

## DUBAI ACCREDITATION DEPARTMENT

### REPORT ON PTP 184<sup>TH</sup> INTER-LABORATORY PROFICIENCY TESTING PROGRAM DETERMINATION OF DRY DENSITY / MOISTURE CONTENT RELATIONSHIP IN SOIL

Date: 30 November 2009

#### 1. INTRODUCTION

This document presents the results of the 184<sup>th</sup> inter-laboratory proficiency-testing program conducted during the month of November involving the determination of **Dry Density / Moisture Content Relationship** with thirty three laboratories participating.

This program is part of the Inter-laboratory Comparison Programs organized by Dubai Accreditation Department (DAC) of Dubai Municipality (DM) for monitoring the validity of test results of laboratories operating in Dubai as a requirement of the Local Order 52/1990 and ISO/IEC 17011: 2004.

#### 2. EXPERIMENTAL DESIGN

##### 2.1 Homogeneity:

DAC had ensured the homogeneity of the samples prior to their distribution to the participating laboratories by conducting homogeneity test on six samples (randomly selected). Based on the test results the homogeneity is statistically evaluated as per *ISO 13528:2005 as explained in DAC-G3-03*.

##### 2.2 Participants:

Thirty three laboratories were participated in this program, the participants are registered and accredited laboratories which are operating in the emirate of Dubai, also the program included other participants laboratories from Abu Dhabi and Qatar..

##### 2.3 Samples Tested:

One (1) soil sample of approximately 25 kg consists of brown fine to medium sand specimen was distributed to all participating laboratories. With each participant being given one sample with a unique identification number provided during the time of collection.

#### 3. CONFIDENTIALITY

Each laboratory is given a code number to maintain confidentiality of results and to protect their identities. Only the concerned laboratory knows its code number.

#### 4. TEST METHOD

Instructions were given to the participants to test the samples for Determination of Dry Density / Moisture Content Relationship as per BS 1377: Part 4:1990 T 3.5.4.2 AMD

## DUBAI ACCREDITATION DEPARTMENT

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### 5. TEST RESULTS

The test results submitted by the participating laboratories are presented in Appendix A. In order to protect the identity of the participating laboratories, each one was assigned a code number. The numbers in the column headings, Lab #, of the tables represents the code numbers for the participating laboratories.

### 6. EVALUATION OF RESULTS

#### 6.1 Method of Analysis

The analysis of the participant's results is based on *ISO 13528:2005 (Statistical Methods for the Use in Proficiency Testing by Inter-laboratory Comparisons)*

#### 6.2 Calculations of Z- Scores

Appendix B gives the details of the calculation of the laboratories results and their Z- Scores which are obtained from the raw data. Also Z- Score and participant's results are represented in a bar chart and X-Y scattered plots C. The Z-Score analysis is based on an international Standard (*ISO 13528:2005*).

#### 6.3 Outlier Results

Test	Labs outside the z-scores $\pm 3$
Maximum Dry Density	Labs : 67 ; 79: 88

After evaluating the Z-Score the test results provided by the above mentioned laboratories are outside the Z - score limits of  $\pm 3$ , the above mentioned laboratories are requested to investigate the root cause of the outlier results, implement corrective action and a report shall be available for checking by assessment team during the nearest assessment visit.

Also other participating laboratories have showed Z-score values higher than **two** which representing **not outlier** but a warring limit, these laboratories are advised to investigate the potential root cause of such results.

### 7. APPENDICES

7.1 Appendix A: Raw Data

7.2 Appendix B: Calculation of z-scores and other statistics

7.3 Appendix C: Charts

---- End of Report ---

## Determination of Dry Density / Moisture Content Relationship in Soil

### Appendix A: Raw Data

**Table - 1: Maximum Dry Density**

Lab #	Sample No.	Results
Lab G01	18401	1.87
Lab 3	18403	1.87
Lab 39	18404	1.87
Lab 4	18405	1.88
Lab 56	18407	1.87
Lab 21	18408	1.87
Lab 7	18409	1.86
Lab 9	18410	1.87
Lab 28	18411	1.86
Lab 23	18413	1.87
Lab EX8	18414	1.86
Lab 88	18415	2
Lab 57	18416	1.87
Lab 58	18417	1.86
Lab 64	18420	1.87
Lab 68	18421	1.87
Lab 66	18422	1.87
Lab 72	18423	1.88
Lab 67	18425	1.92
Lab 71	18426	1.86
Lab 74	18427	1.87
Lab EX7	18429	1.85
Lab 79	18430	1.92
Lab 78	18432	1.87
Lab 82	18433	1.88
Lab 84	18434	1.88
Lab 85	18435	1.87
Lab 89	18436	1.88
Lab EX2	18438	1.85
Lab EX3	18439	1.86
Lab EX4	18440	1.86
Lab EX6	18442	1.88
Lab EX5	18443	1.87

**Table - 2**

Lab #	Sample No.	Results
Lab G01	18401	10
Lab 3	18403	11
Lab 39	18404	10
Lab 4	18405	11
Lab 56	18407	11
Lab 21	18408	10
Lab 7	18409	11
Lab 9	18410	10
Lab 28	18411	11
Lab 23	18413	11
Lab EX8	18414	10
Lab 88	18415	10
Lab 57	18416	11
Lab 58	18417	11
Lab 64	18420	10
Lab 68	18421	12
Lab 66	18422	12
Lab 72	18423	10.3
Lab 67	18425	10.8
Lab 71	18426	11
Lab 74	18427	11
Lab EX7	18429	11
Lab 79	18430	10
Lab 78	18432	11
Lab 82	18433	11
Lab 84	18434	11
Lab 85	18435	10
Lab 89	18436	11
Lab EX2	18438	10.4
Lab EX3	18439	10.8
Lab EX4	18440	11.6
Lab EX6	18442	11
Lab EX5	18443	10

Appendix - B Calculations of Z-Score and Other Statistics

Table -1 Maximum Dry Density

Iteration	0	$\bar{x} - x^*$	1	$(x_i - x^*)^2$	2	$(x_i - x^*)^2$	3	$(x_i - x^*)^2$	4	$(x_i - x^*)^2$	5	$(x_i - x^*)^2$	6	$(x_i - x^*)^2$	Z Score
$\delta = 1.5 s^*$	---		0.02		0.02		0.02		0.02		0.02		0.01		
$x^* - \delta$	---		1.85		1.85		1.85		1.85		1.86		1.86		
$x^* + \delta$	---		1.89		1.89		1.89		1.89		1.89		1.89		
Lab EX2	1.85	0.02	1.85	0.00	1.85	0.00	1.85	0.00	1.85	0.00	1.86	0.00	1.86	0.00	-2.05
Lab EX7	1.85	0.02	1.85	0.00	1.85	0.00	1.85	0.00	1.85	0.00	1.86	0.00	1.86	0.00	-2.05
Lab 28	1.86	0.01	1.86	0.00	1.86	0.00	1.86	0.00	1.86	0.00	1.86	0.00	1.86	0.00	-1.03
Lab 58	1.86	0.01	1.86	0.00	1.86	0.00	1.86	0.00	1.86	0.00	1.86	0.00	1.86	0.00	-1.03
Lab 7	1.86	0.01	1.86	0.00	1.86	0.00	1.86	0.00	1.86	0.00	1.86	0.00	1.86	0.00	-1.03
Lab 71	1.86	0.01	1.86	0.00	1.86	0.00	1.86	0.00	1.86	0.00	1.86	0.00	1.86	0.00	-1.03
Lab EX3	1.86	0.01	1.86	0.00	1.86	0.00	1.86	0.00	1.86	0.00	1.86	0.00	1.86	0.00	-1.03
Lab EX4	1.86	0.01	1.86	0.00	1.86	0.00	1.86	0.00	1.86	0.00	1.86	0.00	1.86	0.00	-1.03
Lab EX8	1.86	0.01	1.86	0.00	1.86	0.00	1.86	0.00	1.86	0.00	1.86	0.00	1.86	0.00	-1.03
Lab 21	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	-0.02
Lab 23	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	-0.02
Lab 3	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	-0.02
Lab 39	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	-0.02
Lab 56	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	-0.02
Lab 57	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	-0.02
Lab 64	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	-0.02
Lab 66	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	-0.02
Lab 68	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	-0.02
Lab 74	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	-0.02
Lab 78	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	-0.02
Lab 85	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	-0.02
Lab 9	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	-0.02
Lab EX5	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	-0.02
Lab G01	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	-0.02
Lab 4	1.88	0.01	1.88	0.00	1.88	0.00	1.88	0.00	1.88	0.00	1.88	0.00	1.88	0.00	1.00
Lab 72	1.88	0.01	1.88	0.00	1.88	0.00	1.88	0.00	1.88	0.00	1.88	0.00	1.88	0.00	1.00
Lab 82	1.88	0.01	1.88	0.00	1.88	0.00	1.88	0.00	1.88	0.00	1.88	0.00	1.88	0.00	1.00
Lab 84	1.88	0.01	1.88	0.00	1.88	0.00	1.88	0.00	1.88	0.00	1.88	0.00	1.88	0.00	1.00
Lab 89	1.88	0.01	1.88	0.00	1.88	0.00	1.88	0.00	1.88	0.00	1.88	0.00	1.88	0.00	1.00
Lab EX6	1.88	0.01	1.88	0.00	1.88	0.00	1.88	0.00	1.88	0.00	1.88	0.00	1.88	0.00	1.00
Lab 67	1.92	0.05	1.89	0.00	1.89	0.00	1.89	0.00	1.89	0.00	1.89	0.00	1.89	0.00	5.07
Lab 79	1.92	0.05	1.89	0.00	1.89	0.00	1.89	0.00	1.89	0.00	1.89	0.00	1.89	0.00	5.07
Lab 88	2	0.13	1.89	0.00	1.89	0.00	1.89	0.00	1.89	0.00	1.89	0.00	1.89	0.00	13.21
Average	1.88		1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	
SD	0.03		0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	
New $x^*$	1.87	0.01	1.87	0.01	1.87	0.01	1.87	0.01	1.87	0.01	1.87	0.01	1.87	0.01	
New $s^*$	0.01		0.01		0.01		0.01		0.01		0.01		0.01		

N 33

Target value	1.87
Low Acceptable	1.84
High Acceptable	1.90
Acceptable Range	1.84 - 1.90

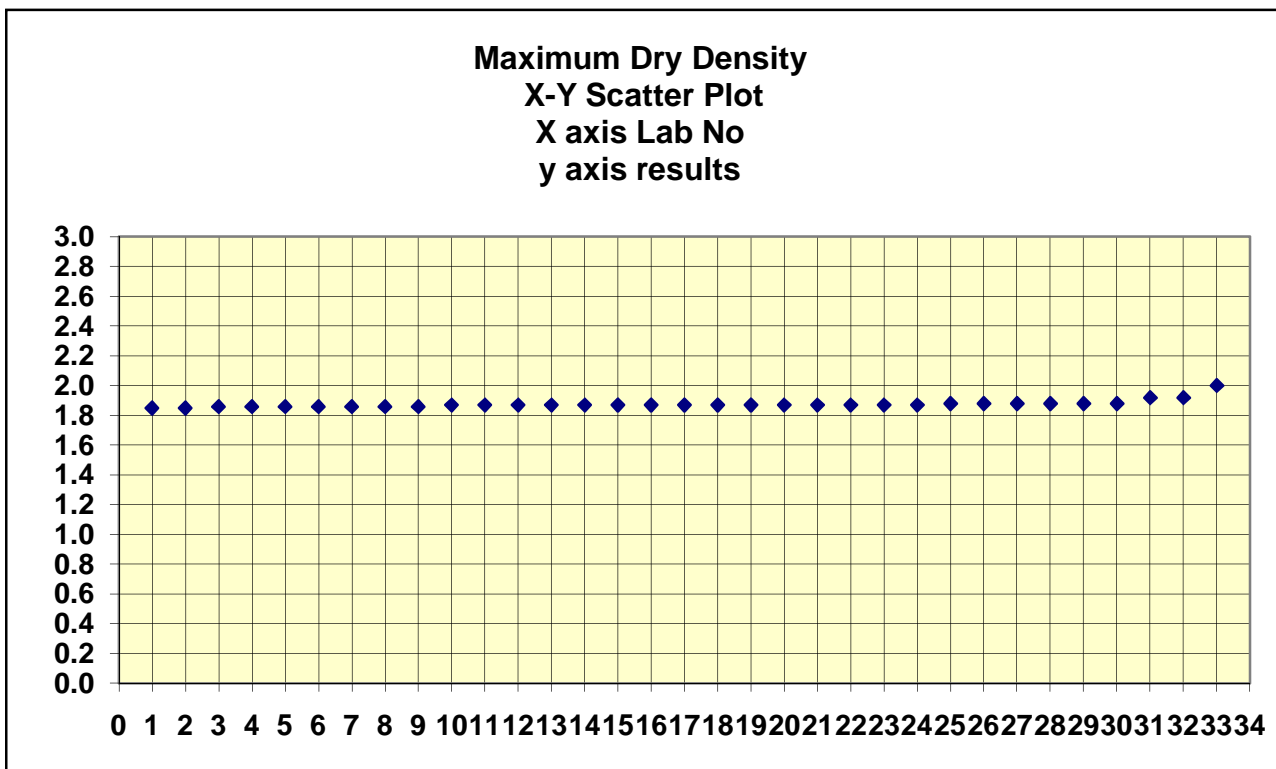
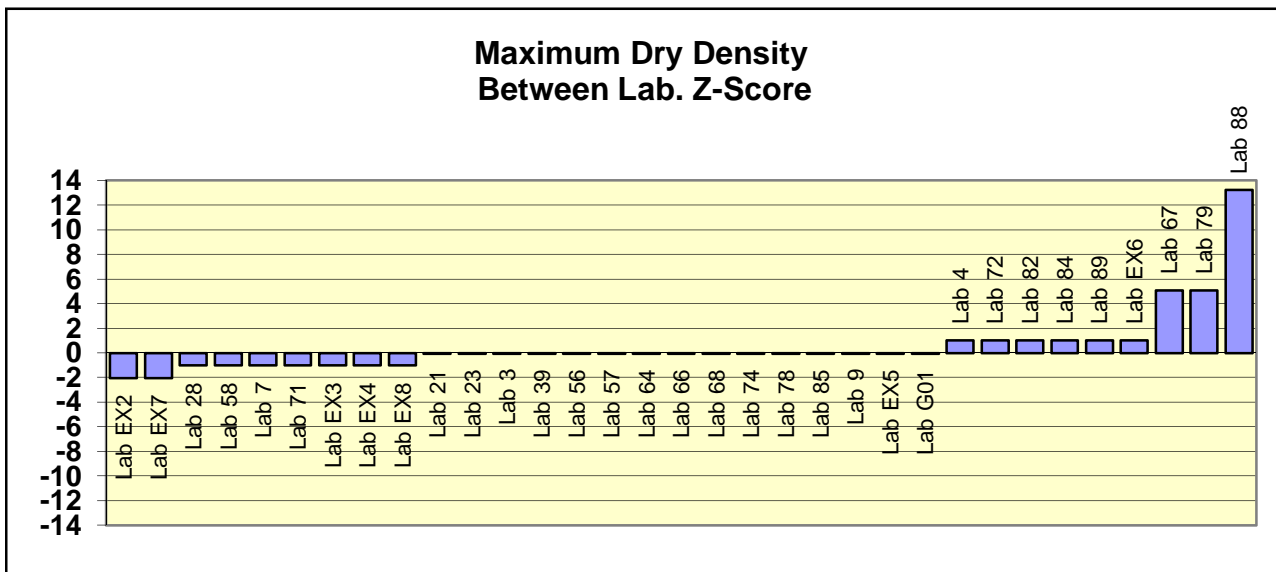
**Table - 2 Optimum Moisture Content**

Iteration	0	$\bar{x} - x^*$	1	$(x_i - x^*)^2$	2	$(x_i - x^*)^2$	3	$(x_i - x^*)^2$	4	$(x_i - x^*)^2$	5	$(x_i - x^*)^2$	6	$(x_i - x^*)^2$	Z Score
$\delta = 1.5 s^*$	---		<b>0.81</b>		<b>0.82</b>		<b>0.77</b>		<b>0.75</b>		<b>0.75</b>		<b>0.74</b>		
$x^* - \delta$	---		<b>10.19</b>		<b>9.95</b>		<b>9.99</b>		<b>10.00</b>		<b>10.00</b>		<b>10.00</b>		
$x^* + \delta$	---		<b>11.81</b>		<b>11.59</b>		<b>11.53</b>		<b>11.50</b>		<b>11.50</b>		<b>11.49</b>		
Lab 21	10.0	1.00	10.19	0.34	10.19	0.32	10.19	0.31	10.19	0.31	10.19	0.31	10.19	0.31	-1.51
Lab 39	10.0	1.00	10.19	0.34	10.19	0.32	10.19	0.31	10.19	0.31	10.19	0.31	10.19	0.31	-1.51
Lab 64	10.0	1.00	10.19	0.34	10.19	0.32	10.19	0.31	10.19	0.31	10.19	0.31	10.19	0.31	-1.51
Lab 79	10.0	1.00	10.19	0.34	10.19	0.32	10.19	0.31	10.19	0.31	10.19	0.31	10.19	0.31	-1.51
Lab 85	10.0	1.00	10.19	0.34	10.19	0.32	10.19	0.31	10.19	0.31	10.19	0.31	10.19	0.31	-1.51
Lab 88	10.0	1.00	10.19	0.34	10.19	0.32	10.19	0.31	10.19	0.31	10.19	0.31	10.19	0.31	-1.51
Lab 9	10.0	1.00	10.19	0.34	10.19	0.32	10.19	0.31	10.19	0.31	10.19	0.31	10.19	0.31	-1.51
Lab EX5	10.0	1.00	10.19	0.34	10.19	0.32	10.19	0.31	10.19	0.31	10.19	0.31	10.19	0.31	-1.51
Lab EX8	10.0	1.00	10.19	0.34	10.19	0.32	10.19	0.31	10.19	0.31	10.19	0.31	10.19	0.31	-1.51
Lab G01	10.0	1.00	10.19	0.34	10.19	0.32	10.19	0.31	10.19	0.31	10.19	0.31	10.19	0.31	-1.51
Lab 72	10.3	0.70	10.30	0.22	10.30	0.21	10.30	0.20	10.30	0.20	10.30	0.20	10.30	0.20	-0.90
Lab EX2	10.4	0.60	10.40	0.14	10.40	0.13	10.40	0.12	10.40	0.12	10.40	0.12	10.40	0.12	-0.70
Lab 67	10.8	0.20	10.80	0.00	10.80	0.00	10.80	0.00	10.80	0.00	10.80	0.00	10.80	0.00	0.11
Lab EX3	10.8	0.20	10.80	0.00	10.80	0.00	10.80	0.00	10.80	0.00	10.80	0.00	10.80	0.00	0.11
Lab 23	11.0	0.00	11.00	0.05	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	0.51
Lab 28	11.0	0.00	11.00	0.05	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	0.51
Lab 3	11.0	0.00	11.00	0.05	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	0.51
Lab 4	11.0	0.00	11.00	0.05	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	0.51
Lab 56	11.0	0.00	11.00	0.05	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	0.51
Lab 57	11.0	0.00	11.00	0.05	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	0.51
Lab 58	11.0	0.00	11.00	0.05	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	0.51
Lab 7	11.0	0.00	11.00	0.05	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	0.51
Lab 71	11.0	0.00	11.00	0.05	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	0.51
Lab 74	11.0	0.00	11.00	0.05	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	0.51
Lab 78	11.0	0.00	11.00	0.05	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	0.51
Lab 82	11.0	0.00	11.00	0.05	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	0.51
Lab 84	11.0	0.00	11.00	0.05	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	0.51
Lab 89	11.0	0.00	11.00	0.05	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	0.51
Lab EX6	11.0	0.00	11.00	0.05	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	0.51
Lab EX7	11.0	0.00	11.00	0.05	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	11.00	0.06	0.51
Lab EX4	11.6	0.60	11.60	0.69	11.59	0.69	11.53	0.60	11.50	0.57	11.50	0.56	11.49	0.56	1.72
Lab 66	12.0	1.00	11.81	1.08	11.59	0.69	11.53	0.60	11.50	0.57	11.50	0.56	11.49	0.56	2.52
Lab 68	12.0	1.00	11.81	1.08	11.59	0.69	11.53	0.60	11.50	0.57	11.50	0.56	11.49	0.56	2.52
<b>Average</b>	<b>10.7</b>		<b>10.77</b>	<b>7.42</b>	<b>10.76</b>	<b>6.58</b>	<b>10.75</b>	<b>6.28</b>	<b>10.75</b>	<b>6.17</b>	<b>10.75</b>	<b>6.14</b>	<b>10.75</b>	<b>6.12</b>	
<b>SD</b>	<b>0.58</b>		<b>0.48</b>	<b>0.23</b>	<b>0.45</b>	<b>0.21</b>	<b>0.44</b>	<b>0.20</b>	<b>0.44</b>	<b>0.19</b>	<b>0.44</b>	<b>0.19</b>	<b>0.44</b>	<b>0.19</b>	
<b>New x*</b>	<b>11.00</b>	<b>0.20</b>	<b>10.77</b>	<b>0.48</b>	<b>10.76</b>	<b>0.45</b>	<b>10.75</b>	<b>0.44</b>	<b>10.75</b>	<b>0.44</b>	<b>10.75</b>	<b>0.44</b>	<b>10.75</b>	<b>0.44</b>	
<b>New s*</b>	<b>0.54</b>		<b>0.55</b>		<b>0.51</b>		<b>0.50</b>		<b>0.50</b>		<b>0.50</b>		<b>0.50</b>		

N 33

Target value	<b>10.75</b>
Low Acceptable	<b>9.26</b>
High Acceptable	<b>12.24</b>
Acceptable Range	<b>9.44-12.21</b>

**Appendix - C Charts Dry Density Moisture Content Relationship in Soil**



### Appendix - C Charts Dry Density Moisture Content Relationship in Soil

