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Solar PV Facilities

Geotechnical Investigation - Addendum Report Additional Work

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PROJECT 276120 - SOLAR PV FACILITIES

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
A	Issued for internal review	Carol White	Dr GV Price	Dr GV Price	13-Feb-13	N/A	
B	Draft Report	Carol White	Dr GV Price	Dr GV Price	13-Feb-13	N/A	
C	Final Report	Carol White	Dr GV Price	Dr GV Price	04-Ma-13		
D	Draft Report	Carol White	Dr GV Price	Dr GV Price	13-Feb-13	N/A	

CONTENTS

1. INTRODUCTION

1.1 GENERAL

WorleyParsons geotechnical services was, on 26 September 2013, appointed by Arup to undertake an additional geotechnical investigation at the proposed new Solar PV Facility site, located at ERIC Building: Avonside Road (off Lower Germiston Road), Rosherville, Cleveland, Johannesburg, South Africa. This after Ms C White of WorleyParsons had, on 12 September 2013 provided Mr P Reis Neto of Arup with a methodology proposal and cost for the geotechnical investigation.

The geotechnical investigation would ascertain the foundation conditions available at the new PV facility site, and provide recommendations regarding founding for the new structures.

1.2 WorleyParsons PROPOSAL

(As per the request of the client)

Field Investigation

- Field investigations comprising excavation of trial holes at the site
- 3X Trial holes, would be excavated using a TLB
- Lowbed transportation of the TLB would be required to site
- Removal of disturbed samples for laboratory testing
- Profiling of Trial Holes using the method of Jennings *et al* with presentation using DotPlot
- 3X Compaction Tests
- 3X Dynamic Cone Penetration tests to determine bearing capacity and quality of *in situ* materials
- Compilation of an addendum to the report already submitted outling the findings of the investigation

1.3 AIM OF THIS REPORT

This report is aimed at determining the geology and founding conditions at the site and from these providing a geotechnical assessment of the geotechnical conditions with founding recommendations.

1.4 STRUCTURE OF THIS REPORT

The structure and content of the report continues as follows:

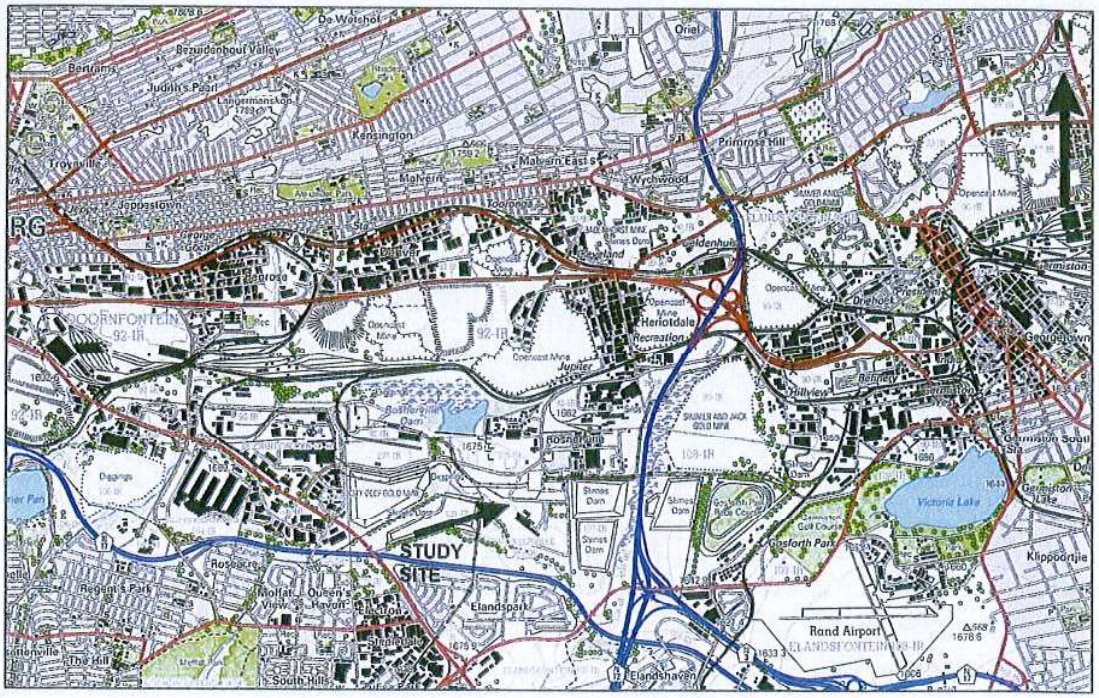
Chapter 2	Method of Investigation
Chapter 3	Site Description
Chapter 4	Geology
Chapter 5	Field Testing
Chapter 6	Laboratory Testing
Chapter 7	Geotechnical Appraisal

2. METHOD OF INVESTIGATION

The study area was indicated to WorleyParsons staff by the client on the day staff established on site for field investigations, namely 27 September 2013, with field investigations completed the same day.

Field investigations comprised the excavation and profiling of 3 trial holes at selected positions on the site; DCP testing and removal of disturbed samples for laboratory tests. The trial holes have been profiled according to the method of Jennings *et al* with presentation using DotPlot, and have been included as Appendix 1. DCP results have been included as Appendix 2 and Laboratory results as Appendix 3.

From this information a geotechnical report has been compiled outlining the findings of the investigation.



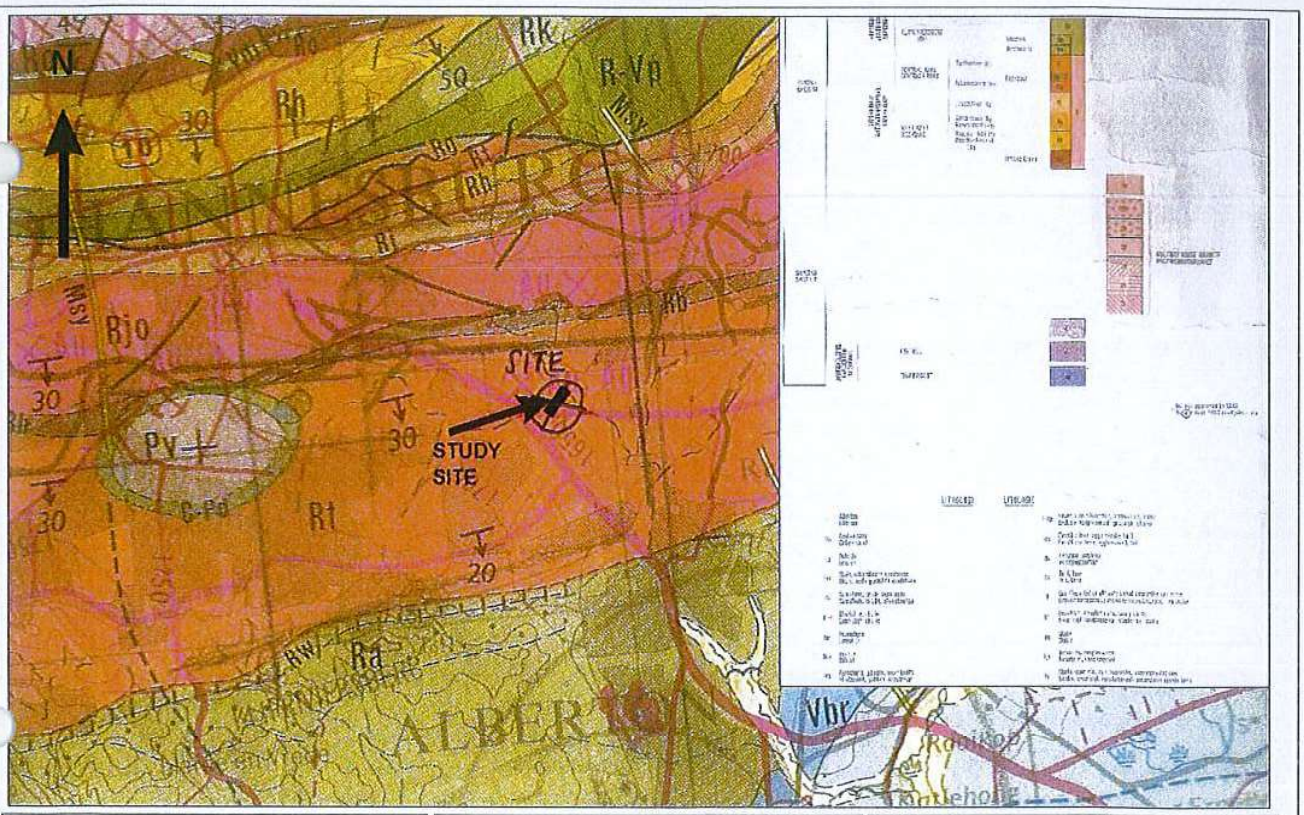
PROJECT: SOLAR PV FACILITIES	FIGURE 3.1: LOCALITY PLAN	WorleyParsons	Scale: Not to scale Date: February 2013

4. GEOLOGY

The rocks of the Witwatersrand Supergroup (2800-2300Ma) dominate the area in which the site is located. The site is specifically underlain by the Turffontein Subgroup which forms part of the Central Rand Group. To the north of the study area the relatively older rocks of the Johannesburg Subgroup and the West Rand Group are found as well as the basement granites of the Halfway House Formation. Two major faults are found north of the site introducing a lens of younger Ventersdorp Supergroup rocks. The Witwatersrand Supergroup rocks in the area are dipping to the south at angles between 20° and 50° indicating a dome structure centred on the granite basement. To the south of the study area feldspar porpheries, basaltic lavas and tuff of the Ventersdorp Supergroup are once again encountered. Syenitic dykes are present in the area but there was no evidence found of these dykes on site.

The Turffontein Subgroup is a sedimentary unit comprising mainly upward coarsening sequences of sandstone and conglomerate which is locally dipping at 20-30° to the south. The Turffontien Subgroup represents the final phase of deposition in the Witwatersrand basin and was deposited mainly under alluvial braid-plain and alluvial fan conditions. The conglomerates formed under these conditions were subject to erosional degradation leading to the formation of placers, known as the Kimberley Reefs. Locally deep erosional channels formed and these are generally filled by pyritic sands and mudstones.

Trial holes dug on site intersect quartzitic sandstone and together with minor mudstone horizons indicate founding of the site within one of the geological erosion channels or otherwise location in the lower part of the Turffontein sequence before conglomerate development.



PROJECT: **SOLAR PV FACILITIES**	**FIGURE 4.1: GEOLOGY PLAN**	**WorleyParsons**	**Scale: Not to scale** **Date: February 2013**

5. FIELD TESTING

5.1 TRIAL HOLE INVESTIGATIONS

The three trial holes on site intersected a relatively consistent profile *type* but with varying *depth* to rock as determined by individual locations. A generalised profile is as follows:

- *Slightly moist, dark brown, loose, intact GRAVELLY SILT: Colluvium overlying*
- *Pinkish brown, highly to completely weathered, closely jointed, soft to medium hard rock QUARTZITIC SANDSTONE overlying*
- *Light pink brown, moderately weathered, closely jointed, medium hard to hard rock, QUARTZITIC SANDSTONE*

Individual Trial Hole profiles compiled in DotPlot format are presented as appended.

Depth to rock head is variable with depth to refusal also highly variable as tabulated below. No groundwater seepage was intersected in any of the Trial Holes. The relatively water-tight massive quartzitic sandstone base and overlying near-surface permeable colluvium, however indicate perched groundwater conditions after rain are a distinct possibility.

Table 5.1: Unconsolidated soil thickness

Trial Hole	*Thickness of Colluvium (m)*	*Thickness of Pebble Marker (m)*	*Thickness of soft to medium hard rock Quartzitic Sandstone (m)*	*Thickness of med-hard to hard rock Quartzitic Sandstone (m)*	*Depth of Trial Hole (m)*
TH9	0.18	0.22	1.70	-	2.10
TH10	0.50	-	0.90	0.10	1.50
TH11	0.50	-	0.70	0.10	1.30

Trial holes generally represent only point sources of information which must be borne in mind when interpreting results, and there should be no interpolation between trial holes. Variations, furthermore, will occur and should be expected.

A photograph of each Trial Hole is included over page with individual profiles presented in DotPlot format in Appendix 1.

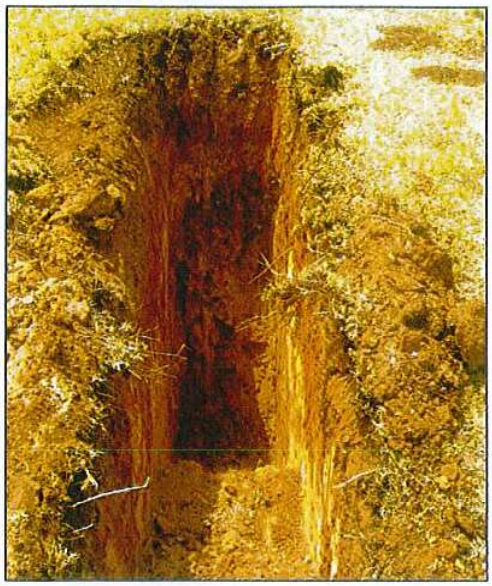


Plate 1: Trial Hole 9 Narrow Face

S 26° 13' 55.7" E 28° 06' 50.6"

Plate 2: Trial Hole 9 Sidewall

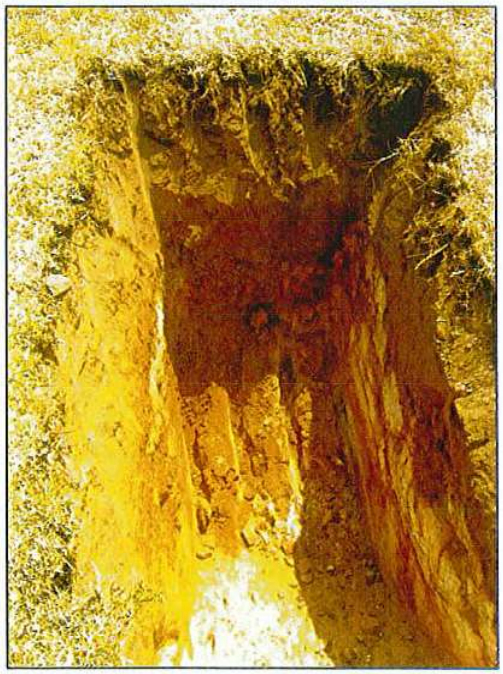


Plate 3: Trial Hole 10 Narrow Face

S 26° 13' 57.3" E 28° 06' 50.1"

Plate 4: Trial Hole 10 Sidewall

Plate 5: Trial Hole 11 Narrow Face

S 26° 13' 58.0" E 28° 06' 51.2"

Plate 6: Trial Hole 11 Sidewall

5.2 DCP TESTING

Four Dynamic Cone Penetrometer (DCP) tests have been undertaken with one at each trial hole position and one in TH 9. DCP positions vary with 3 placed at surface and one at a depth of 1.60m within trial hole number 9

Results are consistent with the soil profile and indicate that bearing capacities are in general relatively high in the underlying rock, varying from 233kPa to >900kPa. Soft spots are indicated lower down in some of the profiles. The bearing capacities shown by all DCP tests show an increase with hardness as the penetration decreases within the underlying rock. The DCP results are included in the report as Appendix 2.

It is very important to note though that DCP values should only be used for comparative purposes and not as a finite standard since dynamic penetration will vary with variations in moisture content. A wet profile will therefore indicate far lower bearing capacity values.

PROJECT: **SOLAR PV FACILITY**	**FIGURE 5.1: TRIAL HOLE LOCALITY PLAN UPDATED**	**WorleyParsons**	**Scale: Not to scale** **Date: October 2013**

6. LABORATORY TESTING

This section of the report presents the findings of the laboratory testing undertaken on disturbed samples retrieved for that purpose. Laboratory testing has been undertaken by CiviLab of Johannesburg on disturbed samples removed from site as described. Major aspects of the testing are indicated in Table 6.1.1. With the complete set of test results included as Appendix 3.

6.1 LABORATORY TEST RESULTS

Table 6.1.1 Laboratory Test Results

Sample #	TH	Dep. (m)	Description	Moisture Density Relationship		Field Density Data		
				Maximum Dry Density (kg/m^3)	Optimum Moisture Content (%)	Dry Density (kg/m^3)	Moisture Content (%)	Compaction (%)
2158-1	9	1600 - 1900	*Pinkish brown, highly to completely weathered, Quartzitic Sandstone*	2052	8.7	1863	8.3	90.8

Where:-
TH: Trial Hole
Dep: Depth

Soil Compaction Testing (density tests) is performed in order to determine the *in situ* soil compaction level. This compaction is a comparison of the maximum MOD AASHTO laboratory compaction to the field density and recorded as a percentage of maximum.

Laboratory results for this site show that field density is 90.8% of the maximum MOD AASHTO density at Optimum Moisture Content. Additional compaction tests could not be undertaken due to the intersection of rock. Please refer to section 7.4 Structure Foundations.

7. GEOTECHNICAL APPRAISAL

7.1 GENERAL

Trial hole excavations on site indicate a profile of a thin covering of colluvial gravelly silt overlying either highly weathered quartzitic sandstone or harder moderate/ slightly weathered quartzitic sandstone on which the TLB refuses.

7.2 FOUNDING DEPTHS

The rockhead depth varies from 0,4m to 0,5m with TLB refusal within the weathered rock varying between 1,3m and 1,5m. Founding on harder; less weathered rock at depth has the advantage of attaining founding in a better quality rockmass with higher bearing capacities should this be required. It also means that any soft spots or zones of clay with potential heave/ shrinkage are avoided thereby eliminating any geotechnical differential settlement; heave or shrinkage problems. Trial hole excavations intersected rock in two of the trial holes. Weathering of the rock decreases with depth followed by a corresponding increase in the hardness and bearing capacity of the rock and ultimately TLB refusal.

7.3 FOUNDING– PV SOLAR BASES

It is recommended that all the PV solar bases be located within the underlying rock. Contractor's structural engineer, however, must determine the final design, depth and type of foundations required.

Methodologies that could be of some potential assistance to the structural engineer include the following:

7.3.1 Concrete Block Bases

Concrete block bases should in all instances be founded at the level of the underlying rock. Where the rock is highly weathered the bases should be socketed a minimum of 200mm into the weathered rock.

7.3.2 Hammered/ Driven Founding

Solar PV panels could be installed on support columns driven into the underlying substrata via hammering into the ground. This, however, can only be performed where the underlying rockmass is completely weathered and the rock therefore soft. Since this occurs over a relatively small area of the overall site it may be of only limited potential.

7.3.3 Drilled Founding

Percussion bored holes could be considered for founding of columns in areas underlain by hard rock. Here founding can either be achieved by backfilling the predrilled boreholes with

the excavated drill material and then ramming the panel columns to refusal or by grouting of the columns with a cement grout.

Note that there are other methods that can be considered such as screw anchorage, etc. Those listed are therefore only options to be *considered* and have been included as an aid to the structural engineer only.

7.4 STRUCTURE FOUNDATIONS

The recommended geotechnical outcome is to construct foundations for the new buildings on rock since this will provide high bearing capacity and obviate geotechnical problems derived from possible differential settlement in the near-surface loose colluvium. It is therefore recommended that all foundations be founded at least 200mm into the underlying harder moderately weathered rock at TLB refusal depth.

If the rock does prove somewhat deep; perhaps in excess of 1,5m, then a system such as trench-fill could be considered using compacted inert geotechnical materials to minimize concrete footing depths. If trench fill is used, strip footings will be required but with some articulation in walls in order to accommodate any slight post-construction settlements. Foundations should be lightly reinforced, brickforce included in the walls and joint articulation provided, again to minimise any post-construction differential movements

Appendix 1 – Trial Hole Logs

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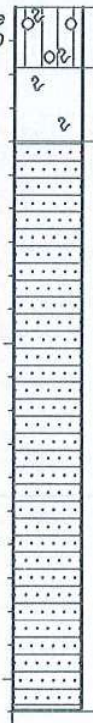
HOLE No: TH9
Sheet 1 of 1

JOB NUMBER: 276120

Scale 1:20



0.00 Slightly moist, dark brown, medium dense, intact, GRAVELLY SILT with abundant roots.

0.18 Pebble marker with abundant roots.

0.40 Pinkish brown, highly to completely weathered, closely jointed, soft to medium hard rock: QUARTZITIC SANDSTONE.

2.10

NOTES

1) End of hole at 2.10m.

2) No water.

3) TLB stopped @ 2.10m.

4) Sample TH9/MOD&CBR @ 1.60m.

5) Co-ordinates: S 26 13' 55.7" E 28 06' 50.6"

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY : C. WHITE
TYPE SET BY : CAJ
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 29 SEPTEMBER 2013
DATE : 07/10/2013 08:58
TEXT : ..hase2\TrialHoles\TH9.doc

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TH9

D09D TERRECO

dotPLOT 7009 PBpH67

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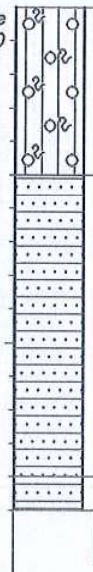
ARUP (PTY) LTD
Arup Solar PV Facilities

HOLE No: TH10
Sheet 1 of 1

JOB NUMBER: 276120

Scale 1:20



0.00 Slightly moist, dark brown, medium dense, intact: GRAVELLY SILT with abundant roots.

0.50 Pinkish brown, highly to completely weathered, closely jointed, soft to medium hard rock: QUARTZITIC SANDSTONE.

1.40 Pinkish brown, moderately weathered, closely to widely jointed, medium hard to hard rock: QUARTZITIC SANDSTONE.

1.50

NOTES

1) End of hole at 1.50m.

2) No water.

3) TLB refusal @ 1.40m.

4) Co-ordinates: S 26 13' 57.3" E 28 06' 50.1"

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY : C. WHITE
TYPE SET BY : CAJ
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 29 SEPTEMBER 2013
DATE : 07/10/2013 08:58
TEXT : ..ase2\TrialHoles\TH10.doc

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TH10

D09D TERRECO

dotPLOT 7009 PBpH67

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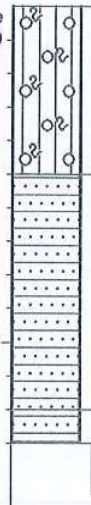
Arup Solar PV Facilities

HOLE No: TH11
Sheet 1 of 1

JOB NUMBER: 276120

Scale 1:20



0.00 Slightly moist, dark brown, medium dense, intact: GRAVELLY SILT with abundant roots.

0.50 Pinkish brown, highly to completely weathered, closely jointed, soft to medium hard rock: QUARTZITIC SANDSTONE.

1.20 Pinkish brown, moderately weathered, closely to widely jointed, medium hard to hard rock: QUARTZITIC SANDSTONE.

1.30

NOTES

1) End of hole at 1.30m.

2) No water.

3) TLB refusal @ 1.30m.

4) Sample TH11/MOD&CBR @ 1.00m.

5) Co-ordinates: S 26 13' 58.0" E 28 06' 51.2"

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY : C. WHITE

INCLINATION :
DIAM :
DATE :
DATE : 29 SEPTEMBER 2013

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TH11

TYPE SET BY : CAJ
SETUP FILE : STANDARD.SET

DATE : 07/10/2013 08:58
TEXT : ..ase2\TrialHoles\TH11.doc

Appendix 2 – DCP Results

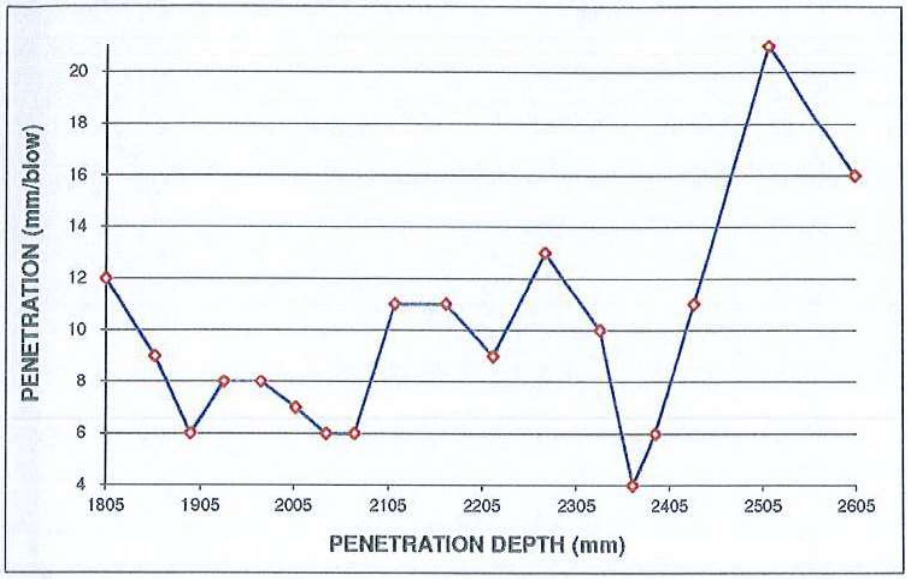
DYNAMIC CONE PENETROMETER TEST

TERRECO

Job Name Arup Solar Facilites

File No: Job No: GT471 Date of Test: 27/09/2013

DCP No: Trial Hole 9 Location: S 26° 13' 55.7" E 28° 06' 50.6"



Penetration Guide mm/blow	Consistency
< 5	Very Dense
5 - 10	Dense
10 - 30	Med Dense
30 - 75	Loose
75 -100	Very Loose

NOTE :
Stated consistencies do not apply to cohesive materials. Describe using "stiff or firm or soft".

Depth of hole in which DCP was taken : 1600 mm below NGL Readings : 19

Applied Factor : 1.5 times Terzaghi's value

Remarks :

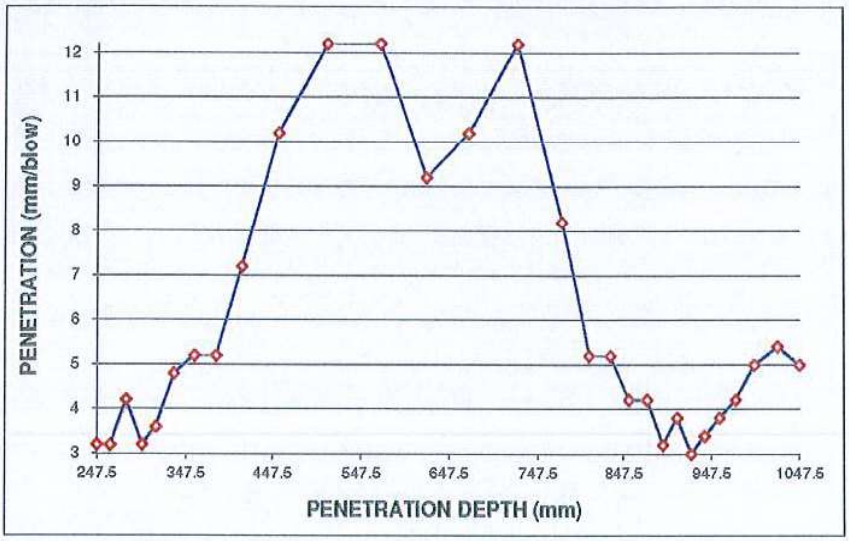
Reading No.	Layer From	Layer To	Average Layer Depth	Field Reading Blows/layer	Level Below NGL mm	DCP No DN mm/blow	Equiv. N Value	Approx In-situ CBR	Approx EASBP kPa
1	110	175	142.5	0					
2	175	235	205	5	1805	12	25	18	427
3	235	280	257.5	5	1857.5	9	33	26	578
4	280	310	295	5	1895	6	50	44	900
5	310	350	330	5	1930	8	38	31	654
6	350	390	370	5	1970	8	38	31	654
7	390	425	407.5	5	2007.5	7	43	36	751
8	425	455	440	5	2040	6	50	44	900
9	455	485	470	5	2070	6	50	44	900
10	485	540	512.5	5	2112.5	11	27	20	468
11	540	595	567.5	5	2167.5	11	27	20	468
12	595	640	617.5	5	2217.5	9	33	26	578
13	640	705	672.5	5	2272.5	13	23	16	392
14	705	755	730	5	2330	10	30	23	518
15	755	775	765	5	2365	4	50	76	900
16	775	805	790	5	2390	6	50	44	900
17	805	860	832.5	5	2432.5	11	27	20	468
18	860	965	912.5	5	2512.5	21	14	9	233
19	965	1045	1005	5	2605	16	19	12	314
20	1045								

DYNAMIC CONE PENETROMETER TEST

TERRECO

Job Name Arup Solar Facilities
File No: Job No: GT471 Date of Test: 27/09/2013

DCP No: Trial Hole 9 Location: S 26° 13' 55.7" E 28° 06' 50.6"



Penetration Guide	
mm/blow	Consistency
< 5	Very Dense
5 - 10	Dense
10 - 30	Med Dense
30 - 75	Loose
75 -100	Very Loose

NOTE :
Stated consistencies do not apply to cohesive materials. Describe using "stiff or firm or soft".

Depth of hole in which DCP was taken : 0 mm below NGL Readings : 30
Applied Factor : 1.5 times Terzaghi's value
Remarks :

Reading No.	Layer From	Layer To	Average Layer Depth	Field Reading Blows/layer	Level Below NGL mm	DCP No DN mm/blow	Equiv. N Value	Approx In-situ CBR	Approx EASBP kPa
1	125	240	182.5	0					
2	240	255	247.5	5	247.5	3	50	110	900
3	255	270	262.5	5	262.5	3	50	110	900
4	270	290	280	5	280	4	50	76	900
5	290	305	297.5	5	297.5	3	50	110	900
6	305	322	313.5	5	313.5	3	50	94	900
7	322	345	333.5	5	333.5	5	50	63	900
8	345	370	357.5	5	357.5	5	50	56	900
9	370	395	382.5	5	382.5	5	50	56	900
10	395	430	412.5	5	412.5	7	43	36	751
11	430	480	455	5	455	10	30	23	518
12	480	540	510	5	510	12	25	18	427
13	540	600	570	5	570	12	25	18	427
14	600	645	622.5	5	622.5	9	33	26	578
15	645	695	670	5	670	10	30	23	518
16	695	755	725	5	725	12	25	18	427
17	755	795	775	5	775	8	38	31	654
18	795	820	807.5	5	807.5	5	50	56	900
19	820	845	832.5	5	832.5	5	50	56	900
20	845	865	855	5	855	4	50	76	900
21	865	885	875	5	875	4	50	76	900
22	885	900	892.5	5	892.5	3	50	110	900
23	900	918	909	5	909	4	50	87	900

24	918	932	925	5	925	3	50	110	900
25	932	948	940	5	940	3	50	101	900
26	948	966	957	5	957	4	50	87	900
27	966	986	976	5	976	4	50	76	900
28	986	1010	998	5	998	5	50	60	900
29	1010	1036	1023	5	1023	5	50	54	900
30	1036	1060	1048	5	1048	5	50	60	900
31	1060								
32									

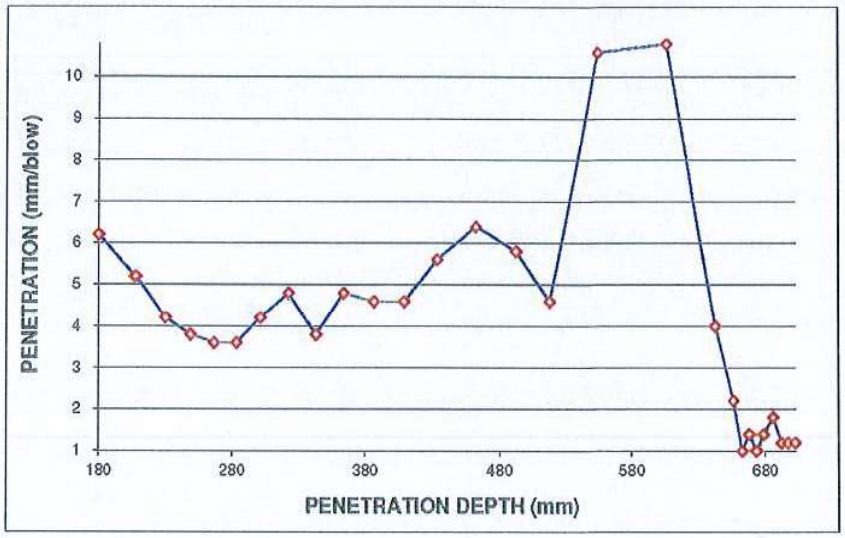
DYNAMIC CONE PENETROMETER TEST

TERRECO

Job Name Arup Solar Facilities

File No: Job No: GT471 Date of Test: 27/09/2013

DCP No: Trial Hole 10 Location: S 26° 13' 57.3" E 28° 06' 50.1"



Penetration Guide	
mm/blow	Consistency
< 5	Very Dense
5 - 10	Dense
10 - 30	Med Dense
30 - 75	Loose
75 -100	Very Loose

NOTE :
Stated consistencies do not apply to cohesive materials. Describe using "stiff or firm or soft".

Depth of hole in which DCP was taken : 0 mm below NGL Readings : 29

Applied Factor : 1.5 times Terzaghi's value

Remarks :

Reading No.	Layer From	Layer To	Average Layer Depth	Field Reading Blows/layer	Level Below NGL mm	DCP No DN mm/blow	Equiv. N Value	Approx In-situ CBR	Approx EASBP kPa
1	85	165	125	0					
2	165	195	180	5	180	6	50	44	900
3	195	220	207.5	5	207.5	5	50	56	900
4	220	240	230	5	230	4	50	76	900
5	240	258	249	5	249	4	50	87	900
6	258	275	266.5	5	266.5	3	50	94	900
7	275	292	283.5	5	283.5	3	50	94	900
8	292	312	302	5	302	4	50	76	900
9	312	335	323.5	5	323.5	5	50	63	900
10	335	353	344	5	344	4	50	87	900
11	353	376	364.5	5	364.5	5	50	63	900
12	376	398	387	5	387	4	50	67	900
13	398	420	409	5	409	4	50	67	900
14	420	447	433.5	5	433.5	5	50	51	900
15	447	478	462.5	5	462.5	6	48	43	851
16	478	506	492	5	492	6	50	49	900
17	506	528	517	5	517	4	50	67	900
18	528	580	554	5	554	10	29	22	497
19	580	633	606.5	5	606.5	11	28	21	487
20	633	652	642.5	5	642.5	4	50	81	900
21	652	662	657	5	657	2	50	110	900
22	662	666	664	5	664	1	50	110	900
23	666	672	669	5	669	1	50	110	900

24	672	676	674	5	674	1	50	110	900
25	676	682	679	5	679	1	50	110	900
26	682	690	686	5	686	2	50	110	900
27	690	695	692.5	5	692.5	1	50	110	900
28	695	700	697.5	5	697.5	1	50	110	900
29	700	705	702.5	5	702.5	1	50	110	900
30	705								
31									
32									

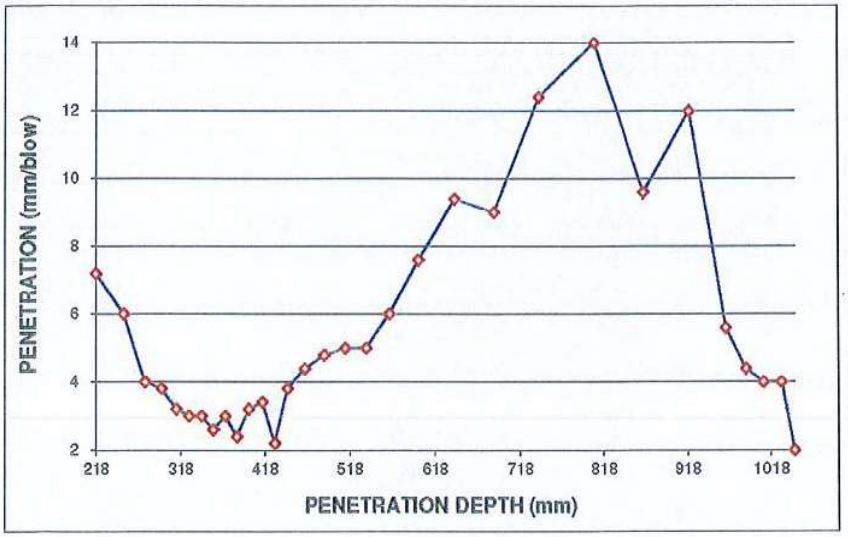
DYNAMIC CONE PENETROMETER TEST

TERRECO

Job Name Arup Solar Facilities

File No: Job No: GT471 Date of Test: 27/09/2013

DCP No: Trial Hole 11 Location: S 26° 13' 58.0" E 28° 06' 51.2"



Penetration Guide	
mm/blow	Consistency
< 5	Very Dense
5 - 10	Dense
10 - 30	Med Dense
30 - 75	Loose
75 -100	Very Loose

NOTE :
Stated consistencies do not apply to cohesive materials. Describe using "stiff or firm or soft".

Depth of hole in which DCP was taken : 0 mm below NGL Readings : 32

Applied Factor : 1.5 times Terzaghi's value

Remarks :

Reading No.	Layer From	Layer To	Average Layer Depth	Field Reading Blows/layer	Level Below NGL mm	DCP No DN mm/blow	Equiv. N Value	Approx In-situ CBR	Approx EASBP kPa
1	130	200	165	0					
2	200	236	218	5	218	7	42	35	729
3	236	266	251	5	251	6	50	44	900
4	266	286	276	5	276	4	50	76	900
5	286	305	295.5	5	295.5	4	50	81	900
6	305	321	313	5	313	3	50	101	900
7	321	336	328.5	5	328.5	3	50	110	900
8	336	351	343.5	5	343.5	3	50	110	900
9	351	364	357.5	5	357.5	3	50	110	900
10	364	379	371.5	5	371.5	3	50	110	900
11	379	391	385	5	385	2	50	110	900
12	391	407	399	5	399	3	50	101	900
13	407	424	415.5	5	415.5	3	50	94	900
14	424	435	429.5	5	429.5	2	50	110	900
15	435	454	444.5	5	444.5	4	50	81	900
16	454	476	465	5	465	4	50	67	900
17	476	500	488	5	488	5	50	60	900
18	500	525	512.5	5	512.5	5	50	56	900
19	525	550	537.5	5	537.5	5	50	56	900
20	550	580	565	5	565	6	50	44	900
21	580	618	599	5	599	8	39	33	689
22	618	665	641.5	5	641.5	9	32	25	552
23	665	710	687.5	5	687.5	9	33	26	578

24	710	772	741	5	741	12	24	17	412
25	772	842	807	5	807	14	21	15	362
26	842	890	866	5	866	10	31	24	540
27	890	950	920	5	920	12	25	18	427
28	950	978	964	5	964	6	50	49	900
29	978	1000	989	5	989	4	50	67	900
30	1000	1020	1010	5	1010	4	50	76	900
31	1020	1040	1030	5	1030	4	50	76	900
32	1040	1050	1045	5	1045	2	50	110	900
33	1050								
34									

Appendix 3 – Laboratory Results

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Civilab

Civil Engineering Testing Laboratories

Client	: WORLEYPARSONS RSA (PTY) LTD (C	Date Received:	27/09/2013
Project	: Rosherville	Date Reported:	07/10/2013
Project No:	2013-B-2158	Page No. :	2 of 3

MOISTURE DENSITY RELATIONSHIP

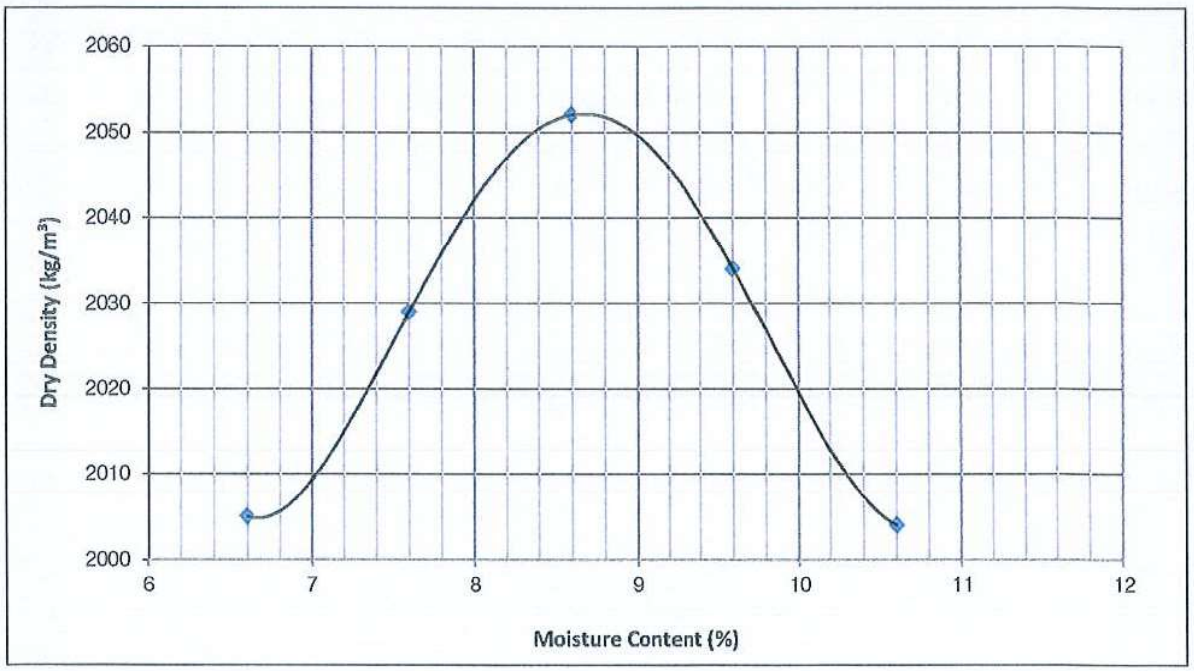
Laboratory Number		1
Field Number		TP9
Client Reference		
Depth (m)		1.6-1.9
Position		
Coordinates	X	
	Y	
Description		Insitu
Additional Information		
Calcrete / Crushed Stabilizing Agent		

Maximum Dry Density & Optimum Moisture Content - TMH1 Method A7

Compactive Effort:	Modified AASHTO

Dry Density	kg/m³	2005	2029	2052	2034	2004	
Moisture Content	%	6.6	7.6	8.6	9.6	10.6	

Max. Dry Density	kg/m³	2052
Optimum Moisture	%	8.7



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Civilab
Civil Engineering Testing Laboratories

Compaction Control: Nuclear Method

Project:	ROSHERVILLE - ESKOM		
Project Number:	2013-B-2158	Date Tested:	27 SEPTEMBER 2013
Description:	IN SITU		
Layer or Reduced Level:	IN SITU		

Field Reference			Moisture Density Relationship			Field Density Data		
Test Number	Position	Testing Depth (mm)	Lab. Sample Ref.	Maximum Dry Density (kg/m^3)	Optimum Moisture Content (%)	Dry Density (kg/m^3)	Moisture Content (%)	Compaction (%)
1	TP 9	1600 - 1900	2158-1	2052	8.7	1863	8.3	90.8

Remarks: The tests were in accordance with Method A10(b): Method C of TMH1 of 1986
Moisture contents were determined in accordance with paragraph 3.5 of Method A7 of TMH1 of 1986.

Sketch:

The tests were executed according to test method A10(b) method C of TMH1 of 1986.
The results reported relate only to the positions and depths tested.