



Australian Government
Department of Industry,
Science and Resources

National
Measurement
Institute

Proficiency Test Final Report AQA 25-12 Metals, Nutrients, and Anions in Soil

October 2025

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ACKNOWLEDGMENTS

This study was conducted by the National Measurement Institute Australia (NMIA). Support funding was provided by the Australian Government Department of Industry, Science and Resources.

I would like to thank the management and staff of the participating laboratories for supporting the study. It is only through widespread participation that we can provide an effective service to laboratories.

The assistance of the following NMIA staff members in the planning, conduct and reporting of the study is acknowledged.

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SUMMARY

This report presents the results of the proficiency test AQA 25-12 Metals, Nutrients, and Anions in Soil. The study covers the measurement of acid extractable elements: Ag, Al, As, B, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Ga, Hg, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Rb, S, Sb, Se, Sn, Sr, Th, Tl, U, V and Zn. Measurement of pH, electrical conductivity (EC), water soluble bromide (Br^-), chloride (Cl^-), fluoride (F^-), orthophosphate-P ($\text{PO}_4^{3-}\text{-P}$), and sulphate (SO_4^{2-}) and of total Kjeldahl nitrogen (TKN), 2M KCl extractable ammonium nitrogen ($\text{NH}_4^+\text{-N}$) and 2M KCl extractable nitrate nitrogen ($\text{NO}_3^-\text{-N}$) were also included in the program.

The sample set consisted of one dried biosolid sample, one dried soil (sediment) sample, and one dried agricultural soil sample.

Thirty 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 deviation 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;*

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

Of 838 z-scores, 743 (89%) were acceptable with $|z| \leq 2.0$.

Of 838 E_n -scores, 679 (81%) were acceptable with $|E_n| < 1.0$.

Laboratories 1, 2, and 11 returned the highest number of acceptable z scores (47).

Laboratory 1 also returned the highest number of acceptable E_n -scores (47 out of 47 reported).

- ii. evaluate the laboratories' methods used in determination of inorganic analytes in soil;*

Low levels of Ag and B in Sample S2, followed by Rb, were the acid extractable elements that challenged most participants' analytical techniques.

Most of the chloride results from the ion chromatographic method were lower than those measured using a colorimetric method. Spectrophotometry has low specificity and is susceptible to interference from coloured species.

Caution should be exercised when using the ion chromatographic method for low level fluoride measurements, as it may be difficult to quantify. Similarly, 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. compare the performance of participant laboratories with their past performance;*

Over the last 28 studies of inorganic analytes in soil, the average proportion of acceptable scores was 90% for z-scores and 80% for E_n -scores.

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

Of 899 numerical results, 891 (99%) were reported with an expanded measurement uncertainty. The magnitude of the reported expanded uncertainties was within the range 0.08% to 217% of the reported value. An example of evaluating measurement uncertainty using proficiency testing data only is given in Appendix 3.

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

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

1 INTRODUCTION

1.1 NMIA Proficiency Testing Program

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

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

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

AQA 25-12 is the 37th 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;
- evaluate the laboratories' methods used in determination of inorganic analytes in soil;
- 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 proficiency tests is described in the NMIA Chemical Proficiency Testing Study Protocol.² The statistical methods used are described in the NMIA Chemical Proficiency Statistical Manual.³ These documents have been prepared with reference to ISO Standard 17043¹ and The International Harmonized Protocol for Proficiency Testing of (Chemical) Analytical Laboratories.⁴

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

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

2 STUDY INFORMATION

2.1 Selection of Matrices and Inorganic Analytes

The 57 tests were selected from those for which an investigation level is published in the Guideline on the Investigation Levels for Soil and Groundwater, promulgated by the National Environmental Protection Council (NEPC)⁵ and from analytes commonly measured in soil.

2.2 Participation

Thirty laboratories participated and all submitted results.

The timetable of the study was:

Invitation issued:	7 July 2025
Samples dispatched:	4 August 2025
Results due:	29 August 2025
Interim report issued:	4 September 2025
Preliminary report issued:	12 September 2025

2.3 Test Material Specification

Three samples were provided for analysis:

Sample S1 was 25 g of dried biosolid;

Sample S2 was 30 g of dried soil (sediment); and

Sample S3 was 75 g of dried agricultural soil.

2.4 Laboratory Code

All participant laboratories were assigned a confidential code number.

2.5 Sample Preparation, Analysis and Homogeneity Testing

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 S1, S2, and S3 except for Sn in S1 and Na in S2. Partial homogeneity was also conducted on the water-soluble anions in Sample S3. Participants' results gave no reason to question the homogeneity of these tests for most analytes. The results from the partial homogeneity tests are reported in the present study as homogeneity value.

The preparation, analysis and homogeneity testing of the study samples are described in Appendix 1.

2.6 Stability of Analytes

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

2.7 Sample Storage, Dispatch and Receipt

The samples were dispatched by courier on 4 August 2025.

A description of the test samples and instructions for participants, and a form for participants to confirm the receipt of the test samples, were sent with the samples.

An Excel spreadsheet for the electronic reporting of results was e-mailed to participants.

2.8 Instructions to Participants

Participants were instructed as follows:

- 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 ($\text{NH}_4^+\text{-N}$) and 2M KCl extractable nitrate-N ($\text{NO}_3^-\text{-N}$).

- Report on as received basis in units of mg/kg except for EC and pH. EC results are to be reported in units of $\mu\text{S/cm}$.

SAMPLE S1 Dried Biosolid		SAMPLE S2 Dried Soil (sediment)		SAMPLE S3 Dried Agricultural Soil	
Test	Estimated Value [mg/kg]	Test	Estimated Value [mg/kg]	Test	Estimated Value [mg/kg]
Ag	0.5-20	Ag	0.5-20	Ca (acid extractable)	50-2000
As	0.5-20	Al	1000-40000	Fe (acid extractable)	1000-40000
B	5-200	As	5-200	K (acid extractable)	50-2000
Bi	0.5-20	B	0.5-20	Mg (acid extractable)	50-2000
Cd	0.5-20	Ba	5-200	Na (acid extractable)	5-200
Cr	5-200	Be	0.05-2	P (acid extractable)	50-2000
Cu	50-2000	Co	5-200	S (acid extractable)	50-2000
Hg	0.5-20	Cr	5-200	Sr (acid extractable)	5-200
Li	0.5-20	Cu	5-200	Water Soluble Bromide (Br^-) - 1:5 soil/water extract	0.5-20
Mn	50-2000	Ga	0.5-20	Water Soluble Chloride (Cl^-) - 1:5 soil/water extract	5-200
Ni	5-200	Mo	0.5-20	Water Soluble Fluoride (F^-) - 1:5 soil/water extract	0.5-20
Pb	0.5-20	Na	5-200	Water Soluble Orthophosphate-P ($\text{PO}_4^{3-}\text{-P}$) - 1:5 soil/water extract	<5
Sb	5-200	Ni	5-200	Water Soluble Sulphate (SO_4^{2-}) - 1:5 soil/water extract	5-200
Se	0.5-20	Pb	5-200	EC of 1:5 soil/water extract	NA ($\mu\text{S/cm}$)
Sn	5-200	Rb	0.5-20	pH of 1:5 soil/water suspension	2-14
Sr	50-2000	Se	0.05-2	Kjeldahl nitrogen, total (TKN)	50-20000
Tl	0.5-20	Th	0.5-20	2M KCl Extractable (Nitrate-N)	0.5-20
U	0.5-20	V	5-200	2M KCl Extractable (Ammonium-N)	5-200
V	5-200	Zn	50-2000		
Zn	50-2000				

2.9 Interim and Preliminary Reports

An interim report was emailed to participants on 4 September 2025.

A preliminary report was emailed to all participants on 12 September 2025. 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.

No data from the Preliminary Report has been changed in the present Final Report.

3 PARTICIPANT LABORATORY INFORMATION

3.1 Test Method Summaries

Summaries of test methods are transcribed in Tables 1 to 8.

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. HCl (1:1) (mL)	Vol. H ₂ O ₂ (mL)	Other (mL)
1	AS4479; USEPA 3050; 200.8; 200.7, 6010, 6020	Yes	0.5	95-100	120	3	3				
2	Acid Digestion of sediment, sludges and soil- USEPA 3050		1	95	90	3	3				
3	In-house method	No	2	95 -105	60	4	12				4 (H ₂ O)
4	EPA (Environmental Protection Agency) 1994 Method 200.8		2	109°	60	800	400				
5	In-house method		0.5	95	60	3	2			2	
7	USEPA 3010		2	95-105	60	4	12				
8*	USEPA 3051A	Yes	0.5	105	125	3	9				8 (H ₂ O)
9	SCP Science DigiPrep apparatus digestion block		0.5	96	150	8	5				
10	EPA Method 200.7	No	0.5	95	120	2	2				10 (H ₂ O)
11	In House - referencing APHA 3125	No	0.4	120	60	2.5	7.5				
12	APHA 3125 (Modified)	No	1	110	65	3	1.5				
13	USEPA-6010C (Except Mercury by USEPA-7471B)		1	120		5	5				
14			0.5	98	60	0.5					
15	EPA 200.2		0.5	95	30	2	1	NA	NA	NA	4 (H ₂ O)
16	USEPA 3050		2	100	60	4	12				4 (H ₂ O)
17	EPA Method 3050B Acid Digestion of Sediments, Sludges and Soils		0.5	85	240	3	3				
18*	Soil Chemical Methods - Australasia (Raymod and Lyons) - Method 17B1		0.5	95	120	18.75	6.25				
19	USEPA 200.7 and 200.8	NA	1.5	95	90	1	1.5			1	
20			1	95	120	2	1				
21*	EPA 200.2		0.5	95	60	1	1				5 (H ₂ O)
22*	Milestone Application note for Acid Digestion SK-Environmental-035		0.2	210	35	10	1			1	
23	USEPA Method 6010c, USEPA Methods 7471B, 7470A, 7471B	No	1	90-98	90	3	3				
24	US EPA 200.2	NA	1	95	50	2	2				10 (H ₂ O)
25	In House method	No	2	95	60	4	12				
26	Acid Digestion of sediment, sludges and soil- USEPA 3050		1	95	90	3	3				
27*	USEPA Method 3050	Yes	3	95	120	10	5	10		6	
28		No	0.5	95	180	5	5				
30*	US EPA 3050 B		1.0121	98	100		5	10			

*Additional information in Table 8.

Table 2 Methodology for Total Kjeldahl Nitrogen

Lab. Code	Method Reference	Digestion	Distillation	Other Test Method	Measurement Method	Instrument
1		Yes	Yes		Titrimetric method	Foss
2	Rayment G. E and Lyons D. J. (2011)	NA		Combustion	TKN = TN-NO _x (Dumas)	LECO
5	European Standard - Determination of Kjeldahl Nitrogen in soil, biowaste and sewage sludge 2005-08.	Yes	Yes		Titrimetric method	FOSS
8	USEPA 351.2	Yes	No		Colorimetric - salicylate method	SFA
12	APHA: 4500-N(org) B	Yes	Yes		Titrimetric method	NA
16	In-House Method	Yes			Colorimetric - salicylate method	FIA
17	European Standard - Determination of Kjeldahl Nitrogen in soil, biowaste and sewage sludge 2005-08.	Yes	Yes		Titrimetric method	FOSS
19	Inhouse	Yes	No		Colorimetric - salicylate method	FIA
20		Yes	Yes	In-House Method	Titrimetric method	
22*	According to EN 13342 and DIN ISO 11261, modified by BUCHI (BUCHI 2013)	Yes	Yes		Titrimetric method	Manual Analysis
23	APHA latest Edition. Analytical Methods for Waters and Wastewaters 4500-Inorg-D	Yes	No		Colorimetric - salicylate method	DA
26	Rayment G. E and Lyons D. J. (2011)	NA		Combustion	TKN = TN-NO _x (Dumas)	LECO
27*	APHA Method 4500-N Org D	Yes	No	No	Colorimetric - salicylate method	DA

*Additional information in Table 8.

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

Lab. Code	Method Reference		Sample Mass (g)	Extraction Solution 2M KCl Volume (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
1			9	90	1 Hour	SFA with Fluorescence Detector	Colorimetric-Sulfanilamide-NEDD Cd reduction	SFA	SFA
2	APHA	APHA	5	50	2	Colorimetric - Phenate method	Colorimetric - Vanadium III method	DA	DA
5		APHA, Standard Methods for the Examination of Water and Wastewater, Method 4500-NO3 F	10	0	1		Colorimetric-Sulfanilamide-NEDD Cd reduction		SFA
8	APHA 4500NH3 G	APHA 4500NO3 I	5	50	2	Colorimetric - Phenate method	Colorimetric-Sulfanilamide-NEDD Cd reduction	DA	FIA
11*	In-House Method	In-House Method	2	20	1	Colorimetric - Salicylate method	Colorimetric - Vanadium III method	FIA	FIA
16		In-House Method	10	50	1		Colorimetric - Vanadium III method		DA
17	APHA, Standard Methods for Examination of Water and Wastewater, 4500-NH3-N	APHA, Standard Methods for the Examination of Water and Wastewater, Method 4500-NO3 F	10	0	1	Colorimetric - Phenate method	Colorimetric-Sulfanilamide-NEDD Cd reduction	FIA	FIA
19	Inhouse	Inhouse	2	20	1	Colorimetric - Phenate method	Colorimetric-Sulfanilamide-NEDD hydrazine reduction	FIA	FIA
22	Method 10205 TNT Plus 831-HACH	Method 8171 Cadmium Reduction-HACH	5	50	1	Colorimetric - Salicylate method	Colorimetric - Salicylate method	Manual Analysis	Other
23	APHA latest Edition. Analytical Methods for Waters and Wastewaters 4500-Inorgs-D	APHA latest Edition. Analytical Methods for Waters and Wastewaters 4500-NO2-B, 4500-NO3 E and 4500-N C	2.5	25	1.5	Colorimetric - Phenate method	Colorimetric - Vanadium III method	DA	DA
26	APHA	APHA	5	50	2	Colorimetric - Phenate method	Colorimetric - Vanadium III method	DA	DA

Lab. Code	Method Reference		Sample Mass (g)	Extraction Solution 2M KCl Volume (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
27	Rayment and Lyons Method 7C1	NA	5	50	1 hr	OPA method	No	FIA	NA
29	7C2b	7C2b	10	100	1	Colorimetric - Salicylate method	Colorimetric-Sulfanilamide-NEDD Cd reduction	FIA	FIA

*Additional information in Table 8.

Table 4 Methodology for Water Soluble Bromide

Lab. Code	Method Reference	Sample Mass (g)	Water Volume (mL)	Shake Time (hours)	Measurement Method	Measurement Instrument
1		8	40	1 hour	Ion Chromatographic Method	IC
2	APHA	5	25	2	Ion Chromatographic Method	IC
3		8 g	40 mL	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	Ion Chromatographic Method	IC
6		20	100	1		
7		5	50	1		
8	USEPA 300.1	20	100	1	Ion Chromatographic Method	IC
12		20	100	1	Ion Chromatographic Method	IC
16	In-House Method	10	50	1	Ion Chromatographic Method	IC
17	APHA, Standard Methods for the Examination of Water and Wastewater, Method 4110 Page 4-5 to 4-12	10	50	1	Ion Chromatographic Method	IC
23	APHA latest Edition. Analytical Methods for Waters and Wastewaters, 4110b. Ion Chromatography with Chemical Suppression of Eluent Conductivity	10	50	1.5	Ion Chromatographic Method	IC
26	APHA	5	25	2	Ion Chromatographic Method	IC
27	APHA 4110 D	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	Measurement Instrument
1		8	40	1 hour	Ion Chromatographic Method	IC
2	APHA	5	25	2	Ion Chromatographic Method	IC
3		8 g	40 mL	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	Ion Chromatographic Method	IC
6	NORM-021-SEMARNAT-2000 AS-20	20	100	1	Argentometric Titration	Titration
7	APHA-4500-Cl E	5	50	1	Ferricyanide Colorimetric Method	DA
8	APHA 4500Cl G	20	100	1	Mercuric Thiocyanate	DA
11		2	10	1	Mercuric Nitrate Titration	SFA
12		20	100	1	Ion Chromatographic Method	IC
16	In-House Method	10	50	1	Ion Chromatographic Method	IC
17	APHA, Standard Methods for the Examination of Water and Wastewater, Method 4110 Page 4-5 to 4-12	10	50	1	Ion Chromatographic Method	IC
20	In-House Method					DA
22	USEPA Silver Nitrate Buret Titration Method 8225- HACH	10	50	1	Argentometric Titration	Manual Analysis
23	APHA latest Edition. Analytical Methods for Waters and Wastewaters, 4110b. Ion Chromatography with Chemical Suppression of Eluent Conductivity.	10	50	1.5	Ion Chromatographic Method	IC
26	APHA	5	25	2	Ion Chromatographic Method	IC
27	APHA Method 4500-Cl- G	10	50	1	Mercuric Thiocyanate	DA
29	5A1				Mercuric Thiocyanate	FIA

Table 6 Methodology for Water Soluble Fluoride

Lab. Code	Method Reference	Sample Mass (g)	Water Volume (mL)	Shake Time (hours)	Measurement Method	Measurement Instrument
1		8	40	1 hour	Ion Selective Electrode Method	Omnis
2	APHA	5	25	2	Ion Selective Electrode Method	Fluoride Selective Electrode
3		8 g	40 mL	1	NA	NA
5	APHA, Standard Methods for the Examination of Water and Wastewater, Method 4110 Page 4-5 to 4-12	10	50	1	Ion Chromatographic Method	IC
6		20	100	1		
7		5	50	1		
8	APHA 4500F C	20	100	1	Ion Selective Electrode Method	Fluoride Selective Electrode
11		2	10	1	Ion Selective Electrode Method	Fluoride Selective Electrode
16	In-House Method	10	50	1	Ion Chromatographic Method	IC
17	APHA, Standard Methods for the Examination of Water and Wastewater, Method 4110 Page 4-5 to 4-12	10	50	1	Ion Chromatographic Method	IC
20	In-House Method				Ion Selective Electrode Method	Fluoride Selective Electrode
22*	USEPA SPADNS Method 8029- HACH	10	50	1	Other	Other
23	APHA latest Edition. Standard Methods for the Examination of Water and Wastewater, 4500 F-C	10	50	1.5	Ion Selective Electrode Method	Fluoride Selective Electrode
26	APHA	5	25	2	Ion Selective Electrode Method	Fluoride Selective Electrode
27	APHA Method 4500-F- C	10	50	1	Ion Selective Electrode Method	Fluoride Selective Electrode

*Additional information in Table 8.

Table 7 Methodology for Water Soluble Orthophosphate-P

Lab. Code	Method Reference	Sample Mass (g)	Water Volume (mL)	Shake Time (hours)	Measurement Method	Measurement Instrument
1		8	40	1 hour	Ion Chromatographic Method	IC
2	APHA	5	25	2	Ascorbic Acid Colorimetric Method	DA
3		8 g	40 mL	1	Ascorbic Acid Colorimetric Method	DA
5	APHA, Standard Methods for the Examination of Water and Wastewater, Method 4110 Page 4-5 to 4-12	10	50	1	Ion Chromatographic Method	IC
6		20	100	1		
7	APHA 4500-P-B-D	5	50	1	Ascorbic Acid Colorimetric Method	DA
8	APHA 4500P G	20	100	1	Ascorbic Acid Colorimetric Method	FIA
11		2	10	1	Vanadomolybdophosphoric Colorimetric Method	FIA
16	In-House Method	10	50	1	Ascorbic Acid Colorimetric Method	DA
17	APHA, Standard Methods for the Examination of Water and Wastewater, Method 4500-P G	10	50	1	Vanadomolybdophosphoric Colorimetric Method	FIA
20	In-House Method				Ascorbic Acid Colorimetric Method	DA
22	USEPA PhosVer 3 (Ascorbic Acid) Method 8048- HACH	10	50	1	Ascorbic Acid Colorimetric Method	Manual Analysis
23	APHA latest Edition. Standard Methods for the Examination of Water and Wastewater, 4500-P E&J	10	50	1.5	Ascorbic Acid Colorimetric Method	DA
26	APHA	5	25	2	Ascorbic Acid Colorimetric Method	DA
27	APHA Method 4500-P F	10	50	1	Ascorbic Acid Colorimetric Method	DA

Table 8 Methodology for Water Soluble Sulphate

Lab. Code	Method Reference	Sample Mass (g)	Water Volume (mL)	Shake Time (hours)	Measurement Method	Measurement Instrument
1		8	40	1 hour	Ion Chromatographic Method	IC
2	APHA	5	25	2	Ion Chromatographic Method	IC
3		8 g	40 mL	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	Ion Chromatographic Method	IC
6	NORM-021-SEMARNAT-2000 AS-20	20	100	1	Turbidimetric Method	UV-VIS
7	APHA 4500 - SO4 E	5	50	1	Turbidimetric Method	DA
8	USEPA 200.8	20	100	1	ICP-Method	ICP-MS
11		2	10	1	ICP-Method	ICP-OES
12		20	100	1	Ion Chromatographic Method	IC

Lab. Code	Method Reference	Sample Mass (g)	Water Volume (mL)	Shake Time (hours)	Measurement Method	Measurement Instrument
16	In-House Method	10	50	1	Ion Chromatographic Method	IC
17	APHA, Standard Methods for the Examination of Water and Wastewater, Method 4110 Page 4-5 to 4-12	10	50	1	Ion Chromatographic Method	IC
20	In-House Method				Colorimetric Method	DA
22	USEPA SulfaVer 4 Method 8051 HACH	10	50	1	Turbidimetric Method	Manual Analysis
23	APHA latest Edition. Analytical Methods for Waters and Wastewaters, 4110b. Ion Chromatography with Chemical Suppression of Eluent Conductivity.	10	50	1.5	Ion Chromatographic Method	IC
26	APHA	5	25	2	Ion Chromatographic Method	IC
27*	USEPA Method 6010D (2018) and APHA Method 3120	10	50	1	ICP-Method	ICP-OES

*Additional information in Table 8.

3.2 Instruments Used for Measurements

The instruments and settings used by participants for acid extractable elements are presented in Appendix 5.

3.3 Additional Information

Participants had the option to report additional information for each sample analysed. These are transcribed in Table 8.

Table 8 Additional information

Lab Code	Additional Information
6	S3: Methodology for conductivity: ISO 11265:1994
8	S3: We also analyse P with TKN (TKP) and got a significantly higher recovery. Water soluble Sulphate was determined after extraction by ICPMS/MS S as SO ₄ , suspect the result will be higher.
11	2M KCl Extractable Ammonium-N and Nitrate-N: 1M KCl used not 2M KCl.
18	Acid Extractable Elements Instrument Technique: For Sodium analysis on the AAS 1mL of CsCl matrix modifier is added per 10mL of sample.
21	Acid Extractable Elements Methodology: Samples initially left in contact with 1ml HCl & 1ml HNO ₃ at room temp. for approx 5 minutes before water is added.
22	Acid Extractable Element Instrument Technique: Measurements were done using Atomic Absorption Spectrometry and Digital Flame Analyser. Total Kjeldahl Nitrogen: Digital Titrator with specific pH endpoint. Fluoride: Manual Analysis using Spectrophotometer.
27	Acid Extractable Elements Instrument Technique: Instrument for Hg: Cetac Hg Analyser. Total Kjeldahl Nitrogen: Block Digestion and DA. Sulphate: Sulphur results from OES was converted to SO ₄ since the DA results were too negative indicating possible matrix interference.
30	S3: Chloride: The PQL has been raised due to sample matrix. Iron in excess of 10 mg/L interferes by masking the end point.

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 9 and 10.

Table 9 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	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - CRM Duplicate Analysis		Nordtest Report TR537
2	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples	Recoveries of SS	ISO/GUM
3*	Coverage factor not reported	Control Samples - CRM	CRM	Other
4	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Duplicate Analysis	Instrument Calibration Recoveries of SS	Eurachem/CITAC Guide
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 $k = 2$	Control Samples - CRM Duplicate Analysis	CRM	Eurachem/CITAC Guide
7	Bottom Up (ISO/GUM, fish bone/ cause and effect diagram) Coverage factor not reported	Control Samples - CRM Instrument Calibration	CRM Instrument Calibration	ISO/GUM
8	Top Down - precision and evaluations of the method and laboratory bias $k = 2$	Control Samples - SS Duplicate Analysis	CRM Recoveries of SS	
9	Top Down - precision and evaluations of the method and laboratory bias $k = 2$	Duplicate Analysis	CRM	Eurachem/CITAC Guide
10	Top Down - precision and evaluations of the method and laboratory bias $k = 2$	Control Samples - CRM Duplicate Analysis	CRM Instrument Calibration Recoveries of SS	ISO/GUM
11	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - Reference Material / Ex PT Sample Duplicate Analysis	CRM	Nordtest Report TR537
12	Other: Internal Quality Guidelines Coverage factor not reported	Control Samples Duplicate Analysis Instrument Calibration	CRM Instrument Calibration	
13	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	NMI Uncertainty Course
14	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Control Samples - CRM	CRM	Eurachem/CITAC Guide
15	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Instrument Calibration	Instrument Calibration	
16	Top Down - precision and evaluations of the method and	Control Samples - CRM Duplicate Analysis	CRM Instrument	ASTM E2554-13

Lab. Code	Approach to Evaluating MU	Information Sources for MU Evaluation ^a		Guide Document for Evaluating MU
		Precision	Method Bias	
	laboratory bias k = 2		Calibration Recoveries of SS	
17	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
18	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - SS Duplicate Analysis	Recoveries of SS	NATA General Accreditation, Guidance, Estimating and Reporting MU (Replace TN 33)
19	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
20	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - SS Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Recoveries of SS	Eurachem/CITAC Guide
21	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	CRM Instrument Calibration Recoveries of SS	ISO/GUM
22	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Control Samples Duplicate Analysis Instrument Calibration	CRM Instrument Calibration	
23	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Duplicate Analysis	Recoveries of SS	NATA Technical Notes 33
24	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
25	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - SS	Recoveries of SS	ISO/GUM
26	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples	Recoveries of SS	ISO/GUM
27	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
28	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Control Samples - Reference Material / Ex PT Sample	Laboratory Bias from PT Studies	ISO/GUM
29	Top Down - reproducibility (standard deviation) from PT studies used directly Coverage factor not reported	Control Samples - CRM Instrument Calibration		Nordtest Report TR537
30	Coverage factor not reported	Control samples - CRM	CRM Instrument Calibration Recoveries of SS Standard Purity	Eurachem/CITAC Guide

*Additional information in Table 10. ^aRM = Reference Material, CRM = Certified Reference Material, SS = Spiked samples

Table 10 Additional Information for Basis of Uncertainty Evaluation

Lab Code	Additional Information
3	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.

These comments are presented in Table 11.

Table 11 Participant Comments

Lab. Code	Participants' Comments	Study Coordinator's Response
8	Could TKP or sulphuric acid Total P be included next time.	Thank you for your feedback. These tests will be included in our future studies if there is sufficient interest.
9	Future study for Volatile Fatty Acids in wastewater would be handy if there is enough interest.	

4 PRESENTATION OF RESULTS AND STATISTICAL ANALYSIS

4.1 Results Summary

Participant results are listed in Tables 12 to 67 with resultant summary statistics: robust average, median, mean, number of numeric results, maximum, minimum, robust standard deviation (SD_{rob}) and robust coefficient of variation (CV_{rob}). Bar charts of results and performance scores are presented in Figures 2 to 57. An example chart with interpretation guide is shown in Figure 1.

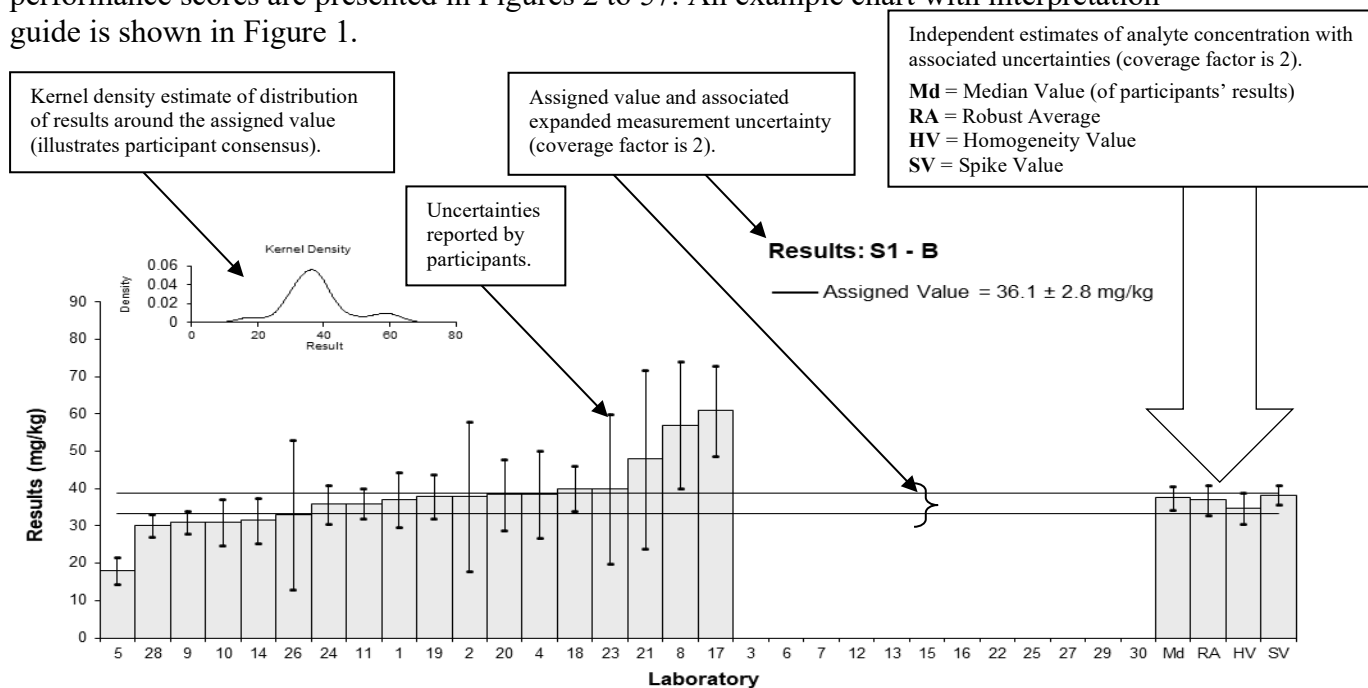


Figure 1 Guide to Presentation of Results

4.2 Outliers and Extreme Outliers

Outliers were results less than 50% and greater than 150% of the robust average and were removed before assigned value calculation. Extreme outliers (gross errors) were obvious blunders, such as those with incorrect units, decimal errors, or results from a different proficiency test item and were removed for calculation of summary statistics.^{3, 4, 6}

4.3 Assigned Value

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

4.4 Robust Average and Robust Between-Laboratory Coefficient of Variation

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

4.5 Standard Deviation for Proficiency Assessment

The standard deviation for proficiency assessment ($SDPA, \sigma$) is the product of the assigned value (X) and the performance coefficient of variation (PCV). This value is used for

calculation of participant z-score and provides scaling for laboratory deviation from the assigned value.

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

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

4.6 z-Score

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

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

Where:

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

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

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

4.7 E_n-Score

An example of E_n-score calculation using data from the present study is given in Appendix 2. The E_n-score is complementary to the z-score in assessing laboratory performance.

E_n-score includes measurement uncertainty and is calculated according to Equation 3 below:

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

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.

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

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

4.8 Traceability and Measurement Uncertainty

Laboratories accredited to AS ISO/IEC Standard 17025⁸ must establish and demonstrate the traceability and measurement uncertainty associated with their test results. Guidelines for quantifying uncertainty in analytical measurement are described in the Eurachem/CITAC Guide.⁹

5 TABLES AND FIGURES

Table 12

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	1.45	0.29	-0.13	-0.11
2	2	0.5	1.71	0.93
3	NT	NT		
4	NR	NR		
5*	0.72	0.144	-2.58	-2.84
6	NT	NT		
7	NT	NT		
8	1.46	0.39	-0.10	-0.07
9	NT	NT		
10	1.2	0.3	-0.97	-0.77
11	1.43	0.2	-0.20	-0.20
12	NT	NT		
13	NR	NR		
14	<2	0.5		
15	NT	NT		
16	NT	NT		
17	1.2	0.24	-0.97	-0.87
18	<5	NR		
19	0.80	0.28	-2.32	-1.90
20	<5	NR		
21	1.48	0.9	-0.03	-0.01
22	NT	NT		
23	2	0.6	1.71	0.79
24	1.56	0.43	0.23	0.14
25	NT	NT		
26	1.8	1	1.04	0.30
27	1.47	0.441	-0.07	-0.04
28	1.34	0.13	-0.50	-0.57
29	NT	NT		
30	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	1.49	0.23
Spike Value	Not Spiked	
Homogeneity Value	1.42	0.17
Robust Average	1.43	0.27
Median	1.46	0.18
Mean	1.42	
N	14	
Max	2	
Min	0.72	
Robust SD	0.40	
Robust CV	28%	

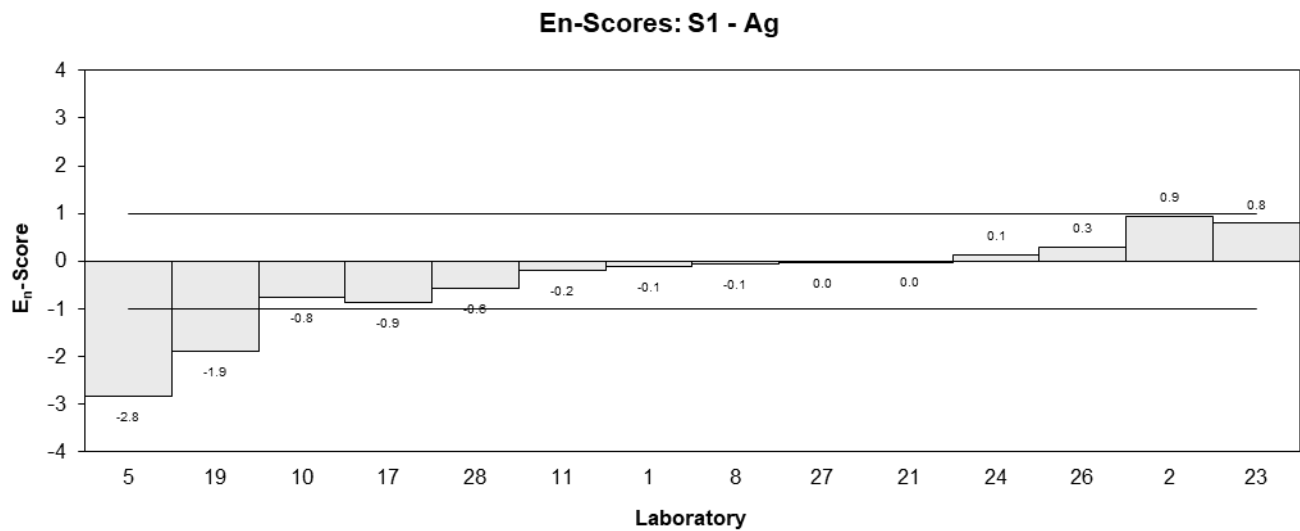
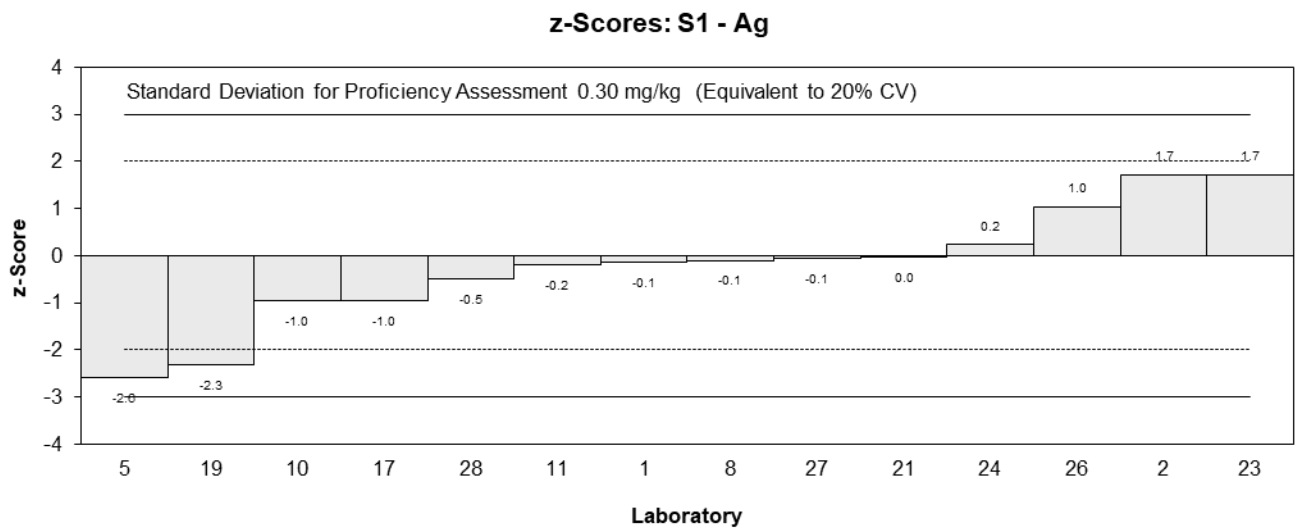
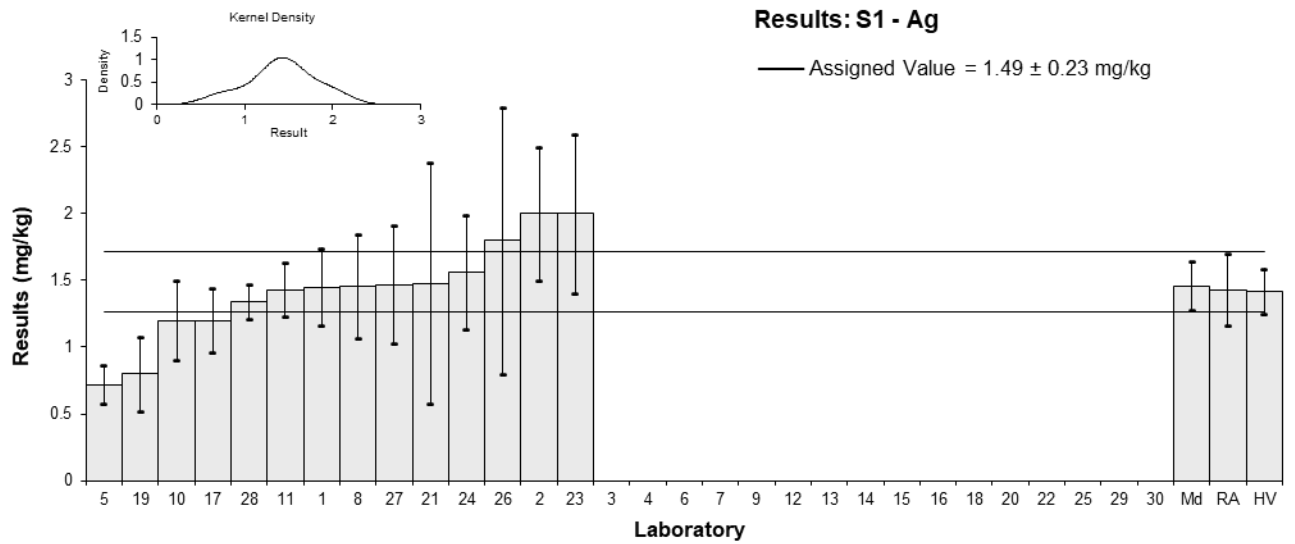


Figure 2

Table 13

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	3.44	0.69	0.20	0.13
2	4	4	1.32	0.16
3	NT	NT		
4	3.45	1.035	0.22	0.10
5	2.2	0.44	-2.28	-2.05
6	NT	NT		
7	NT	NT		
8	3.30	0.79	-0.08	-0.05
9	3	0.66	-0.68	-0.46
10	<5	NR		
11	3.29	0.4	-0.10	-0.10
12	3.64	4	0.60	0.07
13	NR	NR		
14	2.00	0.2	-2.67	-3.40
15	NT	NT		
16	NT	NT		
17	2.9	0.58	-0.88	-0.65
18	<5	NR		
19	3.00	0.98	-0.68	-0.33
20	<5	NR		
21	3.24	0.5	-0.20	-0.17
22	NT	NT		
23	<4	NR		
24	3.50	0.38	0.32	0.31
25	NT	NT		
26	4	4	1.32	0.16
27	4.48	1.344	2.28	0.82
28	3.45	0.35	0.22	0.23
29	NT	NT		
30	NT	NT		

Statistics

Assigned Value	3.34	0.34
Spike Value	Not Spiked	
Homogeneity Value	3.26	0.39
Robust Average	3.34	0.34
Median	3.37	0.30
Mean	3.31	
N	16	
Max	4.48	
Min	2	
Robust SD	0.55	
Robust CV	16%	

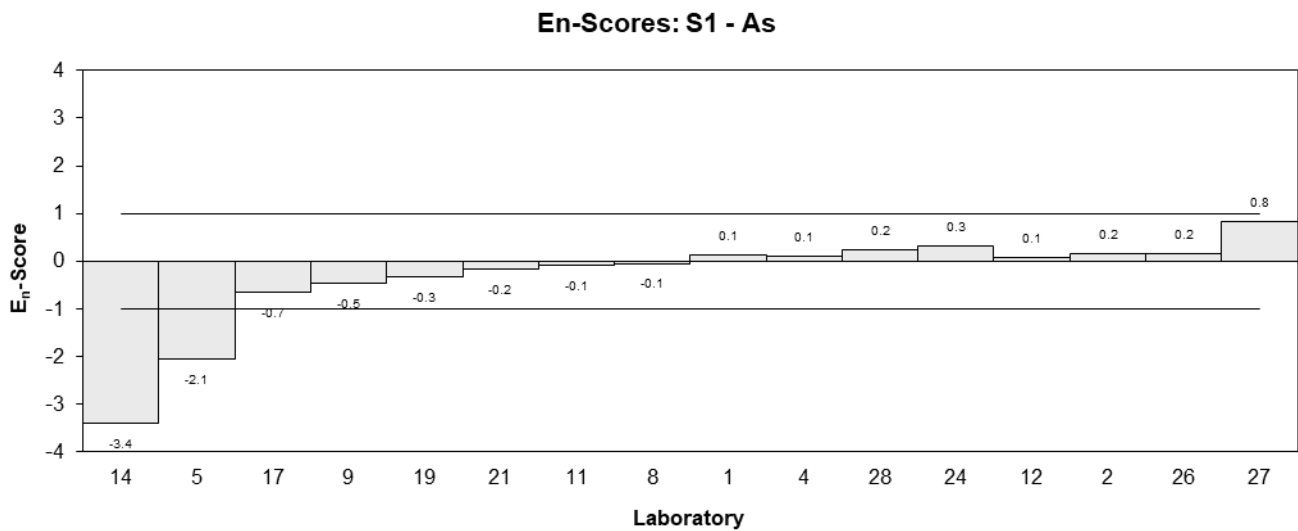
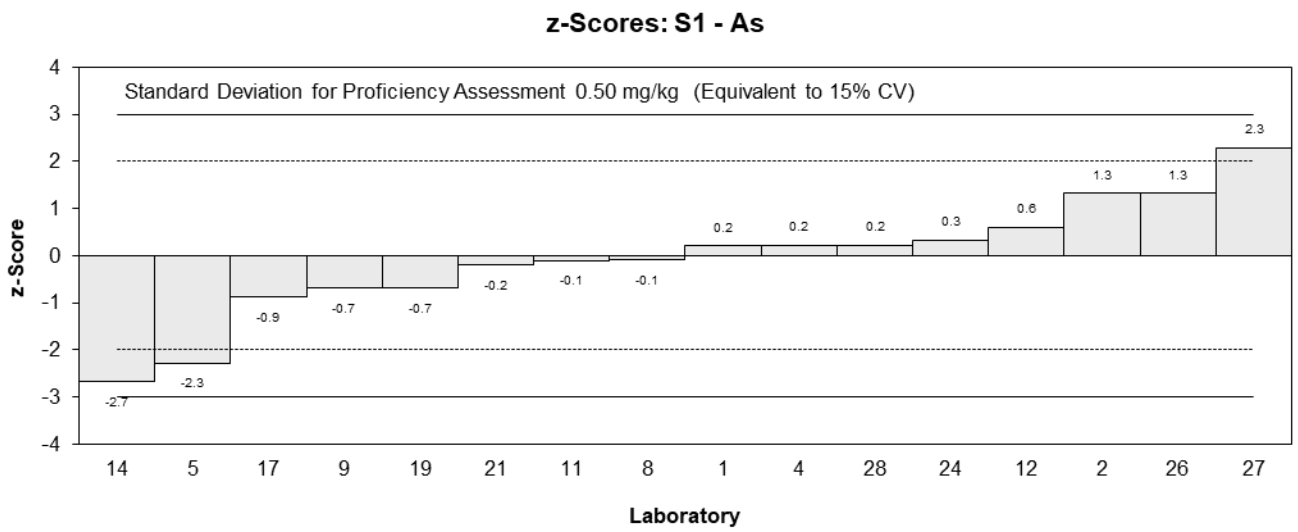
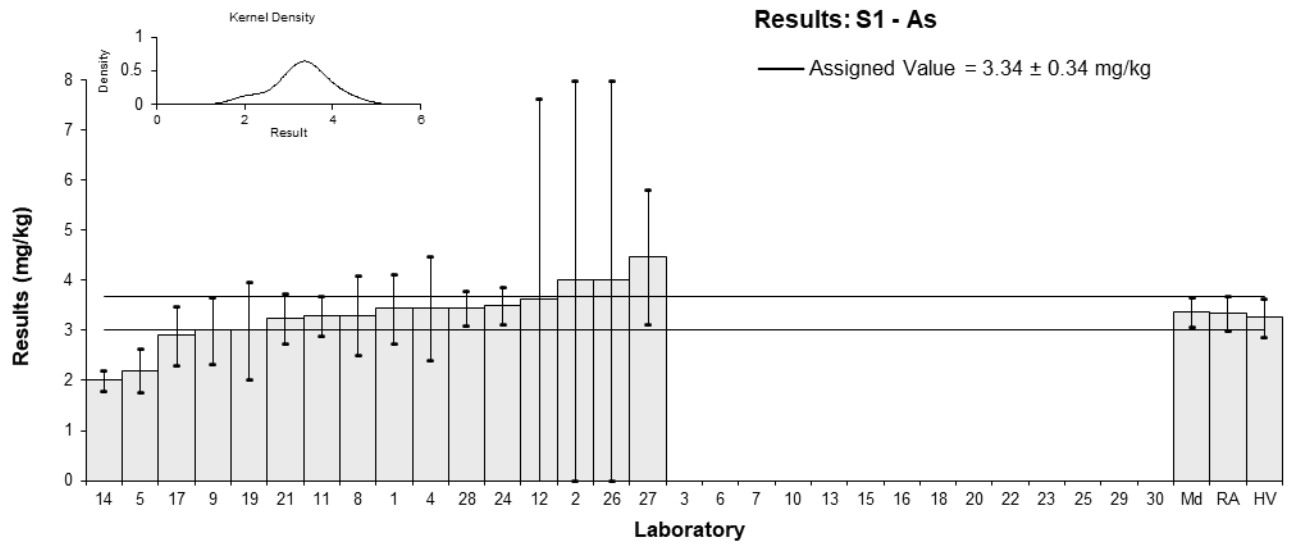


Figure 3

Table 14

Sample Details

Sample No.	S1
Matrix	Biosolid
Analyte	B
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	37.1	7.4	0.18	0.13
2	38	20	0.35	0.09
3	NT	NT		
4	38.5	11.55	0.44	0.20
5*	18	3.6	-3.34	-3.97
6	NT	NT		
7	NT	NT		
8*	57	17	3.86	1.21
9	31	3.1	-0.94	-1.22
10	31	6.2	-0.94	-0.75
11	36	4.0	-0.02	-0.02
12	NT	NT		
13	NR	NR		
14	31.5	6.0	-0.85	-0.69
15	NT	NT		
16	NT	NT		
17*	60.9	12.18	4.58	1.98
18	40	6.0	0.72	0.59
19	37.8	5.9	0.31	0.26
20	38.4	9.6	0.42	0.23
21	47.9	23.9	2.18	0.49
22	NT	NT		
23	40	20	0.72	0.19
24	35.8	5.2	-0.06	-0.05
25	NT	NT		
26	33	20	-0.57	-0.15
27	NT	NT		
28	30.2	3.02	-1.09	-1.43
29	NT	NT		
30	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	36.1	2.8
Spike Value	38.3	2.6
Homogeneity Value	34.8	4.2
Robust Average	37.0	4.0
Median	37.5	3.1
Mean	37.9	
N	18	
Max	60.9	
Min	18	
Robust SD	6.7	
Robust CV	18%	

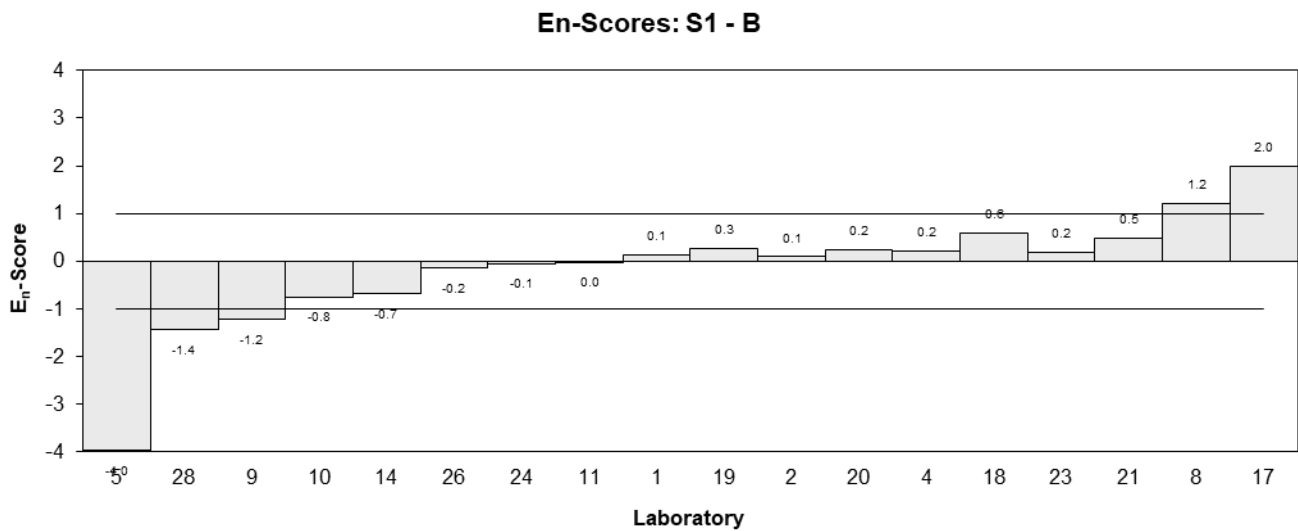
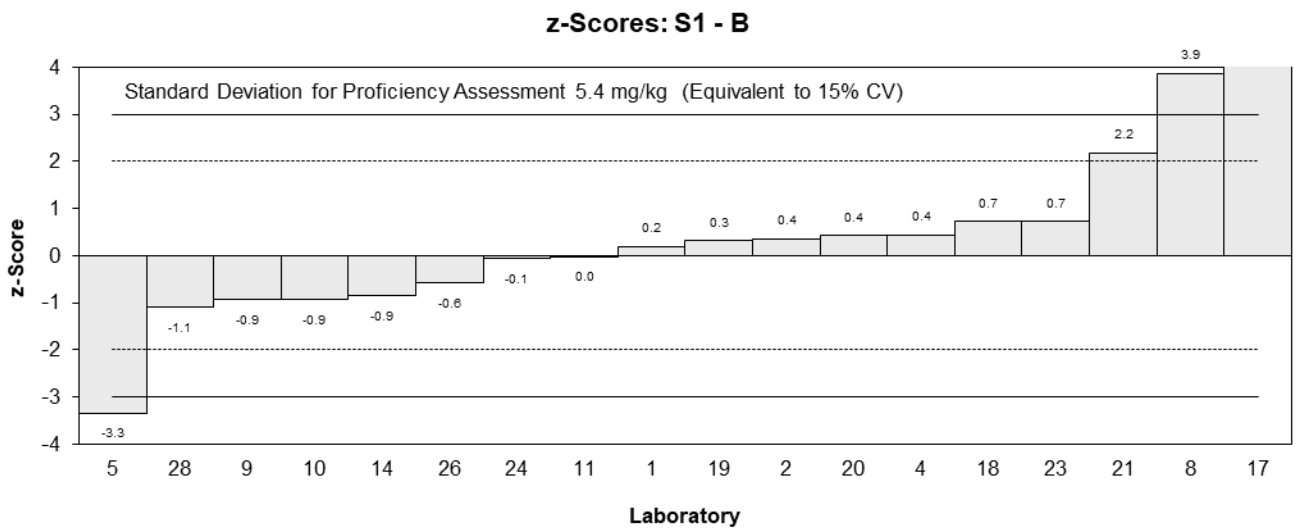
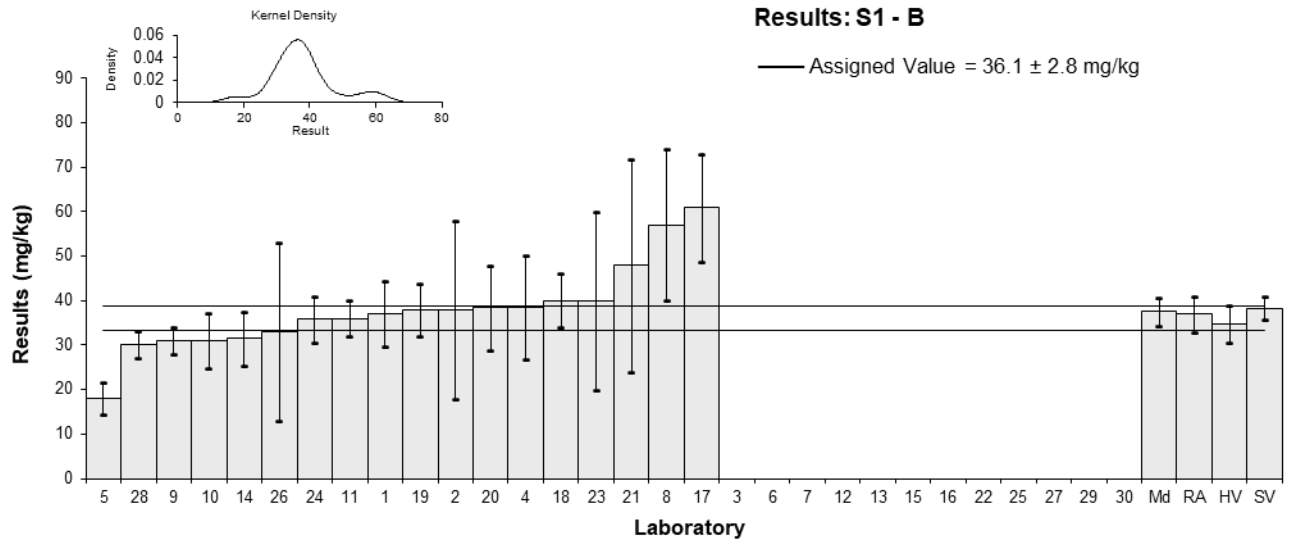


Figure 4

Table 15

Sample Details

Sample No.	S1
Matrix	Biosolid
Analyte	Bi
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	6.93	1.39	0.14	0.10
2	7	2	0.21	0.10
3	NT	NT		
4	7.18	2.154	0.38	0.18
5*	2.9	0.58	-3.82	-5.70
6	NT	NT		
7	NT	NT		
8	6.80	1.43	0.01	0.01
9	NT	NT		
10	NT	NT		
11	6.67	0.7	-0.12	-0.15
12	NT	NT		
13	NR	NR		
14	6.67	1.0	-0.12	-0.11
15	NT	NT		
16	NT	NT		
17	8	1.6	1.19	0.74
18	NT	NT		
19	6.40	1.28	-0.38	-0.29
20	7.6	1.9	0.80	0.42
21	6.33	1.9	-0.45	-0.24
22	NT	NT		
23	7	2	0.21	0.10
24	6.73	0.95	-0.06	-0.06
25	NT	NT		
26	6	2	-0.78	-0.39
27	NT	NT		
28	6.20	0.62	-0.58	-0.82
29	NT	NT		
30	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	6.79	0.36
Spike Value	Not Spiked	
Homogeneity Value	6.95	0.83
Robust Average	6.73	0.38
Median	6.73	0.32
Mean	6.56	
N	15	
Max	8	
Min	2.9	
Robust SD	0.59	
Robust CV	8.8%	

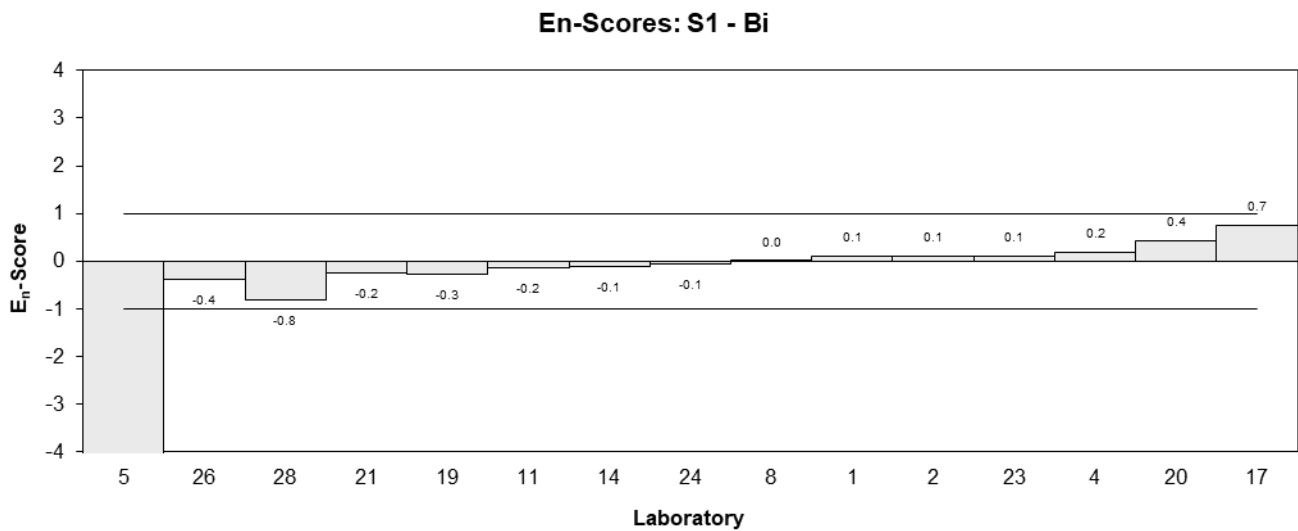
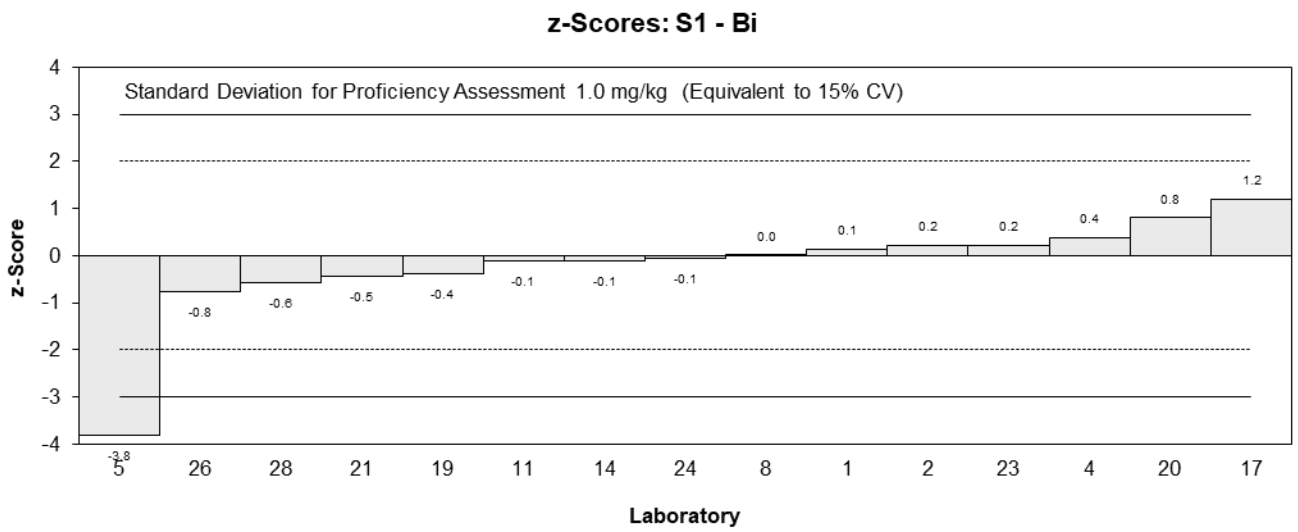
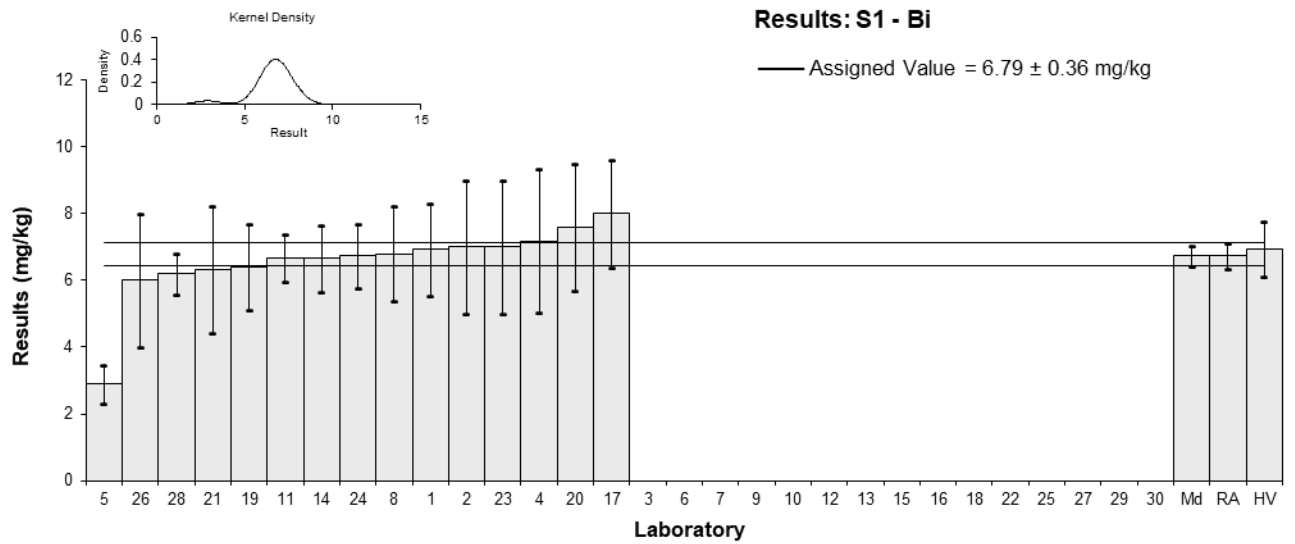


Figure 5

Table 16

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	0.996	0.199	-0.09	-0.07
2	1	0.3	-0.07	-0.03
3	NT	NT		
4	1.125	0.3375	0.76	0.34
5	0.86	0.172	-0.99	-0.85
6	NT	NT		
7	NT	NT		
8	1.00	0.20	-0.07	-0.05
9	<1	NR		
10	<1	NR		
11	1.01	0.1	0.00	0.00
12	1.10	NR	0.59	2.25
13	NR	NR		
14	<1	0.3		
15	NT	NT		
16	NT	NT		
17	1.03	0.206	0.13	0.10
18*	5	0.75	26.34	5.31
19	0.90	0.30	-0.73	-0.36
20	1.02	0.26	0.07	0.04
21	0.97	0.3	-0.26	-0.13
22	NT	NT		
23	1	0.3	-0.07	-0.03
24	0.98	0.12	-0.20	-0.24
25	NT	NT		
26	0.96	0.5	-0.33	-0.10
27	1.16	0.348	0.99	0.43
28	0.997	0.1	-0.09	-0.12
29	NT	NT		
30	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	1.01	0.04
Spike Value	1.03	0.09
Homogeneity Value	0.93	0.11
Robust Average	1.02	0.05
Median	1.00	0.03
Mean	1.24	
N	17	
Max	5	
Min	0.86	
Robust SD	0.084	
Robust CV	8.3%	

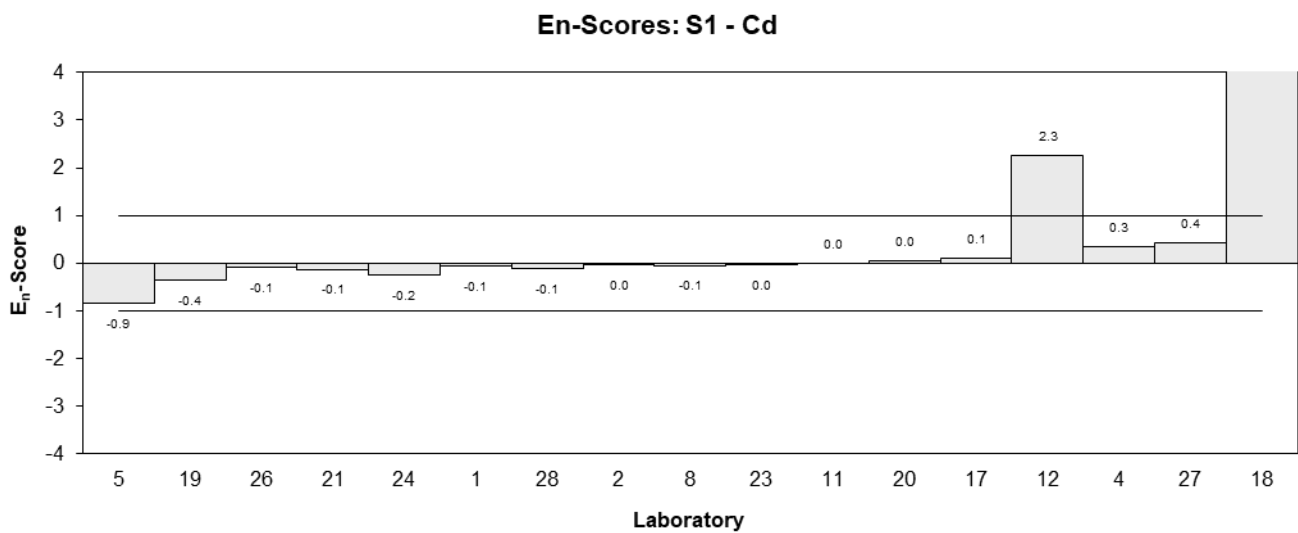
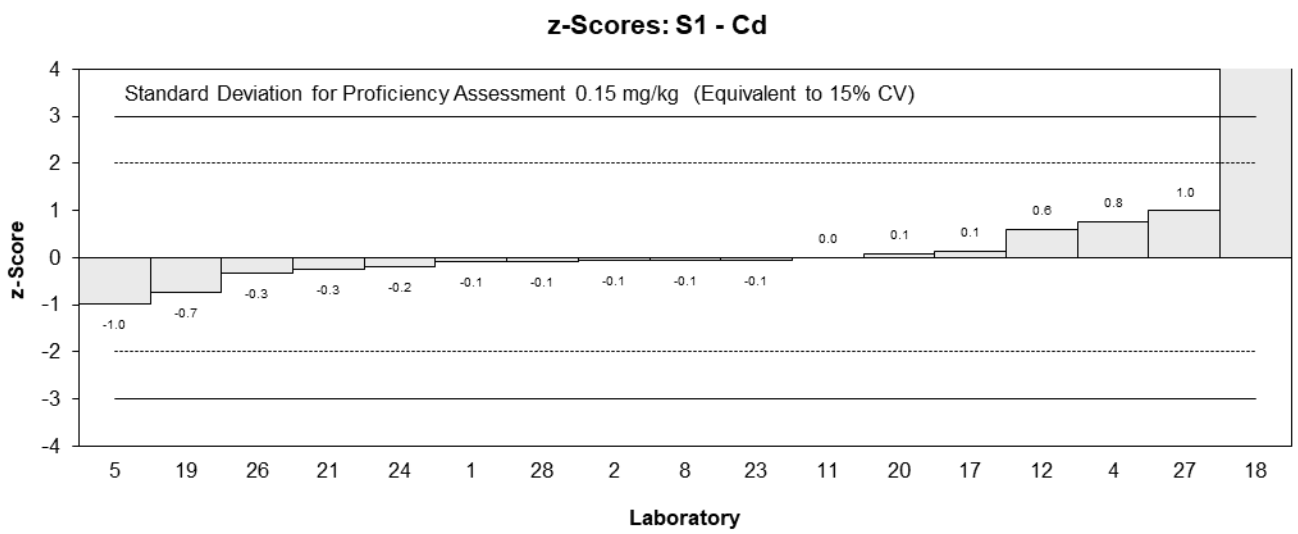
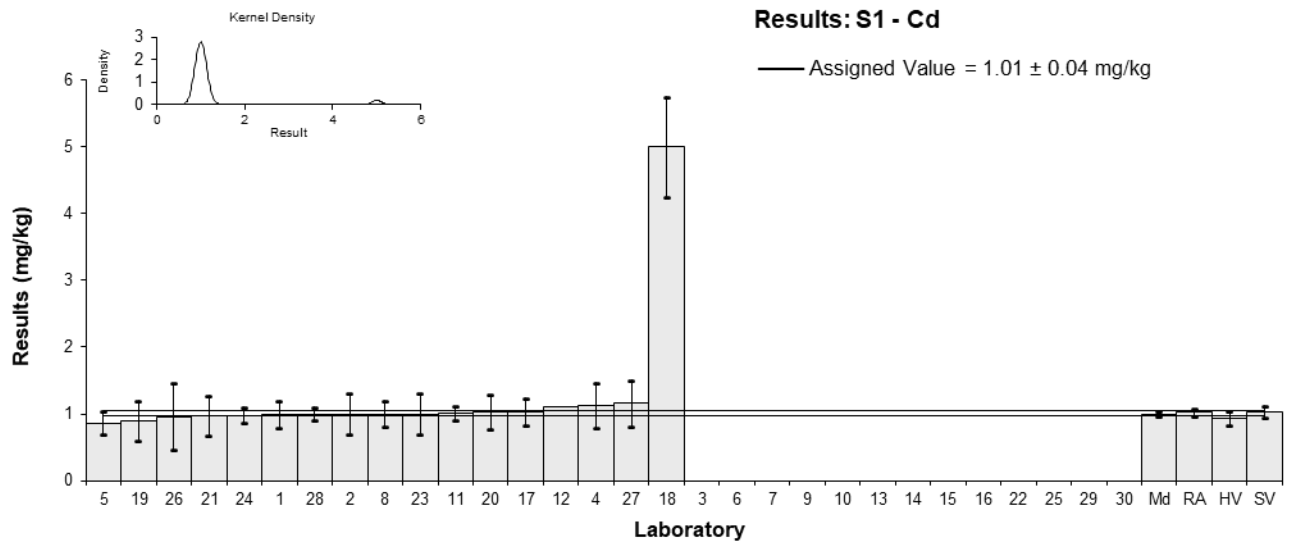


Figure 6

Table 17

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	79.5	15.9	1.32	0.90
2	85	20	1.76	1.00
3	NT	NT		
4	51.8	15.54	-0.88	-0.61
5	45	9	-1.42	-1.38
6	NT	NT		
7	NT	NT		
8	65.8	13.8	0.23	0.17
9	57	14.82	-0.47	-0.34
10	64	7.7	0.09	0.09
11	77.1	8.0	1.13	1.16
12	NT	NT		
13	NR	NR		
14	58.7	10.0	-0.33	-0.31
15	NT	NT		
16	NT	NT		
17	74.2	14.84	0.90	0.65
18*	30	4.5	-2.62	-3.18
19	40.0	6.9	-1.82	-1.98
20	52.7	13.2	-0.81	-0.63
21	61.4	15.0	-0.12	-0.08
22	NT	NT		
23	77	20	1.12	0.64
24	48.8	5.9	-1.12	-1.28
25	NT	NT		
26	78	20	1.20	0.68
27	44.77	13.431	-1.44	-1.11
28	71.9	7.19	0.72	0.77
29	NT	NT		
30	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	62.9	9.3
Spike Value	55.6	5.7
Homogeneity Value	67.5	8.1
Robust Average	61.5	9.6
Median	61	11
Mean	61.2	
N	19	
Max	85	
Min	30	
Robust SD	17	
Robust CV	27%	

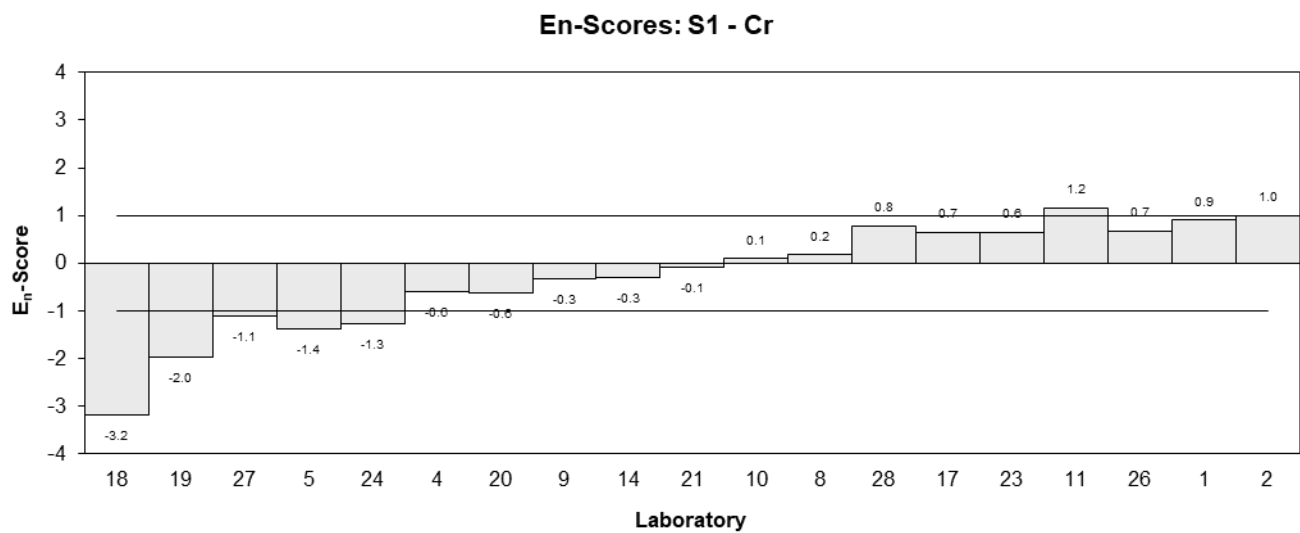
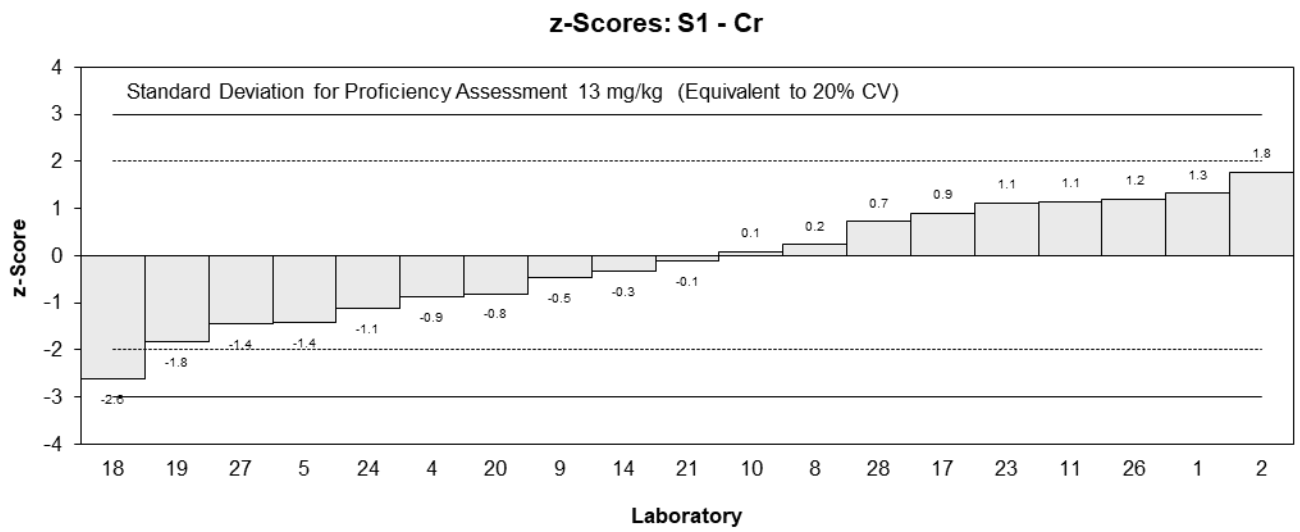
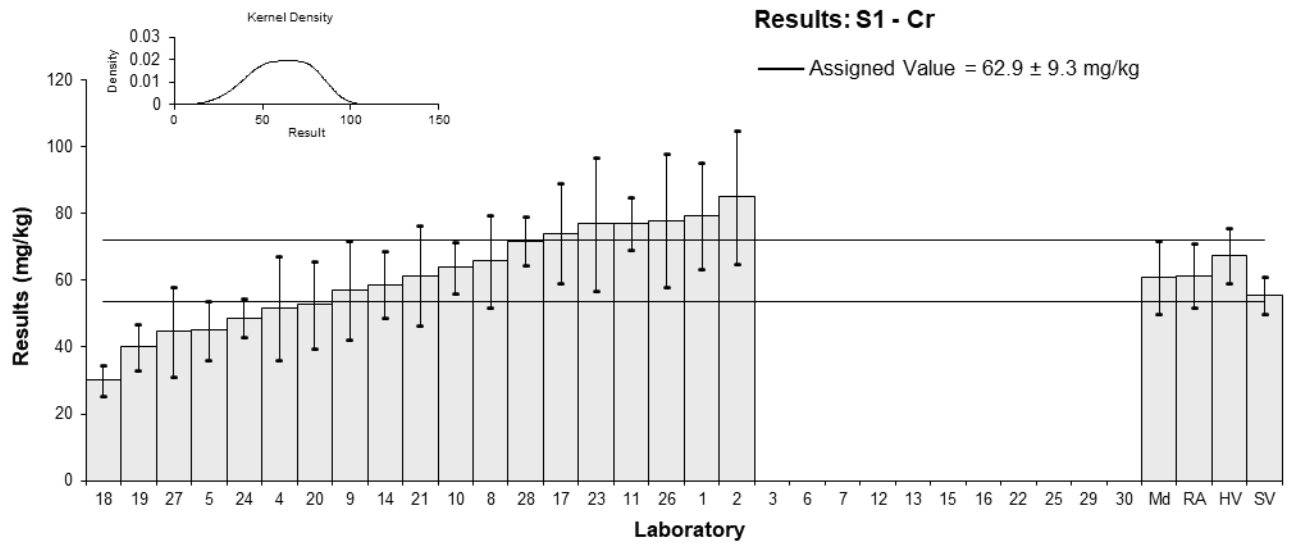


Figure 7

Table 18

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	368	74	0.26	0.18
2	380	90	0.49	0.28
3	NT	NT		
4	380	114	0.49	0.22
5	230	46	-2.34	-2.49
6	NT	NT		
7	NT	NT		
8	323.0	45.2	-0.58	-0.63
9	290	46.4	-1.21	-1.28
10	350	56	-0.08	-0.07
11	337	35	-0.32	-0.43
12	366.49	40	0.24	0.28
13	NR	NR		
14	331	46.0	-0.43	-0.46
15	NT	NT		
16	NT	NT		
17	339	67.8	-0.28	-0.21
18	400	60	0.87	0.73
19	376	50	0.41	0.41
20	358	89.5	0.08	0.04
21	318	100	-0.68	-0.35
22	NT	NT		
23	380	80	0.49	0.32
24	347	49	-0.13	-0.13
25	NT	NT		
26	390	100	0.68	0.35
27	394.58	118.374	0.76	0.34
28	334	33.4	-0.38	-0.52
29	NT	NT		
30	NT	NT		

Statistics

Assigned Value	354	19
Spike Value	Not Spiked	
Homogeneity Value	373	45
Robust Average	354	19
Median	354	20
Mean	350	
N	20	
Max	400	
Min	230	
Robust SD	34	
Robust CV	9.5%	

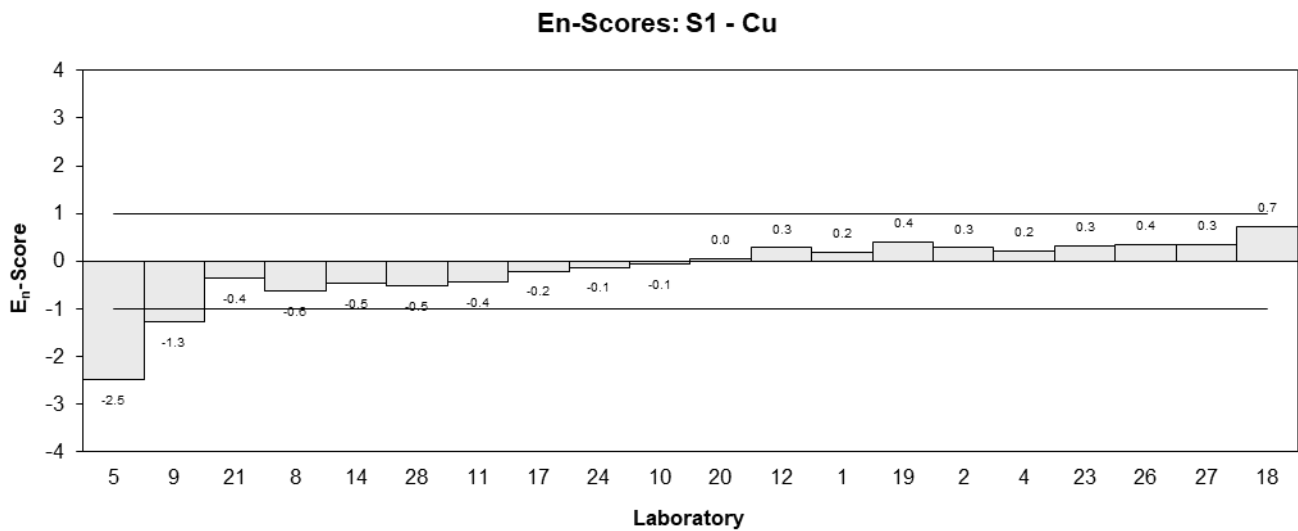
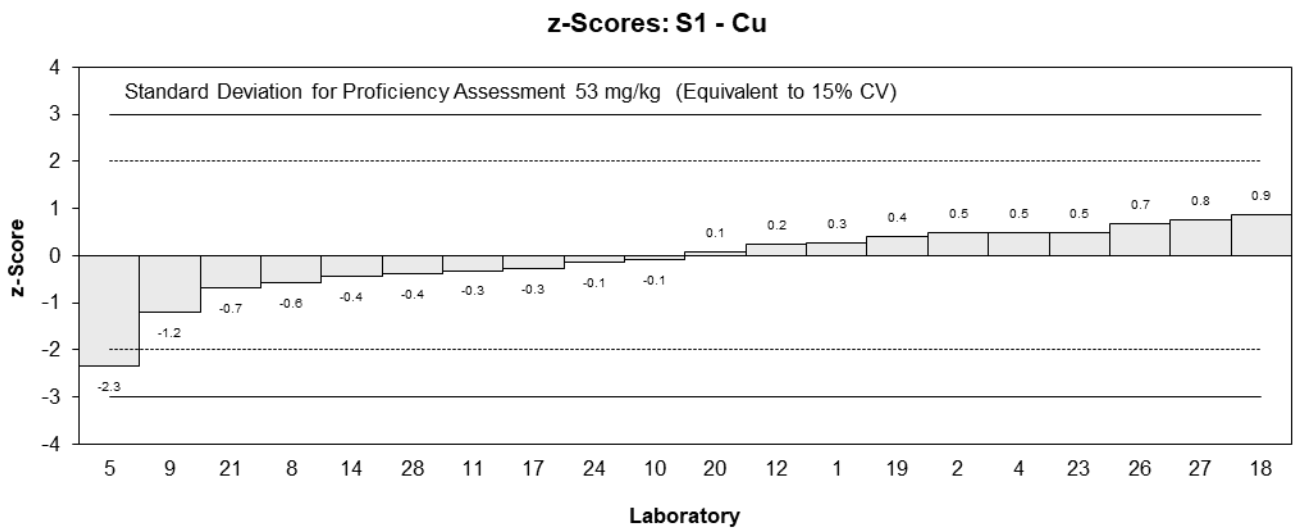
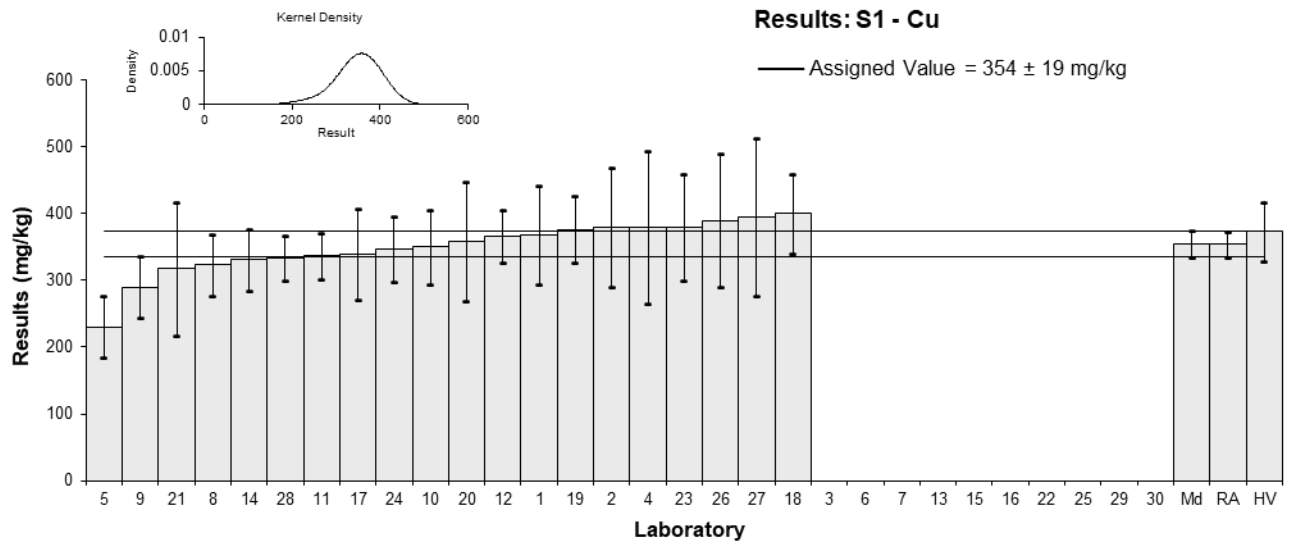


Figure 8

Table 19

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	1.27	0.25	0.70	0.44
2	1	0.3	-0.87	-0.47
3	NT	NT		
4	1.35	0.405	1.16	0.48
5	NT	NT		
6	NT	NT		
7	NT	NT		
8	1.20	0.28	0.29	0.17
9	<1	NR		
10	0.9	0.2	-1.45	-1.10
11	1.15	0.2	0.00	0.00
12	1.13	0.1	-0.12	-0.13
13	1.1	0.2	-0.29	-0.22
14	<1	0.3		
15	NT	NT		
16	NT	NT		
17	0.83	0.166	-1.86	-1.61
18	NT	NT		
19	1.20	0.34	0.29	0.14
20	1.31	0.33	0.93	0.46
21	0.96	0.4	-1.10	-0.46
22	NT	NT		
23	1	0.3	-0.87	-0.47
24	1.29	0.16	0.81	0.72
25	NT	NT		
26	1.2	0.4	0.29	0.12
27	1.39	0.417	1.39	0.56
28	NT	NT		
29	NT	NT		
30	NT	NT		

Statistics

Assigned Value	1.15	0.11
Spike Value	1.30	0.07
Homogeneity Value	1.22	0.15
Robust Average	1.15	0.11
Median	1.18	0.12
Mean	1.14	
N	16	
Max	1.39	
Min	0.83	
Robust SD	0.18	
Robust CV	16%	

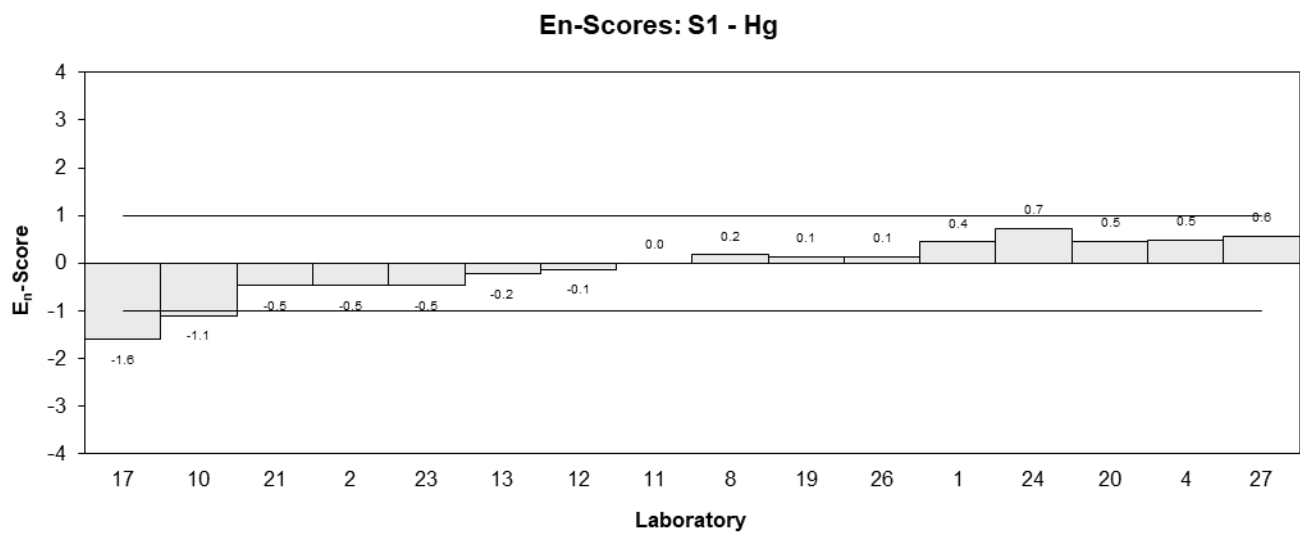
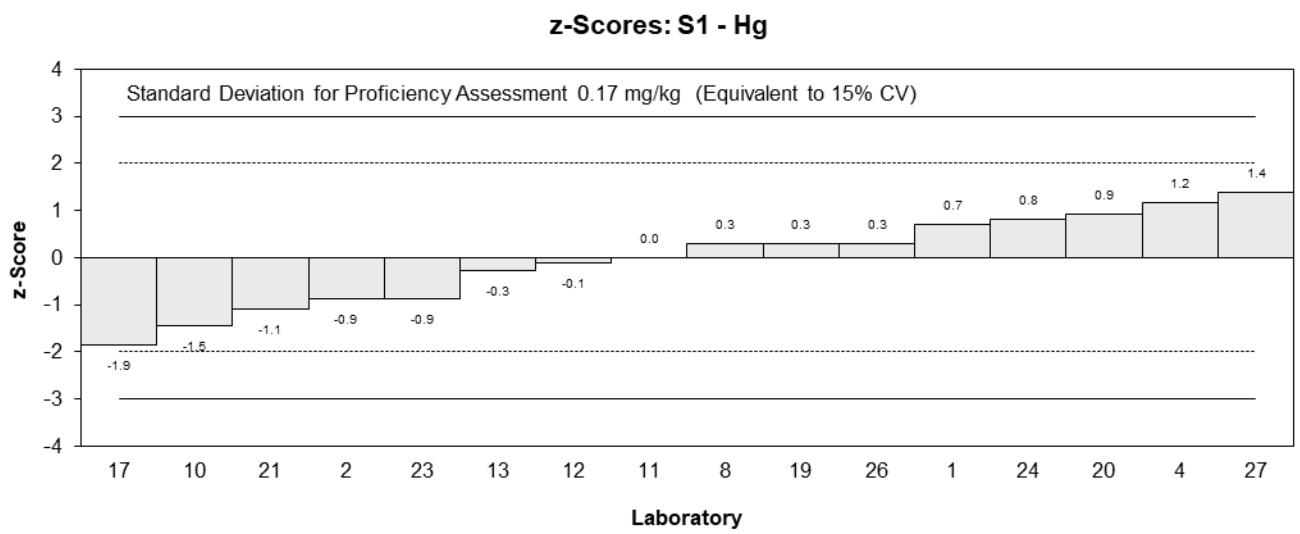
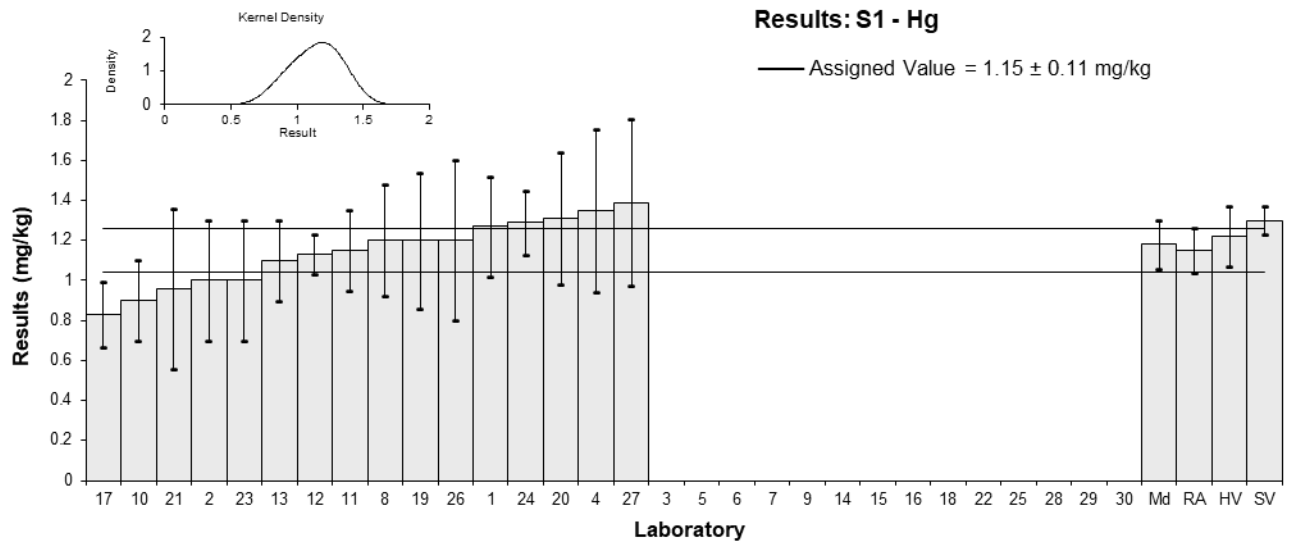


Figure 9

Table 20

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	NR	NR		
2	2	0.5	0.95	0.46
3	NT	NT		
4	1.95	0.585	0.76	0.32
5	NT	NT		
6	NT	NT		
7	NT	NT		
8	1.80	0.61	0.19	0.08
9	1.7	0.17	-0.19	-0.19
10	NT	NT		
11	1.42	0.15	-1.26	-1.32
12	NT	NT		
13	NR	NR		
14	1.57	0.30	-0.69	-0.50
15	NT	NT		
16	NT	NT		
17	0.96	0.192	-3.01	-2.85
18	NT	NT		
19	1.50	0.17	-0.95	-0.95
20	<10	NR		
21	1.9	0.6	0.57	0.24
22	NT	NT		
23	2	0.6	0.95	0.40
24	1.85	0.35	0.38	0.25
25	NT	NT		
26	2	1	0.95	0.25
27	NT	NT		
28	NT	NT		
29	NT	NT		
30	NT	NT		

Statistics

Assigned Value	1.75	0.20
Spike Value	Not Spiked	
Homogeneity Value	1.61	0.19
Robust Average	1.75	0.20
Median	1.83	0.19
Mean	1.72	
N	12	
Max	2	
Min	0.96	
Robust SD	0.27	
Robust CV	16%	

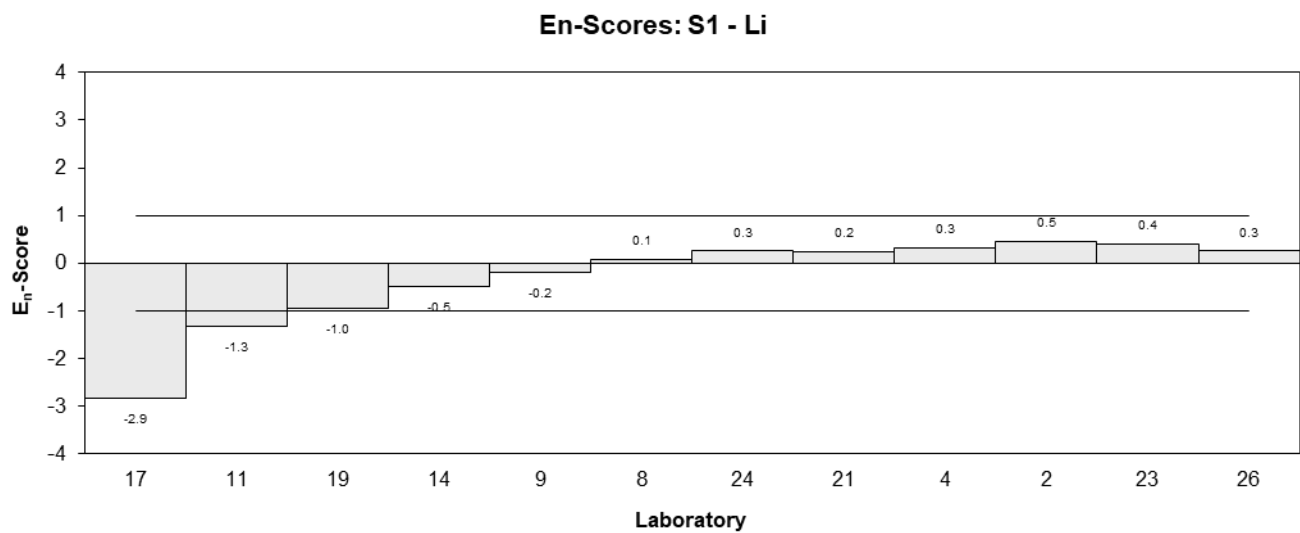
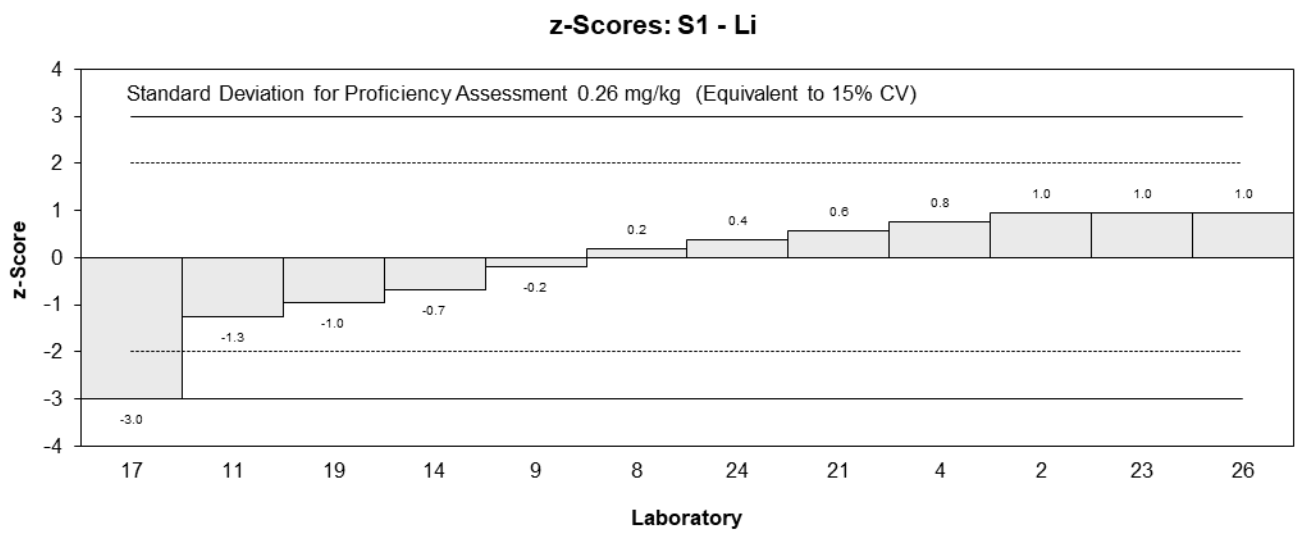
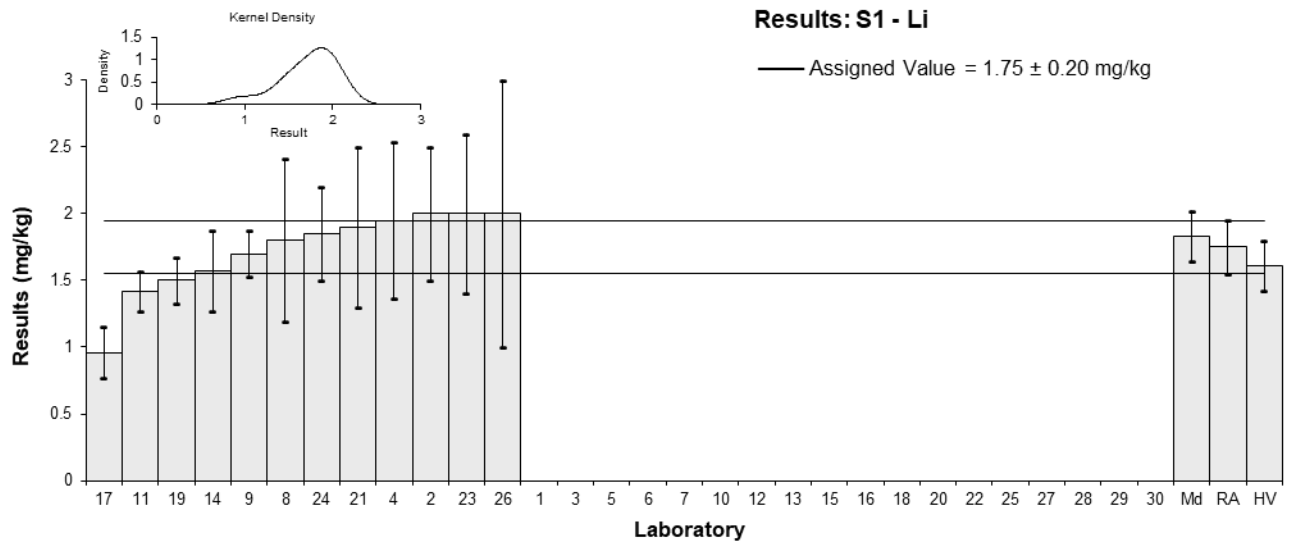


Figure 10

Table 21

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	441	88	0.43	0.20
2	460	80	0.87	0.45
3	NT	NT		
4	445.5	133.65	0.53	0.17
5	280	56	-3.38	-2.42
6	NT	NT		
7	NT	NT		
8	397.0	95.3	-0.61	-0.27
9	340	34	-1.96	-2.13
10	410	57	-0.31	-0.22
11	406	40	-0.40	-0.38
12	446.32	50	0.55	0.44
13	404	59	-0.45	-0.31
14	327	45	-2.27	-1.97
15	NT	NT		
16	NT	NT		
17	406	81.2	-0.40	-0.20
18	460	69	0.87	0.52
19	421	69	-0.05	-0.03
20	444	111	0.50	0.19
21	402	70.0	-0.50	-0.29
22	NT	NT		
23	430	90	0.17	0.08
24	434	44	0.26	0.23
25	NT	NT		
26	450	100	0.64	0.27
27	485.71	145.713	1.48	0.43
28	430	43	0.17	0.15
29	NT	NT		
30	NT	NT		

Statistics

Assigned Value	423	19
Spike Value	Not Spiked	
Homogeneity Value	463	56
Robust Average	423	19
Median	430	19
Mean	415	
N	21	
Max	485.71	
Min	280	
Robust SD	34	
Robust CV	8.2%	

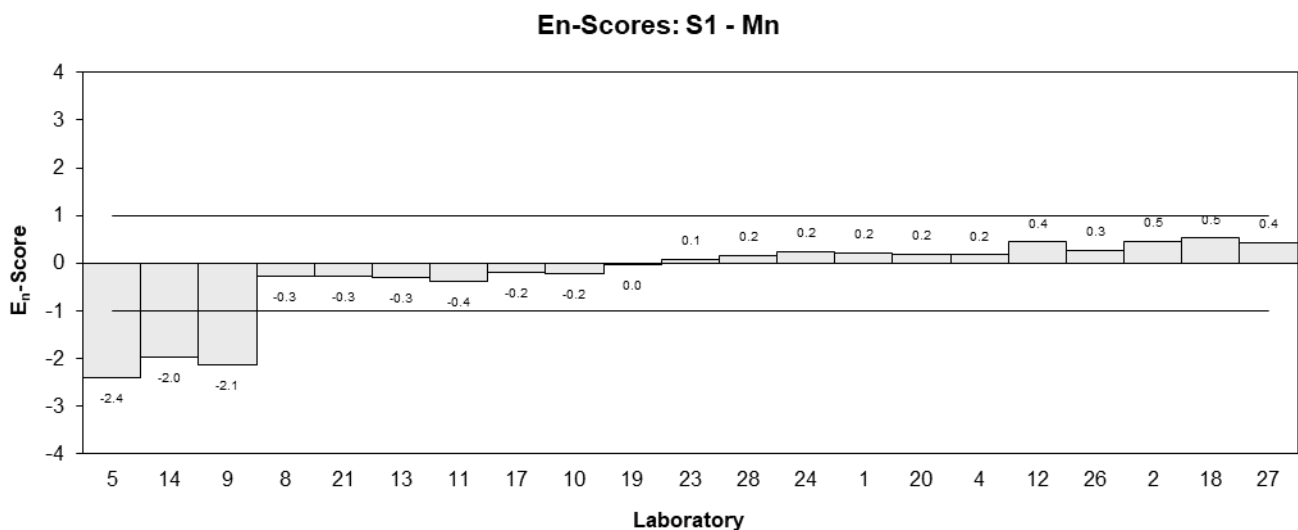
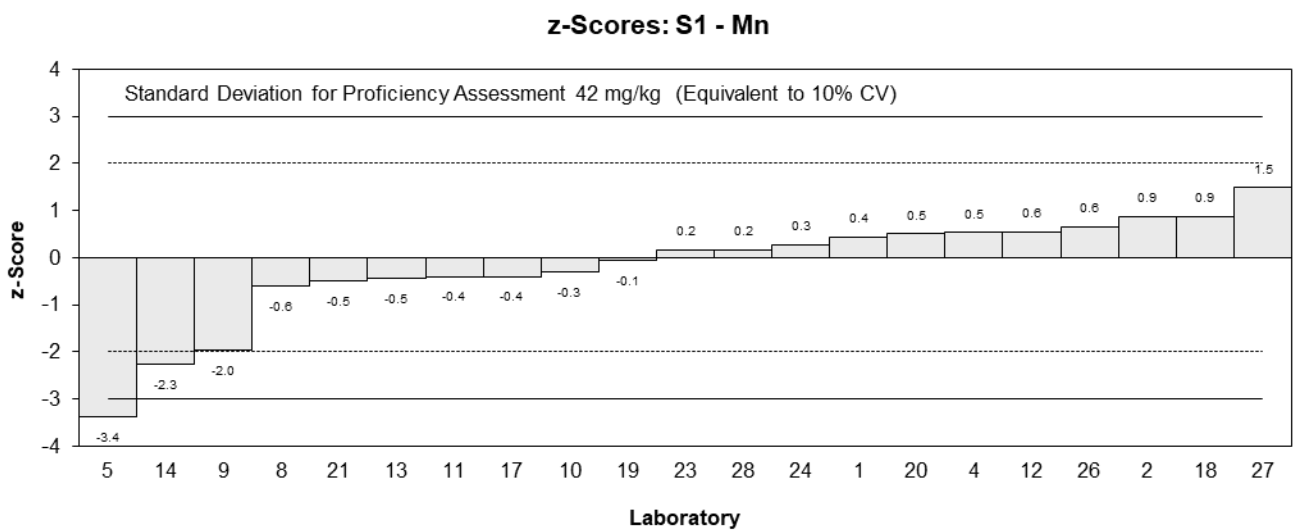
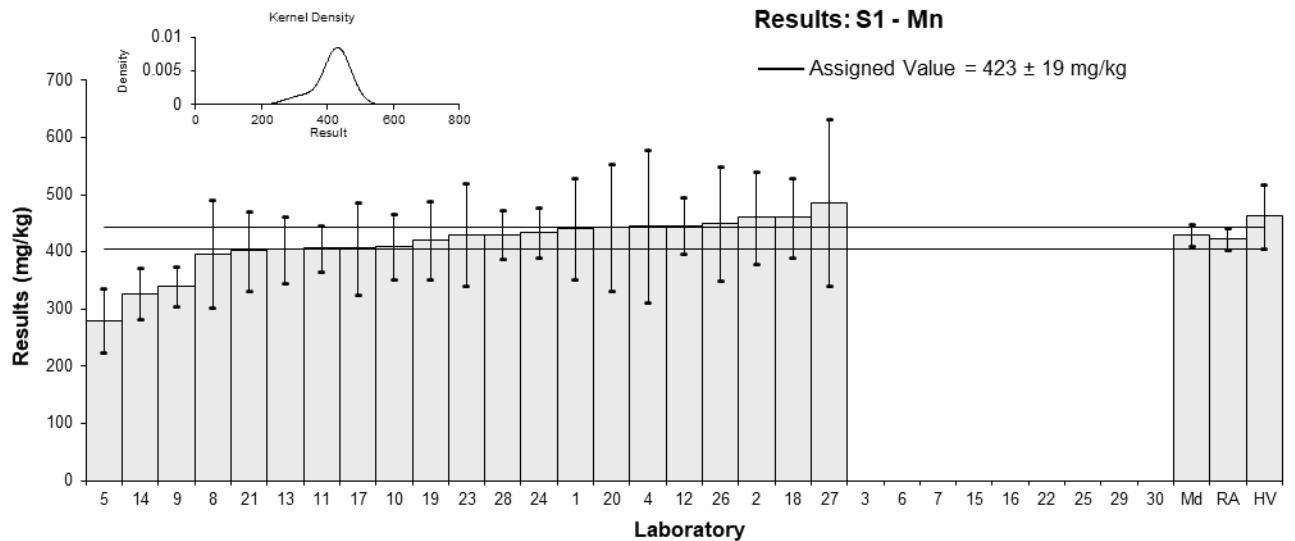


Figure 11

Table 22

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	118	24	1.57	0.65
2	110	30	0.78	0.26
3	NT	NT		
4	105	31.5	0.29	0.09
5	NT	NT		
6	NT	NT		
7	NT	NT		
8	103.0	10.3	0.10	0.09
9	87	21.75	-1.47	-0.67
10	100	6	-0.20	-0.26
11	107	11	0.49	0.41
12	113.24	10	1.10	1.01
13	91	21	-1.08	-0.51
14	81.5	11.0	-2.01	-1.70
15	NT	NT		
16	NT	NT		
17	102.3	20.46	0.03	0.01
18	100	15	-0.20	-0.13
19	94.9	10.2	-0.70	-0.63
20	101	25.2	-0.10	-0.04
21	99.4	20.0	-0.25	-0.13
22	NT	NT		
23	110	20	0.78	0.39
24	97.9	9.8	-0.40	-0.37
25	NT	NT		
26	110	30	0.78	0.26
27	103.53	31.059	0.15	0.05
28	103	10.3	0.10	0.09
29	NT	NT		
30	NT	NT		

Statistics

Assigned Value	102	5
Spike Value	96.1	4.5
Homogeneity Value	93	11
Robust Average	102	5
Median	103	4
Mean	102	
N	20	
Max	118	
Min	81.5	
Robust SD	8.3	
Robust CV	8.1%	

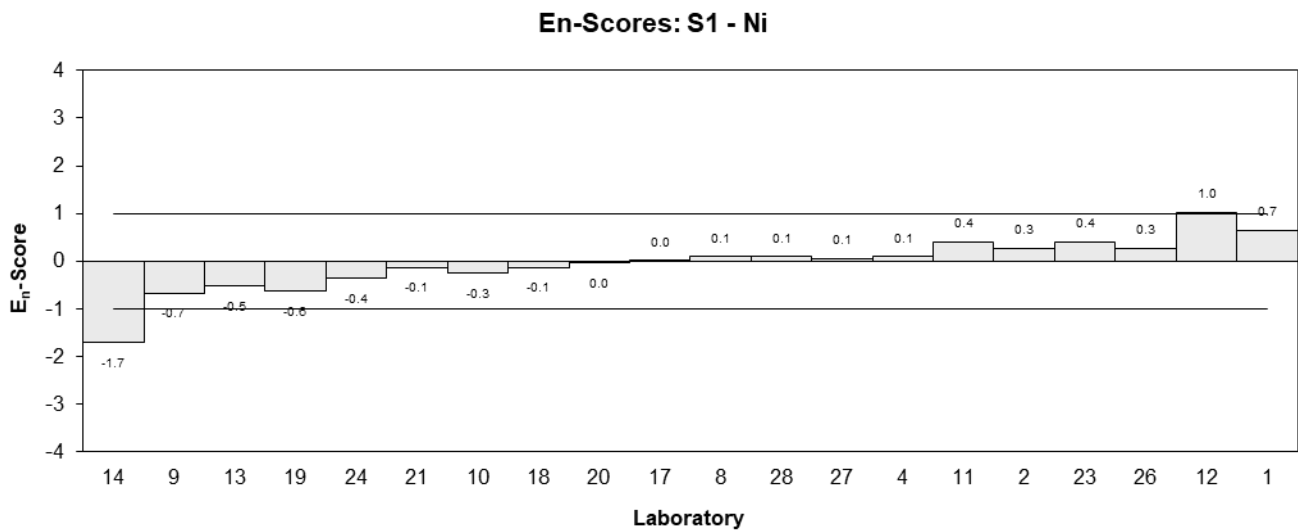
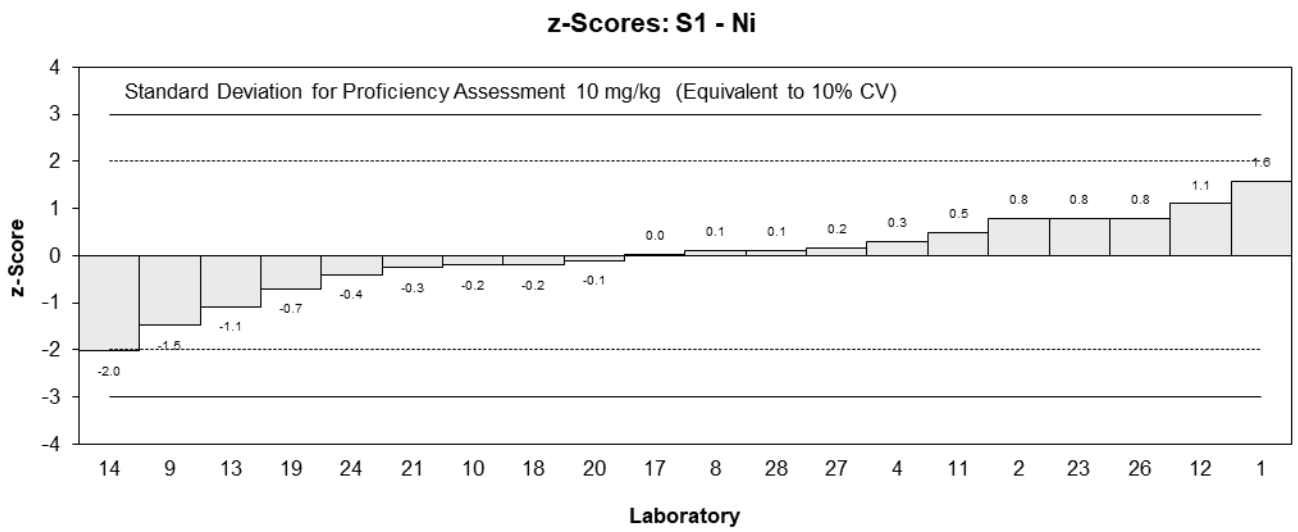
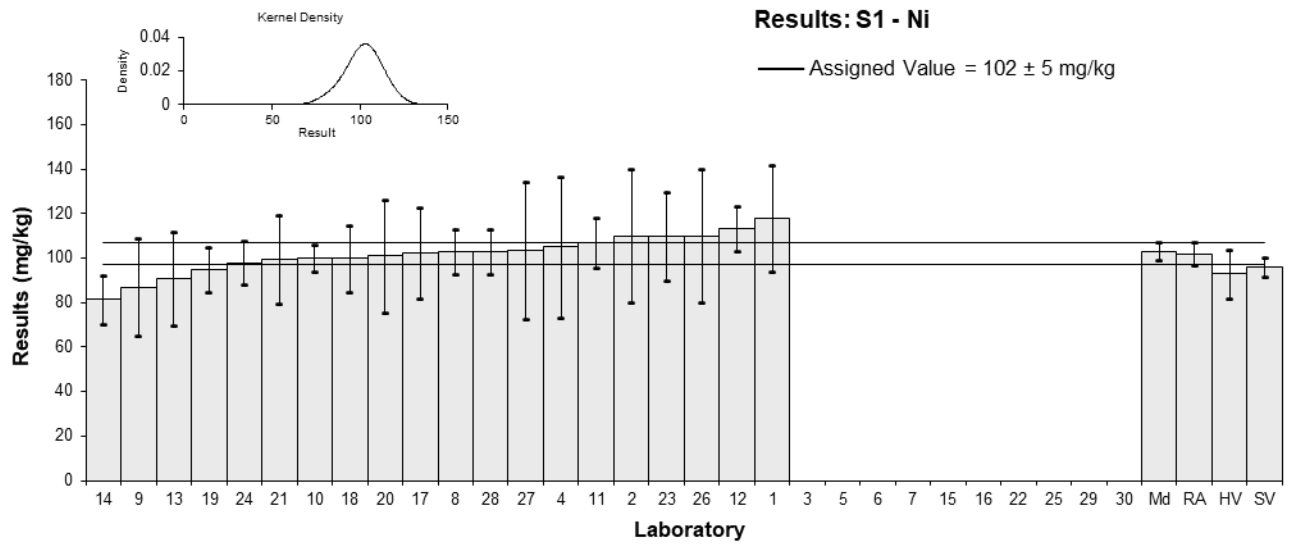


Figure 12

Table 23

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	13.1	2.6	0.48	0.22
2	13	4	0.40	0.12
3	NT	NT		
4	13.25	3.975	0.60	0.19
5	7.1	1.42	-4.32	-3.41
6	NT	NT		
7	NT	NT		
8	12.8	2.3	0.24	0.12
9	10	1.6	-2.00	-1.43
10	12	1.2	-0.40	-0.36
11	11.8	1.5	-0.56	-0.42
12	12.37	1	-0.10	-0.11
13	NR	NR		
14	13.3	2.0	0.64	0.38
15	NT	NT		
16	NT	NT		
17	13.2	2.64	0.56	0.26
18	10	1.5	-2.00	-1.51
19	13.9	3.8	1.12	0.36
20	14.1	3.6	1.28	0.44
21	11.5	4.0	-0.80	-0.25
22	NT	NT		
23	13	4	0.40	0.12
24	12.1	1.5	-0.32	-0.24
25	NT	NT		
26	13	4	0.40	0.12
27	16.2	4.86	2.96	0.75
28	12.0	1.2	-0.40	-0.36
29	NT	NT		
30	NT	NT		

Statistics

Assigned Value	12.5	0.7
Spike Value	Not Spiked	
Homogeneity Value	12.8	1.5
Robust Average	12.5	0.7
Median	12.9	0.7
Mean	12.4	
N	20	
Max	16.2	
Min	7.1	
Robust SD	1.3	
Robust CV	10%	

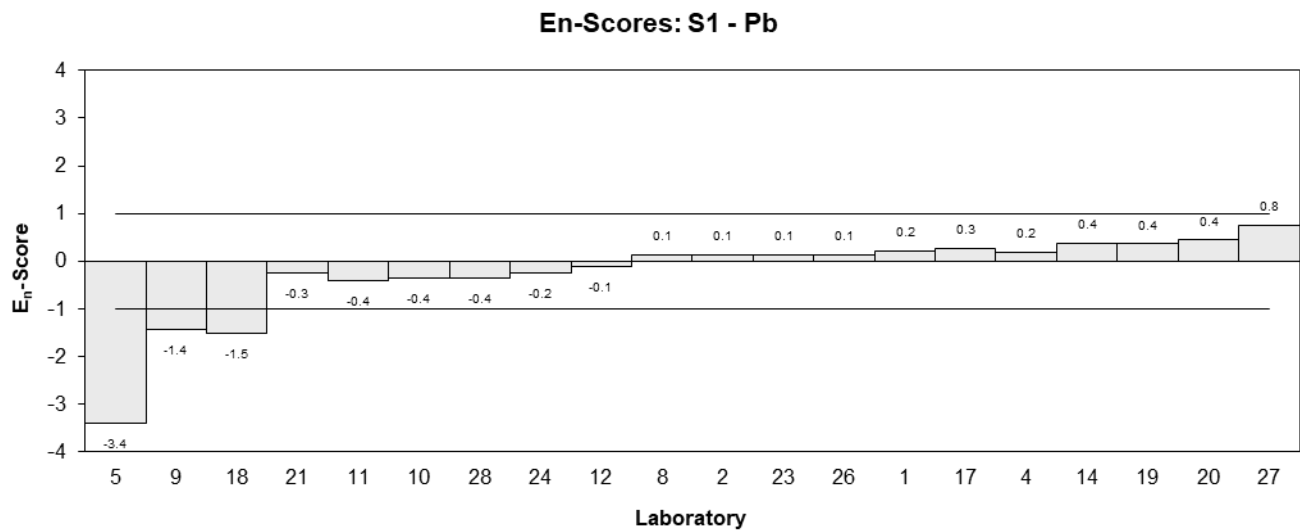
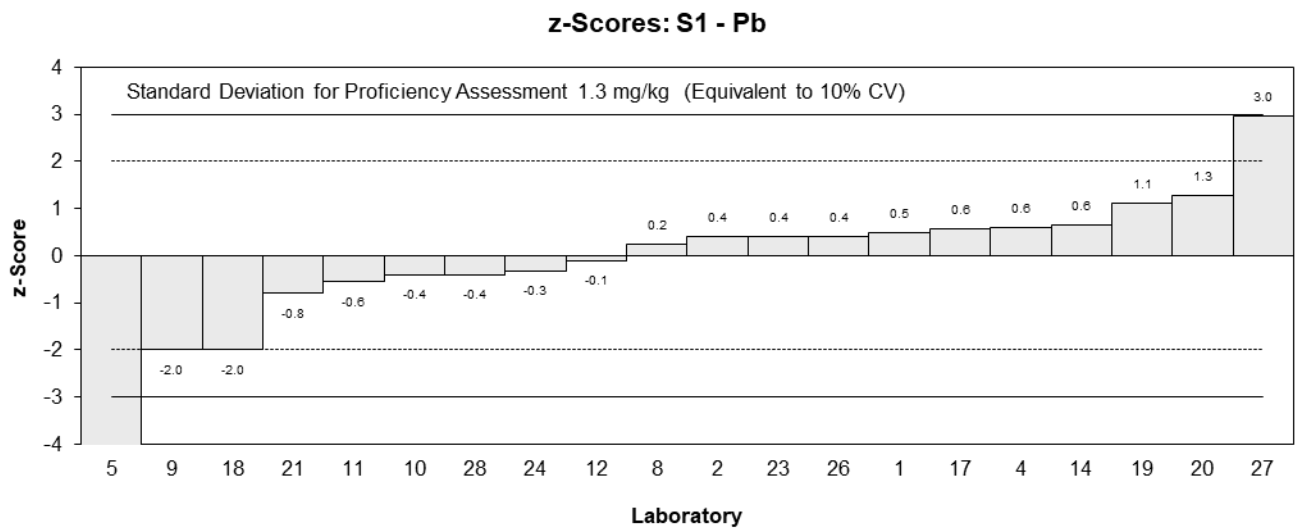
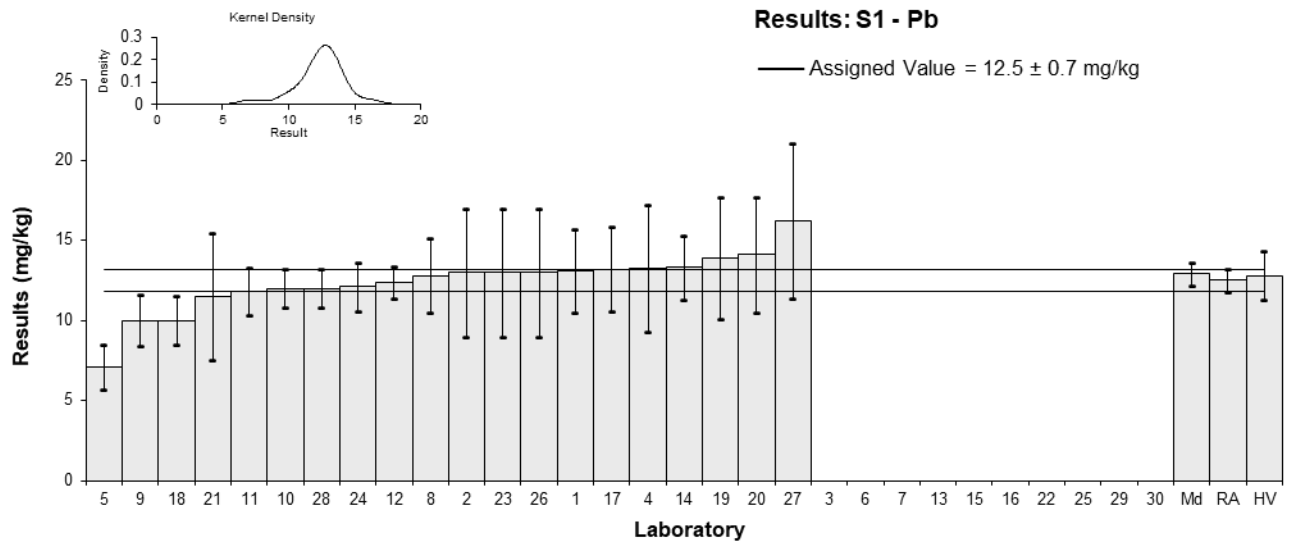


Figure 13

Table 24

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	106	21	-0.36	-0.26
2	120	20	0.48	0.36
3	NT	NT		
4	122.5	36.75	0.62	0.28
5	65	13	-2.80	-2.87
6	NT	NT		
7	NT	NT		
8	131.0	30.1	1.13	0.60
9	NT	NT		
10	110	30	-0.12	-0.06
11	119	12	0.42	0.45
12	127.27	10	0.91	1.08
13	NR	NR		
14	72.8	14.0	-2.33	-2.28
15	NT	NT		
16	NT	NT		
17	102.2	20.44	-0.58	-0.43
18	100	15	-0.71	-0.67
19	100	13	-0.71	-0.73
20	114	29	0.12	0.07
21	118	25.0	0.36	0.22
22	NT	NT		
23	110	20	-0.12	-0.09
24	127	26	0.89	0.54
25	NT	NT		
26	130	30	1.07	0.57
27	82.77	24.831	-1.74	-1.09
28	124	12.4	0.71	0.75
29	NT	NT		
30	NT	NT		

Statistics

Assigned Value	112	10
Spike Value	139	7
Homogeneity Value	110	13
Robust Average	112	10
Median	114	10
Mean	110	
N	19	
Max	131	
Min	65	
Robust SD	17	
Robust CV	15%	

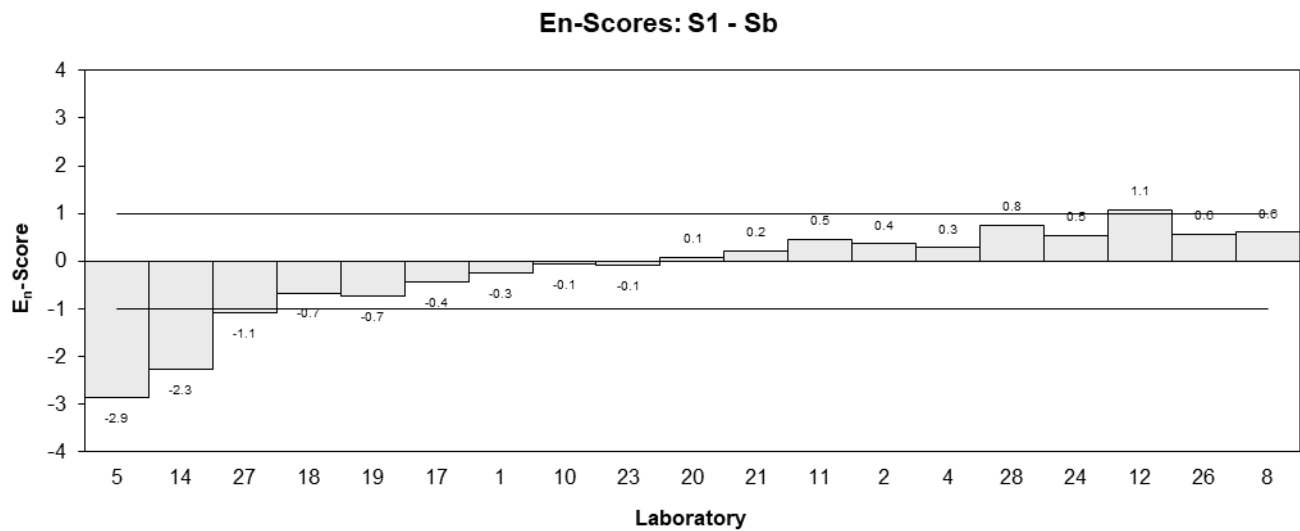
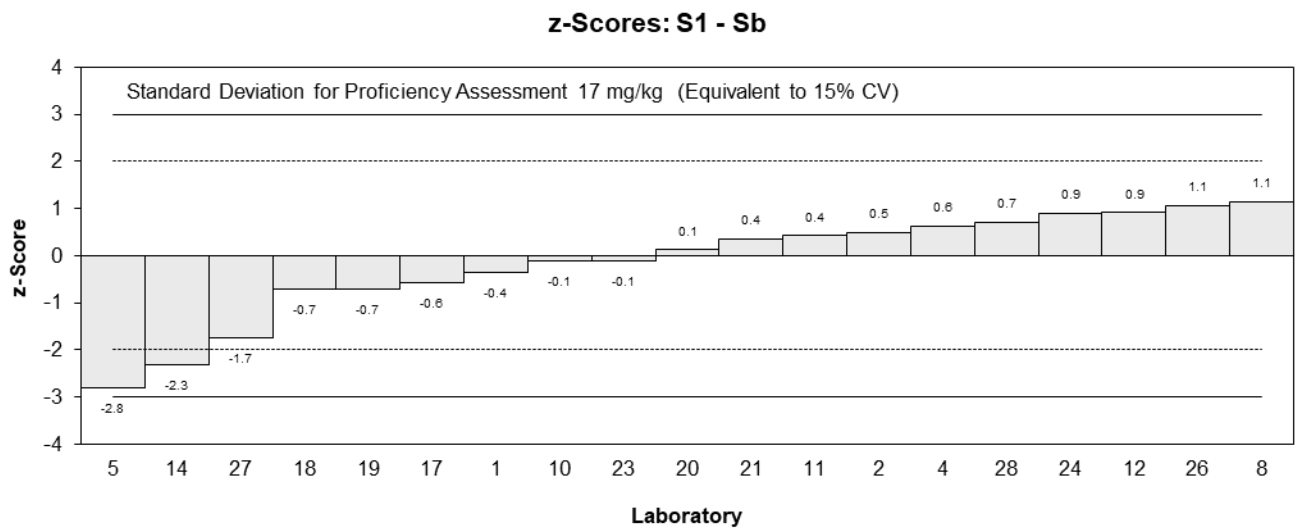
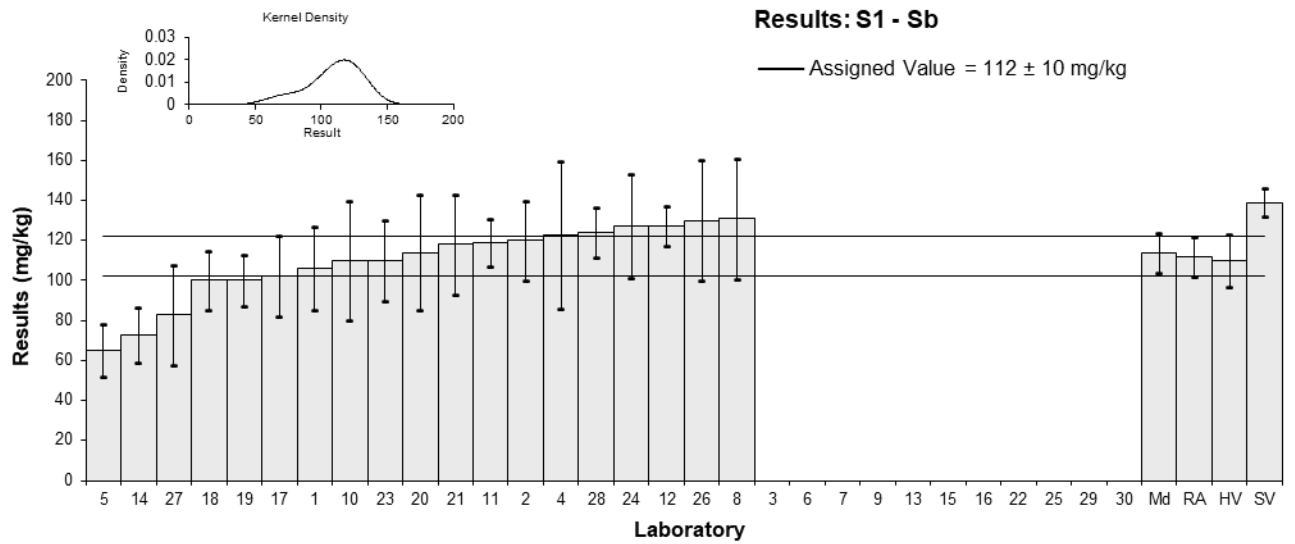


Figure 14

Table 25

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	4.81	0.96	0.27	0.22
2	5	2	0.48	0.21
3	NT	NT		
4	5.3	1.59	0.81	0.43
5	2.4	0.48	-2.37	-2.75
6	NT	NT		
7	NT	NT		
8	4.0	1.0	-0.61	-0.48
9	4	2	-0.61	-0.27
10	<5	NR		
11	4.10	0.5	-0.50	-0.58
12	5.45	0.5	0.98	1.12
13	NR	NR		
14	2.7	0.35	-2.04	-2.61
15	NT	NT		
16	NT	NT		
17	5.4	1.08	0.92	0.67
18	<5	NR		
19	4.40	1.69	-0.18	-0.09
20	5.2	1.3	0.70	0.44
21	4.81	2.0	0.27	0.12
22	NT	NT		
23	3	1	-1.71	-1.33
24	4.8	1.6	0.26	0.14
25	NT	NT		
26	6	3	1.58	0.47
27	< 2	< 2		
28	5.10	0.51	0.59	0.67
29	NT	NT		
30	NT	NT		

Statistics

Assigned Value	4.56	0.62
Spike Value	Not Spiked	
Homogeneity Value	4.64	0.56
Robust Average	4.56	0.62
Median	4.81	0.53
Mean	4.50	
N	17	
Max	6	
Min	2.4	
Robust SD	1.0	
Robust CV	23%	

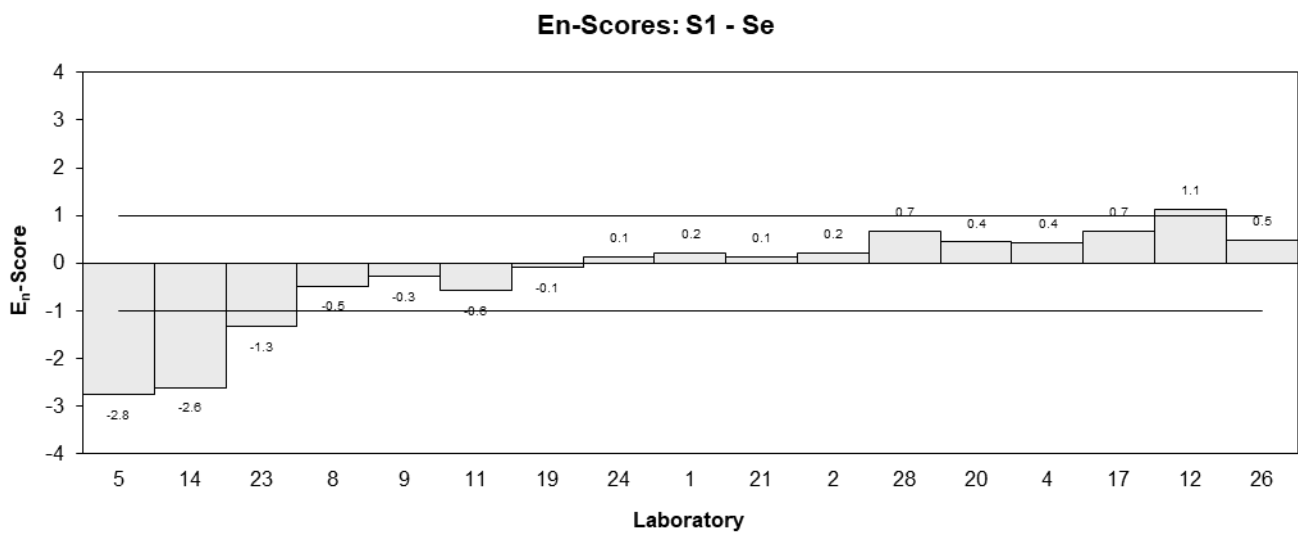
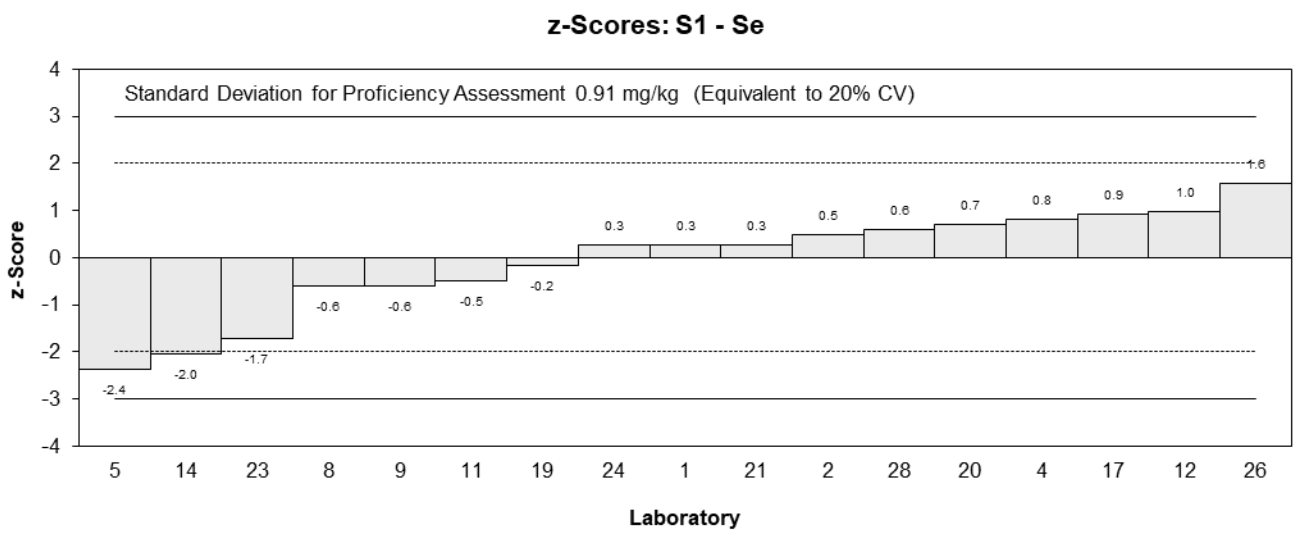
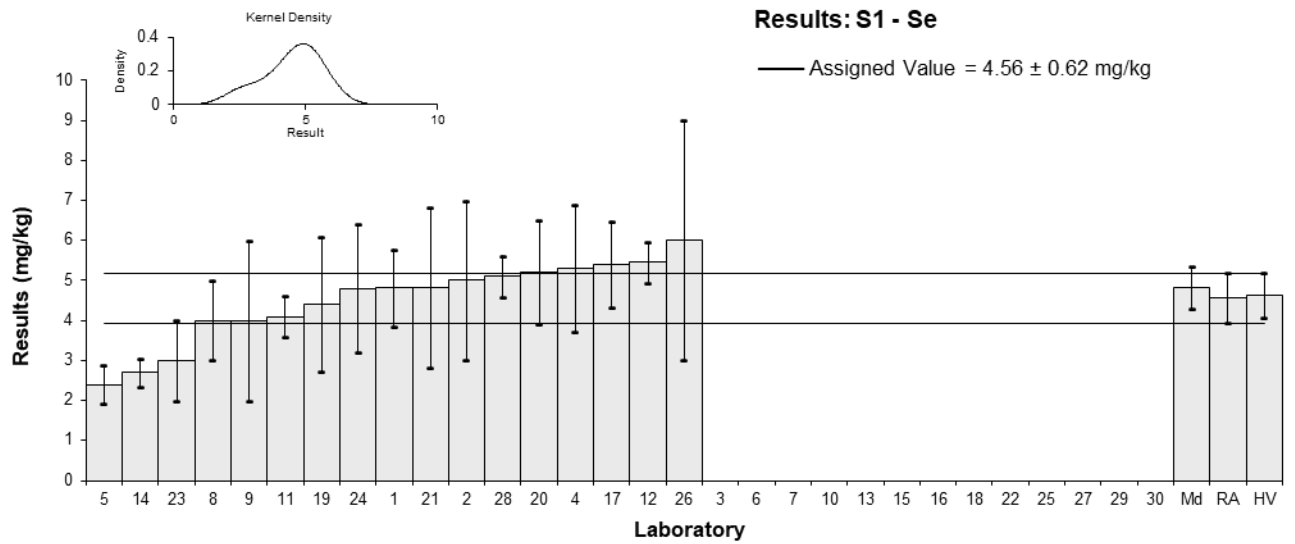


Figure 15

Table 26

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	29.3	5.9	-0.20	-0.14
2	31	8	0.18	0.10
3	NT	NT		
4	32.55	9.765	0.52	0.23
5*	10	2	-4.46	-6.31
6	NT	NT		
7	NT	NT		
8	30.8	8.9	0.13	0.06
9	33	3.3	0.62	0.68
10	26	7.3	-0.93	-0.54
11	35	4.0	1.06	1.02
12	NT	NT		
13	NR	NR		
14*	11.8	2.4	-4.06	-5.31
15	NT	NT		
16	NT	NT		
17	23.7	4.74	-1.43	-1.21
18	NT	NT		
19	23.0	4.9	-1.59	-1.31
20	28.5	7.12	-0.38	-0.23
21	33.7	25.0	0.77	0.14
22	NT	NT		
23	26	6	-0.93	-0.65
24	34.9	4.9	1.04	0.85
25	NT	NT		
26	31	10	0.18	0.08
27	31.05	9.315	0.19	0.09
28	31.8	3.18	0.35	0.40
29	NT	NT		
30	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	30.2	2.5
Spike Value	Not Spiked	
Robust Average	29.1	3.0
Median	30.9	2.3
Mean	28.0	
N	18	
Max	35	
Min	10	
Robust SD	5.1	
Robust CV	17%	

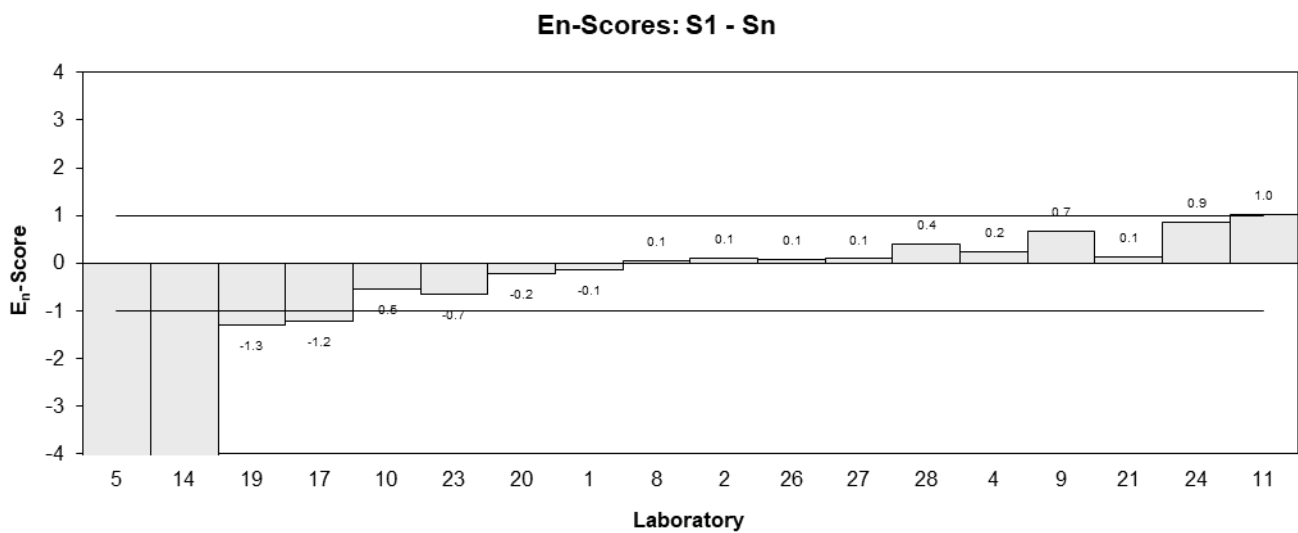
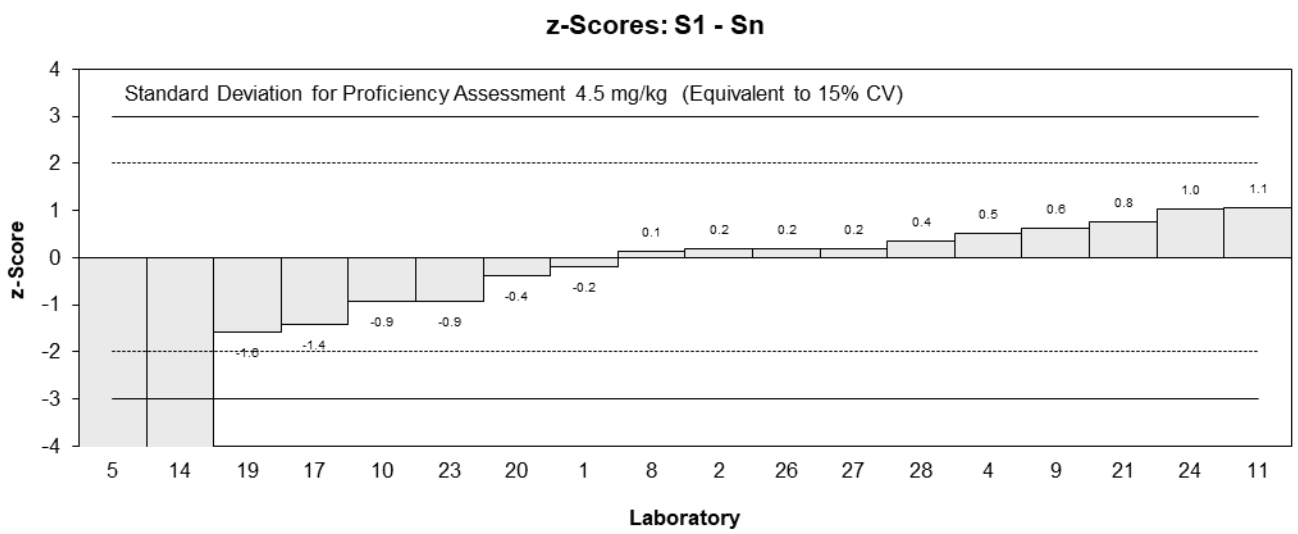
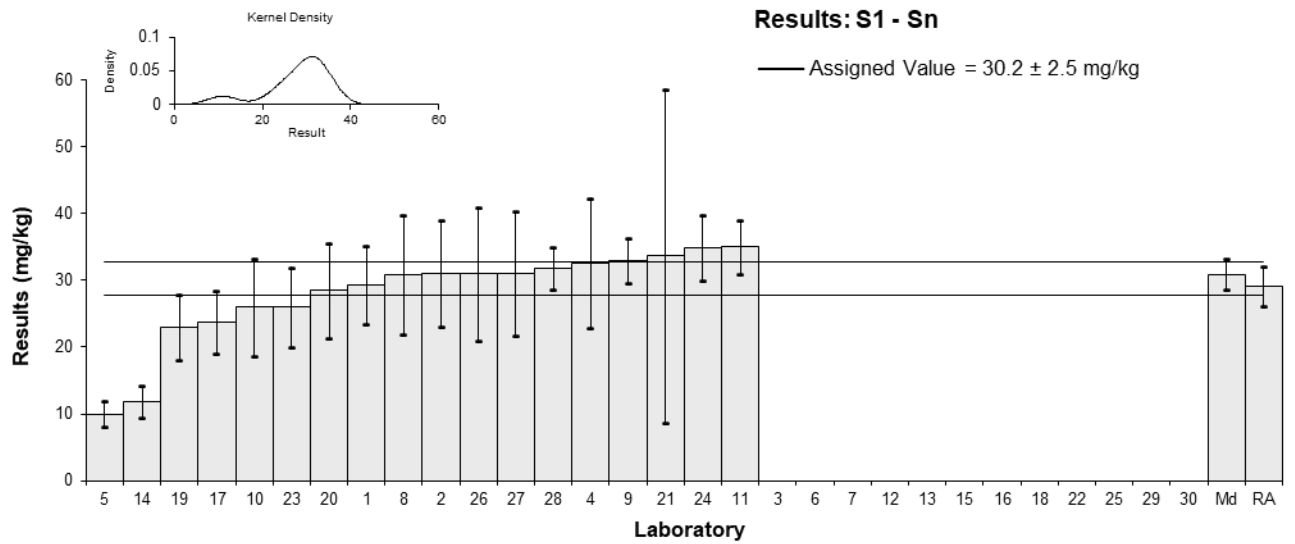


Figure 16

Table 27

Sample Details

Sample No.	S1
Matrix	Biosolid
Analyte	Sr
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	248	50	0.21	0.09
2	260	50	0.70	0.32
3	NT	NT		
4	240.5	72.15	-0.10	-0.03
5	150	30	-3.83	-2.66
6	NT	NT		
7	NT	NT		
8	203.0	44.7	-1.65	-0.83
9	230	23	-0.53	-0.45
10	220	44	-0.95	-0.48
11	231	23	-0.49	-0.41
12	228.93	20	-0.58	-0.52
13	NR	NR		
14	360	60	4.81	1.87
15	NT	NT		
16	NT	NT		
17	221.8	44.36	-0.87	-0.44
18	300	45	2.35	1.18
19	230	38	-0.53	-0.31
20	214	54	-1.19	-0.51
21	361	108	4.86	1.08
22	NT	NT		
23	250	50	0.29	0.13
24	257	42	0.58	0.31
25	NT	NT		
26	260	70	0.70	0.24
27	271.0	81.30	1.15	0.34
28	234	23.4	-0.37	-0.30
29	NT	NT		
30	NT	NT		

Statistics

Assigned Value	243	18
Spike Value	Not Spiked	
Homogeneity Value	245	29
Robust Average	243	18
Median	237	15
Mean	249	
N	20	
Max	361	
Min	150	
Robust SD	32	
Robust CV	13%	

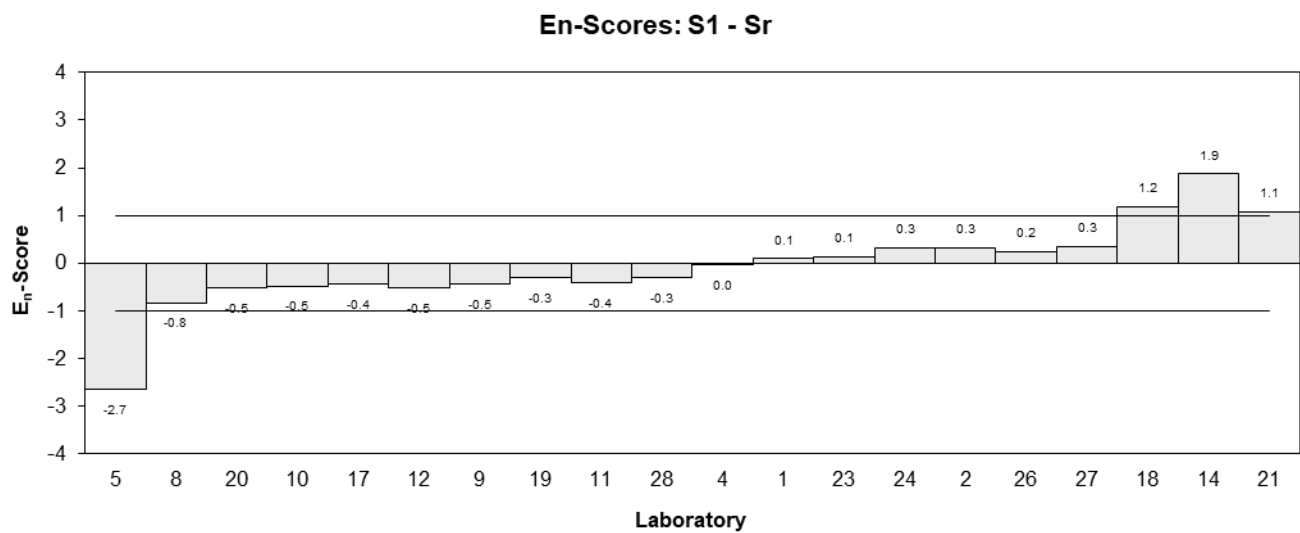
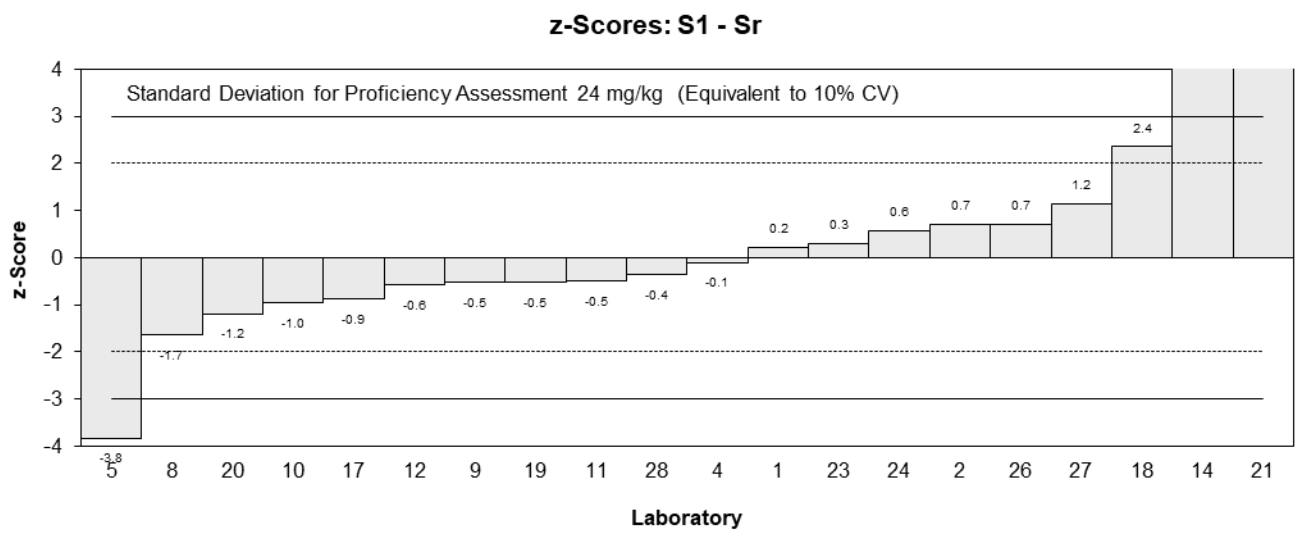
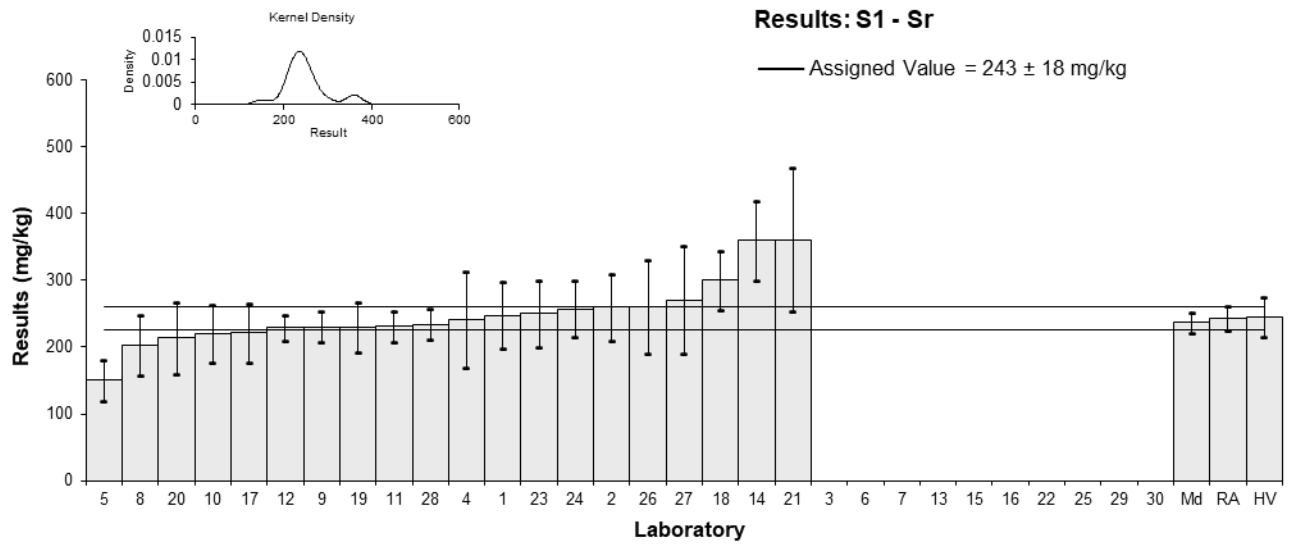


Figure 17

Table 28

Sample Details

Sample No.	S1
Matrix	Biosolid
Analyte	TI
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	1.58	0.32	0.75	0.47
2	<2	NR		
3	NT	NT		
4	NR	NR		
5	0.72	0.144	-3.29	-3.73
6	NT	NT		
7	NT	NT		
8	1.50	0.36	0.38	0.21
9	NT	NT		
10	NT	NT		
11	1.36	0.2	-0.28	-0.26
12	NT	NT		
13	NR	NR		
14	<1	0.3		
15	NT	NT		
16	NT	NT		
17	1.57	0.314	0.70	0.45
18	<5	NR		
19	1.30	0.45	-0.56	-0.26
20	<5	NR		
21	1.36	0.4	-0.28	-0.14
22	NT	NT		
23	<2	NR		
24	1.40	0.20	-0.09	-0.09
25	NT	NT		
26	<2	NR		
27	NT	NT		
28	1.49	0.15	0.33	0.36
29	NT	NT		
30	NT	NT		

Statistics

Assigned Value	1.42	0.12
Spike Value	1.61	0.08
Homogeneity Value	1.65	0.20
Robust Average	1.42	0.12
Median	1.40	0.12
Mean	1.36	
N	9	
Max	1.58	
Min	0.72	
Robust SD	0.14	
Robust CV	10%	

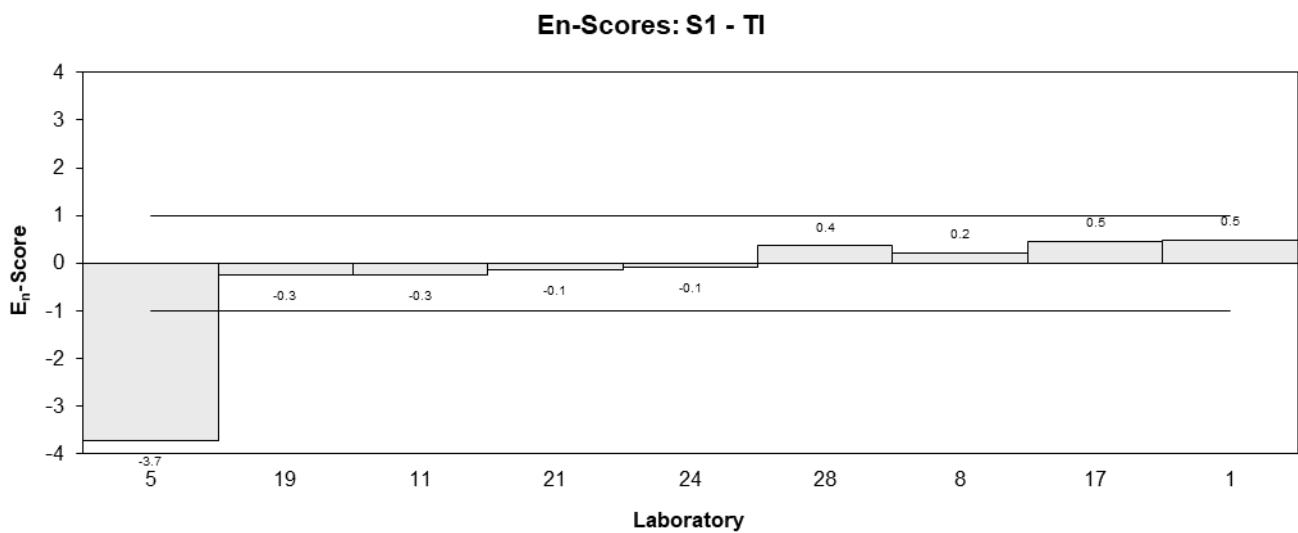
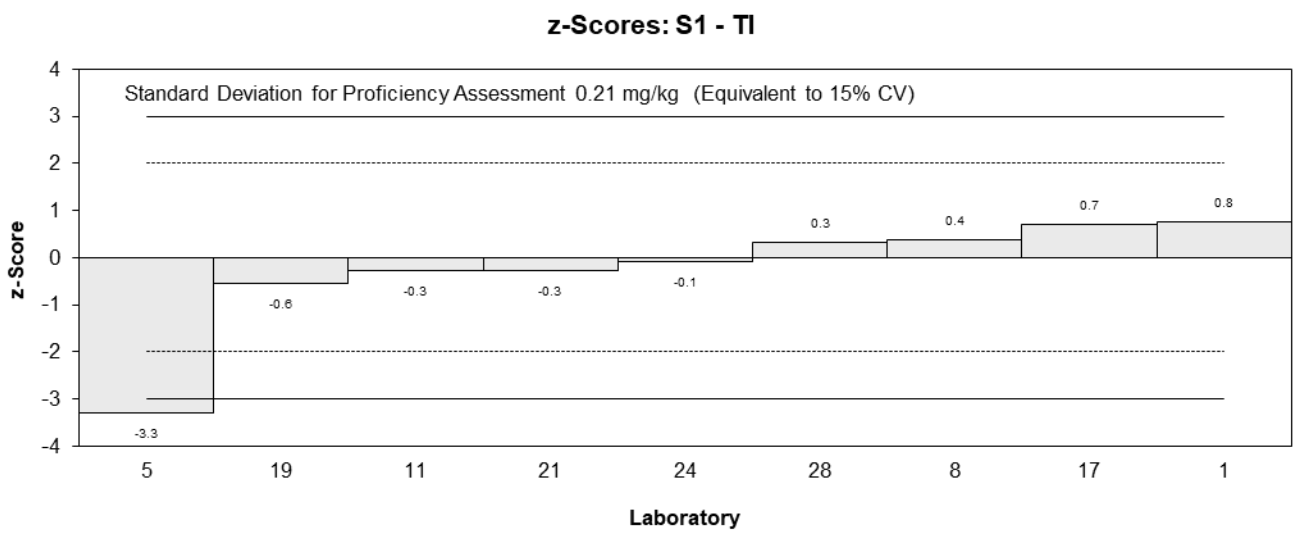
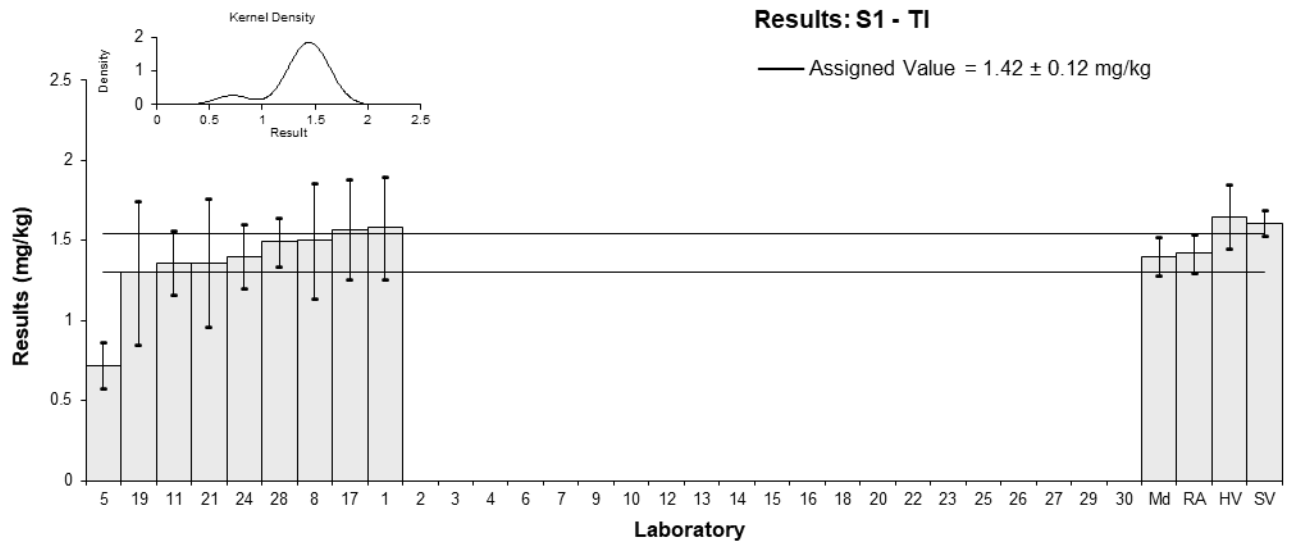


Figure 18

Table 29

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	1.80	0.36	0.40	0.19
2	1.8	0.4	0.40	0.17
3	NT	NT		
4	1.73	0.519	0.00	0.00
5	0.89	0.178	-4.86	-4.47
6	NT	NT		
7	NT	NT		
8	1.69	0.35	-0.23	-0.11
9	1.8	0.18	0.40	0.37
10	NT	NT		
11	1.60	0.2	-0.75	-0.62
12	NT	NT		
13	NR	NR		
14	<1	0.3		
15	NT	NT		
16	NT	NT		
17	1.67	0.334	-0.35	-0.18
18	NT	NT		
19	1.77	0.53	0.23	0.07
20	<5	NR		
21	NT	NT		
22	NT	NT		
23	1.8	0.4	0.40	0.17
24	1.73	0.25	0.00	0.00
25	NT	NT		
26	1.7	0.5	-0.17	-0.06
27	NT	NT		
28	1.81	0.18	0.46	0.42
29	NT	NT		
30	NT	NT		

Statistics

Assigned Value	1.73	0.06
Spike Value	1.75	0.16
Homogeneity Value	1.87	0.22
Robust Average	1.73	0.06
Median	1.73	0.07
Mean	1.68	
N	13	
Max	1.81	
Min	0.89	
Robust SD	0.082	
Robust CV	4.7%	

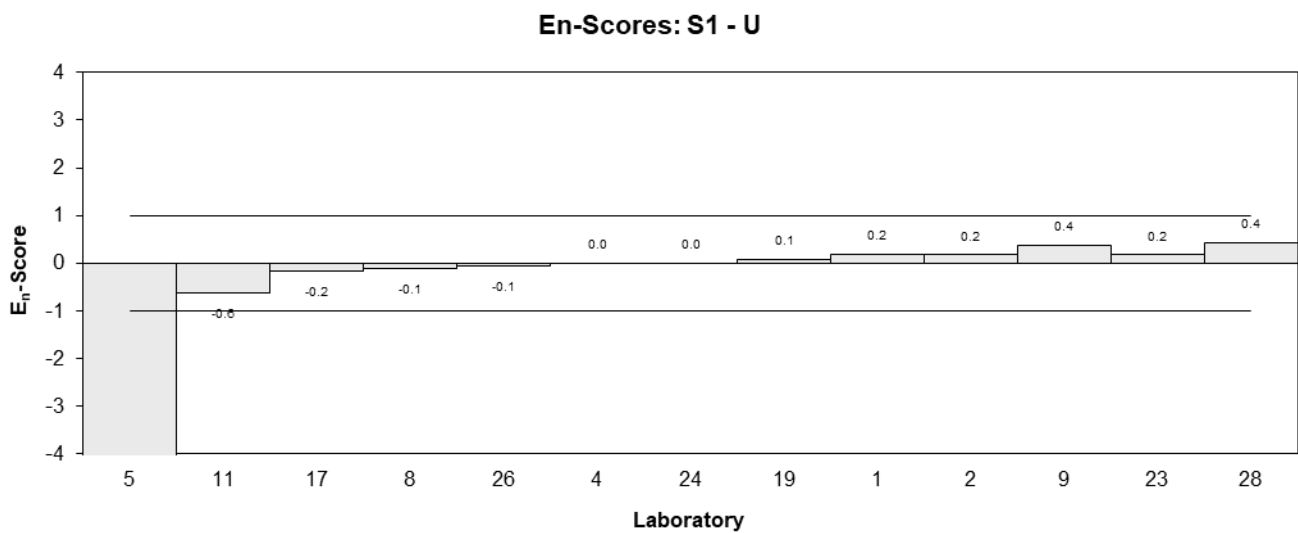
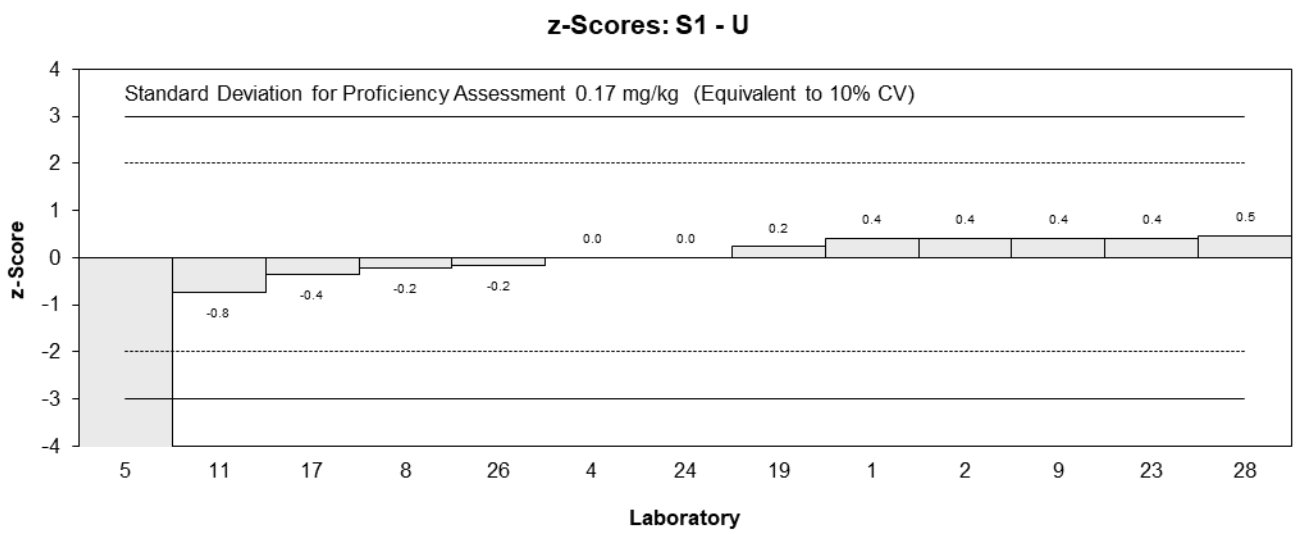
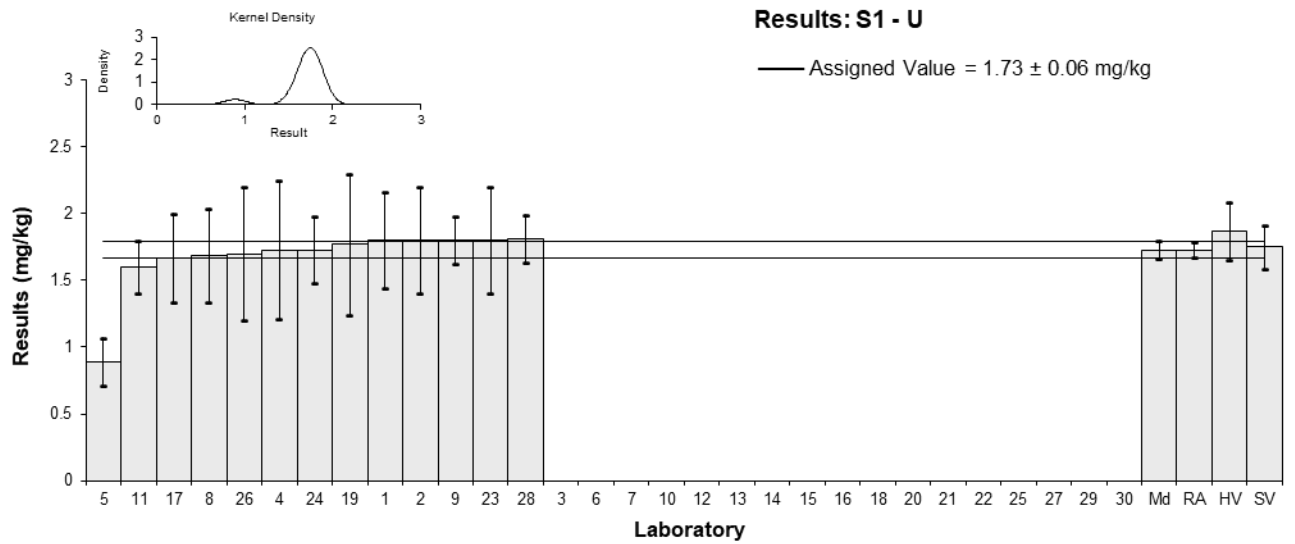


Figure 19

Table 30

Sample Details

Sample No.	S1
Matrix	Biosolid
Analyte	V
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	35.3	7.1	0.13	0.09
2	37	6	0.46	0.38
3	NT	NT		
4	38.35	11.505	0.72	0.32
5	22	4.4	-2.43	-2.56
6	NT	NT		
7	NT	NT		
8	33.6	7.7	-0.19	-0.12
9	34	3.4	-0.12	-0.15
10	37	6.7	0.46	0.34
11	30.3	3.0	-0.83	-1.16
12	34.00	3	-0.12	-0.16
13	NR	NR		
14	40.7	5.0	1.18	1.12
15	NT	NT		
16	NT	NT		
17	34.4	6.88	-0.04	-0.03
18	30	4.5	-0.89	-0.92
19	32.0	4.3	-0.50	-0.54
20	43.3	11	1.68	0.78
21	30.0	13.4	-0.89	-0.34
22	NT	NT		
23	36	7	0.27	0.19
24	33.7	8.9	-0.17	-0.10
25	NT	NT		
26	39	10	0.85	0.43
27	34.79	10.437	0.04	0.02
28	32.3	3.23	-0.44	-0.59
29	NT	NT		
30	NT	NT		

Statistics

Assigned Value	34.6	2.2
Spike Value	37.1	3.6
Homogeneity Value	35.4	4.2
Robust Average	34.6	2.2
Median	34.2	2.1
Mean	34.4	
N	20	
Max	43.3	
Min	22	
Robust SD	3.9	
Robust CV	11%	

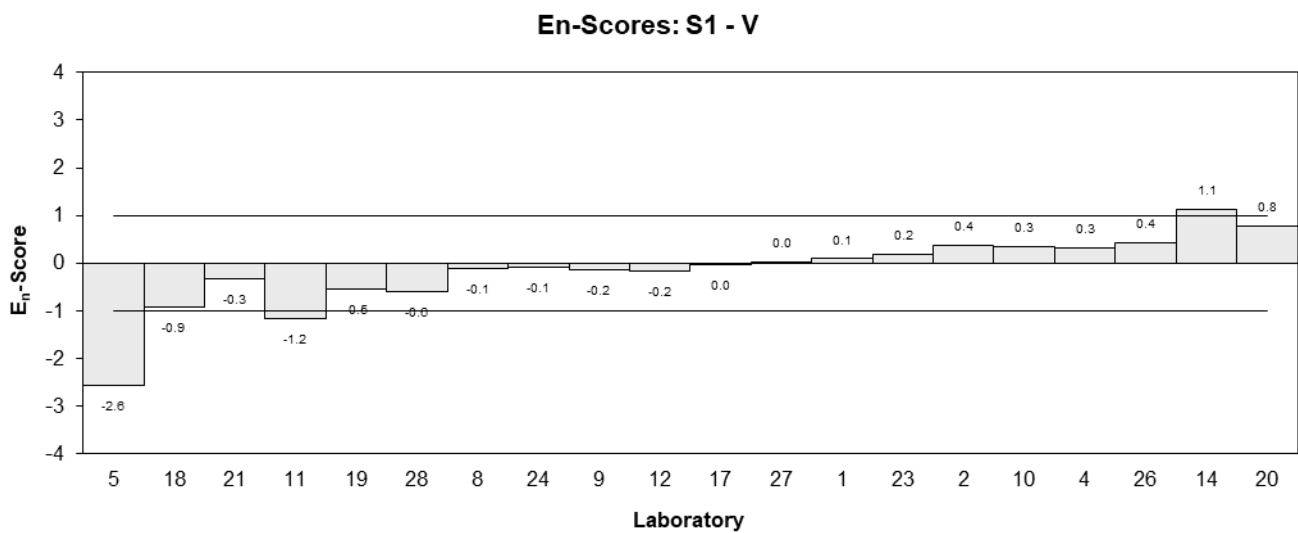
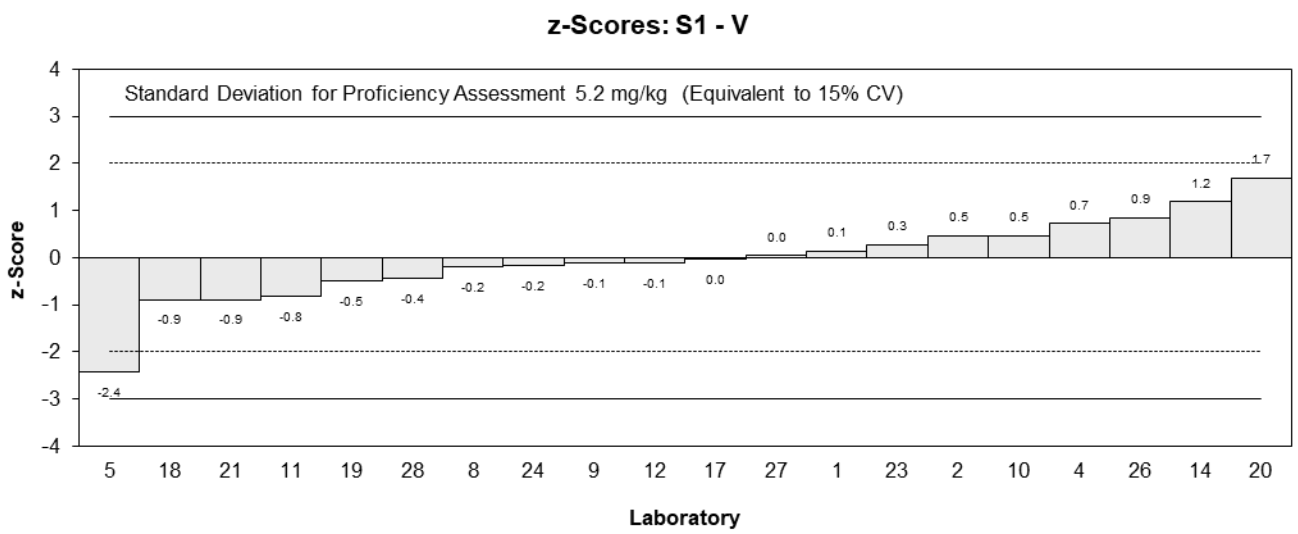
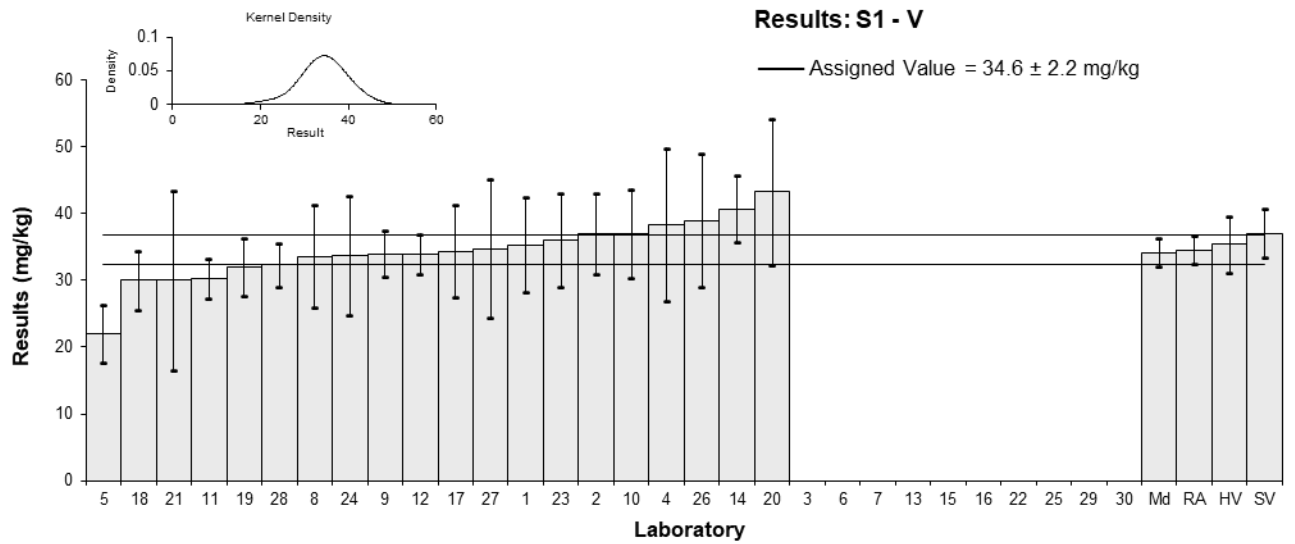


Figure 20

Table 31

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	849	170	0.87	0.39
2	860	200	1.01	0.39
3	NT	NT		
4	857	257.1	0.97	0.29
5	750	150	-0.40	-0.20
6	NT	NT		
7	NT	NT		
8	790.0	126.4	0.12	0.07
9	670	147.4	-1.42	-0.73
10	690	28	-1.17	-2.10
11	769	77	-0.15	-0.14
12	795.25	80	0.18	0.16
13	NR	NR		
14	499	50	-3.61	-4.71
15	NT	NT		
16	NT	NT		
17	728.5	145.7	-0.67	-0.35
18	800	120	0.24	0.15
19	790	93	0.12	0.09
20	833	208	0.67	0.25
21	765	75.0	-0.20	-0.20
22	NT	NT		
23	750	200	-0.40	-0.15
24	810	130	0.37	0.22
25	NT	NT		
26	810	200	0.37	0.14
27	826.7	248.01	0.59	0.18
28	770	77	-0.14	-0.13
29	NT	NT		
30	NT	NT		

Statistics

Assigned Value	781	33
Spike Value	Not Spiked	
Homogeneity Value	803	96
Robust Average	781	33
Median	790	32
Mean	771	
N	20	
Max	860	
Min	499	
Robust SD	60	
Robust CV	7.7%	

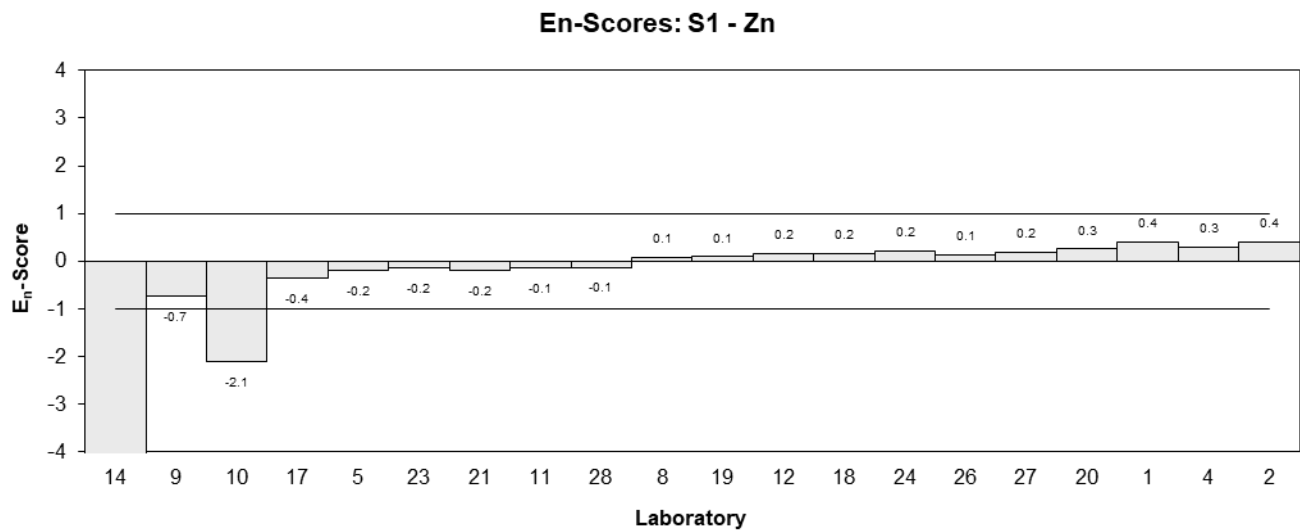
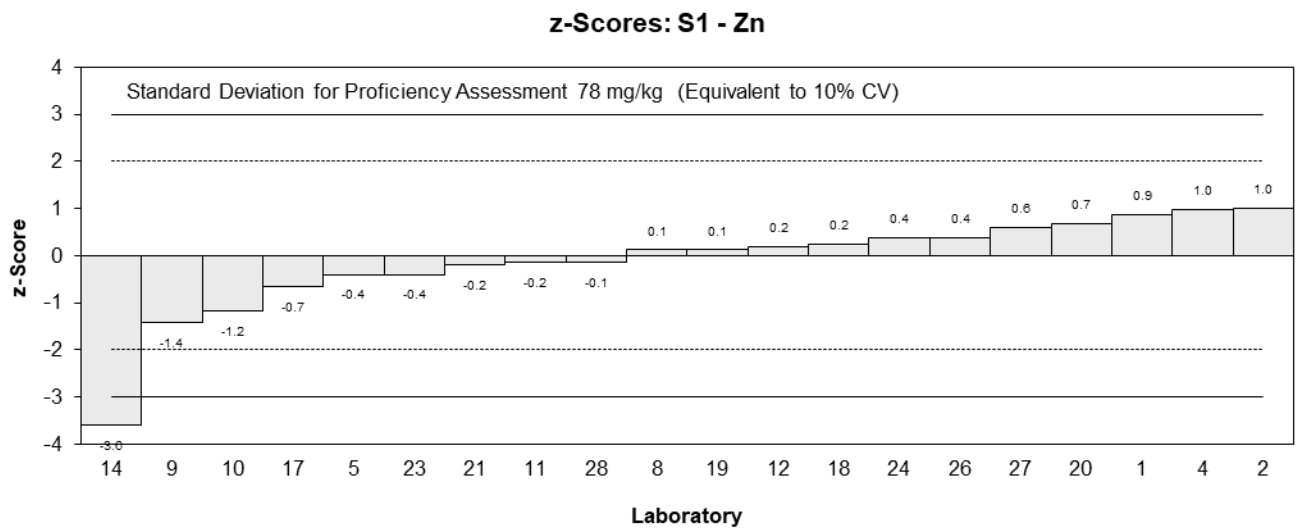
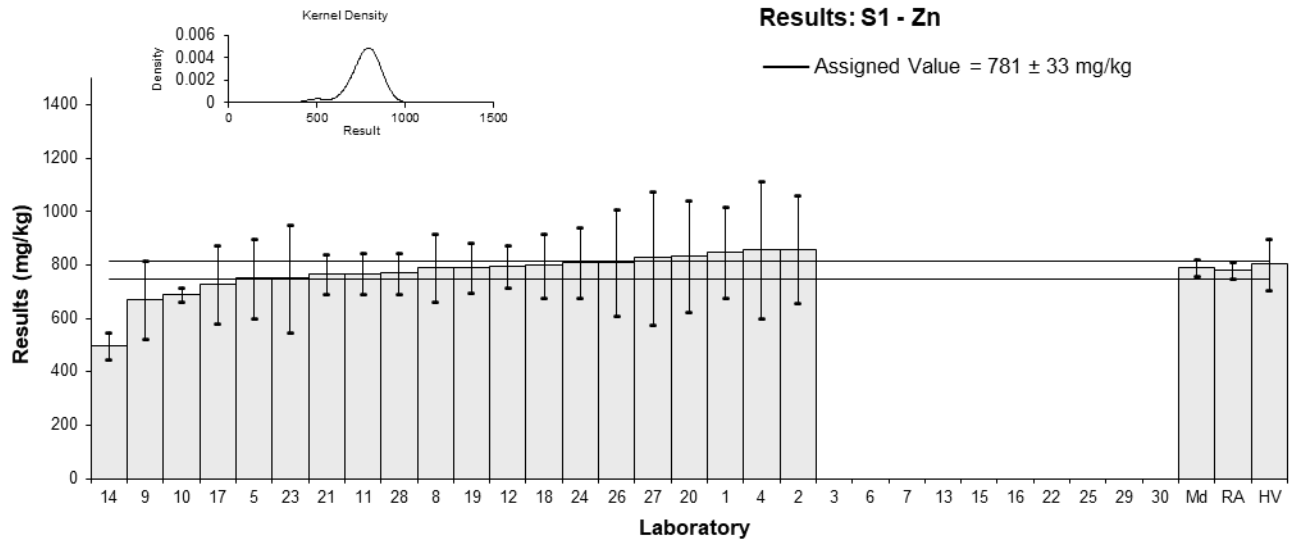


Figure 21

Table 32

Sample Details

Sample No.	S2
Matrix	Soil (sediment)
Analyte	Ag
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	<1	NR
3	NT	NT
4	NR	NR
5	0.13	0.026
6	NT	NT
7	NT	NT
8	0.31	0.09
9	NT	NT
10	0.3	0.1
11	<1	NR
12	NT	NT
13	NR	NR
14	0.62	0.05
15	NT	NT
16	NT	NT
17	0.42	0.084
18	<5	NR
19	0.13	0.04
20	<5	NR
21	NT	NT
22	NT	NT
23	<1	NR
24	0.452	0.065
25	NT	NT
26	<1	NR
27	0.38	0.114
28	0.273	0.03
29	NT	NT
30	NT	NT

Statistics

Assigned Value	Not Set	
Spike Value	Not Spiked	
Homogeneity Value	0.323	0.039
Robust Average	0.33	0.14
Median	0.31	0.14
Mean	0.34	
N	9	
Max	0.62	
Min	0.13	
Robust SD	0.17	
Robust CV	50%	

Results: S2 - Ag

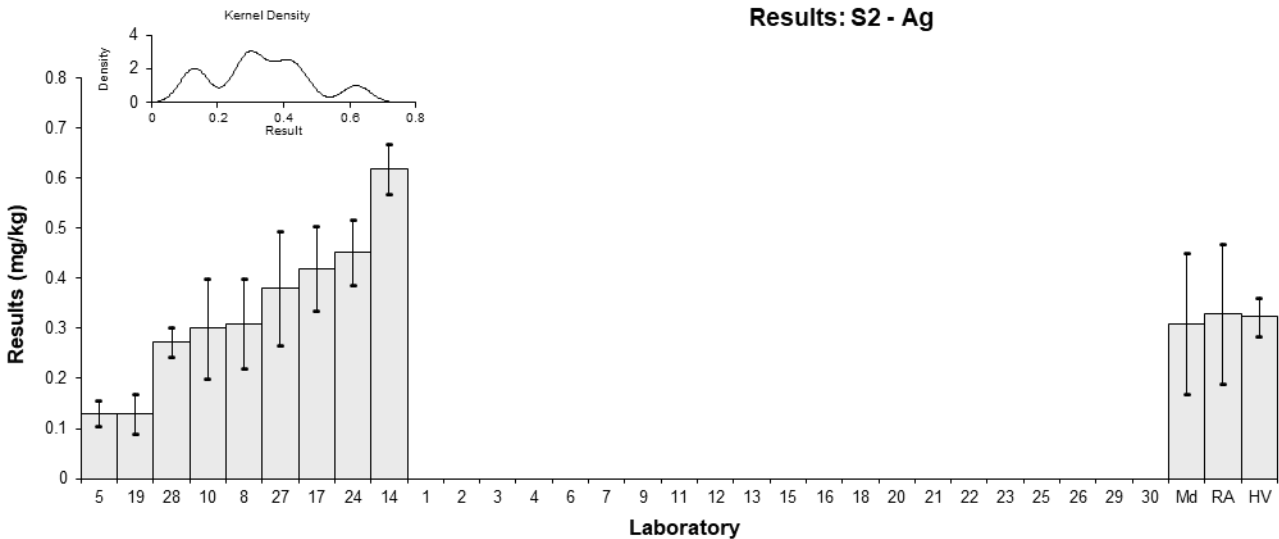


Figure 22

Table 33

Sample Details

Sample No.	S2
Matrix	Soil (sediment)
Analyte	Al
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	15900	3180	0.46	0.22
2	15000	5000	-0.13	-0.04
3	NT	NT		
4	NR	NR		
5	12000	2400	-2.11	-1.29
6	NT	NT		
7	NT	NT		
8	15500	3720	0.20	0.08
9	14900	6258	-0.20	-0.05
10	16000	3680	0.53	0.21
11	13900	1400	-0.86	-0.85
12	NT	NT		
13	14500	760	-0.46	-0.72
14*	43300	6000	18.49	4.66
15	NT	NT		
16	NT	NT		
17	14966	748.3	-0.15	-0.24
18	20000	3000	3.16	1.57
19	15000	1600	-0.13	-0.12
20	15500	3332.5	0.20	0.09
21	NT	NT		
22	NT	NT		
23	16000	5000	0.53	0.16
24	14900	1800	-0.20	-0.16
25	NT	NT		
26	16000	5000	0.53	0.16
27	13932.27	4179.681	-0.83	-0.30
28	15429	1543	0.15	0.14
29	NT	NT		
30	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	15200	600
Spike Value	Not Spiked	
Homogeneity Value	16200	1900
Robust Average	15300	600
Median	15200	600
Mean	16800	
N	18	
Max	43300	
Min	12000	
Robust SD	1000	
Robust CV	6.7%	

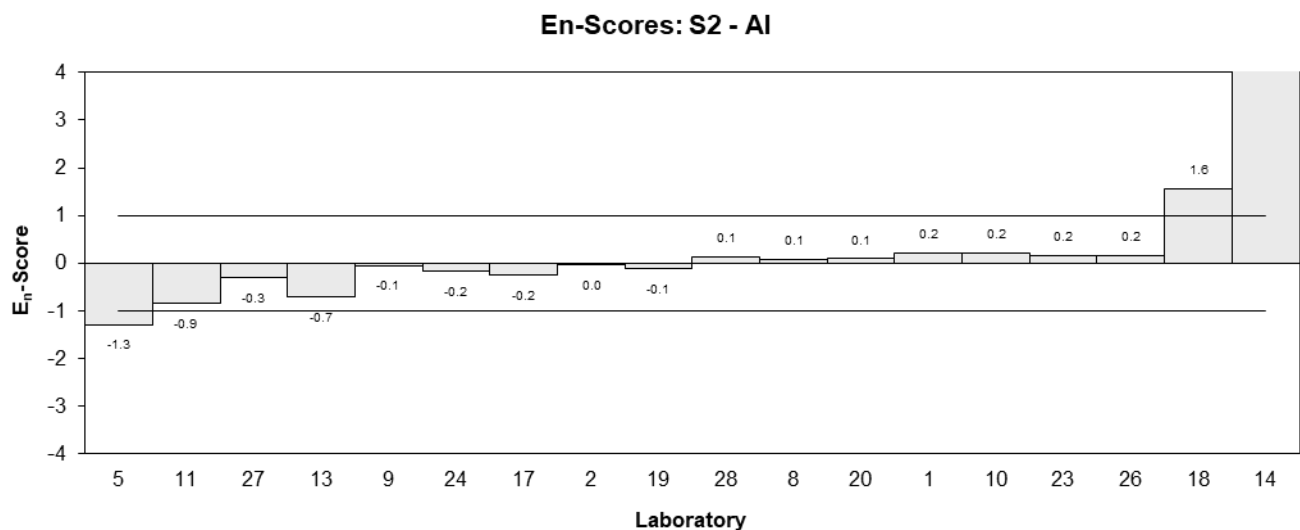
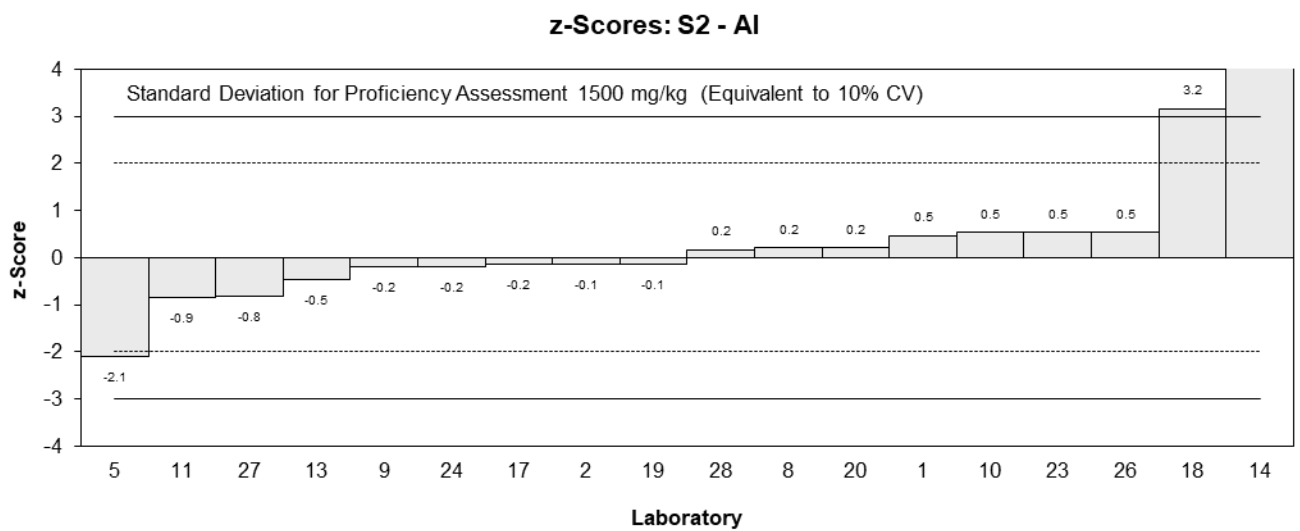
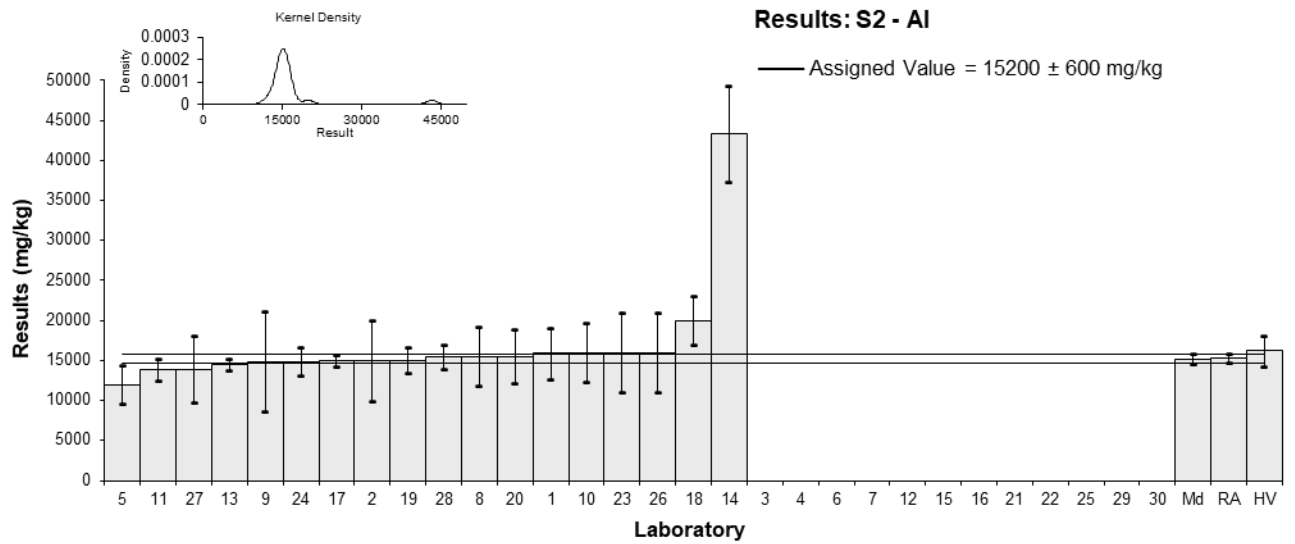


Figure 23

Table 34

Sample Details

Sample No.	S2
Matrix	Soil (sediment)
Analyte	As
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	34.1	6.8	0.04	0.03
2	36	10	0.41	0.20
3	NT	NT		
4	36.6	10.98	0.53	0.24
5	28	5.6	-1.16	-0.97
6	NT	NT		
7	NT	NT		
8	34.2	8.2	0.06	0.04
9	32	7.04	-0.37	-0.26
10	35	3.5	0.22	0.26
11	36.6	4.0	0.53	0.59
12	34.39	3	0.10	0.13
13	31	6	-0.57	-0.45
14	20.1	2.0	-2.71	-4.53
15	NT	NT		
16	NT	NT		
17	29.98	5.996	-0.77	-0.61
18	40	6.0	1.20	0.95
19	29.9	9.1	-0.79	-0.43
20	32.7	6.54	-0.24	-0.17
21	NT	NT		
22	NT	NT		
23	39	10	1.00	0.50
24	35.4	3.6	0.29	0.35
25	NT	NT		
26	41	10	1.40	0.69
27	31.88	9.564	-0.40	-0.21
28	32.7	3.27	-0.24	-0.30
29	NT	NT		
30	NT	NT		

Statistics

Assigned Value	33.9	2.3
Spike Value	Not Spiked	
Homogeneity Value	30.2	3.6
Robust Average	33.9	2.3
Median	34.2	2.0
Mean	33.5	
N	20	
Max	41	
Min	20.1	
Robust SD	4.1	
Robust CV	12%	

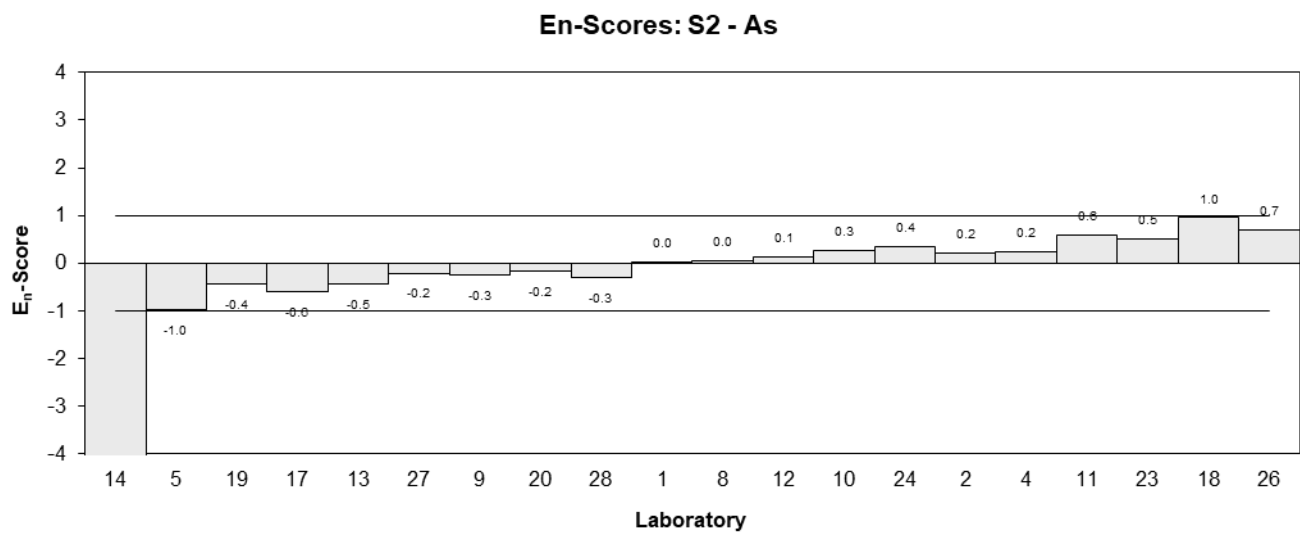
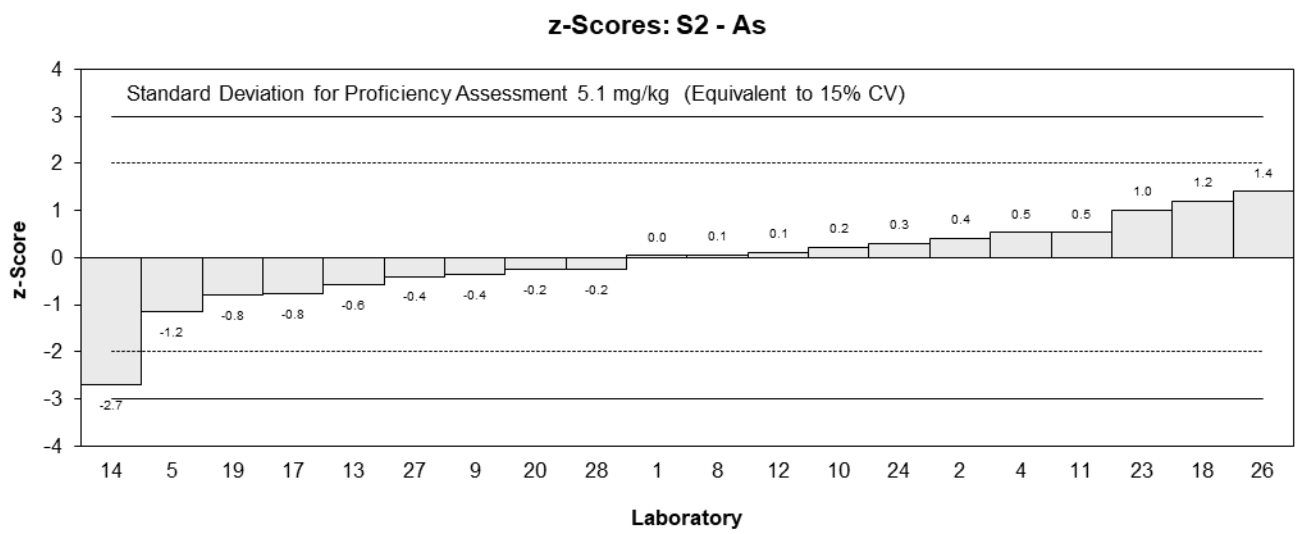
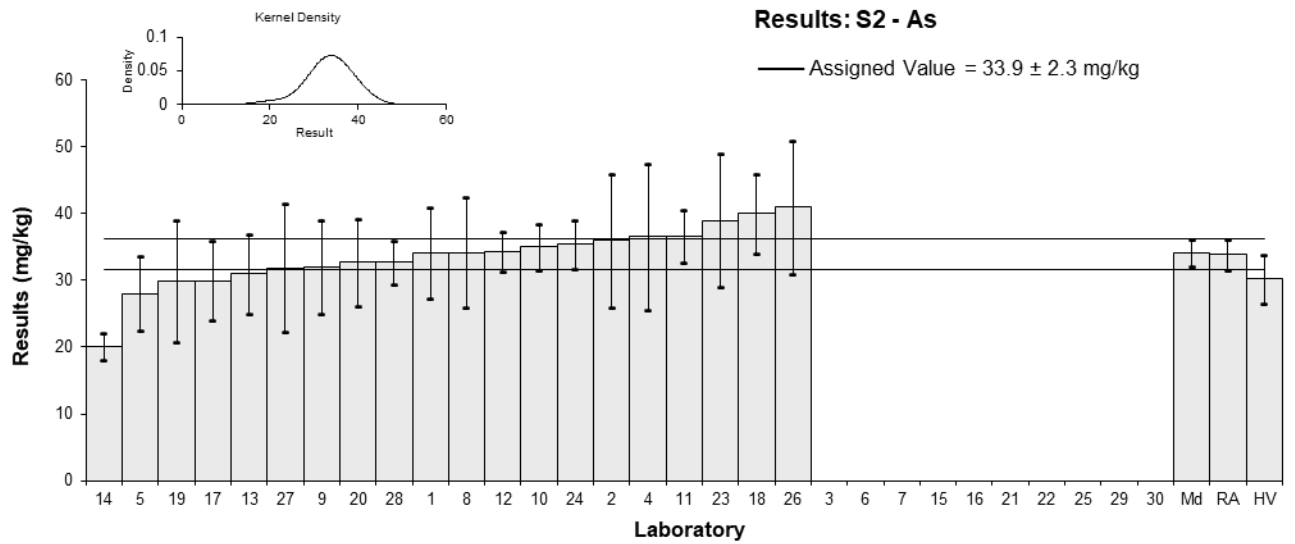


Figure 24

Table 35

Sample Details

Sample No.	S2
Matrix	Soil (sediment)
Analyte	B
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	2.94	0.59
2	<10	NR
3	NT	NT
4	1.3	0.39
5**	51	10.2
6	NT	NT
7	NT	NT
8	<20	NR
9	<1	NR
10	2.8	0.6
11	2.3	0.3
12	NT	NT
13	NR	NR
14**	24	5
15	NT	NT
16	NT	NT
17**	32.3	6.46
18	<5	NR
19	4.00	0.59
20	<10	NR
21	NT	NT
22	NT	NT
23	<10	NR
24	2.8	1.4
25	NT	NT
26	<10	NR
27	< 5	< 5
28	1.96	0.196
29	NT	NT
30	NT	NT

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	Not Set	
Spike Value	Not Spiked	
Homogeneity Value	1.53	0.18
Robust Average	2.59	0.91
Median	2.80	0.70
Mean	2.59	
N	7	
Max	4	
Min	1.3	
Robust SD	0.96	
Robust CV	37%	

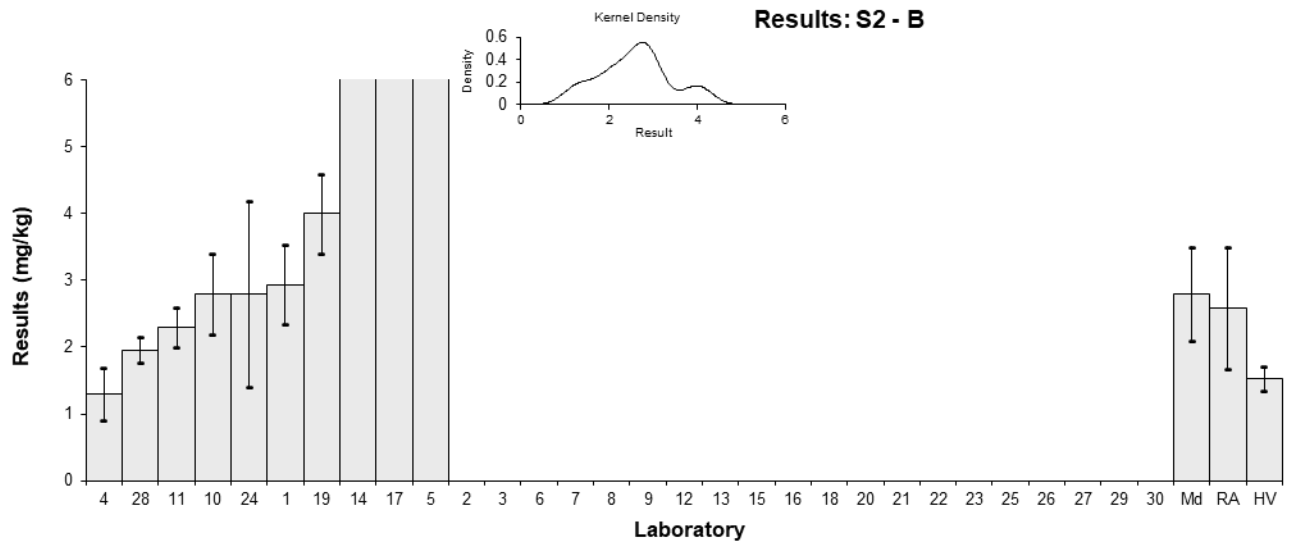


Figure 25

Table 36

Sample Details

Sample No.	S2
Matrix	Soil (sediment)
Analyte	Ba
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	61.0	12.2	1.26	0.94
2	46	10	-0.28	-0.24
3	NT	NT		
4	44.2	13.26	-0.46	-0.32
5	34	6.8	-1.51	-1.78
6	NT	NT		
7	NT	NT		
8	74.4	23.1	2.64	1.09
9	47	4.7	-0.17	-0.26
10*	100	14	5.27	3.47
11	46.9	4.7	-0.18	-0.27
12	NT	NT		
13	40	4	-0.89	-1.41
14*	184	30	13.89	4.46
15	NT	NT		
16	NT	NT		
17	51.4	10.28	0.28	0.24
18	60	9.0	1.16	1.11
19	53.0	5.6	0.44	0.59
20	47.4	8.06	-0.13	-0.14
21	NT	NT		
22	NT	NT		
23	41	10	-0.79	-0.70
24	44.6	7.2	-0.42	-0.48
25	NT	NT		
26	48	10	-0.07	-0.06
27	48.97	14.691	0.03	0.02
28	51.3	5.13	0.27	0.37
29	NT	NT		
30	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	48.7	4.7
Spike Value	Not Spiked	
Homogeneity Value	56.8	6.8
Robust Average	50.8	6.1
Median	48.0	3.2
Mean	59.1	
N	19	
Max	184	
Min	34	
Robust SD	11	
Robust CV	21%	

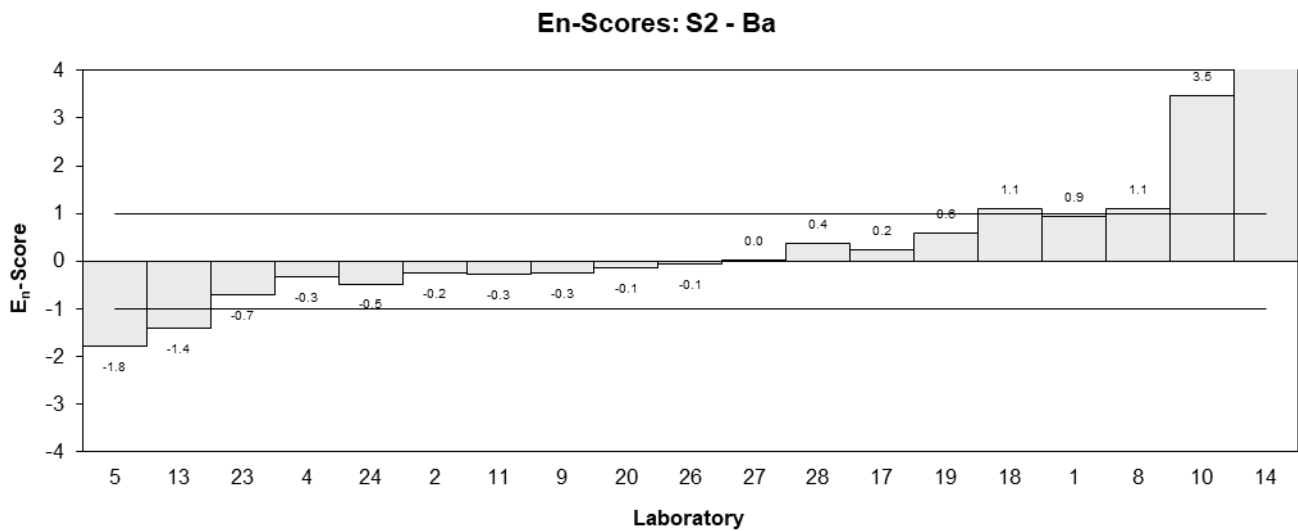
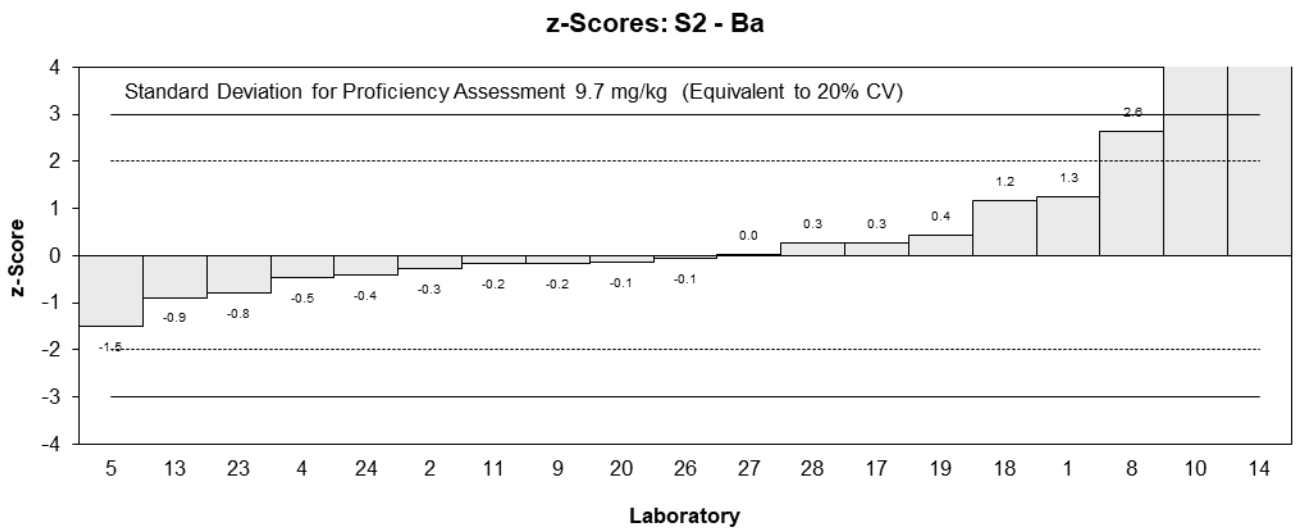
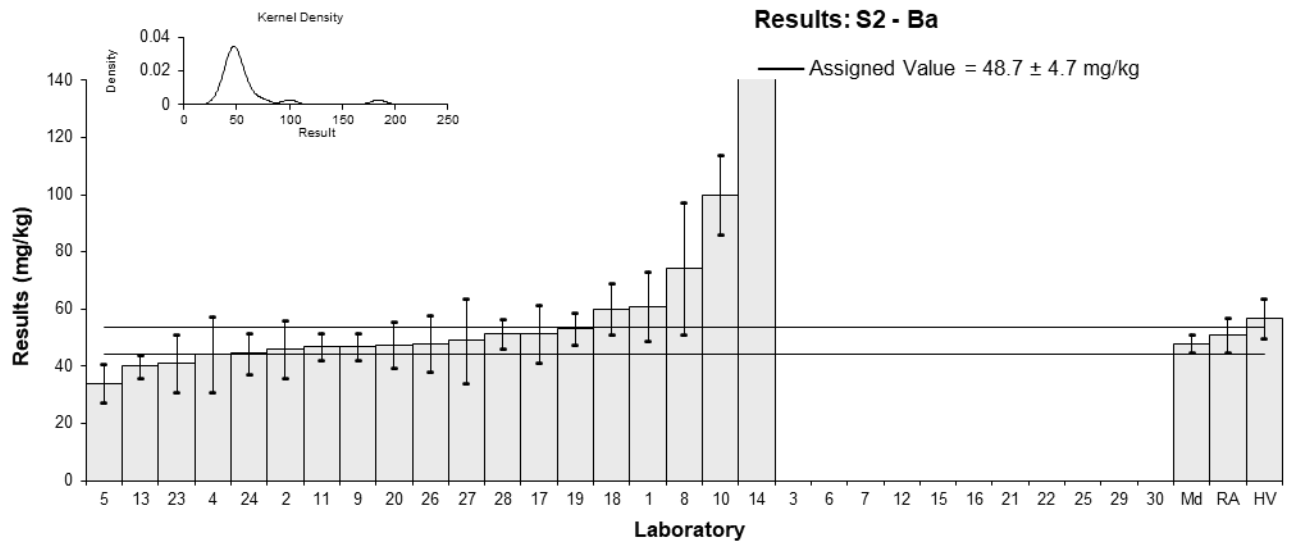


Figure 26

Table 37

Sample Details

Sample No.	S2
Matrix	Soil (sediment)
Analyte	Be
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	0.585	0.117	0.56	0.35
2	<1	NR		
3	NT	NT		
4	0.545	0.1635	0.06	0.03
5	0.76	0.152	2.72	1.36
6	NT	NT		
7	NT	NT		
8	0.5	0.2	-0.49	-0.19
9	<1	NR		
10	0.61	0.1	0.86	0.62
11	0.55	0.1	0.12	0.09
12	NT	NT		
13	NR	NR		
14*	0.89	0.18	4.32	1.86
15	NT	NT		
16	NT	NT		
17	0.29	0.058	-3.09	-3.15
18	<5	NR		
19	0.52	0.14	-0.25	-0.13
20	<5	NR		
21	NT	NT		
22	NT	NT		
23	<1	NR		
24	0.510	0.093	-0.37	-0.28
25	NT	NT		
26	<1	NR		
27	0.5	0.15	-0.49	-0.25
28*	0.249	0.025	-3.59	-4.89
29	NT	NT		
30	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	0.540	0.054
Spike Value	Not Spiked	
Homogeneity Value	0.529	0.063
Robust Average	0.54	0.13
Median	0.533	0.045
Mean	0.542	
N	12	
Max	0.89	
Min	0.249	
Robust SD	0.17	
Robust CV	32%	

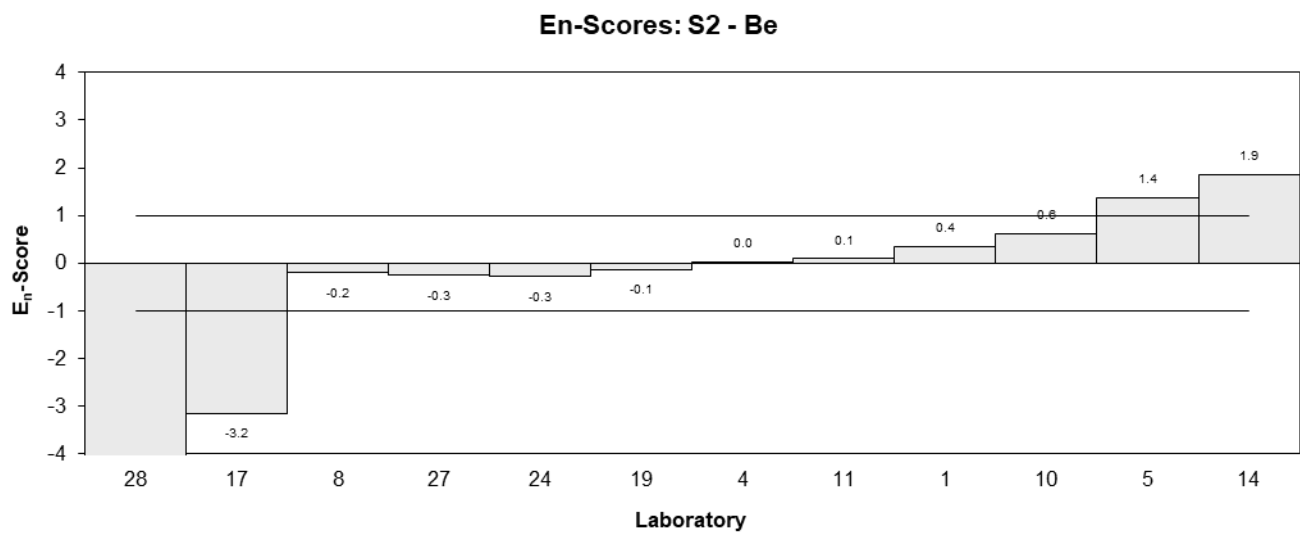
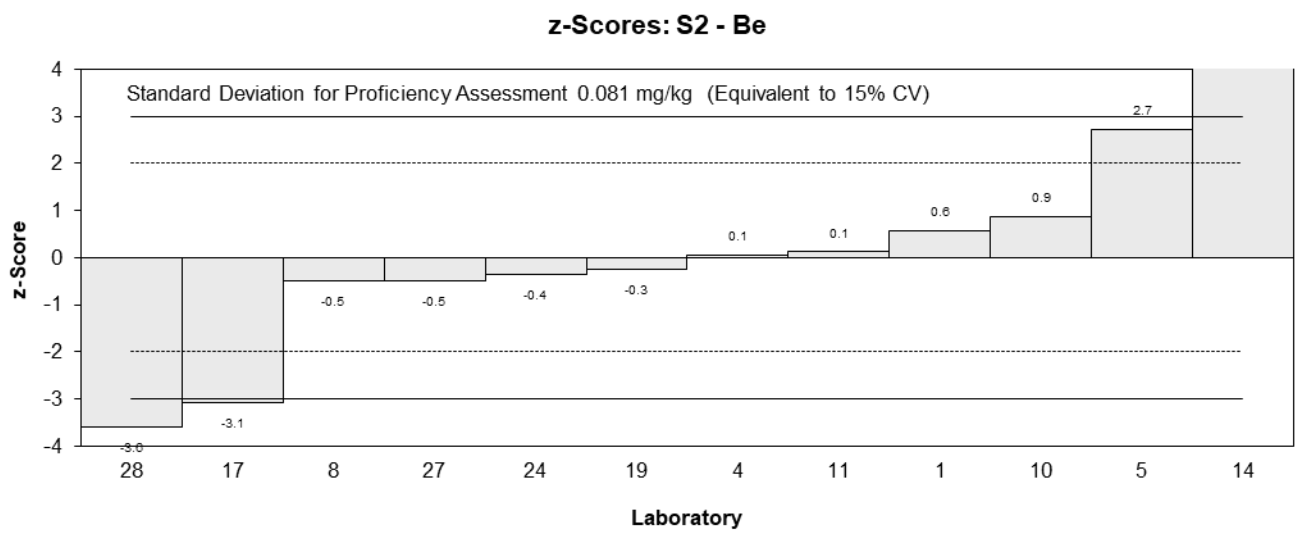
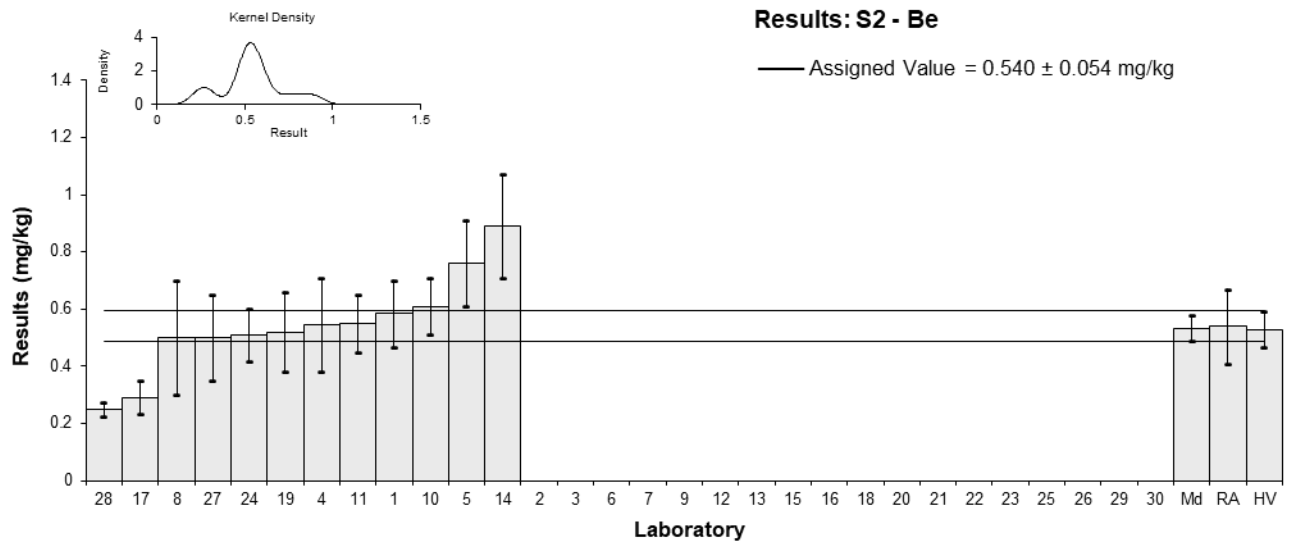


Figure 27

Table 38

Sample Details

Sample No.	S2
Matrix	Soil (sediment)
Analyte	Co
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	17.9	3.6	0.23	0.11
2	17	6	-0.29	-0.08
3	NT	NT		
4	20.15	6.045	1.51	0.43
5	15	3	-1.43	-0.78
6	NT	NT		
7	NT	NT		
8	16.4	2.3	-0.63	-0.43
9	18	1.8	0.29	0.24
10	18	2	0.29	0.22
11	19	2.0	0.86	0.66
12	NT	NT		
13	15	2	-1.43	-1.10
14	14.9	1.9	-1.49	-1.18
15	NT	NT		
16	NT	NT		
17	17.5	3.5	0.00	0.00
18	20	3.0	1.43	0.78
19	17.3	2.6	-0.11	-0.07
20	19.5	3.2	1.14	0.59
21	NT	NT		
22	NT	NT		
23	17	5	-0.29	-0.10
24	17.5	1.5	0.00	0.00
25	NT	NT		
26	20	6	1.43	0.41
27	17.99	5.397	0.28	0.09
28	14.8	1.48	-1.54	-1.46
29	NT	NT		
30	NT	NT		

Statistics

Assigned Value	17.5	1.1
Spike Value	Not Spiked	
Homogeneity Value	18.5	2.2
Robust Average	17.5	1.1
Median	17.5	0.9
Mean	17.5	
N	19	
Max	20.15	
Min	14.8	
Robust SD	2.0	
Robust CV	11%	

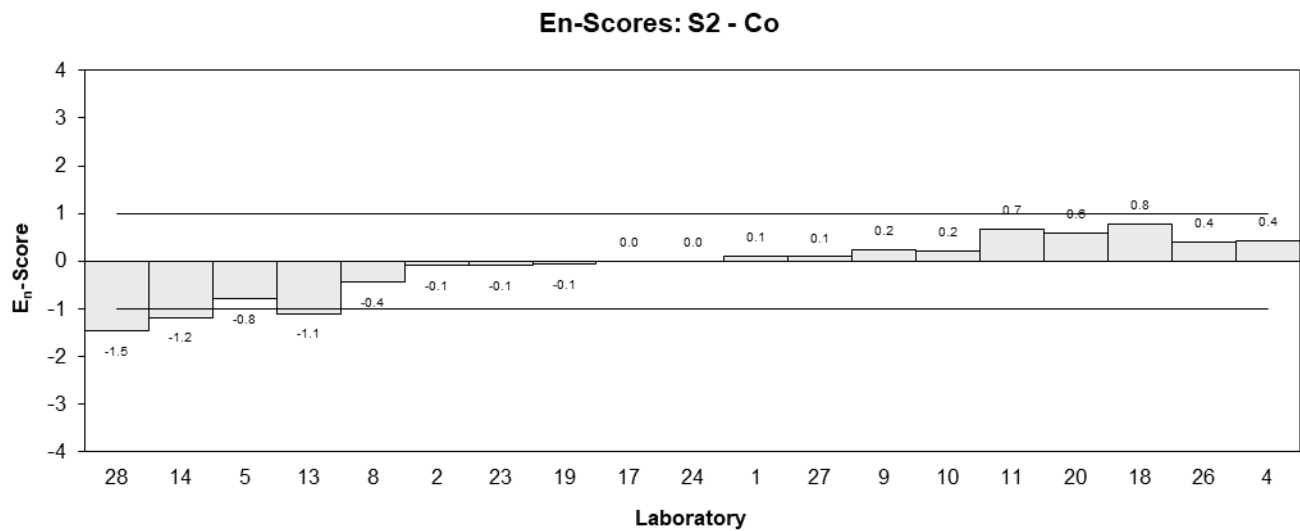
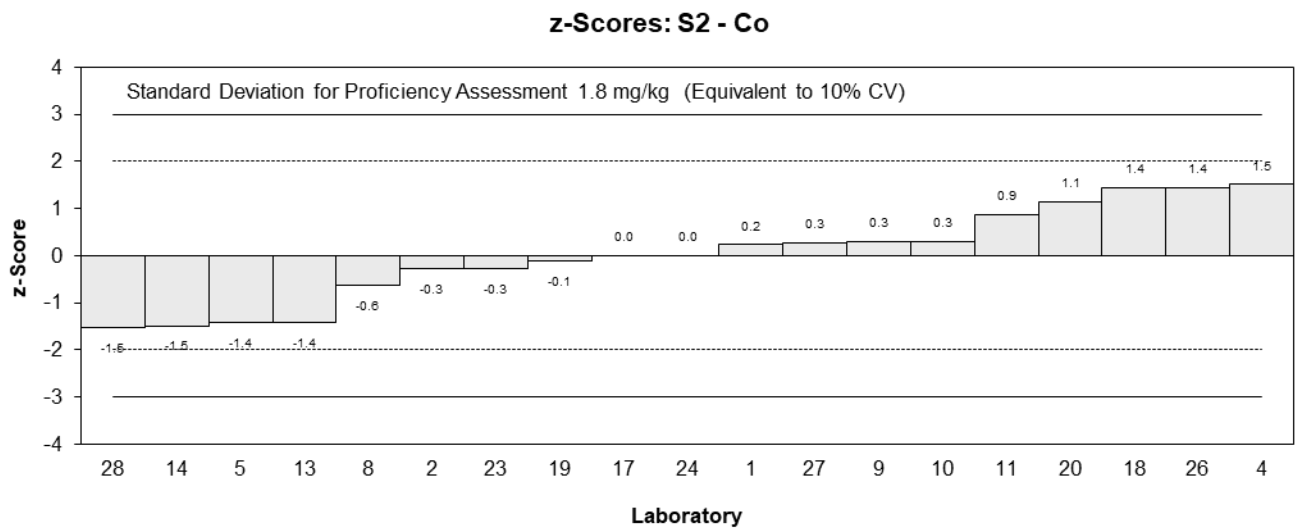
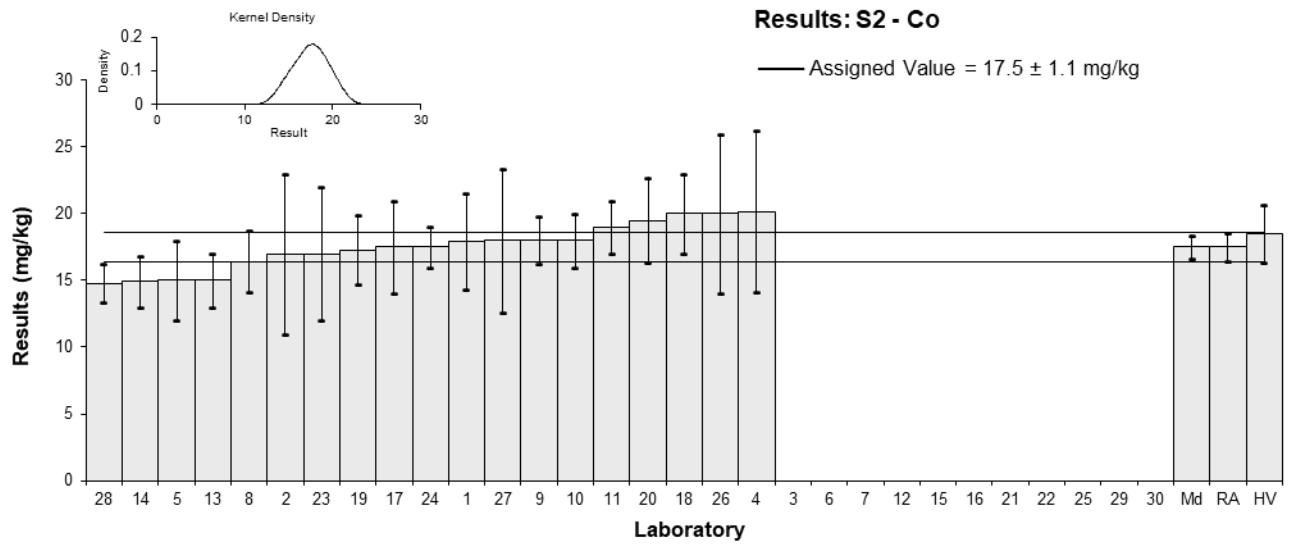


Figure 28

Table 39

Sample Details

Sample No.	S2
Matrix	Soil (sediment)
Analyte	Cr
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	41.4	8.3	0.58	0.38
2	44	10	1.03	0.57
3	NT	NT		
4	38.75	11.625	0.11	0.05
5	30	6	-1.42	-1.22
6	NT	NT		
7	NT	NT		
8	31.7	6.7	-1.12	-0.88
9	37	9.62	-0.19	-0.11
10	43	5.2	0.86	0.83
11	37.6	4.0	-0.09	-0.10
12	40.18	4	0.36	0.43
13	33	5	-0.89	-0.89
14	53.7	9.1	2.73	1.64
15	NT	NT		
16	NT	NT		
17	41.8	8.36	0.65	0.42
18	20	3.0	-3.17	-4.41
19	36.0	4.9	-0.37	-0.37
20	41.2	7.3	0.54	0.40
21	NT	NT		
22	NT	NT		
23	38	8	-0.02	-0.01
24	36.2	4.4	-0.33	-0.36
25	NT	NT		
26	42	10	0.68	0.38
27	35.16	10.548	-0.51	-0.27
28	37.7	3.37	-0.07	-0.09
29	NT	NT		
30	NT	NT		

Statistics

Assigned Value	38.1	2.8
Spike Value	Not Spiked	
Homogeneity Value	41.8	5.0
Robust Average	38.1	2.8
Median	37.9	2.9
Mean	37.9	
N	20	
Max	53.7	
Min	20	
Robust SD	5.0	
Robust CV	13%	

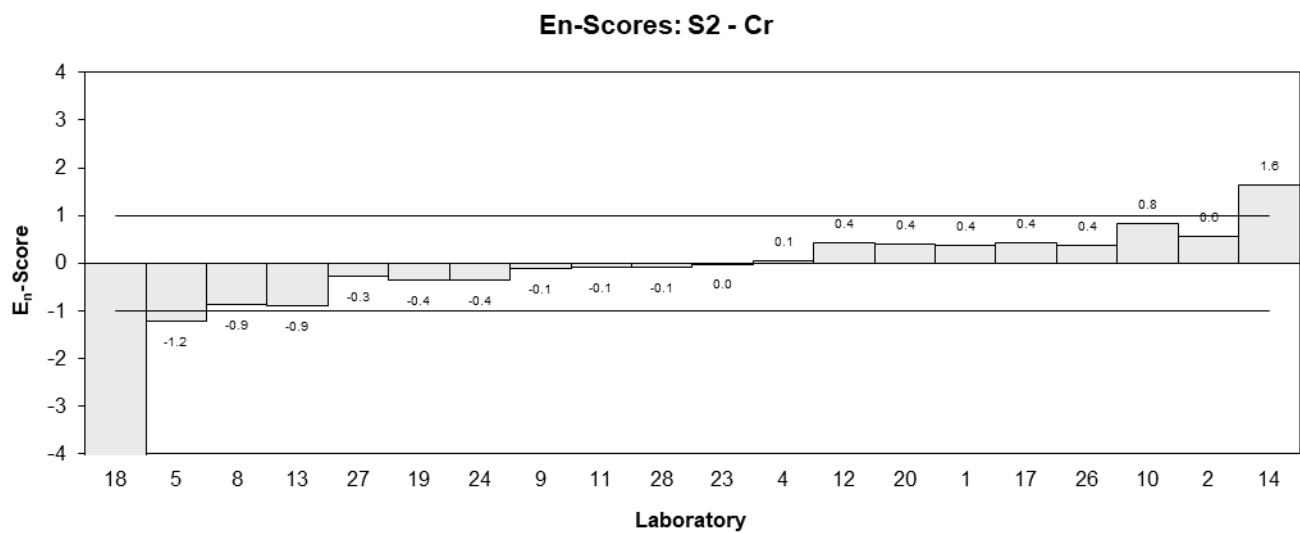
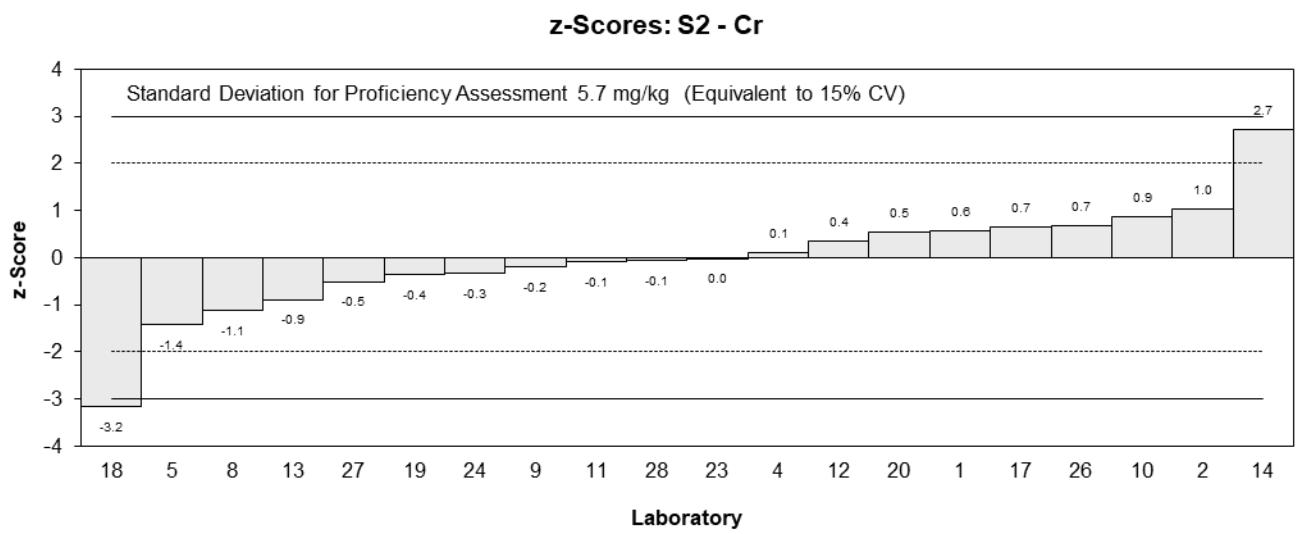
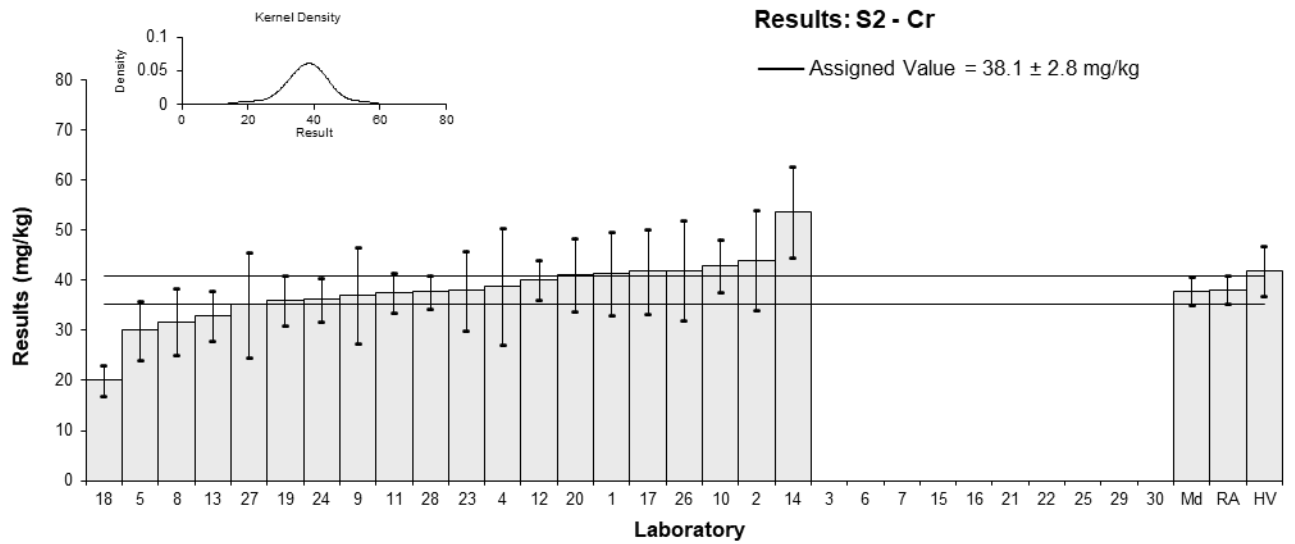


Figure 29

Table 40

Sample Details

Sample No.	S2
Matrix	Soil (sediment)
Analyte	Cu
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	35.8	7.2	1.01	0.62
2	35	7	0.84	0.53
3	NT	NT		
4	34.6	10.38	0.75	0.33
5	26	5.2	-1.09	-0.90
6	NT	NT		
7	NT	NT		
8	27.3	3.8	-0.81	-0.87
9	33	5.28	0.41	0.33
10	36	5.8	1.05	0.79
11	32	3.2	0.19	0.23
12	NT	NT		
13	NR	NR		
14	25.6	3.6	-1.18	-1.30
15	NT	NT		
16	NT	NT		
17	29.4	5.88	-0.36	-0.27
18	30	4.5	-0.24	-0.22
19	34.2	3.6	0.66	0.73
20	29.2	3.1	-0.41	-0.50
21	NT	NT		
22	NT	NT		
23	31	6	-0.02	-0.02
24	29.8	4.2	-0.28	-0.27
25	NT	NT		
26	31	10	-0.02	-0.01
27	32.41	9.723	0.28	0.13
28	27.4	2.74	-0.79	-1.05
29	NT	NT		
30	NT	NT		

Statistics

Assigned Value	31.1	2.2
Spike Value	Not Spiked	
Homogeneity Value	29.8	3.6
Robust Average	31.1	2.2
Median	31.0	2.3
Mean	31.1	
N	18	
Max	36	
Min	25.6	
Robust SD	3.7	
Robust CV	12%	

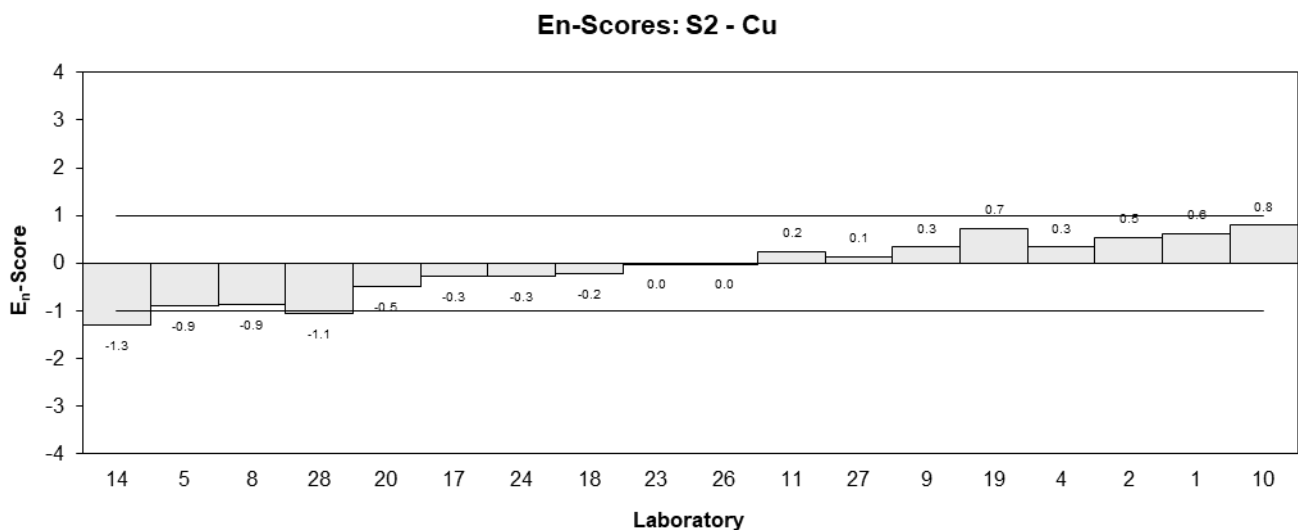
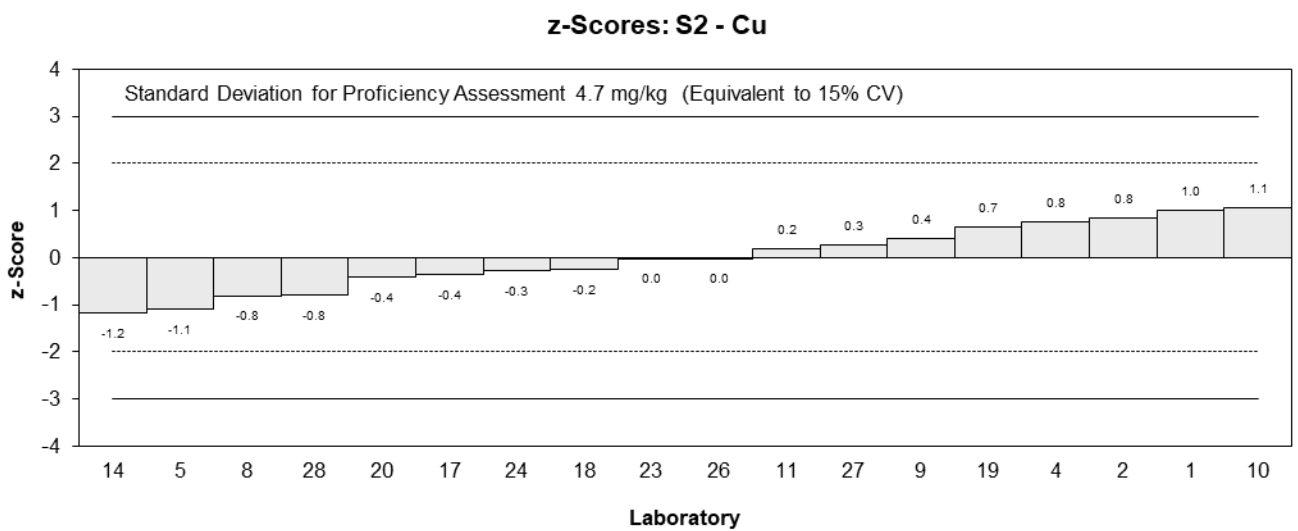
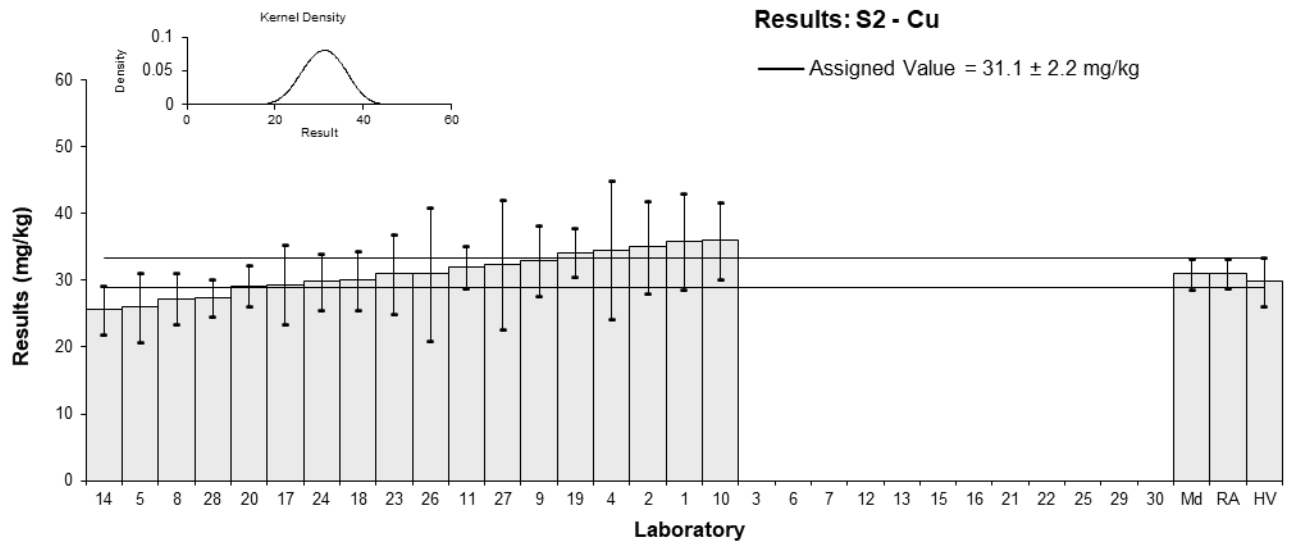


Figure 30

Table 41

Sample Details

Sample No.	S2
Matrix	Soil (sediment)
Analyte	Ga
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	5.02	1.00
2	6	2
3	NT	NT
4	NT	NT
5	NT	NT
6	NT	NT
7	NT	NT
8	NT	NT
9	NT	NT
10	NT	NT
11	NT	NT
12	NT	NT
13	NR	NR
14	NT	NT
15	NT	NT
16	NT	NT
17**	28	5.6
18	NT	NT
19	NR	NR
20	NR	NR
21	NT	NT
22	NT	NT
23	4	1
24	NT	NT
25	NT	NT
26	5	3
27	NT	NT
28	NT	NT
29	NT	NT
30	NT	NT

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	Not Set	
Spike Value	Not Spiked	
Homogeneity Value	5.15	0.62
Robust Average	NA (N<6)	
Median	5.01	0.93
Mean	5.01	
N	4	
Max	6	
Min	4	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

Results: S2 - Ga

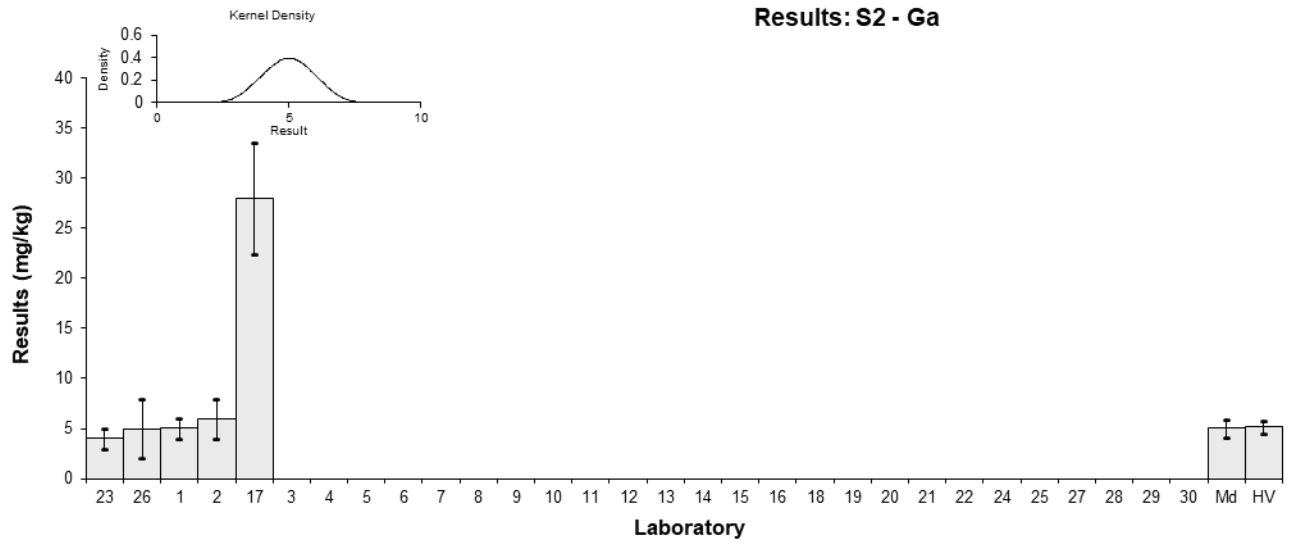


Figure 31

Table 42

Sample Details

Sample No.	S2
Matrix	Soil (sediment)
Analyte	Mo
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	0.822	0.164	0.27	0.20
2	1	1	1.41	0.22
3	NT	NT		
4	0.845	0.2535	0.42	0.23
5	0.47	0.094	-1.99	-1.93
6	NT	NT		
7	NT	NT		
8	0.9	0.2	0.77	0.50
9	<20	NR		
10	<5	NR		
11	0.87	0.1	0.58	0.55
12	0.620	0.06	-1.03	-1.12
13	NR	NR		
14	<1	0.3		
15	NT	NT		
16	NT	NT		
17	0.6	0.12	-1.15	-1.02
18	<5	NR		
19	0.70	0.24	-0.51	-0.29
20	<5	NR		
21	NT	NT		
22	NT	NT		
23	<1	NR		
24	0.74	0.11	-0.26	-0.23
25	NT	NT		
26	1	1	1.41	0.22
27*	1.26	0.378	3.08	1.20
28	0.759	0.076	-0.13	-0.14
29	NT	NT		
30	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	0.78	0.13
Spike Value	Not Spiked	
Homogeneity Value	0.814	0.098
Robust Average	0.81	0.14
Median	0.82	0.13
Mean	0.81	
N	13	
Max	1.26	
Min	0.47	
Robust SD	0.20	
Robust CV	24%	

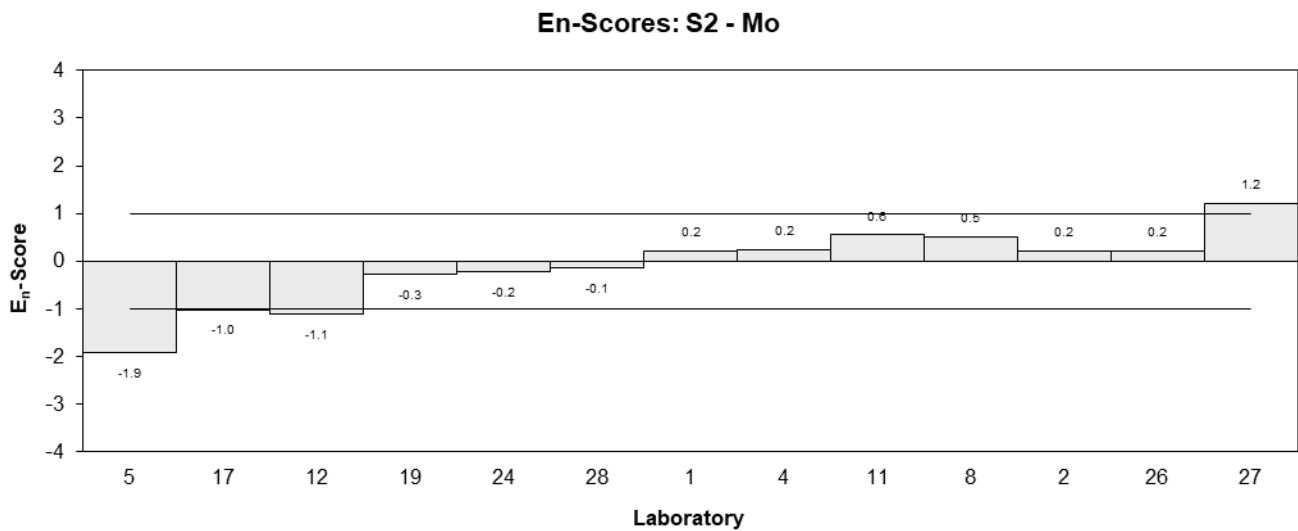
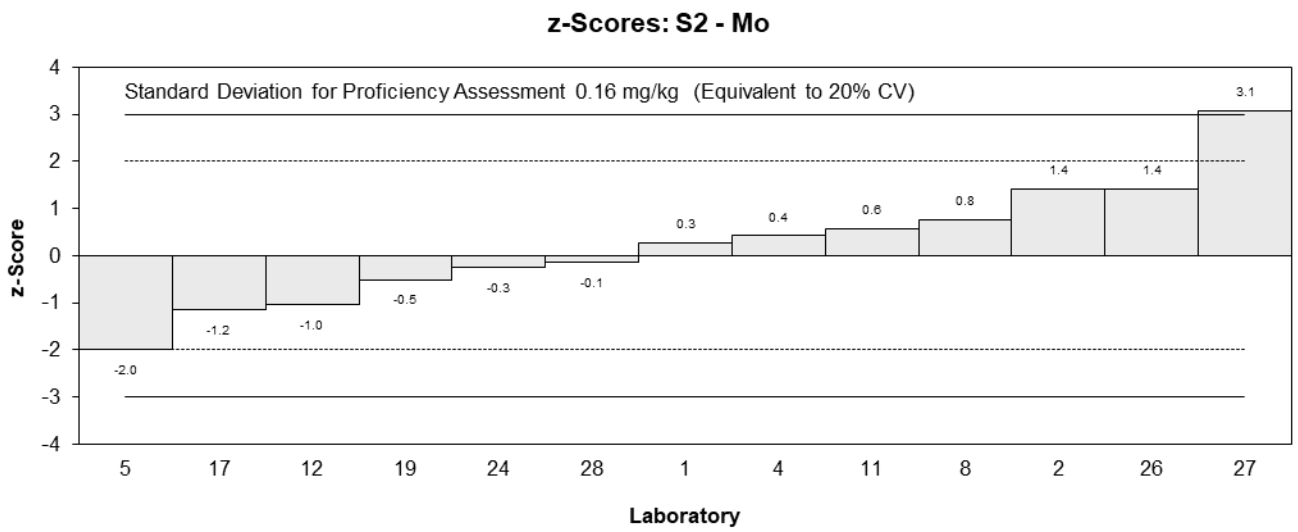
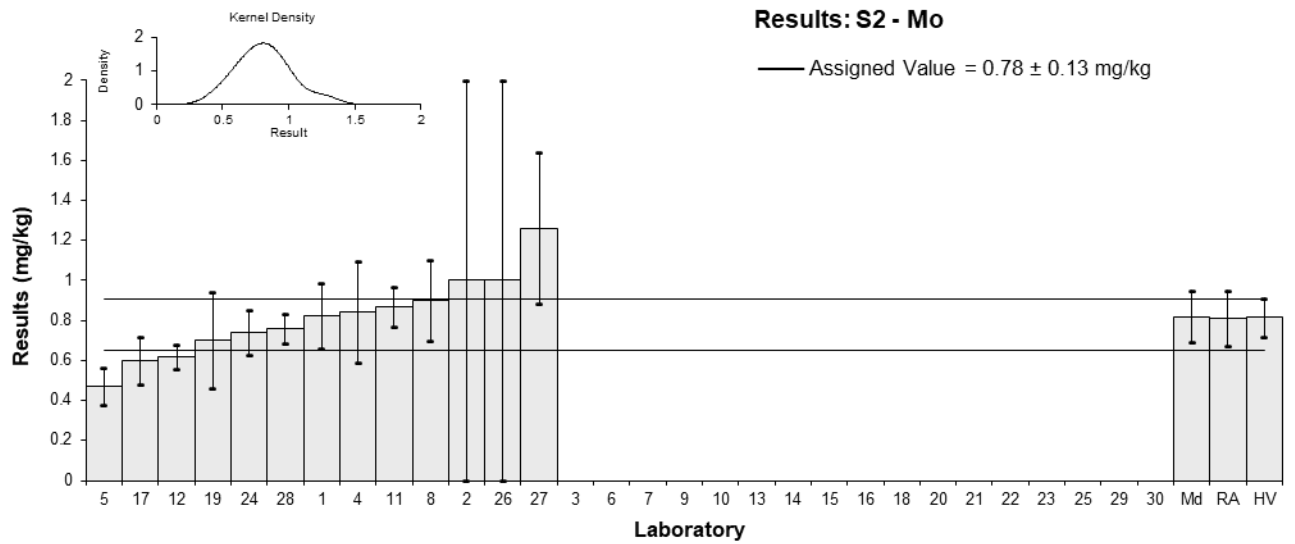


Figure 32

Table 43

Sample Details

Sample No.	S2
Matrix	Soil (sediment)
Analyte	Na
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	NR	NR		
2	120	30	1.33	0.60
3	NT	NT		
4	<130	NR		
5*	290	58	12.67	3.18
6	NT	NT		
7	NT	NT		
8	NR	NR		
9	NT	NT		
10*	750	75	43.33	8.52
11	79	8.0	-1.40	-1.30
12	NT	NT		
13	NR	NR		
14**	27200	800	1,806.67	33.87
15	NT	NT		
16	NT	NT		
17	120	24	1.33	0.72
18	100	15	0.00	0.00
19	70.0	8.6	-2.00	-1.83
20	109	22	0.60	0.35
21	NT	NT		
22	NT	NT		
23	110	30	0.67	0.30
24	101	31	0.07	0.03
25	NT	NT		
26	110	30	0.67	0.30
27	90.7	27.21	-0.62	-0.30
28	85.3	8.53	-0.98	-0.90
29	NT	NT		
30	NT	NT		

* Outlier, ** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	100	14
Spike Value	Not Spiked	
Robust Average	107	18
Median	109	11
Mean	164	
N	13	
Max	750	
Min	70	
Robust SD	26	
Robust CV	24%	

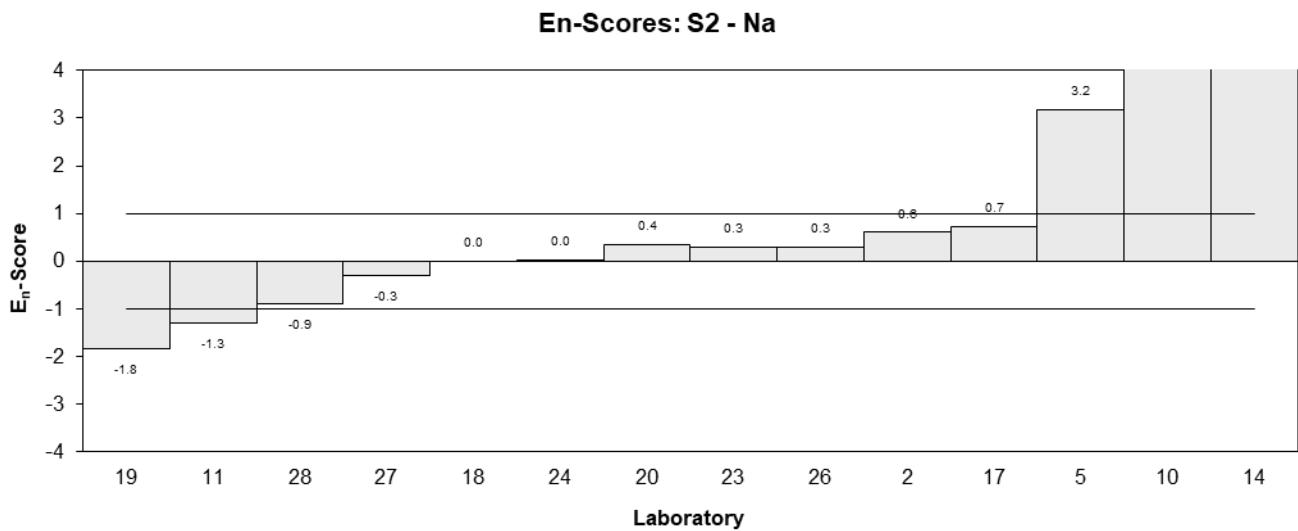
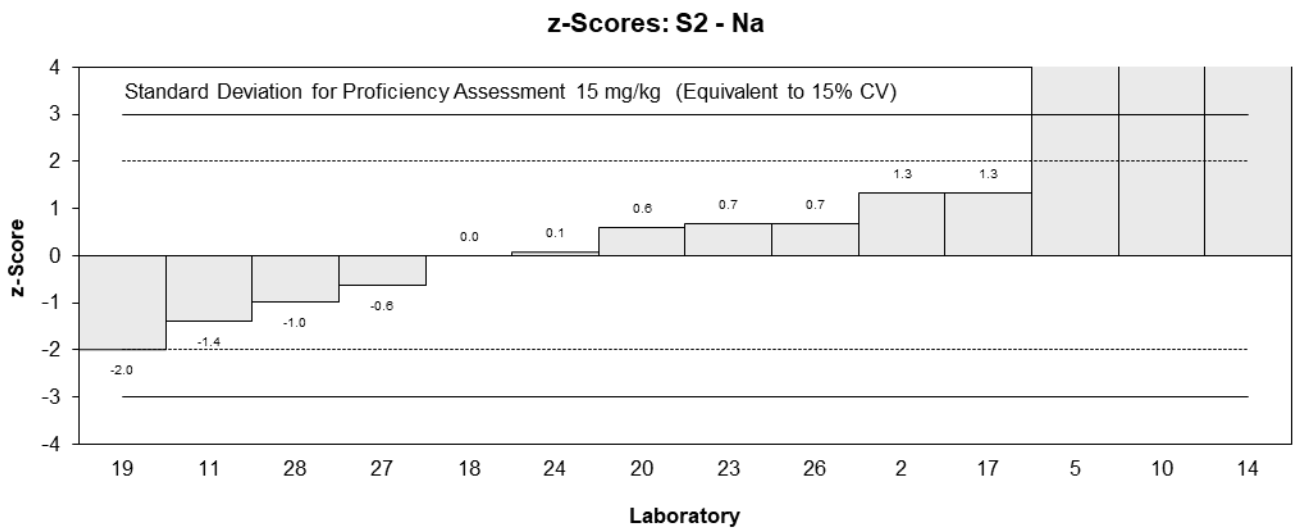
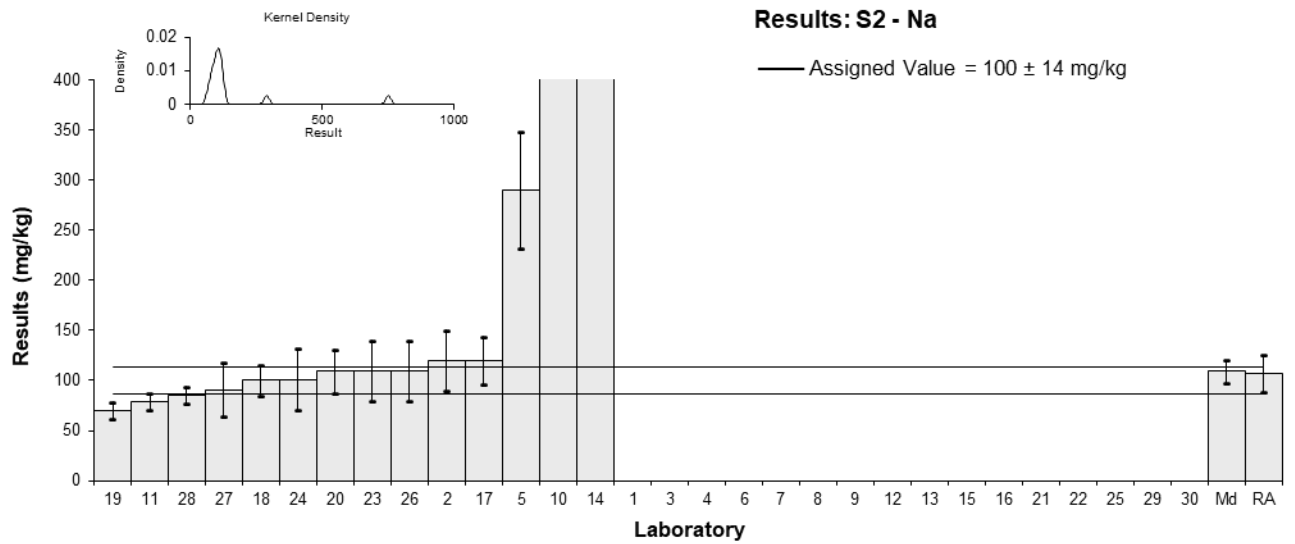


Figure 33

Table 44

Sample Details

Sample No.	S2
Matrix	Soil (sediment)
Analyte	Ni
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	84.2	16.8	0.28	0.13
2	82	20	0.01	0.00
3	NT	NT		
4	90.6	27.18	1.06	0.32
5	NT	NT		
6	NT	NT		
7	NT	NT		
8	74.4	7.4	-0.92	-0.92
9	83	20.75	0.13	0.05
10	82	4.9	0.01	0.02
11	82.1	8.2	0.02	0.02
12	NT	NT		
13	NR	NR		
14	62.7	9	-2.34	-2.00
15	NT	NT		
16	NT	NT		
17	79.5	15.9	-0.29	-0.15
18	90	13.5	0.99	0.58
19	84.0	9.1	0.26	0.22
20	86.2	13.8	0.53	0.30
21	NT	NT		
22	NT	NT		
23	81	20	-0.11	-0.04
24	79.4	8.0	-0.31	-0.29
25	NT	NT		
26	81	20	-0.11	-0.04
27	85.98	25.794	0.50	0.16
28	71.0	7.1	-1.33	-1.38
29	NT	NT		
30	NT	NT		

Statistics

Assigned Value	81.9	3.4
Spike Value	Not Spiked	
Homogeneity Value	80.1	9.6
Robust Average	81.9	3.4
Median	82.0	2.2
Mean	81.1	
N	17	
Max	90.6	
Min	62.7	
Robust SD	5.6	
Robust CV	6.9%	

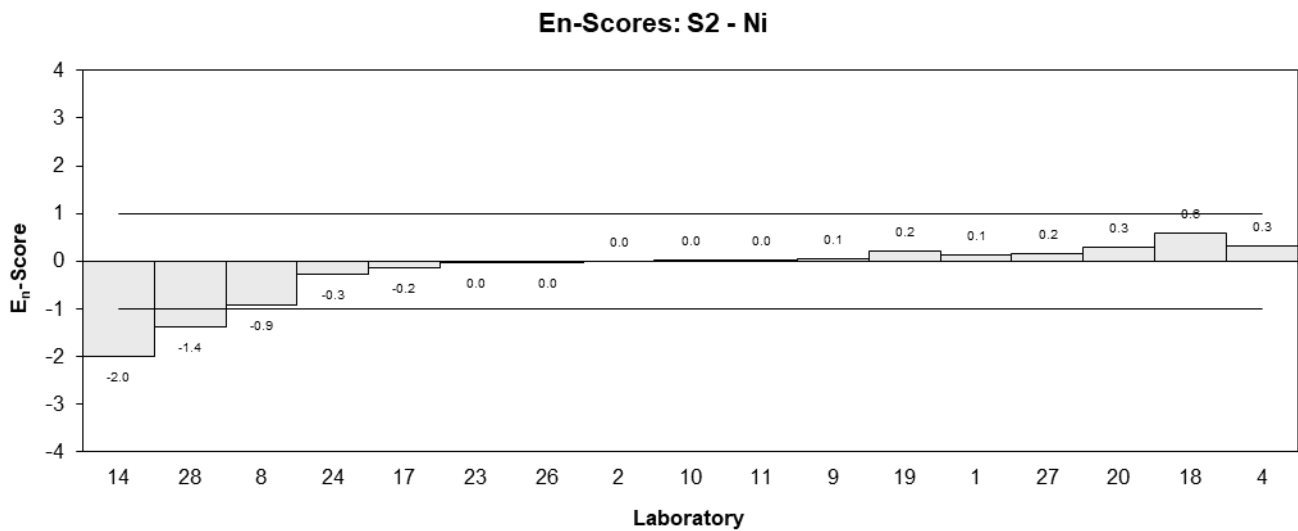
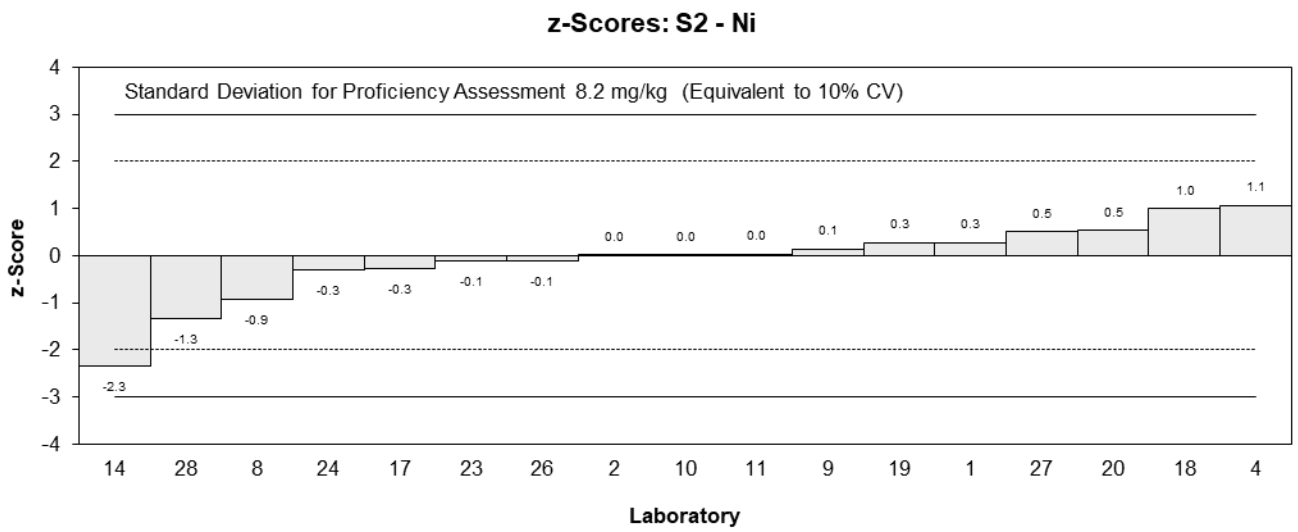
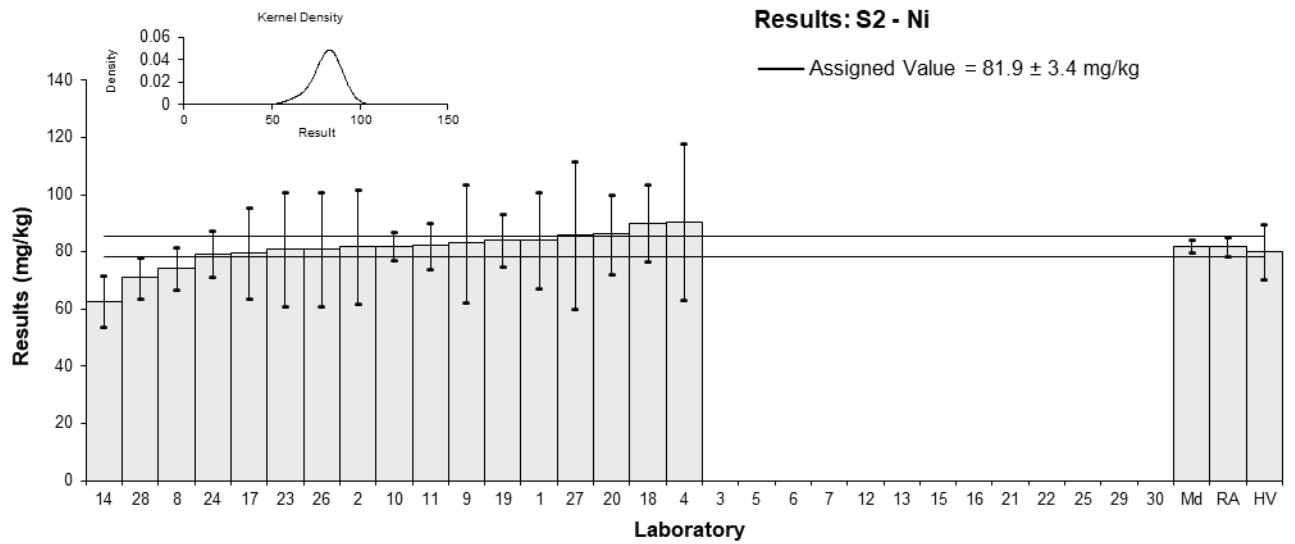


Figure 34

Table 45

Sample Details

Sample No.	S2
Matrix	Soil (sediment)
Analyte	Pb
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	47.0	9.4	0.59	0.39
2	46	20	0.43	0.14
3	NT	NT		
4	43.75	13.125	0.08	0.04
5	33	6.6	-1.57	-1.43
6	NT	NT		
7	NT	NT		
8	43.4	7.4	0.03	0.03
9	58	9.28	2.28	1.53
10	53	5.3	1.51	1.65
11	38.8	4.0	-0.68	-0.91
12	38.50	4	-0.73	-0.97
13	NR	NR		
14	42.4	6	-0.12	-0.12
15	NT	NT		
16	NT	NT		
17	39.85	7.97	-0.52	-0.40
18	40	6.0	-0.49	-0.49
19	53.0	14.6	1.51	0.66
20	44.9	6.73	0.26	0.23
21	NT	NT		
22	NT	NT		
23	39	10	-0.65	-0.41
24	43.0	5.2	-0.03	-0.03
25	NT	NT		
26	42	20	-0.19	-0.06
27	43.9	13.17	0.11	0.05
28	40.5	4.05	-0.42	-0.55
29	NT	NT		
30	NT	NT		

Statistics

Assigned Value	43.2	2.7
Spike Value	Not Spiked	
Homogeneity Value	41.2	4.9
Robust Average	43.2	2.7
Median	43.0	2.6
Mean	43.7	
N	19	
Max	58	
Min	33	
Robust SD	4.8	
Robust CV	11%	

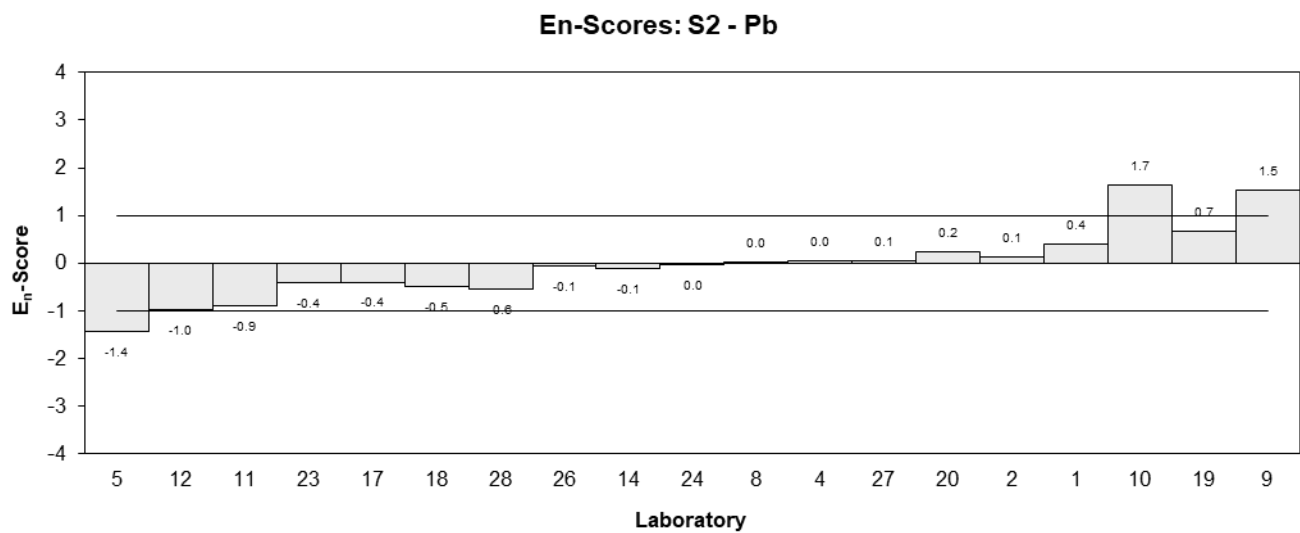
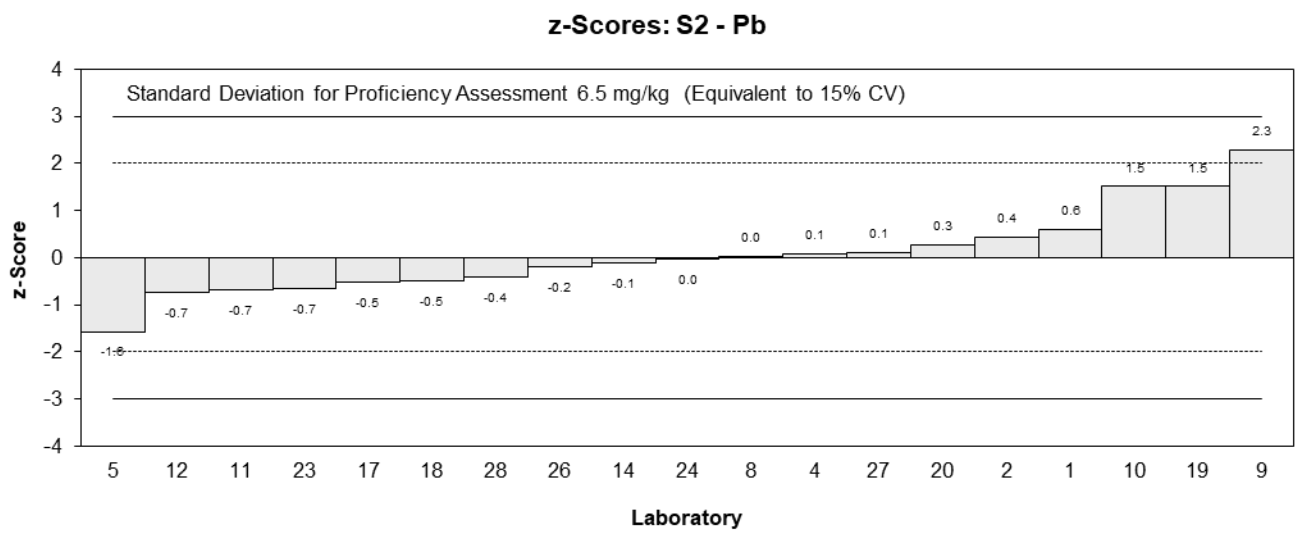
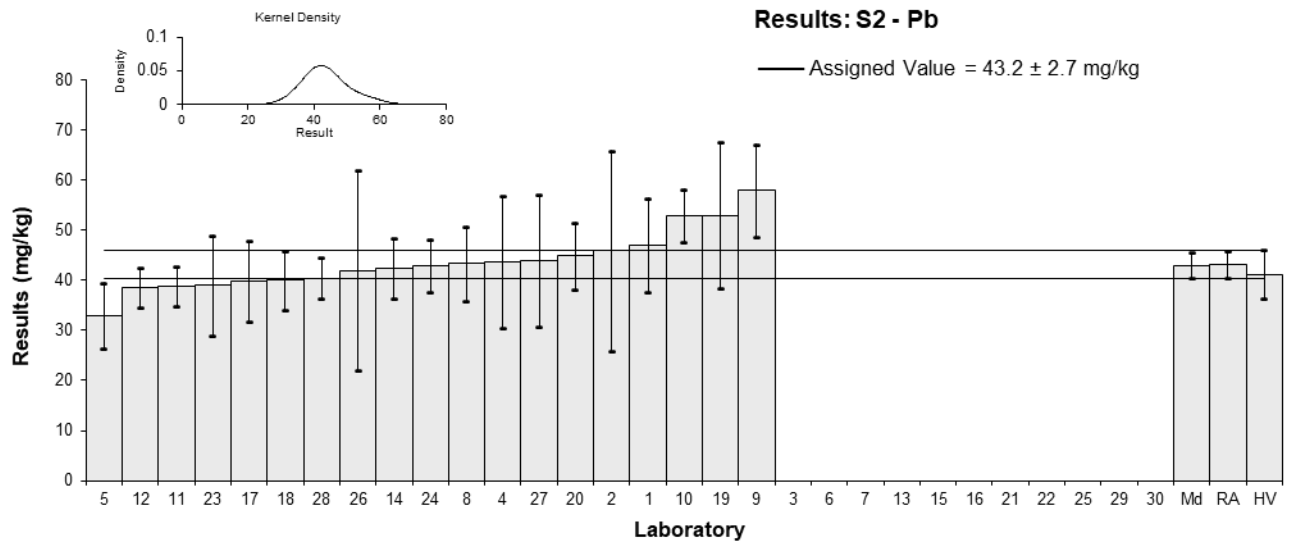


Figure 35

Table 46

Sample Details

Sample No.	S2
Matrix	Soil (sediment)
Analyte	Rb
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	5	2
3	NT	NT
4	5.245	1.5735
5	NT	NT
6	NT	NT
7	NT	NT
8	NT	NT
9	NT	NT
10	NT	NT
11	NT	NT
12	NT	NT
13	NR	NR
14	37.9	7
15	NT	NT
16	NT	NT
17	2.5	0.5
18	NT	NT
19	NR	NR
20	NR	NR
21	NT	NT
22	NT	NT
23	2	0.8
24	5.0	1.1
25	NT	NT
26	5	2
27	NT	NT
28	6.20	0.62
29	NT	NT
30	NT	NT

Statistics

Assigned Value	Not Set	
Spike Value	Not Spiked	
Homogeneity Value	6.49	0.78
Robust Average	4.9	2.0
Median	5.00	0.95
Mean	8.61	
N	8	
Max	37.9	
Min	2	
Robust SD	2.2	
Robust CV	46%	

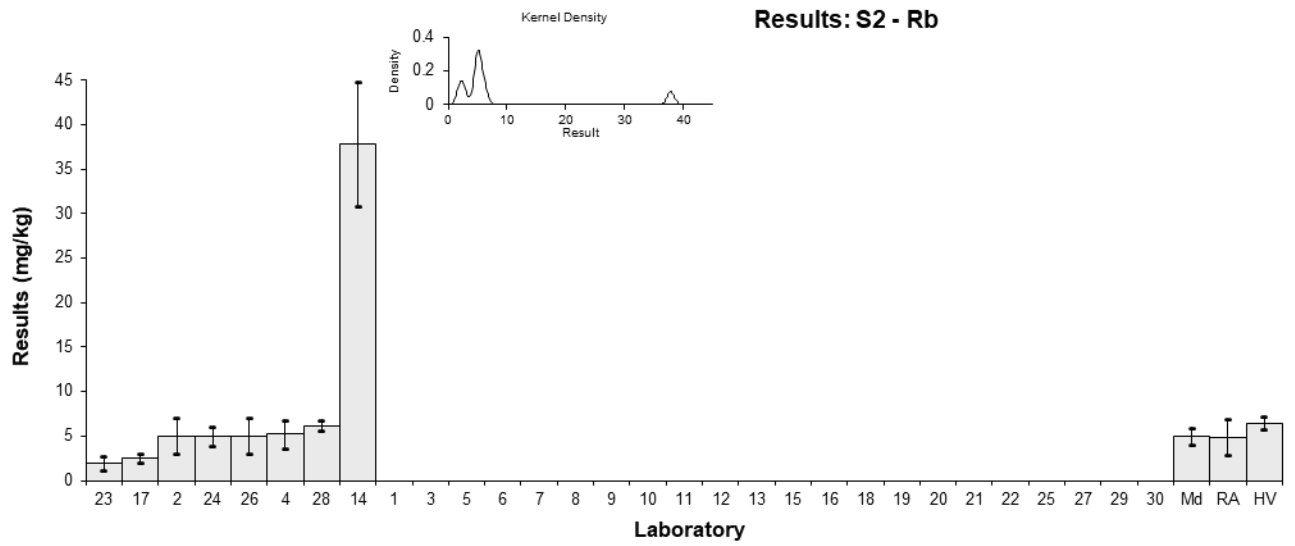


Figure 36

Table 47

Sample Details

Sample No.	S2
Matrix	Soil (sediment)
Analyte	Se
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.704	0.141	0.42	0.30
2	<2	NR		
3	NT	NT		
4	0.995	0.2985	2.65	1.08
5*	2.6	0.52	15.00	3.67
6	NT	NT		
7	NT	NT		
8	0.6	0.1	-0.38	-0.34
9*	4.0	2	25.77	1.67
10	<5	NR		
11	0.56	0.1	-0.69	-0.61
12	NT	NT		
13	NR	NR		
14	<1	0.3		
15	NT	NT		
16	NT	NT		
17	0.71	0.142	0.46	0.33
18	<5	NR		
19	0.50	0.19	-1.15	-0.68
20	<3	NR		
21	NT	NT		
22	NT	NT		
23	<2	NR		
24	0.6	1.3	-0.38	-0.04
25	NT	NT		
26	<2	NR		
27	< 2	< 2		
28	0.722	0.072	0.55	0.55
29	NT	NT		
30	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	0.65	0.11
Spike Value	Not Spiked	
Homogeneity Value	0.666	0.080
Robust Average	0.80	0.27
Median	0.71	0.15
Mean	1.20	
N	10	
Max	4	
Min	0.5	
Robust SD	0.34	
Robust CV	43%	

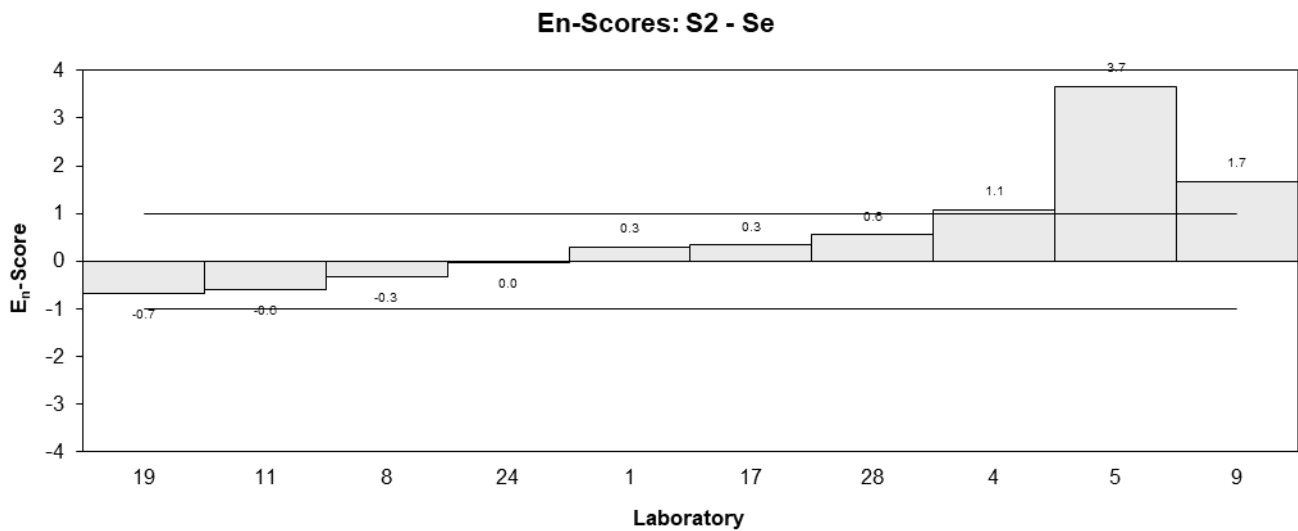
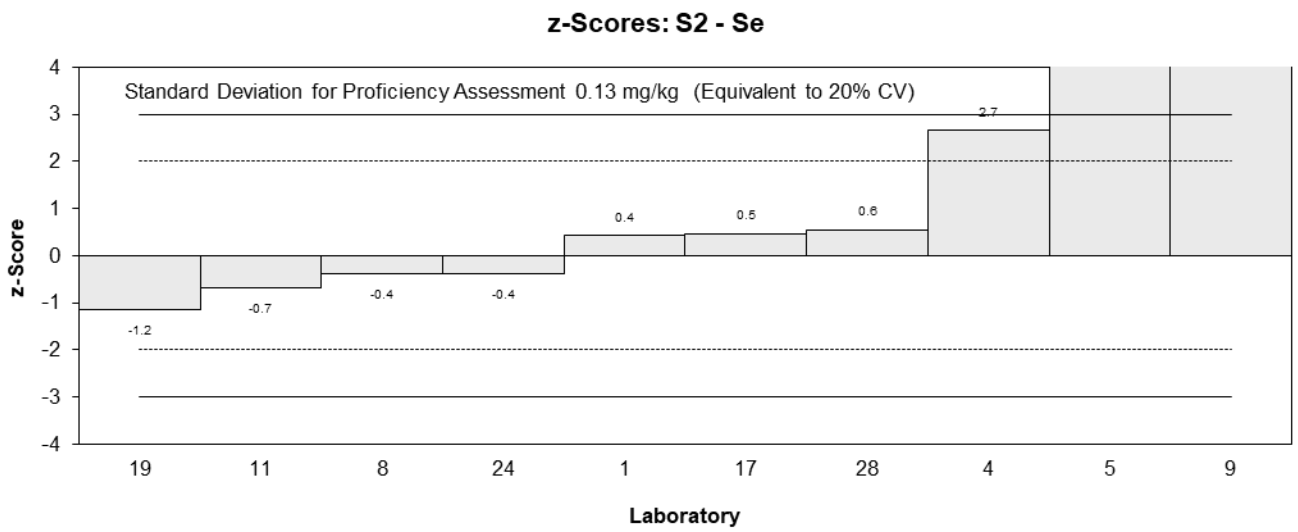
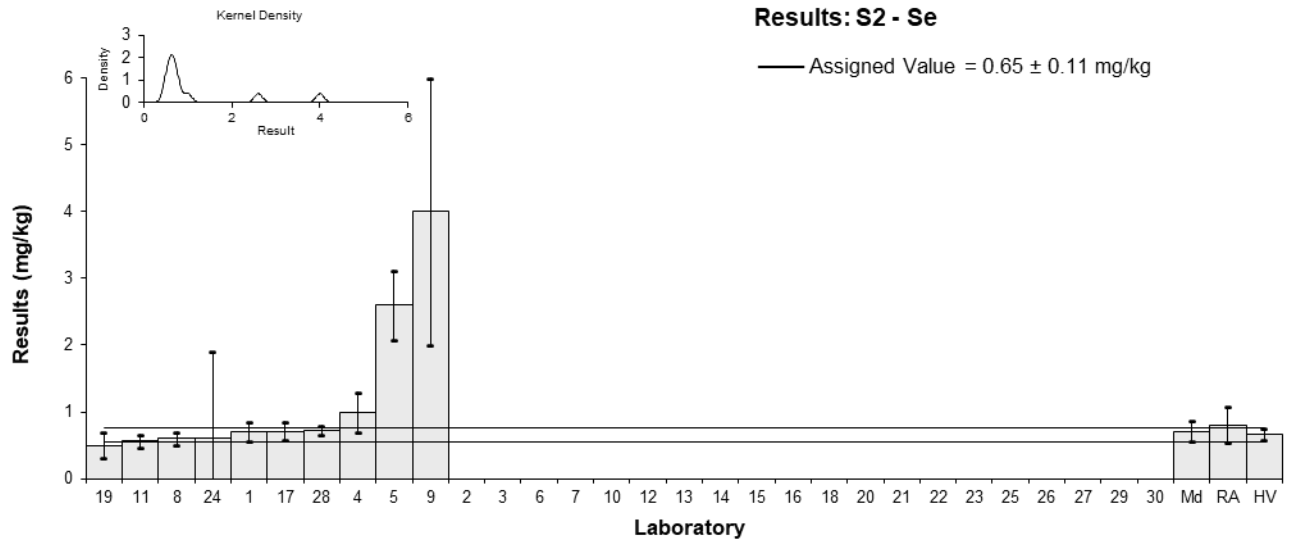


Figure 37

Table 48

Sample Details

Sample No.	S2
Matrix	Soil (sediment)
Analyte	Th
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	2.59	0.52	0.89	0.57
2	2	0.6	-0.45	-0.27
3	NT	NT		
4	NT	NT		
5	1.5	0.3	-1.59	-1.31
6	NT	NT		
7	NT	NT		
8	2.8	0.7	1.36	0.73
9	NT	NT		
10	NT	NT		
11	2.87	0.3	1.52	1.26
12	NT	NT		
13	NR	NR		
14	NT	NT		
15	NT	NT		
16	NT	NT		
17*	4.3	0.86	4.77	2.17
18	NT	NT		
19	1.80	0.63	-0.91	-0.52
20	<5	NR		
21	NT	NT		
22	NT	NT		
23	2	0.6	-0.45	-0.27
24	NT	NT		
25	NT	NT		
26	2	1	-0.45	-0.18
27	NT	NT		
28	2.24	0.022	0.09	0.09
29	NT	NT		
30	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	2.20	0.44
Spike Value	Not Spiked	
Homogeneity Value	2.38	0.29
Robust Average	2.30	0.49
Median	2.12	0.46
Mean	2.41	
N	10	
Max	4.3	
Min	1.5	
Robust SD	0.62	
Robust CV	27%	

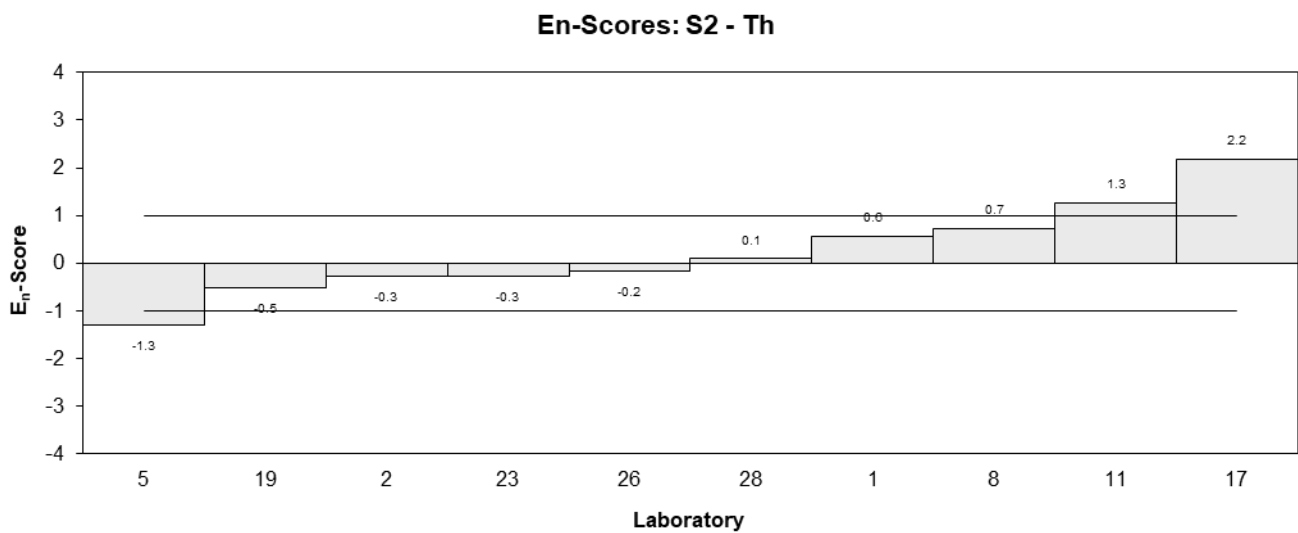
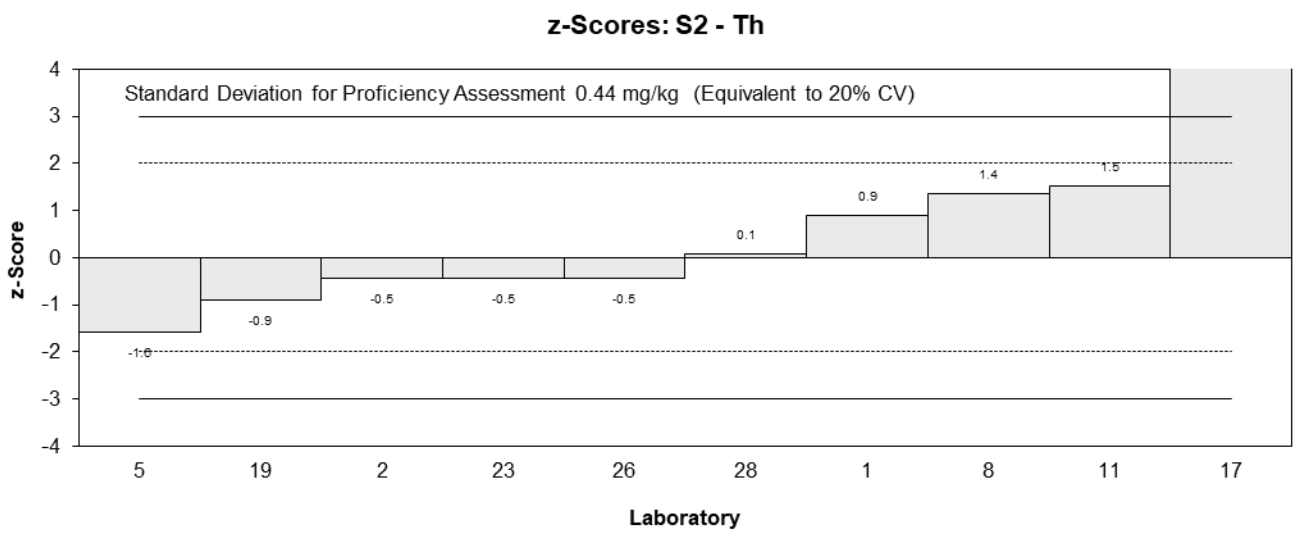
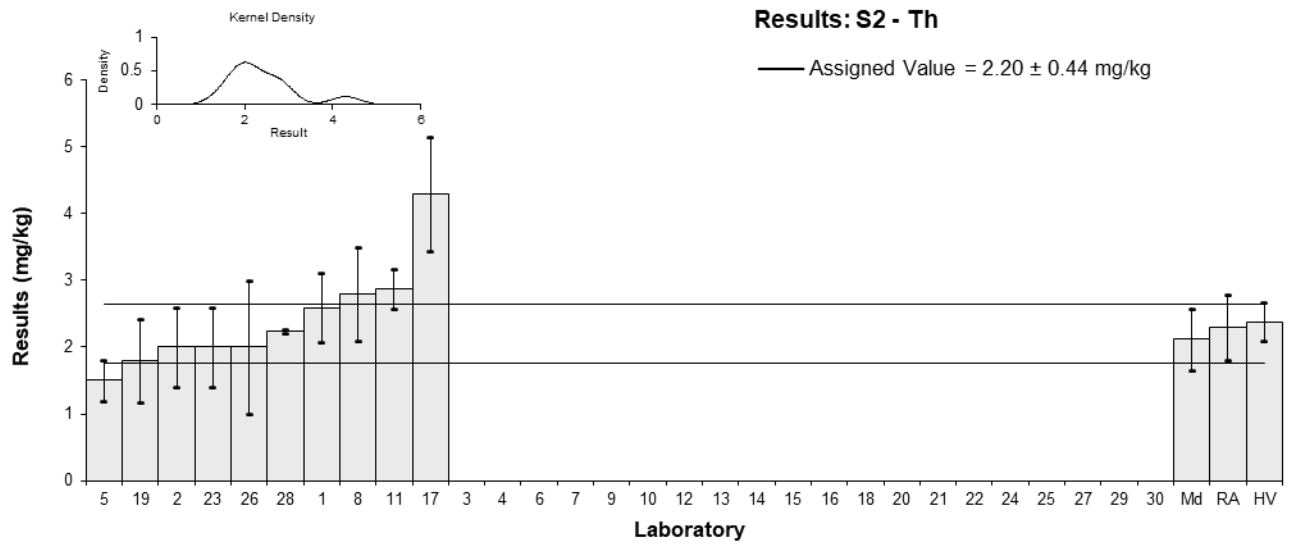


Figure 38

Table 49

Sample Details

Sample No.	S2
Matrix	Soil (sediment)
Analyte	V
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	41.7	8.3	0.59	0.39
2	38	10	-0.05	-0.03
3	NT	NT		
4	42	12.6	0.64	0.29
5	31	6.2	-1.27	-1.09
6	NT	NT		
7	NT	NT		
8	39.4	9.1	0.19	0.12
9	43	4.3	0.82	0.94
10	49	8.8	1.86	1.17
11	39.5	4.0	0.21	0.25
12	NT	NT		
13	34	6	-0.75	-0.66
14*	88.8	9	8.79	5.41
15	NT	NT		
16	NT	NT		
17	39.7	7.94	0.24	0.17
18	30	4.5	-1.44	-1.61
19	37.0	5.0	-0.23	-0.23
20	39.9	7.2	0.28	0.21
21	NT	NT		
22	NT	NT		
23	39	10	0.12	0.07
24	37.2	9.3	-0.19	-0.11
25	NT	NT		
26	42	10	0.64	0.36
27	34.44	10.332	-0.67	-0.36
28	34.4	3.44	-0.68	-0.92
29	NT	NT		
30	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	38.3	2.5
Spike Value	Not Spiked	
Homogeneity Value	37.6	4.5
Robust Average	38.7	2.8
Median	39.4	2.2
Mean	41.1	
N	19	
Max	88.8	
Min	30	
Robust SD	4.8	
Robust CV	12%	

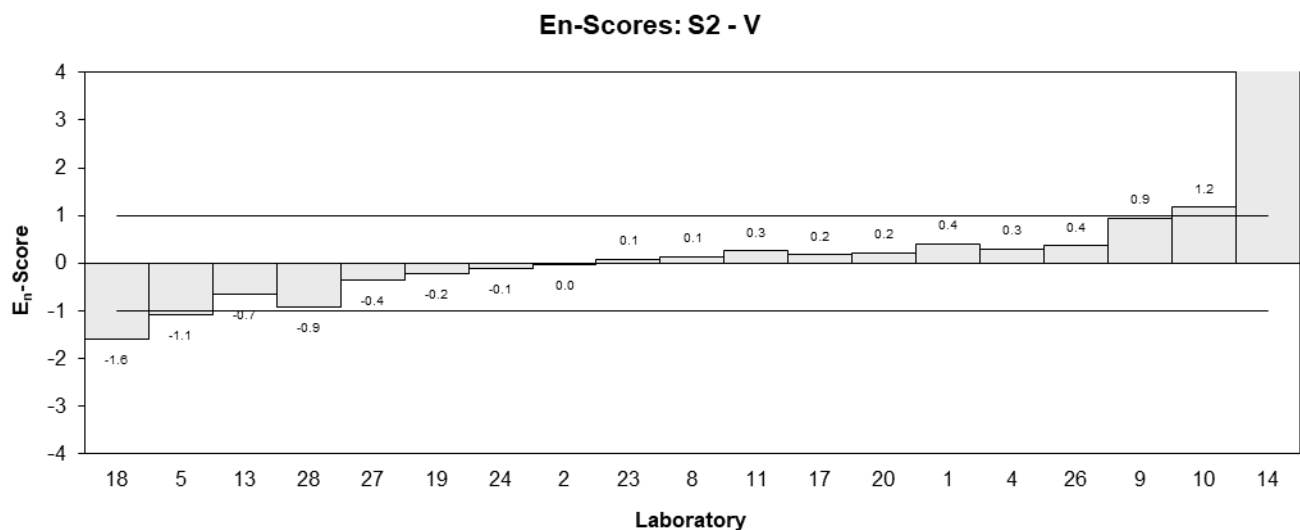
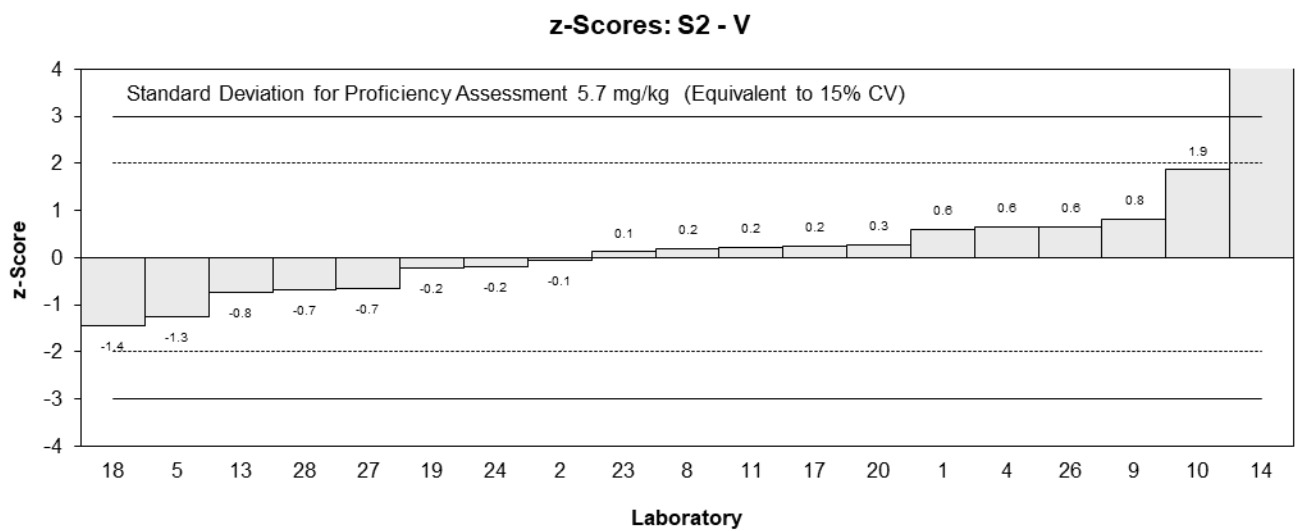
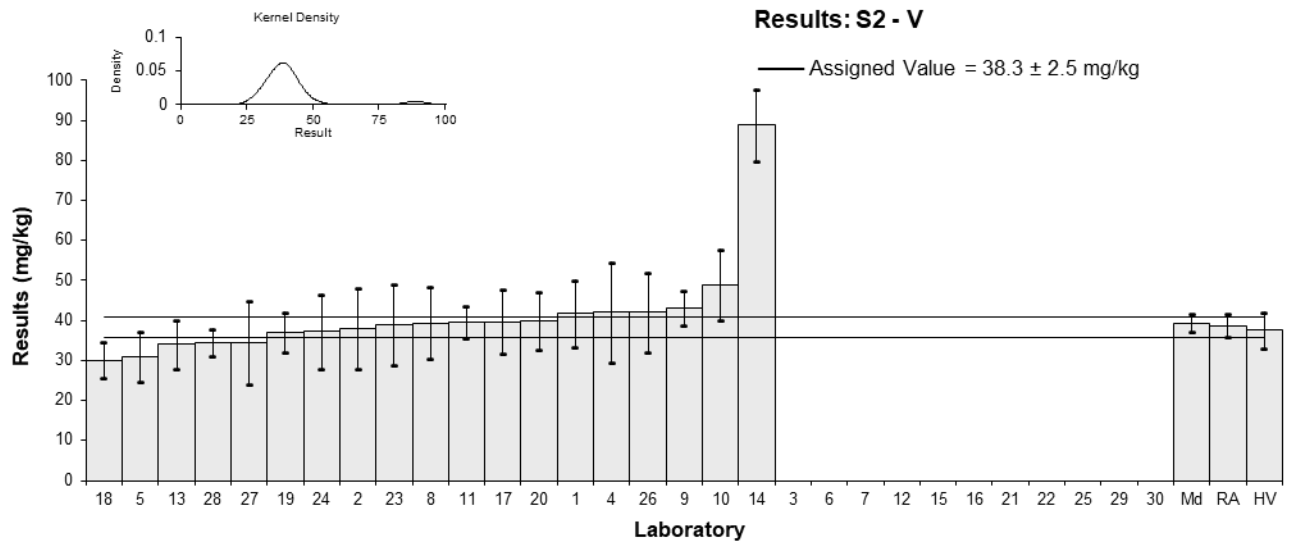


Figure 39

Table 50

Sample Details

Sample No.	S2
Matrix	Soil (sediment)
Analyte	Zn
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	197	39	0.82	0.37
2	170	50	-0.66	-0.23
3	NT	NT		
4	215.5	64.65	1.84	0.51
5	150	30	-1.76	-0.99
6	NT	NT		
7	NT	NT		
8	197	31.5	0.82	0.44
9	210	46.2	1.54	0.59
10	170	6.8	-0.66	-0.87
11	167	17	-0.82	-0.72
12	NT	NT		
13	177	32	-0.27	-0.15
14	118	14	-3.52	-3.47
15	NT	NT		
16	NT	NT		
17	173	34.6	-0.49	-0.25
18	200	30	0.99	0.56
19	183	22	0.05	0.04
20	177	39.65	-0.27	-0.12
21	NT	NT		
22	NT	NT		
23	170	50	-0.66	-0.23
24	186	30	0.22	0.12
25	NT	NT		
26	210	60	1.54	0.46
27	176.41	52.923	-0.31	-0.10
28	173	17.3	-0.49	-0.43
29	NT	NT		
30	NT	NT		

Statistics

Assigned Value	182	12
Spike Value	Not Spiked	
Homogeneity Value	190	23
Robust Average	182	12
Median	177	8
Mean	180	
N	19	
Max	215.5	
Min	118	
Robust SD	21	
Robust CV	12%	

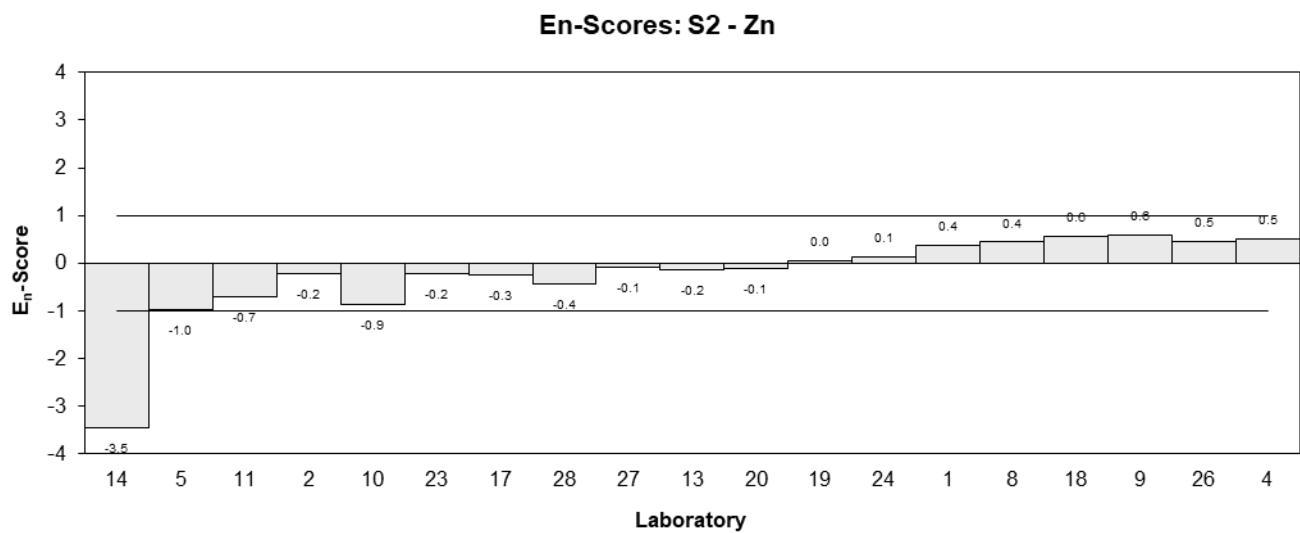
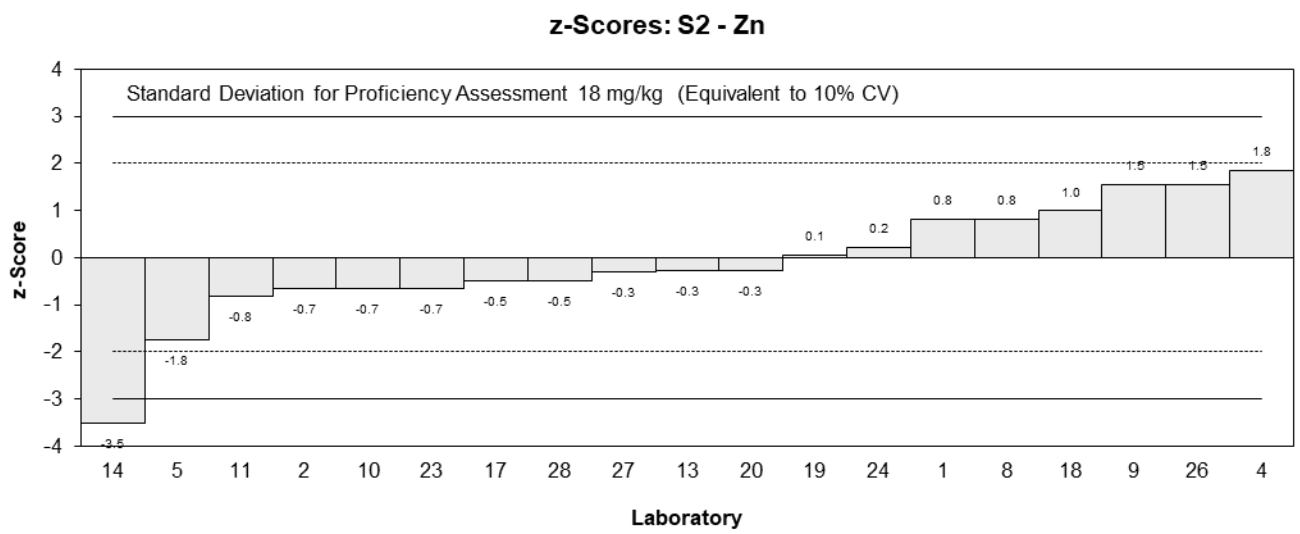
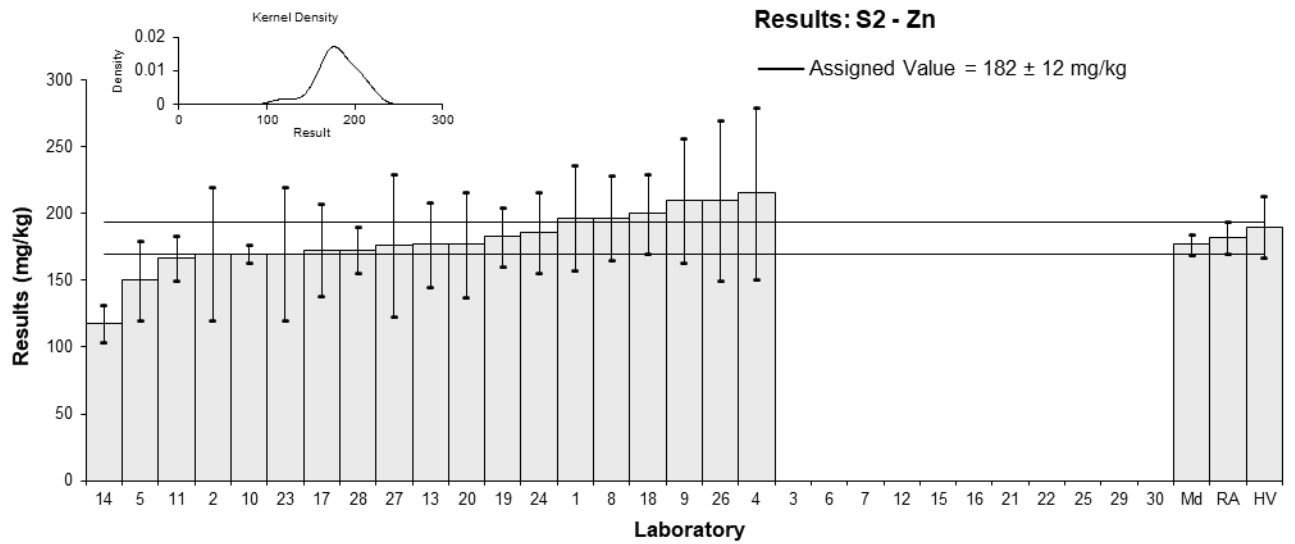


Figure 40

Table 51

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	838	168	-0.50	-0.25
2	790	200	-1.04	-0.44
3	887.7	98.8	0.06	0.05
4	NT	NT		
5	590	118	-3.31	-2.24
6	NR	NR		
7	800	200	-0.93	-0.40
8	896	233	0.16	0.06
9	NT	NT		
10*	1900	133	11.54	7.07
11	963	97	0.92	0.73
12	NT	NT		
13	NR	NR		
14	1084	150	2.29	1.26
15	912	NR	0.34	0.55
16	820	245	-0.70	-0.25
17	NT	NT		
18	NT	NT		
19	830	90	-0.59	-0.49
20	774	155	-1.22	-0.66
21	NT	NT		
22	1225	20	3.89	5.86
23	840	200	-0.48	-0.20
24	NT	NT		
25	852	260	-0.34	-0.11
26	950	200	0.77	0.33
27	912.2	273.66	0.34	0.11
28	892	89.2	0.11	0.10
29	NR	NR		
30	1010	100	1.45	1.12

* Outlier, see Section 4.2

Statistics

Assigned Value	882	55
Spike Value	Not Spiked	
Homogeneity Value	831	100
Robust Average	894	63
Median	890	54
Mean	938	
N	20	
Max	1900	
Min	590	
Robust SD	110	
Robust CV	13%	

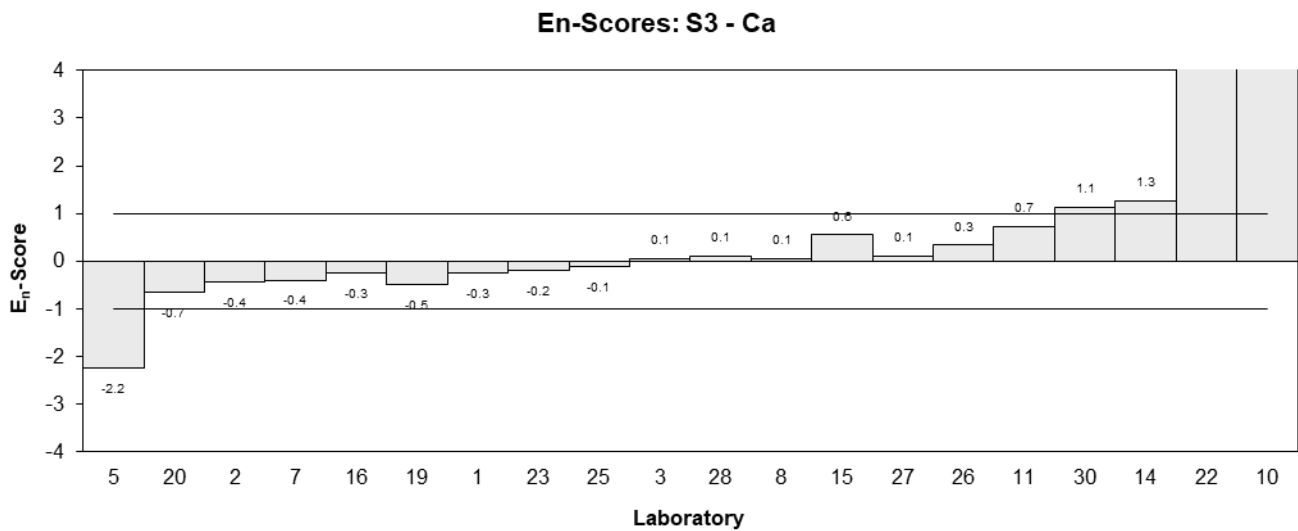
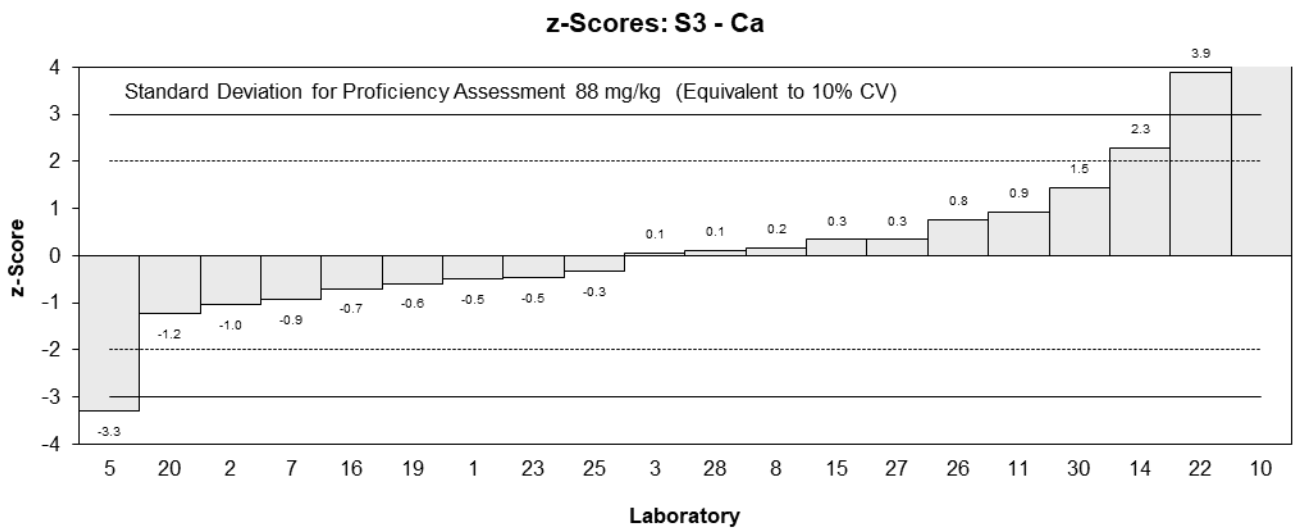
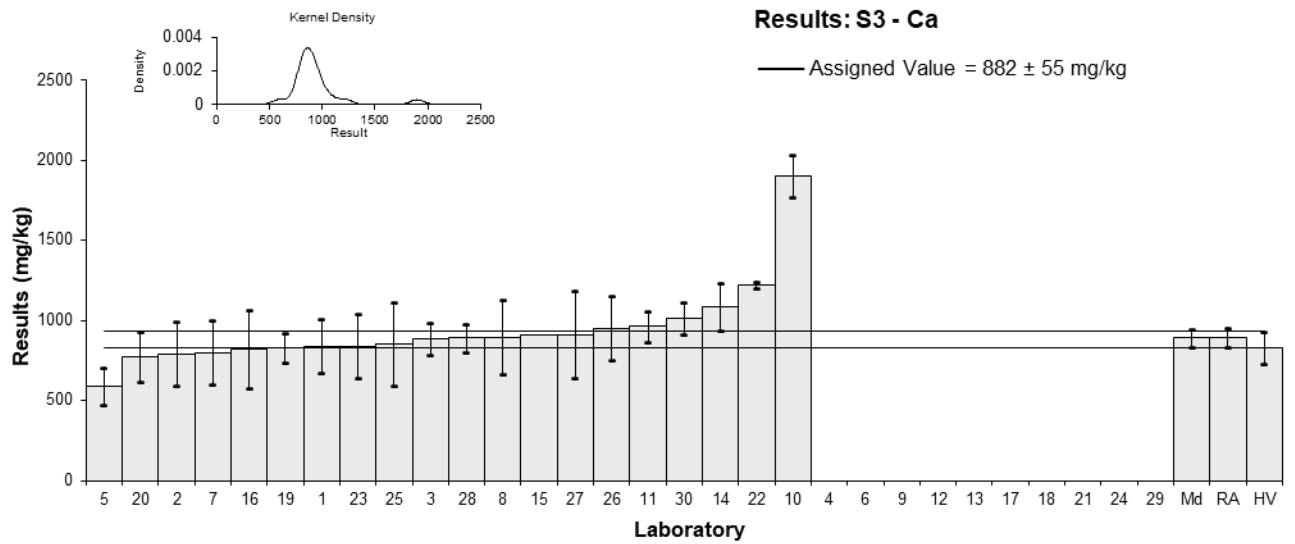


Figure 41

Table 52

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	18204	3640	-0.32	-0.16
2	19000	5000	0.11	0.04
3	17096	2293	-0.91	-0.69
4	NT	NT		
5*	9100	1820	-5.16	-4.78
6	NR	NR		
7	20000	4000	0.64	0.29
8	15500	4185	-1.76	-0.77
9	NT	NT		
10	18000	2340	-0.43	-0.32
11	18800	1880	0.00	0.00
12	NT	NT		
13	21674	3318	1.53	0.84
14	19400	2500	0.32	0.23
15	NT	NT		
16	18291	5487	-0.27	-0.09
17	NT	NT		
18	NT	NT		
19	18300	2400	-0.27	-0.20
20	16800	3360	-1.06	-0.57
21	NT	NT		
22	17390	1670	-0.75	-0.74
23	21000	6000	1.17	0.36
24	NT	NT		
25	19000	3800	0.11	0.05
26	21000	5000	1.17	0.43
27	20320.41	6096.123	0.81	0.25
28	17983	1800	-0.43	-0.41
29	NR	NR		
30	18300	1650	-0.27	-0.27

* Outlier, see Section 4.2

Statistics

Assigned Value	18800	900
Spike Value	Not Spiked	
Homogeneity Value	18800	2300
Robust Average	18600	1000
Median	18300	800
Mean	18300	
N	20	
Max	21674	
Min	9100	
Robust SD	1800	
Robust CV	9.6%	

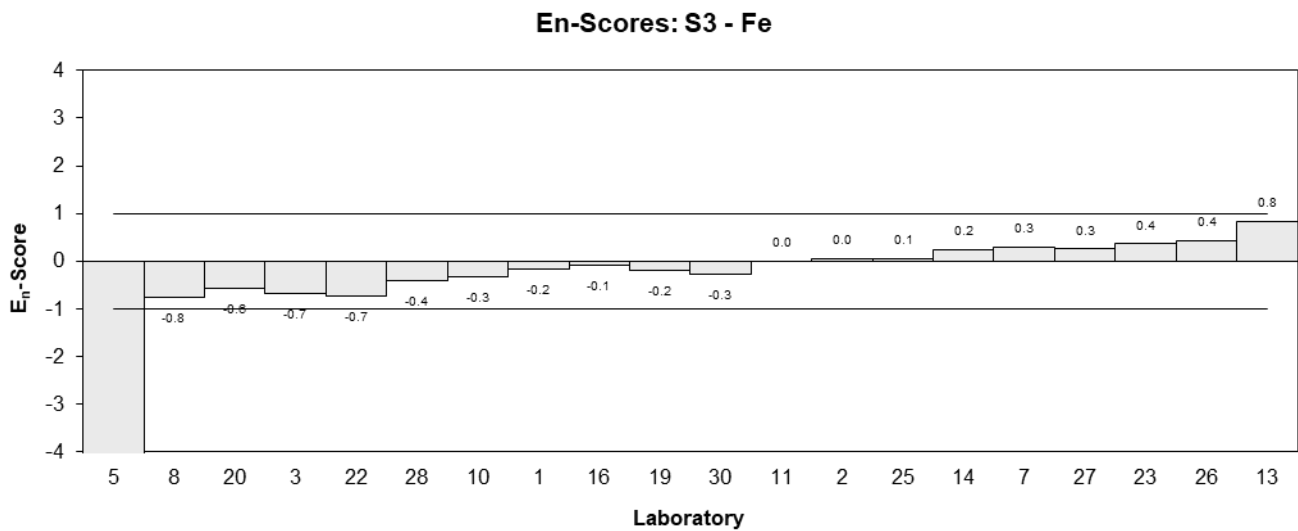
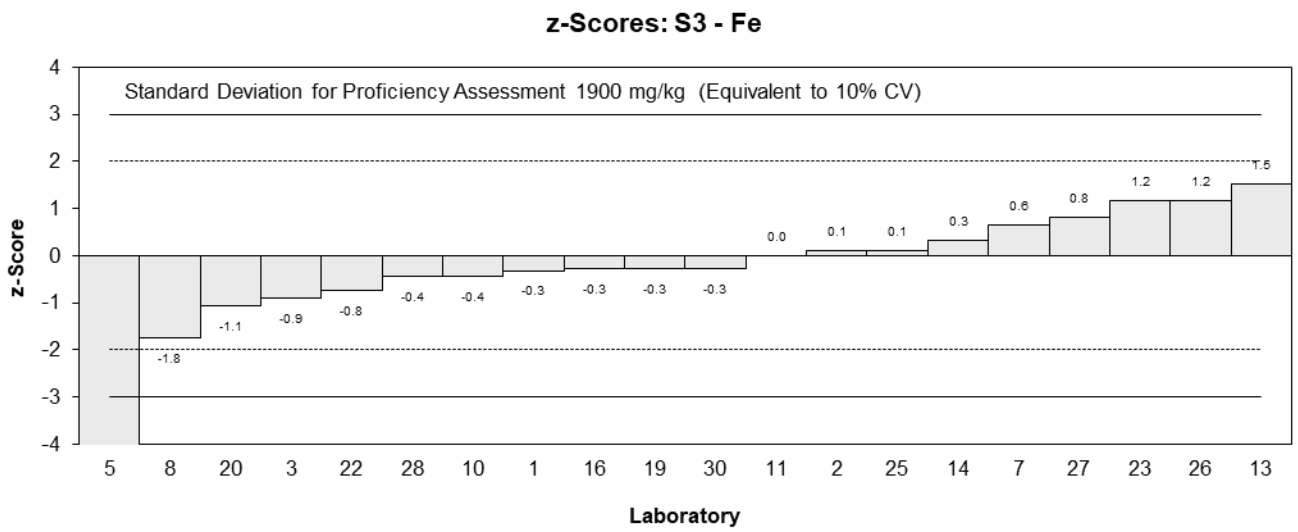
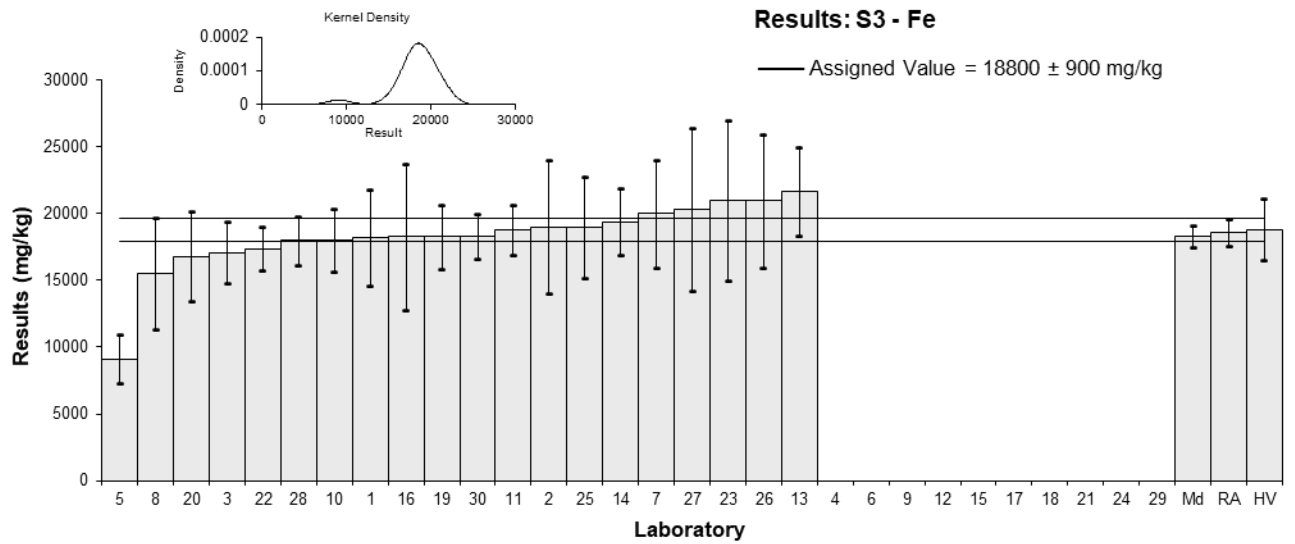


Figure 42

Table 53

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	740	148	-0.39	-0.29
2	740	200	-0.39	-0.22
3	684.1	60.9	-0.86	-1.21
4	NT	NT		
5	910	182	1.05	0.65
6	NR	NR		
7	620	130	-1.41	-1.17
8	871	174	0.72	0.46
9	NT	NT		
10	1000	60	1.82	2.56
11	753	75	-0.28	-0.35
12	NT	NT		
13	NR	NR		
14*	3600	600	23.87	4.67
15	618	NR	-1.42	-2.90
16	722	213	-0.54	-0.29
17	NT	NT		
18	NT	NT		
19	740	165	-0.39	-0.26
20	866	173.2	0.68	0.44
21	NT	NT		
22	850	110	0.54	0.51
23	740	200	-0.39	-0.22
24	NT	NT		
25	880	270	0.80	0.34
26	810	200	0.20	0.12
27	769.4	230.82	-0.14	-0.07
28	867	86.7	0.69	0.78
29	NR	NR		
30	788	75	0.02	0.02

* Outlier, see Section 4.2

Statistics

Assigned Value	786	58
Spike Value	Not Spiked	
Homogeneity Value	775	93
Robust Average	796	62
Median	779	66
Mean	928	
N	20	
Max	3600	
Min	618	
Robust SD	110	
Robust CV	14%	

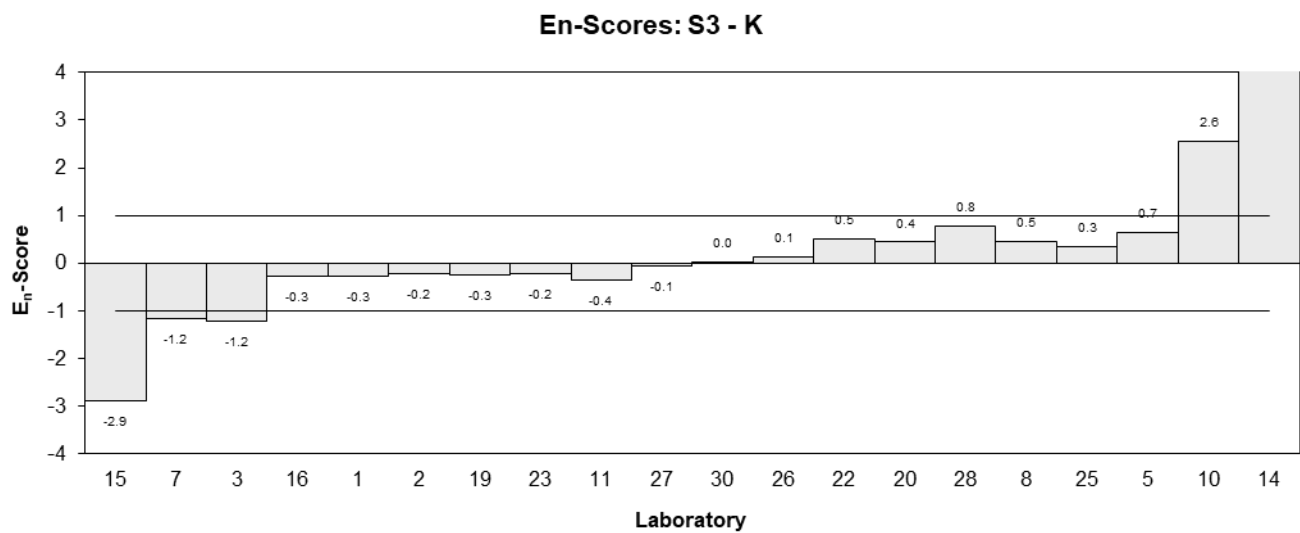
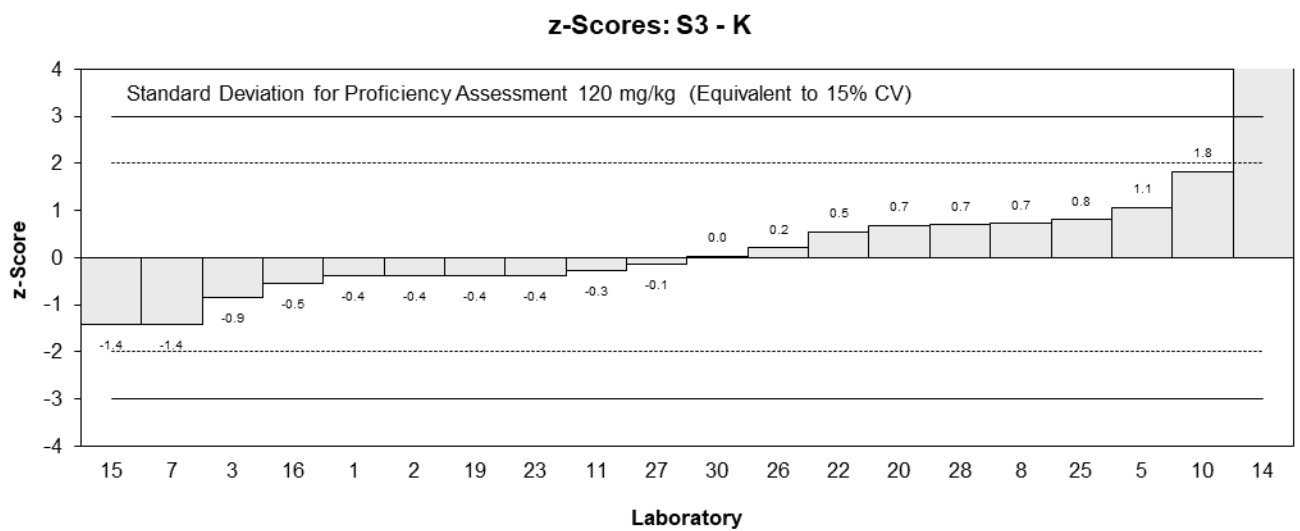
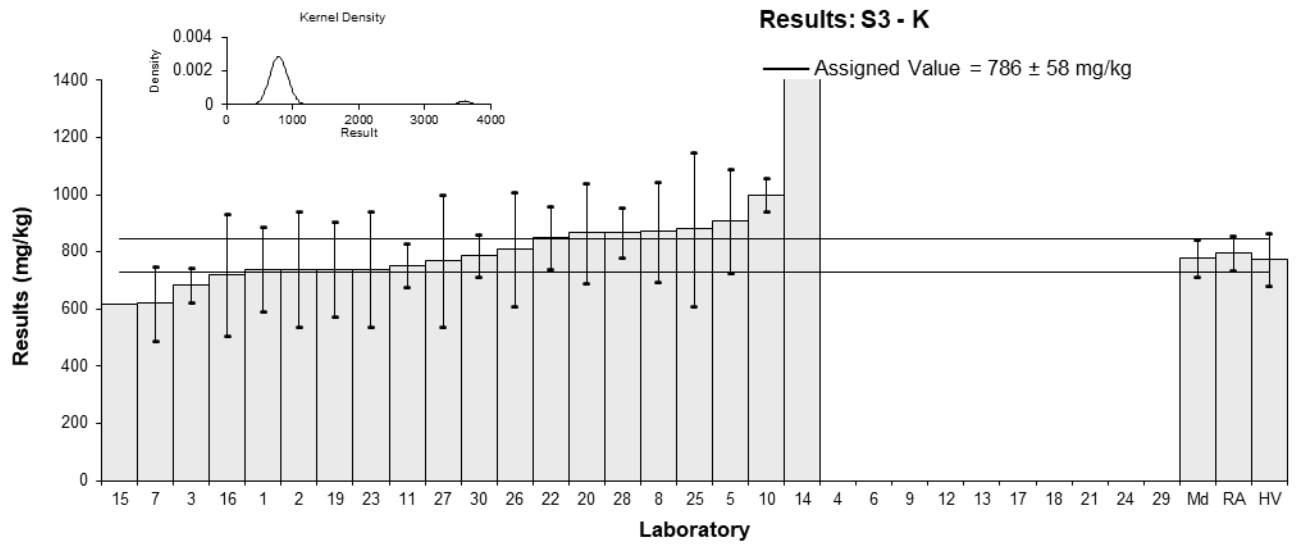


Figure 43

Table 54

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	406	81	0.47	0.31
2	330	100	-0.86	-0.46
3	339.6	45.1	-0.69	-0.69
4	NT	NT		
5*	630	126	4.42	1.92
6	NR	NR		
7	320	64	-1.04	-0.81
8	412	95	0.58	0.33
9	NT	NT		
10*	800	48	7.41	7.09
11	392	39	0.23	0.25
12	NT	NT		
13	379	63	0.00	0.00
14*	1021	150	11.29	4.17
15	307	NR	-1.27	-2.06
16	371	111	-0.14	-0.07
17	NT	NT		
18	NT	NT		
19	434	59	0.97	0.80
20	430	86	0.90	0.55
21	NT	NT		
22	360	20	-0.33	-0.47
23	360	100	-0.33	-0.18
24	NT	NT		
25	500	150	2.13	0.79
26	470	100	1.60	0.86
27	337.4	101.22	-0.73	-0.39
28	412	41.2	0.58	0.61
29	NR	NR		
30	295	28	-1.48	-1.87

* Outlier, see Section 4.2

Statistics

Assigned Value	379	35
Spike Value	Not Spiked	
Homogeneity Value	428	51
Robust Average	402	46
Median	392	42
Mean	443	
N	21	
Max	1021	
Min	295	
Robust SD	84	
Robust CV	21%	

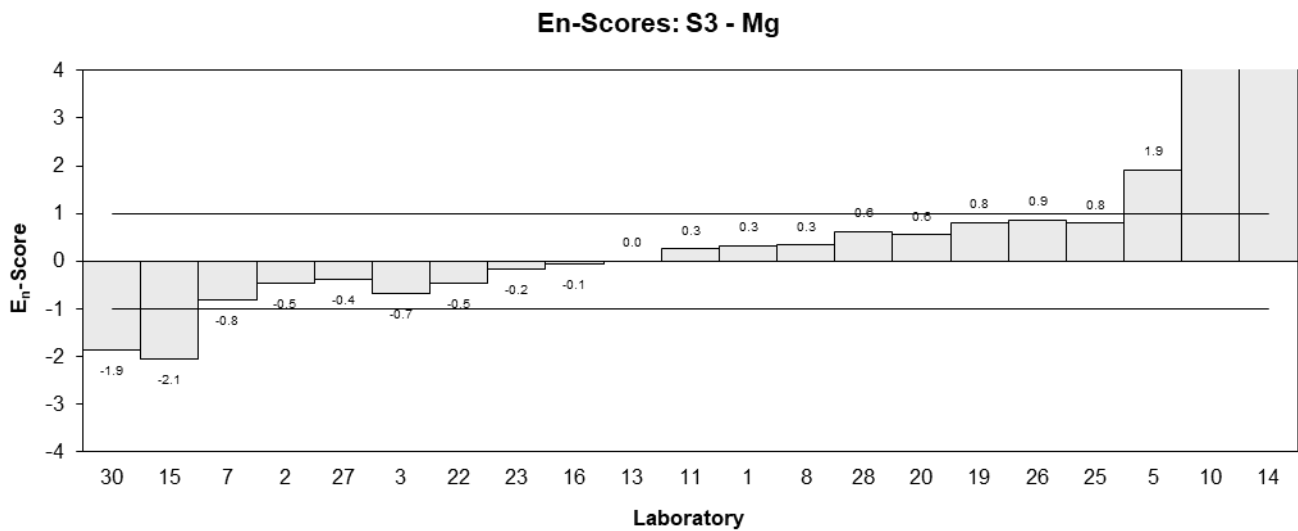
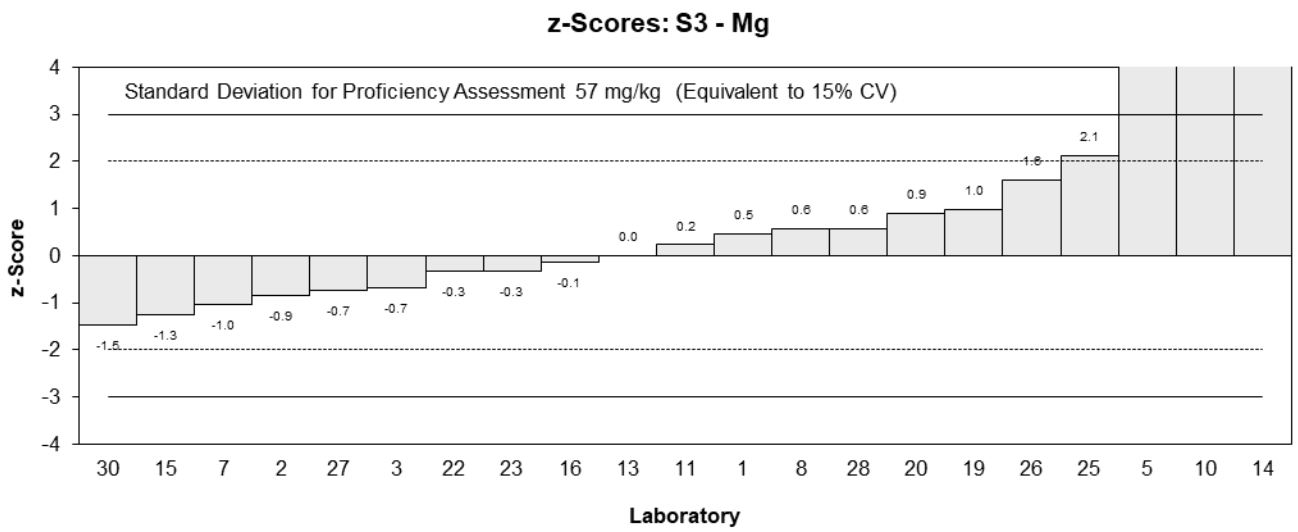
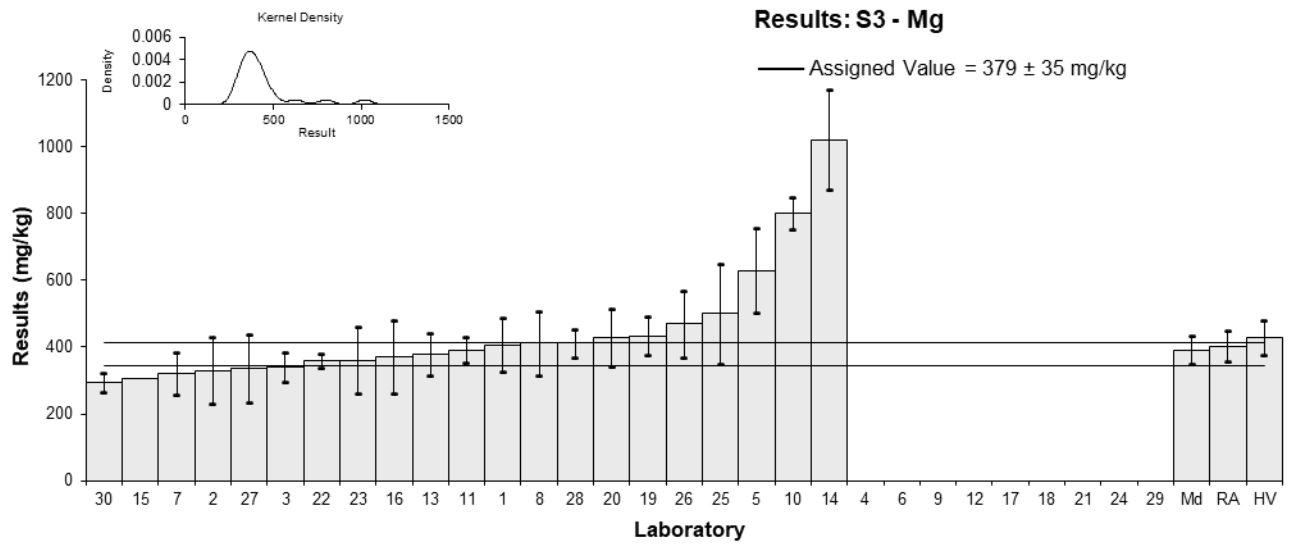


Figure 44

Table 55

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	NR	NR		
2	33	10	-0.16	-0.09
3	27.11	3.56	-1.02	-0.80
4	NT	NT		
5**	960	192	135.76	4.82
6	NR	NR		
7	<50	NR		
8**	631	139	87.52	4.29
9	NT	NT		
10**	570	57	78.58	9.31
11	<50	NR		
12	NT	NT		
13	NR	NR		
14	<200	50		
15	20	NR	-2.07	-1.76
16	31.5	9.45	-0.38	-0.21
17	NT	NT		
18	NT	NT		
19	<20	NR		
20	<50	NR		
21	NT	NT		
22*	225	50	27.99	3.77
23	40	10	0.87	0.46
24	NT	NT		
25	29	9	-0.75	-0.42
26	40	20	0.87	0.27
27	37.6	11.28	0.51	0.25
28	NT	NT		
29	NR	NR		
30	53.4	5.3	2.83	2.01

* Outlier, ** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	34.1	8.0
Spike Value	Not Spiked	
Homogeneity Value	48.0	5.8
Robust Average	37	10
Median	35.3	6.4
Mean	53.7	
N	10	
Max	225	
Min	20	
Robust SD	13	
Robust CV	35%	

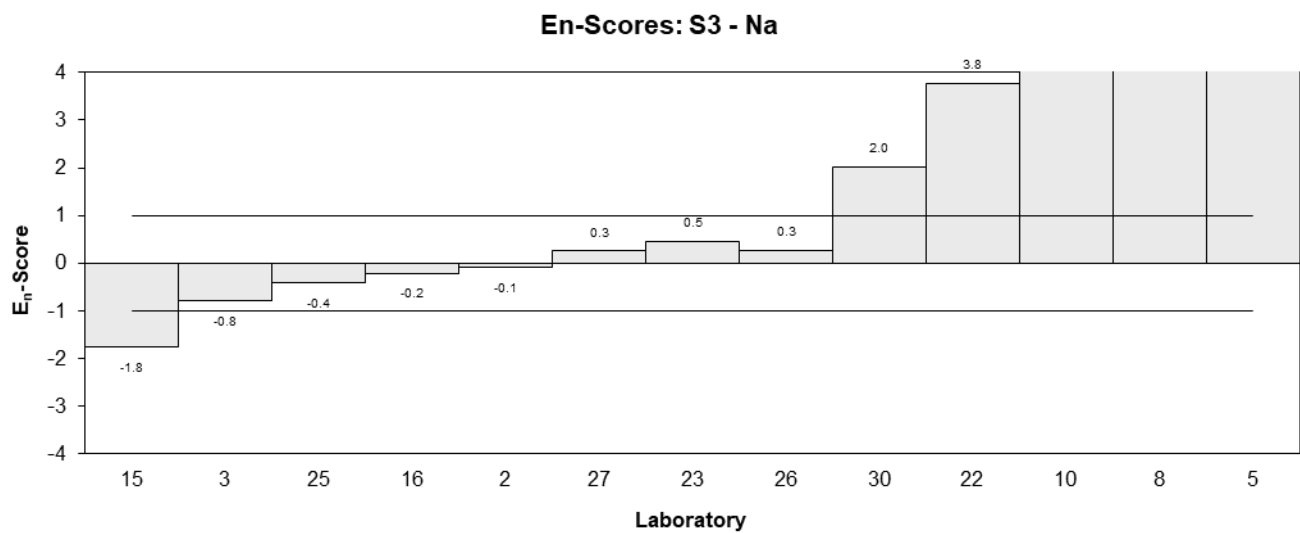
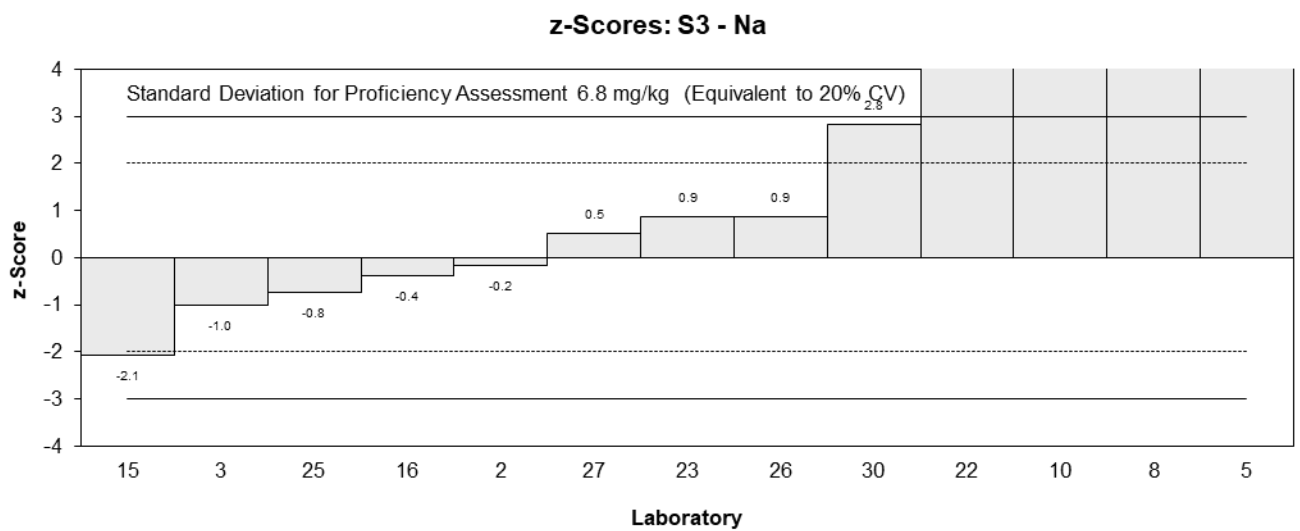
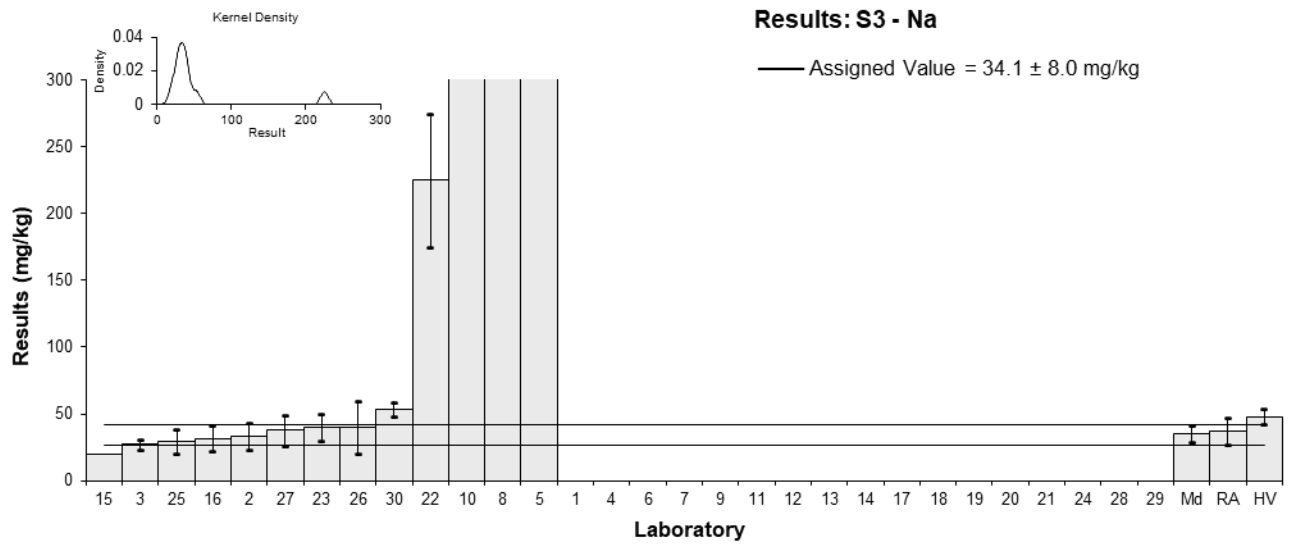


Figure 45

Table 56

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	384	77	0.03	0.01
2	350	100	-0.86	-0.33
3	339.7	51.4	-1.13	-0.80
4	NT	NT		
5*	660	132	7.23	2.08
6	NR	NR		
7	400	80	0.44	0.21
8	346	107	-0.97	-0.34
9	NT	NT		
10	NT	NT		
11	386	39	0.08	0.07
12	397.00	40	0.37	0.32
13	NR	NR		
14	NT	NT		
15	378	65	-0.13	-0.07
16	406	122	0.60	0.19
17	NT	NT		
18	NT	NT		
19	410	64	0.70	0.41
20	360	72	-0.60	-0.31
21	NT	NT		
22*	97	5	-7.47	-17.06
23	370	100	-0.34	-0.13
24	NT	NT		
25	400	120	0.44	0.14
26	410	100	0.70	0.27
27	396.02	118.806	0.34	0.11
28	394	39.4	0.29	0.26
29	NR	NR		
30	NR	NR		

* Outlier, see Section 4.2

Statistics

Assigned Value	383	16
Spike Value	Not Spiked	
Homogeneity Value	388	47
Robust Average	383	18
Median	390	16
Mean	382	
N	18	
Max	660	
Min	97	
Robust SD	30	
Robust CV	8%	

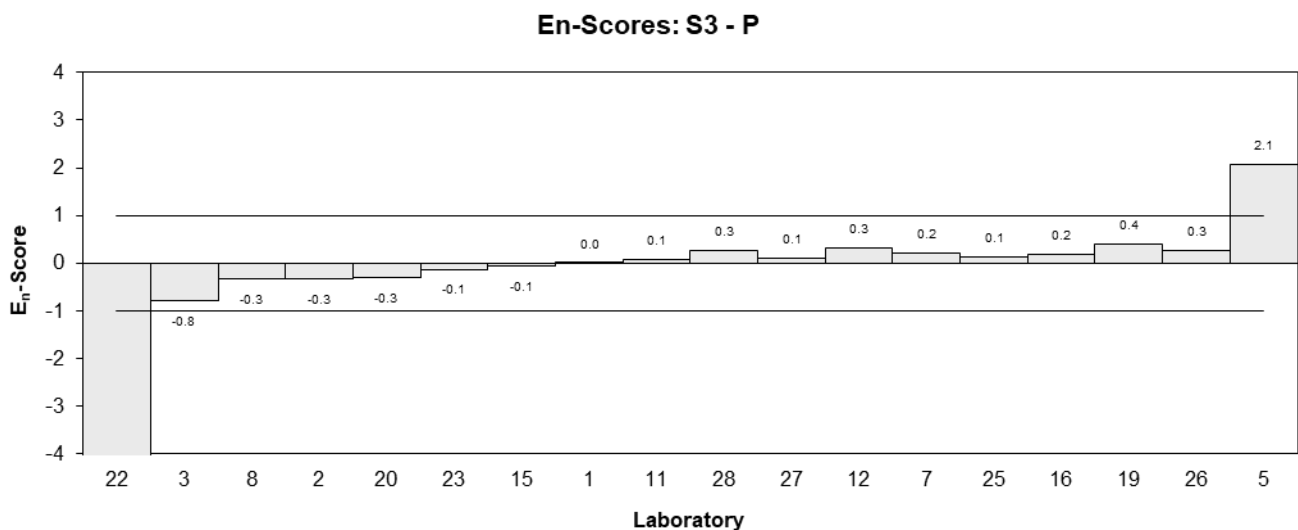
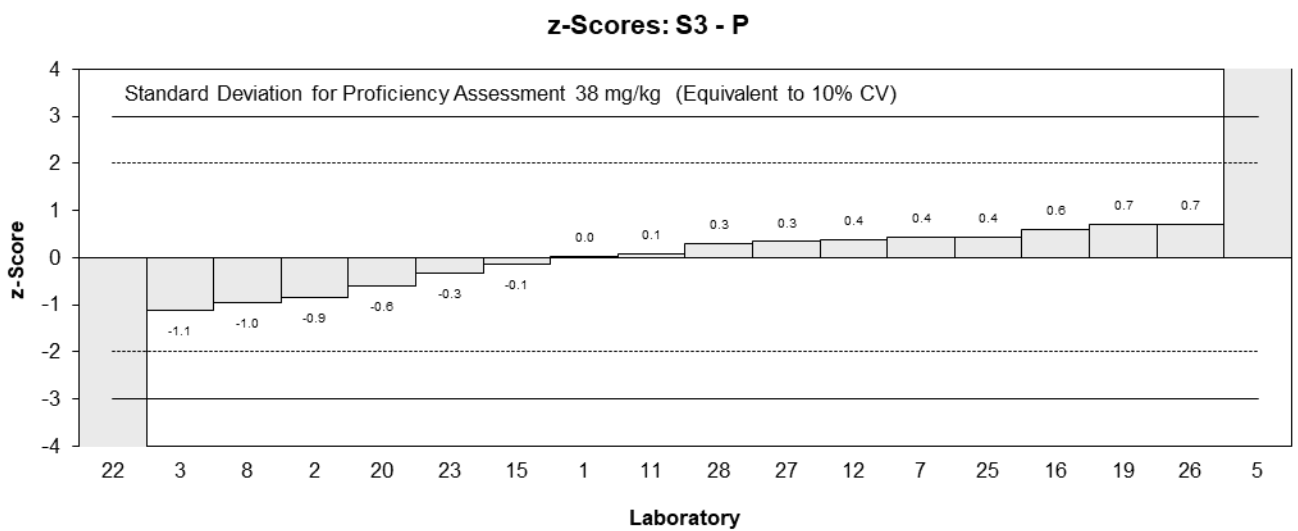
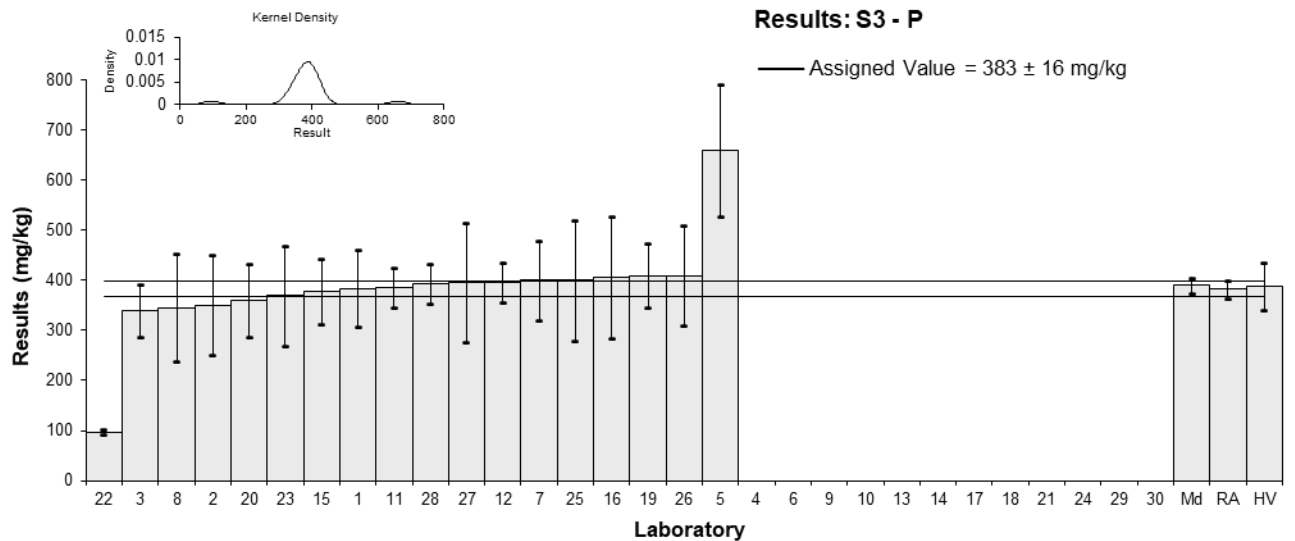


Figure 46

Table 57

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	367	73	0.43	0.20
2	330	100	-0.62	-0.22
3	< 200	NR		
4	NT	NT		
5*	1100	220	21.25	3.39
6	NR	NR		
7	<200	NR		
8	324	71	-0.80	-0.39
9	NT	NT		
10*	560	62	5.91	3.26
11	350	35	-0.06	-0.05
12	379.97	40	0.79	0.65
13	NR	NR		
14	NT	NT		
15	346	60	-0.17	-0.10
16	< 200	NR		
17	NT	NT		
18	NT	NT		
19	342	47	-0.28	-0.20
20	342	68.4	-0.28	-0.14
21	NT	NT		
22	NT	NT		
23	350	100	-0.06	-0.02
24	NT	NT		
25	NT	NT		
26	370	100	0.51	0.18
27	377.6	113.28	0.73	0.22
28	340	34	-0.34	-0.32
29	NR	NR		
30	NR	NR		

* Outlier, see Section 4.2

Statistics

Assigned Value	352	15
Spike Value	Not Spiked	
Homogeneity Value	358	43
Robust Average	358	18
Median	350	18
Mean	420	
N	14	
Max	1100	
Min	324	
Robust SD	27	
Robust CV	7.6%	

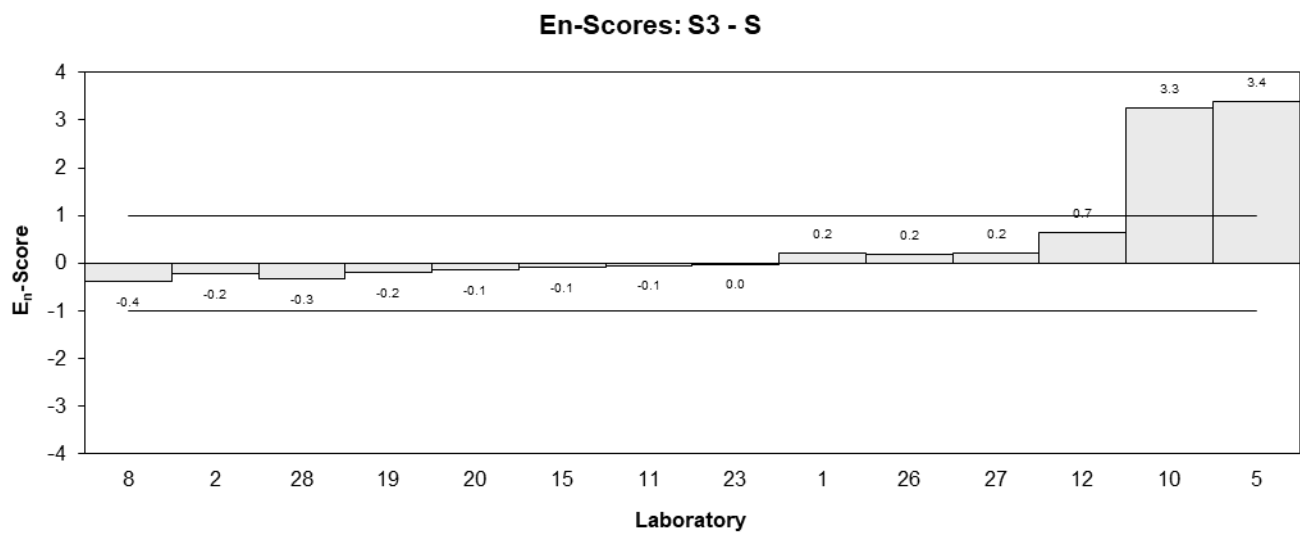
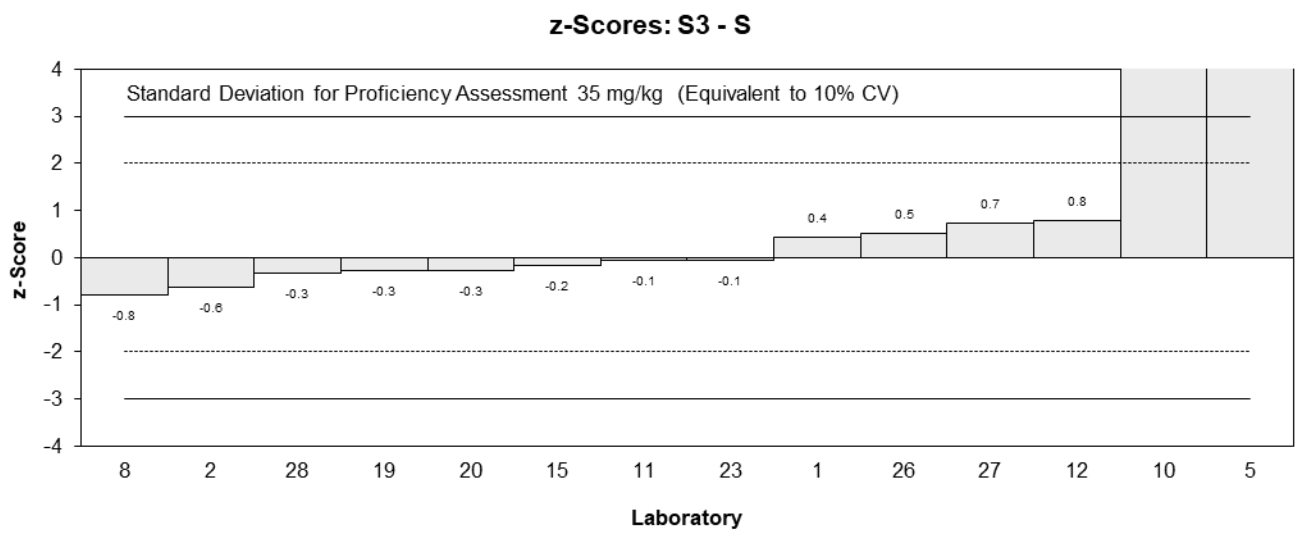
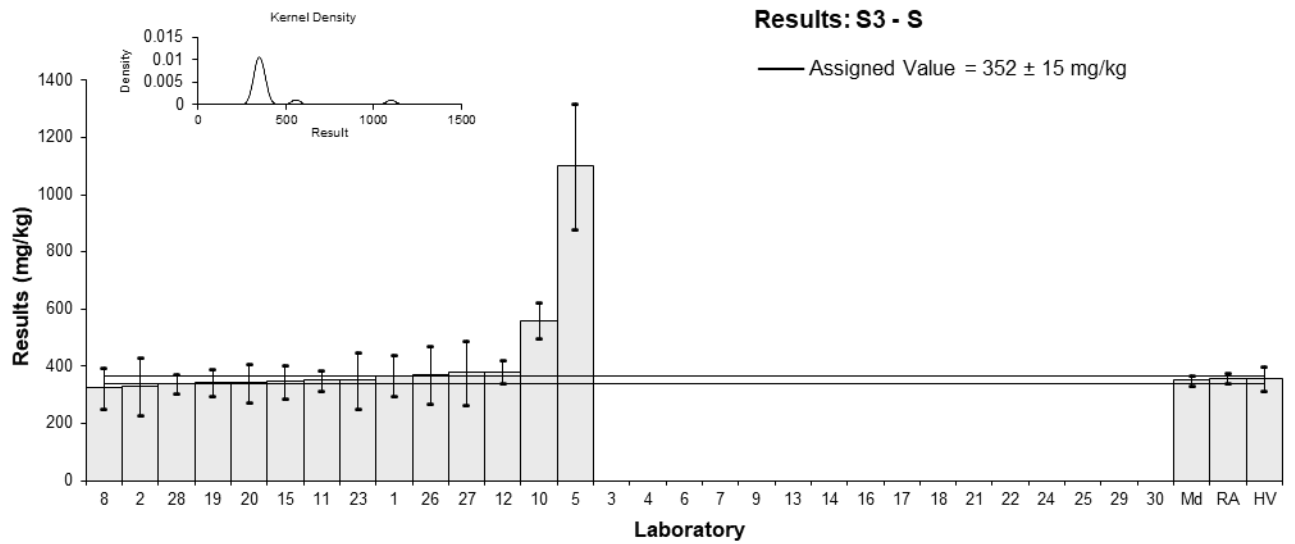


Figure 47

Table 58

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	16.7	3.3	1.40	0.79
2	11	5	-1.35	-0.53
3	12.01	1.42	-0.86	-0.84
4	NT	NT		
5	8.7	1.74	-2.46	-2.16
6	NR	NR		
7	12	2.5	-0.87	-0.61
8	14.6	3.2	0.39	0.22
9	NT	NT		
10*	27	5.4	6.38	2.34
11	13.6	1.5	-0.10	-0.09
12	NT	NT		
13	NR	NR		
14*	58	10	21.35	4.36
15	NT	NT		
16	15.3	4.60	0.72	0.31
17	NT	NT		
18	NT	NT		
19	15	2.5	0.58	0.40
20	15.8	2.7	0.97	0.64
21	NT	NT		
22	NT	NT		
23	14	4	0.10	0.05
24	NT	NT		
25*	23	5	4.44	1.75
26	16	5	1.06	0.42
27	NT	NT		
28	13.1	1.31	-0.34	-0.34
29	NR	NR		
30	NR	NR		

* Outlier, see Section 4.2

Statistics

Assigned Value	13.8	1.6
Spike Value	Not Spiked	
Homogeneity Value	14.1	1.7
Robust Average	15.2	2.7
Median	14.8	1.7
Mean	17.9	
N	16	
Max	58	
Min	8.7	
Robust SD	4.3	
Robust CV	28%	

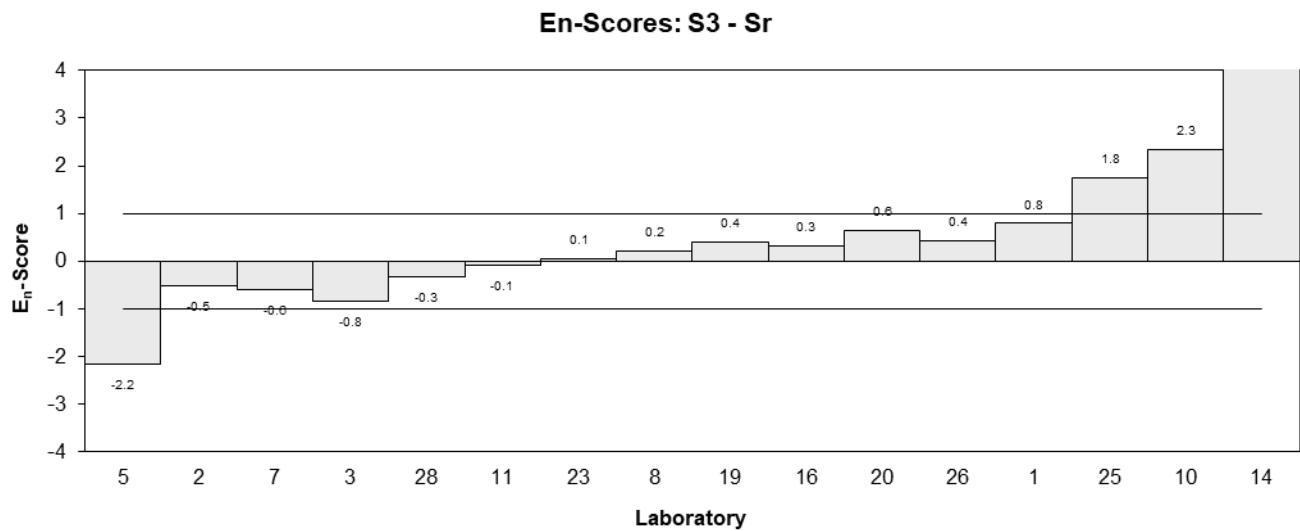
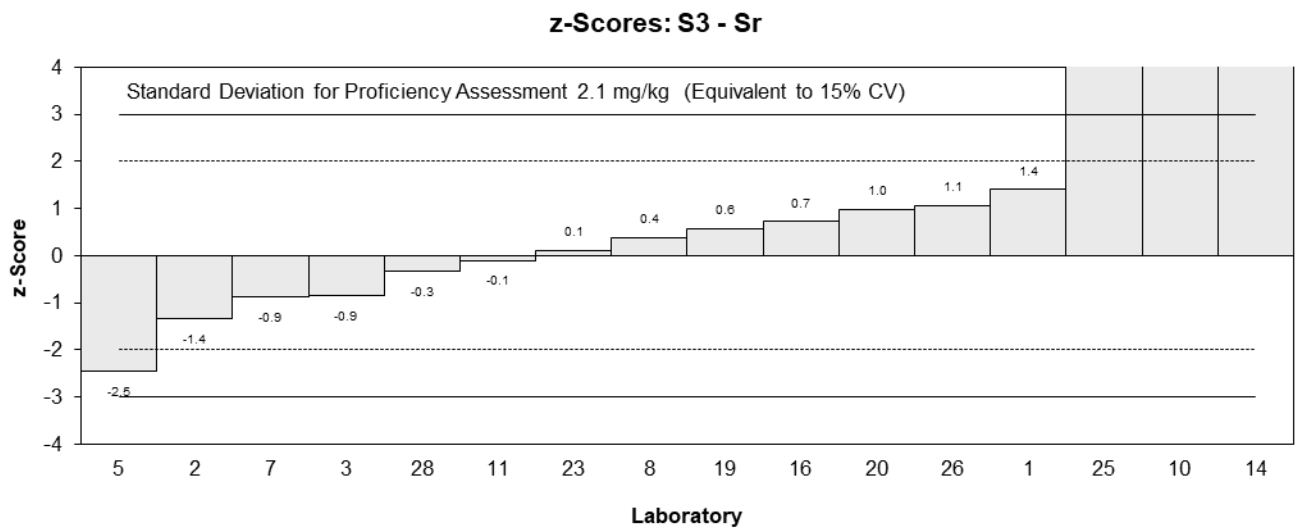
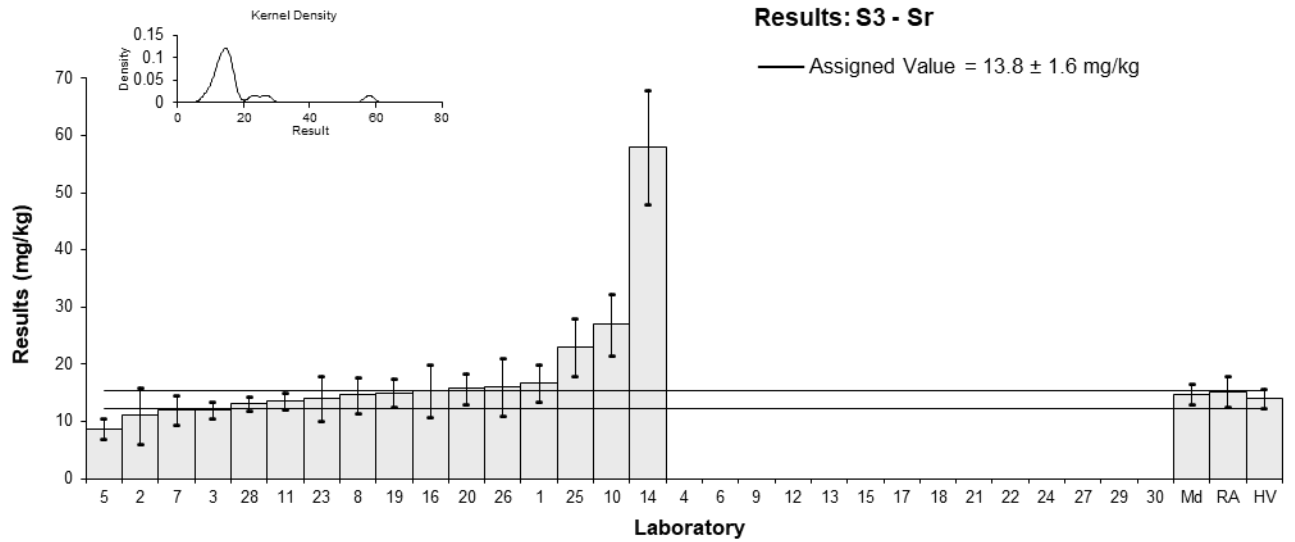


Figure 48

Table 59

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty
1	<1	NR
2	<2.5	NR
3	< 5	NR
4	NT	NT
5	1.52	0.304
6	NR	NR
7	NT	NT
8	2.1	0.3
9	NT	NT
10	NT	NT
11	NT	NT
12	1.391	0.1
13	NR	NR
14	NT	NT
15	NT	NT
16	< 5	NR
17	1.84	0.368
18	NT	NT
19	NR	NR
20	NR	NR
21	NT	NT
22	NT	NT
23	<2.5	NR
24	NT	NT
25	NT	NT
26	<3	NR
27	1.79	0.537
28	NR	NR
29	NR	NR
30	NR	NR

Statistics

Assigned Value	Not Set	
Spike Value	Not Spiked	
Homogeneity Value	1.85	0.37
Robust Average	NA (N<6)	
Median	1.79	0.45
Mean	1.73	
N	5	
Max	2.1	
Min	1.391	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

Results: S3 - Bromide

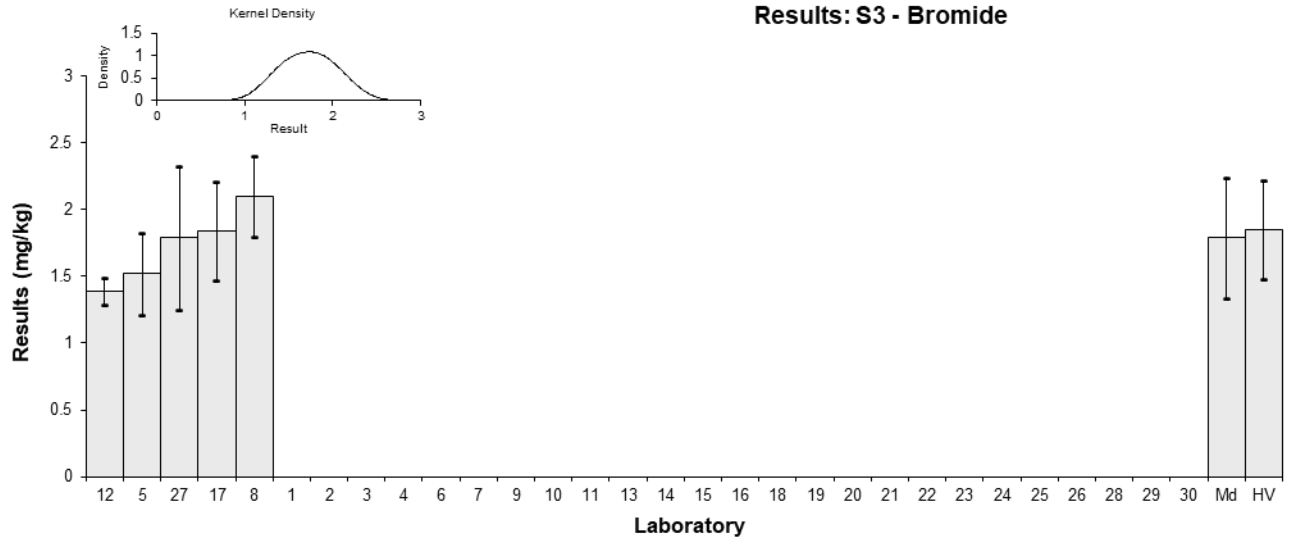


Figure 49

Table 60

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty
1	15	3
2	10	10
3	17.95	5.4
4	NT	NT
5	16.7	3.34
6	19.99	0.29
7	40	8
8	26.5	4.0
9	NT	NT
10	NT	NT
11	18.3	2.0
12	15.137	0.1
13	NR	NR
14	NT	NT
15	NT	NT
16	47.6	14.8
17	17.6	3.52
18	NT	NT
19	NR	NR
20	30	4.8
21	NT	NT
22	43	5
23	15	10
24	NT	NT
25	NT	NT
26	10	10
27	31.6	9.48
28	NR	NR
29	20.23	NR
30	<200	NR

Statistics

Assigned Value	Not Set	
Spike Value	Not Spiked	
Homogeneity Value	15.8	3.2
Robust Average	22.5	6.9
Median	18.3	3.0
Mean	23.2	
N	17	
Max	47.6	
Min	10	
Robust SD	11	
Robust CV	50%	

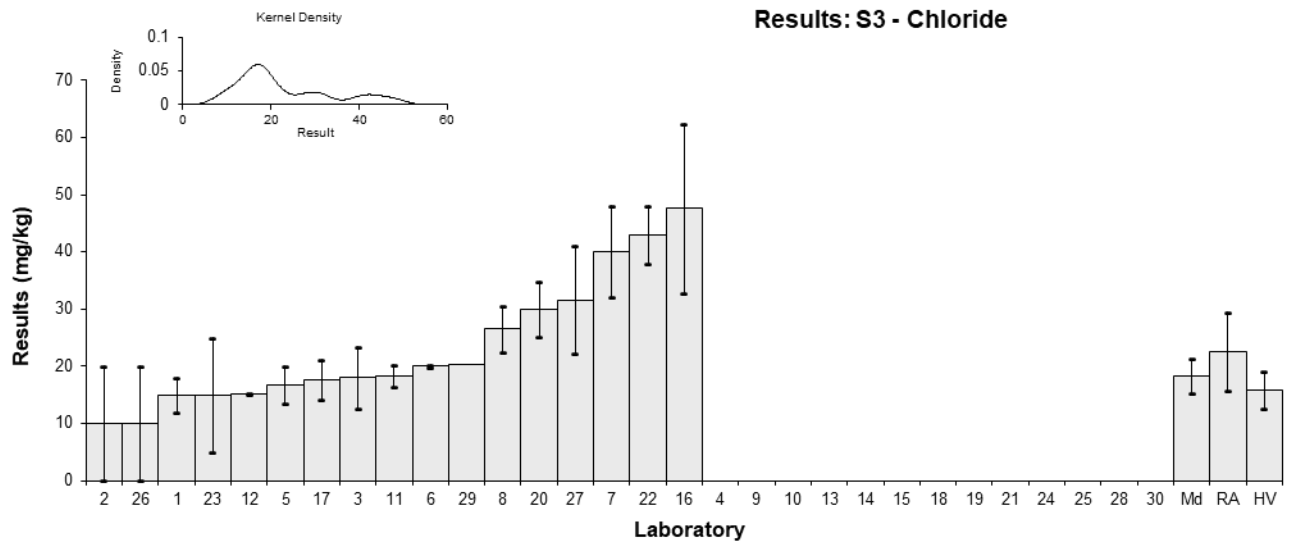


Figure 50

Table 61

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	1.5	0.3	-0.10	-0.08
2	1.3	1	-0.75	-0.22
3	NT	NT		
4	NT	NT		
5**	11.6	2.32	32.91	4.32
6	NR	NR		
7	NT	NT		
8	1.8	0.2	0.88	0.86
9	NT	NT		
10	NT	NT		
11	1.7	0.2	0.56	0.54
12	NT	NT		
13	NR	NR		
14	NT	NT		
15	NT	NT		
16**	21.8	6.54	66.24	3.10
17**	12.7	2.54	36.50	4.38
18	NT	NT		
19	NR	NR		
20	<5	NR		
21	NT	NT		
22**	15.05	0.15	44.18	47.77
23	1.2	1	-1.08	-0.32
24	NT	NT		
25	NT	NT		
26	1.7	1	0.56	0.17
27	1.52	0.456	-0.03	-0.02
28	NR	NR		
29	NR	NR		
30	NR	NR		

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	1.53	0.24
Spike Value	Not Spiked	
Homogeneity Value	1.60	0.32
Robust Average	1.53	0.24
Median	1.52	0.25
Mean	1.53	
N	7	
Max	1.8	
Min	1.2	
Robust SD	0.25	
Robust CV	16%	

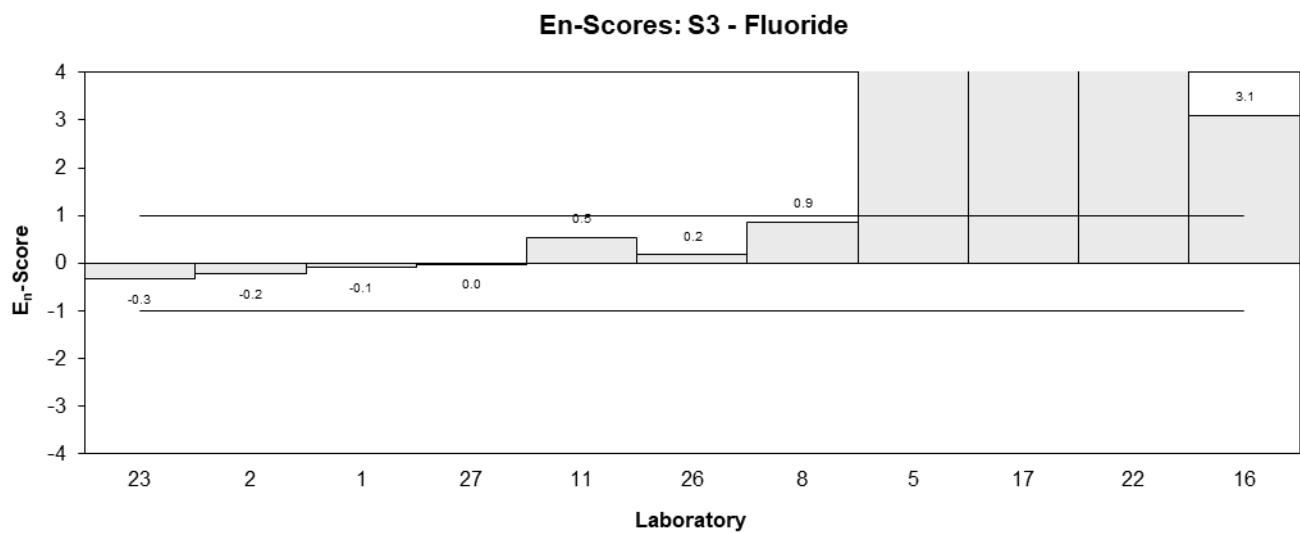
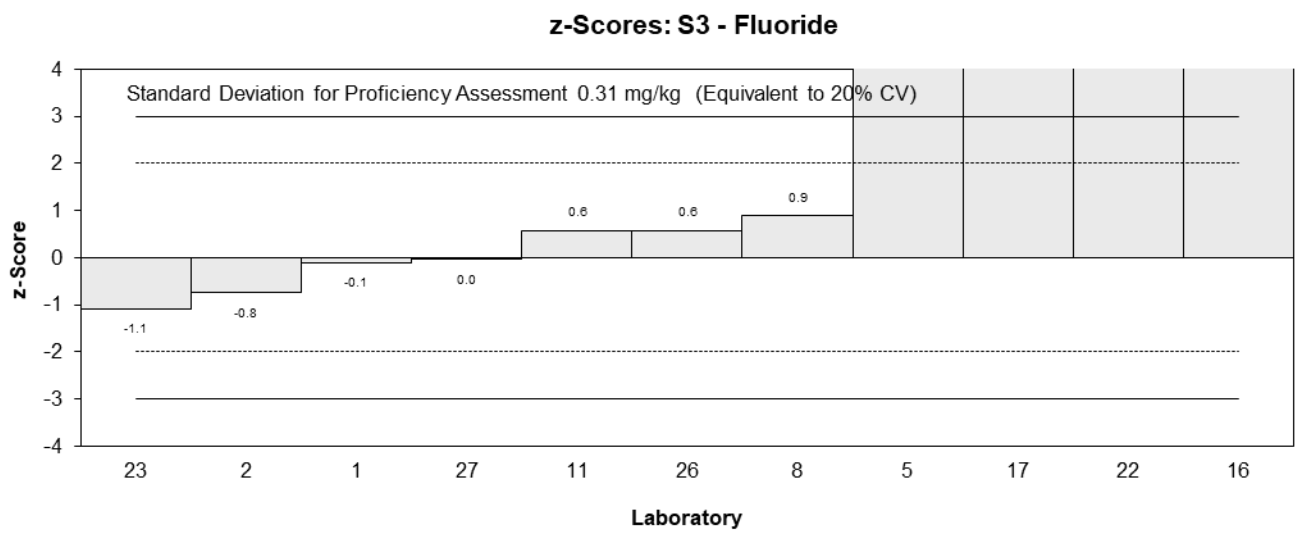
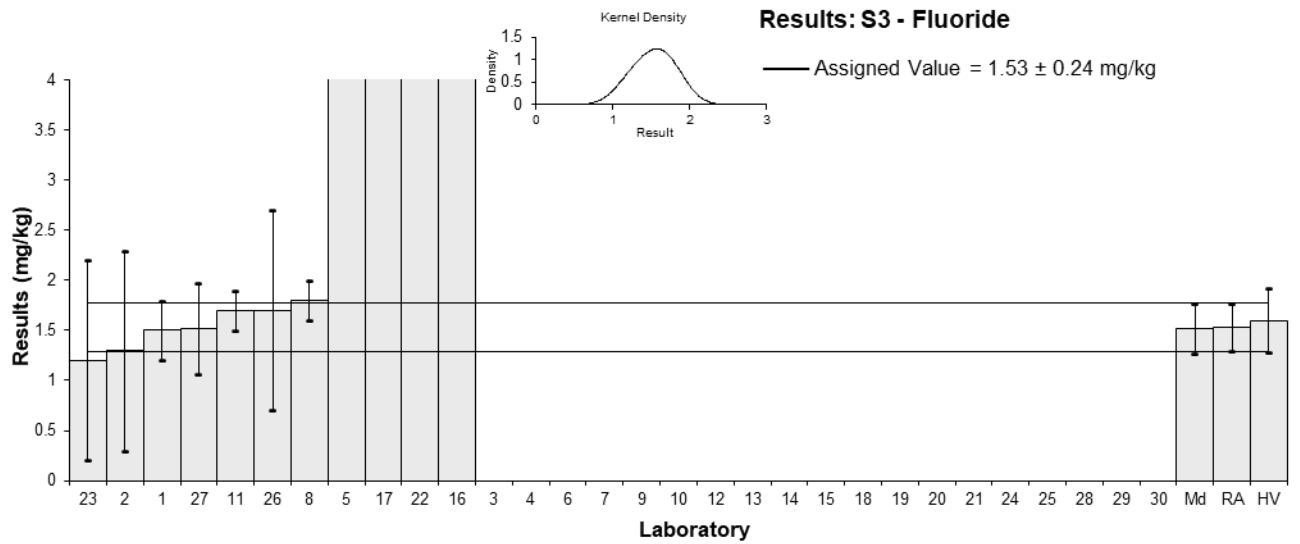


Figure 51

Table 62

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty
1	<1	NR
2	<0.5	NR
3	< 10	NR
4	NT	NT
5	0.59	0.118
6	NR	NR
7	< 1	NR
8	0.44	0.11
9	NT	NT
10	<5	NR
11	0.62	0.1
12	NT	NT
13	NR	NR
14	NT	NT
15	NT	NT
16	< 10	NR
17**	0.056	0.0112
18	NT	NT
19	NR	NR
20	0.4	0.06
21	NT	NT
22	0.55	0.12
23	<0.5	NR
24	NT	NT
25	NT	NT
26	<0.5	NR
27	1.30	0.39
28	NR	NR
29	NR	NR
30	NR	NR

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	Not Set	
Spike Value	Not Spiked	
Homogeneity Value	0.389	0.078
Robust Average	0.57	0.18
Median	0.57	0.14
Mean	0.65	
N	6	
Max	1.3	
Min	0.4	
Robust SD	0.17	
Robust CV	30%	

Results: S3 - Orthophosphate-P

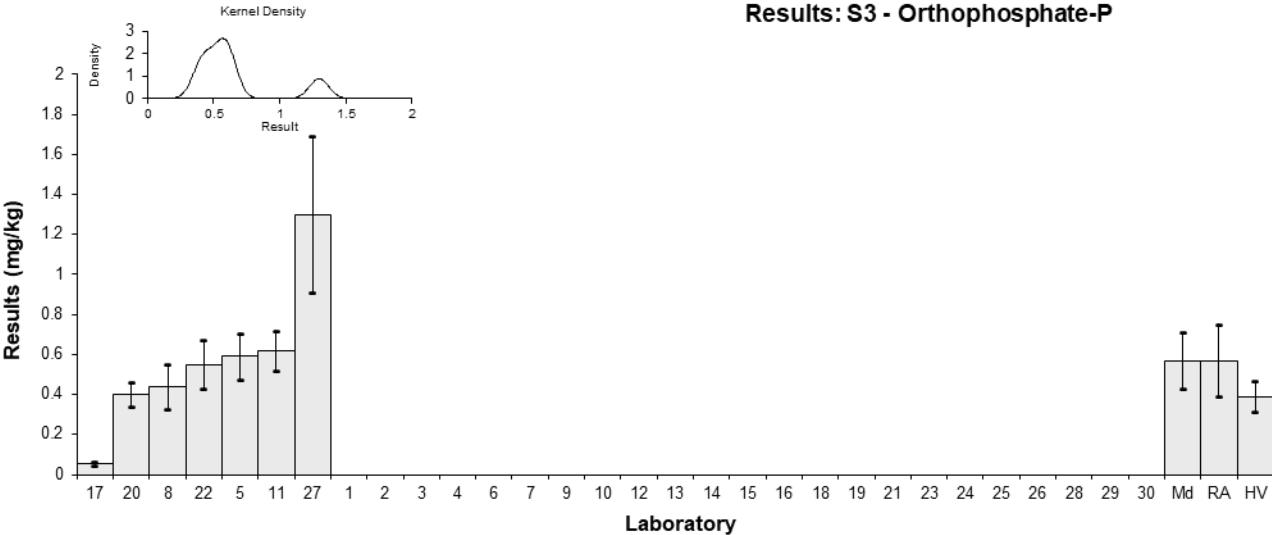


Figure 52

Table 63

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	130	26	-0.58	-0.51
2	160	50	0.44	0.24
3	169.6	50.9	0.77	0.41
4	NT	NT		
5	130	26	-0.58	-0.51
6	168	13.5	0.71	0.84
7	< 250	NR		
8	203	37	1.90	1.32
9	NT	NT		
10	NT	NT		
11	214	22	2.28	2.20
12	123.182	0.1	-0.81	-1.13
13	NR	NR		
14	NT	NT		
15	NT	NT		
16	148.8	44.6	0.06	0.04
17	118.4	23.68	-0.97	-0.90
18	NT	NT		
19	NR	NR		
20	<50	NR		
21	NT	NT		
22	140	15	-0.24	-0.27
23	148	50	0.03	0.02
24	NT	NT		
25	NT	NT		
26	130	50	-0.58	-0.31
27	101.4	30.42	-1.55	-1.23
28	NR	NR		
29	NR	NR		
30*	50	5.0	-3.30	-4.49

* Outlier, see Section 4.2

Statistics

Assigned Value	147	21
Spike Value	Not Spiked	
Homogeneity Value	122	24
Robust Average	143	22
Median	140	19
Mean	142	
N	15	
Max	214	
Min	50	
Robust SD	35	
Robust CV	24%	

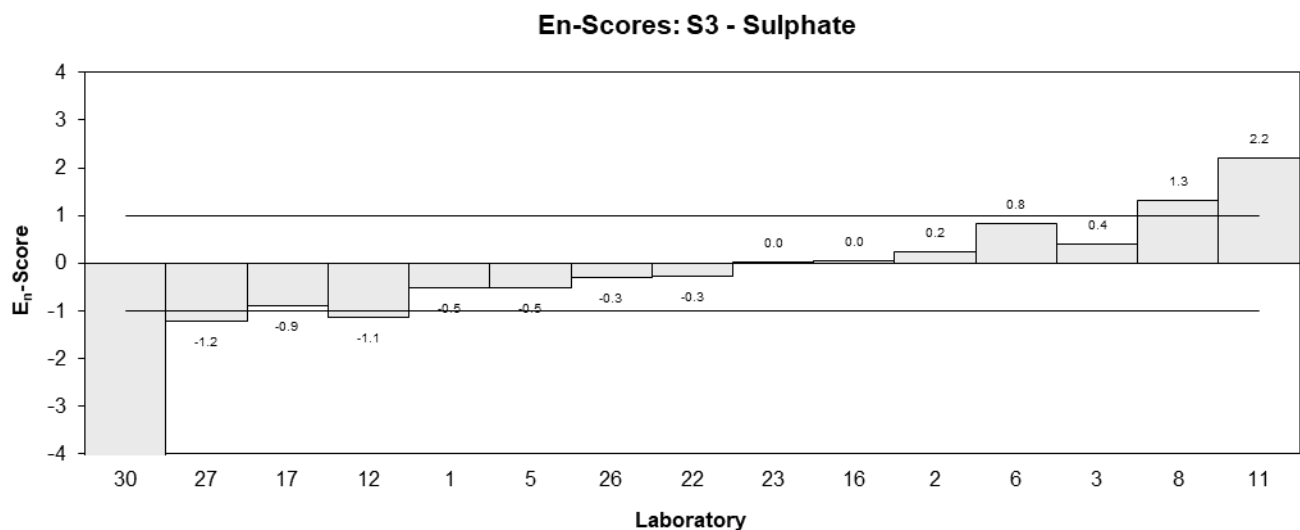
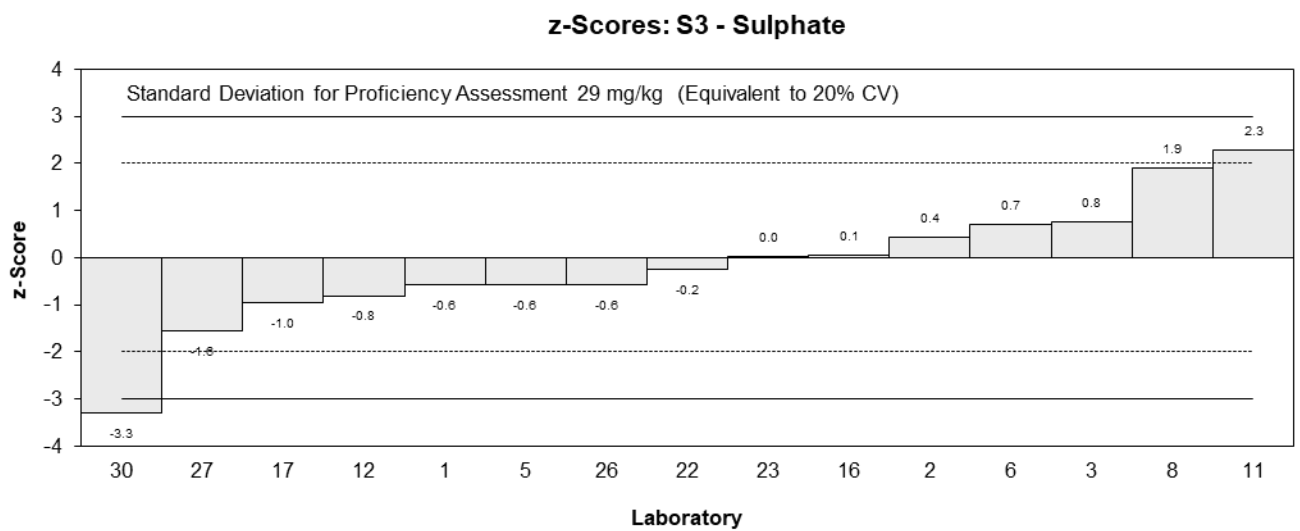
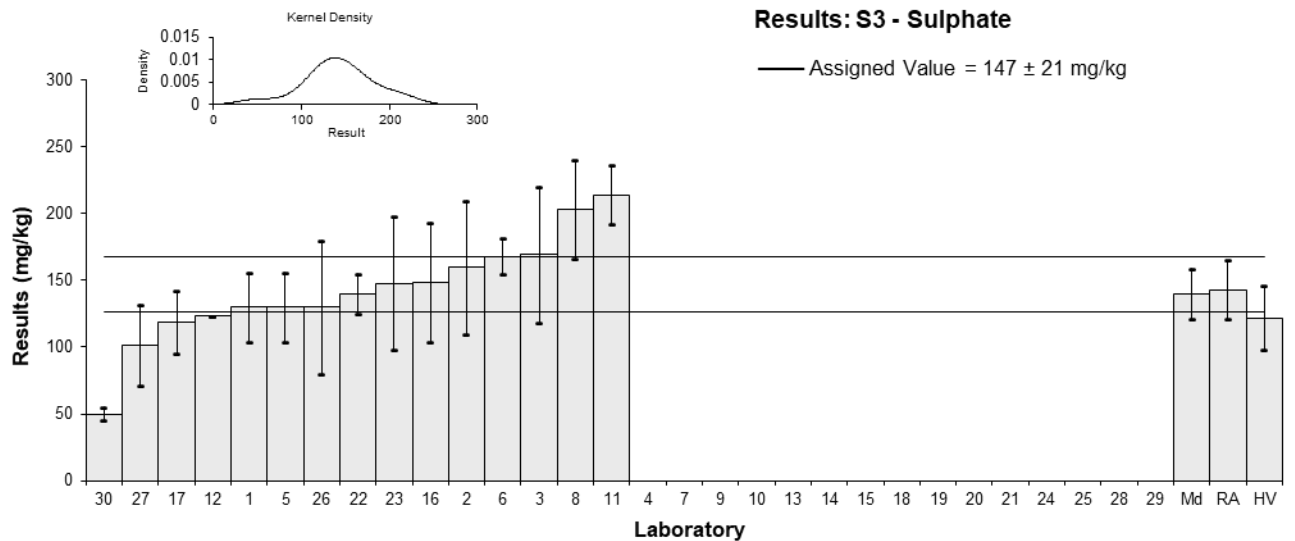


Figure 53

Table 64

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	250	50	0.00	0.00
2	250	40	0.00	0.00
3	261.5	78.5	0.46	0.15
4	NT	NT		
5	200	40	-2.00	-1.23
6	250	1.18	0.00	0.00
7	250	50	0.00	0.00
8	253	30	0.12	0.10
9	NT	NT		
10	310	3.1	2.40	7.84
11	243	24	-0.28	-0.28
12	241	20	-0.36	-0.42
13	NR	NR		
14	250	30	0.00	0.00
15	266	NR	0.64	2.29
16	230.1	69.0	-0.80	-0.29
17	250	50	0.00	0.00
18	NT	NT		
19	255.2	25.52	0.21	0.20
20	240	24	-0.40	-0.40
21	NT	NT		
22	290	18	1.60	2.07
23	270	80	0.80	0.25
24	NT	NT		
25	231.4	46.3	-0.74	-0.40
26	260	80	0.40	0.12
27	243.5	73.05	-0.26	-0.09
28	NR	NR		
29	237	22	-0.52	-0.56
30	250	6.0	0.00	0.00

Statistics

Assigned Value	250	7
Spike Value	Not Spiked	
Robust Average	250	7
Median	250	7
Mean	251	
N	23	
Max	310	
Min	200	
Robust SD	14	
Robust CV	5.7%	

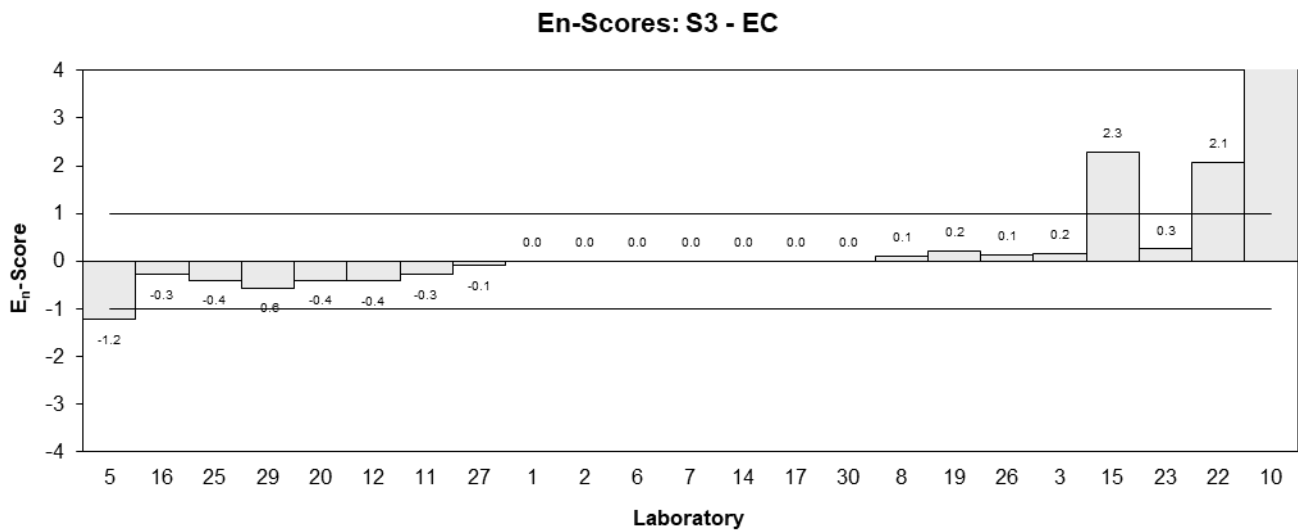
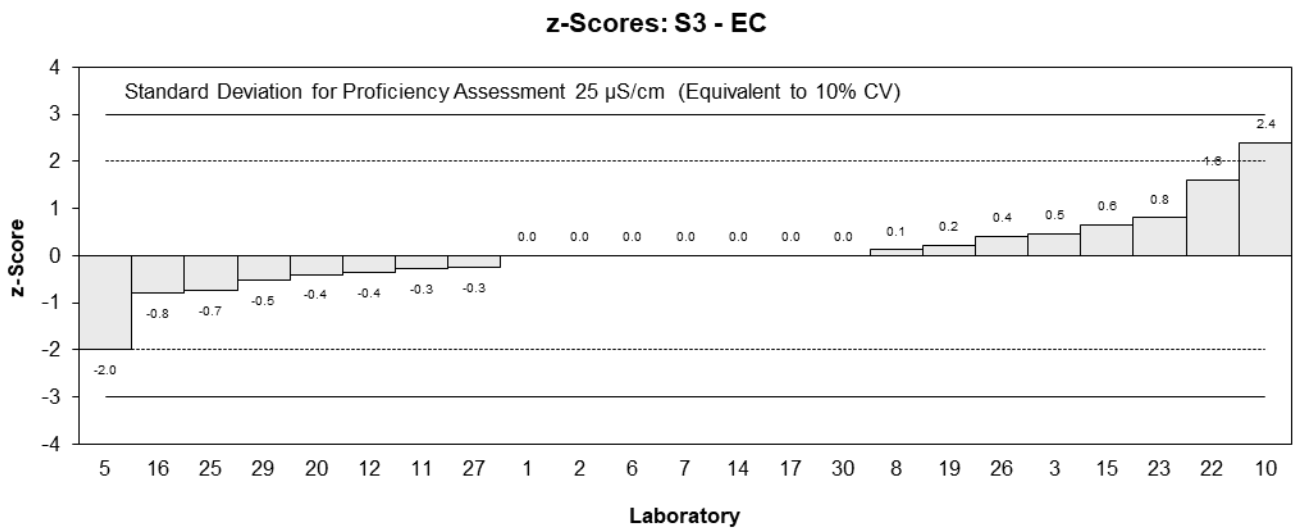
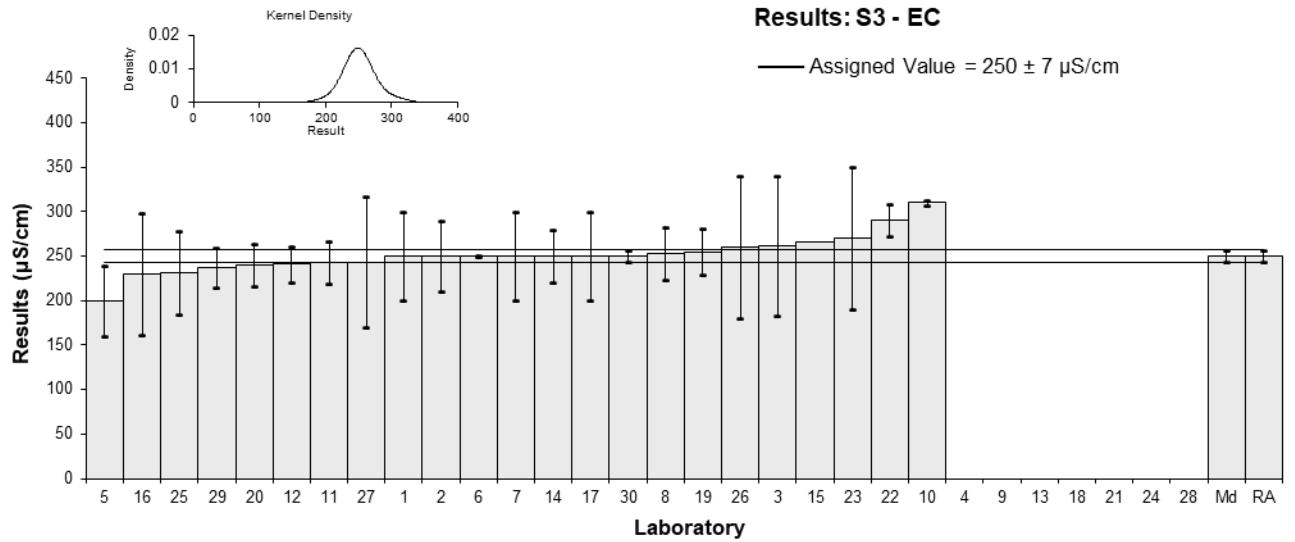


Figure 54

Table 65

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	pH

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	4.6	0.9	0.31	0.06
2	4.7	0.2	0.94	0.74
3	4.59	0.2	0.25	0.20
4	NT	NT		
5	4.53	0.906	-0.13	-0.02
6	NR	NR		
7	4.5	0.3	-0.31	-0.17
8	4.5	0.2	-0.31	-0.25
9	NT	NT		
10	4.6	NR	0.31	1.25
11	4.57	0.2	0.13	0.10
12	4.59	0.1	0.25	0.37
13	NR	NR		
14	4.57	0.2	0.13	0.10
15	NT	NT		
16	4.51	0.3	-0.25	-0.13
17	4.7	0.94	0.94	0.16
18	NT	NT		
19	4.47	0.06	-0.50	-1.11
20	4.5	0.3	-0.31	-0.17
21	NT	NT		
22	4.44	0.10	-0.69	-1.02
23	4.5	0.2	-0.31	-0.25
24	NT	NT		
25	4.55	0.30	0.00	0.00
26	4.6	0.2	0.31	0.25
27	4.59	0.2	0.25	0.20
28	NR	NR		
29	4.52	0.15	-0.19	-0.19
30	4.4	0.1	-0.94	-1.39

Statistics

Assigned Value	4.55	0.04
Spike Value	Not Spiked	
Robust Average	4.55	0.04
Median	4.55	0.04
Mean	4.55	
N	21	
Max	4.7	
Min	4.4	
Robust SD	0.070	
Robust CV	1.5%	

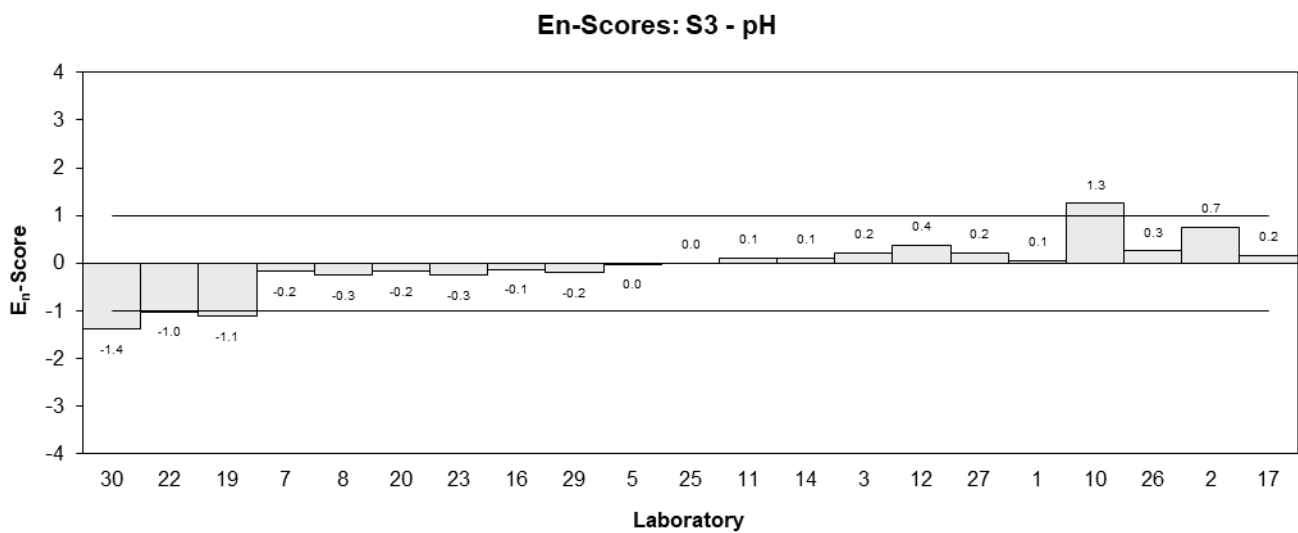
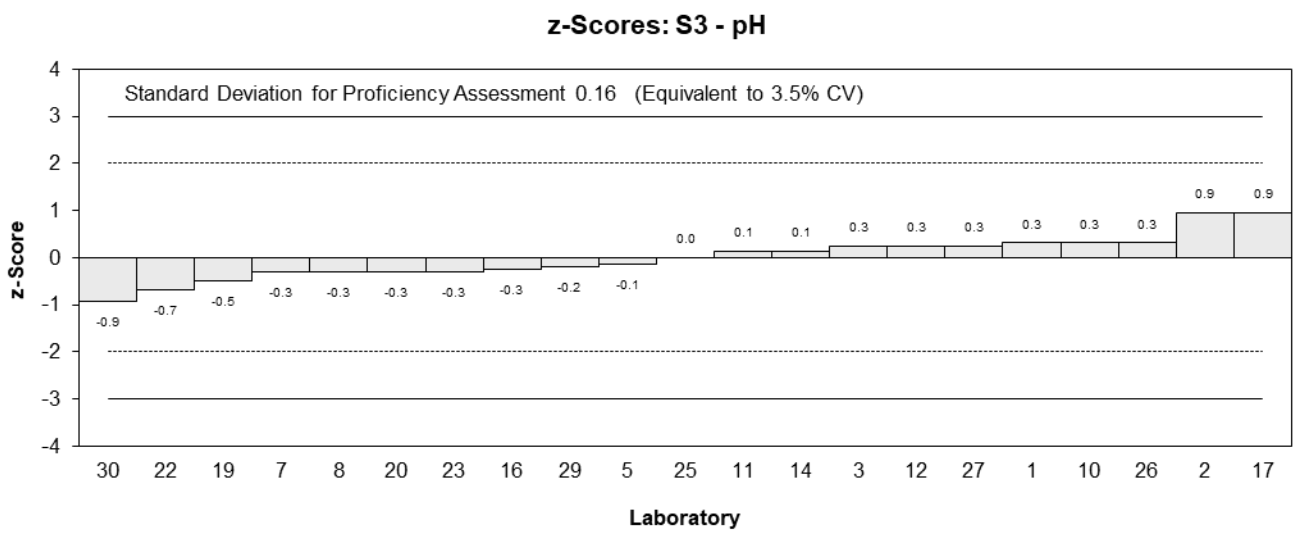
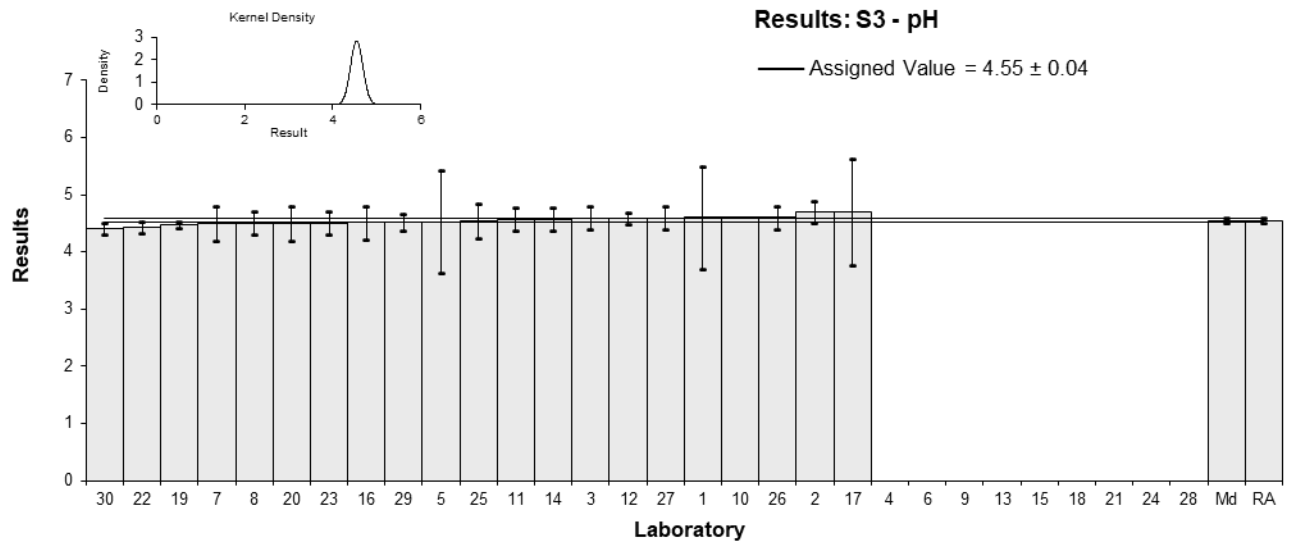


Figure 55

Table 66

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	36	7.2	-0.36	-0.34
2	43	10	0.54	0.39
3	NT	NT		
4	NT	NT		
5	NT	NT		
6	NR	NR		
7	NT	NT		
8	42.0	10.5	0.41	0.29
9	NT	NT		
10	NT	NT		
11	35.3	3.5	-0.45	-0.68
12	NT	NT		
13	NR	NR		
14	NT	NT		
15	NT	NT		
16	NT	NT		
17	27.6	5.52	-1.44	-1.67
18	NT	NT		
19	41.3	8.2	0.32	0.28
20	NR	NR		
21	NT	NT		
22*	67.8	3.5	3.74	5.61
23	40	10	0.15	0.11
24	NT	NT		
25	NT	NT		
26*	6.7	4	-4.14	-5.82
27	40.28	12.084	0.19	0.12
28	NR	NR		
29*	6.74	2.36	-4.13	-7.17
30	NR	NR		

* Outlier, see Section 4.2

Statistics

Assigned Value	38.8	3.8
Spike Value	Not Spiked	
Robust Average	35	11
Median	40.0	4.5
Mean	35.2	
N	11	
Max	67.8	
Min	6.7	
Robust SD	15	
Robust CV	43%	

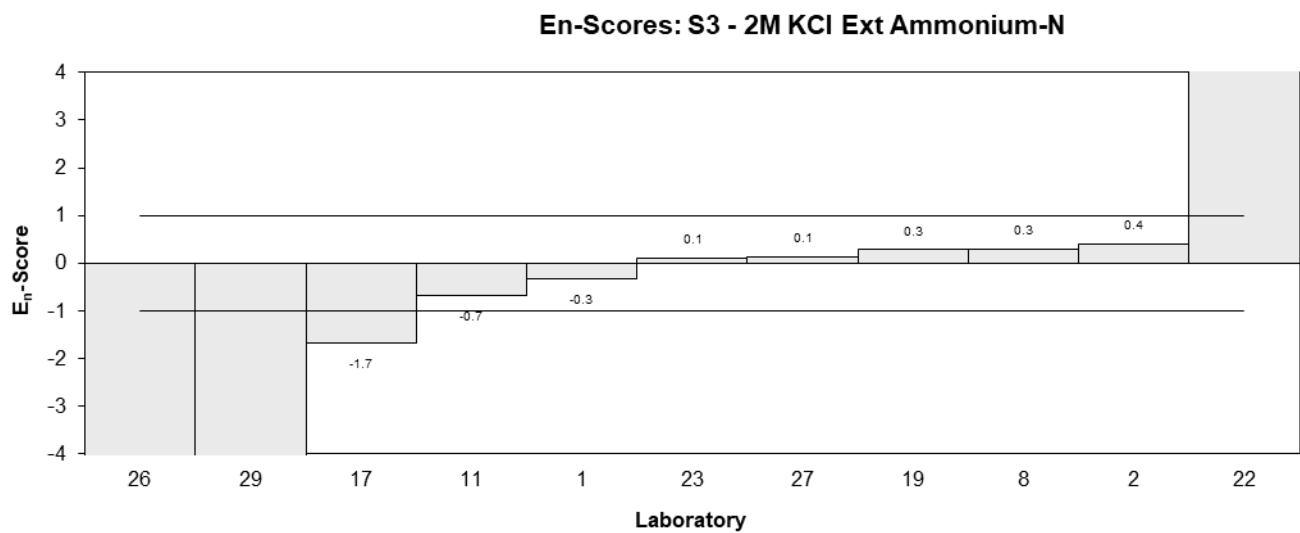
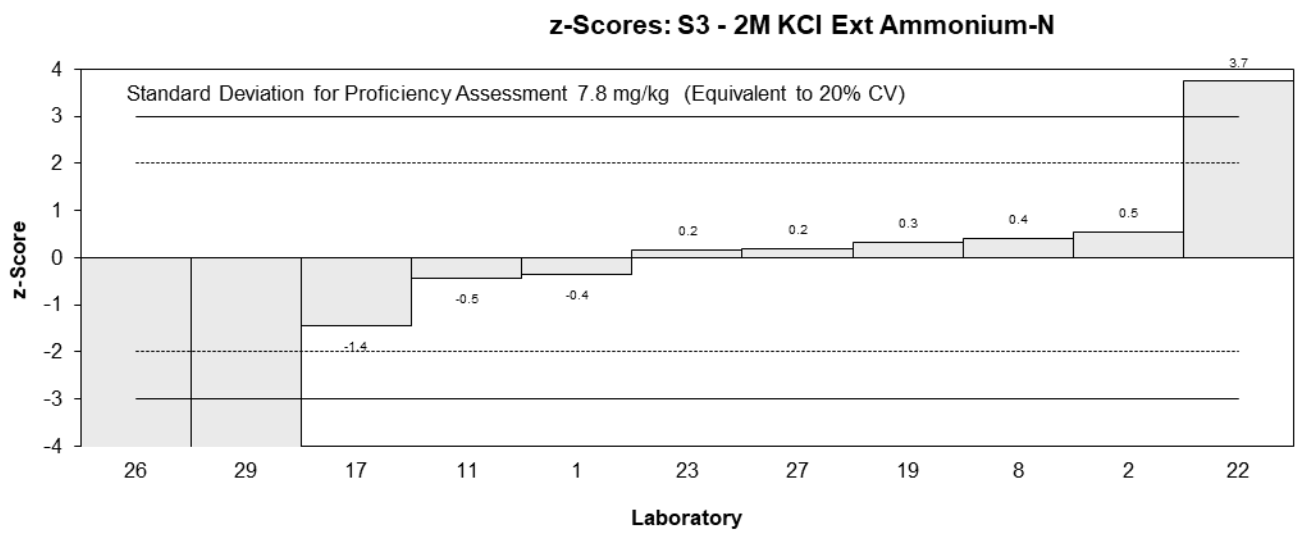
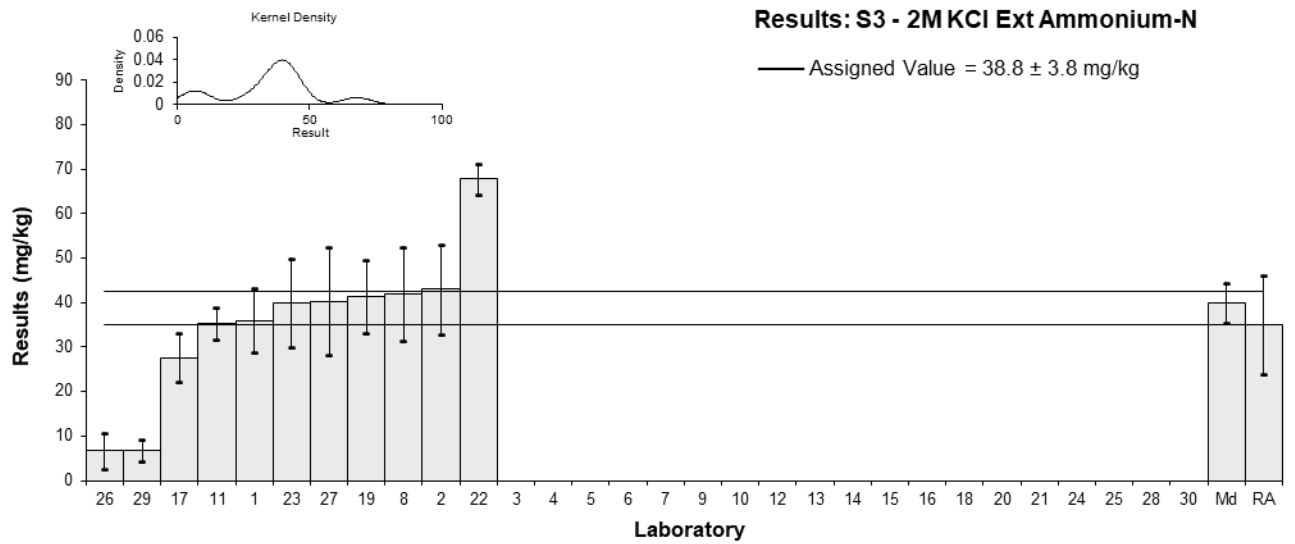


Figure 56

Table 67

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	7.0	1.4	0.38	0.29
2	8.2	3	1.31	0.54
3	NT	NT		
4	NT	NT		
5	7.23	1.446	0.56	0.42
6	NR	NR		
7	NT	NT		
8	5.6	1.34	-0.69	-0.54
9	NT	NT		
10	NT	NT		
11	5.8	0.6	-0.54	-0.60
12	NT	NT		
13	NR	NR		
14	NT	NT		
15	NT	NT		
16	6	1.8	-0.38	-0.24
17	6.6	1.32	0.08	0.06
18	NT	NT		
19	<5	NR		
20	NR	NR		
21	NT	NT		
22	3.65	0.35	-2.19	-2.69
23	7.5	4	0.77	0.24
24	NT	NT		
25	NT	NT		
26*	52	20	35.00	2.27
27	NT	NT		
28	NR	NR		
29*	44.05	1.11	28.88	25.13
30	NR	NR		

* Outlier, see Section 4.2

Statistics

Assigned Value	6.5	1.0
Spike Value	Not Spiked	
Robust Average	7.2	1.9
Median	7.0	1.3
Mean	14.0	
N	11	
Max	52	
Min	3.65	
Robust SD	2.5	
Robust CV	34%	

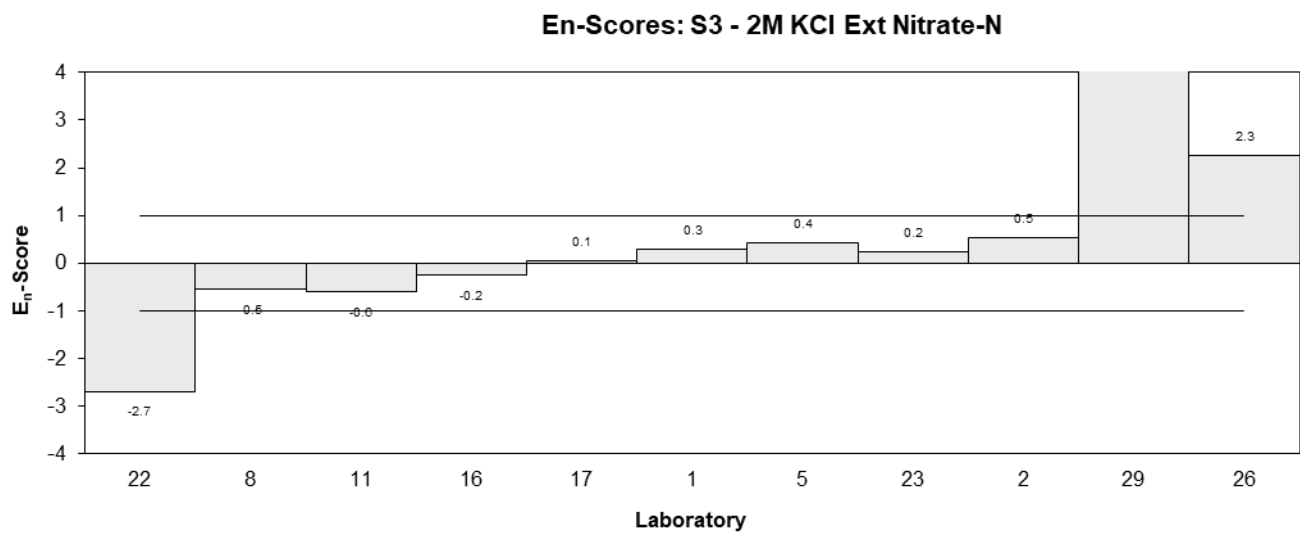
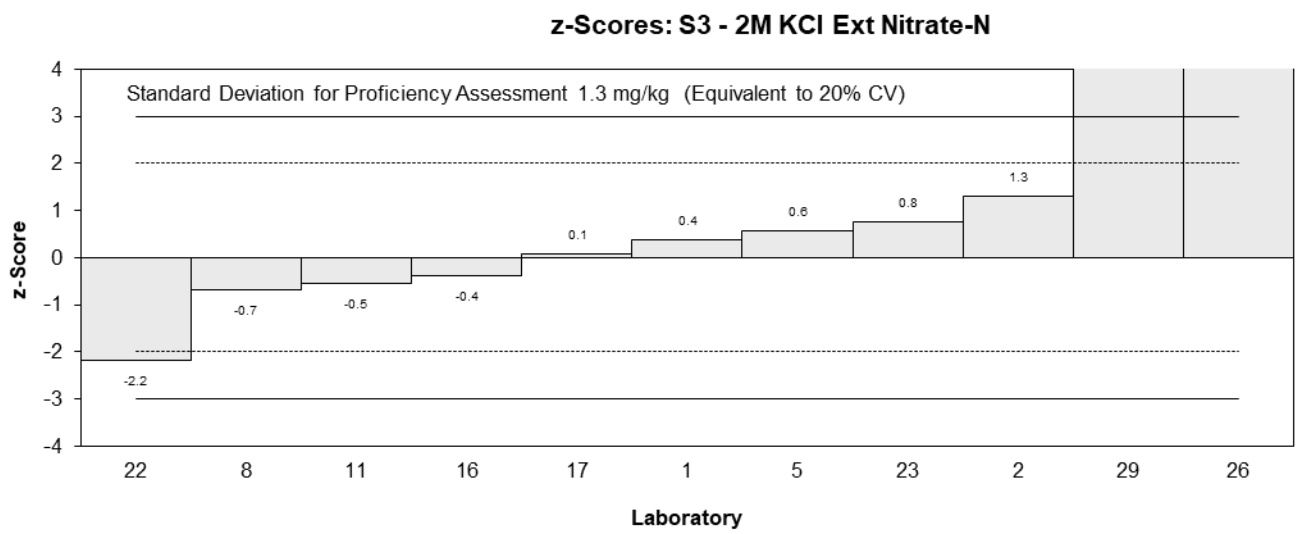
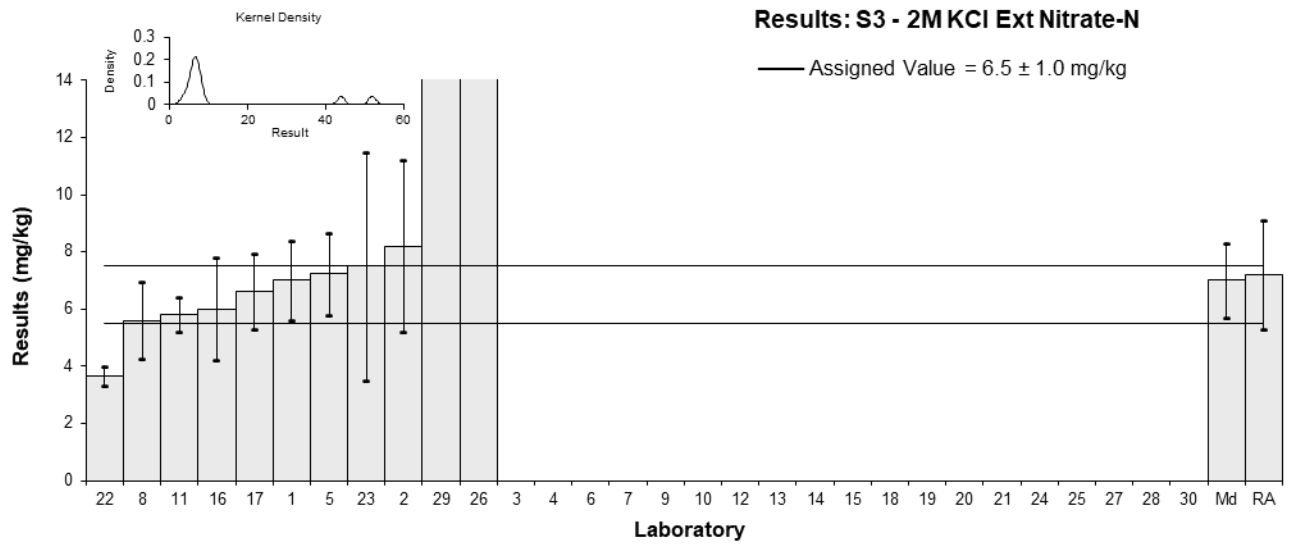


Figure 57

6 DISCUSSION OF RESULTS

6.1 Assigned Value and Traceability

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 'Statistical methods for use in proficiency testing by interlaboratory comparisons'. Results less than 50% and more than 150% of the robust average were removed before calculation of each assigned value (see subchapters 4.2 and 4.3).^{3,6} Appendix 2 sets out the calculation of the robust average of As in Sample S1 and its associated uncertainty.

No assigned value was set for Ag, B, Ga, and Rb in S2, and bromide, chloride, and orthophosphate-P 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 median of participants' results and/or the homogeneity value. Descriptive statistics for these elements are presented in Section 5.

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

6.2 Measurement Uncertainty Reported by Participants

Participants were asked to report an evaluation of the expanded measurement uncertainty associated with their results. 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.⁸

Participants were asked to report an evaluation of the expanded measurement uncertainty associated with their results. Of 899 numerical results, 891 (99%) were reported with an expanded measurement uncertainty. The magnitude of these expanded uncertainties was within the range 0.08% to 217% of the reported value. The participants used a wide variety of procedures to evaluate their expanded measurement uncertainties. These are presented in Table 9.

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 inter-laboratory comparison studies.^{9 - 14}

Participation in PT programs allows participants to check that their evaluations of measurement uncertainty is reasonable. Results and the expanded MU are presented in the bar charts for each analyte in this study (Figures 2 to 57) 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, 15 laboratories reported results for Sulphate in S3. The uncertainty of the assigned value evaluated from the robust standard deviation of the 15 laboratories' results is 21 mg/kg (14% of the assigned value). Laboratory 12 might have under-estimated their expanded measurement uncertainty of 0.1 mg/kg (0.08% of their reported value) as an uncertainty evaluated from one measurement cannot be smaller than the uncertainty evaluated from 15 measurements.

Alternatively, evaluations of uncertainties for Al in S2 larger than 3600 mg/kg (the uncertainty of the assigned value, 600 mg/kg plus the allowable variation from the assigned value, the SDPA of 1500 mg/kg, multiplied by 2, the coverage factor for a confidence interval of 95%), should also be viewed as suspect. For example, the expanded measurement

uncertainty reported by **Laboratory 9** for Al in S2 of 6258 mg/kg might have been over-estimated.

Laboratories 6, 11, 12, 22, 28, and 30 should review their calculation procedure for evaluating measurement uncertainty as some of their uncertainties were very low.

Laboratories 2, 12, 24, and 26 reported evaluations of expanded uncertainty for some of their measurement results equal to larger than the results themselves. These laboratories should also review their evaluation procedure as it might not be fit-for-purpose.

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.¹⁰ An example of evaluating measurement uncertainty using only proficiency testing is given in Appendix 3.

Laboratory 14 attached an evaluation of the expanded measurement uncertainty to a result 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.⁹

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, a result of 728.5 ± 145.7 mg/kg, it is better to report 730 ± 150 mg/kg or instead of 0.585 ± 0.117 mg/kg, it is better to report 0.59 ± 0.12 mg/kg.⁹

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. SDPA's equivalent to 3.5% to 20% performance coefficient of variation (PCV) was 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 assessment of laboratory performance, independent of group performance.

The between-laboratory coefficient of variation predicted by the Thompson-Horwitz equation⁷ and between-laboratory coefficient of variation from reported results in this study are presented for comparison in Table 68.

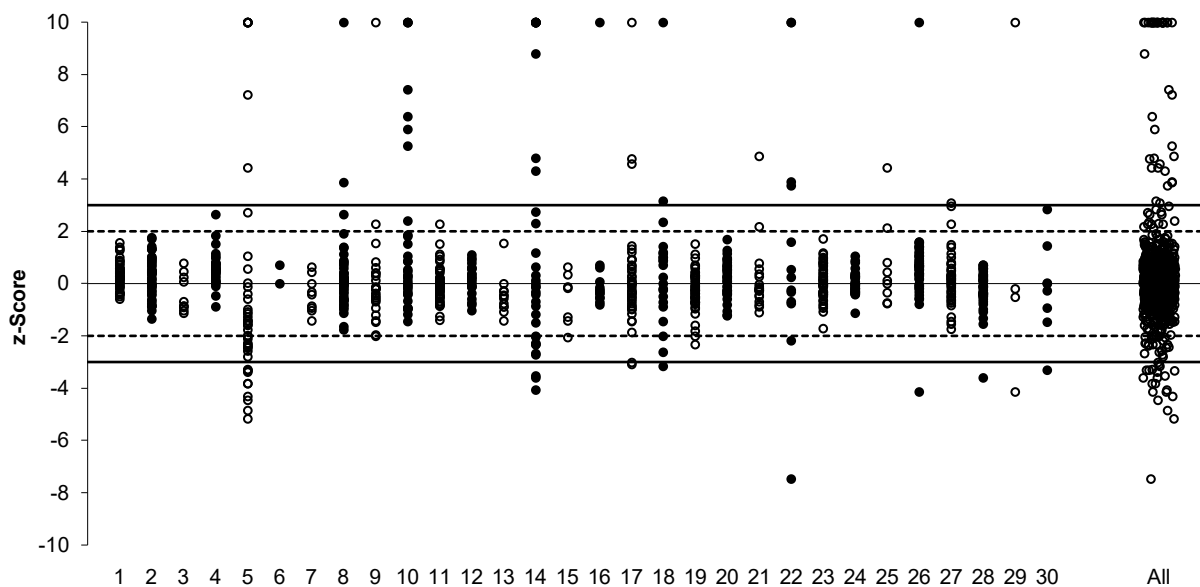
The dispersal of participants' z-scores is graphically presented by laboratory in Figure 58 and by test in Figure 60. Of 838 results for which z-scores were calculated, 743 (89%) returned an acceptable score of $|z| \leq 2.0$, and 33 (4%) were questionable with a score of $2.0 < |z| < 3.0$. Participants with multiple z-scores larger than 2.0 or smaller than -2.0 should check for laboratory bias.

Summary of participants' reported results and performance is presented in Figure 61.

Laboratories 1, 2 and 11 returned the highest number of acceptable z-scores with 47.

Laboratory 11 reported results for 48 analytes, while **Laboratories 1 and 2** reported results for 47 analytes.

All results reported by **Laboratories 23** (45), **20** (36), **24** (34), **12** (22), **13** (12), **3** (10), **7** (9) and **6** (2) returned acceptable z-scores.



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

Figure 58 z-Score Dispersal by Laboratory

6.4 E_n -score

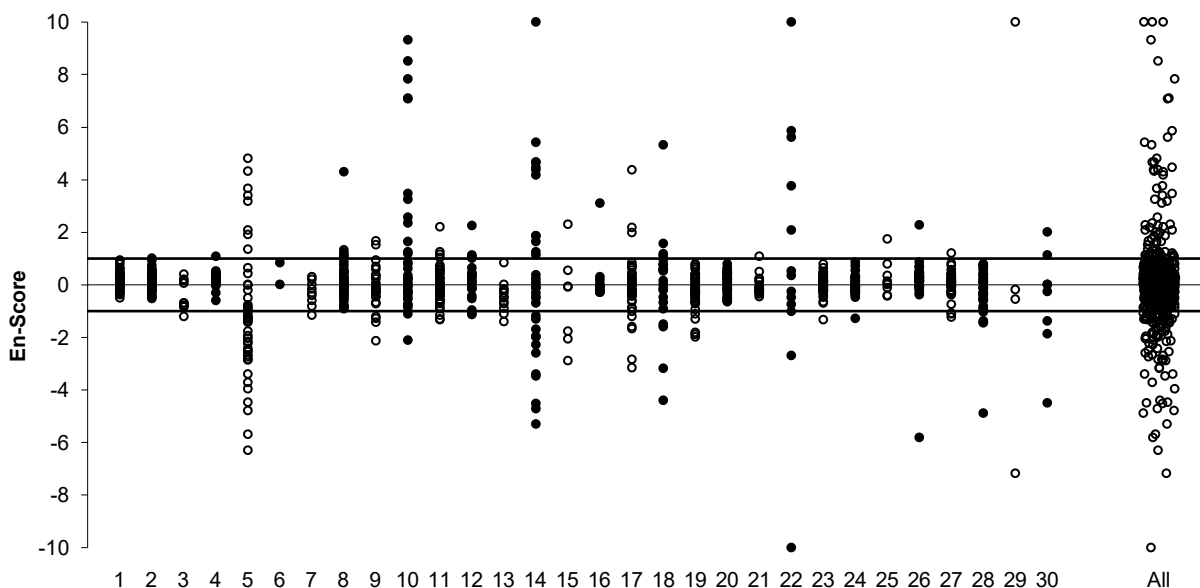
E_n -score can be interpreted in conjunction with z-scores. The E_n -score indicates how closely a result agrees with the assigned value considering the respective uncertainties. An unacceptable E_n -score for an analyte can either be caused by an inappropriate measurement, an inappropriate evaluation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

The dispersal of participants' E_n -scores is graphically presented in Figure 59. Where a laboratory did not report an expanded uncertainty with a result, an expanded uncertainty of zero (0) was used to calculate the E_n -score.

Of 838 results for which E_n -scores were calculated, 679 (81%) 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 1 returned the highest number of acceptable E_n -scores (47 out of 47 reported).

All results reported by **Laboratories 20** (36) and **6** (2) returned acceptable E_n -scores.



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

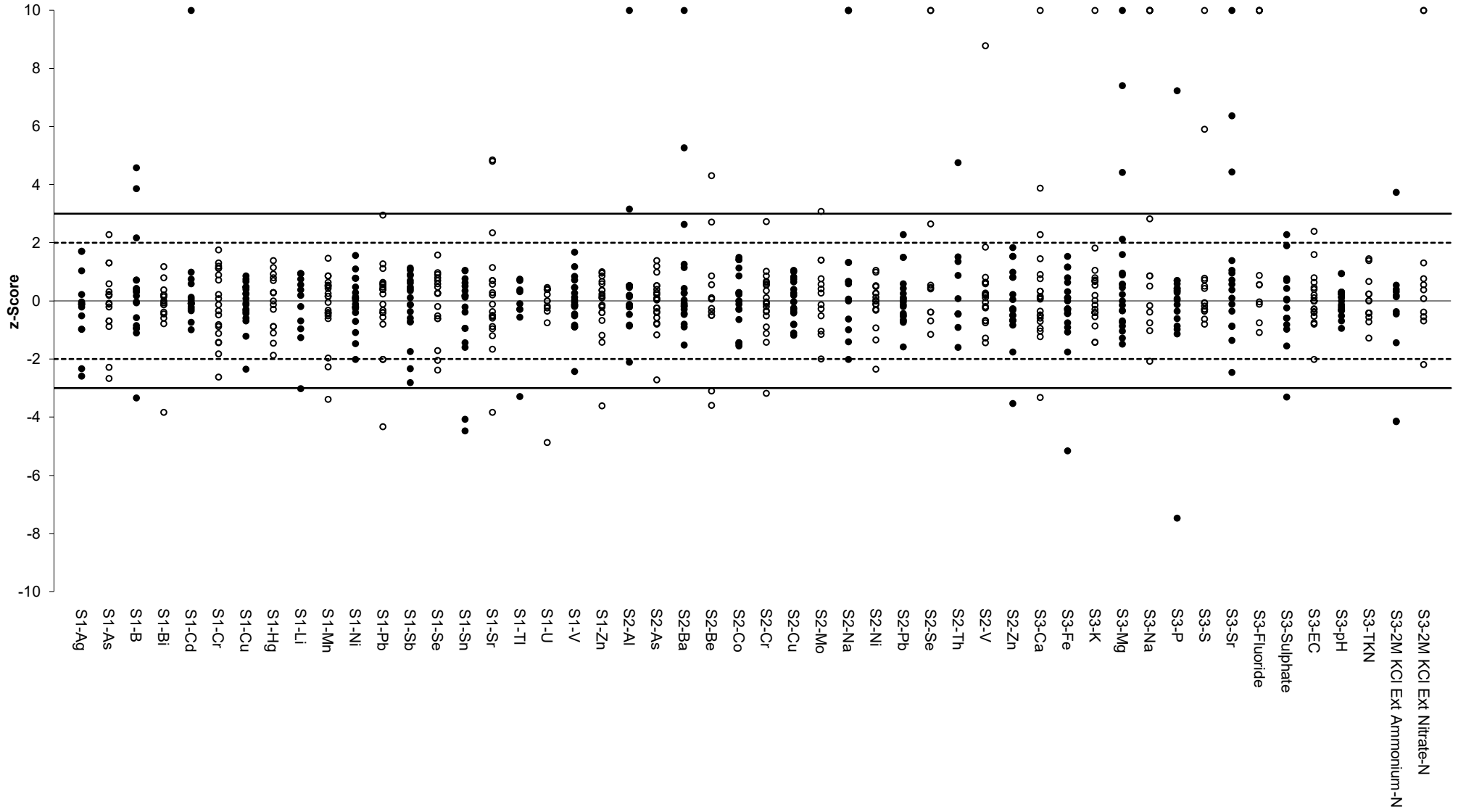
Figure 59 E_n -Score Dispersal by Laboratory

Table 68 Standard Deviation for Proficiency Assessment, Thompson/Horwitz and Between-Laboratory CV

Sample	Test	Assigned Value (mg/kg)	SDPA (as PCV, %)	Thompson/Horwitz CV (%)	Between Laboratories CV* (%)
S1	Ag	1.49	20	15	23
S1	As	3.34	15	13	16
S1	B	36.1	15	9.3	12
S1	Bi	6.79	15	12	7.9
S1	Cd	1.01	15	16	7.1
S1	Cr	62.9	20	8.6	25
S1	Cu	354	15	6.6	9.5
S1	Hg	1.15	15	16	16
S1	Li	1.75	15	15	16
S1	Mn	423	10	6.4	8.2
S1	Ni	102	10	8	8.1
S1	Pb	12.5	10	11	10
S1	Sb	112	15	7.9	15
S1	Se	4.56	20	13	23
S1	Sn	30.2	15	9.6	13
S1	Sr	243	10	7	13
S1	Tl	1.42	15	15	10
S1	U	1.73	10	15	4.7
S1	V	34.6	15	9.4	11
S1	Zn	781	10	5.9	7.7
S2	Ag	Not Set	Not Set	NA	50
S2	Al	15200	10	3.8	6.1
S2	As	33.9	15	9.4	12
S2	B	Not Set	Not Set	NA	37
S2	Ba	48.7	20	8.9	16
S2	Be	0.540	15	18	13
S2	Co	17.5	10	10	11
S2	Cr	38.1	15	9.2	13
S2	Cu	31.1	15	9.5	12
S2	Mo	0.78	20	17	22
S2	Na	100	15	8	18
S2	Ni	81.9	10	8.2	6.9
S2	Pb	43.2	15	9.1	11
S2	Rb	Not Set	Not Set	NA	46
S2	Se	0.65	20	17	19
S2	Th	2.20	20	14	24
S2	V	38.3	15	9.2	11
S2	Zn	182	10	7.3	12
S3	Ca	882	10	5.8	11
S3	Fe	18800	10	3.6	8.7
S3	K	786	15	5.9	13
S3	Mg	379	15	6.5	16
S3	Na	34.1	20	9.4	28
S3	P	383	10	6.5	6.7
S3	S	352	10	6.6	5.9
S3	Sr	13.8	15	11	16
S3	Chloride	Not Set	Not Set	NA	50
S3	Fluoride	1.53	20	15	16
S3	Orthophosphate-P	Not Set	Not Set	NA	31
S3	Sulphate	147	20	7.5	21
S3	EC	250 (µS/cm)	10	NA	5.7

Sample	Test	Assigned Value (mg/kg)	SDPA (as PCV, %)	Thompson/ Horwitz CV (%)	Between Laboratories CV* (%)
S3	pH	4.55	3.5	NA	1.5
S3	TKN	3090	15	4.8	13
S3	2M KCl Ext Ammonium-N	38.8	20	9.2	11
S3	2M KCl Ext Nitrate-N	6.5	20	12	19

NA = Not Available, *Robust between Laboratories CV with outliers removed.



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

Figure 60 z-Score Dispersal by Test

Summary of Participant's Performance in AQA 25-12 Samples S1, S2 and S3

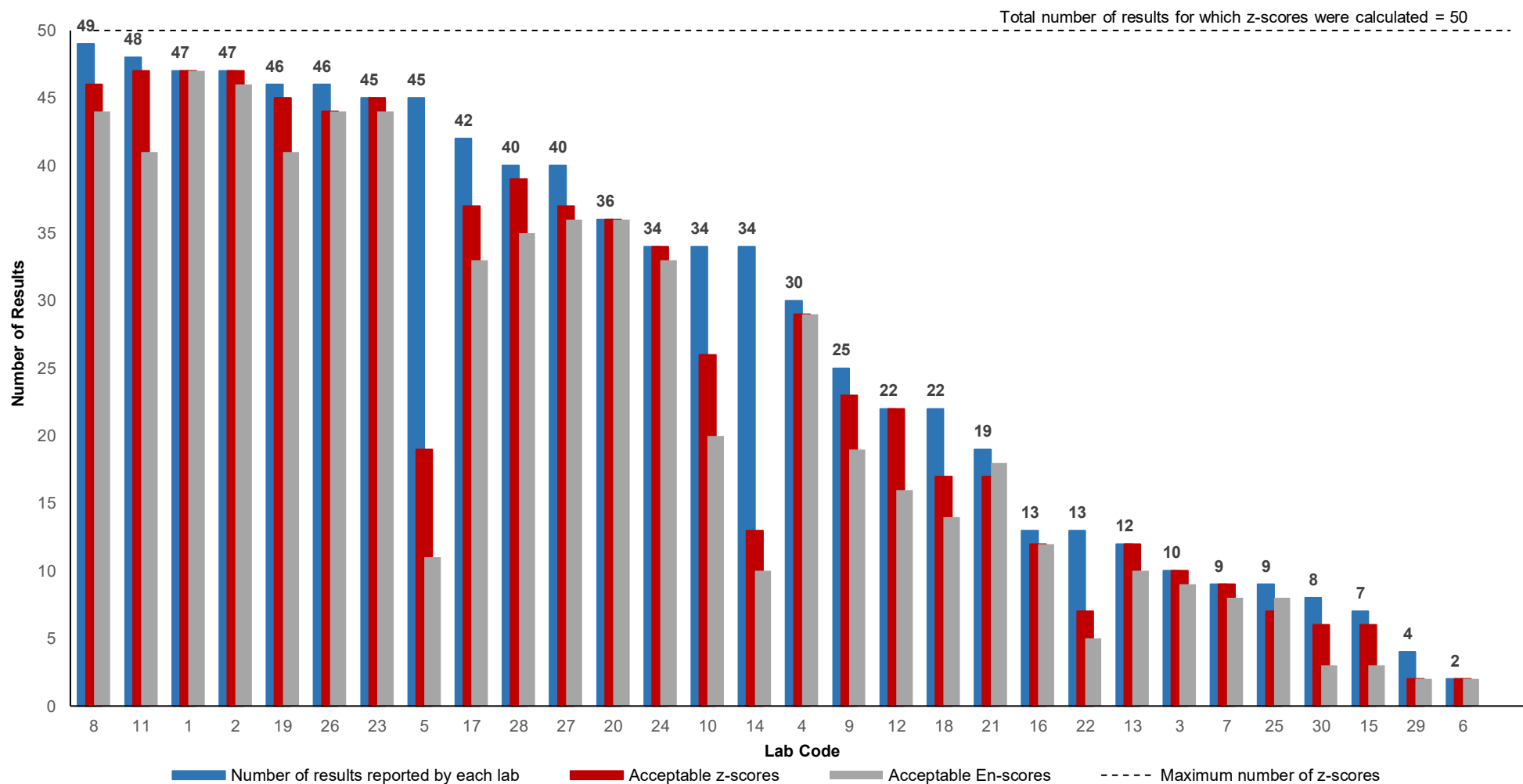


Figure 61 Summary of Participants' Performance

Table 69 Summary of Participants' Results and Performance in Sample S1

Lab Code	Ag (mg/kg)	As (mg/kg)	B (mg/kg)	Bi (mg/kg)	Cd (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Hg (mg/kg)	Li (mg/kg)	Mn (mg/kg)
AV	1.49	3.34	36.1	6.79	1.01	62.9	354	1.15	1.75	423
HV	1.42	3.26	34.8	6.95	0.93	67.5	373	1.22	1.61	463
1	1.45	3.44	37.1	6.93	0.996	79.5	368	1.27	NR	441
2	2	4	38	7	1	85	380	1	2	460
3	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
4	NR	3.45	38.5	7.18	1.125	51.8	380	1.35	1.95	445.5
5	0.72	2.2	18	2.9	0.86	45	230	NT	NT	280
6	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
7	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
8	1.46	3.30	57	6.80	1.00	65.8	323.0	1.20	1.80	397.0
9	NT	3	31	NT	<1	57	290	<1	1.7	340
10	1.2	<5	31	NT	<1	64	350	0.9	NT	410
11	1.43	3.29	36	6.67	1.01	77.1	337	1.15	1.42	406
12	NT	3.64	NT	NT	1.10	NT	366.49	1.13	NT	446.32
13	NR	NR	NR	NR	NR	NR	NR	1.1	NR	404
14	<2	2.00	31.5	6.67	<1	58.7	331	<1	1.57	327
15	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
16	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
17	1.2	2.9	60.9	8	1.03	74.2	339	0.83	0.96	406
18	<5	<5	40	NT	5	30	400	NT	NT	460
19	0.80	3.00	37.8	6.40	0.90	40.0	376	1.20	1.50	421
20	<5	<5	38.4	7.6	1.02	52.7	358	1.31	<10	444
21	1.48	3.24	47.9	6.33	0.97	61.4	318	0.96	1.9	402
22	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
23	2	<4	40	7	1	77	380	1	2	430
24	1.56	3.50	35.8	6.73	0.98	48.8	347	1.29	1.85	434
25	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
26	1.8	4	33	6	0.96	78	390	1.2	2	450
27	1.47	4.48	NT	NT	1.16	44.77	394.58	1.39	NT	485.71
28	1.34	3.45	30.2	6.20	0.997	71.9	334	NT	NT	430
29	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
30	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

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

Table 69 Summary of Participants' Results and Performance in Sample S1 (Continued)

Lab Code	Ni (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Sn (mg/kg)	Sr (mg/kg)	Tl (mg/kg)	U (mg/kg)	V (mg/kg)	Zn (mg/kg)
AV	102	12.5	112	4.56	30.2	243	1.42	1.73	34.6	781
HV	93	12.8	110	4.64	NA	245	1.65	1.87	35.4	803
1	118	13.1	106	4.81	29.3	248	1.58	1.80	35.3	849
2	110	13	120	5	31	260	<2	1.8	37	860
3	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
4	105	13.25	122.5	5.3	32.55	240.5	NR	1.73	38.35	857
5	NT	7.1	65	2.4	10	150	0.72	0.89	22	750
6	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
7	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
8	103.0	12.8	131.0	4.0	30.8	203.0	1.50	1.69	33.6	790.0
9	87	10	NT	4	33	230	NT	1.8	34	670
10	100	12	110	<5	26	220	NT	NT	37	690
11	107	11.8	119	4.10	35	231	1.36	1.60	30.3	769
12	113.24	12.37	127.27	5.45	NT	228.93	NT	NT	34.00	795.25
13	91	NR	NR	NR	NR	NR	NR	NR	NR	NR
14	81.5	13.3	72.8	2.7	11.8	360	<1	<1	40.7	499
15	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
16	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
17	102.3	13.2	102.2	5.4	23.7	221.8	1.57	1.67	34.4	728.5
18	100	10	100	<5	NT	300	<5	NT	30	800
19	94.9	13.9	100	4.40	23.0	230	1.30	1.77	32.0	790
20	101	14.1	114	5.2	28.5	214	<5	<5	43.3	833
21	99.4	11.5	118	4.81	33.7	361	1.36	NT	30.0	765
22	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
23	110	13	110	3	26	250	<2	1.8	36	750
24	97.9	12.1	127	4.8	34.9	257	1.40	1.73	33.7	810
25	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
26	110	13	130	6	31	260	<2	1.7	39	810
27	103.53	16.2	82.77	<2	31.05	271.0	NT	NT	34.79	826.7
28	103	12.0	124	5.10	31.8	234	1.49	1.81	32.3	770
29	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
30	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

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

Table 70 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)	Be (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Ga (mg/kg)	Mo (mg/kg)	Na (mg/kg)	Ni (mg/kg)	Pb (mg/kg)	Rb (mg/kg)	Se (mg/kg)	Th (mg/kg)	V (mg/kg)	Zn (mg/kg)	
AV	Not Set	15200	33.9	Not Set	48.7	0.540	17.5	38.1	31.1	Not Set	0.78	100	81.9	43.2	Not Set	0.65	2.20	38.3	182	
HV	0.323	16200	30.2	1.53	56.8	0.529	18.5	41.8	29.8	5.15	0.814	NA	80.1	41.2	6.49	0.666	2.38	37.6	190	
1	NR	15900	34.1	2.94	61.0	0.585	17.9	41.4	35.8	5.02	0.822	NR	84.2	47.0	NR	0.704	2.59	41.7	197	
2	<1	15000	36	<10	46	<1	17	44	35	6	1	120	82	46	5	<2	2	38	170	
3	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	
4	NR	NR	36.6	1.3	44.2	0.545	20.15	38.75	34.6	NT	0.845	<130	90.6	43.75	5.245	0.995	NT	42	215.5	
5	0.13	12000	28	51	34	0.76	15	30	26	NT	0.47	290	NT	33	NT	2.6	1.5	31	150	
6	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	
7	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	
8	0.31	15500	34.2	<20	74.4	0.5	16.4	31.7	27.3	NT	0.9	NR	74.4	43.4	NT	0.6	2.8	39.4	197	
9	NT	14900	32	<1	47	<1	18	37	33	NT	<20	NT	83	58	NT	4.0	NT	43	210	
10	0.3	16000	35	2.8	100	0.61	18	43	36	NT	<5	750	82	53	NT	<5	NT	49	170	
11	<1	13900	36.6	2.3	46.9	0.55	19	37.6	32	NT	0.87	79	82.1	38.8	NT	0.56	2.87	39.5	167	
12	NT	NT	34.39	NT	NT	NT	NT	40.18	NT	NT	0.620	NT	NT	38.50	NT	NT	NT	NT	NT	
13	NR	14500	31	NR	40	NR	15	33	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	34	177
14	0.62	43300	20.1	24	184	0.89	14.9	53.7	25.6	NT	<1	27200	62.7	42.4	37.9	<1	NT	88.8	118	
15	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	
16	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	
17	0.42	14966	29.98	32.3	51.4	0.29	17.5	41.8	29.4	28	0.6	120	79.5	39.85	2.5	0.71	4.3	39.7	173	
18	<5	20000	40	<5	60	<5	20	20	30	NT	<5	100	90	40	NT	<5	NT	30	200	
19	0.13	15000	29.9	4.00	53.0	0.52	17.3	36.0	34.2	NR	0.70	70.0	84.0	53.0	NR	0.50	1.80	37.0	183	
20	<5	15500	32.7	<10	47.4	<5	19.5	41.2	29.2	NR	<5	109	86.2	44.9	NR	<3	<5	39.9	177	
21	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	
22	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	
23	<1	16000	39	<10	41	<1	17	38	31	4	<1	110	81	39	2	<2	2	39	170	
24	0.452	14900	35.4	2.8	44.6	0.510	17.5	36.2	29.8	NT	0.74	101	79.4	43.0	5.0	0.6	NT	37.2	186	
25	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	
26	<1	16000	41	<10	48	<1	20	42	31	5	1	110	81	42	5	<2	2	42	210	
27	0.38	13932.27	31.88	<5	48.97	0.5	17.99	35.16	32.41	NT	1.26	90.7	85.98	43.9	NT	<2	NT	34.44	176.41	
28	0.273	15429	32.7	1.96	51.3	0.249	14.8	37.7	27.4	NT	0.759	85.3	71.0	40.5	6.20	0.722	2.24	34.4	173	
29	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	
30	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	

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

Table 71 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	882	18800	786	379	34.1	383	352	13.8	Not Set
HV	831	18800	775	428	48	388	358	14.1	1.85
1	838	18204	740	406	NR	384	367	16.7	<1
2	790	19000	740	330	33	350	330	11	<2.5
3	887.7	17096	684.1	339.6	27.11	339.7	< 200	12.01	< 5
4	NT	NT	NT	NT	NT	NT	NT	NT	NT
5	590	9100	910	630	960	660	1100	8.7	1.52
6	NR	NR	NR	NR	NR	NR	NR	NR	NR
7	800	20000	620	320	<50	400	<200	12	NT
8	896	15500	871	412	631	346	324	14.6	2.1
9	NT	NT	NT	NT	NT	NT	NT	NT	NT
10	1900	18000	1000	800	570	NT	560	27	NT
11	963	18800	753	392	<50	386	350	13.6	NT
12	NT	NT	NT	NT	NT	397.00	379.97	NT	1.391
13	NR	21674	NR	379	NR	NR	NR	NR	NR
14	1084	19400	3600	1021	<200	NT	NT	58	NT
15	912	NT	618	307	20	378	346	NT	NT
16	820	18291	722	371	31.5	406	< 200	15.3	< 5
17	NT	NT	NT	NT	NT	NT	NT	NT	1.84
18	NT	NT	NT	NT	NT	NT	NT	NT	NT
19	830	18300	740	434	<20	410	342	15	NR
20	774	16800	866	430	<50	360	342	15.8	NR
21	NT	NT	NT	NT	NT	NT	NT	NT	NT
22	1225	17390	850	360	225	97	NT	NT	NT
23	840	21000	740	360	40	370	350	14	<2.5
24	NT	NT	NT	NT	NT	NT	NT	NT	NT
25	852	19000	880	500	29	400	NT	23	NT
26	950	21000	810	470	40	410	370	16	<3
27	912.2	20320.41	769.4	337.4	37.6	396.02	377.6	NT	1.79
28	892	17983	867	412	NT	394	340	13.1	NR
29	NR	NR	NR	NR	NR	NR	NR	NR	NR
30	1010	18300	788	295	53.4	NR	NR	NR	NR

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

Table 71 Summary of Participants' Results and Performance for Sample S3 (continued)

Lab Code	Chloride (mg/kg)	Fluoride (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	Not Set	1.53	Not Set	147	250	4.55	3090	38.8	6.5
HV	15.8	1.6	0.389	122	NA	NA	NA	NA	NA
1	15	1.5	<1	130	250	4.6	2900	36	7.0
2	10	1.3	<0.5	160	250	4.7	3400	43	8.2
3	17.95	NT	< 10	169.6	261.5	4.59	NT	NT	NT
4	NT	NT	NT	NT	NT	NT	NT	NT	NT
5	16.7	11.6	0.59	130	200	4.53	3100	NT	7.23
6	19.99	NR	NR	168	250	NR	NR	NR	NR
7	40	NT	< 1	< 250	250	4.5	2900	NT	NT
8	26.5	1.8	0.44	203	253	4.5	3740	42.0	5.6
9	NT	NT	NT	NT	NT	NT	NT	NT	NT
10	NT	NT	<5	NT	310	4.6	NT	NT	NT
11	18.3	1.7	0.62	214	243	4.57	NT	35.3	5.8
12	15.137	NT	NT	123.182	241	4.59	3090	NT	NT
13	NR	NR	NR	NR	NR	NR	NR	NR	NR
14	NT	NT	NT	NT	250	4.57	NT	NT	NT
15	NT	NT	NT	NT	266	NT	NT	NT	NT
16	47.6	21.8	< 10	148.8	230.1	4.51	2835	NT	6
17	17.6	12.7	0.056	118.4	250	4.7	3760	27.6	6.6
18	NT	NT	NT	NT	NT	NT	NT	NT	NT
19	NR	NR	NR	NR	255.2	4.47	2758	41.3	<5
20	30	<5	0.4	<50	240	4.5	3200	NR	NR
21	NT	NT	NT	NT	NT	NT	NT	NT	NT
22	43	15.05	0.55	140	290	4.44	3200	67.8	3.65
23	15	1.2	<0.5	148	270	4.5	2900	40	7.5
24	NT	NT	NT	NT	NT	NT	NT	NT	NT
25	NT	NT	NT	NT	231.4	4.55	NT	NT	NT
26	10	1.7	<0.5	130	260	4.6	NR	6.7	52
27	31.6	1.52	1.30	101.4	243.5	4.59	2500.9	40.28	NT
28	NR	NR	NR	NR	NR	NR	NR	NR	NR
29	20.23	NR	NR	NR	237	4.52	NR	6.74	44.05
30	<200	NR	NR	50	250	4.4	NR	NR	NR

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

6.5 Participants' Results and Analytical Methods for Acid Extractable Elements

A summary of participants' results, and performance is presented in Tables 69 to 71 and in Figures 58 to 61.

Sample S1 was a biosolid, while Sample S2 was a sediment. The analysis of acid-extractable elements in the sediment (S2) posed greater challenges to participants' analytical techniques; overall, the robust between-laboratory coefficients of variation (CVs) were higher in S2 than in S1

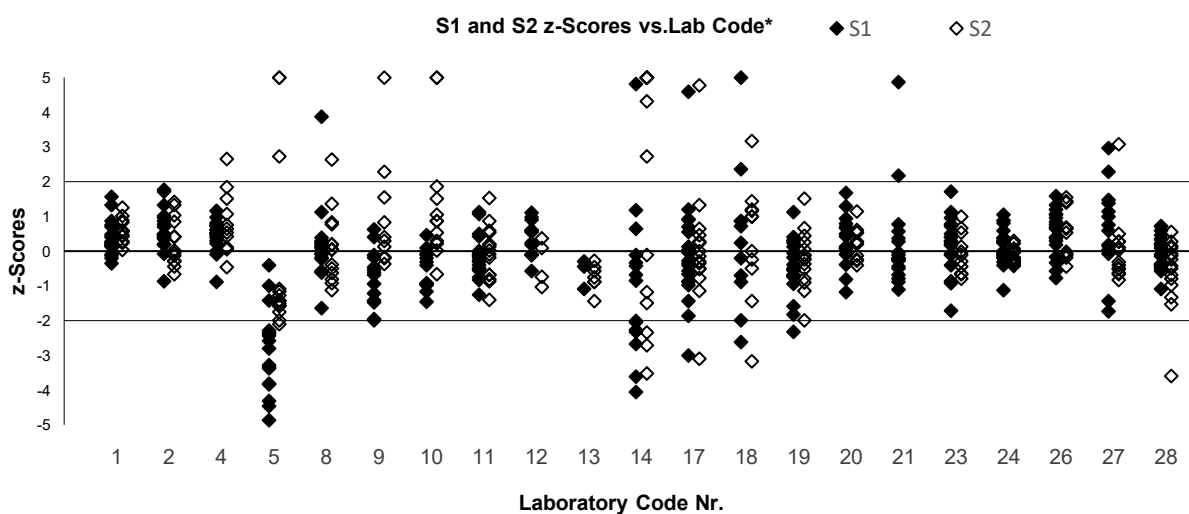
Low levels of Ag and B in Sample S2, followed by Rb, were the acid extractable elements that challenged most participants' analytical techniques. The between-laboratory coefficients of variation (CVs) for these tests exceeded 35%.

Most of unsatisfactory results reported by Laboratory 5 were lower than the assigned values by approximately the same factor of 0.5. Issues with the calculation or preparation procedures for the sample or standards may explain this bias.

The method descriptions provided by participants for acid extractable elements are presented in Tables 1 and 8, with instrumental conditions presented in Appendix 5.

Extraction Methods

The request was for acid extractable elements; 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, 15-18} 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 conventionally defined by procedures involving extractions: with aqua regia or with various amounts of HNO₃, HCl, in combination or alone and most of these methods produce comparable results.¹⁹⁻²³



Scores of >5 or <-5 have been plotted as 5 or -5.

Figure 62 z-Scores for Acid Extractable Elements in S1 and S2 vs. Laboratory Code

In the present study, most participants 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 a mixture of HNO₃ and HCl.

Laboratory 14 used only 0.5 mL of nitric acid for sample extraction and applied an acid-to-sample size ratio of 1:1. Most of the results they reported for acid-extractable elements were lower than the assigned values (Figure 62). This may be because some acid-extractable elements can only be partially recovered from soil when nitric acid alone is used for extraction.

Laboratories should consider using matrix-matched control samples to assess the effectiveness of their digestion regime.

Individual Element Commentary

Arsenic level in biosolid S1 was 3.34 mg/kg and in soil (sediment) S2 was 33.9 mg/kg. Laboratory 14 may need to review their standard preparation procedure as both results reported by them in S1 and S2 were lower than the assigned value by the same factor of 0.59 (Figure 63).

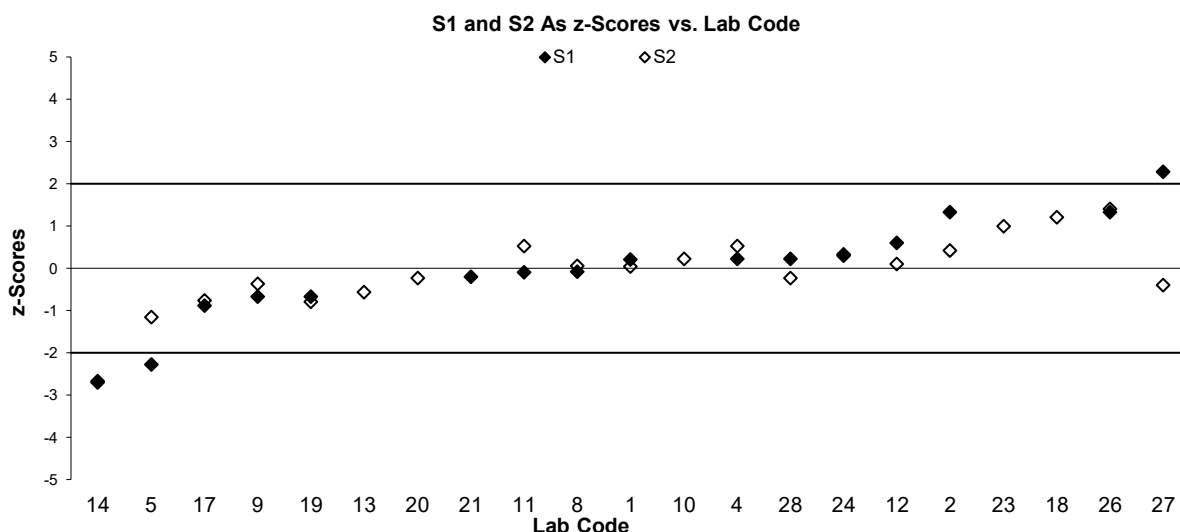


Figure 63 S1 and S2 As z-Scores vs. Laboratory Code

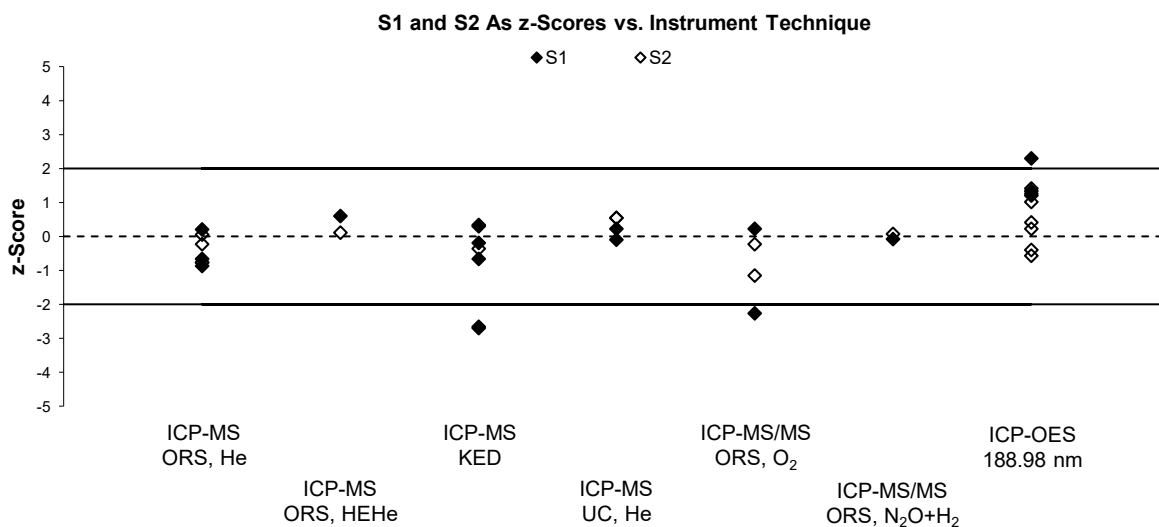
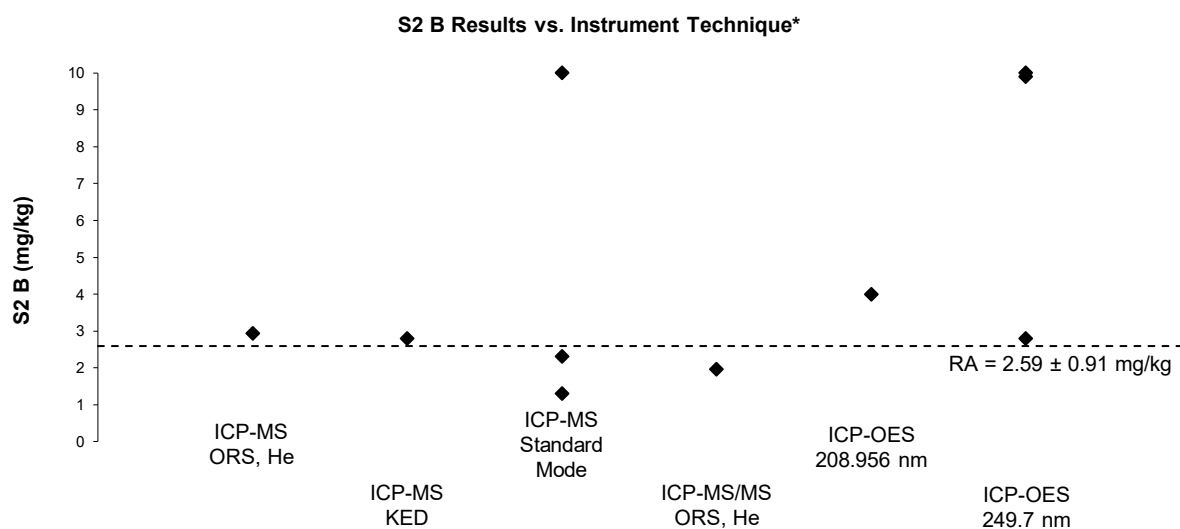


Figure 64 S1 and S2 As z-Scores vs. Instrumental Technique

Plots of participants' performance versus the instrumental techniques used for As measurements in Samples S1 and S2 are presented in Figure 64. Most participants used ICP-MS in collision mode. Seven laboratories reported using ICP-OES with a wavelength of 188.98 nm. Caution should be exercised when using ICP-OES to measure As at parts-per-billion levels in solution. The As concentration in Sample S1 was low, at 3.34 mg/kg, and excessive dilution may have challenged the sensitivity limits of ICP-OES. Of the seven laboratories that measured As using ICP-OES, three reported results below their reporting limit, and one laboratory reported a numerical result that returned an unacceptable z-score in S1.

Boron measurements at low level in sample S2 challenged participants' analytical techniques. Only 10 laboratories reported results; the results were highly variable, and no assigned value could be set.

Plots of B results in Sample S2 versus the instrumental technique are presented in Figure 65. Iron concentration in sample S2 was high, around 53000 mg/kg. Caution should be exercised when using ICP-OES with wavelength 249.7 nm to measure B in soil samples, which typically contain high level of Fe. Without applying a correction equation, the Fe emission line at 249.771 nm can directly interfere with the B line at 249.7 nm.



*The results reported by Laboratories 5, 14, and 17 have been plotted as 10 mg/kg.

Figure 65 S2 B Results vs. Instrumental Technique

Chromium, Nickel, and Vanadium are three elements whose measurement is strongly depended on the digestion regime. Participants' performance for these elements in the two study samples is presented in Figures 66 to 68.

Participants whose z-scores are consistently on the same side of the zero line may need to investigate potential method bias. Both overly aggressive and insufficient digestion regimes could explain some of these biased results.

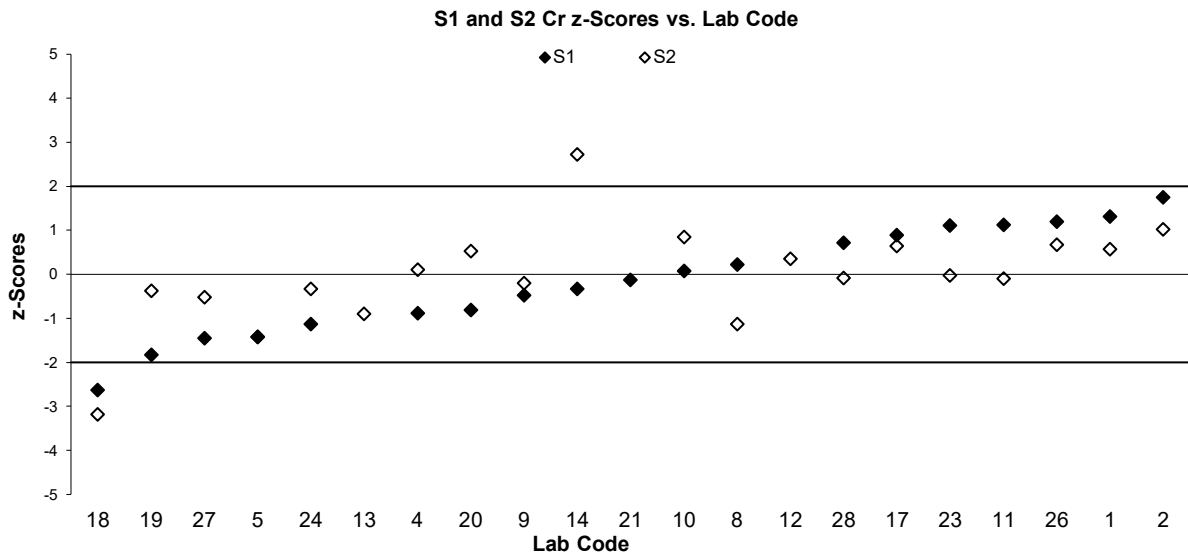


Figure 66 S1 and S2 Cr z-Scores vs. Laboratory Code

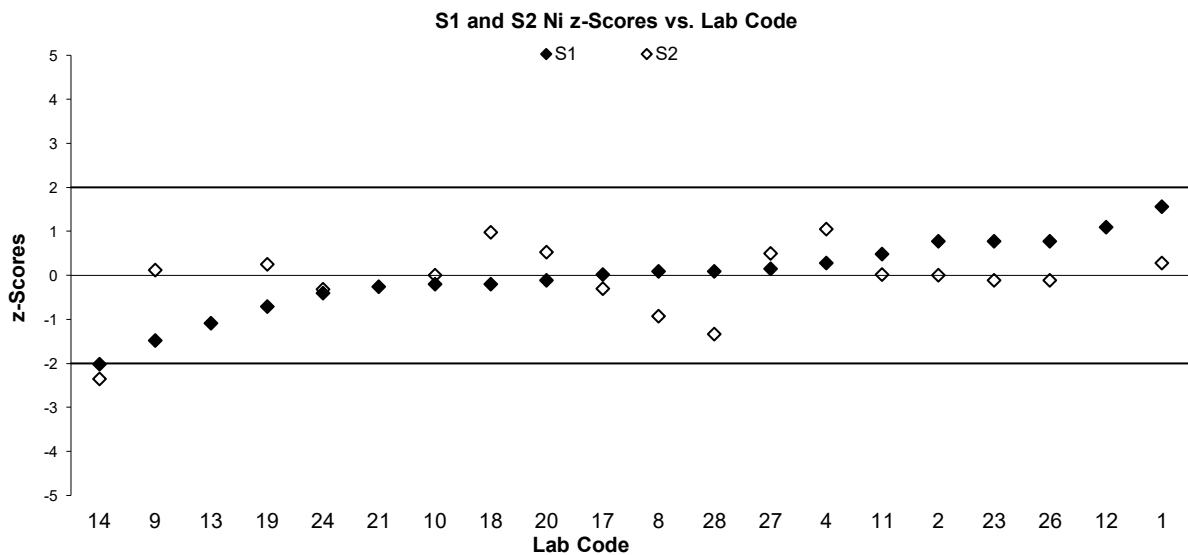
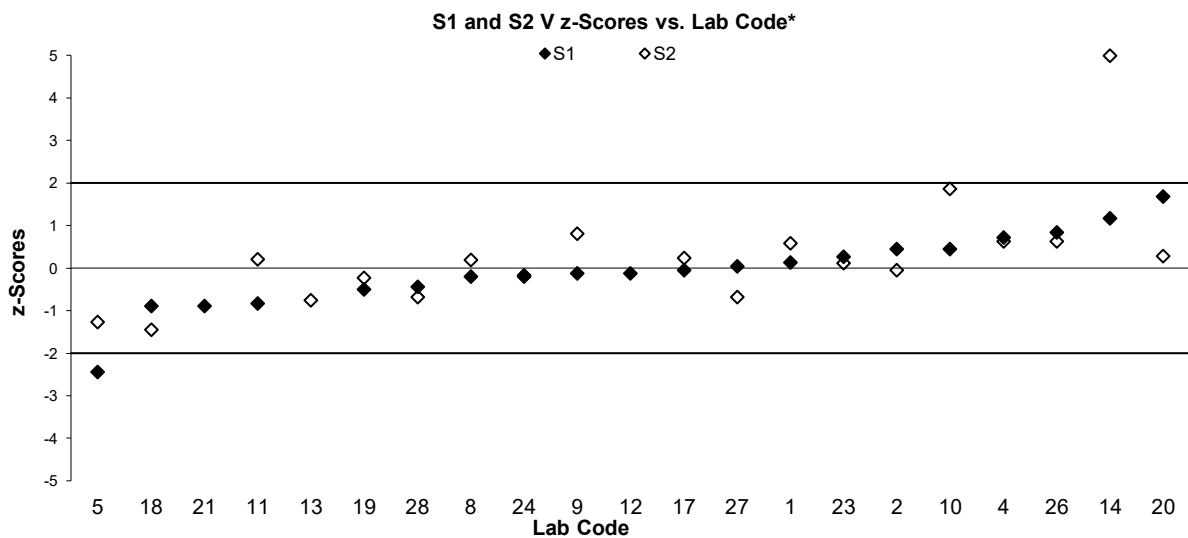


Figure 67 S1 and S2 Ni z-Scores vs. Laboratory Code



*Laboratory 14 S2 z-Score of 8.79 was plotted as 5.

Figure 68 S1 and S2 V z-Scores vs. Laboratory Code

Chromium Plots of participants results reported for Cr in S1 and S2 versus instrumental technique are presented in Figure 69. The wavelength at 267.716 nm offers better sensitivity than 283.563 nm. Therefore, 267.716 nm is recommended when measuring Cr in solution at parts-per billion level by ICP-OES.

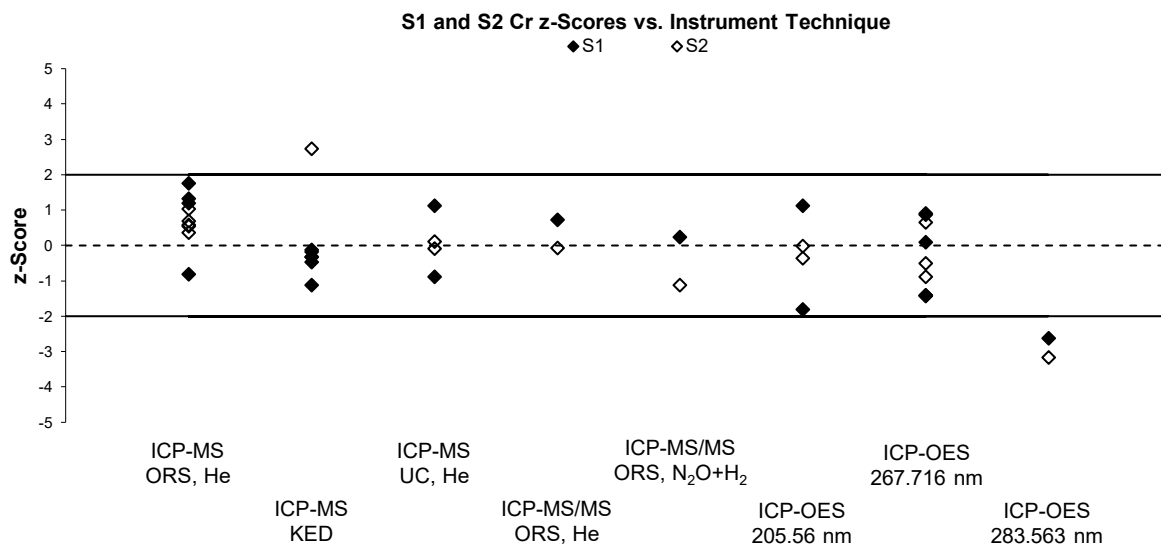


Figure 69 S1 and S2 Cr z-Scores vs. Instrumental Technique

Gallium A limited number of participants reported results for Ga in Sample S2. All 6 reported results were in good agreement with each other, with the homogeneity value (HV), and with the median value except for one (Figure 70).

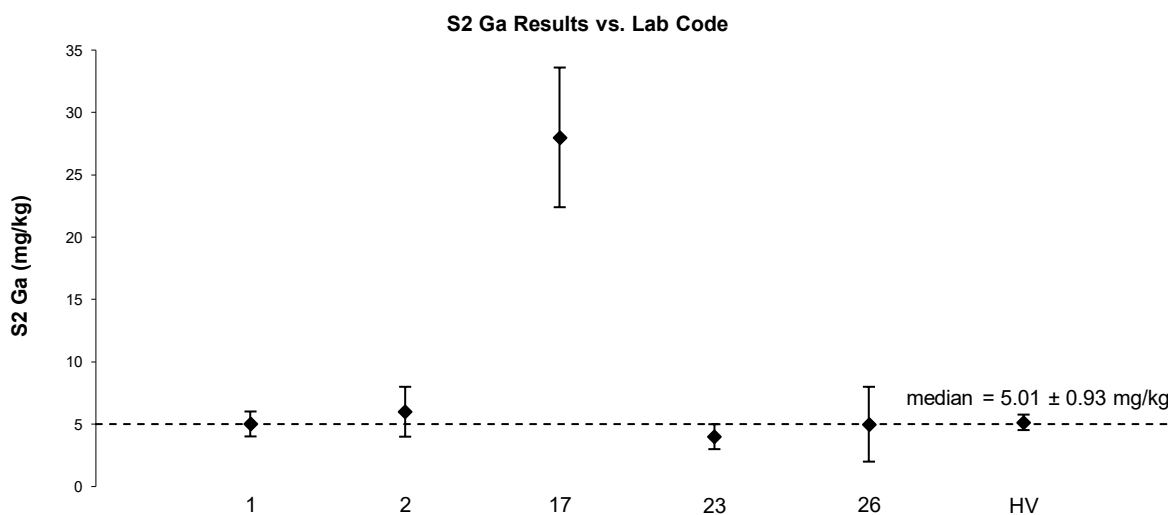
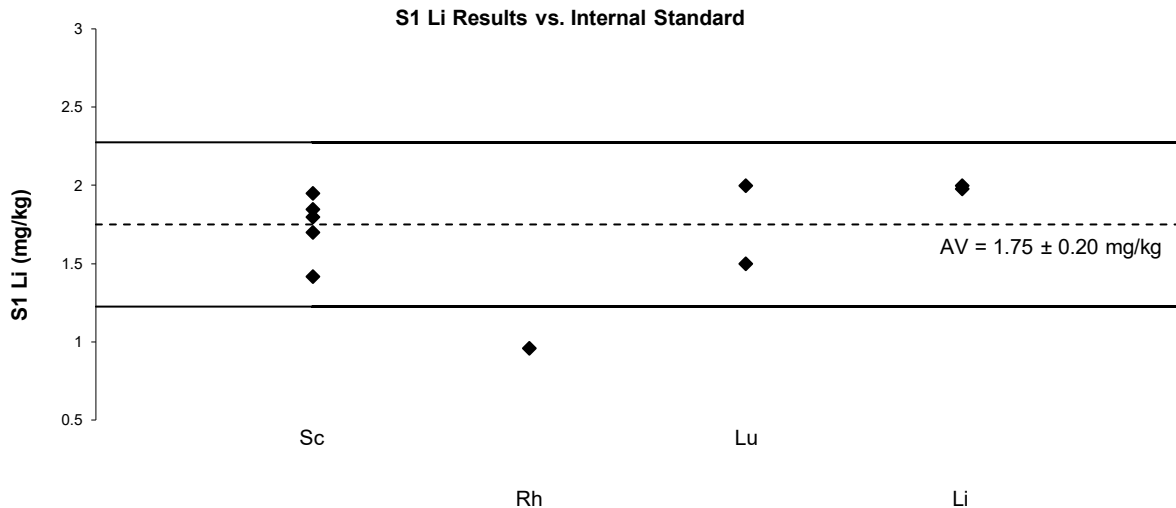


Figure 70 S2 Ga Results vs. Lab Code

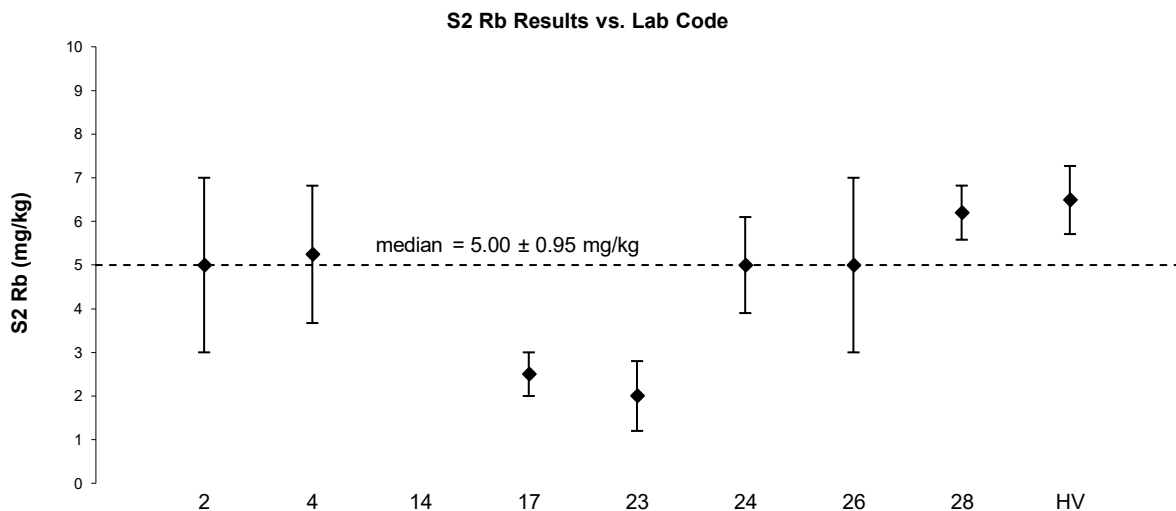
Lithium ICP-MS has low sensitivity for light elements such as Li due to space-charge effects. Using an internal standard with similar behaviour may help to overcome this issue. Figure 71 presents participants' results for Li in Sample S1 versus the internal standard used.



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

Figure 71 S1 Li Results vs. Internal Standard

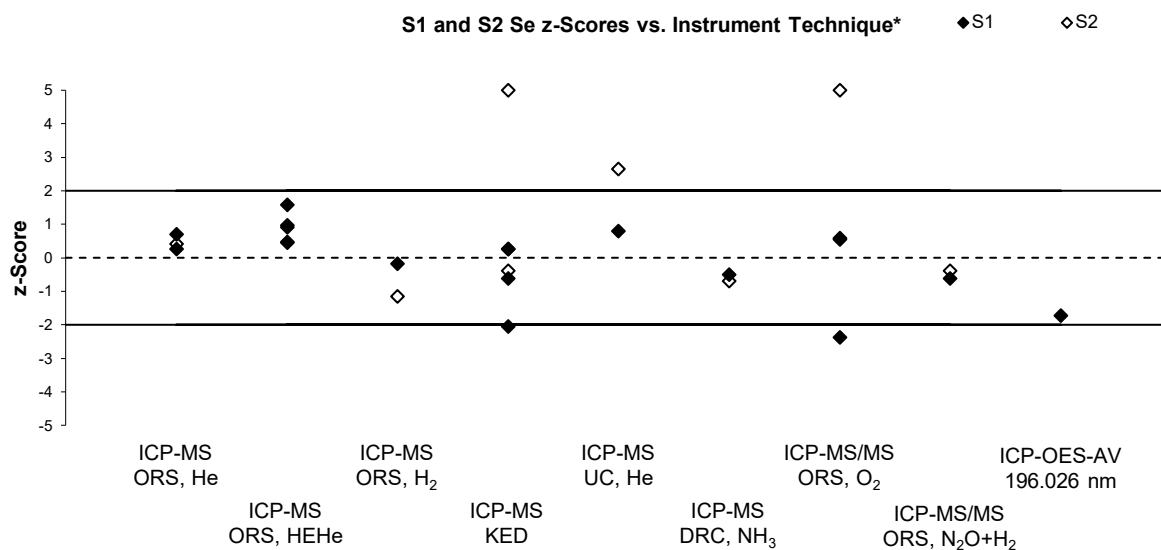
Rubidium Only eight laboratories reported results for Rb in S2; the results were varied with a between-laboratories CV of 46% (Figure 72). No assigned value was set for this test.



Laboratory 14 result is off scale

Figure 72 S2 Rb Results vs. Lab Code

Selenium Of the 17 laboratories that reported results for Se in Sample S1, all but two produced acceptable results. Laboratories used various instrumental techniques (Figure 73). Molecular ions originating from dissolved salts with a mass similar to the Se isotope used for elemental determination can cause severe interference. As a result, false positives and concentrations significantly higher than the true values are frequently observed when Se is measured by ICP-MS. Unresolved interferences may explain the high Se results that returned not acceptable z-scores.



*Laboratory 5 S2 z-score of 15.00 and Laboratory 9 S2 z-score of 25.77 have been plotted as 5.

Figure 73 S1 and S2 Se z-Scores vs. Instrumental Technique

Silver level in S2 was low and challenged participants' analytical techniques. Only nine laboratories reported results for this test. The results were highly variable, with a between-laboratory coefficient of variation (CV) of 50%, and no assigned value could be set. Plots of participants' results, along with the homogeneity value (HV) and the robust average (RA) of the reported results, are presented in Figure 74

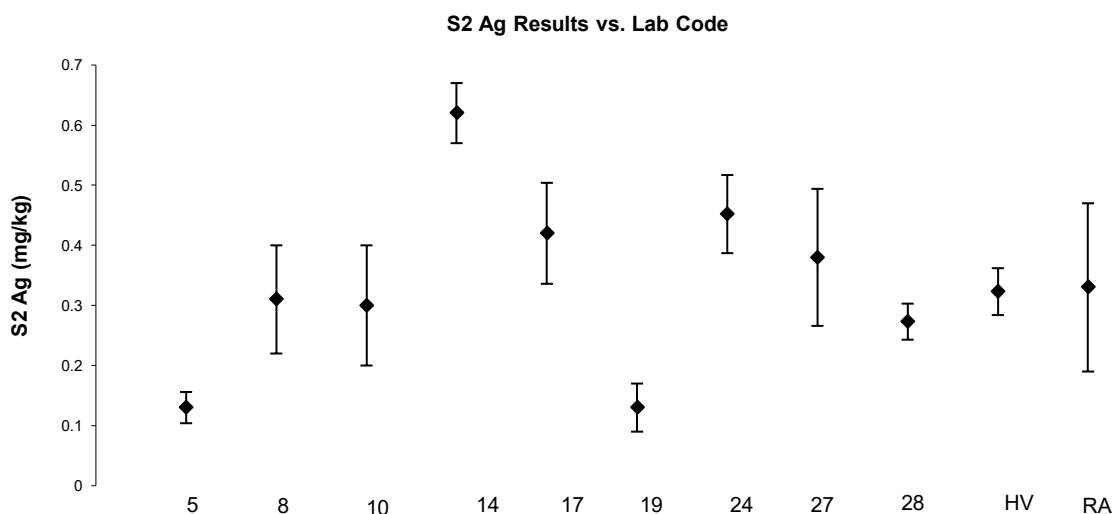
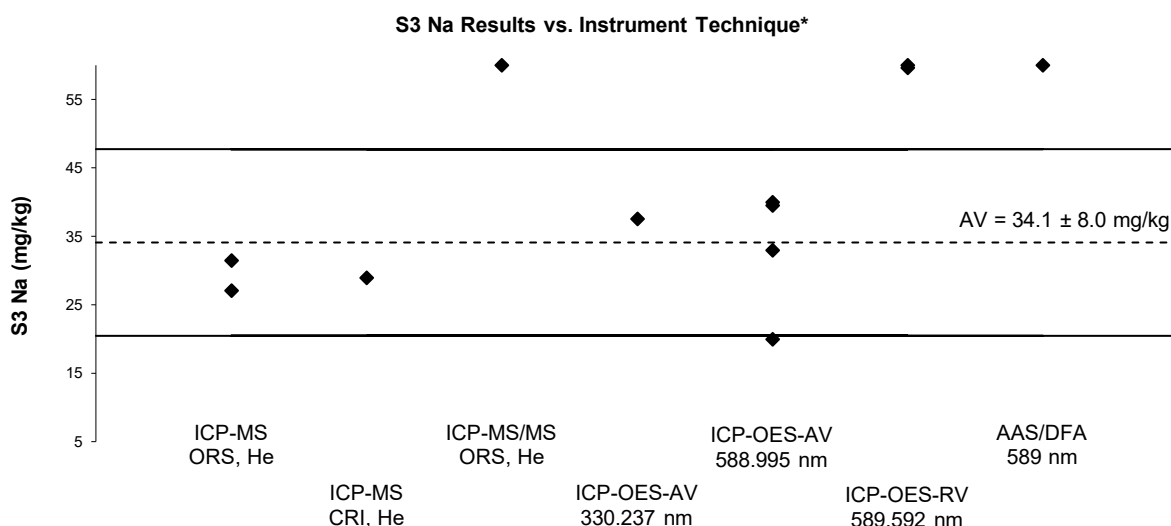


Figure 74 S2 Ag Results vs. Lab Code

Sodium Participants' results versus the instrumental techniques used for Na measurement in S3 are presented in Figure 75. ICP-OES in axial view with the wavelength 588.995 nm was the preferred measurement technique.

Laboratory 18 used for Na determination Atomic Absorption Spectroscopy (AAS) with Direct Flame Atomisation (DFA), they also reported: "For Sodium analysis on the AAS 1mL of CsCl matrix modifier is added per 10 mL of sample."

The Na concentration in Sample S3 was low, at 34.1 mg/kg, which may explain the unsatisfactory results obtained using AAS and ICP-OES with radial view (RV). These techniques are known to offer lower sensitivity compared to ICP-OES with axial view, which could have contributed to the poor performance.



*The extreme outliers reported by laboratories 5, 8, and 10, and laboratory 22's result of 225 mg/kg plotted as 60 mg/kg. Laboratory 30 did not provide information. Horizontal lines on charts are the results corresponding to z-scores of 2 and -2.

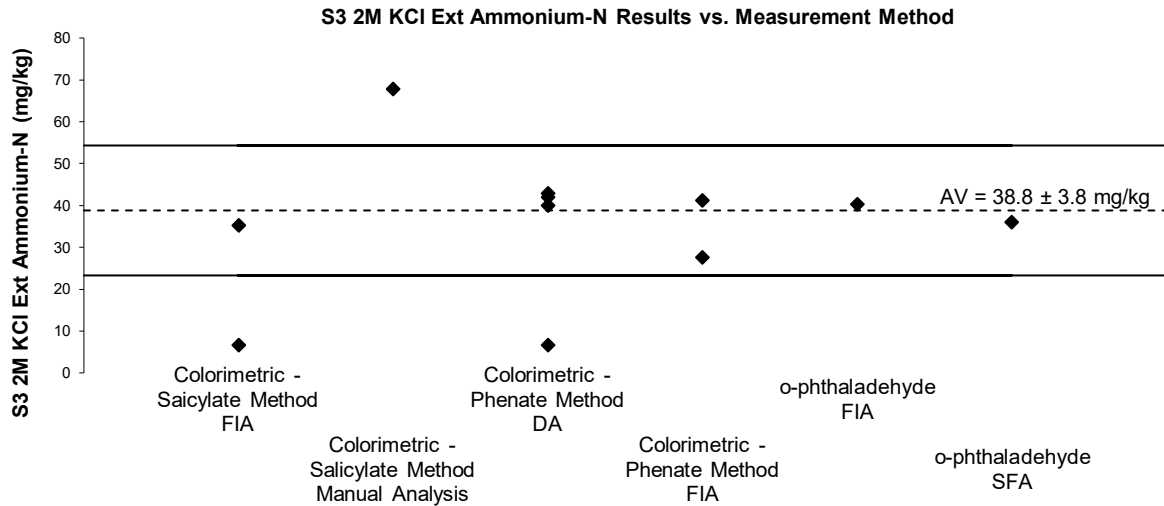
Figure 75 S3 Na Results vs. Instrumental Technique

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 but one participant used a soil/2M KCl ratio of 1:10.

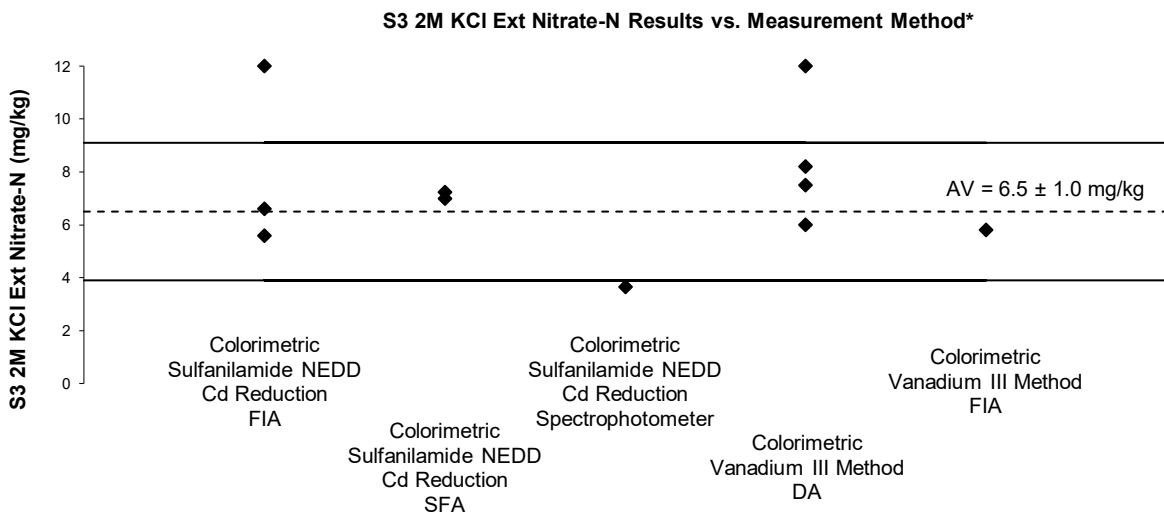
2M KCl-Extractable Ammonium-Nitrogen Plots of participants' results versus the analytical methods and instrumental techniques used are presented in Figure 76. Most participants used either the salicylate method or the phenate method. Two laboratories reported ammonium-nitrogen measurements in soil using the o-phthalaldehyde method with SFA or FIA detection.



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

Figure 76 S3 2M KCl Ext NH_4^+ -N Results vs. Measurement Method

2M KCl Extractable Nitrate-Nitrogen Five laboratories have used the Vanadium (III) Chloride for NO_3^- -N reduction to NO_2^- -N (five), with six 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 77).



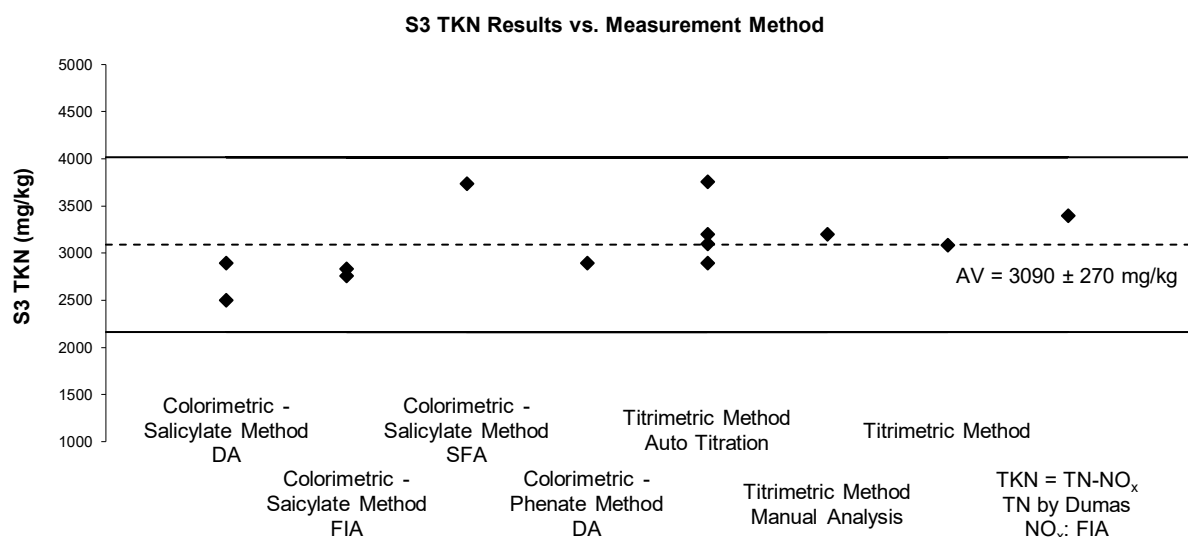
*Laboratory 26 result of 52 mg/kg and Laboratory 29 result of 44.05 mg/kg plotted as 12 mg/kg. Horizontal lines on charts are the results corresponding to z-scores of 2 and -2.

Figure 77: S3 2M KCl Ext NO_3^- -N Results vs. Measurement Method

Transcription errors may explain the unacceptable results reported by Laboratories 26 and 29. They reported values of 6.7 mg/kg and 6.74 mg/kg, respectively, for 2M KCl-extractable NH_4^+ -N in Sample S3, and values of 52 mg/kg and 44.05 mg/kg, respectively, for 2M KCl-extractable NO_3^- -N in the same sample.

6.7 Participants' Results and Analytical Methods for Total Kjeldahl Nitrogen

TKN assigned value was 3090 mg/kg; all participant laboratories that reported results returning acceptable z-scores. Plots of participants' results versus the measurement methods used are presented in Figure 78.



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

Figure 78 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.^{24, 25} 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 8. All participating laboratories but one used a soil/water ratio of 1:5, Laboratory 7 used a ratio of 1:10.

Individual Water-Soluble Anion Commentary

Bromide Only five laboratories reported results for bromide in S3. All reported results, except for one, were in good agreement with each other - within their expanded uncertainties and consistent with the homogeneity value (HV) of 1.85 mg/kg. All laboratories used the Ion Chromatographic Method (Figure 79).

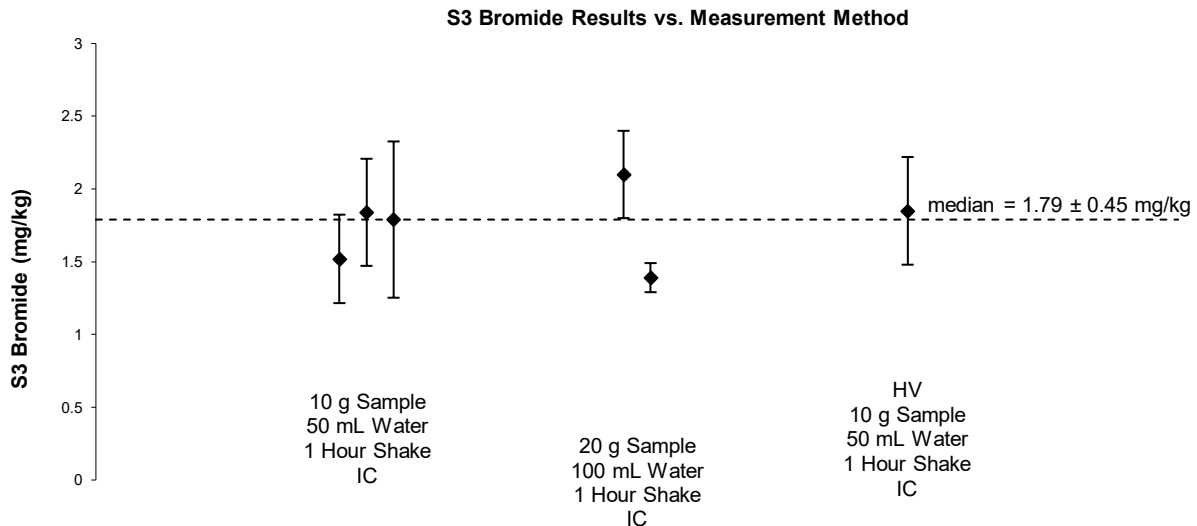


Figure 79 S3 Bromide Results vs. Measurement Method

Chloride concentration in Sample S3 was low, with a robust average of 22.5 mg/kg, which challenged participants' analytical techniques. The results were variable with a between-laboratory CV of 50% and no assigned value could be set (Figure 80). Most of the chloride results from the ion chromatographic method were lower than those measured using a colorimetric method. Spectrophotometry has low specificity and is susceptible to interference from coloured species.

Caution should also be exercised when using the argentometric method. 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 interfere by masking the endpoint (assigned value in S3 is 18800 mg/kg).

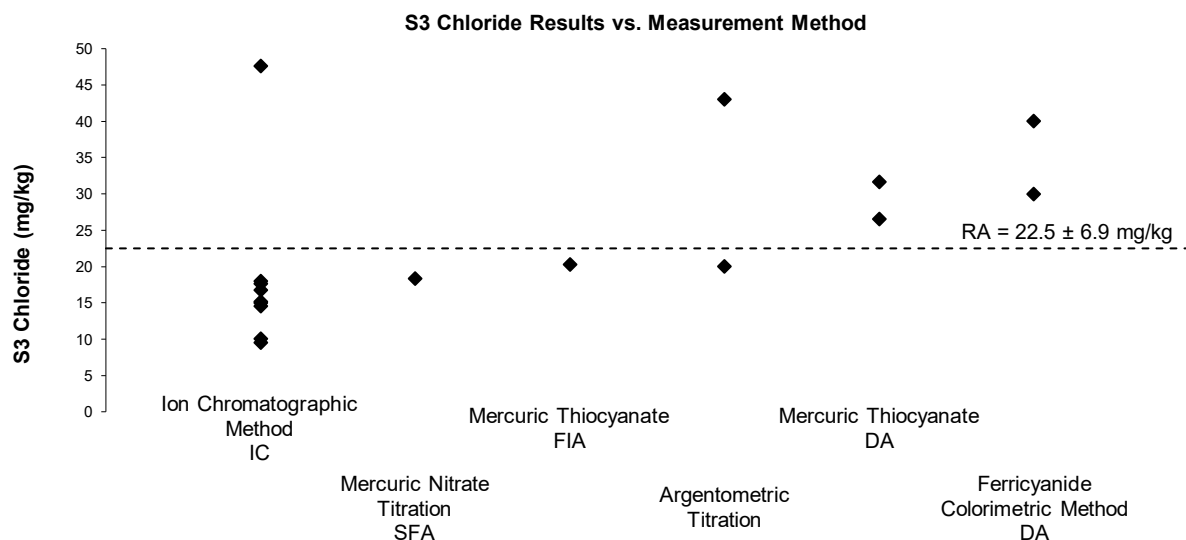


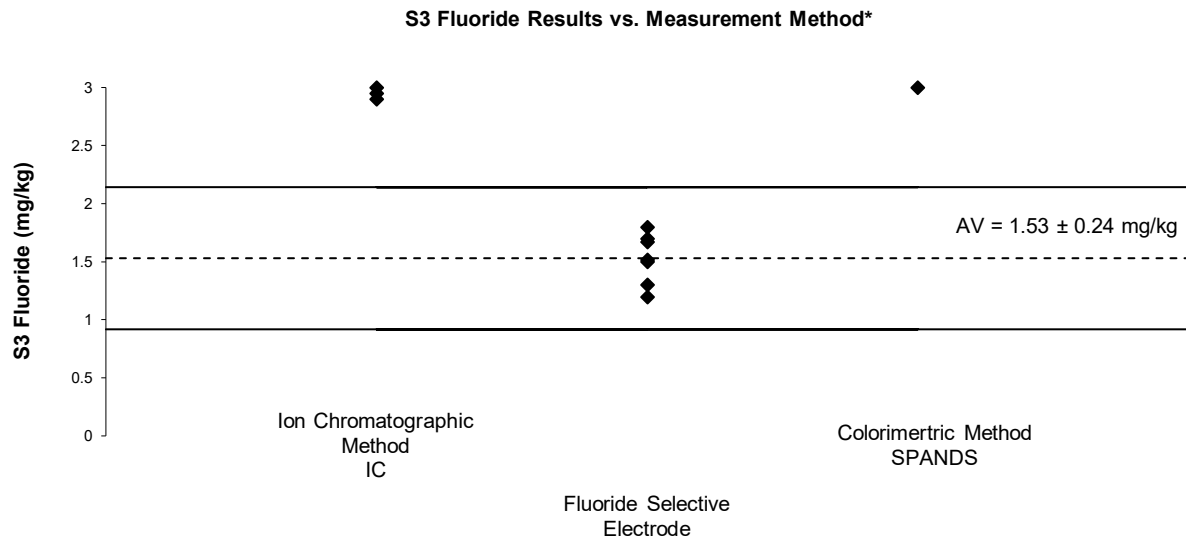
Figure 80 S3 Chloride Results vs. Measurement Method

Fluoride Eleven laboratories reported results for fluoride in Sample S3 (Figure 81).

Caution should be exercised when the ion chromatographic method is used for low level fluoride measurements. Fluoride has a low molecular weight and valence charge and is not retained by the columns in the normal elution times like for the other ions. Low level fluoride may be difficult to quantify due to negative contribution of the “water dip” (corresponding to

elution of water) or due to interference from the simple organic acids which may elute close to fluoride.²⁶

Caution should also be exercised when fluoride is measured by the colorimetric method as it suffers from interference from chlorides.²⁶



Results >3 mg/kg were plotted as 3 mg/kg. Horizontal lines on charts are the results corresponding to z-scores of 2 and -2.

Figure 81 S3 Fluoride Results vs. Measurement Technique

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 82).

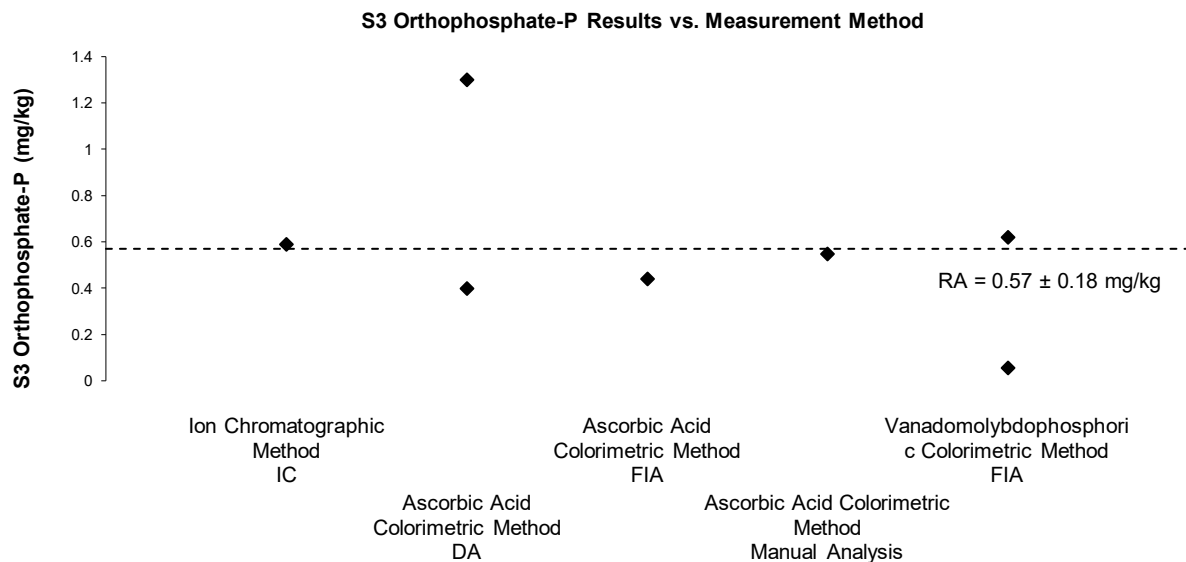
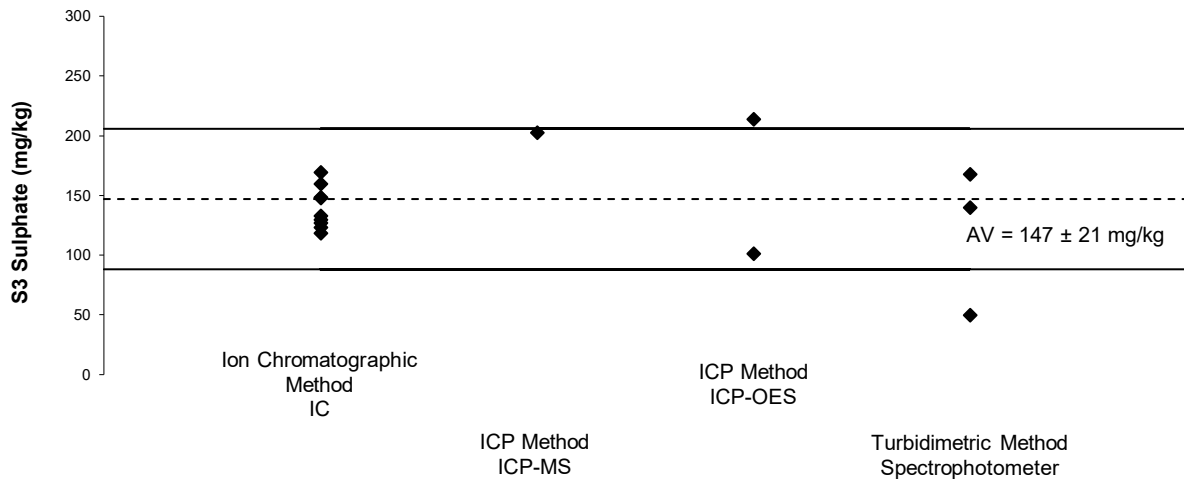


Figure 82 S3 Orthophosphate-P Results vs. Method

Sulphate A distribution of participants' results with the analytical method used is presented in Figure 83.

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

S3 Sulphate Results vs. Measurement Method



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

Figure 83 S3 Sulphate Results vs. Measurement Technique

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

AQA 25-12 is the 37th NMIA proficiency study of inorganic analytes in soil. A summary of participants’ performance over the last 13 years of studies is presented in Figure 84.

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

Over time laboratories should expect at least 95% of its scores to lay within the range $|z| \leq 2.0$. Scores in the range $2.0 < |z| < 3.0$ occasionally can 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 are an indication of method or laboratory bias, even if all are within the acceptable range.

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.

6.10 Reference Materials and Certified Reference Materials

Participants reported whether control samples (spiked samples, certified reference materials-CRMs or matrix specific reference materials-RMs) had been used (Table 72).

Table 72 Control Samples Used by Participants

Lab. Code	Description of Control Samples
1	CRM: Agal 10 & Agal 12
2	SS
3	CRM: Trace Metals in Drinking Water Standard - 29 Components CPA Chem; QCS-01-05 ICP Quality Control Standard #1; High Purity Standards CCV-1 Solution A; High Purity Standards CCV-1 Solution B; NMI AGAL-12 Biosoil; Australian Chemical Reagents Multi Element Standard; Australian Chemical Reagents Mixed Anion Standard; ERA Mercury WasteWatR
4	SS
6	CRM: Chloride Reference Material 1000 mg/L NSI Lab
7	CRM

Lab. Code	Description of Control Samples
8	SS: AGAL 10, AGAL 12, CRM055 Sewage Sludge 4, NMI Metals Nutrients & Anions in Soil
9	CRM
10	CRM
11	RM / Ex PT Sample: AGAL 12 (metals) In house AG reference
12	CRM: IRM Soil25
13	CRM: AGAL-12
14	CRM
16	CRM
18	SS
19	SS
20	SS
21	RM / Ex PT Sample: AGAL 10 / AGAL 12
22	CRM: San Joaquin soil, Hay Powder, Tomato Leaves
23	SS
25	SS
26	SS
27	SS
28	RM / Ex PT Sample
29	CRM: ASPAC 13959, 13957,10593,13039,13954,13958,13964,14160,15204
30	CRM

Matrix matched control samples taken through all steps of the analytical process, are one of the most valuable quality control tools for assessing the methods' performance. 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 '*²⁷

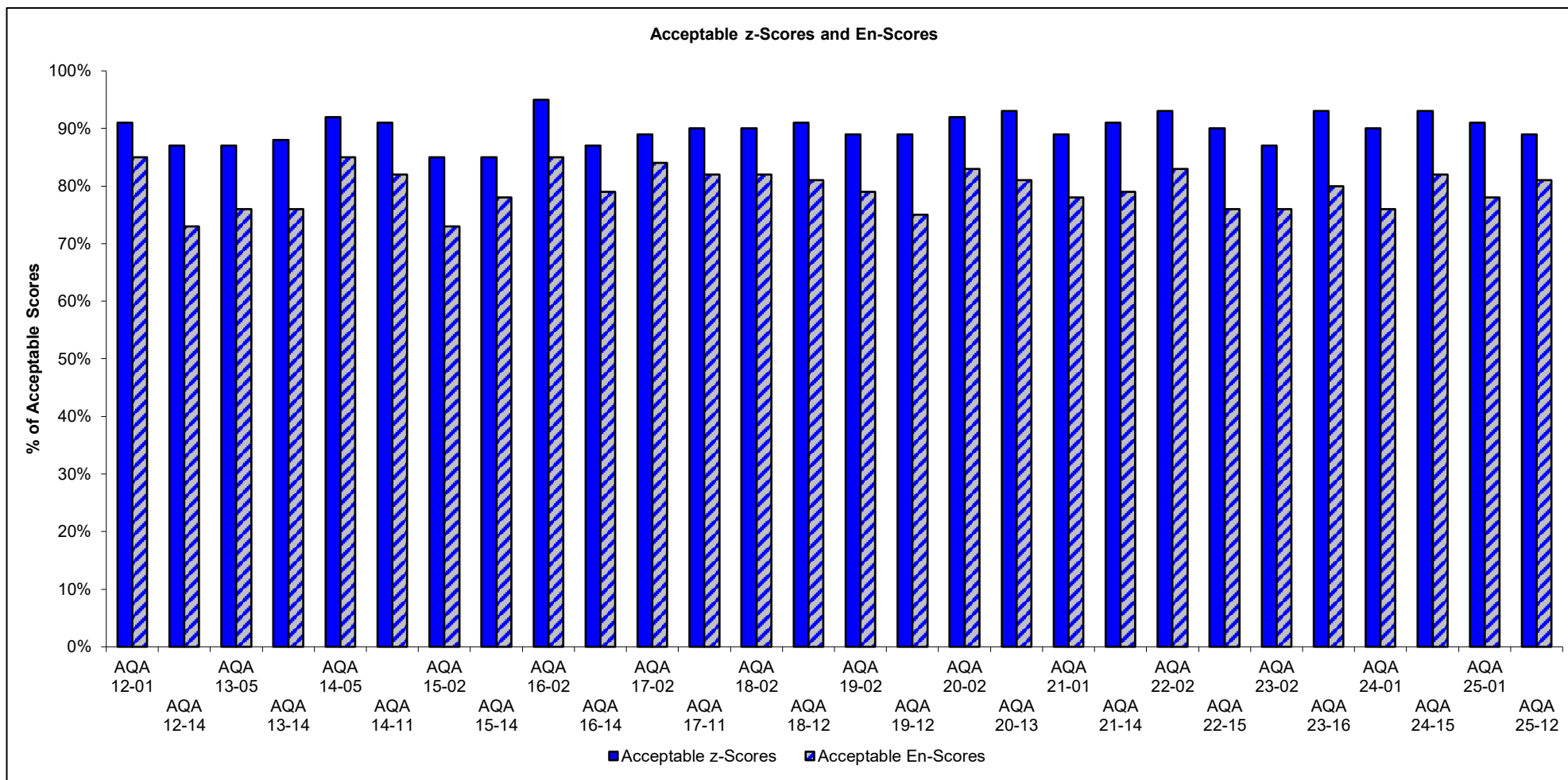


Figure 84 Participants' Performance over Time

7 REFERENCES

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

- [1] ISO17043, Conformity assessment – *General requirements for proficiency testing*.
- [2] NMI Chemical Proficiency Testing Study Protocol, viewed October 2025, < <https://www.industry.gov.au> >.
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APPENDIX 1 - SAMPLE PREPARATION, ANALYSIS AND HOMOGENEITY TESTING

Sample Preparation

Sample S1 was a biosolid that was fortified for nine analytes, then dried, ground, and sieved before being thoroughly mixed and divided into portions of 25 g each.

Sample S2 was a sediment soil that was 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.

Sample Analysis and Homogeneity Testing

The same preparation procedure used in previous NMIA proficiency testing (PT) studies for inorganic analytes in soil was followed for Samples S1, S2, and S3. A partial homogeneity test was conducted for acid-extractable elements in Samples S1, S2, and S3, except for Sn in S1 and Na in S2.

Partial homogeneity testing was also performed for water-soluble bromide, chloride, fluoride, orthophosphate-P, and sulphur in Sample S3. Three bottles were analysed in duplicate, and the average of these results was reported as the homogeneity value. Measurements were conducted under repeatability conditions and in random order.

Sample Analysis for Acid Extractable Elements

The homogeneity analysis was conducted by the CRV section of NMIA in accordance with method NT2.49.²⁸ A test portion of approximately 0.5 g of soil 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 samples were digested using 3 mL of concentrated nitric acid and 3 mL of concentrated hydrochloric acid on a hot block at $95^{\circ}\text{C} \pm 5^{\circ}\text{C}$. After digestion, each sample was diluted to 40 mL with reagent grade water and then further diluted as necessary.

The measurement instrument was calibrated using external standards for the targeted analytes. A set of quality control samples—including blanks, blank matrix spikes, matrix-matched reference materials, duplicates, and sample matrix spikes—was processed using the same procedures and analysed concurrently with the samples. A summary of the instrument conditions used, and the ion/wavelength monitored for each analyte is given in Table 73.

Table 73 Instrumental Technique used for Acid Extractable Elements

Analyte	Instrument	Internal Standard	Reaction/ Collision Cell (if applicable)	Cell Mode/Gas (if applicable)	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Ion (m/z) / Wavelength (nm)
Ag	ICP-MS	Rh	ORS	He	800	NA	107 m/z
Al	ICP-MS	Rh	NA	NA	800	NA	27 m/z
As	ICP-MS	Rh	ORS	He	800	NA	75 m/z
B	ICP-MS	Rh	NA	NA	800	NA	11 m/z
Ba	ICP-MS	Rh	ORS	He	800	NA	137 m/z
Be	ICP-MS	Rh	NA	NA	800	NA	9 m/z
Bi	ICP-MS	Ir	ORS	He	800	NA	209 m/z
Ca	ICP-OES	Y	NA	NA	NA	800	422.673 nm
Cd	ICP-MS	Rh	ORS	He	800	NA	111 m/z
Co	ICP-MS	Rh	ORS	He	800	NA	59 m/z
Cr	ICP-MS	Rh	ORS	He	800	NA	52 m/z

Cu	ICP-MS	Rh	ORS	He	800	NA	63 m/z
Fe	ICP-OES	Y	NA	NA	NA	800	238.204 nm
Ga	ICP-MS	Rh	ORS	He	800	NA	71 m/z
Hg	ICP-MS	Rh	ORS	He	800	NA	201 m/z
K	ICP-OES	Y	NA	NA	NA	800	766.491 nm
Li	ICP-MS	Rh	ORS	He	800	NA	7 m/z
Mg	ICP-OES	Y	NA	NA	NA	800	285.213 nm
Mn	ICP-MS	Rh	ORS	He	800	NA	55 m/z
Mo	ICP-MS	Rh	ORS	He	800	NA	95 m/z
Na	ICP-OES	Y	NA	NA	NA	800	588.995 nm
Ni	ICP-MS	Rh	ORS	He	800	NA	60 m/z
P	ICP-OES	Y	NA	NA	NA	800	213.618 nm
Pb	ICP-MS	Ir	ORS	He	800	NA	206 m/z
Rb	ICP-MS	Rh	ORS	He	800	NA	85 m/z
S	ICP-OES	Y	NA	NA	NA	800	181.972 nm
Sb	ICP-MS	Rh	ORS	He	800	NA	121 m/z
Se	ICP-MS	Rh	ORS	HEHe	800	NA	78 m/z
Sr	ICP-OES	Y	NA	NA	800	800	421.552 nm
Th	ICP-MS	Rh	ORS	He	800	NA	232 m/z
Tl	ICP-MS	Rh	ORS	He	800	NA	205 m/z
U	ICP-MS	Ir	ORS	He	800	NA	238 m/z
V	ICP-MS	Rh	ORS	He	800	NA	51 m/z
Zn	ICP-MS	Rh	ORS	He	800	NA	64 m/z

NA = Not Applicable

Sample Analysis for Water Soluble Anions

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

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 74.

Table 74 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 Orthophosphate-P	Ion Chromatographic Method	IC
Water Soluble Sulphate	Ion Chromatographic Method	IC

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

A2.1 Robust Average and Associated Uncertainty

When the robust average is calculated using the procedure described in ISO 13528,⁶ the uncertainty is evaluated as:

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

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 75.

Table 75 Uncertainty of Assigned Value for As in Sample S1

No. results (p)	16
Robust Average	3.34 mg/kg
$S_{rob\ av}$	0.55 mg/kg
$u_{rob\ av}$	0.17 mg/kg
k	2
$U_{rob\ av}$	0.34 mg/kg

The assigned value for As in Sample S1 is **3.34 ± 0.34 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 Equation 2 and Equation 3 respectively (see page 18). A worked example is set out below in Table 76.

Table 76 z-Score and E_n-score for As Result Reported by Laboratory 21 in S1

As Result mg/kg	Assigned Value mg/kg	Set Target Standard Deviation	z-Score	E _n -Score
3.24 ± 0.5	3.34 ± 0.34	15% as CV or 0.15 x 3.34 = =0.501 mg/kg	$z = \frac{(3.24 - 3.34)}{0.501}$ $z = -0.20$	$En = \frac{(3.14 - 3.34)}{\sqrt{0.5^2 + 0.34^2}}$ $En = -0.17$

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 laboratories variation) can also be used to evaluate the uncertainty of their measurement results.^{10, 12} An example is given.

Between 2009 and 2025 NMIA carried out 32 proficiency tests of metals in soil. These studies involved analyses of acid-extractable elements at low and high levels in dried soil, moist soil, biosolid, clay, compost, sediment and sludge.

Laboratory X submitted results for As in all 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 77 and 78). The pooled standard deviation of the robust CV over these PT samples for each concentration range gives evaluations of the relative standard uncertainty of 9.7% 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 79 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 77 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
Average					9.8%*
$pooled\ s\% = \sqrt{\frac{((19 - 1) \times 8.5^2 + (13 - 1) \times 15^2 + \dots + (20 - 1) \times 12^2)}{361 - 18}}$					9.7%

* The pooled standard deviation was used

Table 78 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
Average					12%*
$pooled\ s\% = \sqrt{\frac{((11 - 1) \times 16^2 + (12 - 1) \times 15^2 + \dots + (16 - 1) \times 16^2)}{443 - 27}}$					13%

* The pooled standard deviation was used.

Table 79 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 45 different PT samples over seventeen years can be assumed to include all the relevant uncertainty components (different matrices, operators, reagents, calibrators etc.), and so complies with AS ISO/IEC 17025.⁸

APPENDIX 4 - ACRONYMS AND ABBREVIATIONS

AAS	Atomic Absorption Spectroscopy
AOAC	Association of Official Agricultural Chemists
APHA	American Public Health Association
ASPAC	Australasian Soil and Plant Analysis Council
AV	Assigned Value
CITAC	Cooperation on International Traceability in Analytical Chemistry
CRI	Collision Reaction Interface
CRM	Certified Reference Material
CV	Coefficient of Variation
CVAAS	Cold Vapour Atomic Absorption Spectroscopy
CV _{rob}	Robust Coefficient of Variation
DA	Discreet Analyser
DRC	Dynamic Reaction Cell
EC	Electrical conductivity
FIA	Flow Injection Analyser
GUM	Guide to the Expression of Uncertainty in Measurement
HEHe	High energy He mode
HV	Homogeneity Value
ICP-MS	Quadrupole - Inductively Coupled Plasma - Mass Spectrometry
ICP-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
Md	Median
Min	Minimum value in a set of results
MU	Measurement Uncertainty
MV	Median Value
N	Number of Participants
NATA	National Association of Testing Authorities
NIST	National Institute of Standards and Technology (of the United States of America)
NMIA	National Measurement Institute Australia
NR	Not Reported
NT	Not Tested
OPA	Orthophthaldialdehyde
ORS	Octopole Reaction System
PCV	Performance Coefficient of Variation
PT	Proficiency Test

RA	Robust Average
RM	Reference Material
CV _{rob}	Robust Coefficient of Variation
SD _{rob}	Robust Standard Deviation
SDPA	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 _a /σ	Analytical standard deviation divided by the target standard deviation
SFA	Segment Flow Analyser
SRM	Standard Reference Material (Trademark of NIST)
TKN	Total Kjeldahl nitrogen
σ	Standard Deviation for Proficiency Assessment
UC	Universal Cell
USEPA	United States Environmental Protection Agency
UV-Vis	Ultraviolet and Visible Spectroscopy

APPENDIX 5 - INSTRUMENT DETAILS

Table 80 Instrument Conditions Ag

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	NA	107
2	ICP-OES-AV	Lutetium	NA	NA	50	NA	328.068nm
5	ICP-MS	Rh	ORS			NA	107
8	ICP-MS/MS	Sc	ORS	N2O + H2	100	NA	107
9	ICP-MS	Y 89	KED	He	NA	5000	107
10	ICP-OES-RV					NA	328.068
11	ICP-MS	Rh	NA	NA	625	NA	109
12	ICP-MS	Te-125	ORS	Standard Mode	40	NA	107
17	ICP-MS	Rh	ORS			NA	107
18	ICP-OES-AV				500	NA	328.068
19	ICP-MS	Ge	ORS	He	0.09	NA	109
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	107
23	ICP-OES-AV	Lu	NA	NA	50	NA	328.289
24	ICP-MS	Rh	KED	He	1000/400	NA	109
26	ICP-OES-AV	Lutetium	NA	NA	50	NA	328.068nm
27	ICP-OES-AV	Lu			83	NA	328.068
28	ICP-MS/MS	Te	ORS	He	1000	NA	

Table 81 Instrument Conditions A1

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	800	27
2	ICP-OES-AV	Lutetium	NA	NA	50	NA	236.705nm
5	ICP-OES-RV	Y377	NA			NA	396.152
8	ICP-MS/MS	Sc	ORS	N2O + H2	100	NA	27
9	ICP-MS	Rh 103	KED	He	NA	5000	27
10	ICP-OES-RV					NA	167.019
11	ICP-MS	Sc	UC	He	625	NA	27
12	ICP-MS	Rh-103	ORS	Standard Mode	40	NA	27
13	ICP-OES-AV				NA		396.153
17	ICP-OES-RV	Y377	NA			NA	396.152
18	ICP-OES-AV				50000	NA	167.02
19	ICP-OES-AV	Lu	NA	NA	0.09	NA	237.312
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	27
23	ICP-OES-AV	Lu	NA	NA	50	NA	236.705
24	ICP-MS	Sc	KED	He	1000	NA	27
26	ICP-OES-AV	Lutetium	NA	NA	50	NA	236.705nm
27	ICP-OES-AV	Lu			83	NA	396.152
28	ICP-OES-AV-buffer				1000	NA	237.312

Table 82 Instrument Conditions As

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	800	75
2	ICP-OES-AV	Lutetium	NA	NA	50	NA	188.980nm
4	ICP-MS	Rh	UC	He	250	NA	
5	ICP-MS	Rh	ORS			NA	75
8	ICP-MS/MS	Rh	ORS	N2O + H2	100	NA	75 -> 91
9	ICP-MS	Rh 103	KED	He	5000	5000	75
10	ICP-OES-RV					NA	188.98
11	ICP-MS	Rh	UC	He	625	NA	75
12	ICP-MS	Rh-103	ORS	HEHe	40	NA	75
13	ICP-OES-AV				NA		188.982
17	ICP-MS	Rh	ORS			NA	75
18	ICP-OES-AV				500	NA	188.98
19	ICP-MS	Ge	ORS	He	0.09	NA	75
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	75
23	ICP-OES-AV	Lu	NA	NA	50	NA	188.98
24	ICP-MS	Te	KED	He	400	NA	75
26	ICP-OES-AV	Lutetium	NA	NA	50	NA	188.980nm
27	ICP-OES-AV	Lu			83	NA	188.98
28	ICP-MS/MS	Te	ORS	O2	1000	NA	

Table 83 Instrument Conditions B

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	800	11
2	ICP-MS	Lithium	ORS	No Gas	1000	NA	m/z 11
4	ICP-MS	Sc			250	NA	
5	ICP-OES-RV	Te214	NA			NA	249.678
8	ICP-MS/MS	Rh	ORS	No Gas	100	NA	11
9	ICP-MS	Sc 45	KED	He	5000	NA	11
10	ICP-OES-RV					NA	249.678
11	ICP-MS	Sc	NA	NA	625	NA	10
12	ICP-MS	Rh-103	ORS	Standard Mode	40	NA	11
13	ICP-OES-AV				NA		208.957
17	ICP-OES-RV	Te214	NA			NA	249.678
18	ICP-OES-AV				500	NA	208.956
19	ICP-OES-AV	Lu	NA	NA	0.09	NA	208.956
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	11
23	ICP-OES-AV	Lu	NA	NA	50	NA	182.577
24	ICP-MS	Sc	KED	He	400	NA	10
26	ICP-MS	Lithium	ORS	No Gas	1000	NA	m/z 11
27	ICP-OES-AV	Lu			83	NA	182.577
28	ICP-MS/MS	Sc	ORS	He	1000	NA	

Table 84 Instrument Conditions Ba

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	NA	800	134
2	ICP-MS	Lutetium	ORS	No Gas	1000	NA	m/z 137
4	ICP-MS	In			250	NA	
5	ICP-OES-RV	Y371	NA			NA	493.408
8	ICP-MS/MS	Ir	ORS	N2O + H2	100	NA	137
9	ICP-MS	In-1 115	KED	He	NA	5000	138
10	ICP-OES-RV					NA	455.403
11	ICP-MS	Rh	NA	NA	625	NA	138
12	ICP-MS	Te-125	ORS	Standard Mode	40	NA	137
17	ICP-OES-RV	Y371	NA			NA	493.408
18	ICP-OES-AV				500	NA	455.403
19	ICP-OES-RV	Lu	NA	NA	0.09	NA	455.403
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	137
23	ICP-OES-AV	Lu	NA	NA	50	NA	230.424
24	ICP-MS	Tb	KED	He	400	NA	137
26	ICP-MS	Lutetium	ORS	No Gas	1000	NA	m/z 137
27	ICP-OES-AV	Lu			83	NA	493.408
28	ICP-MS/MS	Te	ORS	He	1000	NA	

Table 85 Instrument Conditions Be

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	NA	800	9
2	ICP-MS	Lithium	ORS	No Gas	1000	NA	m/z 9
4	ICP-MS	Sc			250	NA	
5	ICP-MS	Rh	NA			NA	9
8	ICP-MS/MS	Sc	ORS	No Gas	100	NA	9
9	ICP-MS	Sc-2 45	KED	He	5000	NA	9
10	ICP-OES-RV					NA	
11	ICP-MS	Sc	NA	NA	625	NA	9
12	ICP-MS	Rh-103	ORS	Standard Mode	40	NA	9
13	ICP-OES-AV				NA		313.107
17	ICP-MS	Rh	NA			NA	9
18	ICP-OES-AV				500	NA	234.861
19	ICP-MS	Li6	ORS	He	0.09	NA	9
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	9
23	ICP-OES-AV	Lu	NA	NA	50	NA	313.107
24	ICP-MS	Sc	KED	He	400	NA	9
26	ICP-MS	Lithium	ORS	No Gas	1000	NA	m/z 9
27	ICP-OES-AV	Lu			83	NA	313.042
28	ICP-MS/MS	Sc	ORS	He	1000	NA	

Table 86 Instrument Conditions Bi

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir	ORS	He	800	NA	209
2	ICP-MS	Lutetium	ORS	No Gas	1000	NA	m/z 209
4	ICP-MS	Ir			250	NA	
5	ICP-OES-RV	Y377	NA				223.061
8	ICP-MS/MS	Ir	ORS	He	100	NA	209
11	ICP-MS	Ir	NA	NA	625	NA	209
12	ICP-MS	Ir-193	ORS	Standard Mode	40	NA	209
17	ICP-OES-RV	Y377	NA				223.061
19	ICP-MS	Ir	ORS	He	0.09	NA	209
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	209
23	ICP-MS	Lu	ORS	standard mode	1000	NA	209
24	ICP-MS	Tb	KED	He	400	NA	209
26	ICP-MS	Lutetium	ORS	No Gas	1000	NA	m/z 209
28	ICP-MS/MS	Te	ORS	He	1000	NA	

Table 87 Instrument Conditions Ca

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	NA	43
2	ICP-OES-AV	Lutetium	NA	NA	NA	50	315.887nm
3	ICP-MS	Sc	ORS	H2	NA	100	40
5	ICP-OES-RV	Y377	NA		NA		317.933
7	ICP-MS	Sc		H2	NA		
8	ICP-MS/MS	Sc	ORS	N2O + H2	NA		40
10	ICP-OES-RV				NA		315.887
11	ICP-MS	Sc	UC	He	NA	625	44
12	ICP-MS	Rh-103	ORS	Standard Mode	NA	160	44
13	ICP-OES-AV				NA		317.933
15	ICP-OES-AV	NA	NA	NA	NA	50	315.887
16	ICP-MS	45 sC	ORS	H2	NA	20	40
17	ICP-OES-RV	Y377	NA		NA		317.933
19	ICP-OES-RV	Lu	NA	NA	NA	0.09	422.673
20	ICP-OES	Cs,Y	NA	NA	NA	500	317.993
22	AAS		NA		NA	1	620
23	ICP-OES-AV	Lu	NA	NA	NA	1000	315.887
25	ICP-MS	Scandium	CRI	H2	NA	500	40
26	ICP-OES-AV	Lutetium	NA	NA	NA	50	315.887nm
27	ICP-OES-AV	Lu			NA	83	317.933
28	ICP-OES-AV-buffer				NA	1000	430.253

Table 88 Instrument Conditions Cd

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	800	111
2	ICP-MS	Rhodium	ORS	He	1000	NA	m/z 111
4	ICP-MS	Rh			250	NA	
5	ICP-MS	Rh	ORS			NA	111
8	ICP-MS/MS	Rh	ORS	He	100	NA	111
9	ICP-MS	In-1 115	KED	He	5000	5000	111
10	ICP-OES-RV					NA	214.439
11	ICP-MS	Rh	NA	NA	625	NA	111
12	ICP-MS	Te-125	ORS	He	40	NA	111
13	ICP-OES-AV				NA		228.802
17	ICP-MS	Rh	ORS			NA	111
18	ICP-OES-AV				500	NA	226.502
19	ICP-MS	In	ORS	He	0.09	NA	111
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	111
23	ICP-OES-AV	Lu	NA	NA	50	NA	228.802
24	ICP-MS	Rh	KED	He	400	NA	111
26	ICP-MS	Rhodium	ORS	He	1000	NA	m/z 111
27	ICP-OES-AV	Lu			83	NA	214.439
28	ICP-MS/MS	Ge	ORS	He	1000	NA	

Table 89 Instrument Conditions Co

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	NA	59
2	ICP-MS	Rhodium	ORS	He	1000	NA	m/z 59
4	ICP-MS	Sc	UC	He	250	NA	
5	ICP-OES-RV	Te214	NA			NA	228.615
8	ICP-MS/MS	Rh	ORS	He	100	NA	59
9	ICP-MS	Ge-1 72	KED	He	5000	NA	59
10	ICP-OES-RV					NA	228.615
11	ICP-MS	Ge	UC	He	625	NA	59
12	ICP-MS	Rh-103	ORS	He	40	NA	59
13	ICP-OES-AV				NA		228.616
17	ICP-OES-RV	Te214	NA			NA	228.615
18	ICP-OES-AV				500	NA	231.16
19	ICP-OES-AV	Ge	NA	NA	0.09	NA	230.786
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	59
23	ICP-OES-AV	Lu	NA	NA	50	NA	228.615
24	ICP-MS	Ga	KED	He	400	NA	59
26	ICP-MS	Rhodium	ORS	He	1000	NA	m/z 59
27	ICP-OES-AV	Lu			83	NA	230.786
28	ICP-MS/MS	Ge	ORS	He	1000	NA	

Table 90 Instrument Conditions Cr

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	800	52
2	ICP-MS	Rhodium	ORS	He	1000	NA	m/z 52
4	ICP-MS	Sc	UC	He	250	NA	
5	ICP-OES-RV	Te214	NA			NA	267.716
8	ICP-MS/MS	Rh	ORS	N2O + H2	100	NA	52
9	ICP-MS	Rh 103	KED	He	5000	5000	52
10	ICP-OES-RV					NA	267.716
11	ICP-MS	Sc	UC	He	625	NA	52
12	ICP-MS	Rh-103	ORS	He	40	NA	52
13	ICP-OES-AV				NA		267.716
17	ICP-OES-RV	Te214	NA			NA	267.716
18	ICP-OES-AV				500	NA	283.563
19	ICP-OES-AV	Ge	NA	NA	0.09	NA	205.56
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	52
23	ICP-OES-AV	Lu	NA	NA	50	NA	205.56
24	ICP-MS	Sc	KED	He	400	NA	52
26	ICP-MS	Rhodium	ORS	He	1000	NA	m/z 52
27	ICP-OES-AV	Lu			83	NA	267.716
28	ICP-MS/MS	Ge	ORS	He	1000	NA	

Table 91 Instrument Conditions Cu

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	800	63
2	ICP-OES-AV	Lutetium	NA	NA	50	NA	324.754nm
4	ICP-MS	Ga	UC	He	250	NA	
5	ICP-OES-RV	Y377	NA			NA	327.395
8	ICP-MS/MS	Rh	ORS	He	100	NA	63
9	ICP-MS	Rh 103	KED	He	5000	5000	63
10	ICP-OES-RV					NA	324.754
11	ICP-MS	Ge	UC	He	625	NA	63
12	ICP-MS	Te-125	ORS	Standard Mode	40	NA	133
17	ICP-OES-RV	Y377	NA			NA	327.395
18	ICP-OES-AV				500	NA	324.754
19	ICP-OES-AV	Ge	NA	NA	0.09	NA	324.754
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	63
23	ICP-OES-AV	Lu	NA	NA	50	NA	324.754
24	ICP-MS	Ga	KED	He	400	NA	63
26	ICP-OES-AV	Lutetium	NA	NA	50	NA	324.754nm
27	ICP-OES-AV	Lu			83	NA	327.395
28	ICP-MS/MS	Ge	ORS	He	1000	NA	

Table 92 Instrument Conditions Fe

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	NA	56
2	ICP-OES-AV	Lutetium	NA	NA	NA	2500	234.350nm
3	ICP-MS/MS	Sc	ORS	He	NA	5000	56
5	ICP-OES-RV	Te214	NA		NA		259.94
7	ICP-MS	Sc		He	NA		
8	ICP-MS/MS	Rh	ORS	N2O + H2	NA		56
9	ICP-MS	Rh 103	KED	He	5000	NA	57
10	ICP-OES-RV				NA		234.35
11	ICP-MS	Sc	UC	He	NA	625	56
12	ICP-MS	Rh-103	ORS	He	40	NA	63
13	ICP-OES-AV					NA	238.204
16	ICP-MS	45 sC	ORS	He	NA	20	56
17	ICP-OES-RV	Te214	NA		NA		259.94
19	ICP-OES-AV	Ge	NA	NA	NA	0.09	238.204
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	NA	500	56
22	AAS		NA		NA	10	248.3
23	ICP-OES-AV	Lu	NA	NA	5000	5000	261.382
25	ICP-MS	Scandium	CRI	He	NA	500	56
26	ICP-OES-AV	Lutetium	NA	NA	NA	2500	234.350nm
27	ICP-OES-AV	Lu			83	83	238.204
28	ICP-OES-AV-buffer				NA	1000	238.204

Table 93 Instrument Conditions Ga

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	NA	71
2	ICP-MS	Rhodium	ORS	He	1000	NA	m/z 71
8			ORS			NA	39
12	ICP-MS	Rh-103	ORS	HEHe	40	160	56
23	ICP-MS/MS	Ge	ORS	standard mode	50	NA	71
26	ICP-MS	Rhodium	ORS	He	1000	NA	m/z 71

Table 94 Instrument Conditions Hg

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir	ORS	He	800	800	202
2	CVAAS	NA	NA	NA	500	NA	253.7nm
4	ICP-MS	Ir			250	NA	
5	ICP-MS	Ir	ORS			NA	202
8	ICP-MS/MS	Ir	ORS	He	100	NA	202
9	ICP-MS	Ir 193	KED	He	5000	5000	202
10	ICP-OES-RV					NA	
11	ICP-MS	Ir	NA	NA	625	NA	201
12	ICP-MS	Ir-193	ORS	He	40	NA	201
13	FIMS				NA		253.7
17	ICP-MS	Ir	ORS			NA	202
19	ICP-MS	Ir	ORS	He	0.09	NA	202
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	201
23	CVAAS	NA	NA	NA	500	NA	253.7
24	ICP-MS	Tb	KED	He	400	NA	201
26	CVAAS	NA	NA	NA	500	NA	253.7nm
27	CVAAS					NA	253.7

Table 95 Instrument Conditions K

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-OES-AV	Y	NA	NA	800	800	766.491
2	ICP-OES-AV	Lutetium	NA	NA	NA	50	766.491nm
3	ICP-MS	Sc	ORS	He	NA	100	39
5	ICP-OES-RV	Y377	NA		NA		766.491
7	ICP-MS	Sc		He	NA		
8	ICP-MS/MS	Sc	ORS	N2O + H2	NA		39
10	ICP-OES-RV				NA		766.491
11	ICP-MS	Sc	UC	He	NA	625	39
12	ICP-MS	Rh-103	ORS	He	NA	160	39
15	ICP-OES-AV	NA	NA	NA	NA	50	766.491
16	ICP-MS	45 sC	ORS	He	NA	20	39
17	ICP-OES-RV	Y377	NA		NA		766.491
19	ICP-OES-RV	Lu	NA	NA	NA	0.09	766.491
20	ICP-OES	Cs,Y	NA	NA	NA	500	766.491
22	AAS		NA		NA	1	768
23	ICP-OES-AV	Lu	NA	NA	NA	1000	766.491
25	ICP-MS	Scandium	CRI	He	NA	500	39
26	ICP-OES-AV	Lutetium	NA	NA	NA	50	766.491nm
27	ICP-OES-AV	Lu			NA	83	769.897
28	ICP-OES-AV-buffer				NA	1000	766.491

Table 96 Instrument Conditions Li

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	NA	7
2	ICP-MS	Lithium	ORS	No Gas	1000	NA	m/z 7
4	ICP-MS	Sc			250	NA	
5	ICP-MS	Rh	ORS			NA	7
8	ICP-MS/MS	Sc	ORS	No Gas	100	NA	7
9	ICP-MS	Sc - 45	KED	He	5000	NA	7
10	ICP-OES-RV					NA	670.783
11	ICP-MS	Sc	NA	NA	625	NA	7
12	ICP-MS	Rh-103	ORS	Standard Mode	40	NA	7
17	ICP-MS	Rh	ORS			NA	7
19	ICP-OES-RV	Lu	NA	NA	0.09	NA	670.783
20	ICP-OES	Cs,Y	NA	NA	500	NA	670.783
23	ICP-OES-AV	Lu	NA	NA	50	NA	670.783
24	ICP-MS	Sc	KED	He	1000	NA	7
26	ICP-MS	Lithium	ORS	No Gas	1000	NA	m/z 7

Table 97 Instrument Conditions Mg

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-OES-AV	Y	NA	NA	800	800	279.078
2	ICP-OES-AV	Lutetium	NA	NA	NA	50	279.800nm
3	ICP-MS	Sc	ORS	He	NA	100	24
5	ICP-OES-RV	Y377	NA		NA		280.27
7		Sc		He	NA		
8	ICP-MS/MS	Sc	ORS	He	NA		24
10	ICP-OES-RV				NA		383.23
11	ICP-MS	Sc	UC	He	NA	625	25
12	ICP-MS	Rh-103	ORS	He	NA	160	24
13	ICP-OES-AV					NA	279.077
15	ICP-OES-AV	NA	NA	NA	NA	50	279.078
16	ICP-MS	45 sC	ORS	He	NA	20	24
17	ICP-OES-RV	Y377	NA		NA		280.27
19	ICP-OES-RV	Lu	NA	NA	NA	0.09	285.213
20	ICP-OES	Cs,Y	NA	NA	NA	500	285.213
22	AAS		NA		NA	10	285.2
23	ICP-OES-AV	Lu	NA	NA	NA	1000	279.8
25	ICP-MS	Scandium	CRI	He	NA	500	24
26	ICP-OES-AV	Lutetium	NA	NA	NA	50	279.800nm
27	ICP-OES-AV	Lu			NA	83	383.829
28	ICP-OES-AV-buffer				NA	1000	285.213

Table 98 Instrument Conditions Mn

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	800	55
2	ICP-MS	Rhodium	ORS	He	1000	NA	m/z 55
4	ICP-MS	Rh	UC	He	250	NA	
5	ICP-OES-RV	Te214	NA			NA	191.446
8	ICP-MS/MS	Rh	ORS	N2O + H2	100	NA	55
9	ICP-MS	Rh 103	KED	He	5000	5000	55
10	ICP-OES-RV					NA	257.61
11	ICP-MS	Sc	UC	He	625	NA	55
12	ICP-MS	Rh-103	ORS	He	40	NA	55
13	ICP-OES-AV				NA		257.61
17	ICP-OES-RV	Te214	NA			NA	191.446
18	ICP-OES-AV				500	NA	294.921
19	ICP-OES-AV	Lu	NA	NA	0.09	NA	257.61
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	55
23	ICP-OES-AV	Lu	NA	NA	50	NA	257.61
24	ICP-MS	Sc	KED	He	1000	NA	55
26	ICP-MS	Rhodium	ORS	He	1000	NA	m/z 55
27	ICP-OES-AV	Lu			83	NA	260.568
28	ICP-OES-AV-buffer				1000	NA	257.61

Table 99 Instrument Conditions Mo

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	NA	800	95
2	ICP-MS	Lutetium	ORS	He	1000	NA	m/z 95
4	ICP-MS	Rh	UC	He	250	NA	
5	ICP-OES-RV	Te214	NA			NA	204.598
8	ICP-MS/MS	Rh	ORS	N2O + H2	100	NA	98 -> 130
9	ICP-MS	Y 89	KED	He	5000	5000	98
10	ICP-OES-RV					NA	202.032
11	ICP-MS	Rh	NA	NA	625	NA	95
12	ICP-MS	Te-125	ORS	Standard Mode	40	NA	95
13	ICP-OES-AV				NA		202.031
17	ICP-OES-RV	Te214	NA			NA	204.598
18	ICP-OES-AV				500	NA	202.032
19	ICP-MS	Ge	ORS	He	0.09	NA	95
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	95
23	ICP-OES-AV	Lu	NA	NA	50	NA	202.032
24	ICP-MS	Rh	KED	He	400	NA	98
26	ICP-MS	Lutetium	ORS	He	1000	NA	m/z 95
27	ICP-OES-AV	Lu			83	NA	202.568
28	ICP-MS/MS	Ge	ORS	He	1000	NA	

Table 100 Instrument Conditions Na

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-OES-AV	Y	NA	NA	800	800	588.995
2	ICP-OES-AV	Lutetium	NA	NA	50	50	588.995nm
3	ICP-MS	Sc	ORS	He	NA	100	23
5	ICP-OES-RV	Y377	NA		NA		589.592
7	ICP-MS	Sc		He	NA		
8	ICP-MS/MS	Sc	ORS	He	100		23
10	ICP-OES-RV						589.592
11	ICP-MS	Sc	UC	He	625	625	23
12	ICP-MS	Rh-103	ORS	He	40	160	23
15	ICP-OES-AV	NA	NA	NA	NA	50	588.995
16	ICP-MS	45 sC	ORS	He	NA	20	23
17	ICP-OES-RV	Y377	NA		NA		589.592
18	AAS				50	NA	589.0
19	ICP-OES-RV	Lu	NA	NA	0.09	0.09	589.592
20	ICP-OES	Cs,Y	NA	NA	500	500	588.995
22	AAS		NA		NA	1	589
23	ICP-OES-AV	Lu	NA	NA	1000	1000	588.995
24	ICP-MS	Sc	KED	He	1000	NA	23
25	ICP-MS	Scandium	CRI	He	NA	500	23
26	ICP-OES-AV	Lutetium	NA	NA	50	50	588.995nm
27	ICP-OES-AV	Lu			83	83	330.237
28	ICP-OES-AV-buffer				1000	1000	588.995

Table 101 Instrument Conditions Ni

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	NA	60
2	ICP-OES-AV	Lutetium	NA	NA	50	NA	231.604nm
4	ICP-MS	Rh	UC	He	250	NA	
5	ICP-OES-RV	Te214	NA			NA	216.555
8	ICP-MS/MS	Rh	ORS	He	100	NA	60
9	ICP-MS	Rh 103	KED	He	5000	5000	60
10	ICP-OES-RV					NA	216.555
11	ICP-MS	Ge	UC	He	625	NA	60
12	ICP-MS	Rh-103	ORS	He	40	NA	60
13	ICP-OES-AV				NA		231.604
17	ICP-OES-RV	Te214	NA			NA	216.555
18	ICP-OES-AV				500	NA	231.604
19	ICP-OES-AV	Lu	NA	NA	0.09	NA	221.648
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	60
23	ICP-OES-AV	Lu	NA	NA	50	NA	231.604
24	ICP-MS	Ga	KED	He	400	NA	60
26	ICP-OES-AV	Lutetium	NA	NA	50	NA	231.604nm
27	ICP-OES-AV	Lu			83	NA	231.604
28	ICP-MS/MS	Ge	ORS	He	1000	NA	

Table 102 Instrument Conditions P

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	800	31
2	ICP-OES-AV	Lutetium	NA	NA	NA	50	213.618nm
3	ICP-MS	Sc	ORS	He	NA	500	31
5	ICP-OES-RV	Te214	NA		NA		177.434
7	ICP-MS	Sc		He	NA		
8	ICP-MS/MS	Rh	ORS	N2O + H2	NA		31 -> 47
11	ICP-MS	Sc	UC	He	NA	625	31
12	ICP-OES-AV	Sc	NA	NA	40	40	177.495
15	ICP-OES-AV	NA	NA	NA	NA	50	213.618
16	ICP-MS	45 sC	ORS	He	NA	20	31
17	ICP-OES-RV	Te214	NA		NA		177.434
19	ICP-OES-AV	Lu	NA	NA	NA	0.09	177.434
20	ICP-OES	Cs,Y	NA	NA	NA	500	213.618
22	AAS		NA	NA	NA	1	880
23	ICP-OES-AV	Lu	NA	NA	NA	1000	182.143
25	ICP-MS	Scandium	CRI	HEHe	NA	500	31
26	ICP-OES-AV	Lutetium	NA	NA	NA	50	213.618nm
27	ICP-OES-AV	Lu			NA	83	213.618
28	ICP-OES-AV-buffer				NA	1000	213.618

Table 103 Instrument Conditions Pb

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir	ORS	He	800	800	208
2	ICP-OES-AV	Lutetium	NA	NA	50	NA	220.353nm
4	ICP-MS	Ir			250	NA	
5	ICP-OES-RV	Te214	NA			NA	220.353
8	ICP-MS/MS	Ir	ORS	He	100	NA	208
9	ICP-MS	Ir 193	KED	He	5000	NA	208
10	ICP-OES-RV					NA	22.353
11	ICP-MS	Ir	NA	NA	625	NA	206+207+208
12	ICP-MS	Ir-193	ORS	Standard Mode	40	160	208
13	ICP-OES-AV				NA		220.353
17	ICP-OES-RV	Te214	NA			NA	220.353
18	ICP-OES-AV				500	NA	220.353
19	ICP-MS	Ge	ORS	He	0.09	NA	208
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	208
23	ICP-OES-AV	Lu	NA	NA	50	NA	220.353
24	ICP-MS	Tb	KED	He	400	NA	206+207+208
26	ICP-OES-AV	Lutetium	NA	NA	50	NA	220.353nm
27	ICP-OES-AV	Lu			83	NA	220.353
28	ICP-MS/MS	Te	ORS	He	1000	NA	

Table 104 Instrument Conditions Rb

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	NA	800	85
2	ICP-MS	Rhodium	ORS	He	1000	NA	m/z 85
4	ICP-MS	Rh			250	NA	
23	ICP-MS	Ge	ORS	standard mode	1000	NA	85
24	ICP-MS	Rh	KED	He	400	NA	85
26	ICP-MS	Rhodium	ORS	He	1000	NA	m/z 85
28	ICP-MS/MS	Te	ORS	He	1000	NA	

Table 105 Instrument Conditions S

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-OES-AV	Y	NA	NA	800	NA	181.972
2	ICP-OES-AV	Lutetium	NA	NA	NA	50	181.972nm
3	ICP-MS	Sc	ORS	H2	NA	100	33
5	ICP-OES-RV	Te214	NA		NA		180.669
7	ICP-MS	Sc		H2	NA		
8	ICP-MS/MS	Sc	ORS	N2O + H2	NA		32 -> 48
11	ICP-OES-AV	Lu	NA	NA	NA	62.5	181.975
12	ICP-OES-AV	Sc	NA	NA	40	40	S 180.731
15	ICP-OES-AV	NA	NA	NA	NA	50	181.972
16	ICP-MS	45 sC	ORS	H2	NA	20	33
17	ICP-OES-RV	Te214	NA		NA		180.669
19	ICP-OES-AV	Lu	NA	NA	NA	0.09	180.669
20	ICP-OES	Cs,Y	NA	NA	NA	500	181.972
23	ICP-OES-AV	Lu	NA	NA	NA	1000	181.972
26	ICP-OES-AV	Lutetium	NA	NA	NA	50	181.972nm
27	ICP-OES-AV	Lu			NA	83	181.972
28	ICP-OES-AV-buffer				NA	1000	181.972

Table 106 Instrument Conditions Sb

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	NA	121
2	ICP-MS	Indium	ORS	No Gas	1000	NA	m/z 121
4	ICP-MS	Rh			250	NA	
8	ICP-MS/MS	Rh	ORS	N2O + H2	100	NA	121
10	ICP-OES-RV					NA	217.582
11	ICP-MS	Rh	NA	NA	625	NA	121
12	ICP-MS	Te-125	ORS	Standard Mode	40	NA	121
13	ICP-OES-AV				NA		206.836
18	ICP-OES-AV				500	NA	206.834
19	ICP-OES-AV	Lu	NA	NA	0.09	NA	206.834
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	121
23	ICP-OES-AV	Lu	NA	NA	50	NA	206.834
24	ICP-MS	Rh	KED	He	400	NA	121
26	ICP-MS	Indium	ORS	No Gas	1000	NA	m/z 121
27	ICP-OES-AV	Lu			83	NA	206.834
28	ICP-MS/MS	Ge	ORS	He	1000	NA	

Table 107 Instrument Conditions Se

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	800	78
2	ICP-MS	Germanium	ORS	HEHe	1000	NA	m/z 78
4	ICP-MS	Rh	UC	He	250	NA	
5	ICP-MS	Rh	ORS			NA	78
8	ICP-MS/MS	Rh	ORS	N2O + H2	100	NA	80 -> 96
9	ICP-MS	Rh 103	KED	He	5000	5000	82
10	ICP-OES-RV					NA	196.026
11	ICP-MS	Rh	DRC	NH3	625	NA	82
12	ICP-MS	Te-125	ORS	HEHe	40	NA	78
17	ICP-MS	Rh	ORS			NA	78
18	ICP-OES-AV				500	NA	196.026
19	ICP-MS	Ge	ORS	H2	0.09	NA	78
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	78
23	ICP-OES-AV	Lu	NA	NA	50	NA	196.026
24	ICP-MS	Te	KED	He	400	NA	82
26	ICP-MS	Germanium	ORS	HEHe	1000	NA	m/z 78
27	ICP-OES-AV	Lu			83	NA	196.026
28	ICP-MS/MS	Ge	ORS	O2	1000	NA	

Table 108 Instrument Conditions Sn

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	NA	800	118
2	ICP-MS	Indium	ORS	He	1000	NA	m/z 118
4	ICP-MS	Rh			250	NA	
5	ICP-MS	Rh	ORS			NA	118
8	ICP-MS/MS	Rh	ORS	N2O + H2	100	NA	28
9	ICP-MS	In-1 115	KED	He	5000	NA	118
11	ICP-MS	Rh	NA	NA	625	NA	118
12	ICP-MS	Te-125	ORS	He	40	NA	118
17	ICP-MS	Rh	ORS			NA	118
19	ICP-OES-AV	Lu	NA	NA	0.09	NA	189.925
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	118
23	ICP-OES-AV	Lu	NA	NA	50	NA	189.925
24	ICP-MS	Rh	KED	He	400	NA	120
26	ICP-MS	Indium	ORS	He	1000	NA	m/z 118
27	ICP-OES-AV	Lu			83	NA	189.925
28	ICP-MS/MS	Ge	ORS	He	1000	NA	

Table 109 Instrument Conditions Sr

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	NA	88
2	ICP-MS	Rhodium	ORS	He	1000	1000	m/z 88
3	ICP-MS	Rh	ORS	He	NA	500	88
4	ICP-MS	Rh			250	NA	
5	ICP-OES-RV	Y371	NA		NA		407.771
7	ICP-MS	Rh		He	NA		
8	ICP-MS/MS	Rh	ORS	N2O + H2	100		118
9	ICP-MS	Y 89	KED	He	5000	NA	88
11	ICP-MS	Rh	NA	NA	625	625	88
12	ICP-MS	Te-125	ORS	Standard Mode	40	NA	88
16	ICP-MS	103 rH	ORS	He	NA	20	88
17	ICP-OES-RV	Y371	NA		NA		407.771
18	ICP-OES-AV				500	NA	407.771
19	ICP-OES-AV	Lu	NA	NA	0.09	0.09	421.552
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	500	88
23	ICP-OES-AV	Lu	NA	NA	50	NA	421.552
24	ICP-MS	Rh	KED	He	400	NA	88
25	ICP-MS	Rhodium	CRI	He	NA	500	88
26	ICP-MS	Rhodium	ORS	He	1000	1000	m/z 88
27	ICP-OES-AV	Lu			83	NA	407.771
28	ICP-MS/MS	Te	ORS	He	1000	1000	

Table 110 Instrument Conditions Th

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir	ORS	He	800	NA	232
2	ICP-MS	Lutetium	ORS	No Gas	1000	NA	m/z 232
5	ICP-MS	Ir				NA	232
8	ICP-MS/MS	Ir	ORS	He	100	NA	232
11	ICP-MS	Ir	NA	NA	625	NA	232
17	ICP-MS	Ir				NA	232
19	ICP-MS	Ir	ORS	He	0.09	NA	232
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	232
23	ICP-MS/MS	Ge	ORS	Standard Mode	50	NA	232
26	ICP-MS	Lutetium	ORS	No Gas	1000	NA	m/z 232
28	ICP-MS/MS	Te	ORS	He	1000	NA	

Table 111 Instrument Conditions T1

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir	ORS	He	NA	800	205
2	ICP-MS	Lutetium	ORS	No Gas	1000	NA	m/z 205
8	ICP-MS/MS	Ir	ORS	He	100	NA	205
11	ICP-MS	Ir	NA	NA	625	NA	205
18	ICP-OES-AV				500	NA	190.794
19	ICP-MS	Ir	ORS	He	0.09	NA	205
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	205
23	ICP-OES-AV	Lu	NA	NA	NA	50	190.794
24	ICP-MS	Tb	KED	He	400	NA	205
26	ICP-MS	Lutetium	ORS	No Gas	1000	NA	m/z 205
28	ICP-MS/MS	Te	ORS	He	1000	NA	

Table 112 Instrument Conditions U

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir	ORS	He	800	NA	238
2	ICP-MS	Lutetium	ORS	No Gas	1000	NA	m/z 238
4	ICP-MS	Ir			250	NA	
5	ICP-OES-RV	Y371			NA		263.553
8	ICP-MS/MS	Ir	ORS	He	100	NA	238
9	ICP-MS	Ir 193	KED	He	NA	5000	238
11	ICP-MS	Ir	NA	NA	625	NA	238
12	ICP-MS	Ir-193	ORS	Standard Mode	40	NA	238
17	ICP-OES-RV	Y371			NA		263.553
19	ICP-MS	Ir	ORS	He	0.09	NA	238
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	238
23	ICP-MS	Lu	ORS	standard mode	1000	NA	238
24	ICP-MS	Tb	KED	He	400	NA	238
26	ICP-MS	Lutetium	ORS	No Gas	1000	NA	m/z 238
28	ICP-MS/MS	Te	ORS	He	1000	NA	

Table 113 Instrument Conditions V

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	NA	800	51
2	ICP-OES-AV	Lutetium	NA	NA	50	NA	292.401nm
4	ICP-MS	Sc	UC	He	250	NA	
5	ICP-OES-RV	Y371				NA	310.229
8	ICP-MS/MS	Sc	ORS	N2O + H2	100	NA	51 -> 67
9	ICP-MS	Sc 45	KED	He	5000	5000	51
10	ICP-OES-RV					NA	292.401
11	ICP-MS	Sc	UC	He	625	NA	51
12	ICP-MS	Rh-103	ORS	He	40	NA	51
13	ICP-OES-AV				NA		292.402
17	ICP-OES-RV	Y371				NA	310.229
18	ICP-OES-AV				500	NA	292.401
19	ICP-OES-AV	Lu	NA	NA	0.09	NA	310.229
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	51
23	ICP-OES-AV	Lu	NA	NA	50	NA	292.401
24	ICP-MS	Sc	KED	He	400	NA	51
26	ICP-OES-AV	Lutetium	NA	NA	50	NA	292.401nm
27	ICP-OES-AV	Lu			83	NA	292.401
28	ICP-MS/MS	Te	ORS	He	1000	NA	

Table 114 Instrument Conditions Zn

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S2 Final Dilution Factor	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Rh	ORS	He	800	800	64
2	ICP-OES-AV	Lutetium	NA	NA	50	NA	206.200nm
4	ICP-MS	Rh	UC	He	250	NA	
5	ICP-OES-RV	Te214				NA	202.548
8	ICP-MS/MS	Rh	ORS	N2O + H2	100	NA	66
9	ICP-MS	Rh 103	KED	He	5000	5000	66
10	ICP-OES-RV					NA	206.2
11	ICP-MS	Ge	UC	He	625	NA	66
12	ICP-MS	Rh-103	ORS	He	40	NA	66
13	ICP-OES-AV				NA		213.857
17	ICP-OES-RV	Te214				NA	202.548
18	ICP-OES-AV				500	NA	206.2
19	ICP-OES-AV	Lu	NA	NA	0.09	NA	213.857
20	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	500	NA	66
23	ICP-OES-AV	Lu	NA	NA	50	NA	206.2
24	ICP-MS	Ga	KED	He	400	NA	66
26	ICP-OES-AV	Lutetium	NA	NA	50	NA	206.200nm
27	ICP-OES-AV	Lu			83	NA	213.857
28	ICP-MS/MS	Ge	ORS	He	1000	NA	

END OF REPORT