

# **EAST AFRICAN COMMUNITY**

## **PROFICIENCY TESTING**

### **SCHEME**



Physikalisch-Technische Bundesanstalt  
Braunschweig und Berlin

**EAC Proficiency Testing Scheme**  
**Chemical composition of drinking water**  
**August - December 2006**

**1<sup>st</sup> Round EAC PT Report**  
**December 2006**

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## Preface

### **East African Community Proficiency Testing Scheme Proficiency Testing for Water Testing Laboratories 1<sup>st</sup> Round EAC WATER PT REPORT DECEMBER 2006**

This report and the appendices hereto, contain information that is pertaining to the EAC Water PT Round 1. The information contained herein shall only be used by the participants of this study for the purpose of the inter-laboratory performance evaluation. Any publication, copying or distribution of these reports or its appendices is strictly prohibited

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# Acronyms

AR.....	analytical reagent
EAC.....	East African Community
ISO.....	International Organisation for Standardisation
KEBS.....	Kenya Bureau of Standards
MAD.....	median absolute difference
PT.....	proficiency testing
PTB.....	Physikalisch Technische Bundesanstalt
RSD.....	relative standard deviation
SQMT.....	standardisation, quality assurance, metrology and testing
TBS.....	Tanzania Bureau of Standards
UNBS.....	Uganda National Bureau of Standards

## CONTENTS

## PAGE

Preface.....	i
Acronyms.....	ii
1. Introduction.....	1
2. Sample preparation.....	1
3. Homogeneity and stability studies.....	2
4. Analysis instructions.....	2
5. Sample dispatch.....	3
6. Return date for the results.....	3
7. Result evaluation and performance assessment.....	3
8. Dissemination of report.....	5
9. Acknowledgements.....	5
10. Comments.....	6
References.....	6
Appendix.....	7
<i>Appendix 1 Tables and figures of participants results.....</i>	<i>7</i>

## Tables

Table 1:	Constitution of sample 2006.08/1.....	1
Table 2:	Constitution of sample 2006.08/2 .....	2
Table 3	Medians and reproducibility standard deviations and upper limits for the Relative Standard Deviation for PT assessment .....	4
Table 4:	Summary of laboratories' performance on Calcium content determination.....	7
Table 5:	Summary of laboratories' performance on Magnesium content determination.....	8
Table 6:	Summary of laboratories' performance on Potassium content determination.....	9
Table 7:	Summary of laboratories' performance on Sodium content determination .....	10
Table 8:	Summary of laboratories' performance on Total Hardness determination .....	11
Table 9:	Summary of laboratories' performance on Chloride content determination.....	12
Table 10:	Summary of laboratories' performance on Sulphate content determination .....	13
Table 11:	Summary of laboratories' performance on pH content determination .....	14
Table 12:	Summary of laboratories' performance on Electrical conductivity determination.....	15

## Figures

Figure 1:	Laboratories' performance and Z-scores for calcium content determination.....	7
Figure 2:	Laboratories' performance and Z-scores for Magnesium content determination.....	8
Figure 3:	Laboratories' performance and Z-scores for Potassium content determination.....	9
Figure 4:	Laboratories' performance and Z-scores for Sodium content determination .....	10
Figure 5:	Laboratories' performance and Z-scores for Total hardness determination .....	11
Figure 6:	Laboratories' performance and Z-scores for Chloride content determination .....	12
Figure 7:	Laboratories' performance and Z-scores for Sulphate content determination .....	13
Figure 8:	Laboratories' performance and Z-scores for pH determination .....	14
Figure 9:	Laboratories' performance and Z-scores for Electrical Conductivity determination.....	15

## 1. Introduction

The primary aim of the EAC Proficiency Testing (PT) Scheme, to which this very PT round belongs, is to provide a quality assurance tool to laboratories in the region and to compare performance and take remedial action where necessary to facilitate improvement. Participation in this PT should therefore lead to a higher standard of performance for these types of measurements. This scheme focuses among other things on improving laboratory-testing capabilities with an aim of producing accurate and reliable results that can be respected and trusted within and beyond the borders of EAC region.

This first PT round, held in September 2006 involved East African laboratories, engaged in water analyses, to analyse two water samples; one for sulphate, chloride, electrical conductivity, pH; and the other one for total hardness, calcium, potassium, sodium, and magnesium. The results of this evaluation in which twenty (20) laboratories participated, form the basis of this report and are summarized in this report.

## 2. Sample preparation

The August-September 2006 EAC PT Round 1 consisted of the analysis of two water samples, one sample (2006.08/1) containing the cations Calcium, Magnesium, Sodium, Potassium; while the second one (2006.08/2) contained the anions chloride and sulphate. The sample matrix used was pure water at room temperature (26 °C).

Sample 2006.08/1 (Cation sample) was constituted as indicated in the Table 1 below, with acid preservation:

**Table 1: Constitution of sample 2006.08/1**

Determinand	Chemical	Cation sample (2006.08/1) constituted to 25 litres
Calcium	CaCl <sub>2</sub> .2H <sub>2</sub> O	4.4521g
Magnesium	MaCl <sub>2</sub> .6H <sub>2</sub> O	4.3278g
Sodium	NaCl	1.6511g
Potassium	KCl	0.3659g
Total hardness	CaCl <sub>2</sub> .2H <sub>2</sub> O	
	MaCl <sub>2</sub> .6H <sub>2</sub> O	

Sample 2006.08/2 (anion sample) was constituted as indicated in the Table 2 below, without acid preservation:

**Table 2: Constitution of sample 2006.08/2**

<b>Determinand</b>	<b>Chemical</b>	<b>Anion sample (2006.08/2) constituted to 25 litres</b>
Chloride	KCl	2.2495g
Sulphate	K <sub>2</sub> SO <sub>4</sub>	1.2809g
pH	-	-
Conductivity	-	-

Analytical Grade (AR) chemicals, supplied by *BDH* were used. The chemicals for the cation sample were added in their respective quantities as indicated in the tables above, to a container containing 25 litres of distilled water matrix and homogenized adequately. A quantity of 37.5 mls of Concentrated Nitric acid (AR) was added the mixture and homogenized adequately. The same was done to the chemicals for the anion sample. After proper mixing to ensure homogeneity, approximately 500 ml aliquots of each sample were transferred to properly washed and twice rinsed with distilled water 500 ml polyethylene bottles, and the bottles tightly capped with screw caps, and appropriately labelled (2006.08/1 and 2006.08/2 for cation sample and anion sample respectively). The samples were kept at room temperature after preparation.

### **3. Homogeneity and stability studies**

A set of two batches, one batch consisting ten randomly selected cation samples were analysed in duplicate for the parameters to be tested which included Calcium, Magnesium, Sodium, Potassium, Total hardness; the second batch consisting ten randomly selected anion samples, were analysed in duplicate for parameters Chloride, Sulphate, pH, Conductivity. The second set each of consisting of fifteen randomly selected samples were analysed for similar parameters as in the first set. The results together with their statistical evaluation showed that the samples were sufficiently homogenous and sufficiently stable in respect to the parameters of test. The statistical evaluation was carried out using procedures in Annex B of *ISO 13258 (2005) Statistical methods for use in proficiency testing by interlaboratory comparisons*

### **4. Analysis instructions**

Analysis instructions were included in the dispatch together with a hard copy of the results template to each of the participating laboratory. The participating laboratories were requested to analyse the samples for the following determinands:

Sample 2006.08/1 (*Cation sample*)

Calcium, Magnesium, Sodium, Potassium, Total hardness

Sample 2006.08/2 (Anion sample)  
Chloride, Sulphate, pH, Conductivity

Participants were allowed to use any method of their choice for the analysis but were requested to indicate on the results template sheet the details of the analytical methods and equipment used in the analysis. Duplicate test analysis per sample as supplied was requested.

A period of approximately one month was allowed for the analysis of the samples and submission of the results on the results template sheet provided. Laboratory code numbers were subsequently allocated to the laboratories as their results were received by the PT provider. Each laboratory code is confidential and will only be known to the PT provider and the respective laboratory.

## 5. Sample dispatch

Thirty (30) sets (each consisting 500 ml anion sample and 500 ml cation sample) of samples were dispatched using courier services, on the 22<sup>nd</sup> August 2006. The samples for participants in Kenya were dispatched to Kenya Bureau of Standards (KEBS) and those for participants in Tanzania were dispatched to Tanzania Bureau of Standards (TBS), for onward delivery to the participants. Sent together with each set of samples was a results template sheet.

## 6. Return date for the results

The receipt date for results was set at 22<sup>nd</sup> September 2006 latest. Results of analysis were received from twenty (20) laboratories. Ten (10) laboratories did not submit results, and no reason was given despite the PT provider's reminders to all the sample recipients.

## 7. Result evaluation and performance assessment

Evaluation and assessment performance was based on ISO 13528: 2005 and robust versions for the determination of the consensus means  $\bar{X}$  and the standard deviations  $S_R$ .

The z-scores were used as basis for the proficiency assessment:

$$z - score = \frac{x_i - \bar{X}}{\hat{\sigma}}$$

$x_i$  is laboratory result

$\bar{X}$  is assigned value for the determinand

$\hat{\sigma}$  is standard deviation for proficiency assessment

$|z| \leq 2$  = satisfactory performance

$2 < |z| < 3$  = questionable performance

$|z| \geq 3$  = unsatisfactory performance

The assigned values used for the calculation of z-scores were the medians of all the participating laboratories (as a robust estimate for the consensus mean). The assigned value,  $X$ , i.e. the best estimate of the true concentration of each determinand, was set as a consensus of the results submitted by participants. *The Robust Statistics version based on the MAD* (median absolute difference) was used for the statistical evaluation of the proficiency testing results. The standard deviations for proficiency assessment  $\hat{\sigma}$  were identical with the reproducibility standard deviations from the intercomparison  $s_R$  in those cases where the latter were smaller than the upper limits for  $\hat{\sigma}$  given in Table 3. A robust statistics method<sup>1</sup> was used to reduce the impact of outliers on the reproducibility standard deviations  $s_R$  (Table 3).

The upper limit for the relative standard deviation (RSD) for each parameter as indicated in Table 3 were agreed upon at the November 2006 2<sup>nd</sup> PT follow-up meeting held in Dar es Salaam, that was composed by a PTB consultant and representatives of the three EAC PT providers. Such upper limits are usually set in PT scheme in order to avoid unrealistic large tolerance limits due to a wide scatter of laboratory results

**Table 3 Medians and reproducibility standard deviations and upper limits for the Relative Standard Deviation for PT assessment**

<b>Determinand</b>	<b>Median</b>	<b><math>s_R</math></b>	<b>Upper limit for Relative Standard Deviation (RSD)</b>
Sulphate (mg/l)	31.5	5.655	20%
Chloride (mg/l)	43.1	10.5675	20%
pH	5.818	0.5812	10%
electrical conductivity ( $\mu\text{S/cm}$ )	259.333	19.125	10%
Calcium (mg/l)	32.63	4.4687	20%
Magnesium (mg/l)	21.2083	4.24167	20%
Potassium (mg/l)	7.432	2.385	20%
Sodium (mg/l)	26	12.0175	20%
Total hardness (mgCaCO <sub>3</sub> /l)	161.8	24.375	20%

<sup>1</sup> Robust statistics: a method of coping with outliers. Analytical Methods Committee No.6 Apr 2001. Royal Society of Chemistry 2001



The upper limit for the relative standard deviation (RSD) for each parameter as indicated in Table 3 were agreed upon at the November 2006 2<sup>nd</sup> PT follow-up meeting held in Dar es Salaam, that was composed by a PTB consultant and representatives of the three EAC PT providers. Such upper limits are usually set in PT scheme in order to avoid unrealistic large tolerance limits due to a wide scatter of laboratory results.

The general criterion for z scores was as follows:

$|z| \leq 2$  = satisfactory performance

$2 < |z| < 3$  = questionable performance

$|z| \geq 3$  = unsatisfactory performance

Tabular and graphical representations (figures) have been used to show and determine a participant's performance variability, identify general trends and spot inconsistencies. Though  $2 < |z\text{-score}| < 3$  is regarded as questionable performance, for this PT round 1 and for a start, the tolerance limits have been set at  $+3 \leq z \leq -3$  for upper and lower tolerance respectively. The tables and figures used were; Summary of laboratories' performance, and Laboratories' performance and Z-scores (see Appendix 12.1)

## **8. Dissemination of report**

A hard copy and a soft copy of this report were sent to each of the participating laboratories. The report contained a brief summary of all the results from the participating laboratories, and a Certificate of Participation.

## **9. Acknowledgements**

The participating laboratories that carried out the analyses are gratefully acknowledged. The EAC Testing Subcommittee Contact Persons in Kenya and Tanzania (Kenya Bureau of Standards, and Tanzania Bureau of Standards respectively) are specially acknowledged for dispatching the water PT samples to the participants in their respective countries, and for coordinating the exercise in their respective countries on our behalf.

Equally acknowledged are the PTB for their technical, financial and logistical support, and Dr Roland Becker, (Federal Institute for Materials Research and Testing, BAM, Germany) as consultant on behalf of PTB (Germany), for his guidance in this entire maiden exercise. Appreciation is equally extended to the EAC Testing Technical Subcommittee for the support. Our appreciation is also extended to the management and staff of Uganda National Bureau of Standards (UNBS) for their input in ensuring the success of this maiden PT provision exercise.

Particular appreciation is extended to the staff of the UNBS Chemistry laboratory for their cooperation and untiring commitment to the success of this exercise.

## 10. Comments

It is recommended that the e-mail system be used as the preferred medium of communication. All queries, comments and feedback maybe forwarded to the PT Provider. Records shall be maintained of all complaints, investigations and corrective actions taken.

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Chemistry laboratory  
Uganda National Bureau of Standards  
Kampala, Uganda.

## References

1. Robust statistics: a method of coping with outliers. Analytical Methods Committee No.6 Apr 2001. Royal Society of Chemistry 2001
2. ISO/IEC 17025:2005, General requirements for competence of testing and Calibration Laboratories
3. EAC Proficiency Testing Protocol
4. IUPAC/ISO/AOAC International Harmonised Protocol for the Proficiency testing of (Chemical) Analytical Laboratories.

# Appendix

## Appendix 1 Tables and figures of participants results

Table 4: Summary of laboratories' performance on Calcium content determination

Calcium content determination for sample 2006.08/1							
Code	Assigned value (mg/l)	Lab value (mg/l)	Assigned Standard Deviation for assessment (mg/l)	RSD (%)	Z-Score	Assessment (S, Q, U)	
1	32.63	32.85	4.46875	13.7	0.05	S	
2	32.63	28.4	4.4687	13.7	-0.95	S	
3		NR					
4	32.63	35.125	4.4687	13.7	0.559	S	
5	32.63	31.3	4.4687	13.7	-0.3	S	
6	32.63	33.467	4.4687	13.7	0.188	S	
7	32.63	36.083	4.4687	13.7	0.774	S	
8	32.63	39	4.4687	13.7	1.427	S	
9	32.63	40	4.4687	13.7	1.65	S	
10		NR					
11	32.63	64	4.4687	13.7	7.021	U	
12	32.63	0	4.4687	13.7	-7.3	U	
13	32.63	32	4.4687	13.7	-0.14	S	
14	32.63	26.54	4.4687	13.7	-1.36	S	
15	32.63	32.2	4.4687	13.7	-0.1	S	
16	32.63	27.5	4.4687	13.7	-1.15	S	
17	32.63	35	4.4687	13.7	0.531	S	
19	32.63	33.73	4.4687	13.7	0.247	S	
20	32.63	32.4	4.4687	13.7	-0.05	S	
21	32.63	11.965	4.4687	13.7	-4.62	U	

**KEY**  
 NR; no result reported by laboratory. Assessment: S; satisfactory, Q; questionable, U; unsatisfactory

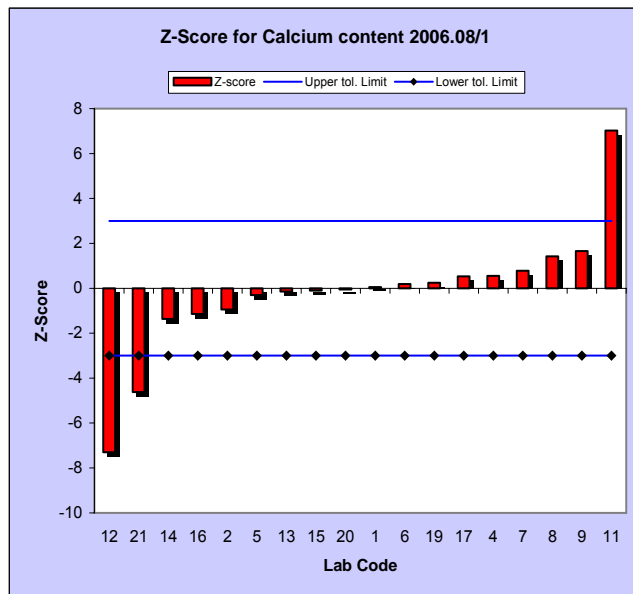
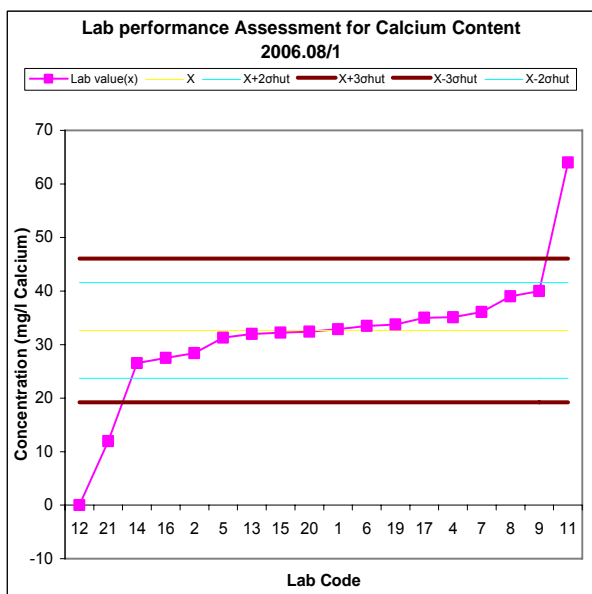
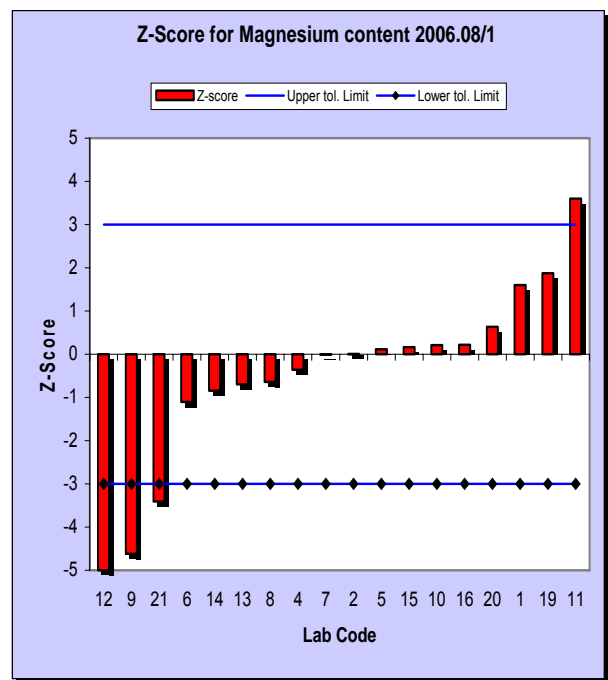
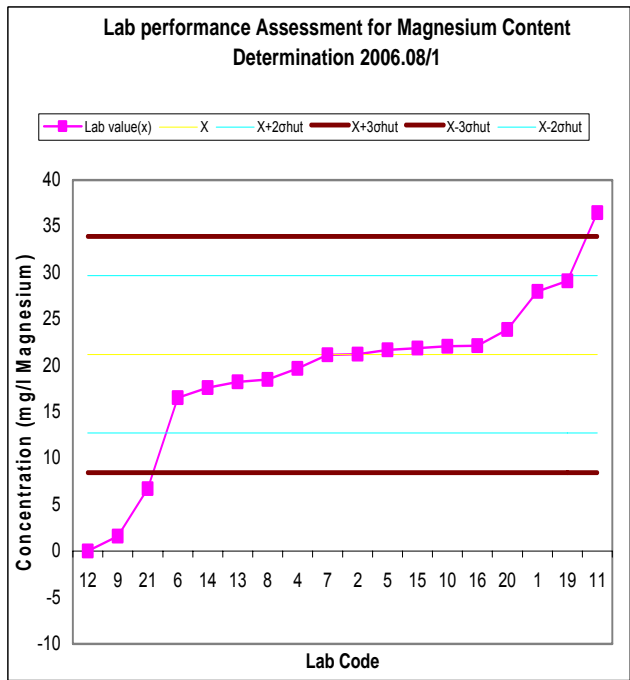


Figure 1: Laboratories' performance and Z-scores for calcium content determination

**Table 5: Summary of laboratories' performance on Magnesium content determination**

Magnesium content determination for sample 2006.08/1							
Code	Assigned value (mg/l)	Lab value (mg/l)	Assigned Standard Deviation for assessment (mg/l)	RSD (%)	Z-Score	Assessment (S, Q, U)	
1	21.2083	28	4.24167	20	1.60118	S	
2	21.2083	21.25	4.24167	20	0.00982	S	
3		NR					
4	21.2083	19.685	4.24167	20	-0.35914	S	
5	21.2083	21.7	4.24167	20	0.11591	S	
6	21.2083	16.533	4.24167	20	-1.10216	S	
7	21.2083	21.167	4.24167	20	-0.00982	S	
8	21.2083	18.5	4.24167	20	-0.63851	S	
9	21.2083	1.6	4.24167	20	-4.62279	U	
10	21.2083	22.1	4.24167	20	0.21022	S	
11	21.2083	36.48	4.24167	20	3.60039	U	
12	21.2083	0	4.24167	20	-5	U	
13	21.2083	18.24	4.24167	20	-0.6998	S	
14	21.2083	17.61	4.24167	20	-0.84833	S	
15	21.2083	21.9	4.24167	20	0.16306	S	
16	21.2083	22.145	4.24167	20	0.22083	S	
17		NR					
19	21.2083	29.14	4.24167	20	1.86994	S	
20	21.2083	23.9	4.24167	20	0.63458	S	
21	21.2083	6.745	4.24167	20	-3.40982	U	

**KEY**  
 NR; no result reported by laboratory. Assessment: S; satisfactory, Q; questionable, U; unsatisfactory

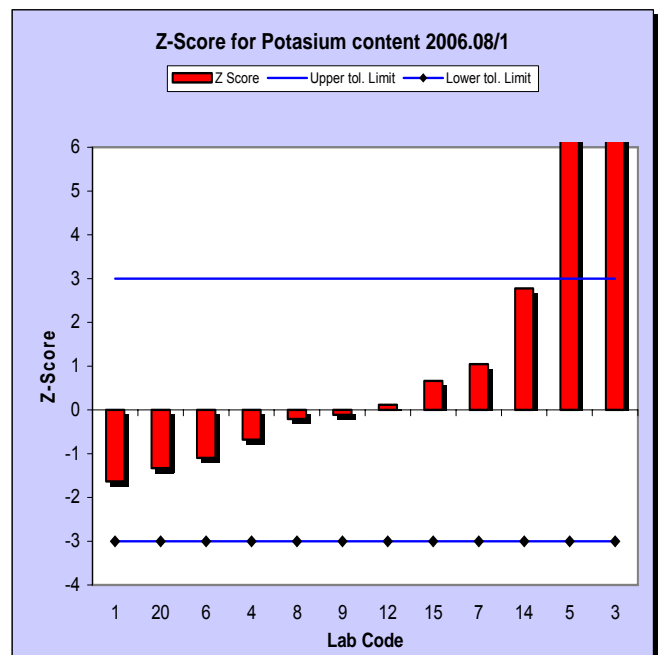
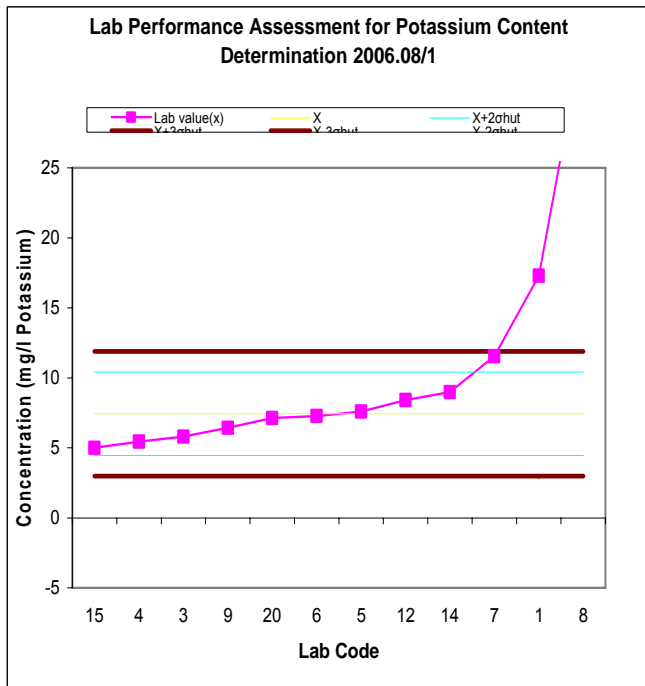


**Figure 2: Laboratories' performance and Z-scores for Magnesium content determination**

**Table 6: Summary of laboratories' performance on Potassium content determination**

Potassium content determination for sample 2006.08/1							
Code	Assigned value (mg/l)	Lab value (mg/l)	Assigned Standard Deviation for assessment (mg/l)	RSD (%)	Z-Score	Assessment (S, Q, U)	
1	7.432	17.3	1.48633	20	6.639	U	
2		NR					
3	7.432	5.8	1.48633	20	-1.1	S	
4	7.432	5.45	1.48633	20	-1.33	S	
5	7.432	7.6	1.48633	20	0.113	S	
6	7.432	7.2633	1.48633	20	-0.11	S	
7	7.432	11.557	1.48633	20	2.775	Q	
8	7.432	34.5	1.48633	20	18.21	U	
9	7.432	6.425	1.48633	20	-0.68	S	
10		NR					
11		NR					
12	7.432	8.41	1.48633	20	0.658	S	
13		NR					
14	7.432	8.98	1.48633	20	1.042	S	
15	7.432	5	1.48633	20	-1.64	S	
16		NR					
17		NR					
19		NR					
20		NR					
21	7.432	7.12	1.48633	20	-0.21	S	

**KEY**  
 NR; no result reported by laboratory. Assessment: S; satisfactory, Q; questionable, U; unsatisfactory

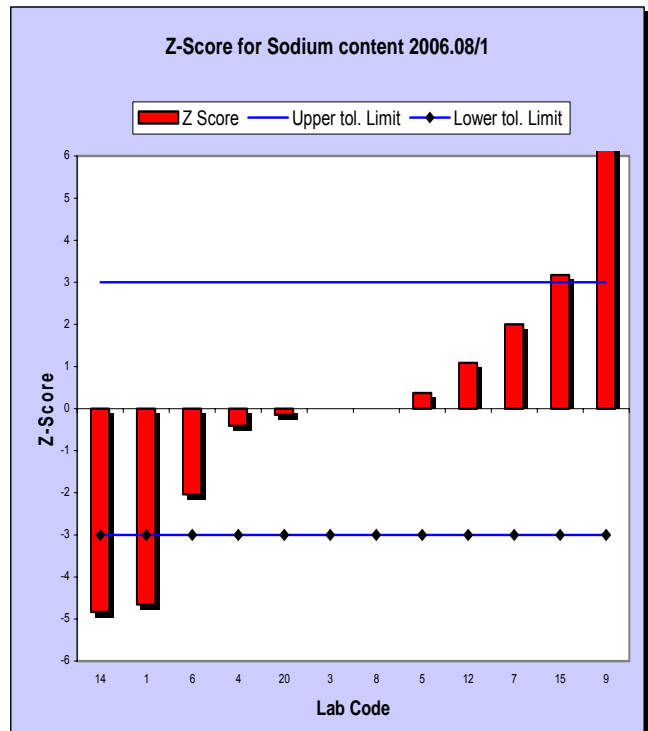
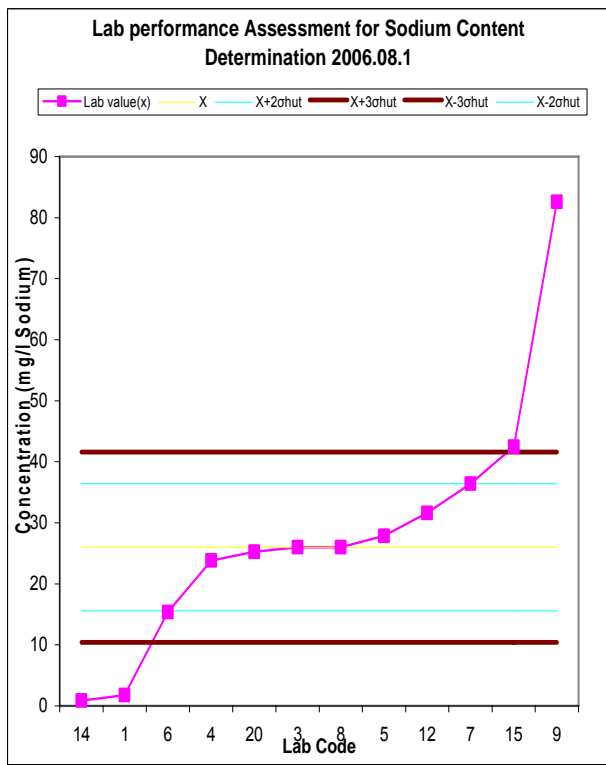


**Figure 3: Laboratories' performance and Z-scores for Potassium content determination**

**Table 7: Summary of laboratories' performance on Sodium content determination**

Sodium content determination for sample 2006.08/1							
Code	Assigned value (mg/l)	Lab value (mg/l)	Assigned Standard Deviation for assessment (mg/l)	RSD (%)	Z-Score	Assessment (S, Q, U)	
1	26	1.8	5.2	20	-4.65385	C	
2		NR					
3	26	26	5.2	20	0	S	
4	26	23.85	5.2	20	-0.41346	S	
5	26	27.9	5.2	20	0.36538	S	
6	26	15.4	5.2	20	-2.03846	Q	
7	26	36.403	5.2	20	2.00064	Q	
8	26	26	5.2	20	0	S	
9	26	82.59	5.2	20	10.8827	U	
10		NR					
11		NR					
12	26	31.62	5.2	20	1.08077	S	
13		NR					
14	26	0.87	5.2	20	-4.83269	U	
15	26	42.5	5.2	20	3.17308	U	
16		NR					
17		NR					
19		NR					
20	26	25.25	5.2	20	-0.14423	S	
21		NR					

**KEY**  
NR; no result reported by laboratory. Assessment: S; satisfactory, Q; questionable, U; unsatisfactory

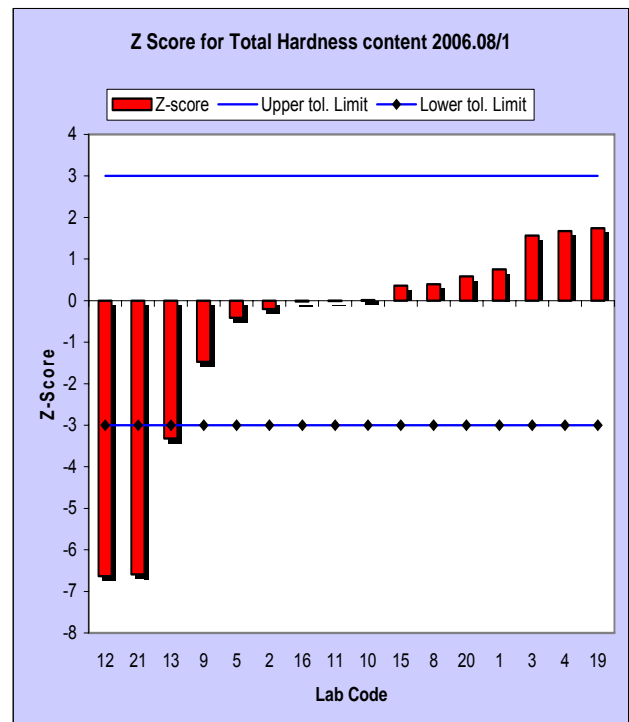
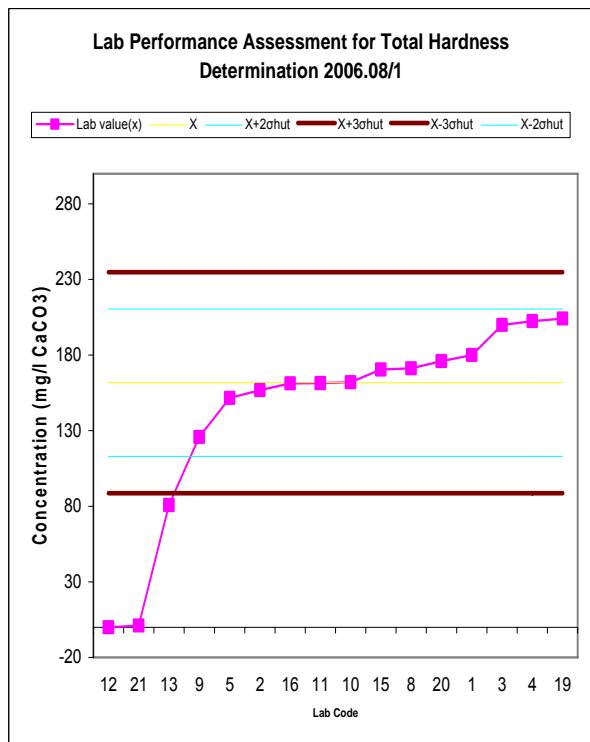


**Figure 4: Laboratories' performance and Z-scores for Sodium content determination**

**Table 8: Summary of laboratories' performance on Total Hardness determination**

Total Hardness determination for sample 2006.08/1								
Code	Assigned value (mgCaCO <sub>3</sub> /l)	Lab value (mgCaCO <sub>3</sub> /l)	Assigned Standard Deviation for assessment (mgCaCO <sub>3</sub> /l)	RSD (%)	Z-Score	Assessment (S, Q, U)		
1	161.8	180	24.375	15.07	0.749	S		
2	161.8	156.8	24.375	15.07	-0.2	S		
3	161.8	200	24.375	15.07	1.569	S		
4	161.8	202.5	24.375	15.07	1.672	S		
5	161.8	151.7	24.375	15.07	-0.41	S		
6		NR						
7		NR						
8	161.8	171.3	24.375	15.07	0.392	S		
9	161.8	125.9	24.375	15.07	-1.47	S		
10	161.8	162	24.375	15.07	0.01	S		
11	161.8	161.5	24.375	15.07	-0.01	S		
12	161.8	0	24.375	15.07	-6.64	U		
13	161.8	80.75	24.375	15.07	-3.32	U		
14		NR						
15	161.8	170.5	24.375	15.07	0.359	S		
16	161.8	161.25	24.375	15.07	-0.02	S		
17		NR						
19	161.8	204.18	24.375	15.07	1.741	S		
20	161.8	176	24.375	15.07	0.585	S		
21	161.8	1.153	24.375	15.07	-6.59	U		

**KEY**  
 NR; no result reported by laboratory. Assessment: S; satisfactory, Q; questionable, U; unsatisfactory

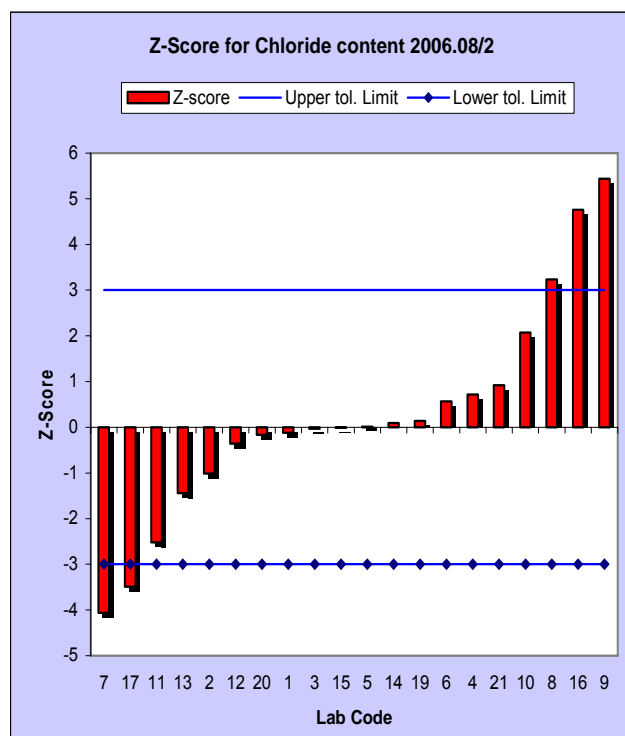
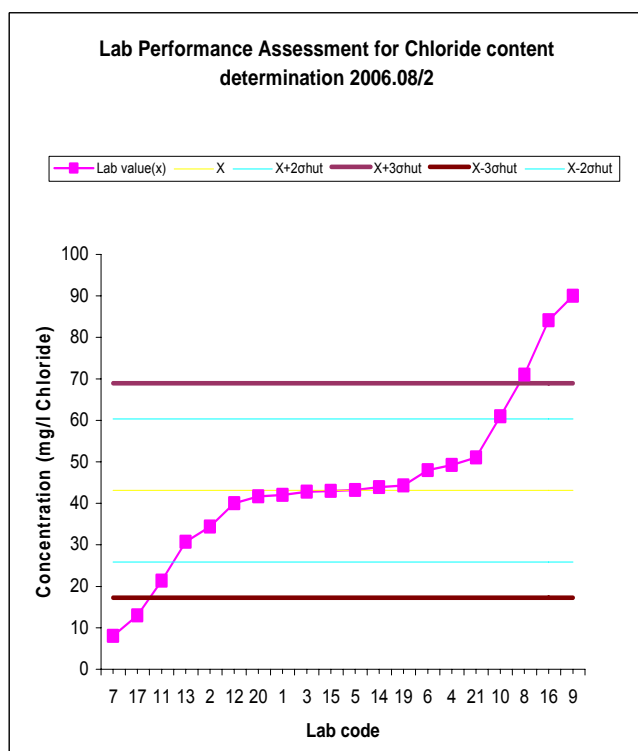


**Figure 5: Laboratories' performance and Z-scores for Total hardness determination**

**Table 9: Summary of laboratories' performance on Chloride content determination**

Chloride content determination for sample 2006.08/2							
Code	Assigned value (mg/l)	Lab value (mg/l)	Assigned Standard Deviation for assessment (mg/l)	RSD (%)	Z-Score	Assessment (S, Q, U)	
1	43.1	42.05	8.62	20	-0.12	S	
2	43.1	34.375	8.62	20	-1.01	S	
3	43.1	42.8	8.62	20	-0.03	S	
4	43.1	49.265	8.62	20	0.715	S	
5	43.1	43.2	8.62	20	0.012	S	
6	43.1	47.987	8.62	20	0.567	S	
7	43.1	8.079	8.62	20	-4.06	U	
8	43.1	71	8.62	20	3.237	U	
9	43.1	90	8.62	20	5.441	U	
10	43.1	60.95	8.62	20	2.071	Q	
11	43.1	21.385	8.62	20	-2.52	Q	
12	43.1	40	8.62	20	-0.36	S	
13	43.1	30.693	8.62	20	-1.44	S	
14	43.1	43.9	8.62	20	0.093	S	
15	43.1	43	8.62	20	-0.01	S	
16	43.1	84.14	8.62	20	4.761	U	
17	43.1	13	8.62	20	-3.49	U	
19	43.1	44.315	8.62	20	0.141	S	
20	43.1	41.7	8.62	20	-0.16	S	
21	43.1	51.025	8.62	20	0.919	S	

**KEY**  
NR; no result reported by laboratory. Assessment: S; satisfactory, Q; questionable, U; unsatisfactory



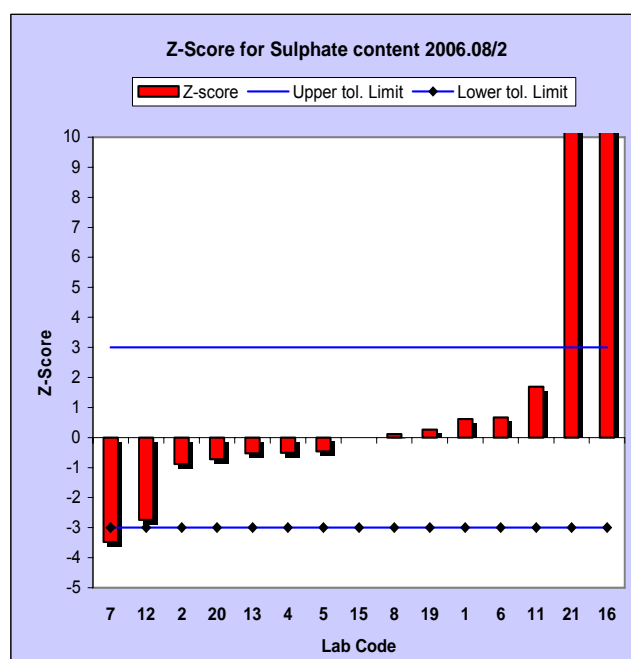
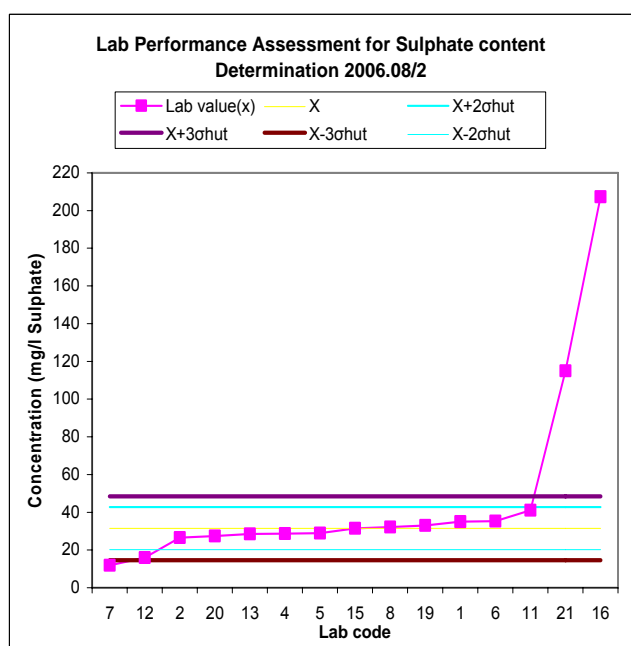
**Figure 6: Laboratories' performance and Z-scores for Chloride content determination**



**Table 10: Summary of laboratories' performance on Sulphate content determination**

Sulphate content determination for sample 2006.08/2							
Code	Assigned value (mg/l)	Lab value (mg/l)	Assigned Standard Deviation for assessment (mg/l)	RSD (%)	Z-Score	Assessment (S, Q, U)	
1	31.5	35	5.655	17.952	0.61892	S	
2	31.5	26.5	5.655	17.952	-0.88417	S	
3		NR					
4	31.5	28.635	5.655	17.952	-0.50663	S	
5	31.5	28.9	5.655	17.952	-0.45977	S	
6	31.5	35.27	5.655	17.952	0.66667	S	
7	31.5	11.827	5.655	17.952	-3.47893	U	
8	31.5	32.15	5.655	17.952	0.11494	S	
9		NR					
10		NR					
11	31.5	41.06	5.655	17.952	1.69054	S	
12	31.5	16	5.655	17.952	-2.74094	Q	
13	31.5	28.53	5.655	17.952	-0.5252	S	
12		NR			-5.57029	U	
15	31.5	31.5	5.655	17.952	0	S	
16	31.5	207.36	5.655	17.952	31.0981	U	
17		NR					
19	31.5	33	5.655	17.952	0.26525	S	
20	31.5	27.4	5.655	17.952	-0.72502	S	
21	31.5	115.01	5.655	17.952	14.7675	U	

**KEY**  
 NR; no result reported by laboratory. Assessment: S; satisfactory, Q; questionable, U; unsatisfactory



**Figure 7: Laboratories' performance and Z-scores for Sulphate content determination**

Table 11: Summary of laboratories' performance on pH content determination

pH determination for sample 2006.08/2							
Code	Assigned value	Lab value	Assigned Standard Deviation for assessment	RSD (%)	Z-Score	Assessment (S, Q, U)	
1	5.818	5.15	0.5812	9.991	-1.15	S	
2	5.818	6.53	0.5812	9.991	1.226	S	
3	5.818	5.775	0.5812	9.991	-0.07	S	
4	5.818	5.325	0.5812	9.991	-0.85	S	
5	5.818	5.86	0.5812	9.991	0.073	S	
6	5.818	5.82	0.5812	9.991	0.004	S	
7	5.818	5.72	0.5812	9.991	-0.17	S	
8	5.818	6	0.5812	9.991	0.314	S	
9		NR					
10	5.818	5.305	0.5812	9.991	-0.88	S	
11	5.818	5.4	0.5812	9.991	-0.72	S	
12	5.818	6.235	0.5812	9.991	0.718	S	
13	5.818	5.8175	0.5812	9.991	0	S	
14	5.818	5.65	0.5812	9.991	-0.29	S	
15	5.818	6.145	0.5812	9.991	0.563	S	
16	5.818	5.2	0.5812	9.991	-1.06	S	
17	5.818	8.255	0.5812	9.991	4.194	U	
19	5.818	5.43	0.5812	9.991	-0.67	S	
20	5.818	7.055	0.5812	9.991	2.129	Q	
21	5.818	6.1	0.5812	9.991	0.486	S	

**KEY**  
 NR; no result reported by laboratory. Assessment: S; satisfactory, Q; questionable, U; unsatisfactory

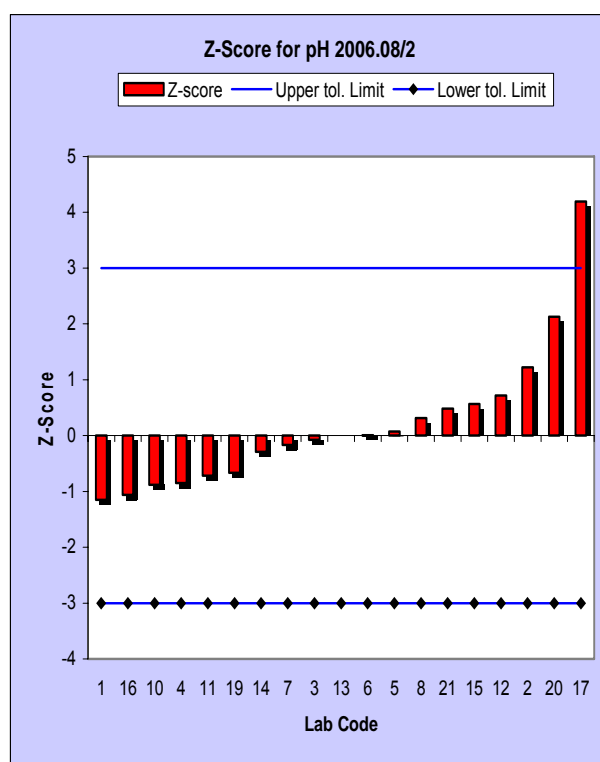
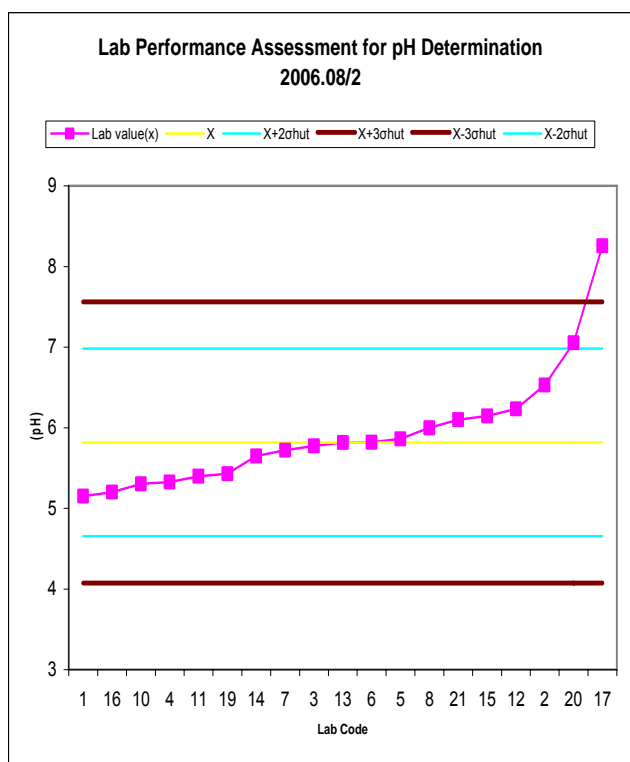
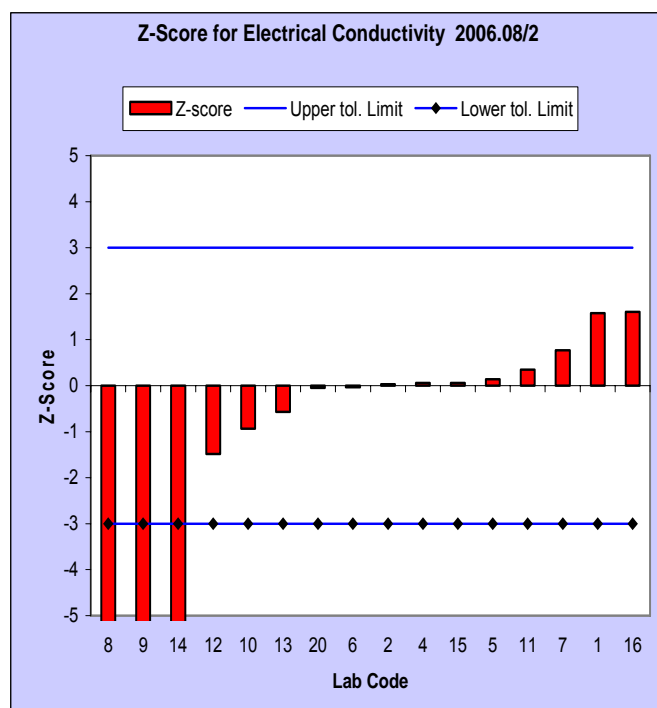
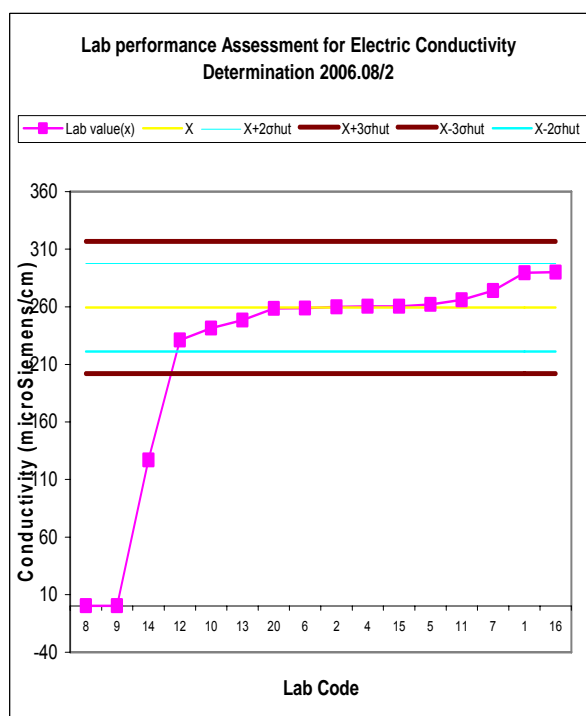


Figure 8: Laboratories' performance and Z-scores for pH determination

**Table 12: Summary of laboratories' performance on Electrical conductivity determination**

Electrical Conductivity determination for sample 2006.08/2						
Code	Assigned value (µS/cm)	Lab value (µS/cm)	Assigned Standard Deviation for assessment (µS/cm)	RSD (%)	Z-Score	Assessment (S, Q, U)
1	259.333	289.5	19.125	7.3747	1.57734	S
2	259.333	260	19.125	7.3747	0.03486	S
3		NR				
4	259.333	260.5	19.125	7.3747	0.061	S
5	259.333	262	19.125	7.3747	0.13943	S
6	259.333	258.67	19.125	7.3747	-0.03486	S
7	259.333	274	19.125	7.3747	0.76688	S
8	259.333	0.25	19.125	7.3747	-13.5468	U
9	259.333	0.26	19.125	7.3747	-13.5463	U
10	259.333	241.45	19.125	7.3747	-0.93508	S
11	259.333	266	19.125	7.3747	0.34858	S
12	259.333	231	19.125	7.3747	-1.48148	S
13	259.333	248.5	19.125	7.3747	-0.56645	S
14	259.333	127	19.125	7.3747	-6.91939	U
15	259.333	260.5	19.125	7.3747	0.061	S
16	259.333	290	19.125	7.3747	1.60349	S
17		NR				
19		NR				
20	259.333	258.5	19.125	7.3747	-0.04357	S
21		NR				

KEY  
 NR; no result reported by laboratory. Assessment: S; satisfactory, Q; questionable, U; unsatisfactory, µS/cm; microsiemens per centimetre



**Figure 9: Laboratories' performance and Z-scores for Electrical Conductivity determination**