CETANZ

Civil Engineering Testing Association of New Zealand

TECHNICAL REPORT ON

PLASTICITY INDEX PROFICIENCY 2011

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PLASTICITY INDEX PROFICIENCY 2011

1. Introduction

This report serves to summarise the results of the 2010 CETANZ Plasticity Index Testing Proficiency.

In September 2010 CETANZ arranged a Plasticity Index and Linear Shrinkage test proficiency. OPUS Hamilton volunteered to design, prepare and distribute samples to approximately 27 New Zealand Laboratories. PQ Systems Pty Ltd was engaged to carry our data analysis. Three different soil samples were sent in duplicate to the following laboratories:

Babbage Geotechnical Laboratory
Central Testing Services – Alexandra
Civil Engineering Laboratory Services Ltd – Nelson
Coffey Information - East Tamaki
Coffey Information - Tauranga
Downer– Auckland
Downer– Christchurch
Envirolab Geotest
Fulton Hogan Laboratory – Dunedin
Geotechnics - Auckland
Geotechnics - Tauranga
Higgins
Holcim Laboratory – Auckland
Materials Advisory and Testing Services
Northland Soil Mechanics & Testing – Whangarei
OPUS International Consultants - Auckland
OPUS International Consultants - Dunedin
OPUS International Consultants - Gisborne
OPUS International Consultants - Hamilton
OPUS International Consultants - Napier
OPUS International Consultants - New Plymouth
OPUS International Consultants - Rotorua
OPUS International Consultants - Tauranga
OPUS International Consultants - Wanganui
OPUS International Consultants - Whangarei
Stevenson Laboratory Ltd
Test Lab – Wanganui

Laboratories were issued laboratory identification numbers by Keith Towl of IANZ so as to keep the identity of the laboratory confidential. All results were returned before the end of November 2011. Laboratories # 22 & 25 did not return results.

The purpose of the scheme was to:

1. Provide results that should enable participants to improve their performance.
2. Provide information relevant for calculation of uncertainty.
3. Contribute to confidence of mutual users of Civil Engineering Laboratories.
4. Identify problems with, or between, Laboratories.
5. Provide an indication of the industry's ability to perform the test method.
6. Potentially identifying needs for test method improvement.

2. Sample Preparation

Three materials (Silty Clays) were selected from the Auckland – Waikato region representing three significantly different Plasticity Index values. The bulk samples were rotary hoed and mixed to ensure homogeneity. Test Samples were split into representative test portions and sent to laboratories. Laboratories were asked to carry out the test as detailed in the method and ensure that the same technician completed all tests. Laboratories were asked to completed a result return form and attaché laboratory I.D. as assigned by IANZ and return results to OPUS Laboratory Hamilton.

3. Analysis

Analysis has been carried out by Dr Jackie Graham of PQ Systems Pty Ltd. The final report for which is included in this document.

4. Conclusion

See executive summary to follow.

5. References

NZS 4402: 1986: Test 2.2 Determination of The Liquid Limit
NZS 4402: 1986: Test 2.3 Determination of the Plastic Limit
NZS 4402: 1986: Test 2.4 Determination of the Plasticity Index

4. Disclaimer

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Plasticity Index Proficiency test results

2011

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Executive summary

This assessment reviews plasticity index. 3 samples were prepared and each laboratory received 2 portions of each sample. The ability of the laboratory to produce the same results from the same sample is assessed along with a comparison between the laboratories. The finding of the study is as follows:

- Plasticity index classification shows that sample B and C were defined as MH or OH by all laboratories. However sample A produced results which would considerably impact on the classification; 42% of results classified as CH or OH, 22% classified as CL or OL, 2% classified as ML or OL, and 34% results were borderline between the different classifications.
- Z-scores have been used to analyse the individual results and show questionable results for laboratory 6 when testing sample B.
- Strong biases are present. Laboratories 1, 6, 8, 9, 15, 17, 21, and 27 show a high bias. Whilst laboratories 2, 4, 5, 10, 16, 18, and 26 have a low bias.
- Laboratory 20 was found to have repeatability issues; indicating a poor ability to get similar results when testing portions of the same sample.

Plasticity Index Classification

The following table summarises the laboratories' ability to identify soil type using the plasticity chart. All laboratories were able to clearly classify samples B and C as MH or OH as there was no difficulty in making this judgement using the plasticity chart and the 'A' line. However this was not the case with sample A. The following table clearly shows this difficulty. There are considerable differences between laboratories and a number of laboratories had difficulty reproducing the first result.

		Sample A			Sample B			Sample C		
Lab ID	Test #	Liquid Limit	Plasticity Index	Classification	Liquid Limit	Plasticity	Classification	Liquid Limit	Plasticity Index	Classification
Lab 1	1	53	28	CH or OH	103	40	MH or OH	79	27	MH or OH
Lab 1	2	53	28	CH or OH	101	38	MH or OH	75	22	MH or OH
Lab 2	1	49	25	CL or OL	92	28	MH or OH	70	18	MH or OH
Lab 2	2	46	20	CL or OL	92	30	MH or OH	70	18	MH or OH
Lab 3	1	52	25	BORDERLINE CH or OH	101	38	MH or OH	76	20	MH or OH
Lab 3	2	49	25	CL or OL	102	43	MH or OH	71	19	MH or OH
Lab 4	1	51	22	BORDERLINE CH or OH	102	27	MH or OH	75	16	MH or OH
Lab 4	2	49	20	ML or OL	102	28	MH or OH	74	16	MH or OH
Lab 5	1	50	25	BORDERLINE CL or OL	98	27	MH or OH	81	22	MH or OH
Lab 5	2	49	23	CL or OL	98	28	MH or OH	75	18	MH or OH
Lab 6	1	55	29	CH or OH	103	49	MH or OH	75	26	MH or OH
Lab 6	2	54	29	CH or OH	103	50	MH or OH	79	28	MH or OH
Lab 7	1	45	20	BORDERLINE CL or OL	102	35	MH or OH	77	22	MH or OH
Lab 7	2	46	21	BORDERLINE CL or OL	102	35	MH or OH	76	21	MH or OH
Lab 8	1	52	30	CH or OH	103	41	MH or OH	77	25	MH or OH
Lab 8	2	52	29	CH or OH	103	44	MH or OH	78	28	MH or OH
Lab 9	1	52	28	CH or OH	104	39	MH or OH	81	27	MH or OH
Lab 9	2	53	29	CH or OH	102	36	MH or OH	82	28	MH or OH
Lab 10	1	51	24	BORDERLINE CH or OH	97	28	MH or OH	71	15	MH or OH
Lab 10	2	53	26	CH or OH	93	25	MH or OH	73	16	MH or OH
Lab 11	1	52	26	CH or OH	92	27	MH or OH	78	23	MH or OH
Lab 11	2	52	27	CH or OH	95	31	MH or OH	76	21	MH or OH
Lab 12	1	53	29	CH or OH	103	42	MH or OH	77	21	MH or OH
Lab 12	2	52	27	CH or OH	100	36	MH or OH	78	22	MH or OH
Lab 13	1	50	26	BORDERLINE CL or OL	104	39	MH or OH	78	21	MH or OH
Lab 13	2	50	26	BORDERLINE CL or OL	108	41	MH or OH	82	24	MH or OH
Lab 14	1	52	26	CH or OH	107	39	MH or OH	78	24	MH or OH
Lab 14	2	50	25	BORDERLINE CL or OL	105	39	MH or OH	76	20	MH or OH
Lab 15	1	54	32	CH or OH	103	44	MH or OH	77	27	MH or OH
Lab 15	2	52	30	CH or OH	103	45	MH or OH	76	24	MH or OH
Lab 16	1	48	21	CL or OL	98	29	MH or OH	70	16	MH or OH
Lab 16	2	48	21	CL or OL	95	28	MH or OH	71	15	MH or OH
Lab 17	1	51	27	CH or OH	105	41	MH or OH	81	27	MH or OH
Lab 17	2	50	26	BORDERLINE CL or OL	106	42	MH or OH	82	29	MH or OH
Lab 18	1	47	23	CL or OL	104	40	MH or OH	78	23	MH or OH
Lab 18	2	48	23	CL or OL	99	36	MH or OH	74	21	MH or OH
Lab 19	1	51	27	CH or OH	102	37	MH or OH	77	24	MH or OH
Lab 19	2	51	26	CH or OH	101	35	MH or OH	76	22	MH or OH
Lab 20	1	52	25	BORDERLINE CH or OH	104	32	MH or OH	79	20	MH or OH
Lab 20	2	51	23	BORDERLINE CH or OH	110	40	MH or OH	81	25	MH or OH
Lab 21	1	56	27	BORDERLINE CH or OH	111	43	MH or OH	86	30	MH or OH
Lab 21	2	56	28	BORDERLINE CH or OH	111	39	MH or OH	86	30	MH or OH
Lab 22	1									
Lab 22	2									
Lab 23	1	54	26	BORDERLINE CH or OH	102	36	MH or OH	78	23	MH or OH
Lab 23	2	49	23	CL or OL	103	37	MH or OH	82	22	MH or OH
Lab 24	1	49	26	CL or OL	97	36	MH or OH	78	26	MH or OH
Lab 24	2	50	26	BORDERLINE CL or OL	103	41	MH or OH	85	30	MH or OH
Lab 25	1									
Lab 25	2									
Lab 26	1	50	24	BORDERLINE CL or OL	85	27	MH or OH	64	16	MH or OH
Lab 26	2	47	22	CL or OL	87	24	MH or OH	64	18	MH or OH
Lab 27	1	52	27	CH or OH	104	38	MH or OH	82	27	MH or OH
Lab 27	2	52	26	CH or OH	104	38	MH or OH	81	26	MH or OH

Plasticity Index variation in comparison to study averages

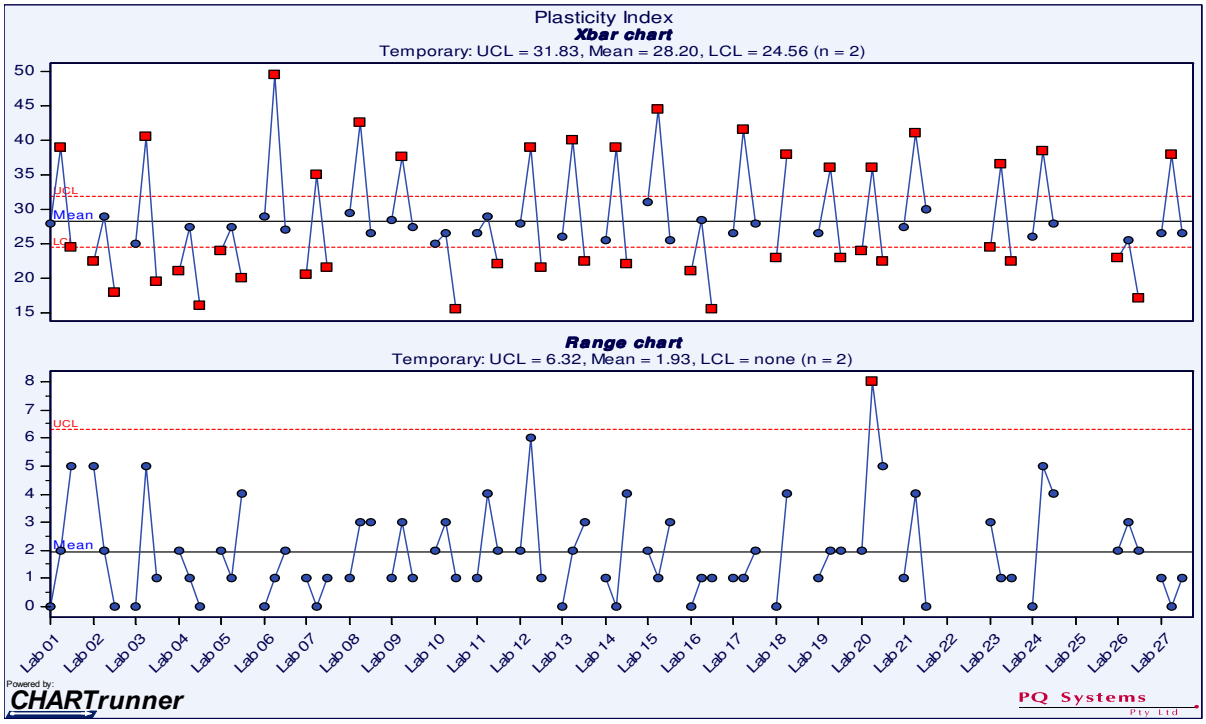
In this analysis the difference between the individual laboratory results and the overall study average is shown. Also on the table is the z-score. Z-scores are interpreted as follows: a score less than or equal to 2 is considered satisfactory, a score greater than 2 but less than or equal to 3 is considered questionable while a score greater than 3 is considered unsatisfactory.

		Sample A			Sample B			Sample C		
Lab ID	Test #	Plasticity	Difference	z-score	Plasticity	Difference	z-score	Plasticity	Difference	z-score
Lab 1	1	28	2	0.86	40	4	0.59	27	4	1.03
Lab 1	2	28	2	0.86	38	2	0.28	22	-1	0.13
Lab 2	1	25	-1	0.19	28	-8	1.29	18	-5	1.06
Lab 2	2	20	-6	1.94	30	-6	0.98	18	-5	1.06
Lab 3	1	25	-1	0.19	38	2	0.28	20	-3	0.60
Lab 3	2	25	-1	0.19	43	7	1.06	19	-4	0.83
Lab 4	1	22	-4	1.24	27	-9	1.45	16	-7	1.53
Lab 4	2	20	-6	1.94	28	-8	1.29	16	-7	1.53
Lab 5	1	25	-1	0.19	27	-9	1.45	22	-1	0.13
Lab 5	2	23	-3	0.89	28	-8	1.29	18	-5	1.06
Lab 6	1	29	3	1.21	49	13	2.01	26	3	0.79
Lab 6	2	29	3	1.21	50	14	2.16	28	5	1.26
Lab 7	1	20	-6	1.94	35	-1	0.19	22	-1	0.13
Lab 7	2	21	-5	1.59	35	-1	0.19	21	-2	0.37
Lab 8	1	30	4	1.56	41	5	0.75	25	2	0.56
Lab 8	2	29	3	1.21	44	8	1.22	28	5	1.26
Lab 9	1	28	2	0.86	39	3	0.44	27	4	1.03
Lab 9	2	29	3	1.21	36	0	0.03	28	5	1.26
Lab 10	1	24	-2	0.54	28	-8	1.29	15	-8	1.76
Lab 10	2	26	0	0.16	25	-11	1.76	16	-7	1.53
Lab 11	1	26	0	0.16	27	-9	1.45	23	0	0.10
Lab 11	2	27	1	0.51	31	-5	0.82	21	-2	0.37
Lab 12	1	29	3	1.21	42	6	0.91	21	-2	0.37
Lab 12	2	27	1	0.51	36	0	0.03	22	-1	0.13
Lab 13	1	26	0	0.16	39	3	0.44	21	-2	0.37
Lab 13	2	26	0	0.16	41	5	0.75	24	1	0.33
Lab 14	1	26	0	0.16	39	3	0.44	24	1	0.33
Lab 14	2	25	-1	0.19	39	3	0.44	20	-3	0.60
Lab 15	1	32	6	2.27	44	8	1.22	27	4	1.03
Lab 15	2	30	4	1.56	45	9	1.38	24	1	0.33
Lab 16	1	21	-5	1.59	29	-7	1.13	16	-7	1.53
Lab 16	2	21	-5	1.59	28	-8	1.29	15	-8	1.76
Lab 17	1	27	1	0.51	41	5	0.75	27	4	1.03
Lab 17	2	26	0	0.16	42	6	0.91	29	6	1.49
Lab 18	1	23	-3	0.89	40	4	0.59	23	0	0.10
Lab 18	2	23	-3	0.89	36	0	0.03	21	-2	0.37
Lab 19	1	27	1	0.51	37	1	0.12	24	1	0.33
Lab 19	2	26	0	0.16	35	-1	0.19	22	-1	0.13
Lab 20	1	25	-1	0.19	32	-4	0.66	20	-3	0.60
Lab 20	2	23	-3	0.89	40	4	0.59	25	2	0.56
Lab 21	1	27	1	0.51	43	7	1.06	30	7	1.72
Lab 21	2	28	2	0.86	39	3	0.44	30	7	1.72
Lab 23	1	26	0	0.16	36	0	0.03	23	0	0.10
Lab 23	2	23	-3	0.89	37	1	0.12	22	-1	0.13
Lab 24	1	26	0	0.16	36	0	0.03	26	3	0.79
Lab 24	2	26	0	0.16	41	5	0.75	30	7	1.72
Lab 26	1	24	-2	0.54	27	-9	1.45	16	-7	1.53
Lab 26	2	22	-4	1.24	24	-12	1.92	18	-5	1.06
Lab 27	1	27	1	0.51	38	2	0.28	27	4	1.03
Lab 27	2	26	0	0.16	38	2	0.28	26	3	0.79

The data in the table clearly indicates that Laboratory 6 for sample B had significantly different results. Further analysis is in the following charts.

Plasticity Index comparison of results using and average and range chart

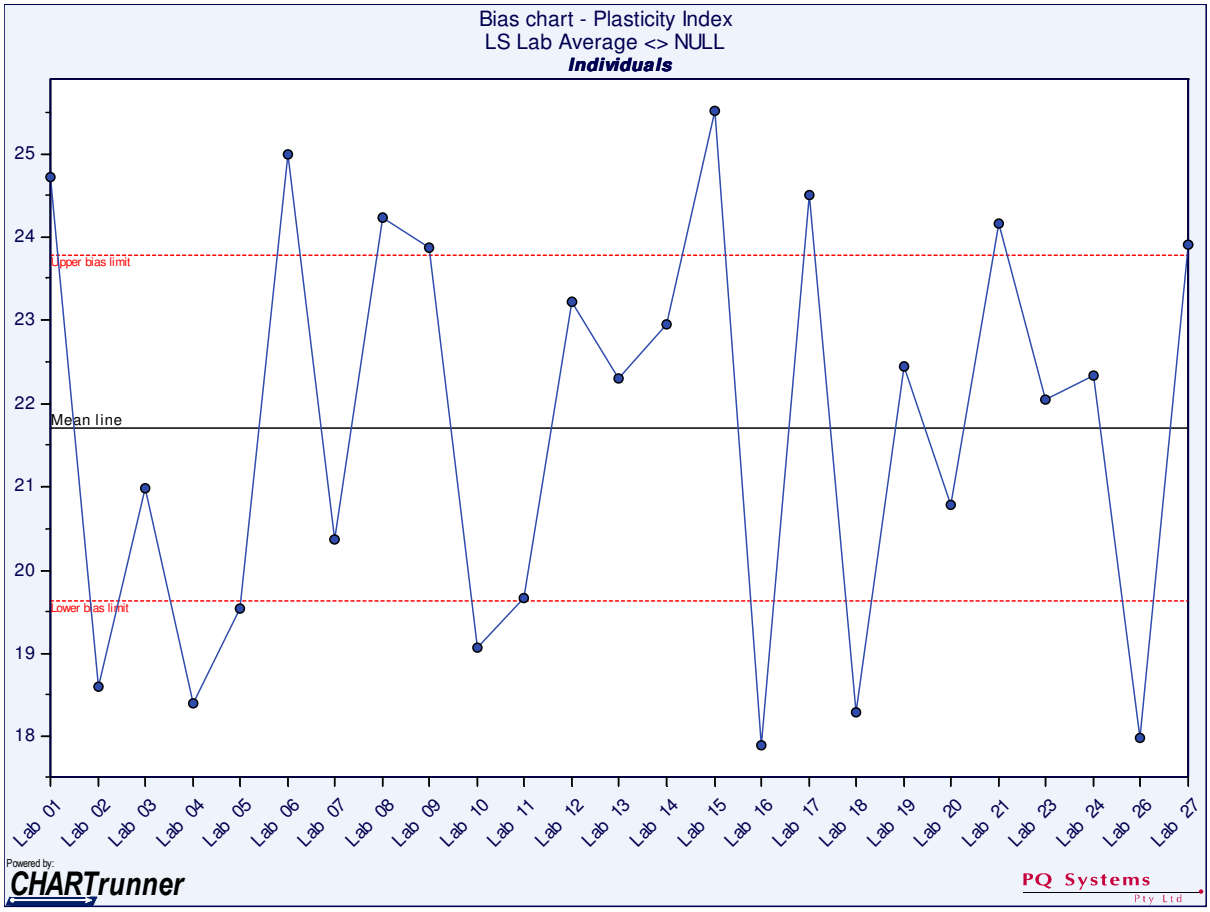
The following chart shows the results for the study.



The average chart shows the laboratories in order from 1 to 27. Each laboratory shows three results, which represents the average for sample A, B, and C. Ideally each laboratories results should look the same. From this chart bias issues are immediately apparent; this is assessed further in the next section.

The range chart shows the differences in the test results for sample A, B, and C separately for each laboratory. It shows the average difference between test results is 2 units. Ideally all results will be below the upper control limit. Note that Lab 20 has a result above the upper control limit indicating the result is significantly different to all others. This is a concern as it shows an inability to repeat the test consistently; it should be noted that this could be caused by poor sample preparation. Although it is the only laboratory with a significant difference which tends to suggest a testing issue is present.

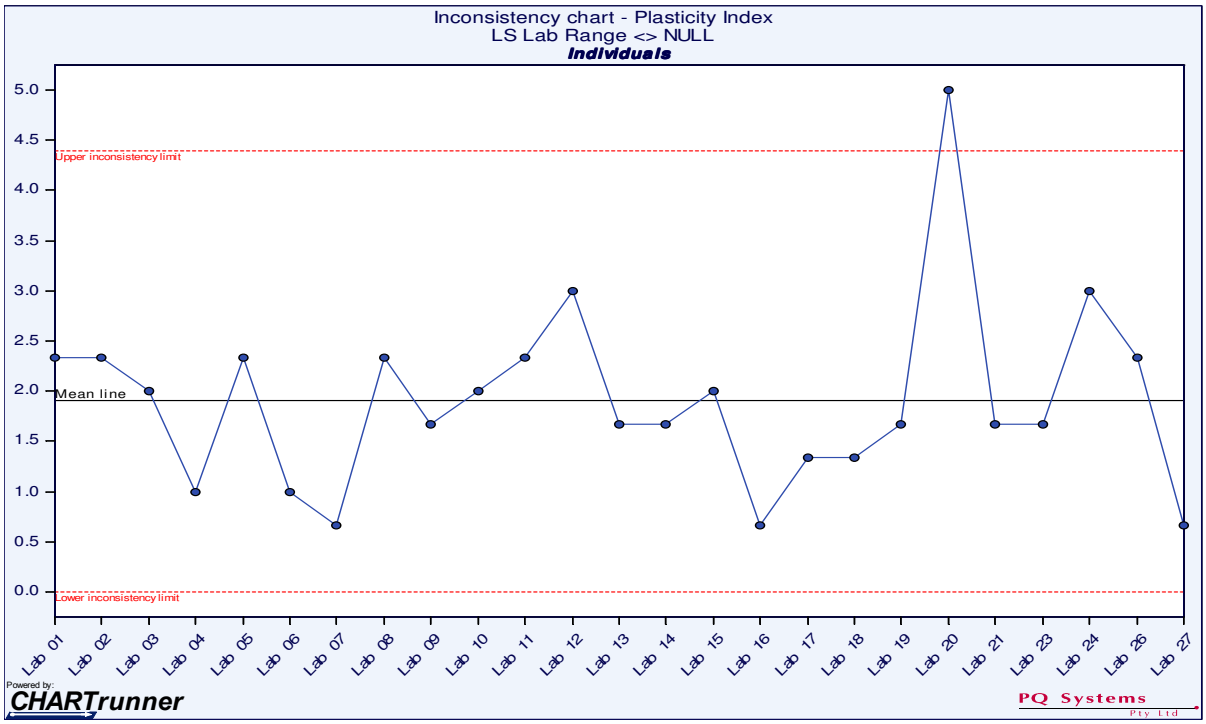
Plasticity Index bias assessment



The bias charts takes the average for all 3 samples, 6 results, and compares them. Ideally all laboratories would be inside the control limits.

The bias chart shows that laboratories 1, 6, 8, 9, 15, 17, 21, 27 each has a high bias while laboratories 2, 4, 5, 10, 16, 18, 26 each has a low bias compared to all results. These biases are statistically significant and require further assessment.

Plasticity Index inconsistency assessment



This assessment reviews the overall ability of each laboratory to reproduce the same results by comparing the average range of the 3 sets of samples for each laboratory. Ideally all results should be inside the control limits. The inconsistency chart shows that laboratory 20 is significantly less consistent than all other laboratories.