NEW YORK STATE | Department of Health | Wadsworth Center

New York State Biomonitoring Program for Trace Elements

Event #1, 2023

Trace Elements in Whole Blood, Urine, and Serum

April, 2023

Wadsworth Center
NEW YORK STATE DEPARTMENT OF HEALTH
Trace Elements Laboratory

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Event #1, 2023:
Trace Elements in Whole Blood, Urine, and Serum

4/7/2023

Dear Laboratory Director,

This report summarizes performance for the first 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 #2, 2023) will be shipped May 17, 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 #1, 2023

Trace Elements in Whole Blood

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NEW YORK STATE DEPARTMENT OF HEALTH
Trace Elements Laboratory

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Event #1, 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 25 elements were reported by at least one participant: Ag, Al, Ba, Be, Bi, Cs, Cu, I, Li, 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 #1, 2023: Summary Statistics

Whole Blood As (µg/L)					
	BE23-01	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
Target (Arithmetic Mean ($\bar{x}$))	18.9	31.7	8.8	4.55	1.72
Upper Limit	24.9	38.0	14.8	10.55	7.72
Lower Limit	12.9	25.4	2.8	0.00	0.00
Arithmetic SD (s)	0.5	0.5	0.2	0.19	0.11
Arithmetic RSD (%)	2.6	1.6	2.7	4.2	6.4
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 #1, 2023:
Performance of Participating Laboratories

Whole Blood As (µg/L)						
Lab Code	**Method**	**BE23-01**	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
	Target	**18.9**	**31.7**	**8.8**	**4.55**	**1.72**
103	ICP-MS/MS	18.4	31.5	8.37	4.33	1.56
110	ICP-MS/MS	19.1	31.4	8.84	4.38	1.72
147	ICP-MS	18.2	31.4	8.91	4.70	1.90
264	ICP-MS	19.24	31.44	8.96	4.74	1.73
293	DRC/CC-ICP-MS	19.55	32.7	8.63	4.71	1.7
391	ICP-MS	*7.331 ↓	*26.0	*4.48	<0.000	<0.000
597	ICP-MS/MS	18.9	31.9	8.99	4.44	1.72

Based on the grading criteria for As in Whole Blood, 97% 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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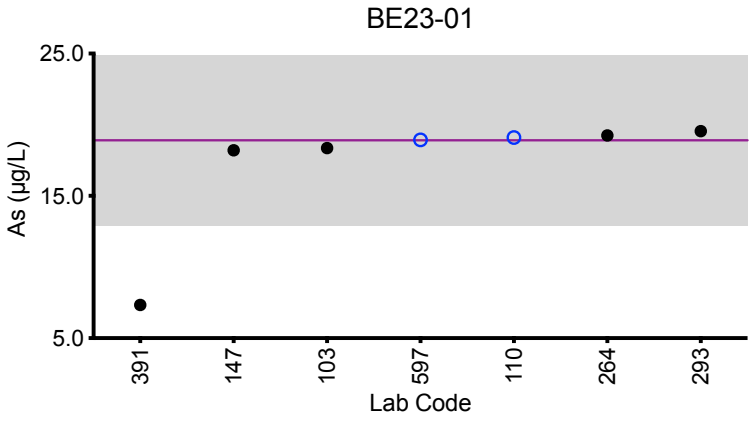
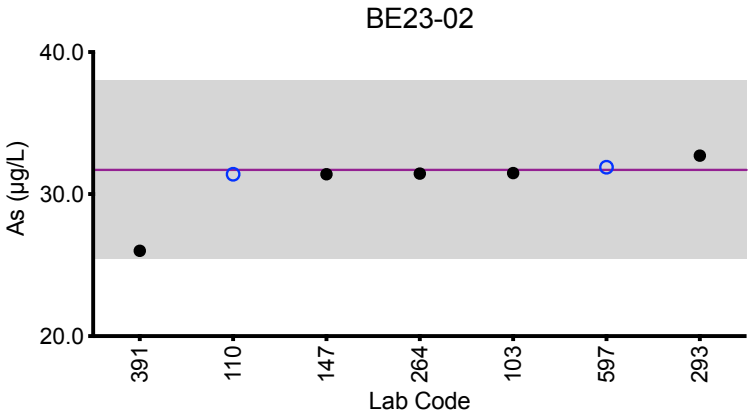
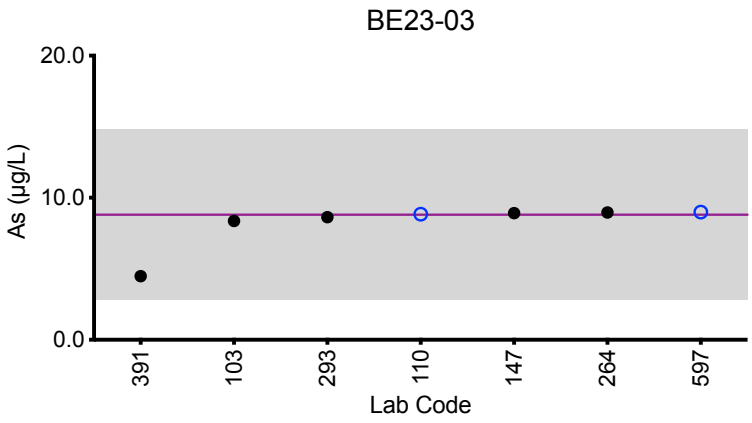
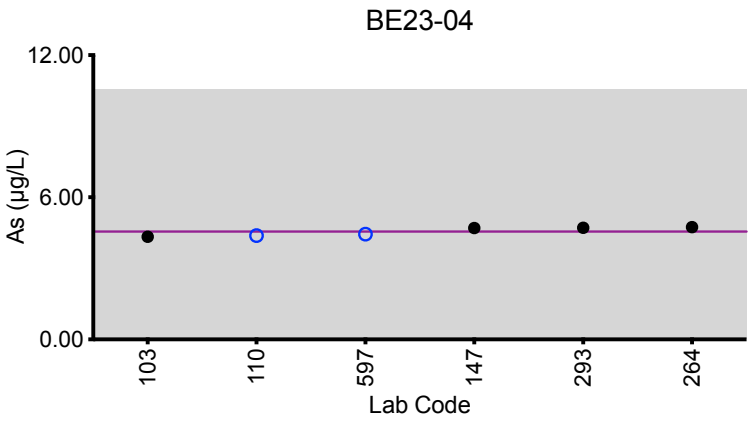
Results for Event #1, 2023: Summary Figures

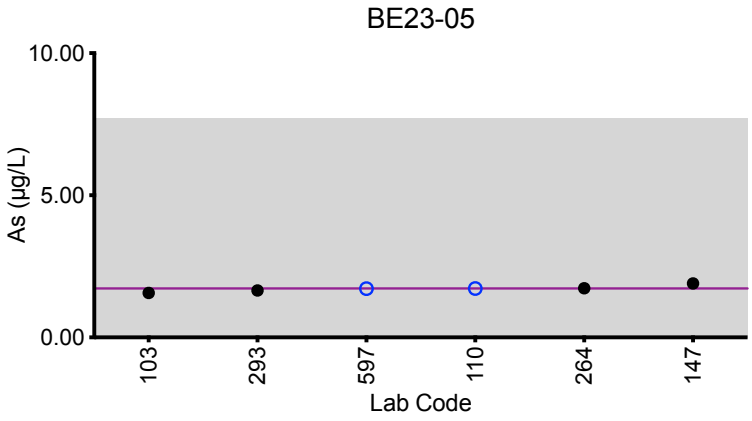
Whole Blood As











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 #1, 2023: Summary Statistics

Whole Blood Cd (µg/L)					
	BE23-01	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
Target (Robust Mean (x*))	1.57	6.07	9.8	0.78	3.32
Upper Limit	2.57	7.07	11.3	1.78	4.32
Lower Limit	0.57	5.07	8.3	0.00	2.32
Robust SD (s*)	0.05	0.16	0.5	0.03	0.10
Robust RSD (%)	3.2	2.6	5.1	4.1	3.0
Number of Sample Measurements (N)	11	12	12	10	12
Standard Uncertainty (*u*)	0.02	0.06	0.2	0.01	0.04

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 #1, 2023:
Performance of Participating Laboratories

Whole Blood Cd (µg/L)						
Lab Code	**Method**	**BE23-01**	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
	Target	**1.57**	**6.07**	**9.8**	**0.78**	**3.32**
103	ICP-MS/MS	1.54	5.96	9.91	0.779	3.33
107	ICP-MS/MS	1.585	6.075	9.784	0.770	3.366
110	ICP-MS	1.56	6.13	10.0	0.80	3.36
116	ICP-MS/MS	1.76	6.27	10.6	<1.50	3.64
147	ICP-MS	1.64	6.62	10.6	0.900	3.81
264	ICP-MS	1.59	5.94	10.18	0.79	3.31
293	DRC/CC-ICP-MS	1.56	5.70	9.360	0.8	3.16
391	ICP-MS	<0.000 ↓	5.95	8.117 ↓	<0.000	0.77 ↓
597	ICP-MS/MS	1.53	6.05	9.61	0.751	3.27
605	ICP-MS	1.51	6.10	9.50	0.755	3.28
606	ICP-MS/MS	1.42	6.04	9.53	0.711	3.26
686	ICP-MS	1.61	6.20	9.84	0.764	3.50

Based on the grading criteria for Cd in Whole Blood, 95% 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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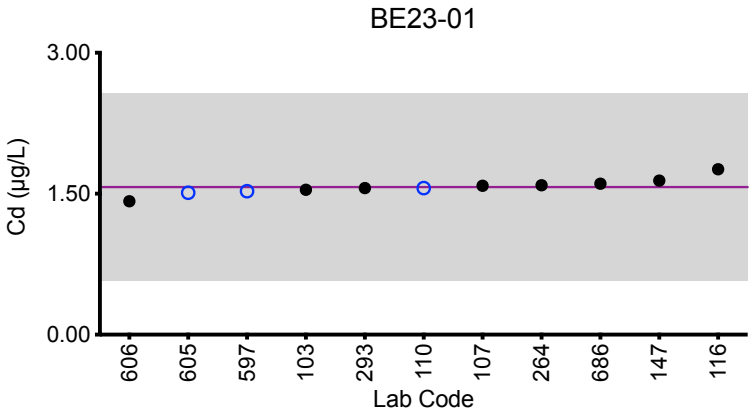
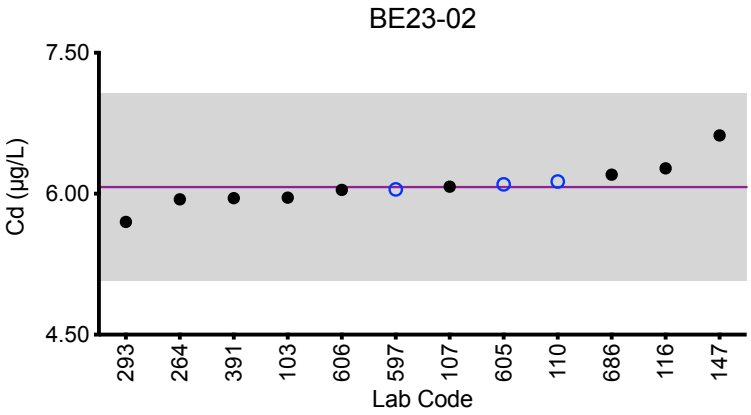
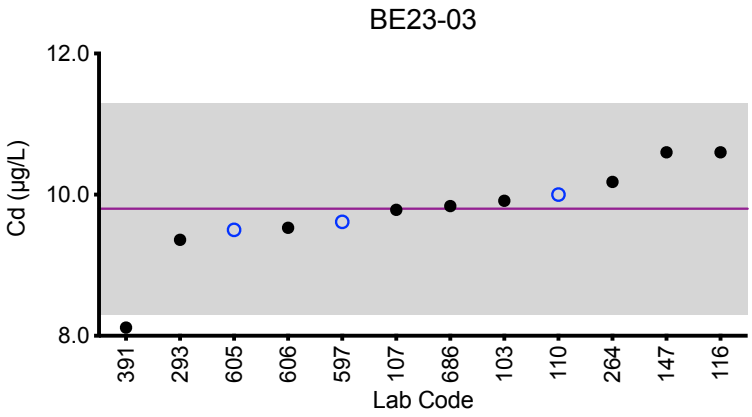
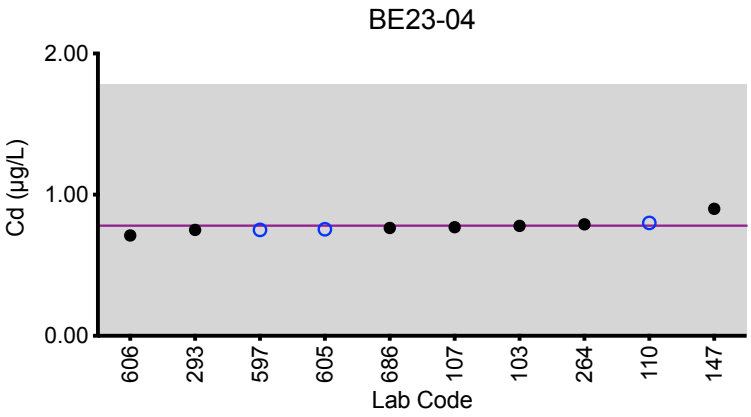
Results for Event #1, 2023: Summary Figures

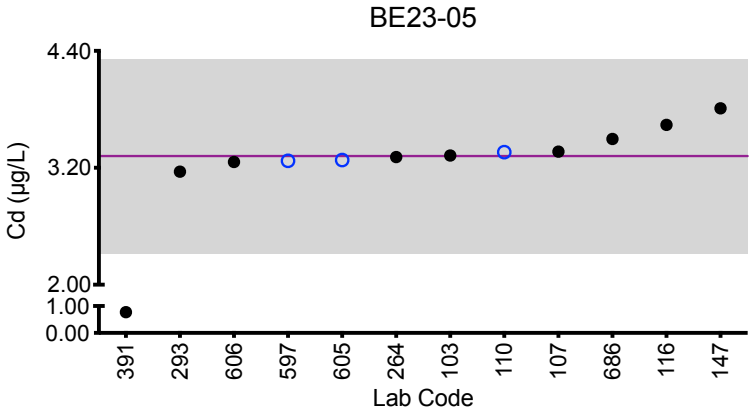
Whole Blood Cd











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 6.7 µg/L.

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Results for Event #1, 2023: Summary Statistics

Whole Blood Co (µg/L)					
	BE23-01	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
Target (Arithmetic Mean ($\bar{x}$))	0.58	2.47	15.2	5.0	1.11
Upper Limit	2.08	3.97	18.2	6.5	2.61
Lower Limit	0.00	0.97	12.2	3.5	0.00
Arithmetic SD (s)	0.04	0.17	0.6	0.4	0.07
Arithmetic RSD (%)	7.2	6.9	3.9	8.0	6.3
Number of Sample Measurements (N)	8	8	7	8	7

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 #1, 2023:
Performance of Participating Laboratories

Whole Blood Co (µg/L)						
Lab Code	**Method**	**BE23-01**	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
	Target	**0.58**	**2.47**	**15.2**	**5.0**	**1.11**
103	ICP-MS/MS	0.593	2.48	15.0	5.01	1.13
110	ICP-MS/MS	0.58	2.50	15.5	5.12	1.14
147	ICP-MS	0.660	2.73	16.0	5.70	1.21
255	ICP-MS	0.53	2.4	14	4.7	1
264	ICP-MS	0.61	2.52	15.11	5.13	1.07
293	DRC/CC-ICP-MS	0.58	2.44	15.57	5.01	1.14
391	ICP-MS	0.53	2.12	*18.72 ↑	4.12	*0.53
597	ICP-MS/MS	0.580	2.54	15.1	5.07	1.09

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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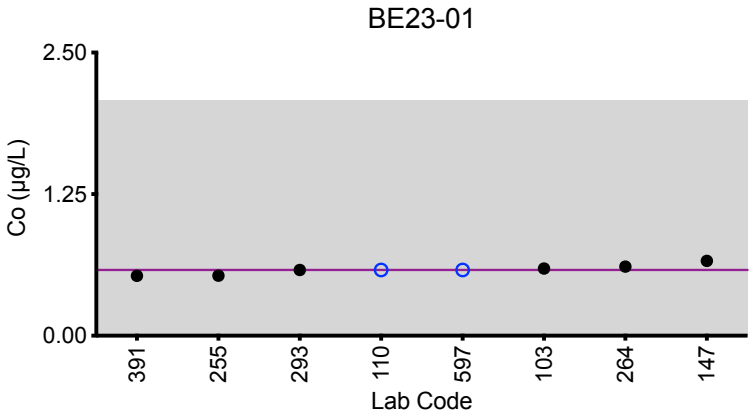
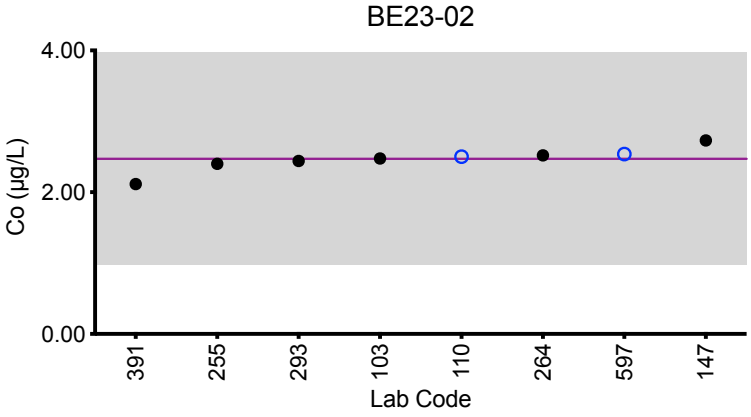
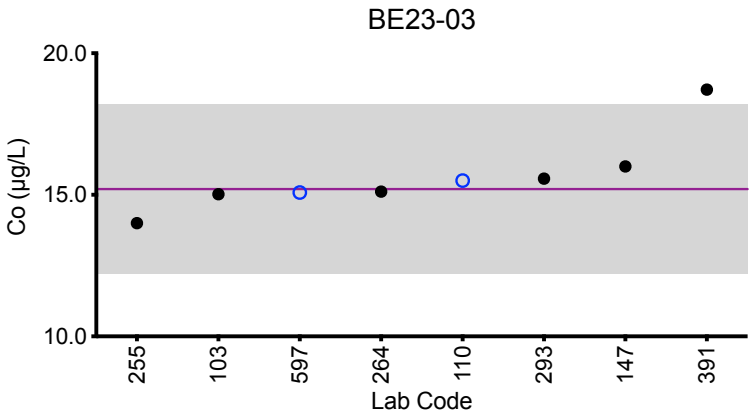
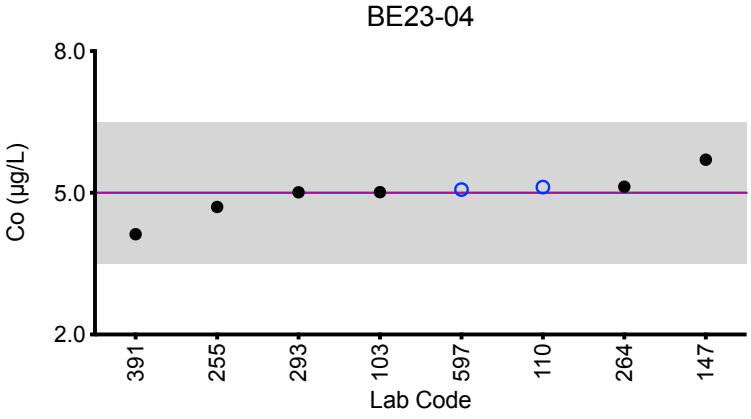
Results for Event #1, 2023: Summary Figures

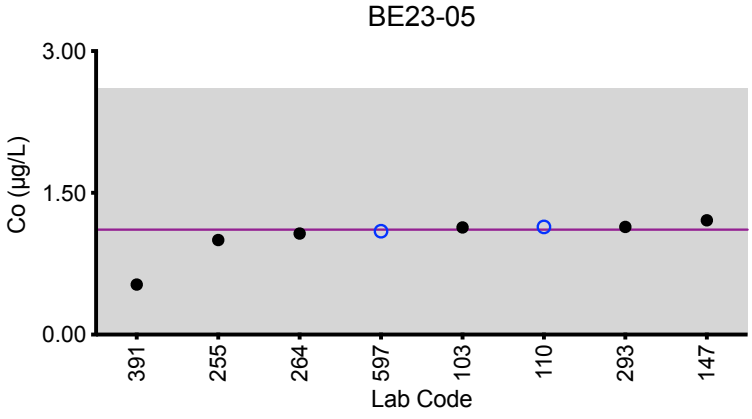
Whole Blood Co











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 #1, 2023:
Summary Statistics

Whole Blood Cr (µg/L)					
	BE23-01	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
Target (Arithmetic Mean ($\bar{x}$))	9.1	2.9	1.23	0.68	5.08
Upper Limit	11.1	4.9	3.23	2.68	7.08
Lower Limit	7.1	0.9	0.00	0.00	3.08
Arithmetic SD (s)	1.0	0.5	0.22	0.14	0.22
Arithmetic RSD (%)	11	17	18	21	4.3
Number of Sample Measurements (N)	8	7	6	5	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 #1, 2023:
Performance of Participating Laboratories

Whole Blood Cr (µg/L)						
Lab Code	**Method**	**BE23-01**	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
	Target	**9.1**	**2.9**	**1.23**	**0.68**	**5.08**
103	ICP-MS/MS	7.74	3.64	<1.50	<1.50	4.81
110	ICP-MS/MS	9.47	2.53	1.13	0.70	5.12
147	DRC/CC-ICP-MS	10.3	2.99	1.02	0.759	5.41
255	ICP-MS	9.5	2.5	1.2	<1.0	4.9
264	ICP-MS	9.75	3.25	1.66	0.83	5.30
293	DRC/CC-ICP-MS	9.45	2.49	1.21	0.63	5.05
391	ICP-MS	7.29	*6.75 ↑	*3.64 ↑	*1.84	*6.15
597	ICP-MS/MS	9.59	2.58	1.15	0.469	4.95

Based on the grading criteria for Cr in Whole Blood, 95% 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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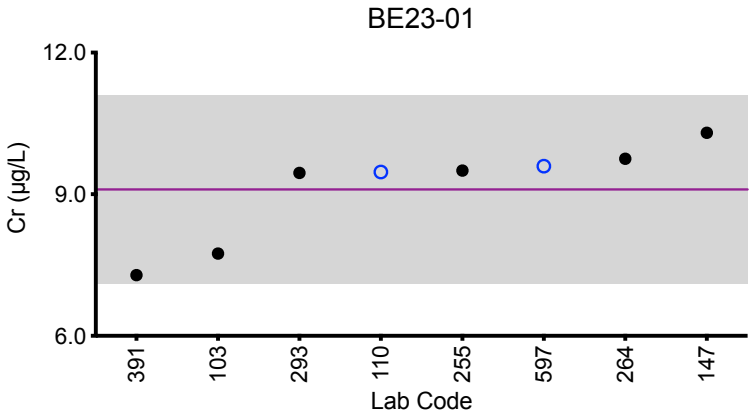
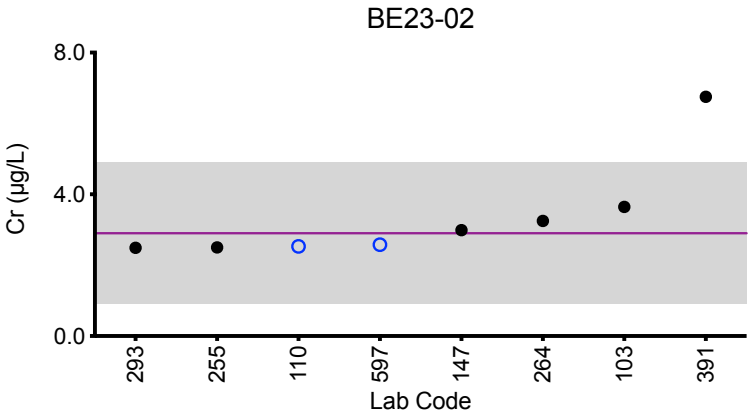
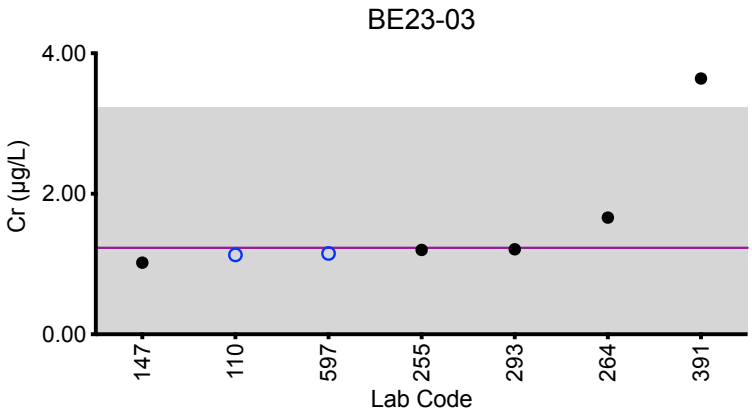
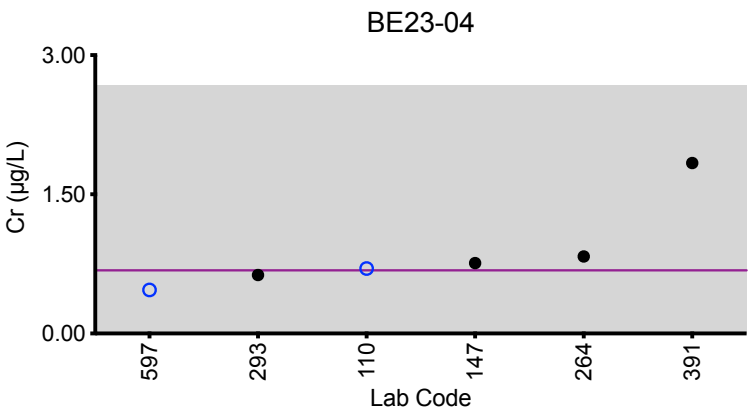
Results for Event #1, 2023: Summary Figures

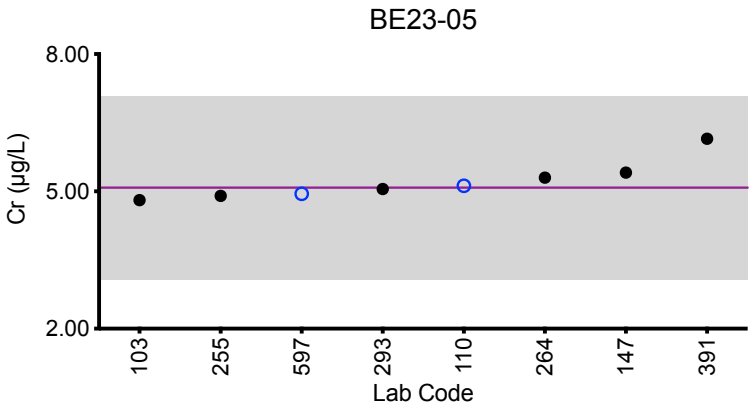
Whole Blood Cr











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 #1, 2023: Summary Statistics

Whole Blood Hg (µg/L)					
	BE23-01	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
Target (Robust Mean (x*))	0.99	0.56	6.5	22.4	2.86
Upper Limit	3.99	3.56	9.5	29.1	5.86
Lower Limit	0.00	0.00	3.5	15.7	0.00
Robust SD (s*)	0.12	0.06	0.6	1.9	0.23
Robust RSD (%)	12	11	9.2	8.5	8.0
Number of Sample Measurements (N)	10	11	12	12	12
Standard Uncertainty (*u*)	0.05	0.02	0.2	0.7	0.08

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 #1, 2023:
Performance of Participating Laboratories

Whole Blood Hg (µg/L)						
Lab Code	**Method**	**BE23-01**	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
	Target	**0.99**	**0.56**	**6.5**	**22.4**	**2.86**
103	ICP-MS/MS	1.04	0.759	7.11	22.6	2.92
107	ICP-MS/MS	0.94	0.56	6.75	22.62	2.73
110	ICP-MS	0.86	0.43	6.39	21.3	2.75
116	ICP-MS/MS	<1.50	<1.50	6.90	24.1	2.90
147	ICP-MS	0.991	0.564	6.58	23.7	2.85
264	ICP-MS	1.19	0.69	5.58	22.21	2.56
293	DRC/CC-ICP-MS	0.7	0.44	4.5	16.81	2.12
391	CV-AAS	0.0	0.22	1.7 ↓	5.03 ↓	22.29 ↑
597	ICP-MS/MS	0.909	0.573	6.16	21.0	2.70
605	ICP-MS	1.03	0.570	6.69	23.1	2.96
606	ICP-MS/MS	1.15	0.576	7.23	26.0	3.48
686	ICP-MS	0.982	0.530	6.72	23.4	2.95

Based on the grading criteria for Hg in Whole Blood, 95% 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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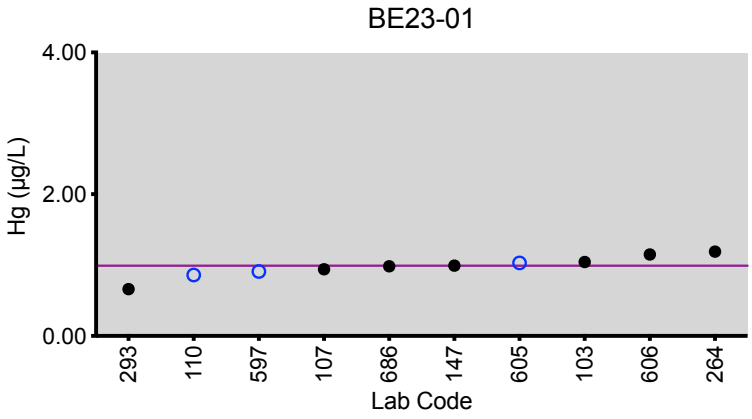
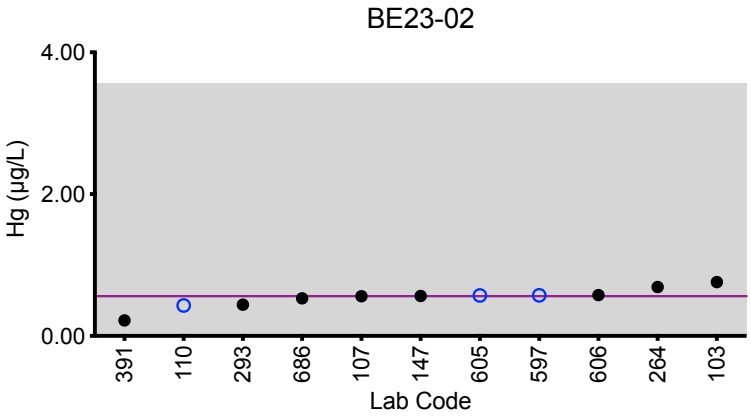
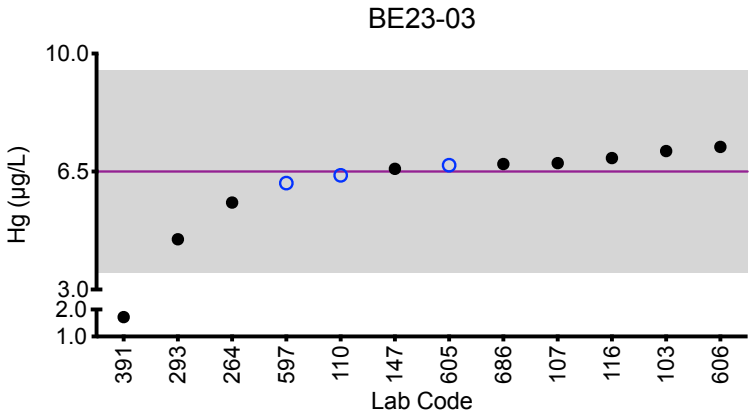
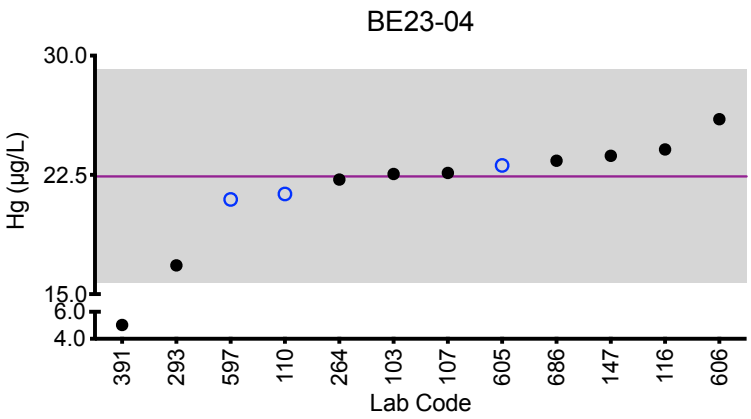
Results for Event #1, 2023: Summary Figures

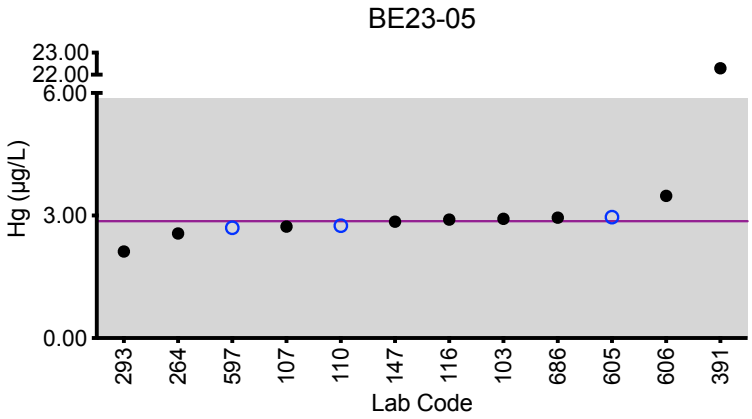
Whole Blood Hg











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 #1, 2023: Summary Statistics

Whole Blood Mn (µg/L)					
	BE23-01	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
Target (Arithmetic Mean ($\bar{x}$))	18.4	23.0	17.6	26.6	13
Upper Limit	21.5	26.9	20.6	31.1	16
Lower Limit	15.3	19.1	14.6	22.1	10
Arithmetic SD (s)	2.3	2.2	2.1	2.4	3
Arithmetic RSD (%)	13	9.6	12	9.0	22
Number of Sample Measurements (N)	8	8	8	8	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 #1, 2023:
Performance of Participating Laboratories

Whole Blood Mn (µg/L)						
Lab Code	**Method**	**BE23-01**	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
	Target	**18.4**	**23.0**	**17.6**	**26.6**	**13**
107	ICP-MS/MS	18.91	22.88	17.10	26.93	11.77
110	ICP-MS	16.3	22.0	16.6	25.9	11.0
147	ICP-MS	20.6	26.6	20.4	31.4 ↑	14.6
264	ICP-MS	21.87 ↑	25.80	20.88 ↑	28.08	15.85
293	DRC/CC-ICP-MS	14.9 ↓	20.04	14.7	24.0	9.77 ↓
391	ICP-MS	19.6	22.17	18.2	24.1	17.69 ↑
597	ICP-MS/MS	16.8	21.7	16.3	25.5	11.0
606	ICP-MS/MS	18.1	22.6	16.9	26.6	11.8

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

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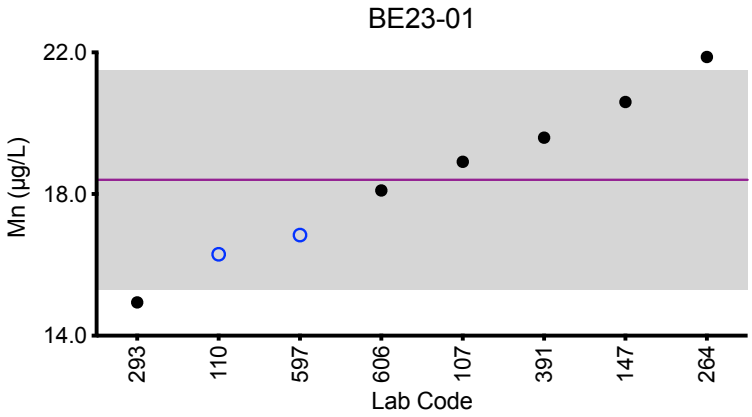
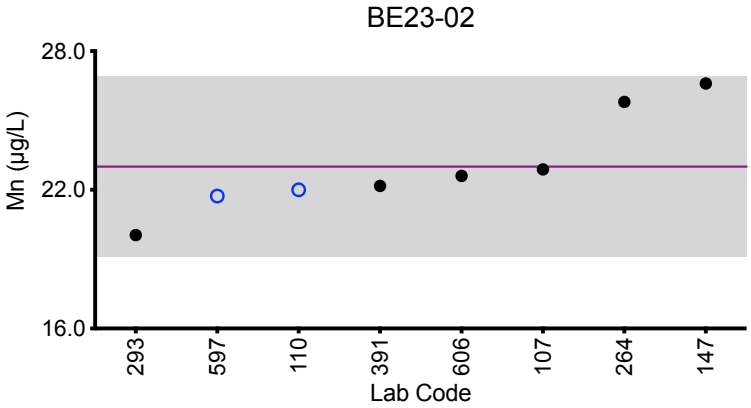
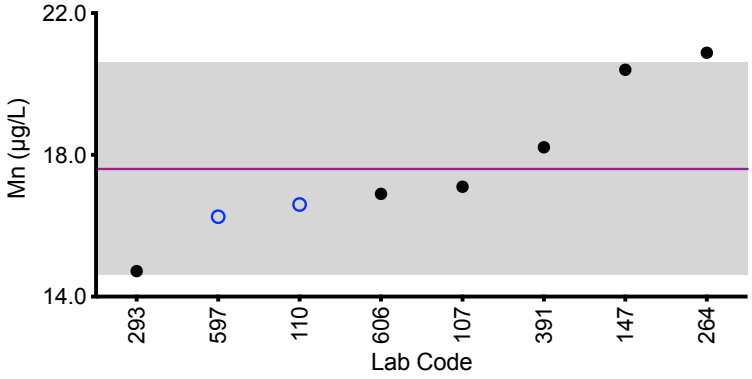
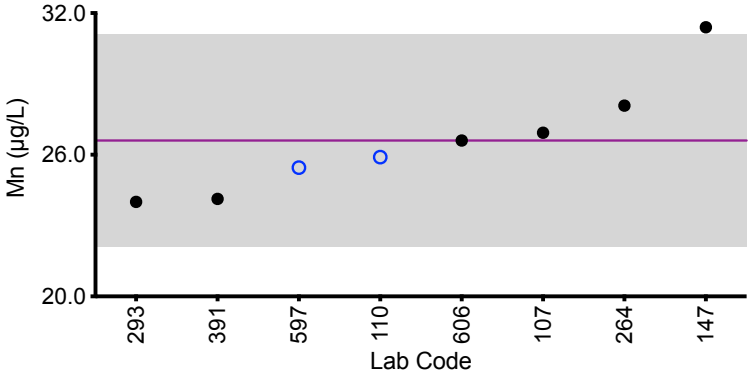
Results for Event #1, 2023: Summary Figures

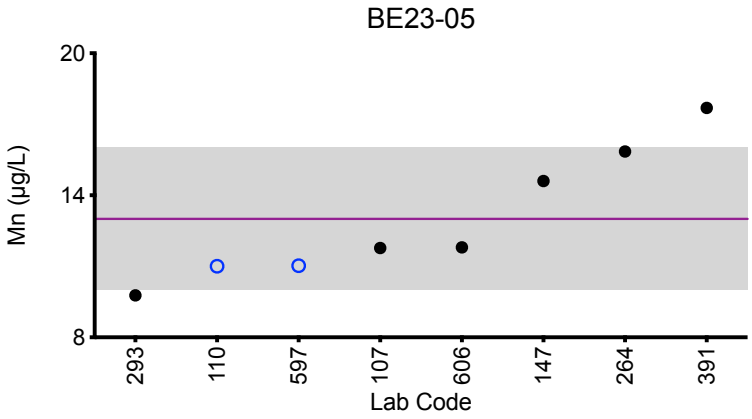
Whole Blood Mn











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 #1, 2023: Summary Statistics

Whole Blood Pb (µg/dL)					
	BE23-01	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
Target (Robust Mean (x*))	21.9	0.66	2.22	0.96	4.14
Upper Limit	24.1	2.66	4.22	2.96	6.14
Lower Limit	19.7	0.00	0.22	0.00	2.14
Robust SD (s*)	0.4	0.03	0.07	0.12	0.13
Robust RSD (%)	1.8	5.1	3.2	12	3.1
Number of Sample Measurements (N)	13	7	12	8	12
Standard Uncertainty (*u*)	0.2	NA	0.02	NA	0.05

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 samples BE23-02 and BE23-04.

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Results for Event #1, 2023:
Performance of Participating Laboratories

Whole Blood Pb (µg/dL)						
Lab Code	**Method**	**BE23-01**	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
	Target	**21.9**	**0.66**	**2.22**	**0.96**	**4.14**
103	ICP-MS/MS	21.5	0.689	2.19	0.963	4.07
107	ICP-MS/MS	21.999	0.660	2.172	0.938	4.034
110	ICP-MS	21.7	0.67	2.18	0.91	4.12
116	ICP-MS/MS	22.4	<3.00	2.27	<3.00	4.30
147	ICP-MS	22.4	0.700	2.32	1.13	4.27
264	ICP-MS	21.82	0.61	2.17	0.85	4.15
293	DRC/CC-ICP-MS	22.33	0.62	2.27	0.8	4.14
343	ASV-LeadCare	18.7 ↓	<3.3	<3.3	<3.3	<3.3
391	ETAAS-Z	22.47	*1.22	3.26	*1.5	4.87
597	ICP-MS/MS	21.4	0.656	2.15	0.935	4.03
605	ICP-MS	22.0	<1.00	2.28	1.13	4.13
606	ICP-MS/MS	21.9	<1.00	2.15	<1.00	3.92
686	ICP-MS	22.0	<1.00	2.20	<1.00	4.16

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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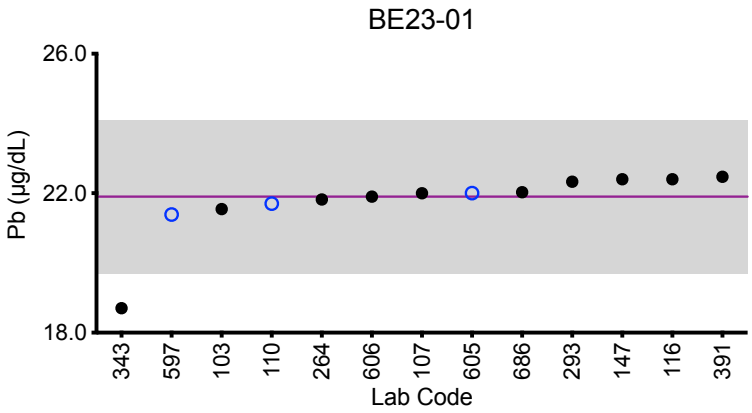
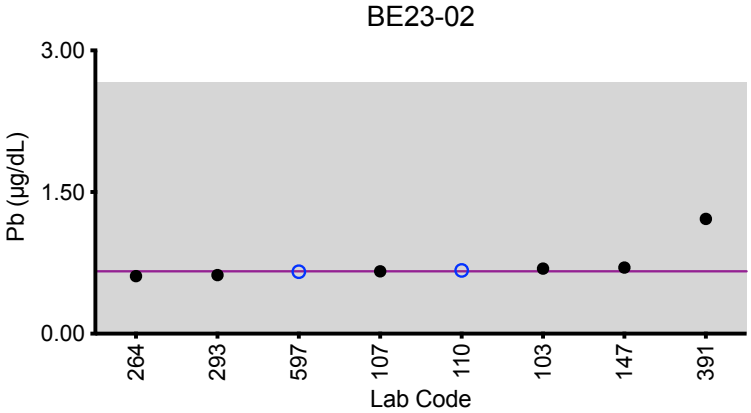
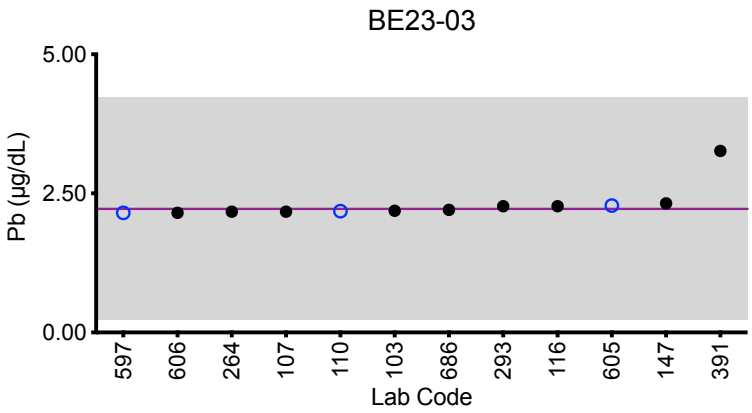
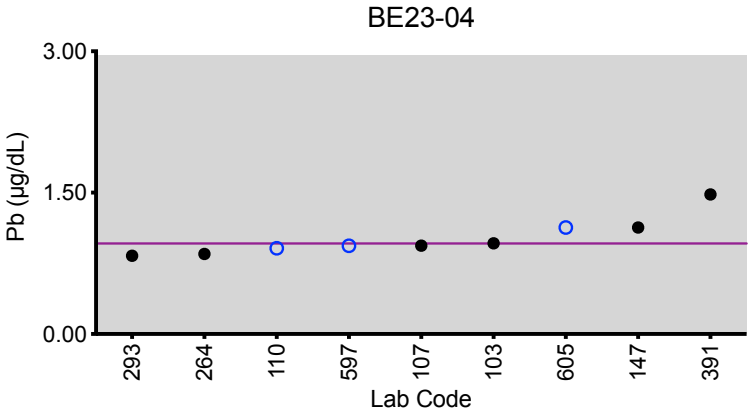
Results for Event #1, 2023: Summary Figures

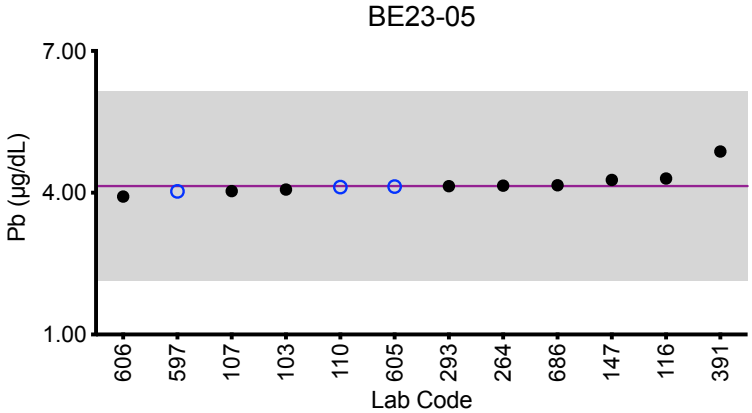
Whole Blood Pb











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 #1, 2023:
Laboratory Data and Summary Statistics

Whole Blood Mo (µg/L)

Lab Code	Method	BE23-01	BE23-02	BE23-03	BE23-04	BE23-05
103	ICP-MS/MS	2.34	<1.50	3.71	7.80	<1.50
110	ICP-MS/MS	2.71	0.64	3.85	8.06	1.11
147	ICP-MS	2.63	0.676	4.06	8.40	1.04
264	ICP-MS	<0.01	<0.01	<0.01	*1.07	<0.01
442	DRC/CC-ICP-MS	2.43	0.546	3.61	7.59	0.916
597	ICP-MS/MS	2.45	0.524	3.74	7.66	0.882

Summary Statistics

	BE23-01	BE23-02	BE23-03	BE23-04	BE23-05
Arithmetic Mean ($\bar{x}$)	2.51	0.60	3.79	7.9	0.99
Arithmetic SD (s)	0.15	0.07	0.17	0.3	0.11
Arithmetic RSD (%)	6.0	12	4.5	4.2	11
Number of Sample Measurements (N)	5	4	5	5	4

*Denotes a statistical Outlier.

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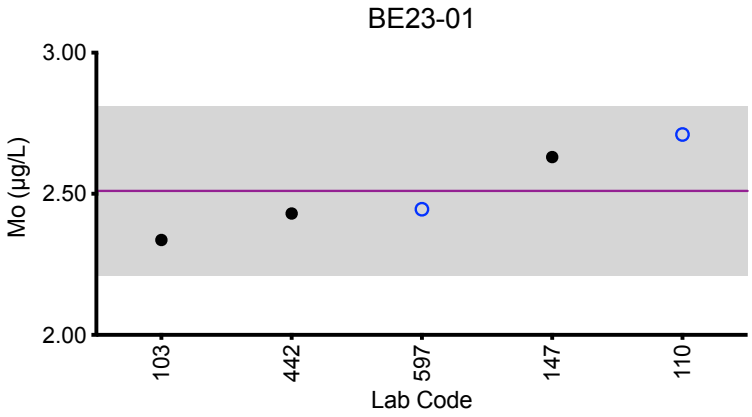
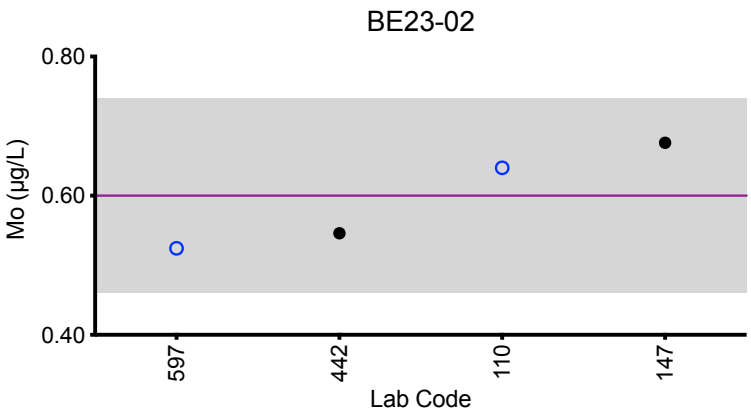
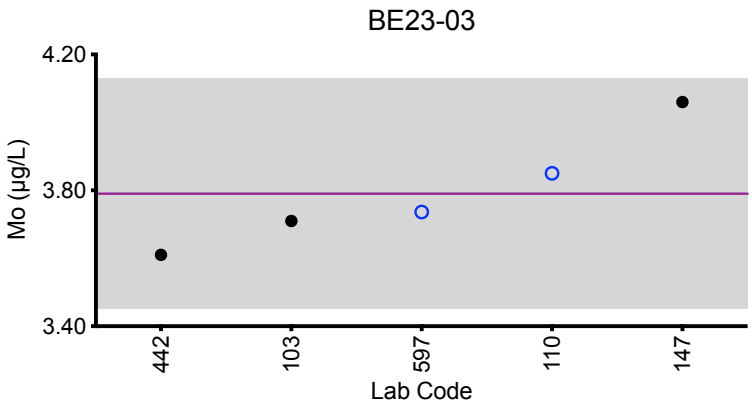
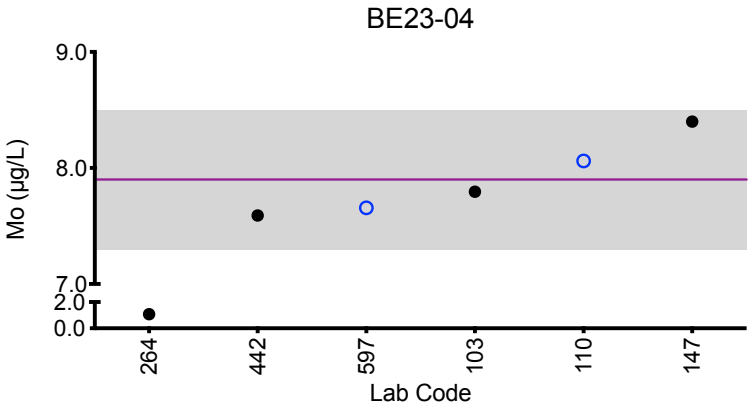
Results for Event #1, 2023: Summary Figures

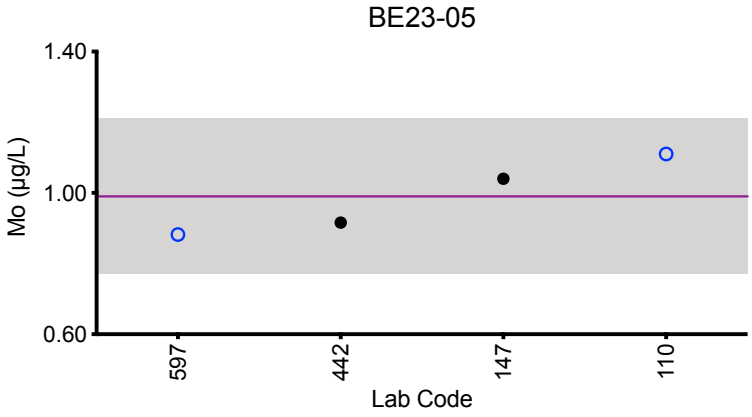
Whole Blood Mo











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 #1, 2023:
Laboratory Data and Summary Statistics

Whole Blood Sb (µg/L)

Lab Code	Method	BE23-01	BE23-02	BE23-03	BE23-04	BE23-05
103	ICP-MS/MS	2.90	*6.17	0.391	0.752	1.61
110	ICP-MS/MS	3.53	8.01	0.54	0.99	2.21
147	ICP-MS	3.82	8.51	0.564	1.08	2.39
264	ICP-MS	3.62	8.21	0.43	0.85	2.44
293	DRC/CC-ICP-MS	3.2	7.6	0.5	1.0	2.0
442	DRC/CC-ICP-MS	3.79	8.37	0.544	1.08	2.35
597	ICP-MS/MS	3.58	8.35	0.538	1.02	2.23

Summary Statistics

	BE23-01	BE23-02	BE23-03	BE23-04	BE23-05
Arithmetic Mean ($\bar{x}$)	3.5	8.2	0.50	0.97	2.2
Arithmetic SD (s)	0.3	0.3	0.07	0.12	0.3
Arithmetic RSD (%)	9.5	4.0	14	12	13
Number of Sample Measurements (N)	7	6	7	7	7

*Denotes a statistical Outlier.

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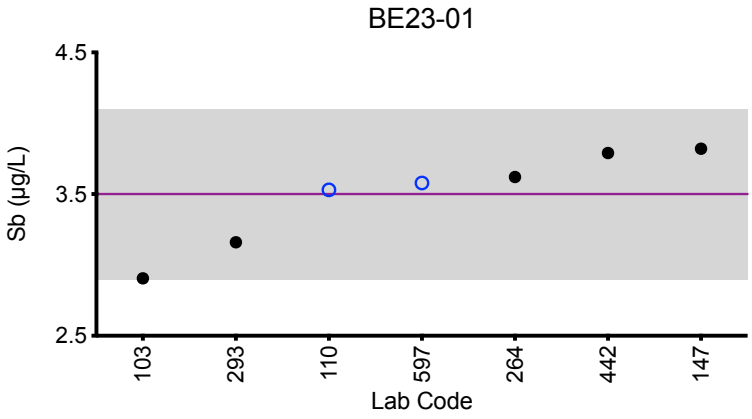
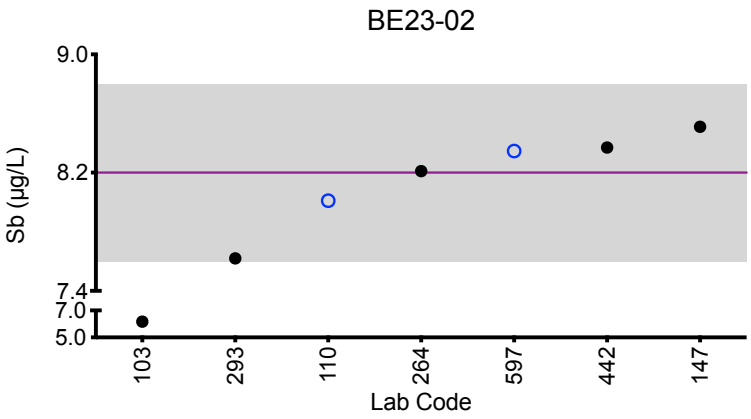
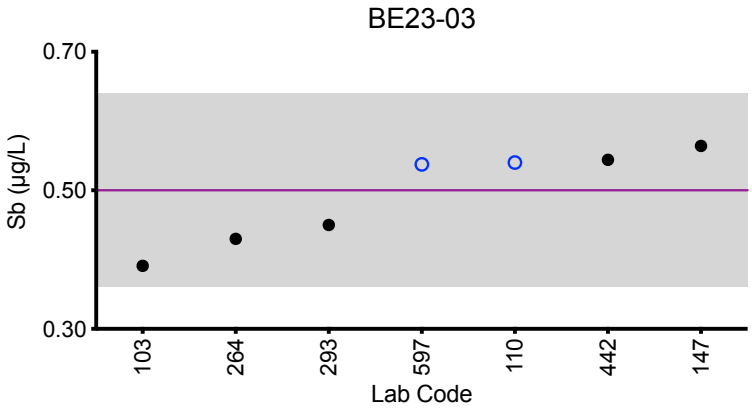
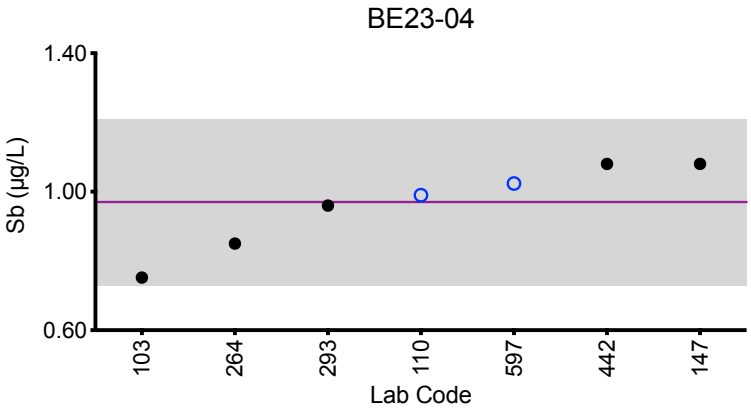
Results for Event #1, 2023: Summary Figures

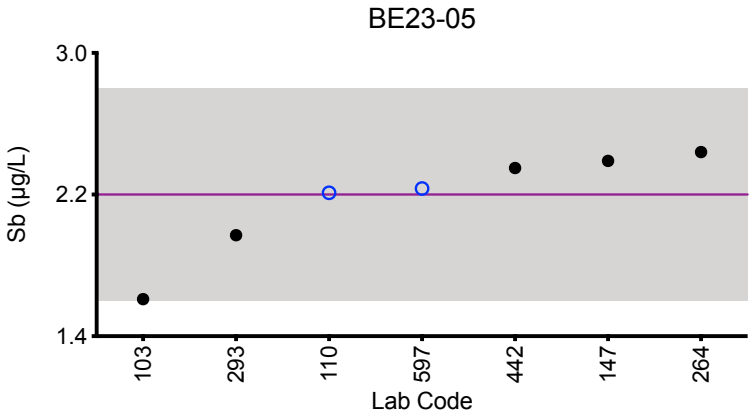
Whole Blood Sb











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 #1, 2023:
Laboratory Data and Summary Statistics

Whole Blood Se (µg/L)

Lab Code	Method	BE23-01	BE23-02	BE23-03	BE23-04	BE23-05
103	ICP-MS/MS	145	119	238	331	168
107	ICP-MS/MS	154.6	121.5	247.8	346.3	179.3
110	ICP-MS/MS	147	115	244	316	178
147	ICP-MS	145	116	242	339	172
264	ICP-MS	160.8	124.9	261.1	350.8	179.5
293	DRC/CC-ICP-MS	146	115	216	319	162
597	ICP-MS/MS	145	116	245	322	175

Summary Statistics

	BE23-01	BE23-02	BE23-03	BE23-04	BE23-05
Arithmetic Mean ($\bar{x}$)	149	118	242	332	173
Arithmetic SD (s)	6	4	14	14	7
Arithmetic RSD (%)	4.0	3.2	5.8	4.2	4.0
Number of Sample Measurements (N)	7	7	7	7	7

*Denotes a statistical Outlier.

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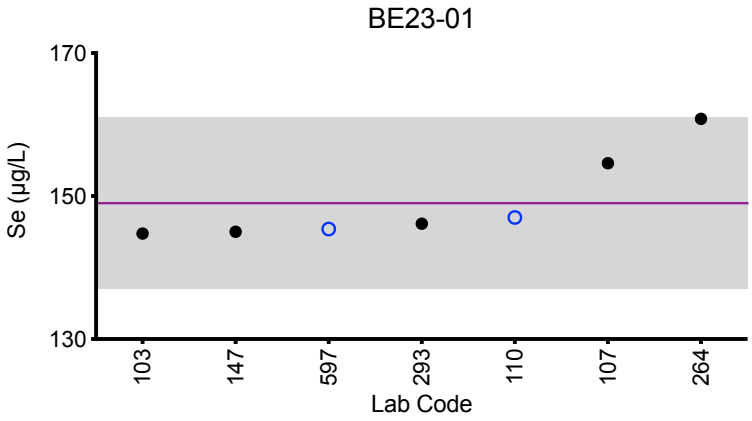
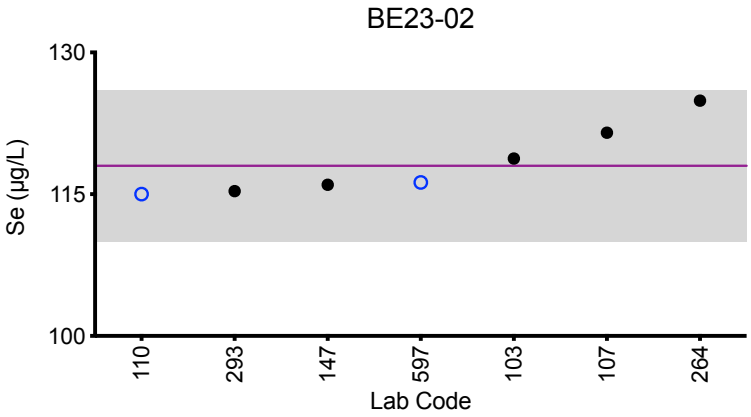
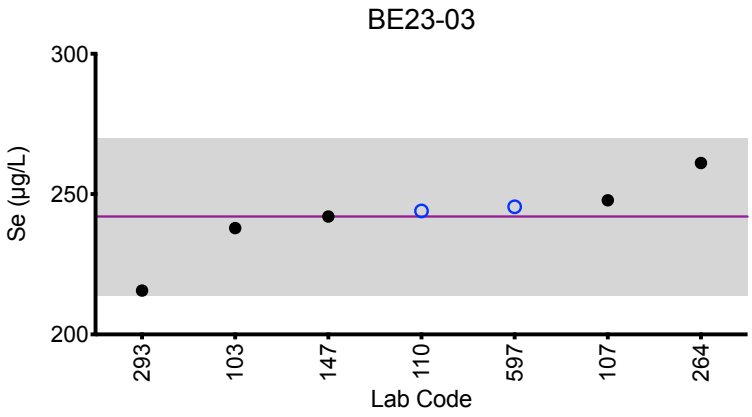
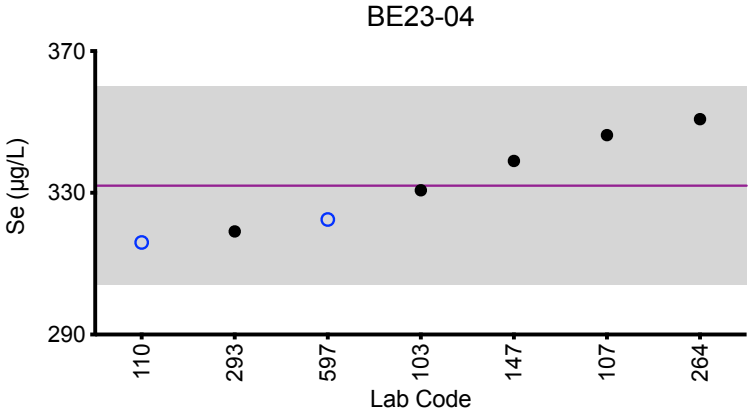
Results for Event #1, 2023: Summary Figures

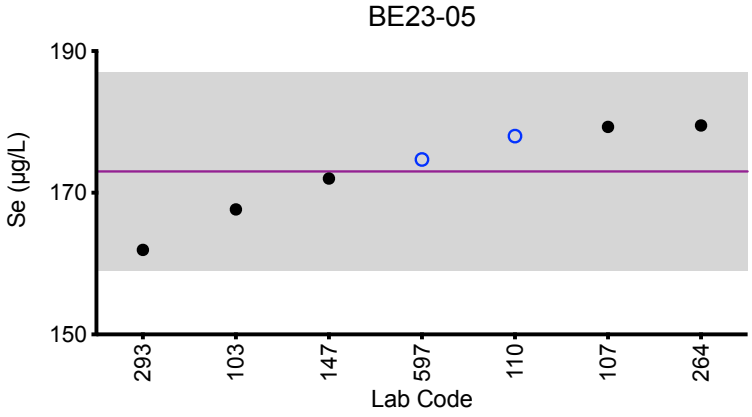
Whole Blood Se











Legend:
o HHEAR Labs ● Other Labs
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Gray area = ±2SD of the mean.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Whole Blood Tl (µg/L)

Lab Code	Method	BE23-01	BE23-02	BE23-03	BE23-04	BE23-05
103	ICP-MS/MS	0.680	0.117	1.12	0.369	3.28
110	ICP-MS/MS	0.70	0.12	1.13	0.36	3.45
147	ICP-MS	0.726	0.132	1.17	0.413	3.52
264	ICP-MS	0.67	0.11	1.11	0.33	3.44
293	DRC/CC-ICP-MS	0.68	0.12	1.100	0.35	3.36
597	ICP-MS/MS	0.665	0.117	1.10	0.345	3.31

Summary Statistics

	BE23-01	BE23-02	BE23-03	BE23-04	BE23-05
Arithmetic Mean ($\bar{x}$)	0.687	0.119	1.12	0.36	3.39
Arithmetic SD (s)	0.023	0.007	0.03	0.03	0.09
Arithmetic RSD (%)	3.3	5.9	2.3	8.0	2.7
Number of Sample Measurements (N)	6	6	6	6	6

*Denotes a statistical Outlier.

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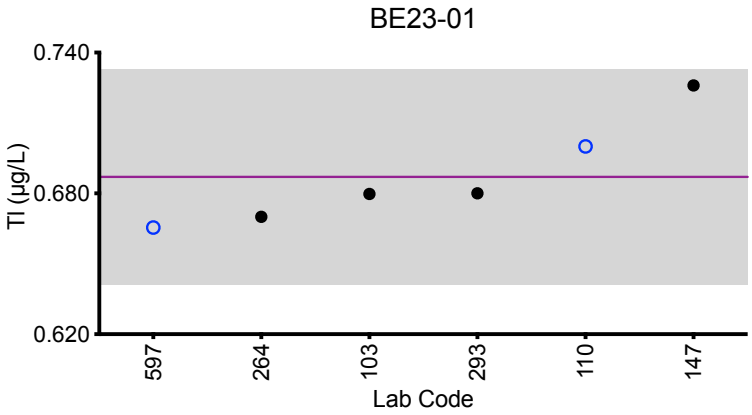
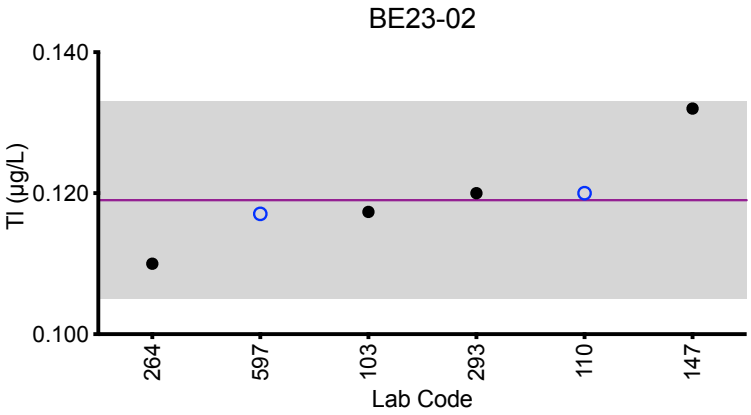
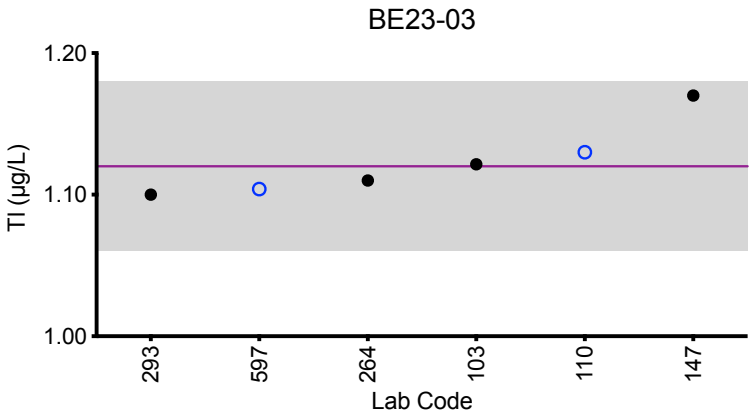
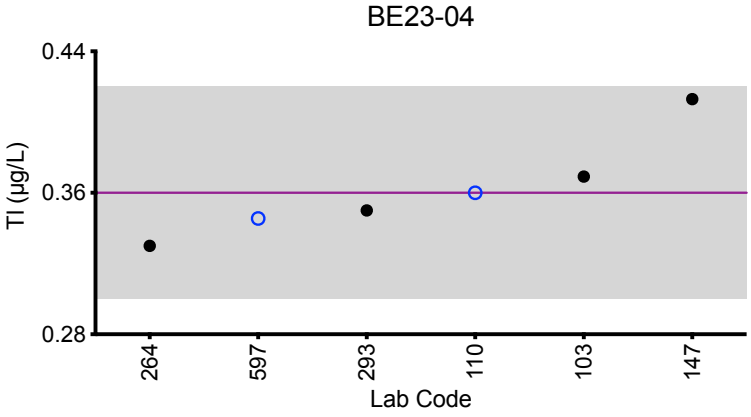
Results for Event #1, 2023: Summary Figures

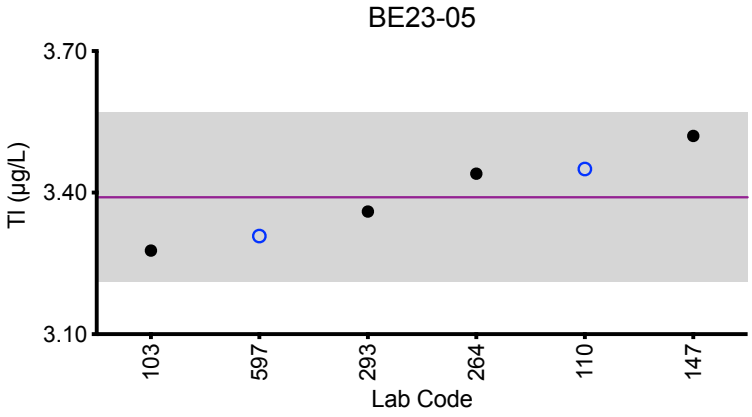
Whole Blood Tl











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 #1, 2023:
Laboratory Data and Summary Statistics

Whole Blood Ba (µg/L)						
Lab Code	**Method**	**BE23-01**	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
110	ICP-MS/MS	1.54	6.29	2.83	1.89	3.91
147	ICP-MS	1.34	6.51	2.98	2.77	3.80
597	ICP-MS/MS	1.32	5.99	2.50	1.60	3.88
Summary Statistics						
		BE23-01	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
Arithmetic Mean ($\bar{x}$)		1.40	6.3	2.8	2.1	3.86
Arithmetic SD (s)		0.12	0.3	0.3	0.6	0.06
Arithmetic RSD (%)		8.6	4.8	9.0	29	1.6
Number of Sample Measurements (N)		3	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Whole Blood Be (µg/L)						
Lab Code	**Method**	**BE23-01**	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
110	ICP-MS/MS	5.68	0.64	2.43	4.44	1.00
147	ICP-MS	5.32	<0.991	2.25	4.27	1.04
597	ICP-MS/MS	5.48	0.655	2.25	4.12	0.917
Summary Statistics						
		BE23-01	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
Arithmetic Mean ($\bar{x}$)		5.5	0.647	2.31	4.28	0.99
Arithmetic SD (s)		0.2	0.011	0.10	0.16	0.06
Arithmetic RSD (%)		3.3	1.7	4.3	3.7	6.1
Number of Sample Measurements (N)		3	2	3	3	3

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Whole Blood Bi (µg/L)						
Lab Code	**Method**	**BE23-01**	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
147	ICP-MS	<0.0334	<0.0334	0.374	<0.0334	0.362
597	ICP-MS/MS	<0.0299	<0.0299	0.350	<0.0299	0.364
Summary Statistics						
		BE23-01	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
Arithmetic Mean ($\bar{x}$)		NA	NA	0.36	NA	0.363
Arithmetic SD (s)		NA	NA	0.02	NA	0.001
Arithmetic RSD (%)		NA	NA	4.7	NA	0.39
Number of Sample Measurements (N)		NA	NA	2	NA	2

*Denotes a statistical Outlier.

Statistical data was not calculated for BE23-01, BE23-02 and BE23-04 based on a lack of consensus among participating labs.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Whole Blood Cs (µg/L)						
Lab Code	**Method**	**BE23-01**	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
110	ICP-MS/MS	1.08	1.65	1.24	1.66	1.23
147	ICP-MS	1.05	1.61	1.16	1.62	1.20
597	ICP-MS/MS	1.05	1.61	1.19	1.62	1.22
Summary Statistics						
		BE23-01	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
Arithmetic Mean ($\bar{x}$)		1.06	1.62	1.20	1.63	1.217
Arithmetic SD (s)		0.02	0.02	0.04	0.02	0.015
Arithmetic RSD (%)		1.6	1.4	3.3	1.4	1.2
Number of Sample Measurements (N)		3	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Whole Blood Cu (µg/L)						
Lab Code	**Method**	**BE23-01**	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
110	ICP-MS/MS	933	1540	860	721	1840
147	ICP-MS	978	1645	915	807	1970
597	ICP-MS/MS	940	1590	869	728	1870

Summary Statistics					
	BE23-01	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
Arithmetic Mean ($\bar{x}$)	950	1590	880	750	1890
Arithmetic SD (s)	24	50	30	50	70
Arithmetic RSD (%)	2.5	3.1	3.4	6.7	3.7
Number of Sample Measurements (N)	3	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Whole Blood Ni (µg/L)						
Lab Code	**Method**	**BE23-01**	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
103	ICP-MS/MS	2.15	<1.50	11.2	4.98	1.62
110	ICP-MS/MS	2.79	1.20	12.3	5.22	2.03
147	ICP-MS	2.63	0.975	12.5	5.40	1.77
597	ICP-MS/MS	2.51	0.833	11.8	4.63	1.64
Summary Statistics						
		BE23-01	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
Arithmetic Mean ($\bar{x}$)		2.5	1.0	12.0	5.1	1.8
Arithmetic SD (s)		0.3	0.2	0.6	0.3	0.2
Arithmetic RSD (%)		11	19	5.0	5.9	11
Number of Sample Measurements (N)		4	3	4	4	4

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Whole Blood Pt (µg/L)						
Lab Code	**Method**	**BE23-01**	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
110	ICP-MS/MS	0.474	5.52	2.11	5.08	0.822
293	DRC/CC-ICP-MS	0.44	4.85	1.67	4.20	0.69
Summary Statistics						
		BE23-01	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
Arithmetic Mean ($\bar{x}$)		0.46	5.2	1.9	4.6	0.76
Arithmetic SD (s)		0.02	0.5	0.3	0.6	0.09
Arithmetic RSD (%)		4.3	9.6	16	13	12
Number of Sample Measurements (N)		2	2	2	2	2

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Whole Blood Sn (µg/L)						
Lab Code	**Method**	**BE23-01**	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
110	ICP-MS/MS	5.83	0.75	1.67	2.95	0.36
147	ICP-MS	5.86	0.757	1.71	3.12	0.365
597	ICP-MS/MS	5.59	0.68	1.55	2.76	0.312
Summary Statistics						
		BE23-01	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
Arithmetic Mean ($\bar{x}$)		5.76	0.73	1.64	2.9	0.35
Arithmetic SD (s)		0.15	0.04	0.08	0.2	0.03
Arithmetic RSD (%)		2.6	5.5	4.9	6.1	8.6
Number of Sample Measurements (N)		3	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Whole Blood Sr (µg/L)						
Lab Code	**Method**	**BE23-01**	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
103	ICP-MS/MS	19.4	22.4	31.3	23.1	31.5
147	ICP-MS	19.8	23.4	33.2	24.4	32.9
597	ICP-MS/MS	20.2	24.1	32.5	23.4	32.6
Summary Statistics						
		BE23-01	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
Arithmetic Mean ($\bar{x}$)		19.8	23.3	32.3	23.6	32.3
Arithmetic SD (s)		0.4	0.9	1.0	0.7	0.7
Arithmetic RSD (%)		2.0	3.9	3.1	3.0	2.2
Number of Sample Measurements (N)		3	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Whole Blood Ti (µg/L)						
Lab Code	**Method**	**BE23-01**	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
200	DRC/CC-ICP-MS	5.9	4.1	10.9	7.3	6.1
442	ICP-MS/MS	3.35	1.20	8.83	5.75	2.40
597	ICP-MS/MS	4.31	2.32	9.04	6.40	3.30
Summary Statistics						
		BE23-01	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
Arithmetic Mean ($\bar{x}$)		4.5	NA	9.6	6.5	NA
Arithmetic SD (s)		1.3	NA	1.1	0.8	NA
Arithmetic RSD (%)		29	NA	11	12	NA
Number of Sample Measurements (N)		3	NA	3	3	NA

*Denotes a statistical Outlier.

Statistical data was not calculated for BE23-02 and BE23-05 based on a lack of consensus among participating labs.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Whole Blood U (µg/L)						
Lab Code	**Method**	**BE23-01**	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
103	ICP-MS/MS	<0.0500	0.142	<0.0500	0.110	0.0927
110	ICP-MS/MS	0.0284	0.158	0.0207	0.123	0.0966
147	ICP-MS	0.0279	0.152	0.0229	0.124	0.0914
597	ICP-MS/MS	0.0285	0.161	0.0202	0.115	0.0938
Summary Statistics						
		BE23-01	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
Arithmetic Mean ($\bar{x}$)		0.0283	0.153	0.0213	0.118	0.094
Arithmetic SD (s)		0.0003	0.008	0.0014	0.007	0.002
Arithmetic RSD (%)		1.1	5.2	6.6	5.9	2.4
Number of Sample Measurements (N)		3	4	3	4	4

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Whole Blood V (µg/L)

Lab Code	Method	BE23-01	BE23-02	BE23-03	BE23-04	BE23-05
110	ICP-MS/MS	0.11	1.47	4.87	0.63	2.20
147	DRC/CC-ICP-MS	0.0878	1.48	4.77	0.622	2.34
597	ICP-MS/MS	0.0983	1.42	4.78	0.580	2.18

Summary Statistics

	BE23-01	BE23-02	BE23-03	BE23-04	BE23-05
Arithmetic Mean ($\bar{x}$)	0.099	1.46	4.81	0.61	2.24
Arithmetic SD (s)	0.011	0.03	0.06	0.03	0.09
Arithmetic RSD (%)	11	2.1	1.2	4.9	4.0
Number of Sample Measurements (N)	3	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Whole Blood W (µg/L)						
Lab Code	**Method**	**BE23-01**	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
110	ICP-MS/MS	2.29	0.26	0.54	1.25	3.30
200	ICP-MS	2.87	0.30	0.700	1.53	4.27
597	ICP-MS/MS	2.28	0.225	0.504	1.29	3.26
Summary Statistics						
		BE23-01	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
Arithmetic Mean ($\bar{x}$)		2.5	0.26	0.58	1.36	3.6
Arithmetic SD (s)		0.3	0.04	0.10	0.15	0.6
Arithmetic RSD (%)		12	15	17	11	17
Number of Sample Measurements (N)		3	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Whole Blood Zn (µg/L)						
Lab Code	**Method**	**BE23-01**	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
110	ICP-MS/MS	5630	4760	6990	4720	6960
147	ICP-MS	5660	5000	7190	5137	7124
597	ICP-MS/MS	5520	4830	6930	4700	6870
Summary Statistics						
		BE23-01	**BE23-02**	**BE23-03**	**BE23-04**	**BE23-05**
Arithmetic Mean ($\bar{x}$)		5600	4860	7040	4850	6980
Arithmetic SD (s)		70	120	140	250	130
Arithmetic RSD (%)		1.3	2.5	2.0	5.2	1.9
Number of Sample Measurements (N)		3	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Additional Elements in Whole Blood

Whole Blood Ag (µg/L)

Lab Code	Method	BE23-01	BE23-02	BE23-03	BE23-04	BE23-05
147	ICP-MS	0.167	<0.151	<0.151	<0.151	<0.151

Whole Blood Al (µg/L)

Lab Code	Method	BE23-01	BE23-02	BE23-03	BE23-04	BE23-05
147	ICP-MS	<4.86	<4.86	<4.86	<4.86	<4.86
597	ICP-MS/MS	9.38	<3.88	6.17	7.67	10.3

Whole Blood I (µg/L)

Lab Code	Method	BE23-01	BE23-02	BE23-03	BE23-04	BE23-05
147	ICP-MS	26.5	24.4	20.3	26.1	20.0

Whole Blood Li (µg/L)

Lab Code	Method	BE23-01	BE23-02	BE23-03	BE23-04	BE23-05
147	ICP-MS	0.784	0.819	0.854	0.826	0.763

Whole Blood Mg (µg/L)

Lab Code	Method	BE23-01	BE23-02	BE23-03	BE23-04	BE23-05
597	ICP-MS/MS	27000	27800	34400	27200	34500

Whole Blood Te (µg/L)

Lab Code	Method	BE23-01	BE23-02	BE23-03	BE23-04	BE23-05
110	ICP-MS/MS	0.03	0.01	0.04	0.02	0.03
147	ICP-MS	<0.0561	<0.0561	<0.0561	<0.0561	<0.0561

Whole Blood Th (µg/L)

Lab Code	Method	BE23-01	BE23-02	BE23-03	BE23-04	BE23-05
147	ICP-MS	<0.0255	<0.0255	<0.0255	<0.0255	<0.0255
597	ICP-MS/MS	0.0157	<0.00741	<0.00741	<0.00741	<0.00741

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Event #1, 2023

Trace Elements in Urine

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Trace Elements Laboratory

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Event #1, 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 22 elements were reported by at least one participant: Ag, Al, 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 #1, 2023: Summary Statistics

	Urine As (µg/L)				
	UE23-01	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
Target (Robust Mean (x*))	22.8	7.6	34.9	44	1.2
Upper Limit	28.8	13.6	41.9	53	7.2
Lower Limit	16.8	1.6	27.9	35	0.0
Robust SD (s*)	1.6	0.6	2.6	4	0.2
Robust RSD (%)	7.0	7.9	7.4	9.3	20
Number of Sample Measurements (N)	15	15	15	15	10
Standard Uncertainty (*u*)	0.5	0.2	0.8	1	0.1

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 #1, 2023:
Performance of Participating Laboratories

Urine As (µg/L)						
Lab Code	**Method**	**UE23-01**	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
	Target	**22.8**	**7.6**	**34.9**	**44**	**1.2**
103	ICP-MS/MS	21.6	7.02	32.4	40.8	1.06
107	DRC/CC-ICP-MS	21.87	6.81	33.82	36.98	0.96
110	DRC/CC-ICP-MS	24.0	7.87	37.1	46.9	1.31
116	ICP-MS/MS	25.4	7.51	35.3	45.2	<5.00
147	ICP-MS	21.8	7.18	33.9	42.1	0.876
220	DRC/CC-ICP-MS	24.7	8.60	38.5	49.0	<2.0
264	ICP-MS	23.55	8.13	36.16	45.28	1.47
293	DRC/CC-ICP-MS	21.32	7.11	32.13	40.63	1.07
391	ICP-MS	38.401 ↑	19.848 ↑	55.662 ↑	72.918 ↑	8.199 ↑
399	DRC/CC-ICP-MS	21.6	7.10	32.7	40.4	1.15
442	ICP-MS/MS	21.6	7.33	32.7	41	1.21
597	ICP-MS/MS	22.6	7.93	36.6	45.1	1.36
605	ICP-MS	22.9	7.96	35.2	45.9	<2.00
606	ICP-MS/MS	23.9	7.97	35.9	47.4	<2.00
686	DRC/CC-ICP-MS	19.9	7.61	31.9	41.4	<6.00

Based on the grading criteria for As in Urine, 93% 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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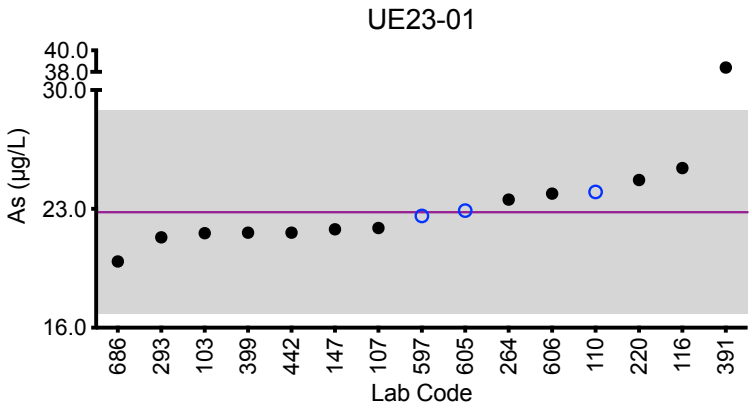
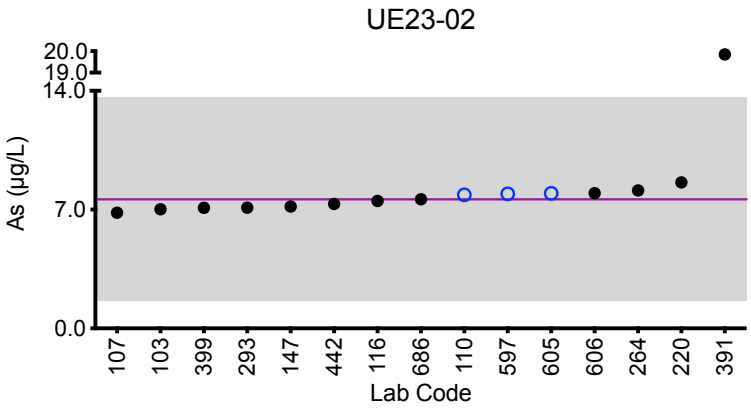
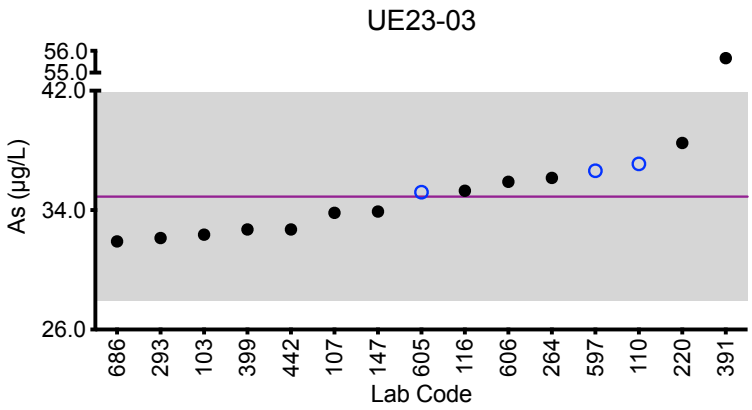
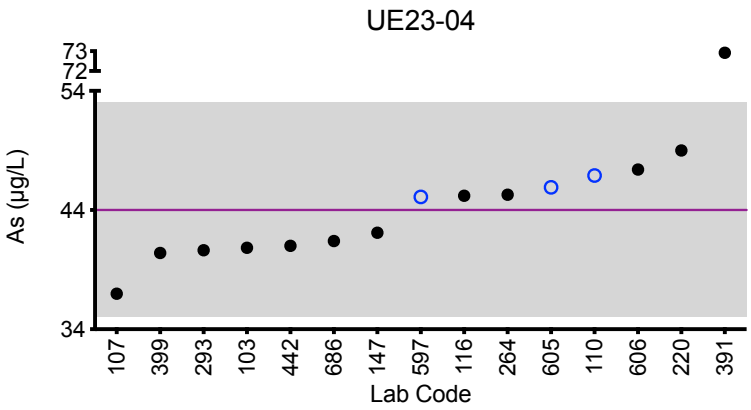
Results for Event #1, 2023: Summary Figures

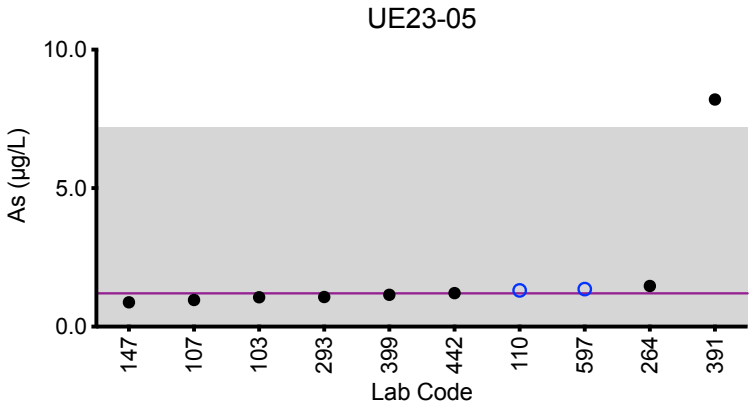
Urine As











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 #1, 2023: Summary Statistics

	Urine Ba (µg/L)				
	UE23-01	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
Target (Robust Mean (x*))	0.69	5.2	7.1	1.10	2.87
Upper Limit	1.69	6.3	8.5	2.10	3.87
Lower Limit	0.00	4.2	5.7	0.10	1.87
Robust SD (s*)	0.04	0.4	0.4	0.07	0.20
Robust RSD (%)	5.8	7.5	5.6	6.4	7.0
Number of Sample Measurements (N)	11	11	11	11	11
Standard Uncertainty (*u*)	0.02	0.1	0.1	0.03	0.07

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 #1, 2023:
Performance of Participating Laboratories

		Urine Ba (µg/L)				
Lab Code	**Method**	**UE23-01**	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
	Target	**0.69**	**5.2**	**7.1**	**1.10**	**2.87**
107	ICP-MS	0.625	4.819	6.776	1.064	2.692
110	ICP-MS	0.68	5.57	7.64	1.19	3.12
116	ICP-MS/MS	0.969	4.78	6.89	0.984	2.6
147	ICP-MS	0.761	5.32	7.45	1.12	3.08
220	ICP-MS	0.71	5.54	7.65	1.21	3.10
264	ICP-MS	0.64	4.82	6.65	1.07	2.68
399	ICP-MS/MS	0.712	5.20	7.12	1.13	2.86
597	ICP-MS/MS	0.668	4.89	6.78	1.07	2.83
605	ICP-MS	0.700	5.34	7.18	1.12	2.89
606	ICP-MS/MS	0.484	5.75	6.92	0.994	2.85
686	ICP-MS	0.690	5.27	7.18	1.13	2.89

Based on the grading criteria for Ba 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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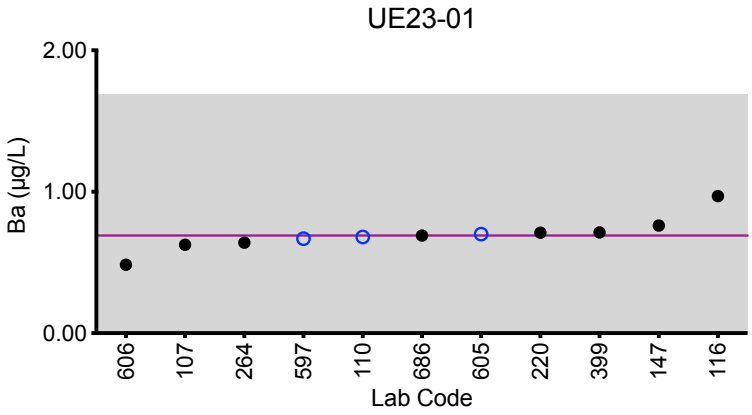
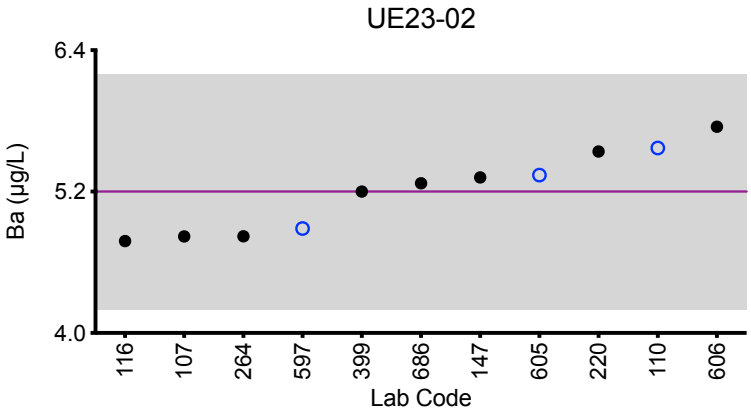
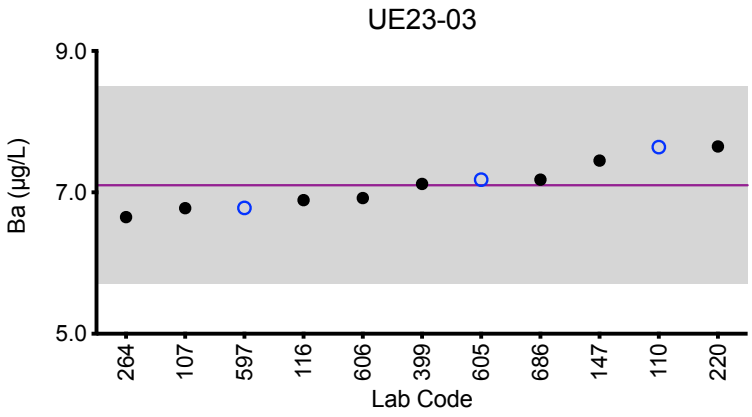
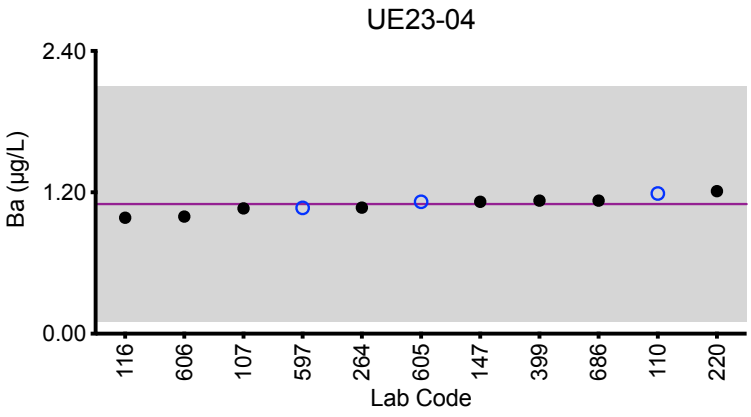
Results for Event #1, 2023: Summary Figures

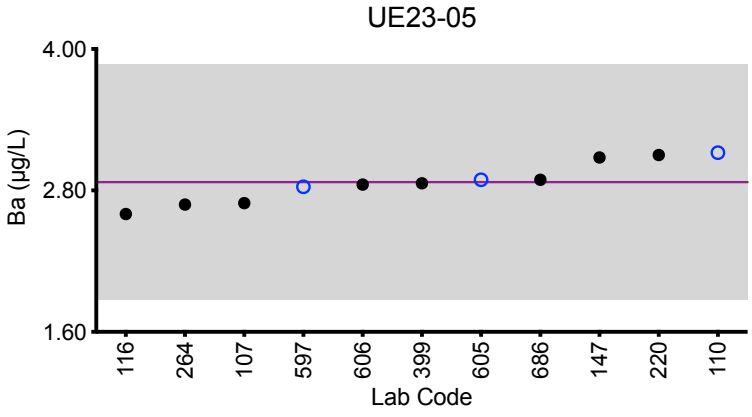
Urine Ba











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 #1, 2023: Summary Statistics

	Urine Be (µg/L)				
	UE23-01	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
Target (Robust Mean (x*))	1.44	5.20	0.81	0.60	3.35
Upper Limit	2.44	6.24	1.81	1.60	4.35
Lower Limit	0.44	4.16	0.00	0.00	2.35
Robust SD (s*)	0.04	0.23	0.03	0.03	0.18
Robust RSD (%)	2.8	4.4	3.7	4.7	5.4
Number of Sample Measurements (N)	11	11	11	11	11
Standard Uncertainty (*u*)	0.02	0.09	0.01	0.01	0.07

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 #1, 2023:
Performance of Participating Laboratories

Urine Be (µg/L)						
Lab Code	**Method**	**UE23-01**	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
	Target	**1.44**	**5.20**	**0.81**	**0.60**	**3.35**
107	ICP-MS	1.415	4.886	0.798	0.571	3.123
110	ICP-MS	1.45	5.24	0.81	0.61	3.35
116	ICP-MS/MS	1.41	4.91	0.743	0.576	3.12
147	ICP-MS	1.57	5.46	0.823	0.587	3.57
220	ICP-MS	1.53	5.40	0.87	0.65	3.52
264	ICP-MS	1.42	5.06	0.80	0.57	3.25
293	ICP-MS	1.41	5.31	0.78	0.59	3.28
399	ICP-MS/MS	1.37	5.00	0.798	0.605	3.21
597	ICP-MS/MS	1.42	5.25	0.805	0.576	3.41
605	ICP-MS	1.51	5.42	0.847	0.637	3.49
686	ICP-MS	1.47	5.26	0.843	0.631	3.50

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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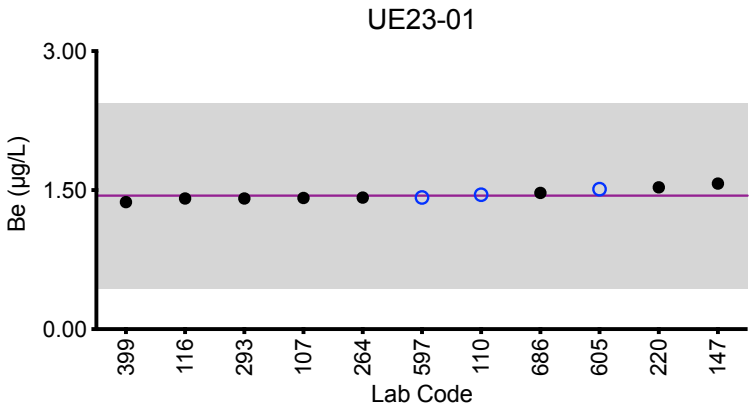
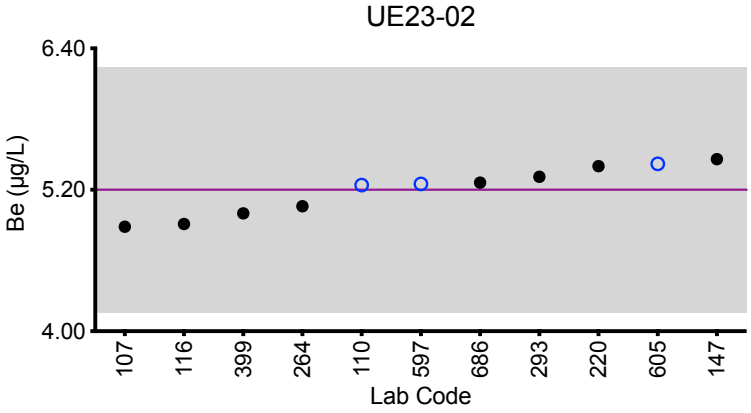
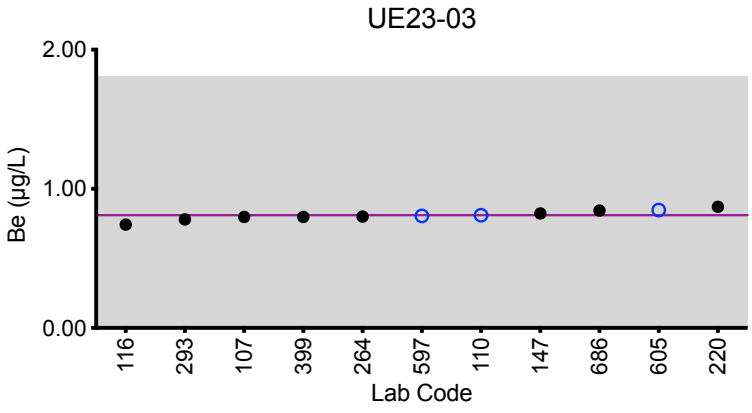
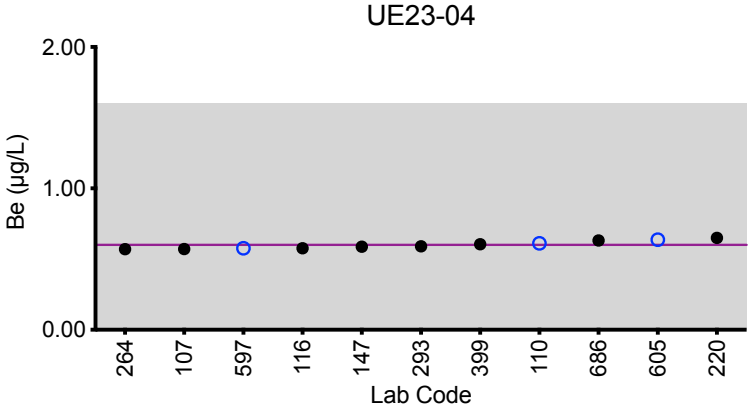
Results for Event #1, 2023: Summary Figures

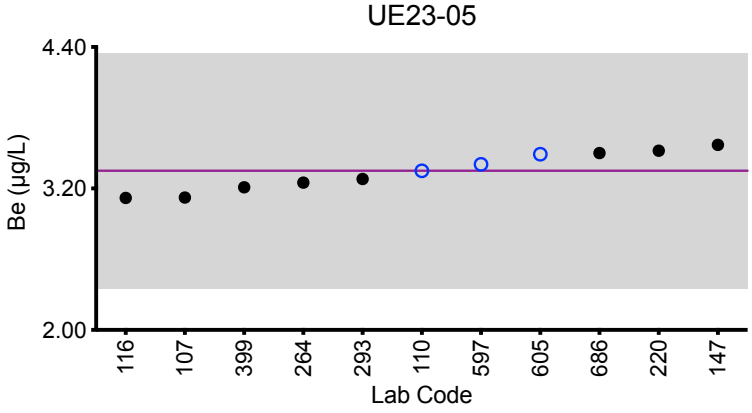
Urine Be











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 #1, 2023: Summary Statistics

	Urine Cd (µg/L)				
	UE23-01	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
Target (Robust Mean (x*))	1.74	0.388	3.43	0.75	2.63
Upper Limit	2.74	1.388	4.43	1.75	3.63
Lower Limit	0.74	0.000	2.43	0.00	1.63
Robust SD (s*)	0.06	0.022	0.12	0.04	0.10
Robust RSD (%)	3.4	5.7	3.5	5.8	3.8
Number of Sample Measurements (N)	16	15	16	15	16
Standard Uncertainty (*u*)	0.02	0.007	0.04	0.01	0.03

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 #1, 2023:
Performance of Participating Laboratories

		Urine Cd (µg/L)				
Lab Code	**Method**	**UE23-01**	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
	Target	**1.74**	**0.388**	**3.43**	**0.75**	**2.63**
103	ICP-MS/MS	1.74	0.388	3.57	0.741	2.69
107	DRC/CC-ICP-MS	1.758	0.366	3.279	0.699	2.496
110	ICP-MS	1.73	0.389	3.27	0.735	2.53
116	ICP-MS/MS	2.31	0.386	3.70	0.776	2.75
147	ICP-MS	1.73	0.361	3.38	0.714	2.68
220	ICP-MS	1.76	0.40	3.42	0.79	2.65
264	ICP-MS	1.83	0.36	3.65	0.81	2.75
293	DRC/CC-ICP-MS	1.74	0.38	3.43	0.73	2.57
324	ICP-MS	1.754	<1	3.305	<1	2.510
391	ICP-MS	1.675	0.538	3.353	0.844	2.581
399	DRC/CC-ICP-MS	1.69	0.384	3.46	0.734	2.65
442	ICP-MS/MS	1.58	0.412	3.55	0.734	2.6
597	ICP-MS/MS	1.65	0.367	3.41	0.696	2.55
605	ICP-MS	1.87	0.401	3.49	0.841	2.85
606	ICP-MS/MS	1.67	0.419	3.35	0.772	2.62
686	ICP-MS	1.74	0.391	3.43	0.747	2.63

Based on the grading criteria for Cd in Urine, 100% of results were satisfactory, with 0 of the 16 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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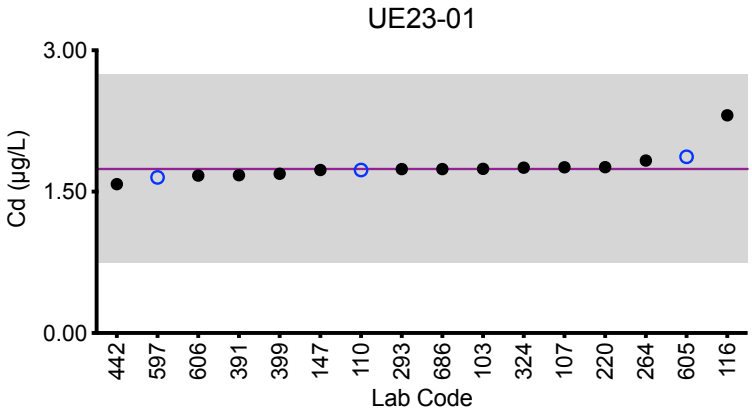
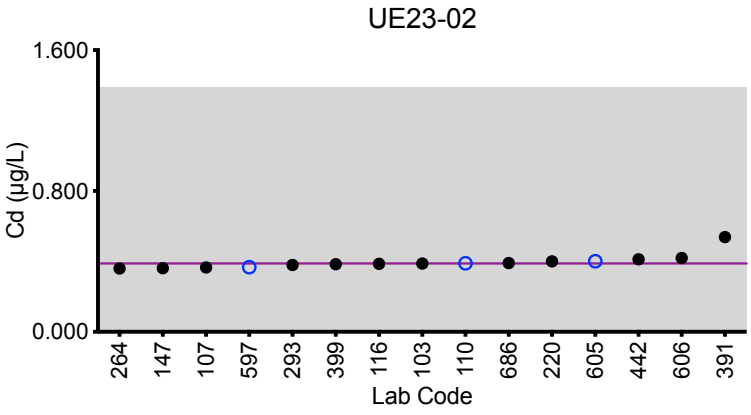
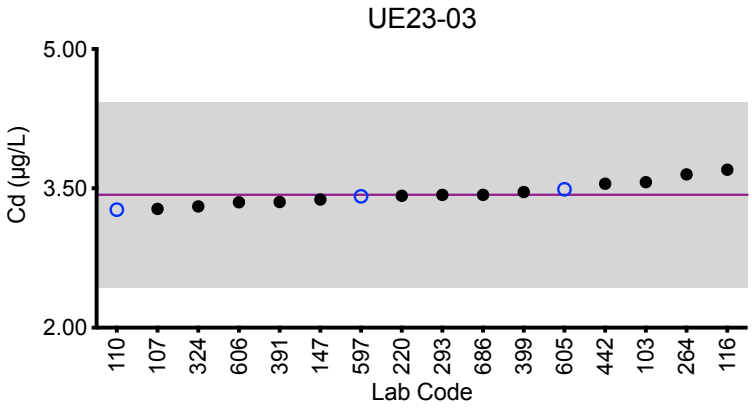
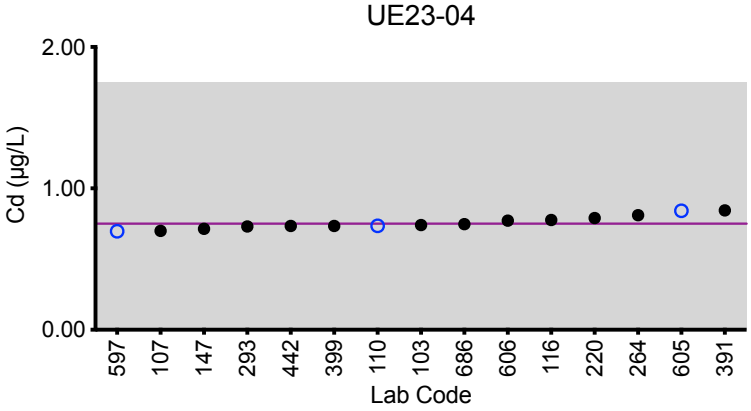
Results for Event #1, 2023: Summary Figures

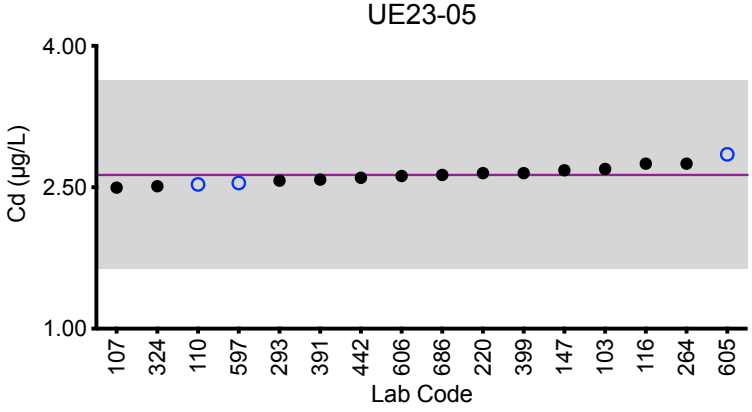
Urine Cd











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 #1, 2023: Summary Statistics

	Urine Co (µg/L)				
	UE23-01	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
Target (Robust Mean (x*))	1.64	0.80	5.02	1.04	2.98
Upper Limit	3.14	2.30	6.52	2.54	4.48
Lower Limit	0.14	0.00	3.52	0.00	1.48
Robust SD (s*)	0.08	0.07	0.24	0.12	0.18
Robust RSD (%)	4.9	8.8	4.8	12	6.0
Number of Sample Measurements (N)	13	12	13	13	13
Standard Uncertainty (*u*)	0.03	0.03	0.08	0.04	0.06

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 #1, 2023:
Performance of Participating Laboratories

		Urine Co (µg/L)				
Lab Code	**Method**	**UE23-01**	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
	Target	**1.64**	**0.80**	**5.02**	**1.04**	**2.98**
103	ICP-MS/MS	1.53	0.722	4.76	0.935	2.78
107	ICP-MS	1.567	0.731	4.815	0.918	2.810
110	ICP-MS	1.70	0.86	5.16	1.14	3.02
147	ICP-MS	1.62	0.784	4.95	0.984	2.92
220	ICP-MS	1.78	0.92	5.69	1.26	3.32
264	ICP-MS	1.69	0.81	5.16	1.04	3.00
293	DRC/CC-ICP-MS	1.67	0.78	5.03	0.98	3.03
324	ICP-MS	1.582	<1	4.759	1.095	2.786
391	ICP-MS	1.628	0.984	4.817	1.102	3.664
399	DRC/CC-ICP-MS	1.53	0.740	4.87	0.918	2.79
597	ICP-MS/MS	1.61	0.777	5.03	0.914	2.90
605	ICP-MS	1.70	0.890	5.25	1.13	3.04
606	ICP-MS/MS	1.69	0.764	5.26	1.14	3.11

Based on the grading criteria for Co in Urine, 100% 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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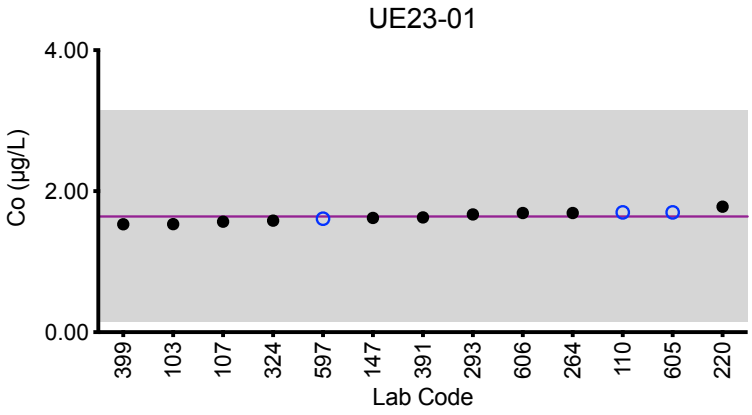
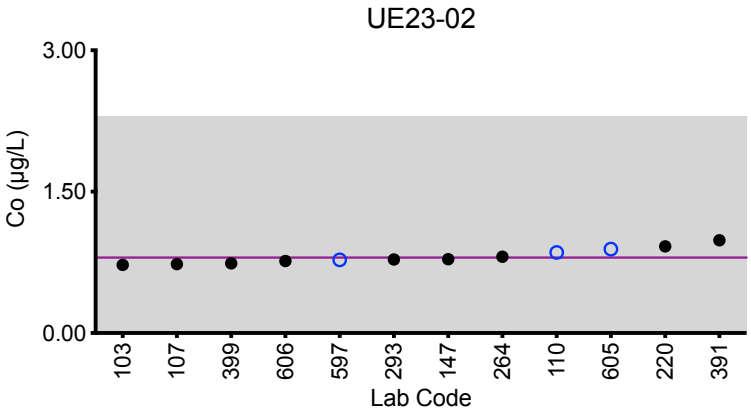
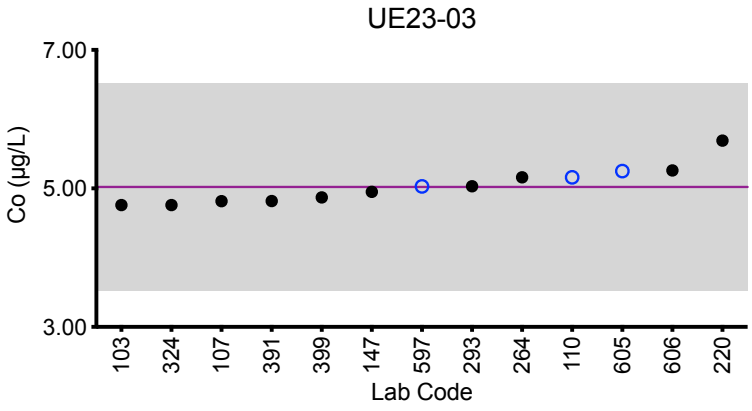
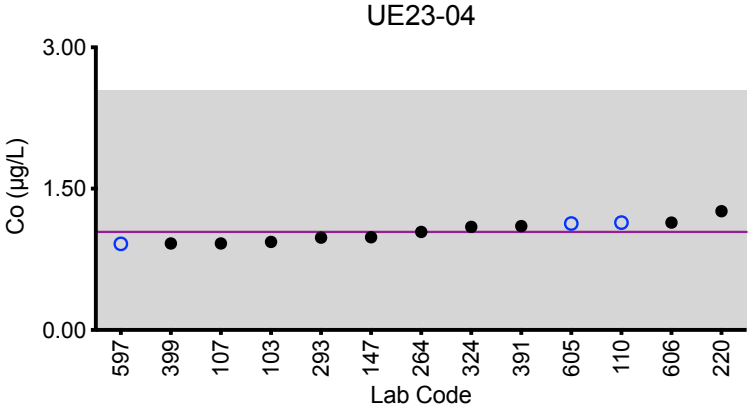
Results for Event #1, 2023: Summary Figures

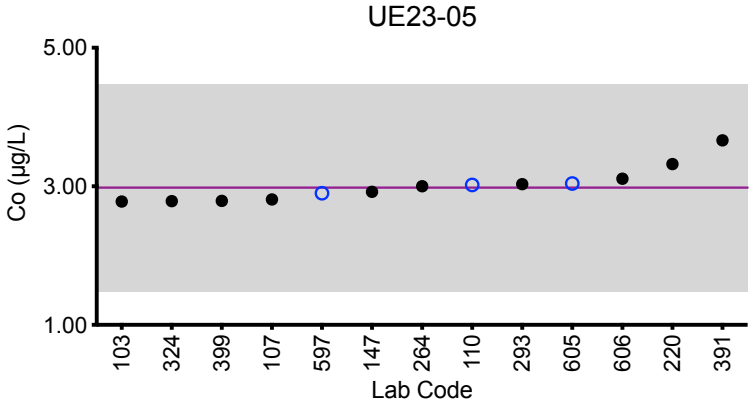
Urine Co











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 #1, 2023: Summary Statistics

	Urine Cr (µg/L)				
	UE23-01	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
Target (Robust Mean (x*))	3.4	0.52	5.6	2.3	3.5
Upper Limit	6.4	3.52	8.6	5.3	6.5
Lower Limit	0.4	0.00	2.6	0.0	0.5
Robust SD (s*)	0.4	0.18	0.5	0.4	0.3
Robust RSD (%)	11	35	8.9	17	9.1
Number of Sample Measurements (N)	11	8	11	11	11
Standard Uncertainty (*u*)	0.1	NA	0.2	0.2	0.1

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

An arithmetic mean, SD, RSD and n are provided for sample UE23-02.

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Results for Event #1, 2023:
Performance of Participating Laboratories

		Urine Cr (µg/L)				
Lab Code	**Method**	**UE23-01**	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
	Target	**3.4**	**0.52**	**5.6**	**2.3**	**3.5**
103	ICP-MS/MS	2.77	<0.600	4.39	2.03	3.07
107	DRC/CC-ICP-MS	3.05	0.23	5.16	1.65	3.24
110	DRC/CC-ICP-MS	4.18	*1.07	6.49	3.26	4.23
116	ICP-MS/MS	3.59	0.360	5.59	2.06	3.27
147	DRC/CC-ICP-MS	3.64	0.460	5.98	2.19	3.72
264	ICP-MS	3.66	0.68	5.96	2.59	3.64
293	DRC/CC-ICP-MS	3.31	0.66	5.42	2.33	3.54
324	ICP-MS	3.685	*1.104	5.702	2.762	3.732
391	ICP-MS	2.502	0.781	5.261	2.51	3.712
597	ICP-MS/MS	3.29	0.499	5.43	2.04	3.01
605	ICP-MS	3.56	0.462	5.73	2.35	3.52

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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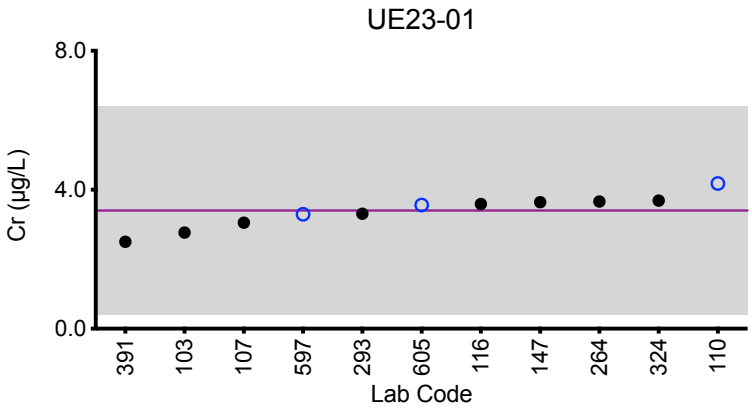
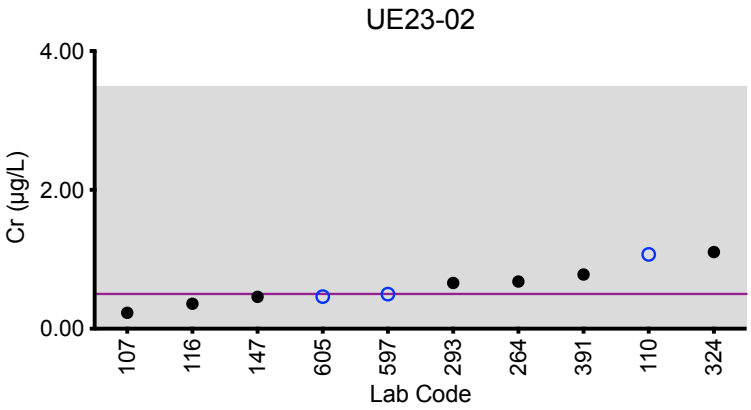
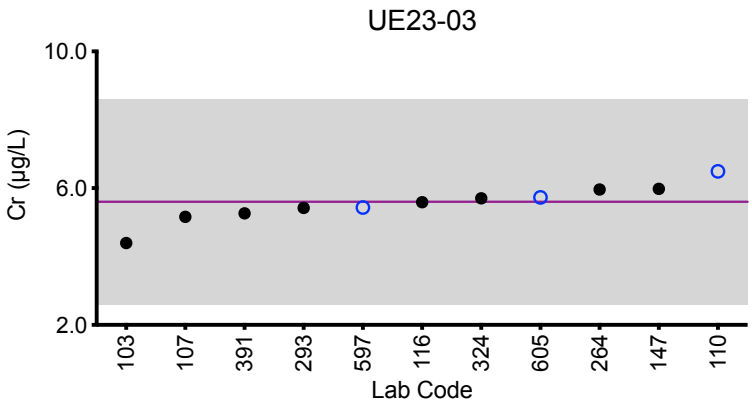
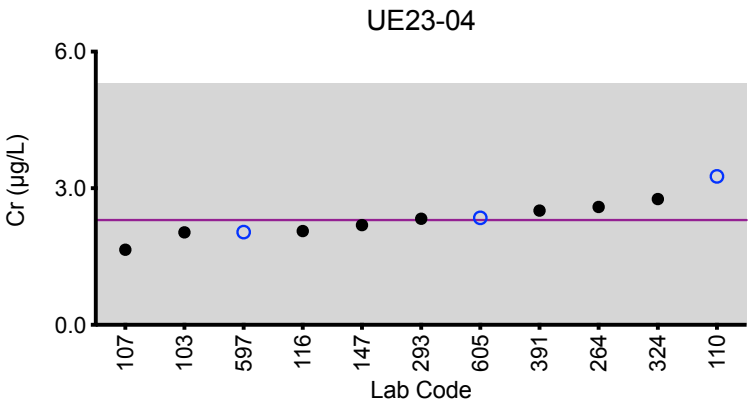
Results for Event #1, 2023: Summary Figures

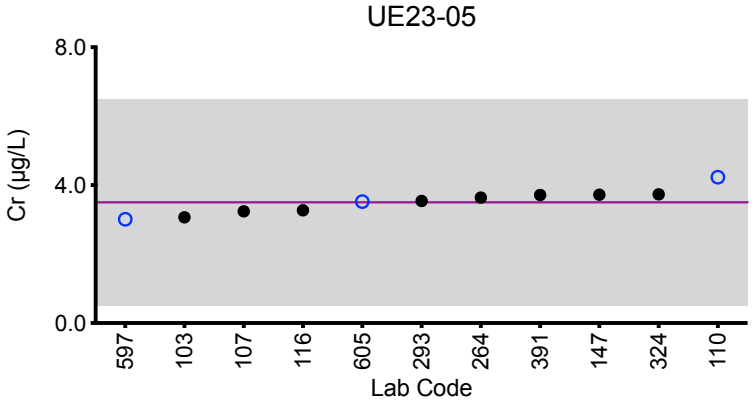
Urine Cr











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 #1, 2023: Summary Statistics

	Urine Hg (µg/L)				
	UE23-01	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
Target (Robust Mean (x*))	4.5	2.9	11.0	19.6	1.05
Upper Limit	7.5	5.9	14.3	25.5	4.05
Lower Limit	1.5	0.0	7.7	13.7	0.00
Robust SD (s*)	0.5	0.3	1.1	2.3	0.23
Robust RSD (%)	11	12	10	12	22
Number of Sample Measurements (N)	13	13	13	13	12
Standard Uncertainty (*u*)	0.2	0.1	0.4	0.8	0.08

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 #1, 2023:
Performance of Participating Laboratories

		Urine Hg (µg/L)				
Lab Code	**Method**	**UE23-01**	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
	Target	**4.5**	**2.9**	**11.0**	**19.6**	**1.05**
103	ICP-MS/MS	4.57	2.91	10.7	19.9	1.04
107	DRC/CC-ICP-MS	4.04	4.48	15.66 ↑	16.56	4.10 ↑
110	ICP-MS	4.33	2.63	10.1	18.3	0.808
116	ICP-MS/MS	3.71	2.26	8.78	16.7	0.761
147	ICP-MS	4.37	2.75	10.5	18.2	1.02
264	ICP-MS	10.30 ↑	3.73	11.87	22.42	1.24
293	DRC/CC-ICP-MS	4.07	2.67	9.92	18.51	1.13
391	ICP-MS	5.45	3.082	13.473	21.965	0.824
442	ICP-MS/MS	4.55	2.91	10.4	19.5	0.862
597	ICP-MS/MS	4.42	2.63	10.5	18.5	1.12
605	ICP-MS	4.78	2.74	11.5	22.1	<1.00
606	ICP-MS/MS	4.83	2.90	11.7	20.5	1.29
686	ICP-MS	4.90	3.17	11.6	21.7	1.09

Based on the grading criteria for Hg in Urine, 95% 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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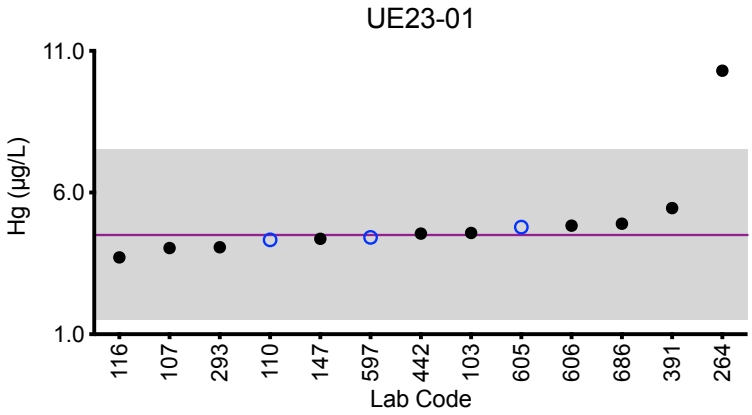
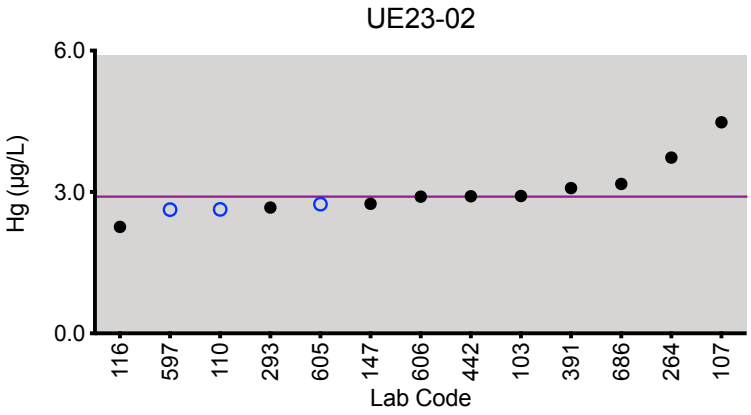
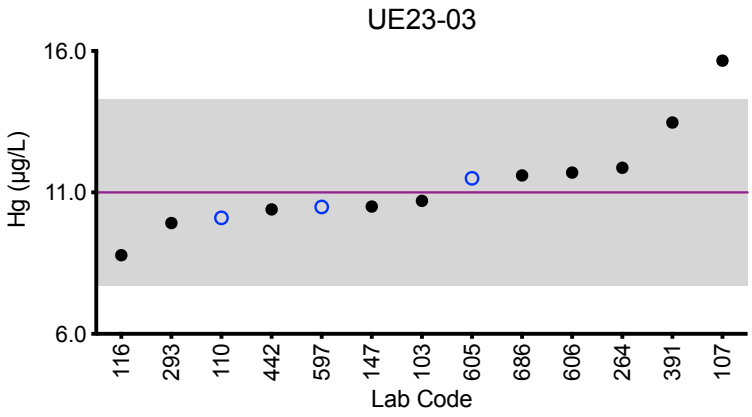
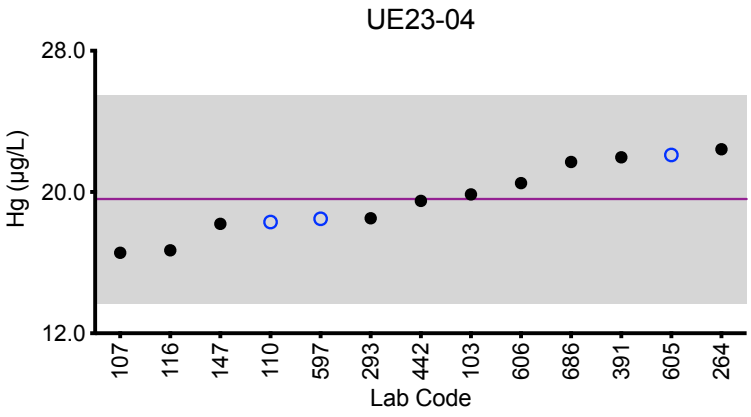
Results for Event #1, 2023: Summary Figures

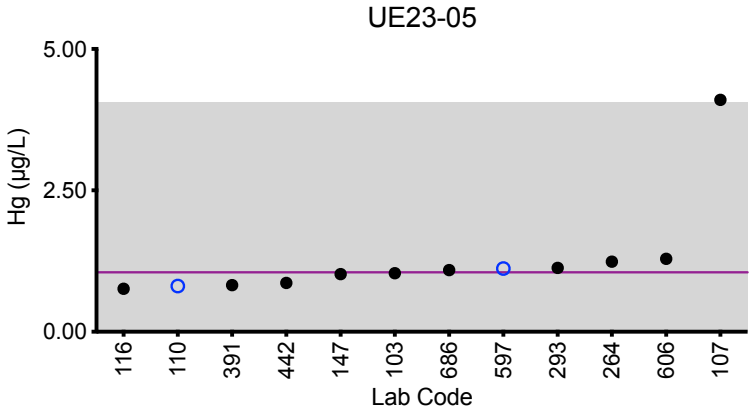
Urine Hg











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 #1, 2023: Summary Statistics

	Urine Mn (µg/L)				
	UE23-01	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
Target (Robust Mean (x*))	1.08	6.2	0.53	2.91	3.9
Upper Limit	1.63	7.8	1.08	3.64	4.9
Lower Limit	0.53	4.7	0.00	2.18	2.9
Robust SD (s*)	0.13	0.4	0.07	0.22	0.3
Robust RSD (%)	12	5.8	13	7.6	7.9
Number of Sample Measurements (N)	14	14	13	14	14
Standard Uncertainty (*u*)	0.04	0.1	0.02	0.07	0.1

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 #1, 2023:
Performance of Participating Laboratories

		Urine Mn (µg/L)				
Lab Code	**Method**	**UE23-01**	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
	Target	**1.08**	**6.2**	**0.53**	**2.91**	**3.9**
103	ICP-MS/MS	0.974	5.77	0.468	2.63	3.67
107	DRC/CC-ICP-MS	0.973	5.731	0.479	2.677	3.518
110	DRC/CC-ICP-MS	1.08	6.46	0.53	2.93	4.02
116	ICP-MS/MS	2.72 ↑	6.45	0.575	2.87	4.36
147	DRC/CC-ICP-MS	1.15	6.65	0.582	3.18	4.29
220	DRC/CC-ICP-MS	1.06	6.43	0.56	2.96	4.03
264	ICP-MS	1.07	6.36	0.55	2.87	4.02
293	DRC/CC-ICP-MS	0.96	6.06	0.43	2.75	3.79
324	ICP-MS	1.069	6.253	<1	3.005	3.875
391	ICP-MS	1.499	4.232 ↓	0.176	3.703 ↑	2.997
399	DRC/CC-ICP-MS	0.923	5.77	0.536	2.66	3.67
597	ICP-MS/MS	1.07	6.05	0.522	2.89	3.89
605	ICP-MS	1.06	6.62	0.748	2.97	3.93
606	ICP-MS/MS	2.03 ↑	6.29	0.604	4.40 ↑	4.92 ↑

Based on the grading criteria for Mn in Urine, 91% of results were satisfactory, with 2 of the 14 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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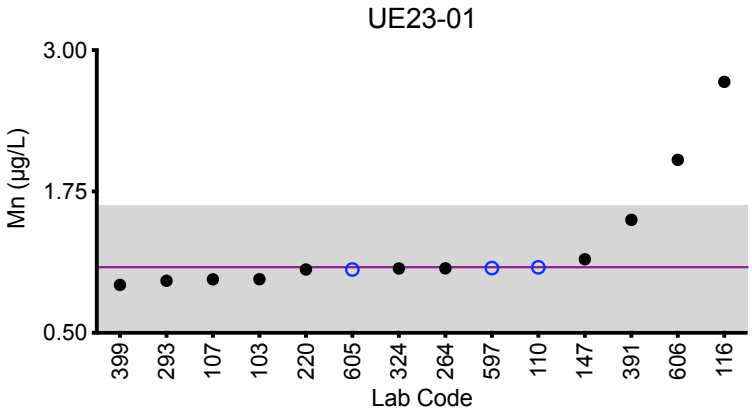
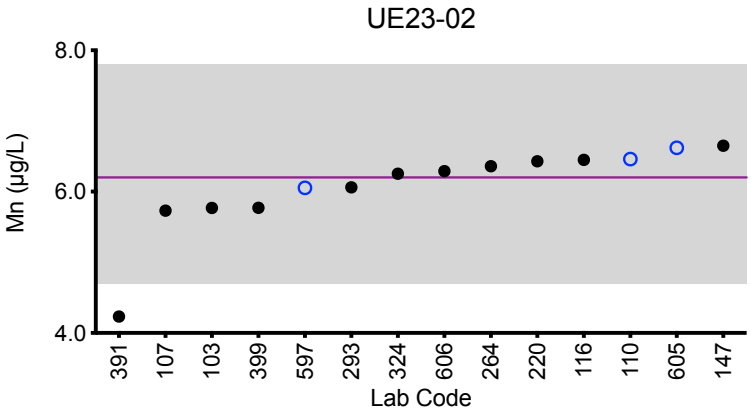
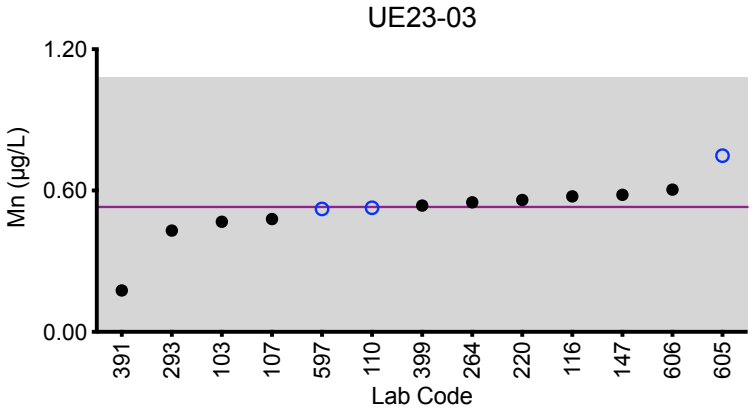
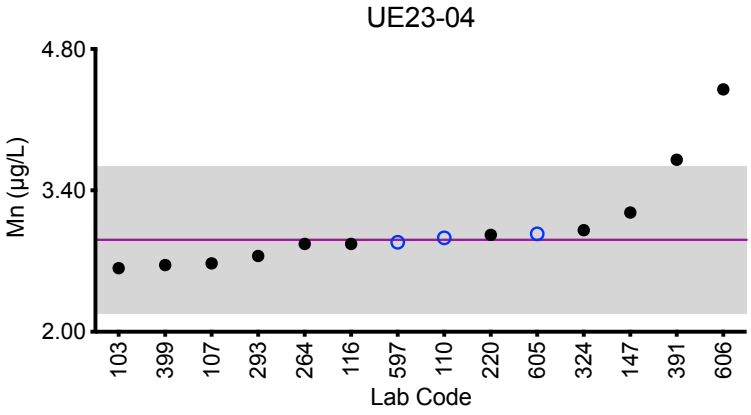
Results for Event #1, 2023: Summary Figures

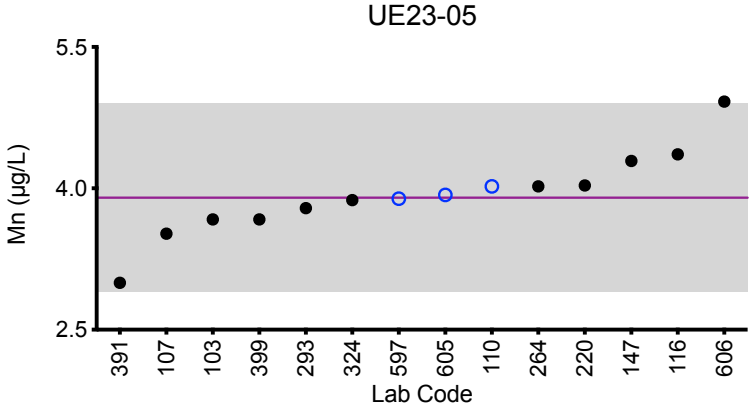
Urine Mn











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 #1, 2023: Summary Statistics

	Urine Pb (µg/L)				
	UE23-01	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
Target (Robust Mean (x*))	1.85	7.75	0.47	4.08	11.1
Upper Limit	2.85	9.30	1.47	5.08	13.3
Lower Limit	0.85	6.20	0.00	3.08	8.9
Robust SD (s*)	0.07	0.22	0.06	0.13	0.4
Robust RSD (%)	3.8	2.8	13	3.2	3.5
Number of Sample Measurements (N)	16	16	15	16	16
Standard Uncertainty (*u*)	0.02	0.07	0.02	0.04	0.1

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 #1, 2023:
Performance of Participating Laboratories

		Urine Pb (µg/L)				
Lab Code	**Method**	**UE23-01**	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
	Target	**1.85**	**7.75**	**0.47**	**4.08**	**11.1**
103	ICP-MS/MS	1.88	7.72	0.438	4.21	11.2
107	ICP-MS	1.874	7.834	0.472	4.065	11.416
110	ICP-MS	1.78	7.59	0.43	3.93	10.7
116	ICP-MS/MS	1.80	7.27	0.415	3.93	10.2
147	ICP-MS	1.87	7.77	0.450	4.06	10.9
220	ICP-MS	1.81	7.90	0.39	4.18	11.4
264	ICP-MS	2.07	8.15	0.50	4.16	11.53
293	DRC/CC-ICP-MS	1.85	7.68	0.86	3.96	11.1
324	ICP-MS	1.875	7.766	<1	4.112	10.756
391	ICP-MS	1.682	7.083	0.538	3.773	10.133
399	ICP-MS/MS	1.83	7.71	0.523	4.07	11.1
442	ICP-MS/MS	1.94	7.89	0.497	4.18	11.3
597	ICP-MS/MS	1.78	7.60	0.453	3.99	10.9
605	ICP-MS	1.93	8.28	0.457	4.28	11.7
606	ICP-MS/MS	1.78	7.61	0.409	4.08	11.4
686	ICP-MS	1.89	7.95	0.518	4.17	11.3

Based on the grading criteria for Pb in Urine, 100% of results were satisfactory, with 0 of the 16 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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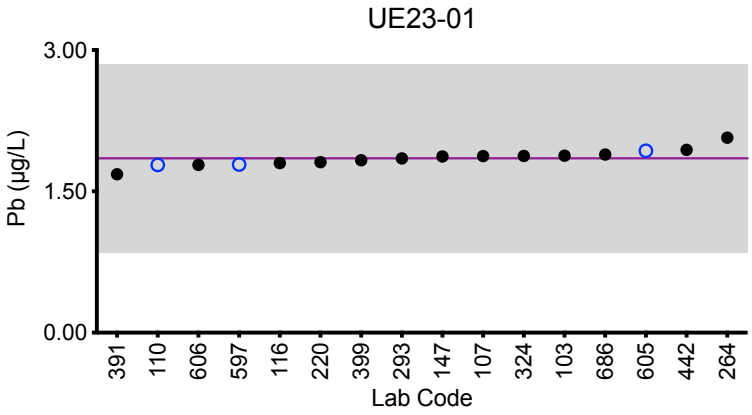
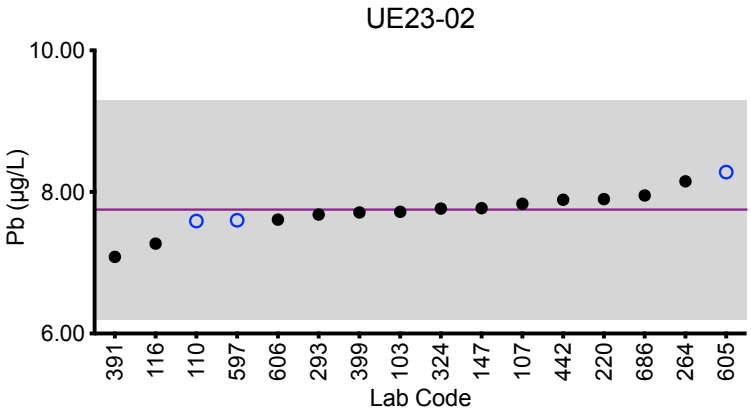
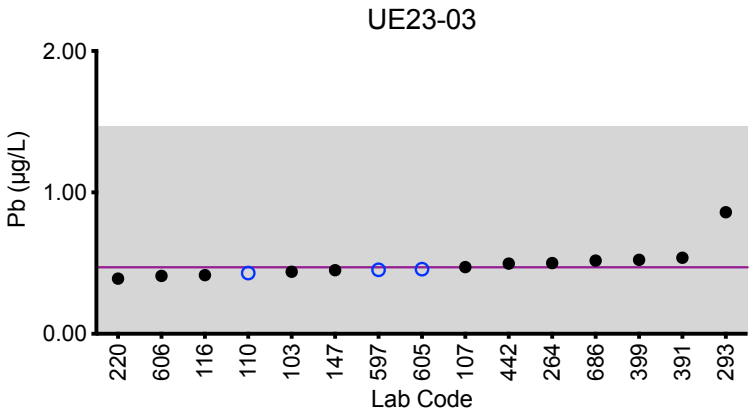
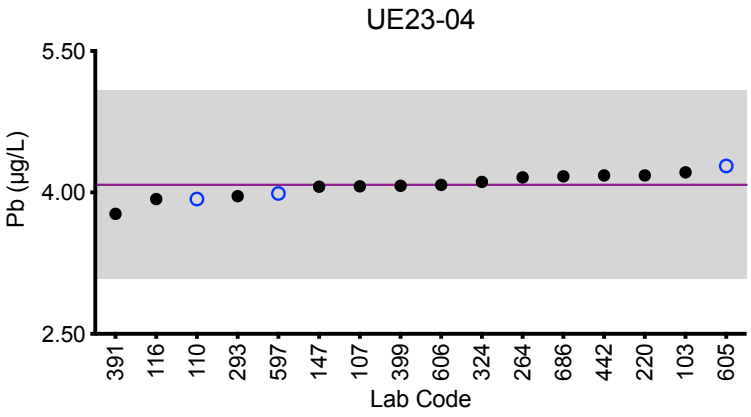
Results for Event #1, 2023: Summary Figures

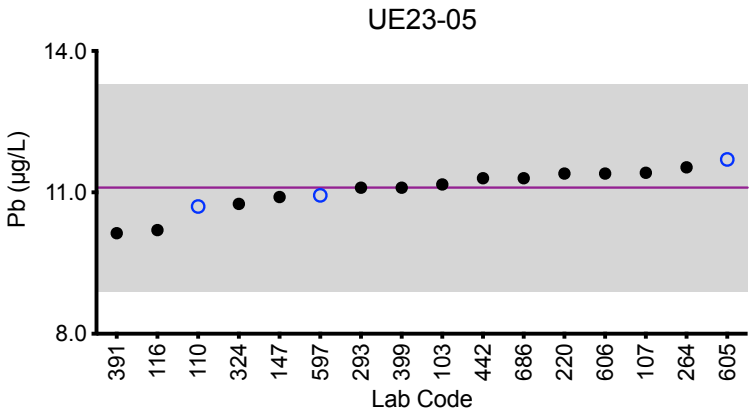
Urine Pb











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 #1, 2023: Summary Statistics

Urine Tl (µg/L)					
	UE23-01	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
Target (Robust Mean (x*))	3.85	0.232	1.60	0.76	3.05
Upper Limit	4.62	0.432	1.92	0.96	3.66
Lower Limit	3.08	0.032	1.28	0.56	2.44
Robust SD (s*)	0.09	0.025	0.06	0.03	0.12
Robust RSD (%)	2.3	11	3.8	4.6	3.9
Number of Sample Measurements (N)	14	14	14	14	14
Standard Uncertainty (*u*)	0.03	0.008	0.02	0.01	0.04

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 #1, 2023:
Performance of Participating Laboratories

Urine Tl (µg/L)						
Lab Code	**Method**	**UE23-01**	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
	Target	**3.85**	**0.232**	**1.60**	**0.76**	**3.05**
103	ICP-MS/MS	3.86	0.219	1.62	0.787	3.07
107	ICP-MS	3.872	0.226	1.583	0.762	2.996
110	ICP-MS	3.81	0.233	1.57	0.751	3.03
116	ICP-MS/MS	3.49	0.384	1.54	0.650	2.68
147	ICP-MS	4.27	0.258	1.74	0.816	3.41
220	ICP-MS	3.83	0.20	1.58	0.74	3.00
264	ICP-MS	4.00	0.24	1.66	0.79	3.18
293	DRC/CC-ICP-MS	4.05	0.25	1.6	0.78	3.12
391	ICP-MS	3.431	0.206	1.434	0.662	2.696
399	ICP-MS/MS	3.83	0.230	1.57	0.738	3.03
597	ICP-MS/MS	3.88	0.245	1.64	0.767	3.16
605	ICP-MS	4.04	0.253	1.70	0.777	3.12
606	ICP-MS/MS	3.78	0.226	1.61	0.759	2.96
686	ICP-MS	3.81	0.148	1.52	0.677	3.05

Based on the grading criteria for Tl in Urine, 100% of results were satisfactory, with 0 of the 14 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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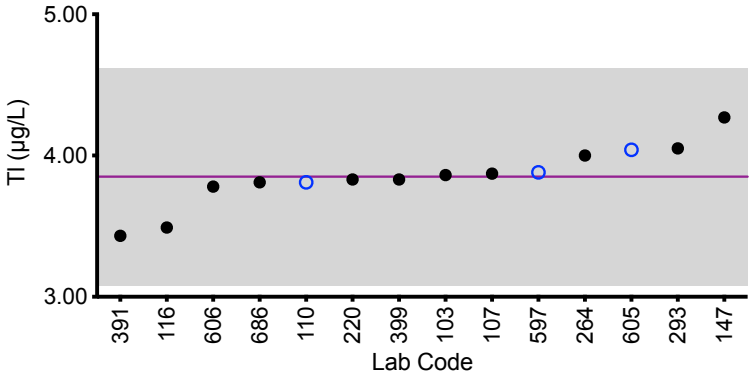
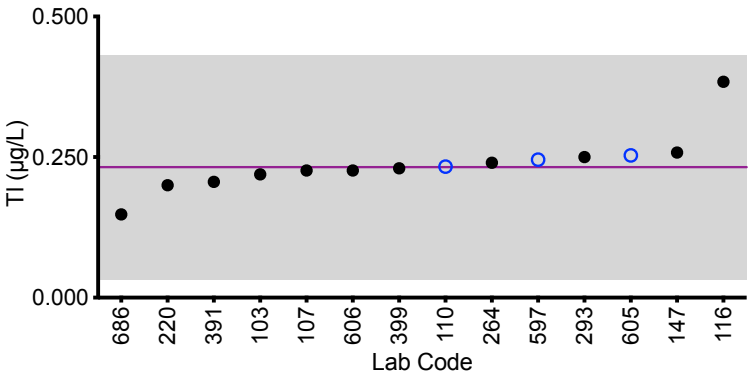
Results for Event #1, 2023: Summary Figures

Urine Tl

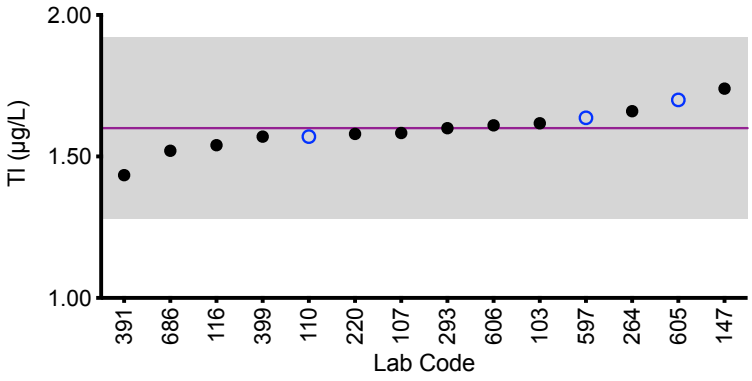
UE23-01



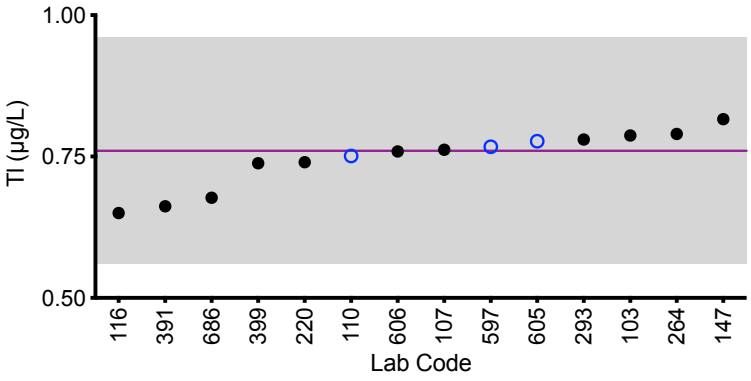
UE23-02



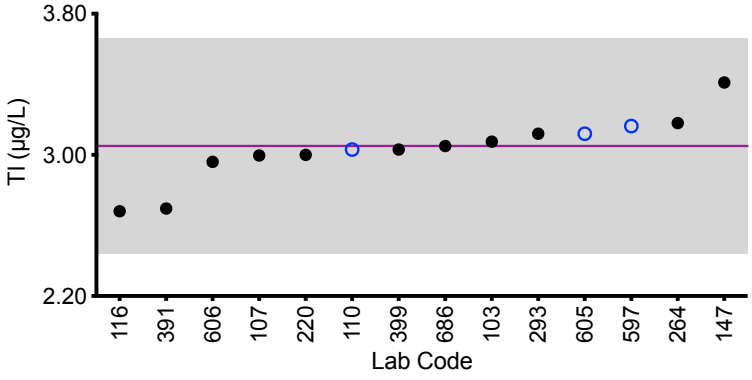
UE23-03



UE23-04



UE23-05



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 #1, 2023: Summary Statistics

	Urine U (µg/L)				
	UE23-01	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
Target (Robust Mean (x*))	0.0217	0.154	0.005	0.127	0.100
Upper Limit	0.0517	0.185	0.035	0.157	0.130
Lower Limit	0.0000	0.123	0.000	0.097	0.070
Robust SD (s*)	0.0020	0.008	0.001	0.009	0.008
Robust RSD (%)	9.2	5.2	9.8	7.1	8.4
Number of Sample Measurements (N)	14	14	6	14	14
Standard Uncertainty (*u*)	0.0007	0.003	NA	0.003	0.003

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.

An arithmetic mean, SD, RSD and n are provided for sample UE23-03.

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Results for Event #1, 2023:
Performance of Participating Laboratories

Urine U (µg/L)						
Lab Code	**Method**	**UE23-01**	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
	Target	**0.0217**	**0.154**	**0.005**	**0.127**	**0.100**
103	ICP-MS/MS	0.0205	0.154	<0.0200	0.123	0.0937
107	ICP-MS	0.138 ↑	1.350 ↑	*4.656 ↑	0.670 ↑	2.026 ↑
110	ICP-MS	0.0200	0.156	0.0051	0.123	0.100
116	ICP-MS/MS	0.0230	0.147	<0.0150	0.131	0.0930
147	ICP-MS	0.0203	0.150	<0.00809	0.118	0.0971
220	ICP-MS	0.021	0.153	0.0056	0.125	0.103
264	ICP-MS	0.02	0.14	<0.01	0.12	0.09
324	ICP-MS	0.019	0.143	0.005	0.115	0.086
391	ICP-MS	0.034	0.169	*0.028	0.151	0.135 ↑
399	ICP-MS/MS	0.023	0.176	0.006	0.140	0.110
597	ICP-MS/MS	0.0228	0.152	0.00478	0.131	0.101
605	ICP-MS	0.022	0.158	0.006	0.130	0.101
606	ICP-MS/MS	0.021	0.153	<0.005	0.121	0.099
686	ICP-MS	0.0219	0.159	<0.0150	0.126	0.102

Based on the grading criteria for U in Urine, 91% 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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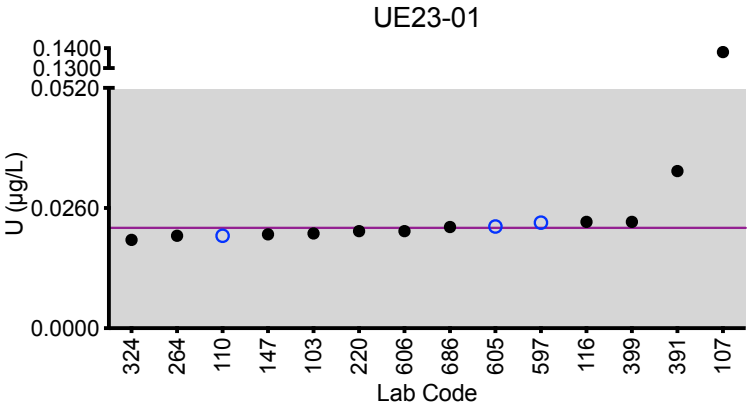
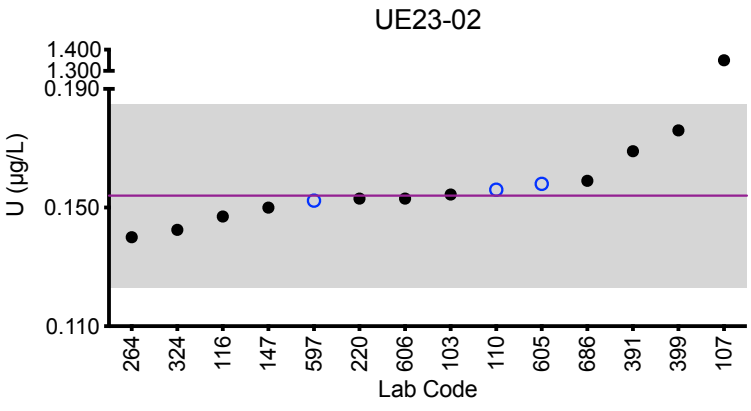
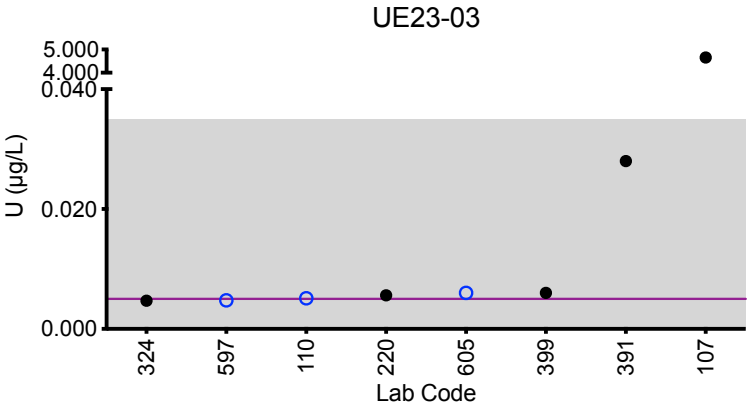
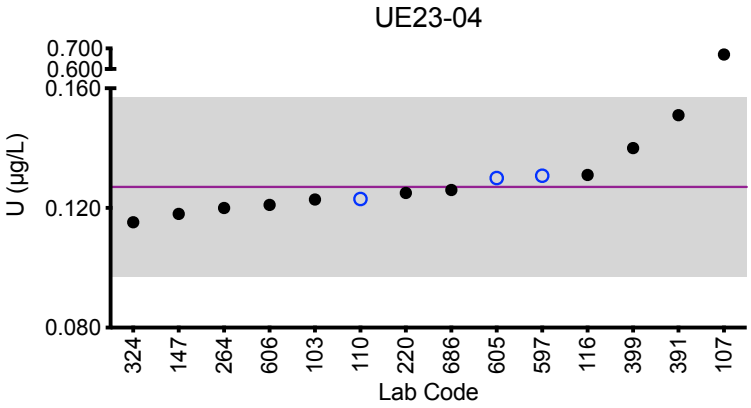
Results for Event #1, 2023: Summary Figures

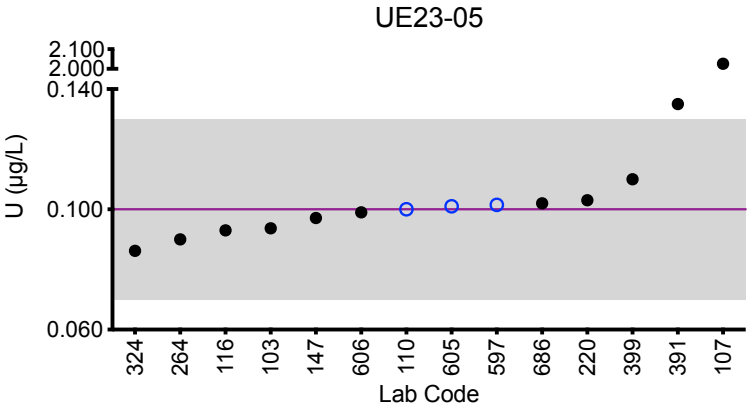
Urine U











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 #1, 2023:
Laboratory Data and Summary Statistics

Urine Al (µg/L)

Lab Code	Method	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
147	ICP-MS	<13.8	<13.8	<13.8	17.6	20.9
264	ICP-MS	7.07	9.78	8.47	19.68	20.75
293	DRC/CC-ICP-MS	7.82	12.95	8.9	19.43	17.27
324	ICP-MS	8.220	11.281	9.977	19.607	19.759
391	ICP-MS	11.823	12.567	11.434	19.151	20.788
597	ICP-MS/MS	4.94	6.38	<4.03	17.6	17.8

Summary Statistics

	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
Arithmetic Mean ($\bar{x}$)	8	11	9.7	18.8	19.5
Arithmetic SD (s)	2	3	1.3	1.0	1.6
Arithmetic RSD (%)	31	25	13	5.3	8.2
Number of Sample Measurements (N)	5	5	4	6	6

*Denotes a statistical Outlier.

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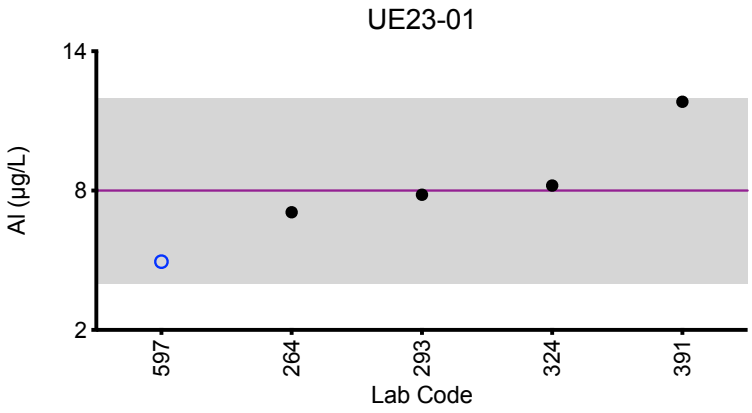
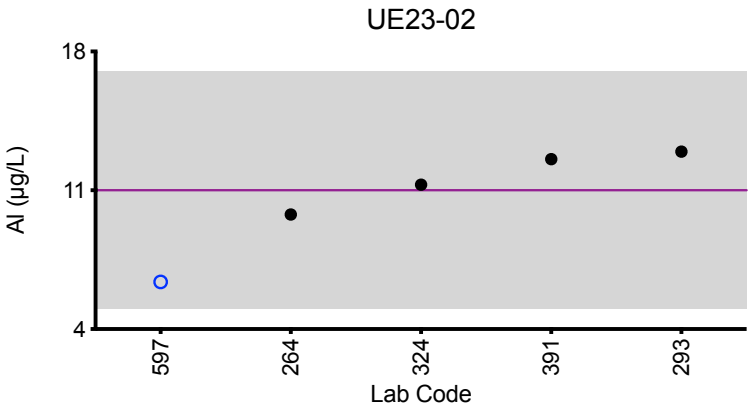
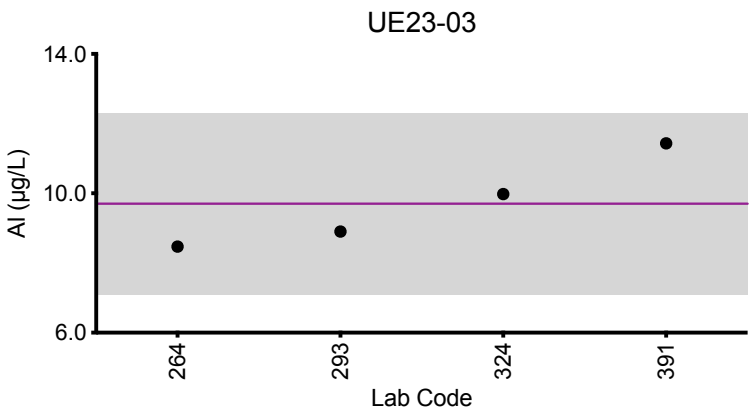
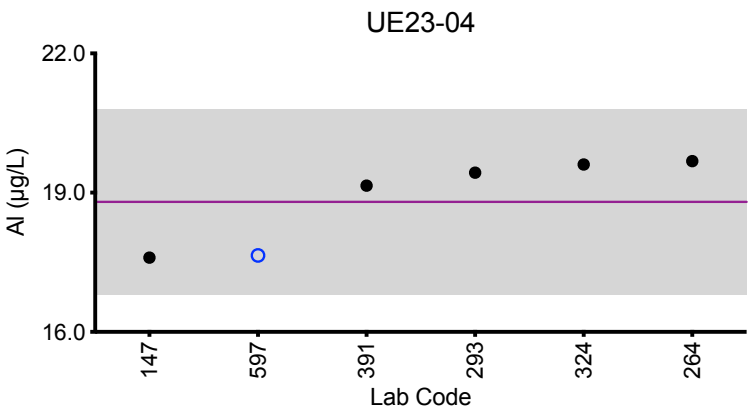
Results for Event #1, 2023: Summary Figures

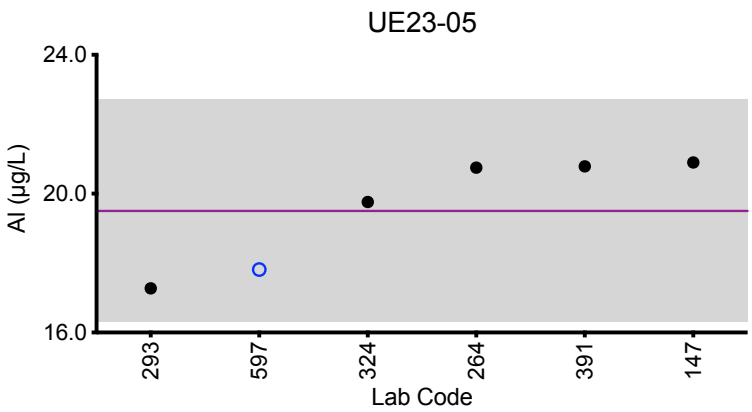
Urine Al











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 #1, 2023:
Laboratory Data and Summary Statistics

Urine Cs (µg/L)

Lab Code	Method	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
107	ICP-MS	3.35	8.26	1.63	2.82	10.81
110	ICP-MS	3.69	9.40	1.83	3.16	12.1
147	ICP-MS	3.51	8.73	1.75	2.86	11.1
220	ICP-MS	3.61	9.14	1.85	3.12	11.8
264	ICP-MS	3.30	8.41	1.66	2.87	10.70
399	ICP-MS/MS	3.46	8.86	1.73	2.90	11.1
597	ICP-MS/MS	3.26	8.37	1.67	2.87	10.7
605	ICP-MS	3.69	9.06	1.79	3.07	11.9
606	ICP-MS/MS	3.35	8.47	1.69	2.88	10.9

Summary Statistics

	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
Arithmetic Mean ($\bar{x}$)	3.47	8.7	1.73	2.95	11.2
Arithmetic SD (s)	0.17	0.4	0.08	0.13	0.5
Arithmetic RSD (%)	4.9	4.6	4.6	4.4	4.5
Number of Sample Measurements (N)	9	9	9	9	9

*Denotes a statistical Outlier.

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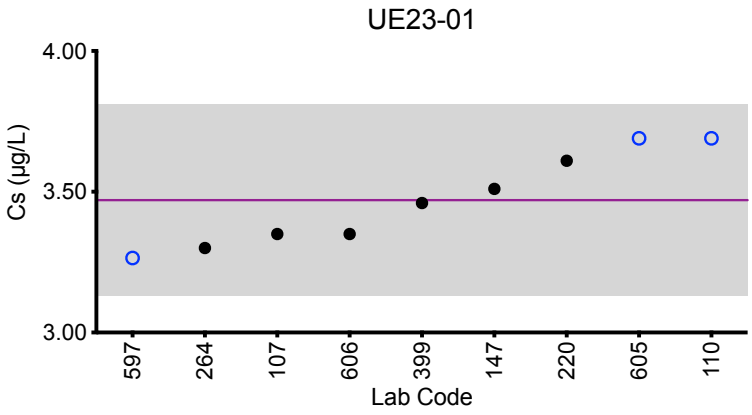
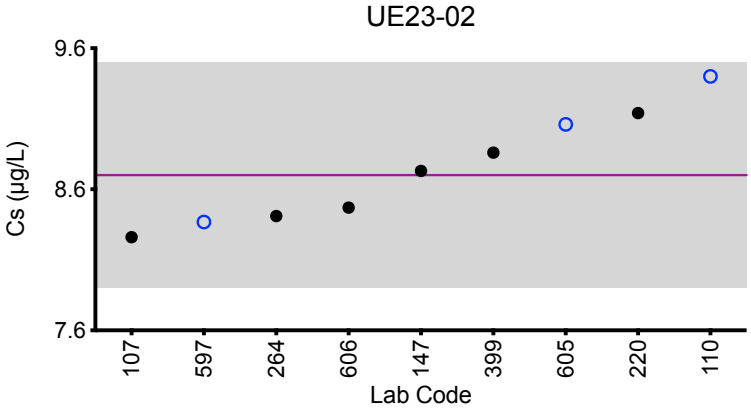
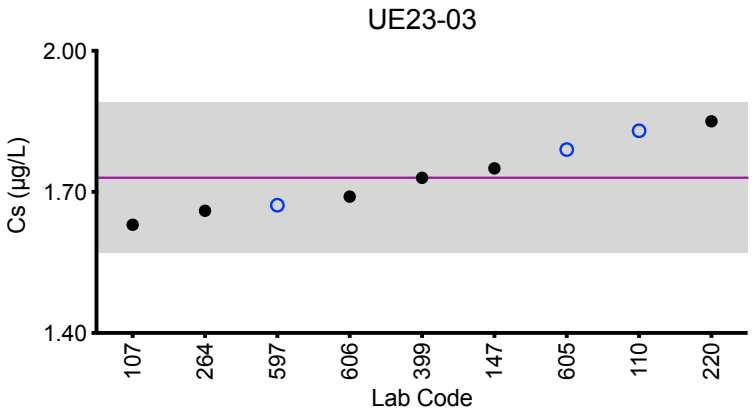
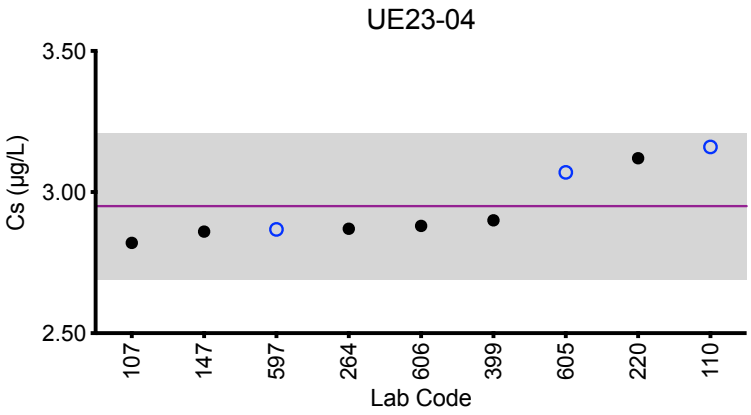
Results for Event #1, 2023: Summary Figures

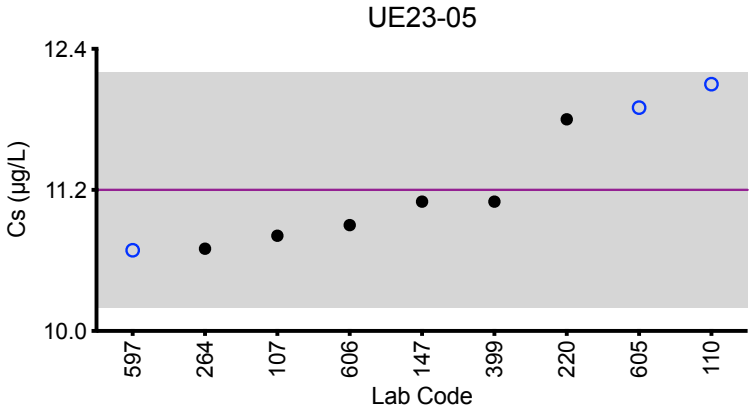
Urine Cs











Legend:
o HHEAR Labs ● Other Labs
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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Urine Cu (µg/L)						
Lab Code	**Method**	**UE23-01**	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
110	ICP-MS	27.2	76.1	39.2	*16.5	*15.8
116	ICP-MS/MS	20.1	67.5	33.0	5.54	7.86
147	ICP-MS	28.9	83.2	43.2	*18.7	*17.2
264	ICP-MS	26.84	77.54	37.17	6.39	9.50
293	DRC/CC-ICP-MS	19.07	64.84	31.15	5.09	7.63
324	ICP-MS	20.729	71.618	33.826	6.018	8.821
391	ICP-MS	16.141	58.472	28.009	4.36	7.63
597	ICP-MS/MS	21.4	70.6	34.8	6.93	9.48

Summary Statistics					
	UE23-01	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
Arithmetic Mean ($\bar{x}$)	23	71	35	5.7	8.5
Arithmetic SD (s)	5	8	5	0.9	0.9
Arithmetic RSD (%)	22	11	14	16	11
Number of Sample Measurements (N)	8	8	8	6	6

*Denotes a statistical Outlier.

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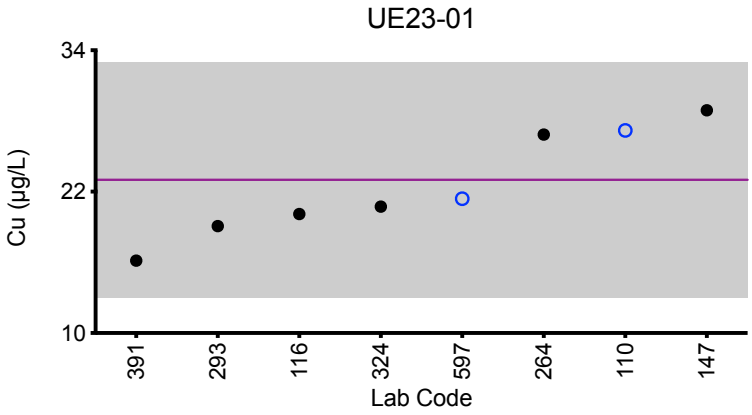
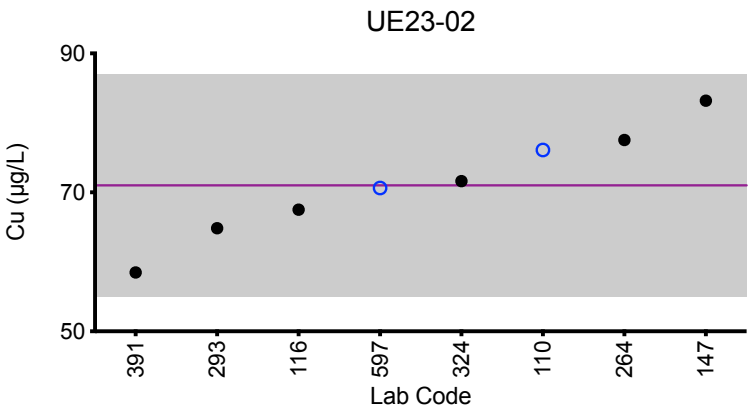
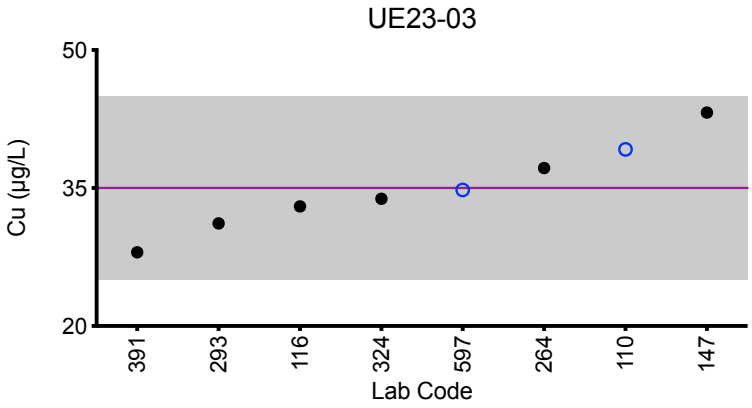
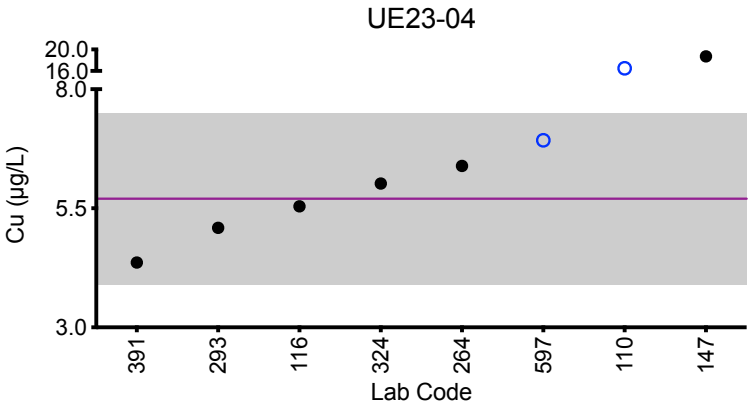
Results for Event #1, 2023: Summary Figures

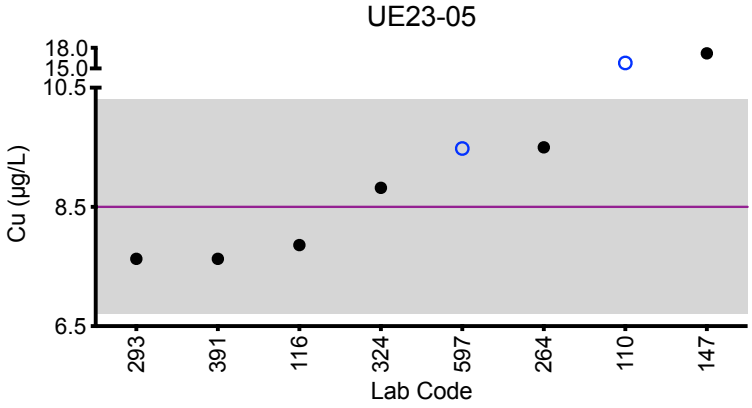
Urine Cu











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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Urine Mo (µg/L)

Lab Code	Method	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
103	ICP-MS/MS	91.7	16.5	61.4	38.6	48.9
107	ICP-MS	89.84	16.37	60.29	38.90	45.32
110	ICP-MS	99.5	18.4	65.8	42.5	52.0
147	ICP-MS	91.0	16.8	61.5	38.1	47.1
220	ICP-MS	96.0	17.8	65.6	41.6	49.9
264	ICP-MS	80.18	17.09	53.75	37.29	40.05
293	DRC/CC-ICP-MS	91.36	17.18	59.61	37.5	47.64
324	ICP-MS	92.770	16.928	61.732	38.058	46.782
399	ICP-MS/MS	95.3	17.4	64.2	40.2	48.6
597	ICP-MS/MS	87.9	16.1	60.4	37.2	46.4
605	ICP-MS	97.1	18.2	65.2	41.7	49.1
606	ICP-MS/MS	94.2	17.3	62.4	39.6	49.0

Summary Statistics

	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
Robust Mean (x*)	93	17.2	62	39.2	47.9
Robust SD (s*)	4	0.8	3	2.0	1.9
Robust RSD (%)	4.4	4.7	4.5	5.1	4.0
Number of Sample Measurements (N)	12	12	12	12	12
Standard Uncertainty (*u*)	1	0.3	1	0.7	0.7

*Denotes a statistical Outlier.

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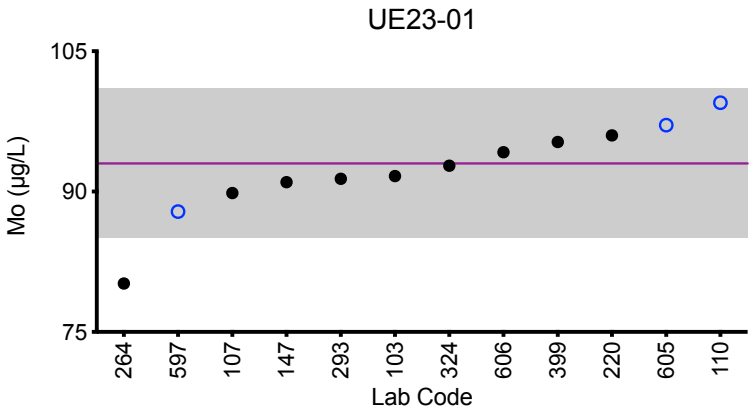
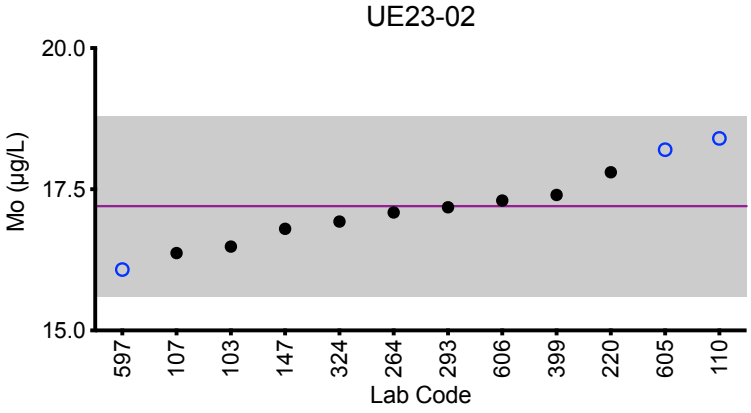
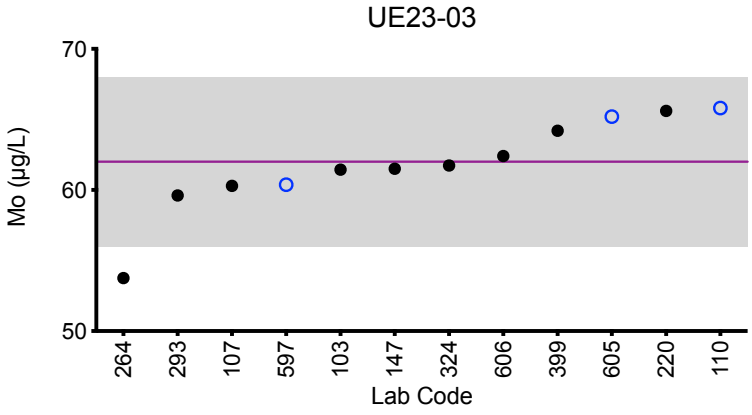
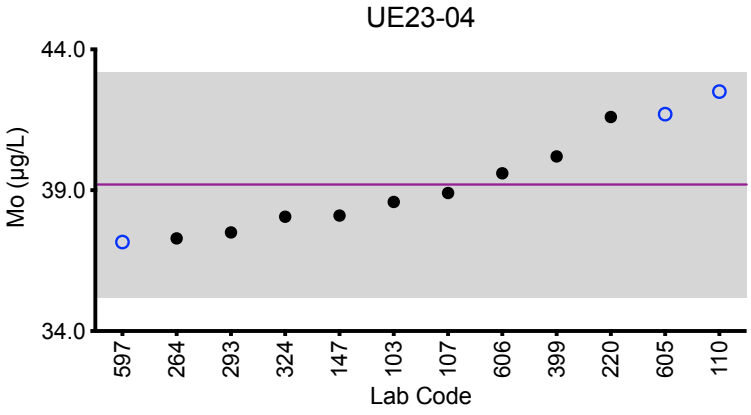
Results for Event #1, 2023: Summary Figures

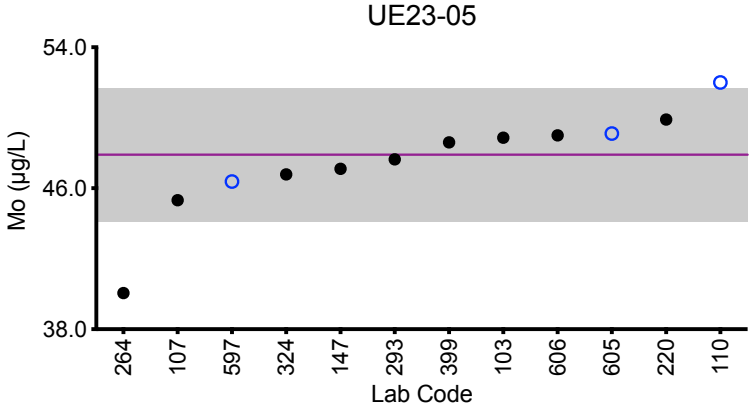
Urine Mo











Legend:
o HHEAR Labs ● Other Labs
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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Urine Ni (µg/L)

Lab Code	Method	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
103	ICP-MS/MS	4.71	3.23	5.90	1.55	7.71
107	DRC/CC-ICP-MS	4.99	3.17	6.83	1.41	8.40
110	ICP-MS	5.93	4.11	8.02	4.49	9.21
147	ICP-MS	5.24	3.42	6.69	1.64	8.57
264	ICP-MS	5.45	3.45	6.95	1.89	8.76
293	DRC/CC-ICP-MS	5.23	3.36	6.84	2.67	8.23
324	ICP-MS	5.210	3.640	6.266	2.519	7.894
391	ICP-MS	8.191	4.91	6.631	2.219	12.202
442	DRC/CC-ICP-MS	5.3	3.31	6.96	1.71	8.03
597	ICP-MS/MS	5.26	3.29	6.52	1.94	8.41
605	ICP-MS	5.14	3.35	6.88	1.66	8.61

Summary Statistics

	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
Robust Mean (x*)	5.25	3.39	6.77	2.0	8.5
Robust SD (s*)	0.18	0.15	0.23	0.5	0.5
Robust RSD (%)	3.4	4.4	3.4	25	5.9
Number of Sample Measurements (N)	11	11	11	11	11
Standard Uncertainty (*u*)	0.07	0.06	0.09	0.2	0.2

*Denotes a statistical Outlier.

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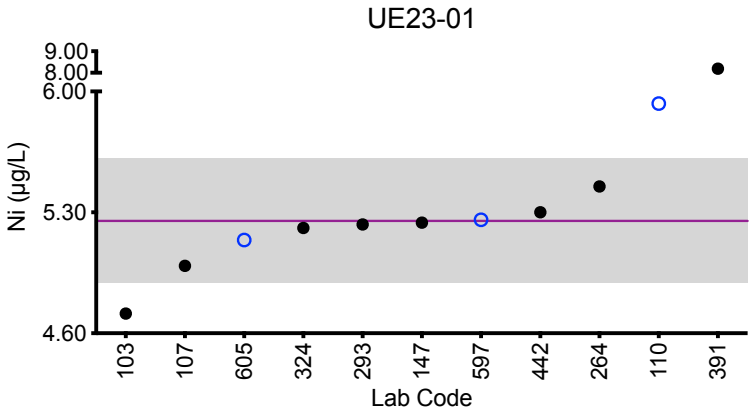
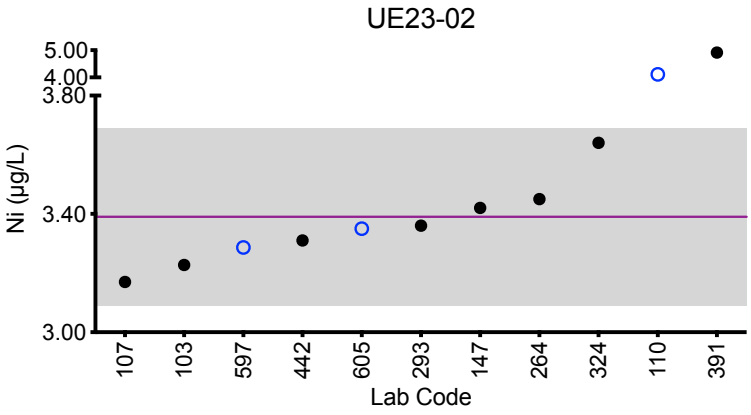
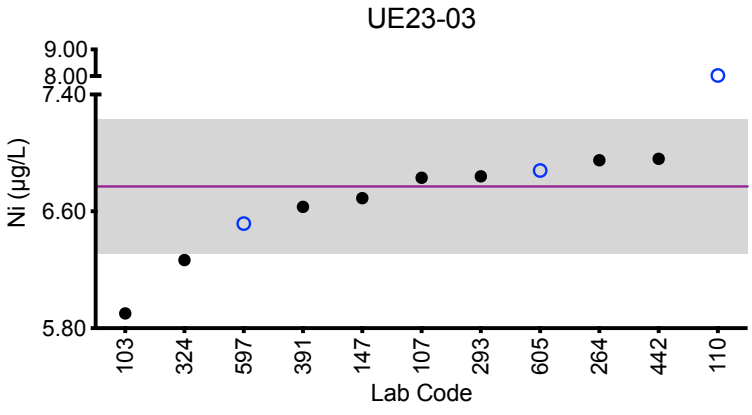
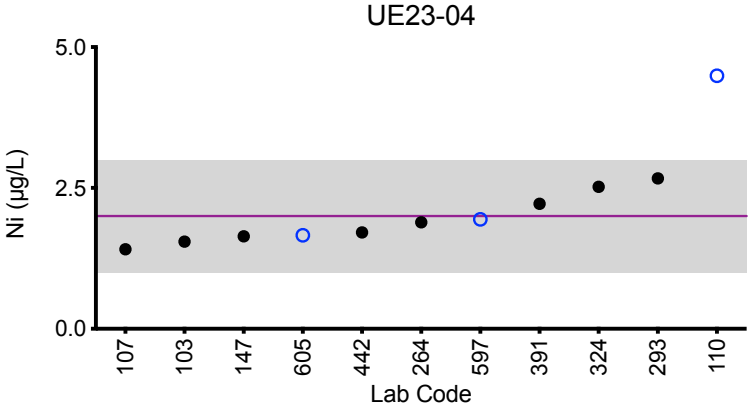
Results for Event #1, 2023: Summary Figures

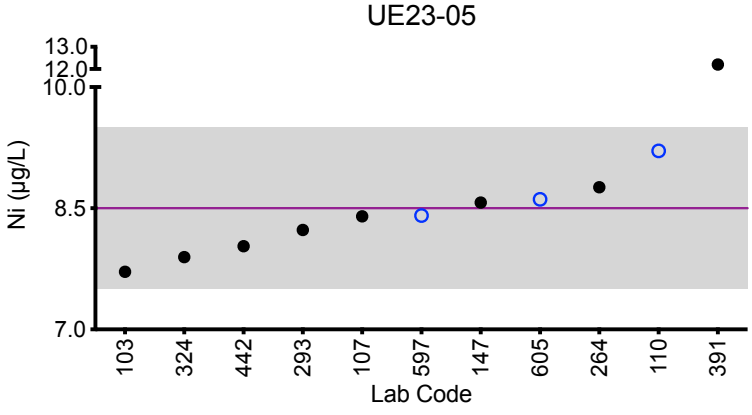
Urine Ni











Legend:

o HHEAR Labs ● Other Labs

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Urine Pt (µg/L)

Lab Code	Method	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
107	ICP-MS	0.2953	2.0123	0.6916	1.0894	3.0068
110	ICP-MS	0.308	2.01	0.681	1.10	3.10
220	ICP-MS	*0.25	*1.64	*0.57	0.93	2.55
264	ICP-MS	0.32	1.99	0.67	1.06	2.60
293	DRC/CC-ICP-MS	0.3	2.07	0.65	1.02	2.89
399	ICP-MS/MS	0.293	2.02	0.668	1.08	2.97
605	ICP-MS	0.312	2.07	0.685	1.11	2.91

Summary Statistics

	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
Arithmetic Mean ($\bar{x}$)	0.305	2.03	0.674	1.06	2.86
Arithmetic SD (s)	0.010	0.03	0.015	0.06	0.21
Arithmetic RSD (%)	3.3	1.6	2.2	5.7	7.3
Number of Sample Measurements (N)	6	6	6	7	7

*Denotes a statistical Outlier.

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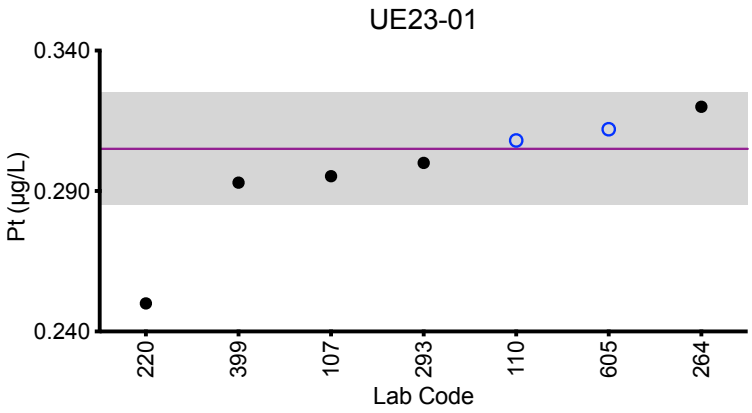
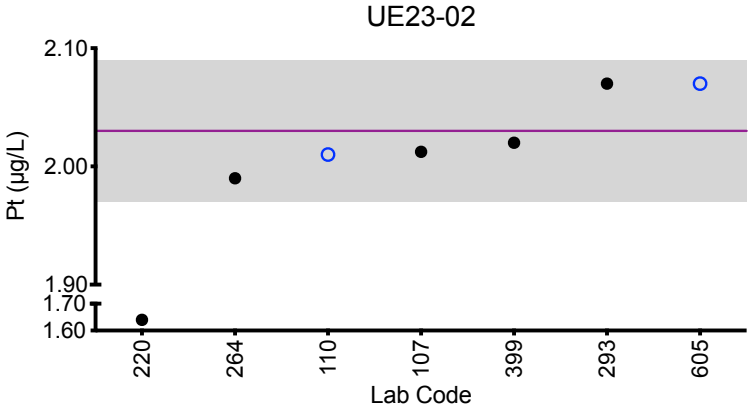
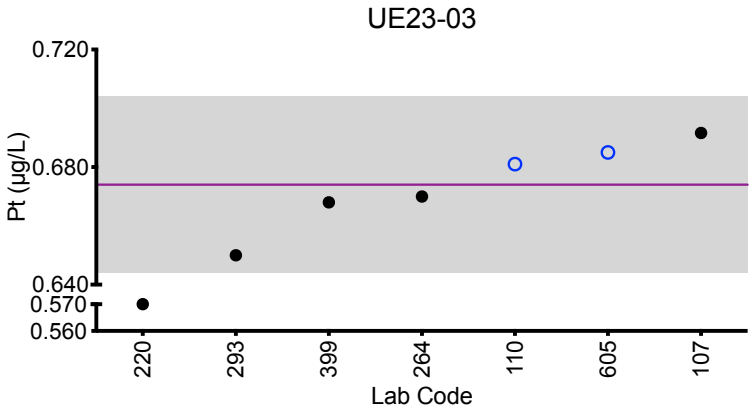
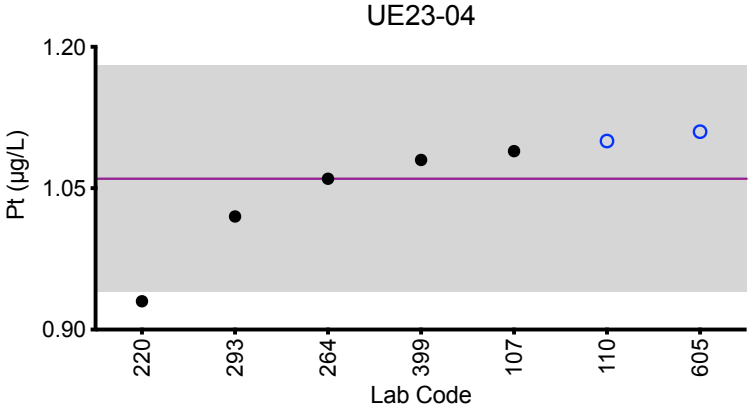
Results for Event #1, 2023: Summary Figures

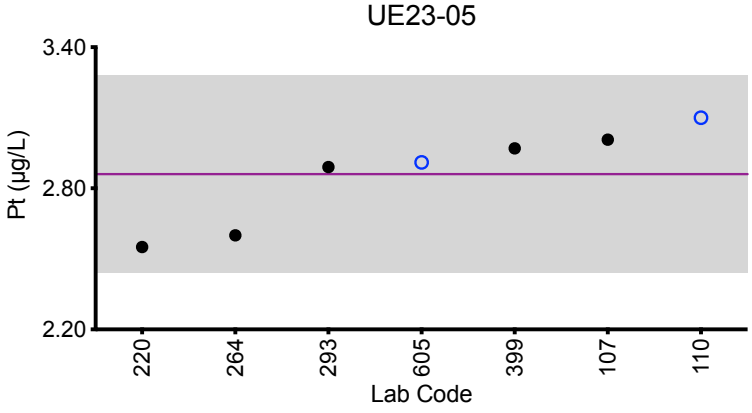
Urine Pt











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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Urine Sb (µg/L)

Lab Code	Method	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
103	ICP-MS/MS	2.18	1.20	0.855	0.380	0.582
107	ICP-MS	2.861	1.494	0.899	0.390	0.555
110	ICP-MS	2.96	1.59	0.896	0.420	0.566
147	ICP-MS	2.87	1.57	0.933	0.400	0.558
220	ICP-MS	2.85	1.66	0.96	0.45	0.52
264	ICP-MS	2.39	1.34	0.80	0.34	0.45
293	DRC/CC-ICP-MS	2.8	1.62	0.89	0.41	0.62
324	ICP-MS	2.940	1.605	<1	<1	<1
399	ICP-MS/MS	2.90	1.55	0.929	0.403	0.567
597	ICP-MS/MS	2.69	1.51	0.863	0.420	0.555
605	ICP-MS	2.91	1.67	0.807	<0.800	<0.800
606	ICP-MS/MS	2.90	1.61	0.940	0.433	0.526

Summary Statistics

	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
Robust Mean (x*)	2.85	1.57	0.89	0.41	0.55
Robust SD (s*)	0.09	0.08	0.06	0.02	0.03
Robust RSD (%)	3.2	5.1	6.7	6.1	5.4
Number of Sample Measurements (N)	12	12	11	10	10
Standard Uncertainty (*u*)	0.03	0.03	0.02	0.01	0.01

*Denotes a statistical Outlier.

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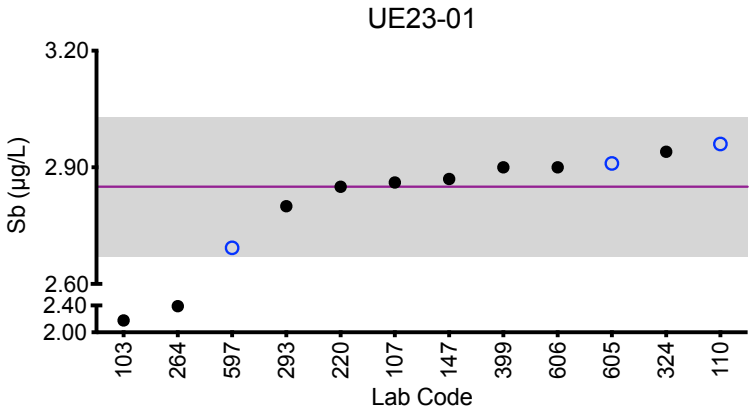
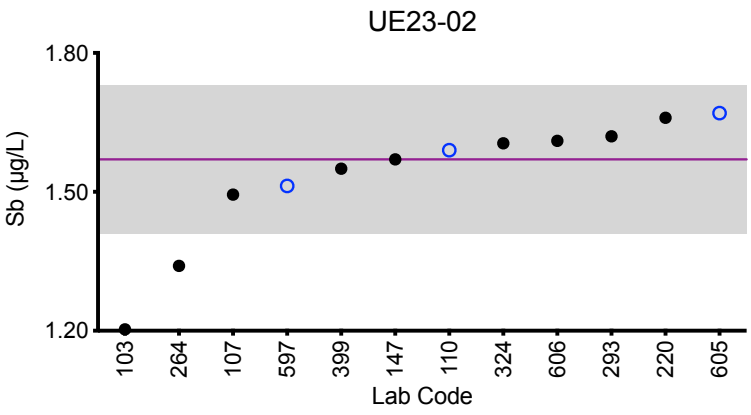
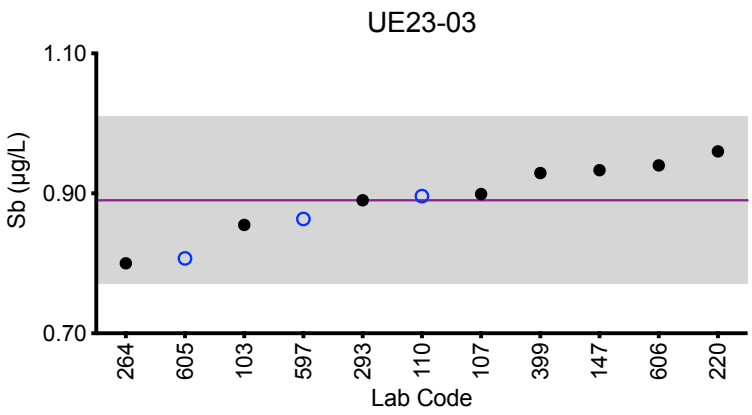
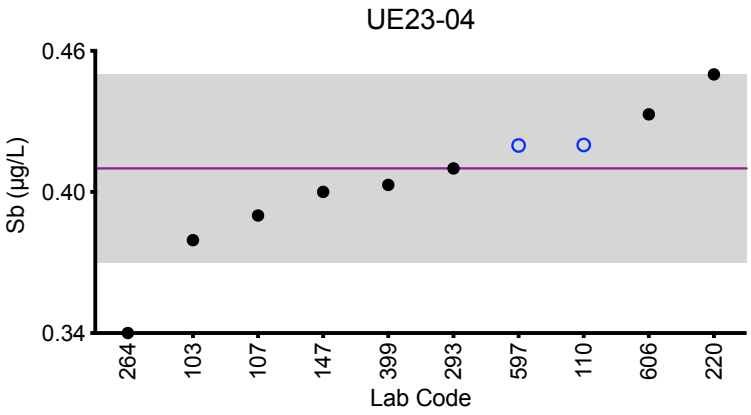
Results for Event #1, 2023: Summary Figures

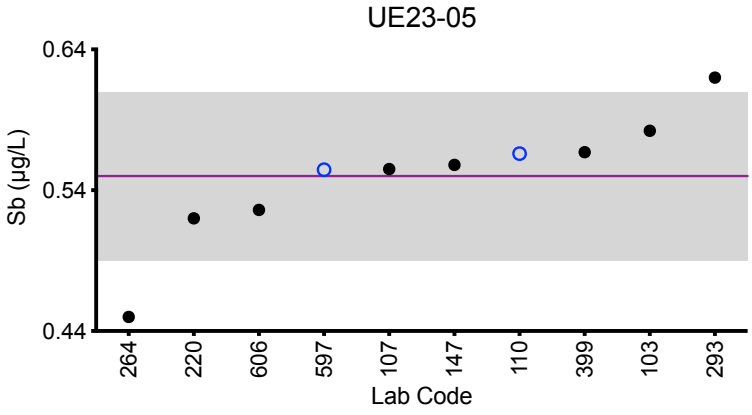
Urine Sb











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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Urine Se (µg/L)

Lab Code	Method	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
103	ICP-MS/MS	74.7	205	160	292	79.5
110	DRC/CC-ICP-MS	75.7	217	167	324	88.7
147	ICP-MS	75.5	209	159	289	78.8
293	DRC/CC-ICP-MS	64.77	186.41	141.39	265.4	72.67
597	ICP-MS/MS	78.8	224	176	314	88.6

Summary Statistics

	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
Arithmetic Mean ($\bar{x}$)	74	208	161	297	82
Arithmetic SD (s)	5	14	13	23	7
Arithmetic RSD (%)	6.8	6.7	8.1	7.7	8.5
Number of Sample Measurements (N)	5	5	5	5	5

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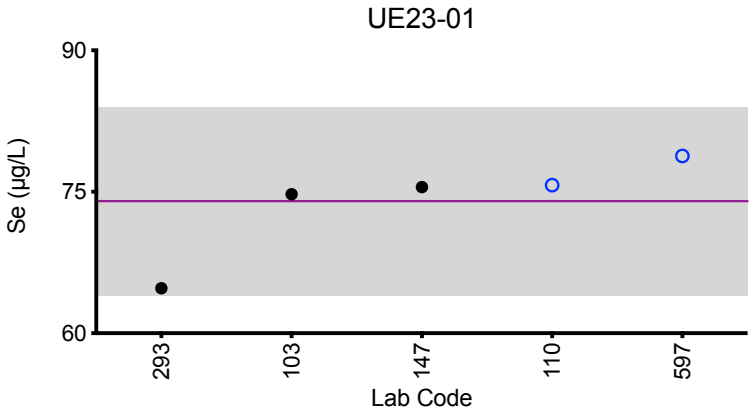
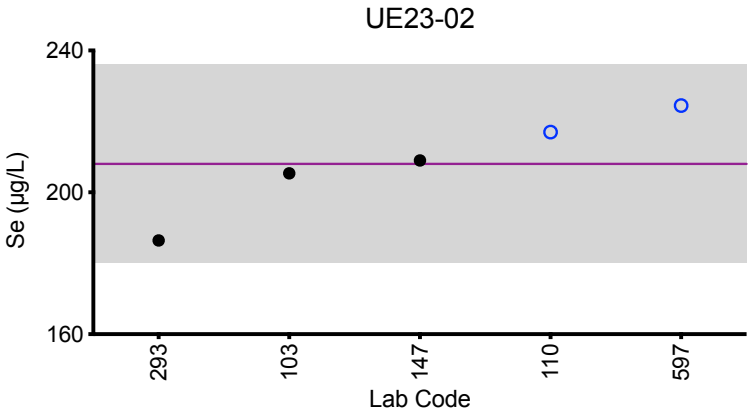
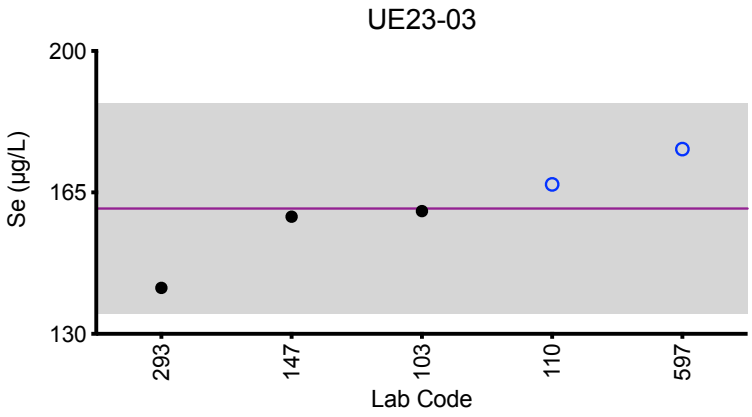
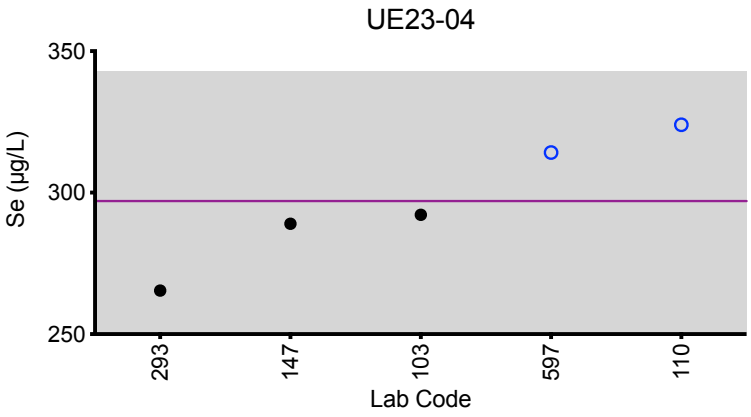
Results for Event #1, 2023: Summary Figures

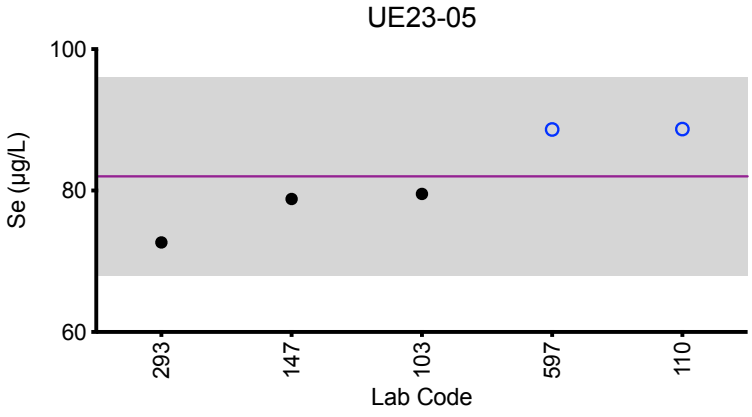
Urine Se











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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Urine Sn (µg/L)

Lab Code	Method	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
107	ICP-MS	0.30	4.00	0.64	1.62	0.75
110	ICP-MS	0.30	4.37	0.61	2.57	0.85
147	ICP-MS	0.277	4.24	0.481	1.78	0.716
220	ICP-MS	<0.4	4.31	<0.4	2.01	0.62
264	ICP-MS	*0.15	3.49	0.21	0.90	0.46
324	ICP-MS	<1	4.272	<1	2.288	<1
399	ICP-MS/MS	0.318	5.08	0.590	2.13	0.867
597	ICP-MS/MS	0.267	4.48	0.448	1.75	0.738
605	ICP-MS	<0.900	4.63	<0.900	2.42	<0.900

Summary Statistics

	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
Arithmetic Mean ($\bar{x}$)	0.292	4.3	0.50	1.9	0.71
Arithmetic SD (s)	0.020	0.4	0.16	0.5	0.14
Arithmetic RSD (%)	6.8	10	32	26	20
Number of Sample Measurements (N)	5	9	6	9	7

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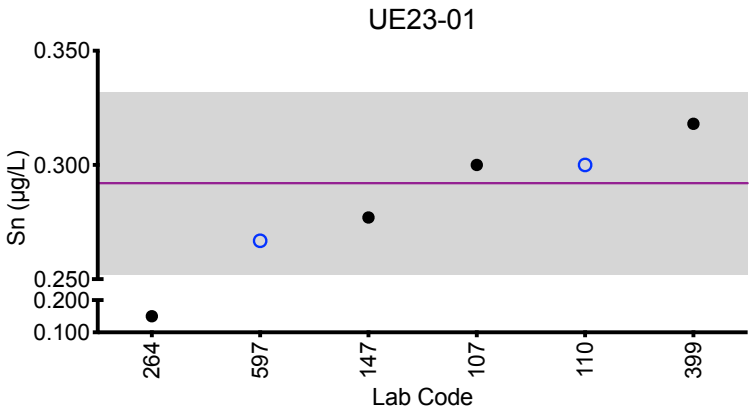
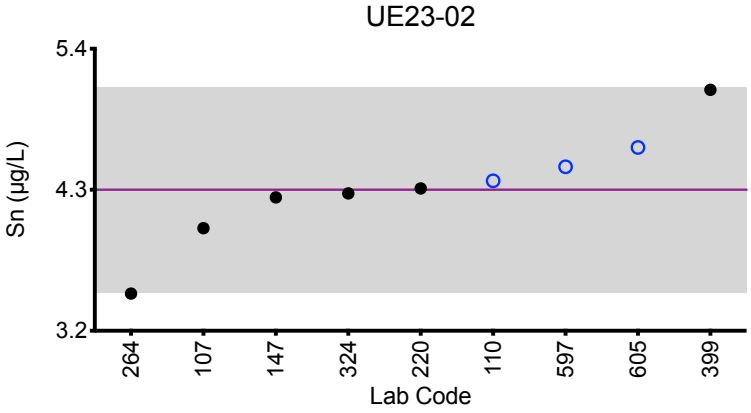
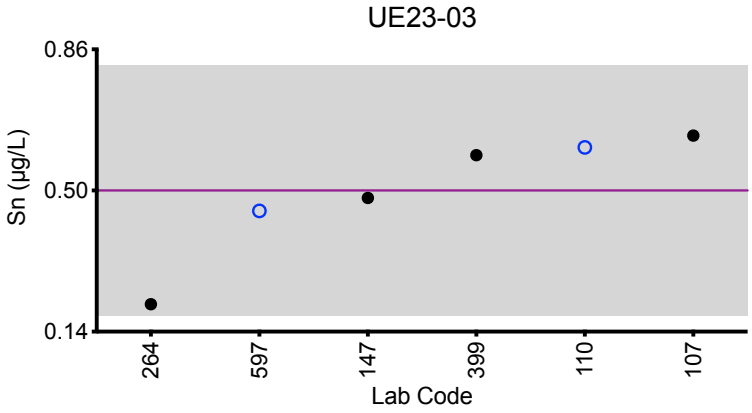
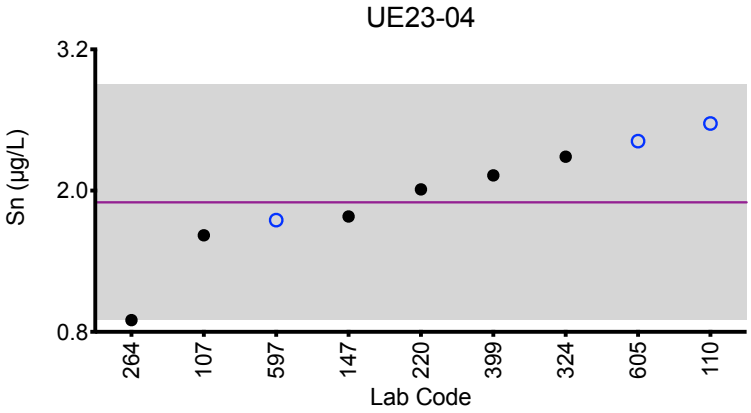
Results for Event #1, 2023: Summary Figures

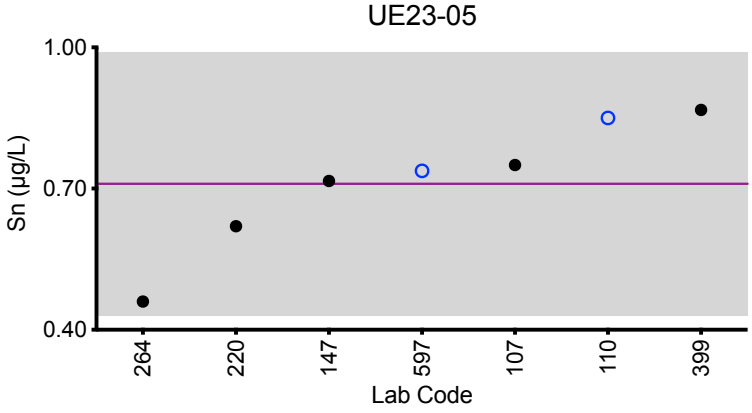
Urine Sn











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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Urine Sr (µg/L)						
Lab Code	**Method**	**UE23-01**	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
103	ICP-MS/MS	129	28.0	192	96.6	87.7
107	ICP-MS	121.6	26.9	181.7	95.0	81.0
200	ICP-MS	141	30.9	206	109	95.1
220	ICP-MS	134	30.9	206	106	92.4
264	ICP-MS	118.9	26.54	178.9	93.95	81.46
399	DRC/CC-ICP-MS	127	28.4	194	98.2	87.6
597	ICP-MS/MS	123	27.6	188	94.4	86.4
605	ICP-MS	136	30.9	203	106	92.1
Summary Statistics						
		UE23-01	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
Arithmetic Mean ($\bar{x}$)		129	28.8	194	100	88
Arithmetic SD (s)		8	1.9	11	6	5
Arithmetic RSD (%)		6.2	6.6	5.7	6.0	5.7
Number of Sample Measurements (N)		8	8	8	8	8

*Denotes a statistical Outlier.

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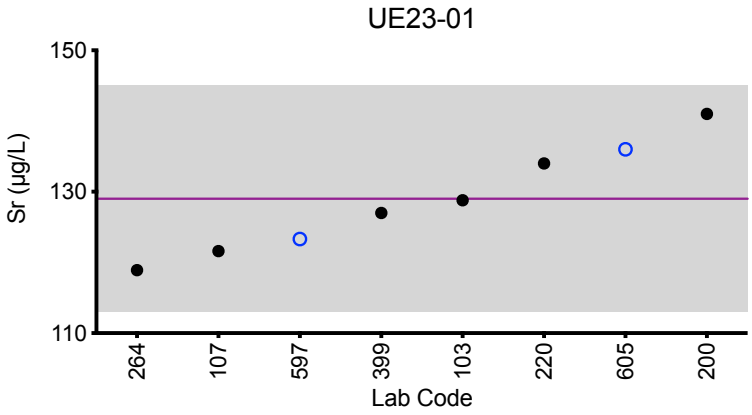
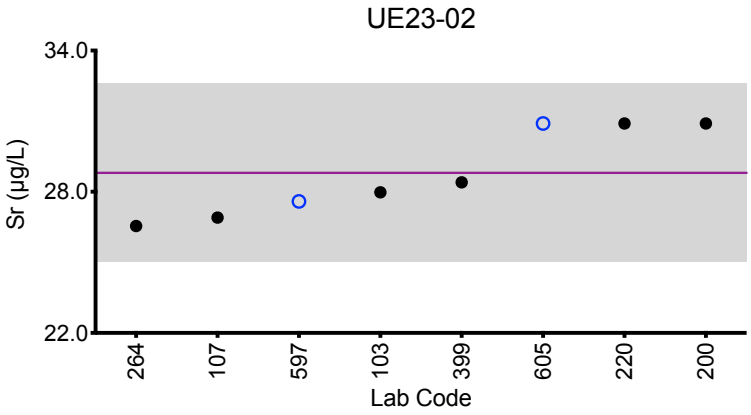
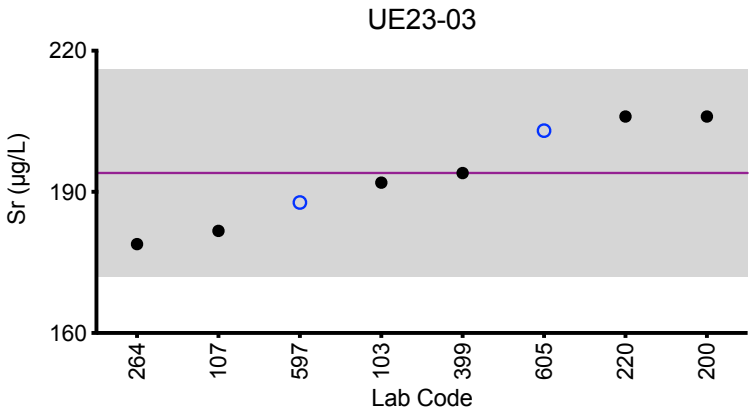
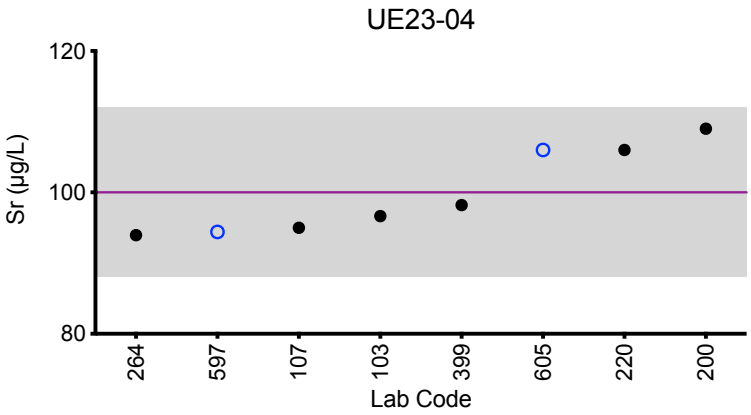
Results for Event #1, 2023: Summary Figures

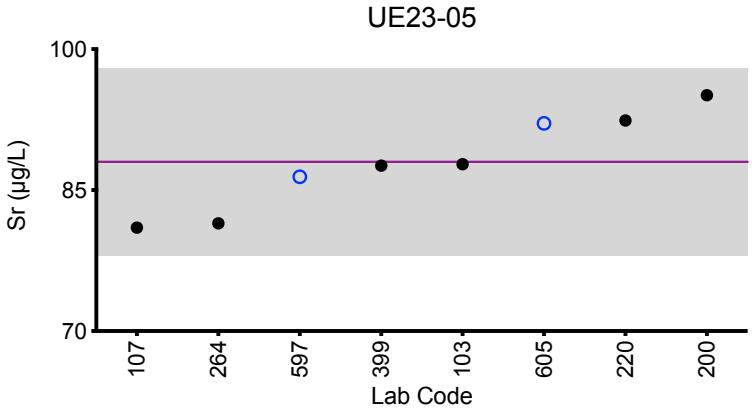
Urine Sr











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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Urine V (µg/L)

Lab Code	Method	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
116	ICP-MS/MS	*0.610	0.627	2.27	4.14	0.909
147	DRC/CC-ICP-MS	0.429	0.648	1.98	3.56	0.903
293	DRC/CC-ICP-MS	0.44	0.67	2.05	3.75	*0.98
597	ICP-MS/MS	0.424	0.630	2.11	3.70	0.915
605	ICP-MS	<0.300	0.657	2.27	4.23	0.890

Summary Statistics

	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
Arithmetic Mean ($\bar{x}$)	0.431	0.646	2.14	3.9	0.904
Arithmetic SD (s)	0.008	0.018	0.13	0.3	0.011
Arithmetic RSD (%)	1.9	2.8	6.1	7.5	1.2
Number of Sample Measurements (N)	3	5	5	5	4

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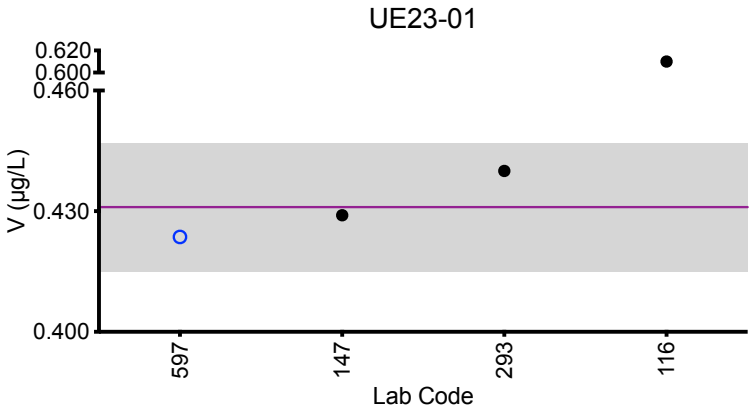
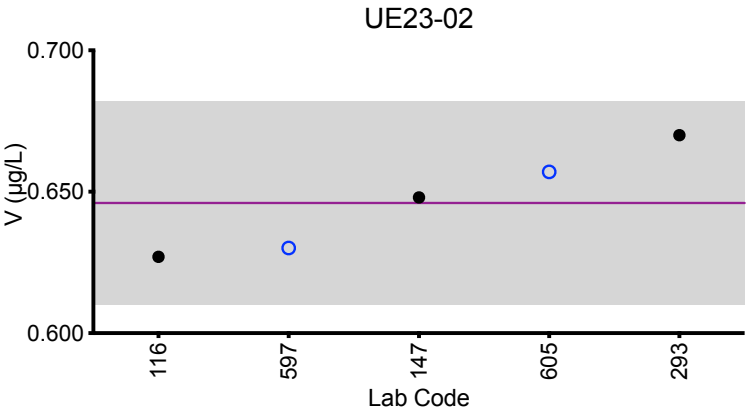
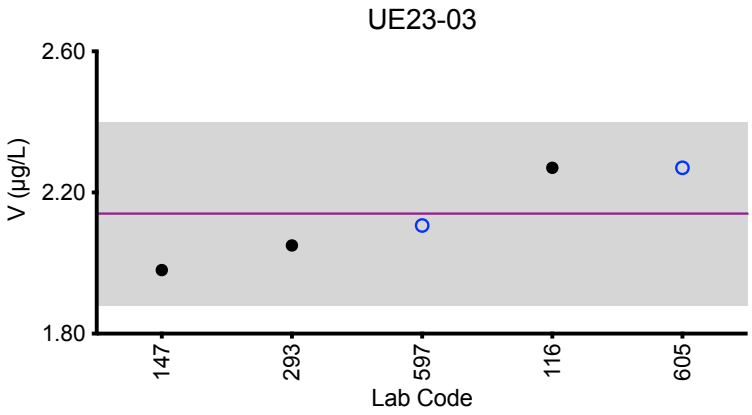
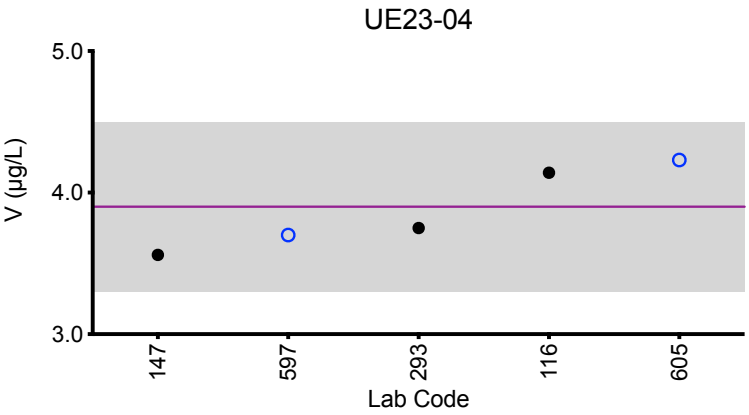
Results for Event #1, 2023: Summary Figures

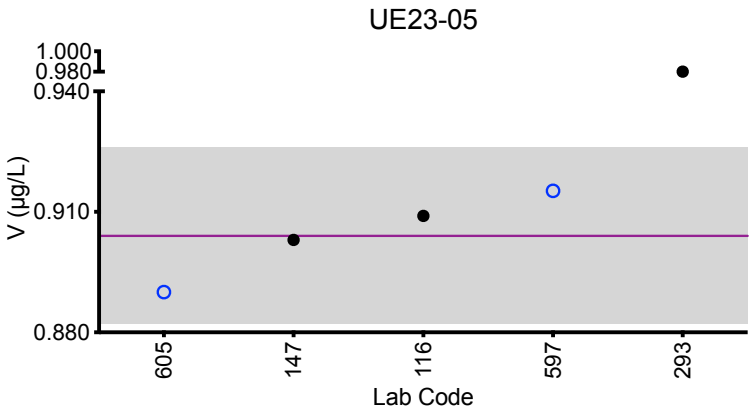
Urine V











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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Urine W (µg/L)

Lab Code	Method	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
107	ICP-MS	0.138	1.350	4.656	0.670	2.026
110	ICP-MS	0.159	1.46	4.90	0.712	2.18
147	ICP-MS	<0.171	1.29	4.45	0.668	1.95
200	ICP-MS	0.13	1.24	3.93	0.66	2.2
220	ICP-MS	0.16	1.4	4.87	0.71	2.08
264	ICP-MS	0.10	1.31	4.47	0.70	1.95
324	ICP-MS	<1	1.385	4.578	<1	2.004
399	ICP-MS/MS	0.142	1.44	4.72	0.683	2.05
597	ICP-MS/MS	0.178	1.40	4.82	0.678	2.11
605	ICP-MS	<0.180	1.47	4.92	0.721	2.16
606	ICP-MS/MS	0.181	1.42	4.67	0.581	3.87

Summary Statistics

	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
Robust Mean (x*)	0.15	1.38	4.67	0.68	2.09
Robust SD (s*)	0.03	0.07	0.22	0.03	0.12
Robust RSD (%)	18	5.1	4.7	4.4	5.7
Number of Sample Measurements (N)	8	11	11	10	11
Standard Uncertainty (*u*)	NA	0.03	0.08	0.01	0.04

*Denotes a statistical Outlier.

An arithmetic mean, SD, RSD and n are provided for sample UE23-01.

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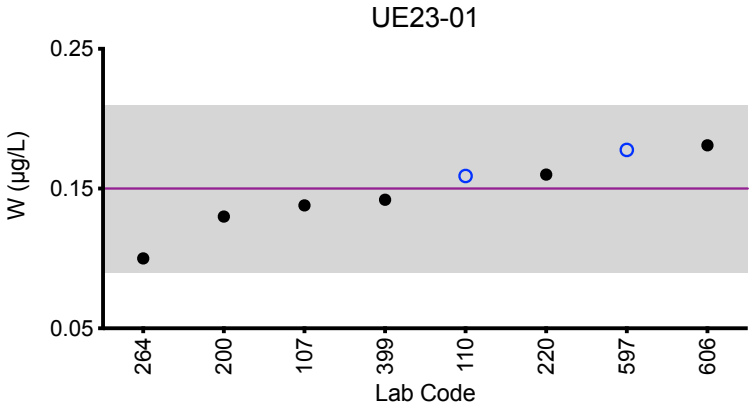
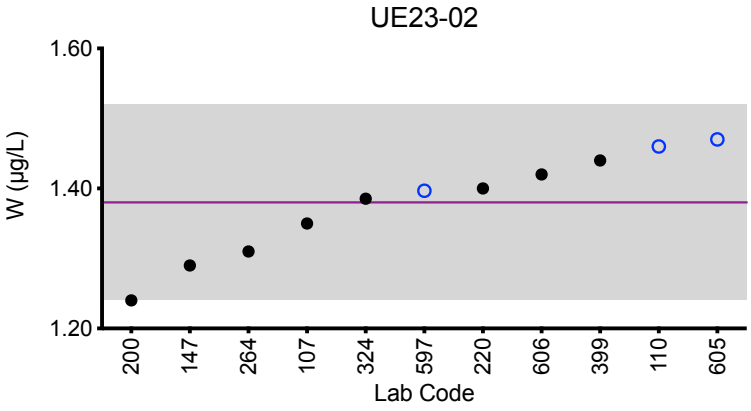
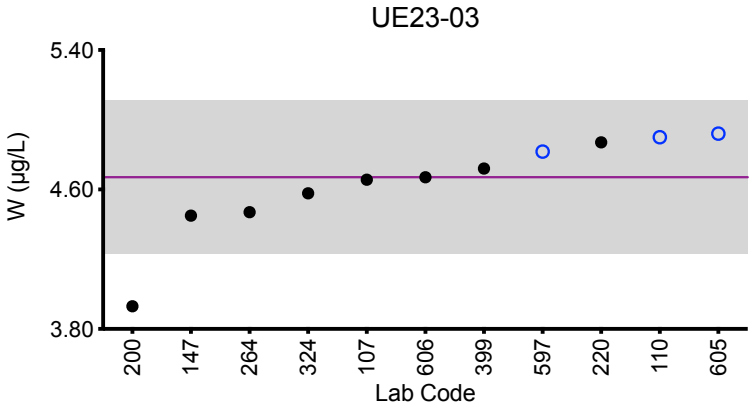
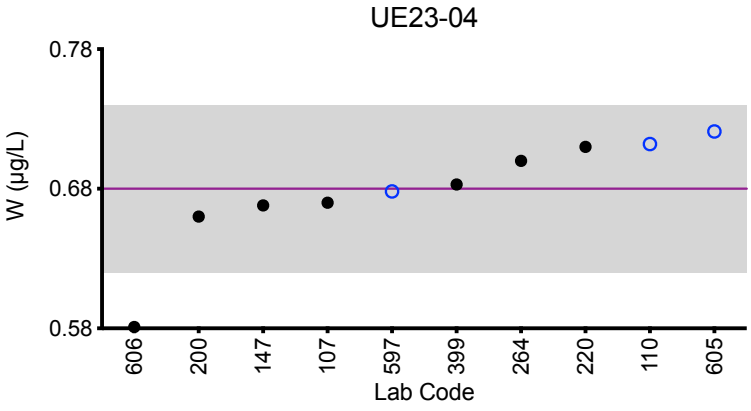
Results for Event #1, 2023: Summary Figures

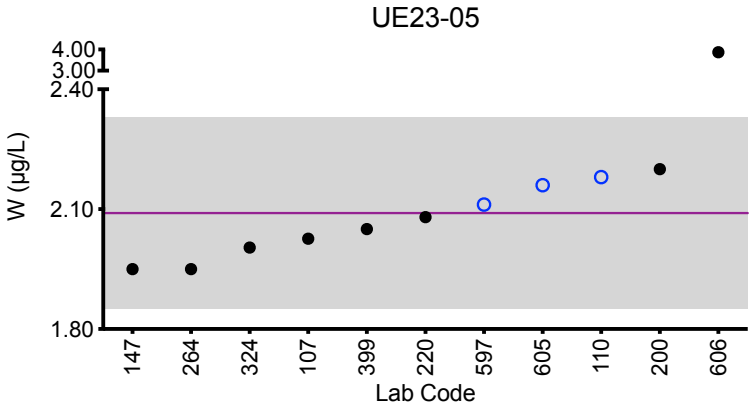
Urine W











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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Urine Zn (µg/L)

Lab Code	Method	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
110	ICP-MS	116	180	103	288	157
147	ICP-MS	112	199	99.3	269	156
264	ICP-MS	129.22	184.88	102.10	289.60	163.00
293	DRC/CC-ICP-MS	112.42	175.16	98.69	267.32	147.06
324	ICP-MS	102.527	169.753	93.781	275.639	149.796
391	ICP-MS	93.45	157.485	92.679	272.654	155.035
597	ICP-MS/MS	104	165	94.4	274	151

Summary Statistics

	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
Arithmetic Mean ($\bar{x}$)	110	176	98	277	154
Arithmetic SD (s)	11	14	4	9	5
Arithmetic RSD (%)	10	8.0	4.1	3.2	3.2
Number of Sample Measurements (N)	7	7	7	7	7

*Denotes a statistical Outlier.

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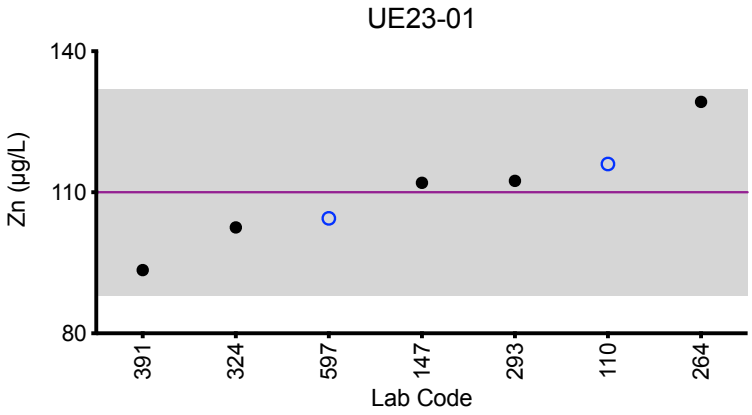
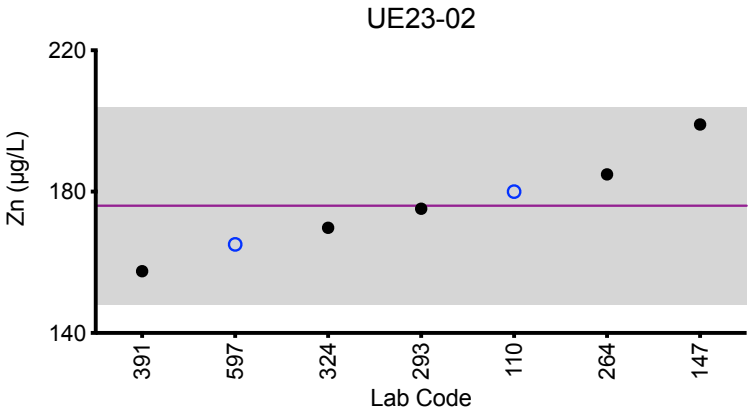
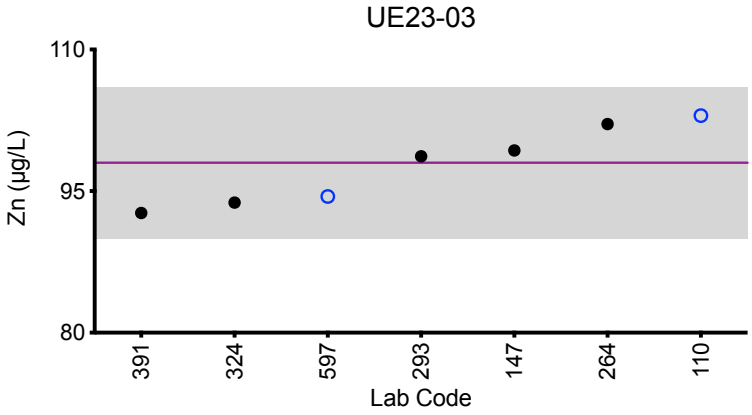
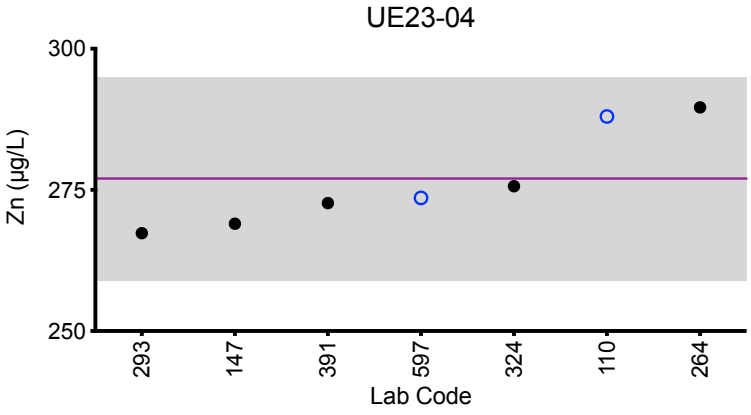
Results for Event #1, 2023: Summary Figures

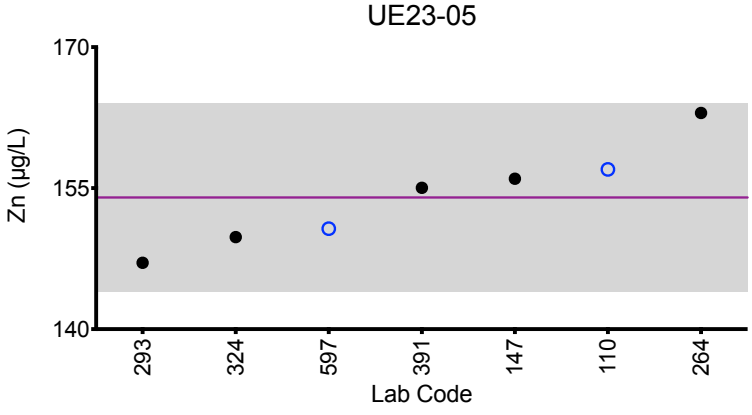
Urine Zn











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 #1, 2023:
Laboratory Data and Summary Statistics

Urine Te (µg/L)						
Lab Code	**Method**	**UE23-01**	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
110	ICP-MS	1.16	0.141	0.323	2.06	0.659
147	ICP-MS	0.902	0.115	0.223	1.65	0.569

Summary Statistics					
	UE23-01	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
Arithmetic Mean ($\bar{x}$)	1.0	0.13	0.27	1.9	0.61
Arithmetic SD (s)	0.2	0.02	0.07	0.3	0.06
Arithmetic RSD (%)	17	14	26	16	9.8
Number of Sample Measurements (N)	2	2	2	2	2

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Urine Ti (µg/L)

Lab Code	Method	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
442	ICP-MS/MS	3.3	1.2	8.37	3.91	1.51
597	ICP-MS/MS	3.91	<1.90	9.80	6.77	3.27

Summary Statistics

	UE23-01	UE23-02	UE23-03	UE23-04	UE23-05
Arithmetic Mean ($\bar{x}$)	3.6	NA	9.1	NA	NA
Arithmetic SD (s)	0.4	NA	1.0	NA	NA
Arithmetic RSD (%)	11	NA	11	NA	NA
Number of Sample Measurements (N)	2	NA	2	NA	NA

*Denotes a statistical Outlier.

Statistical data was not calculated for UE23-02, UE23-04 and UE23-05 based on a lack of consensus among participating labs.

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Results for Event #1, 2023: Additional Elements in Urine

Urine Ag (µg/L)						
Lab Code	**Method**	**UE23-01**	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
147	ICP-MS	<0.151	<0.151	<0.151	<0.151	<0.151

Urine Bi (µg/L)						
Lab Code	**Method**	**UE23-01**	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
147	ICP-MS	<0.0794	<0.0794	<0.0794	<0.0794	<0.0794
264	ICP-MS	<0.01	<0.01	<0.01	<0.01	<0.01
597	ICP-MS/MS	<0.0244	<0.0244	<0.0244	<0.0244	<0.0244

Urine Fe (µg/L)						
Lab Code	**Method**	**UE23-01**	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
324	ICP-MS	7.192	9.094	4.095	11.419	7.396

Urine I (µg/L)						
Lab Code	**Method**	**UE23-01**	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
147	ICP-MS	33.2	38.4	76.2	146	138

Urine Li (µg/L)						
Lab Code	**Method**	**UE23-01**	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
147	ICP-MS	8.19	9.44	15.6	27.3	9.99

Urine Mg (µg/L)						
Lab Code	**Method**	**UE23-01**	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
597	ICP-MS/MS	15200	17500	27700	52000	25300

Urine Th (µg/L)						
Lab Code	**Method**	**UE23-01**	**UE23-02**	**UE23-03**	**UE23-04**	**UE23-05**
147	ICP-MS	<0.102	<0.102	<0.102	<0.102	<0.102
597	ICP-MS/MS	0.0227	0.0155	0.0158	0.0325	0.0188

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Event #1, 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 #1, 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 25 were reported by at least one participant: As, Ba, Be, Bi, Cd, Cs, Fe, Hg, I, Li, Mg, Mn, Mo, Ni, Pb, Pt, Sb, Sn, Sr, 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 #1, 2023: Summary Statistics

	Serum Al (µg/L)				
	SE23-01	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
Target (Arithmetic Mean ($\bar{x}$))	77	8.4	42	16.3	27.9
Upper Limit	92	13.4	50	21.3	33.5
Lower Limit	62	3.4	34	11.3	22.3
Arithmetic SD (s)	5	1.7	4	1.4	2.2
Arithmetic RSD (%)	6.5	20	9.5	8.7	7.9
Number of Sample Measurements (N)	6	5	6	5	5

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 #1, 2023:
Performance of Participating Laboratories

		Serum Al (µg/L)				
Lab Code	**Method**	**SE23-01**	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
	Target	**77**	**8.4**	**42**	**16.3**	**27.9**
147	ETAAS-Z	76.1	8.34	43.7	17.2	30.5
264	ICP-MS	79.49	7.43	39.48	14.79	27.36
293	DRC/CC-ICP-MS	72.58	9.14	40.86	17.74	29.03
391	ETAAS-Z	83.20	*24.2 ↑	49.23	*28.4 ↑	*42.3 ↑
485	HR-ICP-MS	81.1	10.7	39.2	17.1	27.9
597	ICP-MS/MS	69.6	6.19	36.6	14.8	24.6

Based on the grading criteria for Al in Serum, 90% of results were satisfactory, with 1 of the 6 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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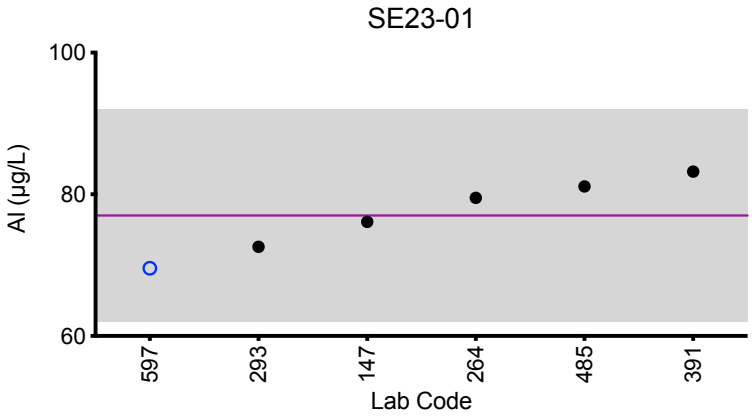
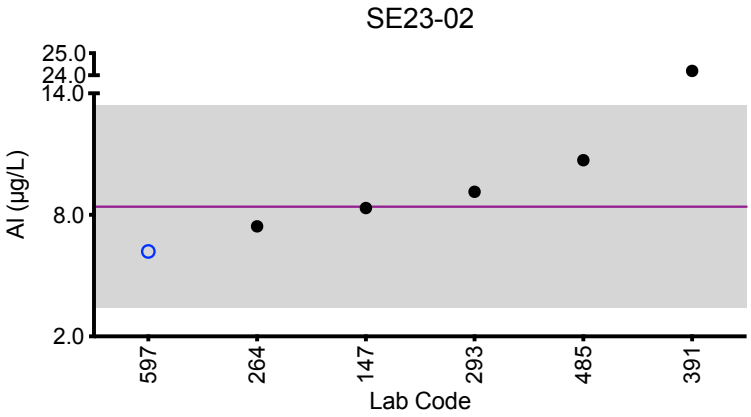
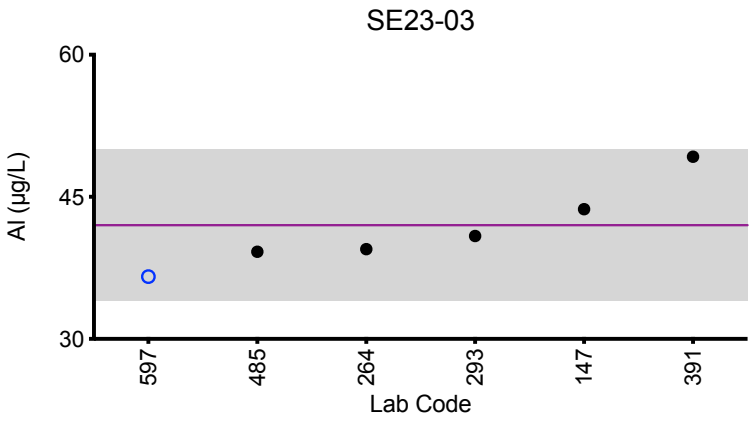
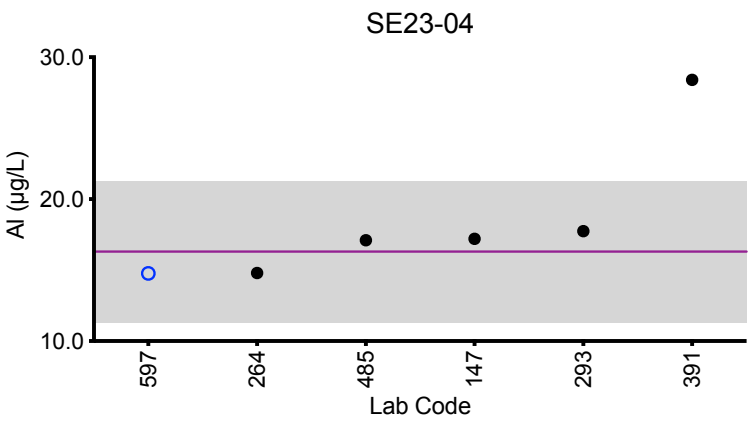
Results for Event #1, 2023: Summary Figures

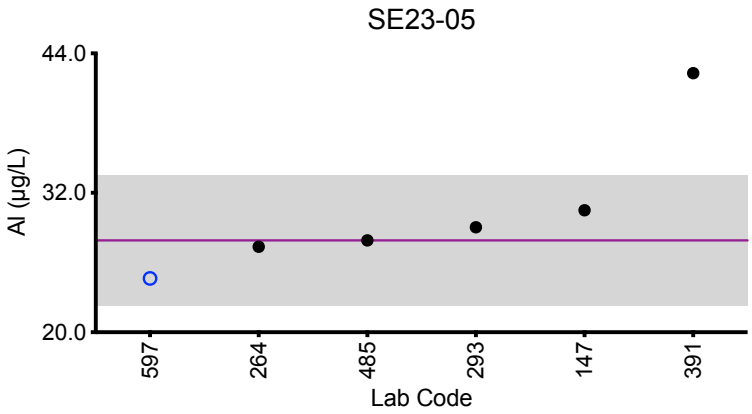
Serum Al











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 #1, 2023: Summary Statistics

	Serum Co (µg/L)				
	SE23-01	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
Target (Arithmetic Mean ($\bar{x}$))	0.473	9.9	1.00	3.28	3.89
Upper Limit	1.973	11.4	2.50	4.78	5.39
Lower Limit	0.000	8.4	0.00	1.78	2.39
Arithmetic SD (s)	0.020	0.4	0.02	0.14	0.18
Arithmetic RSD (%)	4.2	3.8	1.8	4.3	4.6
Number of Sample Measurements (N)	7	7	6	7	7

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 #1, 2023:
Performance of Participating Laboratories

Serum Co (µg/L)						
Lab Code	**Method**	**SE23-01**	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
	Target	**0.473**	**9.9**	**1.00**	**3.28**	**3.89**
103	ICP-MS/MS	0.456	9.67	0.969	3.23	3.83
110	ICP-MS/MS	0.47	10.1	1.01	3.41	3.96
147	DRC/CC-ICP-MS	0.441	9.13	*0.878	3.02	3.54
264	ICP-MS	0.48	10.19	1.01	3.37	4.00
293	DRC/CC-ICP-MS	0.5	10.05	1.01	3.36	3.99
485	HR-ICP-MS	0.476	10.2	1.02	3.37	4.11
597	ICP-MS/MS	0.491	9.90	1.01	3.20	3.83

Based on the grading criteria for Co 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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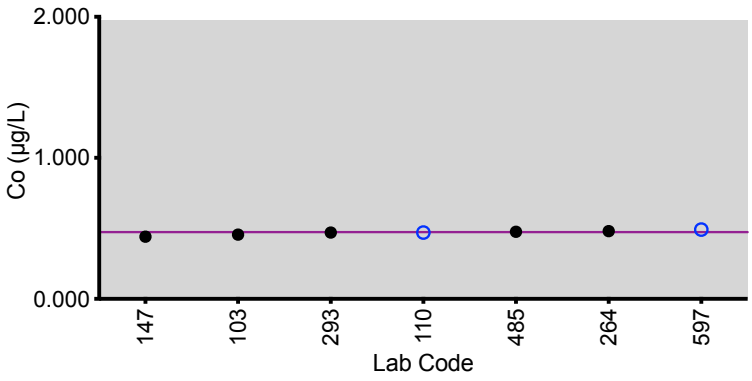
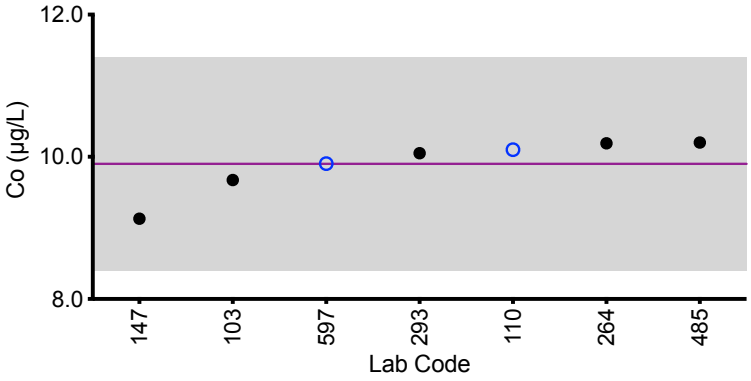
Results for Event #1, 2023: Summary Figures

Serum Co

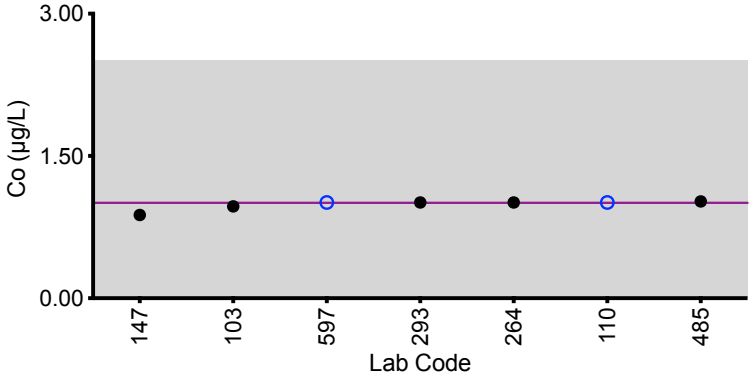
SE23-01



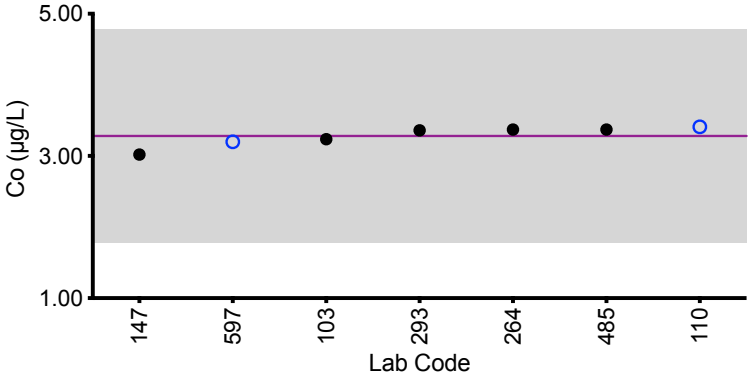
SE23-02



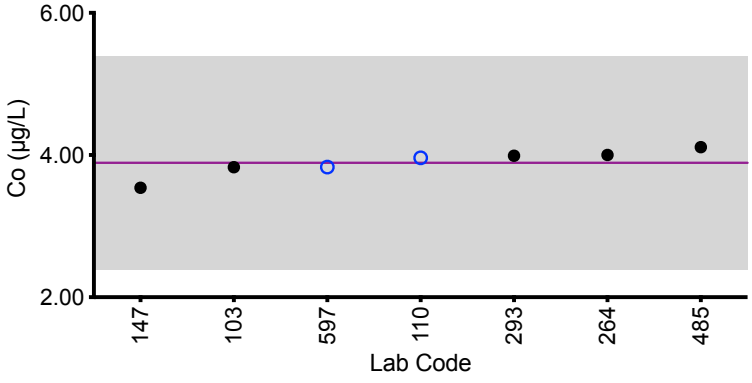
SE23-03



SE23-04



SE23-05



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 #1, 2023: Summary Statistics

	Serum Cr (µg/L)				
	SE23-01	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
Target (Arithmetic Mean ($\bar{x}$))	4.9	1.33	0.68	2.27	9.2
Upper Limit	6.9	3.33	2.68	4.27	11.2
Lower Limit	2.9	0.00	0.00	0.27	7.2
Arithmetic SD (s)	0.3	0.11	0.09	0.11	0.6
Arithmetic RSD (%)	6.7	8.3	13	4.8	6.5
Number of Sample Measurements (N)	7	7	6	6	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 #1, 2023:
Performance of Participating Laboratories

		Serum Cr (µg/L)				
Lab Code	**Method**	**SE23-01**	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
	Target	**4.9**	**1.33**	**0.68**	**2.27**	**9.2**
103	ICP-MS/MS	4.34	1.29	0.584	2.13	8.40
110	ICP-MS/MS	4.96	1.21	*3.40 ↑	2.30	9.23
147	DRC/CC-ICP-MS	4.69	1.20	0.577	2.20	8.68
264	ICP-MS	5.42	1.44	0.79	*2.80	9.94
293	DRC/CC-ICP-MS	5.08	1.29	0.72	2.45	9.64
485	HR-ICP-MS	5.00	1.43	0.666	2.28	9.44
597	ICP-MS/MS	4.91	1.43	0.730	2.28	8.81

Based on the grading criteria for Cr in Serum, 97% 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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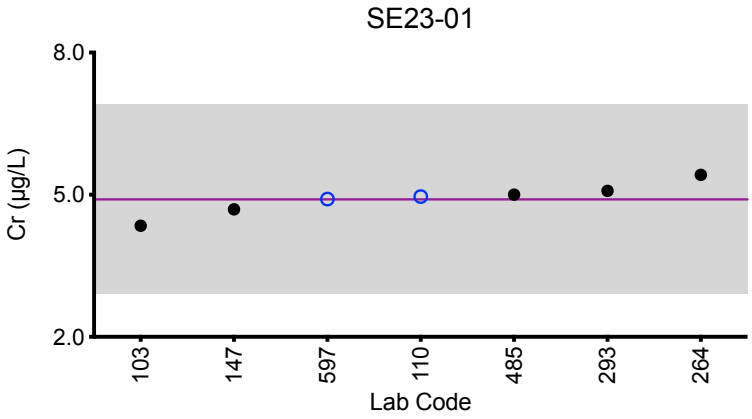
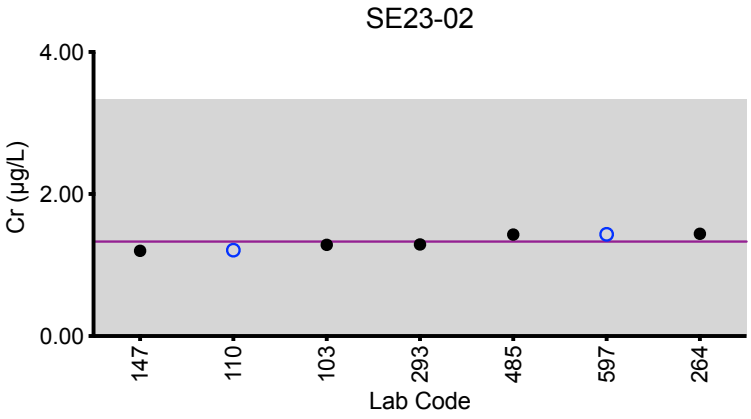
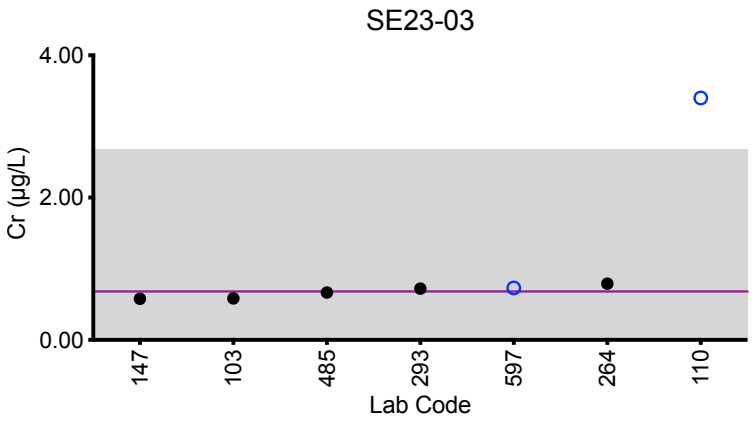
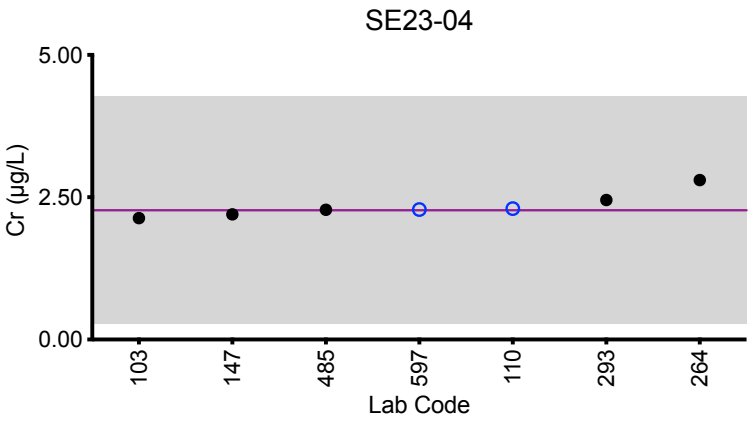
Results for Event #1, 2023: Summary Figures

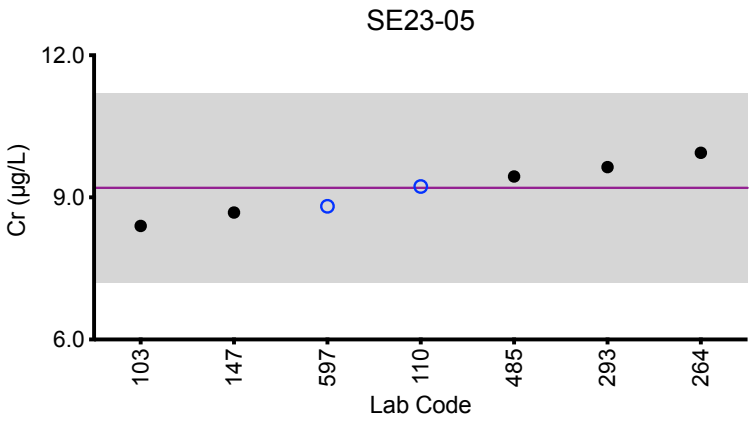
Serum Cr











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 #1, 2023: Summary Statistics

	Serum Cu (µg/L)				
	SE23-01	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
Target (Arithmetic Mean ($\bar{x}$))	1210	790	1530	1260	910
Upper Limit	1390	910	1760	1450	1050
Lower Limit	1030	670	1300	1070	770
Arithmetic SD (s)	50	40	70	70	70
Arithmetic RSD (%)	4.1	5.1	4.6	5.6	7.7
Number of Sample Measurements (N)	7	7	7	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 #1, 2023:
Performance of Participating Laboratories

		Serum Cu (µg/L)				
Lab Code	**Method**	**SE23-01**	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
	Target	**1210**	**790**	**1530**	**1260**	**910**
107	DRC/CC-ICP-MS	1254	833	1636	1375	1056 ↑
110	ICP-MS/MS	1230	808	1560	1270	895
147	DRC/CC-ICP-MS	1144	743	1442	1201	858
264	ICP-MS	1249	825	1580	1299	934
293	DRC/CC-ICP-MS	1189	801	1519	1259	896
436	FAAS	1143	730	1429	1143	826
597	ICP-MS/MS	1240	799	1560	1260	901

Based on the grading criteria for Cu in Serum, 97% 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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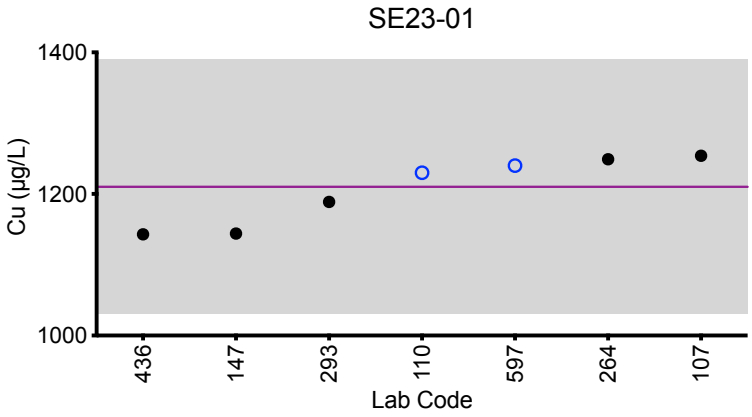
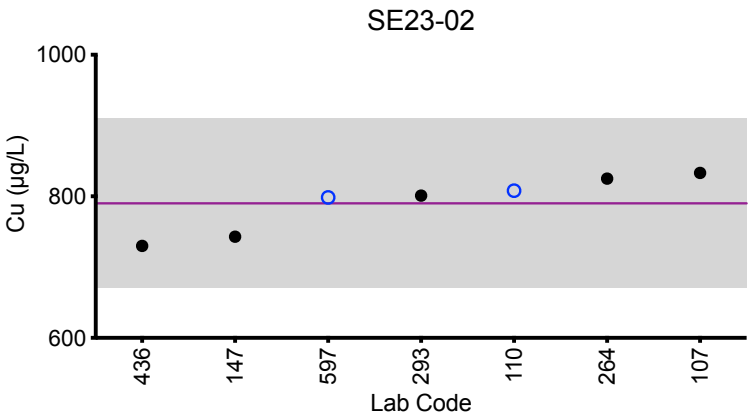
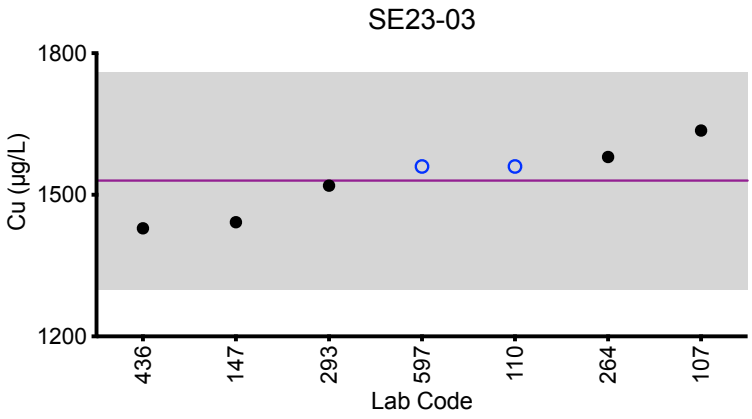
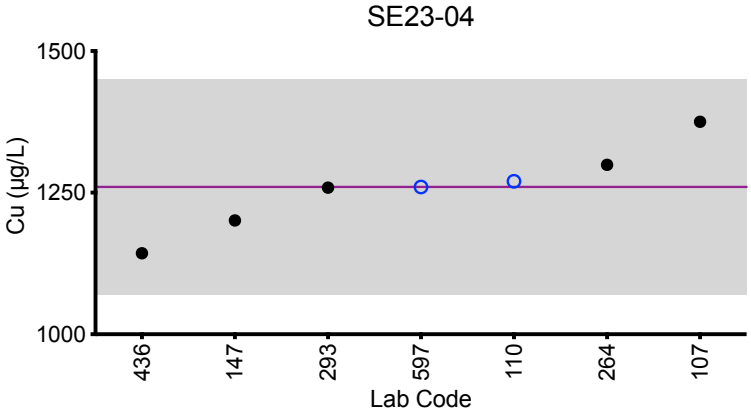
Results for Event #1, 2023: Summary Figures

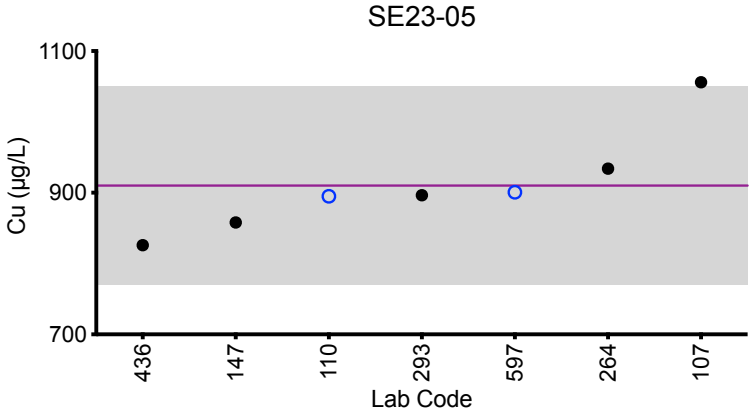
Serum Cu











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 #1, 2023: Summary Statistics

Serum Se (µg/L)					
	SE23-01	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
Target (Arithmetic Mean ($\bar{x}$))	130	281	98	208	160
Upper Limit	156	337	118	250	192
Lower Limit	104	225	78	166	128
Arithmetic SD (s)	6	11	3	8	7
Arithmetic RSD (%)	4.6	3.9	3.4	3.8	4.4
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 #1, 2023:
Performance of Participating Laboratories

		Serum Se (µg/L)				
Lab Code	**Method**	**SE23-01**	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
	Target	**130**	**281**	**98**	**208**	**160**
103	ICP-MS/MS	137	293	100	210	159
107	DRC/CC-ICP-MS	127.3	275.3	95.4	204.2	154.9
110	ICP-MS/MS	131	283	97.9	206	157
147	DRC/CC-ICP-MS	123	260	94.0	194	151
264	ICP-MS	135.92	283.51	101.04	208.42	160.37
293	DRC/CC-ICP-MS	135	293	103	216	163
436	A-7	122	284	94	220	174
597	ICP-MS/MS	132	278	97.6	203	158

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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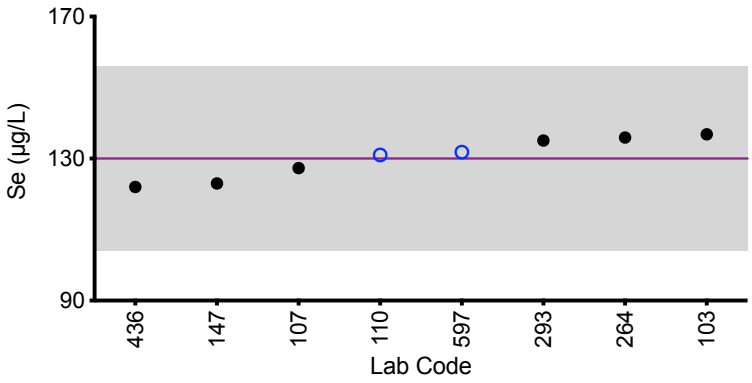
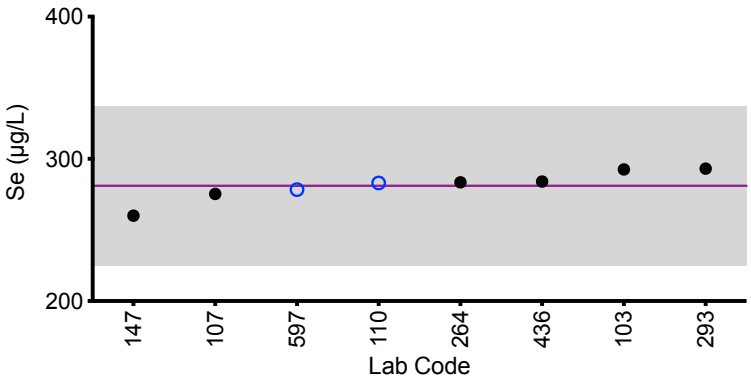
Results for Event #1, 2023: Summary Figures

Serum Se

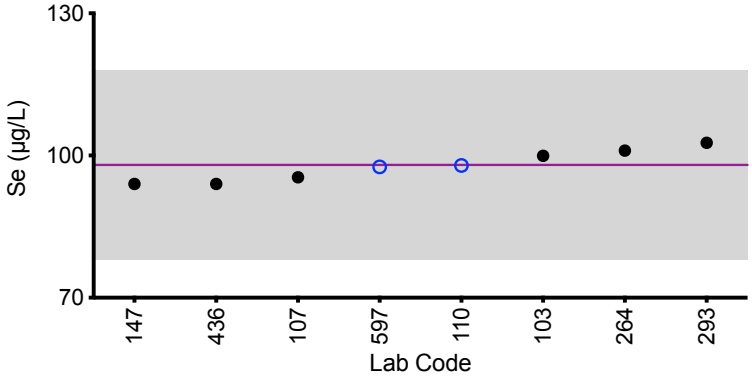
SE23-01



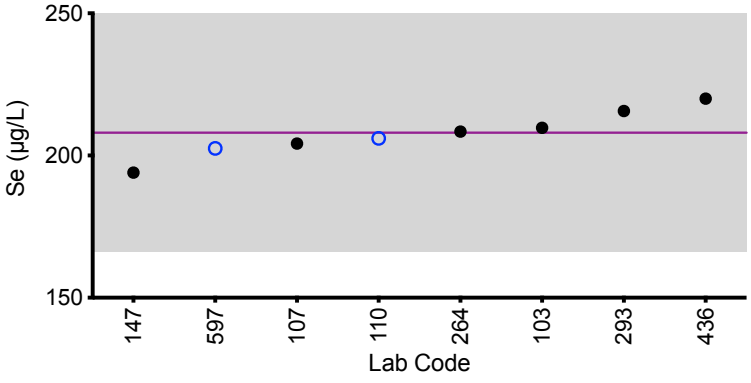
SE23-02



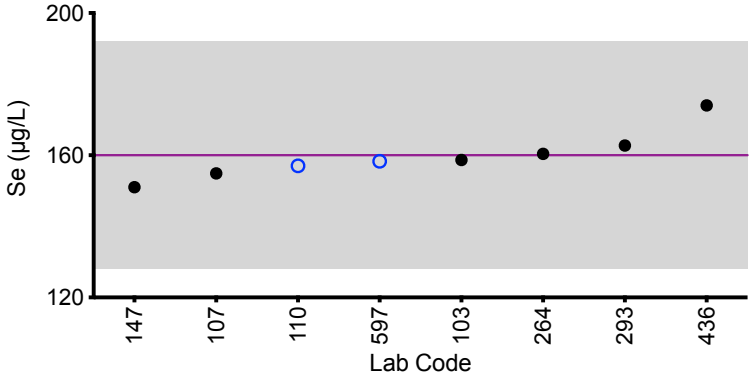
SE23-03



SE23-04



SE23-05



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 #1, 2023: Summary Statistics

Serum Zn (µg/L)					
	SE23-01	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
Target (Arithmetic Mean ($\bar{x}$))	581	742	849	702	749
Upper Limit	668	853	976	807	861
Lower Limit	494	631	722	597	637
Arithmetic SD (s)	20	24	35	21	31
Arithmetic RSD (%)	3.4	3.2	4.1	3.0	4.1
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 #1, 2023:
Performance of Participating Laboratories

		Serum Zn (µg/L)				
Lab Code	**Method**	**SE23-01**	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
	Target	**581**	**742**	**849**	**702**	**749**
107	DRC/CC-ICP-MS	608	749	864	673	801
110	ICP-MS/MS	593	770	873	729	759
147	DRC/CC-ICP-MS	552	699	784	680	706
264	ICP-MS	576	739	846	708	742
293	DRC/CC-ICP-MS	569	745	843	706	739
597	ICP-MS/MS	590	750	881	715	747

Based on the grading criteria for Zn in Serum, 100% 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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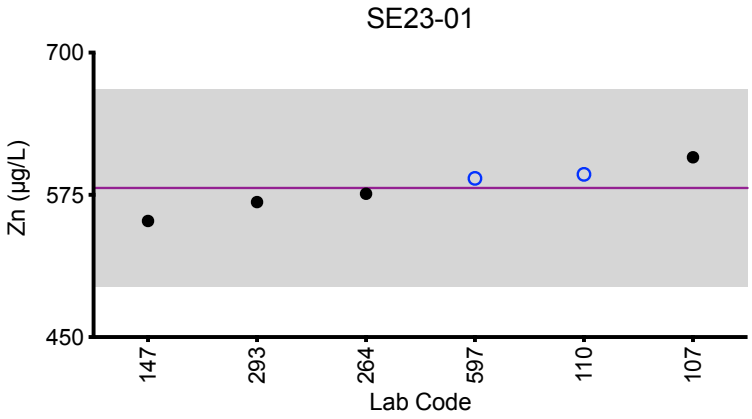
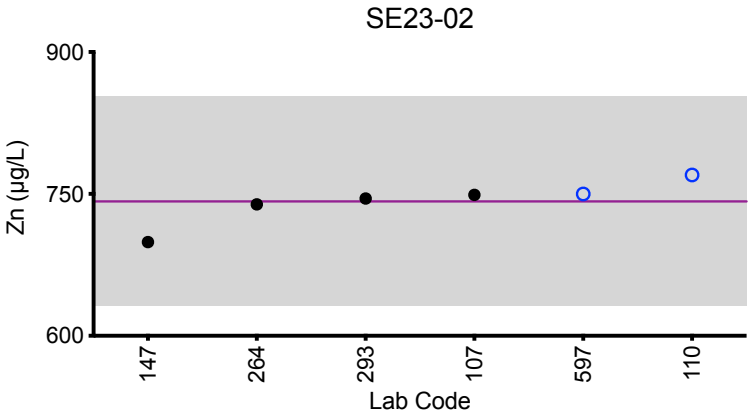
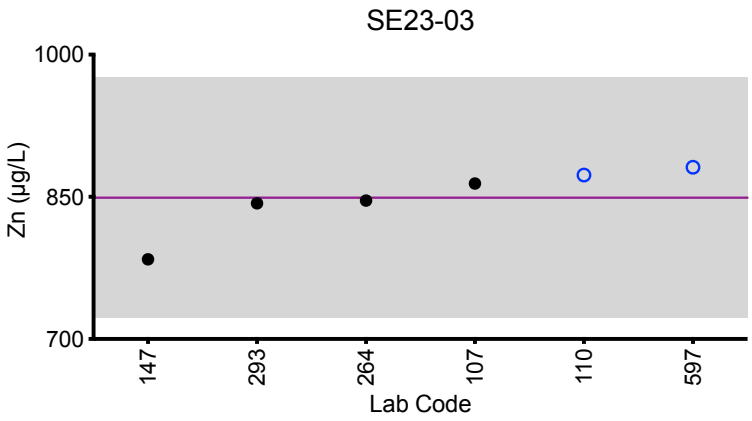
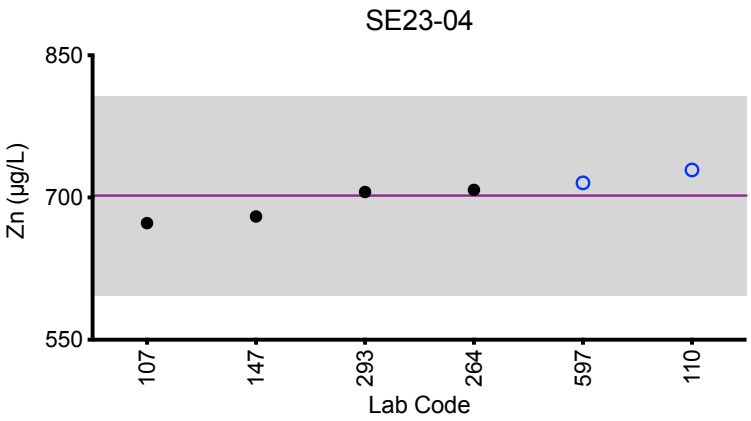
Results for Event #1, 2023: Summary Figures

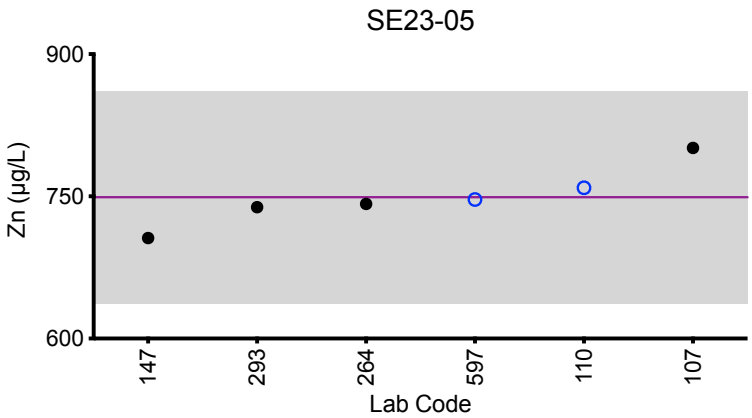
Serum Zn











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 #1, 2023:
Laboratory Data and Summary Statistics

Serum Mn (µg/L)

Lab Code	Method	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
103	ICP-MS/MS	8.63	11.0	2.84	1.43	5.68
110	ICP-MS/MS	8.8	11.2	3.0	1.5	5.7
147	DRC/CC-ICP-MS	8.30	9.84	2.72	1.37	5.31
264	ICP-MS	9.10	11.40	*3.48	*2.07	6.25
293	DRC/CC-ICP-MS	8.640	11.19	2.92	1.37	5.620
597	ICP-MS/MS	8.67	10.7	2.88	1.35	5.46

Summary Statistics

	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
Arithmetic Mean ($\bar{x}$)	8.7	10.9	2.87	1.40	5.7
Arithmetic SD (s)	0.3	0.6	0.10	0.06	0.3
Arithmetic RSD (%)	3.0	5.5	3.5	4.3	5.6
Number of Sample Measurements (N)	6	6	5	5	6

*Denotes a statistical Outlier.

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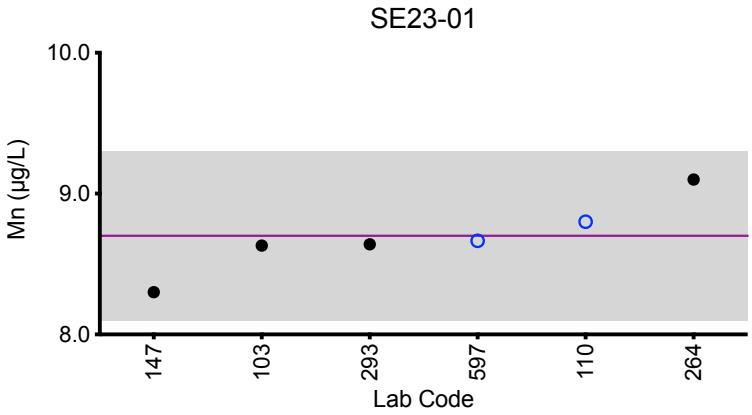
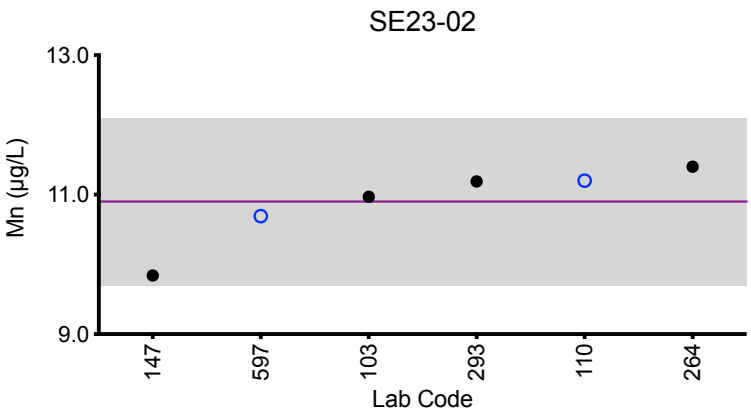
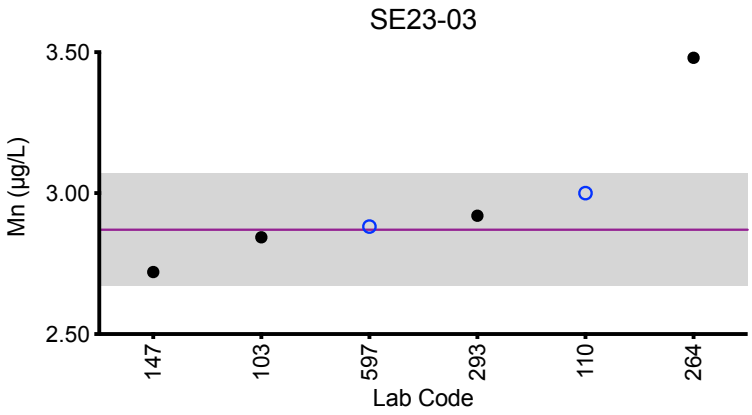
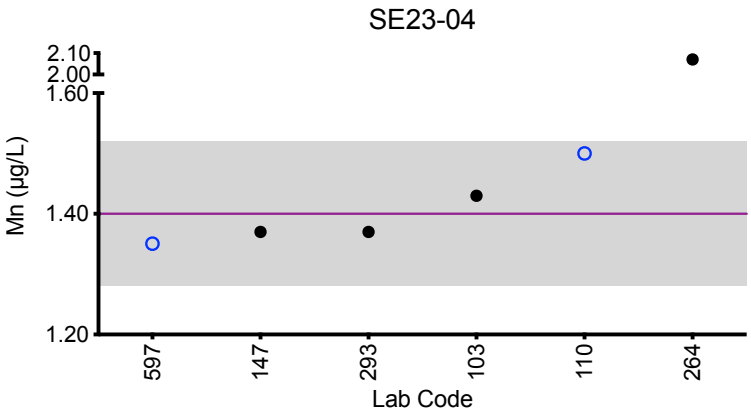
Results for Event #1, 2023: Summary Figures

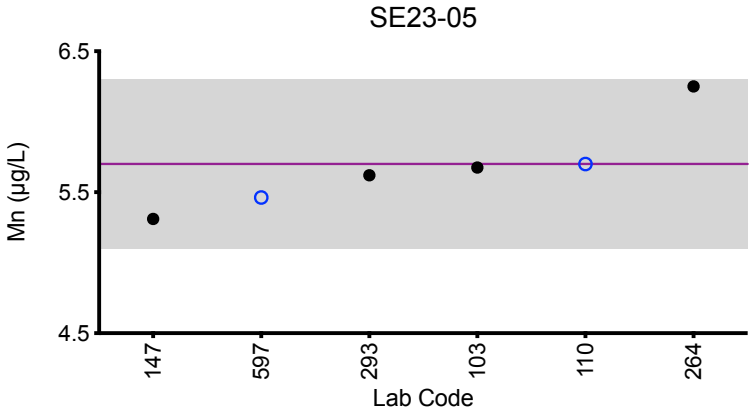
Serum Mn











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 #1, 2023:
Laboratory Data and Summary Statistics

Serum Mo (µg/L)						
Lab Code	**Method**	**SE23-01**	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
103	ICP-MS/MS	0.410	3.73	2.35	5.48	1.34
110	ICP-MS/MS	0.50	3.85	2.35	5.52	1.45
147	DRC/CC-ICP-MS	0.512	3.61	2.29	5.34	1.45
293	DRC/CC-ICP-MS	*0.920	3.800	2.360	5.350	1.620
485	HR-ICP-MS	<1	3.86	2.47	*6.14	1.39
597	ICP-MS/MS	0.499	3.67	2.28	5.18	1.32
Summary Statistics						
		SE23-01	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
Arithmetic Mean ($\bar{x}$)		0.48	3.75	2.35	5.37	1.43
Arithmetic SD (s)		0.05	0.10	0.07	0.13	0.11
Arithmetic RSD (%)		10	2.7	3.0	2.4	7.7
Number of Sample Measurements (N)		4	6	6	5	6

*Denotes a statistical Outlier.

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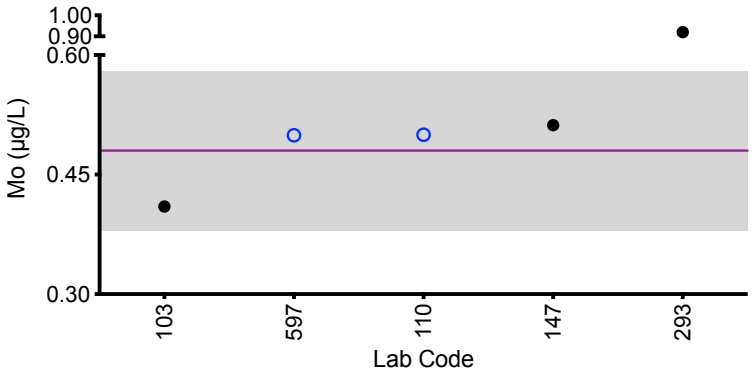
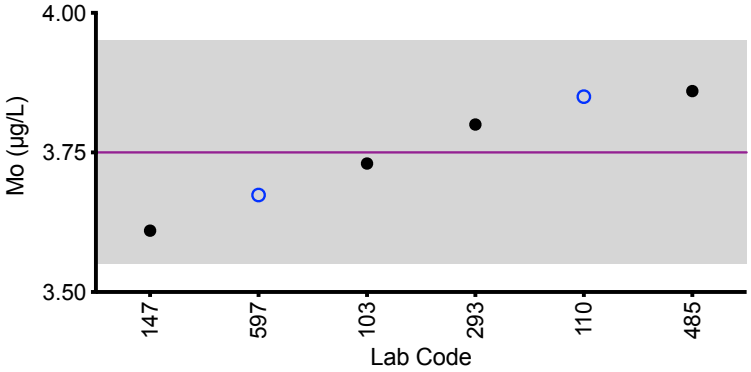
Results for Event #1, 2023: Summary Figures

Serum Mo

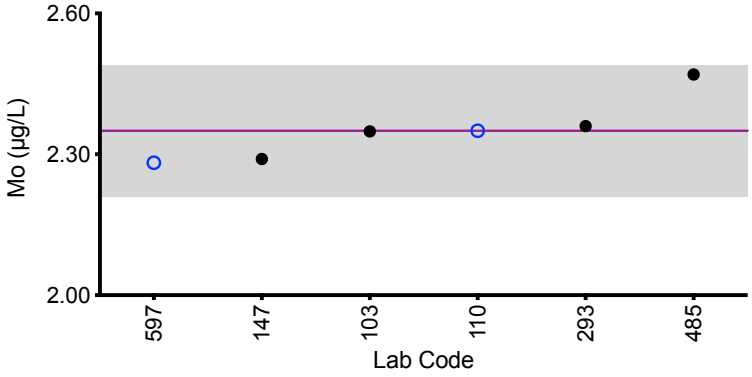
SE23-01



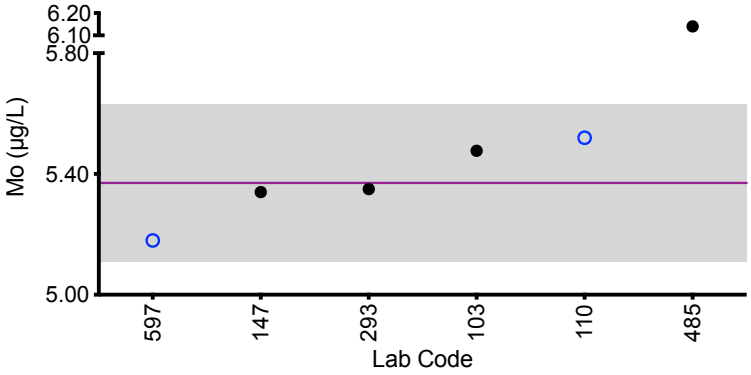
SE23-02



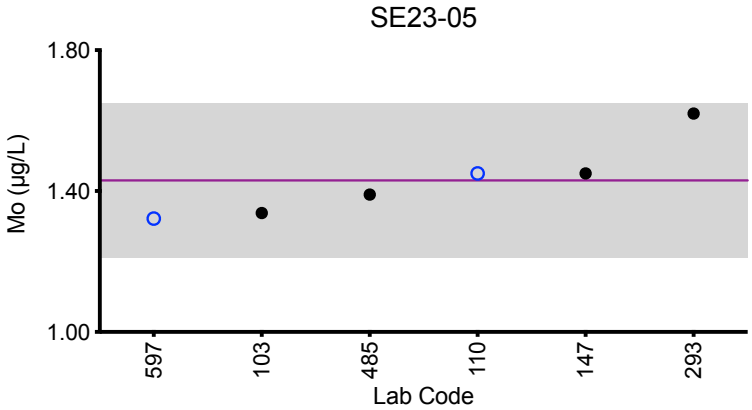
SE23-03



SE23-04



SE23-05



Legend:
o HHEAR Labs ● Other Labs
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Gray area = ±2SD of the mean.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Serum Ni (µg/L)

Lab Code	Method	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
103	ICP-MS/MS	3.81	1.50	7.60	5.31	3.03
110	ICP-MS/MS	4.1	1.8	8.0	5.5	3.2
147	DRC/CC-ICP-MS	3.69	1.54	7.22	5.10	2.94
293	DRC/CC-ICP-MS	3.99	1.77	7.98	5.67	3.42
442	DRC/CC-ICP-MS	3.85	1.62	8.03	5.72	3.16
485	HR-ICP-MS	3.96	1.58	7.84	5.54	3.20
597	ICP-MS/MS	*3.07	*0.799	6.83	4.51	2.42

Summary Statistics

	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
Arithmetic Mean ($\bar{x}$)	3.90	1.64	7.6	5.3	3.1
Arithmetic SD (s)	0.15	0.12	0.5	0.4	0.3
Arithmetic RSD (%)	3.8	7.3	6.6	7.5	10
Number of Sample Measurements (N)	6	6	7	7	7

*Denotes a statistical Outlier.

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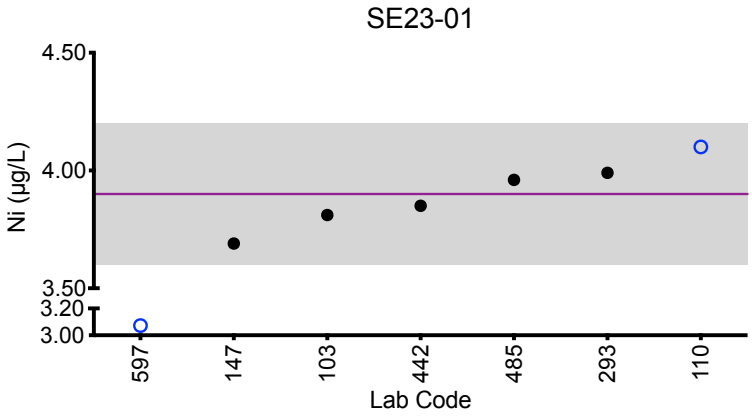
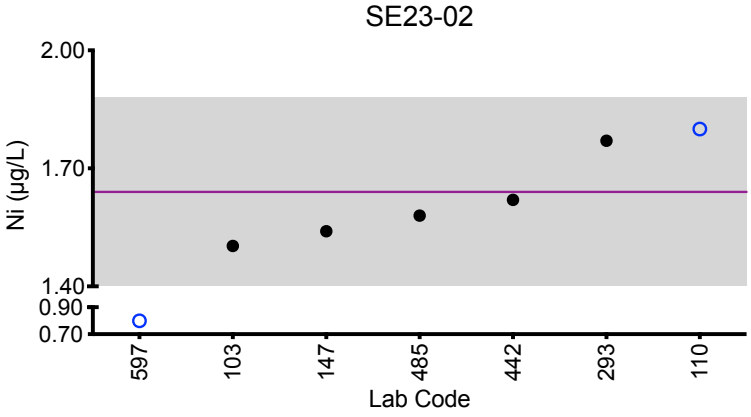
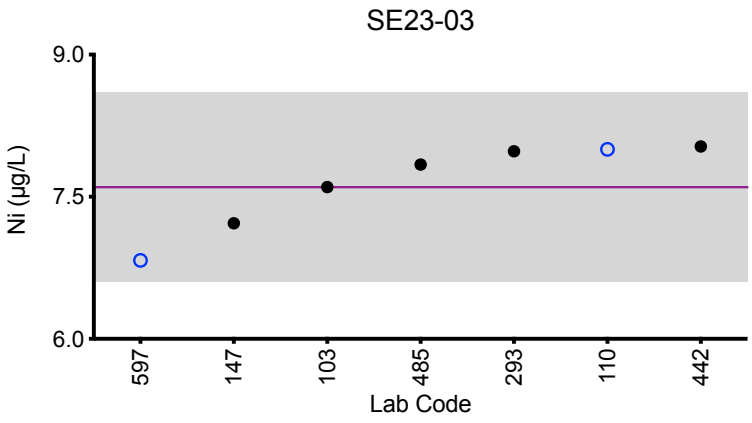
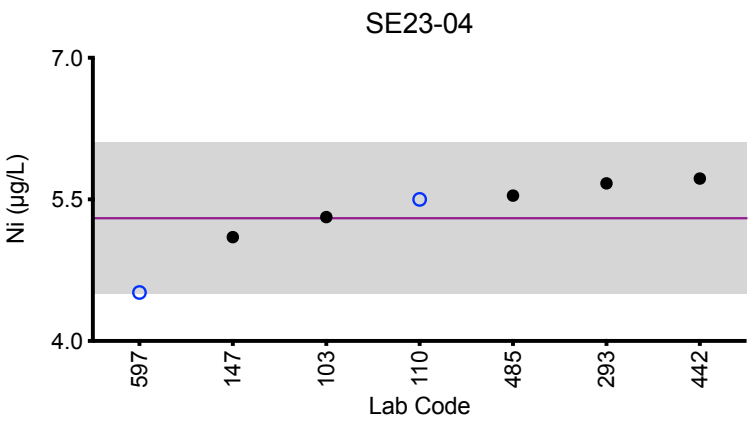
Results for Event #1, 2023: Summary Figures

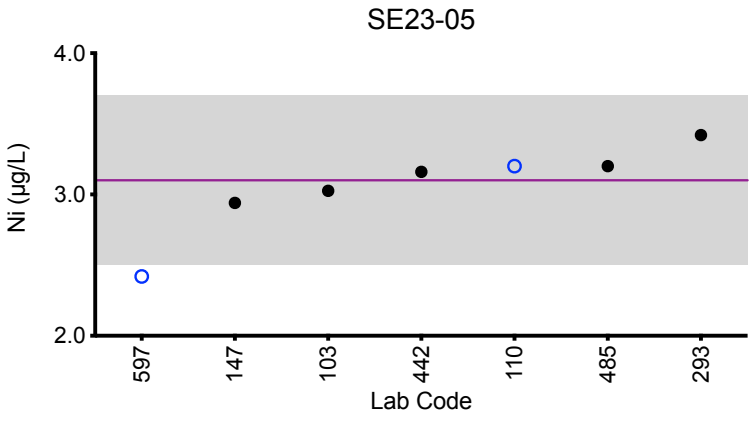
Serum Ni











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 #1, 2023:
Laboratory Data and Summary Statistics

Serum V (µg/L)

Lab Code	Method	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
110	ICP-MS/MS	0.81	2.05	0.54	1.43	3.57
147	DRC/CC-ICP-MS	0.684	1.86	0.455	1.31	3.36
293	DRC/CC-ICP-MS	0.75	1.98	0.51	1.51	3.7
485	HR-ICP-MS	0.728	1.99	0.497	1.40	3.60
597	ICP-MS/MS	0.754	1.98	0.502	1.48	3.55

Summary Statistics

	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
Arithmetic Mean ($\bar{x}$)	0.75	1.97	0.50	1.43	3.56
Arithmetic SD (s)	0.05	0.07	0.03	0.08	0.12
Arithmetic RSD (%)	6.7	3.6	6.2	5.6	3.4
Number of Sample Measurements (N)	5	5	5	5	5

*Denotes a statistical Outlier.

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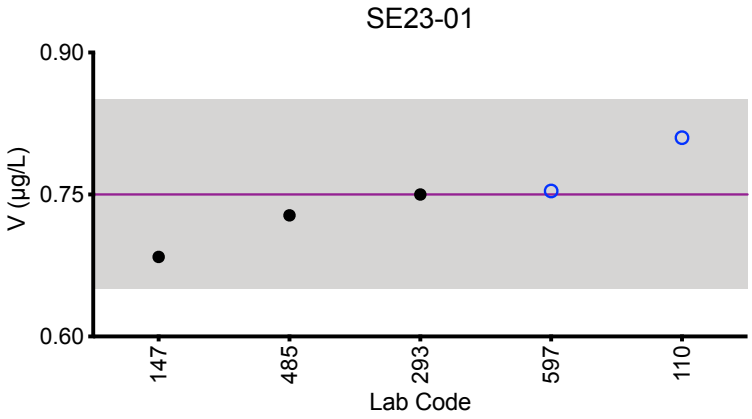
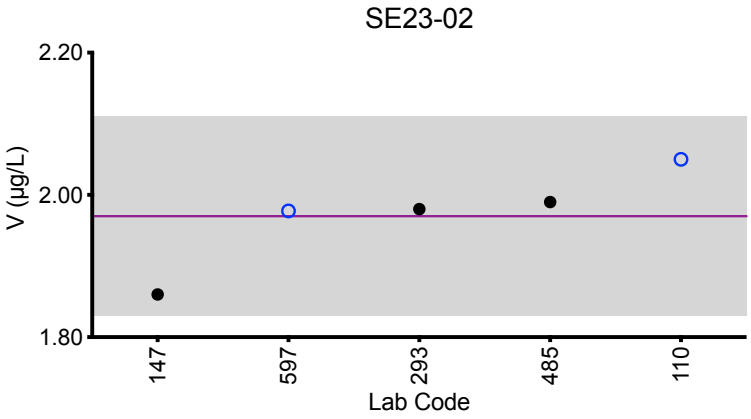
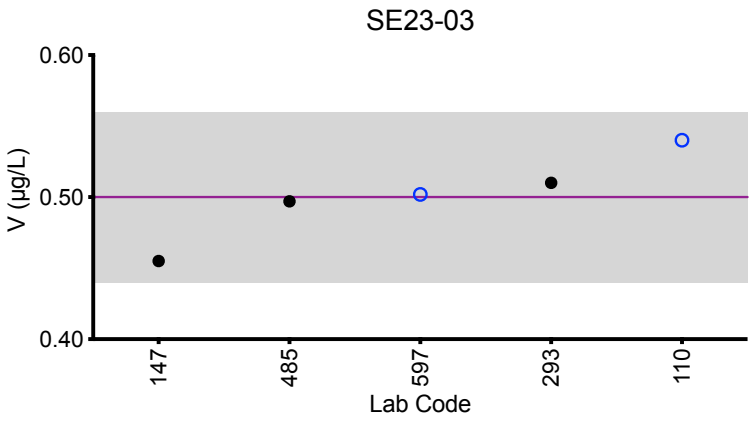
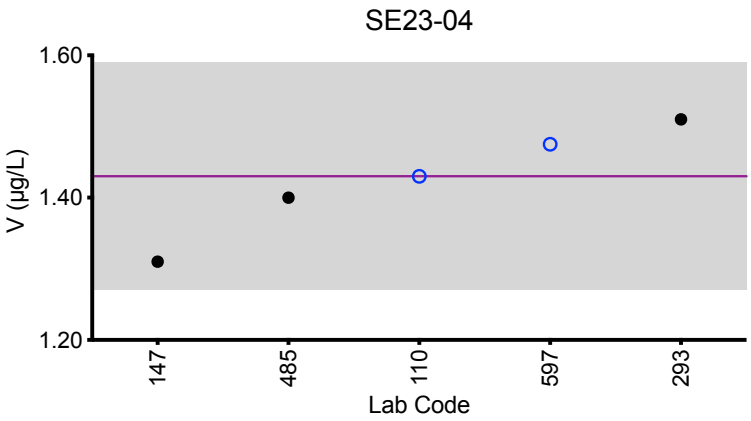
Results for Event #1, 2023: Summary Figures

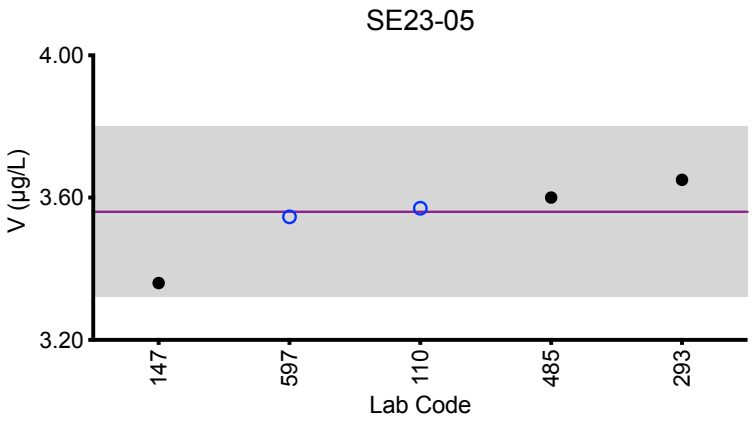
Serum V











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 #1, 2023:
Laboratory Data and Summary Statistics

Serum As (µg/L)

Lab Code	Method	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
103	ICP-MS/MS	1.01	8.28	3.37	14.3	4.87
110	ICP-MS/MS	1.02	8.16	3.14	14.2	4.85
147	DRC/CC-ICP-MS	1.03	7.29	3.05	12.6	4.40
597	ICP-MS/MS	1.07	8.03	3.29	13.8	4.78

Summary Statistics

	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
Arithmetic Mean ($\bar{x}$)	1.03	7.9	3.21	13.7	4.7
Arithmetic SD (s)	0.03	0.4	0.14	0.8	0.2
Arithmetic RSD (%)	2.5	5.1	4.4	5.8	4.7
Number of Sample Measurements (N)	4	4	4	4	4

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Serum Ba (µg/L)						
Lab Code	**Method**	**SE23-01**	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
110	ICP-MS/MS	3.36	0.70	2.67	1.70	2.15
147	ICP-MS	3.10	0.556	2.45	1.58	1.81
597	ICP-MS/MS	3.27	0.649	2.88	1.59	2.00
Summary Statistics						
		SE23-01	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
Arithmetic Mean ($\bar{x}$)		3.24	0.64	2.7	1.62	2.0
Arithmetic SD (s)		0.13	0.07	0.2	0.07	0.2
Arithmetic RSD (%)		4.0	11	8.2	4.3	8.5
Number of Sample Measurements (N)		3	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Serum Be (µg/L)						
Lab Code	**Method**	**SE23-01**	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
110	ICP-MS/MS	2.08	4.36	0.96	3.36	0.45
147	ICP-MS	1.97	3.77	0.937	2.75	0.488
293	ICP-MS	2.09	4.05	0.94	3.17	0.48
597	ICP-MS/MS	2.21	4.42	1.01	3.29	0.504

Summary Statistics					
	SE23-01	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
Arithmetic Mean ($\bar{x}$)	2.09	4.2	0.96	3.1	0.48
Arithmetic SD (s)	0.10	0.3	0.03	0.3	0.02
Arithmetic RSD (%)	4.8	7.1	3.1	8.6	4.8
Number of Sample Measurements (N)	4	4	4	4	4

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Serum Cd (µg/L)

Lab Code	Method	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
103	ICP-MS/MS	7.76	4.20	0.935	2.61	0.227
110	ICP-MS/MS	7.54	4.25	0.93	2.60	0.23
147	ICP-MS	7.14	4.06	0.905	2.47	0.223
597	ICP-MS/MS	7.25	3.95	0.891	2.51	0.229

Summary Statistics

	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
Arithmetic Mean ($\bar{x}$)	7.4	4.12	0.92	2.55	0.227
Arithmetic SD (s)	0.3	0.14	0.02	0.07	0.003
Arithmetic RSD (%)	3.8	3.4	2.3	2.7	1.3
Number of Sample Measurements (N)	4	4	4	4	4

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Serum Cs (µg/L)						
Lab Code	**Method**	**SE23-01**	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
110	ICP-MS/MS	0.64	0.74	1.02	1.93	0.66
597	ICP-MS/MS	0.665	0.746	1.04	2.00	0.661
Summary Statistics						
		SE23-01	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
Arithmetic Mean ($\bar{x}$)		0.65	0.743	1.03	1.97	0.661
Arithmetic SD (s)		0.02	0.004	0.01	0.05	0.001
Arithmetic RSD (%)		2.8	0.54	1.4	2.5	0.11
Number of Sample Measurements (N)		2	2	2	2	2

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Serum Hg (µg/L)

Lab Code	Method	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
103	ICP-MS/MS	2.43	4.42	0.960	3.34	0.659
110	ICP-MS/MS	2.49	4.24	0.95	3.03	0.61
597	ICP-MS/MS	2.23	4.09	0.983	2.94	0.679

Summary Statistics

	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
Arithmetic Mean ($\bar{x}$)	2.38	4.3	0.96	3.1	0.65
Arithmetic SD (s)	0.14	0.2	0.02	0.2	0.04
Arithmetic RSD (%)	5.9	4.0	1.8	6.8	6.2
Number of Sample Measurements (N)	3	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Serum I (µg/L)						
Lab Code	**Method**	**SE23-01**	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
147	ICP-MS	57.8	55.2	56.6	38.1	38.5
442	ICP-MS	59.2	58.2	61.1	40.0	40.7
Summary Statistics						
		SE23-01	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
Arithmetic Mean ($\bar{x}$)		58.5	57	59	39.0	40
Arithmetic SD (s)		1.0	2	3	1.3	2
Arithmetic RSD (%)		1.7	3.7	5.1	3.3	4.0
Number of Sample Measurements (N)		2	2	2	2	2

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Serum Mg (µg/L)						
Lab Code	**Method**	**SE23-01**	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
264	ICP-MS	19653.0	20616.0	18844.0	18920.0	20850.0
597	ICP-MS/MS	19800	20200	18800	18400	20300
Summary Statistics						
		SE23-01	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
Arithmetic Mean ($\bar{x}$)		19730	20400	18820	18700	20600
Arithmetic SD (s)		100	300	30	400	400
Arithmetic RSD (%)		0.51	1.5	0.16	2.1	1.9
Number of Sample Measurements (N)		2	2	2	2	2

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Serum Pb (µg/L)						
Lab Code	**Method**	**SE23-01**	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
103	ICP-MS/MS	0.512	1.88	2.69	13.5	5.26
110	ICP-MS/MS	0.60	1.98	2.81	13.3	5.23
597	ICP-MS/MS	0.612	1.92	2.69	12.7	4.90
Summary Statistics						
		SE23-01	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
Arithmetic Mean ($\bar{x}$)		0.57	1.93	2.73	13.2	5.1
Arithmetic SD (s)		0.05	0.05	0.07	0.4	0.2
Arithmetic RSD (%)		8.8	2.6	2.6	3.0	3.9
Number of Sample Measurements (N)		3	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Serum Pt (µg/L)

Lab Code	Method	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
110	ICP-MS/MS	1.19	0.132	0.377		0.740
264	ICP-MS	1.21	0.09	0.34	0.40	0.77
293	DRC/CC-ICP-MS	1.17	0.13	0.38	0.42	0.80

Summary Statistics

	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
Arithmetic Mean ($\bar{x}$)	1.19	0.12	0.37	0.41	0.77
Arithmetic SD (s)	0.02	0.02	0.02	0.01	0.03
Arithmetic RSD (%)	1.7	21	6.0	3.4	3.9
Number of Sample Measurements (N)	3	3	3	2	3

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Serum Sb (µg/L)

Lab Code	Method	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
103	ICP-MS/MS	3.98	0.819	3.29	2.26	6.34
110	ICP-MS/MS	4.80	0.97	4.19	2.46	7.22
147	ICP-MS	4.33	0.885	3.69	2.22	6.60
597	ICP-MS/MS	4.63	0.941	4.00	2.51	6.76

Summary Statistics

	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
Arithmetic Mean ($\bar{x}$)	4.4	0.90	3.8	2.36	6.7
Arithmetic SD (s)	0.4	0.07	0.4	0.14	0.4
Arithmetic RSD (%)	9.1	7.8	11	5.9	6.0
Number of Sample Measurements (N)	4	4	4	4	4

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Serum Sn (µg/L)						
Lab Code	**Method**	**SE23-01**	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
110	ICP-MS/MS	6.61	2.69	3.53	5.02	0.62
597	ICP-MS/MS	6.16	2.42	3.29	4.35	0.529
Summary Statistics						
		SE23-01	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
Arithmetic Mean ($\bar{x}$)		6.4	2.6	3.4	4.7	0.57
Arithmetic SD (s)		0.3	0.2	0.2	0.5	0.06
Arithmetic RSD (%)		4.7	7.4	5.0	11	11
Number of Sample Measurements (N)		2	2	2	2	2

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Serum Sr (µg/L)

Lab Code	Method	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
103	ICP-MS/MS	98.2	92.2	49.8	92.5	69.3
200	ICP-MS	*129.0	*122.0	*63.4	*124.0	*90.2
597	ICP-MS/MS	98.0	92.3	50.7	92.6	69.7

Summary Statistics

	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
Arithmetic Mean ($\bar{x}$)	98.1	92.3	50.3	92.6	69.5
Arithmetic SD (s)	0.1	0.1	0.6	0.1	0.3
Arithmetic RSD (%)	0.14	0.080	1.3	0.080	0.41
Number of Sample Measurements (N)	2	2	2	2	2

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Serum Ti (µg/L)						
Lab Code	**Method**	**SE23-01**	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
200	DRC/CC-ICP-MS	5.2	4.6	2.6	10.1	6.0
442	ICP-MS/MS	5.25	3.61	1.34	10	7.95
485	HR-ICP-MS	4.63	3.36	0.870	8.94	7.15
597	ICP-MS/MS	*7.55	*6.55	4.10	*12.5	*10.5

Summary Statistics					
	SE23-01	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
Arithmetic Mean ($\bar{x}$)	5.0	3.9	NA	9.68	7.0
Arithmetic SD (s)	0.3	0.7	NA	0.64	1.0
Arithmetic RSD (%)	6.9	17	NA	6.6	14
Number of Sample Measurements (N)	3	3	NA	3	3

*Denotes a statistical Outlier.

Statistical data was not calculated for SE23-04 based on a lack of consensus among participating labs.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Serum Tl (µg/L)

Lab Code	Method	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
103	ICP-MS/MS	0.882	2.26	1.62	0.344	0.696
110	ICP-MS/MS	0.91	2.28	1.67	0.34	0.70
147	ICP-MS	0.836	2.13	1.57	0.341	0.677
597	ICP-MS/MS	0.804	2.01	1.51	0.319	0.624

Summary Statistics

	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
Arithmetic Mean ($\bar{x}$)	0.86	2.17	1.59	0.336	0.67
Arithmetic SD (s)	0.05	0.13	0.07	0.011	0.03
Arithmetic RSD (%)	5.8	6.0	4.4	3.3	4.5
Number of Sample Measurements (N)	4	4	4	4	4

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Serum U (µg/L)

Lab Code	Method	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
103	ICP-MS/MS	0.139	0.109	0.155	0.0703	0.184
110	ICP-MS/MS	0.139	0.107	0.153	0.068	0.188
597	ICP-MS/MS	0.138	0.105	0.134	0.0669	0.177

Summary Statistics

	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
Arithmetic Mean ($\bar{x}$)	0.1387	0.107	0.147	0.068	0.183
Arithmetic SD (s)	0.0006	0.002	0.012	0.002	0.006
Arithmetic RSD (%)	0.43	1.9	8.2	2.5	3.3
Number of Sample Measurements (N)	3	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #1, 2023:
Laboratory Data and Summary Statistics

Serum W (µg/L)

Lab Code	Method	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
110	ICP-MS/MS	4.72	1.03	2.89	1.29	0.28
597	ICP-MS/MS	4.42	0.900	2.72	1.18	0.229

Summary Statistics

	SE23-01	SE23-02	SE23-03	SE23-04	SE23-05
Arithmetic Mean ($\bar{x}$)	4.6	0.96	2.81	1.24	0.25
Arithmetic SD (s)	0.2	0.09	0.12	0.08	0.04
Arithmetic RSD (%)	4.3	9.4	4.3	6.5	16
Number of Sample Measurements (N)	2	2	2	2	2

*Denotes a statistical Outlier.

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Results for Event #1, 2023: Additional Elements in Serum

Serum Bi (µg/L)						
Lab Code	**Method**	**SE23-01**	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
147	ICP-MS	<0.0397	<0.0397	<0.0397	<0.0397	<0.0397
597	ICP-MS/MS	<0.0300	<0.0300	<0.0300	<0.0300	<0.0300

Serum Fe (µg/L)						
Lab Code	**Method**	**SE23-01**	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
264	ICP-MS	1228.00	852.00	1187.00	974.00	1486.00

Serum Li (µg/L)						
Lab Code	**Method**	**SE23-01**	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
147	ICP-MS	0.749	0.495	0.557	0.715	0.902

Serum Th (µg/L)						
Lab Code	**Method**	**SE23-01**	**SE23-02**	**SE23-03**	**SE23-04**	**SE23-05**
597	ICP-MS/MS	<0.00488	<0.00488	<0.00488	<0.00488	<0.00488

References

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

2. Taylor A, Angerer J, Arnaud J, Claeys F, Jones RL, Mazarrasa O, Mairiaux E, Menditto A, Parsons PJ, Patriarca M, Pineau A, Valkonen S, Weber J-P, Weykamp C. Occupational and environmental laboratory medicine: A network of EQAS organisers. Accreditation and Quality Assurance. 2006;11(8-9):435-9. PubMed PMID: 086NJ-0011.

Summary of Participant Survey Responses

Thank you for taking the time to complete our 2022 Participant Survey. We appreciate your feedback and suggestions to improve the quality of the program.

Several participants expressed an interest in expanding the current panel to include arsenic species in urine, specifically Monomethylarsonic acid (MMA), Dimethylarsinic acid (DMA), Arsenobetaine (AsB), Arsenocholine (AsC) and inorganic arsenic species (i.e., Σ As^{3+} and As^{5+}). It was interesting to see a recent paper published on the determination of arsenic species in the NYS PT urine samples (1). While the PT program does not currently supplement As species into the urine pools, some were measurable nonetheless. The arsenic species determined were endogenous. Several participants suggested including Hg species to the whole blood panel.

Based on these suggestions, we plan to evaluate the feasibility of including speciation measurements as a one-time educational event. Educational events are not intended to be graded as confidence in assigned values is limited by the number of participants that report results. If your laboratory is interested in participating in an educational event for urine As species and/or blood Hg species, then please reach out to us at trel@health.ny.gov.

1. Quarles CD, Sullivan P, Bohlim N, Saetveit N. Rapid automated total arsenic and arsenic speciation by inductively coupled plasma mass spectrometry. Journal of Analytical Atomic Spectrometry. 2022;37(6):1240-6. doi: 10.1039/D2JA00055E.