NEW YORK STATE | Department of Health | Wadsworth Center

New York State Biomonitoring Program for Trace Elements

Event #2, 2023

Trace Elements in Whole Blood, Urine, and Serum

July, 2023

Wadsworth Center
NEW YORK STATE DEPARTMENT OF HEALTH
Trace Elements Laboratory

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Event #2, 2023:
Trace Elements in Whole Blood, Urine, and Serum

7/26/2023

Dear Laboratory Director,

This report summarizes performance for the second biomonitoring proficiency test (PT) event of 2023 for Trace Elements in Whole Blood, Urine, and Serum. One of the key goals of this PT program is to achieve harmonization of biomonitoring data for trace elements. In this report, we summarize the responses to our recent survey request. Please refer to the attachement at the end of the report for more details.

Target Value Assignment and Performance Evaluation:
For these PT materials, target values have been assigned for a limited number of trace elements that are gradable under criteria set by the NYS DOH Biomonitoring PT program. See assay-specific narratives for details. Data for additional trace elements are reported and are included here in order to characterize the PT materials more completely. Participant data and descriptive statistics are provided for educational purposes. No target value or acceptable range is implied.

Where the data permit, robust statistics were used to assign target values based on Algorithm A as defined by ISO 13528:2005E *Statistical methods for use in proficiency testing by inter-laboratory comparisons* [1]. Acceptable ranges for the graded elements are based on consensus criteria and/or those set by the NYS DOH's PT program. For example, some are fixed based on US regulatory guidelines (Pb, Cd) while for other elements the criteria are based on a consensus of the Network of PT scheme organizers for trace elements in occupational and environmental laboratory medicine [2]. Quality specifications are element and matrix specific; full details are provided under each element specific narrative.

A confidential, three-digit code number assigned by PT program staff identifies all laboratory participants.

Samples for the next PT event (Event #3, 2023) will be shipped September 6, 2023. Comments about this report may be directed to trel@health.ny.gov.

Sincerely,

Patrick J. Parsons, PhD
Chief, Inorganic and Nuclear Chemistry,
Division of Environmental Sciences
Wadsworth Center

Kayla Mehigan
Coordinator, Biomonitoring PT Program,
Division of Environmental Sciences
Wadsworth Center

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Event #2, 2023

Trace Elements in Whole Blood

Wadsworth Center
NEW YORK STATE DEPARTMENT OF HEALTH
Trace Elements Laboratory

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Event #2, 2023:
Trace Elements in Whole Blood

PT Materials

Human whole blood was purchased from Zen-Bio, Inc. and preserved with K_2EDTA. The company certifies that this material was "non-reactive" for HBsAg, HBV DNA, HIV-1,2 Ab, HIV-1 RNA, HCV Ab, HCV RNA, and STS. Units of whole blood were filtered into polypropylene containers through cheesecloth to remove particulates and supplemented with arsenic (As), cadmium (Cd), cobalt (Co), chromium (Cr), mercury (Hg), manganese (Mn), lead (Pb), barium (Ba), beryllium (Be), copper (Cu), molybdenum (Mo), nickel (Ni), platinum (Pt), antimony (Sb), selenium (Se), tin (Sn), titanium (Ti), thallium (Tl), uranium (U), vanadium (V), tungsten (W), and zinc (Zn). Whole blood samples were homogenized overnight prior to aliquoting 2-mL into polypropylene vials. PT samples were stored at -80°C until the week of the PT event, when they were thawed at 4°C prior to circulation to laboratories

Graded Elements

Seven elements in whole blood are formally graded: As, Cd, Co, Cr, Hg, Mn, and Pb. Target values for the graded elements are assigned to these pools based on (a) the robust mean calculated from data reported by all laboratories, or (b) if a robust mean is not possible, the arithmetic mean after outlier deletion.

Additional Elements

An additional 22 elements were reported by at least one participant: Al, Ba, Be, Bi, Cs, Cu, Mg, Mo, Ni, Pt, Sb, Se, Sn, Sr, Te, Th, Ti, Tl, U, V, W, and Zn. These data are included here to provide a more complete characterization of the PT materials. All results reported by participant laboratories are tabulated and organized by lab code. The PT data are graphed for visual comparison purposes for all elements where at least five laboratories reported a value greater than the LOD. A statistical summary table is provided for samples where at least two comparable values were reported as above the LOD.

The summary statistics for the additional elements are provided for educational purposes only, i.e., no acceptable response is implied. However, it is expected that each laboratory would wish to investigate a potential source of bias if warranted by these data. Future events might result in additional elements becoming graded if a consensus can be reached regarding desired quality specifications.

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Results for Event #2, 2023: Summary Statistics

Whole Blood As (µg/L)					
	BE23-06	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
Target (Arithmetic Mean ($\bar{x}$))	15.5	10.5	2.37	45.8	5.5
Upper Limit	21.5	16.5	8.37	55.0	11.5
Lower Limit	9.5	4.5	0.00	36.6	0.0
Arithmetic SD (s)	0.9	0.5	0.14	2.3	0.3
Arithmetic RSD (%)	5.8	4.8	5.9	5.0	5.9
Number of Sample Measurements (N)	6	6	6	6	6

The acceptable range is based on quality specifications:
±6 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±6 µg/L at concentrations less than or equal to 30 µg/L. These quality specifications were established by New York State Department of Health's Wadsworth Center, the PT Program organizer.

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Results for Event #2, 2023:
Performance of Participating Laboratories

Whole Blood As (µg/L)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
	Target	**15.5**	**10.5**	**2.37**	**45.8**	**5.5**
103	ICP-MS/MS	16.4	10.7	2.44	46.4	5.55
110	ICP-MS/MS	16.5	10.1	2.48	47.3	5.72
247	ICP-MS/MS	14.7	9.87	2.22	41.8	5.05
264	ICP-MS	14.44	10.78	2.42	47.00	5.69
293	DRC/CC-ICP-MS	15.73	11.1	2.49	47.92	5.7
391	ICP-MS	*1.60 ↓	*1.4 ↓	*0.81	*2.09 ↓	*0.5
597	ICP-MS/MS	15.0	10.6	2.18	44.4	5.07

Based on the grading criteria for As in Whole Blood, 91% of results were satisfactory, with 1 of the 7 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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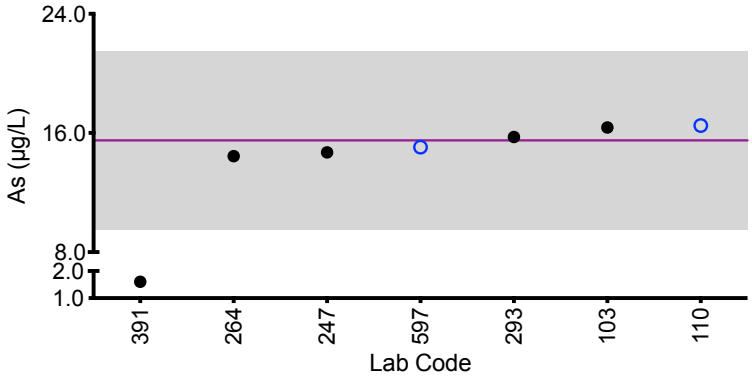
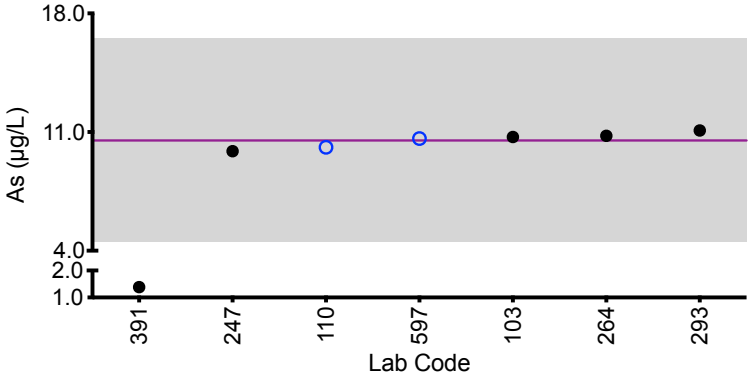
Results for Event #2, 2023: Summary Figures

Whole Blood As

BE23-06



BE23-07



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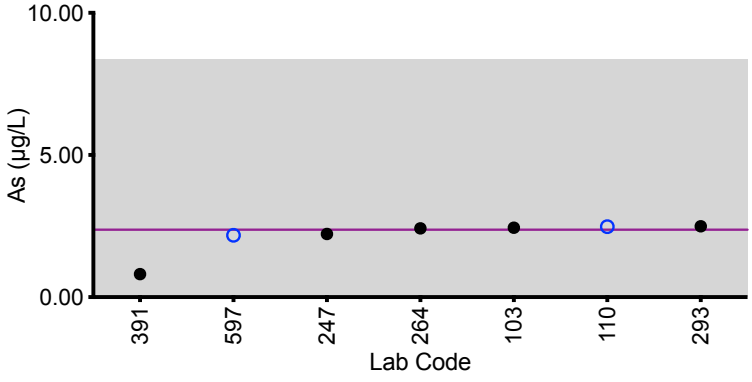
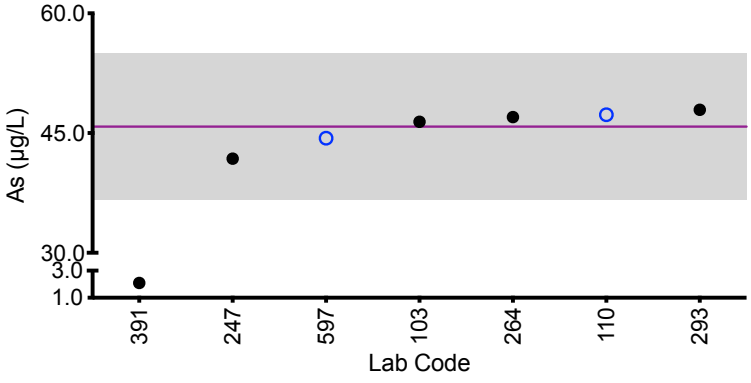


BE23-09



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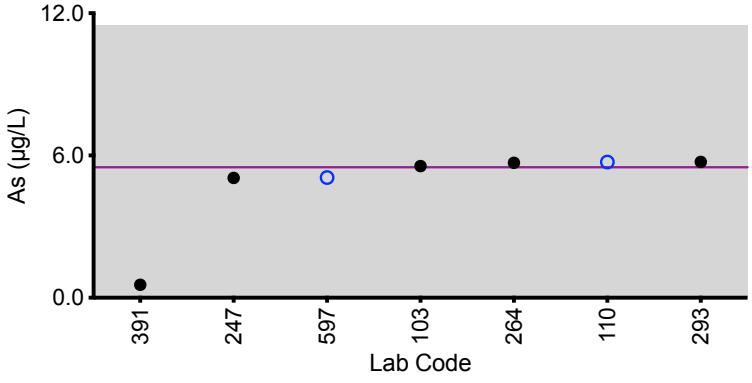

Legend:

o HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the arithmetic mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±6 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±6 µg/L at concentrations less than or equal to 30 µg/L.

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Results for Event #2, 2023: Summary Statistics

Whole Blood Cd (µg/L)					
	BE23-06	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
Target (Robust Mean (x*))	3.25	0.69	8.1	0.98	13.0
Upper Limit	4.25	1.69	9.3	1.98	14.6
Lower Limit	2.25	0.00	6.9	0.00	11.4
Robust SD (s*)	0.17	0.04	0.5	0.05	0.8
Robust RSD (%)	5.2	5.4	6.2	5.1	6.2
Number of Sample Measurements (N)	11	11	12	11	12
Standard Uncertainty (*u*)	0.06	0.01	0.2	0.02	0.3

The acceptable range is based on quality specifications:
±1 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±1 µg/L at concentrations less than or equal to 6.7 µg/L. These quality specifications are based on those used by US OSHA for occupational exposure.

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Results for Event #2, 2023:
Performance of Participating Laboratories

Whole Blood Cd (µg/L)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
	Target	**3.25**	**0.69**	**8.1**	**0.98**	**13.0**
103	ICP-MS/MS	3.21	0.671	8.41	1.01	13.3
107	ICP-MS/MS	3.230	0.669	8.029	0.982	12.895
110	ICP-MS	3.33	0.70	8.35	0.99	13.5
116	ICP-MS/MS	3.28	<1.50	7.24	<1.50	12.0
247	ICP-MS/MS	2.91	0.674	7.34	0.825	12.1
264	ICP-MS	2.92	0.61	7.72	0.93	12.15
293	DRC/CC-ICP-MS	3.21	0.71	8.100	1.0	12.90
391	ICP-MS	<0.00 ↓	6.91 ↑	10.261 ↑	0.4	16.75 ↑
597	ICP-MS/MS	3.21	0.685	8.03	0.914	13.1
605	ICP-MS	3.35	0.663	8.41	0.992	13.6
606	ICP-MS/MS	3.47	0.816	8.11	1.16	12.7
686	ICP-MS	3.44	0.729	8.67	1.02	13.7

Based on the grading criteria for Cd in Whole Blood, 93% of results were satisfactory, with 1 of the 12 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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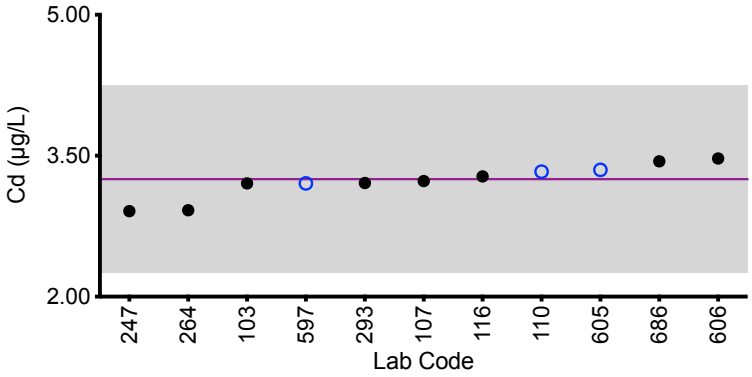
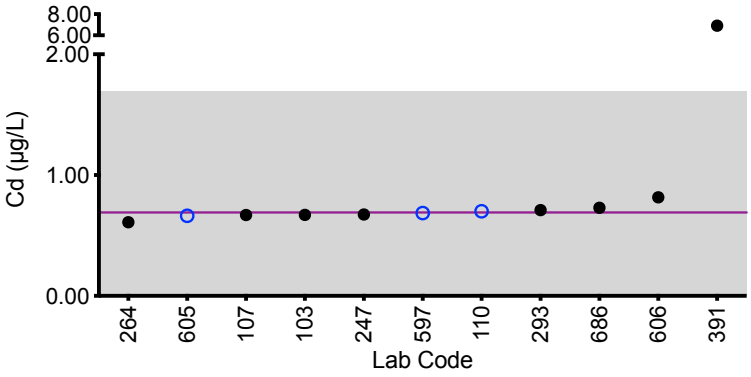
Results for Event #2, 2023: Summary Figures

Whole Blood Cd

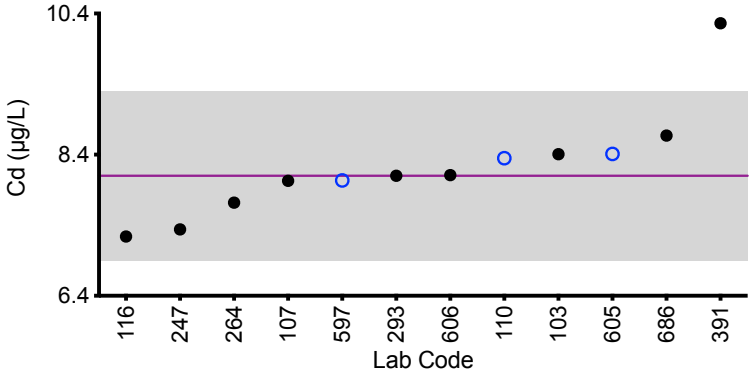
BE23-06



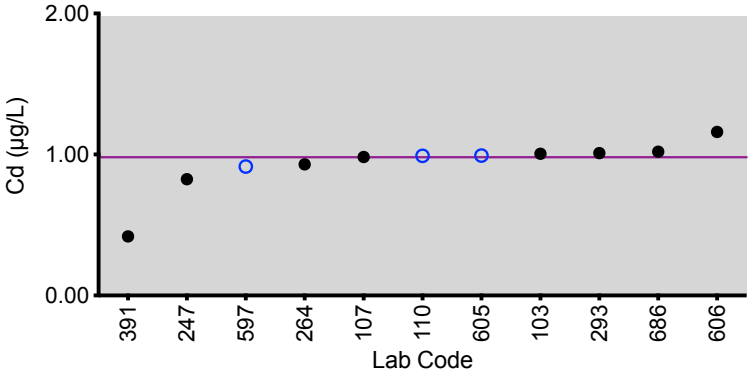
BE23-07



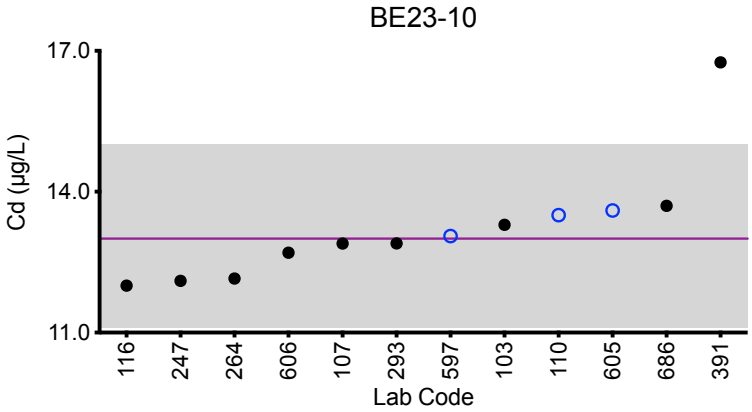
BE23-08



BE23-09



BE23-10



Legend:

o HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±1 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±1 µg/L at concentrations less than or equal to 6.7 µg/L.

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Results for Event #2, 2023: Summary Statistics

Whole Blood Co (µg/L)					
	BE23-06	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
Target (Arithmetic Mean ($\bar{x}$))	2.24	0.58	5.96	1.61	0.98
Upper Limit	3.74	2.08	7.46	3.11	2.48
Lower Limit	0.74	0.00	4.46	0.11	0.00
Arithmetic SD (s)	0.13	0.03	0.21	0.09	0.20
Arithmetic RSD (%)	5.8	4.6	3.5	5.6	20
Number of Sample Measurements (N)	7	7	8	8	8

The acceptable range is based on quality specifications:
±1.5 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±1.5 µg/L at concentrations less than or equal to 7.5 µg/L. These quality specifications were established based on discussions with the US FDA, and represent a consensus from a network of Trace Element PT program organizers

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Results for Event #2, 2023:
Performance of Participating Laboratories

Whole Blood Co (µg/L)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
	Target	**2.24**	**0.58**	**5.96**	**1.61**	**0.98**
103	ICP-MS/MS	2.30	0.600	6.04	1.68	0.892
110	ICP-MS/MS	2.38	0.57	6.22	1.71	0.91
247	ICP-MS/MS	2.19	0.599	5.66	1.57	0.831
255	ICP-MS	2.1	0.53	5.7	1.5	0.82
264	ICP-MS	2.07	0.59	6.11	1.70	0.90
293	DRC/CC-ICP-MS	2.39	0.61	6.15	1.64	0.90
391	ICP-MS	*0.77	*5.32 ↑	5.81	1.48	1.38
597	ICP-MS/MS	2.28	0.578	6.03	1.61	1.17

Based on the grading criteria for Co in Whole Blood, 98% of results were satisfactory, with 0 of the 8 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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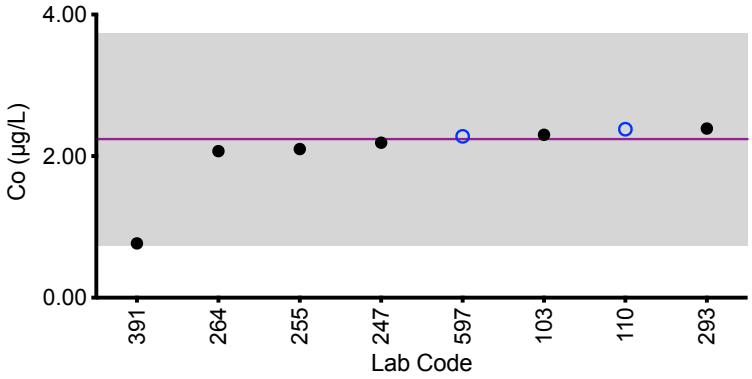
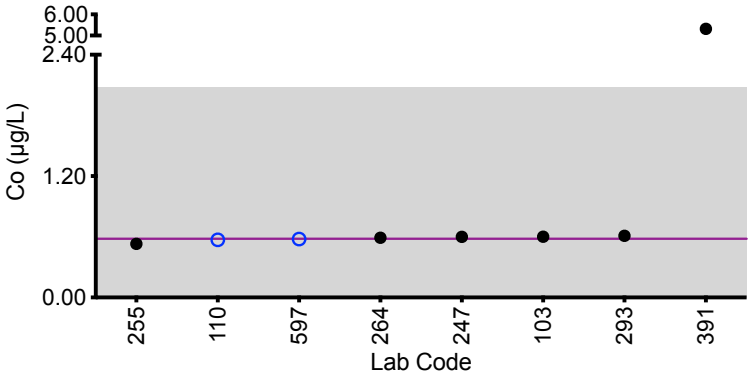
Results for Event #2, 2023: Summary Figures

Whole Blood Co

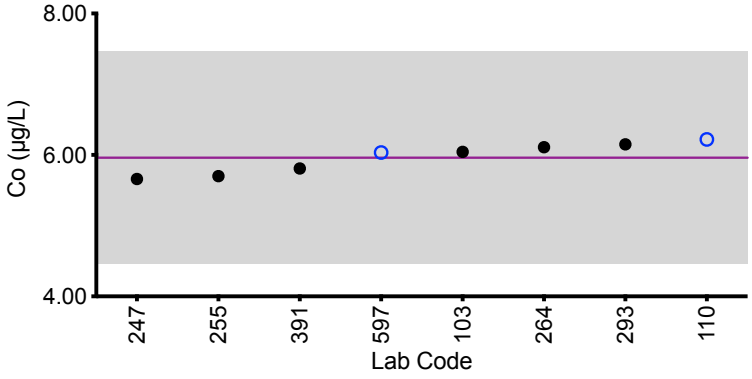
BE23-06



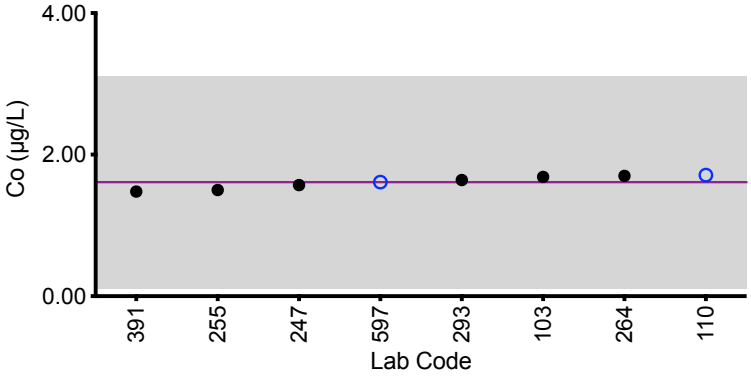
BE23-07



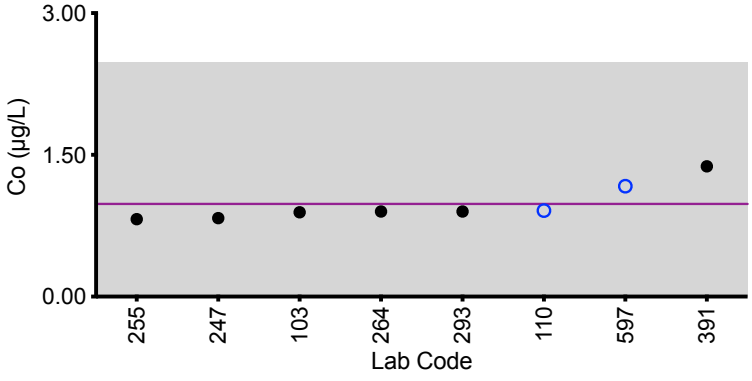
BE23-08



BE23-09



BE23-10



Legend:

o HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the arithmetic mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±1.5 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±1.5 µg/L at concentrations less than or equal to 7.5 µg/L.

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Results for Event #2, 2023:
Summary Statistics

Whole Blood Cr (µg/L)					
	BE23-06	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
Target (Arithmetic Mean ($\bar{x}$))	5.5	0.67	1.45	2.4	12.9
Upper Limit	7.5	2.67	3.45	4.4	15.5
Lower Limit	3.5	0.00	0.00	0.4	10.3
Arithmetic SD (s)	0.3	0.11	0.09	0.6	0.6
Arithmetic RSD (%)	5.5	16	6.2	25	4.7
Number of Sample Measurements (N)	7	5	6	8	8

The acceptable range is based on quality specifications:
±2 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±2 µg/L at concentrations less than or equal to 10 µg/L. These quality specifications were established based on discussions with the US FDA, and represent a consensus from a network of Trace Element PT program organizers

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Results for Event #2, 2023:
Performance of Participating Laboratories

Whole Blood Cr (µg/L)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
	Target	**5.5**	**0.67**	**1.45**	**2.4**	**12.9**
103	ICP-MS/MS	5.15	<1.50	<1.50	2.06	13.3
110	ICP-MS/MS	5.82	0.83	1.56	2.59	13.2
247	ICP-MS/MS	5.15	0.653	1.44	2.37	11.9
255	ICP-MS	5.8	<1.0	1.4	2.6	13
264	ICP-MS	5.36	*1.46	1.46	3.35	13.87
293	DRC/CC-ICP-MS	5.80	0.69	1.53	2.58	13.31
391	ICP-MS	*0.37 ↓	0.61	*0.83	1.10	12.42
597	ICP-MS/MS	5.43	0.545	1.31	2.46	12.4

Based on the grading criteria for Cr in Whole Blood, 98% of results were satisfactory, with 0 of the 8 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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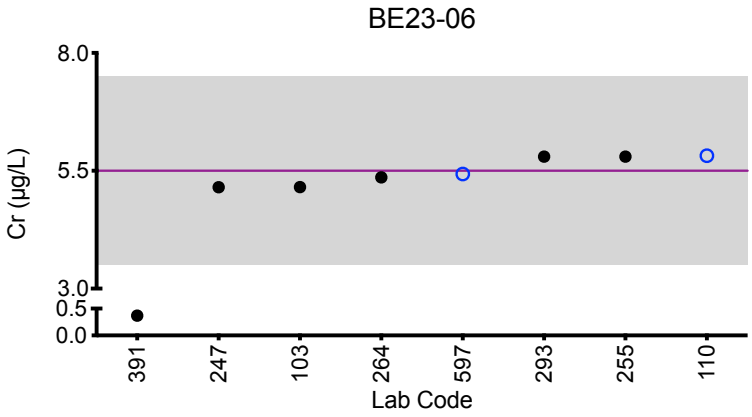
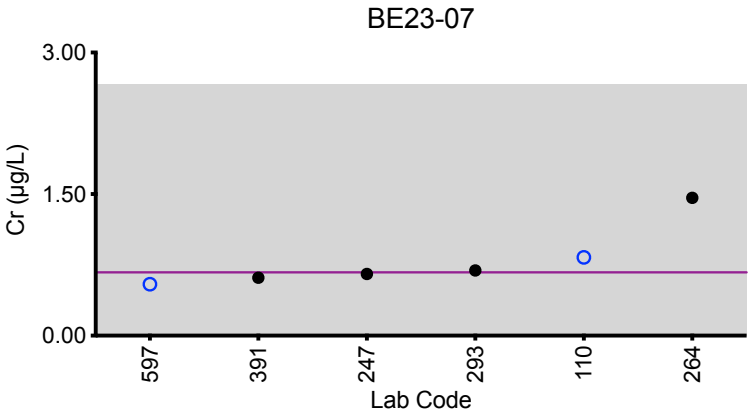
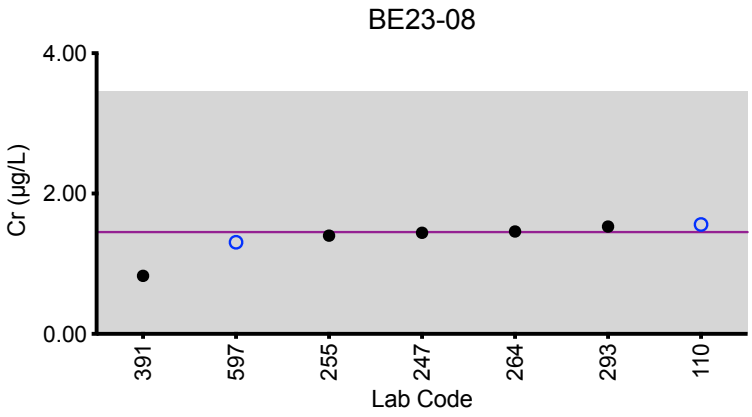
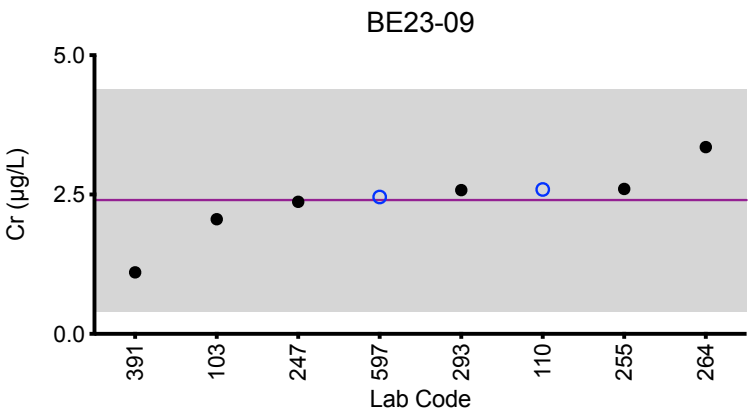
Results for Event #2, 2023: Summary Figures

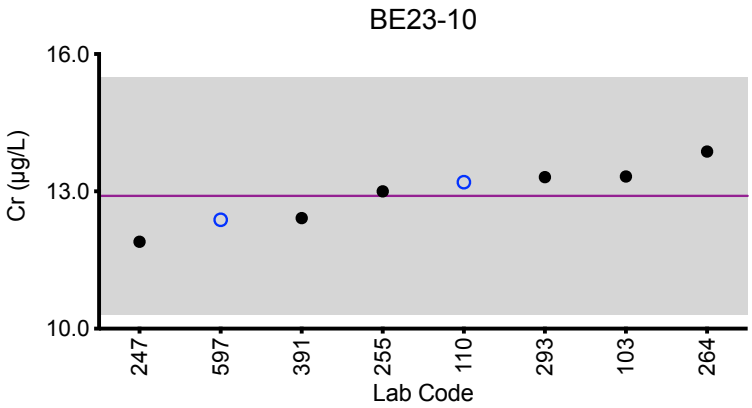
Whole Blood Cr











Legend:

o HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the arithmetic mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±2 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±2 µg/L at concentrations less than or equal to 10 µg/L.

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Results for Event #2, 2023: Summary Statistics

Whole Blood Hg (µg/L)					
	BE23-06	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
Target (Robust Mean (x*))	19.8	1.62	0.86	10.3	3.7
Upper Limit	25.7	4.62	3.86	13.4	6.7
Lower Limit	13.9	0.00	0.00	7.2	0.7
Robust SD (s*)	2.2	0.21	0.14	1.6	0.8
Robust RSD (%)	11	13	16	16	22
Number of Sample Measurements (N)	12	11	10	12	12
Standard Uncertainty (*u*)	0.8	0.08	0.06	0.6	0.3

The acceptable range is based on quality specifications:
±3 µg/L or ±30% around the target value, whichever is greater; thus, it is fixed at ±3 µg/L at concentrations less than or equal to 10 µg/L. These quality specifications were established by New York State Department of Health's Wadsworth Center, the PT Program organizer.

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Results for Event #2, 2023:
Performance of Participating Laboratories

Whole Blood Hg (µg/L)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
	Target	**19.8**	**1.62**	**0.86**	**10.3**	**3.7**
103	ICP-MS/MS	20.3	1.71	0.913	10.9	4.04
107	ICP-MS/MS	20.53	1.53	0.76	10.56	3.87
110	ICP-MS	18.6	1.19	0.57	9.88	2.95
116	ICP-MS/MS	20.0	<1.50	<1.50	11.0	4.15
247	ICP-MS/MS	18.6	1.59	0.946	9.81	3.82
264	ICP-MS	17.21	1.88	0.93	9.04	3.19
293	DRC/CC-ICP-MS	14.9	1.26	0.7	8.40	2.79
391	CV-AAS	20.8	2.44	*-0.7	7.76	2.39
597	ICP-MS/MS	18.5	1.44	0.763	9.72	3.52
605	ICP-MS	22.0	1.70	0.994	12.2	4.61
606	ICP-MS/MS	25.0	1.69	0.880	12.8	4.87
686	ICP-MS	21.6	1.65	1.01	11.6	4.33

Based on the grading criteria for Hg in Whole Blood, 98% of results were satisfactory, with 0 of the 12 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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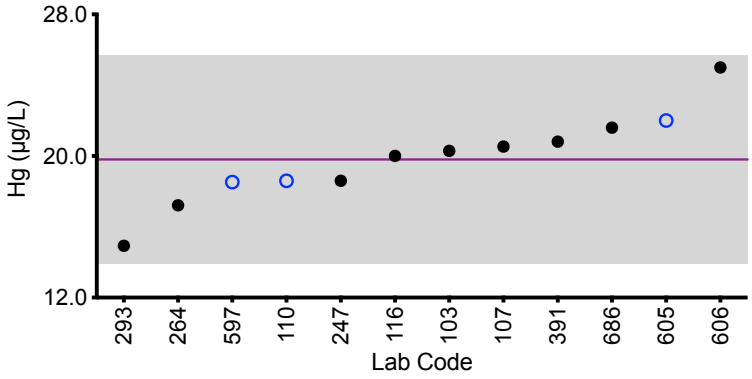
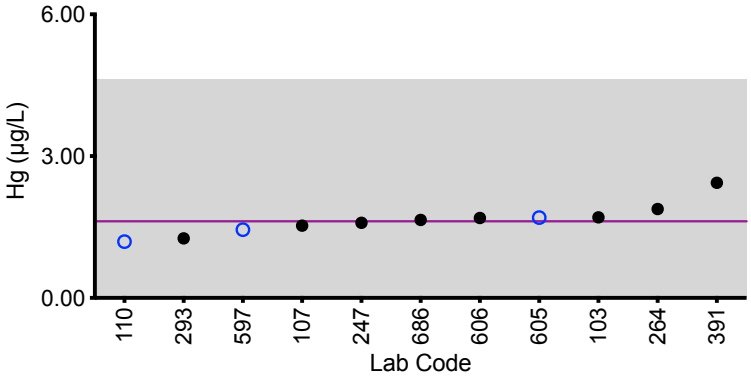
Results for Event #2, 2023: Summary Figures

Whole Blood Hg

BE23-06



BE23-07



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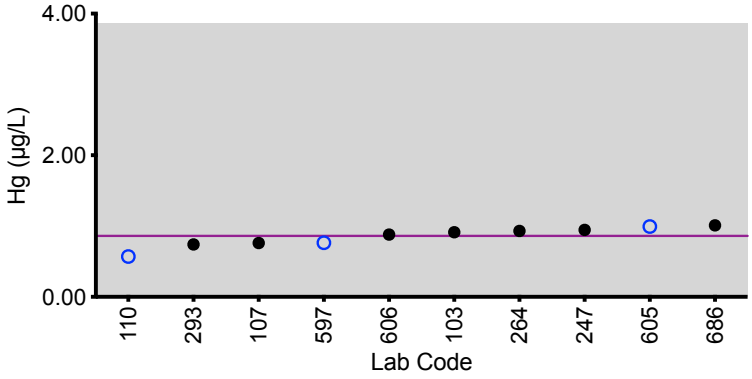
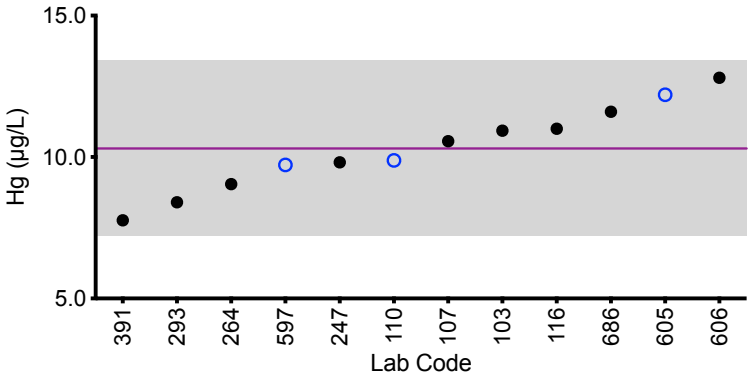
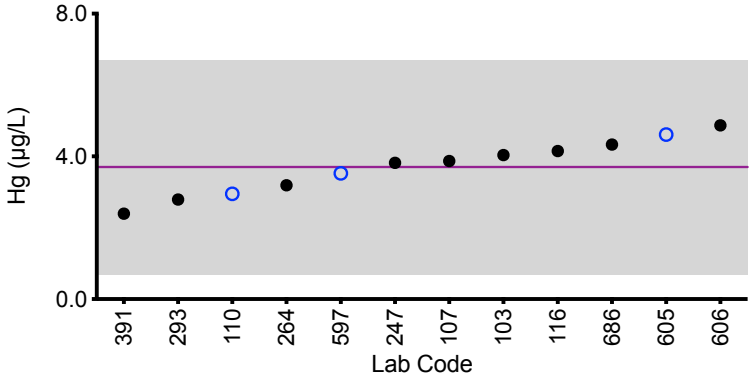


BE23-09



BE23-10



Legend:

○ HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±3 µg/L or ±30% around the target value, whichever is greater; thus, it is fixed at ±3 µg/L at concentrations less than or equal to 10 µg/L.

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Results for Event #2, 2023: Summary Statistics

Whole Blood Mn (µg/L)					
	BE23-06	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
Target (Arithmetic Mean ($\bar{x}$))	7.2	21.7	21.8	8.9	22.4
Upper Limit	10.2	25.4	25.5	11.9	26.2
Lower Limit	4.2	18.0	18.1	5.9	18.6
Arithmetic SD (s)	0.6	2.3	2.3	0.7	2.2
Arithmetic RSD (%)	8.6	11	11	7.9	9.8
Number of Sample Measurements (N)	6	8	8	7	8

The acceptable range is based on quality specifications:
±3 µg/L or ±17% around the target value, whichever is greater; thus, it is fixed at ±3 µg/L at concentrations less than or equal to 17.7 µg/L. These quality specifications were recently proposed by a network of Trace Element PT program organizers (Praamsma M, et al. An assessment of clinical laboratory performance for the determination of manganese in blood and urine. Clinical Chemistry Laboratory Medicine 2016; 54(12): 1921-1928).

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Results for Event #2, 2023:
Performance of Participating Laboratories

Whole Blood Mn (µg/L)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
	Target	**7.2**	**21.7**	**21.8**	**8.9**	**22.4**
107	ICP-MS/MS	7.52	21.82	21.86	9.32	22.77
110	ICP-MS	7.3	20.9	21.5	9.7	22.8
247	ICP-MS/MS	6.92	20.3	20.3	8.46	21.1
264	ICP-MS	*14.57 ↑	25.65 ↑	26.32 ↑	*13.61 ↑	27.14 ↑
293	DRC/CC-ICP-MS	6.2	18.18	18.4	8.2	20.65
391	ICP-MS	*19.8 ↑	24.37	23.0	8.0	20.31
597	ICP-MS/MS	7.25	21.0	20.4	9.21	21.5
606	ICP-MS/MS	8.05	21.7	22.4	9.55	22.8

Based on the grading criteria for Mn in Whole Blood, 85% of results were satisfactory, with 1 of the 8 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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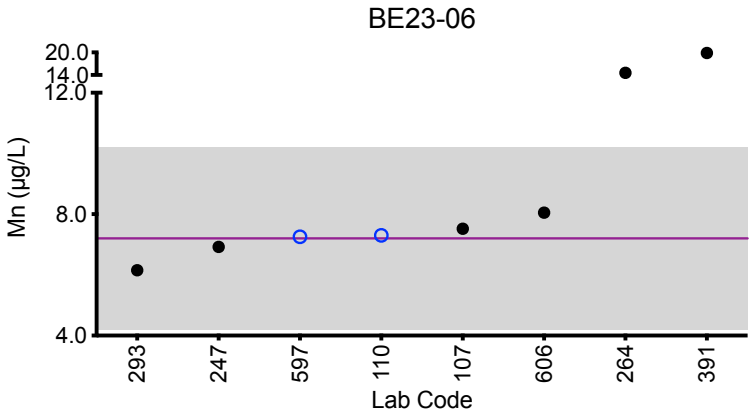
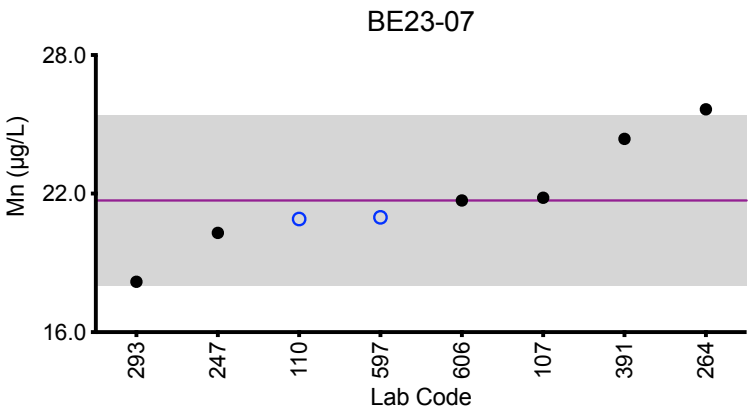
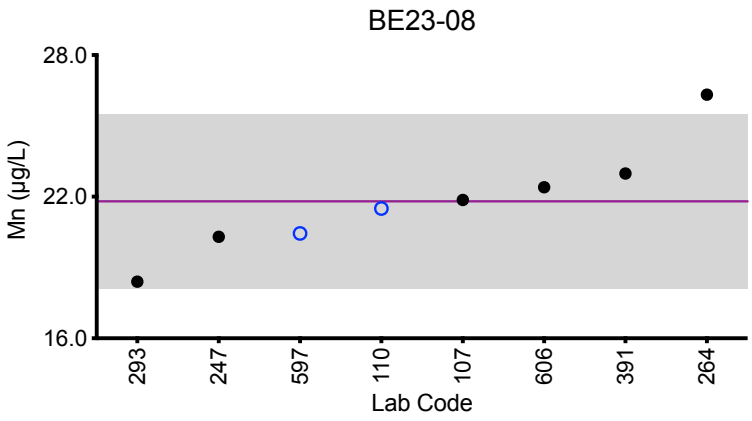
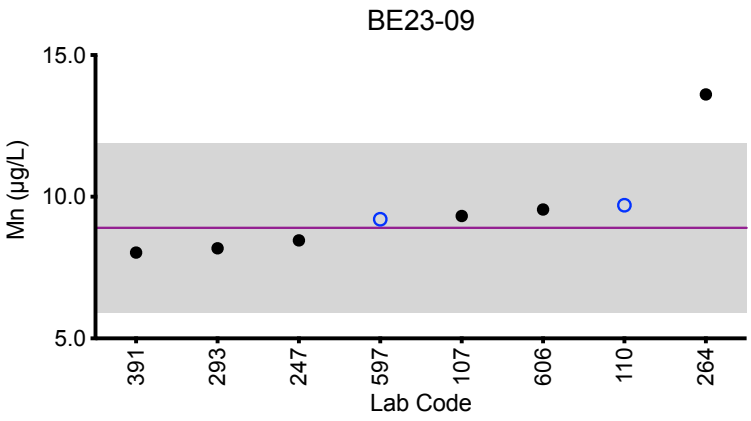
Results for Event #2, 2023: Summary Figures

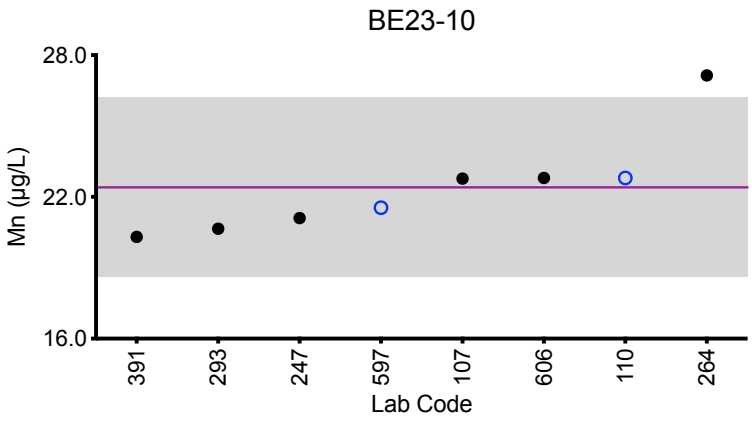
Whole Blood Mn











Legend:

o HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the arithmetic mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±3 µg/L or ±17% around the target value, whichever is greater; thus, it is fixed at ±3 µg/L at concentrations less than or equal to 17.7 µg/L.

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Results for Event #2, 2023: Summary Statistics

Whole Blood Pb (µg/dL)					
	BE23-06	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
Target (Robust Mean (x*))	0.72	5.9	2.51	18.1	1.14
Upper Limit	2.72	7.9	4.51	20.1	3.14
Lower Limit	0.00	3.9	0.51	16.1	0.00
Robust SD (s*)	0.10	0.3	0.19	0.9	0.10
Robust RSD (%)	14	5.1	7.6	5.2	8.8
Number of Sample Measurements (N)	8	13	11	13	11
Standard Uncertainty (*u*)	NA	0.1	0.07	0.3	0.04

The acceptable range is based on quality specifications:
±2 µg/dL or ±10% around the target value, whichever is greater; thus, it is fixed at ±2 µg/dL at concentrations less than or equal to 20 µg/dL. These quality specifications are recommended by the Clinical Laboratory Standards Institute (CLSI, C40-A2) and have been proposed for use in proficiency testing programs approved under CLIA by the Centers for Medicare and Medicaid Services (CMS) in the USA. (https://clsi.org/standards/products/clinical-chemistry-and-toxicology/documents/c40/)

An arithmetic mean, SD, RSD and n are provided for sample BE23-06.

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Results for Event #2, 2023:
Performance of Participating Laboratories

Whole Blood Pb (µg/dL)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
	Target	**0.72**	**5.9**	**2.51**	**18.1**	**1.14**
103	ICP-MS/MS	0.676	6.02	2.57	18.7	1.16
107	ICP-MS/MS	0.697	5.980	2.501	18.337	1.142
110	ICP-MS	0.63	5.76	2.35	17.5	1.08
116	ICP-MS/MS	<3.00	5.85	<3.00	17.5	<3.00
247	ICP-MS/MS	0.62	5.57	2.34	16.8	1.03
264	ICP-MS	0.65	5.24	2.22	16.10	1.01
293	DRC/CC-ICP-MS	0.83	6.00	2.48	18.4	1.24
343	ASV-LeadCare	<3.3	4.0	<3.3	17.5	<3.3
391	ETAAS-Z	0.91	6.87	3.20	21.9 ↑	1.12
597	ICP-MS/MS	0.728	6.00	2.50	18.1	1.14
605	ICP-MS	<1.00	6.21	2.71	19.2	1.27
606	ICP-MS/MS	<1.00	5.90	2.50	18.1	1.13
686	ICP-MS	<1.00	6.18	2.65	18.7	1.27

Based on the grading criteria for Pb in Whole Blood, 98% of results were satisfactory, with 0 of the 13 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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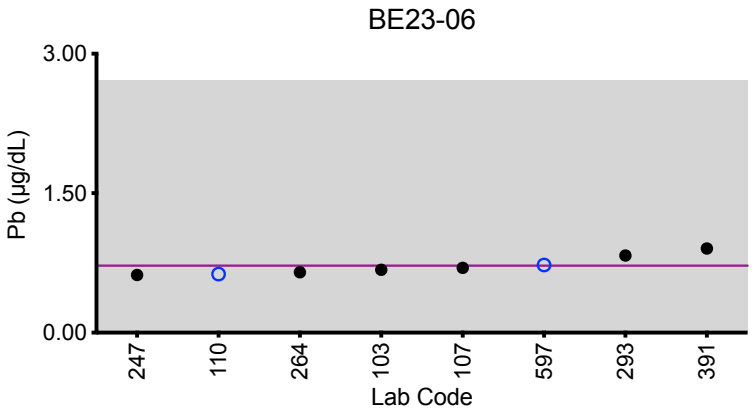
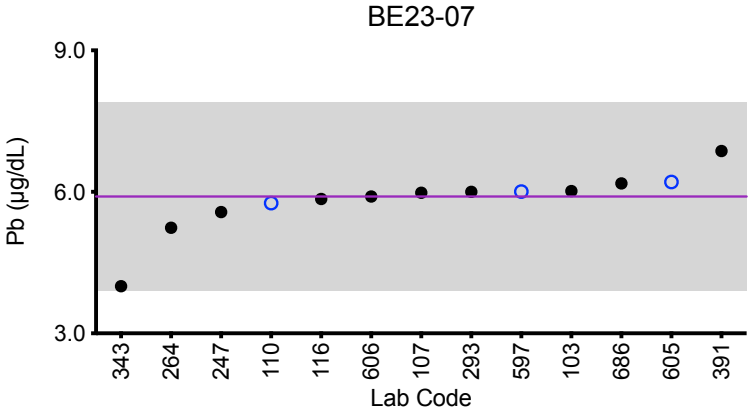
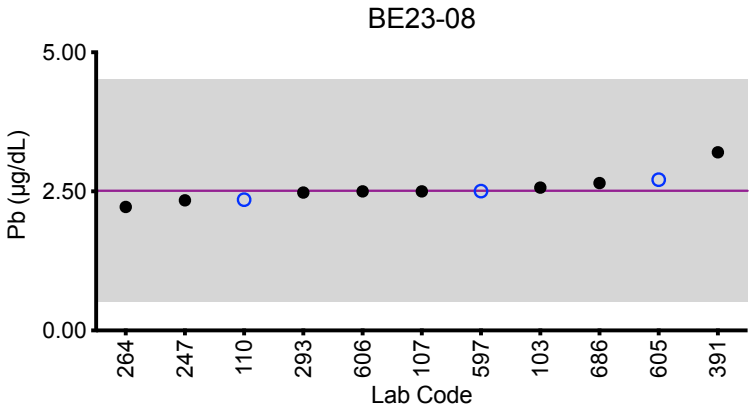
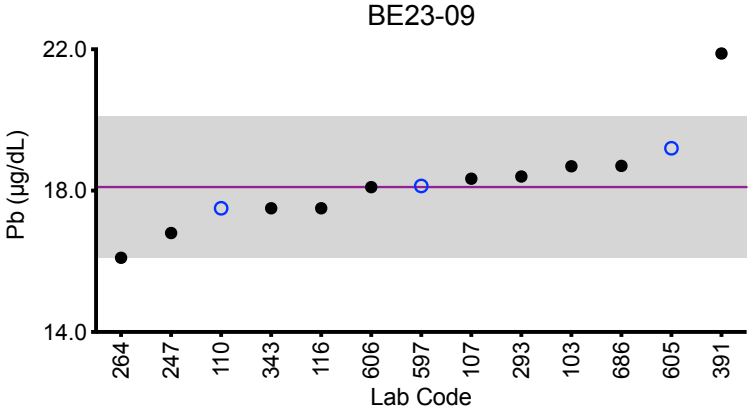
Results for Event #2, 2023: Summary Figures

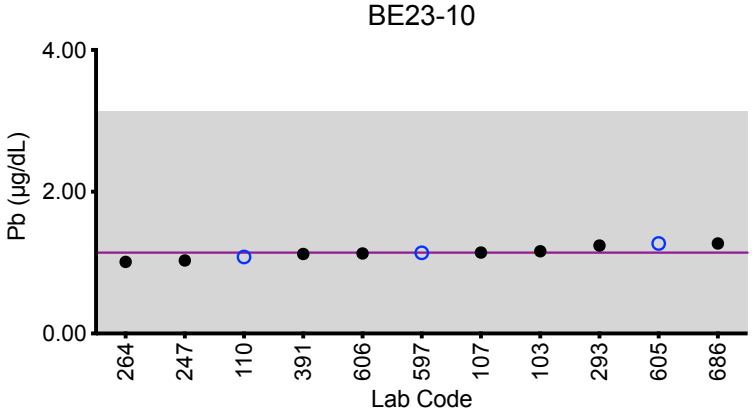
Whole Blood Pb











Legend:

o HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±2 µg/dL or ±10% around the target value, whichever is greater; thus, it is fixed at ±2 µg/dL at concentrations less than or equal to 20 µg/dL.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Whole Blood Mo (µg/L)

Lab Code	Method	BE23-06	BE23-07	BE23-08	BE23-09	BE23-10
103	ICP-MS/MS	3.95	<1.50	<1.50	7.20	5.09
110	ICP-MS/MS	4.08	1.48	0.65	7.04	5.14
264	ICP-MS	3.24	1.29	0.91	3.85	2.78
442	DRC/CC-ICP-MS	3.76	1.44	0.66	6.72	4.84
597	ICP-MS/MS	3.71	1.31	0.628	6.21	4.53

Summary Statistics

	BE23-06	BE23-07	BE23-08	BE23-09	BE23-10
Arithmetic Mean ($\bar{x}$)	3.7	1.38	0.71	6.2	4.5
Arithmetic SD (s)	0.3	0.09	0.13	1.4	1.0
Arithmetic RSD (%)	8.5	6.5	18	23	22
Number of Sample Measurements (N)	5	4	4	5	5

*Denotes a statistical Outlier.

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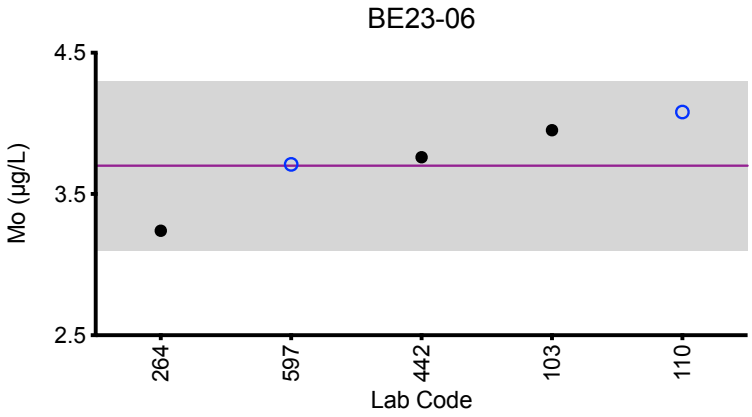
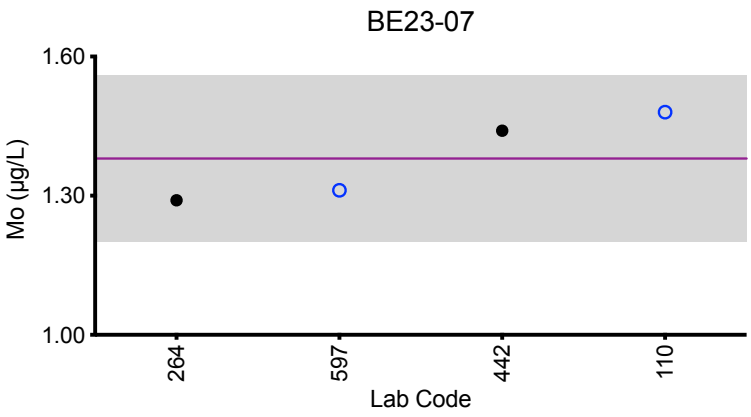
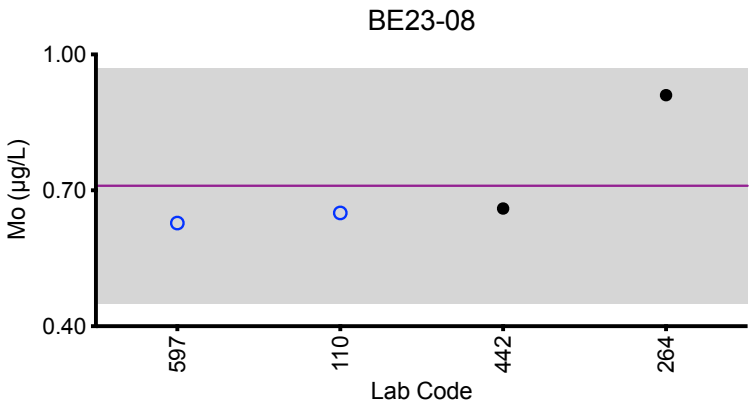
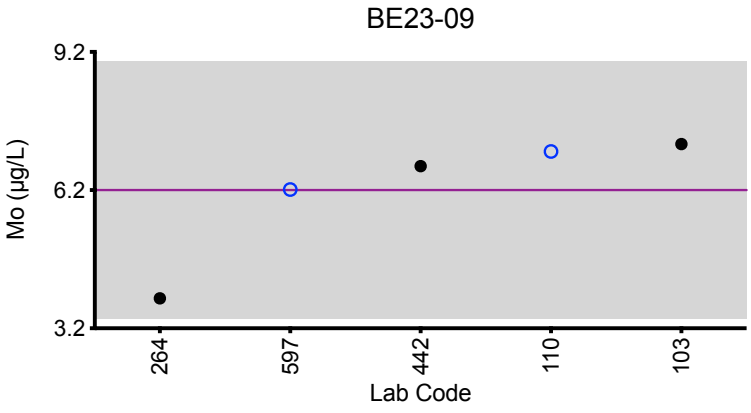
Results for Event #2, 2023: Summary Figures

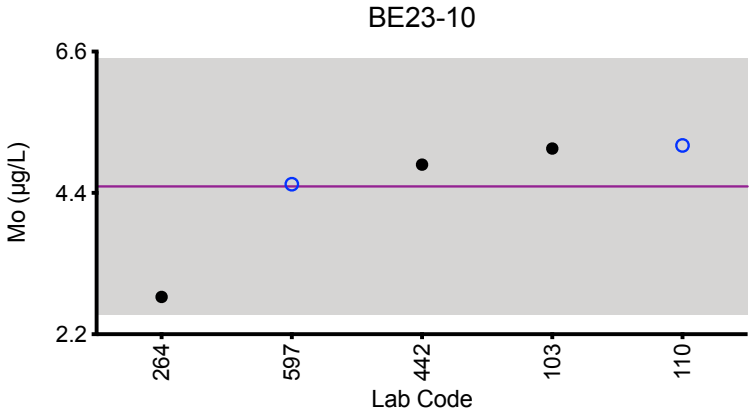
Whole Blood Mo











Legend:
o HHEAR Labs ● Other Labs
Horizontal purple line = arithmetic mean of all laboratories.
Gray area = ±2SD of the mean.

The mean and ±2SD of all laboratories are not intended to be quality specifications and are included for informational purposes only.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Whole Blood Sb (µg/L)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
103	ICP-MS/MS	1.02	4.24	0.578	8.28	2.89
110	ICP-MS/MS	1.35	5.82	0.78	10.4	3.66
264	ICP-MS	1.86	5.90	0.65	10.25	*5.81
293	DRC/CC-ICP-MS	1.3	5.9	0.7	8.9	3.2
442	DRC/CC-ICP-MS	1.81	6.24	0.880	10.2	3.88
597	ICP-MS/MS	1.37	6.55	0.779	10.2	3.62
Summary Statistics						
		BE23-06	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
Arithmetic Mean ($\bar{x}$)		1.5	5.8	0.73	9.7	3.5
Arithmetic SD (s)		0.3	0.8	0.11	0.9	0.4
Arithmetic RSD (%)		22	14	15	9.3	11
Number of Sample Measurements (N)		6	6	6	6	5

*Denotes a statistical Outlier.

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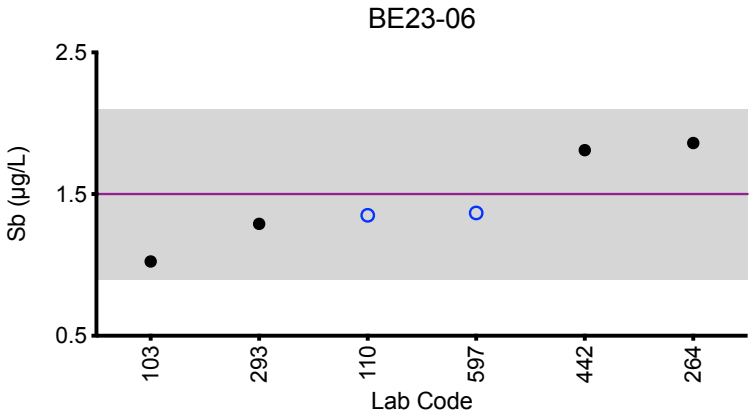
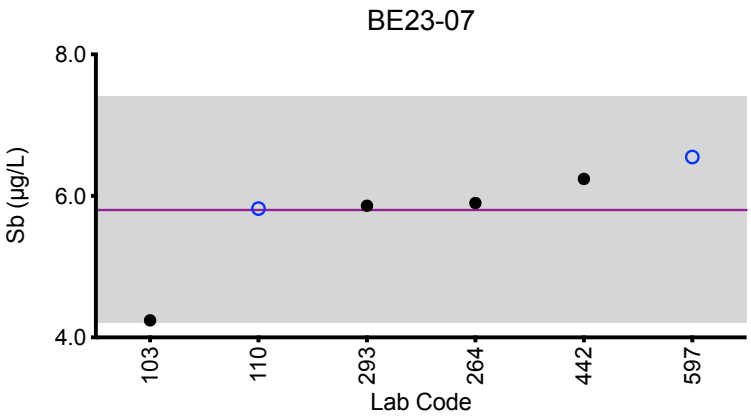
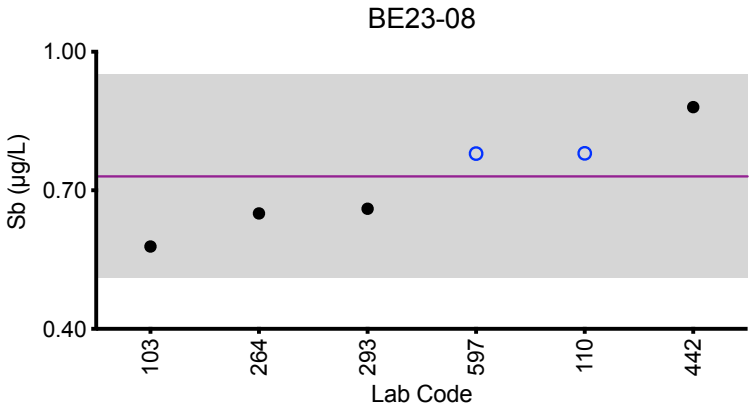
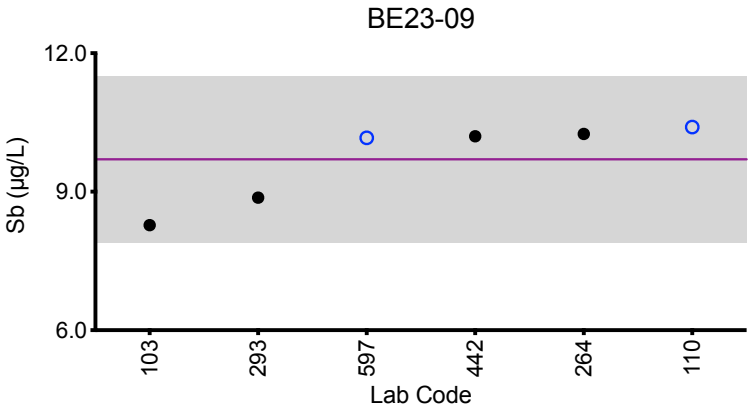
Results for Event #2, 2023: Summary Figures

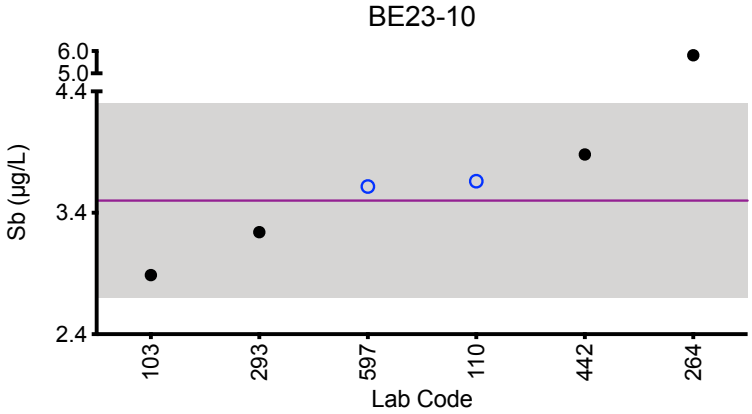
Whole Blood Sb











Legend:
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Horizontal purple line = arithmetic mean of all laboratories.
Gray area = ±2SD of the mean.

The mean and ±2SD of all laboratories are not intended to be quality specifications and are included for informational purposes only.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Whole Blood Se (µg/L)

Lab Code	Method	BE23-06	BE23-07	BE23-08	BE23-09	BE23-10
103	ICP-MS/MS	159	132	366	192	219
107	ICP-MS/MS	160.7	132.9	355.5	187.5	218.7
110	ICP-MS/MS	157	120	356	187	213
247	ICP-MS/MS	162	138	360	183	224
264	ICP-MS	145	136	366	201	229
293	DRC/CC-ICP-MS	129	110	294	153	169
597	ICP-MS/MS	147	125	340	179	203

Summary Statistics

	BE23-06	BE23-07	BE23-08	BE23-09	BE23-10
Arithmetic Mean ($\bar{x}$)	151	128	348	183	211
Arithmetic SD (s)	12	10	25	15	20
Arithmetic RSD (%)	7.9	7.8	7.2	8.2	9.5
Number of Sample Measurements (N)	7	7	7	7	7

*Denotes a statistical Outlier.

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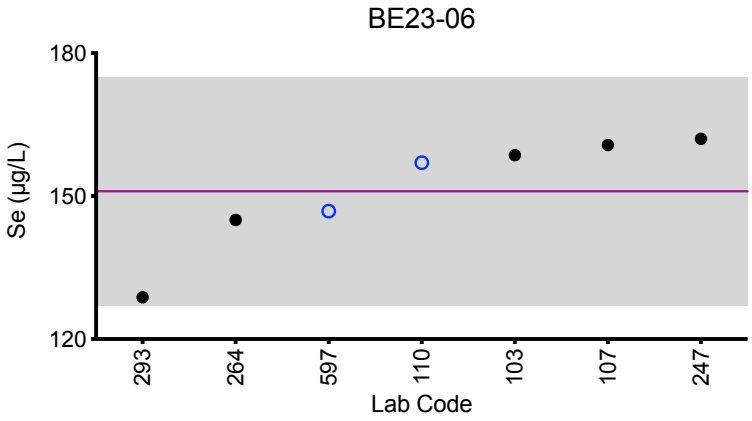
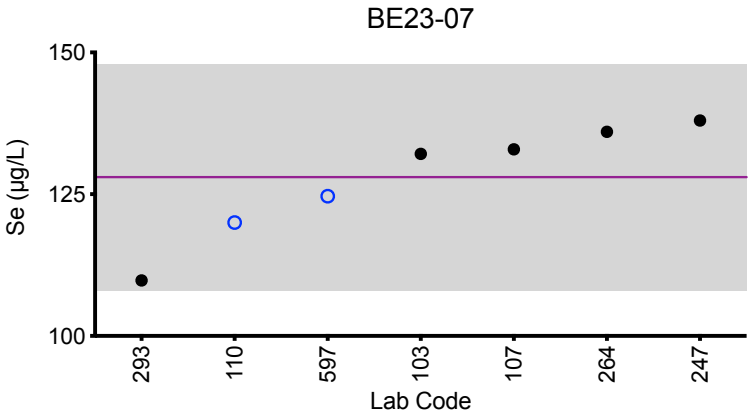
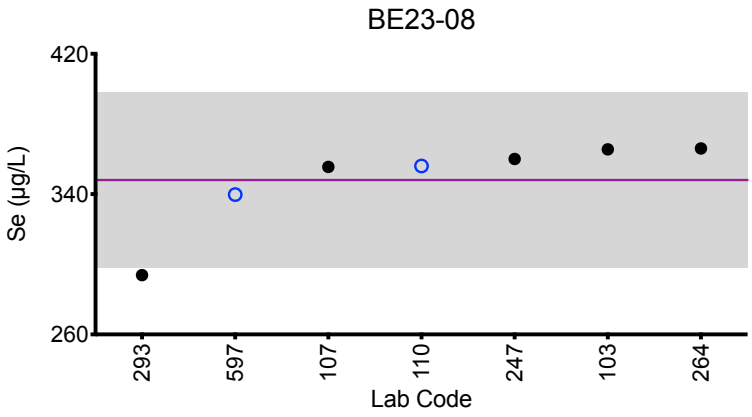
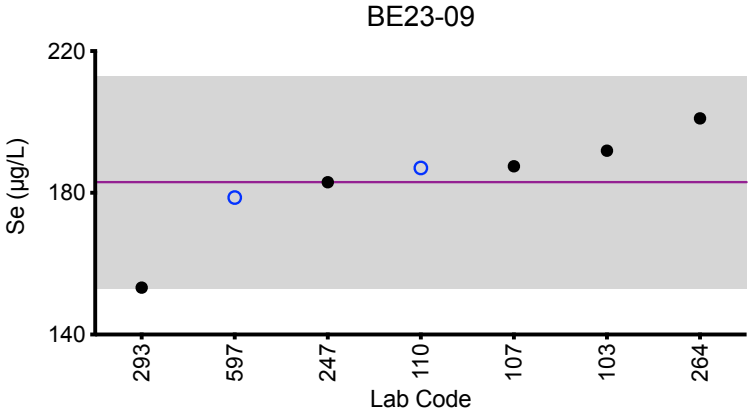
Results for Event #2, 2023: Summary Figures

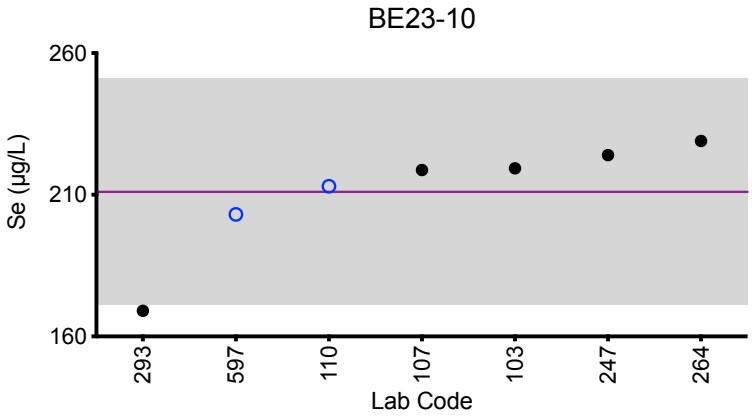
Whole Blood Se











Legend:
o HHEAR Labs ● Other Labs
Horizontal purple line = arithmetic mean of all laboratories.
Gray area = ±2SD of the mean.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Whole Blood Tl (µg/L)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
103	ICP-MS/MS	0.209	1.42	0.140	3.01	0.448
110	ICP-MS/MS	0.22	1.32	0.16	3.01	0.41
264	ICP-MS	0.24	1.34	0.15	2.89	0.42
293	DRC/CC-ICP-MS	0.25	1.39	0.160	2.89	0.43
597	ICP-MS/MS	0.219	1.42	0.152	2.99	0.430
Summary Statistics						
		BE23-06	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
Arithmetic Mean ($\bar{x}$)		0.228	1.38	0.152	2.96	0.428
Arithmetic SD (s)		0.017	0.05	0.008	0.06	0.014
Arithmetic RSD (%)		7.5	3.6	5.3	2.1	3.3
Number of Sample Measurements (N)		5	5	5	5	5

*Denotes a statistical Outlier.

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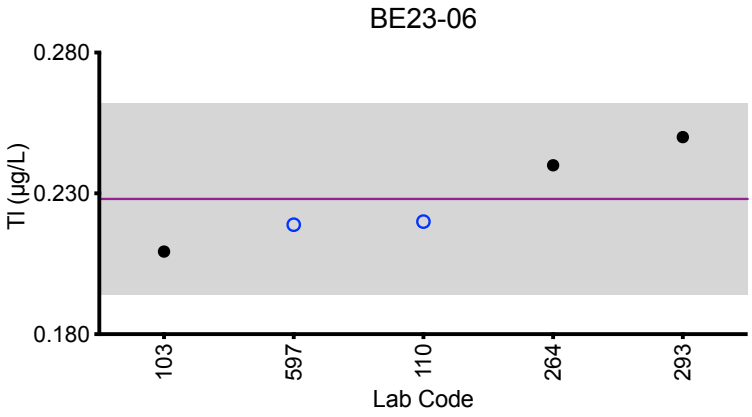
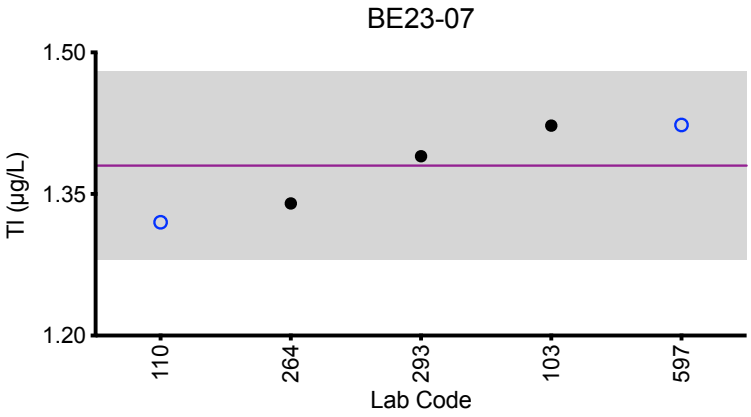
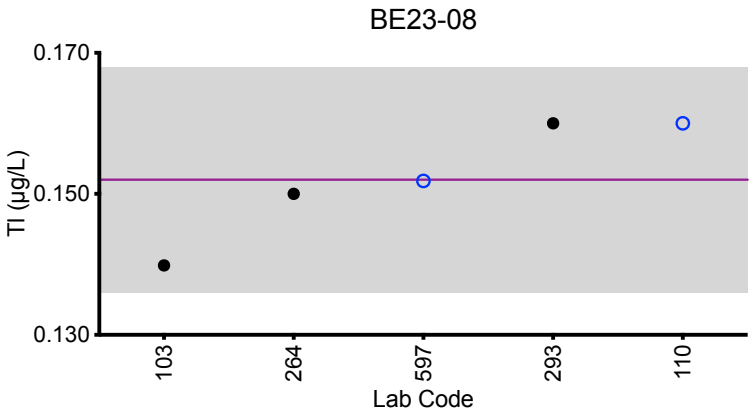
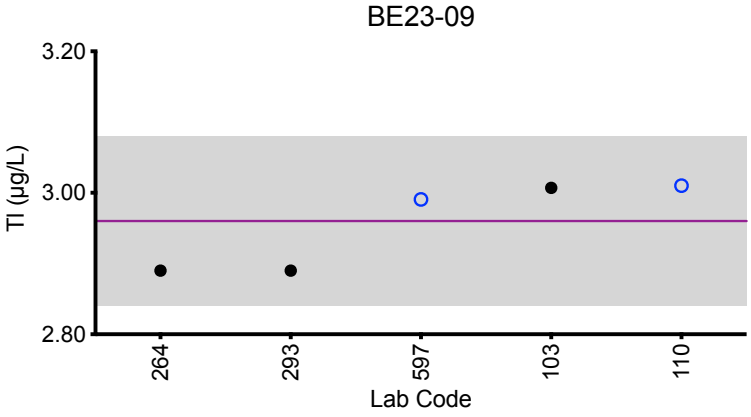
Results for Event #2, 2023: Summary Figures

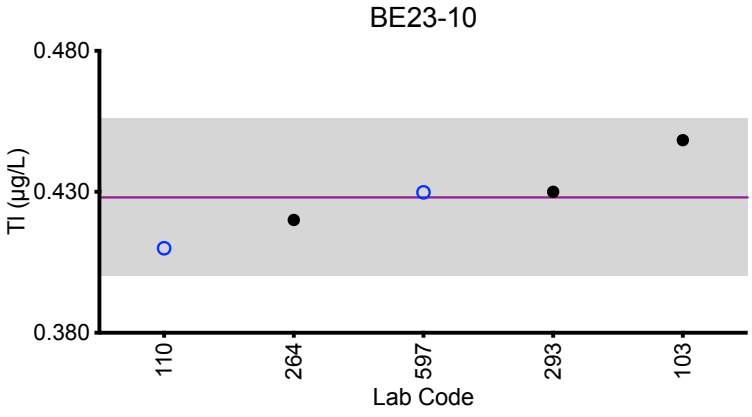
Whole Blood Tl











Legend:
o HHEAR Labs ● Other Labs
Horizontal purple line = arithmetic mean of all laboratories.
Gray area = ±2SD of the mean.

The mean and ±2SD of all laboratories are not intended to be quality specifications and are included for informational purposes only.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Whole Blood Ba (µg/L)

Lab Code	Method	BE23-06	BE23-07	BE23-08	BE23-09	BE23-10
110	ICP-MS/MS	2.09	3.35	1.49	7.35	4.15
597	ICP-MS/MS	2.36	3.63	1.30	7.44	3.56

Summary Statistics

	BE23-06	BE23-07	BE23-08	BE23-09	BE23-10
Arithmetic Mean ($\bar{x}$)	2.2	3.5	1.40	7.39	3.9
Arithmetic SD (s)	0.2	0.2	0.13	0.06	0.4
Arithmetic RSD (%)	8.5	5.7	9.3	0.81	10
Number of Sample Measurements (N)	2	2	2	2	2

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Whole Blood Be (µg/L)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
110	ICP-MS/MS	0.65	4.76	2.23	5.41	0.84
597	ICP-MS/MS	0.511	5.31	2.11	6.24	0.816
Summary Statistics						
		BE23-06	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
Arithmetic Mean ($\bar{x}$)		0.58	5.0	2.17	5.8	0.83
Arithmetic SD (s)		0.10	0.4	0.08	0.6	0.02
Arithmetic RSD (%)		17	7.7	3.7	10	2.1
Number of Sample Measurements (N)		2	2	2	2	2

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Whole Blood Cs (µg/L)

Lab Code	Method	BE23-06	BE23-07	BE23-08	BE23-09	BE23-10
110	ICP-MS/MS	3.34	1.17	1.07	1.93	2.11
597	ICP-MS/MS	3.20	1.25	1.03	1.90	2.04

Summary Statistics

	BE23-06	BE23-07	BE23-08	BE23-09	BE23-10
Arithmetic Mean ($\bar{x}$)	3.27	1.21	1.05	1.92	2.08
Arithmetic SD (s)	0.10	0.06	0.03	0.02	0.05
Arithmetic RSD (%)	3.1	4.7	2.9	1.1	2.4
Number of Sample Measurements (N)	2	2	2	2	2

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Whole Blood Cu (µg/L)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
110	ICP-MS/MS	658	2290	1010	942	782
247	ICP-MS/MS	620	2326	945	851	737
597	ICP-MS/MS	577	2180	881	844	669
Summary Statistics						
		BE23-06	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
Arithmetic Mean ($\bar{x}$)		620	2270	950	880	730
Arithmetic SD (s)		40	80	60	50	60
Arithmetic RSD (%)		6.5	3.5	6.3	5.7	8.2
Number of Sample Measurements (N)		3	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Whole Blood Ni (µg/L)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
103	ICP-MS/MS	1.02	<1.50	1.78	5.64	3.43
110	ICP-MS/MS	1.67	0.91	2.26	5.92	3.45
597	ICP-MS/MS	1.00	0.555	1.79	5.73	2.91
Summary Statistics						
		BE23-06	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
Arithmetic Mean ($\bar{x}$)		1.2	NA	1.9	5.76	3.3
Arithmetic SD (s)		0.4	NA	0.3	0.14	0.3
Arithmetic RSD (%)		33	NA	16	2.4	9.1
Number of Sample Measurements (N)		3	NA	3	3	3

*Denotes a statistical Outlier.

Statistical data was not calculated for BE23-07 based on a lack of consensus among participating labs.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Whole Blood Pt (µg/L)

Lab Code	Method	BE23-06	BE23-07	BE23-08	BE23-09	BE23-10
110	ICP-MS/MS	0.975	3.34	1.39	0.537	6.03
293	DRC/CC-ICP-MS	0.75	3.00	1.11	0.30	4.71

Summary Statistics

	BE23-06	BE23-07	BE23-08	BE23-09	BE23-10
Arithmetic Mean ($\bar{x}$)	0.9	3.2	1.3	NA	5.4
Arithmetic SD (s)	0.2	0.2	0.2	NA	0.9
Arithmetic RSD (%)	19	6.3	16	NA	17
Number of Sample Measurements (N)	2	2	2	NA	2

*Denotes a statistical Outlier.

Statistical data was not calculated for BE23-09 based on a lack of consensus among participating labs.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Whole Blood Sn (µg/L)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
110	ICP-MS/MS	5.86	0.50	3.39	0.36	1.06
597	ICP-MS/MS	5.66	0.385	3.15	0.350	0.998
Summary Statistics						
		BE23-06	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
Arithmetic Mean ($\bar{x}$)		5.8	0.44	3.3	0.355	1.03
Arithmetic SD (s)		0.1	0.08	0.2	0.007	0.04
Arithmetic RSD (%)		2.4	18	5.2	2.0	3.9
Number of Sample Measurements (N)		2	2	2	2	2

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Whole Blood Sr (µg/L)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
103	ICP-MS/MS	38.9	46.4	20.7	25.2	35.4
110	ICP-MS/MS	39.1	45.4	21.2	24.8	36.5
597	ICP-MS/MS	37.5	46.6	19.9	24.1	36.1
Summary Statistics						
		BE23-06	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
Arithmetic Mean ($\bar{x}$)		38.5	46.1	20.6	24.7	36.0
Arithmetic SD (s)		0.9	0.6	0.7	0.6	0.6
Arithmetic RSD (%)		2.3	1.3	3.4	2.4	1.7
Number of Sample Measurements (N)		3	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Whole Blood Ti (µg/L)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
200	DRC/CC-ICP-MS	3.7	3.7	4.2	7.2	6.0
597	ICP-MS/MS	3.84	4.43	4.78	8.54	6.40
Summary Statistics						
		BE23-06	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
Arithmetic Mean ($\bar{x}$)		3.77	4.1	4.5	7.9	6.2
Arithmetic SD (s)		0.10	0.5	0.4	0.9	0.3
Arithmetic RSD (%)		2.7	12	8.9	11	4.8
Number of Sample Measurements (N)		2	2	2	2	2

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Whole Blood U (µg/L)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
103	ICP-MS/MS	0.0593	0.175	<0.0500	0.0743	0.138
110	ICP-MS/MS	0.0664	0.185	0.0310	0.0772	0.142
597	ICP-MS/MS	0.0633	0.183	0.0346	0.0730	0.130
Summary Statistics						
		BE23-06	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
Arithmetic Mean ($\bar{x}$)		0.063	0.181	0.033	0.075	0.137
Arithmetic SD (s)		0.004	0.005	0.003	0.002	0.006
Arithmetic RSD (%)		6.3	2.8	9.1	2.9	4.4
Number of Sample Measurements (N)		3	3	2	3	3

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Whole Blood V (µg/L)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
110	ICP-MS/MS	2.32	0.27	0.49	1.17	3.12
597	ICP-MS/MS	2.18	0.251	0.443	1.18	2.92
Summary Statistics						
		BE23-06	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
Arithmetic Mean ($\bar{x}$)		2.25	0.261	0.47	1.175	3.0
Arithmetic SD (s)		0.10	0.013	0.03	0.007	0.1
Arithmetic RSD (%)		4.4	5.2	6.4	0.60	4.6
Number of Sample Measurements (N)		2	2	2	2	2

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Whole Blood W (µg/L)

Lab Code	Method	BE23-06	BE23-07	BE23-08	BE23-09	BE23-10
110	ICP-MS/MS	0.15	1.34	5.01	0.62	2.15
200	ICP-MS	0.20	1.62	5.70	0.74	2.30
597	ICP-MS/MS	0.161	1.46	4.78	0.610	2.01

Summary Statistics

	BE23-06	BE23-07	BE23-08	BE23-09	BE23-10
Arithmetic Mean ($\bar{x}$)	0.17	1.47	5.2	0.66	2.15
Arithmetic SD (s)	0.03	0.14	0.5	0.07	0.15
Arithmetic RSD (%)	18	9.5	9.6	11	6.7
Number of Sample Measurements (N)	3	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Whole Blood Zn (µg/L)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
110	ICP-MS/MS	5220	5720	5760	5330	5270
247	ICP-MS/MS	4453	5690	5060	4569	4700
597	ICP-MS/MS	4960	5810	5370	5200	4880
Summary Statistics						
		BE23-06	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
Arithmetic Mean ($\bar{x}$)		4900	5740	5400	5000	5000
Arithmetic SD (s)		400	60	400	400	300
Arithmetic RSD (%)		8.2	1.1	7.4	8.1	5.9
Number of Sample Measurements (N)		3	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Additional Elements in Whole Blood

Whole Blood Al (µg/L)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
597	ICP-MS/MS	4.02	6.73	2.92	4.28	4.29
Whole Blood Bi (µg/L)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
597	ICP-MS/MS	<0.0187	0.0219	<0.0187	<0.0187	<0.0187
Whole Blood Mg (µg/L)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
597	ICP-MS/MS	26800	27900	26700	28900	27600
Whole Blood Te (µg/L)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
110	ICP-MS/MS	0.01	0.00	0.01	0.01	0.00
Whole Blood Th (µg/L)						
Lab Code	**Method**	**BE23-06**	**BE23-07**	**BE23-08**	**BE23-09**	**BE23-10**
597	ICP-MS/MS	0.0268	0.0230	0.0221	0.0152	0.0266

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Event #2, 2023

Trace Elements in Urine

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Trace Elements Laboratory

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Event #2, 2023:
Trace Elements in Urine

PT Materials

Urine was collected from volunteer donors into polyethylene containers and stored at 4°C. Following collection, urine was acidified to 1% (v/v) with nitric acid and mixed with a sulfamic acid solution (stock solution contained 200 mg/mL sulfamic acid and 10% (v/v) Triton-X 100) to a final concentration of 1% (v/v) to stabilize Hg. Urine was stored frozen at -80°C pending further preparation. The urine was thawed at room temperature and precipitated salts removed by centrifugation. Urine supernatants were combined into five separate pools. Each urine pool was supplemented with arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), cobalt (Co),chromium (Cr), mercury (Hg), manganese (Mn), lead (Pb), thallium (Tl), uranium (U), aluminum (Al), cesium (Cs), copper (Cu), molybdenum (Mo), nickel (Ni), platinum (Pt), antimony (Sb) selenium (Se), tin (Sn), strontium (Sr), tellurium (Te), titanium (Ti), vanadium (V), tungsten (W), and zinc (Zn). PT samples were stored at -80°C until the week of the PT event, when they were thawed at 4°C prior to circulation to laboratories for analysis.

Graded Elements

Eleven elements in urine are formally graded: As, Ba, Be, Cd, Co, Cr, Hg, Mn, Pb, Tl, and U. Target values for the graded elements are assigned to these pools based on (a) the robust mean calculated from data reported by all laboratories, or (b) if a robust mean is not possible, the arithmetic mean after outlier deletion.

Additional Elements

An additional 23 elements were reported by at least one participant: Ag, Al, B, Bi, Cs, Cu, Fe, I, Li, Mg, Mo, Ni, Pt, Sb, Se, Sn, Sr, Te, Th, Ti, V, W, and Zn. These data are included here to provide a more complete characterization of the PT materials. All results reported by participant laboratories are tabulated and organized by lab code. The PT data are graphed for visual comparison purposes for all elements where at least five laboratories reported a value greater than the LOD. A statistical summary table is provided for samples where at least two comparable values were reported as above the LOD.

The summary statistics for the additional elements are provided for educational purposes only, i.e., no acceptable response is implied. However, it is expected that each laboratory would wish to investigate a potential source of bias if warranted by these data. Future events might result in additional elements becoming graded if a consensus can be reached regarding desired quality specifications.

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Results for Event #2, 2023: Summary Statistics

	Urine As (µg/L)				
	UE23-06	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
Target (Robust Mean (x*))	4.0	50.5	10.1	5.4	32.5
Upper Limit	10.0	60.6	16.1	11.4	39.0
Lower Limit	0.0	40.4	4.1	0.0	26.0
Robust SD (s*)	0.4	2.7	0.6	0.4	1.6
Robust RSD (%)	9.2	5.3	5.9	7.4	4.9
Number of Sample Measurements (N)	14	15	15	14	15
Standard Uncertainty (*u*)	0.1	0.9	0.2	0.1	0.5

The acceptable range is based on quality specifications:
±6 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±6 µg/L at concentrations less than or equal to 30 µg/L. These quality specifications are based on the same criteria used by the US Centers for Disease Control Prevention (CDC) for public health labs participating in the Laboratory Response Network (LRN) PT program for Toxic Metals.

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Results for Event #2, 2023:
Performance of Participating Laboratories

		Urine As (µg/L)				
Lab Code	**Method**	**UE23-06**	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
	Target	**4.0**	**50.5**	**10.1**	**5.4**	**32.5**
103	ICP-MS/MS	3.90	52.5	10.4	5.30	33.2
107	DRC/CC-ICP-MS	3.79	48.54	9.58	4.88	32.22
110	DRC/CC-ICP-MS	4.49	52.6	10.7	5.76	34.0
116	ICP-MS/MS	12.2 ↑	54.1	15.8	15.2 ↑	40.1 ↑
147	ICP-MS	2.54	49.0	9.44	4.12	32.1
220	DRC/CC-ICP-MS	4.06	51.5	10.5	5.64	33.7
264	ICP-MS	4.66	45.15	9.32	5.93	28.78
293	DRC/CC-ICP-MS	3.81	50.99	10.06	5.08	31.18
391	ICP-MS	5.903	59.751	10.35	5.575	40.007 ↑
399	DRC/CC-ICP-MS	3.87	49.5	10.2	5.24	32.3
442	ICP-MS/MS	3.63	47.6	9.51	5.32	31.2
597	ICP-MS/MS	3.85	47.7	9.57	5.18	31.0
605	ICP-MS	3.96	50.3	10.1	5.28	32.4
606	ICP-MS/MS	4.37	51.7	10.6	5.58	33.1
686	DRC/CC-ICP-MS	<6.00	50.2	10.1	<6.00	31.8

Based on the grading criteria for As in Urine, 95% of results were satisfactory, with 1 of the 15 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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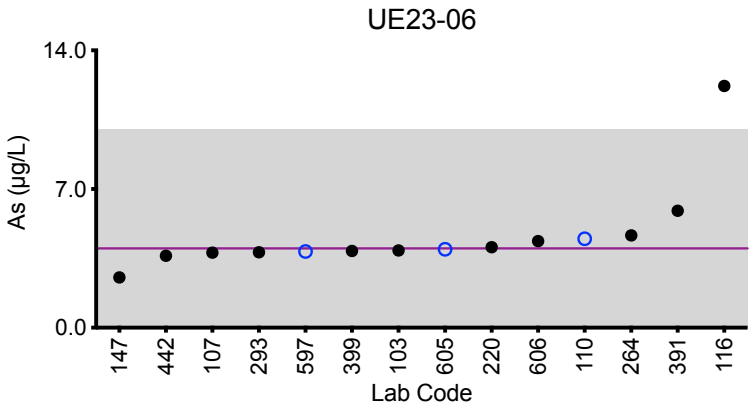
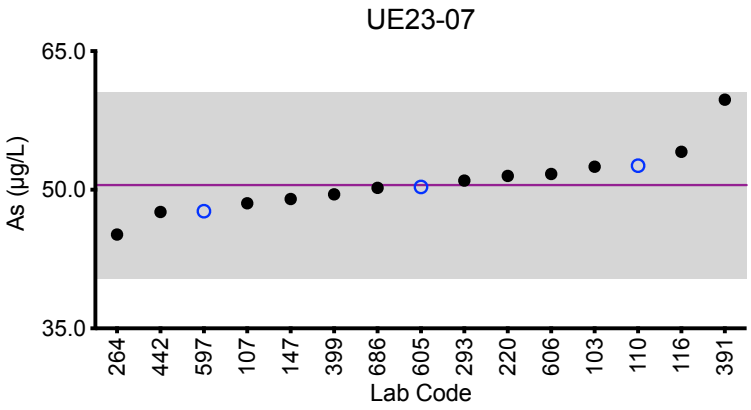
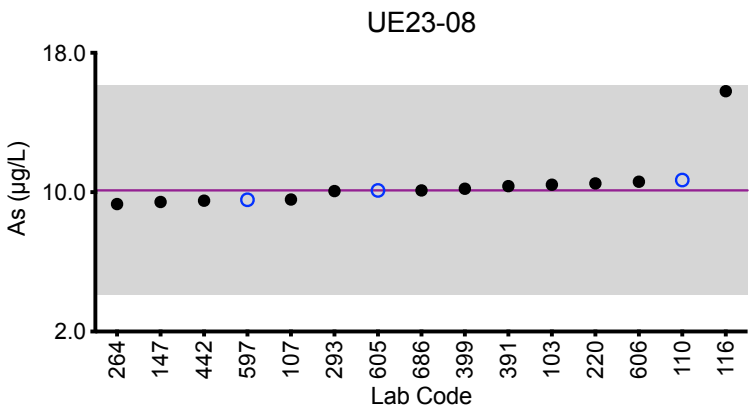
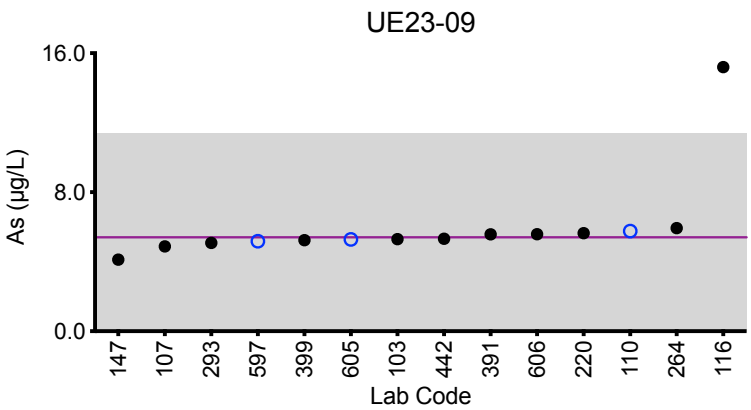
Results for Event #2, 2023: Summary Figures

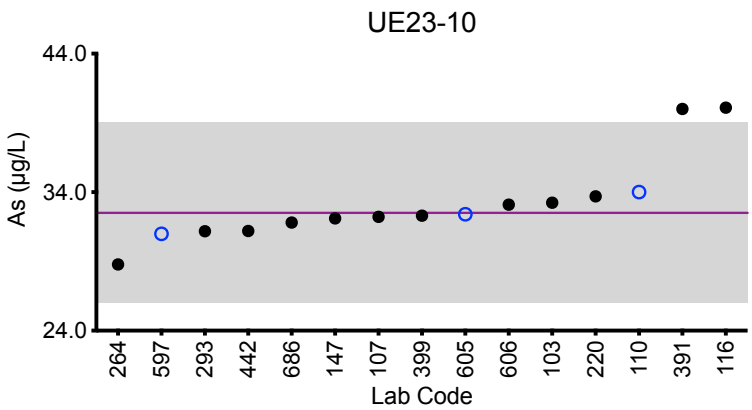
Urine As











Legend:

o HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±6 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±6 µg/L at concentrations less than or equal to 30 µg/L.

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Results for Event #2, 2023:
Summary Statistics

	Urine Ba (µg/L)				
	UE23-06	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
Target (Robust Mean (x*))	1.33	7.8	0.66	3.76	0.55
Upper Limit	2.33	9.4	1.66	4.76	1.55
Lower Limit	0.33	6.2	0.00	2.76	0.00
Robust SD (s*)	0.10	0.5	0.05	0.23	0.05
Robust RSD (%)	7.5	6.4	7.6	6.1	9.1
Number of Sample Measurements (N)	12	12	12	12	10
Standard Uncertainty (*u*)	0.03	0.2	0.02	0.08	0.02

The acceptable range is based on quality specifications:
±1 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±1 µg/L at concentrations less than or equal to 5 µg/L. These quality specifications are based on the same criteria used by the US Centers for Disease Control Prevention (CDC) for public health labs participating in the Laboratory Response Network (LRN) PT program for Toxic Metals.

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Results for Event #2, 2023:
Performance of Participating Laboratories

Urine Ba (µg/L)						
Lab Code	**Method**	**UE23-06**	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
	Target	**1.33**	**7.8**	**0.66**	**3.76**	**0.55**
107	ICP-MS	1.406	8.152	0.665	3.969	0.529
110	ICP-MS	1.54	8.58	0.73	4.29	0.62
116	ICP-MS/MS	1.18	7.05	0.690	3.58	0.528
147	ICP-MS	1.30	7.95	0.666	3.80	0.659
220	ICP-MS	1.35	8.19	0.659	3.94	0.514
264	ICP-MS	1.21	6.61	0.57	3.33	0.47
293	DRC/CC-ICP-MS	1.34	7.46	0.63	3.69	0.52
399	ICP-MS/MS	1.38	8.28	0.710	3.82	0.577
597	ICP-MS/MS	1.25	7.62	0.671	3.72	0.536
605	ICP-MS	1.33	7.82	0.619	3.71	<0.6
606	ICP-MS/MS	1.29	7.44	0.605	3.50	0.601
686	ICP-MS	1.45	8.04	0.722	3.91	<0.600

Based on the grading criteria for Ba in Urine, 100% of results were satisfactory, with 0 of the 12 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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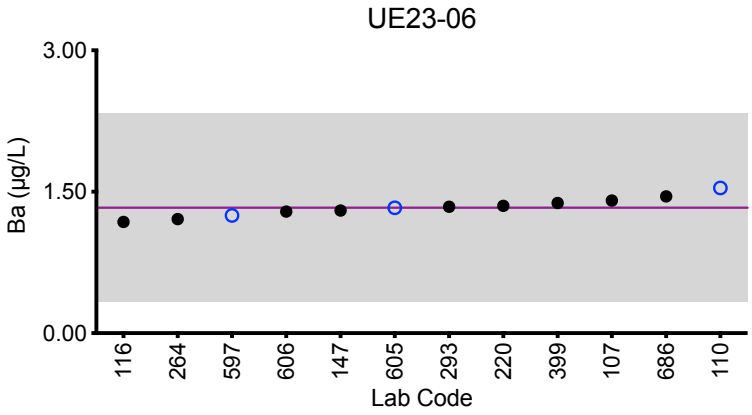
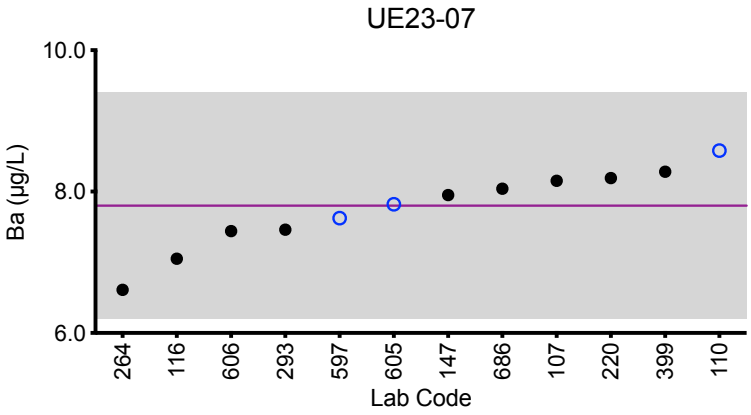
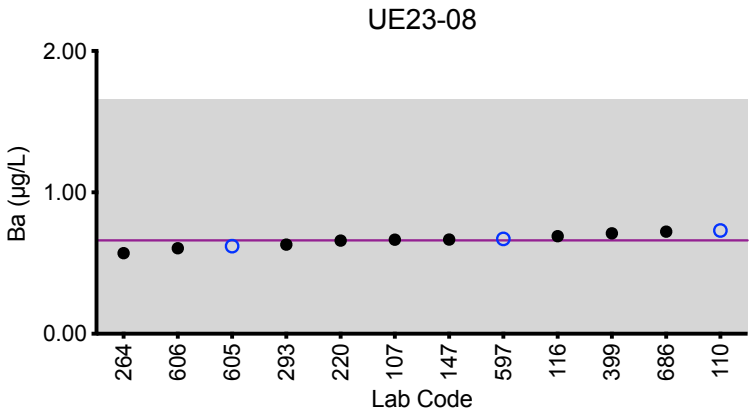
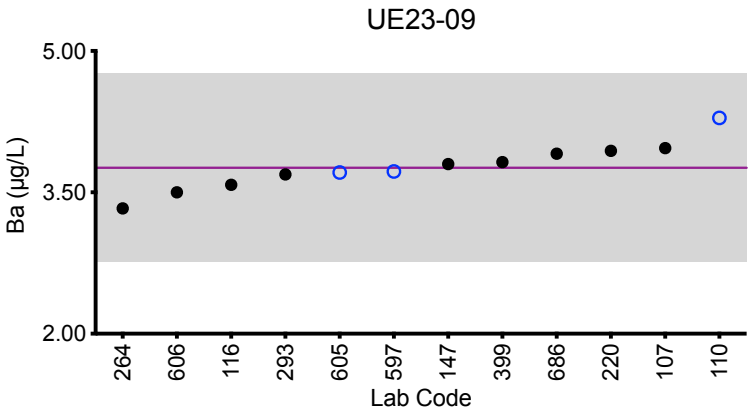
Results for Event #2, 2023: Summary Figures

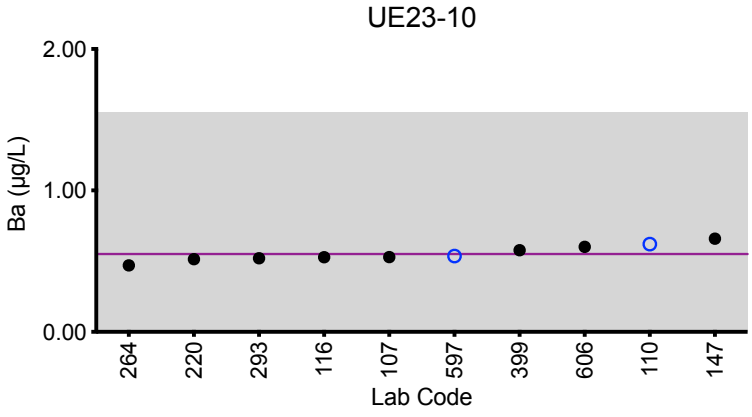
Urine Ba











Legend:

o HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±1 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±1 µg/L at concentrations less than or equal to 5 µg/L.

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Results for Event #2, 2023: Summary Statistics

	Urine Be (µg/L)				
	UE23-06	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
Target (Robust Mean (x*))	2.06	0.867	0.548	1.11	4.03
Upper Limit	3.06	1.867	1.548	2.11	5.03
Lower Limit	1.06	0.000	0.000	0.11	3.03
Robust SD (s*)	0.07	0.012	0.013	0.04	0.15
Robust RSD (%)	3.4	1.4	2.4	3.3	3.7
Number of Sample Measurements (N)	11	11	11	11	11
Standard Uncertainty (*u*)	0.03	0.004	0.005	0.01	0.06

The acceptable range is based on quality specifications:
±1 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±1 µg/L at concentrations less than or equal to 5 µg/L. These quality specifications are based on the same criteria used by the US Centers for Disease Control Prevention (CDC) for public health labs participating in the Laboratory Response Network (LRN) PT program for Toxic Metals.

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Results for Event #2, 2023:
Performance of Participating Laboratories

		Urine Be (µg/L)				
Lab Code	**Method**	**UE23-06**	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
	Target	**2.06**	**0.867**	**0.548**	**1.11**	**4.03**
107	ICP-MS	2.117	0.860	0.519	1.078	3.887
110	ICP-MS	2.03	0.84	0.55	1.10	4.02
116	ICP-MS/MS	1.97	0.868	0.474	1.06	3.82
147	ICP-MS	2.04	0.874	0.534	1.08	3.91
220	ICP-MS	2.11	0.871	0.555	1.14	4.19
264	ICP-MS	2.17	0.88	0.58	1.17	4.26
293	ICP-MS	2.07	0.85	0.54	1.13	4.06
399	ICP-MS/MS	2.05	0.872	0.552	1.09	3.98
597	ICP-MS/MS	2.01	0.942	0.547	1.10	3.95
605	ICP-MS	2.00	0.861	0.557	1.08	4.10
686	ICP-MS	2.13	0.868	0.558	1.15	4.12

Based on the grading criteria for Be in Urine, 100% of results were satisfactory, with 0 of the 11 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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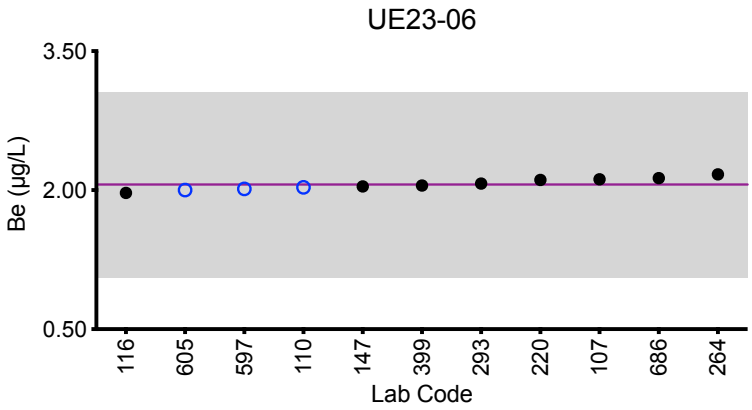
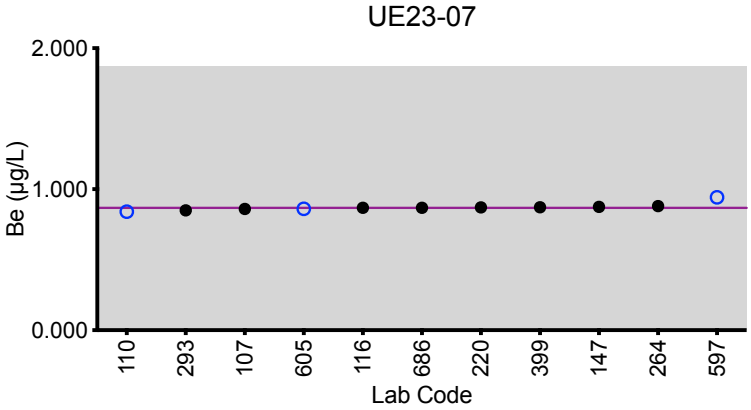
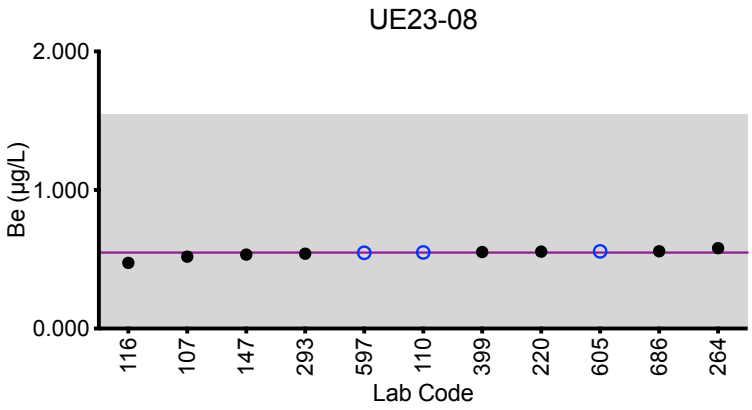
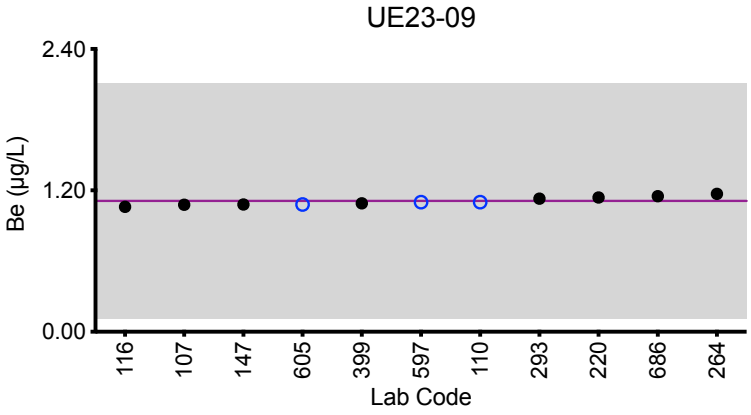
Results for Event #2, 2023: Summary Figures

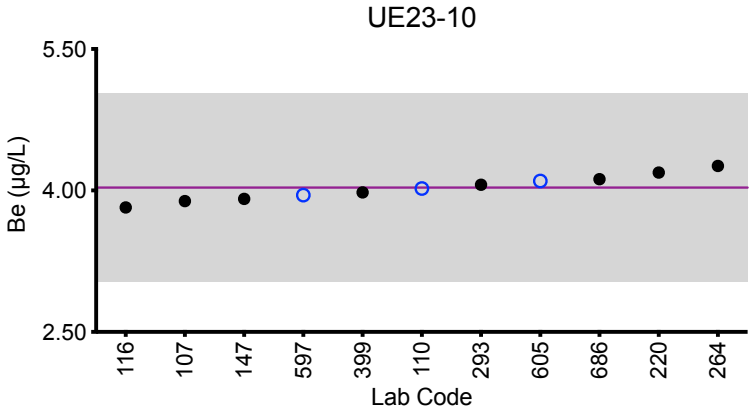
Urine Be











Legend:

o HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±1 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±1 µg/L at concentrations less than or equal to 5 µg/L.

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Results for Event #2, 2023: Summary Statistics

	Urine Cd (µg/L)				
	UE23-06	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
Target (Robust Mean (x*))	1.97	3.05	0.202	0.74	5.06
Upper Limit	2.97	4.05	1.202	1.74	6.06
Lower Limit	0.97	2.05	0.000	0.00	4.06
Robust SD (s*)	0.14	0.23	0.023	0.07	0.26
Robust RSD (%)	7.1	7.5	11	9.5	5.1
Number of Sample Measurements (N)	16	16	13	15	16
Standard Uncertainty (*u*)	0.04	0.07	0.008	0.02	0.08

The acceptable range is based on quality specifications:
±1 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±1 µg/L at concentrations less than or equal to 6.6 µg/L. These quality specifications are based on the same criteria used by the US Centers for Disease Control Prevention (CDC) for public health labs participating in the Laboratory Response Network (LRN) PT program for Toxic Metals.

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Results for Event #2, 2023:
Performance of Participating Laboratories

		Urine Cd (µg/L)				
Lab Code	**Method**	**UE23-06**	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
	Target	**1.97**	**3.05**	**0.202**	**0.74**	**5.06**
103	ICP-MS/MS	2.01	3.19	0.216	0.790	5.18
107	DRC/CC-ICP-MS	1.929	2.938	0.167	0.687	5.079
110	ICP-MS	2.16	3.29	0.23	0.82	5.43
116	ICP-MS/MS	1.80	2.86	<0.200	0.665	4.96
147	ICP-MS	2.01	3.21	0.208	0.767	5.07
220	ICP-MS	1.81	2.66	0.197	0.718	4.84
264	ICP-MS	2.07	2.68	0.17	0.83	4.37
293	DRC/CC-ICP-MS	2.09	3.33	0.19	0.8	5.38
324	ICP-MS	2.112	3.070	<1	<1	5.076
391	ICP-MS	0.935 ↓	1.87 ↓	0.228	0.625	2.847 ↓
399	DRC/CC-ICP-MS	2.00	3.21	0.222	0.770	5.27
442	ICP-MS/MS	1.91	3.15	0.16	0.678	5.24
597	ICP-MS/MS	1.93	3.03	0.199	0.688	4.89
605	ICP-MS	1.88	3.06	0.203	0.726	4.94
606	ICP-MS/MS	1.91	2.94	0.215	0.741	4.91
686	ICP-MS	2.10	3.23	<0.240	0.794	5.32

Based on the grading criteria for Cd in Urine, 96% of results were satisfactory, with 1 of the 16 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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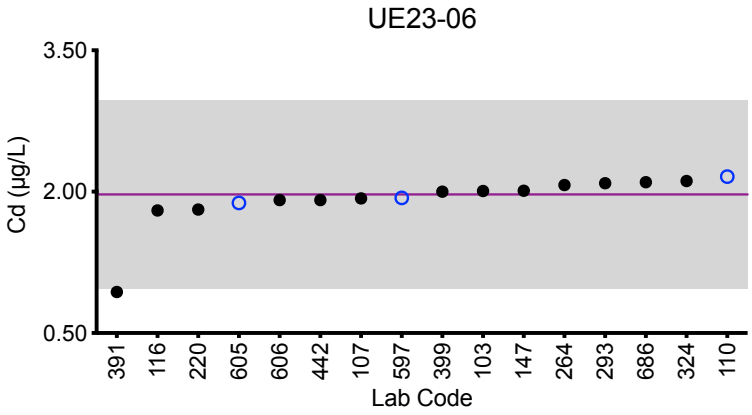
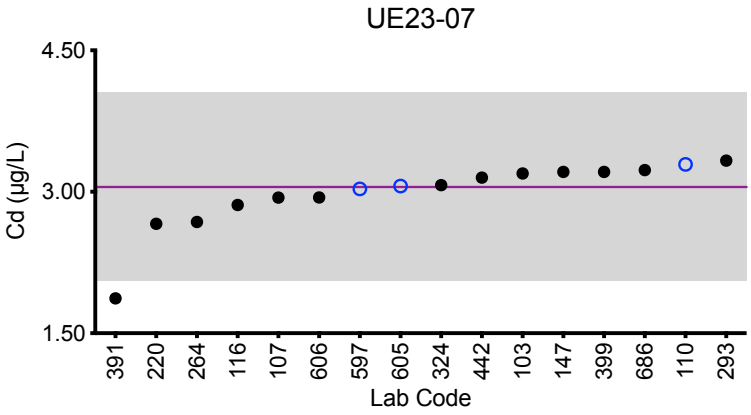
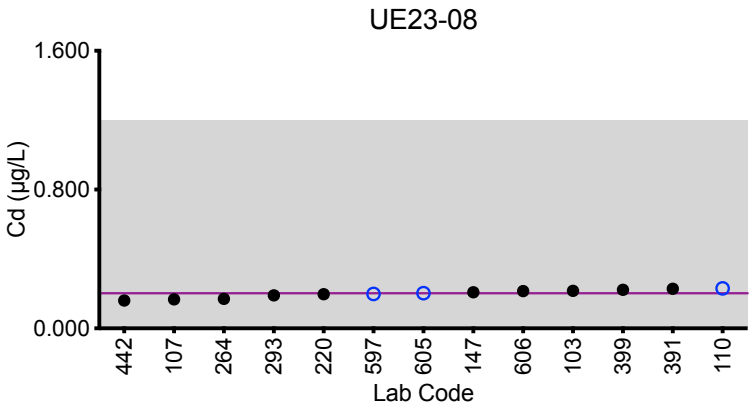
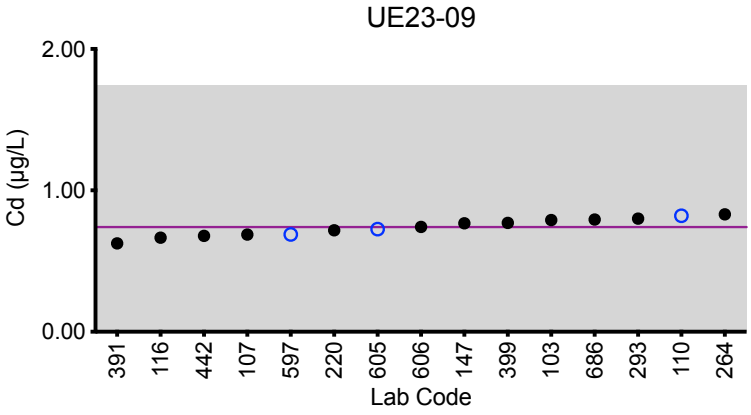
Results for Event #2, 2023: Summary Figures

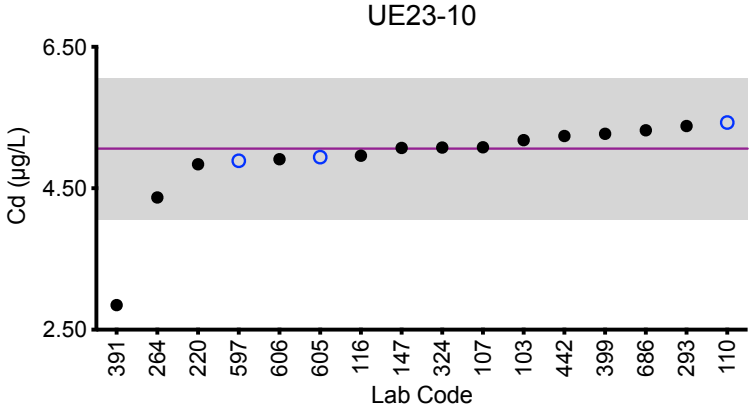
Urine Cd











Legend:

o HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±1 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±1 µg/L at concentrations less than or equal to 6.6 µg/L.

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Results for Event #2, 2023: Summary Statistics

	Urine Co (µg/L)				
	UE23-06	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
Target (Robust Mean (x*))	0.54	3.79	2.02	0.90	5.8
Upper Limit	2.04	5.29	3.52	2.40	7.3
Lower Limit	0.00	2.29	0.52	0.00	4.3
Robust SD (s*)	0.03	0.23	0.11	0.05	0.3
Robust RSD (%)	4.8	6.1	5.4	5.6	5.3
Number of Sample Measurements (N)	12	13	13	12	13
Standard Uncertainty (*u*)	0.01	0.08	0.04	0.02	0.1

The acceptable range is based on quality specifications:
±1.5 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±1.5 µg/L at concentrations less than or equal to 10 µg/L. These quality specifications were established based on discussions with the US FDA, and represent a consensus from a network of Trace Element PT program organizers

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Results for Event #2, 2023:
Performance of Participating Laboratories

		Urine Co (µg/L)				
Lab Code	**Method**	**UE23-06**	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
	Target	**0.54**	**3.79**	**2.02**	**0.90**	**5.8**
103	ICP-MS/MS	0.530	3.92	2.06	0.877	5.86
107	ICP-MS	0.516	3.736	1.961	0.859	5.721
110	ICP-MS	0.70	4.05	2.19	1.00	6.16
147	ICP-MS	0.556	3.55	1.86	0.878	5.42
220	ICP-MS	0.766	4.07	2.23	1.09	6.22
264	ICP-MS	0.53	3.31	1.74	0.95	5.09
293	DRC/CC-ICP-MS	0.54	4.06	2.07	0.92	6.14
324	ICP-MS	<1	3.718	2.010	<1	5.693
391	ICP-MS	0.413	3.068	1.403	0.458	3.853 ↓
399	DRC/CC-ICP-MS	0.523	3.73	1.98	0.880	5.70
597	ICP-MS/MS	0.548	3.83	2.04	0.870	5.98
605	ICP-MS	0.525	3.83	2.02	0.868	5.81
606	ICP-MS/MS	0.599	3.78	2.11	0.932	5.86

Based on the grading criteria for Co in Urine, 98% of results were satisfactory, with 0 of the 13 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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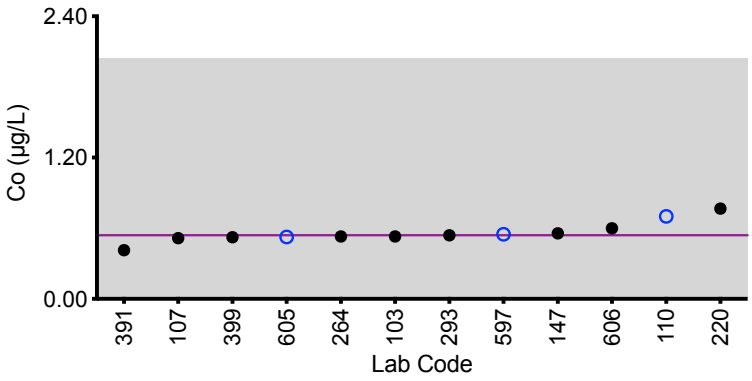
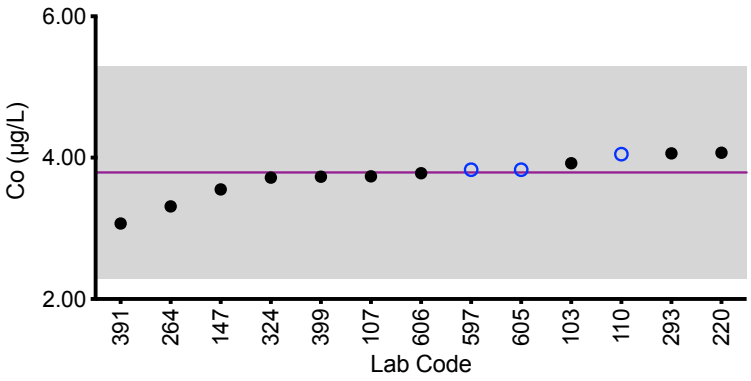
Results for Event #2, 2023: Summary Figures

Urine Co

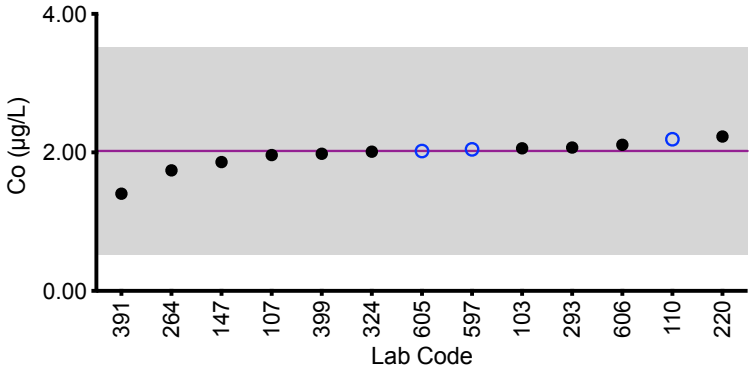
UE23-06



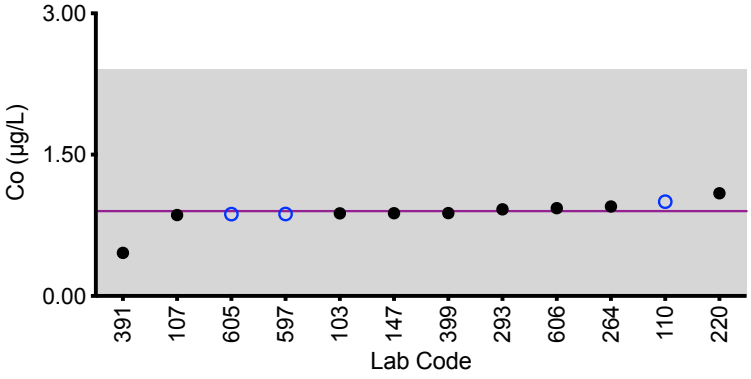
UE23-07



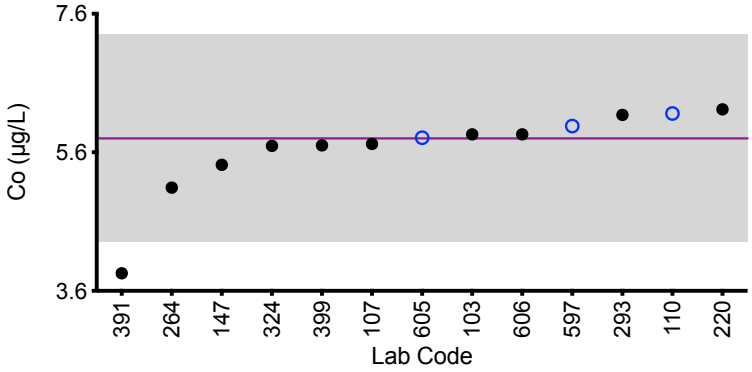
UE23-08



UE23-09



UE23-10



Legend:

o HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±1.5 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±1.5 µg/L at concentrations less than or equal to 10 µg/L.

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Results for Event #2, 2023: Summary Statistics

	Urine Cr (µg/L)				
	UE23-06	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
Target (Robust Mean (x*))	7.3	0.86	3.2	4.1	5.8
Upper Limit	10.3	3.86	6.2	7.1	8.8
Lower Limit	4.3	0.00	0.2	1.1	2.8
Robust SD (s*)	0.8	0.17	0.4	0.5	0.7
Robust RSD (%)	11	20	11	12	12
Number of Sample Measurements (N)	11	11	11	11	11
Standard Uncertainty (*u*)	0.3	0.07	0.1	0.2	0.3

The acceptable range is based on quality specifications:
±3 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±3 µg/L at concentrations less than or equal to 15 µg/L. These quality specifications were established based on discussions with the US FDA, and represent a consensus from a network of Trace Element PT program organizers

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Results for Event #2, 2023:
Performance of Participating Laboratories

		Urine Cr (µg/L)				
Lab Code	**Method**	**UE23-06**	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
	Target	**7.3**	**0.86**	**3.2**	**4.1**	**5.8**
103	ICP-MS/MS	7.08	1.22	3.07	3.86	5.52
107	DRC/CC-ICP-MS	6.96	0.72	3.09	3.69	5.75
110	ICP-MS	8.13	0.93	3.68	4.55	6.51
116	ICP-MS/MS	6.67	0.590	2.95	3.75	5.48
147	DRC/CC-ICP-MS	8.27	0.900	3.68	4.70	7.07
264	ICP-MS	8.01	0.74	2.96	4.59	5.11
293	DRC/CC-ICP-MS	7.67	0.8	3.42	4.2	6.17
324	ICP-MS	7.180	1.080	3.330	4.156	5.845
391	ICP-MS	5.566	1.113	2.45	2.716	4.196
597	ICP-MS/MS	7.53	0.732	3.26	4.06	5.72
605	ICP-MS	6.63	0.832	3.59	3.79	6.51

Based on the grading criteria for Cr in Urine, 100% of results were satisfactory, with 0 of the 11 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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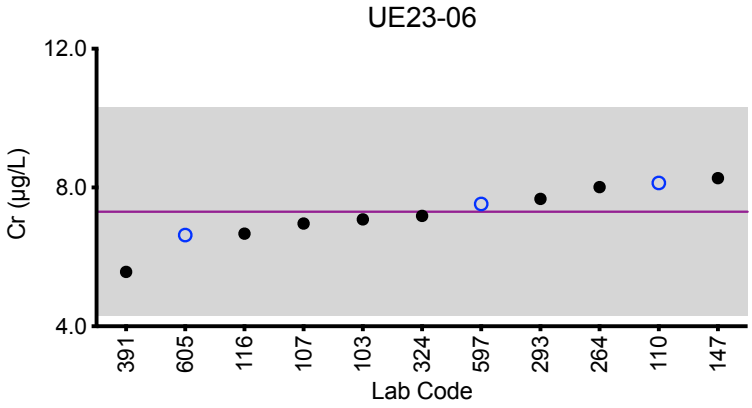
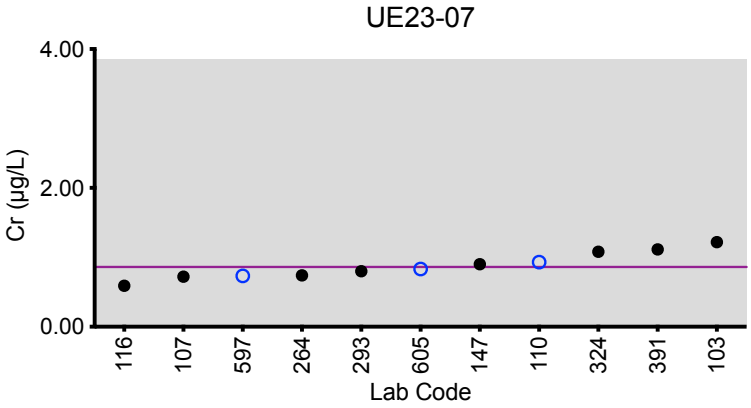
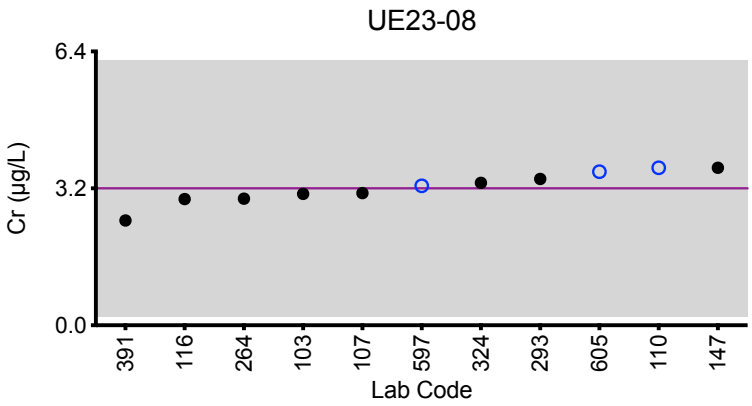
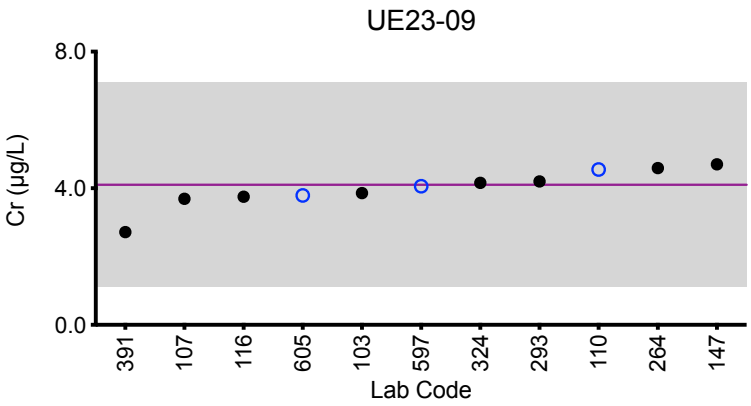
Results for Event #2, 2023: Summary Figures

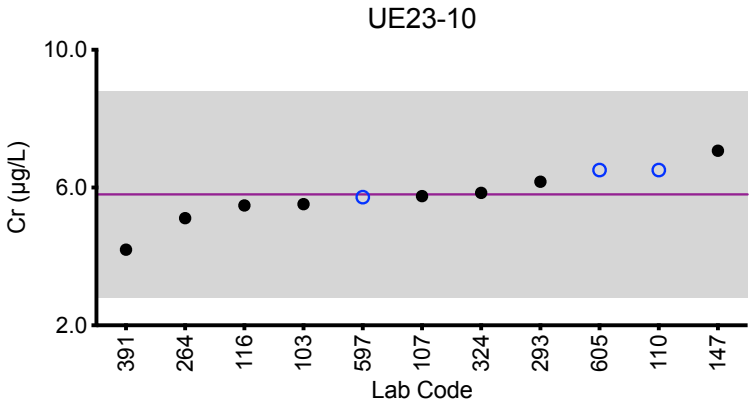
Urine Cr











Legend:

o HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±3 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±3 µg/L at concentrations less than or equal to 15 µg/L.

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Results for Event #2, 2023: Summary Statistics

	Urine Hg (µg/L)				
	UE23-06	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
Target (Robust Mean (x*))	5.2	3.22	25.7	2.24	0.53
Upper Limit	8.2	6.22	33.4	5.24	3.53
Lower Limit	2.2	0.22	18.0	0.00	0.00
Robust SD (s*)	0.6	0.20	0.6	0.23	0.06
Robust RSD (%)	12	6.2	2.3	10	11
Number of Sample Measurements (N)	12	12	12	12	10
Standard Uncertainty (*u*)	0.2	0.07	0.2	0.08	0.02

The acceptable range is based on quality specifications:
±3 µg/L or ±30% around the target value, whichever is greater; thus, it is fixed at ±3 µg/L at concentrations less than or equal to 10 µg/L. These quality specifications were established by New York State Department of Health's Wadsworth Center, the PT Program organizer.

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Results for Event #2, 2023:
Performance of Participating Laboratories

		Urine Hg (µg/L)				
Lab Code	**Method**	**UE23-06**	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
	Target	**5.2**	**3.22**	**25.7**	**2.24**	**0.53**
103	ICP-MS/MS	5.53	3.42	26.9	2.34	0.540
107	DRC/CC-ICP-MS	4.63	3.15	25.36	1.92	0.52
110	ICP-MS	5.29	3.02	25.9	2.12	0.391
116	ICP-MS/MS	4.66	3.14	23.3	1.83	0.536
147	ICP-MS	4.95	3.21	25.7	2.19	0.554
264	ICP-MS	6.69	3.37	25.35	2.45	0.44
293	DRC/CC-ICP-MS	5.21	3.26	26.04	2.27	0.59
391	ICP-MS	3.131	1.703	13.226 ↓	0.832	0.253
442	ICP-MS/MS	5.25	3.01	25.7	2.34	0.547
597	ICP-MS/MS	5.67	3.37	25.4	2.39	0.649
605	ICP-MS	5.42	3.38	27.6	2.27	<1.00
606	ICP-MS/MS	5.79	3.44	28.5	2.68	<1.00

Based on the grading criteria for Hg in Urine, 98% of results were satisfactory, with 0 of the 12 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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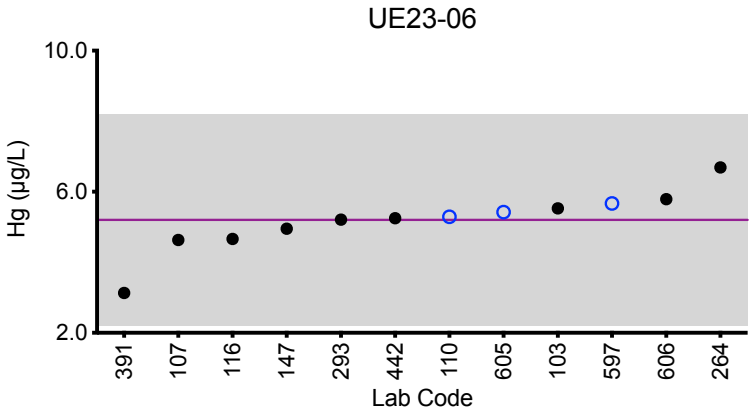
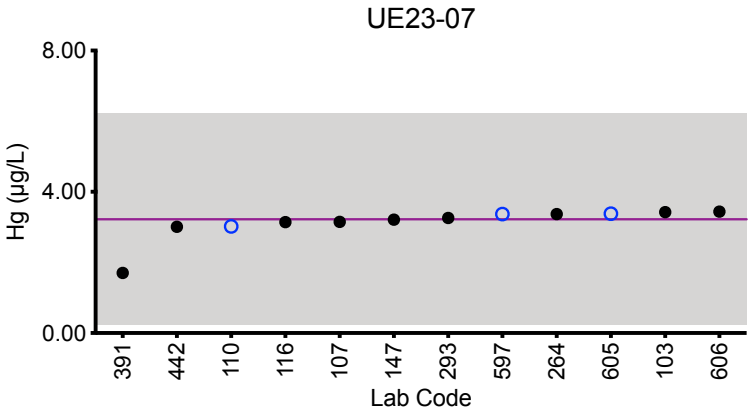
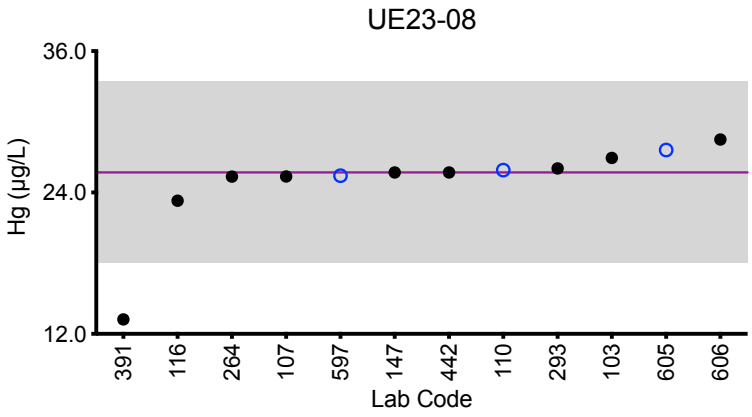
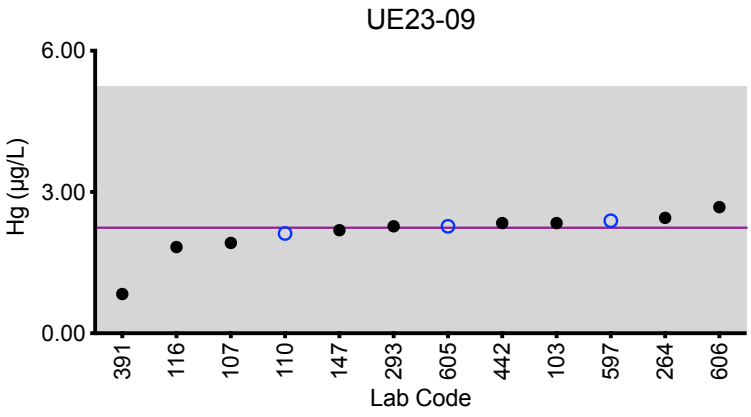
Results for Event #2, 2023: Summary Figures

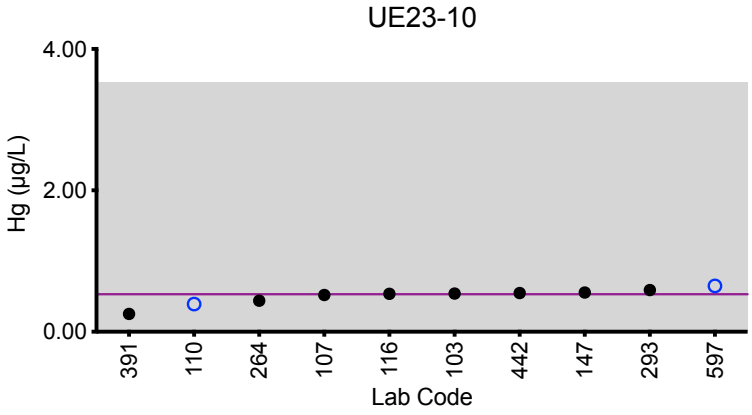
Urine Hg











Legend:

o HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±3 µg/L or ±30% around the target value, whichever is greater; thus, it is fixed at ±3 µg/L at concentrations less than or equal to 10 µg/L.

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Results for Event #2, 2023: Summary Statistics

	Urine Mn (µg/L)				
	UE23-06	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
Target (Robust Mean (x*))	4.9	8.2	3.39	1.45	0.63
Upper Limit	6.1	10.3	4.24	2.00	1.18
Lower Limit	3.7	6.2	2.54	0.90	0.08
Robust SD (s*)	0.3	0.6	0.19	0.12	0.08
Robust RSD (%)	6.5	7.3	5.6	8.3	13
Number of Sample Measurements (N)	13	13	13	13	12
Standard Uncertainty (*u*)	0.1	0.2	0.07	0.04	0.03

The acceptable range is based on quality specifications:
±0.55 µg/L or ±25% around the target value, whichever is greater; thus, it is fixed at ±0.55 µg/L at concentrations less than or equal to 2.2 µg/L. Quality specifications for Mn are consistent with those used by other External Quality Assessment Schemes for trace elements. (Praamsma M, et al. An assessment of clinical laboratory performance for the determination of manganese in blood and urine. Clinical Chemistry and Laboratory Medicine.2016; 54(12): 1921-1928).

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Results for Event #2, 2023:
Performance of Participating Laboratories

		Urine Mn (µg/L)				
Lab Code	**Method**	**UE23-06**	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
	Target	**4.9**	**8.2**	**3.39**	**1.45**	**0.63**
103	ICP-MS/MS	4.98	8.55	3.52	1.35	0.619
107	DRC/CC-ICP-MS	4.432	7.275	3.007	1.316	0.545
110	DRC/CC-ICP-MS	5.02	8.60	3.52	1.45	0.63
116	ICP-MS/MS	4.28	7.25	2.91	1.37	0.524
147	DRC/CC-ICP-MS	5.38	9.62	3.90	1.69	0.786
220	DRC/CC-ICP-MS	4.96	8.43	3.42	1.49	0.645
264	ICP-MS	5.02	7.24	2.93	1.55	0.56
293	DRC/CC-ICP-MS	5	8.73	3.53	1.46	0.71
324	ICP-MS	4.756	7.901	3.326	1.450	<1
391	ICP-MS	3.721	6.772	2.436 ↓	0.846 ↓	0.602
399	DRC/CC-ICP-MS	NR	NR	NR	NR	NR
597	ICP-MS/MS	4.74	8.33	3.45	1.44	0.702
605	ICP-MS	4.89	8.38	3.40	1.44	0.619
606	ICP-MS/MS	5.33	8.60	3.53	1.65	0.664

Based on the grading criteria for Mn in Urine, 97% of results were satisfactory, with 1 of the 14 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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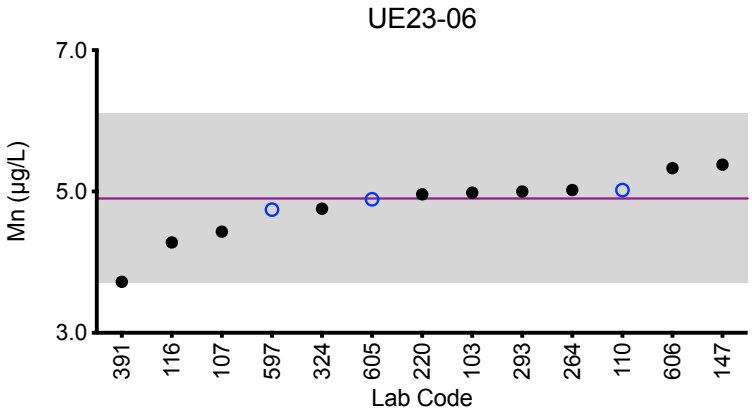
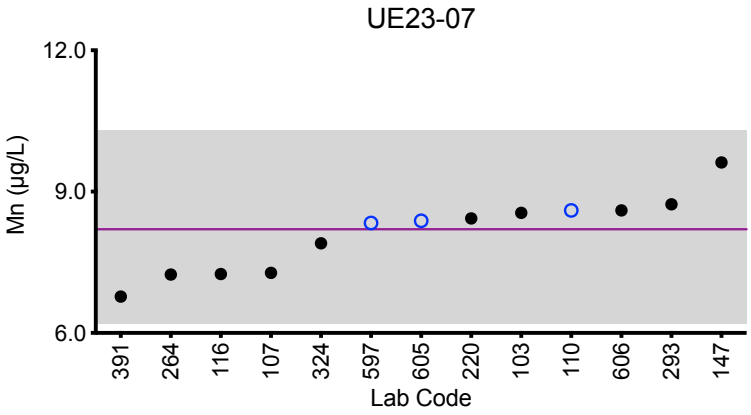
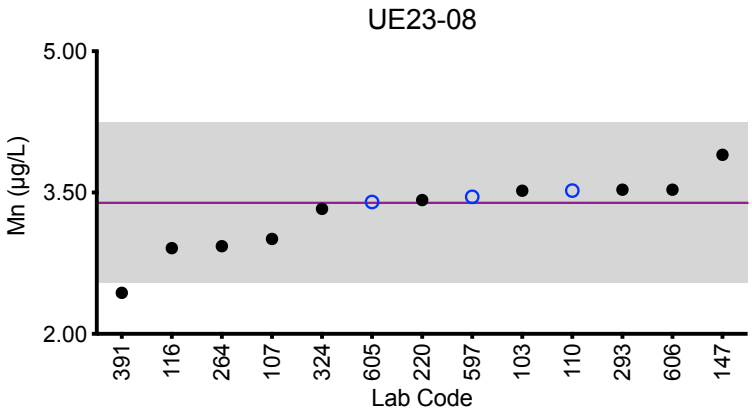
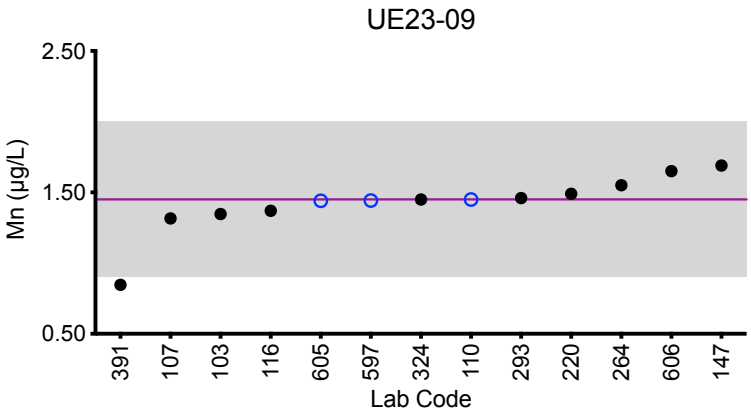
Results for Event #2, 2023: Summary Figures

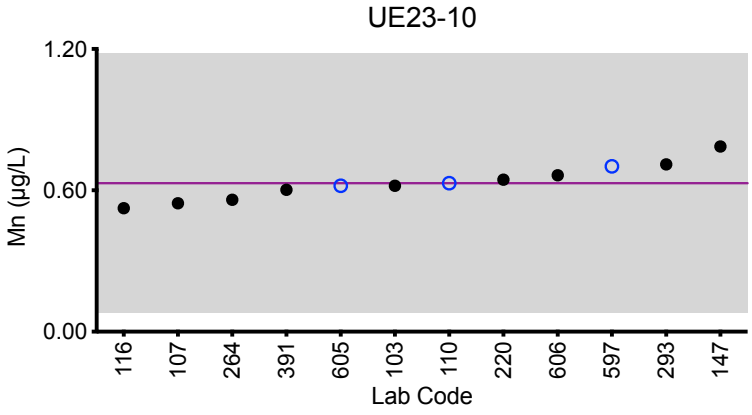
Urine Mn











Legend:

o HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±0.55 µg/L or ±25% around the target value, whichever is greater; thus, it is fixed at ±0.55 µg/L at concentrations less than or equal to 2.2 µg/L.

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Results for Event #2, 2023: Summary Statistics

	Urine Pb (µg/L)				
	UE23-06	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
Target (Robust Mean (x*))	9.10	1.36	0.45	4.94	2.17
Upper Limit	10.92	2.36	1.45	5.94	3.17
Lower Limit	7.28	0.36	0.00	3.94	1.17
Robust SD (s*)	0.25	0.05	0.04	0.12	0.10
Robust RSD (%)	2.7	3.7	8.0	2.4	4.6
Number of Sample Measurements (N)	16	16	15	16	16
Standard Uncertainty (*u*)	0.08	0.02	0.01	0.04	0.03

The acceptable range is based on quality specifications:
±1 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±1 µg/L at concentrations less than or equal to 5 µg/L. These quality specifications are based on the same criteria used by the US Centers for Disease Control Prevention (CDC) for public health labs participating in the Laboratory Response Network (LRN) PT program for Toxic Metals.

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Results for Event #2, 2023:
Performance of Participating Laboratories

		Urine Pb (µg/L)				
Lab Code	**Method**	**UE23-06**	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
	Target	**9.10**	**1.36**	**0.45**	**4.94**	**2.17**
103	ICP-MS/MS	9.48	1.30	0.360	4.96	2.07
107	ICP-MS	9.287	1.380	0.469	5.016	2.229
110	DRC/CC-ICP-MS	8.91	1.37	0.46	4.83	2.17
116	ICP-MS/MS	8.31	1.27	0.390	4.63	2.01
147	ICP-MS	8.95	1.34	0.485	4.89	2.11
220	ICP-MS	8.81	1.36	0.429	4.90	2.15
264	ICP-MS	9.53	1.55	0.51	5.15	2.30
293	DRC/CC-ICP-MS	9.18	1.4	0.46	5.02	2.29
324	ICP-MS	9.239	1.369	<1	5.071	2.174
391	ICP-MS	5.612 ↓	1.065	0.282	2.693 ↓	1.26
399	ICP-MS/MS	9.22	1.46	0.490	5.06	2.26
442	ICP-MS/MS	9.04	1.34	0.448	4.95	2.11
597	ICP-MS/MS	9.19	1.37	0.467	4.93	2.20
605	ICP-MS	8.98	1.35	0.433	4.85	2.16
606	ICP-MS/MS	9.13	1.33	0.473	4.93	2.11
686	ICP-MS	9.15	1.49	0.449	4.99	2.27

Based on the grading criteria for Pb in Urine, 98% of results were satisfactory, with 1 of the 16 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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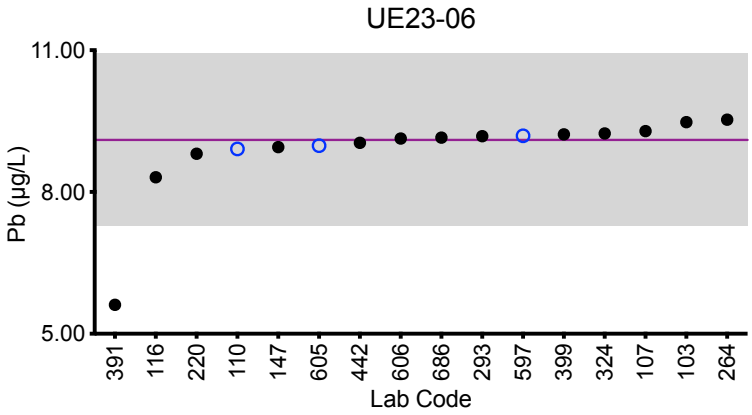
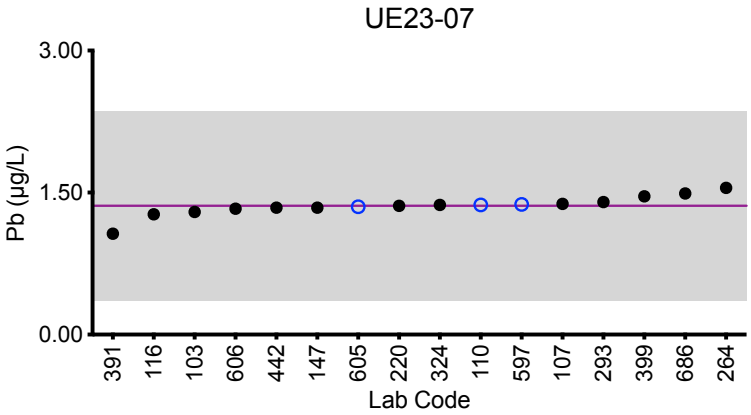
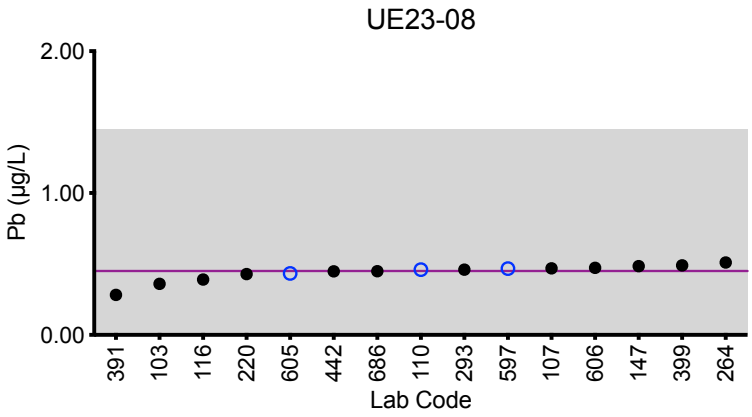
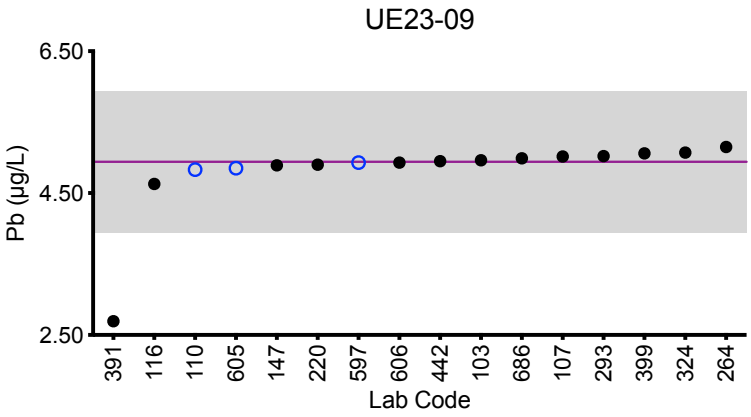
Results for Event #2, 2023: Summary Figures

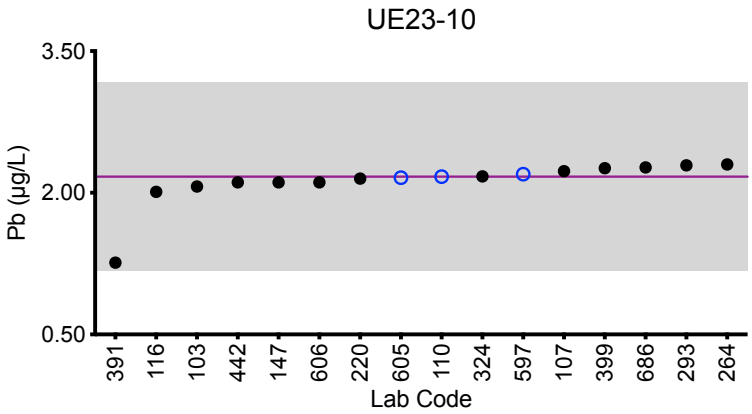
Urine Pb











Legend:

o HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±1 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±1 µg/L at concentrations less than or equal to 5 µg/L.

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Results for Event #2, 2023: Summary Statistics

	Urine Tl (µg/L)				
	UE23-06	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
Target (Robust Mean (x*))	2.02	1.50	3.33	0.862	0.300
Upper Limit	2.42	1.80	4.00	1.062	0.500
Lower Limit	1.62	1.20	2.66	0.662	0.100
Robust SD (s*)	0.05	0.05	0.12	0.021	0.009
Robust RSD (%)	2.5	3.3	3.6	2.4	2.9
Number of Sample Measurements (N)	13	13	13	13	13
Standard Uncertainty (*u*)	0.02	0.02	0.04	0.007	0.003

The acceptable range is based on quality specifications:
±0.2 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±0.2 µg/L at concentrations less than or equal to 1 µg/L. These quality specifications are based on the same criteria used by the US Centers for Disease Control Prevention (CDC) for public health labs participating in the Laboratory Response Network (LRN) PT program for Toxic Metals.

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Results for Event #2, 2023:
Performance of Participating Laboratories

		Urine Tl (µg/L)				
Lab Code	**Method**	**UE23-06**	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
	Target	**2.02**	**1.50**	**3.33**	**0.862**	**0.300**
103	ICP-MS/MS	2.06	1.52	3.32	0.859	0.307
107	ICP-MS	2.041	1.488	3.337	0.846	0.299
110	ICP-MS	2.03	1.73	3.34	0.85	0.31
147	ICP-MS	2.02	1.56	3.43	0.893	0.323
220	ICP-MS	1.92	1.47	3.21	0.840	0.295
264	ICP-MS	2.12	1.54	3.49	0.90	0.31
293	DRC/CC-ICP-MS	2.14	1.62	3.58	0.91	0.32
391	ICP-MS	0.866 ↓	0.681 ↓	1.806 ↓	0.366 ↓	0.066 ↓
399	ICP-MS/MS	2.02	1.50	3.34	0.871	0.295
597	ICP-MS/MS	1.99	1.44	3.25	0.855	0.298
605	ICP-MS	2.01	1.49	3.29	0.854	0.296
606	ICP-MS/MS	1.98	1.47	3.24	0.872	0.293
686	ICP-MS	2.05	1.51	3.36	0.866	0.293

Based on the grading criteria for Tl in Urine, 92% of results were satisfactory, with 1 of the 13 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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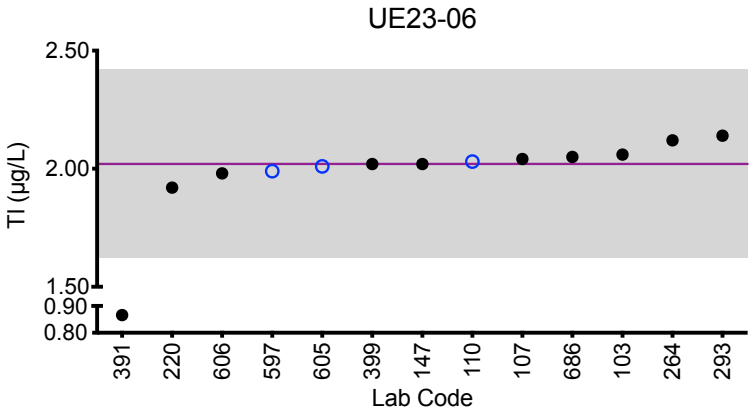
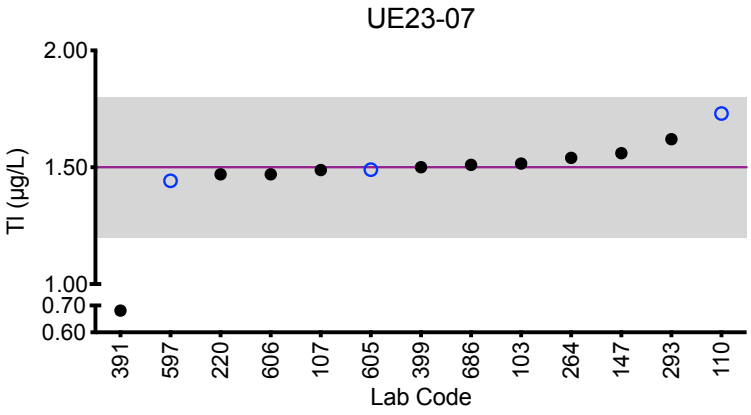
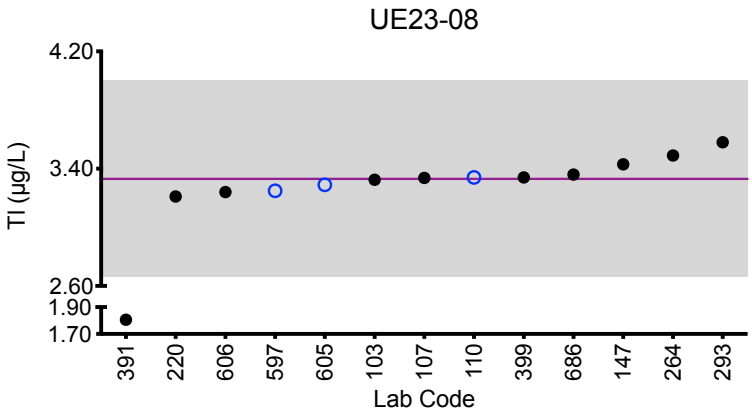
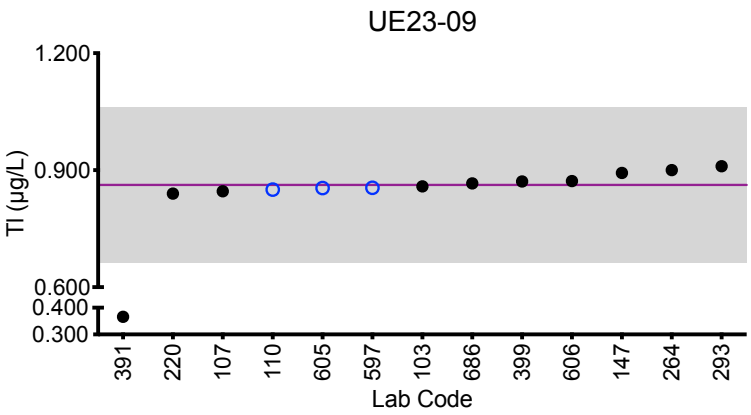
Results for Event #2, 2023: Summary Figures

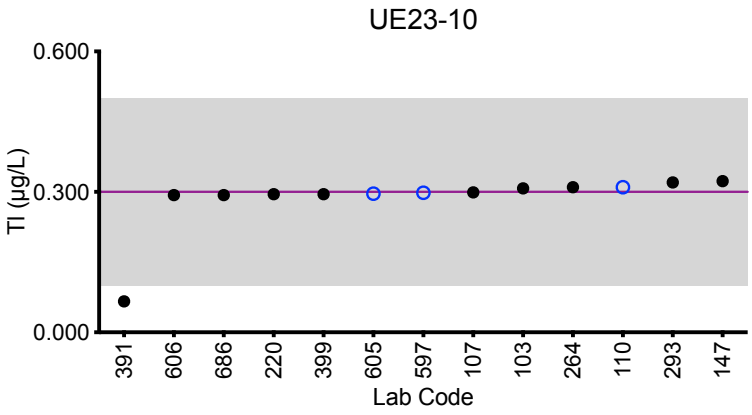
Urine Tl











Legend:

o HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±0.2 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±0.2 µg/L at concentrations less than or equal to 1 µg/L.

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Results for Event #2, 2023: Summary Statistics

	Urine U (µg/L)				
	UE23-06	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
Target (Robust Mean (x*))	0.165	0.044	0.194	0.068	0.0074
Upper Limit	0.198	0.074	0.233	0.098	0.0374
Lower Limit	0.132	0.014	0.155	0.038	0.0000
Robust SD (s*)	0.006	0.003	0.011	0.004	0.0013
Robust RSD (%)	3.6	6.8	5.7	5.8	18
Number of Sample Measurements (N)	14	14	14	14	11
Standard Uncertainty (*u*)	0.002	0.001	0.004	0.001	0.0005

The acceptable range is based on quality specifications:
±0.03 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±0.03 µg/L at concentrations less than or equal to 0.15 µg/L. These quality specifications are based on the same criteria used by the US Centers for Disease Control Prevention (CDC) for public health labs participating in the Laboratory Response Network (LRN) PT program for Toxic Metals.

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Results for Event #2, 2023:
Performance of Participating Laboratories

Urine U (µg/L)						
Lab Code	**Method**	**UE23-06**	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
	Target	**0.165**	**0.044**	**0.194**	**0.068**	**0.0074**
103	ICP-MS/MS	0.170	0.0464	0.220	0.0721	<0.0200
107	ICP-MS	0.1777	0.0464	0.2019	0.0678	0.0077
110	ICP-MS	0.1658	0.0458	0.203	0.0720	0.0071
116	ICP-MS/MS	0.162	0.0430	0.188	0.0700	<0.0150
147	ICP-MS	0.162	0.0433	0.194	0.0674	0.00810
220	ICP-MS	0.167	0.044	0.203	0.069	0.006
264	ICP-MS	0.17	0.04	0.20	0.07	0.01
324	ICP-MS	0.1473	0.0376	0.1699	0.0576	0.0060
391	ICP-MS	0.134	0.097 ↑	0.127 ↓	0.08	0.05 ↑
399	ICP-MS/MS	0.152	0.046	0.187	0.065	0.007
597	ICP-MS/MS	0.165	0.0411	0.1864	0.0643	0.00617
605	ICP-MS	0.166	0.045	0.197	0.063	0.007
606	ICP-MS/MS	0.171	0.047	0.196	0.067	0.008
686	ICP-MS	0.166	0.0418	0.192	0.0668	<0.0150

Based on the grading criteria for U in Urine, 96% of results were satisfactory, with 1 of the 14 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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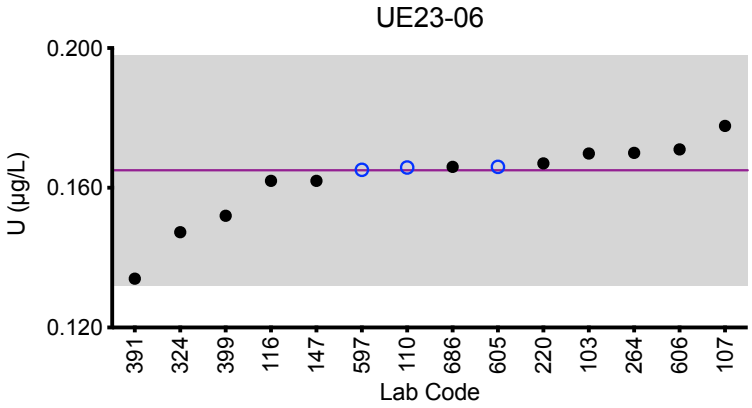
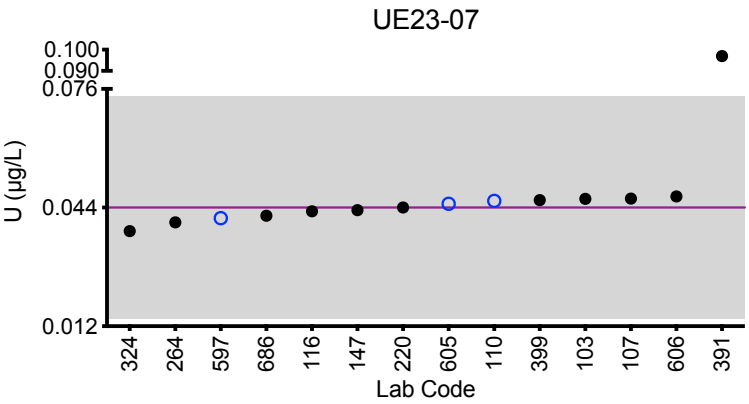
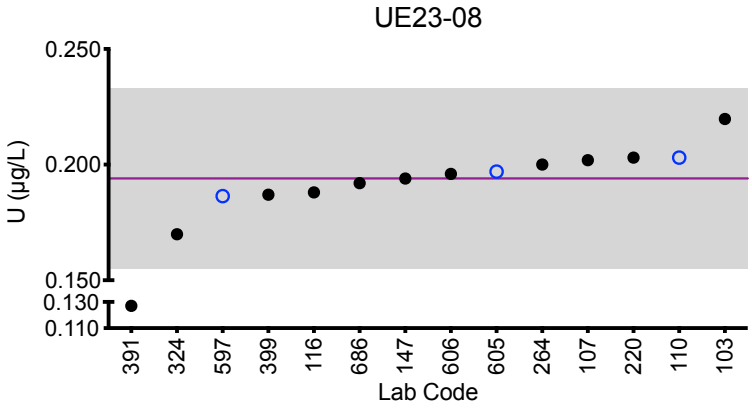
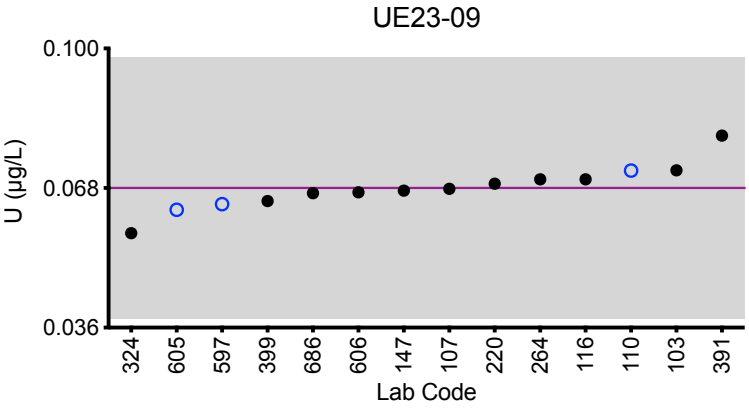
Results for Event #2, 2023: Summary Figures

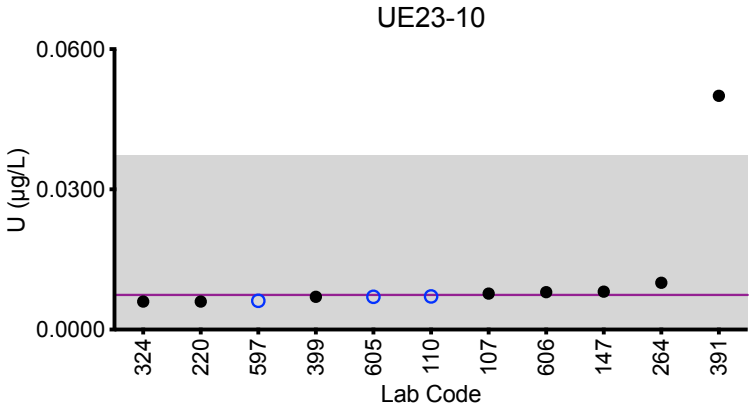
Urine U











Legend:

o HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±0.03 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±0.03 µg/L at concentrations less than or equal to 0.15 µg/L.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Urine Al (µg/L)

Lab Code	Method	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
147	ICP-MS	24.5	13.8	13.9	18.6	*13.8
264	ICP-MS	24.29	6.58	9.37	17.93	5.52
293	DRC/CC-ICP-MS	24.82	9.17	11.87	16.46	7.82
324	ICP-MS	20.723	11.385	11.209	15.661	9.352
597	ICP-MS/MS	20.6	7.12	9.71	13.3	6.39

Summary Statistics

	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
Arithmetic Mean ($\bar{x}$)	23	10	11.2	16.4	7
Arithmetic SD (s)	2	3	1.8	2.1	2
Arithmetic RSD (%)	9.1	31	16	13	23
Number of Sample Measurements (N)	5	5	5	5	4

*Denotes a statistical Outlier.

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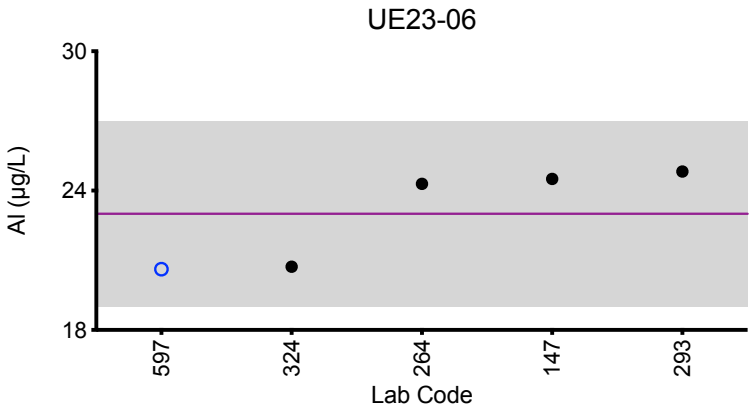
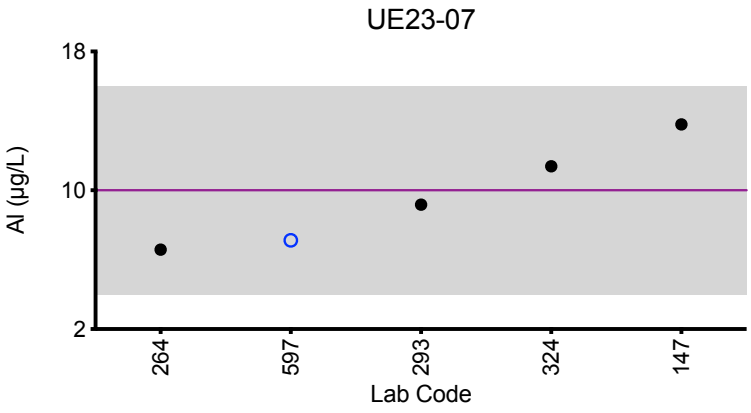
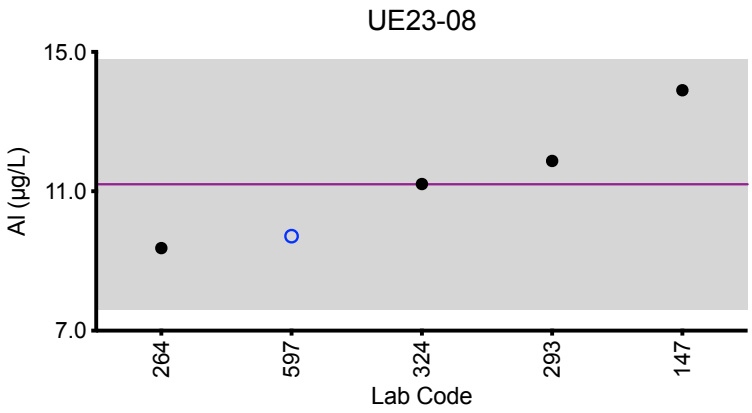
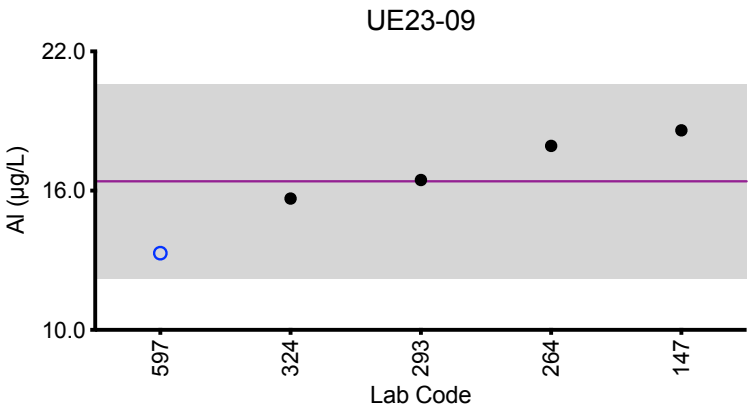
Results for Event #2, 2023: Summary Figures

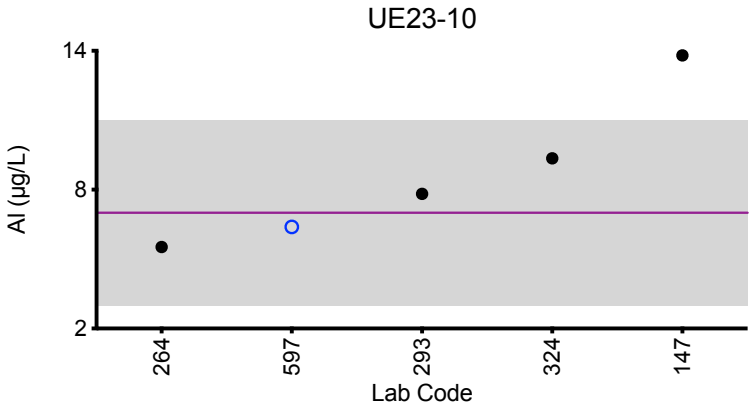
Urine Al











Legend:
o HHEAR Labs ● Other Labs
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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Urine Cs (µg/L)

Lab Code	Method	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
107	ICP-MS	10.69	1.14	3.02	1.44	4.07
110	ICP-MS	12.0	1.26	3.37	1.62	4.60
147	ICP-MS	10.2	1.16	3.15	1.48	4.25
220	ICP-MS	10.7	1.16	3.13	1.47	4.22
264	ICP-MS	8.74	0.89	2.47	1.19	3.30
399	ICP-MS/MS	10.6	1.17	3.10	1.48	4.15
597	ICP-MS/MS	10.0	1.12	2.94	1.35	4.00
605	ICP-MS	10.3	1.13	2.97	1.41	4.01
606	ICP-MS/MS	10.1	1.07	2.88	1.40	3.81

Summary Statistics

	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
Arithmetic Mean ($\bar{x}$)	10.4	1.12	3.00	1.43	4.0
Arithmetic SD (s)	0.9	0.10	0.25	0.12	0.4
Arithmetic RSD (%)	8.7	8.9	8.3	8.4	8.6
Number of Sample Measurements (N)	9	9	9	9	9

*Denotes a statistical Outlier.

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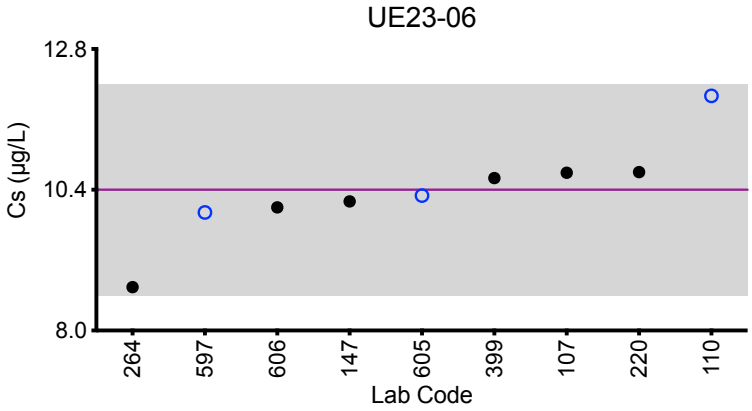
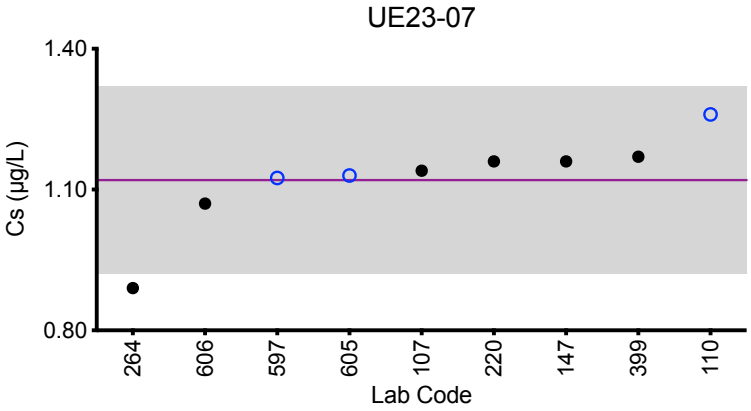
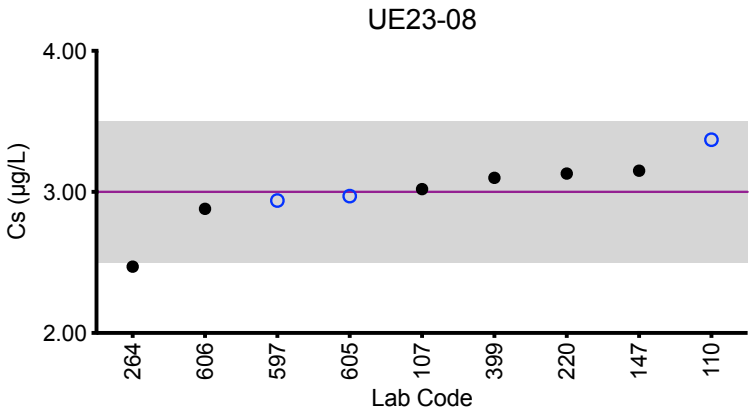
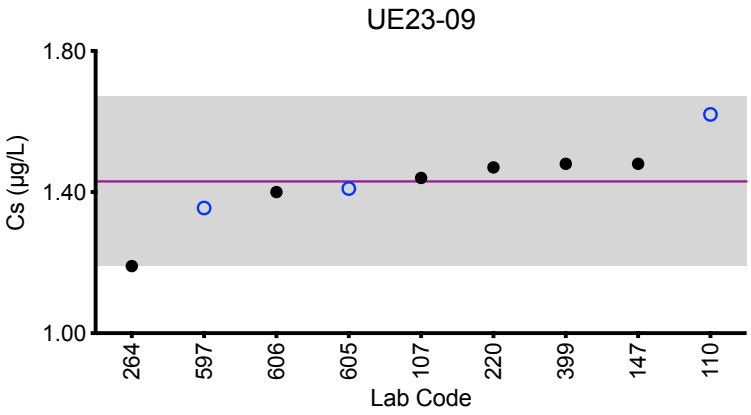
Results for Event #2, 2023: Summary Figures

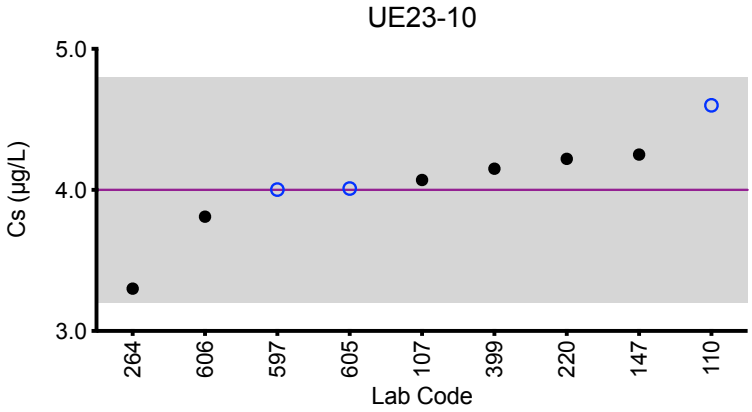
Urine Cs











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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Urine Cu (µg/L)

Lab Code	Method	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
110	ICP-MS	17.0	*24.2	66.4	42.7	106
116	ICP-MS/MS	10.2	12.0	55.1	37.8	90.9
147	ICP-MS	*20.8	17.3	64.2	46.7	100
264	ICP-MS	11.36	11.83	50.40	41.48	82.99
293	DRC/CC-ICP-MS	10.81	12.71	59.12	38.14	95.36
324	ICP-MS	11.585	13.090	58.721	39.752	96.080
391	ICP-MS	7.024	9.372	46.559	21.493	76.995
597	ICP-MS/MS	10.6	12.6	57.2	36.7	91.4

Summary Statistics

	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
Arithmetic Mean ($\bar{x}$)	11	13	57	38	92
Arithmetic SD (s)	3	2	7	7	9
Arithmetic RSD (%)	26	19	12	18	9.8
Number of Sample Measurements (N)	7	7	8	8	8

*Denotes a statistical Outlier.

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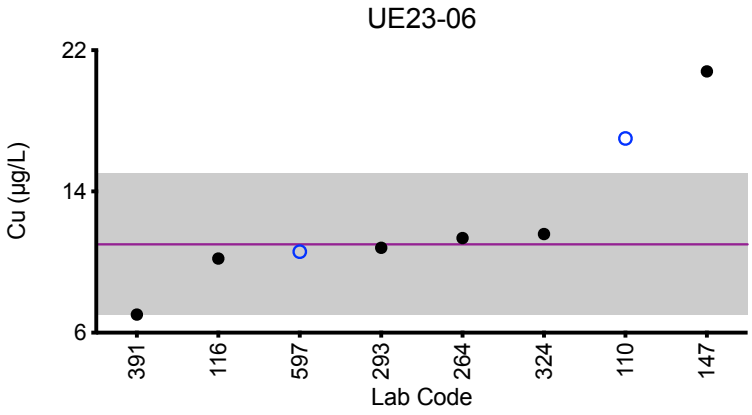
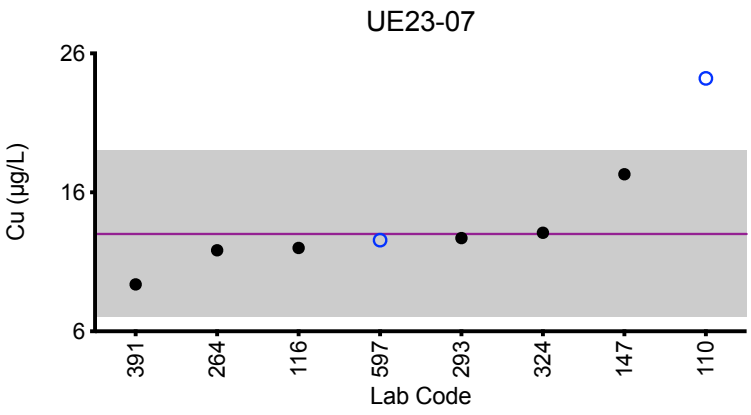
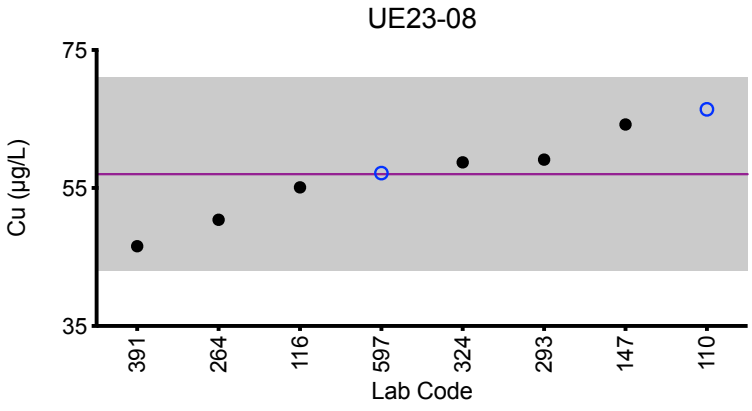
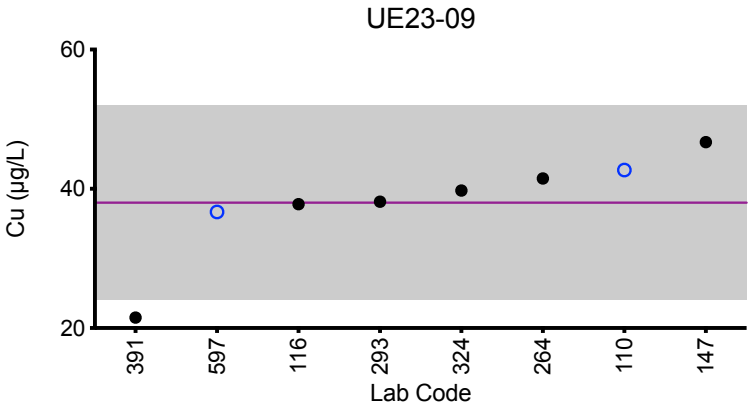
Results for Event #2, 2023: Summary Figures

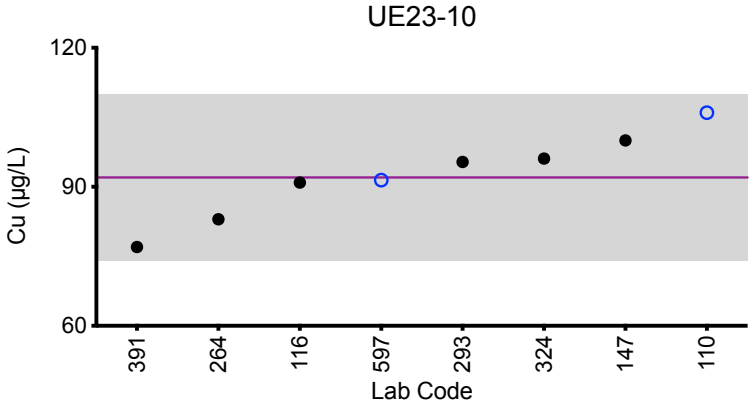
Urine Cu











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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Urine Mo (µg/L)

Lab Code	Method	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
103	ICP-MS/MS	94.8	38.0	9.70	36.4	45.6
107	ICP-MS	97.59	37.63	9.44	36.24	45.57
110	ICP-MS	99.2	39.5	10.3	37.9	48.7
147	ICP-MS	90.2	35.7	9.39	34.5	43.9
220	ICP-MS	95.8	39.9	9.00	36.4	46.1
264	ICP-MS	73.83	27.04	6.72	27.28	33.18
293	DRC/CC-ICP-MS	93.29	37.98	10.34	36.95	45.37
324	ICP-MS	92.666	37.400	9.692	35.583	45.930
399	ICP-MS/MS	92.6	37.3	9.58	35.7	45.3
597	ICP-MS/MS	80.9	32.2	8.46	30.5	39.8
605	ICP-MS	91.4	36.2	9.01	34.7	43.5
606	ICP-MS/MS	94.4	37.6	9.67	36.2	45.3

Summary Statistics

	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
Robust Mean (x*)	93	37.3	9.5	35.7	45.1
Robust SD (s*)	4	1.6	0.6	1.2	1.2
Robust RSD (%)	4.1	4.3	6.3	3.4	2.7
Number of Sample Measurements (N)	12	12	12	12	12
Standard Uncertainty (*u*)	1	0.6	0.2	0.4	0.4

*Denotes a statistical Outlier.

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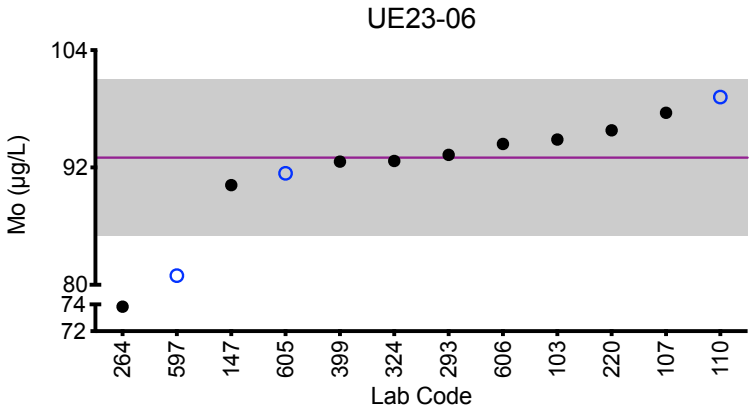
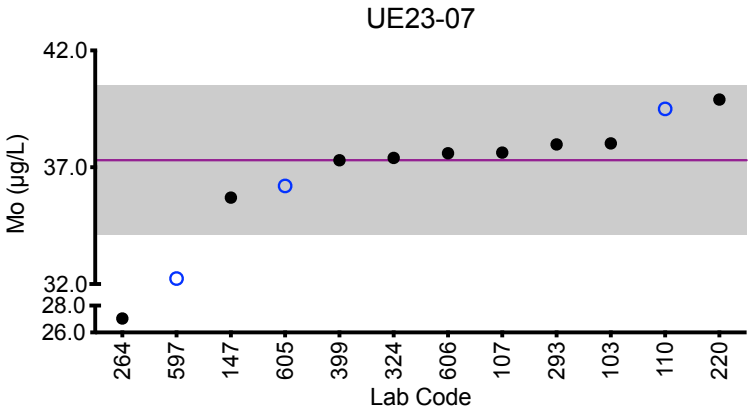
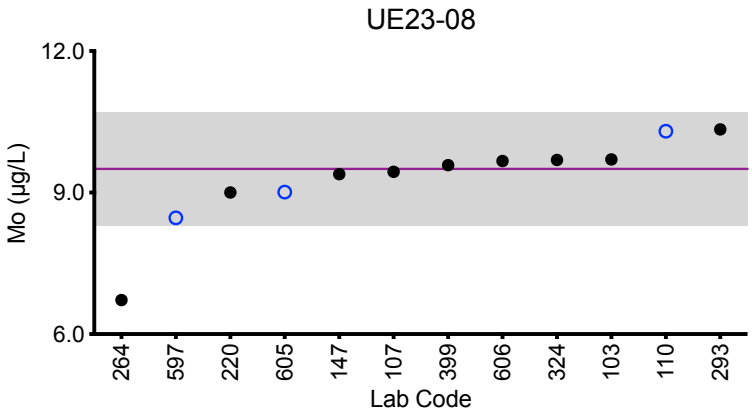
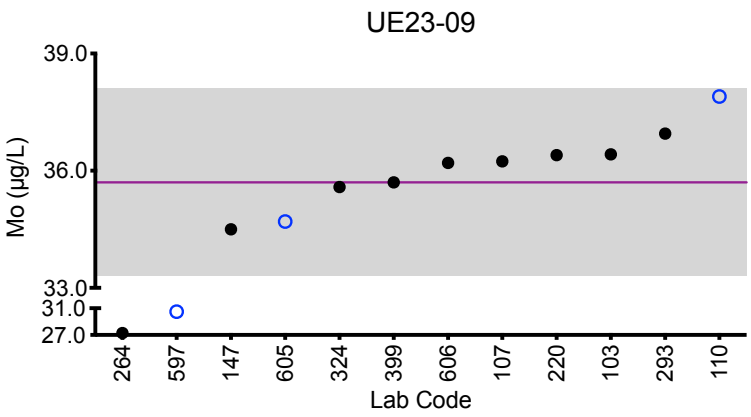
Results for Event #2, 2023: Summary Figures

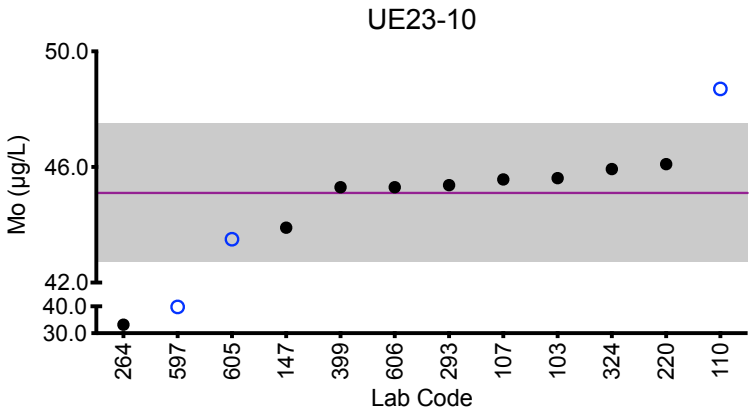
Urine Mo











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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Urine Ni (µg/L)

Lab Code	Method	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
103	ICP-MS/MS	2.48	6.65	4.09	<0.600	2.44
107	DRC/CC-ICP-MS	2.09	6.11	3.30	0.43	2.28
110	ICP-MS	3.69	7.01	4.19	*1.65	3.33
147	ICP-MS	2.25	6.40	3.70	0.611	2.50
264	ICP-MS	2.47	5.80	3.23	0.77	2.34
293	DRC/CC-ICP-MS	2.64	7.01	4.08	0.9	2.83
324	ICP-MS	2.851	6.357	3.728	1.234	2.842
391	ICP-MS	1.602	4.997	2.548	0.444	1.848
442	DRC/CC-ICP-MS	2.43	6.85	3.88	0.596	2.78
597	ICP-MS/MS	2.75	6.92	4.18	1.08	3.05
605	ICP-MS	2.24	6.65	3.68	0.626	2.60

Summary Statistics

	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
Robust Mean (x*)	2.5	6.5	3.7	0.8	2.6
Robust SD (s*)	0.4	0.4	0.4	0.3	0.4
Robust RSD (%)	15	6.2	11	43	15
Number of Sample Measurements (N)	11	11	11	10	11
Standard Uncertainty (*u*)	0.1	0.2	0.2	0.1	0.1

*Denotes a statistical Outlier.

An arithmetic mean, SD, RSD and n are provided for sample UE23-09.

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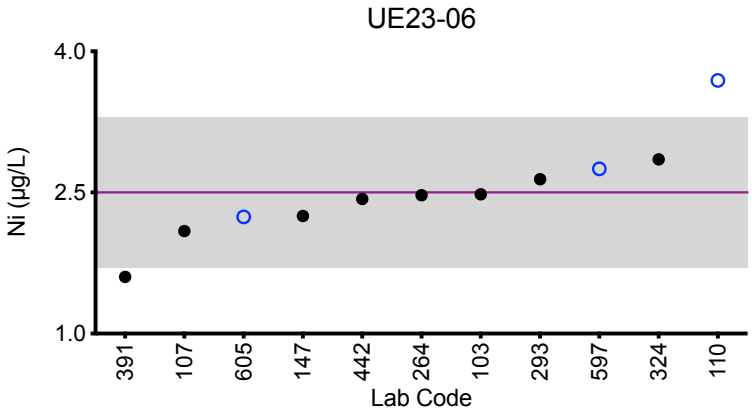
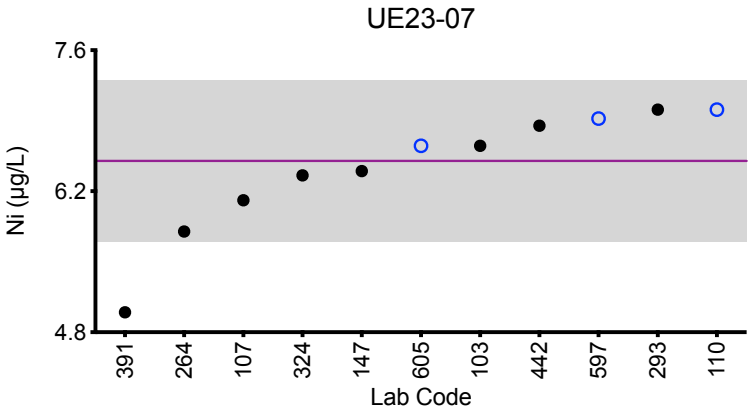
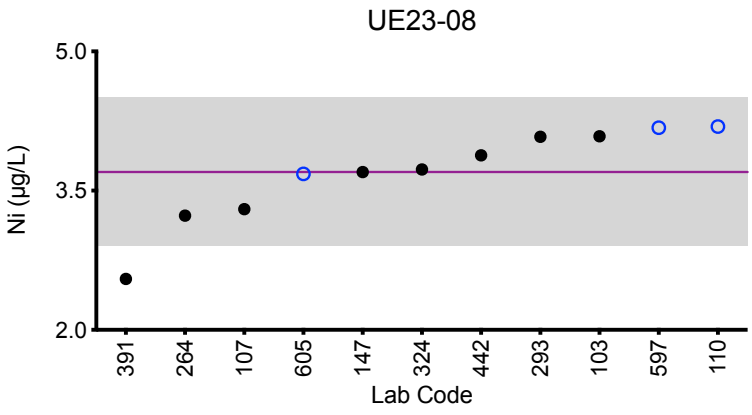
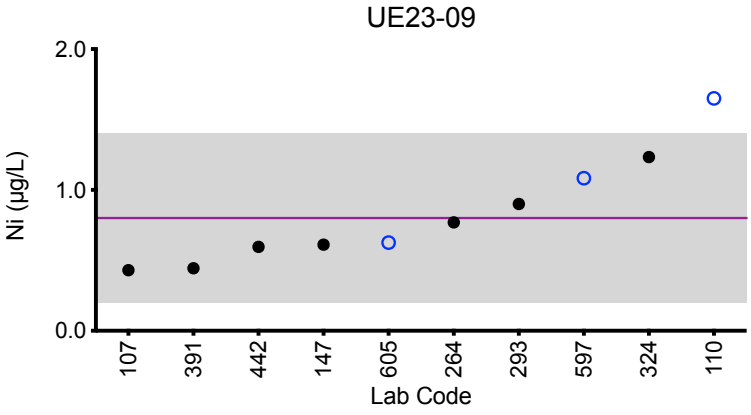
Results for Event #2, 2023: Summary Figures

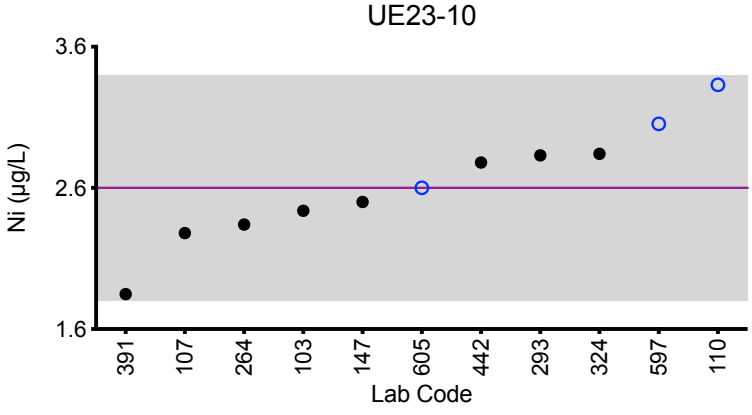
Urine Ni











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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Urine Pt (µg/L)

Lab Code	Method	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
107	ICP-MS	3.7000	1.0898	0.1797	0.3428	0.8389
110	ICP-MS	3.68	1.11	0.172	0.336	0.849
220	ICP-MS	3.61	1.14	0.187	0.339	0.861
264	ICP-MS	3.69	1.12	0.19	0.36	0.85
293	DRC/CC-ICP-MS	3.68	1.14	0.21	0.34	0.87
605	ICP-MS	3.55	1.08	0.165	0.326	0.813

Summary Statistics

	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
Arithmetic Mean ($\bar{x}$)	3.65	1.11	0.184	0.341	0.847
Arithmetic SD (s)	0.06	0.03	0.016	0.011	0.020
Arithmetic RSD (%)	1.6	2.2	8.7	3.2	2.4
Number of Sample Measurements (N)	6	6	6	6	6

*Denotes a statistical Outlier.

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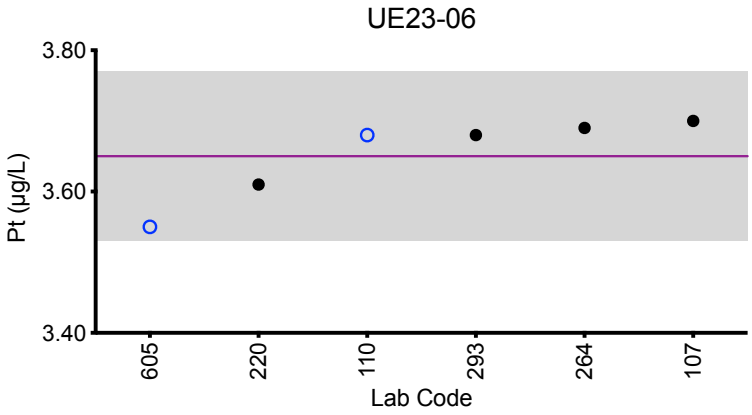
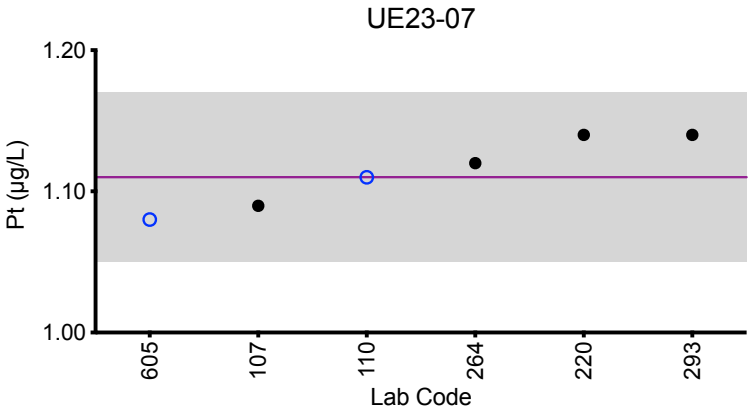
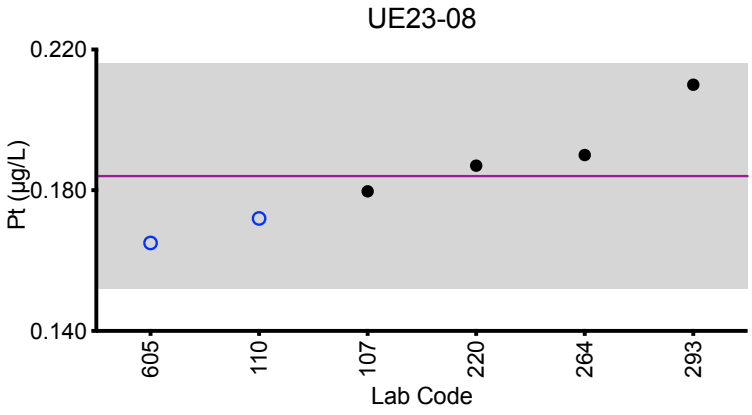
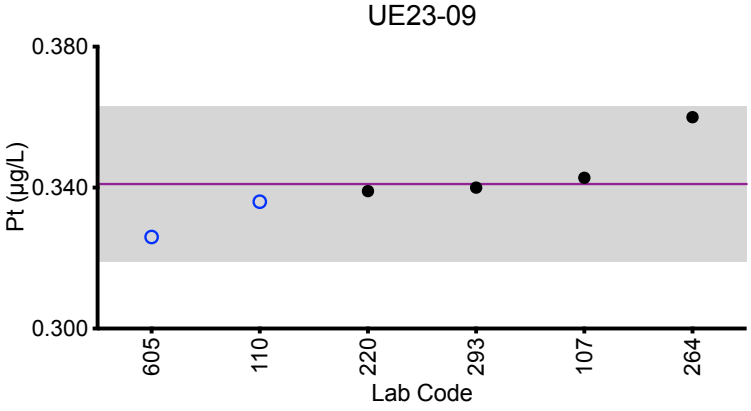
Results for Event #2, 2023: Summary Figures

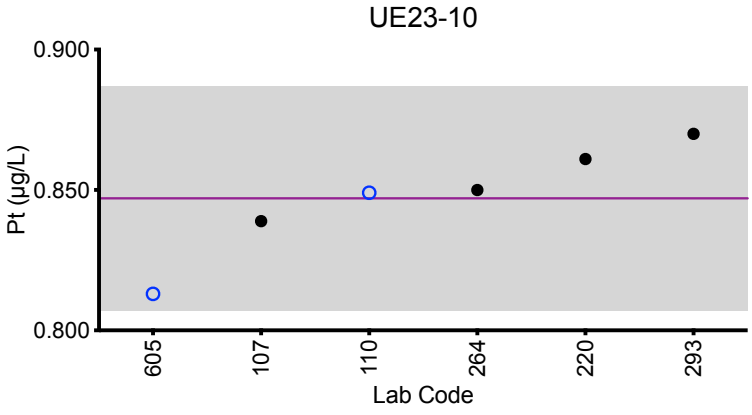
Urine Pt











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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Urine Sb (µg/L)

Lab Code	Method	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
103	ICP-MS/MS	1.11	0.276	0.798	0.0727	1.95
107	ICP-MS	1.161	0.307	0.841	0.101	2.196
110	ICP-MS	1.30	0.394	0.921	0.096	2.49
147	ICP-MS	1.19	0.319	0.875	0.0902	2.19
220	ICP-MS	1.17	0.328	0.893	0.107	2.37
264	ICP-MS	1.06	0.25	0.74	0.08	1.99
293	DRC/CC-ICP-MS	1.29	0.35	1.02	0.12	2.34
324	ICP-MS	1.253	<1	<1	<1	2.315
399	ICP-MS/MS	1.22	0.318	0.881	0.094	2.33
597	ICP-MS/MS	1.15	0.318	0.822	0.118	2.14
605	ICP-MS	1.22	<0.800	0.818	<0.800	2.26
606	ICP-MS/MS	1.17	0.319	0.869	0.083	2.21

Summary Statistics

	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
Robust Mean (x*)	1.19	0.318	0.86	0.096	2.24
Robust SD (s*)	0.07	0.019	0.06	0.018	0.15
Robust RSD (%)	5.9	5.8	7.3	19	6.7
Number of Sample Measurements (N)	12	10	11	10	12
Standard Uncertainty (*u*)	0.02	0.007	0.02	0.007	0.05

*Denotes a statistical Outlier.

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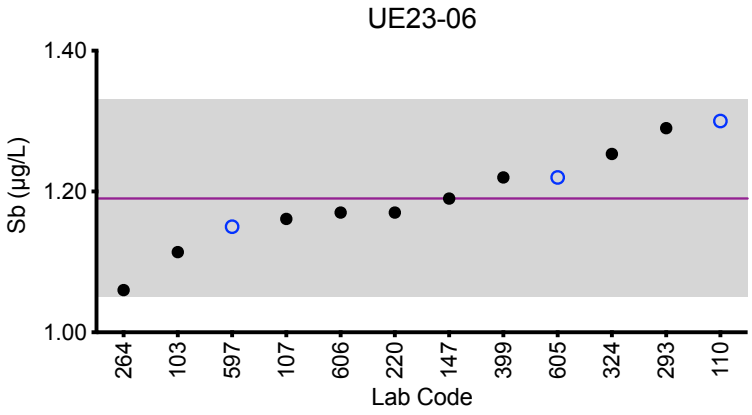
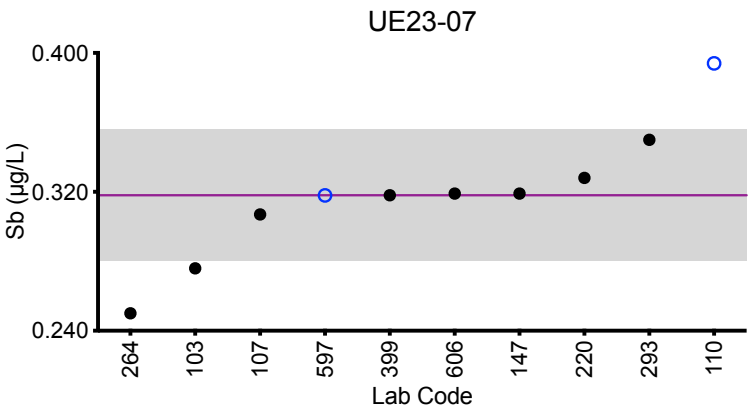
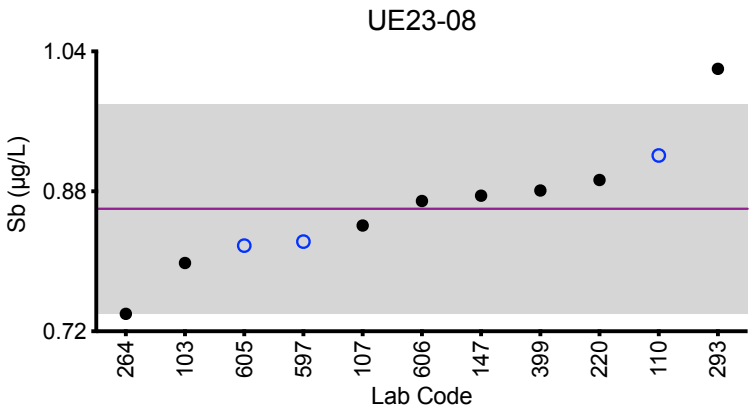
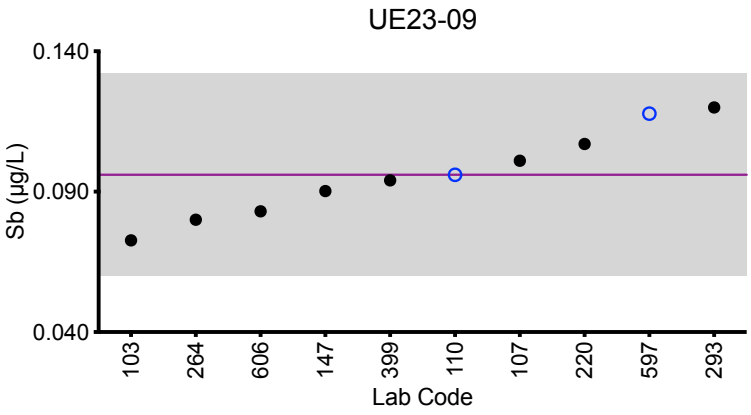
Results for Event #2, 2023: Summary Figures

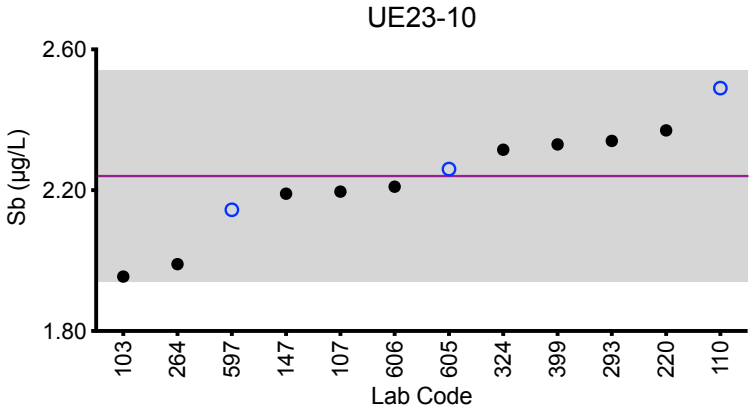
Urine Sb











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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Urine Se (µg/L)						
Lab Code	**Method**	**UE23-06**	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
103	ICP-MS/MS	147	47.6	192	94.8	232
110	DRC/CC-ICP-MS	*169	57.2	200	103	234
147	ICP-MS	143	44.9	183	91.6	209
293	DRC/CC-ICP-MS	144.55	46.6	188.78	94	228.28
597	ICP-MS/MS	143	47.9	181	92.1	214
Summary Statistics						
		UE23-06	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
Arithmetic Mean ($\bar{x}$)		144.4	49	189	95	223
Arithmetic SD (s)		1.9	5	8	5	11
Arithmetic RSD (%)		1.3	10	4.2	5.3	4.9
Number of Sample Measurements (N)		4	5	5	5	5

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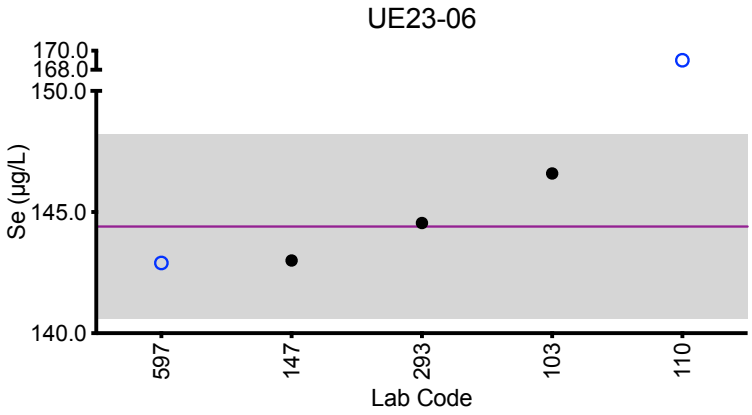
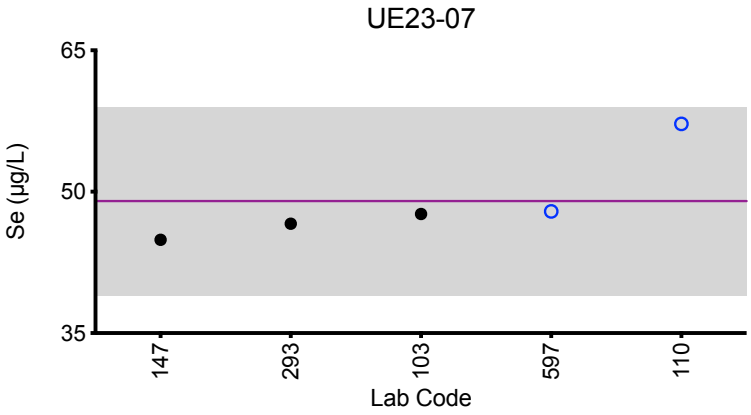
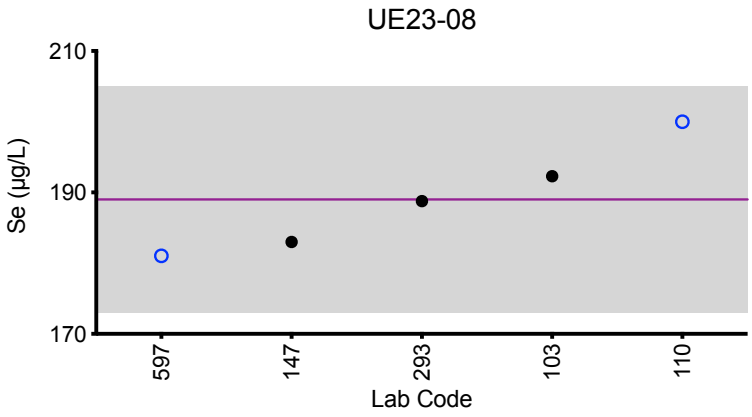
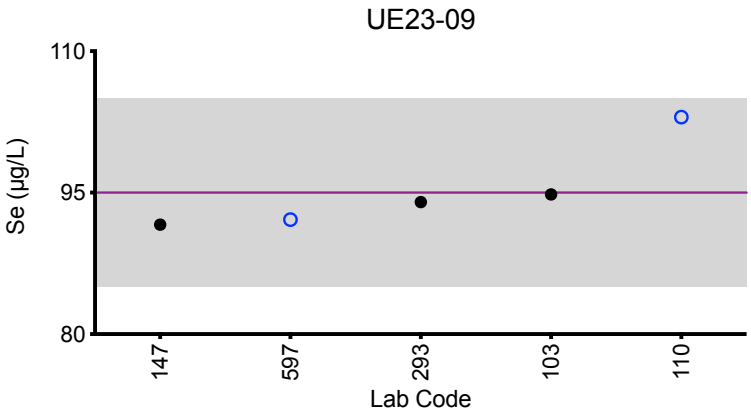
Results for Event #2, 2023: Summary Figures

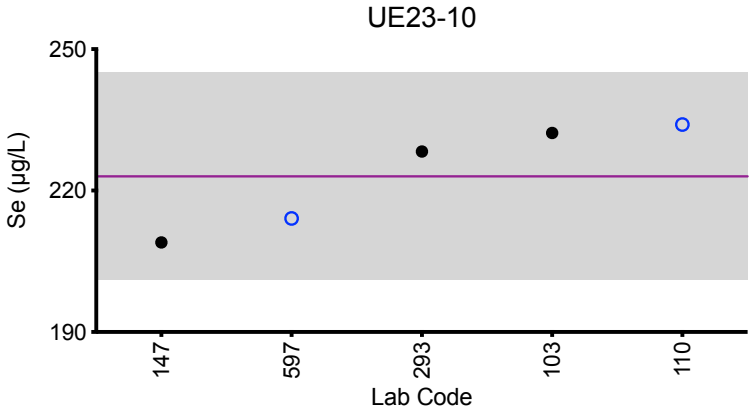
Urine Se











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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Urine Sn (µg/L)

Lab Code	Method	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
107	ICP-MS	3.64	3.26	0.69	2.09	0.60
110	ICP-MS	3.87	3.62	0.55	2.68	0.53
147	ICP-MS	2.91	2.85	0.441	1.94	0.397
220	ICP-MS	2.19	2.78	<0.4	1.38	<0.4
264	ICP-MS	2.42	2.53	0.54	1.57	0.49
324	ICP-MS	3.179	3.293	<1	2.199	<1
399	ICP-MS/MS	4.13	4.06	0.720	2.87	0.656
597	ICP-MS/MS	2.32	2.76	0.561	1.29	0.555
605	ICP-MS	3.27	3.11	<0.900	2.3	<0.900

Summary Statistics

	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
Arithmetic Mean ($\bar{x}$)	3.1	3.1	0.58	2.0	0.54
Arithmetic SD (s)	0.7	0.5	0.10	0.6	0.09
Arithmetic RSD (%)	23	16	17	30	17
Number of Sample Measurements (N)	9	9	6	9	6

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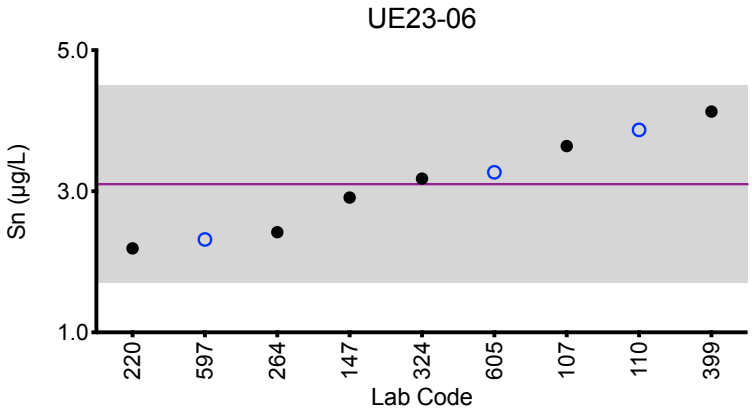
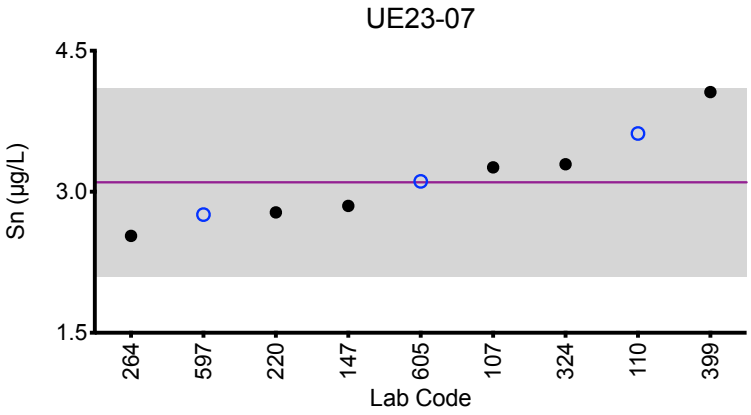
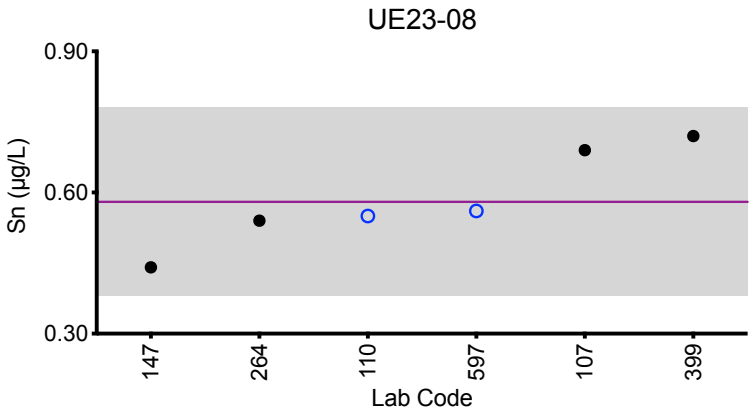
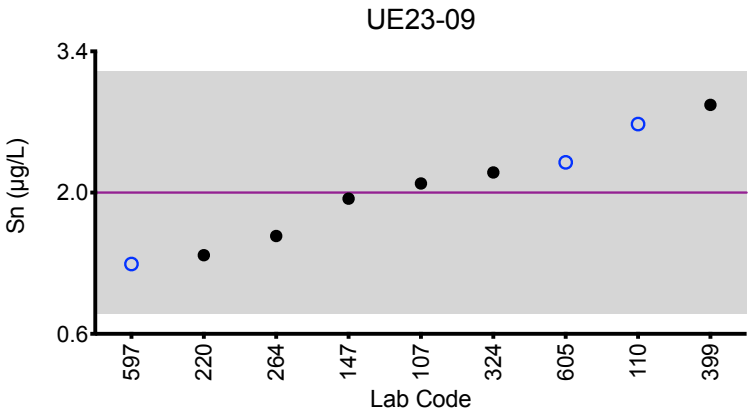
Results for Event #2, 2023: Summary Figures

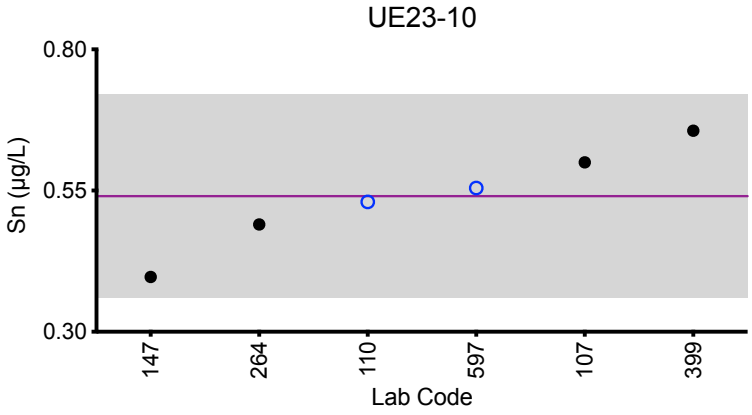
Urine Sn











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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Urine Sr (µg/L)

Lab Code	Method	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
103	ICP-MS/MS	62.2	116	258	67.9	44.2
107	ICP-MS	65.3	120.4	280.9	71.4	46.4
200	ICP-MS	61.6	107	241	64.4	40.2
220	ICP-MS	61.7	110	253	69.5	45.5
264	ICP-MS	50.60	92.14	264.54	55.95	36.72
399	DRC/CC-ICP-MS	61.7	112	266	69.5	44.8
597	ICP-MS/MS	58.4	109	242	64.6	43.6
605	ICP-MS	61.8	115	256	69.0	45.1

Summary Statistics

	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
Arithmetic Mean ($\bar{x}$)	60	110	258	67	43
Arithmetic SD (s)	4	8	13	5	3
Arithmetic RSD (%)	6.7	7.3	5.1	7.5	7.4
Number of Sample Measurements (N)	8	8	8	8	8

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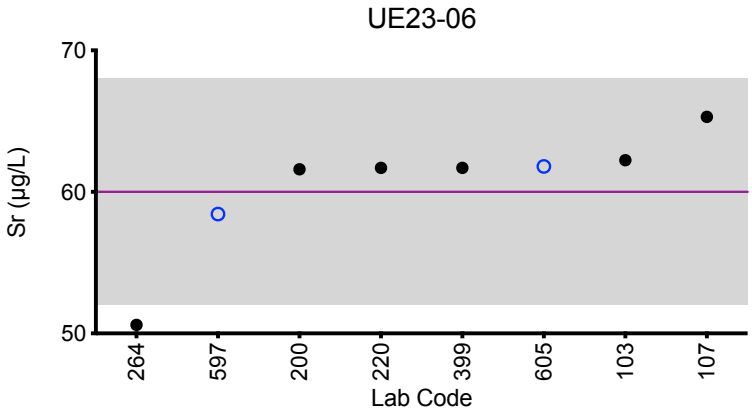
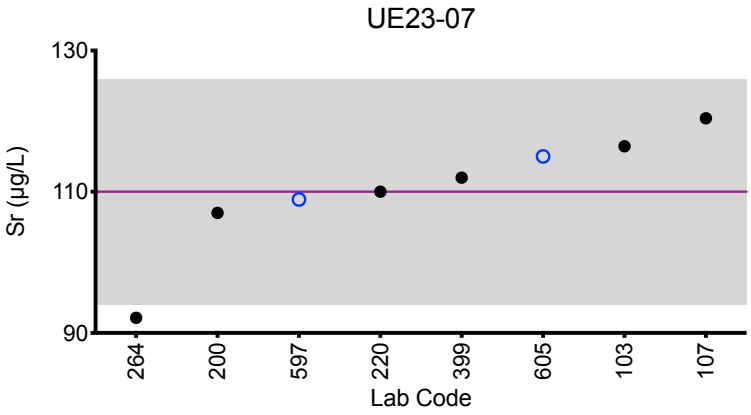
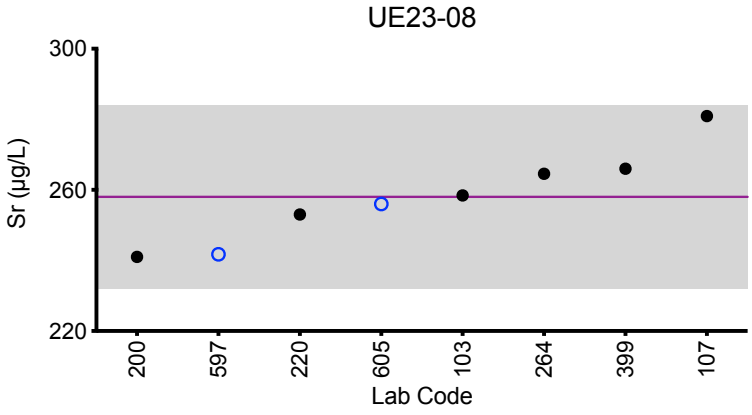
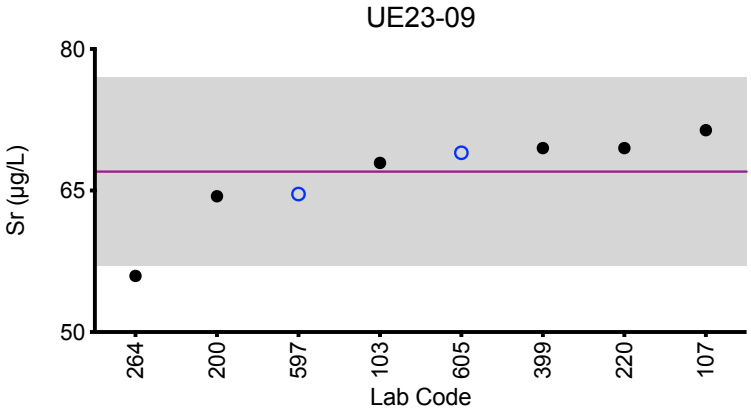
Results for Event #2, 2023: Summary Figures

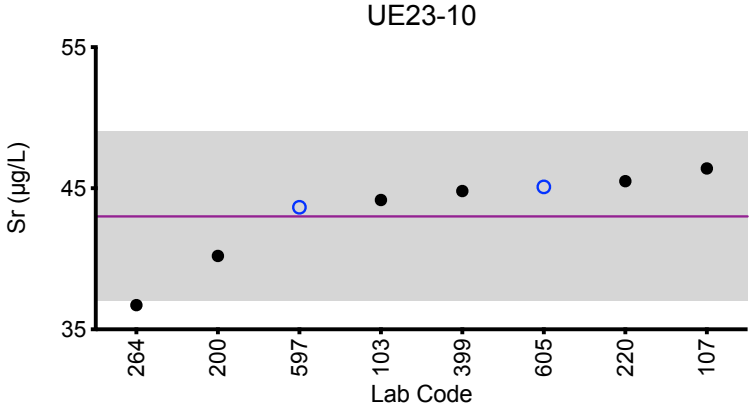
Urine Sr











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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Urine V (µg/L)

Lab Code	Method	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
116	ICP-MS/MS	0.825	3.00	1.23	0.418	1.83
147	DRC/CC-ICP-MS	0.974	3.47	1.38	0.468	2.26
293	DRC/CC-ICP-MS	0.89	3.2	1.23	0.44	2.08
597	ICP-MS/MS	0.903	3.22	1.32	0.439	2.07
605	ICP-MS	0.868	3.40	1.32	0.321	2.08

Summary Statistics

	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
Arithmetic Mean ($\bar{x}$)	0.89	3.26	1.30	0.42	2.06
Arithmetic SD (s)	0.05	0.18	0.07	0.06	0.15
Arithmetic RSD (%)	5.6	5.5	5.4	14	7.3
Number of Sample Measurements (N)	5	5	5	5	5

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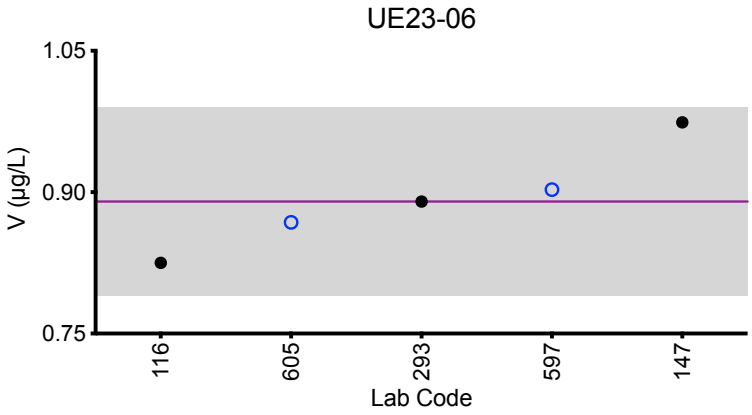
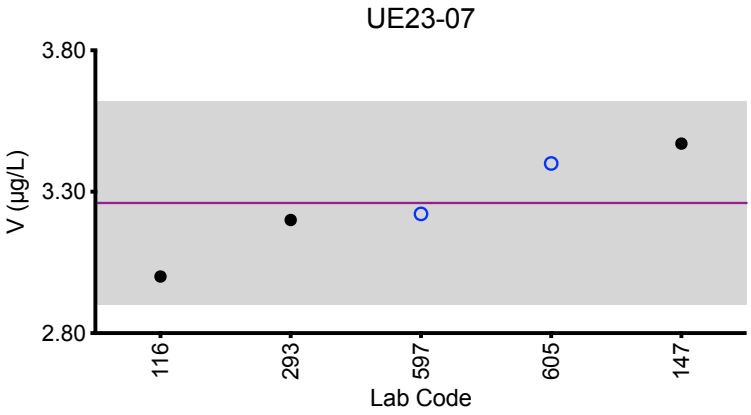
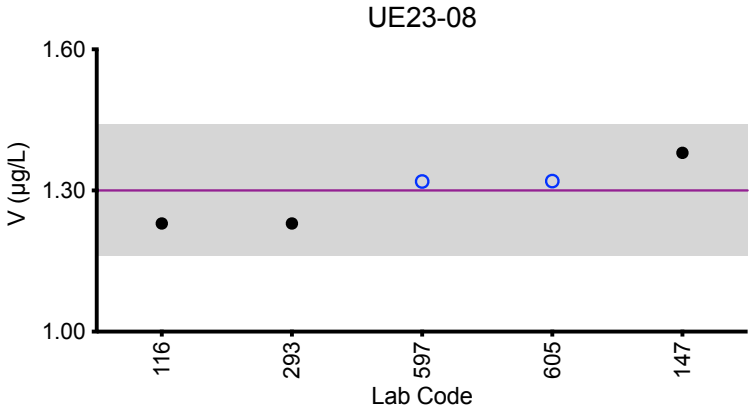
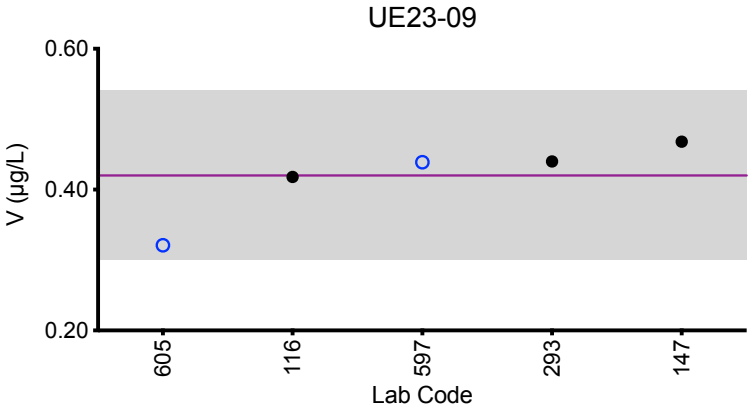
Results for Event #2, 2023: Summary Figures

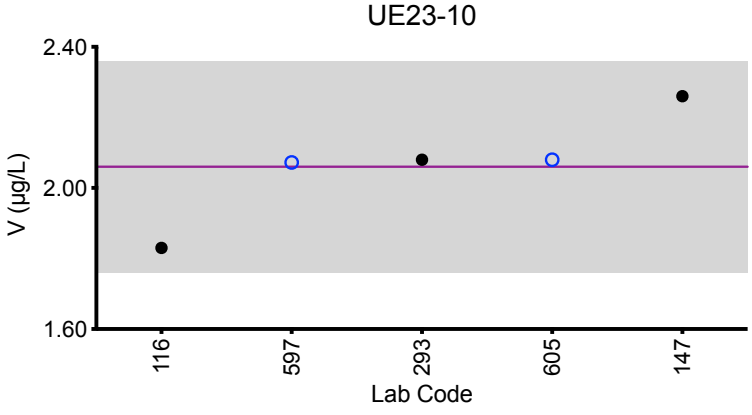
Urine V











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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Urine W (µg/L)

Lab Code	Method	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
107	ICP-MS	1.173	3.457	0.788	1.986	0.480
110	ICP-MS	1.14	3.67	0.834	2.11	0.481
147	ICP-MS	1.11	3.53	0.789	2.06	0.489
200	ICP-MS	1.23	2.78	0.66	1.95	0.37
220	ICP-MS	1.12	3.63	0.816	2.04	0.489
264	ICP-MS	1.10	3.46	0.78	1.97	0.42
324	ICP-MS	1.117	3.622	<1	1.997	<1
399	ICP-MS/MS	1.10	3.56	0.811	1.99	0.474
597	ICP-MS/MS	1.13	3.48	0.757	2.01	0.479
605	ICP-MS	1.10	3.40	0.770	1.94	0.444
606	ICP-MS/MS	1.09	3.49	0.799	1.97	0.439

Summary Statistics

	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
Robust Mean (x*)	1.12	3.51	0.79	1.99	0.469
Robust SD (s*)	0.03	0.11	0.03	0.04	0.020
Robust RSD (%)	2.3	3.1	3.9	1.9	4.3
Number of Sample Measurements (N)	11	11	10	11	10
Standard Uncertainty (*u*)	0.01	0.04	0.01	0.01	0.008

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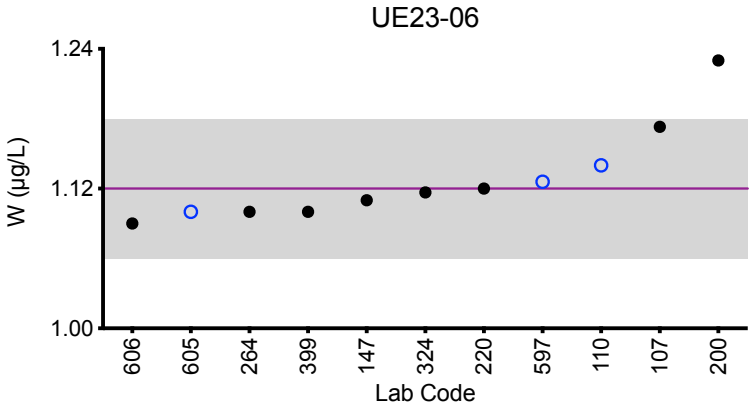
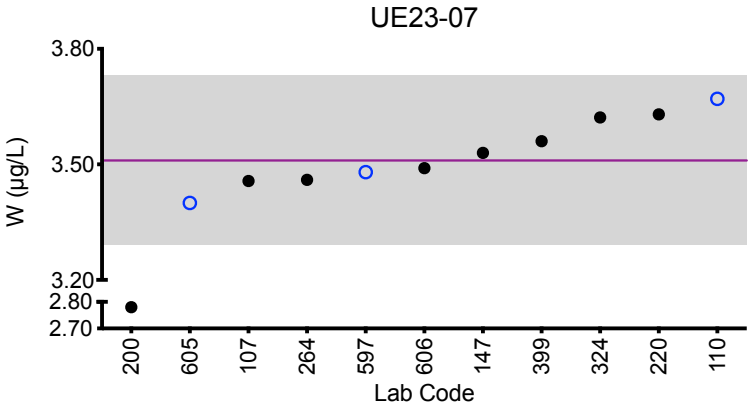
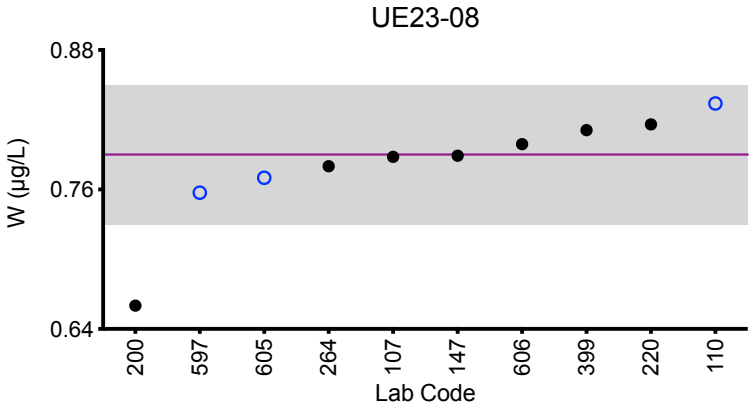
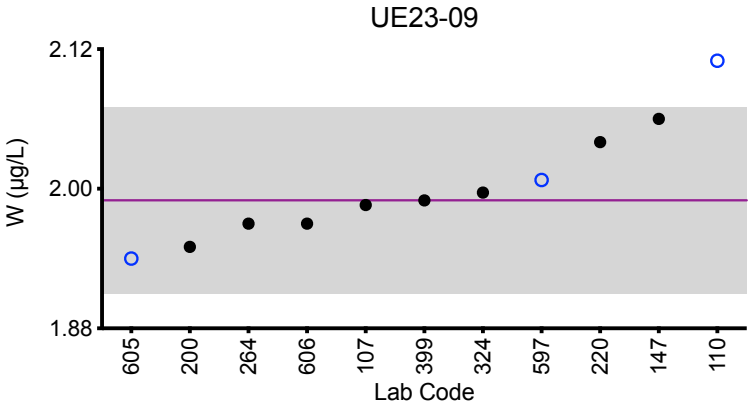
Results for Event #2, 2023: Summary Figures

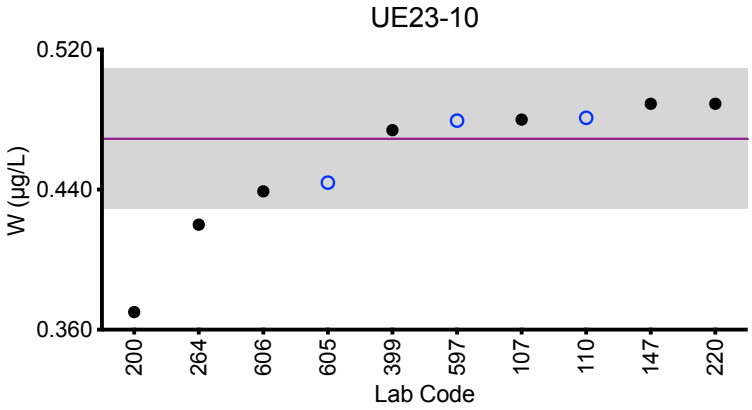
Urine W











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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Urine Zn (µg/L)

Lab Code	Method	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
110	ICP-MS	595	113	165	814	244
147	ICP-MS	617	84.3	168	843	243
264	ICP-MS	648.79	67.42	139.22	907.00	207.60
293	DRC/CC-ICP-MS	615.69	73.2	154.25	827.45	227.45
324	ICP-MS	616.319	75.362	156.103	835.937	231.962
391	ICP-MS	683.81	71.977	160.264	*106.021	239.173
597	ICP-MS/MS	579	66.7	147	772	211

Summary Statistics

	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
Arithmetic Mean ($\bar{x}$)	622	79	156	830	229
Arithmetic SD (s)	35	16	10	40	15
Arithmetic RSD (%)	5.6	20	6.4	4.8	6.6
Number of Sample Measurements (N)	7	7	7	6	7

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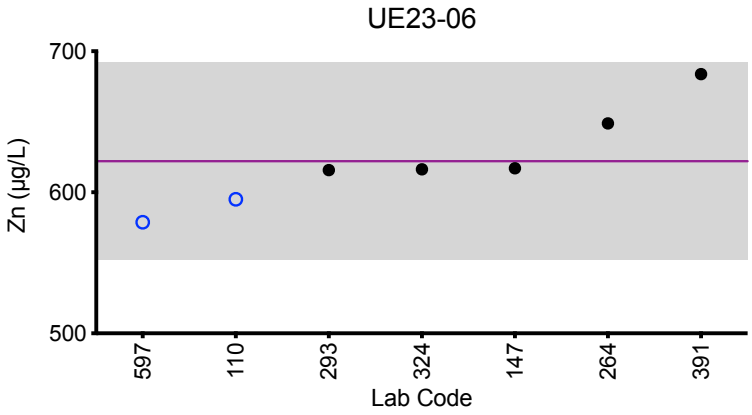
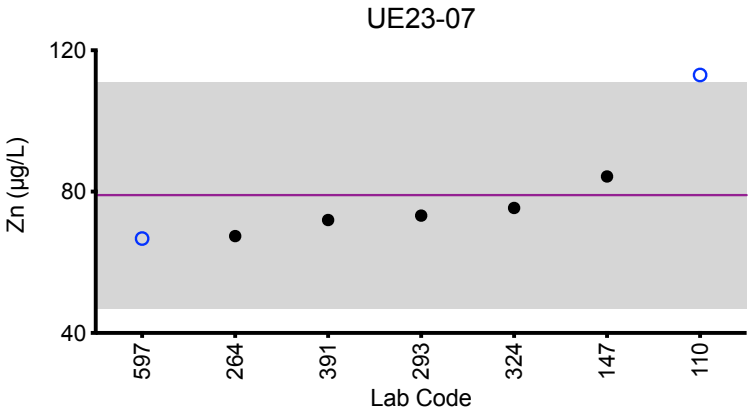
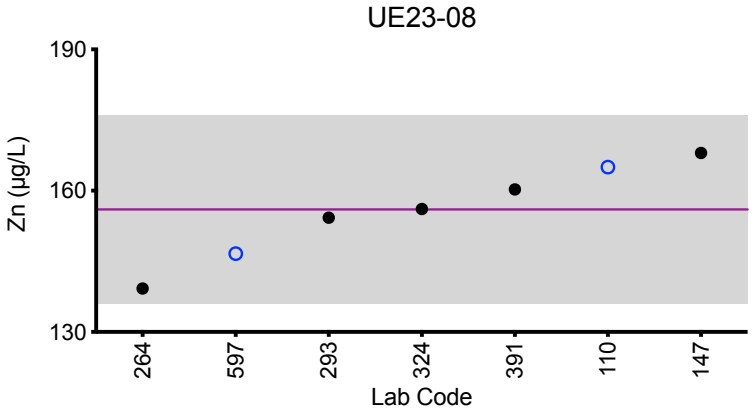
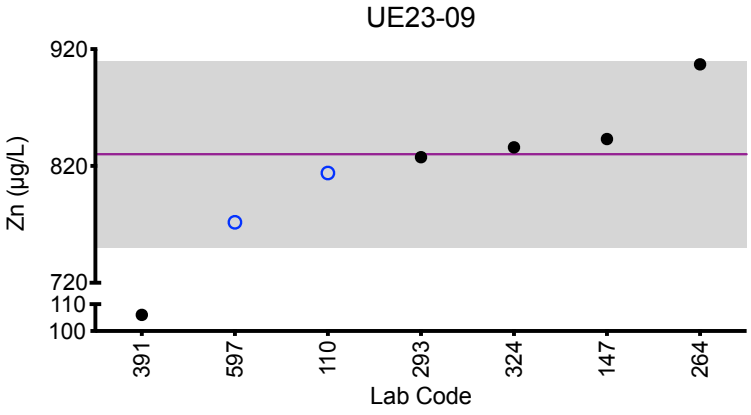
Results for Event #2, 2023: Summary Figures

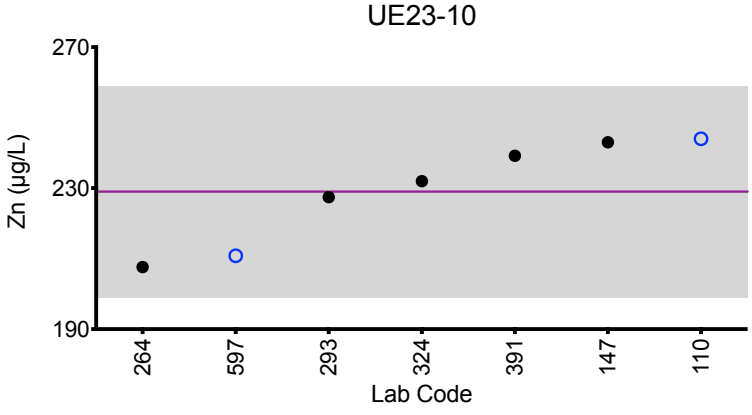
Urine Zn











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Horizontal purple line = arithmetic mean of all laboratories.
Gray area = ±2SD of the mean.

The mean and ±2SD of all laboratories are not intended to be quality specifications and are included for informational purposes only.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Urine Bi (µg/L)						
Lab Code	**Method**	**UE23-06**	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
147	ICP-MS	0.0794	0.0794	0.0794	0.0794	0.0794
264	ICP-MS	0.07	0.05	0.04	0.03	0.04
597	ICP-MS/MS	<0.0245	<0.0245	<0.0245	<0.0245	<0.0245

Summary Statistics					
	UE23-06	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
Arithmetic Mean ($\bar{x}$)	0.075	0.07	NA	NA	NA
Arithmetic SD (s)	0.007	0.02	NA	NA	NA
Arithmetic RSD (%)	9.3	32	NA	NA	NA
Number of Sample Measurements (N)	2	2	NA	NA	NA

*Denotes a statistical Outlier.

Statistical data was not calculated for UE23-08, UE23-09 and UE23-10 based on a lack of consensus among participating labs.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Urine I (µg/L)

Lab Code	Method	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
110	ICP-MS	199	73.6	99.8	171	73.7
147	ICP-MS	197	73.2	96.6	178	69.4

Summary Statistics

	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
Arithmetic Mean ($\bar{x}$)	198	73.4	98	175	72
Arithmetic SD (s)	1	0.3	2	5	3
Arithmetic RSD (%)	0.71	0.41	2.3	2.9	4.2
Number of Sample Measurements (N)	2	2	2	2	2

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Urine Te (µg/L)

Lab Code	Method	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
110	ICP-MS	0.202	1.42	0.700	0.752	3.37
147	ICP-MS	0.218	1.42	0.685	0.698	3.37

Summary Statistics

	UE23-06	UE23-07	UE23-08	UE23-09	UE23-10
Arithmetic Mean ($\bar{x}$)	0.210	1.42	0.693	0.72	3.37
Arithmetic SD (s)	0.011	0.00	0.011	0.04	0.00
Arithmetic RSD (%)	5.2	0.0	1.6	5.6	0.0
Number of Sample Measurements (N)	2	2	2	2	2

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Urine Th (µg/L)						
Lab Code	**Method**	**UE23-06**	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
147	ICP-MS	0.102	0.102	0.102	0.102	0.102
597	ICP-MS/MS	0.0491	0.0181	0.0244	0.0339	0.0103
Summary Statistics						
		UE23-06	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
Arithmetic Mean ($\bar{x}$)		NA	NA	NA	NA	NA
Arithmetic SD (s)		NA	NA	NA	NA	NA
Arithmetic RSD (%)		NA	NA	NA	NA	NA
Number of Sample Measurements (N)		NA	NA	NA	NA	NA

*Denotes a statistical Outlier.

Statistical data was not calculated for UE23-06, UE23-07, UE23-08, UE23-09 and UE23-10 based on a lack of consensus among participating labs.

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Results for Event #2, 2023: Additional Elements in Urine

Urine Ag (µg/L)						
Lab Code	**Method**	**UE23-06**	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
147	ICP-MS	0.151	0.151	0.151	0.151	0.151

Urine B (µg/L)						
Lab Code	**Method**	**UE23-06**	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
200	ICP-MS	1156	363	388	794	266

Urine Fe (µg/L)						
Lab Code	**Method**	**UE23-06**	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
324	ICP-MS	12.405	5.800	4.853	8.253	6.193

Urine Li (µg/L)						
Lab Code	**Method**	**UE23-06**	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
147	ICP-MS	14.2	4.77	5.88	11.6	3.12

Urine Mg (µg/L)						
Lab Code	**Method**	**UE23-06**	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
597	ICP-MS/MS	38200	13300	12300	23500	14600

Urine Ti (µg/L)						
Lab Code	**Method**	**UE23-06**	**UE23-07**	**UE23-08**	**UE23-09**	**UE23-10**
597	ICP-MS/MS	4.61	1.87	6.99	2.01	2.53

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Event #2, 2023

Trace Elements in Serum

Wadsworth Center
NEW YORK STATE DEPARTMENT OF HEALTH
Trace Elements Laboratory

NEW YORK STATE | Department of Health | Wadsworth Center

Event #2, 2023:
Trace Elements in Serum

PT Materials

Test materials were prepared from human serum obtained from Zen-Bio, Inc. The company certifies that these materials were tested by FDA approved methods and found to be negative for HIV 1Ž2 and HIV-1 RNA, and non-reactive to HBsAg, HCV3 and STS. Units of serum were filtered into polypropylene containers through cheesecloth to remove particulates and supplemented with aluminum (Al), cobalt (Co), chromium (Cr), copper (Cu), selenium (Se), zinc, (Zn), arsenic (As), beryllium (Be), cadmium (Cd), mercury (Hg), manganese (Mn), molybdenum (Mo), nickel (Ni), lead (Pb), platinum (Pt), antimony (Sb), tin (Sn), strontium (Sr), titanium (Ti), thallium (Tl), uranium (U), vanadium (V) and tungsten (W). PT samples were stored at -80°C until the week of the PT event, when they were thawed at 4°C prior to circulation to laboratories for analysis.

Graded Elements

Six elements in serum are formally graded: Al, Co, Cr, Cu, Se, and Zn. Target values for the graded elements are assigned to these pools based on (a) the robust mean calculated from data reported by all laboratories, or (b) if a robust mean is not possible, the arithmetic mean after outlier deletion.

Additional Elements

An additional 27 were reported by at least one participant: As, B, Ba, Be, Bi, Cd, Cs, Fe, Hg, I, Li, Mg, Mn, Mo, Ni, Pb, Pt, Sb, Sn, Sr, Te, Th, Ti, Tl, U, V, and W. These data are included here to provide a more complete characterization of the PT materials. All results reported by participant laboratories are tabulated and organized by lab code. The PT data are graphed for visual comparison purposes for all elements where at least five laboratories reported a value greater than the LOD. A statistical summary table is provided for samples where at least two comparable values were reported as above the LOD.

The summary statistics for the additional elements are provided for educational purposes only, i.e., no acceptable response is implied. However, it is expected that each laboratory would wish to investigate a potential source of bias if warranted by these data. Future events might result in additional elements becoming graded if a consensus can be reached regarding desired quality specifications.

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Results for Event #2, 2023: Summary Statistics

	Serum Al (µg/L)				
	SE23-06	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
Target (Arithmetic Mean ($\bar{x}$))	34.3	21.2	9.1	75.4	13.9
Upper Limit	41.2	26.2	14.1	90.5	18.9
Lower Limit	27.4	16.2	4.1	60.3	8.9
Arithmetic SD (s)	0.9	1.1	2.2	2.9	1.5
Arithmetic RSD (%)	2.6	5.2	24	3.8	11
Number of Sample Measurements (N)	6	5	6	6	6

The acceptable range is based on quality specifications:
±5 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±5 µg/L at concentrations less than or equal to 25 µg/L. These quality specifications were established by New York State Department of Health's Wadsworth Center, the PT Program organizer.

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Results for Event #2, 2023:
Performance of Participating Laboratories

		Serum Al (µg/L)				
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
	Target	**34.3**	**21.2**	**9.1**	**75.4**	**13.9**
147	ETAAS-Z	34.4	21.6	10.7	75.8	16.0
264	ICP-MS	33.12	19.22	5.68	75.24	12.54
293	DRC/CC-ICP-MS	34.14	21.77	9.14	74.73	13.98
391	ETAAS-Z	33.54	*30.61 ↑	11.77	70.43	15.15
485	HR-ICP-MS	34.90	21.9	9.48	77.7	13.8
597	ICP-MS/MS	35.6	21.4	7.84	78.7	11.9

Based on the grading criteria for Al in Serum, 97% of results were satisfactory, with 0 of the 6 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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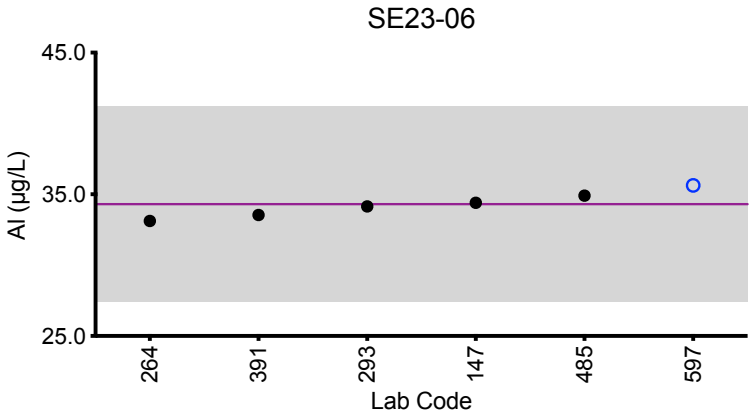
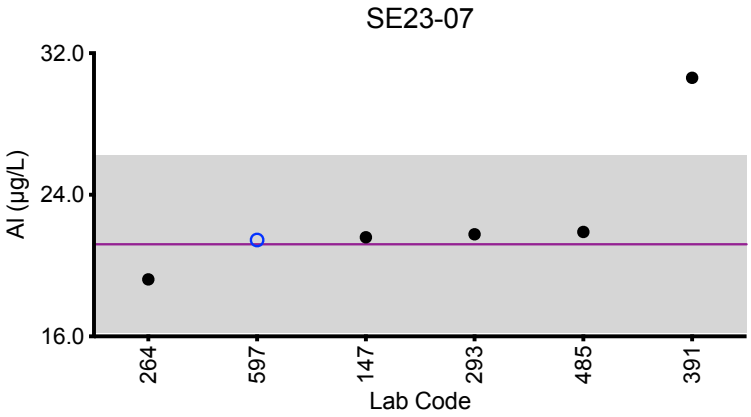
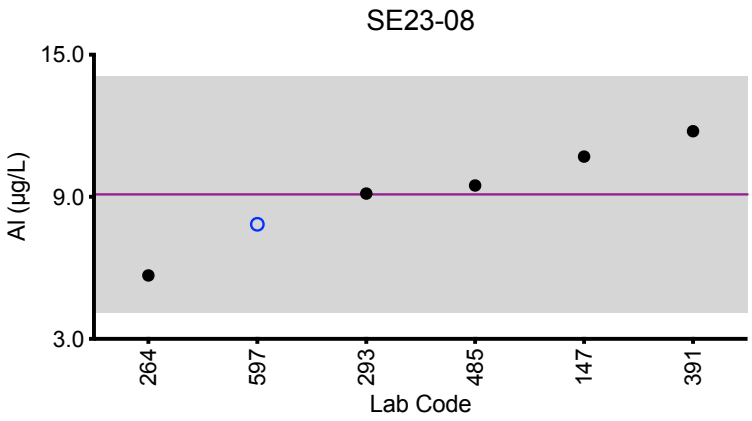
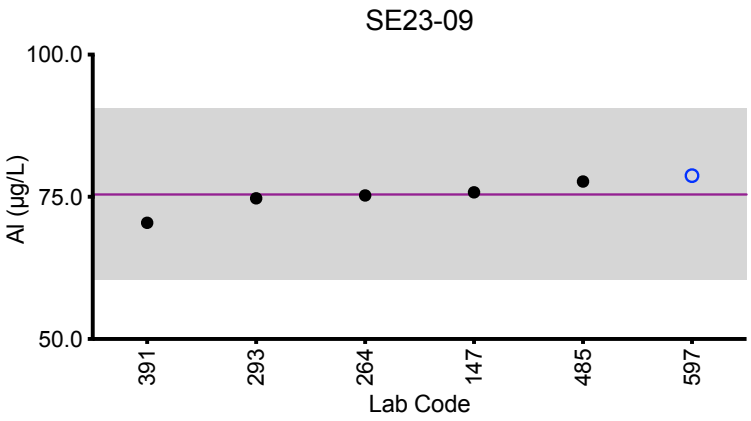
Results for Event #2, 2023: Summary Figures

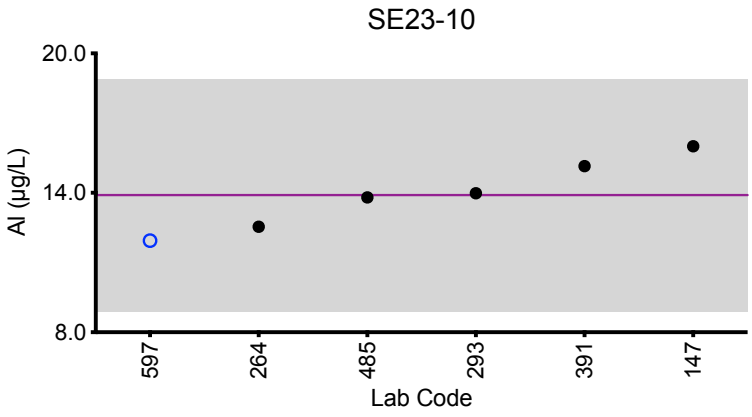
Serum Al











Legend:

o HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the arithmetic mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±5 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±5 µg/L at concentrations less than or equal to 25 µg/L.

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Results for Event #2, 2023:
Summary Statistics

Serum Co (µg/L)					
	SE23-06	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
Target (Arithmetic Mean ($\bar{x}$))	20.5	1.93	0.750	2.54	9.5
Upper Limit	23.6	3.43	2.250	4.04	11.0
Lower Limit	17.4	0.43	0.000	1.04	8.0
Arithmetic SD (s)	0.6	0.06	0.025	0.16	0.5
Arithmetic RSD (%)	2.9	3.1	3.3	6.3	5.3
Number of Sample Measurements (N)	7	8	8	8	8

The acceptable range is based on quality specifications:
±1.5 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±1.5 µg/L at concentrations less than or equal to 10 µg/L. These quality specifications were established based on discussions with the US FDA, and represent a consensus from a network of Trace Element PT program organizers

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Results for Event #2, 2023:
Performance of Participating Laboratories

Serum Co (µg/L)						
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
	Target	**20.5**	**1.93**	**0.750**	**2.54**	**9.5**
103	ICP-MS/MS	19.5	1.83	0.721	2.31	8.82
110	ICP-MS/MS	20.9	1.87	0.76	2.48	9.29
147	DRC/CC-ICP-MS	20.6	1.90	0.775	2.48	9.23
264	ICP-MS	21.40	2.01	0.75	2.60	9.90
293	DRC/CC-ICP-MS	20.6	1.97	0.77	2.63	9.61
442	DRC/CC-ICP-MS	20.1	1.93	0.705	2.45	8.97
485	HR-ICP-MS	20.7	1.98	0.77	2.53	9.44
597	ICP-MS/MS	*24.3 ↑	1.91	0.752	2.85	10.5

Based on the grading criteria for Co in Serum, 98% of results were satisfactory, with 0 of the 8 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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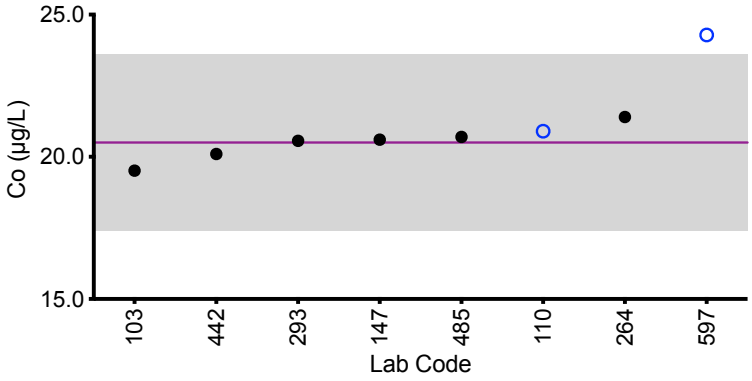
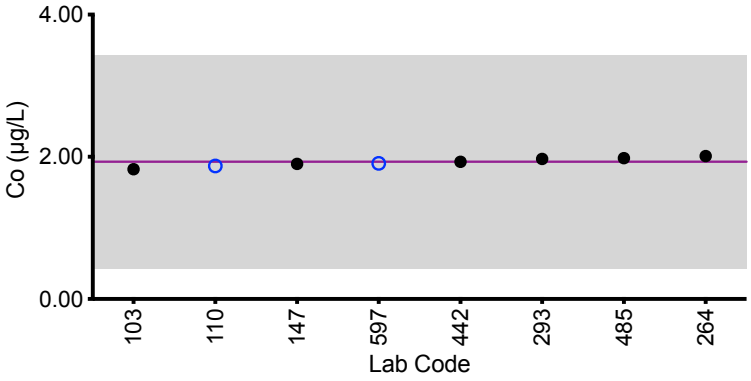
Results for Event #2, 2023: Summary Figures

Serum Co

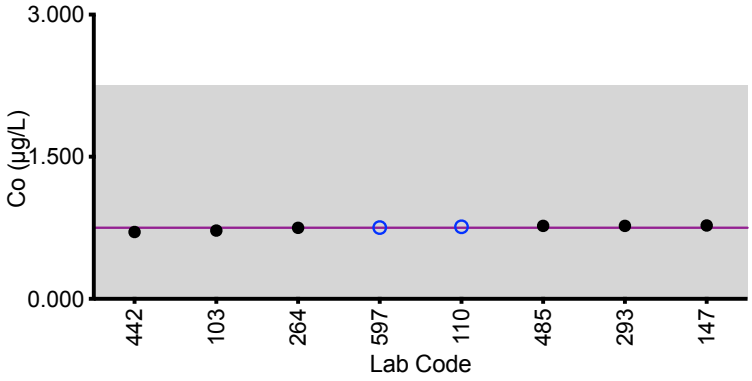
SE23-06



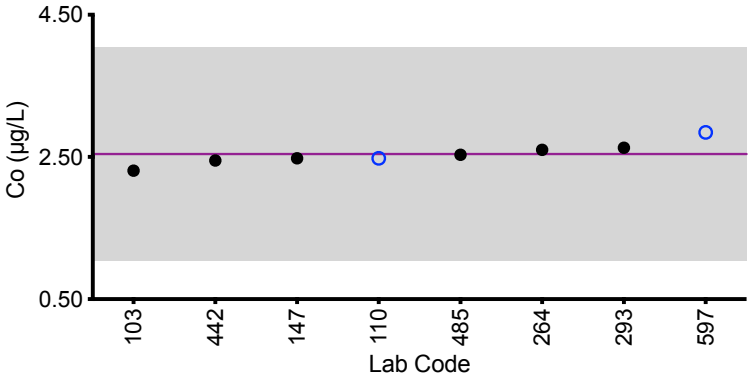
SE23-07



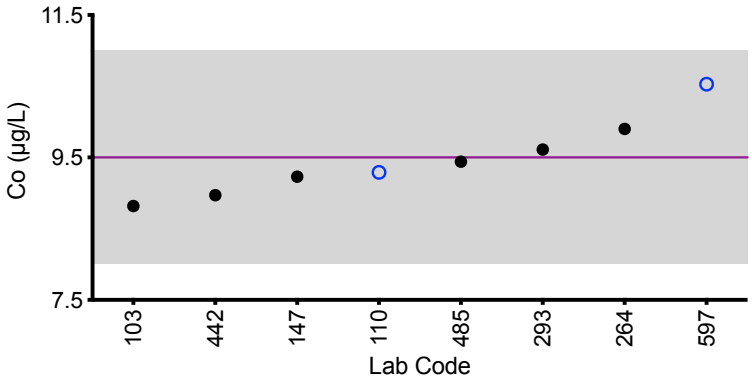
SE23-08



SE23-09



SE23-10



Legend:
o HHEAR Labs ● Other Labs
Horizontal purple line = assigned target value based on the arithmetic mean of all laboratories.
Gray area = acceptable range based on quality specifications:
±1.5 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±1.5 µg/L at concentrations less than or equal to 10 µg/L.

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Results for Event #2, 2023:
Summary Statistics

	Serum Cr (µg/L)				
	SE23-06	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
Target (Arithmetic Mean ($\bar{x}$))	3.1	7.9	4.60	1.9	0.87
Upper Limit	5.1	9.9	6.60	3.9	2.87
Lower Limit	1.1	5.9	2.60	0.0	0.00
Arithmetic SD (s)	0.4	0.3	0.23	0.3	0.15
Arithmetic RSD (%)	11	4.1	5.0	13	17
Number of Sample Measurements (N)	7	7	7	7	7

The acceptable range is based on quality specifications:
±2 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±2 µg/L at concentrations less than or equal to 10 µg/L. These quality specifications were established based on discussions with the US FDA, and represent a consensus from a network of Trace Element PT program organizers

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Results for Event #2, 2023:
Performance of Participating Laboratories

		Serum Cr (µg/L)				
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
	Target	**3.1**	**7.9**	**4.60**	**1.9**	**0.87**
103	ICP-MS/MS	2.80	7.38	4.28	1.68	0.721
110	ICP-MS/MS	3.15	8.21	4.68	1.91	0.82
147	DRC/CC-ICP-MS	3.06	7.85	4.73	1.79	0.972
264	ICP-MS	2.54	7.78	4.30	1.55	0.70
293	DRC/CC-ICP-MS	3.19	8.39	4.89	2.13	0.88
485	HR-ICP-MS	3.12	7.90	4.60	1.90	0.86
597	ICP-MS/MS	3.67	8.02	4.72	2.28	1.14

Based on the grading criteria for Cr in Serum, 100% of results were satisfactory, with 0 of the 7 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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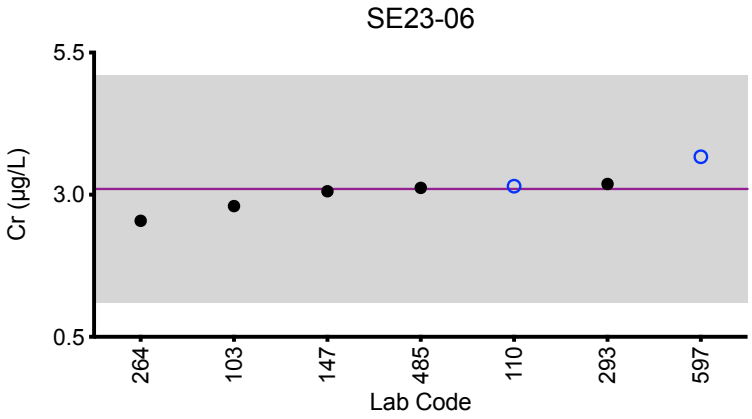
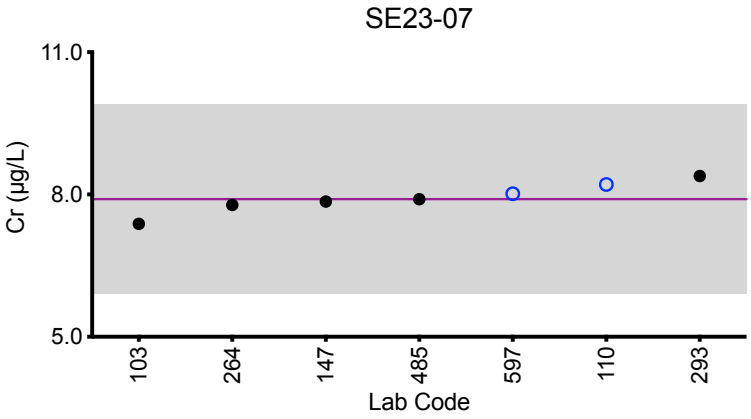
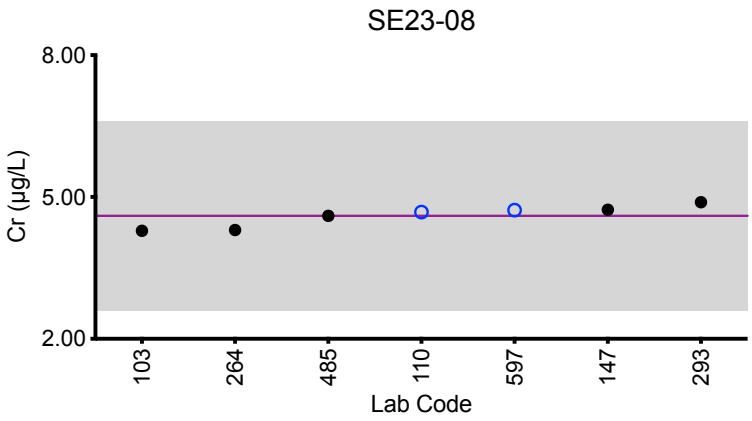
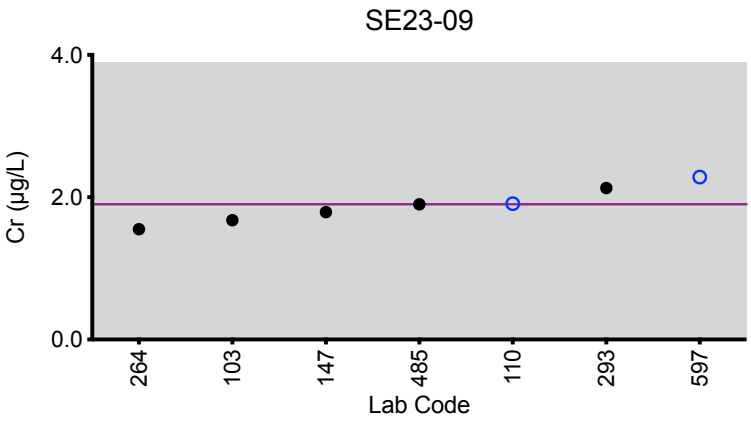
Results for Event #2, 2023: Summary Figures

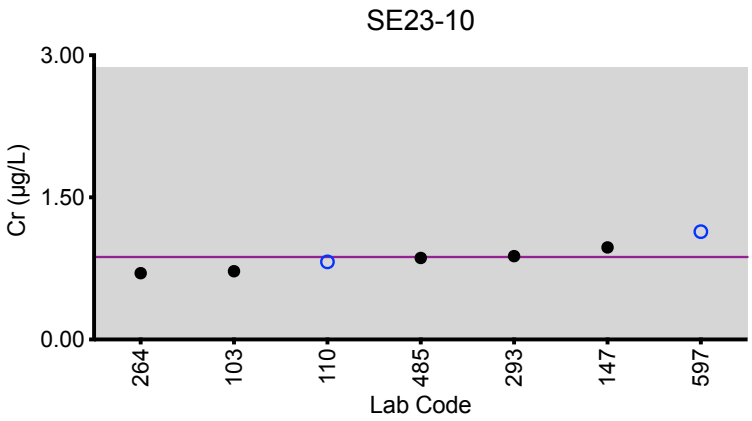
Serum Cr











Legend:

o HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the arithmetic mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±2 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±2 µg/L at concentrations less than or equal to 10 µg/L.

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Results for Event #2, 2023: Summary Statistics

Serum Cu (µg/L)					
	SE23-06	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
Target (Arithmetic Mean ($\bar{x}$))	1313	1100	900	1950	1010
Upper Limit	1510	1270	1035	2240	1160
Lower Limit	1116	940	765	1660	860
Arithmetic SD (s)	29	50	22	170	60
Arithmetic RSD (%)	2.2	4.5	2.4	8.7	5.9
Number of Sample Measurements (N)	6	7	6	7	7

The acceptable range is based on quality specifications:
±95 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±95 µg/L at concentrations less than or equal to 635 µg/L. These quality specifications were established by New York State Department of Health's Wadsworth Center, the PT Program organizer.

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Results for Event #2, 2023:
Performance of Participating Laboratories

Serum Cu (µg/L)						
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
	Target	**1313**	**1100**	**900**	**1950**	**1010**
107	DRC/CC-ICP-MS	1318	1146	932	2044	1063
110	ICP-MS/MS	1330	1100	898	1900	986
147	DRC/CC-ICP-MS	1280	1109	894	1925	972
264	ICP-MS	1352	1147	913	1996	1038
293	DRC/CC-ICP-MS	1278	1074	865	1894	966
436	FAAS	1317	1000	*700 ↓	1651 ↓	953
597	ICP-MS/MS	*1530 ↑	1130	897	2210	1120

Based on the grading criteria for Cu in Serum, 91% of results were satisfactory, with 1 of the 7 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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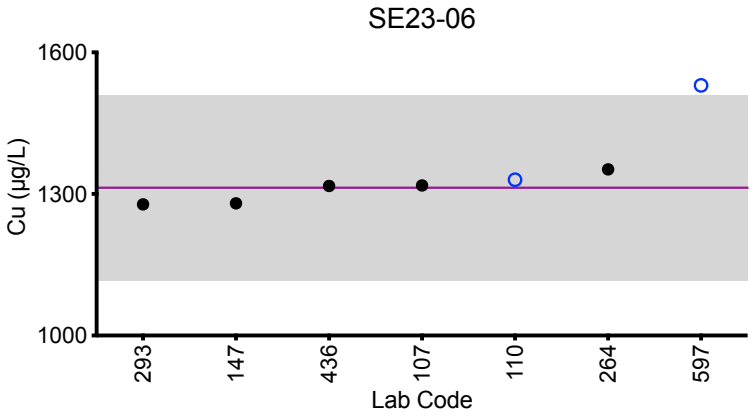
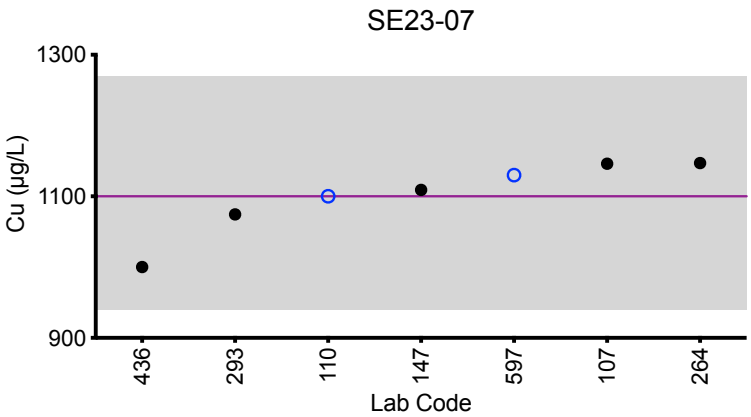
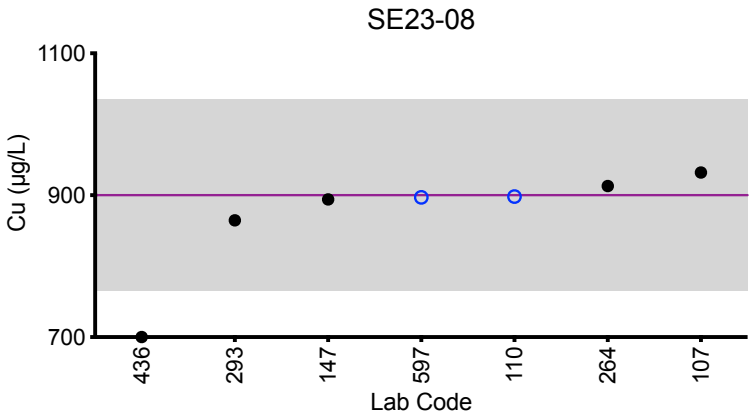
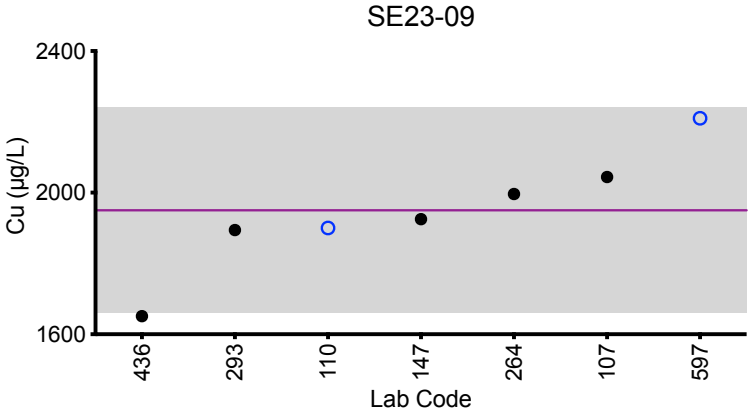
Results for Event #2, 2023: Summary Figures

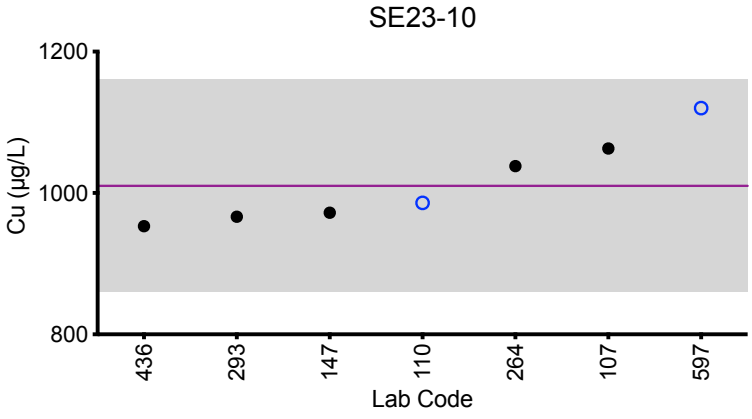
Serum Cu











Legend:

o HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the arithmetic mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±95 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±95 µg/L at concentrations less than or equal to 635 µg/L.

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Results for Event #2, 2023: Summary Statistics

	Serum Se (µg/L)				
	SE23-06	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
Target (Arithmetic Mean ($\bar{x}$))	138	106	155	243	202
Upper Limit	166	127	186	292	242
Lower Limit	110	85	124	194	162
Arithmetic SD (s)	6	3	4	12	7
Arithmetic RSD (%)	4.3	3.0	2.7	4.9	3.5
Number of Sample Measurements (N)	8	8	8	8	8

The acceptable range is based on quality specifications:
±2 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±2 µg/L at concentrations less than or equal to 10 µg/L. These quality specifications were established by New York State Department of Health's Wadsworth Center, the PT Program organizer.

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Results for Event #2, 2023:
Performance of Participating Laboratories

		Serum Se (µg/L)				
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
	Target	**138**	**106**	**155**	**243**	**202**
103	ICP-MS/MS	134	104	154	236	196
107	DRC/CC-ICP-MS	133.6	108.4	153.7	238.0	200.1
110	ICP-MS/MS	137	104	153	237	194
147	DRC/CC-ICP-MS	138	109	158	241	197
264	ICP-MS	138.59	107.27	154.26	246.68	203.28
293	DRC/CC-ICP-MS	139	109	159	251	208
436	A-7	130	100	160	227	201
597	ICP-MS/MS	150	104	147	265	214

Based on the grading criteria for Se in Serum, 100% of results were satisfactory, with 0 of the 8 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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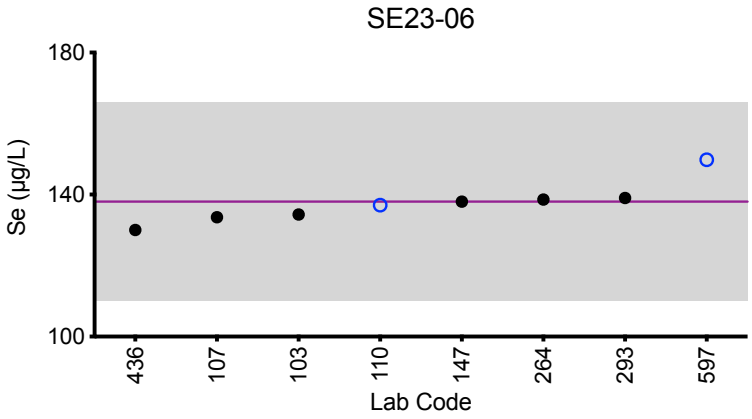
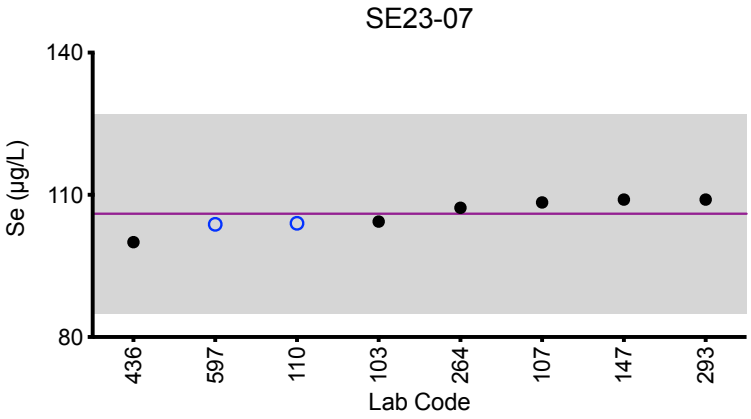
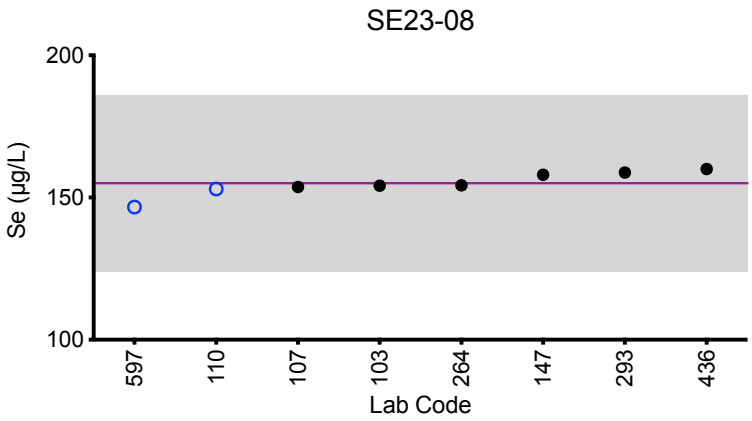
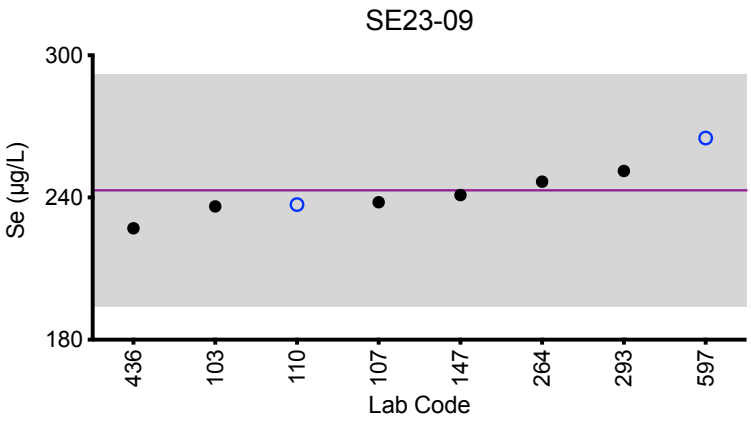
Results for Event #2, 2023: Summary Figures

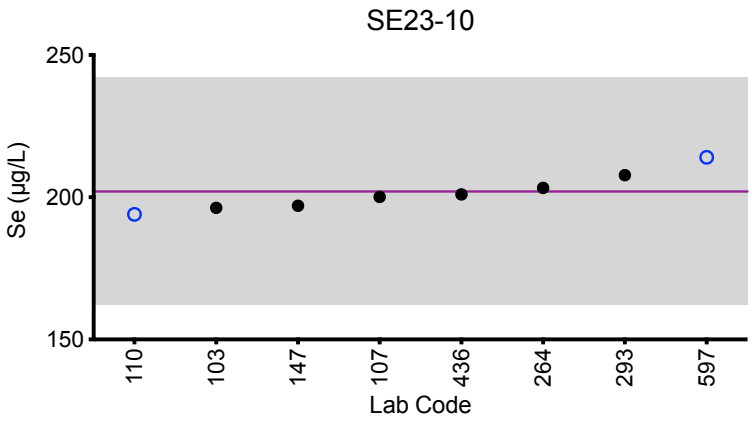
Serum Se











Legend:

o HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the arithmetic mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±2 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±2 µg/L at concentrations less than or equal to 10 µg/L.

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Results for Event #2, 2023: Summary Statistics

Serum Zn (µg/L)					
	SE23-06	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
Target (Arithmetic Mean ($\bar{x}$))	1160	1380	910	1580	630
Upper Limit	1330	1590	1050	1820	720
Lower Limit	990	1170	770	1340	540
Arithmetic SD (s)	100	60	40	120	50
Arithmetic RSD (%)	8.6	4.3	4.4	7.6	7.9
Number of Sample Measurements (N)	6	6	6	6	6

The acceptable range is based on quality specifications:
±15 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±15 µg/L at concentrations less than or equal to 100 µg/L. These quality specifications were established by New York State Department of Health's Wadsworth Center, the PT Program organizer.

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Results for Event #2, 2023:
Performance of Participating Laboratories

		Serum Zn (µg/L)				
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
	Target	**1160**	**1380**	**910**	**1580**	**630**
107	DRC/CC-ICP-MS	1155	1453	968	1665	675
110	ICP-MS/MS	1150	1358	908	1560	605
147	DRC/CC-ICP-MS	1093	1333	882	1490	600
264	ICP-MS	1125	1363	893	1518	618
293	DRC/CC-ICP-MS	1078	1294	863	1464	582
597	ICP-MS/MS	1360 ↑	1450	953	1790	716

Based on the grading criteria for Zn in Serum, 97% of results were satisfactory, with 0 of the 6 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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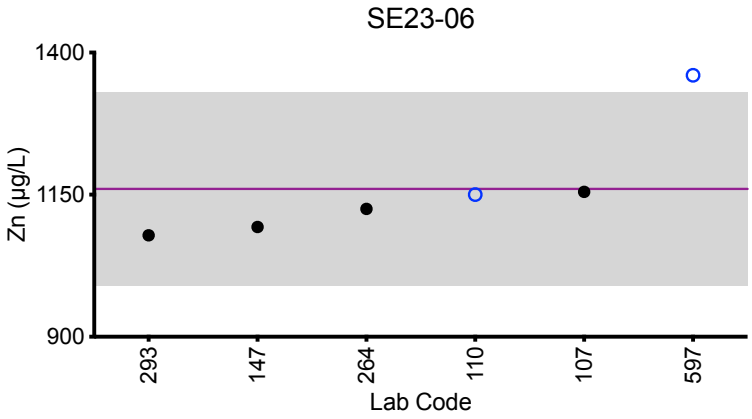
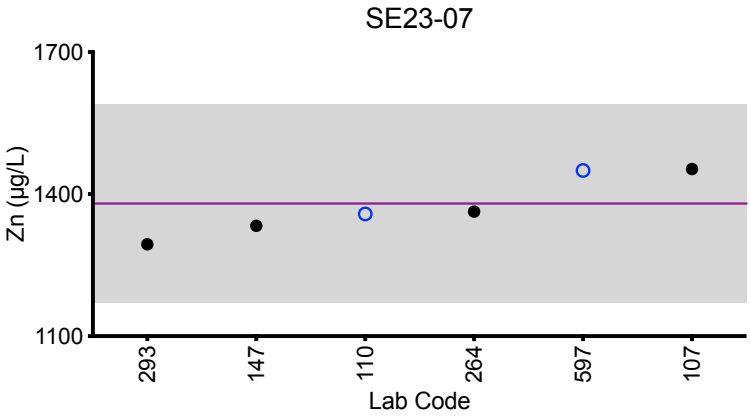
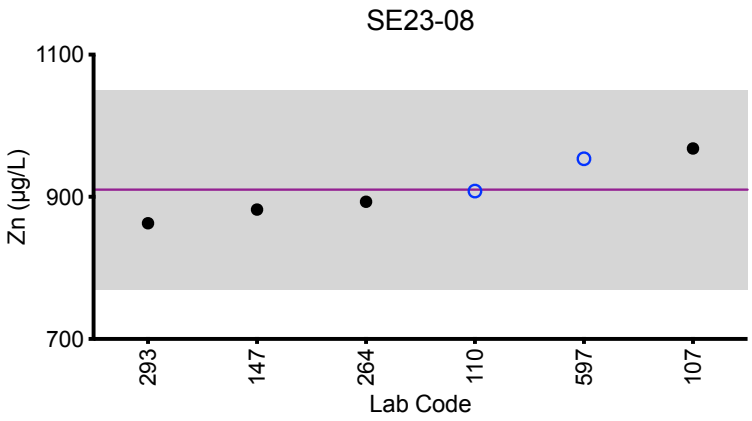
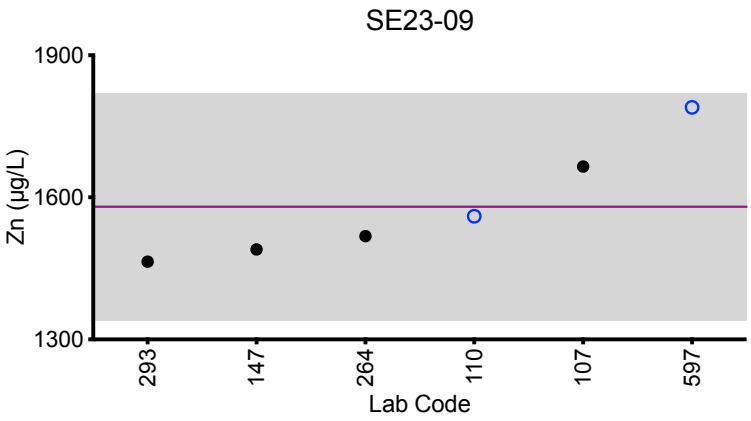
Results for Event #2, 2023: Summary Figures

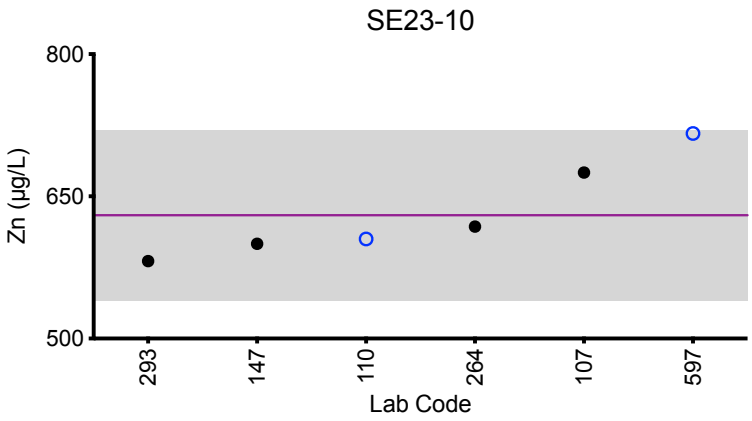
Serum Zn











Legend:

o HHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the arithmetic mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±15 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±15 µg/L at concentrations less than or equal to 100 µg/L.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Serum Mn (µg/L)						
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
103	ICP-MS/MS	3.32	14.0	2.25	7.52	5.57
110	ICP-MS/MS	3.51	13.8	2.36	7.46	5.5
147	DRC/CC-ICP-MS	3.62	14.7	2.49	7.75	5.78
264	ICP-MS	2.38	12.95	*1.46	6.36	4.61
293	DRC/CC-ICP-MS	3.430	14.56	2.39	8.19	5.780
597	ICP-MS/MS	4.00	14.4	2.43	8.61	6.38
Summary Statistics						
		SE23-06	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
Arithmetic Mean ($\bar{x}$)		3.4	14.1	2.38	7.6	5.6
Arithmetic SD (s)		0.5	0.6	0.09	0.8	0.6
Arithmetic RSD (%)		15	4.3	3.8	11	11
Number of Sample Measurements (N)		6	6	5	6	6

*Denotes a statistical Outlier.

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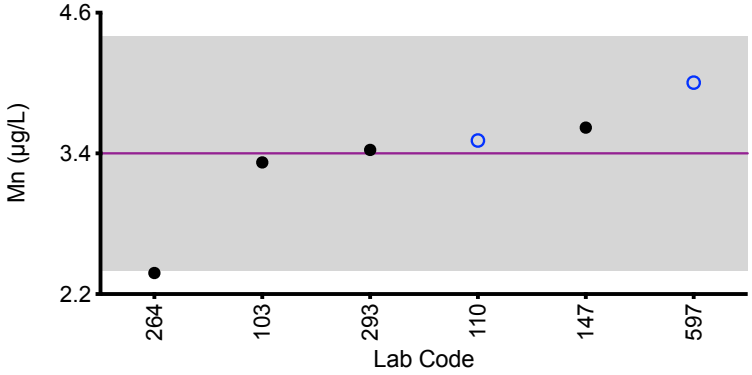
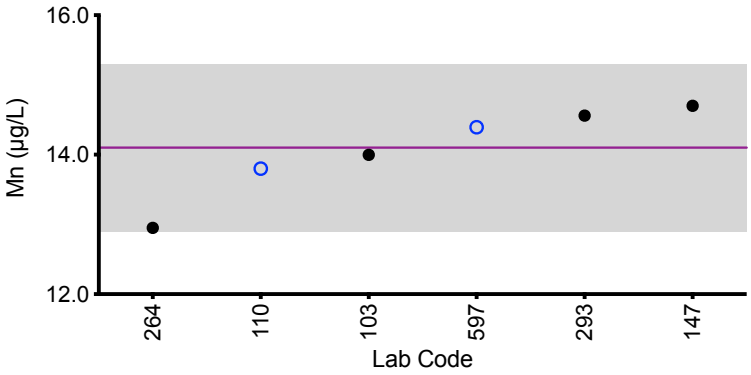
Results for Event #2, 2023: Summary Figures

Serum Mn

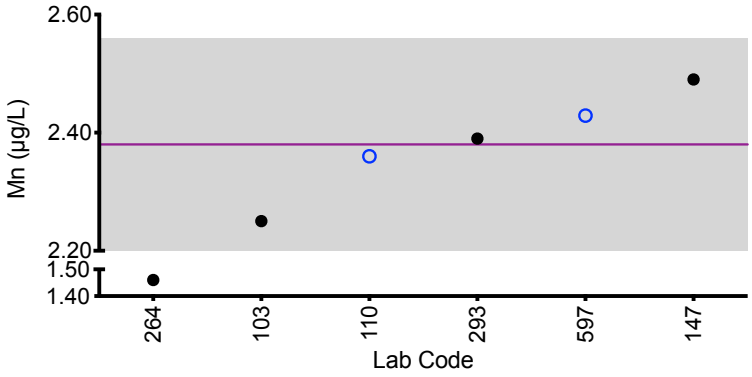
SE23-06



SE23-07



SE23-08



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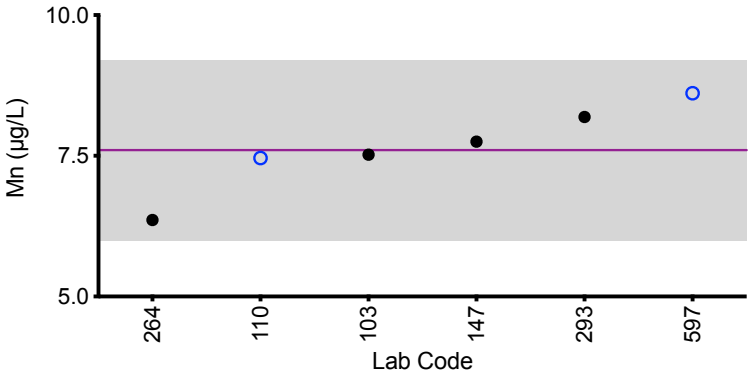
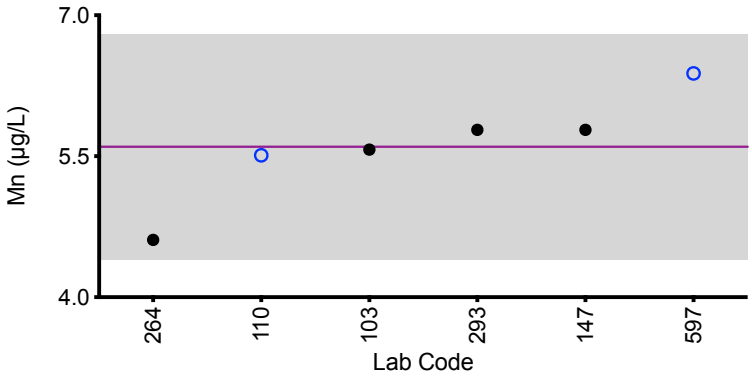


SE23-10



Legend:
o HHEAR Labs ● Other Labs
Horizontal purple line = arithmetic mean of all laboratories.
Gray area = ±2SD of the mean.

The mean and ±2SD of all laboratories are not intended to be quality specifications and are included for informational purposes only.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Serum Mo (µg/L)

Lab Code	Method	SE23-06	SE23-07	SE23-08	SE23-09	SE23-10
103	ICP-MS/MS	1.92	5.05	0.918	3.77	2.07
110	ICP-MS/MS	1.94	5.14	0.68	3.87	2.15
147	DRC/CC-ICP-MS	2.01	5.20	0.888	3.96	2.24
293	DRC/CC-ICP-MS	2.360	5.500	0.830	4.190	2.340
442	DRC/CC-ICP-MS	2.04	5.08	0.850	3.85	2.24
485	HR-ICP-MS	1.87	5.65	<1	4.03	2.24
597	ICP-MS/MS	2.03	4.72	0.652	3.98	2.21

Summary Statistics

	SE23-06	SE23-07	SE23-08	SE23-09	SE23-10
Arithmetic Mean ($\bar{x}$)	2.02	5.2	0.80	3.95	2.21
Arithmetic SD (s)	0.16	0.3	0.11	0.14	0.08
Arithmetic RSD (%)	7.9	5.9	14	3.5	3.6
Number of Sample Measurements (N)	7	7	6	7	7

*Denotes a statistical Outlier.

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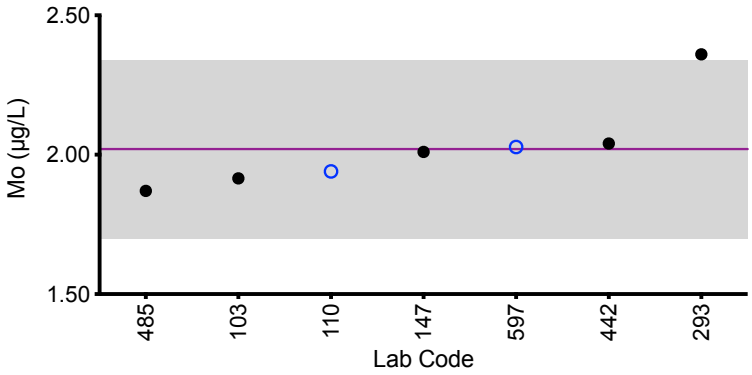
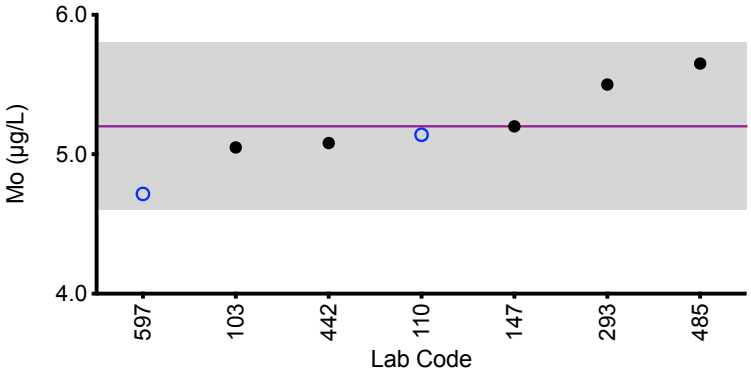
Results for Event #2, 2023: Summary Figures

Serum Mo

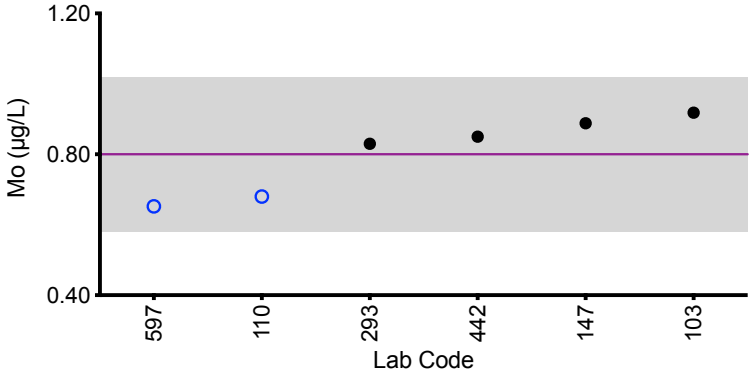
SE23-06



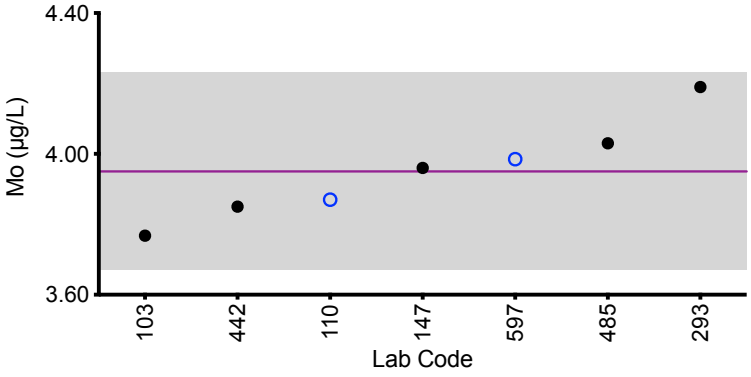
SE23-07



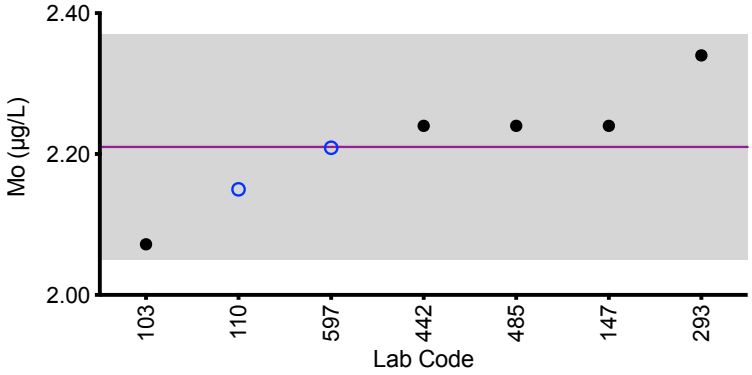
SE23-08



SE23-09



SE23-10



Legend:
o HHEAR Labs ● Other Labs
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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Serum Ni (µg/L)						
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
103	ICP-MS/MS	7.94	1.73	1.10	7.40	2.76
110	ICP-MS/MS	7.95	1.94	1.19	7.45	2.84
147	DRC/CC-ICP-MS	7.99	1.83	1.14	7.80	2.87
293	DRC/CC-ICP-MS	9.01	*2.62	*1.71	8.77	3.31
485	HR-ICP-MS	7.90	1.83	1.09	7.92	2.86
597	ICP-MS/MS	9.57	1.82	1.05	8.98	3.31
Summary Statistics						
		SE23-06	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
Arithmetic Mean ($\bar{x}$)		8.4	1.83	1.11	8.1	3.0
Arithmetic SD (s)		0.7	0.07	0.05	0.7	0.3
Arithmetic RSD (%)		8.3	3.8	4.5	8.6	8.4
Number of Sample Measurements (N)		6	5	5	6	6

*Denotes a statistical Outlier.

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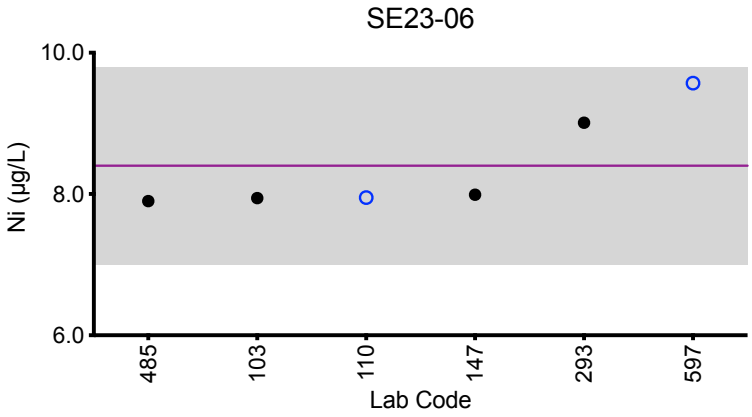
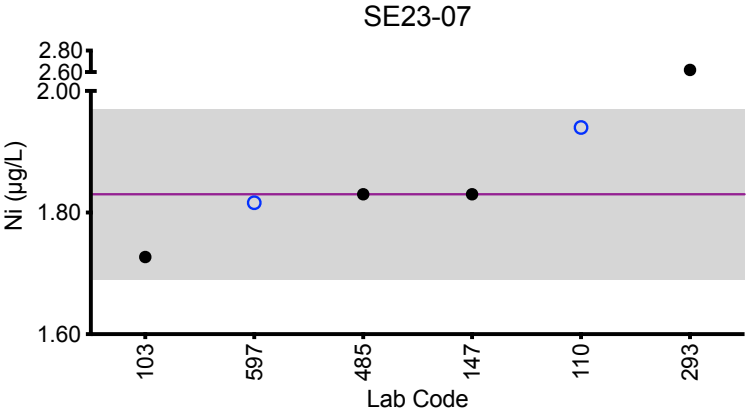
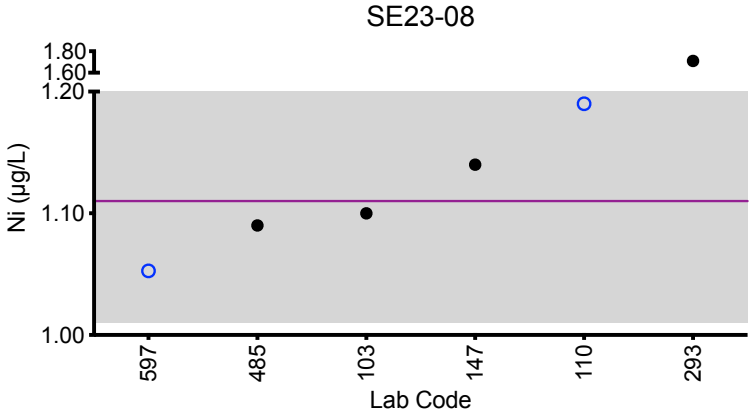
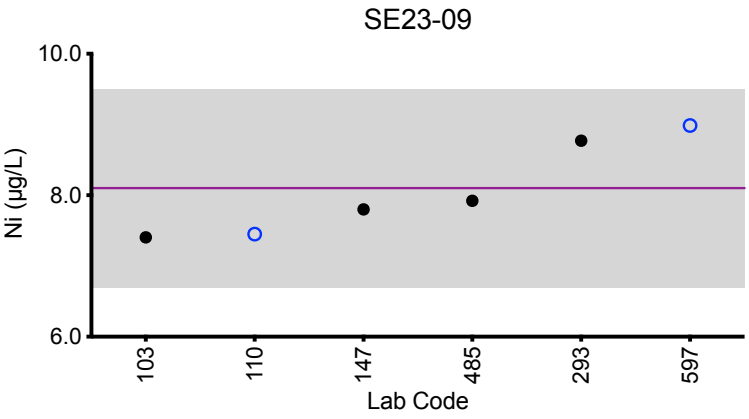
Results for Event #2, 2023: Summary Figures

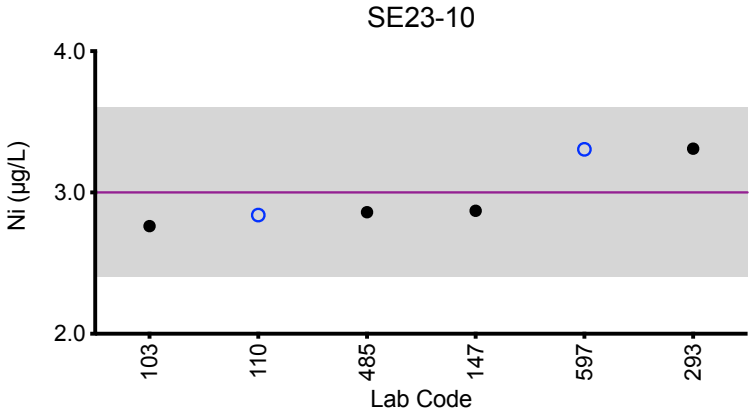
Serum Ni











Legend:
o HHEAR Labs ● Other Labs
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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Serum V (µg/L)

Lab Code	Method	SE23-06	SE23-07	SE23-08	SE23-09	SE23-10
110	ICP-MS/MS	0.66	4.06	1.29	1.83	2.52
147	DRC/CC-ICP-MS	0.603	3.97	1.18	1.74	2.48
293	DRC/CC-ICP-MS	0.74	4.62	1.45	1.96	2.9
485	HR-ICP-MS	0.63	4.09	1.22	1.83	2.47
597	ICP-MS/MS	0.735	4.04	1.25	2.04	2.93

Summary Statistics

	SE23-06	SE23-07	SE23-08	SE23-09	SE23-10
Arithmetic Mean ($\bar{x}$)	0.67	4.2	1.28	1.88	2.7
Arithmetic SD (s)	0.06	0.3	0.10	0.12	0.2
Arithmetic RSD (%)	9.1	6.3	7.8	6.4	8.6
Number of Sample Measurements (N)	5	5	5	5	5

*Denotes a statistical Outlier.

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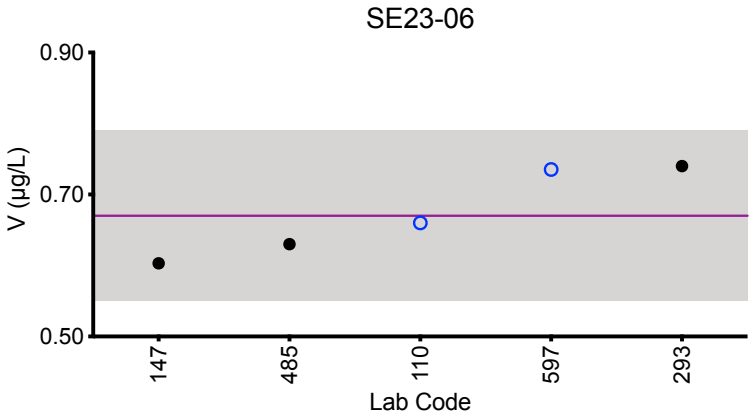
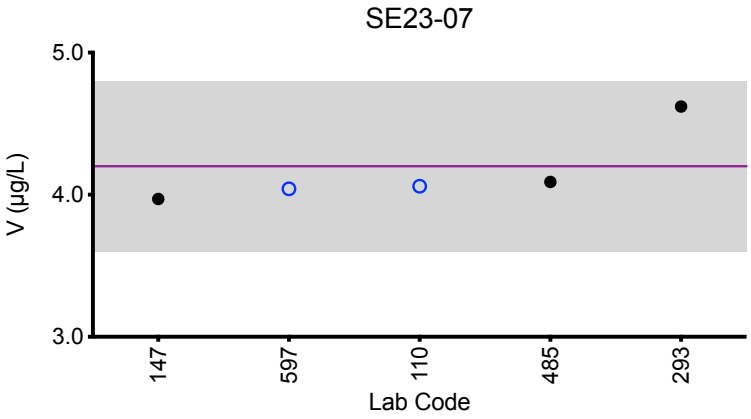
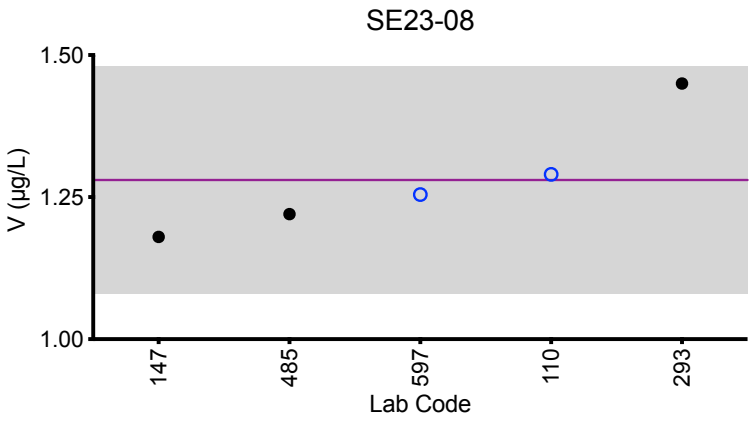
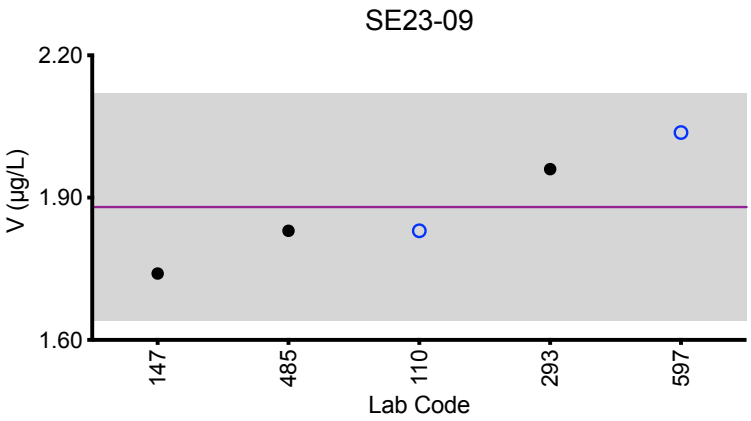
Results for Event #2, 2023: Summary Figures

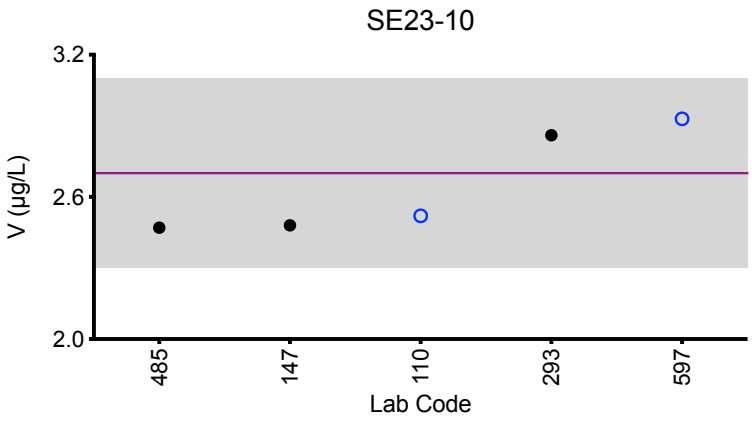
Serum V











Legend:
o HHEAR Labs ● Other Labs
Horizontal purple line = arithmetic mean of all laboratories.
Gray area = ±2SD of the mean.

The mean and ±2SD of all laboratories are not intended to be quality specifications and are included for informational purposes only.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Serum As (µg/L)

Lab Code	Method	SE23-06	SE23-07	SE23-08	SE23-09	SE23-10
103	ICP-MS/MS	25.1	1.80	5.53	2.70	13.1
110	ICP-MS/MS	25.0	1.78	5.32	2.69	12.5
147	DRC/CC-ICP-MS	24.2	1.80	5.44	2.76	12.7
597	ICP-MS/MS	26.6	1.72	5.01	3.05	14.2

Summary Statistics

	SE23-06	SE23-07	SE23-08	SE23-09	SE23-10
Arithmetic Mean ($\bar{x}$)	25.2	1.77	5.3	2.80	13.1
Arithmetic SD (s)	1.0	0.04	0.2	0.17	0.8
Arithmetic RSD (%)	4.0	2.3	4.3	6.1	6.1
Number of Sample Measurements (N)	4	4	4	4	4

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Serum Ba (µg/L)

Lab Code	Method	SE23-06	SE23-07	SE23-08	SE23-09	SE23-10
110	ICP-MS/MS	1.80	1.10	1.21	3.64	3.52
147	ICP-MS	1.66	1.24	1.35	2.93	3.71
597	ICP-MS/MS	1.89	1.33	1.48	3.38	4.26

Summary Statistics

	SE23-06	SE23-07	SE23-08	SE23-09	SE23-10
Arithmetic Mean ($\bar{x}$)	1.78	1.22	1.35	3.3	3.8
Arithmetic SD (s)	0.12	0.12	0.14	0.4	0.4
Arithmetic RSD (%)	6.7	9.8	10	12	11
Number of Sample Measurements (N)	3	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Serum Be (µg/L)						
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
110	ICP-MS/MS	3.54	0.74	1.53	2.74	4.59
147	ICP-MS	3.23	0.800	1.35	2.69	4.24
293	ICP-MS	3.27	0.75	1.38	2.82	4.45
597	ICP-MS/MS	3.68	0.679	1.39	3.19	4.72

Summary Statistics					
	SE23-06	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
Arithmetic Mean ($\bar{x}$)	3.4	0.74	1.41	2.9	4.5
Arithmetic SD (s)	0.2	0.05	0.08	0.2	0.2
Arithmetic RSD (%)	6.4	6.8	5.7	7.9	4.7
Number of Sample Measurements (N)	4	4	4	4	4

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Serum Bi (µg/L)						
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
147	ICP-MS	0.0397	0.0397	0.0410	0.118	0.0563
597	ICP-MS/MS	<0.0237	<0.0237	0.0293	0.108	<0.0237
Summary Statistics						
		SE23-06	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
Arithmetic Mean ($\bar{x}$)		NA	NA	0.035	0.113	NA
Arithmetic SD (s)		NA	NA	0.008	0.007	NA
Arithmetic RSD (%)		NA	NA	23	6.2	NA
Number of Sample Measurements (N)		NA	NA	2	2	NA

*Denotes a statistical Outlier.

Statistical data was not calculated for SE23-06, SE23-07 and SE23-10 based on a lack of consensus among participating labs.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Serum Cd (µg/L)						
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
103	ICP-MS/MS	3.29	0.351	1.42	0.717	2.50
110	ICP-MS/MS	3.32	0.34	1.38	0.72	2.46
147	ICP-MS	3.25	0.367	1.41	0.737	2.53
597	ICP-MS/MS	3.96	0.374	1.46	0.868	2.96
Summary Statistics						
		SE23-06	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
Arithmetic Mean ($\bar{x}$)		3.5	0.358	1.42	0.76	2.6
Arithmetic SD (s)		0.3	0.015	0.03	0.07	0.2
Arithmetic RSD (%)		8.6	4.2	2.1	9.2	8.8
Number of Sample Measurements (N)		4	4	4	4	4

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Serum Cs (µg/L)						
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
110	ICP-MS/MS	0.40	0.45	0.42	0.57	0.47
597	ICP-MS/MS	0.459	0.468	0.420	0.656	0.538
Summary Statistics						
		SE23-06	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
Arithmetic Mean ($\bar{x}$)		0.43	0.459	0.42	0.61	0.50
Arithmetic SD (s)		0.04	0.013	0.00	0.06	0.05
Arithmetic RSD (%)		9.3	2.8	0.0	9.8	10
Number of Sample Measurements (N)		2	2	2	2	2

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Serum Hg (µg/L)						
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
103	ICP-MS/MS	3.29	1.04	1.60	2.95	6.76
110	ICP-MS/MS	3.17	0.79	1.49	2.92	6.31
597	ICP-MS/MS	3.68	0.890	1.51	3.31	7.21
Summary Statistics						
		SE23-06	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
Arithmetic Mean ($\bar{x}$)		3.4	0.91	1.53	3.1	6.8
Arithmetic SD (s)		0.3	0.13	0.06	0.2	0.5
Arithmetic RSD (%)		8.8	14	3.9	7.2	7.4
Number of Sample Measurements (N)		3	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Serum Mg (µg/L)						
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
264	ICP-MS	21484.00	16923.00	19334.50	20654.18	18237.81
597	ICP-MS/MS	25200	16900	19500	23400	20200
Summary Statistics						
		SE23-06	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
Arithmetic Mean ($\bar{x}$)		23000	16912	19420	22000	19200
Arithmetic SD (s)		3000	16	120	1900	1400
Arithmetic RSD (%)		13	0.09	0.62	8.6	7.3
Number of Sample Measurements (N)		2	2	2	2	2

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Serum Pb (µg/L)						
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
103	ICP-MS/MS	3.72	10.4	2.45	5.42	1.16
110	ICP-MS/MS	3.85	9.80	2.37	6.02	1.16
597	ICP-MS/MS	4.58	10.8	2.42	6.37	1.47
Summary Statistics						
		SE23-06	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
Arithmetic Mean ($\bar{x}$)		4.1	10.3	2.41	5.9	1.3
Arithmetic SD (s)		0.5	0.5	0.04	0.5	0.2
Arithmetic RSD (%)		12	4.9	1.7	8.5	14
Number of Sample Measurements (N)		3	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Serum Pt (µg/L)

Lab Code	Method	SE23-06	SE23-07	SE23-08	SE23-09	SE23-10
110	ICP-MS/MS	1.24	0.101	0.365	0.529	0.820
264	ICP-MS	*0.87	<0.10	<0.10	*0.15	*0.49
293	DRC/CC-ICP-MS	1.32	0.11	0.39	0.57	0.84

Summary Statistics

	SE23-06	SE23-07	SE23-08	SE23-09	SE23-10
Arithmetic Mean ($\bar{x}$)	1.28	0.106	0.38	0.55	0.80
Arithmetic SD (s)	0.06	0.006	0.02	0.03	0.01
Arithmetic RSD (%)	4.4	5.7	4.8	5.3	1.7
Number of Sample Measurements (N)	2	2	2	2	2

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Serum Sb (µg/L)						
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
103	ICP-MS/MS	0.662	1.31	2.19	0.850	4.36
110	ICP-MS/MS	0.65	1.25	2.25	0.88	4.16
147	ICP-MS	0.634	1.31	2.14	0.870	4.21
597	ICP-MS/MS	0.710	1.26	2.04	0.93	4.55
Summary Statistics						
		SE23-06	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
Arithmetic Mean ($\bar{x}$)		0.66	1.28	2.15	0.88	4.32
Arithmetic SD (s)		0.03	0.03	0.09	0.03	0.18
Arithmetic RSD (%)		4.5	2.3	4.2	3.4	4.2
Number of Sample Measurements (N)		4	4	4	4	4

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Serum Sn (µg/L)						
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
110	ICP-MS/MS	5.20	3.26	1.02	0.51	6.34
597	ICP-MS/MS	5.74	3.21	1.06	0.609	7.03
Summary Statistics						
		SE23-06	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
Arithmetic Mean ($\bar{x}$)		5.5	3.23	1.04	0.56	6.7
Arithmetic SD (s)		0.4	0.04	0.03	0.07	0.5
Arithmetic RSD (%)		7.3	1.2	2.9	13	7.5
Number of Sample Measurements (N)		2	2	2	2	2

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Serum Sr (µg/L)						
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
103	ICP-MS/MS	391	237	180	449	239
200	ICP-MS	424	265	195	487	257
597	ICP-MS/MS	438	236	179	507	272
Summary Statistics						
		SE23-06	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
Arithmetic Mean ($\bar{x}$)		418	246	185	480	256
Arithmetic SD (s)		24	16	9	30	17
Arithmetic RSD (%)		5.7	6.5	4.9	6.3	6.6
Number of Sample Measurements (N)		3	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Serum Ti (µg/L)						
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
200	DRC/CC-ICP-MS	4.70	4.60	3.10	3.60	3.60
442	ICP-MS/MS	6.38	4.13	2.47	2.08	3.34
485	HR-ICP-MS	6.35	4.37	2.50	2.03	3.40
597	ICP-MS/MS	8.03	5.50	4.11	3.33	4.64
Summary Statistics						
		SE23-06	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
Arithmetic Mean ($\bar{x}$)		6.4	4.7	3.0	2.8	3.7
Arithmetic SD (s)		1.4	0.6	0.8	0.8	0.6
Arithmetic RSD (%)		22	13	27	29	16
Number of Sample Measurements (N)		4	4	4	4	4

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Serum Tl (µg/L)

Lab Code	Method	SE23-06	SE23-07	SE23-08	SE23-09	SE23-10
103	ICP-MS/MS	4.47	0.809	3.31	2.23	0.378
110	ICP-MS/MS	4.72	0.84	3.37	2.30	0.37
147	ICP-MS	4.49	0.815	3.28	2.20	0.363
597	ICP-MS/MS	5.64	0.869	3.49	2.72	0.442

Summary Statistics

	SE23-06	SE23-07	SE23-08	SE23-09	SE23-10
Arithmetic Mean ($\bar{x}$)	4.8	0.83	3.36	2.4	0.39
Arithmetic SD (s)	0.6	0.03	0.09	0.2	0.04
Arithmetic RSD (%)	13	3.2	2.7	10	10
Number of Sample Measurements (N)	4	4	4	4	4

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Serum U (µg/L)						
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
103	ICP-MS/MS	0.0273	0.279	0.110	0.160	0.235
110	ICP-MS/MS	0.0266	0.276	0.101	0.157	0.236
597	ICP-MS/MS	0.0339	0.279	0.102	0.196	0.276

Summary Statistics					
	SE23-06	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
Arithmetic Mean ($\bar{x}$)	0.029	0.278	0.104	0.17	0.25
Arithmetic SD (s)	0.004	0.002	0.005	0.02	0.02
Arithmetic RSD (%)	14	0.61	4.8	13	9.2
Number of Sample Measurements (N)	3	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #2, 2023:
Laboratory Data and Summary Statistics

Serum W (µg/L)

Lab Code	Method	SE23-06	SE23-07	SE23-08	SE23-09	SE23-10
110	ICP-MS/MS	1.19	0.24	0.57	2.50	0.73
200	ICP-MS	1.10	0.24	0.55	2.24	0.64
597	ICP-MS/MS	1.32	0.245	0.563	2.86	0.803

Summary Statistics

	SE23-06	SE23-07	SE23-08	SE23-09	SE23-10
Arithmetic Mean ($\bar{x}$)	1.20	0.242	0.561	2.5	0.72
Arithmetic SD (s)	0.11	0.003	0.010	0.3	0.08
Arithmetic RSD (%)	9.2	1.2	1.8	12	11
Number of Sample Measurements (N)	3	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #2, 2023: Additional Elements in Serum

Serum B (µg/L)						
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
200	ICP-MS	82	70	30	89	39

Serum Fe (µg/L)						
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
264	ICP-MS	234.04	153.75	1226.39	627.00	735.61

Serum I (µg/L)						
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
147	ICP-MS	55.0	53.9	62.4	78.5	43.9

Serum Li (µg/L)						
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
147	ICP-MS	0.798	0.638	0.724	0.796	0.671

Serum Te (µg/L)						
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
110	ICP-MS/MS	0.01	0.01	0.00	0.01	0.00

Serum Th (µg/L)						
Lab Code	**Method**	**SE23-06**	**SE23-07**	**SE23-08**	**SE23-09**	**SE23-10**
597	ICP-MS/MS	<0.00892	<0.00892	<0.00892	<0.00892	<0.00892

References

1. ISO/FDIS-13528 (2005) Statistical methods for use in proficiency testing by interlaboratory comparisons. International Organization for Standardization, Geneva.

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