



CERTIFICATE OF PARTICIPATION

This certificate confirms that:

Public Health Bureau, Yunlin County

took part in:

LEAP MICRO Proficiency Test **DWM0154**

Start Date: 16/06/2021

Total Coliforms , Escherichia coli in Drinking Water

and were allocated laboratory number **35**.

The performance of the laboratory is shown in the relevant report, which is available from the secure pages at fapas.com

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Fapas® – Water and Environmental Report DWM054

Drinking Water Microbiology

June-July 2021

PARTICIPANT LABORATORY NUMBER

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SUMMARY

1. The test materials for Fapas® – Drinking Water Microbiology proficiency test Distribution DWM054 were dispatched in June 2021. Three test materials were provided for nine examinations in this distribution:

Test Material A	DWM0154 Enumeration of total coliforms
Test Material A	DWM0154 Enumeration of <i>Escherichia coli</i>
Test Material B	DWM0254 Colony count after 3 days at 22°C
Test Material B	DWM0254 Colony count after 2 days at 37°C
Test Material C	DWM0354 Enumeration of enterococci
Test Material C	DWM0354 Enumeration of <i>Pseudomonas aeruginosa</i>
Test Material C	DWM0354 Enumeration of <i>Clostridium perfringens</i>
Test Material C	DWM0354 Enumeration of <i>Clostridium</i> spp.
Test Material C	DWM0354 Enumeration of Sulphite Reducing Clostridia (SRC)

2. An assigned value (x_a) was determined for each proficiency test in enumeration and in conjunction with the standard deviation for proficiency (σ_p) was used to calculate a z-score for each result. However, those for *Clostridium* spp. are not provided.

3. Results for this proficiency test are summarised as follows:

Test Material A

organism	assigned value, x_a SQRT cfu/100ml	number of scores, $ z \leq 2$	total number of scores	% $ z \leq 2$
Total Coliforms	5.57	35	40	88
<i>Escherichia coli</i>	4.46	35	38	92

Test Material B

organism	assigned value, x_a SQRT cfu/ml	number of scores, $ z \leq 2$	total number of scores	% $ z \leq 2$
Colony Counts (22°C/3 days)	9.62	18	21	86
Colony Counts (37°C/2 days)	10.4	21	25	84

Test Material C

organism	assigned value, $\bar{x}_a$ SQRT cfu/100ml	number of scores, $ z \leq 2$	total number of scores	% $ z \leq 2$
Enterococci	5.87	20	25	80
<i>Pseudomonas aeruginosa</i>	7.43	22	24	92
<i>Clostridium perfringens</i>	6.20	12	13	92
<i>Clostridium</i> spp.	not set	n/a	n/a	n/a
Sulphite Reducing Clostridia (SRC)	6.20	6	7	86

n/a – not applicable

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1. INTRODUCTION

1.1. Proficiency Testing

Proficiency testing aims to provide an independent assessment of the competence of participating laboratories. Together with the use of validated methods, proficiency testing is an essential element of laboratory quality assurance.

Further details of the Fapas® – Water and Environmental proficiency tests are available in our protocols [4, 5].

2. TEST MATERIAL

2.1. Preparation

Preparation of the samples for this proficiency test was sub-contracted to a laboratory meeting the quality requirements of the scheme's accreditation [3].

Each test material comprised of a small glass vial containing an inoculum pellet, sealed with a rubber bung and crimp-capped. The organisms present in the inoculum pellets were as follows:

- Test Material A *Escherichia coli* and *Klebsiella planticola*
- Test Material B *Enterococcus faecalis* and *Staphylococcus epidermidis*
- Test Material C *Enterococcus faecalis*, *Pseudomonas aeruginosa*,
Clostridium perfringens

The test materials were stored at +4°C ±2°C until dispatch.

2.2. Homogeneity

To test for homogeneity, randomly selected test materials were analysed in duplicate by a laboratory meeting the quality requirements of the scheme's accreditation [3].

These data showed sufficient homogeneity and were not included in the subsequent calculation of the assigned values.

2.3. Dispatch

The start date was 16 June 2021. Test materials were sent to 57 participants.

3. RESULTS

The instructions for reporting results were as follows:

- Start the analysis between 16 June and 25 June 2021.
- For proficiency tests DWM0154 (Test Material A), DWM0354 (Test Material C):
Results for Results for Total Coliforms, *Escherichia coli*, Enterococci,
Clostridium perfringens, *Clostridium* spp., Sulphite Reducing Clostridia and
Pseudomonas aeruginosa must be reported in cfu/100ml.
- For proficiency test DWM0254 (Test Material B):
Results for colony counts must be reported in cfu/ml.

Results were submitted by 56 participants (98%) before the closing date for this test, 07 July 2021.

Each participant was given a laboratory number, assigned in order of receipt of results. The reported analyte concentrations are given in Tables 1 to 5.

Participants' comments are given in Table 6.

The analytical methods used by each participant are summarised in APPENDIX I.

4. STATISTICAL EVALUATION OF RESULTS

The results submitted by participants were statistically analysed in order to provide an assigned value for each proficiency test in enumeration. The assigned values were then used in combination with the standard deviation for proficiency, σ_p , to calculate a z-score [6] for each result. The procedure is detailed in the relevant protocols [4, 5].

Further background on the procedure followed can be found in the IUPAC International Harmonised Protocol for the Proficiency Testing of Analytical Chemistry Laboratories [7].

4.1. Calculation of the Assigned Value, x_a

The assigned value, x_a , for each test in enumeration was derived from the consensus of the results submitted by participants.

The procedure used to derive this consensus involved:

- i) exclusion, if present, of any non numerical results i.e. qualitative or semi-quantitative results,
- ii) a square root transformation of submitted results to obtain a normal distribution,
- iii) exclusion, if present, of any results that were approximately 10, 100 or 1000 × greater or smaller than the majority of submitted results (as these were considered to be reporting errors).

For the Total Coliforms, *Escherichia coli*, Colony Counts (37°C/2 days), Enterococci and *Pseudomonas aeruginosa* examinations this procedure was straightforward and the robust mean was chosen as the assigned value.

For the Colony Counts (22°C/3 days), *Clostridium perfringens* and Sulphite Reducing Clostridia (SRC) examinations the median was chosen as the assigned value as this was considered the best measure of consensus due to the low number of data points.

No assigned value has been set for the test enumeration of *Clostridium* spp. due to low number of results.

The assigned values for all proficiency tests in enumeration, together with their uncertainties are shown in Table 7.

4.2. Standard Deviation for Proficiency, σ_p

A fixed standard deviation has been set at a value that reflects best practice for the analyses in question and the appropriate members of the Fapas® Advisory Committee have agreed these values.

The values for σ_p used to calculate z-scores from the reported results of this test are given in Table 7.

4.3. Individual z-Scores

Participants' z-scores were calculated as:

$$z = \frac{(x - x_a)}{\sigma_p}$$

where x = the square root of the participant's reported result,

x_a = the assigned value, see Table 7,

and σ_p = the standard deviation for proficiency, see Table 7.

Participants' z-scores for all proficiency tests in enumeration are given in Tables 1 to 5 and shown as histograms in Figures 1 to 8. It is possible for the z-scores published in this report to differ slightly from the z-score that can be calculated using the formula given above. These differences arise from the necessary rounding of the actual assigned values and standard deviations for proficiency prior to their publication in Table 7.

The number and percentage of z-scores in the range $-2 \leq z \leq 2$ for all proficiency tests in enumeration are given in Table 8.

5. INTERPRETATION OF SCORES

In normal circumstances, over time, about 95% of z-scores will lie in the range $-2 \leq z \leq 2$. Occasional scores in the range $2 < |z| < 3$ are to be expected, at a rate of 1 in 20. Whether or not such scores are of importance can only be decided by considering them in the context of the other scores obtained by that laboratory.

Scores where $|z| > 3$ are to be expected at a rate of about 1 in 300. Given this rarity, such z-scores very strongly indicate that the result is not fit-for-purpose and almost certainly requires investigation.

The consideration of a set or sequence of z-scores over time provides more useful information than a single z-score. Examples of suitable methods of comparison are provided in the IUPAC International Harmonised Protocol for the Proficiency Testing of Analytical Chemistry Laboratories [7].

6. REFERENCES

- 1 Adobe Approved Trust List,
<https://helpx.adobe.com/acrobat/kb/approved-trust-list2.html#Whatisit>
accessed 08/01/2021.
- 2 GlobalSign PDF Signing Tool, <https://www.globalsign.com/en/digital-signatures/>
accessed 08/01/2021.
- 3 ISO/IEC 17043:2010, Conformity assessment – General requirements for proficiency testing.
- 4 Fapas[®], 2021, Protocol for Proficiency Testing Schemes, Version 7, January 2021, Part 1 – Common Principles.
- 5 Fapas[®], 2021, Protocol for Proficiency Testing Schemes, Version 7, April 2021, Part 5 – Fapas[®] Water and Environmental scheme (LEAP).
- 6 AMC Tech Brief No. 74, z-Scores and other scores in chemical proficiency testing – their meanings, and some common misconceptions, *Anal. Methods*, 2016, **8**, 5553.
- 7 Thompson, M., Ellison, S.L.R. and Wood, R., 2006, The International Harmonised Protocol for the Proficiency Testing of Analytical Chemistry Laboratories, *Pure Appl. Chem.*, **78**, No. 1, 145–196.

Table 1: Results and z-Scores for Enumeration of Total Coliforms and *Escherichia coli*

laboratory number	organism							
	Total Coliforms assigned value: 5.57 SQRT cfu/100ml				<i>Escherichia coli</i> assigned value: 4.46 SQRT cfu/100ml			
	result cfu/100ml	SQRT cfu/100ml	method	z-score	result cfu/100ml	SQRT cfu/100ml	method	z-score
001	32	5.66	MPN	0.1	24	4.90	MPN	0.3
002	41	6.40	membrane filtration	0.6	24	4.90	membrane filtration	0.3
005	29	5.39	membrane filtration	-0.1	7	2.65	membrane filtration	-1.2
006	28	5.29	Membrane Filtration Method	-0.2	18	4.24	Membrane Filtration Method	-0.1
007	57	7.55	MPN	1.3	35	5.92	MPN	1.0
008	26	5.10	membrane filtration	-0.3	21	4.58	membrane filtration	0.1
009					27	5.20	Membrane Filtration	0.5
010					24	4.90	Membrane Filtration	0.3
011					4	2.00	membrane filtration	-1.6
012	18	4.24	membrane filtration	-0.9	9	3.00	membrane filtration	-1.0
013	0 #	0	membrane filtration	-3.7	0 #	0	membrane filtration	-3.0

z-scores outside $|z| > 2$ are shown in **bold**, see Section 5

* samples analysed outside of the required time frame

samples received outside of the required time frame

Table 1 (continued): Results and z-Scores for Enumeration of Total Coliforms and *Escherichia coli*

laboratory number	organism							
	Total Coliforms assigned value: 5.57 SQRT cfu/100ml				<i>Escherichia coli</i> assigned value: 4.46 SQRT cfu/100ml			
	result cfu/100ml	SQRT cfu/100ml	method	z-score	result cfu/100ml	SQRT cfu/100ml	method	z-score
014	20.196	4.49	IDEXX/MPN	-0.7	12.07	3.47	IDEXX/MPN	-0.7
015	24	4.90	membran filtration	-0.4	16	4.00	membran filtration	-0.3
016	58	7.62	membrane filtration	1.4	36	6.00	membrane filtration	1.0
018	38	6.16	Membrane filtration	0.4	23	4.80	Membrane filtration	0.2
019	26	5.10	membrane	-0.3	16	4.00	membrane	-0.3
020	40	6.32	membrane filtration	0.5				
021	14	3.74	membrane filtration	-1.2	10	3.16	membrane filtration	-0.9
022	25 *	5.00	Membrane filtration	-0.4	21 *	4.58	Membrane filtration	0.1
023	53 *	7.28	membrane filtration	1.1	27 *	5.20	membrane filtration	0.5
024	32	5.66	membrane filtration	0.1	13	3.61	membrane filtration	-0.6
025	9	3.00	membrane filtration	-1.7	12	3.46	membrane filtration	-0.7

z-scores outside $|z| > 2$ are shown in **bold**, see Section 5

* samples analysed outside of the required time frame

samples received outside of the required time frame

Table 1 (continued): Results and z-Scores for Enumeration of Total Coliforms and *Escherichia coli*

laboratory number	organism							
	Total Coliforms assigned value: 5.57 SQRT cfu/100ml				<i>Escherichia coli</i> assigned value: 4.46 SQRT cfu/100ml			
	result cfu/100ml	SQRT cfu/100ml	method	z-score	result cfu/100ml	SQRT cfu/100ml	method	z-score
026	32	5.66	membrana filtrante	0.1	16	4.00	membrana filtrante	-0.3
028	24	4.90	Collilert 18	-0.4	18	4.24	Collilert 18	-0.1
029	34 *	5.83	membrane filtration	0.2				
031	30.4	5.51	Colilert18	0.0	22.8	4.77	Colilert18	0.2
034	27	5.20	MPN	-0.2	24	4.90	MPN	0.3
035	40	6.32	membrane filtration	0.5				
036	42 *	6.48	Membrane Filtration	0.6	23 *	4.80	Membrane Filtration	0.2
038	8.7 #	2.95	MPN	-1.7	6.4 #	2.53	MPN	-1.3
040	15 *	3.87	Membrane filtration	-1.1	13 *	3.61	Membrane filtration	-0.6
041	32	5.66	membrane filtration	0.1	18	4.24	membrane filtration	-0.1
043	32	5.66	Filtration	0.1	27	5.20	Filtration	0.5

z-scores outside $|z| > 2$ are shown in **bold**, see Section 5

* samples analysed outside of the required time frame

samples received outside of the required time frame

Table 1 (continued): Results and z-Scores for Enumeration of Total Coliforms and *Escherichia coli*

laboratory number	organism							
	Total Coliforms assigned value: 5.57 SQRT cfu/100ml				<i>Escherichia coli</i> assigned value: 4.46 SQRT cfu/100ml			
	result cfu/100ml	SQRT cfu/100ml	method	z-score	result cfu/100ml	SQRT cfu/100ml	method	z-score
044	49 *	7.00	MPN	1.0	33 *	5.74	MPN	0.9
045	32	5.66	membrane filtration	0.1	20	4.47	membrane filtration	0.0
046	21	4.58	membrane filtration	-0.7	22	4.69	membrane filtration	0.2
049	43	6.56	Filtration	0.7	19	4.36	Filtration	-0.1
051	45	6.71	Filtration	0.8	22	4.69	Filtration	0.2
052	37	6.08	membrane filtration	0.3	22	4.69	membrane filtration	0.2
053	5.6E+2	23.7	membrane filtration	12.1	1.9E+2	13.8	membrane filtration	6.2
054	4.6E+2	21.4	membrane filtration	10.6				
055	4.8E+2	21.9	membrane filtration	10.9	1.2E+2	11.0	membrane filtration	4.3
056	4.3E+2 *	20.7	MPN	10.1				

z-scores outside $|z| > 2$ are shown in **bold**, see Section 5

* samples analysed outside of the required time frame

samples received outside of the required time frame

Table 2: Results and z-Scores for Colony Count after 3 days at 22°C and after 2 days at 37°C

laboratory number	organism					
	Colony Counts (22°C/3 days) assigned value: 9.62 SQRT cfu/ml			Colony Counts (37°C/2 days) assigned value: 10.4 SQRT cfu/ml		
	result cfu/ml	SQRT cfu/ml	z-score	result cfu/ml	SQRT cfu/ml	z-score
002	100	10.0	0.3	150	12.2	1.5
003	92	9.59	0.0	126	11.2	0.6
004				103	10.1	-0.2
007	82	9.06	-0.4	101	10.0	-0.3
008	72	8.49	-0.9	92	9.59	-0.7
012	98	9.90	0.2	122	11.0	0.5
016	102	10.1	0.4	128	11.3	0.7
017	99	9.95	0.3	130	11.4	0.8
018	8	2.83	-5.4	10	3.16	-5.8
022	54 *	7.35	-1.8	65 *	8.06	-1.9
025	86	9.27	-0.3	82	9.06	-1.1
026	110	10.5	0.7	140	11.8	1.1

z-scores outside $|z| > 2$ are shown in **bold**, see Section 5

* samples analysed outside of the required time frame

samples received outside of the required time frame

Table 2 (continued): Results and z-Scores for Colony Count after 3 days at 22°C and after 2 days at 37°C

laboratory number	organism					
	Colony Counts (22°C/3 days) assigned value: 9.62 SQRT cfu/ml			Colony Counts (37°C/2 days) assigned value: 10.4 SQRT cfu/ml		
	result cfu/ml	SQRT cfu/ml	z-score	result cfu/ml	SQRT cfu/ml	z-score
030	86	9.27	-0.3	108	10.4	0.0
031				60.35	7.77	-2.1
032	85 *	9.22	-0.3	82 *	9.06	-1.1
039	95 *	9.75	0.1	125 *	11.2	0.6
040	87.27 *	9.34	-0.2	124.54 *	11.2	0.6
043	95	9.75	0.1	88	9.38	-0.8
045	93 *	9.64	0.0	120 *	11.0	0.4
048				110	10.5	0.0
049	92	9.59	0.0	154	12.4	1.6
051	104	10.2	0.5	141	11.9	1.2
052				69	8.31	-1.7
053	5.0E+3	70.7	48.9	4.6E+3	67.8	45.9
054	4.8E+3	69.3	47.7	4.5E+3	67.1	45.3

z-scores outside $|z| > 2$ are shown in **bold**, see Section 5

* samples analysed outside of the required time frame

samples received outside of the required time frame

Table 3: Results and z-Scores for Enumeration of Enterococci

laboratory number	organism			
	Enterococci			
	assigned value: 5.87 SQRT cfu/100ml			
	result cfu/100ml	SQRT cfu/100ml	method	z-score
002	24	4.90	membrane filtration	-0.8
007	1	1.00	MPN	-3.9
008	30	5.48	membrane filtration	-0.3
009	38	6.16	Membrane Filtration	0.2
010	35	5.92	Membrane Filtration	0.0
012	46	6.78	membrane filtration	0.7
014				
016	45	6.71	membrane filtration	0.7
018	44	6.63	Membrane filtration	0.6
022	30 *	5.48	Membrane filtration	-0.3
026	28	5.29	membrane filtration	-0.5
027	24 *	4.90	MPN	-0.8
029	33 *	5.74	membrane filtration	-0.1
031	8.9	2.98	multiple tube	-2.3
033				

z-scores outside $|z| > 2$ are shown in **bold**, see Section 5

* samples analysed outside of the required time frame

samples received outside of the required time frame

Table 3 (continued): Results and z-Scores for Enumeration of Enterococci

laboratory number	organism			
	Enterococci assigned value: 5.87 SQRT cfu/100ml			
	result cfu/100ml	SQRT cfu/100ml	method	z-score
034	1	1.00	MPN	-3.9
037				
040	20 *	4.47	Membrane filtration	-1.1
041	50	7.07	membrane filtration	1.0
042				
043	40	6.32	Filtration	0.4
045	32	5.66	membrane filtration	-0.2
046	36	6.00	membrane filtration	0.1
047	38	6.16	membrane filtration	0.2
049	40	6.32	Filtration	0.4
050				
051	41	6.40	Filtration	0.4
052	35	5.92	Membrane filtration	0.0
053	8.8E+2	29.7	membrane filtration	19.0
054	9.0E+2	30.0	membrane filtration	19.3

z-scores outside $|z| > 2$ are shown in **bold**, see Section 5

* samples analysed outside of the required time frame

samples received outside of the required time frame

Table 4: Results and z-Scores for Enumeration of *Pseudomonas aeruginosa*

laboratory number	organism			
	<i>Pseudomonas aeruginosa</i>			
	assigned value: 7.43 SQRT cfu/100ml			
	result cfu/100ml	SQRT cfu/100ml	method	z-score
002	58	7.62	membrane filtration	0.1
007	56	7.48	MPN	0.0
008	38	6.16	membrane filtration	-0.8
009				
010				
012	54	7.35	membrane filtration	-0.1
014	37.566	6.13	IDEXX/MPN	-0.9
016	60	7.75	membrane filtration	0.2
018	80	8.94	Membrane filtration	1.0
022	42 *	6.48	Membrane filtration	-0.6
026				
027				
029	46 *	6.78	membrane filtration	-0.4
031	37.4	6.12	Pseudalert	-0.9
033				

z-scores outside $|z| > 2$ are shown in **bold**, see Section 5

* samples analysed outside of the required time frame

samples received outside of the required time frame

Table 4 (continued): Results and z-Scores for Enumeration of *Pseudomonas aeruginosa*

laboratory number	organism			
	<i>Pseudomonas aeruginosa</i> assigned value: 7.43 SQRT cfu/100ml			
	result cfu/100ml	SQRT cfu/100ml	method	z-score
034	59	7.68	membrane filtration	0.2
037	37	6.08	HRN EN ISO 16266:2008	-0.9
040	40 *	6.32	Membrane filtration	-0.7
041	53	7.28	membrane filtration	-0.1
042				
043	92	9.59	Filtration	1.4
045	63	7.94	membrane filtration	0.3
046	66	8.12	membrane filtration	0.5
047	73	8.54	membrane filtration	0.7
049	84	9.17	Filtration	1.2
050	49	7.00	MPN	-0.3
051	85	9.22	Filtration	1.2
052	35	5.92	Membrane filtration	-1.0
053	1.1E+3	33.2	membrane filtration	17.2
054	1.1E+3	33.2	membrane filtration	17.2

z-scores outside $|z| > 2$ are shown in **bold**, see Section 5

* samples analysed outside of the required time frame

samples received outside of the required time frame

Table 5: Results and z-Scores for *Clostridium perfringens*, *Clostridium* spp. and Sulphite Reducing Clostridia

laboratory number	organism											
	<i>Clostridium perfringens</i> assigned value: 6.20 SQRT cfu/100ml				<i>Clostridium</i> spp. assigned value: not set				Sulphite Reducing Clostridia (SRC) assigned value: 6.20 SQRT cfu/100ml			
	result cfu/100ml	SQRT cfu/100ml	method	z-score	result cfu/100ml	SQRT cfu/100ml	method	z-score	result cfu/100ml	SQRT cfu/100ml	method	z-score
002	54	7.35	membrane filtration	0.8					41	6.40	membrane filtration	0.1
007												
008	47	6.86	membrane filtration	0.4								
009												
010												
012	36	6.00	membrane filtration	-0.1								
014												
016	30	5.48	membrane filtration	-0.5								
018	0	0	Membrane filtration	-4.1	0	0	Membrane filtration		0	0	Membrane filtration	-4.1
022	40 *	6.32	Membrane filtration	0.1					36 *	6.00	Membrane filtration	-0.1

z-scores outside $|z| > 2$ are shown in **bold**, see Section 5

* samples analysed outside of the required time frame

samples received outside of the required time frame

Table 5 (continued): Results and z-Scores for *Clostridium perfringens*, *Clostridium* spp. and Sulphite Reducing Clostridia

laboratory number	organism											
	<i>Clostridium perfringens</i> assigned value: 6.20 SQRT cfu/100ml				<i>Clostridium</i> spp. assigned value: not set				Sulphite Reducing Clostridia (SRC) assigned value: 6.20 SQRT cfu/100ml			
	result cfu/100ml	SQRT cfu/100ml	method	z-score	result cfu/100ml	SQRT cfu/100ml	method	z-score	result cfu/100ml	SQRT cfu/100ml	method	z-score
026												
027												
029												
031	37.0	6.08	membrane filtration	-0.1								
033									28	5.29	membrane filtration	-0.6
034												
037												
040	35 *	5.92	Membrane filtration	-0.2	44 *	6.63	Membrane filtration		44 *	6.63	Membrane filtration	0.3
041	12	3.46	membrane filtration	-1.8	46	6.78	membrane filtration		67	8.19	membrane filtration	1.3
042	46.5 *	6.82	Membrane filtration	0.4								

z-scores outside $|z| > 2$ are shown in **bold**, see Section 5

* samples analysed outside of the required time frame

samples received outside of the required time frame

Table 5 (continued): Results and z-Scores for *Clostridium perfringens*, *Clostridium* spp. and Sulphite Reducing Clostridia

laboratory number	organism											
	<i>Clostridium perfringens</i> assigned value: 6.20 SQRT cfu/100ml				<i>Clostridium</i> spp. assigned value: not set				Sulphite Reducing Clostridia (SRC) assigned value: 6.20 SQRT cfu/100ml			
	result cfu/100ml	SQRT cfu/100ml	method	z-score	result cfu/100ml	SQRT cfu/100ml	method	z-score	result cfu/100ml	SQRT cfu/100ml	method	z-score
043												
045	49	7.00	membrane filtration	0.5								
046	31	5.57	membrane filtration	-0.4								
047	48	6.93	membrane filtration	0.5					35	5.92	membrane filtration	-0.2
049												
050												
051												
052												
053												
054												

z-scores outside $|z| > 2$ are shown in **bold**, see Section 5

* samples analysed outside of the required time frame

samples received outside of the required time frame

Table 6: Participants' Comments**Test Material A**

laboratory number	comments
006	Sample was received on 23/6/2021.
013	RECEIVED AT ROOM TEMPERATURE ON 25/06/2021
019	RM
022	Escherichia coli confirmed using TBX agar
038	Sample was received on 05.07.2021
040	Analysis as per ISO 9308-1 2014, Membrane filter with pore size 0.45um used, Medium used is Chromogenic Coliform Agar
043	la date de reception de l'échantillon est : le 23/06/2021 a température ambiante.
044	Accredited method SMEWW-APHA-AWWA-WEF Part 9221 F. Item 1, 23rd. Edition.2017. Multiple-Tube Fermentation Technique for Members of the Coliform Group. Escherichia coli Procedure Using Fluorogenic Substrate. Escherichia Coli Test (EC-MUG Medium). Muestra lleg ³ tardamente, se informo a FAPAS por e-mail. Se hiz ³ corrida en paralelo con m ³ todo filtraci ² n de membrana (Total Coliform = 26 ufc/100 ml, E. Coli= 16 ufc/100 ml)

comments are as submitted by participants but some may have been edited to maintain participant anonymity

Test Material B

laboratory number	comments
003	Samples received non cooled, but at room temperature.
040	Analysis done as per ISO 6222:1999 and the calculation done according to ISO 8199:2005
045	samples analyzed outside of the required time frame

comments are as submitted by participants but some may have been edited to maintain participant anonymity

Test Material C

laboratory number	comments
040	Enterococci- ISO -7899 Membrane filtration method Psedomonas aeruginosa- ISO 16266 Membrane filtration method Clostridium perfringens- 14189 Membrane filtration method Sulphite reducing clostridia- ISO 6461

comments are as submitted by participants but some may have been edited to maintain participant anonymity

Table 7: Assigned Values and Standard Deviations for Proficiency

Test Material A

organism	data points, <i>n</i>	assigned value, x_a SQRT cfu/100ml	uncertainty, <i>u</i>	standard deviation for proficiency, σ_p	
Total Coliforms	35	5.57	0.19	ffp	1.50
<i>Escherichia coli</i>	37	4.46	0.17	ffp	1.50

ffp = fitness-for-purpose criteria

Test Material B

organism	data points, <i>n</i>	assigned value, x_a SQRT cfu/ml	uncertainty, <i>u</i>	standard deviation for proficiency, σ_p	
Colony Counts (22°C/3 days)	18	9.62	0.12	ffp	1.25
Colony Counts (37°C/2 days)	22	10.4	0.3	ffp	1.25

ffp = fitness-for-purpose criteria

Test Material C

organism	data points, <i>n</i>	assigned value, x_a SQRT cfu/100ml	uncertainty, <i>u</i>	standard deviation for proficiency, σ_p	
Enterococci	21	5.87	0.17	ffp	1.25
<i>Pseudomonas aeruginosa</i>	22	7.43	0.27	ffp	1.50
<i>Clostridium perfringens</i>	12	6.20	0.28	ffp	1.50
<i>Clostridium</i> spp.	n/a	not set	n/a	n/a	n/a
Sulphite Reducing Clostridia (SRC)	6	6.20	0.22	ffp	1.50

ffp = fitness-for-purpose criteria

n/a – not applicable

Table 8: Number and Percentage of z-Scores where $|z| \leq 2$

Test Material A

organism	number of scores where $ z \leq 2$	total number of scores	% $ z \leq 2$
Total Coliforms	35	40	88
<i>Escherichia coli</i>	35	38	92

Test Material B

organism	number of scores where $ z \leq 2$	total number of scores	% $ z \leq 2$
Colony Counts (22°C/3 days)	18	21	86
Colony Counts (37°C/2 days)	21	25	84

Test Material C

organism	number of scores where $ z \leq 2$	total number of scores	% $ z \leq 2$
Enterococci	20	25	80
<i>Pseudomonas aeruginosa</i>	22	24	92
<i>Clostridium perfringens</i>	12	13	92
<i>Clostridium</i> spp.	n/a	n/a	n/a
Sulphite Reducing Clostridia (SRC)	6	7	86

n/a – not applicable

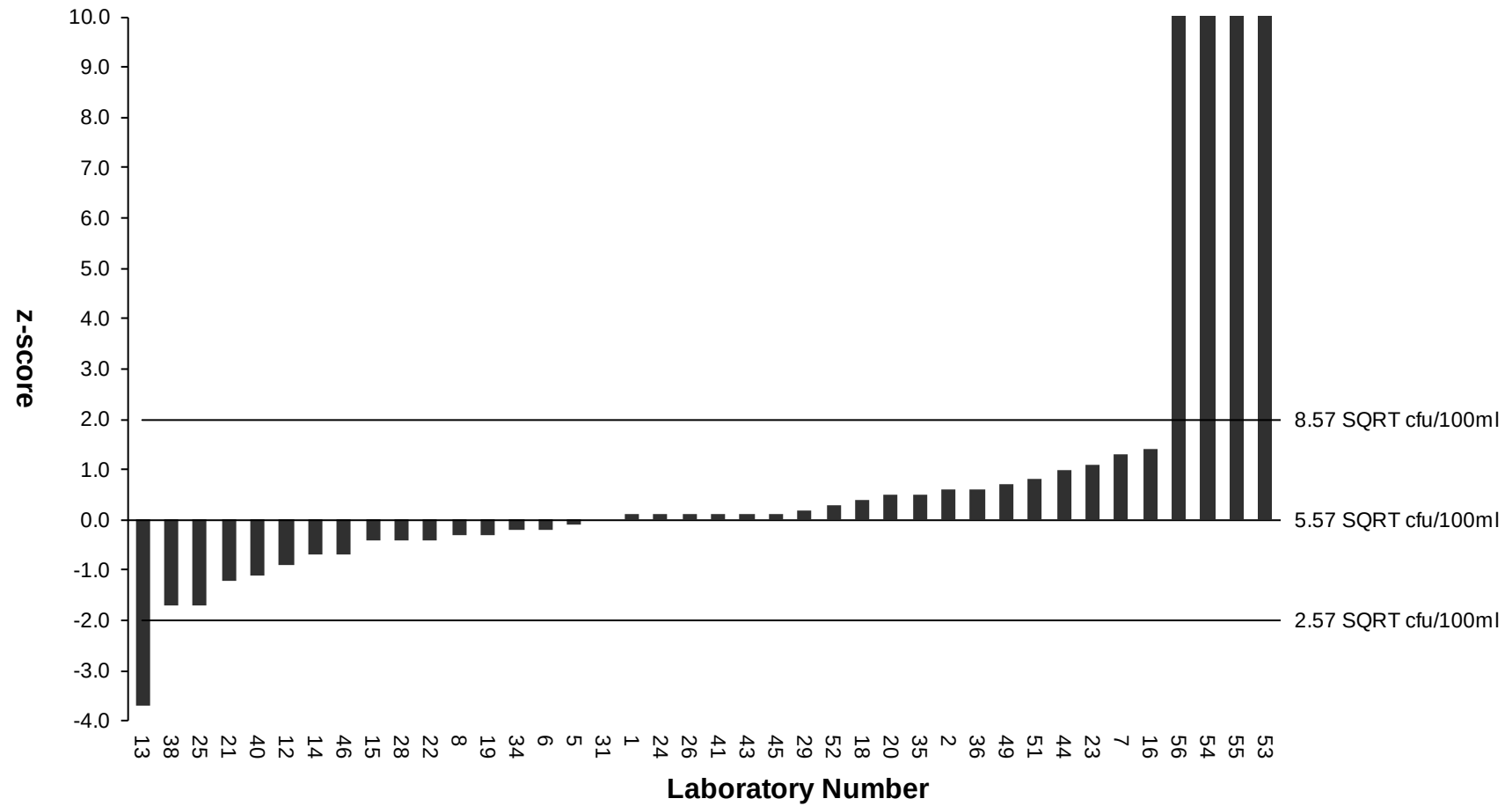


Figure 1: z-Scores for Enumeration of Total Coliforms

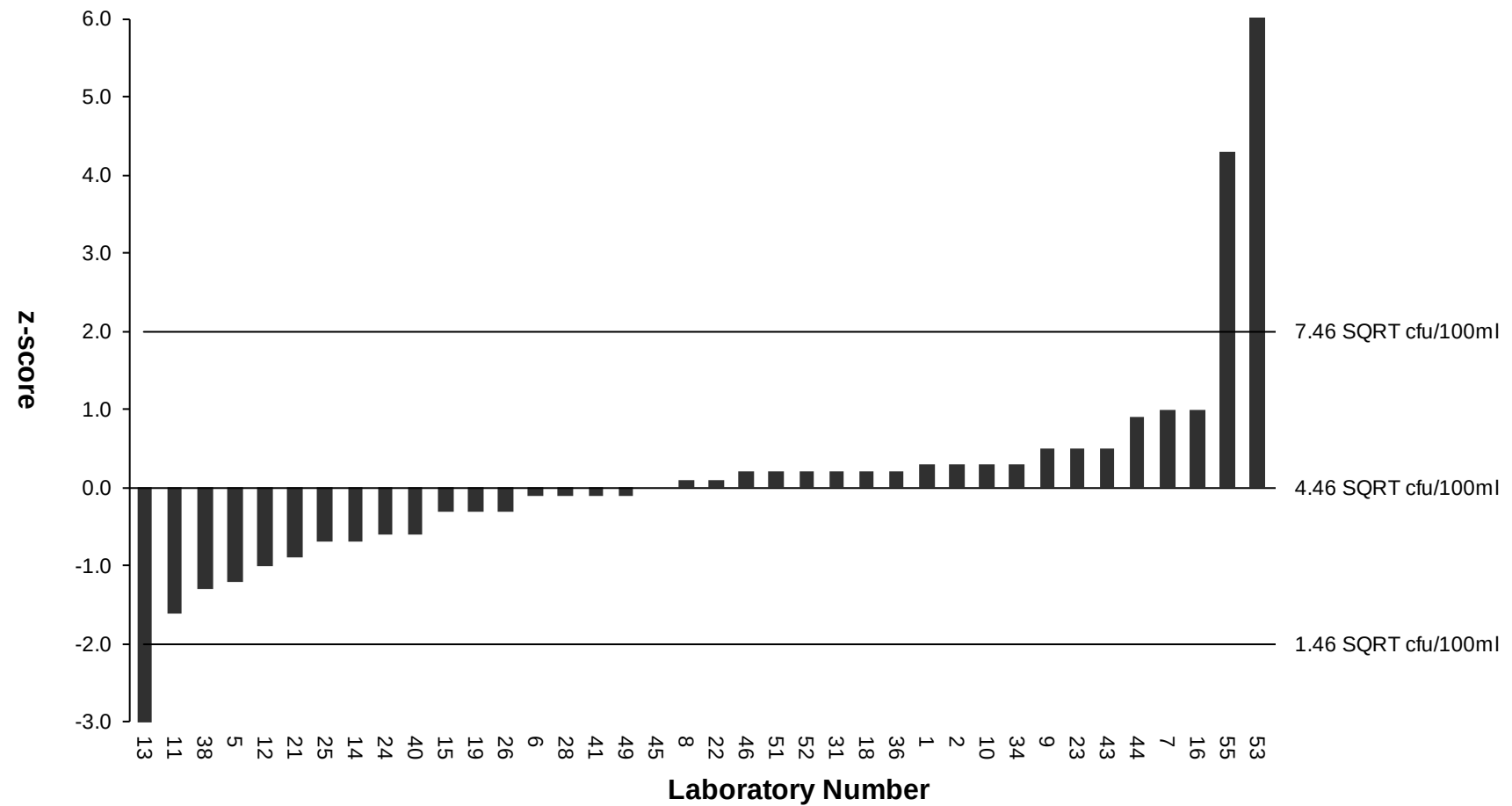


Figure 2: z-Scores for Enumeration of *Escherichia coli*

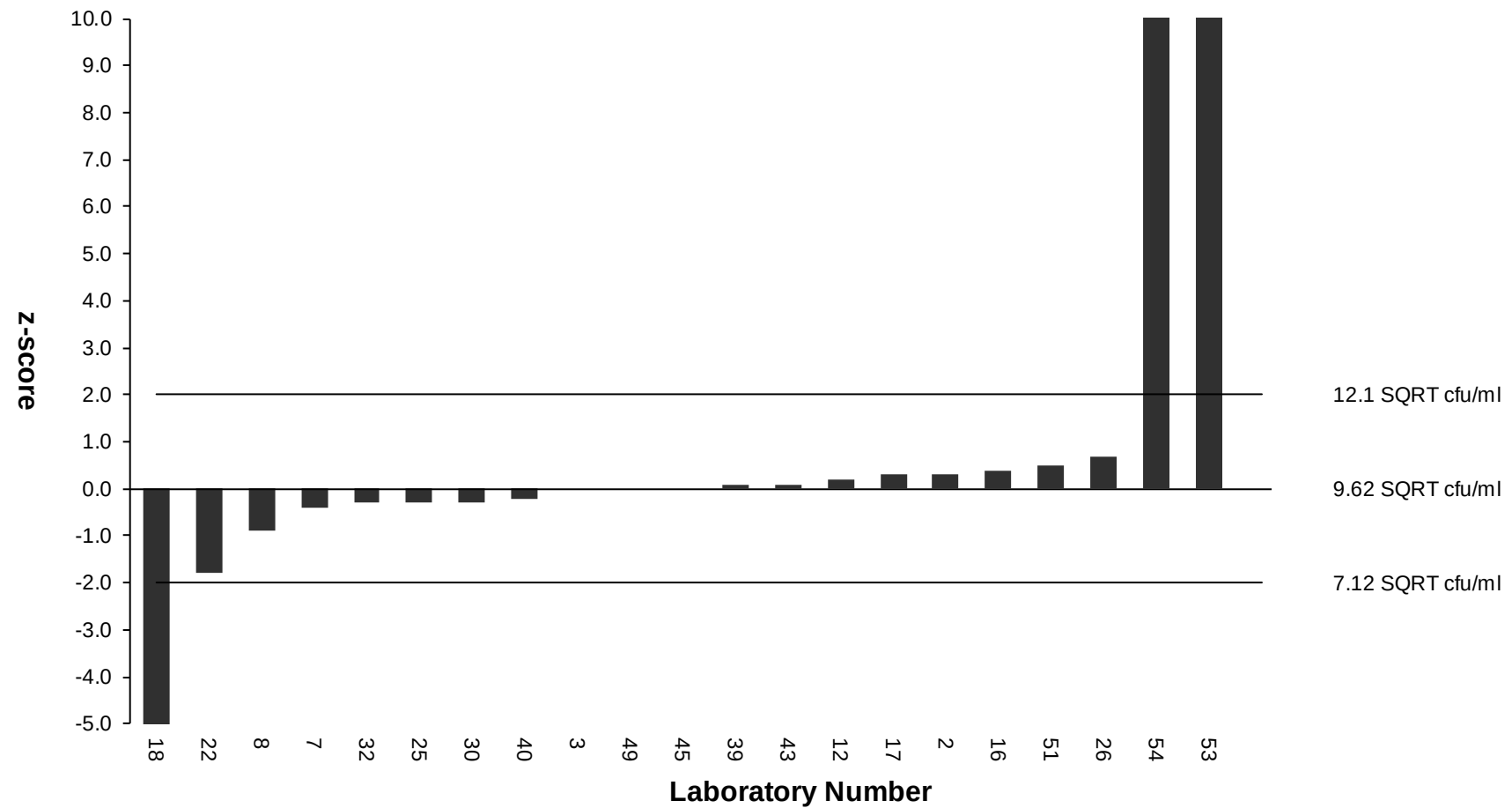


Figure 3: z-Scores for Colony Count after 3 days at 22°C

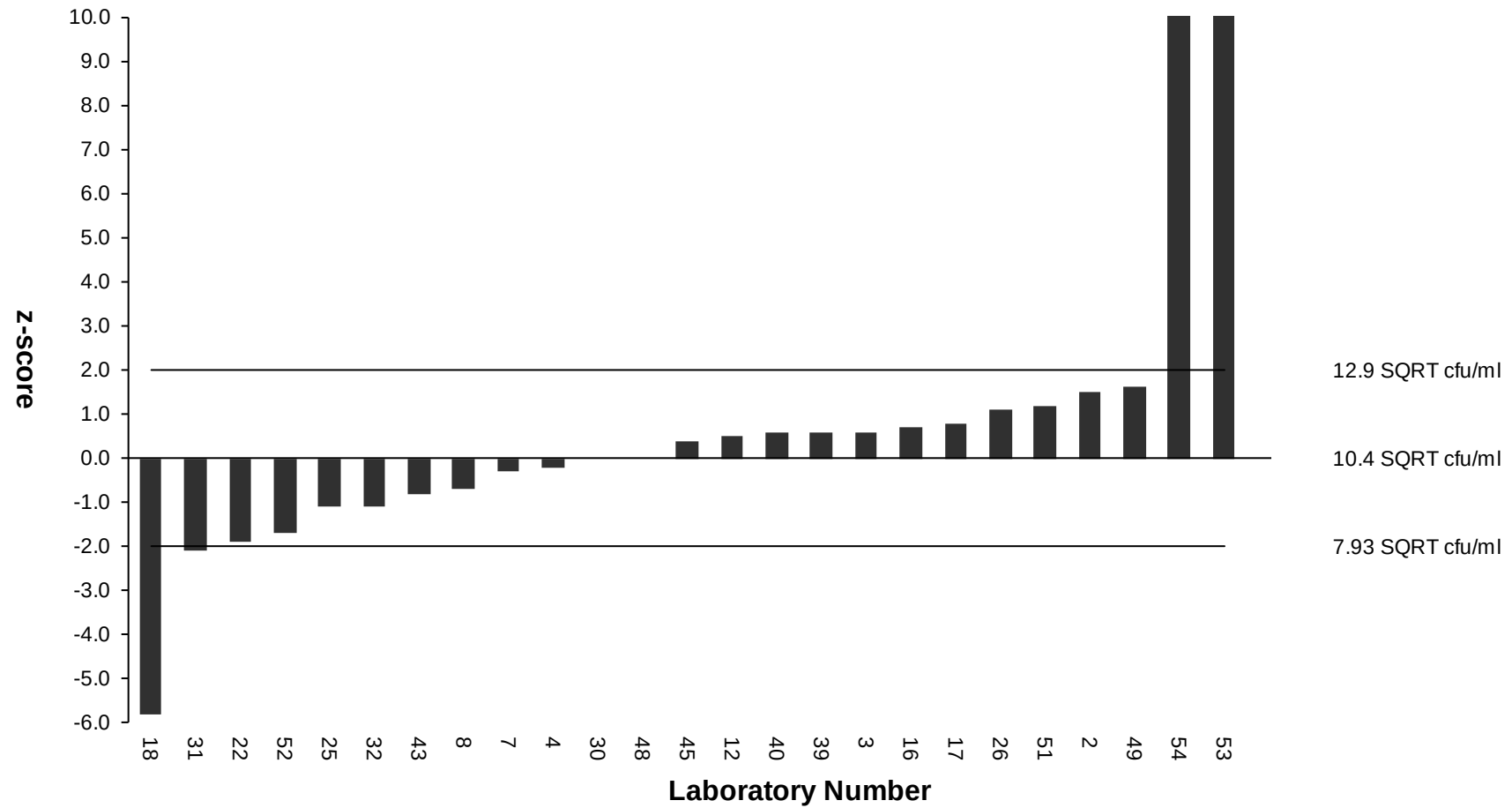


Figure 4: z-Scores for Colony Count after 2 days at 37°C

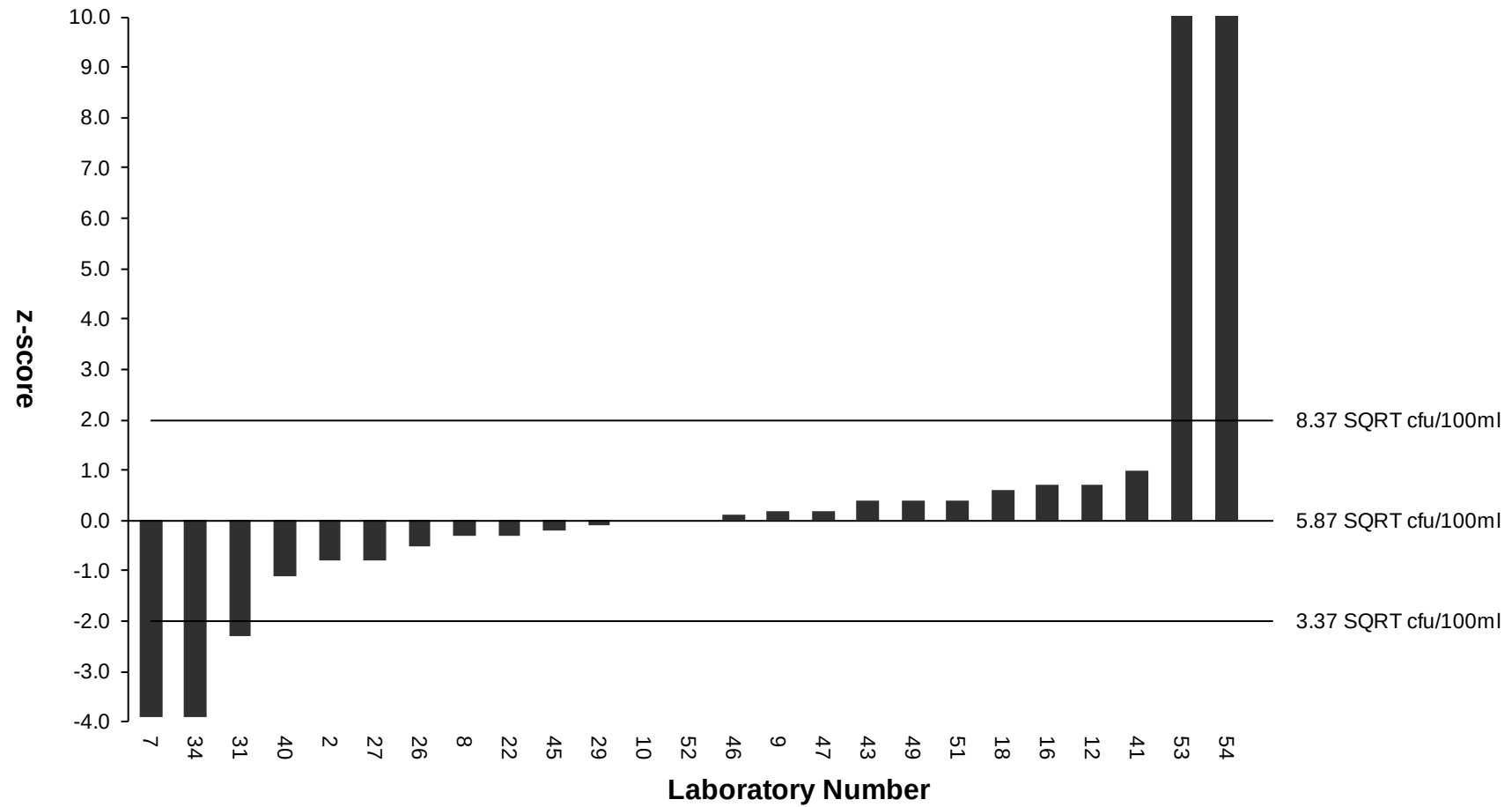


Figure 5: z-Scores for Enumeration of Enterococci

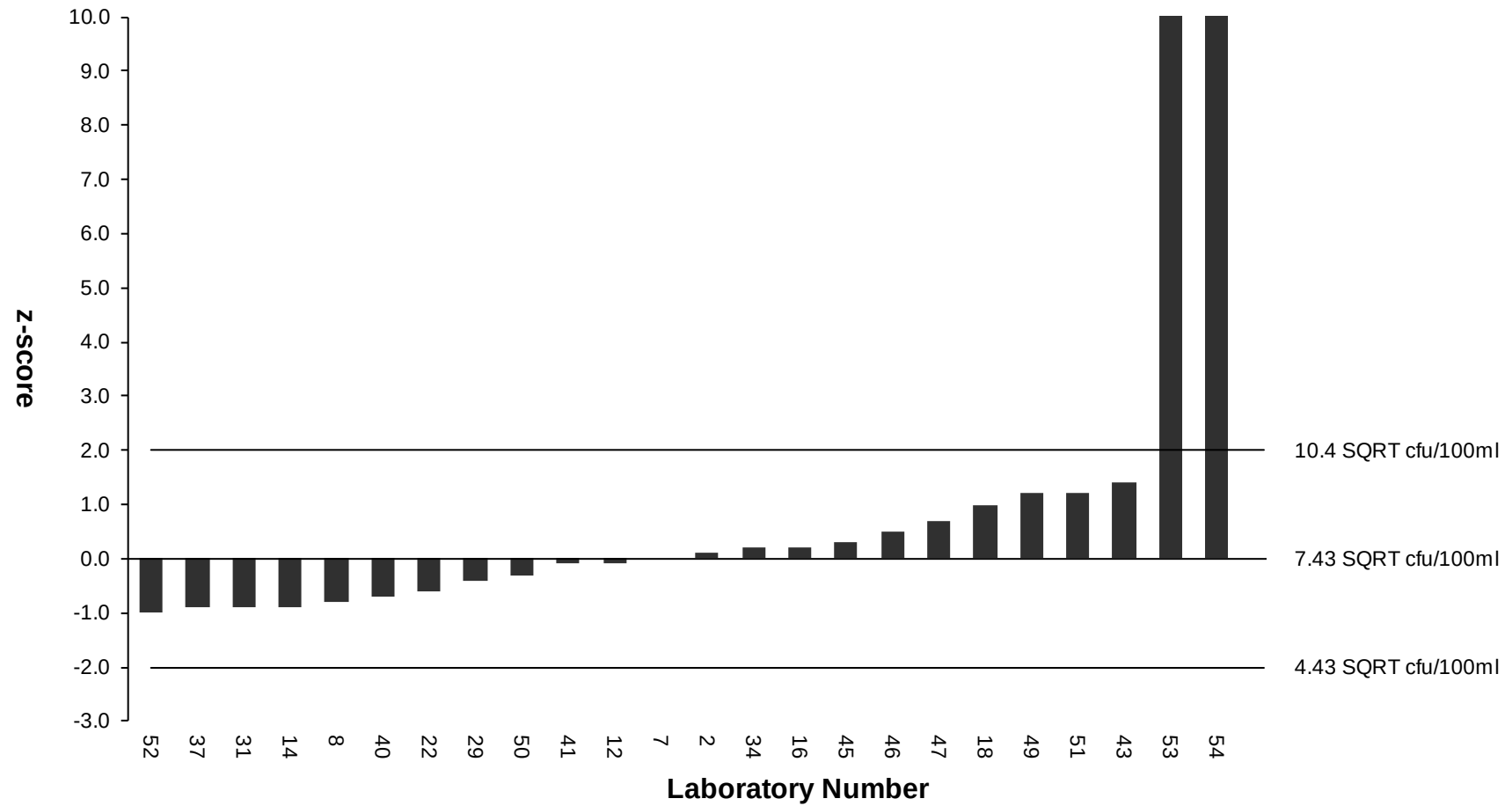


Figure 6: z-Scores for Enumeration of *Pseudomonas aeruginosa*

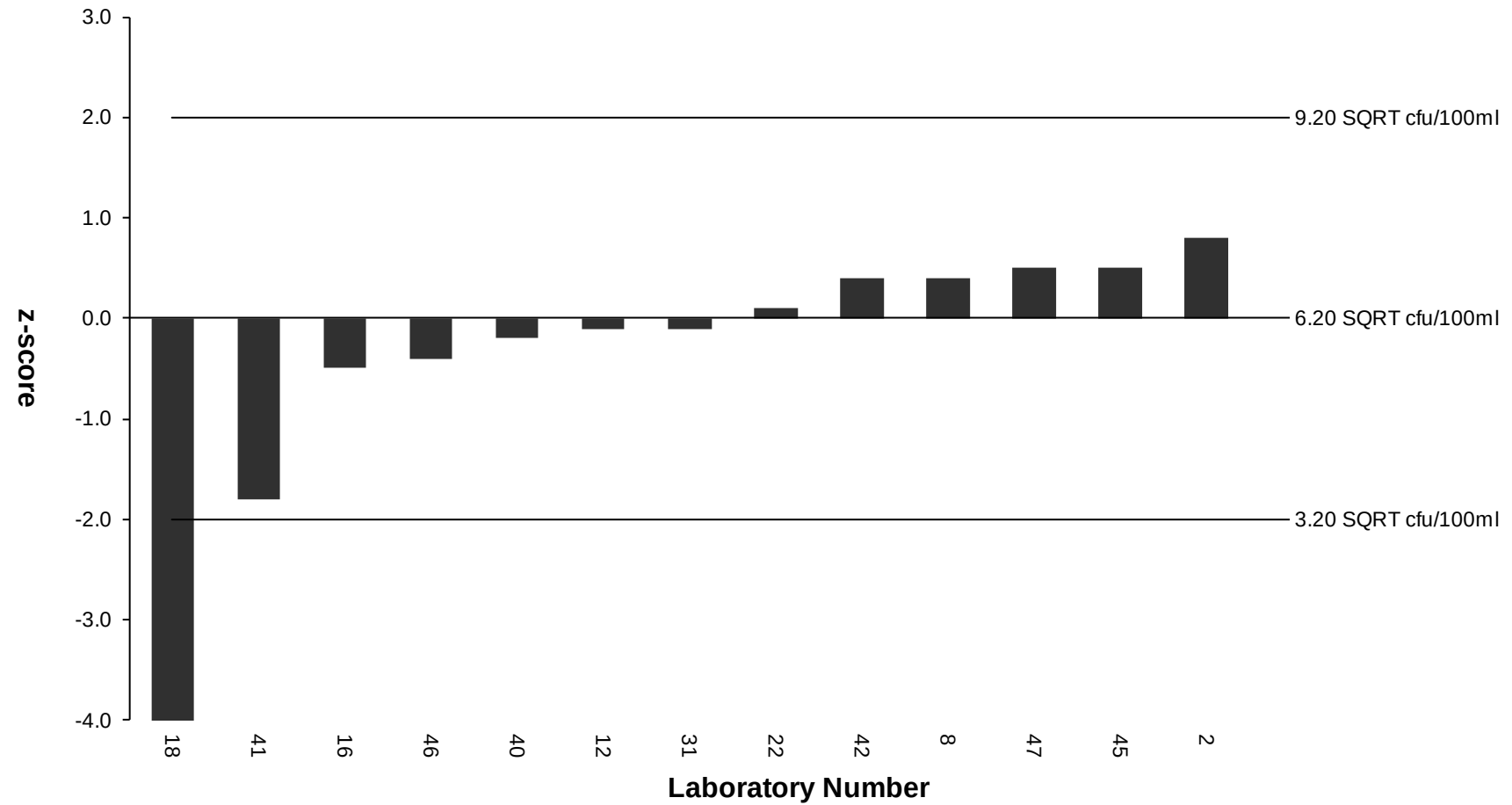


Figure 7: z-Scores for Enumeration of *Clostridium perfringens*

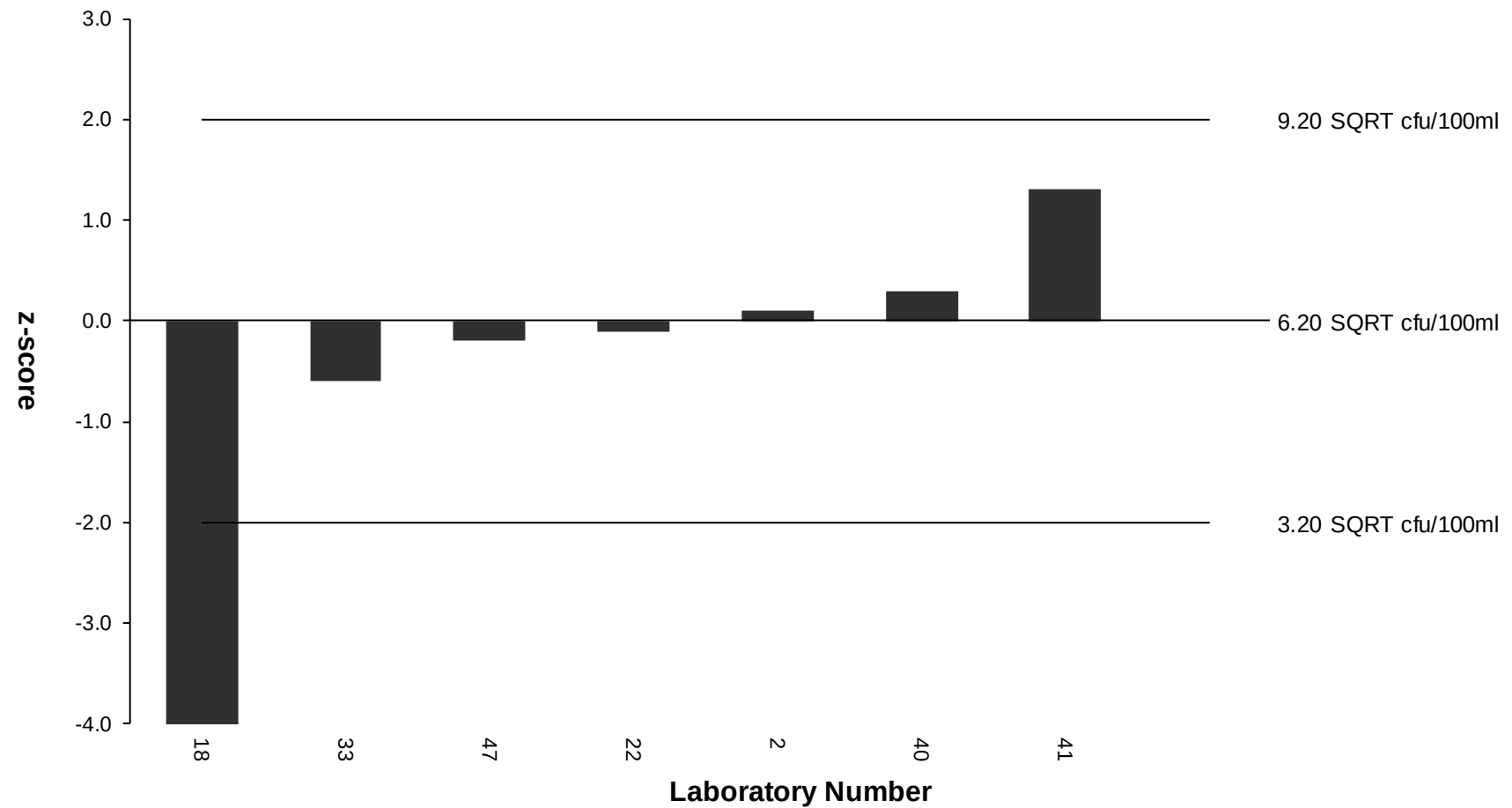


Figure 8: z-Scores for Enumeration of Sulphite Reducing Clostridia (SRC)

APPENDIX I: Analytical Methods Used by Participants

Methods are tabulated according to the information supplied by participants but some responses may have been combined or edited for clarity. In addition, responses not in English may have been omitted.

Total Coliforms

Accredited Method Used	laboratory number
no	005 008 015 038 043 044 045
yes	001 002 012 013 014 016 018 019 020 021 022 023 024 026 028 029 031 034 035 036 040 041 052 053 054 055 056
National or International Standard (ISO) Used	laboratory number
ISO 9308-1:2014 (membrane filtration)	005 008 013 015 016 018 019 020 022 040 053 054 055
ISO 9308-2:2012 (MPN - most probable number)	014 028 034 038 056
SCA MoDW (2009) - Part 4	002 024
apat cnr irsa 7010 c man 29 2004	023
APHA	036 052
IDEXX Colilert-10	001
NM ISO 9308-1/2019	043
SMEWW-APHA-AWWA-WEF Part 9221B, 23rd Edition, 2017. Multiple-Tube Fermentation Technique for Members of the Coliform Group. Standard Total Coliform Fermentation Technique) (NMP/ ml)	044
SR EN ISO 9308-1:2015/ A 1:2017	021
Standard method / 9222B - 2017	012
standard method for the examination of water and waste water 23RD,edition2017	031
UNI EN ISO 9308-1:2017	026

If the method is not an ISO Standard, state a reference for the method.	laboratory number
9223-A,B	031
American standard method	012
APHA 9222 B	052
APHA 9222 J	036
Goverment required	005
MOHWM0020.00, Amended, Dec 17, 2013	035
NA	040
Not applicable	038

Method	laboratory number
membrane filtration	002 005 008 012 013 015 016 018 019 020 021 023 024 026 035 036 040 041 043 045 052 053 054 055
Colilert-18	001 014 028 031 034 038
multiple tube (MPN - most probable number)	044 056

Media	laboratory number
Colilert-18	001 014 028 031 034 038 053
Membrane Lactose Glucoronide Agar (MLGA)	002 024
Chromogenic Coliform Agar (CCA)	008 013 015 016 018 019 021 022 026 036 040 041 043 045 053 055
Lauryl Tryptose Broth(LST)	056
m ENDO Agar	054
M.Endo & MFC medium	012
m-Endo agar	005
m-Endo agar LES	035
Using Fluorogenic Substrate. Escherichia Coli Test (EC-MUG Medium)	044

Incubation Time (hours) / Incubation Temperature (°C)	laboratory number
4/30 then 14/37	015 024 028
4/30 then 14/44	002
24/37	013
18/35	031
18/37	014
20h / 36 C	034
21/37	008 026
21-24/36-38	021
24 h Y 36TAC	043
24 hours 37 degree celsius	040
24/35	020 035 036 052 053 054 055 056
24/35 (TC) & 24/44 (Ec)	012
24/35TAC	005
24/36	019 045
36 oC for 18 to 22 hrs	038
37h/21-24h	041
TC 37 for 24hr, EC 44 for 24h	022

Confirmation of the identity	laboratory number
no	001 005 012 013 014 015 028 034 036 038
yes	002 008 016 018 019 020 021 022 023 024 026 031 035 040 041 043 045 052 053 054 055 056

Number of colonies used for confirmation	laboratory number
1	031
10	002 016 018 019 024 026 043 045 053 054 056
112	020
4	008 021
5	022 023 052
Ecoli-13 (Purple to dark blue) Coliforms -2 (Pink colonies) Total coliforms-15	040
Not applicable	038

Confirmation Tests	laboratory number
Oxidase	002 008 016 018 019 021 024 026 040 041 043 045 052
Indole	002 024 052
beta-Galactosidase	024 054 056
Lactose fermentation	002 020 021 024 052 054 056
API	024 053 055
Not applicable	038
Vitek 2	031

Confirmation (Selective Media)	laboratory number
Brilliant Green Bile Broth (BGBB)	020 021 052 053 055 056
Lactose Peptone Water	002 024
BGLB(Brilliant Green Lactose Bile Broth), Lauryl Tryptose Broth(LST)	054
colilert18	031
Oxidase Test	040
TSA	016 026

Escherichia coli

Accredited Method Used	laboratory number
no	005 008 015 038 043 045
yes	002 009 010 011 012 013 014 016 018 019 021 023 024 028 031 034 036 040 041 044 052 053 055

National or International Standard (ISO) Used	laboratory number
ISO 9308-1:2014 (membrane filtration)	005 008 013 015 016 018 019 040 053 055
ISO 9308-2:2012 (MPN - most probable number)	014 028 034 038
SCA MoDW (2009) - Part 4	002 009 010 024
apat cnr irsa 7030 f man 29 2003	023
APHA 9222D FOR E.COLI	052
NM ISO 9308-1/2019	043
SMEWW-APHA-AWWA-WEF Part 9221 F. Item 1, 044 23rd. Edition.2017.Multiple-Tube Fermentation Technique for Members of the Coliform Group. Escherichia coli Procedure Using Fluorogenic Substrate. Escherichia Coli Test (EC-MUG Medium). NMP/100 ml	
SR EN ISO 9308-1:2015/ A 1:2017	021
Standard method 9222F&G/2017	012
If the method is not an ISO Standard, state a reference for the method.	laboratory number
9223-A,B	031
American standard method	012
APHA	052
APHA 9222 J	036
Goverment required	005
NA	040
Not applicable	038
US EPA 1603	011
Method	laboratory number
membrane filtration	002 005 008 009 010 011 012 013 015 016 018 019 021 024 036 040 041 043 045 052 053 055
Colilert-18	014 028 031 034 038
multiple tube (MPN - most probable number)	044

Media	laboratory number
Colilert-18	014 028 031 034 038 053
Membrane Lactose Glucoronide Agar (MLGA)	002 009 010 024
Chromogenic Coliform Agar (CCA)	008 015 016 018 019 021 036 040 041 043 045 053 055
m. Endo Ager LES for Total Coliform and m-Fc Agar for E.coli	052
M.Endo & MFC medium	012
modified mTEC Agar	011
Using Fluorogenic Substrate. Escherichia Coli Test (EC-MUG Medium)	044

Incubation Time (hours) / Incubation Temperature (°C)	laboratory number
4/30 then 14/37	015 024 028
4/30 then 14/44	002 009 010
18/35	031
18/37	014
2/35 then 22/44.5	011
20h / 36 C	034
21/37	008
21-24/36-38	021
24 h Y 36TAC	043
24 hours 37 C	016
24 hours, 37 degree celsius	040
24/35	036 053 055
24/35 (TC) & 24/44 (Ec)	012
24/36	019 045
24/44.5 for E. Coli	052

Confirmation of the identity	laboratory number
no	005 008 009 010 014 015 018 021 024 034 036 038 043
yes	002 011 012 016 019 028 031 040 041 045 052 053 055

Number of colonies used for confirmation	laboratory number
1	031
10	002 016 019
13	040
2	011
4	012
4 colonies for E. coli	052
5	045
Not applicable	038

Confirmation Tests	laboratory number
Oxidase	002 040 041
Indole	002 012 019
Lactose fermentation	002
API	011 045 053 055
Indole Test For E-coli	052
none	016

Confirmation (Selective Media)	laboratory number
Brilliant Green Bile Broth (BGBB)	053
TBX	022
colilert18	031
used selective media EMB agar for E-coli	052
Tryptone Water	002 012

Colony Counts (22°C/3 days)

Accredited Method Used	laboratory number
no	008 040 045
yes	002 003 012 016 017 018 022 026 030 032 039 049 051 053 054

National or International Standard (ISO) Used	laboratory number
ISO 8199:2005	053 054
ISO 6222:1999	008 016 017 018 022 026 039 040
SCA MoDW (2012) - Part 7	002 049 051
Korean Food Code	030
Standard method 9215B/2017	012
The Microbiology of Drinking Water(ES 05701.1d,2021,South Korea)-Total Colony Counts-Pour Plate Method	032
TrinkwV 판15, 1c 01.2001	003
If the method is not an ISO Standard, state a reference for the method.	laboratory number
American standard method	012
Method is based on DIN EN ISO 6222:1999, but uses different lower temperature and shorter incubation (48h/20℃)	003
NA	040
Method	laboratory number
Spread plate	045 053
Pour plate	002 003 008 012 016 017 018 022 026 030 032 040 049 051 054
Media	laboratory number
Plate Count Agar (PCA)	012 022 030 053
Yeast Extract Agar (YEA)	002 008 016 017 018 039 040 049 051
R2A Agar	032
DEV Agar	003
m-HPC agar	054
TRYPTICASE SOY AGAR (TSA)	045
water PCA	026

Colony Counts (37°C/2 days)

Accredited Method Used	laboratory number
no	008 031 040 045
yes	002 003 012 016 017 018 022 030 032 039 048 052 053 054

National or International Standard (ISO) Used	laboratory number
ISO 8199:2005	053 054
ISO 6222:1999	016 017 018 022 039 040
SCA MoDW (2012) - Part 7	002
APHA 9215 B	052
CHINA	048
Korean Food Code	030
Standard method 9215B/2017	012
The Microbiology of Drinking Water(ES 05701.1d,2021,South Korea)-Total Colony Counts-Pour Plate Method	032
TrinkwV 표준 15, 1c 01.2001	003

If the method is not an ISO Standard, state a reference for the method.	laboratory number
9230A,B	031
American standard method	012
GB/T 5750.12-2006	048
Method is based on DIN EN ISO 6222:1999, but uses different lower temperature and shorter incubation (48h/20°C)	003
NA	040

Method	laboratory number
Spread plate	031 045 053
Pour plate	002 003 008 012 016 017 018 022 030 032 040 048 054
MEMF/pour plate	052

Media	laboratory number
Plate Count Agar (PCA)	012 022 030 031 032 052 053
Yeast Extract Agar (YEA)	002 008 016 017 018 039 040
DEV Agar	003
m-HPC agar	054
Nutrient Agar	048
TRYPTICASE SOY AGAR (TSA)	045

Enterococci

Accredited Method Used	laboratory number
no	008 031 040 043 045
yes	002 009 010 012 016 018 022 026 029 034 041 046 047 051 052 053 054

National or International Standard (ISO) Used	laboratory number
ISO 8199:2005	053 054
ISO 7899-2:2000	012 016 018 026 040 047
SCA MoDW (2012) - Part 5	002 009 010 051
AFNOR IDX 33/03-10/13	034
APHA 9230 C	052
NM ISO7899-2/2007	043
PN-EN ISO 7899-2:2004	008
Standard Methods for the examination of water and wastewater 23rd ed2017	031

If the method is not an ISO Standard, state a reference for the method.	laboratory number
9230	031
AFNOR IDX 33/03-10/13	034
APHA 9230 C	052
NA	040

Method	laboratory number
membrane filtration	002 008 009 010 012 016 018 022 026 040 041 043 045 047 051 052 053 054
multiple tube (MPN - most probable number)	031 034

Media	laboratory number
KF Streptococcus Agar	022 053 054
Slanetz and Bartley Agar	002 008 009 010 012 016 018 026 040 043 045 047 051 052
Azide dextrose	031
Enterolert-DW	034

Incubation Time (hours) / Incubation Temperature (°C)	laboratory number
24/41	034
44/37	008 009 010 026 040 047 051
48/37	002 012 016 022 041
24/35	052
44/36	045
48/35	031 053 054
48h ã 36Â°C	043

Confirmation of the identity	laboratory number
no	012 034
yes	002 008 009 010 016 018 022 026 031 040 041 043 045 047 051 052 053 054

Number of colonies used for confirmation	laboratory number
10	002 051 053 054
100%	031
20	040
38	047
40 et 4	043
5	022 045 052
all	008 016
All colonies	009
All colonies	010

Confirmation Tests	laboratory number
Aesculin hydrolysis by sub-culture	051 053 054
Aesculin hydrolysis by membrane transfer	008 009 010 016 018 026 040 043 047
Catalase reaction	002 022 053 054
Bile tolerance	002 053 054
Salt tolerance	052
Bile Aesculin Azide	041
Bile Esculin Agar	045
Bile esculin Azide agar,Brain heart infusion broth	031

Pseudomonas aeruginosa

Accredited Method Used	laboratory number
no	008 018 040 043 045 052
yes	002 012 014 016 022 029 031 034 037 041 047 050 053 054

National or International Standard (ISO) Used	laboratory number
ISO 16266:2006	012 016 018 034 037 040 047
ISO 8199:2005	053 054
SCA MoDW (2010) - Part 8	002
APHA 9213 E	052
Bacterial Enzyme Detection Technology "Pseudalert ÄfÄ,Ä,Ä® " From IDEXX	031
ISO16266-2:2018	014
NM ISO16266	043
PN-EN ISO 16266:2009	008
Standard Method for Examination of Water and Wastewater 23rd edition chapter 9	050

If the method is not an ISO Standard, state a reference for the method.	laboratory number
APHA 9213E	052
NA	040
Standard Method for Examination of Water and Wastewater 23rd edition chapter 9	050

Method	laboratory number
membrane filtration	002 008 012 016 018 022 034 037 040 041 043 045 047 052 053 054
multiple tube (MPN - most probable number)	050
Pseudalert	014 031

Media	laboratory number
Pseudomonas Agar with CFC supplement	043
Pseudomonas Agar with CN supplement	002 008 012 016 018 022 034 040 041 047 053 054
Asparagine broth	050
Cetrimide	052
Cetrimide agar	045

Incubation Time (hours) / Incubation Temperature (°C)	laboratory number
48/37	002 008 012 016 018 022 034 040 041 043 047
24/38	014 031
24/42	053 054
44/36	045
48/35	052
48h/35C	050

Confirmation of the identity	laboratory number
no	008 012 014 016 018 034
yes	002 022 031 040 041 043 045 047 050 052 053 054

Number of colonies used for confirmation	laboratory number
10	002 043 047 054
100%	031
5	022 040 045 052

Confirmation Test	laboratory number
Oxidase	002 016 043 045 047 050 052 054
Casein hydrolysis	053 054
Acetamide, King's B	047
API 20 E	022
Oxidase, Kings B medium, Acetamide broth	040
VITEK 2	031

Clostridium perfringens

Accredited Method Used	laboratory number
no	002 008 016 018 031 040 045 047
yes	012 041 042

National or International Standard (ISO) Used	laboratory number
ISO 14189:2013 (membrane filtration)	012 018 040 042 047
SCA MoDW (2010) - Part 6	002
PN-EN ISO 14189:2016-10	008
If the method is not an ISO Standard, state a reference for the method.	laboratory number
membrane filtration	031
NA	040
TS 8020 EN 26461-2	016
Method	laboratory number
anaerobic jar	002
membrane filtration	008 012 016 018 031 040 041 042 047
membrane filtration + anaerobic jar	045
Media	laboratory number
Sulfite Polymixin Sulphadiazine Agar (SPS)	045
Tryptose Sulphite Cycloserine Agar (TSC) with egg	012 040 041
Tryptose Sulphite Cycloserine Agar (TSC) without egg	018 042 047
Tryptose Cycloserine Agar	008
perfringens Agar base	031
Sulfite iron agar	016
Incubation Time (hours) / Incubation Temperature (°C)	laboratory number
21/44	002 008 012 040 042 047
24/35	031
24/36	045
48/37	016

Confirmation of the identity	laboratory number
no	012 018
yes	002 008 016 031 040 041 042 045 047

Number of colonies used for confirmation	laboratory number
10	002 008 047
100%	031
2	045
5	040 042
all	016

Confirmation of the identity of the colonies grown	laboratory number
Lactose fermentation	002
API 20A	045
acid phosphatase reaction	008 041 042 047
Acid phosphatase reaction and Blood agar	040
discoloration by ammonium hydroxide vapor	016
Vitek 2 system	031

Method (acid phos.)	laboratory number
by dropping reagent on the colonies	042
by smearing colony on pre-soaked filter paper	008 040 041 047

***Clostridium* spp.**

Accredited Method Used	laboratory number
no	018 040
yes	041

National or International Standard (ISO) Used	laboratory number
ISO 6461-2:1986 (membrane filtration)	040
ISO 14189:2013 (membrane filtration)	018

Method	laboratory number
membrane filtration	018 040 041

Media	laboratory number
Sulfite Polymixin Sulphadiazine Agar (SPS)	018
Tryptose Sulphite Cycloserine Agar (TSC) with egg	041
Tryptose Sulphite Cycloserine Agar (TSC) without egg	040

Incubation Time (hours)	laboratory number
24	040 041
48	018

Incubation Temperature (°C)	laboratory number
37	018 040
44	041

Sulphite Reducing Clostridia (SRC)

Accredited Method Used	laboratory number
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no	002 040 047
yes	018 033 041

National or International Standard (ISO) Used	laboratory number
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ISO 6461-2:1986 (membrane filtration)	040
ISO 14189:2013 (membrane filtration)	018
SCA Microbiology of Recreational & Environmental Waters (2015) part 6	002 047
ISO 26461-2	033

Method	laboratory number
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anaerobic jar	033
membrane filtration	002 018 040 041 047

Media	laboratory number
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Sulfite Polymixin Sulphadiazine Agar (SPS)	018
Tryptose Sulphite Cycloserine Agar (TSC) with egg	033 047
Tryptose Sulphite Cycloserine Agar (TSC) without egg	002 040
Sulfite Iron Tryptose Sulfite (TS)	041

Incubation Time (hours)	laboratory number
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24	002 040 047
48	018 033 041

Incubation Temperature (°C)	laboratory number
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37	002 018 033 040 041 047
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APPENDIX II: Fapas® SecureWeb, Protocol and Contact Details

1. Fapas® SECUREWEB

Access to the secure area of our website is only available to participants in our proficiency tests. Please contact us if you require a UserID and Password. Fapas® SecureWeb allows participants to:

- Obtain their laboratory numbers for the proficiency tests in which they have participated.
- View the results they submitted in past and current proficiency tests.
- Submit their results and methods for current tests.
- Review future tests they have ordered.
- Order proficiency tests, reference materials and quality control materials.
- Freely download copies of reports (PDF file), of proficiency tests in which they have participated.
- View charts of their z-scores obtained in previous Fapas® – Water Microbiology proficiency tests.

2. PROTOCOL

The Protocols [4, 5] set out how Fapas® – Water & Environmental is organised. Copies can be downloaded from our website.

3. CONTACT DETAILS

This report was prepared and authorised on behalf of Fapas® by Stilian Hristov (Round Coordinator). Participants with any comments or concerns about this proficiency test should contact:

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