laboratory
14 6 9 1 3 18 15 20 5
-1.8
-0.3
-0.1
0.0
-0.1
0.1
0.1
0.9
1.0

Figure 2

Table 14

Sample Details

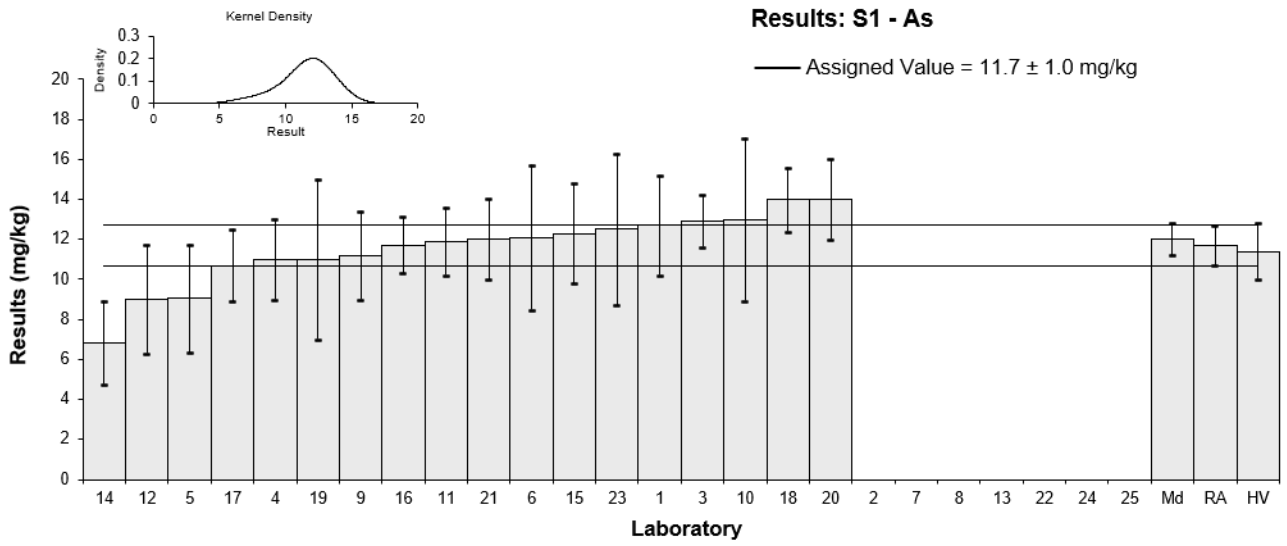
Sample No.	S1
Matrix	Soil
Analyte	As
Unit	mg/kg

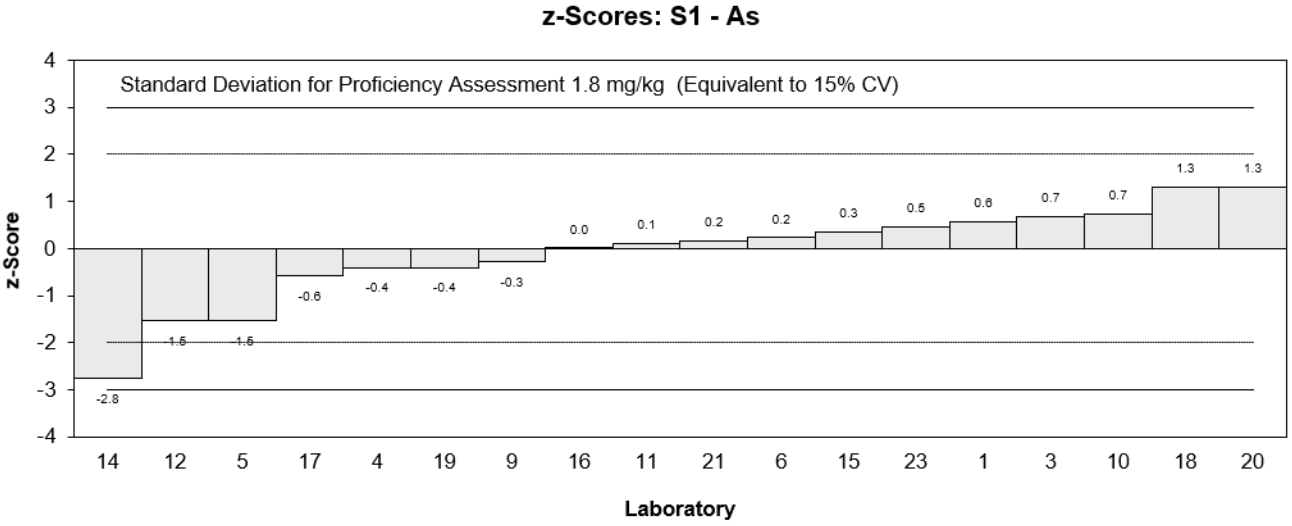
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	12.7	2.5	0.57	0.37
2	NT	NT		
3	12.9	1.3	0.68	0.73
4	11	2	-0.40	-0.31
5	9.04	2.712	-1.52	-0.92
6	12.1	3.63	0.23	0.11
7	NT	NT		
8	NT	NT		
9	11.2	2.2	-0.28	-0.21
10	13	4.06	0.74	0.31
11	11.9	1.7	0.11	0.10
12	9.01	2.703	-1.53	-0.93
13	NT	NT		
14	6.85	2.09	-2.76	-2.09
15	12.3	2.5	0.34	0.22
16	11.721	1.416	0.01	0.01
17	10.7	1.8	-0.57	-0.49
18	14	1.6	1.31	1.22
19	11	4.0	-0.40	-0.17
20	14	2	1.31	1.03
21	12	2.02	0.17	0.13
22	NT	NT		
23	12.5	3.8	0.46	0.20
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	11.7	1.0
Spiked Value	Not Spiked	
Homogeneity Value	11.4	1.4
Robust Average	11.7	1.0
Median	12.0	0.8
Mean	11.6	
N	18	
Max	14	
Min	6.85	
Robust SD	1.7	
Robust CV	14%	


Kernel Density
Density
Result
Results: S1 - As
Assigned Value = 11.7 ± 1.0 mg/kg
Results (mg/kg)
14 12 5 17 4 19 9 16 11 21 6 15 23 1 3 10 18 20 2 7 8 13 22 24 25 Md RA HV
Laboratory


z-Scores: S1 - As
Standard Deviation for Proficiency Assessment 1.8 mg/kg (Equivalent to 15% CV)
z-Score
-2.8 -1.5 -1.5 -0.6 -0.4 -0.4 -0.3 0.0 0.1 0.2 0.2 0.3 0.5 0.6 0.7 0.7 1.3 1.3
14 12 5 17 4 19 9 16 11 21 6 15 23 1 3 10 18 20
Laboratory

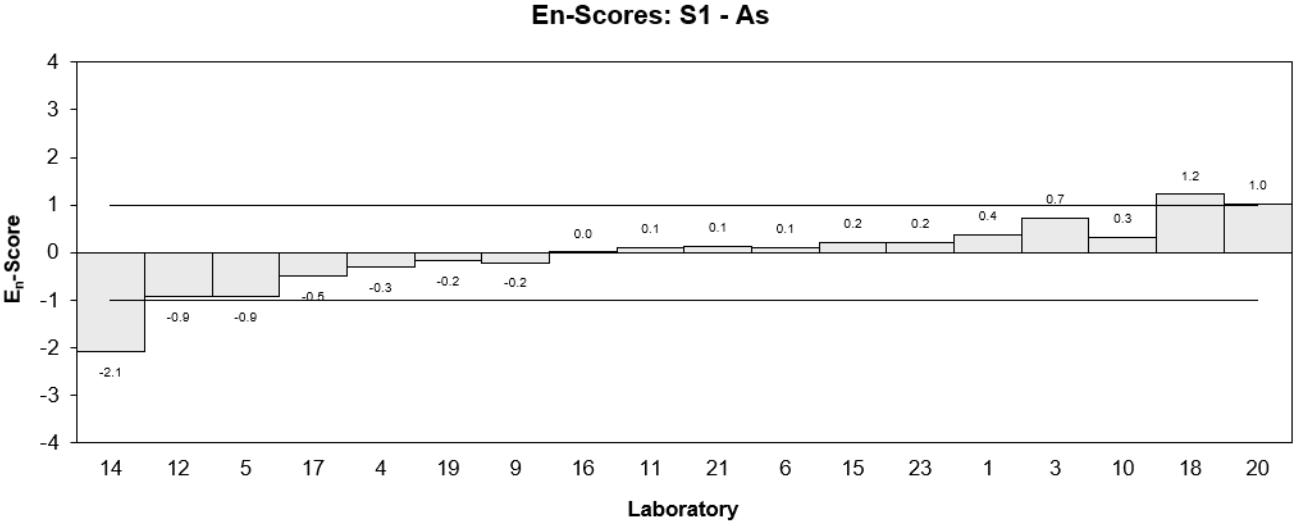

En-Scores: S1 - As
En-Score
-2.1 -0.9 -0.9 -0.5 -0.3 -0.2 -0.2 0.0 0.1 0.1 0.1 0.2 0.2 0.4 0.7 0.3 1.2 1.0
14 12 5 17 4 19 9 16 11 21 6 15 23 1 3 10 18 20
Laboratory

Figure 3

Table 15

Sample Details

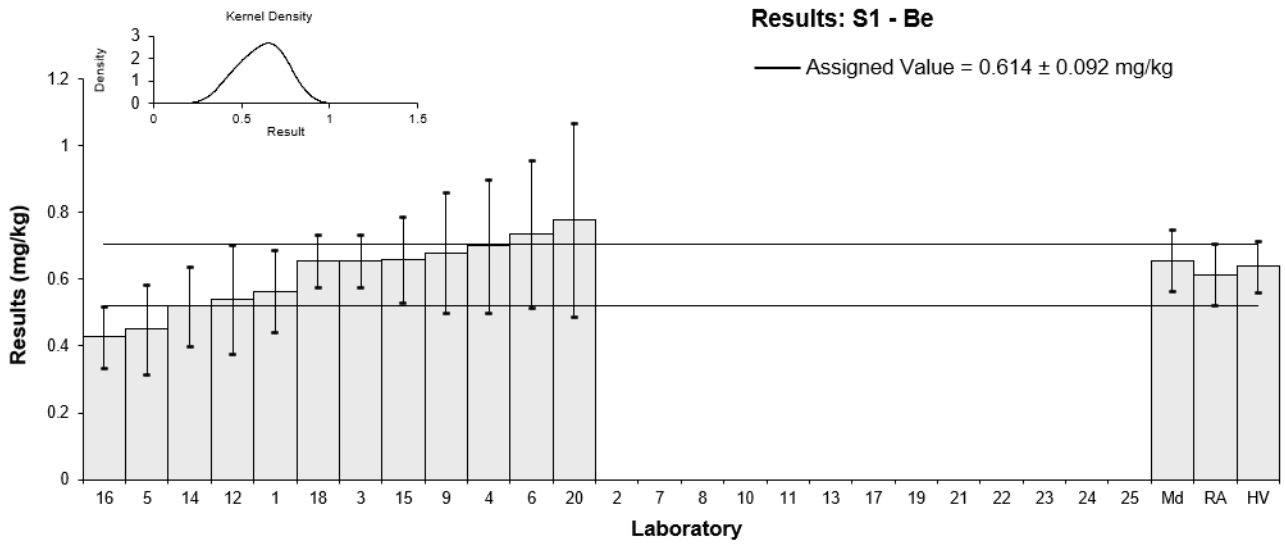
Sample No.	S1
Matrix	Soil
Analyte	Be
Unit	mg/kg

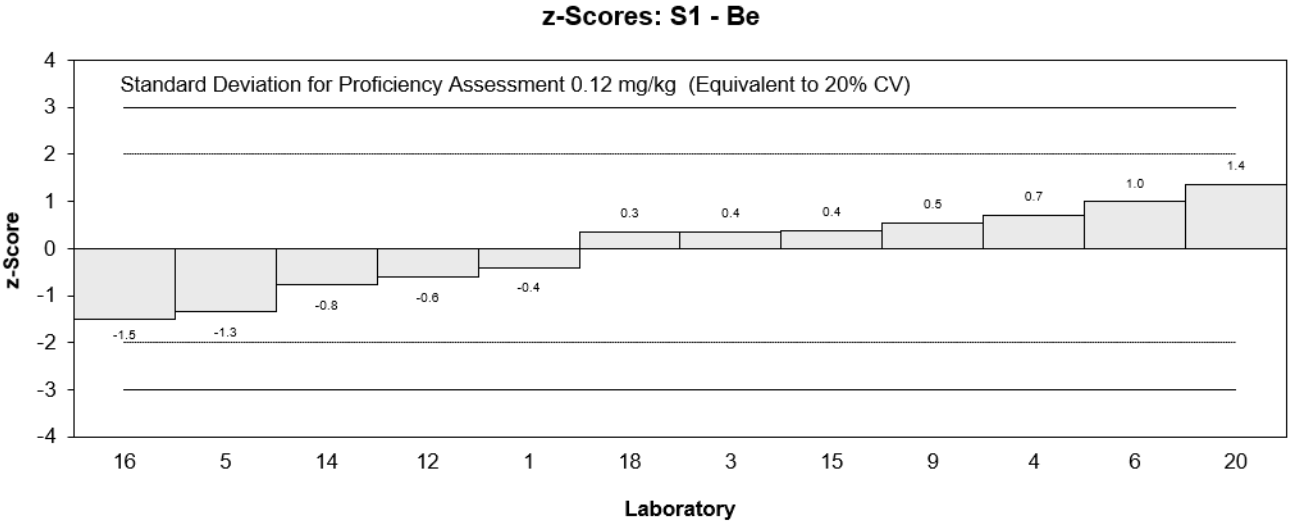
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.565	0.124	-0.40	-0.32
2	NT	NT		
3	0.657	0.079	0.35	0.35
4	0.7	0.2	0.70	0.39
5	0.45	0.135	-1.34	-1.00
6	0.736	0.2208	0.99	0.51
7	NT	NT		
8	NT	NT		
9	0.68	0.18	0.54	0.33
10	<2	NR		
11	< 2	NR		
12	0.54	0.162	-0.60	-0.40
13	NT	NT		
14	0.52	0.12	-0.77	-0.62
15	0.66	0.13	0.37	0.29
16	0.428	0.092	-1.51	-1.43
17	<1	NR		
18	0.656	0.08	0.34	0.34
19	NT	NT		
20	0.78	0.29	1.35	0.55
21	<1	NR		
22	NT	NT		
23	NT	NT		
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	0.614	0.092
Spiked Value	Not Spiked	
Homogeneity Value	0.639	0.077
Robust Average	0.614	0.092
Median	0.657	0.092
Mean	0.614	
N	12	
Max	0.78	
Min	0.428	
Robust SD	0.13	
Robust CV	21%	


Results: S1 - Be
Assigned Value = 0.614 ± 0.092 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
16 5 14 12 1 18 3 15 9 4 6 20 2 7 8 10 11 13 17 19 21 22 23 24 25 Md RA HV


z-Scores: S1 - Be
Standard Deviation for Proficiency Assessment 0.12 mg/kg (Equivalent to 20% CV)
z-Score
-1.5 -1.3 -0.8 -0.6 -0.4 0.3 0.4 0.4 0.5 0.7 1.0 1.4
Laboratory
16 5 14 12 1 18 3 15 9 4 6 20

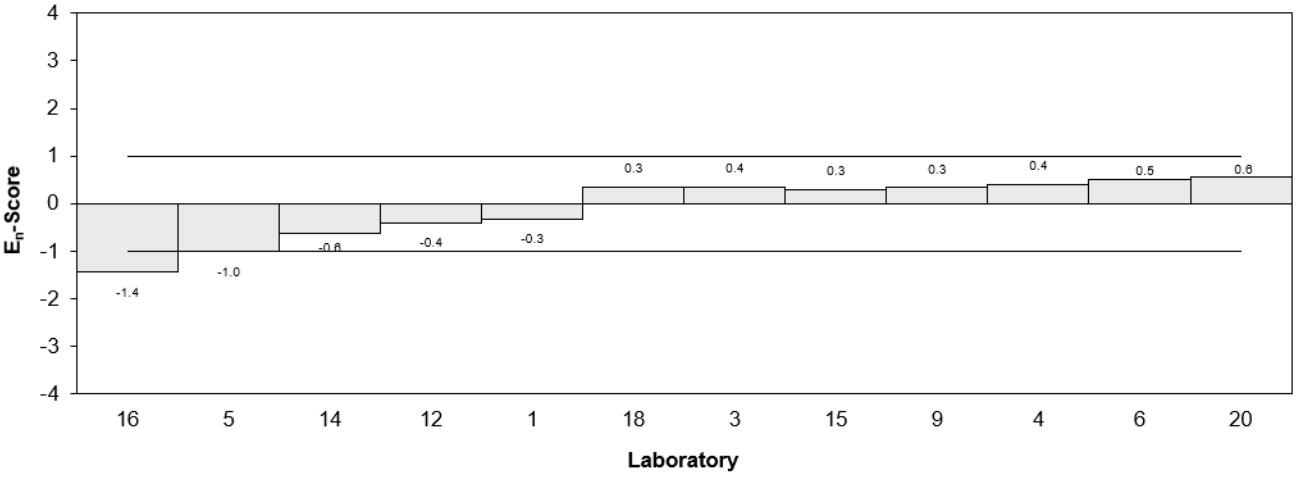

En-Scores: S1 - Be
En-Score
-1.4 -1.0 -0.6 -0.4 -0.3 0.3 0.4 0.3 0.3 0.4 0.5 0.6
Laboratory
16 5 14 12 1 18 3 15 9 4 6 20

Figure 4

Table 16

Sample Details

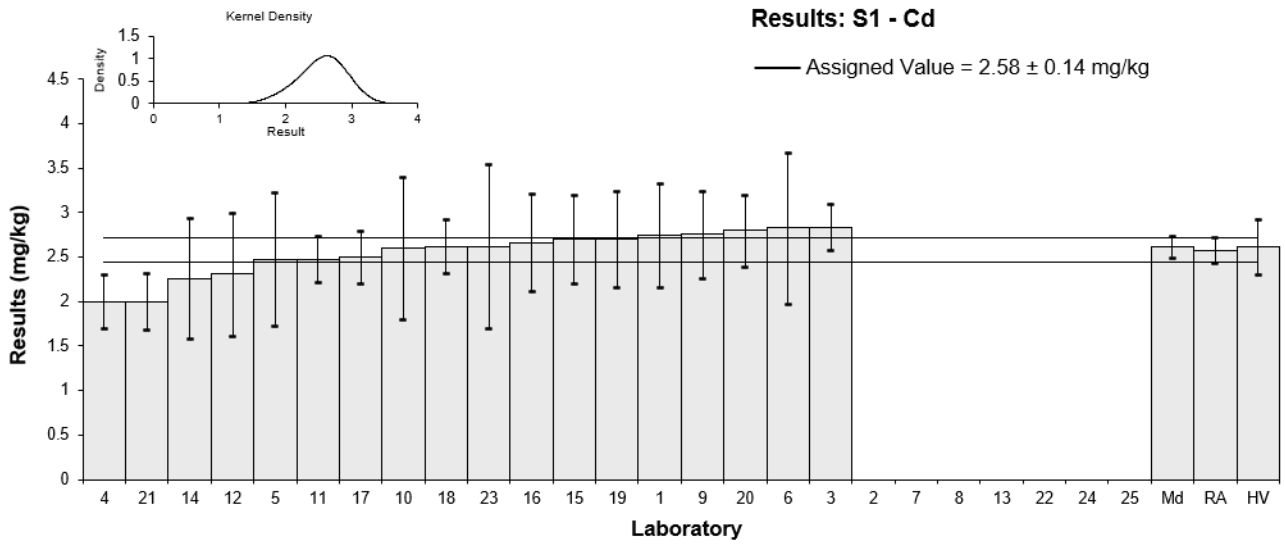
Sample No.	S1
Matrix	Soil
Analyte	Cd
Unit	mg/kg

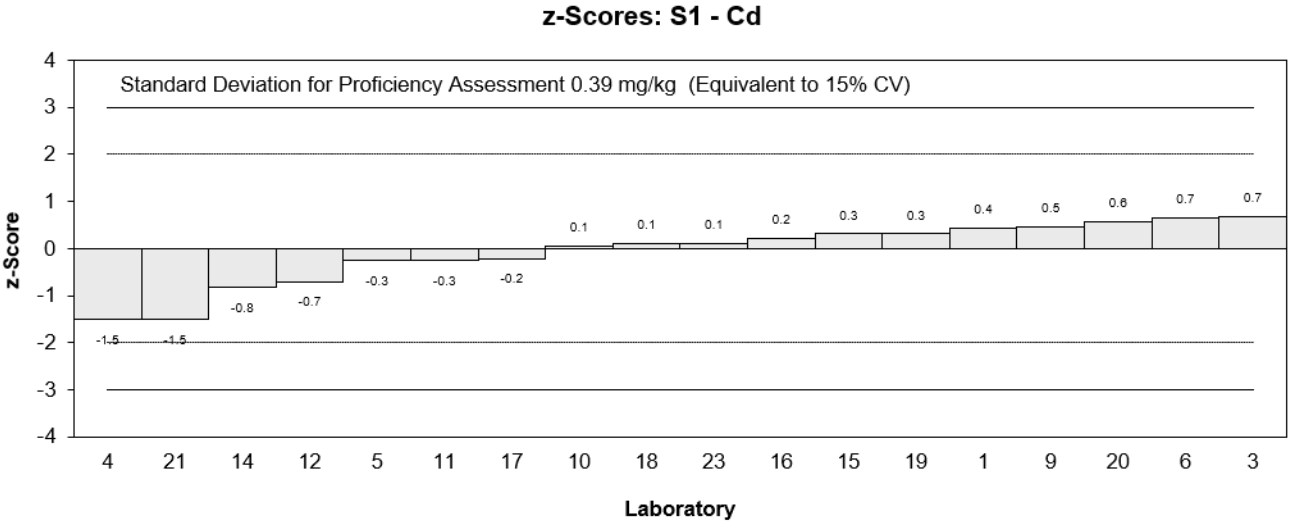
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	2.75	0.58	0.44	0.28
2	NT	NT		
3	2.84	0.26	0.67	0.88
4	2	0.3	-1.50	-1.75
5	2.48	0.744	-0.26	-0.13
6	2.83	0.849	0.65	0.29
7	NT	NT		
8	NT	NT		
9	2.76	0.49	0.47	0.35
10	2.6	0.80	0.05	0.02
11	2.48	0.26	-0.26	-0.34
12	2.31	0.693	-0.70	-0.38
13	NT	NT		
14	2.26	0.68	-0.83	-0.46
15	2.7	0.5	0.31	0.23
16	2.664	0.550	0.22	0.15
17	2.50	0.30	-0.21	-0.24
18	2.62	0.3	0.10	0.12
19	2.7	0.54	0.31	0.22
20	2.8	0.4	0.57	0.52
21	2	0.32	-1.50	-1.66
22	NT	NT		
23	2.62	0.92	0.10	0.04
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	2.58	0.14
Spiked Value	Not Spiked	
Homogeneity Value	2.62	0.31
Robust Average	2.58	0.14
Median	2.62	0.12
Mean	2.55	
N	18	
Max	2.84	
Min	2	
Robust SD	0.24	
Robust CV	9.2%	


Kernel Density
Density
Result
Results: S1 - Cd
Assigned Value = 2.58 ± 0.14 mg/kg
Results (mg/kg)
Laboratory
4 21 14 12 5 11 17 10 18 23 16 15 19 1 9 20 6 3 2 7 8 13 22 24 25 Md RA HV


z-Scores: S1 - Cd
Standard Deviation for Proficiency Assessment 0.39 mg/kg (Equivalent to 15% CV)
z-Score
-1.5 -1.5 -0.8 -0.7 -0.3 -0.3 -0.2 0.1 0.1 0.1 0.2 0.3 0.3 0.4 0.5 0.6 0.7 0.7
Laboratory
4 21 14 12 5 11 17 10 18 23 16 15 19 1 9 20 6 3

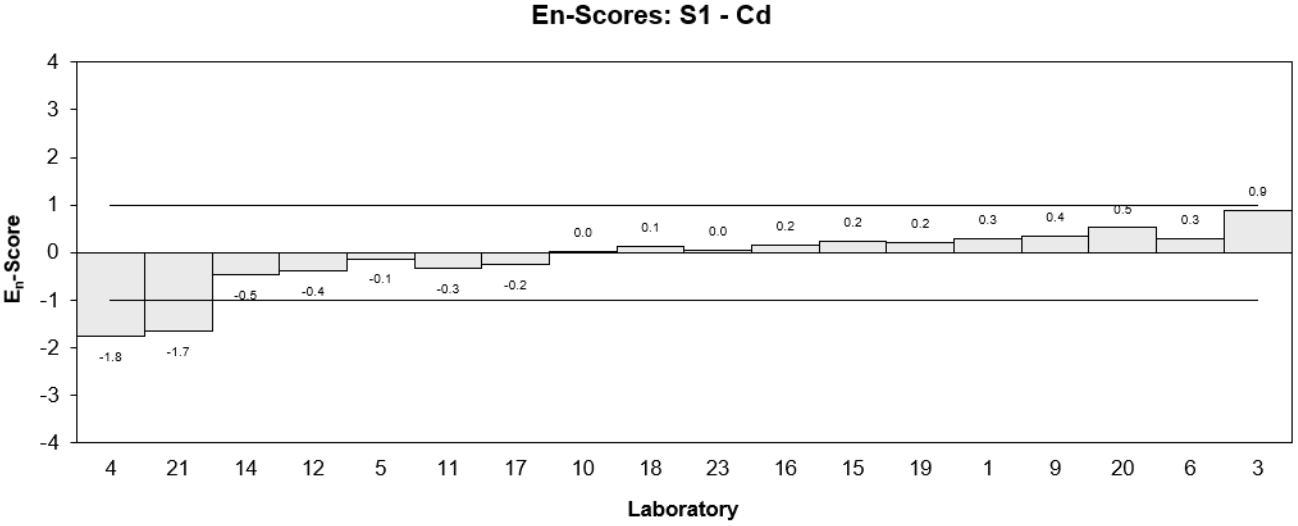

En-Scores: S1 - Cd
En-Score
-1.8 -1.7 -0.5 -0.4 -0.1 -0.3 -0.2 0.0 0.1 0.0 0.2 0.2 0.2 0.3 0.4 0.5 0.3 0.9
Laboratory
4 21 14 12 5 11 17 10 18 23 16 15 19 1 9 20 6 3

Figure 5

Table 17

Sample Details

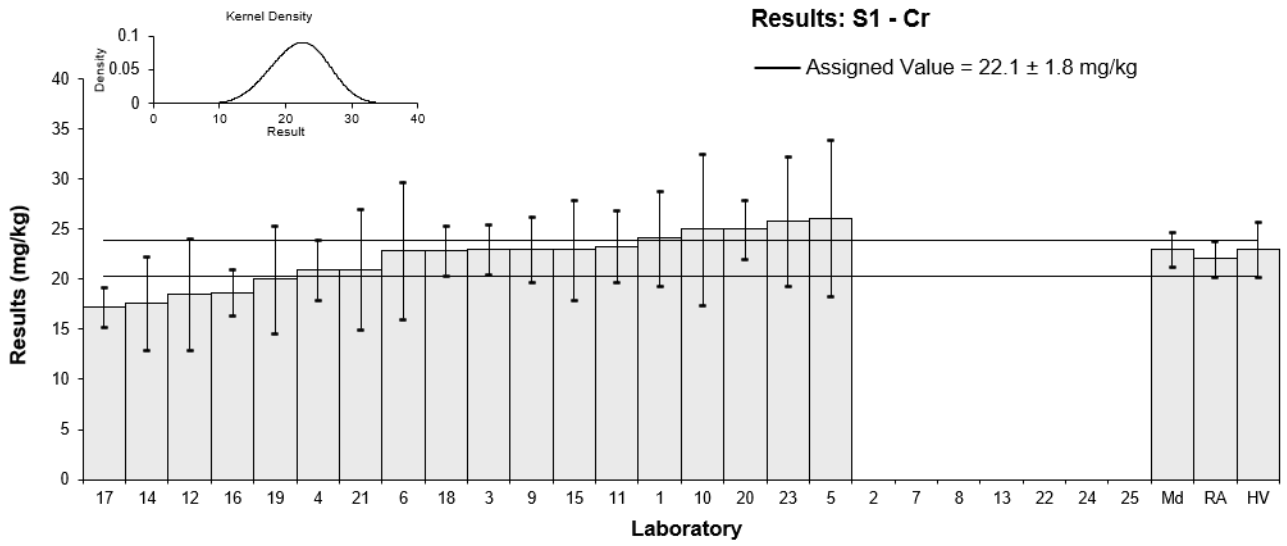
Sample No.	S1
Matrix	Soil
Analyte	Cr
Unit	mg/kg

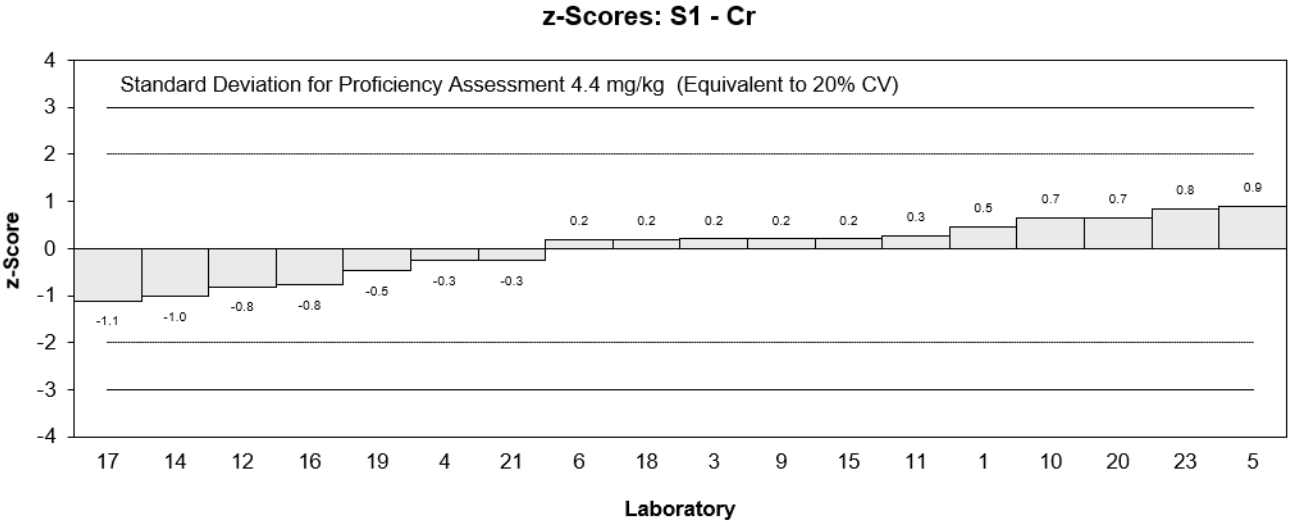
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	24.1	4.8	0.45	0.39
2	NT	NT		
3	23.0	2.5	0.20	0.29
4	21	3	-0.25	-0.31
5	26.1	7.83	0.90	0.50
6	22.9	6.87	0.18	0.11
7	NT	NT		
8	NT	NT		
9	23.0	3.3	0.20	0.24
10	25	7.6	0.66	0.37
11	23.3	3.6	0.27	0.30
12	18.51	5.553	-0.81	-0.61
13	NT	NT		
14	17.6	4.7	-1.02	-0.89
15	23	5	0.20	0.17
16	18.691	2.339	-0.77	-1.16
17	17.2	2.0	-1.11	-1.82
18	22.9	2.5	0.18	0.26
19	20	5.4	-0.48	-0.37
20	25	3	0.66	0.83
21	21	6.0	-0.25	-0.18
22	NT	NT		
23	25.8	6.5	0.84	0.55
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	22.1	1.8
Spiked Value	Not Spiked	
Homogeneity Value	23.0	2.8
Robust Average	22.1	1.8
Median	23.0	1.7
Mean	22.1	
N	18	
Max	26.1	
Min	17.2	
Robust SD	3.1	
Robust CV	14%	


Results: S1 - Cr
Assigned Value = 22.1 ± 1.8 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
17 14 12 16 19 4 21 6 18 3 9 15 11 1 10 20 23 5 2 7 8 13 22 24 25 Md RA HV


z-Scores: S1 - Cr
Standard Deviation for Proficiency Assessment 4.4 mg/kg (Equivalent to 20% CV)
z-Score
-1.1 -1.0 -0.8 -0.8 -0.5 -0.3 -0.3 0.2 0.2 0.2 0.2 0.2 0.3 0.5 0.7 0.7 0.8 0.9
Laboratory
17 14 12 16 19 4 21 6 18 3 9 15 11 1 10 20 23 5

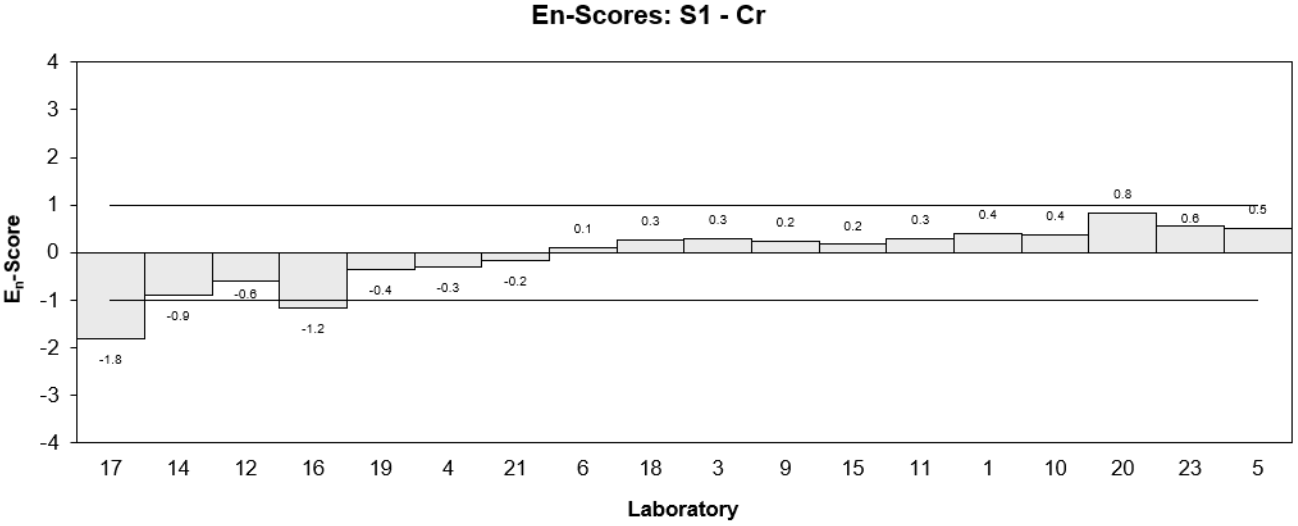

En-Scores: S1 - Cr
En-Score
-1.8 -0.9 -0.6 -1.2 -0.4 -0.3 -0.2 0.1 0.3 0.3 0.2 0.2 0.3 0.4 0.4 0.8 0.6 0.5
Laboratory
17 14 12 16 19 4 21 6 18 3 9 15 11 1 10 20 23 5

Figure 6

Table 18

Sample Details

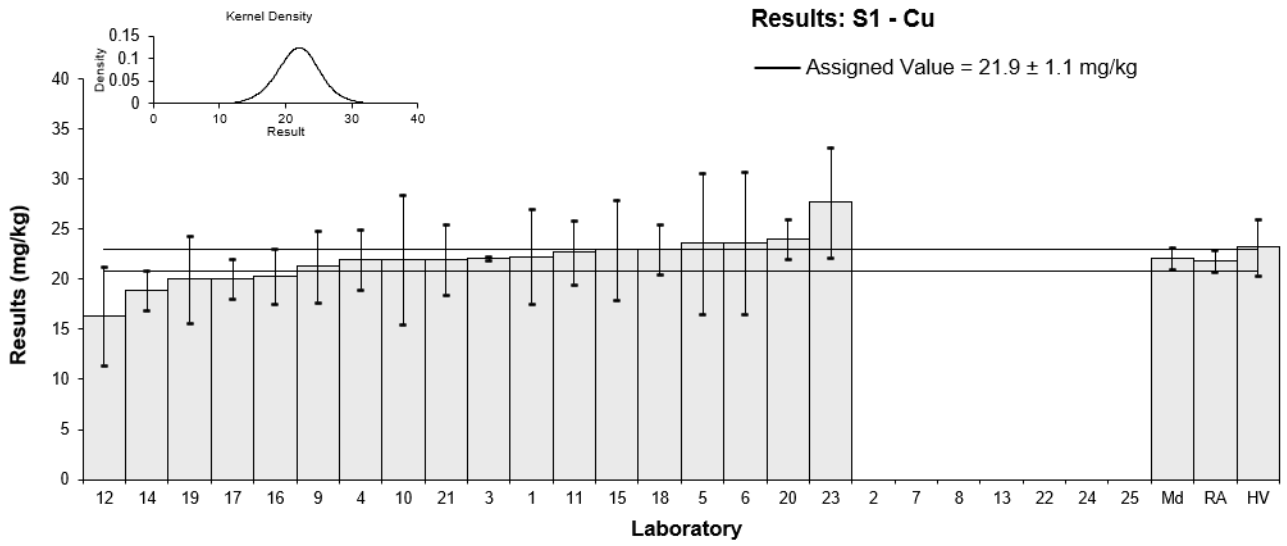
Sample No.	S1
Matrix	Soil
Analyte	Cu
Unit	mg/kg

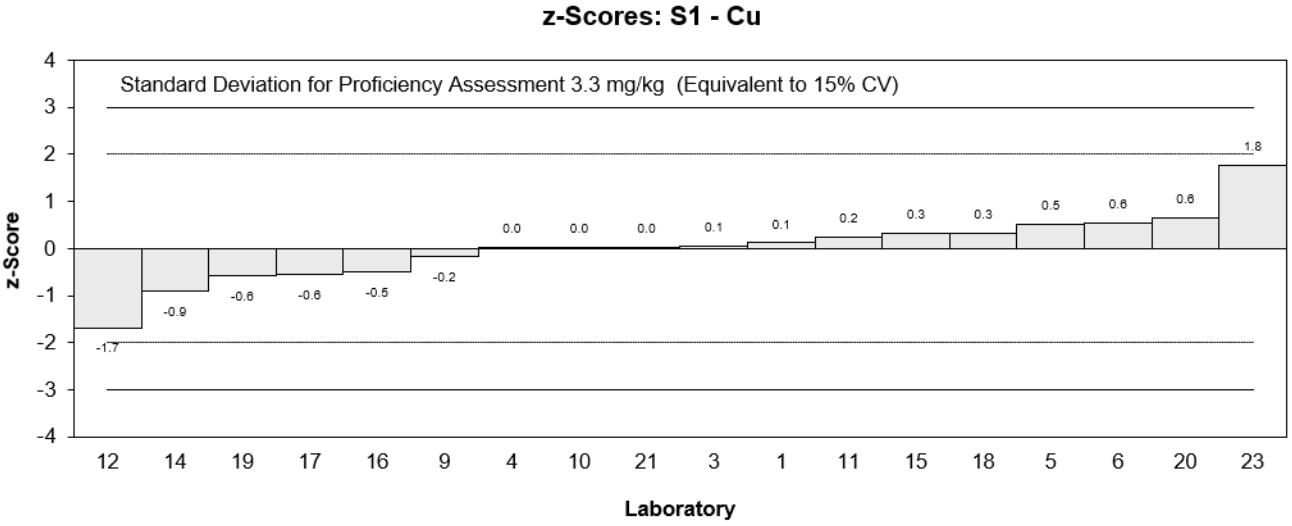
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	22.3	4.7	0.12	0.08
2	NT	NT		
3	22.1	0.2	0.06	0.18
4	22	3	0.03	0.03
5	23.6	7.08	0.52	0.24
6	23.7	7.11	0.55	0.25
7	NT	NT		
8	NT	NT		
9	21.3	3.6	-0.18	-0.16
10	22	6.5	0.03	0.02
11	22.7	3.2	0.24	0.24
12	16.37	4.911	-1.68	-1.10
13	NT	NT		
14	18.9	2.0	-0.91	-1.31
15	23	5	0.33	0.21
16	20.274	2.760	-0.49	-0.55
17	20.1	2.0	-0.55	-0.79
18	23.0	2.5	0.33	0.40
19	20	4.3	-0.58	-0.43
20	24	2	0.64	0.92
21	22	3.54	0.03	0.03
22	NT	NT		
23	27.7	5.5	1.77	1.03
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	21.9	1.1
Spiked Value	Not Spiked	
Homogeneity Value	23.2	2.8
Robust Average	21.9	1.1
Median	22.1	1.1
Mean	21.9	
N	18	
Max	27.7	
Min	16.37	
Robust SD	1.9	
Robust CV	8.6%	


Kernel Density
Density
Result
Results: S1 - Cu
Assigned Value = 21.9 ± 1.1 mg/kg
Results (mg/kg)
Laboratory
12 14 19 17 16 9 4 10 21 3 1 11 15 18 5 6 20 23 2 7 8 13 22 24 25 Md RA HV


z-Scores: S1 - Cu
Standard Deviation for Proficiency Assessment 3.3 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
12 14 19 17 16 9 4 10 21 3 1 11 15 18 5 6 20 23
-1.7 -0.9 -0.6 -0.6 -0.5 -0.2 0.0 0.0 0.0 0.1 0.1 0.2 0.3 0.3 0.5 0.6 0.6 1.8

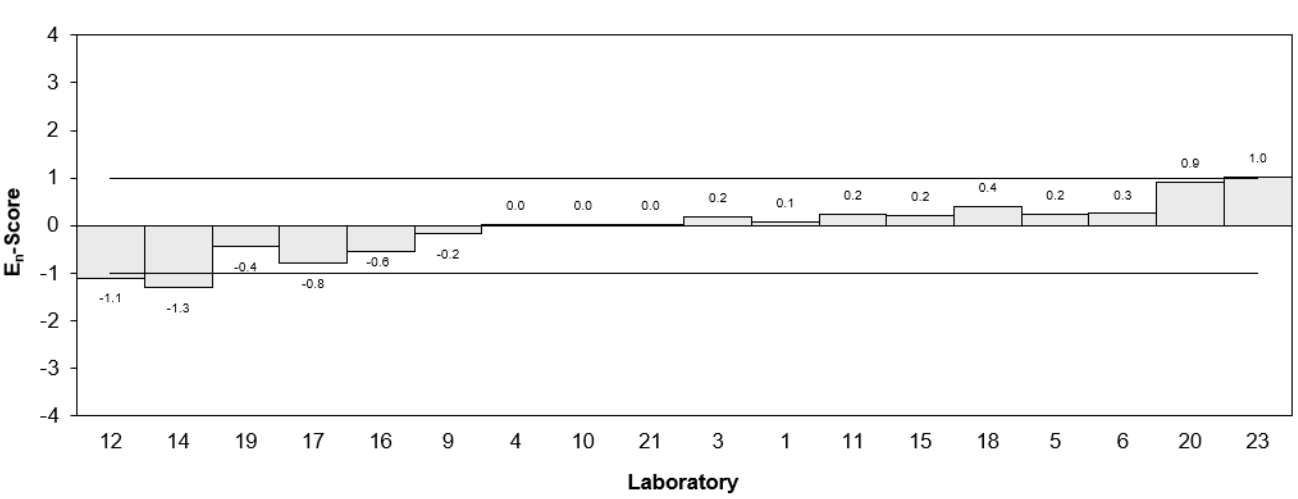

En-Scores: S1 - Cu
En-Score
Laboratory
12 14 19 17 16 9 4 10 21 3 1 11 15 18 5 6 20 23
-1.1 -1.3 -0.4 -0.8 -0.6 -0.2 0.0 0.0 0.0 0.2 0.1 0.2 0.2 0.4 0.2 0.3 0.9 1.0

Figure 7

Table 19

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	NT	NT
4	NT	NT
5	1.10	0.33
6	NT	NT
7	NT	NT
8	NT	NT
9	NT	NT
10	NT	NT
11	NT	NT
12	NT	NT
13	NT	NT
14	NR	NR
15	6.6	1.3
16	4.494	NR
17	3.19	0.80
18	NT	NT
19	NT	NT
20	NR	NR
21	5.8	0.89
22	NT	NT
23	NT	NT
24	NT	NT
25	NT	NT

Statistics

Assigned Value	Not Set	
Spiked Value	Not Spiked	
Homogeneity Value	7.48	0.90
Robust Average	NA (N<6)	
Median	4.5	2.2
Mean	4.2	
N	5	
Max	6.6	
Min	1.10	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

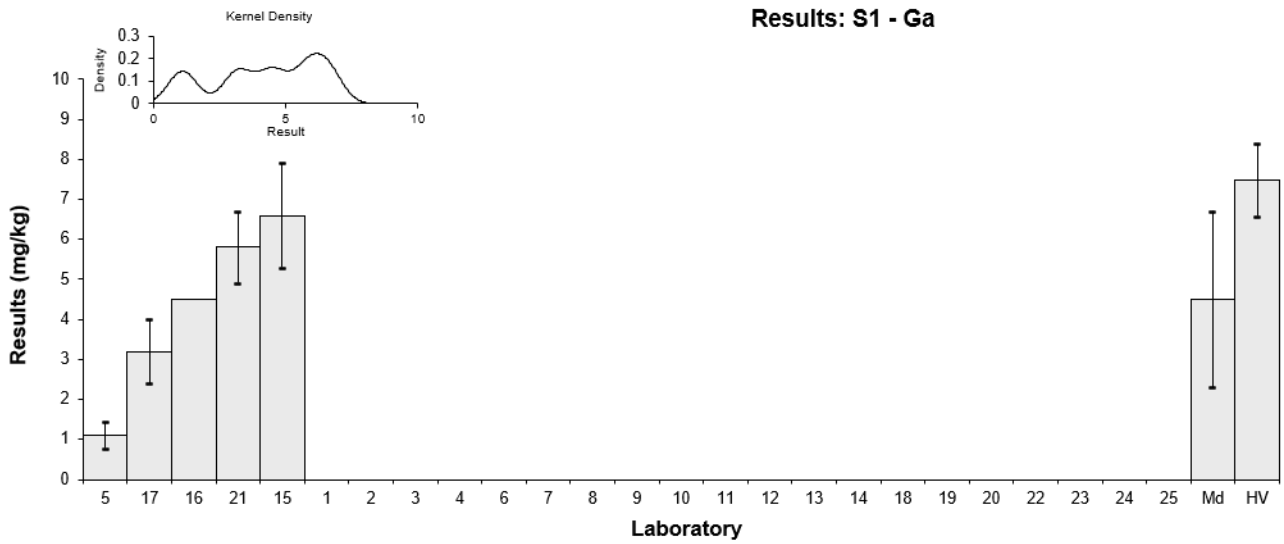

Results: S1 - Ga
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
5 17 16 21 15 1 2 3 4 6 7 8 9 10 11 12 13 14 18 19 20 22 23 24 25 Md HV

Figure 8

Table 20

Sample Details

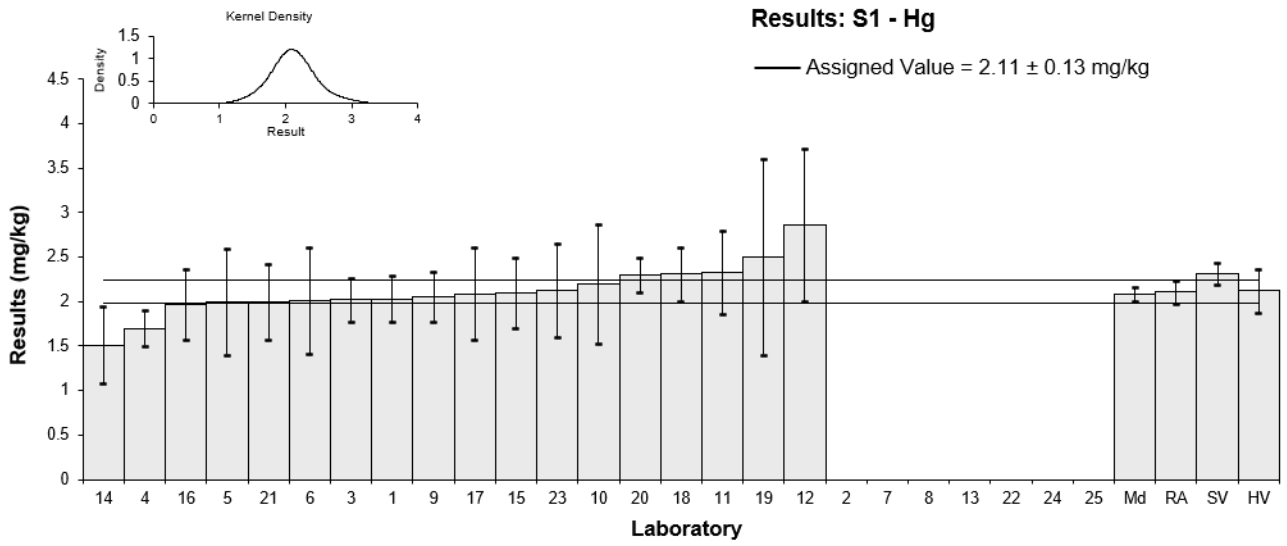
Sample No.	S1
Matrix	Soil
Analyte	Hg
Unit	mg/kg

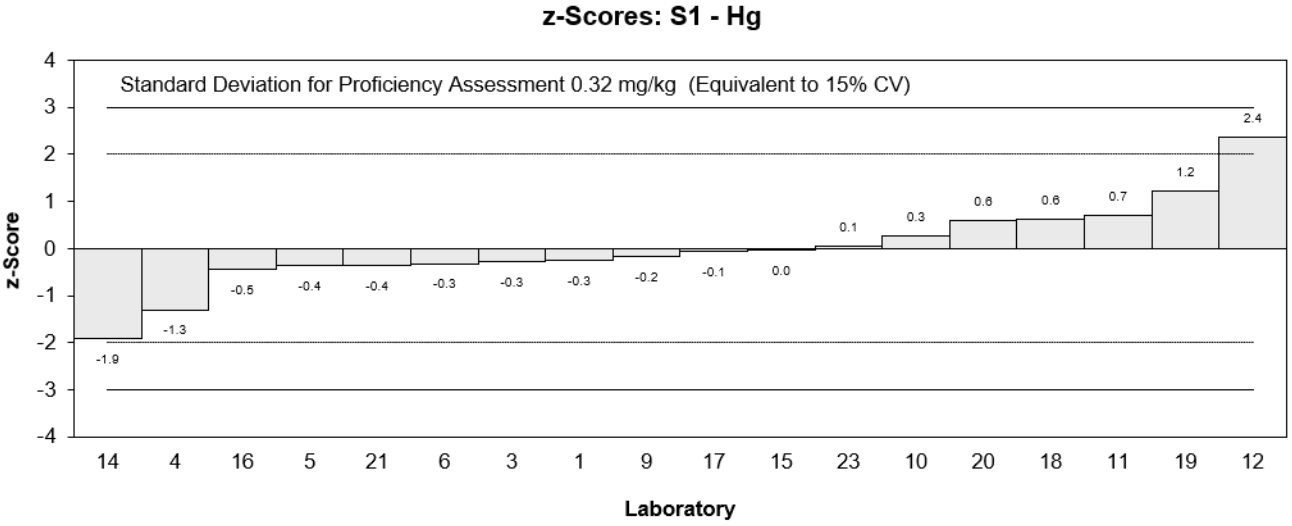
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	2.03	0.26	-0.25	-0.28
2	NT	NT		
3	2.02	0.24	-0.28	-0.33
4	1.7	0.2	-1.30	-1.72
5	2.00	0.6	-0.35	-0.18
6	2.01	0.603	-0.32	-0.16
7	NT	NT		
8	NT	NT		
9	2.06	0.28	-0.16	-0.16
10	2.2	0.67	0.28	0.13
11	2.33	0.47	0.70	0.45
12	2.86	0.857	2.37	0.87
13	NT	NT		
14	1.51	0.43	-1.90	-1.34
15	2.1	0.4	-0.03	-0.02
16	1.966	0.40	-0.45	-0.34
17	2.09	0.52	-0.06	-0.04
18	2.31	0.3	0.63	0.61
19	2.5	1.1	1.23	0.35
20	2.3	0.2	0.60	0.80
21	2.0	0.428	-0.35	-0.25
22	NT	NT		
23	2.13	0.53	0.06	0.04
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	2.11	0.13
Spiked Value	2.31	0.12
Homogeneity Value	2.12	0.25
Robust Average	2.11	0.13
Median	2.08	0.08
Mean	2.12	
N	18	
Max	2.86	
Min	1.51	
Robust SD	0.22	
Robust CV	10%	


Kernel Density
Density
Result
Results: S1 - Hg
Assigned Value = 2.11 ± 0.13 mg/kg
Results (mg/kg)
Laboratory
14 4 16 5 21 6 3 1 9 17 15 23 10 20 18 11 19 12 2 7 8 13 22 24 25 Md RA SV HV


z-Scores: S1 - Hg
Standard Deviation for Proficiency Assessment 0.32 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
14 4 16 5 21 6 3 1 9 17 15 23 10 20 18 11 19 12
-1.9 -1.3 -0.5 -0.4 -0.4 -0.3 -0.3 -0.3 -0.2 -0.1 0.0 0.1 0.3 0.6 0.6 0.7 1.2 2.4

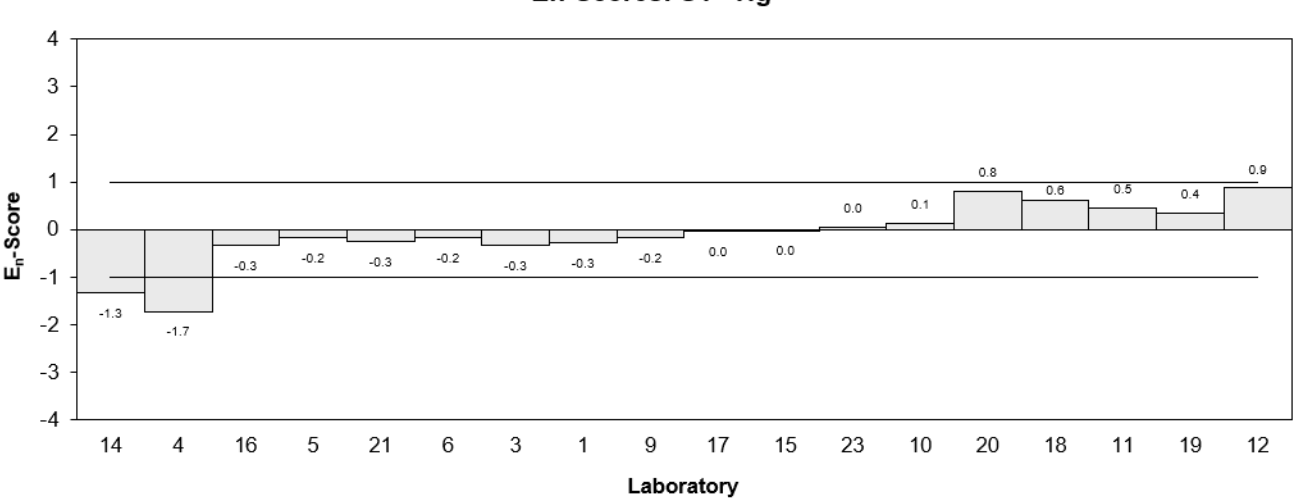

En-Scores: S1 - Hg
En-Score
Laboratory
14 4 16 5 21 6 3 1 9 17 15 23 10 20 18 11 19 12
-1.3 -1.7 -0.3 -0.2 -0.3 -0.2 -0.3 -0.3 -0.2 0.0 0.0 0.0 0.1 0.8 0.6 0.5 0.4 0.9

Figure 9

Table 21

Sample Details

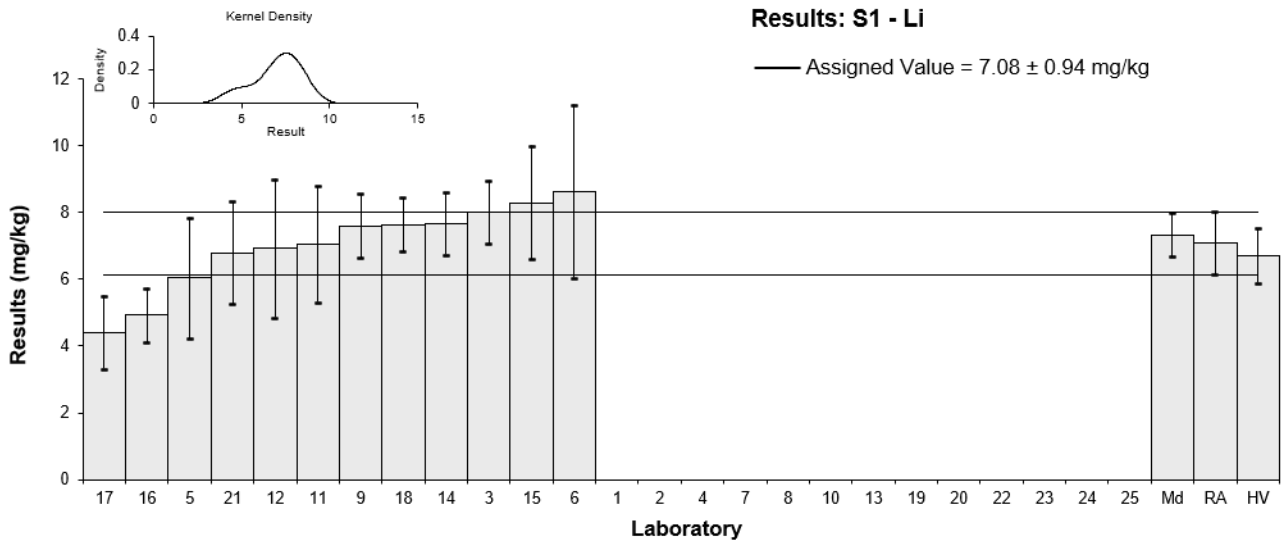
Sample No.	S1
Matrix	Soil
Analyte	Li
Unit	mg/kg

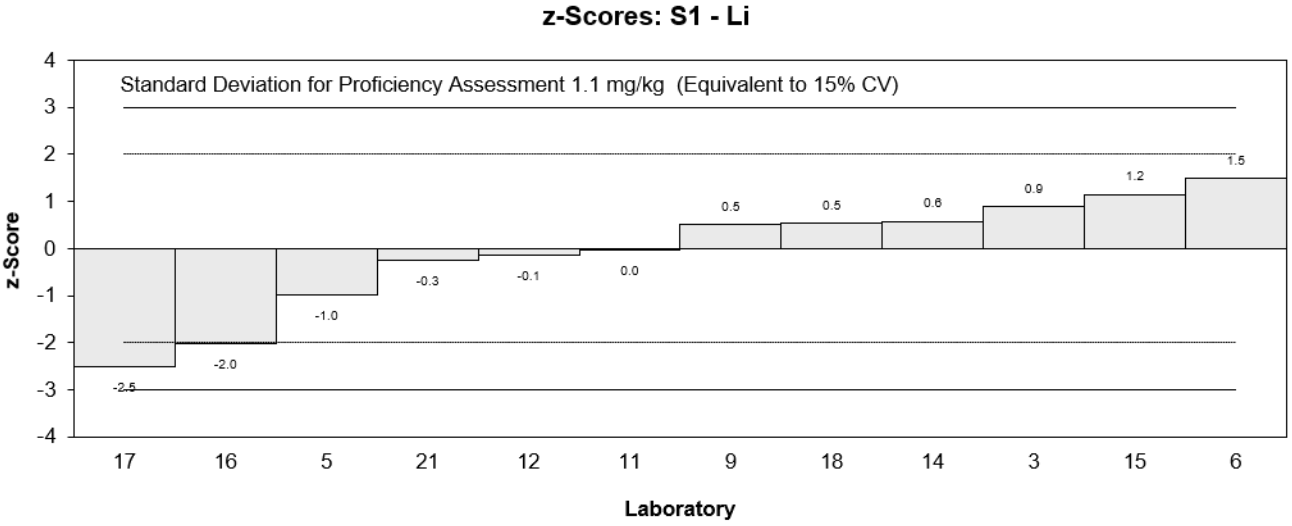
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	8.01	0.95	0.88	0.70
4	NT	NT		
5	6.04	1.812	-0.98	-0.51
6	8.65	2.595	1.48	0.57
7	NT	NT		
8	NT	NT		
9	7.61	0.96	0.50	0.39
10	<10	NR		
11	7.05	1.74	-0.03	-0.02
12	6.93	2.079	-0.14	-0.07
13	NT	NT		
14	7.67	0.93	0.56	0.45
15	8.3	1.7	1.15	0.63
16	4.924	0.817	-2.03	-1.73
17	4.41	1.09	-2.51	-1.86
18	7.64	0.8	0.53	0.45
19	NT	NT		
20	NR	NR		
21	6.8	1.54	-0.26	-0.16
22	NT	NT		
23	NT	NT		
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	7.08	0.94
Spiked Value	Not Spiked	
Homogeneity Value	6.71	0.81
Robust Average	7.08	0.94
Median	7.33	0.65
Mean	7.00	
N	12	
Max	8.65	
Min	4.41	
Robust SD	1.3	
Robust CV	18%	


Kernel Density
Density
Result
Results: S1 - Li
Assigned Value = 7.08 ± 0.94 mg/kg
Results (mg/kg)
Laboratory
17 16 5 21 12 11 9 18 14 3 15 6 1 2 4 7 8 10 13 19 20 22 23 24 25 Md RA HV


z-Scores: S1 - Li
Standard Deviation for Proficiency Assessment 1.1 mg/kg (Equivalent to 15% CV)
z-Score
-2.5
-2.0
-1.0
-0.3
-0.1
0.0
0.5
0.5
0.6
0.9
1.2
1.5
Laboratory
17 16 5 21 12 11 9 18 14 3 15 6

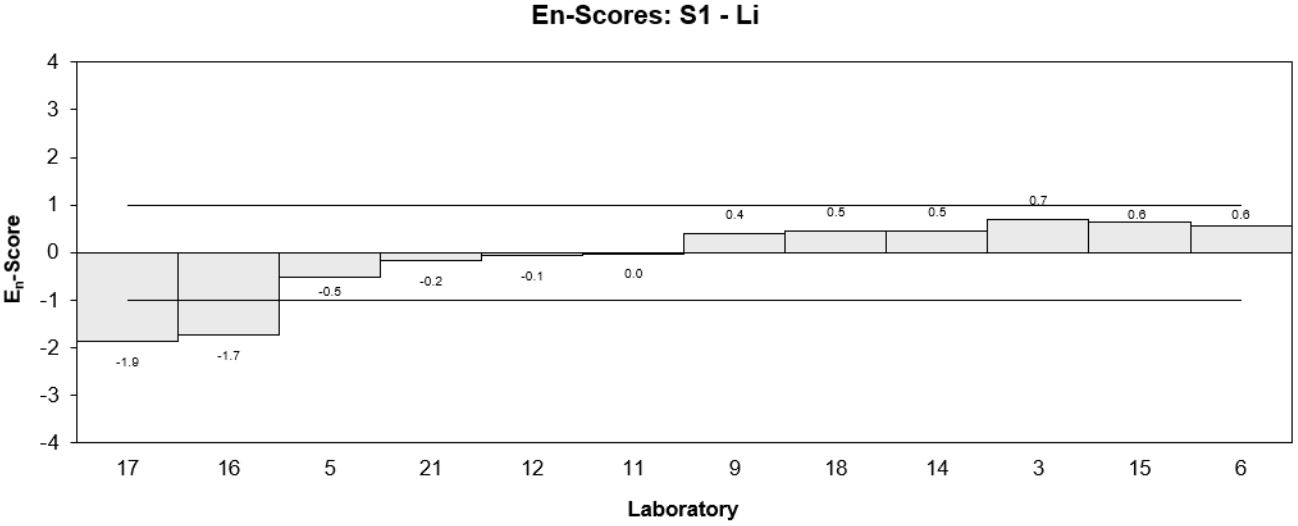

En-Scores: S1 - Li
En-Score
-1.9
-1.7
-0.5
-0.2
-0.1
0.0
0.4
0.5
0.5
0.7
0.6
0.6
Laboratory
17 16 5 21 12 11 9 18 14 3 15 6

Figure 10

Table 22

Sample Details

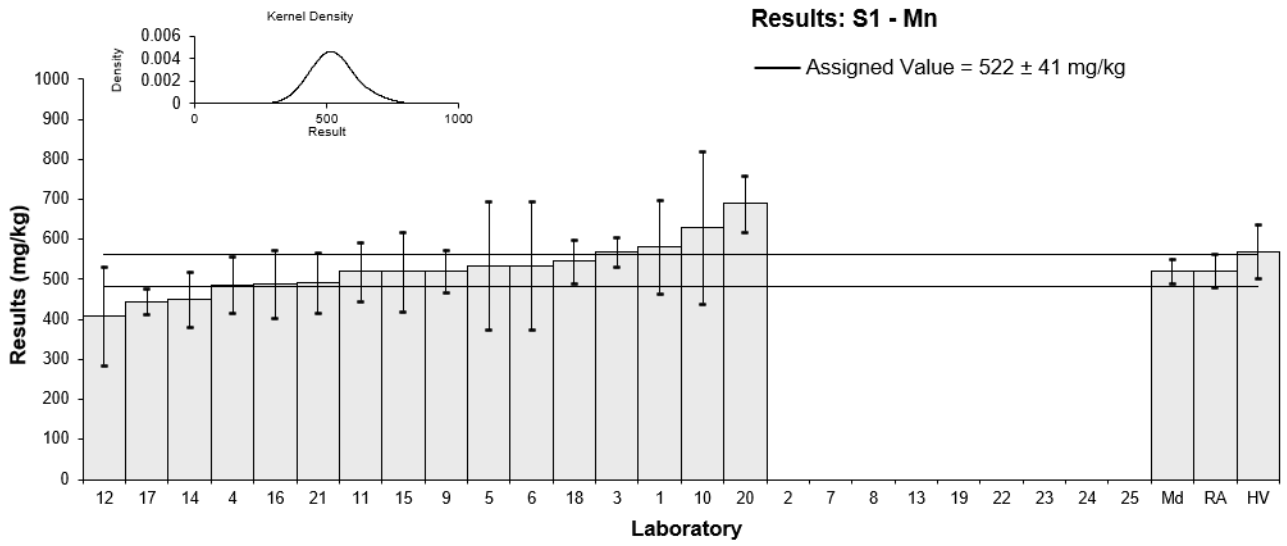
Sample No.	S1
Matrix	Soil
Analyte	Mn
Unit	mg/kg

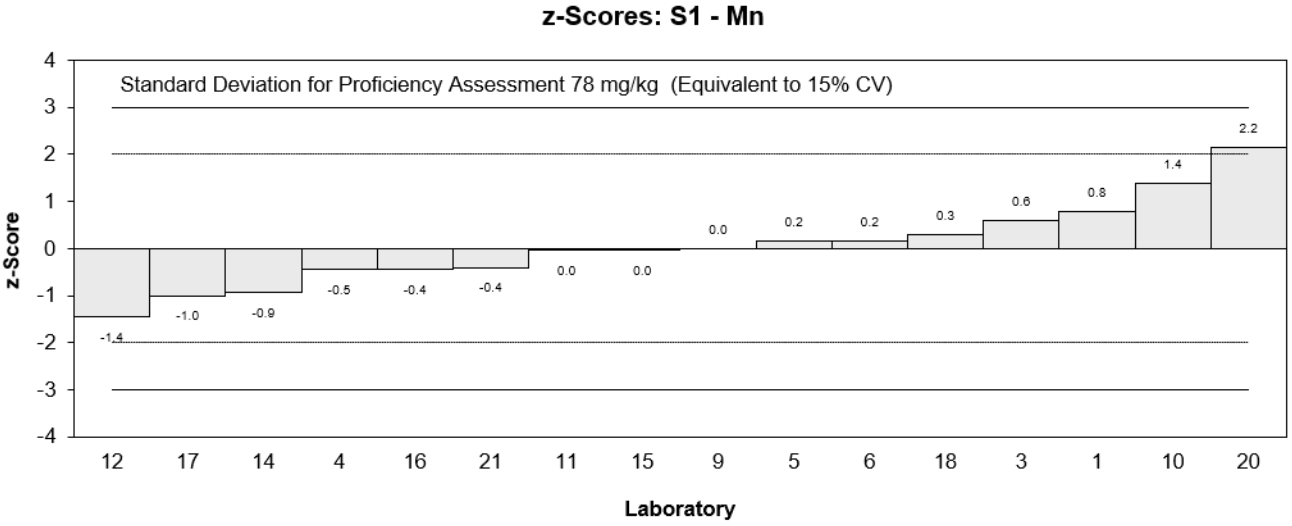
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	583	117	0.78	0.49
2	NT	NT		
3	569	36	0.60	0.86
4	487	71	-0.45	-0.43
5	534	160.2	0.15	0.07
6	534	160.2	0.15	0.07
7	NT	NT		
8	NT	NT		
9	522	53	0.00	0.00
10	630	190	1.38	0.56
11	520	73	-0.03	-0.02
12	409	123	-1.44	-0.87
13	NT	NT		
14	450	70	-0.92	-0.89
15	520	100	-0.03	-0.02
16	487.340	84.9	-0.44	-0.37
17	444	32	-1.00	-1.50
18	545	55	0.29	0.34
19	NT	NT		
20	690	70	2.15	2.07
21	491	75	-0.40	-0.36
22	NT	NT		
23	NT	NT		
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	522	41
Spiked Value	Not Spiked	
Homogeneity Value	570	68
Robust Average	522	41
Median	521	31
Mean	526	
N	16	
Max	690	
Min	409	
Robust SD	66	
Robust CV	13%	


Kernel Density
Density
Result
Results: S1 - Mn
Assigned Value = 522 ± 41 mg/kg
Results (mg/kg)
Laboratory
12 17 14 4 16 21 11 15 9 5 6 18 3 1 10 20 2 7 8 13 19 22 23 24 25 Md RA HV


z-Scores: S1 - Mn
Standard Deviation for Proficiency Assessment 78 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
12 17 14 4 16 21 11 15 9 5 6 18 3 1 10 20

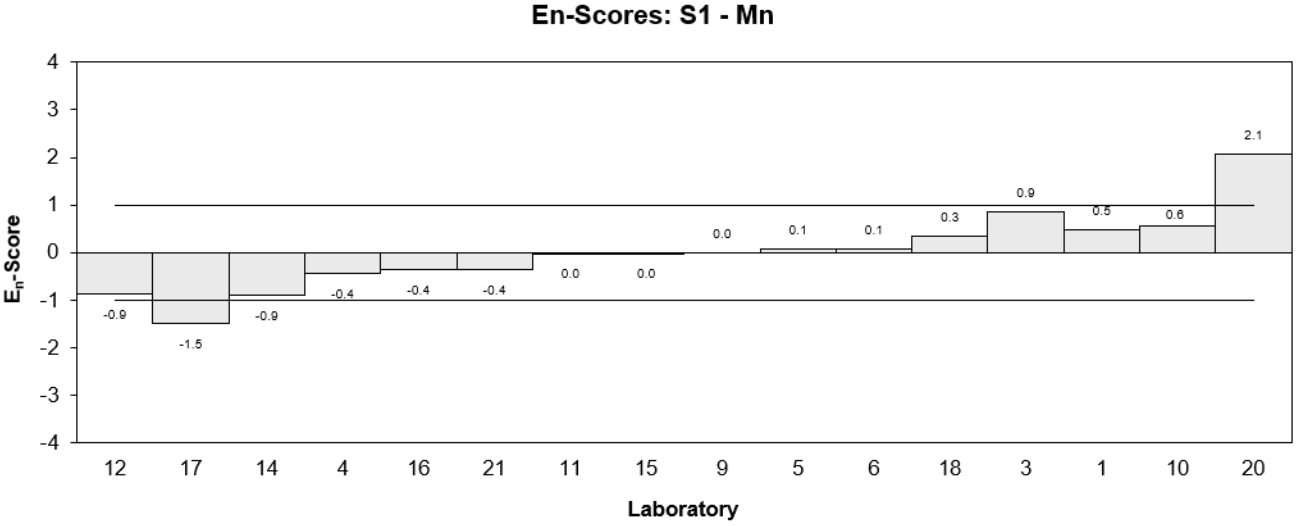

En-Scores: S1 - Mn
En-Score
Laboratory
12 17 14 4 16 21 11 15 9 5 6 18 3 1 10 20

Figure 11

Table 23

Sample Details

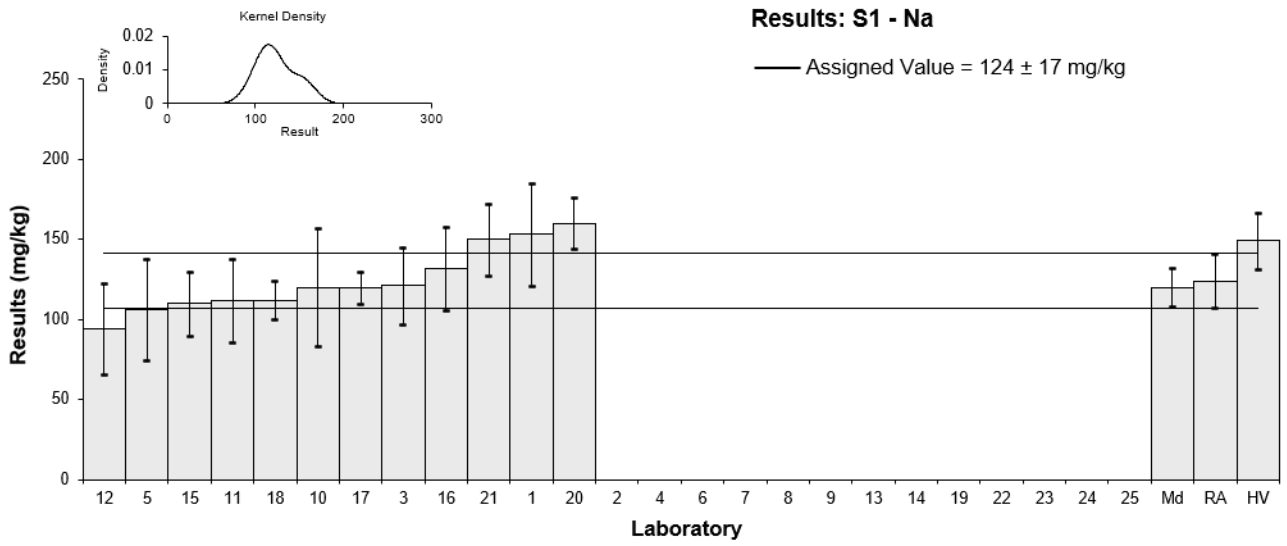
Sample No.	S1
Matrix	Soil
Analyte	Na
Unit	mg/kg

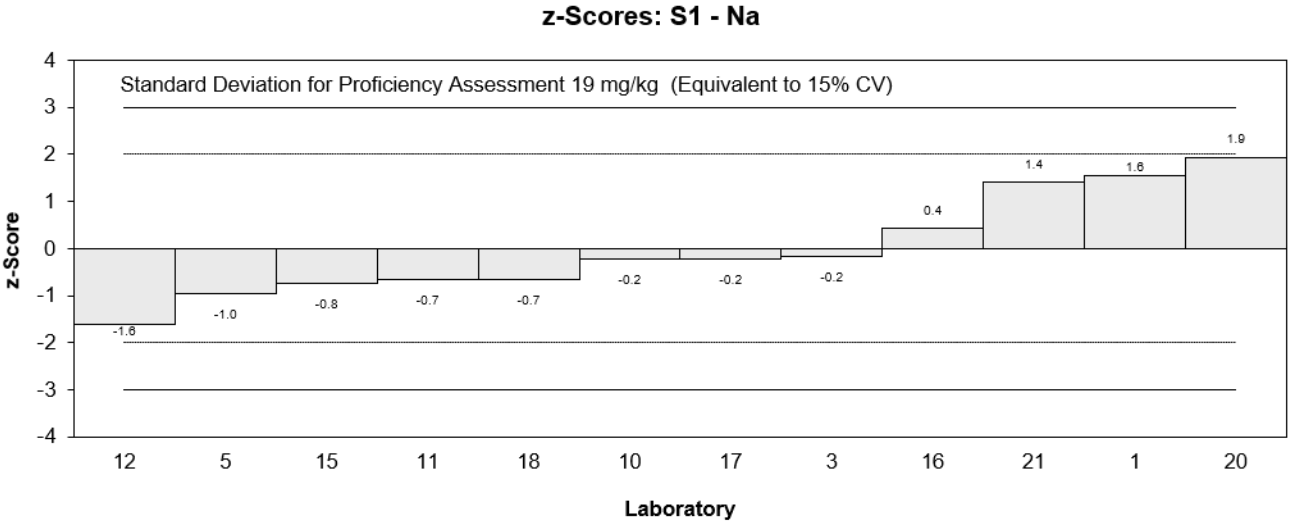
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	153	32	1.56	0.80
2	NT	NT		
3	121	24	-0.16	-0.10
4	NT	NT		
5	106	31.8	-0.97	-0.50
6	<125	NR		
7	NT	NT		
8	NT	NT		
9	NT	NT		
10	120	37	-0.22	-0.10
11	112	26	-0.65	-0.39
12	94.2	28.26	-1.60	-0.90
13	NT	NT		
14	NR	NR		
15	110	20	-0.75	-0.53
16	131.868	26.3	0.42	0.25
17	120	10	-0.22	-0.20
18	112	12	-0.65	-0.58
19	NR	NR		
20	160	16	1.94	1.54
21	150	22.5	1.40	0.92
22	NT	NT		
23	NT	NT		
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	124	17
Spiked Value	Not Spiked	
Homogeneity Value	149	18
Robust Average	124	17
Median	120	12
Mean	124	
N	12	
Max	160	
Min	94.2	
Robust SD	23	
Robust CV	18%	


Kernel Density
Density
Result
Results: S1 - Na
Assigned Value = 124 ± 17 mg/kg
Results (mg/kg)
Laboratory
12 5 15 11 18 10 17 3 16 21 1 20 2 4 6 7 8 9 13 14 19 22 23 24 25 Md RA HV


z-Scores: S1 - Na
Standard Deviation for Proficiency Assessment 19 mg/kg (Equivalent to 15% CV)
z-Score
-1.6 -1.0 -0.8 -0.7 -0.7 -0.2 -0.2 -0.2 0.4 1.4 1.6 1.9
Laboratory
12 5 15 11 18 10 17 3 16 21 1 20

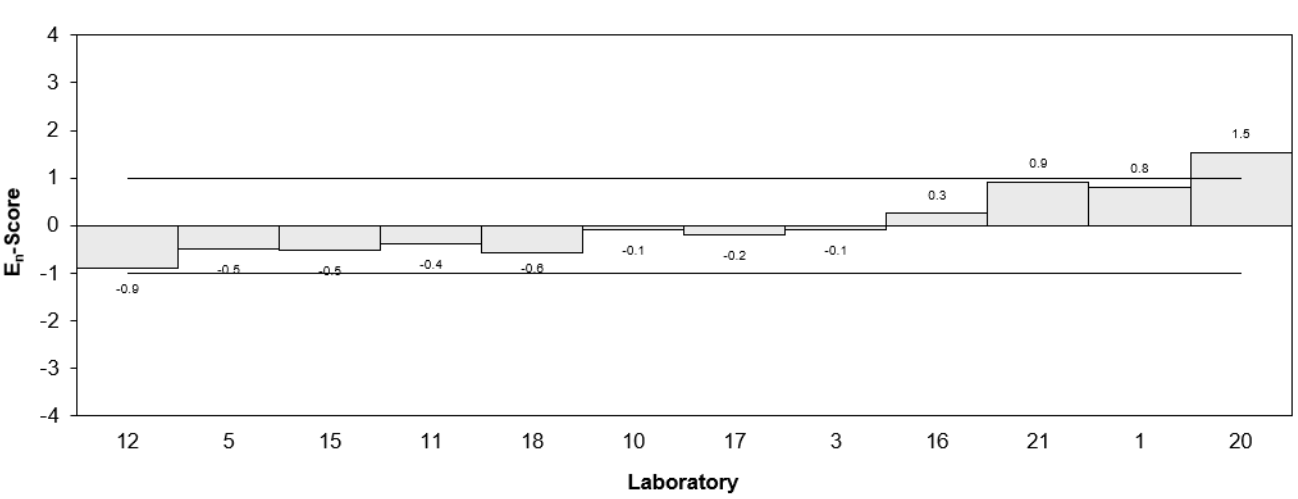

En-Scores: S1 - Na
En-Score
-0.9 -0.5 -0.5 -0.4 -0.6 -0.1 -0.2 -0.1 0.3 0.9 0.8 1.5
Laboratory
12 5 15 11 18 10 17 3 16 21 1 20

Figure 12

Table 24

Sample Details

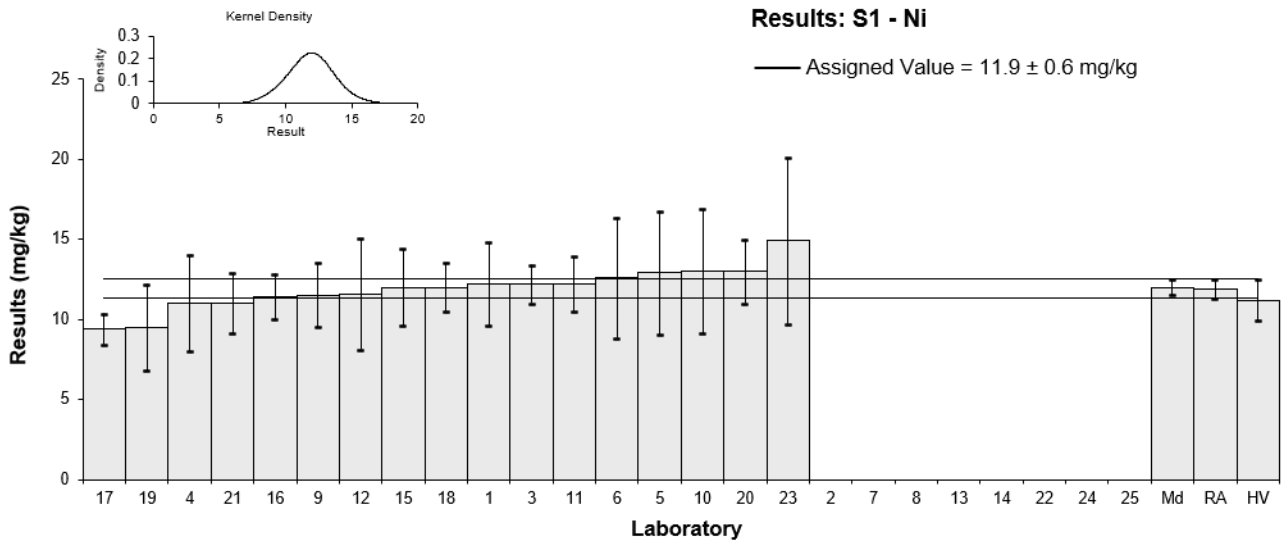
Sample No.	S1
Matrix	Soil
Analyte	Ni
Unit	mg/kg

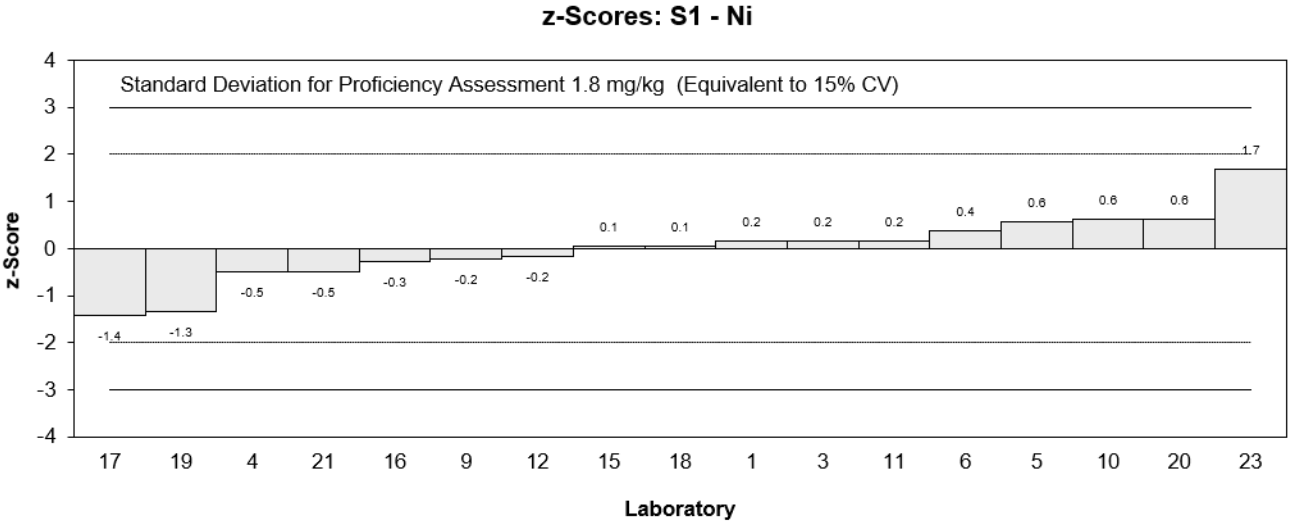
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	12.2	2.6	0.17	0.11
2	NT	NT		
3	12.2	1.2	0.17	0.22
4	11	3	-0.50	-0.29
5	12.9	3.87	0.56	0.26
6	12.6	3.78	0.39	0.18
7	NT	NT		
8	NT	NT		
9	11.5	2.0	-0.22	-0.19
10	13	3.9	0.62	0.28
11	12.2	1.7	0.17	0.17
12	11.58	3.474	-0.18	-0.09
13	NT	NT		
14	NR	NR		
15	12	2.4	0.06	0.04
16	11.405	1.425	-0.28	-0.32
17	9.39	0.96	-1.41	-2.22
18	12	1.5	0.06	0.06
19	9.5	2.7	-1.34	-0.87
20	13	2	0.62	0.53
21	11	1.87	-0.50	-0.46
22	NT	NT		
23	14.9	5.2	1.68	0.57
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	11.9	0.6
Spiked Value	Not Spiked	
Homogeneity Value	11.2	1.3
Robust Average	11.9	0.6
Median	12.0	0.5
Mean	11.9	
N	17	
Max	14.9	
Min	9.39	
Robust SD	1	
Robust CV	8.7%	


Kernel Density
Density
Result
Results: S1 - Ni
Assigned Value = 11.9 ± 0.6 mg/kg
Results (mg/kg)
Laboratory
17 19 4 21 16 9 12 15 18 1 3 11 6 5 10 20 23 2 7 8 13 14 22 24 25 Md RA HV


z-Scores: S1 - Ni
Standard Deviation for Proficiency Assessment 1.8 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
17 19 4 21 16 9 12 15 18 1 3 11 6 5 10 20 23

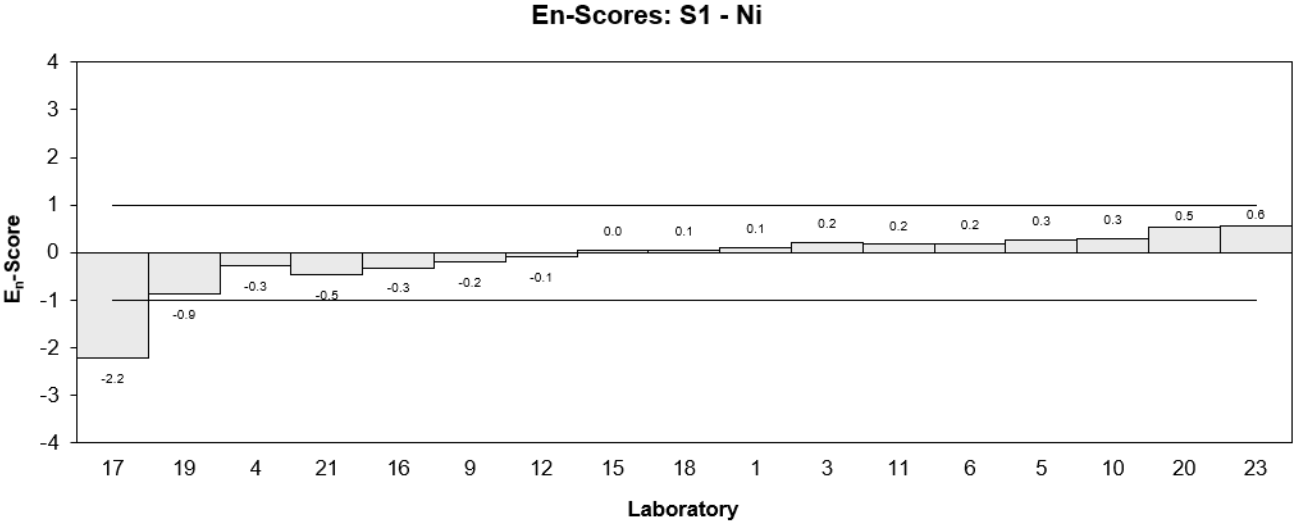

En-Scores: S1 - Ni
En-Score
Laboratory
17 19 4 21 16 9 12 15 18 1 3 11 6 5 10 20 23

Figure 13

Table 25

Sample Details

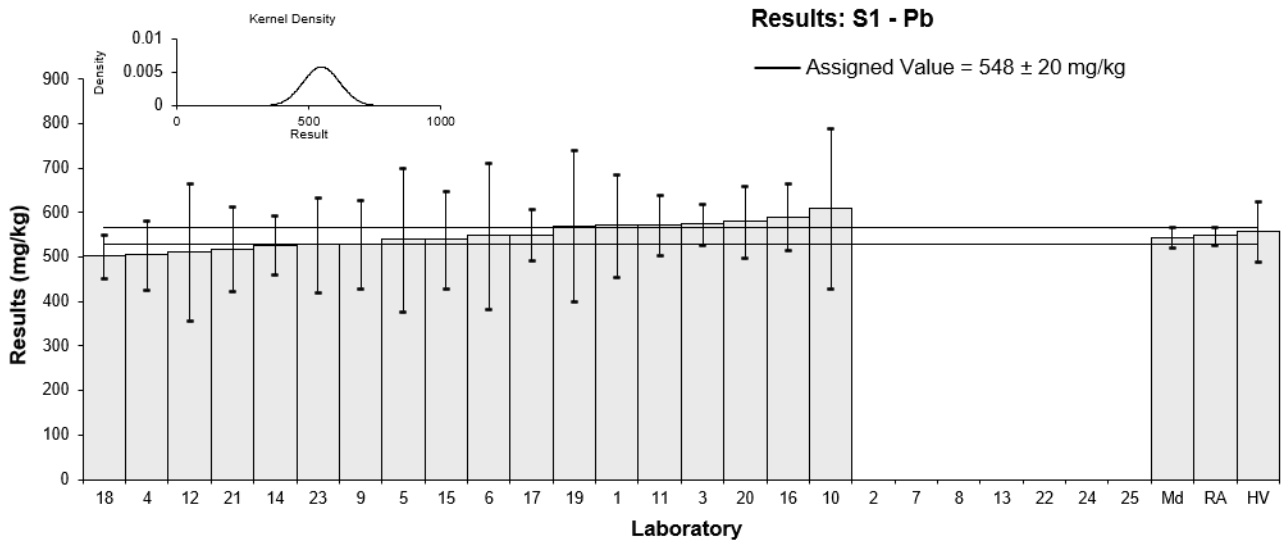
Sample No.	S1
Matrix	Soil
Analyte	Pb
Unit	mg/kg

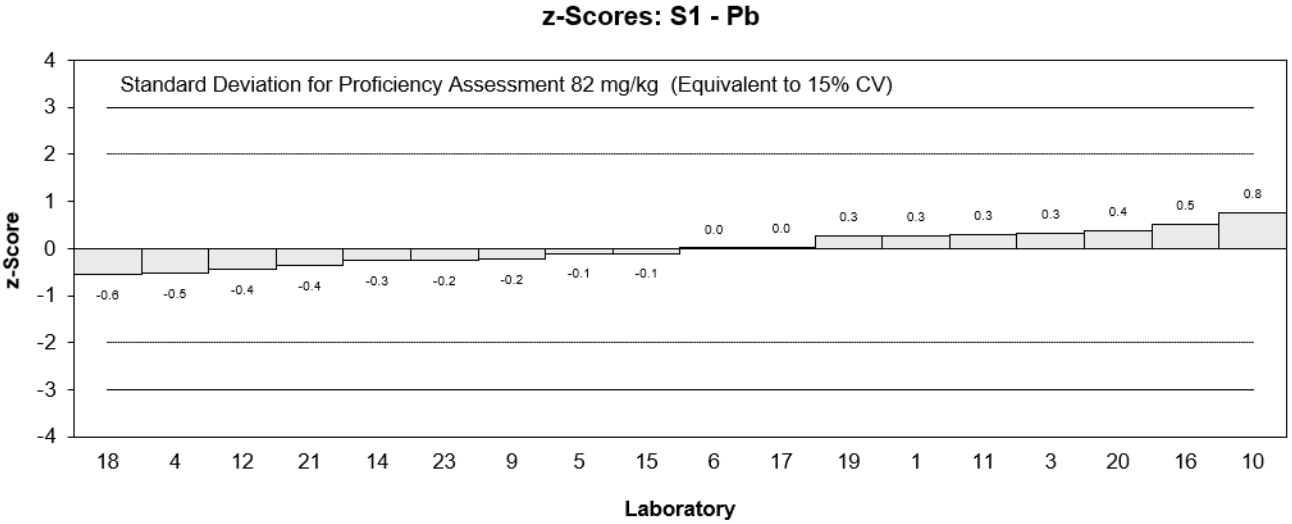
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	571	114	0.28	0.20
2	NT	NT		
3	574	45	0.32	0.53
4	505	78	-0.52	-0.53
5	540	162	-0.10	-0.05
6	549	164.7	0.01	0.01
7	NT	NT		
8	NT	NT		
9	530	100	-0.22	-0.18
10	610	180	0.75	0.34
11	573	67	0.30	0.36
12	512	153	-0.44	-0.23
13	NT	NT		
14	527	67	-0.26	-0.30
15	540	110	-0.10	-0.07
16	590.164	75.2	0.51	0.54
17	550	58	0.02	0.03
18	502	50	-0.56	-0.85
19	570	170	0.27	0.13
20	580	80	0.39	0.39
21	519	94.19	-0.35	-0.30
22	NT	NT		
23	528	106	-0.24	-0.19
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	548	20
Spiked Value	Not Spiked	
Homogeneity Value	558	67
Robust Average	548	20
Median	545	23
Mean	548	
N	18	
Max	610	
Min	502	
Robust SD	34	
Robust CV	6.2%	


Results: S1 - Pb
Assigned Value = 548 ± 20 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
18 4 12 21 14 23 9 5 15 6 17 19 1 11 3 20 16 10 2 7 8 13 22 24 25 Md RA HV


z-Scores: S1 - Pb
Standard Deviation for Proficiency Assessment 82 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
18 4 12 21 14 23 9 5 15 6 17 19 1 11 3 20 16 10
-0.6 -0.5 -0.4 -0.4 -0.3 -0.2 -0.2 -0.1 -0.1 0.0 0.0 0.3 0.3 0.3 0.3 0.4 0.5 0.8

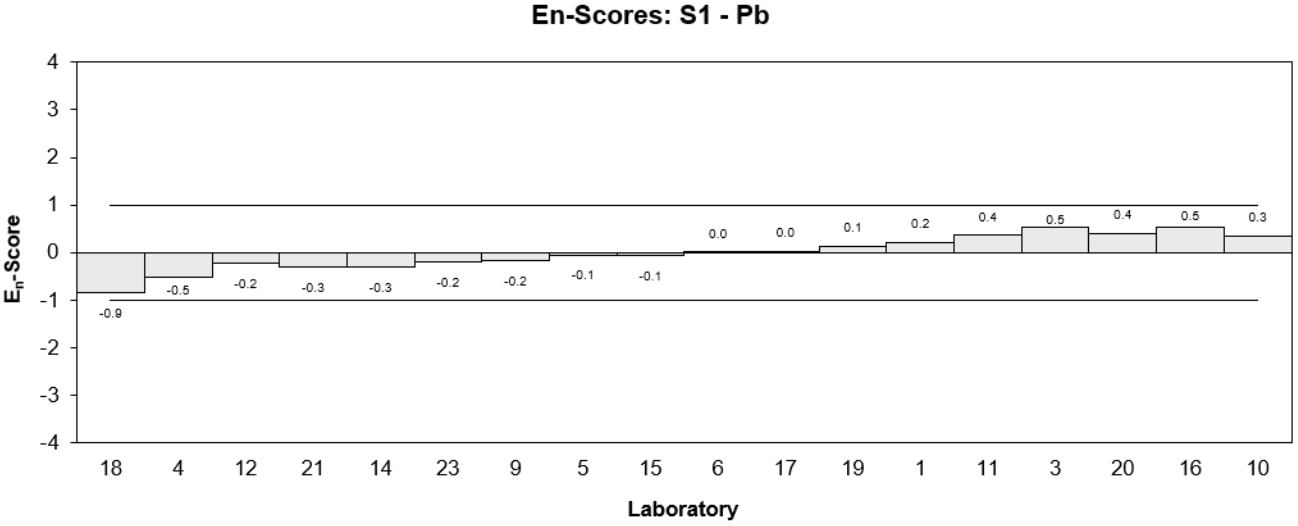

En-Scores: S1 - Pb
En-Score
Laboratory
18 4 12 21 14 23 9 5 15 6 17 19 1 11 3 20 16 10
-0.9 -0.5 -0.2 -0.3 -0.3 -0.2 -0.2 -0.1 -0.1 0.0 0.0 0.1 0.2 0.4 0.5 0.4 0.5 0.3

Figure 14

Table 26

Sample Details

Sample No.	S1
Matrix	Soil
Analyte	Rb
Unit	mg/kg

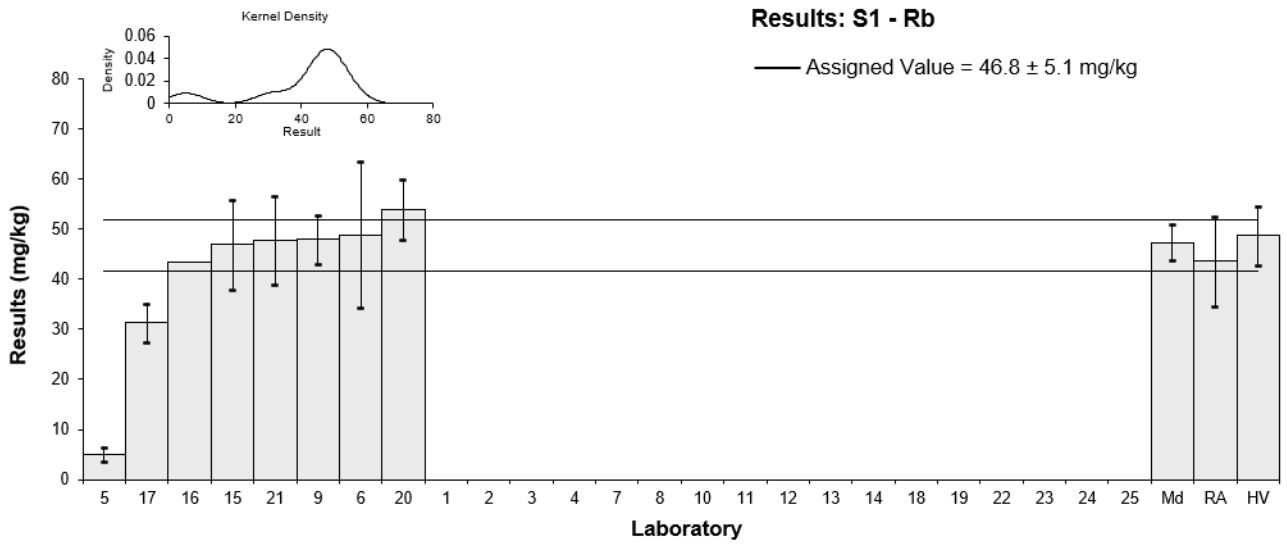
Participant Results

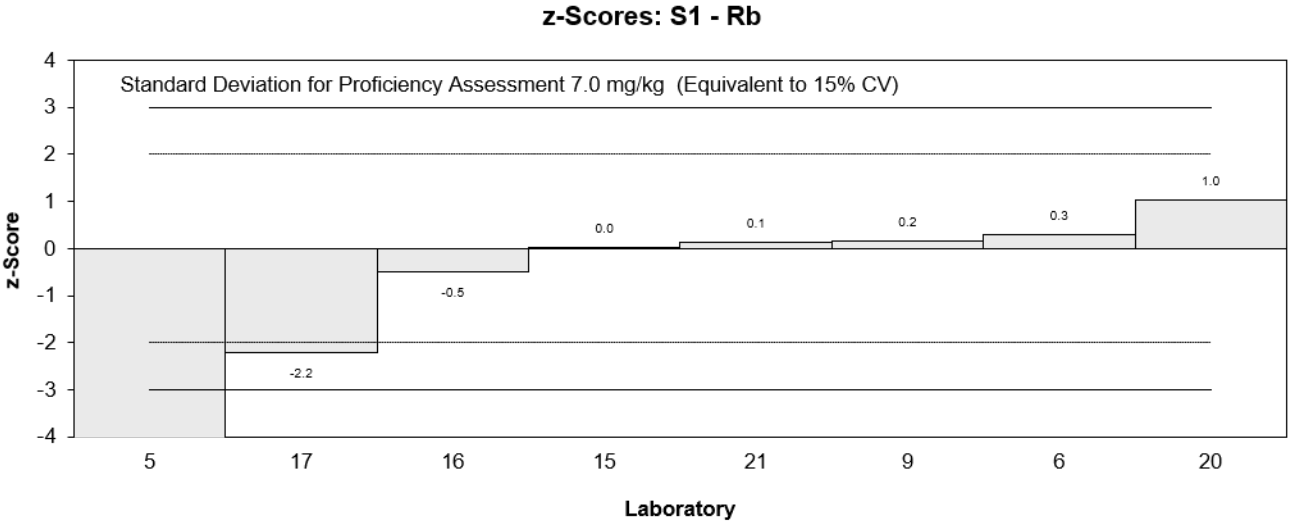
Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	NT	NT		
4	NT	NT		
5*	5	1.5	-5.95	-7.86
6	48.9	14.67	0.30	0.14
7	NT	NT		
8	NT	NT		
9	48.0	4.9	0.17	0.17
10	NT	NT		
11	NT	NT		
12	NT	NT		
13	NT	NT		
14	NR	NR		
15	47	9	0.03	0.02
16	43.373	NR	-0.49	-0.67
17	31.3	3.9	-2.21	-2.41
18	NT	NT		
19	NT	NT		
20	54	6	1.03	0.91
21	47.7	8.85	0.13	0.09
22	NT	NT		
23	NT	NT		
24	NT	NT		
25	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	46.8	5.1
Spiked Value	Not Spiked	
Homogeneity Value	48.8	5.9
Robust Average	43.6	9.0
Median	47.4	3.6
Mean	41	
N	8	
Max	54	
Min	5	
Robust SD	10	
Robust CV	23%	


Kernel Density
Density
Result
Results: S1 - Rb
Assigned Value = 46.8 ± 5.1 mg/kg
Results (mg/kg)
Laboratory
5 17 16 15 21 9 6 20 1 2 3 4 7 8 10 11 12 13 14 18 19 22 23 24 25 Md RA HV


z-Scores: S1 - Rb
Standard Deviation for Proficiency Assessment 7.0 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
5 17 16 15 21 9 6 20
-2.2
-0.5
0.0
0.1
0.2
0.3
1.0

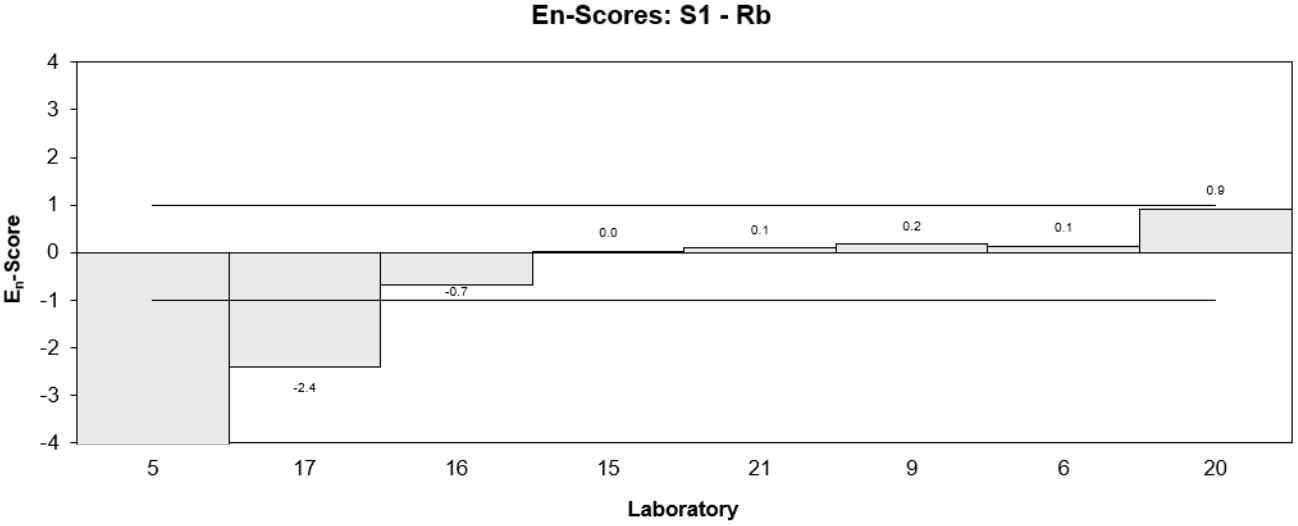

En-Scores: S1 - Rb
En-Score
Laboratory
5 17 16 15 21 9 6 20
-2.4
-0.7
0.0
0.1
0.2
0.1
0.9

Figure 15

Table 27

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty
1	84.2	34.5
2	NT	NT
3	85.5	16
4	35	NR
5	35.2	10.56
6	68.4	20.52
7	NT	NT
8	NT	NT
9	48.4	8.8
10	89	27
11	89.3	12.7
12	19.66	5.898
13	NT	NT
14	27.9	3.7
15	67	13
16	38.542	11.45
17	34.4	5.5
18	102	10
19	NT	NT
20	82	8
21	51	NR
22	NT	NT
23	NT	NT
24	NT	NT
25	NT	NT

Statistics

Assigned Value	Not Set	
Spiked Value	100	5
Homogeneity Value	69.8	8.4
Robust Average	60	19
Median	59	23
Mean	60	
N	16	
Max	102	
Min	19.66	
Robust SD	30	
Robust CV	50%	

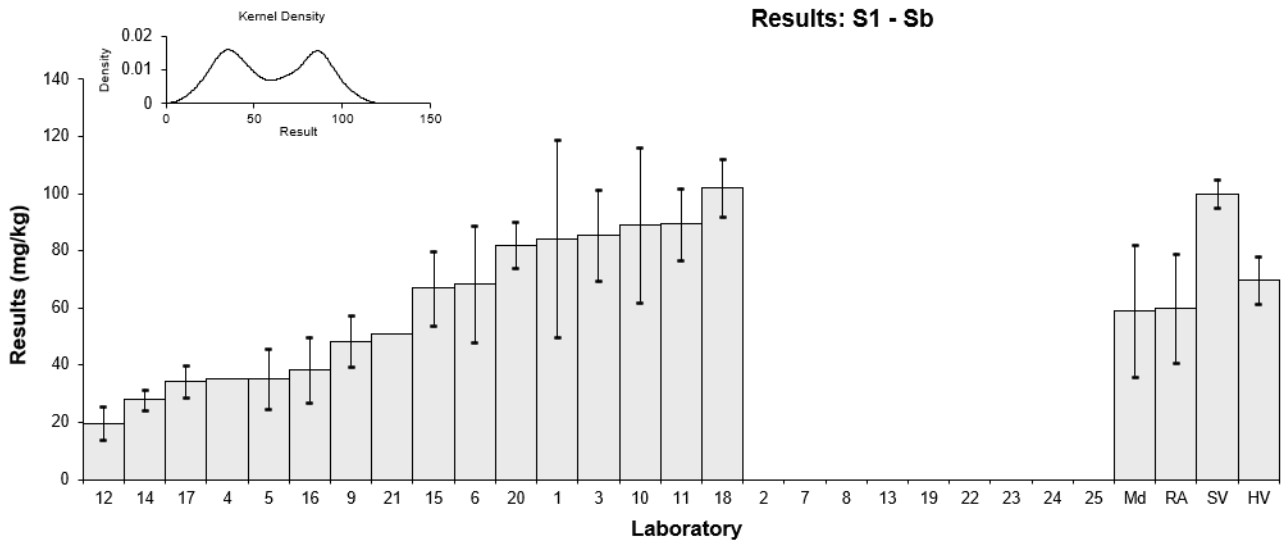

Results: S1 - Sb
Kernel Density
Density
0.02
0.01
0
0
50
100
150
Result
Results (mg/kg)
140
120
100
80
60
40
20
0
12 14 17 4 5 16 9 21 15 6 20 1 3 10 11 18 2 7 8 13 19 22 23 24 25 Md RA SV HV
Laboratory

Figure 16

Table 28

Sample Details

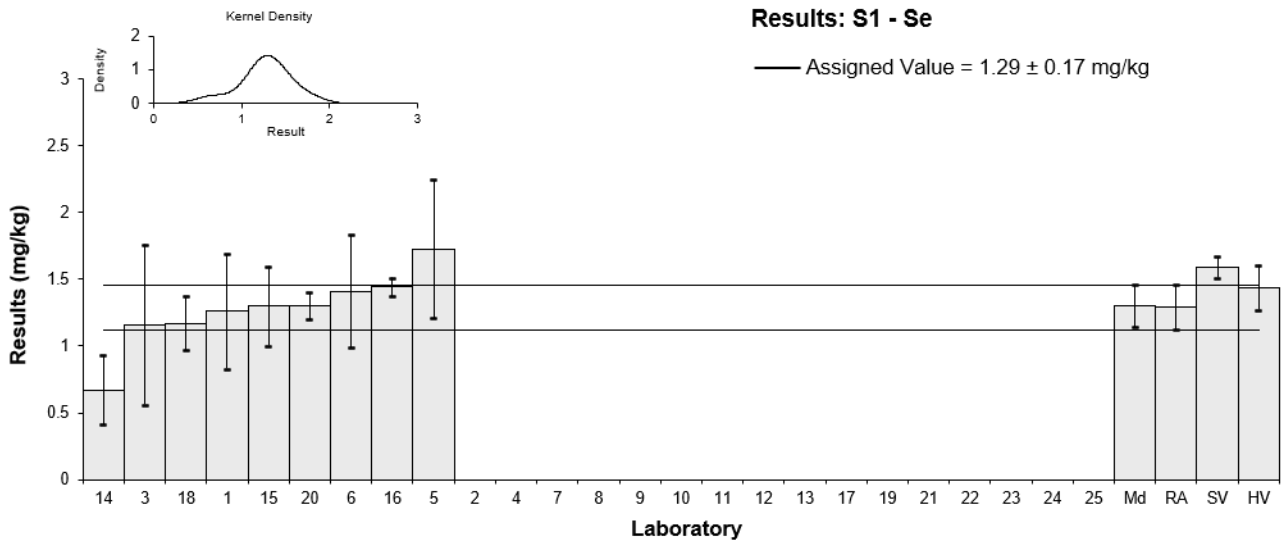
Sample No.	S1
Matrix	Soil
Analyte	Se
Unit	mg/kg

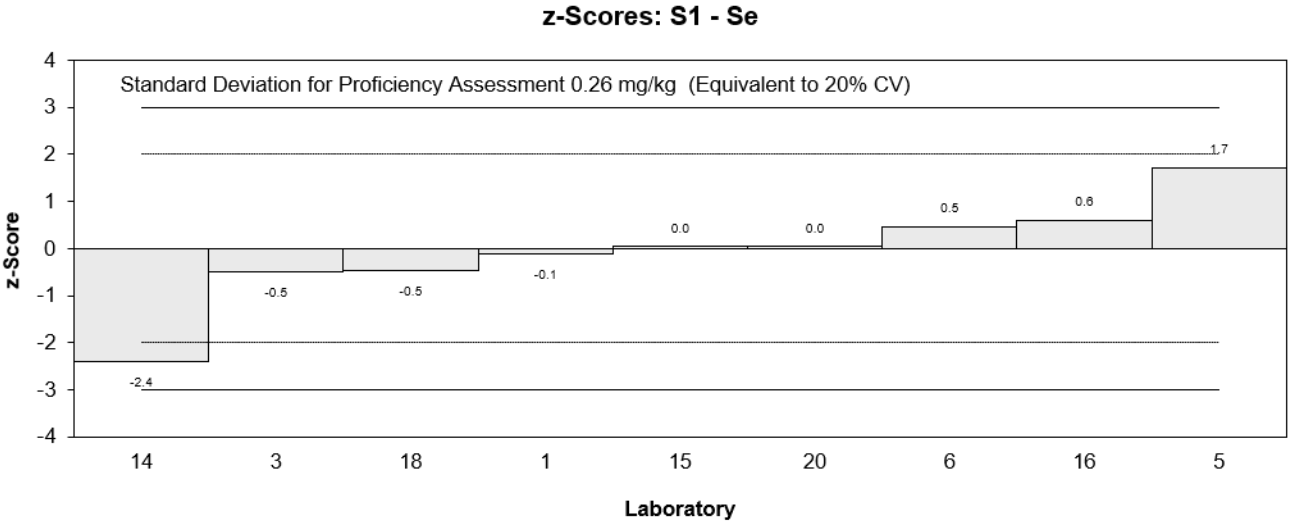
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	1.26	0.43	-0.12	-0.06
2	NT	NT		
3	1.16	0.6	-0.50	-0.21
4	NT	NT		
5	1.73	0.519	1.71	0.81
6	1.41	0.423	0.47	0.26
7	NT	NT		
8	NT	NT		
9	<20	14		
10	<2	NR		
11	< 2	NR		
12	<2	<2		
13	NT	NT		
14	0.67	0.26	-2.40	-2.00
15	1.3	0.3	0.04	0.03
16	1.442	0.070	0.59	0.83
17	<5	NR		
18	1.17	0.2	-0.47	-0.46
19	NT	NT		
20	1.3	0.1	0.04	0.05
21	<5	NR		
22	NT	NT		
23	<5	NR		
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	1.29	0.17
Spiked Value	1.59	0.08
Homogeneity Value	1.44	0.17
Robust Average	1.29	0.17
Median	1.30	0.16
Mean	1.27	
N	9	
Max	1.73	
Min	0.67	
Robust SD	0.2	
Robust CV	16%	


Kernel Density
Density
Result
Results: S1 - Se
Assigned Value = 1.29 ± 0.17 mg/kg
Results (mg/kg)
Laboratory
14 3 18 1 15 20 6 16 5 2 4 7 8 9 10 11 12 13 17 19 21 22 23 24 25 Md RA SV HV


z-Scores: S1 - Se
Standard Deviation for Proficiency Assessment 0.26 mg/kg (Equivalent to 20% CV)
z-Score
Laboratory
14 3 18 1 15 20 6 16 5
-2.4
-0.5
-0.5
-0.1
0.0
0.0
0.5
0.6
1.7

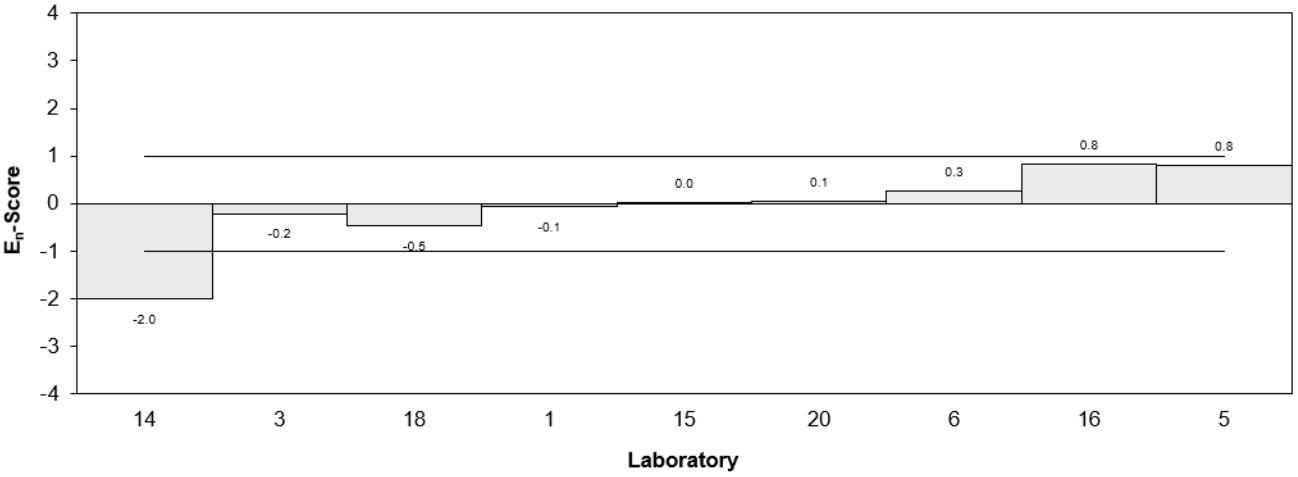

En-Scores: S1 - Se
En-Score
Laboratory
14 3 18 1 15 20 6 16 5
-2.0
-0.2
-0.5
-0.1
0.0
0.1
0.3
0.8
0.8

Figure 17

Table 29

Sample Details

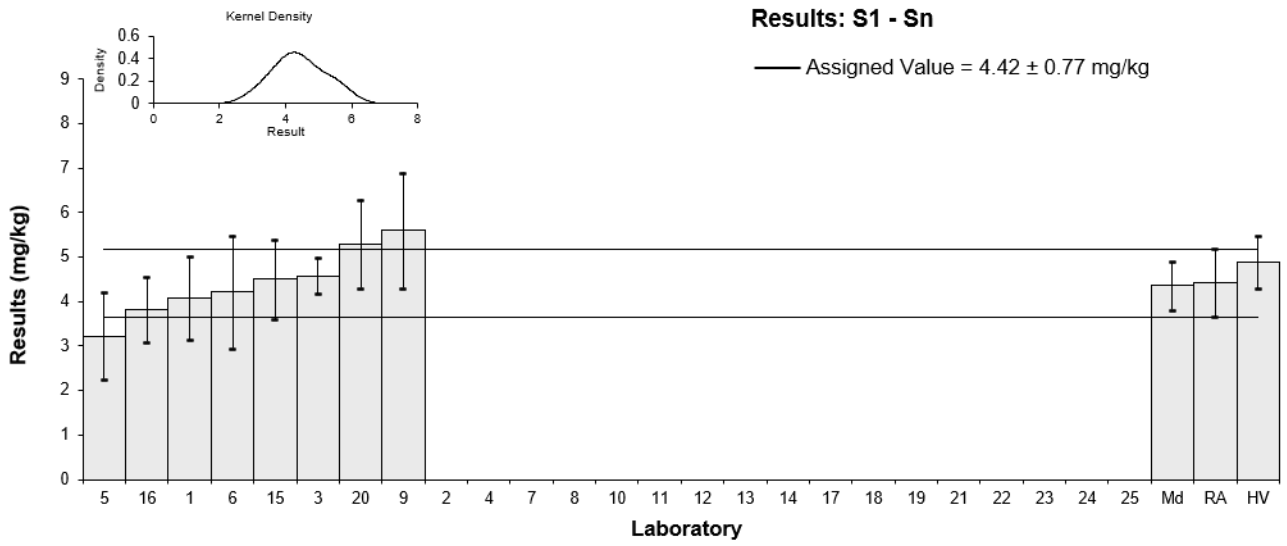
Sample No.	S1
Matrix	Soil
Analyte	Sn
Unit	mg/kg

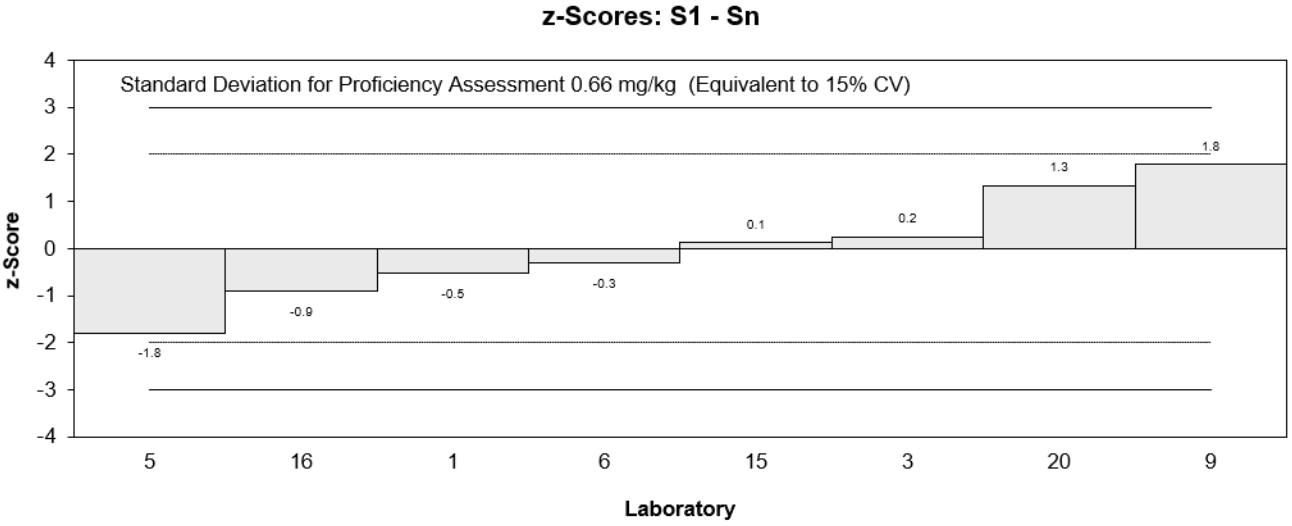
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	4.07	0.94	-0.53	-0.29
2	NT	NT		
3	4.58	0.41	0.24	0.18
4	NT	NT		
5	3.23	0.969	-1.79	-0.96
6	4.22	1.266	-0.30	-0.13
7	NT	NT		
8	NT	NT		
9	5.6	1.3	1.78	0.78
10	<10	NR		
11	< 10	NR		
12	<3	<3		
13	NT	NT		
14	NR	NR		
15	4.5	0.9	0.12	0.07
16	3.821	0.733	-0.90	-0.56
17	<5	NR		
18	NT	NT		
19	NT	NT		
20	5.3	1.0	1.33	0.70
21	<5	NR		
22	NT	NT		
23	NT	NT		
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	4.42	0.77
Spiked Value	Not Spiked	
Homogeneity Value	4.88	0.59
Robust Average	4.42	0.77
Median	4.36	0.54
Mean	4.42	
N	8	
Max	5.6	
Min	3.23	
Robust SD	0.87	
Robust CV	20%	


Kernel Density
Density
Result
Results: S1 - Sn
Assigned Value = 4.42 ± 0.77 mg/kg
Results (mg/kg)
Laboratory
5 16 1 6 15 3 20 9 2 4 7 8 10 11 12 13 14 17 18 19 21 22 23 24 25 Md RA HV


z-Scores: S1 - Sn
Standard Deviation for Proficiency Assessment 0.66 mg/kg (Equivalent to 15% CV)
z-Score
-1.8
-0.9
-0.5
-0.3
0.1
0.2
1.3
1.8
Laboratory
5 16 1 6 15 3 20 9

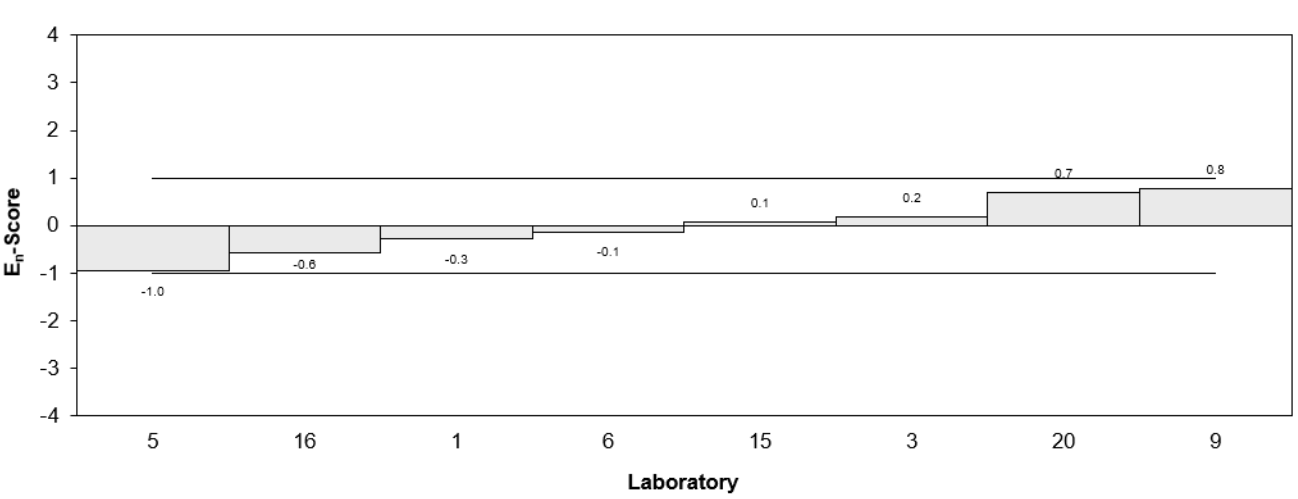

En-Scores: S1 - Sn
En-Score
-1.0
-0.6
-0.3
-0.1
0.1
0.2
0.7
0.8
Laboratory
5 16 1 6 15 3 20 9

Figure 18

Table 30

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty
1	1.24	0.26
2	NT	NT
3	1.45	0.15
4	NT	NT
5	1.67	0.501
6	0.972	0.2916
7	NT	NT
8	NT	NT
9	0.839	0.084
10	<10	NR
11	< 10	NR
12	NT	NT
13	NT	NT
14	NR	NR
15	1.2	0.2
16	0.719	0.104
17	0.553	0.099
18	1.4	0.2
19	NT	NT
20	2.2	0.2
21	0.8	0.132
22	NT	NT
23	NT	NT
24	NT	NT
25	NT	NT

Statistics

Assigned Value	Not Set	
Spiked Value	Not Spiked	
Homogeneity Value	1.41	0.17
Robust Average	1.16	0.36
Median	1.20	0.40
Mean	1.19	
N	11	
Max	2.2	
Min	0.553	
Robust SD	0.47	
Robust CV	41%	

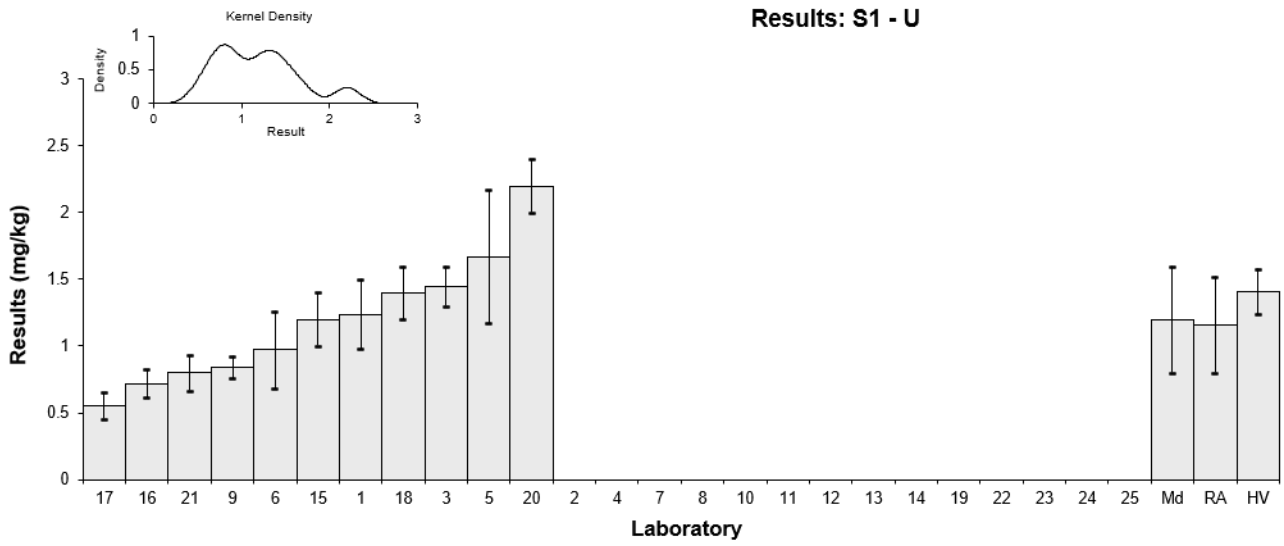

Results: S1 - U
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
17 16 21 9 6 15 1 18 3 5 20 2 4 7 8 10 11 12 13 14 19 22 23 24 25 Md RA HV

Figure 19

Table 31

Sample Details

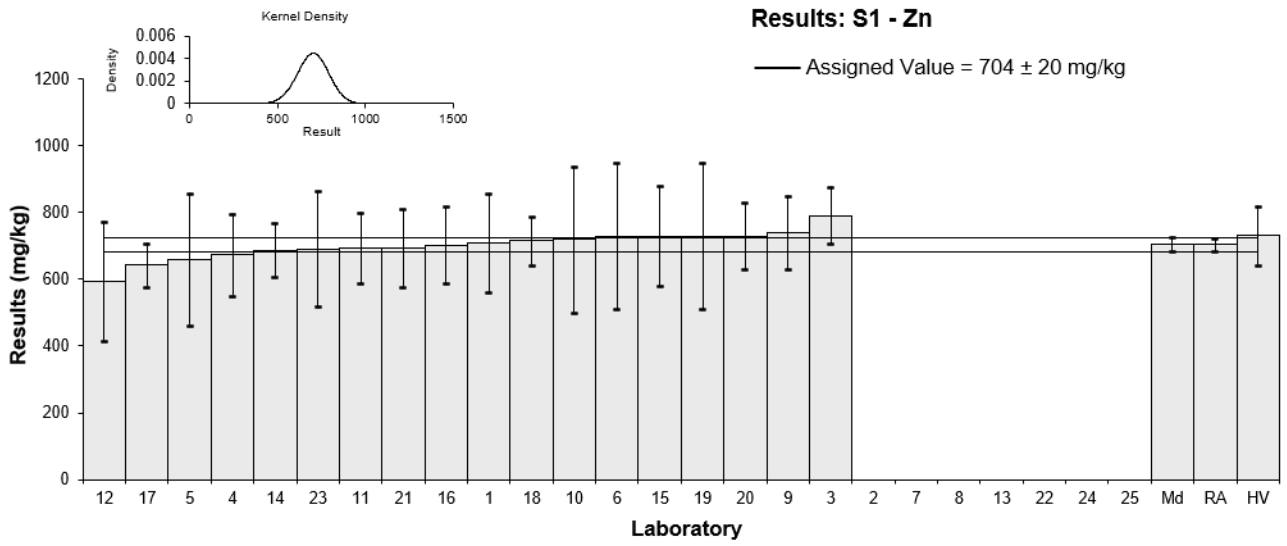
Sample No.	S1
Matrix	Soil
Analyte	Zn
Unit	mg/kg

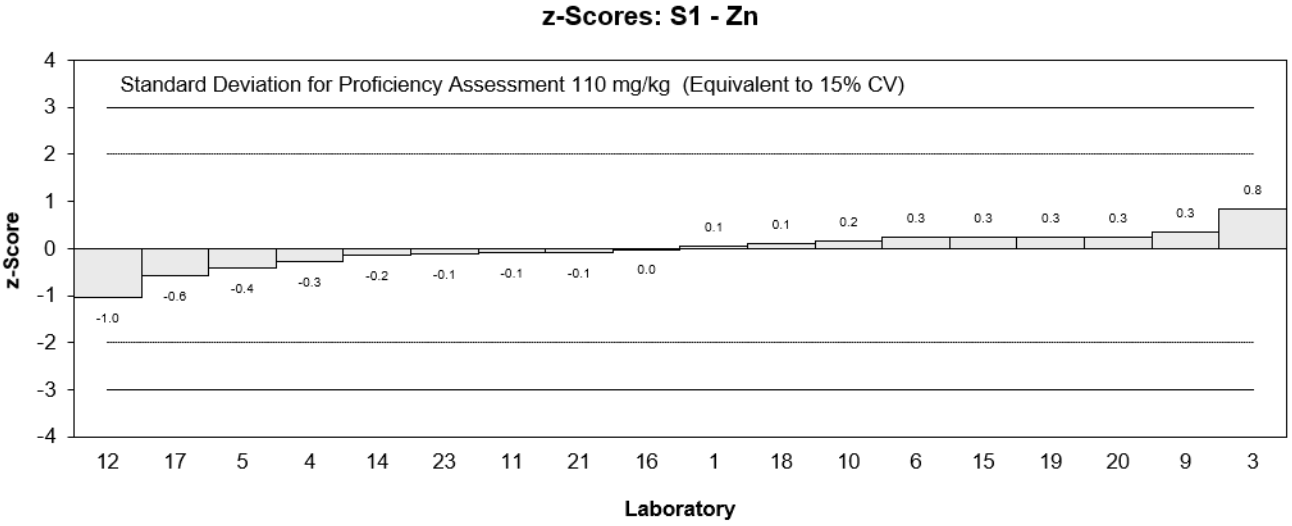
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	710	149	0.06	0.04
2	NT	NT		
3	792	85	0.83	1.01
4	674	123	-0.28	-0.24
5	661	198.3	-0.41	-0.22
6	730	219	0.25	0.12
7	NT	NT		
8	NT	NT		
9	740	110	0.34	0.32
10	720	220	0.15	0.07
11	694	107	-0.09	-0.09
12	595	179	-1.03	-0.61
13	NT	NT		
14	688	80	-0.15	-0.19
15	730	150	0.25	0.17
16	702.641	115.4	-0.01	-0.01
17	643	66	-0.58	-0.88
18	716	72	0.11	0.16
19	730	220	0.25	0.12
20	730	100	0.25	0.25
21	694	116.88	-0.09	-0.08
22	NT	NT		
23	692	173	-0.11	-0.07
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	704	20
Spiked Value	Not Spiked	
Homogeneity Value	732	88
Robust Average	704	20
Median	706	21
Mean	702	
N	18	
Max	792	
Min	595	
Robust SD	35	
Robust CV	4.9%	


Kernel Density
Density
0.006
0.004
0.002
0
0
500
1000
1500
Result
Results: S1 - Zn
Assigned Value = 704 ± 20 mg/kg
Results (mg/kg)
1200
1000
800
600
400
200
0
12 17 5 4 14 23 11 21 16 1 18 10 6 15 19 20 9 3 2 7 8 13 22 24 25 Md RA HV
Laboratory


z-Scores: S1 - Zn
Standard Deviation for Proficiency Assessment 110 mg/kg (Equivalent to 15% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-1.0 -0.6 -0.4 -0.3 -0.2 -0.1 -0.1 -0.1 0.0 0.1 0.1 0.2 0.3 0.3 0.3 0.3 0.3 0.8
12 17 5 4 14 23 11 21 16 1 18 10 6 15 19 20 9 3
Laboratory

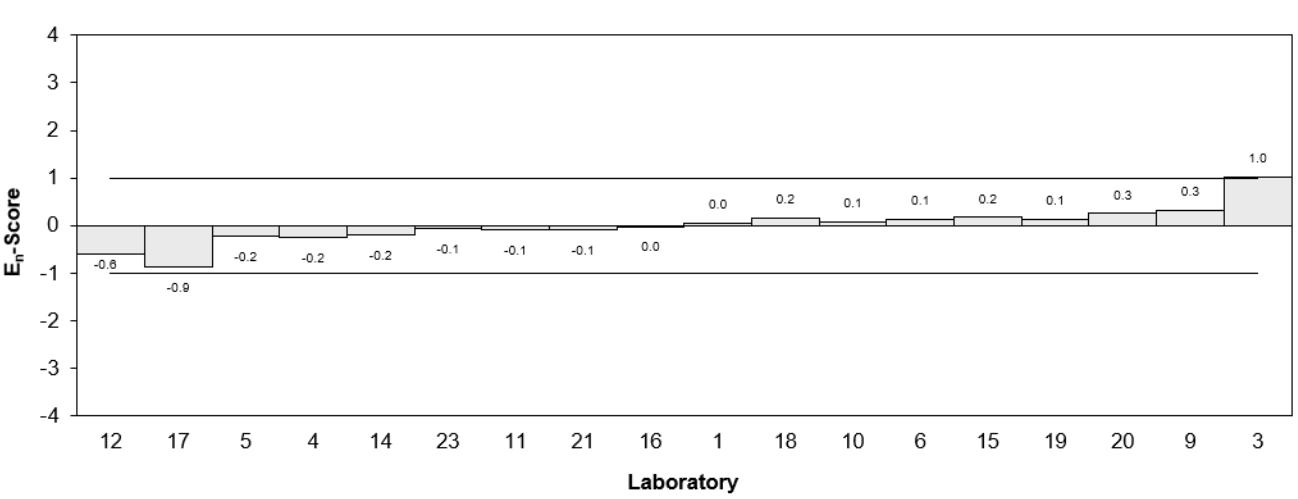

En-Scores: S1 - Zn
En-Score
4
3
2
1
0
-1
-2
-3
-4
-0.6 -0.9 -0.2 -0.2 -0.2 -0.1 -0.1 -0.1 0.0 0.0 0.2 0.1 0.1 0.2 0.1 0.3 0.3 1.0
12 17 5 4 14 23 11 21 16 1 18 10 6 15 19 20 9 3
Laboratory

Figure 20

Table 32

Sample Details

Sample No.	S2
Matrix	Compost
Analyte	Ag
Unit	mg/kg

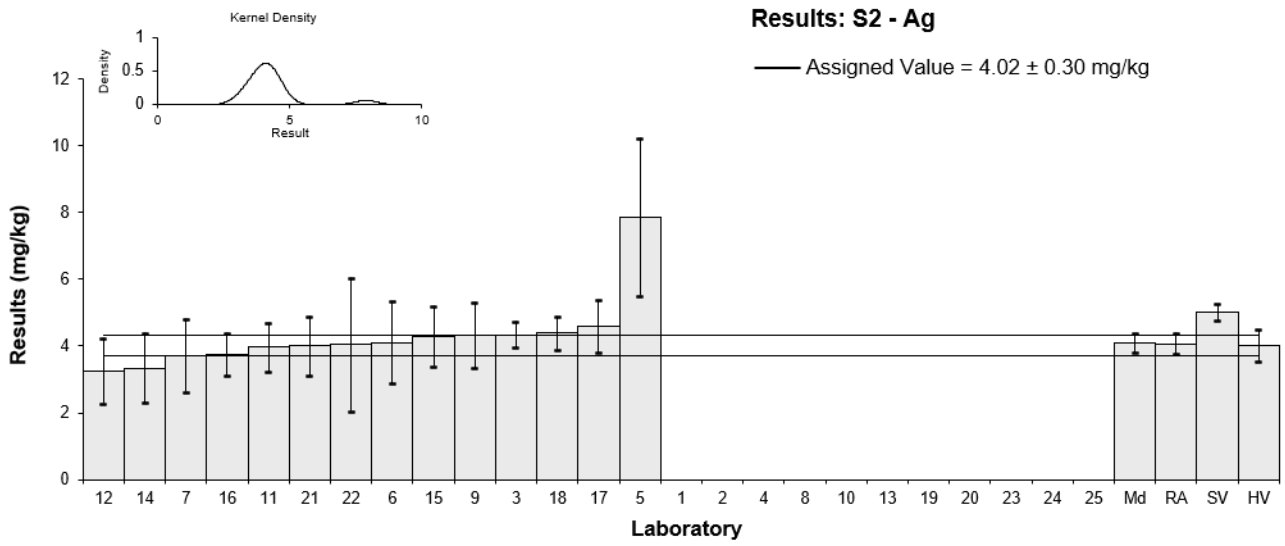
Participant Results

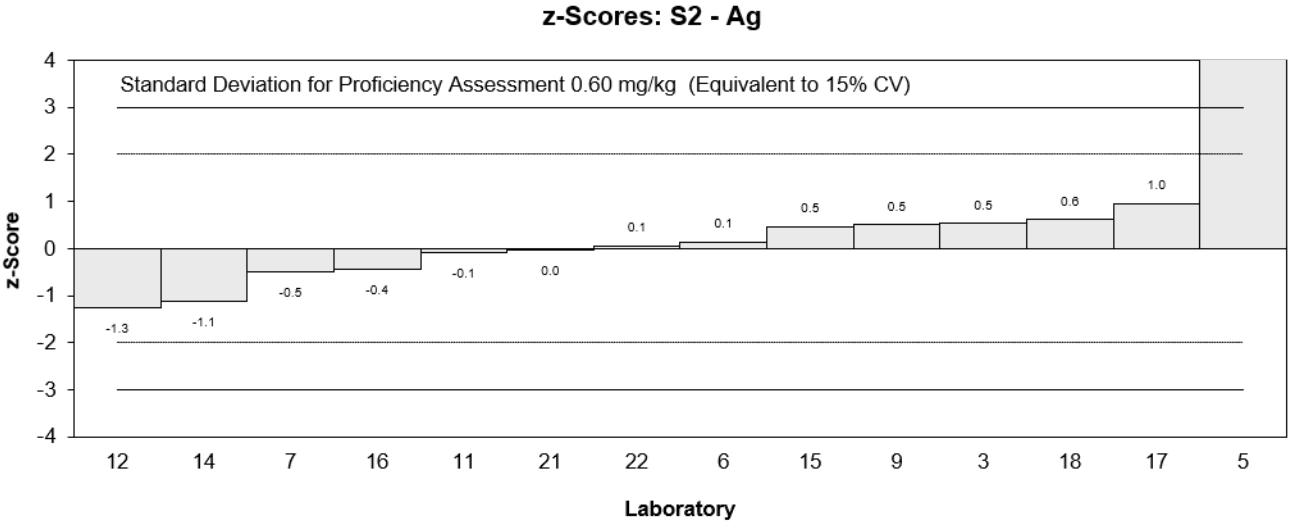
Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	4.34	0.39	0.53	0.65
4	NT	NT		
5*	7.88	2.364	6.40	1.62
6	4.1	1.23	0.13	0.06
7	3.72	1.1	-0.50	-0.26
8	NT	NT		
9	4.32	0.99	0.50	0.29
10	<5	NR		
11	3.97	0.74	-0.08	-0.06
12	3.26	0.978	-1.26	-0.74
13	NT	NT		
14	3.34	1.05	-1.13	-0.62
15	4.3	0.9	0.46	0.30
16	3.753	0.642	-0.44	-0.38
17	4.59	0.79	0.95	0.67
18	4.39	0.5	0.61	0.63
19	NT	NT		
20	NT	NT		
21	4	0.9	-0.03	-0.02
22	4.05	2	0.05	0.01
23	NT	NT		
24	NT	NT		
25	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	4.02	0.30
Spiked Value	5.01	0.25
Homogeneity Value	4.00	0.48
Robust Average	4.07	0.32
Median	4.08	0.29
Mean	4.29	
N	14	
Max	7.88	
Min	3.26	
Robust SD	0.49	
Robust CV	12%	


Results: S2 - Ag
Assigned Value = 4.02 ± 0.30 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
12 14 7 16 11 21 22 6 15 9 3 18 17 5 1 2 4 8 10 13 19 20 23 24 25 Md RA SV HV


z-Scores: S2 - Ag
Standard Deviation for Proficiency Assessment 0.60 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
12 14 7 16 11 21 22 6 15 9 3 18 17 5
-1.3 -1.1 -0.5 -0.4 -0.1 0.0 0.1 0.1 0.5 0.5 0.5 0.6 1.0

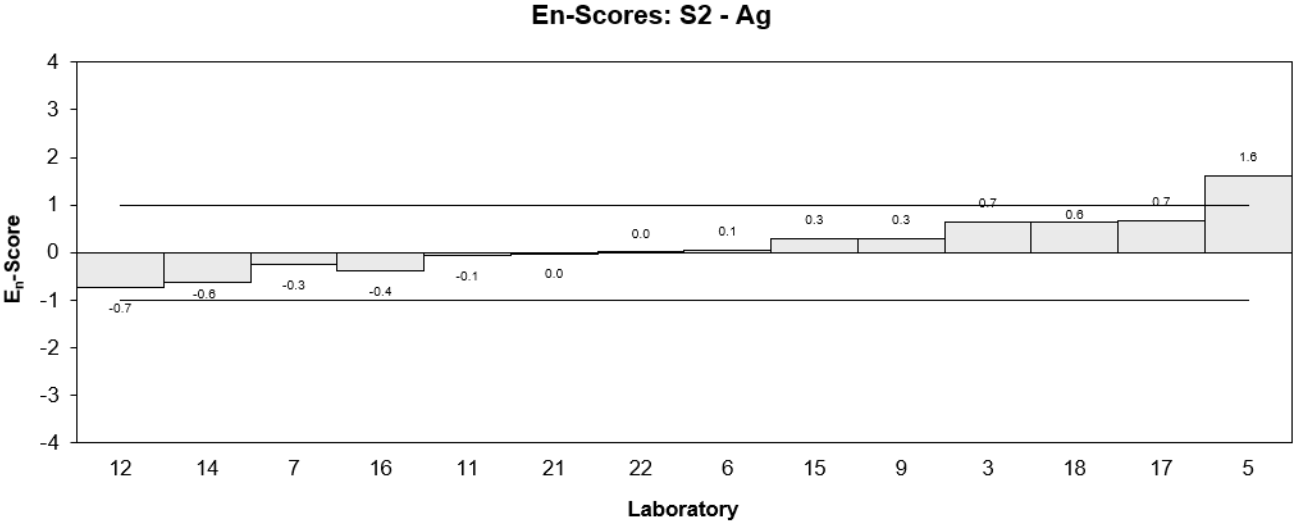

En-Scores: S2 - Ag
En-Score
Laboratory
12 14 7 16 11 21 22 6 15 9 3 18 17 5
-0.7 -0.6 -0.3 -0.4 -0.1 0.0 0.0 0.1 0.3 0.3 0.7 0.6 0.7 1.6

Figure 21

Table 33

Sample Details

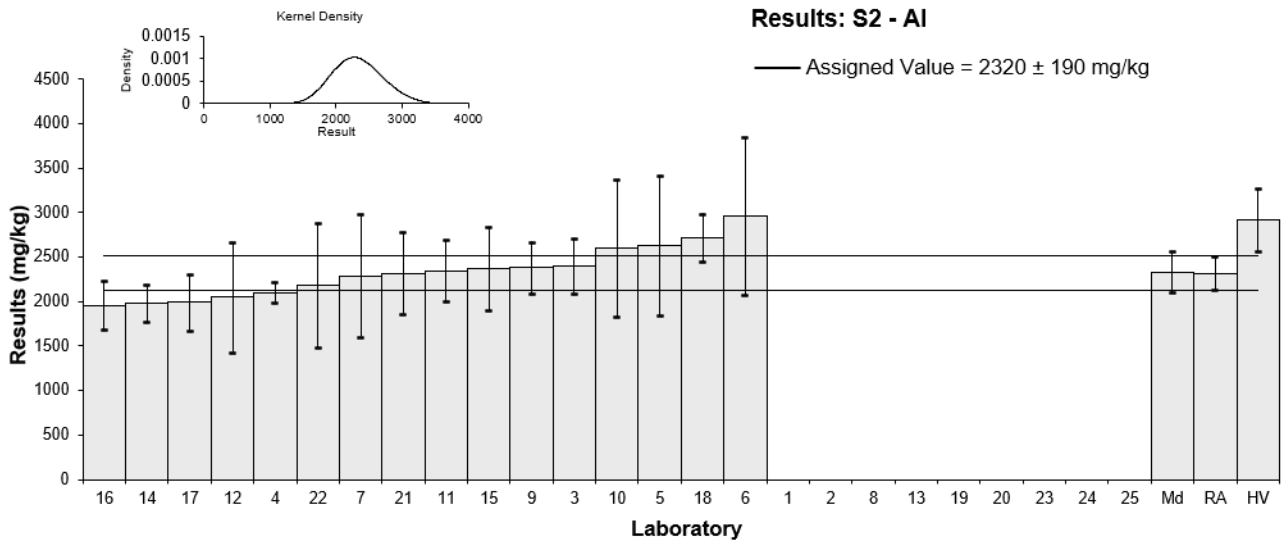
Sample No.	S2
Matrix	Compost
Analyte	Al
Unit	mg/kg

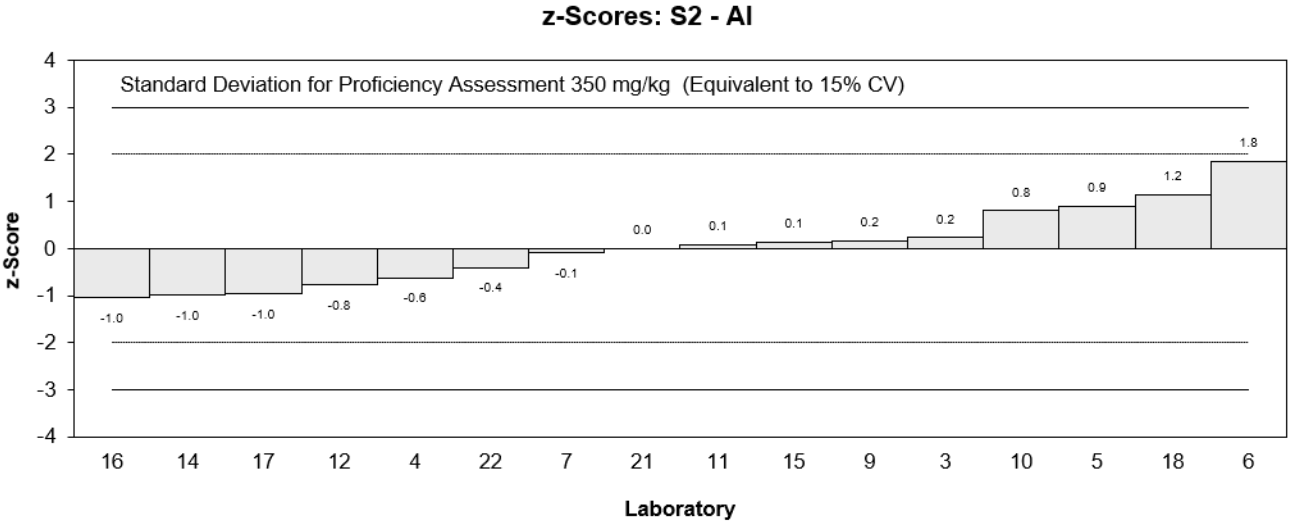
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	2400	304	0.23	0.22
4	2105	110	-0.62	-0.98
5	2630	789	0.89	0.38
6	2960	888	1.84	0.70
7	2291	687	-0.08	-0.04
8	NT	NT		
9	2380	290	0.17	0.17
10	2600	770	0.80	0.35
11	2344	346	0.07	0.06
12	2048	614	-0.78	-0.42
13	NT	NT		
14	1980	208	-0.98	-1.21
15	2370	470	0.14	0.10
16	1959.428	272.4	-1.04	-1.09
17	1990	312	-0.95	-0.90
18	2720	270	1.15	1.21
19	NT	NT		
20	NT	NT		
21	2320	459.3	0.00	0.00
22	2182	700	-0.40	-0.19
23	NT	NT		
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	2320	190
Spiked Value	Not Spiked	
Homogeneity Value	2920	350
Robust Average	2320	190
Median	2330	230
Mean	2330	
N	16	
Max	2960	
Min	1959.428	
Robust SD	300	
Robust CV	13%	


Kernel Density
Density
Result
Results: S2 - Al
Assigned Value = 2320 ± 190 mg/kg
Results (mg/kg)
Laboratory
16 14 17 12 4 22 7 21 11 15 9 3 10 5 18 6 1 2 8 13 19 20 23 24 25 Md RA HV


z-Scores: S2 - Al
Standard Deviation for Proficiency Assessment 350 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
16 14 17 12 4 22 7 21 11 15 9 3 10 5 18 6

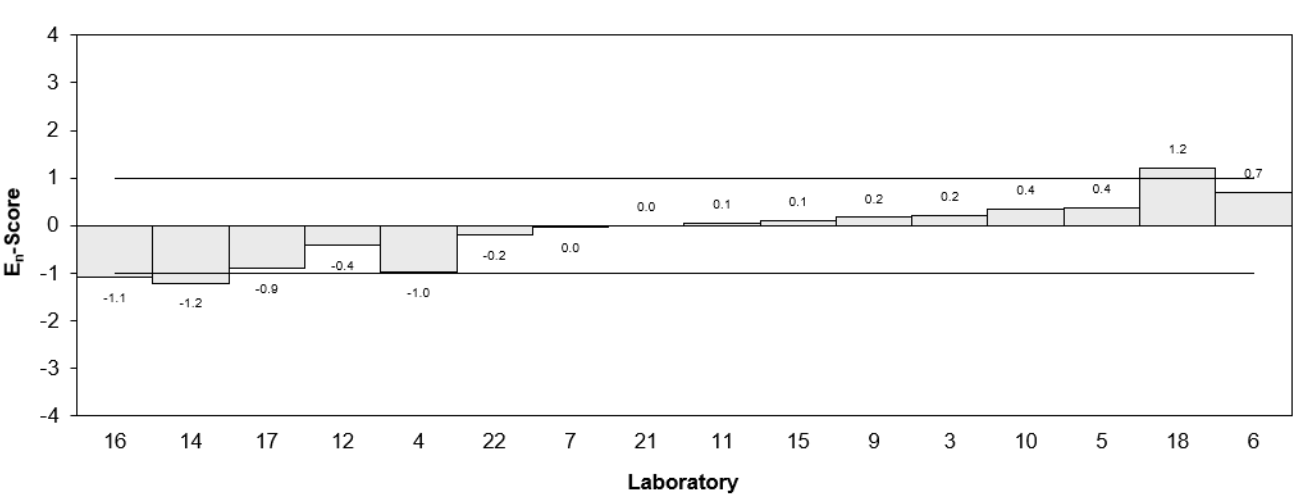

En-Scores: S2 - Al
En-Score
Laboratory
16 14 17 12 4 22 7 21 11 15 9 3 10 5 18 6

Figure 22

Table 34

Sample Details

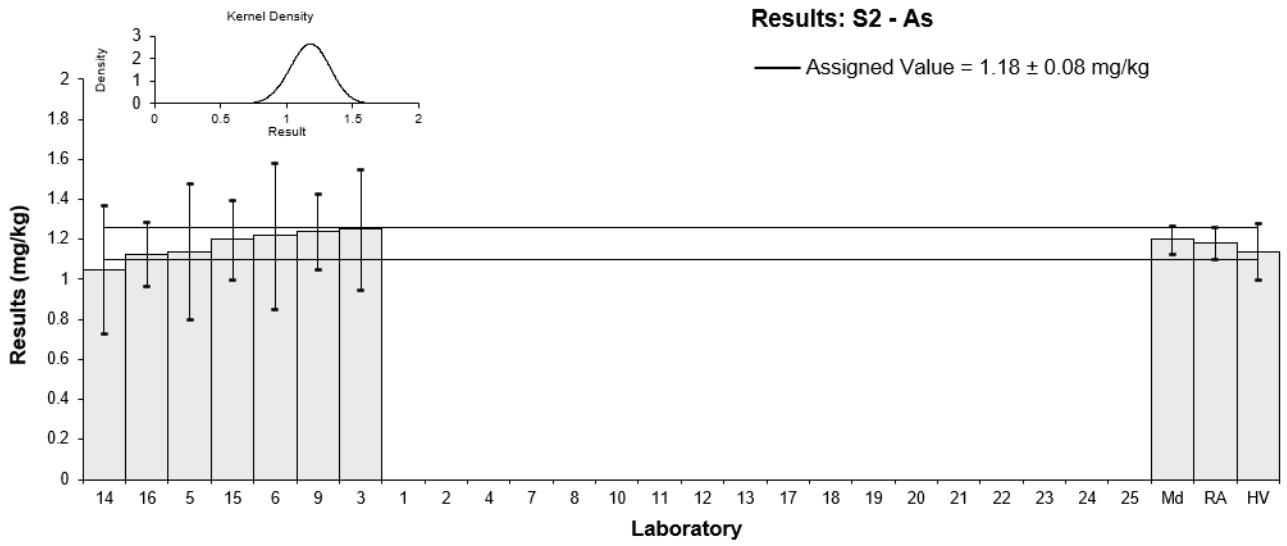
Sample No.	S2
Matrix	Compost
Analyte	As
Unit	mg/kg

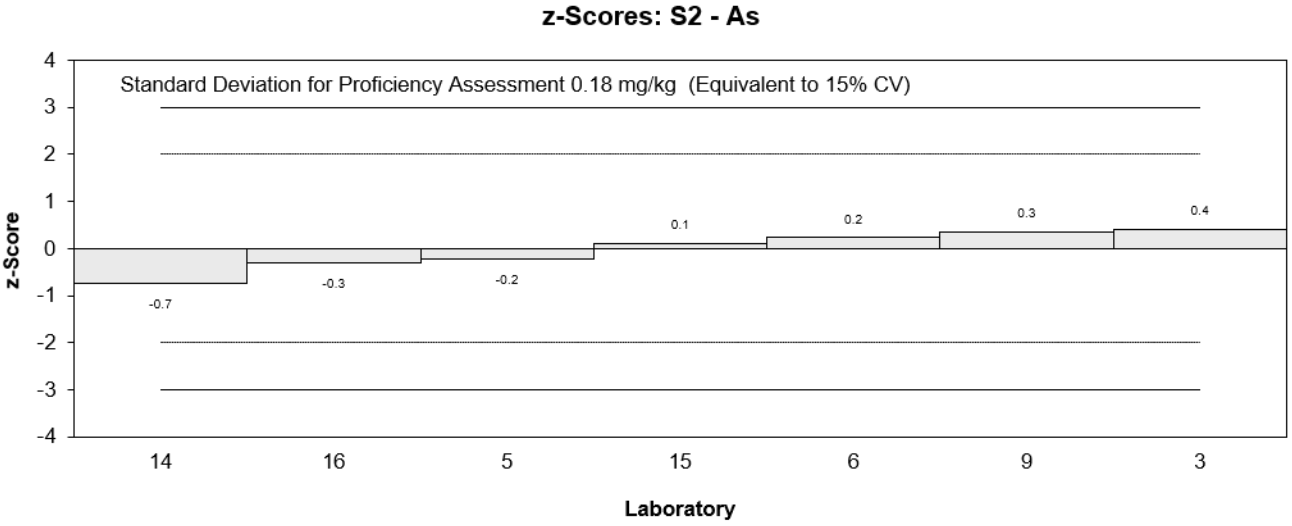
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	1.25	0.3	0.40	0.23
4	NT	NT		
5	1.14	0.342	-0.23	-0.11
6	1.22	0.366	0.23	0.11
7	< 2	NR		
8	NT	NT		
9	1.24	0.19	0.34	0.29
10	<2	NR		
11	< 2	NR		
12	<1	<1		
13	NT	NT		
14	1.05	0.32	-0.73	-0.39
15	1.2	0.2	0.11	0.09
16	1.127	0.161	-0.30	-0.29
17	<5	NR		
18	<2	NR		
19	NT	NT		
20	NT	NT		
21	<5	NR		
22	< 2	NR		
23	NT	NT		
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	1.18	0.08
Spiked Value	Not Spiked	
Homogeneity Value	1.14	0.14
Robust Average	1.18	0.08
Median	1.20	0.07
Mean	1.18	
N	7	
Max	1.25	
Min	1.05	
Robust SD	0.081	
Robust CV	6.9%	


Kernel Density
Density
Result
Results: S2 - As
Assigned Value = 1.18 ± 0.08 mg/kg
Results (mg/kg)
Laboratory
14 16 5 15 6 9 3 1 2 4 7 8 10 11 12 13 17 18 19 20 21 22 23 24 25 Md RA HV


z-Scores: S2 - As
Standard Deviation for Proficiency Assessment 0.18 mg/kg (Equivalent to 15% CV)
z-Score
-0.7
-0.3
-0.2
0.1
0.2
0.3
0.4
14 16 5 15 6 9 3
Laboratory

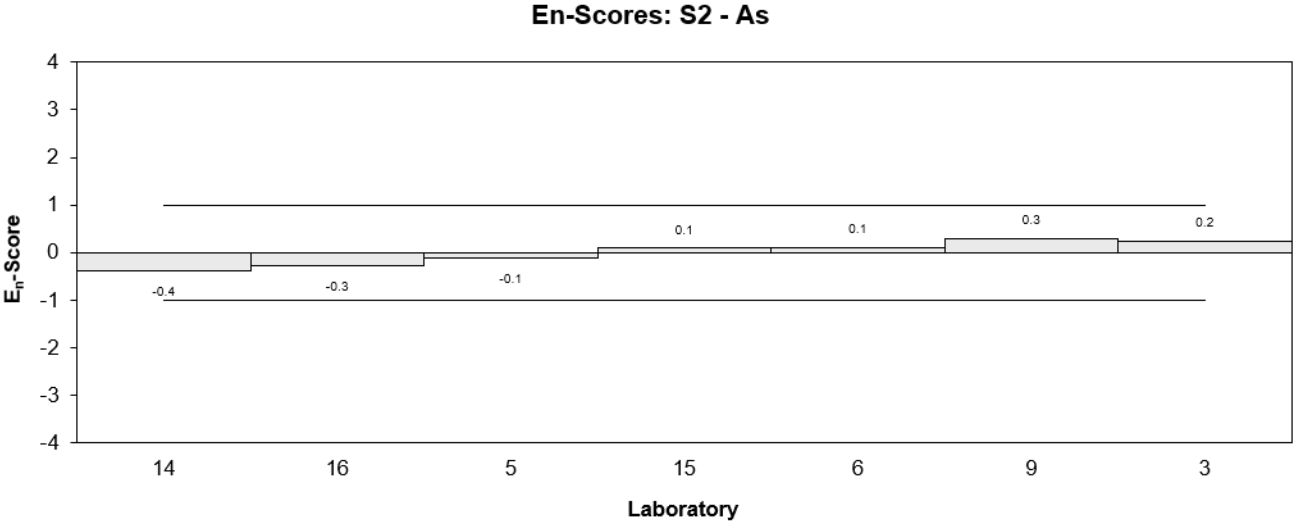

En-Scores: S2 - As
En-Score
-0.4
-0.3
-0.1
0.1
0.1
0.3
0.2
14 16 5 15 6 9 3
Laboratory

Figure 23

Table 35

Sample Details

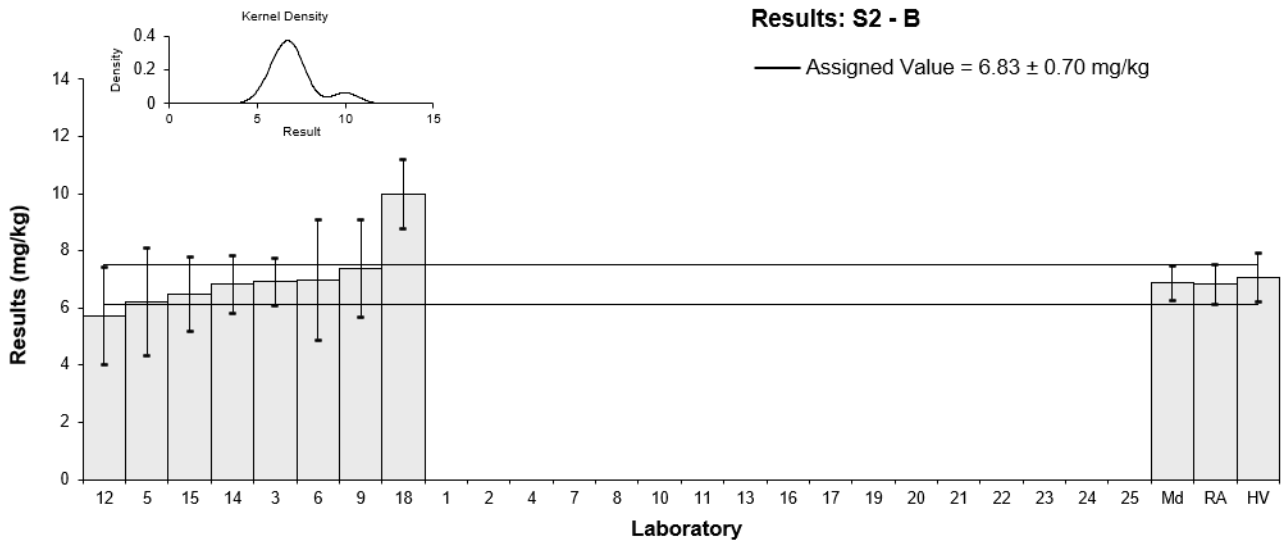
Sample No.	S2
Matrix	Compost
Analyte	B
Unit	mg/kg

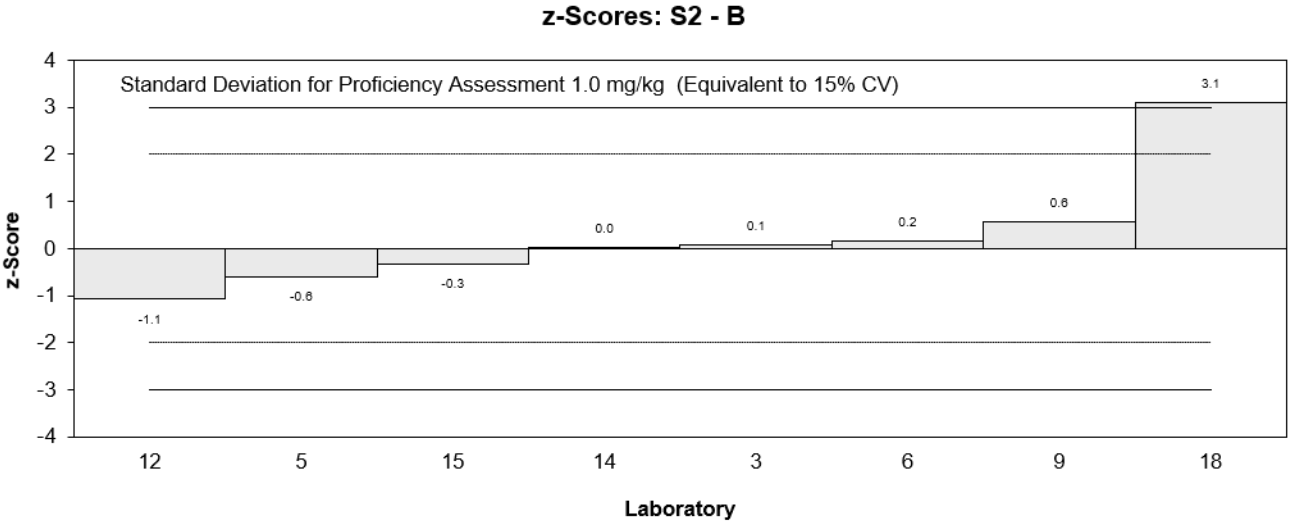
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	6.92	0.83	0.09	0.08
4	NT	NT		
5	6.23	1.869	-0.59	-0.30
6	6.99	2.097	0.16	0.07
7	< 20	NR		
8	NT	NT		
9	7.4	1.7	0.56	0.31
10	<10	NR		
11	< 10	NR		
12	5.74	1.722	-1.06	-0.59
13	NT	NT		
14	6.85	1.00	0.02	0.02
15	6.5	1.3	-0.32	-0.22
16	<50	NR		
17	<50	NR		
18	10	1.2	3.09	2.28
19	NT	NT		
20	NT	NT		
21	<50	NR		
22	< 20	NR		
23	NT	NT		
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	6.83	0.70
Spiked Value	Not Spiked	
Homogeneity Value	7.07	0.85
Robust Average	6.83	0.70
Median	6.89	0.59
Mean	7.08	
N	8	
Max	10	
Min	5.74	
Robust SD	0.8	
Robust CV	12%	


Kernel Density
Density
Result
Results: S2 - B
Assigned Value = 6.83 ± 0.70 mg/kg
Results (mg/kg)
Laboratory
12 5 15 14 3 6 9 18 1 2 4 7 8 10 11 13 16 17 19 20 21 22 23 24 25 Md RA HV


z-Scores: S2 - B
Standard Deviation for Proficiency Assessment 1.0 mg/kg (Equivalent to 15% CV)
z-Score
-1.1
-0.6
-0.3
0.0
0.1
0.2
0.6
3.1
Laboratory
12 5 15 14 3 6 9 18

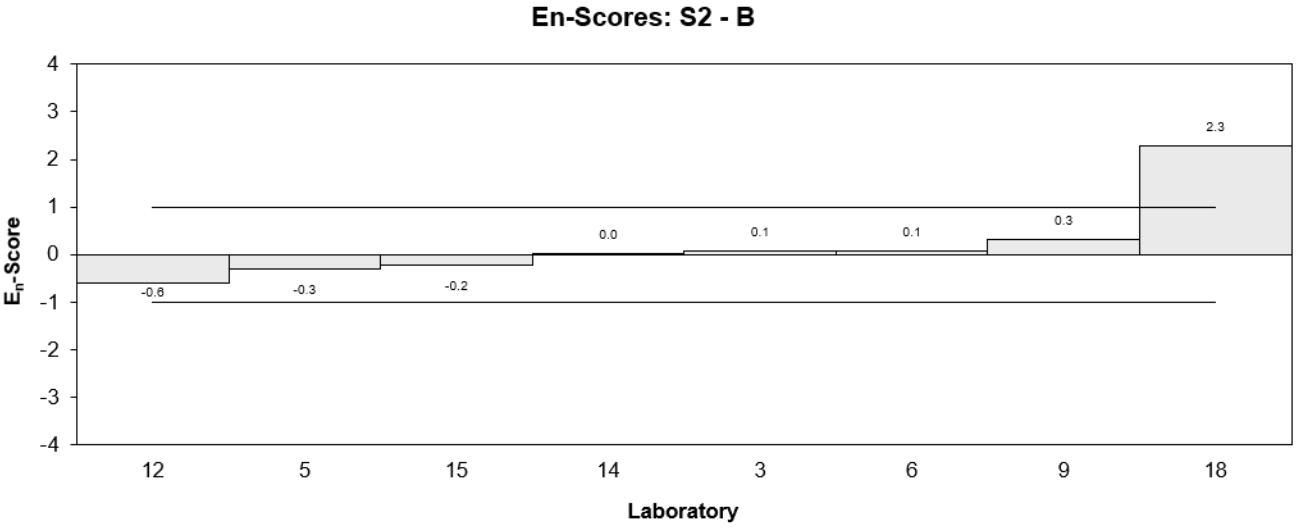

En-Scores: S2 - B
En-Score
-0.6
-0.3
-0.2
0.0
0.1
0.1
0.3
2.3
Laboratory
12 5 15 14 3 6 9 18

Figure 24

Table 36

Sample Details

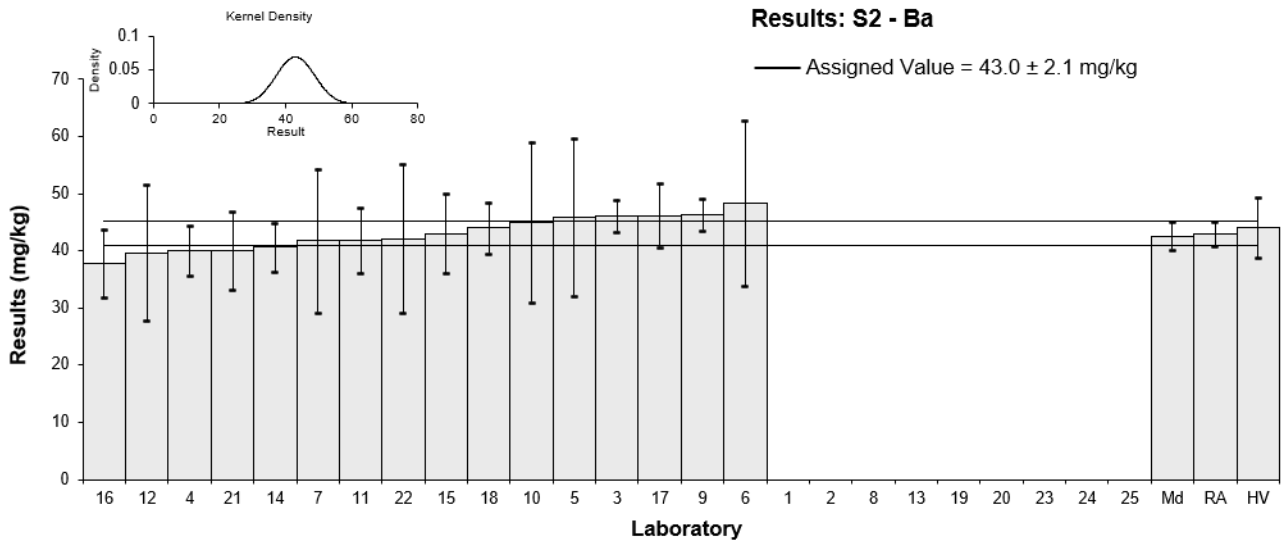
Sample No.	S2
Matrix	Compost
Analyte	Ba
Unit	mg/kg

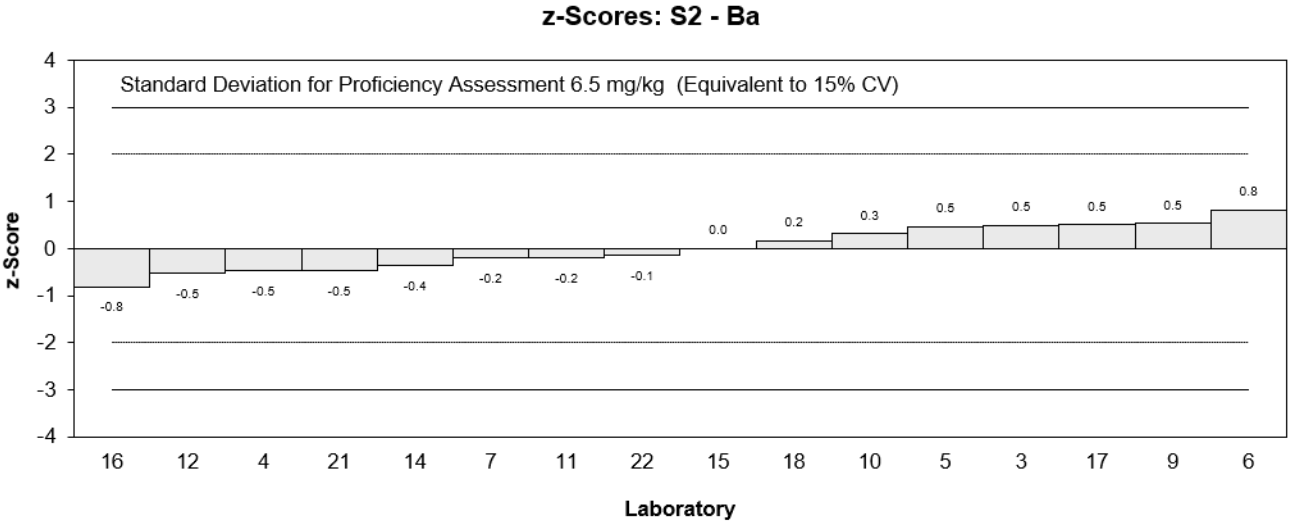
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	46.1	2.8	0.48	0.89
4	40	4.3	-0.47	-0.63
5	45.9	13.77	0.45	0.21
6	48.3	14.49	0.82	0.36
7	41.8	12.54	-0.19	-0.09
8	NT	NT		
9	46.4	2.8	0.53	0.97
10	45	14	0.31	0.14
11	41.8	5.7	-0.19	-0.20
12	39.63	11.889	-0.52	-0.28
13	NT	NT		
14	40.6	4.3	-0.37	-0.50
15	43	7	0.00	0.00
16	37.8	5.97	-0.81	-0.82
17	46.2	5.6	0.50	0.54
18	44	4.5	0.16	0.20
19	NT	NT		
20	NT	NT		
21	40	6.86	-0.47	-0.42
22	42.1	13	-0.14	-0.07
23	NT	NT		
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	43.0	2.1
Spiked Value	Not Spiked	
Homogeneity Value	44.0	5.3
Robust Average	43.0	2.1
Median	42.6	2.4
Mean	43.0	
N	16	
Max	48.3	
Min	37.8	
Robust SD	3.4	
Robust CV	7.9%	


Kernel Density
Density
Result
Results: S2 - Ba
Assigned Value = 43.0 ± 2.1 mg/kg
Results (mg/kg)
16 12 4 21 14 7 11 22 15 18 10 5 3 17 9 6 1 2 8 13 19 20 23 24 25 Md RA HV
Laboratory


z-Scores: S2 - Ba
Standard Deviation for Proficiency Assessment 6.5 mg/kg (Equivalent to 15% CV)
z-Score
-0.8 -0.5 -0.5 -0.5 -0.4 -0.2 -0.2 -0.1 0.0 0.2 0.3 0.5 0.5 0.5 0.5 0.8
16 12 4 21 14 7 11 22 15 18 10 5 3 17 9 6
Laboratory

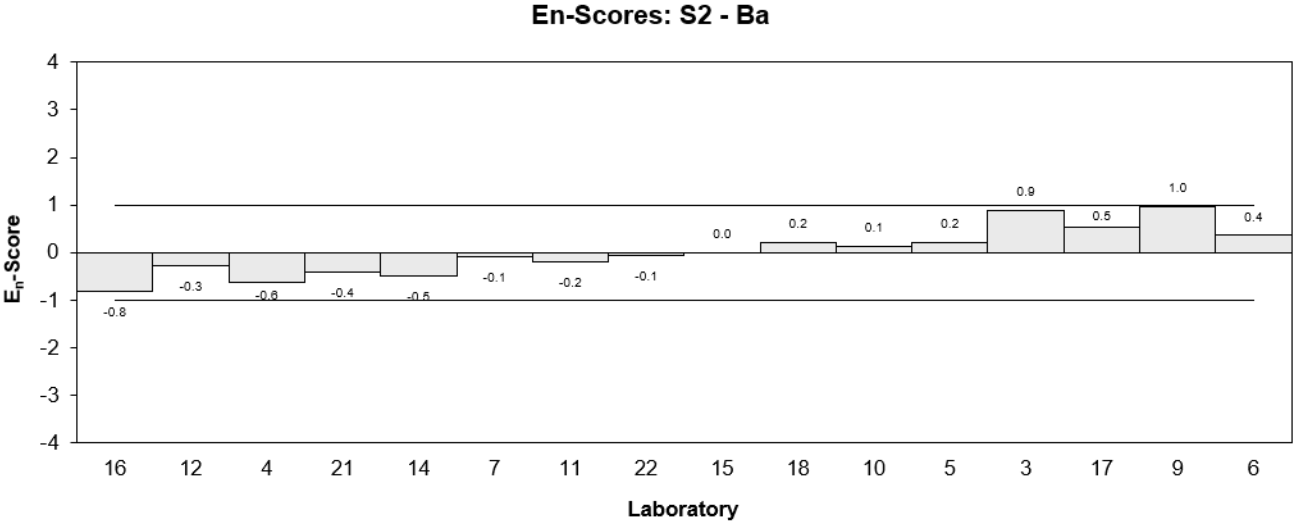

En-Scores: S2 - Ba
En-Score
-0.8 -0.3 -0.6 -0.4 -0.5 -0.1 -0.2 -0.1 0.0 0.2 0.1 0.2 0.9 0.5 1.0 0.4
16 12 4 21 14 7 11 22 15 18 10 5 3 17 9 6
Laboratory

Figure 25

Table 37

Sample Details

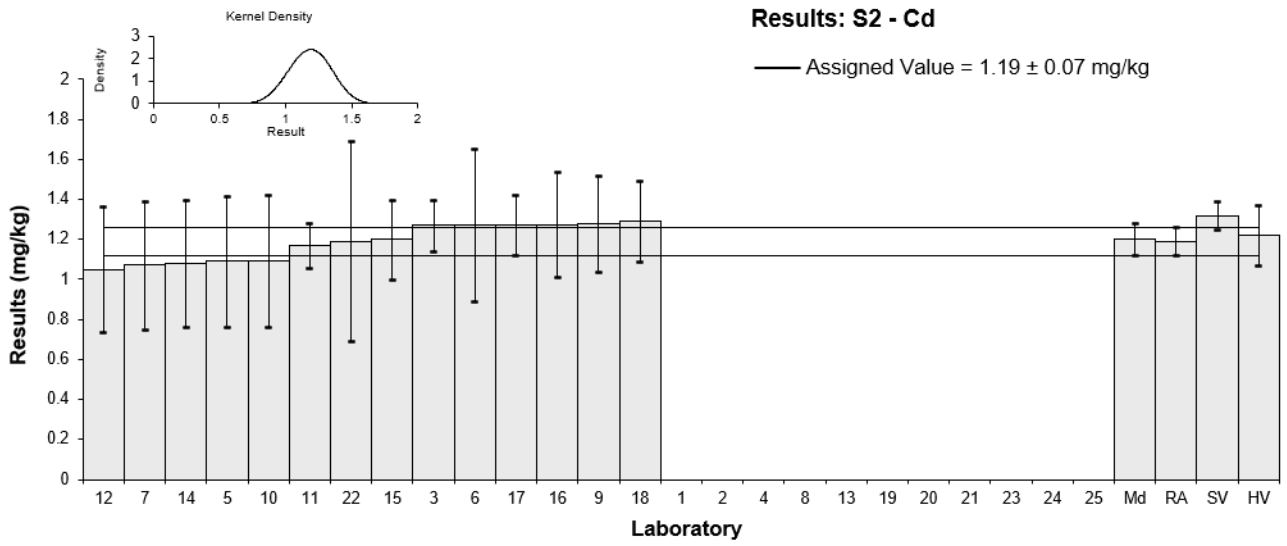
Sample No.	S2
Matrix	Compost
Analyte	Cd
Unit	mg/kg

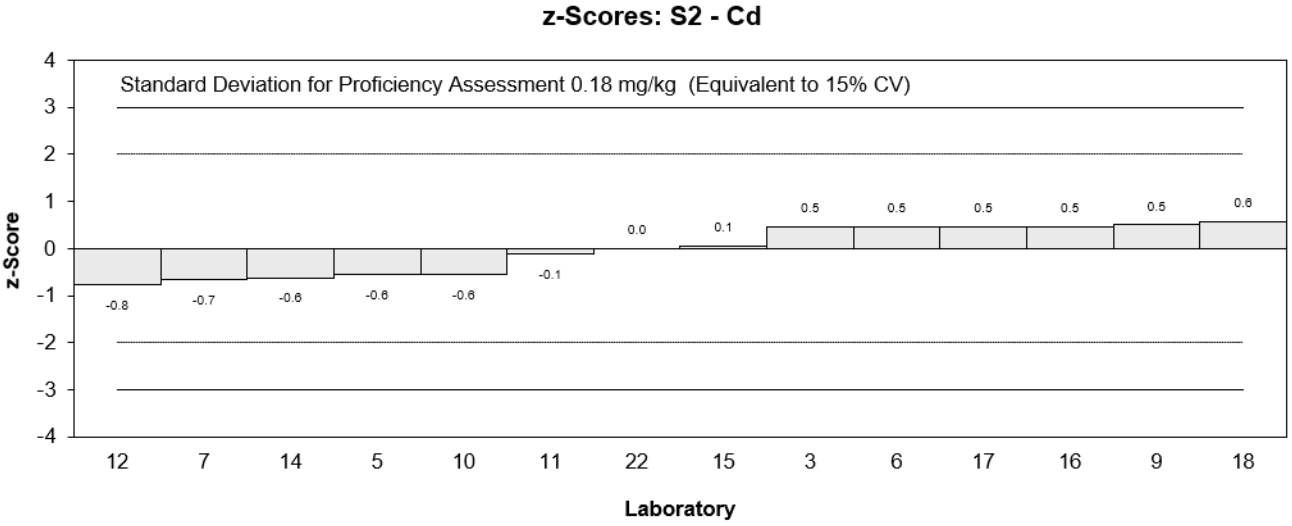
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	1.27	0.13	0.45	0.54
4	NT	NT		
5	1.09	0.327	-0.56	-0.30
6	1.27	0.381	0.45	0.21
7	1.071	0.321	-0.67	-0.36
8	NT	NT		
9	1.28	0.24	0.50	0.36
10	1.09	0.33	-0.56	-0.30
11	1.17	0.11	-0.11	-0.15
12	1.05	0.315	-0.78	-0.43
13	NT	NT		
14	1.08	0.32	-0.62	-0.34
15	1.2	0.2	0.06	0.05
16	1.273	0.263	0.46	0.30
17	1.27	0.15	0.45	0.48
18	1.29	0.2	0.56	0.47
19	NT	NT		
20	NT	NT		
21	<1	NR		
22	1.19	0.5	0.00	0.00
23	NT	NT		
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	1.19	0.07
Spiked Value	1.32	0.07
Homogeneity Value	1.22	0.15
Robust Average	1.19	0.07
Median	1.20	0.08
Mean	1.19	
N	14	
Max	1.29	
Min	1.05	
Robust SD	0.1	
Robust CV	8.8%	


Kernel Density
Density
Result
Results: S2 - Cd
Assigned Value = 1.19 ± 0.07 mg/kg
Results (mg/kg)
12 7 14 5 10 11 22 15 3 6 17 16 9 18 1 2 4 8 13 19 20 21 23 24 25 Md RA SV HV
Laboratory


z-Scores: S2 - Cd
Standard Deviation for Proficiency Assessment 0.18 mg/kg (Equivalent to 15% CV)
z-Score
-0.8 -0.7 -0.6 -0.6 -0.6 -0.1 0.0 0.1 0.5 0.5 0.5 0.5 0.5 0.6
12 7 14 5 10 11 22 15 3 6 17 16 9 18
Laboratory

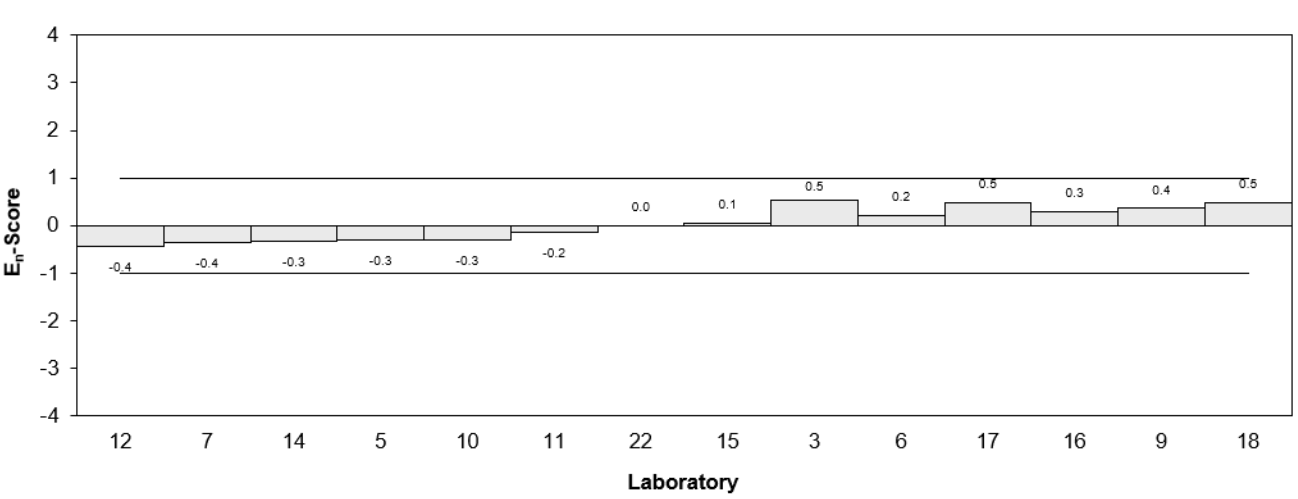

En-Scores: S2 - Cd
En-Score
-0.4 -0.4 -0.3 -0.3 -0.3 -0.2 0.0 0.1 0.5 0.2 0.5 0.3 0.4 0.5
12 7 14 5 10 11 22 15 3 6 17 16 9 18
Laboratory

Figure 26

Table 38

Sample Details

Sample No.	S2
Matrix	Compost
Analyte	Co
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	3.05	0.43
4	NT	NT
5	2.70	0.81
6	2.09	0.627
7	< 5	NR
8	NT	NT
9	1.95	0.38
10	<5	NR
11	< 5	NR
12	1.73	0.519
13	NT	NT
14	1.65	0.53
15	2.8	0.6
16	1.710	0.177
17	<2	NR
18	3.4	0.4
19	NT	NT
20	NT	NT
21	<2	NR
22	< 5	NR
23	NT	NT
24	NT	NT
25	NT	NT

Statistics

Assigned Value	Not Set	
Spiked Value	Not Spiked	
Homogeneity Value	3.00	0.36
Robust Average	2.34	0.62
Median	2.09	0.54
Mean	2.34	
N	9	
Max	3.4	
Min	1.65	
Robust SD	0.74	
Robust CV	32%	

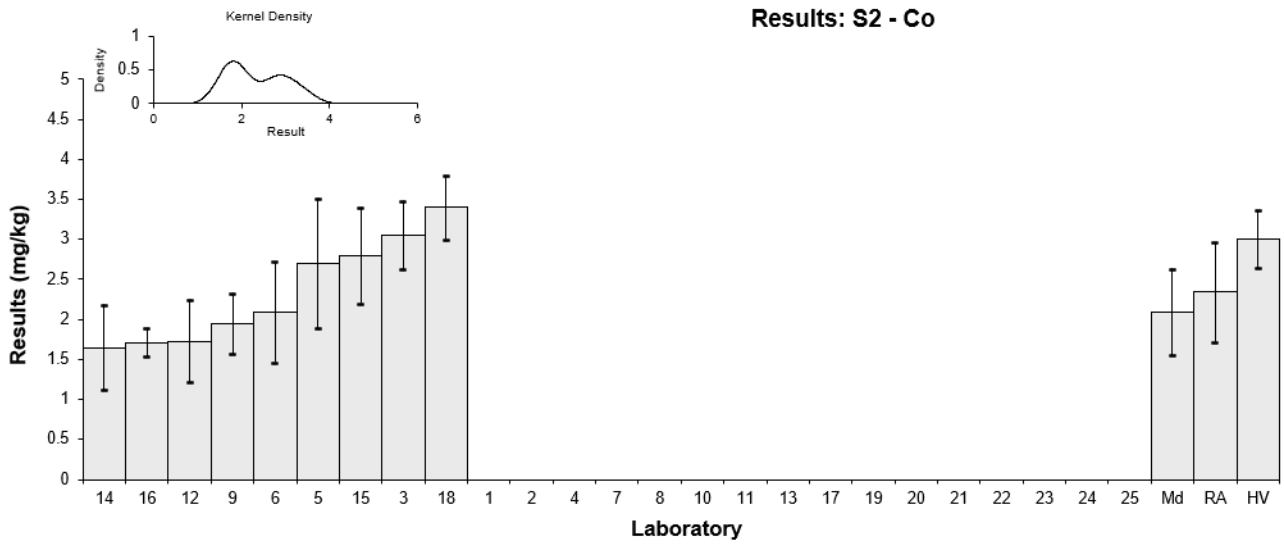

Results: S2 - Co
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
14 16 12 9 6 5 15 3 18 1 2 4 7 8 10 11 13 17 19 20 21 22 23 24 25 Md RA HV

Figure 27

Table 39

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	90.4	9.0
4	NT	NT
5	86.5	25.95
6	14.9	4.47
7	90.7	27.2
8	NT	NT
9	11.8	2.1
10	91	27
11	97.6	12.6
12	15.31	4.593
13	NT	NT
14	9.25	2.45
15	80	16
16	10.994	1.398
17	9.52	1.13
18	97	9.8
19	NT	NT
20	NT	NT
21	11	3.1
22	92.2	30
23	NT	NT
24	NT	NT
25	NT	NT

Statistics

Assigned Value	Not Set	
Spiked Value	Not Spiked	
Homogeneity Value	91	11
Robust Average	54	30
Median	80	17
Mean	54	
N	15	
Max	97.6	
Min	9.25	
Robust SD	46	
Robust CV	86%	

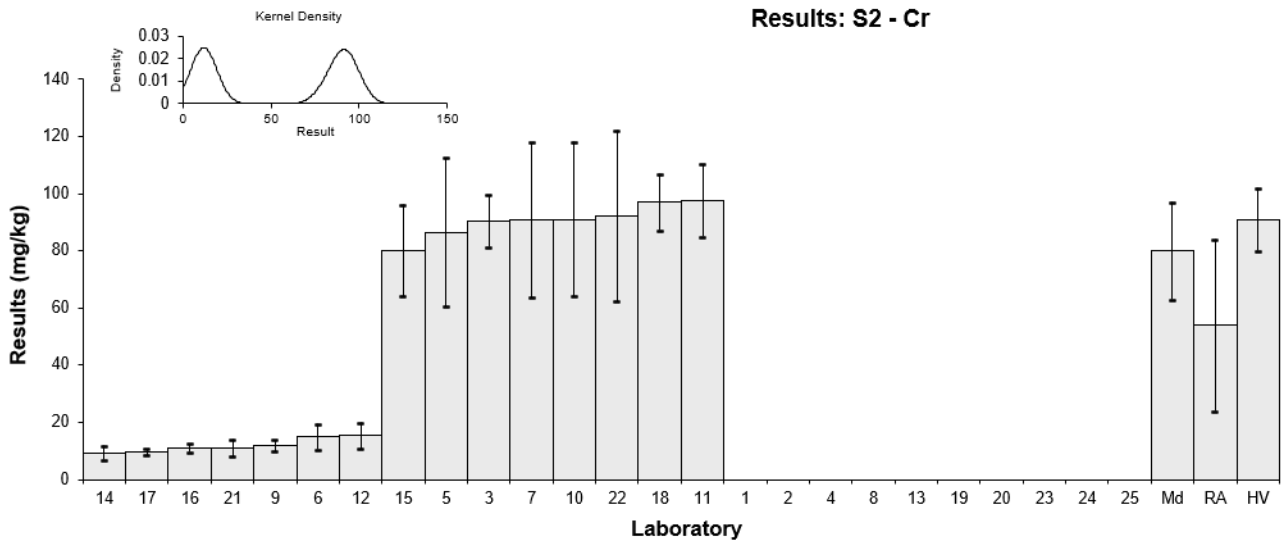

Results: S2 - Cr
Kernel Density
Density
0.03
0.02
0.01
0
0
50
100
150
Result
Results (mg/kg)
140
120
100
80
60
40
20
0
14 17 16 21 9 6 12 15 5 3 7 10 22 18 11 1 2 4 8 13 19 20 23 24 25 Md RA HV
Laboratory

Figure 28

Table 40

Sample Details

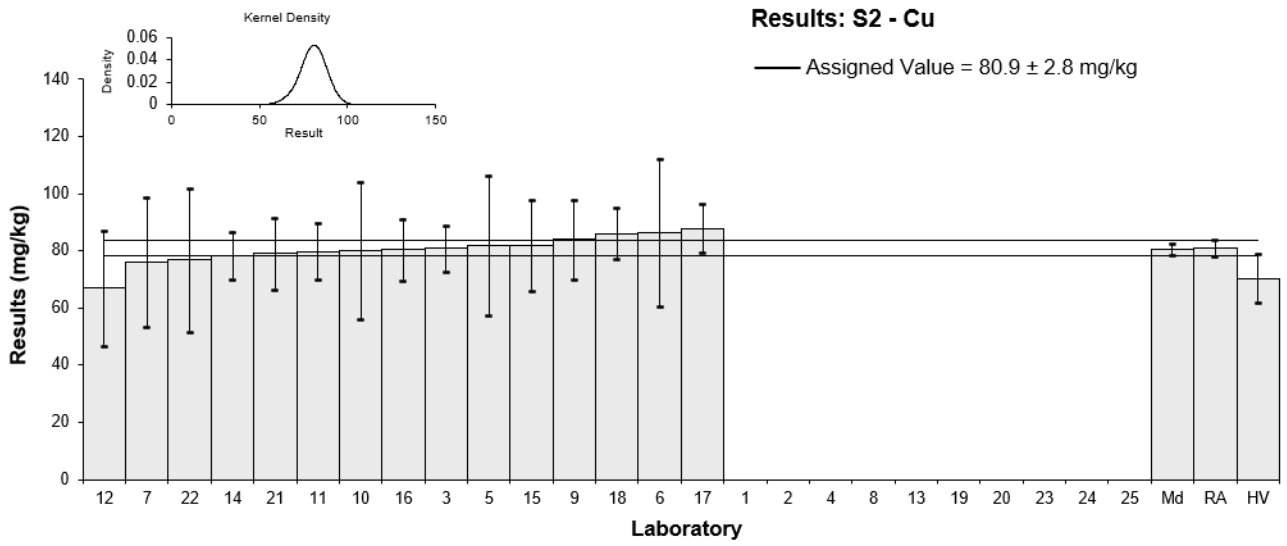
Sample No.	S2
Matrix	Compost
Analyte	Cu
Unit	mg/kg

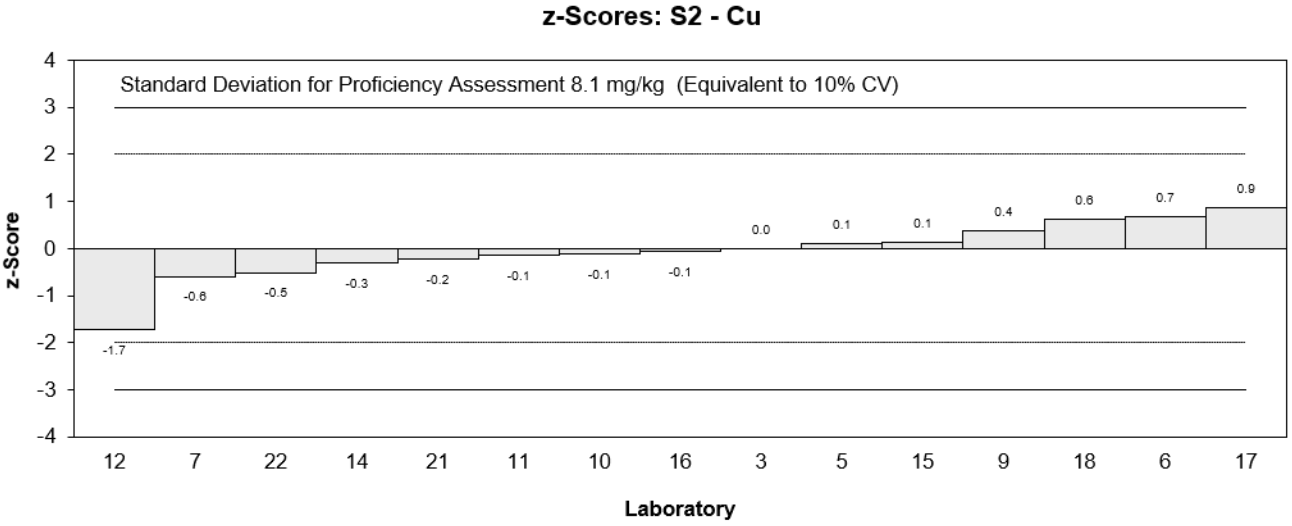
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	80.9	8.1	0.00	0.00
4	NT	NT		
5	81.8	24.54	0.11	0.04
6	86.4	25.92	0.68	0.21
7	76.1	22.8	-0.59	-0.21
8	NT	NT		
9	84	14	0.38	0.22
10	80	24	-0.11	-0.04
11	79.8	9.9	-0.14	-0.11
12	66.92	20.076	-1.73	-0.69
13	NT	NT		
14	78.4	8.2	-0.31	-0.29
15	82	16	0.14	0.07
16	80.459	10.8	-0.05	-0.04
17	87.9	8.4	0.87	0.79
18	86	9.0	0.63	0.54
19	NT	NT		
20	NT	NT		
21	79	12.7	-0.23	-0.15
22	76.8	25	-0.51	-0.16
23	NT	NT		
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	80.9	2.8
Spiked Value	Not Spiked	
Homogeneity Value	70.4	8.4
Robust Average	80.9	2.8
Median	80.5	2.0
Mean	80.4	
N	15	
Max	87.9	
Min	66.92	
Robust SD	4.3	
Robust CV	5.4%	


Kernel Density
Density
Result
Results: S2 - Cu
Assigned Value = 80.9 ± 2.8 mg/kg
Results (mg/kg)
Laboratory
12 7 22 14 21 11 10 16 3 5 15 9 18 6 17 1 2 4 8 13 19 20 23 24 25 Md RA HV


z-Scores: S2 - Cu
Standard Deviation for Proficiency Assessment 8.1 mg/kg (Equivalent to 10% CV)
z-Score
-1.7 -0.6 -0.5 -0.3 -0.2 -0.1 -0.1 -0.1 0.0 0.1 0.1 0.4 0.6 0.7 0.9
Laboratory
12 7 22 14 21 11 10 16 3 5 15 9 18 6 17

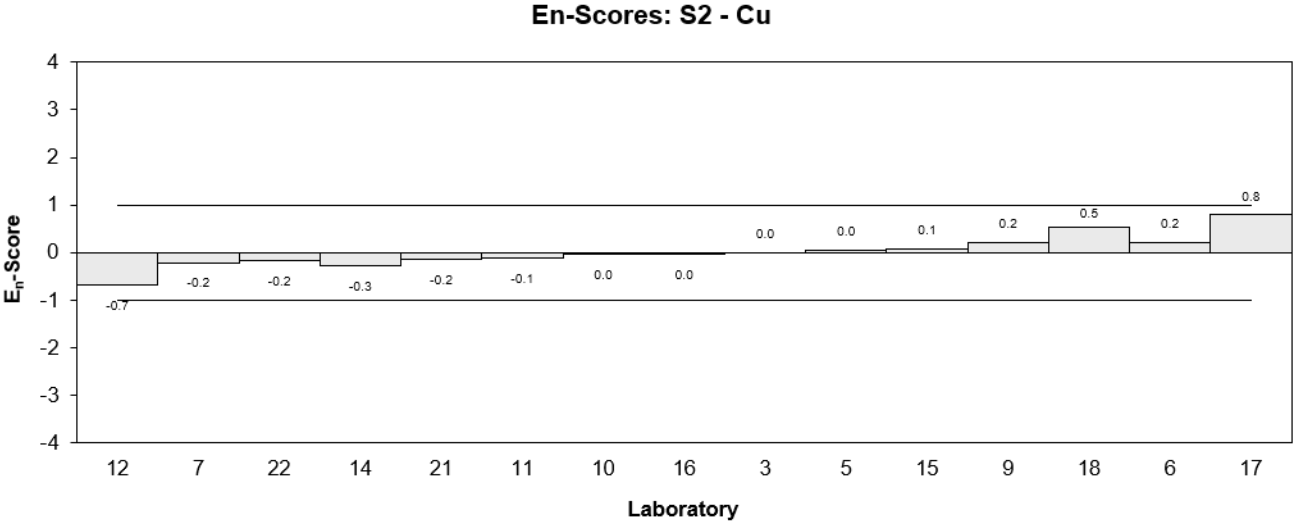

En-Scores: S2 - Cu
En-Score
-0.7 -0.2 -0.2 -0.3 -0.2 -0.1 0.0 0.0 0.0 0.0 0.1 0.2 0.5 0.2 0.8
Laboratory
12 7 22 14 21 11 10 16 3 5 15 9 18 6 17

Figure 29

Table 41

Sample Details

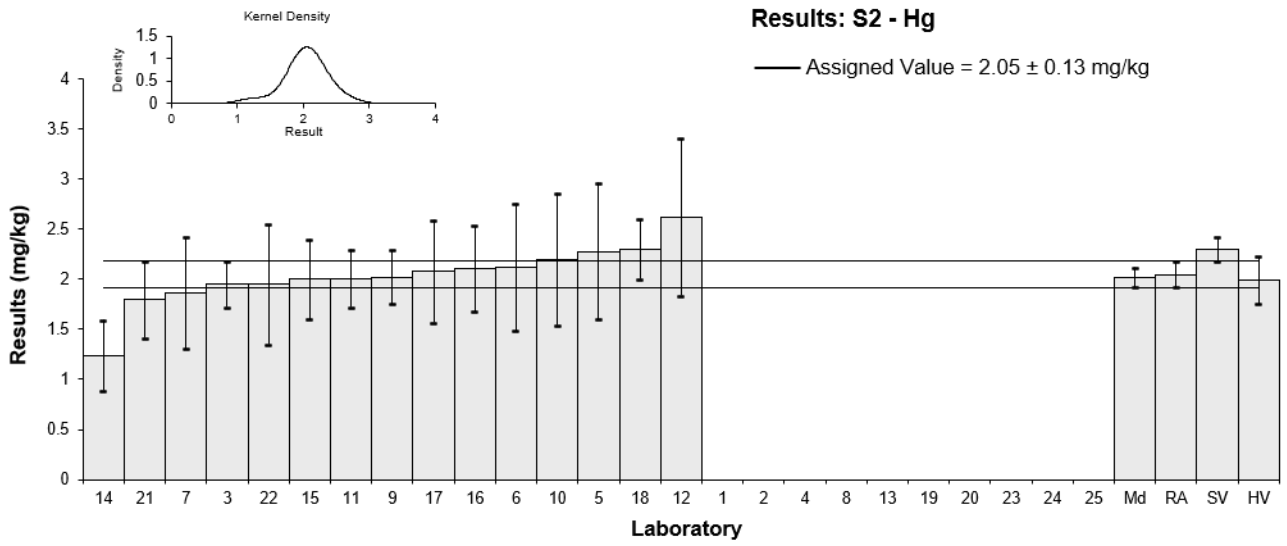
Sample No.	S2
Matrix	Compost
Analyte	Hg
Unit	mg/kg

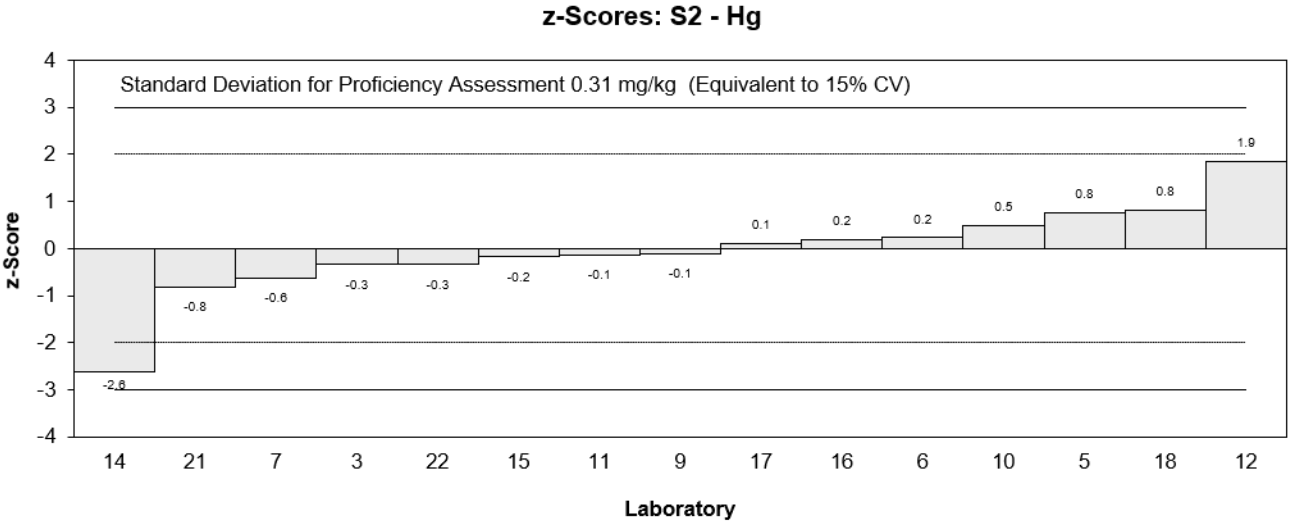
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	1.95	0.23	-0.33	-0.38
4	NT	NT		
5	2.28	0.684	0.75	0.33
6	2.12	0.636	0.23	0.11
7	1.86	0.558	-0.62	-0.33
8	NT	NT		
9	2.02	0.27	-0.10	-0.10
10	2.2	0.66	0.49	0.22
11	2.01	0.29	-0.13	-0.13
12	2.62	0.786	1.85	0.72
13	NT	NT		
14	1.24	0.35	-2.63	-2.17
15	2.0	0.4	-0.16	-0.12
16	2.104	0.43	0.18	0.12
17	2.08	0.51	0.10	0.06
18	2.30	0.3	0.81	0.76
19	NT	NT		
20	NT	NT		
21	1.8	0.385	-0.81	-0.62
22	1.95	0.6	-0.33	-0.16
23	NT	NT		
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	2.05	0.13
Spiked Value	2.30	0.12
Homogeneity Value	1.99	0.24
Robust Average	2.05	0.13
Median	2.02	0.10
Mean	2.04	
N	15	
Max	2.62	
Min	1.24	
Robust SD	0.21	
Robust CV	10%	


Results: S2 - Hg
Kernel Density
Density
Result
Assigned Value = 2.05 ± 0.13 mg/kg
Results (mg/kg)
14 21 7 3 22 15 11 9 17 16 6 10 5 18 12 1 2 4 8 13 19 20 23 24 25 Md RA SV HV
Laboratory


z-Scores: S2 - Hg
Standard Deviation for Proficiency Assessment 0.31 mg/kg (Equivalent to 15% CV)
z-Score
-2.6 -0.8 -0.6 -0.3 -0.3 -0.2 -0.1 -0.1 0.1 0.2 0.2 0.5 0.8 0.8 1.9
14 21 7 3 22 15 11 9 17 16 6 10 5 18 12
Laboratory

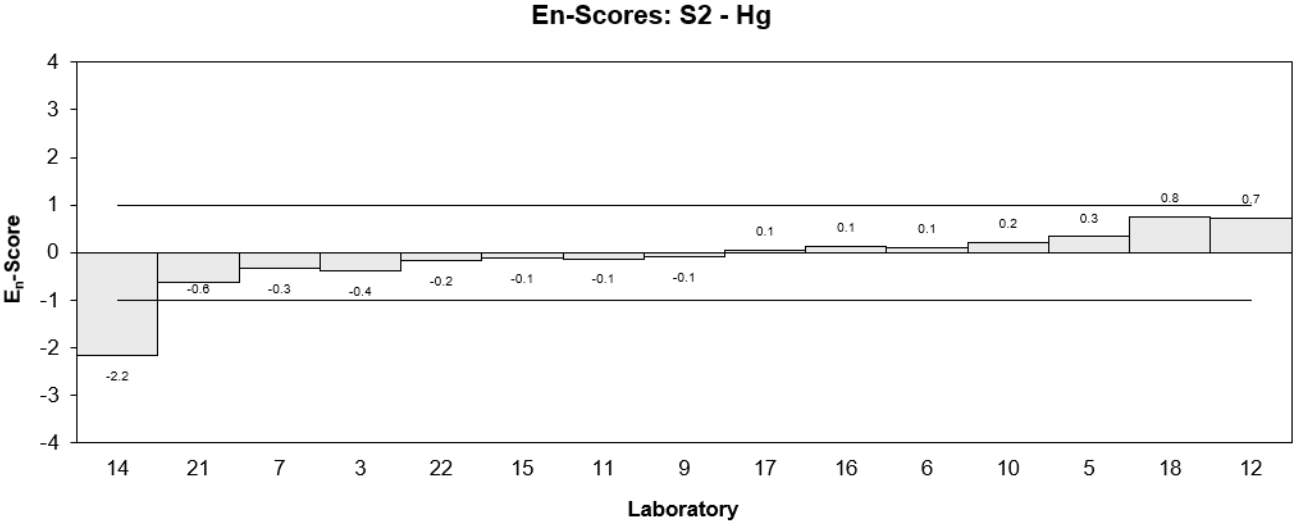

En-Scores: S2 - Hg
En-Score
-2.2 -0.6 -0.3 -0.4 -0.2 -0.1 -0.1 -0.1 0.1 0.1 0.1 0.2 0.3 0.8 0.7
14 21 7 3 22 15 11 9 17 16 6 10 5 18 12
Laboratory

Figure 30

Table 42

Sample Details

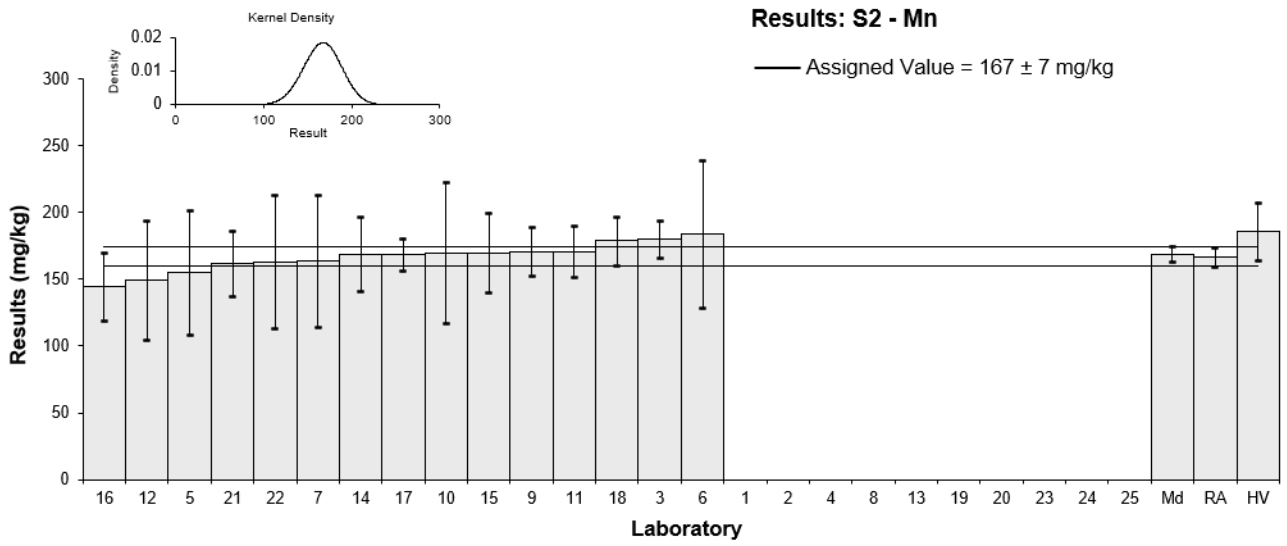
Sample No.	S2
Matrix	Compost
Analyte	Mn
Unit	mg/kg

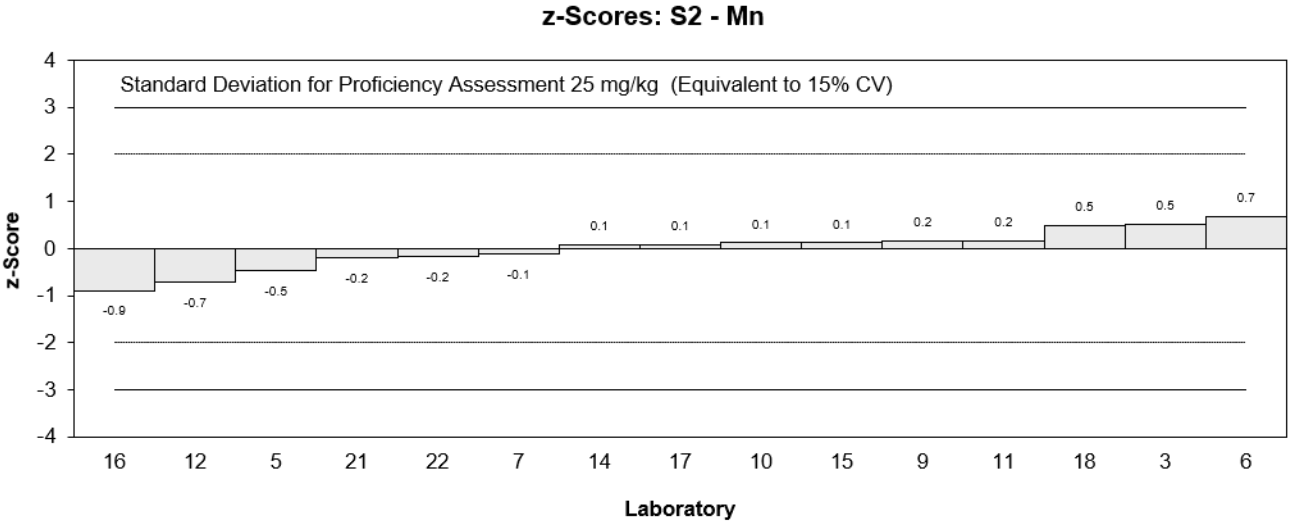
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	180	14	0.52	0.83
4	NT	NT		
5	155	46.5	-0.48	-0.26
6	184	55.2	0.68	0.31
7	164	49.2	-0.12	-0.06
8	NT	NT		
9	171	18	0.16	0.21
10	170	53	0.12	0.06
11	171	19	0.16	0.20
12	149.15	44.745	-0.71	-0.39
13	NT	NT		
14	169	28	0.08	0.07
15	170	30	0.12	0.10
16	144.814	25.2	-0.89	-0.85
17	169	12	0.08	0.14
18	179	18	0.48	0.62
19	NT	NT		
20	NT	NT		
21	162	24.86	-0.20	-0.19
22	163	50	-0.16	-0.08
23	NT	NT		
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	167	7
Spiked Value	Not Spiked	
Homogeneity Value	186	22
Robust Average	167	7
Median	169	6
Mean	167	
N	15	
Max	184	
Min	144.814	
Robust SD	11	
Robust CV	6.9%	


Kernel Density
Density
0.02
0.01
0
0
100
200
300
Result
Results: S2 - Mn
Assigned Value = 167 ± 7 mg/kg
Results (mg/kg)
300
250
200
150
100
50
0
16 12 5 21 22 7 14 17 10 15 9 11 18 3 6 1 2 4 8 13 19 20 23 24 25 Md RA HV
Laboratory


z-Scores: S2 - Mn
Standard Deviation for Proficiency Assessment 25 mg/kg (Equivalent to 15% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-0.9 -0.7 -0.5 -0.2 -0.2 -0.1 0.1 0.1 0.1 0.1 0.2 0.2 0.5 0.5 0.7
16 12 5 21 22 7 14 17 10 15 9 11 18 3 6
Laboratory

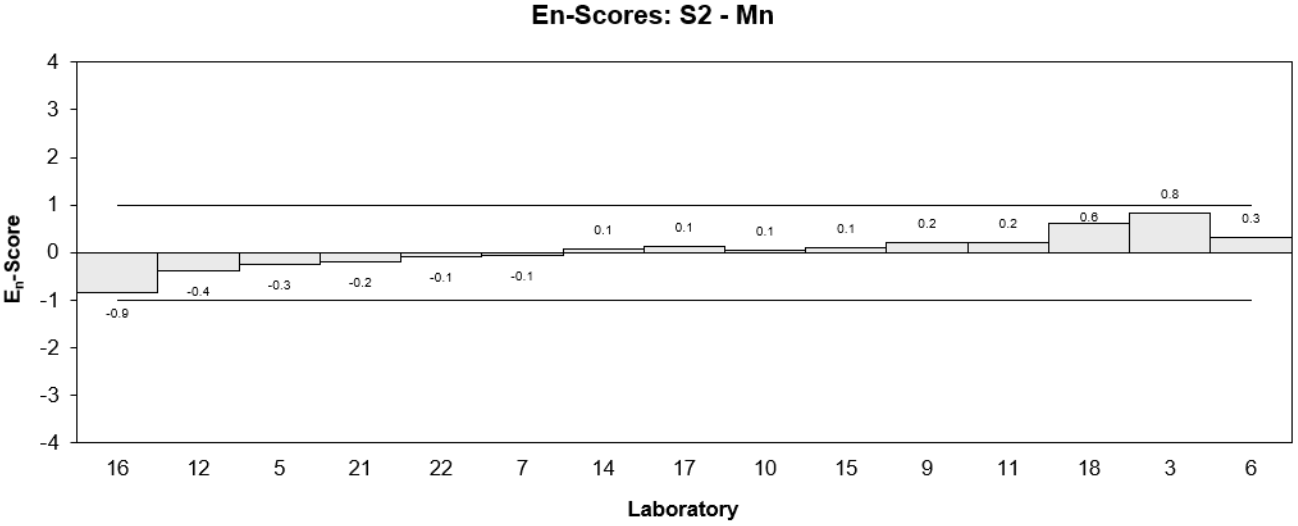

En-Scores: S2 - Mn
En-Score
4
3
2
1
0
-1
-2
-3
-4
-0.9 -0.4 -0.3 -0.2 -0.1 -0.1 0.1 0.1 0.1 0.1 0.2 0.2 0.6 0.8 0.3
16 12 5 21 22 7 14 17 10 15 9 11 18 3 6
Laboratory

Figure 31

Table 43

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	6.49	0.65
4	NT	NT
5	6.71	2.013
6	1.01	0.303
7	6.1	1.83
8	NT	NT
9	0.81	0.30
10	<10	NR
11	6.22	0.96
12	1.35	0.405
13	NT	NT
14	NR	NR
15	5.2	1.0
16	0.718	0.136
17	<2	NR
18	7.1	0.8
19	NT	NT
20	NT	NT
21	<2	NR
22	6.60	3.5
23	NT	NT
24	NT	NT
25	NT	NT

Statistics

Assigned Value	Not Set	
Spiked Value	Not Spiked	
Homogeneity Value	5.66	0.68
Robust Average	4.4	2.4
Median	6.1	1.0
Mean	4.4	
N	11	
Max	7.1	
Min	0.718	
Robust SD	3.1	
Robust CV	71%	

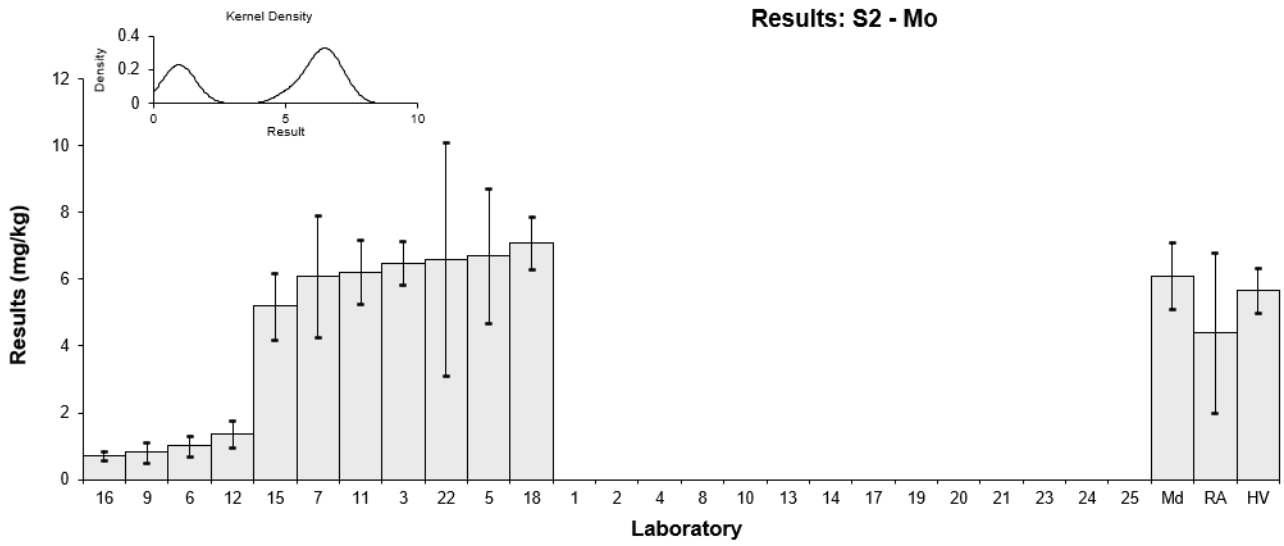

Results: S2 - Mo
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
16 9 6 12 15 7 11 3 22 5 18 1 2 4 8 10 13 14 17 19 20 21 23 24 25 Md RA HV

Figure 32

Table 44

Sample Details

Sample No.	S2
Matrix	Compost
Analyte	Ni
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	51.4	5.1
4	NT	NT
5	48.7	14.61
6	8.71	2.613
7	51.04	15.31
8	NT	NT
9	7.1	1.6
10	51	15.2
11	54.8	6.7
12	9.75	2.925
13	NT	NT
14	5.40	1.39
15	44	9
16	6.174	0.784
17	5.62	0.59
18	58	6.0
19	NT	NT
20	NT	NT
21	6	1.03
22	52.6	16
23	NT	NT
24	NT	NT
25	NT	NT

Statistics

Assigned Value	Not Set	
Spiked Value	Not Spiked	
Homogeneity Value	50.3	6.0
Robust Average	31	17
Median	44	13
Mean	31	
N	15	
Max	58	
Min	5.40	
Robust SD	26	
Robust CV	86%	

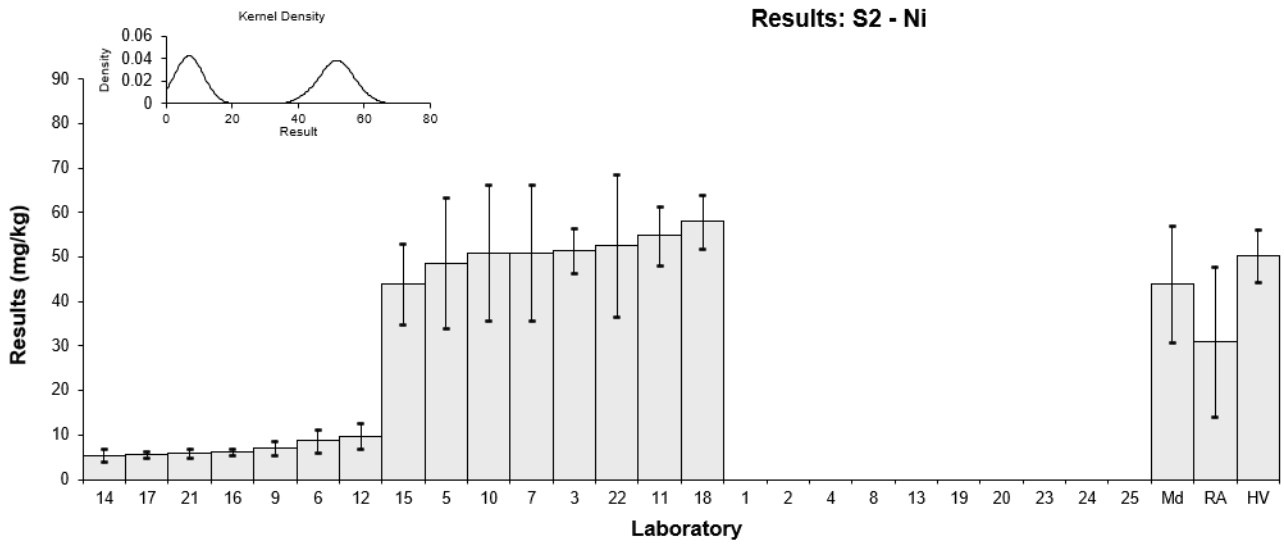

Results: S2 - Ni
Kernel Density
Density
0.06
0.04
0.02
0
0
20
40
60
80
Result
Results (mg/kg)
90
80
70
60
50
40
30
20
10
0
14 17 21 16 9 6 12 15 5 10 7 3 22 11 18 1 2 4 8 13 19 20 23 24 25 Md RA HV
Laboratory

Figure 33

Table 45

Sample Details

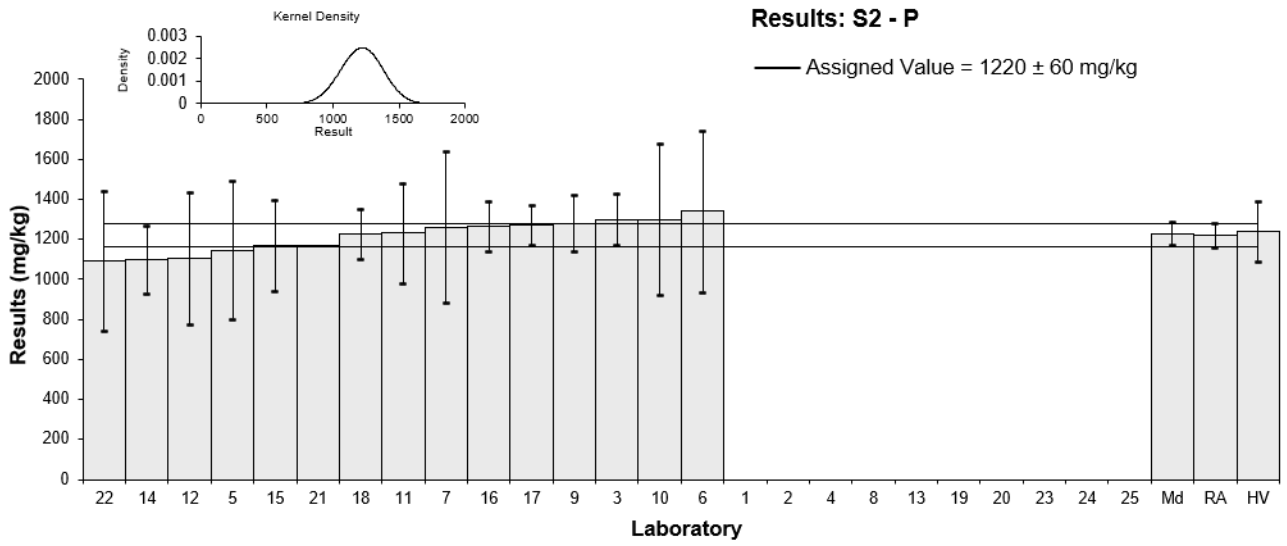
Sample No.	S2
Matrix	Compost
Analyte	P
Unit	mg/kg

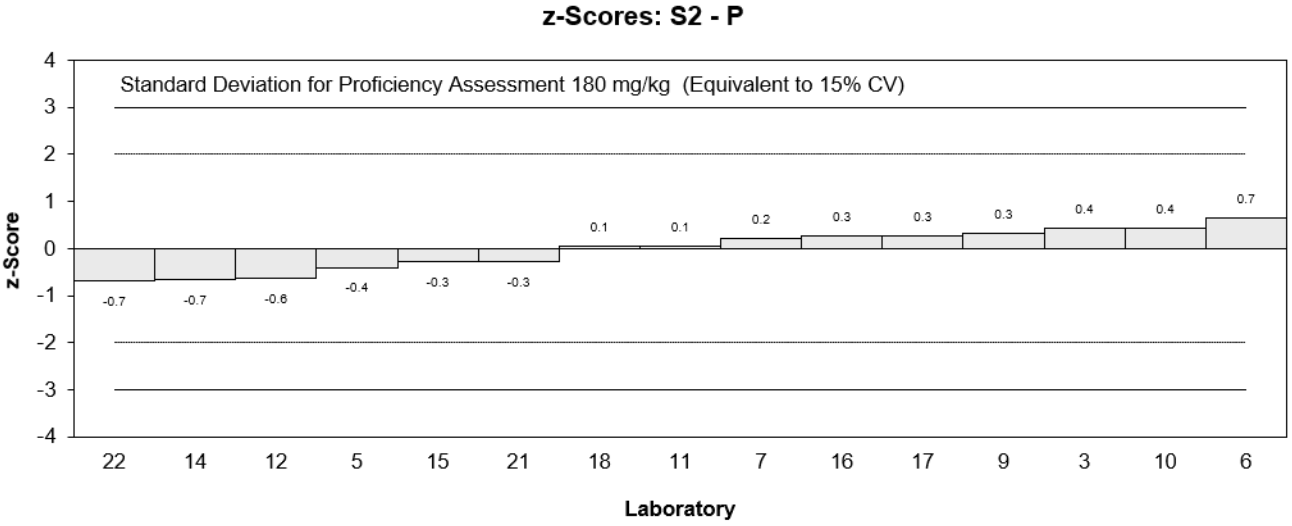
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	1300	130	0.44	0.56
4	NT	NT		
5	1147	344.1	-0.40	-0.21
6	1340	402	0.66	0.30
7	1260	378	0.22	0.10
8	NT	NT		
9	1280	140	0.33	0.39
10	1300	380	0.44	0.21
11	1231	251	0.06	0.04
12	1105	331	-0.63	-0.34
13	NT	NT		
14	1100	170	-0.66	-0.67
15	1170	230	-0.27	-0.21
16	1267.225	125.3	0.26	0.34
17	1270	100	0.27	0.43
18	1230	125	0.05	0.07
19	NT	NT		
20	NT	NT		
21	1170	NR	-0.27	-0.83
22	1094	350	-0.69	-0.35
23	NT	NT		
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	1220	60
Spiked Value	Not Spiked	
Homogeneity Value	1240	150
Robust Average	1220	60
Median	1230	60
Mean	1220	
N	15	
Max	1340	
Min	1094	
Robust SD	91	
Robust CV	7.5%	


Kernel Density
Density
Result
Results: S2 - P
Assigned Value = 1220 ± 60 mg/kg
Results (mg/kg)
Laboratory
22 14 12 5 15 21 18 11 7 16 17 9 3 10 6 1 2 4 8 13 19 20 23 24 25 Md RA HV


z-Scores: S2 - P
Standard Deviation for Proficiency Assessment 180 mg/kg (Equivalent to 15% CV)
z-Score
-0.7 -0.7 -0.6 -0.4 -0.3 -0.3 0.1 0.1 0.2 0.3 0.3 0.3 0.4 0.4 0.7
Laboratory
22 14 12 5 15 21 18 11 7 16 17 9 3 10 6

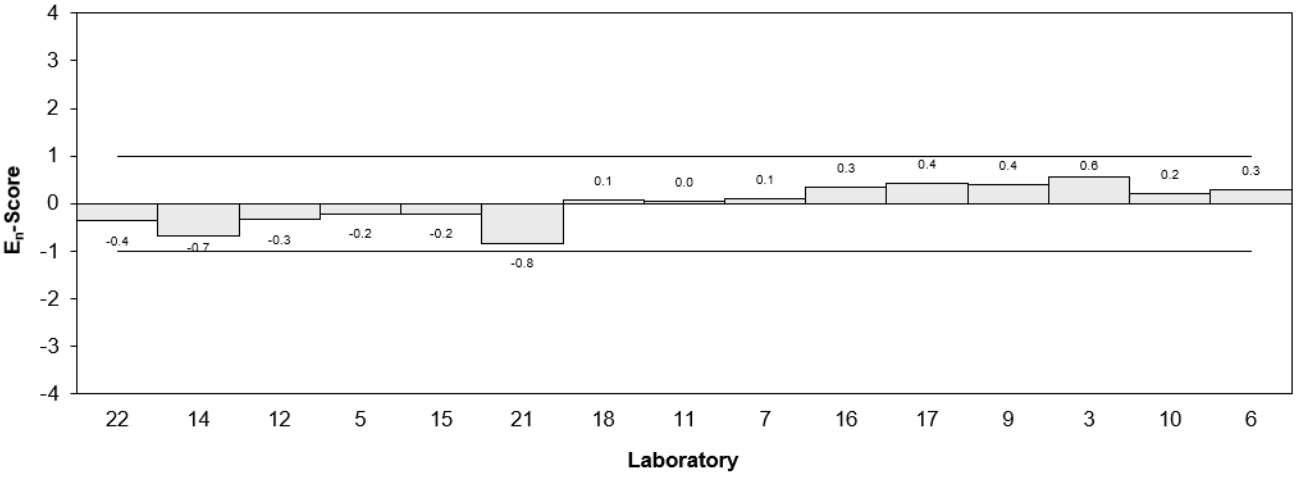

En-Scores: S2 - P
En-Score
-0.4 -0.7 -0.3 -0.2 -0.2 -0.8 0.1 0.0 0.1 0.3 0.4 0.4 0.6 0.2 0.3
Laboratory
22 14 12 5 15 21 18 11 7 16 17 9 3 10 6

Figure 34

Table 46

Sample Details

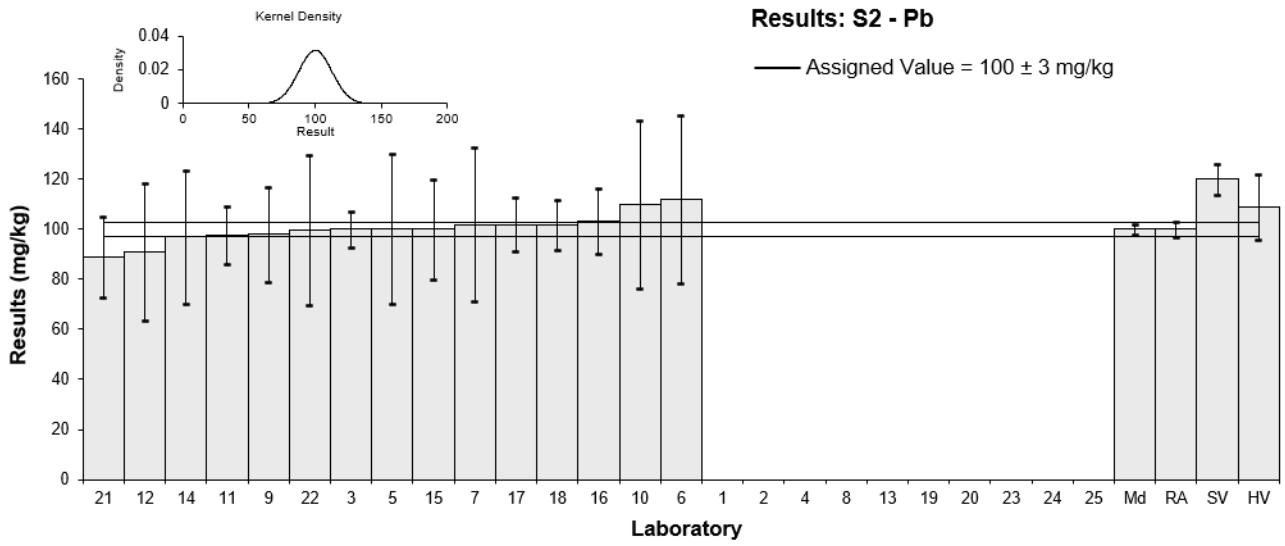
Sample No.	S2
Matrix	Compost
Analyte	Pb
Unit	mg/kg

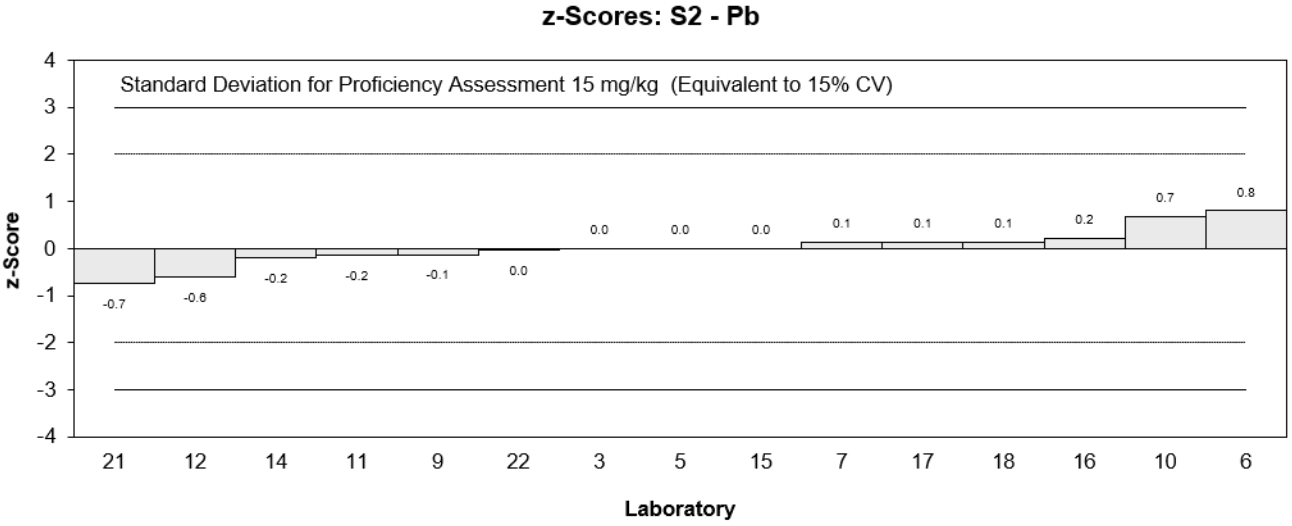
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	100	7	0.00	0.00
4	NT	NT		
5	100	30	0.00	0.00
6	112	33.6	0.80	0.36
7	102	30.6	0.13	0.07
8	NT	NT		
9	98	19	-0.13	-0.10
10	110	33.5	0.67	0.30
11	97.7	11.7	-0.15	-0.19
12	91	27.3	-0.60	-0.33
13	NT	NT		
14	97.1	26.7	-0.19	-0.11
15	100	20	0.00	0.00
16	103.321	13.18	0.22	0.25
17	102	11	0.13	0.18
18	102	10	0.13	0.19
19	NT	NT		
20	NT	NT		
21	89	16.19	-0.73	-0.67
22	99.6	30	-0.03	-0.01
23	NT	NT		
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	100	3
Spiked Value	120	6
Homogeneity Value	109	13
Robust Average	100	3
Median	100	2
Mean	100	
N	15	
Max	112	
Min	89	
Robust SD	4.6	
Robust CV	4.6%	


Results: S2 - Pb
Assigned Value = 100 ± 3 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
21 12 14 11 9 22 3 5 15 7 17 18 16 10 6 1 2 4 8 13 19 20 23 24 25 Md RA SV HV


z-Scores: S2 - Pb
Standard Deviation for Proficiency Assessment 15 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
21 12 14 11 9 22 3 5 15 7 17 18 16 10 6
-0.7 -0.6 -0.2 -0.2 -0.1 0.0 0.0 0.0 0.0 0.1 0.1 0.1 0.2 0.7 0.8

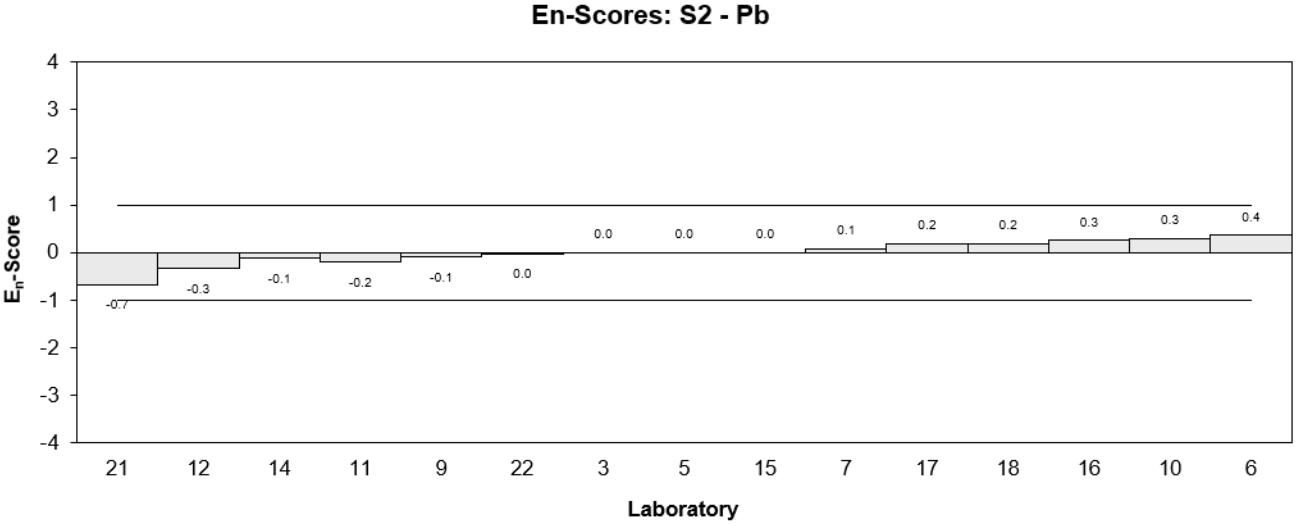

En-Scores: S2 - Pb
En-Score
Laboratory
21 12 14 11 9 22 3 5 15 7 17 18 16 10 6
-0.7 -0.3 -0.1 -0.2 -0.1 0.0 0.0 0.0 0.0 0.1 0.2 0.2 0.3 0.3 0.4

Figure 35

Table 47

Sample Details

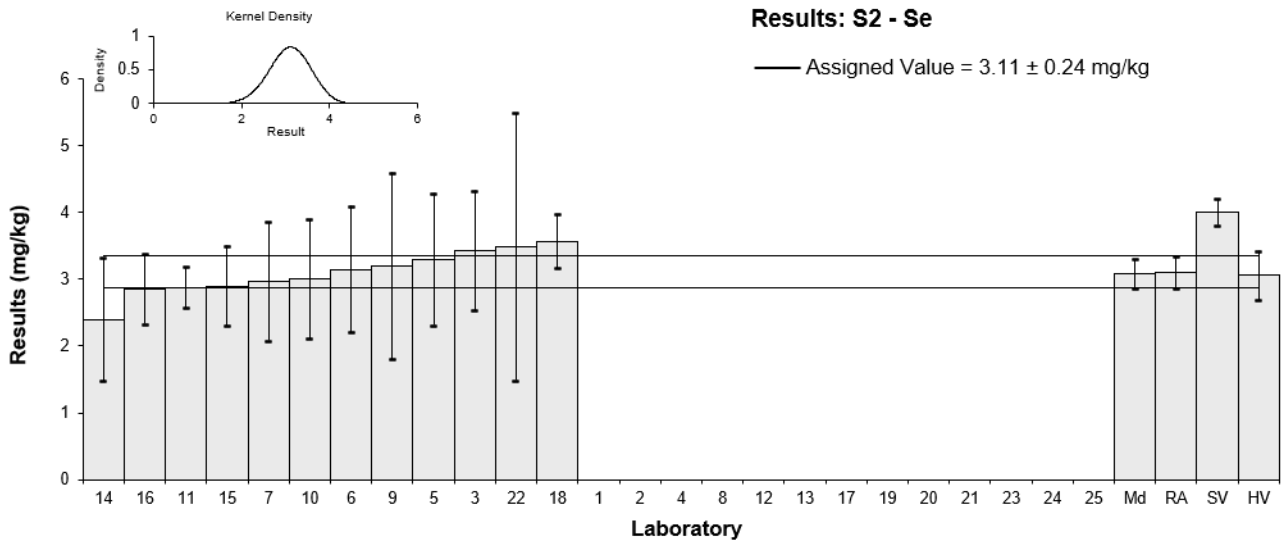
Sample No.	S2
Matrix	Compost
Analyte	Se
Unit	mg/kg

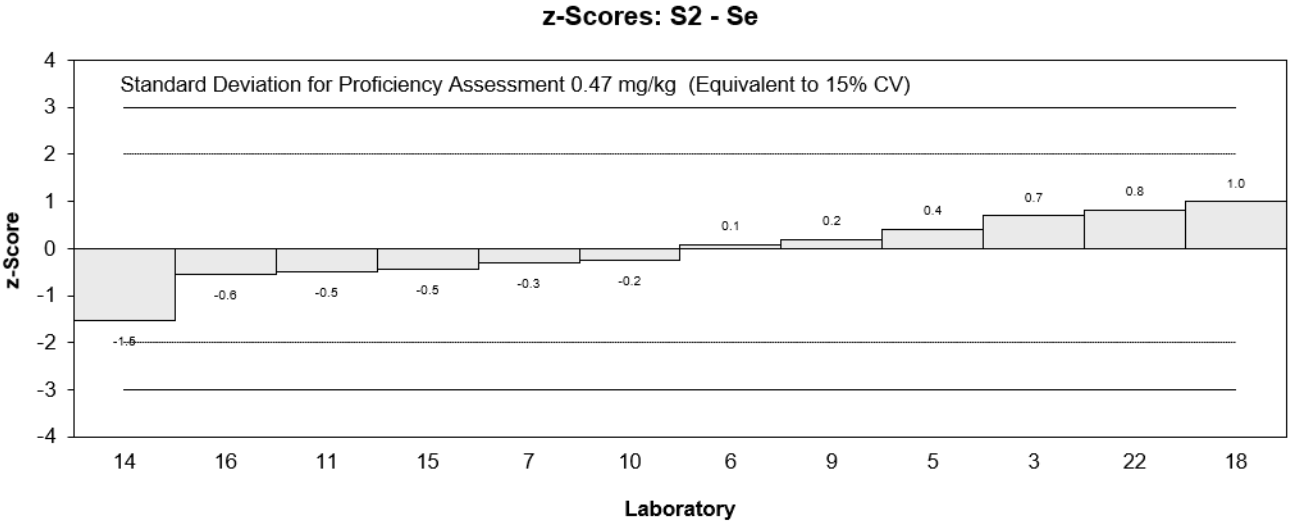
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	3.43	0.9	0.69	0.34
4	NT	NT		
5	3.30	0.99	0.41	0.19
6	3.15	0.945	0.09	0.04
7	2.97	0.891	-0.30	-0.15
8	NT	NT		
9	3.2	1.4	0.19	0.06
10	3.0	0.894	-0.24	-0.12
11	2.88	0.31	-0.49	-0.59
12	<2	<2		
13	NT	NT		
14	2.40	0.92	-1.52	-0.75
15	2.9	0.6	-0.45	-0.32
16	2.852	0.524	-0.55	-0.45
17	<5	NR		
18	3.57	0.4	0.99	0.99
19	NT	NT		
20	NT	NT		
21	<5	NR		
22	3.49	2	0.81	0.19
23	NT	NT		
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	3.11	0.24
Spiked Value	4.01	0.20
Homogeneity Value	3.06	0.37
Robust Average	3.11	0.24
Median	3.08	0.22
Mean	3.10	
N	12	
Max	3.57	
Min	2.40	
Robust SD	0.33	
Robust CV	11%	


Kernel Density
Density
Result
Results: S2 - Se
Assigned Value = 3.11 ± 0.24 mg/kg
Results (mg/kg)
14 16 11 15 7 10 6 9 5 3 22 18 1 2 4 8 12 13 17 19 20 21 23 24 25 Md RA SV HV
Laboratory


z-Scores: S2 - Se
Standard Deviation for Proficiency Assessment 0.47 mg/kg (Equivalent to 15% CV)
z-Score
-1.5 -0.6 -0.5 -0.5 -0.3 -0.2 0.1 0.2 0.4 0.7 0.8 1.0
14 16 11 15 7 10 6 9 5 3 22 18
Laboratory

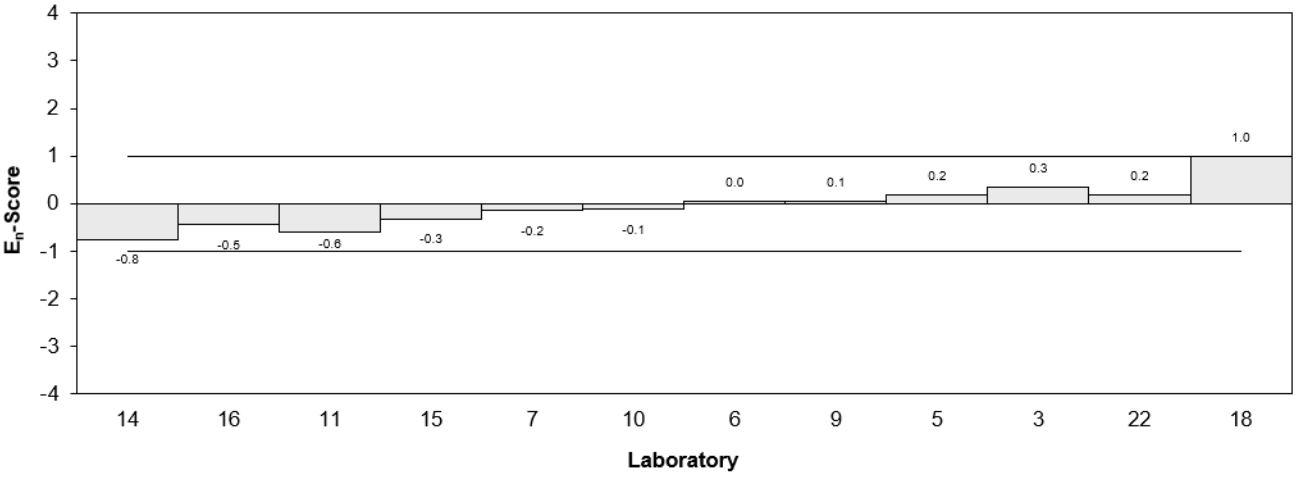

En-Scores: S2 - Se
En-Score
-0.8 -0.5 -0.6 -0.3 -0.2 -0.1 0.0 0.1 0.2 0.3 0.2 1.0
14 16 11 15 7 10 6 9 5 3 22 18
Laboratory

Figure 36

Table 48

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	0.536	0.080
4	NT	NT
5	0.69	0.207
6	0.52	0.156
7	< 10	NR
8	NT	NT
9	0.411	0.087
10	<10	NR
11	< 10	NR
12	<3	<3
13	NT	NT
14	NR	NR
15	<0.5	NR
16	0.426	0.135
17	<5	NR
18	NT	NT
19	NT	NT
20	NT	NT
21	<5	NR
22	< 10	NR
23	NT	NT
24	NT	NT
25	NT	NT

Statistics

Assigned Value	Not Set	
Spiked Value	Not Spiked	
Homogeneity Value	0.455	0.055
Robust Average	NA (N<6)	
Median	0.52	0.16
Mean	0.517	
N	5	
Max	0.69	
Min	0.411	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

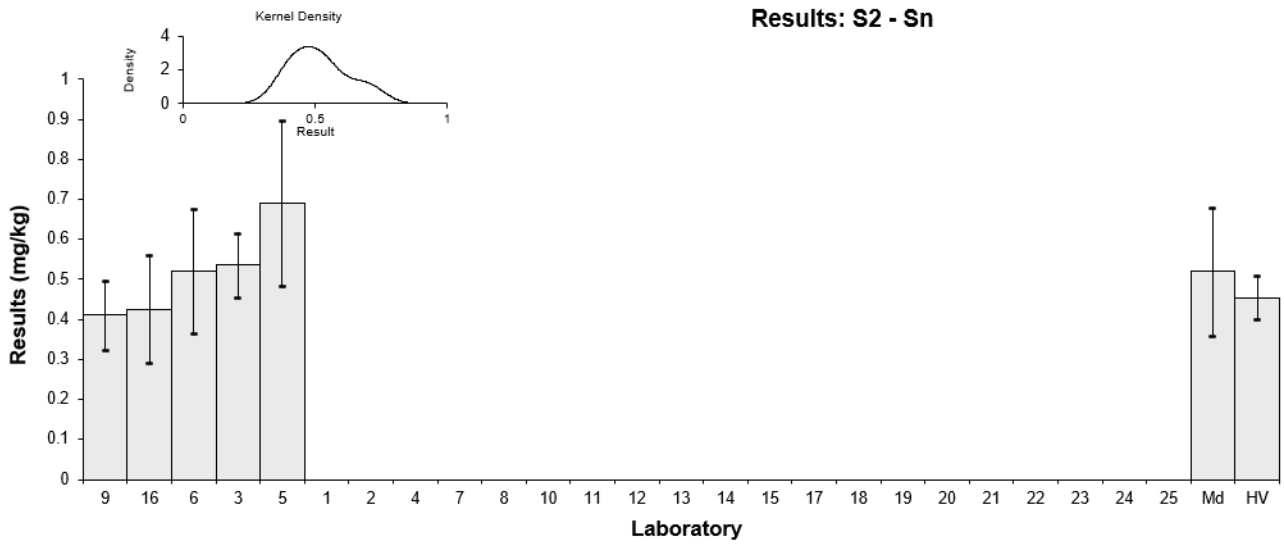

Results: S2 - Sn
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
9 16 6 3 5 1 2 4 7 8 10 11 12 13 14 15 17 18 19 20 21 22 23 24 25 Md HV

Figure 37

Table 49

Sample Details

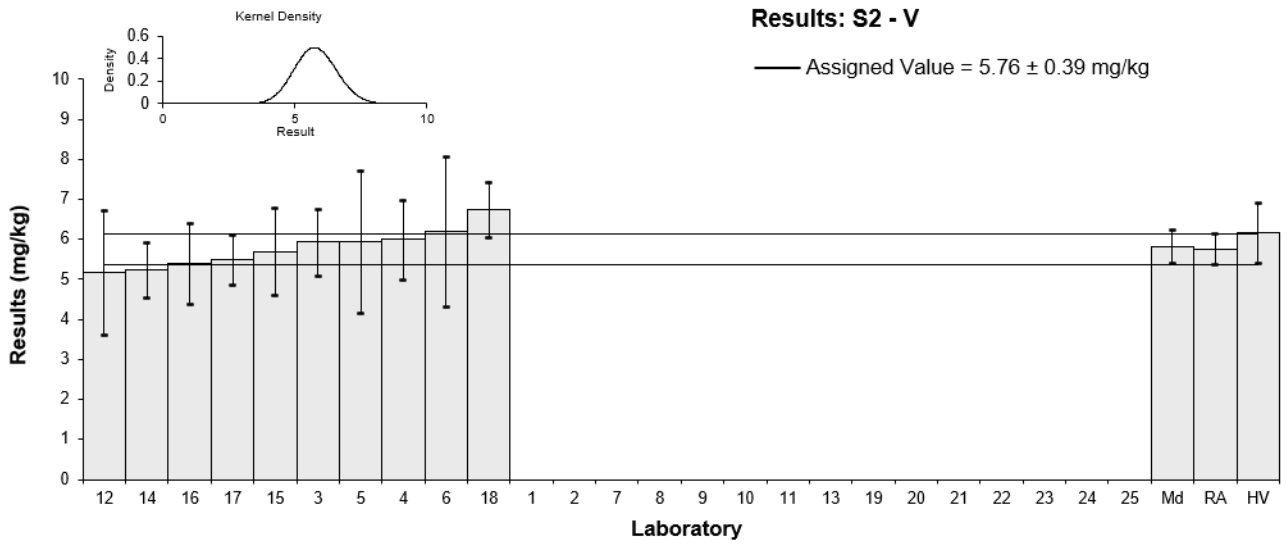
Sample No.	S2
Matrix	Compost
Analyte	V
Unit	mg/kg

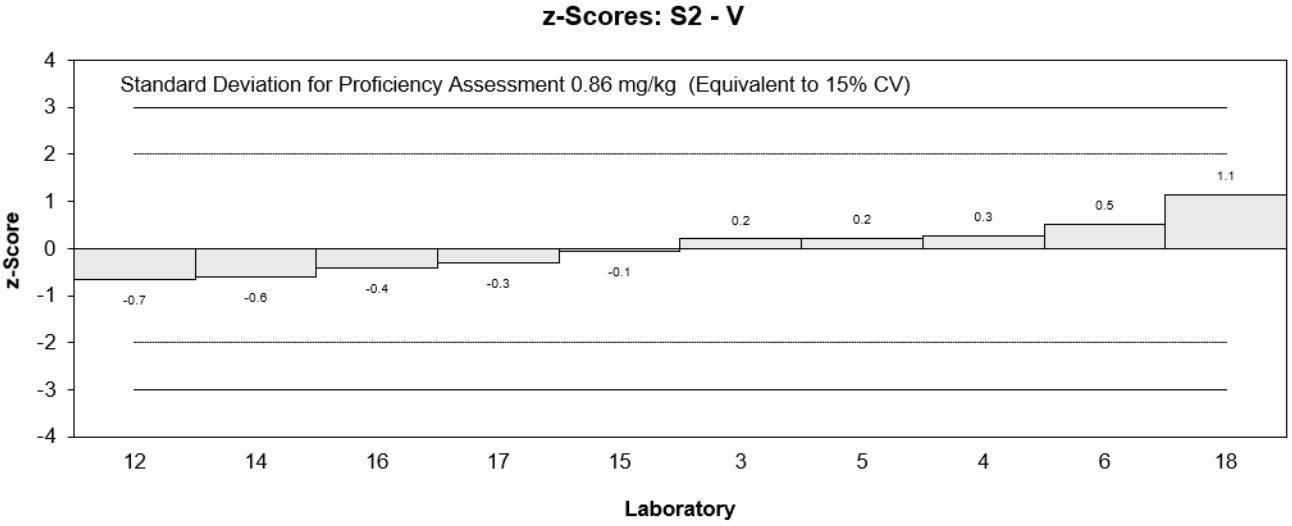
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	5.93	0.83	0.20	0.19
4	6	1	0.28	0.22
5	5.95	1.785	0.22	0.10
6	6.20	1.86	0.51	0.23
7	< 10	NR		
8	NT	NT		
9	<10	6.7		
10	<10	NR		
11	< 10	NR		
12	5.18	1.554	-0.67	-0.36
13	NT	NT		
14	5.24	0.70	-0.60	-0.65
15	5.7	1.1	-0.07	-0.05
16	5.397	1.0	-0.42	-0.34
17	5.49	0.62	-0.31	-0.37
18	6.74	0.7	1.13	1.22
19	NT	NT		
20	NT	NT		
21	<5	NR		
22	< 10	NR		
23	NT	NT		
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	5.76	0.39
Spiked Value	Not Spiked	
Homogeneity Value	6.17	0.74
Robust Average	5.76	0.39
Median	5.82	0.42
Mean	5.78	
N	10	
Max	6.74	
Min	5.18	
Robust SD	0.49	
Robust CV	8.5%	


Kernel Density
Density
Result
Results: S2 - V
Assigned Value = 5.76 ± 0.39 mg/kg
Results (mg/kg)
Laboratory
12 14 16 17 15 3 5 4 6 18 1 2 7 8 9 10 11 13 19 20 21 22 23 24 25 Md RA HV


z-Scores: S2 - V
Standard Deviation for Proficiency Assessment 0.86 mg/kg (Equivalent to 15% CV)
z-Score
-0.7 -0.6 -0.4 -0.3 -0.1 0.2 0.2 0.3 0.5 1.1
Laboratory
12 14 16 17 15 3 5 4 6 18

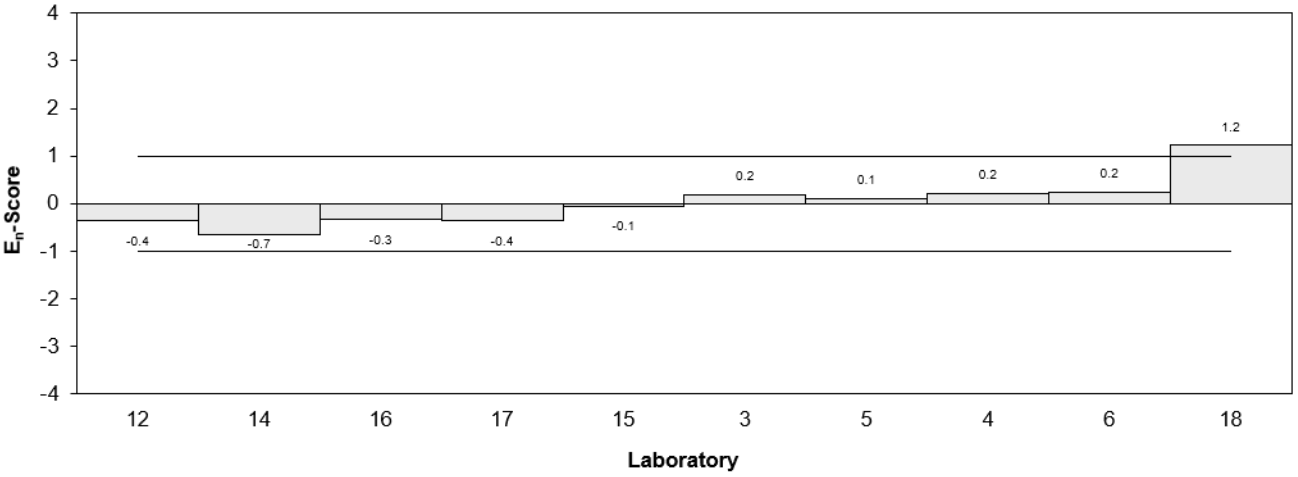

En-Scores: S2 - V
En-Score
-0.4 -0.7 -0.3 -0.4 -0.1 0.2 0.1 0.2 0.2 1.2
Laboratory
12 14 16 17 15 3 5 4 6 18

Figure 38

Table 50

Sample Details

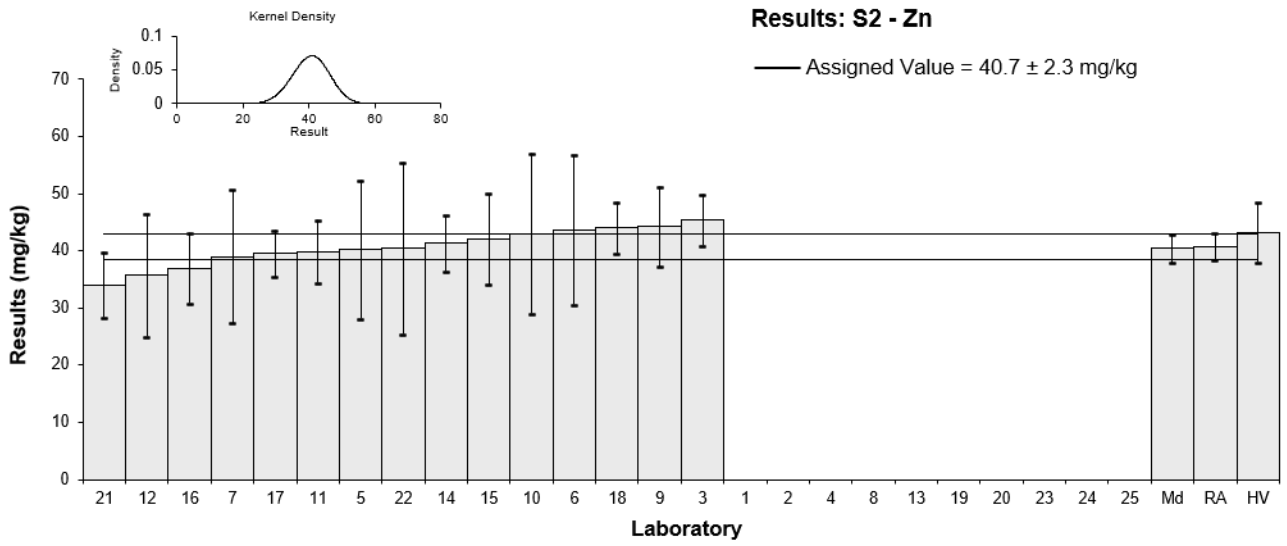
Sample No.	S2
Matrix	Compost
Analyte	Zn
Unit	mg/kg

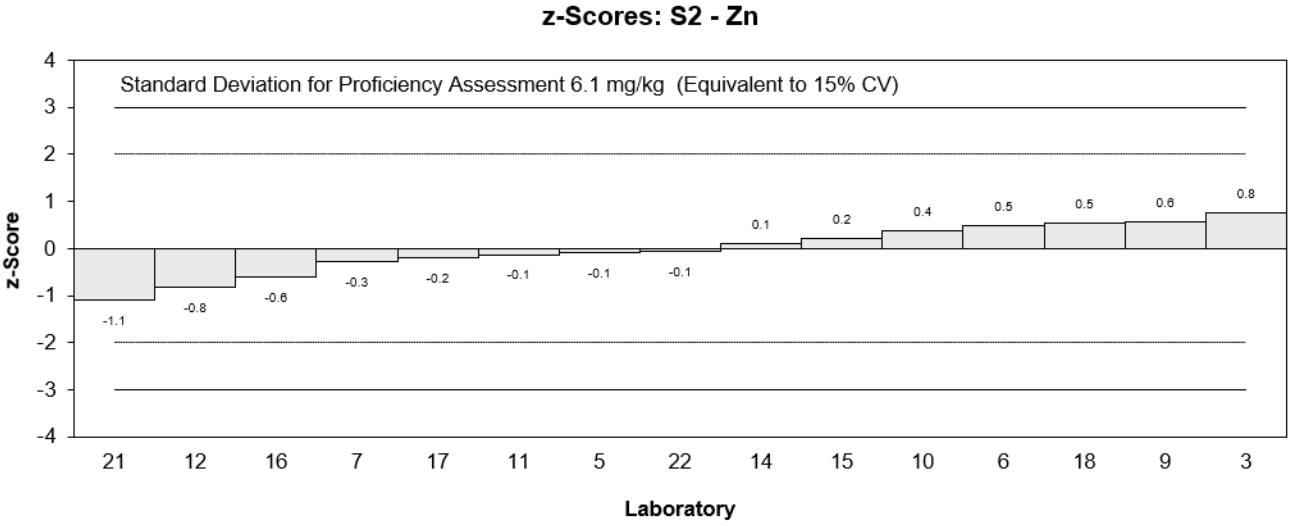
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	45.4	4.5	0.77	0.93
4	NT	NT		
5	40.2	12.06	-0.08	-0.04
6	43.6	13.08	0.48	0.22
7	38.99	11.697	-0.28	-0.14
8	NT	NT		
9	44.2	7.0	0.57	0.48
10	43	14	0.38	0.16
11	39.9	5.5	-0.13	-0.13
12	35.7	10.71	-0.82	-0.46
13	NT	NT		
14	41.3	4.9	0.10	0.11
15	42	8	0.21	0.16
16	36.948	6.197	-0.61	-0.57
17	39.5	4.1	-0.20	-0.26
18	44	4.5	0.54	0.65
19	NT	NT		
20	NT	NT		
21	34	5.73	-1.10	-1.09
22	40.4	15	-0.05	-0.02
23	NT	NT		
24	NT	NT		
25	NT	NT		

Statistics

Assigned Value	40.7	2.3
Spiked Value	Not Spiked	
Homogeneity Value	43.2	5.2
Robust Average	40.7	2.3
Median	40.4	2.5
Mean	40.6	
N	15	
Max	45.4	
Min	34	
Robust SD	3.5	
Robust CV	8.6%	


Kernel Density
Density
Result
Results: S2 - Zn
Assigned Value = 40.7 ± 2.3 mg/kg
Results (mg/kg)
Laboratory
21 12 16 7 17 11 5 22 14 15 10 6 18 9 3 1 2 4 8 13 19 20 23 24 25 Md RA HV


z-Scores: S2 - Zn
Standard Deviation for Proficiency Assessment 6.1 mg/kg (Equivalent to 15% CV)
z-Score
-1.1 -0.8 -0.6 -0.3 -0.2 -0.1 -0.1 -0.1 0.1 0.2 0.4 0.5 0.5 0.6 0.8
Laboratory
21 12 16 7 17 11 5 22 14 15 10 6 18 9 3

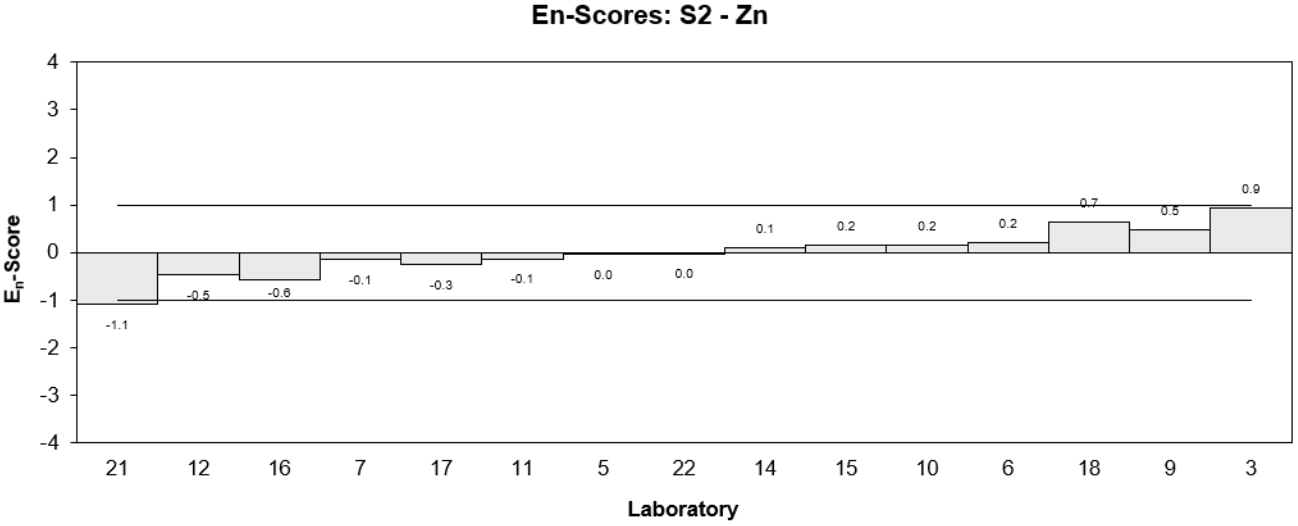

En-Scores: S2 - Zn
En-Score
-1.1 -0.5 -0.6 -0.1 -0.3 -0.1 0.0 0.0 0.1 0.2 0.2 0.2 0.7 0.5 0.9
Laboratory
21 12 16 7 17 11 5 22 14 15 10 6 18 9 3

Figure 39

Table 51

Sample Details

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

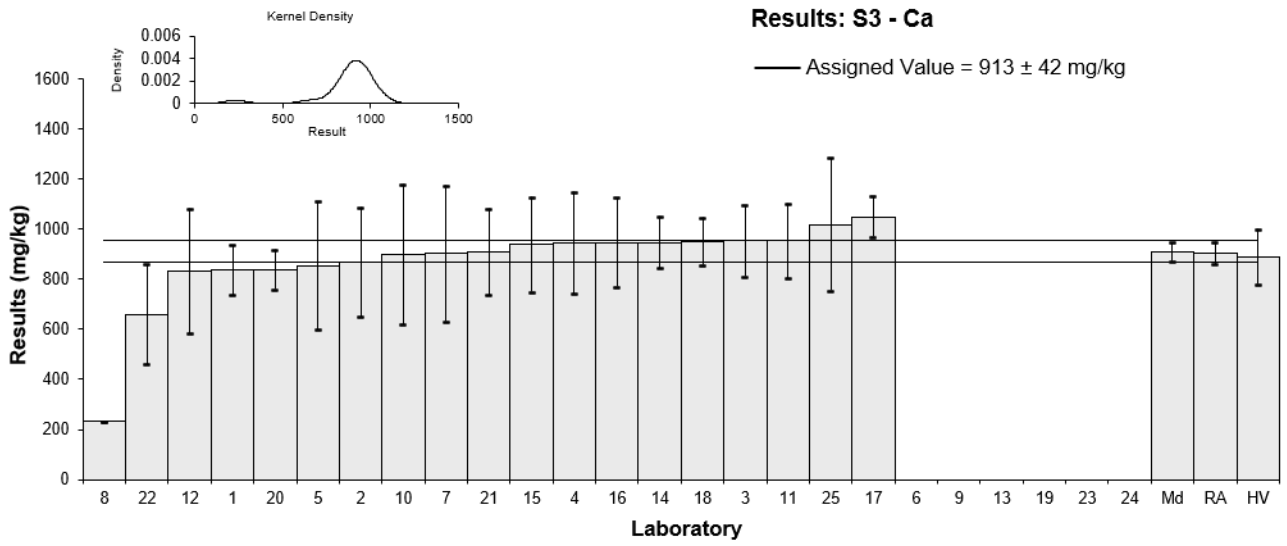
Participant Results

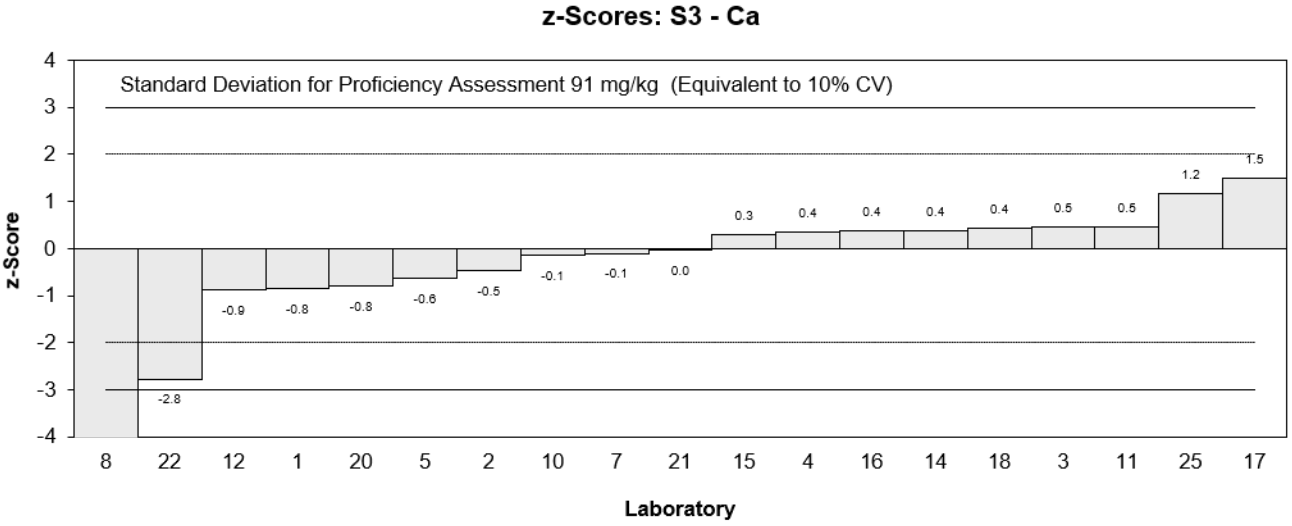
Lab. Code	Result	Uncertainty	z	E_n
1	836	100	-0.84	-0.71
2	869	220	-0.48	-0.20
3	954	142	0.45	0.28
4	945	204	0.35	0.15
5	855	256.5	-0.64	-0.22
6	NT	NT		
7	904	271	-0.10	-0.03
8*	231.75	0.68	-7.46	-16.22
9	NT	NT		
10	900	280	-0.14	-0.05
11	954	150	0.45	0.26
12	834	250	-0.87	-0.31
13	NT	NT		
14	948	103	0.38	0.31
15	940	190	0.30	0.14
16	947.839	177.72	0.38	0.19
17	1050	81	1.50	1.50
18	953	95	0.44	0.39
19	NT	NT		
20	840	80	-0.80	-0.81
21	910	173.7	-0.03	-0.02
22	660	200	-2.77	-1.24
23	NT	NT		
24	NR	NR		
25	1020	265	1.17	0.40

* Outlier, see Section 4.2

Statistics

Assigned Value	913	42
Spiked Value	Not Spiked	
Homogeneity Value	890	110
Robust Average	906	45
Median	910	37
Mean	871	
N	19	
Max	1050	
Min	231.75	
Robust SD	78	
Robust CV	8.6%	


Kernel Density
Density
0.006
0.004
0.002
0
0
500
1000
1500
Result
Results: S3 - Ca
Assigned Value = 913 ± 42 mg/kg
Results (mg/kg)
1600
1400
1200
1000
800
600
400
200
0
8 22 12 1 20 5 2 10 7 21 15 4 16 14 18 3 11 25 17 6 9 13 19 23 24 Md RA HV
Laboratory


z-Scores: S3 - Ca
Standard Deviation for Proficiency Assessment 91 mg/kg (Equivalent to 10% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-2.8
-0.9
-0.8
-0.8
-0.6
-0.5
-0.1
-0.1
0.0
0.3
0.4
0.4
0.4
0.4
0.5
0.5
1.2
1.5
8 22 12 1 20 5 2 10 7 21 15 4 16 14 18 3 11 25 17
Laboratory

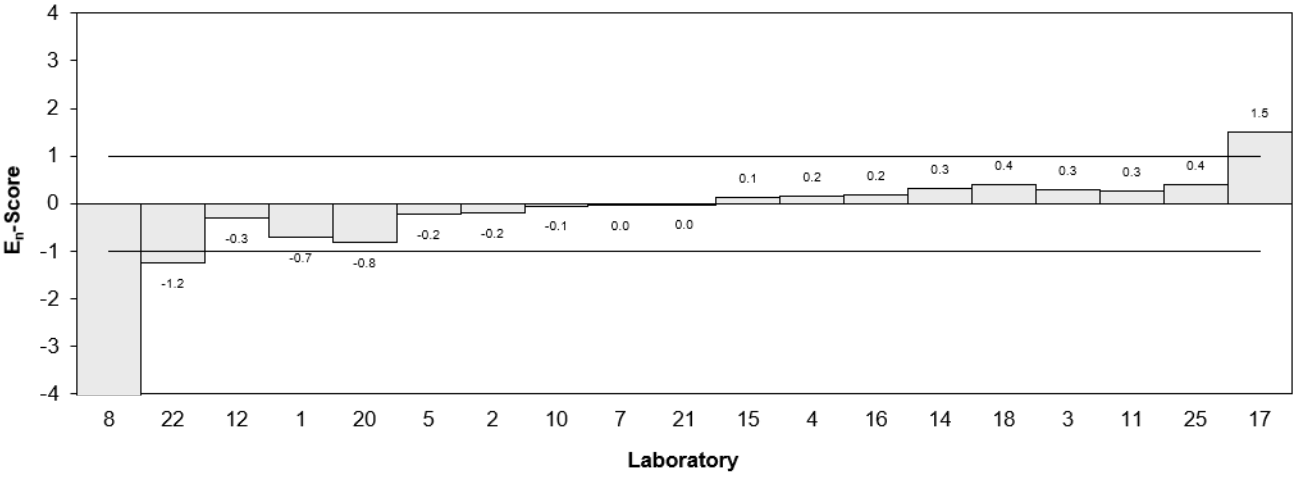

En-Scores: S3 - Ca
En-Score
4
3
2
1
0
-1
-2
-3
-4
-1.2
-0.3
-0.7
-0.8
-0.2
-0.2
-0.1
0.0
0.0
0.1
0.2
0.2
0.3
0.4
0.3
0.3
0.4
1.5
8 22 12 1 20 5 2 10 7 21 15 4 16 14 18 3 11 25 17
Laboratory

Figure 40

Table 52

Sample Details

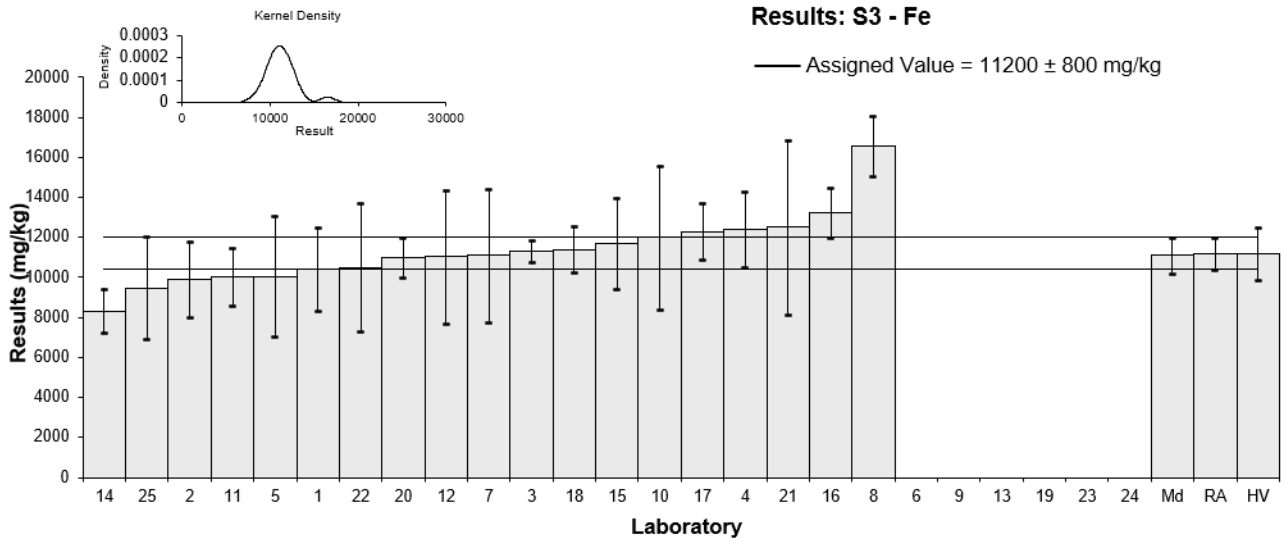
Sample No.	S3
Matrix	Soil
Analyte	Fe
Unit	mg/kg

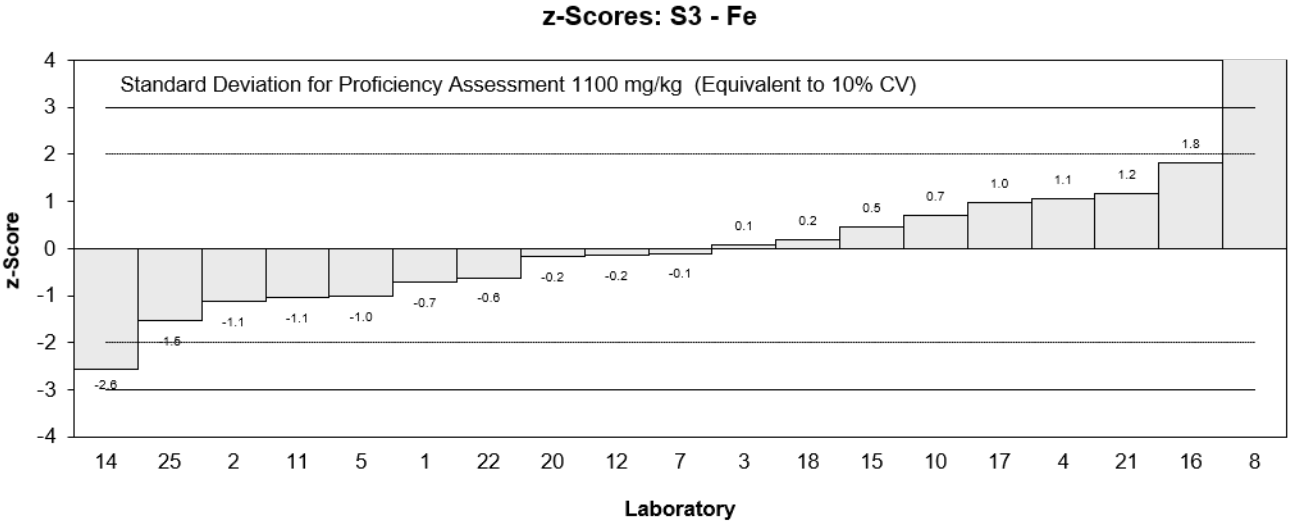
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	10400	2100	-0.71	-0.36
2	9930	1890	-1.13	-0.62
3	11300	548	0.09	0.10
4	12382	1896	1.06	0.57
5	10058	3017.4	-1.02	-0.37
6	NT	NT		
7	11089	3326	-0.10	-0.03
8	16557.2	1488.4	4.78	3.17
9	NT	NT		
10	12000	3600	0.71	0.22
11	10023	1445	-1.05	-0.71
12	11028	3308	-0.15	-0.05
13	NT	NT		
14	8330	1100	-2.56	-2.11
15	11700	2300	0.45	0.21
16	13246.614	1234.685	1.83	1.39
17	12300	1404	0.98	0.68
18	11400	1140	0.18	0.14
19	NT	NT		
20	11000	1000	-0.18	-0.16
21	12500	4350	1.16	0.29
22	10507	3200	-0.62	-0.21
23	NT	NT		
24	NR	NR		
25	9470.0	2556.9	-1.54	-0.65

Statistics

Assigned Value	11200	800
Spiked Value	Not Spiked	
Homogeneity Value	11200	1300
Robust Average	11200	800
Median	11100	900
Mean	11300	
N	19	
Max	16557.2	
Min	8330	
Robust SD	1400	
Robust CV	12%	


Results: S3 - Fe
Kernel Density
Density
Result
Assigned Value = 11200 ± 800 mg/kg
Results (mg/kg)
Laboratory
14 25 2 11 5 1 22 20 12 7 3 18 15 10 17 4 21 16 8 6 9 13 19 23 24 Md RA HV


z-Scores: S3 - Fe
Standard Deviation for Proficiency Assessment 1100 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
14 25 2 11 5 1 22 20 12 7 3 18 15 10 17 4 21 16 8

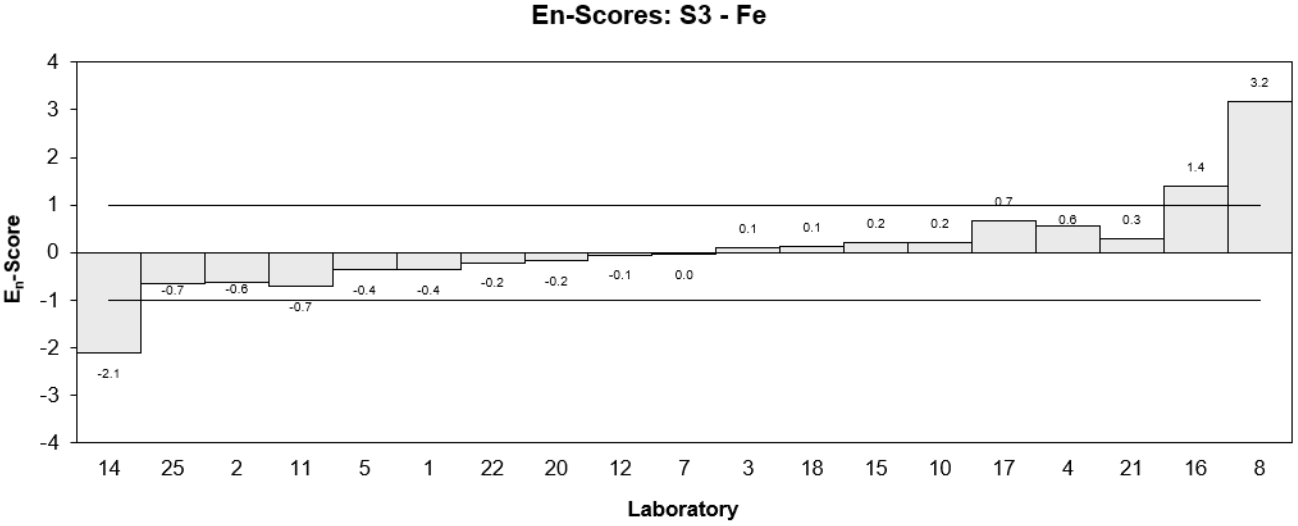

En-Scores: S3 - Fe
En-Score
Laboratory
14 25 2 11 5 1 22 20 12 7 3 18 15 10 17 4 21 16 8

Figure 41

Table 53

Sample Details

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

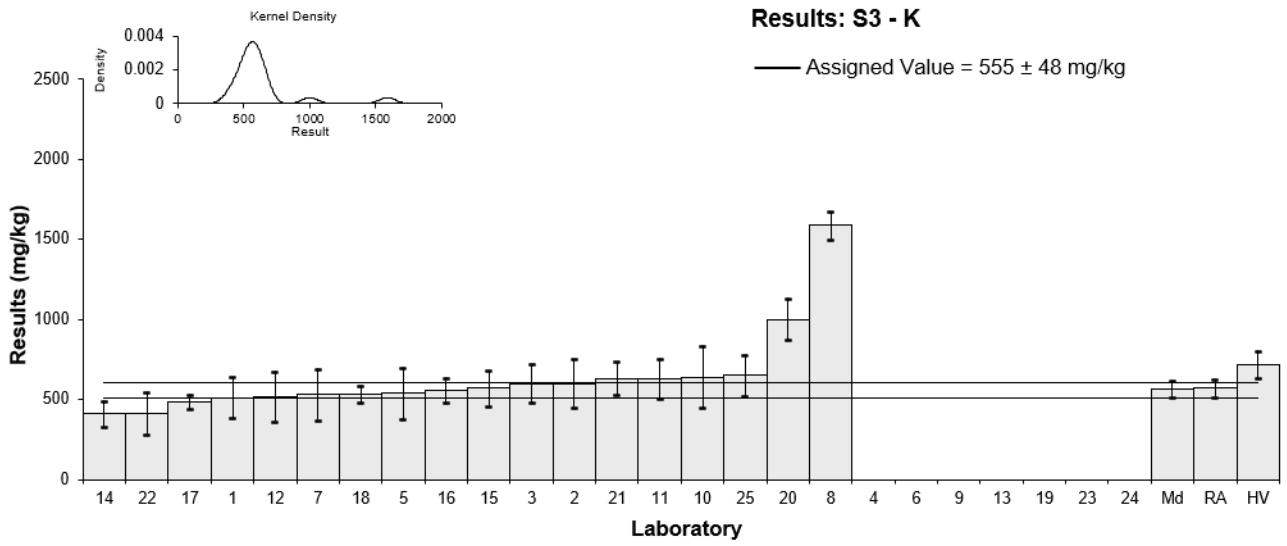
Participant Results

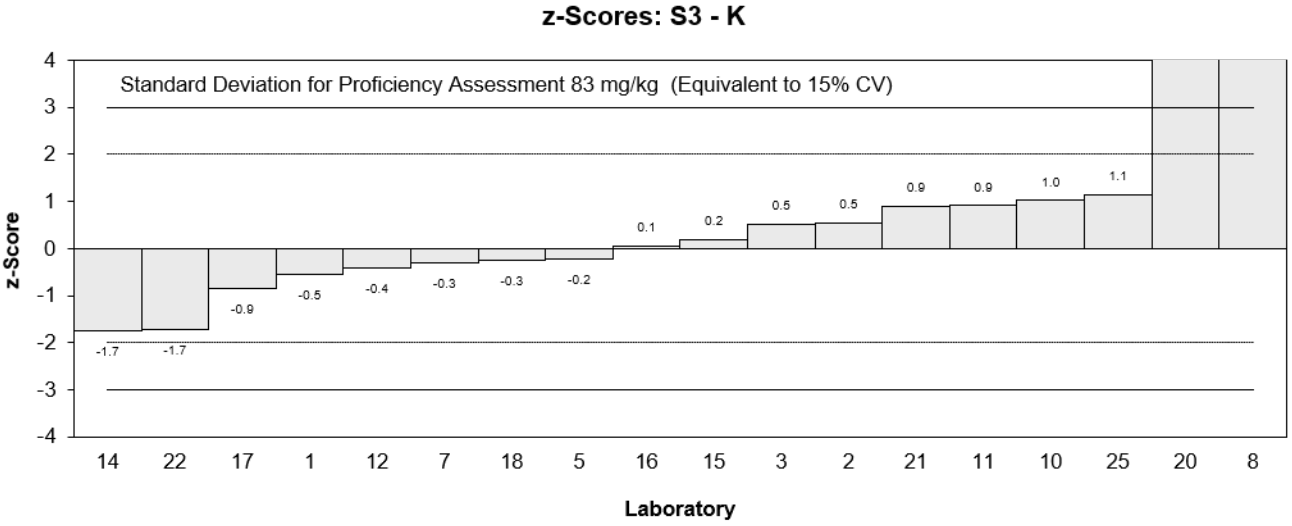
Lab. Code	Result	Uncertainty	z	E_n
1	510	127	-0.54	-0.33
2	600	150	0.54	0.29
3	598	120	0.52	0.33
4	NT	NT		
5	537	161.1	-0.22	-0.11
6	NT	NT		
7	530	159	-0.30	-0.15
8*	1586.77	87.11	12.39	10.37
9	NT	NT		
10	640	194	1.02	0.43
11	631	123	0.91	0.58
12	520	156	-0.42	-0.21
13	NT	NT		
14	410	80	-1.74	-1.55
15	570	110	0.18	0.12
16	559.746	77.03	0.06	0.05
17	484	46	-0.85	-1.07
18	533	55	-0.26	-0.30
19	NT	NT		
20*	1000	130	5.35	3.21
21	630	103.2	0.90	0.66
22	411	130	-1.73	-1.04
23	NT	NT		
24	NR	NR		
25	650	130	1.14	0.69

* Outlier, see Section 4.2

Statistics

Assigned Value	555	48
Spiked Value	Not Spiked	
Homogeneity Value	717	86
Robust Average	571	56
Median	565	52
Mean	630	
N	18	
Max	1586.77	
Min	410	
Robust SD	95	
Robust CV	17%	


Kernel Density
Density
0.004
0.002
0
0
500
1000
1500
2000
Result
Results: S3 - K
Assigned Value = 555 ± 48 mg/kg
Results (mg/kg)
2500
2000
1500
1000
500
0
14 22 17 1 12 7 18 5 16 15 3 2 21 11 10 25 20 8 4 6 9 13 19 23 24 Md RA HV
Laboratory


z-Scores: S3 - K
Standard Deviation for Proficiency Assessment 83 mg/kg (Equivalent to 15% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-1.7 -1.7 -0.9 -0.5 -0.4 -0.3 -0.3 -0.2 0.1 0.2 0.5 0.5 0.9 0.9 1.0 1.1
14 22 17 1 12 7 18 5 16 15 3 2 21 11 10 25 20 8
Laboratory

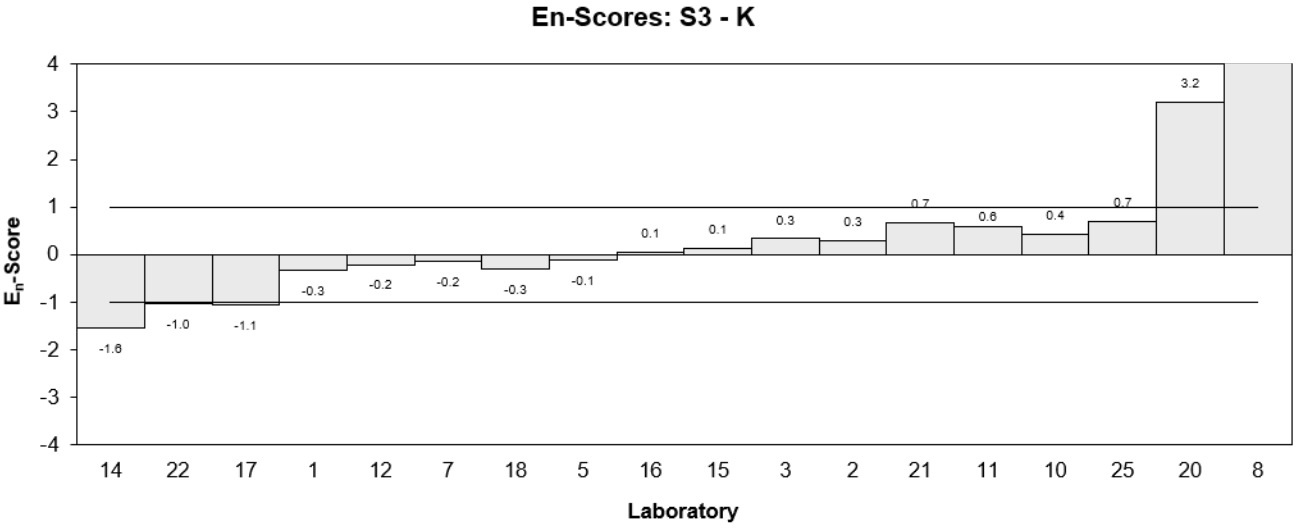

En-Scores: S3 - K
En-Score
4
3
2
1
0
-1
-2
-3
-4
-1.6 -1.0 -1.1 -0.3 -0.2 -0.2 -0.3 -0.1 0.1 0.1 0.3 0.3 0.7 0.6 0.4 0.7 3.2
14 22 17 1 12 7 18 5 16 15 3 2 21 11 10 25 20 8
Laboratory

Figure 42

Table 54

Sample Details

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

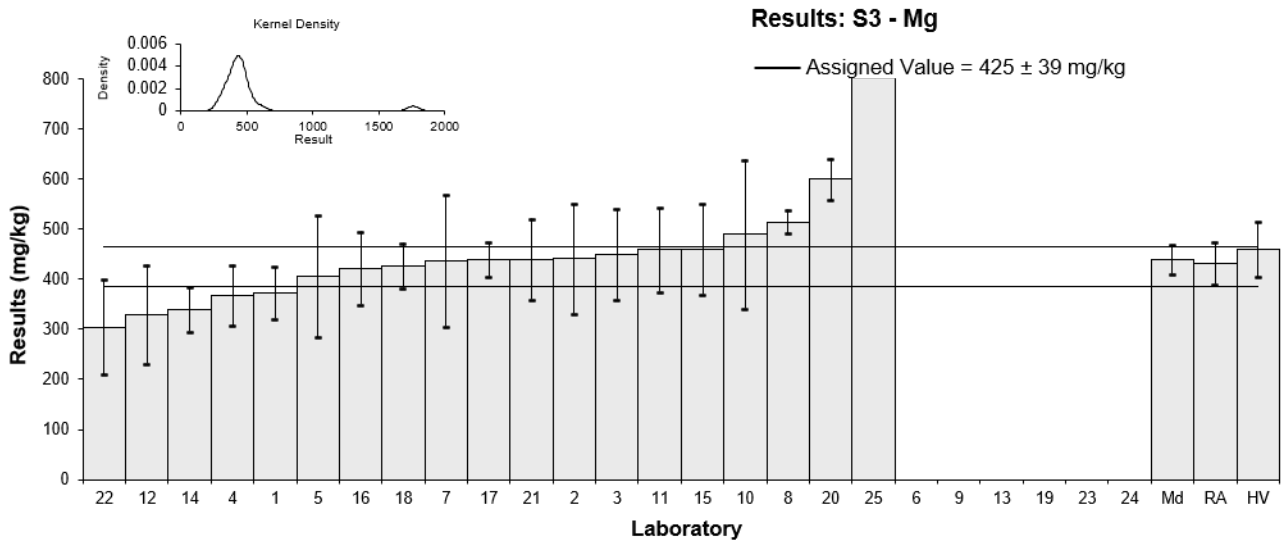
Participant Results

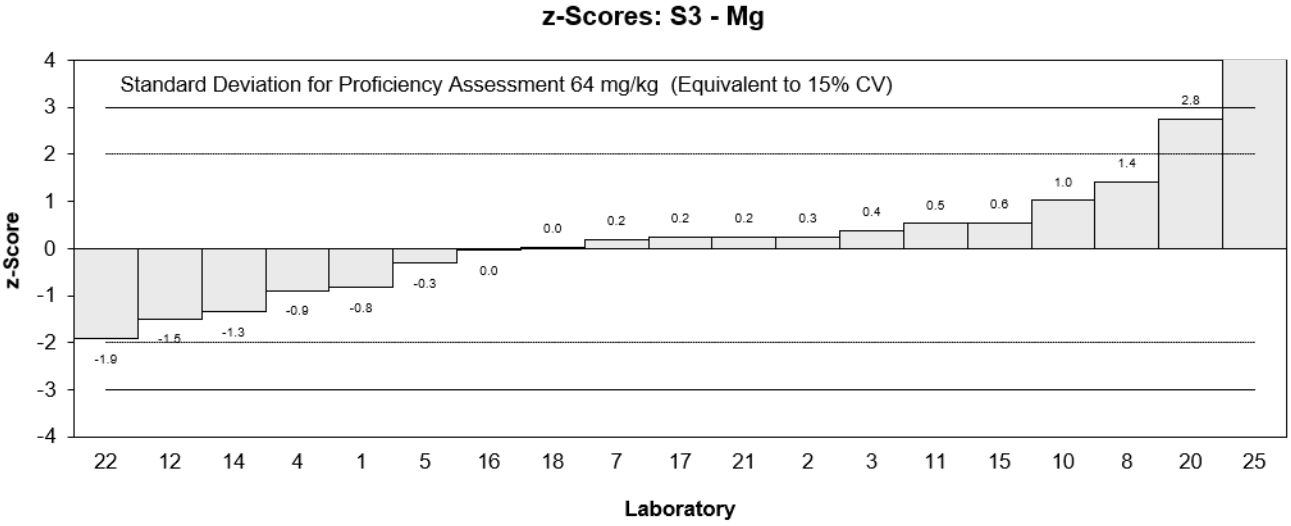
Lab. Code	Result	Uncertainty	z	E_n
1	373	52	-0.82	-0.80
2	441	110	0.25	0.14
3	450	90	0.39	0.25
4	368	61	-0.89	-0.79
5	406	121.8	-0.30	-0.15
6	NT	NT		
7	437	131	0.19	0.09
8	514.85	23.96	1.41	1.96
9	NT	NT		
10	490	149	1.02	0.42
11	459	84	0.53	0.37
12	330	99	-1.49	-0.89
13	NT	NT		
14	340	45	-1.33	-1.43
15	460	90	0.55	0.36
16	422.560	72.66	-0.04	-0.03
17	440	34	0.24	0.29
18	427	45	0.03	0.03
19	NT	NT		
20	600	42	2.75	3.05
21	440	80.8	0.24	0.17
22	304	95	-1.90	-1.18
23	NT	NT		
24	NR	NR		
25*	1760	405	20.94	3.28

* Outlier, see Section 4.2

Statistics

Assigned Value	425	39
Spiked Value	Not Spiked	
Homogeneity Value	460	55
Robust Average	432	42
Median	440	29
Mean	500	
N	19	
Max	1760	
Min	304	
Robust SD	74	
Robust CV	17%	


Results: S3 - Mg
Kernel Density
Density
Result
Assigned Value = 425 ± 39 mg/kg
Results (mg/kg)
Laboratory
22 12 14 4 1 5 16 18 7 17 21 2 3 11 15 10 8 20 25 6 9 13 19 23 24 Md RA HV


z-Scores: S3 - Mg
Standard Deviation for Proficiency Assessment 64 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
22 12 14 4 1 5 16 18 7 17 21 2 3 11 15 10 8 20 25

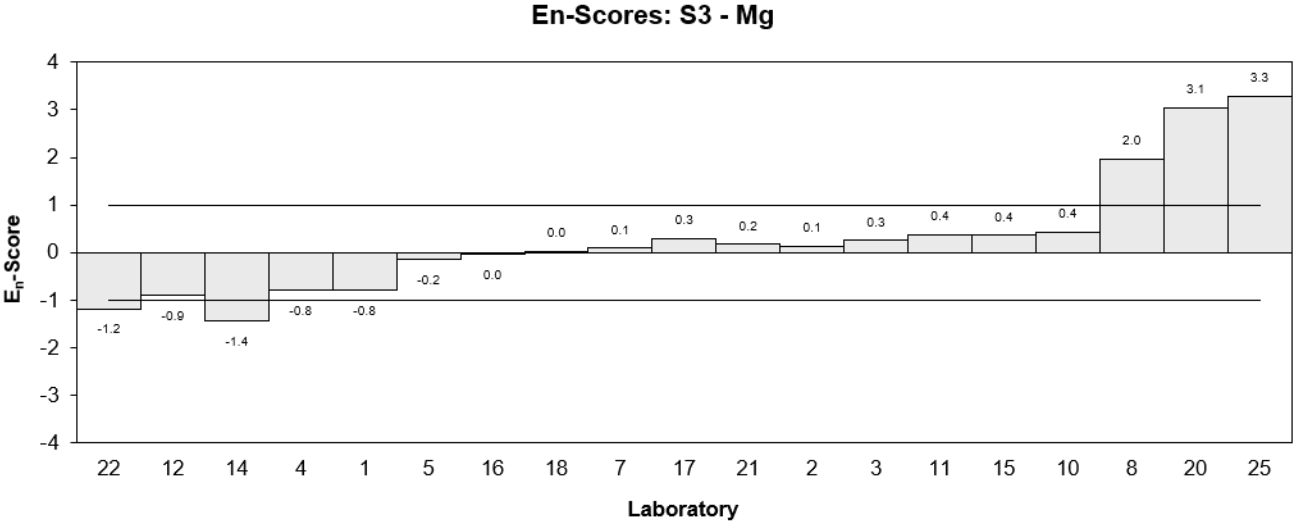

En-Scores: S3 - Mg
En-Score
Laboratory
22 12 14 4 1 5 16 18 7 17 21 2 3 11 15 10 8 20 25

Figure 43

Table 55

Sample Details

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

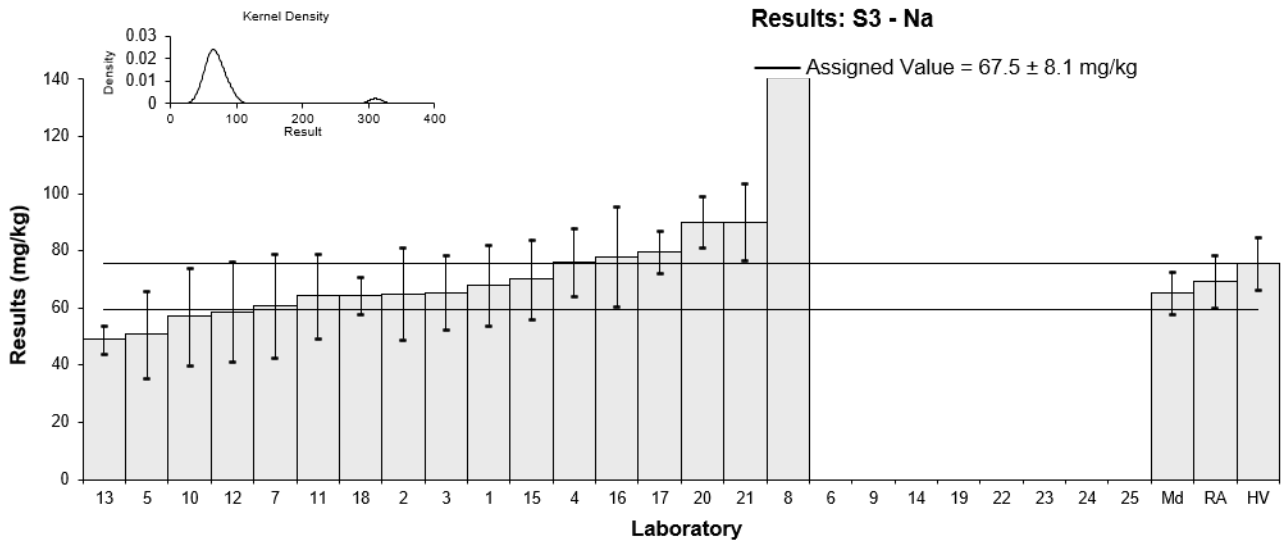
Participant Results

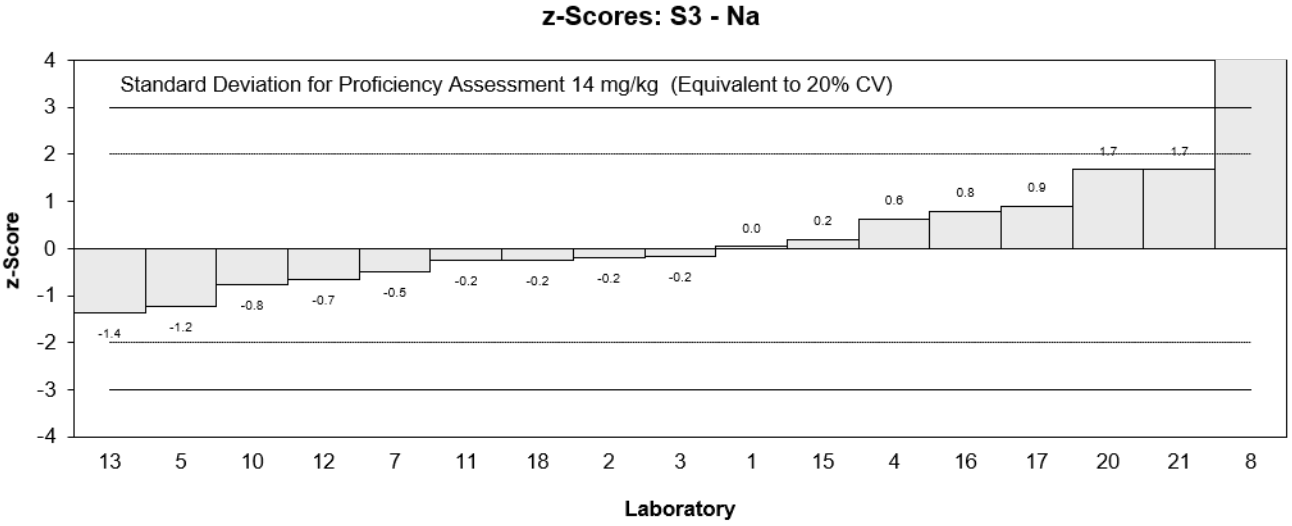
Lab. Code	Result	Uncertainty	z	E_n
1	68	14	0.04	0.03
2	65	16	-0.19	-0.14
3	65.3	13	-0.16	-0.14
4	76	12	0.63	0.59
5	50.7	15.21	-1.24	-0.97
6	NT	NT		
7	60.7	18.21	-0.50	-0.34
8*	310.42	89.50	17.99	2.70
9	NT	NT		
10	57	17	-0.78	-0.56
11	64.2	14.7	-0.24	-0.20
12	58.7	17.61	-0.65	-0.45
13	49	5	-1.37	-1.94
14	NR	NR		
15	70	14	0.19	0.15
16	77.978	17.47	0.78	0.54
17	79.5	7.4	0.89	1.09
18	64.2	6.5	-0.24	-0.32
19	NT	NT		
20	90	9	1.67	1.86
21	90	13.5	1.67	1.43
22	< 250	NR		
23	NT	NT		
24	NR	NR		
25	<500	NR		

* Outlier, see Section 4.2

Statistics

Assigned Value	67.5	8.1
Spiked Value	Not Spiked	
Homogeneity Value	75.6	9.1
Robust Average	69.3	9.0
Median	65.3	7.5
Mean	82	
N	17	
Max	310.42	
Min	49	
Robust SD	15	
Robust CV	22%	


Kernel Density
Density
Result
Results: S3 - Na
Assigned Value = 67.5 ± 8.1 mg/kg
Results (mg/kg)
Laboratory
13 5 10 12 7 11 18 2 3 1 15 4 16 17 20 21 8 6 9 14 19 22 23 24 25 Md RA HV


z-Scores: S3 - Na
Standard Deviation for Proficiency Assessment 14 mg/kg (Equivalent to 20% CV)
z-Score
-1.4 -1.2 -0.8 -0.7 -0.5 -0.2 -0.2 -0.2 -0.2 0.0 0.2 0.6 0.8 0.9 1.7 1.7
Laboratory
13 5 10 12 7 11 18 2 3 1 15 4 16 17 20 21 8

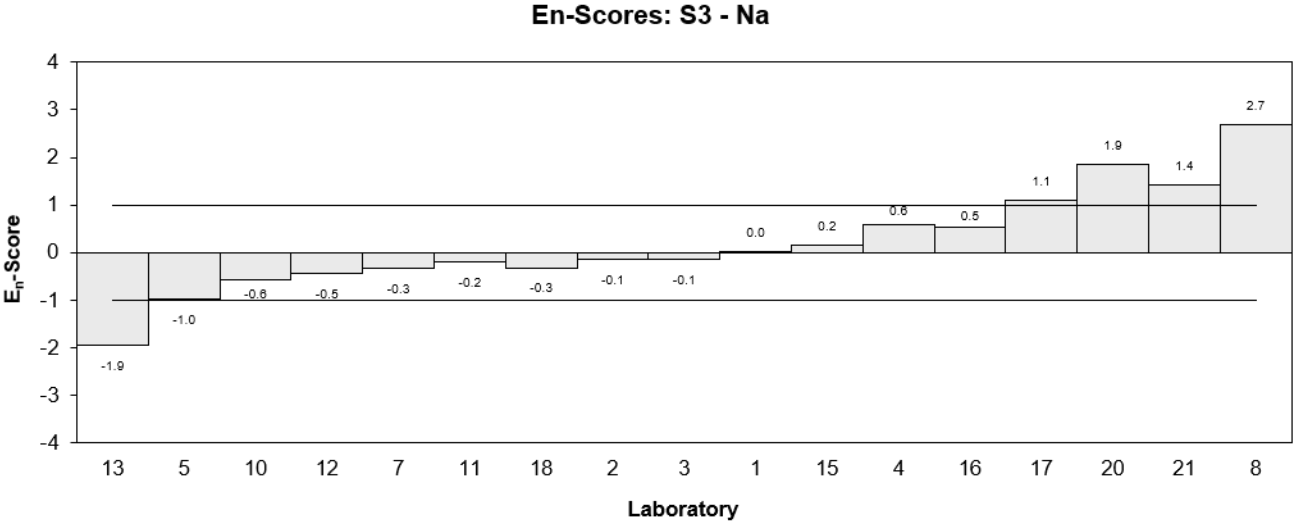

En-Scores: S3 - Na
En-Score
-1.9 -1.0 -0.6 -0.5 -0.3 -0.2 -0.3 -0.1 -0.1 0.0 0.2 0.6 0.5 1.1 1.9 1.4 2.7
Laboratory
13 5 10 12 7 11 18 2 3 1 15 4 16 17 20 21 8

Figure 44

Table 56

Sample Details

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

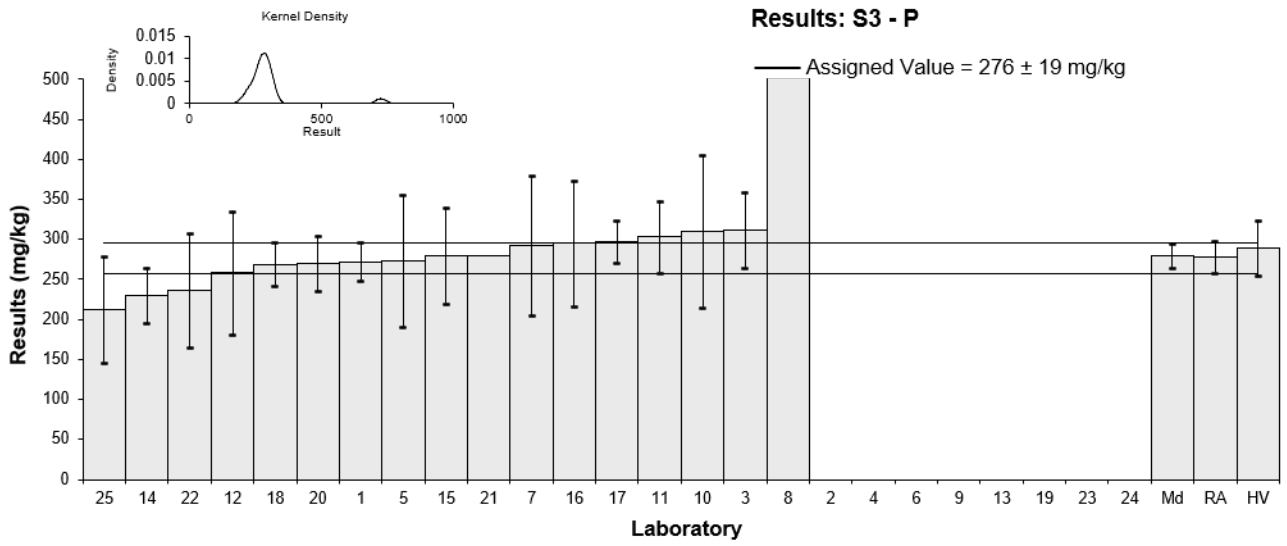
Participant Results

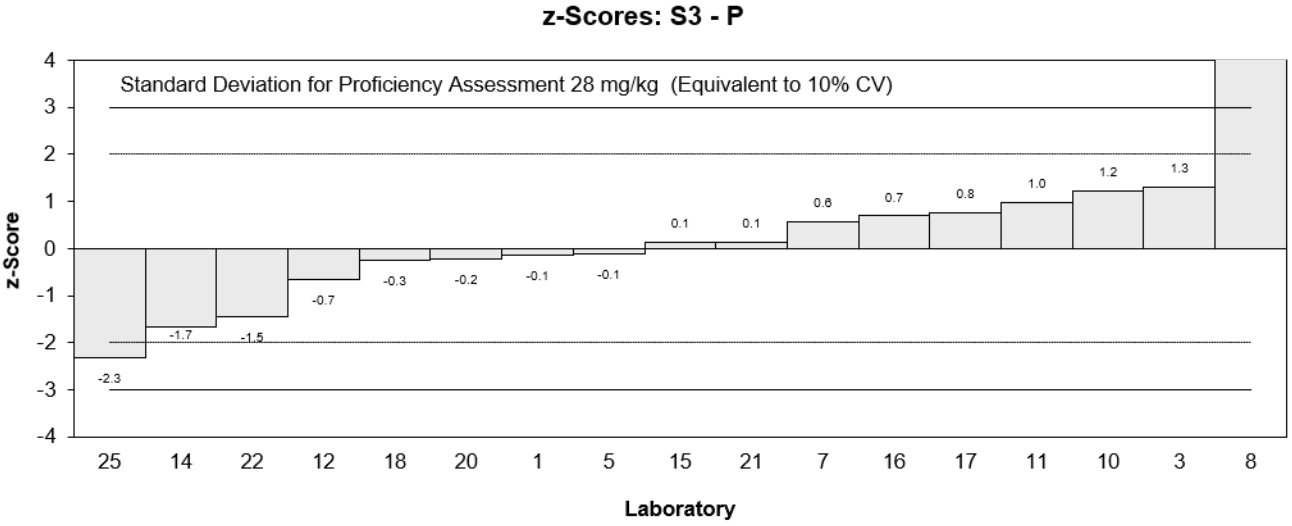
Lab. Code	Result	Uncertainty	z	E_n
1	272	24	-0.14	-0.13
2	NT	NT		
3	312	47	1.30	0.71
4	NT	NT		
5	273	81.9	-0.11	-0.04
6	NT	NT		
7	292	87.6	0.58	0.18
8*	724.83	222.76	16.26	2.01
9	NT	NT		
10	310	95	1.23	0.35
11	303	45	0.98	0.55
12	258	77	-0.65	-0.23
13	NT	NT		
14	230	35	-1.67	-1.16
15	280	60	0.14	0.06
16	294.979	78.050	0.69	0.24
17	297	26	0.76	0.65
18	269	27	-0.25	-0.21
19	NT	NT		
20	270	35	-0.22	-0.15
21	280	NR	0.14	0.21
22	236	71	-1.45	-0.54
23	NT	NT		
24	NR	NR		
25	212	66	-2.32	-0.93

* Outlier, see Section 4.2

Statistics

Assigned Value	276	19
Spiked Value	Not Spiked	
Homogeneity Value	289	35
Robust Average	278	20
Median	280	15
Mean	301	
N	17	
Max	724.83	
Min	212	
Robust SD	32	
Robust CV	12%	


Results: S3 - P
Kernel Density
Density
Result
Assigned Value = 276 ± 19 mg/kg
Results (mg/kg)
Laboratory
25 14 22 12 18 20 1 5 15 21 7 16 17 11 10 3 8 2 4 6 9 13 19 23 24 Md RA HV


z-Scores: S3 - P
Standard Deviation for Proficiency Assessment 28 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
25 14 22 12 18 20 1 5 15 21 7 16 17 11 10 3 8

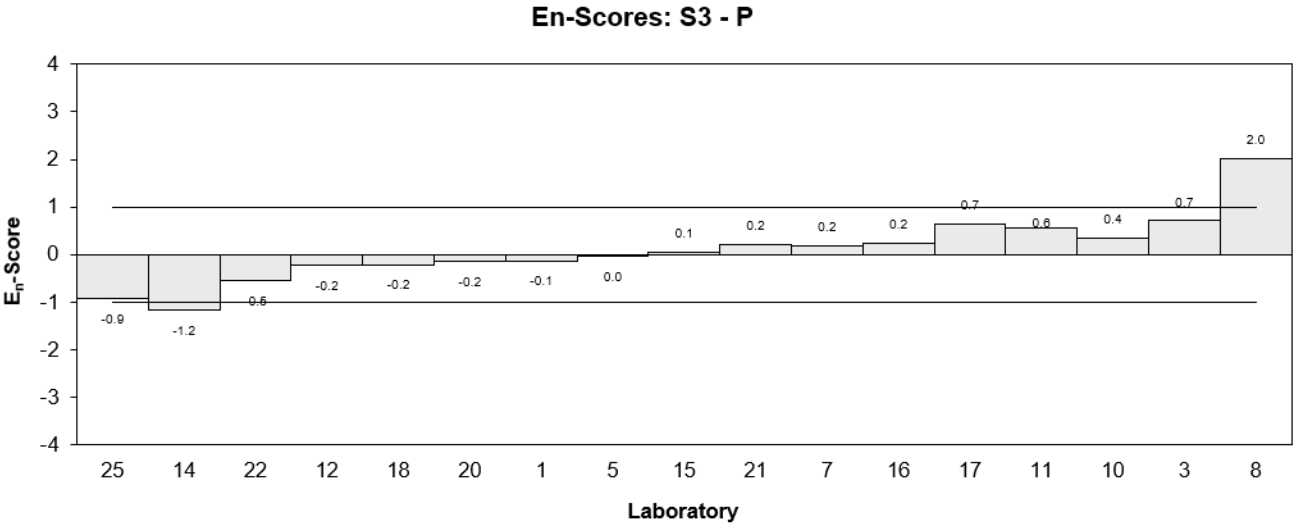

En-Scores: S3 - P
En-Score
Laboratory
25 14 22 12 18 20 1 5 15 21 7 16 17 11 10 3 8

Figure 45

Table 57

Sample Details

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

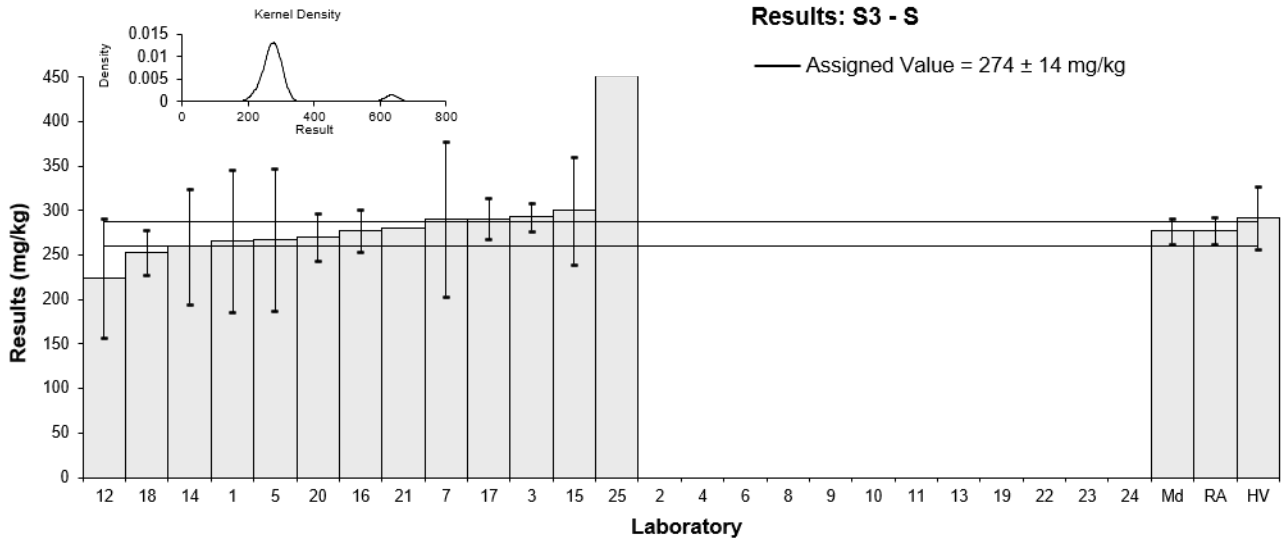
Participant Results

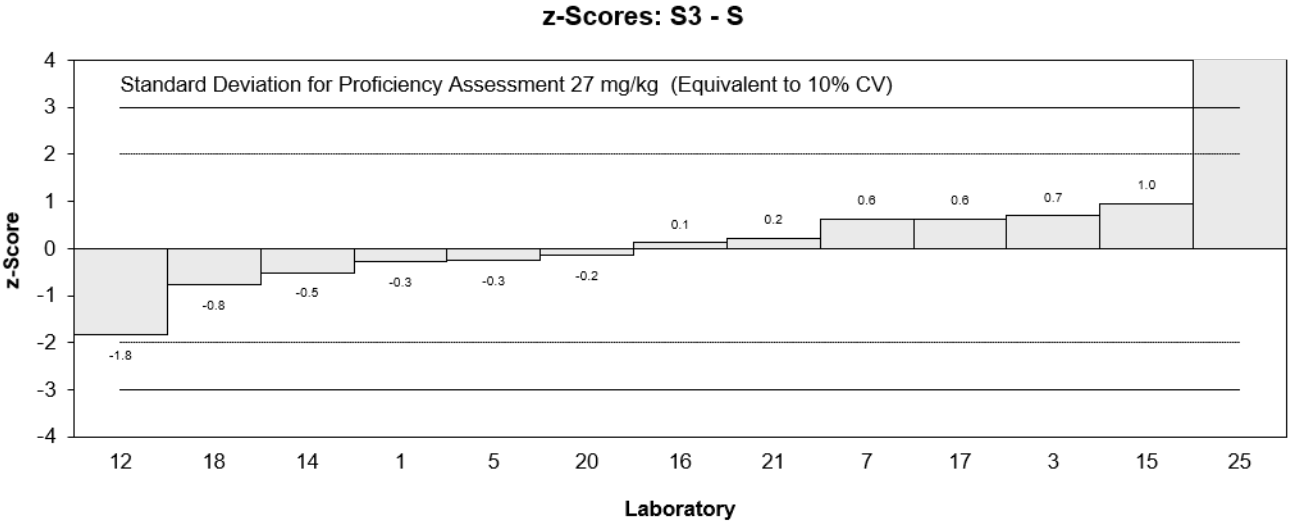
Lab. Code	Result	Uncertainty	z	E_n
1	266	80	-0.29	-0.10
2	NT	NT		
3	293	16	0.69	0.89
4	NT	NT		
5	267	80.1	-0.26	-0.09
6	NT	NT		
7	291	87.3	0.62	0.19
8	NT	NT		
9	NT	NT		
10	NT	NT		
11	NT	NT		
12	224	67	-1.82	-0.73
13	NT	NT		
14	260	65	-0.51	-0.21
15	300	60	0.95	0.42
16	277.170	23.8	0.12	0.11
17	291	23	0.62	0.63
18	253	25	-0.77	-0.73
19	NT	NT		
20	270	27	-0.15	-0.13
21	280	NR	0.22	0.43
22	< 1000	NR		
23	NT	NT		
24	NR	NR		
25*	635	114	13.18	3.14

* Outlier, see Section 4.2

Statistics

Assigned Value	274	14
Spiked Value	Not Spiked	
Homogeneity Value	292	35
Robust Average	277	15
Median	277	14
Mean	301	
N	13	
Max	635	
Min	224	
Robust SD	22	
Robust CV	7.9%	


Results: S3 - S
Assigned Value = 274 ± 14 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
12 18 14 1 5 20 16 21 7 17 3 15 25 2 4 6 8 9 10 11 13 19 22 23 24 Md RA HV


z-Scores: S3 - S
Standard Deviation for Proficiency Assessment 27 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
12 18 14 1 5 20 16 21 7 17 3 15 25
-1.8 -0.8 -0.5 -0.3 -0.3 -0.2 0.1 0.2 0.6 0.6 0.7 1.0

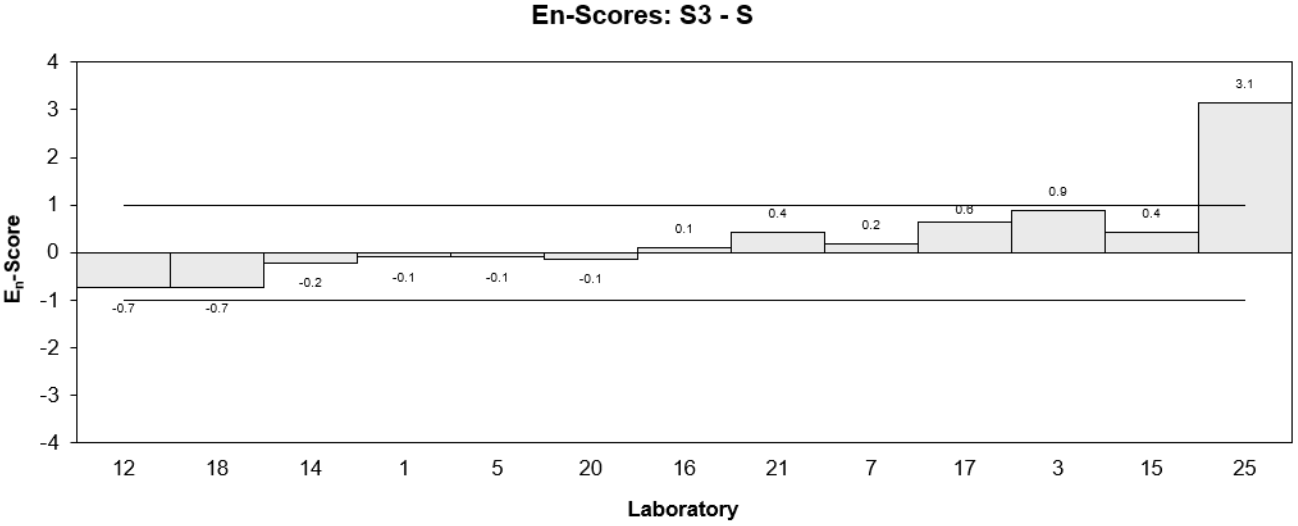

En-Scores: S3 - S
En-Score
Laboratory
12 18 14 1 5 20 16 21 7 17 3 15 25
-0.7 -0.7 -0.2 -0.1 -0.1 -0.1 0.1 0.4 0.2 0.6 0.9 0.4 3.1

Figure 46

Table 58

Sample Details

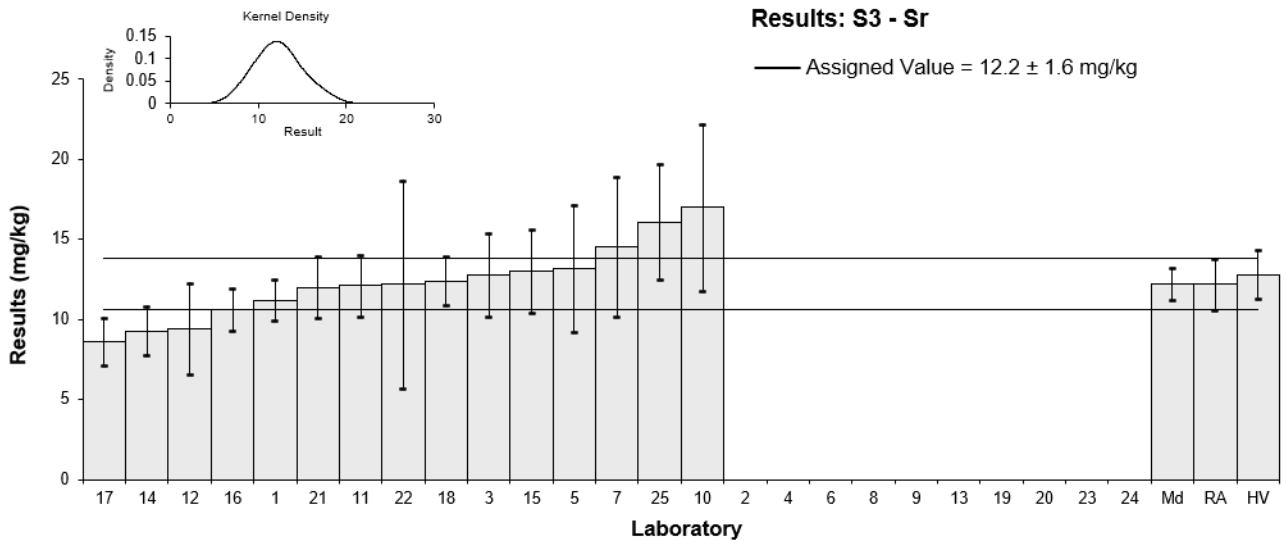
Sample No.	S3
Matrix	Soil
Analyte	Sr
Unit	mg/kg

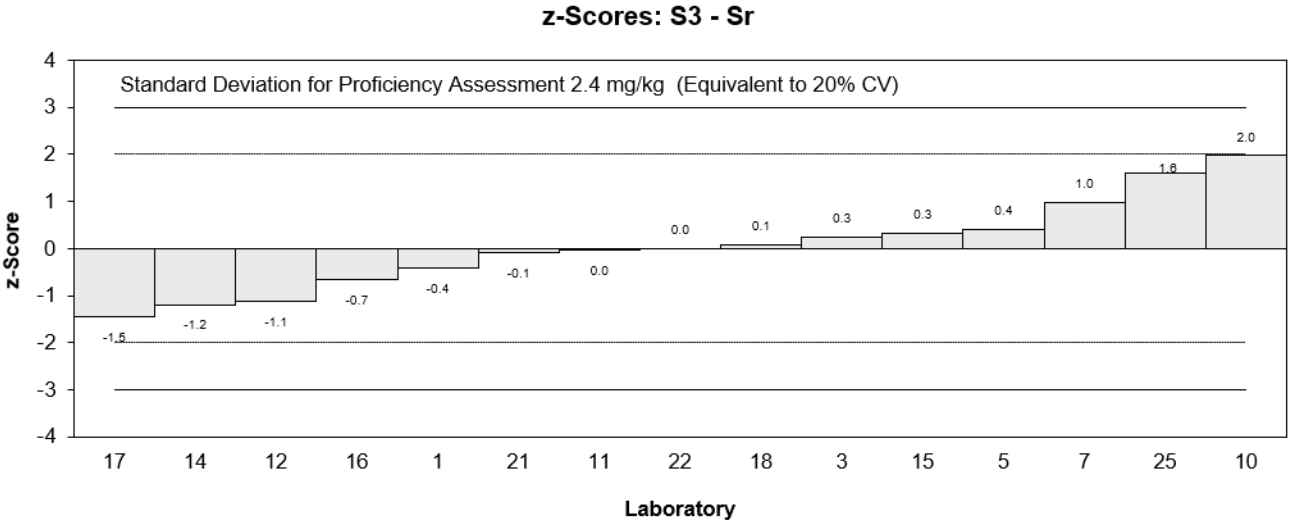
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	11.2	1.3	-0.41	-0.49
2	NT	NT		
3	12.8	2.6	0.25	0.20
4	NT	NT		
5	13.2	3.96	0.41	0.23
6	NT	NT		
7	14.56	4.37	0.97	0.51
8	NT	NT		
9	NT	NT		
10	17	5.2	1.97	0.88
11	12.1	1.9	-0.04	-0.04
12	9.44	2.832	-1.13	-0.85
13	NT	NT		
14	9.29	1.53	-1.19	-1.31
15	13	2.6	0.33	0.26
16	10.616	1.337	-0.65	-0.76
17	8.64	1.49	-1.46	-1.63
18	12.4	1.5	0.08	0.09
19	NT	NT		
20	NR	NR		
21	12	1.94	-0.08	-0.08
22	12.2	6.5	0.00	0.00
23	NT	NT		
24	NR	NR		
25	16.1	3.6	1.60	0.99

Statistics

Assigned Value	12.2	1.6
Spiked Value	Not Spiked	
Homogeneity Value	12.8	1.5
Robust Average	12.2	1.6
Median	12.2	1.0
Mean	12.3	
N	15	
Max	17	
Min	8.64	
Robust SD	2.5	
Robust CV	21%	


Results: S3 - Sr
Assigned Value = 12.2 ± 1.6 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
17 14 12 16 1 21 11 22 18 3 15 5 7 25 10 2 4 6 8 9 13 19 20 23 24 Md RA HV


z-Scores: S3 - Sr
Standard Deviation for Proficiency Assessment 2.4 mg/kg (Equivalent to 20% CV)
z-Score
-1.5 -1.2 -1.1 -0.7 -0.4 -0.1 0.0 0.0 0.1 0.3 0.3 0.4 1.0 1.6 2.0
Laboratory
17 14 12 16 1 21 11 22 18 3 15 5 7 25 10

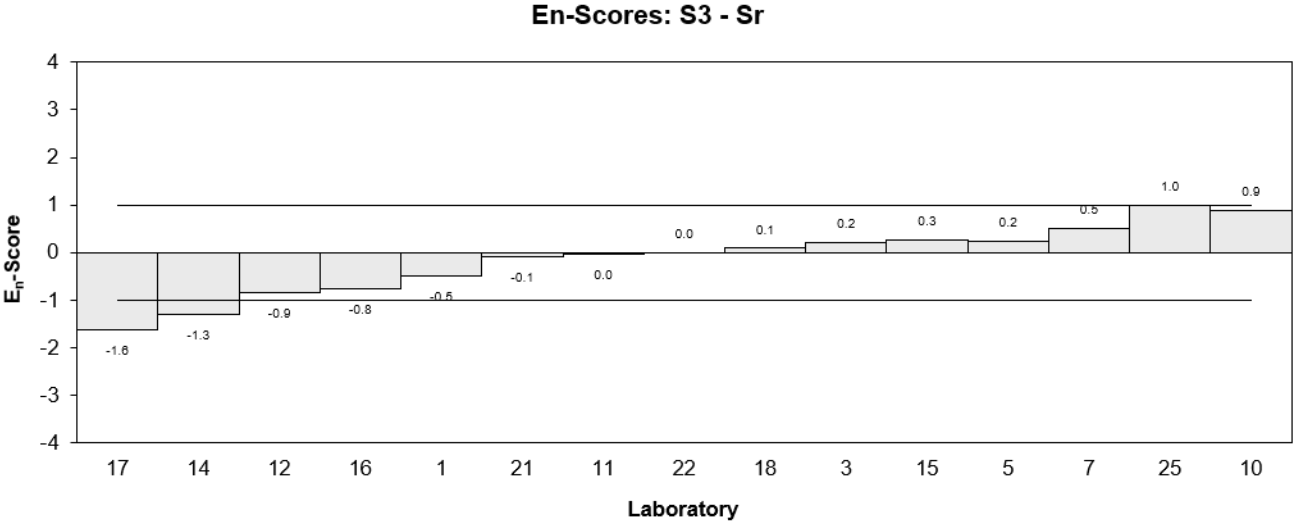

En-Scores: S3 - Sr
En-Score
-1.6 -1.3 -0.9 -0.8 -0.5 -0.1 0.0 0.0 0.1 0.2 0.3 0.2 0.5 1.0 0.9
Laboratory
17 14 12 16 1 21 11 22 18 3 15 5 7 25 10

Figure 47

Table 59

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	NT	NT
4	NT	NT
5	11	3.3
6	NT	NT
7	NT	NT
8	NT	NT
9	NT	NT
10	NT	NT
11	< 5	NR
12	2.16	0.648
13	NT	NT
14	NR	NR
15	1.0	0.2
16	NT	NT
17	1.12	0.11
18	NT	NT
19	NT	NT
20	NR	NR
21	0.71	0.066
22	NT	NT
23	NT	NT
24	NR	NR
25	1.70	0.21

Statistics

Assigned Value	Not Set	
Spiked Value	Not Spiked	
Homogeneity Value	1.43	0.29
Robust Average	1.7	1.1
Median	1.41	0.84
Mean	2.9	
N	6	
Max	11	
Min	0.71	
Robust SD	1.1	
Robust CV	64%	

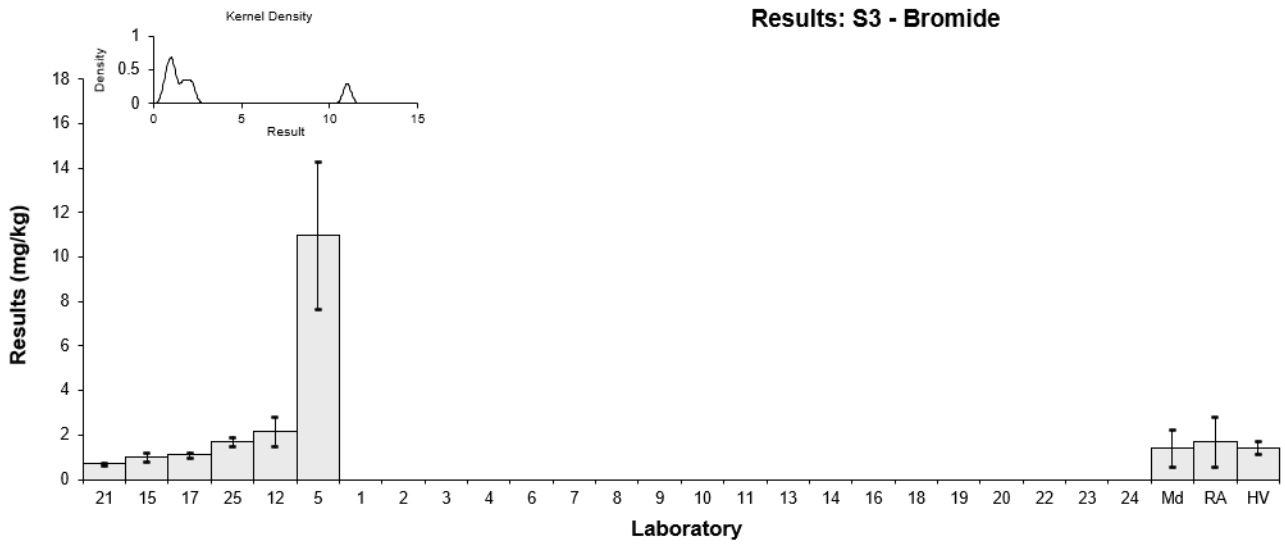

Results: S3 - Bromide
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
21 15 17 25 12 5 1 2 3 4 6 7 8 9 10 11 13 14 16 18 19 20 22 23 24 Md RA HV

Figure 48

Table 60

Sample Details

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

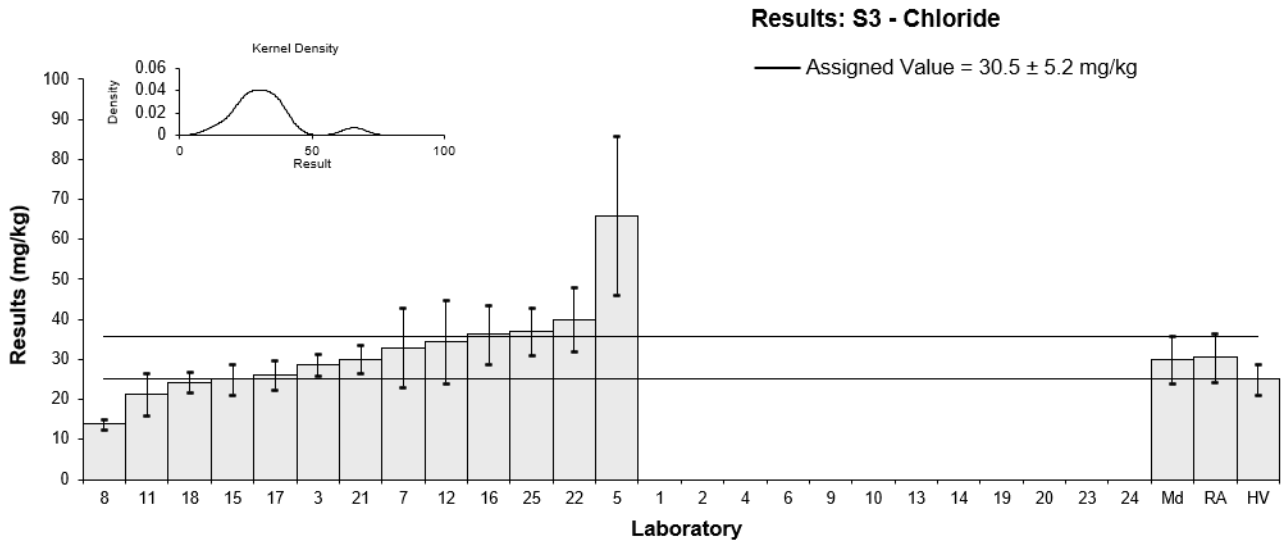
Participant Results

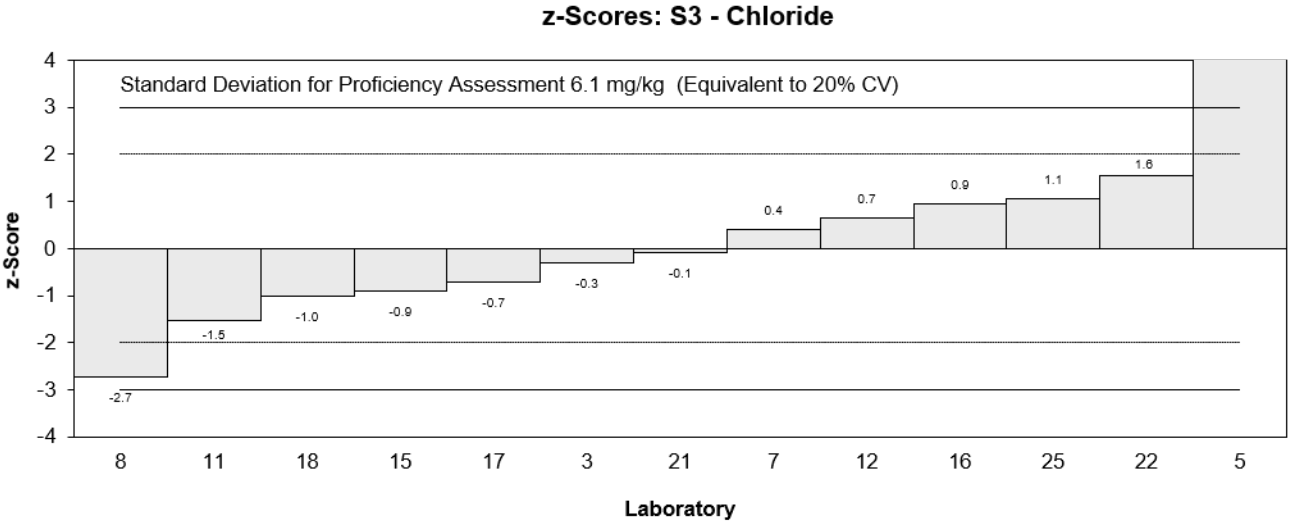
Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	28.6	2.7	-0.31	-0.32
4	NT	NT		
5*	66	19.8	5.82	1.73
6	NT	NT		
7	33	9.9	0.41	0.22
8*	13.8	1.26	-2.74	-3.12
9	NT	NT		
10	NT	NT		
11	21.2	5.3	-1.52	-1.25
12	34.5	10.35	0.66	0.35
13	NT	NT		
14	NR	NR		
15	25	3.8	-0.90	-0.85
16	36.248	7.370	0.94	0.64
17	26.1	3.6	-0.72	-0.70
18	24.3	2.5	-1.02	-1.07
19	NT	NT		
20	NR	NR		
21	30	3.53	-0.08	-0.08
22	40	8	1.56	1.00
23	NT	NT		
24	NR	NR		
25	37	6	1.07	0.82

* Outlier, see Section 4.2

Statistics

Assigned Value	30.5	5.2
Spiked Value	Not Spiked	
Homogeneity Value	25.0	3.8
Robust Average	30.5	6.0
Median	30.0	5.9
Mean	32.0	
N	13	
Max	66	
Min	13.8	
Robust SD	8.7	
Robust CV	28%	


Results: S3 - Chloride
Assigned Value = 30.5 ± 5.2 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
8 11 18 15 17 3 21 7 12 16 25 22 5 1 2 4 6 9 10 13 14 19 20 23 24 Md RA HV


z-Scores: S3 - Chloride
Standard Deviation for Proficiency Assessment 6.1 mg/kg (Equivalent to 20% CV)
z-Score
Laboratory
8 11 18 15 17 3 21 7 12 16 25 22 5
-2.7 -1.5 -1.0 -0.9 -0.7 -0.3 -0.1 0.4 0.7 0.9 1.1 1.6

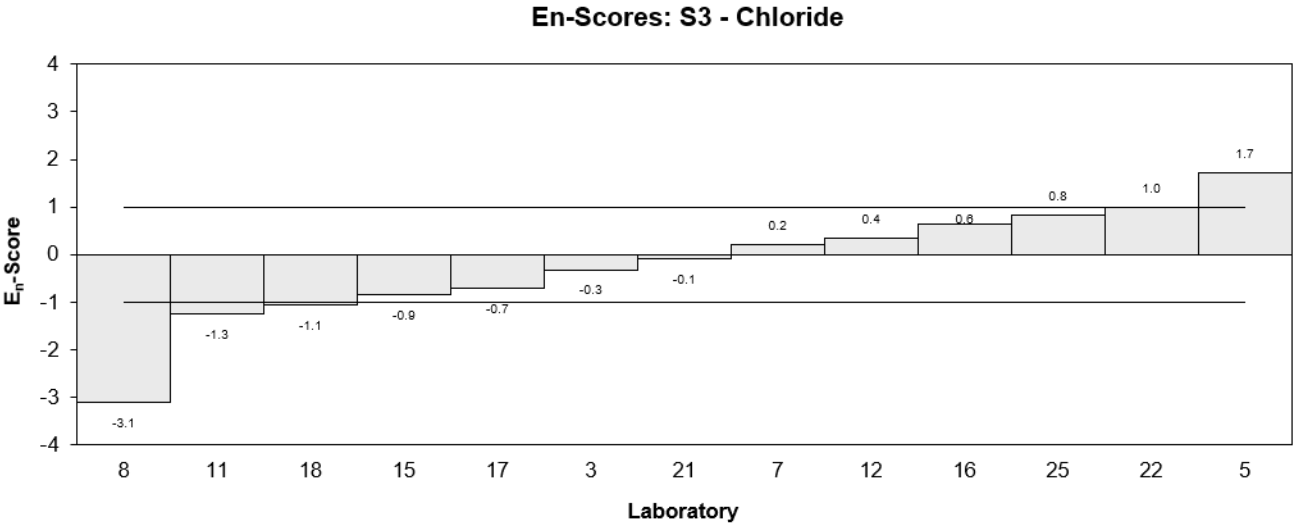

En-Scores: S3 - Chloride
En-Score
Laboratory
8 11 18 15 17 3 21 7 12 16 25 22 5
-3.1 -1.3 -1.1 -0.9 -0.7 -0.3 -0.1 0.2 0.4 0.6 0.8 1.0 1.7

Figure 49

Table 61

Sample Details

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

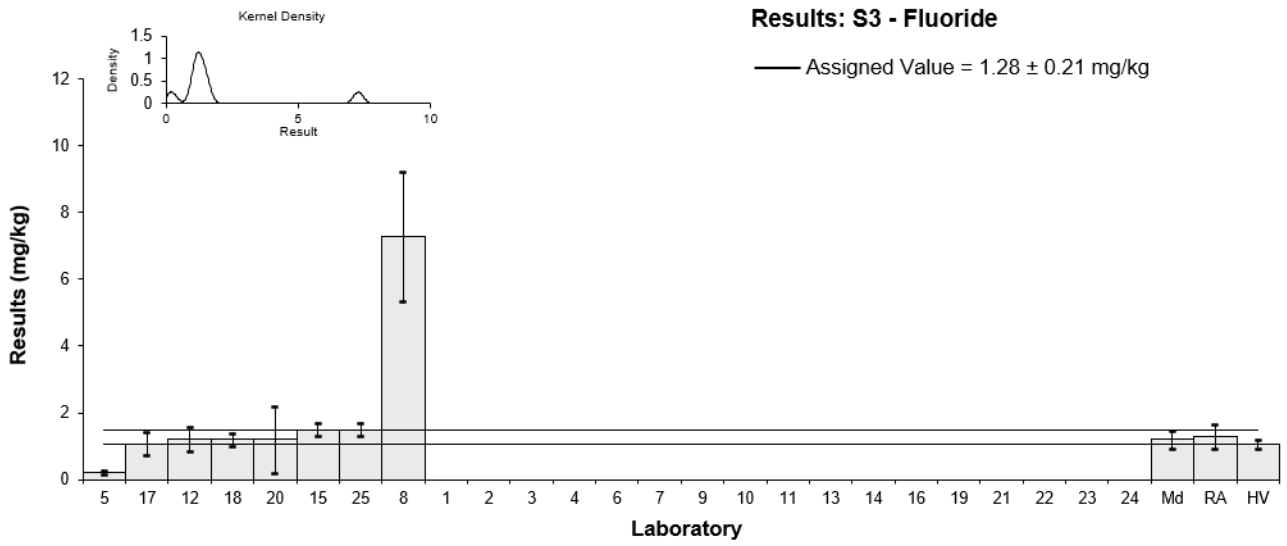
Participant Results

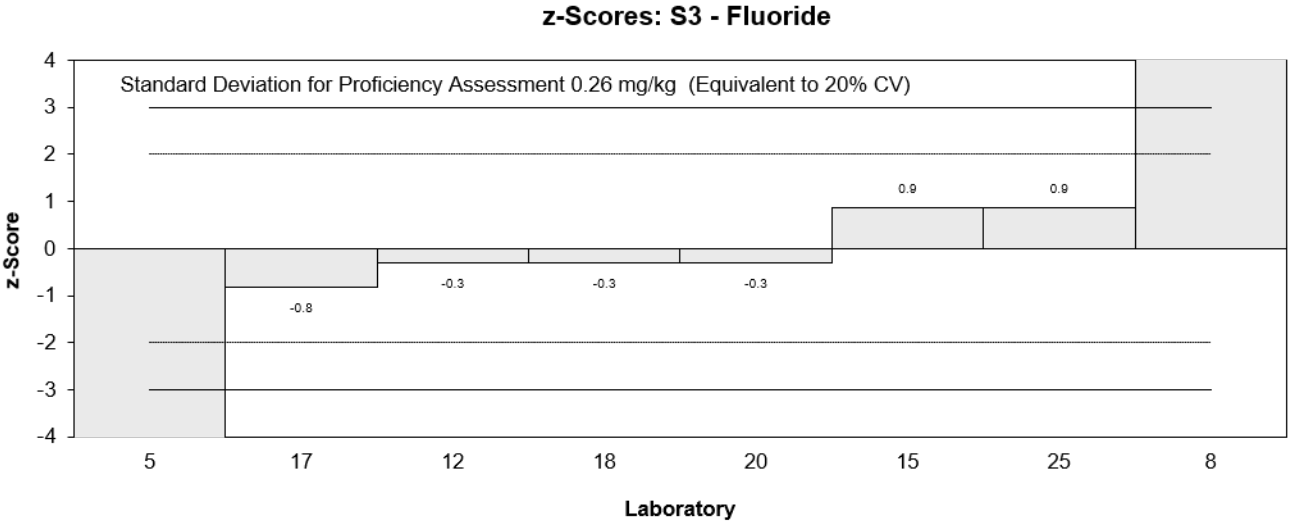
Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	NT	NT		
4	NT	NT		
5*	0.21	0.06	-4.18	-4.90
6	NT	NT		
7	NT	NT		
8*	7.28	1.94	23.44	3.07
9	NT	NT		
10	NT	NT		
11	NT	NT		
12	1.2	0.36	-0.31	-0.19
13	NT	NT		
14	NR	NR		
15	1.5	0.2	0.86	0.76
16	NT	NT		
17	1.07	0.34	-0.82	-0.53
18	1.2	0.2	-0.31	-0.28
19	NT	NT		
20	1.2	1	-0.31	-0.08
21	<1	NR		
22	NT	NT		
23	NT	NT		
24	NR	NR		
25	1.5	0.2	0.86	0.76

* Outlier, see Section 4.2

Statistics

Assigned Value	1.28	0.21
Spiked Value	Not Spiked	
Homogeneity Value	1.07	0.14
Robust Average	1.28	0.36
Median	1.20	0.28
Mean	1.9	
N	8	
Max	7.28	
Min	0.21	
Robust SD	0.41	
Robust CV	32%	


Results: S3 - Fluoride
Assigned Value = 1.28 ± 0.21 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
5 17 12 18 20 15 25 8 1 2 3 4 6 7 9 10 11 13 14 16 19 21 22 23 24 Md RA HV


z-Scores: S3 - Fluoride
Standard Deviation for Proficiency Assessment 0.26 mg/kg (Equivalent to 20% CV)
z-Score
-0.8
-0.3
-0.3
-0.3
0.9
0.9
Laboratory
5 17 12 18 20 15 25 8

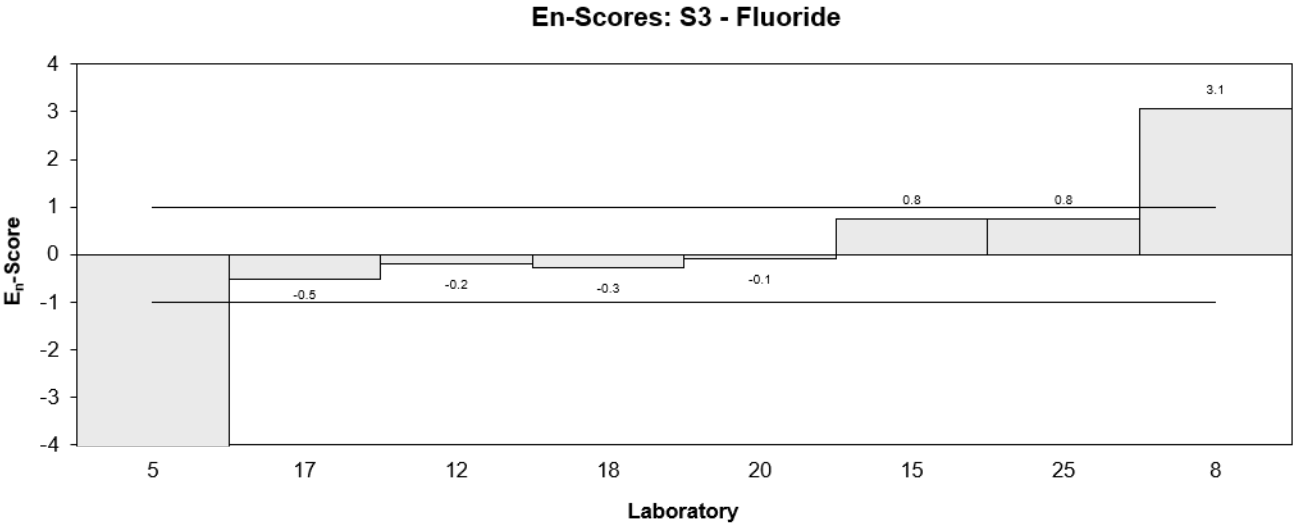

En-Scores: S3 - Fluoride
En-Score
-0.5
-0.2
-0.3
-0.1
0.8
0.8
3.1
Laboratory
5 17 12 18 20 15 25 8

Figure 50

Table 62

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	NT	NT
4	NT	NT
5	1.84	0.552
6	NT	NT
7	NT	NT
8	NT	NT
9	NT	NT
10	NT	NT
11	32.8	8.2
12	<0.2	<0.2
13	NT	NT
14	NR	NR
15	<1	NR
16	NT	NT
17	2.03	0.20
18	NT	NT
19	NT	NT
20	NR	NR
21	0.98	0.159
22	NT	NT
23	NT	NT
24	NR	NR
25	0.35	0.05

Statistics

Assigned Value	Not Set	
Spiked Value	Not Spiked	
Robust Average	NA (N<6)	
Median	1.8	1.4
Mean	8	
N	5	
Max	32.8	
Min	0.35	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

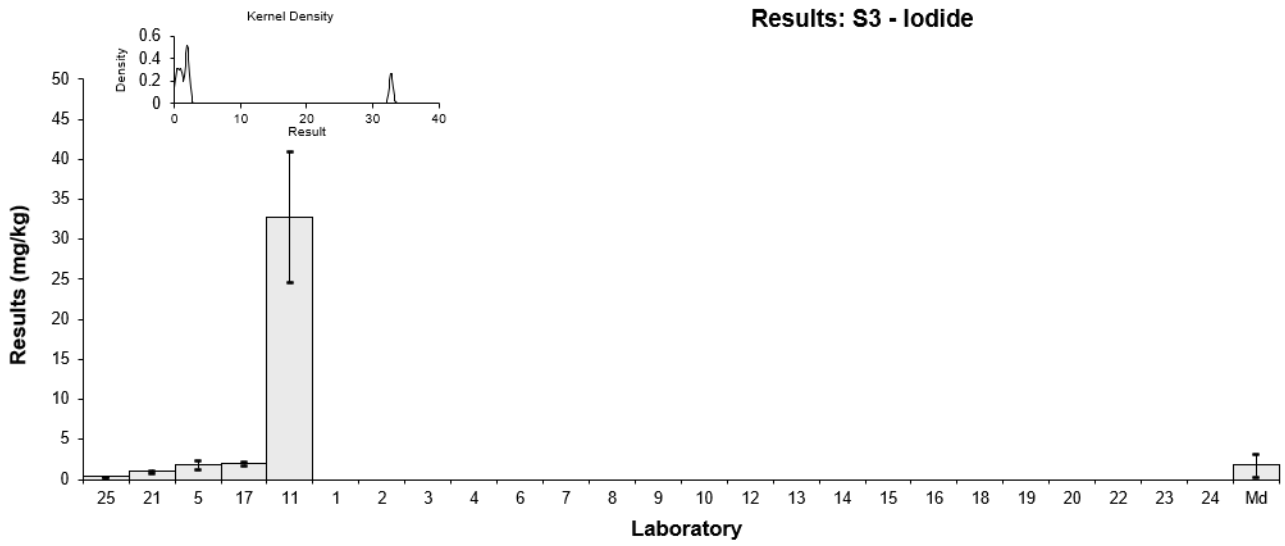

Results: S3 - Iodide
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
25 21 5 17 11 1 2 3 4 6 7 8 9 10 12 13 14 15 16 18 19 20 22 23 24 Md

Figure 51

Table 63

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	NT	NT
4	NT	NT
5	0.56	0.168
6	NT	NT
7	< 10	NR
8	1.48	0.22
9	NT	NT
10	NT	NT
11	NT	NT
12	1.18	0.354
13	NT	NT
14	NR	NR
15	<1	NR
16	0.215	0.03
17	0.284	0.030
18	1.65	0.2
19	NT	NT
20	NR	NR
21	0.4	0.041
22	< 1	NR
23	NT	NT
24	NR	NR
25	0.29	0.08

Statistics

Assigned Value	Not Set	
Spiked Value	Not Spiked	
Robust Average	0.76	0.59
Median	0.48	0.30
Mean	0.76	
N	8	
Max	1.65	
Min	0.215	
Robust SD	0.66	
Robust CV	88%	

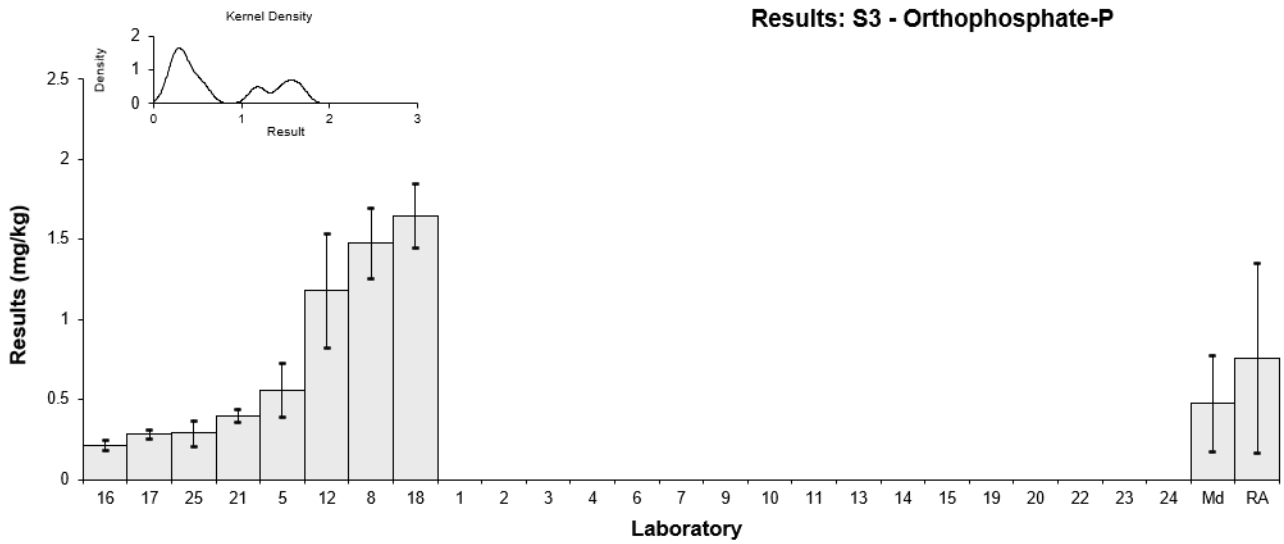

Results: S3 - Orthophosphate-P
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
16 17 25 21 5 12 8 18 1 2 3 4 6 7 9 10 11 13 14 15 19 20 22 23 24 Md RA

Figure 52

Table 64

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	96.4	6.9
4	NT	NT
5	30.7	9.21
6	NT	NT
7	83.2	23
8	85	5
9	NT	NT
10	NT	NT
11	98.5	24.6
12	151.7	45.51
13	NT	NT
14	NR	NR
15	85	13
16	153.562	24.08549
17	169	10
18	151	15
19	NT	NT
20	NR	NR
21	100	17.77
22	< 250	NR
23	NT	NT
24	NR	NR
25	175	32

Statistics

Assigned Value	Not Set	
Spiked Value	Not Spiked	
Homogeneity Value	92	14
Robust Average	116	34
Median	99	36
Mean	115	
N	12	
Max	175	
Min	30.7	
Robust SD	47	
Robust CV	41%	

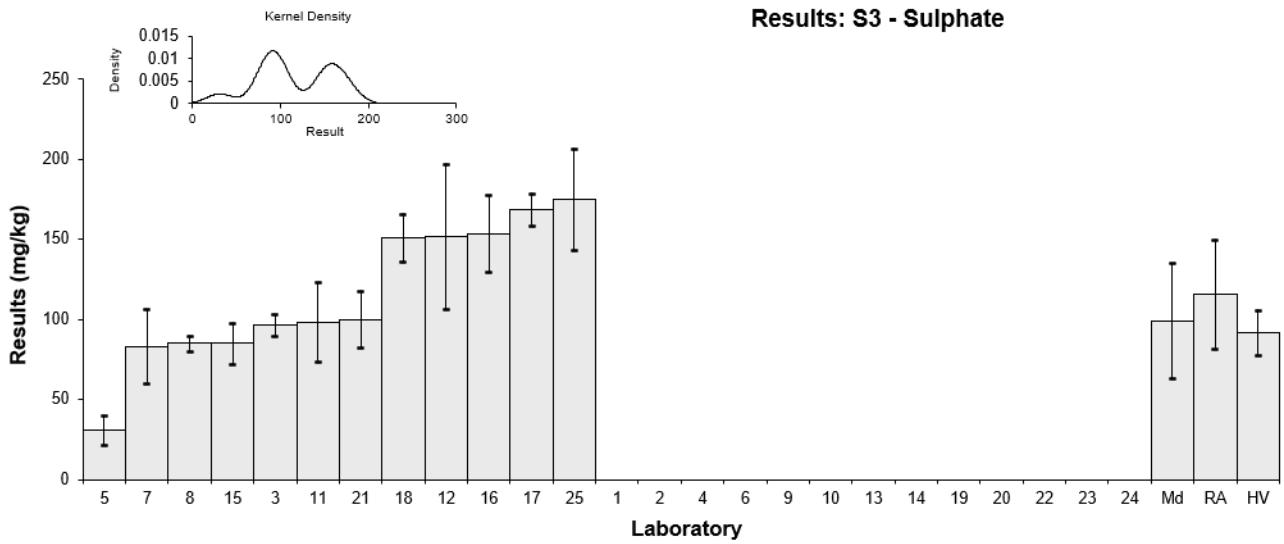

Results: S3 - Sulphate
Kernel Density
Density
0.015
0.01
0.005
0
0
100
200
300
Result
Results (mg/kg)
250
200
150
100
50
0
5
7
8
15
3
11
21
18
12
16
17
25
1
2
4
6
9
10
13
14
19
20
22
23
24
Md
RA
HV
Laboratory

Figure 53

Table 65

Sample Details

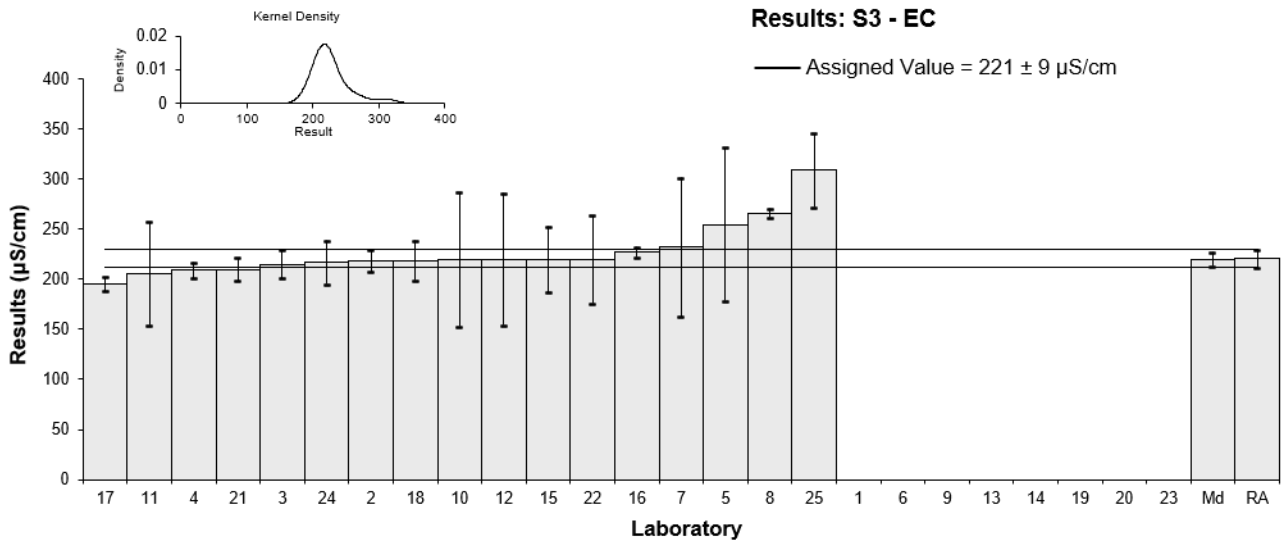
Sample No.	S3
Matrix	Soil
Analyte	EC
Unit	µS/cm

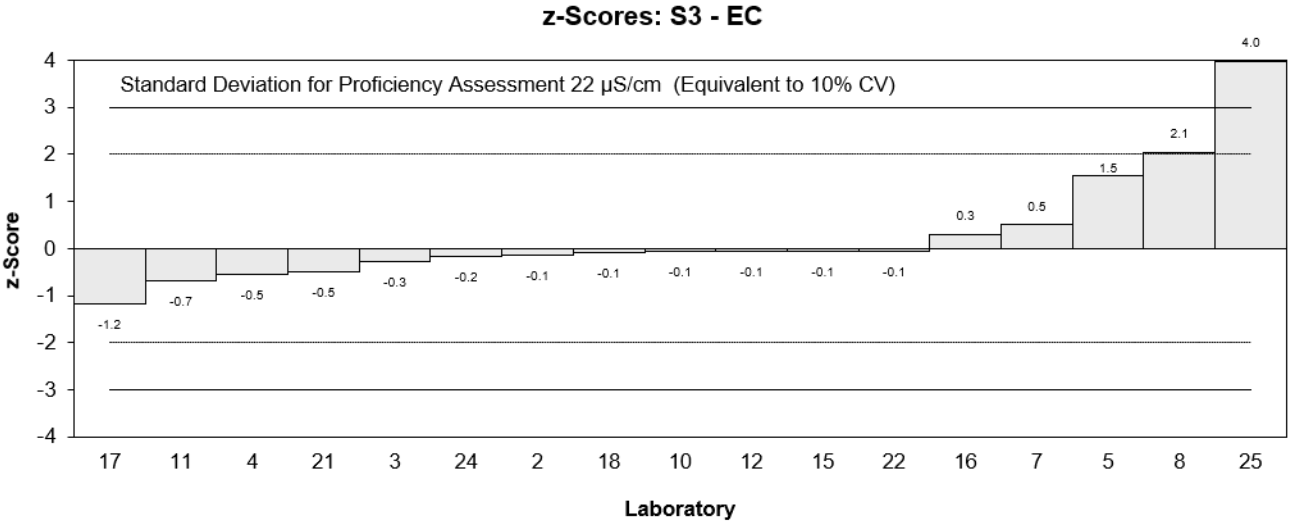
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	218	11	-0.14	-0.21
3	215	14	-0.27	-0.36
4	209	8	-0.54	-1.00
5	255	76.5	1.54	0.44
6	NT	NT		
7	232	69.6	0.50	0.16
8	266.33	4.50	2.05	4.50
9	NT	NT		
10	220	67	-0.05	-0.01
11	205.9	51.5	-0.68	-0.29
12	220	66	-0.05	-0.02
13	NT	NT		
14	NR	NR		
15	220	33	-0.05	-0.03
16	227.317	5.168	0.29	0.61
17	195	7	-1.18	-2.28
18	219	20	-0.09	-0.09
19	NT	NT		
20	NR	NR		
21	210	11.41	-0.50	-0.76
22	220	44	-0.05	-0.02
23	NT	NT		
24	217	22	-0.18	-0.17
25	309	37	3.98	2.31

Statistics

Assigned Value	221	9
Spiked Value	Not Spiked	
Robust Average	221	9
Median	220	7
Mean	227	
N	17	
Max	309	
Min	195	
Robust SD	15	
Robust CV	6.6%	


Kernel Density
Density
Result
Results: S3 - EC
Assigned Value = 221 ± 9 µS/cm
Results (µS/cm)
Laboratory
17 11 4 21 3 24 2 18 10 12 15 22 16 7 5 8 25 1 6 9 13 14 19 20 23 Md RA


z-Scores: S3 - EC
Standard Deviation for Proficiency Assessment 22 µS/cm (Equivalent to 10% CV)
z-Score
Laboratory
17 11 4 21 3 24 2 18 10 12 15 22 16 7 5 8 25

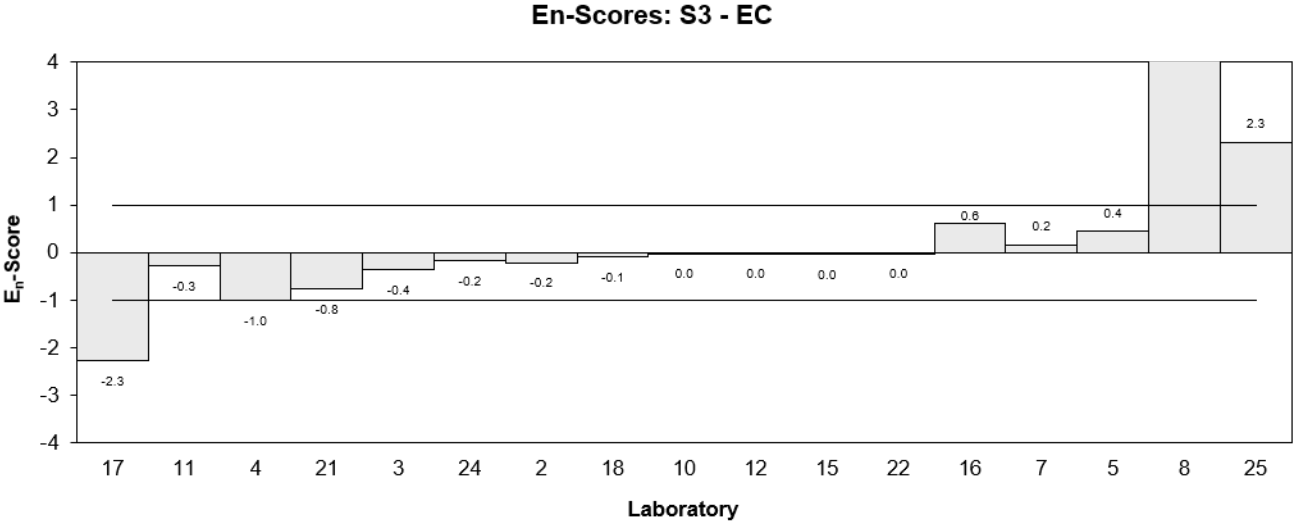

En-Scores: S3 - EC
En-Score
Laboratory
17 11 4 21 3 24 2 18 10 12 15 22 16 7 5 8 25

Figure 54

Table 66

Sample Details

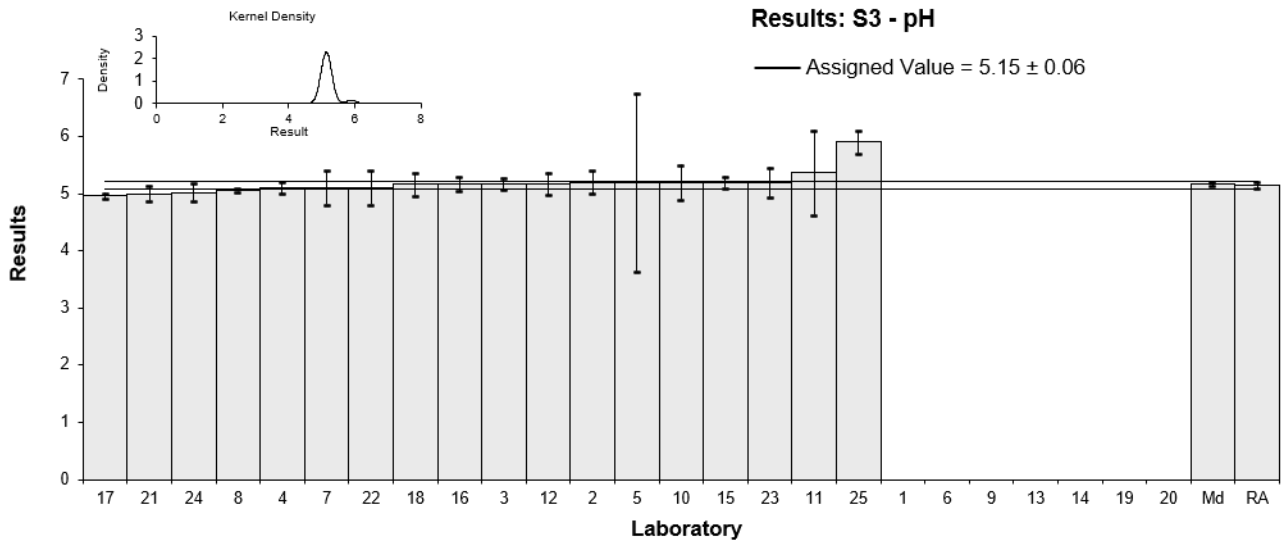
Sample No.	S3
Matrix	Soil
Analyte	pH

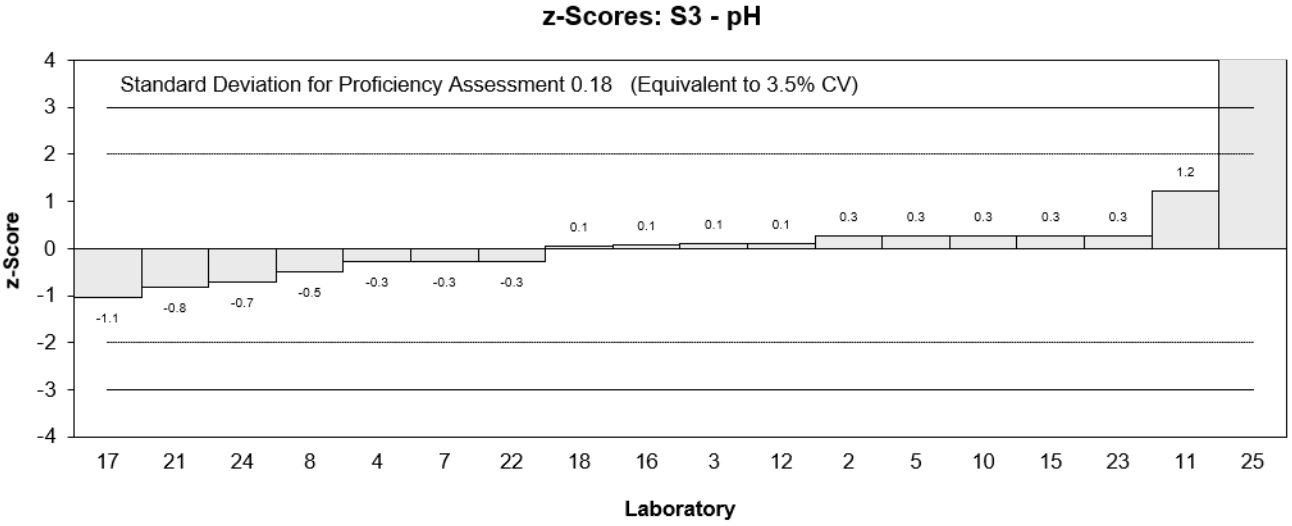
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	5.2	0.2	0.28	0.24
3	5.17	0.09	0.11	0.18
4	5.1	0.1	-0.28	-0.43
5	5.2	1.56	0.28	0.03
6	NT	NT		
7	5.1	0.3	-0.28	-0.16
8	5.06	0.03	-0.50	-1.34
9	NT	NT		
10	5.2	0.30	0.28	0.16
11	5.37	0.74	1.22	0.30
12	5.17	0.2	0.11	0.10
13	NT	NT		
14	NR	NR		
15	5.2	0.1	0.28	0.43
16	5.164	0.12	0.08	0.10
17	4.96	0.05	-1.05	-2.43
18	5.16	0.2	0.06	0.05
19	NT	NT		
20	NR	NR		
21	5.0	0.13	-0.83	-1.05
22	5.1	0.3	-0.28	-0.16
23	5.2	0.26	0.28	0.19
24	5.02	0.15	-0.72	-0.80
25	5.9	0.2	4.16	3.59

Statistics

Assigned Value	5.15	0.06
Spiked Value	Not Spiked	
Robust Average	5.15	0.06
Median	5.17	0.04
Mean	5.18	
N	18	
Max	5.9	
Min	4.96	
Robust SD	0.1	
Robust CV	2%	


Results: S3 - pH
Kernel Density
Density
Result
Assigned Value = 5.15 ± 0.06
Results
17 21 24 8 4 7 22 18 16 3 12 2 5 10 15 23 11 25 1 6 9 13 14 19 20 Md RA
Laboratory


z-Scores: S3 - pH
Standard Deviation for Proficiency Assessment 0.18 (Equivalent to 3.5% CV)
z-Score
-1.1 -0.8 -0.7 -0.5 -0.3 -0.3 -0.3 0.1 0.1 0.1 0.1 0.3 0.3 0.3 0.3 0.3 1.2
17 21 24 8 4 7 22 18 16 3 12 2 5 10 15 23 11 25
Laboratory

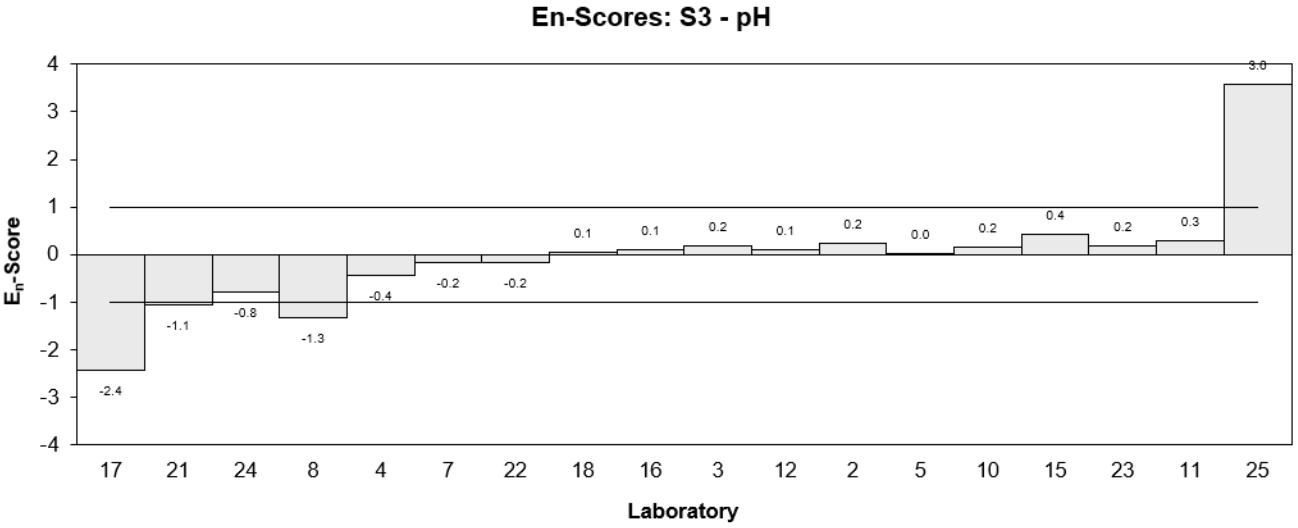

En-Scores: S3 - pH
En-Score
-2.4 -1.1 -0.8 -1.3 -0.4 -0.2 -0.2 0.1 0.1 0.2 0.1 0.2 0.0 0.2 0.4 0.2 0.3 3.6
17 21 24 8 4 7 22 18 16 3 12 2 5 10 15 23 11 25
Laboratory

Figure 55

Table 67

Sample Details

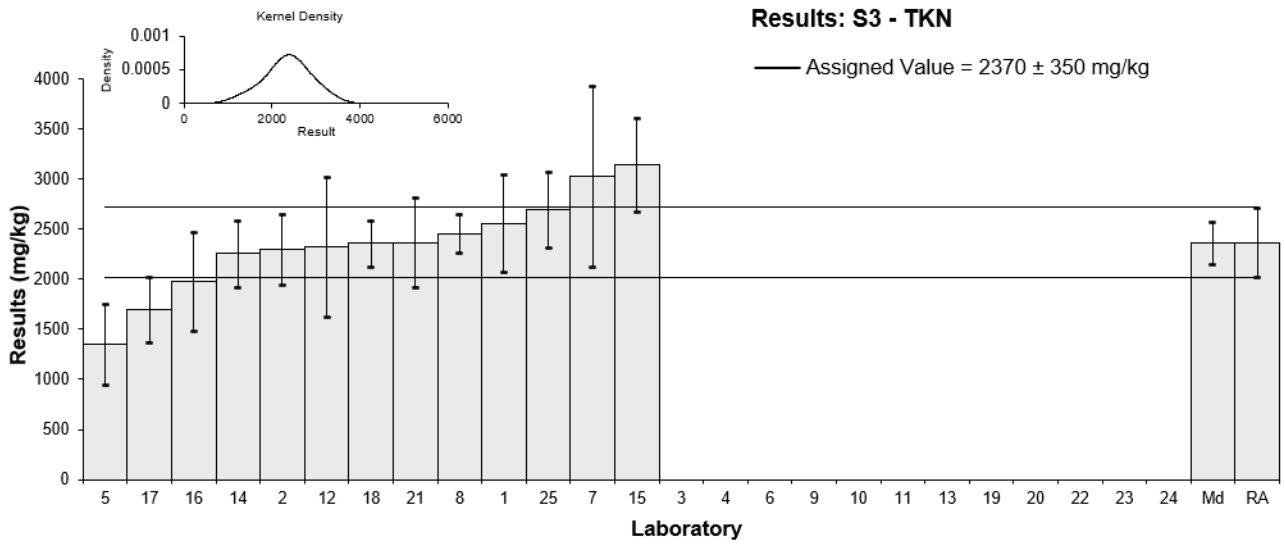
Sample No.	S3
Matrix	Soil
Analyte	TKN
Unit	mg/kg

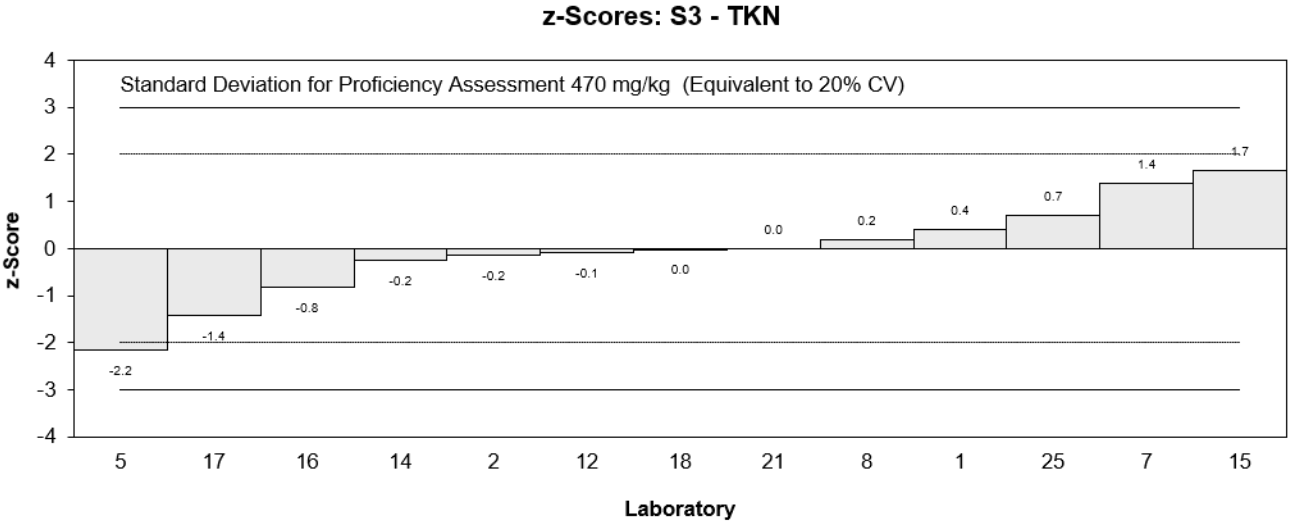
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	2560	490	0.40	0.32
2	2300	350	-0.15	-0.14
3	NT	NT		
4	NT	NT		
5	1349	404.7	-2.15	-1.91
6	NT	NT		
7	3031	909	1.39	0.68
8	2459.76	195.93	0.19	0.22
9	NT	NT		
10	NT	NT		
11	NT	NT		
12	2332	699	-0.08	-0.05
13	NT	NT		
14	2256	338	-0.24	-0.23
15	3150	470	1.65	1.33
16	1982.41	495.7	-0.82	-0.64
17	1700	331	-1.41	-1.39
18	2359	236	-0.02	-0.03
19	NT	NT		
20	NR	NR		
21	2370	453.28	0.00	0.00
22	NT	NT		
23	NT	NT		
24	NR	NR		
25	2700	378	0.70	0.64

Statistics

Assigned Value	2370	350
Spiked Value	Not Spiked	
Robust Average	2370	350
Median	2360	210
Mean	2350	
N	13	
Max	3150	
Min	1349	
Robust SD	500	
Robust CV	21%	


Results: S3 - TKN
Assigned Value = 2370 ± 350 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
5 17 16 14 2 12 18 21 8 1 25 7 15 3 4 6 9 10 11 13 19 20 22 23 24 Md RA


z-Scores: S3 - TKN
Standard Deviation for Proficiency Assessment 470 mg/kg (Equivalent to 20% CV)
z-Score
Laboratory
5 17 16 14 2 12 18 21 8 1 25 7 15
-2.2 -1.4 -0.8 -0.2 -0.2 -0.1 0.0 0.0 0.2 0.4 0.7 1.4 1.7

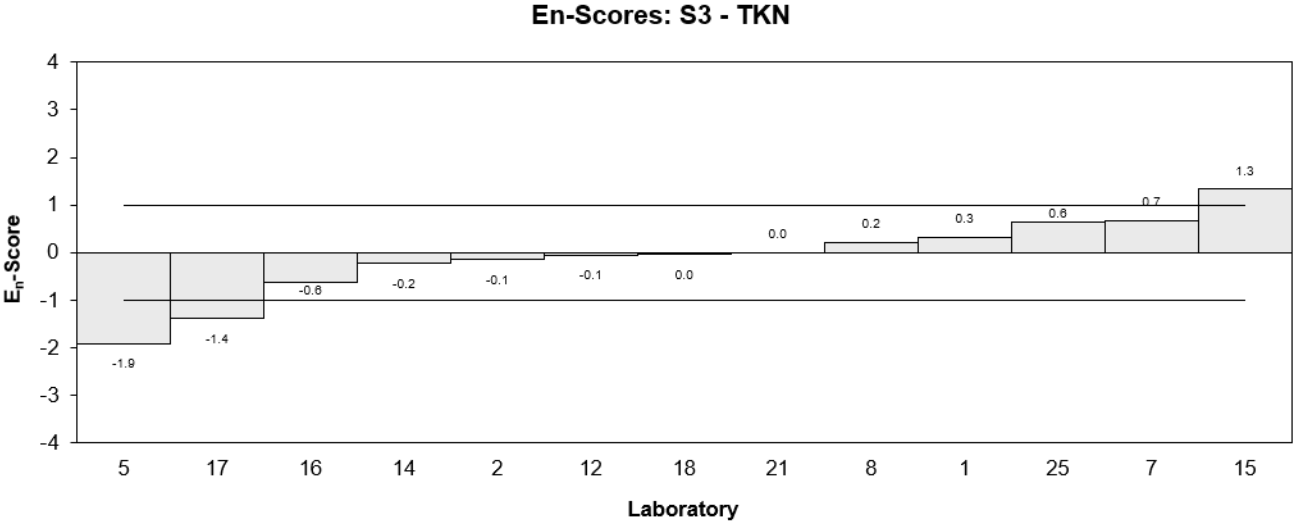

En-Scores: S3 - TKN
En-Score
Laboratory
5 17 16 14 2 12 18 21 8 1 25 7 15
-1.9 -1.4 -0.6 -0.2 -0.1 -0.1 0.0 0.0 0.2 0.3 0.6 0.7 1.3

Figure 56

Table 68

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	2M KCl Ext Ammonium-N
Unit	mg/kg

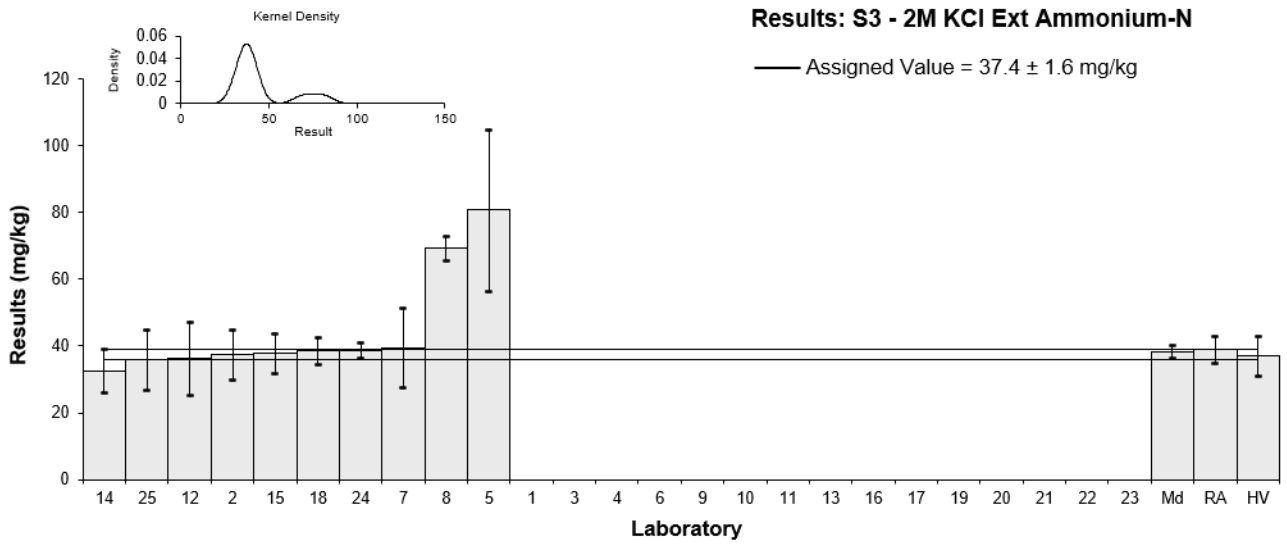
Participant Results

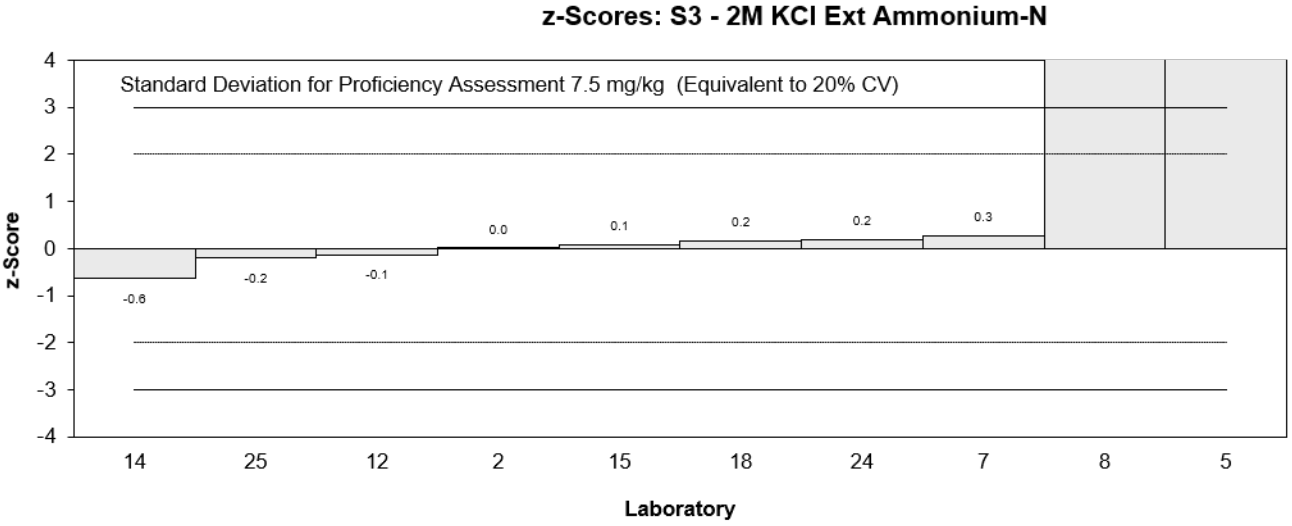
Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	37.5	7.5	0.01	0.01
3	NT	NT		
4	NT	NT		
5*	80.8	24.24	5.80	1.79
6	NT	NT		
7	39.5	11.85	0.28	0.18
8*	69.4	3.6	4.28	8.12
9	NT	NT		
10	NT	NT		
11	NT	NT		
12	36.41	10.92	-0.13	-0.09
13	NT	NT		
14	32.6	6.52	-0.64	-0.71
15	38	6	0.08	0.10
16	NT	NT		
17	NT	NT		
18	38.7	4.0	0.17	0.30
19	NT	NT		
20	NR	NR		
21	NR	NR		
22	NT	NT		
23	NT	NT		
24	38.77	2.36	0.18	0.48
25	36	9	-0.19	-0.15

* Outlier, see Section 4.2

Statistics

Assigned Value	37.4	1.6
Spiked Value	Not Spiked	
Homogeneity Value	37.0	5.9
Robust Average	39.0	3.9
Median	38.4	1.8
Mean	45	
N	10	
Max	80.8	
Min	32.6	
Robust SD	4.9	
Robust CV	13%	


Kernel Density
Density
Result
Results: S3 - 2M KCl Ext Ammonium-N
Assigned Value = 37.4 ± 1.6 mg/kg
Results (mg/kg)
Laboratory
14 25 12 2 15 18 24 7 8 5 1 3 4 6 9 10 11 13 16 17 19 20 21 22 23 Md RA HV


z-Scores: S3 - 2M KCl Ext Ammonium-N
Standard Deviation for Proficiency Assessment 7.5 mg/kg (Equivalent to 20% CV)
z-Score
-0.6 -0.2 -0.1 0.0 0.1 0.2 0.2 0.3
Laboratory
14 25 12 2 15 18 24 7 8 5

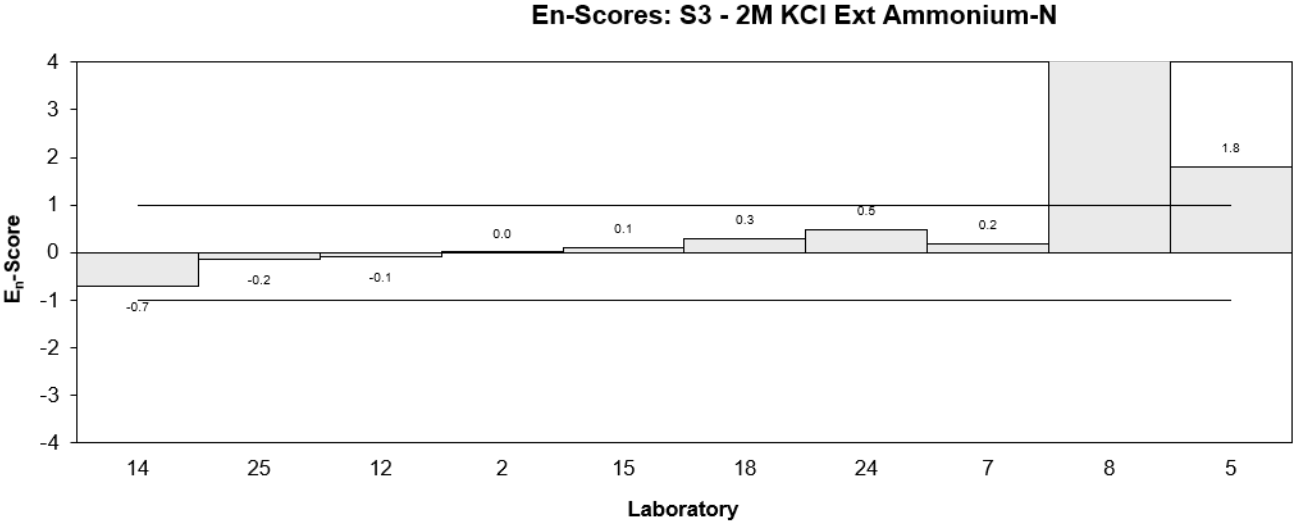

En-Scores: S3 - 2M KCl Ext Ammonium-N
En-Score
-0.7 -0.2 -0.1 0.0 0.1 0.3 0.5 0.2 1.8
Laboratory
14 25 12 2 15 18 24 7 8 5

Figure 57

Table 69

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	2M KCl Ext Nitrate-N
Unit	mg/kg

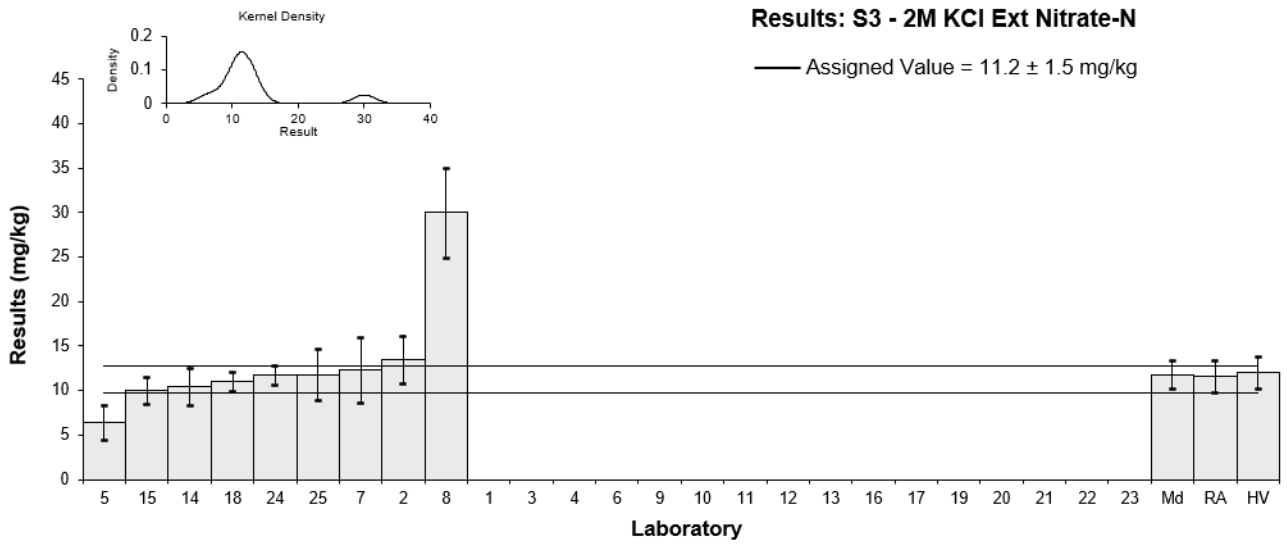
Participant Results

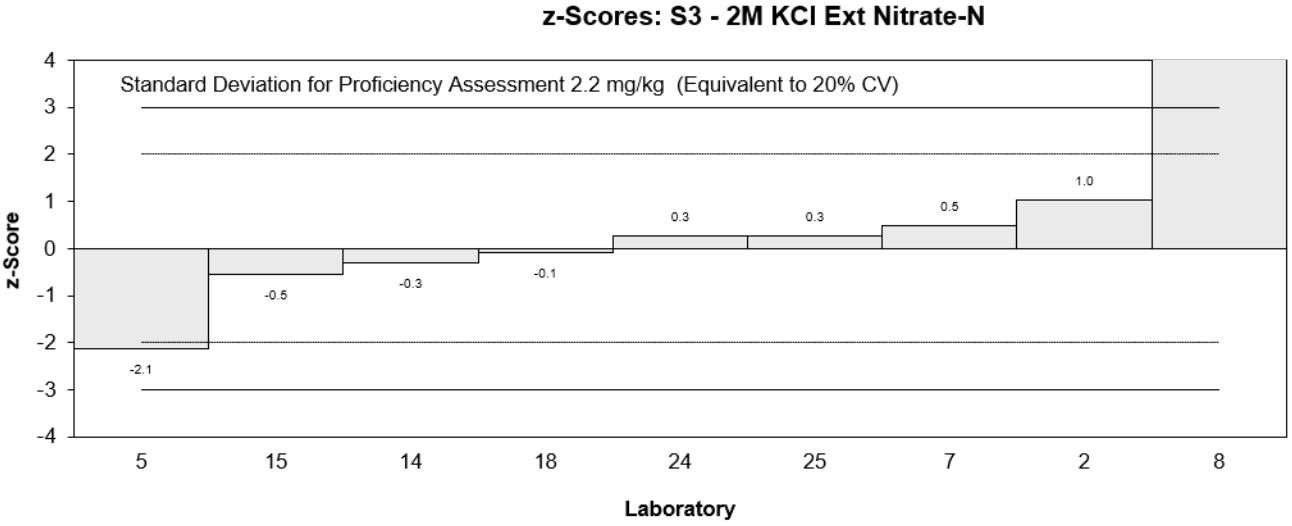
Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	13.5	2.7	1.03	0.74
3	NT	NT		
4	NT	NT		
5	6.46	1.93	-2.12	-1.94
6	NT	NT		
7	12.3	3.69	0.49	0.28
8*	30	5	8.39	3.60
9	NT	NT		
10	NT	NT		
11	NT	NT		
12	NT	NT		
13	NT	NT		
14	10.51	2.1	-0.31	-0.27
15	10	1.5	-0.54	-0.57
16	NT	NT		
17	NT	NT		
18	11.0	1.1	-0.09	-0.11
19	NT	NT		
20	NR	NR		
21	NR	NR		
22	NT	NT		
23	NT	NT		
24	11.79	1.11	0.26	0.32
25	11.8	2.9	0.27	0.18

* Outlier, see Section 4.2

Statistics

Assigned Value	11.2	1.5
Spiked Value	Not Spiked	
Homogeneity Value	12.0	1.8
Robust Average	11.6	1.8
Median	11.8	1.6
Mean	13.0	
N	9	
Max	30	
Min	6.46	
Robust SD	2.2	
Robust CV	19%	


Kernel Density
Density
Result
Results: S3 - 2M KCl Ext Nitrate-N
Assigned Value = 11.2 ± 1.5 mg/kg
Results (mg/kg)
Laboratory
5 15 14 18 24 25 7 2 8 1 3 4 6 9 10 11 12 13 16 17 19 20 21 22 23 Md RA HV


z-Scores: S3 - 2M KCl Ext Nitrate-N
Standard Deviation for Proficiency Assessment 2.2 mg/kg (Equivalent to 20% CV)
z-Score
-2.1
-0.5
-0.3
-0.1
0.3
0.3
0.5
1.0
Laboratory
5 15 14 18 24 25 7 2 8

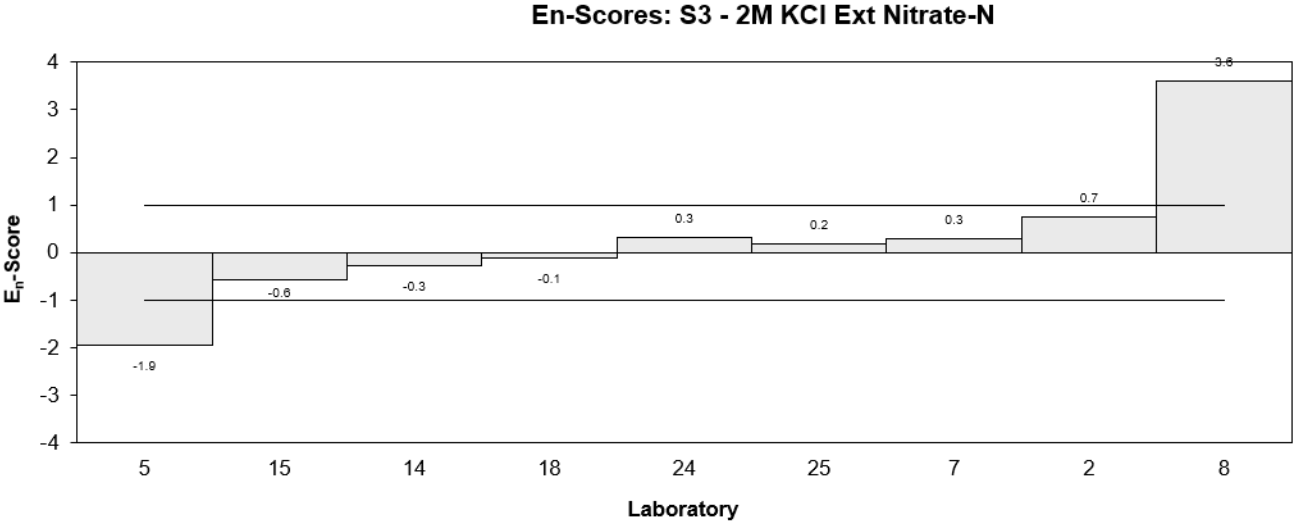

En-Scores: S3 - 2M KCl Ext Nitrate-N
En-Score
-1.9
-0.6
-0.3
-0.1
0.3
0.2
0.3
0.7
3.6
Laboratory
5 15 14 18 24 25 7 2 8

Figure 58

6 DISCUSSION OF RESULTS

6.1 Assigned Value

Assigned values for the tests in the study samples were the robust averages of participants' results. The robust averages and their associated expanded uncertainties were calculated using the procedure described in ISO13528. Results less than 50% and more than 150% of the robust average were removed before the calculation of each assigned value.[4,7] Appendix 2 sets out the calculation for the expanded uncertainty of the robust average of As in Sample S1.

No assigned value was set for Ga, Sb, and U in S1, Co, Cr, Mo, Ni, and Sn in S2, and bromide, iodide, orthophosphate-P, and sulphate in S3 because the reported results were either too few or too variable. However, participants may still compare their reported results for some of these tests with the other participants' results, with the median of participants' results and/or the homogeneity value. Descriptive statistics for these analytes are presented in Section 5.

Traceability: The consensus of participants' results is not traceable to any external reference, so although expressed in SI units, metrological traceability 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. It is a requirement of ISO/IEC 17025 that laboratories have procedures to evaluate the uncertainty of chemical measurements and to report this in specific circumstances, including when the client's instruction so requires.[9] Of 759 numerical results, 752 (99%) were reported with an expanded measurement uncertainty. The magnitude of these expanded uncertainties was within the range 0.29% to 83% of the reported value. The participants used a wide variety of procedures to evaluate their expanded measurement uncertainties. These are presented in Table 11.

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 evaluations of method and laboratory bias, and top-down approach using only the reproducibility from interlaboratory comparison studies.[10 – 15]

Participation in PT programs allows laboratories to check that their evaluations of measurement uncertainty are reasonable. Results and the expanded MU are presented in the bar charts for each analyte in this study (Figures 2 to 58). As a simple rule of thumb, when the uncertainty evaluation is smaller than uncertainty of the assigned value, or larger than the uncertainty of the assigned value plus twice the SDPA, then this should be reviewed as suspect. For example, 18 laboratories reported results for Cu in S1. The uncertainty of the assigned value evaluated from the robust standard deviation of the 18 laboratories' results is 1.1 mg/kg (5% relative). Laboratory 3 might have underestimated their expanded measurement uncertainty of 0.2 mg/kg (0.9% relative) as 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 1.17 mg/kg calculated from the uncertainty of the assigned value 0.24 mg/kg plus the allowable variation from the assigned value, the SDPA of 0.467 mg/kg, multiplied by 2, the coverage factor for a confidence interval of 95% (37% relative), should also be viewed as suspect. For example, the expanded measurement uncertainty reported by Laboratory 22 for Se in S2 of 2 mg/kg might have been overestimated.

Laboratories 3, 8, 17, 18, and 20 should review their procedure for evaluating measurement uncertainty as some of their uncertainties may have been underestimated. Laboratories 5, 7, 10, 12, and 22 should also review their measurement uncertainty evaluation procedure, as several of their uncertainties may have been overestimated.

When a laboratory has successfully participated in at least 6 proficiency testing studies, the standard deviation of these studies alone, can also be used to evaluate the uncertainty of their measurement results. [11] An example of evaluating measurement uncertainty using only proficiency testing data is given in Appendix 3.

Laboratory 9 attached an evaluation of the expanded measurement uncertainty to some results reported as being less than their limit of reporting. An evaluation of uncertainty expressed as a value cannot be attached to a result expressed as a range.[10]

One participant reported using the NATA GAG Estimating and Reporting MU as their guide; this document has been officially removed from the NATA website and is considered obsolete.

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, for a result of 310.42 ± 89.50 mg/kg, it is better to report 310 ± 90 mg/kg or instead of 41.8 ± 12.54 mg/kg, it is better to report 42 ± 13 mg/kg.[10]

6.3 z-Score

The z-score compares the participant's deviation from the assigned value with the standard deviation for proficiency assessment (SDPA).

The SDPA defines acceptable performance in a proficiency test. SDPAs equivalent to 3.5% to 20% PCV were used to calculate z-scores. Unlike the standard deviation based on between-laboratory CV, setting the SDPA as a realistic set value enables z-scores to be used as fixed reference value points for assessments of laboratory performance, independent of the group performance.

The between-laboratory CVs, the CVs predicted by the Thompson-Horwitz equation,[8] and the SDPAs as PCVs are presented for comparison in Tables 70 and 71.

Table 70 Between-Laboratory CVs, Thompson/Horwitz CVs, and Standard Deviations for Proficiency Assessment for Scored Analytes

Sample	Analyte	Numeric Results Reported*	Assigned Value (mg/kg)	Between-Laboratory CV* (%)	Thompson-Horwitz CV (%)	SDPA (as PCV, %)
S1	Ag	9	1.08	10	16	15
S1	As	18	11.7	14	11	15
S1	Be	12	0.614	21	17	20
S1	Cd	18	2.58	9.2	14	15
S1	Cr	18	22.1	14	10	20
S1	Cu	18	21.9	8.6	10	15
S1	Hg	18	2.11	10	14	15
S1	Li	12	7.08	18	12	15
S1	Mn	16	522	13	6.2	15
S1	Na	12	124	18	7.7	15
S1	Ni	17	11.9	8.7	11	15

Sample	Analyte	Numeric Results Reported*	Assigned Value (mg/kg)	Between-Laboratory CV* (%)	Thompson-Horwitz CV (%)	SDPA (as PCV, %)
S1	Pb	18	548	6.2	6.2	15
S1	Rb	7	46.8	11	9	15
S1	Se	9	1.29	16	15	20
S1	Sn	8	4.42	20	13	15
S1	Zn	18	704	4.9	6	15
S2	Ag	13	4.02	11	13	15
S2	Al	16	2320	13	5	15
S2	As	7	1.18	6.9	16	15
S2	B	8	6.83	12	12	15
S2	Ba	16	43.0	7.9	9.1	15
S2	Cd	14	1.19	8.8	16	15
S2	Cu	15	80.9	5.4	8.3	10
S2	Hg	15	2.05	10	14	15
S2	Mn	15	167	6.9	7.4	15
S2	P	15	1220	7.5	5.5	15
S2	Pb	15	100	4.6	8	15
S2	Se	12	3.11	11	13	15
S2	V	10	5.76	8.5	12	15
S2	Zn	15	40.7	8.6	9.2	15
S3	Ca	18	913	7.7	5.7	10
S3	Fe	19	11200	12	3.9	10
S3	K	16	555	14	6.2	15
S3	Mg	18	425	16	6.4	15
S3	Na	16	67.5	19	8.5	20
S3	P	16	276	11	6.9	10
S3	S	12	274	7.1	6.9	10
S3	Sr	15	12.2	21	11	20
S3	Chloride	11	30.5	22	9.6	20
S3	Fluoride	6	1.28	16	15	20
S3	EC	17	221 (µS/cm)	6.6	NA	10
S3	pH	18	5.15	2	NA	3.5
S3	TKN	13	2370	21	5	20
S3	2M KCl Ext Ammonium-N	8	37.4	5	9.3	20
S3	2M KCl Ext Nitrate-N	8	11.2	15	11	20

*Values exclude outliers if applicable. Shaded cells represent between-laboratory CVs higher than both the SDPA and the Thompson-Horwitz CV. NA = Not Available.

Table 71 Between-Laboratory CVs and Thompson/Horwitz CVs for Non-Scored Analytes

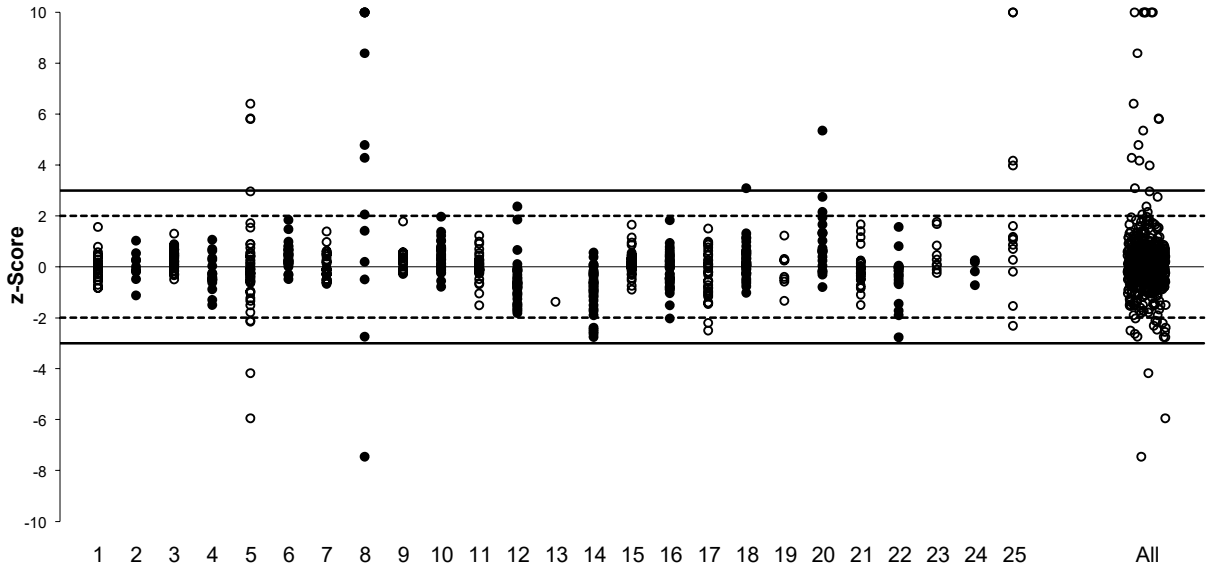
Sample	Analyte	Numeric Results Reported	Robust Average or Median* (mg/kg)	Between-Laboratory CV** (%)	Thompson-Horwitz CV (%)
S1	Ga	5	4.5	43	13
S1	Sb	16	60	50	8.6
S1	U	11	1.16	41	16
S2	Co	9	2.34	32	14
S2	Cr	15	54	86	8.8
S2	Mo	11	4.4	71	13
S2	Ni	15	31	86	9.5
S2	Sn	5	0.52	27	18
S3	Bromide	6	1.7	64	15
S3	Iodide	5	1.8	69	15
S3	Orthophosphate-P	8	0.76	88	17
S3	Sulphate	12	116	41	7.8

*Robust average or median as applicable (assigned value not set). ** Between Laboratory CV calculated as Robust CV or MADe. Shaded cells represent between-laboratory CVs higher than the Thompson-Horwitz CV.

The dispersal of participants' z-scores is graphically presented by laboratory in Figure 59 and by test in Figure 60. Of 641 results for which z-scores were calculated, 604 (94%) returned an acceptable score of $|z| \leq 2.0$, and 18 (3%) were questionable with a z-score of $2.0 < |z| < 3.0$.

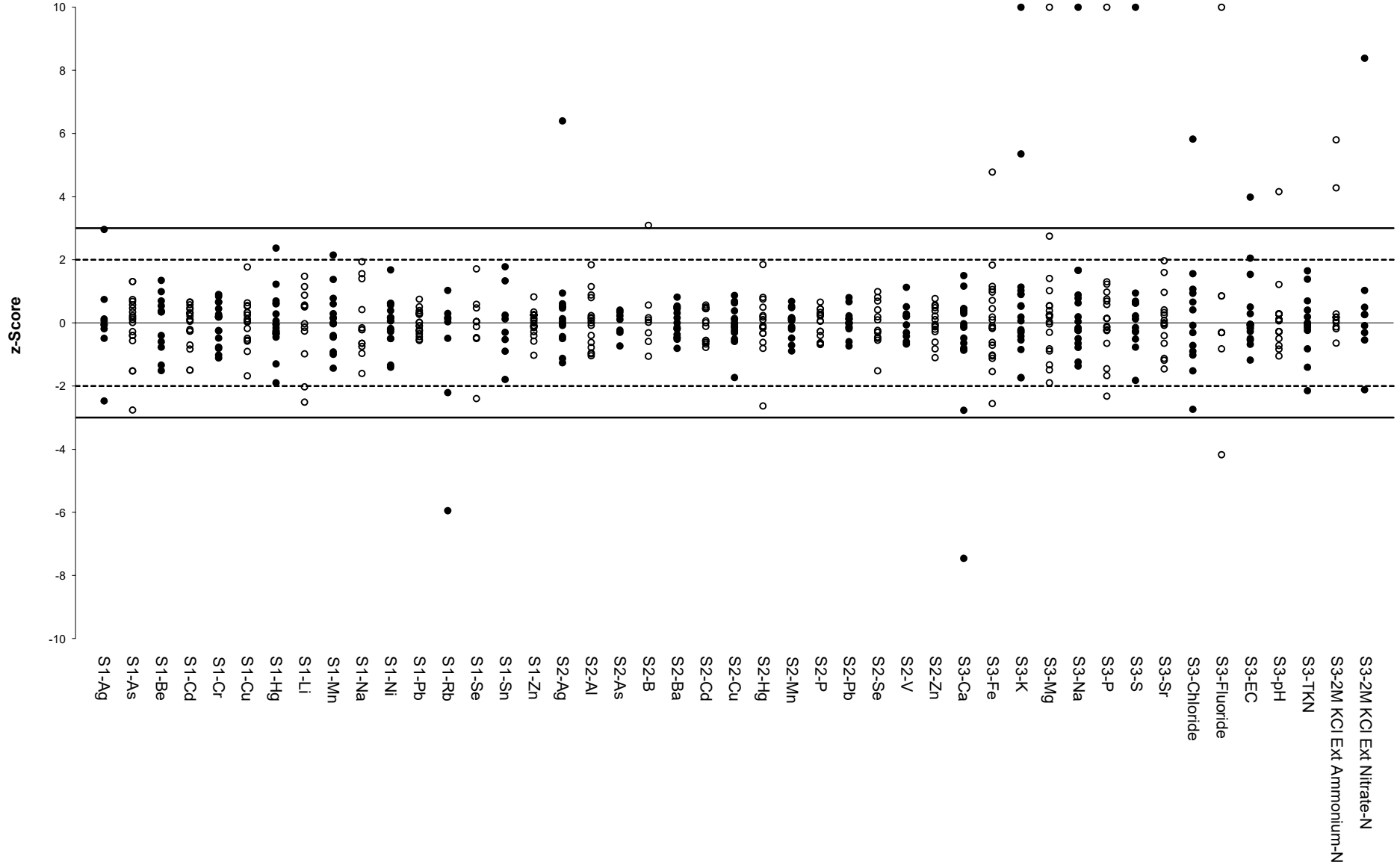
Summaries of participants' reported results and performance are presented in Tables 72 to 74, and Figure 62.

Laboratory 15 received acceptable z-scores for all 45 scored analytes.



Scores greater than 10 have been plotted as 10.

Figure 59 z-Score Dispersal by Laboratory



Scores greater than 10 have been plotted as 10.

Figure 60 z-Score Dispersal by Test

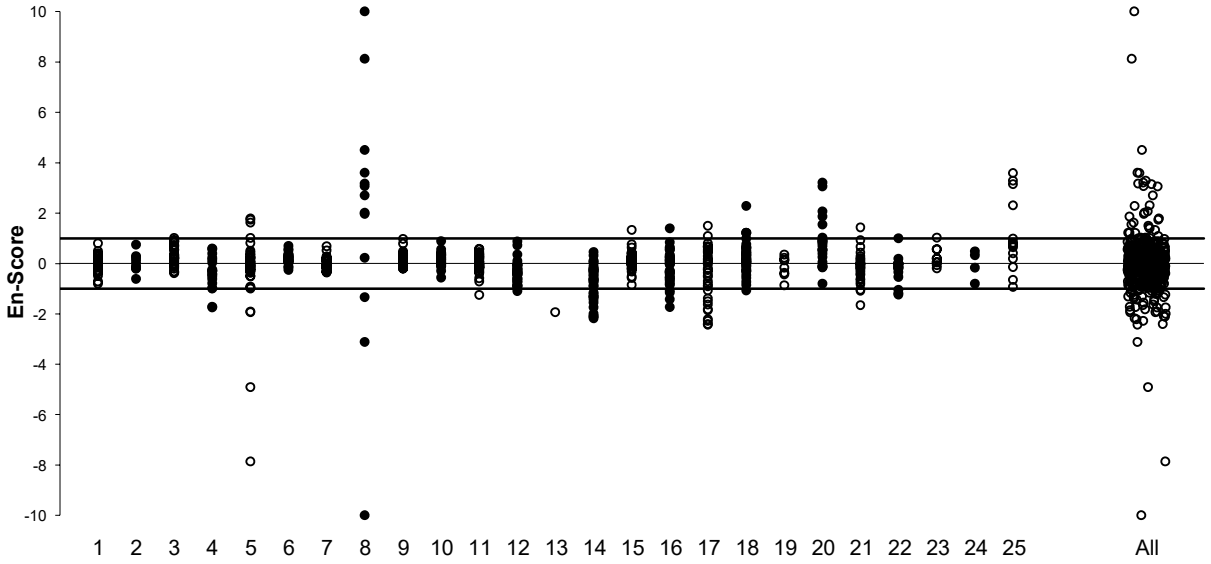
6.4 E_n-score

The E_n-score indicates how closely a result agrees with the assigned value, taking into consideration their respective uncertainties.

E_n-Scores can be interpreted in conjunction with z-scores. A not acceptable E_n-score 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 61. Where a participant did not report an uncertainty with a result, an expanded uncertainty of zero (0) was used to calculate the En-score. Of 641 results for which E_n-scores were calculated, 559 (87%) returned an acceptable score of $|E_n| < 1.0$ indicating agreement of the participants' results with the assigned values within their respective expanded measurement uncertainties.

Laboratory 15 who reported the largest number of acceptable results (45) returned acceptable E_n-scores for all these results except one.



Scores greater than 10 or less than -10 have been plotted as 10 or -10.

Figure 61 E_n-Score Dispersal by Laboratory

Table 72 Summary of Participants' Results and Performance in Sample S1

Lab Code	Ag (mg/kg)	As (mg/kg)	Be (mg/kg)	Cd (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Ga (mg/kg)	Hg (mg/kg)	Li (mg/kg)	Mn (mg/kg)
AV	1.08	11.7	0.614	2.58	22.1	21.9	Not Set	2.11	7.08	522
HV	1.07	11.4	0.639	2.62	23.0	23.2	7.48	2.12	6.71	570
1	1.07	12.7	0.565	2.75	24.1	22.3	NT	2.03	NT	583
2	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
3	1.07	12.9	0.657	2.84	23.0	22.1	NT	2.02	8.01	569
4	NT	11	0.7	2	21	22	NT	1.7	NT	487
5	1.56	9.04	0.45	2.48	26.1	23.6	1.10	2.00	6.04	534
6	1	12.1	0.736	2.83	22.9	23.7	NT	2.01	8.65	534
7	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
8	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
9	1.05	11.2	0.68	2.76	23.0	21.3	NT	2.06	7.61	522
10	<5	13	<2	2.6	25	22	NT	2.2	<10	630
11	< 2	11.9	< 2	2.48	23.3	22.7	NT	2.33	7.05	520
12	<1	9.01	0.54	2.31	18.51	16.37	NT	2.86	6.93	409
13	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
14	0.68	6.85	0.52	2.26	17.6	18.9	NR	1.51	7.67	450
15	1.1	12.3	0.66	2.7	23	23	6.6	2.1	8.3	520
16	<2	11.721	0.428	2.664	18.691	20.274	4.494	1.966	4.924	487.340
17	<2	10.7	<1	2.50	17.2	20.1	3.19	2.09	4.41	444
18	1.09	14	0.656	2.62	22.9	23.0	NT	2.31	7.64	545
19	NT	11	NT	2.7	20	20	NT	2.5	NT	NT
20	1.2	14	0.78	2.8	25	24	NR	2.3	NR	690
21	<2	12	<1	2	21	22	5.8	2.0	6.8	491
22	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
23	NT	12.5	NT	2.62	25.8	27.7	NT	2.13	NT	NT
24	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
25	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

AV = Assigned Value, HV = Homogeneity Value, NT = Not Tested, NR = Not Reported. Light grey shaded cells are results that were not scored. Dark grey shaded cells are results which returned a questionable or unacceptable z-score.

Table 72 Summary of Participants' Results and Performance in Sample S1 (continued)

Lab Code	Na (mg/kg)	Ni (mg/kg)	Pb (mg/kg)	Rb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Sn (mg/kg)	U (mg/kg)	Zn (mg/kg)
AV	124	11.9	548	46.8	Not Set	1.29	4.42	Not Set	704
HV	149	11.2	558	48.8	69.8	1.44	4.88	1.41	732
1	153	12.2	571	NT	84.2	1.26	4.07	1.24	710
2	NT	NT	NT	NT	NT	NT	NT	NT	NT
3	121	12.2	574	NT	85.5	1.16	4.58	1.45	792
4	NT	11	505	NT	35	NT	NT	NT	674
5	106	12.9	540	5	35.2	1.73	3.23	1.67	661
6	<125	12.6	549	48.9	68.4	1.41	4.22	0.972	730
7	NT	NT	NT	NT	NT	NT	NT	NT	NT
8	NT	NT	NT	NT	NT	NT	NT	NT	NT
9	NT	11.5	530	48.0	48.4	<20	5.6	0.839	740
10	120	13	610	NT	89	<2	<10	<10	720
11	112	12.2	573	NT	89.3	< 2	< 10	< 10	694
12	94.2	11.58	512	NT	19.66	<2	<3	NT	595
13	NT	NT	NT	NT	NT	NT	NT	NT	NT
14	NR	NR	527	NR	27.9	0.67	NR	NR	688
15	110	12	540	47	67	1.3	4.5	1.2	730
16	131.868	11.405	590.164	43.373	38.542	1.442	3.821	0.719	702.641
17	120	9.39	550	31.3	34.4	<5	<5	0.553	643
18	112	12	502	NT	102	1.17	NT	1.4	716
19	NR	9.5	570	NT	NT	NT	NT	NT	730
20	160	13	580	54	82	1.3	5.3	2.2	730
21	150	11	519	47.7	51	<5	<5	0.8	694
22	NT	NT	NT	NT	NT	NT	NT	NT	NT
23	NT	14.9	528	NT	NT	<5	NT	NT	692
24	NT	NT	NT	NT	NT	NT	NT	NT	NT
25	NT	NT	NT	NT	NT	NT	NT	NT	NT

AV = Assigned Value, HV = Homogeneity Value, NT = Not Tested, NR = Not Reported. Light grey shaded cells are results that were not scored. Dark grey shaded cells are results which returned a questionable or unacceptable z-score.

Table 73 Summary of Participants' Results and Performance in Sample S2

Lab Code	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	B (mg/kg)	Ba (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Hg (mg/kg)
AV	4.02	2320	1.18	6.83	43.0	1.19	Not Set	Not Set	80.9	2.05
HV	4.00	2920	1.14	7.07	44.0	1.22	3.00	91	70.4	1.99
1	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
2	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
3	4.34	2400	1.25	6.92	46.1	1.27	3.05	90.4	80.9	1.95
4	NT	2105	NT	NT	40	NT	NT	NT	NT	NT
5	7.88	2630	1.14	6.23	45.9	1.09	2.70	86.5	81.8	2.28
6	4.1	2960	1.22	6.99	48.3	1.27	2.09	14.9	86.4	2.12
7	3.72	2291	< 2	< 20	41.8	1.071	< 5	90.7	76.1	1.86
8	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
9	4.32	2380	1.24	7.4	46.4	1.28	1.95	11.8	84	2.02
10	<5	2600	<2	<10	45	1.09	<5	91	80	2.2
11	3.97	2344	< 2	< 10	41.8	1.17	< 5	97.6	79.8	2.01
12	3.26	2048	<1	5.74	39.63	1.05	1.73	15.31	66.92	2.62
13	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
14	3.34	1980	1.05	6.85	40.6	1.08	1.65	9.25	78.4	1.24
15	4.3	2370	1.2	6.5	43	1.2	2.8	80	82	2.0
16	3.753	1959.428	1.127	<50	37.8	1.273	1.710	10.994	80.459	2.104
17	4.59	1990	<5	<50	46.2	1.27	<2	9.52	87.9	2.08
18	4.39	2720	<2	10	44	1.29	3.4	97	86	2.30
19	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
20	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
21	4	2320	<5	<50	40	<1	<2	11	79	1.8
22	4.05	2182	< 2	< 20	42.1	1.19	< 5	92.2	76.8	1.95
23	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
24	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
25	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

AV = Assigned Value, HV = Homogeneity Value, NT = Not Tested. Light grey shaded cells are results that were not scored. Dark grey shaded cells are results which returned a questionable or unacceptable z-score.

Table 73 Summary of Participants' Results and Performance in Sample S2 (continued)

Lab Code	Mn (mg/kg)	Mo (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Se (mg/kg)	Sn (mg/kg)	V (mg/kg)	Zn (mg/kg)
AV	167	Not Set	Not Set	1220	100	3.11	Not Set	5.76	40.7
HV	186	5.66	50.3	1240	109	3.06	0.455	6.17	43.2
1	NT	NT	NT	NT	NT	NT	NT	NT	NT
2	NT	NT	NT	NT	NT	NT	NT	NT	NT
3	180	6.49	51.4	1300	100	3.43	0.536	5.93	45.4
4	NT	NT	NT	NT	NT	NT	NT	6	NT
5	155	6.71	48.7	1147	100	3.30	0.69	5.95	40.2
6	184	1.01	8.71	1340	112	3.15	0.52	6.20	43.6
7	164	6.1	51.04	1260	102	2.97	< 10	< 10	38.99
8	NT	NT	NT	NT	NT	NT	NT	NT	NT
9	171	0.81	7.1	1280	98	3.2	0.411	<10	44.2
10	170	<10	51	1300	110	3.0	<10	<10	43
11	171	6.22	54.8	1231	97.7	2.88	< 10	< 10	39.9
12	149.15	1.35	9.75	1105	91	<2	<3	5.18	35.7
13	NT	NT	NT	NT	NT	NT	NT	NT	NT
14	169	NR	5.40	1100	97.1	2.40	NR	5.24	41.3
15	170	5.2	44	1170	100	2.9	<0.5	5.7	42
16	144.814	0.718	6.174	1267.225	103.321	2.852	0.426	5.397	36.948
17	169	<2	5.62	1270	102	<5	<5	5.49	39.5
18	179	7.1	58	1230	102	3.57	NT	6.74	44
19	NT	NT	NT	NT	NT	NT	NT	NT	NT
20	NT	NT	NT	NT	NT	NT	NT	NT	NT
21	162	<2	6	1170	89	<5	<5	<5	34
22	163	6.60	52.6	1094	99.6	3.49	< 10	< 10	40.4
23	NT	NT	NT	NT	NT	NT	NT	NT	NT
24	NT	NT	NT	NT	NT	NT	NT	NT	NT
25	NT	NT	NT	NT	NT	NT	NT	NT	NT

AV = Assigned Value, HV = Homogeneity Value, NT = Not Tested, NR = Not Reported. Light grey shaded cells are results that were not scored.

Table 74 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)	Bromide (mg/kg)
AV	913	11200	555	425	67.5	276	274	12.2	Not Set
HV	890	11200	717	460	75.6	289	292	12.8	1.43
1	836	10400	510	373	68	272	266	11.2	NT
2	869	9930	600	441	65	NT	NT	NT	NT
3	954	11300	598	450	65.3	312	293	12.8	NT
4	945	12382	NT	368	76	NT	NT	NT	NT
5	855	10058	537	406	50.7	273	267	13.2	11
6	NT	NT	NT	NT	NT	NT	NT	NT	NT
7	904	11089	530	437	60.7	292	291	14.56	NT
8	231.75	16557.2	1586.77	514.85	310.42	724.83	NT	NT	NT
9	NT	NT	NT	NT	NT	NT	NT	NT	NT
10	900	12000	640	490	57	310	NT	17	NT
11	954	10023	631	459	64.2	303	NT	12.1	< 5
12	834	11028	520	330	58.7	258	224	9.44	2.16
13	NT	NT	NT	NT	49	NT	NT	NT	NT
14	948	8330	410	340	NR	230	260	9.29	NR
15	940	11700	570	460	70	280	300	13	1.0
16	947.839	13246.614	559.746	422.560	77.978	294.979	277.170	10.616	NT
17	1050	12300	484	440	79.5	297	291	8.64	1.12
18	953	11400	533	427	64.2	269	253	12.4	NT
19	NT	NT	NT	NT	NT	NT	NT	NT	NT
20	840	11000	1000	600	90	270	270	NR	NR
21	910	12500	630	440	90	280	280	12	0.71
22	660	10507	411	304	< 250	236	< 1000	12.2	NT
23	NT	NT	NT	NT	NT	NT	NT	NT	NT
24	NR	NR	NR	NR	NR	NR	NR	NR	NR
25	1020	9470.0	650	1760	<500	212	635	16.1	1.70

AV = Assigned Value, HV = Homogeneity Value, NT = Not Tested, NR = Not Reported. Light grey shaded cells are results that were not scored. Dark grey shaded cells are results which returned a questionable or unacceptable z-score.

Table 74 Summary of Participants' Results and Performance for Sample S3 (continued)

Lab Code	Chloride (mg/kg)	Fluoride (mg/kg)	Iodide (mg/kg)	Orthophosphate-P (mg/kg)	Sulphate (mg/kg)	EC (µS/cm)	pH	TKN (mg/kg)	2M KCl Ext Ammonium-N (mg/kg)	2M KCl Ext Nitrate-N (mg/kg)
AV	30.5	1.28	Not Set	Not Set	Not Set	221	5.15	2370	37.4	11.2
HV	25.0	1.07	NA	NA	92	NA	NA	NA	37.0	12.0
1	NT	NT	NT	NT	NT	NT	NT	2560	NT	NT
2	NT	NT	NT	NT	NT	218	5.2	2300	37.5	13.5
3	28.6	NT	NT	NT	96.4	215	5.17	NT	NT	NT
4	NT	NT	NT	NT	NT	209	5.1	NT	NT	NT
5	66	0.21	1.84	0.56	30.7	255	5.2	1349	80.8	6.46
6	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
7	33	NT	NT	< 10	83.2	232	5.1	3031	39.5	12.3
8	13.8	7.28	NT	1.48	85	266.33	5.06	2459.76	69.4	30
9	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
10	NT	NT	NT	NT	NT	220	5.2	NT	NT	NT
11	21.2	NT	32.8	NT	98.5	205.9	5.37	NT	NT	NT
12	34.5	1.2	<0.2	1.18	151.7	220	5.17	2332	36.41	NT
13	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
14	NR	NR	NR	NR	NR	NR	NR	2256	32.6	10.51
15	25	1.5	<1	<1	85	220	5.2	3150	38	10
16	36.248	NT	NT	0.215	153.562	227.317	5.164	1982.41	NT	NT
17	26.1	1.07	2.03	0.284	169	195	4.96	1700	NT	NT
18	24.3	1.2	NT	1.65	151	219	5.16	2359	38.7	11.0
19	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
20	NR	1.2	NR	NR	NR	NR	NR	NR	NR	NR
21	30	<1	0.98	0.4	100	210	5.0	2370	NR	NR
22	40	NT	NT	< 1	< 250	220	5.1	NT	NT	NT
23	NT	NT	NT	NT	NT	NT	5.2	NT	NT	NT
24	NR	NR	NR	NR	NR	217	5.02	NR	38.77	11.79
25	37	1.5	0.35	0.29	175	309	5.9	2700	36	11.8

AV = Assigned Value, HV = Homogeneity Value, NA = Not Available, NT = Not Tested, NR = Not Reported. Light grey shaded cells are results that were not scored. Dark grey shaded cells are results which returned a questionable or unacceptable z-score.

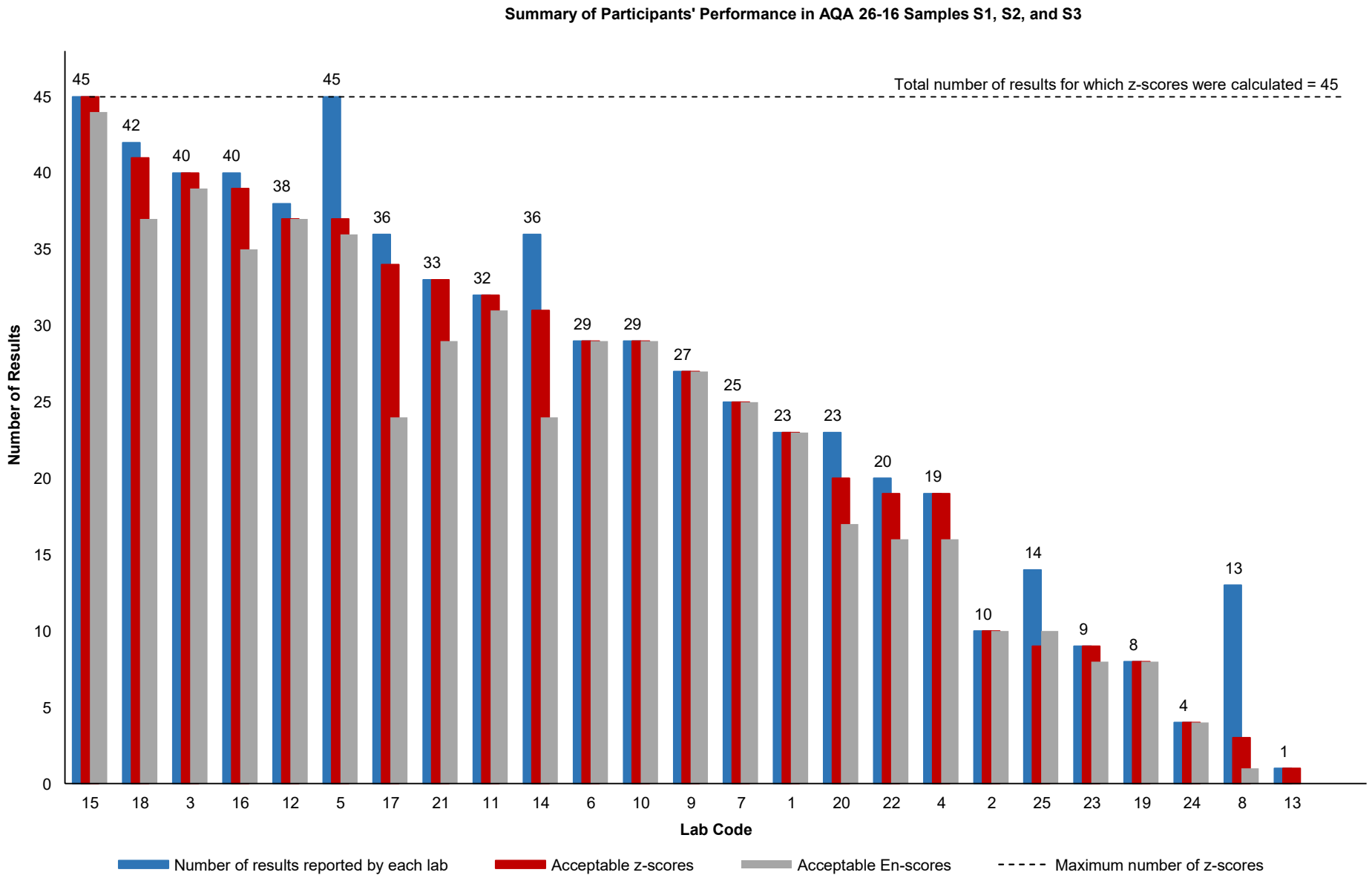


Figure 62 Summary of Participants' Performance

6.5 Participants' Results and Analytical Methods for Acid Extractable Elements

Summaries of participants' results and performance for scored analytes in this PT study are presented in Tables 72 to 74, and Figure 62.

Cr and Ni in compost sample S2 challenged participants' analytical techniques compared with soil sample S1. While all results reported for these analytes in the soil sample returned acceptable z-scores, there was no agreement among the results reported for the compost sample, and no assigned values could be established.

Ga is not in the analytical suite of too many laboratories, only 5 reported results.

The method descriptions provided by participants for acid extractable elements are presented in Tables 1 and 10, and the instrumental conditions are presented in Appendix 4.

Extraction Methods

Sample S1 was soil, Sample S2 was compost, and Sample S3 was agricultural soil. Participants were asked to use their routine method and to report results for acid extractable elements in these three matrices. NMIA 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) 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. There is no standardisation of methods for acid extractable elements. In general methods are defined by procedures involving aqua regia extractions or using various amounts of HNO_3, HCl, in combination or alone. Most of these methods produce comparable results.[20-24]

In the present study, participants used the same extraction method for all three samples. Most used an extraction method involving a sample size between 0.5 g and 1 g, an extraction temperature between 95°C and 105°C, an extraction time between 60 and 120 minutes, and various mixtures of HNO_3 and HCl.

Laboratories 6, 9, 12, 14, 17, and 21 reported using small volumes of acids, dilute acids and/or hydrogen peroxide, which may have reduced the effective acid strength of the digestion mixture. The results reported by these laboratories for Co, Cr, and Ni in S2 and U in S1 were biased low. They may have extracted only a fraction of these analytes from the compost and soil matrix. Laboratories should consider using matrix-matched control samples to assess the effectiveness of their digestion regime.

Laboratory 8 reported using a sample size of 0.25 g for analysis. Caution should be exercised when such a small sample size is taken for analysis as this might not be representative of the whole sample. They also reported using a high digestion temperature of 180ºC. Most of the results reported by them were biased high. The aggressive digestion regime applied to a small sample size might explain the bias.

Individual Element Commentary

Antimony The between-laboratory CV for Sb in Sample S1 was 50%. It was more than 5 times the value predicted by the Thompson-Horwitz model (8.6%).[8]

Antimony is an element whose recovery strongly depends on the acids employed for digestion. It is known that when only nitric acid is used, Sb is transformed into a mixture of

insoluble oxides (Sb_2O_3, Sb_2O_5, $Sb_4O_4(OH)_2(NO_3)_2$) but when hydrochloric acid is also involved it changes into chloro-complexes ($SbCl_6^-$). In an aqueous solution, sufficient hydrogen ion concentration must be maintained to prevent $SbCl_6^-$ hydrolysis.[23,24] Laboratories should consider using matrix matched control samples to assess their digestion regime and include their uncertainty in the overall measurement uncertainty for Sb measurements in soil.

Arsenic. The As level in sample S1 was approximately 10 times higher than in sample S2 and results were more variable. For ICP-MS measurements, multiple dilutions may have been required to bring the analyte concentration in the solution within the instrument calibration range. The additional dilution steps may explain the greater results' variability observed for sample S1.

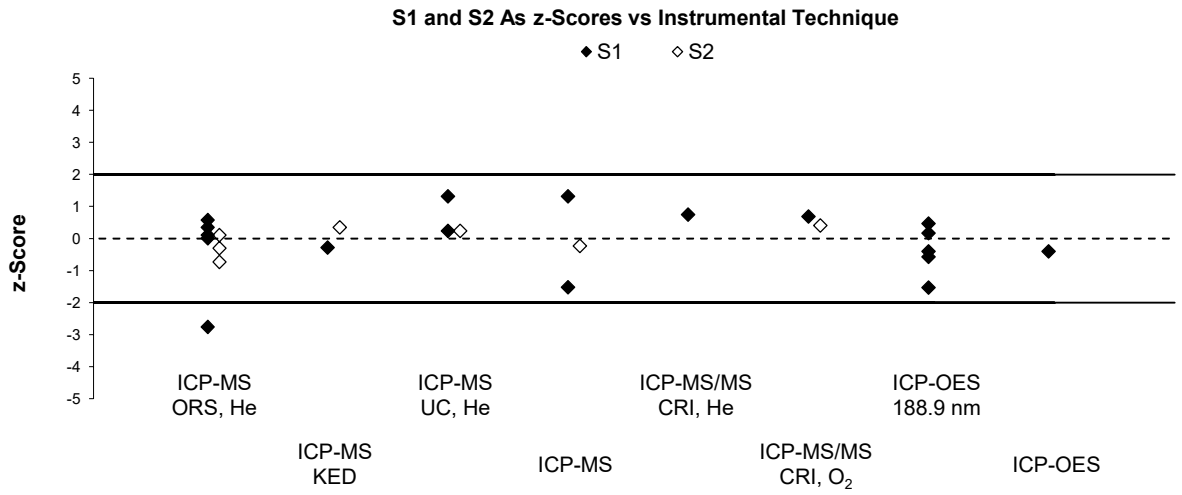
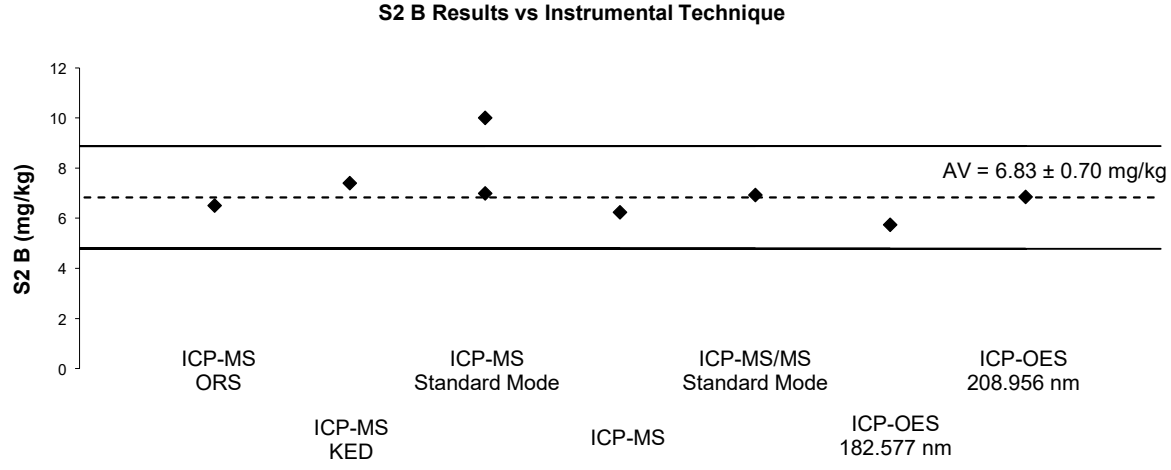


Figure 63 S1 and S2 As z-Scores vs Instrumental Technique

Beryllium between laboratory CV in Sample S1 was 21%, higher than that predicted by Thompson-Horwitz (17%).[8] The assigned value of 0.614 mg/kg was close to many laboratories' limits of reporting and might have challenged their analytical techniques.

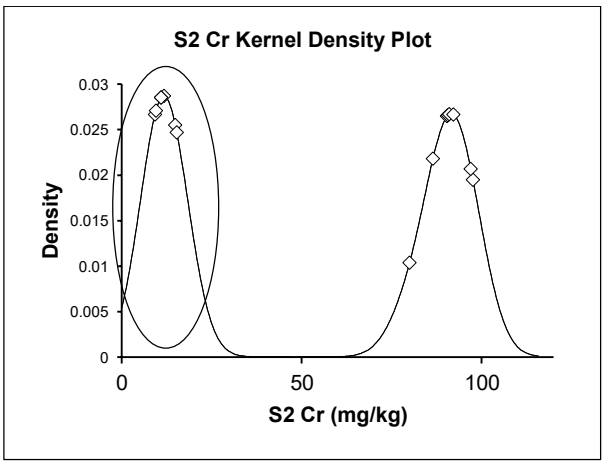
Boron level in the compost Sample S2 was at 6.83 mg/kg, below the reporting limit of 7 participants. Only 8 laboratories reported numeric results for this test. Figure 64 presents plots of participants' results for B in Sample S2 vs instrumental technique. ICP-MS was the preferred analytical technique. No trend was observed in the results with respect to the instrumental technique used.

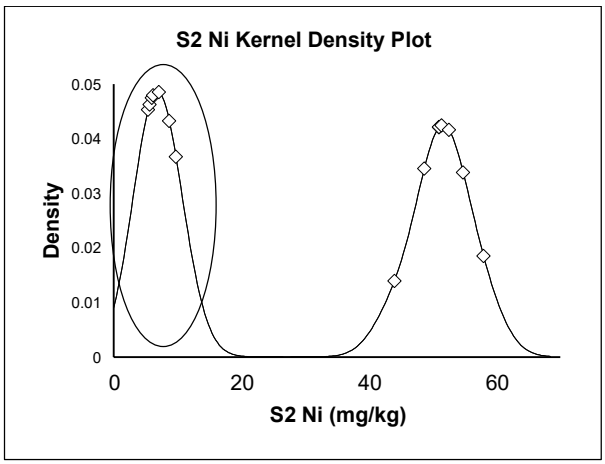


Horizontal lines are equivalent to z-scores of 2 and -2 respectively.

Figure 64 S2 B Results vs Instrumental Technique

Chromium and **Nickel** extraction efficiency strongly depends on the digestion regime. A distribution of participants' results for the compost Sample S2 with the extraction technique used is presented in Figure 65.





Lab Code*	Cr Results (mg/kg)	Ni Results (mg/kg)	Digestion Regime				
			Sample mass (g)	Staggered	Temp (°C)	Time (min)	Reagents
14	9.25	5.40	0.5	NA	95	90	1 mL HNO_3, 1.5 mL HCl, **1 mL H_2O_2**
17	9.52	5.62	1	Yes	95 ± 5	60	2 mL HNO_3, 10 mL HCl, **2 mL H_2O_2**
21	11	6	1	Yes	95	60	2 mL HNO_3 (1:1), 10 mL HCl (1:4), **2 mL H_2O_2**
9	11.8	7.1	1	NA	95	50	2 mL HNO_3, 2 mL HCl, **10 mL H_2O**
6	14.9	8.71	2	No	109	60	800 mL HNO_3, 400 mL HCl, **1200 mL H_2O**
12	15.31	9.75	3	Yes	95	120	10 mL HNO_3, 5 mL HCl, **10 mL HNO_3 (1:1), 6 mL H_2O_2**
15	80	44	1	Yes	100	120	3 mL HNO_3, 3 mL HCl
5	86.5	48.7	0.5	NA	85	240	5 mL HNO_3, 5 mL HCl
3	90.4	51.4	0.5	Yes	95	120	3 mL HNO_3, 4 mL HCl, 1.5 mL H_2O_2
7	90.7	51.04	2		95-105	60	4 mL HNO_3, 12 mL HCl, 4 mL H_2O
HV	91	50.3	0.7	Yes	95 ± 5	120	3 mL HNO_3, 3 mL HCl
10	91	51	2	No	105	60	0.4 mL HNO_3, 1.2 mL HCl
22	92.2	52.6	2		95-105	60	4 mL HNO_3, 12 mL HCl
18	97	58	0.4	No	120	60	2.5 mL HNO_3, 7.5 mL HCl
11	97.6	54.8	2	No	95-105	60	4 mL HNO_3, 12 mL HCl, 4 mL H_2O

*HV = Homogeneity Value.

Figure 65 Extraction Methods for Cr and Ni in Sample S2

The results reported by participants for Cr and Ni have a similar (bimodal) distribution. All low results were reported by laboratories that used a small volume of acid, dilute acids and/or hydrogen peroxide, which may have reduced the effective acid strength of the digestion mixture. These laboratories may have only extracted a fraction of the Cr and Ni present in compost. This could result in an underestimation of the metal content and, consequently, an incorrect assessment of the anthropogenic contribution to the compost.

Cobalt in Sample S2 was another analyte that challenged participants' analytical techniques. As for Cr and Ni, Co can be strongly influenced by the digestion regime, particularly when methods differ in acid strength. Most of the biased low Co results were reported by laboratories that used small volumes of acids or dilute acids in their digestion regimes. Plots of participants' results versus the instrumental techniques used are presented in Figure 66. No apparent relationship was observed between the reported results and the instrumental techniques used.

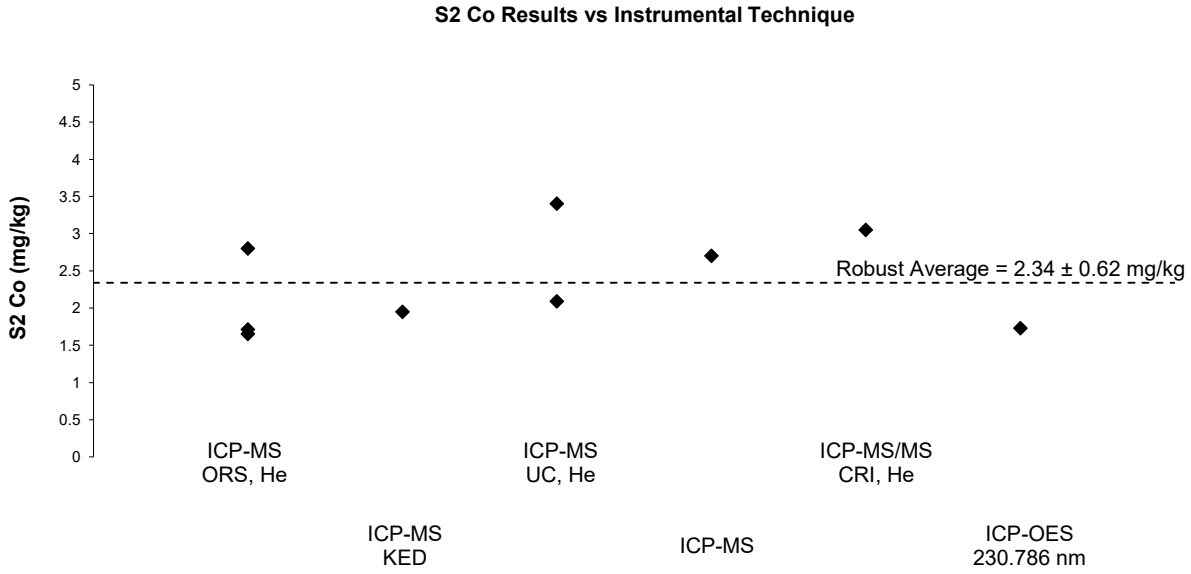
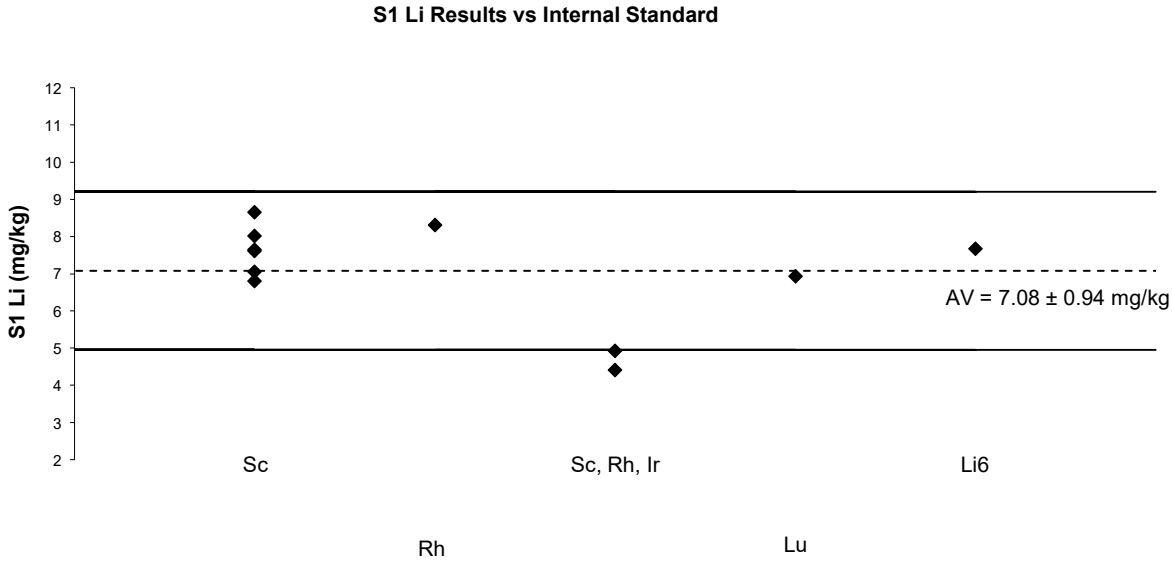


Figure 66 S2 Co Results vs Instrumental Technique

Lithium ICP-MS has low sensitivity for light elements such as Li due to space-charge effects. Using an internal standard with similar behaviour may help to overcome this issue. Figure 67 presents participants' results for Li in Sample S1 versus the internal standard used.



Horizontal lines are equivalent to z-scores of 2 and -2 respectively.

Figure 67 S1 Li Results vs Internal Standard

Mercury levels in the two study samples were similar. Participants used a wide variety of analytical techniques for Hg measurements and most produced acceptable results (Figure 68).

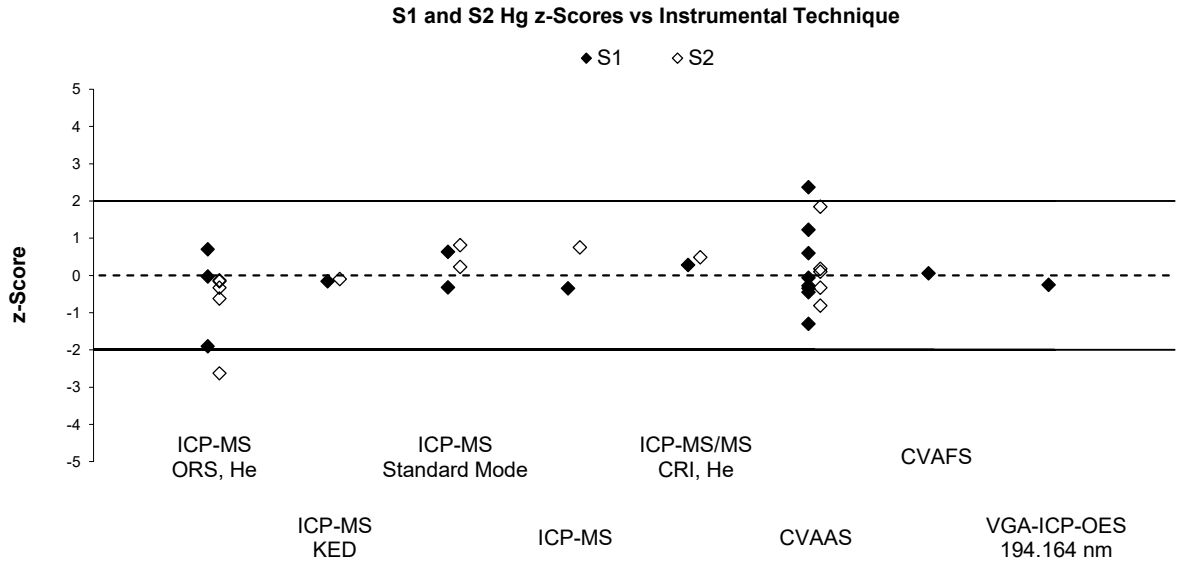


Figure 68 S1 and S2 Hg z-Scores vs Instrumental Technique

Molybdenum results reported by participants in Sample S2 have a similar bimodal distribution to Cr and Ni. All results from laboratories using water and/or hydrogen peroxide to dilute their digestion solution were biased low. The final acidity level in the diluted solution used for instrument analysis may not be sufficient to ensure the stability of Mo.

Selenium Of the 14 laboratories that reported numeric results for Se in Samples S1 or S2, all but one produced acceptable results. Participants used various instrumental techniques (Figure 69). Two laboratories reported using ICP-MS/MS in reaction mode, one with hydrogen and one with oxygen for Se determination.

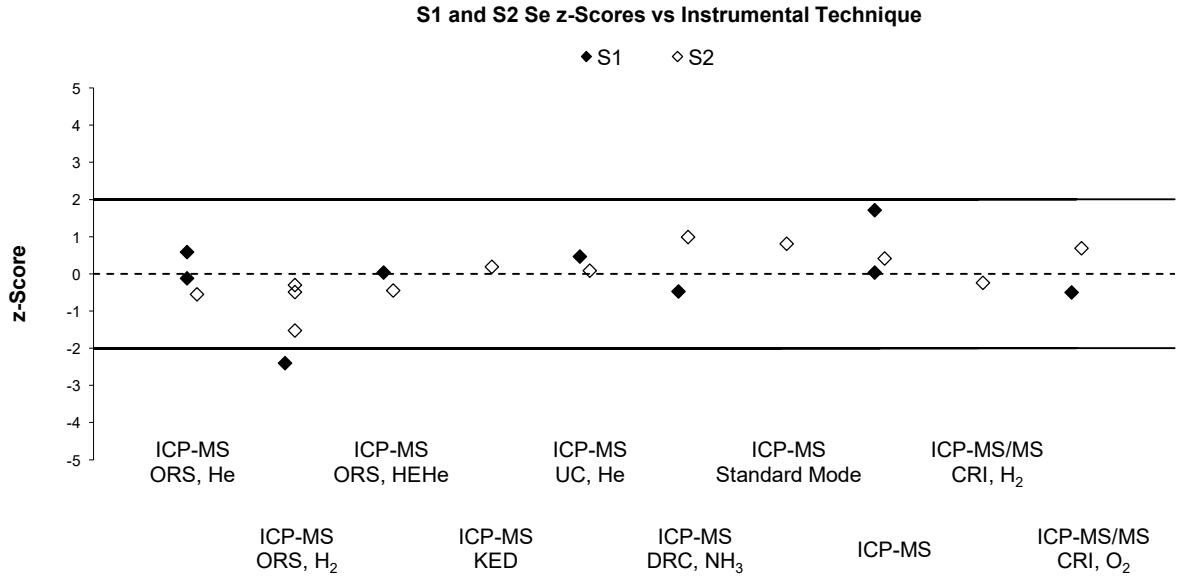
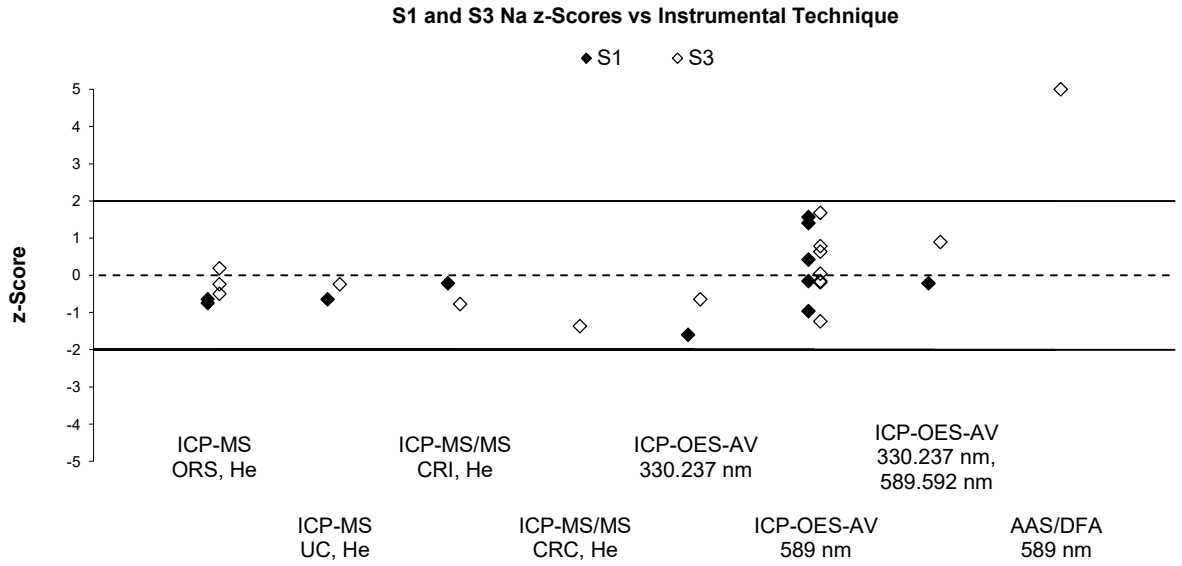


Figure 69 S1 and S2 Se z-Scores vs Instrumental Technique

Sodium Participants' results versus the instrumental techniques used for Na measurement in Samples S1 and S3 are presented in Figure 70. ICP-OES in axial view with the wavelength 589 nm was the preferred measurement technique.

Laboratory 8 used Atomic Absorption Spectroscopy (AAS) with a Digital Flame Analyser (DFA) for Na determination in Sample S3. The laboratory also reported: "0.25 g microwave digested sample was made up to 50 mL with distilled water then further diluted 10 times." Na concentration in Sample S3 was low, at 67.5 mg/kg, and AAS with DFA may not have been sufficiently sensitive for the accurate determination of Na at this low concentration.



Scores greater than 5 have been plotted as 5.

Figure 70 S1 and S3 Na z-Scores vs Instrumental Technique

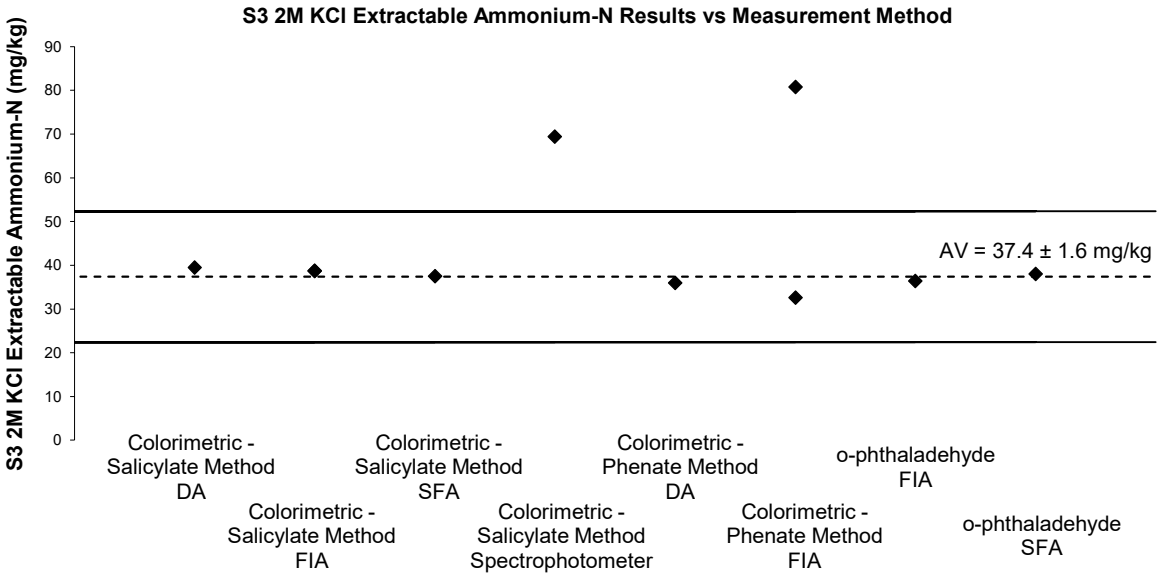
Uranium results in Sample S1 were variable with a between-laboratory CV of 41%. The U level in soil was centred around the value of 1.16 mg/kg. All low results (below 1 mg/kg) were produced by laboratories using water and/or hydrogen peroxide. As for Cr and Ni, these laboratories may have extracted only a fraction of U from the compost sample because they dilute acids.

6.6 Participants' Results and Analytical Methods for 2M KCl Extractable Ammonium-N and Nitrate-N

Mineral nitrogen components, ammonium (NH_4^+), nitrite (NO_2^-) and nitrate (NO_3^-), are of particular interest when soil fertility is assessed. While water can extract NO_3^--N and NO_2^--N from a majority of soils, NH_4^+-N has to be displaced by another cation when the surface soil colloids are negatively charged.[25]

The participating laboratories were asked to analyse the sample using their normal measurement technique, but to follow the preparation procedure for the soil extract which involved a soil/2M KCl ratio of 1:10 and a mixing time of one hour. The method descriptions provided by participants are presented in Table 3. All participants used a soil/2M KCl ratio of 1:10.

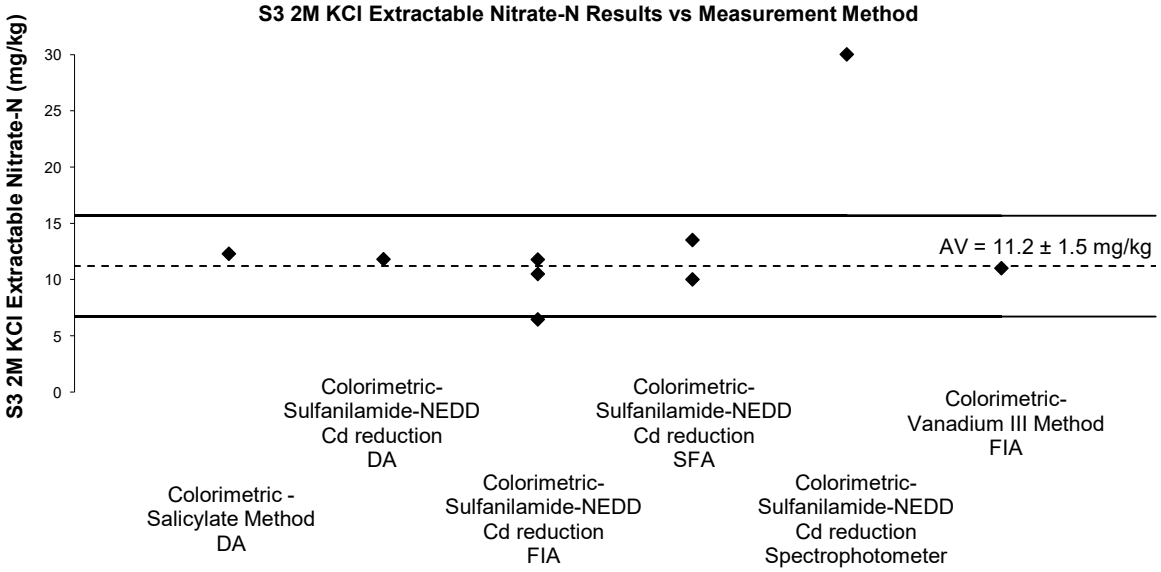
2M KCl-Extractable Ammonium-Nitrogen Plots of participants' results versus the analytical methods and instrumental techniques used are presented in Figure 71. Most participants used either the salicylate method or the phenate method. Two laboratories reported ammonium-nitrogen measurements in soil using the o-phthalaldehyde method with SFA or FIA detection.



Horizontal lines are equivalent to z-scores of 2 and -2 respectively.

Figure 71 S3 2M KCl Ext NH_4^+-N Results vs Measurement Method

2M KCl Extractable Nitrate-Nitrogen Only one laboratory reported using Vanadium (III) Chloride for NO_3^--N reduction to NO_2^--N, with seven using NO_3^--N reduction to NO_2^--N by passage of the clarified soil extract through a Cd-Cu reduction column followed by NO_x (the reduced NO_2^--N plus original NO_2^--N) measurements (Figure 72).



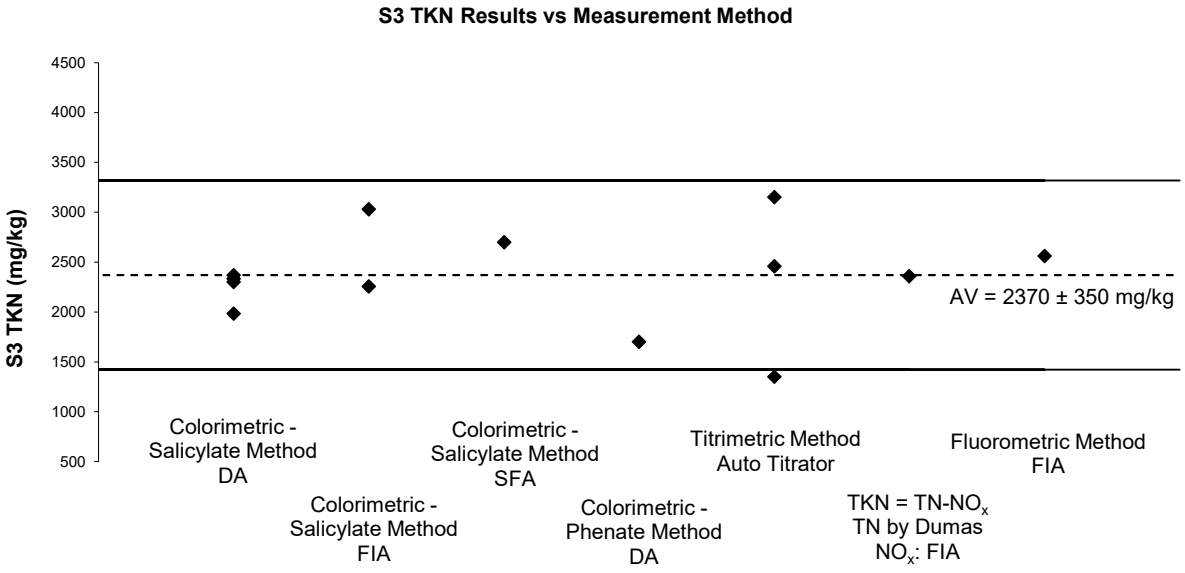
Horizontal lines are equivalent to z-scores of 2 and -2 respectively.

Figure 72 S3 2M KCl Ext NO_3^--N Results vs Measurement Method

Incorrect dilution factors may explain the non-acceptable result reported by Laboratory 8 (3 times higher than the assigned value).

6.7 Participants' Results and Analytical Methods for Total Kjeldahl Nitrogen

TKN assigned value was 2370 mg/kg. All reported results returned acceptable z-scores except one (Figure 73).



Horizontal lines are equivalent to z-scores of 2 and -2 respectively.

Figure 73 S3 TKN Results vs Measurement Technique

6.8 Participants' Results and Analytical Methods for Water Soluble Anions

Measurement of water-soluble anions in soil is an empirical procedure – where the method of extraction defines the measurand.[25, 26] With testing laboratories using different methods, each could be considered to be measuring a different measurand that is their version of 'water soluble anions in soil'. This lack of uniformity in the procedures can make the comparison of participants' results difficult.

In a previous study of metals and anions in soil AQA 11-12, NMIA conducted a study on water soluble anions content in soil using the same instrumental technique on two extraction procedures: one involved a soil/water ratio of 1:5 and the other a soil/water ratio of 1:10. The fluoride, orthophosphate and sulphate results were found to change in direct proportion with the amount of water used in the extraction procedure.

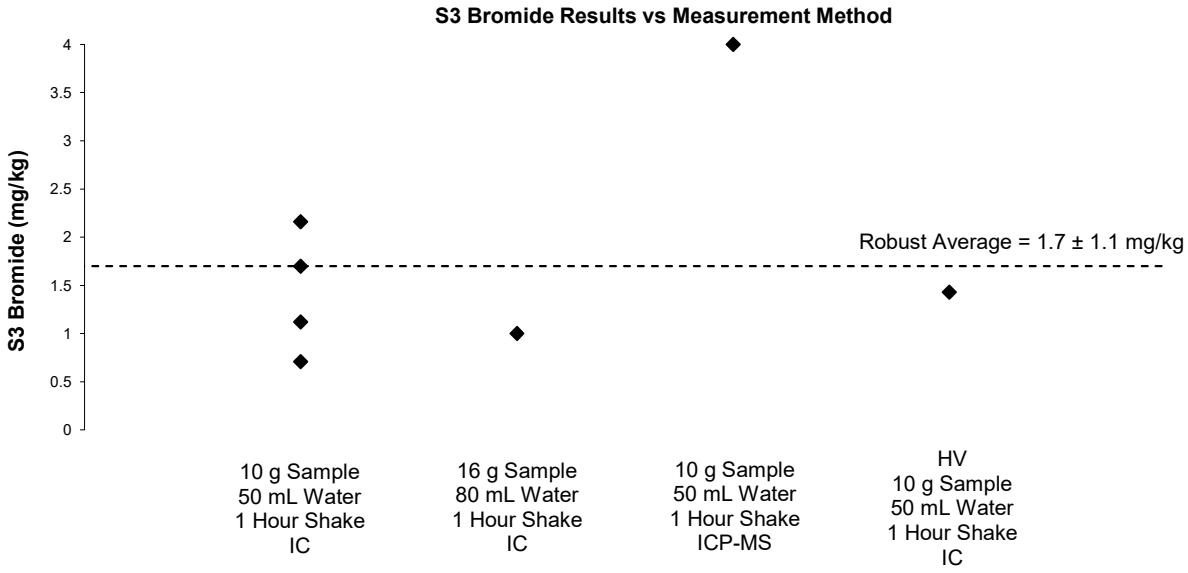
In the present study participating laboratories were asked to analyse the sample using their normal measurement technique but to follow the same preparation procedure for the soil extract which involved: a soil/water ratio of 1:5 and a mixing time of one hour.

The method descriptions and instrumental techniques used by participants are presented in Tables 4 to 9. All participating laboratories but one used a soil/water ratio of 1:5. Laboratory 22 used a ratio of 1:10.

Individual Water-Soluble Anion Commentary

Bromide Only 6 participants reported results for bromide in S3. The reported results were variable with a between-laboratory CV of 64%.

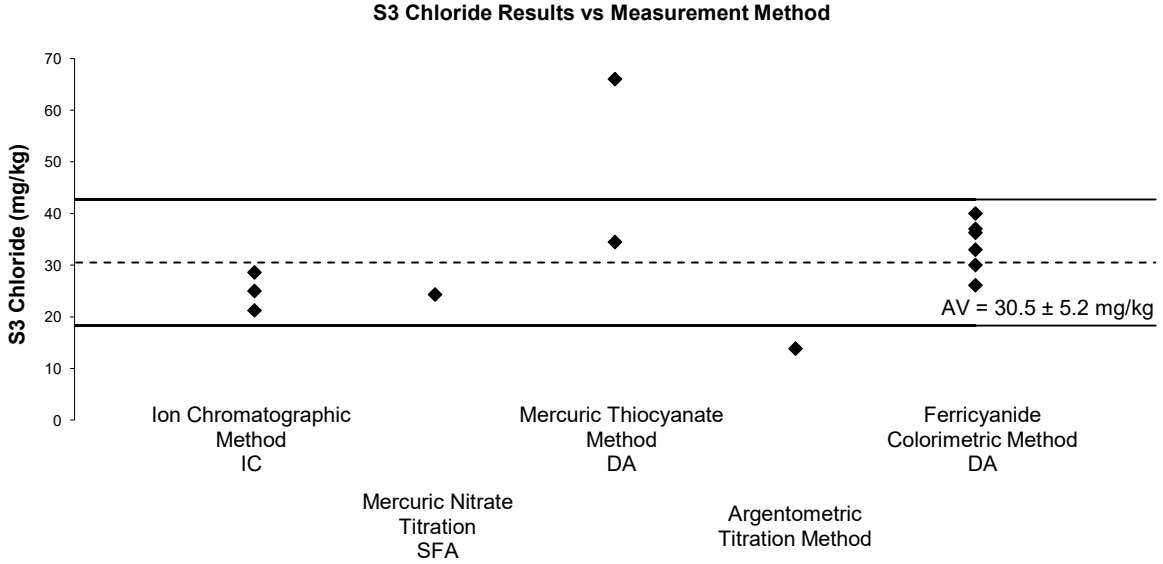
All laboratories but one used the Ion Chromatographic Method (Figure 74). Laboratory 5 reported using ICP-MS for analysis. Caution should be exercised when ICP-MS is used for bromide determination as this technique measures elemental bromine from both bromide and bromate.



Results greater than 4 mg/kg have been plotted as 4 mg/kg.

Figure 74 S3 Bromide Results vs Measurement Method

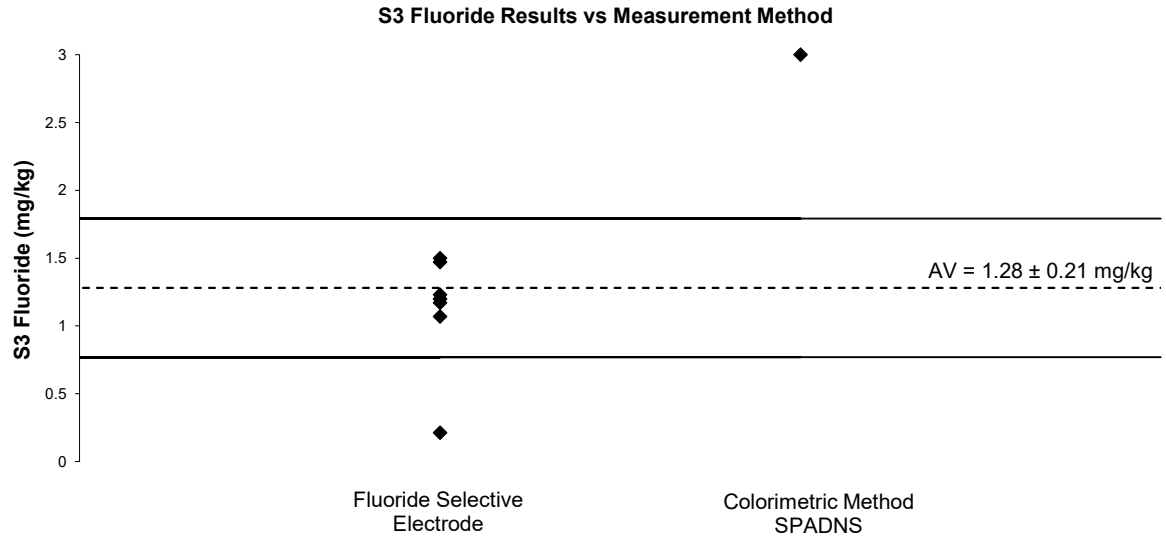
Chloride Caution should be exercised when using the argentometric method (Figure 75). This technique is suitable for clear aqueous solutions where the end point can be easily detected; however, the presence of Fe in the extraction solution may also interfere by masking the endpoint.[26]



Horizontal lines are equivalent to z-scores of 2 and -2 respectively.

Figure 75 S3 Chloride Results vs Measurement Method

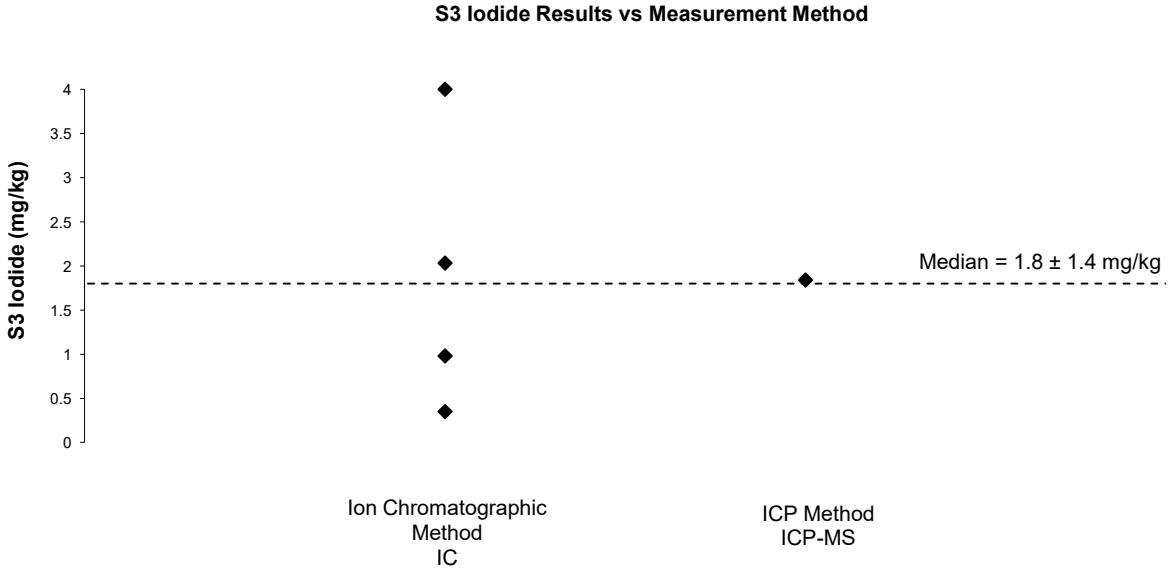
Fluoride Eight laboratories reported results for fluoride in Sample S3. All participants reported using fluoride selective electrode (FSE) but one (Figure 76). Laboratory 8 reported using SPADNS and returned a not acceptable z-score, biased high. Caution should be exercised when fluoride is measured by the colorimetric method as it suffers from interference from chlorides.[26]



Horizontal lines are equivalent to z-scores of 2 and -2 respectively. Results greater than 3 mg/kg have been plotted as 3 mg/kg.

Figure 76 S3 Fluoride Results vs Measurement Technique

Iodide Only 5 laboratories reported results for iodide in S3. All participants but one used the ion chromatographic method for iodide analysis (Figure 77).



Results greater than 4 mg/kg have been plotted as 4 mg/kg.

Figure 77 S3 Iodide Results vs Method

Orthophosphate-P level in S3 was low, which may explain the variability in participants' results. Ascorbic acid colorimetric method was the most popular method used by participants for the measurement of orthophosphate-P (Figure 78).

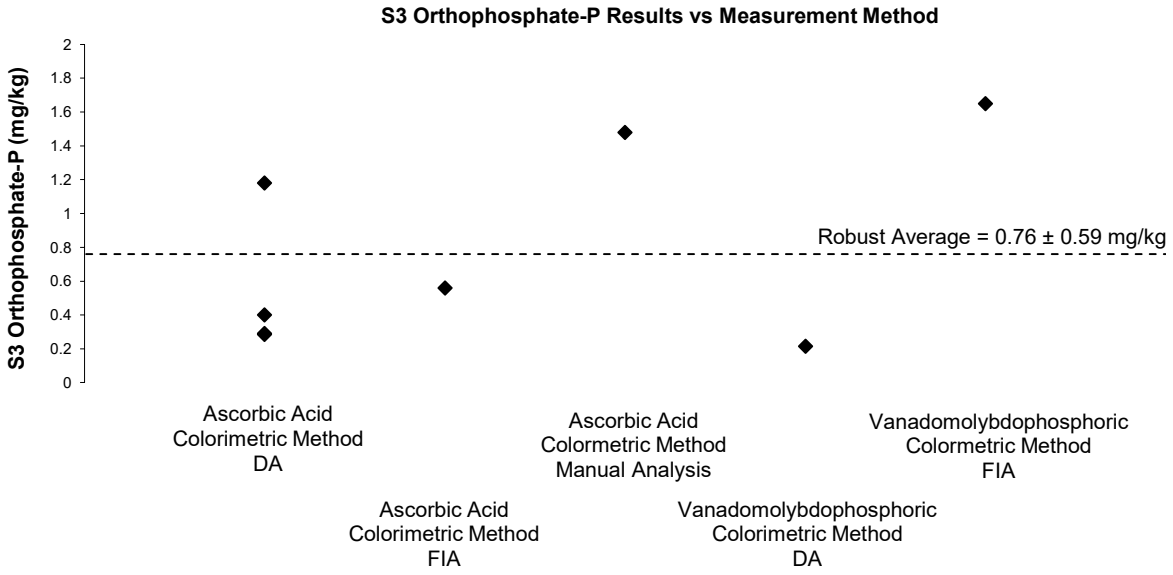


Figure 78 S3 Orthophosphate-P Results vs Method

Sulphate Plots of participants' results with the analytical method used are presented in Figure 79. All results from ICP-OES and ICP-MS measurements were higher than those produced by other techniques. False positive results can be produced when sulphate is measured by ICP-OES or ICP-MS: these techniques measure total S and not only S from sulphate compounds.

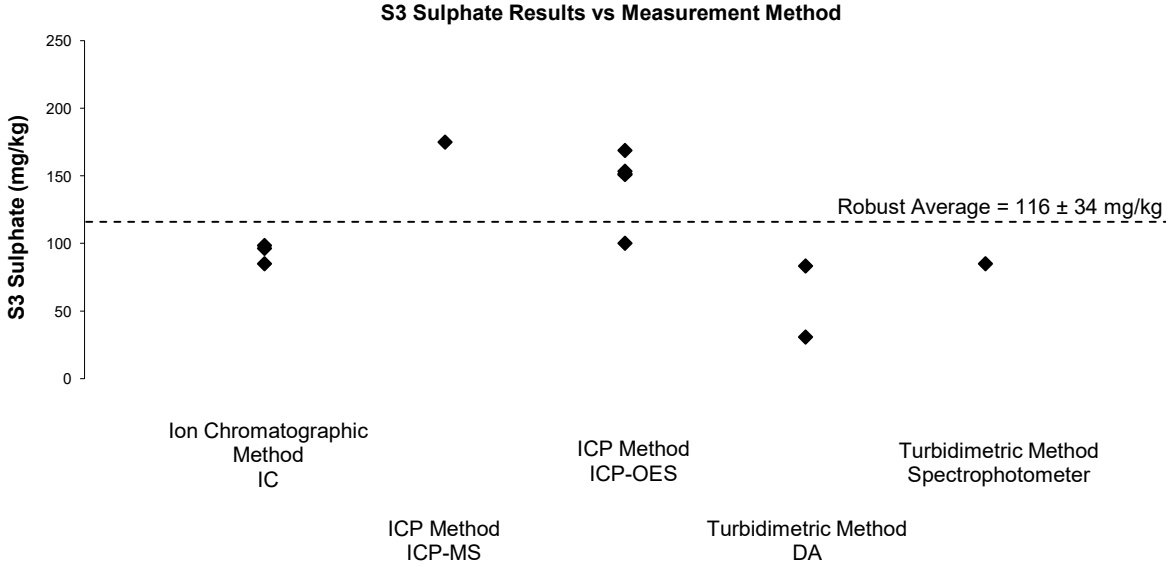


Figure 79 S3 Sulphate Results vs Measurement Technique

6.9 Regulatory Compliance Assessment

The Australian Standard for Composts, Soil Conditioners, and Mulches (AS 4454) is the benchmark standard for compost quality in Australia.[6] A key component of AS 4454 is the control of contaminants, including heavy metals, with maximum allowable limits.

To support laboratories in assessing their performance around the maximum limits, selected analytes were spiked into Sample S2 at concentrations close to the relevant maximum allowable limit (Table 75).

Table 75 AS 4454 Maximum Allowable Limits and Sample S2 Assigned Values

Analyte	Maximum Allowable Limit (mg/kg)	Assigned Value (mg/kg)
Cd	1	1.19 ± 0.07
Hg	1	2.05 ± 0.13
Pb	150	100 ± 3
Se	5	3.11 ± 0.24

When a test result is used to determine whether a sample complies with an upper control limit, the measurement uncertainty of that result is critical. ISO/IEC 17025 defines a decision rule for such assessments as a 'rule that describes how measurement uncertainty is accounted for when stating conformity with a specified requirement'.[9] To determine whether a sample meets a regulatory limit, considering the reported result and its associated uncertainty, decision rules generally provide three possible outcomes: Pass, Fail, or Inconclusive when further testing may be required (Figure 80).[10]

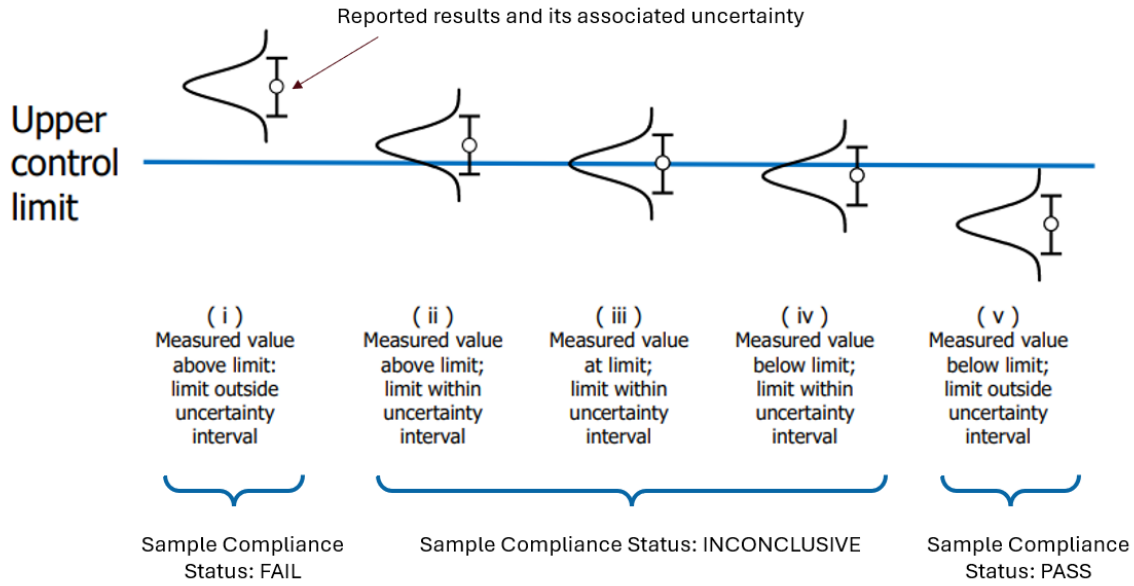


Figure 80 Assessment of Compliance with an Upper Limit

Figures 81 to 84 show comparisons of the spiked value (SV), assigned value (AV), participants' results, and maximum allowable limits for Cd, Hg, Pb, and Se in the compost Sample S2.

The Cd concentration in the compost sample was close to the maximum allowable limit of 1 mg/kg, at 1.19 ± 0.07 mg/kg. When measurement uncertainty is considered, a correct assessment would classify the sample as either non-compliant or inconclusive.

Fourteen participants reported results for Cd in this sample: six classified the sample as non-compliant, while the remaining eight reported an inconclusive outcome (Figure 81).

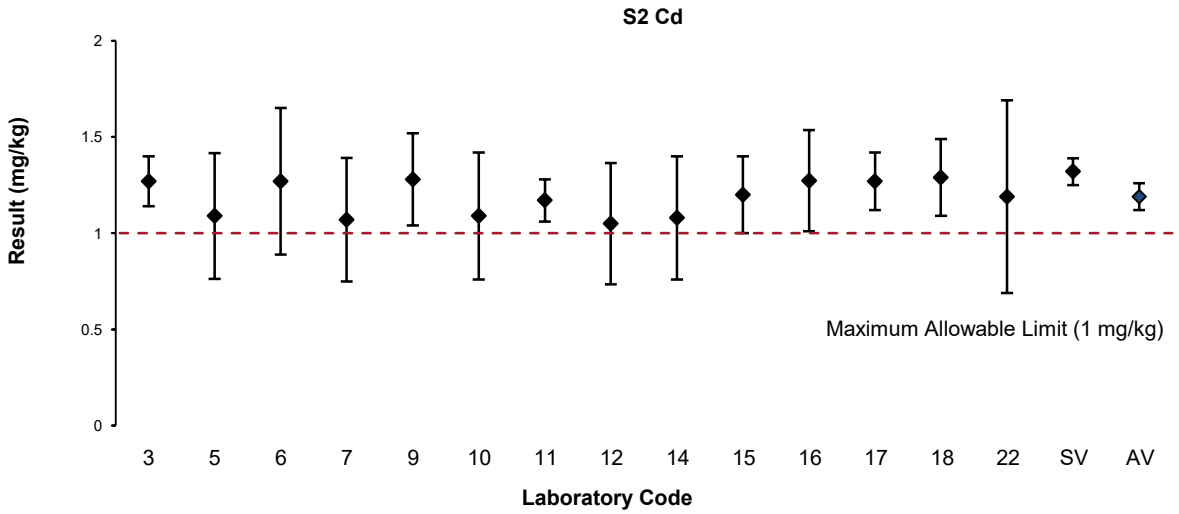


Figure 81 Sample S2 Cd Results and Maximum Allowable Limit

Hg was spiked at 2.30 mg/kg, approximately double the maximum allowable limit of 1 mg/kg (Figure 84). All participants but one returned acceptable z-scores and correctly indicated the sample as not compliant.

Laboratory 14 returned a questionable z-score and when their measurement uncertainty is considered, would deem the status of the sample as inconclusive. Bias correction may help avoid making the wrong decision.

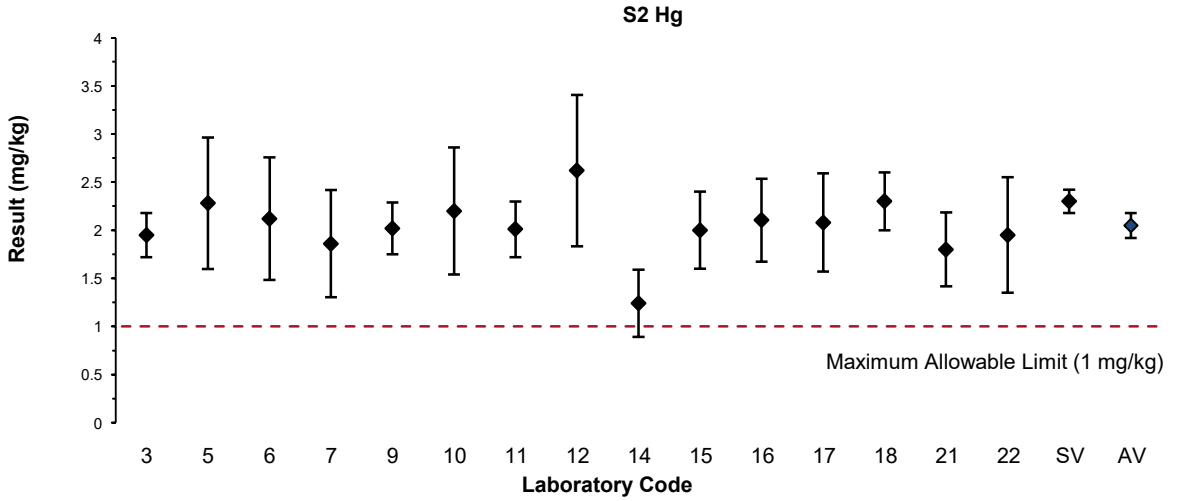


Figure 82 Sample S2 Hg Results and Maximum Allowable Limit

All 15 results reported for Pb in Sample S2 returned acceptable z-scores and E_n-scores and all correctly indicated the sample's status for this analyte as compliant (Figure 83).

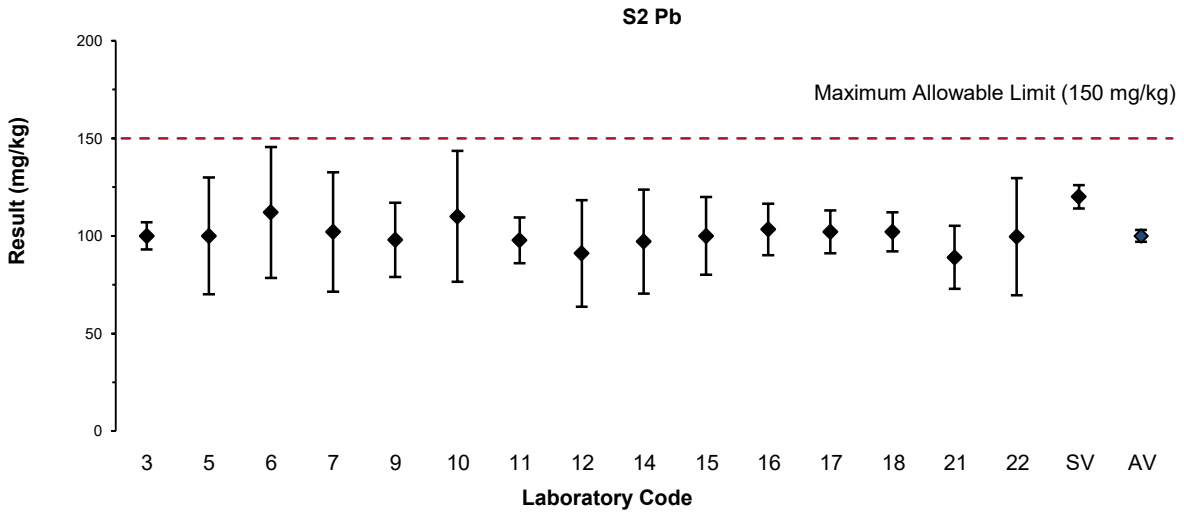


Figure 83 Sample S2 Pb Results and Maximum Allowable Limit

Both the spiked value and assigned value for Se were below the maximum allowable limit of 5 mg/kg (Figure 84). Laboratory 22 returned an acceptable result for Se with an uncertainty of 57% of their reported value, which may have been overestimated. When assessed against the maximum limit, the sample was also incorrectly classified as inconclusive. This laboratory may need to review their uncertainty evaluation procedures as their reported uncertainty is not fit for purpose.

Laboratories 17 and 21 both reported LOR values at the maximum limit for Se, at 5 mg/kg. These laboratories should consider reviewing the fitness for purpose of their LORs for the measurement of Se in compost.

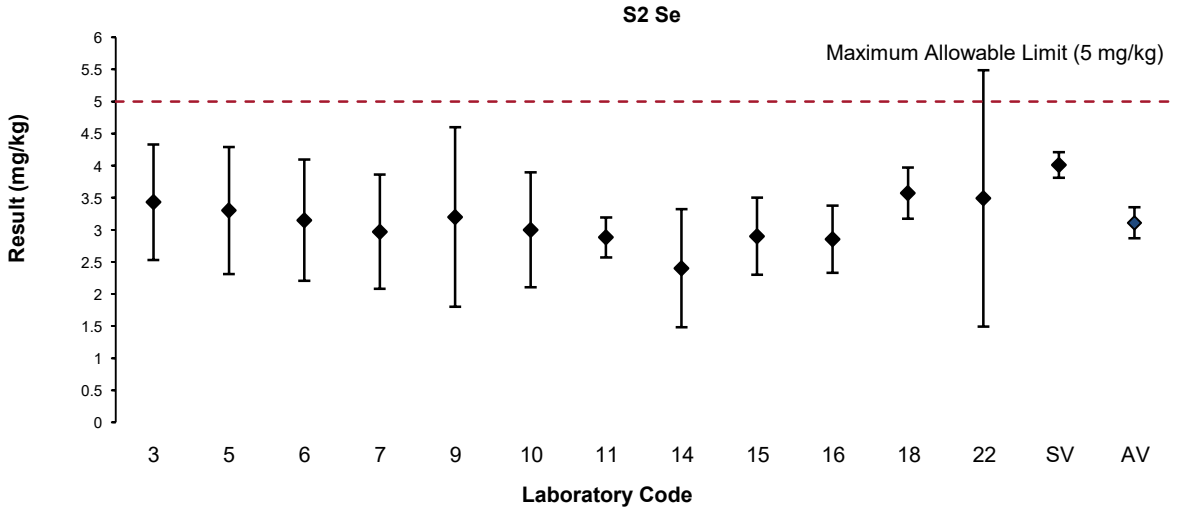


Figure 84 Sample S2 Se Results and Maximum Allowable Limit

6.10 Comparison with Previous NMIA Proficiency Tests Studies of Metals in Soil

AQA 26-16 is the 39th NMIA proficiency study of inorganic analytes in soil.

A summary of participants' performance over the last 15 years of studies is presented in Figure 85.

Over this period, the average proportion of acceptable scores was 90% for z-scores and 80% for E_n-scores. 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.

6.11 Reference Materials and Certified Reference Materials

Proficiency testing and matrix matched control samples taken through all steps of the analytical process are highly valuable quality control tools for assessing extraction efficiency. Control samples used by participants in this study are presented in Table 76.

Table 76 Control Samples Used by Participants

Lab. Code	Description of Control Samples
1	AQA, Inhouse
2	CRM, SS
3	CRM: CRM036
4	CRM: AGAL 12
6	SS
7	CRM
8	CRM: San Joaquin soil, Tomato Leaves, Hay Powder
10	CRM, SS
11	CRM: ICP Quality Control Standard #1 (ACR), AQA 20-13 S2 RM, AQA 22-02 S1 RM, AQA 24-15 S3 RM
12	SS
13	RM / Ex PT Sample
14	SS
15	CRM: AGAL 10 & AGAL 12
16	CRM
17	CRM: Various
18	RM / Ex PT Sample: AGAL 12 (metals). In house AG reference
19	RM / Ex PT Sample
20	CRM: PACS3
21	SS
22	CRM
23	CRM
24	CRM: Aspac 13957-QC, Aspac 13959-QC, Aspac 15759-QC
25	CRM: Sigma-Aldrich Sewage Sludge 4 CRM055-50G

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 '*[28]

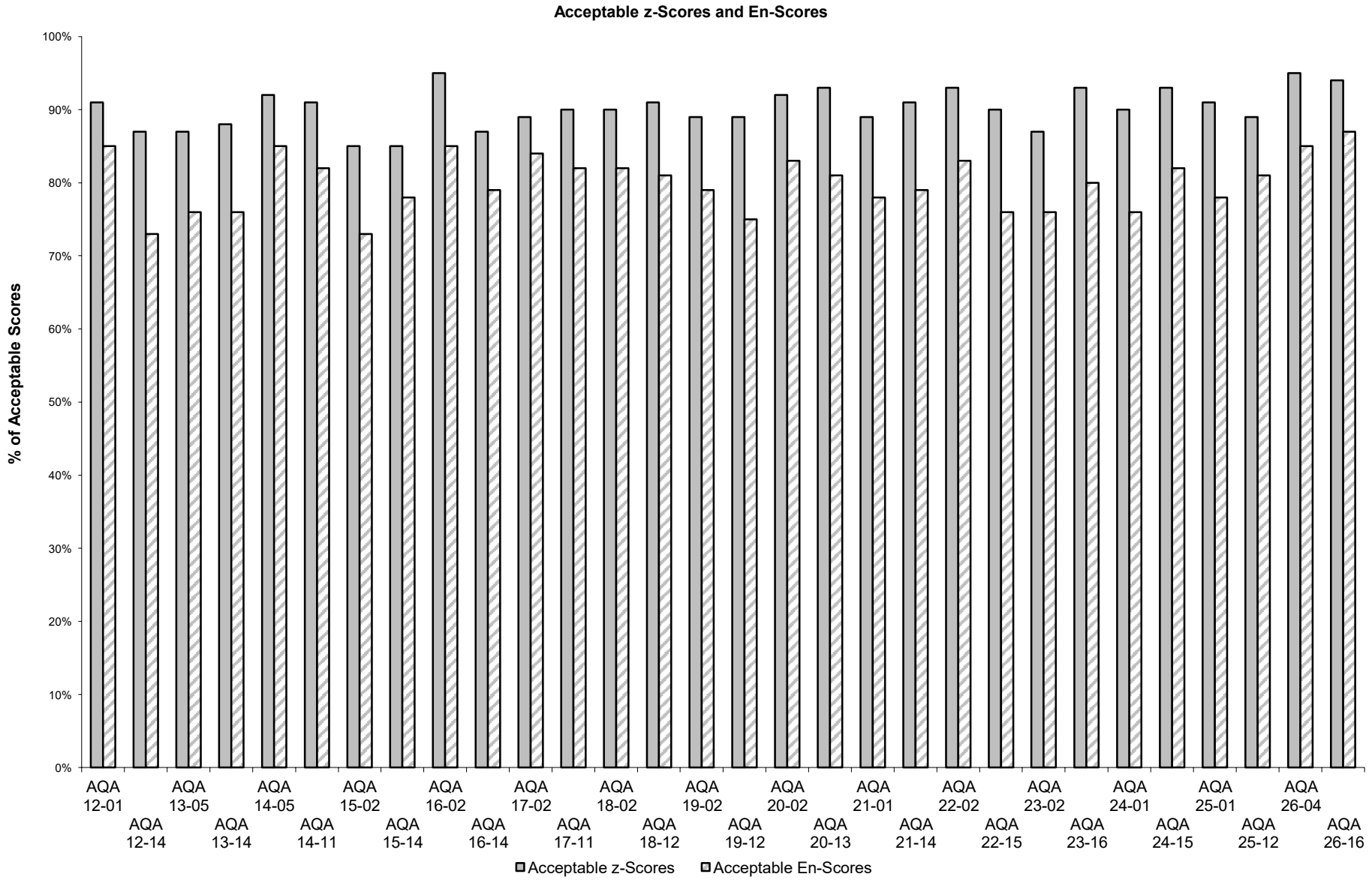


Figure 85 Participants' Performance over Time

7 REFERENCES

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

[1] ISO/IEC 17043, *Conformity assessment – General requirements for the competence of proficiency testing providers*.

[2] Commonwealth of Australia, Department of Industry, Science and Resources, NMIA, 2026, *Study Protocol for Proficiency Testing*, viewed October 2026, <https://www.industry.gov.au/sites/default/files/2020-10/cpt_study_protocol.pdf>.

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APPENDIX 1 - SAMPLE PREPARATION, ANALYSIS, AND HOMOGENEITY ASSESSMENT

A1.1 Sample Preparation

The same preparation procedure used in previous NMIA PT studies for inorganic analytes in soil was followed for Samples S1, S2, and S3.

Sample S1 was a soil matrix fortified for 3 analytes, then dried, ground, and sieved before being thoroughly mixed and divided into portions of 30 g each.

Sample S2 was a compost matrix fortified for 5 analytes, then dried, ground, and sieved prior to thorough mixing and division into portions of 30 g each.

Sample S3 was an agricultural soil. The soil was dried, ground, and sieved before being mixed and divided into portions of 75 g each.

A1.2 Sample Analysis and Homogeneity Assessment

Sample Analysis for Acid Extractable Elements

A partial homogeneity test was conducted for acid-extractable elements in Samples S1 and S3. A full homogeneity test was conducted for Sample S2. The results from these tests and participants' results in this study gave no reason to question the samples' homogeneity.

The acid-extractable homogeneity analyses were conducted by the CRV section of NMIA in accordance with method NT2.49.[29] A test portion of approximately 0.5 g was used for Samples S1 and S3, and 0.7 g for Sample S2. Each portion 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 Type I 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 spikes, 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 77.

Table 77 Instrumental Technique used for Acid Extractable Elements

Analyte	Instrument	Internal Standard	Reaction/ Collision Cell (if applicable)	Cell Mode/Gas (if applicable)	Final Dilution Factor (S1/S3)	Final Dilution Factor (S2)	Ion (m/z) / Wavelength (nm)
Ag	ICP-MS	Rh	ORS	He	800	800	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	NA	800	11 m/z
Ba	ICP-MS	Rh	ORS	He	NA	800	134 m/z
Be	ICP-MS	Rh	NA	NA	800	NA	9 m/z
Ca	ICP-OES	Y	NA	NA	800	NA	422.673 nm
Cd	ICP-MS	Rh	ORS	He	800	800	111 m/z
Co	ICP-MS	Rh	ORS	He	NA	800	59 m/z
Cr	ICP-MS	Rh	ORS	He	800	800	52 m/z
Cu	ICP-MS	Rh	ORS	He	800	800	63 m/z
Fe	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	202 m/z

Analyte	Instrument	Internal Standard	Reaction/ Collision Cell (if applicable)	Cell Mode/Gas (if applicable)	Final Dilution Factor (S1/S3)	Final Dilution Factor (S2)	Ion (m/z) / Wavelength (nm)
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	800	NA	23 m/z
Na (S3)	ICP-OES	Y	NA	NA	800	NA	588.592 nm
Ni	ICP-MS	Rh	ORS	He	800	800	60 m/z
P (S2)	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 + 207 + 208 m/z
Rb	ICP-MS	Rh	ORS	He	800	NA	85 m/z
S	ICP-OES	Y	NA	NA	800	NA	181.972 nm
Sb	ICP-MS	Rh	ORS	He	800	NA	121 m/z
Se	ICP-MS	Rh	ORS	HEHe	800	800	78 m/z
Sn	ICP-MS	Rh	ORS	He	800	800	118 m/z
Sr	ICP-OES	Y	NA	NA	800	NA	421.552 nm
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

NA = Not Applicable.

Homogeneity Assessment for Acid Extractable Elements in Sample S2

Homogeneity testing for Sample S2 was based on that described by Thompson and Fearn,[30] which is also the procedure described in the International Harmonised Protocol for Proficiency Testing.[4]

A minimum of 6 containers of Sample S2 were selected at random. Duplicate test portions were taken from each bottle, and the concentrations of the acid-extractable analytes were determined. Measurements were performed under repeatability conditions in a randomised order. The results of the homogeneity assessment are presented in Tables 78 to 96. Sample S2 was found to be sufficiently homogeneous for all acid-extractable analytes of interest.

Table 78 Sample S2 Ag Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
5	3.99	3.99
16	3.90	3.91
23	4.15	4.01
30	4.01	4.06
35	3.96	4.08
42	3.93	4.00
Mean	4.00	
CV	3%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.49	0.78	**Pass**
s_{an}/σ	0.098	0.50	**Pass**
s^2_{sam}	0.0020	0.078	**Pass**

Table 79 Sample S2 Al Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
5	2910	2900
16	2790	2980
23	3010	2880
30	2850	2920
35	2860	2830
42	2950	2870
52	3140	2960
Mean	2920	
CV	5.7%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.39	0.73	**Pass**
s_{an}/σ	0.19	0.50	**Pass**
s^2_{sam}	820	46000	**Pass**

Table 80 Sample S2 As Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
5	1.10	1.12
16	1.09	1.14
23	1.15	1.11
30	1.12	1.15
35	1.16	1.12
42	1.14	1.13
52	1.26	1.21
Mean	1.14	
CV	4.6%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.27	0.73	**Pass**
s_{an}/σ	0.15	0.50	**Pass**
s^2_{sam}	0.0014	0.0065	**Pass**

Table 81 Sample S2 B Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
5	6.82	7.04
16	6.72	6.83
23	7.27	7.08
30	6.84	7.22
35	6.82	7.12
42	7.54	6.94
52	7.39	7.27
Mean	7.07	
CV	6.4%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.51	0.73	**Pass**
s_{an}/σ	0.21	0.50	**Pass**
s^2_{sam}	0.013	0.28	**Pass**

Table 82 Sample S2 Ba Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
5	43.9	46.7
23	44.8	44.2
30	42.0	43.9
35	42.1	44.6
42	42.9	42.7
52	47.0	43.5
Mean	44.0	
CV	7.2%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.41	0.78	**Pass**
s_{an}/σ	0.24	0.50	**Pass**
s^2_{sam}	0.062	13	**Pass**

Table 83 Sample S2 Cd Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
5	1.22	1.24
16	1.17	1.19
23	1.26	1.22
30	1.22	1.24
35	1.22	1.24
42	1.22	1.20
Mean	1.22	
CV	3.1%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.56	0.78	**Pass**
s_{an}/σ	0.10	0.50	**Pass**
s^2_{sam}	0.00032	0.0073	**Pass**

Table 84 Sample S2 Co Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
5	2.97	2.97
16	2.89	2.89
23	3.11	3.00
30	2.96	3.08
35	2.91	3.00
42	3.05	2.95
52	3.19	3.01
Mean	3.00	
CV	4.9%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.43	0.73	**Pass**
s_{an}/σ	0.12	0.50	**Pass**
s^2_{sam}	0.0021	0.076	**Pass**

Table 85 Sample S2 Cr Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
5	90	89
16	87	87
23	94	92
30	91	93
35	90	90
42	92	90
52	99	93
Mean	91	
CV	4.2%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.68	0.73	**Pass**
s_{an}/σ	0.11	0.50	**Pass**
s^2_{sam}	6.1	68	**Pass**

Table 86 Sample S2 Cu Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
5	69.8	68.8
16	67.2	68.9
23	72.5	70.5
30	68.6	71.2
35	68.1	70.7
42	71.4	69.0
52	76.6	71.7
Mean	70.4	
CV	5.5%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.48	0.73	**Pass**
s_{an}/σ	0.27	0.50	**Pass**
s^2_{sam}	2.0	15	**Pass**

Table 87 Sample S2 Hg Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
5	2.01	1.96
16	1.90	1.91
23	2.05	2.01
30	1.95	2.01
35	1.95	2.03
42	1.97	1.98
52	2.14	2.00
Mean	1.99	
CV	4.8%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.60	0.73	**Pass**
s_{an}/σ	0.16	0.50	**Pass**
s^2_{sam}	0.0015	0.020	**Pass**

Table 88 Sample S2 Mn Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
5	185	186
16	177	177
23	191	185
30	189	190
35	182	195
42	189	185
52	193	183
Mean	186	
CV	5.4%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.49	0.73	**Pass**
s_{an}/σ	0.18	0.50	**Pass**
s^2_{sam}	4.4	180	**Pass**

Table 89 Sample S2 Mo Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
5	5.62	5.47
16	5.45	5.50
23	5.92	5.70
30	5.54	5.77
35	5.57	5.65
42	5.54	5.62
52	6.17	5.71
Mean	5.66	
CV	5.6%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.61	0.73	**Pass**
s_{an}/σ	0.14	0.50	**Pass**
s^2_{sam}	0.014	0.28	**Pass**

Table 90 Sample S2 Ni Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
5	50.0	48.9
16	48.1	48.4
23	52.1	50.3
30	49.8	51.3
35	49.3	50.4
42	50.5	49.6
52	54.3	50.8
Mean	50.3	
CV	4.9%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.59	0.73	**Pass**
s_{an}/σ	0.12	0.50	**Pass**
s^2_{sam}	1.1	21	**Pass**

Table 91 Sample S2 P Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
5	1220	1240
16	1180	1200
23	1280	1240
30	1210	1260
35	1190	1230
42	1260	1210
52	1340	1220
Mean	1240	
CV	6.4%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.58	0.73	**Pass**
s_{an}/σ	0.21	0.50	**Pass**
s^2_{sam}	69	8700	**Pass**

Table 92 Sample S2 Pb Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
5	108	109
16	105	102
23	112	110
30	107	111
35	106	114
42	110	108
52	120	109
Mean	109	
CV	7.2%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.51	0.73	**Pass**
s_{an}/σ	0.24	0.50	**Pass**
s^2_{sam}	2.1	73	**Pass**

Table 93 Sample S2 Se Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
5	3.06	3.05
16	2.97	3.11
23	3.13	3.07
30	2.97	3.11
35	2.96	3.07
42	3.02	3.01
52	3.28	3.03
Mean	3.06	
CV	6%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.53	0.73	**Pass**
s_{an}/σ	0.20	0.50	**Pass**
s^2_{sam}	0.00001	0.052	**Pass**

Table 94 Sample S2 Sn Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
5	0.445	0.408
16	0.419	0.425
23	0.434	0.445
35	0.440	0.483
42	0.491	0.457
52	0.507	0.509
Mean	0.455	
CV	8.5%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.41	0.78	**Pass**
s_{an}/σ	0.21	0.50	**Pass**
s^2_{sam}	0.00088	0.0023	**Pass**

Table 95 Sample S2 V Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
5	6.07	6.05
16	5.84	6.01
23	6.36	6.09
30	6.08	6.11
35	5.94	6.12
42	6.21	6.15
52	6.82	6.49
Mean	6.17	
CV	4.3%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.44	0.73	**Pass**
s_{an}/σ	0.14	0.50	**Pass**
s^2_{sam}	0.047	0.19	**Pass**

Table 96 Sample S2 Zn Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
5	42.8	43.2
16	41.7	42.3
23	44.2	43.1
30	43.2	43.6
35	42.3	43.9
42	43.7	42.3
52	45.5	42.4
Mean	43.2	
CV	4.9%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.60	0.73	**Pass**
s_{an}/σ	0.16	0.50	**Pass**
s^2_{sam}	0.00001	9.5	**Pass**

Sample Analysis for Nutrients and Anions

Partial homogeneity testing was also performed for all nutrients and anions in Sample S3 except for pH, EC, and TKN. Three bottles were analysed, and the average of these results was reported as the homogeneity value. Measurements were conducted under repeatability conditions and in a random order.

Analyses for all the tests other than acid extractable elements were conducted by the Inorganics Section of NMIA.

For water soluble anions, a test portion of 10 g was weighed into a 50 mL polypropylene container. The container was then filled with deionised water. The suspension was shaken at room temperature for 1 h, centrifuged, and filtered through 0.45 µm filter. A summary of the measurement methods and instrumental techniques is presented in Table 97.

The results for water soluble iodide and orthophosphate-P were less than 1 mg/L.

Table 97 Summary of the Measurement Methods and Instrumental Techniques used by NMIA

Anion	Measurement Method	Instrument
Water Soluble Bromide	Ion Chromatographic Method	IC
Water Soluble Chloride	Ion Chromatographic Method	IC
Water Soluble Fluoride	Ion Selective Electrode	Fluoride Selective Electrode
Water Soluble Iodide	Ion Chromatographic Method	IC
Water Soluble Orthophosphate-P	Ion Chromatographic Method	IC
Water Soluble Sulphate	Ion Chromatographic Method	IC
2M KCl Extractable Ammonium-N	o-phthalaldehyde	SFA
2M KCl Extractable Nitrate-N	Colorimetric Sulphanilamide NEDD Cd reduction	SFA

APPENDIX 2 - ROBUST AVERAGE AND ASSOCIATED UNCERTAINTY, Z-SCORE AND E_N SCORE CALCULATIONS

A2.1 Robust Average and Associated Uncertainty

The robust averages were calculated using the procedure described in ISO 13528.[7] The associated uncertainties were evaluated as according to Equation 4.

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

where:

$u_{rob\ av}$ is the standard uncertainty of the robust average

$S_{rob\ av}$ is the standard deviation of the robust average

p is the 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 98.

Table 98 Uncertainty Evaluation for As in Sample S1

No. results (p)	18
Robust Average	11.7 mg/kg
$S_{rob\ av}$	1.7 mg/kg
$u_{rob\ av}$	0.50 mg/kg
k	2
$U_{rob\ av}$	1.0 mg/kg

The assigned value for As in Sample S1 is 11.7 ± 1.0 mg/kg.

A2.2 z-Score and E_n-Score Calculations

For each participant's result, a z-score and E_n-score are calculated according to Equations 2 and 3 respectively (see Section 4).

A worked example is set out below in Table 99.

Table 99 z-Score and E_n-score Calculation for As Result Reported by Laboratory 21 in S1

Participant Result (mg/kg)	Assigned Value (mg/kg)	Standard Deviation for Proficiency Assessment	z-Score	E_n-Score
12 ± 2.02	11.7 ± 1.0	15% as PCV, or: 0.15 × 11.7 = 1.755 mg/kg	$z = \frac{12 - 11.7}{1.755}$ = 0.17	$E_n = \frac{12 - 11.7}{\sqrt{2.02^2 + 1.0^2}}$ = 0.13

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 2026 NMIA carried out 34 proficiency tests of metals in soil. These studies involved analyses of acid-extractable elements at low and high levels in dried soil, moist soil, biosolids, clay, compost, sediment, and sludge.

Laboratory X submitted results for As in all these PTs. Most reported results returned acceptable z-scores. This data can usefully be separated into two ranges of results 10 to 50 mg/kg and 1 to 10 mg/kg (Tables 100 and 101). The pooled standard deviation of the robust CV over these PT samples for each concentration range gives evaluations of the relative standard uncertainty of 9.9% and 13% respectively. Using a coverage factor of two gives relative expanded uncertainties of 20% and 26% respectively, at a level of confidence of approximately 95%.

Table 102 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 50 mg/kg.

Table 100 Laboratory X Reported Results for As at 10 to 50 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
AQA 25-12	S2 – Sediment	36.6	33.9	20	12
AQA 26-04	S2 – Moist Sediment	32.0	32.9	23	9.4
AQA 26-16	S1 - Soil	14	11.7	18	14
				Average	9.9%*
$\boldsymbol{pooled\ s\%} = \sqrt{\frac{((\mathbf{19}-\mathbf{1})\times \mathbf{8.5^2} + (\mathbf{13}-\mathbf{1})\times \mathbf{15^2} + \cdots\cdots + (\mathbf{18}-\mathbf{1})\times \mathbf{14^2})}{\mathbf{402}-\mathbf{20}}}$					**9.9%**

* The pooled standard deviation was used

Table 101 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
AQA 25-12	S1 – Biosolid	3.29	3.34	16	16
AQA 26-04	S1 - Soil	8.49	9.47	22	6.9
				Average	12%*
$\boldsymbol{pooled\ s\%} = \sqrt{\frac{((\mathbf{11}-\mathbf{1})\times\mathbf{16^2}+(\mathbf{12}-\mathbf{1})\times\mathbf{15^2}+\cdots\cdots+(\mathbf{22}-\mathbf{1})\times\mathbf{6.9^2})}{\mathbf{465}-\mathbf{28}}}$					**13%**

* The pooled standard deviation was used.

Table 102 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
50	10

The evaluations of 26% and 20% relative passes the test of being reasonable, and the analysis of the 48 different PT samples over eighteen years can be assumed to include all the relevant uncertainty components (different matrices, operators, reagents, calibrators etc.), and so complies with ISO/IEC 17025.[9]

APPENDIX 4 - INSTRUMENT DETAILS

Table 103 Instrument Conditions Ag

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-MS		ORS	He	100	NA	107
3	ICP-MS/MS	In		Standard Mode	500	500	107
5	ICP-MS			He			
6	ICP-MS	Rh	NA	Standard Mode	250	NA	NA
7	ICP-MS	Rh	ORS	He	NA	20	107 (m/z)
9	ICP-MS	Rh	KED	He	1000	1000	109
10	ICP-MS/MS	Rh	CRI	He	500	NA	107
11	ICP-MS	Rh	ORS	He	500	500	107 (m/z)
12	ICP-OES-AV	Lu			83	83	328.068
14	ICP-MS	Ge	ORS	He	0.1	0.1	109
15	ICP-MS	Rh	ORS	He	800	800	109
16	ICP-OES-AV	Eu			NA		328.068
17	ICP-OES-AV	Eu & Cs	NA	NA	50	50	328.069 nm
18	ICP-MS	Rh	NA	NA	625	NA	109
21	ICP-OES-AV	Eu			50	50	328.069
22	ICP-MS	Rh	NA	He	NA		

Table 104 Instrument Conditions Al

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-MS		ORS	He	100	NA	27
3	ICP-OES-AV-buffer	Y			NA	50	394.401
4	ICP-OES-AV					NA	308.215
5	ICP-OES-AV				NA		396.152
6	ICP-MS	Sc	NA	Standard Mode	250	NA	NA
7	ICP-MS	Sc	ORS	He	NA	20	27 (m/z)
9	ICP-MS	Sc	KED	He	NA	1000	27
10	ICP-MS/MS	Sc	CRI	He	500	NA	27
11	ICP-MS	Sc	ORS	He	NA	500	27 (m/z)
12	ICP-OES-AV	Lu			NA	83	396.152
14	ICP-OES-AV	Lu	NA	NA	NA	0.1	237.312
15	ICP-MS	Rh	ORS	NA	NA	800	27
16	ICP-OES-AV	Eu			NA		236.705
17	ICP-OES-AV	Eu & Cs	NA	NA	NA	50	236.707, 308.215, 396.15 nm
18	ICP-MS	Sc	UC	He	625	NA	27
21	ICP-OES-AV	Eu			NA	50	396.153
22	ICP-MS	Sc	NA	He	NA		

Table 105 Instrument Conditions As

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-MS		ORS	He	100	NA	75
3	ICP-MS/MS	Ge	CRI	O2	500	500	75
4	ICP-OES-AV				NA		188.982
5	ICP-MS			He			
6	ICP-MS	Rh	UC	He	250	NA	NA
7	ICP-MS	Rh	ORS	He	NA	20	75 (m/z)
9	ICP-MS	Rh	KED	He	1000	400	75
10	ICP-MS/MS	Rh	CRI	He	500	500	27
11	ICP-MS	Rh	ORS	He	500	500	75 (m/z)
12	ICP-OES-AV	Lu			83	83	188.98
14	ICP-MS	Ge	ORS	He	0.1	0.1	75
15	ICP-MS	Rh	ORS	He	800	800	75
16	ICP-MS	Sc,Ir,Rh	ORS	He			75
17	ICP-OES-AV	Eu & Cs	NA	NA	50	50	188.89 nm
18	ICP-MS	Rh	UC	He	625	NA	75
21	ICP-OES-AV	Eu			50	50	188.98
22	ICP-MS	Rh	NA	He	NA		
23	ICP-OES-AV				100		188.98

Table 106 Instrument Conditions B

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-OES-AV-buffer	Lu			100	NA	249.678
3	ICP-MS/MS	Sc		Standard Mode	NA	500	11
4	ICP-OES-AV						
5	ICP-MS			He	NA		249.678
6	ICP-MS	Sc	NA	Standard Mode	250	NA	NA
7	ICP-MS	Sc	NA	NA	NA	20	11 (m/z)
9	ICP-MS	Sc	KED	He	NA	400	10
10	ICP-MS/MS	Sc	CRI	No Gas	500	500	11
11	ICP-MS	Sc	ORS	He	NA	500	11 (m/z)
12	ICP-OES-AV	Lu			NA	83	182.577
14	ICP-OES-AV	Lu	NA	NA	NA	0.1	208.956
15	ICP-MS	Rh	ORS	NA	NA	800	11
16	ICP-OES-AV	Eu			NA		249.772
17	ICP-OES-AV	Eu & Cs	NA	NA	NA	50	249.773 nm
18	ICP-MS	Sc	NA	NA	625	NA	10
21	ICP-OES-AV	Eu			NA	50	249.773
22	ICP-MS	SC	NA	Standard Mode	NA		

Table 107 Instrument Conditions Ba

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-MS		ORS	He	100	NA	138
3	ICP-MS/MS	In		Standard Mode	NA	500	137
4	ICP-OES-AV					NA	233.527
5	ICP-MS			He	NA		493.408
6	ICP-MS	In	NA	Standard Mode	250	NA	NA
7	ICP-MS	Rh	ORS	He	NA	20	135 (m/z)
9	ICP-MS	Tb	KED	He	NA	1000	137
10	ICP-MS/MS	Rh	CRI	He	500	500	135
11	ICP-MS	Rh	ORS	He	NA	500	135 (m/z)
12	ICP-OES-AV	Lu			NA	83	493.408
14	ICP-OES-RV	Lu	NA	NA	NA	0.1	455.403
15	ICP-MS	Rh	ORS	He	NA	800	137
16	ICP-MS	Sc,Ir,Rh	ORS	He	NA		137
17	ICP-OES-AV	Eu & Cs	NA	NA	NA	50	585.369 nm
18	ICP-MS	Rh	NA	NA	625	NA	138
21	ICP-OES-AV	Eu			NA	50	585.369
22	ICP-MS	Rh	NA	He	NA		

Table 108 Instrument Conditions Be

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-OES-AV-buffer	Lu			100	NA	313.042
3	ICP-MS/MS	Sc		Standard Mode	500	NA	9
4	ICP-OES-AV				NA		313.157
5	ICP-MS			He		NA	
6	ICP-MS	Sc	NA	Standard Mode	250	NA	NA
9	ICP-MS	Sc	KED	He	1000	NA	9
10	ICP-MS/MS	Sc	CRI	No Gas	NA	500	9
11	ICP-MS	Sc	ORS	Standard Mode	500	NA	9 (m/z)
12	ICP-OES-AV	Lu			83	NA	313.042
14	ICP-MS	Li6	ORS	He	0.1	NA	9
15	ICP-MS	Rh	ORS	NA	800	NA	9
16	ICP-MS	Sc,Ir,Rh	ORS	He		NA	9
17	ICP-OES-AV	Eu & Cs	NA	NA	50	NA	313.042 nm
18	ICP-MS	Sc	NA	NA	625	NA	9
21	ICP-OES-AV	Eu			50	NA	313.042

Table 109 Instrument Conditions Ca

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-OES-AV-buffer	Lu			100	NA	430.253
2	ICP-OES-AV	Y 371.029	NA	NA	50	NA	430.253 (nm)
3	ICP-OES-AV-buffer	Y			50	NA	315.887
4	ICP-OES-AV				NA		317.933
5	ICP-OES-AV					NA	223.061
7	ICP-MS	Sc	ORS	H2	100	NA	40 (m/z)
8	Other				500	NA	620
10	ICP-MS/MS	Sc	CRI	H2	500	NA	40
11	ICP-MS	Sc	ORS	H2	100	NA	40 (m/z)
12	ICP-OES-AV	Lu			83	NA	317.933
14	ICP-OES-RV	Lu	NA	NA	0.1	NA	422.673
15	ICP-OES-RV	Y	NA	NA	800	NA	422.673
16	ICP-OES-AV	Eu				NA	315.885
17	ICP-OES-AV	Eu & Cs	NA	NA	50	NA	315.887, 370.602 nm
18	ICP-MS	Sc	UC	He	NA	625	44
21	ICP-OES-AV	Eu			50	NA	315.885
22	ICP-MS	Sc	NA	H2		NA	
25	ICP-MS	Sc	ORS	H2He	1000	NA	40

Table 110 Instrument Conditions Cd

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-MS		ORS	He	100	NA	114
3	ICP-MS/MS	Ge	CRI	He	500	500	111
4	ICP-OES-AV				NA		228.812
5	ICP-MS			He			
6	ICP-MS	Rh	NA	Standard Mode	250	NA	NA
7	ICP-MS	Rh	ORS	He	NA	20	111 (m/z)
9	ICP-MS	Rh	KED	He	1000	1000	111
10	ICP-MS/MS	Rh	CRI	He	NA	500	111
11	ICP-MS	Rh	ORS	He	500	500	111 (m/z)
12	ICP-OES-AV	Lu			83	83	214.439
14	ICP-MS	In	ORS	He	0.1	0.1	111
15	ICP-MS	Rh	ORS	He	800	800	111
16	ICP-MS	Sc,Ir,Rh	ORS	He			111
17	ICP-OES-AV	Eu & Cs	NA	NA	50	50	226.502 nm
18	ICP-MS	Rh	NA	NA	625	NA	111
21	ICP-OES-AV	Eu			50	50	226.502
22	ICP-MS	Rh	NA	He	NA		
23	ICP-OES-AV				100		214.439

Table 111 Instrument Conditions Co

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-MS		ORS	He	100	NA	59
3	ICP-MS/MS	Ge	CRI	He	NA	500	59
4	ICP-OES-AV						
5	ICP-MS			He	NA		
6	ICP-MS	Rh	UC	He	250	NA	NA
7	ICP-MS	Sc	ORS	He	NA	20	59 (m/z)
9	ICP-MS	Ga	KED	He	NA	1000	59
10	ICP-MS/MS	Sc	CRI	He	NA	500	59
11	ICP-MS	Sc	ORS	He	NA	500	59 (m/z)
12	ICP-OES-AV	Lu			NA	83	230.786
14	ICP-MS	Ge	ORS	He	NA	0.1	59
15	ICP-MS	Rh	ORS	He	NA	800	59
16	ICP-MS	Sc,Ir,Rh	ORS	He		NA	59
17	ICP-OES-AV	Eu & Cs	NA	NA	NA	50	228.616 nm
18	ICP-MS	Ge	UC	He	625	NA	59
21	ICP-OES-AV	Eu			NA	50	228.616
22	ICP-MS	Sc	NA	He	NA		

Table 112 Instrument Conditions Cr

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-MS		ORS	He	100	NA	52
3	ICP-MS/MS	Ge	CRI	He	500	500	52
4	ICP-OES-AV				NA		267.716
5	ICP-MS			He			
6	ICP-MS	Sc	UC	He	250	NA	NA
7	ICP-MS	Sc	ORS	He	NA	20	52 (m/z
9	ICP-MS	Sc	KED	He	1000	1000	52
10	ICP-MS/MS	Sc	CRI	He	500	500	52
11	ICP-MS	Sc	ORS	He	500	500	52 (m/z
12	ICP-OES-AV	Lu			83	83	267.716
14	ICP-MS	Ge	ORS	He	0.1	0.1	52
15	ICP-MS	Rh	ORS	He	800	800	52
16	ICP-MS	Sc,Ir,Rh	ORS	He			52
17	ICP-OES-AV	Eu & Cs	NA	NA	50	50	267.716 nm
18	ICP-MS	Sc	UC	He	625	NA	52
21	ICP-OES-AV	Eu			50	50	267.716
22	ICP-MS	Sc	NA	He	NA		
23	ICP-OES-AV				100		267.716

Table 113 Instrument Conditions Cu

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-MS		ORS	He	100	NA	65
3	ICP-MS/MS	Ge	CRI	He	500	500	63
4	ICP-OES-AV				NA		324.752
5	ICP-MS			He			
6	ICP-MS	Rh	UC	He	250	NA	NA
7	ICP-MS	Sc	ORS	He	NA	20	63 (m/z
9	ICP-MS	Ga	KED	He	1000	1000	63
10	ICP-MS/MS	Sc	CRI	He	500	500	63
11	ICP-MS	Sc	ORS	He	500	500	63 (m/z
12	ICP-OES-AV	Lu			83	83	327.395
14	ICP-OES-AV	Lu	NA	NA	0.1	0.1	324.754
15	ICP-MS	Rh	ORS	He	800	800	65
16	ICP-MS	Sc,Ir,Rh	ORS	He			63
17	ICP-OES-AV	Eu & Cs	NA	NA	50	50	327.395 nm
18	ICP-MS	Ge	UC	He	625	NA	63
21	ICP-OES-AV	Eu			50	50	327.397
22	ICP-MS	Sc	NA	He	NA		
23	ICP-OES-AV				100		324.754

Table 114 Instrument Conditions Fe

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-MS		ORS	He	100	NA	56
2	ICP-OES-AV	Y 371.029	NA	NA	50	NA	370.792 (nm)
3	ICP-OES-AV-buffer	Y			50	NA	273.955
4	ICP-OES-AV				NA		238.204
5	ICP-OES-AV					NA	259.94
7	ICP-MS	Sc	ORS	He	20	NA	56 (m/z)
8	Other				500	NA	248.3
10	ICP-MS/MS	Sc	CRI	He	500	NA	56
11	ICP-MS	Sc	ORS	He	5000	NA	56 (m/z)
12	ICP-OES-AV	Lu			83	NA	238.204
14	ICP-OES-AV	Lu	NA	NA	0.1	NA	238.204
15	ICP-OES-RV	Y	NA	NA	800	NA	238.204
16	ICP-OES-AV	Eu				NA	258.588
17	ICP-OES-AV	Eu & Cs	NA	NA	50	NA	238.204, 258.588, 259.940 nm
18	ICP-MS	Sc	UC	He	625	625	56
21	ICP-OES-AV	Eu			50	NA	238.204
22	ICP-MS	Sc	NA	He		NA	
25	ICP-MS	Sc	ORS	H2He	1000	NA	56

Table 115 Instrument Conditions Ga

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
5	ICP-MS			He		NA	
15	ICP-MS	Rh	ORS	He	800	NA	69
16	ICP-MS	Sc,Ir,Rh	ORS	He		NA	71
17	ICP-MS	Ir, Rh & Sc	NA	NA	50	NA	71 m/z
21	ICP-MS	Sc	ORS	He	50	NA	71

Table 116 Instrument Conditions Hg

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	VGA-ICP-OES				100	NA	194.164
3	CVAAS				1000	1000	253.7
4	FIMS				NA		253.7
5	ICP-MS			He			
6	ICP-MS	Ir	NA	Standard Mode	250	NA	NA
7	ICP-MS	Lu	ORS	He	NA	20	202 (m/z)
9	ICP-MS	Tb	KED	He	1000	1000	201
10	ICP-MS/MS	Lu	CRI	He	500	NA	202
11	ICP-MS	Lu	ORS	He	500	500	202 (m/z)
12	CVAAS	Lu			83	83	253.7
14	ICP-MS	Ir	ORS	He	0.1	0.1	202
15	ICP-MS	Ir	ORS	He	800	800	202
16	AAS	NA					253.7
17	CETAC	NA	NA	NA	50	50	253.7 nm
18	ICP-MS	Ir	NA	NA	625	NA	201
21	CVAAS				50		253.7
22	ICP-MS	Lu	NA	He	NA		
23	CVAFS				10000		

Table 117 Instrument Conditions K

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-OES-AV-buffer	Lu			100	NA	766.491
2	ICP-OES-AV	Y 371.029	NA	NA	50	NA	769.897 (nm)
3	ICP-OES-AV-buffer	Y			50	NA	766.49
5	ICP-OES-AV					NA	766.491
7	ICP-MS	Ge	ORS	He	100	NA	39 (m/z)
8	Other				500	NA	766.5
10	ICP-MS/MS	Sc	CRI	He	500	NA	39
11	ICP-MS	Sc	ORS	He	100	NA	39 (m/z)
12	ICP-OES-AV	Lu			83	NA	769.897
14	ICP-OES-AV	Lu	NA	NA	0.1	NA	766.491
15	ICP-MS	Rh	ORS	He	800	NA	39
16	ICP-OES-AV	Eu				NA	766.491
17	ICP-OES-AV	Eu & Cs	NA	NA	50	NA	404.721, 766.491 nm
18	ICP-MS	Sc	UC	He	NA	625	39
21	ICP-OES-AV	Eu			50	NA	766.485
22	ICP-MS	Sc	NA	He		NA	
25	ICP-MS	Sc	ORS	He	1000	NA	39

Table 118 Instrument Conditions Li

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-OES-AV-buffer	Lu			100	NA	670.783
3	ICP-MS/MS	Sc	CRI	He	500	NA	7
5	ICP-MS			He		NA	
6	ICP-MS	Sc	NA	Standard Mode	250	NA	NA
7	NA	NA	NA	NA	NA	NA	7 (m/z)
9	ICP-MS	Sc	KED	He	1000	NA	7
10	ICP-MS/MS	Sc	CRI	No Gas	500	NA	7
11	ICP-MS	Sc	ORS	Standard Mode	500	NA	7 (m/z)
12	ICP-OES-AV	Lu			83	NA	670.783
14	ICP-MS	Li6	ORS	He	0.1	NA	7
15	ICP-MS	Rh	ORS	NA	800	NA	7
16	ICP-MS	Sc,Ir,Rh	ORS	He		NA	7
17	ICP-MS	Ir, Rh & Sc	NA	NA	50	NA	7 m/z
18	ICP-MS	Sc	NA	NA	625	NA	7
21	ICP-MS	Sc			50	NA	7

Table 119 Instrument Conditions Mg

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-OES-AV-buffer	Lu			100	NA	279.078
2	ICP-OES-AV	Y 371.029	NA	NA	50	NA	277.983 (nm)
3	ICP-OES-AV-buffer	Y			50	NA	279.077
4	ICP-OES-AV				NA		279.077
5	ICP-OES-AV					NA	280.27
7	ICP-MS	Sc	ORS	He	100	NA	24 (m/z)
8	Other				500	NA	285.2
10	ICP-MS/MS	Sc	CRI	He	500	NA	24
11	ICP-MS	Sc	ORS	He	100	NA	24 (m/z)
12	ICP-OES-AV	Lu			83	NA	383.829
14	ICP-OES-RV	Lu	NA	NA	0.1	NA	285.213
15	ICP-MS	Rh	ORS	He	800	NA	24
16	ICP-OES-AV	Eu				NA	383.33
17	ICP-OES-AV	Eu & Cs	NA	NA	50	NA	383.829 nm
18	ICP-MS	Sc	UC	He	NA	625	25
21	ICP-OES-AV	Eu			50	NA	383.83
22	ICP-MS	Sc	NA	He		NA	
25	ICP-MS	Sc	ORS	He	1000	NA	24

Table 120 Instrument Conditions Mn

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-MS		ORS	He	100	NA	55
3	ICP-OES-AV-buffer	Y			50	50	257.61
4	ICP-OES-AV				NA		257.61
5	ICP-OES-AV						257.61
6	ICP-MS	Sc	UC	He	250	NA	NA
7	ICP-MS	Sc	ORS	He	NA	20	55 (m/z)
9	ICP-MS	Sc	KED	He	1000	1000	55
10	ICP-MS/MS	Sc	CRI	He	500	500	55
11	ICP-MS	Sc	ORS	He	500	500	55 (m/z)
12	ICP-OES-AV	Lu			83	83	260.568
14	ICP-OES-AV	Lu	NA	NA	0.1	0.1	257.61
15	ICP-MS	Rh	ORS	He	800	800	55
16	ICP-MS	Sc,Ir,Rh	ORS	He			55
17	ICP-OES-AV	Eu & Cs	NA	NA	50	50	261.021 nm
18	ICP-MS	Sc	UC	He	625	NA	55
21	ICP-OES-AV	Eu			50	50	261.021
22	ICP-MS	Sc	NA	He	NA		

Table 121 Instrument Conditions Mo

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-MS		ORS	He	100	NA	98
3	ICP-MS/MS	In		Standard Mode	NA	500	95
4	ICP-OES-AV						
5	ICP-MS			He	NA		
6	ICP-MS	Rh	UC	He	250	NA	NA
7	ICP-MS	Rh	ORS	He	NA	20	95 (m/z)
9	ICP-MS	Rh	KED	He	NA	1000	98
10	ICP-MS/MS	Sc	CRI	He	500	NA	95
11	ICP-MS	Rh	ORS	He	NA	500	95 (m/z)
12	ICP-OES-AV	Lu			NA	83	202.568
15	ICP-MS	Rh	ORS	He	NA	800	95
16	ICP-MS	Sc,Ir,Rh	ORS	He			95
17	ICP-OES-AV	Eu & Cs	NA	NA	NA	50	202.032 nm
18	ICP-MS	Rh	NA	NA	625	NA	95
21	ICP-OES-AV	Eu			NA	50	202.032
22	ICP-MS	Rh	NA	He	NA		

Table 122 Instrument Conditions Na

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-OES-AV-buffer	Lu			100	NA	589.592
2	ICP-OES-AV	Y 371.029	NA	NA	50	NA	588.995 (nm)
3	ICP-OES-AV-buffer	Y			50	NA	589.592
4	ICP-OES-AV				NA		589.592
5	ICP-OES-AV					NA	589.592
6	ICP-MS	Sc	NA	He	250	NA	NA
7	ICP-MS	Sc	ORS	He	100	NA	23 (m/z)
8					500	NA	589
10	ICP-MS/MS	Sc	CRI	He	500	500	23
11	ICP-MS	Sc	ORS	He	100	NA	23 (m/z)
12	ICP-OES-AV	Lu			83	NA	330.237
13	ICP-MS/MS	Sc	CRC	He	100	NA	NA
15	ICP-MS	Rh	ORS	He	80	NA	23
16	ICP-OES-AV	Eu				NA	589.592
17	ICP-OES-AV	Eu & Cs	NA	NA	50	NA	330.237, 589.592 nm
18	ICP-MS	Sc	UC	He	625	625	23
21	ICP-OES-AV	Eu			50	NA	589.593
22	ICP-MS	Sc	NA	He		NA	
25	ICP-MS	Rh	ORS	He	1000	NA	23

Table 123 Instrument Conditions Ni

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-MS		ORS	He	100	NA	60
3	ICP-MS/MS	Ge	CRI	He	500	500	221.648
4	ICP-OES-AV				NA		231.604
5	ICP-OES-AV						216.555
6	ICP-MS	Rh	UC	He	250	NA	NA
7	ICP-MS	Sc	ORS	He	NA	20	60 (m/z)
9	ICP-MS	Ga	KED	He	1000	1000	60
10	ICP-MS/MS	Sc	CRI	He	500	500	60
11	ICP-MS	Sc	ORS	He	500	500	60 (m/z)
12	ICP-OES-AV	Lu			83	83	231.604
14	ICP-MS	Ge	ORS	He	0.1	0.1	60
15	ICP-MS	Rh	ORS	He	800	800	60
16	ICP-MS	Sc,Ir,Rh	ORS	He			60
17	ICP-OES-AV	Eu & Cs	NA	NA	50	50	231.604nm
18	ICP-MS	Ge	UC	He	625	NA	60
21	ICP-OES-AV	Eu			50	50	231.604
22	ICP-MS	Sc	NA	He	NA		
23	ICP-OES-AV				100		216.555

Table 124 Instrument Conditions P

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-OES-AV-buffer	Lu				NA	213.618
3	ICP-OES-AV-buffer	Y			50	50	214.914
4	ICP-OES-AV						
5	ICP-OES-AV						177.434
6	ICP-MS	Sc	NA	He	250	NA	NA
7	ICP-MS	Sc	ORS	He	100	100	31 (m/z)
8	Other				500	NA	880
9	ICP-MS	Sc	KED	He	NA	1000	31
10	ICP-MS/MS	Sc	CRI	HEHe	500	500	31
11	ICP-MS	Sc	ORS	He	500	500	31 (m/z)
12	ICP-OES-AV	Lu			83	83	213.618
14	ICP-OES-AV	Lu	NA	NA	0.1	0.1	177.434
15	ICP-MS	Rh	ORS	HEHe	800	800	31
16	ICP-OES-AV	Eu				NA	185.827
17	ICP-OES-AV	Eu & Cs	NA	NA	50	50	185.827 nm
18	ICP-MS	Sc	UC	He	NA	625	31
21	ICP-OES-AV	Eu			50	50	185.827
22	ICP-MS	Sc	NA	He			
25	ICP-MS	Rh	ORS	HEHe	1000	NA	31

Table 125 Instrument Conditions Pb

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-MS		ORS	He	100	NA	208
3	ICP-OES-AV-buffer	Y			50	50	220.353
4	ICP-OES-AV				NA		220.353
5	ICP-MS			He			220.353
6	ICP-MS	Ir	NA	Standard Mode	250	NA	NA
7	ICP-MS	Lu	ORS	He	NA	20	208 (m/z)
9	ICP-MS	Tb	KED	He	1000	1000	206+207+208
10	ICP-MS/MS	Lu	CRI	He	500	500	208
11	ICP-MS	Lu	ORS	He	500	500	208 (m/z)
12	ICP-OES-AV	Lu			83	83	220.353
14	ICP-MS	Ir	ORS	He	0.1	0.1	208
15	ICP-MS	Ir	ORS	He	800	800	208
16	ICP-MS	Sc,Ir,Rh	ORS	He		NA	208
17	ICP-OES-AV	Eu & Cs	NA	NA	50	50	185.827 nm
18	ICP-MS	Ir	NA	NA	625	NA	206+207+208
21	ICP-OES-AV	Eu			50	50	220.354
22	ICP-MS	Lu	NA	He	NA		
23	ICP-OES-AV				100		220.353

Table 126 Instrument Conditions Rb

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
5	ICP-MS			He		NA	
6	ICP-MS	Rh	NA	Standard Mode	250	NA	NA
9	ICP-MS	Rh	KED	He	1000	NA	85
15	ICP-MS	Rh	ORS	He	800	NA	85
16	ICP-MS	Sc,Ir,Rh	ORS	He		NA	85
17	ICP-MS	Ir, Rh & Sc	NA	NA	50	NA	85 m/z
21	ICP-MS	Sc	ORS	He	50	NA	85

Table 127 Instrument Conditions S

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-OES-AV-buffer	Lu				NA	181.972
3	ICP-OES-AV-buffer	Y			50	NA	181.975
5	ICP-OES-AV					NA	180.669
7	ICP-MS	Sc	ORS	H2	100	NA	34 (m/z)
12	ICP-OES-AV	Lu			83	NA	181.972
14	ICP-OES-AV	Lu	NA	NA	0.1	NA	180.669
15	ICP-OES-AV	Y	NA	NA	800	NA	181.972
16	ICP-OES-AV	Eu				NA	181.972
17	ICP-OES-AV	Eu & Cs	NA	NA	50	NA	178.165,181.972 nm
18	ICP-OES-AV	Y	NA	NA	NA	62.5	181.975
21	ICP-OES-AV	Eu			50	NA	181.972
22	ICP-MS	Sc	NA	H2		NA	
25	ICP-MS	Rh	ORS	H2He	1000	NA	34

Table 128 Instrument Conditions Sb

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-MS		ORS	He	100	NA	121
3	ICP-OES-AV-buffer	Y			50	NA	206.836
4	ICP-OES-AV				NA		206.836
5	ICP-MS			He		NA	
6	ICP-MS	Rh	NA	Standard Mode	250	NA	NA
7	ICP-MS	Rh	ORS	He	NA	NA	123 (m/z)
9	ICP-MS	Rh	KED	He	1000	NA	121
10	ICP-MS/MS	Rh	CRI	He	500	NA	123
11	ICP-MS	Rh	ORS	He	500	NA	123 (m/z)
12	ICP-OES-AV	Lu			83	NA	206.834
14	ICP-OES-AV	Lu	NA	NA	0.1	NA	206.834
15	ICP-MS	Rh	ORS	He	800	NA	121
16	ICP-MS	Sc,Ir,Rh	ORS	He		NA	121
17	ICP-OES-AV	Eu & Cs	NA	NA	50	NA	178.165,181.972 nm
18	ICP-MS	Rh	NA	NA	625	NA	121
21	ICP-OES-AV	Eu			50	NA	206.834

Table 129 Instrument Conditions Se

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-MS		ORS	He	100	NA	78
3	ICP-MS/MS	Ge	CRI	O2	500	500	80
5	ICP-MS			He			
6	ICP-MS	Rh	UC	He	250	NA	NA
7	ICP-MS	Rh	ORS	H2	NA	20	78 (m/z)
9	ICP-MS	Te	KED	He	1000	400	82
10	ICP-MS/MS	Sc	CRI	H2	500	500	78
11	ICP-MS	Rh	ORS	H2	500	500	78 (m/z)
12	ICP-OES-AV	Lu			83	83	196.026
14	ICP-MS	Ge	ORS	H2	0.1	0.1	78
15	ICP-MS	Rh	ORS	HEHe	800	800	77
16	ICP-MS	Sc,Ir,Rh	ORS	He			78
17	ICP-OES-AV	Eu & Cs	NA	NA	50	50	206.834 nm
18	ICP-MS	Rh	DRC	NH3	625	NA	82
21	ICP-OES-AV	Eu			50	50	196.026
22	ICP-MS	Sc	NA	H2	NA		
23	ICP-OES-AV				100		196.026

Table 130 Instrument Conditions Sn

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-MS		ORS	He	100	NA	118
3	ICP-MS/MS	In		Standard Mode	500	500	118
5	ICP-MS			He			
6	ICP-MS	Rh	NA	Standard Mode	250	NA	NA
7	ICP-MS	Rh	ORS	He	NA	20	118 (m/z)
9	ICP-MS	Rh	KED	He	1000	400	120
10	ICP-MS/MS	Rh	CRI	He	500	500	118
11	ICP-MS	Rh	ORS	He	500	500	118 (m/z)
12	ICP-OES-AV	Lu			83	83	189.925
14	NA	NA	NA	NA	NA	0.1	NA
15	ICP-MS	Rh	ORS	He	800	800	118
16	ICP-MS	Sc,Ir,Rh	ORS	He		NA	118
17	ICP-OES-AV	Eu & Cs	NA	NA	50	50	189.926 nm
21	ICP-OES-AV	Eu			50	50	189.926
22	ICP-MS	Rh	NA	He	NA		

Table 131 Instrument Conditions Sr

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-OES-AV-buffer	Lu			100	NA	407.771
3	ICP-OES-AV-buffer	Y			50	NA	421.552
5	ICP-MS			He		NA	
7	ICP-MS	Rh	ORS	He	20	NA	88 (m/z)
10	ICP-MS/MS	Sc	CRI	He	500	500	88
11	ICP-MS	Rh	ORS	He	500	NA	88 (m/z)
12	ICP-OES-AV	Lu			83	NA	407.771
14	ICP-MS	Ge	ORS	He	0.1	NA	88
15	ICP-MS	Rh	ORS	He	800	NA	88
16	ICP-MS	Sc,Ir,Rh	ORS	He		NA	88
17	ICP-OES-AV	Eu & Cs	NA	NA	50	NA	430.545 nm
18	ICP-MS	Rh	NA	NA	625	NA	88
21	ICP-OES-AV	Eu			50	NA	430.545
22	ICP-MS	Rh	NA	He		NA	
25	ICP-MS	Rh	ORS	H2He	1000	NA	88

Table 132 Instrument Conditions U

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-MS		ORS	He	100	NA	238
3	ICP-MS/MS	Ir			500	NA	238
5	ICP-MS			He		NA	
6	ICP-MS	Ir	NA	Standard Mode	250	NA	NA
7	ICP-MS	Lu	ORS	He	NA	NA	238 (m/z)
9	ICP-MS	Tb	KED	He	1000	NA	238
10	ICP-MS/MS	Lu	CRI	NA	500	NA	238
11	ICP-MS	Lu	ORS	He	500	NA	238 (m/z)
15	ICP-MS	Ir	ORS	He	800	NA	238
16	ICP-MS	Sc,Ir,Rh	ORS	He	NA		238
17	ICP-MS	Ir, Rh & Sc	NA	NA	50	NA	238 m/z
18	ICP-MS	Ir	NA	NA	625	NA	238
21	ICP-MS	Ir	ORS	He	50	NA	238

Table 133 Instrument Conditions V

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-MS		ORS	He	100	NA	51
3	ICP-MS/MS	Ge	CRI	He	NA	500	51
4	ICP-OES-AV					NA	292.402
5	ICP-MS			He	NA		
6	ICP-MS	Sc	UC	He	250	NA	NA
7	ICP-MS	Sc	ORS	He	NA	20	51 (m/z)
9	ICP-MS	Sc	KED	He	NA	400	51
10	ICP-MS/MS	Sc	CRI	NA	500	500	51
11	ICP-MS	Sc	ORS	He	NA	500	51 (m/z)
12	ICP-OES-AV	Lu			NA	83	292.401
14	ICP-OES-AV	Lu	NA	NA	NA	0.1	310.229
15	ICP-MS	Rh	ORS	He	NA	800	85
16	ICP-MS	Sc,Ir,Rh	ORS	He			51
17	ICP-OES-AV	Eu & Cs	NA	NA	NA	50	311.837 nm
18	ICP-MS	Sc	UC	He	625	NA	51
21	ICP-OES-AV	Eu			NA	50	311.839
22	ICP-MS	Sc	NA	He	NA		

Table 134 Instrument Conditions Zn

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
1	ICP-MS		ORS	He	100	NA	66
3	ICP-OES-AV-buffer	Y			50	50	213.857
4	ICP-OES-AV				NA		213.857
5	ICP-OES-AV						206.229
6	ICP-MS	Rh	UC	He	250	NA	NA
7	ICP-MS	Sc	ORS	He	NA	20	66 (m/z)
9	ICP-MS	Ga	KED	He	1000	1000	66
10	ICP-MS/MS	Sc	CRI	NA	500	500	66
11	ICP-MS	Sc	ORS	He	500	500	66 (m/z)
12	ICP-OES-AV	Lu			83	83	213.857
14	ICP-OES-AV	Lu	NA	NA	0.1	0.1	213.857
15	ICP-MS	Rh	ORS	He	800	800	66
16	ICP-MS	Sc,Ir,Rh	ORS	He			66
17	ICP-OES-AV	Eu & Cs	NA	NA	50	50	206.2, 334.502 nm
18	ICP-MS	Ge	UC	He	625	NA	66
21	ICP-OES-AV	Eu			50	50	206.202
22	ICP-MS	Sc	NA	He	NA		
23	ICP-OES-AV				100		206.2

APPENDIX 5 - ACRONYMS AND ABBREVIATIONS

AAS	Atomic Absorption Spectroscopy
APHA	American Public Health Association
AS	Australian Standard
ASPAC	Australasian Soil and Plant Analysis Council
ASTM	American Society for Testing and Materials
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
CVAFS	Cold Vapour Atomic Fluorescence Spectroscopy
CV_{rob}	Robust Coefficient of Variation
DA	Discreet Analyser
DFA	Digital Flame Analyser
DRC	Dynamic Reaction Cell
EC	Electrical conductivity
FIA	Flow Injection Analyser
GAG	General Accreditation Guidance
GLOSOLAN	Global Soil Laboratory Network
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-MS/MS	Inductively Coupled Plasma – Tandem Mass Spectrometry
ICP-OES	Inductively Coupled Plasma - Optical Emission 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
k	Coverage Factor
KED	Kinetic Energy Discrimination
Max	Maximum value in a set of results
MADe	Median Absolute Deviation
Md	Median
Min	Minimum value in a set of results
MU	Measurement Uncertainty
N	Number of Participants
NA	Not Applicable
NATA	National Association of Testing Authorities, Australia
NEPM	National Environment Protection Measure
NMIA	National Measurement Institute Australia

NR	Not Reported
NT	Not Tested
OPA	Orthophtaldialdehyde
ORS	Octopole Reaction System
PCV	Performance Coefficient of Variation
PT	Proficiency Test
QA/QC	Quality Assurance / Quality Control
RA	Robust Average
RM	Reference Material
SD	Standard Deviation
SDPA, σ	Standard Deviation for Proficiency Assessment
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 standard deviation for proficiency asessment
SFA	Segment Flow Analyser
SRM	Standard Reference Material (Trademark of NIST)
TKN	Total Kjeldahl nitrogen
TKP	Total Kjeldahl phosphorous
TN	Total nitrogen
UC	Universal Cell
USEPA	United States Environmental Protection Agency
UV-Vis	Ultraviolet and Visible Spectroscopy

END OF REPORT