Geotechnical Report for

Bokamoso Solar Plant, Near Leeudoringstad, North West Province

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1. INTRODUCTION AND TERMS OF REFERENCE

1.1 Scope

This report presents the preliminary findings of a geotechnical investigation for the proposed 75MW solar farm at Bokamoso, between Orkney and Leeudoringstad along the R502, in the North West province. The field investigation was conducted during July 2014 and the area comprises approximately 130ha of vacant land. It is understood that the proposed development will comprise a single axis tracker photovoltaic (PV) solar plant, substation and associated infrastructure.

1.2 Terms of Appointment

The work was carried out in accordance with our quote, Quote 775 dated June 2014. Appointment was confirmed by a letter of acceptance of the quote received from Kabu Kaseu on the 10th of July 2014.

1.3 Aims and Methodology

The objectives of the study are:

- To analyse the geotechnical conditions present, assess the general suitability of the site and to make recommendations for site works for the proposed development.
- To provide foundation recommendations for the proposed development and to comment on geotechnical factors that would have an impact on the development of the site to enable economic design and construction of the proposed development.
- To identify relevant ground-related features and determine the variability of ground conditions and the effect of such variability on the proposed development.

The following methodology was adopted to realise the aims of the study:

- Review of available geological records and site plans.
- Undertaking of a geotechnical site investigation comprising TLB excavated trial pits to profile soils, investigate soil strengths/capacities and identify potential problem soils on site.
- Dynamic Penetrometer Light (DPL) and Dynamic Penetrometer Super Heavy (DPSH), probe test to investigate soil strength and capacities.

- Undertaking of laboratory testing to establish geotechnical and design parameters of the soils.
- Identification of relevant ground-related features and their influence on the proposed development.

1.4 Codes of Practices and Standards

The investigation was carried according to standard practice codes and guidelines including the 2010 SAICE Geotechnical Division Site Investigation Code of Practice.

1.5 Limitations of Assessment

The investigation comprised a limited number of testing positions and is not likely to reveal the detail of the conditions that will become evident during construction. It is thus imperative that a Competent Person inspects all excavations to ensure that conditions at variance with those predicted do not occur and to undertake an interpretation of the facts supplied in this report to apply to on-site conditions as exposed during development of the site.

Our opinions can only be based on what was visible at the time the survey was conducted. This report has been prepared for the exclusive use of the client, with specific application to the proposed project.

2. DESCRIPTION OF SITE AND SURROUNDING AREA

2.1 Information Sources

The following information sources were consulted and made available;

- Geological Map, Sheet 2726 (Kroonstad) at a scale of 1:250 000.
- Google Earth images of the site.
- Previous Vela VKE/SMEC Reports on projects in the area.
- Layout plans of the solar plant infrastructure.
- Solar panel designs and loads.
- Published technical references (listed in Section 8 of this report)

2.2 Location and Site description

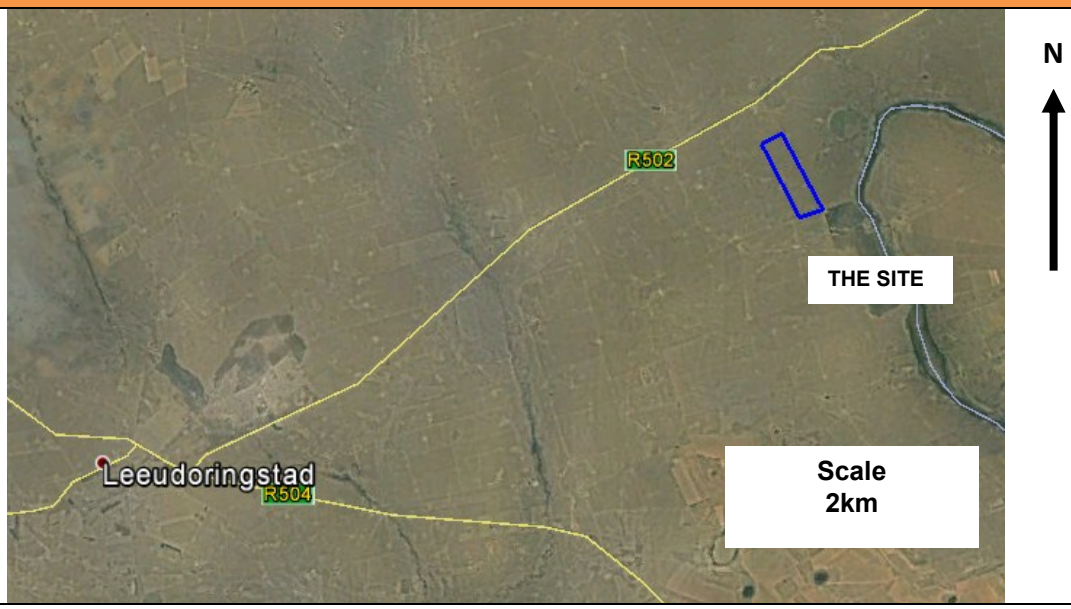
The Bokamoso site, allocated for the proposed development, is situated between Orkney and Leeudoringstad along the R502 in the North West Province. The site is situated at approximate GPS co-ordinates of 27.16077°S and 26.403160°E within the Klerksdorp District Municipality area. The area of the proposed development is 130 Ha section of the Matjiesspruit Farm, and is currently used as grazing for cattle. Access to the site is from the gravel road to the north east of the site running from the R502. A site location plan and aerial imagery of the site are given as Figures 2.1 and 2.2 hereunder.

2.3 Drainage and Topography

The farm is generally flat, with slopes of less than 2%. The site does slope slightly from the north-west down to the south-east, towards the Vaal River. The farm is undeveloped and used for grazing, with the surface area characterised by dry sand, with scattered andesite and quartzite cobbles and boulders. Andesite also outcrops in various areas across site; the ground cover generally becomes sandier towards the eastern section of the site.

Figure 2.1: Site Location Plan.

Figure 2.2: Aerial Imagery of the Site.



2.4 Climate

The area has a semi-arid climate according to the Koppen climate classification, with warm to hot summers and cool, dry winters. The average annual precipitation is about 580mm with most rainfall occurring mainly during summer. Thunderstorms are common in the summer months. The average maximum daily temperatures vary from 29ºC in January to 18ºC in July, but temperatures can drop to 0^0C.

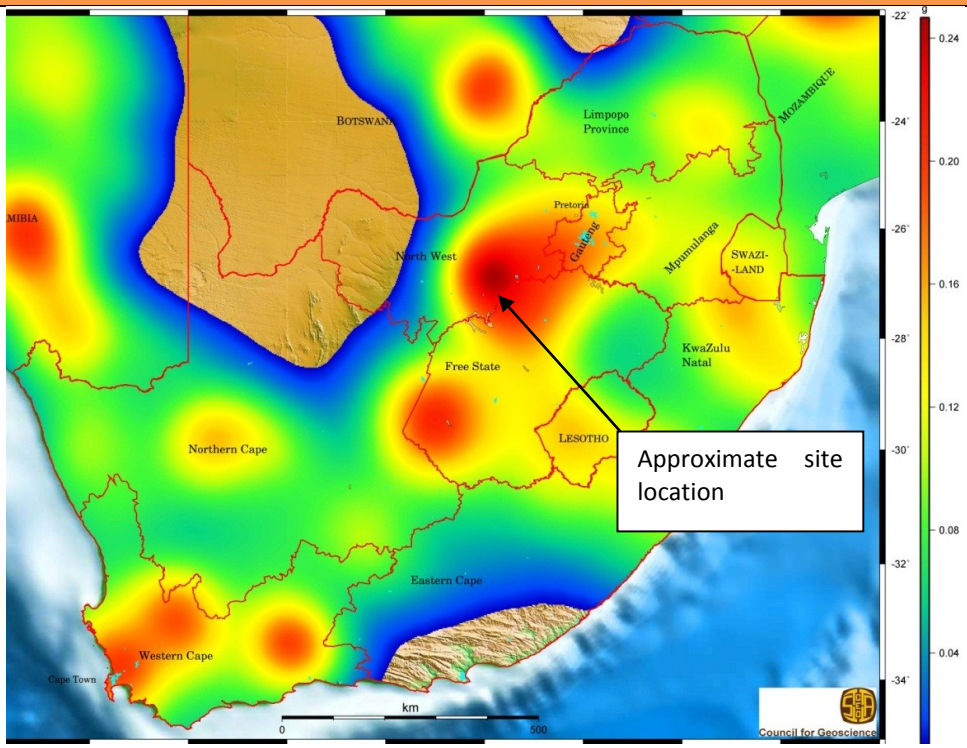
Climate determines the mode and rate of weathering. The effect of climate on the weathering process (i.e. soil formation) is determined by the climatic N-value defined by Weinert.

The climatic N-value is about 4.8 for the Klerksdorp area. The chemical disintegration of rocks will therefore be dominant over mechanical decomposition.

2.5 Seismicity

According to the Seismic Hazard Map of South Africa contained in the South African Loading Code - SANS 10160 the peak ground acceleration (g) with a 10% probability of being exceeded in a 50 year period for the site is in the order of 0.2 – 0.24g. This factor will have to be taken into account in the design of structures, but given the types of structures envisaged, should not be restrictive. An extract of this map indicating the position of the site is provided below in Figure 2.3.

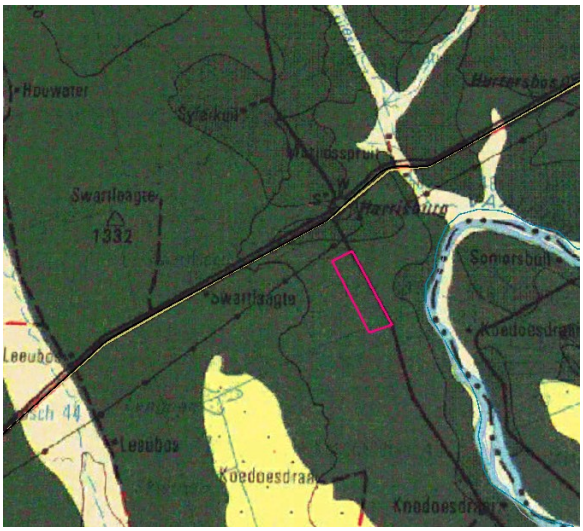
Figure 2.3: Seismic Hazard Map of South Africa.



3. GEOLOGY

According to the Geological Map of Kroonstad 2726 (scale 1:250 000) the entire site is underlain by andersite of the Allanridge Formation, Ventersdorp Supergroup. Alluvial material, associated with the Vaal River, partly covers the south eastern part of the site. Figure 3.1 indicates the geology of the site and the surrounding area.

Figure 3.1: Regional Geological Extract.



	Rock Types	Formation	Era / Super Group	Eon
	Alluvium		Quaternary Era	Cenozoic
	Aeolian			
	Andesite	Allenridge	Ventersdorp Supergroup	Late Archean / Early Proterozoic

The Allanridge Formation is the uppermost unit of the Ventersdorp Supergroup. It is composed of fine-grained, intermediate composition, amygdaloidal and slightly porphyritic lava. It usually follows conformably on the Bothaville Formation, but it is known to lap onto the basement near the margins of the Ventersdorp Basin.

The constituent minerals in andesite usually weather to produce a well-defined colour sequence in the residual soil. Pyroxenes alter to chlorite which provides the distinct green colour which is particularly prevalent in lower zones of residual soil. As the chlorite alters higher in the profile, iron in the lattice structure oxidises and hydrates to form limonite or yellow ochre and provides yellow coloured material. In upper zones, above the water table, where the soil may be seasonally desiccated, haematite or red ochre is produced, providing a characteristic red or reddish brown colour, particularly near the surface.

Iron compounds often become concentrated in the upper zones of the residual soil to form ferricrete. This is produced by seasonal precipitation and gradual accumulation of insoluble iron oxides and hydroxides within the soil mass. Its development depends on the amount of iron available and on repeated annual fluctuations in the water table levels.

Bedrock is covered by a relatively thin surface veneer that comprises sandy gravel, being sandier within the floodplains of the local streams and within the vicinity of the pans.

photo of the black clay is included as Figure 5.3. The clay is underlain by residual andesite and is also evident in Figure 5.3.

Laboratory Testing: Two foundation indicator tests were conducted on samples obtained from this layer. The material was found to have a very high PI of up to 34. The material also classifies as “medium” to “high” expansiveness based on the van der Merwe method. This indicates that clay is highly active and heave is to be expected when moisture is introduced to the material. A pH and conductivity test was also conducted on the clayey material. The conductivity test indicated the black clay to be mildly corrosive.

Figure 5.3: Black Clay (underlain by residual andesite)

DPL and DPSH Testing: Four DPL and DPSH tests were conducted through the black clay. The average equivalent SPT N value is 19 and ranges from 8 to 36. Once again it has to be stated that these N values are probably overestimated. In the clay this particular due to the apparent strength provided by high suction pressures within the soil structure. Very high suction pressures are associated with dry fine grained soils.

5.1.4 Andesite Boulders

Various size and shape andesite boulders were encountered on site. Larger boulders were specifically encountered towards the west. The layer is clast supported and mostly present within a red sandy matrix, which is believed to be the upper horizon of residual andesite. Boulders were yellow, brown, black and blue in colour. The thickness of this layer varies greatly across site. Excavation with the TLB often refused in this layer. A typical photo of the andesite boulders is included as Figure 5.4.

Laboratory Testing: No laboratory testing was conducted on material from this layer as it would not be practical.

DPL and DPSH Testing: A total of 21 DPL or DPSH tests were conducted in the andesite boulder layer. Most of the DPL/DPSH tests refused on the boulders. The minimum equivalent SPT N value that was found in this layer was 11. DPL and DPSH testing is not suited for layers where boulders occur, thus no meaningful parameters can be deduced from DPL and DPSH testing.

Figure 5.4: Andesite Boulders

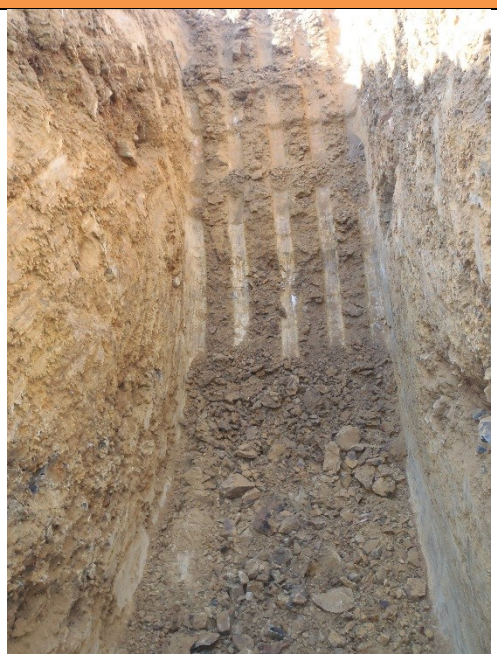
5.1.5 Residual Andesite

Although the andesite boulder layer also classifies as residual andesite, the residual andesite material here refers to the clayey gravel, generally yellow residual andesite. The layer is encountered beneath the transported/pedogenic layer. At shallow depths the residual andesite is a clayey gravel becoming less clayey and sandier with depth. Gravel excavated from shallower depths typically breaks down to sub-rounded and rounded particles, but becomes more angular and generally larger with depth. The layer is light yellow to light brownish yellow which is blotched black in most areas. Weathering generally decreases with depth and over the total area of the site, refusal on medium hard rock andesite occurred in most of the test pits. Many of the samples were tested to have a unified classification different from their logged makeup, this is due to the fact that the cobbles and larger gravel, making up large parts of the samples were often too large to be foundation indicator tested and for this reason generally matrix rich samples were taken for testing. A typical photo of the residual andesite is included as Figure 5.5.

Laboratory Testing: A total of 7 foundation indicator tests, 2 CBR tests, 1 double oedometer, 1 pH and conductivity test, and 1 triaxial test were conducted on the residual andesite (including the test on the material from the pedogenic layer).

Foundation Indicator tests indicated the residual andesite to have a PI of about 20 to 30 and is generally classified as a SC/GC material. The potential expansiveness is generally classified as “Low” to “Medium” according to the van der Merwe expansiveness classification.

Figure 5.4: Residual Andesite



Mod AASHTO/CBR testing indicates that this material classifies as a worse than G9 material. The residual andesite is not recommended for construction purposes. The maximum dry density of the material is about 1910 kg/m³ and the optimum moisture content 12 – 14%. CBR values are however very low.

The pH of the material indicates the material to be fairly neutral whilst the conductivity indicates the soil to be classified as “corrosive”.

Double oedometer results indicate that collapse settlement classifies as “trouble”. The fundamentals of this analysis uses the difference in settlement between the samples tested at natural moisture content and the sample tested saturated, at a pressure of 200kPa. It is expected that loads from the PV panels will not be as high, thus lower percentages of collapse and less differential settlement is expected. As mentioned the soil becomes more granular and less weathered with depth, thus the thickness of soil where collapse may occur is generally not very thick and does not comprise the entire residual andesite layer. The results from the saturated sample are further scrutinised to obtain the following information; the sample swelled by approximately 7.8% at 9.9 kPa and the swell pressure of the soil is in the order of 50kPa.

The effective strength parameters obtained from consolidated triaxial testing indicate slightly lower strength parameters than what is typically found in literature for this type of material. An effective friction angle of 29 öwith no cohesion was obtained. From the stress paths, it is evident that the sample indicated contractive behaviour. The coefficient of volume compressibility values obtained from the consolidation stage of the test are similar to what is found in literature for this type of material. The sample swelled by between 3.9 and 5.9% at 25kPa, which correlates well with the % swell and swell pressure values deduced from the saturation stage of the double oedometer. Although the % swell are considered to be quite high, similar to the collapse potential results from the double oedometer, that it will only be a thin layer of material that is susceptible to swell.

DPL and DPSH Testing: A total of 20 DPL and DPSH tests were undertaken in the residual andesite material. Refusal generally occurred at fairly shallow depths. SPT N values of less than 15 was however encountered at 6 positions with a minimum equivalent SPT N value of 11. This indicates that the consistency of the residual andesite varies significantly across the site.

5.2 Groundwater

No ground water seepage was recorded in any of the test pits. The permanent ground water level is anticipated to be deep in this area. It is anticipated no seepage will be encountered during conventional construction. Although seepage may occur directly after precipitation events.

5.3 Expansive, Dispersive and Collapsible Soils

The soils on site consist predominantly of residual sand and gravel. Laboratory results do indicate the residual andesite to have a collapsible grain structure and that the material might be subjected to heave with an increase in moisture content. The layer of residual andesite does however become more granular and less weathered with depth, where collapse settlement and heave will be less. The possible effect of differential settlement under load due to collapse settlement and the possible heave that might occur with changes in moisture content, will have to be considered when considering possible founding solutions.

The black clay found in the south-eastern part of the site is thought to be potentially expansive and the veneer of transported aeolian sand might have a collapsible grain structure. It is therefore recommended that the proposed foundations are placed below these horizons or alternatively these horizons are removed and replaced with more competent materials.

5.4 Excavation Conditions

Boulder class B excavation is anticipated at 0-1.0m in Zone A, below which the profile is envisaged to grade from soft, to intermediate and eventually hard conditionswith depth. Soft excavations conditions are anticipated to depths of between 1.0-2.0m in Zone B, 1.0-3.0m in Zone C and to depths in excess of 3.0m in Zone D. Below this the excavation will grade to intermediate and finally hard excavation conditions with depth.

The excavation conditions are described in Table 5.1 below:

Table 5.1: Excavation class description as per SANS 1200D

Excavation Class	Description
Soft	Excavation in material that can be efficiently removed by a back-acting excavator of flywheel power approximately 0.10 kW per millimetre of tined-bucket width, without the use of pneumatic tools such as paving breakers
Intermediate	Excavation in material that requires a back-acting excavator of flywheel power exceeding 0.10 kW per millimetre of tined-bucket width or the use of pneumatic tools before removal by equipment equivalent to that specified for soft excavation.
Hard	Hard rock excavation shall be excavation in material (excluding boulder excavation) that cannot be efficiently removed without blasting or wedging and splitting.
Boulder (excavation class A)	Excavation in material containing more than 40% by volume of boulders of size in the range of 0.03 – 20m^3, in a matrix of soft or smaller boulders.
Boulder (excavation class B)	Excavation in material containing 10-40% by volume of boulders of size in the range of 0.03 - 20m^3, in a matrix of soft or smaller boulders.

5.5 Soil Profiles

As discussed in section 4.1 and illustrated in Figure 4.3 the site is divided into 4 zones.

Zone A

Zone A is characterised by shallow refusal, generally where refusal occurs at less than 1m. Refusal at such shallow depths are generally on andesite boulders in a sand matrix. Some of the test pits in the east of the site refused on medium hard rock andesite at shallow depths. Andesite ourcrops are common in Zone A.

Zone B

Zone B is found on the southern side of the site. The typical profile consists of the alluvial clay material overlying residual andesite clayey gravels. The alluvial material is slightly calcified, highly plastic and has a medium to high potential expansiveness.

Zone C

Zone C is characterised by residual andesitic gravel encountered at depths between 0.5m and 1.5m where refusal occurred on the residual soil. Some weakly cemented pedogenic gravel material is typically encountered below the upper aeolian sand.

Zone D

Zone D is characterised as the area where refusal on the andesitic residual soils and bedrock was only found at greater depths or where the test pits did not refuse. Some weakly cemented pedogenic gravel material is typically encountered below the upper aeolian sand.

6. FOUNDATIONS DESIGN PARAMETERS

Table 6.1: Pile design material properties.

Soil Description	ABP[1] (kPa)	UCS (MPa)	γ [2] (kN/m³)	c[3] (kPa)	Φ[4] (deg)	K_h (K_v)[5] (MN/m³)	Equivalent Estimated SPT-N
Alluvial Clay	0-50	-	17	20	20	5	8
Transported Aeolian Sand	0-50	-	17	5	29	2 (2)	8
Pedogenic Gravel	100-150	-	19	5	32	14 (14)	10
Boulders and Residual Andesite Gravel	150-300	-	19	10	29	18 (18)	11
Soft to Medium Hard Andesite Bedrock	>1000	10	26	50	40	120 (120)	80

1. Allowable bearing pressure (assumes 25mm of differential settlement as acceptable). This is evaluated for individual structures below, and is based on observation of the insitu materials, DPL and DPSH testing.
2. The UCS was calculated from the observation of rock materials on site.
3. Soil dry density (in situ/compacted): Based on modified AASHTO density results, dynamic probe testing and observation of the soils. Density for rock considering single laboratory UCS test.
4. Effective cohesion.
5. The effective friction angle were determined from both shear strength laboratory testing, and from literature based on the Atterburg Limits, grading and observed consistency of the soils. Residual Andesite soil value determined from consolidated undrained triaxial testing.
6. The Terzaghi Coefficient of subgrade reaction, is a value that represents the stiffness of the founding layers in a vertical (Kv) and horizontal (Kv) direction, these values are equal in cohesion-less soils, an massive rock. These values represent the applied stress through strain of the material, and is dependent on the founding materials, the depth and the diameter of the foundation. Due to the dependence of this value on the dimensions of the foundations, they were calculated assuming the micro-pile foundations of 0.205mm diameter and 1.5m depth.
7. SPT-N values were conservatively calculated using correlation of the SPT-N value with the DPSH blow count.

Table 6.2: Andesite Rock Estimated Design Parameters.

Hardness Description	Estimated Calculated UCS* (MPa)	Estimated RQD
Soft to Medium Hard Rock	10*	40**

* Calculated from observed and logged rock condition.
**GSI calculated from observed rock conditions and RQD correlated from Hoek et.al. (2013).

7. FOUNDATION RECOMMENDATIONS

Based on the investigations, conditions on the site are generally good, and there appears to be no (geotechnical) reasons for the development of the site not to continue, provided that precautionary measures as discussed in this report are incorporated in the design and development of the site

Due to the variation in the geotechnical conditions across the site. The foundation recommendations will be vary for each geotechnical zone of the site.

7.1 Photovoltaic Panel Foundations

The proposed foundation types recommended for the various geotechnical zones of the site are described below:

1. Driven piles – these piles are end bearing piles are generally driven into soil horizons and require to be driven to at least approximately 2m depth to provide the to impart sufficient resistance to the uplift and moment forces acting on the piles. In areas where penetration to this depth is difficult due to boulders, or bedrock shallower than 1.5m, this founding method is not viable
2. Cast in situ concrete piles –this methods entails drilling using conventional shothole rigs, which can pierce through boulders and shallow bedrock to the proposed pile depth. The drilled hole is then filled with concrete to support the panel.
3. Concrete block foundations– these foundation are typically founded at shallow depth, and unlift and moment forces are resisted by the weight of the foundation. These foundation must be founded in the residual andesite soils on site, or be a soil raft must be constructed from the residual andesite soil up to the proposed founding depth. It is anticipated that materials for the raft will have to be imported to the site.
4. Pre-drilling, filling with sand then driving posts – this method again involves drilling using conventional shothole rigs to the proposed pile depth. The pre-drilled holes would are then filled with compacted sand and the posts rammed into the filled holes. This method is suitable for difficult penetration conditions, however, the "double handling" involved in this process may make it costly.

From the methods described above the predrilled cast in-situ piles are anticipated to be the most appropriate founding method for Zones A, B and C. It is envisaged that driven piles will be the most appropriated foundation method for Zone D, although it maybe advantageous to found the entire development on predrilled cast in-situ piles.

7.2 Panel Foundations (Concept Pile Foundation Design)

In order to evaluate the feasibility of a percussion pile founding solution, a conceptual design has been undertaken and is discussed below.

Diagram 7.1. provides a side view of the solar panels.

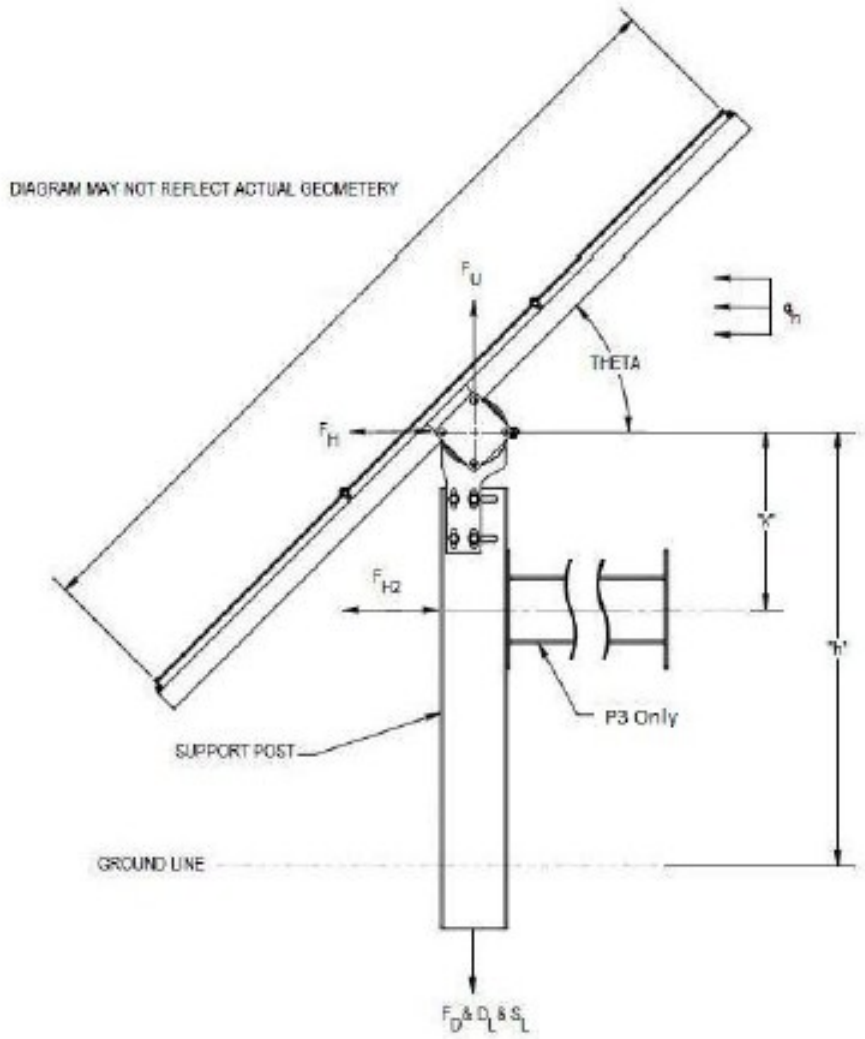


Diagram 7.1: Side view of solar panels.

The loads as provided by SunEdison LLC are summarised in Table 7.1.

Table 7.1: Loads applied to solar panel support, at stow and at full tilt in coma's.

Post Type	Panel Position	Maximum tensile force (kN) ($F_u + D_L$)	Maximum compressive force (kN) ($F_D + D_L$)	Maximum lateral force (kN)	Maximum bending moment (kN.m)
Row Posts "P1"	At stow (0°)	-0.178	6.94	0.444	0
	Full tilt (45°)	+0.266 (comp)	6.49	0.444	8.43
Driveline Post "P2"	At stow (0°)	0	4.45	1.779	11.37
	Full tilt (45°)	+0.445 (comp)	4.00	1.779	4.74
Bedframe Post "P3"	At stow (0°)	-0.890	3.56	0.444	33.38
	Full tilt (45°)	-0.445	3.11	0.444	33.03

Based on Table 7.1 and when reviewing resulting shaft stresses whilst assuming that a 40MPa grout will be used to construct the micropiles and applying appropriate reduction stresses due to the installation method, it is evident that the moments would be most critical in inducing large shaft stresses (i.e. $\frac{M}{Z}$ dominating). Therefore when considering the lateral wind load and dead load, not considering wind up, as it is assumed that these loads cannot occur simultaneously, a 0.195m micropile is required for row posts "P1", 0.215m micropile for row post "P2" and a 0.32m for "P3" when limiting the allowable shaft stress to 0.4x(f_{cu} – installation reduction). Assuming the maximum percussion hole size is 250mm the design of Bedframe post "P3"'s reinforcement design would need to be looked at in detail to increase the 0.4x(f_{cu} – installation reduction).

Axial Loading:

The axial pile capacity in cohensionless soils is derived from shaft capacity and end bearing.

The shaft friction may be calculated by the equation:

$fs = K \cdot p'_o \cdot \tan \delta$

where: K = coefficient of lateral earth pressure

(ratio of horizontal to vertical normal effective stress);

p'_o = effective overburden stress at the point in question;

δ = friction angle between soil and pile wall.

The unit end bearing may be computed by the equation:

$q = p'_o \cdot Nq$

where: p'_o = effective overburden stress at the pile tip;

Nq = dimensionless bearing capacity factor

Considering the maximum tension (only shaft friction) vs. maximum compressive force (shaft friction and end bearing) the most critical case can be assumed to be in compression. And therefore the axial capacity of the pile in combination with the lateral loads and moments will be the determining factor influencing the pile lengths for the 0.25m micropile. Eurocode 7 and SANS10160-5 suggests that the characteristic ultimate capacity should be calculated by using the following statistical analysis:

$$R_{c,k} = \text{Min}\{\frac{(R_{c;cal})_{mean}}{\xi_3} ; \frac{(R_{c;cal})_{min}}{\xi_4}\}$$

where ξ3 and ξ4 are correlation factors that depend on the number of profiles of test, n, and are applied respectively:

to the mean values $(R_{c;cal})_{mean} = (R_{b;cal} + R_{s;cal})_{mean}$ and $(R_{c;cal})_{min} = (R_{b;cal} + R_{s;cal})_{min.}$

When only considering axial load, the $\frac{(R_{c;cal})_{min}}{\xi_4}$ was most critical at position R10K5 , and a 3m long pile is required resist the maximum compressive load of 6.94 kN.

Moment Loading:

Different equations and methods exist to determine the ultimate lateral resistance of rigid elsatic piles. It was estimated for the depth of the pile and the depth of the pile and modulus of subgrade reactions provided in Table 6.1 that the piles would act somewhere inbetween a rigid and elastic pile, therefore Brinch and Hansen's method was considered for rigid piles.

The method can briefly be summarised as illustrated in Diagram 7.2 below, where the rotation point is calculated by taking the moments about the point of application of the horizontal load.

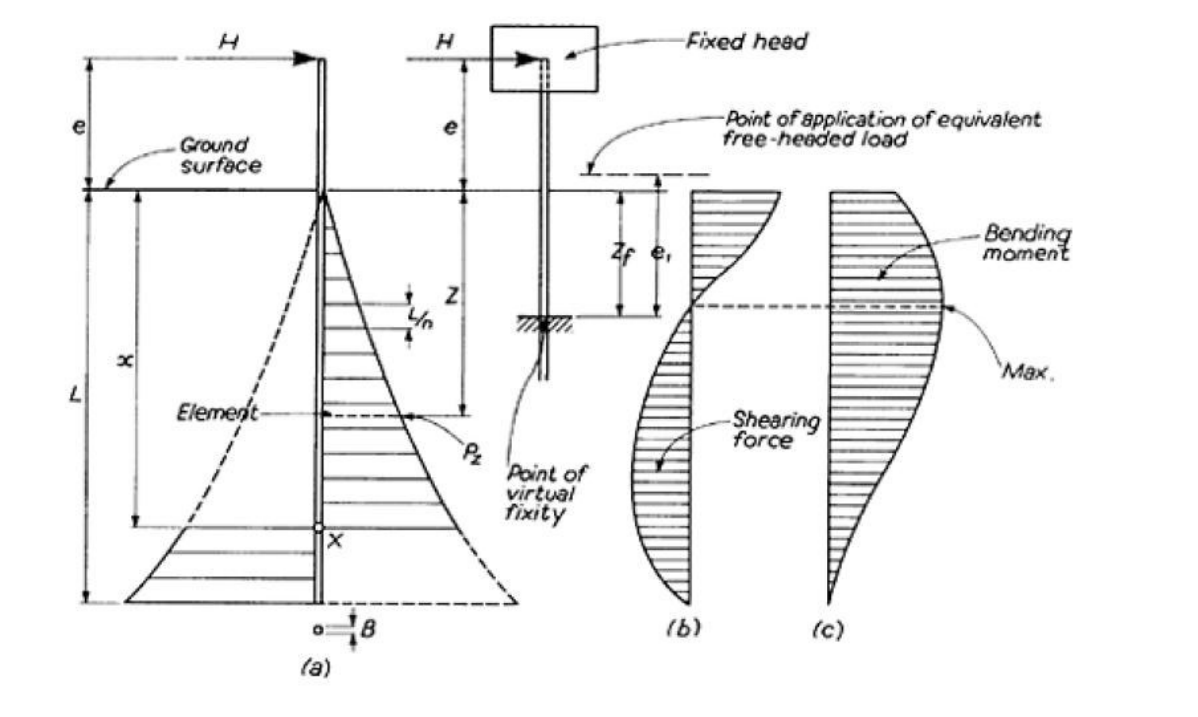


Diagram 7.2: Brinch Hansen's method for calculating ultimate lateral resistance of short piles.

Assessing the pile length required to resist the axial load it can be found that sufficient moment resistance is provided by the soil.

Reinforcement: It is assumed the piles will be constructed using 40MPa grout. Based on a minimum cover to spiral reinforcement of 50mm it is estimated that 5Y12s, 7Y12s and 8Y20s will be required on "P1", "P2" and "P3" respectively.

Recommendation: Although just a concept design that must be confirmed by the SunEdison engineers it is recommended that 250mm percussion drilled Micropiles be installed on all posts ato a minimum depth of 3m. Although it must be noted that this conceptual design is for the worst case scenario of materials on site.

7.3 Substation Foundations

Based on design drawings of the site layout the substation is positioned in geotechnical Zone C of the site. The profile in this area consists of upper soil layers of potentially collapsible aeolian sand and sporadic pedocrete, these layers are not considered suitable as founding horizons for the substation. The andesite bedrock is considered a suitable founding horizon for this structure and is relatively shallow. Therefore it is suggested that the substation is constructed on an engineered soil raft built up from andesite bedrock. The raft design will have to meet the anticipated loads of the substation.

Soil Raft (mattress): This involves the installation of a layer of engineered fill material, to provide a founding layer of known thickness and strength parameters below the entire substation site and the surrounding buildings. It is anticipated that the foundation loads placed on these soil raft will result in minimal settlements. The addition of steel or fabric reinforcement strips may be considered to strengthen the raft, and potentially allow for a thinner raft. Alternatively mass concrete can be used instead of a soil raft, and can be laid onto bedrock or the residual soils up to the proposed founding level of the substation.

- *Constructions Method*: The soil raft should be constructed by removing all the upper soil layers down to intact bedrock, anticipated to be at depths of approximately 1-3m. Once excavated suitable material (as specified in the raft design) must be compacted in 300mm layers using a whacker or vibratory roller at -1% to +2% of optimum moisture content. This must be carried out from the bedrock to the required thickness (as specified in the raft design). It is recommended that the raft is built to a level above the surrounding egl to assist drainage away from the structures foundations. The in-situ materials are not anticipated to meet the specifications for the soil raft, therefore this material will have to be imported to site.

- *Excavatibility*: Soft to intermediate excavation conditions are anticipated down to bedrock upon which the raft will be constructed.

7.4 Drainage System

Due to residual andesite layer being susceptible to swell and possible collapse settlement it is recommended that a stormwater drainage system be incorporated to avoid excessive amounts of water entering subsurface soils.

Furthermore a risk to the proposed development, with respect to water/drainage, is the potential erosion of soils from around the foundations of the solar panels, thus affecting their resistance to movement due to moment and uplift forces. Due to the consistent alignment of these panels across the site, rainwater will wash off the panels and be concentrated to specific channels, thus increasing the speed of soil erosion at these locations and the potential for ingress. This must be addressed in the stormwater system for the site.

7.5 Roads and Materials

The residual andesite was tested to be classified as a worse than G9 material (according to the COLTO classification as presented in the test results (by Soillab). The material is thus not suited for use in road layer works.

The following are specifications for materials for unpaved rural roads, in accordance with Clause 3.3 in TRH20 (1990):

- Maximum size: 37.5 mm
- Oversize index (IO)[a]: = 5 per cent
- Shrinkage product (SP)[b]: 100 - 365 (max. of 240 preferable)
- Grading coefficient (GC)[c]: 16 - 34
- CBR: = 15 at = 95 per cent Mod AASHO compaction and OMC[d]

a: IO = Oversize Index (per cent retained on 37.5 mm sieve)

b: SP = Linear shrinkage x per cent passing 0.425 mm sieve

c: GC = (Per cent passing 26.5 mm – per cent passing 2.0 mm) x per cent passing 4.75 mm/100

d: tested immediately after compaction

The CBR samples tested have been assessed against the above criteria and are tabulated below:

Table 7.2: Suitability for Use for Unpaved Road Design

Material description	Maximum Size (mm)	IO	SP	GC	CBR at 95% Mod AASHTO
Residual Andesite (R3K4)	13.2	0	774	25.8	8
Residual Andesite (R4K4)	4.75	0	603	31.02	5

From the above it can be seen that none of the on-site materials achieve the required specifications for unpaved road material.

However, the residual gravel soils are probably the most readily available, abundant and hard wearing of the material on site and could be utilised for unpaved road construction, provided that larger particles (cobbles or boulders) be removed. Furthermore, the roads/tracks will be solely used for access and not heavily trafficked. It must be noted however, these roads are notoriously dusty and this influence on the effectiveness of the PV panels should be borne in mind.

7.6 Flooding Risk

The 1:50 and 1:100 year flood lines were not determined as it falls outside the scope of this report. With the site's proximity to the Vaal River it should be established as a matter of course.

7.7 Stability of Trenches

During the test pit investigation minor sidewall collapse was observed within the upper transported soils, as this layer is shallow significant sidewall collapse is not anticipate in shallow excavations on site. Excavations to 1.2m depth can be excavated vertically. Excavations deeper than this will need to be shored or battered. It must however be noted that the trial pits excavated during the geotechnical investigation will give an optimistic indication of the stability of long trench excavations. It remains the responsibility of the contractor and engineer on site to ensure that excavations are safe.

The soils should be stable enough for the predrilled holes at the pile positions to remain open prior to filling with concrete.

7.8 Soil Thermal Conductivity

From the test results it is clear that the thermal conductivity of the soil is too low to be used for bedding for the cable installation. The thermal conductivity of the soil should be at least 1.2 W/°K.m to be suitable for cable bedding material. Therefore, suitable bedding material must be imported for the cable surround when installing underground cables during construction.

8. CONCLUSIONS

This report details the preliminary results of a geotechnical investigation for the proposed 75MW solar farm at Bokamoso, about 30km south west of Orkney, North West Province. The development will include PV solar panels and a local substation in the norhern part of the site, with additional building and connecting power lines.

The farm is underlain by andesite of the Allenridge Formation. Bedrock is generally shallow and is overlain by some pedogenic material and aeolian sands. Some alluvial material was encountered in the southern part of the site. The site is divided into 4 zones, broadly characterised according to the depth to rock. The groundwater table was not encountered during this investigation.

There does not appear any significant geotechnical constraints to developing the site. It was however indicated that the south eastern part of the site is unsuitable for development as it is classified as a wetland area.

Geotechnical conditions affecting the proposed development are:

- Shallow medium hard to hard bedrock and boulders in areas, where hard excavation with localised blasting might be required for solar panel columns and trenches for collector cables might need to be placed at shallow depths.
- The low bearing capacities and variability of the alluvial, aeolian and pedogenic soils, makes them un-suitable as a founding horizon without the use of soil improvement techniques.
- Although the residual andesite generally provides a suitable founding horizon there are areas where very low SPT N values were encountered, these soils were tested to have a 'trouble' classification of collapse potential and moderate heave.
- Despite the above the residual soils are anticipated to be a suitable founding medium for the proposed pre-drilled cast in-situ or driven piles.
- The shallow bedrock or residual andesitic to basaltic gravels are considered a competent founding horizon for the proposed PV panels.
- It is recommended that the substation and surrounding infrastructure is founded on soil rafts, built up from intact bedrock.
- Precautions may be necessary due to possible influence of seismic activity in the area.

Generalized proposed founding recommendations are given in Section 8 above.

We trust that this report will be found to be complete and adequate for your consideration. Should further elaboration be required for any portion of this project, we would be pleased to provide assistance.

Respectfully submitted,

SMEC South Africa (Pty) Ltd

APPENDIX A: SITE PLANS

APPENDIX B1: TEST PIT PROFILE AND IN-SITU TESTING SUMMARY

Table A: Summary of test-pits

Position No.	Co-ordinate(WGS084 Lo26)		Black clay		Aeolian sand		Pedogenic material		Andesite Boulders		Residual Andesite		Test pit refusal	DPSH refusal	Electrical Resistivity
	X	Y	m	SPT[1]	m	SPT[1]	m	SPT	m	SPT[1]	m	SPT[1]			
RSKS	3005142.18	-39660.46	-	-	0.7	>50**	0.4				1.3		@2.4m Residual Andesite	0.6m	x
R1K1	3005433.45	-39301.61	-	-	0.2	30* ref **	0.4	ref*	-	-	2.1	43*	@2.7m Residual Andesite	0.3m	-
R2K1	3005562.94	-39370.03	-	-	0.4	34*	-	-	0.4	ref*	-	-	@0.8m Andesite Boulders	-	-
R3K1	3005701.68	-39441.18	-	-	0.4	28*	0.4	ref*			2	35*	@2.8m Residual Andesite	-	-
R4K1	3005840.41	-39509.56	-	-	-	-	-	-	0.85	31*	-	-	@0.85m Andesite Boulders	-	-
R5K1	3005972.98	-39577.97	-	-	-	-	-	-	0.55	34*	-	-	@0.55m Andesite Boulders	-	-
R6K1	3006108.64	-39649.12	-	-	-	-	-	-	0.4	44* 23**	-	-	@0.4m Andesite Boulders	1.2m	-
R7K1	3006244.27	-39709.25	-	-	-	-	-	-	0.4	11 – 38**	-	-	@0.4m Andesite Boulders	3.9m	x
R8K1	3006370.69	-39780.43	-	-	0.3	38*	-	-	0.8	27*	-	-	@1.1m Andesite Boulders	-	-
R9K1	3006512.50	-39848.80	Andesite Outcrop On Surface												
R10K1	3006645.08	-39919.95	-	-	-	-	-	-	0.5	30*	-	-	@0.5m Andesite Boulders	-	-

Table A: Summary of test-pits

Position No.	Co-ordinate(WGS084 Lo26)		Black clay		Aeolian sand		Pedogenic material		Andesite Boulders		Residual Andesite		Test pit refusal	DPSH refusal	Electrical Resistivity
	X	Y	m	SPT[1]	m	SPT[1]	m	SPT	m	SPT[1]	m	SPT[1]			
R11K1	3006777.65	-39985.60	-	-	-	-	-	-	0.5	ref* 26**	-	-	@0.5m Andesite Boulders	1.2m	-
R12K1	3006916.39	-40056.73	Andesite Outcrop On Surface												
R13K1	3007048.97	-40125.12	-	-	-	-	-	-	0.3	-	-	-	@0.3m Andesite Boulders	-	-
R1K2	3005381.47	-39409.15	Andesite Outcrop On Surface												
R2K2	3005510.96	-39477.57	-	-	0.35	35* 22**	-	-	0.25	44* ref**	-	-	@0.6m Andesite Boulders	0.9m	x
R3K2	3005649.70	-39548.71	-	-	0.4	41*	0.6	ref*	-	-	1.1	-	@2.1m Residual Andesite	-	-
R4K2	3005785.34	-39614.36	Andesite Outcrop On Surface												
R5K2	3005915.83	-38030.90	-	-	-	ref* 13**	0.8	46**	-	-	2***	ref**	No refusal	1.2m	-
R6K2	3006053.57	-39753.91	-	-	0.2	33*	-	-	-	-	1	ref**	@1.2m Residual Andesite	-	-
R7K2	3006192.27	-39814.04	-	-	-	-	1.8	39* ref**	-	-	0.3	-	@2.1m Residual Andesite	0.9m	-
R8K2	3006334.11	-39890.67	-	-	0.6	43*	0.1	ref*	-	-	-	-	@0.7m Residual Andesite	-	-
R9K2	3006368.19	-39959.38	-	-	0.3	38*	-	-	0.5	ref*	-	-	@0.8m Residual Andesite	-	-
R10K2	3006596.18	-40027.48	-	-	0.35	38* 12**	1.2	ref* ref**	-	-	1.55	-	No refusal	1.2m	x

Table A: Summary of test-pits

Position No.	Co-ordinate(WGS084 Lo26)		Black clay		Aeolian sand		Pedogenic material		Andesite Boulders		Residual Andesite		Test pit refusal	DPSH refusal	Electrical Resistivity
	X	Y	m	SPT[1]	m	SPT[1]	m	SPT	m	SPT[1]	m	SPT[1]			
R11K2	3006728.75	-40093.12	-	-	-	-	-	-	0.35	-	-	-	@0.35m Andesite Boulders	-	-
R12K2	3006846.87	-38512.56	-	-	-	-	-	-	0.35	-	-	-	-	-	-
R13K2	3007000.06	-40229.89	Andesite Outcrop On Surface												
R14K2	3007123.52	-40336.85	0.4	10**	-	-	0.9	ref**	-	-	0.6	-	@2.1m Residual Andesite	0.9m	-
R1K3	3005326.39	-39513.95	-	-	0.5	27*	-	-	-	-	0.2	-	@0.7m Residual Andesite	-	-
R2K3	3005455.90	-39585.12	-	-	0.4	27*	0.7	44*	-	-	1.6	44*	@2.7m Residual Andesite	-	-
R3K3	3005594.63	-39656.26	-	-	0.5	21* 14**	1	35* ref**	-	-	1.4	ref*	@2.9m Residual Andesite	0.6m	-
R4K3	3005733.35	-39721.90	-	-	0.2	26*	-	-	-	-	1	33*	@1.2m Residual Andesite	-	-
R5K3	3005865.93	-39790.30	-	-	0.3	29* 20**	0.45	ref* 38**	-	-	1.35	13**	No Refusal	3.6m	x
R6K3	3006001.59	-39861.45	-	-	0.4	33*	0.5	ref*	-	-	2.1	ref*	No Refusal	-	-
R7K3	3006137.23	-39927.09	-	-	-	-	-	-	0.8	28*	0.4	33*	@1.2m Residual Andesite	-	-
R8K3	3006279.05	-39998.21	-	-	0.3	35* 11**	-	-	-	-	1.4	ref* 15**	@1.7m Residual Andesite	2.1m	-

Table A: Summary of test-pits

Position No.	Co-ordinate(WGS084 Lo26)		Black clay		Aeolian sand		Pedogenic material		Andesite Boulders		Residual Andesite		Test pit refusal	DPSH refusal	Electrical Resistivity
	X	Y	m	SPT[1]	m	SPT[1]	m	SPT	m	SPT[1]	m	SPT[1]			
R9K3	3006408.44	-40033.59	-	-	-	-	-	-	0.9	35*	-	-	@0.9m Andesite Boulders	-	-
R10K3	3006544.20	-40135.01	-	-	-	-	-	-	0.7	44*	-	-	@0.7m Andesite Boulders	-	-
R11K3	3006676.77	-40200.65	-	-	0.5	44*	-	-	-	-	0.35	ref*	@0.85m Residual Andesite	-	-
R12K3	3006818.60	-40274.52	-	-	-	-	-	-	0.6	ref**	-	-	@0.6m Andesite Boulders	0.6m	x
R13K3	3006951.17	-40340.16	Andesite Outcrop On Surface												
R14K3	3007063.31	-40467.26	0.4	-	-	-	0.45	-	-	-	0.35	-	@1.2m Residual Andesite	-	-
R1K4	3005271.30	-39610.49	Andesite Outcrop On Surface												
R2K4	3005406.96	-39681.64	-	-	0.4	27*	-	-	1.2	-	1	36*	@2.2m Residual Andesite	-	-
R3K4	3005542.62	-39752.79	-	-	0.5	25*	-	-	0.9	23*	0.5	ref*	@1.9m Residual Andesite	-	-
R4K4	3005681.35	-39823.93	-	-	0.4	28*	-	-	1.1	ref*	0.8	-	@2.3m Residual Andesite	-	-
R5K4	3005810.84	-39889.59	-	-	0.4	30**	-	-	0.95	>50**	1.85***	14**	No Refusal	2.4m	-
R6K4	3005949.58	-39960.73	-	-	0.4	28*	-	-	0.2	-	1.6	-	@2.2m Residual Andesite	-	-

Table A: Summary of test-pits

Position No.	Co-ordinate(WGS084 Lo26)		Black clay		Aeolian sand		Pedogenic material		Andesite Boulders		Residual Andesite		Test pit refusal	DPSH refusal	Electrical Resistivity
	X	Y	m	SPT[1]	m	SPT[1]	m	SPT	m	SPT[1]	m	SPT[1]			
R7K4	3006088.31	-40029.11	-	-	0.5	-	-	-	1.2	-	1.1	-	@2.8m Residual Andesite	-	-
R8K4	3006220.91	-40103.02	-	-	0.4	14**	0.4	ref**	-	-	2.4***	-	No Refusal	0.6m	x
R9K4	3006356.56	-40171.40	-	-	0.45	29*	0.2	ref*	-	-	1.95	-	@2.6m Residual Andesite	-	-
R10K4	3006489.14	-40239.80	-	-	0.4	-	-	-	-	-	0.8	-	@1.2m Residual Andesite	-	-
R11K4	3006624.80	-40310.94	-	-	0.35	-	-	-	0.25	-	-	-	@0.6m Andesite Boulders	-	-
R12K4	3006766.62	-40382.06	-	-	-	-	-	-	0.3	-	-	-	@0.3m Andesite Boulders	-	-
R13K4	3006902.28	-40453.19	0.8	25* 8**	-	-	0.3	47* 10**	-	-	0.5	11**	@1.6m Residual Andesite	5.4m	x
R14K4	3007028.68	-40513.34	-	-	-	-	-	-	0.4	-	-	-	@0.4m Andesite Boulders	-	-
R1K5	3005222.34	-39701.50	Andesite Outcrop On Surface												
R2K5	3005216.22	-39712.54	-	-	0.35	28**	0.1	ref**	-	-	1.75	-	@2.2m Residual Andesite	0.6m	x
R3K5	3005351.88	-39783.69	-	-	0.4	ref*	0.4	-	-	-	1	-	@1.8m Residual Andesite	-	-
R4K5	3005490.62	-39854.83	-	-	0.1	-	0.5	-	-	-	0.6	-	@1.2m Residual Andesite	-	-

Table A: Summary of test-pits

Position No.	Co-ordinate(WGS084 Lo26)		Black clay		Aeolian sand		Pedogenic material		Andesite Boulders		Residual Andesite		Test pit refusal	DPSH refusal	Electrical Resistivity
	X	Y	m	SPT[1]	m	SPT[1]	m	SPT	m	SPT[1]	m	SPT[1]			
R5K5	3005626.28	-39925.98	-	-	0.1	-	0.3	-	-	-	-	-	@0.4m Residual Andesite	-	-
R6K5	3005755.77	-39994.39	-	-	0.1	-	-	-	-	-	-	-	@0.1m Residual Andesite	-	-
R7K5	3005894.51	-40065.52	-	-	0.5	23**	0.3	>50**	-	-	2.4***	ref**	No refusal	0.9m	-
R8K5	3006033.25	-40136.66	-	-	0.2	37*	0.2	ref*	-	-	0.4	-	@0.8m Residual Andesite	-	-
R9K5	3006168.92	-40207.80	-	-	0.1	30*	0.3	ref*	-	-	2.6***	-	No Refusal	-	-
R10K5	3006304.59	-40281.69	-	-	0.15	39* 8**	0.4	ref* 12**	-	-	2.8***	44* 7**	No Refusal	2.7m	x
R11K5	3006437.18	-40352.84	-	-	0.4	-	0.8	-	-	-	0.8	-	@2m Residual Andesite	-	-
R12K5	3006575.91	-40421.22	Andesite Outcrop On Surface												
R13K5	3006711.58	-40495.11	Andesite Outcrop On Surface												
R14K5	3006850.29	-40555.22	0.3	36*	-	-	0.3	ref*	-	-	0.6	-	@1.2m Residual Andesite	-	-
R15K5	3006989.08	-40640.11	0.4	-	-	-	0.25	-	-	-	0.75	-	@1.4m Residual Andesite	-	-

[1] - Minimum SPT N value for layer.

* - Equivalent SPT N value derived from DCP results

**- Equivalent SPT N value derived from DPSH results

***- Indicated thickness (no refusal)

APPENDIX B2: DETAILED PROFILES

TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R10K1
X COORD: 3,006,645
Y COORD: Lo26 -39,919
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0		0.00	Ground Surface	
			Loose SAND with some gravel, cobbles and boulders Dry, red brown, with andesite boulders of 150-300mm.	
0.5		0.50	**Refusal on ANDESITE boulders** End of Log	
1.0				
1.5				
2.0				
2.5				
3.0				

NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

SMEC South Africa
Consulting Engineers
+27 (0)12 481 3800
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Template: SMEC TP04

TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R10K2
X COORD: 3,006,596
Y COORD: Lo26 -40,027
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
	0.35	**Loose silty SAND** Dry light brown, transported aeolian.	
0.5, 1.0, 1.5	1.55	**Silty SAND** Slight moist, grey, white, areas of calcification, calcrete with nodlules of 10-15mm	
2.0, 2.5, 3.0	3.10	**Very dense sandy GRAVEL** Dry to slightly moist, light orange to yellow, mottled black, residual adesite, angular, becoming angular with depth.	
3.5, 4.0		**Refusal on medium hard rock ANDESITE.** End of Log	

NOTES 1: Sample @ 1.4m
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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Template: SMEC TP04

TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R10K3
X COORD: 3,006,544
Y COORD: Lo26 -39,135
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
		0.00	Ground Surface	
0.0			**Loose sandy BOULDERS with some gravel and cobbles** Slightly moist, with andesite boulders up to 400mm	
0.5		0.90		
			Refusal on ANDESITE boulders End of Log	
1.0				
1.5				
2.0				
2.5				
3.0				

NOTES 1: No samples
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R10K4
X COORD: 3,006,489
Y COORD: Lo26 -40,239
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
		0.00	Ground Surface	
0.0			**Very loose to loose silty sand** Dry, light brown, transported, aeolian	
		0.40	**Very dense sandy GRAVEL** Slightly moist, light yellow, stained black, intact, residual gravel andesite, becoming more angular with depth.	
0.5				
1.0		1.20	**Refusal on medium hard rock ANDESITE..** End of Log	
1.5				
2.0				
2.5				
3.0				

NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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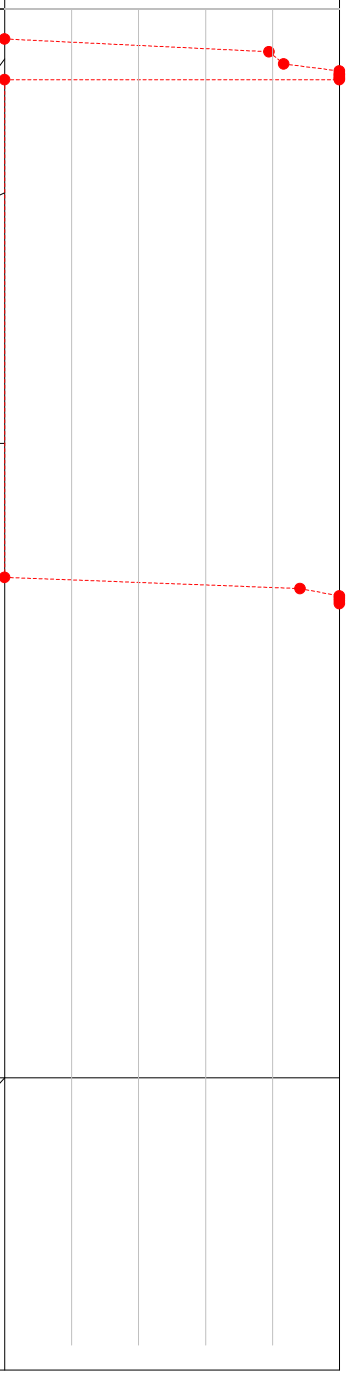
TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R10K5
X COORD: 3,006,306
Y COORD: Lo26 -40,281
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
	0.15	**Loose silty SAND, with some gravel** Dry to slightly moist, light brown, transported, some with andesite gravel.	
0.5	0.55	**Loose silty SAND** Slightlt moist, greyish brown, stained white, some calcified areas.	
1.0	1.30	**Very dense clayey GRAVEL** Stained orange and yellow, intact, scatted areas of grey clay, residual, andesite with smaller gravel and cobbles, some calcification visible.	
1.5		**Very dense clayey SAND** Slightly moist, yellow, intact, residual andesite, becoming more angular with depth, less weathering with depth.	
2.0			
2.5			
3.0	3.20		
3.5		**Excavation terminated at maximum reach of TLB.** End of Log	
4.0			



NOTES 1: Sample R10K5 @ 0-1.6m
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R11K1
X COORD: 3,006,777
Y COORD: Lo26 -39,985
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Silty sandy BOULDERS with some gravel, cobbles and boulders** Dry, dark brown, transported, silty sand with andesite gravel cobbles and boulders.	
	0.50	**Refusal on ANDESITE boulders.** End of Log	
0.5			
1.0			
1.5			
2.0			
2.5			
3.0			

NOTES 1:
2:
3:
4:

MACHINE: 428F CAT TLB Excavator.
DIAM:
FILE REF:

DATE PROFILED: 24/07/2014
PROFILED BY: T.GROBLER Prof Reg:
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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R11K2
X COORD: 3,006,728
Y COORD: Lo26 -40,093
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0		0.00	Ground Surface	
			Loose silty SAND Slightly moist, red brown, transported with andesite boulders.	
		0.35	**Refusal on ANDESITE boulders**	
0.5			End of Log	
1.0				
1.5				
2.0				
2.5				
3.0				

NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
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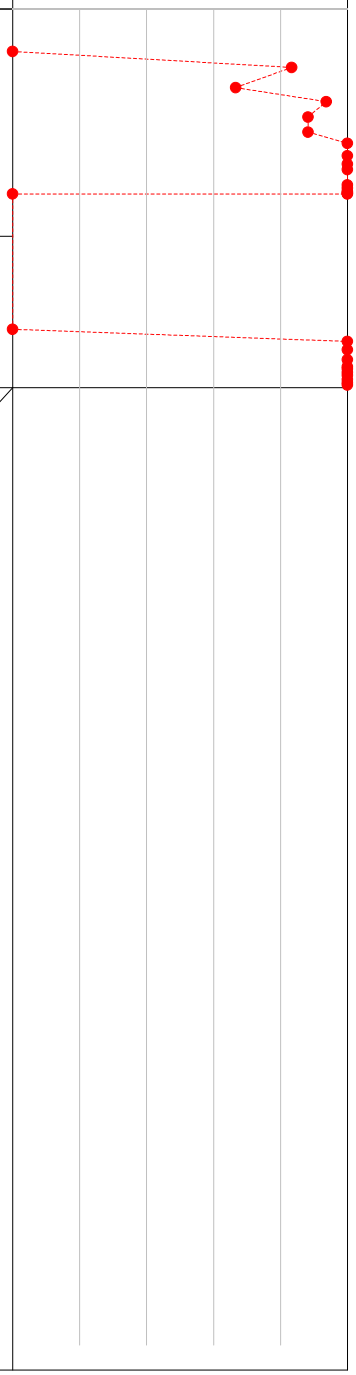
TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R11K3
X COORD: 3,006,676
Y COORD: Lo26 -40,200
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose silty SAND with some gravel and boulders** Dry, redish brown, transported, aeolian sand in adesite boulders.	
0.5	0.51	**Dense sand GRAVEL with some boulders** Slightly moist, becoming orange + yellow with depth, stained light grey, residual andesite.	
	0.85	**Refusal on medium hard rock ANDESITE.** End of Log	
1.0			
1.5			
2.0			
2.5			
3.0			



NOTES 1: No samples
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R11K4
X COORD: 3,006,624
Y COORD: Lo26 -40,310
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose silty sand** Dry, light brownish yellow, transported, aeolian.	
	0.35	**Loose to medium dense sandy BOULDERS with some gravel and cobbles** Slightly moist, red brown sand, blacky yellow andesite, residual, angular boulders of 180-300mm.	
0.5	0.60	**Refusal on ANDESITE boulders.**	
		End of Log	
1.0			
1.5			
2.0			
2.5			
3.0			

NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator.
DIAM:
FILE REF:

DATE PROFILED: 24/07/2014
PROFILED BY: T.GROBLER Prof Reg:
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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEDORINGSTAD

HOLE NO: R11K5
X COORD: 3,006,437
Y COORD: Lo26 -40,352
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
		Loose SAND, with clay Dry, light brown, transported aeolian.	
	0.40		
0.5		**Medium dense SAND** Slightlt moist, pale orange yellow, intact, residual andesite with some ferruginisation.	
1.0	1.20		
		Very dense clayey GRAVEL Yellowish grey, stained white, intact, residual, sub-angular to angular andesite.	
1.5	2.00		
2.0		**Refusal on medium hard rock ANDESITE.** End of Log	
2.5			
3.0			

NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator.
DIAM:
FILE REF:

DATE PROFILED: 24/07/2014
PROFILED BY: T.GROBLER Prof Reg:
CHECKED BY: Prof Reg:

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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R12K1
X COORD: 3,006,916
Y COORD: Lo26 -40,056
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
		0.00	Ground Surface	
0.0			**Refusal.Andesite outcrop on surface.**	
0.5				
1.0				
1.5				
2.0				
2.5				
3.0				

NOTES 1: No samples
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R12K2
X COORD: 3,006,846
Y COORD: Lo26 -38,512
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0		0.00	Ground Surface	
			Loose silty SAND Slightly moist, red brown, transported with andersite boulders.	
		0.35	**Refusal on andesite boulders.**	
0.5			End of Log	
1.0				
1.5				
2.0				
2.5				
3.0				

NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R12K3
X COORD: 3,006,818
Y COORD: Lo26 -40,271
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
		0.00	Ground Surface	
0.0			**Loose sandy BOULDERS with some gravel and cobbles** Dry, red brown, mixture of aeolian sand and andesite boulders.	
0.5		0.60		
			Refusal on ANDESITE boulders. End of Log	
1.0				
1.5				
2.0				
2.5				
3.0				

NOTES 1: No samples
2: Roots at 0.6m
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R12K4
X COORD: 3,006,624
Y COORD: Lo26 -40,310
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
		0.00	Ground Surface	
0.0			**Sandy COBBLES** Slighty moist, red brown, transported. Andesite boulder sand cobbles of 190-320mm.	
		0.30	**Refusal on ANDESITE boulders.**	
0.5			End of Log	
1.0				
1.5				
2.0				
2.5				
3.0				

NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R12K5
X COORD: 3,006,575
Y COORD: Lo26 -40,421
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0		0.00	Ground Surface	
		0.10	**Loose silty SAND** Aeolian with andesite boulders.	
			Refusal, ANDESITE outcrop on surface.	
			End of Log	
0.5				
1.0				
1.5				
2.0				
2.5				
3.0				

NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R13K1
X COORD: 3,007,048
Y COORD: Lo26 -40,125
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0		0.00	Ground Surface	
			Loose silty SAND with cobbles Dry, yellow sand, red andesite, boulders of 220-400mm.	
		0.30	**Refusal on andesite boulders**	
0.5			End of Log	
1.0				
1.5				
2.0				
2.5				
3.0				

NOTES 1: No samples
2: Boulders on surface with quartzite cobbles.
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R13K2
X COORD: 3,007,000
Y COORD: Lo26 -40,229
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
		0.00	Ground Surface	
0.0			**Refusal. andesite boulders on surface**	
0.5				
1.0				
1.5				
2.0				
2.5				
3.0				

NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R13K3
X COORD: 3,006,951
Y COORD: Lo26 -40,134
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
		0.00	Ground Surface	
0.0			**Refusal. Andesite boulders on surface.**	
0.5				
1.0				
1.5				
2.0				
2.5				
3.0				

NOTES 1: No samples
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R13K4
X COORD: 3,006,902
Y COORD: Lo26 -40,453
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
		Loose sandy CLAY Slightly moist, dark brown, speckled white, transported, some calcified material.	
0.5	0.80		
		Loose sandy CLAY Slightly moist, light brown, stained white, scattered areas with calcrete, nodules of 10-15 nodules.	
1.0	1.10		
		Dense to very dense sandy GRAVEL with clay Slighty moist, pale orange yellow, stained white, residual andesite, becoming more angular with depth.	
1.5	1.60		
		Refusal on medium hard rock ANDESITE	
		End of Log	
2.0			
2.5			
3.0			

NOTES 1: Sample R13K4 @ 1.5m
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R13K5
X COORD: 3,006,711
Y COORD: Lo26 -40,495
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0		0.00	Ground Surface	
		0.10	**Loose silty SAND** Aeolian sand with andesite boulders.	
			Refusal, andesite outcrop surface.	
			End of Log	
0.5				
1.0				
1.5				
2.0				
2.5				
3.0				

NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R14K2
X COORD: 3,007,123
Y COORD: Lo26 -40,336
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose silty sandy CLAY with some cobbles and boulders** Dry to slightly moist, black, speckled white, some areas of calcification.	
	0.40		
0.5		**Silty sandy CLAY** Slightly moist, black with scattered areas of white calcified material.	
1.0			
	1.30		
1.5		**Medium hard rock ANDESITE** Slightly moist, light yellow, angular gravel, residual.	
2.0	2.10		
		Refusal om mediium hard rock ANDESITE. End of Log	
2.5			
3.0			

NOTES 1: Sample R14K2 @ 0.3m
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R14K3
X COORD: 3,006,951
Y COORD: Lo26 -40,134
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose clayey SAND** Dry, dark brown, stained grey.	
	0.40		
0.5		**Medium dense clayey SAND** Slightly moist, dark brown, speckled white, calcified material	
	0.85		
1.0		**Very dense sandy GRAVEL with some clay and silt** Dry, pale orange yellow, intact, residual andesite becoming more angular with depth.	
	1.20		
		Refusal on mediun hard rock Andesite	
		End of Log	
1.5			
2.0			
2.5			
3.0			

NOTES 1: No samples
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R14K4
X COORD: 3,006,028
Y COORD: Lo26 -40,513
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
		0.00	Ground Surface	
0.0			**Loose sandy BOULDERS with some gravel and cobbles** Slightly moist, red brown, speckled white, areas of calcification visible.	
		0.40	**Refusal on andesite boulders.** End of Log	
0.5				
1.0				
1.5				
2.0				
2.5				
3.0				

NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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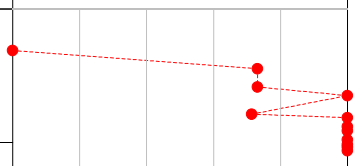
TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R14K5
X COORD: 3,006,850
Y COORD: Lo26 -40,555
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose silty CLAY** Slightly moist, black, transported.	
	0.30		
0.5		**Stiff silty CLAY** Light grey, speckled white, scattered areas of calcification.	
	0.60		
1.0		**Very dense sandy GRAVEL with clay** Slightly moist, greyish yellow, stained white, intact, residual andesite.	
	1.20		
1.5		**Refusal on medium hard rock ANDESITE.** End of Log	
2.0			
2.5			
3.0			



NOTES 1: No sample
2: Difficult excavation in medium hard rock andesite
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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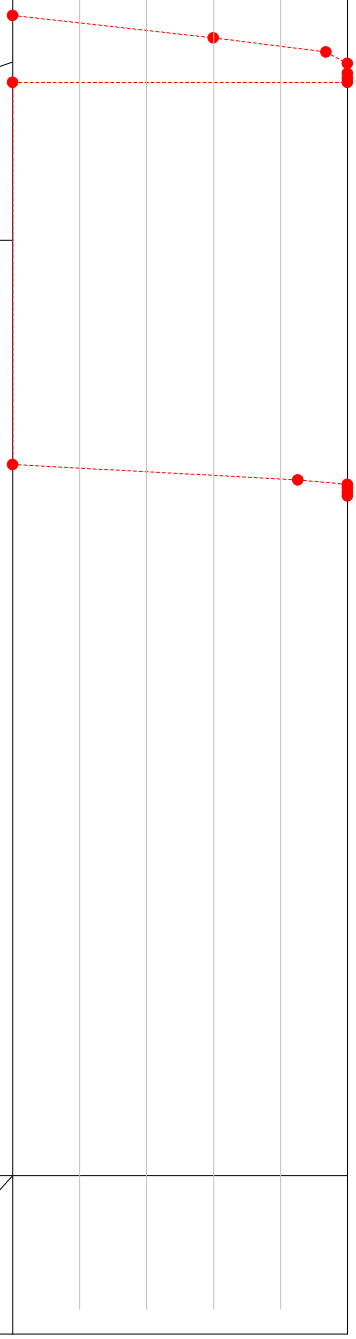
TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R1K1
X COORD: 3,005,433
Y COORD: Lo26 -39,301
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
	0.20	**Loose to medium dense silty SAND, with some gravel** Slightly moist, light brown, transported Aeolian.	
0.5	0.60	**Silty GRAVEL** Slightly moist, light brown, red and black, with areas of ferruginisation.	
1.0		**Dense to very dense clayey SAND** Dry to slightly moist, light yellow and grey residual andesite, becoming more angular with depth.	
1.5			
2.0			
2.5	2.70	**Resfusal on medium hard rock ANDESITE.**	
3.0		End of Log	



NOTES 1: No samples
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R1K2
X COORD: 3,005,318
Y COORD: Lo26 -39,1409
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0		0.00	Ground Surface	
			ANDESITE outcrop on surface	
0.5				
1.0				
1.5				
2.0				
2.5				
3.0				

NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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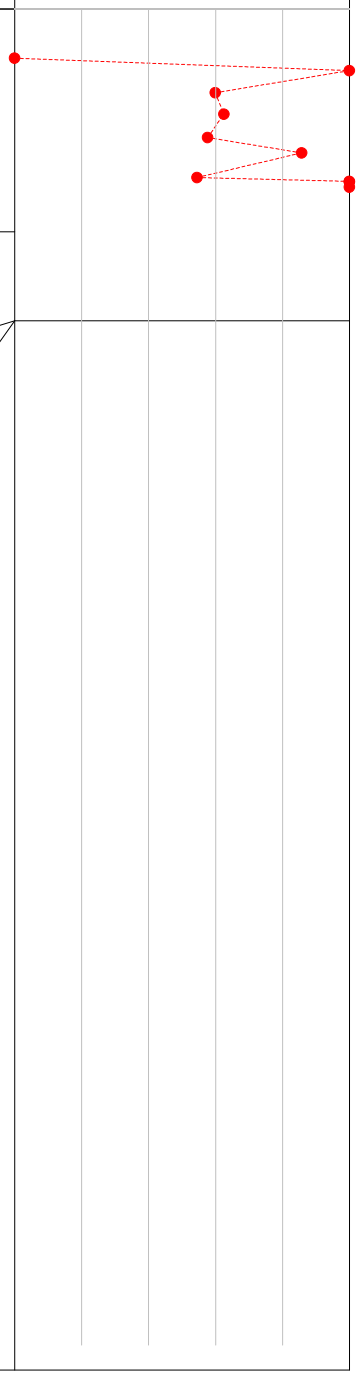
TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R1K3
X COORD: 3,005,236
Y COORD: Lo26 -39,513
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
		Loose silty SAND with gravel and cobbles Slightly moist, red brown, aeolian	
0.5	0.50	**Dense sandy GRAVEL** Slightly moist, pale orange yellow, grey, residual andesite.	
	0.70	**Refusal on medium hard rock ANDESITE.**	
		End of Log	
1.0			
1.5			
2.0			
2.5			
3.0			



NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R1K4
X COORD: 3,005,271
Y COORD: Lo26 -39,610
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0		0.00	Ground Surface	
			ANDESITE outcrop on surface.	
0.5				
1.0				
1.5				
2.0				
2.5				
3.0				

NOTES 1: No samples
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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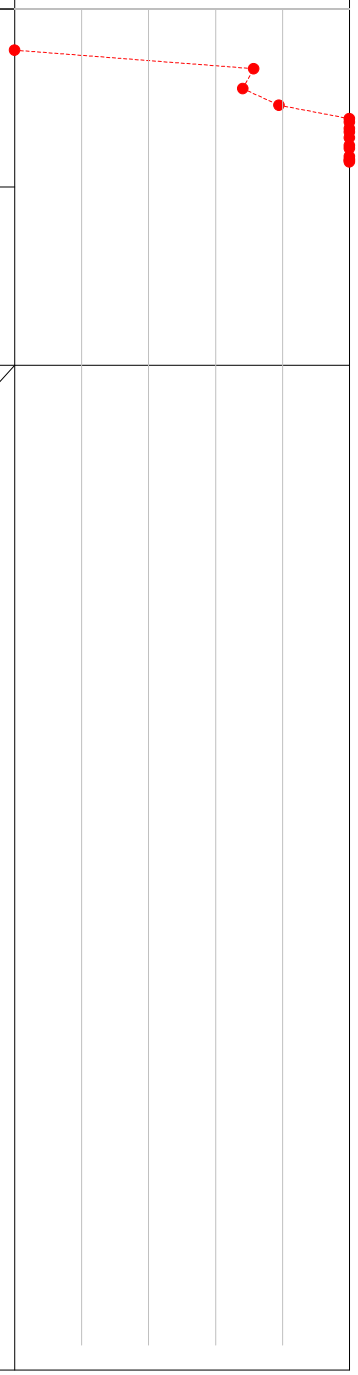
TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R2K1
X COORD: 3,005,562
Y COORD: Lo26 -39,370
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium dense silty SAND** Slightly moist, light brown, transported Aeolian.	
	0.40		
0.5		**Medium dense silty SAND** Slightly moist, light brown, red and black, with areas of ferruginisation.	
	0.80		
		Refusal on ANDESITE boulders	
		End of Log	
1.0			
1.5			
2.0			
2.5			
3.0			



NOTES 1: No samples
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R1K4
X COORD: 3,005,271
Y COORD: Lo26 -39,610
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
		0.00	Ground Surface	
0.0			**Refusal. Andesite outcrop on surface.**	
0.5				
1.0				
1.5				
2.0				
2.5				
3.0				

NOTES 1: No samples
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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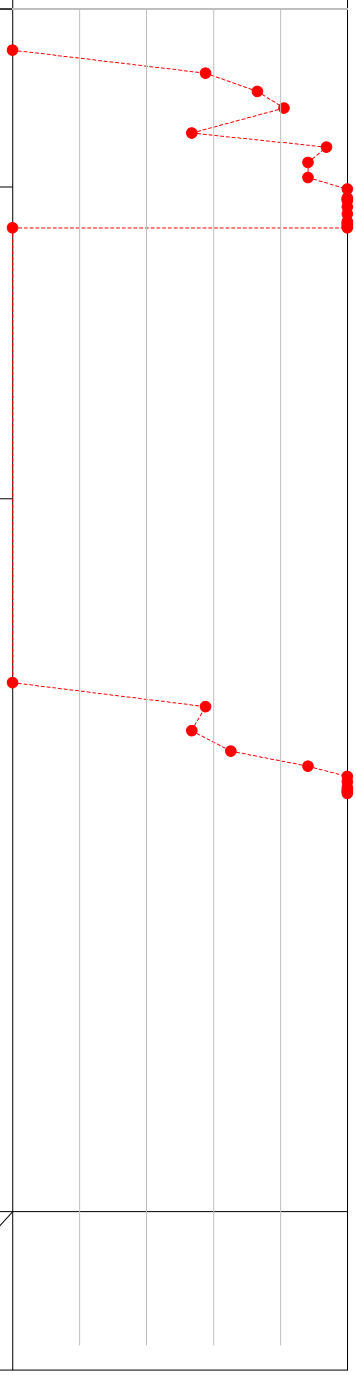
TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R2K3
X COORD: 3,005,445
Y COORD: Lo26 -39,585
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
	0.40	**Loose to medium silty SAND with some gravel and cobbles** Dry, light brown, transported, aeolian.	
0.5	1.10	**Soft rock ANDESITE, cobbles, boulders and large gravels** Slightly moist, brownish, blotched black, some ferruginisation.	
1.0	2.70	**Dense to very dense sandy GRAVEL with some silt and cobbles** Slightly moist, light yellow, stained light brown, residual andesite, less weathering with depth.	
1.5			
2.0			
2.5		**Refusal on medium hard rock ANDESITE.** End of Log	
3.0			



NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
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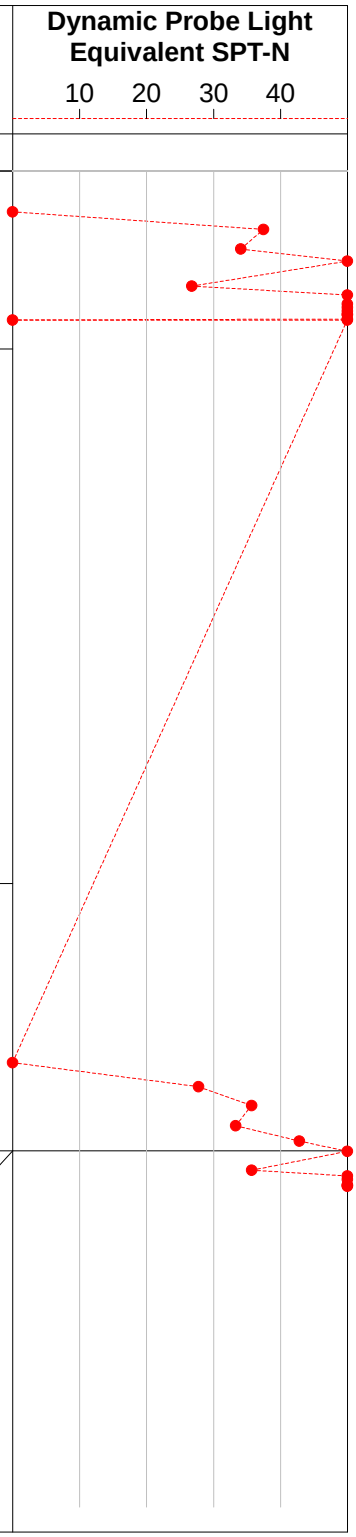
TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R2K4
X COORD: 3,005,406
Y COORD: Lo26 -39,681
ELEVATION:

Depth		Description
0.0	0.00	Ground Surface
		Medium dense to dense silty SAND with some gravel Dry, light brown, transported, in andesite gravel.
	0.40	**Dense silty SAND** Slightly moist, brownish red, blotched black, some visible ferruginisation, with scattered angular sub-rounded andesite boulders.
1.60		**Dense to very dense sandy GRAVEL with cobbles and boulders** Slightly moist, pale orange yellow, residual, intact andesite, becoming more angular with depth.
2.20		**Refusal on medium hard rock Andesite.** End of Log



NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator.
DIAM:
FILE REF:
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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R2K5
X COORD: 3,006,216
Y COORD: Lo26 -39,712
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
	0.35	**Medium dense silty SAND with gravel** Dry, red brown, mottled black, ferraginisation material, sub-rounded andesite gravel in aeolian sand matrix.	
0.5	0.45	**Medium dense silty SAND with gravel** Dry to slightly moist, red brown, mottled black, some ferraginisation visible, sub-rounded andesite boulders up to 150mm.	
1.0		**Dense SAND with boulders** Dry to slightly moist, red brown, mottled black, ferruginisation up to 1.2m, sub-rounded boulders, andesite becoming more angular and with increasing particle size with depth.	
1.5			
2.0	2.20	**Refusal on medium hard rock ANDESITE.** End of Log	
2.5			
3.0			

NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
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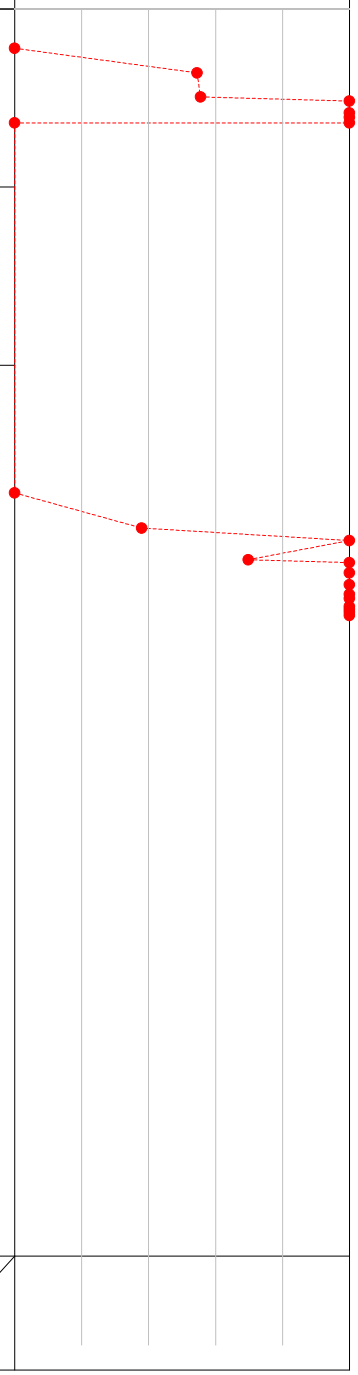
TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R3K1
X COORD: 3,005,701
Y COORD: Lo26 -39,441
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
	0.40	**Loose to medium dense silty SAND** Dry, light brown, transported Aeolian.	
0.5	0.80	**Dense to very dense silty SAND** Slightly moist, light brown, red and black, with ferruginisation evident.	
1.0	2.80	**Desnse to very dense, silty SAND** Dry to slightly moist, light yellow to grey, residual andesite, becoming more angular with depth, intact structure.	
1.5			
2.0			
2.5			
3.0		**Refusal on medium hard rock ANDESITE.** End of Log	



NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R3K2
X COORD: 3,005,649
Y COORD: Lo26 -39,548
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
		Medium dense silty SAND Dry, dark brown, transported.	
0.5	0.40	**Medium dense to dense sandy GRAVEL** Dry, orange, andersite gravel at the bottom.	
1.0	1.00	**Dense to very dense clayey GRAVEL** Dark grey and blueish gravel, light orange/yellow clay, sub-rounded gravel, becoming more angular with depth	
1.5			
2.0	2.10	**Refusal on medium hard rock ANDESITE.** End of Log	
2.5			
3.0			

NOTES 1: Samples TP/R2K2 @ 0-0.8m
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R3K3
X COORD: 3,005,594
Y COORD: Lo26 -39,656
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
		Medium dense silty SAND Slightly moist, brown, transported, aeolian.	
0.5	0.50	**Medium dense, silty SAND with gravel** Dry, brown stained red, ferruginisation present.	
1.0			
1.5	1.50	**Dense to very dense, cleyey GRAVEL** Slightly moist, light brown becoming yellow grey, intact, residual andesite. Gravel becoming more angular with depth.	
2.0			
2.5	2.90	**Refusal on medium hard rock ANDESITE.**	
3.0			

NOTES 1:
2:
3:
4:

MACHINE: 428F CAT TLB Excavator.
DIAM:
FILE REF:

DATE PROFILED: 24/07/2014
PROFILED BY: T.GROBLER Prof Reg:
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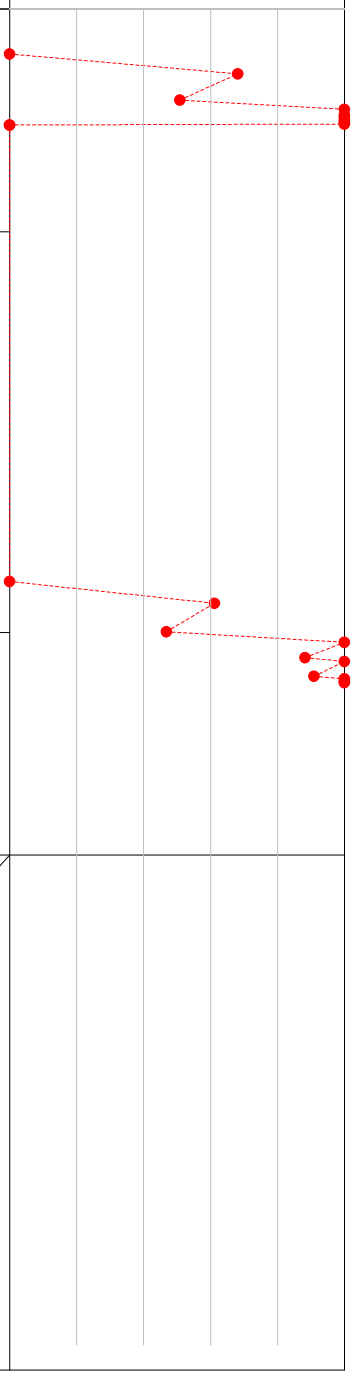
TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R3K4
X COORD: 3,005,406
Y COORD: Lo26 -39,681
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
		Medium dense to dense silty SAND with some gravel Dry, light brown, transported, aeolian sand mixed with angular andesite gravel	
0.5	0.50	**Dense silty SAND** Slightly moist, brownish red, blotched black, scattered ferruginised areas, with scattered andesite boulders.	
1.0	1.40	**Very dense clayey GRAVEL with some sand** Slightly moist, light yellowish orange, blotched black, intact, residual andesite.	
1.5	1.90	**Refusal on medium hard rock ANDESITE.** End of Log	
2.0			
2.5			
3.0			



NOTES 1: Sample R3K4 @ 1.9m
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R3K5
X COORD: 3,006,351
Y COORD: Lo26 -39,783
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Medium dense silty SAND with some gravel** Dry, brown, rounded andesite gravel in silty sand.	
	0.40		
0.5		**Medium dense silty SAND** Moist red brown, blotched black, scattered areas of ferruginised quartzite cobbles	
	0.80		
1.0		**Dense to very dense sandy GRAVEL with clay** Slightly moist, light yellow brown, intact, residual andesite.	
1.5	1.80		
		Refusal on medium hard rock ANDESITE.	
		End of Log	
2.0			
2.5			
3.0			

NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R4K1
X COORD: 3,005,840
Y COORD: Lo26 -39,509
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose sandy BOULDERS with gravel boulders** Slightly moist, red brown, andesite bouldrs of 200 up to 350mm, sub-rounded to angular.	
0.5			
	0.85	**Refusal on ANDESITE boulders**	
1.0		End of Log	
1.5			
2.0			
2.5			
3.0			

NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R4K2
X COORD: 3,005,785
Y COORD: Lo26 -39,614
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0		0.00	Ground Surface	
			ANDESITE outcrop on surface.	
0.5				
1.0				
1.5				
2.0				
2.5				
3.0				

NOTES 1:
2:
3:
4:

MACHINE: 428F CAT TLB Excavator.
DIAM:
FILE REF:

DATE PROFILED: 24/07/2014
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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R4K3
X COORD: 3,005,733
Y COORD: Lo26 -39,721
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0	0.20	**Medium silty SAND with some gravel** Slightly moist, grey brown, aeolian sand in andesite gravel.	
0.5		**Dense to very dense, silty SAND with gravel** Slightly moist, orange yellow, stained black at depth, residual andesite, weathering decreasing with depth, gravel becoming more angular with depth.	
1.0	1.20	**Refusal on medium hard rock ANDESITE.** End of Log	
1.5			
2.0			
2.5			
3.0			

NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator.
DIAM:
FILE REF:

DATE PROFILED: 24/07/2014
PROFILED BY: T.GROBLER Prof Reg:
CHECKED BY: Prof Reg:

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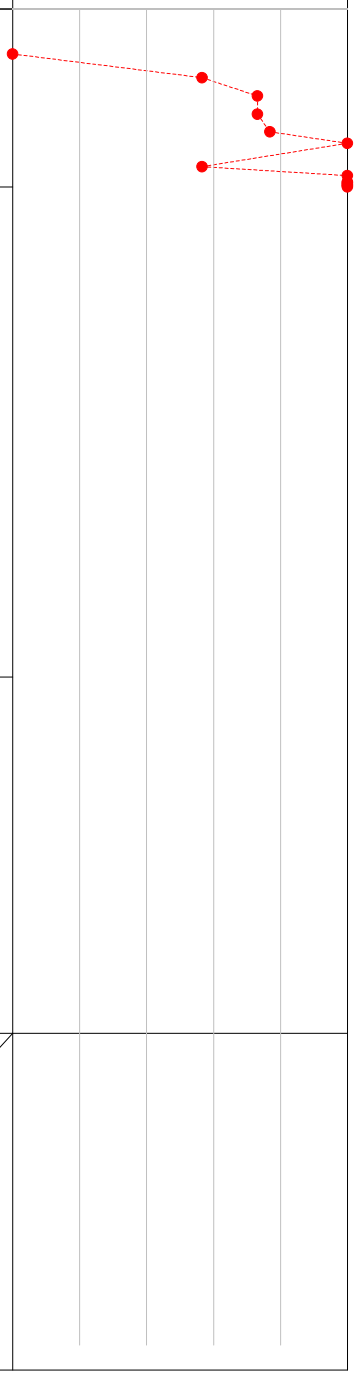
TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R4K4
X COORD: 3,005,406
Y COORD: Lo26 -39,681
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Medium dense to dense silty SAND with some gravel** Moist, light brown, transported, aeolian sand mixed with angular andesite gravel.	
	0.40		
0.5		**Dense silty SAND** Slightly moist, brownish red, blotched black, ferruginised material with scattered andesite boulders of 180-300mm.	
1.0			
	1.50		
1.5		**Very dense clayey GRAVEL with some sand** Slightly moist, light yellowish orange, blotched black, intact, becoming more angular with depth, residual andesite.	
2.0			
	2.30		
		Refusal on medium hard rock ANDESITE. End of Log	
2.5			
3.0			



NOTES 1: Sample R4K4 @1.1m
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R4K5
X COORD: 3,006,490
Y COORD: Lo26 -39,854
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
		0.00	Ground Surface	
0.0		0.10	**Loose sandy GRAVEL** Dry, light brown sand in andesite gravel.	
0.5		0.60	**Medium dense sandy GRAVEL** Dry, red brown blotched black. Clast supported, ferruginisation in areas	
1.0		1.20	**Medium dense sandy GRAVEL** Dry, light yellow, stained white grey, intact, residual, scattered andesite boulders of 180-300mm, sub-rounded to angular.	
1.5			**Refusal on medium hard rock ANDESITE.** End of Log	
2.0				
2.5				
3.0				

NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R5K1
X COORD: 3,005,972
Y COORD: Lo26 -39,577
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
		0.00	Ground Surface	
0.0			**Loose to medium sandy BOULDERS with some gravel and cobbles** Slightly moist, yellowish grey sand, becoming more orange with depth, andesite boulders of 160-330mm.	
0.5		0.55	**Refusal on ANDESITE boulders**	
			End of Log	
1.0				
1.5				
2.0				
2.5				
3.0				

NOTES 1: Samples TP/R3K1 @0m
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R5K2
X COORD: 3,005,915
Y COORD: Lo26 -38,030
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
		0.00	Ground Surface	
0.0			**ANDESITE outcrop on surface.**	
0.5				
1.0				
1.5				
2.0				
2.5				
3.0				

NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEDORINGSTAD

HOLE NO: R5K3
X COORD: 3,005,865
Y COORD: Lo26 -39,790
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.00		Ground Surface	
0.0	0.00–0.30	**Medium dense sandy GRAVEL** Dry light brown, transported, aeolian sand mixed with andesite gravel.	
0.5	0.30–0.75	**Medium dense sandy GRAVEL with some cobbles** Slight moist, brownish red, blotched black, ferruginisation in areas.	
1.0, 1.5	0.75–1.95	**Medium dense, silty, sandy GRAVEL** Slightly moist, yellow brown, stained red, sandy clay in gravel, residual andesite, becoming more angular with depth.	
2.0, 2.5, 3.0	1.95–3.10	**Dense sandy GRAVEL** Slightly moist, brownish orange, becoming yellow with depth.	
3.10		**Excavation terminated at maximum reach of TLB.** End of Log	
3.5, 4.0			

NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator.
DIAM:
FILE REF:

DATE PROFILED: 24/07/2014
PROFILED BY: T.GROBLER Prof Reg:
CHECKED BY: Prof Reg:

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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R5K4
X COORD: 3,005,810
Y COORD: Lo26 -39,889
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
	0.40	**Medium dense to dense silty SAND with some gravel** Moist, light brown, transported, aeolian sand mixed with andesite gravel.	
0.5, 1.0	1.35	**Dense silty SAND** Slightly moist, brownish red, blotched black, ferruginised material with scattered andesite boulders, sub-rounded boulders of 120-330mm.	
1.5, 2.0, 2.5, 3.0	3.10	**Very dense clayey GRAVEL with some sand** Slightly moist, light yellowish orange, blotched black, intact, becoming more angular with depth, residual andesite.	
3.5, 4.0		**Hole terminated at maximum TLB reach.** End of Log	

NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R5K5
X COORD: 3,005,626
Y COORD: Lo26 -39,925
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0	0.10	**Loose to medium dense silty SAND** Slightly moist, red brown, transported aeolian.	
	0.40	**Dense to very dense sandy GRAVEL with clay** Slightly moist, yellow, mottled black, intact, residual, andesite, some ferruginisation, very small nodules.	
0.5		**Resfusal on medium hard rock ANDESITE.** End of Log	
1.0			
1.5			
2.0			
2.5			
3.0			

NOTES 1: No samples
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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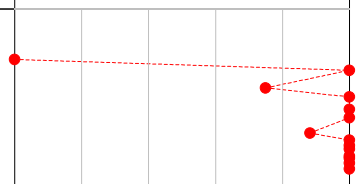
TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R6K1
X COORD: 3,006,108
Y COORD: Lo26 -39,649
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium sandy BOULDERS with some gravel and cobbles** Slightly moist, red brown, boulders in aeolian sand.	
	0.40	**Refusal on ANDESITE boulders.** End of Log	
0.5			
1.0			
1.5			
2.0			
2.5			
3.0			



NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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Template: SMEC TP04

TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R6K2
X COORD: 3,005,053
Y COORD: Lo26 -39,753
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
	0.20	**Loose silty SAND** Dry, brown, transported, aeolian.	
0.5	0.60	**Loose Sandy GRAVEL** Slightly moist, dark brown, blotched black, some ferruginisation, angular andesite gravel.	
1.0	1.20	**Dense sandy GRAVEL** Silght moist, yellowish grey, intact, residual, angular, andesite. Matrix supported.	
1.5		**Refusal on, medium hard rock ANDESITE** End of Log	
2.0			
2.5			
3.0			

NOTES 1: No sample
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEUDORINGSTAD

HOLE NO: R6K3
X COORD: 3,006,137
Y COORD: Lo26 -39,927
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
		Loose silty SAND Dry light brown, transported, aeolian.	
	0.40		
0.5		**Medium dense sandy GRAVEL with boulders** Slight moist, dark brown, stained red, with andesite boulders of 190-330mm.	
	0.90		
1.0		**Very dense silty SAND with some cobbles** Slightly moist, light brown, stained grey, residual andesite, more angular with depth, less weathering with depth.	
1.5			
2.0			
2.5			
3.0	3.00	**Hole stopped at maximum TLB reach.**	
		End of Log	
3.5			
4.0			

NOTES 1: Sample R6K3 @ 2.2m
2:
3:
4:

MACHINE: 428F CAT TLB Excavator. DATE PROFILED: 24/07/2014
DIAM: PROFILED BY: T.GROBLER Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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Template: SMEC TP04

TRIAL PIT LOG

CLIENT: SunEdison
PROJECT: BOKAMOSO
PROJECT NO: JG0002/01
SITE: LEEDORINGSTAD

HOLE NO: R6K4
X COORD: 3,005,949
Y COORD: Lo26 -39,966
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N
		0.00	Ground Surface	
0.0			Medium dense to dense silty SAND with some	
		0.40		
0.5		0.60		
1.0				
1.5				
2.0		2.20		
2.5				
3.0				

NOTES 1:
2:
3:
4:

MACHINE: DATE PROFILED:
DIAM: PROFILED BY: Prof Reg:
FILE REF: CHECKED BY: Prof Reg:

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APPENDIX B3: LOGGING PARAMETERS

1. SOIL DESCRIPTIVE TERMS

DESCRIPTIVE ORDER:
1. CONSISTENCY 2. SOIL TYPE 3. MOISTURE CONDITION 4. COLOUR 5. SOIL STRUCTURE 6. ORIGIN

1.(a) CONSISTENCY: GRANULAR SOILS

S P T "N"	GRAVELS & SANDS Generally free draining soils		TYPICAL DRY DENSITY (kg/m^3)
< 4	VERY LOOSE	Crumbles very easily when scraped with geological pick	< 1450
4-10	LOOSE	Small resistance to penetration by sharp pick point	1450-1600
10-30	MEDIUM DENSE	Considerable resistance to penetration by sharp pick point	1600-1750
30-50	DENSE	Very high resistance to penetration by sharp pick point. Requires many blows of pick for excavation	1750-1925
> 50	VERY DENSE	High resistance to repeated blows of geological pick. Requires power tools for excavation	> 1925

1(b) CONSISTENCY: COHESIVE SOILS

S P T "N"	SILTS & CLAYS and combination with SANDS Generally slow draining soils		UCS (kPa)
< 2	VERY SOFT	Pick point easily pushed in 100mm. Easily moulded by fingers	< 50
2-4	SOFT	Pick point easily pushed in 30-40mm. Moulded by fingers with some pressure. Easily penetrated by thumb.	50-125
4-8	FIRM	Pick point penetrates up to 10mm. Very difficult to mould with fingers. Indented by thumb with effort. Spade just penetrates.	125-500
8-15	STIFF	Slight indentation by pushing in pick point. Cannot be moulded by fingers. Penetrated by thumbnail. Pick necessary to excavate.	250-500
15-30	VERY STIFF	Slight indentation by blow of pick point.. Requires power tools for excavation.	500-1000

2. SOIL TYPE

SOIL TYPE	PARTICLE SIZE (mm)
CLAY	< 0,002
SILT	0,002 – 0,06
SAND	0,06 – 2
GRAVEL	2 – 60*
COBBLES	60 – 200*
BOULDERS	> 200*

* Specify aver/max sizes, hardness, shape and proportion

3. MOISTURE CONDITION

DRY	No water detectable
SLIGHTLY MOIST	Water just discernable
MOIST	Water easily discernable
VERY MOIST	Water can be squeezed out
WET	Generally below the water table

4. COLOUR

Described at natural moisture content, as seen in profile (unless otherwise specified).

SPECKLED	Very small patches of colour < 2 mm
MOTTLED	Irregular patches of colour 2 – 6 mm
BLOTCHED	Large irregular patches 6 – 20 mm
BANDED	Approximately parallel bands of varying colour
STREAKED	Randomly orientated streaks of colour
STAINED	Local colour variations: associated with discontinuity surfaces
Described using bedding thickness criteria. (e.g. thickly banded, thinly streaked, etc.)	

5. SOIL STRUCTURE

INTACT	No structure present
FISSURED	Presence of discontinuities, possibly cemented
SLICKENSIDED	Very smooth, glossy, often striated discontinuity planes
SHATTERED	Presence of open fissures. Soil breaks into gravel size blocks
MICRO-SHATTERED	Small scale shattering, very closely spaced open fissures. Soil breaks into sand size crumbs
RESIDUAL STRUCTURES	Relict bedding, lamination, foliation, etc.

6. ORIGIN

TRANSPORTED	Alluvium, hillwash, talus, etc.
RESIDUAL	Weathered from parent rock e.g. residual granite
PEDOCRETES	Ferricrete, laterite, silcrete, calcrete, etc.

DEGREE OF CEMENTATION OF PEDOCRETES		UCS (MPa)
VERY WEAKLY CEMENTED	Some material can be crumbled between finger and thumb. Disintegrates under knife blade to a friable state.	0,1 – 0,5
WEAKLY CEMENTED	Cannot be crumbled between strong fingers. Some material can be crumbled by strong pressure between thumb and hard surface. Under light hammer blows disintegrates to friable state.	0,5 – 2
CEMENTED	Material crumbles under firm blows of sharp pick point. Grains can be dislodged with some difficulty by a knife blade.	2 – 5
STRONGLY CEMENTED	Firm blows of sharp pick point on hand-held specimen show 1-3mm indentations. Grains cannot be dislodged by knife blade.	5 – 10
VERY STRONGLY CEMENTED	Hand-held specimen can be broken by single firm blow of hammerhead. Similar appearance to concrete.	10 - 25

REFERENCE: Guidelines for Soil and Rock Logging (SAIEG – AEG – SAICE) (1990)

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2. ROCK DESCRIPTIVE TERMS

DESCRIPTIVE ORDER: 1. HARDNESS 2. ROCK TYPE 3. WEATHERING 4. COLOUR 5. FRACTURE SPACING 6. DISCONTINUITY SURFACE DESCRIPTION 7. GRAIN SIZE 8. ROCK FORMATION NAME

1. ROCK HARDNESS

HARDNESS	DESCRIPTION	UCS (MPa)
VERY SOFT	Material crumbles under firm blows of pick point. Can be peeled with a knife. SPT refusal. Too hard to cut triaxial sample by hand	1 – 3
SOFT ROCK	Firm blows with pick point: 2-4mm indents. Can just be scraped with a knife	3 - 10
MEDIUM HARD ROCK	Firm blows of pick head will break hand-held specimen. Cannot be scraped or peeled with a knife.	10 - 25

HARDNESS	DESCRIPTION	UCS (MPa)
HARD ROCK	Breaks with difficulty, rings when struck Point load or laboratory test results necessary to distinguish between categories	25 – 70
VERY HARD ROCK		70 – 200
VERY VERY HARD ROCK		> 200

2. ROCK TYPE

Quartzite, sandstone, granite, limestone, etc.

4. COLOUR

Described in the dry state unless otherwise indicated

3. WEATHERING

DEGREE OF WEATHERING	EXTENT OF DISCOLOURATION	FRACTURE CONDITION	SURFACE CHARACTERISTICS	ORIGINAL FABRIC	GRAIN BOUNDARY CONDITION
UNWEATHERED	None	Closed or stained	Unchanged	Preserved	Tight
SLIGHTLY WEATHERED	< 20% of fracture spacing on both sides of fracture	Discoloured, may contain thin filling	Partial discolouration. Often unweathered rock colour	Preserved	Tight
MODERATELY WEATHERED	>20% of fracture spacing on both side of fracture	Discoloured, may contain thick filling	Partial to complete discolouration. Not friable except poorly cemented rocks	Preserved	Partial opening
HIGHLY WEATHERED	Throughout	-	Friable, possibly pitted	Mainly preserved	Partial separation. Not easily indented with knife. Does not slake
COMPLETELY WEATHERED	Throughout	-	Resembles a soil	Partially preserved	Complete separation. Easily indented with knife. Slakes

5. DISCONTINUITY SPACING

SEPARATION (mm)	SPACING (foliation, cleavage, bedding, etc.)	SPACING (fractures, joints, etc.)
< 6	very intensely	very highly
6 – 20	intensely	
20 – 60	very thinly	highly
60 – 200	thinly	
200 – 600	medium	moderately
600 – 2000	thickly	slightly
> 2000	very thickly	very slightly

6. DISCONTINUITY SURFACE DESCRIPTION

6.1 JOINT FILLING

JOINT FILL TYPE	DEFINITION (wall separation specified in mm)
CLEAN	No fracture filling
STAINED	Colouration of rock only. No recognisable filling material
FILLED	Fracture filled with finite thickness filling material

6.2 DISCONTINUITY ORIENTATION

Discontinuity inclinations (i.e. of joints, bedding, faults

6.3 ROUGHNESS OF DISCONTINUITY PLANES

CLASSIFICATION	DESCRIPTION
SMOOTH	Appears smooth and is essentially smooth to the touch. May be slickensided *
SLIGHTLY ROUGH	Asperities on the fracture surface are visible and can be distinctly felt
MEDIUM ROUGH	Asperities are clearly visible and fracture surface feels abrasive
ROUGH	Large angular asperities can be seen. Some ridge and high side angle steps evident
VERY ROUGH	Near vertical steps and ridges occur on the fracture surface

* Where slickensides occur the direction of the slickensides should be recorded

7. GRAIN SIZE

CLASSIFICATION	SIZE (mm)	RECOGNITION
VERY FINE GRAINED	< 0.2	Individual grains cannot be seen with a hand lens
FINE GRAINED	0.2 – 0.6	Just visible as individual grains under hand lens
MEDIUM GRAINED	0.6 – 2	Grains clearly visible under hand lens, just visible to the naked eye
COARSE GRAINED	2 – 6	Grains clearly visible to the naked eye
VERY COARSE GRAINED	> 6	Grains measurable

8. ROCK FORMATION

Brixton Formation, Halfway House Granite Dome etc.

REFERENCE: Guidelines for Soil and Rock Logging (SAIEG – AEG – SAICE) (1990)

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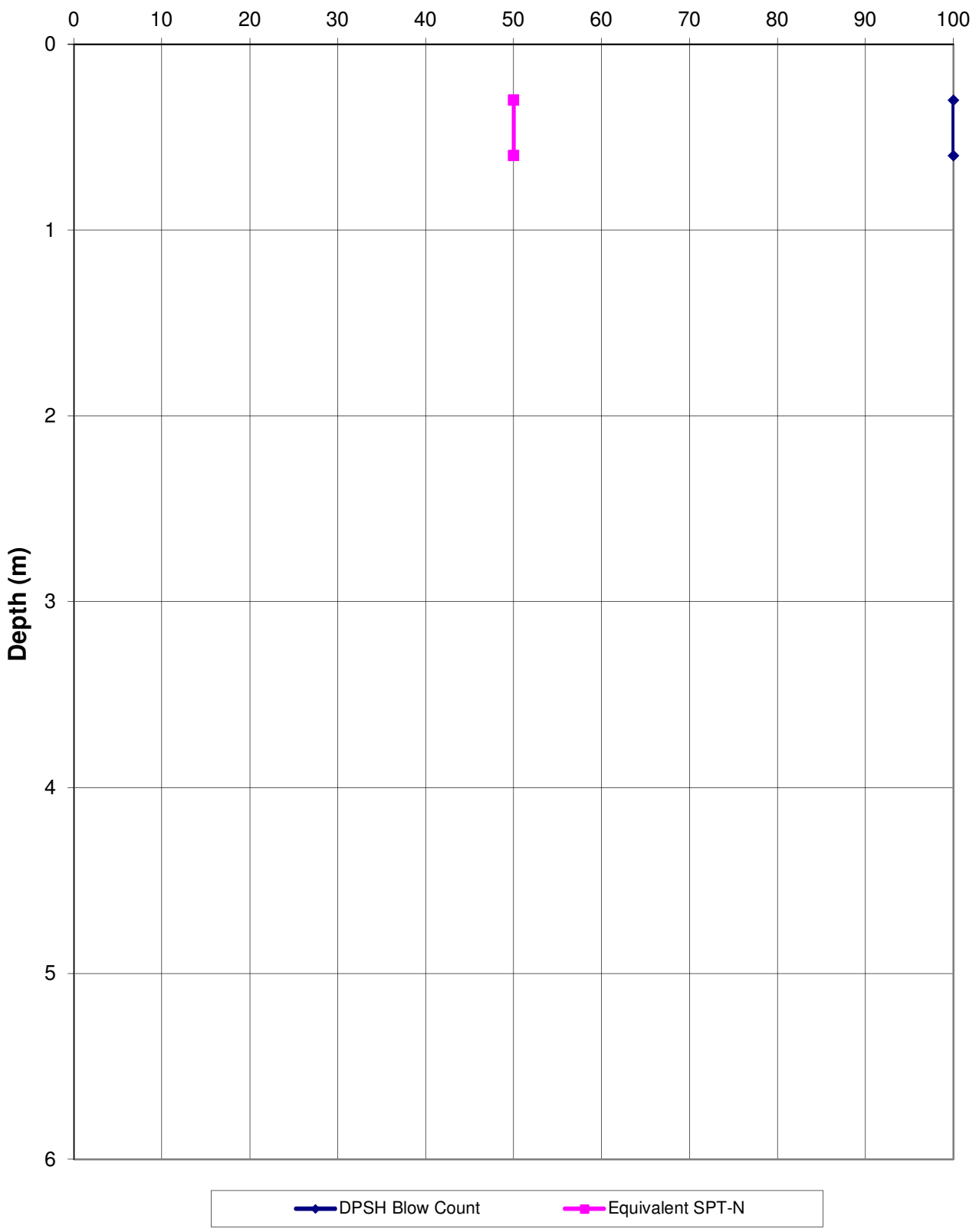
APPENDIX C: DPSH RESULTS



DPSH GRAPH	R1K1			
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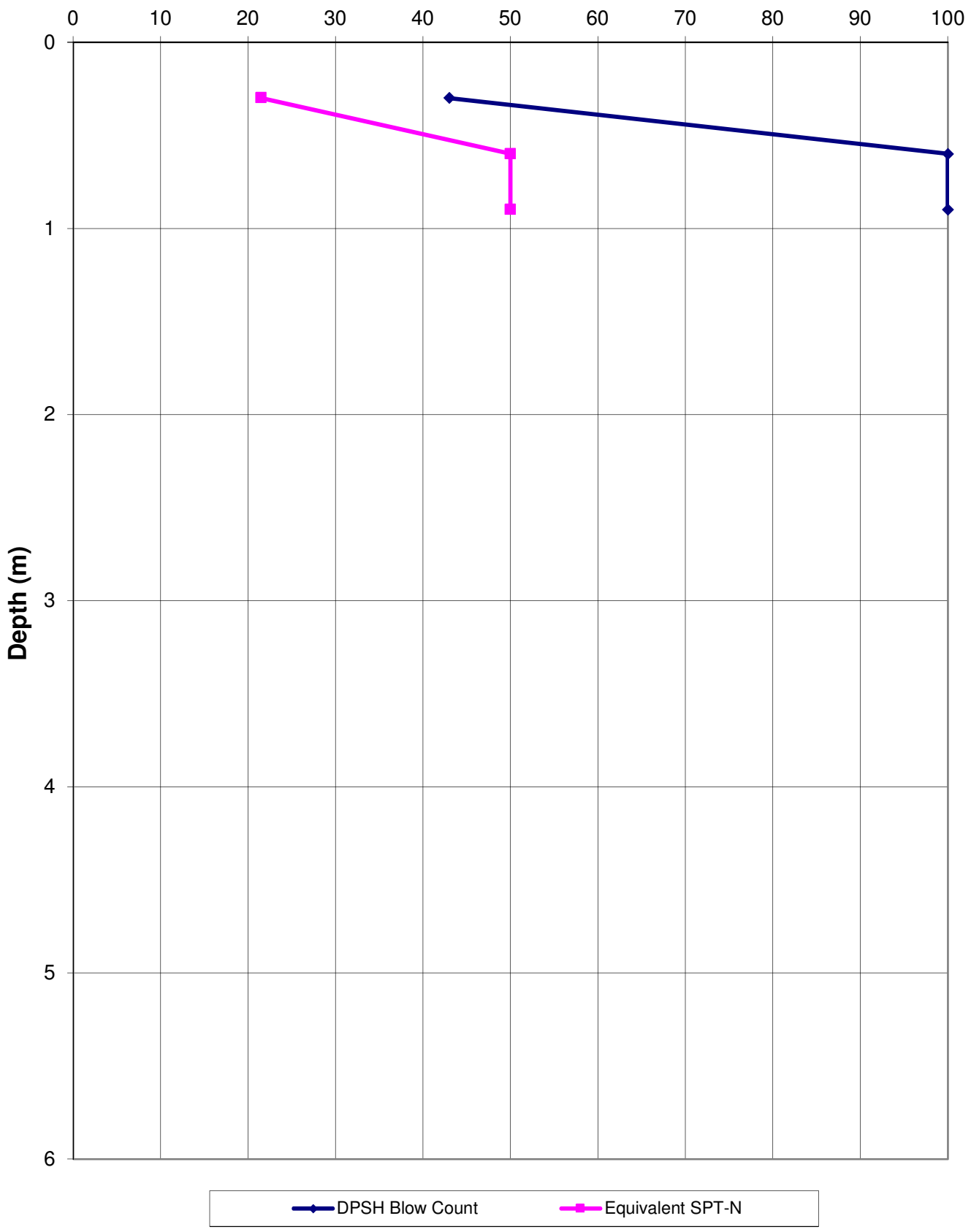
	Checked	fp	12/08/2014	



DPSH GRAPH	R2K2			
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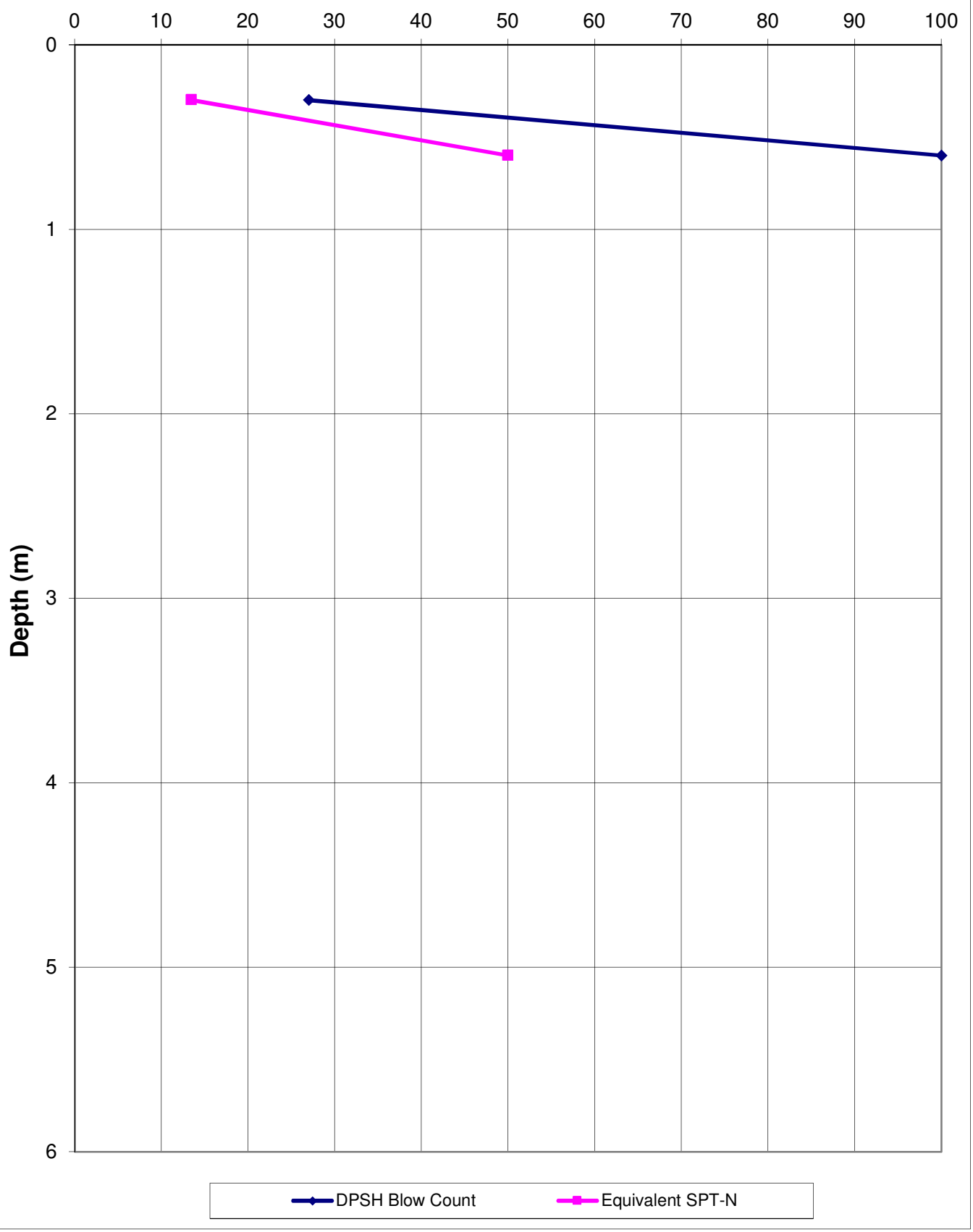
	Checked	fp	12/08/2014	



DPSH GRAPH	R3K3		
GEOTECHNICAL INVESTIGATION BOKAMOSO SOLAR PARK	Compliled	tg	12/08/2014
	Checked	fp	12/08/2014

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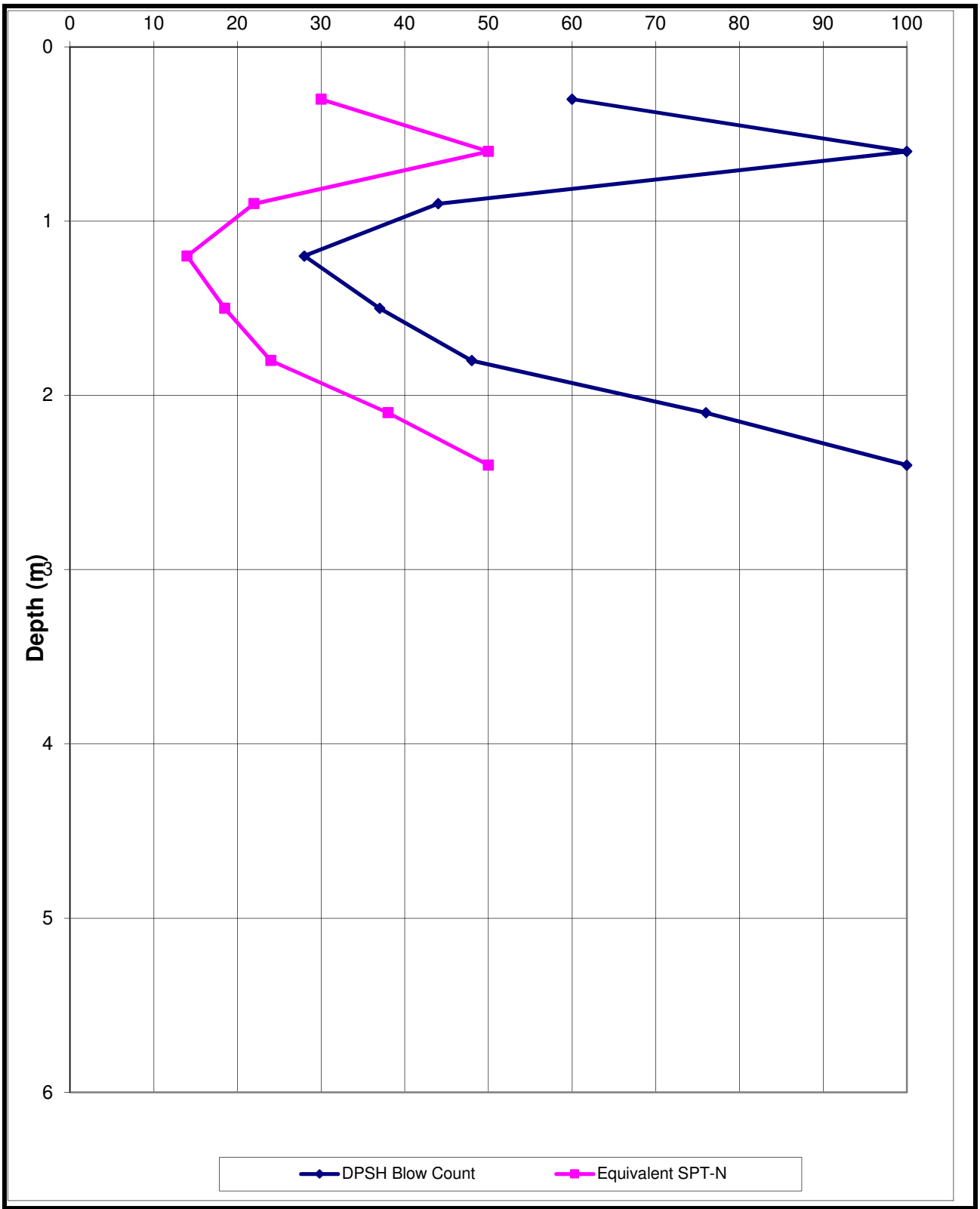
DPSH GRAPH	R5K3			
GEOTECHNICAL INVESTIGATION BOKAMOSO SOLAR PARK	Compliled	tg	12/08/2014	SMEC
	Checked	fp	12/08/2014	



DPSH GRAPH	R5K4			
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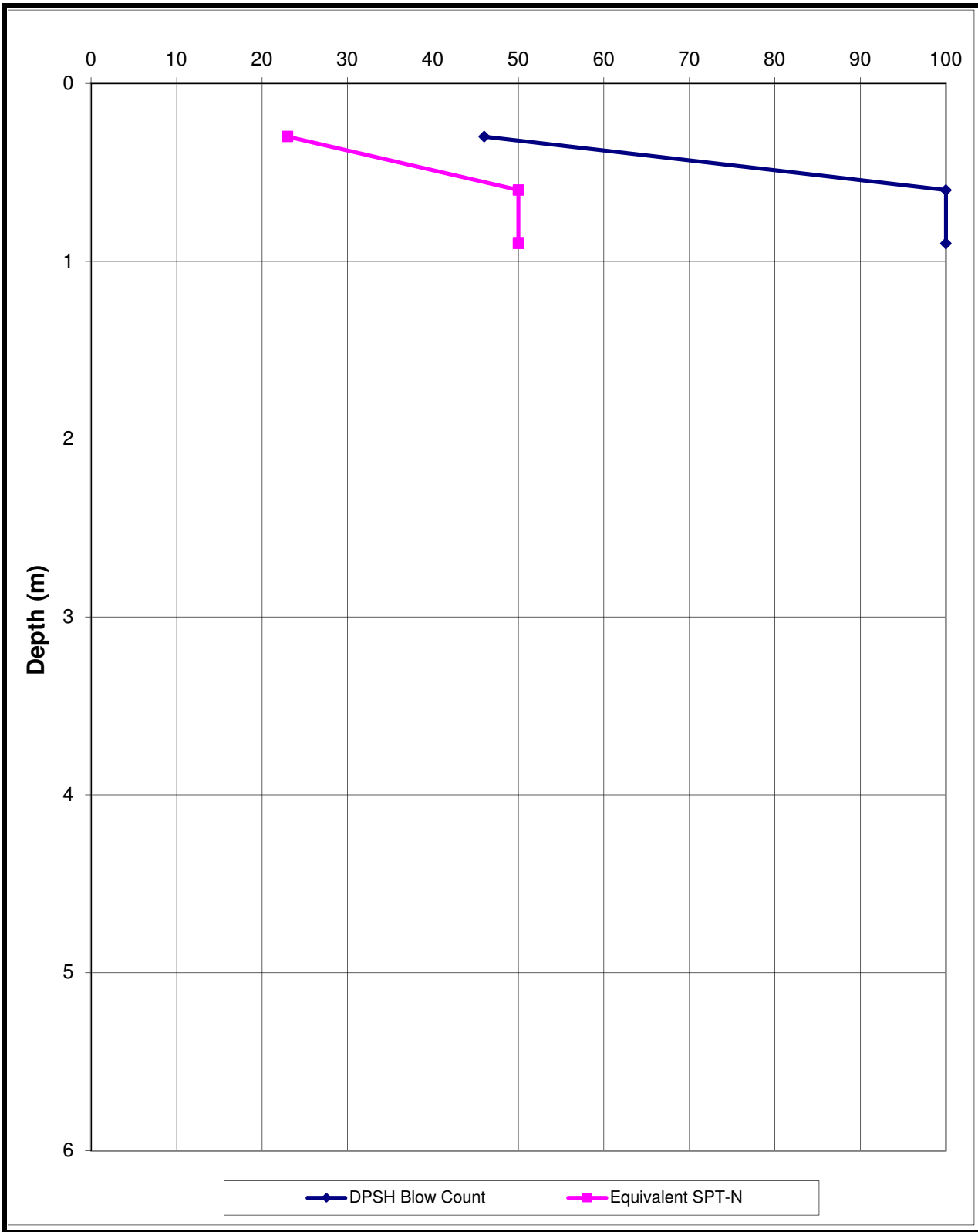
	Checked	fp	12/08/2014	



DPSH GRAPH	R7K5			
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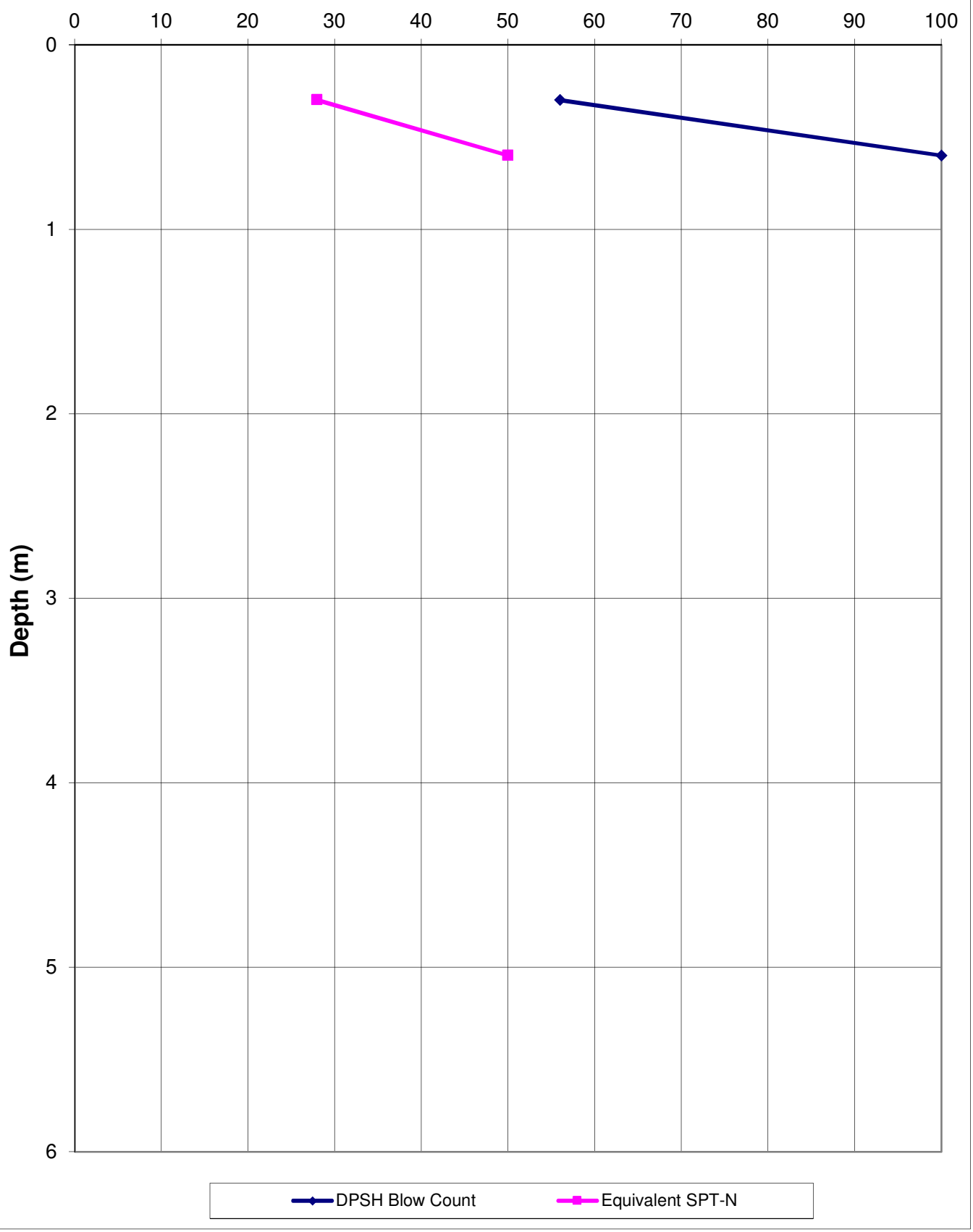
	Checked	fp	12/08/2014	



DPSH GRAPH	R2K5			
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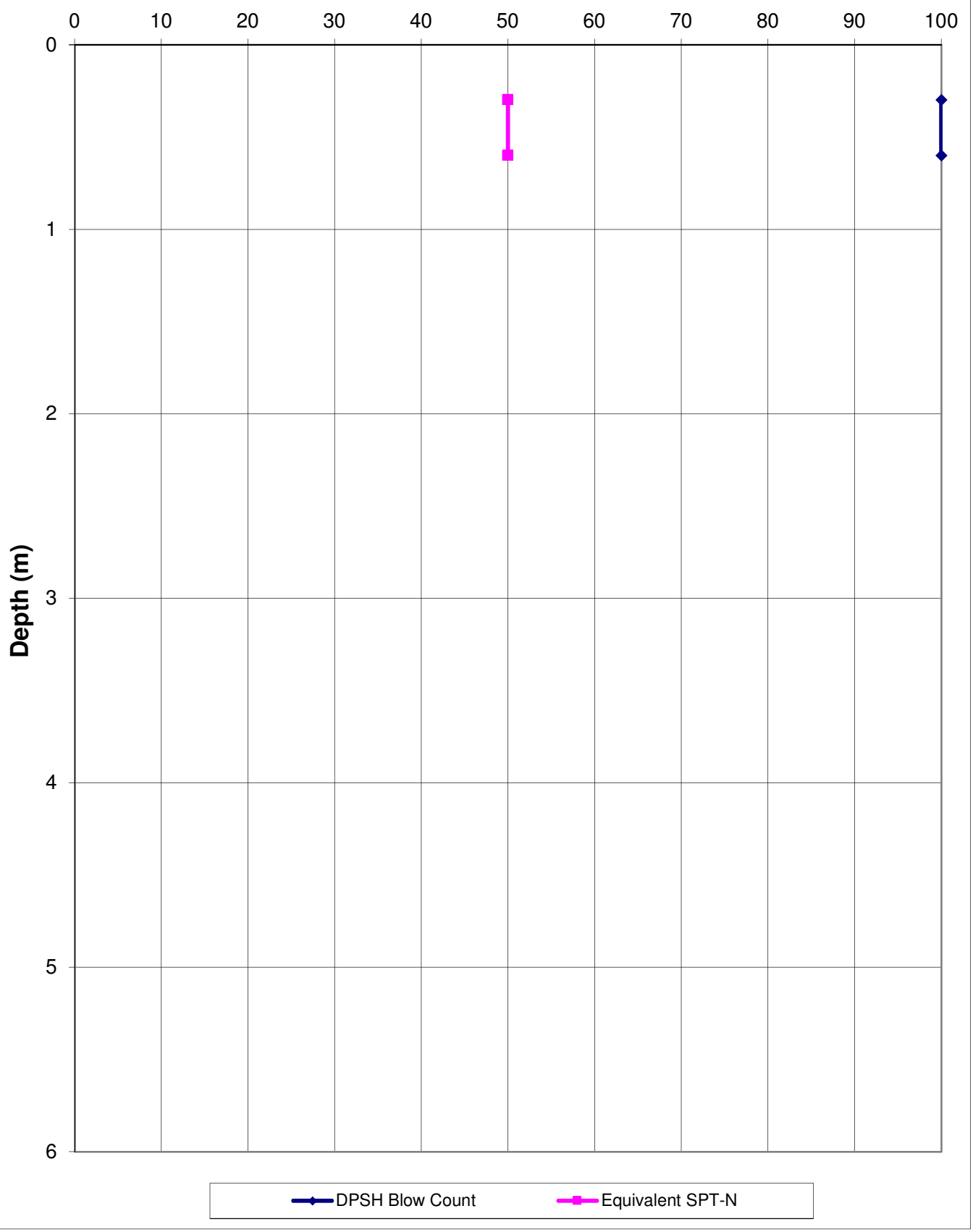
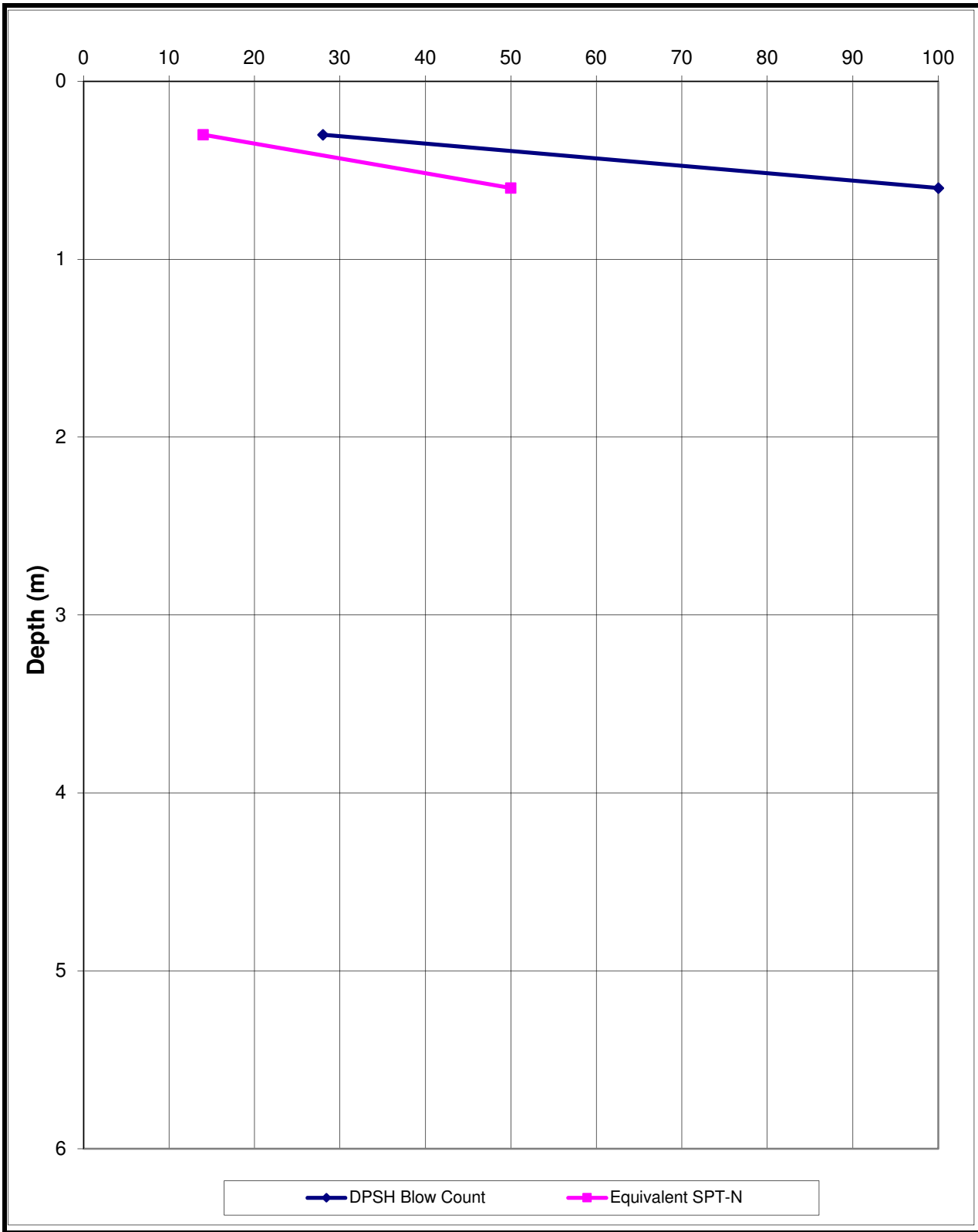
	Checked	fp	12/08/2014	



DPSH GRAPH	RSKS			
GEOTECHNICAL INVESTIGATION BOKAMOSO SOLAR PARK	Compliled	tg	12/08/2014	SMEC
	Checked	fp	12/08/2014	



DPSH GRAPH	R8K4			
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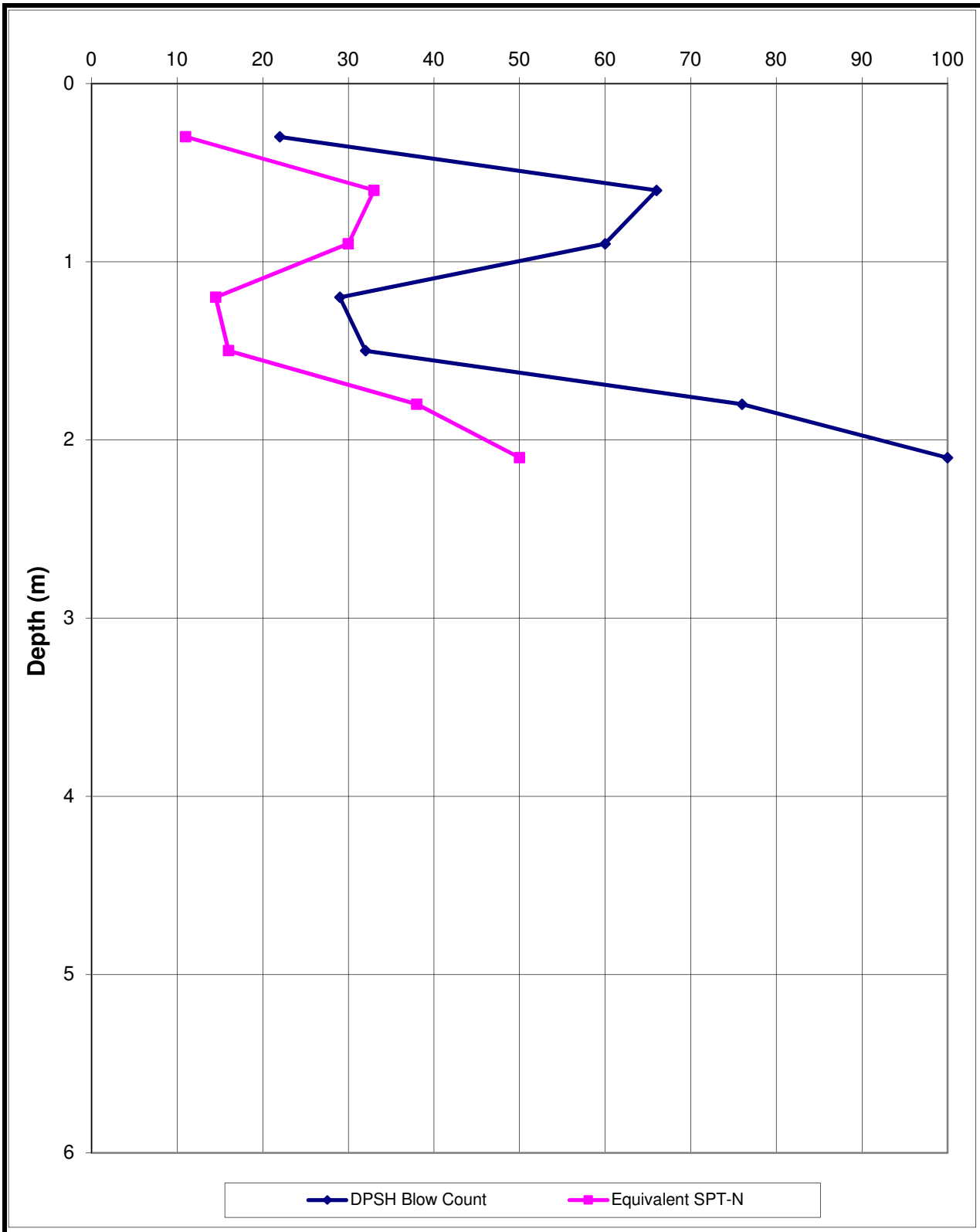
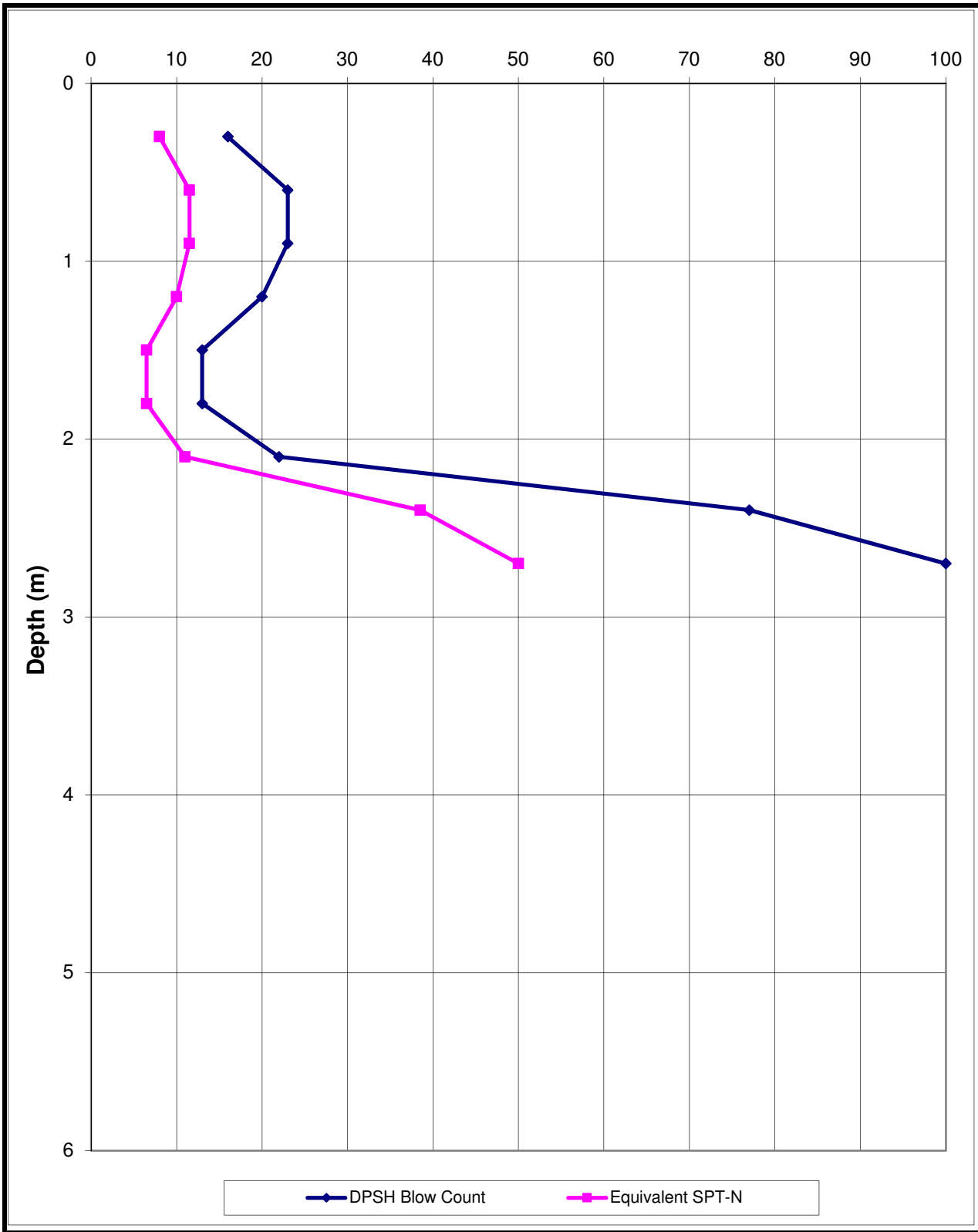
	Checked	fp	12/08/2014	



DPSH GRAPH	R8K3			
GEOTECHNICAL INVESTIGATION BOKAMOSO SOLAR PARK	Compliled	tg	12/08/2014	SMEC
	Checked	fp	12/08/2014	



DPSH GRAPH	R10K5			
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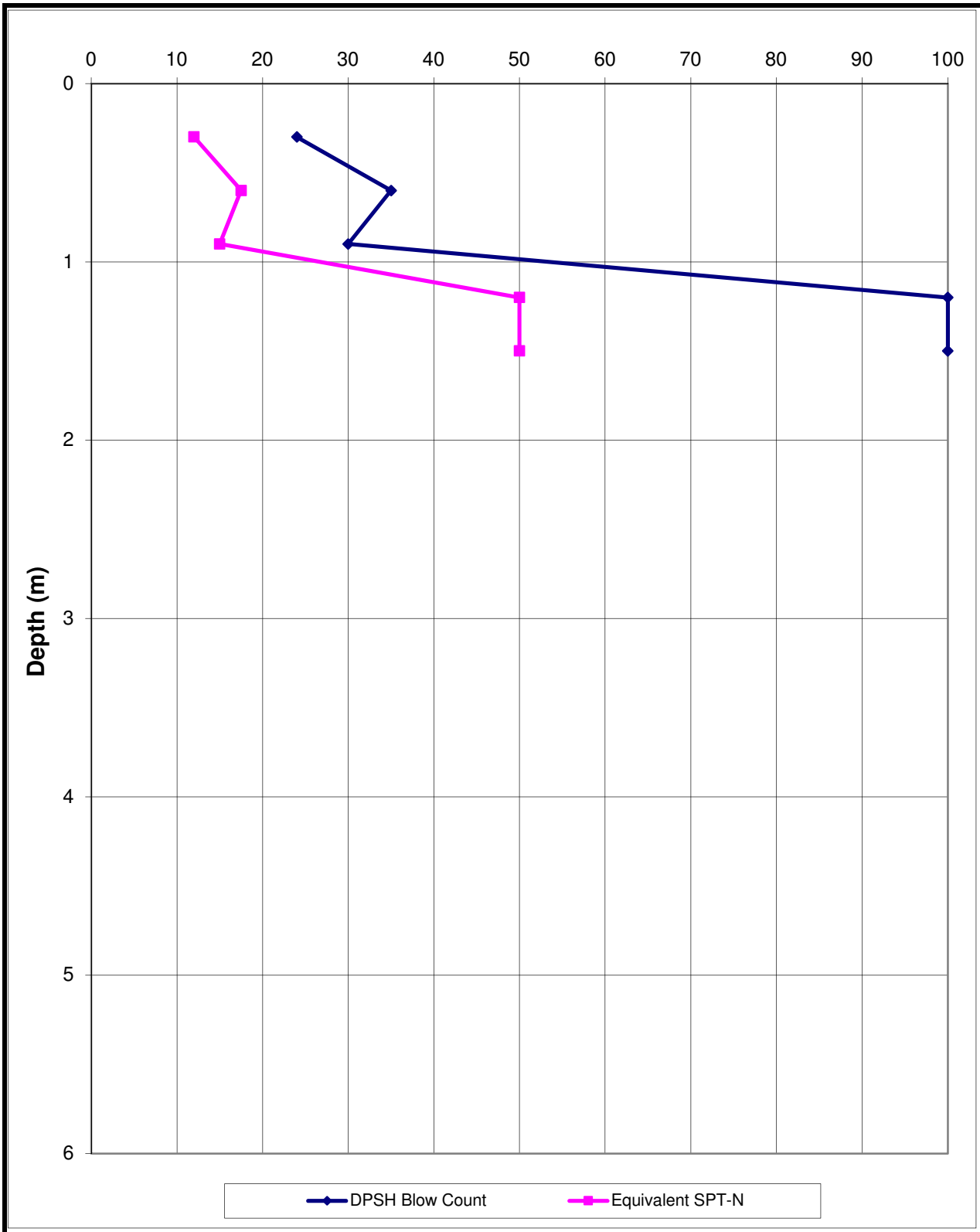
	Checked	fp	12/08/2014	



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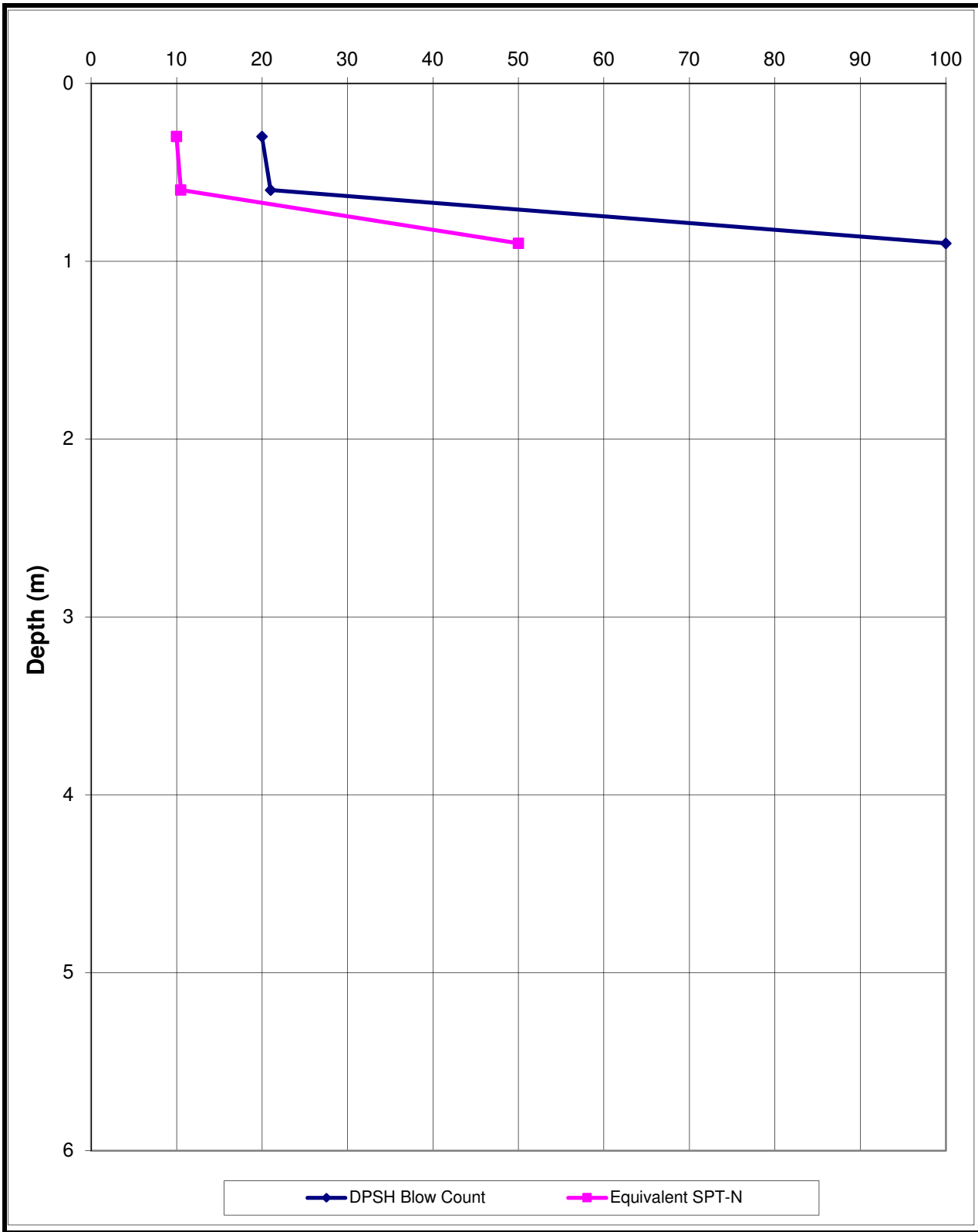

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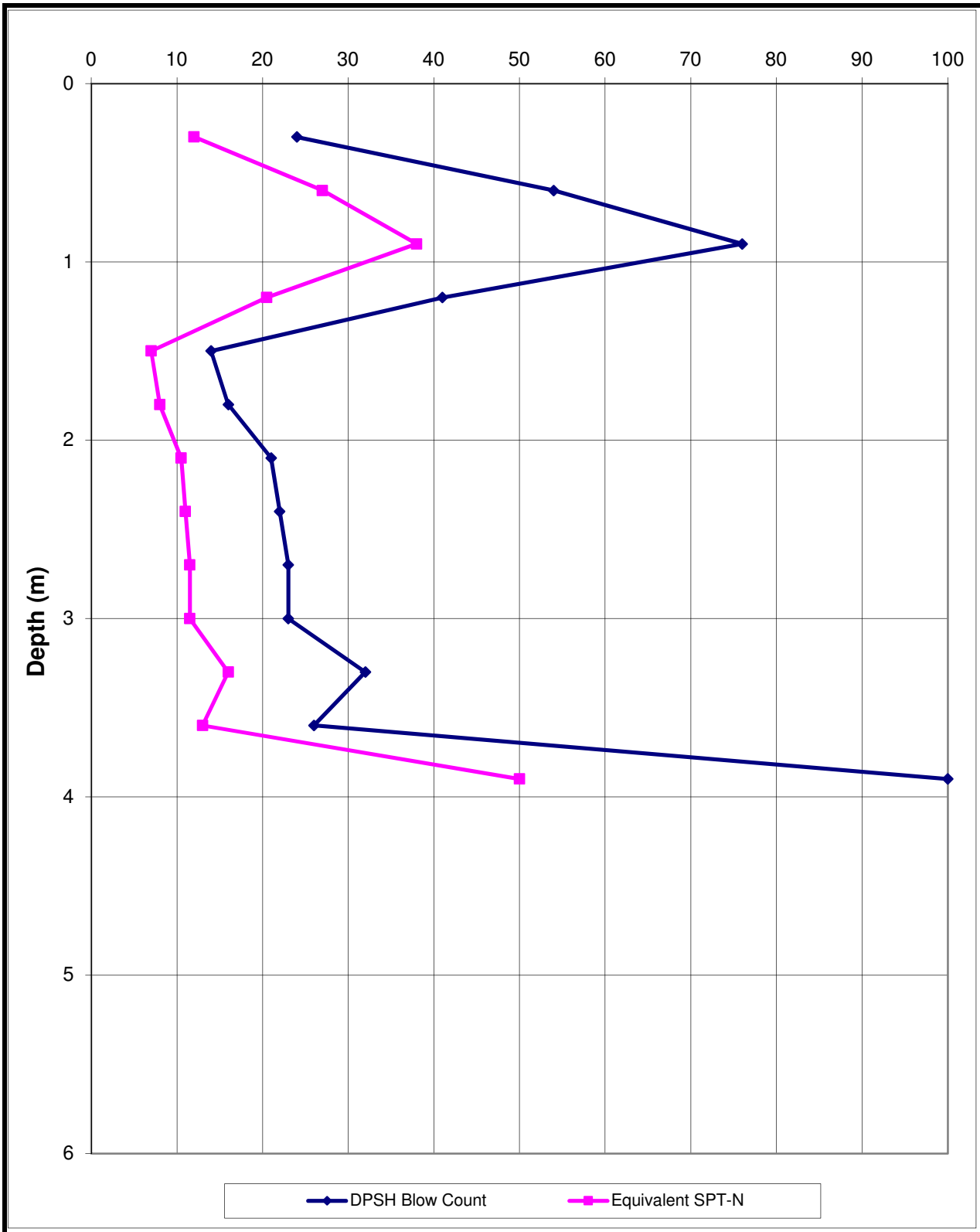

DPSH GRAPH	R7K1			
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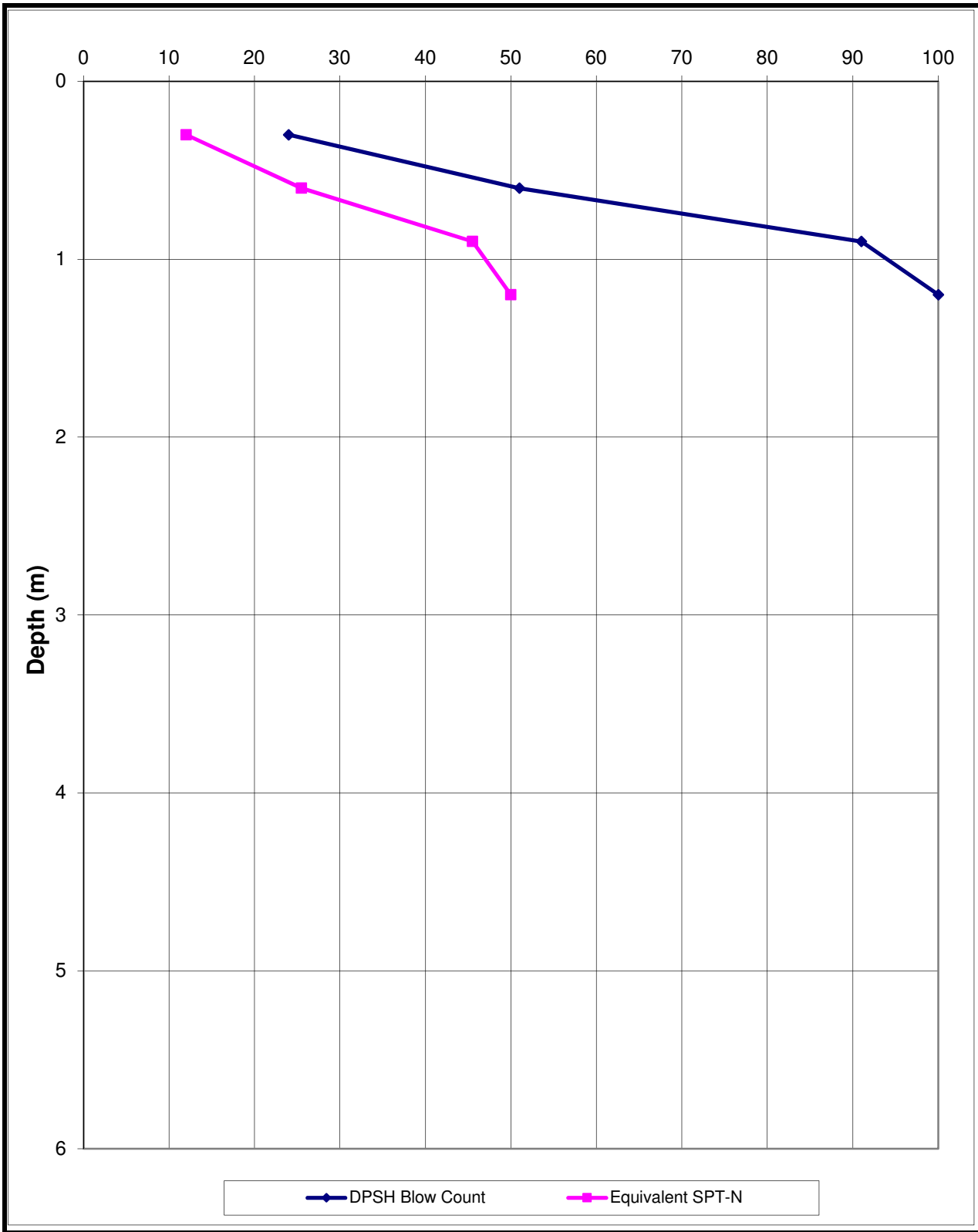

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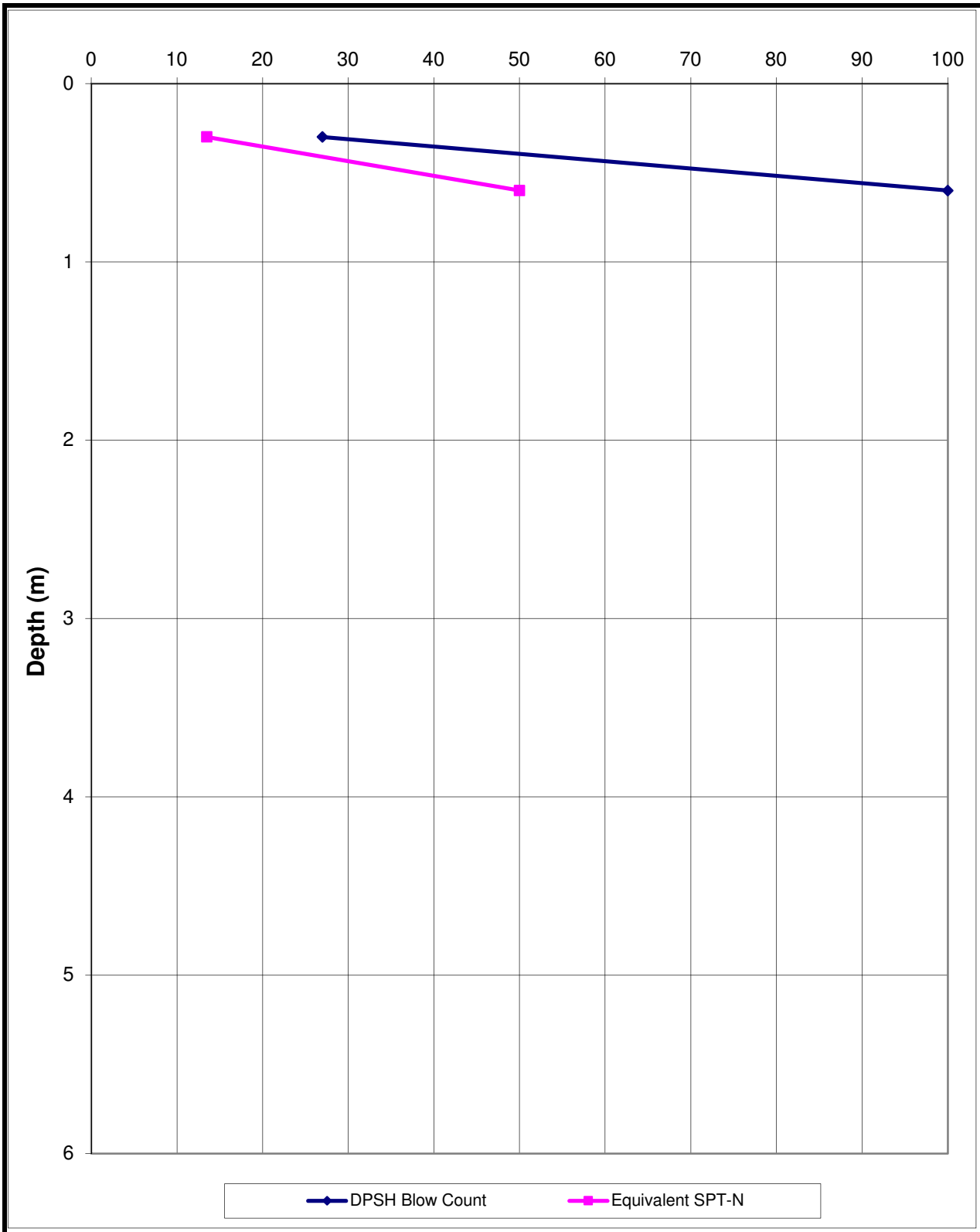

DPSH GRAPH	R12K3			
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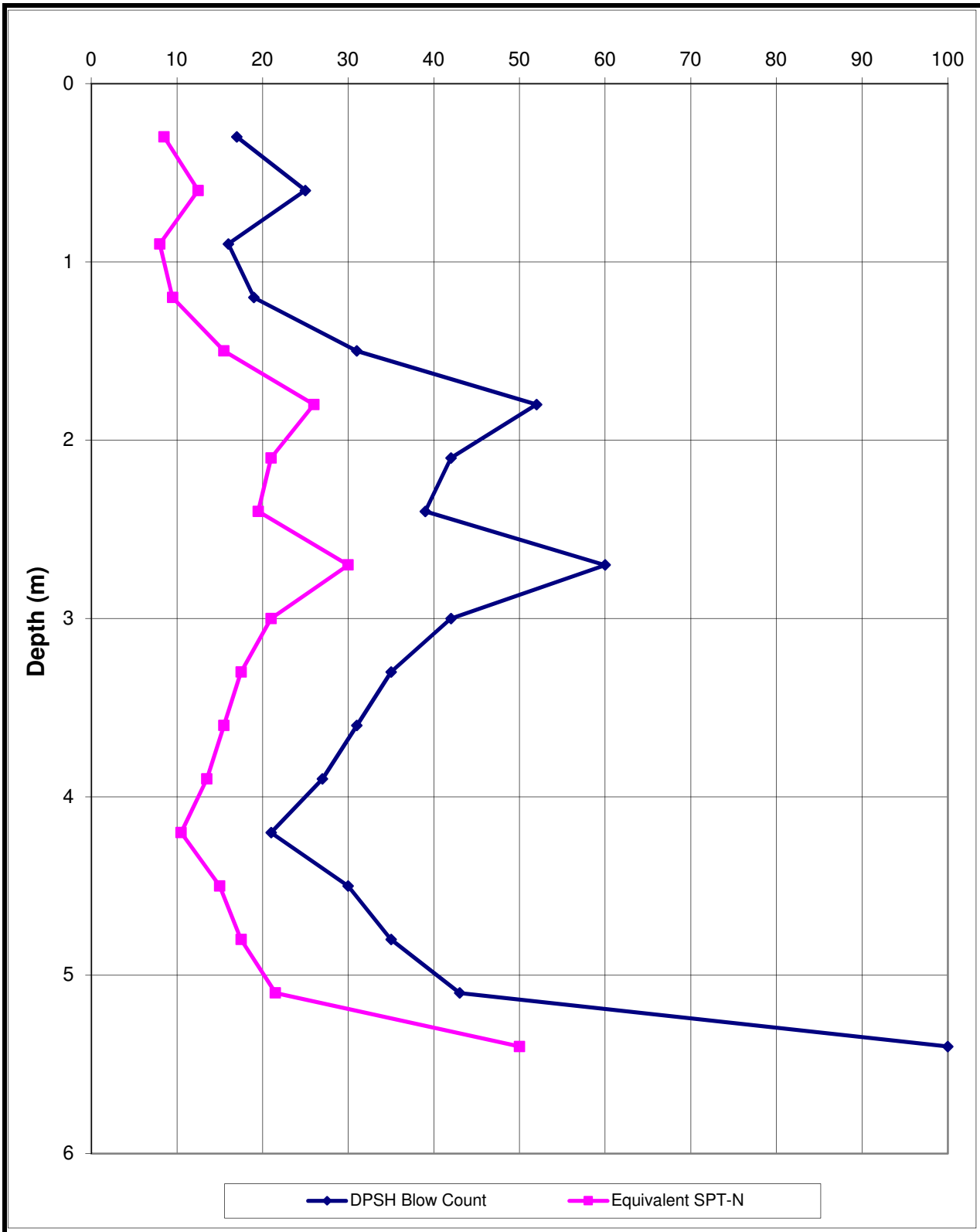

DPSH GRAPH	R13K4			
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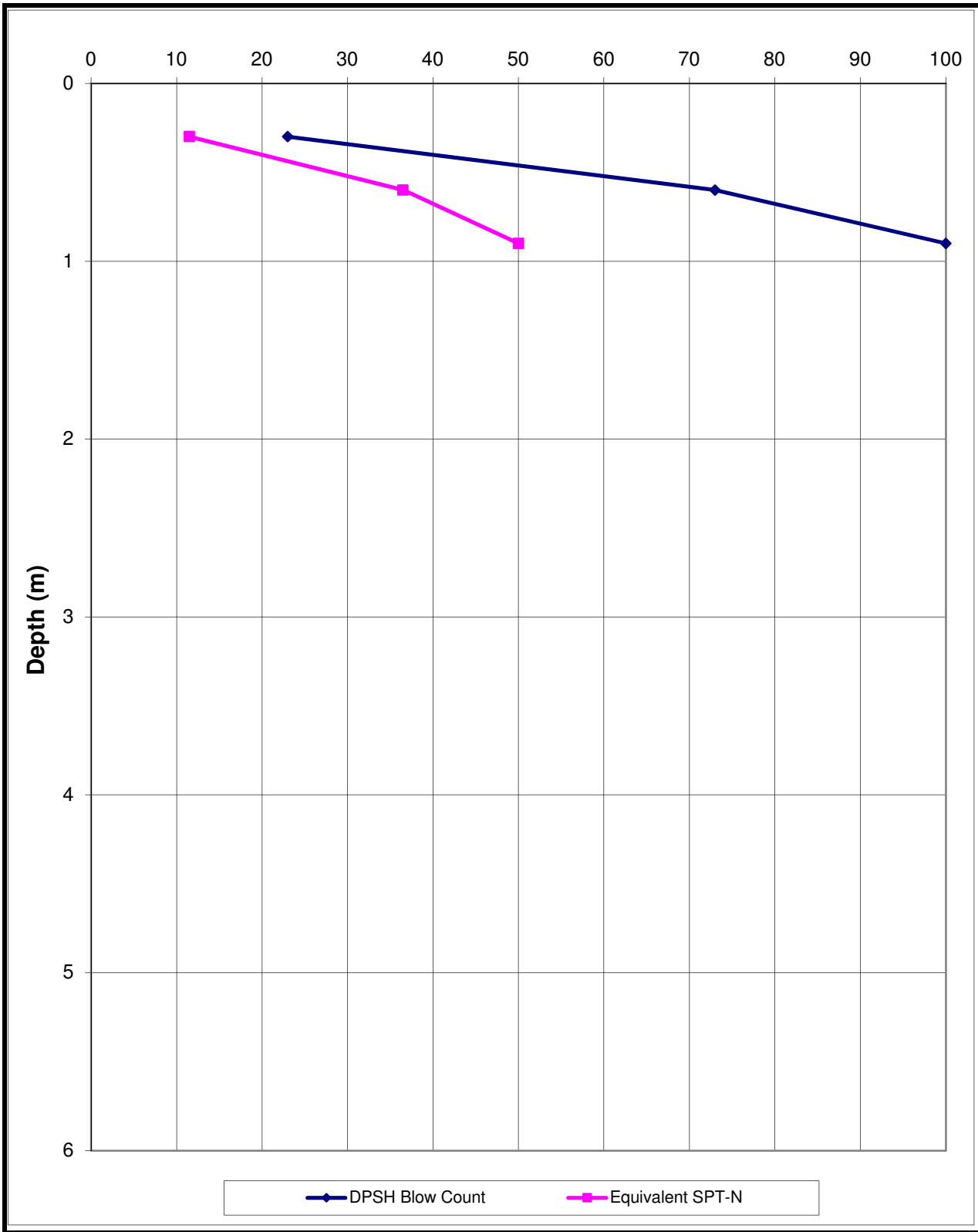

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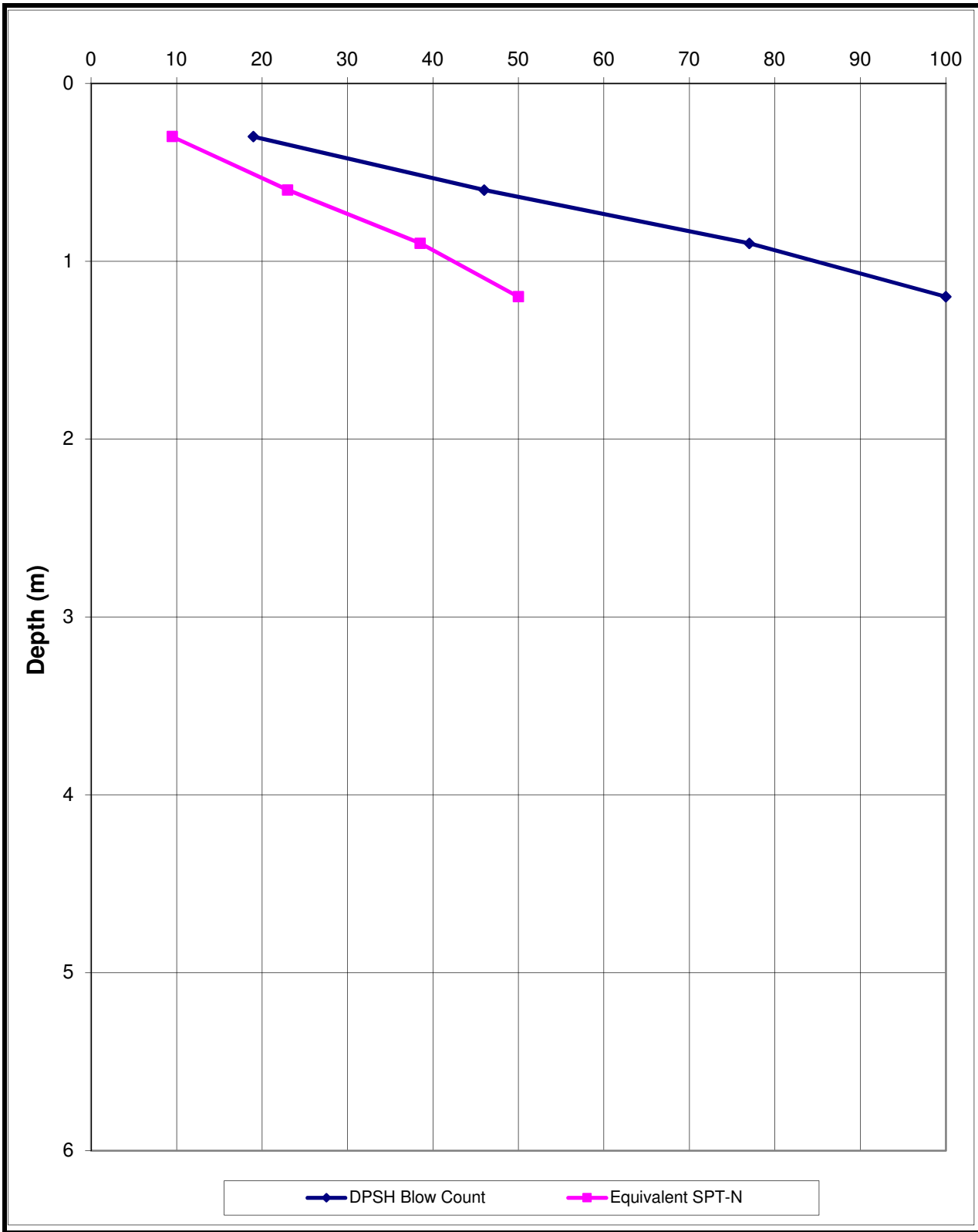

DPSH GRAPH	R6K1			
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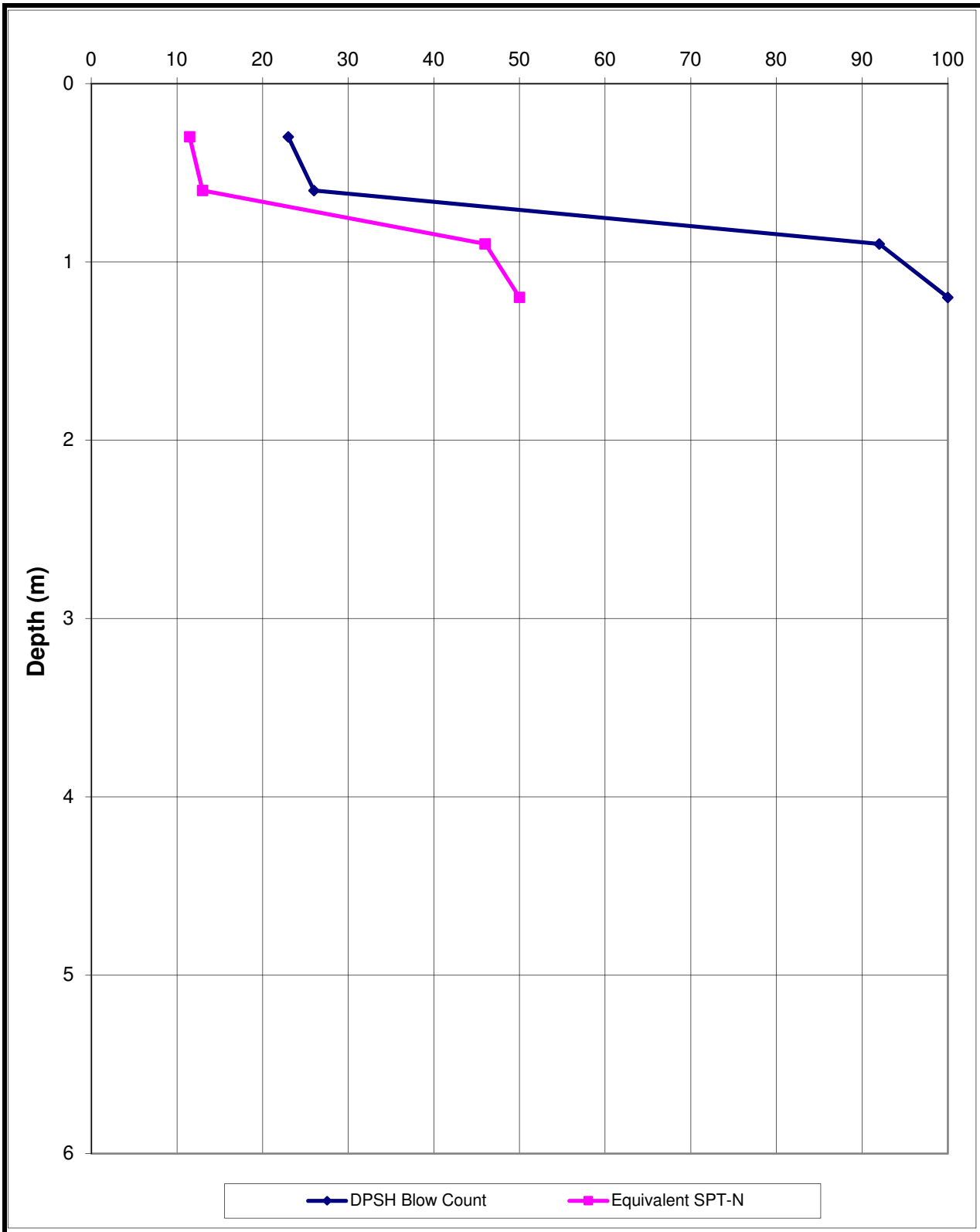

DPSH GRAPH	R5K2			
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	Checked	fp	12/08/2014	

APPENDIX D: ELECTRICAL RESISTIVITY RESULTS

APPENDIX

SUMMARISED DATA FOR EACH TRAVERSE
BAKOMOSO

Tables

1 R2K2
2 R2K5
3 R5K3
4 R7K1
5 R8K4
6 R10K5
7 R10K5
8 R12K3
9 R13K4
10 RSKS
11 R2K5_200 (5m electrode separation)
12 RSKS_200 (5m electrode separation)

Tabulations
Spacing = distance in metres between electrodes (MN) used to measure potential difference.
Count = number of samples.
Resistance in ohms from average apparent conductivity.
The left three columns are from lines orientated north-south, the right three columns are summarises of data from lines orientated west-east.

Graphs
Horizontal axis - electrode separation in metres;
Vertical axis - resistance in ohms.

Table 1: R2K2

Separation	Count	Resistance	Separation	Count	Resistance
0.25	23	804.28	0.25	19	636.47
0.50	47	312.44	0.50	46	322.37
0.75	26	200.91	0.75	26	181.59
1.00	30	97.10	1.00	30	110.89
1.50	27	40.56	1.50	27	50.85
2.00	24	19.85	2.00	24	25.92
2.50	22	10.18	2.50	22	14.25
3.00	19	5.44	3.00	19	7.97
3.50	17	3.21	3.50	17	4.76
4.00	14	2.13	4.00	14	3.16
4.50	11	1.59	4.50	11	2.26
5.00	9	1.26	5.00	9	1.63
5.50	6	1.08	5.50	6	1.16
6.00	3	0.94	6.00	3	0.93

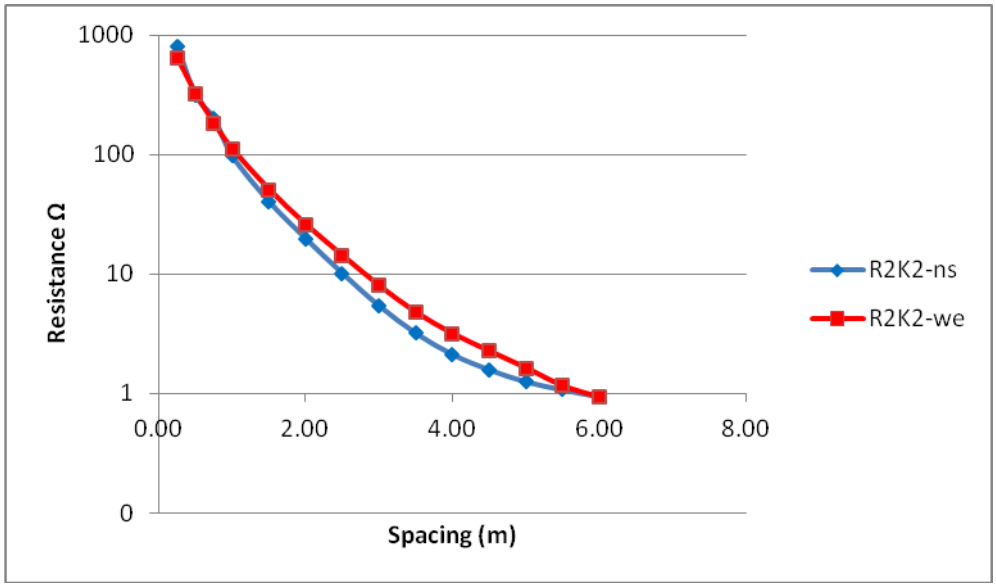

Figure 1: Curves for R2K2

Table 2: R2K5

Separation	Count	Resistance	Separation	Count	Resistance
0.25	29	1174.8	0.25	20	842.6
0.50	50	380.1	0.5	42	314.4
0.75	30	213.9	0.75	23	168.2
1.00	31	103.1	1	31	86.59
1.50	28	40.24	1.5	28	32.67
2.00	26	17.87	2	26	13.85
2.50	23	8.74	2.5	23	6.70
3.00	21	4.70	3	21	3.70
3.50	18	2.74	3.5	18	2.28
4.00	15	1.92	4	15	1.65
4.50	12	1.43	4.5	12	1.38
5.00	10	1.18	5.00	10	1.20
5.50	7	1.00	5.50	7	1.06
6.00	5	0.88	6.00	5	0.94

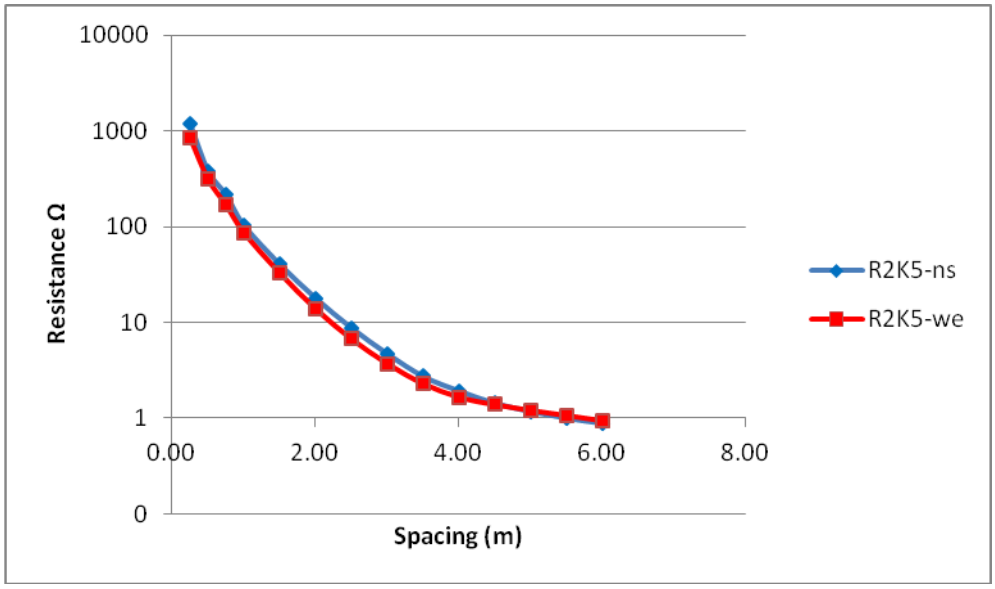

Figure 2: Curves for R2K5

Table 3: R5K3

Separation	Count	Resistance	Separation	Count	Resistance
0.25	21	444.2	0.25	17	431.7
0.50	47	215.1	0.50	45	175.9
0.75	26	96.04	0.75	25	110.26
1.00	31	65.32	1.00	30	58.08
1.50	28	21.57	1.50	26	24.08
2.00	25	8.05	2.00	23	10.88
2.50	23	3.86	2.50	22	4.93
3.00	20	2.32	3.00	19	2.75
3.50	18	1.70	3.50	17	1.90
4.00	15	1.42	4.00	14	1.53
4.50	12	1.30	4.50	11	1.35
5.00	10	1.21	5.00	9	1.25
5.50	7	1.13	5.50	6	1.18
6.00	4	1.05	6.00	3	1.14

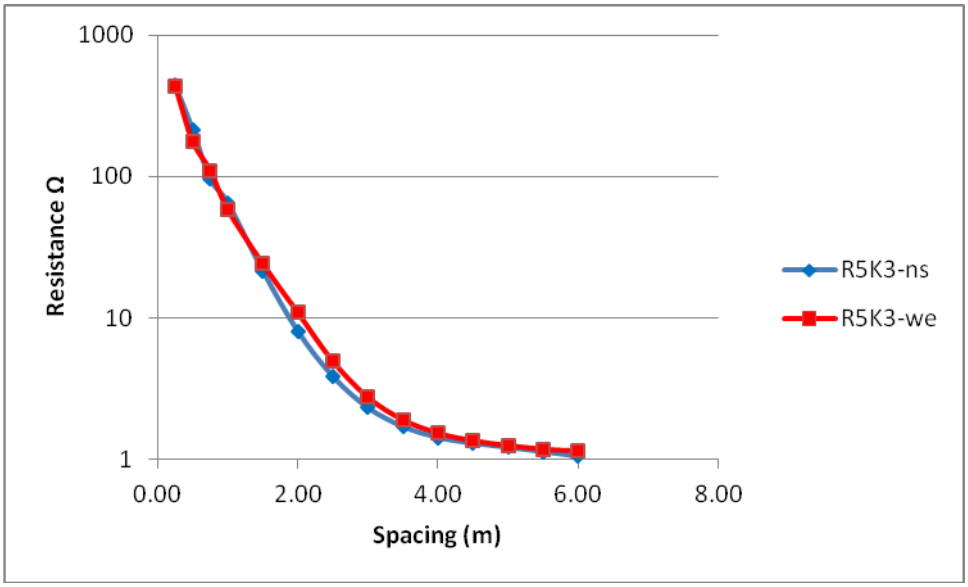

Figure 3: Curves for R5K3

Table 4: R7K1

Separation	Count	Resistance	Separation	Count	Resistance
0.25	25	282.47	0.25	20	315.40
0.50	46	98.96	0.50	43	101.33
0.75	26	40.38	0.75	23	48.39
1.00	30	23.09	1.00	31	23.50
1.50	27	6.79	1.50	28	6.98
2.00	24	2.75	2.00	25	3.08
2.50	22	1.61	2.50	23	1.80
3.00	19	1.15	3.00	20	1.26
3.50	17	0.94	3.50	18	0.99
4.00	14	0.82	4.00	15	0.82
4.50	11	0.74	4.50	12	0.70
5.00	9	0.69	5.00	10	0.63
5.50	6	0.65	5.50	7	0.56
6.00	3	0.61	6.00	4	0.52

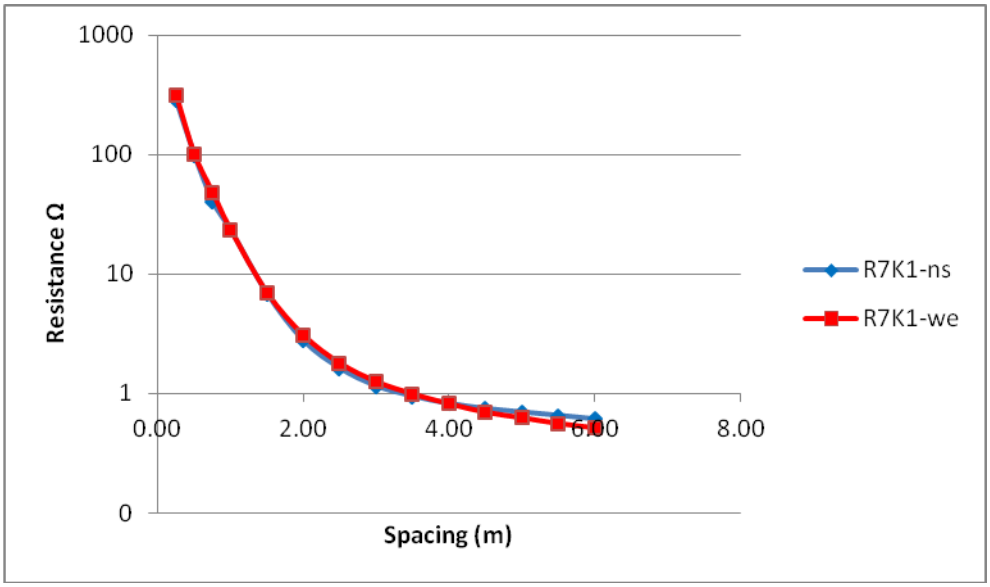

Figure 4: Curves for R7K1

Table 5: R8K4

Separation	Count	Resistance	Separation	Count	Resistance
0.25	23	540.27	0.25	25	535.39
0.50	41	260.07	0.50	47	160.60
0.75	24	71.09	0.75	27	81.07
1.00	27	63.32	1.00	31	33.69
1.50	23	15.24	1.50	28	10.89
2.00	21	4.93	2.00	25	4.40
2.50	20	2.55	2.50	23	2.39
3.00	17	1.73	3.00	20	1.64
3.50	17	1.34	3.50	18	1.30
4.00	14	1.13	4.00	15	1.11
4.50	11	0.97	4.50	12	0.99
5.00	9	0.87	5.00	10	0.89
5.50	6	0.77	5.50	7	0.82
6.00	3	0.70	6.00	4	0.75

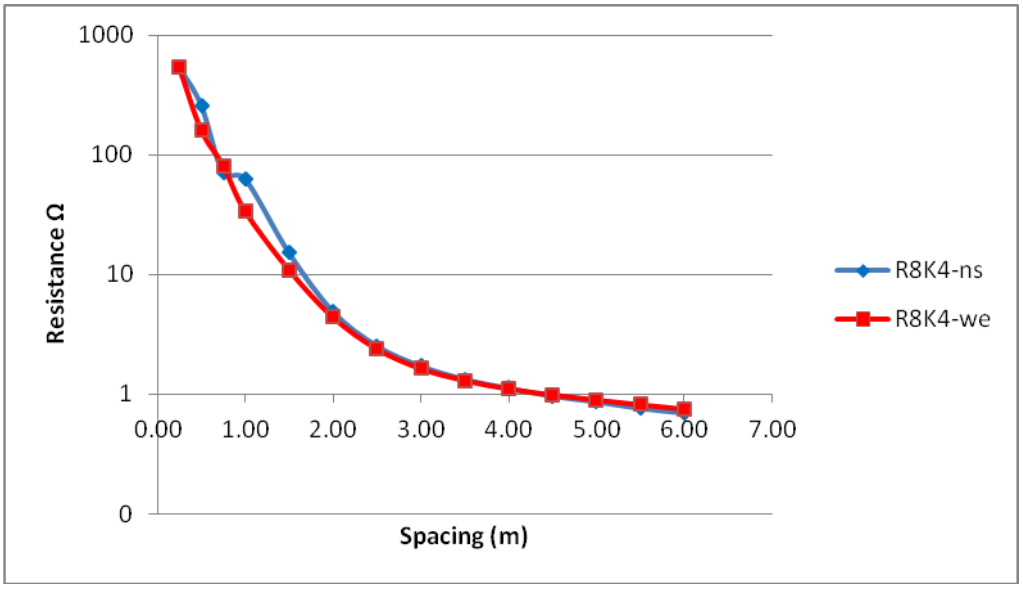

Figure 5: Curves for R8K4

Table 6: R10K2

Separation	Count	Resistance	Separation	Count	Resistance
0.25	20	41.94	0.25	11	36.56
0.50	42	17.40	0.50	28	12.41
0.75	27	8.29	0.75	19	7.88
1.00	31	6.06	1.00	28	5.94
1.50	28	3.62	1.50	26	3.77
2.00	26	2.38	2.00	26	2.58
2.50	23	1.73	2.50	23	1.89
3.00	21	1.35	3.00	21	1.47
3.50	18	1.12	3.50	18	1.21
4.00	15	0.99	4.00	15	1.04
4.50	12	0.87	4.50	12	0.93
5.00	10	0.80	5.00	10	0.85
5.50	7	0.76	5.50	7	0.78
6.00	5	0.72	6.00	5	0.73

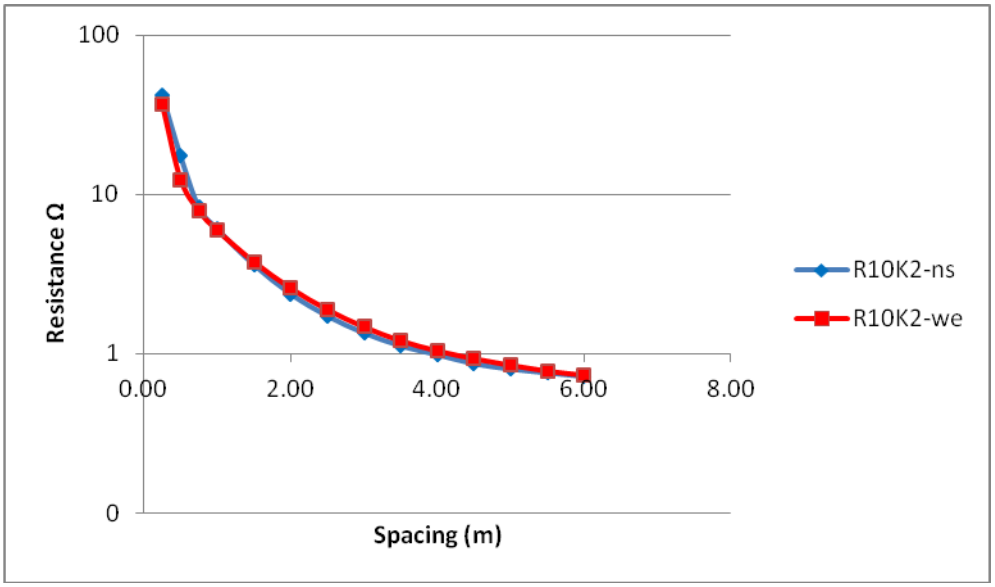

Figure 6: Curves for R10K2

Table 7: R10K5

Separation	Count	Resistance	Separation	Count	Resistance
0.25	17	201.98	0.25	21	198.63
0.50	35	56.56	0.50	39	49.69
0.75	17	21.82	0.75	23	22.25
1.00	27	10.86	1.00	27	11.18
1.50	25	3.96	1.50	25	4.05
2.00	22	2.17	2.00	22	2.13
2.50	19	1.50	2.50	19	1.43
3.00	17	1.19	3.00	17	1.13
3.50	16	0.99	3.50	16	0.94
4.00	13	0.86	4.00	13	0.82
4.50	12	0.76	4.50	12	0.73
5.00	8	0.68	5.00	8	0.65
5.50	7	0.61	5.50	7	0.60
6.00	5	0.56	6.00	5	0.55

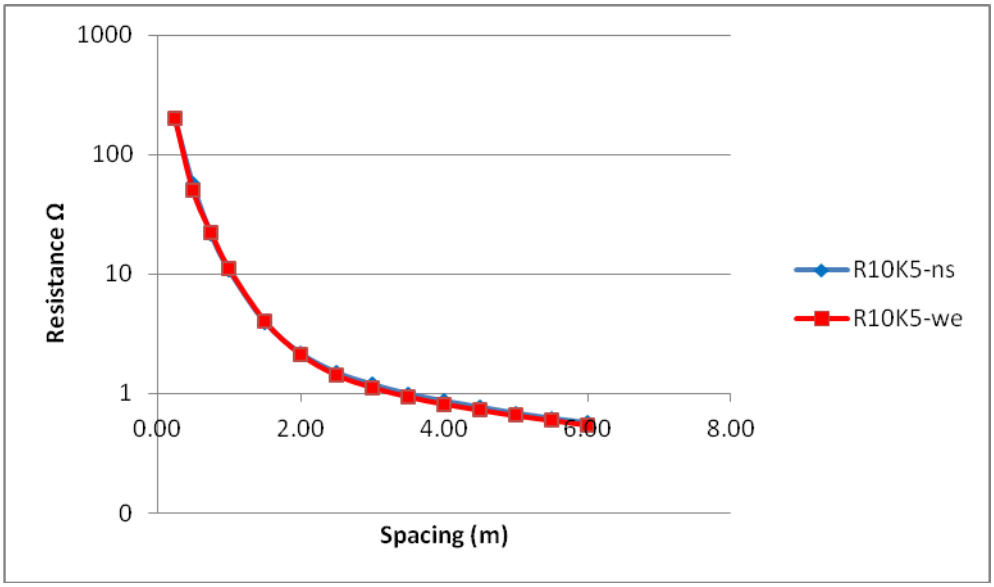

Figure 7: Curves for R10K5

Table 8: R12K3

Separation	Count	Resistance	Separation	Count	Resistance
0.25	26	273.17	0.25	24	295.18
0.50	45	133.07	0.50	47	112.44
0.75	26	63.03	0.75	27	69.21
1.00	30	35.07	1.00	30	33.19
1.50	27	11.42	1.50	27	12.36
2.00	24	4.42	2.00	24	5.27
2.50	22	2.07	2.50	22	2.39
3.00	19	1.22	3.00	19	1.36
3.50	17	0.87	3.50	17	0.94
4.00	14	0.69	4.00	14	0.71
4.50	11	0.58	4.50	12	0.58
5.00	9	0.50	5.00	9	0.49
5.50	6	0.44	5.50	6	0.44
6.00	3	0.39	6.00	3	0.40

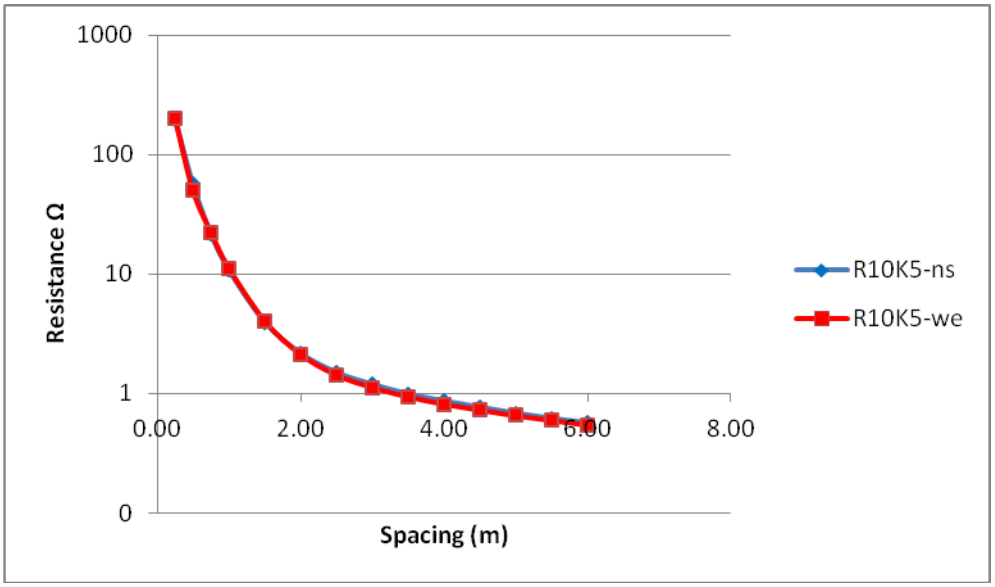

Figure 8: Curves for R12K3

Table 9: R13K4

Separation	Count	Resistance	Separation	Count	Resistance
0.25	22	19.87	0.25	18	21.35
0.50	44	5.46	0.50	43	5.71
0.75	27	3.69	0.75	27	4.03
1.00	30	3.18	1.00	30	3.27
1.50	27	2.44	1.50	27	2.56
2.00	24	1.94	2.00	24	2.00
2.50	22	1.59	2.50	22	1.63
3.00	19	1.31	3.00	19	1.34
3.50	17	1.10	3.50	17	1.11
4.00	14	0.93	4.00	14	0.92
4.50	11	0.80	4.50	11	0.78
5.00	9	0.70	5.00	9	0.67
5.50	6	0.62	5.50	6	0.59
6.00	3	0.55	6.00	3	0.52

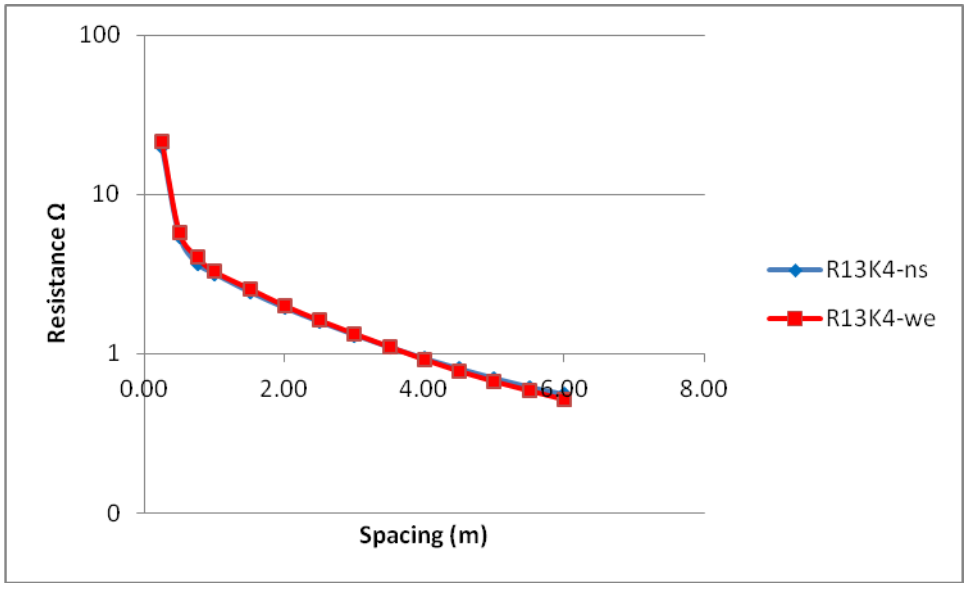

Figure 9: Curves for R13K4

Table 10: RSKS

Separation	Count	Resistance	Separation	Count	Resistance
0.25	25	973.4	0.25	21	716.4
0.50	43	330.4	0.50	46	250.5
0.75	23	194.5	0.75	25	106.6
1.00	31	82.86	1.00	29	40.6
1.50	28	27.10	1.50	28	11.1
2.00	26	9.62	2.00	25	4.88
2.50	23	4.23	2.50	23	2.99
3.00	21	2.46	3.00	20	2.18
3.50	17	1.82	3.50	18	1.70
4.00	14	1.47	4.00	15	1.42
4.50	12	1.24	4.50	12	1.24
5.00	10	1.22	5.00	10	1.13
5.50	7	1.06	5.50	7	1.05
6.00	5	1.01	6.00	4	0.97

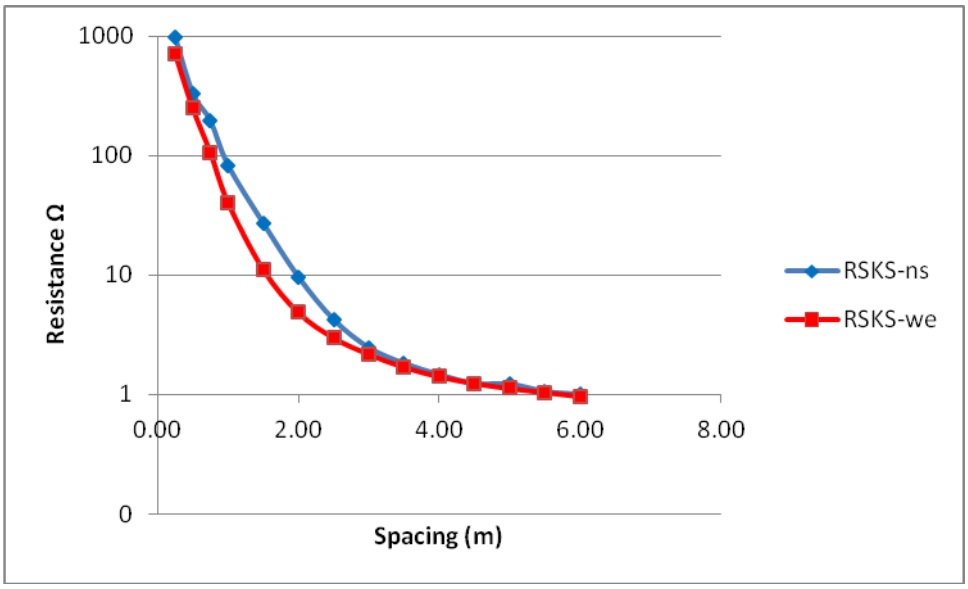

Figure 10: Curves for RSKS

Table 11: R2K5_200

Separation	Count	Resistance	Separation	Count	Resistance
5	37	1.13	5	29	1.20
10	35	0.74	10	34	0.68
15	32	0.70	15	32	0.63
20	15	0.68	20	15	0.62
30	12	0.66	30	8	0.64
40	9	0.66	40	7	0.66
50	6	0.65	50	5	0.68
60	3	0.65	60	3	0.71

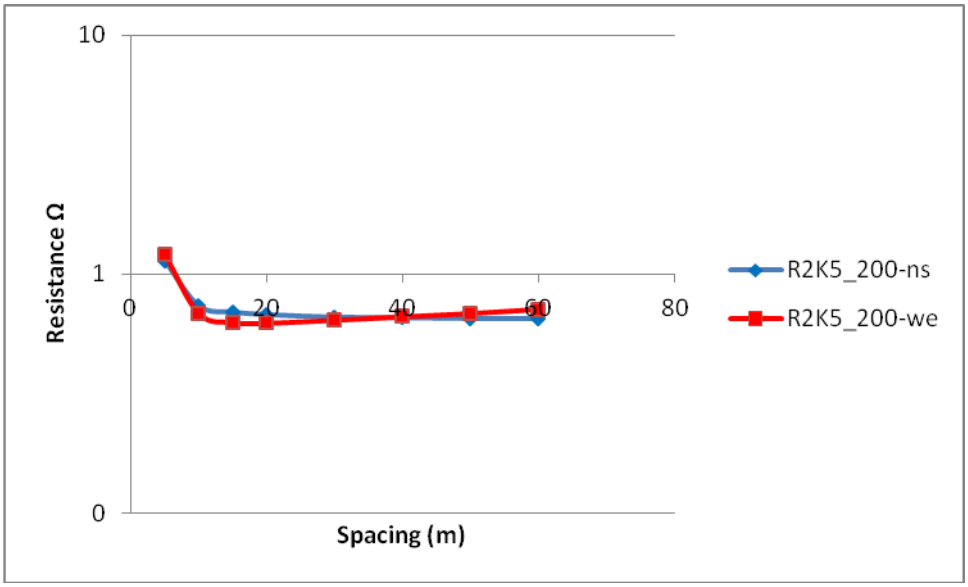

Figure 11: Curves for R2K5_200

Table 12: RSKS_200

Separation	Count	Resistance	Separation	Count	Resistance
5	34	1.13	5	35	1.13
10	35	0.64	10	33	0.73
15	32	0.58	15	30	0.66
20	15	0.57	20	14	0.63
30	12	0.58	30	11	0.61
40	9	0.60	40	8	0.60
50	6	0.64	50	5	0.58
60	3	0.66	60	2	0.53

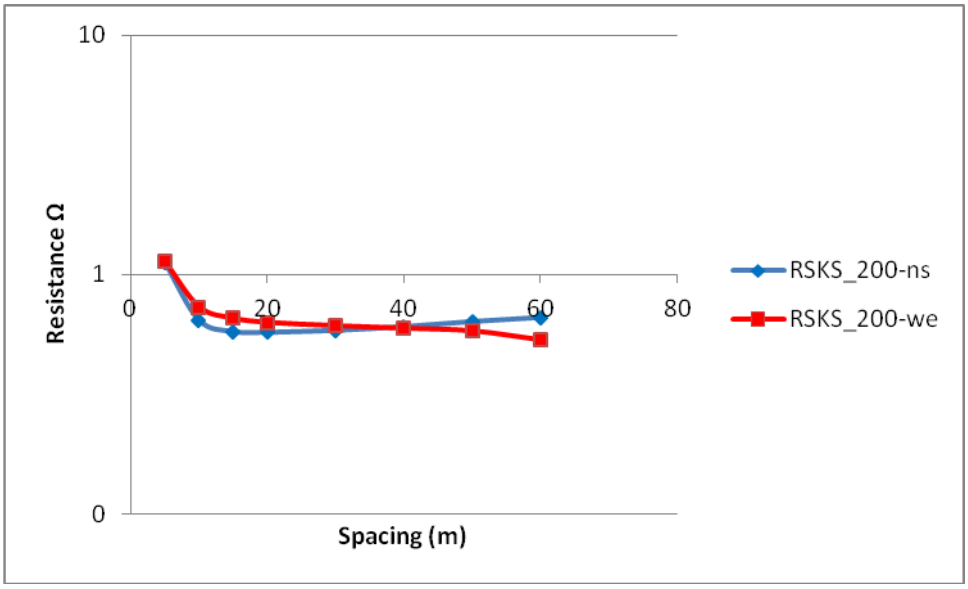

Figure 12: Curves for RSKS_200

APPENDIX E: THERMAL CONDUCTIVITY RESULTS

Client:	SMEC
Project:	BOKAMOSO
Project No.:	S14-0833
Date:	06/08/2014

THERMAL CONDUCTIVITY

(SANS 10198-5)

Soillab No.	Sample No.	Moisture %	Thermal Conductivity (K) W/m.K	Thermal Resistivity (p) ˚C.cm/W	Volumetric Specific heat (c) $mJ/m^3.K$	Thermal Diffusivity (D) mm^2/s
S14-0833-01	R5/K5	20.4	0.936	109.32	3.387	0.281
S14-0833-02	R14/K2	15.2	1.228	82.68	3.648	0.348
S14-0833-03	R13/K4	17.9	0.824	129.10	3.487	0.241
S14-0833-04	R10/K2	14.1	0.574	178.00	2.681	0.221
S14-0833-05	R3/K2 YELLOW BROWN	17.6	1.019	101.64	3.210	0.317
S14-0833-06	R3/K2 DARK BROWN	17.8	1.243	80.61	4.382	0.288
S14-0833-07	R6/K3	18.4	1.140	89.26	3.778	0.312

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Soillab Pretoria

APPENDIX F: LABORATORY RESULTS

Double Oedometer

Project:	Bokamosa
Client:	SMEC South Africa
Geolab Job Nr:	G14-0080
Test Method:	Jennings & TMH 6 ST10

Sample Nr:	R4-K4
Sample Depth:	-
Date:	2014/09/09

Natural Moisture Content

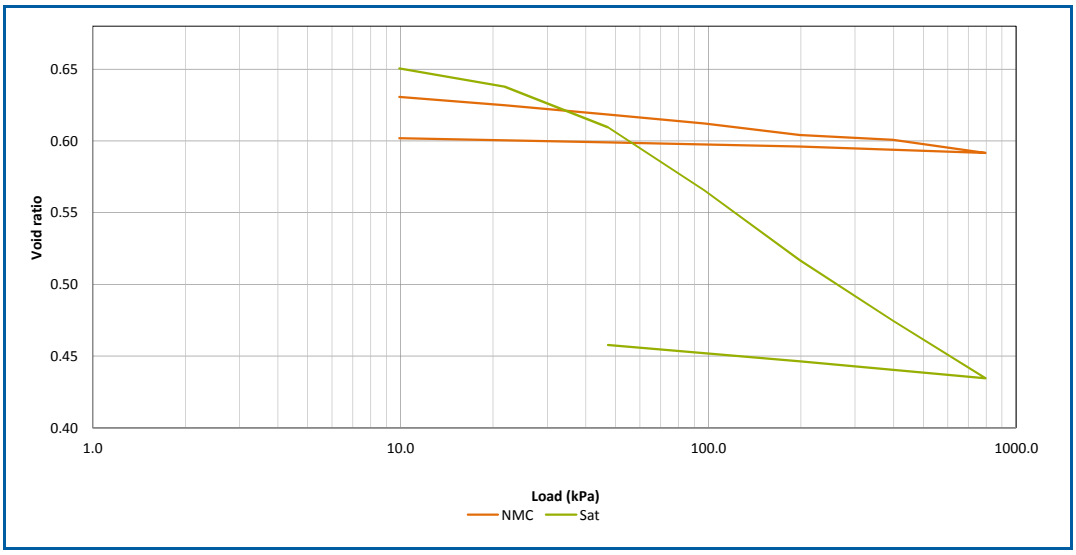
	Initial	Final	
Sample Height:	20.10	19.68	mm
Sample Weight:	116.6	113.4	g
Dry Density:	1627	1661	kg/m³
Density	1918	1905	kg/m³
Moisture Content:	17.9	14.7	%
Void Ratio:	0.636	0.602	
Saturation:	74.9	64.8	%
Specific Gravity:	2.661		Mg/m³

Saturated

	Initial	Final	
Sample Height:	19.78	18.42	mm
Sample Weight:	114.2	119.2	g
Dry Density:	1659	1782	kg/m³
Density	1910	2141	kg/m³
Moisture Content:	15.1	20.2	%
Void Ratio:	0.604	0.494	
Saturation:	66.6	108.7	%
Specific Gravity:	2.661		Mg/m³

Load kPa	Height mm	Void Ratio
0.0	20.1	0.636
9.9	20.036	0.631
21.8	19.965	0.625
47.3	19.886	0.618
97.2	19.808	0.612
198.4	19.71	0.604
398.0	19.667	0.601
795.1	19.556	0.592
198.4	19.612	0.596
47.3	19.647	0.599
9.9	19.681	0.602

Load kPa	Height mm	Void Ratio
0.0	19.78	0.604
0.0	19.78	0.604
9.9	20.355	0.651
21.8	20.199	0.638
47.3	19.849	0.610
97.2	19.307	0.566
198.4	18.707	0.517
398.0	18.185	0.475
795.1	17.691	0.435
198.4	17.835	0.446
47.3	17.977	0.458
9.9	18.418	0.494



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Consolidated Undrained Triaxial

Results Summary

Project:	Bokamoso
Client:	SMEC South Africa
Geolab Job Nr:	G14-0080
Test Method:	BS1377-8:1990

Sample Nr:	R4K4
Sample Depth:	1.1m
Date:	2014/09/12

Results		
ϕ' =	**29.0**	**°**
c' =	**0.0**	**kPa**

Sampling Method:	Block
Disturbed/Undist:	Disturbed
Remoulded To:	100% Wax

Initial Sample Details	**1**	**2**	**3**	
Sample Length:	140	140	140	mm
Sample Diameter:	70	70	70	mm
Sample Mass:	1042.0	1041.8	1042.7	g
Dry Density:	1670	1665	-	kg/m³
Density:	1934	1934	1935	kg/m³
Void Ratio:	0.593	0.598	-	
Moisture Content:	13.6	13.9	-	%
Specific Gravity:	2.661			Mg/m³

Flush Stage	**1**	**2**	**3**	
Volume Change:	21.2	22.9	31.7	ml
% Volume Change:	3.9	4.3	5.9	%

Saturation Stage	**1**	**2**	**3**	
Final B Value	0.97	0.98	0.97	
Final Back Pressure	498	400	300	kPa

Consolidation Stage	**1**	**2**	**3**	
Effective Stress:	100	200	400	kPa
Volume Change:	29.192	34.249	53.437	ml
Height After Consolidation:	137.57	137.15	135.63	mm
Diameter After Consolidation:	70.09	69.97	69.67	mm
Void Ratio Before Consolidation:	0.656	0.666	-	
Void Ratio After Consolidation:	0.569	0.564	-	
Coef Of Volume Comp (m_{vi}):	0.863	0.508	-	m²/MN
Coefficient Of Consolidation (c_v):	22.6	11.9	-	m²/year

Shear Stage	**1**	**2**	**3**	
Rate of Shear:	0.02330	0.01311	-	mm/min
Failure Criteria:	Maximum Stress Ratio			
Deviator Stress at Failure:	61.2	126.7	-	kPa
Stress Ratio at Failure:	2.8	2.9	-	
Strain at Failure:	16.8	15.4	-	%

Final Sample Details	**1**	**2**	**3**	
Dry Density:	1695	1701	-	kg/m³
Density:	2105	2087	-	kg/m³
Void Ratio:	0.569	0.564	-	
Moisture Content:	23.52	22.07	-	%

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Consolidated Undrained Triaxial

Consolidation Stage

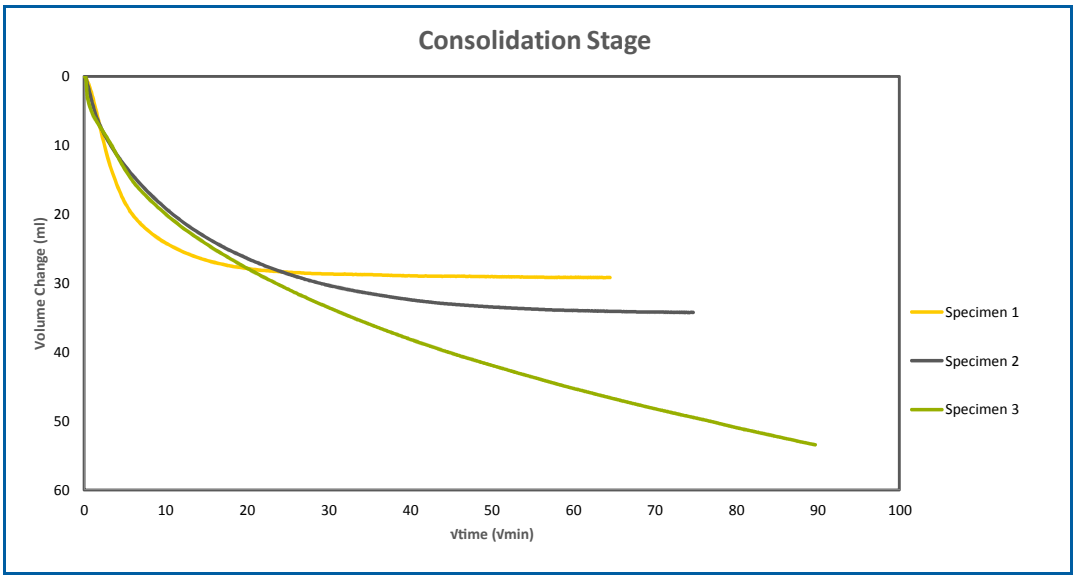
Project:	Bokamoso
Client:	SMEC South Africa
Geolab Job Nr:	G14-0080

Sample Nr:	R4K4
Sample Depth:	1.1m
Date:	2014/09/12

Initial Conditions	1	2	3	
Initial Cell Pressure:	600	600	900	kPa
Initial Back Pressure:	500	400	500	kPa
Void Ratio:	0.656	0.666	-	
Drainage Method:	From one end only			

Final Conditions	1	2	3	
Volume Change:	29.2	34.2	53.4	
Volumetric Strain:	5.21	6.10	9.37	%
Corrected Length:	137.57	137.15	135.63	mm
Corrected Diameter:	70.09	69.97	69.67	mm
Void Ratio:	0.569	0.564	-	

Calculations and Parameters	1	2	3	
t_{100}:	518	990	-	min
Coeff of Consolidation (c_v):	22.56	11.89	-	m²/year
Calculated Shear Speed:	0.0234	0.0131	-	mm/min
Coeff of Volume Comp (m_{vl}):	0.863	0.508	-	m²/MN



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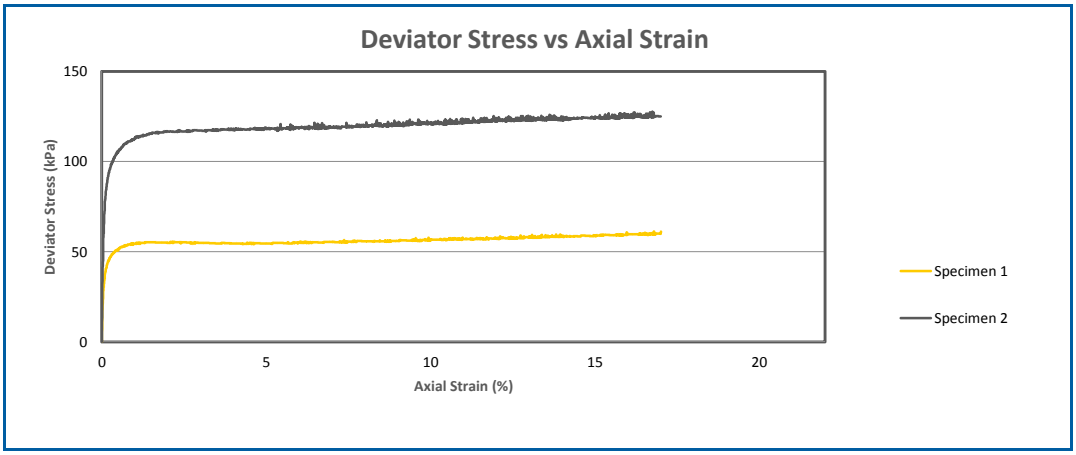
Consolidated Undrained Triaxial

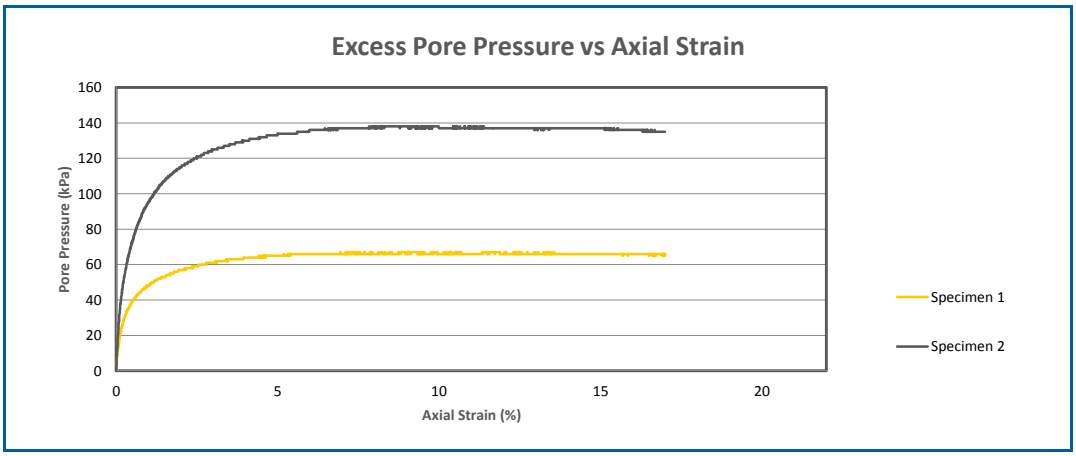
Shear Stage

Project:	Bokamoso
Client:	SMEC South Africa
Geolab Job Nr:	G14-0080

Sample Nr:	R4K4
Sample Depth:	1.1m
Date:	2014/09/12

Shear	**1**	**2**	**3**	
σ_1' at Failure:	95.2	193.7	0.0	kPa
σ_3' at Failure:	34.0	67.0	0.0	kPa
Failure Criteria:	Maximum Stress Ratio			
Deviator Stress at Failure:	61.2	126.7	0.0	kPa
Stress Ratio at Failure:	2.80	2.89	#DIV/0!	
Strain at Failure:	16.80	15.42	0.00	%
Calculated Shear Speed:	0.0234	0.0131	0.0000	mm/min
Actual Shear Speed:	0.0233	0.0131	#DIV/0!	mm/min





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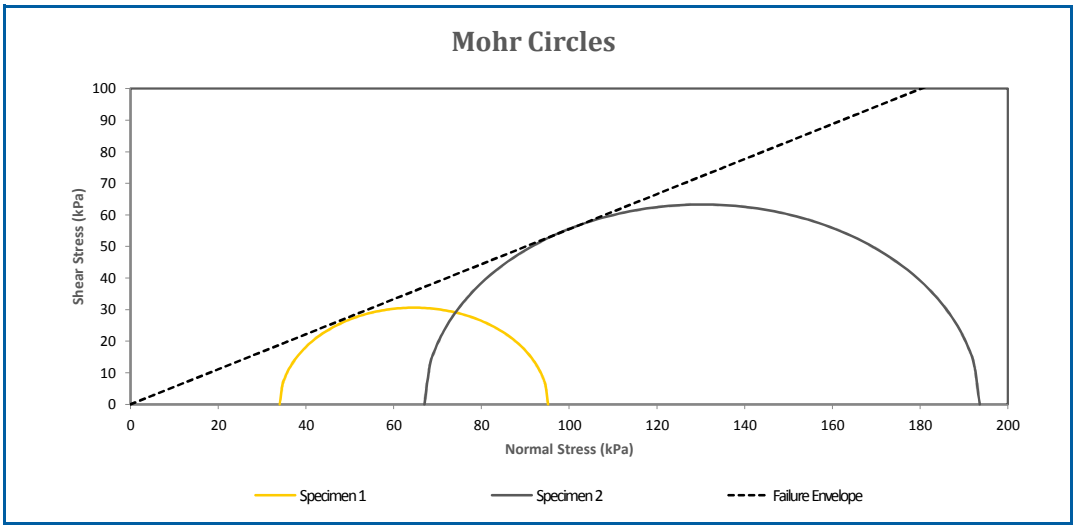
Consolidated Undrained Triaxial

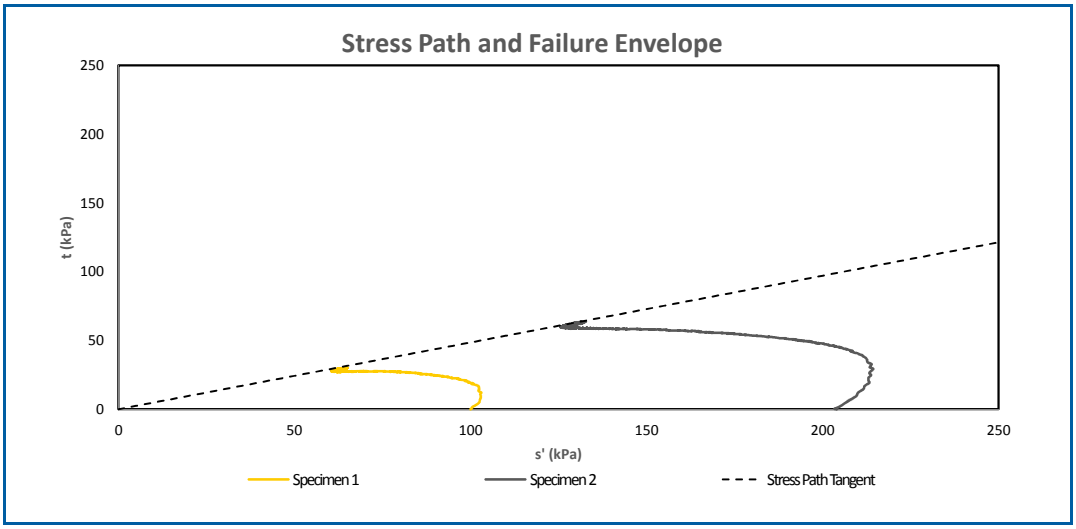
Shear Stage

Project:	Bokamoso
Client:	SMEC South Africa
Geolab Job Nr:	G14-0080

Sample Nr:	R4K4
Sample Depth:	1.1m
Date:	2014/09/12

Results			
θ=	**25.9**	**°**	*Stress Path Tangent*
t_0=	**0.0**	**kPa**	
ϕ' =	**29.0**	**°**	*Mohr-Coulomb Failure Envelope*
c' =	**0.0**	**kPa**	





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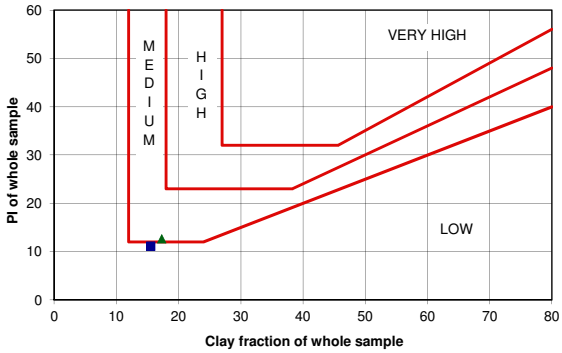
PARTICLE SIZE ANALYSIS

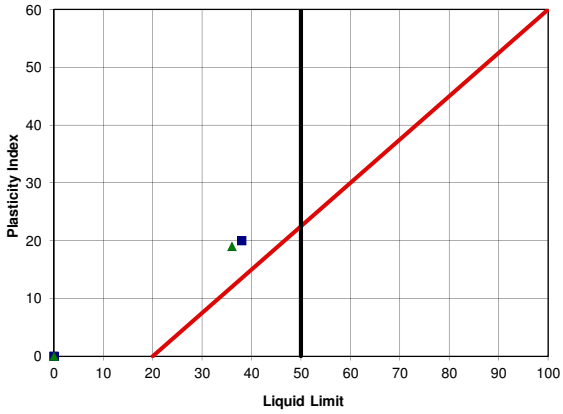
Sample No.	1	2
Soillab sample no.	S14-0833-1	S14-0833-2
Depth (m)	1.9	1.1
Position	R3/K4	R4/K4
Material Description	DARK YELLOW SHALE GRAVELLY SAND	DARK BROWN GRAVELLY SAND
Moisture (%)		
Dispersion (%)		
SCREEN ANALYSIS (% PASSING) **(TMH 1 A1(a) & A5)**		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	100	100
26.5 mm	100	100
19.0 mm	100	100
13.2 mm	98	100
4.75 mm	86	94
2.00 mm	70	75
0.425 mm	56	67
0.075 mm	39	36
HYDROMETER ANALYSIS (% PASSING) **(TMH 1 A6)**		
0.040 mm	31	29
0.027 mm	28	27
0.013 mm	23	24
0.005 mm	21	21
0.002 mm	16	17
% Clay	16	17
% Silt	20	16
% Sand	34	42
% Gravel	30	25
ATTERBERG LIMITS **(TMH 1 A2 - A4)**		
Liquid Limit	38	36
Plasticity Index	20	19
Linear Shrinkage (%)	9.0	9.0
Grading Modulus	1.36	1.22
Uniformity coefficient	-	-
Coefficient of curvature	-	-
Classification	A-6 (3)	A-6 (2)
Unified Classification	SC	SC
Chart Reference	■	▲

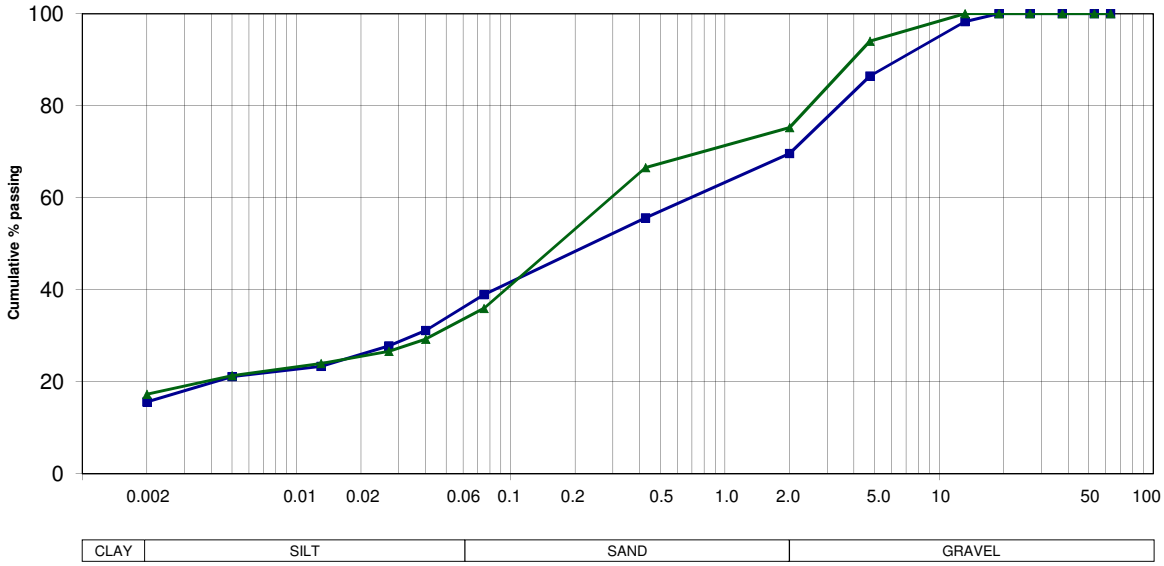
PROJECT : BOKAMOSO
JOB No. : S14-0833
DATE : 01-08-2014

POTENTIAL EXPANSIVENESS



PLASTICITY CHART



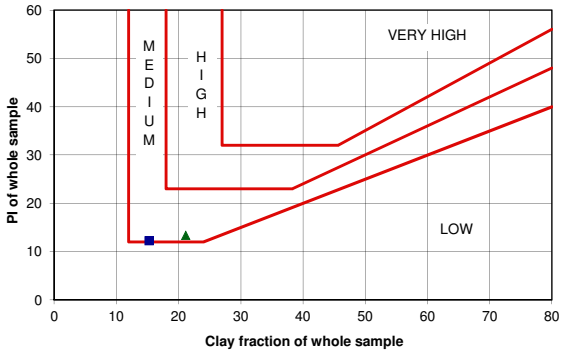


PARTICLE SIZE ANALYSIS

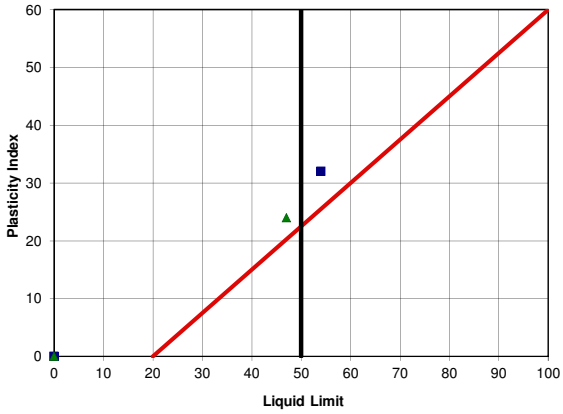
Sample No.	3	4
Soillab sample no.	S14-0833-3	S14-0833-4
Depth (m)	1.5	0.3
Position	R3/K2	R14/K2
Material Description	LIGHT BROWN SANDY GRAVEL	DARK BROWN SANDY GRAVEL
Moisture (%)		
Dispersion (%)		
SCREEN ANALYSIS (% PASSING) **(TMH 1 A1(a) & A5)**		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	73	100
26.5 mm	60	100
19.0 mm	60	95
13.2 mm	60	87
4.75 mm	56	71
2.00 mm	44	61
0.425 mm	38	56
0.075 mm	29	40
HYDROMETER ANALYSIS (% PASSING) **(TMH 1 A6)**		
0.040 mm	23	31
0.027 mm	21	29
0.013 mm	18	26
0.005 mm	17	23
0.002 mm	15	21
% Clay	15	21
% Silt	11	15
% Sand	18	25
% Gravel	56	39
ATTERBERG LIMITS **(TMH 1 A2 - A4)**		
Liquid Limit	54	47
Plasticity Index	32	24
Linear Shrinkage (%)	14.0	12.0
Grading Modulus	1.88	1.44
Uniformity coefficient	-	-
Coefficient of curvature	-	-
Classification	A-2-7 (3)	A-7-6 (5)
Unified Classification	GC	SC
Chart Reference	■	▲

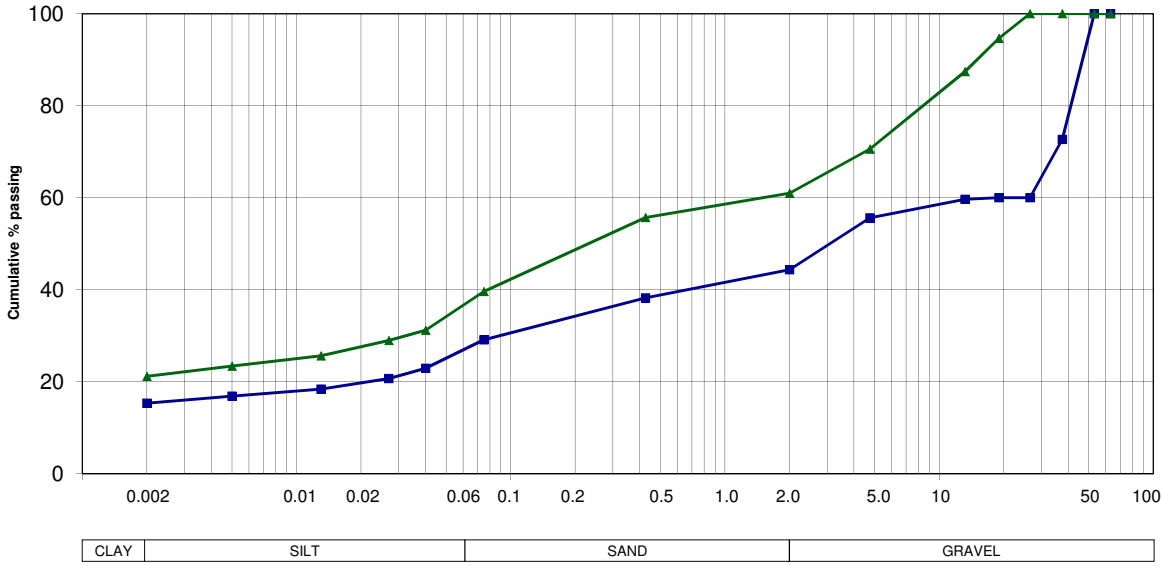
PROJECT : BOKAMOSO
JOB No. : S14-0833
DATE : 01-08-2014

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





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Client:	SMEC SOUTH AFRICA (GEOTECHNICAL)
Project:	BOKAMOSO
Project No.:	S14-0833
Date:	04-08-2014

pH & CONDUCTIVITY - TMH 1 A20 & A21T

Soillab No	Sample Position	Sample Depth (m)	pH	Electrical Conductivity S/m
S14-0833-01	R3K4	1.9	8.01	0.0246
S14-0833-04	R14K2	0.3	6.81	0.0641

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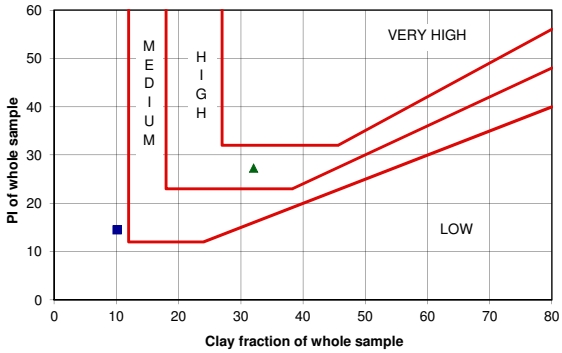
PARTICLE SIZE ANALYSIS

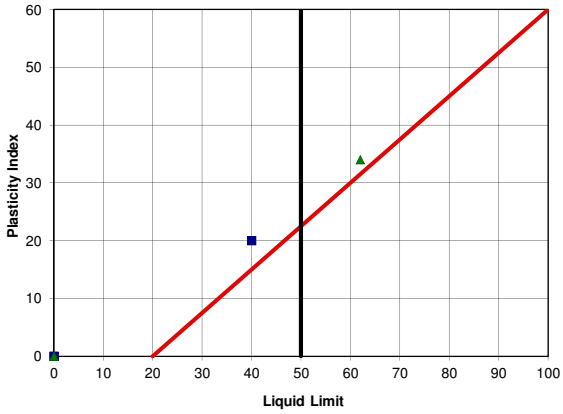
Sample No.	5	6
Soillab sample no.	S14-0833-5	S14-0833-6
Depth (m)	2.2	1.5
Position	R6/K3	R13/K4
Material Description	DARK YELLOW ORANGE SILTY SAND	LIGHT BROWN FERRICRETE CLAYEY SAND
Moisture (%)		
Dispersion (%)		
SCREEN ANALYSIS (% PASSING) **(TMH 1 A1(a) & A5)**		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	100	100
26.5 mm	100	100
19.0 mm	100	100
13.2 mm	99	100
4.75 mm	92	96
2.00 mm	85	88
0.425 mm	72	80
0.075 mm	33	59
HYDROMETER ANALYSIS (% PASSING) **(TMH 1 A6)**		
0.040 mm	26	47
0.027 mm	22	43
0.013 mm	17	40
0.005 mm	13	37
0.002 mm	10	32
% Clay	10	32
% Silt	20	22
% Sand	55	34
% Gravel	15	12
ATTERBERG LIMITS **(TMH 1 A2 - A4)**		
Liquid Limit	40	62
Plasticity Index	20	34
Linear Shrinkage (%)	8.5	12.0
Grading Modulus	1.09	0.72
Uniformity coefficient	-	-
Coefficient of curvature	-	-
Classification	A-2-6 (2)	A-7-6 (18)
Unified Classification	SC	CH
Chart Reference	■	▲

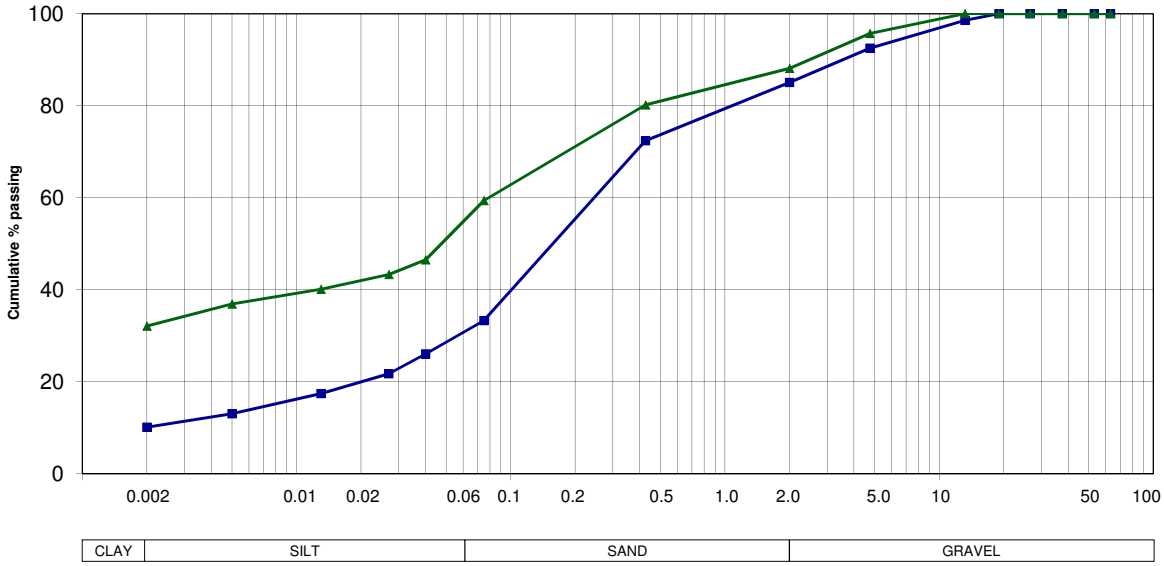
PROJECT : BOKAMOSO
JOB No. : S14-0833
DATE : 01-08-2014

POTENTIAL EXPANSIVENESS



PLASTICITY CHART



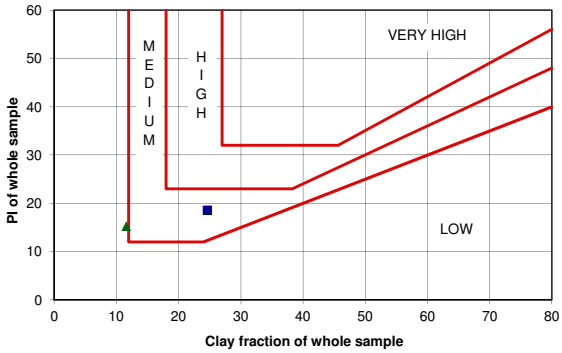


PARTICLE SIZE ANALYSIS

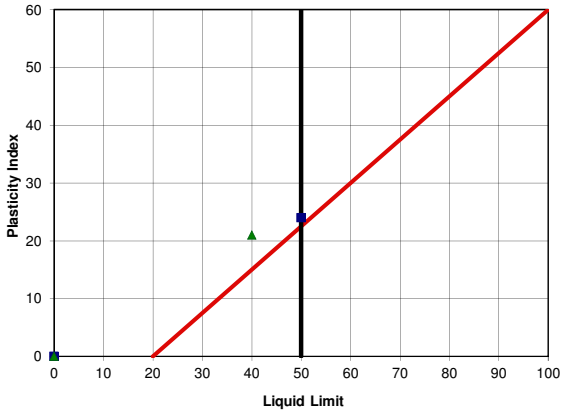
Sample No.	7	8
Soillab sample no.	S14-0833-7	S14-0833-8
Depth (m)	1.4	1.8
Position	R10/K2	RSKS
Material Description	DARK BROWN SILTY SAND	DARK YELLOW ORANGE SHALE SILTY SAND
Moisture (%)		
Dispersion (%)		
SCREEN ANALYSIS (% PASSING) **(TMH 1 A1(a) & A5)**		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	100	100
26.5 mm	96	100
19.0 mm	95	100
13.2 mm	94	99
4.75 mm	90	94
2.00 mm	85	85
0.425 mm	77	72
0.075 mm	57	41
HYDROMETER ANALYSIS (% PASSING) **(TMH 1 A6)**		
0.040 mm	42	35
0.027 mm	37	32
0.013 mm	34	25
0.005 mm	29	17
0.002 mm	25	12
% Clay	25	12
% Silt	26	26
% Sand	34	47
% Gravel	15	15
ATTERBERG LIMITS **(TMH 1 A2 - A4)**		
Liquid Limit	50	40
Plasticity Index	24	21
Linear Shrinkage (%)	12.0	10.0
Grading Modulus	0.81	1.02
Uniformity coefficient	-	-
Coefficient of curvature	-	-
Classification	A-7-6 (11)	A-6 (4)
Unified Classification	CL	SC
Chart Reference	■	▲

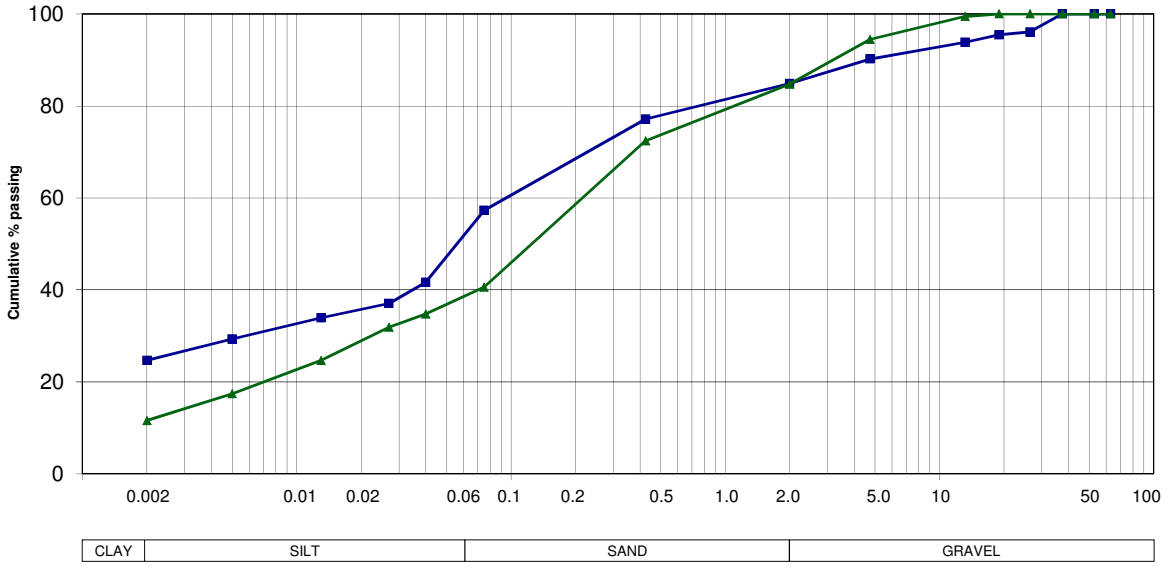
PROJECT : BOKAMOSO
JOB No. : S14-0833
DATE : 01-08-2014

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





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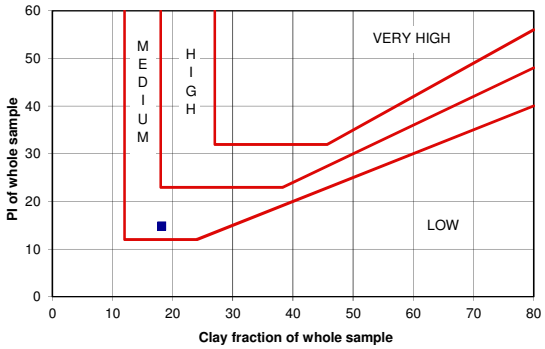
PARTICLE SIZE ANALYSIS

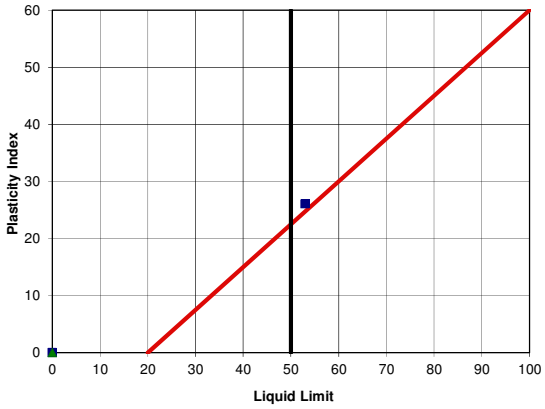
Sample No.	9	
Soillab sample no.	S14-0833-9	
Depth (m)	2.1	
Position	R4/K4	
Material Description	DARK YELLOW FERRICRETE SANDY GRAVEL	
Moisture (%)		
Dispersion (%)		
SCREEN ANALYSIS (% PASSING) **(TMH 1 A1(a) & A5)**		
63.0 mm	100	
53.0 mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	100	
13.2 mm	99	
4.75 mm	87	
2.00 mm	67	
0.425 mm	57	
0.075 mm	42	
HYDROMETER ANALYSIS (% PASSING) **(TMH 1 A6)**		
0.040 mm	32	
0.027 mm	28	
0.013 mm	25	
0.005 mm	22	
0.002 mm	18	
% Clay	18	
% Silt	19	
% Sand	30	
% Gravel	33	
ATTERBERG LIMITS **(TMH 1 A2 - A4)**		
Liquid Limit	53	
Plasticity Index	26	
Linear Shrinkage (%)	12.0	
Grading Modulus	1.34	
Uniformity coefficient	-	
Coefficient of curvature	-	
Classification	A-7-6 (6)	
Unified Classification	SC	
Chart Reference		

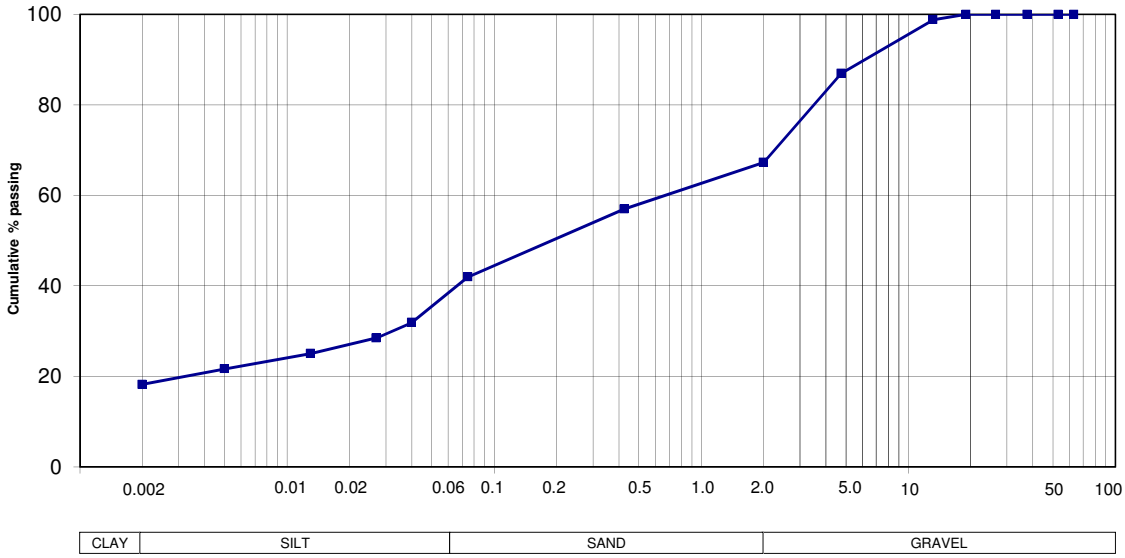
PROJECT : BOKAMOSO
JOB No. : S14-0833
DATE : 01-08-2014

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





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SOIL ANALYSIS BY ..... : SOILLAB (Pty) Ltd
Lab reference No. ..... : S14-0833

Date Printed : 2014-08-20

Customer ..... : SMEC
Job Description ..... : BOKAMOSO
Road Number ..... :

Job Number ..... : S14-0833
Contract Number .... :
Date ..... : 2014-08-01

SAMPLE DESCRIPTION						
Sample Number	54344	54345				
Sample Position	R3/K4	R4/K4				
Sample Depth (mm)	1900	1100				
Material Description	DARK YELLOW, SHALE CLAY WITH GRAVEL	DARK BROWN, FERRICRETE SANDY CLAY				
Max size of boulder (mm)	-	-				
SCREEN ANALYSIS (% PASS)						
75,00 mm	100	100				
63,00 mm	100	100				
53,00 mm	100	100				
37,50 mm	100	100				
26,50 mm	100	100				
19,00 mm	100	100				
13,20 mm	98	100				
4,750 mm	86	94				
2,000 mm	70	75				
0,425 mm	56	67				
0,075 mm	46	46				
SOIL MORTAR						
Coarse Sand 2,000-0,425	20	12				
Coarse Fine Sd 0,425-0,250	2	3				
Medium Fine Sd 0,250-0,150	4	7				
Fine Fine Sand 0,150-0,075	9	16				
Material <0,075	65	62				
CONSTANTS						
Grading Modulus	1.28	1.12				
Liquid Limit	38	36				
Plasticity Index	20	19				
Linear Shrinkage (%)	9.0	9.0				
Sand Equivalent						
Classification - TRB	A-6 (5)	A-6 (5)				
Classification - COLTO	>G9	>G9				
CBR / UCS VALUES	CBR	CBR				
MOD. AASHTO						
Max Dry Density (kg/m³)	1912	1914				
Optimum Moisture Cont (%) ...	14.1	12.2				
Moulding Moisture Cont (%) ...	14.2	12.3				
Dry Density (kg/m³)	1917	1933				
% of Max Dry Density	100.3	101.0				
100% Mod CBR/UCS	15	12				
% Swell	0.7	1.3				
NRB						
Dry Density (kg/m³)	1819	1827				
% of Max Dry Density	95.1	95.5				
100% NRB CBR/UCS	8	6				
% Swell	0.9	1.5				
PROCTOR						
Dry Density (kg/m³)	1718	1729				
% of Max Dry Density	89.9	90.3				
100% Proc CBR/UCS	3	2				
% Swell	0.8	0.9				
CBR / UCS VALUES						
100% Mod AASHTO	15	11				
98% Mod AASHTO	11	8				
97% Mod AASHTO	10	7				
95% Mod AASHTO	8	5				
93% Mod AASHTO	5	4				
90% Mod AASHTO	3	2				
SOILLAB NO	S14-0833-01	S14-0833-02				