REPORT TO TGC ENGINEERS CC. ON A GEOTECHNICAL INVESTIGATION FOR A PROPOSED NEW LANDFILL, CANDIDATE SITE 1 KRANTZ FONTEIN FARM KOKSTAD

1. INTRODUCTION

Drennan, Maud and Partners was requested by Mr Graham Payne of TGC Engineers cc. to undertake a geotechnical investigation of candidate Site 1 Krantz Fontein Farm for the proposed new landfill to service Kokstad. The aim of the investigation was to determine:

- Site geology and subsoil conditions.
- The overall stability of the site and stability considerations regarding the proposed earthworks.
- The excavatability within the site footprint.
- The availability of suitable materials for re-use in the liner system.
- Surface and sub-surface seepage conditions.

2. SITE DESCRIPTION

Site 1 is located as the crow flies approximately 2.1km east of Kokstad, 3km south east of the existing landfill site, 150m south east of the Mzintlava River and 500m south east of Bhongweni Township (refer to the Locality Plan, Drawing No. 22233/1A).

The site is located on the southern portion of Krantz Fontein Farm property on the lower portion of the north-facing slope of a prominent topographical spur. Slope gradients are considered of gentle to moderate steepness (7° to 11°).

The site is bordered to the north east by a broad north-west draining valley line with a planar slope conformation, which eventually drains into the Mzintlava River some 300m north west of the landfill site.

A derelict structure is located on the site, as indicated on the Locality Plan as well as the Geology and Seepage Zone Plan (Drawing No. 22233/1A & 2). This structure is expected to be in excess of 30 years old and may have some historical importance. The relevant Consultant will have to determine the status of this structure and the impact this would have on the proposed development of the site as a landfill.

3. FIELD INVESTIGATION

Plate 1. Approximate Extent of Original Landfill Development Footprint (North ↑). Courtesy of Google Earth.

The proposed development area, as indicated by TGC Engineers cc (Plate 1 above), was investigated on the 20th June 2012 by means of inspection pitting using an Bell HD 820R track mounted excavator, as well as excavation of auger holes along the valley line, seismic testing, Dynamic Cone Penetrometer (DCP) testing and selection of soil and water samples for laboratory analysis.

The inspection pits, designated IP1 to IP13, were examined and described by an Engineering Geologist in accordance with the standard method of profiling recommended by Jennings, J.E, Brink, A.B.A and Williams, A.A.B (1973).

Following the findings of this investigation, it was decided that additional investigative work was required immediately north-west of the original development footprint. As such, on the 5th July 2012, a total of nine additional inspection pits, designated IP14 to IP22, were excavated using the same plant as described above. These pits were examined and described by an Engineering Geologist on the following day, 6th July 2012, in accordance with the standard method of profiling mentioned above. Furthermore, additional seismic testing was carried out across this area (refer to Plate 2 overleaf for the approximate extent of the total investigated area).

Plate 2. Approximate Extent of Recommended Landfill Development Footprint (±13.5ha) (North ↑). Courtesy of Google Earth.

Summarised in Table 1 below, are the coordinate positions for each of the inspection pits, which were recorded using a hand held Garmin GPS 60CSx device with an accuracy of about 3.0m. In addition, the positions have been marked on Drawing No. 22233/2, and the resultant soil profiles are included herewith as Appendix A.

Table 1. Coordinate Positions of the Inspection Pits

IP №	S	E	IP №	S	E
1	30°33'14.80''	29°27'40.80''	12	30°33'02.70''	29°27'37.00''
2	30°33'12.40''	29°27'43.50''	13	30°33'04.30''	29°27'41.40''
3	30°33'11.20''	29°27'45.90''	14	30°33'02.70''	29°27'30.10''
4	30°33'07.30''	29°27'41.90''	15	30°33'01.50''	29°27'33.70''
5	30°33'08.40''	29°27'40.40''	16	30°33'00.00''	29°27'36.80''
6	30°33'09.60''	29°27'37.70''	17	30°32'57.90''	29°27'31.50''
7	30°33'07.40''	29°27'33.70''	18	30°32'59.00''	29°27'29.70''

IP №	S	E	IP №	S	E
8	30°33'04.20''	29°27'34.10''	**19**	30°33'00.80''	29°27'26.00''
9	30°33'05.80''	29°27'37.30''	**20**	30°32'56.00''	29°27'26.10''
10	30°33'04.90''	29°27'44.00''	**21**	30°32'57.90''	29°27'24.10''
11	30°33'07.00''	29°27'45.20''	**22**	30°32'57.20''	29°27'21.30''

A total of twenty six Dynamic Cone Penetrometer tests, designated DCP1 to DCP26, were carried out along a grid where additional information was considered necessary across the original development area. The results of the DCP tests are recorded graphically in Appendix B of this report. DCP's 1 to 5, DCP15, DCP16 and DCP's 19 to 26 correspond to the area of the site expected to be underlain by shale, DCP6 and DCP14 in the area across the upper south western portion of the site underlain by sandstone, and DCP's 7 to 13 and DCP17 and DCP18 to the area of the original development area underlain by dolerite.

For ease of evaluation, Table 2 below, provides a qualitative indication of the consistency of the cohesive and non-cohesive soils based on the DCP results. It should be noted that the results are specific to DM&P testing equipment and should be used with caution as it is only provided as a guide.

Table 2. Subsoil Consistency Inferred from the DCP Test Results

Cohesive Soils		Non-Cohesive Soils	
№ of blows/300 mm Penetration	**Subsoil Consistency**	**№ of blows/300 mm Penetration**	**Subsoil Consistency**
< 4	Very Soft	< 8	Very Loose
4 - 8	Soft	8 - 18	Loose
9 - 15	Firm	19 - 54	Medium Dense
16 - 24	Stiff	54 - 90	Dense
25 - 54	Very Stiff	> 90	Very Dense
>54	Hard		

Thirteen auger holes, designated AH1 to AH13, were excavated to a maximum depth of 0.5m along the drainage feature located to the north-east of the landfill development footprint. The positions of the auger holes were also recorded using a hand held Garmin GPS 60CSx device, as such the positions shown on the Seepage Zone Drawing No. 22233/3 are relatively accurately depicted. The resultant soil profiles are included herewith as Appendix C. In addition, the results of this profiling exercise are discussed under Section 6 below.

A total of seven (7 №) 30m seismic traverses, designated T1 to T7, were carried out at site specific locations as indicated on Drawing No. 22233/2 using a 12 channel, signal enhanced, refraction seismograph. The results of the seismic testing are graphically presented in Appendix D and will be discussed in detailed under Section 8.

The following sample analysis was performed by Thekwini Soils Laboratory in Durban to determine the suitability of materials for use in the liner system:

- Full grading including Atterberg Limits and hydrometer analysis to 2 micron size
- Proctor Density
- In-situ Permeability tests
- Re-compacted Permeability tests (95% Proctor)
- Re-compacted Shear box tests (95% Proctor)

The results of the grading, Proctor density and permeability tests are summarised in Table 3. Laboratory Test Summary Table, included herewith in Appendix E. In addition, the material analyses are graphically presented and included with the summary table in Appendix E. Furthermore, the results have been tabulated under Section 4.1 to 4.3 below for ease of reference. Finally, the results are discussed in detail under Section 8 of this report.

The shear box test results are graphically presented in Appendix F of this report, tabulated under Section 4.4 and discussed in detail under Section 7.

Water samples were recovered from the drainage valley line across the north eastern site boundary, as well as from the Mzintlava River approximately 2km downstream of the site. These samples were returned to b.n. kirk (natal) cc. testing laboratory for background chemical analysis. The results of the testing are summarised in Appendix G of this report and tabulated below under Section 4.5.

4. LABORATORY TEST RESULTS

4.1 Grading Analysis

The results of the grading analyses are summarised in the Laboratory Test Summary Table (Table 3) included in Appendix E of this report along with the graphical representations of the material analyses. Furthermore, the results are discussed in detail under Table 4 below.

Table 4. Grading Test Results

IP №	Material Description	LL	LS (%)	PI	% Clay	Classification	
						AASHTO	Unified
IP1	Orange speckled dark grey, clayey SILT (Residual Dolerite)	55.7	11.3	22.3	29	A-7-5	MH
IP2	Highly weathered, olive, medium hard to hard rock SHALE (Beaufort Group)	35.3	4.7	9.1	12	A-4	SM
IP4	Brown speckled very dark grey and patched olive, clayey sandy GRAVEL (Residual Shale - Poorly Developed Ferricrete)	47.6	10.7	21.1	20	A-7-6	SC
IP6	Medium weathered, dark blue, hard rock DOLERITE (Karoo)	43.1	6	12	7	A-2-7	GM
IP7	Medium weathered, grey and olive, hard rock SANDSTONE (Beaufort Group)	33.3	5.3	10.1	6	A-2-6	SC
IP8	Grey, silty sandy GRAVEL (Colluvium)	29.9	6.7	13.1	15	A-6	SC
IP11	Very dark grey, CLAY (Hillwash)	52.7	14.7	29.1	52	A-7-6	CH
IP11	Completely weathered, yellow, soft rock, sandy SHALE (Beaufort Group)	33.2	2.7	5.2	8	A-1-b	GM
IP14	Medium weathered, yellow, soft to medium hard rock SANDSTONE (Beaufort Group)	28.3	2.7	5.1	5	A-1-a	GM
IP18	Dark orange, silty CLAY (Residual Shale)	29.5	6	12.1	37	A-6	CL

4.2 Proctor Density Test Results

The results of the Proctor density tests are summarised in the Laboratory Test Summary Table (Table 3) included in Appendix E. In addition, the results are discussed in detail under Table 5 below.

Table 5. Proctor Density Test Results

IP №	Sample №	Depth (m)	Description	Proctor Density (kg/m^3)	O.M.C (%)
IP1	06100	0.9 - 2.6	Orange speckled dark grey, clayey SILT (Residual Dolerite)	1251	31.6
IP2	06101	1.9 - 3.0	Highly weathered, olive, medium hard to hard rock SHALE (Beaufort Group)	1670	15.4
IP4	06103	0.2 - 0.7	Brown speckled very dark grey and patched olive, clayey sandy GRAVEL (Residual Shale - Poorly Developed Ferricrete)	1605	19.4
IP6	06014	1.0 - 1.9	Medium weathered, dark blue, hard rock DOLERITE (Karoo)	1604	19.7
IP7	06105	0.9 - 1.5	Medium weathered, grey and olive, hard rock SANDSTONE (Beaufort Group)	1745	15.7
IP11	06108	0.0 - 0.6	Very dark grey, CLAY (Hillwash)	1798	13.5
IP11	06107	0.8 - 1.9	Completely weathered, yellow, soft rock, sandy SHALE (Beaufort Group)	1534	19.6
IP14	07040	0.65 - 1.6	Medium weathered, yellow, soft to medium hard rock SANDSTONE (Beaufort Group)	1840	13.5
IP18	07041	0.4 - 1.6	Dark orange, silty CLAY (Residual Shale)	1638	16.2

4.3 Permeability Test Results

Permeability tests were carried out on four selected disturbed samples of the materials occurring on the site, and tested at in-situ density or re-compacted to 95% Proctor Density. The results of the permeability tests are summarised in Table 6 below and included in the Laboratory Test Summary Table (Table 3) attached herewith in Appendix E.

Table 6. Permeability Test Results

IP №	Sample №	Depth (m)	Description	Sample Type	% Fines (Clay & Silt)	Permeability (cms^{-1})
4	06103	0.2 - 0.7	Brown speckled very dark grey and patched olive, clayey sandy GRAVEL (Residual Shale - Poorly Developed Ferricrete)	Recomp. To 95% Proctor	38	1.68×10^{-8}
11	06108	0.0 - 0.6	Very dark grey, CLAY (Hillwash)	In-Situ	92	6.76×10^{-8}
11	06107	0.8 - 1.9	Completely weathered, yellow, soft rock, sandy SHALE (Beaufort Group)	Recomp. To 95% Proctor	23	1.91×10^{-7}
14	07041	0.4 - 1.6	Dark orange, silty CLAY (Residual Shale)	Recomp. To 95% Proctor	73	9.96×10^{-8}

4.4 Shear Box Tests

Consolidated Drained shear box tests were carried out on five selected disturbed samples of the materials occurring on the site, re-compacted to 95% Proctor Density, to obtain an indication of the shear strength properties of the prevailing materials. The results of the shear box tests are summarised in Table 7 overleaf. In addition, the results are graphically presented in Appendix F of this report.

Table 7. Shear Box Test Results

IP №	Sample №	Depth (m)	Description	Sample Type	% Fines (Clay & Silt)	Friction Angle (⌀°)	Cohesion (kPa)
1	06100	0.9 - 2.6	Orange speckled dark grey, clayey SILT (Residual Dolerite)	Recomp. To 95% Proctor	73	26	6
2	06101	1.9 - 3.0	Highly weathered, olive, medium hard to hard rock SHALE (Beaufort Group)	Recomp. To 95% Proctor	42	30	2
6	06104	1.0 - 1.9	Medium weathered, dark blue, hard rock DOLERITE (Karoo)	Recomp. To 95% Proctor	21	31	3
7	06105	0.9 - 1.5	Medium weathered, grey and olive, hard rock SANDSTONE (Beaufort Group)	Recomp. To 95% Proctor	21	31	4
14	07040	0.65 - 1.6	Highly weathered, yellow, soft to medium hard rock SANDSTONE (Beaufort Group)	Recomp. To 95% Proctor	13	32	10

4.5 Water Sample Test Results

As part of a preliminary background analysis, water samples were recovered from the drainage valley line across the north eastern site boundary (WS1), as well as from the Mzintlava River approximately 2km downstream of the landfill site (WS3). The results have been tabulated overleaf.

Table 8. Water Sample Test Results

Determinand	WS1 - Drainage Valley Line	WS3 - Mzintlava River
Conductivity at 25°C (mS/m)	57	14
Total Dissolved Solids (mg/L)	374	94
pH at 25°C	8.0	7.7
Sulphate as SO_4^{2-} Acute Health -1 (mg/L)	3.4	0.95
Sulphate as SO_4^{2-} Aesthetic (mg/L)	3.4	0.95
Total Hardness as $CaCO_3$ (mg/L)	268	90
Calcium Hardness as $CaCO_3$ (mg/L)	120	28
Calcium as Ca (mg/L)	48	112
Magnesium as Mg (mg/L)	35	15
Ammonia as N (mg/L)	<0.1	<0.1
Chloride as Cl^- (mg/L)	15	8
Potassium as K (mg/L)	2.3	2.3
Sodium as Na (mg/L)	48	24
p alkalinity (mg/L)	<2	<2
m alkalinity (mg/L)	2.4	50
Phosphorous as PO_4 (mg/L)	0.8	2.6
Chemical Oxygen Demand (mg/L)	17	20
Biological Oxygen Demand (mg/L)	11	1.3
E.coli or faecal coliforms (Counts per 100ml)	0	72

5. SITE GEOLOGY

The regional geology is shown on the Geological Plan Drawing No. 22233/1B taken from the 1:250 000 3028 Kokstad Geological Sheet, and indicates the area to be underlain by parent Adelaide Formation (Beaufort Group) shale and fine grained sandstone bedrock with a large dolerite sill intrusion up-slope and south-west of the proposed landfill site.

In addition, inspection pitting encountered shallow (at 1.2 - 1.6m below existing ground level) hard rock quartzite in the vicinity of IP14, IP15, IP19 and IP20. The quartzite most likely formed as a result of the fine grained parent sandstone bedrock being baked during the emplacement of the dolerite sill intrusion and subsequent metamorphism (refer to the area in "green" hatch on Drawing No. 22233/2 for the approximate extent of the quartzite).

5.1 Adelaide Formation (Beaufort Group)

Across the footprint of the landfill, completely to highly weathered bedrock of the Adelaide Formation can be expected at a shallow depth of 0.4 to 1.6m below existing ground level, and can be described as follows:

- Olive or grey stained dark grey, orange and red, laminated to thinly bedded, very close to closely jointed, soft rock shale which was found to contain 2 - 4mm thick reddish brown clay in-fill material, grey gravely clay in-fill material and iron oxide staining on typically smooth joint surfaces;

- Yellow stained dark brown and orange, very thinly to thinly bedded, very close to medium jointed, soft to medium hard rock sandstone. Joint surfaces in the sandstone are smooth and contain up to 5mm thick dark brown clayey in-fill material, as well as iron oxide staining.

The completely to highly weathered bedrock is typically thin, in the order of 0.2 to 1.1m thick, however thickens to up to 2.2m towards the lower north east portion of the site (refer to IP10, IP11 and IP16) where weathering processes have been more active adjacent to the drainage valley line.

Below the completely to highly weathered bedrock, medium weathered shale or sandstone bedrock can be expected and can be described as a grey and olive stained dark orange, yellow or reddish brown, very thinly to thinly bedded, close to medium jointed, hard rock that was found to contain between 2 and 5mm thick reddish brown and grey clay in-fill material as well as iron oxide staining on slightly rough to smooth joint

surfaces (the approximate area expected to be underlain by shale has been left un-hatched on Drawing No. 22233/2, and the area expected to be underlain by sandstone has been hatched “brown” on this drawing).

The above mentioned quartzite can be described as a medium weathered, grey or olive, medium bedded, close to widely jointed, hard rock which contains typically smooth joint surfaces which do contain iron oxide staining and up to 2mm thick greyish brown clay in-fill material.

Where present, the residuum derived from the in-situ weathering of the shale, sandstone and quartzite bedrock can be described as follows, and is in the order of 0.2 to 1.2m thick (average of 0.5m):

- Brownish red to red patched orange, firm to stiff, sandy clay, or;
- Olive or dark orange variably patched, stiff, fissured, sandy or silty clay, which may or may not contain irregular, platy gravels of shale, or;
- Brown speckled light yellow, very dark grey and orange, clayey sandy gravel, where affected by water for a prolonged period to produce a poorly developed ferricrete horizon (refer to IP4, IP5 and IP21).

The overlying fine gravity deposited soil, loosely term “hillwash”, covers the majority of the site and can be described as follows:

- Greyish brown to dark grey, firm to stiff, fissured or shattered, very fine to fine grained sandy clay or clay in the order of 0.45m thick (range of 0.25 to 0.6m), which may or may not overlie the above mentioned residuum.

Across the lower portions of the site, the gravity deposit is coarse grained, and can be described as a brown, medium dense, silty or clayey “colluvial” sand in the order of 0.2m thick (refer to IP13 and IP15).

Across the upper portions of the site, the colluvium is in the order of 0.35m thick (range of 0.2 to 0.5m) and can be described as a typically grey, firm to stiff, shattered, sandy clay containing gravels, cobbles and boulders of the shale, sandstone and dolerite bedrock (refer to IP4, IP5, IP8 and IP14).

5.2 Karoo Dolerite

As mentioned above, a large intrusive dolerite body has been identified immediately south-west and up-slope of the landfill footprint, the approximate areas of which has been hatched “red” on Drawing No. 22233/2. In addition, it must be understood, that thin intrusive dolerite bodies may also appear within the sedimentary bedrock of the Adelaide Formation below the depths investigated to.

In essence the subsoil profile across the dolerite intrusion comprises a 0.3 to 0.5m thick colluvium described as a grey, firm to stiff, shattered, sandy clay, overlying dark red or orange, stiff to very stiff, residual sandy clays, clayey silts or medium dense clayey sand which can be up to 2.0m in thickness. Both the colluvium and residuum were often found to contain gravel to boulder size, hard rock, rounded corestones. The degree of weathering of the intrusive dolerite body will vary locally depending on its exposure to weathering processes, mainly determined by structural features as well as moisture. The dolerite bedrock in the vicinity of IP1 is generally expected to be more deeply weathered than the bedrock intersected everywhere else.

6. SEEPAGE ZONES

Based on the auger profiles, as far as soil morphology indicators are concerned, the soil within the drainage channel, can be described as follows:

- Very moist to wet, very dark grey, silty or sandy CLAY, in places containing a sulphidic smell.

The above soil description is typical of a permanent / semi-permanent degree of wetness. However, it was also observed that the area immediately adjacent and up-slope of the drainage channel towards the proposed area of landfill development, do not show any soil conditions typical of soil saturation. Despite this, we are of the opinion that although limited in lateral extent (being restricted to the confines of the drainage channel), the defined zone provides stormwater attenuation for natural seepage, and will provide for stormwater run-off from the planned development, and a buffer zone is likely to be required.

As such, reference should be made to the "blue" line on Drawing No. 22233/3, which roughly marks the edge of the drainage feature on the development side. At this stage a 32m buffer zone has been applied, however will be at the discretion of the Local Authority and the appointed Environmental Officer.

In addition, there is an area of the slope that is hatched "blue" on Drawing No. 22233/3 which indicates an area also considered to be affected by permanent subsoil seepage. This area is likely to represent a spring utilising a fracture zone along the dolerite / shale contact zone in this area as a preferential flow path. The landfill footprint can not be located in this area of permanent seepage, and it was for this reason that the footprint of the landfill was shifted north-west.

Across the investigated site, it is considered that the sloping area is well drained surficially, the soil and weathered bedrock being relatively impermeable. No shallow water table is present on the site, however there are two areas, as shown in "light blue" hatch on Drawing No. 22233/3, which highlight the anticipated extent of seasonal subsoil seepage, which should be taken into account during the subsoil layout planning for preliminary design.

In saying this, as the site is scrubbed / developed, the position (s) of further localised seepage will be identified and drained via subsoil drains.

7. SITE STABILITY

No evidence of past or on-going slope instability was identified during the investigation.

That said, the Adelaide Formation is a sedimentary rock formation and is prone to instability, particularly where dolerite of the likes across this area, has intruded the parent bedrock. In addition, sequences of completely weathered shale are known to weather to clay lenses. These clay lenses may cause stability problems where present, especially where locally the predominant dip direction of the structural features of the sedimentary bedrock is dipping out of the slope.

The shale, sandstone and quartzite bedrock displays numerous localised variations in the dip of the bedding planes, and was expected due to the close proximity to the dolerite intrusion contact zone. Refer to Table 9 overleaf for a summary of the bedding dip and dip direction, where recorded, and comments thereto:

Table 9. Recorded Shale, Sandstone & Quartzite Bedding Dip & Dip Directions

IP №	Rock Type	Dip (°)	Dip Direction (°)	Comment
5	Shale	22	256 (WSW)	No stability concern
7	Shale & Sandstone	7 - 8	020 - 026 (NNE)	Localised stability concern
8	Shale	4	202 (SSW)	No stability concern
9	Shale	10	190 (SSW)	No stability concern
13	Shale	4 - 10	237 - 268 (SW to W)	No stability concern
14	Sandstone	6	318 (NW)	No stability concern
15	Sandstone	10	170 (SSE)	No stability concern
17	Shale	10	108 (ESE)	No stability concern
19	Quartzite	10	094 (E)	Localised stability concern
20	Quartzite	4	123 (NE)	No stability concern
21	Shale	4	313 (NW)	No stability concern
22	Shale	10	150 (SSE)	No stability concern

Bedding of the Adelaide Formation shale, sandstone and quartzite was in most instances found to be dipping favourably back into the slope, with the exception of two observed locations, namely IP7 and IP19. Here the bedding planes of the sedimentary rock were found to be dipping between 7° and 10° out of the slope (NNE to E) in close proximity to the dolerite intrusion contact zone.

Where observed, the shale, sandstone and quartzite was found to display ten major joint sets (J1 - J10), namely:

- J1: 80°/150 - 165° (Dip direction of SSE into slope)
- J2: 80 - 90°/173 - 187° (Dip direction of S into slope)
- J3: 78 - 85°/262 - 266° (Dip direction of W into slope)
- J4: 82 - 84°/237 - 245° (Dip direction of SW into slope)
- J5: 90°/110 - 126° (Dip direction of roughly SE perpendicular to slope)
- J6: 78 - 82°/193 - 212° (Dip direction of SSW into slope)
- J7: 54 - 87°/292° - 330° (Dip direction of NW locally out of slope)
- J8: 70 - 86°/076 - 088° (Dip direction of ENE locally out of slope)
- J9: 78 - 88°/360 - 008° (Dip direction of N locally out of slope)
- J10: 80 - 86°/014 - 041° (Dip direction of NNE to NE locally out of slope)

Where observed, the dolerite was found to display four major joint sets (J1 - J4), namely:

- J1: 70°/157° (Dip direction of SSE into slope)
- J2: 80°/120° (Dip direction of SE perpendicular to slope)
- J3: 70 - 77°/235 - 245° (Dip direction of SW into slope)
- J4: 88°/330° (Dip direction of NW locally out of slope)

The shale, sandstone and quartzite bedrock displays four major joint sets, namely J7 to J10, which are potentially adversely dipping in a NW through to NE direction out of slope at localised areas across the landfill footprint. As with the above mentioned areas where localised planar type failure could occur, these areas should also be observed for localised joint controlled wedge type failures.

Taking the above into consideration, it is considered essential that the earthwork be overseen by a competent Geotechnical Engineer or Engineering Geologist during construction, to identify these adversely dipping structural planes and completely weathered clay lenses within the weathered Adelaide Formation bedrock.

The laboratory shear box test results reveal the following:

- The highly weathered, olive, medium hard rock shale has an angle of internal friction (⌀) of 30° and a cohesion value of 2kPa.
- The highly weathered, yellow, soft to medium hard rock sandstone has an angle of internal friction (⌀) of 32° and a cohesion value of 10kPa.
- The medium weathered, grey and olive, hard rock sandstone has an angle of internal friction (⌀) of 31° and a cohesion value of 4kPa.
- The orange, stiff to very stiff, residual dolerite clayey silt has an angle of internal friction (⌀) of 26° and a cohesion value of 6kPa.
- The medium weathered, dark blue, hard rock dolerite has an angle of internal friction (⌀) of 31° and a cohesion value of 3kPa.

For preliminary design purposes, theoretically, the creation of temporary cut embankments to a maximum gradient of 1 in 2 (26°) for the hillwash, colluvium, residuum and completely weathered bedrock, increased to a gradient of 1 in 1.75 (30°) in the highly to medium weathered, shale, sandstone and quartzite bedrock, is not expected to produce potentially unstable slopes. However to allow suitable workable conditions for liner placement, consideration will have to be given to a permanent cut embankment gradient of 1 in 2.5 (22°).

Stability analysis on the final "filled" cell configuration (s) will be analysed during design stage. A Factor of Safety against failure for worst case sections drawn through the proposed landfill cell (s) on completion of the proposed filling, will be based on the landfills maximum thickness, the landfill crest level and the stability berm crest level.

8. EXCAVATABILITY

Drawing No. 22233/4 provides inferred rippability depths, below which blasting is anticipated. In addition, the results of the rippability assessment is summarised in Table 10 below.

Table 10. Rippability Assessment

Traverse №	Rock Type	Seismic Velocity Range (m/s)	Depth Range (m)	Rippability	
				D7G	D8K
T2	Shale	405 - 1257	0.0 - 8.6	R	R
		> 3100	8.6 +	NR	NR
T4	Shale	468 - 1199	0.0 - 5.7	R	R
		> 3100	5.7 +	NR	NR
T5	Shale	549 - 1485	0.0 - 5.5	MR	R
		> 3100	5.5 +	NR	NR
T6	Sandstone / Quartzite	367 - 1606	0.0 - 5.7	MR	R
		> 3200	5.7 +	NR	NR
T7	Sandstone / Quartzite	364 - 1489	6.3	MR	R
		> 3200	6.3 +	NR	NR
T3	Shale	385	0.0 - 1.2	R	R
		1837	1.2 - 6.6	NR	R
		> 3100	6.6 +	NR	NR

Note: The cell block shading above matches the hatch used in Drawing No. 22233/4. It must be noted that this assessment is based purely on the seismic velocities recorded and the description of the materials recovered from the shallow inspection pits.

The following should be used for preliminary design purposes:

- Clear Hatch - Approximate area of the site expected to be rippable using a D7 bulldozer or equivalent to a depth of between 5.7 and 8.6m below existing ground level.

- Orange Hatch - Approximate area of the site expected to be only marginally rippable using a D7, and rippable using a D8 bulldozer or equivalents to a depth of between 5.5 and 6.3m below existing ground level.

- Red Hatch - Approximate area of the site expected to be only rippable using a D8 bulldozer or equivalent to a depth of approximately 6.6m below existing ground level (may vary locally across this area).

9. ON-SITE MATERIALS SUITABILITY

9.1 Clay Liner

The DWA "Minimum Requirements for Waste Disposal by Landfill" stipulate the following for a clay liner soil:

- Plasticity Index >10%
- Particle size <25mm
- Permeability <1 x 10^{-6} cm/s (preferably $\leq$1 x 10^{-8} cm/s in laboratory tests as laboratory tests can be up to two orders of magnitude lower than field tests).

Table 3 of Appendix C summarises the laboratory soil test results and shows that the following soils are anticipated to be suitable for use as a clay liner:

- Hillwash - Greyish brown to dark grey, firm to stiff, very fine to fine grained sandy clay or clay in the order of 0.45m thick (range of 0.25 to 0.6m).

- Residual shale, sandstone and quartzite - In the order of 0.2 to 1.2m thick (average of 0.5m) brownish red to red sandy clay, or, olive or dark orange variably patched, sandy or silty clay, which may or may not contain irregular, platy gravel fragments. Where gravelly, sorting will be required and particles greater than 25mm diameter removed.

Drawing No. 22233/5 shows the inferred extent of these potential clay liner soils. Approximately 91 400m^3 of clayey hillwash, colluvium and residuum is expected to be available on site as clay liner material. In addition, a further 18 500m^3 (shale derived - vicinity of IP3) and 25 900m^3 (dolerite derived - vicinity of IP1) of clayey material is expected to be available at the two potential borrow sites located immediately south-east of the landfill site (refer to Drawing No. 22233/5 for the approximate location of the two potential borrow sites).

The subsoil profile underlying the dolerite borrow comprises a 0.3 to 0.5m thick colluvium described as a grey sandy clay, overlying dark red or orange residual sandy clays and clayey silts which can be up to 2.0m in thickness. Both the colluvium and residuum were found to contain gravel to boulder size, hard rock, rounded corestones and will require suitable sorting before use as clay liner material.

The completely weathered shale bedrock revealed an acceptable permeability test result. However, it must be noted that the laboratory test was carried out on the material fines, and from visual assessment of compaction of the shale, often the resultant product is a material that contains resistant gravel/cobble/boulder fragments amongst clayey patches. These zones of rock fragments are likely to be permeable while the fines less permeable. As such, we are of the opinion that the shale bedrock would not be suitable for use as clay liner material.

The clay liner must be compacted to a minimum dry density of 95% Proctor maximum dry density at a water content of Proctor optimum +2%.

The responsible Engineer will have to determine whether sufficient material is available on site for use in the clay liner system. Alternatively, consideration should be given to locating a suitable borrow pit, or as a last resort a GCL liner. It should be stressed that the placement of a GCL Liner system is critical so as not to induce instability below the waste pile.

Below, the clay liner will require a Base Preparation Layer (G Layer) and Leakage Detection and Collection Layer (D Layer) both 150mm thick. Above the clay liner, a 150mm Leachate Collection Layer (A Layer) will be required. The base preparation layer must comprise a compacted layer of reworked in-situ soil compacted to the same specification as the clay liner. As benching of the site to create stable platforms on which the waste pile will be created is likely to expose rock at a shallow depth across the site, material for the preparation layer will have to be stockpiled during excavation and then brought back in and suitably compacted.

The leakage detection and collection layer and leachate collection layer should consist of single sized gravel or crushed rock having a size of between 38 and 50mm. The highly to medium weathered shale, sandstone and quartzite excavated out across the landfill footprint is expected to be suitable material, however will require crushing to obtain the required grading.

Material considered suitable for use as cover material should display a Plasticity Index between 5 and 15 and a maximum particle size of 25mm. The soil and soft weathered bedrock are considered suitable for use as landfill cover material, however may require sorting to meeting the required grading requirement.

10. CONCLUSIONS

The site is located on the southern portion of Krantz Fontein Farm property on the lower portion of the north-facing slope of a prominent topographical spur. Slope gradients are considered of gentle to moderate steepness (7° to 11°). The site is bordered to the north east by a broad drainage valley line with a planar slope conformation, draining this area is a north westerly direction and eventually drains into the Mzintlava River some 300m north west of the landfill site.

A derelict structure is located on the site. This structure is expected to be in excess of 30 years old and may have some historical importance.

The recommended landfill development footprint is approximately 13.5ha in extent and is underlain by completely to highly weathered sedimentary bedrock of the Adelaide Formation (Beaufort Group), which can be expected at a shallow depth of 0.4 to 1.6m below existing ground level.

The completely to highly weathered bedrock is in the order of 0.2 to 1.1m thick, however thickens towards the lower north east portion of the site where weathering processes have been more active adjacent to the drainage valley line. Below the completely to highly weathered bedrock, medium weathered, hard rock shale, sandstone or quartzite bedrock can be expected (the geology of the site is shown on Drawing No. 22233/2).

Where present, the residuum derived from the in-situ weathering of the shale, sandstone and quartzite bedrock can typically be described as a sandy or silty clay which may or may not contain irregular gravel rock fragments, and is expected to be in the order of 0.2 to 1.2m thick.

The overlying hillwash covers the majority of the site and can be described as a greyish brown to dark grey, very fine to fine grained sandy clay or clay in the order of 0.45m thick (range of 0.25 to 0.6m), which may in some areas directly overlie weathered bedrock.

Across the lower portions of the site, the gravity deposit can be described as a brown silty or clayey colluvial sand in the order of 0.2m thick. Across the upper portions of the site, the colluvium is in the order of 0.35m thick (range of 0.2 to 0.5m) and can be described as a dark grey sandy clay containing gravels, cobbles and boulders of shale, sandstone and dolerite.

A large intrusive dolerite body has been identified immediately south-west and up-slope of the landfill footprint. In addition, thin intrusive dolerite bodies may also appear within the sedimentary bedrock of the Adelaide Formation below the depths investigated to. The subsoil profile across the dolerite intrusion comprises a 0.3 to 0.5m thick colluvium described as a grey sandy clay, overlying dark red or orange residual sandy clays, clayey silts or clayey sands which can be up to 2.0m in thickness. Both the colluvium and residuum were found to contain gravel to boulder size, hard rock, rounded corestones.

No evidence of past or on-going slope instability was identified during the investigation. That said, the Adelaide Formation is a sedimentary rock formation and is prone to instability, particularly where dolerite of the likes across this area, has intruded the parent bedrock. Taking the above into consideration, it is considered essential that the earthwork be overseen by a competent Geotechnical Engineer or Engineering Geologist during construction, to identify adversely dipping structural planes and completely weathered clay lenses within the weathered Adelaide Formation bedrock.

For preliminary design purposes, the creation of temporary cut embankments to a gradient of 1 : 2 (26°) for the hillwash, colluvium, residuum and completely weathered bedrock, increased to a gradient of 1 : 1.75 (30°) in the highly to medium weathered, shale, sandstone and quartzite bedrock, is not expected to produce potentially unstable slopes. To allow liner placement, a permanent cut embankment gradient of 1 : 2.5 (22°) is recommended at this stage of development.

Drawing No. 22233/3 shows the extent of seepage zones requiring drainage beneath the liner system. Once the site is scrubbed, the positions of further minor localised seepage zones on side slopes will be identified and drained via subsoil drainage.

Refer to Drawing No. 22233/4 for a rippability assessment of the site and the depths below which blasting is anticipated. Based on the results the following should be used for preliminary design purposes:

- Clear Hatch - Approximate area of the site expected to be rippable using a D7 bulldozer or equivalent to a depth of between 5.7 and 8.6m below existing ground level.

- Orange Hatch - Approximate area of the site expected to be only marginally rippable using a D7, and rippable using a D8 bulldozer or equivalents to a depth of between 5.5 and 6.3m below existing ground level.

- Red Hatch - Approximate area of the site expected to be only rippable using a D8 bulldozer or equivalent to a depth of approximately 6.6m below existing ground level.

Drawing No. 22233/5 shows the inferred extent of potential clay liner soils. Approximately 91 400m^3 of clayey hillwash, colluvium and residuum is expected to be available on site as clay liner material. In addition, a further 18 500m^3 shale derived, and 25 900m^3 (dolerite derived clayey material is expected to be available at two potential borrow sites located immediately south-east of the landfill site.

B. RAASCH Pr.Sci.Nat.

REFERENCE 22233

AUGUST 2012

DRENNAN, MAUD AND PARTNERS
68 Peter Mokaba Ridge, Tollgate,
DURBAN, 4001

/kr

REPORT TO TGC ENGINEERS CC.

ON A

GEOTECHNICAL INVESTIGATION

FOR A

PROPOSED NEW LANDFILL,

CANDIDATE SITE 1

KRANTZ FONTEIN FARM

KOKSTAD

DRENNAN, MAUD AND PARTNERS
CONSULTING CIVIL ENGINEERS AND ENGINEERING GEOLOGISTS

68 Peter Mokaba Ridge,
Tollgate, Durban, 4001

Ref № 22233

AUGUST 2012

CONTENTS

CONTENTS continued.

APPENDIX A

INSPECTION PIT PROFILES (IP1 - IP22)

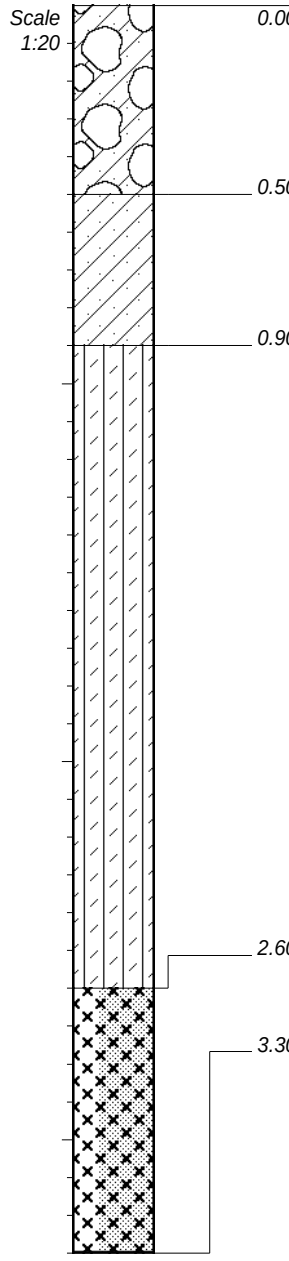
DRENNAN MAUD & PARTNERS

Consulting Civil Engineers and Engineering Geologists

TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

HOLE No: **IP 1**
Sheet 1 of 1

JOB NUMBER: **22233**



SMPL.	TEST
Bulk Disturbed	Ind, P, SB

0.00 – 0.50: Very slightly moist, dark brown, firm, shattered, fine grained boulder sandy CLAY containing up to 400mm diameter, sub-rounded to rounded, hard rock dolerite corestones (Colluvium).

0.50 – 0.90: Slightly moist, dark brownish red, stiff, fissured, fine grained sandy CLAY containing occasional cobble size dolerite corestones (Residual Dolerite).

0.90 – 2.60: Slightly moist, orange speckled dark grey, stiff to very stiff, appears intact, clayey SILT containing numerous irregular, soft to medium hard rock, ferruginised dolerite fragments particularly at the base of the horizon (Residual Dolerite).

2.60 – 3.30: Completely weathered, dark yellow, soft rock DOLERITE recovered as a clayey sand material (Karoo Supergroup).

NOTES

1) No groundwater seepage intersected at the time of the investigation.

2) No pit sidewall collapse.

3) Easy mechanical excavation.

4) No refusal.

5) Maximum reach of the machine excavating uphill at an awkward angle on a boulder slope.

6) Residual dolerite material taken between 0.9 and 2.6m for full grading (Ind), Proctor Density (P) and Re-compacted Shear Box (SB) laboratory testing.

CONTRACTOR : PONDO CIVILS
MACHINE : BELL HD820R
DRILLED BY : NA
PROFILED BY : B.R

TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

INCLINATION : NA
DIAM : NA
DATE : NA
DATE : 20/06/2012

DATE : 20/08/12 17:00
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION : N/A
X-COORD :
Y-COORD :

HOLE No: **IP 1**

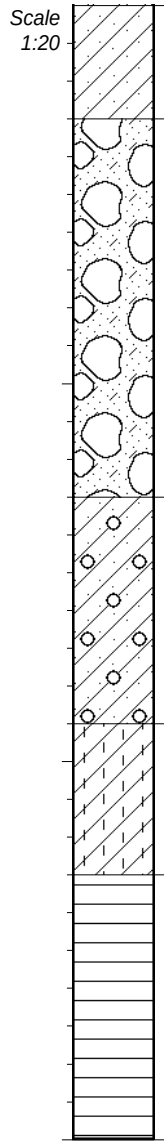
DRENNAN MAUD & PARTNERS

Consulting Civil Engineers and Engineering Geologists

TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

HOLE No: IP 2
Sheet 1 of 1

JOB NUMBER: 22233



0.00 – 0.30: Very slightly moist, dark grey, firm, shattered, fine grained sandy CLAY containing numerous roots (Hillwash).

0.30 – 1.30: Very slightly moist, dark dusky red extensively patched dark grey, medium dense to dense, boulder clayey SAND containing up to 350mm diameter, sub-rounded, hard rock dolerite corestones (Residual Dolerite).

1.30 – 1.90: Slightly moist, dark orange patched dark grey and dark olive, stiff, gravely sandy CLAY containing irregular fragments of shale that are up to cobble size (Dolerite / Shale Contact Zone).

1.90 – 2.30: Slightly moist, light yellow patched orange and dark grey, stiff to very stiff, silty CLAY (Residual Shale).

2.30 – 3.00: Highly weathered, olive stained dark grey on joint surfaces, very thinly bedded (approx. 30mm), closely jointed (approx. 100mm), joint surfaces display a smooth texture and contain iron-oxide staining, medium hard to hard rock SHALE recovered as irregular cobble and boulder size fragments (Beaufort Group).

SMPL.	TEST
Bulk Disturbed	Ind, P, SB

NOTES

1) This profile represents the contact with the parent bedrock shale and the overlying intrusive dolerite.

2) No groundwater seepage intersected at the time of the investigation, however evidence from the profiling reveals that seasonal seepage affects the shale / dolerite contact zone.

3) Machine refusing at the base of the pit.

4) Residual clay and highly weathered shale bedrock mix taken between 1.9 and 3.0m for full grading (Ind), Proctor Density (P) and Re-compacted Shear Box (SB) laboratory testing.

CONTRACTOR : PONDO CIVILS
MACHINE : BELL HD820R
DRILLED BY : NA
PROFILED BY : B.R

TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 20/06/2012

DATE : 20/08/12 17:00
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION : N/A
X-COORD :
Y-COORD :

HOLE No: IP 2

DRENNAN MAUD & PARTNERS

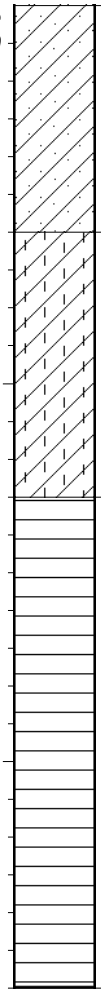
Consulting Civil Engineers and Engineering Geologists

TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

HOLE No: IP 3
Sheet 1 of 1

JOB NUMBER: 22233

Scale 1:20



0.00	Very slightly moist, dark grey patched dusky orange, stiff, shattered, fine grained sandy CLAY (Hillwash).
0.60	Very slightly moist, light yellowish grey patched orange, stiff, appears intact, silty CLAY becoming gravely closer to the contact with the underlying shale bedrock (Residual Shale).
1.30	Highly weathered, olive extensively stained yellow and grey on joint surfaces, very thinly bedded (approx. 30mm), closely jointed (60 – 100mm), joint surfaces are smooth, dry and contain iron-oxide staining, medium hard rock SHALE recovered as irregular, blocky gravel to boulder size fragments (30 – 300mm) (Beaufort Group). **Note: The bedding dip and dip direction is not easily discernible, however there is an indication that at this location, the bedding is dipping towards south east at a shallow angle (< 10°).**
2.60	

1

2

NOTES

1) No groundwater seepage intersected at the time of the investigation.

2) No pit sidewall collapse.

3) Machine refusing on light grey, more tightly jointed, hard rock shale exposed at the base of the pit. Therefore the pit was abandoned.

SMPL.	*TEST*

CONTRACTOR : PONDO CIVILS
MACHINE : BELL HD820R
DRILLED BY : NA
PROFILED BY : B.R

TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 20/06/2012

DATE : 20/08/12 17:00
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION : N/A
X-COORD :
Y-COORD :

HOLE No: IP 3

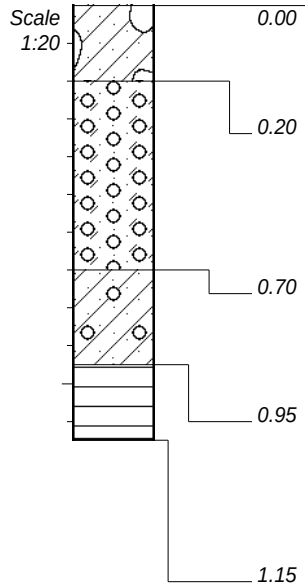
DRENNAN MAUD & PARTNERS

Consulting Civil Engineers and Engineering Geologists

TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

HOLE No: **IP 4**
Sheet 1 of 1

JOB NUMBER: **22233**



SMPL.	TEST		
Bulk Disturbed	Ind, P, Perm	1	Very slightly moist, brown, stiff, micro-shattered, fine grained cobble sandy CLAY containing up to 200mm diameter, rounded, hard rock dolerite corestones as well as roots (Colluvium).
			Slightly moist, brown extensively speckled very dark grey and orange and patched olive, medium dense, fissured, clayey sandy GRAVEL containing numerous dark grey, rounded, hard rock ferricrete nodules and ferruginised fragments of shale (Ferruginised Residual Shale – Poorly Developed Ferricrete Horizon).
			Slightly moist, olive extensively patched yellow, stiff, fissured, gravely sandy CLAY containing numerous irregular, medium hard to hard rock shale fragments (Residual Shale).
			Medium weathered, grey stained dark orange on joints which are also patched dark grey, very thinly bedded (approx. 30mm), close but tightly jointed (50 – 100mm), joint surfaces are smooth, moist and contain up to 2mm thick reddish brown clay infill material, hard rock SHALE (Beaufort Group).

NOTES

1) No groundwater seepage intersected at the time of the investigation, however this location is expected to be affected by a seasonally perched water table due to the presence of the poorly developed ferricrete horizon.

2) Machine refusing at the base of the pit.

3) Ferruginised residual shale material taken between 0.2 and 0.7m for full grading (Ind), Proctor Density (P) and Re-compacted Permeability (Perm) laboratory testing.

CONTRACTOR : PONDO CIVILS
MACHINE : BELL HD820R
DRILLED BY : NA
PROFILED BY : B.R

INCLINATION :
DIAM : NA
DATE : NA
DATE : 20/06/2012

ELEVATION : N/A
X-COORD :
Y-COORD :

HOLE No: **IP 4**

TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

DATE : 20/08/12 17:00
TEXT : ..C:\DOTIN\SPMASTER.DOC

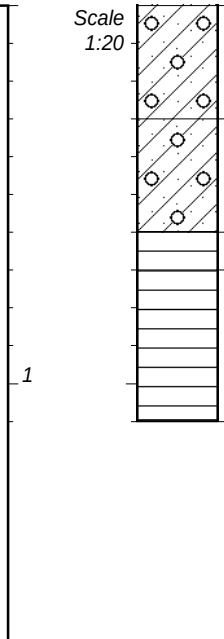
DRENNAN MAUD & PARTNERS

Consulting Civil Engineers and Engineering Geologists

TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

HOLE No: IP 5
Sheet 1 of 1

JOB NUMBER: 22233



Slightly moist, dark grey, firm, fine grained gravely sandy CLAY containing numerous rounded, gravel size fragments of dolerite (Colluvium).

Slightly moist, reddish brown extensively speckled very dark grey and orange, firm, gravely sandy CLAY containing numerous irregular and sub-rounded ferricrete nodules and ferruginised rock fragments as well as up to cobble size (60mm), sub-rounded, hard rock dolerite corestones (Ferruginised Colluvium – Poorly Developed Ferricrete Horizon).

Highly weathered, grey, laminated (approx. 5mm), very closely jointed, joint surfaces are smooth, moist and contain iron-oxide staining, soft rock SHALE (Beaufort Group).
Note: Bedding (Dip / Dip Direction): 22°/256°.

Medium weathered, light olive grey, very thinly bedded (approx. 25mm), closely jointed (approx. 100mm), joint surfaces are slightly rough to smooth, moist and contain iron-oxide staining, some joints also contain up to 2mm thick grey clay infill material, hard rock SHALE (Beaufort Group).
Note: Major Joints (Dip / Dip Direction): 70°/040° and 60°/094°.

NOTES

1) No groundwater seepage intersected at the time of the investigation, however evidence from the profiling reveals that seasonal seepage affects the transported soil / shale bedrock contact zone i.e. presence of ferricrete nodules.

2) Shale bedrock appears baked, which occurred during emplacement of the dolerite intrusive body.

3) Machine refusing at the base of the pit.

SMPL.	*TEST*

CONTRACTOR : PONDO CIVILS
MACHINE : BELL HD820R
DRILLED BY : NA
PROFILED BY : B.R

INCLINATION :
DIAM : NA
DATE : NA
DATE : 20/06/2012

ELEVATION : N/A
X-COORD :
Y-COORD :

TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

DATE : 20/08/12 17:00
TEXT : ..C:\DOTIN\SPMASTER.DOC

HOLE No: IP 5

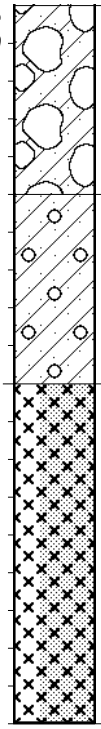
DRENNAN MAUD & PARTNERS

Consulting Civil Engineers and Engineering Geologists

TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

HOLE No: IP 6
Sheet 1 of 1

JOB NUMBER: 22233



Very slightly moist, greyish brown, firm, shattered, fine grained boulder sandy CLAY containing up to 300mm diameter hard rock dolerite corestones (Colluvium).

Slightly moist, dark red extensively patched dark orange and dark grey, stiff, micro fissured, very fine grained gravely sandy CLAY containing numerous sub-rounded ferricrete nodules, irregular fragments of rock and boulder size (up to 400mm) hard rock dolerite corestones (Ferruginised Residual Dolerite – Poorly Developed Ferricrete Horzion).

Medium weathered, dark blue extensively stained dark red on joints, closely jointed (40 – 100mm), joint surfaces contain iron-oxide staining and up to 2mm thick dark red clay infill material, hard rock DOLERITE (Karoo Supergroup).

SMPL.	TEST
Bulk Disturbed	Ind, P, SB

NOTES

1) No groundwater seepage intersected at the time of the investigation, however this location is expected to be affected by seasonally perched water table due to the presence of the poorly developed ferricrete horizon.

2) No pit sidewall collapse.

3) Machine refusing at the base of the pit.

4) Residual clay and medium weathered dolerite bedrock mix taken between 1.0 and 1.9m for full grading (Ind), Proctor Density (P) and Re-compacted Shear Box (SB) laboratory testing.

CONTRACTOR : PONDO CIVILS
MACHINE : BELL HD820R
DRILLED BY : NA
PROFILED BY : B.R

INCLINATION :
DIAM : NA
DATE : NA
DATE : 20/06/2012

ELEVATION : N/A
X-COORD :
Y-COORD :

TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

DATE : 20/08/12 17:00
TEXT : ..C:\DOTIN\SPMASTER.DOC

HOLE No: IP 6

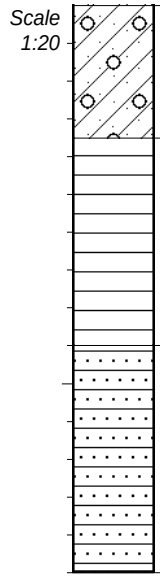
DRENNAN MAUD & PARTNERS

Consulting Civil Engineers and Engineering Geologists

TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

HOLE No: IP 7
Sheet 1 of 1

JOB NUMBER: 22233



Slightly moist, brown extensively speckled dark grey and dark orange, firm, shattered, gravely sandy CLAY containing numerous rounded hard rock ferricrete nodules (Ferruginised Hillwash – Poorly Developed Ferricrete Horizon).

Highly weathered, olive stained dark grey and orange on joints, very thinly bedded (20 – 25mm), closely jointed (50 – 100mm), joint surfaces are smooth and contain 2 – 4mm thick, slightly moist, reddish brown clay infill material and iron-oxide staining, soft rock SHALE (Beaufort Group).
Note: Bedding (Dip / Dip Direction): 07°/026° (out of slope).
Note: Major Joints (Dip / Dip Direction): 89°/139° and 84°/161°.

Medium weathered, grey and olive stained dark reddish brown on joints, very thin to thinly bedded (up to 60mm), medium jointed (100 – 200mm), joint surfaces are smooth and contain thick, moist, slickensided, dark reddish brown clay infill material, hard rock, gritty, SANDSTONE (Beaufort Group).
Note: Bedding (Dip / Dip Direction): 08°/020° (out of slope).
Note: Major Joints (Dip / Dip Direction): 88°/166° and 80°/200°.

SMPL.	TEST
Bulk Disturbed	Ind, P, SB

NOTES

1) No groundwater seepage intersected at the time of the investigation.

2) No pit sidewall collapse.

3) Machine refusing at the base of the pit.

4) Medium weathered sandstone bedrock taken between 0.9 and 1.5m for full grading (Ind), Proctor Density (P) and Re-compacted Shear Box (SB) laboratory testing.

CONTRACTOR : PONDO CIVILS
MACHINE : BELL HD820R
DRILLED BY : NA
PROFILED BY : B.R

TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 20/06/2012

DATE : 20/08/12 17:00
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION : N/A
X-COORD :
Y-COORD :

HOLE No: IP 7

DRENNAN MAUD & PARTNERS

Consulting Civil Engineers and Engineering Geologists

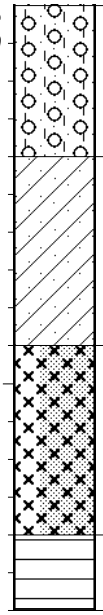
TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

HOLE No: IP 8
Sheet 1 of 1

JOB NUMBER: 22233

Indicator	Ind

Scale 1:20



0.00 Very slightly moist, grey, medium dense, silty sandy GRAVEL containing roots (Colluvium).

0.40 Slightly moist, dark brownish red, stiff, appears micro fissured, very fine and fine grained sandy CLAY containing ferruginised, hard rock dolerite fragments at the base of the horizon (Residual Dolerite).

0.90 Highly weathered, dark orange, closely jointed (40 – 100mm), joint surfaces are slightly rough and contain iron-oxide staining and < 2mm thick clay infill material, soft rock DOLERITE (Karoo Supergroup).
Note: Major Joints (Dip / Dip Direction): 70°/157° and 80°/120°.

1

1.40 Medium weathered, light olive, very thinly bedded (approx. 30mm), closely jointed (approx. 50mm), joint surfaces are smooth and contain up to 2mm thick, moist, dark red clay infill material and iron-oxide staining, medium hard rapidly to hard rock and tightly jointed, SHALE (Beaufort Group).
Note: Bedding (Dip / Dip Direction): 04°/202°.
Note: Major Joints (Dip / Dip Direction): 80°/150°.

1.60

NOTES

1) This profile represents the contact with the parent bedrock shale and the overlying intrusive dolerite.

2) No groundwater seepage intersected at the time of the investigation, however evidence from the profiling reveals that seasonal seepage affects the shale / dolerite contact zone i.e. presence of ferruginised rock fragments.

3) Shale bedrock appears baked, which occurred during emplacement of the dolerite intrusive body.

4) Machine refusing at the base of the pit.

5) Colluvial material taken between 0.0 and 0.4m for full grading (Ind) laboratory testing.

SMPL.	TEST

CONTRACTOR : PONDO CIVILS
MACHINE : BELL HD820R
DRILLED BY : NA
PROFILED BY : B.R

INCLINATION :
DIAM : NA
DATE : NA
DATE : 20/06/2012

ELEVATION : N/A
X-COORD :
Y-COORD :

HOLE No: IP 8

TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

DATE : 20/08/12 17:00
TEXT : ..C:\DOTIN\SPMASTER.DOC

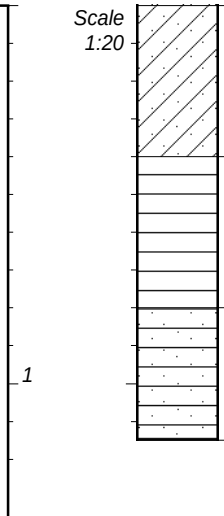
DRENNAN MAUD & PARTNERS

Consulting Civil Engineers and Engineering Geologists

TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

HOLE No: IP 9
Sheet 1 of 1

JOB NUMBER: 22233



Very slightly moist, brown, firm, micro shattered, very fine grained sandy CLAY containing roots and occasional gravel size, sub-rounded, hard rock dolerite corestones (Hillwash).

Highly weathered, olive extensively stained dark red on joints, very thinly bedded (10 – 25mm), typically closely jointed (50 – 80mm) however some joints are medium spaced (up to 270mm), joint surfaces are smooth and contain extensive thin (<1mm thick), dry clay infill material and iron-oxide staining, soft rock SHALE (Beaufort Group).
Note: Bedding (Dip / Dip Direction): 10°/190°.
Note: Major Joints (Dip / Dip Direction): 80°/165°, 90°/180° and 90°/126°.

Medium weathered, olive extensively stained yellow on joints, closely jointed (approx. 80mm), joint surfaces are smooth, tight and contain no infill material, medium hard rapidly to hard rock, slightly gritty, sandy SHALE (Beaufort Group).

NOTES

1) No groundwater seepage intersected at the time of the investigation.

2) No pit sidewall collapse.

3) Machine refusing at the base of the pit.

SMPL.	*TEST*

CONTRACTOR : PONDO CIVILS
MACHINE : BELL HD820R
DRILLED BY : NA
PROFILED BY : B.R

TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 20/06/2012

DATE : 20/08/12 17:00
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION : N/A
X-COORD :
Y-COORD :

HOLE No: IP 9

DRENNAN MAUD & PARTNERS

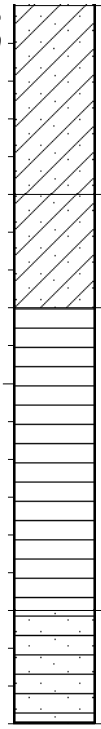
Consulting Civil Engineers and Engineering Geologists

TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

HOLE No: IP 10
Sheet 1 of 1

JOB NUMBER: 22233

Scale 1:20



0.00	Slightly moist, brown, firm, shattered, fine grained sandy CLAY (Hillwash).
0.50	
	Slightly moist, brownish red patched dark orange, firm, appears micro fissured, very fine and fine grained sandy CLAY (Residual Shale).
0.80	
	Highly weathered, olive stained very light grey and dark orange on joints, thinly bedded (30 – 45mm), medium to widely jointed (150 – 350mm), joint surfaces are smooth and contain < 2mm thick clay infill and iron-oxide staining, soft to medium hard rock SHALE recovered as irregular, gravel to boulder size fragments (30 – 350mm) (Beaufort Group).
1.60	
	Highly weathered, grey stained dark yellow, tightly jointed, medium hard to slightly hard rock sandy SHALE (Beaufort Group).
1.90	

NOTES

1) No groundwater seepage intersected at the time of the investigation.

2) Ni pit sidewall collapse.

3) Machine labouring extensively at the base of the pit, therefore the pit was abandoned.

SMPL.	TEST
1	

CONTRACTOR : PONDO CIVILS
MACHINE : BELL HD820R
DRILLED BY : NA
PROFILED BY : B.R

INCLINATION :
DIAM : NA
DATE : NA
DATE : 20/06/2012

ELEVATION : N/A
X-COORD :
Y-COORD :

HOLE No: IP 10

TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

DATE : 20/08/12 17:00
TEXT : ..C:\DOTIN\SPMASTER.DOC

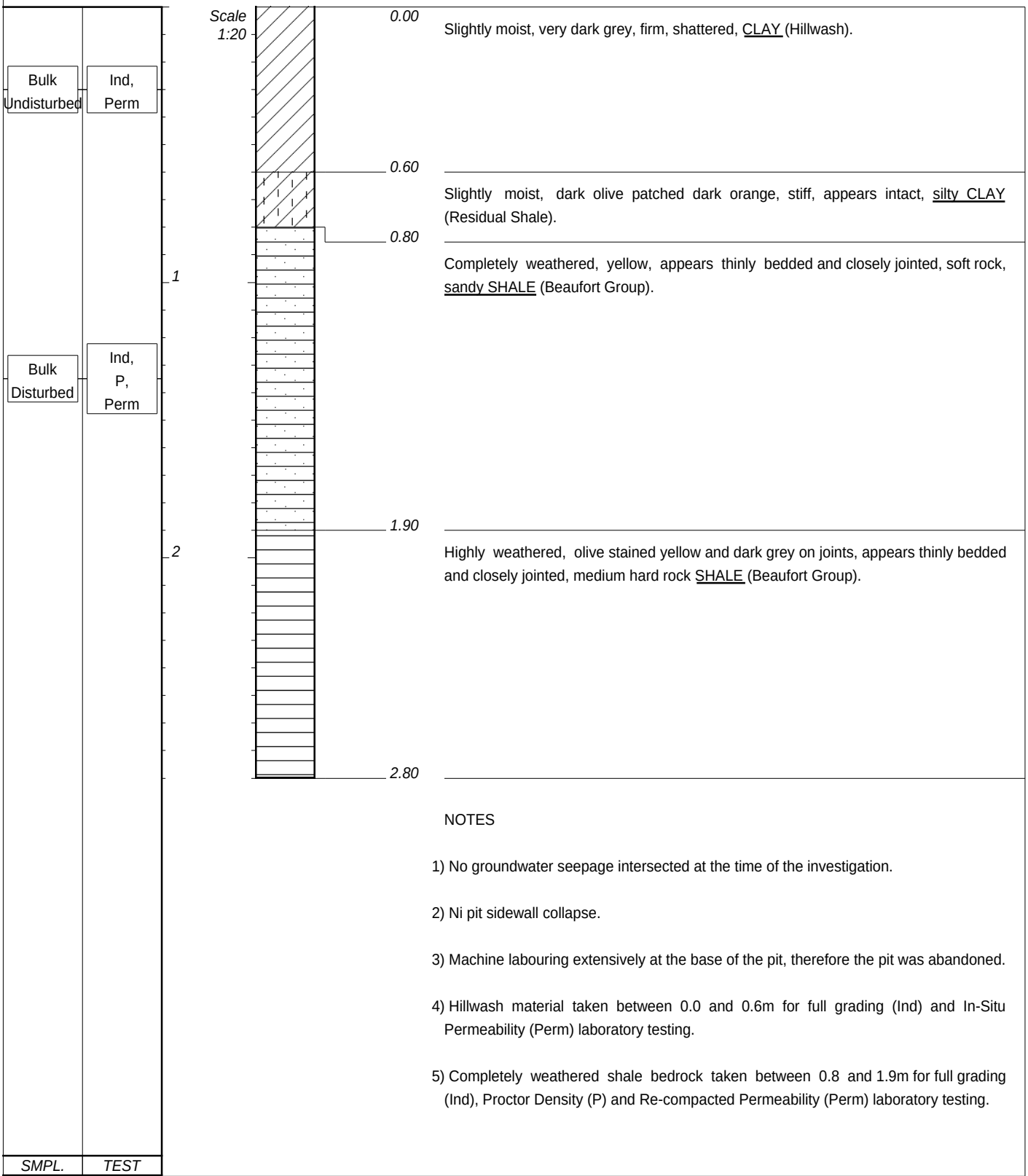
DRENNAN MAUD & PARTNERS

Consulting Civil Engineers and Engineering Geologists

TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

HOLE No: IP 11
Sheet 1 of 1

JOB NUMBER: 22233



NOTES

1) No groundwater seepage intersected at the time of the investigation.

2) Ni pit sidewall collapse.

3) Machine labouring extensively at the base of the pit, therefore the pit was abandoned.

4) Hillwash material taken between 0.0 and 0.6m for full grading (Ind) and In-Situ Permeability (Perm) laboratory testing.

5) Completely weathered shale bedrock taken between 0.8 and 1.9m for full grading (Ind), Proctor Density (P) and Re-compacted Permeability (Perm) laboratory testing.

CONTRACTOR : PONDO CIVILS
MACHINE : BELL HD820R
DRILLED BY : NA
PROFILED BY : B.R

INCLINATION :
DIAM : NA
DATE : NA
DATE : 20/06/2012

ELEVATION : N/A
X-COORD :
Y-COORD :

HOLE No: IP 11

TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

DATE : 20/08/12 17:00
TEXT : ..C:\DOTIN\SPMASTER.DOC

DRENNAN MAUD & PARTNERS

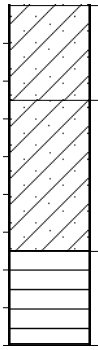
Consulting Civil Engineers and Engineering Geologists

TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

HOLE No: IP 12
Sheet 1 of 1

JOB NUMBER: 22233

Scale 1:20



0.00	Very slightly moist, light brown, stiff, mocro fissured, sandy CLAY (Hillwash).
0.25	Very slightly moist, brownish red patched orange, stiff, appears intact, slightly gravely, very fine grained sandy CLAY (Residual Shale).
0.65	Medium weathered, grey stained dark red and grey on joints, thinly bedded, close but tightly jointed, hard rock SHALE (Beaufort Group).
0.90	

NOTES

1) No groundwater seepage intersected at the time of the investigation.

2) Shale bedrock appears baked, which occurred during emplacement of the dolerite intrusive body.

3) No pit sidewall collapse.

4) Machine refusing at the base of the pit.

SMPL.	TEST

CONTRACTOR : PONDO CIVILS
MACHINE : BELL HD820R
DRILLED BY : NA
PROFILED BY : B.R

INCLINATION :
DIAM : NA
DATE : NA
DATE : 20/06/2012

ELEVATION : N/A
X-COORD :
Y-COORD :

HOLE No: IP 12

TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

DATE : 20/08/12 17:00
TEXT : ..C:\DOTIN\SPMASTER.DOC

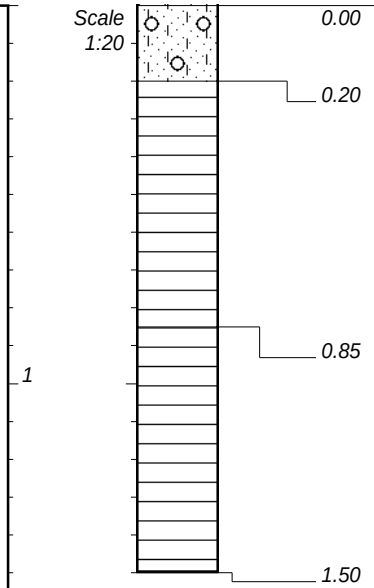
DRENNAN MAUD & PARTNERS

Consulting Civil Engineers and Engineering Geologists

TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

HOLE No: IP 13
Sheet 1 of 1

JOB NUMBER: 22233



Very slightly moist, brown, medium dense, gravely silty SAND containing numerous roots (Colluvium).

Highly weathered, olive stained metallic blue on joints, thinly bedded (30 – 70mm), close to medium jointed (60 – 150mm), joint surfaces are smooth and contain extensive thin (<1mm thick), dry silty sand infill material and iron-oxide staining some bedding planes contain < 1mm thick, olive clay infill material, medium hard rock SHALE (Beaufort Group).
Note: Bedding (Dip / Dip Direction): 04°/237°.
Note: Major Joints (Dip / Dip Direction): 88°/360°, 54°/330°, 82°/237° and 54°/292°.

Medium weathered, light olive stained yellow on joints, very thin to thinly bedded (15 – 50mm), close to medium jointed (50 – 150mm), joint surfaces are smooth and contain minor iron-oxide staining and clay infill material, medium hard to hard rock SHALE (Beaufort Group).
Note: Bedding (Dip / Dip Direction): 10°/268°.
Note: Major Joints (Dip / Dip Direction): 82°/237°, 80°/173° and 87°/297°.

NOTES

1) No groundwater seepage intersected at the time of the investigation.

2) Some minor collapse of the highly weathered shale bedrock during logging of the profile.

3) Machine refusing at the base of the pit.

SMPL.	TEST

CONTRACTOR : PONDO CIVILS
MACHINE : BELL HD820R
DRILLED BY : NA
PROFILED BY : B.R

INCLINATION :
DIAM : NA
DATE : NA
DATE : 20/06/2012

ELEVATION : N/A
X-COORD :
Y-COORD :

HOLE No: IP 13

TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

DATE : 20/08/12 17:00
TEXT : ..C:\DOTIN\SPMASTER.DOC

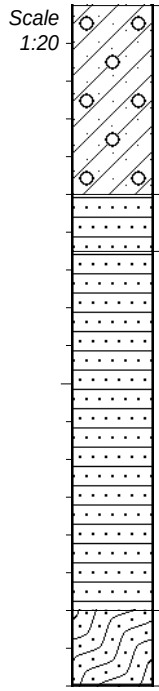
DRENNAN MAUD & PARTNERS

Consulting Civil Engineers and Engineering Geologists

TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

HOLE No: **IP 14**
Sheet 1 of 1

JOB NUMBER: 22233



SMPL.	TEST
Bulk Disturbed	Ind, P, SB

Very slightly moist, grey, extensively shattered, stiff, very gravely sandy CLAY containing cobbles (70 – 120mm diameter) of rounded, light orange, soft to medium hard rock sandstone as well as roots (Colluvium).

Completely weathered, dark orange extensively speckled dark grey and yellow, gritty, very soft rock SANDSTONE (Beaufort Group).

Highly weathered, yellow extensively stained dark brown and orange on joints, very thinly bedded (25 – 30mm), medium jointed (70 – 300mm), joint surfaces are smooth and some contain up to 5mm thick dry and dessicated, dark brown clay infill material, most joint surfaces contain iron-oxide staining and rootlets, gritty, soft to medium hard rock SANDSTONE (Beaufort Group).
Note: Bedding (Dip / Dip Direction): 06°/318°.
Note: Major Joints (Dip / Dip Direction): 78°/262° and 82°/187° (in-filled joint).

Medium weathered, grey, close to medium jointed (60 – 150mm), joint surfaces are smooth and contain approximately 1mm thick dark reddish brown clay infill material on some, up to 3mm thick dark yellow silty sandy infill material on others, however most joints are tight and contain just minor iron-oxide staining, baked, hard rock QUARTZITE (Beaufort Group).
Note: Rock contains very light bands which often contain very dark grey mineralisation.
Note: Major Joints (Dip / Dip Direction): 84°/245° and 82°/315°.

NOTES

1) No groundwater seepage intersected at the time of the investigation, however is likely to occur seasonally utilising joint surfaces within the completely and highly weathered sandstone bedrock as preferential flow paths.

2) No pit sidewall collapse.

3) Machine refusing at the base of the pit.

4) Highly weathered sandstone bedrock taken between 0.65 and 1.6m for full grading (Ind), Proctor Density (P) and Re-compacted Shear Box (SB) laboratory testing.

CONTRACTOR : PONDO CIVILS
MACHINE : BELL HD820R
DRILLED BY : NA
PROFILED BY : B.R

INCLINATION :
DIAM : NA
DATE : NA
DATE : 06/07/2012

ELEVATION : N/A
X-COORD :
Y-COORD :

TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

DATE : 20/08/12 17:00
TEXT : ..C:\DOTIN\SPMASTER.DOC

HOLE No: **IP 14**

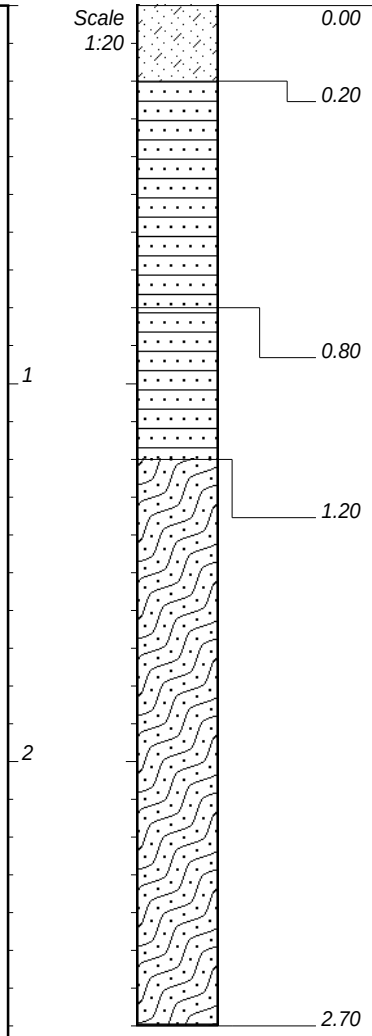
DRENNAN MAUD & PARTNERS

Consulting Civil Engineers and Engineering Geologists

TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

HOLE No: **IP 15**
Sheet 1 of 1

JOB NUMBER: 22233



Very slightly moist, brown, medium dense, fine grained clayey SAND containing roots (Colluvium).

Highly weathered, yellow stained dark metallic blue and dark red on joints, thinly bedded (25 – 50mm), closely jointed (50 – 100mm), most joint surfaces have opened during the excavation process and contain clayey sand infill material from the colluvial horizon above as well as numerous roots and iron-oxide staining, gritty, soft rock SANDSTONE (Beaufort Group).
Note: Bedding (Dip / Dip Direction): 10°/170°.
Note: Major Joints (Dip / Dip Direction): 85°/266°, 86°/076°, 70°/088° and 84°/178°.

Highly weathered, yellow, thinly bedded (25 – 50mm), very closely jointed (10 – 50mm), most joint surfaces have opened during the excavation process and contain clayey sand infill material from the colluvial horizon above as well as numerous roots, gritty, soft rock SANDSTONE (Beaufort Group).

Medium weathered, olive stained dark red, orange and dark grey on joints, widely jointed (250 – 500mm), joint surfaces are slightly rough and most contain iron-oxide staining and micaceous mineralisation, some joints also contain < 2mm thick dark olive, slickensided clay infill material, baked, medium hard to hard rock QUARTZITE (Beaufort Group).
Note: Major Joints (Dip / Dip Direction): 90°/126° and 78°/008°.

NOTES

1) No groundwater seepage intersected at the time of the investigation.

2) No pit sidewall collapse.

3) Machine refusing at the base of the pit.

4) On the downslope side of the pit, the completely to highly weathered sandstone has weathered completely to produce a dark yellow, slightly clayey, silty sand material.

SMPL.	*TEST*

CONTRACTOR : PONDO CIVILS
MACHINE : BELL HD820R
DRILLED BY : NA
PROFILED BY : B.R

INCLINATION :
DIAM : NA
DATE : NA
DATE : 06/07/2012

ELEVATION : N/A
X-COORD :
Y-COORD :

HOLE No: **IP 15**

TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

DATE : 20/08/12 17:00
TEXT : ..C:\DOTIN\SPMASTER.DOC

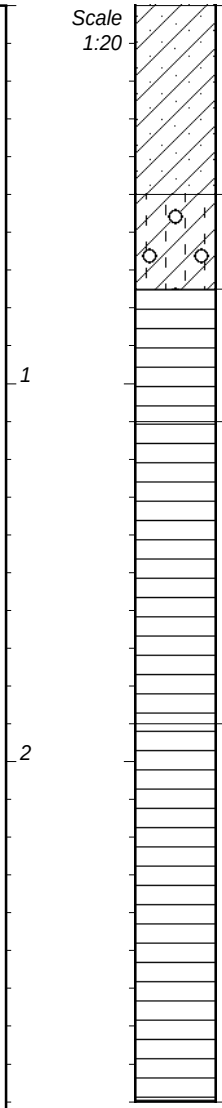
DRENNAN MAUD & PARTNERS

Consulting Civil Engineers and Engineering Geologists

TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

HOLE No: IP 16
Sheet 1 of 1

JOB NUMBER: 22233



0.00 — Very slightly moist, light greyish brown, micro-fissured, stiff, fine grained sandy CLAY containing roots and becoming gravely with depth (Hillwash).

0.50 — Very slightly moist, dark red, extensively fissured, ferruginised, stiff, gravely silty CLAY (Residual Shale).

0.75 — Completely weathered, yellow stained dark red, thinly bedded, closely jointed, joints contain iron-oxide staining, soft rock SHALE (Beaufort Group).

1.10 — Highly weathered, grey stained red on joints, thinly bedded, closely jointed (30 – 150mm), joints contain up to 4mm thick olive to grey, gravely clay infill material, soft to medium hard rock SHALE (Beaufort Group).

1.90 — Highly to medium weathered, grey stained dark grey on joints, thin to medium bedded, medium to widely jointed, joint surfaces are tight, smooth and contain iron-oxide staining, medium hard rock SHALE (Beaufort Group).

2.90

NOTES

1) No groundwater seepage intersected at the time of the investigation.

2) No pit sidewall collapse.

3) Machine refusing at the base of the pit.

4) Unable to get into this pit to measure the bedding and joint orientations due to the excessive depth. However, the bedding of the shale does appear to be dipping back into the slope at this location.

SMPL.	TEST

CONTRACTOR : PONDO CIVILS
MACHINE : BELL HD820R
DRILLED BY : NA
PROFILED BY : B.R
TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 06/07/2012
DATE : 20/08/12 17:00
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION : N/A
X-COORD :
Y-COORD :

HOLE No: IP 16

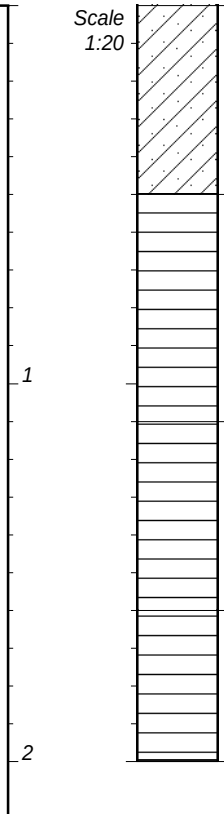
DRENNAN MAUD & PARTNERS

Consulting Civil Engineers and Engineering Geologists

TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

HOLE No: IP 17
Sheet 1 of 1

JOB NUMBER: 22233



Very slightly moist, brown, micro-fissured, firm to stiff, fine grained sandy CLAY containing roots (Hillwash).

Completely weathered, reddish brown stained dark grey, very closely jointed, very soft rock SHALE recovered as ferruginised rock fragments in a fine grained sandy clay matrix (Beaufort Group).

Highly weathered, grey stained reddish brown on joints, closely jointed (30 – 40mm), joint surfaces are smooth and contain up to 2mm thick colluvial sandy clay infill material from above, soft rock SHALE (Beaufort Group).
Note: Bedding (Dip / Dip Direction): 10°/108°.
Note: Major Joints (Dip / Dip Direction): 82°/193°.

Highly rapidly to medium weathered, olive grey, thinly bedded, close to medium jointed (50 – 240mm), joint surfaces are slightly rough to smooth and contain up to 2mm thick yellowish grey clay infill material and occasional iron-oxide staining, medium hard to hard rock SHALE (Beaufort Group).
Note: Major Joints (Dip / Dip Direction): 82°/026° and 86°/014°, and 90°/110°.

NOTES

1) No groundwater seepage intersected at the time of the investigation.

2) No pit sidewall collapse.

3) Machine refusing at the base of the pit.

SMPL.	TEST

CONTRACTOR : PONDO CIVILS
MACHINE : BELL HD820R
DRILLED BY : NA
PROFILED BY : B.R

TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 06/07/2012

DATE : 20/08/12 17:00
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION : N/A
X-COORD :
Y-COORD :

HOLE No: IP 17

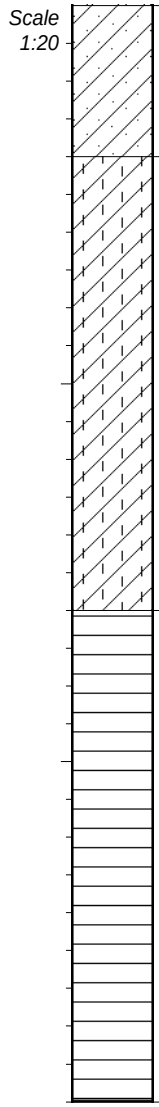
DRENNAN MAUD & PARTNERS

Consulting Civil Engineers and Engineering Geologists

TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

HOLE No: IP 18
Sheet 1 of 1

JOB NUMBER: 22233



SMPL.	TEST
Bulk Disturbed	Ind, P, Perm

0.00 – 0.40: Very slightly moist, greyish brown, appears micro-fissured, firm, fine grained sandy CLAY (Hillwash).

0.40 – 1.60: Very slightly moist, dark orange, appears relatively intact, ferruginised, stiff, silty CLAY containing occasional very dark grey ferruginised rock fragments of shale (Residual Shale).

1.60 – 2.90: Highly rapidly to medium weathered, grey stained reddish brown and yellow on joints, appear very thinly bedded, close to medium jointed (up to 400mm spacing with depth), medium hard to hard rock SHALE (Beaufort Group).

NOTES

1) No groundwater seepage intersected at the time of the investigation, however due to the ferruginisation of the residual shale horizon, is likely that seepage occurs in this area seasonally perched on the underlying weathered shale bedrock.

2) No pit sidewall collapse.

3) Machine refusing at the base of the pit.

4) Bedding of the shale bedrock not discernible at this location.

5) Residual shale material taken between 0.4 and 1.6m for full grading (Ind), Proctor Density (P) and Re-compacted Permeability (Perm) laboratory testing.

CONTRACTOR : PONDO CIVILS
MACHINE : BELL HD820R
DRILLED BY : NA
PROFILED BY : B.R

INCLINATION :
DIAM : NA
DATE : NA
DATE : 06/07/2012

ELEVATION : N/A
X-COORD :
Y-COORD :

TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

DATE : 20/08/12 17:00
TEXT : ..C:\DOTIN\SPMASTER.DOC

HOLE No: IP 18

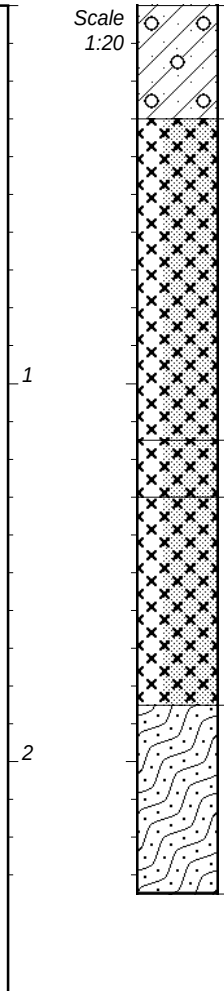
DRENNAN MAUD & PARTNERS

Consulting Civil Engineers and Engineering Geologists

TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

HOLE No: **IP 19**
Sheet 1 of 1

JOB NUMBER: 22233



Very slightly moist, grey, extensively shattered, stiff, very gravely sandy CLAY containing cobbles (70 – 120mm diameter) of rounded, light orange, soft to medium hard rock sandstone as well as roots (Colluvium).

Highly weathered, yellow extensively stained dark brown and orange on joints, typically medium jointed (250 – 350mm), however there are some closely spaced low angle joint surfaces as well, joint surfaces are smooth and contain extensive 3mm thick dark greyish brown clay infill material and rootlets, as well as extensive iron-oxide staining, soft rock, sugar DOLERITE (Karoo Supergroup).
Note: Major Joints (Dip / Dip Direction): 70°/245°, 88°/330° and 77°/235°.

Completely weathered, dark grey extensively patched dark red and yellow, very soft rock DOLERITE recovered as clayey gravel material (Karoo Supergroup).

Highly weathered, yellow extensively stained dark brown and orange on joints, typically medium jointed (250 – 350mm), however there are some closely spaced low angle joint surfaces as well, joint surfaces are smooth and contain extensive 3mm thick dark greyish brown clay infill material and rootlets, as well as extensive iron-oxide staining, some joint surfaces are moist, soft rock DOLERITE (Karoo Supergroup).
Note: Major Joint (Dip / Dip Direction): 10°/094° (low angle and mimics the bedding of the underlying quartzite).

Medium weathered, light bluish grey, typically medium jointed (110 – 300mm), joint surfaces are smooth, moist and contain up to 1mm thick dark brown clay infill material as well as iron-oxide staining, hard rock QUARTZITE (Beaufort Group).
Note: Major Joints (Dip / Dip Direction): 78°/203° and 80°/212°, and 80°/338°.

NOTES

1) No groundwater seepage intersected at the time of the investigation, however is likely to occur seasonally in the completely and highly weathered dolerite bedrock utilising joint planes as preferential flow paths.

2) No pit sidewall collapse.

3) Machine refusing at the base of the pit.

SMPL.	*TEST*

CONTRACTOR : PONDO CIVILS
MACHINE : BELL HD820R
DRILLED BY : NA
PROFILED BY : B.R

INCLINATION :
DIAM : NA
DATE : NA
DATE : 06/07/2012

ELEVATION : N/A
X-COORD :
Y-COORD :

HOLE No: **IP 19**

TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

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DRENNAN MAUD & PARTNERS

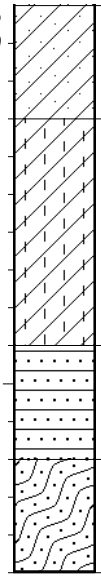
Consulting Civil Engineers and Engineering Geologists

TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

HOLE No: IP 20
Sheet 1 of 1

JOB NUMBER: 22233

Scale 1:20



0.00	Very slightly moist, brown, micro-fissured, firm to stiff, fine grained sandy CLAY containing roots (Hillwash).
0.30	Very slightly moist, dark orange, micro-fissured, ferruginised, stiff, silty CLAY containing occasional very dark grey ferruginised rock fragments of shale (Residual Shale).
0.90	Highly weathered, yellow, thinly bedded (25 – 50mm), very closely jointed (10 – 50mm), most joint surfaces have opened during the excavation process and contain clayey sand infill material from the colluvial horizon above as well as numerous roots, gritty, soft rock SANDSTONE (Beaufort Group).
1.20	Medium weathered, olive extensively stained dark red on joints, medium bedded (100 – 150mm), medium jointed (100 – 160mm), joint surfaces are slightly rough and contain up to 2mm thick greyish brown clay infill material with rootlets where open, as well as iron-oxide staining, medium hard to hard rock QUARTZITE (Beaufort Group). **Note: Bedding (Dip / Dip Direction): 04°/123°.** Note: Major Joints (Dip / Dip Direction): 80°/015° and 84°/096°.
1.50	

1

NOTES

1) No groundwater seepage intersected at the time of the investigation, however due to the ferruginisation of the residual shale horizon, is likely that seepage occurs in this area seasonally perched on the underlying weathered shale bedrock.

2) No pit sidewall collapse.

3) Machine refusing at the base of the pit.

SMPL.	TEST

CONTRACTOR : PONDO CIVILS
MACHINE : BELL HD820R
DRILLED BY : NA
PROFILED BY : B.R

TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 06/07/2012

DATE : 20/08/12 17:00
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION : N/A
X-COORD :
Y-COORD :

HOLE No: IP 20

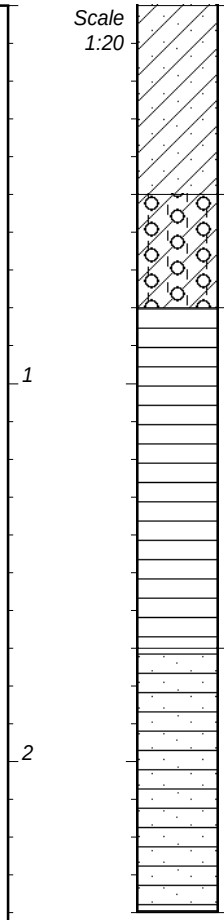
DRENNAN MAUD & PARTNERS

Consulting Civil Engineers and Engineering Geologists

TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

HOLE No: IP 21
Sheet 1 of 1

JOB NUMBER: 22233



SMPL.	TEST		
		0.00	Very slightly moist, brown, micro-fissured, firm to stiff, fine grained sandy CLAY containing roots and occasional hard rock dolerite corestones (Colluvium).
		0.50	Very slightly moist, dark brown extensively speckled light yellow and orange, extensively fissured, firm, GRAVELS of shale and ferricrete nodules in a silty clay matrix containing occasional cobbles of dolerite (Ferruginised Residual Shale – Poorly Developed Ferricrete Horizon).
		0.80	Highly weathered, light yellow extensively stained dark grey and red on joints, very thinly bedded (20 – 40mm), medium jointed (120 – 240mm), joint surfaces are smooth and contain up to 3mm thick brown clay infill material and extensive iron-oxide staining, there are also occasional roots in open joint surfaces, medium hard rock SHALE (Beaufort Group). **Note: Bedding (Dip / Dip Direction): 04°/313°.** Note: Major Joints (Dip / Dip Direction): 86°/041° and 70°/310°.
		1.70	Highly to medium weathered, light brown stained grey and orange on joints, medium jointed, joints contain extensive greyish brown clay infill material up to 2mm thick and occasional iron-oxide staining, medium hard to hard rock, sandy SHALE (Beaufort Group).
		2.40	

NOTES

1) No groundwater seepage intersected at the time of the investigation, however due to the ferruginisation of the residual shale horizon, is likely that seepage occurs in this area seasonally perched on the underlying weathered shale bedrock, as well as utilising the joints in the highly weathered shale bedrock as preferential flow paths.

2) No pit sidewall collapse.

3) Machine refusing at the base of the pit.

CONTRACTOR : PONDO CIVILS
MACHINE : BELL HD820R
DRILLED BY : NA
PROFILED BY : B.R

INCLINATION :
DIAM : NA
DATE : NA
DATE : 06/07/2012

ELEVATION : N/A
X-COORD :
Y-COORD :

TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

DATE : 20/08/12 17:00
TEXT : ..C:\DOTIN\SPMASTER.DOC

HOLE No: IP 21

DRENNAN MAUD & PARTNERS

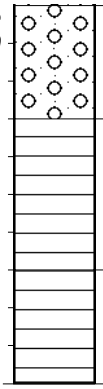
Consulting Civil Engineers and Engineering Geologists

TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

HOLE No: IP 22
Sheet 1 of 1

JOB NUMBER: 22233

Scale 1:20



		0.00	Slightly moist, greyish brown, medium dense, sandy clayey GRAVEL containing occasional rounded, hard rock dolerite cobbles at surface level (Colluvium).
		0.30	Completely weathered, grey extensively stained grey on joints, very thinly bedded (10 – 20mm), very close to closely jointed, joint surfaces are smooth and contain moist clay infilled surfaces and occasional iron-oxide staining, soft rock SHALE (Beaufort Group). **Note: Bedding (Dip / Dip Direction): 10°/150°.**
		0.70	Medium weathered, grey, tightly jointed, hard rock SHALE (Beaufort Group).
	1	1.00	

NOTES

1) No groundwater seepage intersected at the time of the investigation, however is likely that seepage occurs in this area seasonally utilising the joints in the completely weathered shale bedrock as preferential flow paths.

2) No pit sidewall collapse.

3) Machine refusing at the base of the pit.

SMPL.	TEST

CONTRACTOR : PONDO CIVILS
MACHINE : BELL HD820R
DRILLED BY : NA
PROFILED BY : B.R

INCLINATION :
DIAM : NA
DATE : NA
DATE : 06/07/2012

ELEVATION : N/A
X-COORD :
Y-COORD :

HOLE No: IP 22

TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

DATE : 20/08/12 17:00
TEXT : ..C:\DOTIN\SPMASTER.DOC

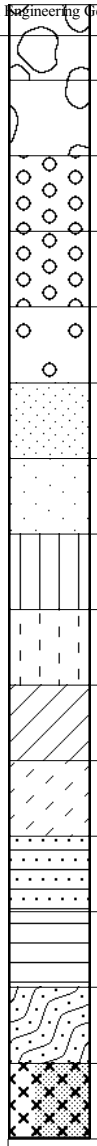
DRENNAN MAUD & PARTNERS

Consulting Civil Engineers and Engineering Geologists

TGC ENGINEERS
PROPOSED KOKSTAD LANDFILL

LEGEND
Sheet 1 of 1

JOB NUMBER: 22233



BOULDER	{SA01}
COBBLE	{SA48}
GRAVEL	{SA02}
GRAVELS	{SA02}
GRAVELY	{SA03}
SAND	{SA04}
SANDY	{SA05}
SILT	{SA06}
SILTY	{SA07}
CLAY	{SA08}
CLAYEY	{SA09}
SANDSTONE	{SA11}
SHALE	{SA12}
QUARTZITE	{SA15}
DOLERITE	{SA18}{SA42}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

INCLINATION :
DIAM :
DATE :
DATE :

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : B.R
SETUP FILE : DMPSP.SET

DATE : 20/08/12 17:00
TEXT : ..C:\DOTIN\SPMASTER.DOC

LEGEND
SUMMARY OF SYMBOLS

APPENDIX B

DYNAMIC CONE PENETROMETER TEST RESULTS (DCP1 - DCP26)

Dynamic Cone Penetrometer

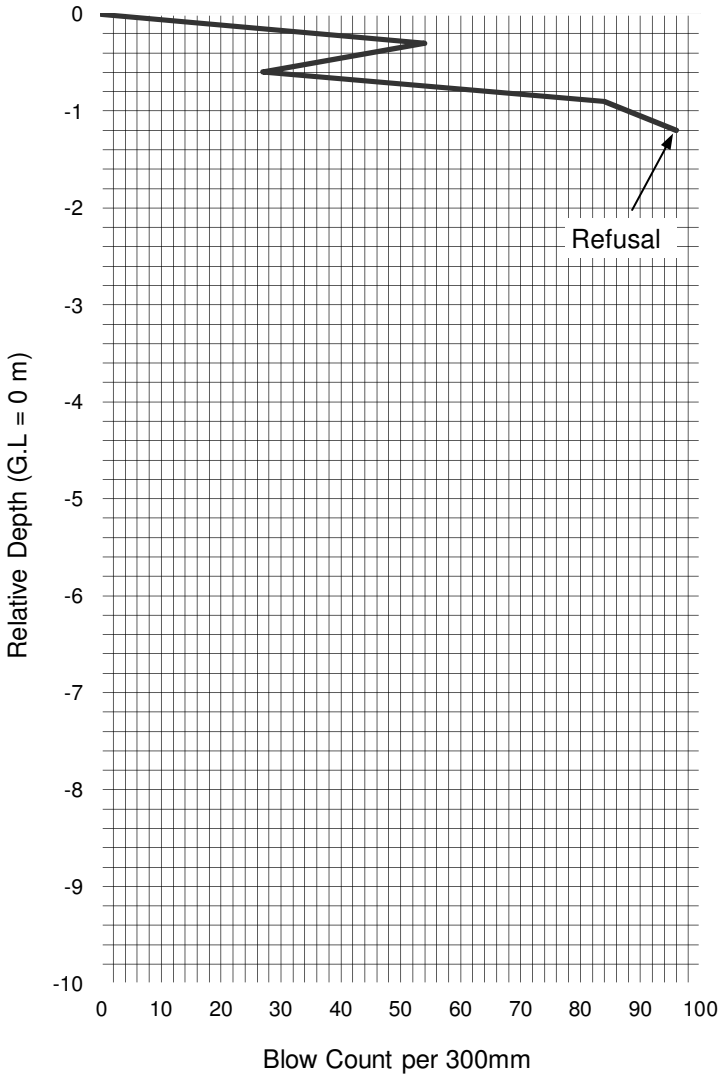
Test No. : 1

Project : **Kokstad Landfill**
Client: **TGC Engineers cc.**

Date:	21-06-2012	Remarks:	Underlain by Shale
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	54
-0.6	27
-0.9	84
-1.2	96

Blow Count vs Depth



Reference No. : **22233**

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

Dynamic Cone Penetrometer

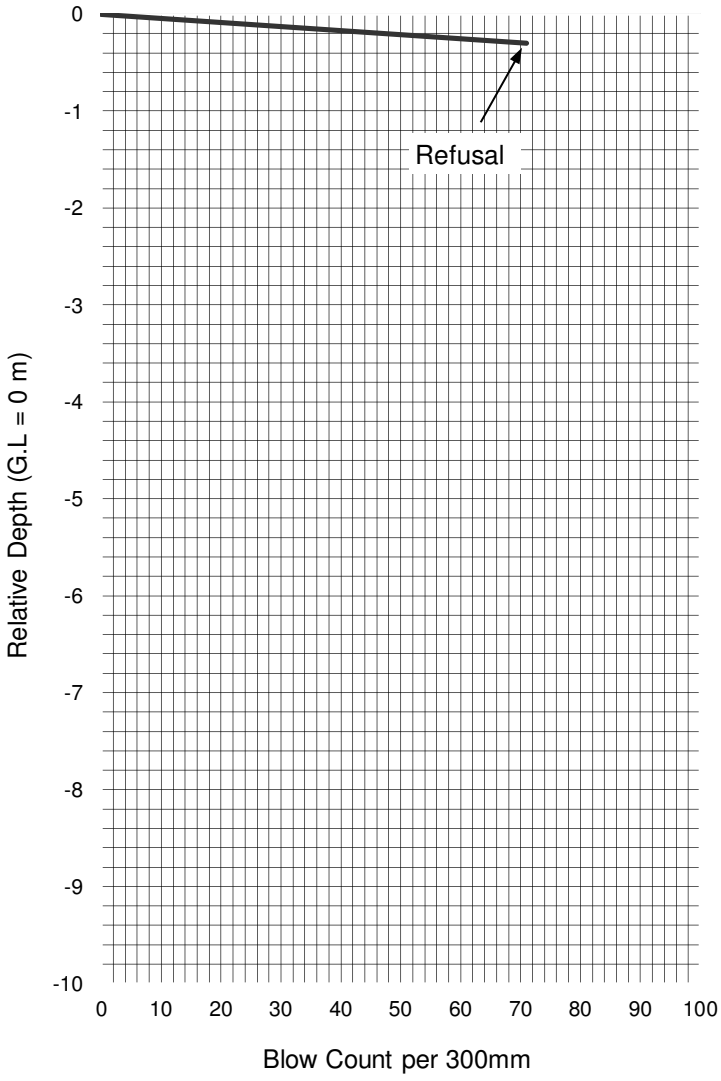
Test No. : 2

Project : **Kokstad Landfill**
Client: **TGC Engineers cc.**

Date:	21-06-2012	Remarks:	Underlain by Shale
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	71

Blow Count vs Depth



Reference No. : **22233**

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

Dynamic Cone Penetrometer

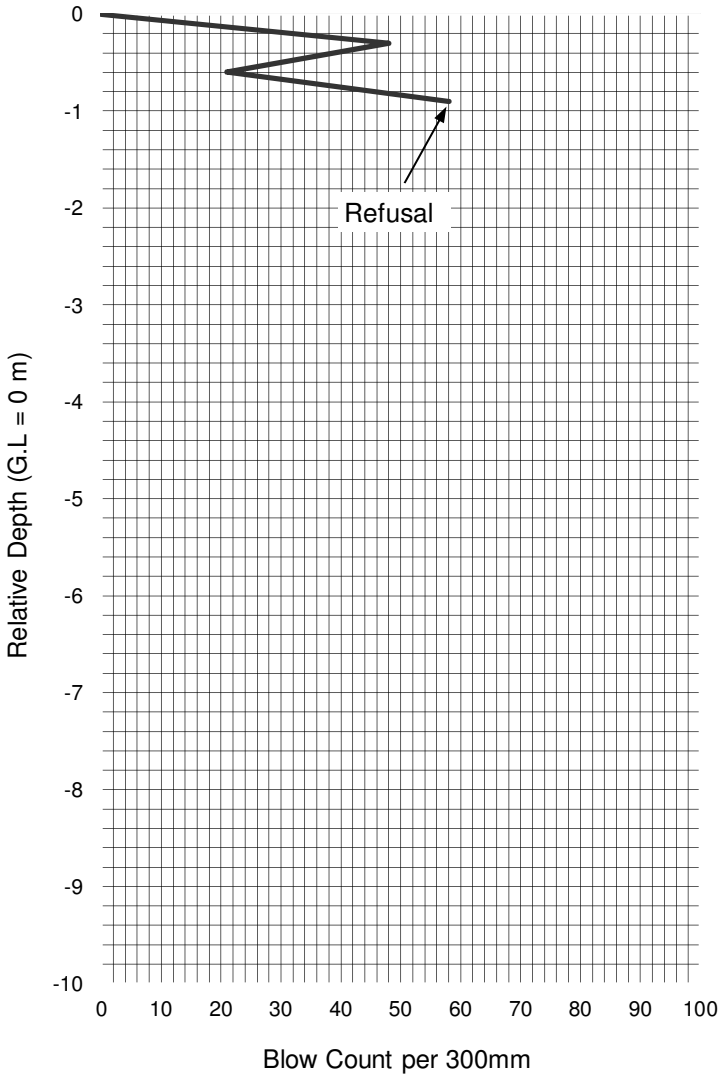
Test No. : 3

Project : **Kokstad Landfill**
Client: **TGC Engineers cc.**

Date:	21-06-2012	Remarks:	Underlain by Shale
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	48
-0.6	21
-0.9	58

Blow Count vs Depth



Reference No. : 22233

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

Dynamic Cone Penetrometer

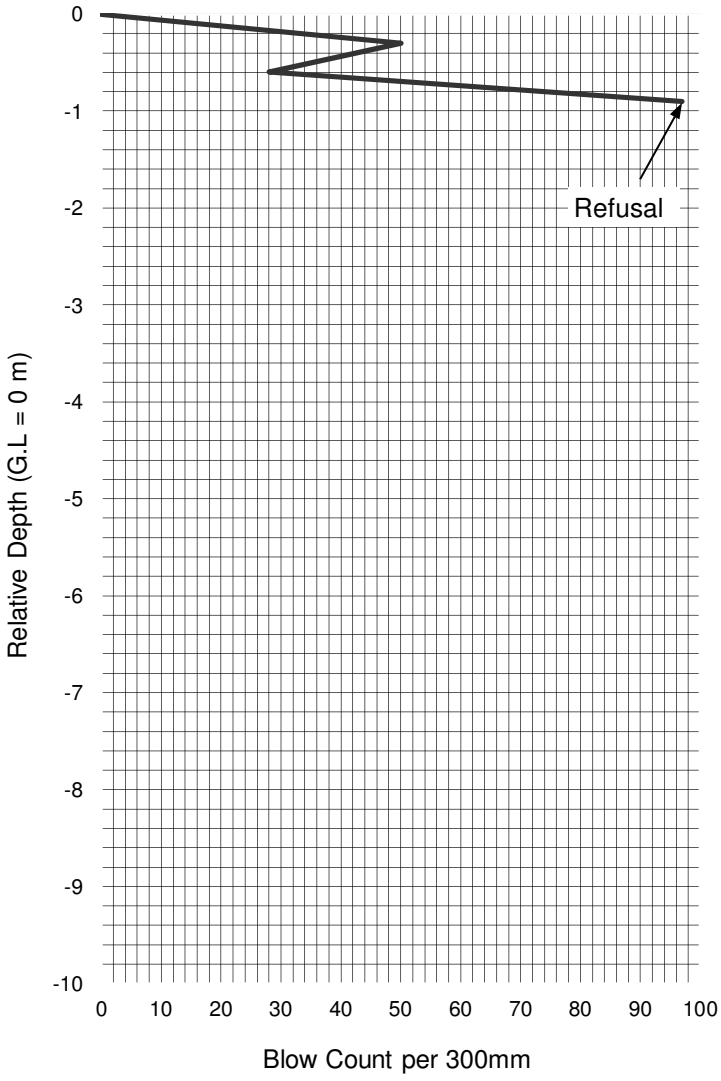
Test No. : 4

Project : **Kokstad Landfill**
Client: **TGC Engineers cc.**

Date:	21-06-2012	Remarks:	Underlain by Shale
Test Location:	Site 1 Krantz Fontein Farm		intruded by Dolerite
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	50
-0.6	28
-0.9	97

Blow Count vs Depth



Reference No. : 22233

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

Dynamic Cone Penetrometer

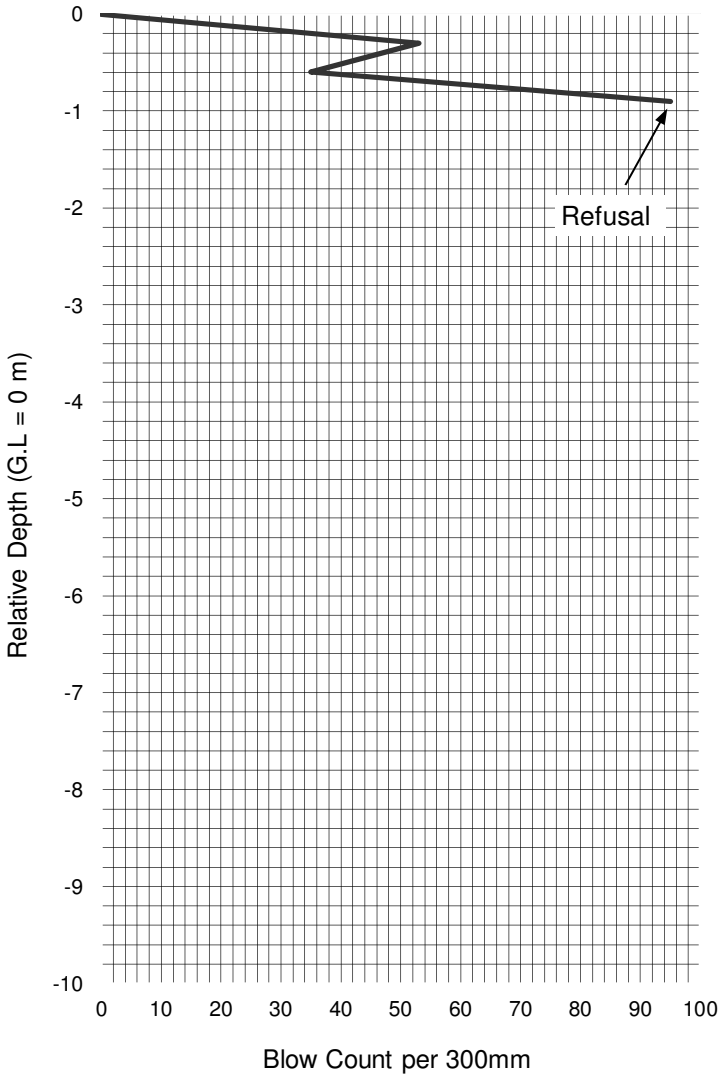
Test No. : 5

Project : **Kokstad Landfill**
Client: **TGC Engineers cc.**

Date:	21-06-2012	Remarks:	Underlain by Shale
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	53
-0.6	35
-0.9	95

Blow Count vs Depth



Reference No. : **22233**

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

Dynamic Cone Penetrometer

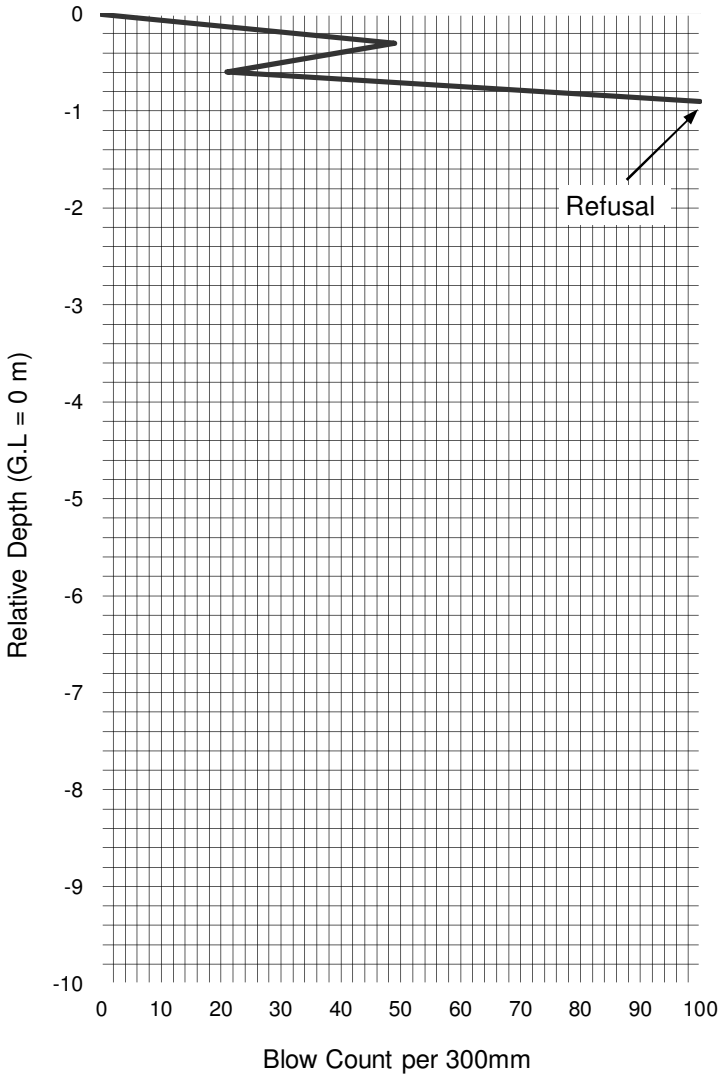
Test No. : 6

Project : **Kokstad Landfill**
Client: **TGC Engineers cc.**

Date:	21-06-2012	Remarks:	Underlain by Sandstone
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	49
-0.6	21
-0.9	100

Blow Count vs Depth



Reference No. : **22233**

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

Dynamic Cone Penetrometer

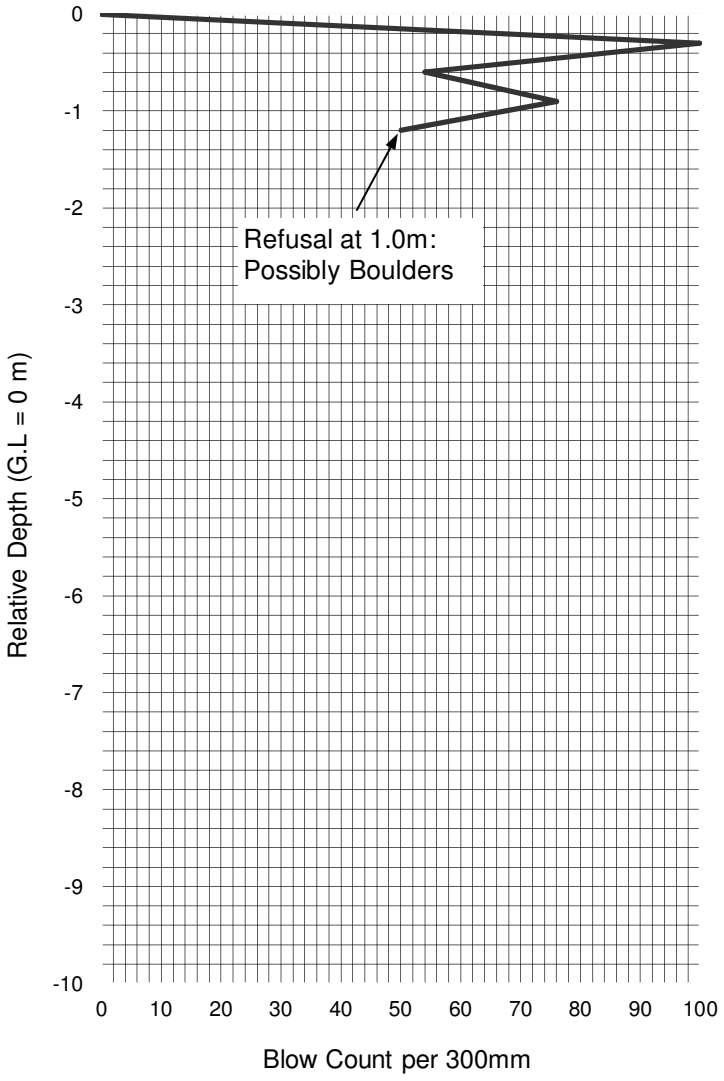
Test No. : 7

Project : **Kokstad Landfill**
Client: **TGC Engineers cc.**

Date:	21-06-2012	Remarks:	Underlain by Dolerite
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	100
-0.6	54
-0.9	76
-1.2	50

Blow Count vs Depth



Reference No. : 22233

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

Dynamic Cone Penetrometer

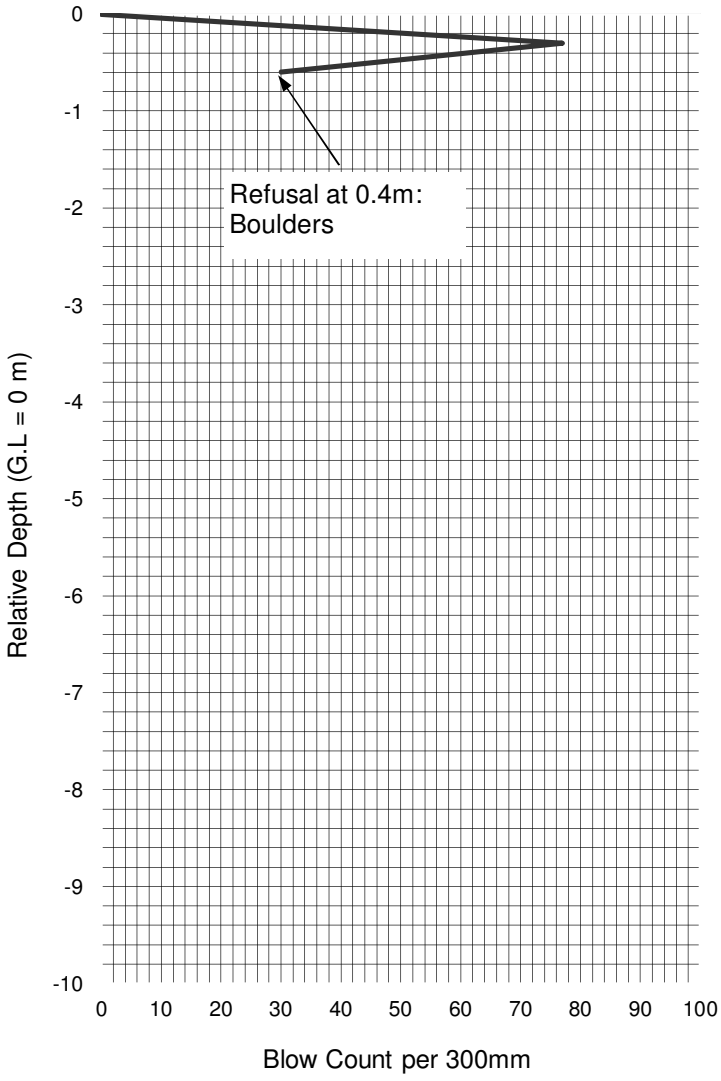
Test No. : 8

Project : **Kokstad Landfill**
Client: **TGC Engineers cc.**

Date:	21-06-2012	Remarks:	Underlain by Dolerite
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	77
-0.6	30

Blow Count vs Depth



Reference No. : 22233

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

Dynamic Cone Penetrometer

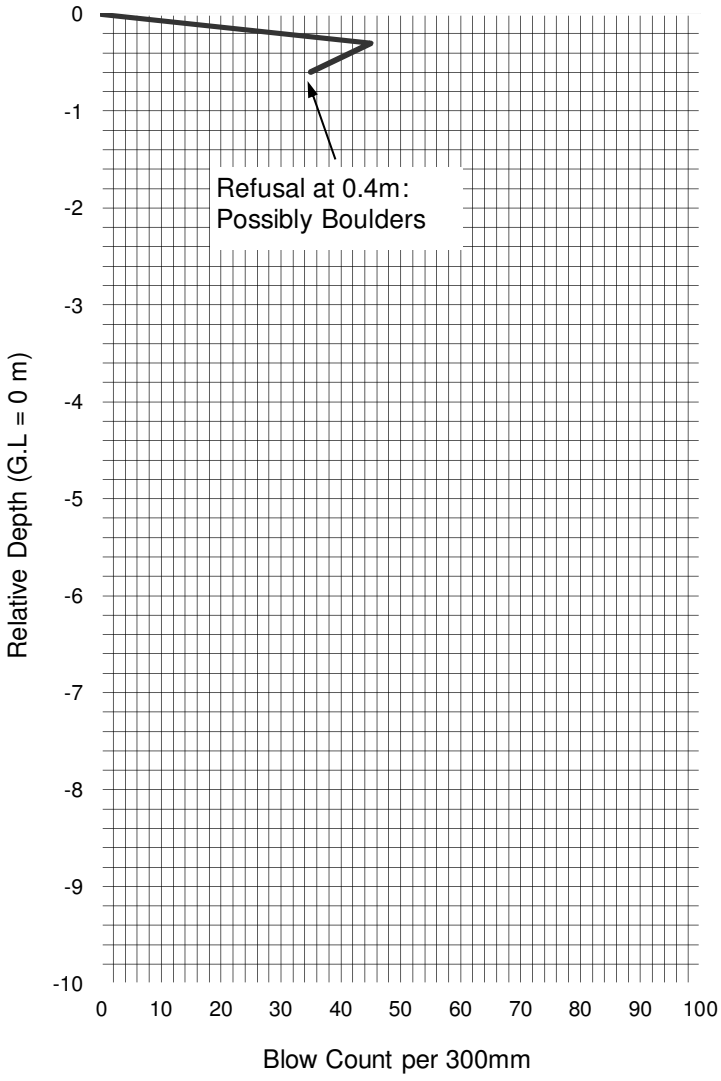
Test No. : 9

Project : **Kokstad Landfill**
Client: **TGC Engineers cc.**

Date:	21-06-2012	Remarks:	Underlain by Dolerite
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	45
-0.6	35

Blow Count vs Depth



Reference No. : 22233

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

Dynamic Cone Penetrometer

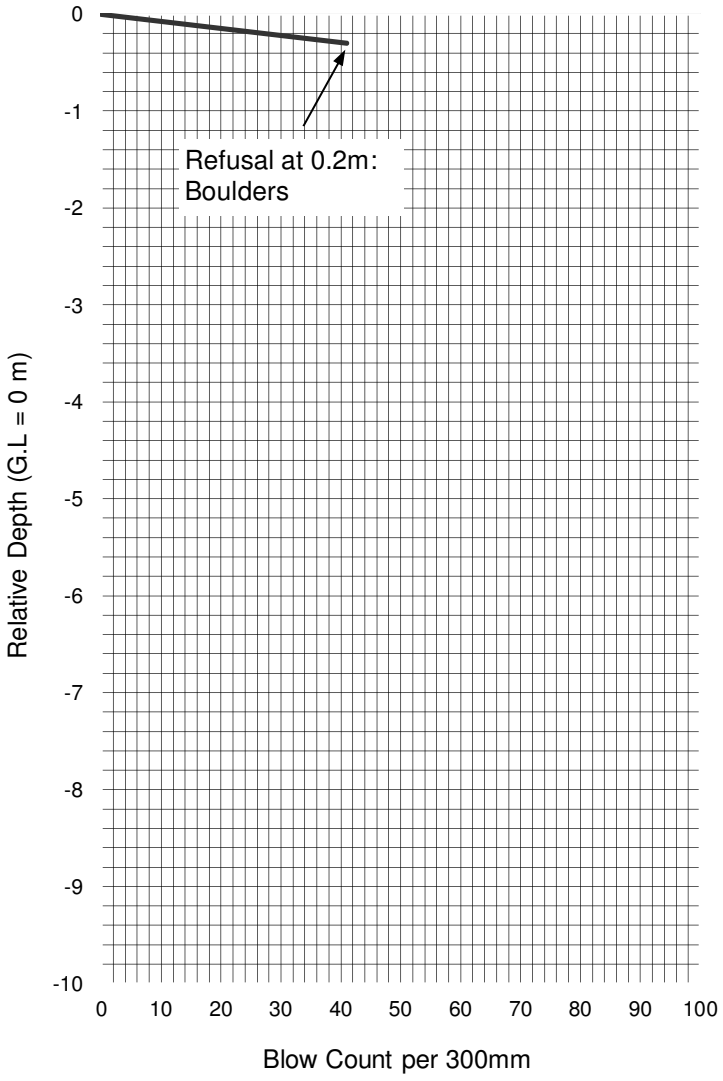
Test No. : 10

Project : **Kokstad Landfill**
Client: **TGC Engineers cc.**

Date:	21-06-2012	Remarks:	Underlain by Dolerite
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	41

Blow Count vs Depth



Reference No. : 22233

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

Dynamic Cone Penetrometer

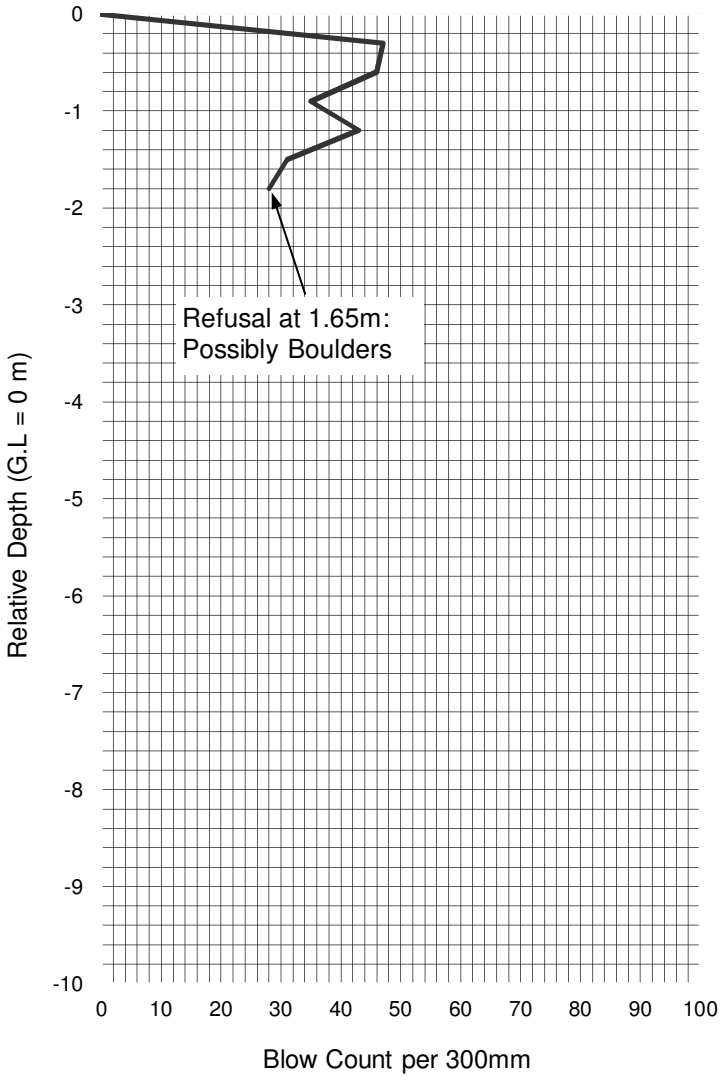
Test No. : 11

Project : **Kokstad Landfill**
Client: **TGC Engineers cc.**

Date:	21-06-2012	Remarks:	Underlain by Dolerite
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	47
-0.6	46
-0.9	35
-1.2	43
-1.5	31
-1.8	28

Blow Count vs Depth



Reference No. : 22233

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

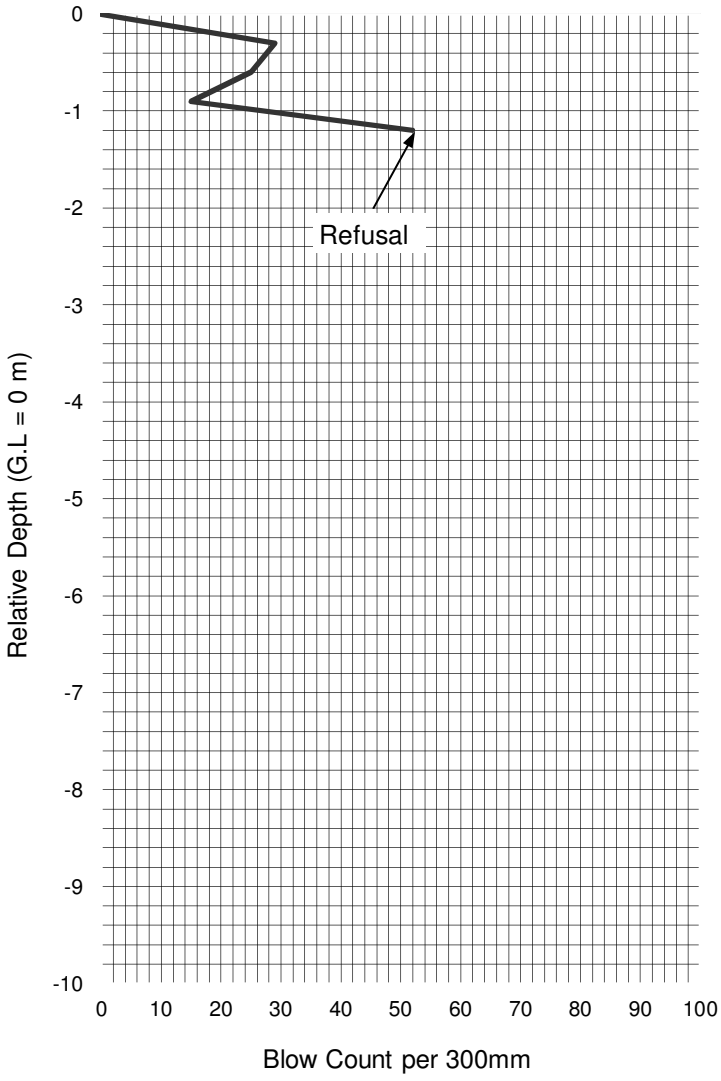
Dynamic Cone Penetrometer

Test No. : 12

Project :	**Kokstad Landfill**		
Client:	**TGC Engineers cc.**		
Date:	21-06-2012	Remarks:	Underlain by Dolerite
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	29
-0.6	25
-0.9	15
-1.2	52

Blow Count vs Depth



Reference No. : 22233

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

Dynamic Cone Penetrometer

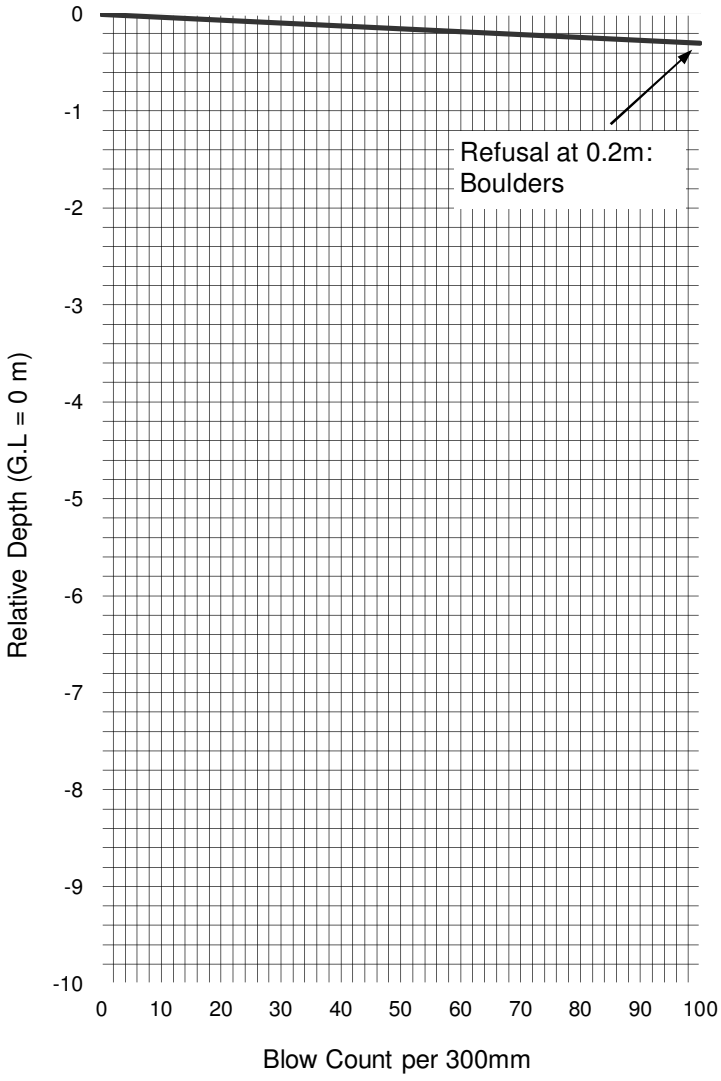
Test No. : 13

Project : **Kokstad Landfill**
Client: **TGC Engineers cc.**

Date:	21-06-2012	Remarks:	Underlain by Dolerite
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	100

Blow Count vs Depth



Reference No. : 22233

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

Dynamic Cone Penetrometer

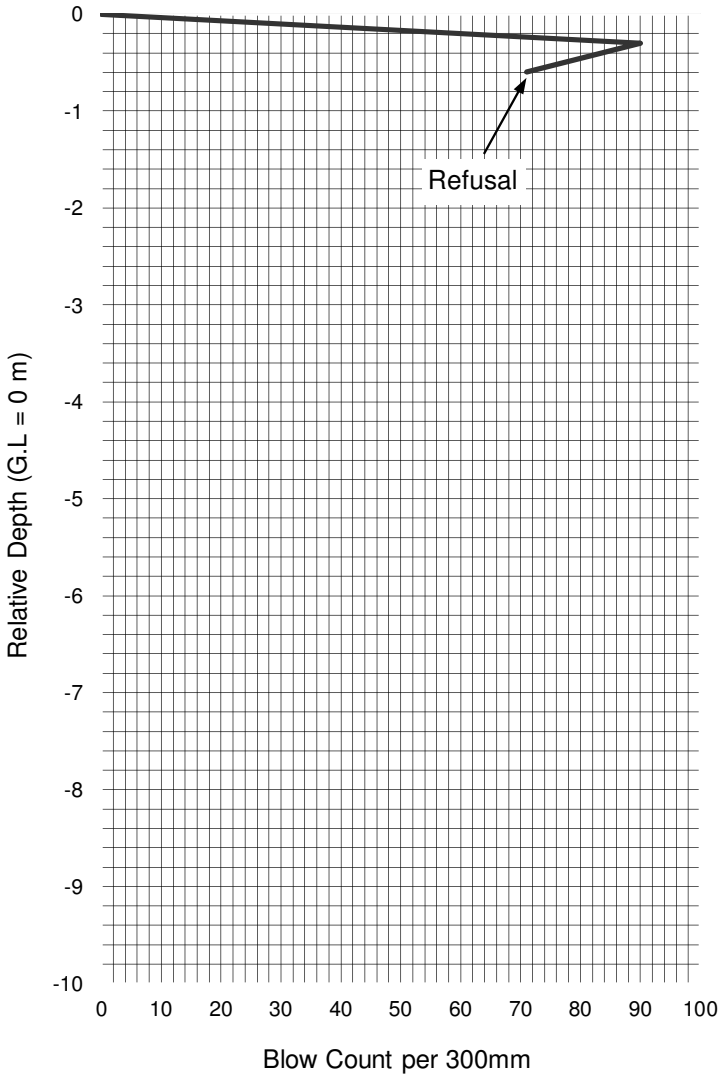
Test No. : 14

Project : **Kokstad Landfill**
Client: **TGC Engineers cc.**

Date:	21-06-2012	Remarks:	Underlain by Sandstone
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	90
-0.6	71

Blow Count vs Depth



Reference No. : 22233

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

Dynamic Cone Penetrometer

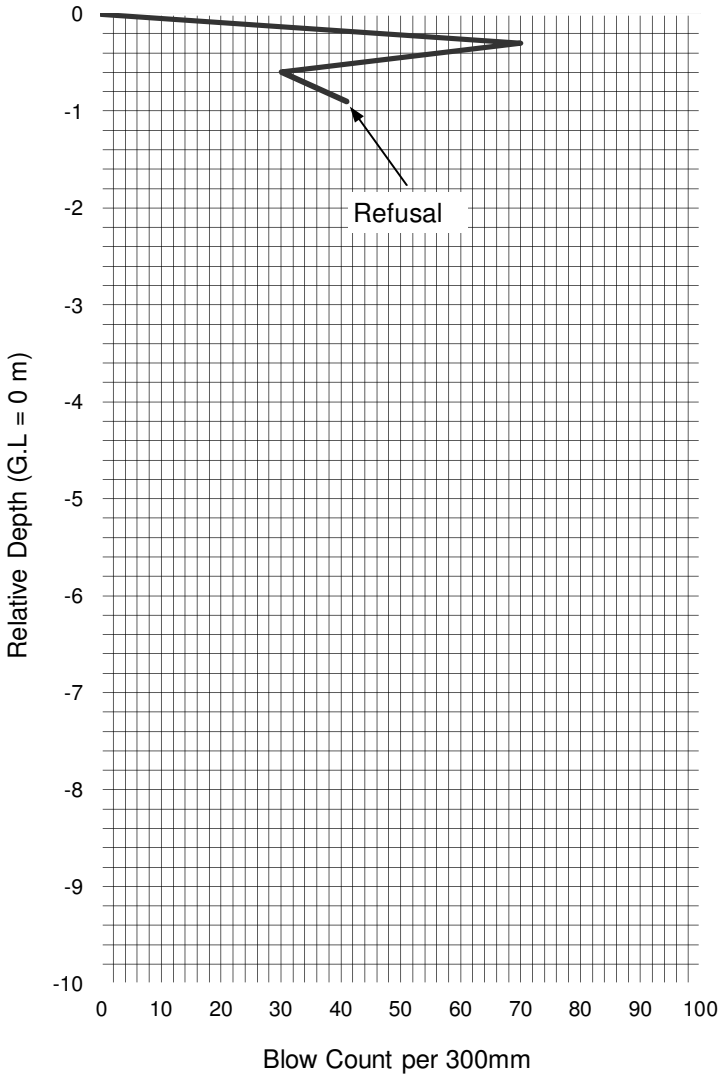
Test No. : 15

Project : **Kokstad Landfill**
Client: **TGC Engineers cc.**

Date:	21-06-2012	Remarks:	Underlain by Shale
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	70
-0.6	30
-0.9	41

Blow Count vs Depth



Reference No. : 22233

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

Dynamic Cone Penetrometer

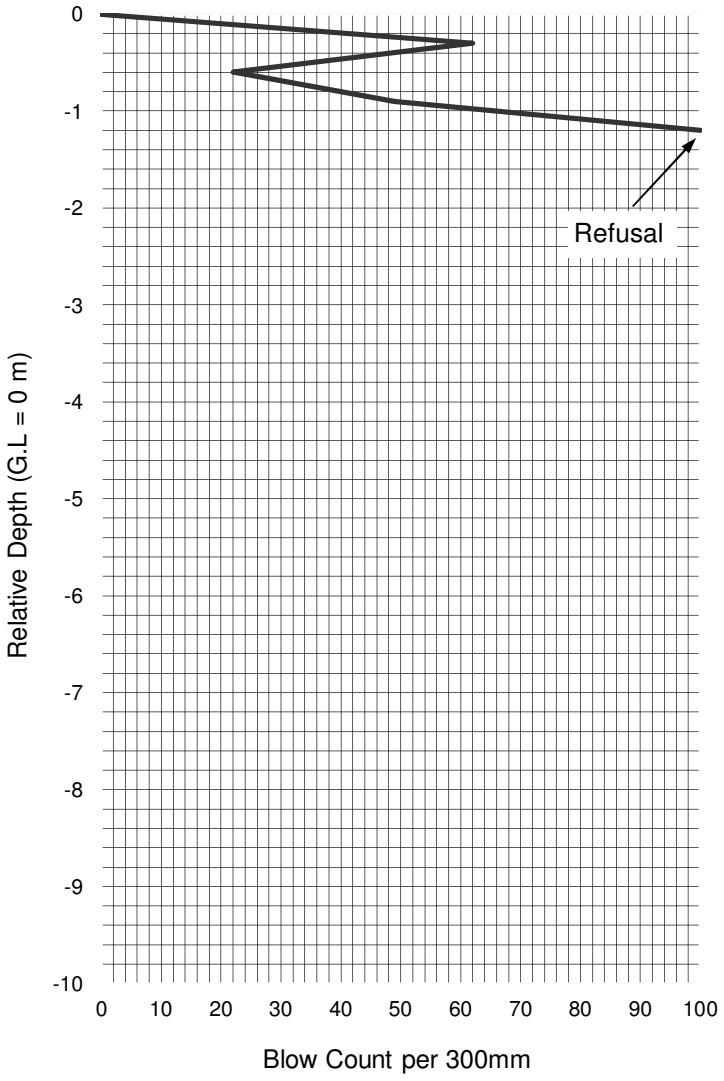
Test No. : 16

Project : **Kokstad Landfill**
Client: **TGC Engineers cc.**

Date:	21-06-2012	Remarks:	Underlain by Shale
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	62
-0.6	22
-0.9	49
-1.2	100

Blow Count vs Depth



Reference No. : 22233

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

Dynamic Cone Penetrometer

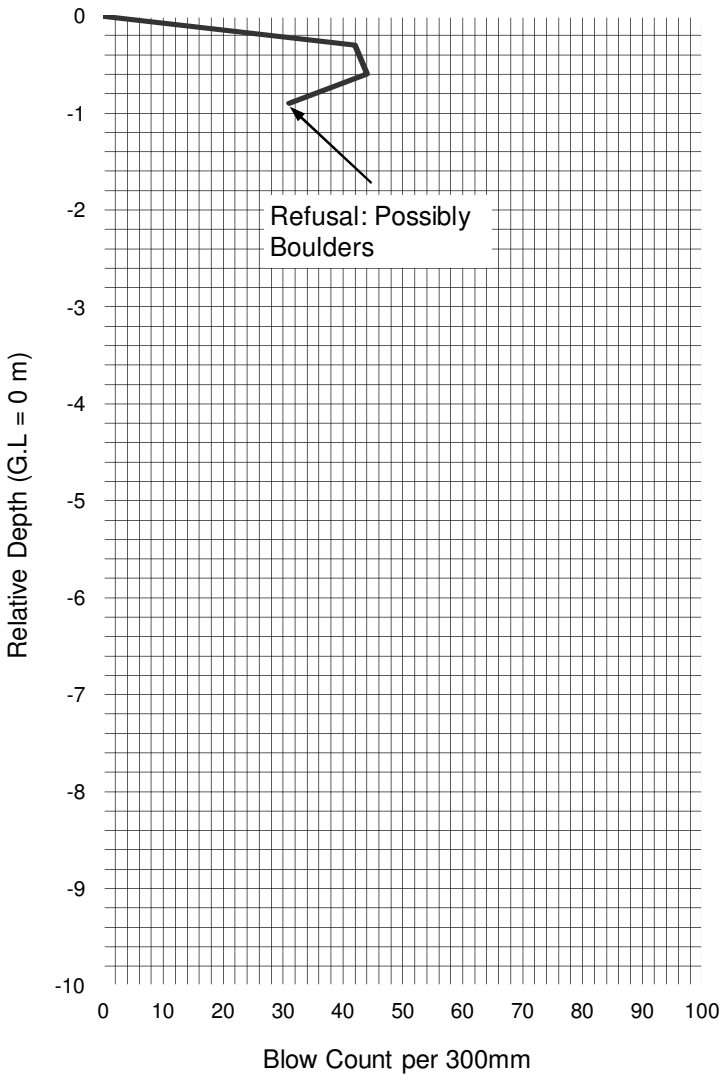
Test No. : 17

Project : **Kokstad Landfill**
Client: **TGC Engineers cc.**

Date:	21-06-2012	Remarks:	Underlain by Dolerite
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	42
-0.6	44
-0.9	31

Blow Count vs Depth



Reference No. : 22233

Drennan Maud & Partners.

Fig. No. -

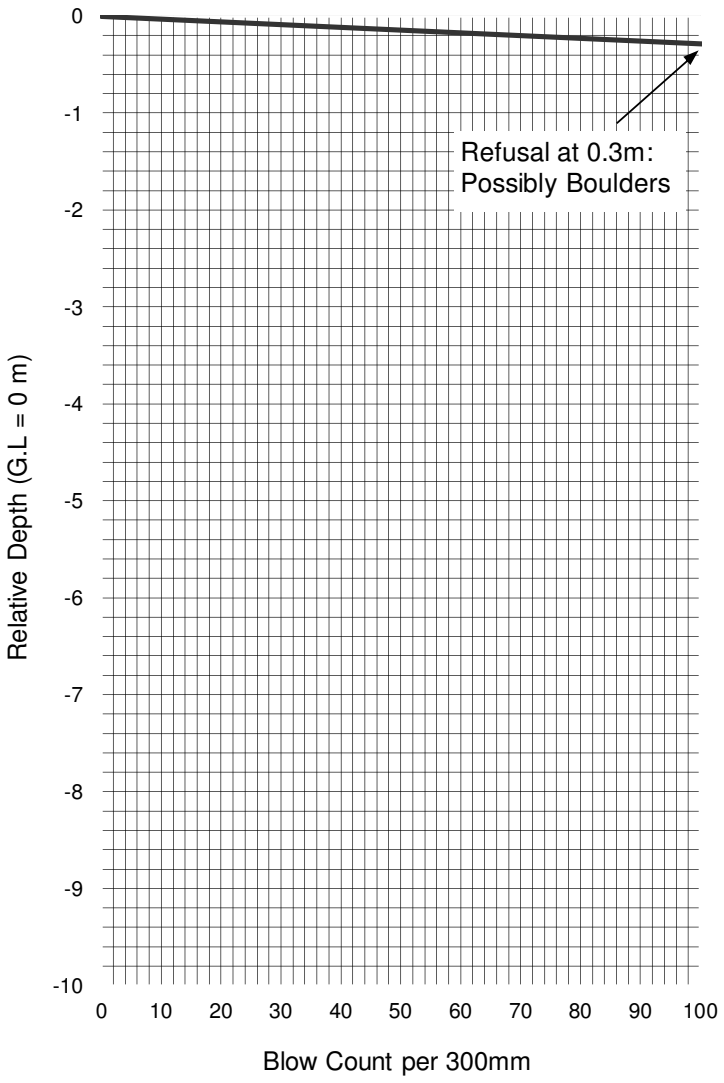
Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

Dynamic Cone Penetrometer

Test No. : 18

Project :	**Kokstad Landfill**		
Client:	**TGC Engineers cc.**		
Date:	21-06-2012	Remarks:	Underlain by Dolerite
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	105



Reference No. : 22233

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

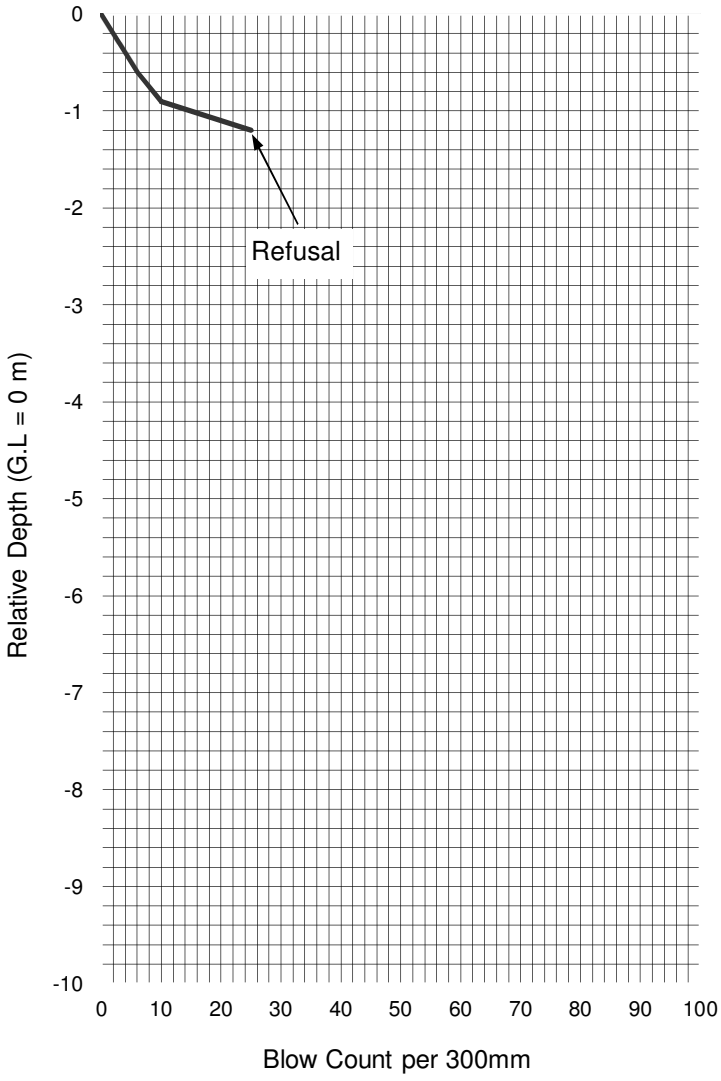
Dynamic Cone Penetrometer

Test No. : 19

Project :	**Kokstad Landfill**		
Client:	**TGC Engineers cc.**		
Date:	21-06-2012	Remarks:	Underlain by Shale
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	3
-0.6	6
-0.9	10
-1.2	25

Blow Count vs Depth



Reference No. : 22233

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

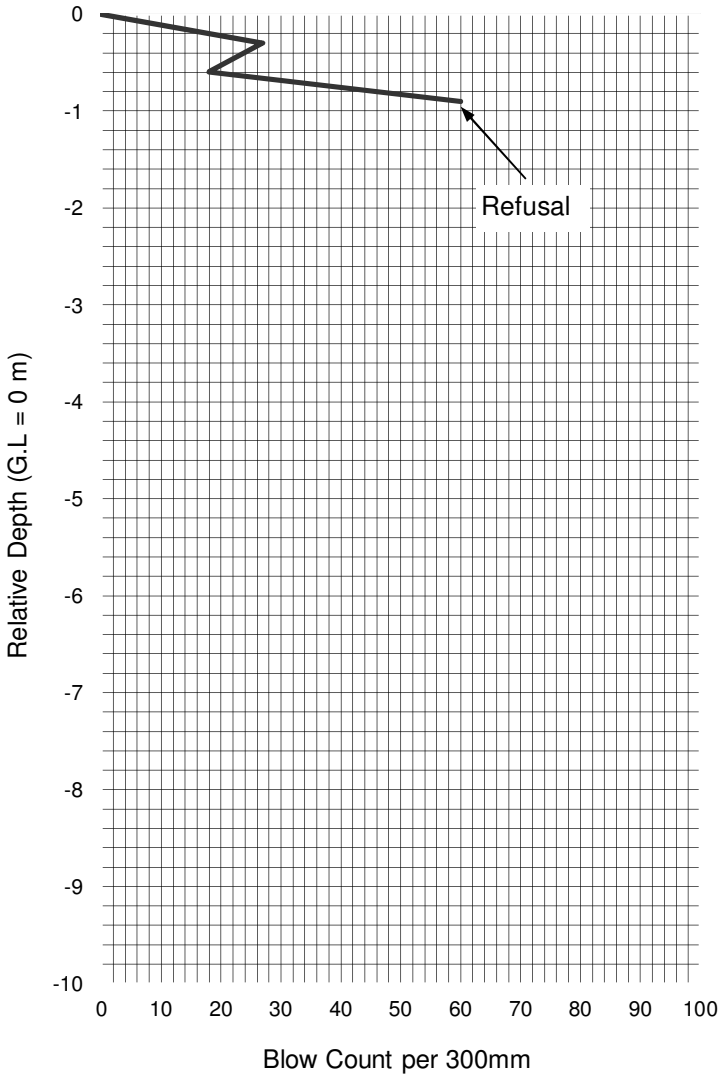
Dynamic Cone Penetrometer

Test No. : 20

Project :	**Kokstad Landfill**		
Client:	**TGC Engineers cc.**		
Date:	21-06-2012	Remarks:	Underlain by Shale
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	27
-0.6	18
-0.9	60

Blow Count vs Depth



Reference No. : 22233

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

Dynamic Cone Penetrometer

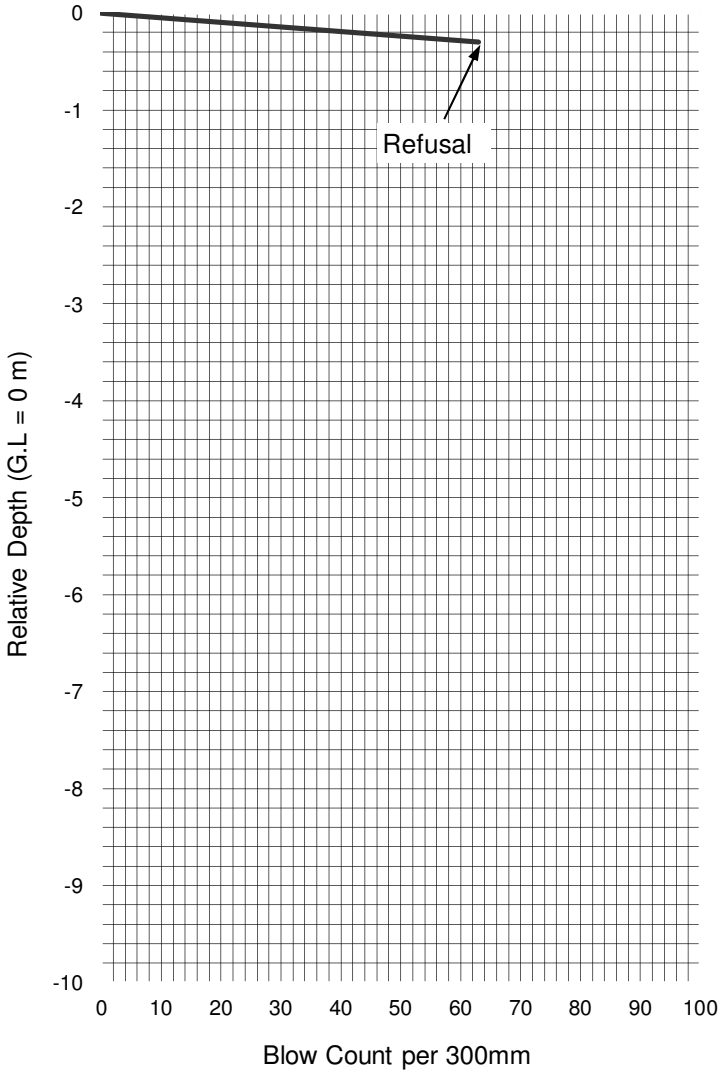
Test No. : 21

Project : **Kokstad Landfill**
Client: **TGC Engineers cc.**

Date:	21-06-2012	Remarks:	Underlain by Shale
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	63

Blow Count vs Depth



Reference No. : **22233**

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

Dynamic Cone Penetrometer

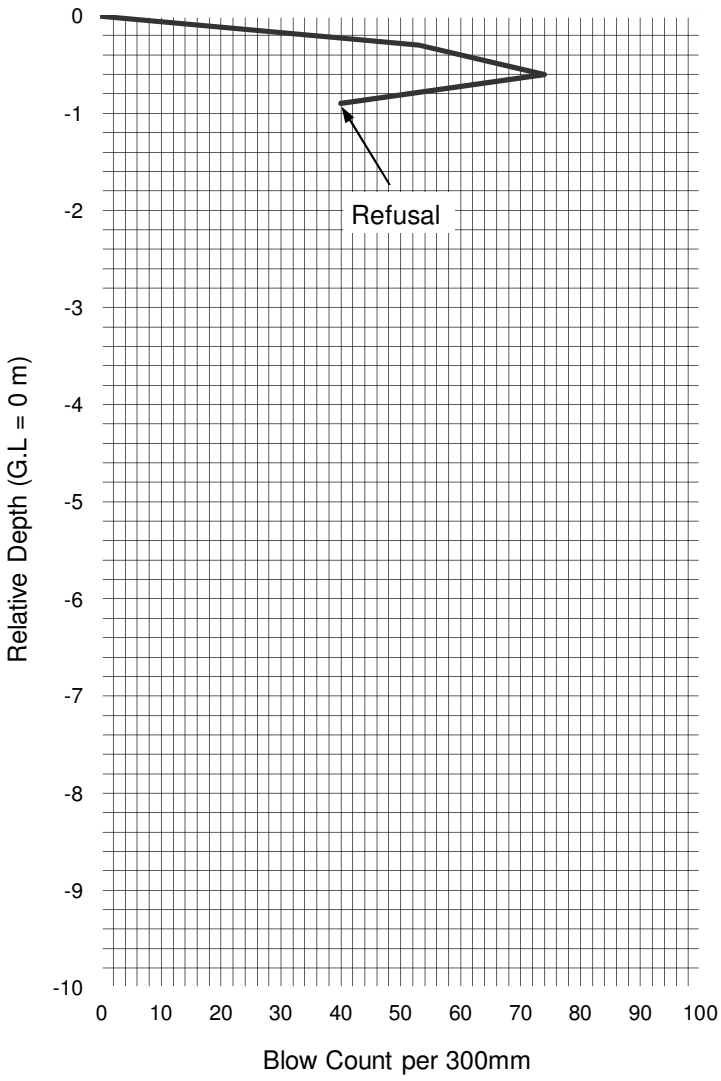
Test No. : 22

Project : **Kokstad Landfill**
Client: **TGC Engineers cc.**

Date:	21-06-2012	Remarks:	Underlain by Shale
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	53
-0.6	74
-0.9	40

Blow Count vs Depth



Reference No. : 22233

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

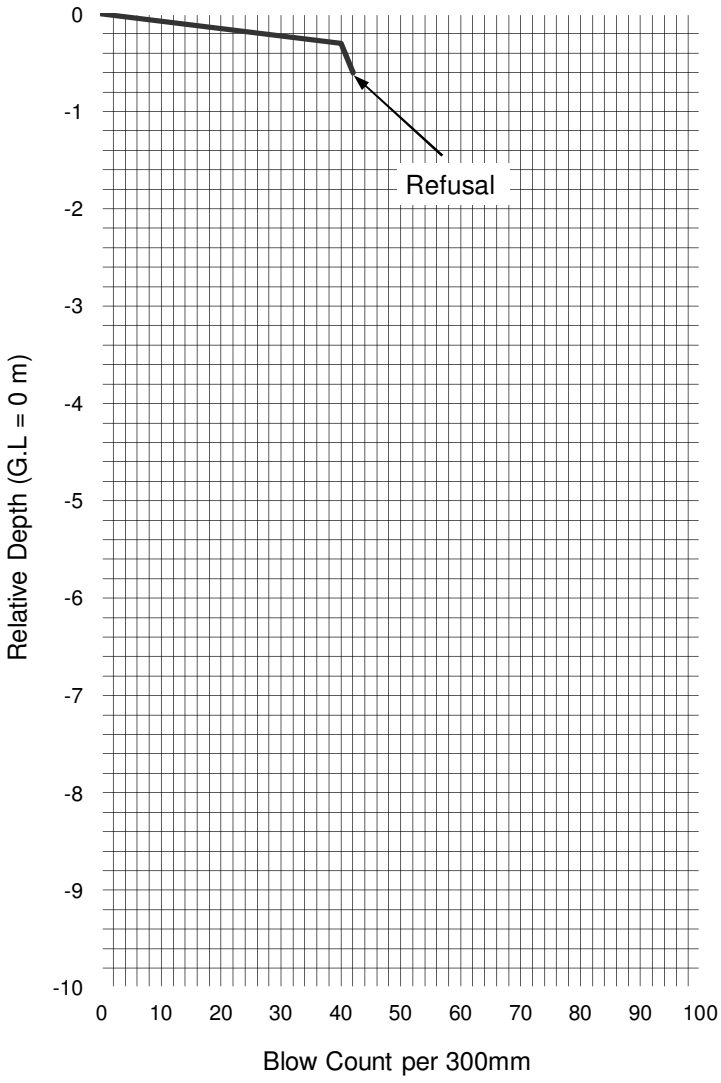
Dynamic Cone Penetrometer

Test No. : 23

Project :	**Kokstad Landfill**		
Client:	**TGC Engineers cc.**		
Date:	21-06-2012	Remarks:	Underlain by Shale
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	40
-0.6	42

Blow Count vs Depth



Reference No. : 22233

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

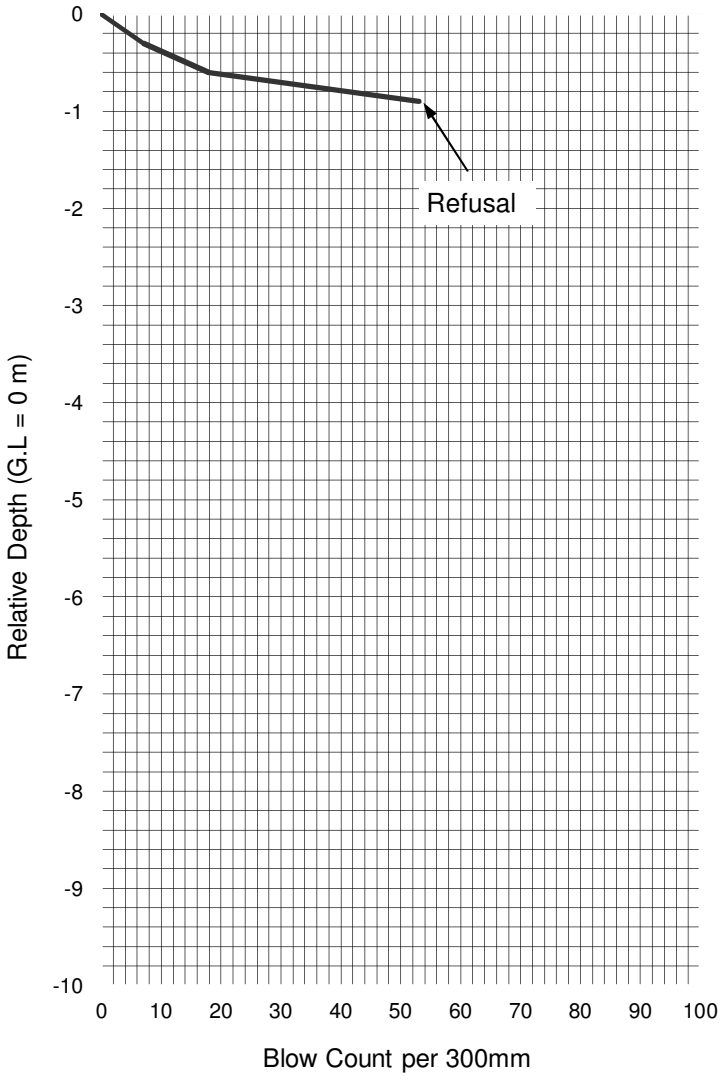
Dynamic Cone Penetrometer

Test No. : 24

Project :	**Kokstad Landfill**		
Client:	**TGC Engineers cc.**		
Date:	21-06-2012	Remarks:	Underlain by Shale
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	7
-0.6	18
-0.9	53

Blow Count vs Depth



Reference No. : 22233

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

Dynamic Cone Penetrometer

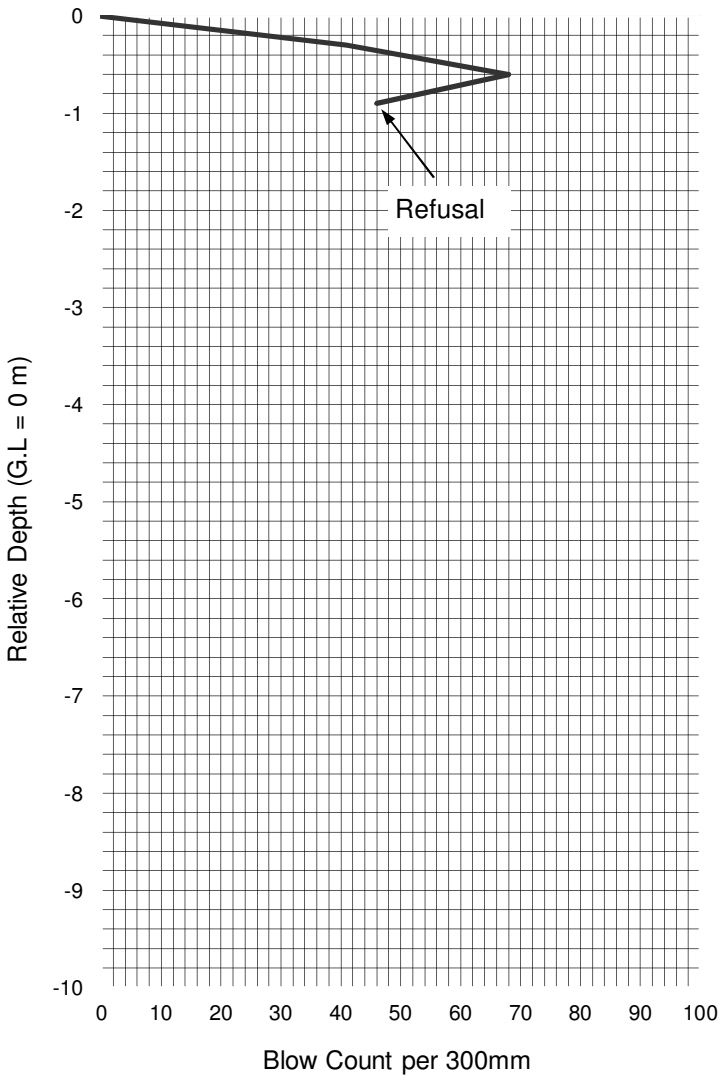
Test No. : 25

Project : **Kokstad Landfill**
Client: **TGC Engineers cc.**

Date:	21-06-2012	Remarks:	Underlain by Shale
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	41
-0.6	68
-0.9	46

Blow Count vs Depth



Reference No. : 22233

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

Dynamic Cone Penetrometer

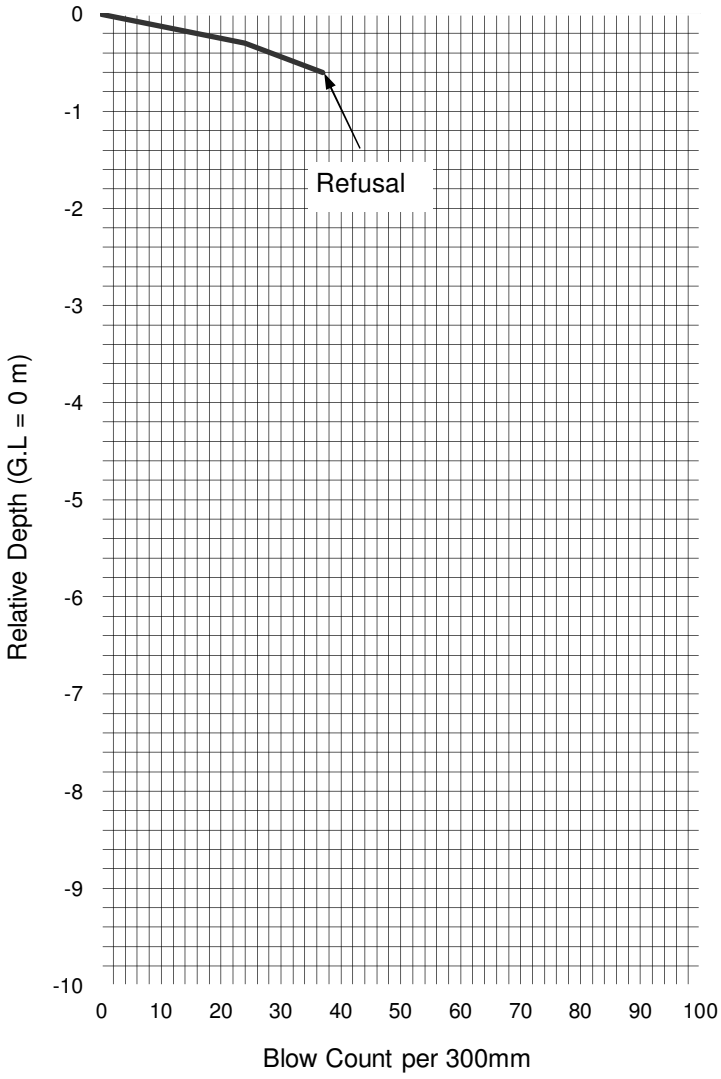
Test No. : 26

Project : **Kokstad Landfill**
Client: **TGC Engineers cc.**

Date:	21-06-2012	Remarks:	Underlain by Shale
Test Location:	Site 1 Krantz Fontein Farm		-
Date of Test:	20-06-2012	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	24
-0.6	37

Blow Count vs Depth



Reference No. : 22233

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

APPENDIX C

AUGER HOLE PROFILES (AH1 - AH13)

AUGER HOLE PROFILES
KOKSTAD LANDFILL

AH 1

Depth (m)	Description
0,00 - 0,50	Relatively moist, very dark grey, silty CLAY containing occasional rock fragments (Alluvium).
Note:	No sulphidic smell. The profile is moist from 0.35m depth. Auger located at the edge of the wet zone.

AH 2

Depth (m)	Description
0,00 - 0,20	Very slightly moist, brown, fine grained sandy CLAY containing occasional small light yellow rock fragments (Hillwash).
Note:	Refusal of auger. No mottling. Auger located in line with tree line about 15m from the edge of the wet zone.

AH 3

Depth (m)	Description
0,00 - 0,50	Very moist, very dark grey, silty CLAY (Alluvium).
Note:	No sulphidic smell. Auger located at the edge of the wet zone.

AH 4

Depth (m)	Description
0,00 - 0,40	Moist, dark grey very lightly speckled orange, very fine and fine grained sandy CLAY (Hillwash).
0,40 - 0,50	Moist, greyish brown patched dusky orange, very fine and fine grained sandy CLAY (Hillwash).
Note:	No sulphidic smell. Auger located at edge of tree line and the wet zone.

AH 5

Depth (m)	Description
0,00 - 0,50	Moist to very moist, very dark grey, silty CLAY containing a very slight sulphidic smell (Alluvium)
Note:	Auger located at the edge of the wet zone.

AUGER HOLE PROFILES
KOKSTAD LANDFILL

AH 6

Depth (m)	Description
0,00 - 0,05	Very slightly moist, light brown, very fine and fine grained sandy CLAY (Hillwash).
Note:	Auger hole located amongst trees some 20m from the edge of the wet zone.

AH 7

Depth (m)	Description
0,00 - 0,30	Wet, dark grey, very fine and fine grained sandy CLAY (Alluvium).
Note:	No sulphidic smell. Hole abandoned due to continuous collapse of the saturated clay material in to the hole. Auger hole located about 5m within the wet zone.

AH 8

Depth (m)	Description
0,00 - 0,20	Slightly moist, brown, sandy CLAY containing very small orange rock fragments (Hillwash).
Note:	Slow excavation, therefore the hole was abandoned. Auger hole located about 10m from the edge of the wet zone.

AH 9

Depth (m)	Description
0,00 - 0,10	Very moist, grey mottled orange, very fine and fine grained sandy CLAY containing a sulphidic smell (Alluvium).
0,10 - 0,50	Wet, very dark grey mottled orange, silty CLAY containing a sulphidic smell (Alluvium).
Note:	Auger located at the edge of the wet zone. Water table intersected at the base of the hole.

AH 10

Depth (m)	Description
0,00 - 0,18	Slightly moist, brown mottled orange, speckled very light grey, slightly gravely, sandy CLAY (Hillwash).
0,18 - 0,25	Slightly moist, yellow patched orange, gravely sandy CLAY (Residual Sandstone).
Note:	Auger located 5m up-slope of AH9.

AUGER HOLE PROFILES
KOKSTAD LANDFILL

AH 11

Depth (m)	Description
0,00 - 0,10	Very slightly moist, brown, gravely sandy CLAY containing orange, very soft rock fragments (Hillwash).
Note:	Auger located 5m up-slope of AH10.

AH 12

Depth (m)	Description
0,00 - 0,35	Very moist, grey extensively mottled brownish orange, very fine and fine grained sandy CLAY containing a sulphidic smell (Alluvium).
0,35 - 0,50	Wet, very dark grey, silty CLAY containing a sulphidic smell (Alluvium).
Note:	Auger located just downstream of dam wall at the edge of the wet zone.

AH 13

Depth (m)	Description
0,00 - 0,05	Very moist, dark grey to very dark grey, very fine and fine grained sandy CLAY (Alluvium).
Note:	No sulphidic smell. No mottling. Auger located 5m up-slope of AH12.

APPENDIX D

SEISMIC TEST RESULTS

SEISMIC SURVEY

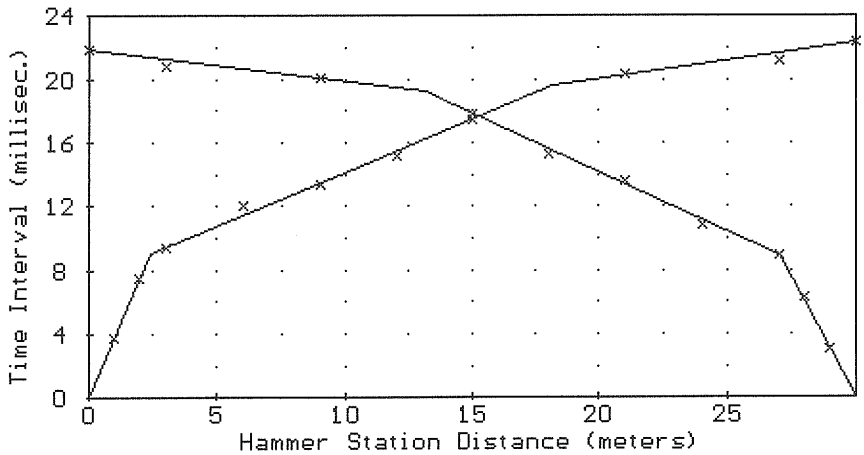
REF.NO: 22233 PROJECT: KOKSTAD LANDFILL

DATE: 20-06-2012

TRAVERSE NO: 1

FIELD DATA

Distance (m)	Forward (ms)	Reverse (ms)	Distance (m)	Forward (ms)	Reverse (ms)
1.0	2.8	2.8	12.0	14.2	15.0
2.0	6.5	6.0	15.0	16.5	17.6
3.0	8.4	8.7	21.0	19.3	19.8
6.0	11.0	10.6	27.0	20.2	20.6
9.0	12.4	13.4	30.0	21.4	21.6



TIME-DISTANCE RELATIONSHIP

FORWARD

V1 ≈ 270m/s D1 ≈ 1m
V2 ≈ 1481m/s D2 ≈ 7.2m
V3 ≈ 4286m/s D3 ≈ 13.1m
V4 ≈ 6429m/s*

REVERSE

V1 ≈ 339m/s D1 ≈ 1.2m Dip. ≈ -0.5°
V2 ≈ 1348m/s D2 ≈ 7.4m True V2 ≈ 1412m/s
V3 ≈ 5000m/s D3 ≈ 13.4m
V4 ≈ 7500m/s*

NOTE: Velocity marked '*' has been assumed to define the minimum proven depth of the material with the next lowest velocity.

SEISMIC SURVEY

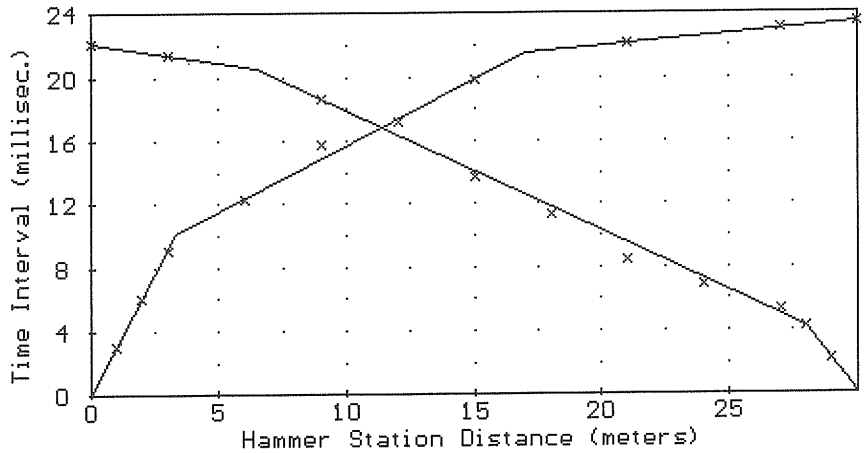
REF.NO: 22233 PROJECT: KOKSTAD LANDFILL

DATE: 20-06-2012

TRAVERSE NO: 2

FIELD DATA

Distance (m)	Forward (ms)	Reverse (ms)	Distance (m)	Forward (ms)	Reverse (ms)
1.0	3.0	2.9	12.0	17.1	12.0
2.0	6.0	5.0	15.0	19.7	14.4
3.0	9.0	6.0	21.0	22.0	19.4
6.0	12.2	7.6	27.0	23.0	22.1
9.0	15.6	9.2	30.0	23.4	22.8



TIME-DISTANCE RELATIONSHIP

FORWARD

V1 ≈ 333m/s D1 ≈ 1.2m
V2 ≈ 1200m/s D2 ≈ 8.1m
V3 ≈ 6429m/s D3 ≈ 14.3m
V4 ≈ 9643m/s*

REVERSE

V1 ≈ 476m/s D1 ≈ 0.7m
V2 ≈ 1319m/s D2 ≈ 9.1m
V3 ≈ 4286m/s D3 ≈ 14.8m
V4 ≈ 6428m/s*

Dip. ≈ 0.7°
True V2 ≈ 1257m/s

NOTE: Velocity marked '*' has been assumed to define the minimum proven depth of the material with the next lowest velocity.

SEISMIC SURVEY

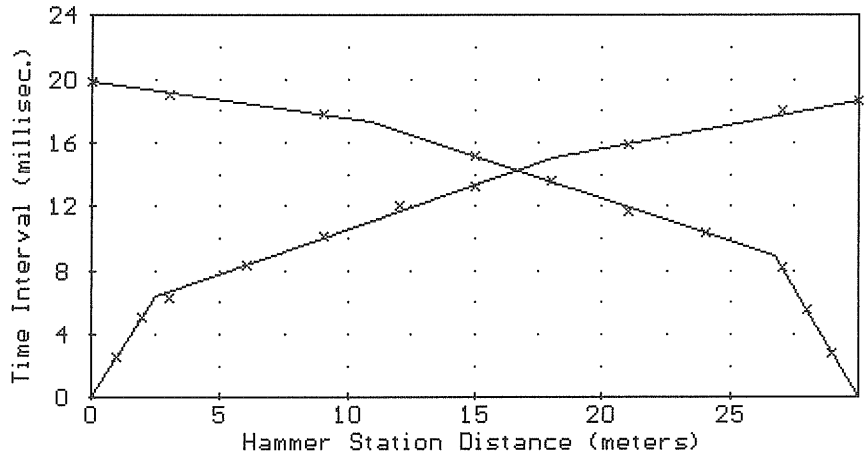
REF.NO: 22233 PROJECT: KOKSTAD LANDFILL

DATE: 20-06-2012

TRAVERSE NO: 3

FIELD DATA

Distance (m)	Forward (ms)	Reverse (ms)	Distance (m)	Forward (ms)	Reverse (ms)
1.0	3.0	2.8	12.0	12.4	13.6
2.0	5.5	5.6	15.0	13.7	15.2
3.0	6.7	8.2	21.0	16.3	17.8
6.0	8.7	10.4	27.0	18.4	19.0
9.0	10.5	11.7	30.0	19.0	19.8



TIME-DISTANCE RELATIONSHIP

FORWARD

V1 ≈ 400m/s D1 ≈ 1m
V2 ≈ 1800m/s D2 ≈ 5.9m
V3 ≈ 3333m/s D3 ≈ 11.4m
V4 ≈ 5000m/s*

REVERSE

V1 ≈ 370m/s D1 ≈ 1.3m Dip. ≈ 0.3°
V2 ≈ 1875m/s D2 ≈ 7.3m True V2 ≈ 1837m/s
V3 ≈ 4500m/s D3 ≈ 13m
V4 ≈ 6750m/s*

NOTE: Velocity marked '*' has been assumed to define the minimum proven depth of the material with the next lowest velocity.

SEISMIC SURVEY

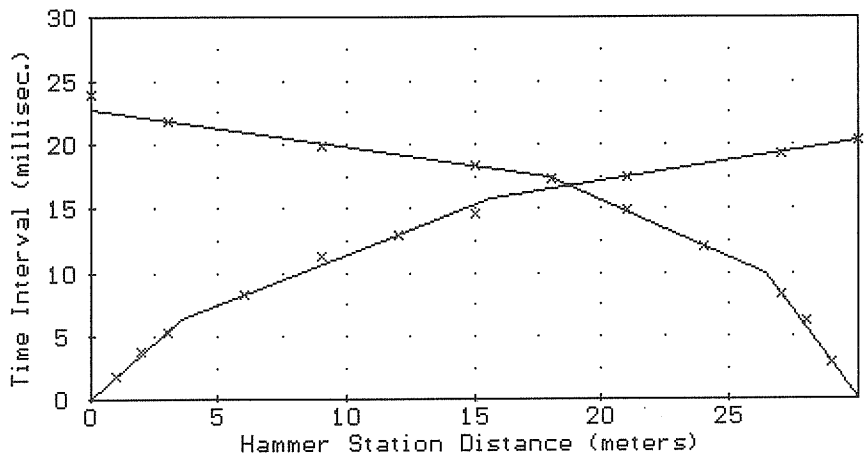
REF.NO: 22233 PROJECT: KOKSTAD LANDFILL

DATE: 20-06-2012

TRAVERSE NO: 4

FIELD DATA

Distance (m)	Forward (ms)	Reverse (ms)	Distance (m)	Forward (ms)	Reverse (ms)
1.0	0.6	3.0	12.0	11.7	17.5
2.0	2.6	6.3	15.0	13.4	18.4
3.0	4.1	8.5	21.0	16.2	20.0
6.0	7.0	12.2	27.0	18.0	22.0
9.0	10.0	15.0	30.0	19.0	24.0



TIME-DISTANCE RELATIONSHIP

FORWARD		REVERSE		
V1 ≈ 571m/s	D1 ≈ 1.1m	V1 ≈ 364m/s	D1 ≈ 1.3m	Dip. ≈ -1.9°
V2 ≈ 1277m/s	D2 ≈ 6m	V2 ≈ 1132m/s	D2 ≈ 5.3m	True V2 ≈ 1199m/s
V3 ≈ 3214m/s	D3 ≈ 11.9m	V3 ≈ 3333m/s	D3 ≈ 11.4m	
V4 ≈ 4821m/s*		V4 ≈ 5000m/s*		

NOTE: Velocity marked '*' has been assumed to define the minimum proven depth of the material with the next lowest velocity.

SEISMIC SURVEY

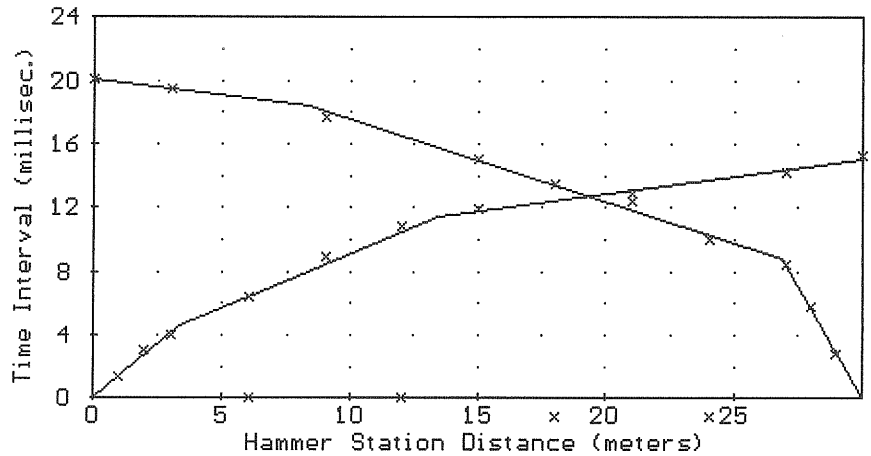
REF.NO: 22233 PROJECT: KOKSTAD LANDFILL

DATE: 21-06-2012

TRAVERSE NO: 5

FIELD DATA

Distance (m)	Forward (ms)	Reverse (ms)	Distance (m)	Forward (ms)	Reverse (ms)
1.0	2.5	2.8	15.0	13.1	15.0
2.0	4.2	5.8	18.0	0.0	0.0
3.0	5.2	8.4	21.0	14.0	17.7
6.0	7.6	10.0	24.0	0.0	0.0
9.0	10.1	12.4	27.0	15.4	19.4
12.0	12.0	13.5	30.0	16.4	20.0



TIME-DISTANCE RELATIONSHIP

FORWARD

V1 ≈ 741m/s D1 ≈ 1m
V2 ≈ 1485m/s D2 ≈ 5.5m
V3 ≈ 4597m/s D3 ≈ 11.6m
V4 ≈ 6896m/s*

REVERSE

V1 ≈ 357m/s D1 ≈ 1.3m
V2 ≈ 1935m/s D2 ≈ 8.4m
V3 ≈ 5000m/s D3 ≈ 14m
V4 ≈ 7500m/s*

Dip. ≈ 3.7°
True V2 ≈ 1677m/s

NOTE: Velocity marked '*' has been assumed to define the minimum proven depth of the material with the next lowest velocity.

SEISMIC SURVEY

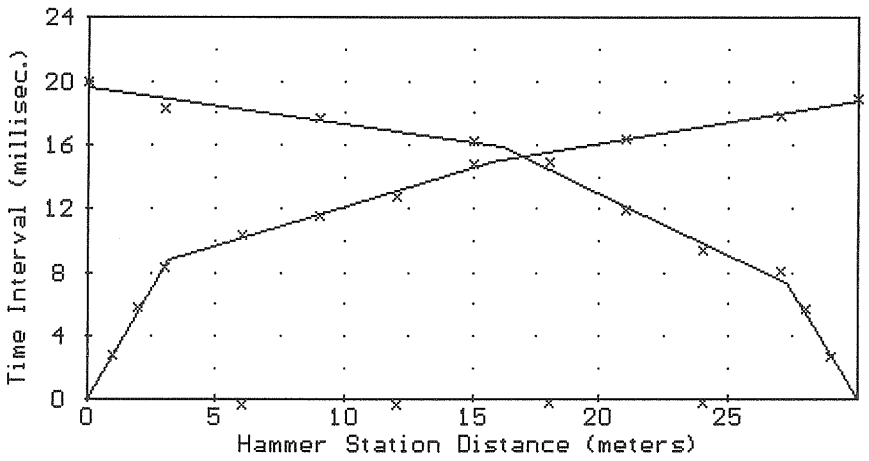
REF.NO: 22233 PROJECT: KOKSTAD LANDFILL

DATE: 21-06-2012

TRAVERSE NO: 6

FIELD DATA

Distance (m)	Forward (ms)	Reverse (ms)	Distance (m)	Forward (ms)	Reverse (ms)
1.0	3.0	3.0	15.0	15.0	16.5
2.0	6.0	6.0	18.0	0.0	0.0
3.0	8.5	8.4	21.0	16.6	18.0
6.0	10.6	9.7	24.0	0.0	0.0
9.0	11.8	12.2	27.0	18.0	18.6
12.0	13.0	15.2	30.0	19.1	20.3



TIME-DISTANCE RELATIONSHIP

FORWARD		REVERSE		
V1 ≈ 364m/s	D1 ≈ 1.3m	V1 ≈ 370m/s	D1 ≈ 1m	Dip. ≈ -3°
V2 ≈ 2083m/s	D2 ≈ 5.4m	V2 ≈ 1310m/s	D2 ≈ 6m	True V2 ≈ 1606m/s
V3 ≈ 3684m/s	D3 ≈ 11.1m	V3 ≈ 4403m/s	D3 ≈ 12.1m	
V4 ≈ 5526m/s*		V4 ≈ 6604m/s*		

NOTE: Velocity marked '*' has been assumed to define the minimum proven depth of the material with the next lowest velocity.

SEISMIC SURVEY

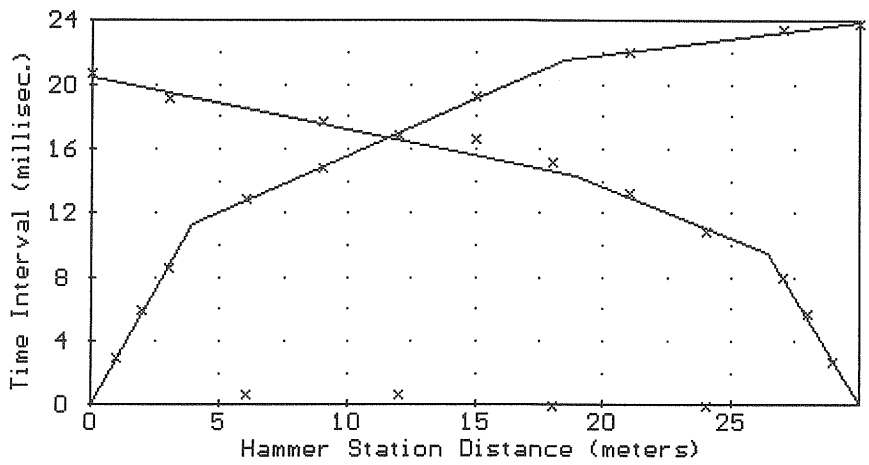
REF.NO: 22233 PROJECT: KOKSTAD LANDFILL

DATE: 21-06-2012

TRAVERSE NO: 7

FIELD DATA

Distance (m)	Forward (ms)	Reverse (ms)	Distance (m)	Forward (ms)	Reverse (ms)
1.0	3.0	2.0	15.0	19.3	16.0
2.0	6.0	5.0	18.0	0.0	0.0
3.0	8.7	7.3	21.0	22.1	17.0
6.0	13.0	10.2	24.0	0.0	0.0
9.0	14.9	12.6	27.0	23.5	18.5
12.0	17.0	14.5	30.0	23.9	20.0



TIME-DISTANCE RELATIONSHIP

FORWARD		REVERSE		
V1 ≈ 351m/s	D1 ≈ 1.5m	V1 ≈ 377m/s	D1 ≈ 1.4m	Dip. ≈ 0.6°
V2 ≈ 1429m/s	D2 ≈ 8.2m	V2 ≈ 1554m/s	D2 ≈ 4.4m	True V2 ≈ 1489m/s
V3 ≈ 4884m/s	D3 ≈ 14.1m	V3 ≈ 3111m/s	D3 ≈ 10.5m	
V4 ≈ 7326m/s*		V4 ≈ 4667m/s*		

NOTE: Velocity marked '*' has been assumed to define the minimum proven depth of the material with the next lowest velocity.

APPENDIX E

GRADING, PROCTOR DENSITY & PERMEABILITY LABORATORY TEST RESULTS

Job Description: Kokstad Landfill - Ref. 22233
Job no.: 6604
Date: 04-07-2012

Table 3
Laboratory Test Summary

THEKWINI SOILS LAB. CC
V.A.T. REGISTRATION NO. 4590210961.
68 Ridge Road, Tollgate, DURBAN
Tel : (031) 201-8992
P.O. Box 30464, MAYVILLE, 4058
Fax : (031) 201-7920

Lab no.		06100	06101	06103	06104	06105	06106	06108	06107	07040	07041
Location		IP 1	IP 2	IP 4	IP 6	IP 7	IP 8	IP 11	IP 11	IP 14	IP 18
Depth		0.9 - 2.6m	1.9 - 3.0m	0.20 - 0.7m	1.0 - 1.9m	0.9 - 1.5m	0.0 - 0.4m	0.0 - 0.6m	0.8 - 1.9m	0.65 - 1.6m	0.4 - 1.6m
Description		Org.Cl.SILT	H/Wh.Olv.	Br.Cl.Sa.GRAVEL	M/Wh.Dk.Bl.	M/Wh.Gr.&Olv.	Gr.Si.Sa.GRAVEL	V.Dk.Gr.CLAY	C/Wh.Yel.	H/Wh.Yel.	Dk.Org.Si.CLAY
		(Res. Dolerite)	SHALE	(Res.Shale: PDF)	DOLERITE (Karoo)	SANDSTONE	(Colluvium)	(Hillwash)	Sa.SHALE	SANDSTONE	(Res. Shale)
Binder Material		-	-	-	-	-	-	-	-	-	-
Particle Size (mm)	75		96	100	92	95			90	87	
	53		90	95	79	88			85	77	
	37.5		86	91	70	85			73	69	
	26.5		81	87	62	82			66	59	
	19		77	86	59	80			60	55	
	13.2	100	72	69	47	67	100		49	44	
	9.5	98	69	63	43	62	97		43	39	100
	4.75	97	66	56	36	55	86	100	38	34	100
	2	96	64	47	33	48	69	100	34	31	95
	0.425	89	61	43	29	36	58	99	31	27	86
	0.25	85	59	42	27	31	56	99	30	24	85
	0.15	80	55	41	25	27	53	97	27	19	82
	0.075	74	45	39	21	22	45	93	24	14	75
	0.05	71	41	37	20	20	40	91	23	13	71
	0.02	56	29	30	15	14	29	77	17	9	57
	0.005	37	16	24	10	9	20	62	12	7	43
	0.002	29	12	20	7	6	15	52	8	5	37
Soil Mortar	Coarse Sand <2.0 >0.425mm	7.1	4.5	8.1	11.6	24.0	16.1	0.7	8.4	13.7	9.1
	Fine Sand <0.425>0.05mm	26.8	56.8	58.2	70.6	60.4	50.1	9.0	71.0	75.4	26.4
	Silt <0.05 >0.005	31.4	23.2	11.3	9.4	8.9	16.6	28.4	9.9	5.1	25.2
	Clay <0.005	34.7	15.4	22.4	8.5	6.6	17.2	61.9	10.7	5.9	39.3
Atterberg Limits	Liquid Limit	55.7	35.3	47.6	43.1	33.3	29.9	52.7	33.2	28.3	29.5
	Plasticity Index	22.3	9.1	21.1	12	10.1	13.1	29.1	5.2	5.1	12.1
	Linear Shrinkage	11.3	4.7	10.7	6	5.3	6.7	14.7	2.7	2.7	6
	Natural MC	-	-	-	-	-	-	-	-	-	-
Proctor Density	Dry Density kg/m^3	1251	1670	1605	1604	1745		1798	1534	1840	1638
	OMC	31.6	15.4	19.4	19.7	15.7		13.5	19.6	13.5	16.2
CBR	100%										
	98%										
	95%										
	93% (Inferred)										
	90%										
	CBR Swell										
AASHTO Soil Classification		A - 7 - 5 (18)	A - 4 (1)	A - 7 - 6 (3)	A - 2 - 7 (0)	A - 2 - 6 (0)	A - 6 (2)	A - 7 - 6 (30)	A - 1 - b (0)	A - 1 - a (0)	A - 6 (7)
Grading Modulus		0.41	1.29	1.72	2.17	1.94	1.28	0.09	2.11	2.29	0.44
TRH 14 (1985)											
Permeability cm/sec				1.68×10^{-8}				6.76×10^{-8}	1.91×10^{-7}		9.96×10^{-8}

MATERIALS ANALYSIS

THEKWINI SOILS LAB. CC
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Fax : (031) 201-7920

Project: Kokstad Landfill - Ref. 22233

Ref no.: 6604 **Lab no.:** 06100 **Borehole/Pit no.:** IP 1 **Fig no.:** -

Depth: 0.9 - 2.6m

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	97.6
4.75	96.9
2	95.6
0.425	88.8
0.25	85.0
0.15	80.3
0.075	74.5
0.05	71.2
0.02	55.9
0.005	37.3
0.002	28.6

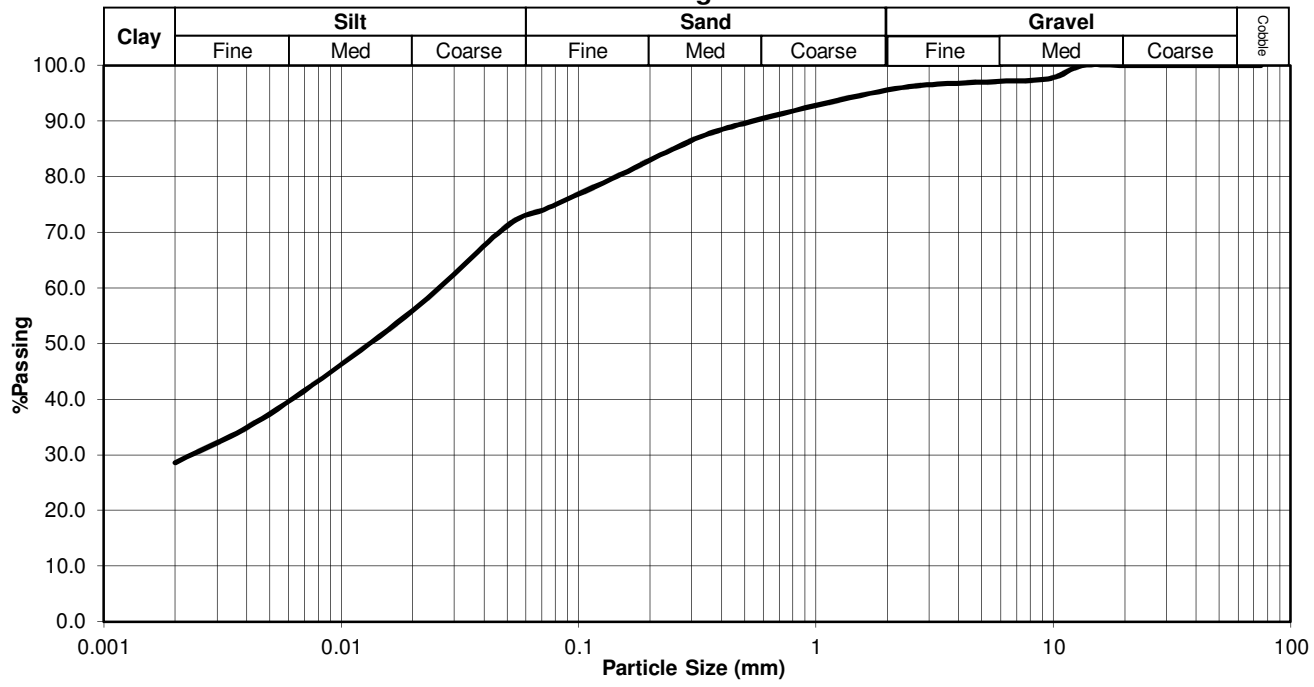
M.I.T SIZE CLASSIFICATION	
Cobble%	0.0
Gravel%	4.4
Coarse	0.0
Medium	2.9
Fine	1.5
Sand%	23.1
Coarse	6.0
Medium	6.9
Fine	10.2
Silt%	43.9
Coarse	16.6
Medium	17.3
Fine	10.0
Clay%	28.6

PLASTICITY	
Liquid Limit	55.7
Plasticity Index	22.3
Linear Shrinkage	11.3

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	NA
Grading Modulus	0.41

CLASSIFICATION	
Potential Expansiveness	Medium
Group Index	18
AASHTO Soil Classification	A - 7 - 5
Unified Classification	MH or OH

Grading Curve



Ref no.: 6604 Fig no.: -

MATERIALS ANALYSIS

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Project: Kokstad Landfill - Ref. 22233

Ref no.: 6604 **Lab no.:** 06101 **Borehole/Pit no.:** IP 2 **Fig no.:** -

Depth: 1.9 - 3.0m

Grading Analysis	
Grain Size (mm)	%Passing
75	96.4
53	89.7
37.5	86.3
26.5	80.7
19	77.4
13.2	72.0
9.5	68.5
4.75	66.1
2	64.3
0.425	61.4
0.25	59.0
0.15	55.0
0.075	45.0
0.05	40.5
0.02	29.0
0.005	16.2
0.002	12.5

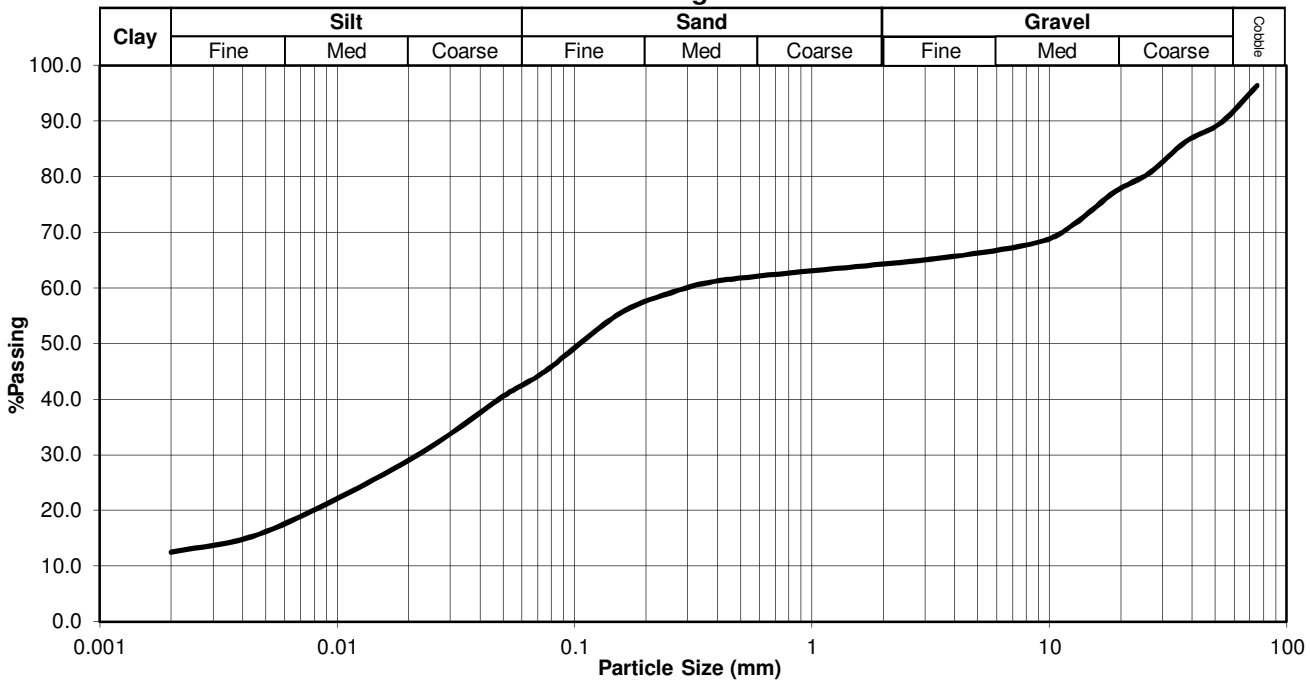
M.I.T SIZE CLASSIFICATION	
Cobble%	8.2
Gravel%	27.5
Coarse	14.0
Medium	11.1
Fine	2.4
Sand%	22.0
Coarse	2.6
Medium	4.7
Fine	14.7
Silt%	29.8
Coarse	13.3
Medium	12.0
Fine	4.5
Clay%	12.5

PLASTICITY	
Liquid Limit	35.3
Plasticity Index	9.1
Linear Shrinkage	4.7

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	NA
Grading Modulus	1.29

CLASSIFICATION	
Potential Expansiveness	Low
Group Index	1
AASHTO Soil Classification	A - 4
Unified Classification	SM

Grading Curve



Ref no.: 6604 Fig no.: -

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Fax : (031) 201-7920

Project: Kokstad Landfill - Ref. 22233

Ref no.: 6604 **Lab no.:** 06103 **Borehole/Pit no.:** IP 4 **Fig no.:** -

Depth: 0.20 - 0.7m

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	94.8
37.5	90.5
26.5	86.8
19	85.8
13.2	68.6
9.5	63.4
4.75	56.5
2	46.7
0.425	42.9
0.25	42.2
0.15	41.1
0.075	38.6
0.05	36.7
0.02	29.7
0.005	24.4
0.002	20.1

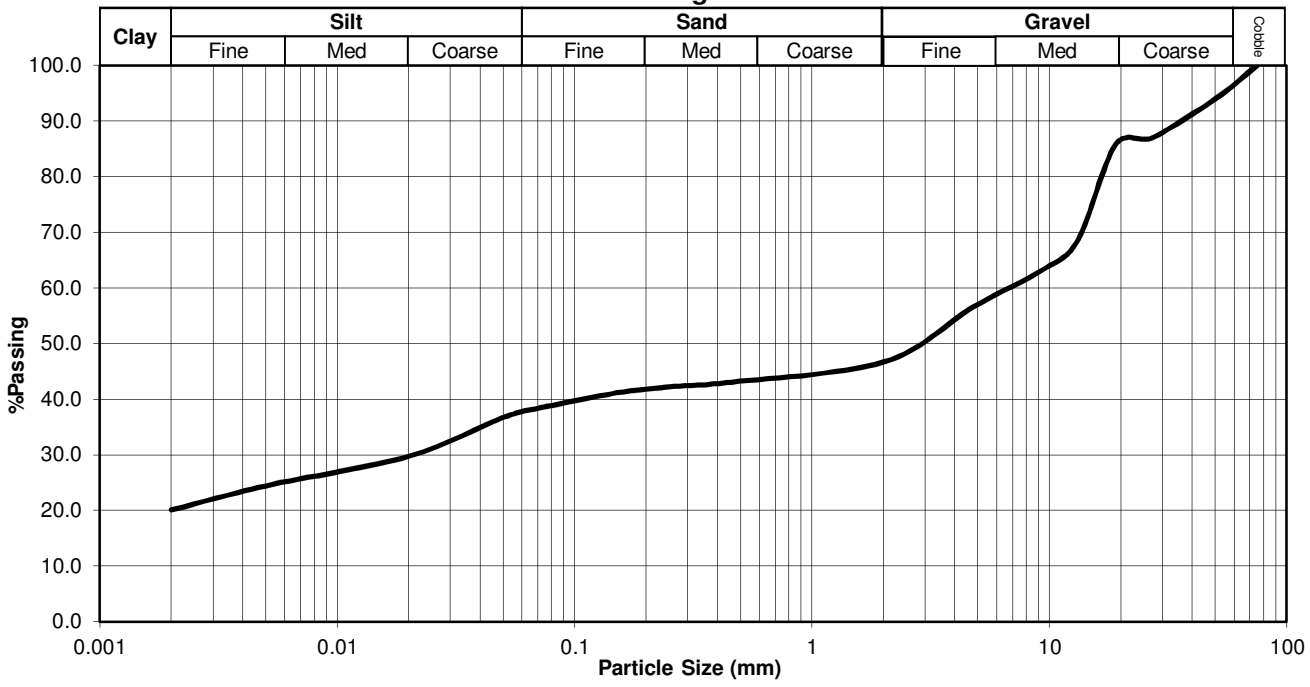
M.I.T SIZE CLASSIFICATION	
Cobble%	3.6
Gravel%	49.8
Coarse	10.5
Medium	27.6
Fine	11.6
Sand%	9.2
Coarse	3.3
Medium	1.7
Fine	4.2
Silt%	17.4
Coarse	7.7
Medium	5.0
Fine	4.7
Clay%	20.1

PLASTICITY	
Liquid Limit	47.6
Plasticity Index	21.1
Linear Shrinkage	10.7

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	NA
Grading Modulus	1.72

CLASSIFICATION	
Potential Expansiveness	Low
Group Index	3
AASHTO Soil Classification	A - 7 - 6
Unified Classification	SC

Grading Curve



Ref no.: 6604 Fig no.: -

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Project: Kokstad Landfill - Ref. 22233

Ref no.: 6604 **Lab no.:** 06104 **Borehole/Pit no.:** IP 6 **Fig no.:** -

Depth: 1.0 - 1.9m

Grading Analysis	
Grain Size (mm)	%Passing
75	92.2
53	79.3
37.5	69.9
26.5	62.3
19	58.8
13.2	47.3
9.5	43.2
4.75	36.3
2	32.5
0.425	28.8
0.25	27.4
0.15	25.3
0.075	21.3
0.05	20.2
0.02	15.1
0.005	9.6
0.002	7.3

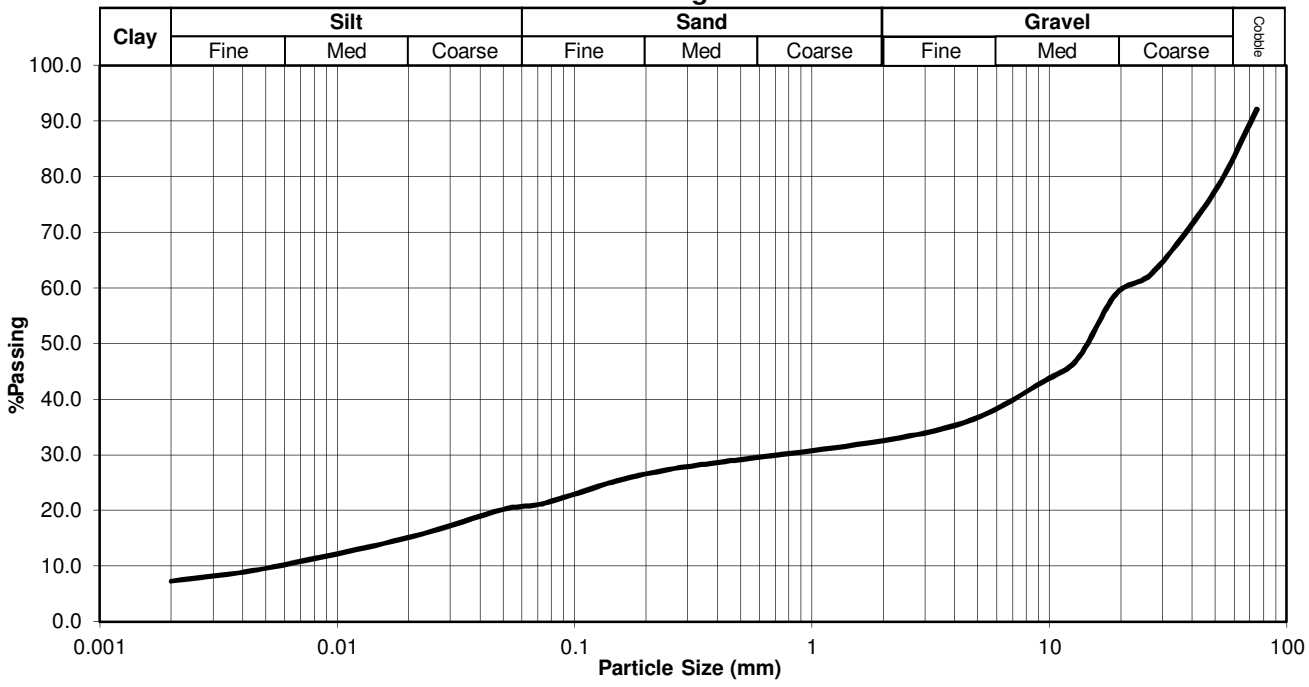
M.I.T SIZE CLASSIFICATION	
Cobble%	16.6
Gravel%	50.9
Coarse	24.2
Medium	21.1
Fine	5.6
Sand%	11.9
Coarse	3.4
Medium	2.9
Fine	5.7
Silt%	13.3
Coarse	5.5
Medium	5.2
Fine	2.7
Clay%	7.3

PLASTICITY	
Liquid Limit	43.1
Plasticity Index	12
Linear Shrinkage	6

GRADING	
D10 Size (mm)	0.0056
Uniformity Coefficient	>99
Grading Modulus	2.17

CLASSIFICATION	
Potential Expansiveness	Low
Group Index	0
AASHTO Soil Classification	A - 2 - 7
Unified Classification	GM

Grading Curve



Ref no.: 6604 Fig no.: -

MATERIALS ANALYSIS

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Project: Kokstad Landfill - Ref. 22233

Ref no.: 6604 **Lab no.:** 06105 **Borehole/Pit no.:** IP 7 **Fig no.:** -

Depth: 0.9 - 1.5m

Grading Analysis	
Grain Size (mm)	%Passing
75	94.6
53	88.1
37.5	84.9
26.5	82.3
19	80.1
13.2	67.4
9.5	61.7
4.75	54.6
2	47.9
0.425	36.4
0.25	31.0
0.15	26.6
0.075	22.2
0.05	20.5
0.02	14.4
0.005	8.7
0.002	6.0

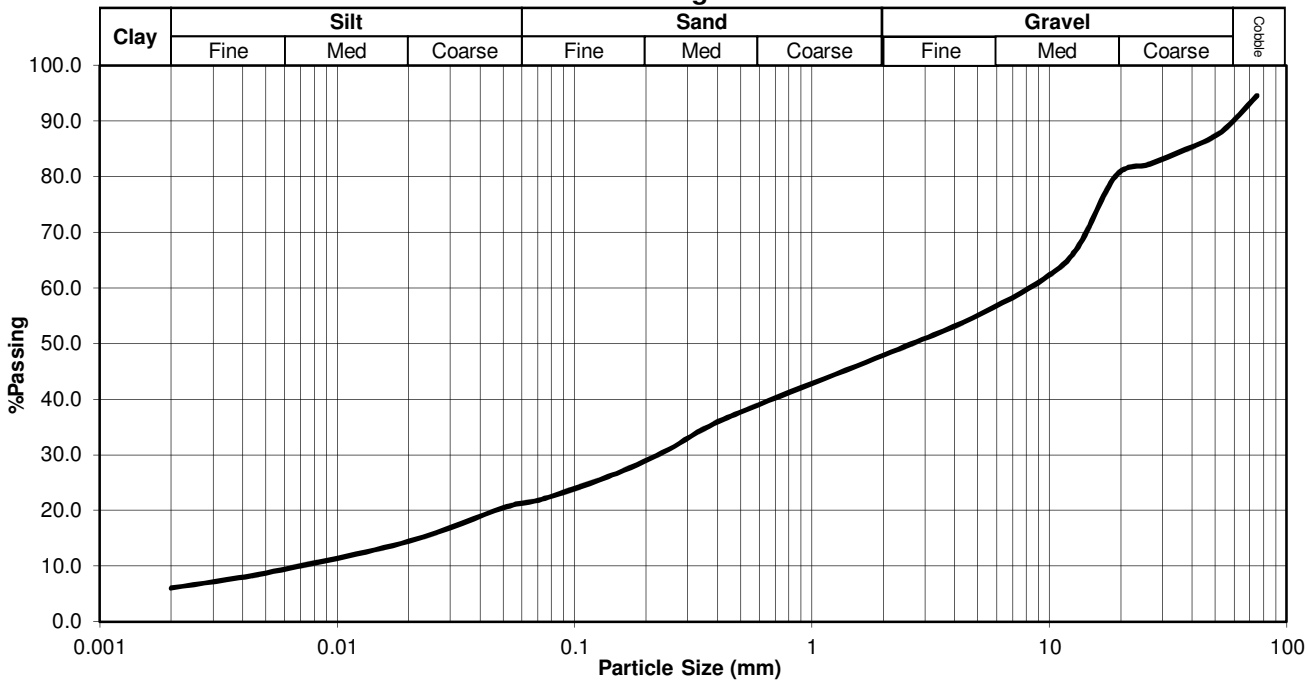
M.I.T SIZE CLASSIFICATION	
Cobble%	9.9
Gravel%	42.2
Coarse	9.8
Medium	23.9
Fine	8.6
Sand%	26.7
Coarse	10.2
Medium	8.9
Fine	7.7
Silt%	15.1
Coarse	6.7
Medium	5.3
Fine	3.1
Clay%	6.0

PLASTICITY	
Liquid Limit	33.3
Plasticity Index	10.1
Linear Shrinkage	5.3

GRADING	
D10 Size (mm)	0.0068
Uniformity Coefficient	>99
Grading Modulus	1.94

CLASSIFICATION	
Potential Expansiveness	Low
Group Index	0
AASHTO Soil Classification	A - 2 - 6
Unified Classification	SC

Grading Curve



Ref no.: 6604 Fig no.: -

MATERIALS ANALYSIS

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Project: Kokstad Landfill - Ref. 22233

Ref no.: 6604 **Lab no.:** 06106 **Borehole/Pit no.:** IP 8 **Fig no.:** -

Depth: 0.0 - 0.4m

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	97.2
4.75	85.6
2	69.3
0.425	58.1
0.25	56.2
0.15	52.6
0.075	44.6
0.05	40.3
0.02	28.8
0.005	20.5
0.002	15.2

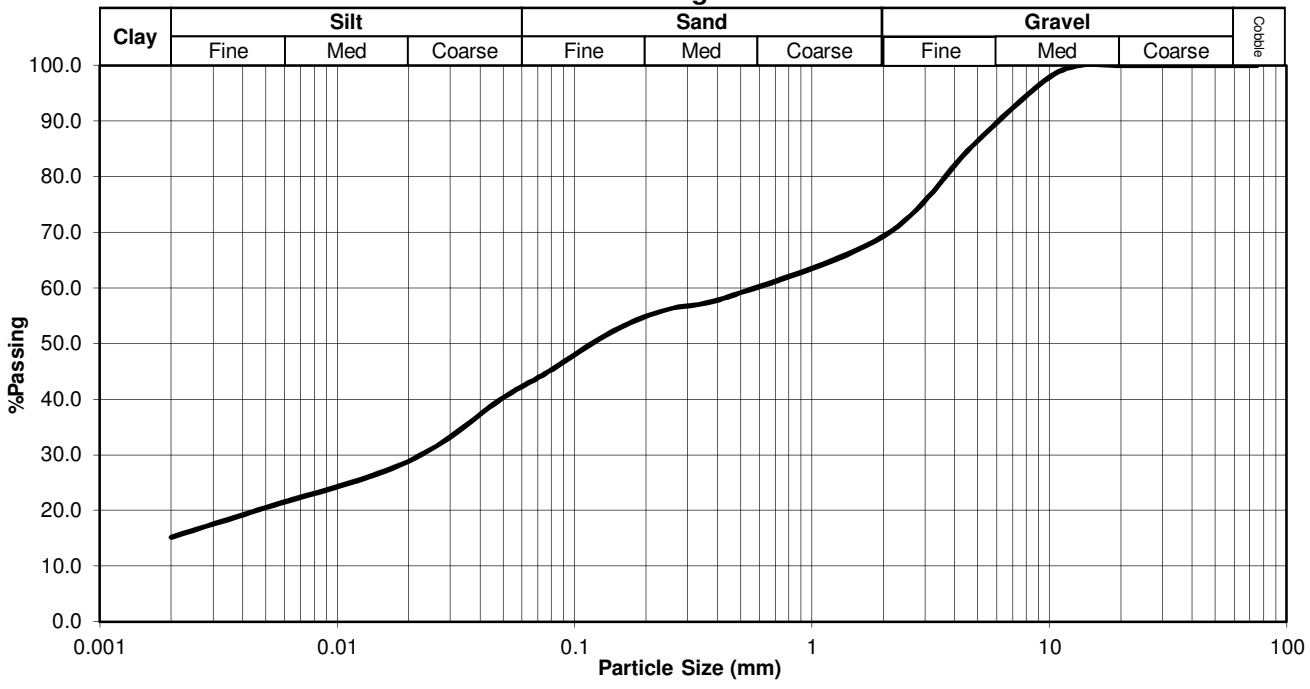
M.I.T SIZE CLASSIFICATION	
Cobble%	0.0
Gravel%	30.7
Coarse	0.0
Medium	11.4
Fine	19.3
Sand%	27.3
Coarse	9.9
Medium	5.0
Fine	12.4
Silt%	26.8
Coarse	13.2
Medium	7.8
Fine	5.9
Clay%	15.2

PLASTICITY	
Liquid Limit	29.9
Plasticity Index	13.1
Linear Shrinkage	6.7

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	NA
Grading Modulus	1.28

CLASSIFICATION	
Potential Expansiveness	Low
Group Index	2
AASHTO Soil Classification	A - 6
Unified Classification	SC

Grading Curve



Ref no.: 6604 Fig no.: -

MATERIALS ANALYSIS

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Project: Kokstad Landfill - Ref. 22233

Ref no.: 6604 **Lab no.:** 06108 **Borehole/Pit no.:** IP 11 **Fig no.:** -

Depth: 0.0 - 0.6m

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	100.0
4.75	100.0
2	99.7
0.425	99.0
0.25	98.5
0.15	97.2
0.075	92.7
0.05	90.9
0.02	77.1
0.005	62.4
0.002	51.5

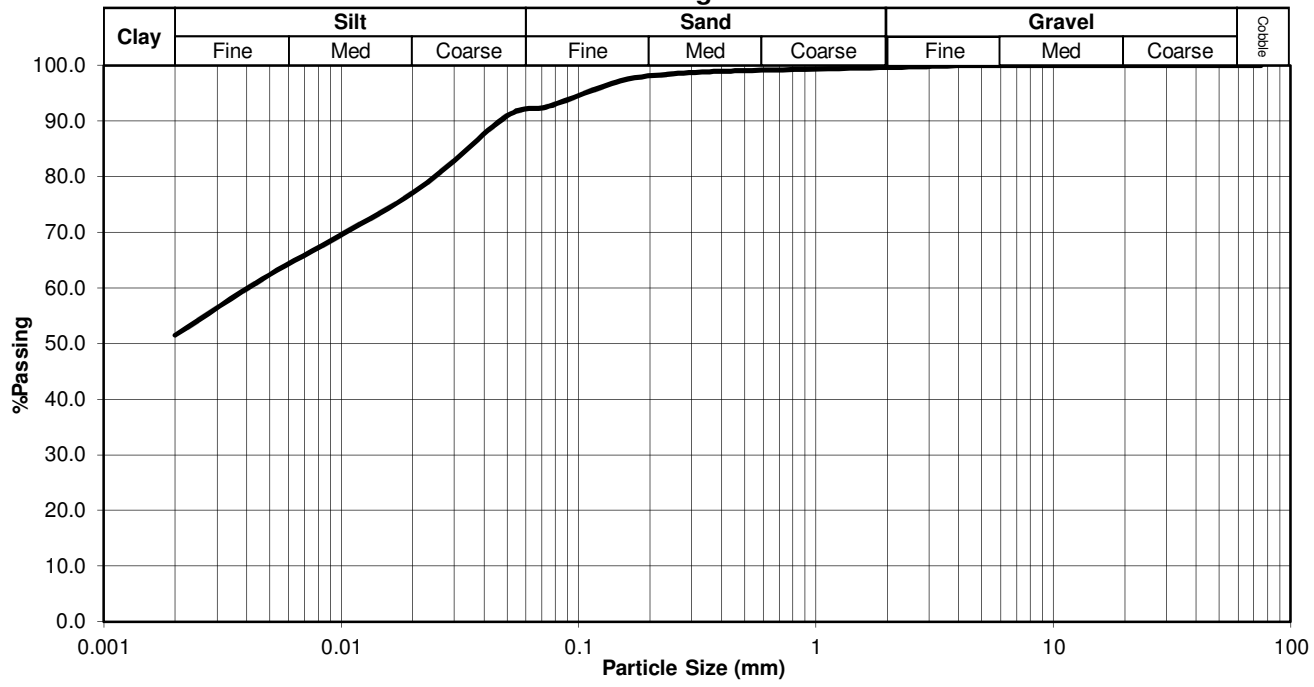
M.I.T SIZE CLASSIFICATION	
Cobble%	0.0
Gravel%	0.3
Coarse	0.0
Medium	0.0
Fine	0.3
Sand%	8.0
Coarse	0.6
Medium	1.2
Fine	6.2
Silt%	40.1
Coarse	14.6
Medium	13.7
Fine	11.8
Clay%	51.5

PLASTICITY	
Liquid Limit	52.7
Plasticity Index	29.1
Linear Shrinkage	14.7

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	NA
Grading Modulus	0.09

CLASSIFICATION	
Potential Expansiveness	Medium
Group Index	30
AASHTO Soil Classification	A - 7 - 6
Unified Classification	CH or OH

Grading Curve



Ref no.: 6604 Fig no.: -

MATERIALS ANALYSIS

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Project: Kokstad Landfill - Ref. 22233

Ref no.: 6604 **Lab no.:** 06107 **Borehole/Pit no.:** IP 11 **Fig no.:** -

Depth: 0.8 - 1.9m

Grading Analysis	
Grain Size (mm)	%Passing
75	90.2
53	84.6
37.5	73.3
26.5	65.9
19	60.0
13.2	49.0
9.5	43.5
4.75	38.2
2	33.9
0.425	31.0
0.25	29.5
0.15	27.3
0.075	23.8
0.05	22.5
0.02	17.0
0.005	11.7
0.002	7.8

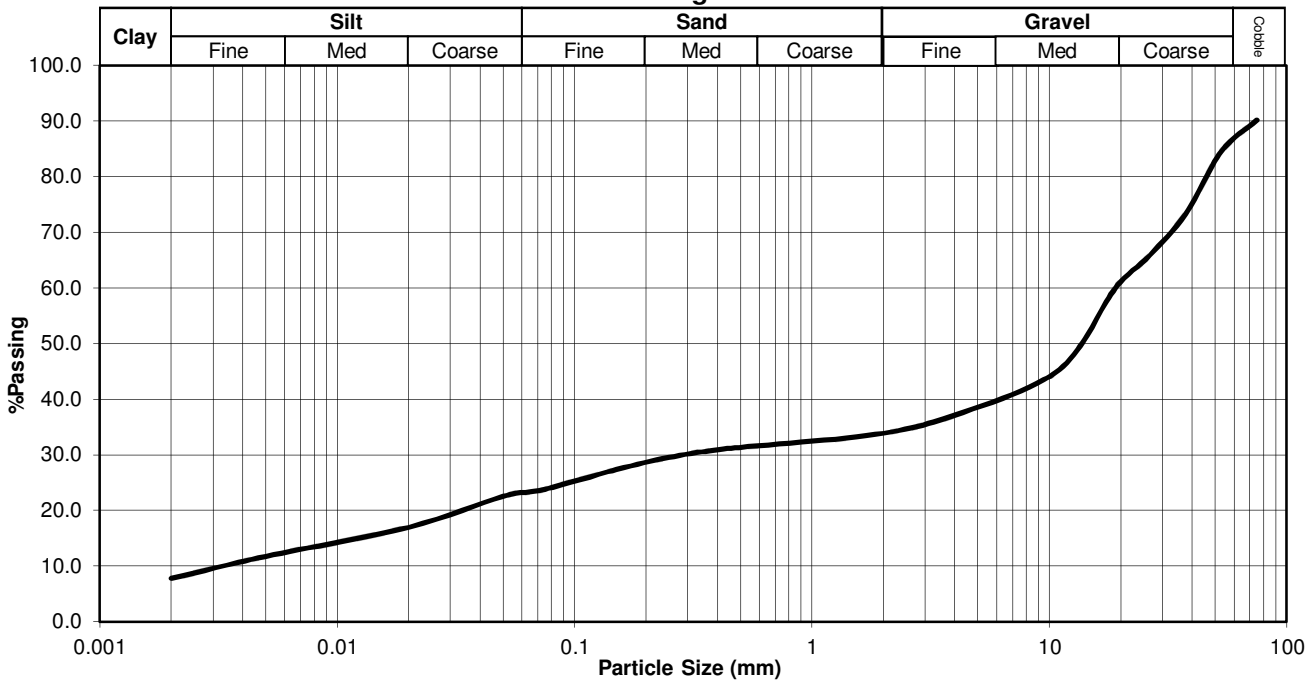
M.I.T SIZE CLASSIFICATION	
Cobble%	13.7
Gravel%	52.5
Coarse	25.6
Medium	21.2
Fine	5.7
Sand%	10.8
Coarse	2.5
Medium	2.9
Fine	5.4
Silt%	15.2
Coarse	6.1
Medium	4.9
Fine	4.3
Clay%	7.8

PLASTICITY	
Liquid Limit	33.2
Plasticity Index	5.2
Linear Shrinkage	2.7

GRADING	
D10 Size (mm)	0.0033
Uniformity Coefficient	>99
Grading Modulus	2.11

CLASSIFICATION	
Potential Expansiveness	Low
Group Index	0
AASHTO Soil Classification	A - 1 - b
Unified Classification	GM

Grading Curve



Ref no.: 6604 Fig no.: -

MATERIALS ANALYSIS

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Project: Kokstad Landfill - Ref. 22233

Ref no.: 6604 **Lab no.:** 07040 **Borehole/Pit no.:** IP 14 **Fig no.:** -

Depth: 0.65 - 1.6m

Grading Analysis	
Grain Size (mm)	%Passing
75	86.9
53	76.7
37.5	69.1
26.5	59.5
19	54.6
13.2	43.6
9.5	38.6
4.75	34.0
2	30.9
0.425	26.7
0.25	23.7
0.15	18.8
0.075	13.9
0.05	12.7
0.02	9.2
0.005	6.8
0.002	5.0

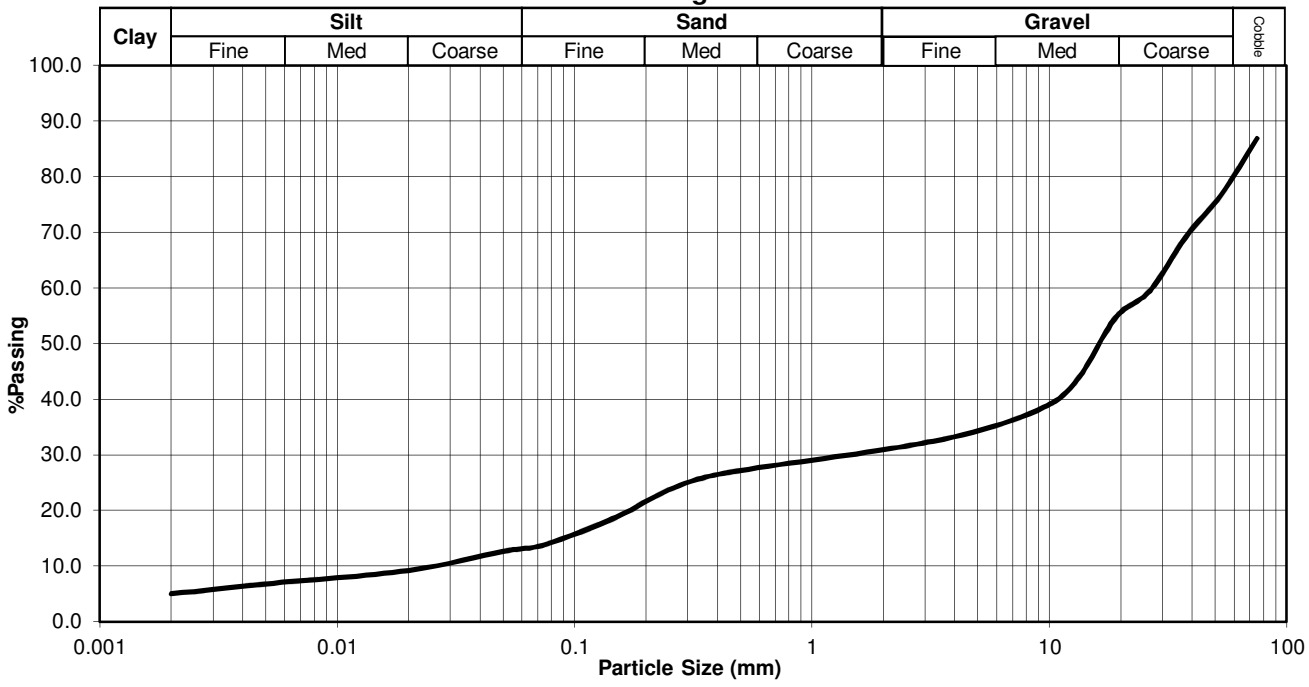
M.I.T SIZE CLASSIFICATION	
Cobble%	20.0
Gravel%	49.1
Coarse	24.7
Medium	20.1
Fine	4.3
Sand%	17.8
Coarse	3.8
Medium	5.9
Fine	8.1
Silt%	8.1
Coarse	3.9
Medium	2.2
Fine	2.0
Clay%	5.0

PLASTICITY	
Liquid Limit	28.3
Plasticity Index	5.1
Linear Shrinkage	2.7

GRADING	
D10 Size (mm)	0.025
Uniformity Coefficient	>99
Grading Modulus	2.29

CLASSIFICATION	
Potential Expansiveness	Low
Group Index	0
AASHTO Soil Classification	A - 1 - a
Unified Classification	GM

Grading Curve



Ref no.: 6604 Fig no.: -

MATERIALS ANALYSIS

THEKWINI SOILS LAB. CC
V.A.T. REGISTRATION NO. 4590210961.
68 Ridge Road, Tollgate, DURBAN
Tel : (031) 201-8992
P.O. Box 30464, MAYVILLE, 4058
Fax : (031) 201-7920

Project: Kokstad Landfill - Ref. 22233

Ref no.: 6604 **Lab no.:** 07041 **Borehole/Pit no.:** IP 18 **Fig no.:** -

Depth: 0.4 - 1.6m

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	100.0
4.75	99.9
2	94.9
0.425	86.3
0.25	85.3
0.15	82.1
0.075	74.9
0.05	70.9
0.02	56.9
0.005	43.2
0.002	36.7

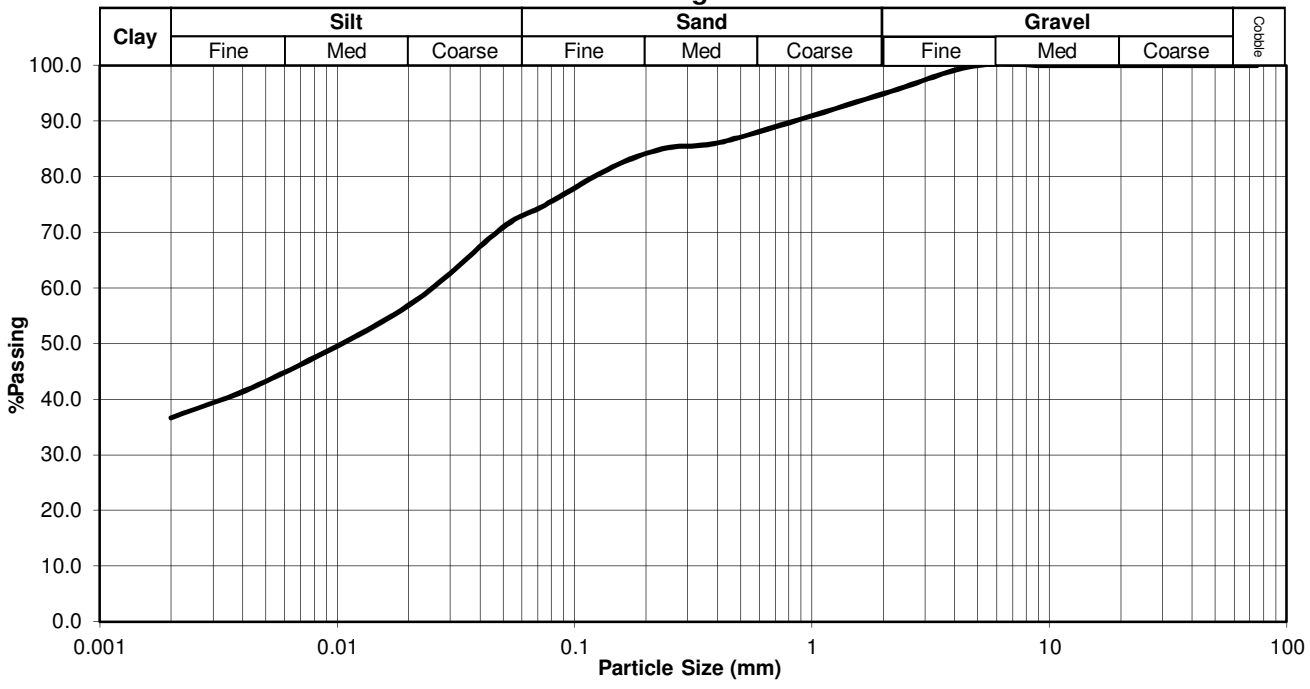
M.I.T SIZE CLASSIFICATION	
Cobble%	0.0
Gravel%	5.1
Coarse	0.0
Medium	0.1
Fine	5.0
Sand%	22.4
Coarse	7.6
Medium	3.6
Fine	11.2
Silt%	35.9
Coarse	15.7
Medium	12.8
Fine	7.4
Clay%	36.7

PLASTICITY	
Liquid Limit	29.5
Plasticity Index	12.1
Linear Shrinkage	6

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	NA
Grading Modulus	0.44

CLASSIFICATION	
Potential Expansiveness	Low
Group Index	7
AASHTO Soil Classification	A - 6
Unified Classification	CL or OL

Grading Curve



Ref no.: 6604 Fig no.: -

APPENDIX F

SHEAR BOX TEST RESULTS

CONSOLIDATED DRAINED SHEAR BOX TEST

THEKWINI SOILS LAB. CC

V.A.T. REGISTRATION NO. 4590210961.

68 Ridge Road, Tollgate, DURBAN
Tel : (031) 201-8992

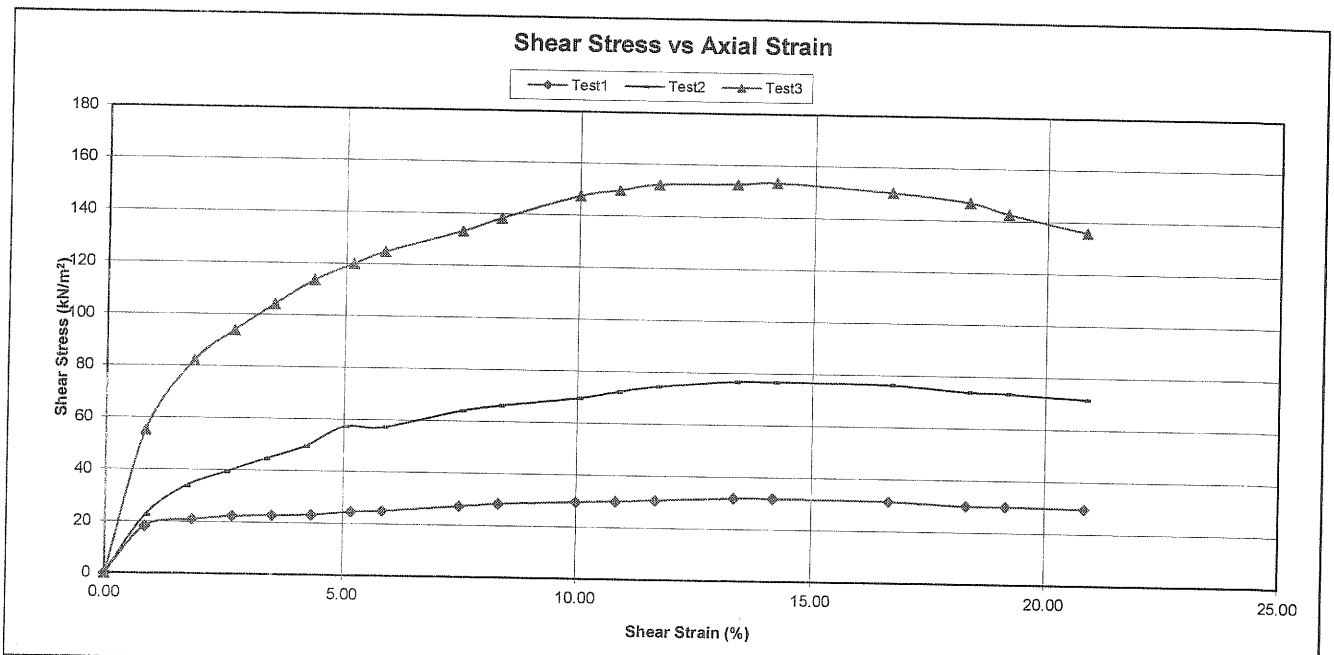
P.O. Box 30464, MAYVILLE, 4058
Fax : (031) 201-7920

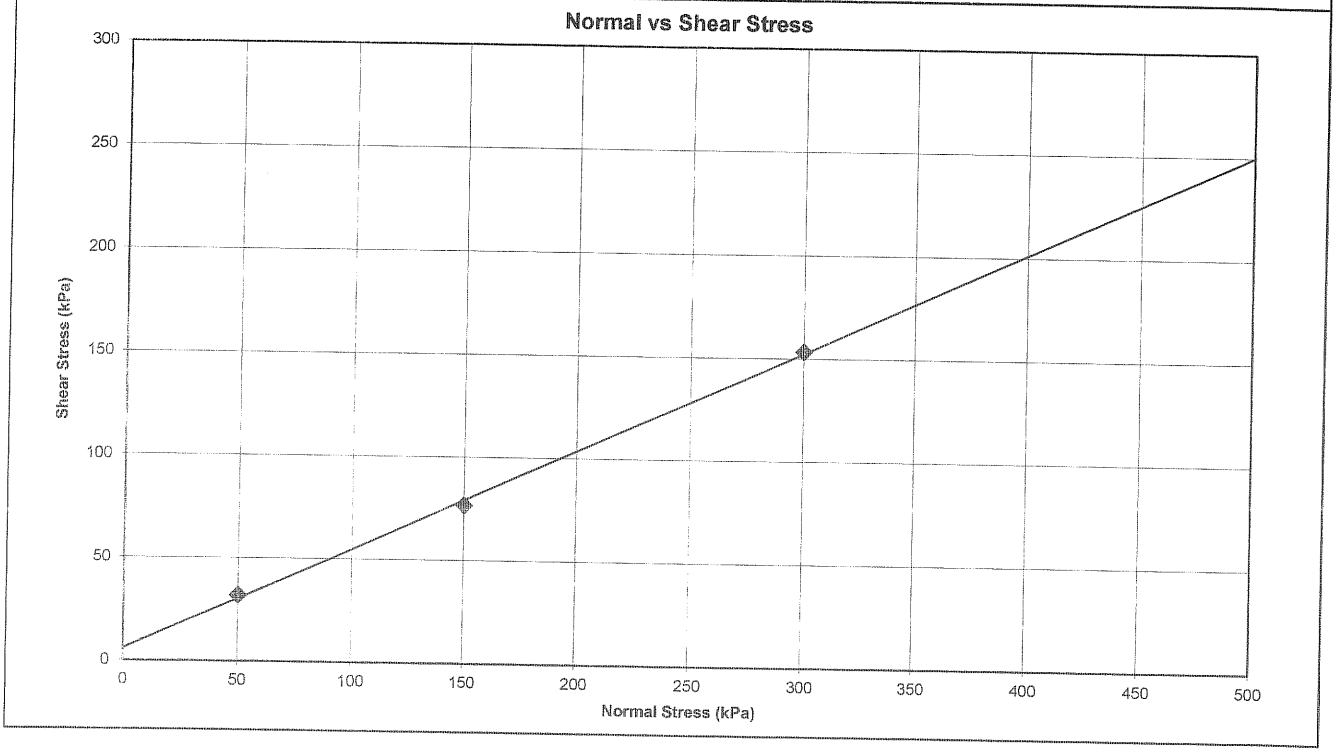
Project Kokstad Landfill - Ref. 22233
Ref no. 6604
Lab no. 06100 **Sample Type**
Depth (m): 0.9 - 2.6 Recompacted To 95% of Proc.
Position: IP 1 **Description:**
Org.Cl.SILT (Res. Dolerite)

	Test 1	Test 2	Test 3
Normal Stress (kN/m^2)	50	150	300
Dry Density (kg/m^3)	1188	1188	1188
Moisture Content (%)	31.6	31.6	31.6
Shear Strain (%)	13.3	13.3	14.2
Shear Stress (kN/m^2)	31.9	76.7	153.4

Shear Strength Perameters

Angle of Internal Friction (O°)	26
Cohesion (kPa)	6





CONSOLIDATED DRAINED SHEAR BOX TEST

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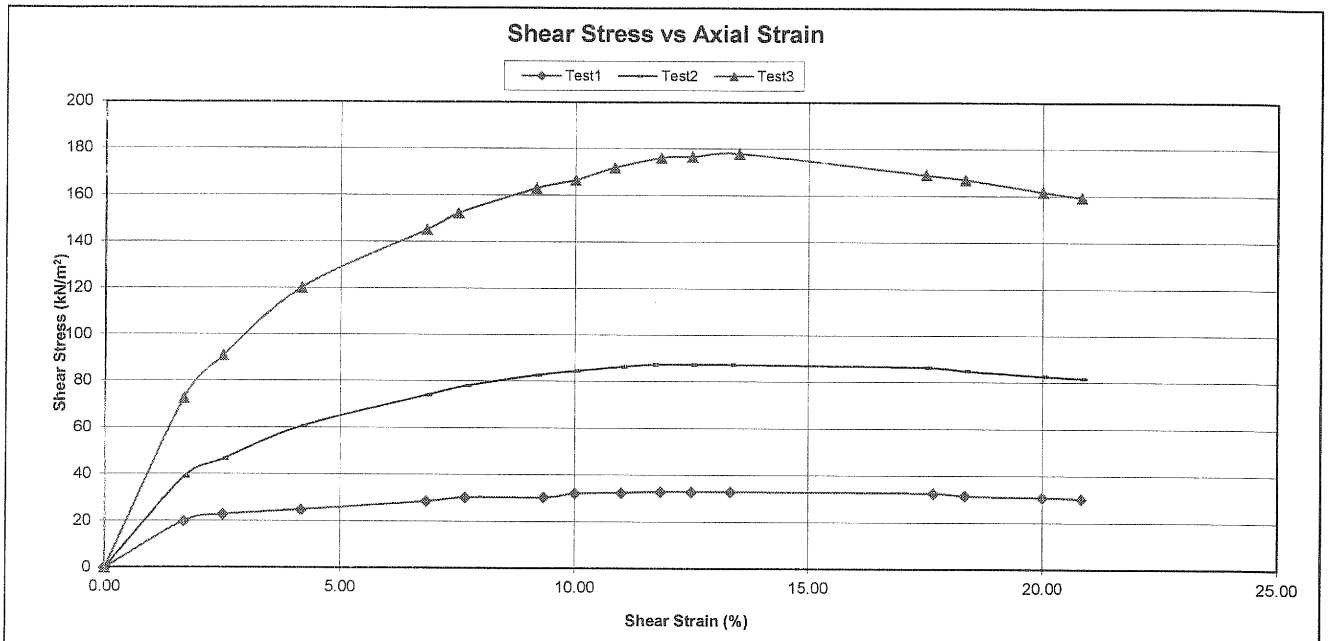
V.A.T. REGISTRATION NO. 4590210961.
68 Ridge Road, Tollgate, DURBAN
Tel : (031) 201-8992
P.O. Box 30464, MAYVILLE, 4058
Fax : (031) 201-7920

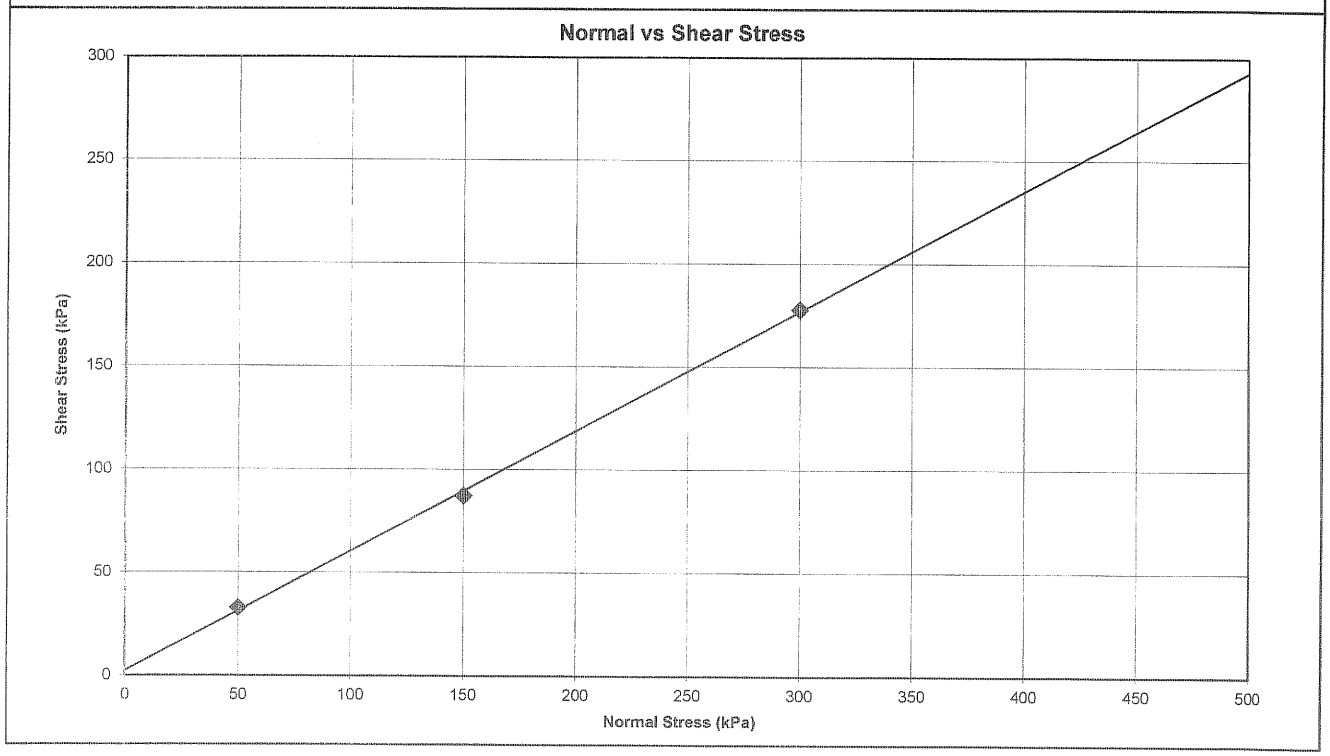
Project Kokstad Landfill - Ref. 22233
Ref no. 6604
Lab no. 06101 **Sample Type**
Depth (m): 1.9 - 3.0 Recompacted To 95% of Proc.
Position: IP 2 **Description:**
H/Wh.Olv.SHALE

	Test 1	Test 2	Test 3
Normal Stress (kN/m^2)	50	150	300
Dry Density (kg/m^3)	1587	1587	1587
Moisture Content (%)	15.4	15.4	15.4
Shear Strain (%)	11.8	11.7	13.5
Shear Stress (kN/m^2)	32.9	87.3	177.9

Shear Strength Perameters

Angle of Internal Friction (O°)	30
Cohesion (kPa)	2





CONSOLIDATED DRAINED SHEAR BOX TEST

THEKWINI SOILS LAB. CC

V.A.T. REGISTRATION NO. 4590210961.

68 Ridge Road, Tollgate, DURBAN
Tel : (031) 201-8992

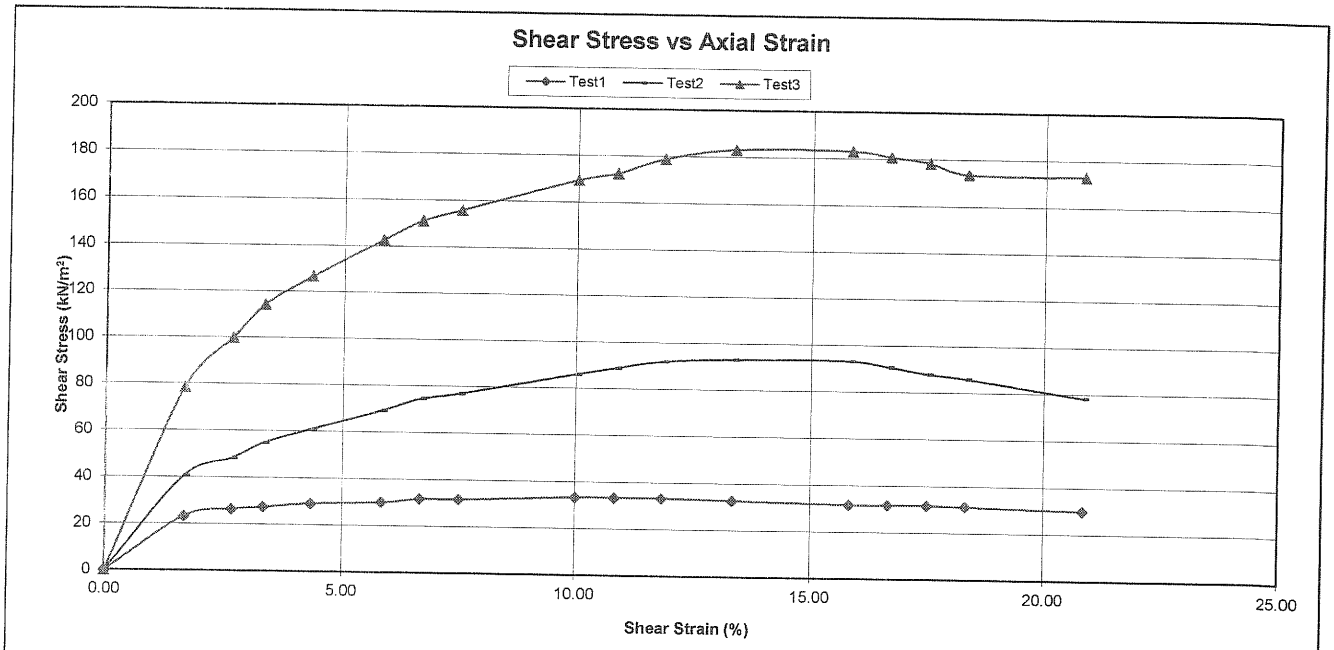
P.O. Box 30464, MAYVILLE, 4058
Fax : (031) 201-7920

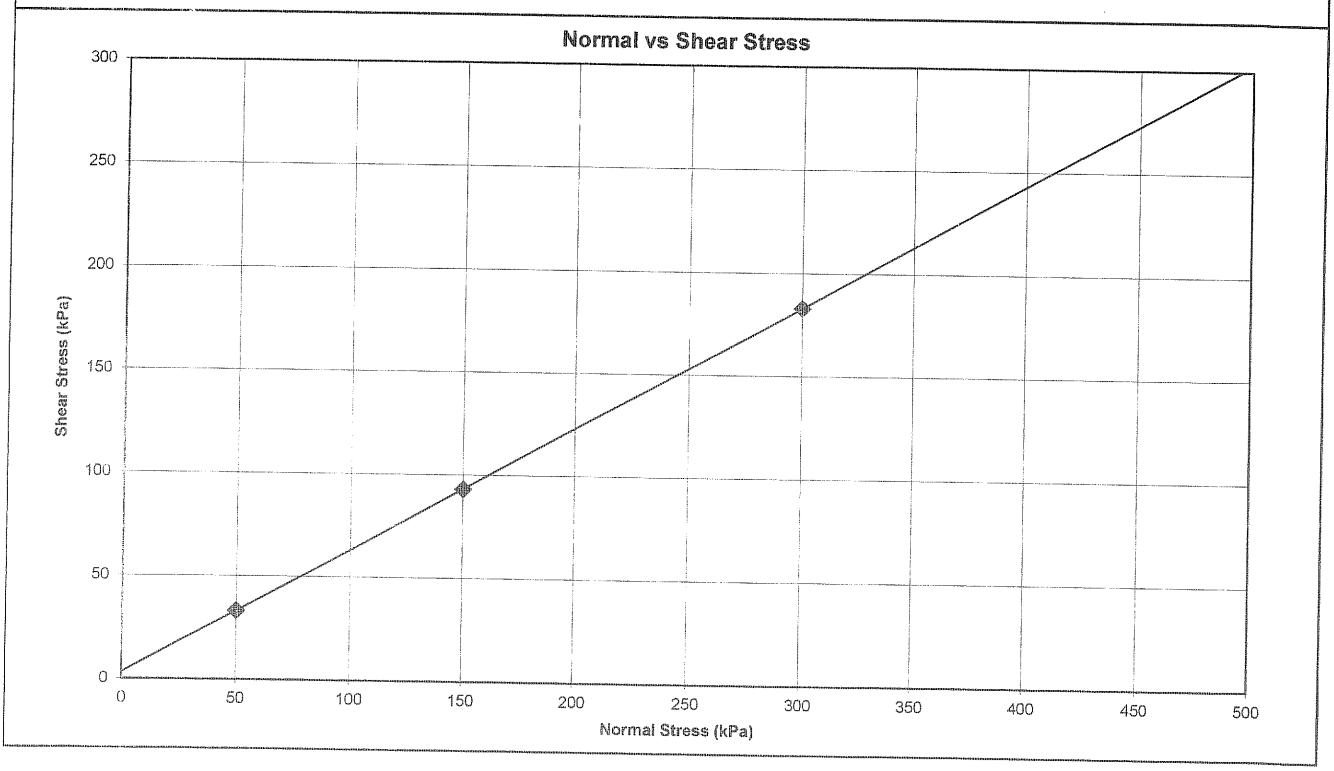
Project Kokstad Landfill - Ref. 22233
Ref no. 6604
Lab no. 06104 **Sample Type**
Depth (m): 1.0 - 1.9 Recompacted To 95% of Proc.
Position: IP 6 **Description:**
M/Wh.Dk.Bl. DOLERITE

	Test 1	Test 2	Test 3
Normal Stress (kN/m^2)	50	150	300
Dry Density (kg/m^3)	1524	1524	1524
Moisture Content (%)	19.7	19.7	19.7
Shear Strain (%)	10.0	13.3	13.3
Shear Stress (kN/m^2)	33.4	93.2	183.2

Shear Strength Perameters

Angle of Internal Friction (O°)	31
Cohesion (kPa)	3





CONSOLIDATED DRAINED SHEAR BOX TEST

THEKWINI SOILS LAB. CC
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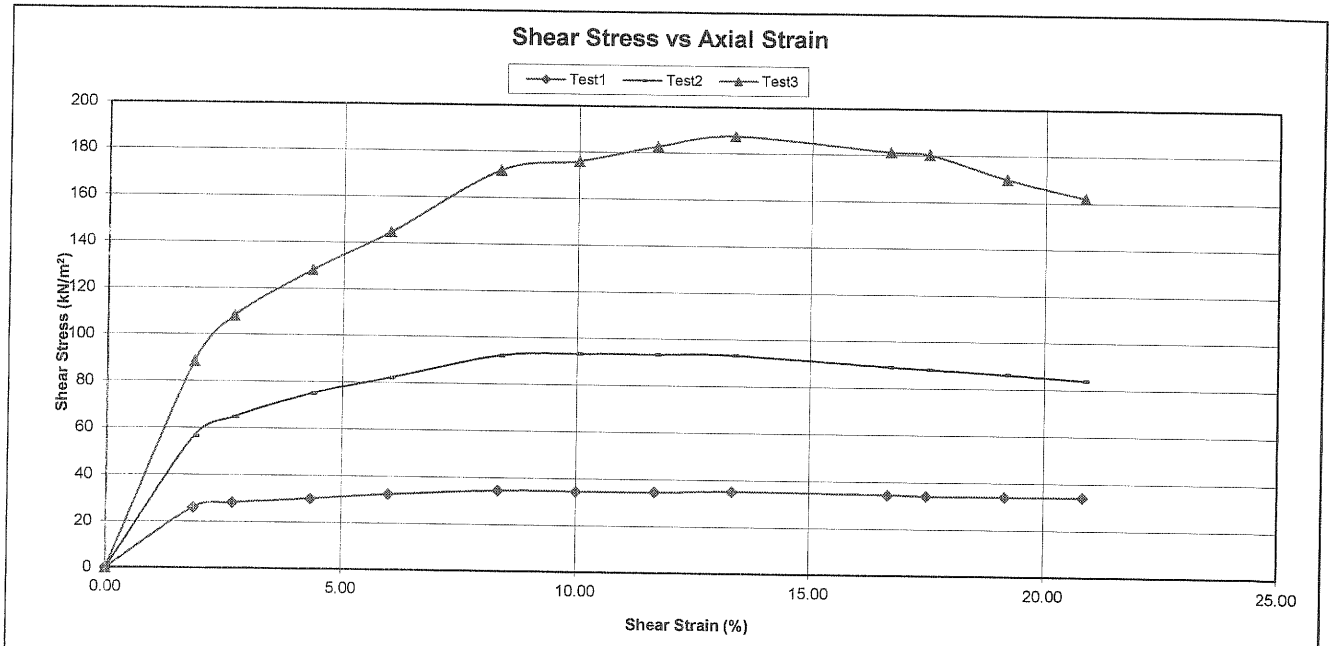
68 Ridge Road, Tollgate, DURBAN
Tel : (031) 201-8992
P.O. Box 30464, MAYVILLE, 4058
Fax : (031) 201-7920

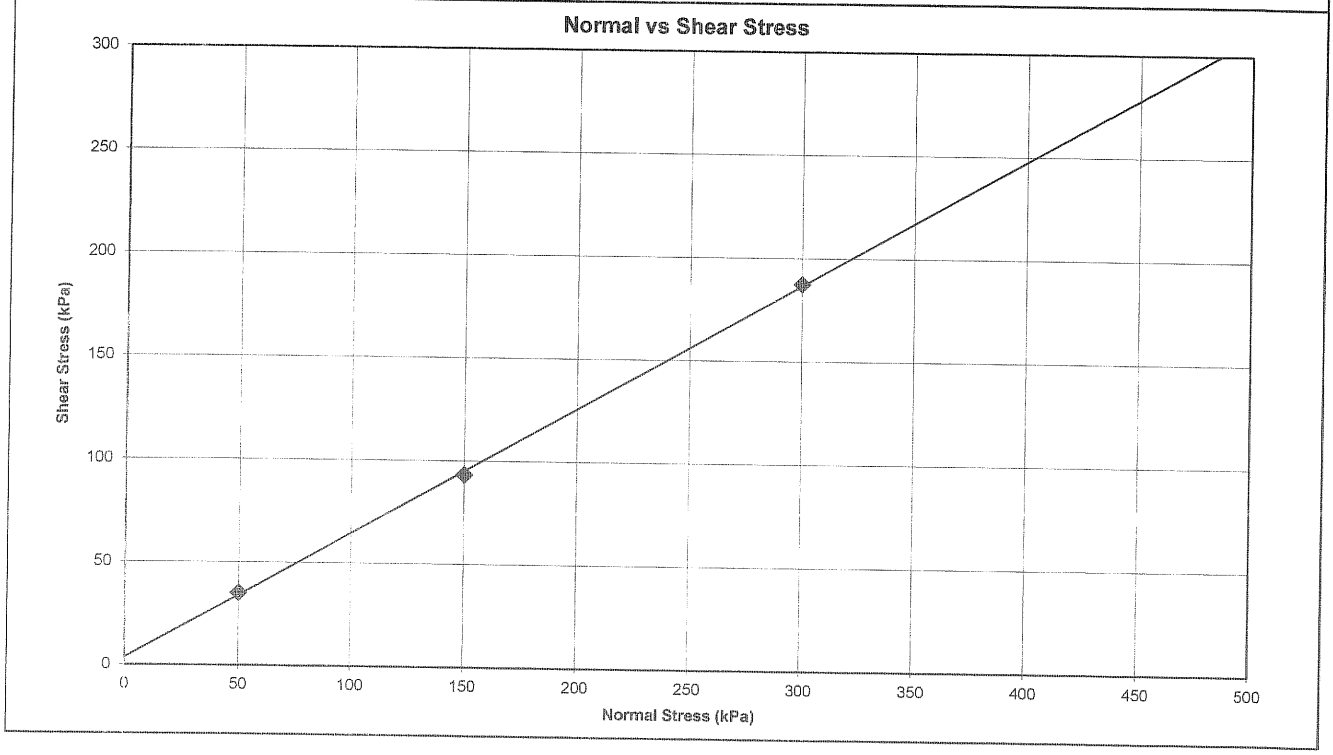
Project Kokstad Landfill - Ref. 22233
Ref no. 6604
Lab no. 06105 **Sample Type**
Depth (m): 0.9 - 1.5 Recompacted to 95% of Proc.
Position: IP 7 **Description:**
M/Wh.Gr. SANDSTONE

	Test 1	Test 2	Test 3
Normal Stress (kN/m^2)	50	150	300
Dry Density (kg/m^3)	1658	1658	1658
Moisture Content (%)	15.7	15.7	15.7
Shear Strain (%)	13.3	10.0	13.3
Shear Stress (kN/m^2)	35.3	93.3	187.5

Shear Strength Perameters

Angle of Internal Friction (O°)	31
Cohesion (kPa)	4





CONSOLIDATED DRAINED SHEAR BOX TEST

THEKWINI SOILS LAB. CC

V.A.T. REGISTRATION NO. 4590210961.

68 Ridge Road, Tollgate, DURBAN
Tel : (031) 201-8992

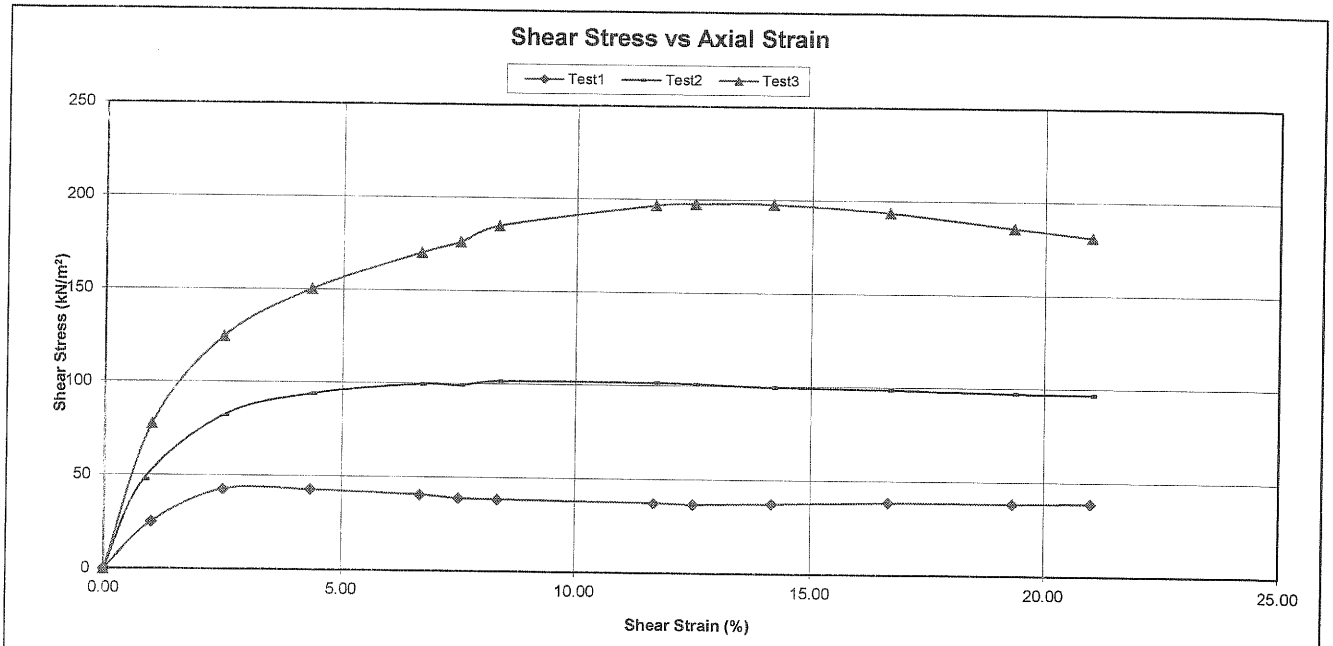
P.O. Box 30464, MAYVILLE, 4058
Fax : (031) 201-7920

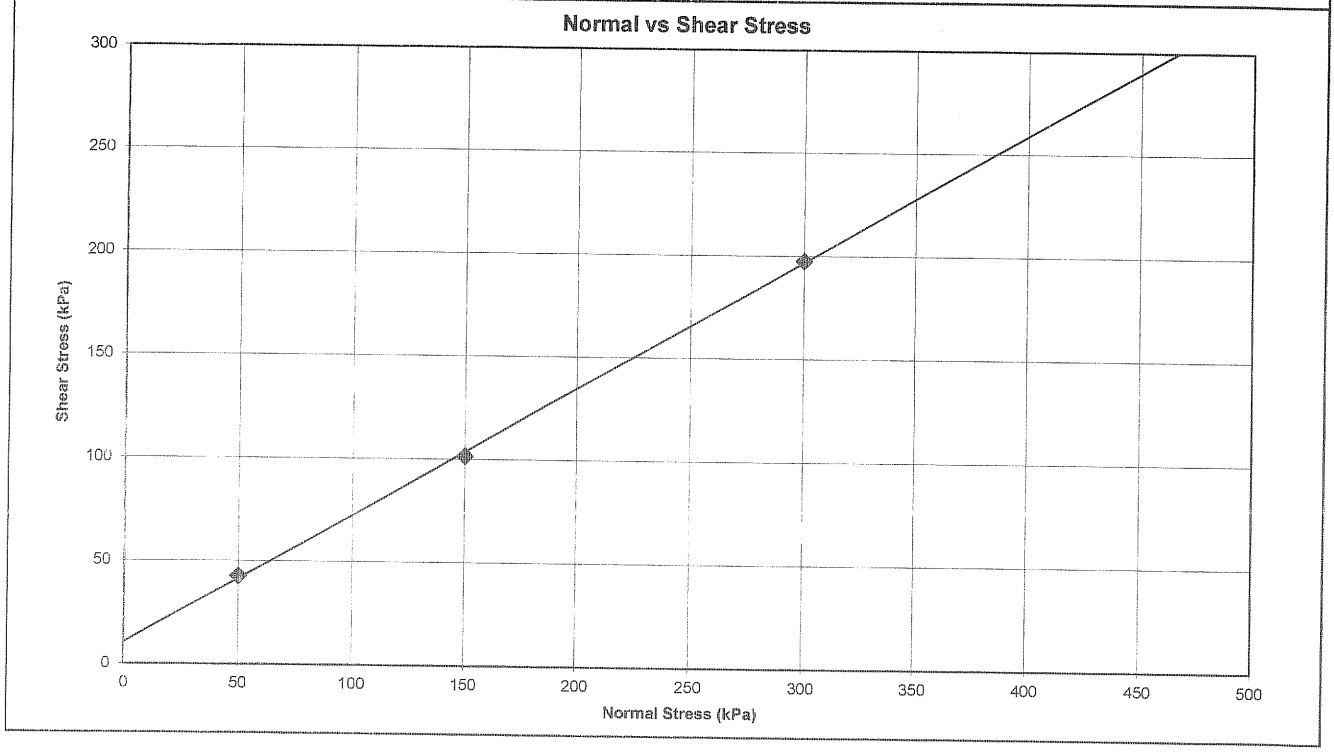
Project Kokstad Landfill - Ref. 22233
Ref no. 6604
Lab no. 07040 **Sample Type**
Depth (m): 0.65 - 1.6 Recompacted to 95% of Proc.
Position: IP 14 **Description:**
H/Wh.Yel.SANDSTONE

	Test 1	Test 2	Test 3
Normal Stress (kN/m^2)	50	150	300
Dry Density (kg/m^3)	1748	1748	1748
Moisture Content (%)	13.4	13.4	13.4
Shear Strain (%)	2.5	8.3	12.5
Shear Stress (kN/m^2)	42.8	101.5	197.6

Shear Strength Perameters

Angle of Internal Friction (O^o)	32
Cohesion (kPa)	10





APPENDIX G

WATER SAMPLE TEST RESULTS

b.n. kirk (natal) cc

Reg.No. CK 94/15428/23

Water, Sewage & Industrial Effluent Testing Laboratory /
Monitoring and Plant Operation

45 Eaton Road, Congella, Durban P.O. Box 30140, Mayville, 4058 RSA
Tel : (031) 205 1245 Fax : (031) 205 6904 E-mail: bnkirk@mweb.co.za

CERTIFICATE OF ANALYSIS - BN Kirk (Natal)cc

CLIENT:	Drennan Maud and Partners	BNK Reference No.:	DMP 16-07 Kokstad
ADDRESS:	68 Peter Mokaba Ridge Tollgate 4001		
ATTENTION:	***B Raasch***	Clients Order. No	22233 Ref No Kokstad Landfill
eMail:	Group details	DATE RECEIVED	16-07-2012
Report Date	13-Aug-12	ANALYSIS DATE	27-07-2012

ANALYTICAL RESULTS

1		2	3	4	
Determinand	**Test Method No**	**SANS 241-1:2011 Physical, aesthetic, operational, chemical and Microbiological determinands**			**WS1 Kokstad Landfill**
		Risk	**Unit**	**Standard limits [a]**	
Physical and aesthetic determinands					
Conductivity at 25°C	P09/044	*Aesthetic*	*mS/m*	*≤ 170*	57
Total Dissolved Solids	P09/031	*Aesthetic*	*mg/L*	*≤ 1200*	374
pH at 25°C [c]	P09/042	*Operational*	*pH units*	*≥ 5 to ≤ 9.7*	8.0
Chemical determinands - macro-determinands					
Sulphate as SO_4^{2-}	P09/035	*Acute health - 1*	*mg/L*	*≤ 500*	3.4
		Aesthetic	*mg/L*	*≤ 250*	3.4
Total Hardness as CaCO3	P09/013	*n/s*	*mg/L*	*n/s*	268
Calcium Hardness as CaCO3	P09/005	*n/s*	*mg/L*	*n/s*	120
Calcium as Ca	P09/004	*n/s*	*mg/L*	*n/s*	48
Magnesium as Mg	P09/016	*n/s*	*mg/L*	*n/s*	35
Ammonia as N	P09/002	*Aesthetic*	*mg/L*	*≤ 1.5*	<0.1
Chloride as Cl^-	P09/007	*Aesthetic*	*mg/L*	*≤ 300*	15
Potassium as K	P09/047	*n/s*	*mg/L*	*n/s*	2.3
Sodium as Na	P09/047	*Aesthetic*	*mg/L*	*≤ 200*	48
p alkalinity		*n/s*	*mg/L*	*n/s*	<2
m alkalinity		*n/s*	*mg/L*	*n/s*	204
Phosphorous as PO4 Total		*ns*	*mg/L*	*n/s*	0.8
Chemical Oxygen Demand	P09/006	*n/s*	*mg/L*	*n/s*	17
Biological Oxygen Demand	P09/003	*n/s*	*mg/L*	*n/s*	11

a = The health-related standards are based on the consumption of 2 L of water per day per person of a mass of 60kg over a period of 70 years.

b = Values in excess of those given in column 4 may negatively impact disinfection.

c = Low pH values can result in structural problems in the distribution system.

d = This is equivalent to nitrate at 50mg NO_3^- /L and nitrite as 3mg NO_2^- /L

e = Microcystin only needs to be measured where an algal bloom (>20 000 cyanobacteria cells per millilitre) is present in a raw water source. In the absence of algal monitoring, an algal bloom is deemed to occur where the surface water is visibly green in the vicinity of the abstraction, or samples taken have a strong musty odour.

MICROBIOLOGICAL RESULTS

E.coli [a] or faecal coliforms [b]	P09/046	*Acute health - 1*	*Count per 100ml*	*Not detected*	0

a = Definitive, preferred indicator of faecal pollution.

b = Indicator of unacceptable microbial water quality, could be tested instead of E.coli , but is not the preferred indicator of faecal pollution.
Also provides information on treatment efficiency and aftergrowth in distribution networks.

c = Confirms a risk of human infection and faecal pollution and also provides information on treatment efficiency. The detection of selected viruses confirms faecal pollution of human origin.

d = Confirms a risk of infection and faecal pollution and also provides information on treatment efficiency.
The detection of selected protozoan parasites confirms a human health risk.

e = Indicates potential faecal pollution and provides information on treatment efficiency and aftergrowth.

f = Process indicator that provides information on treatment efficiency, aftergrowth in distribution networks and adequacy of disinfectant residuals.

g = Process indicator that provides information on treatment efficiency.

TECHNICAL SIGNATORY:

V Moothi - Microbiology Supervisor

D Subban - Chemistry Supervisor

for and on behalf of B N KIRK (Natal)cc

D. Bester-LABORATORY MANAGER

13-Aug-12
Date

Disclaimer:

1. *While every reasonable precaution is taken in obtaining these results the Company does not accept responsibility for any matters arising from the further use of these results.*
2. *In the case of sample/s submitted by the client, the results expressed in this certificate represent only the sample/s as received.*
3. *This certificate shall not be reproduced except in full, without the written approval of the Company*

End of Report

b.n. kirk (natal) cc Reg.No. CK 94/15428/23

Water, Sewage & Industrial Effluent Testing Laboratory /
Monitoring and Plant Operation

45 Eaton Road, Congella, Durban P.O. Box 30140, Mayville, 4058 RSA
Tel : (031) 205 1245 Fax : (031) 205 6904 E-mail: bnkirk@mweb.co.za

CERTIFICATE OF ANALYSIS - BN Kirk (Natal)cc

CLIENT:	Drennan Maud and Partners	BNK Reference No.:	DMP 26-06 Kokstad
ADDRESS:	68 Peter Mokaba Ridge Tollgate 4001		
ATTENTION:	*B Raasch*	Clients Order. No	22233
eMail:	Group details	DATE RECEIVED	26-06-2012
Report Date	10-07-2012	ANALYSIS DATE	05-07-2012

ANALYTICAL RESULTS

1		2	3	4	
Determinand	**Test Method No**	**SANS 241-1:2011 Physical, aesthetic, operational, chemical and Microbiological determinands**			**WS3 Kokstad Landfill**
		Risk	**Unit**	**Standard limits [a]**	
Physical and aesthetic determinands					
Conductivity at 25°C	P09/044	*Aesthetic*	*mS/m*	*≤ 170*	**14**
Total Dissolved Solids	P09/031	*Aesthetic*	*mg/L*	*≤ 1200*	**94**
pH at 25°C [c]	P09/042	*Operational*	*pH units*	*≥ 5 to ≤ 9.7*	**7.7**
Chemical determinands - macro-determinands					
Sulphate as SO_4^{2-}	P09/035	*Acute health - 1*	*mg/L*	*≤ 500*	**0.95**
		Aesthetic	*mg/L*	*≤ 250*	**0.95**
Total Hardness as CaCO3	P09/013	*n/s*	*mg/L*	*n/s*	**90**
Calcium Hardness as CaCO3	P09/005	*n/s*	*mg/L*	*n/s*	**28**
Calcium as Ca	P09/004	*n/s*	*mg/L*	*n/s*	**112**
Magnesium as Mg	P09/016	*n/s*	*mg/L*	*n/s*	**15**
Ammonia as N	P09/002	*Aesthetic*	*mg/L*	*≤ 1.5*	**<0.1**
Chloride as Cl^-	P09/007	*Aesthetic*	*mg/L*	*≤ 300*	**8.0**
Potassium as K	P09/047	*n/s*	*mg/L*	*n/s*	**2.3**
Sodium as Na	P09/047	*Aesthetic*	*mg/L*	*≤ 200*	**24**
p alkalinity		*n/s*	*mg/L*	*n/s*	**<2**
m alkalinity		*n/s*	*mg/L*	*n/s*	**50**
Phosphorous as PO4 Total		*ns*	*mg/L*	*n/s*	**2.6**
Chemical Oxygen Demand	P09/006	*n/s*	*mg/L*	*n/s*	**20**
Biological Oxygen Demand	P09/003	*n/s*	*mg/L*	*n/s*	**1.3**

a = The health-related standards are based on the consumption of 2 L of water per day per person of a mass of 60kg over a period of 70 years.

b = Values in excess of those given in column 4 may negatively impact disinfection.

c = Low pH values can result in structural problems in the distribution system.

d = This is equivalent to nitrate at 50mg NO_3^- /L and nitrite as 3mg NO_2^- /L

e = Microcystin only needs to be measured where an algal bloom (>20 000 cyanobacteria cells per millilitre) is present in a raw water source. In the absence of algal monitoring, an algal bloom is deemed to occur where the surface water is visibly green in the vicinity of the absiraction, or samples taken have a strong musty odour.

MICROBIOLOGICAL RESULTS

E.coli [a] or faecal coliforms [b]	P09/046	*Acute health - 1*	*Count per 100ml*	*Not detected*	**72**

a = Definitive, preferred indicator of faecal pollution.

b = Indicator of unacceptable microbial water quality, could be tested instead of E.coli , but is not the preferred indicator of faecal pollution.

Also provides information on treatment efficiency and aftergrowth in distribution networks.

c = Confirms a risk of human infection and faecal pollution and also provides information on treatment efficiency. The detection of selected viruses confirms faecal pollution of human origin.

d = Confirms a risk of infection and faecal pollution and also provides information on treatment efficiency.

The detection of selected protozoan parasites confirms a human health risk.

e = Indicates potential faecal pollution and provides information on treatment efficiency and aftergrowth.

f = Process indicator that provides information on treatment efficiency, aftergrowth in distribution networks and adequacy of disinfectant residuals.

g = Process indicator that provides information on treatment efficiency.

TECHNICAL SIGNATORY: CHEMISTRY SUPERVISOR:

D. SUBBAN

MICROBIOLOGY SUPERVISOR:

for and on behalf of B N KIRK (Natal)cc

10-07-2012

D. Bester-LABORATORY MANAGER

Date

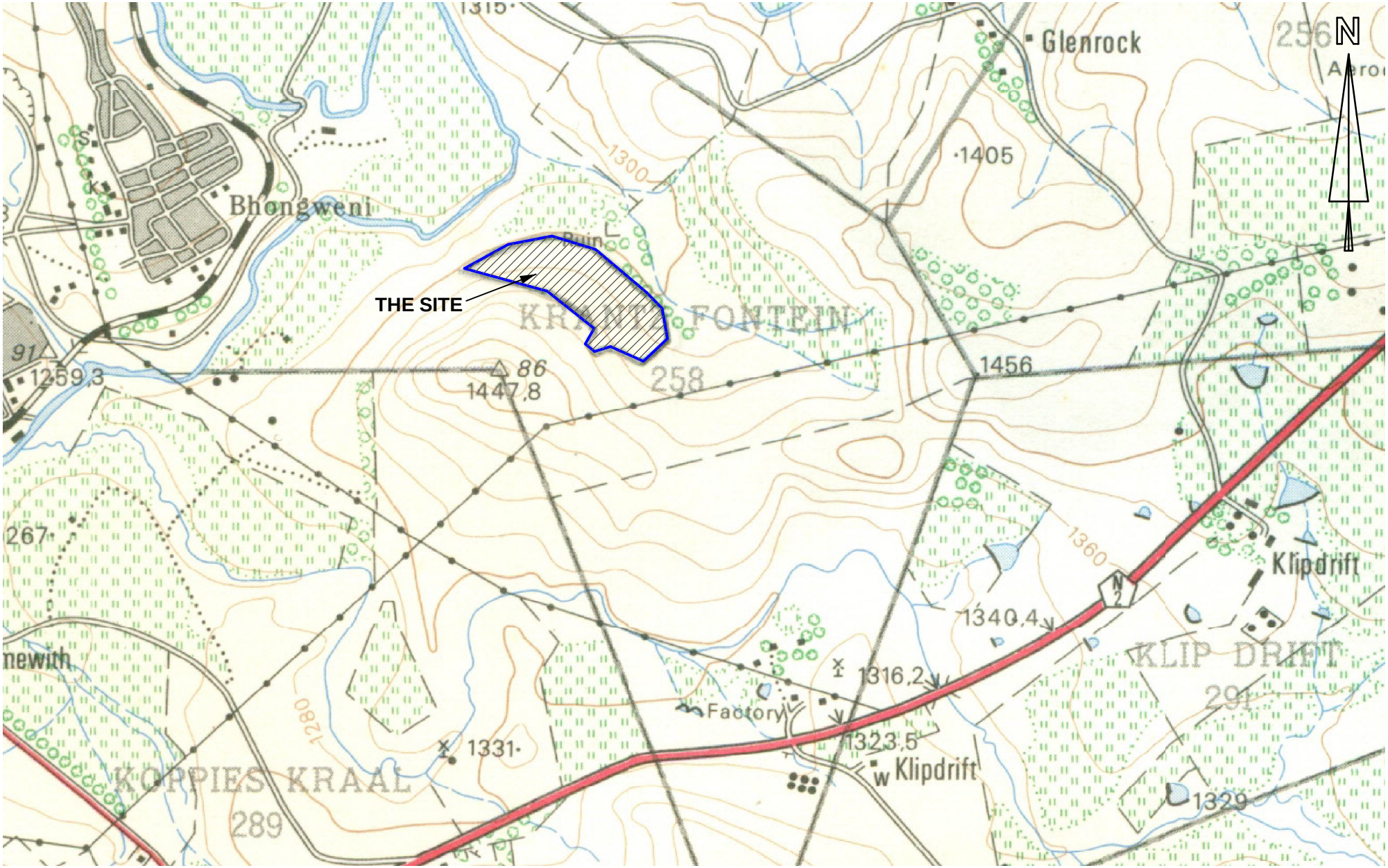
Disclaimer:

1. *While every reasonable precaution is taken in obtaining these results the Company does not accept responsibility for any matters arising from the further use of these results.*
2. *In the case of sample/s submitted by the client, the results expressed in this certificate represent only the sample/s as received.*
3. *This certificate shall not be reproduced except in full, without the written approval of the Company*

End of Report

DRAWING No. 22233/1A

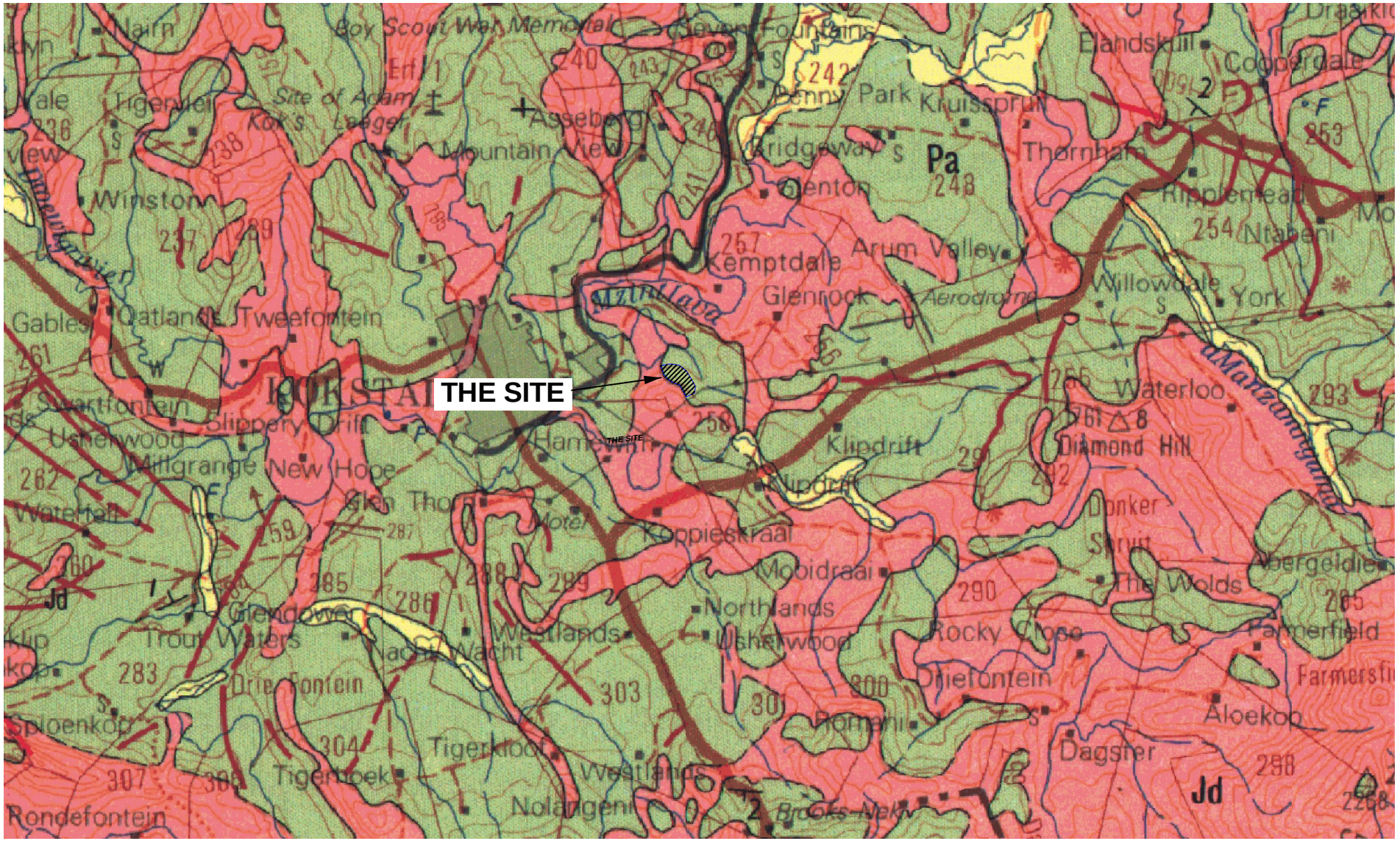
LOCALITY PLAN



DRENNAN, MAUD AND PARTNERS Consulting Civil Engineers	DESIGNED : B.R. DRAWN : S.P. DATE : 20/08/2012 SCALE : N.T.S. CHECKED :	**LOCALITY PLAN** **PROPOSED LANDFILL DEVELOPMENT** **SITE 1 KRANTZ FONTEIN FARM, KOKSTAD**	REF. NO. 22233 FIG. NO. 1A

DRAWING No. 22233/1B

GEOLOGICAL PLAN



KEY

SHALE, FINE GRAINED SANDSTONE QUARTZITE (ADELAIDE FORMATION, BEAUFORT GROUP)

KAROO DOLERITE (INTRUSIVE)

DRENNAN, MAUD AND PARTNERS
Consulting Civil Engineers

DESIGNED :	B.R.
DRAWN :	S.P.
DATE :	22/08/2012
SCALE :	N.T.S.
CHECKED :	

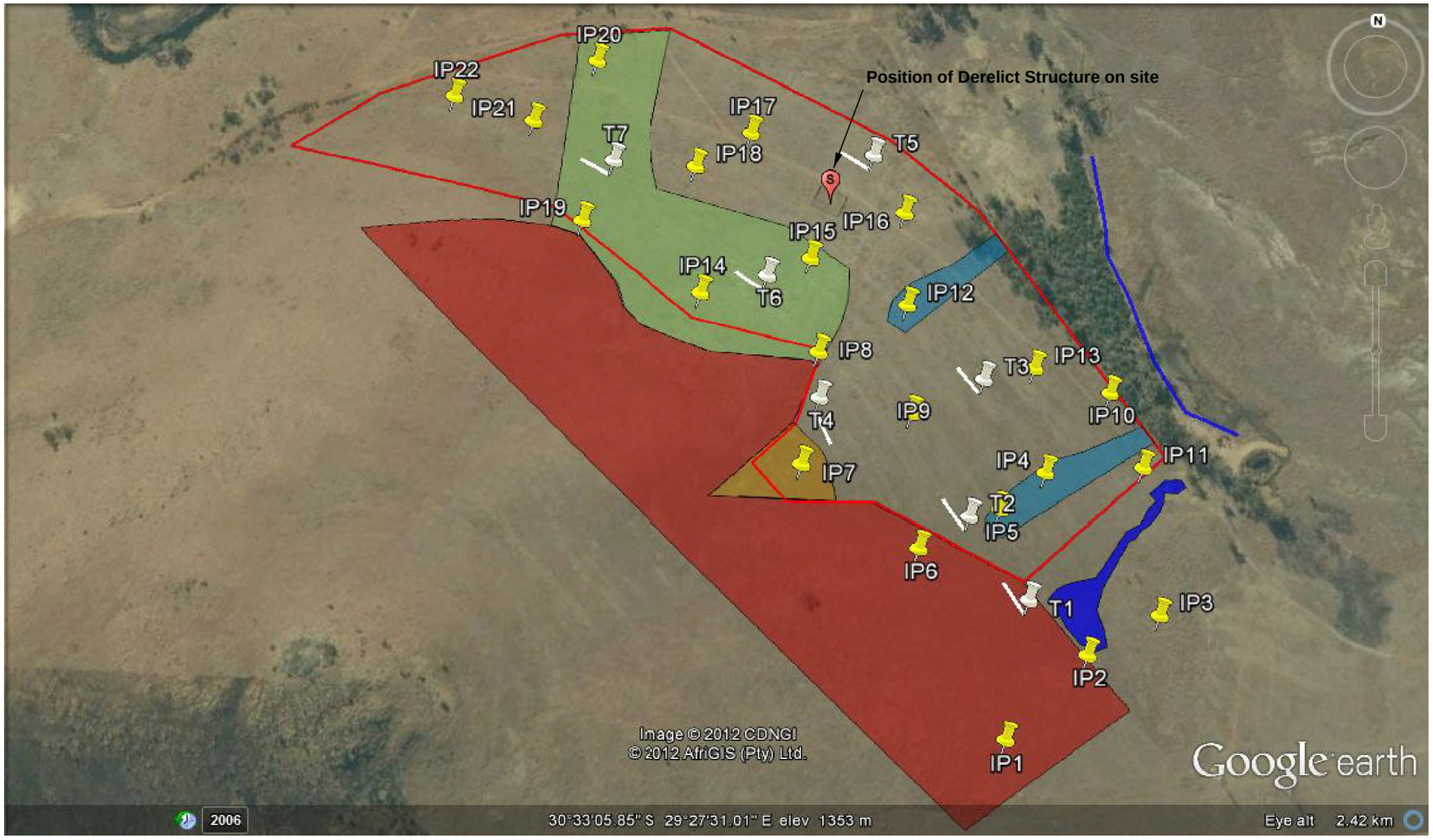
GEOLOGICAL PLAN
PROPOSED LANDFILL DEVELOPMENT
SITE 1 KRANTZ FONTEIN FARM, KOKSTAD

REF. NO. 22233

FIG. NO. 1B

DRAWING No. 22233/2

GEOLOGY & SEEPAGE ZONES



KEY

Approximate Positions of Inspection Pits

T4 Approximate Positions of Seismic Traverses

Edge of area affected by permanent or at least seasonal groundwater seepage (as determined by auger hole profiling). At this stage a 32m buffer zone has been applied, however this must be determined by the requirements of the Local Authority and the Appointed Environmental Officer.

Approx. area of the site which can be described as an area of permanent seepage. This area is likely to represent a spring, utilising a fractured zone along the shale / dolerite contact zone in this area as a preferential flow path. The landfill cannot be located in this area.

Approx. areas of the site likely to be affected by seasonal groundwater seepage.

Extent of area that is recommended for use as the proposed landfill based on the results of the geotechnical investigation

Approx. area of the site underlain by shale and sandy shale of the Adelaide Formation (Beaufort Group).

Approx. area of the site underlain by sandstone of the Adelaide Formation (Beaufort Group).

Approx. area of the site underlain by sandstone and quartzite of the Adelaide Formation (Beaufort Group).

Approx. area of the site intruded by a large dolerite sill (Karoo Supergroup).

DRENNAN, MAUD & PARTNERS

Consulting Civil Engineers & Engineering Geologists

68 Ridge Road
Tollgate
DURBAN
4001
Telephone 201-8992

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4058
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e-mail:dmp@iafrica.com

DESIGNED : B.R.
DRAWN : S.P.
DATE : 17/08/2012
SCALE : N.T.S.
CHECKED :

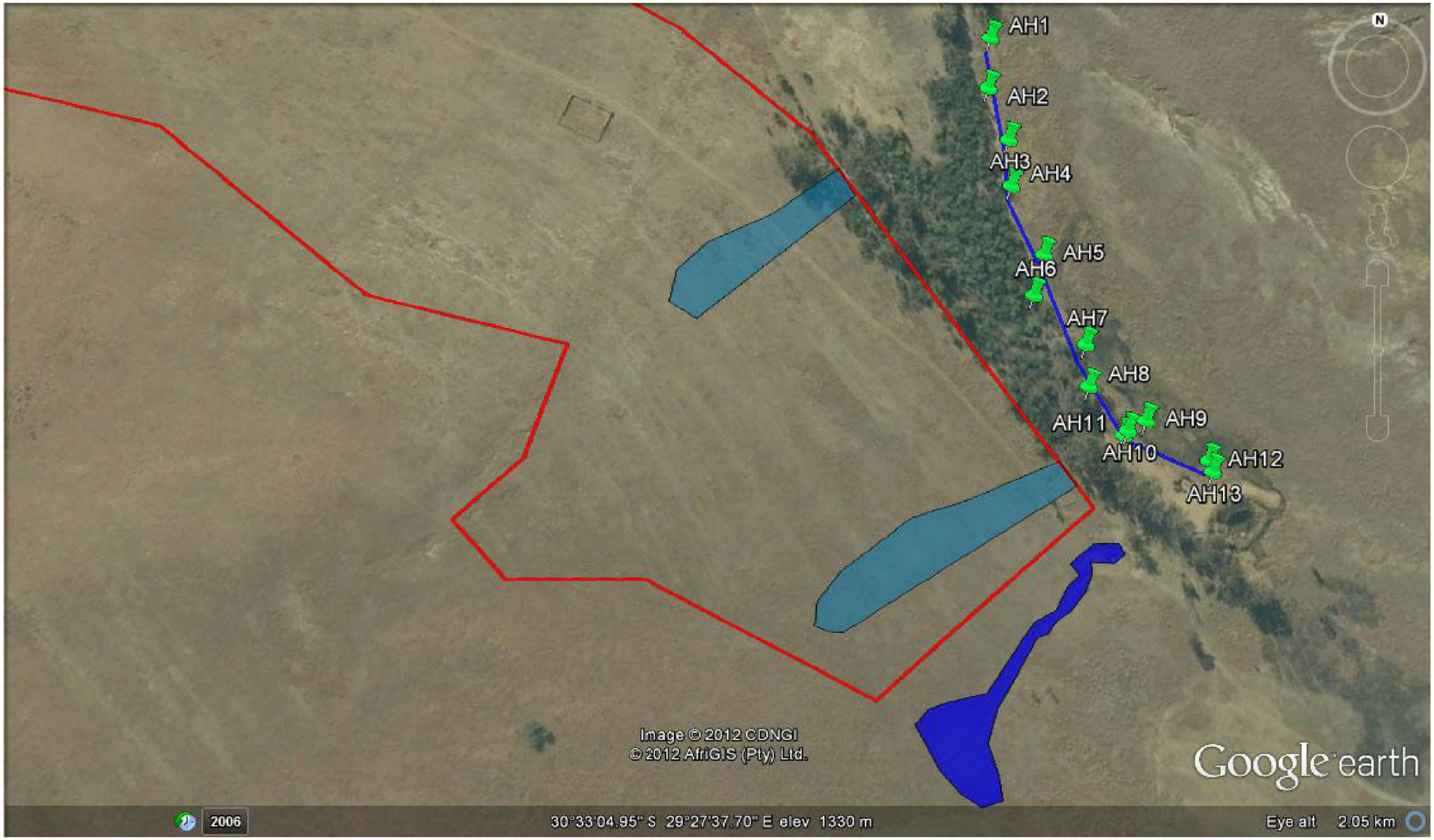
GEOTECHNICAL INVESTIGATION FOR LANDFILL DEVELOPMENT, KOKSTAD
SITE GEOLOGY & SEEPAGE

REF. NO. 22233

FIG. NO. 2

DRAWING No. 22233/3

FOCUS ON SEEPAGE ZONES



KEY

Approx. position of Auger Holes

Edge of area affected by permanent or at least seasonal groundwater seepage (as determined by auger hole profiling). At this stage a 32m buffer zone has been applied, however this must be determined by the requirements of the Local Authority and the Appointed Environmental Officer.

Approx. area of the site which can be described as an area of permanent seepage. This area is likely to represent a spring, utilising a fractured zone along the shale / dolerite contact zone in this area as a preferential flow path. The landfill cannot be located in this area.

Approx. areas of the site likely to be affected by seasonal groundwater seepage.

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DRAWN :	S.P.
DATE :	17/08/2012
SCALE :	N.T.S.
CHECKED :	

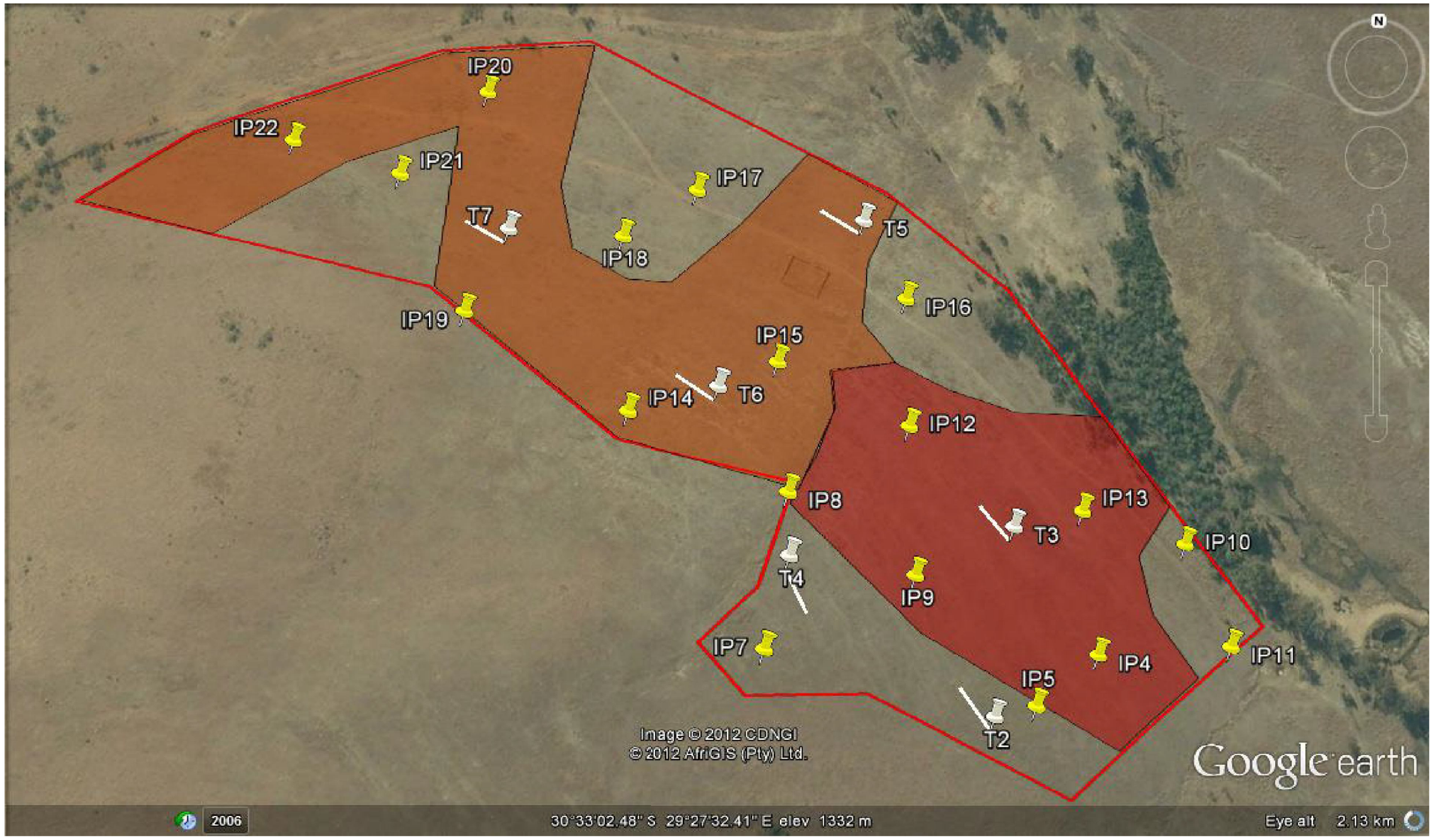
GEOTECHNICAL INVESTIGATION FOR LANDFILL DEVELOPMENT, KOKSTAD
FOCUS ON SEEPAGE ZONES

REF. NO. **22233**

FIG. NO. **3**

DRAWING No. 22233/4

RIPPABILITY ASSESSMENT



KEY

Approximate Positions of Relevant Inspection Pits

T4 Approximate Positions of Relevant Seismic Traverses

Approx. area of the site expected to be only marginally rippable using a D7 bulldozer or equivalent, and rippable using a D8 bull dozer or equivalent to a depth of between 5.5 and 6.3m. Below these depths, blasting is expected.

Approx. area of the site expected to be only rippable using a D8 bulldozer or equivalent to a depth of approximately 6.6m. Below these depths, blasting is expected.

Approx. area of the site expected to be rippable using a D7 bulldozer or equivalent to a depth of between 5.7 and 8.6m. Below these depths, blasting is expected.

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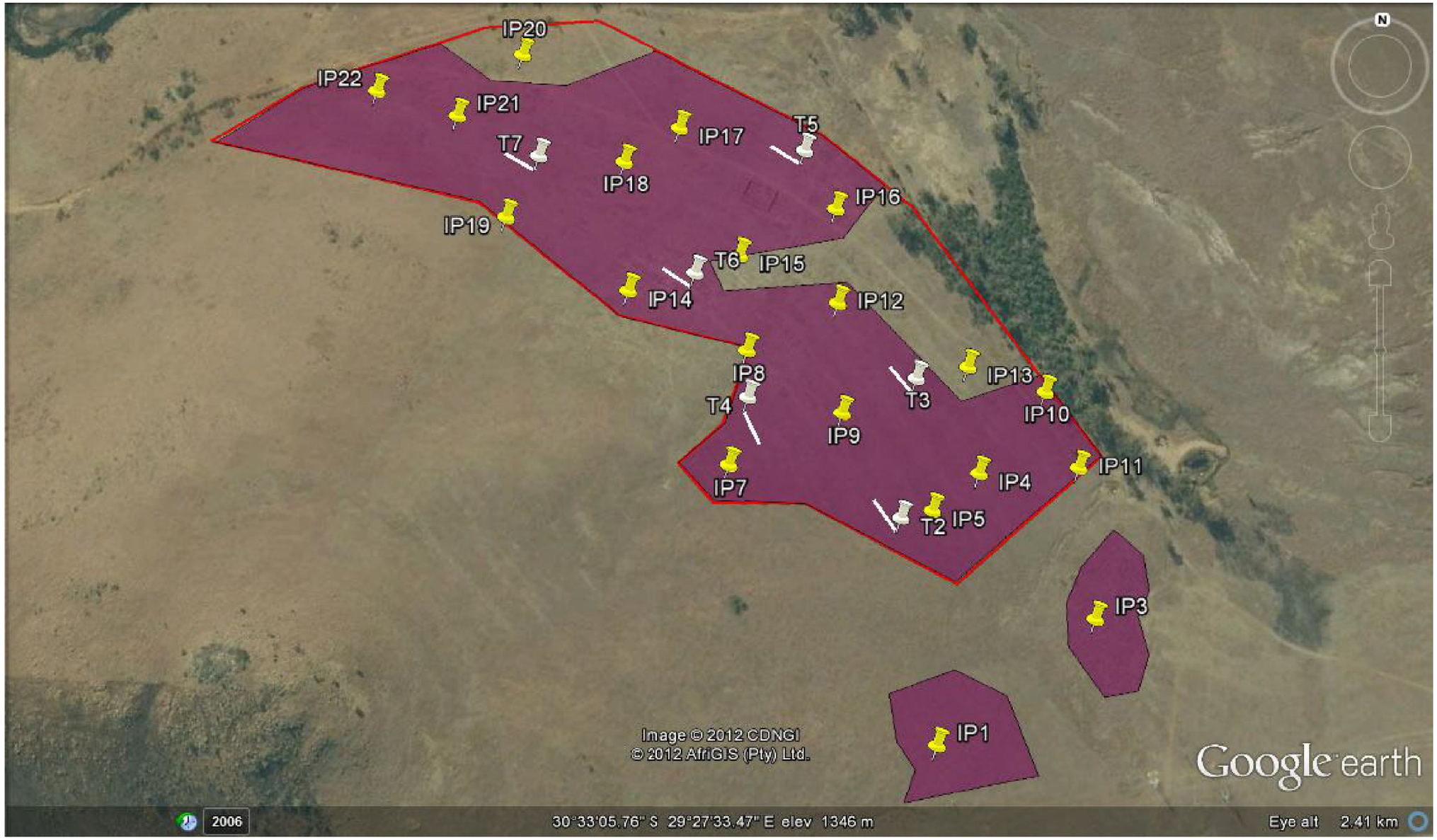
GEOTECHNICAL INVESTIGATION FOR LANDFILL DEVELOPMENT, KOKSTAD
RIPPABILITY ASSESSMENT

REF. NO. 22233

FIG. NO. 4

DRAWING No. 22233/5

SUITABLE ON-SITE SOILS FOR USE IN THE LINER SYSTEM



KEY

Approximate Positions of Relevant Inspection Pits

T4 Approximate Positions of Relevant Seismic Traverses

Extent of area that is recommended for use as the proposed landfill based on the results of the geotechnical investigation

Anticipated Extent of Suitable "Clay Liner Soils"

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GEOTECHNICAL INVESTIGATION FOR LANDFILL DEVELOPMENT, KOKSTAD
SUITABLE ON-SITE SOILS FOR USE IN THE LINER SYSTEM

REF. NO. 22233

FIG. NO. 5