



GEOHYDROLOGICAL REPORT

Groundwater source development at Manenzhe village.

**For
Kwezi V3 Engineers**

**Mutale Municipality
Vhembe District
Limpopo Province**

**REPORT-VSALEB/PR05/045
August 2005**

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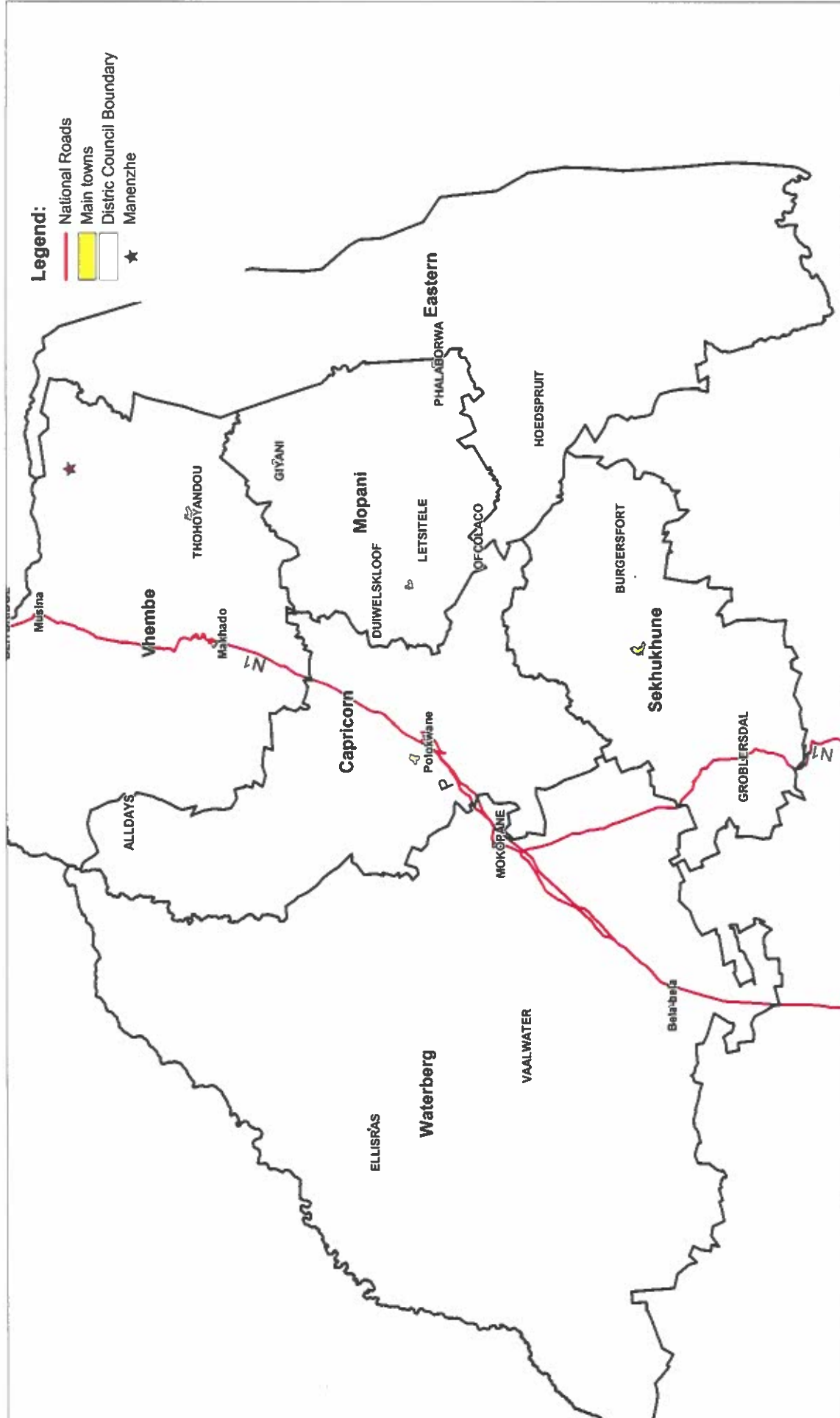
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Map A : Locality Map



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Scale 1 : 2,500,500
 Scanned Maps

1 INTRODUCTION:

1.1 Background:

Kwezi V3 Consulting Engineers appointed VSA Leboa Consulting in May 2005 as geohydrological consultant for the development of groundwater sources at Manenzhe village. This project forms part of the Manenzhe/Bale water supply project –VDM541/MIG under the Vhembe District Municipality. The geohydrological actions at Manenzhe village included a first phase satellite imagery interpretation, geophysical survey, the drilling and testing of one new production borehole and the testing of one existing borehole under supervision of a consultant. On completion of the project a data report was compiled. Two copies of these were forwarded to the consulting engineer and one The Department of Water Affairs and Forestry. This data will be captured electronically to update the National Ground Water Data Base and Grip Web site.

1.2 Location:

The Manenzhe project is approximately 60km east of Tshipise. The project area falls within the Vhembe District Municipality in the Limpopo province. The village coordinates is more or less at latitude 22° 28' 00"S and longitude 30° 41' 00"E and falls on 1:50 000 map sheets 2230BC Mulaladrif.

1.3 Objective:

The objective was to develop one new groundwater source near the village and to test one existing borehole. These sources must supply in the demand of Manenzhe and Bale.

1.4 Methodology:

- VSA Leboa Submit a phased approach quotation.
- Appointment for the drilling and testing contractor through the geohydrological Consultant.
- Terra Aster satellite imagery interpretation and geophysical field survey on selected traverses.
- Drilling and testing by appointed contractors under supervision of the consultant.
- Management recommendation.
- Final Geohydrological data report.

2 REGIONAL GEOLOGY:

Table 1 : Regional geology as obtained from the 1:250 000 geological map series 2230 Messina.

Age	Super group	Formation	Lithological description	
Quaternary				
Triassic	Karoo	Letaba. (Jl)	Basalt: massive, fine-grained, dark-grey or greenish black in colour.	
		Clarens	Tshipise (Trct)	Fine-grained whitish to pinkish sandstone
			Red Rocks (Trcr)	Fine-grained, white and red mottled argillaceous sandstone.

2.1 Quaternary Deposits:

Quaternary Deposits in the area consist of alluvium, sand, scree, gravel, calcrete and ferricrete.

2.2 Karoo Supergroup:

Underlying the study area are rocks of the Karoo Supergroup consisting of the lower argillaceous and arenaceous Tshidzi, Madzaringwe, Mikambeni and Fripp Formations grouped together, the Solitude and Klopperfontein Formations grouped together, the Bosbokpoort and Clarens Formations and the upper basaltic volcanic Letaba Formation.

2.2.1 Letaba Formation:

Rocks of the Letaba formation underlay the study area. This Formation, forming part of the upper succession of the Karoo Supergroup, is almost entirely composed of basaltic lava with subordinate andesite, rhyolite and tuffs. Outcrops are generally poor but the basalt could be described as massive, fine-grained, dark-grey or greenish black in color.

2.2.2 Clarens Formation.

Two members are described under this formation the first being the younger Tshipise (Trct) Member and the second the Red Rocks (Trcr) Member. The Tshipise Member is described to consist of fine-grained whitish to pinkish sandstone. In H22-0878 basalt was drilled and at a depth of 54m sandstone

was struck. A blow yield of 3l/s was measured. Deeper strikes in this rocks resulted in a blow yield of 10l/s. The drilling was stopped at 164m as drilling conditions become very difficult.

Rocks of the Red Rocks Member were drilled at H22-0877 and H22-0862. Very low yields were obtained in both holes.

2.3 Structural geology:

Two intersecting fault systems can be recognized transecting both Karoo and Soutpansberg strata. The first is composed of faults which trend east northeast, parallel to the regional strike, and delineate major horst-and-graben structures. The throw is either to the north or south with the maximum vertical displacement believed not to exceed 500m. The second fault system is oblique to the regional strike and has faults trending west-northwest to northwest. The throw is generally to the south –west with vertical displacement estimated to be up to 1500m. (Siloam fault).

Various inferred lineaments are indicated on the Aster satellite imagery interpretation. Geophysical traverses were done at some of the interpreted lineaments resulting in the drilling of three new boreholes.

3 REMOTE SENSING:

ASTER (Advanced Spaceborne Thermal Emission and Radiometer) is an imaging instrument on board Terra - the first Earth Observing System (EOS) satellite. Terra was launched on December 18, 1999 from the Vandenberg Air Force Base in California and flies in a sun synchronous polar orbit, crossing the equator in the morning at 10:30.

ASTER is one of the five state-of-the-art instrument sensor systems onboard Terra with a unique combination of wide spectral coverage and high spatial resolution in the visible near infrared through short wave infrared to the thermal infrared regions. A consortium of Japanese government, industry, and research groups built it. ASTER data is expected to contribute to a wide array of global change-related application areas including vegetation and ecosystem dynamics, hazard monitoring, geology and soils, land surface climatology, hydrology, and land cover change.

ASTER consists of three different subsystems; the Visible and Near Infrared (VNIR), the Short wave Infrared (SWIR) and the Thermal Infrared (TIR). The VNIR subsystem consists of two independent telescope assemblies. One is vertical looking and has three detector arrays collecting data in the visible green, visible red and near Infrared wavelengths, while a backward looking telescope has one detector array in the same spectral band as the near infrared of the vertical array. These infrared arrays (3N and 3B) generate an along-track stereo image pair with a base-to-height ratio of 0.6 and an intersection angle of 27.7 degrees and can be used to create Digital Elevation Models (DEM's).

4 GEOPHYSICAL INVESTIGATION:

The position of ground geophysical surveys was chosen on interpretation of the local geological features, topography and the results of the imagery interpretation. The magnetic and electromagnetic methods were employed to locate possible zones that may have a bearing on the occurrence and storage of groundwater. Two geophysical survey lines were done with lengths ranging from 300m to 500m with a total of 800m on completion. Field readings were measured at intervals of 10m for the EM-34 (20 and 40m coil separation) and 5m for the magnetometer. This data was plotted and anomalies interpreted to locate the most promising sites that could lead to the successful development of production boreholes. Man made topographical features such as power lines can influence and restrict the optimal usage of geophysical methods. Where possible traverses were done to avoid these influences.

4.1 The Magnetic method:

The different magnetic susceptibilities of different rock types result in contrasting magnetic signatures. Analysis of the amplitude or intensity of the magnetic anomalies as well as its graphical shape taking in account the traverse direction bears some relationship to magnetic mineral content, size, depth, shape and orientation of the buried body or structure. Hence, the magnetic data may be interpreted to represent dykes, geological contacts and faults that may have a bearing on the occurrence, storage and movement of the groundwater. A Chemtron model G5 proton-precision magnetometer (Fig.1) was used, measuring directly the strength of the total magnetic field at a given locality.



Figure 1 : The Chemtron model G5 proton-precision magnetometer.

4.2 Frequency Domain Electromagnetic Methods:

The operating principles of the EM-34 system are briefly discussed below. The technique provides rapid and easy measurement of terrain conductivities and facilitates the detection of steeply dipping



Figure 2: The EM-34 System.

conductor type targets such as dykes, fracture zones, faults etc. through electromagnetic coupling. The EM-34 (Fig.2) is a moving source-moving receiver system, which measures the ratio of the quadrate component of the secondary magnetic field to the free space primary magnetic field. A cable connects the transmitter and receiver units, acting as a reference to the primary magnetic field.

The twenty and forty metres coil separations used for the EM-34 profiling allowed relatively rapid surveying and, in general, low noise levels. The receiver unit is calibrated to indicate apparent conductivity (1-300 mS/m). At low values of terrain conductivity (<100 mS/m), apparent conductivities are linearly proportional to actual conductivities. For resistive terrains (low conductivities), the vertical depth of exploration over the homogeneous or horizontally stratified earth for coil separations of 10, 20 or 40m are 15, 30 and 60m (horizontal coils) and 7.5, 15 and 30m (vertical coils) respectively. The lateral extent of the volume of the earth, whose conductivity is sensed, approximates the vertical depth and small changes in conductivity (5 to 10 mS/m) are readily and accurately measured. The detect ability of fracture zone depends on their width, the thickness and conductivity of the overburden layer, the quality of the groundwater and the depth of the ground water level.

4.3 Results of the geophysical investigation:

Table 2: Summary of geophysical investigation:

Traverse Number	Length (m)	Co-ordinates Start	Co-ordinates End	Interpreted Target	Drill Position	Borehole Number
Line 1	300	22° 28' 17.5"	22° 28' 23.3"	Possible deep weathering in the Sandstone	35	H22-0877
		30° 40' 56.0"	30° 40' 47.7"		80	H22-0862
Line 2	500	22° 28' 19.7" 30° 40' 34.1"	22° 28' 04.5" 30° 40' 39.6"	Contact zone Basalt and Sandstone	380	H22-0878

5 PERCUSSION DRILLING:

Three boreholes were drilled and field marked to specifications as laid down by the Department of Water Affairs and Forestry in their "Minimum Standards and Guidelines for Groundwater Resource Development for the community Water Supply and Sanitation Program"

The method employed for the sinking of water supply boreholes was that of rotary air percussion



Figure 3 : The rotary air percussion drill rig

drilling employing a down-the-hole (TDH) hammer. This drilling technique is ideally suited for hard rock formations. The cuttings brought to the surface by air return from the bore were collected and described for each meter drilled. The lithologies described are presented in borehole logs in the Appendix, together with all other relevant information pertaining to and obtained from the boreholes.

Water intersections were recorded, and blow yields measured using a V-notch. By using a dip meter, the static water level of the boreholes was determined.

H22-0878 was drilled and developed as a production borehole by installing 165mm x 4mm steel casing from the surface through the unstable and fractured material to at least 3m in solid rock. Gravel pack and a sanitary seal were installed as per DWAF specification. The sanitary seal is installed to prevent the ingress of potentially contaminated surface water into the borehole via the borehole sidewall and the outside of the casing. Due to budget constraints the hole were drilled to 84m penetrating the sandstone from 54m. The Department of Water Affairs is currently doing research on the sandstone basalt contact and they agreed to help the project by drilling the hole deeper. Drilling was stopped at 164m due to difficult drilling conditions. The blow yield was 10l/s due to fractures in the sandstone. The results of the drilling phase is summarized in Table 3:

5.1 Drilling Results

Table 3: Summary of drilling results:

Geophysical target	Borehole Number	Depth (m)	Water strike (m)	Aquifer	Blow yield l/s
Line 1/80	H22-0862	86		Fractures	Seepage
Line 1/40	H22-0877	152		Fractures	Seepage
Line 2/380	H22-0878	164	54 >100	Contact basalt and sandstone and deep fractures in the sandstone	10 l/s

6 TEST PUMPING AND RESULTS:

The correct operation and utilisation of boreholes result from the assessment of the productive capacity (sustainable yield) of the borehole as well as the productivity of the aquifer supporting the borehole. Such knowledge is provided by data analysis of boreholes subjected to detailed pumping test programs. Test pumping provides a means of identifying potential constraints on the performance of a borehole and on the exploitation of the groundwater resource. The recognition and understanding of these constraints would result in proper groundwater utilization and management. One new production and one existing production borehole was subjected to the full testing program consisting of a step draw down test and a constant discharge test. The recommendations on the available abstraction volume for the tested boreholes were calculated using the FC-method. This method calculate the available volume of abstraction as such that the static water level will not reach the main water strikes in a 2-year period with no recharge to the aquifer.

6.1 Step down test:

The **step draw down test** is performed to assess the efficiency of the borehole, and to determine at which rate a longer duration test (constant discharge test) can be performed. It entails pumping the hole at two or more sequentially higher pumping rates each maintained for an equal length of time (generally not less than 60 minutes and seldom longer than 120 minutes). The magnitude by which the water level in the borehole drops (known as the **draw down**) in response to these known pumping rates is measured and recorded in accordance with a prescribed time schedule. The water level is also measured and recorded, again to a prescribed time schedule, for a period of time immediately following the period of pumping. This represents the period of recovery in which the water level rises towards its starting level before pumping.

6.2 Constant Discharge test:

The **constant discharge test** is performed to determine aquifer parameter values (transmissivity and storativity) and to determine the possible existence of groundwater barrier boundaries. The test entails pumping the borehole at a single pumping rate, which is kept constant for the entire duration of the test (8-72 hours). The draw down in water level in the borehole during the course of the test is again measured and recorded according to a prescribed time schedule. In the case of the constant discharge test the recovery period is also measured and recorded.

The data obtained from the constant discharge test permits the calculation of the specific capacity of the borehole at the set-pumping rate after a substantially longer period of pumping. A comparison of this value with those obtained from the step draw down test offers a means of assessing the more realistic productivity of the borehole under operating conditions.

6.3 Testing Results:

Table 4: Summary of testing results:

BOREHOLE	STATUS	TESTING PROGRAM	RECOVERY	RECOMMENDATION
H22-0878	Newly drilled	4x 60 min step tests and a 4320 min constant test with recovery measurements.	99% within 2640minutes	6.20 l/s for 10hours 4.00l/s for 24hours.
H22-0152	Existing borehole	4x 60 min step tests and a 2880 min constant test with recovery measurements.	99.7% within pumping time	3.10l/s for 10hours 2.00l/s for 24hours.

7 HYDROCHEMISTRY:

Groundwater samples were collected at the final pumping stage of the testing program at H22-0152 and H22-0878. The samples were sent to UIS Analytical Services (PTY) Ltd for the preliminary analysis as well as to the DWAF Laboratory in Pretoria for a full analysis of the main hydro chemical concentrations (macro elements) in the groundwater samples. Elements analysed for include: F, Fe, Mn, Ca, Mg, Na, K, Cl, NO₃ and NO₂ as N, SO₄, PO₄, NH₄, CO₂, HCO₃. The laboratory analyses expressed in mg/l are presented in Table 6.

At the time of reporting only the preliminary analysis was available.

7.1 Water quality:

Water quality of domestic water, utilized for human consumption and food preparation, must be safe to use if the consumers' health is to be protected. For this reason the "Quality of Domestic Water Supplies" (Second edition, 1998) was set forward by the Department of Water Affairs and Forestry, Department of Health and the Water Research Commission in 1998. This document facilitates the evaluation of water on the basis of five water quality classes:

Table 5: Classification parameters.

Class	PH	TDS	EC	Total Hardness	Ca	Mg	Cl	SO ₄	NO ₃	Na	K	F
Class 0	5.00-9.50	<450	<70	0-200	0-80	<30-70	<100	<100-200	<6	<100	<25	<0.7
Class 1	4.50-5.00	450-1000	70-150	200-300	80-150	70-100	100-200	200-400	6-10	100-200	25-50	0.7-1.00
Class 2	4-4.50	1000-2400	150-370	300-600	150-300	100-200	200-600	400-600	10-20	200-400	50-100	1.00-1.50
Class 3	3.00-4.00	2400-3400	370-520	>600	>300	200-400	600-1200	600-1000	20-40	400-1000	100-500	1.50-3.50
Class 4	<3->11	>3400	>520			>400	>1200	>1000	>40	>1000	>500	>3.50

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.

7.2 Chemical Results:

Table 6: Preliminary hydro chemical results:

BOREHOLE	Ph	EC	TDS	Fe	Mn	Cl	N	SO4	F	CLASS
H22-0152	7.38	91	882	0.08	0.01	116.6	47.6	12	0.7	4
H22-0878	7.55	79	740	0.05	0.05	62.8	27.8	6.2	0.6	3

Domestic use: Hydro chemical results of H22-0152 are classified as a dangerous water quality (class 4) due to the Nitrate and Nitrite (N) concentration in the groundwater.

Hydro chemical results of H22-0878 are classified as a poor water quality (class 3) due to the Nitrate and Nitrite (N) concentration in the groundwater.

7.2.1 Health effects humans

7.2.1.1 Nitrate:

Nitrate range 20-40mg/l: Possible chronic risk to some babies. Nitrate has the potential to cause tiredness and failure to thrive. This is the most common effect and is chronic in nature. In extreme case cyanosis and difficulty in breathing in bottle fed infants under the age of 1 year may occur. This rare condition is due to reduction of nitrate to nitrite, which then combines with the red blood pigment, haemoglobin to form methaemoglobin in the presence of an abnormal gut flora.

8 CONCLUSIONS:

- The methodology followed led to the successful development of a new ground water source.
- A good groundwater target in the area is the basalt sandstone contact that will yield some water in most cases.
- It seems that the contact must be struck within 100m and that the underlying sandstone must be penetrated for at least another 100m.
- Hydro chemical results of H22-0152 are classified as a dangerous water quality (class 4) due to the Nitrate and Nitrite (N) concentration in the groundwater. This water source were the only source for many years and will be difficult to inform the community about it's dangers.
- Hydro chemical results of H22-0878 are classified as a poor water quality (class 3) due to the Nitrate and Nitrite (N) concentration in the groundwater.
- Nitrate range 20-40mg/l: Possible chronic risk to some babies. Nitrate has the potential to cause tiredness and failure to thrive. This is the most common effect and is chronic in nature. In extreme case cyanosis and difficulty in breathing in bottle fed infants under the age of 1

year may occur. This rare condition is due to reduction of nitrate to nitrite, which then combines with the red blood pigment, haemoglobin to form methaemoglobin in the presence of an abnormal gut flora.

9 RECOMMENDATIONS:

- Class 3 and 4 water quality is usually not equipped for human consumption. H22-0152 was the only source for many years and it will be difficult to de-commission. The District Municipality and the community should be informed and if they agree to use the boreholes it can be equipped with warning boards informing the community of the dangers. The nitrate pollution is usually due to poor sanitation practices and it should be addressed.

10 REFERENCE:

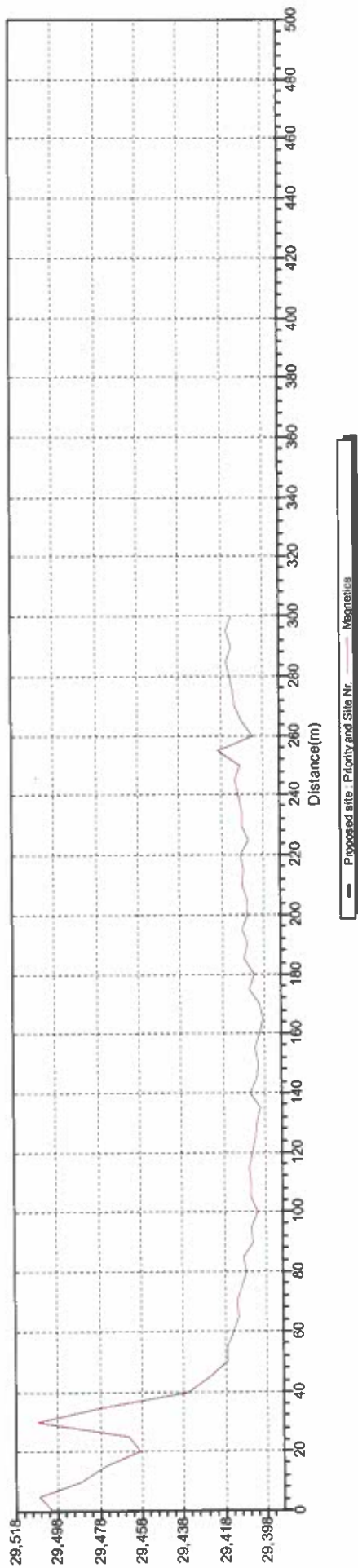
- Existing information from the grip Internet site, The National Groundwater Data Base and The Limpopo Aquabase Data Base. This information sites is updated and maintained by The Department of Water Affairs and Forestry.
- BRANDL, G. (1986). The geology of the Messina area: Expl. Sheet geol. Surv. S. Afr., 2230 (Messina),
- Water Research Commission No TT101/98 (1998). Quality of domestic water supplies. Volume 1 Assessment Guide.

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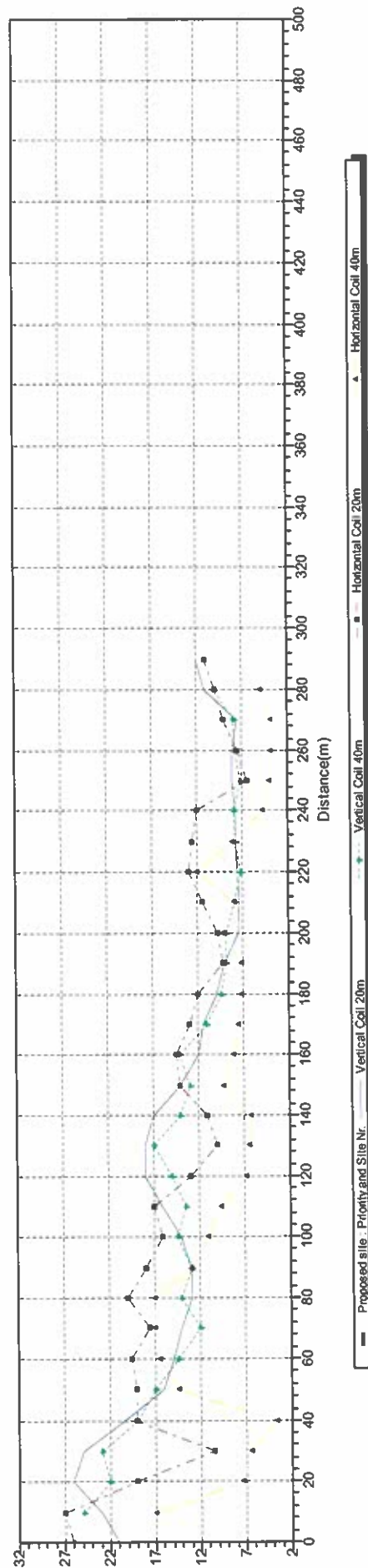
Appendix

Geophysical Traverse

Magnetic Traverse: 20050627TRAV0003
VHEM/EMANENZHE/PRO05/045/EMANENZ1



EM34 Traverse: 20050627TRAV0003
VHEM/EMANENZHE/PRO05/045/EMANENZ1



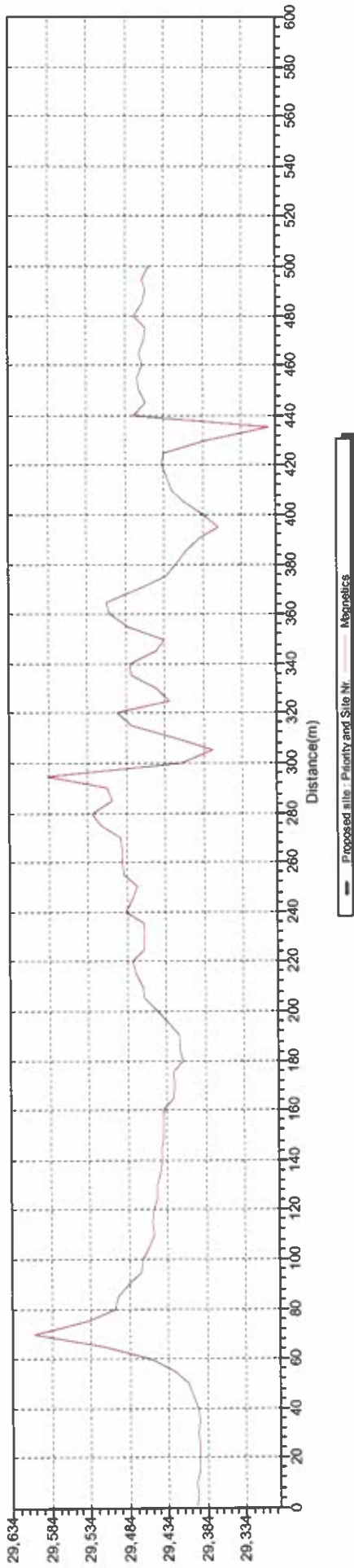
PROJECT DESCRIPTION:
popo Province/Manenzhe/Mataula
OBC

Tr name: Vhenda
start: 22° 28' 17.5" Lat end: 22° 28' 23.3"
g start: 30° 40' 56.0" Long end: 30° 40' 47.7"
240° NE-SW

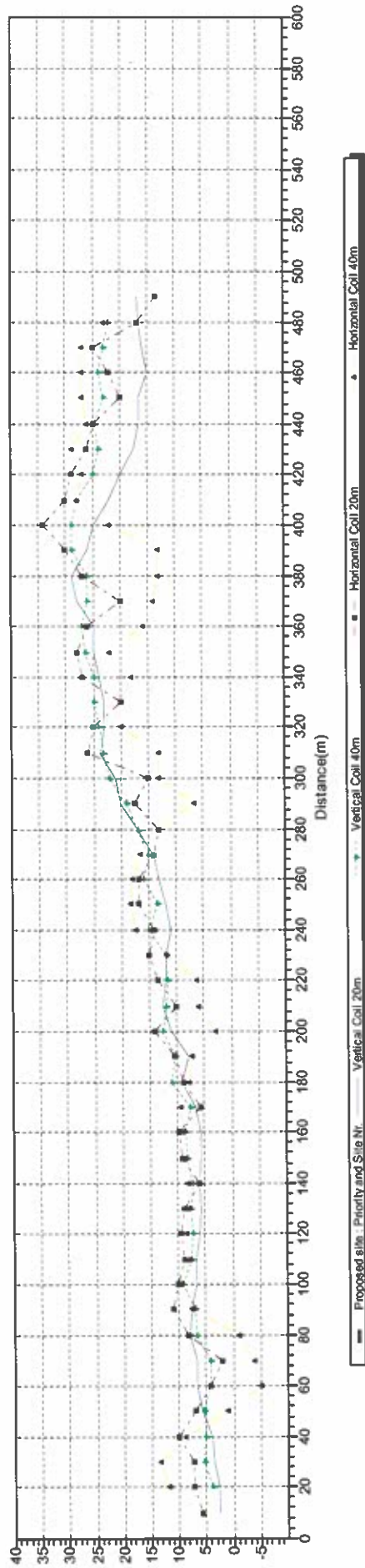


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Magnetic Traverse: 20050627TRAV0004
VHEMBE/MANENZHE/PRO05/045/LINE 2



EM34 Traverse: 20050627TRAV0004
VHEMBE/MANENZHE/PRO05/045/LINE 2



PROJECT DESCRIPTION:
Koppe Province/Manenzhe/Malaula

Site name: Vhembe
Start: 22° 28' 19.7" Lat end: 22° 28' 04.5"
15° S-N 30° 40' 34.1" Long end: 30° 40' 39.6"



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Borehole Logs

(Per Borehole)

Borehole Construction and Geological Log

Date compiled: 2005/08/22

BASIC SITE INFORMATION: Site Identifier: 2230BCV0052 Number: H22-0862 Site type: Borehole

Distr./Farm No.: LPMT095

Site Name/Des.: DOPPIE/MANENZHE

Region Type: District Council

Region Descr.: VHEMBE/MUTALE

Latitude [°]: 22.471944

Reg./BB.:

Topo-set.: Flat surface, plain

Depth [m]: 86.00

Longitude [°]: 30.681583

Site status: Unused

Col. ht. [m]: 0.40

Altitude [m]: 473.00

G-Nr.:

Site purp.: Exploration

Diam. [mm]: 165

Coord. acc.: Accurate to within 100 units

Use applic.:

Drain. reg.:

Coord. meth.: Global Positioning System

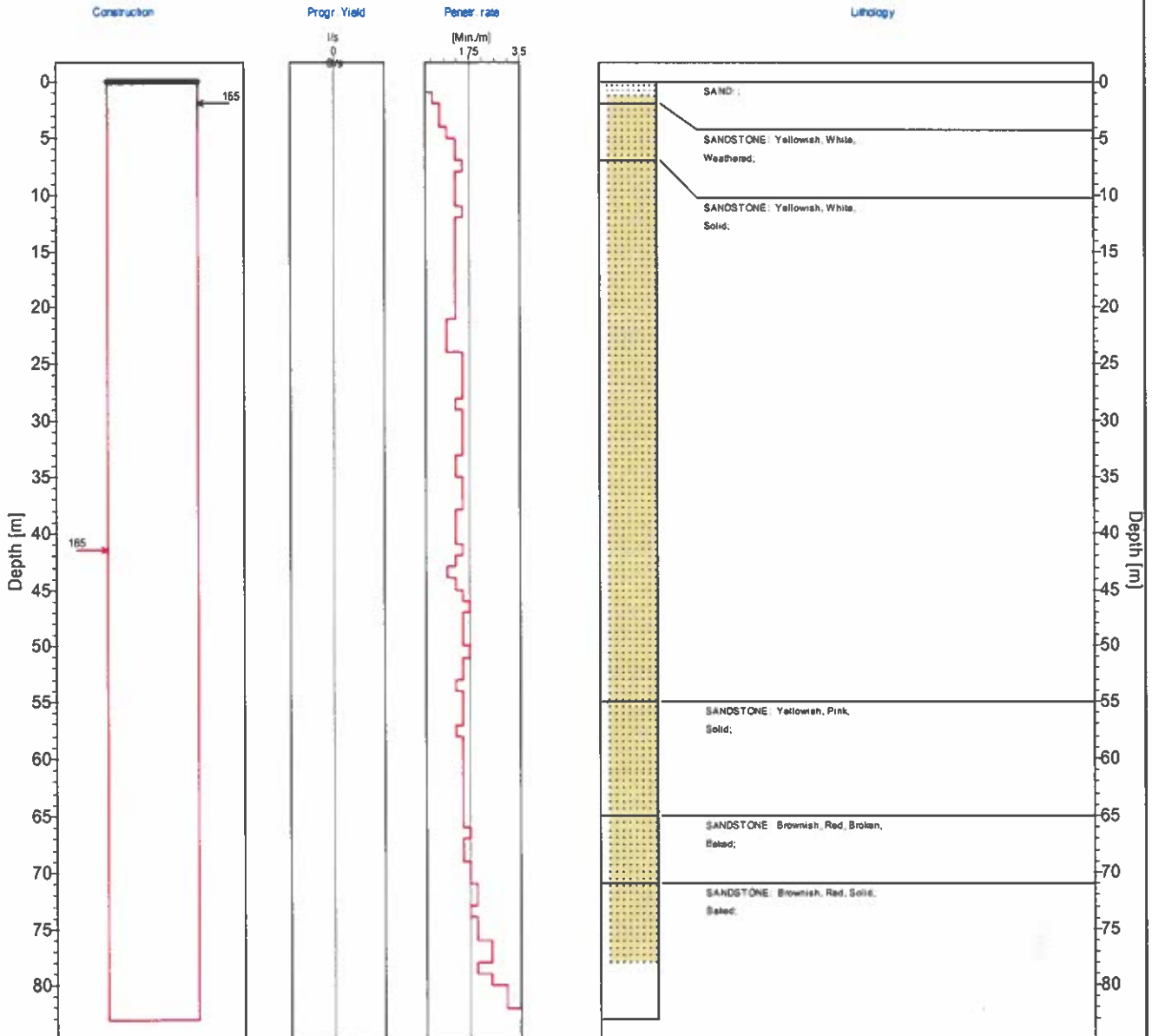
Equipment: No equipment

Rep. inst.: VSA

Coordinate System: Geographic Decimal Degrees (Longitude/Latitude), WGS 1984

Construction and Geohydrological Legend

-  Hole
-  Casing (plain/perforated, slotted)
-  Screen/ Mesh Screen
-  Piezometer
-  165 Hole diameter (mm)
-  152 Casing diameter (mm)
-  Waterlevel with date meas
-  0.50 Piezometer (Nr & Diameter (mm))



COMMENT:



VSA Leboa Consulting (Pty) Ltd.
 P.O.Box 222, Pietersburg, 0700
 Tel: 015 296 2004 / 296 2300
 Fax: 015 296 2300
 E-mail: vsaleboa@mweb.co.za

Borehole Construction and Geological Log

Date compiled: 2005/08/22

BASIC SITE INFORMATION: Site Identifier: 2230BCV0053 Number: H22-0877 Site type: Borehole

Distr./Farm No.: LPMT095

Site Name/Des.: DOPPIE/MANENZHE

Region Type: District Council

Region Descr.: VHEMBE/MUTALE

Latitude [°]: 22.471694

Reg./BB.:

Topo-set.: Flat surface, plain

Depth [m]: 152.00

Longitude [°]: 30.681972

Site status: Unused

Col. ht. [m]: 0.50

Altitude [m]: 472.00

G-Nr.:

Site purp.: Exploration

Diam. [mm]: 165

Coord. acc.: Accurate to within 100 units

Use applic.:

Drain. reg.:

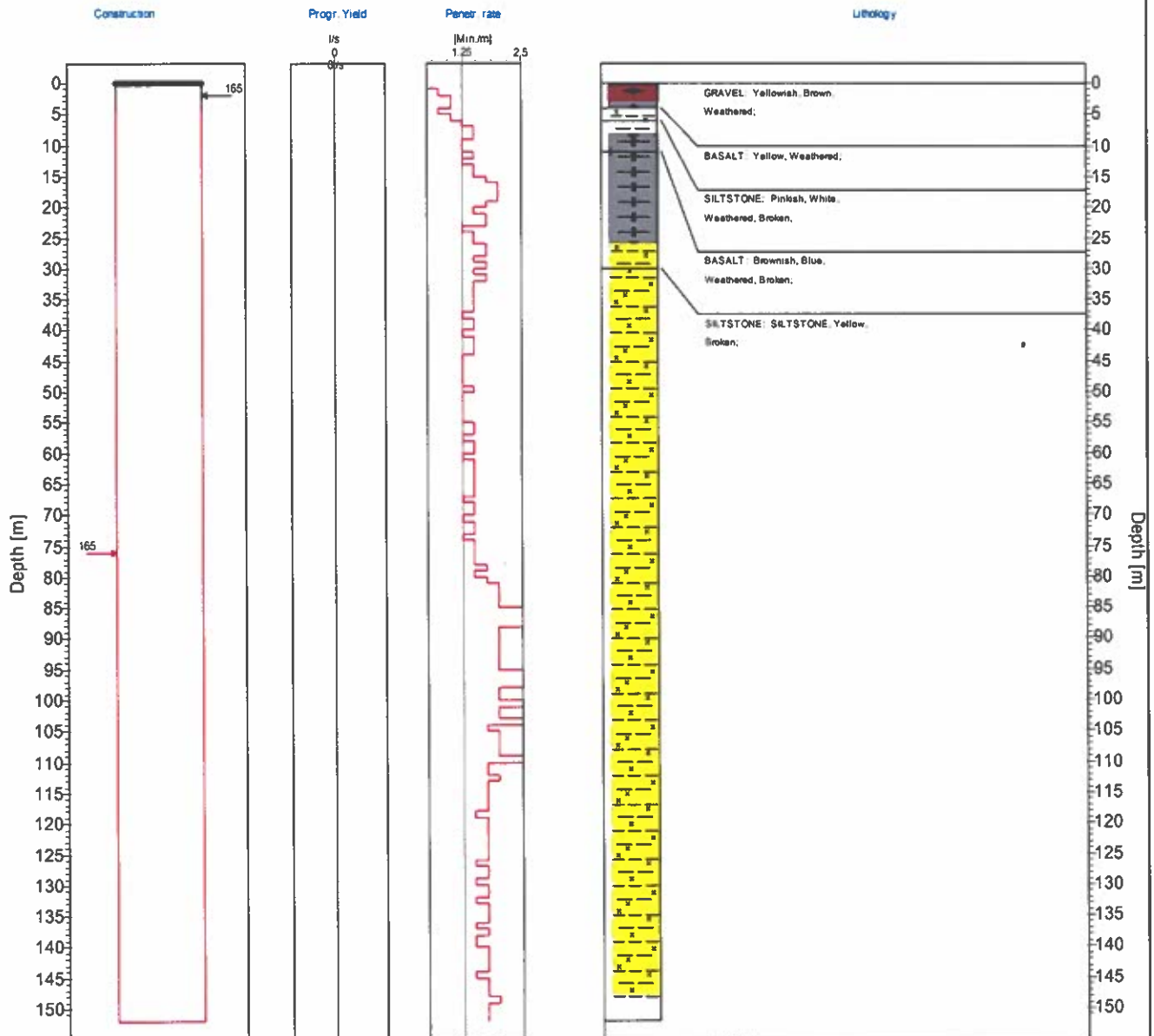
Coord. meth.:

Equipment: No equipment

Rep. inst.: VSA

Coordinate System: Geographic Decimal Degrees (Longitude/Latitude), WGS 1984

Construction and Geohydrological Legend



COMMENT:



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Borehole Construction and Geological Log

Date compiled: 2005/08/22

BASIC SITE INFORMATION: Site Identifier: 2230BCV0054 Number: H22-0878 Site type: Borehole

Distr./Farm No.: LPLT000

Site Name/Des.: STATELAND/MATAULU

Region Type: District Council

Region Descr.: VHEMBE/MUTALE

Latitude [°]: 22.468944

Reg./BB.:

Topo-set:

Depth [m]: 165.00

Longitude [°]: 30.677250

Site status:

Col. ht. [m]: 0.48

Altitude [m]: 473.00

G-Nr.:

Site purp.:

Diam. [mm]: 165

Coord. acc.: Accurate to within 100 units

Use applic.:

Drain. reg.: A80J

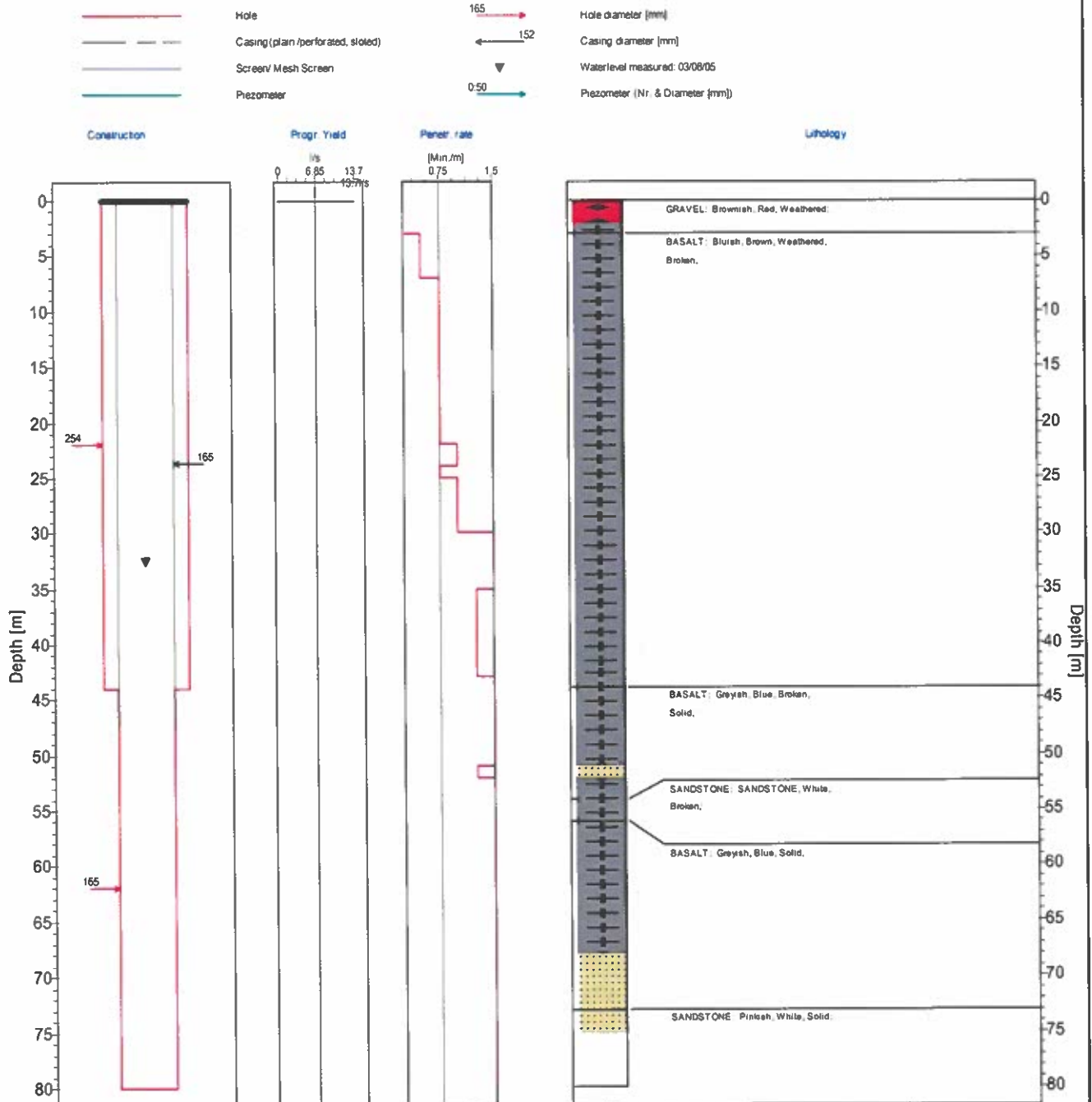
Coord. meth.:

Equipment: No equipment

Rep. inst.: VSA

Coordinate System: Geographic Decimal Degrees (Longitude/Latitude), WGS 1984

Construction and Geohydrological Legend



COMMENT:

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Test Pumping Results

(Per Borehole)

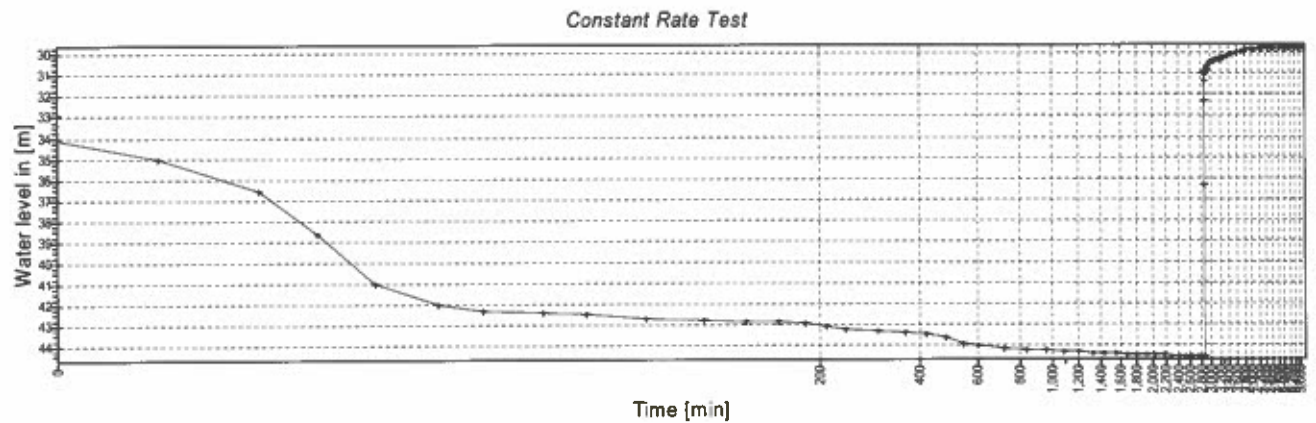
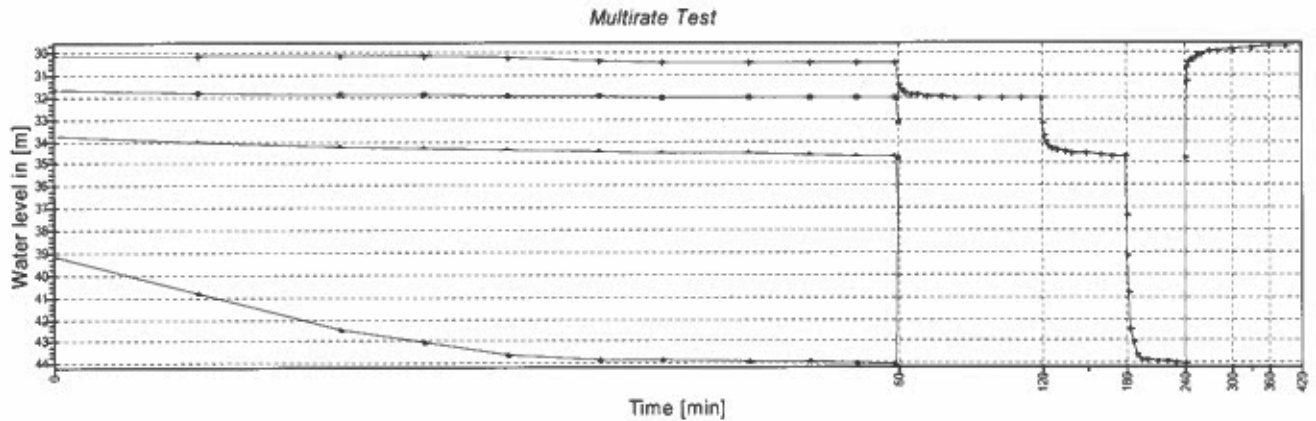
PUMPING TEST REPORT

Date compiled: 2005/08/22

BASIC SITE INFORMATION: Site Identifier: 2230BCV0050 Number: H22-0152 Site type: Borehole
 Distr./Farm No.: LPLT000 Site Name/Des.: STATELAND/MANENZHE

Latitude [°]	22.471390	Alt. No. 1:	Diam. [mm]:	165	Water lev. [m]:	29.08
Longitude [°]	30.678330	Alt. No. 2:	Depth [m]:	77.24	Piezometer:	0
Altitude [m]:	480.00	Rep. inst.: VSA	Col. ht. [mm]:	0.54	Date WL meas.:	20050614

Coordinate System: Geographic Decimal Degrees (Longitude/Latitude), WGS 1984



PUMPING TEST:		Depth to intake [m]	Starting Date	Ending Date	Transmis. [m ² /d]	Rec. abs. [l/s]
Rep. Inst.	Meth. tested		Date	Date		Storativ.
VSA	Multirate test	56.50	20050614	20050614		
VSA	Constant rate test	56.50	20050614	20050618		

TESTING DETAILS:		Durat. [min]	Depth to intk. [m]	Disch. rate [l/s]	Drawd. [m]	Recov. [m]	Rec. Dur. [min]	Trans. [m ² /d]	Perm. [m/d]	Storat.	Q/st
Description	Time start.										
MULTI STEP 1	1341	60	56.50	0.47	30.45						0.02
MULTI STEP 2	1441	60	56.50	1.01	31.99						0.03
MULTI STEP 3	1541	60	56.50	2.05	34.67						0.06
MULTI STEP 4	1641	60	56.50	5.21	44.05	29.70	32	180			0.12
CONSTANT RATE	2046	2880	56.50	5.15	44.51	29.75	33	2880			0.12



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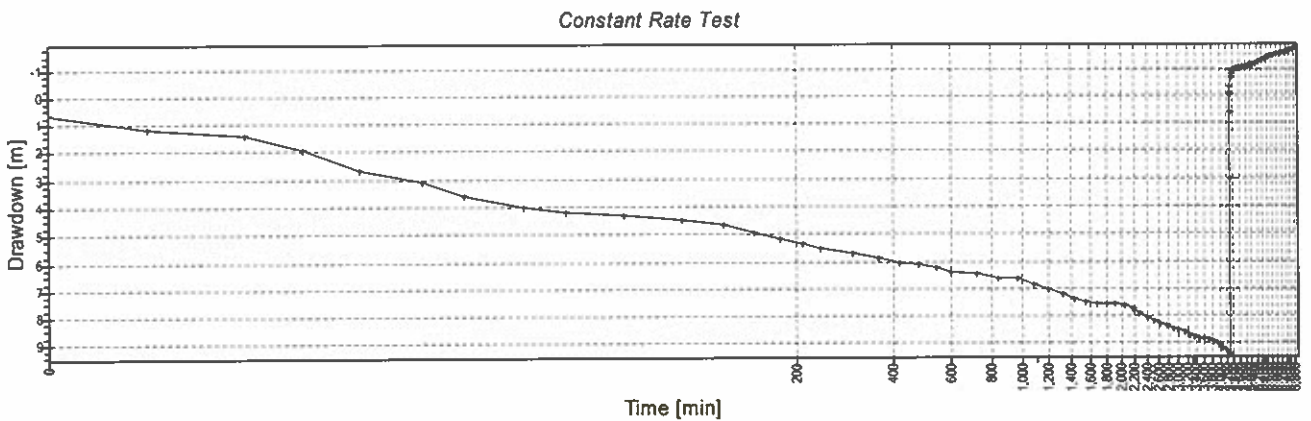
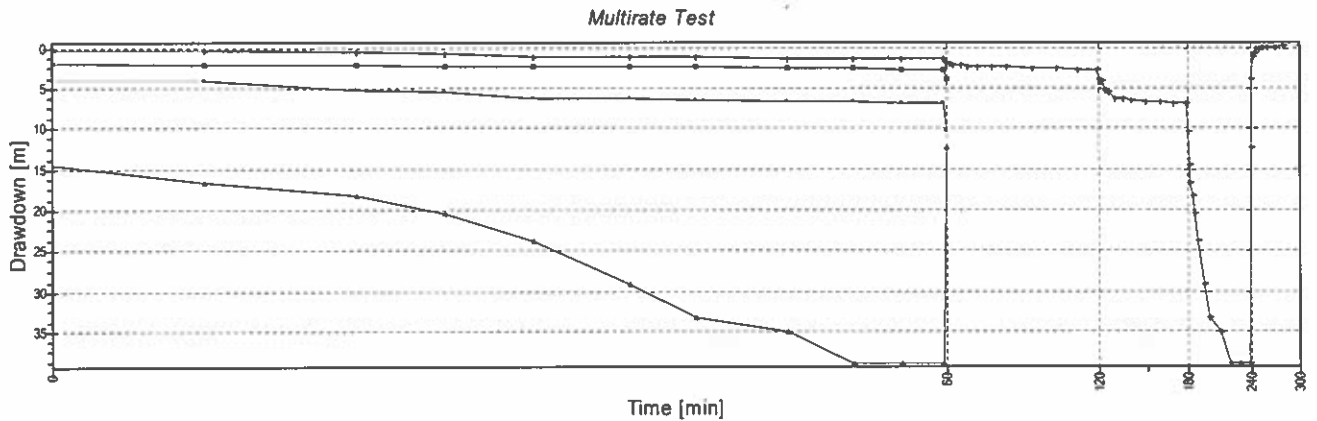
PUMPING TEST REPORT

Date compiled: 2005/08/22

BASIC SITE INFORMATION: Site Identifier: 2230BCV0054 Number: H22-0878 Site type: Borehole
 Distr./Farm No.: LPLT000 Site Name/Des.: STATELAND/MATAULU

Latitude [°]	22.468944	Alt. No. 1:	Diam. [mm]:	165	Water lev. [m]:	32.52
Longitude [°]	30.677250	Alt. No. 2:	Depth [m]:	165.00	Piezometer:	0
Altitude [m]:	473.00	Rep. inst.: VSA	Col. ht. [mm]:	0.48	Date WL meas.:	20050803

Coordinate System: Geographic Decimal Degrees (Longitude/Latitude), WGS 1984



PUMPING TEST:		Depth to intake [m]	Starting Date	Ending Date	Transmis. [m ² /d]	Rec. abs. [l/s]
Rep. Inst.	Meth. tested		Time	Time	Storativ.	
VSA	Multirate test	72.80	20050803 1301	20050803 1800		
VSA	Constant rate test	72.80	20050803 1801	20050808 1400		

TESTING DETAILS:		Durat. [min]	Depth to intk. [m]	Disch. rate [l/s]	Drawd. [m]	Recov. [m]	Rec. Dur. [min]	Trans. [m ² /d]	Perm. [m/d]	Storat.	Q/st
Description	Time start.										
MULTI STEP 1	1301	60	72.80	2.50	1.52						1.64
MULTI STEP 2	1401	60	72.80	5.30	3.00						1.77
MULTI STEP 3	1501	60	72.80	10.00	7.14						1.40
MULTI STEP 4	1601	60	72.80	13.70	39.35	0 100	60				0.35
CONSTANT RATE	1801	4320	72.80	12.02	11.18	0.01 99	2640				1.08



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Management
Recommendation
(Per Borehole)

MANAGEMENT RECOMMENDATIONS

BASIC SITE INFORMATION: Site Identifier: 2230BCV0050 Number: H22-0152 Site type: Borehole

Distr./Farm No.: LPLT000 Site Name/Descr.: STATELAND/MANENZHE

Latitude [°]:	22.471390	Alt. No. 1:	Diam. [mm]:	165	Water lev. [m]:	29.08
Longitude [°]:	30.678330	Alt. No. 2:	Depth [m]:	77.24	WL status:	Static
Altitude [m]:	480.00	Rep. inst.: VSA	Col. ht. [m]:	0.54	Date WL meas.:	20050614

Coordinate System: Geographic Decimal Degrees (Longitude/Latitude), WGS 1984

EXISTING EQUIPMENT:

Pump:
 Type of Inst.: Mono-type pump Pulley Diam. [mm]: 140
 Manufacturer: ORBIT Depth to Intk. [m]: 41.20

Engine:
 Manufacturer: Power Rating [kW]
 Type of Power: Diesel engine Pulley Diam. [mm]:

USE APPLICATION:

Site Status: In use
 Purpose: Production (water supply)
 Consumer: Non-urban
 Application: Domestic - all purposes

WATER CHEMISTRY:

Sample No.:	510/2005	Date sampled:	20050616	Depth sampl. [m]:	0	Comment:	
Main Parameters:			Calculated Parameters:		Bacteriol. Parameters:		
pH:	7.38	Na:	Cl:	116.6	Langel.:	E.Coli:	
EC: [mS/m]	91 †	K:	NO3 as N:	47.6 ‡	Aggr-Ind:	7.78	Faec. co:
TDS:	882 †	Si:	SO4:	12	Ion-bal:	-100.00	Total Co:
T. Alk.:		Al:	F:	0.7	CaCO3:		SPC:
Ca:		Fe:	0.08	Concentrations in [mg/l], Bact. param. in counts/100ml; Chemistry Standard: SABS for human consumption			
Mg:		Mn:	0.01	† Value exceeds recommended maximum limit ‡ Value exceeds maximum allowable limit			
				! Value exceeds recommended minimum limit Value exceeds minimum allowable limit			

AQUIFER INFORMATION:

Depth to Top [m]	Depth to Bot. [m]	Yield [l/s]	Method meas.	Aquifer type	Comment
0.00	0.00	5.21	Notch (V- or U-notch)		PUMP SUCTION

CASING DETAILS:

Depth to Top [m]	to Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Type of openings	Openings [mm]:		Hor. Dist.	Vert. Dist.
						Length	Width		
0.00	11.18	165	Steel	4					

TESTING DETAILS:

Description	Date	Durat. [min]	Depth to intk. [m]	Disch. rate [l/s]	Drawd. [m]	Recovery %	[min]	T [m ² /d]	Storage	Comment
MULTI STEP 1	20050614	60	56.50	0.47	30.45					
MULTI STEP 2	20050614	60	56.50	1.01	31.99					
MULTI STEP 3	20050614	60	56.50	2.05	34.67					
MULTI STEP 4	20050614	60	56.50	5.21	44.05	29.70	99	180		
CONSTANT RATE	20050614	2880	56.50	5.15	44.51	29.75	99	2880	29	

RECOMMENDATIONS:

Prior.	Rec. equipm.	Depth to intk. [m]	Type of power	Duty cyc. [hrs]	Disch. rate [l/s]	Water quality description	Dyn. water level [m]	Crit. water level [m]
1		48.00		24	2.00	CLASS 4		
2		48.00		10	3.10	CLASS 4		44.50

Note:

Note: FC PRIORITY 2



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MANAGEMENT RECOMMENDATIONS

Date compiled: 2005/08/22

BASIC SITE INFORMATION: Site Identifier: 2230BCV0054 Number: H22-0878 Site type: Borehole

Distr./Farm No.: LPLT000 Site Name/Descr.: STATELAND/MATAULU

Latitude [°]: 22.468944	Alt. No. 1:	Diam. [mm]: 165	Water lev. [m]: 32.52
Longitude [°]: 30.677250	Alt. No. 2:	Depth [m]: 165.00	WL status: Static
Altitude [m]: 473.00	Rep. inst.: VSA	Col. ht. [m]: 0.48	Date WL meas.: 20050803

Coordinate System: Geographic Decimal Degrees (Longitude/Latitude), WGS 1984

EXISTING EQUIPMENT:

Pump:		Pulley Diam. [mm]:	
Type of Inst.: No equipment		Depth to Intk. [m]:	
Manufacturer:		Power Rating [kW]	
Engine:		Pulley Diam. [mm]:	
Manufacturer:			
Type of Power:			

USE APPLICATION:

Site Status:
Purpose:
Consumer:
Application:

WATER CHEMISTRY:

Sample No.: 661/2005	Date sampled: 20050803	Depth sampl. [m]: 0	Comment:
Main Parameters:		Calculated Parameters:	
pH: 7.55	Na:	Cl: 62.8	Langel.: E.Coli:
EC: [mS/m] 79 †	K:	NO3 as N: 27.8 ‡	Aggr-Ind: 7.95 Faec. co:
TDS: 740 †	Si:	SO4: 6.2	Ion-bal: -100.00 Total Co:
T. Alk.:	Al:	F: 0.6	CaCO3: SPC:
Ca:	Fe: 0.05	Concentrations in [mg/l]; Bact. param. in counts/100ml; Chemistry Standard: SABS for human consumption	
Mg:	Mn: 0.05	† Value exceeds recommended maximum limit ‡ Value exceeds maximum allowable limit	
! Value exceeds recommended minimum limit ; Value exceeds minimum allowable limit			

AQUIFER INFORMATION:

Depth to Top [m]	Depth to Bot. [m]	Yield[l/s]	Method meas.	Aquifer type	Comment
0.00	0.00	13.70	Notch (V- or U-notch)		TESTED

CASING DETAILS:

Depth to Top [m]	to Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Type of openings	Openings [mm]:		Hor. Dist.	Vert. Dist.
						Length	Width		
0.00	47.46	165	Steel	6	Plain casing				

TESTING DETAILS:

Description	Date	Durat. [min]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery %	[min]	T [m³/d]	Storage	Comment
MULTI STEP 1	20050803	60	72.80	2.50	1.52					
MULTI STEP 2	20050803	60	72.80	5.30	3.00					
MULTI STEP 3	20050803	60	72.80	10.00	7.14					
MULTI STEP 4	20050803	60	72.80	13.70	39.35	0	100	60		
CONSTANT RATE	20050803	4320	72.80	12.02	11.18	0.01	99	2640		

RECOMMENDATIONS:

Prior.	Rec. equipm.	Depth to intk. [m]	Type of power	Duty cyc. [hrs]	Disch. rate [l/s]	Water quality description	Dyn. water level [m]	Crit. water level [m]
1		54.00		10	6.20			
Note:								
2		54.00		24	4.00	CLASS 3		44.00
Note: FC PRIORITY 2								



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Summary

Main

H22-0152

Applicable	Method	Sustainable yield (l/s)	Std. Dev	Early T (m ² /d)	Late T (m ² /d)	S	AD used
	Basic FC	2.26	0.91	37	29.2	1.10E-03	14.8
	Advanced FC	2.38		37	29.2	1.00E-03	14.8
	FC inflection point	2.25	0.90				14.8
	Cooper-Jacob	2.13	1.38		29.0	1.06E-03	14.8
	FC Non-Linear	0.82	0.72	29.0		1.00E-03	14.8
	Barker	2.15	0.83	K ₁ = 200	S _s =	1.06E-03	14.8
	Average Q sust (l/s)	2.23	0.10	b = 0.20	Fractal dimension n =	1.95	

Recommended abstraction rate (L/s) **2.00** for 24 hours per day

Hours per day of pumping **10** 3.10 L/s for 10 hours per day
 2.8l/s for 12 hours/day
 Amount of water allowed to be abstracted per month 5184 m³ 3.5l/s for 8 hours/day

Borehole could satisfy the basic human need of 6912 persons

Is the water suitable for domestic use (Yes/No) **Yes**

Comments

This double porosity aquifer is characterised by a good fracture network, consisting of fractures with good extent.

Skin effects and well losses have an influence on early time data.

Linear flow was experienced for the first 15 minutes of the test where water was coming from the fractures.

After 15 minutes the fracture network was encountered at approximately 13m - 14.8m drawdown.

Water was still drawn from this network when the test was terminated after 48 hours with no sign of dewatering of the network.

The T-value of the formation is in the order of 29.

The aim of the recommended maximum safe yield is to prevent the fracture network encountered during the test from dewatering. The limits of the network are however unknown from the test data. A best possible recommendation is made from aquifer characteristics revealed from available data.

Recommended depth of pump = 48m

Critical depth = 44.5m (fracture network encountered during test)

Static water level used during test = 29.7m

Casing depth = 11.2m

Assumptions

One no-flow boundary at 200m

No rainfall recharge

No other production boreholes in the same aquifer

Summary

Main

H22-0878

Applicable	Method	Sustainable yield (l/s)	Std. Dev	Early T (m ² /d)	Late T (m ² /d)	S	AD used
	Basic FC	4.90	2.14	85	67.8	2.20E-03	12.0
	Advanced FC	5.08		85	67.8	1.00E-03	12.0
	FC inflection point	4.23	2.00				8.2
	Cooper-Jacob	4.73	3.06		67.9	1.08E-03	12.0
	FC Non-Linear	4.41	3.89	68.0		1.00E-03	12.0
	Barker	4.63	1.91	$K_f =$ 500		$S_s =$ 1.06E-03	12.0
	Average Q sust (l/s)	4.65	0.31	$b =$ 0.20	Fractal dimension $n =$	1.95	

Recommended abstraction rate (L/s) **4.00** for 24 hours per day

Hours per day of pumping **10** 6.20 L/s for 10 hours per day
5.5l/s for 12 hours/day
7l/s for 8 hours/day

Amount of water allowed to be abstracted per month 10368 m³

Borehole could satisfy the basic human need of 13824 persons

Is the water suitable for domestic use (Yes/No)

Comments

This double porosity aquifer is characterised by a good fracture network, consisting of fractures with good extent.

Skin effects and well losses have an influence on early time data.

Linear flow was experienced for the first 20 minutes of the test where water was coming from the fractures.

After 20 minutes the fracture network was encountered with fractures at 6.1m, 8.2m, 9.3m and 10.7m drawdown within the weathered basalt formation.

After approximately 38 hours, the influence of one no-flow boundary could be detected in the drawdown levels.

The test was terminated after 72 hours with no sign of dewatering of aquifer in the recovery data.

The main waterstrike at 54m depth within the fractured sandstone formation, was not reached during the constant test.

The T-value of the formation is in the order of 68.

According to the step drawdown test, the maximum yield of the borehole is 13.7l/s.

The aim of the recommended maximum safe yield is to prevent the main waterstrike from dewatering.

Recommended depth of pump = 54m (main waterstrike)

Critical depth = 44m (fracture network encountered during test)

Static water level used during test = 33m

Casing depth = 44m

Assumptions

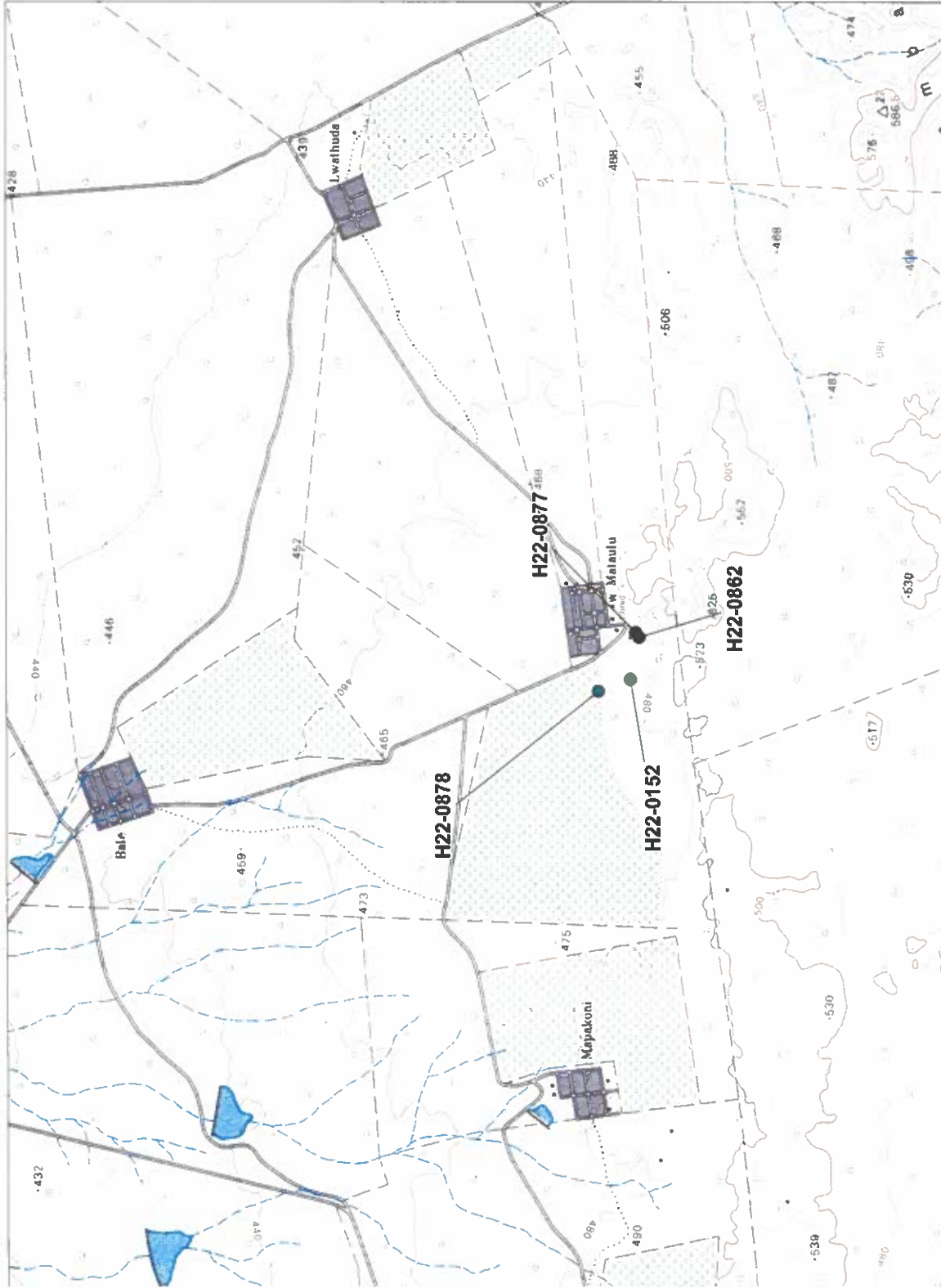
One no-flow boundary at 200m

No rainfall recharge

No other production boreholes in the same aquifer

Maps

Map B : Borehole positions and recommended abstraction yields.



Recommended Yield
(m³/Day)

- 0 to 0.99 (2)
- 255 to 269.99 (1)
- 345 to 359.99 (1)

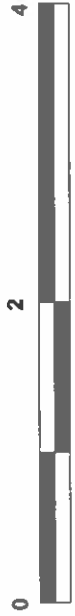


Prepared by:



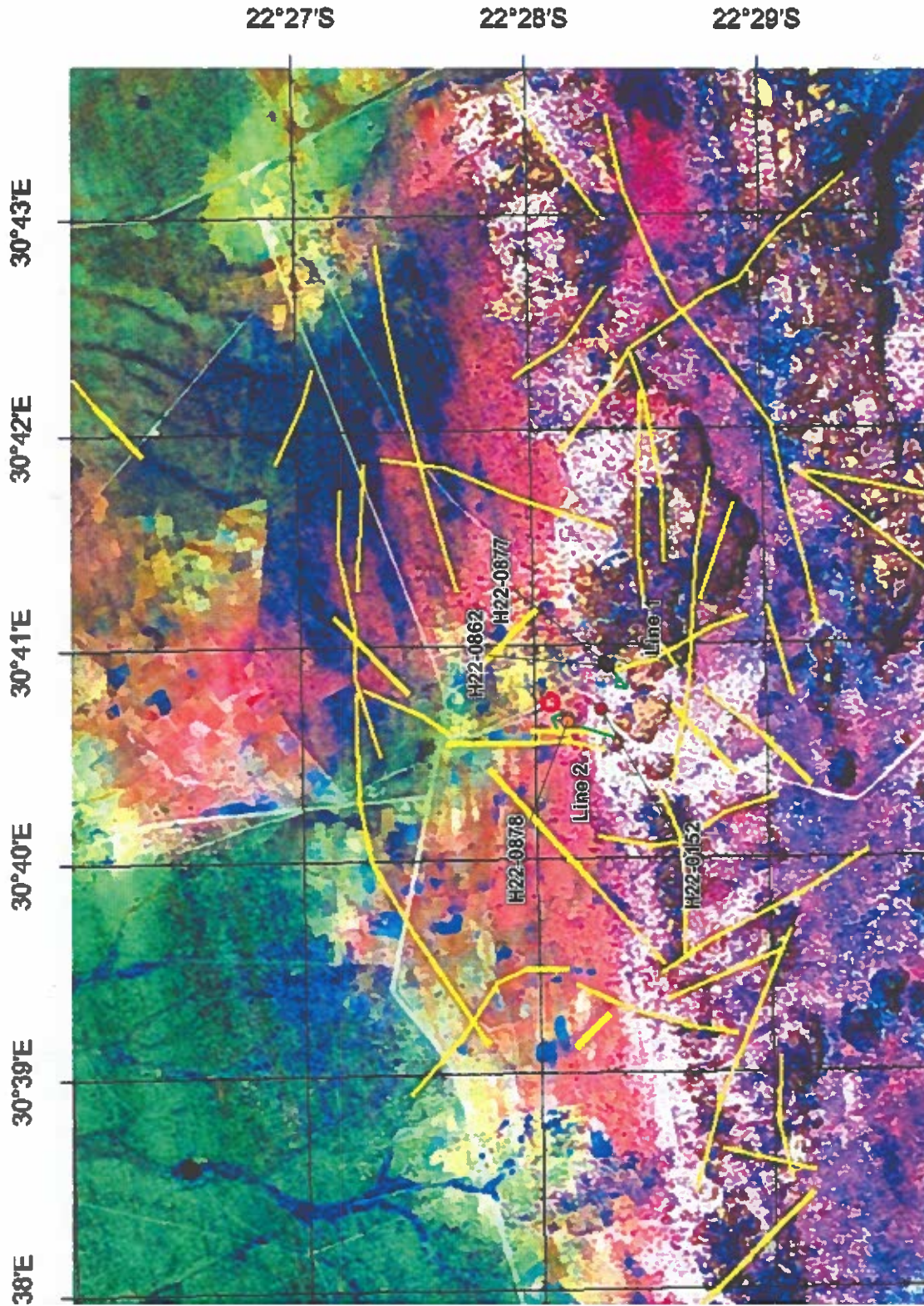
Scale & Projection

Projection: Geographical Coordinate System (Longitude, Latitude)
 Color Projection



1 : 50 000

Map C : Satellite imagery interpretation and geophysical traverse



Prepared By:



Scale & Projection

Projection: Geographical (Longitude & Latitude)
WGS84 Projection



kilometres
1 : 50 000