

***Report to NAC JV on a Geotechnical Investigation on Sector K  
and Sector L (Duffs Road to Phoenix 2 Reservoir) of the  
Proposed Northern Aqueduct Pipeline Augmentation***

**Reference : 11-107**

**Dated : August 2012**

**DRAFT**

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## **1. TERMS OF REFERENCE**

Moore Spence Jones (Pty) Ltd was invited by Knight Piesold Consulting on behalf of the Northern Aqueduct Consultants Joint Venture to submit a tender for the provision of geotechnical services for the proposed pipeline from Duffs Road to Phoenix 2 Reservoir, known as the Northern Aqueduct Pipeline. In a letter accompanying their proposal dated 10<sup>th</sup> March 2011, Moore Spence Jones provided cost estimates based on a Schedule of Quantities provided by Knight Piesold. In a signed agreement dated 18<sup>th</sup> March 2011, Moore Spence Jones received an appointment to proceed with the investigation.

Subsequent to the investigation work carried out in 2011, Knight Piesold appointed Moore Spence Jones in July 2012 to carry out the following additional pipeline investigation:

- Sector K : Duffs Road to Phoenix 1 Reservoir offtake (total length 2029m)
- Sector L : Phoenix 1 reservoir to Phoenix 2 Reservoir offtake (total length 4005m)

The requirements for this investigation were established in a kick-off meeting with Messrs R Rodrigues and P Govender of Knight Piesold on 16<sup>th</sup> July 2012. A site visit was conducted immediately after these discussions to confirm the scope of work.

## **2. INFORMATION SUPPLIED**

In addition to contractual and technical information provided in 2011, the following information was made available by Knight Piesold electronically:

- Orthophotos of the proposed route showing the proposed pipeline route through the existing servitude.
- Orthophotos of the proposed route showing the proposed pipeline route through the existing servitude and with accompanying photographs.
- Proposed Northern Aqueduct Pipeline – Background Information Document.
- Map book containing the pipeline route and existing services according to GIS records.
- Drawing titled NAPHASE3\_exportCAD supplied by Knight Piesold.

## **3. DESCRIPTION OF THE PIPELINE ROUTE**

The proposed pipeline route for sector K commences at the offtake located in the median of the M25. It crosses over the Piesang River on the area between northern side of the Duffs Road bridge and south of the existing water pipeline bridge crossing, as shown in Photos 1 and 2. It then curves northwards with the Phoenix 6 reservoir and Phoenix 1 reservoir to the west and east of the pipeline respectively. The initial alignment of the pipeline is on the floodplain, west of the Piesang River, with the R102 to the south. Subsistence farming was observed on the floodplain.

In the section between Duffs road and the end of Eleka road, two main alternative routes crossing the Piesang River, identified by Knight Piesold to establish the most economical or shortest route, were explored.

- i. The first or preferred alternative route starts at the offtake on the R102 and heads south then changes direction close to the R102 and heads eastward to cross the Piesang River adjacent to the Duffs Road Bridge. From Mount Moriah Road it crosses under the road and changes

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direction at the intersection of Eleka Road and Simunye Avenue and heads northward following Simunye Avenue up until it joins the line of the original pipeline route running in the powerline servitude (Photos 1 and 2).



**Photos 1 and 2: Preferred route for crossing the Piesang River (see Figure 1).  
Note existing water pipeline bridge over the river**

- ii. The second alternative starts at the offtake on the M25 and the turn off heading south east through the floodplain to the edge of the R102, then east past the river (bridge overpass), then east on a foot track at the corner of the R102 and Mount Moriah Drive. It then heads approximately northwest on the line of the original route near the dead end of Eleka road, or starting the bottom of the slope approximately 50m from the intersection up along a foot track to the end of Eleka Road (Photos 3 & 4).



**Photo 3: Northwest view overlooking the floodplain Of Piesang River where the pipeline will commence (at EWS water trunk mains shown at the background On right-hand side). Also the M25 is at the far background**



**Photo 4: West view overlooking the sand flood-plain where the pipeline bends in an east direction. The M25 is at the far background**

From the river crossing the pipeline heads eastwards up a relatively steep slope which is highly vegetated, then curves in a north east direction parallel to Eleka Road. The pipeline continues along the north east trend from the beginning of Eleka Road, passes the Phoenix 6 reservoir and carries on until approximately 50m past a tarred road, STR 122309.

The area on either side of the pipeline in this portion is moderately vegetated from STR 122309. The pipeline changes direction and now heads in a north to north-west direction to the Phoenix 2 reservoir. The pipeline passes several tarred roads (at least 15 of them) and a double track railway line. On both sides of the pipeline there is moderate to high vegetation, residential areas and occasional recreational grounds. Sector K (approximately 2km) ends near STR 122322 and Sector L (approximately 4km) commences nearby STR 122323.



**Photo 5: Shale cutting near Phoenix 1 reservoir  
(part of an off-shoot of Sector K approximately 500m  
east of proposed pipeline)**

It must be noted that along the entire pipeline route there are abundant services which mainly run along the tarred road near the residential areas. These include water and sewer mains, trunk mains (underground) and eThekini electricity cables, both overhead and underground. Sector L of the Northern Aqueduct ends at the Phoenix 2 Reservoir located on the northern side of the Phoenix Highway.

## **4. FIELDWORK**

The fieldwork for the investigation, which was conducted between 17 July 2012 and 7 August 2012, comprised of the following:-

- Geological mapping,
- Augered boreholes, and
- Dynamic Cone Penetrometer (light) tests.

A cable avoidance tool (CAT) was used in the test positions where the presence or lack of buried services was in doubt. The CAT tool was used in conjunction with the map book containing the existing GIS service records.

### **4.1 Geological Mapping**

Geological mapping was conducted primarily for the alternative Piesang River crossing route, and to a lesser extent where cuttings and other exposures presented themselves, to obtain information regarding any presence of slip-scars and the dip and dip direction of bedding planes and joints of rock as well as the general geology of the areas along the pipeline route/s which were suspected to be geologically unstable. The cuttings were profiled<sup>1</sup> by an engineering geologist. In total, twenty one positions were profiled, designated MP1 to MP15, P1, P11 and Cutting 1 to Cutting 4.

Generally shale bedrock was encountered with occasional sandstone and dolerite. The dip and dip direction of the Shale and Sandstone varied widely over a short distance between mapping positions.

Copies of the geological mapping logs are provided in Appendix A.

### **4.2 Augered Boreholes**

Boreholes, drilled using hand auger tools, were found to be very successful in areas where non-obtrusive methods (due to abundant services, built-up residential and environmentally sensitive areas) were required.

Fifty two augered boreholes, designated AH1 to AH32, AH101 to AH113, AH Alt1 to AH Alt7, were excavated at the approximate positions shown in Figures K-1, L-1 and L-2. These boreholes were excavated at locations on the pipeline route due to the use of a mechanical digger such as a TLB being both impractical and hazardous as the proposed pipeline alignment lies beneath tarred roads in some areas, and also the presence of an abundance of services. The augered boreholes were drilled to refusal depths ranging from 0.19m (AH Alt6) to 2.24m (AH103) below existing ground level.

Samples recovered from the flight of the auger were logged<sup>1</sup>.

Copies of the hand augered borehole logs are provided in Appendix B.

#### 4.3 Dynamic Cone Penetrometer (Light) Tests

In order to avoid the breaching of any services by the DPL tests, each DPL test was conducted in the hole of the augered borehole which was predrilled to 1.5m depth or earlier refusal on bedrock.

The DPL tests were conducted through the augered boreholes from ground level to refusal. In total, seventy four DPL tests were conducted, designated DPL1 to DPL41, DPL101 to DPL118 DPL Alt1 to DPL Alt8, DPL FT1 to DPL FT4 and DPL Cutting 1 to DPL Cutting 3.

DPL refusal was generally encountered at shallow depths corresponding to that of auger refusal ranging from 0.3 to 0.6 metres below ground level, however, DPL103 to DPL105, carried out on the Piesang River flood plain, were advanced to greater depths of 6 metres below existing ground level.

It must be noted that in addition to bedrock, refusal could also occur on dense or stiff layers, boulders or similar competent material and is not necessarily indicative of rock.

The results of these cone penetrometer tests, consisting of plots of blowcount and inferred soil strength against penetration depth, are given in Appendix C.

### 5. GEOLOGY

#### 5.1 General Geology of the Area

Sectors K and L of the proposed pipeline route are underlain by Pietermaritzburg Formation shale and Vryheid Formation sandstone. Both the Pietermaritzburg formation shale and Vryheid formation sandstones are extensively intruded both on a local and regional scale by Jurassic dolerite. Regionally, certain parts of the area under investigation are characterised by folding and faulting.

#### 5.2 Detailed Geology along the Pipeline Route

The detailed soil and rock geology encountered along the route is summarised in Table 1 below.

<sup>1</sup> Geoterminology Workshop (2002) – Guidelines for Soil and Rock Logging – SAIEG-AEG-SAICE (Geotech Div) pp47

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**Table 1**  
**Summary of Geology**

Sector	Chainage (m)	Test/Inferred Generalised Ground Subsoil Conditions	Other Comments
K	0 to 360  Take-off on R102 running parallel to Duffs road to beginning of Mount Moriah road (Preferred Piesang River Crossing Route)	<p>AH Alt1 to AH Alt3 DPL Alt1 to DPL Alt3, DPL 111, DPL FT4 MP 10 and MP 12</p> <p><b>ON FLOODPLAIN</b> 0.00-0.82m Slightly moist to Moist brown loose intact slightly clayey silty fine to medium sand. Alluvium 0.82-&gt;6.0m (in places) Moist to wet brown loose intact medium to coarse grained sand.</p> <p><b>EDGES OF FLOODPLAIN</b> 0.12-0.25m Slightly moist khaki brown speckled yellow and orange sandy gravelly clay. Residual shale 0.25-0.45m Orangey brown highly weathered fine grained no visible jointing very soft rock shale.</p> <p><b>NEAR FOOT OF SLOPE</b> Geology: Shale  Structural readings: <u>Shale</u> Dip and dip direction of bedding on south facing slope : 70°/340°, 68/345  Shale is greyish to greenish brown highly weathered fine grained thinly laminated closely bedded very soft rock, occasional alteration due to contact metamorphism due to dolerite intrusions on local/regional scale.</p>	<ul style="list-style-type: none"> <li>Anticipate groundwater seepage at the water table (within alluvium layer).</li> <li>DPL generally goes deep compared to auger boreholes, attains depths of up to 6m in flood plain.</li> <li>On the floodplain anticipate alluvium/residual shale to depth of up to 6.0m (DPL117 and DPL ALT3).</li> <li>NOTE: It is evident that it had rained the previous day as well as on the day of the site investigation of the alternative route positions.</li> </ul>
K	Part of the original pipeline route (Alternate Piesang River Crossing Route) between 0 and 400	<p>AH 101 to AH 105 DPL 101 to DPL 108 MP1 TO MP3</p> <p><b>ON FLOODPLAIN</b> 0.00-2.24m Slightly moist to moist brown loose to medium dense silty Sand. Alluvium.</p> <p><b>ON SLOPE</b> 0.00-1.15m Slightly moist light grey to light brown speckled white medium dense intact gravelly silty sand. Gravel consists of angular to subangular shale fragments.</p> <p>Geology: Shale and sandstone  Structural readings: <u>Shale</u> Dip and dip direction of bedding on west facing slope : 26°/328°, 16°/344°, 14°/311°  Shale is greyish to greenish brown highly weathered fine grained thinly laminated closely bedded very soft rock, occasional alteration due to contact metamorphism due to dolerite intrusions on local/regional scale.</p>	<ul style="list-style-type: none"> <li>On the west facing slope the shale beds dip North West to North of North West. Sandstone beds dip North.</li> <li>On the West facing slope anticipate dense residual shale or very soft to soft rock shale at &gt;1.2-1.5m.</li> </ul>

Sector	Chainage (m)	Test/Inferred Generalised Ground Subsoil Conditions	Other Comments
		<u>Sandstone</u> Dip and dip direction of bedding on west facing slope : 16°/007°  Sandstone is cream white medium weathered closely jointed medium bedded soft rock.	
K	400 to 1020  Between dead end of Eleka Road and T-Junction of Eleka Road and Simunye Avenue	AH 1 to AH 2, AH Alt4 to AH Alt7 DPL 1 to DPL 2, DPL Alt4 to DPL Alt8  0.00-0.30m Slightly moist brown to dark brown loose to medium dense intact slightly gravelly clayey Sand. Colluvium. 0.05-0.84m Moist brown mottled red and yellow firm to stiff with depth intact Clay. Residual shale. >0.84m Anticipate stiff soil or very soft rock shale.	<ul style="list-style-type: none"> <li>Shallow auger refusal.</li> <li>DPL tests went down deeper, beyond the refusal depth of auger.</li> <li>The deep DPL refusals may have been caused by recent rainfall percolating down through the soil into stiff soil or soft bedrock making it softer.</li> </ul>
K	1040 to 2029  Between Eleka Road, Simunye Avenue T-Junction and end of Sector K	AH 3 to AH 7 DPL 3 to DPL 7  0.00-0.80m Slightly moist to moist greyish brown to yellowish brown very soft to stiff with depth intact gravelly sandy Clay. Colluvium. 0.00-1.50m Slightly moist to moist dark grey to light brown very soft to soft with depth intact clayey silty Sand. Alluvium. > 1.50m Anticipate residual soil. > 2.40m Anticipate soft rock shale.	<ul style="list-style-type: none"> <li>Shallow auger refusal.</li> <li>Maximum auger depth = 1.50m (AH6 and AH7).</li> <li>Shallow DPL refusal.</li> <li>Maximum depth = 2.40m (DPL6).</li> </ul>
L	0 to 440  Start of Sector K: STR 122323 and Ranmoor Crescent	AH 8 to AH 10 DPL 8 to DPL 10  0.00-0.50m Dry to slightly moist light greyish to light brown loose to medium dense intact gravelly silty sand. Gravel consists of angular to subangular shale fragments. Colluvium. 0.00-1.00m Slightly moist greyish light brown to greyish dark brown soft to firm intact silty sandy Clay. Colluvium. > 1.00m Anticipate very soft to soft rock shale.	<ul style="list-style-type: none"> <li>Shallow auger refusal.</li> <li>Maximum auger depth = 1.00m (AH8).</li> <li>Shallow DPL refusal.</li> <li>Maximum depth = 1.50m (DPL8).</li> </ul>
L	620 to 1160  Between STR 122325 and Phoenix Reservoir 1	Cutting1 to Cutting 4 DPL Cutting 1 to DPL Cutting 3  0.0-0.30m Dry to slightly moist greyish dark brown to yellowish brown medium dense to dense intact gravelly clayey silty Sand. Colluvium. 0.20-1.60m Yellowish light brown highly weathered closely jointed thinly laminated soft rock Shale.  0.30-1.80m Light greyish brown completely weathered medium hard rock with reddish brown corestone boulders (0.2-10m diameter).	<ul style="list-style-type: none"> <li>Groundwater seepage was encountered at Cutting 4 at a depth of 0.70m.</li> </ul>
L		AH 11 to AH 14 DPL 11 to DPL 14  0.00-0.50m Slightly moist greyish to yellowish brown very soft to stiff intact gravelly silty sandy Clay.	<ul style="list-style-type: none"> <li>Shallow auger refusal, DLP tests were deeper than auger refusal depth.</li> <li>Maximum auger depth = 1.50m (AH14).</li> </ul>

Sector	Chainage (m)	Test/Inferred Generalised Ground Subsoil Conditions	Other Comments
		<p>Colluvium. 0.00-1.50m Slightly moist to moist greyish brown to light brown loose to medium dense intact clayey silty Sand. Alluvium. &gt; 1.50m Anticipate residual soil. &gt; 2.70m Anticipate dense residual soil/soft rock shale.</p>	<ul style="list-style-type: none"> <li>Maximum DPL refusal depth = 2.70m (DPL14).</li> </ul>
L	1340 to 1960	<p>AH15 to AH18 DPL15 to DPL18</p> <p>0.00-0.40m Dry to slightly moist, greyish brown to dark brown very loose to medium dense intact gravelly silty sand. Colluvium. 0.18-0.40m Slightly moist greyish light brown to yellowish brown soft to firm gravelly silty sandy Clay. Residual Shale. &gt;0.40m Anticipate soft rock shale.</p>	<ul style="list-style-type: none"> <li>Shallow auger refusal, 0.40m (AH15 and AH18).</li> <li>DPL tests go deeper than auger refusal, up to 1.5m (DPL15).</li> </ul>
L	2140 to 2840	<p>AH 19 to AH 24 DPL 19 to DPL 24</p> <p>0.00-0.76m Slightly moist greyish brown to yellowish brown soft to firm intact gravelly sandy Clay. Colluvium. 0.00-1.50m Slightly moist to moist greyish brown to dark brown loose to dense intact gravelly clayey Sand. &gt; 1.50m Anticipate residual soil / soft bedrock.</p>	<ul style="list-style-type: none"> <li>Shallow auger refusal</li> <li>Maximum depth : 1.50m (AH22)</li> <li>DPL tests went down to 3.00m (DPL21 and DPL22).</li> </ul>
L	2860 to 3460	<p>AH 25 to AH 28 DPL 25 to DPL 28</p> <p>0.00-0.70m Dry to slightly moist dark grey to light brown medium dense to dense intact clayey silty or gravelly Sand. Colluvium 0.00-0.90m Slightly moist greyish brown and yellowish brown soft to firm sandy silty or gravelly silty Clay. Residual shale &gt; 0.90m Anticipate residual soil/soft rock shale.</p>	<ul style="list-style-type: none"> <li>Shallow auger and DPL refusals, 0.90m (AH25) and 1.20m (AH26).</li> </ul>
L	3640 to 4004.49	<p>AH 29 to AH 32 DPL 29 to DPL 32</p> <p>0.00-0.84m Dry to slightly moist greyish dark brown to khaki light brown soft to firm intact sandy silty gravelly Clay. Residual shale 0.00-1.23m Slightly moist to moist dark greyish brown loose to medium dense intact silty clayey Sand. &gt; 0.84m Anticipate residual soil. &gt; 2.10m Anticipate soft rock shale.</p>	<ul style="list-style-type: none"> <li>Shallow auger and DPL refusals.</li> <li>Auger refusal &lt; 1.50m.</li> <li>DPL refusal &lt;3.00m.</li> <li>Maximum auger depth: 1.23m (AH30).</li> <li>Maximum DPL depth: 2.10m (DPL30).</li> </ul>

## 6. GROUNDWATER

Groundwater seepage was encountered at Cutting 4 (at 0.70m) and in auger holes AH103 (2.24m), AH ALT 1 (1.63m), and AH ALT2 (1.46m). The auger hole positions are located near the piesang river, which would account for the relatively shallow water table encountered at these positions.

Groundwater can generally be expected to occur at the interface between transported soils and the underlying residual soils and/or bedrock, particularly during and after rainfall periods.

Groundwater seepage can also be expected to proliferate in the vicinity of rivers and drainage systems, which incorporate numerous drainage lines, shallow valleys and riverlets.

## 7. MATERIALS ASSESSMENT

### 7.1 Bedding and Backfill Requirements

The Northern Aqueduct bedding material requirements were established in 2011 as the following:

- a) **Selected Granular Fill** – Required for the bedding material (includes cradle and blanket material) surrounding the pipe and defined as material complying with the following requirements (Table 2).

**Table 2  
Grading Envelope for Selected Granular Fill (PSLB 3.1)**

GRADING ANALYSIS RANGE	
SIEVE SIZE (mm)	PERCENTAGE PASSING
6.700	90 to 100
4.750	80 to 90
2.360	65 to 80
1.180	50 to 65
0.600	35 to 50
0.425	25 to 35
0.300	15 to 25
0.150	5 to 15
0.075	0 to 5

The material shall be free of organic matter and shall have a compactability factor of not more than 0.4. The material should classify as silty fine sand having a pipe-soil stiffness ratio E' of not less than 5.0 MPa. It is required that the larger grains (4.0 to 7.0mm in size) be rounded and not sharp and angular.

Should material meeting the specification for Selected Granular Fill not be available then where suitable the Engineer will approve Selected Fill Material as the blanket material.

- b) **Selected Fill Material** is to be used above the pipe surround material. This material shall have a PI not exceeding 10 and shall be free from vegetation and from lumps and angular stones. Maximum particle size shall be 30mm with at least 60% passing the 6.75mm sieve. The material shall be granular and non-flaky and shall contain no organic matter. It shall have a pH greater than 5.5 and shall not cake or form lumps when drying out.

### 7.2 Suitability of Insitu Materials

It was indicated by Mr Rodrigues at the kick-off meeting on 16th July 2012 that the insitu materials along Sectors K and L of the route are unlikely to present suitable bedding materials. It was accepted that suitable bedding materials would need to be imported from commercial sources.

## 8. DEVELOPMENT GUIDELINES AND RECOMMENDATIONS

### 8.1 Proposed Pipeline

The proposed pipeline for Sectors K and L will be constructed of a 1200mm diameter continuously welded steel pipe.

Bedding and Blanketing Requirements are outlined in the Table 3 below and form the basis for the calculation of trench depths.

**Table 3  
Bedding and Blanketing Requirements**

Pipe Diameter	Minimum Thickness of Selected Granular Material (SGM)	Minimum Thickness of Selected Fill Material Blanket (SFM)	Minimum Thickness of General Backfill
Up to and including 1200mm diameter	Bed: 200mm Cover: 300mm	200mm	1.0m

The trench depth for Sectors K and L is therefore 3.0m.

The trench width has been determined in accordance with SABS 1200 DB Earthworks (Pipe Trenches) as follows:

External diameter of pipe barrel (mm)

- Up to and including 700
- 700 up to and including 1000
- 1000 up to and including 2000

Side allowance on each side (mm)

- 300
- 400
- 500

The thickness of road layerworks are not taken into consideration when calculating the above minimum trench depths.

### 8.2 Trenchability

The results of the fieldwork, providing an indication of the trenchability of the soils along the pipeline route, are summarised in Table 4 attached. The excavation or trenchability requirements for the materials encountered along the pipeline route have been classified according to SABS1200DM.

In summary, the following volumes of materials of the various excavation classes are anticipated (Table 5).

**Table 5  
Summary of Anticipated Excavation Requirements**

Excavation Class	Estimated Volume (m <sup>3</sup> )		Total (m <sup>3</sup> )
	Sector K	Sector L	
Soft	10190	17396	27586
Intermediate	3201	9037	12238
Hard	0	0	0

Note: Pipe diameter: 1.2mØ

Trench width: 2.2m

Trench depth: 3.0m

It has been indicated by Knight Piesold that the volumes given above are to be treated as indicative only based on anticipated trench depths and widths which are a function of the design. Therefore, the volumes of material given in the tables above should be viewed as provisional quantities. The calculation of the quantities does not include for any batter slopes of trench sidewalls or additional excavation for scour valves or other pipeline infrastructure.

## **8.3 Trench Stability**

### **8.3.1 General**

With particular reference to the stability of the sidewalls of trenches it is important to ensure that the toe of the stockpile of soil removed is placed a distance from the trench at least equal to the depth of the trench<sup>2</sup>. The safety issues regarding excavation and working in open, unsupported trenches should fall in line with the requirements of the General Safety Regulations promulgated by Government Notice No. R1031 of 30 May 1986 as amended. It is generally required that trenches deeper than 1.5m must be adequately shored where there is a possibility of collapse. With pipeline trenches in particular there is a tendency to open the trench over significant lengths thereby increasing the risk of sidewall collapse. In any event there must be provision for safe access not more than every 20m along the trench length.

Key issues regarding the stability of trench sidewalls is;-

- Unstable sidewallsSoft wet soil conditions.
- Surcharge loading at edges of trenches
- Groundwater seepage
- Rainwater runoff

Of these both surcharge loading and control of rainwater runoff can be managed. Surcharge in the form of stockpiling of backfill, or trenching machinery (pipe laying rigs), must be placed well away from the edge of the trench. The other issues such as soft soils and groundwater ingress must fall under daily audits by professionals well experienced in these matters, otherwise shoring must be introduced.

### **8.3.2 Unstable Trench Sidewalls – Shale Areas**

The pipeline is predominantly underlain by a soil mantle up to about 1.5 metres thick in places, overlying weathered shale of the Pietermaritzburg Formation. The soil mantel may range from fill materials which are loose/ unconsolidated to fairly competent without the need to support excavation sides. As a general indication the soil mantle above the shale bedrock should be battered at a safe angle not steeper than 1V:1H should the excavations need to remain open for more than 24 hours. Incidence of rain or groundwater may require that this temporary batter slope should be flattened to promote stability, at the request of the Engineer.

Generally the underlying shales are flatly or horizontally bedded and it is not anticipated that these will result in trench failure even where a near vertical excavation wall is formed. However, care must be taken to ensure that where trenches are cut through shale bedrock and there is evidence of steeply dipping shales which result in the daylighting of bedding or other joint planes into the excavation that a potentially unstable trench sidewall does not occur. It will thus be important that during construction Moore Spence Jones are requested to confirm the safe angle of batter where such conditions manifest themselves.

### **8.3.3 Unstable Trench Sidewall – Soft / Loose Alluvial Soils**

Soft and very loose soil conditions will be encountered where the pipeline crosses the flat, alluvial section of the Piesang River valley at Duffs Road. The alluvial soils can be expected to have very shallow groundwater conditions with associated sidewall collapse at or below the groundwater seepage.

In this area it is thus anticipated that it will be necessary to allow for lateral support in formf sheet piles or trench sheeters. Dewatering of groundwater should also be allowed for.

<sup>2</sup> Lateral Support in Surface Excavations. Code of Practice 1989. The South African Institute of Civil Engineers, Geotechnical Division

## 8.4 Pipe Jacking – Phoenix Highway

Pipe jacking will be required beneath the Phoenix Highway, where the pipeline crosses to connect with the Phoenix Reservoir 2, as shown in Figure L-2.

In EXP1, the exposure created by a proving excavation by Durban Metro on the existing pipeline route, indicates the following:

0 to 1.5m Fill material and pipeline bedding

1.5 to 2.0m Highly to moderately weathered, very soft rock to soft rock shale (Pietermaritzburg Group).

The results of DPL31 and DPL36 to DPL40 tend to confirm this assessment. Refusal of the DPL occurred at a depth of between 0.8 and 3.0m, on average 1.5m, indicating that shale probably of soft rock occurs below this depth.

The pipejacking conditions are not anticipated to be troublesome since the bulk of the excavation occurs within the residual shales and shales of very soft to soft rock strength as these are approximately horizontally bedded and can be removed by jackhammer. The excavation class of the shales is expected to be Intermediate.

No groundwater was observed in the excavation in EXP1 and as such it is anticipated that the pipejacks will be carried out in dry conditions unless there are leaks from the nearby pipeline and/or reservoir which may create groundwater problems.

## 9. CONCLUSIONS

This report contains the results of a geotechnical investigation carried out for Sector K and L, some 6km in length, of the Northern Aqueduct Pipeline Augmentation.

The likely trenching requirements for the materials along Sector K and L of the pipeline route have been evaluated by insitu field tests. The detailed results of the excavation requirements are given in Table 4 of this report. Estimated volumes of the various excavation classes of material are given.

Bedding material meeting Selected Granular Fill as specified is generally absent from the soil profile and will need to be imported. Most excavated materials will, however, be suitable for Selected Fill and general backfill purposes.

On pipeline contracts it is generally accepted that the digging of trenches for the pipeline route becomes in effect an extension of the geotechnical investigation. It is therefore important that the geotechnical consultant becomes involved in the construction of the pipeline, not only to review geotechnical matters but also to take charge of issues relating to sidewall stability and bedding material.

Finally, the ground conditions described in this report refer specifically to those encountered in the geological mapping, augered boreholes, and DPL tests put down on site. It is therefore quite possible that conditions at variance with those discussed above can be encountered elsewhere on the sites during construction. It is therefore important that Moore Spence Jones (Pty) Ltd carry out periodic inspections of the open excavations. Any change from the anticipated ground conditions could then be taken into account to avoid unnecessary expense. In this regard it is important that the construction phase of the project be treated as an augmentation of the geotechnical investigation.

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DRAFT

TABLE 4  
NORTHERN AQUEDUCT AUGMENTATION  
SECTOR K  
EXCAVABILITY TABLE



Chainage (m)	0	60	90	120	130	
DPL POSITION		DPL101		DPL102		DPL ALT2
AUGER HOLE / INSPECTION PIT POSITIONS	AH101		AH ALT 1		AH113	
DEPTH (mm)						
0.0	0.2 Light greyish brown gravelly silty SAND.					
0.3	REFUSAL	27		5	0.30 Dark brown gravelly clayey SAND.	25
0.6		46	0.82 Brown clayey silty SAND. Alluvium.	24		37
0.9		29		20		REFUSAL
1.2		12		15		
1.5		REFUSAL	1.63 Brown SAND. Alluvium.	15	1.50 Dark greyish brown silty SAND.	1.55 Dark brown silty clayey SAND.
1.8			1.70 Brown SAND. Alluvium.	10	REFUSAL	29
2.1			END	7		END
2.4				7		
2.7				6		
3.0				7		
3.3				9		
3.6				8		
3.9				12		
4.2				26		
4.5						
4.8						
5.1						
5.4						
5.7						
6.0						
SOFT EXCAVATION m <sup>3</sup>	139		267		139	363
INTERMEDIATE EXCAVATION m <sup>3</sup>	119		65		89	
HARD EXCAVATION m <sup>3</sup>						
TOTALS (m <sup>3</sup> )	257			228		
MIN TRENCH WIDTH (m)	2.20	2.20	2.20	2.20	2.20	2.20
MINIMUM TRENCH DEPTH (m)	3.0	3.0	3.0	3.0	3.0	3.0
PIPE DIAMETER (m)	1.20	1.20	1.20	1.20	1.20	1.20
TRENCH INSTABILITY						YES
GROUNDWATER						YES



Chainage (m)	190	210	230	240	240		
DPL POSITION	DPL116		DPL115		DPL114		DPL ALT3
AUGER HOLE / INSPECTION PIT POSITIONS		AH12		AH11		AH ALT3	
DEPTH (mm)							
0.0					0.12 Brown black SAND. Alluvium.		
0.3	40	0.30 Light grey to light brown silty SAND.	45	0.25 Light grey to light brown gravelly silty SAND.	13	0.25 Khaki brown sandy gravelly CLAY. Residual Shale.	19
0.6	58	REFUSAL	REFUSAL	REFUSAL	37	0.45 Orangey brown very soft rock SHALE.	60
0.9	REFUSAL			REFUSAL	REFUSAL		34
1.2							20
1.5							26
1.8							16
2.1							20
2.4							26
2.7							13
3.0							22
3.3							25
3.6							21
3.9							18
4.2							19
4.5							18
4.8							45
5.1						REFUSAL	
5.4							
5.7							
6.0							
SOFT EXCAVATION m <sup>3</sup>			264				119
INTERMEDIATE EXCAVATION m <sup>3</sup>			264				26
HARD EXCAVATION m <sup>3</sup>							
TOTALS (m <sup>3</sup> )							
MIN TRENCH WIDTH (m)	2.20	2.20	2.20	2.20	2.20	2.20	2.20
MINIMUM TRENCH DEPTH (m)	3.0	3.0	3.0	3.0	3.0	3.0	3.0
PIPE DIAMETER (m)	1.20	1.20	1.20	1.20	1.20	1.20	1.20
TRENCH INSTABILITY		YES					
GROUNDWATER		YES					

Chainage (m)	280	320	380		
DPL POSITION		DPL113		DPL112	DPL111
AUGER HOLE / INSPECTION PIT POSITIONS	AH110		AH109		AH108
DEPTH (mm)					
0.0			0.20 Light grey to light brown gravelly silty clayey SAND.		
0.3		18	END	27	0.30 Light to greyish brown silty gravelly SAND.
0.6		25		19	REFUSAL
0.9	0.90 Light greyish brown gravelly silty SAND.	28		REFUSAL	REFUSAL
1.2	REFUSAL	REFUSAL			
1.5					
1.8					
2.1					
2.4					
2.7					
3.0					
3.3					
3.6					
3.9					
4.2					
4.5					
4.8					
5.1					
5.4					
5.7					
6.0					
SOFT EXCAVATION m <sup>3</sup>			462		
INTERMEDIATE EXCAVATION m <sup>3</sup>			462		
HARD EXCAVATION m <sup>3</sup>					
<b>TOTALS (m<sup>3</sup>)</b>					
MIN TRENCH WIDTH (m)	2.20	2.20	2.20	2.20	2.20
MINIMUM TRENCH DEPTH (m)	3.0	3.0	3.0	3.0	3.0
PIPE DIAMETER (m)	1.20	1.20	1.20	1.20	1.20
TRENCH INSTABILITY					
GROUNDWATER					

Chainage (m)	420	540	680	760	850
DPL POSITION			DPL ALT4		
AUGER HOLE / INSPECTION PIT POSITIONS	AH04	AH ALT4	AH ALT5		AH ALT6
DEPTH (mm)					
0.0		0.05 Brown gravelly clayey SAND. Colluvium.	0.08 Brown clayey SAND. Colluvium.		0.19 Brown slightly gravelly CLAY.
0.3		0.36 Brown mottled red and khaki CLAY. Residual Shale.	15	16	19 REFUSAL
0.6	0.80 Dark greyish brown gravelly sandy CLAY. Colluvium.	END	24	0.84 Brown mottled red and yellow CLAY. Residual Shale.	16 10
0.9	END		25	REFUSAL	17 7
1.2			14		21 15
1.5			17		29 18
1.8			15		34 REFUSAL
2.1			36		80
2.4			REFUSAL		REFUSAL
2.7					
3.0					
3.3					
3.6					
3.9					
4.2					
4.5					
4.8					
5.1					
5.4					
5.7					
6.0					
SOFT EXCAVATION m <sup>3</sup>			2673		
INTERMEDIATE EXCAVATION m <sup>3</sup>			396		
HARD EXCAVATION m <sup>3</sup>					
<b>TOTALS (m<sup>3</sup>)</b>					
MIN TRENCH WIDTH (m)		2.20	2.20	2.20	2.20
MINIMUM TRENCH DEPTH (m)		3.0	3.0	3.0	3.0
PIPE DIAMETER (m)		1.20	1.20	1.20	1.20
TRENCH INSTABILITY					
GROUNDWATER					



Chainage (m)	850	1010	1040	
DPL POSITION	DPL ALT7	DPL ALT8		DPL3
AUGER HOLE / INSPECTION PIT POSITIONS		AH ALT7		AH3
DEPTH (mm)				
0.0		0.06 Brown clayey SAND. Colluvium.		
0.3	23	0.51 Brown CLAY. Residual Shale.	13	0.43 Greyish brown silty SAND. Colluvium.
0.6	20	END	100	REFUSAL
0.9	REFUSAL		REFUSAL	
1.2				
1.5				
1.8				
2.1				
2.4				
2.7				
3.0				
3.3				
3.6				
3.9				
4.2				
4.5				
4.8				
5.1				
5.4				
5.7				
6.0				
SOFT EXCAVATION m <sup>3</sup>			924	
INTERMEDIATE EXCAVATION m <sup>3</sup>			924	
HARD EXCAVATION m <sup>3</sup>				
TOTALS (m <sup>3</sup> )				
MIN TRENCH WIDTH (m)	2.20	2.20	2.20	2.20
MINIMUM TRENCH DEPTH (m)	3.0	3.0	3.0	3.0
PIPE DIAMETER (m)	1.20	1.20	1.20	1.20
TRENCH INSTABILITY				
GROUNDWATER				

Chainage (m)	1220	1460	1650	1860	2029
DPL POSITION		DPL4		DPL5	
AUGER HOLE / INSPECTION PIT POSITIONS	AH4		AH5		AH6
DEPTH (mm)					END OF SECTOR K
0.0					
0.3		1	0.55 Orangey brown clayey silty SAND. Alluvium.	3	1
0.6	0.80 Dark greyish brown gravelly sandy CLAY. Colluvium.	1	0.80 Greyish brown clayey silty SAND. Alluvium.	1	1
0.9	END	1	REFUSAL	86	1.00 Greyish brown silty SAND.
1.2		18		49	1
1.5		22		END	1.50 Greyish brown silty sandy CLAY.
1.8		56			1.50 Dark grey to light brown slightly silty clayey SAND. Alluvium.
2.1		59			32
2.4			REFUSAL		END
2.7					50
3.0					
3.3					
3.6					
3.9					
4.2					
4.5					
4.8					
5.1					
5.4					
5.7					
6.0					
SOFT EXCAVATION m <sup>3</sup>			4841		10190
INTERMEDIATE EXCAVATION m <sup>3</sup>			855		3201
HARD EXCAVATION m <sup>3</sup>					0
<b>TOTALS (m<sup>3</sup>)</b>					<b>13391</b>
MIN TRENCH WIDTH (m)	2.20	2.20	2.20	2.20	2.20
MINIMUM TRENCH DEPTH (m)	3.0	3.0	3.0	3.0	3.0
PIPE DIAMETER (m)	1.20	1.20	1.20	1.20	1.20
TRENCH INSTABILITY					
GROUNDWATER					13,391
					TOTAL TRENCH VOLUME (m <sup>3</sup> )

TABLE 4  
NORTHERN AQUEDUCT AUGMENTATION  
SECTOR L  
EXCAVABILITY TABLE



Chainage (m)	0	240	440	640	
DPL POSITION		DPL8		DPL9	
AUGER HOLE / INSPECTION PIT POSITIONS	AH8		AH9		AH10
DEPTH (mm)					
0.0		0.26 Greyish light brown gravelly silty sandy CLAY. Colluvium.			
0.3	7	END	36	0.50 Light greyish brown gravelly silty SAND. Colluvium.	7
0.6	23		39	REFUSAL	27
0.9	18		27		52
1.2	1.00 Greyish dark brown silty sandy CLAY. Colluvium.	31	35		46
1.5		37	REFUSAL		END
1.8		REFUSAL			
2.1					REFUSAL
2.4					
2.7					
3.0					
3.3					
3.6					
SOFT EXCAVATION m <sup>3</sup>			3419		
INTERMEDIATE EXCAVATION m <sup>3</sup>			1465		
HARD EXCAVATION m <sup>3</sup>					
TOTALS (m <sup>3</sup> )	4884		0		
MIN TRENCH WIDTH (m)	2.20	2.20	2.20	2.20	2.20
MINIMUM TRENCH DEPTH (m)	3.0	3.0	3.0	3.0	3.0
PIPE DIAMETER (m)	1.20	1.20	1.20	1.20	1.20
TRENCH INSTABILITY					
GROUNDWATER					



Chainage (m)	840		1020		1160	
DPL POSITION		DPL12		DPL13		DPL14
AUGER HOLE / INSPECTION PIT POSITIONS	AH12		AH13		AH14	
DEPTH (mm)						
0.0	0.20 Dark to light grey gravelly silty SAND. Colluvium.					
0.3	REFUSAL	55		1		26
0.6		REFUSAL	0.60 Greyish brown silty sandy CLAY.	1		25
0.9			END	9	1.0 Dark brown clayey silty SAND. Alluvium.	11
1.2				37	1.20 Light brown silty SAND. Alluvium.	12
1.5				55	1.50 Light grey to light brown clayey SAND.	18
1.8				REFUSAL	END	12
2.1						14
2.4						50
2.7						
3.0						
3.3						
3.6					REFUSAL	
SOFT EXCAVATION m <sup>3</sup>	502		739		1122	
INTERMEDIATE EXCAVATION m <sup>3</sup>	752		317			
HARD EXCAVATION m <sup>3</sup>						
<b>TOTALS (m<sup>3</sup>)</b>			<b>1056</b>			
MIN TRENCH WIDTH (m)	2.20	2.20	2.20	2.20	2.20	2.20
MINIMUM TRENCH DEPTH (m)	3.0	3.0	3.0	3.0	3.0	3.0
PIPE DIAMETER (m)	1.20	1.20	1.20	1.20	1.20	1.20
TRENCH INSTABILITY						
GROUNDWATER						



Chainage (m)	1360		1560		1760	
DPL POSITION		DPL15		DPL16		DPL17
AUGER HOLE / INSPECTION PIT POSITIONS	AH15		AH16		AH17	
DEPTH (mm)						
0.0	0.18 Greyish brown silty sandy CLAY. Colluvium.			0.20 Light greyish brown gravelly silty SAND. Colluvium.		
0.3	0.40 Greyish to yellowish brown gravelly silty sandy CLAY. Residual Shale.	14	0.32 Brown mottled gravelly silty CLAY. Residual Shale.	15	REFUSAL	1
0.6	END	27	0.35 Orangey brown soft rock SHALE.	33		10
0.9		17	REFUSAL	45		46
1.2		33		REFUSAL		47
1.5		29				REFUSAL
1.8		END				
2.1						
2.4						
2.7						
3.0						
3.3						
3.6						
SOFT EXCAVATION m <sup>3</sup>	924		792		924	
INTERMEDIATE EXCAVATION m <sup>3</sup>	396		528		396	
HARD EXCAVATION m <sup>3</sup>						
<b>TOTALS (m<sup>3</sup>)</b>						
MIN TRENCH WIDTH (m)	2.20	2.20	2.20	2.20	2.20	2.20
MINIMUM TRENCH DEPTH (m)	3.0	3.0	3.0	3.0	3.0	3.0
PIPE DIAMETER (m)	1.20	1.20	1.20	1.20	1.20	1.20
TRENCH INSTABILITY						
GROUNDWATER						



Chainage (m)	1960		2160		2360	
DPL POSITION		DPL18		DPL19		DPL20
AUGER HOLE / INSPECTION PIT POSITIONS	AH18		AH19		AH20	
DEPTH (mm)						
0.0						
0.3	0.40 Greyish to dark brown gravelly silty SAND. Colluvium.	33		23	0.36 Light to dark brown gravelly silty SAND. Colluvium.	46
0.6	REFUSAL	39	0.76 Greyish light brown gravelly silty sandy CLAY. Colluvium.	18	REFUSAL	86
0.9		END	END	21		END
1.2				REFUSAL		
1.5						
1.8						
2.1						
2.4						
2.7						
3.0						
3.3						
3.6						
SOFT EXCAVATION m <sup>3</sup>		1188			990	
INTERMEDIATE EXCAVATION m <sup>3</sup>		792			990	
HARD EXCAVATION m <sup>3</sup>						
TOTALS (m <sup>3</sup> )						
MIN TRENCH WIDTH (m)	2.20	2.20	2.20	2.20	2.20	2.20
MINIMUM TRENCH DEPTH (m)	3.0	3.0	3.0	3.0	3.0	3.0
PIPE DIAMETER (m)	1.20	1.20	1.20	1.20	1.20	1.20
TRENCH INSTABILITY						
GROUNDWATER						



Chainage (m)	2540		2740		2820	
DPL POSITION		DPL21		DPL22		DPL23
AUGER HOLE / INSPECTION PIT POSITIONS	AH21		AH22		AH23	
DEPTH (mm)						
0.0						
0.3	0.30 Dark greyish brown gravelly sandy CLAY. Colluvium.	24		30	0.50 Greyish brown silty sandy CLAY. Colluvium.	17
0.6	END	18	0.75 Dark greyish brown clayey SAND.	24	END	34
0.9		13		8		REFUSAL
1.2		13		14		
1.5		12	1.50 Dark brown to light grey silty clayey SAND.	23		
1.8		14	END	23		
2.1		27		33		
2.4		31		41		
2.7		26		59		
3.0	REF		REF			
3.3						
3.6						
SOFT EXCAVATION m <sup>3</sup>		1782			429	
INTERMEDIATE EXCAVATION m <sup>3</sup>					429	
HARD EXCAVATION m <sup>3</sup>						
TOTALS (m <sup>3</sup> )						
MIN TRENCH WIDTH (m)	2.20	2.20	2.20	2.20	2.20	2.20
MINIMUM TRENCH DEPTH (m)	3.0	3.0	3.0	3.0	3.0	3.0
PIPE DIAMETER (m)	1.20	1.20	1.20	1.20	1.20	1.20
TRENCH INSTABILITY						
GROUNDWATER						

Chainage (m)	2840	2860	3060	3260				
DPL POSITION		DPL24		DPL25		DPL26		DPL27
AUGER HOLE / INSPECTION PIT POSITIONS	AH24		AH25		AH26		AH27	
DEPTH (mm)								
0.0								
0.3		20	0.34 Dark greyish brown silty sandy CLAY. Colluvium.	33		29		53
0.6	0.60 Light grey to light brown gravelly silty clayey SAND.	27		34	0.70 Dark grey to light brown clayey silty SAND.	46	0.60 Greyish and yellowish brown gravelly silty sandy CLAY. Colluvium.	40
0.9	END	40	0.90 Greyish brown silty sandy CLAY lenses.	REFUSAL	END	38	END	30
1.2		51	END			20		REFUSAL
1.5		END				END		
1.8								
2.1								
2.4								
2.7								
3.0								
3.3								
3.6								
SOFT EXCAVATION m <sup>3</sup>			792					
INTERMEDIATE EXCAVATION m <sup>3</sup>				528				
HARD EXCAVATION m <sup>3</sup>								
<b>TOTALS (m<sup>3</sup>)</b>								
MIN TRENCH WIDTH (m)	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20
MINIMUM TRENCH DEPTH (m)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
PIPE DIAMETER (m)	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
TRENCH INSTABILITY								
GROUNDWATER								

Chainage (m)	3460	3660	3860	3960	4000	4005
DPL POSITION		DPL28	DPL29	DPL30	DPL31	DPL32
AUGER HOLE / INSPECTION PIT POSITIONS	AH28		AH29		AH30	
DEPTH (mm)						
0.0	0.20 Light brown gravelly SAND.				0.20 Reddish brown gravelly SAND.	
0.3	END	29		34		38
0.6		80	0.74 Greyish brown slightly sandy silty CLAY, Colluvium,	14		16
0.9		REF	0.84 Khaki light brown silty sandy CLAY.	21	1.02 Dark grey to dark brown silty clayey SAND.	17
1.2			END	89	1.23 Greyish brown silty clayey SAND.	29
1.5				REF	END	30
1.8						38
2.1						40
2.4						
2.7						
3.0						
3.3						
3.6						
SOFT EXCAVATION m <sup>3</sup>	1650		924		792	
INTERMEDIATE EXCAVATION m <sup>3</sup>	1650		396		198	
HARD EXCAVATION m <sup>3</sup>						
TOTALS (m <sup>3</sup> )						
MIN TRENCH WIDTH (m)	2.20	2.20	2.20	2.20	2.20	2.20
MINIMUM TRENCH DEPTH (m)	3.0	3.0	3.0	3.0	3.0	3.0
PIPE DIAMETER (m)	1.20	1.20	1.20	1.20	1.20	1.20
TRENCH INSTABILITY						
GROUNDWATER						
						TOTALS (m <sup>3</sup> )
						17396
						9037
						0
						26433
						TOTAL TRENCH VOLUME (m3)
						26.433

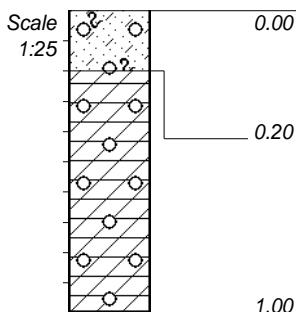
## **APPENDIX A**

**DRAFT**



Report on Sector K & Sector L (Duffs Road to Phoenix 2 Reservoir) of  
the Proposed Northern Aqueduct Pipeline Augmentation

Path : H:\11\11-107\Reports\Draft Report - Sectors K & L\11-107 NAC JV Report - Sectors K & L (Draft) (28-08-2012).doc



Dry greyish brown to dark brown medium dense to dense shattered gravelly clayey SAND. Gravel consists of angular to subangular shale fragments with roots. Colluvium.

Dry light greyish speckled orange loose to medium dense intact gravelly CLAY. Gravel consists of SHALE fragments. Residual Shale.

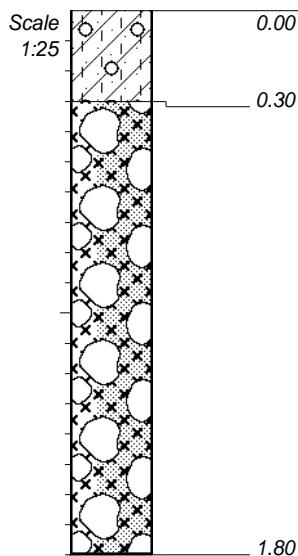
#### NOTES

- 1) Final depth 1.00m
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) No samples taken.
- 5) Shale is more dominant from 0.70--1.00m.

CONTRACTOR :  
MACHINE :  
DRILLED BY :  
PROFILED BY : DC/EN  
TYPE SET BY : NM  
SETUP FILE : MSJA4.SET

INCLINATION :  
DIAM :  
DATE : 17-19/07/2012  
DATE : 17-19/07/2012  
DATE : 14/08/12 15:47  
TEXT : ..\11-107\Logs\Dothead.doc

ELEVATION :  
X-COORD :  
Y-COORD :  
**HOLE No: Cutting 1**



Dry to slightly moist dark greyish brown to yellowish brown medium dense gravelly silty sandy CLAY. Colluvium.

Light greyish brown completely weathered medium hard ROCK with reddish brown boulders (20mm-10m diameter) SOFT ROCK dolerite.

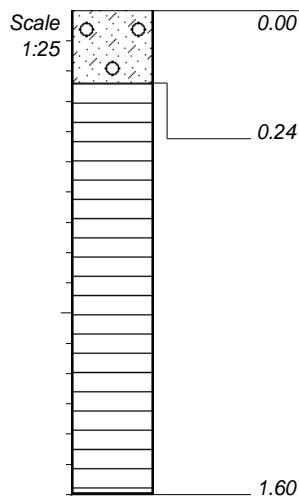
#### NOTES

- 1) Final depth 1.80m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) No samples taken.

CONTRACTOR :  
MACHINE :  
DRILLED BY :  
PROFILED BY : DC/EN  
TYPE SET BY : NM  
SETUP FILE : MSJA4.SET

INCLINATION :  
DIAM :  
DATE : 17-19/07/2012  
DATE : 17-19/07/2012  
DATE : 14/08/12 15:47  
TEXT : ..\11-107\Logs\Dothead.doc

ELEVATION :  
X-COORD :  
Y-COORD :  
**HOLE No: Cutting 2**



Dry to slightly moist dark grey to light grey medium dense to dense intact gravelly clayey SAND. Gravel consist of angular to subangular shale fragments. Colluvium.

Yellowish light brown highly weathered soft ROCK SHALE.

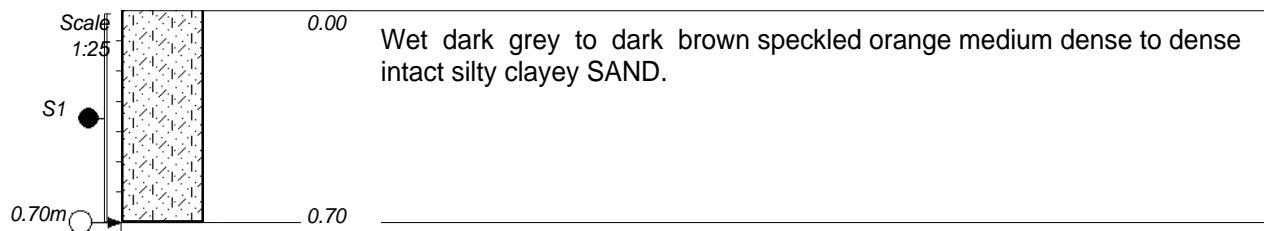
#### NOTES

- 1) Final depth 1.60m
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) No samples taken.
- 5) Shale layer from 0.24--1.60m.

CONTRACTOR :  
MACHINE :  
DRILLED BY :  
PROFILED BY : DC/EN  
TYPE SET BY : NM  
SETUP FILE : MSJA4.SET

INCLINATION :  
DIAM :  
DATE : 17-19/07/2012  
DATE : 17-19/07/2012  
DATE : 14/08/12 15:47  
TEXT : ..\11-107\Logs\Dothead.doc

ELEVATION :  
X-COORD :  
Y-COORD :  
**HOLE No: Cutting 3**



**NOTES**

- 1) Final depth 0.70m
- 2) Groundwater seepage at 0.70m.
- 3) No sidewall collapse.
- 4) Samples taken at :  
S1 0.01--0.70m (1 x Small).

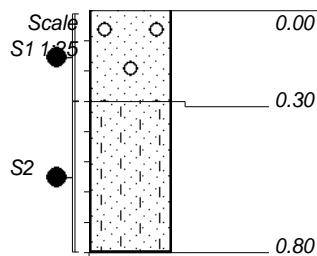
CONTRACTOR :  
MACHINE :  
DRILLED BY :  
PROFILED BY : DC/EN  
TYPE SET BY : NM  
SETUP FILE : MSJA4.SET

INCLINATION :  
DIAM :  
DATE : 17-19/07/2012  
DATE : 17-19/07/2012  
DATE : 14/08/12 15:47  
TEXT : ..\11-107\Logs\Dothead.doc

ELEVATION :  
X-COORD :  
Y-COORD :  
**HOLE No: Cutting 4**

## **APPENDIX B**

**DRAFT**



Slightly moist dark brown loose to medium dense intact slightly gravelly SAND. Colluvium.

Moist dark to light brown with depth loose to medium dense intact fine to medium grained silty SAND. Alluvium.

#### NOTES

- 1) Refusal at 0.80m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples take at :  
 S1 0.01--0.30m (1 x Small)  
 S2 0.30--0.80m (1 x Small)

CONTRACTOR :  
 MACHINE :  
 OPERATOR :  
 PROFILED BY : DC/EN

REVISION : NM  
 SETUP FILE : MSJ2004.SET

INCLINATION :  
 DIAM :  
 DATE DRILLED : 17-19/07/2012  
 DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
 TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
 X-COORD :  
 Y-COORD :

**HOLE No: AH 1**

Scale  
S1 1:25



0.00  
0.30

Slightly moist greyish light brown loose gravelly silty SAND.

**NOTES**

- 1) Final depth 0.30m
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken at :  
S1 0.01--0.30m (1 x Small).
- 5) Refusal on auger hole and DPL.

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

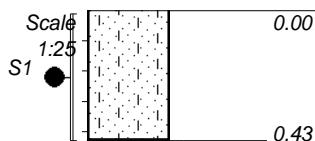
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INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 2**



Moist greyish brown to dark brown loose to medium dense intact fine silty SAND. Colluvium.

**NOTES**

- 1) Refusal at 0.43m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken at :  
S1 0.01--0.43m (1 x Small)

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

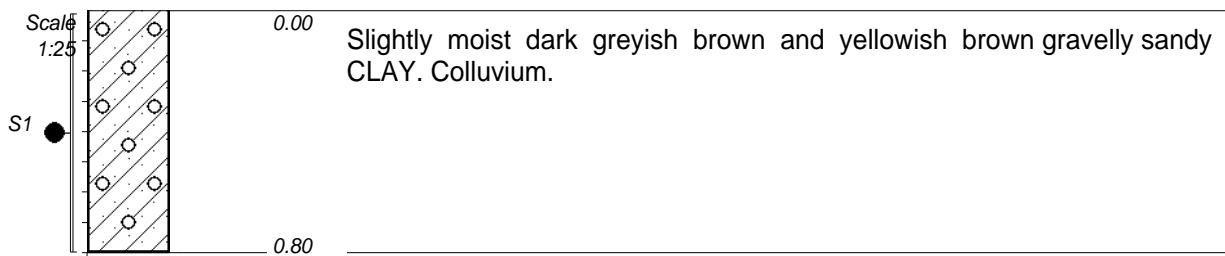
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INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 3**



**NOTES**

- 1) Final depth 0.80m
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken at :  
S1 0.01--0.80m (1 x Small).
- 5) Refusal on auger hole and DPL.

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

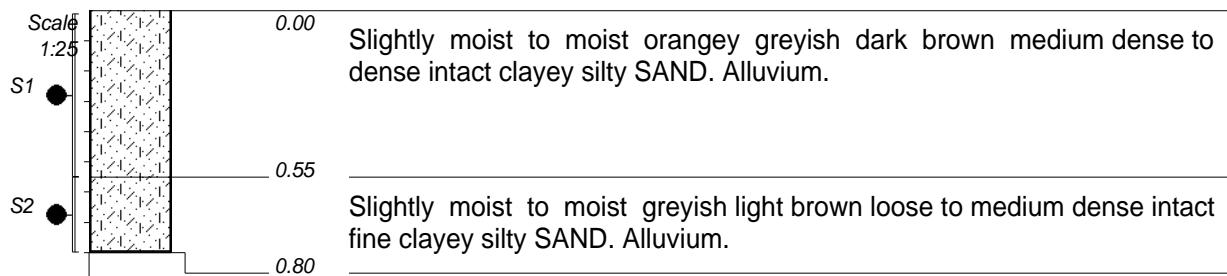
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INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 4**



**NOTES**

- 1) Refusal at 0.8m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken at :  
S1 0.01--0.55m (1 x Small) / S2 0.55--0.80m (1 x Small)

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

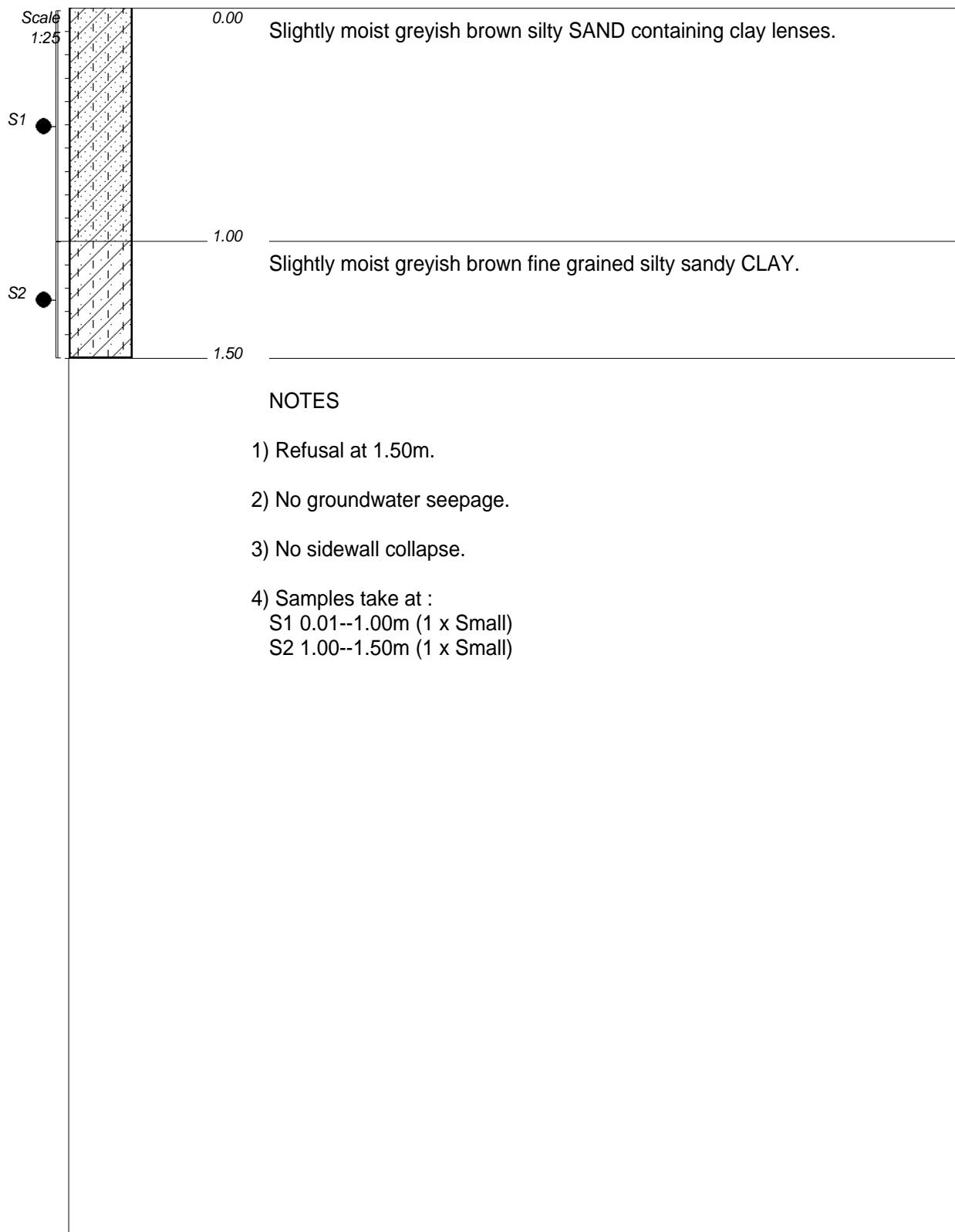
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SETUP FILE : MSJ2004.SET

INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 5**



CONTRACTOR :  
 MACHINE :  
 OPERATOR :  
 PROFILED BY : SL

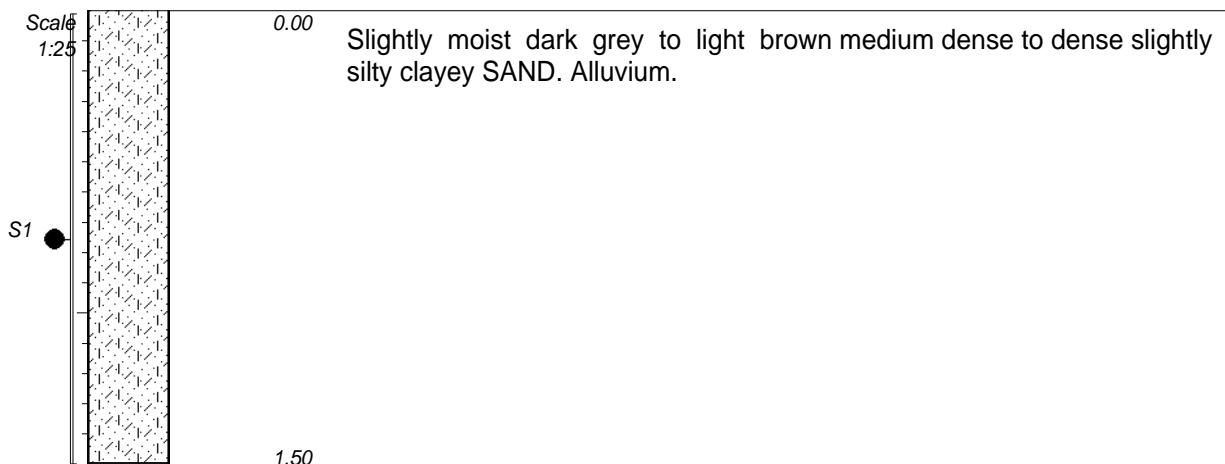
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INCLINATION :  
 DIAM :  
 DATE DRILLED : 18/07/2012  
 DATE PROFILED : 18/07/2012

DATE : 16/08/12 09:23  
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ELEVATION :  
 X-COORD :  
 Y-COORD :

**HOLE No: AH 6**



**NOTES**

- 1) Final depth 1.50m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken at :  
S1 0.01--1.50m (1 x Small)

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

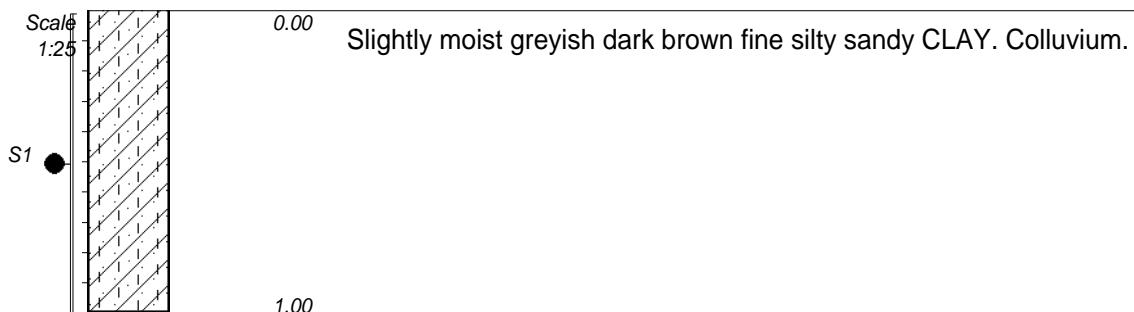
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SETUP FILE : MSJ2004.SET

INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 7**



**NOTES**

- 1) Final depth 1.00m
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken at :  
S1 0.01--1.00m (1 x Small).
- 5) Refusal on auger hole and DPL.

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

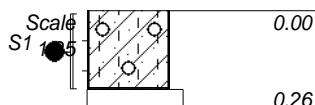
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INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 8**



**NOTES**

- 1) Final depth 0.26m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :  
S1 0.01--0.26m (1 x Small)
- 5) Refusal on auger hole and DPL.

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

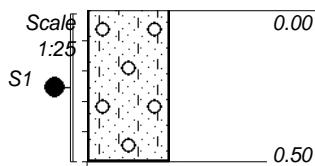
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SETUP FILE : MSJ2004.SET

INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 9**



Dry to slightly moist light greyish to light brown loose to medium dense intact gravelly silty SAND. Gravel consists of angular to subangular shale fragments. Colluvium.

**NOTES**

- 1) Refusal at 0.50m on very dense material.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken at :  
S1 0.01--0.50m (1 x Small)

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

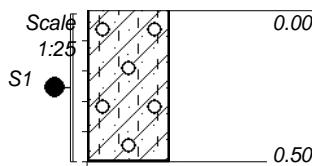
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INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
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ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 10**



Slightly moist greyish to yellowish brown gravelly silty sandy CLAY.  
Colluvium.

**NOTES**

- 1) Final depth 0.50m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :  
S1 0.01--0.50m (1 x Small)
- 5) Refusal on auger hole and DPL.

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

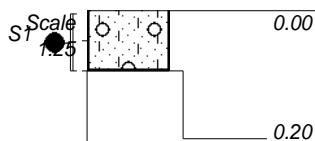
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SETUP FILE : MSJ2004.SET

INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 11**



Slightly moist dark greyish to light grey with depth loose to medium dense intact gravelly silty SAND. Gravel consists of angular to subangular shale fragments. Colluvium.

**NOTES**

- 1) Refusal at 0.20m on dense material.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken at :  
S1 0.01--0.20m (1 x Small)

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

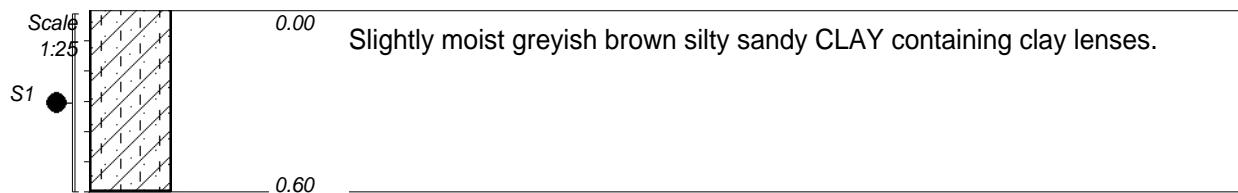
REVISION : NM  
SETUP FILE : MSJ2004.SET

INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 12**



**NOTES**

- 1) Final depth 0.60m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :  
S1 0.01--0.60m ( 1 x Small)
- 5) Refusal on auger hole and DPL.

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

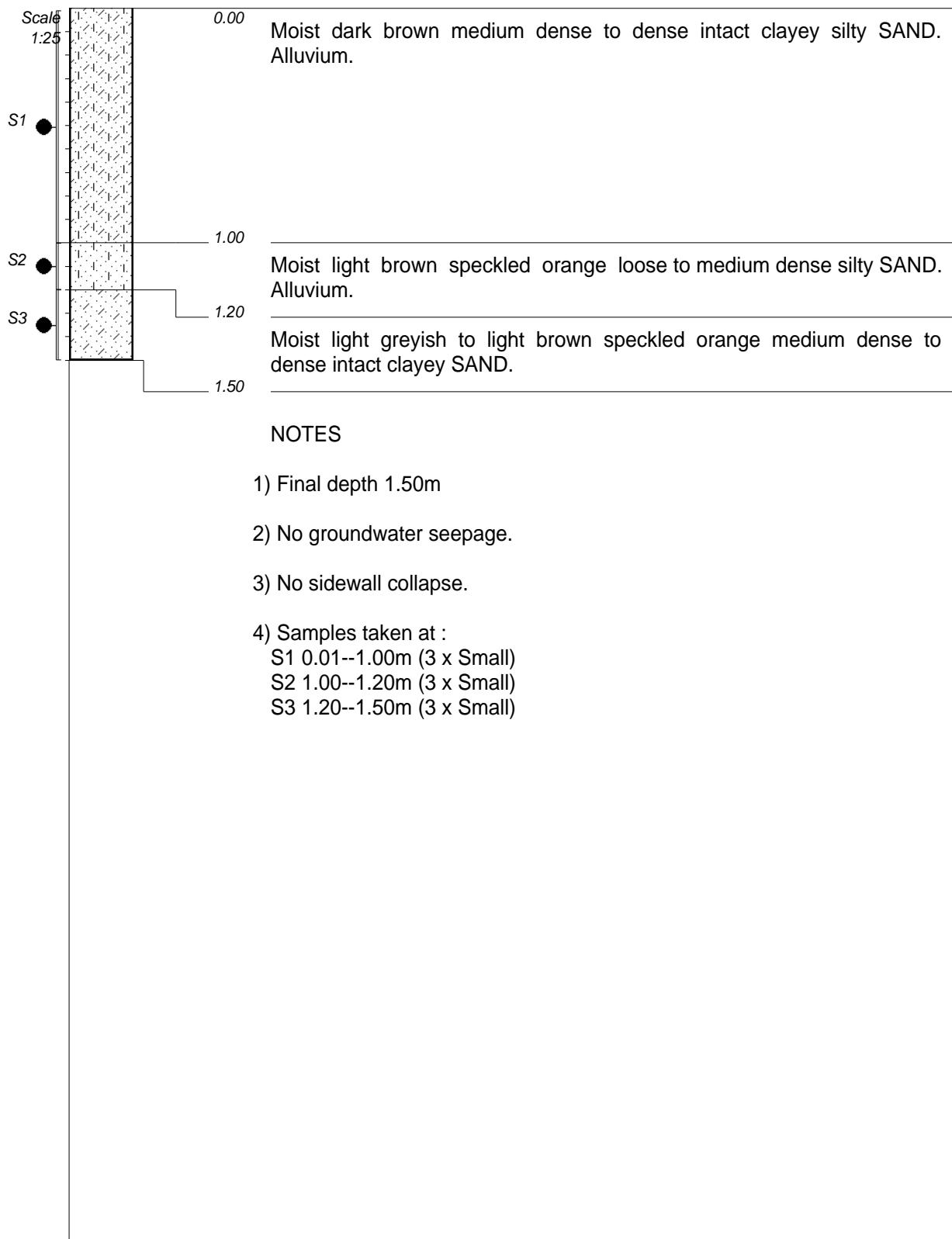
REVISION : NM  
SETUP FILE : MSJ2004.SET

INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 13**



CONTRACTOR :  
 MACHINE :  
 OPERATOR :  
 PROFILED BY : DC/EN

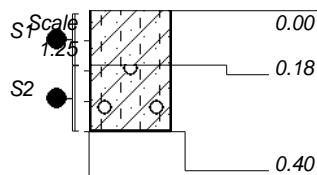
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 DIAM :  
 DATE DRILLED : 17-19/07/2012  
 DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
 TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
 X-COORD :  
 Y-COORD :

**HOLE No: AH 14**



Slightly moist greyish brown silty fine grained sandy CLAY. Colluvium.

Slightly moist greyish light brown to yellowish brown gravelly silty sandy CLAY. Residual Shale.

#### NOTES

- 1) Final depth 0.40m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :
  - S1 0.01--0.18m (1 x Small)
  - S2 0.18--0.40m (1 x Small)
- 5) Refusal on auger hole and DPL.

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

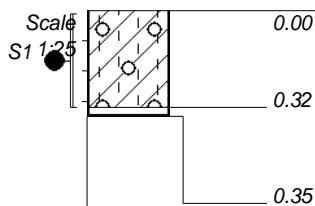
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INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 15**



Moist brown mottled red and orange firm becoming stiff with depth intact gravelly silty CLAY. Residual Shale.

Orangey brown highly weathered fine grained no visible jointing soft rock SHALE.

#### NOTES

- 1) Refusal at 0.35m on soft rock.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :  
S1 0.01--0.32m (1 x Small)

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : SL

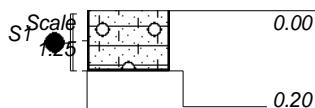
REVISION : NM  
SETUP FILE : MSJ2004.SET

INCLINATION :  
DIAM :  
DATE DRILLED : 21-08-2012  
DATE PROFILED : 21-08-2012

DATE : 21/08/12 14:27  
TEXT : ..\LOGS\AH16\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 16**



Dry to slightly moist light greyish brown medium dense to dense gravelly silty SAND. Gravel consists of angular to subangular SHALE. Colluvium.

**NOTES**

- 1) Refusal at 0.20m on hard material.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken at :  
S1 0.01--0.20m (1 x Small)

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

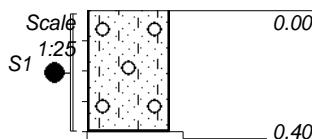
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SETUP FILE : MSJ2004.SET

INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 17**



Dry to slightly moist greyish brown to dark brown speckled orange loose to medium dense intact gravelly silty SAND. Gravel consists of angular to subangular shale fragments. Colluvium.

**NOTES**

- 1) Refusal at 0.40m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :  
S1 0.01--0.40m (1 x Small)

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

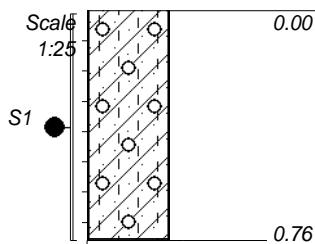
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SETUP FILE : MSJ2004.SET

INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 18**



Slightly moist greyish light brown and yellowish brown gravelly silty fine grained sandy CLAY. Colluvium.

**NOTES**

- 1) Final depth at 0.76m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :  
S1 0.01--0.76m (1 x Small)
- 5) Refusal on auger hole and DPL.

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

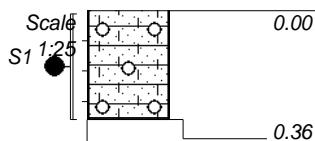
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INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 19**



Dry to slightly moist light brown to dark brown loose to medium dense intact gravelly silty SAND. Gravel consists of angular to subrounded shale fragments. Colluvium.

**NOTES**

- 1) Refusal at 0.36m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :  
S1 0.01--0.36m (1 x Small)

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

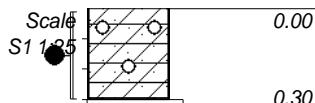
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DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 20**



Slightly moist dark greyish brown intact gravelly sandy CLAY. Gravel consist of angular to subangular SHALE fragments. Colluvium.

**NOTES**

- 1) Final depth at 0.30m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :  
S1 0.01--0.30m (1 x Small)
- 5) Refusal on auger hole and DPL.

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

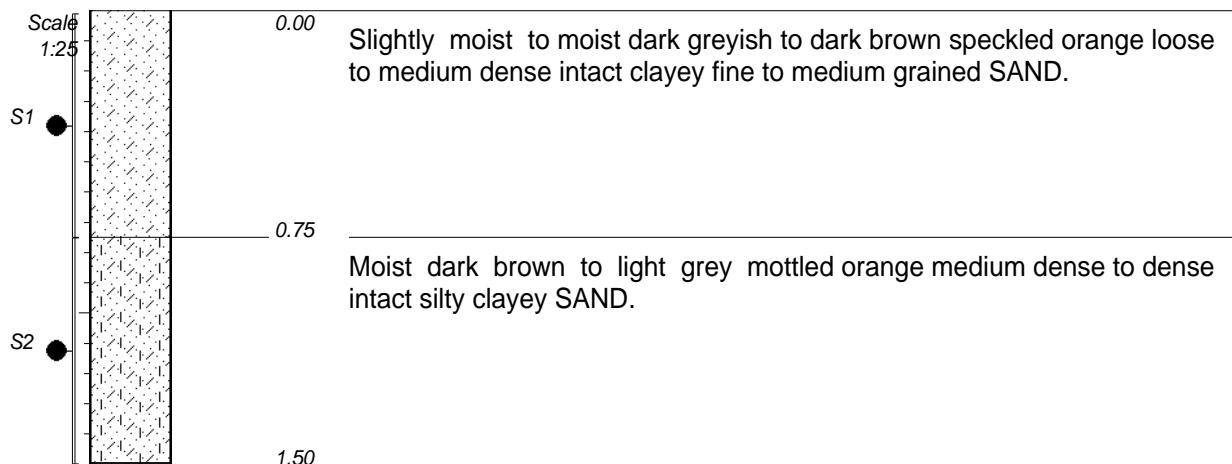
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INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 21**



**NOTES**

- 1) Final depth at 1.50m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :  
 S1 0.01--0.75m (1 x Small)  
 S2 0.75--1.50m (1 x Small)

CONTRACTOR :  
 MACHINE :  
 OPERATOR :  
 PROFILED BY : DC/EN

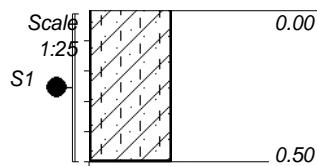
REVISION : NM  
 SETUP FILE : MSJ2004.SET

INCLINATION :  
 DIAM :  
 DATE DRILLED : 17-19/07/2012  
 DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
 TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
 X-COORD :  
 Y-COORD :

**HOLE No: AH 22**



Slightly moist greyish brown silty fine grained sandy CLAY. Colluvium.

**NOTES**

- 1) Final depth at 0.50m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :  
S1 0.01--0.50m (1 x Small)
- 5) Refusal on auger hole and DPL.

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

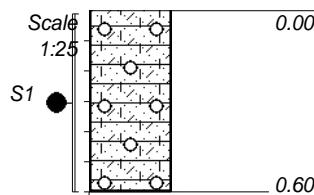
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SETUP FILE : MSJ2004.SET

INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 23**



Slightly moist to moist light grey to light brown loose to medium dense intact gravelly silty clayey SAND. Gravel consists of angular to subangular shale fragments.

**NOTES**

- 1) Final depth at 0.60m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :  
S1 0.01--0.60m (1 x Small)

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

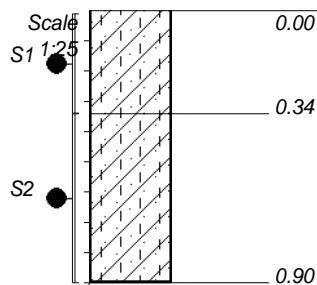
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SETUP FILE : MSJ2004.SET

INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 24**



Slightly moist dark greyish brown speckled light brown slightly silty sandy clay. Colluvium.

Slightly moist greyish brown silty sandy CLAY lenses.

#### NOTES

- 1) Final depth at 0.90m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :  
 S1 0.01--0.34m (1 x Small)  
 S2 0.34--0.90m (1 x Small)
- 5) Refusal on auger hole and DPL.

CONTRACTOR :  
 MACHINE :  
 OPERATOR :  
 PROFILED BY : DC/EN

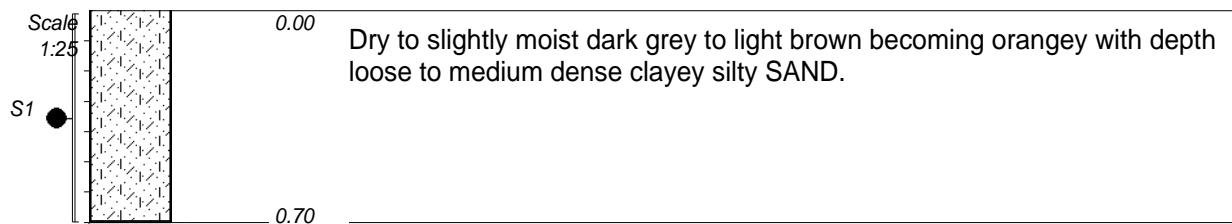
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 SETUP FILE : MSJ2004.SET

INCLINATION :  
 DIAM :  
 DATE DRILLED : 17-19/07/2012  
 DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
 TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
 X-COORD :  
 Y-COORD :

**HOLE No: AH 25**



**NOTES**

- 1) Final depth at 0.70m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :  
S1 0.01--0.70m (1 x Small)

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

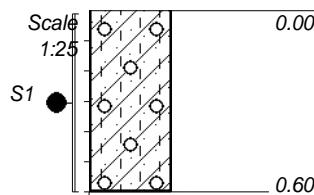
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INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 26**



Slightly moist greyish brown and yellowish brown gravelly silty fine grained sandy CLAY. Colluvium.

**NOTES**

- 1) Final depth at 0.60m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :  
S1 0.01--0.60m (1 x Small)
- 5) Refusal on auger hole and DPL.

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

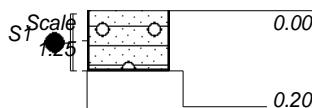
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SETUP FILE : MSJ2004.SET

INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 27**



Dry to slightly moist light brown loose to medium dense intact fine gravelly SAND. Gravel consists of subangular to rounded shale fragments.

**NOTES**

- 1) Final depth at 0.20m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :  
S1 0.01--0.20m (1 x Small)

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

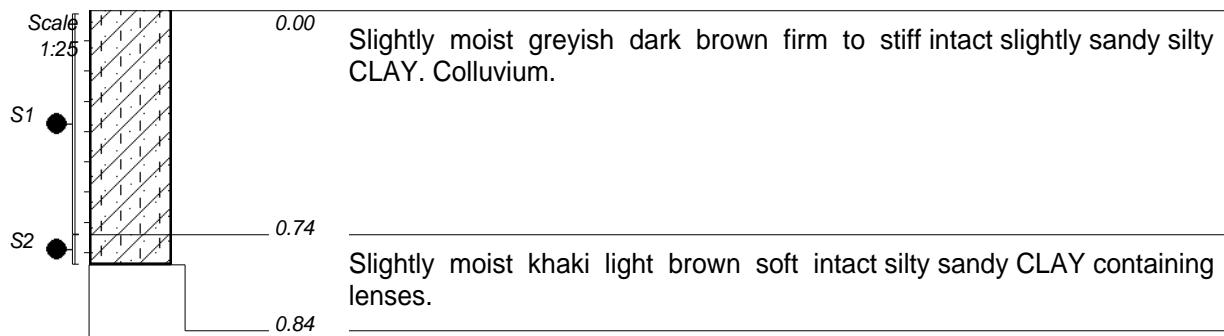
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INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 28**



**NOTES**

- 1) Final depth at 0.84m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :  
 S1 0.01--0.74m (1 x Small)  
 S2 0.74--0.84m (1 x Small)

CONTRACTOR :  
 MACHINE :  
 OPERATOR :  
 PROFILED BY : DC/EN

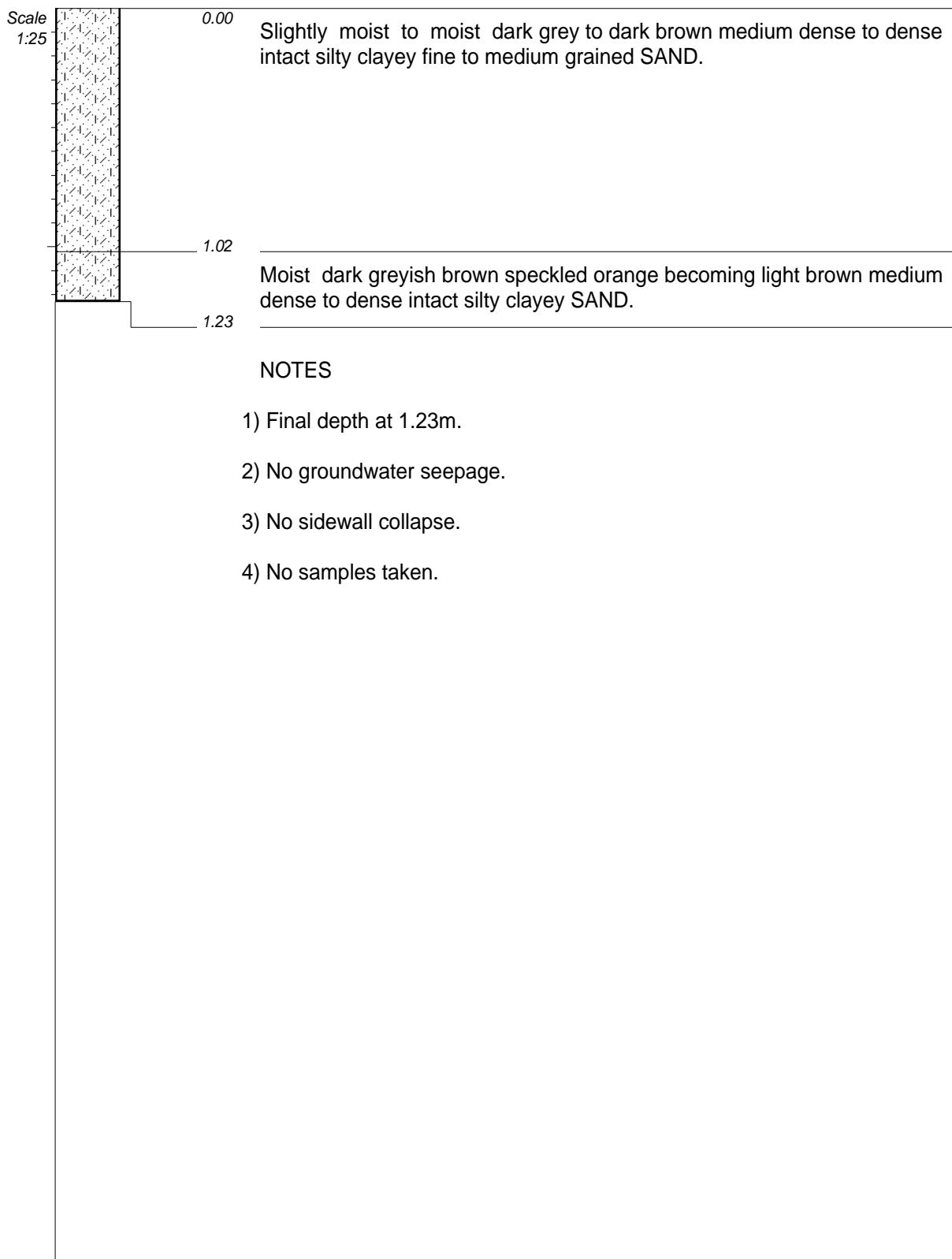
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 SETUP FILE : MSJ2004.SET

INCLINATION :  
 DIAM :  
 DATE DRILLED : 17-19/07/2012  
 DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
 TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
 X-COORD :  
 Y-COORD :

**HOLE No: AH 29**



CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

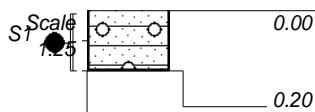
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SETUP FILE : MSJ2004.SET

INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 30**



Dry light reddish brown loose intact gravelly SAND. Gravel consists of subangular to rounded shale fragments.

**NOTES**

- 1) Final depth at 0.20m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken at :  
S1 0.01--0.20m (1 x Small)

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

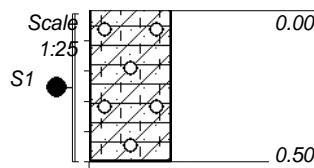
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INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 31**



Dry to slightly moist greyish brown soft intact gravelly silty sandy CLAY.  
Gravel consist of angular to subangular shale fragments.

**NOTES**

- 1) Final depth at 0.50m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken at :  
S1 0.01--0.50m (1 x Small)

CONTRACTOR :  
MACHINE :  
OPERATOR :  
PROFILED BY : DC/EN

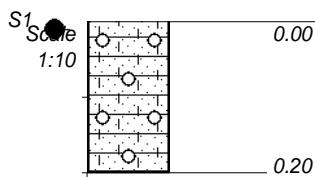
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SETUP FILE : MSJ2004.SET

INCLINATION :  
DIAM :  
DATE DRILLED : 17-19/07/2012  
DATE PROFILED : 17-19/07/2012

DATE : 16/08/12 09:23  
TEXT : ..\11-107\LOGS\DOTHEAD.DOC

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 32**



Slightly moist light greyish brown loose to medium dense intact gravelly silty SAND. Gravel comprises angular to round shale fragments.

#### NOTES

- 1) Refusal at 0.20m on dense material.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken at :  
S1 0.01-0.20m (1 x Small).

CONTRACTOR :  
MACHINE :

DRILLED BY :

PROFILED BY : DC

TYPE SET BY : NM

SETUP FILE : MSJ2004.SET

INCLINATION :

DIAM :

DATE : 06-08-2012

DATE : 06-08-2012

DATE : 15/08/2012 12:19

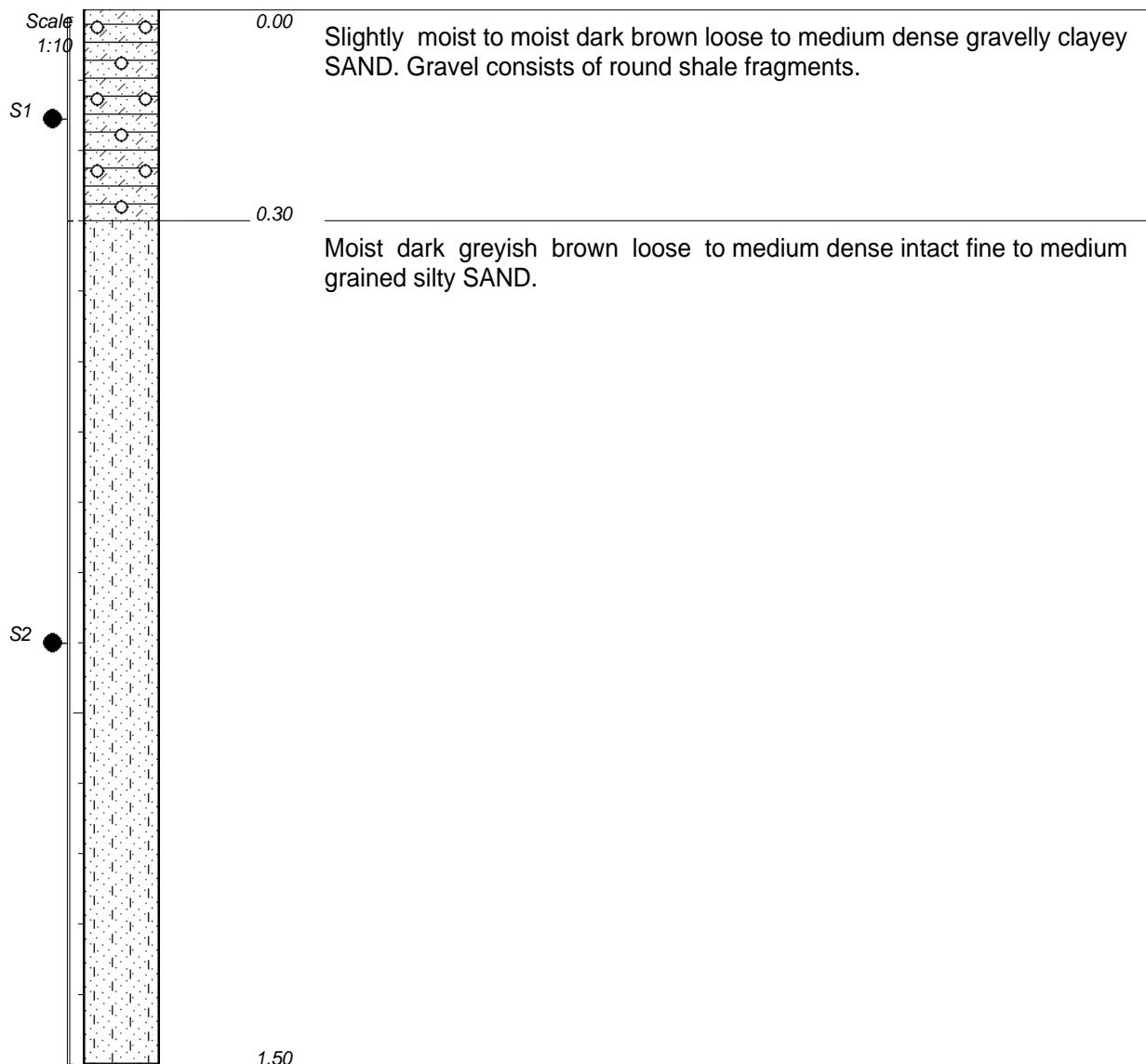
TEXT : ..\Logs\060812\Dothead.doc

ELEVATION :

X-COORD :

Y-COORD :

**HOLE No: AH 101**



**NOTES**

- 1) Refusal at 1.50.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken at :  
 S1 0.01--0.30m (1 x Small)  
 S2 0.30--1.50m (1 x Small).

CONTRACTOR :  
 MACHINE :

DRILLED BY :

PROFILED BY : DC

TYPE SET BY : NM

SETUP FILE : MSJ2004.SET

INCLINATION :

DIAM :

DATE : 06-08-2012

DATE : 06-08-2012

DATE : 15/08/2012 12:19

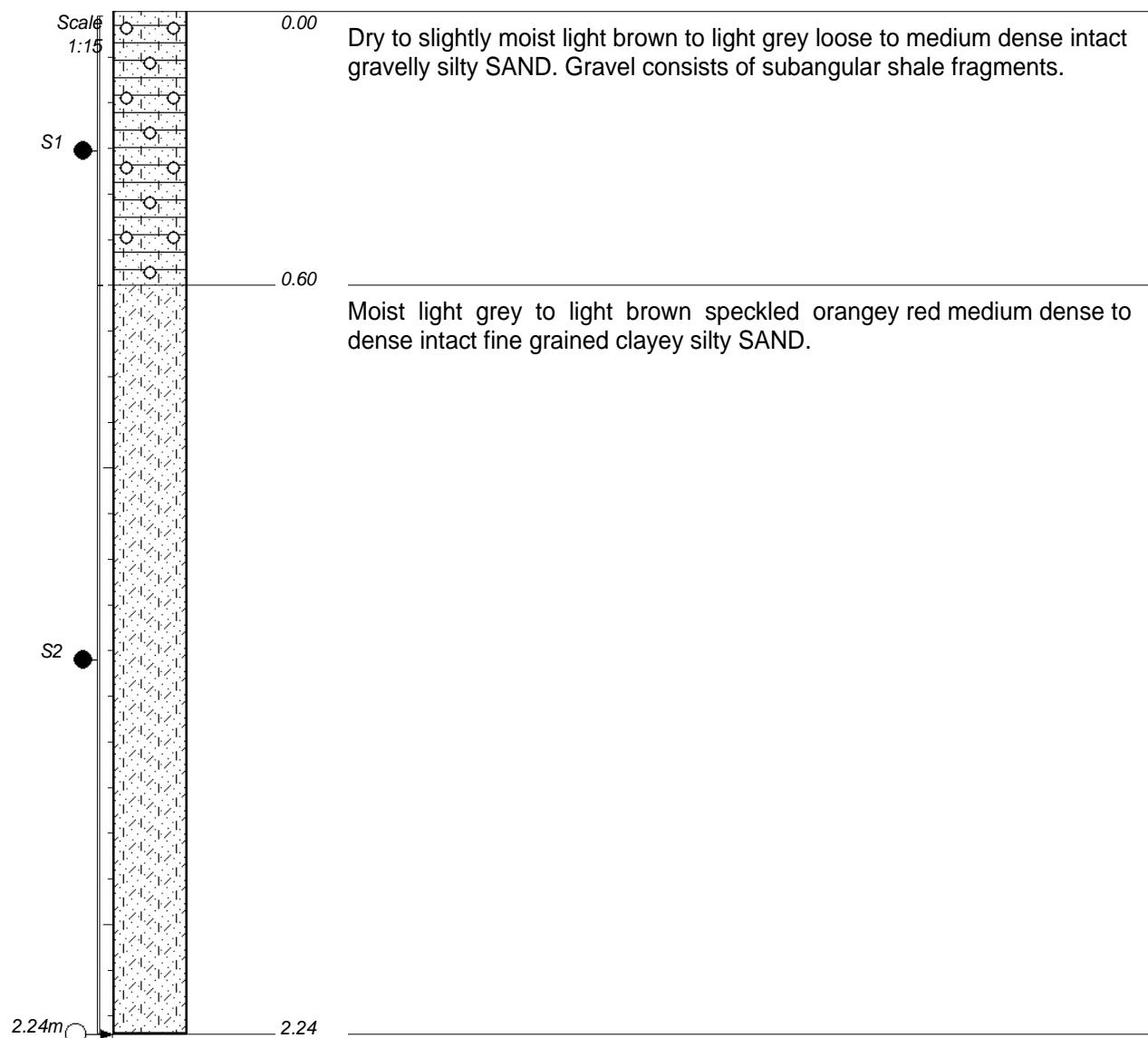
TEXT : ..\Logs\060812\Dothead.doc

ELEVATION :

X-COORD :

Y-COORD :

**HOLE No: AH 102**



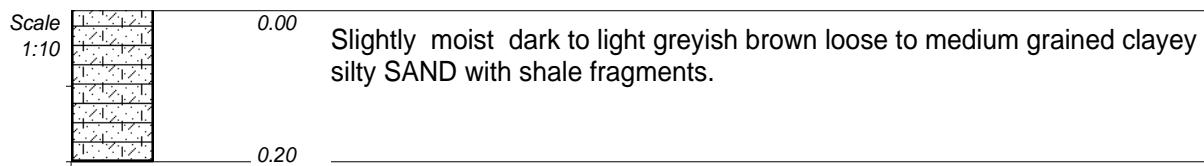
**NOTES**

- 1) Refusal at 2.24m.
- 2) Groundwater seepage at 2.24m.
- 3) Sidewall collapse at 2.24m.
- 4) Samples taken at :  
 S1 0.01--0.60m (1 x Small)  
 S2 0.60--2.24m (1 x Small)

CONTRACTOR :  
 MACHINE :  
 DRILLED BY :  
 PROFILED BY : DC/EN  
 TYPE SET BY : NM  
 SETUP FILE : MSJ2004.SET

INCLINATION :  
 DIAM :  
 DATE : 25/07/2012  
 DATE : 25/07/2012  
 DATE : 15/08/2012 12:21  
 TEXT : ..101107Bridge\Dothead.doc

ELEVATION :  
 X-COORD :  
 Y-COORD :  
**HOLE No: AH 103**



**NOTES**

- 1) Refusal at 0.20m on dense material.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) No samples taken.

CONTRACTOR :  
MACHINE :

DRILLED BY :

PROFILED BY : DC

TYPE SET BY : NM

SETUP FILE : MSJ2004.SET

INCLINATION :

DIAM :

DATE : 03-08-2012

DATE : 03-08-2012

DATE : 15/08/2012 12:19

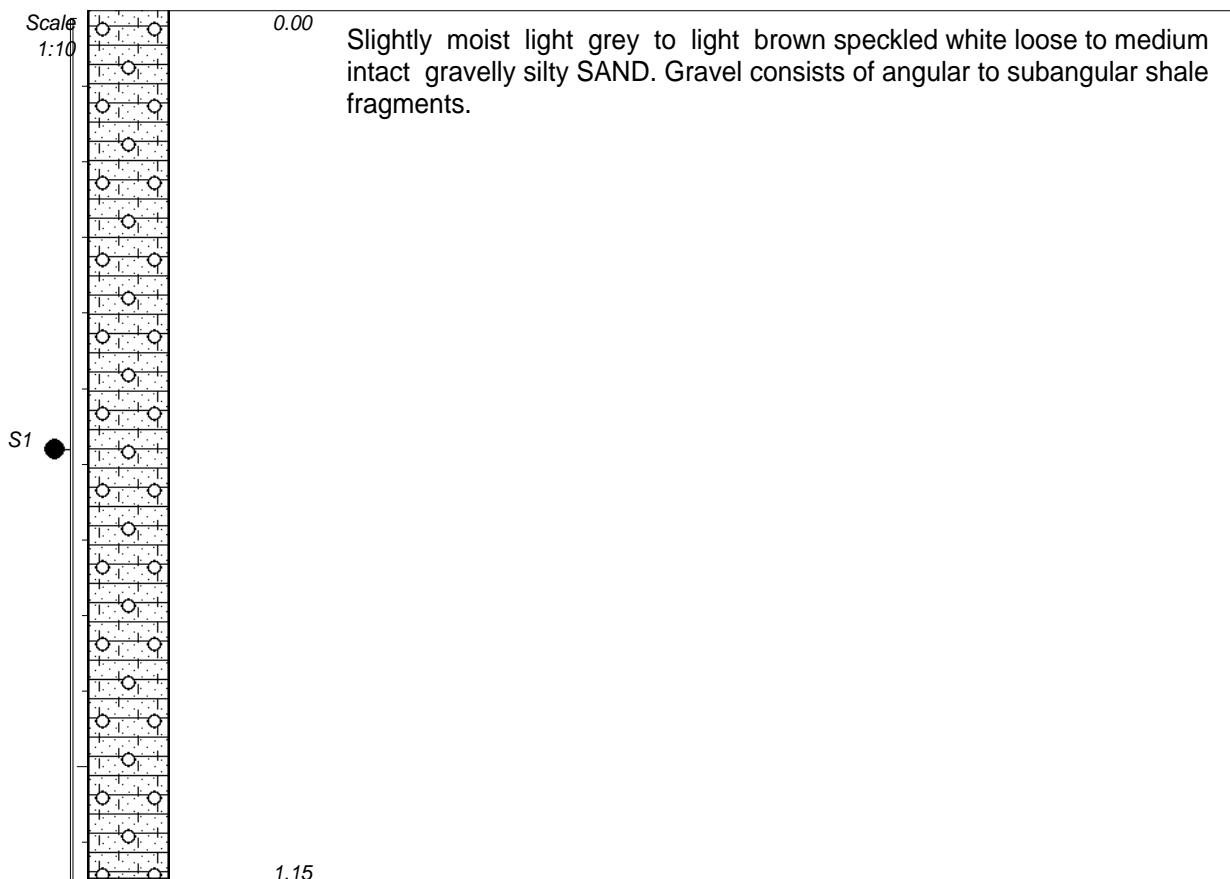
TEXT : ..\Logs\030812\Dothead.doc

ELEVATION :

X-COORD :

Y-COORD :

**HOLE No: AH 104**



#### NOTES

- 1) Refusal at 1.15m on hard material.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken at :  
S1 0.01--1.15m (1 x Small)

CONTRACTOR :  
MACHINE :

DRILLED BY :

PROFILED BY : DC

TYPE SET BY : NM

SETUP FILE : MSJ2004.SET

INCLINATION :

DIAM :

DATE : 03-08-2012

DATE : 03-08-2012

DATE : 15/08/2012 12:19

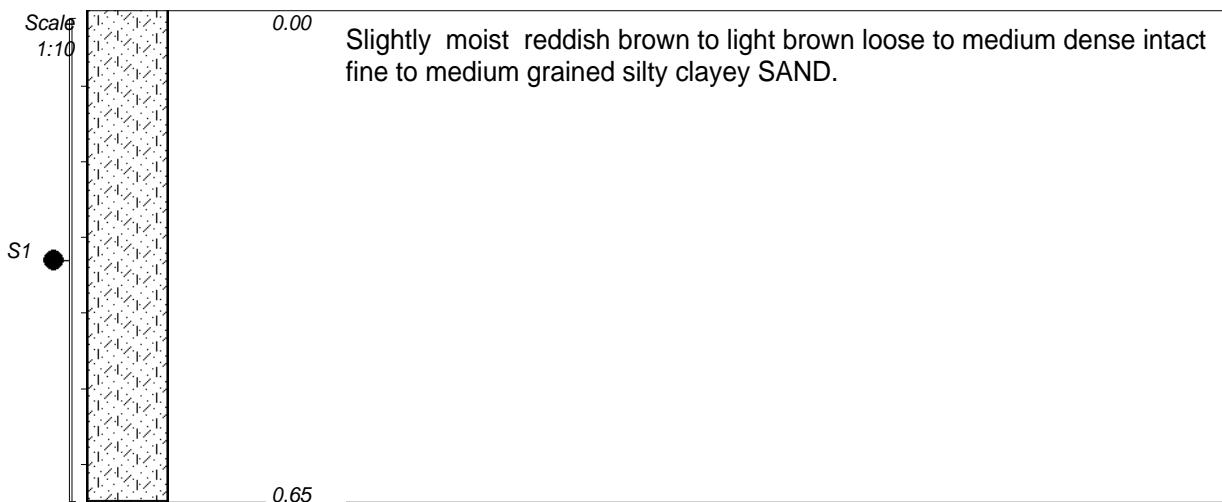
TEXT : ..\Logs\030812\Dothead.doc

ELEVATION :

X-COORD :

Y-COORD :

**HOLE No: AH 105**



#### NOTES

- 1) Refusal at 0.65m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken at :  
S1 0.01--0.65m (1 x Small)

CONTRACTOR :  
MACHINE :  
DRILLED BY :

PROFILED BY : DC

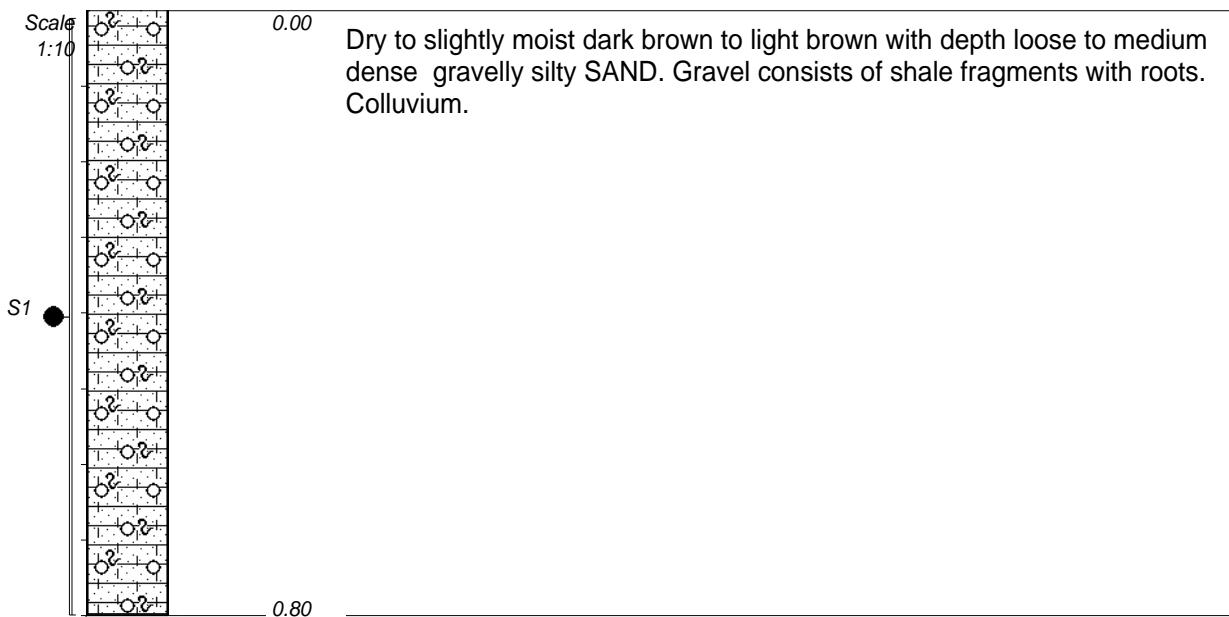
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INCLINATION :  
DIAM :  
DATE : 03-08-2012  
DATE : 03-08-2012

DATE : 15/08/2012 12:19  
TEXT : ..\Logs\030812\Dothead.doc

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 106**



#### NOTES

- 1) Final depth 0.80m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken at :  
S1 0.01--0.80m (1 x Small)

CONTRACTOR :  
MACHINE :

DRILLED BY :  
PROFILED BY : DC

TYPE SET BY : NM  
SETUP FILE : MSJ2004.SET

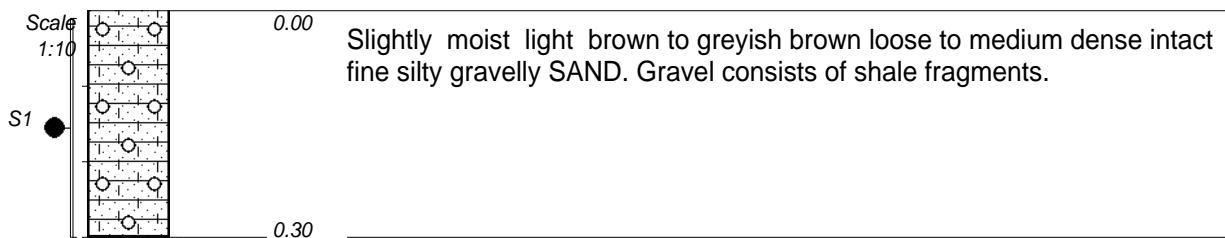
INCLINATION :  
DIAM :  
DATE : 03-08-2012

DATE : 03-08-2012

DATE : 15/08/2012 12:19  
TEXT : ..\Logs\030812\Dothead.doc

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 107**



**NOTES**

- 1) Refusal at 0.30m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken at :  
S1 0.01--0.30m (1 x Small)

CONTRACTOR :  
MACHINE :

DRILLED BY :

PROFILED BY : DC

TYPE SET BY : NM

SETUP FILE : MSJ2004.SET

**INCLINATION :**

**DIAM :**

**DATE : 06-08-2012**

**DATE : 06-08-2012**

**DATE : 15/08/2012 12:19**

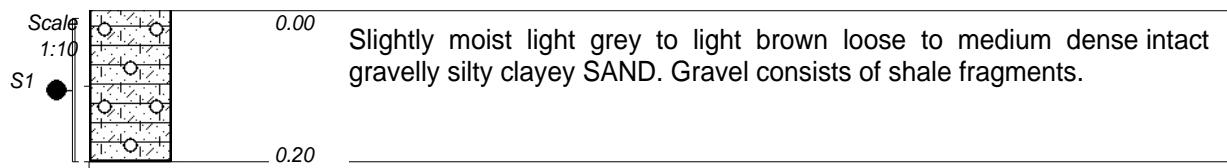
**TEXT : ..\Logs\060812\Dothead.doc**

**ELEVATION :**

**X-COORD :**

**Y-COORD :**

**HOLE No: AH 108**



**NOTES**

- 1) Final depth 0.20m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken at :  
S1 0.01--0.20m (1 x Small)

CONTRACTOR :  
MACHINE :

DRILLED BY :

PROFILED BY : DC

TYPE SET BY : NM

SETUP FILE : MSJ2004.SET

INCLINATION :

DIAM :

DATE : 06-08-2012

DATE : 06-08-2012

DATE : 15/08/2012 12:19

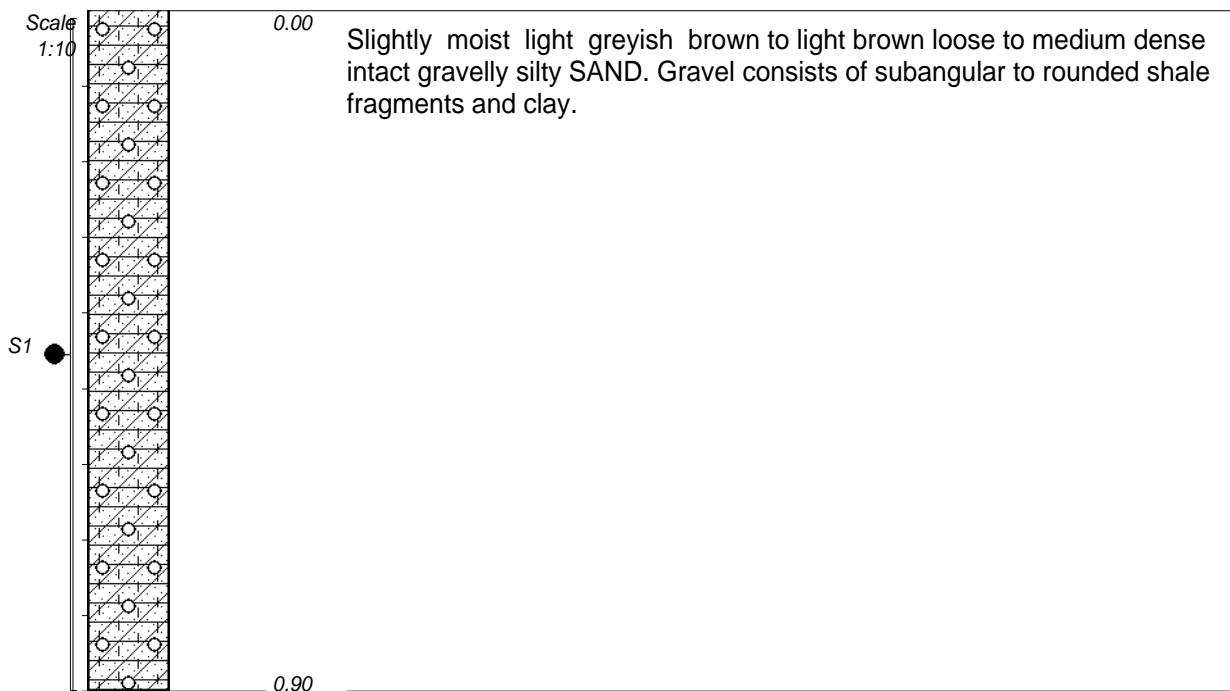
TEXT : ..\Logs\060812\Dothead.doc

ELEVATION :

X-COORD :

Y-COORD :

**HOLE No: AH 109**



#### NOTES

- 1) Final depth 0.90m, refusal on hard material.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken at :  
S1 0.01--0.90m (1 x Small)

CONTRACTOR :  
MACHINE :

DRILLED BY :

PROFILED BY : DC

TYPE SET BY : NM

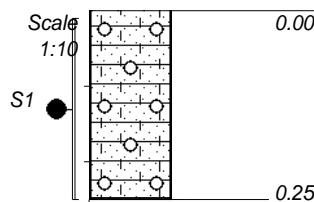
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INCLINATION :  
DIAM :  
DATE : 06-08-2012  
DATE : 06-08-2012

DATE : 15/08/2012 12:19  
TEXT : ..\Logs\060812\Dothead.doc

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH 110**



Slightly moist light grey to light brown loose to medium dense intact gravelly silty SAND. Gravel consists of subangular to rounded shale fragments.

#### NOTES

- 1) Final depth 0.25m, refusal on hard material.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken at :  
S1 0.01--0.25m (1 x Small)

CONTRACTOR :  
MACHINE :

DRILLED BY :

PROFILED BY : DC

TYPE SET BY : NM

SETUP FILE : MSJ2004.SET

INCLINATION :

DIAM :

DATE : 06-08-2012

DATE : 06-08-2012

DATE : 15/08/2012 12:19

TEXT : ..\Logs\060812\Dothead.doc

ELEVATION :

X-COORD :

Y-COORD :

**HOLE No: AH 111**

Scale 1:10	0.00	Slightly moist light grey to light brown loose to medium dense intact fine to medium grained silty SAND.
	0.30	

**NOTES**

- 1) Final depth 0.30.m, refusal on dense material.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) No samples taken.

CONTRACTOR :  
MACHINE :

DRILLED BY :

PROFILED BY : DC

TYPE SET BY : NM

SETUP FILE : MSJ2004.SET

INCLINATION :

DIAM :

DATE : 06-08-2012

DATE : 06-08-2012

DATE : 15/08/2012 12:19

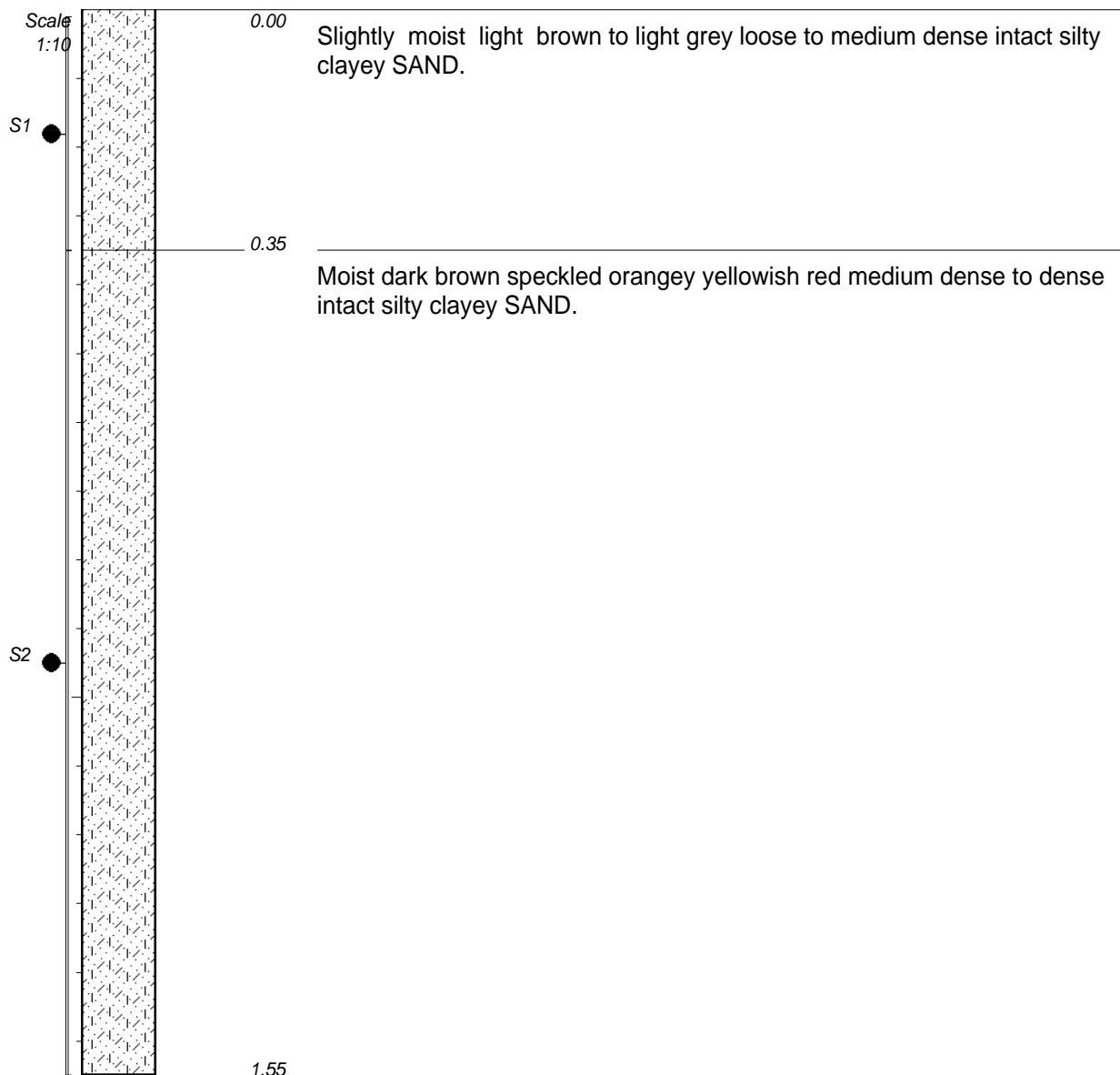
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ELEVATION :

X-COORD :

Y-COORD :

**HOLE No: AH 112**



**NOTES**

- 1) Final depth 1.55.m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken at :  
 S1 0.01--0.35m (1 x Small)  
 S2 0.35--1.55m (1 x Small).

CONTRACTOR :  
 MACHINE :

DRILLED BY :  
 PROFILED BY : DC

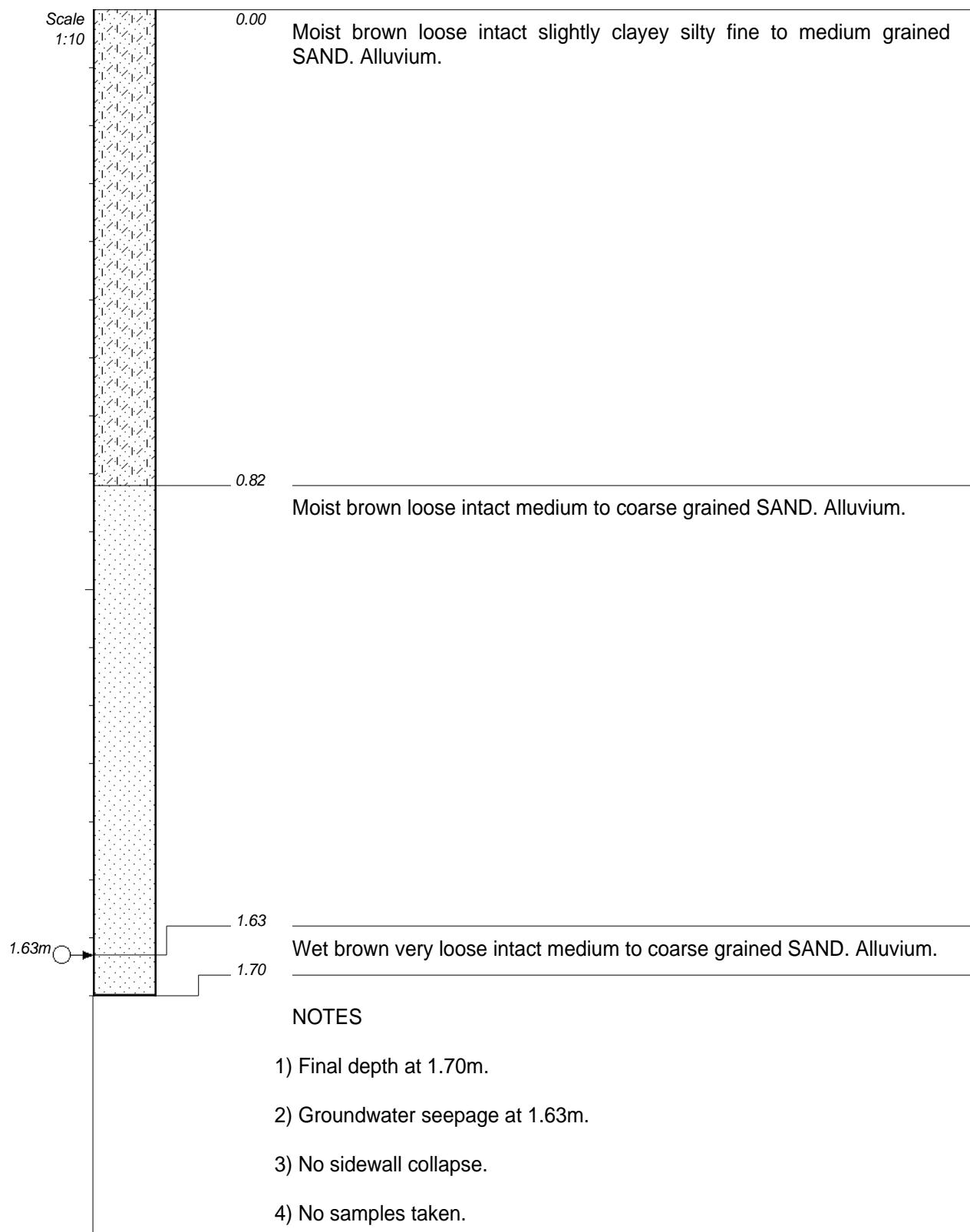
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INCLINATION :  
 DIAM :  
 DATE : 06-08-2012  
 DATE : 06-08-2012

DATE : 15/08/2012 12:19  
 TEXT : ..\Logs\060812\Dothead.doc

ELEVATION :  
 X-COORD :  
 Y-COORD :

**HOLE No: AH 113**



CONTRACTOR :

MACHINE :

DRILLED BY :

PROFILED BY : SL

TYPE SET BY : NM

SETUP FILE : MSJ2004.SET

INCLINATION :

DIAM :

DATE : 07/08/2012

DATE : 07/08/2012

DATE : 15/08/2012 12:20

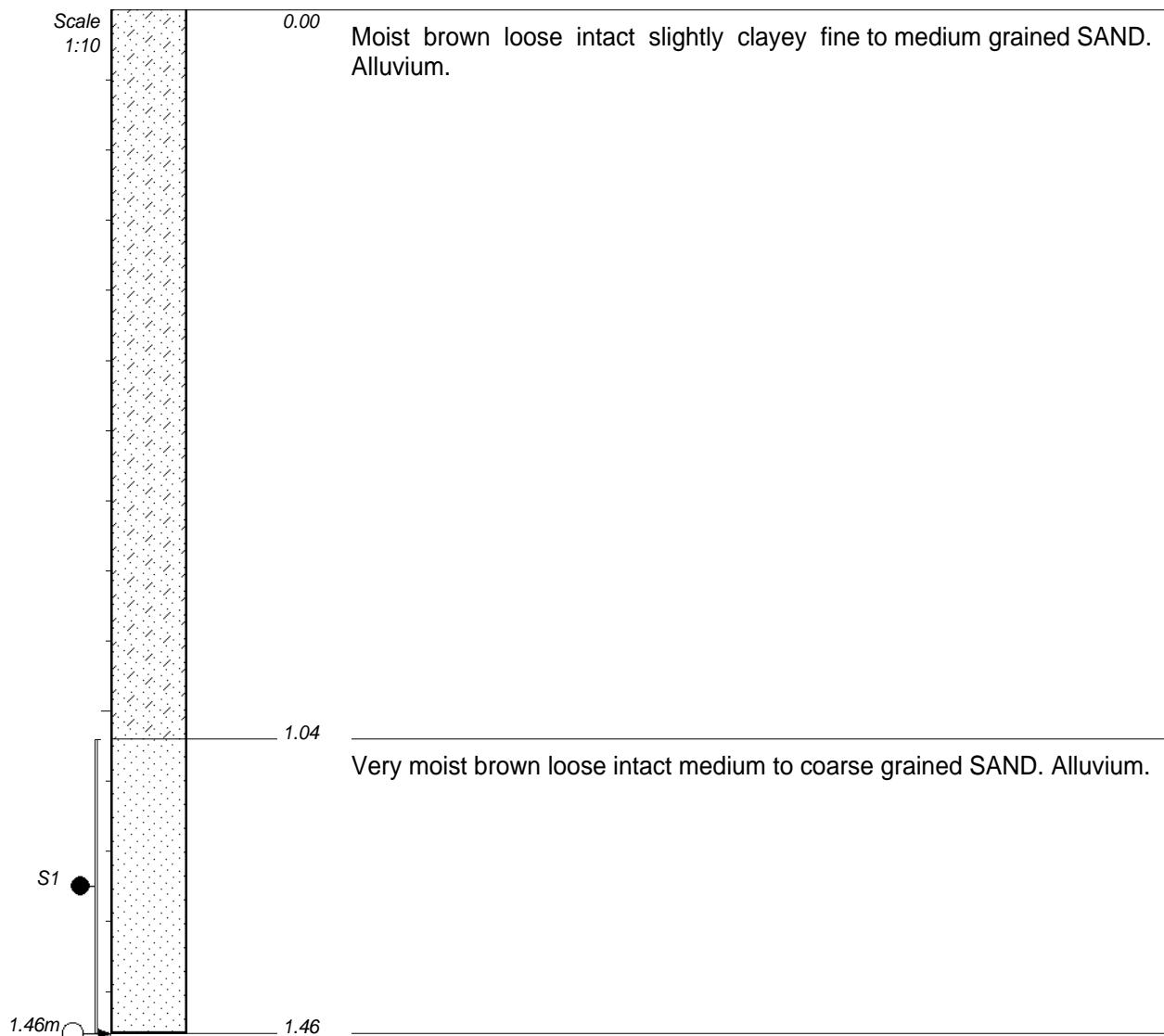
TEXT : ..\Logs\070812\Dothead.doc

ELEVATION :

X-COORD :

Y-COORD :

**HOLE No: AH ALT 1**



**NOTES**

- 1) Final depth at 1.46m.
- 2) Groundwater seepage at 1.46m.
- 3) No sidewall collapse.
- 4) Samples taken at :  
S1 1.04--1.46m (1 x Small).

CONTRACTOR :  
MACHINE :

DRILLED BY :

PROFILED BY : SL

TYPE SET BY : NM

SETUP FILE : MSJ2004.SET

INCLINATION :

DIAM :

DATE : 07/08/2012

DATE : 07/08/2012

DATE : 15/08/2012 12:20

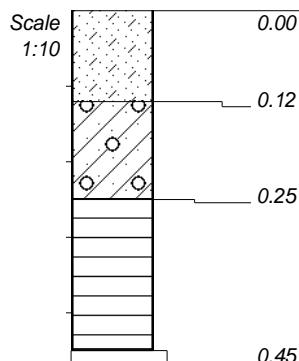
TEXT : ..\Logs\070812\Dothead.doc

ELEVATION :

X-COORD :

Y-COORD :

**HOLE No: AH ALT 2**



#### NOTES

- 1) Refusal at 0.45m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) No samples taken

CONTRACTOR :  
MACHINE :  
DRILLED BY :

PROFILED BY : SL

TYPE SET BY : NM

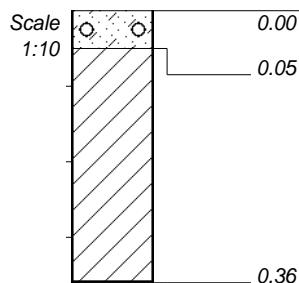
SETUP FILE : MSJ2004.SET

INCLINATION :  
DIAM :  
DATE : 07/08/2012  
DATE : 07/08/2012

DATE : 15/08/2012 12:20  
TEXT : ..\Logs\070812\Dothead.doc

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH ALT 3**



**NOTES**

- 1) Final depth 0.36m.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) No samples taken.

CONTRACTOR :  
MACHINE :

DRILLED BY :

PROFILED BY : SL

TYPE SET BY : NM

SETUP FILE : MSJ2004.SET

INCLINATION :

DIAM :

DATE : 07/08/2012

DATE : 07/08/2012

DATE : 15/08/2012 12:20

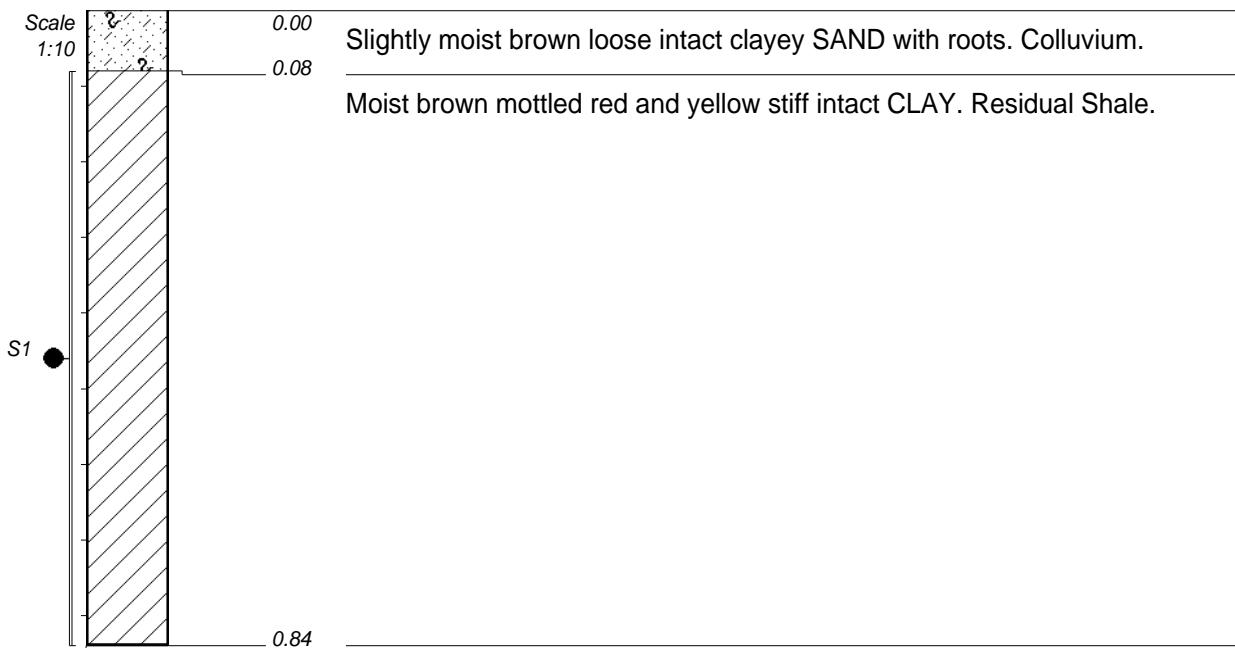
TEXT : ..\Logs\070812\Dothead.doc

ELEVATION :

X-COORD :

Y-COORD :

**HOLE No: AH ALT 4**



**NOTES**

- 1) Final depth 0.84m, refusal on very stiff clay.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken at :  
S1 0.08--0.84m (1 x Small)

CONTRACTOR :  
MACHINE :  
DRILLED BY :

PROFILED BY : SL

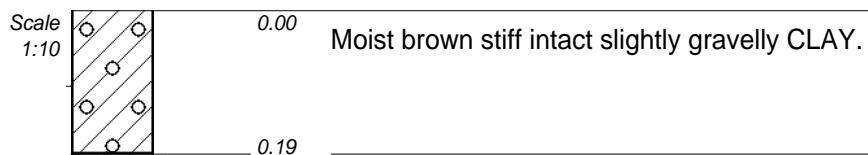
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DIAM :  
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DATE : 07/08/2012

DATE : 15/08/2012 12:20  
TEXT : ..\Logs\070812\Dothead.doc

ELEVATION :  
X-COORD :  
Y-COORD :

**HOLE No: AH ALT 5**



**NOTES**

- 1) Final depth 0.19m, refusal on very stiff clay.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) No samples taken.

CONTRACTOR :  
MACHINE :

DRILLED BY :

PROFILED BY : SL

TYPE SET BY : NM

SETUP FILE : MSJ2004.SET

INCLINATION :

DIAM :

DATE : 07/08/2012

DATE : 07/08/2012

DATE : 15/08/2012 12:20

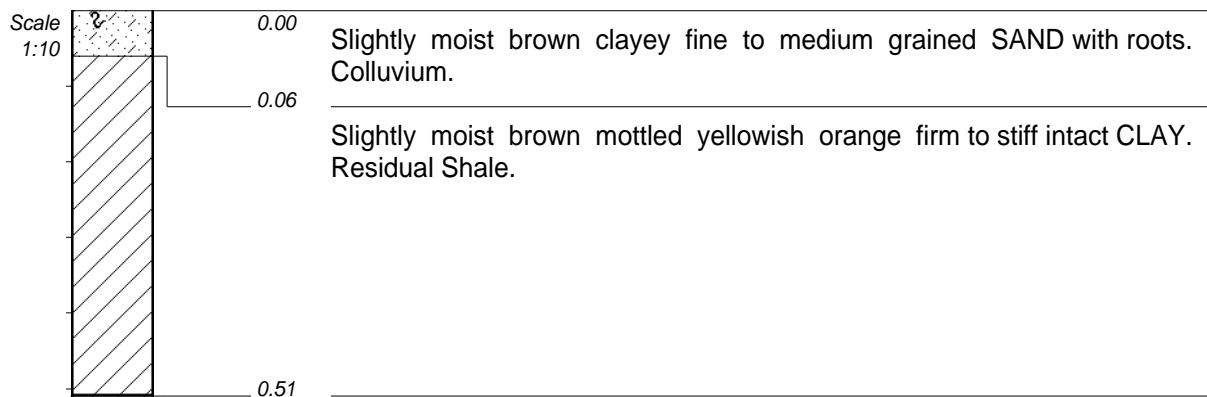
TEXT : ..\Logs\070812\Dothead.doc

ELEVATION :

X-COORD :

Y-COORD :

**HOLE No: AH ALT 6**



**NOTES**

- 1) Final depth 0.51m
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) No samples taken.

CONTRACTOR :  
MACHINE :

DRILLED BY :

PROFILED BY : SL

TYPE SET BY : NM

SETUP FILE : MSJ2004.SET

INCLINATION :

DIAM :

DATE : 07/08/2012

DATE : 07/08/2012

DATE : 15/08/2012 12:20

TEXT : ..\Logs\070812\Dothead.doc

ELEVATION :

X-COORD :

Y-COORD :

**HOLE No: AH ALT 7**

## **APPENDIX C**

**DRAFT**



Report on Sector K & Sector L (Duffs Road to Phoenix 2 Reservoir) of  
the Proposed Northern Aqueduct Pipeline Augmentation

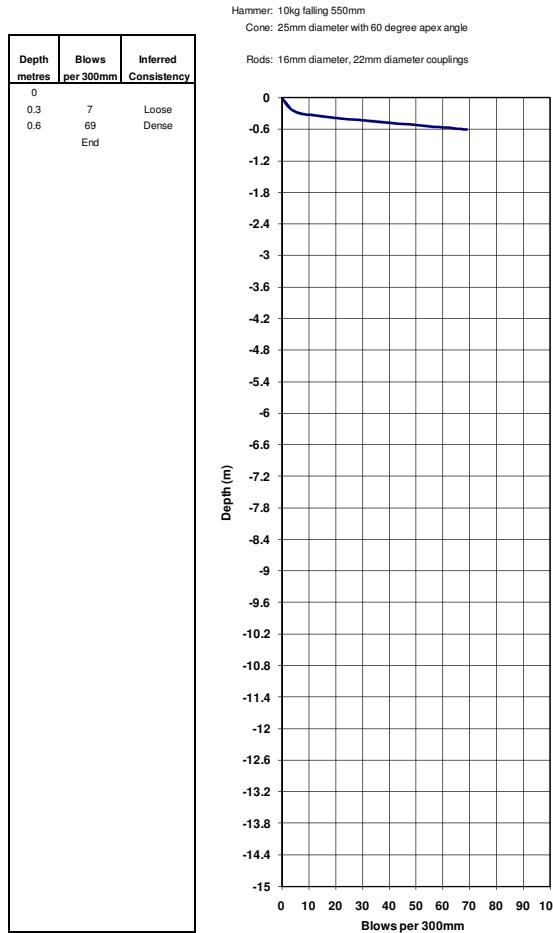
Path : H:\11\11-107\Reports\Draft Report - Sectors K & L\11-107 NAC JV Report - Sectors K & L (Draft) (28-08-2012).doc

Client: Knight Piesold  
Project: NAC  
Section:

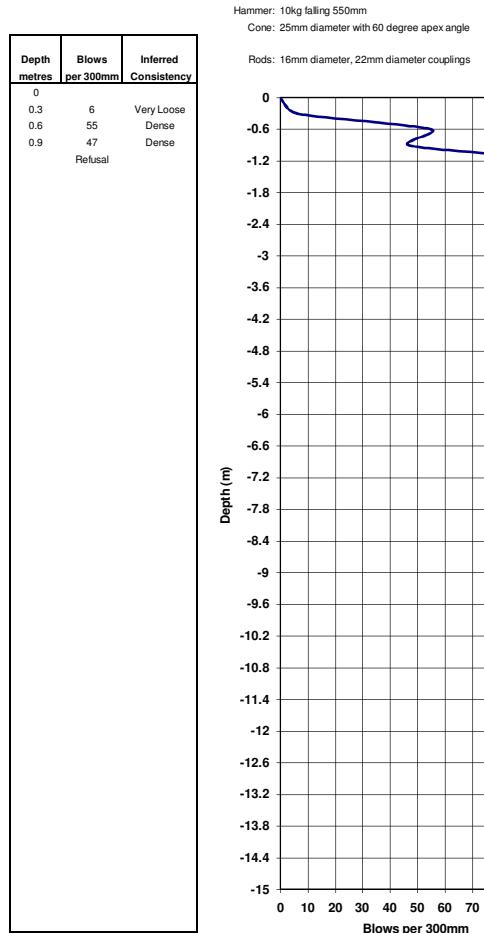
Ref.No. 11-107  
Date: 19-Jul-2012  
Operator: EN/DC

Light Dynamic Penetrometer Probe ..... **Test No. DPL 1**

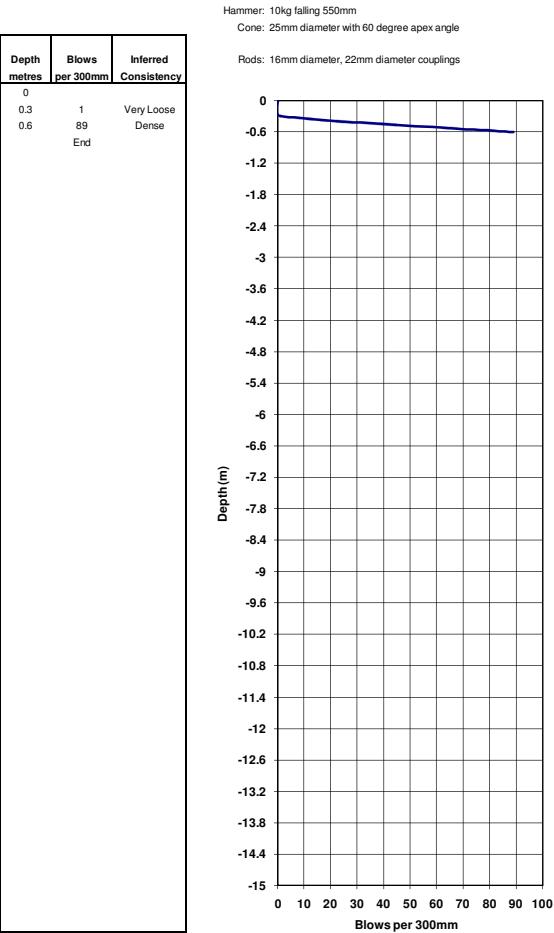
THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION



Light Dynamic Penetrometer Probe ..... **Test No. DPL 2**



Light Dynamic Penetrometer Probe ..... **Test No. DPL 3**

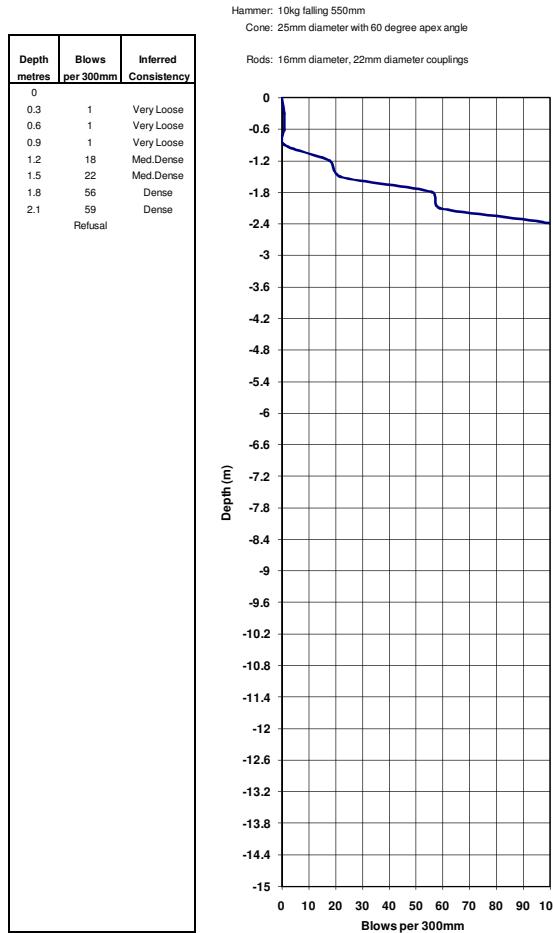


Client: Knight Piesold  
Project: NAC  
Section:

Ref.No. 11-107  
Date: 19-Jul-2012  
Operator: EN/DC

Light Dynamic Penetrometer Probe ..... **Test No.DPL 4**

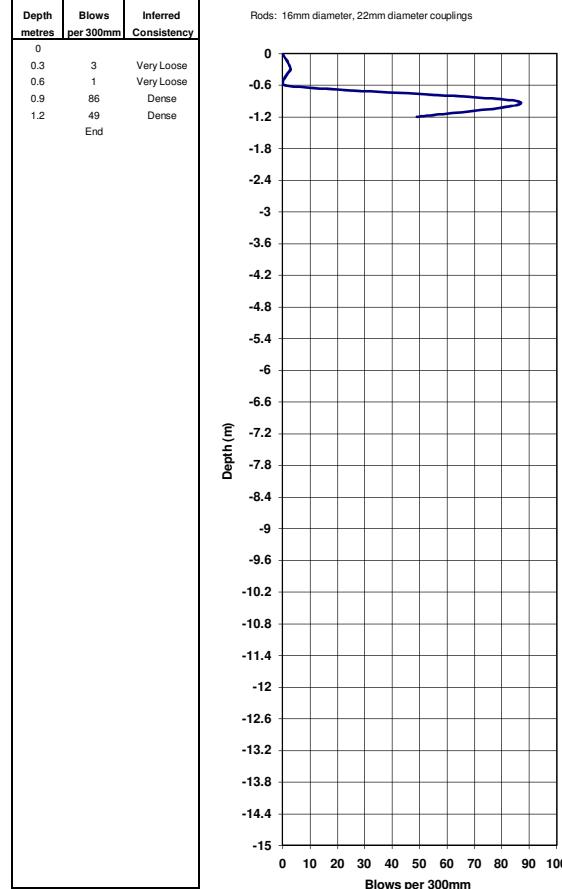
THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION



Light Dynamic Penetrometer Probe ..... **Test No.DPL 5**

Hammer: 10kg falling 550mm  
Cone: 25mm diameter with 60 degree apex angle

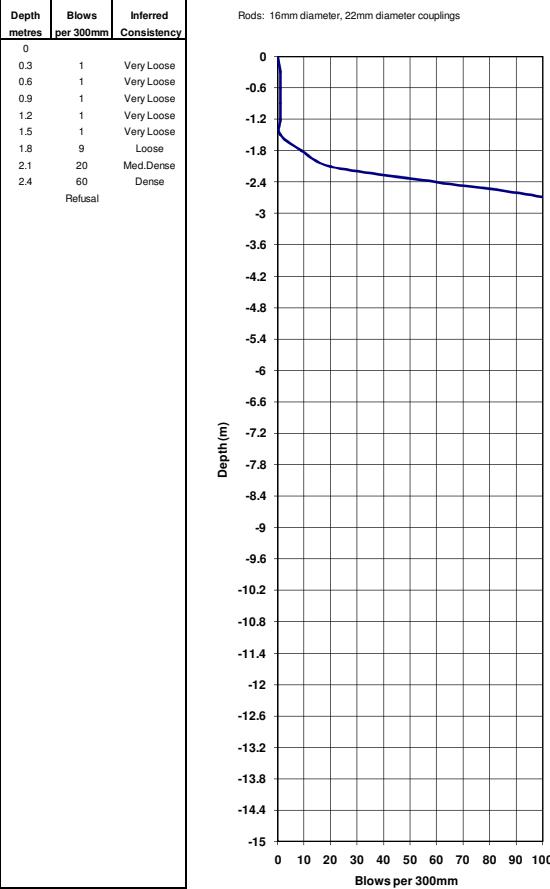
Rods: 16mm diameter, 22mm diameter couplings



Light Dynamic Penetrometer Probe ..... **Test No.DPL 6**

Hammer: 10kg falling 550mm  
Cone: 25mm diameter with 60 degree apex angle

Rods: 16mm diameter, 22mm diameter couplings

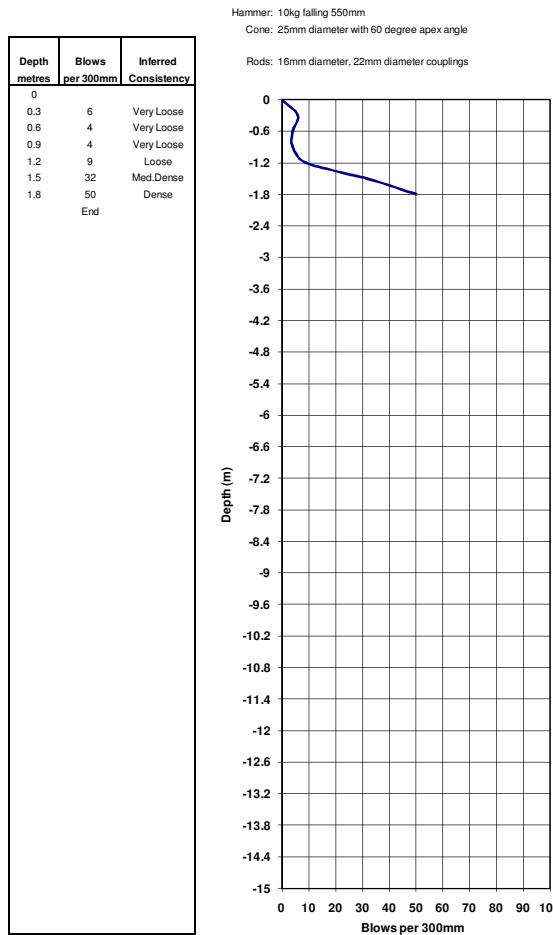


Client: Knight Piesold  
Project: NAC  
Section:

Ref.No. 11-107  
Date: 19-Jul-2012  
Operator: EN/DC

Light Dynamic Penetrometer Probe ..... **Test No.DPL 7**

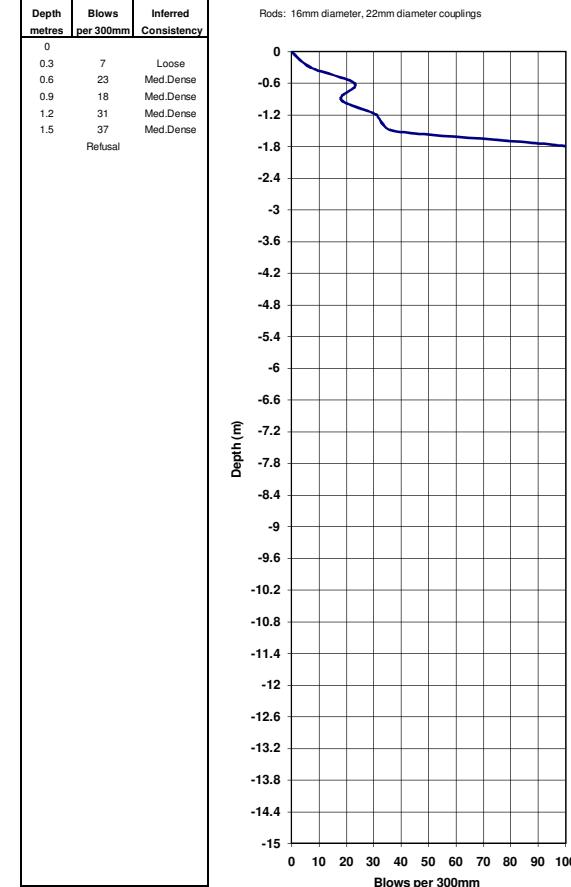
THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION



Light Dynamic Penetrometer Probe ..... **Test No.DPL 8**

Hammer: 10kg falling 550mm  
Cone: 25mm diameter with 60 degree apex angle

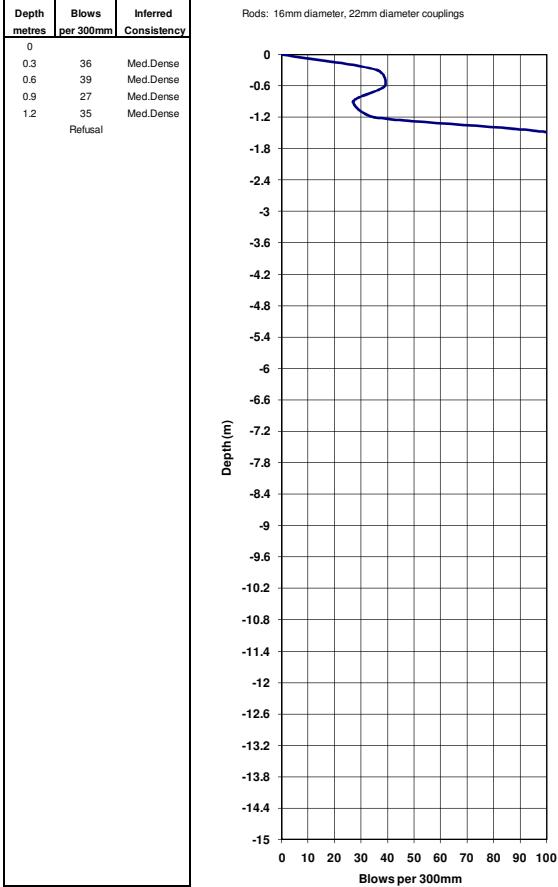
Rods: 16mm diameter, 22mm diameter couplings



Light Dynamic Penetrometer Probe ..... **Test No.DPL 9**

Hammer: 10kg falling 550mm  
Cone: 25mm diameter with 60 degree apex angle

Rods: 16mm diameter, 22mm diameter couplings

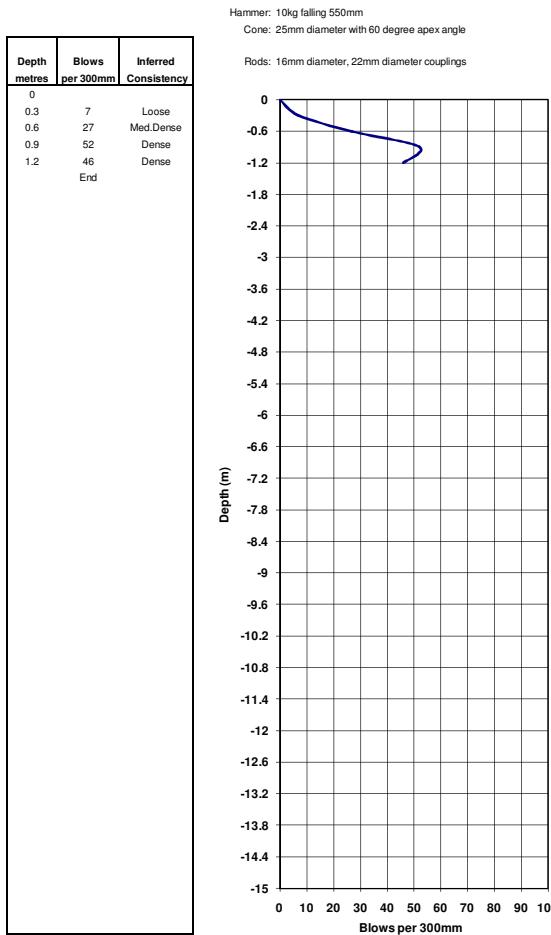


Client: Knight Piesold  
Project: NAC  
Section:

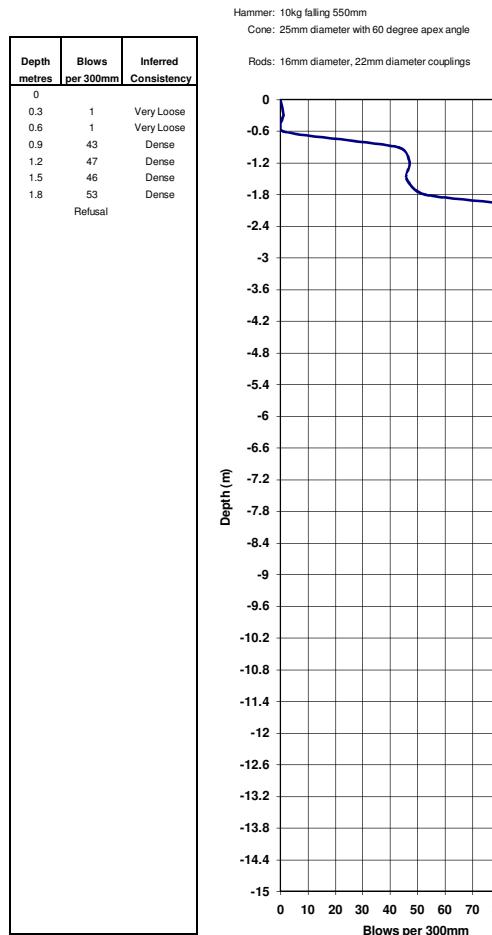
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Date: 23-Jul-2012  
Operator: EN/DC

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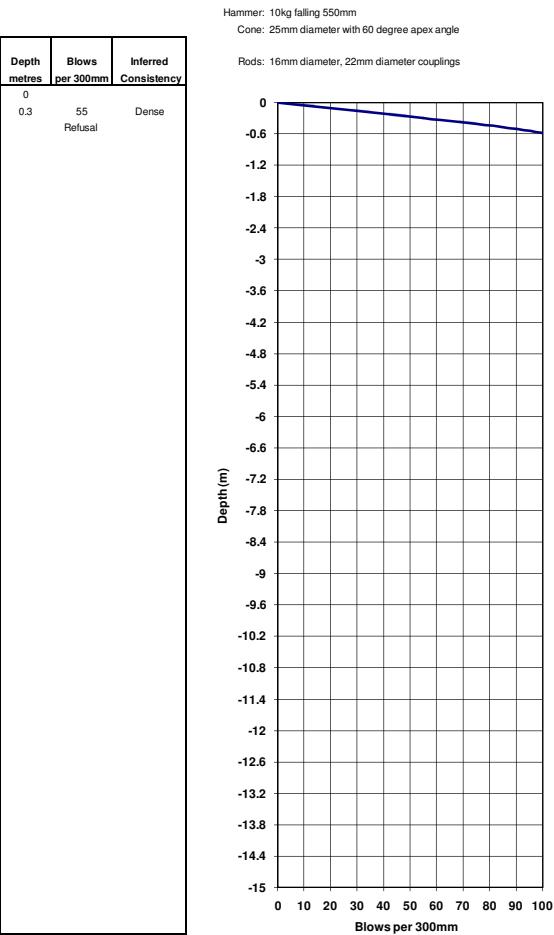
THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION



Light Dynamic Penetrometer Probe ..... **Test No. DPL 11**



Light Dynamic Penetrometer Probe ..... **Test No. DPL 12**



Client: Knight Piesold  
Project: NAC  
Section:

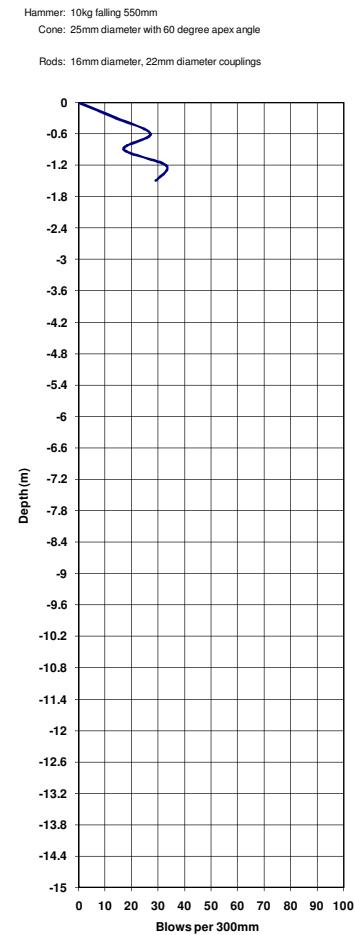
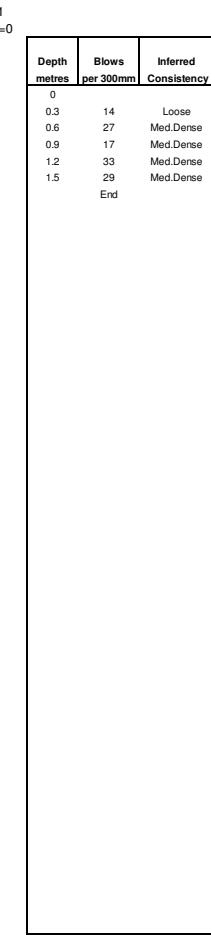
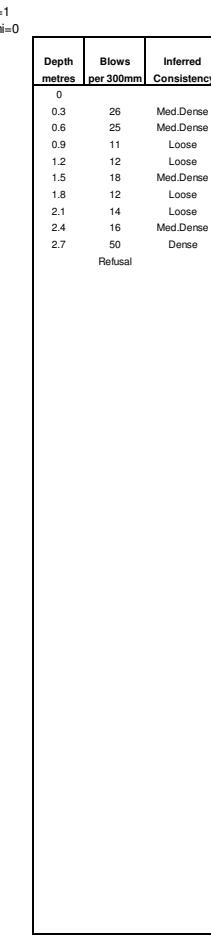
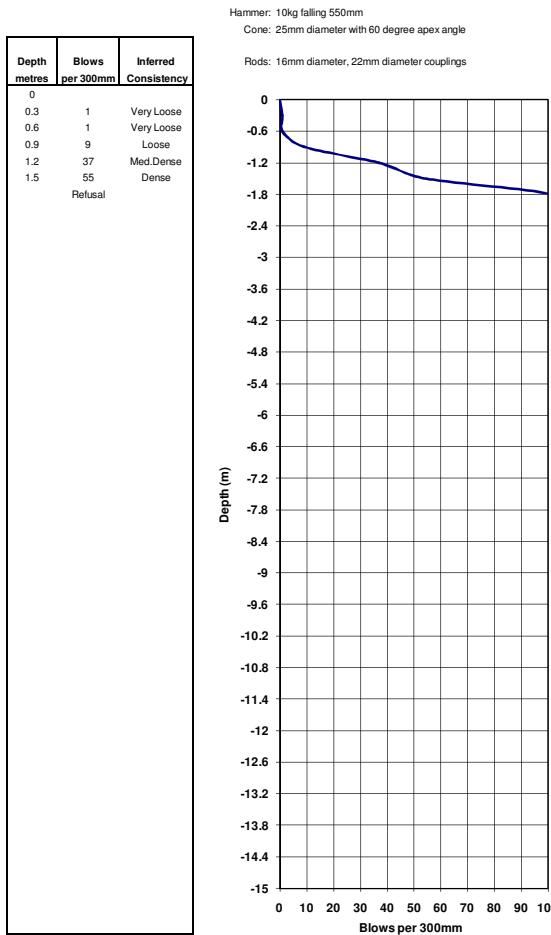
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Date: 19-Jul-2012  
Operator: EN/DC

Light Dynamic Penetrometer Probe ..... **Test No. DPL 13**

Light Dynamic Penetrometer Probe ..... **Test No. DPL 14**

Light Dynamic Penetrometer Probe ..... **Test No. DPL 15**

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION



Client: Knight Piesold  
Project: NAC  
Section:

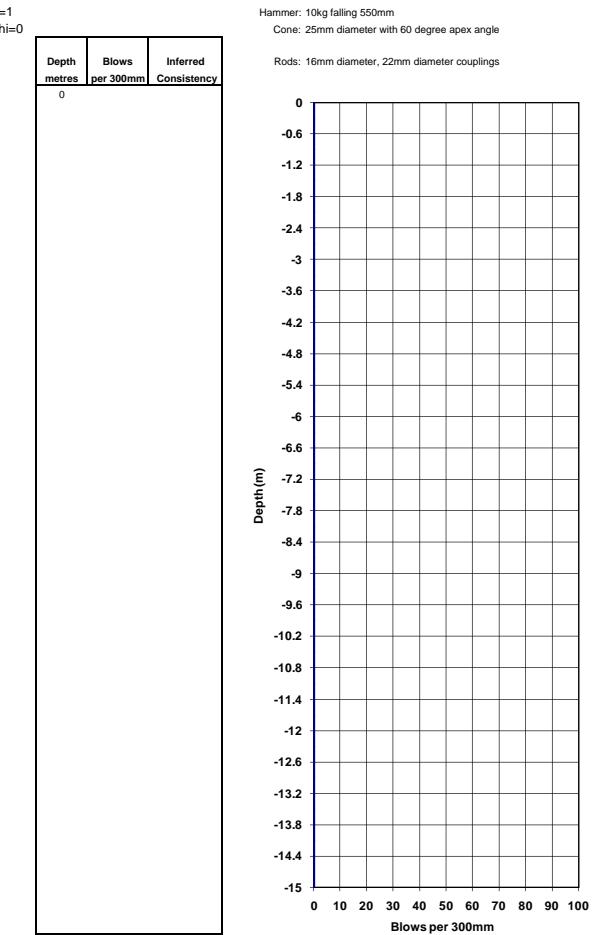
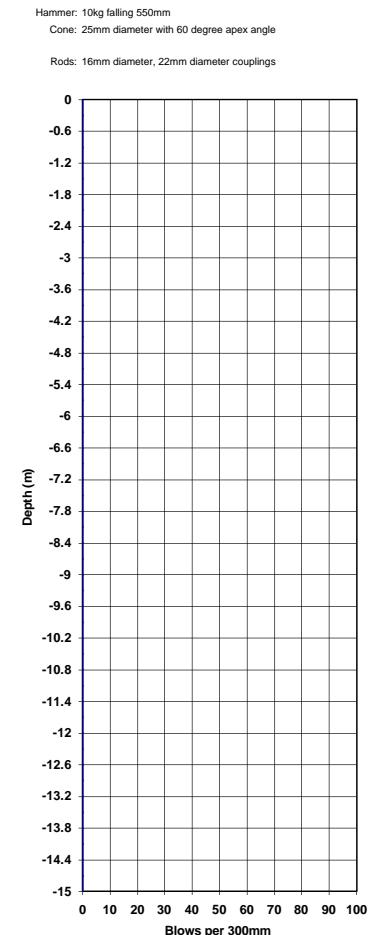
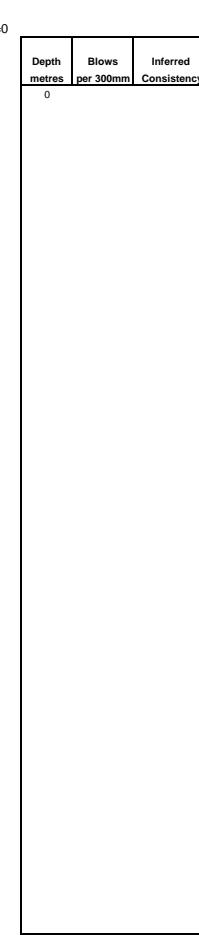
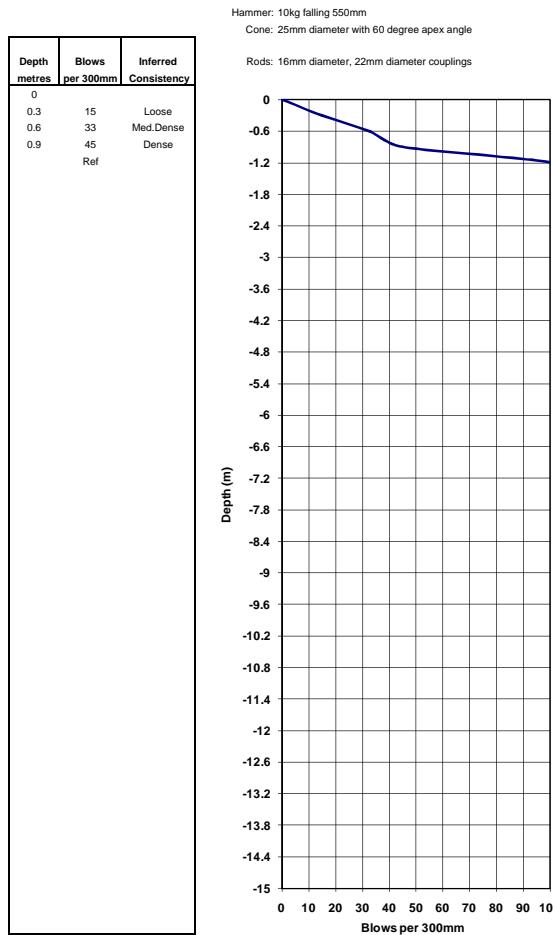
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Date: 21-08-2012  
Operator: EN/DC

Light Dynamic Penetrometer Probe ..... Test No. DPL 16

Light Dynamic Penetrometer Probe ..... Test No. DPL

Light Dynamic Penetrometer Probe ..... Test No. DPL

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

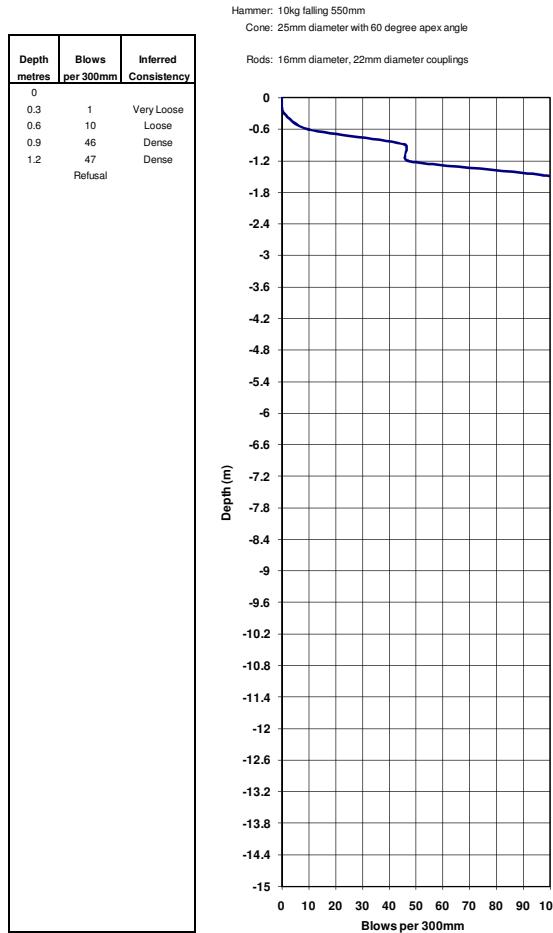


Client: Knight Piesold  
Project: NAC  
Section:

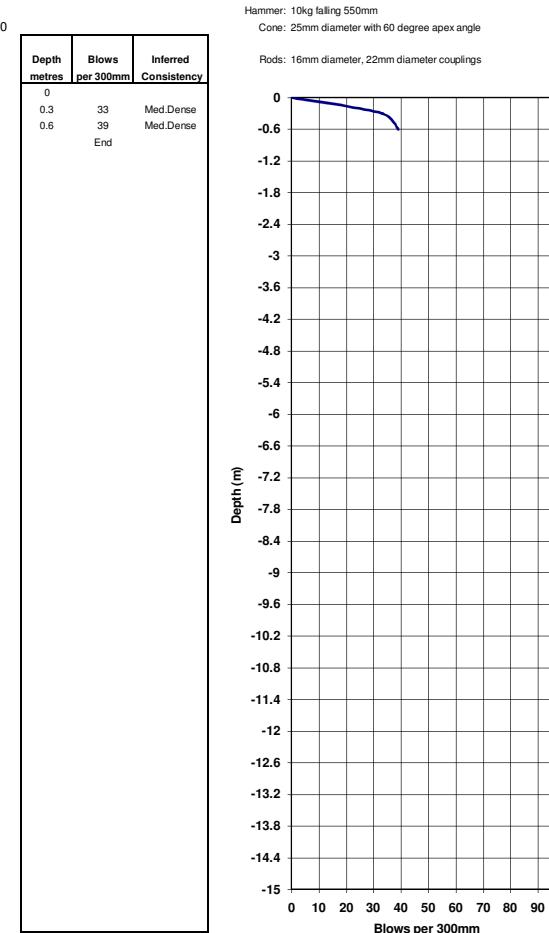
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Date: 24-Jul-2012  
Operator: EN/DC

Light Dynamic Penetrometer Probe ..... **Test No. DPL 17**

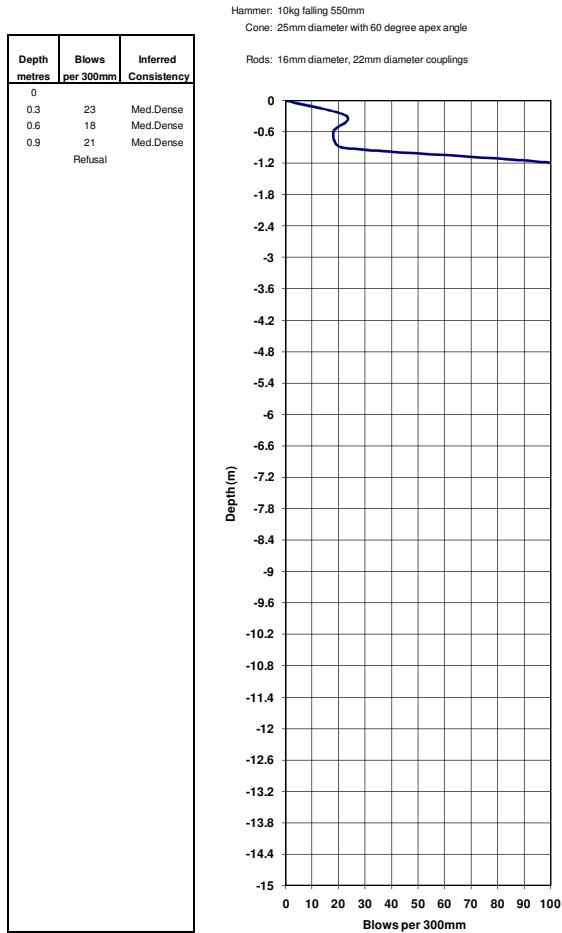
THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION



Light Dynamic Penetrometer Probe ..... **Test No. DPL 18**



Light Dynamic Penetrometer Probe ..... **Test No. DPL 19**

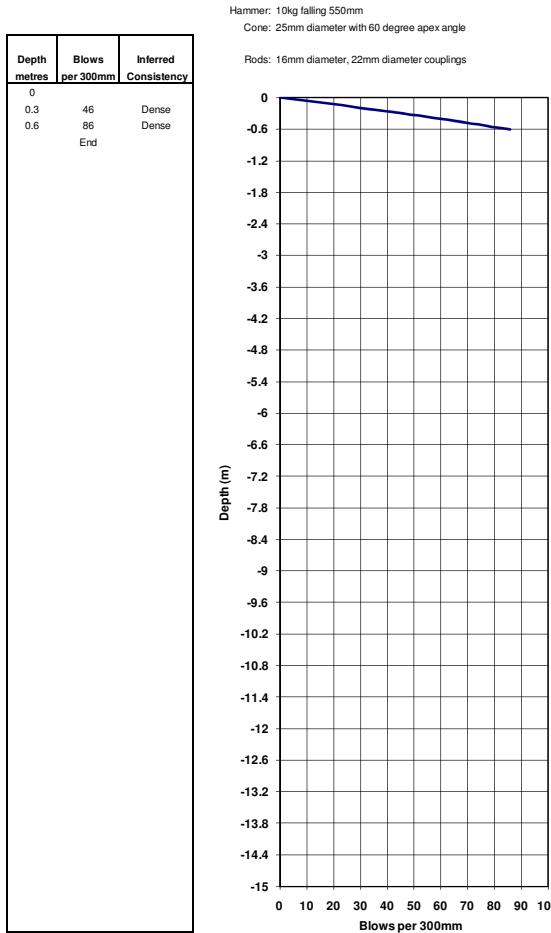


Client: Knight Piesold  
Project: NAC  
Section:

Ref.No. 11-107  
Date: 24-Jul-2012  
Operator: EN/DC

Light Dynamic Penetrometer Probe ..... **Test No.DPL 20**

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION



Light Dynamic Penetrometer Probe ..... **Test No.DPL 21**

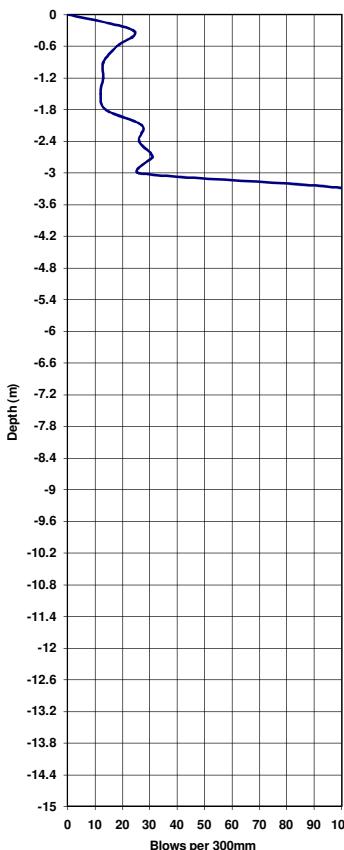
Hammer: 10kg falling 550mm  
Cone: 25mm diameter with 60 degree apex angle

Rods: 16mm diameter, 22mm diameter couplings

S=1  
Phi=0

Depth metres	Blows per 300mm	Inferred Consistency
0	24	Med.Dense
0.6	18	Med.Dense
0.9	13	Loose
1.2	13	Loose
1.5	12	Loose
1.8	14	Loose
2.1	27	Med.Dense
2.4	26	Med.Dense
2.7	31	Med.Dense
3	26	Med.Dense

Refusal



Light Dynamic Penetrometer Probe ..... **Test No.DPL 22**

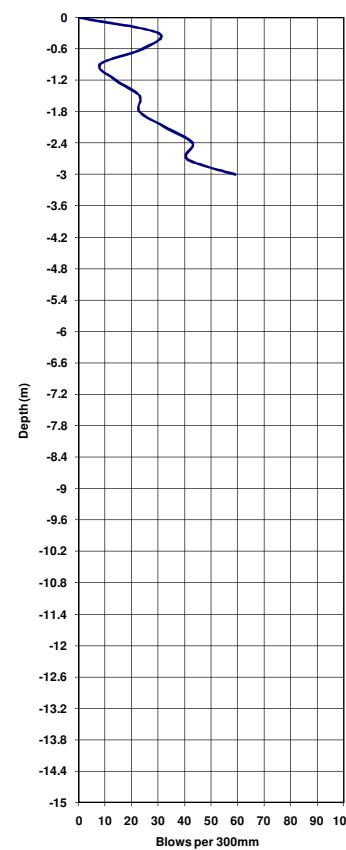
Hammer: 10kg falling 550mm  
Cone: 25mm diameter with 60 degree apex angle

Rods: 16mm diameter, 22mm diameter couplings

S=1  
Phi=0

Depth metres	Blows per 300mm	Inferred Consistency
0	30	Med.Dense
0.6	24	Med.Dense
0.9	8	Loose
1.2	14	Loose
1.5	23	Med.Dense
1.8	23	Med.Dense
2.1	33	Med.Dense
2.4	43	Dense
2.7	41	Dense
3	59	Dense

End



Client: Knight Piesold  
Project: NAC  
Section:

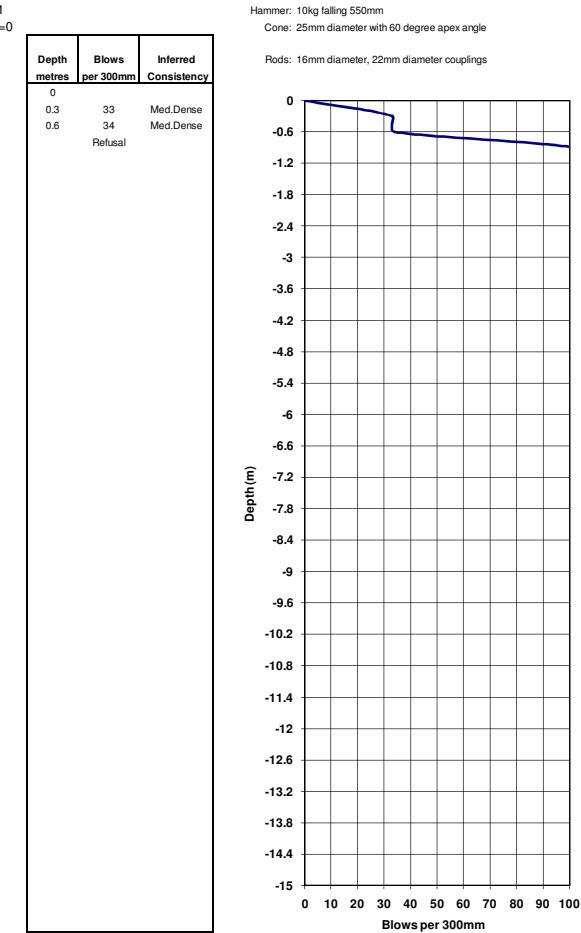
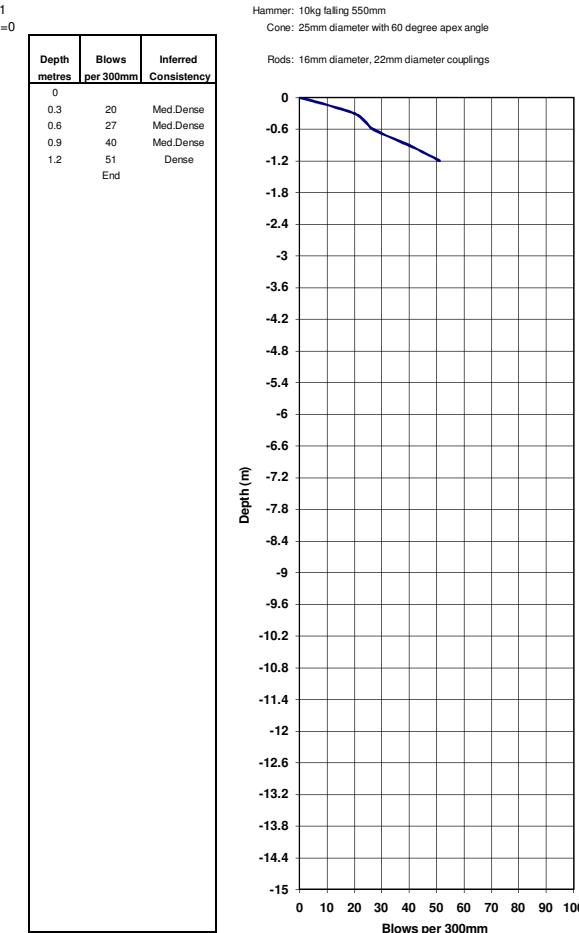
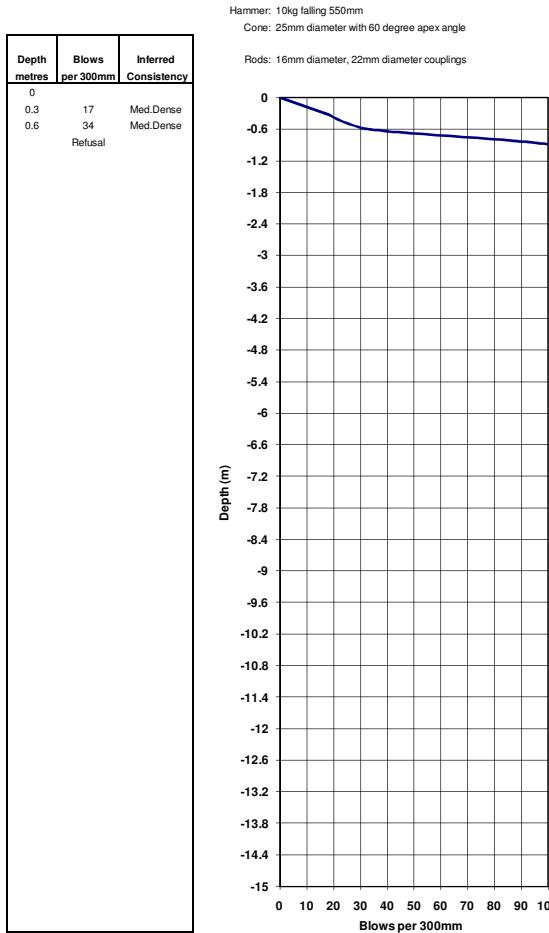
Ref.No. 11-107  
Date: 24-Jul-2012  
Operator: EN/DC

Light Dynamic Penetrometer Probe ..... **Test No. DPL 23**

Light Dynamic Penetrometer Probe ..... **Test No. DPL 24**

Light Dynamic Penetrometer Probe ..... **Test No. DPL 25**

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION



Client: Knight Piesold  
Project: NAC  
Section:

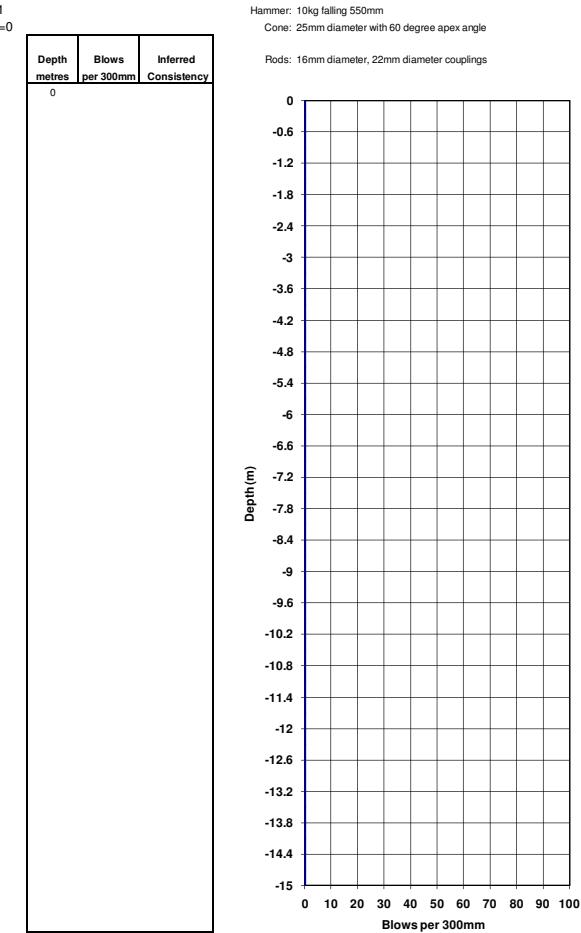
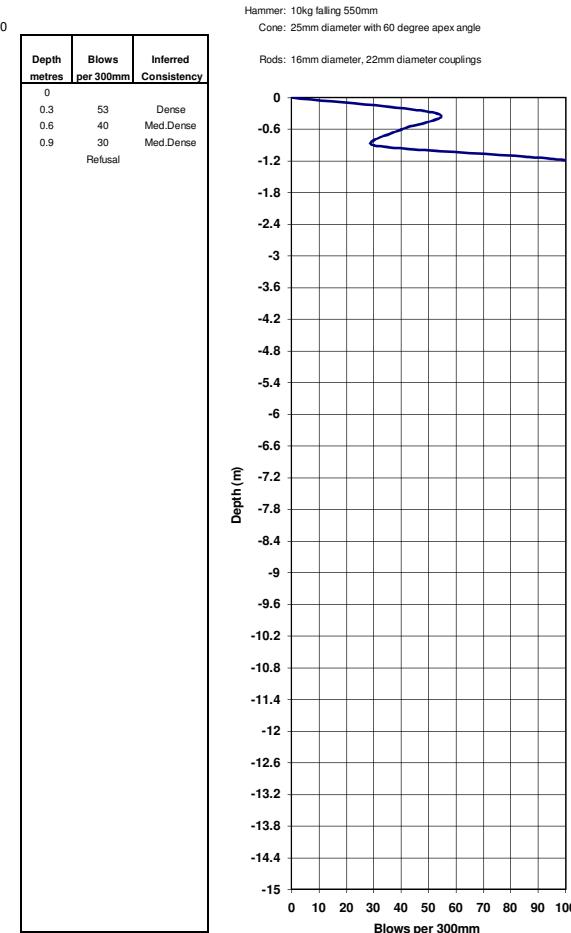
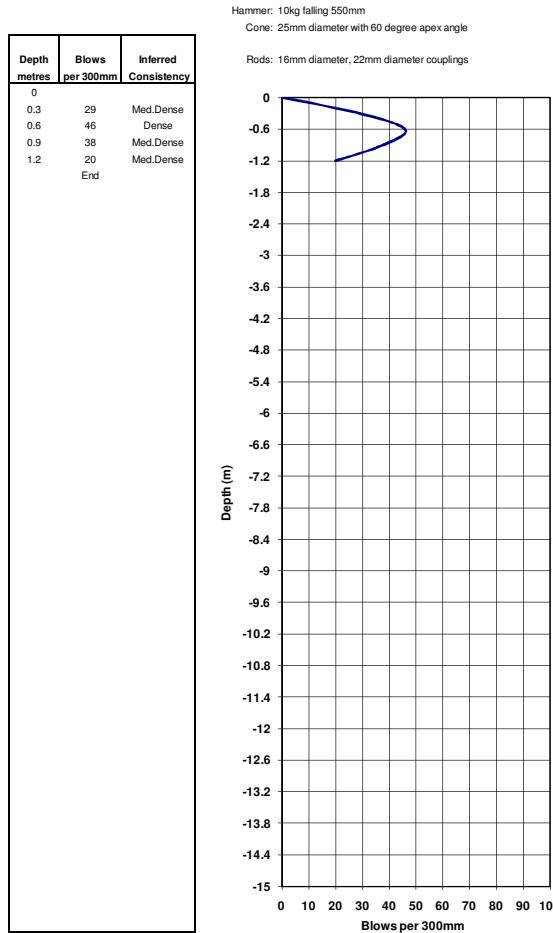
Ref.No. 11-107  
Date: 24-Jul-2012  
Operator: EN/DC

Light Dynamic Penetrometer Probe ..... **Test No. DPL 26**

Light Dynamic Penetrometer Probe ..... **Test No. DPL 27**

Light Dynamic Penetrometer Probe ..... **Test No. DPL**

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION



Client: Knight Piesold  
Project: NAC  
Section:

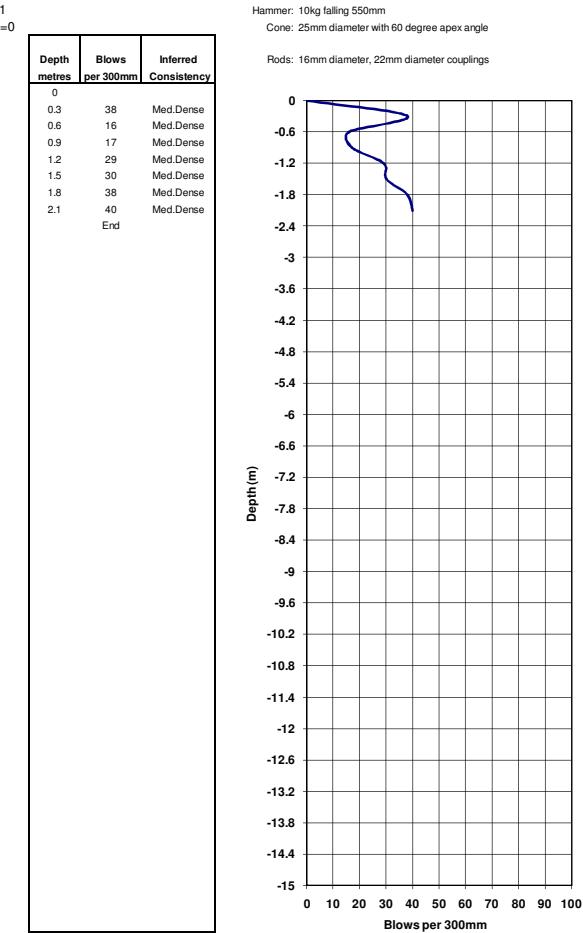
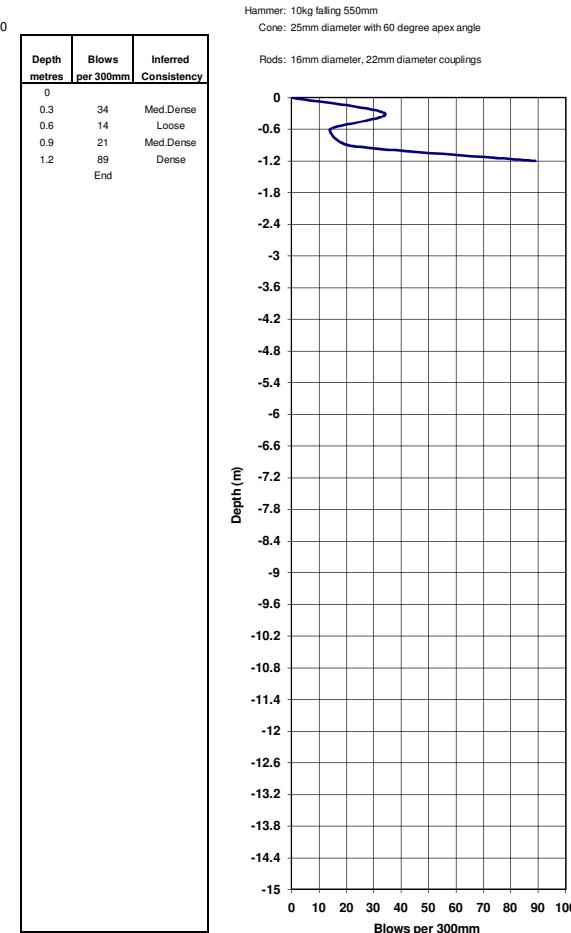
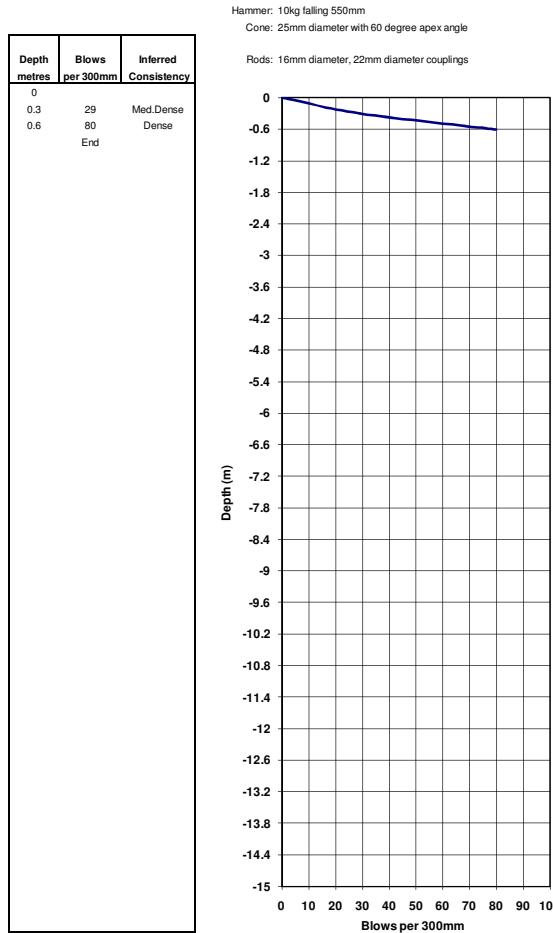
Ref.No. 11-107  
Date: 30-Jul-2012  
Operator: EN/DC

Light Dynamic Penetrometer Probe ..... **Test No. DPL 28**

Light Dynamic Penetrometer Probe ..... **Test No. DPL 29**

Light Dynamic Penetrometer Probe ..... **Test No. DPL 30**

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION



Client: Knight Piesold  
Project: NAC  
Section:

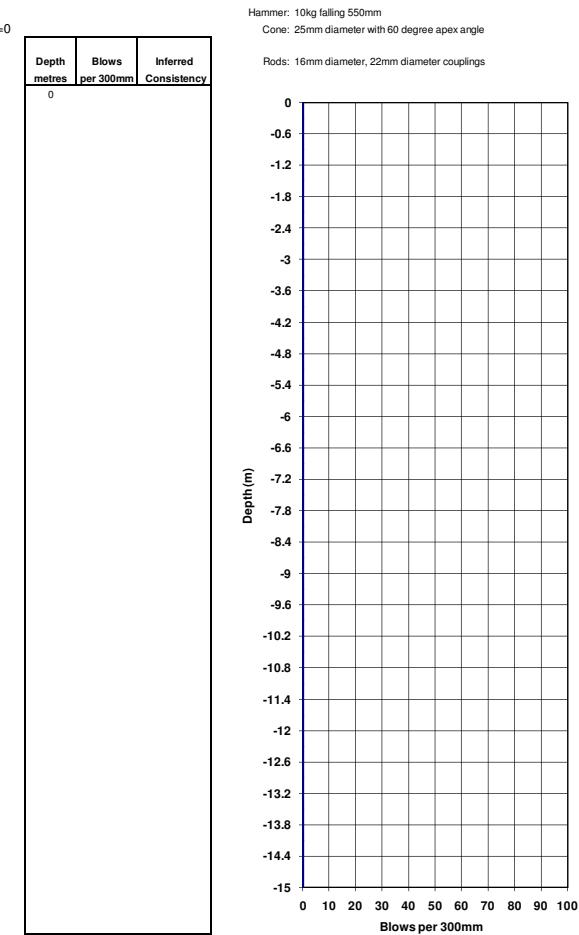
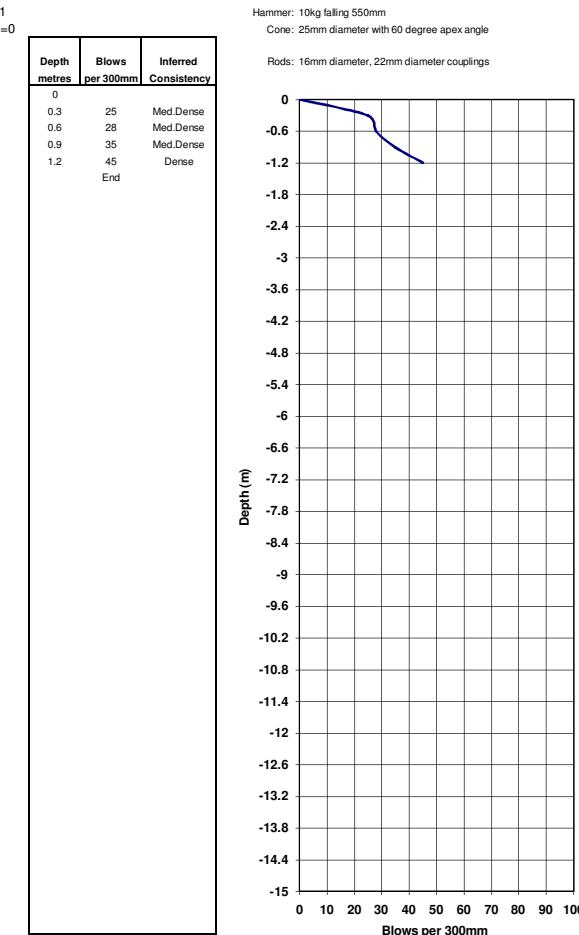
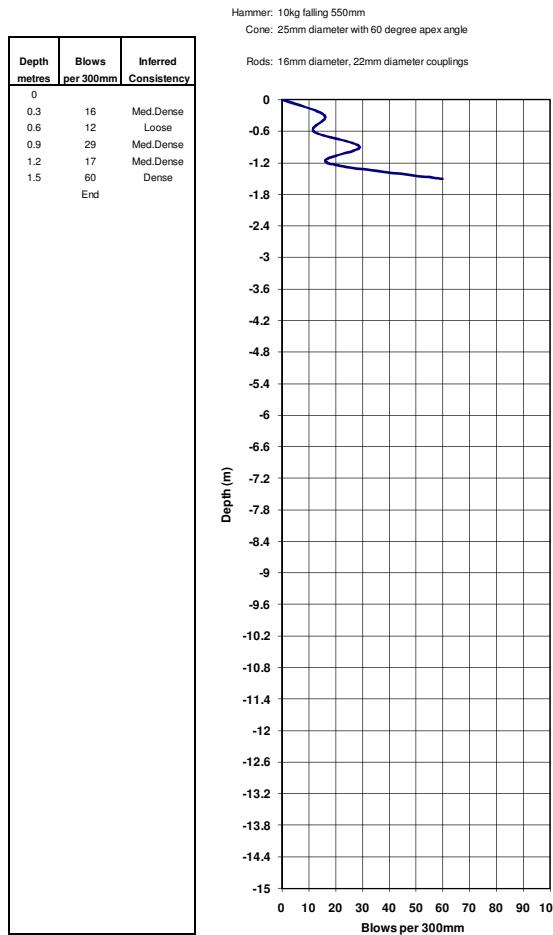
Ref.No. 11-107  
Date: 30-Jul-2012  
Operator: EN/DC

Light Dynamic Penetrometer Probe ..... **Test No.DPL 31**

Light Dynamic Penetrometer Probe ..... **Test No.DPL 32**

Light Dynamic Penetrometer Probe ..... **Test No.DPL**

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION



Client: Knight Piesold  
Project: NAC  
Section:

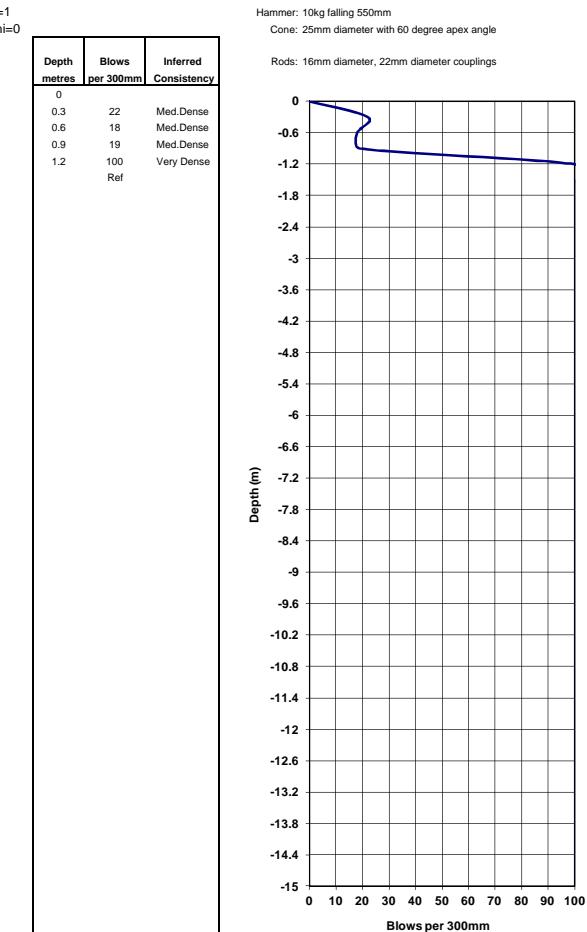
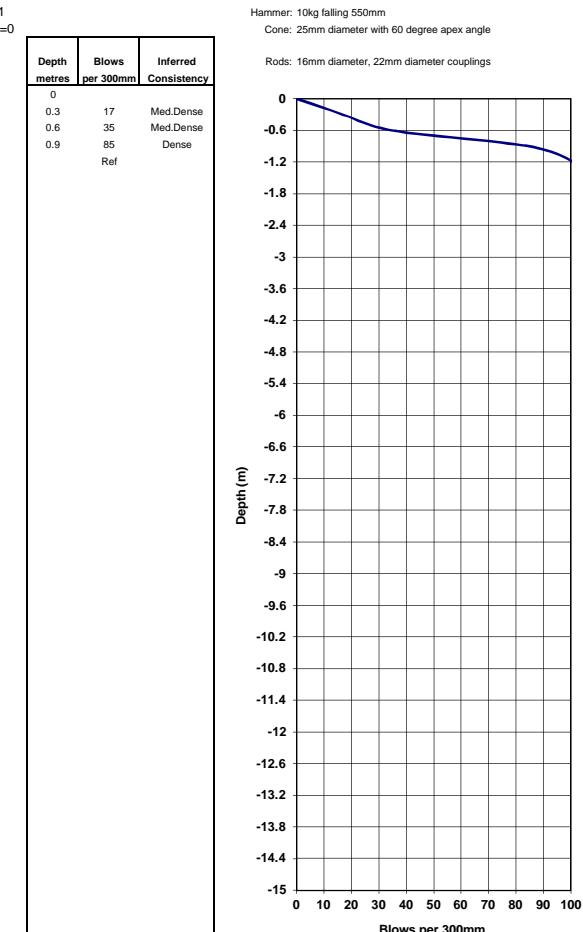
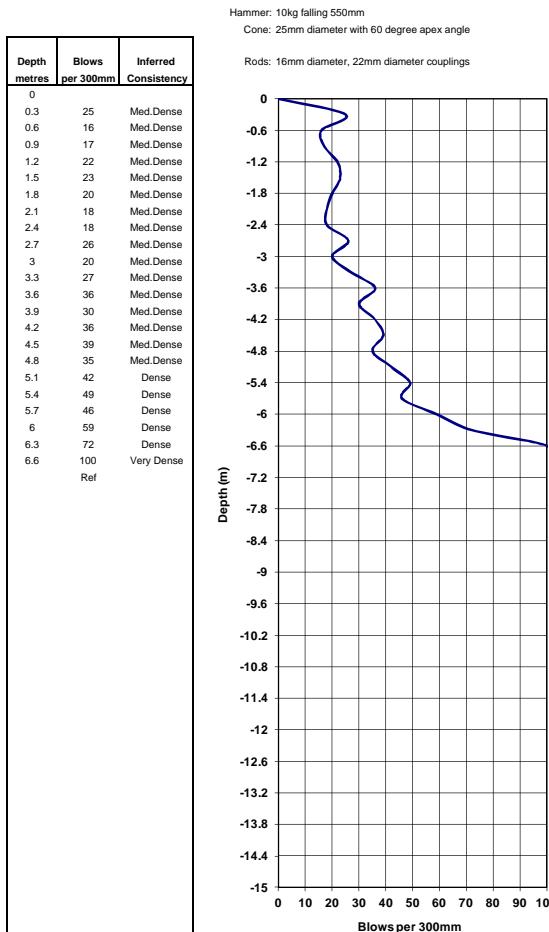
Ref.No. 11-107  
Date: 23/08/2012  
Operator: VKJM/RSS

Light Dynamic Penetrometer Probe ..... Test No.DPL 33

Light Dynamic Penetrometer Probe ..... Test No.DPL 34

Light Dynamic Penetrometer Probe ..... Test No.DPL 35

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION



Client: Knight Piesold  
Project: NAC  
Section:

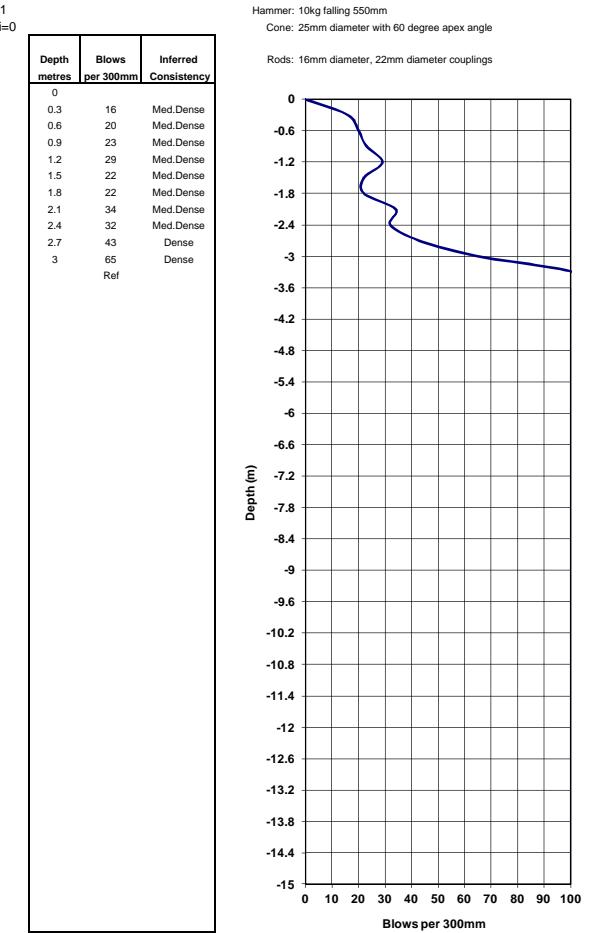
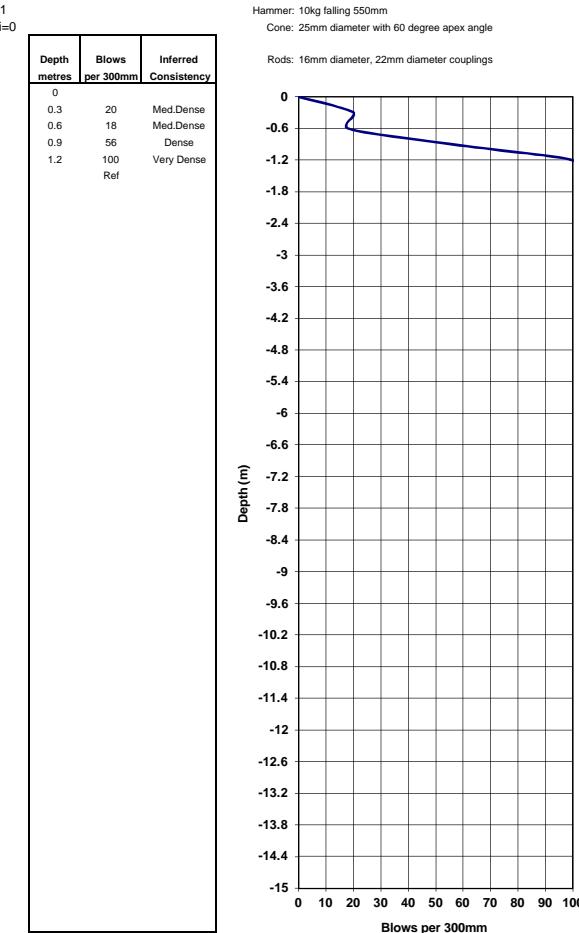
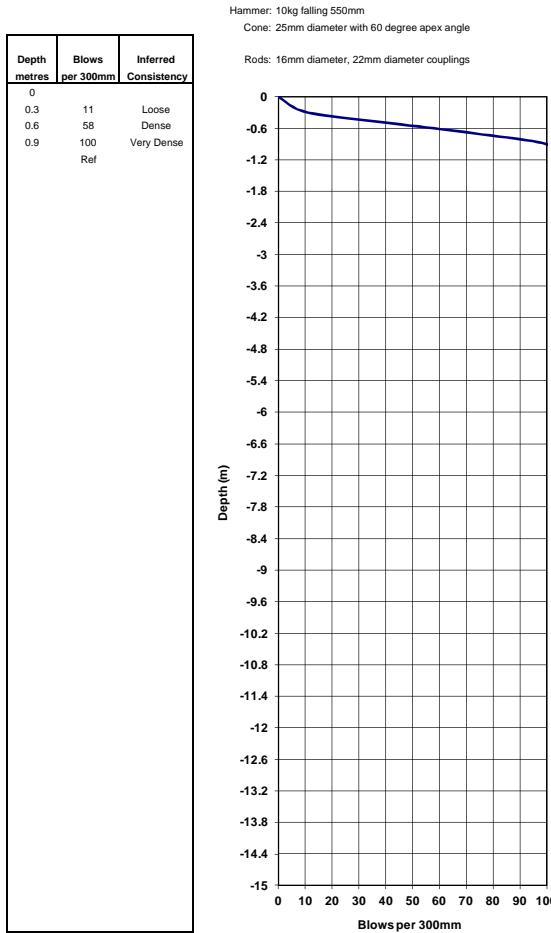
Ref.No. 11-107  
Date: 23/08/2012  
Operator: VK/JM/RSG

Light Dynamic Penetrometer Probe ..... Test No. DPL 36

Light Dynamic Penetrometer Probe ..... Test No. DPL 37

Light Dynamic Penetrometer Probe ..... Test No. DPL 38

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION



Client: Knight Piesold  
Project: NAC  
Section:

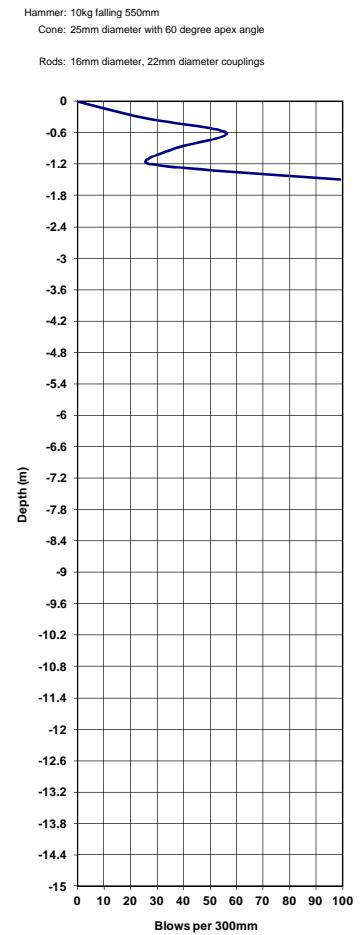
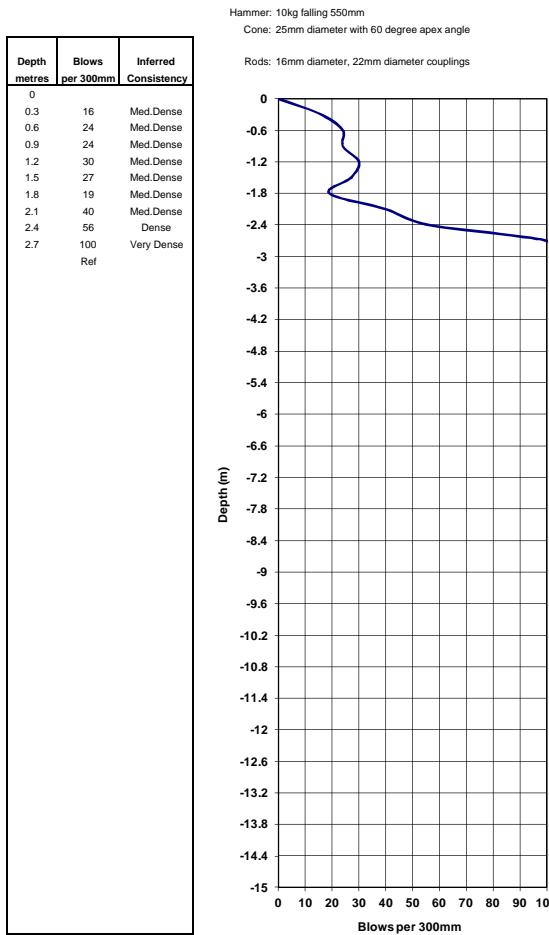
Ref.No. 11-107  
Date: 23/08/2012  
Operator: VK/JM/RSG

Light Dynamic Penetrometer Probe ..... Test No. DPL 39

Light Dynamic Penetrometer Probe ..... Test No. DPL 40

Light Dynamic Penetrometer Probe ..... Test No. DPL 41

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

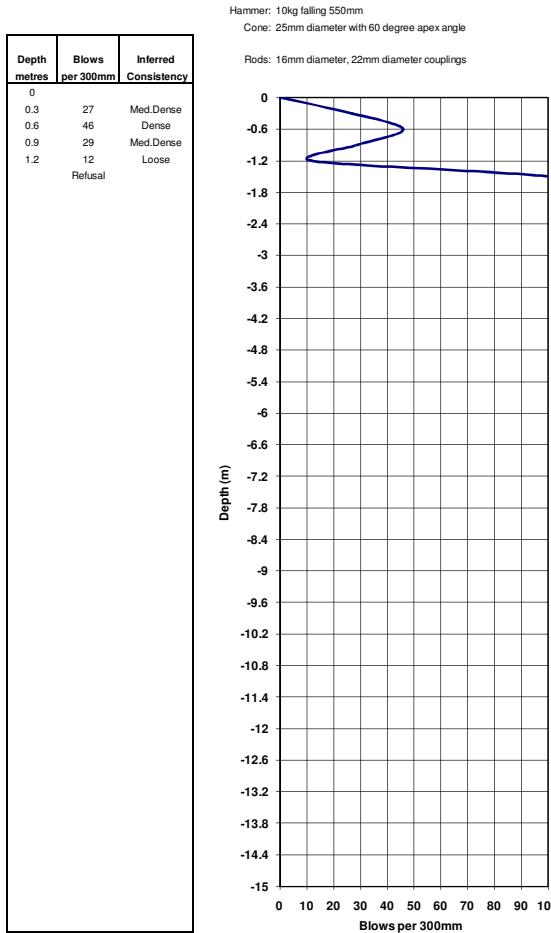


Client: Knight Piesold  
Project: NAC  
Section:

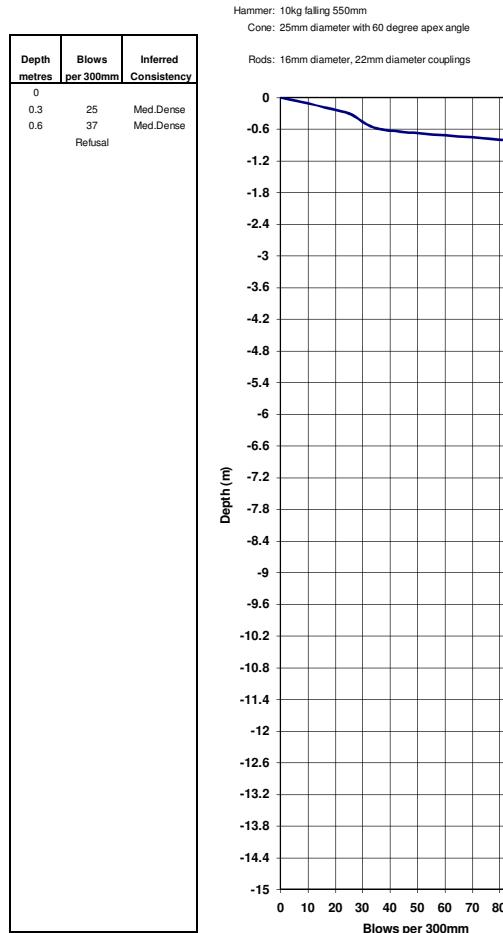
Ref.No. 11-107  
Date: 2-Aug-2012  
Operator: DC

Light Dynamic Penetrometer Probe ..... **Test No.DPL 101**

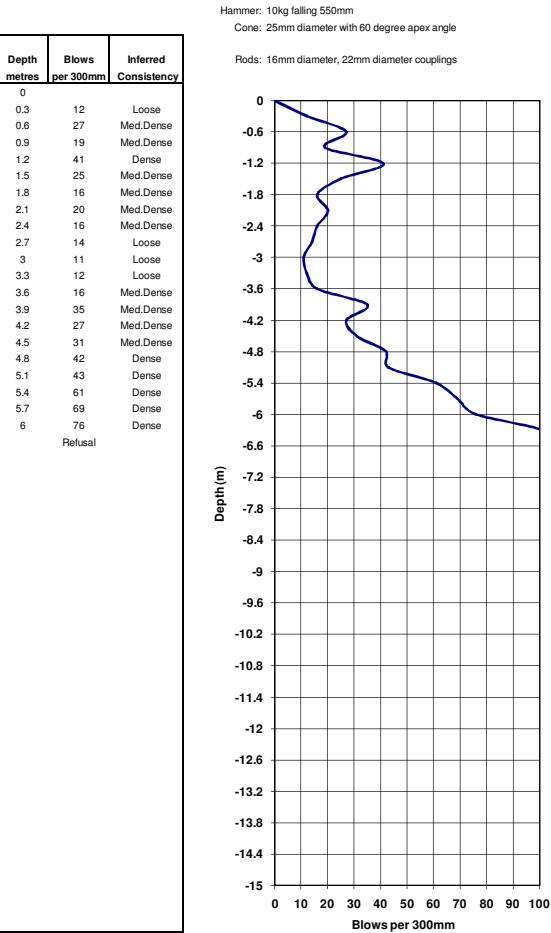
THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION



Light Dynamic Penetrometer Probe ..... **Test No.DPL 102**



Light Dynamic Penetrometer Probe ..... **Test No.DPL 103**

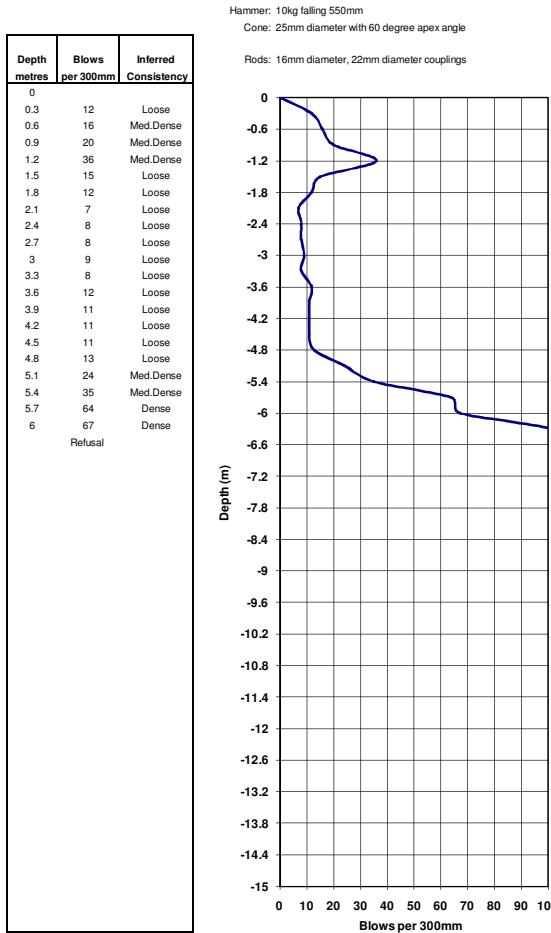


Client: Knight Piesold  
Project: NAC  
Section:

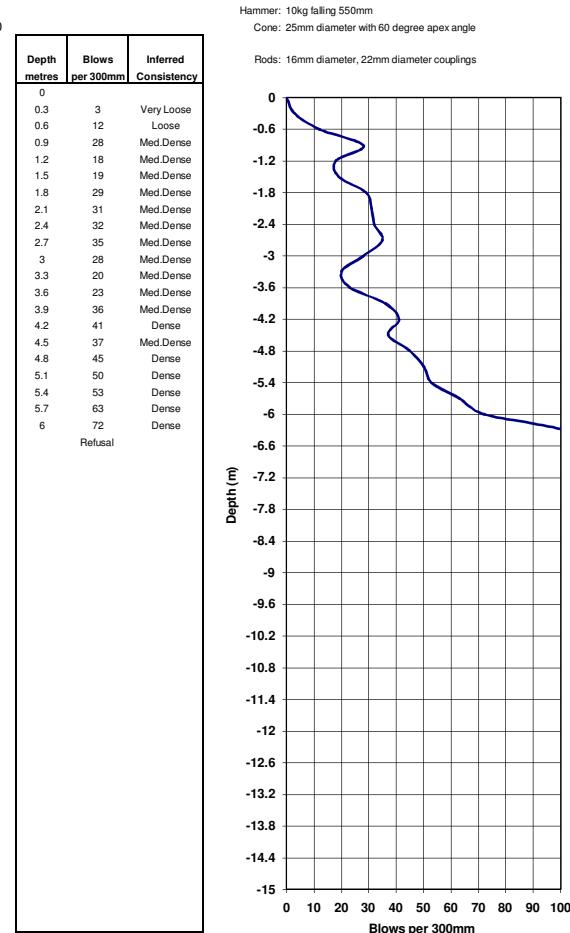
Ref.No. 11-107  
Date: 2-Aug-2012  
Operator: DC

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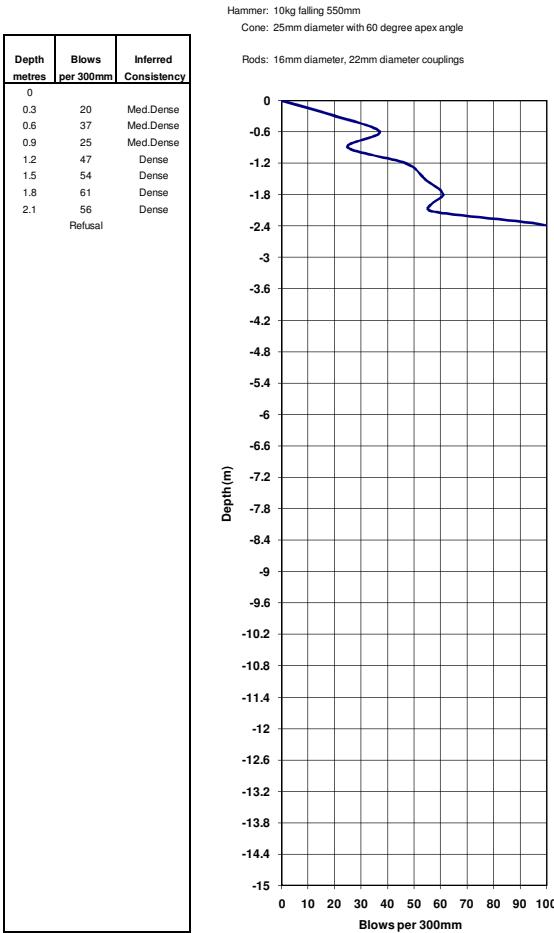
THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION



Light Dynamic Penetrometer Probe ..... **Test No. DPL 105**



Light Dynamic Penetrometer Probe ..... **Test No. DPL 106**



Client: Knight Piesold  
Project: NAC  
Section:

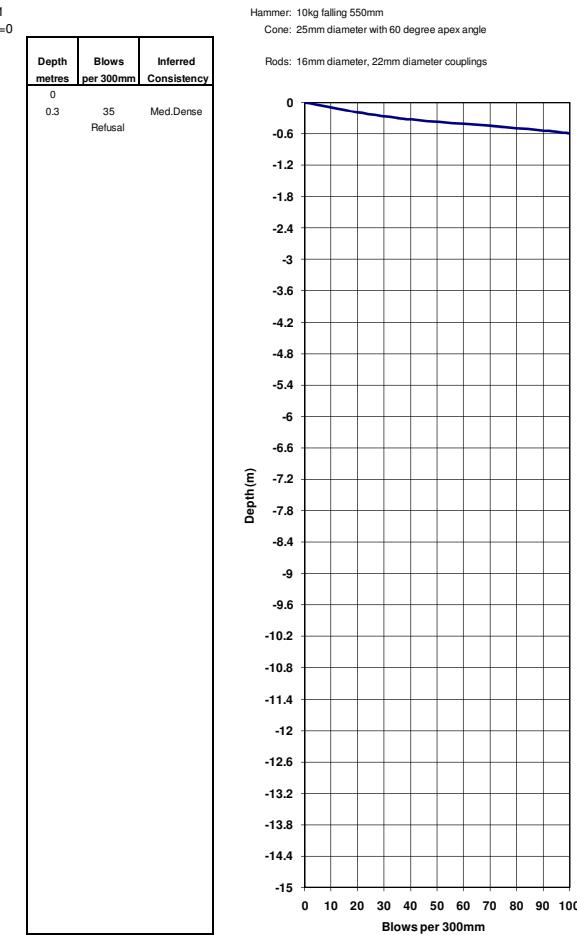
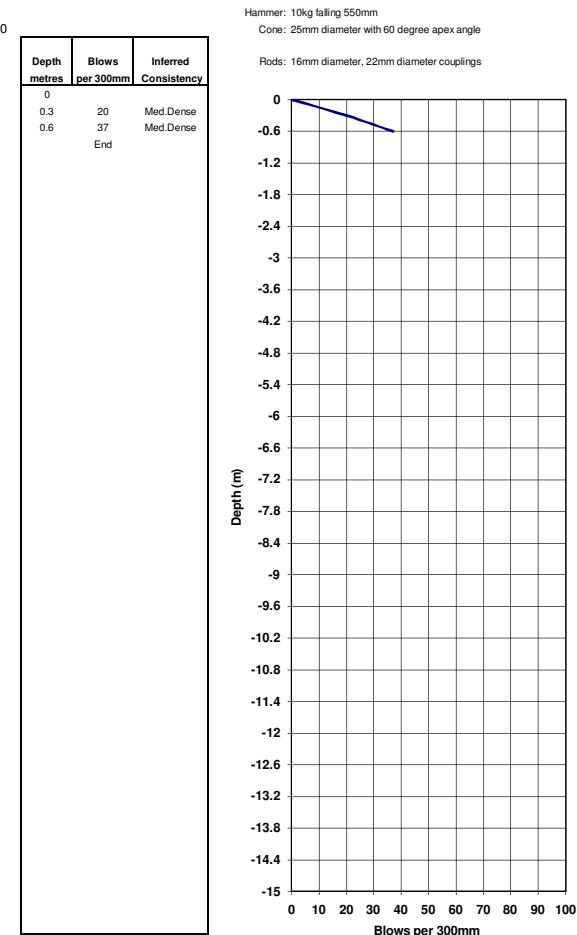
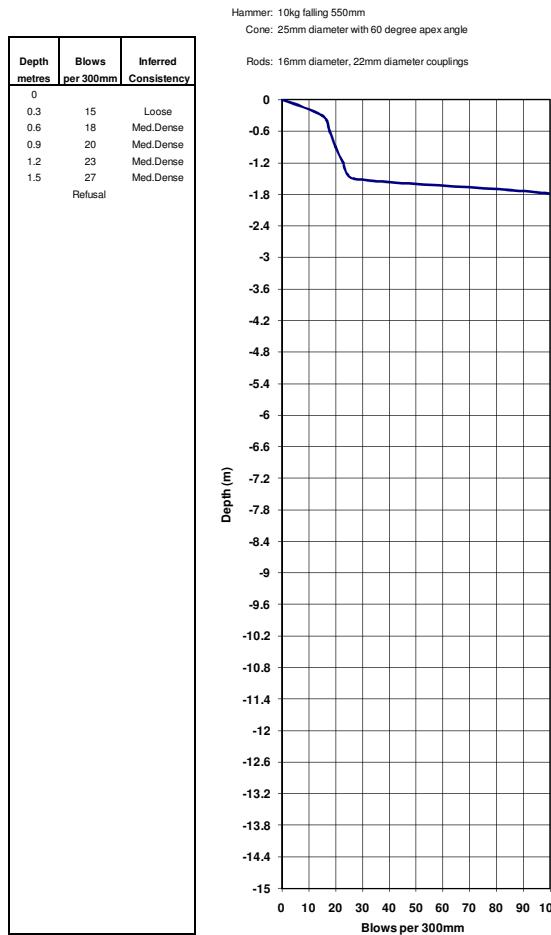
Ref.No. 11-107  
Date: 03-08-2012  
Operator: DC

Light Dynamic Penetrometer Probe ..... **Test No. DPL 107**

Light Dynamic Penetrometer Probe ..... **Test No. DPL 108**

Light Dynamic Penetrometer Probe ..... **Test No. DPL 109**

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION



Client: Knight Piesold  
Project: NAC  
Section:

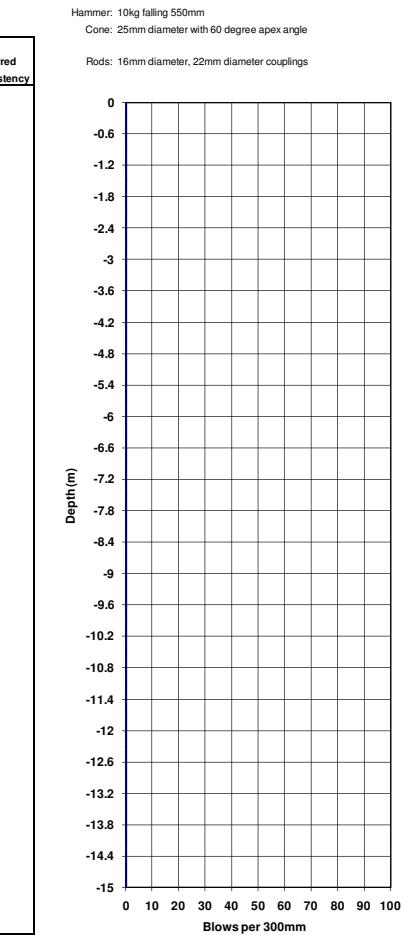
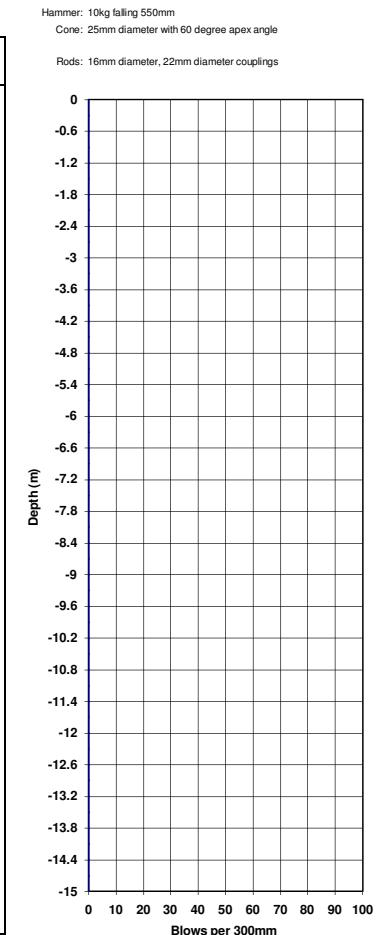
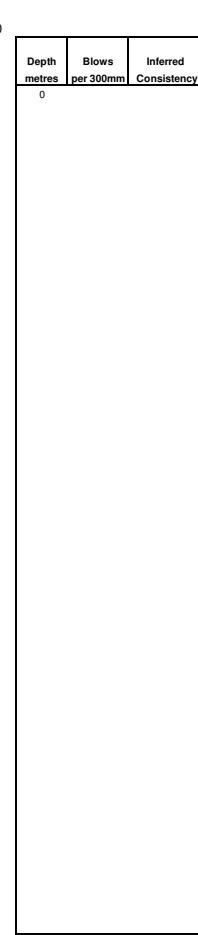
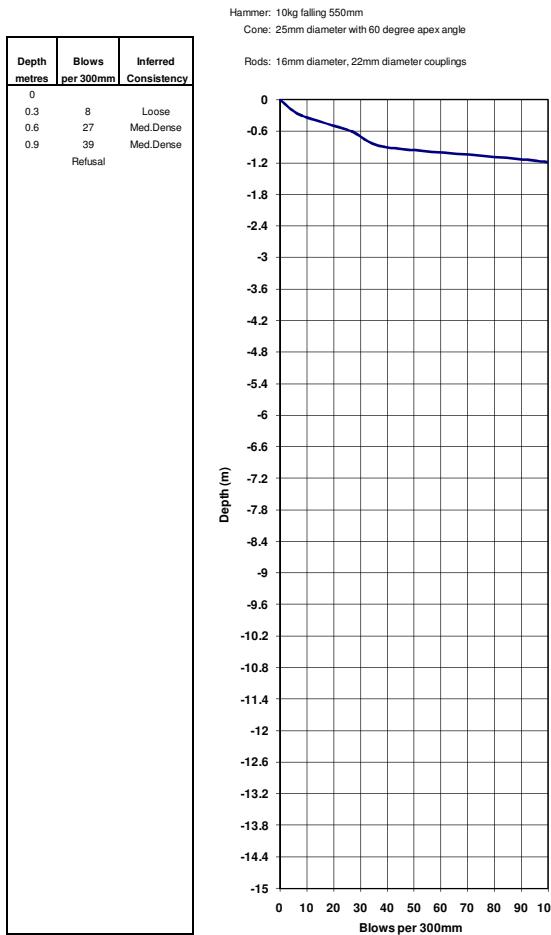
Ref.No. 11-107  
Date: 03-08-2012  
Operator: DC

Light Dynamic Penetrometer Probe ..... **Test No.DPL 110**

Light Dynamic Penetrometer Probe ..... **Test No.DPL**

Light Dynamic Penetrometer Probe ..... **Test No.DPL**

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION



Client: Knight Piesold  
Project: NAC  
Section:

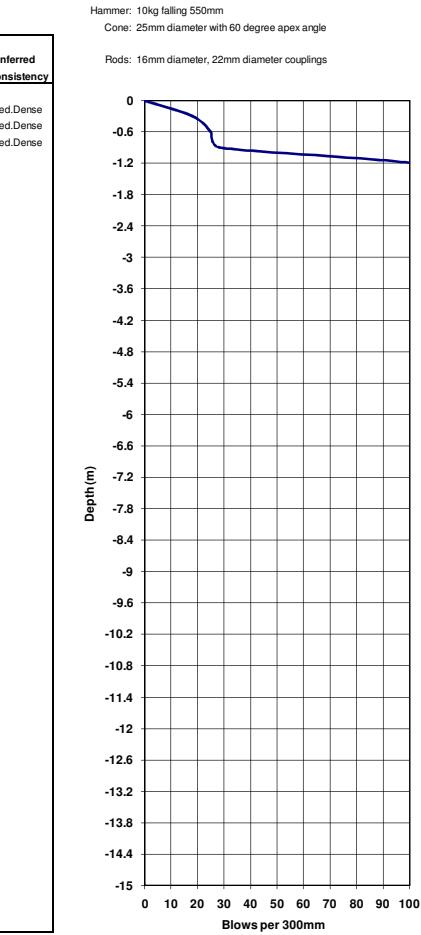
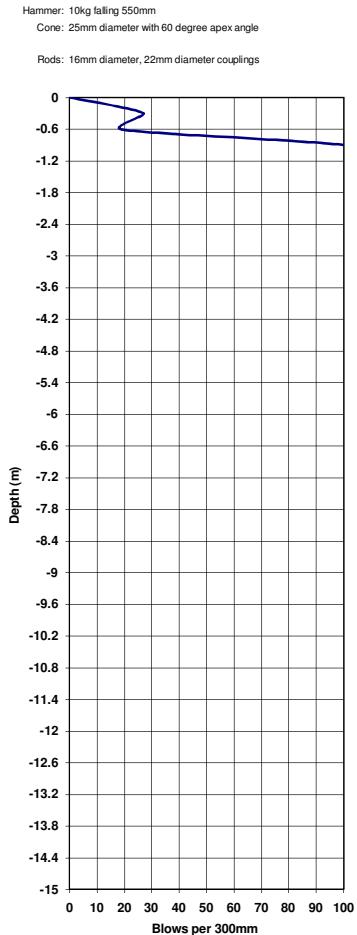
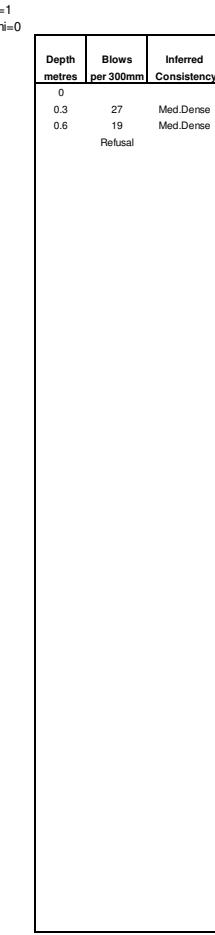
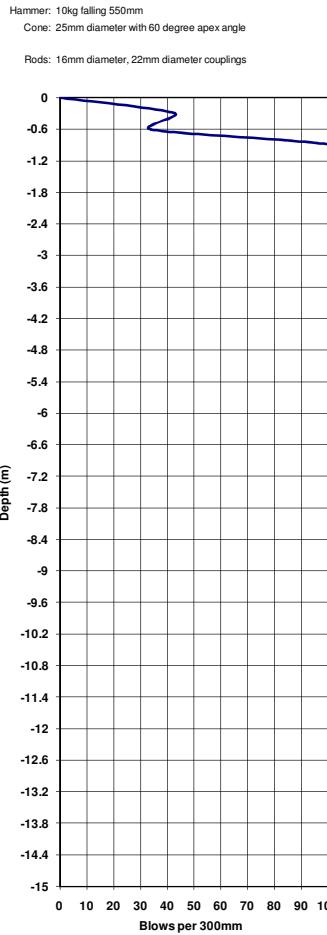
Ref.No. 11-107  
Date: 6-Aug-2012  
Operator: DC

Light Dynamic Penetrometer Probe ..... **Test No. DPL 111**

Light Dynamic Penetrometer Probe ..... **Test No. DPL 112**

Light Dynamic Penetrometer Probe ..... **Test No. DPL 113**

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION



Client: Knight Piesold  
Project: NAC  
Section:

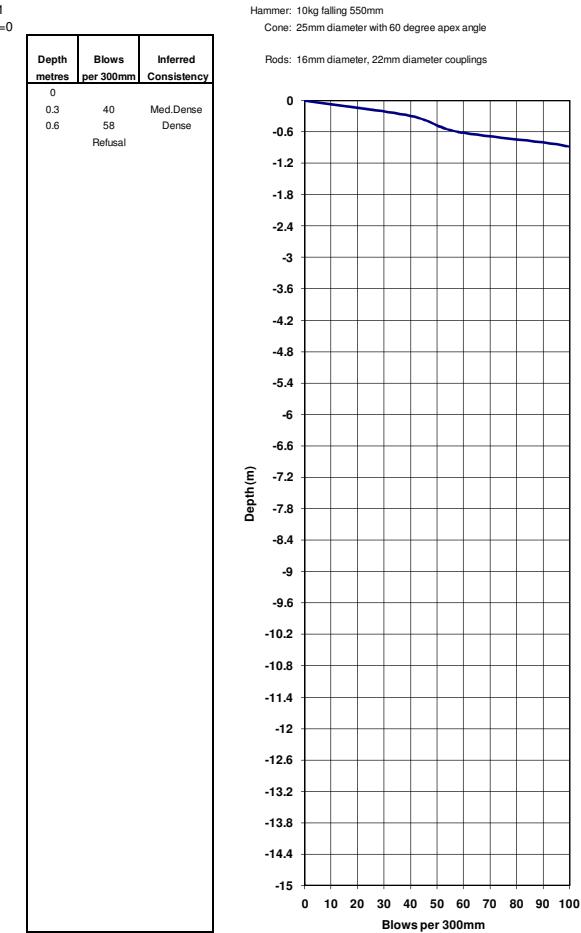
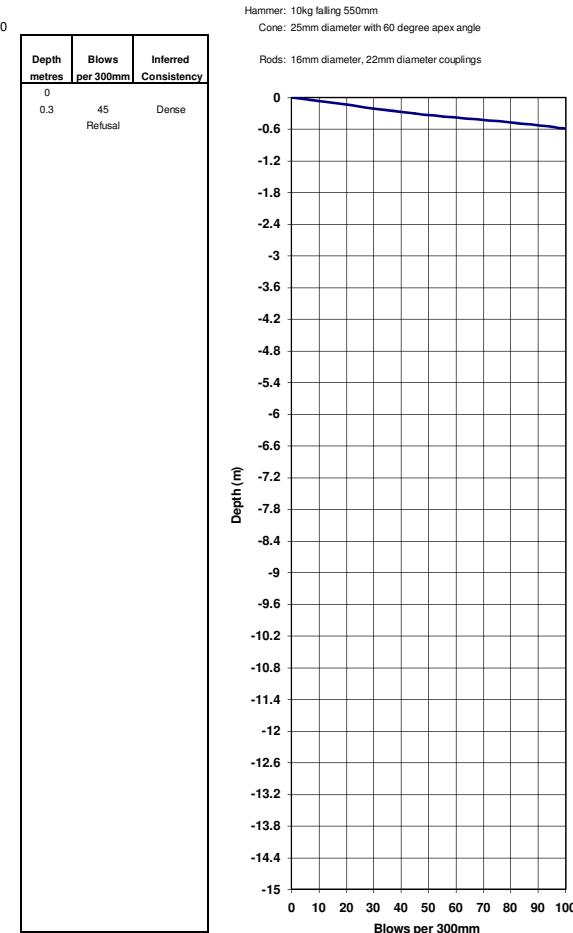
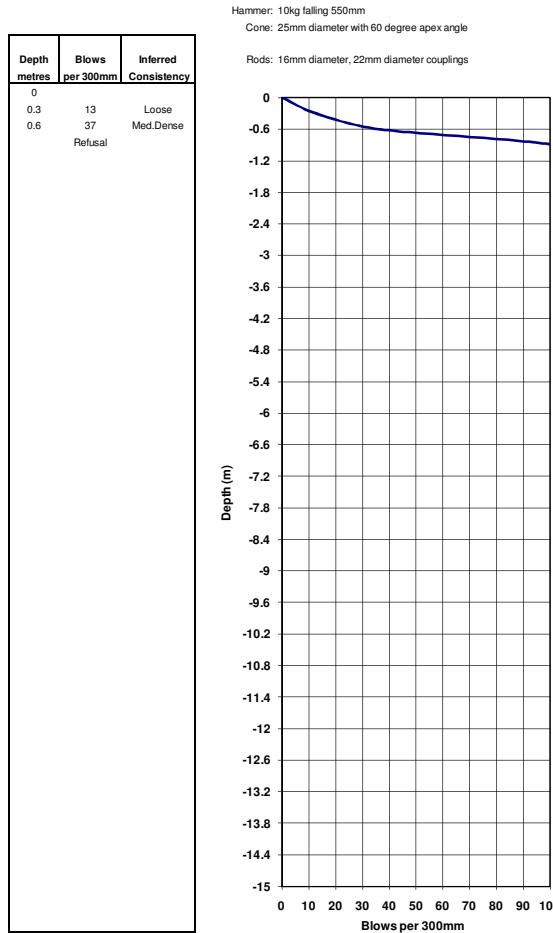
Ref.No. 11-107  
Date: 6-Aug-2012  
Operator: DC

Light Dynamic Penetrometer Probe ..... **Test No. DPL 114**

Light Dynamic Penetrometer Probe ..... **Test No. DPL 115**

Light Dynamic Penetrometer Probe ..... **Test No. DPL 116**

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

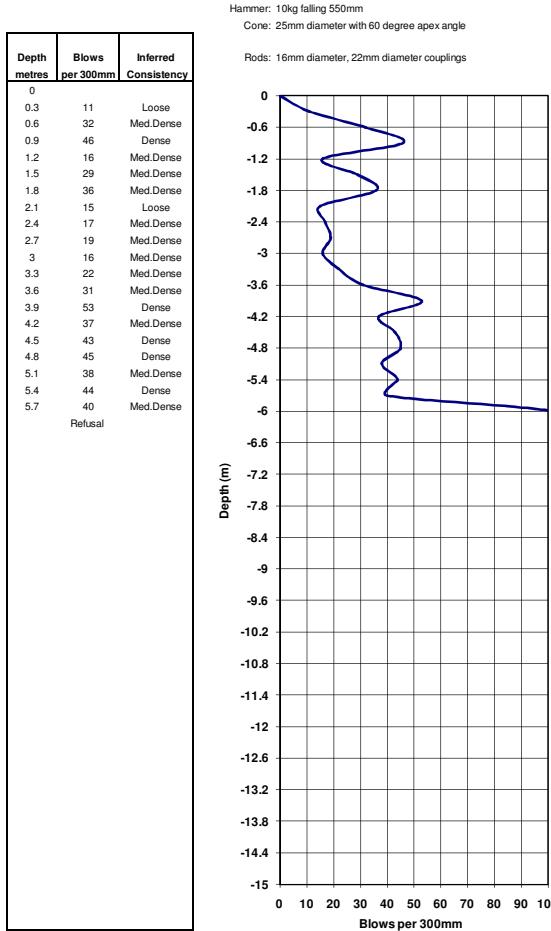


Client: Knight Piesold  
Project: NAC  
Section:

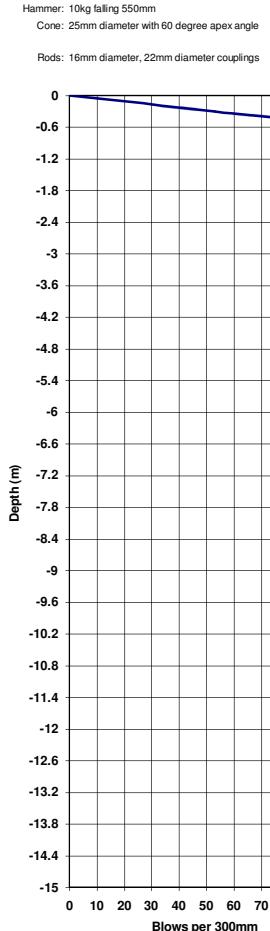
Ref.No. 11-107  
Date: 6-Aug-2012  
Operator: DC

Light Dynamic Penetrometer Probe ..... **Test No. DPL 117**

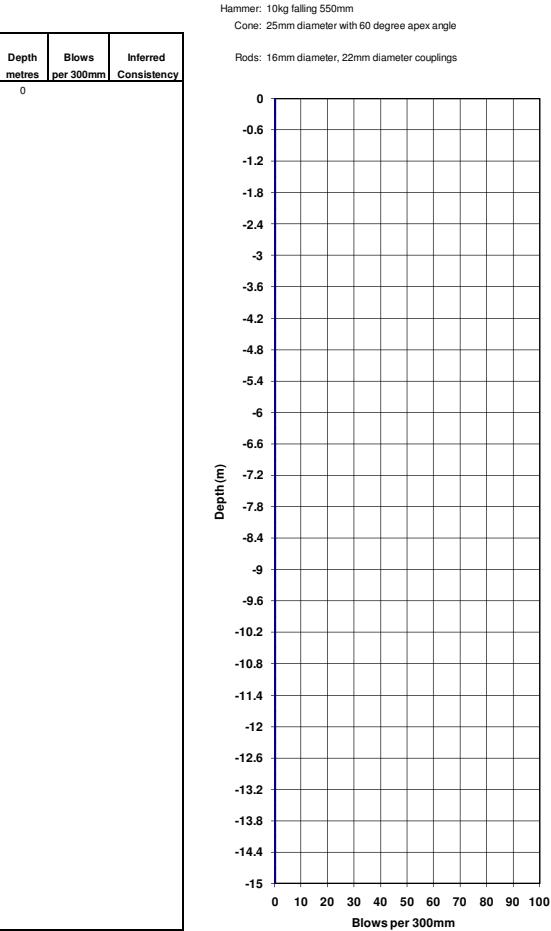
THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION



Light Dynamic Penetrometer Probe ..... **Test No. DPL 118**



Light Dynamic Penetrometer Probe ..... **Test No. DPL**

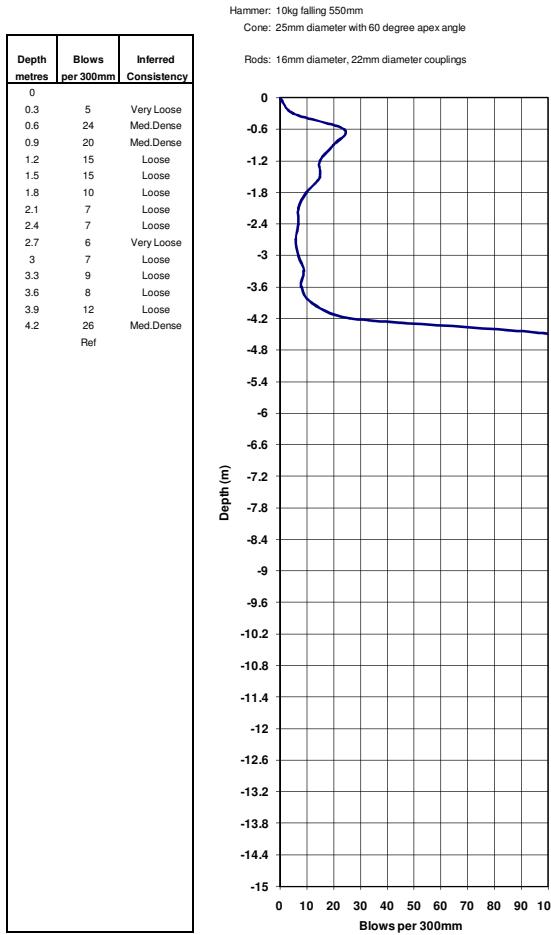


Client: Knight Piesold  
Project: NAC  
Section:

Ref.No. 11-107  
Date: 07/08/2012  
Operator: EN/DC/VK

Light Dynamic Penetrometer Probe ..... **Test No. DPL ALT1**

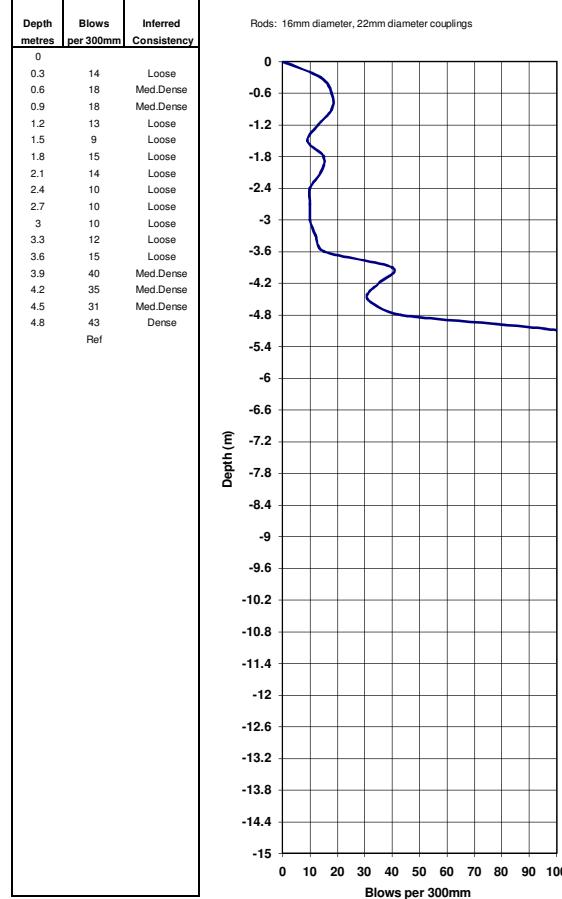
THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION



Light Dynamic Penetrometer Probe ..... **Test No. DPL ALT2**

Hammer: 10kg falling 550mm  
Cone: 25mm diameter with 60 degree apex angle

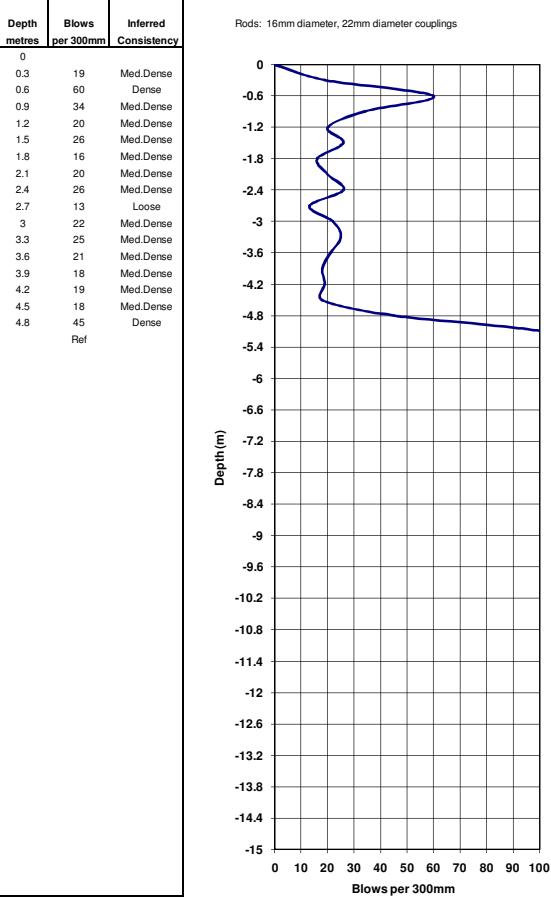
Rods: 16mm diameter, 22mm diameter couplings



Light Dynamic Penetrometer Probe ..... **Test No. DPL ALT3**

Hammer: 10kg falling 550mm  
Cone: 25mm diameter with 60 degree apex angle

Rods: 16mm diameter, 22mm diameter couplings

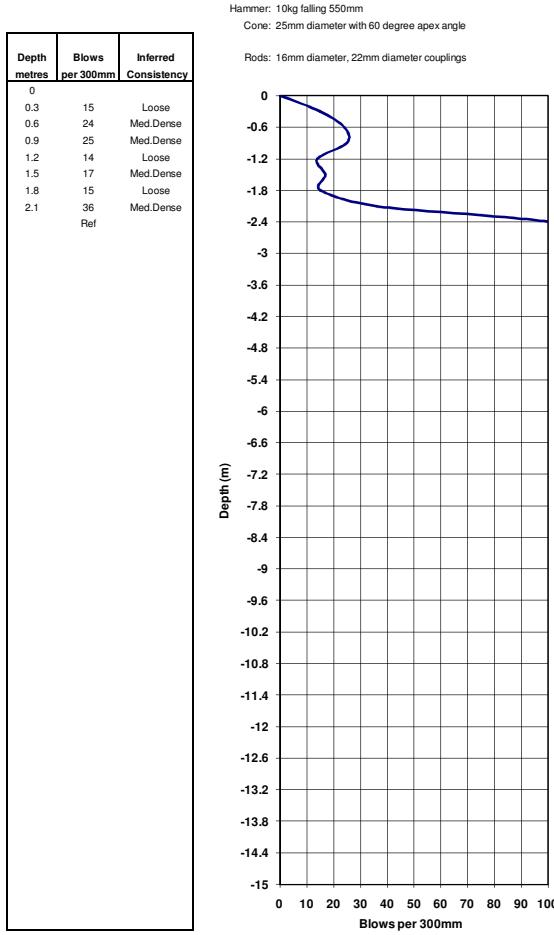


Client: Knight Piesold  
Project: NAC  
Section:

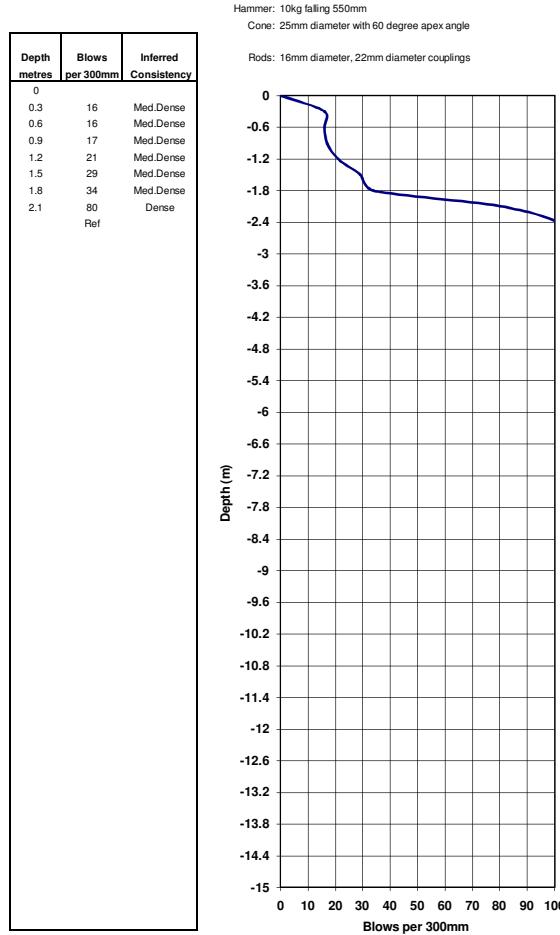
Ref.No. 11-107  
Date: 07/08/2012  
Operator: EN/DC/VK

Light Dynamic Penetrometer Probe ..... **Test No. DPL ALT4**

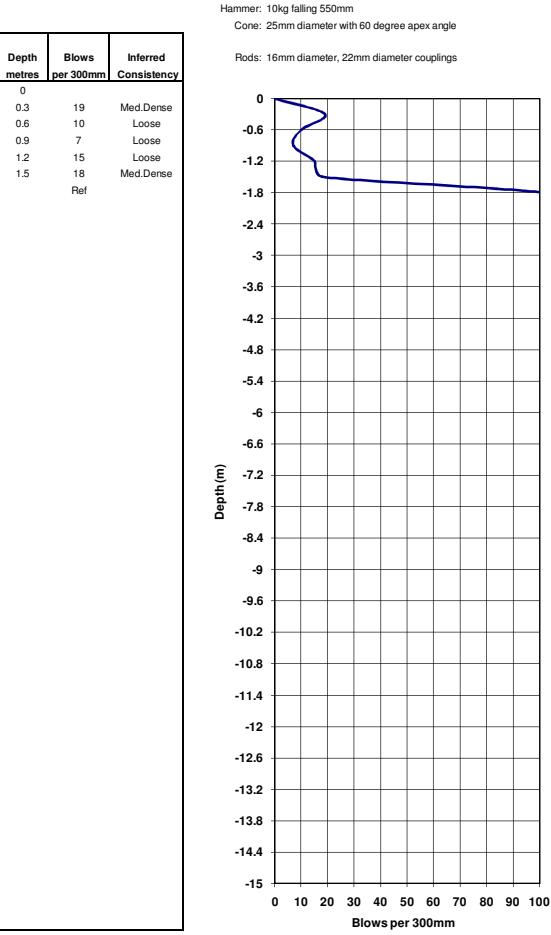
THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION



Light Dynamic Penetrometer Probe ..... **Test No. DPL ALT5**



Light Dynamic Penetrometer Probe ..... **Test No. DPL ALT6**



Client: Knight Piesold  
Project: NAC  
Section:

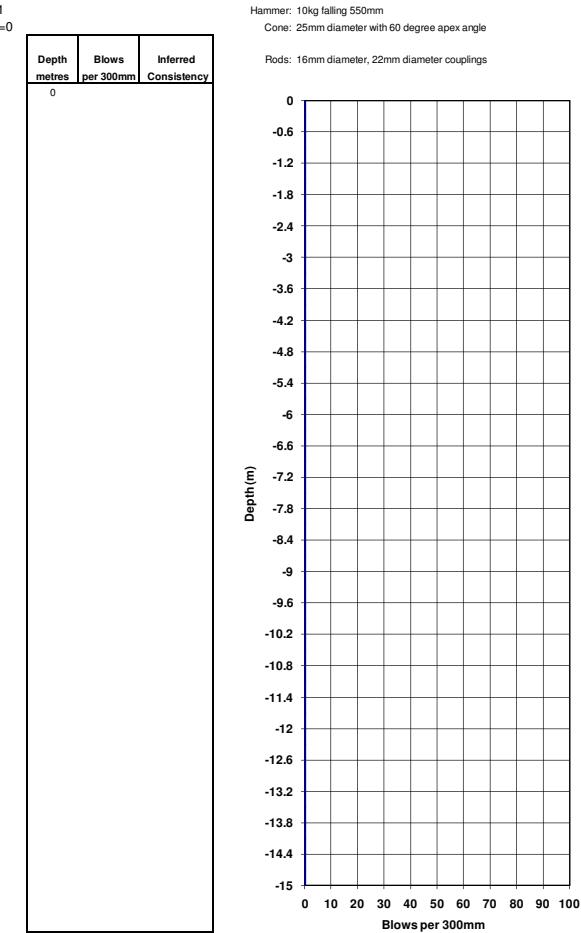
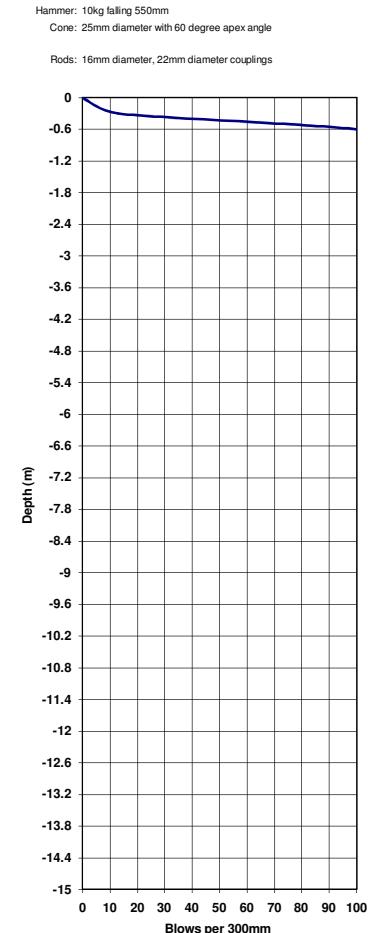
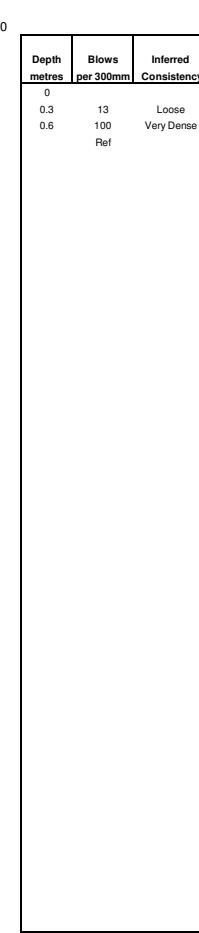
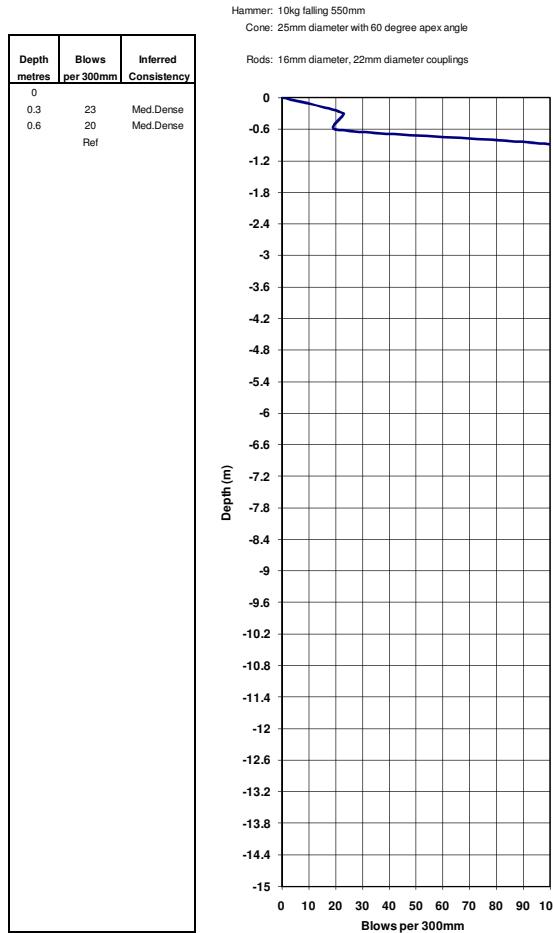
Ref.No. 11-107  
Date: 07/08/2012  
Operator: EN/DC/VK

Light Dynamic Penetrometer Probe ..... **Test No. DPL ALT7**

Light Dynamic Penetrometer Probe ..... **Test No. DPL ALT8**

Light Dynamic Penetrometer Probe ..... **Test No. DPL**

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION



Client: Knight Piesold  
Project: NAC  
Section:

Ref.No. 11-107  
Date: 03-08-2012  
Operator: DC

Light Dynamic Penetrometer Probe ..... Test No.DPL FT1

Light Dynamic Penetrometer Probe ..... Test No.DPL FT2

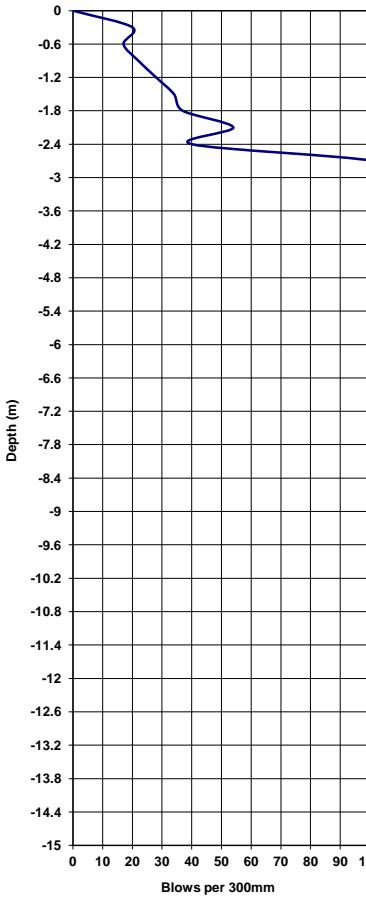
Light Dynamic Penetrometer Probe ..... Test No.DPL FT3

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Hammer: 10kg falling 550mm  
Cone: 25mm diameter with 60 degree apex angle

S=1  
Phi=0

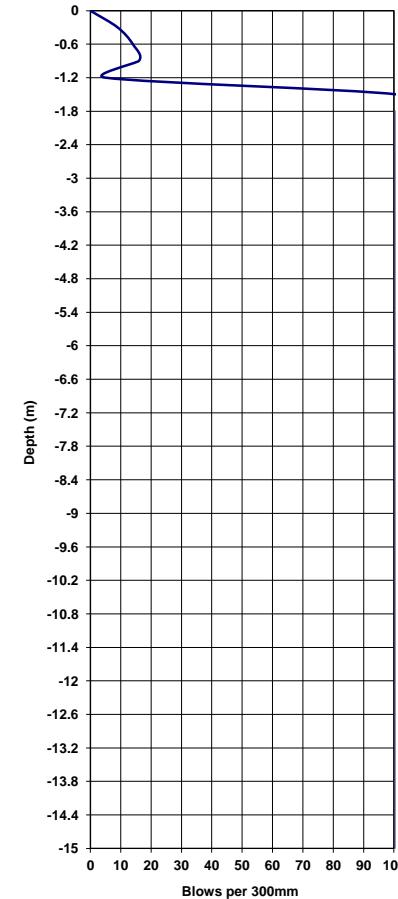
Rods: 16mm diameter, 22mm diameter couplings



Hammer: 10kg falling 550mm  
Cone: 25mm diameter with 60 degree apex angle

S=1  
Phi=0

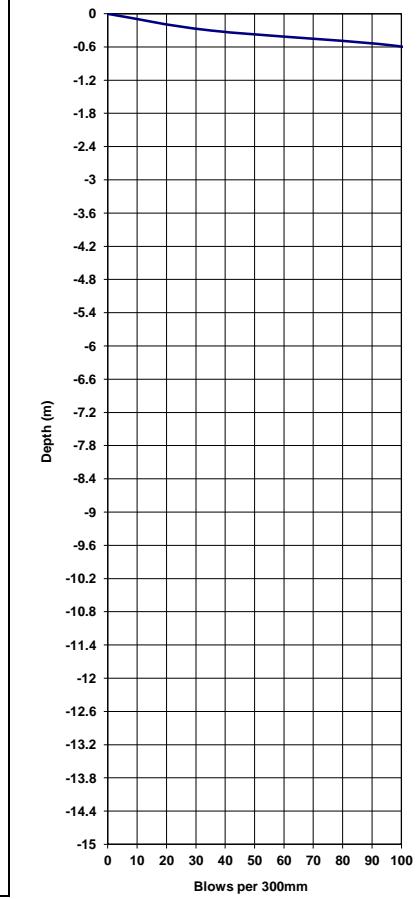
Rods: 16mm diameter, 22mm diameter couplings



Hammer: 10kg falling 550mm  
Cone: 25mm diameter with 60 degree apex angle

S=1  
Phi=0

Rods: 16mm diameter, 22mm diameter couplings



Client: Knight Piesold  
Project: NAC  
Section:

Ref.No. 11-107  
Date: 03-08-2012  
Operator: DC

Light Dynamic Penetrometer Probe ..... Test No.DPL FT4

Light Dynamic Penetrometer Probe ..... Test No.DPL

Light Dynamic Penetrometer Probe ..... Test No.DPL

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Hammer: 10kg falling 550mm  
Cone: 25mm diameter with 60 degree apex angle

Rods: 16mm diameter, 22mm diameter couplings

S=1  
Phi=0

Hammer: 10kg falling 550mm  
Cone: 25mm diameter with 60 degree apex angle

Rods: 16mm diameter, 22mm diameter couplings

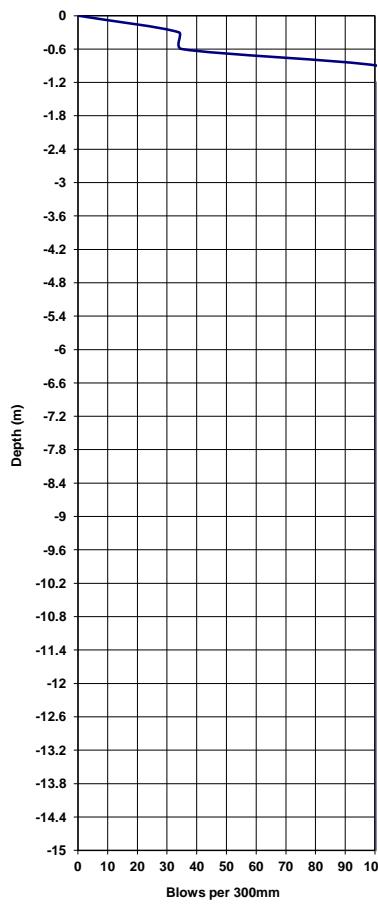
S=1  
Phi=0

Hammer: 10kg falling 550mm  
Cone: 25mm diameter with 60 degree apex angle

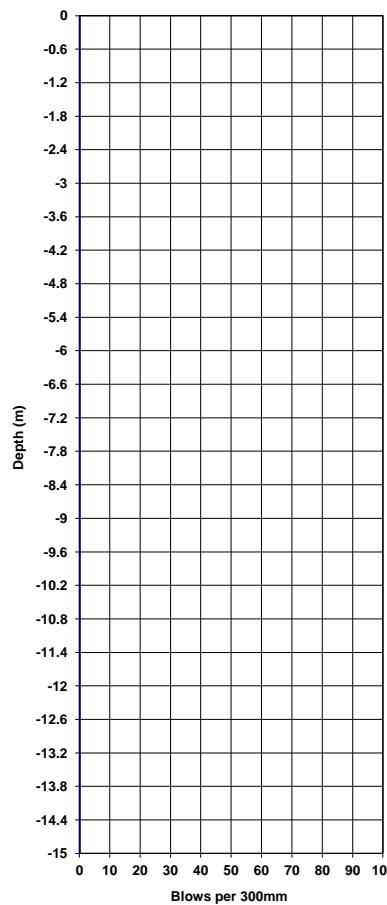
Rods: 16mm diameter, 22mm diameter couplings

S=1  
Phi=0

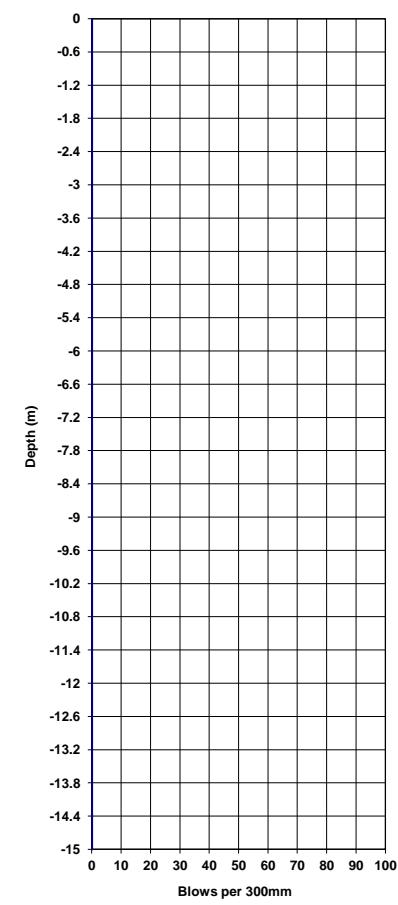
Depth metres	Blows per 300mm	Inferred Consistency
0		
0.3	34	Med.Dense
0.6	35	Med.Dense
		Refusal



Depth metres	Blows per 300mm	Inferred Consistency
0		



Depth metres	Blows per 300mm	Inferred Consistency
0		



Client: Knight Piesold  
Project: NAC  
Section:

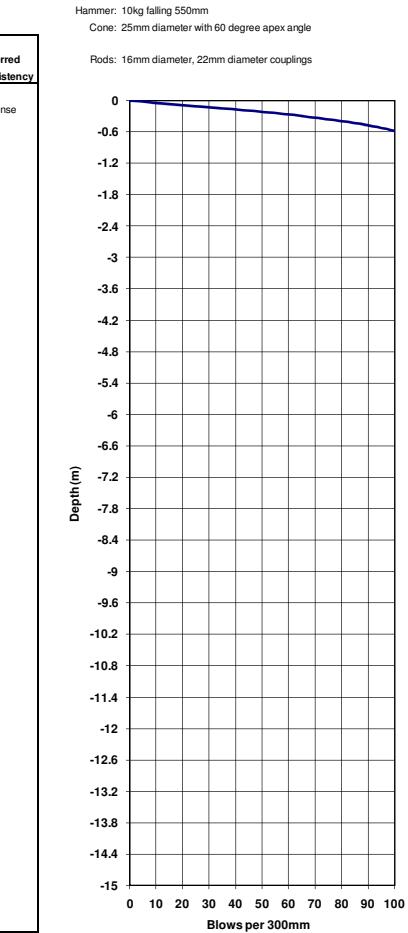
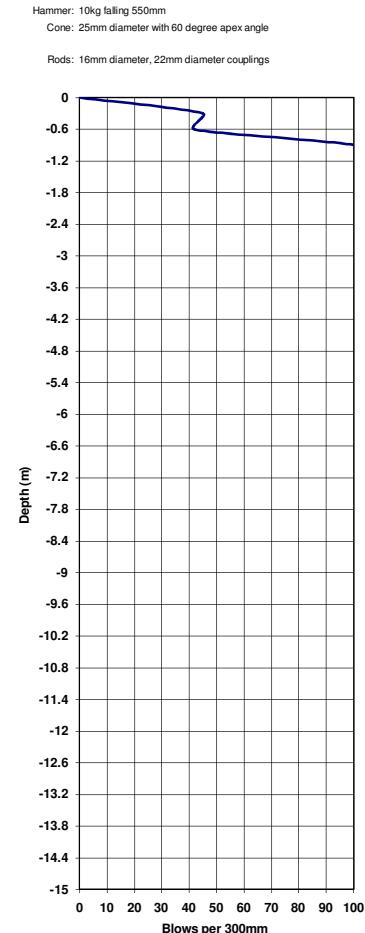
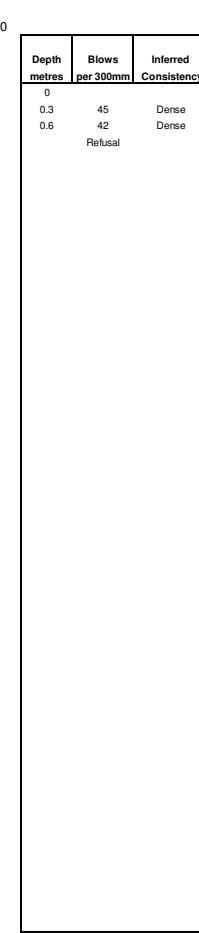
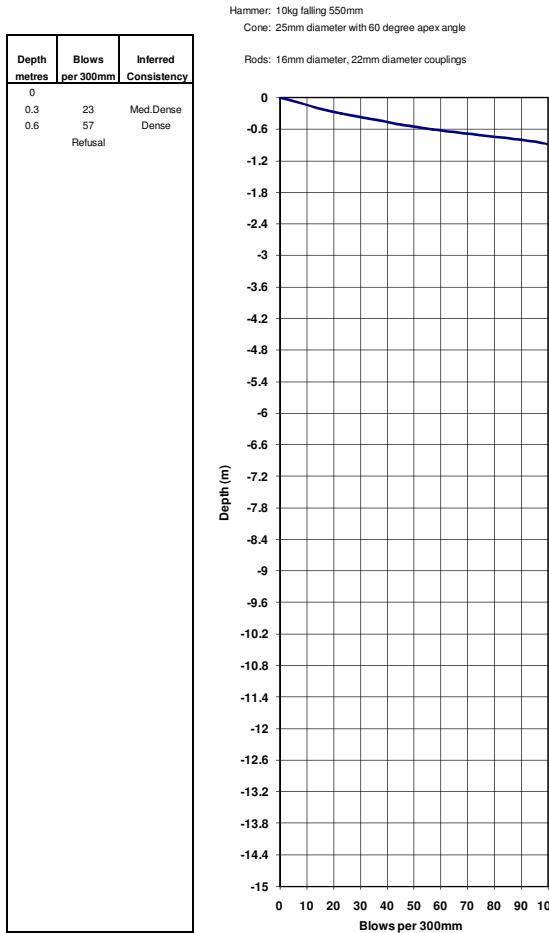
Ref.No. 11-107  
Date: 19-Jul-2012  
Operator: EN/DC

Light Dynamic Penetrometer Probe ..... **Test No. DPL Cutting 1**

Light Dynamic Penetrometer Probe ..... **Test No. DPL Cutting 2**

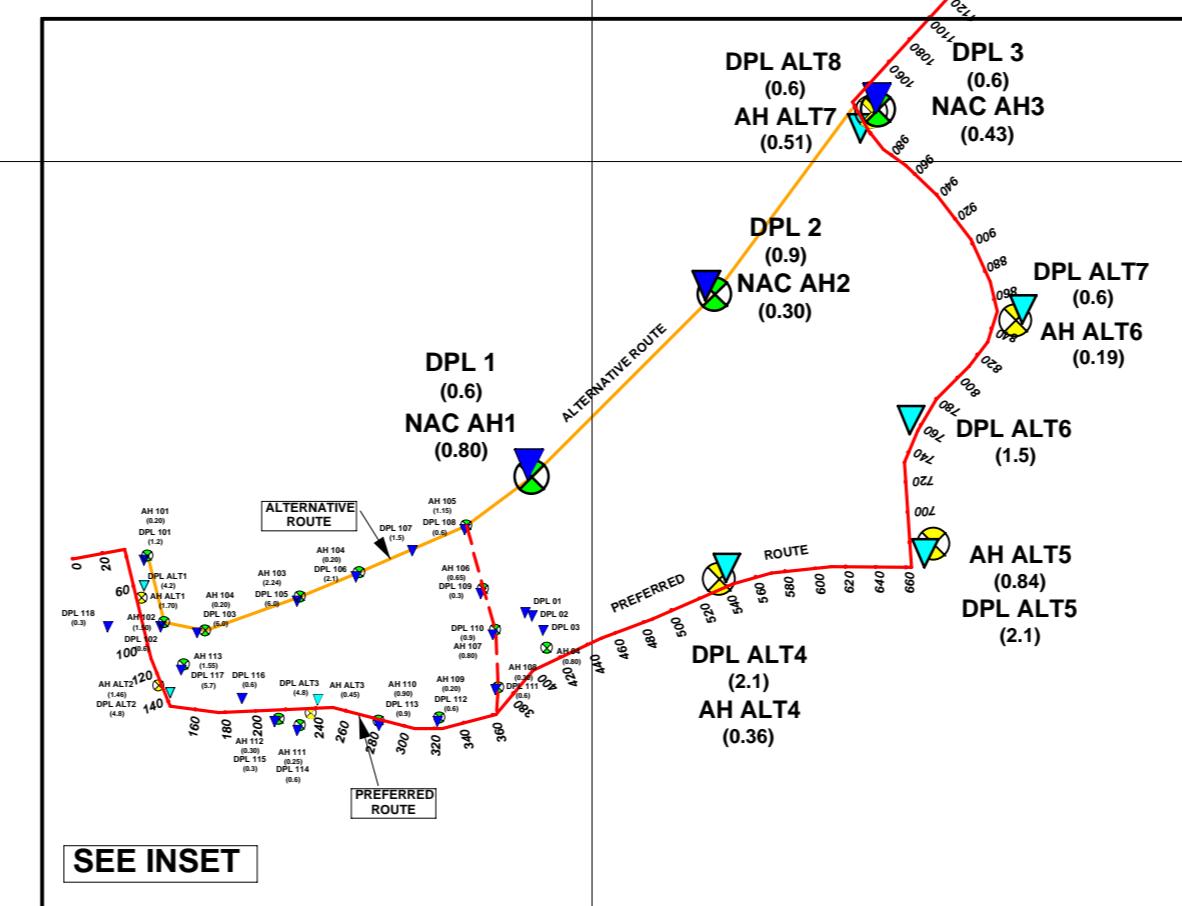
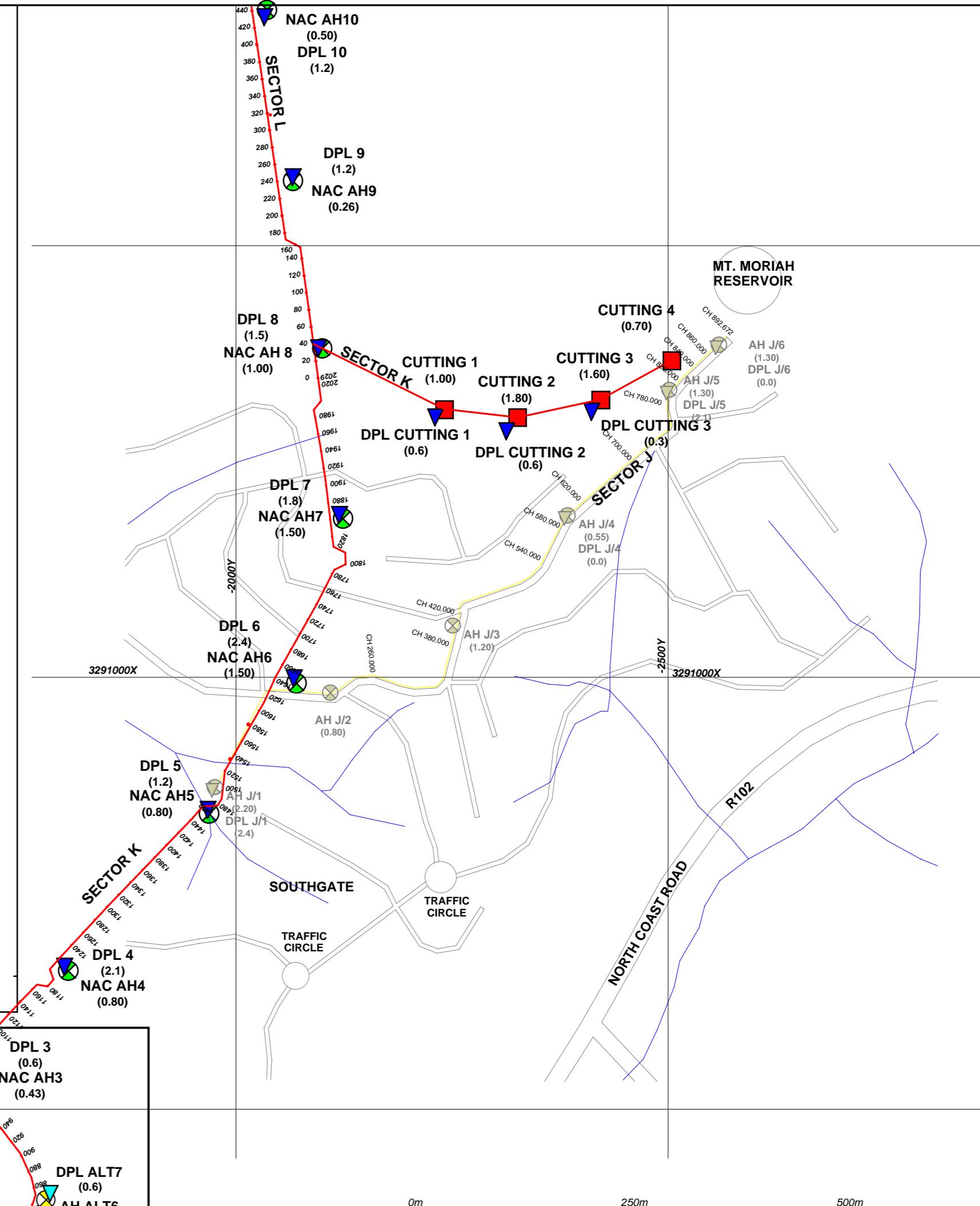
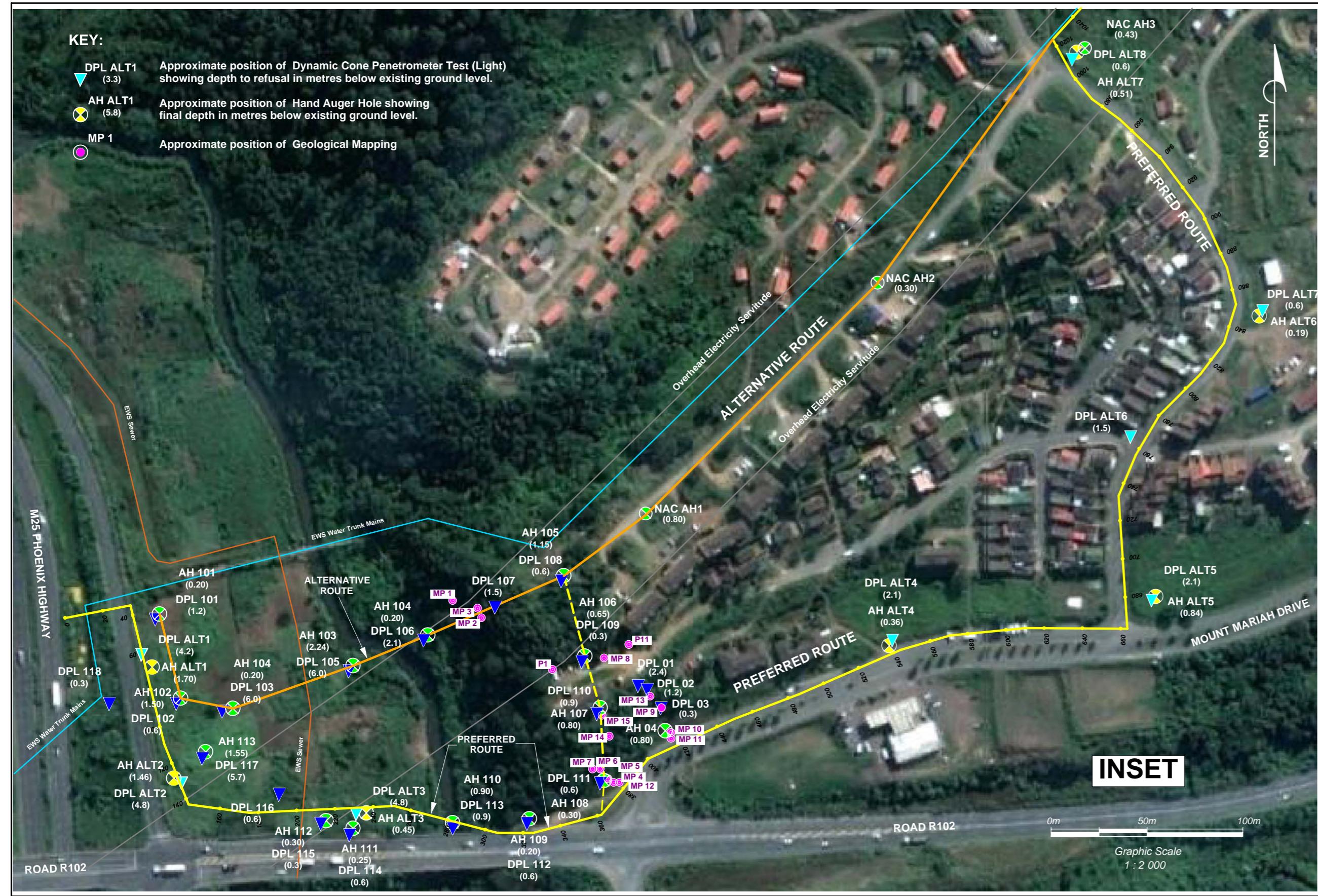
Light Dynamic Penetrometer Probe ..... **Test No. DPL Cutting 3**

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

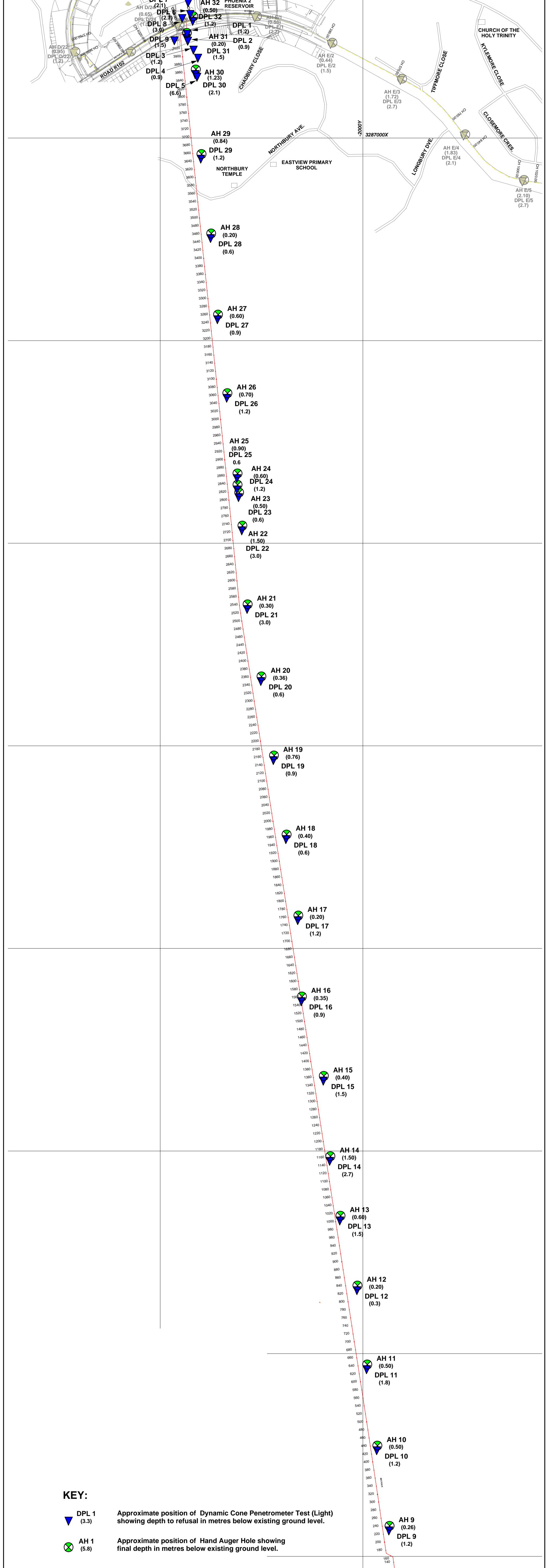


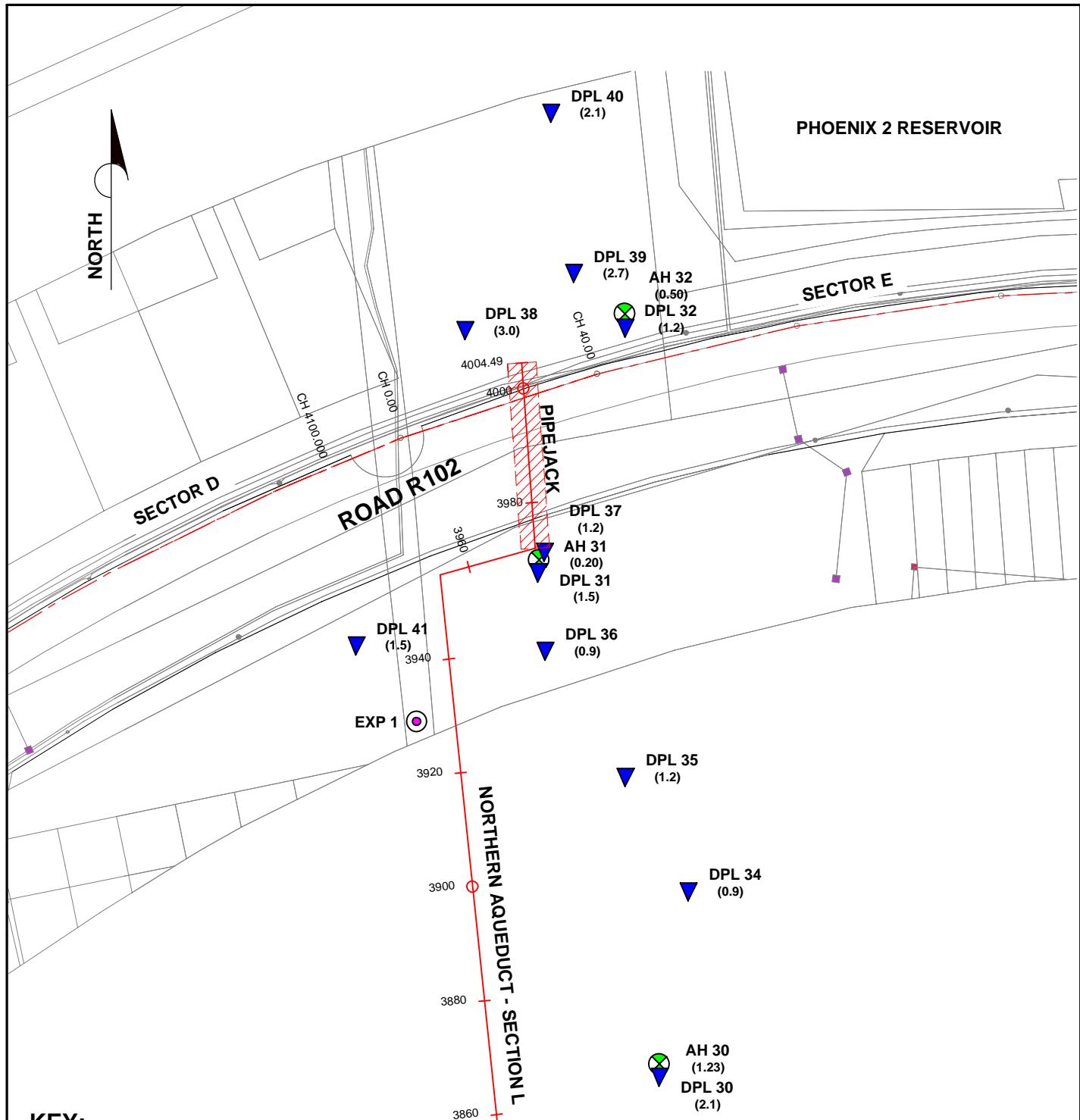
## **FIGURES**

**DRAFT**



Site Plan showing approximate positions of :	KNIGHT PIESOLD CONSULTING	DATE 16/08/2012
	Geotechnical Investigation for Northern Aqueduct Augmentation - Sector K	DRAWN A.S.
		CHECK M.V.R.
		REFERENCE No. 11- 107
Figure No. K-1	Moore Spence Jones Consulting Geotechnical, Civil & Environmental Engineers & Scientists	REV. K-1
Scale 1 : 5000 (On A2 Original)		





Site Plan showing approximate positions of :

- Dynamic Cone Penetrometer Tests (Light)
- Hand Auger Holes
- Exposure Profile

**KNIGHT PIESOLD CONSULTING**

Northern Aqueduct Augmentation Project  
Pipejack under R102, Phoenix Highway - Sector L



**MOORE SPENCE JONES**  
CONSULTING GEOTECHNICAL, CIVIL & ENVIRONMENTAL ENGINEERS & SCIENTISTS

Scale 1 : 1000 (On A4 Original)

DATE 24/08/2012

DRAWN A.S.

CHECK M.R.

REFERENCE No. 11-107

FIGURE No. L-2 REV.