New York State Biomonitoring Program for Trace Elements

Event #1, 2021

Trace Elements in Whole Blood, Urine, and Serum

April, 2021
Dear Laboratory Director,

This report summarizes performance for the first biomonitoring proficiency test (PT) event of 2021 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.

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, 2021) will be shipped June 16, 2021. Comments about this report may be directed to trel@health.ny.gov. If you have not yet enrolled for next year, please contact PT program staff at 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
Event #1, 2021

Trace Elements in Whole Blood
Event #1, 2021: 
Trace Elements in Whole Blood

PT Materials
Human whole blood was purchased from Zen-Bio, Inc. and preserved with K$_2$EDTA. 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 for analysis.

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, 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.

Amended Report
An amended report was issued on 9/9/21 for event #1, 2021. One participant lab reported a low bias with sample BE21-03 resulting in an unacceptable grade, and was unable to find a root cause. A follow up investigation was conducted by our program that confirmed a low bias for their sample BE21-03. In addition, we note that another participant also reported a low bias for their BE21-03.

A review of the homogeneity data for this study did not indicate a problem for BE21-03. However, we cannot be certain that the pool BE21-03 is free from a sporadic low bias, and so we have decided not to grade sample BE21-03. All other samples appear to meet our criteria for PT grading.
<table>
<thead>
<tr>
<th></th>
<th>BE21-01</th>
<th>BE21-02</th>
<th>BE21-03</th>
<th>BE21-04</th>
<th>BE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target</strong></td>
<td>5.2</td>
<td>14.9</td>
<td>7.8</td>
<td>1.95</td>
<td>25.5</td>
</tr>
<tr>
<td><strong>Upper Limit</strong></td>
<td>11.2</td>
<td>20.9</td>
<td>13.8</td>
<td>7.95</td>
<td>31.5</td>
</tr>
<tr>
<td><strong>Lower Limit</strong></td>
<td>0.0</td>
<td>8.9</td>
<td>1.8</td>
<td>0.00</td>
<td>19.5</td>
</tr>
<tr>
<td><strong>Arithmetic SD (s)</strong></td>
<td>0.4</td>
<td>1.5</td>
<td>2.1</td>
<td>0.25</td>
<td>1.6</td>
</tr>
<tr>
<td><strong>Arithmetic RSD (%)</strong></td>
<td>7.3</td>
<td>10</td>
<td>27</td>
<td>13</td>
<td>6.3</td>
</tr>
<tr>
<td><strong>Number of Sample Measurements (N)</strong></td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

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.
### Results for Event #1, 2021: Performance of Participating Laboratories

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>BE21-01</th>
<th>BE21-02</th>
<th>BE21-03</th>
<th>BE21-04</th>
<th>BE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Whole Blood As (µg/L)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Target</strong></td>
<td>5.2</td>
<td>14.9</td>
<td>7.8</td>
<td>1.95</td>
<td>25.5</td>
</tr>
<tr>
<td>103</td>
<td>ICP-MS/MS</td>
<td>5.12</td>
<td>15.2</td>
<td>4.45</td>
<td>1.80</td>
<td>25.5</td>
</tr>
<tr>
<td>110</td>
<td>DRC/CC-ICP-MS</td>
<td>4.92</td>
<td>13.5</td>
<td>7.98</td>
<td>1.60</td>
<td>23.8</td>
</tr>
<tr>
<td>147</td>
<td>ICP-MS</td>
<td>4.93</td>
<td>14.2</td>
<td>8.31</td>
<td>1.83</td>
<td>24.4</td>
</tr>
<tr>
<td>264</td>
<td>ICP-MS</td>
<td>5.65</td>
<td>16.36</td>
<td>8.84</td>
<td>2.06</td>
<td>26.00</td>
</tr>
<tr>
<td>293</td>
<td>DRC/CC-ICP-MS</td>
<td>5.56</td>
<td>16.26</td>
<td>9.23</td>
<td>2.0</td>
<td>28.01</td>
</tr>
<tr>
<td>391</td>
<td>ICP-MS</td>
<td>5.73</td>
<td>16.94</td>
<td>9.93</td>
<td>2.38</td>
<td>27.80</td>
</tr>
<tr>
<td>597</td>
<td>ICP-MS/MS</td>
<td>4.71</td>
<td>13.5</td>
<td>4.46</td>
<td>1.76</td>
<td>23.9</td>
</tr>
<tr>
<td>598</td>
<td>DRC/CC-ICP-MS</td>
<td>5.18</td>
<td>13.2</td>
<td>9.09</td>
<td>2.15</td>
<td>24.8</td>
</tr>
</tbody>
</table>

Based on the grading criteria for As in Whole blood, 100% of results were satisfactory, with 0 of the 8 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.
Results for Event #1, 2021:
Summary Figures

Whole Blood As

Legend:
○ C/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.
### Results for Event #1, 2021: Summary Statistics

#### Whole Blood Cd (µg/L)

<table>
<thead>
<tr>
<th></th>
<th>BE21-01</th>
<th>BE21-02</th>
<th>BE21-03</th>
<th>BE21-04</th>
<th>BE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td><em><em>Target (Robust Mean (x</em>))</em>*</td>
<td>2.30</td>
<td>8.7</td>
<td>0.93</td>
<td>16.1</td>
<td>3.15</td>
</tr>
<tr>
<td><strong>Upper Limit</strong></td>
<td>3.30</td>
<td>10.0</td>
<td>1.93</td>
<td>18.5</td>
<td>4.15</td>
</tr>
<tr>
<td><strong>Lower Limit</strong></td>
<td>1.30</td>
<td>7.4</td>
<td>0.00</td>
<td>13.7</td>
<td>2.15</td>
</tr>
<tr>
<td><em><em>Robust SD (s</em>)</em>*</td>
<td>0.15</td>
<td>0.9</td>
<td>0.10</td>
<td>0.9</td>
<td>0.18</td>
</tr>
<tr>
<td><strong>Robust RSD (%)</strong></td>
<td>6.5</td>
<td>10.0</td>
<td>11.0</td>
<td>5.6</td>
<td>5.7</td>
</tr>
<tr>
<td><strong>Number of Sample Measurements (N)</strong></td>
<td>13</td>
<td>13</td>
<td>12</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td><strong>Standard Uncertainty (u)</strong></td>
<td>0.05</td>
<td>0.3</td>
<td>0.03</td>
<td>0.3</td>
<td>0.06</td>
</tr>
</tbody>
</table>

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.
### Results for Event #1, 2021: Performance of Participating Laboratories

#### Whole Blood Cd (µg/L)

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>BE21-01</th>
<th>BE21-02</th>
<th>BE21-03</th>
<th>BE21-04</th>
<th>BE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>2.30</td>
<td>8.7</td>
<td>0.93</td>
<td>16.1</td>
<td>3.15</td>
<td></td>
</tr>
<tr>
<td>103</td>
<td>ICP-MS/MS</td>
<td>2.42</td>
<td>9.43</td>
<td>0.561</td>
<td>16.3</td>
<td>3.22</td>
</tr>
<tr>
<td>107</td>
<td>ICP-MS/MS</td>
<td>2.235</td>
<td>8.125</td>
<td>0.965</td>
<td>15.525</td>
<td>2.978</td>
</tr>
<tr>
<td>110</td>
<td>ICP-MS</td>
<td>2.45</td>
<td>9.46</td>
<td>0.92</td>
<td>16.3</td>
<td>3.13</td>
</tr>
<tr>
<td>116</td>
<td>ICP-MS/MS</td>
<td>2.21</td>
<td>8.92</td>
<td>&lt;1.5</td>
<td>16.4</td>
<td>3.53</td>
</tr>
<tr>
<td>147</td>
<td>ICP-MS</td>
<td>2.43</td>
<td>9.09</td>
<td>0.950</td>
<td>16.3</td>
<td>3.20</td>
</tr>
<tr>
<td>264</td>
<td>ICP-MS</td>
<td>2.43</td>
<td>9.79</td>
<td>1.01</td>
<td>16.44</td>
<td>3.30</td>
</tr>
<tr>
<td>293</td>
<td>DRC/CC-ICP-MS</td>
<td>2.17</td>
<td>8.76</td>
<td>0.88</td>
<td>15.03</td>
<td>2.97</td>
</tr>
<tr>
<td>391</td>
<td>ICP-MS</td>
<td>2.26</td>
<td>8.82</td>
<td>0.88</td>
<td>15.56</td>
<td>2.96</td>
</tr>
<tr>
<td>597</td>
<td>ICP-MS/MS</td>
<td>2.13</td>
<td>8.53</td>
<td>0.513</td>
<td>15.1</td>
<td>2.91</td>
</tr>
<tr>
<td>598</td>
<td>DRC/CC-ICP-MS</td>
<td>2.04</td>
<td>8.17</td>
<td>0.87</td>
<td>13.7</td>
<td>2.82</td>
</tr>
<tr>
<td>605</td>
<td>ICP-MS</td>
<td>2.35</td>
<td>6.67</td>
<td>↓</td>
<td>0.975</td>
<td>17.4</td>
</tr>
<tr>
<td>606</td>
<td>ICP-MS/MS</td>
<td>2.32</td>
<td>6.35</td>
<td>↓</td>
<td>1.08</td>
<td>16.9</td>
</tr>
<tr>
<td>686</td>
<td>ICP-MS</td>
<td>2.44</td>
<td>9.75</td>
<td>1.02</td>
<td>16.6</td>
<td>3.26</td>
</tr>
</tbody>
</table>

Based on the grading criteria for Cd in Whole blood, 97% of results were satisfactory, with 0 of the 13 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.
Results for Event #1, 2021: Summary Figures

Whole Blood Cd

Legend:
- C/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.
## Results for Event #1, 2021:
### Summary Statistics

<table>
<thead>
<tr>
<th>Whole Blood Co (µg/L)</th>
<th>BE21-01</th>
<th>BE21-02</th>
<th>BE21-03</th>
<th>BE21-04</th>
<th>BE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target (Arithmetic Mean (x̄))</td>
<td>0.54</td>
<td>1.28</td>
<td>3.8</td>
<td>19.9</td>
<td>15.9</td>
</tr>
<tr>
<td>Upper Limit</td>
<td>2.04</td>
<td>2.78</td>
<td>5.3</td>
<td>23.9</td>
<td>19.1</td>
</tr>
<tr>
<td>Lower Limit</td>
<td>0.00</td>
<td>0.00</td>
<td>2.3</td>
<td>15.9</td>
<td>12.7</td>
</tr>
<tr>
<td>Arithmetic SD (s)</td>
<td>0.05</td>
<td>0.08</td>
<td>0.9</td>
<td>1.3</td>
<td>0.9</td>
</tr>
<tr>
<td>Arithmetic RSD (%)</td>
<td>9.3</td>
<td>6.3</td>
<td>24</td>
<td>6.5</td>
<td>5.7</td>
</tr>
<tr>
<td>Number of Sample Measurements (N)</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>

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.
# Results for Event #1, 2021: Performance of Participating Laboratories

## Whole Blood Co (μg/L)

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>BE21-01</th>
<th>BE21-02</th>
<th>BE21-03</th>
<th>BE21-04</th>
<th>BE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target</strong></td>
<td></td>
<td>0.54</td>
<td>1.28</td>
<td>3.8</td>
<td>19.9</td>
<td>15.9</td>
</tr>
<tr>
<td>103</td>
<td>ICP-MS/MS</td>
<td>0.515</td>
<td>1.24</td>
<td>2.22</td>
<td>19.8</td>
<td>15.8</td>
</tr>
<tr>
<td>110</td>
<td>ICP-MS</td>
<td>0.54</td>
<td>1.42</td>
<td>4.46</td>
<td>21.0</td>
<td>16.1</td>
</tr>
<tr>
<td>147</td>
<td>ICP-MS</td>
<td>0.613</td>
<td>1.38</td>
<td>4.40</td>
<td>20.9</td>
<td>16.5</td>
</tr>
<tr>
<td>255</td>
<td>ICP-MS</td>
<td>0.57</td>
<td>1.3</td>
<td>4.3</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>264</td>
<td>ICP-MS</td>
<td>0.57</td>
<td>1.29</td>
<td>4.64</td>
<td>21.74</td>
<td>17.38</td>
</tr>
<tr>
<td>293</td>
<td>DRC/CC-ICP-MS</td>
<td>0.51</td>
<td>1.28</td>
<td>4.19</td>
<td>20.28</td>
<td>16.25</td>
</tr>
<tr>
<td>391</td>
<td>ICP-MS</td>
<td>0.43</td>
<td>1.18</td>
<td>4.17</td>
<td>19.78</td>
<td>16.04</td>
</tr>
<tr>
<td>597</td>
<td>ICP-MS/MS</td>
<td>0.534</td>
<td>1.25</td>
<td>2.53</td>
<td>19.4</td>
<td>15.7</td>
</tr>
<tr>
<td>598</td>
<td>ICP-MS</td>
<td>0.55</td>
<td>1.21</td>
<td>3.68</td>
<td>18.2</td>
<td>14.2</td>
</tr>
</tbody>
</table>

Based on the grading criteria for Co in Whole blood, 100% of results were satisfactory, with 0 of the 9 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.
Results for Event #1, 2021:
Summary Figures

Whole Blood Co

**BE21-01**

**BE21-02**

**BE21-03**

**BE21-04**

**BE21-05**

Legend:
- ○ C/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.
### Results for Event #1, 2021: Summary Statistics

**Whole Blood Cr (µg/L)**

<table>
<thead>
<tr>
<th></th>
<th>BE21-01</th>
<th>BE21-02</th>
<th>BE21-03</th>
<th>BE21-04</th>
<th>BE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target (Arithmetic Mean ((\bar{X}))</strong></td>
<td>0.97</td>
<td>4.6</td>
<td>1.3</td>
<td>NA</td>
<td>6.8</td>
</tr>
<tr>
<td><strong>Upper Limit</strong></td>
<td>2.97</td>
<td>6.6</td>
<td>3.3</td>
<td>NA</td>
<td>8.8</td>
</tr>
<tr>
<td><strong>Lower Limit</strong></td>
<td>0.00</td>
<td>2.6</td>
<td>0.0</td>
<td>NA</td>
<td>4.8</td>
</tr>
<tr>
<td><strong>Arithmetic SD (s)</strong></td>
<td>0.20</td>
<td>0.5</td>
<td>0.4</td>
<td>NA</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Arithmetic RSD (%)</strong></td>
<td>21</td>
<td>11</td>
<td>28</td>
<td>NA</td>
<td>12</td>
</tr>
<tr>
<td><strong>Number of Sample Measurements (N)</strong></td>
<td>7</td>
<td>9</td>
<td>8</td>
<td>NA</td>
<td>9</td>
</tr>
</tbody>
</table>

The acceptable range is based on quality specifications:
\[ \pm 2 \, \mu g/L \text{ or } \pm 20\% \text{ around the target value, whichever is greater; thus, it is fixed at } \pm 2 \, \mu g/L \text{ at concentrations less than or equal to } 10 \, \mu g/L. \] 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.

Statistical data was not calculated for BE21-04 based on a lack of consensus among participating labs. Consequently, a target value cannot be assigned with confidence.
## Results for Event #1, 2021: Performance of Participating Laboratories

### Whole Blood Cr (µg/L)

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>BE21-01</th>
<th>BE21-02</th>
<th>BE21-03</th>
<th>BE21-04</th>
<th>BE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Target</td>
<td>0.97</td>
<td>4.6</td>
<td>1.3</td>
<td>NA</td>
<td>6.8</td>
</tr>
<tr>
<td>103</td>
<td>ICP-MS/MS</td>
<td>&lt;2.50</td>
<td>4.98</td>
<td>&lt;2.50</td>
<td>&lt;2.50</td>
<td>6.84</td>
</tr>
<tr>
<td>110</td>
<td>DRC/CC-ICP-MS</td>
<td>1.12</td>
<td>5.67</td>
<td>1.74</td>
<td>0.20</td>
<td>7.44</td>
</tr>
<tr>
<td>147</td>
<td>DRC/CC-ICP-MS</td>
<td>0.952</td>
<td>4.78</td>
<td>1.54</td>
<td>0.251</td>
<td>7.28</td>
</tr>
<tr>
<td>255</td>
<td>ICP-MS</td>
<td>&lt;1.0</td>
<td>4.5</td>
<td>1.3</td>
<td>&lt;1.0</td>
<td>6.6</td>
</tr>
<tr>
<td>264</td>
<td>ICP-MS</td>
<td>0.89</td>
<td>4.56</td>
<td>1.62</td>
<td>0.53</td>
<td>8.25</td>
</tr>
<tr>
<td>293</td>
<td>DRC/CC-ICP-MS</td>
<td>0.98</td>
<td>4.83</td>
<td>1.63</td>
<td>0.44</td>
<td>6.78</td>
</tr>
<tr>
<td>391</td>
<td>ICP-MS</td>
<td>1.28</td>
<td>4.14</td>
<td>1.03</td>
<td>0.00</td>
<td>6.22</td>
</tr>
<tr>
<td>597</td>
<td>ICP-MS/MS</td>
<td>0.905</td>
<td>4.40</td>
<td>0.700</td>
<td>&lt;0.47</td>
<td>6.34</td>
</tr>
<tr>
<td>598</td>
<td>DRC/CC-ICP-MS</td>
<td>0.63</td>
<td>3.94</td>
<td>1.05</td>
<td>&lt;0.2</td>
<td>5.31</td>
</tr>
</tbody>
</table>

Based on the grading criteria for Cr in Whole blood, 100% of results were satisfactory, with 0 of the 9 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.
Results for Event #1, 2021:  
Summary Figures

Whole Blood Cr

Legend:
○ C/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.
# Results for Event #1, 2021: Summary Statistics

## Whole Blood Hg (µg/L)

<table>
<thead>
<tr>
<th></th>
<th>BE21-01</th>
<th>BE21-02</th>
<th>BE21-03</th>
<th>BE21-04</th>
<th>BE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td><em><em>Target (Robust Mean ( x^</em> ))</em>*</td>
<td>12.2</td>
<td>1.9</td>
<td>25.0</td>
<td>4.76</td>
<td>0.54</td>
</tr>
<tr>
<td><strong>Upper Limit</strong></td>
<td>15.9</td>
<td>4.9</td>
<td>32.5</td>
<td>7.76</td>
<td>3.54</td>
</tr>
<tr>
<td><strong>Lower Limit</strong></td>
<td>8.5</td>
<td>0.0</td>
<td>17.5</td>
<td>1.76</td>
<td>0.00</td>
</tr>
<tr>
<td><em><em>Robust SD ( s^</em> )</em>*</td>
<td>0.5</td>
<td>0.4</td>
<td>3.6</td>
<td>0.20</td>
<td>0.21</td>
</tr>
<tr>
<td><strong>Robust RSD (%)</strong></td>
<td>4.1</td>
<td>21.0</td>
<td>14.4</td>
<td>4.2</td>
<td>39</td>
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<tr>
<td><strong>Number of Sample Measurements (N)</strong></td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td><strong>Standard Uncertainty ( u )</strong></td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
<td>0.07</td>
<td>0.08</td>
</tr>
</tbody>
</table>

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.
Based on the grading criteria for Hg in Whole blood, 100% of results were satisfactory, with 0 of the 13 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.
Results for Event #1, 2021:
Summary Figures

Whole Blood Hg

Legend:
C/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.
### Results for Event #1, 2021: Summary Statistics

#### Whole Blood Mn (µg/L)

<table>
<thead>
<tr>
<th></th>
<th>BE21-01</th>
<th>BE21-02</th>
<th>BE21-03</th>
<th>BE21-04</th>
<th>BE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td><em><em>Target (Robust Mean (x</em>))</em>*</td>
<td>26.1</td>
<td>6.4</td>
<td>13.9</td>
<td>16.9</td>
<td>9.1</td>
</tr>
<tr>
<td><strong>Upper Limit</strong></td>
<td>30.5</td>
<td>9.4</td>
<td>16.9</td>
<td>19.9</td>
<td>12.1</td>
</tr>
<tr>
<td><strong>Lower Limit</strong></td>
<td>21.7</td>
<td>3.4</td>
<td>10.9</td>
<td>13.9</td>
<td>6.1</td>
</tr>
<tr>
<td><em><em>Robust SD (s</em>)</em>*</td>
<td>1.9</td>
<td>1.6</td>
<td>2.5</td>
<td>1.2</td>
<td>1.4</td>
</tr>
<tr>
<td><strong>Robust RSD (%)</strong></td>
<td>7.3</td>
<td>25</td>
<td>18</td>
<td>7.1</td>
<td>15</td>
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<tr>
<td><strong>Number of Sample Measurements (N)</strong></td>
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<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td><strong>Standard Uncertainty (u)</strong></td>
<td>0.7</td>
<td>0.7</td>
<td>0.1</td>
<td>0.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>

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).
## Results for Event #1, 2021: Performance of Participating Laboratories

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>BE21-01</th>
<th>BE21-02</th>
<th>BE21-03</th>
<th>BE21-04</th>
<th>BE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>26.1</td>
<td>6.4</td>
<td>13.9</td>
<td>16.9</td>
<td>9.1</td>
<td></td>
</tr>
<tr>
<td>103</td>
<td>ICP-MS/MS</td>
<td>26.0</td>
<td>6.55</td>
<td>7.33</td>
<td>16.7</td>
<td>8.96</td>
</tr>
<tr>
<td>107</td>
<td>ICP-MS/MS</td>
<td>24.47</td>
<td>5.41</td>
<td>13.82</td>
<td>16.18</td>
<td>8.34</td>
</tr>
<tr>
<td>110</td>
<td>ICP-MS</td>
<td>26.5</td>
<td>5.9</td>
<td>15.0</td>
<td>16.7</td>
<td>9.1</td>
</tr>
<tr>
<td>147</td>
<td>ICP-MS</td>
<td>28.4</td>
<td>8.19</td>
<td>16.5</td>
<td>19.7</td>
<td>11.3</td>
</tr>
<tr>
<td>264</td>
<td>ICP-MS</td>
<td>28.75</td>
<td>8.75</td>
<td>16.63</td>
<td>17.70</td>
<td>10.93</td>
</tr>
<tr>
<td>293</td>
<td>DRC/CC-ICP-MS</td>
<td>24.71</td>
<td>5.66</td>
<td>13.34</td>
<td>15.93</td>
<td>7.96</td>
</tr>
<tr>
<td>391</td>
<td>ICP-MS</td>
<td>26.21</td>
<td>9.04</td>
<td>14.90</td>
<td>18.27</td>
<td>10.78</td>
</tr>
<tr>
<td>597</td>
<td>ICP-MS/MS</td>
<td>25.2</td>
<td>6.72</td>
<td>8.73</td>
<td>16.5</td>
<td>8.61</td>
</tr>
<tr>
<td>598</td>
<td>ICP-MS</td>
<td>21.7</td>
<td>5.17</td>
<td>11.5</td>
<td>14.7</td>
<td>7.13</td>
</tr>
<tr>
<td>606</td>
<td>ICP-MS/MS</td>
<td>26.8</td>
<td>4.06</td>
<td>15.4</td>
<td>17.6</td>
<td>8.91</td>
</tr>
</tbody>
</table>

Based on the grading criteria for Mn in Whole Blood, 100% of results were satisfactory, with 0 of the 10 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.
Results for Event #1, 2021:  
Summary Figures

Whole Blood Mn

Legend:
- C/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 ±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.
### Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>BE21-01</th>
<th>BE21-02</th>
<th>BE21-03</th>
<th>BE21-04</th>
<th>BE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td><em><em>Target (Robust Mean (x</em>))</em>*</td>
<td>0.65</td>
<td>2.81</td>
<td>1.06</td>
<td>10.1</td>
<td>4.81</td>
</tr>
<tr>
<td><strong>Upper Limit</strong></td>
<td>2.65</td>
<td>4.81</td>
<td>3.06</td>
<td>12.1</td>
<td>6.81</td>
</tr>
<tr>
<td><strong>Lower Limit</strong></td>
<td>0.00</td>
<td>0.81</td>
<td>0.00</td>
<td>8.1</td>
<td>2.81</td>
</tr>
<tr>
<td><em><em>Robust SD (s</em>)</em>*</td>
<td>0.03</td>
<td>0.29</td>
<td>0.11</td>
<td>0.7</td>
<td>0.29</td>
</tr>
<tr>
<td><strong>Robust RSD (%)</strong></td>
<td>5.1</td>
<td>10</td>
<td>10</td>
<td>6.9</td>
<td>6.1</td>
</tr>
<tr>
<td><strong>Number of Sample Measurements (N)</strong></td>
<td>8</td>
<td>14</td>
<td>12</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td><strong>Standard Uncertainty (u)</strong></td>
<td>NA</td>
<td>0.09</td>
<td>0.04</td>
<td>0.2</td>
<td>0.09</td>
</tr>
</tbody>
</table>

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/](https://clsi.org/standards/products/clinical-chemistry-and-toxicology/documents/c40/))

An arithmetic mean, SD, RSD and n are provided for sample BE21-01.
### Results for Event #1, 2021:
Performance of Participating Laboratories

#### Whole Blood Pb (µg/dL)

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>BE21-01</th>
<th>BE21-02</th>
<th>BE21-03</th>
<th>BE21-04</th>
<th>BE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>103</td>
<td>ICP-MS/MS</td>
<td>0.672</td>
<td>3.08</td>
<td>0.584</td>
<td>10.2</td>
<td>4.97</td>
</tr>
<tr>
<td>107</td>
<td>ICP-MS/MS</td>
<td>0.661</td>
<td>2.725</td>
<td>1.111</td>
<td>10.096</td>
<td>4.837</td>
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<tr>
<td>110</td>
<td>ICP-MS</td>
<td>0.70</td>
<td>3.06</td>
<td>1.14</td>
<td>10.2</td>
<td>4.91</td>
</tr>
<tr>
<td>116</td>
<td>ICP-MS/MS</td>
<td>&lt;3.0</td>
<td>3.09</td>
<td>&lt;3.0</td>
<td>10.7</td>
<td>5.1</td>
</tr>
<tr>
<td>147</td>
<td>ICP-MS</td>
<td>0.671</td>
<td>3.03</td>
<td>1.12</td>
<td>10.3</td>
<td>5.04</td>
</tr>
<tr>
<td>264</td>
<td>ICP-MS</td>
<td>0.67</td>
<td>2.60</td>
<td>1.02</td>
<td>8.41</td>
<td>4.20</td>
</tr>
<tr>
<td>293</td>
<td>DRC/CC-ICP-MS</td>
<td>0.62</td>
<td>2.89</td>
<td>1.03</td>
<td>9.72</td>
<td>4.76</td>
</tr>
<tr>
<td>343</td>
<td>ASV-LeadCare</td>
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<td>2.7</td>
<td>&lt;1.9</td>
<td>11.2</td>
<td>4.2</td>
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<td>391</td>
<td>ETAAS-Z</td>
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<td>2.61</td>
<td>0.72</td>
<td>9.26</td>
<td>4.16</td>
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<tr>
<td>597</td>
<td>ICP-MS/MS</td>
<td>0.614</td>
<td>2.82</td>
<td>0.63</td>
<td>9.56</td>
<td>4.66</td>
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<tr>
<td>598</td>
<td>ICP-MS</td>
<td>0.61</td>
<td>2.85</td>
<td>1.05</td>
<td>9.52</td>
<td>4.56</td>
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<tr>
<td>605</td>
<td>ICP-MS</td>
<td>&lt;1.00</td>
<td>2.06</td>
<td>1.08</td>
<td>10.7</td>
<td>5.04</td>
</tr>
<tr>
<td>606</td>
<td>ICP-MS/MS</td>
<td>&lt;1.00</td>
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<td>1.24</td>
<td>10.9</td>
<td>5.20</td>
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<td>686</td>
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<td>&lt;1</td>
<td>3.08</td>
<td>1.17</td>
<td>10.1</td>
<td>4.95</td>
</tr>
</tbody>
</table>

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

Results for Event #1, 2021:

Summary Figures

Legend:
- ○ C/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.
## Results for Event #1, 2021: Laboratory Data and Summary Statistics

### Whole Blood Ba (µg/L)

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>BE21-01</th>
<th>BE21-02</th>
<th>BE21-03</th>
<th>BE21-04</th>
<th>BE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>110</td>
<td>ICP-MS</td>
<td>6.8</td>
<td>11.2</td>
<td>1.8</td>
<td>7.0</td>
<td>3.6</td>
</tr>
<tr>
<td>147</td>
<td>ICP-MS</td>
<td>6.79</td>
<td>11.0</td>
<td>2.00</td>
<td>7.62</td>
<td>3.43</td>
</tr>
<tr>
<td>293</td>
<td>DRC/CC-ICP-MS</td>
<td>6.23</td>
<td>10.05</td>
<td>1.44</td>
<td>6.93</td>
<td>3.14</td>
</tr>
<tr>
<td>597</td>
<td>ICP-MS/MS</td>
<td>6.84</td>
<td>9.98</td>
<td>0.992</td>
<td>7.27</td>
<td>3.49</td>
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<td>ICP-MS</td>
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<td>1.68</td>
<td>7.53</td>
<td>3.34</td>
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### Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>BE21-01</th>
<th>BE21-02</th>
<th>BE21-03</th>
<th>BE21-04</th>
<th>BE21-05</th>
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</thead>
<tbody>
<tr>
<td>Arithmetic Mean (x̄)</td>
<td>6.6</td>
<td>10.5</td>
<td>1.6</td>
<td>7.3</td>
<td>3.40</td>
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<tr>
<td>Arithmetic SD (s)</td>
<td>0.3</td>
<td>0.6</td>
<td>0.4</td>
<td>0.3</td>
<td>0.17</td>
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<tr>
<td>Arithmetic RSD (%)</td>
<td>3.9</td>
<td>5.7</td>
<td>25</td>
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<td>5.1</td>
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<td>Number of Sample</td>
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<td>Measurements (N)</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Denotes a statistical Outlier.*
Results for Event #1, 2021:
Summary Figures

Whole Blood Ba

Legend:
○ C/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.
# Results for Event #1, 2021: Laboratory Data and Summary Statistics

## Whole Blood Mo (µg/L)

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>BE21-01</th>
<th>BE21-02</th>
<th>BE21-03</th>
<th>BE21-04</th>
<th>BE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>103</td>
<td>ICP-MS/MS</td>
<td>&lt;1.50</td>
<td>4.09</td>
<td>&lt;1.50</td>
<td>11.0</td>
<td>2.77</td>
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<tr>
<td>147</td>
<td>ICP-MS</td>
<td>0.979</td>
<td>3.98</td>
<td>1.01</td>
<td>10.9</td>
<td>2.83</td>
</tr>
<tr>
<td>264</td>
<td>ICP-MS</td>
<td>*1.96</td>
<td>4.65</td>
<td>*2.23</td>
<td>13.36</td>
<td>2.95</td>
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<tr>
<td>597</td>
<td>ICP-MS/MS</td>
<td>0.909</td>
<td>3.65</td>
<td>0.62</td>
<td>9.70</td>
<td>2.55</td>
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<tr>
<td>598</td>
<td>DRC/CC-ICP-MS</td>
<td>1.05</td>
<td>3.71</td>
<td>1.18</td>
<td>10.4</td>
<td>2.95</td>
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</tbody>
</table>

## Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>BE21-01</th>
<th>BE21-02</th>
<th>BE21-03</th>
<th>BE21-04</th>
<th>BE21-05</th>
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<td><strong>Arithmetic Mean (x̄)</strong></td>
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*Denotes a statistical Outlier.
Results for Event #1, 2021:
Summary Figures

Whole Blood Mo

**Legend:**
- ○ C/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.
Results for Event #1, 2021:
Laboratory Data and Summary Statistics

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
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<th>BE21-02</th>
<th>BE21-03</th>
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*Denotes a statistical Outlier.

Statistical data was not calculated for BE21-01 based on a lack of consensus among participating labs.
Results for Event #1, 2021:
Summary Figures

Whole Blood Sb

Legend:
- C/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, 2021: Laboratory Data and Summary Statistics

#### Whole Blood Se (µg/L)

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<tr>
<th>Lab Code</th>
<th>Method</th>
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<th>BE21-03</th>
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#### Summary Statistics

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*Denotes a statistical Outlier.
Results for Event #1, 2021: Summary Figures

Whole Blood Se

Legend:

○ C/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.
### Results for Event #1, 2021:
Laboratory Data and Summary Statistics

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
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<th>BE21-02</th>
<th>BE21-03</th>
<th>BE21-04</th>
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### Summary Statistics

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<td>25</td>
<td>7.8</td>
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</tbody>
</table>

| Number of Sample Measurements (N) | 7 | 7 | 7 | 7 | 7 |

*Denotes a statistical Outlier.*
Results for Event #1, 2021:
Summary Figures

Whole Blood Tl

Legend:
- C/HHEAR Labs
- Other Labs

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Results for Event #1, 2021:
Laboratory Data and Summary Statistics

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
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<th>BE21-02</th>
<th>BE21-03</th>
<th>BE21-04</th>
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Summary Statistics

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<th>BE21-05</th>
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*Denotes a statistical Outlier.
Results for Event #1, 2021:
Summary Figures

Whole Blood U

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

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# Results for Event #1, 2021:
Laboratory Data and Summary Statistics

## Whole Blood Be (µg/L)

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
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<th>BE21-02</th>
<th>BE21-03</th>
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<tbody>
<tr>
<td>110</td>
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## Summary Statistics

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*Denotes a statistical Outlier.*
# Results for Event #1, 2021:
**Laboratory Data and Summary Statistics**

## Whole Blood Cs (µg/L)

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<th>BE21-03</th>
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## Summary Statistics

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### Whole Blood Cu (µg/L)

<table>
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### Summary Statistics

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<th>BE21-03</th>
<th>BE21-04</th>
<th>BE21-05</th>
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*Denotes a statistical Outlier.*
## Whole Blood Ni (µg/L)

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<td>1.62</td>
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## Summary Statistics

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*Denotes a statistical Outlier.
### Results for Event #1, 2021: Laboratory Data and Summary Statistics

#### Whole Blood Pt (µg/L)

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*Denotes a statistical Outlier.*
## Results for Event #1, 2021:
Laboratory Data and Summary Statistics

### Whole Blood Sn (µg/L)

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### Summary Statistics

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*Denotes a statistical Outlier.

Statistical data was not calculated for BE21-02 based on a lack of consensus among participating labs.
### Whole Blood Sr (µg/L)

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### Summary Statistics

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*Denotes a statistical Outlier.*
### Results for Event #1, 2021:
Laboratory Data and Summary Statistics

**Whole Blood V (µg/L)**

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<th>BE21-05</th>
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**Summary Statistics**

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*Denotes a statistical Outlier.*
Results for Event #1, 2021:
Laboratory Data and Summary Statistics

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Summary Statistics

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*Denotes a statistical Outlier.*
# Whole Blood Zn (µg/L)

**Results for Event #1, 2021:**

**Laboratory Data and Summary Statistics**

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*Denotes a statistical Outlier.*
Results for Event #1, 2021: Additional Elements in Whole blood

### Whole blood Ag (µg/L)

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### Whole blood Al (µg/L)

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### Whole blood Bi (µg/L)

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### Whole blood I (µg/L)

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### Whole blood Li (µg/L)

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### Whole blood Te (µg/L)

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### Whole blood Th (µg/L)

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### Whole blood Ti (µg/L)

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Event #1, 2021

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), 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, B, Bi, Cs, Cu, Fe, I, Li, Mg, Mo, Ni, Pt, Sb, Se, Sn, Sr, Te, Th, 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.
# Results for Event #1, 2021: Summary Statistics

## Urine As (µg/L)

<table>
<thead>
<tr>
<th></th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td><em><em>Target (Robust Mean (x</em>))</em>*</td>
<td>5.56</td>
<td>21.3</td>
<td>36.2</td>
<td>57.3</td>
<td>1.2</td>
</tr>
<tr>
<td><strong>Upper Limit</strong></td>
<td>11.56</td>
<td>27.3</td>
<td>43.4</td>
<td>68.8</td>
<td>7.2</td>
</tr>
<tr>
<td><strong>Lower Limit</strong></td>
<td>0.00</td>
<td>15.3</td>
<td>29.0</td>
<td>45.8</td>
<td>0.0</td>
</tr>
<tr>
<td><em><em>Robust SD (s</em>)</em>*</td>
<td>0.25</td>
<td>1.0</td>
<td>2.0</td>
<td>2.5</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>Robust RSD (%)</strong></td>
<td>4.5</td>
<td>4.7</td>
<td>5.5</td>
<td>4.4</td>
<td>29</td>
</tr>
<tr>
<td><strong>Number of Sample Measurements (N)</strong></td>
<td>14</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>9</td>
</tr>
<tr>
<td><strong>Standard Uncertainty (u)</strong></td>
<td>0.08</td>
<td>0.3</td>
<td>0.6</td>
<td>0.8</td>
<td>NA</td>
</tr>
</tbody>
</table>

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.

An arithmetic mean, SD, RSD and n are provided for sample UE21-05.
### Results for Event #1, 2021: Performance of Participating Laboratories

#### Urine As (µg/L)

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>103</td>
<td>ICP-MS/MS</td>
<td>5.30</td>
<td>20.9</td>
<td>35.8</td>
<td>55.9</td>
<td>1.01</td>
</tr>
<tr>
<td>107</td>
<td>DRC/CC-ICP-MS</td>
<td>5.06</td>
<td>17.99</td>
<td>31.58</td>
<td>49.29</td>
<td>0.87</td>
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<tr>
<td>110</td>
<td>DRC/CC-ICP-MS</td>
<td>5.76</td>
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<td>38.8</td>
<td>59.0</td>
<td>1.29</td>
</tr>
<tr>
<td>116</td>
<td>ICP-MS/MS</td>
<td>&lt;5.00</td>
<td>20.5</td>
<td>35.0</td>
<td>54.7</td>
<td>&lt;5.00</td>
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<tr>
<td>147</td>
<td>ICP-MS</td>
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<tr>
<td>220</td>
<td>DRC/CC-ICP-MS</td>
<td>5.84</td>
<td>23.1</td>
<td>38.2</td>
<td>60.7</td>
<td>&lt;2</td>
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<tr>
<td>264</td>
<td>ICP-MS</td>
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<td>1.24</td>
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<tr>
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<td>57.1</td>
<td>1.04</td>
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<td>399</td>
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<td>5.40</td>
<td>21.0</td>
<td>36.9</td>
<td>58.5</td>
<td>&lt;2.00</td>
</tr>
<tr>
<td>597</td>
<td>ICP-MS/MS</td>
<td>5.38</td>
<td>21.1</td>
<td>36.7</td>
<td>57.8</td>
<td>1.29</td>
</tr>
<tr>
<td>598</td>
<td>DRC/CC-ICP-MS</td>
<td>5.58</td>
<td>19.9</td>
<td>34.1</td>
<td>54.6</td>
<td>0.84</td>
</tr>
<tr>
<td>605</td>
<td>ICP-MS</td>
<td>5.66</td>
<td>24.4</td>
<td>39.0</td>
<td>61.6</td>
<td>&lt;2.00</td>
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<tr>
<td>606</td>
<td>ICP-MS/MS</td>
<td>5.42</td>
<td>21.1</td>
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<td>57.0</td>
<td>&lt;2.00</td>
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<tr>
<td>676</td>
<td>DRC/CC-ICP-MS</td>
<td>5.92</td>
<td>22.5</td>
<td>38.1</td>
<td>58.9</td>
<td>1.98</td>
</tr>
<tr>
<td>686</td>
<td>DRC/CC-ICP-MS</td>
<td>&lt;6</td>
<td>19.2</td>
<td>31.7</td>
<td>50.9</td>
<td>&lt;6</td>
</tr>
</tbody>
</table>

Based on the grading criteria for As 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.
Results for Event #1, 2021:  
Summary Figures

Urine As

Legend:  
○ C/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.
Results for Event #1, 2021:  
Summary Statistics

<table>
<thead>
<tr>
<th>Urine Ba (µg/L)</th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td><em><em>Target (Robust Mean (x</em>))</em>*</td>
<td>1.50</td>
<td>0.72</td>
<td>1.31</td>
<td>5.48</td>
<td>2.44</td>
</tr>
<tr>
<td><strong>Upper Limit</strong></td>
<td>2.50</td>
<td>1.72</td>
<td>2.31</td>
<td>6.58</td>
<td>3.44</td>
</tr>
<tr>
<td><strong>Lower Limit</strong></td>
<td>0.50</td>
<td>0.00</td>
<td>0.31</td>
<td>4.38</td>
<td>1.44</td>
</tr>
<tr>
<td><em><em>Robust SD (s</em>)</em>*</td>
<td>0.09</td>
<td>0.06</td>
<td>0.07</td>
<td>0.28</td>
<td>0.17</td>
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<tr>
<td><strong>Robust RSD (%)</strong></td>
<td>5.9</td>
<td>8.3</td>
<td>5.3</td>
<td>5.1</td>
<td>7.1</td>
</tr>
<tr>
<td><strong>Number of Sample Measurements (N)</strong></td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td><strong>Standard Uncertainty (u)</strong></td>
<td>0.03</td>
<td>0.02</td>
<td>0.02</td>
<td>0.09</td>
<td>0.06</td>
</tr>
</tbody>
</table>

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.
Based on the grading criteria for Ba in Urine, 100% of results were satisfactory, with 0 of the 15 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.
Results for Event #1, 2021:
Summary Figures

Urine Ba

**Legend:**
- O C/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.
# Results for Event #1, 2021: Summary Statistics

**Urine Be (µg/L)**

<table>
<thead>
<tr>
<th></th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td><em><em>Target (Robust Mean (x</em>))</em>*</td>
<td>3.55</td>
<td>4.64</td>
<td>0.67</td>
<td>1.85</td>
<td>1.06</td>
</tr>
<tr>
<td><strong>Upper Limit</strong></td>
<td>4.55</td>
<td>5.64</td>
<td>1.67</td>
<td>2.85</td>
<td>2.06</td>
</tr>
<tr>
<td><strong>Lower Limit</strong></td>
<td>2.55</td>
<td>3.64</td>
<td>0.00</td>
<td>0.85</td>
<td>0.06</td>
</tr>
<tr>
<td>*<em>Robust SD (s</em>)**</td>
<td>0.09</td>
<td>0.23</td>
<td>0.03</td>
<td>0.09</td>
<td>0.07</td>
</tr>
<tr>
<td><strong>Robust RSD (%)</strong></td>
<td>2.5</td>
<td>5.0</td>
<td>4.6</td>
<td>4.9</td>
<td>6.6</td>
</tr>
<tr>
<td><strong>Number of Sample Measurements (N)</strong></td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td><strong>Standard Uncertainty (u)</strong></td>
<td>0.03</td>
<td>0.08</td>
<td>0.01</td>
<td>0.03</td>
<td>0.02</td>
</tr>
</tbody>
</table>

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.
## Results for Event #1, 2021: Performance of Participating Laboratories

### Urine Be (µg/L)

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>3.55</td>
<td>4.64</td>
<td>0.67</td>
<td>1.85</td>
<td>1.06</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>107</td>
<td>ICP-MS</td>
<td>3.353</td>
<td>4.560</td>
<td>0.619</td>
<td>1.696</td>
<td>0.964</td>
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<tr>
<td>110</td>
<td>ICP-MS</td>
<td>3.55</td>
<td>4.40</td>
<td>0.694</td>
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<td>1.09</td>
</tr>
<tr>
<td>116</td>
<td>ICP-MS/MS</td>
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<td>0.685</td>
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<td>0.67</td>
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<tr>
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</tr>
<tr>
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<td>ICP-MS</td>
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<td>0.62</td>
<td>1.84</td>
<td>1.02</td>
</tr>
<tr>
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<td>ICP-MS/MS</td>
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<tr>
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<td>ICP-MS</td>
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</tr>
<tr>
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<td>ICP-MS</td>
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<td>0.673</td>
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<td>1.08</td>
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<td>ICP-MS</td>
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<td>0.704</td>
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<td>1.15</td>
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</tbody>
</table>

Based on the grading criteria for Be 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.
Results for Event #1, 2021:
Summary Figures

Urine Be

Legend:
- C/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.
# Results for Event #1, 2021: Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td><em><em>Target (Robust Mean (x</em>))</em>*</td>
<td>1.98</td>
<td>0.348</td>
<td>1.23</td>
<td>0.81</td>
<td>4.36</td>
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<td><strong>Upper Limit</strong></td>
<td>2.98</td>
<td>1.348</td>
<td>2.23</td>
<td>1.81</td>
<td>5.36</td>
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<tr>
<td><strong>Lower Limit</strong></td>
<td>0.98</td>
<td>0.000</td>
<td>0.23</td>
<td>0.00</td>
<td>3.36</td>
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<tr>
<td><em><em>Robust SD (s</em>)</em>*</td>
<td>0.11</td>
<td>0.029</td>
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<td><strong>Robust RSD (%)</strong></td>
<td>5.6</td>
<td>8.3</td>
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<td><strong>Number of Sample Measurements (N)</strong></td>
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<td><strong>Standard Uncertainty (u)</strong></td>
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<td>0.009</td>
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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.
# Results for Event #1, 2021: Performance of Participating Laboratories

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
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<tbody>
<tr>
<td>103</td>
<td>ICP-MS/MS</td>
<td>2.06</td>
<td>0.370</td>
<td>1.26</td>
<td>0.845</td>
<td>4.69</td>
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<tr>
<td>107</td>
<td>DRC/CC-ICP-MS</td>
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<td>1.165</td>
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<td>ICP-MS</td>
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<tr>
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<td>0.784</td>
<td>4.33</td>
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<td>0.32</td>
<td>1.24</td>
<td>0.80</td>
<td>4.69</td>
</tr>
<tr>
<td>293</td>
<td>DRC/CC-ICP-MS</td>
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</table>

Based on the grading criteria for Cd in Urine, 100% of results were satisfactory, with 0 of the 17 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.
Results for Event #1, 2021:
Summary Figures

**Urine Cd**

**UE21-01**

**UE21-02**

**UE21-03**

**UE21-04**

**UE21-05**

**Legend:**
- C/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.
Results for Event #1, 2021:
Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td><em><em>Target (Robust Mean (x</em>))</em>*</td>
<td>5.98</td>
<td>0.62</td>
<td>2.53</td>
<td>0.84</td>
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<td><strong>Upper Limit</strong></td>
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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.
Results for Event #1, 2021:
Performance of Participating Laboratories

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<tr>
<th>Lab Code</th>
<th>Method</th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
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<tbody>
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<td>ICP-MS/MS</td>
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Based on the grading criteria for Co 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.
Results for Event #1, 2021:
Summary Figures

Urine Co

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Legend:
○C/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.
### Urine Cr (µg/L)

<table>
<thead>
<tr>
<th></th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target (Robust Mean (x*))</td>
<td>0.69</td>
<td>0.36</td>
<td>1.86</td>
<td>4.3</td>
<td>2.07</td>
</tr>
<tr>
<td>Upper Limit</td>
<td>3.69</td>
<td>3.36</td>
<td>4.86</td>
<td>7.3</td>
<td>5.07</td>
</tr>
<tr>
<td>Lower Limit</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>1.3</td>
<td>0.00</td>
</tr>
<tr>
<td>Robust SD (s*)</td>
<td>0.10</td>
<td>0.10</td>
<td>0.19</td>
<td>0.4</td>
<td>0.25</td>
</tr>
<tr>
<td>Robust RSD (%)</td>
<td>14</td>
<td>28</td>
<td>10</td>
<td>8.1</td>
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</tr>
<tr>
<td>Number of Sample Measurements (N)</td>
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<tr>
<td>Standard Uncertainty (u)</td>
<td>NA</td>
<td>NA</td>
<td>0.07</td>
<td>0.1</td>
<td>0.09</td>
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</tbody>
</table>

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 samples UE21-01 and UE21-02.
### Results for Event #1, 2021:
#### Performance of Participating Laboratories

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>103</td>
<td>ICP-MS/MS</td>
<td>0.69</td>
<td>0.36</td>
<td>1.86</td>
<td>4.3</td>
<td>2.07</td>
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<tr>
<td>107</td>
<td>DRC/CC-ICP-MS</td>
<td>&lt;1.00</td>
<td>&lt;1.00</td>
<td>1.85</td>
<td>4.09</td>
<td>1.81</td>
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<td>110</td>
<td>DRC/CC-ICP-MS</td>
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<td>DRC/CC-ICP-MS</td>
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</table>

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.
Results for Event #1, 2021:
Summary Figures

Legend:
- C/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.
Results for Event #1, 2021:  
Summary Statistics

<table>
<thead>
<tr>
<th>Urine Hg (µg/L)</th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
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<tbody>
<tr>
<td><em><em>Target (Robust Mean (x</em>))</em>*</td>
<td>21.1</td>
<td>NA</td>
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<td><strong>Upper Limit</strong></td>
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<td><strong>Robust RSD (%)</strong></td>
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<td>NA</td>
<td>0.2</td>
<td>0.09</td>
<td>0.3</td>
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</tbody>
</table>

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.

Statistical data was not calculated for UE21-02 based on a lack of consensus among participating labs. Consequently, a target value cannot be assigned with confidence.
### Results for Event #1, 2021: Performance of Participating Laboratories

#### Urine Hg (µg/L)

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
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<tbody>
<tr>
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<td>4.16</td>
<td>1.20</td>
<td>10.1</td>
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<tr>
<td>107</td>
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<td>3.14</td>
<td>0.89</td>
<td>9.65</td>
</tr>
<tr>
<td>110</td>
<td>ICP-MS</td>
<td>21.5</td>
<td>1.03</td>
<td>4.01</td>
<td>1.36</td>
<td>10.0</td>
</tr>
<tr>
<td>116</td>
<td>ICP-MS/MS</td>
<td>22.1</td>
<td>&lt;0.50</td>
<td>3.52</td>
<td>0.707</td>
<td>7.31</td>
</tr>
<tr>
<td>147</td>
<td>ICP-MS</td>
<td>20.7</td>
<td>0.491</td>
<td>3.79</td>
<td>1.09</td>
<td>8.87</td>
</tr>
<tr>
<td>264</td>
<td>ICP-MS</td>
<td>34.65</td>
<td>↑</td>
<td>1.23</td>
<td>6.09</td>
<td>1.77</td>
</tr>
<tr>
<td>293</td>
<td>DRC/CC-ICP-MS</td>
<td>20.97</td>
<td>0.37</td>
<td>3.86</td>
<td>1.11</td>
<td>9.61</td>
</tr>
<tr>
<td>597</td>
<td>ICP-MS/MS</td>
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<td>3.53</td>
<td>1.06</td>
<td>8.12</td>
</tr>
<tr>
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<td>3.92</td>
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<td>9.28</td>
</tr>
<tr>
<td>605</td>
<td>ICP-MS</td>
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<td>&lt;1.00</td>
<td>4.08</td>
<td>1.01</td>
<td>10.2</td>
</tr>
<tr>
<td>606</td>
<td>ICP-MS/MS</td>
<td>23.3</td>
<td>&lt;1.00</td>
<td>4.42</td>
<td>1.36</td>
<td>9.66</td>
</tr>
<tr>
<td>676</td>
<td>ICP-MS</td>
<td>18.5</td>
<td>&lt;0.122</td>
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<td>0.513</td>
<td>7.7</td>
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</tbody>
</table>

Based on the grading criteria for Hg in Urine, 97% of results were satisfactory, with 1 of the 12 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.
Results for Event #1, 2021: Summary Figures

Urine Hg

**Legend:**
- **●** C/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.
## Results for Event #1, 2021: Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td><em><em>Target (Robust Mean (x</em>))</em>*</td>
<td>0.45</td>
<td>1.07</td>
<td>2.11</td>
<td>4.9</td>
<td>6.49</td>
</tr>
<tr>
<td><strong>Upper Limit</strong></td>
<td>1.00</td>
<td>1.62</td>
<td>2.66</td>
<td>6.1</td>
<td>8.11</td>
</tr>
<tr>
<td><strong>Lower Limit</strong></td>
<td>0.00</td>
<td>0.52</td>
<td>1.56</td>
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<td>4.87</td>
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<tr>
<td><em><em>Robust SD (s</em>)</em>*</td>
<td>0.03</td>
<td>0.06</td>
<td>0.11</td>
<td>0.3</td>
<td>0.29</td>
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<tr>
<td><strong>Robust RSD (%)</strong></td>
<td>7.1</td>
<td>5.6</td>
<td>5.2</td>
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<tr>
<td><strong>Number of Sample Measurements (N)</strong></td>
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<td><strong>Standard Uncertainty (u)</strong></td>
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<td>0.02</td>
<td>0.04</td>
<td>0.1</td>
<td>0.09</td>
</tr>
</tbody>
</table>

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).
### Results for Event #1, 2021: Performance of Participating Laboratories

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
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</thead>
<tbody>
<tr>
<td>Target</td>
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<td>0.45</td>
<td>1.07</td>
<td>2.11</td>
<td>4.9</td>
<td>6.49</td>
</tr>
<tr>
<td>103</td>
<td>ICP-MS/MS</td>
<td>0.408</td>
<td>1.04</td>
<td>2.08</td>
<td>4.94</td>
<td>6.45</td>
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<tr>
<td>107</td>
<td>DRC/CC-ICP-MS</td>
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<td>0.984</td>
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<tr>
<td>116</td>
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<td>2.13</td>
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<td>2.04</td>
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<td>6.49</td>
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<tr>
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<td>2.11</td>
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<tr>
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<td>2.03</td>
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</table>

Based on the grading criteria for Mn in Urine, 100% of results were satisfactory, with 0 of the 15 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.
Results for Event #1, 2021:
Summary Figures

Urine Mn

C/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.
**Results for Event #1, 2021: Summary Statistics**

<table>
<thead>
<tr>
<th>Urine Pb (µg/L)</th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
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<tbody>
<tr>
<td><em><em>Target (Robust Mean (x</em>))</em>*</td>
<td>0.63</td>
<td>2.72</td>
<td>7.70</td>
<td>1.09</td>
<td>3.73</td>
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<td><strong>Upper Limit</strong></td>
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<td>3.72</td>
<td>9.24</td>
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<td>4.73</td>
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<td>1.72</td>
<td>6.16</td>
<td>0.09</td>
<td>2.73</td>
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<tr>
<td><em><em>Robust SD (s</em>)</em>*</td>
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<td>0.13</td>
<td>0.21</td>
<td>0.06</td>
<td>0.14</td>
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<tr>
<td><strong>Robust RSD (%)</strong></td>
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<td>4.8</td>
<td>2.7</td>
<td>5.5</td>
<td>3.8</td>
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<td><strong>Number of Sample Measurements (N)</strong></td>
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<td>17</td>
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<tr>
<td><strong>Standard Uncertainty (u)</strong></td>
<td>0.02</td>
<td>0.04</td>
<td>0.06</td>
<td>0.02</td>
<td>0.04</td>
</tr>
</tbody>
</table>

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.
**Results for Event #1, 2021:**

**Performance of Participating Laboratories**

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
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<tr>
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<td>2.72</td>
<td>7.70</td>
<td>1.09</td>
<td>3.73</td>
</tr>
<tr>
<td>103</td>
<td>ICP-MS/MS</td>
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<td>7.84</td>
<td>1.12</td>
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<td>8.03</td>
<td>1.16</td>
<td>3.96</td>
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<tr>
<td>293</td>
<td>DRC/CC-ICP-MS</td>
<td>0.61</td>
<td>2.78</td>
<td>7.67</td>
<td>1.08</td>
<td>3.68</td>
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<td>7.68</td>
<td>0.983</td>
<td>3.81</td>
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<td>2.43</td>
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<td>7.42</td>
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</table>

Based on the grading criteria for Pb in Urine, 100% of results were satisfactory, with 0 of the 17 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.
Results for Event #1, 2021: Summary Figures

Urine Pb

**Legend:**
- ○ C/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.
### Urine Tl (µg/L)

<table>
<thead>
<tr>
<th></th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td><em><em>Target (Robust Mean (x</em>))</em>*</td>
<td>0.70</td>
<td>2.18</td>
<td>0.279</td>
<td>1.40</td>
<td>4.48</td>
</tr>
<tr>
<td><strong>Upper Limit</strong></td>
<td>0.90</td>
<td>2.62</td>
<td>0.479</td>
<td>1.68</td>
<td>5.38</td>
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<tr>
<td><strong>Lower Limit</strong></td>
<td>0.50</td>
<td>1.74</td>
<td>0.079</td>
<td>1.12</td>
<td>3.58</td>
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<td><em><em>Robust SD (s</em>)</em>*</td>
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<td>5.0</td>
<td>3.2</td>
<td>3.6</td>
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<tr>
<td><strong>Number of Sample Measurements (N)</strong></td>
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<tr>
<td><strong>Standard Uncertainty (u)</strong></td>
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<td>0.02</td>
<td>0.003</td>
<td>0.02</td>
<td>0.07</td>
</tr>
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</table>

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.
### Results for Event #1, 2021: Performance of Participating Laboratories

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
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<tbody>
<tr>
<td>103</td>
<td>ICP-MS/MS</td>
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<td>1.45</td>
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<td>ICP-MS</td>
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<td>0.270</td>
<td>1.307</td>
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<td>4.43</td>
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<td>4.39</td>
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<tr>
<td>147</td>
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<tr>
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<td>DRC/CC-ICP-MS</td>
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<td>1.37</td>
<td>4.3</td>
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<td>4.59</td>
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</table>

Based on the grading criteria for Tl 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.
Results for Event #1, 2021:
Summary Figures

Urine TI

LEGEND:
○ C/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.
Results for Event #1, 2021:
Summary Statistics

<table>
<thead>
<tr>
<th>Urine U (µg/L)</th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target (Robust Mean (x*))</td>
<td>0.0062</td>
<td>0.0105</td>
<td>0.120</td>
<td>0.0254</td>
<td>0.156</td>
</tr>
<tr>
<td>Upper Limit</td>
<td>0.0362</td>
<td>0.0405</td>
<td>0.150</td>
<td>0.0554</td>
<td>0.187</td>
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<tr>
<td>Lower Limit</td>
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<td>0.0000</td>
<td>0.090</td>
<td>0.0000</td>
<td>0.125</td>
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<td>Robust SD (s*)</td>
<td>0.0015</td>
<td>0.0015</td>
<td>0.004</td>
<td>0.0014</td>
<td>0.008</td>
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<tr>
<td>Robust RSD (%)</td>
<td>24</td>
<td>14</td>
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<td>5.1</td>
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<td>Number of Sample Measurements (N)</td>
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<td>Standard Uncertainty (u)</td>
<td>0.0006</td>
<td>0.0005</td>
<td>0.001</td>
<td>0.0005</td>
<td>0.002</td>
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</table>

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.
### Results for Event #1, 2021: Performance of Participating Laboratories

#### Urine U (µg/L)

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
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</thead>
<tbody>
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<td>Target</td>
<td>0.0062</td>
<td>0.0105</td>
<td>0.120</td>
<td>0.0254</td>
<td>0.156</td>
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<tr>
<td>103</td>
<td>ICP-MS/MS</td>
<td>&lt;0.0200</td>
<td>&lt;0.0200</td>
<td>0.118</td>
<td>&lt;0.0200</td>
<td>0.155</td>
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<tr>
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<td>0.0254</td>
<td>0.161</td>
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<tr>
<td>116</td>
<td>ICP-MS/MS</td>
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<td>0.130</td>
<td>0.0311</td>
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<tr>
<td>147</td>
<td>ICP-MS</td>
<td>&lt;0.00762</td>
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<td>0.123</td>
<td>0.0267</td>
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<tr>
<td>220</td>
<td>ICP-MS</td>
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<td>0.011</td>
<td>0.117</td>
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<tr>
<td>264</td>
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<tr>
<td>399</td>
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<td>0.008</td>
<td>0.121</td>
<td>0.025</td>
<td>0.155</td>
</tr>
<tr>
<td>597</td>
<td>ICP-MS/MS</td>
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<td>&lt;0.03</td>
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<td>&lt;0.03</td>
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<td>598</td>
<td>ICP-MS</td>
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<td>0.01</td>
<td>0.12</td>
<td>0.025</td>
<td>0.16</td>
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<tr>
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<td>ICP-MS</td>
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<td>0.128</td>
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<tr>
<td>606</td>
<td>ICP-MS/MS</td>
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<td>0.010</td>
<td>0.120</td>
<td>0.025</td>
<td>0.155</td>
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<td>607</td>
<td>ICP-MS</td>
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<td>ICP-MS</td>
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<td>0.011</td>
<td>0.121</td>
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<tr>
<td>686</td>
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<td>&lt;0.015</td>
<td>0.118</td>
<td>0.0241</td>
<td>0.153</td>
</tr>
</tbody>
</table>

Based on the grading criteria for U 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.
Results for Event #1, 2021:
Summary Figures

**Urine U**

**Legend:**
- ○ C/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.
Results for Event #1, 2021:
Laboratory Data and Summary Statistics

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>147</td>
<td>ICP-MS</td>
<td>11.5</td>
<td>&lt;9.44</td>
<td>21.8</td>
<td>16.0</td>
<td>&lt;9.44</td>
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<td>ICP-MS</td>
<td>12.47</td>
<td>8.56</td>
<td>19.57</td>
<td>16.53</td>
<td>8.57</td>
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<td>293</td>
<td>DRC/CC-ICP-MS</td>
<td>16.67</td>
<td>10.75</td>
<td>22.04</td>
<td>18.28</td>
<td>6.99</td>
</tr>
<tr>
<td>597</td>
<td>ICP-MS/MS</td>
<td>16.9</td>
<td>14.5</td>
<td>22.1</td>
<td>14.8</td>
<td>8.26</td>
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</table>

Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
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</thead>
<tbody>
<tr>
<td>Arithmetic Mean (x̄)</td>
<td>13.9</td>
<td>11.8</td>
<td>20.7</td>
<td>16.4</td>
<td>8.2</td>
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<tr>
<td>Arithmetic SD (s)</td>
<td>2.6</td>
<td>2.7</td>
<td>1.8</td>
<td>1.3</td>
<td>0.9</td>
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<tr>
<td>Arithmetic RSD (%)</td>
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<td>7.9</td>
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<td>Measurements (N)</td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>

*Denotes a statistical Outlier.
Results for Event #1, 2021: Summary Figures

Urine Al

Legend:
○ C/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.
## Results for Event #1, 2021:
Laboratory Data and Summary Statistics

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
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<tr>
<td>107</td>
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<td>7.27</td>
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<td>1.46</td>
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<td>ICP-MS</td>
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<td>7.06</td>
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<td>10.2</td>
<td>1.71</td>
<td>7.65</td>
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<tr>
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<td>1.67</td>
<td>10.13</td>
<td>1.75</td>
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<tr>
<td>598</td>
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<td>9.56</td>
<td>1.59</td>
<td>7.13</td>
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<td>605</td>
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<td>10.6</td>
<td>1.64</td>
<td>7.89</td>
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<tr>
<td>606</td>
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<td>1.39</td>
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<td>1.59</td>
<td>7.40</td>
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<td>1.39</td>
<td>9.64</td>
<td>1.59</td>
<td>7.16</td>
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### Summary Statistics

<table>
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<tr>
<th></th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
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<tbody>
<tr>
<td>Robust Mean (x*)</td>
<td>12.8</td>
<td>1.42</td>
<td>9.8</td>
<td>1.63</td>
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<tr>
<td>Robust SD (s*)</td>
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<td>Robust RSD (%)</td>
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<td>5.1</td>
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<td>Number of Sample Measurements (N)</td>
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<td>11</td>
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<td>11</td>
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<td>Standard Uncertainty (u)</td>
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<td>0.02</td>
<td>0.2</td>
<td>0.04</td>
<td>0.1</td>
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</tbody>
</table>

*Denotes a statistical Outlier.*
Results for Event #1, 2021: Summary Figures

Legend:
- C/HHEAR Labs
- Other Labs

Horizontal purple line = robust 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.
## Results for Event #1, 2021: Laboratory Data and Summary Statistics

### Urine Cu (µg/L)

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
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<td>ICP-MS</td>
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<td>11.1</td>
<td>28.4</td>
<td>*10.0</td>
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<td>264</td>
<td>ICP-MS</td>
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### Summary Statistics

<table>
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<tr>
<th></th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
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<tbody>
<tr>
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<td>Number of Sample Measurements (N)</td>
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</table>

*Denotes a statistical Outlier.
Results for Event #1, 2021:
Summary Figures

Urine Cu

Legend:
○ C/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.
## Results for Event #1, 2021:
### Laboratory Data and Summary Statistics

### Urine Mo (µg/L)

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>103</td>
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<td>8.66</td>
<td>42.4</td>
<td>85.4</td>
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*Denotes a statistical Outlier.
Results for Event #1, 2021: Summary Figures

Urine Mo

Legend:
- C/HHEAR Labs
- Other Labs

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

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### Results for Event #1, 2021: Laboratory Data and Summary Statistics

**Urine Ni (µg/L)**

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*Denotes a statistical Outlier.*
Results for Event #1, 2021:
Summary Figures

Urine Ni

Legend:
○ C/HHEAR Labs   ● Other Labs
Horizontal purple line = arithmetic mean of all laboratories.
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# Results for Event #1, 2021: Laboratory Data and Summary Statistics

## Urine Pt (µg/L)

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Results for Event #1, 2021:
Summary Figures

Urine Pt

Legend:
○ C/HHEAR Labs  ● Other Labs
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### Urine Sb (µg/L)

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Results for Event #1, 2021:
Summary Figures

Urine Sb

Legend:
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## Urine Se (µg/L)

### Laboratory Data and Summary Statistics

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Results for Event #1, 2021:
Summary Figures

Urine Se

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#### Urine Sn (µg/L)

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*Denotes a statistical Outlier.

An arithmetic mean, SD, RSD and n are provided for samples UE21-01 and UE21-03.
### Results for Event #1, 2021: Summary Figures

**Urine Sn**

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**Legend:**
- ○ C/HHEAR Labs
- ● Other Labs

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

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### Results for Event #1, 2021: Laboratory Data and Summary Statistics

#### Urine Sr (µg/L)

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*Denotes a statistical Outlier.
Results for Event #1, 2021:
Summary Figures

Urine Sr

UE21-01

UE21-02

UE21-03

UE21-04

UE21-05

Legend:
○ C/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.
## Results for Event #1, 2021:
Laboratory Data and Summary Statistics

### Urine V (µg/L)

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### Summary Statistics

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*Denotes a statistical Outlier.*
Results for Event #1, 2021:
Summary Figures

**Urine V**

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**Legend:**
- C/HHEAR Labs
- Other Labs

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## Urine W (µg/L)

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*Denotes a statistical Outlier.
Results for Event #1, 2021:
Summary Figures

Urine W

**Legend:**
- ○C/HHEAR Labs
- ● Other Labs

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## Urine Zn (µg/L)

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<td>133.1</td>
<td>340.7</td>
<td>813.9</td>
<td>235.6</td>
</tr>
<tr>
<td>293</td>
<td>DRC/CC-ICP-MS</td>
<td>149.02</td>
<td>135.95</td>
<td>343.14</td>
<td>822.88</td>
<td>233.33</td>
</tr>
<tr>
<td>324</td>
<td>ICP-MS</td>
<td>152.2619</td>
<td>136.3832</td>
<td>336.5282</td>
<td>814.6085</td>
<td>236.2491</td>
</tr>
<tr>
<td>597</td>
<td>ICP-MS/MS</td>
<td>154</td>
<td>132</td>
<td>338</td>
<td>824</td>
<td>231</td>
</tr>
<tr>
<td>598</td>
<td>ICP-MS</td>
<td>146</td>
<td>120</td>
<td>328</td>
<td>786</td>
<td>215</td>
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</tbody>
</table>

### Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arithmetic Mean (x̅)</strong></td>
<td>159</td>
<td>130</td>
<td>345</td>
<td>831</td>
<td>233</td>
</tr>
<tr>
<td><strong>Arithmetic SD (s)</strong></td>
<td>13</td>
<td>6</td>
<td>16</td>
<td>36</td>
<td>9</td>
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<tr>
<td><strong>Arithmetic RSD (%)</strong></td>
<td>8.2</td>
<td>4.6</td>
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<td>4.3</td>
<td>3.9</td>
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<td><strong>Number of Sample Measurements (N)</strong></td>
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<td>7</td>
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</tr>
</tbody>
</table>

*Denotes a statistical Outlier.*
Results for Event #1, 2021: Summary Figures

Urine Zn

Legend:
○ C/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.
## Results for Event #1, 2021: Laboratory Data and Summary Statistics

### Urine Te (µg/L)

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>110</td>
<td>ICP-MS</td>
<td>0.713</td>
<td>0.410</td>
<td>1.83</td>
<td>1.14</td>
<td>2.86</td>
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<tr>
<td>147</td>
<td>ICP-MS</td>
<td>0.643</td>
<td>0.302</td>
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<td>0.961</td>
<td>2.41</td>
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### Summary Statistics

<table>
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<tr>
<th></th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arithmetic Mean (x̄)</strong></td>
<td>0.68</td>
<td>0.36</td>
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<td>1.05</td>
<td>2.6</td>
</tr>
<tr>
<td><strong>Arithmetic SD (s)</strong></td>
<td>0.05</td>
<td>0.08</td>
<td>0.2</td>
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<td>0.3</td>
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<tr>
<td><strong>Arithmetic RSD (%)</strong></td>
<td>7.4</td>
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<tr>
<td><strong>Number of Sample Measurements (N)</strong></td>
<td>2</td>
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</tr>
</tbody>
</table>

*Denotes a statistical Outlier.
## Results for Event #1, 2021: Additional Elements in Urine

### Urine Ag (µg/L)

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
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</thead>
<tbody>
<tr>
<td>147</td>
<td>ICP-MS</td>
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<td>&lt;0.183</td>
<td>&lt;0.183</td>
<td>&lt;0.183</td>
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### Urine B (µg/L)

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
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<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
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<td>201</td>
<td>562</td>
<td>281</td>
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<td>421</td>
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</table>

### Urine Bi (µg/L)

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
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<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
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</tr>
</thead>
<tbody>
<tr>
<td>147</td>
<td>ICP-MS</td>
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<td>&lt;0.0815</td>
<td>&lt;0.0815</td>
<td>&lt;0.0815</td>
<td>&lt;0.0815</td>
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<tr>
<td>264</td>
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<td>0.03</td>
<td>0.02</td>
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<tr>
<td>597</td>
<td>ICP-MS/MS</td>
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<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
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</table>

### Urine Fe (µg/L)

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
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<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
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</thead>
<tbody>
<tr>
<td>324</td>
<td>ICP-MS</td>
<td>4.594920</td>
<td>6.190382</td>
<td>4.505734</td>
<td>3.591939</td>
<td>7.697611</td>
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</table>

### Urine I (µg/L)

<table>
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<tr>
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<th>Method</th>
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<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
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</thead>
<tbody>
<tr>
<td>147</td>
<td>ICP-MS</td>
<td>&lt;32.9</td>
<td>&lt;32.9</td>
<td>79.0</td>
<td>95.8</td>
<td>91.9</td>
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</table>

### Urine Li (µg/L)

<table>
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<tr>
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<th>Method</th>
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<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
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<tbody>
<tr>
<td>147</td>
<td>ICP-MS</td>
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<td>9.30</td>
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<td>18.2</td>
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</table>

### Urine Mg (µg/L)

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<th>Lab Code</th>
<th>Method</th>
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<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>597</td>
<td>ICP-MS/MS</td>
<td>9300</td>
<td>26200</td>
<td>14700</td>
<td>18800</td>
<td>28000</td>
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### Urine Th (µg/L)

<table>
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<tr>
<th>Lab Code</th>
<th>Method</th>
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<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>147</td>
<td>ICP-MS</td>
<td>&lt;0.0673</td>
<td>&lt;0.0673</td>
<td>&lt;0.0673</td>
<td>&lt;0.0673</td>
<td>&lt;0.0673</td>
</tr>
<tr>
<td>597</td>
<td>ICP-MS/MS</td>
<td>&lt;0.04</td>
<td>&lt;0.04</td>
<td>&lt;0.04</td>
<td>&lt;0.04</td>
<td>&lt;0.04</td>
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</table>

### Urine Ti (µg/L)

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>UE21-01</th>
<th>UE21-02</th>
<th>UE21-03</th>
<th>UE21-04</th>
<th>UE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>597</td>
<td>ICP-MS/MS</td>
<td>2.54</td>
<td>3.24</td>
<td>2.61</td>
<td>3.29</td>
<td>2.66</td>
</tr>
</tbody>
</table>
Event #1, 2021

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 1&2 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, B, Ba, Be, Bi, Cd, Cs, Fe, Hg, I, Li, Mg, Mn, Mo, Ni, Pb, Pt, Sb, Sn, Sr, 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.
### Results for Event #1, 2021: Summary Statistics

<table>
<thead>
<tr>
<th>Serum AI (µg/L)</th>
<th>SE21-01</th>
<th>SE21-02</th>
<th>SE21-03</th>
<th>SE21-04</th>
<th>SE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target (Arithmetic Mean (x))</td>
<td>67</td>
<td>45.7</td>
<td>12.2</td>
<td>16.8</td>
<td>27</td>
</tr>
<tr>
<td>Upper Limit</td>
<td>80</td>
<td>54.8</td>
<td>17.2</td>
<td>21.8</td>
<td>32</td>
</tr>
<tr>
<td>Lower Limit</td>
<td>54</td>
<td>36.6</td>
<td>7.2</td>
<td>11.8</td>
<td>22</td>
</tr>
<tr>
<td>Arithmetic SD (s)</td>
<td>4</td>
<td>3.2</td>
<td>2.1</td>
<td>2.2</td>
<td>4</td>
</tr>
<tr>
<td>Arithmetic RSD (%)</td>
<td>5.9</td>
<td>7.0</td>
<td>17</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>Number of Sample Measurements (N)</td>
<td>4</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

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.
### Results for Event #1, 2021:
**Performance of Participating Laboratories**

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>SE21-01</th>
<th>SE21-02</th>
<th>SE21-03</th>
<th>SE21-04</th>
<th>SE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target</strong></td>
<td></td>
<td>67</td>
<td>45.7</td>
<td>12.2</td>
<td>16.8</td>
<td>27</td>
</tr>
<tr>
<td>147</td>
<td>ETAAS-Z</td>
<td>64.0</td>
<td>47.2</td>
<td>13.3</td>
<td>16.5</td>
<td>26.4</td>
</tr>
<tr>
<td>264</td>
<td>ICP-MS</td>
<td>*6.97</td>
<td>39.43</td>
<td>9.01</td>
<td>13.98</td>
<td>22.11</td>
</tr>
<tr>
<td>293</td>
<td>DRC/CC-ICP-MS</td>
<td>72.58</td>
<td>48.39</td>
<td>13.44</td>
<td>16.13</td>
<td>26.88</td>
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<tr>
<td>391</td>
<td>ETAAS-Z</td>
<td>*32.26</td>
<td>46.32</td>
<td>14.83</td>
<td>20.62</td>
<td>33.49</td>
</tr>
<tr>
<td>485</td>
<td>HR-ICP-MS</td>
<td>67.3</td>
<td>45.7</td>
<td>11.7</td>
<td>16.0</td>
<td>26.2</td>
</tr>
<tr>
<td>597</td>
<td>ICP-MS/MS</td>
<td>64.4</td>
<td>47.4</td>
<td>11.2</td>
<td>17.3</td>
<td>28.7</td>
</tr>
</tbody>
</table>

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.
Results for Event #1, 2021: Summary Figures

Serum Al

Legend:
○ C/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.
## Results for Event #1, 2021: Summary Statistics

<table>
<thead>
<tr>
<th>Serum Co (µg/L)</th>
<th>SE21-01</th>
<th>SE21-02</th>
<th>SE21-03</th>
<th>SE21-04</th>
<th>SE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target (Arithmetic Mean (x))</strong></td>
<td>12.9</td>
<td>1.20</td>
<td>3.77</td>
<td>0.85</td>
<td>1.87</td>
</tr>
<tr>
<td><strong>Upper Limit</strong></td>
<td>14.8</td>
<td>2.70</td>
<td>5.27</td>
<td>2.35</td>
<td>3.37</td>
</tr>
<tr>
<td><strong>Lower Limit</strong></td>
<td>11.0</td>
<td>0.00</td>
<td>2.27</td>
<td>0.00</td>
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</tr>
<tr>
<td><strong>Arithmetic SD (s)</strong></td>
<td>1.0</td>
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<td>0.20</td>
<td>0.05</td>
<td>0.14</td>
</tr>
<tr>
<td><strong>Arithmetic RSD (%)</strong></td>
<td>7.8</td>
<td>5.8</td>
<td>5.3</td>
<td>5.9</td>
<td>7.5</td>
</tr>
<tr>
<td><strong>Number of Sample Measurements (N)</strong></td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

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.
### Results for Event #1, 2021:
Performance of Participating Laboratories

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>SE21-01</th>
<th>SE21-02</th>
<th>SE21-03</th>
<th>SE21-04</th>
<th>SE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>103</td>
<td>ICP-MS/MS</td>
<td>*6.97</td>
<td>↓1.14</td>
<td>3.34</td>
<td>0.827</td>
<td>1.62</td>
</tr>
<tr>
<td>110</td>
<td>ICP-MS</td>
<td>13.8</td>
<td>1.36</td>
<td>3.89</td>
<td>0.94</td>
<td>2.08</td>
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<td>147</td>
<td>DRC/CC-ICP-MS</td>
<td>11.5</td>
<td>1.16</td>
<td>3.81</td>
<td>0.824</td>
<td>1.86</td>
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<td>264</td>
<td>ICP-MS</td>
<td>13.15</td>
<td>1.15</td>
<td>3.70</td>
<td>0.81</td>
<td>1.84</td>
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<tr>
<td>293</td>
<td>DRC/CC-ICP-MS</td>
<td>13</td>
<td>1.19</td>
<td>3.83</td>
<td>0.86</td>
<td>1.88</td>
</tr>
<tr>
<td>485</td>
<td>HR-ICP-MS</td>
<td>13.8</td>
<td>1.19</td>
<td>3.90</td>
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<td>11.9</td>
<td>1.20</td>
<td>3.92</td>
<td>0.813</td>
<td>1.88</td>
</tr>
</tbody>
</table>

Based on the grading criteria for Co 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.
Results for Event #1, 2021: Summary Figures

Serum Co

Legend:
- ○ C/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.
Results for Event #1, 2021: Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>SE21-01</th>
<th>SE21-02</th>
<th>SE21-03</th>
<th>SE21-04</th>
<th>SE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target (Arithmetic Mean (x))</td>
<td>0.32</td>
<td>1.27</td>
<td>0.61</td>
<td>3.06</td>
<td>8.1</td>
</tr>
<tr>
<td>Upper Limit</td>
<td>2.32</td>
<td>3.27</td>
<td>2.61</td>
<td>5.06</td>
<td>10.1</td>
</tr>
<tr>
<td>Lower Limit</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>1.06</td>
<td>6.1</td>
</tr>
<tr>
<td>Arithmetic SD (s)</td>
<td>0.09</td>
<td>0.19</td>
<td>0.20</td>
<td>0.27</td>
<td>0.6</td>
</tr>
<tr>
<td>Arithmetic RSD (%)</td>
<td>27</td>
<td>15</td>
<td>33</td>
<td>8.7</td>
<td>7.4</td>
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<tr>
<td>Number of Sample Measurements (N)</td>
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<td>7</td>
<td>6</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

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.
### Results for Event #1, 2021: Performance of Participating Laboratories

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>SE21-01</th>
<th>SE21-02</th>
<th>SE21-03</th>
<th>SE21-04</th>
<th>SE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>103</td>
<td>ICP-MS/MS</td>
<td>0.32</td>
<td>1.27</td>
<td>0.61</td>
<td>3.06</td>
<td>8.1</td>
</tr>
<tr>
<td>110</td>
<td>DRC/CC-ICP-MS</td>
<td>&lt;0.500</td>
<td>1.15</td>
<td>&lt;0.500</td>
<td>2.95</td>
<td>7.28</td>
</tr>
<tr>
<td>147</td>
<td>DRC/CC-ICP-MS</td>
<td>0.37</td>
<td>1.39</td>
<td>0.84</td>
<td>3.23</td>
<td>9.10</td>
</tr>
<tr>
<td>264</td>
<td>ICP-MS</td>
<td>*0.06</td>
<td>1.03</td>
<td>0.26</td>
<td>2.54</td>
<td>7.65</td>
</tr>
<tr>
<td>293</td>
<td>DRC/CC-ICP-MS</td>
<td>0.35</td>
<td>1.38</td>
<td>0.77</td>
<td>3.35</td>
<td>8.27</td>
</tr>
<tr>
<td>485</td>
<td>HR-ICP-MS</td>
<td>0.243</td>
<td>1.20</td>
<td>0.642</td>
<td>3.12</td>
<td>8.29</td>
</tr>
<tr>
<td>597</td>
<td>ICP-MS/MS</td>
<td>0.427</td>
<td>1.60</td>
<td>0.528</td>
<td>3.22</td>
<td>7.94</td>
</tr>
</tbody>
</table>

Based on the grading criteria for Cr in Serum, 100% of results were satisfactory, with 0 of the 7 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.
Results for Event #1, 2021:
Summary Figures

Legend:
○ C/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.
## Results for Event #1, 2021: Summary Statistics

<table>
<thead>
<tr>
<th>Serum Cu (µg/L)</th>
<th>SE21-01</th>
<th>SE21-02</th>
<th>SE21-03</th>
<th>SE21-04</th>
<th>SE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target (Arithmetic Mean (x))</strong></td>
<td>880</td>
<td>840</td>
<td>2330</td>
<td>1179</td>
<td>1010</td>
</tr>
<tr>
<td><strong>Upper Limit</strong></td>
<td>1010</td>
<td>970</td>
<td>2680</td>
<td>1356</td>
<td>1160</td>
</tr>
<tr>
<td><strong>Lower Limit</strong></td>
<td>750</td>
<td>710</td>
<td>1980</td>
<td>1002</td>
<td>860</td>
</tr>
<tr>
<td><strong>Arithmetic SD (s)</strong></td>
<td>50</td>
<td>40</td>
<td>60</td>
<td>29</td>
<td>50</td>
</tr>
<tr>
<td><strong>Arithmetic RSD (%)</strong></td>
<td>5.7</td>
<td>4.8</td>
<td>2.6</td>
<td>2.5</td>
<td>5.1</td>
</tr>
<tr>
<td><strong>Number of Sample Measurements (N)</strong></td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

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.
### Results for Event #1, 2021:
Performance of Participating Laboratories

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>SE21-01</th>
<th>SE21-02</th>
<th>SE21-03</th>
<th>SE21-04</th>
<th>SE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>880</td>
<td>840</td>
<td>2330</td>
<td>1179</td>
<td>1010</td>
<td></td>
</tr>
<tr>
<td>107</td>
<td>DRC/CC-ICP-MS</td>
<td>919</td>
<td>854</td>
<td>2371</td>
<td>1219</td>
<td>1030</td>
</tr>
<tr>
<td>110</td>
<td>ICP-MS</td>
<td>956</td>
<td>909</td>
<td>2410</td>
<td>1200</td>
<td>1110</td>
</tr>
<tr>
<td>147</td>
<td>DRC/CC-ICP-MS</td>
<td>858</td>
<td>809</td>
<td>2313</td>
<td>1145</td>
<td>982</td>
</tr>
<tr>
<td>264</td>
<td>ICP-MS</td>
<td>860.9</td>
<td>805.6</td>
<td>2249.9</td>
<td>1147.9</td>
<td>1000.6</td>
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<tr>
<td>293</td>
<td>DRC/CC-ICP-MS</td>
<td>858.23</td>
<td>832.8</td>
<td>2275.91</td>
<td>1182.45</td>
<td>998.09</td>
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<tr>
<td>597</td>
<td>ICP-MS/MS</td>
<td>804</td>
<td>854</td>
<td>2350</td>
<td>1182</td>
<td>966</td>
</tr>
</tbody>
</table>

Based on the grading criteria for Cu 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.
Results for Event #1, 2021: Summary Figures

**Serum Cu**

**Legend:**
- O C/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.
# Results for Event #1, 2021: Summary Statistics

## Serum Se (µg/L)

<table>
<thead>
<tr>
<th>Target (Arithmetic Mean (x̅))</th>
<th>SE21-01</th>
<th>SE21-02</th>
<th>SE21-03</th>
<th>SE21-04</th>
<th>SE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Limit</td>
<td>125</td>
<td>154</td>
<td>104.2</td>
<td>306</td>
<td>209</td>
</tr>
<tr>
<td>Lower Limit</td>
<td>83</td>
<td>102</td>
<td>69.4</td>
<td>204</td>
<td>139</td>
</tr>
<tr>
<td>Arithmetic SD (s)</td>
<td>7</td>
<td>5</td>
<td>2.0</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Arithmetic RSD (%)</td>
<td>6.7</td>
<td>3.9</td>
<td>2.3</td>
<td>3.9</td>
<td>4.6</td>
</tr>
<tr>
<td>Number of Sample Measurements (N)</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

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.
<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>SE21-01</th>
<th>SE21-02</th>
<th>SE21-03</th>
<th>SE21-04</th>
<th>SE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>103</td>
<td>ICP-MS/MS</td>
<td>104</td>
<td>128</td>
<td>86.8</td>
<td>255</td>
<td>174</td>
</tr>
<tr>
<td>107</td>
<td>DRC/CC-ICP-MS</td>
<td>106.1</td>
<td>124.2</td>
<td>87.4</td>
<td>256.6</td>
<td>175.1</td>
</tr>
<tr>
<td>110</td>
<td>DRC/CC-ICP-MS</td>
<td>110</td>
<td>130</td>
<td>86.6</td>
<td>242</td>
<td>178</td>
</tr>
<tr>
<td>147</td>
<td>DRC/CC-ICP-MS</td>
<td>102</td>
<td>120</td>
<td>86.1</td>
<td>246</td>
<td>164</td>
</tr>
<tr>
<td>264</td>
<td>ICP-MS</td>
<td>107.6</td>
<td>130.6</td>
<td>89.98</td>
<td>265.4</td>
<td>183.9</td>
</tr>
<tr>
<td>293</td>
<td>DRC/CC-ICP-MS</td>
<td>106.55</td>
<td>132.6</td>
<td>87.61</td>
<td>266.77</td>
<td>180.74</td>
</tr>
<tr>
<td>597</td>
<td>ICP-MS/MS</td>
<td>90.8</td>
<td>127</td>
<td>86.4</td>
<td>248</td>
<td>165.4</td>
</tr>
</tbody>
</table>

Based on the grading criteria for Se 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.
Results for Event #1, 2021:
Summary Figures

Serum Se

Legend:
○C/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.
## Results for Event #1, 2021: Summary Statistics

<table>
<thead>
<tr>
<th>Serum Zn (µg/L)</th>
<th>SE21-01</th>
<th>SE21-02</th>
<th>SE21-03</th>
<th>SE21-04</th>
<th>SE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target (Arithmetic Mean (x̄))</td>
<td>810</td>
<td>630</td>
<td>930</td>
<td>1180</td>
<td>690</td>
</tr>
<tr>
<td>Upper Limit</td>
<td>930</td>
<td>720</td>
<td>1070</td>
<td>1360</td>
<td>790</td>
</tr>
<tr>
<td>Lower Limit</td>
<td>690</td>
<td>540</td>
<td>790</td>
<td>1000</td>
<td>590</td>
</tr>
<tr>
<td>Arithmetic SD (s)</td>
<td>60</td>
<td>60</td>
<td>40</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>Arithmetic RSD (%)</td>
<td>7.4</td>
<td>9.5</td>
<td>4.3</td>
<td>3.4</td>
<td>8.7</td>
</tr>
<tr>
<td>Number of Sample Measurements (N)</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

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.
Results for Event #1, 2021:
Performance of Participating Laboratories

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>SE21-01</th>
<th>SE21-02</th>
<th>SE21-03</th>
<th>SE21-04</th>
<th>SE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>107</td>
<td>DRC/CC-ICP-MS</td>
<td>872</td>
<td>626</td>
<td>962</td>
<td>1231</td>
<td>688</td>
</tr>
</tbody>
</table>
| 110      | ICP-MS          | 875     | 661     | 975     | 1190    | 805     | ←
| 147      | DRC/CC-ICP-MS   | 723     | 548     | 868     | 1113    | 616     |
| 264      | ICP-MS          | 794.6   | 596.8   | 897.8   | 1146.1  | 672.2   |
| 293      | DRC/CC-ICP-MS   | 816.99  | 633.99  | 934.64  | 1209.15 | 692.81 |
| 597      | ICP-MS/MS       | 761     | 723     | 961     | 1210    | 662     |

Based on the grading criteria for Zn in Serum, 93% of results were satisfactory, with 0 of the 6 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.
Results for Event #1, 2021: Summary Figures

Serum Zn

Legend:
○ C/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.
# Results for Event #1, 2021: Laboratory Data and Summary Statistics

## Serum Mn (µg/L)

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>SE21-01</th>
<th>SE21-02</th>
<th>SE21-03</th>
<th>SE21-04</th>
<th>SE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>103</td>
<td>ICP-MS/MS</td>
<td>2.34</td>
<td>0.952</td>
<td>6.21</td>
<td>4.28</td>
<td>15.8</td>
</tr>
<tr>
<td>110</td>
<td>ICP-MS</td>
<td>4.64</td>
<td>1.25</td>
<td>6.98</td>
<td>4.81</td>
<td>20.4</td>
</tr>
<tr>
<td>147</td>
<td>DRC/CC-ICP-MS</td>
<td>4.11</td>
<td>0.941</td>
<td>6.68</td>
<td>4.16</td>
<td>14.8</td>
</tr>
<tr>
<td>264</td>
<td>ICP-MS</td>
<td>5.40</td>
<td>1.44</td>
<td>7.81</td>
<td>5.57</td>
<td>20.67</td>
</tr>
<tr>
<td>293</td>
<td>DRC/CC-ICP-MS</td>
<td>4.35</td>
<td>1</td>
<td>6.96</td>
<td>4.68</td>
<td>17.34</td>
</tr>
<tr>
<td>597</td>
<td>ICP-MS/MS</td>
<td>3.75</td>
<td>1.13</td>
<td>6.92</td>
<td>4.52</td>
<td>16.3</td>
</tr>
</tbody>
</table>

## Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>SE21-01</th>
<th>SE21-02</th>
<th>SE21-03</th>
<th>SE21-04</th>
<th>SE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arithmetic Mean (x̄)</td>
<td>4.1</td>
<td>1.12</td>
<td>6.9</td>
<td>4.7</td>
<td>17.6</td>
</tr>
<tr>
<td>Arithmetic SD (s)</td>
<td>1.0</td>
<td>0.20</td>
<td>0.5</td>
<td>0.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Arithmetic RSD (%)</td>
<td>24</td>
<td>18</td>
<td>7.2</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>Number of Sample Measurements (N)</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

*Denotes a statistical Outlier.
Results for Event #1, 2021: Summary Figures

**Serum Mn**

---

**Legend:**
- ○ C/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.
### Results for Event #1, 2021: Laboratory Data and Summary Statistics

#### Serum Mo (µg/L)

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>SE21-01</th>
<th>SE21-02</th>
<th>SE21-03</th>
<th>SE21-04</th>
<th>SE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>103</td>
<td>ICP-MS/MS</td>
<td>2.43</td>
<td>6.09</td>
<td>0.653</td>
<td>2.05</td>
<td>3.37</td>
</tr>
<tr>
<td>110</td>
<td>ICP-MS</td>
<td>4.85</td>
<td>6.04</td>
<td>0.91</td>
<td>2.26</td>
<td>3.94</td>
</tr>
<tr>
<td>147</td>
<td>DRC/CC-ICP-MS</td>
<td>4.49</td>
<td>5.90</td>
<td>0.832</td>
<td>1.99</td>
<td>3.60</td>
</tr>
<tr>
<td>293</td>
<td>DRC/CC-ICP-MS</td>
<td>4.9</td>
<td>7.39</td>
<td>0.75</td>
<td>1.92</td>
<td>3.5</td>
</tr>
<tr>
<td>485</td>
<td>HR-ICP-MS</td>
<td>4.73</td>
<td>6.15</td>
<td>&lt;1.0</td>
<td>2.13</td>
<td>3.76</td>
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<tr>
<td>597</td>
<td>ICP-MS/MS</td>
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<td>1.69</td>
<td>3.18</td>
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#### Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>SE21-01</th>
<th>SE21-02</th>
<th>SE21-03</th>
<th>SE21-04</th>
<th>SE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arithmetic Mean (x̄)</td>
<td>4.2</td>
<td>6.2</td>
<td>0.75</td>
<td>2.01</td>
<td>3.6</td>
</tr>
<tr>
<td>Arithmetic SD (s)</td>
<td>1.0</td>
<td>0.6</td>
<td>0.12</td>
<td>0.19</td>
<td>0.3</td>
</tr>
<tr>
<td>Arithmetic RSD (%)</td>
<td>24</td>
<td>9.7</td>
<td>16</td>
<td>9.5</td>
<td>7.6</td>
</tr>
<tr>
<td>Number of Sample Measurements (N)</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

*Denotes a statistical Outlier.
Results for Event #1, 2021:
Summary Figures

Serum Mo

Legend:
○ C/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.
# Results for Event #1, 2021: Laboratory Data and Summary Statistics

## Serum Ni (µg/L)

<table>
<thead>
<tr>
<th>Lab Code</th>
<th>Method</th>
<th>SE21-01</th>
<th>SE21-02</th>
<th>SE21-03</th>
<th>SE21-04</th>
<th>SE21-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>110</td>
<td>DRC/CC-ICP-MS</td>
<td>3.23</td>
<td>9.61</td>
<td>1.79</td>
<td>4.49</td>
<td>3.12</td>
</tr>
<tr>
<td>147</td>
<td>DRC/CC-ICP-MS</td>
<td>2.44</td>
<td>7.04</td>
<td>0.659</td>
<td>3.11</td>
<td>1.37</td>
</tr>
<tr>
<td>293</td>
<td>DRC/CC-ICP-MS</td>
<td>2.38</td>
<td>7.33</td>
<td>1.02</td>
<td>3.21</td>
<td>1.4</td>
</tr>
<tr>
<td>485</td>
<td>HR-ICP-MS</td>
<td>2.38</td>
<td>7.40</td>
<td>0.609</td>
<td>3.09</td>
<td>1.44</td>
</tr>
<tr>
<td>597</td>
<td>ICP-MS/MS</td>
<td>3.03</td>
<td>8.19</td>
<td>1.62</td>
<td>4.14</td>
<td>2.59</td>
</tr>
</tbody>
</table>

## Summary Statistics

<table>
<thead>
<tr>
<th></th>
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<th>SE21-03</th>
<th>SE21-04</th>
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<td>Arithmetic Mean ((\bar{x}))</td>
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*Denotes a statistical Outlier.*
Results for Event #1, 2021:
Summary Figures

Serum Ni

Legend:
○ C/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.
## Results for Event #1, 2021:
Laboratory Data and Summary Statistics

### Serum V (µg/L)

<table>
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<tr>
<th>Lab Code</th>
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<th>SE21-04</th>
<th>SE21-05</th>
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*Denotes a statistical Outlier.
Results for Event #1, 2021:
Summary Figures

Serum V

Legend:
○ C/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.
## Results for Event #1, 2021: Laboratory Data and Summary Statistics

### Serum As (µg/L)

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<tr>
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<th>SE21-05</th>
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<td>ICP-MS/MS</td>
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### Summary Statistics

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*Denotes a statistical Outlier.*
## Results for Event #1, 2021:
### Laboratory Data and Summary Statistics

### Serum Ba (µg/L)

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### Summary Statistics

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*Denotes a statistical Outlier.
## Results for Event #1, 2021: Laboratory Data and Summary Statistics

### Serum Be (µg/L)

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### Summary Statistics

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*Denotes a statistical Outlier.
## Results for Event #1, 2021: Laboratory Data and Summary Statistics

### Serum Cd (µg/L)

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<th>SE21-04</th>
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### Summary Statistics

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## Results for Event #1, 2021: Laboratory Data and Summary Statistics

### Serum Cs (µg/L)

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### Summary Statistics

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*Denotes a statistical Outlier.*
# Results for Event #1, 2021:
## Laboratory Data and Summary Statistics

## Serum Hg (µg/L)

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<th>SE21-04</th>
<th>SE21-05</th>
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## Summary Statistics

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*Denotes a statistical Outlier.
## Results for Event #1, 2021: Laboratory Data and Summary Statistics

### Serum Mg (µg/L)

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### Summary Statistics

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<th>SE21-04</th>
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<td>16900</td>
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| **Number of Sample Measurements (N)** | 2 | 2 | 2 | 2 | 2 |

*Denotes a statistical Outlier.
Results for Event #1, 2021:
Laboratory Data and Summary Statistics

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<th>SE21-04</th>
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Summary Statistics

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<td>0.5</td>
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*Denotes a statistical Outlier.
## Results for Event #1, 2021: Laboratory Data and Summary Statistics

### Serum Pt (µg/L)

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<td>ICP-MS</td>
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Results for Event #1, 2021: Laboratory Data and Summary Statistics

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Summary Statistics

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*Denotes a statistical Outlier.
## Results for Event #1, 2021:
### Laboratory Data and Summary Statistics

### Serum Sn (µg/L)

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### Summary Statistics

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*Denotes a statistical Outlier.*
Results for Event #1, 2021:
Laboratory Data and Summary Statistics

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Summary Statistics

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*Denotes a statistical Outlier.
## Results for Event #1, 2021: Laboratory Data and Summary Statistics

### Serum Ti (µg/L)

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### Summary Statistics

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*Denotes a statistical Outlier.

Statistical data was not calculated for SE21-01, SE21-02, SE21-03, SE21-04 and SE21-05 based on a lack of consensus among participating labs.
Results for Event #1, 2021: Laboratory Data and Summary Statistics

**Serum Tl (µg/L)**

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**Summary Statistics**

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# Results for Event #1, 2021:
## Laboratory Data and Summary Statistics

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## Summary Statistics

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**Number of Sample Measurements (N)**

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**Summary Statistics**

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*Denotes a statistical Outlier.
### Results for Event #1, 2021: Additional Elements in Serum

#### Serum B (µg/L)

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#### Serum Bi (µg/L)

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<th>SE21-03</th>
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#### Serum Fe (µg/L)

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<th>SE21-03</th>
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<th>SE21-05</th>
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#### Serum I (µg/L)

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<th>SE21-03</th>
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#### Serum Li (µg/L)

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#### Serum Th (µg/L)

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References
