

# **Crossman, Pape & Associates**

## **Consulting Geotechnical Engineers & Engineering Geologists**

P.O.Box 3557 Cramerview 2060. Tel: (011) 465-1699. Fax: (011) 465-4586. Cell 082 556 7302 & 082 900 8022

27 October 2010

Zitholele Consulting (Pty) Ltd  
P O Box 6002  
Halfway House  
1685

**ATTENTION : Mr T Kaponda**

Dear Sir,

**REPORT NO. 09/18/P1 : GEOTECHNICAL INVESTIGATION FOR PROPOSED  
ADDITIONS - BUSHKOPPIES WASTE WATER  
TREATMENT PLANT : PRELIMINARY REPORT**

Following our initial geotechnical investigation carried out across the site in March 2009 (Report No 09/18/P) we have been requested by Zitholele Consulting to carry out additional geotechnical work across the site. The additional geotechnical work was required as a result of a change in layout of the proposed development as well as insufficient geotechnical information related to the proposed earthworks levels across the site. The current preliminary report covers the most pertinent geotechnical aspects related to the proposed additions and has been provided for tender purposes. A full geotechnical report will follow shortly.

The proposed additions to the Bushkoppies Waste Water Treatment Plant (WWTP) comprise the following major units.

- Three gravity thickener units. Maximum cut depths of the order of 10,5m to 12,0m depth are envisaged for the gravity thickener units.
- Four digester units. These units comprise large tanks, 22,0m in diameter and 20,6m high. Maximum cut depths of the order of 5,5m are envisaged for the digester units.
- A gas holder and boiler house unit. Minimal cut to fill operations are envisaged for the gas holder and boiler house structures.
- A belt press building and belt press sump and feeder pump station. Maximum cut depths of the order of 1,25m are envisaged for the belt press building while maximum cut depths of the order of 7,5m are envisaged for the belt press sump and feeder pump station.
- Sludge drying beds will cover a large portion of the site. Minimal cut to fill operations are envisaged for the sludge drying beds.

## 1. **FIELDWORK**

Five rotary cored boreholes (BH1 to BH5) were drilled across the site by Roelf Fourie Geotechnical Services in October 2010. The recovered borehole core was logged according to recognized practice by an engineering geologist. The positions of the boreholes are shown on the site plan enclosed in Appendix A. Copies of the recorded borehole logs are attached in Appendix B.

## 2. **BULK EARTHWORKS**

### 2.1 **Excavation Procedures**

Excavation procedures for bulk earthworks and for the installation of services have been evaluated according to the South African National Standards standardised classification for excavations (SANS 1200D, DA and DB). The excavation procedures for each of the major units are summarised in Table 1.

### 2.2 **Lateral Support**

Stability to cut faces would have to be provided in the short and long term. In this instance stability could be provided by battering the faces back to suitable slope angles. In the short term a slope angle within the existing fill, transported soils and residual soils of 1:1 is considered adequate for stability purposes whilst in the long term slopes should not exceed 1:2. Drainage should also be provided at the top of all cut faces.

Should the situation arise where excavation faces have to be cut vertically or at angles steeper than that presented above, essentially owing to space constraints, then a suitably designed lateral support system would have to be implemented. In this instance a soil nailing and gunite retaining system would be the most optimum lateral support system.

The above systems would have to be designed by a suitably qualified person.

## 3. **EVALUATION OF FOUNDING CONDITIONS AND FOUNDATION RECOMMENDATIONS**

### 3.1 **Gravity Thickeners**

Maximum cut depths of the order of 10,5m to 12,0m are anticipated for the gravity thickener excavations while minimum cut depths of the order of

5,5m to 7,5m are envisaged. This range in cut depths is due to the semi conical shape of the base of the gravity thickener units.

Considering the above and the relevant borehole logs (BH3 and BH4) it is apparent that across the majority of the gravity thickener excavations, very soft rock or better will be exposed at final terrace level or at shallow depth below lava terrace level. In the areas of deepest cut (greater than 8,4m) soft rock lava is envisaged. An allowable bearing pressure of 1000kPa could be utilised for the very soft rock/soft rock lava. Under the above load conditions total and differential settlements would be insignificant. Conventional strip/spread foundations could be placed directly upon the very soft rock/ soft rock lava bedrock.

### **3.2 Digesters**

Maximum cut depths of the order of 5,5 are envisaged for the digester units with minimum cut depths being of the order of 4,0m. The range in cut depths is due to the semi conical nature of the base of the digester units.

Considering the above and the relevant borehole logs (BH1 and BH2) it is apparent that stiff or better residual lava would be exposed at final terrace level across the digester units cut excavations. An allowable bearing pressure of 300kPa could be utilised for the stiff or better residual lava. Under the above load conditions total settlements of the order of 5mm to 10mm are envisaged. Differential settlements should be taken as 50% of the total settlements. Conventional strip/spread foundations could be employed as suitable foundation types.

### **3.3 Gas Holder / Boiler House**

The proposed gas holder and boiler house are envisaged to consist of lightly loaded structures.

The existing fill, hillwash, pebble marker, nodular ferricrete and reworked residual lava in the vicinity of the gas holder and boiler house are considered to be potentially highly compressible. These soil layers are thus unsuitable for use as founding layers, even for proposed lightly loaded structures.

An allowable bearing pressure of 75kPa could be utilised for the soft to firm or better residual lava. This founding layer occurs at depths varying between 2,0m and 3,0m (average depth 2,5m). Under the above load conditions total settlements of the order of 5mm to 10mm are envisaged. Differential settlements should be taken as 50% of the total settlements. Deeper than normal strip / spread foundations or alternatively mass concrete piers with ground beams to carry all the brickwork could be employed as suitable foundation types.

Alternatively, consideration could be given to founding the gas holder and boiler house on a suitably designed reinforced concrete raft foundations founded at shallow depth within the upper fill and/or nodular ferricrete horizons.

### 3.4 **Belt Press Building / Belt Press Sump and Feeder Pump Station**

The soft reworked residual lava which extends to a depth of the order of 2,0m in the vicinity of the belt press building is considered to be potentially highly compressible. Cut depths of the order of 1,25m are however envisaged below the belt press building. From the relevant test pit soil profile (TP6 see Report 09/18/P) it is noted that firm residual lava occurs below 2,0m depth in the vicinity of the belt press structure.

An allowable bearing pressure of 150kPa could be utilised for the firm or better residual lava. Under the above load conditions total settlements of the order of 5mm to 10mm are envisaged. Differential settlements should be taken as 50% of the total settlements. Conventional strip/spread foundation could be employed as suitable foundation types.

Maximum cut depths of the order of 7,5m are envisaged for the belt press sump and feeder pump station. Considering the above and the relevant borehole log (BH5) it is apparent that very stiff residual lava and/or very soft rock lava would be exposed at final terrace level across the belt press sump and feeder pump station excavation.

An allowable bearing pressure of 400kPa could be utilised for the very stiff or better residual lava. Under the above load conditions total settlements of the order of 5mm to 10mm are envisaged. Differential settlements should be taken as 50% of the total settlements. Conventional strip/spread foundations could be employed as suitable foundation types.

## 4. **SURFACE BEDS**

Lightly loaded **surface beds** for the structures and sludge drying beds could be constructed directly on top of the final terrace platform with the following provisos:

- ◆ The in situ soils should be nominally rolled without vibration where exposed at terrace level. A 300mm thick imported G7 layer should then be placed directly above the in situ soils and compacted in 150mm layers to 90% of Mod AASHTO density at optimum moisture content to provide a consistent working platform.

- In areas of bulk fill the fill should be compacted in 150mm thick layers to 90% of Mod AASHTO density at optimum moisture content.
- Where the cut terrace excavations expose lava bedrock at final terrace level it should be ensured that there is cover of at least 300mm of engineered fill above the lava bedrock prior to placing of surface beds. This would be to provide a consistent foundation platform for the surface beds. This fill should be compacted in 150mm layers to 90% of Mod AASHTO density at optimum moisture content.

## 5. **SUB-SURFACE DRAINAGE**

A perched water table was observed across the southern portions of the site in test pits TP1 to TP9 (see Report 09/18/P). The perched water table occurs at depths varying between 1,3m and 3,3m (average depth 2,25m). The flow rate was observed to vary from slight to moderate and strong in places. The following comments are thus pertinent to the design and construction of the development in terms of sub-surface drainage.

- In areas of cut a system of sub-surface drainage should be installed below all surface beds. In this instance it is our opinion that a blanket drainage system would be required.
- Conventional drainage should be provided behind all retaining structures.
- Due to the plastic near saturated nature of the upper in situ soils across large portions of the site a layer of rockfill would probably be required during construction. This is of particular significance in the area of the digester tanks, gravity thickeners and belt press sump and feeder pump station due to the deep excavations in this area. The rockfill would form a stable working platform upon which layerworks could be compacted and would also allow access to plant equipment. A 600mm thick layer of 200mm to 300mm diameter clean rockfill should be allowed for. The need for rockfill and the extent thereof would have to be assessed when construction proceeds.
- Owing to the depth of the excavations for the digester tanks, gravity thickeners and belt press sump and feeder pump station it is anticipated that dewatering of this area would be required during construction. Thus allowances should be made for the construction of temporary cut off drains, sumps and the use of pumps of adequate capacity.

A handwritten signature in dark ink, appearing to be 'M. Crossman', with a stylized, elongated final stroke.

**M CROSSMAN** Pr. Eng

**CROSSMAN, PAPE & ASSOCIATES**

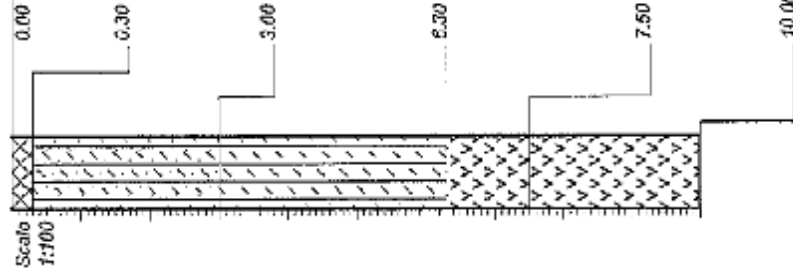
**J DAVEL** Pr.Sci.Nat

TABLE 1 : SUMMARY OF EXCAVATION PROCEDURES - ADDITIONS BUSHKOPPIES WWTP				
Unit	Excavation Procedures			Comments
	Depth to Soft Excavation Material (m)	Depth to Intermediate Excavation Material (m)	Depth to Hard Rock Excavation Material (m)	
Gravity Thickeners	0 - 5,5	5,5 - 8,4	Below 8,4	<b>Soft excavation</b> material occurs to an average depth of 5,5m. <b>Intermediate excavation material</b> occurs on very soft rock lava bedrock between 5,5m and 8,4m depth. The intermediate excavation material could be removed using medium to heavy earthmoving equipment and or power tools. <b>Hard rock excavation</b> material occurs below the intermediate excavation material in the form of soft rock lava bedrock. The soft rock lava would require removal by blasting.
Digesters	0 - 6,15	6,15 - 7,5	Below 7,5	<b>Soft excavation</b> material occurs to an average depth of 6,15m. <b>Intermediate excavation material</b> on very soft rock lava bedrock occurs between 6,15m and 7,5m depth. The intermediate excavation material could be removed using medium to heavy earthmoving equipment and or power tools. <b>Hard rock excavation</b> material occurs below the intermediate excavation material in the form of soft rock lava bedrock. The soft rock lava would require removal by blasting.
Gas Holder/Boiler House	>3,0	None Encountered	None Encountered	<b>Soft excavation</b> material occurs to depths in excess of 3.0m.
Belt Press Building/Belt Press Sump and Feeder Pump Station	0 - 7,5	Below 7,5	None Encountered	<b>Soft excavation</b> material occurs to an average depth of 7,5m. <b>Intermediate excavation material</b> on very soft rock lava bedrock occurs below 7,5 depth. The intermediate excavation material could be removed using medium to heavy earthmoving equipment and or power tools.
Sludge Drying Beds	>3,0	None Encountered	None Encountered	<b>Soft excavation</b> material occurs to depths in excess of 3.0m.

## BUSHKOPPIES WASTE WATER TREATMENT PLANT

Gas Holder/Boiler House	>3,0	None Encountered	None Encountered	Soft excavation material occurs to depths in excess of 3.0m.
Belt Press Building/Belt Press Sump and Feeder Pump Station	0 - 7,5	Below 7,5	None Encountered	Soft excavation material occurs to and average depth of 7,5m. Intermediate excavation material on very soft rock lava bedrock below 7,5 depth. The intermediate excavation material could be removed using medium to heavy earthmoving equipment and or power tools.
Sludge Drying Beds	>3,0	None Encountered	None Encountered	Soft excavation material occurs to depths in excess of 3.0m.

-	-	-	-	1
-	-	-	-	2
-	-	-	-	3
-	-	-	-	4
-	-	-	-	5
-	-	-	-	6
-	-	-	-	7
-	-	-	-	8
-	-	-	-	9
-	-	-	-	10



**NOTES**

1) Borehole stopped at 10m.

% Core Rec	% RQD	Fract No./ Mtrc	SPT W'
------------------	----------	-----------------------	-----------

CONTRACTOR: Roelf Fourie  
MACHINE: Rockdrill R80

DRILLED BY:

PROFILED BY: J Davel

TYPE SET BY: Gleen

SETUP FILE: STANDARD.SET

INCLINATION:

DIM: 54mm

DATE:

DATE: 25/10/2010

DATE: 27/10/10 13:14

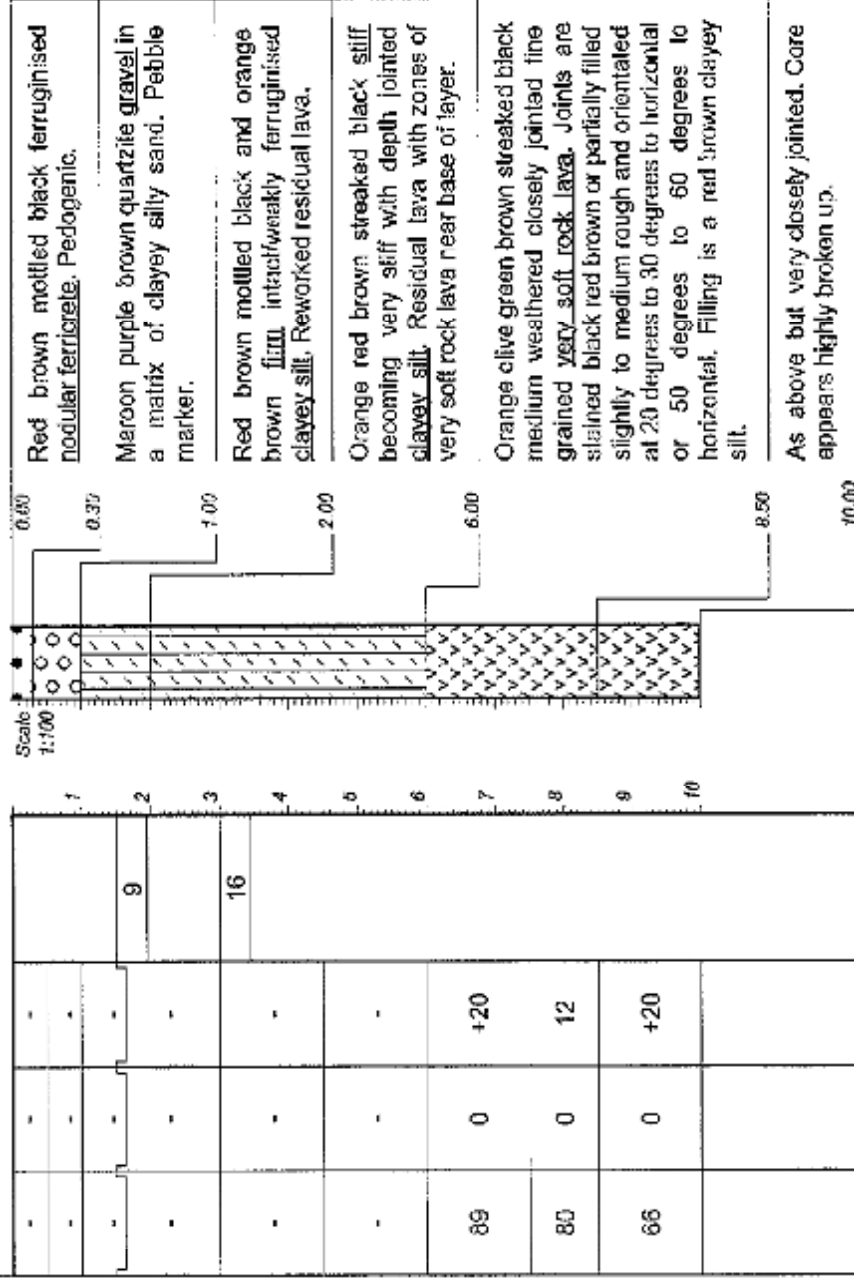
TEXT: ...Profiles\0918BH1.txt

ELEVATION:

X-COORD:

Y-COORD:

**HOLE No: BH1**



### NOTES

1) Borehole stopped at 10.0m.

CONTRACTOR : Roelf Fourie  
MACHINE : Rockdrill R80

DRILLED BY :

PROFILED BY : J Davel

TYPE SET BY : Coleen

SETUP FILE : STANDARD SET

INCLINATION :

DIAM : 54mm

DATE :

DATE : 25/10/2010

DATE : 27/10/10 13:14

TEXT : ...Profiled0818BH1.dwg

ELEVATION :

X-COORD :

Y-COORD :

HOLE No: BH2

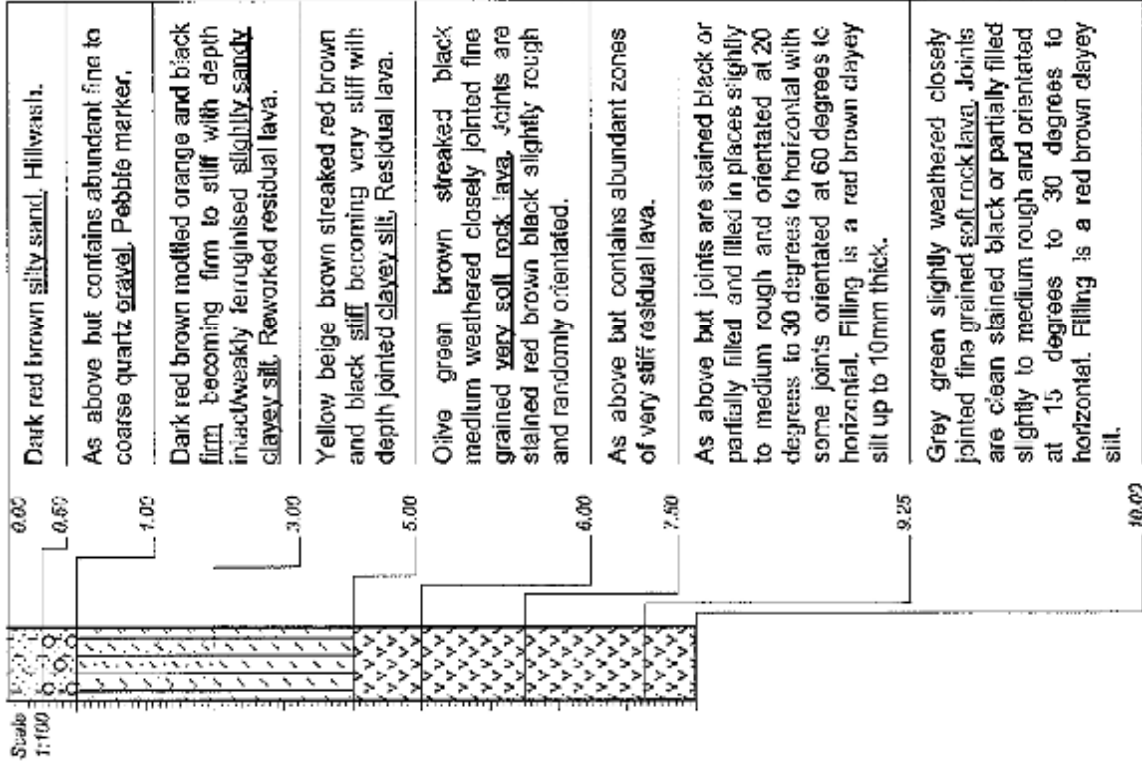
# Crossman Pape & Associates

Zitholele Consulting  
Bushkoppies WWTTP

HOLE No: BH3  
Sheet 1 of 1

JOB NUMBER: 09/18/bh

% Core Rec	% RQD	Fract No./ Metre	SPT Blows
-	-	-	-
-	-	-	9
-	-	-	27
-	-	-	Ref
90	0	+20	
77	0	12	
93	0	16	
100	14	19	



## NOTES

1) Borehole stopped at ±0m.

CONTRACTOR: Roelif Fourie  
MACHINE: Rockdrill R80

DRILLED BY:

PROFILED BY: J Davel

TYPE SET BY: Cateen

SETUP FILE: STANDARD.SET

D07A Crossman Pape and Associates

ANALYST: J.D.

DATE: 25/10/2010

DATE: 25/10/2010

DATE: 25/10/2010

DATE: 25/10/2010

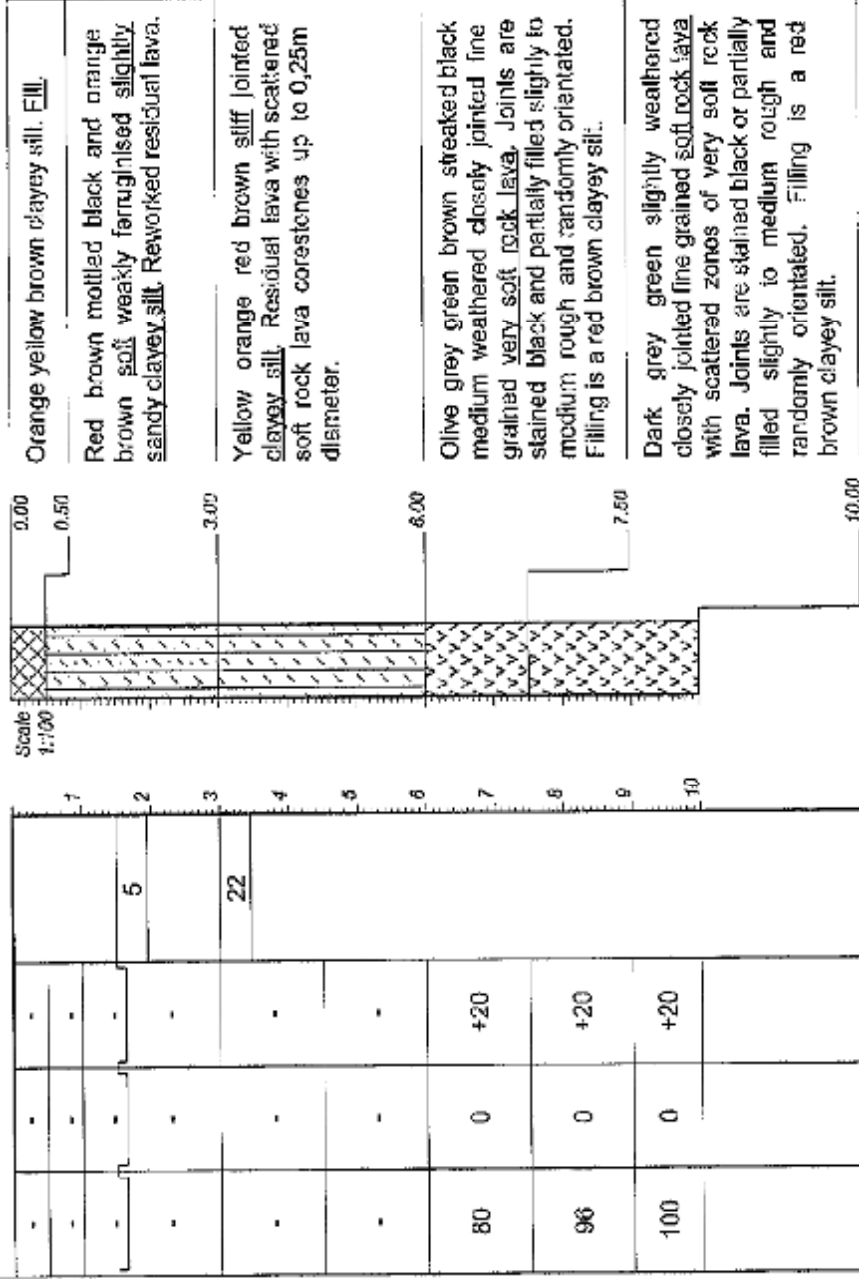
TEXT: J:\Profiles\0918BH.dwg

ELEVATION:

X-COORD:

Y-COORD:

HOLE No: BH3



**NOTES**

1) Borehole stopped at 10m.

% Core Rec	% RQD	Fract No./ Metre	SPT Blows
------------------	----------	------------------------	--------------

CONTRACTOR: Rociff Fourie

MACHINE: Rockdrill R80

DREALED BY:

PROFIED BY: J Davel

TYPE SET BY: Colleen

SETUP FILE: STANDARD.SET

INCLINATION:

DIAM: 54mm

DATE:

DATE: 25/10/2010

DATE: 27/10/10 13:14

TEXT: J:\P\0105\2918BH.m

REMARKS:

X-COORD:

Y-COORD:

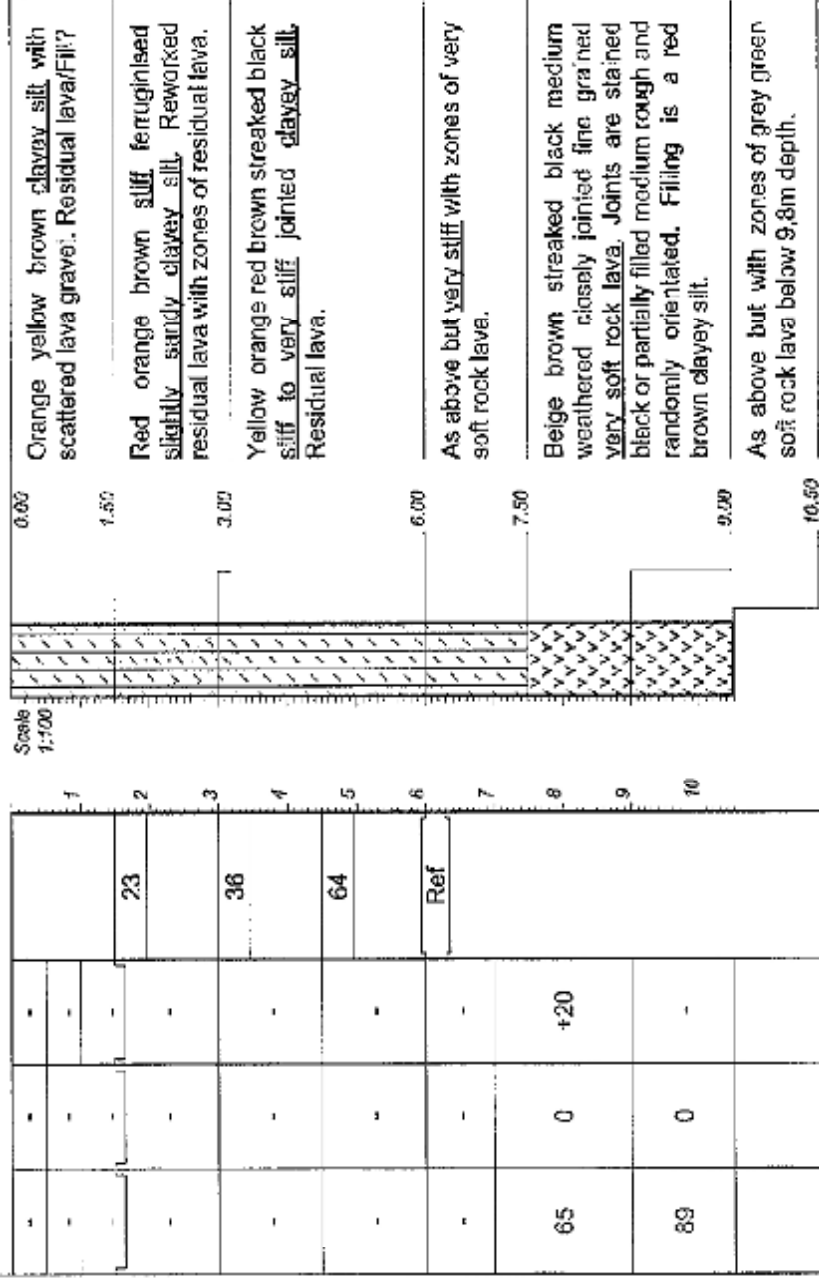
HOLE No: BH4

**Crossman Pape  
& Associates**

Zilcoele Consulting  
Bushkoppies WWTP

HOLE No: BH5  
Sheet 1 of 1

JOB NUMBER: 09/18/bh



**NOTES**

1) Borehole stopped at 10.5m.

CONTRACTOR: Roelf Fourie  
MACHINE: Rockdrill R80  
DRILLED BY:  
PROFILED BY: J Davel  
TYPE SET BY: Gideon  
SETUP FILE: STANDARD.SET  
D07A Crossman Pape and Associates

INCLINATION: DIAM: 54mm  
DATE: 25/10/2010  
DATE: 27/10/10 13:14  
TEXT: .\Profiles\091801.txt

ELEVATION:  
X-COORD:  
Y-COORD:

HOLE No. BH5

# Crossman, Pape & Associates

Consulting Geotechnical Engineers & Engineering Geologists

P.O.Box 3557 Cranmanview 2060. Tel: (011) 465 1699, Fax: (011) 465-4588, Cell 082 556 7302 & 082 903 8022

PROJECT :

BUSHKOPPIES WWTP

PROJECT NO: 09/18/P1

## SITE PLAN SHOWING POSITIONS OF BOREHOLES

