

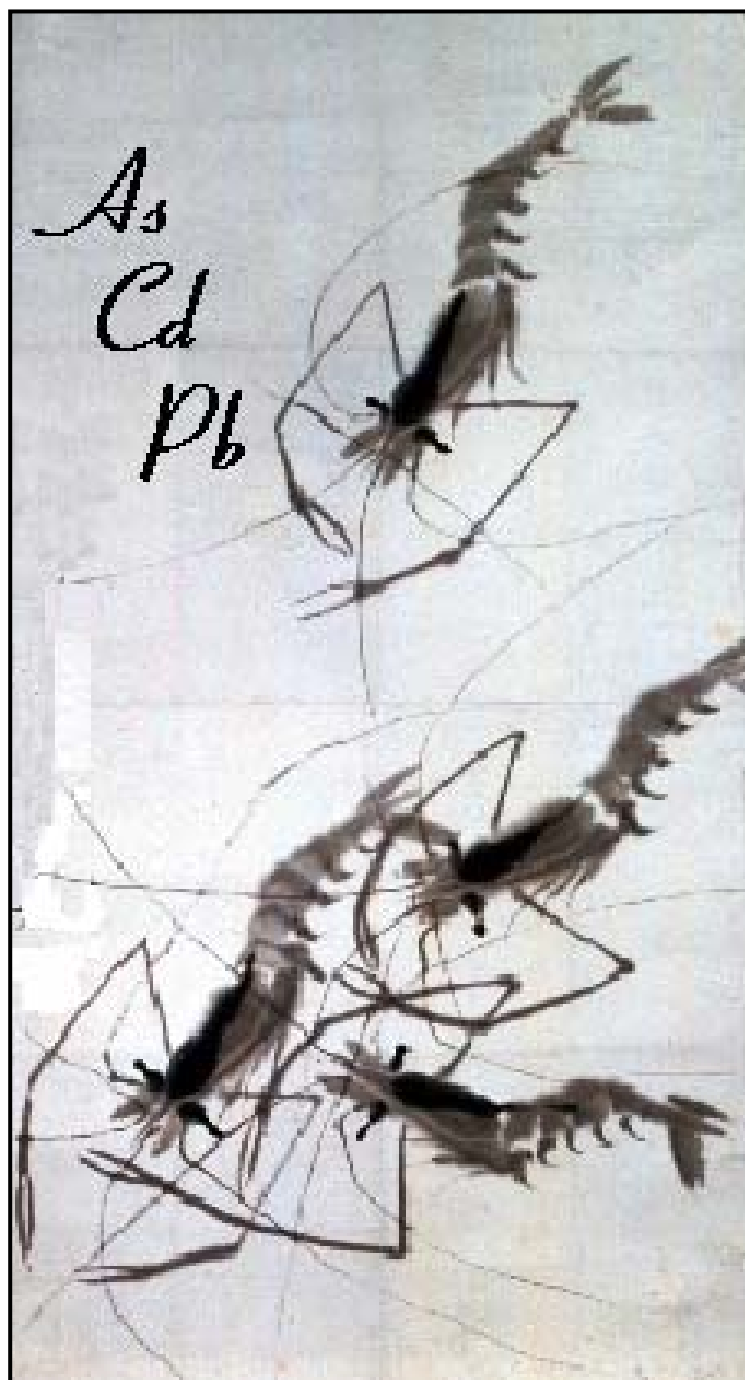


**HEAVY METALS
IN SEAWATER SHRIMP
PROFICIENCY TESTING
PROGRAMME**

APLAC T057

FINAL REPORT

July 2007



**The Programme was organized by
The Hong Kong Government Laboratory
in collaboration with
Hong Kong Accreditation Service
under the auspices of
The Asia-Pacific Laboratory Accreditation Cooperation**



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1. Introduction

- 1.1. This report summarised the results of the proficiency testing programme (APLAC T057) on the quantitative analysis of heavy metals (namely total arsenic, cadmium and lead) in seawater shrimp.
- 1.2. APLAC T057 was organised by the Hong Kong Government Laboratory (HKGL), in collaboration with Hong Kong Accreditation Service (HKAS), under the auspices of the Asia-Pacific Laboratory Accreditation Co-operation (APLAC).
- 1.3. A total of 102 laboratories from 37 different economies participated, 97 participants submitted the results on or before the deadline (APPENDIX I). Each participant was confidentially assigned with a unique laboratory code.

2. Objectives

- 2.1. The programme aimed at providing a means for participants to assess their performance in the analysis for the contents of total arsenic, cadmium and lead in seawater shrimp through interlaboratory comparison.
- 2.2. Test results from participants were evaluated according to the robust statistical techniques that outlined in ISO13528:2005^{8.1} “Statistical methods for use in proficiency testing by interlaboratory comparisons” and the international harmonized protocol for the proficiency testing of analytical chemistry laboratories^{8.2}. z-score was provided as a numerical indicator to reveal individual participant’s analytical competence relative to others in the programme.

3. Test Material

- 3.1. About 10 kg of seawater shrimp samples were purchased from local market. After rinsing with distilled water to remove foreign matters and defatting with n-hexane, the samples were freeze dried (at about -50 °C and < 70mT) for 7 days. The dried shrimp samples were then blended to fine powder, sieved through 250 µm sieves and mixed thoroughly in a rotating drum. Aliquots of about 10 g of powder were packed into clean and nitrogen-flush amber bottles. All sample-containing bottles were γ-irradiated at a dose of about 10 kGy to prevent microbial growth, then sealed



under vacuum and stored at 25 °C prior to dispatch. A total of about 300 bottled samples were prepared.

- 3.2. Homogeneity and stability tests (at 25°C and 37°C from October 2006 to March 2007) of the samples were determined in accordance with the procedures stipulated in APPENDICES II and III respectively and the results were found to be satisfactory.
- 3.3. Samples together with “Instructions to Accreditation Bodies”, “Receipt Form”, “Instructions to Participating Laboratories” and “Results Proforma” were sent to participating accreditation bodies (AB) in November to December 2006. A specimen copy of these instructions was given in APPENDICES IV to VIII.
- 3.4. All AB were informed to read the “Instructions to Accreditation Bodies” and to redirect the sample(s) and the attached documents to their nominated laboratories as soon as possible.
- 3.5. Each participant was provided with one bottle of test sample in the programme.

4. Test Procedures

- 4.1. Participants were required to determine total arsenic, cadmium and lead in seawater shrimp in the test sample according to their appropriate validated methods.
- 4.2. Results of triplicate analyses in mg/kg with three significant figures or three decimal place, whichever was appropriate, should be reported.
- 4.3. Estimation of relative expanded uncertainty measurement of the analysis and technical information of method used were also requested.

5. Statistical Evaluation of Participants' Data

5.1. General Information

- 5.1.1. Analytical results from participants were summarized as follows:

	Total Arsenic	Cadmium	Lead
No. of Results Received	75	97	91



5.1.2. Interim report was issued by HKGL on 28 February 2007 and later forwarded by HKAS to participants through their AB in March 2007. Participants were requested to check their analytical data before 14 May 2007 to ensure the reported data were correct.

5.2. Participants' test results

5.2.1. Test results received from participants were presented in APPENDICES IX to XI. Their methodologies and techniques employed were tabulated in APPENDIX XII.

5.2.2. Consensus mean and standard deviation (SD) computed by robust statistics.

5.2.3. Relative standard deviation was calculated as $SD/\text{consensus mean} \times 100\%$

5.3. Performance evaluation

5.3.1. The performance of each participant was evaluated by means of a performance index, z-score which was calculated as:

$$z = \frac{x_i - m}{S}$$

where x_i = mean of individual participant
 m = computed mean from robust test
 S = computed SD from robust test

5.3.2. z-scores of individual participant were presented in APPENDIX XIII and illustrated graphically in APPENDICES XIV to XVI.

5.3.3. z-score is interpreted as follows:

(a)	$ z \leq 2$	Satisfactory
(b)	$2 < z < 3$	Questionable
(c)	$ z \geq 3$	Unsatisfactory

5.3.4. z-scores marked with asterisk (*) are considered unsatisfactory (i.e. $|z| \geq 3$) and the participants concerned should investigate their results.

5.3.5. Participants having a z-score in the range $2 < |z| < 3$ are encouraged to review their results.



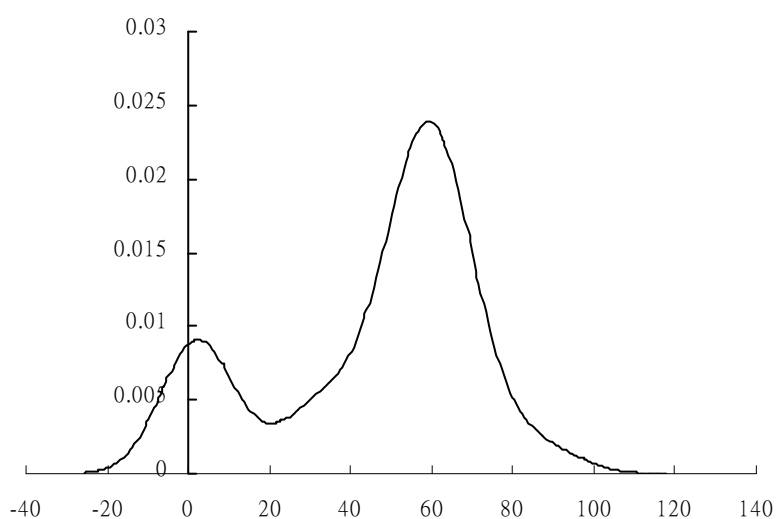
6. Results

6.1. All participants' results were included in the computation of the mean and SD, in mg/kg, by robust test.

	Total Arsenic	Cadmium	Lead
No. of data submitted	75	97	91
No. of data for evaluation	74	92	87
Assigned Value (mg/kg)	60.0*	0.187	1.195
Standard Deviation (mg/kg)	5.16*	0.041	0.416

*The distribution of results for total arsenic was found to be bimodal (skewed with a tail to the lower end) and further analysis showed the robust mean was influenced by the population of very low concentration results. Therefore the mode was considered as the best estimate of central tendency. Kernel density plot (probability vs conc) using Bump-hunting technique showed that the consensus of data to be a mode at 60.0 mg/kg, which was used to be the assigned value for total arsenic in this programme. SD for total arsenic was estimated using Horwitz Equation^{8.3}.

Kernel Density Plot





- 6.2. The assigned value of 60.0 mg/kg for total arsenic was in good agreement with the results from homogeneous test and stability test. In addition, an independent primary measurement method using neutron activation analysis (NAA) showed the total arsenic content was 58.1 ± 1.0 mg/kg ($n=4$). Therefore, those participants who reported a very low concentration should cautiously review their methods as the methods might not be suitable for the analysis of high concentration of organic arsenic in shrimp samples or other seafood matrices.
- 6.3. The distributions of results, in terms of relative standard deviation, were 21.9 % for cadmium and 34.8% for lead respectively.
- 6.4. As shown in APPENDIX XIII, the performance of participants was summarized as follows:

Performance Achieved	Number of Participants (percentage)		
	Total Arsenic	Cadmium	Lead
$ z \leq 2$	43 (58.1 %)	78 (84.8 %)	76 (87.4 %)
$2 < z < 3$	6 (8.1 %)	6 (6.5 %)	3 (3.4 %)
$ z \geq 3$ (Outliers)	25 (33.8 %)	8 (8.7 %)	8 (9.2 %)

In summary, 36 (Lab. Code: 3, 5, 8, 14, 20, 22, 25, 32, 33, 42, 43, 44, 46, 48, 53, 54, 56, 57, 58, 59, 60, 61, 66, 67, 71, 74, 75, 78, 80, 83, 88, 89, 91, 94, 95 and 97) out of the 97 participants (37%) were identified as having reported one or more outlier results; and 42 out of the 253 results submitted were identified as outlier results (16.6 %).

- 6.5. The within-laboratory variations of triplicate analysis were as follows: 0.5 – 31%, an average of 3.6% for total arsenic; 0 – 22%, an average of 4.8% for cadmium and 0.1 – 24%, an average of 6.4% for lead.
- 6.6. Large variation of reported measurement uncertainty (MU) was shown amongst participants. For instance, a minimum of 0.0010337% (Lab. Code 3) and a maximum of 55% (Lab. Code 88), both at the coverage factor of 2, were reported for the analysis of lead. There was some percentage of participants (4.3% to 9.5%) not reporting their MU budgets. The reported MU for all the analysis was summarized as follows:



Reported MU	Number of Participants		
	Total Arsenic	Cadmium	Lead
Not reported	7	4	7
< 5%	24	34	30
5 to 10%	19	14	16
10 to 20%	16	25	18
20 to 30%	6	7	10
> 30%	2	8	6

The information likely indicated that some participants might have hesitations to estimate the MU. It was recommended that more training should be provided, particularly for those laboratories which claimed that their analytical methods were accredited.

7. Remarks

- 7.1. Efforts and supports from all AB and participants in this programme are gratefully noted. Participants are welcome to forward any comments on this PT to the following address:

Dr. Siu-kay WONG
The Secretary of PTAB
Hong Kong Government Laboratory
7/F. Homantin Government Offices,
88 Chung Hau Street, Homanatin,
Hong Kong SAR.

or email to ycwong@govtlab.gov.hk.

8. References

- 8.1. ISO 13528 "Statistical methods for use in proficiency testing by interlaboratory comparisons", **2005**, Geneva, Switzerland.
- 8.2. M. Thompson, S.L. Ellison, R. Wood. The International harmonized protocol for the proficiency testing of analytical



chemistry laboratories (IUPAC technical report), *Pure Appl. Chem.* **2006**, 78:146-196.

- 8.3. W. Horwitz. Evaluation of analytical methods used for regulations of food and drugs, *Anal. Chem.* **1982**, 54:67A-76A.
- 8.4. J.N. Miller, J.C. Miller, Statistics and Chemometrics for Analytical Chemistry, 4th edition, **2000**, Prentice Hill.

APPENDIX I: Geographical Distribution of Participants

ECONOMIES	ENROLLED	RETURNED RESULTS
Australia	4	4
Belgium	2	2
Brunei	1	1
Chile	3	3
China	4	4
Croatia	1	1
Cuba	2	2
Cyprus	2	2
Czech Republic	2	2
Estonia	1	1
Finland	2	1
Germany	1	1
Greece	3	3
Honduras	2	2
Hong Kong	6	6
India	4	4
Indonesia	2	2
Ireland	2	2
Israel	4	4
Italy	4	4
Jordan	1	1
Latvia	2	2
Malaysia	4	3
Mongolia	2	2
New Zealand	3	3
Norway	3	3
Papua New Guinea	2	1
Paraguay	1	1
Philippines	4	2
Portugal	3	3
Romania	4	4
Singapore	4	4
Sweden	2	2
Taiwan	4	4
Thailand	7	6
United Kingdom	1	1
Vietnam	4	4
TOTAL	102	97

APPENDIX II: Homogeneity Test

- a. 16 bottles of powder were randomly selected from a total of 300 bottles. Two test portions of 1 g each were taken from each bottle for duplicate analysis of total arsenic, cadmium and lead by ICP-MS on 29 September 2006.
- b. 32 determinations in a random order were as follows:

	Concentration (mg/kg) of duplicate analysis								
	Total Arsenic			Cadmium			Lead		
Sample Code	#1	#2	Mean	#1	#2	Mean	#1	#2	Mean
3	61.1	60.4	60.7	0.177	0.175	0.176	1.208	1.151	1.179
4	61.7	61.8	61.7	0.174	0.176	0.175	1.205	1.183	1.194
7	62.2	60.4	61.3	0.182	0.183	0.183	1.197	1.181	1.189
16	61.1	61.2	61.1	0.181	0.182	0.182	1.172	1.229	1.201
25	61.2	60.5	60.9	0.175	0.172	0.173	1.174	1.171	1.172
26	60.8	59.9	60.4	0.179	0.179	0.179	1.187	1.168	1.177
31	61.0	61.4	61.2	0.180	0.181	0.180	1.197	1.188	1.192
47	60.2	61.0	60.6	0.174	0.172	0.173	1.194	1.156	1.175
61	60.8	60.2	60.5	0.175	0.171	0.173	1.179	1.134	1.157
84	61.4	61.9	61.7	0.177	0.180	0.179	1.247	1.190	1.218
88	61.2	61.1	61.1	0.171	0.174	0.172	1.183	1.225	1.204
117	60.8	60.6	60.7	0.174	0.175	0.174	1.236	1.209	1.222
11	60.9	59.9	60.4	0.178	0.179	0.179	1.393	1.209	1.301
120	61.4	60.2	60.8	0.177	0.172	0.175	1.165	1.221	1.193
158	60.3	61.3	60.8	0.173	0.176	0.175	1.229	1.179	1.204
217	60.7	60.5	60.6	0.174	0.175	0.175	1.165	1.217	1.191
Mean	60.9			0.176			1.198		
SD	0.42			0.035			0.0322		
RSD (%)	0.70			1.99			2.69		

- c. Homogeneity of samples was evaluated from the absolute difference between the mean value obtained in homogeneity test ($\bar{x}$) and the mean value of the duplicate analysis ($\bar{y}_i$). According to ISO13528:2005^{8,1}, the absolute difference should not be more than 30% of the standard deviation of the proficiency test (σ_R).

$$\text{ie. } |\bar{x} - \bar{y}_i| \leq 0.3\sigma_R$$

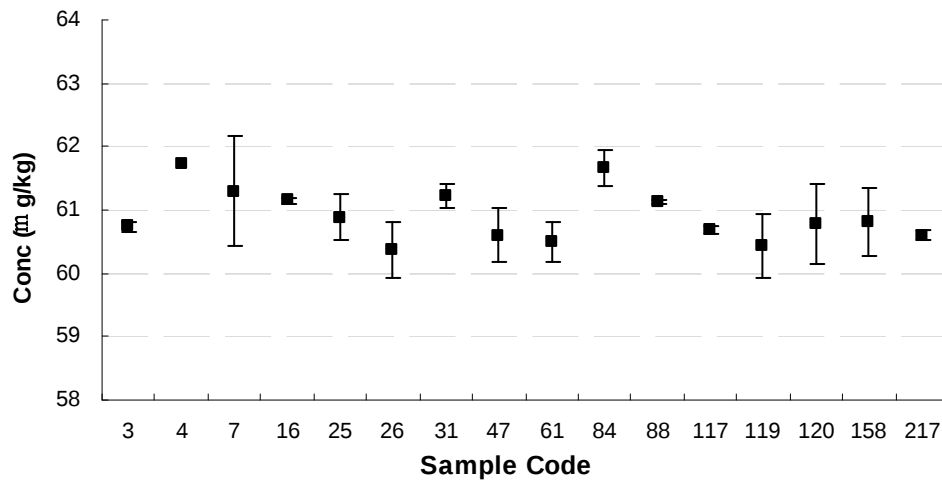
σ_R was estimated using Horwitz^{8,3} equation of $2c^{-0.15}$ where c was the mean concentration (in percent) of analyte from homogeneity test. The results were as follows:

Analyte	$\bar{x}$, mg/kg	σ_R , mg/kg	$0.3\sigma_R$, mg/kg
As	60.9	5.22	1.6
Cd	0.176	0.036	0.011
Pb	1.198	0.185	0.056

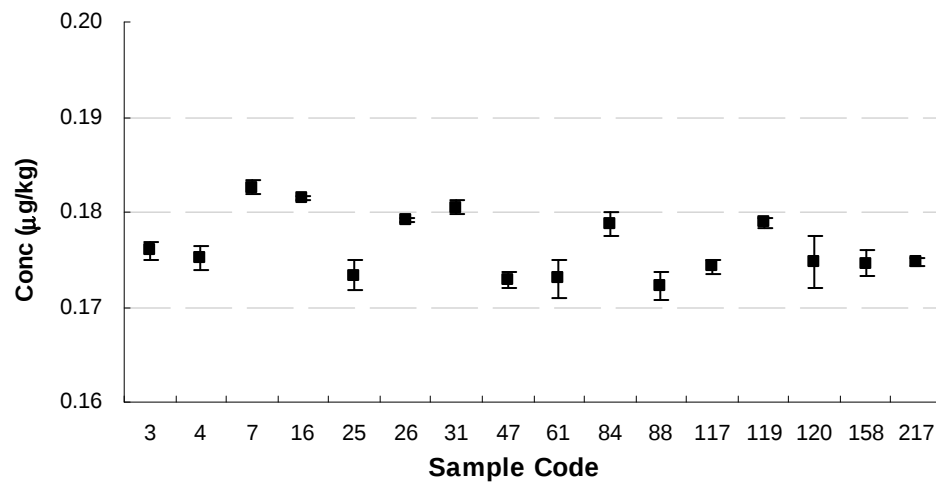
APPENDIX II: Homogeneity Test (Cont'd)

d. Graphical illustrations of selected samples (n =16) in homogeneity tests

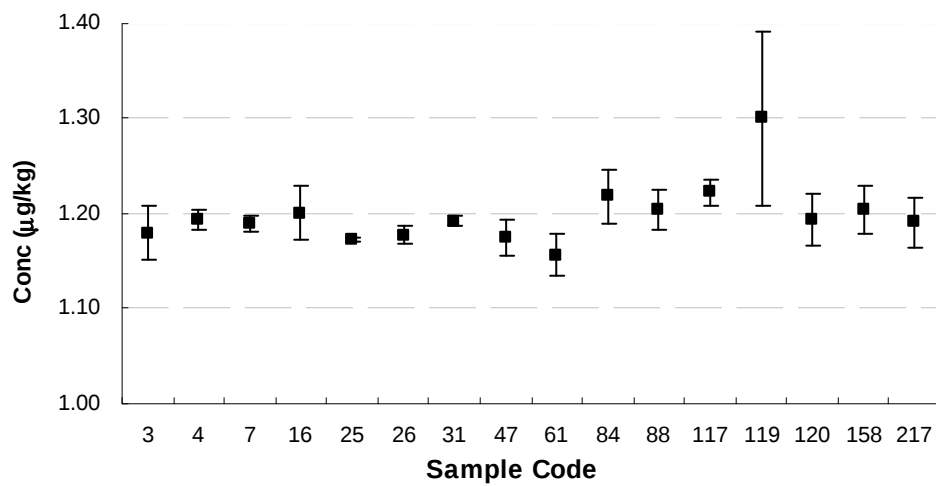
(i) Total Arsenic



(ii) Cadmium



(iii) Lead



APPENDIX II: Homogeneity Test (Cont'd)

- e. Since the absolute differences between the mean value from homogeneity test ($\bar{x}$) and the mean value of the duplicate analysis ($\bar{y}_i$) were found to be less than $0.3\sigma_R$, the materials were considered homogeneous.

APPENDIX III: Stability Test

- Stability test was monitored regularly on a monthly basis from October 2006 to March 2007, which adequately covered the time when the samples were analyzed by participants.
- Samples selected for the stability test were stored at (i) a room temperature of 25 °C and (ii) an elevated temperature of 37 °C.
- One sample from each temperature set was randomly selected and analyzed in duplicate or triplicate under the same operational conditions as those in homogeneity test.
- Stability of samples was evaluated from the absolute difference between the mean value obtained in homogeneity test ($\bar{x}$) and the mean value of each stability test ($\bar{y}_i$). According to ISO13528:2005^{8.1}, the absolute difference should not be more than 30% of the standard deviation of the proficiency test (σ_R).

$$\text{ie. } |\bar{x} - \bar{y}_i| \leq 0.3\sigma_R$$

σ_R was estimated using Horwitz^{8.3} equation of $2 c^{-0.15}$ where c was the mean concentration (in percent) of analyte from homogeneity test (refer to paragraph c of Appendix II).

- Results of the stability tests at 25 °C were summarized below:

(i) Total Arsenic at 25°C

Period	Sample Code	Concentration (mg/kg)					$ \bar{x} - \bar{y}_i $	Status
		#1	#2	#3	$\bar{y}_i$	$\bar{x}$		
Oct 06	46	62.5	62.5	---	62.5	60.9	1.6	Pass
Nov 06	43	62.6	61.6	63.3	62.5	60.9	1.6	Pass
Dec 06	203	61.3	60.3	60.5	60.7	60.9	0.2	Pass
Jan 07	63	60.9	61.8	61.6	61.4	60.9	0.5	Pass
Feb 07	51	60.0	61.3	61.2	60.8	60.9	0.1	Pass
Mar 07	38	60.0	60.6	60.7	60.4	60.9	0.5	Pass

(ii) Total Arsenic at 37°C

Period	Sample Code	Concentration (mg/kg)					$ \bar{x} - \bar{y}_i $	Status
		#1	#2	#3	$\bar{y}_i$	$\bar{x}$		
Oct 06	15	60.5	59.9	---	60.2	60.9	0.7	Pass
Nov 06	31	61.8	62.9	62.2	62.7	60.9	1.4	Pass
Dec 06	35	62.5	62.1	60.5	61.7	60.9	0.8	Pass
Jan 07	90	61.2	60.7	61.1	61.0	60.9	0.1	Pass
Feb 07	6	60.6	61.6	60.5	60.9	60.9	0	Pass
Mar 07	50	60.7	61.1	61.4	61.1	60.9	0.2	Pass

APPENDIX III: Stability Test (Cont'd)

(iii) Cadmium at 25°C

Period	Sample Code	Concentration (mg/kg)					$ \bar{x} - \bar{y}_i $	Status
		#1	#2	#3	$\bar{y}_i$	$\bar{x}$		
Oct 06	46	0.173	0.181	---	0.177	0.176	0.001	Pass
Nov 06	43	0.173	0.173	0.167	0.171	0.176	0.005	Pass
Dec 06	203	0.169	0.168	0.171	0.169	0.176	0.007	Pass
Jan 07	63	0.183	0.183	0.181	0.182	0.176	0.006	Pass
Feb 07	51	0.183	0.177	0.178	0.179	0.176	0.003	Pass
Mar 07	38	0.179	0.183	0.183	0.182	0.176	0.006	Pass

(iv) Cadmium at 37°C

Period	Sample Code	Concentration (mg/kg)					$ \bar{x} - \bar{y}_i $	Status
		#1	#2	#3	$\bar{y}_i$	$\bar{x}$		
Oct 06	15	0.180	0.178	---	0.179	0.176	0.003	Pass
Nov 06	31	0.166	0.174	0.173	0.171	0.176	0.005	Pass
Dec 06	35	0.174	0.172	0.165	0.170	0.176	0.006	Pass
Jan 07	90	0.184	0.188	0.182	0.185	0.176	0.009	Pass
Feb 07	6	0.175	0.181	0.184	0.180	0.176	0.004	Pass
Mar 07	50	0.182	0.184	0.182	0.183	0.176	0.007	Pass

(v) Lead at 25°C

Period	Sample Code	Concentration (mg/kg)					$ \bar{x} - \bar{y}_i $	Status
		#1	#2	#3	$\bar{y}_i$	$\bar{x}$		
Oct 06	46	1.218	1.193	---	1.206	1.198	0.008	Pass
Nov 06	43	1.183	1.209	1.158	1.183	1.198	0.015	Pass
Dec 06	203	1.123	1.137	1.188	1.149	1.198	0.049	Pass
Jan 07	63	1.256	1.321	1.210	1.262	1.198	0.035	Pass
Feb 07	51	1.145	1.202	1.195	1.180	1.198	0.018	Pass
Mar 07	38	1.186	1.240	1.141	1.189	1.198	0.009	Pass

APPENDIX III: Stability Test (Cont'd)

(vi) Lead at 37°C

Period	Sample Code	Concentration (mg/kg)					$ \bar{x} - \bar{y}_i $	Status
		#1	#2	#3	$\bar{y}_i$	$\bar{x}$		
Oct 06	15	1.222	1.171	---	1.197	1.198	0.001	Pass
Nov 06	31	1.164	1.232	1.171	1.189	1.198	0.009	Pass
Dec 06	35	1.175	1.172	1.162	1.170	1.198	0.028	Pass
Jan 07	90	1.259	1.253	1.246	1.253	1.198	0.055	Pass
Feb 07	6	1.209	1.190	1.305	1.235	1.198	0.037	Pass
Mar 07	50	1.162	1.229	1.246	1.212	1.198	0.014	Pass

- f. Since the absolute differences between the mean value from homogeneity test ($\bar{x}$) and the mean value of the stability test ($\bar{y}_i$) were found to be less than $0.3\sigma_R$, the materials were considered to be stable for six-month at 25°C and 37°C.

APPENDIX IV: Instructions to Accreditation Bodies

INSTRUCTIONS (FOR ACCREDITATION BODIES)

1. **ORGANIZATION**

The PT programme on “Heavy metals in food (APLAC T057)” is organized by the Hong Kong Government Laboratory (HKGL) in collaboration with Hong Kong Accreditation Service (HKAS) under the auspices of the Asia-Pacific Laboratory Accreditation Cooperation (APLAC). The main objective of the programme is to evaluate the performance of participating laboratories on the concerned tests through inter-laboratory comparison.

2. **SAMPLE**

Accreditation bodies (AB) should receive the PT samples and instruction information (hard copy and soft copy) from the organizers. The samples that contain about 10 g of dried shrimp powder are properly packaged in amber bottles. Upon receipt, AB should carefully check the samples (number of bottles, physicals conditions, etc.) and shall promptly acknowledge the HKGL by returning the “Receipt Form (for Accreditation Bodies)” electronically to T57@govtlab.gov.hk. New sample(s) will be re-sent by the HKGL for any damaged claims.

AB are recommended to promptly distribute the samples, together with the “Instructions for Participating Laboratories” and “Results Proforma” (hard and soft copy), to their respective participating laboratories. The samples shall be stored in a secure environment at room temperature (around 25°C) before dispatch.

AB shall remind their respective participating laboratories carefully check the sample upon receipt and promptly acknowledge the HKGL by returning the “Receipt Form (for Participating Laboratories)” electronically to T57@govtlab.gov.hk.

3. **RESULTS**

AB shall inform their respective participating laboratories complete Part I and II of the “Result Proforma” and submit electronically to the HKGL on or before 31 January 2007 to T57@govtlab.gov.hk. (Notes: 1. Unless with special reasons, results submitted after the deadline might be rejected by the organizers. 2. To avoid poor transmission quality, results by fax are not accepted.)

4. **ENQUIRIES**

Please contact the representative of the HKGL for further enquiries concerning the programme:

Dr. Siu-kay WONG,
Secretary of the PT Advisory Board,
HKGL.
Email: T57@govtlab.gov.hk

APPENDIX V: Receipt Form for Accreditation Bodies

RECEIPT FORM (FOR ACCREDITATION BODIES)
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From: _____ (Name of AB)	To: Dr. Siu-kay WONG Secretary of the PT Advisory Board Hong Kong Government Laboratory, Hong Kong.
_____ (Contact Person)	

Email: _____	Email: T57@govtlab.gov.hk
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Date: _____

I hereby acknowledge the receipt of _____ # sample(s) for the APLAC T057 programme.

The sample(s) is/are found (☐ damaged / ☐ satisfactory)* and should be (☐ suitable / ☐ not suitable)* for laboratory testing.

Remark(s) : _____

Number of samples

* Tick as appropriate

APPENDIX VI: Instruction to Participating Laboratories

INSTRUCTIONS (FOR PARTICIPATING LABORATORIES)

1. **ORGANIZATION**

The PT programme on “Heavy metals in food (APLAC T057)” is organized by the Hong Kong Government Laboratory (HKGL) in collaboration with Hong Kong Accreditation Service (HKAS) under the auspices of the Asia-Pacific Laboratory Accreditation Cooperation (APLAC). The main objective of the programme is to evaluate the performance of participating laboratories on the concerned tests through inter-laboratory comparison.

2. **SAMPLE**

- (a) Participating laboratories will independently receive an amber sample bottle that containing about 10 g of dried shrimp powder from their respective accreditation bodies (AB).
- (b) Upon receipt of the sample, participating laboratories should carefully inspect the sample for any physical damages and defects.
- (c) Participating laboratories shall promptly acknowledge receipt of the sample by returning the “Receipt Form (for Participating Laboratories)” electronically to the HKGL to T57@govtlab.gov.hk. New sample will be re-sent by the HKGL for any damaged claims.
- (d) Intact sample is recommended to store in a secure environment at room temperature (around 25°C) before use. Sample should be immediately capped after used and be kept in a dry box when not in use.

3. **ANALYSIS**

- (a) Participating laboratories are required to determine the concentration (in **mg/kg**) of total arsenic, cadmium and lead in the sample. Determination should be conducted in triplicate.
- (b) Participating laboratories should use their preferable test methods (could be accredited, in-house, modified, ad hoc methods, etc.) which are normally used to test their customer samples and record the method used on the results sheet.

4. **RESULTS**

- (a) Report all the triplicate data and the arithmetic mean in Part I of the “Results Proforma”.
- (b) Estimate and report the relative expanded uncertainty ($\pm$ %) for individual analyte.
- (c) Fill in the information of your performed analytical method in Part II of the “Results Proforma”.
- (d) Submit the results electronically to the HKGL on or before 31 January 2007 to T57@govtlab.gov.hk using the soft copy of the “Results Proforma” provided. (Notes: 1. Unless with special reasons, results submitted after the deadline might be rejected by the organizers. 2. To avoid poor transmission quality, results by fax are not accepted.)

5. **ENQUIRIES**

Please contact the representative of the HKGL for further enquiries concerning the programme:

Dr. Siu-kay WONG; The Secretary of the PT Advisory Board, HKGL.

Email: T57@govtlab.gov.hk

APPENDIX VII: Receipt Form for Participating Laboratories

RECEIPT FORM (FOR PARTICIPATING LABORATORIES)
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From: _____ (Name of AB)	To: Dr. Siu-kay WONG Secretary of the PT Advisory Board Hong Kong Government Laboratory, Hong Kong.
_____ (Contact Person)	

Email: _____	Email: T57@govtlab.gov.hk
--------------	---------------------------

Date: _____

I hereby acknowledge the receipt of _____ # sample(s) for the APLAC T057 programme.

The sample(s) is/are found (☐ damaged / ☐ satisfactory)* and should be (☐ suitable / ☐ not suitable)* for laboratory testing.

Remark(s) : _____

Number of samples

* Tick as appropriate

APPENDIX VIII: Results Proforma

RESULTS PROFORMA

<Both Part I & II **MUST** be completed by Participating Laboratory>

Name of Participating Laboratory: _____

Contact Person / Post: _____

Part I: Analytical Results

Analyte	§Concentration (in mg/kg , based on as-received weight)				Measurement Uncertainty	
	Data 1	Data 2	Data 3	MEAN	Relative Expanded Uncertainty (%)	Coverage Factor (k)
Total Arsenic (As)						
Cadmium (Cd)						
Lead (Pb)						

§ Report values to 3 significant figures or 3 decimal places, whichever is appropriate

▀ It is the responsibility of the participants to avoid collusion and falsification of result so as to ensure a reliable assessment to be made in this proficiency testing programme

◆ Please submit this “Results Proforma” electronically to the HKGL at T57@govtlab.gov.hk

To be continued ...

APPENDIX VIII: Results Proforma (Cont'd)

RESULTS PROFORMA

<Both Part I & II **MUST** be completed by Participating Laboratory>

Part II: Test Parameters

1. Analytical Instrument(s): ☐ ICP-MS _____
☐ ICP-AES _____
☐ AAS _____
☐ Others _____
(please specify)
2. Digestion Method: ☐ Microwave-assisted _____
☐ Others _____
(please specify)
3. Digestion Medium: _____
4. Digestion Condition(s): _____

5. Method accredited? ☐ Yes
☐ No
6. Other additional information: _____

Date: _____

☐ Tick as appropriate

APPENDIX IX: Participants' Results for Total Arsenic

Lab. Code	Concentration (mg/kg)				Measurement Uncertainty	
	Replicate 1	Replicate 2	Replicate 3	Mean	Rel. Expanded Uncertainty (%)	Coverage Factor
1	57.2	54.6	53.8	55.2	24	2
2	60.2	59.6	60.0	59.9	---	2
3	58.019	58.650	58.638	58.436	0.01766	2
4	73.000	57.000	64.800	64.930	33	4.53
5	33.2	32.9	35.4	33.8	8	2
6	57.4	55.5	63.6	58.9	7.9	2
7	50.0988	48.4734	49.7735	49.4485	2.459	2
8	1.505	1.889	1.172	1.522	25.6	2
9	53.4	55.3	55.0	54.6	15	---
10	63.5	62.0	61.7	62.4	3.86	2.5
11	---	---	---	---	---	---
12	60.1	65.8	64.2	63.4	0.23	2
13	---	---	---	---	---	---
14	1.159	1.136	1.129	1.141	5.98	2
15	56.2	56.3	56.3	56.3	2.54	2
16	---	---	---	---	---	---
17	59.8	63.4	62.5	61.9	15	2
18	---	---	---	---	---	---
19	---	---	---	---	---	---
20	0.504	0.500	0.441	0.482	10	95
21	45.8	45.9	46.1	45.9	10	2
22	4.03	3.68	3.79	3.85	25	2
23	54.7	56.2	55.4	55.4	2.76	2
24	62.9	65.1	64.6	64.2	20	2
25	46.8	46.0	43.8	45.5	3.63	2
26	59.9	60.5	59.5	60.0	3	2
27	54.2	55.6	54.3	54.7	17.8	2
28	75.0	74.9	72.7	74.2	10	2
29	<0.001	<0.001	<0.001	<0.001	---	---
30	57.3	53.8	55.8	55.6	6.3	2
31	63.0	65.0	65.6	64.5	15	2
32	---	---	---	---	---	---
33	6.36	6.53	6.35	6.4	0.4	2
34	---	---	---	---	---	---
35	---	---	---	---	---	---
36	63.4	65.5	68.2	65.7	0.05	2.26
37	---	---	---	---	---	---
38^	58.8	58.3	---	58.6	---	---
39	---	---	---	---	---	---
40	---	---	---	---	---	---
41	---	---	---	---	---	---
42^	90.7	79.3	---	85.0	11.6	2
43	30.654	32.396	31.139	31.396	1.948	2
44	2.49	2.48	2.49	2.49	1.5	2
45	53.483	53.35	52.831	53.221	9.738	2
46	32.4	35.5	33.2	33.7	7.4	2.365
47	---	---	---	---	---	---
48	27.639	28.975	28.227	28.280	11.76	2
49	52.3	54.0	52.3	52.9	6.0	2

“ ^ ” denotes duplicate data submitted by participants

“ # ” denotes single data submitted by participants

“ --- ” denotes data/information was not provided by participants

APPENDIX IX: Participants' Results for Total Arsenic (cont'd)

Lab. Code	Concentration (mg/kg)				Measurement Uncertainty	
	Replicate 1	Replicate 2	Replicate 3	Mean	Rel. Expanded Uncertainty (%)	Coverage Factor
50	---	---	---	---	---	---
51	55.9	56.4	55.2	55.8	10	2
52	55.234	55.927	54.499	55.220	0.338	2
53	0.953	0.972	0.965	0.963	10	2
54	30.7	33.6	37.4	33.9	18.8	2
55	---	---	---	---	---	---
56	27.9	28.9	23.5	26.8	21.5	2
57	---	---	---	---	---	---
58	1.178	1.333	1.286	1.265	±0.014	2
59	71.233	71.375	73.678	72.095	8.4	2.78
60	14.096	14.220	14.150	14.155	0.009	2
61	---	---	---	---	---	---
62	55.6	61.3	58.6	58.5	20.9	2
63	65.1	68.2	65.5	66.3	5	2
64	63.416	63.327	68.625	65.123	---	---
65	68.5	65.7	67.1	67.1	20	2
66^	0.630	0.533	---	0.582	0.1	2
67	1.562	1.450	1.612	1.54	11	2
68^	61.52	59.58	---	60.55	14	2
69	---	---	---	---	---	---
70	---	---	---	---	---	---
71#	91.6	---	---	91.6	---	---
72	65.53	64.81	63.74	64.69	0.16	---
73	53.982	52.376	52.843	53.1	2	---
74	38.3	36.1	37.2	37.2	20	2
75	---	---	---	---	---	---
76	70	67	64	67	8.0	2
77	60.9	60.6	61.0	60.8	5.04	2.13
78	1.40	1.51	1.54	1.48	±0.38	2.5
79	65.6	64.3	66.6	65.5	3.5	---
80	2.646	2.637	2.628	2.637	3.60	2
81	---	---	---	---	---	---
82	61.2	59.5	61.2	60.6	2.5	2
83	---	---	---	---	---	---
84	61.93	62.40	62.86	62.40	23.0	2
85	63.4	58.3	42.5	54.7	49	2.78
86	48.88	43.52	44.51	44.64	6.1	2
87	58.6	58.9	58.4	58.6	8	2
88	2.17	2.09	2.35	2.20	17.1	2
89	57.2	56.0	51.5	54.9	6.30	2
90#	56.2	---	---	56.2	---	---
91	69.680	69.364	67.951	68.998	4.525	2
92	59.3	60.1	60.5	60.0	15	---
93	46.21	46.43	47.16	46.60	12.47	2
94	85.5	87.9	78.0	83.7	6.7	2
95	1.001	1.064	1.024	1.030	11.5	2
96	51.50	51.09	51.62	51.40	---	---
97	59.7	60.9	61.0	60.5	1.2	---

“ ^ ” denotes duplicate data submitted by participants

“ # ” denotes single data submitted by participants

“ --- ” denotes data/information was not provided by participants

APPENDIX X: Participants' Results for Cadmium

Lab. Code	Concentration (mg/kg)				Measurement Uncertainty	
	Replicate 1	Replicate 2	Replicate 3	Mean	Rel. Expanded Uncertainty (%)	Coverage Factor
1	0.184	0.176	0.174	0.178	19	2
2	0.129	0.139	0.129	0.132	13	2
3	0.603	0.471	0.543	0.539	0.001056	2
4	0.267	0.254	0.258	0.260	5.3	2.2
5	0.09	0.11	0.14	0.11	45	2
6	0.161	0.155	0.171	0.162	5.56	2
7	0.2399	0.2399	0.2396	0.2398	0.102	2
8	0.199	0.204	0.213	0.205	25.6	2
9	0.184	0.177	0.181	0.181	15	N/A
10	0.189	0.182	0.181	0.184	5.92	2.5
11	0.133	0.135	0.135	0.13	47.4	2
12	<0.10	<0.10	<0.10	<0.10	0.009	2
13	0.191	0.196	0.194	0.194	1.5	2
14	0.143	0.138	0.133	0.138	8.84	2
15	0.194	0.198	0.196	0.196	4.94	2
16	<0.100	<0.100	<0.100	<0.100	---	---
17	0.172	0.175	0.185	0.177	16	2
18	0.163	0.165	0.162	0.163	18.40	2
19	0.178	0.169	0.183	0.177	20.18	2
20	0.212	0.225	0.204	0.214	10	98
21	0.179	0.164	0.174	0.172	15	2
22	0.291	0.307	0.298	0.298	20	2
23	0.12	0.139	0.134	0.131	15.4	2
24	0.182	0.178	0.181	0.180	20	2
25	0.194	0.21	0.198	0.201	3.98	2
26	0.177	0.183	0.175	0.178	4	2
27	0.201	0.187	0.181	0.190	22.4	2
28	0.176	0.177	0.176	0.176	7.3	2
29	<0.001	<0.001	<0.001	<0.001	---	---
30	0.205	0.208	0.206	0.206	1.5	2
31	0.189	0.193	0.192	0.191	15	2
32	0.161	0.160	0.161	0.161	0.719	2
33	0.20	0.21	0.19	0.20	0.02	2
34	0.184	0.184	0.194	0.187	16.5	2
35	0.1	0.1	0.1	0.1	10.1	2
36	0.181	0.189	0.187	0.186	1.08	2.26
37	0.170	0.172	0.169	0.170	16	2
38^	0.201	0.194	---	0.197	---	---
39	0.170	0.170	0.176	0.172	0.016	2
40	0.295	0.258	0.319	0.291	---	---
41	0.197	0.196	0.199	0.197	15	2
42^	0.305	0.251	---	0.278	7.4	2
43	0.212	0.191	0.199	0.201	4.054	2
44	0.137	0.137	0.136	0.137	2	2
45	0.155	0.142	0.138	0.145	40.210	2
46	0.193	0.210	0.198	0.200	4.5	2.365
47	0.213	0.213	0.183	0.203	12.8	2
48	0.184	0.176	0.184	0.181	12.68	2
49	0.220	0.190	0.218	0.209	11.2	2

“ ^ ” denotes duplicate data submitted by participants

“ # ” denotes single data submitted by participants

“ --- ” denotes data/information was not provided by participants

APPENDIX X: Participants' Results for Cadmium (Cont'd)

Lab. Code	Concentration (mg/kg)				Measurement Uncertainty	
	Replicate 1	Replicate 2	Replicate 3	Mean	Rel. Expanded Uncertainty (%)	Coverage Factor
50^	0.213	0.217	---	0.215	35	2
51	0.183	0.175	0.180	0.179	12	2
52	0.143	0.131	0.131	0.135	0.008	2
53	0.176	0.160	0.186	0.174	10	2
54	0.182	0.190	0.196	0.189	7.36	2
55	0.188	0.204	0.189	0.194	2.673	2
56	0.201	0.203	0.211	0.205	5.2	2
57	0.67	0.67	0.68	0.67	31	2
58	0.165	0.174	0.160	0.166	±0.011	2
59	0.426	0.417	0.383	0.409	11.7	2.78
60	0.180	0.1750	0.198	0.184	0.130	2
61	0.2	0.3	0.3	0.27	0.115	2
62	0.170	0.176	0.164	0.170	15.7	2
63	0.142	0.146	0.148	0.145	5	2
64	0.185	0.177	0.176	0.179	---	---
65	0.198	0.209	0.210	0.206	20	2
66^	0.958	0.876	---	0.917	0.05	2
67	0.1497	0.1337	0.1354	0.140	4.5	2
68^	0.19	0.18	---	0.19	9.8	2
69	0.158	0.147	0.151	0.152	7.17	2
70	0.279	0.286	0.286	0.283	21	2
71#	<0.2	---	---	<0.2	---	---
72	0.19	0.19	0.18	0.19	0.01	---
73	0.100	0.104	0.110	0.105	0.010	---
74	0.191	0.183	0.179	0.185	16	2
75	0.153	0.158	0.164	0.158	8.86	2
76	0.178	0.175	0.170	0.174	7.3	2
77	0.140	0.138	0.135	0.138	0.028	2.13
78	0.064	0.068	0.062	0.065	0.017	2
79	0.187	0.188	0.187	0.187	0.6	---
80	0.187	0.185	0.191	0.188	2.75	2
81	0.149	0.174	0.176	0.166	36	2
82	0.188	0.192	0.186	0.189	1.6	2
83	0.586	0.554	0.573	0.571	---	---
84	0.19	0.20	0.19	0.19	24.0	2
85	0.248	0.180	0.203	0.189	21	2.20
86	0.148	0.138	0.156	0.147	47.6	2
87	0.182	0.189	0.182	0.184	10	2
88	0.067	0.058	0.047	0.057	49	2
89	0.249	0.384	0.309	0.314	24.8	2
90#	0.180	---	---	0.180	---	---
91	1.038	1.123	1.126	1.096	0.187	2
92	0.189	0.197	0.187	0.191	20	---
93	0.200	0.256	0.255	0.237	15.75	2
94	0.23	0.27	0.29	0.27	0.03	2
95	0.121	0.115	0.119	0.118	11.5	2
96	<1.00	<1.00	<1.00	---	---	---
97	0.5	0.5	0.6	0.5	0.1	2.001

“ ^ ” denotes duplicate data submitted by participants

“ # ” denotes single data submitted by participants

“ --- ” denotes data/information was not provided by participants

APPENDIX XI: Participants' Results for Lead

Lab. Code	Concentration (mg/kg)				Measurement Uncertainty	
	Replicate 1	Replicate 2	Replicate 3	Mean	Rel. Expanded Uncertainty (%)	Coverage Factor
1	1.16	1.21	1.23	1.20	17	2
2	1.28	1.30	1.29	1.29	13	2
3	4.440	4.250	4.345	4.345	0.0010337	2
4	1.417	1.403	1.451	1.424	6.8	4.53
5	0.46	0.41	0.36	0.41	24	2
6	1.05	1.05	1.11	1.07	3.74	2
7	---	---	---	---	---	---
8	1.424	1.297	1.145	1.289	25.6	2
9	0.577	0.479	0.491	0.516	15	N/A
10	1.22	1.23	1.19	1.21	4.29	2.5
11	1.472	1.411	1.565	1.49	47.4	2
12	0.75	1.00	0.99	0.91	0.07	2
13	0.985	1.018	1.008	1.004	1.9	2
14	0.302	0.341	0.339	0.327	7.27	2
15	1.09	1.12	1.14	1.12	4.15	2
16	<0.300	<0.300	<0.300	<0.300	---	---
17	1.08	1.04	1.19	1.10	33	2
18	1.30	1.45	1.38	1.37	32.12	2
19	1.181	1.248	1.133	1.187	21.42	2
20	1.036	1.005	1.088	1.043	10	97
21	0.621	0.569	0.535	0.575	35	2
22	0.728	0.610	0.748	0.695	25	2
23	1.10	1.10	1.08	1.09	2.14	2
24	1.20	1.22	1.20	1.21	20	2
25	2.37	2.67	2.60	2.55	3.61	2
26	1.14	1.14	1.13	1.14	5	2
27	1.55	1.65	1.48	1.56	20.9	2
28	1.16	1.14	1.15	1.15	6.6	2
29	<0.04	<0.04	<0.04	<0.04	---	---
30	1.60	1.67	1.72	1.66	7.2	2
31	1.28	1.53	1.28	1.36	15	2
32	10.700	11.000	11.250	10.983	5.014	2
33	0.90	0.92	0.95	0.9	0.1	2
34	1.093	1.122	1.115	1.110	---	---
35	---	---	---	---	---	---
36	1.40	1.46	1.39	1.42	2.82	2.26
37	1.350	1.302	1.288	1.313	18	2
38^	1.39	1.21	---	1.30	---	---
39	0.948	0.944	1.091	0.994	0.068	2
40^	1.800	1.245	---	1.523	---	---
41	1.075	1.173	1.041	1.096	17	2
42^	1.94	1.60	---	1.77	17.2	2
43	0.418	0.436	0.496	0.450	5.704	2
44	3.37	3.36	3.37	3.37	1.0	2
45	1.619	1.629	1.578	1.608	2.508	2
46	1.45	1.39	1.49	1.44	7.2	2.571
47	1.067	0.872	0.823	0.921	12.8	2
48	0.835	0.808	0.820	0.821	8.19	2
49	1.38	1.46	1.39	1.31	10.5	2

“ ^ ” denotes duplicate data submitted by participants

“ # ” denotes single data submitted by participants

“ --- ” denotes data/information was not provided by participants

APPENDIX XI: Participants' Results for Lead (Cont'd)

Lab. Code	Concentration (mg/kg)				Measurement Uncertainty	
	Replicate 1	Replicate 2	Replicate 3	Mean	Rel. Expanded Uncertainty (%)	Coverage Factor
50	---	---	---	---	---	---
51	1.31	1.28	1.34	1.31	10	2
52	0.816	0.787	0.763	0.789	0.049	2
53	1.027	1.072	1.280	1.120	10	2
54	0.955	0.899	0.989	0.948	12.6	2
55	1.472	1.644	1.533	1.550	3.252	2
56	1.40	1.35	1.38	1.38	3.7	2
57	2.72	3.19	2.83	2.91	13	2
58	<0.010	<0.010	<0.010	<0.010	---	---
59	0.582	0.578	0.644	0.601	14.3	2.78
60	<0.400	<0.400	<0.400	---	---	---
61	1.95	2.25	3.45	2.55	1.587	2
62	1.12	1.24	1.21	1.19	9.75	2
63	1.28	1.31	1.29	1.29	5	2
64	1.284	1.282	1.304	1.290	---	---
65	1.32	1.39	1.39	1.37	20	2
66^	0.197	0.198	---	0.198	0.1	2
67	1.215	1.123	1.186	1.17	6.9	2
68^	1.27	1.29	---	1.28	14	2
69	1.324	1.270	1.271	1.288	6.21	2
70	1.99	1.88	1.98	1.95	25	2
71#	1.30	---	---	1.30	---	---
72	1.06	1.13	1.05	1.08	0.04	---
73	0.944	0.996	0.980	0.973	0.120	---
74	1.45	1.15	1.17	1.26	26	2
75	4.219	3.937	4.080	4.079	0.39	2
76	1.44	1.70	1.90	1.68	10.1	2
77	0.553	0.577	0.565	0.565	0.037	2.13
78	0.51	0.55	0.49	0.52	±0.14	2
79	1.32	1.30	1.37	1.33	5.4	---
80	1.290	1.301	1.300	1.297	4.50	2
81	0.558	0.604	0.622	0.595	30	2
82	---	---	---	---	---	---
83	0.946	0.797	1.090	0.944	---	---
84	1.30	1.33	1.17	1.27	31.0	2
85	0.783	1.090	0.942	0.938	27	2.57
86	---	---	---	---	---	---
87	1.043	1.013	1.033	1.030	10	2
88	0.071	0.058	0.048	0.059	55	2
89	2.87	3.91	2.39	3.06	29.4	2
90#	1.13	---	---	1.13	---	---
91	0.460	0.479	0.549	0.496	0.113	2
92	1.66	1.23	1.31	1.40	15	---
93	1.556	1.580	1.675	1.604	4.51	2
94	1.39	1.45	1.13	1.32	0.12	2
95	0.796	0.838	0.783	0.806	11.5	2
96	<2.00	<2.00	<2.00	---	---	---
97	1.7	1.6	1.7	1.7	11.5	2

“ ^ ” denotes duplicate data submitted by participants

“ # ” denotes single data submitted by participants

“ --- ” denotes data/information was not provided by participants

APPENDIX XII: Participants' Methodologies & Techniques

Lab Code	Instrumentation	Digestion Method	Digestion Medium	Accreditation Status
1	ICP-AES for As; ICP-MS for Cd & Pb	Microwave-assisted	HNO ₃ /H ₂ O ₂	YES
2	ICP-AES	Hotplate digestion	HNO ₃ /HClO ₄	YES
3	ICP-AES for As, AAS for Cd & Pb	Microwave-assisted	HNO ₃ /HClO ₄	YES
4	AAS -GF	Microwave-assisted	HNO ₃ /H ₂ O ₂	NO
5	ICP-MS	Microwave-assisted	HNO ₃	YES
6	ICP-MS	Microwave-assisted	HNO ₃	NO
7	ICP-AES	Microwave-assisted	HNO ₃ /HClO ₄	YES
8	AAS-GF & Hot Vapour	Microwave-assisted	HNO ₃	NO
9	ICP-AES for As; AAS-GF for Cd, Pb	Hotplate digestion	HNO ₃ /H ₂ SO ₄	NO
10	ICP-MS	Heating Block	HNO ₃ /HF	YES
11	AAS	Microwave-assisted	HNO ₃ /H ₂ O ₂	YES
12	ICP-AES	Hotplate digestion	HNO ₃ /HClO ₄	YES
13	AAS	High pressure bomb in heating block	HNO ₃	YES
14	AAS	Microwave assisted	HNO ₃ /HCl	YES
15	AAS	Microwave-assisted	HNO ₃	YES
16	ICP-AES	60 degC for 1 hr	HNO ₃	NO
17	ICP-MS	Wet digestion	H ₂ SO ₄	YES
18	AAS for Cd, AAS-GF for Pb	Dry ashing at 400°C	HNO ₃ /HCl	YES
19	AAS	Microwave-assisted	HNO ₃ /HCl	YES
20	AAS-GF for As; AAS for Pb & Cd	Microwave-assisted	HNO ₃ /H ₂ O ₂	Yes
21	AAS	Microwave-assisted	HNO ₃ /H ₂ O ₂	YES
22	ICP-AES, AAS	Microwave assisted, dry ashing	HNO ₃ /HCl	YES
23	ICP-MS	Closed vessels digestion using hot block	HNO ₃ /H ₂ O ₂	YES
24	AAS-GF	High pressure decomposition vessels	HNO ₃	YES for Cd & Pb
25	AAS: HVG for As, Flame for Cd & Pb	Microwave-assisted & dry ashing	HNO ₃ /HCl	YES
26	ICP-AES for As; ICP-MS for Cd, Pb,	Microwave-assisted	HNO ₃ /H ₂ O ₂	NO
27	ICP-MS, -AES	Microwave-assisted	HNO ₃ /H ₂ O ₂	NO
28	ICP-MS	Microwave-assisted	HNO ₃	YES
29	AAS	---	---	YES
30	ICP-MS	Microwave-assisted	HNO ₃	YES
31	ICP-MS	Microwave-assisted	HNO ₃	YES
32	AAS for Pb,Cd	Microwave-assisted	HCl	YES
33	AAS	Microwave-assisted	HNO ₃ /H ₂ O ₂	YES
34	AAS	Water bath at 95 C for 2 hrs	HNO ₃	YES for Cd
35	AAS	Dry ashing	HNO ₃	YES
36	ICP-MS	Microwave-assisted	HNO ₃ , H ₂ O ₂	YES
37	AAS	Dry ashing	---	YES
38	ICP-MS	Microwave-assisted	HNO ₃ /H ₂ O ₂	YES
39	AAS-EA	Dry ashing	HNO ₃	YES
40	AAS	Others	Mg(NO ₃) ₂	NO
41	AAS	Water bath at 95°C	---	YES
42	ICP-MS	Wet Digestion	HNO ₃	YES
43	AAS	Dry Ashing	HNO ₃ /HCl	YES
44	AAS	Wet digestion	HNO ₃ /H ₂ SO ₄	YES
45	AAS	Wet digestion & dry ashing	HNO ₃ /H ₂ SO ₄ /HClO ₄	YES
46	AFS for As; AAS for Pb , Cd	High pressure digestion & ashing	HNO ₃ /H ₂ O ₂	YES
47	AAS	Muffle furnace	---	YES
48	AAS	Wet digestion	HNO ₃	YES for Pb
49	AAS-EA	Microwave-assisted	HNO ₃ /H ₂ O ₂	NO

“---” denotes data/information was not provided by participants

APPENDIX XII: Participants' Methodologies & Techniques (Cont'd)

Lab Code	Instrumentation	Digestion Method	Digestion Medium	Accreditation Status
50	AAS	Digestion		YES
51	ICP-MS	Microwave-assisted	HNO ₃ /H ₂ O ₂	YES
52	ICP-MS	Microwave-assisted	HNO ₃ /H ₂ O ₂	YES
53	AAS for As; ICP-AES for Cd, Pb	Hot plate	HNO ₃ /H ₂ O ₂	YES for As
54	AAS for Pb & Cd, AFS for As	Wet digestion & dry ashing	HNO ₃ /HClO ₄	YES
55	AAS	Dry ashing	HCl	YES
56	AAS	Microwave-assisted	HNO ₃ /HCl	Yes
57	AAS	Dry ashing	HCl	YES
58	AAS	Hot plate digestions	HNO ₃ /H ₂ O ₂ /HCl	No
59	AAS-GF	Acid digestion	HNO ₃ /HClO ₄ /H ₂ SO ₄	Yes
60	AAS	---	AOAC 937.07, 972.23, 986.15	Yes
61	AAS	Oven digestion in Teflon bombs	HNO ₃	NO
62	ICP-MS	Ashing in furnace & acid digestion	HCl for As, H ₂ SO ₄ for Pb, Cd	NO
63	ICP-MS	Hot Block digestion	HNO ₃	YES
64	ICP-MS	Microwave-assisted	HNO ₃ /HCl	NO
65	ICP-MS	Microwave-assisted	HNO ₃	NO
66	AAS for As, ICP-OES for Pb, Cd	Reflux	HNO ₃	YES
67	ICP-AES	Microwave-assisted	HNO ₃	Yes
68	ICP-MS	Microwave-assisted	HNO ₃ /H ₂ O ₂	NO
69	AAS	AOAC Official Method 999.11	AOAC 999.11	NO
70	AAS	Dry ashing		YES
71	ICP-MS	Microwave-assisted	HNO ₃ /H ₂ O ₂	YES
72	ICP-MS	Microwave-assisted	HNO ₃	YES
73	ICP-AES	---	---	---
74	AAS	Dry ashing	Mg(NO ₃) ₂	YES
75	AAS	Hot Plate digestion	HNO ₃	NO
76	ICP-AES for As, ICP-MS for Pb, Cd	Wet Oxidation	Aqua regia	NO
77	Hydride-AAS for As, AAS-GF for Pb, Cd	Dry ashing	MgO/Mg(NO ₃) ₂ for As, HNO ₃ /HCl for Pb, Cd	NO
78	AAS	Ashing	---	YES
79	ICP-MS	Microwave-assisted	HNO ₃	YES
80	AAS	Ashing	HNO ₃	YES
81	AAS	Microwave-assisted	HNO ₃ /H ₂ O ₂	YES
82	AAS	Wet oxidation	H ₂ SO ₄ /HNO ₃ /HClO ₄	YES
83	FAAS, GFAAS	AOAC Official Method 999.11	HCl	NO
84	ICP-MS	Microwave-assisted	HNO ₃ /H ₂ O ₂	YES
85	ICP-MS, AAS	Microwave-assisted		YES
86	ICP-AES	Microwave-assisted	HNO ₃ /H ₂ O ₂	YES
87	AAS	Microwave-assisted	HNO ₃	YES
88	Polarography	Dry ashing & wet digestion	HNO ₃ /HClO ₄ for As, AOAC 982.23 for Cd, Pb	YES for Pb & Cd
89	Hydride AAS for As ASV for Cd and Pb	Dry ashing for Cd and Pb, wet digestion plus dry ashing for As	HNO ₃ /HCl	NO
90	ICP-MS	Microwave-assisted	HNO ₃ /H ₂ O ₂	YES
91	Hg-AAS & AAS-GF	Microwave, wet & dry ashing	H ₂ SO ₄ /HNO ₃ /HClO ₄	NO
92	ICP-MS	Microwave-assisted	HNO ₃ /H ₂ O ₂	YES
93	AAS-GF	Hotplate	HNO ₃ /H ₂ O ₂	YES
94	XRF for As, AAS & ASV for Cd, Pb	Wet digestion	HF/HNO ₃ /HClO ₄	NO
95	ICP	Dry ashing	HNO ₃ /HCl	NO
96	ICP-MS	Microwave-assisted	HNO ₃ /H ₂ O ₂	NO
97	AAS	Microwave-assisted	HNO ₃ /H ₂ O ₂	YES

“---” denotes data/information was not provided by participants

APPENDIX XIII: z-Scores of Participants

Lab. Code	Total Arsenic		Cadmium		Lead	
	Reported mean	z-score	Reported mean	z-score	Reported mean	z-score
1	55.2	-0.93	0.178	-0.21	1.20	0.01
2	59.9	-0.01	0.132	-1.3	1.29	0.23
3	58.436	-0.30	0.539	8.5	4.345	7.6
4	64.930	0.96	0.260	1.8	1.424	0.55
5	33.8	-5.1	0.11	-1.8	0.41	-1.9
6	58.9	-0.21	0.162	-0.59	1.07	-0.30
7	49.4485	-2.0	0.2398	1.3	---	NA
8	1.522	-11	0.205	0.45	1.289	0.23
9	54.6	-1.1	0.181	-0.15	0.516	-1.6
10	62.4	0.47	0.184	-0.07	1.21	0.04
11	---	NA	0.13	-1.3	1.49	0.71
12	63.4	0.65	<0.10	NA	0.91	-0.68
13	---	NA	0.194	0.17	1.004	-0.46
14	1.141	-11	0.138	-1.2	0.327	-2.1
15	56.3	-0.73	0.196	0.22	1.12	-0.18
16	---	NA	<0.100	NA	<0.300	NA
17	61.9	0.37	0.177	-0.23	1.10	-0.22
18	---	NA	0.163	-0.57	1.37	0.42
19	---	NA	0.177	-0.24	1.187	-0.02
20	0.482	-12	0.214	0.65	1.043	-0.36
21	45.9	-2.7	0.172	-0.35	0.575	-1.5
22	3.85	-11	0.298	2.7	0.695	-1.2
23	55.4	-0.89	0.131	-1.3	1.09	-0.24
24	64.2	0.81	0.180	-0.16	1.21	0.03
25	45.5	-2.8	0.201	0.34	2.55	3.2
26	60.0	-0.01	0.178	-0.20	1.14	-0.14
27	54.7	-1.0	0.190	0.07	1.56	0.88
28	74.2	2.8	0.176	-0.25	1.15	-0.11
29	<0.001	NA	<0.001	NA	<0.04	NA
30	55.6	-0.85	0.206	0.46	1.66	1.1
31	64.5	0.88	0.191	0.11	1.36	0.41
32	---	NA	0.161	-0.63	10.983	24
33	6.4	-10	0.20	0.32	0.9	-0.65
34	---	NA	0.187	0.01	1.110	-0.20
35	---	NA	0.1	-2.1	---	NA
36	65.7	1.1	0.186	-0.03	1.42	0.54
37	---	NA	0.170	-0.40	1.313	0.28
38	58.6	-0.28	0.197	0.25	1.30	0.25
39	---	NA	0.172	-0.36	0.994	-0.48
40	---	NA	0.291	2.5	1.523	0.79
41	---	NA	0.197	0.25	1.096	-0.24
42	85.0	4.8	0.278	2.2	1.77	1.4
43	31.396	-5.5	0.201	0.34	0.450	-1.8
44	2.49	-11	0.137	-1.2	3.37	5.2
45	53.221	-1.3	0.145	-1.0	1.608	0.99
46	33.7	-5.1	0.200	0.32	1.44	0.60
47	---	NA	0.203	0.39	0.921	-0.66
48	28.280	-6.1	0.181	-0.13	0.821	-0.90
49	52.9	-1.4	0.209	0.54	1.31	0.28

“---” denotes data/information was not provided by participants

“NA” denotes z-score not assessed

Outliers are bolded

APPENDIX XIII: z-Scores of Participants (Cont'd)

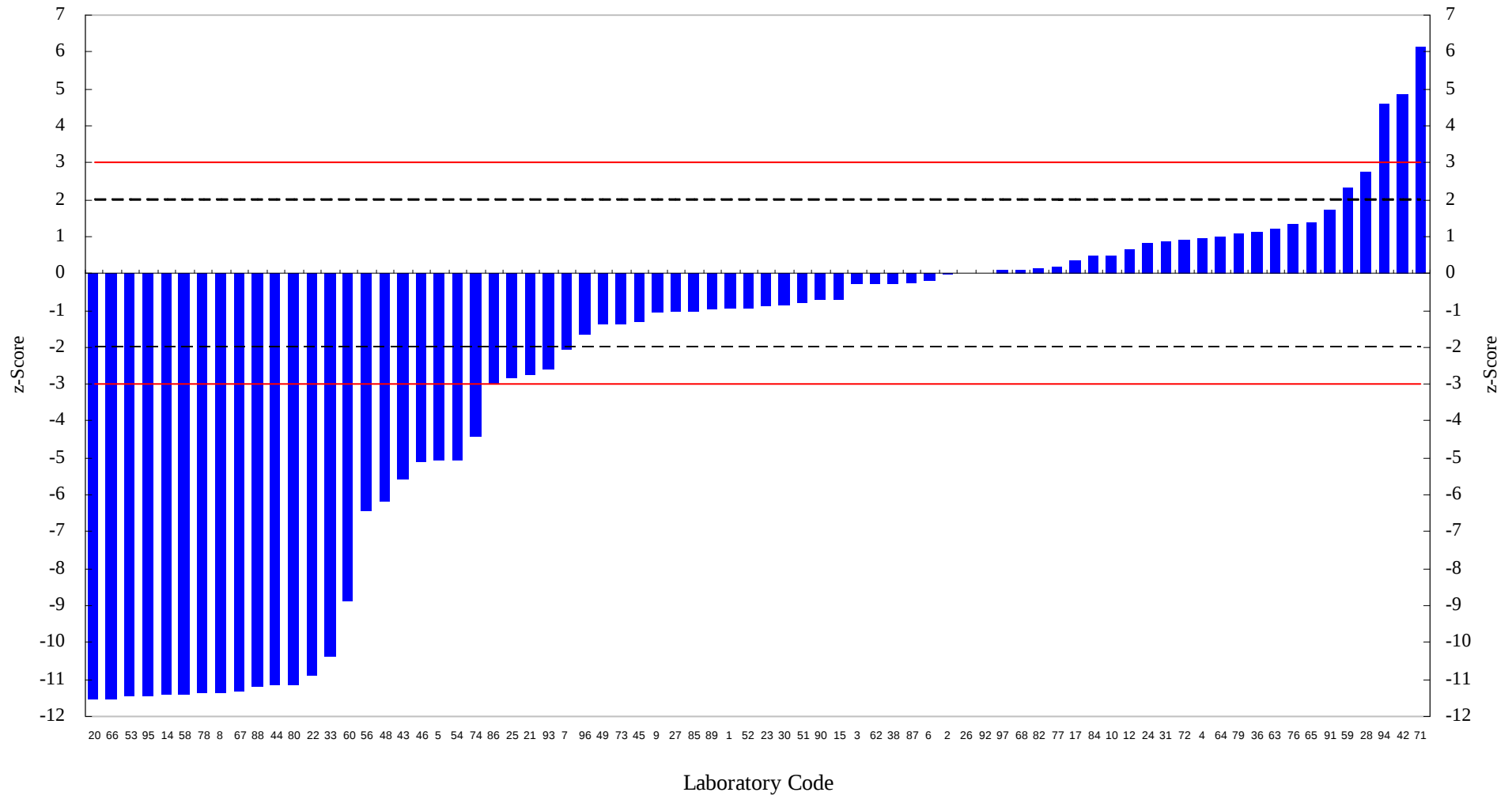
Lab. Code	Total Arsenic		Cadmium		Lead	
	Reported mean	z-score	Reported mean	z-score	Reported mean	z-score
50	---	NA	0.215	0.68	---	NA
51	55.8	-0.81	0.179	-0.18	1.31	0.28
52	55.220	-0.93	0.135	-1.2	0.789	-0.98
53	0.963	-11	0.174	-0.31	1.120	-0.18
54	33.9	-5.1	0.189	0.05	0.948	-0.59
55	---	NA	0.194	0.17	1.550	0.85
56	26.8	-6.4	0.205	0.44	1.38	0.44
57	---	NA	0.67	12	2.91	4.1
58	1.265	-11	0.166	-0.49	<0.010	NA
59	72.095	2.3	0.409	5.4	0.601	-1.4
60	14.155	-8.9	0.184	-0.06	---	NA
61	---	NA	0.27	2.0	2.55	3.3
62	58.5	-0.29	0.170	-0.40	1.19	-0.01
63	66.3	1.2	0.145	-1.0	1.29	0.24
64	65.123	0.99	0.179	-0.19	1.290	0.23
65	67.1	1.4	0.206	0.46	1.37	0.42
66	0.582	-12	0.917	18	0.198	-2.4
67	1.54	-11	0.140	-1.1	1.17	-0.05
68	60.55	0.11	0.19	-0.04	1.28	0.20
69	---	NA	0.152	-0.84	1.288	0.22
70	---	NA	0.283	2.3	1.95	1.8
71	91.6	6.1	<0.2	NA	1.30	0.25
72	64.69	0.91	0.19	0	1.08	-0.28
73	53.1	-1.3	0.105	-2.0	0.973	-0.53
74	37.2	-4.4	0.185	-0.04	1.26	0.15
75	---	NA	0.158	-0.69	4.079	6.9
76	67	1.4	0.174	-0.30	1.68	1.2
77	60.8	0.16	0.138	-1.2	0.565	-1.5
78	1.48	-11	0.065	-2.9	0.52	-1.6
79	65.5	1.1	0.187	0.01	1.33	0.32
80	2.637	-11	0.188	0.02	1.297	0.25
81	---	NA	0.166	-0.49	0.595	-1.4
82	60.6	0.12	0.189	0.05	---	NA
83	---	NA	0.571	9.3	0.944	-0.60
84	62.40	0.46	0.19	0.16	1.27	0.17
85	54.7	-1.0	0.189	0.05	0.938	-0.62
86	44.64	-2.98	0.147	-0.95	---	NA
87	58.6	-0.26	0.184	-0.06	1.030	-0.40
88	2.20	-11	0.057	-3.1	0.059	-2.7
89	54.9	-0.99	0.314	3.1	3.06	4.5
90	56.2	-0.74	0.180	-0.16	1.13	-0.16
91	68.998	1.7	1.096	22	0.496	-1.7
92	60.0	-0.01	0.191	0.10	1.40	0.49
93	46.60	-2.6	0.237	1.2	1.604	0.98
94	83.7	4.6	0.27	2.0	1.32	0.31
95	1.030	-11	0.118	-1.7	0.806	-0.93
96	51.40	-1.7	---	NA	---	NA
97	60.5	0.10	0.5	7.6	1.7	1.2

“---” denotes data/information was not provided by participants

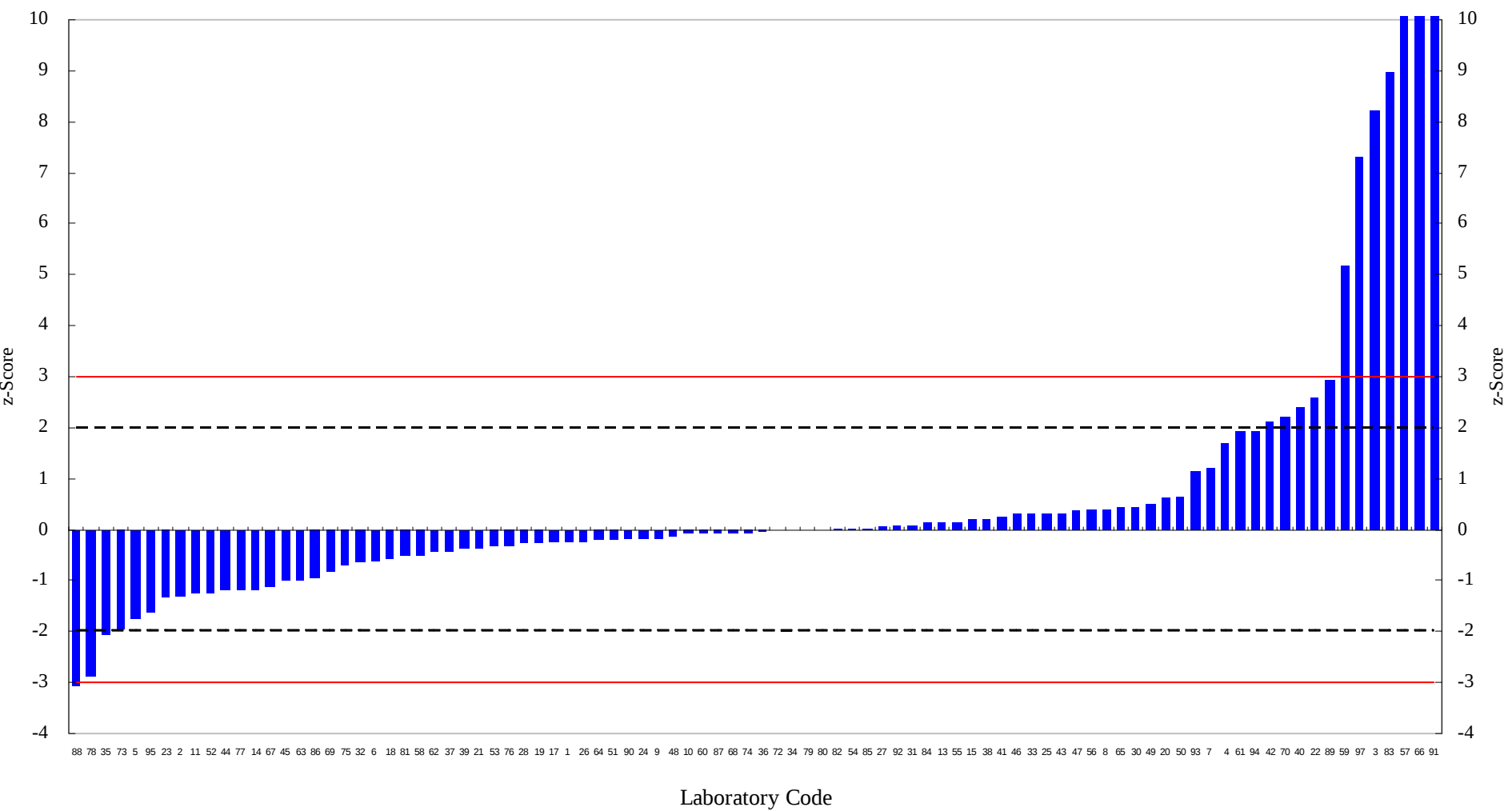
“NA” denotes z-score not assessed

Outliers are bolded

Appendix XIV: Histogram of z-scores of participants for Total ARSENIC



Appendix XV: Histogram of z-scores of participants for CADMIUM



Appendix XVI: Histogram of z-scores of participants for LEAD

