GROUNDWATER RESOURCE INFORMATION PROJECT
EASTERN CAPE PROVINCE

GROUNDWATER INFORMATION SOURCE REFERENCE SHEET

SOURCE REF NR:	AG307 2.2(1521)	Own Archive	X	Copy attached	X
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A: SOURCE DESCRIPTION

District Municipality:	Amatole		Chris Hani	X	O.R Tambo	
	Ukhahlamba		Cacadu		Alfred Nzo	
Local Municipality:	Sakhisizwe					
Institution where Information is held:	AGES EC CC					
Branch of Institution:	East London					
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B: TYPE OF INFORMATION

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	Specify Other:					

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	Yes	No	Complete	Incomplete
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Hydrocensus Data	X		X	
Pump Testing Data	X		X	
Chemical Water Analysis Data	X		X	
Geohydrological Data	X		X	
Spring Data		X		
Remote Sensing Data	X			X
Map Data	X		X	

Comments:

Reviewed by: THOLEKA MAFANYA Date: 21/01/2005 Signed:

AGES
Africa Geo-Environmental Services

FINAL REPORT: **2005/01/02/GENV**

Africa Geo-Environmental Services (Pty) Ltd.

Report on the Geo-Environmental Investigation:

Detailed Geo-Environmental Investigation for the Cala Sanitation project – Sakhisizwe Local municipality EASTERN CAPE PROVINCE

Prepared for:
ARCUS GIBB

January 2005

Project team:

FN De Jager, T Mafanya, Z Ngwaja, T Zangashe

Detailed Geo-Environmental Investigation for the Cala Sanitation project – Sakhisizwe Local municipality EASTERN CAPE PROVINCE

January 2005

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1 INTRODUCTION

1.1 General

A detailed hydrogeological and engineering geological investigation was conducted for the Cala sanitation project in the Sakhisizwe local municipality of the Chris Hani district municipality; with the aim of determining and evaluating the hydrological and engineering geological characteristics of the project area for the construction of proposed VIP latrines.

1.2 Terms of reference

Africa Geo-Environmental Services South Africa (PTY) Ltd – better known as AGES - was appointed by ARCUS GIBB to carry out a Geo-Environmental investigation incorporating, hydrogeological and engineering geological actions, to verify the potential of groundwater pollution from on site sanitation systems and to address technical issues from which decisions can be made regarding appropriate sanitation technology options for the proposed project area. The investigation included detailed soil profiling, laboratory analysis of soil samples and in-situ permeability testing.

1.3 Scope of the investigation

AGES was appointed to render the following hydrogeological and engineering geological consultation services in the project area:

- undertaking of a hydro census within and around the settlement;
- compilation of landscape map;
- assessment of existing threats to groundwater quality;
- evaluation of sanitation options;
- ongoing monitoring of the performance

1.4 Location of study area

The Cala sanitation project area is located in the Sakhisizwe local municipality of the Chris Hani district municipality in the Eastern Cape Province. The centre point of the project area is situated approximately 1.5 km to the southeast of the town Cala at an elevation between 1190 and 1240 m above mean sea level (Figure 1).

1.5 Available Information

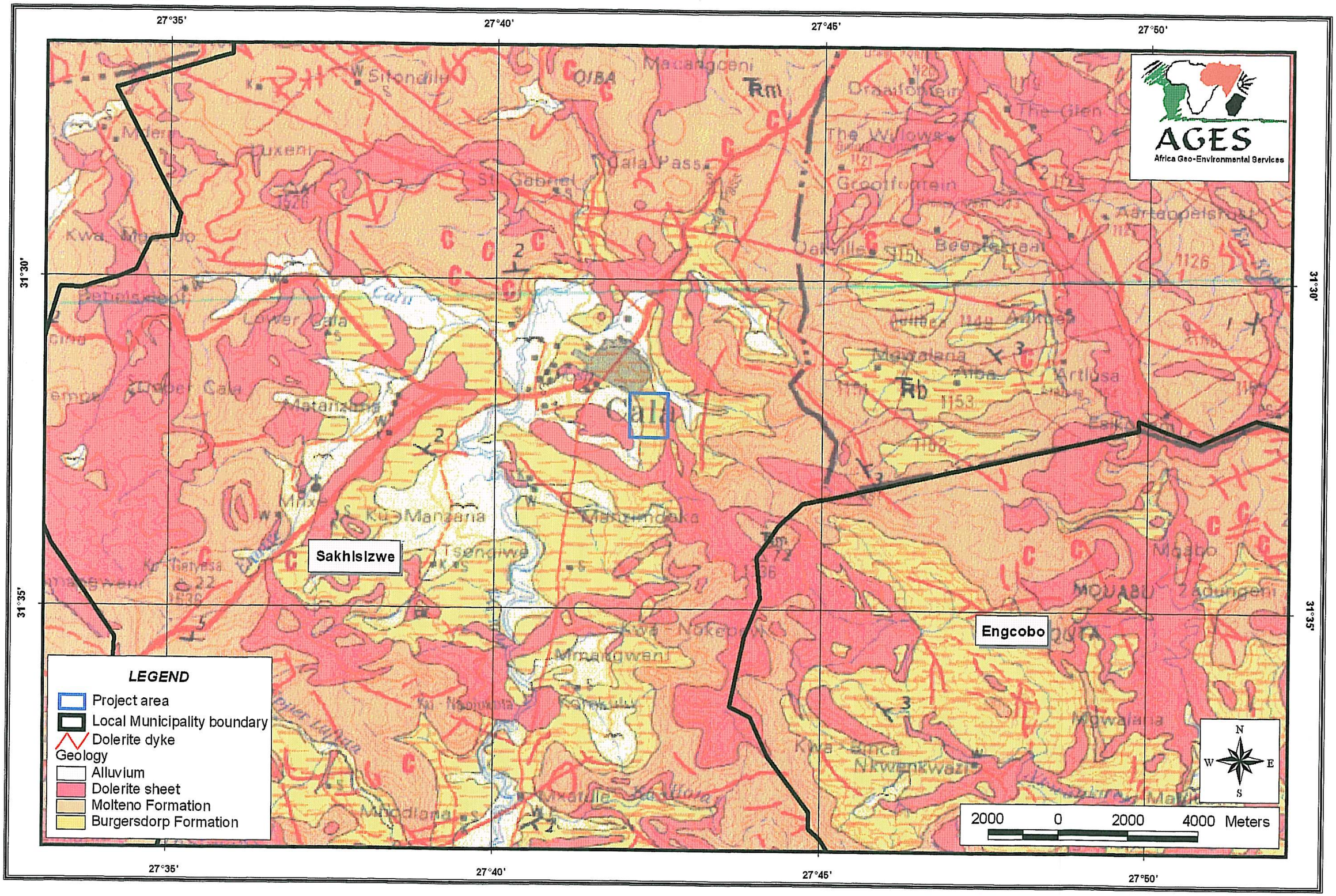
Community liaison and terrain observations were used to verify historical data regarding existing water sources as well as terrain conditions. This was mainly done during the site visits that were made as part of the hydrocensus and soil profiling phases. Field survey forms and liaison documentation is attached in Appendix A for reference.

The following sources of information were used during the investigation:

- <u>Geological maps and information</u>
  - Geological map of the Republic of South Africa and the kingdoms of Lesotho and Swaziland, 1997 ; Scale 1 : 1 000 000

PROJECT: CALA SANITATION GEO-ENVIRONMENTAL INVESTIGATION

Figure 1: Regional geological and locality map



- 3126 QUEENSTOWN; Scale 1 : 250 000

- Topographical maps and information
  - 3127 DA CALA, Second Edition, 1982 ; Scale 1 : 50 000

- Hydrogeological maps and information
  - 3126 QUEENSTOWN, First Edition, 1997; Scale 1 : 500 000

- Aerial photographs
  - Job 765, strip 8, photos 379 and 380; Scale 1 : 50 000
  - Job 765, strip 9, photos 1228 - 1230; Scale 1 : 50 000

- Other information
  - SURFACE WATER RESOURCES OF SOUTH AFRICA 1990, *VOLUME 5*, Water Research Commission, First Edition 1994.
  - Guide to COMMUNITIES and their WATER SERVICES LEVELS, Department of Water Affairs and Forestry; Version 2.
  - Department of Water Affairs and Forestry's National Groundwater Database (NGDB)

2 SITE DESCRIPTION AND INFORMATION

2.1 Site geology and hydrogeological setting

Geology:

According to the Queenstown geological map the project area is partially covered by alluvium associated with the tributaries of the Tsomo River and predominantly underlain by brownish grey and red mudstone and sandstone of the Burgersdorp Formation of the Karoo Supergroup. (Figure 1). The sedimentary rocks typically form horizontally orientated alternating rock layers of varying thickness. The formation dips toward the northeast at an angle of approximately 2 degrees.

Dolerite, in the form of sills, dykes and sheets intruded the strata during the late Karoo volcanism. A prominent dolerite sill intrusion occurs directly east of the area. No prominent faults and shear zones were noted in the study area.

Hydrogeology:

The Queenstown 1 : 500 000 hydrogeological map describes the study area as being underlain by predominantly argillaceous and arenaceous rocks with groundwater most likely to be encountered intergranular and fractured zones, with expected yields of between 0.5 l/s to 2.0 l/s at successful boreholes. The groundwater potential of the study area can be described as *low* to *moderate*.

Soils:

According to the WRC report, SURFACE WATER RESOURCES OF SOUTH AFRICA, referred in paragraph 1.4, the soils in the study area can be described as moderate to deep with a clayey loamy texture with the relief of the area classified as being steep.

2.2 Topography

The study area exhibits morphological elements of typical hillslope development under semi-humid conditions. The village is generally located on the northwestern pediment slope of a northwardly trending ridgecrest. Due to the drainage characteristics of the area only a small variety of landforms are present.

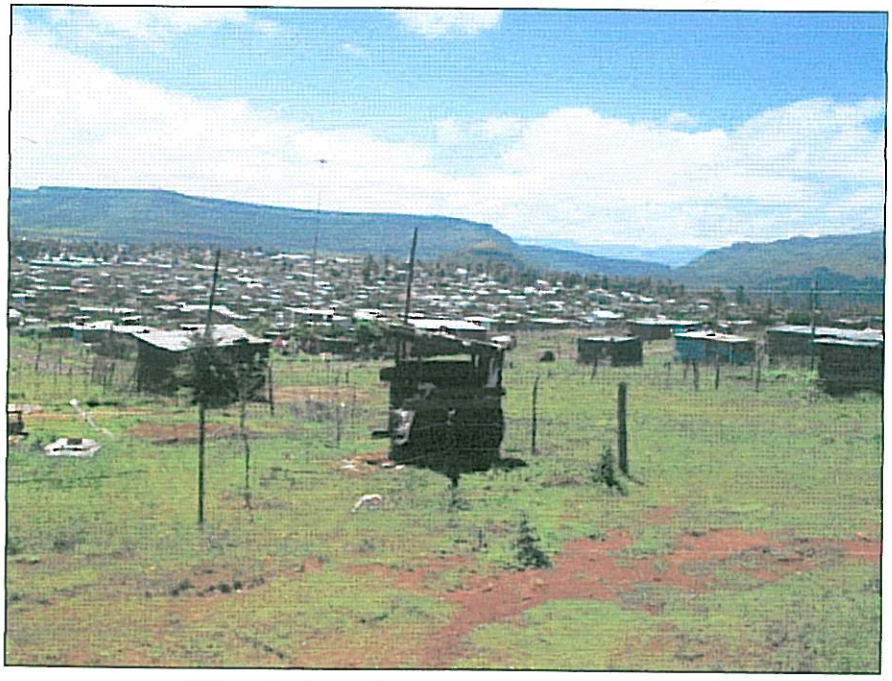


Photo 1: General topography of the study area

The slopes throughout the study area are gentle to moderate, with steep slopes situated just beyond the most eastern section of the project area.

2.3 Drainage

Surface water drainage in the area is drained in a basic westerly direction associated with the small Furrow River and tributaries of the Tsomo River, that drains water in a southern direction to the Indian ocean. Gradients are low to moderate over the majority of the study area, with no steep gradients occurring.

No major dams occur near the village and the surface water that the community use occurs in small streams. Unprotected riverbanks may lead to extensive soil erosion in the study area.

2.4 Climate

The study area is located in the Summer Rainfall Zone of the Republic of South Africa.

According to SURFACE WATER RESOURCES OF SOUTH AFRICA 1990 the project area is located within the S50D quaternary sub-catchment of the Kei River catchment. The area lies within the S5A rainfall zone and receives a mean annual precipitation of approximately 700 mm, and has a mean annual evaporation of between 1500 to 1600 mm. The mean annual runoff is approximately 75 mm.

Weinert's N-value for the area is between 2 and 5, indicating that the dominant mode of weathering is chemical decomposition of the constituent minerals, rather than mechanical disintegration and breakdown.

2.5 Vegetation

The natural vegetation occurring in the study area has been extensively disturbed due to urban development in its direct vicinity. Scattered portions of the area is currently covered by southern tall grassland as well as highland sourveld and dohne sourveld against steeper gradients, with scattered examples of indigenous trees and scrubs.

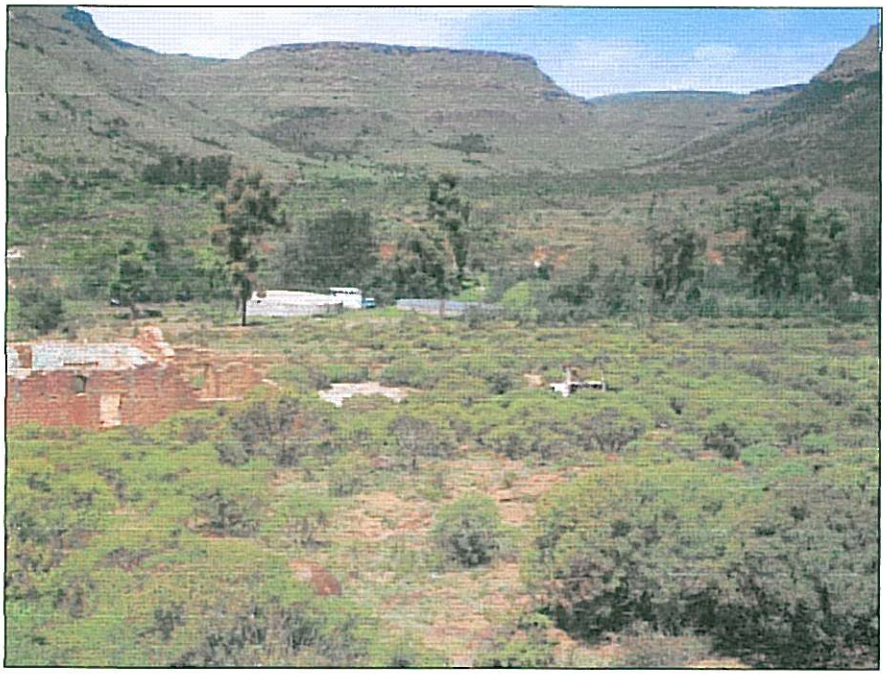


Photo 2: Vegetation outside the project area

2.6 Existing water sources

Surface water drainage in the area is drained in a basic westerly direction associated with the small Furrow River and tributaries of the Tsomo River, that drains water in a southern direction to the Indian ocean. Gradients are low to moderate over the majority of the study area, with no steep gradients occurring. The area can generally be described as a flat to slightly undulating terrain. The community is currently relying on bulk water supply from the Tsomo River. In the events that this bulk water system is not in place due maintenance conditions, Voor stream, which emanates from the mountains, is used to supplement water sources for the entire town of Cala. Some privately owned boreholes were also encountered on few households within the town of Cala.

3 INVESTIGATIVE METHODOLOGY AND TECHNIQUES

3.1 Hydrogeological survey

Geological mapping entailed a walk-over survey of the study area during which rock outcrops were visited and geological formations identified by means of visual identification and the use of available geological maps as mentioned in paragraph 1.4. Geological mapping forms an integral part in the investigation stage to assess the groundwater potential in the area and identify sensitive aquifers and zones where pollution can take place.

A brief hydrocensus was carried out to identify boreholes and prominent springs in the study area. This is done to aid in the assessment of the groundwater potential in the area and community members play a vital role. These boreholes and springs are investigated and important information regarding the water levels; quality and previous usage are annotated.

Remote sensing of the study area was done using stereoscopic aerial photographs as mentioned in paragraph 1.4. Stereoscopic aerial photography is used to delineate geological contacts and identify possible structures that may have an influence on the local underground water potential. These aerial photographs allow the viewer to see the photographed region three dimensionally. The viewer looks down on the photographed area, and can identify landforms, dolerite dykes, sills and linear features that may predict the existence of possible water-bearing features and structures.

3.2 Aquifer Characterisation

The survey aims to evaluate and define a conceptual model of the aquifers present in the study area. It embodies all the important features of the groundwater flow system, while incorporating simplifying assumptions, which include:

(a) a definition of the study area (*modelling domain*);

(b) the known geological and hydrogeological features and characteristics of the area (*geometry*);

(c) the static water levels/piezometric surfaces of the study area (*initial conditions*);

(d) the interaction of the geology and hydrogeology on the boundary of the study area (*boundary conditions*);

(e) a description of the processes and interactions taken place within the study area that will influence the movement of groundwater (*groundwater flow dinamics*)

The conceptual model consists of all relevant ideas, incorporated into an idealisation to develop a better understanding of site conditions, and to be able to communicate this understanding. A groundwater model is a representation of the real system. It is therefore at most an approximation, and the level of accuracy depends on the quality and quantity of the data that is available. The groundwater model in this investigation should therefore *not be seen as a predictive tool*, but rather as a prospective evaluation tool to determine the potential behaviour of the system with time, given a set of changing parameters.

Should pump testing data be available from any existing boreholes in the project area, this data can be used to better understand and characterize the aquifer. Different methods are used to analyze pump-testing data. Two parameters are used to describe the physical properties of an aquifer, namely transmissivity (T) and storativity (S). The first of these two quantifies the rate at which water moves through the aquifer and the latter quantifies the aquifer's ability to release water.

3.3 Engineering geological survey

An engineering geological survey was conducted throughout the study area. Geotechnical surveying entails the identification of the different landforms in the area by means of remote sensing as mentioned in paragraph 3.1. After the relevant landforms have been identified on the different geological formations, test pits are excavated on each landform to determine the sub-surface soil conditions. The individual soil layers in the test pits are described according to the following parameters, which constitute the soil profiling system proposed by Jennings, Brink and Williams (1973): Moisture, Colour, Consistency, Structure, Soil type and Origin, known as the **MCCSSO** system.

Disturbed soil samples are taken of the most important soil layers that will have an influence on the proposed development. The samples are submitted to a soils laboratory and analysed for the determination of its grading characteristics and basic mechanical properties.

3.4 In-situ permeability testing

In-situ permeabilities of the most prominent soil horizons were determined by means of double-ring infiltrometer testing. The test is basically conducted as follows:

After profiling of the soil horizons are conducted, a test pit is excavated into the top portion of the soil layer that is to be tested. Two steel rings, comprising an inner and outer ring of known diameter is driven into the soil layer to prevent water from seeping out underneath the rings. The outer ring is filled with water. The inner ring is then filled with water to the exact level as the outer ring. As soon as the levels are the same, the test commences. (It is very important that the water level in the outer ring is kept at the same level as the inner ring in order to prevent a difference in height that will influence the accuracy of the test).

The water level in the inner ring is measured on certain time intervals. The test is completed when a linear correlation between the infiltration rate and time is reached for a minimum of 30 minutes. The data is represented on a graph of time (s) over infiltration (mm). The permeability of the soil layer is then determined with an equation that is based on Darcy's permeability equation.

3.5 Community awareness creation

Community awareness creation plays a very prominent role throughout all the project phases, but is especially important during the hydrocensus and soil surveying phases. Members of the community are requested by the project team to be present during the implementation of the hydrogeological and geotechnical techniques. The actual techniques that are used are explained to the community while the actual investigation is conducted and the importance and relevance of the techniques are envisaged. Community members are also given the opportunity to ask questions that are answered by the consulting hydrogeologist and/or engineering geologist.

4 RESULTS

4.1 Hydrogeological survey

4.1.1 Community awareness creation

Community awareness plays a very important role in any sanitation project. During this phase community awareness creation regarding the prevention of water borne disease as a result of improper sanitation practices are communicated. No community awareness creation was done as part of this investigation due to budget restrictions. It is however recommended that an awareness program be conducted in future.

4.1.2 Site Geology

Geological mapping of the project area was conducted during the respective site visits of December 2004. Terrain boundaries and conditions were verified and current water sources were inspected and evaluated. Attention was given to the presence of dolerite dykes and sheets and the different landforms that are present on the geological formations.

It was determined that the majority of the study area is underlain by a large dolerite sheet with the southwest portion of the area being underlain by alluvium. The dolerite and alluvium is expected to be underlain by mudstone and sandstone from the Burgersdorp Formation. The orientation of the dolerite sheet could not be measured.

No *dolerite dyke intrusions* are present in the direct vicinity of the study area.

4.1.3 Hydrocensus

A total of six boreholes were identified during the hydrocensus that was conducted in December 2004 (Figure 2). Results are summarised in Table 1 below. The hydrocensus revealed that the majority of these boreholes are still in working condition and are all privately owned. Community liaison document with site observations is attached in Appendix A for reference. .

Village Name	Bh Number	Lat	Long	Status	Pump type	Static water level (mbgl)
Cala	Bh 1	-31.51743	27.68079	In use	Submersible pump	-
Cala	Bh 2	-31.51641	27.68075	In use	Submersible pump	-
Cala	Bh 3	-31.51895	27.67741	Blocked	-	-
Cala	Bh 4	-31.52034	27.67811	In use	Submersible pump	-
Cala	Bh 5	-31.51984	27.67818	Not in use	Open hole	4.5
Cala	Bh 6	-31.52865	27.67563	In use	Submersible pump	-

Table 1 Existing boreholes close to project area

The hydrocensus data also revealed that the majority of these boreholes are equipped with submersible pumps. Water levels could not be measured from these boreholes as most of them were found secured around the wellhead, protecting pumps from being stolen. The hydrocensus results are summarised in Table 1

PROJECT: CALA SANITATION GEO-ENVIRONMENTAL INVESTIGATION

Figure 2: Detailed site layout map

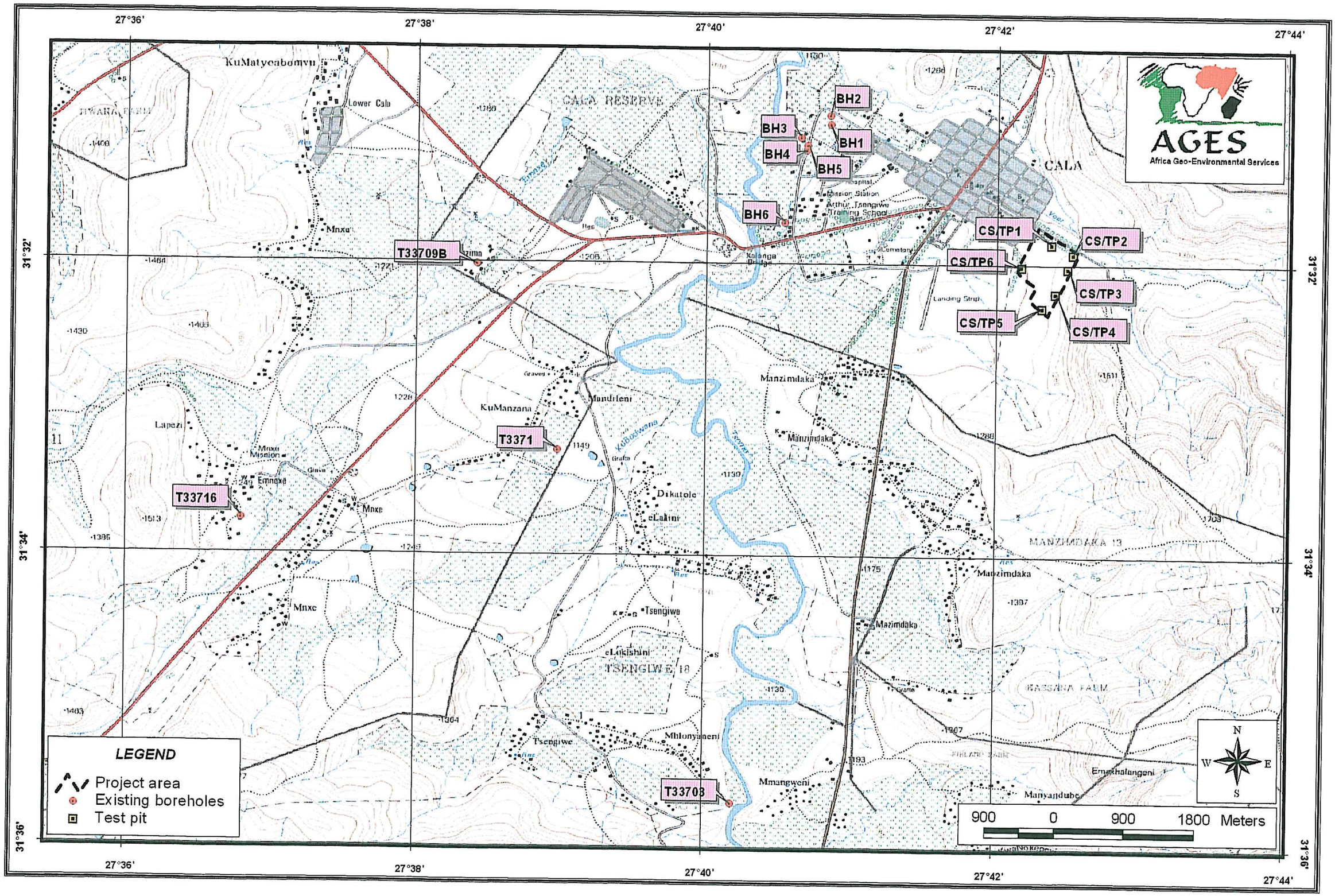


Photo 3 Some of the material used to protect borehole pumps from being stolen

The AGES database was also consulted to find out about the exiting information in the project area and its surroundings. From the search, four boreholes were encountered, located in the surroundings of the project area. The information regarding these boreholes are summarised in the table below:

Village Name	Bh Number	Lat	Long	Static water level (mbgl)	Comments
Manzana	T3371	-31.55472	27.64972	12.65	Pump tested under GeoCon supervision in 2001
New Site	T33709B	-31.53361	27.64028	6.2	Pump tested under GeoCon supervision in 2001
Tsengiwe	T33703	-31.59500	27.67000	3.63	Pump tested under GeoCon supervision in 2001
Lapesini	T33716	-31.56278	27.61333	7.04	Pump tested under GeoCon supervision in 2001

Table 2 Existing information about the boreholes in the project area's surroundings

The information about the boreholes mentioned in Table 2 was incorporated into this report for aquifer characterization.

The Furrow River or stream was also reported to be a main source of water for the Extension 13 community. This stream emanates as a spring from the mountains and is captured halfway on its channel for use. The picture below depicts the capturing point of this stream as it is diverted to a small dam approximately 300m to the south of this position.

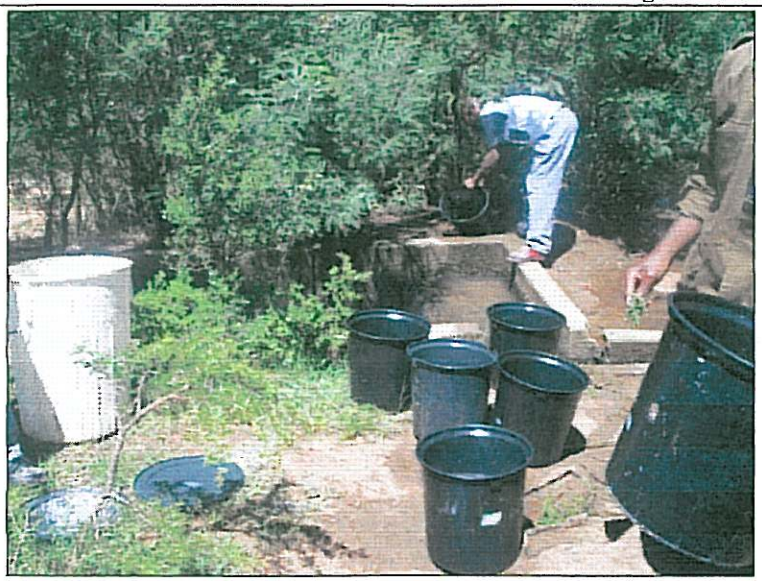


Photo 4 Furrow stream capturing point

4.1.4 Aquifer characteristics

Pump test data for the boreholes T3371, T33709B, T33703 and T33716 was obtained from the AGES database of previous work conducted in the area. These boreholes were noted to fall within the surroundings of the project area and therefore its data could be used to evaluate the aquifer parameters of the underlying aquifer within the project area (Figure 2). The evaluation of the pump test data was done using the Flow Characteristic (FC) Method. The aim to this was to obtain the hydraulic parameters of the aquifer. Pump test data analysis revealed the following:

Borehole Number	Depth (m)	Static water level (mbgl)	Constant discharge test (l/s)	Duration (min)	Recovery test (% recovery)	Duration (min)	T early (m^2/d)	T late (m^2/d)	Average sustainable yield (l/s) 24/24hrs
T3371	72.64	12.65	2.68	1440	86.99	1440	5.72	2.69	0.6
T33709B	59.95	6.2	1.69	2880	99.65	2880	6.98	1.75	0.4
T33703	50.36	3.63	0.26	720	88.99	720	0.64	0.18	0.04
T33716	55.20	7.04	0.58	1440	94.12	1440	1.9	0.49	0.1

Table 3 Summarised pump testing analysis data

The pump test data from all the boreholes revealed shallow groundwater levels, with an average groundwater level of 7.38 mbgl recorded. The pump test data also revealed a good recovery rate from all the pump-tested boreholes, with recovery rates ranging between 86.99 and 99.69% recorded. The transmissivity values obtained from the pump test analyses revealed that the majority of boreholes are mainly supported by fractures and to a lesser extent by the matrix. This is revealed by the high early transmissivity values as compared to late transmissivity values. During the early hours of pumping, groundwater flow towards the boreholes is assumed to be transported by fractures and conduits hence the high flow rates as opposed to low flow rates supported by the matrix.

When the shallow groundwater levels and transmissivity values of the underlying aquifer are taken into

consideration, it can be said that the chances of groundwater pollution can be higher where there is a fracture network which may serve as conduits for pollutants to groundwater. Under normal circumstances where there is no fracture network, the sediments of the underlying aquifer can serve to filter the pollutants before they get to the groundwater. The shallow groundwater levels in the project area are of concern and therefore groundwater protection will have to be given priority.

In view of the water sources in the village area, the underlying aquifer can be regarded as a possible alternative water source. Yields from boreholes in the project area are expected not to exceed 0.5 l/s- 2 l/s over 12-hour duty cycles. Detailed pump test data is included in Appendix B for reference

4.1.5 Water quality

No water samples were taken as part of this investigation. The hydrochemistry results for the pump tested boreholes discussed in paragraph 4.1.4 were used for preliminary assessment of local groundwater quality. Water quality results were evaluated against ***Quality of Domestic Water Supplies; Volume 1;Assessment Guide; Second Edition 1998; Water Research Commission No. TT101/98.***

The purpose of this Guide is to answer the following questions:

- *Is the water suitable for domestic use?*
- *If not, what can be done to make it suitable for use?*
-

The Water quality Assessment Guide defines the following classes:

Class 0	Ideal water quality	Suitable for lifetime use
Class 1	Good water quality	Suitable for use, rare instances of negative effects.
Class 2	Marginal water quality	Conditionally acceptable. Negative effects may occur in some sensitive groups.
Class 3	Poor water quality	Unsuitable for use without treatment. Chronic effects may occur.
Class 4	Dangerous water quality	Totally unsuitable for use. Acute effects may occur.

Table 4 Water Quality Assessment Guide

The results from the analysis revealed that the general water quality in the project area classifies as Class 2 (Marginal water quality) as indicated in Table 5.

SAMPLE NR	SAMPLE TYPE	DRINKING QUALITY	FOOD PREPARATION	BATHING	LAUNDRY
T3371	Groundwater	2	2	2	2
T33709B	Groundwater	2	2	2	2
T33703	Groundwater	2	2	1	2
T33716	Groundwater	2	2	2	2

Table 5 Chemical water results summary table

The observed water quality obtained from the analysed water samples is due to marginally elevated levels of turbidity and the presence of iron. An elevated total coliform concentration was noted at borehole T33703, but at low levels (Class 2).

The overall water quality in the area is of marginal quality that indicates that groundwater is conditionally suitable for drinking use prior to any treatment. A slight murky colour in water may be observed. The effect may affect sensitive groups only. Detailed chemical water analyses data is included in Appendix C for reference.

4.2 Engineering geological survey

4.2.1 Landforms

In the light of the available physiographic information, the study area can be divided into the following landforms (i.e.: areas with similar topography, drainage regime and geological character) according to the systems devised by the National Data Bank for Roads of the Council for Scientific and Industrial Research (CSIR):

- Pediment slope
- Convex and concave side slopes

The extent of the different landforms is the basis for the correlation and extrapolation of the engineering geological results within each landform.

4.2.2 Soil profiles

A total of 6 shallow test pits were profiled during the site visit of 20 December 2004. The test pits were excavated by utilising local labour. Due to the time of the year the excavation of test pits was not done to the satisfaction of the project geologist. Re-excavation of test pits was however not deemed feasible due to the project time frame and budget The test pits were specifically placed to obtain a detailed overview of the succession of soil and rock layers underlying the project area on each identified landform, and to delineate changes in the soil character. Test pits were placed as indicated in Figure 2. Detailed test pit profile logs are attached in Appendix D for reference.

4.2.2.1 Generalised soil profile

The project area was generally found to be covered by hillwash composed of sandy silt and sandy clay, exhibiting a firm to very stiff consistency and intact to micro-shattered structure that extends from the surface to a depth of between 0.20 and 0.90 m (mean 0.48 m). The transported material encountered in Test pit CS/TP5 is deemed to be of alluvial origin and is composted of sandy clay and clay material with at stiff consistency.

The transported material is underlain by slightly ferruginised residual dolerite composed of sandy clay with scattered to abundant ferricrete nodules. The material exhibits a stiff overall consistency and micro-shattered structure with a thickness between 0.30 and in excess of 0.75 m (mean 0.50 m observed in test pits). The residual dolerite becomes less ferruginised with depth. Residual dolerite composed of clayey sand and sandy clay with scattered dolerite boulders and corestones was encountered at the bottom of test pits CS/TP2 and CS/TP4 from a depth of 0.95 and 1.00 m. The material exhibits a firm to stiff consistency and micro-shattered structure.

No bedrock material was encountered in any of the test pits.

4.2.3 Laboratory analysis

Four disturbed samples were taken of the most prominent soil horizons and were submitted to Messrs. Controlab Civil Engineering Materials and Geotechnical Laboratory (East London) for the determination of the standard foundation indicator values (liquid limit, plasticity index & grading) of the different soil materials. A double hydrometer test was also carried out on the samples for determination of the soil dispersivity. Laboratory results are attached in Appendix E for reference.

Detailed processed laboratory results are summarised in the table below:

TABLE 4 Summarised soil test results

SAMPLE NUMBER	SAMPLE DEPTH (m - m)	ORIGIN	GRADING ANALYSES				ATTERBERG LIMITS			LS	MATERIALS CLASSIFICATION		POTENTIALLY ADVERSE GEOTECHNICAL CHARACTERISTICS				CALCULATED PERMEABILITY (cm/sec)
			Gravel %	Sand %	Silt %	Clay %	LL % 1	PI	PI' 2	% 3	A.S.T.M. 4	A.A.S.H.T.O. 5	Expansiveness 6	Collapse 8	Compressibility 9	Dispersiveness 7	1E+01
DS2	0.80 - 0.95	Ferruginised residual dolerite	10	42.7	28.3	19	33	13	9.2	7.5	SC: Clayey sand	N/T	Low risk	High risk	N/T	Low risk	4E-07
DS4	1.00 - 1.30	Residual dolerite	0	54.6	32.4	13	29	14	11.3	7.5	SC: Clayey sand	N/T	Low risk	Very high risk	N/T	Low risk	1E-06
DS5	0.10 - 0.50	Alluvium / Hillwash	0	41.5	36.5	22	23	9	7.9	4.5	CL: Sandy lean clay	N/T	Low risk	Low risk	N/T	Low risk	4E-07
DS6	0.50 - 0.90	Alluvium / Hillwash	0	29.9	53.1	17	25	14	13.6	7.5	CL: Lean clay with sand	N/T	Medium Risk	Low risk	N/T	Medium risk	5E-07

1 Liquid Limit

2 Weighted Plasticity Index (corrected to represent the whole sample)

3 Linear Shrinkage

4 According to the A.S.T.M. Standard on the Unified Soil Classification System

5 According to the American Association of State Highway and Transportation Officials

N/T Not tested

6 Calculated by means of the method proposed by Van der Merwe (1964), as modified by Wilson (1976)

7 Determined by means of the Emmeron Crumb Test

8 Determined by comparing the grain size distribution with grain size limits defined by Knight and Errera

9 Determined by means of special tests

10 Calculated by means of Hazen's permeability equation: $k = 100 \times D_{10}^2$

4.2.4 Excavatability

Excavatability plays an important role in the determination of the type of sanitation system that will be implemented. Pit latrines are generally required to be excavated to a depth ranging between 1.50 and 2.00 metres (ideally 1.80 m), into a suitable permeable soil at the base; while a septic tank system requires at least 2.00 metres of suitable permeable soil from the surface to the base, implying depths in excess of 2.00 metres.

It was generally possible to excavate test pits to a depth ranging between 0.80 and 1.30 m (mean 0.98 m) by utilising local labour. Excavation did not refuse in any of the test pits and it is expected that the required depth can be reached by utilizing motivated local labour for excavation of pits by hand. Alternatively the use of a TLB-type light mechanical excavator is recommended.

The sidewalls of the test pits remained stable during the profiling and the sampling of the test pits, with little or no collapse occurring during profiling.

4.2.5 Groundwater occurrences

Groundwater seepage was not encountered in any of the test pits.

Ferruginised material was however encountered in five test pits (CS/TP1, 2, 3, 4 & 6). Ferruginised material is generally indicative of seasonal perched groundwater table conditions. Liaison with the community revealed that seasonal groundwater seepage does take place in localized areas during the rainfall season.

Static groundwater levels recorded in the study area vary between 3.6 and 12.7 mbgl as recorded at the boreholes mentioned in paragraph 4.1.4.

4.2.6 Permeability

The soils must have permeabilities sufficient to adsorb and drain away the liquid waste but not so high as to pollute the groundwater. Percolation takes place through the base of the pit and through the lower part of the sidewalls. In a fine, homogenous sandy soil for instance, bacteria are generally filtered out within less than 3 metres although viruses travel much further. However, once a pollutant has entered the groundwater it can remain active for a long time.

Pollution of the groundwater via an excessively permeable soil in an area where boreholes and/or springs are used can present a serious health hazard to water consumers.

The following permeability limits for residential and industrial areas utilising *septic tank systems* area proposed by Warwick and Gregg (1971):

- Less than 4×10^{-3} cm/sec to prevent pollution
- Greater than 5×10^{-4} cm/sec to be sufficiently permeable

A lower permeability value can be tolerated in the case of pit latrines and a higher value is permissible where the water table is very deep and there are no boreholes and/or springs in the immediate vicinity of the pit.

4.2.6.1 Double Ring Infiltrometer Testing

A total of four double ring infiltrometer tests (DRIT) were conducted on the most prominent soil horizons as described in paragraph 3.4. Results are summarised in the following table with detailed results attached in Appendix F for reference:

TEST NR	MATERIAL	PERMEABILITY	CLASSIFICATION
DRIT 1	Slightly ferruginised dolerite	1.7×10^{-4} cm/s	Slightly permeable
DRIT 2	Alluvium (clay)	8.3×10^{-5} cm/s	Very slightly permeable
DRIT 3	Ferruginised dolerite	1.3×10^{-3} cm/s	Slightly permeable
DRIT 4	Ferruginised dolerite	2.8×10^{-4} cm/s	Slightly permeable

Table 2: Summary of double-ring infiltrometer tests

4.2.6.2 Calculated permeability using Hazen's equation

Coefficients of permeability for the disturbed samples submitted to Controlab, as mentioned in paragraph 4.2.3, were calculated by using Hazen's permeability equation:

$$\mathbf{k = 100\ D_{10}^{2}}$$

Where: k = coefficient of permeability in cm/sec

D_{10} = maximum particle size (in cm) of the smallest 10 % of the sample

(Holtz and Kovacks (1981) noted that this equation is not very reliable for permeabilities below 10^{-3} cm per second.)

Calculated permeabilities of the four samples range between 1×10^{-6} cm/sec and 5×10^{-7} cm/sec, which classifies the material as being ***very slightly permeable*** to ***practically impermeable***. This value is affected by the grading characteristics of the sample and it is expected that the permeability of this horizon is much higher. The soil structure of the horizons also influences the permeability and it is very likely that permeabilities for the other samples can be expected to be slightly greater than the abovementioned values, also indicated by the in situ permeability testing with the double ring infiltrometer.

5 APPLICATION OF THE GROUNDWATER PROTOCOL

5.1 Assessment of groundwater potential

Regional strategic value:

According to the Aquifer Classification Map of South Africa, the Cala project area is located in an area that is classified as a *MINOR* aquifer.

Local value of the aquifer:

Although the aquifer is not currently being fully utilised - the value of the local aquifer is seen as *moderate to low*. A large percentage of the community's water demand can be met from utilising local groundwater sources. Chemical water quality is expected to be marginal to poor due to elevated levels of faecal coliforms counts, most likely due to poor sanitation practises. Protection of the aquifer at present and future groundwater abstraction points is therefore seen as important.

5.2 Evaluation of groundwater use

The hydrocensus that was carried out revealed that 6 existing boreholes occur within a 3 km radius of the study area with only one being blocked. The use of groundwater in the study area is deemed to be slight, due to bulk water systems that are installed throughout the majority of the area.

Water from springs and rivers is currently being used by the community for drinking and stock watering purposes when the bulk water system is inoperative or in disrepair.

The potential for future use of groundwater in the study area is deemed to be moderate to low.

5.3 Assessment of flag situations

The following flag-situations occur and must be taken note of:

- The base of all pit latrines will be in fractured and weathered sedimentary or igneous bedrock
- Shallow groundwater levels (0-10 m below the base of pits) can be expected in localized areas of the study area but is not very likely
- The formation of contaminated perched water tables at shallow depth within slightly permeable soil material is likely to occur
- The formation of perched water tables in fractured sedimentary bedrock is very likely to take place after heavy precipitation events. Seepage was encountered in one of the excavations during the soil-profiling phase
- Water abstraction points are not fenced off and not used exclusively for water collection purposes
- Existing small cemetery sites were observed within a radius of 75 m of existing boreholes
- Ferruginised soil material was encountered in several test pits in the study area and is indicative of seasonal perched groundwater conditions

5.4 Assessment of the vulnerability of the aquifer

The vulnerability of the underground water source is related to the distance that the contaminant must flow to reach the water table, and the ease with which it can flow through the soil and rock layers above the water table.

Evaluating the project area according to the Groundwater Protocol's (Edition 1) Risk Assessment Table, it is seen that a ***LOW*** to ***POSSIBLE RISK*** exists as far as ground water pollution is concerned throughout the study area.

The vulnerability of the aquifer in the project area can be classified as **HIGH** to **MEDIUM** according to the

Groundwater Protocol (Second edition), due to usually fine sand, deep loam soils with semi-solid rock and groundwater table > 10 m. The aquifer may be vulnerable to many pollutants except those highly absorbed, filtered and/or readily transformed. The overall risk of contamination of the groundwater is deemed to be **HIGH**. Remedial measures should be implemented where necessary in high to medium load risk areas and necessary precautionary measures should be implemented where contaminant load risk is deemed to be minimal.

5.5 Strategic classification of the groundwater

The strategic value of the groundwater is a function of the potential yield of the aquifer, the present or probable future use of the groundwater, and the existence of an alternative water source.

At the Cala project area the potential yield of the aquifer is considered to be 0.1 to 1 Ml/day. Groundwater is not currently a water source in the project area, but it is being utilised by private landowners of the Cala community. It is also possible that the source will be developed in nearby future. Bulk water from Voor (Furrow)- and Tsomo Rivers are the only alternative water source in the area.

Taking the above-mentioned into consideration the relevance of threat of contaminants for the project area can be defined as follow:

- Bacterial and viruses – High risk
- Nitrates – Medium risk
- Chlorides – Minimal risk

5.6 Evaluation of measures to reduce the risk

Due to the classification of the terrain as a **HIGH OVERALL RISK**, the following approach will have to be taken to reduce this High risk. These should be negotiated and decided on by the sanitation engineer in consultation with the Project Hydrogeologist and the community. Risks can be reduced by taking one or more of the following remedial- or precautionary measures:

- Increase the path length of contaminants to groundwater table by constructing shallower pits, raised pits or partially sealed pits.
- Move future groundwater abstraction points sufficiently far from contamination sources or visa versa
- Use less polluting sanitation systems like VIP, eco-san sanitation systems
- Minimise infrastructure such as pit latrines, cattle kraals, sewer pipes, etc close to sensitive areas and areas where groundwater recharge is likely to take place
- Move or install water abstraction points sufficiently far from pollution sources
- Water from groundwater sources that will be used for drinking purposes should be chlorinated before consumption
- Remove liquid effluents from households close to abstraction points, e.g. pipe to wetland

5.7 Groundwater monitoring and sanitary surveillance programme

Monitoring of both the quality and quantity of groundwater at the point of abstraction forms a very essential basis of sustainable management of the resource. Effective and accurate monitoring requires that boreholes and pump operators should be equipped with the essential monitoring equipment (for future groundwater sources near project area):

Measurement of quantity pumped and water table levels

- Water level monitoring-Piezometer Tube of 25 mm or 32 mm diameter must be installed in

boreholes for measuring water levels

- Dip meter for measuring borehole water depth

Measurement of water quality

- A sample tap must be supplied close to the borehole to allow direct sampling of water from the borehole. Alternatively grab-samples should be taken every four months for detailed analysis
- Sterile sample bottles for microbiological analysis
- Clean sample bottles for chemical analysis
- Basic testing equipment for on-site measurement of temperature, pH, conductivity and active chlorine

Pump operators or whoever is responsible for groundwater monitoring should be issued with the relevant monitoring equipment including a dip meter and a record book. It is also very important that the person or people responsible for this exercise should be properly trained for this responsibility and be regularly evaluated to ensure a good quality data is collected.

A sanitation engineer and hydrogeologist should conduct a site inspection in order to assess the continued use of the nearby stream in order to recommended further actions required to ensure a acceptable water supply to the project area.

6 SANITATION DEVELOPMENT POTENTIAL EVALUATION

The development potential of the study area is assessed based on the intended construction of a Ventilated Improved Pit latrine (VIP) sanitation system.

The results of this geo-environmental investigation reveal that the study area can be divided into the following development potential zones: (Figure 3)

6.1 Zone A

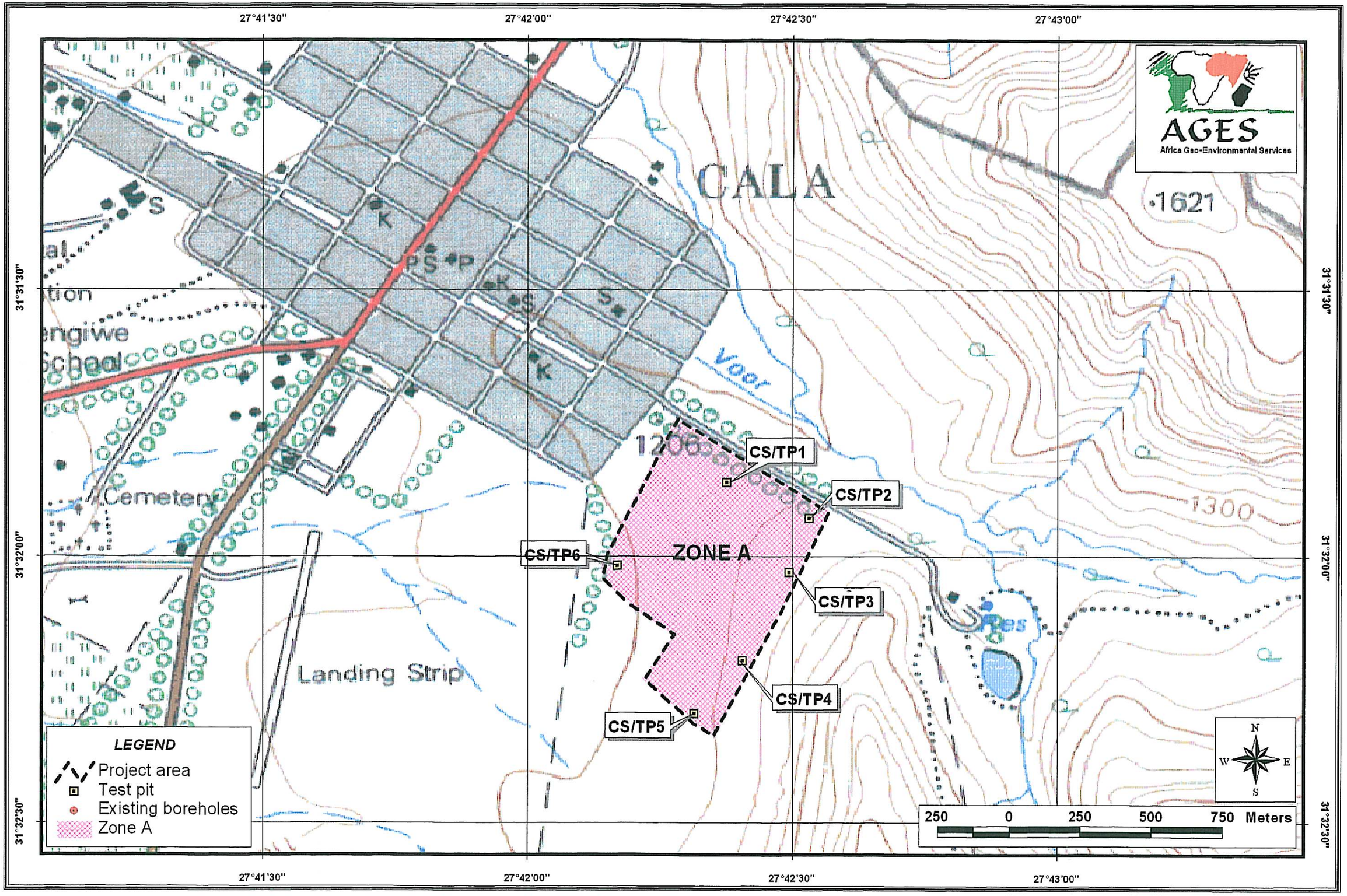
The areas defined as ***Zone A*** is deemed suitable for the development of a VIP sanitation system, provided due cognisance is given to the following:

- *a risk of excavatability problems at or near the surface in localised areas due to the presence of dolerite corestones and fractured dolerite bedrock with a very soft rock to soft rock consistency. This is expected over approximately 80 % of the entire zone*
- *an overall high risk of contamination of groundwater*
- *Permeability problems are foreseen throughout this zone due to the presence of slightly permeable to very slightly permeable soil material that may lead to the flooding of pit latrines.*
- *A risk of pollution of local aquifers in the areas targeted for future groundwater source development*
- *Areas around existing streams that are being utilised for drinking purposes or may possibly be utilised in future for drinking purposes*
- *The presence of slightly to extensively ferruginised material from which seasonal seepage could take place could be encountered during excavation – it is recommended that the specific pit be lined or partially lined to prevent the ingress of seepage into the pit and to prevent pollutants from seeping out of the pit.*
- *The following recommendations are made for this zone:*
    - *The use of power tools or a mechanical excavator may be required in cases where the required depth cannot be reached in the area, alternatively the pit latrine has to be elevated to obtain the required depth or wider shallow pits must be constructed.*
    - *It is recommended that a rudimentary sewerage system that does <u>not</u> rely on seepage for the disposal of liquids be installed. These generally include:*
        - *Ventilated Improved Pit latrines*
        - *Ventilated Improved Vault latrines*
        - *The EnviroLoo*
        - *Aquaprivis*
    - *The pit opening must be protected such that no surface water is allowed to enter the hole.*
    - *Localised rock outcrops have to be avoided by moving pit latrine sites.*
    - *Should extensively ferruginised material from which seepage takes place be encountered during excavation – it is recommended that the specific pit be lined to prevent the ingress of seepage into the pit or the ferruginised material will have to removed within a radius of at least 0.5 metres of the edges of the pit and replaced with an impermeable soil material.*
    - *No pit latrine should be excavated into fractured bedrock. If this is unavoidable, the specific pit should be lined to prevent the possible pollution of the deep aquifer. Alternatively pits should be constructed shallower and wider to allow for shallow bedrock conditions*

From the preliminary results it is recommended that ***<u>all latrines in this zone must be partially lined</u>*** with a

PROJECT: CALA SANITATION GEO-ENVIRONMENTAL INVESTIGATION

Figure 3: Project area zonation map



clay/slurry mixture or cement to prevent the movement of liquids to and from the pit due to the small basal buffer zone that is expected and the proximity to groundwater and surface water features. It is recommended that a system be implemented that does not rely on seepage for the disposal of liquids or sealed units be installed.

7 CONCLUSIONS AND RECOMMENDATIONS

- A detailed hydrogeological and engineering geological investigation was conducted for the Cala sanitation project in the Sakhisizwe local municipality of the Chris Hani district municipality; with the aim of determining and evaluating the hydrological and engineering geological characteristics of the project area for the construction of proposed VIP latrines
- The majority of the study area is underlain by a large dolerite sheet with the southwest portion of the area being underlain by alluvium. The dolerite and alluvium is expected to be underlain by mudstone and sandstone from the Burgersdorp Formation.
- A total of six boreholes were identified during the hydrocensus. The majority of these boreholes are still in working condition and boreholes are all privately owned.
- Due to the underlying geology of the project area in combination with the groundwater recharge potential from surrounding rivers and streams, the groundwater potential of the area is considered to by low to moderate.
- Static groundwater levels recorded in the study area vary between 3.6 and 12.7 mbgl as recorded at the boreholes mentioned in paragraph 4.1.4. This is deemed to represent the regional static groundwater level.
- The general groundwater flow direction is expected to be in a westerly to southwesterly direction, associated with the local topography.
- No water samples were taken at the existing boreholes. Groundwater quality data was obtained from boreholes that were tested by GeoCon during a previous investigation. The water quality of the study area is expected to be of Marginal to Poor drinking water quality.
- The project area was generally found to be covered by hillwash and alluvium composed of sandy silt and sandy clay. The transported material is underlain by slightly ferruginised residual dolerite composed of sandy clay with scattered to abundant ferricrete nodules. Residual dolerite composed of clayey sand and sandy clay with scattered dolerite boulders and corestones was encountered at the bottom of test pits CS/TP2 and CS/TP4 from a depth of 0.95 and 1.00 m. Detailed generalised soil profile descriptions are made in paragraph 4.2.2.
- It was generally possible to excavate test pits to a depth ranging between 0.80 and 1.30 m (mean 0.98 m) by utilising local labour. Excavation did not refuse in any of the test pits and it is expected that the required depth can be reached by utilizing motivated local labour for excavation of pits by hand. Alternatively the use of a TLB-type light mechanical excavator is recommended.
- Measured and calculated permeabilities of the four double ring infiltrometer tests and four soil samples range between 1.3 X 10^{-3} cm/sec and 5 X 10^{-7} cm/sec, which classifies the material as being ***slightly permeable*** to ***practically impermeable***.
- Although the aquifer is not currently being fully utilised - the value of the local aquifer is seen as moderate to low. A portion or even a large degree of the local community's water demand can be met from utilising local groundwater sources. Chemical water quality is expected to be of marginal to poor quality. Protection of the aquifer at abstraction points is therefore seen as important.
- Recommendations regarding the protection of local groundwater source are given in **chapter 5.**
- Recommendations regarding the delineation of the project area are given in **chapter 6.**

8 BIBLIOGRAPHY

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APPENDIX A

LIAISON DOCUMENTATION AND FIELD SURVEY DATA

CALA SANITATION ✓

SANITATION FIELD SURVEY FORM

VILLAGE NAME: Extension 13 DATE: 09/12/04

Boundaries of Ext 13: 31.53252 27.70983; 31.53506 27.70656; 31.53676 27.69976

Site description and information

GPS COORDINATE	S: 31.52973				E: 27.70462				
SITE GEOLOGY	Shale		Mudstone		Sandstone		Dolerite Sheet		
KEY GROUNDWATER POTENTIAL	High	X	Moderate	X	Low				
LIKELY IMPACTED AQUIFER	Primary	X	Shallow fractured		Deep fractured		Perched		
CURRENT WATER SOURCE	GW		SW		BW	X	Other		
TOPOGRAPHY	Ridge crest		Side slope		Pediment slope	X			
SLOPES	Steep		Moderate		Flat	X			
EXISTING SANITATION SYSTEM	No system		Rudimentary system	X	VIP		Other		
SOIL TYPE	Sand	X	Silt		Clay				
ESTIMATED SOIL THICKNESS	<2m		>2m	X					
% ROCK OUTCROP	< 20%		0.4		0.6		> 80%		
REPORTED WATERBORNE DESEASE	Yes		No	X	Type				
VILLAGE DENSITY	40-50 household								
HIGH LOAD AREAS	Informal settlement								

Boreholes and Springs information

Site Nr	GPS Coordinates S	GPS Coordinates E	Status IU/OP/DES	Pump type WM/HP/MI/S	Static Water Level
~~Stream/dam~~	31.53774	27.71326			
Bh 1	31.51643	27.68079			~~flat~~
Bh 2	31.51641	27.68075			- couldn't get access - owner not available
~~Bh 3~~					
~~Bh 4~~	~~31.51548~~	~~27.68035~~			
Bh 3	31.51595	27.67741			blocked

Private bh equipped with submersible pump. Currently in use. - Couldn't measure WL

Stream emanates from the Mt as a spring fed dam

NOTES

- Sources of water = Dam + Tsomo River
- 31.52427 28.67540 → Oxidation Ponds

Extension 13 community uses water from this ~~spring~~ Stream prior it is treated + prior it reaches the dam

Community representative

Name: Sonwabo Bushula Committee: Foreman-Sakhisizwe Municipality Signature: ~~[illegible]~~

AGES representative

Name: ~~[illegible]~~ Mfenya Signature:

AGES
Africa Geo-Environmental Services

CALA SANITATION

SANITATION FIELD SURVEY FORM

VILLAGE NAME: CALA DATE: 09/12/2004

Site description and information

GPS COORDINATE	S:				E:				
SITE GEOLOGY	Shale		Mudstone		Sandstone		Dolerite Sheet		
GROUNDWATER POTENTIAL	High		Moderate		Low				
AQUIFER IMPACTED	Primary		Shallow fractured		Deep fractured		Recent		
CURRENT WATER SOURCE	GW		SW		BW		Other		
TOPOGRAPHY	Ridge crest		Side slope		Pediment slope				
SLOPES	Steep		Moderate		Flat				
EXISTING SANITATION SYSTEM	No system		Rudimentary system		VIP		Other		
SOIL TYPE	Sand		Silt		Clay				
ESTIMATED SOIL THICKNESS	<2m		>2m						
% ROCK OUTCROP	< 20%		0.4		0.6		> 80%		
REPORTED WATERBORNE DESEASE	Yes		No		Type				
VILLAGE DENSITY									
HIGH LOAD AREAS									

Boreholes and Springs information

Site Nr	GPS Coordinates S	GPS Coordinates E	Status IU/OP/ DES	Pump type WM/HP/MI/S P	Static Water Level mbgl
Bh4	31.52034	27.67811	SP		
Bh5	31.51984	27.67818	OPEN HOLE		4.5
Bh6	31.52865	27.67563	SP		

Private bh – equipped with electric pump

→ equipped with electric submersible pump currently in use couldn't measure WL (Sampled)

NOTES:

Community representative

Name: DONWARD BUSHULA Committee: CHAIRMAN Signature:

AGES representative

Name: THOLEKA MAPANGA Signature:

AGES
Africa Geo-Environmental Services

LIAISON - LOCAL AUTHORITIES

S A GeoConsultants (Pty) Ltd
P/Bag X9063, Postnet 203
East London
Tel 043 - 726 2070

Date:	09/12/2004
District:	Sakhisizwe
Community:	Cala Town
Project:	Cala Sanitation

Objectives - GeoCon:	
Objectives - Community:	

Authorities:

Name:	Position:	Signature:	Date:	Remarks:
Sonwabo Bushula	Foreman Sakhisizwe Municipality		09/12/2004	Showed us the entire project area

APPENDIX B

DETAILED PUMP TESTING DATA

CALIBRATION TEST AND RECOVERY

BOREHOLE NO. :	T3371	PROJECT:	PROJECT NO: 2346-00-04
ALTERNATIVE NO. :		SITE NAME:	MANZANA
ALTERNATIVE NO. :		CLIENT:	CASER CONSTRUCTION

BOREHOLE DEPTH (mbdl):	72.64	CASING DEPTH (mbdl):	14.33	PUMP TYPE USED:	P100
DEPTH OF PUMP (mbdl):	39.75	CASING HEIGHT (magl):	0.30	OPERATOR:	ZOLANI - XOLANI
PUMP INLET DIAMETER (mm):	0.17	CASING ID (mm):		CONTRACTOR:	CASER CONSTRUCTION
STATIC WATER LEVEL (mbdl):	12.65	DATUM LEVEL (magl):	0.10	SUPERVISOR:	

DISCHARGE RATE 1

DATE: 12/01/01 TIME: 14H12

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1	1.70		1	
2	1.75		2	
3	1.89	0.62	3	
5	2.04		5	
7	2.15	0.61	7	
10	2.27		10	
15	2.48	0.61	15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	

EXISTING EQUIPMENT DETAIL:

TYPE OF RESERVOIR:

RESERVOIR SIZE:

RESERVOIR CONITION:

STAND HEIGHT (m):

DISCHARGE RATE 2

DATE: 12/01/01 TIME: 14H27

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1	2.62		1	
2	2.88	0.93	2	
3	3.04	1.34	3	
5	3.25		5	
7	3.53	1.33	7	
10	3.70		10	
15	4.02	1.34	15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	

EXISTING EQUIPMENT DETAIL:

TYPE OF ENCLOSURE:

MATERIAL OF ENCLOSURE:

CONDITION OF ENCLOSURE:

WATER METER MANUFACTURER:

WATER METER READING:

DISCHARGE RATE 3

DATE: 12/01/01 TIME: 14H42

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1	4.65		1	
2	5.00	2.51	2	
3	5.33	2.82	3	
5	6.44	3.54	5	
7	7.01		7	
10	7.67	3.53	10	
15			15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	

EXISTING EQUIPMENT DETAIL:

PRESSURE GAUGE MANUFACTURER:

GAUGE READING (KpA):

MONITORING FACILITY:

MAINTAINED:

DISCHARGE RATE 4

DATE: 12/01/01 TIME: 14H57

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1	10.06		1	
2	11.15	7.89	2	
3	11.73		3	
5	14.19	7.88	5	
7	15.47		7	
10	17.95	7.86	10	
15	20.22		15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	

EXISTING EQUIPMENT DETAIL:

PUMP TYPE:

PUMP MANUFACTURER:

PUMP SERIAL No:

PUMP PULLEY DIAMETER (mm):

PUMP INTAKE DEPTH (m):

PUMP RPM:

PUMP CONDITION:

DISCHARGE RATE 5

DATE: 12/01/01 TIME:

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	

EXISTING EQUIPMENT DETAIL:

TYPE OF POWER:

ENGINE MANUACTURER:

ENGINE MODEL:

ENGINE SERIAL No:

ENGINE PULLEY DIAMETER (mm):

POWER RATING (kW):

ENGINE CONDITION:

DISCHARGE RATE 6

DATE: TIME:

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1			1	18.43
2			2	17.00
3			3	15.18
5			5	13.77
7			7	11.15
10			10	10.56
15			15	9.98
			20	9.11
			30	5.27
			40	4.69
			50	4.08
			60	3.68
			70	
			80	
			90	
			100	
			110	
			120	
			150	
			180	
			210	
			240	
			300	
			420	
			480	
			540	
			600	
			660	

EXISTING EQUIPMENT DETAIL:

TYPE OF RISER:

CLASS OF RISER:

DIAMETER OF RISER (mm):

CONDITION OF RISER:

SHAFT DIAMETER (mm):

ELEMENT DIAMETER (mm):

ELEMENT STROKE (mm):

COMMENTS:

DID THE BOREHOLE PRODUCE ANY SILT / SAND / GRAVEL ?

::

STEPPED DISCHARGE TEST AND RECOVERY

BOREHOLE NO. :	T3371	PROJECT:	PROJECT NO: 2346-00-04
ALTERNATIVE NO. :	0	SITE NAME:	MANZANA
ALTERNATIVE NO. :	0	CLIENT:	CASER CONSTRUCTION

BOREHOLE DEPTH (mbdl):	72.64	CASING DEPTH (mbdl):	14.33	PUMP TYPE USED:	P100
DEPTH OF PUMP (mbdl):	39.75	CASING HEIGHT (magl):	0.30	OPERATOR:	ZOLANI - XOLANI
PUMP INLET DIAMETER (mm):	0.165	CASING ID (mm):	0.000	CONTRACTOR:	CASER CONSTRUCTION
STATIC WATER LEVEL (mbdl):	12.65	DATUM LEVEL (magl):	0.10		

DISCHARGE RATE 1

DATE: 13/01/01
TIME: 09H33

Time (min)	Drawdown (m)	Yield (l/s)
1	2.22	
2	2.45	
3	2.67	1.190
5	3.13	
7	3.39	1.580
10	3.70	
15	4.09	1.590
20	4.38	
30	4.85	1.590
40	5.09	
50	5.33	1.580
60	5.52	1.590
70		
80		
90		
100		
110		
120		

Average yield: 1.52

Recovery 1

Time (min)	Recovery 1 (m)
1	
2	
3	
5	
7	
10	
15	
20	
30	
40	
50	
60	
70	
80	
90	
100	
110	
120	
150	
180	
210	
(l/s)	

DISCHARGE RATE 2

DATE: 13/01/01
TIME:

Time (min)	Drawdown (m)	Yield (l/s)
1	5.89	
2	6.06	2.390
3	6.38	3.030
5	7.01	3.220
7	7.33	
10	7.95	3.210
15	8.60	
20	9.26	3.210
30	9.84	
40	10.42	3.200
50	11.11	
60	11.50	3.200
70		
80		
90		
100		
110		
120		

Average yield: 3.06571429

Recovery 2

Time (min)	Recovery 2 (m)
1	
2	
3	
5	
7	
10	
15	
20	
30	
40	
50	
60	
70	
80	
90	
100	
110	
120	
150	
180	
210	

DISCHARGE RATE 3

DATE: 13/01/01
TIME:

Time (min)	Drawdown (m)	Yield (l/s)
1	11.82	
2	12.36	4.560
3	12.87	
4	13.64	4.840
7	14.26	
10	14.69	4.830
15	16.00	
20	17.19	4.840
30	19.21	
40	20.54	4.820
50	22.05	
60	23.02	4.820
70		
80		
90		
100		
110		
120		

Average yield: 4.785

Recovery 3

Time (min)	Recovery 3 (m)
1	
2	
3	
5	
7	
10	
15	
20	
30	
40	
50	
60	
70	
80	
90	
100	
110	
120	
150	
180	
210	

DISCHARGE RATE 4

DATE: 13/01/01
TIME:

Time (min)	Drawdown (m)	Yield (l/s)
1	23.86	
2	24.89	6.31
3	25.53	8.46
5	26.53	
8	26.83	5.75
9	26.83	5.62
10	26.83	5.49

Average yield: 6.326

Recovery 4

Time (min)	Recovery 4 (m)
1	
2	
3	
5	
7	
10	
15	
20	
30	
40	
50	
60	
70	
80	
90	
100	
110	
120	
150	
180	
210	

DISCHARGE RATE 5

DATE: 13/01/01
TIME:

Time (min)	Drawdown (m)	(l/s)
1		
2		
3		
5		
7		
10		
15		
20		
30		
40		
50		
60		
70		
80		
90		
100		
110		
120		

Recovery 5

Time (min)	Recovery 5 (m)
1	
2	
3	
5	
7	
10	
15	
20	
30	
40	
50	
60	
70	
80	
90	
100	
110	
120	
150	
180	
210	
240	
300	
360	
420	
480	
540	
600	
660	
720	
780	

DISCHARGE RATE 6

DATE: 13/01/01
TIME:

Time (min)	Drawdown (m)	Yield (l/s)
1		
2		
3		
5		
7		
10		
15		
20		
30		
40		
50		
60		
70		
80		
90		
100		
110		
120		
150		
180		
210		
240		
300		
360		
420		
480		

Average yield:

Recovery

Time (min)	Recovery (m)
1	23.78
2	22.68
3	21.05
5	19.23
7	16.43
10	14.89
15	12.94
20	10.99
30	9.04
40	7.70
50	6.36
60	5.47
70	5.19
80	4.91
90	4.64
100	4.38
110	4.12
120	3.84
150	3.6
180	3.46
240	3.1

COMMENTS:

CONSTANT DISCHARGE TEST AND RECOVERY

BOREHOLE NO. :	T3371	PROJECT:	PROJECT NO: 2346-00-04	CLIENT:	CASER CONSTRUCTION
ALTERNATIVE NO. :	0	SITE NAME:	MANZANA		
DEPTH OF PUMP (mbdl):	39.75	PUMP TYPE USED:	P100	OPERATOR:	ZOLANI - XOLANI
INLET DIAMETER (mm):	0.165	EXISTING EQUIPMENT:	0	CONTRACTOR:	CASER CONSTRUCTION

TEST STARTED	DATE:	14/01/01	TEST COMPLETED	DATE:		TOTAL TIME - PUMPED (min):	1440
	TIME:	08H45		TIME:		TOTAL TIME-RECOVERY(min):	1440

TOTAL TEST TIME (min):	1440
AVERAGE YIELD (l/s):	2.68

DISCHARGE BOREHOLE

CASING HEIGHT (magl):	0.30
CASING DEPTH (mbdl):	14.33
CASING ID (mm):	0.00
BOREHOLE DEPTH (mbdl):	72.64
WATER LEVEL (mbdl):	12.65
DATUM LEVEL (magl):	0.10

Time (min)	Drawdown (m)	Yield (l/s)	Recovery (m)
1	2.61		23.82
2	2.97	1.25	22.84
3	3.24	2.00	22.09
5	4.16	2.84	20.64
7	5.06		19.64
10	6.16	2.85	18.40
15	7.15		16.63
20	8.02	2.84	15.29
30	8.98		13.19
40	9.55	2.84	11.64
60	10.50		9.81
90	12.24	2.83	8.13
120	13.66		7.45
150	15.60	2.82	6.69
180	16.46		6.33
210	17.41	2.82	6.06
240	18.29		5.80
300	19.72	2.83	5.38
360	21.10		4.97
420	22.46	2.82	4.82
480	22.52		4.63
540	22.74	2.83	4.48
600	22.86		4.31
720	23.24	2.82	4.14
840	23.74		3.95
960	24.22	2.81	3.81
1080	24.71		3.68
1200	25.26	2.82	3.56
1320	25.81		3.49
1440	25.98	2.81	3.38
1080			
1140			
1200			
1260			
1320			
1380			
1440			

OBSERVATION BOREHOLE 1

No. :	
DATUM LEVEL (magl):	
CASING DEPTH (mbdl):	
BOREHOLE DEPTH :	
WATER LEVEL:	
DISTANCE (m):	

Time (min)	Drawdown (m)	Recovery (m)
1		
2		
3		
5		
7		
10		
15		
20		
30		
40		
60		
90		
120		
150		
180		
210		
240		
300		
360		
420		
480		
540		
600		
720		
840		
960		
1080		
1200		
1320		
1440		
1800		
2280		
2880		

OBSERVATION BOREHOLE 2

No. :	
DATUM LEVEL (magl):	
CASING DEPTH (mbdl):	
BOREHOLE DEPTH :	
WATER LEVEL:	
DISTANCE (m):	

Time (min)	Drawdown (m)	Recovery (m)
1		
2		
3		
5		
7		
10		
15		
20		
30		
40		
60		
90		
120		
150		
180		
210		
240		
300		
360		
420		
480		
540		
600		
720		
840		
960		
1080		
1200		
1320		
1440		
1800		
2280		
2880		

OBSERVATION BOREHOLE 3

No. :	
DATUM LEVEL (magl):	
CASING DEPTH (mbdl):	
BOREHOLE DEPTH :	
WATER LEVEL:	
DISTANCE (m):	

Time (min)	Drawdown (m)	Recovery (m)
1		
2		
3		
5		
7		
10		
15		
20		
30		
40		
60		
90		
120		
150		
180		
210		
240		
300		
360		
420		
480		
540		
600		
720		
840		
960		
1080		
1200		
1320		
1440		
1800		
2280		
2880		

DISCHARGE BOREHOLE				OBSERVATION BOREHOLE 1			OBSERVATION BOREHOLE 2			OBSERVATION BOREHOLE 3		
Time (min)	Drawdown (m)	Yield (l/s)	Recovery (m)	Time (min)	Drawdown (m)	Recovery (m)	Time (min)	Drawdown (m)	Recovery (m)	Time (min)	Drawdown (m)	Recovery (m)
1500				1500			1500			1500		
1560				1560			1560			1560		
1620				1620			1620			1620		
1680				1680			1680			1680		
1740				1740			1740			1740		
1800				1800			1800			1800		
1860				1860			1860			1860		
1920				1920			1920			1920		
1980				1980			1980			1980		
2040				2040			2040			2040		
2100				2100			2100			2100		
2160				2160			2160			2160		
2220				2220			2220			2220		
2280				2280			2280			2280		
2340				2340			2340			2340		
2400				2400			2400			2400		
2460				2460			2460			2460		
2520				2520			2520			2520		
2580				2580			2580			2580		
2640				2640			2640			2640		
2700				2700			2700			2700		
2760				2760			2760			2760		
2820				2820			2820			2820		
2880				2880			2880			2880		

DESCRIPTION:	QUANTITY:	UNIT:
ESTABLISHMENT		Sum
INTER HOLE MOVE > 10 km		Km.
FROM: SITE NAME:		
BOREHOLE No:		
INTER HOLE MOVE < 10 km:		No.
REMOVAL AND RE-ERECTION OF PUMP HOUSE:		No.
REMOVAL OF EXISTING EQUIPMENT:		No.
RE-INSTALLATION OF EXISTING EQUIPMENT:		No.
WORK TIME RATE (REPAIRS):		Hour
STANDING TIME:		Hour
LATITUDE: LONGITUDE:		

SUMMARY

DESCRIPTION:	QUANTITY:	UNIT
STRAIGHTNESS TEST:		No.
VERTICALITY TEST:		No.
CASING DETECTION:		No.
STEEL BOREHOLE COVER:		No.
BOREHOLE MARKING:		No.
SITE CLEANING / FINISHING:		No.
REPORTING & DATA RECORDING:		No.
SLUG TEST:		No.
LAYFLAT (m):	50	m
BOREHOLE DEPTH AFTER TEST:	72.66	m
BOREHOLE WATERLEVEL AFTER TEST:	15.6	m

TEST DESCRIPTION STEP	1	2	3	4	5	6	TOTAL: (min)	(hrs)	RECOVERY: (m)	(min)
CALIBRATION TEST:										
TEST DURATION (Minutes)	15	15	10	15			55	0.92	3.68	60
TEST YIELD (l/s)	0.61	1.24	3.10	7.88			MAXIMUM (l/s)	7.9		
DRAWDOWN (m)	2.48	4.02	7.67	20.22			MAXIMUM (m)	20.2		
MULTI-RATE / STEP DRAWDOWN:										
TEST DURATION (Minutes)	60	60	60	10			190	3.17	3.10	240
TEST YIELD (l/s)	1.52	3.07	4.79	6.33			MAXIMUM (l/s)	6.3		
DRAWDOWN (m)	5.5	11.50	23.02	26.83			MAXIMUM (m)	26.8		

RECOVERY TEST			
TIME TOTAL (hrs):			29.00
Cal	Steps	CD	Total
60	240	1440	1740
DRAWDOWN TOTALS (CD):			
AVAILABLE	UTIL-ISED		%
27.1	25.98		95.87

CONSTANT DISCHARGE TEST	TEST DURATION (min)	(hrs)	TEST YIELD (l/s)	DRAWDOWN (m)	RECOVERY: (m)	%	(min)	(hrs)
	1440	24.00	2.68	25.98	3.38	86.99	1440	24.00

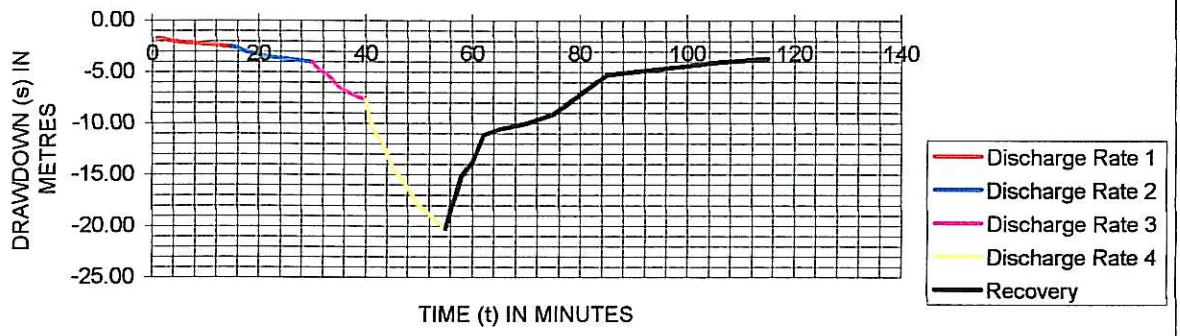
OBSERVATION BOREHOLES:	No. of boreholes	720 (min)	1440 (min)	2880 (min)	>2880 (min) nr.	Time	TOTAL: (min)	(hrs)
							0	0.00

::

BOREHOLE NUMBER: T3371

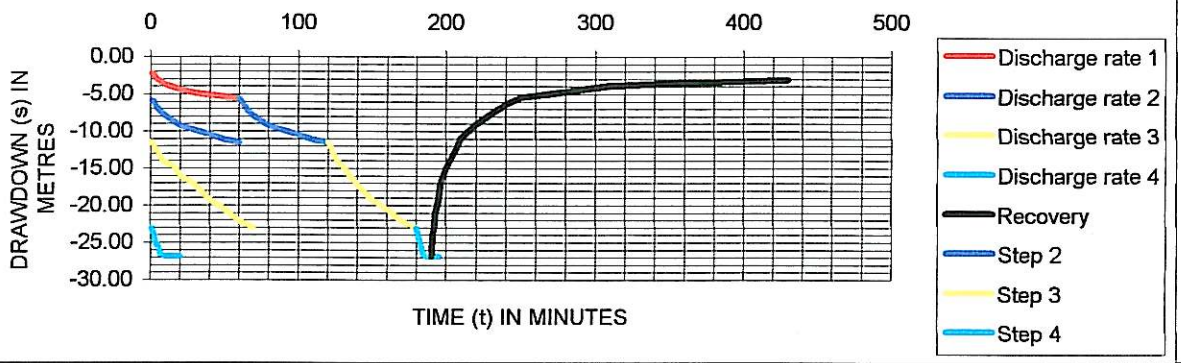
CALIBRATION TEST AND RECOVERY

Discharge 1:	0.61	Discharge 2:	1.24	Discharge 3:	3.10	Discharge 4:	7.88	Discharge 5:		Discharge 6:	
										Drawdown 1:	2.48
										Drawdown 2:	4.02
										Drawdown 3:	7.67
										Drawdown 4:	20.22
										Drawdown 5:	0.00
										Drawdown 6:	0.00
										Duration 1:	15
										Duration 2:	15
										Duration 3:	10
										Duration 4:	15
										Duration 5:	
										Duration 6:	
										Recovery (m):	3.68
										Recovery (min):	60

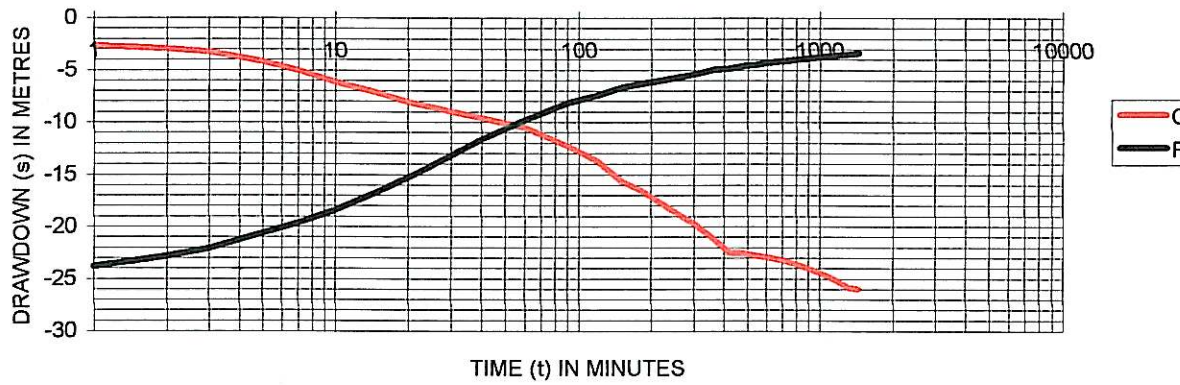


STEPPED DISCHARGE TEST AND RECOVERY

Discharge 1:	1.52	Discharge 2:	3.06571	Discharge 3:	4.785	Discharge 4:	6.326	Discharge 5:		Discharge 6:	
										Drawdown 1:	5.52
										Drawdown 2:	11.50
										Drawdown 3:	23.02
										Drawdown 4:	26.83
										Drawdown 5:	0.00
										Drawdown 6:	
										Duration 1:	60
										Duration 2:	60
										Duration 3:	60
										Duration 4:	10
										Duration 5:	
										Duration 6:	
										Recovery (m):	3.10
										Recovery (min):	240



CONSTANT DISCHARGE TEST AND RECOVERY



TEST INFORMATION

Date tested	14/01/01	Water level (mbgl)	12.65	Depth of pump (mbgl)		39.75
CD duration	1440	CD discharge rate	2.68	CD drawdown		25.98
Available drawdown (m)	27.1	% Recovery after CD	87	% after	1440	min

::

CALIBRATION TEST AND RECOVERY

BOREHOLE NO. :	T33709B	PROJECT:	PROJECT NO: 2346-00-04
ALTERNATIVE NO. :		SITE NAME:	NEW SITE
ALTERNATIVE NO. :		CLIENT:	CASER CONSTRUCTION

BOREHOLE DEPTH (mbdl):	59.95	CASING DEPTH (mbdl):	10.65	PUMP TYPE USED:	P100
DEPTH OF PUMP (mbdl):	56.75	CASING HEIGHT (magl):	0.30	OPERATOR:	ZOLANI-XOLANI
PUMP INLET DIAMETER (mm):	0.17	CASING ID (mm):		CONTRACTOR:	CASER CONSTRUCTION
STATIC WATER LEVEL (mbdl):	6.20	DATUM LEVEL (magl):	0.01	SUPERVISOR:	

DISCHARGE RATE 1

DATE: 17/01/01 TIME: 14H43

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1	0.27		1	
2	0.39	0.31	2	
3	0.47		3	
5	0.54	0.71	5	
7	0.63		7	
10	0.72	0.72	10	
15	0.80	0.72	15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	

EXISTING EQUIPMENT DETAIL:

TYPE OF RESERVOIR:

RESERVOIR SIZE:

RESERVOIR CONITION:

STAND HEIGHT (m):

DISCHARGE RATE 2

DATE: 17/01/01 TIME: 14H58

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1	0.91		1	
2	0.97	1.42	2	
3	1.02		3	
5	1.10	1.43	5	
7	1.23		7	
10	3.16	1.42	10	
15	4.72	1.42	15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	

EXISTING EQUIPMENT DETAIL:

TYPE OF ENCLOSURE:

MATERIAL OF ENCLOSURE:

CONDITION OF ENCLOSURE:

WATER METER MANUFACTURER:

WATER METER READING:

DISCHARGE RATE 3

DATE: 17/01/01 TIME:

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1	6.05		1	
2	7.09	2.1	2	
3	8.63	2.49	3	
5	10.21		5	
7	14.88	3.43	7	
10	19.35		10	
15	23.21	3.43	15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	

EXISTING EQUIPMENT DETAIL:

PRESSURE GAUGE MANUFACTURER:

GAUGE READING (KpA):

MONITORING FACILITY:

MAINTAINED:

DISCHARGE RATE 4

DATE: 17/01/01 TIME:

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1	24.81		1	
2	29.02	4.57	2	
3	33.42		3	
5	42.23	5.23	5	
7	49.72		7	
8	49.72		10	
10	49.72	3.43	15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	

EXISTING EQUIPMENT DETAIL:

PUMP TYPE:
WIND PUMP

PUMP MANUFACTURER:

PUMP SERIAL No:

PUMP PULLEY DIAMETER (mm):

PUMP INTAKE DEPTH (m):

PUMP RPM:

PUMP CONDITION:

DISCHARGE RATE 5

DATE: 17/01/01 TIME:

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	

EXISTING EQUIPMENT DETAIL:

TYPE OF POWER:

ENGINE MANUACTURER:

ENGINE MODEL:

ENGINE SERIAL No:

ENGINE PULLEY DIAMETER (mm):

POWER RATING (kW):

ENGINE CONDITION:

DISCHARGE RATE 6

DATE: TIME:

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1			1	37.06
2			2	27.70
3			3	21.86
5			5	12.54
7			7	6.72
10			10	3.66
15			15	1.55
			20	1.25
			30	1.04
			40	0.93
			50	0.80
			60	0.71
			70	
			80	
			90	
			100	
			110	
			120	
			150	
			180	
			210	
			240	
			300	
			420	
			480	
			540	
			600	
			660	

EXISTING EQUIPMENT DETAIL:

TYPE OF RISER:

CLASS OF RISER:

DIAMETER OF RISER (mm):

CONDITION OF RISER:

SHAFT DIAMETER (mm):

ELEMENT DIAMETER (mm):

ELEMENT STROKE (mm):

COMMENTS:

DID THE BOREHOLE PRODUCE ANY SILT / SAND / GRAVEL ? YES

::

STEPPED DISCHARGE TEST AND RECOVERY

BOREHOLE NO. :	T33709B	PROJECT:	PROJECT NO: 2346-00-04
ALTERNATIVE NO. :	0	SITE NAME:	NEW SITE
ALTERNATIVE NO. :	0	CLIENT:	CASER CONSTRUCTION

BOREHOLE DEPTH (mbdl):	59.95	CASING DEPTH (mbdl):	10.65	PUMP TYPE USED:	P100
DEPTH OF PUMP (mbdl):	56.75	CASING HEIGHT (magl):	0.30	OPERATOR:	ZOLANI-XOLANI
PUMP INLET DIAMETER (mm):	0.165	CASING ID (mm):	0.000	CONTRACTOR:	CASER CONSTRUCTION
STATIC WATER LEVEL (mbdl):	6.20	DATUM LEVEL (magl):	0.01		

DISCHARGE RATE 1		
DATE:	18/01/01	
TIME:	06H15	
Time	Drawdown	Yield
(min)	(m)	(l/s)
1	0.18	
2	0.35	0.810
3	0.47	0.790
5	0.55	0.690
7	0.60	
10	0.66	0.680
15	0.72	
20	0.77	0.680
30	0.83	
40	0.90	0.690
50	0.96	
60	1.01	0.680
70		
80		
90		
100		
110		
120		
Average yield: 0.71714286		

Time	Recovery 1
(min)	(m)
1	
2	
3	
5	
7	
10	
15	
20	
30	
40	
50	
60	
70	
80	
90	
100	
110	
120	
150	
180	
210	
(l/s)	

DISCHARGE RATE 2		
DATE:	18/01/01	
TIME:	07H15	
Time	Drawdown	Yield
(min)	(m)	(l/s)
1	1.09	
2	1.14	1.160
3	1.21	1.300
5	1.31	1.370
7	1.43	
10	2.95	1.380
15	3.35	
20	3.56	1.370
30	3.71	
40	4.09	1.380
50	4.31	
60	4.53	1.370
70		
80		
90		
100		
110		
120		
Average yield: 1.33285714		

Time	Recovery 2
(min)	(m)
1	
2	
3	
5	
7	
10	
15	
20	
30	
40	
50	
60	
70	
80	
90	
100	
110	
120	
150	
180	
210	

DISCHARGE RATE 3		
DATE:	18/01/01	
TIME:	08H15	
Time	Drawdown	Yield
(min)	(m)	(l/s)
1	4.96	
2	5.58	2.020
3	6.22	
4	6.86	2.030
7	7.21	
10	7.45	2.020
15	7.91	
20	8.64	2.010
30	9.23	
40	9.41	2.020
50	9.61	
60	9.69	2.010
70		
80		
90		
100		
110		
120		
Average yield: 2.01833333		

Time	Recovery 3
(min)	(m)
1	
2	
3	
5	
7	
10	
15	
20	
30	
40	
50	
60	
70	
80	
90	
100	
110	
120	
150	
180	
210	

DISCHARGE RATE 4		
DATE:	18/01/01	
TIME:	09H15	
Time	Drawdown	Yield
(min)	(m)	(l/s)
1	11.38	
2	12.17	2.66
3	12.69	
5	13.56	2.77
7	14.88	
10	16.40	2.78
15	17.89	
20	19.07	2.76
30	20.17	
40	21.36	2.75
50	22.40	
60	23.20	2.76
70		
80		
90		
100		
110		
120		
Average yield: 2.74666667		

Time	Recovery 4
(min)	(m)
1	
2	
3	
5	
7	
10	
15	
20	
30	
40	
50	
60	
70	
80	
90	
100	
110	
120	
150	
180	
210	

DISCHARGE RATE 5		
DATE:	18/01/01	
TIME:		
Time	Drawdown	.
(min)	(m)	(l/s)
1		
2		
3		
5		
7		
10		
15		
20		
30		
40		
50		
60		
70		
80		
90		
100		
110		
120		

Time	Recovery 5
(min)	(m)
1	
2	
3	
5	
7	
10	
15	
20	
30	
40	
50	
60	
70	
80	
90	
100	
110	
120	
150	
180	
210	
240	
300	
360	
420	
480	
540	
600	
660	
720	
780	

DISCHARGE RATE 6		
DATE:	18/01/01	
TIME:		
Time	Drawdown	Yield
(min)	(m)	(l/s)
1		
2		
3		
5		
7		
10		
15		
20		
30		
40		
50		
60		
70		
80		
90		
100		
110		
120		
150		
180		
210		
240		
300		
360		
420		
480		
Average yield:		

Time	Recovery
(min)	(m)
1	17.38
2	12.56
3	9.50
5	6.83
7	8.41
10	3.81
15	2.79
20	2.51
30	1.81
40	1.63
50	1.31
60	1.22
70	1.15
80	1.08
90	1.04
100	0.99
110	0.92
120	0.86
150	0.76
180	0.65
240	0.43
240	
300	
360	
420	
480	
540	
600	
660	
720	

COMMENTS:

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CONSTANT DISCHARGE TEST AND RECOVERY

BOREHOLE NO. :	T33709B	PROJECT:	PROJECT NO: 2346-00-04	CLIENT:	CASER CONSTRUCTION
ALTERNATIVE NO. :	0	SITE NAME:	NEW SITE		
DEPTH OF PUMP (mbdl):	56.75	PUMP TYPE USED:	P100	OPERATOR:	ZOLANI-XOLANI
INLET DIAMETER (mm):	0.165	EXISTING EQUIPMENT:	WIND PUMP	CONTRACTOR:	CASER CONSTRUCTION

TEST STARTED	DATE: 19/01/01	TEST COMPLETED	DATE:	TOTAL TIME - PUMPED (min):	2880	TOTAL TEST TIME (min):	2880
	TIME: 09h00		TIME:	TOTAL TIME-RECOVERY(min):	2880	AVERAGE YIELD (l/s):	1.69

DISCHARGE BOREHOLE		OBSERVATION BOREHOLE 1		OBSERVATION BOREHOLE 2		OBSERVATION BOREHOLE 3	
CASING HEIGHT (magl):	0.30	No. :		No. :		No. :	
CASING DEPTH (mbdl):	10.65	DATUM LEVEL (magl):		DATUM LEVEL (magl):		DATUM LEVEL (magl):	
CASING ID (mm):	0.00	CASING DEPTH (mbdl):		CASING DEPTH (mbdl):		CASING DEPTH (mbdl):	
BOREHOLE DEPTH (mbdl):	59.95	BOREHOLE DEPTH :		BOREHOLE DEPTH :		BOREHOLE DEPTH :	
WATER LEVEL (mbdl):	6.20	WATER LEVEL:		WATER LEVEL:		WATER LEVEL:	
DATUM LEVEL (magl):	0.01	DISTANCE (m):		DISTANCE (m):		DISTANCE (m):	

Time (min)	Drawdown (m)	Yield (l/s)	Recovery (m)	Time (min)	Drawdown (m)	Recovery (m)	Time (min)	Drawdown (m)	Recovery (m)	Time (min)	Drawdown (m)	Recovery (m)
1	0.39		17.04	1			1			1		
2	0.53	1.29	13.76	2			2			2		
3	0.67	1.56	12.36	3			3			3		
5	0.80	1.73	10.30	5			5			5		
7	0.92		9.30	7			7			7		
10	1.09	1.74	8.43	10			10			10		
15	1.49		7.81	15			15			15		
20	4.20	1.73	7.18	20			20			20		
30	4.85		6.42	30			30			30		
40	5.66	1.73	6.02	40			40			40		
60	6.35		5.32	60			60			60		
90	7.50	1.72	4.63	90			90			90		
120	8.05		3.96	120			120			120		
150	8.62	1.73	3.31	150			150			150		
180	9.10		2.68	180			180			180		
210	9.57	1.73	2.44	210			210			210		
240	10.04		2.16	240			240			240		
300	10.58	1.72	1.67	300			300			300		
360	11.13		1.39	360			360			360		
420	11.66	1.72	1.24	420			420			420		
480	12.20		1.16	480			480			480		
540	12.57	1.71	1.05	540			540			540		
600	12.94		0.93	600			600			600		
720	14.54	1.72	0.87	720			720			720		
840	14.87		0.74	840			840			840		
960	15.18	1.71	0.63	960			960			960		
1080	15.47		0.57	1080			1080			1080		
1200	15.74	1.72	0.51	1200			1200			1200		
1320	16.33		0.45	1320			1320			1320		
1440	16.79	1.72	0.38	1440			1440			1440		
1800	18.21		0.28	1800			1800			1800		
2280	20.60	1.71	0.19	2280			2280			2280		
2880	22.89	1.71	0.08	2880			2880			2880		
1260												
1320												
1380												
1440												

DISCHARGE BOREHOLE				OBSERVATION BOREHOLE 1			OBSERVATION BOREHOLE 2			OBSERVATION BOREHOLE 3		
Time (min)	Drawdown (m)	Yield (l/s)	Recovery (m)	Time (min)	Drawdown (m)	Recovery (m)	Time (min)	Drawdown (m)	Recovery (m)	Time (min)	Drawdown (m)	Recovery (m)
1500				1500			1500			1500		
1560				1560			1560			1560		
1620				1620			1620			1620		
1680				1680			1680			1680		
1740				1740			1740			1740		
1800				1800			1800			1800		
1860				1860			1860			1860		
1920				1920			1920			1920		
1980				1980			1980			1980		
2040				2040			2040			2040		
2100				2100			2100			2100		
2160				2160			2160			2160		
2220				2220			2220			2220		
2280				2280			2280			2280		
2340				2340			2340			2340		
2400				2400			2400			2400		
2460				2460			2460			2460		
2520				2520			2520			2520		
2580				2580			2580			2580		
2640				2640			2640			2640		
2700				2700			2700			2700		
2760				2760			2760			2760		
2820				2820			2820			2820		
2880				2880			2880			2880		

DESCRIPTION:	QUANTITY:	UNIT:
ESTABLISHMENT		Sum
INTER HOLE MOVE > 10 km		Km.
FROM: SITE NAME:		
BOREHOLE No:		
INTER HOLE MOVE < 10 km:		No.
REMOVAL AND RE-ERECTION OF PUMP HOUSE:		No.
REMOVAL OF EXISTING EQUIPMENT:		No.
RE-INSTALLATION OF EXISTING EQUIPMENT:		No.
WORK TIME RATE (REPAIRS):		Hour
STANDING TIME:		Hour
LATITUDE: LONGITUDE:		

SUMMARY

DESCRIPTION:	QUANTITY:	UNIT
STRAIGHTNESS TEST:		No.
VERTICALITY TEST:		No.
CASING DETECTION:		No.
STEEL BOREHOLE COVER:		No.
BOREHOLE MARKING:		No.
SITE CLEANING / FINISHING:		No.
REPORTING & DATA RECORDING:		No.
SLUG TEST:		No.
LAYFLAT (m):		m
BOREHOLE DEPTH AFTER TEST:		m
BOREHOLE WATERLEVEL AFTER TEST:		m

TEST DESCRIPTION STEP	1	2	3	4	5	6	TOTAL: (min)	(hrs)	RECOVERY: (m)	(min)
CALIBRATION TEST:										
TEST DURATION (Minutes)	15	15	15	10			55	0.92	0.71	60
TEST YIELD (l/s)	0.62	1.42	2.86	4.41			MAXIMUM (l/s)	4.4		
DRAWDOWN (m)	0.80	4.72	23.21	49.72			MAXIMUM (m)	49.7		
MULTI-RATE / STEP DRAWDOWN:										
TEST DURATION (Minutes)	60	60	60	60			240	4.00	0.43	240
TEST YIELD (l/s)	0.72	1.33	2.02	2.75			MAXIMUM (l/s)	2.7		
DRAWDOWN (m)	1.0	4.53	9.69	23.20			MAXIMUM (m)	23.2		

RECOVERY TEST			
TIME TOTAL (hrs):			53.00
Cal	Steps	CD	Total
60	240	2880	3180
DRAWDOWN TOTALS (CD):			
AVAILABLE	UTIL-ISED	%	
50.6	22.89	45.28	

CONSTANT DISCHARGE TEST	TEST DURATION (min)	(hrs)	TEST YIELD (l/s)	DRAWDOWN (m)	RECOVERY: (m)	%	(min)	(hrs)
	2880	48.00	1.69	22.89	0.08	99.65	2880	48.00

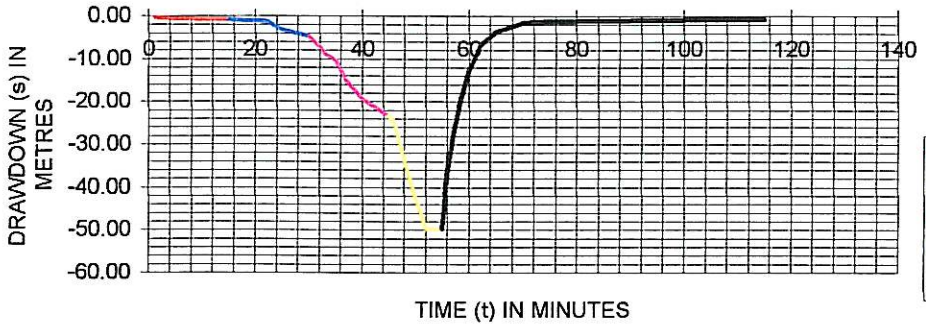
OBSERVATION BOREHOLES:	No. of boreholes	720 (min)	1440 (min)	2880 (min)	>2880 (min) nr.	Time	TOTAL: (min)	(hrs)
							0	0.00

::

BOREHOLE NUMBER: T33709B

CALIBRATION TEST AND RECOVERY

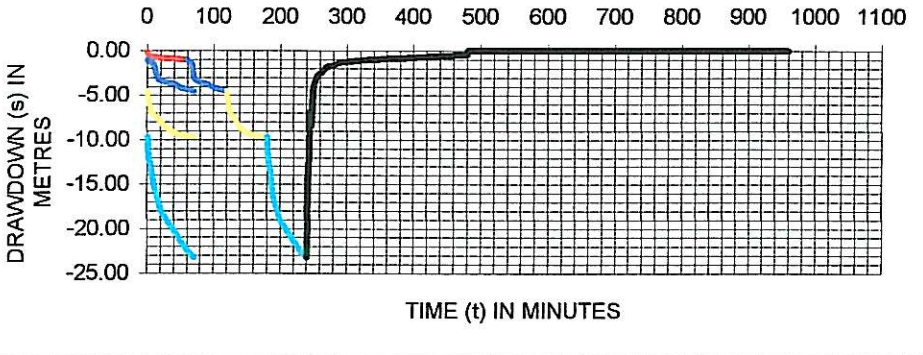
Discharge 1:	0.62	Discharge 2:	1.42	Discharge 3:	2.86	Discharge 4:	4.41	Discharge 5:		Discharge 6:	



Drawdown 1:	0.80
Drawdown 2:	4.72
Drawdown 3:	23.21
Drawdown 4:	49.72
Drawdown 5:	0.00
Drawdown 6:	0.00
Duration 1:	15
Duration 2:	15
Duration 3:	15
Duration 4:	10
Duration 5:	
Duration 6:	
Recovery (m):	0.71
Recovery (min):	60

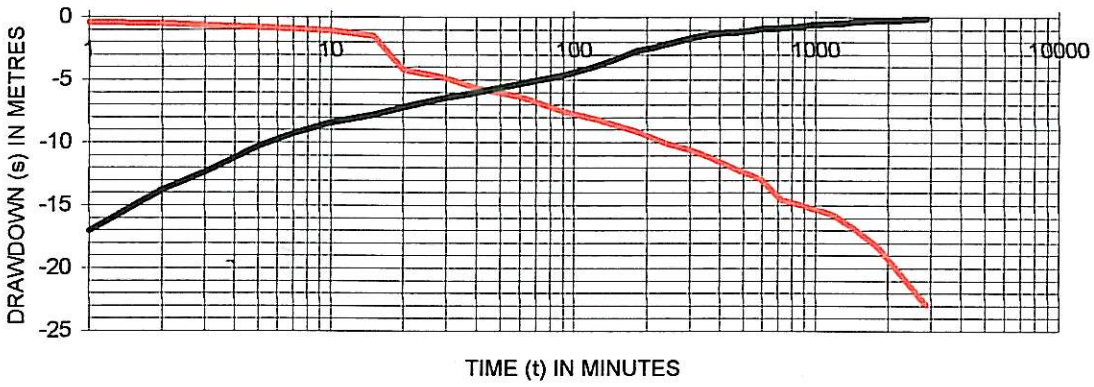
STEPPED DISCHARGE TEST AND RECOVERY

Discharge 1:	0.71714	Discharge 2:	1.33286	Discharge 3:	2.01833	Discharge 4:	2.74667	Discharge 5:		Discharge 6:	



Drawdown 1:	1.01
Drawdown 2:	4.53
Drawdown 3:	9.69
Drawdown 4:	23.20
Drawdown 5:	0.00
Drawdown 6:	
Duration 1:	60
Duration 2:	60
Duration 3:	60
Duration 4:	60
Duration 5:	
Duration 6:	
Recovery (m):	0.43
Recovery (min):	240

CONSTANT DISCHARGE TEST AND RECOVERY



TEST INFORMATION

Date tested	19/01/01	Water level (mbgl)	6.20	Depth of pump (mbgl)		56.75
CD duration	2880	CD discharge rate	1.69	CD drawdown		22.89
Available drawdown (m)	50.55	% Recovery after CD	99.65	% after	2880	min

::

CALIBRATION TEST AND RECOVERY

BOREHOLE NO. :	T33703	PROJECT:	
ALTERNATIVE NO. :		SITE NAME:	TGENGIWE
ALTERNATIVE NO. :		CLIENT:	CASER CONSTRUCTION

BOREHOLE DEPTH (mbdl):	50.36	CASING DEPTH (mbdl):	5.78	PUMP TYPE USED:	P100
DEPTH OF PUMP (mbdl):	45.50	CASING HEIGHT (magl):	0.30	OPERATOR:	
PUMP INLET DIAMETER (mm):	0.165	CASING ID (mm):		CONTRACTOR:	CASER CONSTRUCTION
STATIC WATER LEVEL (mbdl):	3.63	DATUM LEVEL (magl):	0.01	SUPERVISOR:	

DISCHARGE RATE 1

DATE: 01/01/2011 TIME: 15H06

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1	2.95		1	
2	4.44		2	
3	7.20	1.49	3	
5	13.60	1.49	5	
7	30.01		7	
10	30.75	1.48	10	
15	40.32	0.93	15	
17	40.32	0.89		
19	40.32	0.84		

EXISTING EQUIPMENT DETAIL:

TYPE OF RESERVOIR:

RESERVOIR SIZE:

RESERVOIR CONITION:

STAND HEIGHT (m):

DISCHARGE RATE 2

DATE: 40544 TIME:

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	

EXISTING EQUIPMENT DETAIL:

TYPE OF ENCLOSURE:

MATERIAL OF ENCLOSURE:

CONDITION OF ENCLOSURE:

WATER METER MANUFACTURER:

WATER METER READING:

DISCHARGE RATE 3

DATE: 40544 TIME:

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	

EXISTING EQUIPMENT DETAIL:

PRESSURE GAUGE MANUFACTURER:

GAUGE READING (KpA):

MONITORING FACILITY:

MAINTAINED:

DISCHARGE RATE 4

DATE: 40544 TIME:

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	

EXISTING EQUIPMENT DETAIL:

PUMP TYPE:

PUMP MANUFACTURER:

PUMP SERIAL No:

PUMP PULLEY DIAMETER (mm):

PUMP INTAKE DEPTH (m):

PUMP RPM:

PUMP CONDITION:

DISCHARGE RATE 5

DATE: 40544 TIME:

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	

EXISTING EQUIPMENT DETAIL:

TYPE OF POWER:

ENGINE MANUACTURER:

ENGINE MODEL:

ENGINE SERIAL No:

ENGINE PULLEY DIAMETER (mm):

POWER RATING (kW):

ENGINE CONDITION:

DISCHARGE RATE 6

DATE: TIME:

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1			1	39.93
2			2	37.55
3			3	36.47
5			5	34.19
7			7	31.94
10			10	30.14
15			15	27.06
			20	23.24
			30	18.20
			40	13.70
			50	10.41
			60	8.32
			70	
			80	
			90	
			100	
			110	
			120	
			150	
			180	
			210	
			240	
			300	
			420	
			480	
			540	
			600	
			660	

EXISTING EQUIPMENT DETAIL:

TYPE OF RISER:

CLASS OF RISER:

DIAMETER OF RISER (mm):

CONDITION OF RISER:

SHAFT DIAMETER (mm):

ELEMENT DIAMETER (mm):

ELEMENT STROKE (mm):

COMMENTS:

DID THE BOREHOLE PRODUCE ANY SILT / SAND / GRAVEL ?

::

STEPPED DISCHARGE TEST AND RECOVERY

BOREHOLE NO. :	T33703	PROJECT:	0
ALTERNATIVE NO. :	0	SITE NAME:	TGENGIWE
ALTERNATIVE NO. :	0	CLIENT:	CASER CONSTRUCTION

BOREHOLE DEPTH (mbdl):	50.36	CASING DEPTH (mbdl):	5.78	PUMP TYPE USED:	P100
DEPTH OF PUMP (mbdl):	45.50	CASING HEIGHT (magl):	0.30	OPERATOR:	0
PUMP INLET DIAMETER (mm):	0.165	CASING ID (mm):	0.000	CONTRACTOR:	CASER CONSTRUCTION
STATIC WATER LEVEL (mbdl):	3.63	DATUM LEVEL (magl):	0.01		

DISCHARGE RATE 1			Time	*Recovery 1*
DATE:	12/01/01		(min)	(m)
TIME:	08H55		1	
Time	Drawdown	Yield	2	
(min)	(m)	(l/s)	3	
1	2.23		5	
2	2.46		7	
3	3.25	0.190	10	
5	4.01	0.200	15	
7	4.50		20	
10	6.01	0.210	30	
15	7.60		40	
20	8.74	0.210	50	
30	12.61		60	
40	13.64	0.200	70	
50	13.79		80	
60	13.87	0.210	90	
70			100	
80			110	
90			120	
100			150	
110			180	
120			210	
Average yield:	0.20333333	(l/s)		

DISCHARGE RATE 2			Time	*Recovery 2*
DATE:	12/01/01		(min)	(m)
TIME:	09H55		1	
Time	Drawdown	Yield	2	
(min)	(m)	(l/s)	3	
1	14.51		5	
2	13.26	0.330	7	
3	16.10	0.340	10	
5	16.37		15	
7	17.84	0.350	20	
10	19.17		30	
15	21.61	0.380	40	
20	23.03		50	
30	25.81	0.340	60	
40	26.63		70	
50	29.01	0.340	80	
60	30.31		90	
70			100	
80			110	
90			120	
100			150	
110			180	
120			210	
Average yield:	0.34666667			

DISCHARGE RATE 3			Time	*Recovery 3*
DATE:	12/01/01		(min)	(m)
TIME:	10H55		1	
Time	Drawdown	Yield	2	
(min)	(m)	(l/s)	3	
1	31.10		5	
2	31.89	0.500	7	
3	33.05		10	
4	34.87	0.510	15	
7	37.40		20	
10	38.44	0.510	30	
15	39.60		40	
20	40.10	0.500	50	
23	40.32	0.390	60	
25	40.32	0.290	70	
27	40.32	0.190	80	
			90	
			100	
			110	
			120	
			150	
			180	
			210	
Average yield:	0.41285714			

DISCHARGE RATE 4			Time	*Recovery 4*
DATE:	12/01/01		(min)	(m)
TIME:			1	
Time	Drawdown	Yield	2	
(min)	(m)	(l/s)	3	
1			5	
2			7	
3			10	
5			15	
7			20	
10			30	
15			40	
20			50	
30			60	
40			70	
50			80	
60			90	
70			100	
80			110	
90			120	
100			150	
110			180	
120			210	
Average yield:	#DIV/0!			

DISCHARGE RATE 5			Time	*Recovery 5*
DATE:	12/01/01		(min)	(m)
TIME:			1	
Time	Drawdown	.	2	
(min)	(m)	(l/s)	3	
1			5	
2			7	
3			10	
5			15	
7			20	
10			30	
15			40	
20			50	
30			60	
40			70	
50			80	
60			90	
70			100	
80			110	
90			120	
100			150	
110			180	
120			210	
			240	
			300	
			360	
			420	
			480	
			540	
			600	
			660	
			720	
			780	

DISCHARGE RATE 6			Time	*Recovery*
DATE:	12/01/01		(min)	(m)
TIME:			1	37.49
Time	Drawdown	Yield	2	36.87
(min)	(m)	(l/s)	3	35.70
1			5	33.58
2			7	32.18
3			10	30.08
5			15	27.34
7			20	24.30
10			30	21.10
15			40	15.94
20			50	12.01
30			60	9.24
40			70	7.01
50			80	6.10
60			90	6.04
70			100	5.84
80			110	5.57
90			120	5.37
100			150	4.5
110			180	3.49
120			240	3.09
150				
180				
210				
240				
300				
360				
420				
480				
Average yield:			720	

COMMENTS:

::

CONSTANT DISCHARGE TEST AND RECOVERY

BOREHOLE NO. :	T33703	PROJECT:	0	CLIENT:	CASER CONSTRUCTION
ALTERNATIVE NO. :	0	SITE NAME:	TGENGIWE		
DEPTH OF PUMP (mbdl):	45.50	PUMP TYPE USED:	P100	OPERATOR:	0
INLET DIAMETER (mm):	0.165	EXISTING EQUIPMENT:	0	CONTRACTOR:	CASER CONSTRUCTION

TEST STARTED	DATE:	13/01/01	TEST COMPLETED	DATE:		TOTAL TIME - PUMPED (min):	720
	TIME:	07H36		TIME:		TOTAL TIME-RECOVERY(min):	720

TOTAL TEST TIME (min):	720		
AVERAGE YIELD (l/s):	0.26		

DISCHARGE BOREHOLE

CASING HEIGHT (magl):	0.30
CASING DEPTH (mbdl):	5.78
CASING ID (mm):	0.00
BOREHOLE DEPTH (mbdl):	50.36
WATER LEVEL (mbdl):	3.63
DATUM LEVEL (magl):	0.01

Time (min)	Drawdown (m)	Yield (l/s)	Recovery (m)
1	2.23		21.70
2	2.52		21.37
3	2.82		20.10
5	3.62	0.17	19.12
7	3.91	0.21	18.34
10	4.40	0.20	17.70
15	5.59		15.94
20	7.49	0.21	13.41
30	8.87	0.80	11.10
40	9.67		9.20
60	11.30	0.20	8.40
90	12.32		5.01
120	13.00	0.28	4.94
150	13.70		4.75
180	14.67	0.21	4.54
210	15.10		4.33
240	16.36	0.21	4.10
300	16.42		4.00
360	16.96	0.20	3.71
420	17.39		3.65
480	18.01	0.21	3.54
540	20.24		3.49
600	22.10	0.22	3.37
720	27.12	0.20	3.01

OBSERVATION BOREHOLE 1

No. :	
DATUM LEVEL (magl):	
CASING DEPTH (mbdl):	
BOREHOLE DEPTH :	
WATER LEVEL:	
DISTANCE (m):	

Time (min)	Drawdown (m)	Recovery (m)
1		
2		
3		
5		
7		
10		
15		
20		
30		
40		
60		
90		
120		
150		
180		
210		
240		
300		
360		
420		
480		
540		
600		
720		
840		
960		
1080		
1200		
1320		
1440		
1800		
2280		
2880		

OBSERVATION BOREHOLE 2

No. :	
DATUM LEVEL (magl):	
CASING DEPTH (mbdl):	
BOREHOLE DEPTH :	
WATER LEVEL:	
DISTANCE (m):	

Time (min)	Drawdown (m)	Recovery (m)
1		
2		
3		
5		
7		
10		
15		
20		
30		
40		
60		
90		
120		
150		
180		
210		
240		
300		
360		
420		
480		
540		
600		
720		
840		
960		
1080		
1200		
1320		
1440		
1800		
2280		
2880		

OBSERVATION BOREHOLE 3

No. :	
DATUM LEVEL (magl):	
CASING DEPTH (mbdl):	
BOREHOLE DEPTH :	
WATER LEVEL:	
DISTANCE (m):	

Time (min)	Drawdown (m)	Recovery (m)
1		
2		
3		
5		
7		
10		
15		
20		
30		
40		
60		
90		
120		
150		
180		
210		
240		
300		
360		
420		
480		
540		
600		
720		
840		
960		
1080		
1200		
1320		
1440		
1800		
2280		
2880		

DISCHARGE BOREHOLE				OBSERVATION BOREHOLE 1			OBSERVATION BOREHOLE 2			OBSERVATION BOREHOLE 3		
Time	Drawdown	Yield	Recovery	Time	Drawdown	Recovery	Time	Drawdown	Recovery	Time	Drawdown	Recovery
(min)	(m)	(l/s)	(m)	(min)	(m)	(m)	(min)	(m)	(m)	(min)	(m)	(m)
1500				1500			1500			1500		
1560				1560			1560			1560		
1620				1620			1620			1620		
1680				1680			1680			1680		
1740				1740			1740			1740		
1800				1800			1800			1800		
1860				1860			1860			1860		
1920				1920			1920			1920		
1980				1980			1980			1980		
2040				2040			2040			2040		
2100				2100			2100			2100		
2160				2160			2160			2160		
2220				2220			2220			2220		
2280				2280			2280			2280		
2340				2340			2340			2340		
2400				2400			2400			2400		
2460				2460			2460			2460		
2520				2520			2520			2520		
2580				2580			2580			2580		
2640				2640			2640			2640		
2700				2700			2700			2700		
2760				2760			2760			2760		
2820				2820			2820			2820		
2880				2880			2880			2880		

DESCRIPTION:	QUANTITY:	UNIT:
ESTABLISHMENT		Sum
INTER HOLE MOVE > 10 km		Km.
FROM: SITE NAME:		
BOREHOLE No:		
INTER HOLE MOVE < 10 km:		No.
REMOVAL AND RE-ERECTION OF PUMP HOUSE:		No.
REMOVAL OF EXISTING EQUIPMENT:		No.
RE-INSTALLATION OF EXISTING EQUIPMENT:		No.
WORK TIME RATE (REPAIRS):		Hour
STANDING TIME:		Hour
LATITUDE: LONGITUDE:		

SUMMARY

DESCRIPTION:	QUANTITY:	UNIT
STRAIGHTNESS TEST:		No.
VERTICALITY TEST:		No.
CASING DETECTION:		No.
STEEL BOREHOLE COVER:		No.
BOREHOLE MARKING:		No.
SITE CLEANING / FINISHING:		No.
REPORTING & DATA RECORDING:		No.
SLUG TEST:		No.
LAYFLAT (m):	50	m
BOREHOLE DEPTH AFTER TEST:	50.35	m
BOREHOLE WATERLEVEL AFTER TEST:	3.06	m

TEST DESCRIPTION	STEP	1	2	3	4	5	6	TOTAL: (min)	(hrs)	RECOVERY: (m)	(min)
CALIBRATION TEST:											
TEST DURATION (Minutes)		19						19	0.32	8.32	60
TEST YIELD (l/s)		1.35						MAXIMUM (l/s)	1.3		
DRAWDOWN (m)		40.32						MAXIMUM (m)	40.3		
MULTI-RATE / STEP DRAWDOWN:											
TEST DURATION (Minutes)		60	60	27				147	2.45	3.09	240
TEST YIELD (l/s)		0.20	0.35	0.41				MAXIMUM (l/s)	0.4		
DRAWDOWN (m)		13.9	30.31	40.32				MAXIMUM (m)	40.3		

RECOVERY TEST			
TIME TOTAL (hrs):			17.00
Cal	Steps	CD	Total
60	240	720	1020
DRAWDOWN TOTALS (CD):			
AVAILABLE	UTIL-ISED		%
41.9	27.12		64.77

CONSTANT DISCHARGE TEST	TEST DURATION (min)	(hrs)	TEST YIELD (l/s)	DRAWDOWN (m)	RECOVERY: (m)	%	(min)	(hrs)
	720	12.00	0.26	27.12	3.01	88.90	720	12.00

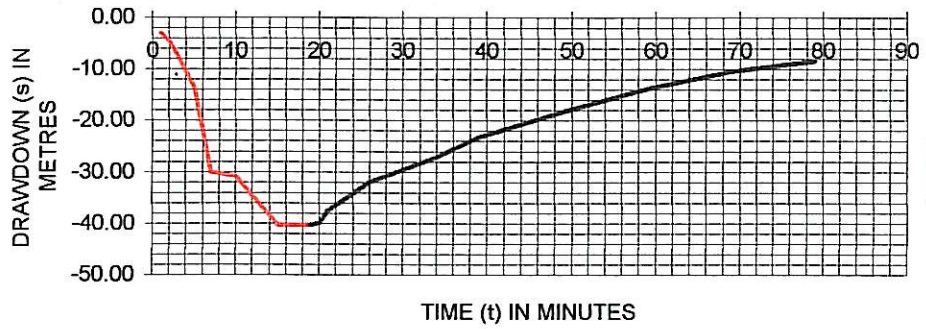
OBSERVATION BOREHOLES:	No. of boreholes	720 (min)	1440 (min)	2880 (min)	>2880 (min) nr.	Time	TOTAL: (min)	(hrs)
							0	0.00

::

BOREHOLE NUMBER: T33703

CALIBRATION TEST AND RECOVERY

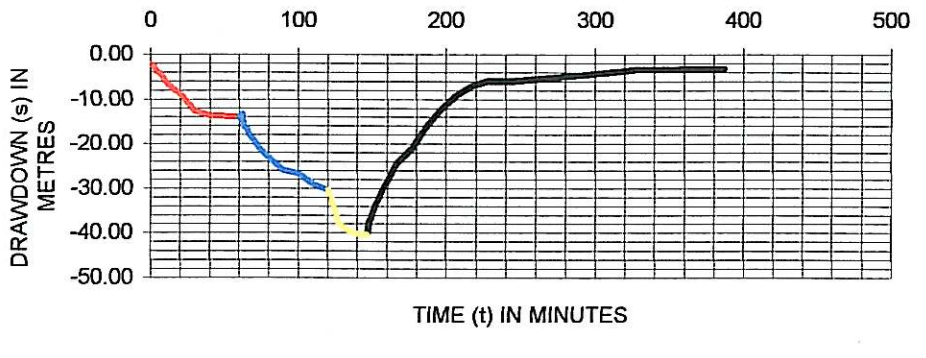
Discharge 1:	1.35	Discharge 2:		Discharge 3:		Discharge 4:		Discharge 5:		Discharge 6:	



Drawdown 1:	40.32
Drawdown 2:	0.00
Drawdown 3:	0.00
Drawdown 4:	0.00
Drawdown 5:	0.00
Drawdown 6:	0.00
Duration 1:	19
Duration 2:	
Duration 3:	
Duration 4:	
Duration 5:	
Duration 6:	
Recovery (m):	8.32
Recovery (min):	60

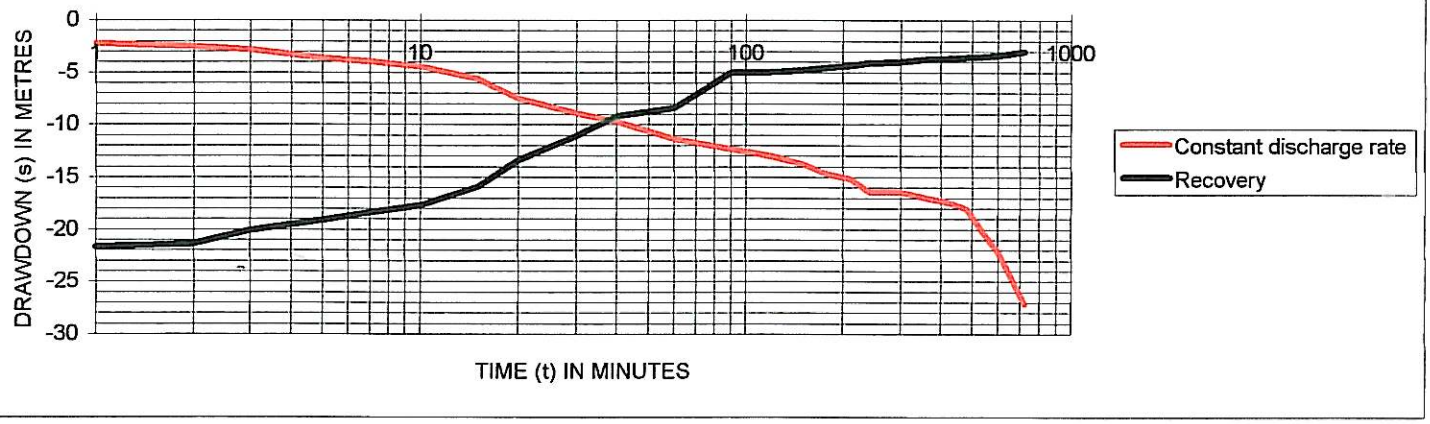
STEPPED DISCHARGE TEST AND RECOVERY

Discharge 1:	0.20333	Discharge 2:	0.34667	Discharge 3:	0.41286	Discharge 4:		Discharge 5:		Discharge 6:	



Drawdown 1:	13.87
Drawdown 2:	30.31
Drawdown 3:	40.32
Drawdown 4:	0.00
Drawdown 5:	0.00
Drawdown 6:	
Duration 1:	60
Duration 2:	60
Duration 3:	27
Duration 4:	
Duration 5:	
Duration 6:	
Recovery (m):	3.09
Recovery (min):	240

CONSTANT DISCHARGE TEST AND RECOVERY



TEST INFORMATION

Date tested	13/01/01	Water level (mbgl)	3.63	Depth of pump (mbgl)		45.5
CD duration	720	CD discharge rate	0.26	CD drawdown		27.12
Available drawdown (m)	41.87	% Recovery after CD	89	% after	720	min

CALIBRATION TEST AND RECOVERY

BOREHOLE NO. :	T33716	PROJECT:	PROJECT NR: 2346-00-04
ALTERNATIVE NO. :		SITE NAME:	LAPASINI
ALTERNATIVE NO. :		CLIENT:	CASER CONSTRUCTION

BOREHOLE DEPTH (mbdl):	55.20	CASING DEPTH (mbdl):	18.10	PUMP TYPE USED:	P150
DEPTH OF PUMP (mbdl):	50.75	CASING HEIGHT (magl):	0.30	OPERATOR:	THEMBA-ISAAC
PUMP INLET DIAMETER (mm):	0.165	CASING ID (mm):		CONTRACTOR:	CASER CONSTRUCTION
STATIC WATER LEVEL (mbdl):	7.04	DATUM LEVEL (magl):	0.10	SUPERVISOR:	

DISCHARGE RATE 1

DATE: 16/01/01 TIME: 12H48

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1	2.35		1	
2	3.75		2	
3	4.97	0.53	3	
5	6.87	0.52	5	
7	8.20		7	
10	9.57	0.53	10	
15	10.89		15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	

EXISTING EQUIPMENT DETAIL:

TYPE OF RESERVOIR:

RESERVOIR SIZE:

RESERVOIR CONITION:

STAND HEIGHT (m):

DISCHARGE RATE 2

DATE: 16/01/01 TIME:

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1	12.43		1	
2	14.01	1.23	2	
3	15.69		3	
5	17.33	1.22	5	
7	18.01		7	
10	18.53	1.21	10	
15	21.84		15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	

EXISTING EQUIPMENT DETAIL:

TYPE OF ENCLOSURE:

MATERIAL OF ENCLOSURE:

CONDITION OF ENCLOSURE:

WATER METER MANUFACTURER:

WATER METER READING:

DISCHARGE RATE 3

DATE: 16/01/01 TIME:

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1	24.50	1.94	1	
2	27.87	2.02	2	
3	31.44		3	
5	38.48	2.01	5	
7	42.60	0.88	7	
9	42.60	0.87	10	
12	42.60	0.85	15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	

EXISTING EQUIPMENT DETAIL:

PRESSURE GAUGE MANUFACTURER:

GAUGE READING (KpA):

MONITORING FACILITY:

MAINTAINED:

DISCHARGE RATE 4

DATE: 16/01/01 TIME:

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	

EXISTING EQUIPMENT DETAIL:

PUMP TYPE:

PUMP MANUFACTURER:

PUMP SERIAL No:

PUMP PULLEY DIAMETER (mm):

PUMP INTAKE DEPTH (m):

PUMP RPM:

PUMP CONDITION:

DISCHARGE RATE 5

DATE: 16/01/01 TIME:

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	

EXISTING EQUIPMENT DETAIL:

TYPE OF POWER:

ENGINE MANUACTURER:

ENGINE MODEL:

ENGINE SERIAL No:

ENGINE PULLEY DIAMETER (mm):

POWER RATING (kW):

ENGINE CONDITION:

DISCHARGE RATE 6

DATE: TIME:

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1			1	38.08
2			2	33.19
3			3	28.78
5			5	21.28
7			7	17.32
10			10	13.05
15			15	8.11
			20	4.40
			30	3.07
			40	2.24
			50	1.86
			60	1.59
			70	
			80	
			90	
			100	
			110	
			120	
			150	
			180	
			210	
			240	
			300	
			420	
			480	
			540	
			600	
			660	

EXISTING EQUIPMENT DETAIL:

TYPE OF RISER:

CLASS OF RISER:

DIAMETER OF RISER (mm):

CONDITION OF RISER:

SHAFT DIAMETER (mm):

ELEMENT DIAMETER (mm):

ELEMENT STROKE (mm):

COMMENTS:

DID THE BOREHOLE PRODUCE ANY SILT / SAND / GRAVEL ?

::

STEPPED DISCHARGE TEST AND RECOVERY

BOREHOLE NO. :	T33716	PROJECT:	PROJECT NR: 2346-00-04
ALTERNATIVE NO. :	0	SITE NAME:	LAPASINI
ALTERNATIVE NO. :	0	CLIENT:	CASER CONSTRUCTION

BOREHOLE DEPTH (mbdl):	55.20	CASING DEPTH (mbdl):	18.10	PUMP TYPE USED:	P150
DEPTH OF PUMP (mbdl):	50.75	CASING HEIGHT (magl):	0.30	OPERATOR:	THEMBA-ISAAC
PUMP INLET DIAMETER (mm):	0.165	CASING ID (mm):	0.000	CONTRACTOR:	CASER CONSTRUCTION
STATIC WATER LEVEL (mbdl):	7.04	DATUM LEVEL (magl):	0.10		

DISCHARGE RATE 1			Time	*Recovery 1*
DATE:	17/01/01		(min)	(m)
TIME:	06H25		1	
Time	Drawdown	Yield	2	
(min)	(m)	(l/s)	3	
1	1.50		5	
2	1.80		7	
3	2.10	0.210	10	
5	2.50		15	
7	2.73	0.210	20	
10	3.01		30	
15	3.20	0.200	40	
20	3.32		50	
30	3.45	0.210	60	
40	3.54		70	
50	3.60	0.220	80	
60	3.67		90	
70			100	
80			110	
90			120	
100			150	
110			180	
120			210	
Average yield:	0.21		(l/s)	

DISCHARGE RATE 2			Time	*Recovery 2*
DATE:	17/01/01		(min)	(m)
TIME:	07H25		1	
Time	Drawdown	Yield	2	
(min)	(m)	(l/s)	3	
1	4.33		5	
2	4.85		7	
3	5.20	0.490	10	
5	5.25	0.400	15	
7	5.34		20	
10	5.57	0.400	30	
15	5.84		40	
20	6.06	0.410	50	
30	6.13		60	
40	6.19	0.420	70	
50	6.24		80	
60	6.30	0.400	90	
70			100	
80			110	
90			120	
100			150	
110			180	
120			210	
Average yield:	0.42			

DISCHARGE RATE 3			Time	*Recovery 3*
DATE:	17/01/01		(min)	(m)
TIME:	08H25		1	
Time	Drawdown	Yield	2	
(min)	(m)	(l/s)	3	
1	7.55		5	
2	8.43	0.870	7	
3	8.77	0.810	10	
4	9.30		15	
7	9.88	0.800	20	
10	10.50		30	
15	11.21	0.810	40	
20	11.54		50	
30	12.03	0.800	60	
40	12.51		70	
50	13.07	0.810	80	
60	13.34		90	
70			100	
80			110	
90			120	
100			150	
110			180	
120			210	
Average yield:	0.81666667			

DISCHARGE RATE 4			Time	*Recovery 4*
DATE:	17/01/01		(min)	(m)
TIME:	09H25		1	
Time	Drawdown	Yield	2	
(min)	(m)	(l/s)	3	
1	16.10		5	
2	17.30		7	
3	17.64	1.69	10	
5	18.01	1.67	15	
7	22.95	1.66	20	
10	25.33		30	
15	29.94	1.67	40	
20	39.72	-	50	
22	42.60	1.49	60	
26	42.60	1.37	70	
30	42.60	1.05	80	
60			90	
70			100	
80			110	
90			120	
100			150	
110			180	
120			210	
Average yield:	1.51428571			

DISCHARGE RATE 5			Time	*Recovery 5*
DATE:	17/01/01		(min)	(m)
TIME:			1	
Time	Drawdown	.	2	
(min)	(m)	(l/s)	3	
1			5	
2			7	
3			10	
5			15	
7			20	
10			30	
15			40	
20			50	
30			60	
40			70	
50			80	
60			90	
70			100	
80			110	
90			120	
100			150	
110			180	
120			210	

DISCHARGE RATE 6			Time	*Recovery*
DATE:	17/01/01		(min)	(m)
TIME:			1	36.14
Time	Drawdown	Yield	2	31.24
(min)	(m)	(l/s)	3	28.88
1			5	19.53
2			7	17.31
3			10	14.46
5			15	8.46
7			20	6.46
10			30	4.66
15			40	3.12
20			50	3.33
30			60	2.92
40			70	2.60
50			80	2.36
60			90	2.23
70			100	2.18
80			110	2.13
90			120	2.08
100			150	1.87
110			180	1.73
120			210	1.51
150			240	1.3
180			300	
210			360	
240			420	
300			480	
360			540	
420			600	
480			660	
			720	
Average yield:			780	

COMMENTS:

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CONSTANT DISCHARGE TEST AND RECOVERY

BOREHOLE NO. :	T33716	PROJECT:	PROJECT NR: 2346-00-04	CLIENT:	CASER CONSTRUCTION
ALTERNATIVE NO. :	0	SITE NAME:	LAPASINI		
DEPTH OF PUMP (mbdl):	50.75	PUMP TYPE USED:	P150	OPERATOR:	THEMBA-ISAAC
INLET DIAMETER (mm):	0.165	EXISTING EQUIPMENT:	0	CONTRACTOR:	CASER CONSTRUCTION

TEST STARTED	DATE: 17/01/01	TEST COMPLETED	DATE:	TOTAL TIME - PUMPED (min):	1440	TOTAL TEST TIME (min):	1440
	TIME: 17h00		TIME:	TOTAL TIME-RECOVERY(min):	1440	AVERAGE YIELD (l/s):	0.58

DISCHARGE BOREHOLE		OBSERVATION BOREHOLE 1		OBSERVATION BOREHOLE 2		OBSERVATION BOREHOLE 3	
CASING HEIGHT (magl):	0.30	No. :		No. :		No. :	
CASING DEPTH (mbdl):	18.10	DATUM LEVEL (magl):		DATUM LEVEL (magl):		DATUM LEVEL (magl):	
CASING ID (mm):	0.00	CASING DEPTH (mbdl):		CASING DEPTH (mbdl):		CASING DEPTH (mbdl):	
BOREHOLE DEPTH (mbdl):	55.20	BOREHOLE DEPTH :		BOREHOLE DEPTH :		BOREHOLE DEPTH :	
WATER LEVEL (mbdl):	7.04	WATER LEVEL:		WATER LEVEL:		WATER LEVEL:	
DATUM LEVEL (magl):	0.10	DISTANCE (m):		DISTANCE (m):		DISTANCE (m):	

Time	Drawdown	Yield	Recovery	Time	Drawdown	Recovery	Time	Drawdown	Recovery	Time	Drawdown	Recovery
(min)	(m)	(l/s)	(m)	(min)	(m)	(m)	(min)	(m)	(m)	(min)	(m)	(m)
1	1.86		21.24	1			1			1		
2	2.11	0.43	18.28	2			2			2		
3	2.70		17.32	3			3			3		
5	2.98	0.51	16.01	5			5			5		
7	3.08		14.88	7			7			7		
10	3.99	0.60	13.50	10			10			10		
15	5.67		11.39	15			15			15		
20	6.12	0.61	9.33	20			20			20		
30	7.83		8.45	30			30			30		
40	8.95	0.58	7.02	40			40			40		
60	9.65		6.09	60			60			60		
90	10.02	0.58	5.42	90			90			90		
120	10.58		5.01	120			120			120		
150	11.03	0.59	4.46	150			150			150		
180	11.66		4.09	180			180			180		
210	11.97	0.60	3.94	210			210			210		
240	12.53		3.72	240			240			240		
300	12.89	0.59	3.54	300			300			300		
360	13.27		3.10	360			360			360		
420	14.35	0.58	2.87	420			420			420		
480	15.45		2.66	480			480			480		
540	16.73	0.59	2.45	540			540			540		
600	17.81		2.12	600			600			600		
720	18.27	0.59	1.82	720			720			720		
840	18.47		1.71	840			840			840		
960	18.82	0.64	1.63	960			960			960		
1080	19.36		1.56	1080			1080			1080		
1200	19.89	0.63	1.42	1200			1200			1200		
1320	20.57		1.33	1320			1320			1320		
1440	21.08	0.63	1.24	1440			1440			1440		
1080				1800			1800			1800		
1140				2280			2280			2280		
1200				2880			2880			2880		
1260												
1320												
1380												
1440												

DISCHARGE BOREHOLE				OBSERVATION BOREHOLE 1			OBSERVATION BOREHOLE 2			OBSERVATION BOREHOLE 3		
Time	Drawdown	Yield	Recovery	Time	Drawdown	Recovery	Time	Drawdown	Recovery	Time	Drawdown	Recovery
(min)	(m)	(l/s)	(m)	(min)	(m)	(m)	(min)	(m)	(m)	(min)	(m)	(m)
1500				1500			1500			1500		
1560				1560			1560			1560		
1620				1620			1620			1620		
1680				1680			1680			1680		
1740				1740			1740			1740		
1800				1800			1800			1800		
1860				1860			1860			1860		
1920				1920			1920			1920		
1980				1980			1980			1980		
2040				2040			2040			2040		
2100				2100			2100			2100		
2160				2160			2160			2160		
2220				2220			2220			2220		
2280				2280			2280			2280		
2340				2340			2340			2340		
2400				2400			2400			2400		
2460				2460			2460			2460		
2520				2520			2520			2520		
2580				2580			2580			2580		
2640				2640			2640			2640		
2700				2700			2700			2700		
2760				2760			2760			2760		
2820				2820			2820			2820		
2880				2880			2880			2880		

DESCRIPTION:	QUANTITY:	UNIT:
ESTABLISHMENT		Sum
INTER HOLE MOVE > 10 km		Km.
FROM: SITE NAME:		
BOREHOLE No:		
INTER HOLE MOVE < 10 km:		No.
REMOVAL AND RE-ERECTION OF PUMP HOUSE:		No.
REMOVAL OF EXISTING EQUIPMENT:		No.
RE-INSTALLATION OF EXISTING EQUIPMENT:		No.
WORK TIME RATE (REPAIRS):		Hour
STANDING TIME:		Hour
LATITUDE: LONGITUDE:		

SUMMARY

DESCRIPTION:	QUANTITY:	UNIT
STRAIGHTNESS TEST:		No.
VERTICALITY TEST:		No.
CASING DETECTION:		No.
STEEL BOREHOLE COVER:		No.
BOREHOLE MARKING:		No.
SITE CLEANING / FINISHING:		No.
REPORTING & DATA RECORDING:		No.
SLUG TEST:		No.
LAYFLAT (m):		m
BOREHOLE DEPTH AFTER TEST:		m
BOREHOLE WATERLEVEL AFTER TEST:		m

TEST DESCRIPTION	STEP	1	2	3	4	5	6	TOTAL:		RECOVERY:	
CALIBRATION TEST:								(min)	(hrs)	(m)	(min)
TEST DURATION (Minutes)		15	15	12				42	0.70	1.59	60
TEST YIELD (l/s)		0.53	1.22	1.43				MAXIMUM (l/s)	1.4		
DRAWDOWN (m)		10.89	21.84	42.60				MAXIMUM (m)	42.6		
MULTI-RATE / STEP DRAWDOWN:											
TEST DURATION (Minutes)		60	60	60	30			210	3.50	1.30	240
TEST YIELD (l/s)		0.21	0.42	0.82	1.51			MAXIMUM (l/s)	1.5		
DRAWDOWN (m)		3.7	6.30	13.34	42.60			MAXIMUM (m)	42.6		

RECOVERY TEST			
TIME TOTAL (hrs):			29.00
Cal	Steps	CD	Total
60	240	1440	1740
DRAWDOWN TOTALS (CD):			
AVAILABLE	UTIL-ISED	%	
43.7	21.08	48.23	

CONSTANT DISCHARGE TEST	TEST DURATION (min)	TEST DURATION (hrs)	TEST YIELD (l/s)	DRAWDOWN (m)	RECOVERY: (m)	%	(min)	(hrs)
	1440	24.00	0.58	21.08	1.24	94.12	1440	24.00

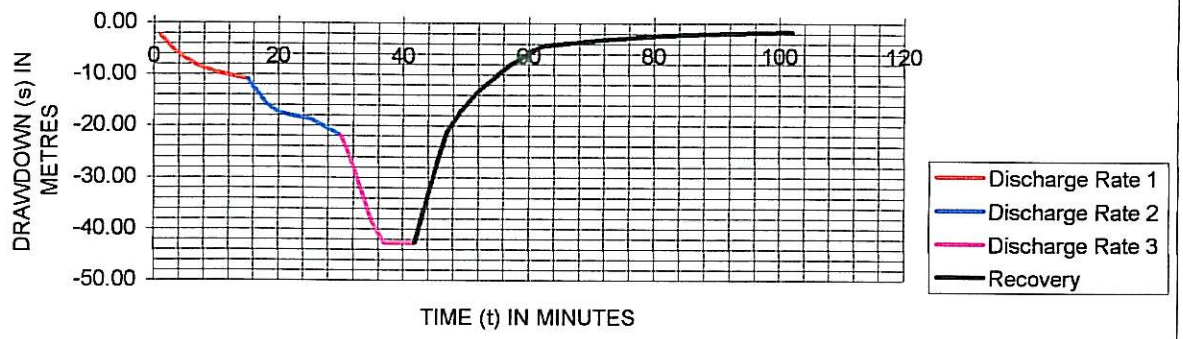
OBSERVATION BOREHOLES:	No. of boreholes	720 (min)	1440 (min)	2880 (min)	>2880 (min) nr.	Time	TOTAL: (min)	(hrs)
							0	0.00

::

BOREHOLE NUMBER: T33716

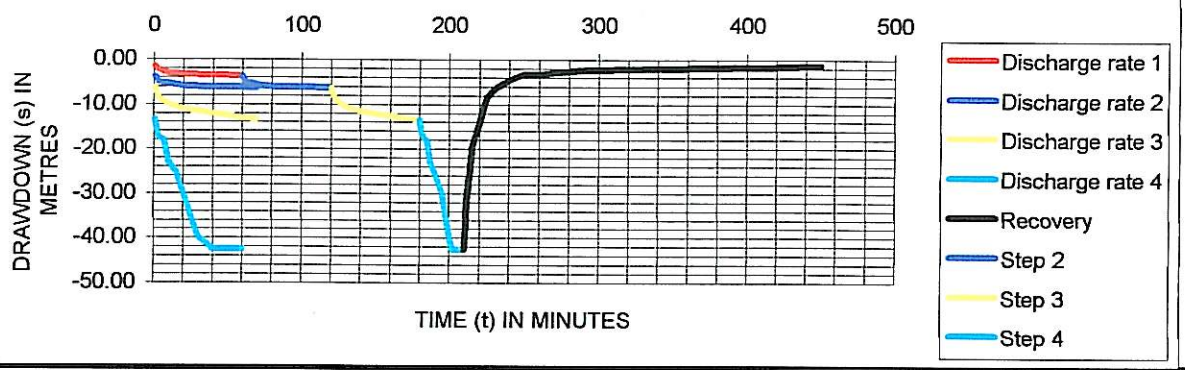
CALIBRATION TEST AND RECOVERY

Discharge 1:	0.53	Discharge 2:	1.22	Discharge 3:	1.43	Discharge 4:		Discharge 5:		Discharge 6:	
										Drawdown 1:	10.89
										Drawdown 2:	21.84
										Drawdown 3:	42.60
										Drawdown 4:	0.00
										Drawdown 5:	0.00
										Drawdown 6:	0.00
										Duration 1:	15
										Duration 2:	15
										Duration 3:	12
										Duration 4:	
										Duration 5:	
										Duration 6:	
										Recovery (m):	1.59
										Recovery (min):	60

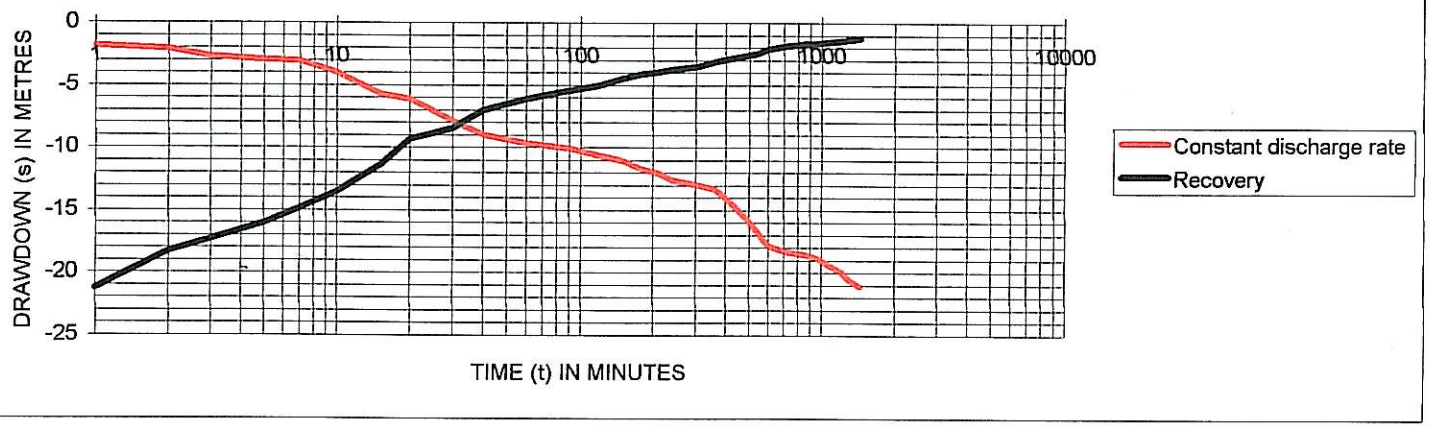


STEPPED DISCHARGE TEST AND RECOVERY

Discharge 1:	0.21	Discharge 2:	0.42	Discharge 3:	0.81667	Discharge 4:	1.51429	Discharge 5:		Discharge 6:	
										Drawdown 1:	3.67
										Drawdown 2:	6.30
										Drawdown 3:	13.34
										Drawdown 4:	42.60
										Drawdown 5:	0.00
										Drawdown 6:	
										Duration 1:	60
										Duration 2:	60
										Duration 3:	60
										Duration 4:	30
										Duration 5:	
										Duration 6:	
										Recovery (m):	1.30
										Recovery (min):	240



CONSTANT DISCHARGE TEST AND RECOVERY



TEST INFORMATION						
Date tested	17/01/01	Water level (mbgl)	7.04	Depth of pump (mbgl)		50.75
CD duration	1440	CD discharge rate	0.58	CD drawdown		21.08
Available drawdown (m)	43.71	% Recovery after CD	94	% after	1440	min

::

APPENDIX C

DETAILED WATER QUALITY DATA

Cala Sanitation

Borehole Id	T3371
Date Sampled	16-Jan-01
Drinking water class	**2**

Sample Number

					Class
Micro-biological properties	**Viable organisms**				0
	Faecal coliforms			0.00	1
	Total coliforms			0.00	1
Physical Properties	**Electrical Conductivity**	*EC*	mS / m	69.60	0
	Total Dissolved Salts	*TDS*	mg / l		0
	pH Value	*pH*		7.13	0
	Turbidity		NTU	15.10	2
Chemical properties	**Arsenic**	*As*	mg / l		0
	Cadmium	*Cd*	mg / l		0
	Calcium	*Ca*	mg / l	43.00	0
	Chloride	*Cl*	mg / l	36.00	0
	Copper	*Cu*	mg / l		0
	Fluoride	*F*	mg / l	0.40	0
	Iron	*Fe*	mg / l	0.29	2
	Total Hardness	$CaCO_3$	mg / l	206.20	1
	Magnesium	*Mg*	mg / l	24.00	0
	Manganese	*Mn*	mg / l		0
	Nitrate	*N*	mg / l	0.50	0
	Nitrate	NO_3	mg / l		0
	Potassium	*K*	mg / l	2.90	0
	Sodium	*Na*	mg / l	68.00	0
	Sulphate	SO_4	mg / l	8.30	0
	Zinc	*Zn*	mg / l		0
Chemical properties (not required for the clasification of domestic drinking water supply)	**Ammonia**	NH_4	mg / l	0.10	
	P - Alkalinity	$CaCO_3$	mg / l		
	M - Alkalinity	*CaCO3*	mg / l	288.00	
	Calcium Hardness	*CaCO3*	mg / l	107.40	
	Magnesium Hardness	*CaCO3*	mg / l	98.80	
	Carbonate	*CaCO3*	mg / l		
	Bicarbonate	HCO_3	mg / l		
	Silica	*Si*	mg / l		
	Phosphor	$P0_4$ *as P*	mg / l		

Class 0	**Ideal water quality**	Suitable for lifetime use
Class 1	**Good water quality**	Suitable for use, rare instances of negative effect
Class 2	**Marginal water quality**	Conditionally acceptable. Negative effects may o in some sensitive groups.
Class 3	**Poor water quality**	Unsuitable for use without treatment. Chronic eff may occur.
Class 4	**Dangerous water quality**	Totally unsuitable for use. Acute effects may occ

Cala Sanitation

Borehole Id	T33709B
Date Sampled	20-Jan-01
Drinking water class	2
Sample Number	

					Class
Micro-biological properties	Viable organisms				0
	Faecal coliforms			0.00	1
	Total coliforms			0.00	1
Physical Properties	Electrical Conductivity	*EC*	mS / m	59.60	0
	Total Dissolved Salts	*TDS*	mg / l		0
	pH Value	*pH*		7.32	0
	Turbidity		NTU	5.10	2
Chemical properties	Arsenic	*As*	mg / l		0
	Cadmium	*Cd*	mg / l		0
	Calcium	*Ca*	mg / l	37.00	0
	Chloride	*Cl*	mg / l	16.00	0
	Copper	*Cu*	mg / l		0
	Fluoride	*F*	mg / l	0.27	0
	Iron	*Fe*	mg / l	0.27	2
	Total Hardness	$CaCO_3$	mg / l	154.20	0
	Magnesium	*Mg*	mg / l	15.00	0
	Manganese	*Mn*	mg / l		0
	Nitrate	*N*	mg / l	0.20	0
	Nitrate	NO_3	mg / l		0
	Potassium	*K*	mg / l	1.70	0
	Sodium	*Na*	mg / l	69.00	0
	Sulphate	SO_4	mg / l	10.00	0
	Zinc	*Zn*	mg / l		0
Chemical properties (not required for the clasification of domestic drinking water supply)	Ammonia	NH_4	mg / l	0.10	
	P - Alkalinity	$CaCO_3$	mg / l		
	M - Alkalinity	*CaCO3*	mg / l	254.00	
	Calcium Hardness	*CaCO3*	mg / l	92.40	
	Magnesium Hardness	*CaCO3*	mg / l	61.80	
	Carbonate	*CaCO3*	mg / l		
	Bicarbonate	HCO_3	mg / l		
	Silica	*Si*	mg / l		
	Phosphor	$P0_4$ as *P*	mg / l		

Class 0	Ideal water quality	Suitable for lifetime use
Class 1	Good water quality	Suitable for use, rare instances of negative effect
Class 2	Marginal water quality	Conditionally acceptable. Negative effects may o in some sensitive groups.
Class 3	Poor water quality	Unsuitable for use without treatment. Chronic eff may occur.
Class 4	Dangerous water quality	Totally unsuitable for use. Acute effects may occ

Cala Sanitation

Borehole Id	T33703
Date Sampled	13-Jan-01
Drinking water class	2
Sample Number	

					Class
Micro-biological properties	Viable organisms				0
	Faecal coliforms				0
	Total coliforms			25.00	2
Physical Properties	Electrical Conductivity	*EC*	mS / m	55.00	0
	Total Dissolved Salts	*TDS*	mg / l		0
	pH Value	*pH*		6.58	0
	Turbidity		NTU	8.30	2
Chemical properties	Arsenic	*As*	mg / l		0
	Cadmium	*Cd*	mg / l		0
	Calcium	*Ca*	mg / l	33.00	0
	Chloride	*Cl*	mg / l	64.00	0
	Copper	*Cu*	mg / l		0
	Fluoride	*F*	mg / l	0.54	0
	Iron	*Fe*	mg / l	0.54	2
	Total Hardness	$CaCO_3$	mg / l	0.00	0
	Magnesium	*Mg*	mg / l	16.90	0
	Manganese	*Mn*	mg / l		0
	Nitrate	*N*	mg / l	0.70	0
	Nitrate	NO_3	mg / l		0
	Potassium	*K*	mg / l	3.50	0
	Sodium	*Na*	mg / l	47.60	0
	Sulphate	SO_4	mg / l	27.00	0
	Zinc	*Zn*	mg / l		0
Chemical properties (not required for the clasification of domestic drinking water supply)	Ammonia	NH_4	mg / l	0.10	
	P - Alkalinity	$CaCO_3$	mg / l		
	M - Alkalinity	*CaCO3*	mg / l	134.00	
	Calcium Hardness	*CaCO3*	mg / l	0.00	
	Magnesium Hardness	*CaCO3*	mg / l	0.00	
	Carbonate	*CaCO3*	mg / l		
	Bicarbonate	HCO_3	mg / l		
	Silica	*Si*	mg / l		
	Phosphor	$P0_4$ *as P*	mg / l		

Class 0	Ideal water quality	Suitable for lifetime use
Class 1	Good water quality	Suitable for use, rare instances of negative effects.
Class 2	Marginal water quality	Conditionally acceptable. Negative effects may occur in some sensitive groups.
Class 3	Poor water quality	Unsuitable for use without treatment. Chronic effects may occur.
Class 4	Dangerous water quality	Totally unsuitable for use. Acute effects may occur.

Cala Sanitation

Borehole Id	T33716
Date Sampled	18-Jan-01
Drinking water class	**2**
Sample Number	

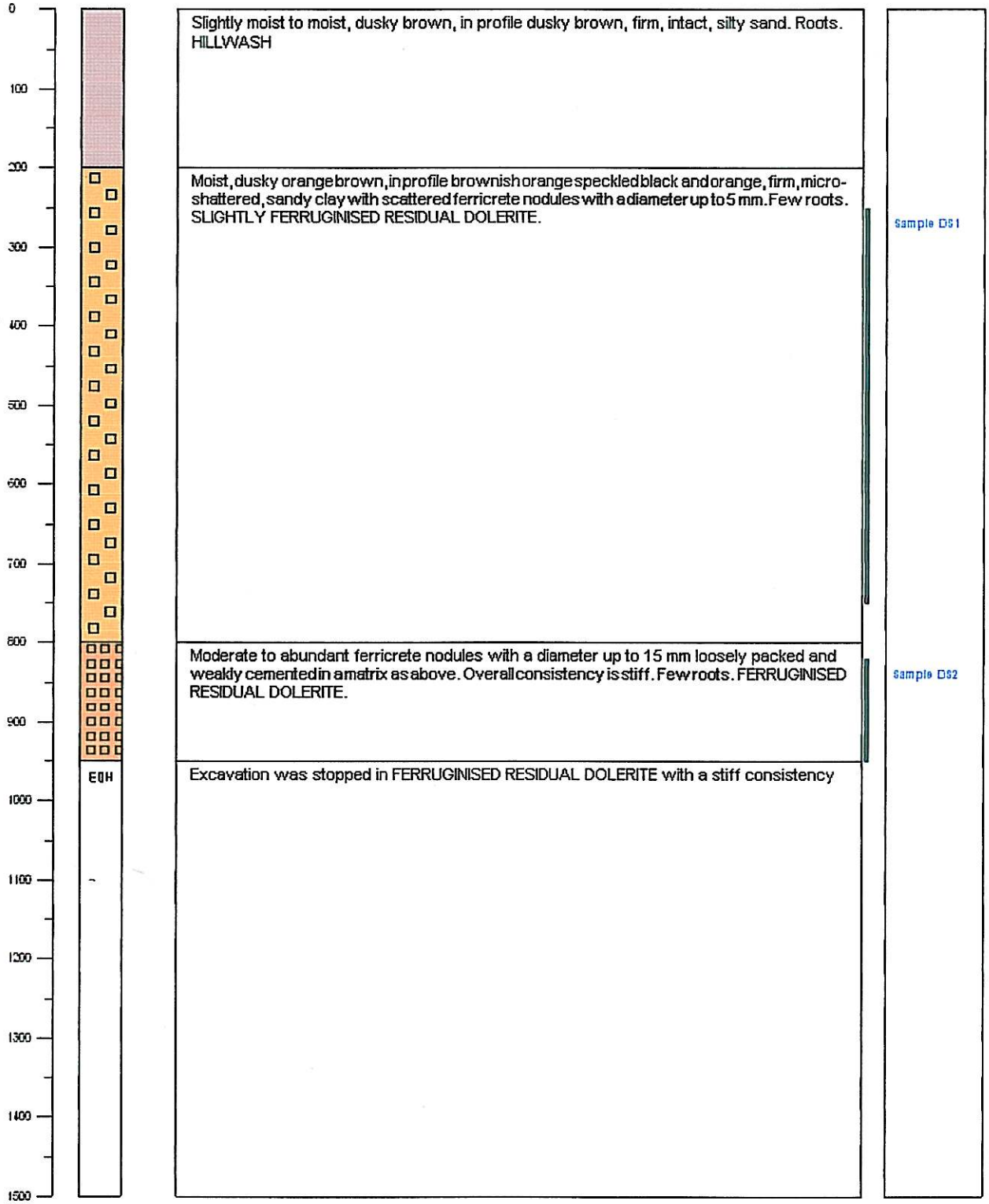
					Class
Micro-biological properties	Viable organisms				0
	Faecal coliforms			0.00	1
	Total coliforms			0.00	1
Physical Properties	Electrical Conductivity	*EC*	mS / m	63.70	0
	Total Dissolved Salts	*TDS*	mg / l		0
	pH Value	*pH*		6.92	0
	Turbidity		NTU	10.00	2
Chemical properties	Arsenic	*As*	mg / l		0
	Cadmium	*Cd*	mg / l		0
	Calcium	*Ca*	mg / l	37.00	0
	Chloride	*Cl*	mg / l	30.00	0
	Copper	*Cu*	mg / l		0
	Fluoride	*F*	mg / l	0.54	0
	Iron	*Fe*	mg / l	0.17	1
	Total Hardness	$CaCO_3$	mg / l	183.00	0
	Magnesium	*Mg*	mg / l	22.00	0
	Manganese	*Mn*	mg / l		0
	Nitrate	*N*	mg / l	0.20	0
	Nitrate	NO_3	mg / l		0
	Potassium	*K*	mg / l	2.20	0
	Sodium	*Na*	mg / l	63.00	0
	Sulphate	SO_4	mg / l	10.00	0
	Zinc	*Zn*	mg / l		0
Chemical properties (not required for the clasification of domestic drinking water supply)	Ammonia	NH_4	mg / l	0.10	
	P - Alkalinity	$CaCO_3$	mg / l		
	M - Alkalinity	*CaCO3*	mg / l	249.00	
	Calcium Hardness	*CaCO3*	mg / l	92.40	
	Magnesium Hardness	*CaCO3*	mg / l	90.60	
	Carbonate	*CaCO3*	mg / l		
	Bicarbonate	HCO_3	mg / l		
	Silica	*Si*	mg / l		
	Phosphor	$P0_4$ as P	mg / l		

Class 0	Ideal water quality	Suitable for lifetime use
Class 1	Good water quality	Suitable for use, rare instances of negative effect
Class 2	Marginal water quality	Conditionally acceptable. Negative effects may o in some sensitive groups.
Class 3	Poor water quality	Unsuitable for use without treatment. Chronic eff may occur.
Class 4	Dangerous water quality	Totally unsuitable for use. Acute effects may occ

APPENDIX D

DETAILED TEST PIT PROFILE LOGS

PROJECT:	**CALA SANITATION**			**TEST PIT NO.:**	**CS/TP1**
CLIENT:	Arcus Gibb	LATITUDE:	-31.53100 ° 34 52 09		
CONTRACTOR:	Local Labour	LONGITUDE:	27.70628 ° 42 22	DATE EXCAVATED:	18 December 2004
MACHINE TYPE:	Hand dug	ELEVATION:	Enter elevation	DATE PROFILED:	20 December 2004



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e-mail: easterncape@ages-group.com
www.ages-group.com

Notes:
Groundwater seepage was not encountered
The sidewalls remained stable during profiling
2 Disturbed samples taken

PROJECT:	**CALA SANITATION**			**TEST PIT NO.:**	**CS/TP2**
CLIENT:	Arcus Gibb	LATITUDE:	-31.532 12 ° 30 56 D2 32 D5		
CONTRACTOR:	Local Labour	LONGITUDE:	27.70887 °	DATE EXCAVATED:	18 December 2004
MACHINE TYPE:	Hand dug	ELEVATION:	Enter elevation	DATE PROFILED:	20 December 2004

Depth	Lithology	Description	Sampling
0		Slightly moist to moist, dusky yellowish brown, in profile dusky yellowish brown, stiff, micro-shattered, sandy silt. Roots. HILLWASH	
300		Slightly moist, dusky orange brown, in profile brownish orange speckled black and yellow blotched brown, stiff, micro-shattered, sandy clay with scattered ferricrete nodules with a diameter up to 5 mm. SLIGHTLY FERRUGINISED RESIDUAL DOLERITE.	
1000		Slightly moist, dusky orange brown, in profile bright yellowish and orange brown speckled and stained black and brown, stiff, micro-shattered, clayey sand with scattered very hard rock dolerite corestones. RESIDUAL DOLERITE.	Sample D53
1100	EOH	Excavation was stopped in RESIDUAL DOLERITE with a stiff consistency	
1500			

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www.ages-group.com

Notes:
Groundwater seepage was not encountered
The sidewalls remained stable during profiling
1 Disturbed samples taken

PROJECT:	**CALA SANITATION**			**TEST PIT NO.:**	**CS/TP3**
CLIENT:	Arcus Gibb	LATITUDE:	-31.53382 °		
CONTRACTOR:	Local Labour	LONGITUDE:	27.70823 °	DATE EXCAVATED:	18 December 2004
MACHINE TYPE:	Hand dug	ELEVATION:	Enter elevation	DATE PROFILED:	20 December 2004

Depth	Lithology	Description	Sampling
0 – 500		Slightly moist to moist, dusky yellowish brown, in profile dusky yellowish brown, very stiff, micro-shattered, sandy silt. Roots. HILLWASH	
500 – 800		Slightly moist, dusky yellowish and reddish brown, in profile dusky orange and yellowish brown, very stiff, intact and micro-shattered, clayey sand with scattered ferricrete nodules with a diameter up to 10 mm. SLIGHLTY FERRUGINISED RESIDUAL DOLERITE.	
800	EOH	Excavation was stopped and near refusal in SLIGHTLY FERRUGINISED RESIDUAL DOLERITE with a very stiff consistency	

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www.ages-group.com

Notes: Groundwater seepage was not encountered

The sidewalls remained stable during profiling

No samples

PROJECT:	**CALA SANITATION**			**TEST PIT NO.:**	**CS/TP4**
CLIENT:	Arcus Gibb	LATITUDE:	-31.53658 °		
CONTRACTOR:	Local Labour	LONGITUDE:	27.70676 °	DATE EXCAVATED:	18 December 2004
MACHINE TYPE:	Hand dug	ELEVATION:	Enter elevation	DATE PROFILED:	20 December 2004

Depth	Lithology	Description	Sampling
0 – 600		Slightly moist, dusky orangey brown, in profile dusky brown speckled yellow and orange, stiff, micro-shattered, sandy clay. Roots. HILLWASH.	
600 – 1000		Moist, dusky orange brown, in profile dusky orange brown streaked and speckled white, firm, micro-shattered, sandy clay with scattered ferricrete nodules with a diameter up to 10mm. few roots. SLIGHTLY FERRUGINISED RESIDUAL DOLERITE.	
1000 – 1300		Moist, dusky reddish brown, in profile brownish red speckeld white, firm, micro-shattered, sandy clay. Few roots. RESIDUAL DOLERITE.	Sample DS4
1300	EOH	Excavation was stopped in RESIDUAL DOLERITE with a firm consistency	

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Notes:

Groundwater seepage was not encountered

The sidewalls remained stable during profiling

1 Disturbed sample was taken

PROJECT:	**CALA SANITATION**			**TEST PIT NO.:**	**CS/TP5**
CLIENT:	Arcus Gibb	LATITUDE:	-31.53823°		
CONTRACTOR:	Local Labour	LONGITUDE:	27.70524°	DATE EXCAVATED:	16 December 2004
MACHINE TYPE:	Hand dug	ELEVATION:	Enter elevation	DATE PROFILED:	20 December 2004

Depth	Lithology	Description	Sampling
0		Slightly moist, dusky yellowish brown, in profile dusky yellowish brown speckled white and black, stiff, micro-shattered, sandy clay. Roots. ALLUVIUM / HILLWASH	Sample DS5
500		Moist, brownish and greyish black, in profile dark brownish black, firm to stiff, micro-shattered, clay. Few Roots. ALLUVIUM / HILLWASH	Sample DS6
900	EOH	Excavation was stopped in ALLUVIUM / HILLWASH with a firm to stiff consistency	

AGES
African Geo-Environmental Services
19 Sansom Road
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Private Bag X9063
EAST LONDON
Tel/Fax. No.: +27 -(0)43 -726 2670
e-mail: easterncape@ages-group.com
www.ages-group.com

Notes:
Groundwater seepage was not encountered
The sidewalls remained stable during profiling
2 Disturbed samples taken

PROJECT:	**CALA SANITATION**			**TEST PIT NO.:**	**CS/TP6**
CLIENT:	Arcus Gibb	LATITUDE:	-31.53361°		
CONTRACTOR:	Local Labour	LONGITUDE:	27.70283°	DATE EXCAVATED:	18 December 2004
MACHINE TYPE:	Hand dug	ELEVATION:	Enter elevation	DATE PROFILED:	20 December 2004

Depth	Lithology	Description	Sampling
0		Slightly moist to moist, dusky brown, in profile brown, firm, micro-shattered, sandy silt. Roots. HILLWASH	
400		Moist, dusky orange brown, in profile dusky brownish orange streaked black, firm, micro-shattered, sandy clay with scattered ferricrete nodules with a diamter up to 10 mm. SLIGHTLY FERRUGINISED RESIDUAL DOLERITE.	
800	EOH	Excavation was stopped in SLIGHTLY FERRUGINISED RESIDUAL DOLERITE with a firm consistency	

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Notes:

Groundwater seepage was not encountered

The sidewalls remained stable during profiling

No samples

Perched groundwater conditions likely to occur

APPENDIX E

DETAILED SOIL ANALYSIS DATA

HEAD OFFICE
10 St. Pauls Road
East London, 5201
P.O. Box 346
East London, 5200
Tel: (043) 722 8565 / 722 5420
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CONTROLAB cc

CIVIL ENGINEERING MATERIALS AND GEOTECHNICAL LABORATORY

CK 90/12841/23

BRANCH OFFICES
Cape Town
Kokstad
Port Elizabeth
Umtata

CLIENT: A G E S
Postnet 203
Private Bag X9063
EAST LONDON, 5200

ATT : Mr F de Jager

PROJECT: CALA

DATE: 20-01-2005

REF: 31252

FOUNDATION INDICATOR

SAMPLE NO	21	22	23	24		
POSITION	Delivered					
	DS 2	DS 4	DS 5	DS 6		
DEPTH						
DESCRIPTION	lt R	lt R	dk Br	dk Br		
	Ferr + cly s	cly s	sdy st	sdy cl		
SIEVE ANALYSIS						
% PASSING 75 mm						
37.5 mm						
19 mm						
9.5 mm	100					
4.75 mm	90	100	100			
2.36 mm	78	96	98	100		
1.18 mm	74	87	95	99		
0.600 mm	73	83	92	98		
0.425 mm	71	81	88	97		
0.300 mm	70	79	85	95		
0.150 mm	61	69	76	87		
0.075 mm	47.3	45.4	58.5	70.1		
MECHANICAL ANALYSIS						
0.06 mm	41	39	50	59		
0.02 mm	28	25	35	32		
0.006 mm	21	17	26	22		
0.002 mm	19	13	22	17		
SOIL CONSTANTS						
LIQUID LIMIT	33	29	23	25		
PLASTICITY INDEX	13	14	9	14		
LINEAR SHRINKAGE	7.5	7.5	4.5	7.5		
DISPERSIVITY						
DOUBLE HYDROMETER %	31	12	29	59		
REMARKS:	Note that 100% indicates a completely dispersive clay sized fraction and 0% indicates completely non dispersive					

APPENDIX F

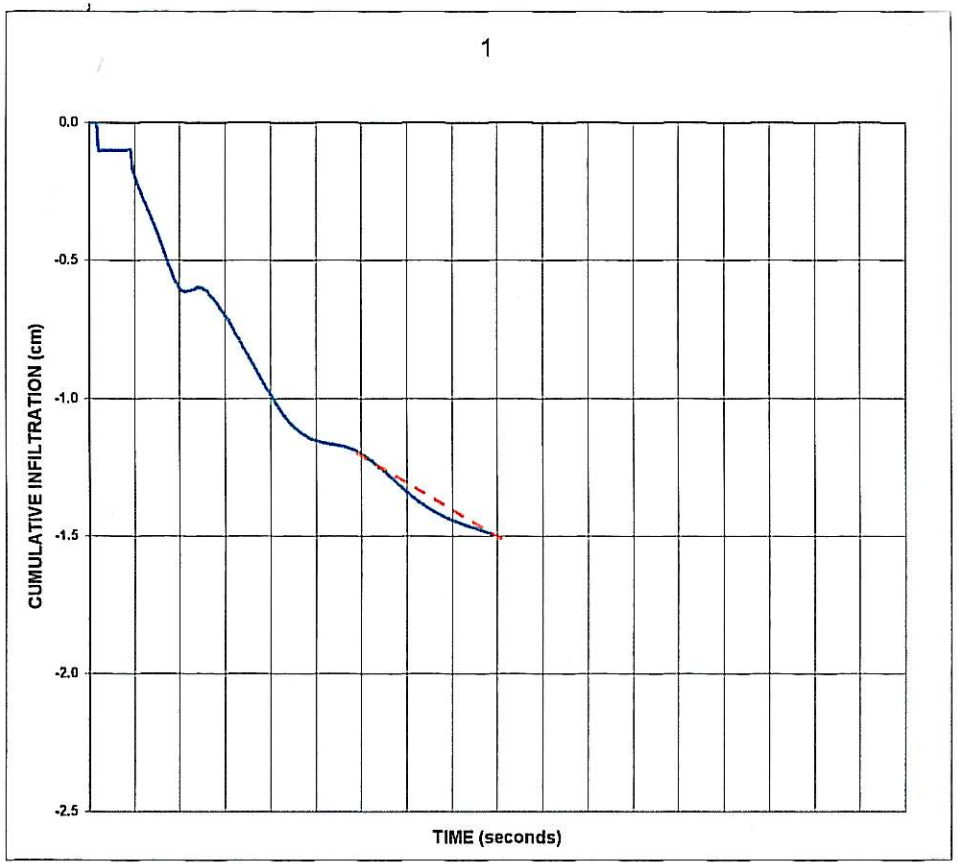
DETAILED DOUBLE RING INFILTROMETER TEST DATA

DOUBLE-RING INFILTROMETER TEST

PROJECT:	Cala Sanitation

Inner Ring Dia.:	28 cm
Ring Height:	24 cm
Test No.:	1
Position:	0.5 mbgl
Material:	

Time (sec)	Cum. Infilt	
0	0.0	
15	0.0	
30	0.0	
45	0.0	
60	0.0	1 min
90	0.0	
120	-0.1	2 min
150	-0.1	
180	-0.1	3 min
210	-0.1	
240	-0.1	4 min
270	-0.1	
300	-0.1	5 min
360	-0.1	6 min
420	-0.1	7 min
480	-0.1	8 min
540	-0.1	9 min
600	-0.2	10 min
900	-0.4	15 min
1200	-0.6	20 min
1500	-0.6	25 min
1800	-0.7	30 min
2700	-1.1	45 min
3600	-1.2	1 HOUR
4500	-1.4	1 hr 15 min
5400	-1.5	1 hr 30 min
6300		1 hr 45 min
7200		2 HOURS
8100		2 hr 15 min
9000		2 hr 30 min
9900		2 hr 45 min
10800		3 HOURS



h_1 =	-1.2	initial height (cm)
h_2 =	-1.5	final height (cm)
t_1 =	1800	time difference (sec)

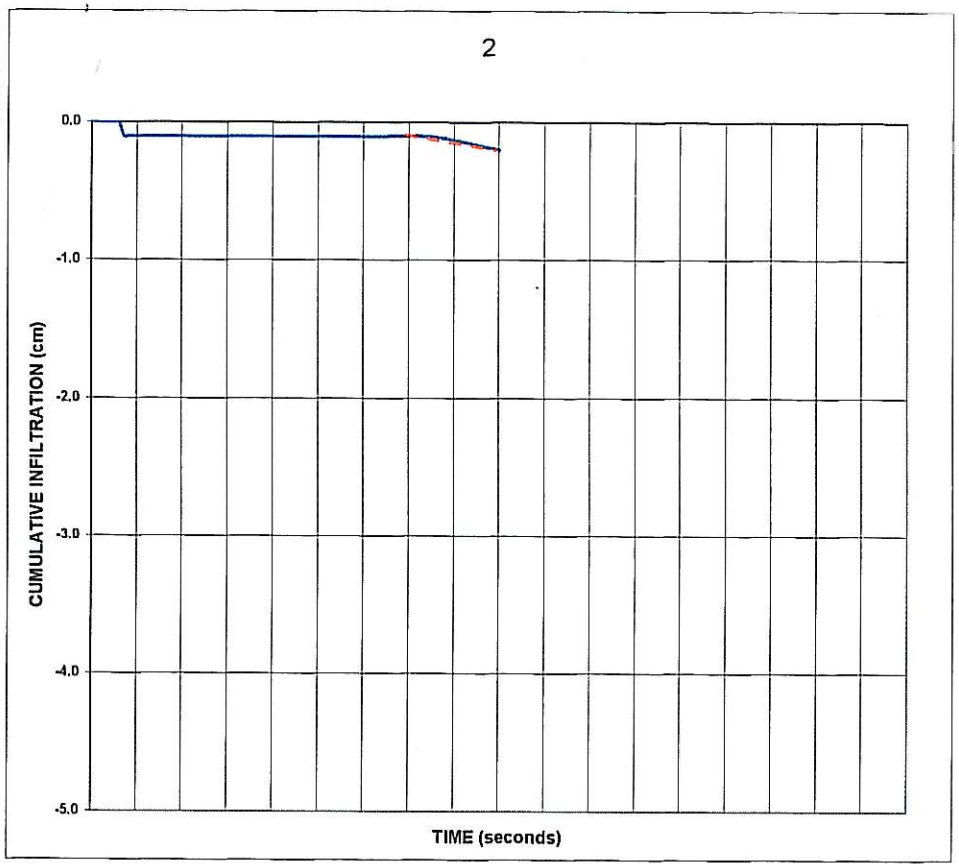
k_m =	-1.7E-04	$cm.s^{-1}$

DOUBLE-RING INFILTROMETER TEST

PROJECT:	Cala Sanitation

Inner Ring Dia.:	28 cm
Ring Height:	24 cm
Test No.:	2
Position:	0.6 mbgl
Material:	

Time (sec)	Cum. Infilt	
0	0.0	
15	0.0	
30	0.0	
45	0.0	
60	0.0	1 min
90	0.0	
120	0.0	2 min
150	0.0	
180	0.0	3 min
210	0.0	
240	0.0	4 min
270	0.0	
300	0.0	5 min
360	0.0	6 min
420	-0.1	7 min
480	-0.1	8 min
540	-0.1	9 min
600	-0.1	10 min
900	-0.1	15 min
1200	-0.1	20 min
1500	-0.1	25 min
1800	-0.1	30 min
2700	-0.1	45 min
3600	-0.1	1 HOUR
4500	-0.1	1 hr 15 min
5400	-0.2	1 hr 30 min
6300		1 hr 45 min
7200		2 HOURS
8100		2 hr 15 min
9000		2 hr 30 min
9900		2 hr 45 min
10800		3 HOURS



h_1 =	-0.1	initial height (cm)
h_2 =	-0.2	final height (cm)
$^*t$ =	1200	time difference (sec)

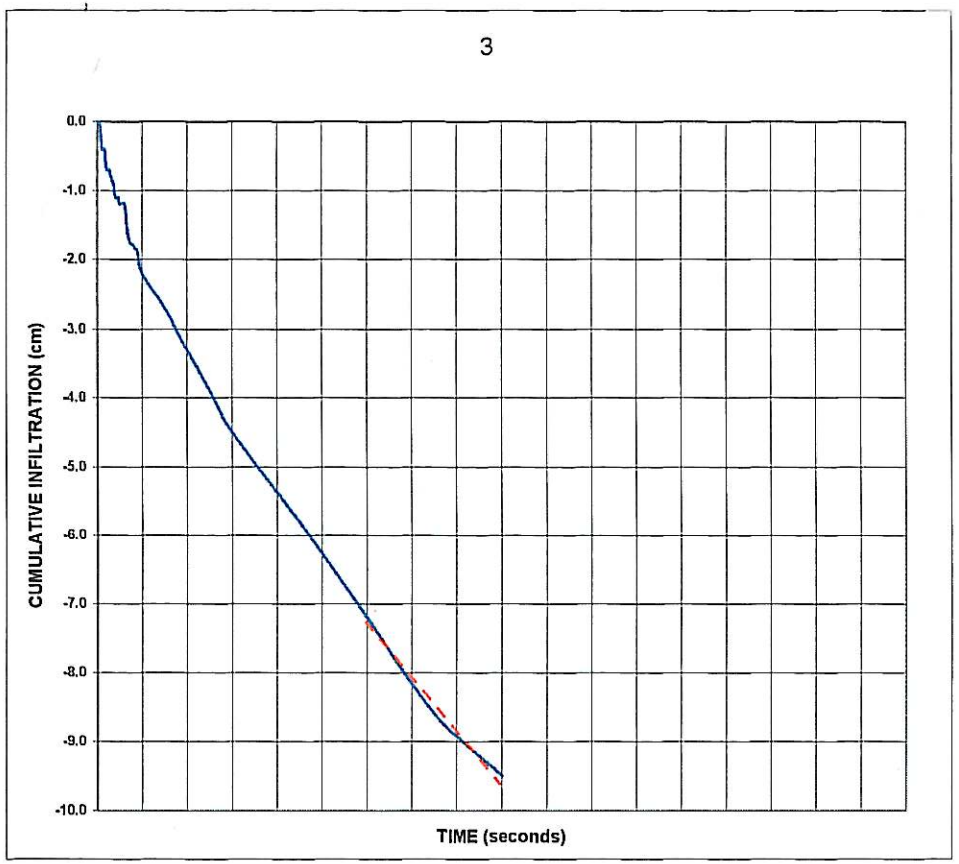
k_m =	-8.3E-05 $cm.s^{-1}$

DOUBLE-RING INFILTROMETER TEST

PROJECT:	Cala Sanitation

Inner Ring Dia.:	28 cm
Ring Height:	24 cm
Test No.:	3
Position:	0.5 mbgl
Material:	

Time (sec)	Cum. Infilt	
0	0.0	
15	0.0	
30	-0.1	
45	-0.2	
60	-0.4	1 min
90	-0.4	
120	-0.7	2 min
150	-0.7	
180	-0.8	3 min
210	-0.9	
240	-1.1	4 min
270	-1.1	
300	-1.2	5 min
360	-1.2	6 min
420	-1.7	7 min
480	-1.8	8 min
540	-1.9	9 min
600	-2.2	10 min
900	-2.7	15 min
1200	-3.3	20 min
1500	-3.9	25 min
1800	-4.5	30 min
2700	-5.8	45 min
3600	-7.2	1 HOUR
4500	-8.6	1 hr 15 min
5400	-9.5	1 hr 30 min
6300		1 hr 45 min
7200		2 HOURS
8100		2 hr 15 min
9000		2 hr 30 min
9900		2 hr 45 min
10800		3 HOURS



h_1 =	-7.2	initial height (cm)
h_2 =	-9.5	final height (cm)
t =	1800	time difference (sec)

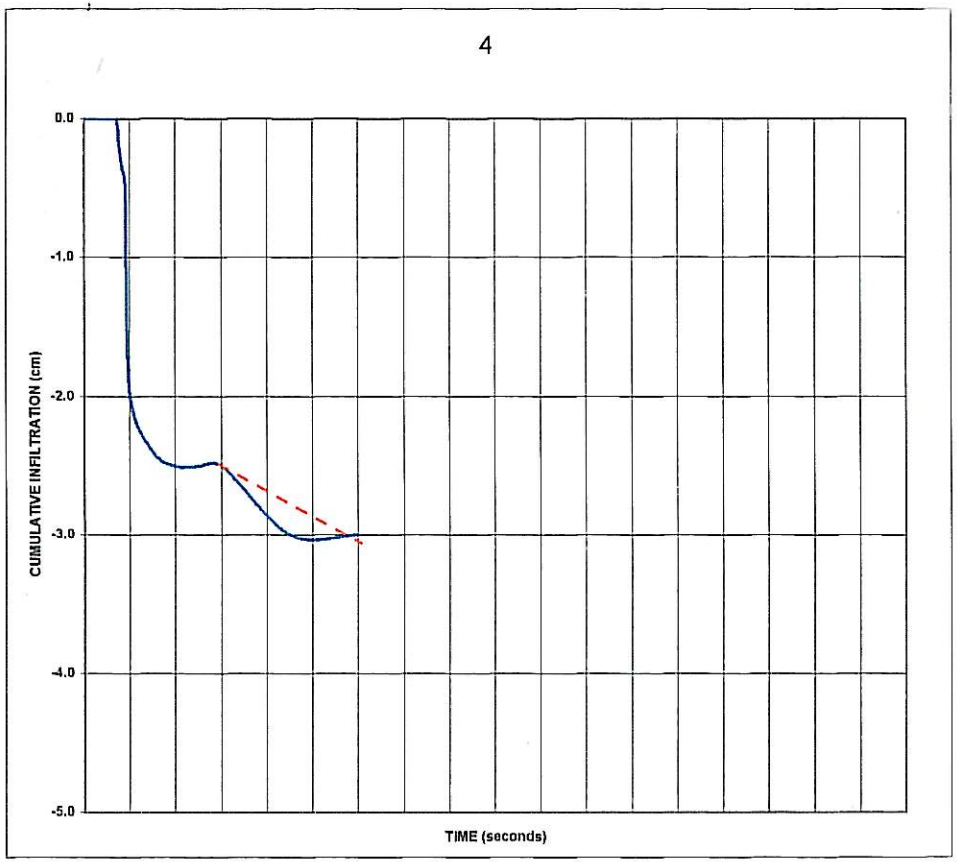
k_m =	-1.3E-03 $cm.s^{-1}$

DOUBLE-RING INFILTROMETER TEST

PROJECT:	Cala Sanitation

Inner Ring Dia.:	28	cm
Ring Height:	24	cm
Test No.:	4	
Position:	0.9 mbgl	
Material:		

Time (sec)	Cum. Infilt	
0	0.0	
15	0.0	
30	0.0	
45	0.0	
60	0.0	1 min
90	0.0	
120	0.0	2 min
150	0.0	
180	0.0	3 min
210	0.0	
240	0.0	4 min
270	0.0	
300	0.0	5 min
360	0.0	6 min
420	0.0	7 min
480	-0.3	8 min
540	-0.5	9 min
600	-2.0	10 min
900	-2.4	15 min
1200	-2.5	20 min
1500	-2.5	25 min
1800	-2.5	30 min
2700	-3.0	45 min
3600	-3.0	1 HOUR
4500		1 hr 15 min
5400		1 hr 30 min
6300		1 hr 45 min
7200		2 HOURS
8100		2 hr 15 min
9000		2 hr 30 min
9900		2 hr 45 min
10800		3 HOURS



h_1 =	-2.5	initial height (cm)
h_2 =	-3.0	final height (cm)
Δt =	1800	time difference (sec)

k_m =	-2.8E-04	$cm.s^{-1}$