PROPOSED HOUSING PROJECT ON PORTION 1 AND THE REMAINDER OF THE FARM SIMS 462 (169 Ha) AND PORTION 1 OF THE FARM UITKOMS 463 (112 Ha), KATHU: FEASIBILITY-STAGE GEOTECHNICAL INVESTIGATIONS

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-	VGI3944	19 NOVEMBER 2015

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SUMMARY

This report presents the results of a Feasibility Stage geotechnical investigation commissioned on Portion 1 of the Remainder of Sims 462 and Portion 1 of Uitkoms 463 on the outskirts of the town of Kathu, in the Northern Cape.

This investigation comprised the excavation, profiling and sampling of 38 test pits, and the review of existing mine data in terms of the potential for dolomite related instability.

Existing information indicates that the **Sims site** is underlain by very thick (57-117m) Kalahari Group material (calcrete, clay, pebble layers), overlying Gamagara Formation shale to 121->234m). No known/confirmed faults are indicated to transect the site. Most of the Sims site is located within the area significantly impacted by groundwater abstraction. The current groundwater elevation range is 1080m AMSL to 1120m AMSL, i.e. 80m to 120m below the OWL. The site is not judged to be on dolomite land.

Existing information indicates that the **Uitkoms site** is underlain by Banded Iron Formation at shallow (10m or less) and to great depth (in excess of 142m). The site is located in the area not impacted by large scale groundwater abstraction. The site is not judged to be on dolomite land.

The proposed development can be described in terms of **two (provisional) primary soil zones** of similar foundation conditions, namely:

Soil Zones	Designation	Description
1	2[(H/C-C1/S-S1)R3]	All the soil layers (i.e. the colluvium, ferruginous pebble marker, pedogenic are of low expansiveness) (H). The colluvium and pedogenic layers comprise low density, collapsible and compressible material (C1/S1), to depths less than 0.5m. Minor to moderate settlement may be anticipated if these materials are placed under load and/or if the moisture content increases. Refusal occurred with a TLB at depths less than 1.5m (R3).

Soil Zones	Designation	Description
2	2[(H/C2/S1-S2)R3]	All the soil layers (i.e. the colluvium, ferruginous pebble marker, pedogenic are of low expansiveness) (H). The colluvium and pedogenic layers comprise low density collapsible and compressible materials to depths greater than 0.5m (C2/S2). Moderate settlement may be anticipated if these materials are placed under load and/or if the moisture content increases. Refusal occurred with a TLB at depths less than 1.5m (R3).

The result of the Consolidation test has not been released by the Soils Laboratory at the time of going to print. The zonation and designations are based on all other laboratory results and experience.

Recommendations are also provided in terms of excavatability, trench sidewall stability, pipe bedding material and compaction characteristics, corrosivity, road construction, and groundwater conditions.

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1. INTRODUCTION

This report presents the results of a Feasibility Stage geotechnical investigation commissioned on Portion 1 of the Remainder of Sims 462 and Portion 1 of Uitkoms 463 on the outskirts of the town of Kathu, in the Northern Cape.

This investigation comprised the excavation, profiling and sampling of test pits, and the review of existing mine data in terms of the potential for dolomite related instability.

This report documents, the terms of reference, location and description of the site, data used, geotechnical conditions and recommendations on the way forward.

2. TERMS OF REFERENCE

VGIconsult is appointed by MacroPlan to undertake a Feasibility Stage Geotechnical Investigation, as set out in proposal number VGI3944P, dated 2 August 2015.

3. SCOPE OF WORK

It was indicated that an Environmental Assessment is underway and that the relevant Department has requested the following: "*A geo-technical assessment must be included as a specialist assessment. The assessment will provide information related to the soil types, soil potential, soil stability, subsoil structure, suitability of the area to support the proposed structures and recommendation for foundations*".

For housing projects compliance must ultimately be achieved with NHBRC Home Building Manual (1999). Township development is to comply with SANS 634 (2012) and if located on dolomite land, compliance is also to be achieved with SANS 1936 (2012).

The proposed land use is indicated as follows:

PORTION 1 OF THE FARM UITKOMS 463					
Zoning	**Description**	**Land Units**	**Total Area (m^2)**	**Avg.**	**%**
RES I	Single Home	163	152261.3	934.1	14
RES II	Group Housing	1	21413.7	21413.7	2
OPEN I	Park	2	14029.8	7014.9	1
OPEN II	Recreation	1	738018.7	738018.7	66
OPEN III	Conservation	3	119976.1	39992.0	11
INST II	Worship	1	8213.2	8213.2	1
TRANS I	Public Street	1	65746.6	65746.6	6
		Total	1119659.4		

PORTION 1 AND THE REMAINDER OF THE FARM SIMS 462					
Zoning	**Description**	**Land Units**	**Total Area (m^2)**	**Avg.**	**%**
RES I	Single Home	538	351362.0	653.1	20.8
RES II	Group Housing	851	389334.0	457.5	23.1
RES III	Flats	4	40376.6	10094.2	2.4
BUS I	Commercial	6	62141.0	10356.8	3.7
OPEN I	Park	29	258905.0	8927.8	15.3
INST II	Worship	6	25103.9	4184.0	1.5
INST I	Education	2	69843.8	34921.9	4.1

PORTION 1 AND THE REMAINDER OF THE FARM SIMS 462					
Zoning	**Description**	**Land Units**	**Total Area (m^2)**	**Avg.**	**%**
AUTH	Municipal Use	2	3940.2	1970.1	0.2
TRANS II	Public Street	1	488011.5	488011.5	28.9
		Total	1689018.0		

4. AVAILABLE INFORMATION

Information sources include:

4.1. Topographic Data

- **Topographic Map, 1: 50 000 Scale Series**: issued by the Chief Directorate: Surveys and Mapping, Department of Land Affairs:

Sheet Name	**Reference**
Kathu	2723 CA

4.2. Geological Information

- **Geological Map, 1: 250 000 Scale Series:** issued by the Geological Survey of South Africa (Council for Geoscience):

Sheet Name	**Reference**
Kuruman	2722

- **The Geology of South Africa**: by MR Johnson, CR Anhaeusser, RJ Thomas, 2006.

4.3. Industry Standards and Publications

- South African National Standard **SANS 1936-1/2/3/4: 2012**, Edition 1 (ISBN 978-0-626-27840-3).
- South African National Standard **SANS 633: 2012**, Soil profiling and rotary percussion borehole logging on dolomite land in Southern Africa for engineering purposes.
- South African National Standard **SANS 634: 2012**, Geotechnical investigations for township development.
- Environmental Earth Sciences, Springer-Verlag: "**A Performance Based Approach to Dolomite Risk Management**" by D Buttrick, N Trollip, R Watermeyer, N Pieterse, A Gerber, Volume 64, Issue 4, p1127 to p1138, dated 2011.
- Journal of the South African Institution of Civil Engineering: "**Proposed Method for Dolomite Land Hazard and Risk Assessment in South Africa**" by Buttrick, Van Schalkwyk, Kleywegt and Watermeyer, Volume 43, Number 2, dated 2001.
- Annals of the Geological Survey of South Africa: "Subsurface subsidences and sinkholes caused by lowering of the dolomitic water-table on the Far West Rand Gold Field of South Africa" by RJ Kleywegt and DR Pike, Volume 16, p77 to p105, dated 1982.
- **Site Investigation Code of Practice SAICE Geotechnical Division,** January 2010.
- **TRH14**, Guidelines for Road Construction Material. Committee of State Road Authorities, Pretoria South Africa, dated 1985.

- South African National Standard **SANS 10160-4: 2011**, Seismic Actions and General Requirements for Buildings, Edition 1.1 (ISBN 978-0-626-26421-4).

- **NHBRC Home Building Manual**, dated 1999.

4.4. Geohydrological Data and Reports

- Groundwater information is made available by the Department of Water Affairs through the National Groundwater Information System (NGIS) which offers read-only access to data from:
  - National Groundwater Archive (NGA);
  - Water Management System (WMS); and
  - Hydstra [http://www.dwa.gov.za/chart/]).

- Report "Geohydrology Guideline Development: Implementation of Dolomite Guideline – Phase 1, Activities 19 & 28: Desktop development of a Dolomite Hydrogeological Compartment Map and explanation booklet", by Martin Holland of Water Geosciences Consulting & Frans Wiegmans of Golder Associates, Project Number 14/14/5/2, dated November 2009.

4.5. Existing Data and Reports

- VGIconsult report "Sishen Iron Ore Company: Regional Dolomite Stability Investigation for Risk Management Purposes", Report Number VGI3193.3, dated 31 July 2012

- Kumba Iron Ore (Sishen Mine) Exploration Borehole Database.

5. DESCRIPTION OF THE STUDY AREA

5.1. Locality

The locality of the sites within the region is displayed in the attached Figure 1. The Sims site flanks the western edge of Kathu town and comprises 169ha. The Uitkoms site flanks the eastern edge of the town and comprises 112ha.

5.2. Site Description

The sites, as seen in aerial photographic coverage, are presented in the attached Figure 2. The Sims site falls gently from west to east from 1210m AMSL to 1205m AMSL at 0.2°. The Uitkoms site is relatively flat and at an elevation of 1230m AMSL.

6. PROCEDURES USED IN THIS STUDY

6.1. Assimilation of Available Data

Data collected from Kumba, the VGIconsult database together with available geological and geohydrological data are first assimilated.

6.2. Map Production (Projection, Co-ordinate System and Datum)

All the drawings in this report are produced using a Geographic Information System (GIS). The projection information of the figures and drawings in this report listed below:

Projection surface:	Mercator (cylinder)
Projection orientation:	Transverse aspect
Datum or reference ellipsoid:	World Geodetic System 84

Central Meridian: In degrees (23 for this study)
False easting and northing: Zero degrees
Scale factor: 1

The drawings and figures are co-ordinated in metres latitude (7 digit value) and longitude (5 or 6 digit value).

6.3. Test Pits

The site investigation was conducted on 13 and 14 October 2015 and consisted of the excavation of 38 test pits on the site using a 71kW (CAT 428F) backhoe machine.

The soil profile of each test pit was described by an engineering geologist using the visual and tactile procedures advocated by Jennings et al (1973). Detailed descriptions of the test pits conducted during the current investigation are provided in Appendix 2 of this report and a summary of the test pits is given in Table 2. The positions of all test pits are shown on Drawing VGI3944/1.

6.4. Boreholes

Various exploration boreholes were drilled in the past on and in proximity to the sites. The borehole logs are presented in Appendix 1 and summarised in Table 1. The positions of the boreholes are displayed on Drawing VGI3944/1.

6.5. Soil Sampling and Testing

The following soil tests were undertaken by GEOSTRADA:

Layer	Depth (m)	Type of samples	Testing instruction
TP02/1	0-0.3	L	Mods CBR + Foundation Indicator + PH Conductivity
TP11/1	0-0.6	S	Foundation Indicator+ PH Conductivity
TP13/1	0-0.4	S	Foundation Indicator+ PH Conductivity
TP15/1	0-0,3	L	Mods CBR + Foundation Indicator
TP24/1	0-0,4	S	Foundation Indicator
TP26/1	0-0,4	L	Mods CBR + Foundation Indicator + PH Conductivity
TP27/1	0-0,2	S	Foundation Indicator
TP36/1	0-0.4	S	Foundation Indicator+ PH Conductivity
TP36/2	0.2	B	Consolidation
TP36/3	0.4-1.1	L	Mods CBR + Foundation Indicator + PH Conductivity
TP22/1	0-0.4	S	Foundation Indicator + PH Conductivity

S = SMALL BAG B = BLOCK SAMPLE L = LARGE BAG

Type of samples	Testing instruction
L	MODS CBR + Foundation Indicator + PH and Conductivity
S	Foundation Indicator
B	Consolidation

Table 2 summarises the results of the laboratory tests and the detailed test results are contained in Appendix 2.

6.6. Geotechnical Near-surface Soils Classification

For the purposes of this report the *broad* geotechnical definitions are defined in terms of several 'geotechnical category designations' (with additions) below: -

Category	Definition	Potential Land Use Based on Geotechnical Assumptions and Subject to Detailed Geotechnical Investigations
1	Most suitable	Potentially most suitable for any type of development including residential, commercial and light (dry) industrial.
2	Intermediate	Potentially suitable for any type of development including residential, commercial and light (dry) industrial, with precautionary and remedial measures.
3	Least favourable	Potentially only suitable for non-residential uses such as commercial and light (dry) industrial development with stringent precautionary and remedial measures.

Various combinations of Categories 1, 2 and/or 3 may be appropriate:

- The prefix describes the primary Category or the predominant characterisation of the zone and the suffix describes the characterisation of anticipated pockets or small sub-areas within the zone. As an example, a designation of Land Development Categories 1(2) indicates that the zone predominantly displays Category 1 conditions with smaller sub-areas of Category 2.

- A designation of Categories 2-3 indicates that the conditions in the zone range from Category 2 to Category 3 and are currently not distinguishable. The first designation (in this case Category 2) is anticipated to represent the predominant geotechnical conditions in the zone.

Geotechnical Category and Designation	Geotechnical Characteristics
Active soils (heave/shrink) H H1 H2 H3	Expected range of total movement at surface: < 7.5 mm 7.5 – 15 mm 15 – 30 mm > 30 mm
Collapsible soils C C1 C2	Expected range of total movement at surface: < 5 mm 5 – 10 mm > 10 mm
Compressible soils S S1 S2	Expected range of total movement at surface: < 5 mm 5 -15 mm > 15 mm
Inundated Areas W	Wet areas, drainage line, seepage zone
T	Steep Slope (>15 degrees)
P	Dolomitic Areas
E	Abandoned borrow areas, dump rock, waste pits and uncontrolled fill.
R R1 R2 R3	Rock Rock outcrop Rock scattered outcrop Rock sub outcrop (surface to minus 1.5 m)

6.7. Potential Erosion and Piping (Dispersive Soils)

Sodium-based clay minerals are susceptible to erosion or piping in the in situ soil profile. The electrical conductivity (EC) of the soil paste provides an indicator of the salinity and potential dispersive behaviour.

6.8. Potential Aggressiveness of Interparticulated Groundwater

According to industry guidelines pH and electrical conductivity (EC) should be measured in selected samples. pH is a measure of the acidity of the soil based on its hydrogen ion concentration and is mathematically defined as the negative logarithm of the hydrogen ion concentration, or $pH = -\log[H^+]$.

The pH of a material ranges on a logarithmic scale from 1-14, where pH 1-6 are acidic, pH 7 is neutral, and pH 8-14 are basic. Lower pH corresponds with higher $[H^+]$, while higher pH is associated with lower $[H^+]$.

Electrical conductivity (EC) is the ability of the material to conduct electrical current through it. EC is measured in Siemens per unit area (e.g. Siemens per metre). The higher the dissolved material in soil sample, the higher the EC of the soil. The electrical conductivity of soils varies depending on the amount of moisture held by soil particles. Sands have a low conductivity, silts have a medium conductivity, and clays have a high conductivity. Consequently, EC correlates strongly to soil particle size and texture.

Soil resistivity is a function of soil moisture and the concentrations of ionic soluble salts and is considered to be most comprehensive indicator of a soil's corrosivity. Typically, the lower the resistivity, the higher will be the corrosivity as indicated in the following Table:

Soil Resistivity (Ohm/m)	Corrosivity Rating
> 200	Essentially non-corrosive
100 to 200	Mildly corrosive
50 to 100	Moderately corrosive
30 to 50	Corrosive
10 to 30	Highly corrosive
< 10	Extremely corrosive

6.9. Earthworks Classifications for Service Trenches

The ease of excavation is a critical financial factor when installing underground services and placement of foundations. The excavatability of material can be grouped into the following three categories according to SABS 1200D:

- Soft excavation (Class A) requires mechanical equipment
- Intermediate excavation (Class B) requires ripping equipment
- Hard rock excavation (Class C) requires blasting or pneumatic rock breaking equipment

6.10. Re-usability of Spoil

Material excavated from the pipe trench may be re-used as fill material if it meets the requirements of SABS 1200LB, as follows:

Selected Granular Fill	***Selected Fill***	***Backfill***
• Granular • Non-cohesive • 0,6mm to 19mm particle size • Free-draining • Compactibility factor <0,4	• Plasticity Index (PI) < 6 • No lumps or stones >30mm diameter • No vegetation	• Little or no organic material • Stones >150mm in diameter • Less than 10% of rocks >50mm in diameter • No large clay lumps

6.11. Seismic Hazard

The seismicity of Southern Africa is typically that of an intra-plate region. The natural seismic regime of a region of this type is characterized by a low-level activity by world standards, with earthquakes randomly distributed in space and time. In South Africa the only part which does not display the characteristics of an intra-plate region is the possible continuation of the East African rift system in the north-eastern region of the country.

The boundaries of the African Plate are conspicuously outlined by a narrow earthquake belt following the Mid-Atlantic and Mid-Indian oceanic ridges. Most of the natural activity around Southern Africa occurs along these features.
Tremors resulting from the deep-mining operations in the gold fields of Gauteng, North West and Free State Provinces, form the bulk of the seismic events recorded by the regional network of seismological stations. The depth of these tremors has been fixed at 2 km below the surface.

The level of amplification induced in structures by seismic events is primarily influenced by the nature and magnitude of the seismic impulse, e.g. magnitude and epicentre of an earthquake, but also by the dynamic stiffness properties of the rock mass and regolith and of the particular structures.

In accordance with SANS 10160 (2012) structures in seismic zones shall, as a minimum, be designed and constructed to resist the effects of seismic ground motions. This standard provides strategies and rules for the design of buildings subject to earthquake actions primarily to safeguard against major catastrophic structural failures and loss of life, not to prevent damage or to maintain function. Figure 1 of SANS 10160-4 presents the seismic zones of South Africa. Two zones are identified, namely:
a) Zone I: Natural seismic activity and
b) Zone II: Regions of mining-induced and natural seismic activity.

SANS 10160-4, Table 3 presents classes of buildings relevant to seismic hazard:

Importance Class	Buildings	Importance Factor (γ_i)
I	Buildings of minor importance for public safety, e.g. agricultural buildings etc.	0.8
II	Ordinary buildings, not belonging to the other categories	1.0
III	Buildings for which seismic resistance is of importance in view of the consequences associated with collapse, e.g. schools, assembly halls, cultural institutions etc.	1.2
IV	Buildings for which integrity during earthquakes is of vital importance for protection e.g. hospitals, fire stations, power plants etc.	1.4
Note: • The numbering of importance classes differ from those in the Eurocode where from the definitions were taken. • Buildings of Importance Class I, II and III in Zone II need only comply with clause 5 and with the minimum requirements for structural and non-structural components and with the requirements for ties, continuity and anchorage, all as detailed in clause 9. • Buildings of Importance Class IV in Zone II shall be treated as buildings located in Zone 1.		

6.12. Dolomite Land

Land underlain by dolomite or limestone residuum or bedrock (or both), within the Malmani Subgroup and Campbell Rand Subgroup, typically at depths of no more than:

a) 60m in areas where no de-watering has taken place and the local authority has jurisdiction, is monitoring and has control over the groundwater levels in the areas under consideration; or
b) 100m in areas where de-watering has taken place or where the local authority has no jurisdiction or control over groundwater levels.

Where dolomite land occurs a Dolomite Area Designation is to be assigned in accordance with SANS 1936 Part 2 (2012).

The definitions of the Dolomite Area Designations, as defined in SANS 1936 Part 1 (2012), are as follows:

D Designation	**Description**
D1	No precautionary measures are required.
D2	General precautionary measures, in accordance with the requirements of SANS 1936-3, that are intended to prevent the concentrated ingress of water into the ground, are required.
D3	Precautionary measures in addition to those pertaining to the prevention of concentrated ingress of water into the ground, in accordance with the relevant requirements of SANS 1936-3, are required.
D4	Additional site-specific precautionary measures are required.*

*Section 4.3.4 states the following specific measures for D4 areas:

a) site characterization, analysis and design, specification of precautionary measures, supervision of implementation and formulation of dolomite risk management plan shall be undertaken by a Competence Level 4 geo-professional;
b) the foundation design and design of the structure, precautionary measures and dolomite risk management plan shall specifically address and effectively mitigate the dolomite risks *(should read hazard)* present on the site;
c) the site characterization, foundation design and design of the structure, precautionary measures and dolomite risk management requirements shall be reviewed and approved by an independent Competence Level 4 geo-professional and, where relevant, by a structural engineer with a similar level of competence; and
d) all aspects of the development proposal shall be reviewed and approved by the local authority who may request a further review by an authority-designated Competence Level 4 peer if required.

The new NHBRC Home Building Manual has been gazetted and is to be published in October 2015. The definition is as follows:

Table 11: Dolomite area designations	
D Designation	**Description**
D1	No precautionary measures are required.
D2	Precautionary measures and dolomite risk management are required to maintain a tolerable hazard rating.
D3	Precautionary measures and dolomite risk management in addition to that described for dolomite area designation D2 are required to achieve a tolerable hazard rating.
D4	Precautionary measures and dolomite risk management in addition to that described for D3 rarely enables a tolerable hazard rating to be achieved.

7. GEOLOGY

7.1. Regional Geological Setting

According to the 1:250 000 scale geological map (refer to Figure 3) the Sims site is located on Tertiary age surface limestone (Tl) and Uitkoms is located on Quaternary age sand (Qs).

The Sishen Iron Ore Mine (including the town of Kathu) is situated on the Maremane Dome. The Dome consists of **carbonate rocks** (predominantly stromatolitic and crinkle laminated dolomite and limestone) of the **Campbell Rand Subgroup, Ghaap Group**, Transvaal Supergroup.

Only the eastern half of the dome is exposed with dolomite outcropping to the south-east of Sishen. **Chert breccia** of the Ghaap Group, as well as **ferruginised brecciated banded ironstone** (BIF) of the **Asbestos Hills Subgroup**, Ghaap Group overlie the Campbell Rand Subgroup.

To the west of the Sishen Mine the Campbell Rand Subgroup is overlain along an angular unconformity by **conglomerate, shale and quartzite** of the **Gamagara Formation**, Olifantshoek Supergroup. Further to the west **Makganyene Formation diamictite** and **Ongeluk Formation andesitic lava** of the Postmasburg Group of the Transvaal Supergroup are thrust over the Gamagara Formation along a north-south striking, westerly dipping, low-angle thrust fault.

Thin, **diabase dykes** with north-south and northeast orientations, have intruded the stratigraphic sequence. Some of the dykes are postulated to form impervious barriers and compartmentalise the groundwater.

A buried glacial valley, filled with **Dwyka tillite and mudstones** has been identified during past reconnaissance drilling. The valley is located between the mine area and Kathu. It has a typical north-south orientation, with a north-west orientation between Dibeng and the mine pit.

Kalahari Group material lie unconformably on lavas, shales and quartzites of the Olifantshoek Supergroup and dolomite/Banded Iron Formation of the Ghaap Group. Two main lithologies can be distinguished, namely basal gravels, assigned to the Wessels Formation, and overlying calcareous clays of the Budin Formation.

The various lithological units anticipated in the project area are as follows:

Lithostratigraphic Unit	Lithology
Kalahari Group -Cenozoic Era (i.e. including Tertiary and Quaternary deposits):	
Gordonia Formation (Quaternary)	Windblown sand
Lonely Formation (Quaternary)	Surface limestone (loosely consolidated low density diatomaceous limestone) formed in shallow freshwater lakes)
Obobogorop Formation (Quaternary)	Gravel (derived from Dwyka Formation)
Mokalanen Formation (at boundary between Quaternary/Tertiary)	Calcrete (forming a sandy limestone or conglomerate with calcareous matrix)
Eden Formation (Tertiary)	Sandstone, siltstone poorly sorted gravel
Budin Formation (Tertiary)	Clays and pebbles
Wessels Formation (Tertiary)	Coarse angular poorly sorted gravel
Unconformity	
	Dolerite dykes and sills (Drakensburg Group age/150 Ma)
Dwyka Formation, Karoo Supergroup	Tillite, mudstone and weathered derivatives
Unconformity	
Gamagara Formation, Olifantshoek Supergroup	Shale, conglomerate and quartzite
	Diabase dykes and sills (possibly of Bushveld Complex age/2061 Ma)
Thrust	
Ongeluk Formation, Postmasburg Group, Transvaal Supergroup	Andesitic lava
Makganyene Formation, Postmasburg Group, Transvaal Supergroup	Diamictite and weathered derivates
Unconformity	
Asbestos Hill Subgroup, Ghaap Group Koegas Subgroup, Ghaap Group	Ferruginised brecciated banded ironstone Manganore ironore, chert breccia: Massive ore Laminated ore Intrusive Banded Iron Formation

Lithostratigraphic Unit	Lithology
	Laminated Ore Banded Iron Formation
Unconformity	
(Wolhaarkop Formation) Campbell Rand Subgroup, Ghaap Group, Transvaal Supergroup	Chert breccia
Unconformity	
Gamohaan-, Kogelbeen-, Papkuil-, Fairfield-, Reivilo-, Monteville Formation, Campbell Rand Subgroup, Ghaap Group, Transvaal Supergroup	Limestone, dolomite, chert, subordinate shale, ooilite and weathering soil derivatives

7.2. Structural Geology

- Sishen Iron Ore Mine is situated in the northern extent of the Maremane Dome area.
- The N-S and E-W trending interference folding that formed the dome dictates a shallow northwards plunge of major fold axes.
- A large number of north/south-trending normal faults are present with variable (<100m) displacements related mainly to the first passive margin-rifting event, and were subsequently reactivated.
- Numerous normal faults displacing stratigraphic units in fault-bounded shale filled basins are also present.

7.3. Local Geology: Kathu area

- A general overview of the geology indicates that the Kalahari Group deposits are relatively extensive in plan and in depth.
- A Karoo age valley (in-filled with shale-rich deposits) has been reported by various authors.
- Dolomite rock is confirmed in 32 of the 76 boreholes drilled in and near to Kathu. Of this set 13 intercept dolomite within 100m of ground surface. Of this set only 3 intercept dolomite bedrock at 60m or shallower.
- Dolomite rock is overlain by chert/chert breccia of the Wolhaarkop Formation in sub-areas. The Formation is relatively thin. In sub-areas the dolomite is overlain by Banded Iron Formation and/or shale of the Gamagara Formation.

Although various boreholes indicate that Kathu is largely not located on dolomite land, attention is drawn to the presence of faults and other structures which transect the subsurface profile. Sinkholes have been observed on such features south-east of the mine pit. In 2012 it was therefore determined that dolomite risk management be applied to the formalised portion of Kathu Town.

7.4. Site Specific Geology

7.4.1. Sims Site

According to Sishen Iron Ore Mine data five boreholes were drilled on the site and an additional two boreholes on/near to the site boundary.

This site is blanketed by 57m to 117m thick Kalahari Group material comprising calcrete, clay and pebbles. The calcrete is 19m to 64m in thickness. The Kalahari deposits are underlain by shale and siltstone of the Gamagara Formation to very great depth (121m to in excess of 234m.

Borehole KM17 is described to intercept Karoo age shale, but considering the borehole logs of the Mine database in the area, this material may in fact be of the Gamagara Formation. Locally the Gamagara shales are underlain by chert breccia of the Wolhaarkop Formation. In Borehole KU1E the chert breccia is overlain by Banded Iron Formation. Exploration Borehole SW410E intercepts a cavity at very great depth below the Kalahari Group. The anticipated Formation is Gamagara Group shale or BIF/Wolhaarkop breccia. The reason for cavity formation during the drilling process is unknown. Only one of the seven boreholes (Borehole SIM430E) intercepted dolomite rock. The depth to dolomite is 121m.

According to the Sishen Mine structural data set no faults transect the site.

As this site is predominantly located in the area of significant impact of groundwater drawdown (refer to Section 8.2) the 100m depth to dolomite rock cut off applies. Notwithstanding this, dolomite rock is greater than 121m, and as no major faults of significance are indicated to transect the site, the site is not judged to be on dolomite land.

7.4.2. Uitkoms Site

According to Sishen Iron Ore Mine data a single borehole was drilled on the site but the mine database has no log for this exploration hole. Six boreholes were drilled in proximity to site. A gravity survey was commissioned for the already formalised portion of Kathu town which indicates a major gravity high flanking the western side of the site. Drilling data indicates that this gravity high probably extends over, onto the Uitkoms site, in particular in the area of proposed housing. The entire northern portion of the development is to remain as open parkland. Boreholes immediately west and south of the site indicate Banded Iron Formation at shallow depth (0m to 10m) to depths in excess of 142m. The BIF is overlain by Kalahari Group deposits. Borehole KBH04 intercepts 36m of Kalahari deposits mantling BIF to at least 90m depth.

According to the Sishen Mine structural data set no faults transect the site.

As this site is predominantly located in the area not impacted by groundwater drawdown (refer to Section 8.2) the 60m depth to dolomite rock cut off could apply. In the interest of dolomite risk management, and as it cannot be stated with certainty that this situation would prevail in perpetuity the 100m cut off is considered. Notwithstanding this, dolomite rock is anticipated at depths in excess of 142m, and as no major faults of significance are indicated to transect the site, the site is not judged to be on dolomite land.

7.5. Past Sinkholes and Subsidences

The CGS sinkhole database indicates no record of sinkholes on or in close proximity to the Sims or Uitkoms sites.

7.6. Near-surface Soils

An 8.45 Ton, 71Kw Backhoe Machine (CAT 428F) capable of excavating to 3.2m depth was hired to study the near-surface conditions.

The materials studied vary in thickness and geotechnical properties. The typical soil profile encountered in test pits excavated in this study can be summarized as follows (Refer to Table 2 and Drawing VGI3944/1):

- A layer of **colluvium** comprising loose silty sand (with exception of TP 36 which has a medium dense consistency), encountered in all the test pits from ground surface to a depth of 0.8m.

- An **isolated fill** layer comprising of mixed gravels, loosely packed in a silty sand matrix, with overall medium dense consistency.

This layer is situated at TP 11 from ground surface to a depth of 0.6m.

- **Nodular calcrete (pedogenic)** layers were encountered below the colluvium as follows:

  - A layer comprising 20% to 30% nodular calcrete loosely packed in a silty sand matrix with an overall medium dense consistency. This layer is observed in test pits TP22 and TP32 between depths of 0.2m to 0.5m.

  - A layer comprising 40% to 50% nodular calcrete loosely packed in a silty sand matrix with an overall medium dense consistency. This layer is observed in majority of test pits between depths of 0m to 1,0m.

  - A layer comprising 60% to 80% nodular calcrete densely packed in a silty sand matrix with an overall dense consistency. This layer is observed in test pits TP30 and TP36 between depths of 0,2m to 1,2m.

- The nodular calcrete is underlain by **very dense honeycomb calcrete** tending to hardpan calcrete from a minimum depth of 0,1m and a maximum depth of 1,2m.

Refusal of the TLB occurred at a depth of 0.1m to 1.2m on very dense honeycomb calcrete tending to hardpan calcrete in all the test pits.

No seepage or groundwater was observed.

8. GEOHYDROLOGY

8.1. Regional and Site-specific Geohydrology

Refer to Figure 4 for pertinent groundwater information.

8.1.1. Quaternary Catchment Area

According to the country wide Quaternary Catchment data the stand is located in Catchment **D73A**.

8.1.2. Groundwater Management Area (WMA)

According to the country wide Water Management Areas data the sites are located in **WMA 10: Lower Vaal.**

8.1.3. Dolomite Groundwater Management Area (GMA)

According to the Water Geosciences Consulting Dolomite Hydrogeological Compartment Map[1] (2009) the stand is located in the **Prieska Sub-Basin Dolomite GMA.**

8.1.4. Dolomite Groundwater Management/Resource Units

According to the Water Geosciences Consulting Dolomite Hydrogeological Compartment Map (2009) the sites are not located within designated Dolomite Groundwater Management- or Resource Units.

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[1] *The map represents the subdivision of the dolomitic surface outcrop of the Ghaap Plateau and the Gauteng/North West dolomites. The major delineation is represented by the dolomitic Groundwater Management Areas (GMA). The names of these GMA's typically correspond closely to the common known dolomitic compartments as established in the late 1980's by the DWA. However, the delineation does not necessarily represent a dolomite compartment or unit.*

8.2. Original Groundwater Level vs. Current Groundwater Level

Several geohydrological investigations have been conducted in the region since the early 1970s. The information was analysed in 2009 by the SIOM appointed geohydrologist Mr. R Meyer in order to formulate a conceptual geohydrological model of the mining area and the immediate surrounding areas.

During 2008 a total of 10 874 005 m^3 of groundwater was abstracted from the SIOM. This was accomplished from three well fields located in the southern mining pit, the northern pit and the so-called western boreholes from which 8 386 600 m^3, 1 602 085 m^3 and 885 320 m^3 were abstracted respectively during 2008. From the two other well fields, referred to as the Kathu and Khai-Appel well fields, supplying the town, country club, game farm adjoining Kathu and the farming requirements of Ferroland, 1 699 366 m^3 and 873 680 m^3 were abstracted respectively. The **total volume of ground water abstraction** during **2008** from these sources amounts to **13 447 051 m^3.**

In 2012 the changes in the groundwater levels experienced in the greater Kathu region was studied by Meyer in order to prepare an **OWL (original groundwater level) contour map** as well as **CWL (current water level) contour map**. Although regular water level monitoring was concentrated in the area immediately surrounding the mining areas, regional hydro-censuses were conducted in 1970-1972 and again in 1994. Sporadic water level measurements were also taken in selected areas since 1970, with the focus being close to the mining area, the alluvial aquifer associated with the non-perennial Gamagara River and the farms around the larger areas around the mine development. The exceptional recharge period between 1973/74 and 1975/76 warrants the choice of pre-1974 water levels as baseline groundwater level. The **hydro-census data** of the **early 1970's** is therefore viewed as the **groundwater level baseline** (OWL) for the regional area around Sishen/Kathu and most of the information used to construct the pre-1974 water level maps are derived from this census, although a few older water levels records were also used.

Very little pre-1974 water level information could be found for the town of Kathu. In addition, many of the older boreholes in the area were drilled as water supply boreholes, and did not necessarily penetrate the Kalahari Group formation with associated groundwater levels presenting conditions in the primary aquifer.

Across the town of Kathu the OWL (original groundwater level elevation) **varies by about 10m**, from **1200m to 1210m AMSL**. Based on current piezometric and groundwater level information, three water level conditions have been identified by Meyer:

1. Areas where the groundwater conditions have **not yet** been **impacted** by the large scale groundwater abstraction.

2. A triangular shaped area between the Kathu and Sekgame dykes where groundwater conditions have been **partially impacted** by groundwater abstraction activities.

   This condition is present below the north eastern part of the original town development and to the south of the golf course.

3. An area in the southern and south-western portion where groundwater conditions have been **significantly impacted** by the groundwater abstraction.

The Uitkoms site is located in the area not impacted by large scale groundwater abstraction.

Most of the Sims site is located within the area significantly impacted by groundwater abstraction. The current groundwater elevation range is 1080m AMSL to 1120m AMSL, i.e. 80m to 120m below the OWL.

9. NEAR SURFACE GEOTECHNICAL EVALUATION

The geotechnical evaluation of the near surface soil horizons and their properties on the site are based on the interpretation of the geology, the soil profiles and the laboratory test results:

9.1. Engineering Properties and Material Characteristics

9.1.1. Activity (swelling/shrinking) or Expansive Potential of soils within 1.2m from natural ground level

The foundation indicator test results indicate that all the soil layers have a low potential expansiveness (<7.5mm).

9.1.2. Potentially Collapsible Soils within 1.2m from natural ground level

The colluvium, comprising loose silty sand and extending to an anticipated maximum depth of 0.9m, is potentially highly collapsible. The medium dense nodular calcrete, as well as the fill, has a moderate collapse potential. The colluvial/pedogenic horizon is of greater thickness (> 0.5m) in Soils Zone 2 necessitating a C2 designation.

9.1.3. Potentially Compressible Soils within 1.2m from natural ground level

The colluvium is highly compressible and extends to an anticipated maximum depth of 0.9m. The medium dense nodular calcrete and fill is potentially moderately compressible. The colluvial/pedogenic horizon is of greater thickness (> 0.5m) in Soils Zone 2 necessitating a S2 designation.

9.1.4. Potential Aggressiveness of Interparticulated Groundwater

Our assessment of the pH- and resistivity values is as follows:

Test Pit No.	Sample Depth	Material origin	pH: natural soil	Descriptor: natural soil
TP02/1	0-0.3	Calcrete	7.30	Pedogenic
TP11/1	0-0.6	Fill	7.89	Fill
TP13/1	0-0.4	Transported	7.80	Colluvium
TP26/1	0-0,4	Calcrete	7.92	Pedogenic
TP36/1	0-0.4	Transported	8.03	Colluvium
TP36/3	0.4-1.1	Calcrete	8.35	Pedogenic
TP22/1	0-0.4	Transported	7.44	Colluvium

The samples submitted for pH testing revealed that all the soil layers (fill, colluvium and calcrete) are neutral to alkaline, with a pH value of 7.30 to 8.35.

It is therefore foreseen that no real potential exists for an aggressive environment towards steel within the subsurface profile.

9.1.5. Potential Erosion and Piping (Dispersive Soils)[2]

Sodium-based clay minerals are susceptible to erosion or piping in the in situ soil profile. The electrical conductivity of the soil paste provides an indicator of the salinity and potential dispersive behaviour.

[2] when soil types are subjected to a hydraulic gradient

The conductivity results are provided in the tables at the end of the report. Our assessment of these values follows:

Test Pit No.	Sample Depth	Soil Origin	Conductivity (S.m)	Dispersive characersitics[1]
TP02/1	0-0.3	Calcrete	0.163	None
TP11/1	0-0.6	Fill	0.139	None
TP13/1	0-0.4	Transported	0.071	None
TP26/1	0-0,4	Calcrete	0.1133	None
TP36/1	0-0.4	Transported	0.142	None
TP36/3	0.4-1.1	Calcrete	0.154	None
TP22/1	0-0.4	Transported	0.154	None
[1]Conductivities in excess of 0.5 S.m. may be associated with dispersive characteristics in soil units				

9.1.6. Seepage

A perched water table was not intercepted in the test pits. A perched groundwater table is however anticipated on the soil/rock contact at a depth of 0.1m and 1.2m below ground surface during the rainy season.

9.2. Natural Slope Stability and Erosion

The general flat slope (less than 6 degrees) over the site will not present slope stability problems or a hazard to structures placed on this area.

However, the fine nature of many, if not most of the soil units encountered during investigations is such that after removal of natural soil cover they present a potential erosion problem during periods of heavy rains and also dust removal by high winds of the dry season.

9.3. Sidewall Stability in Excavations

Seepage of groundwater into open works (here related to a perched water table on the soil/rock interface during the rainy season) may induce sidewall instability.

9.4. Earthworks Classifications for Service Trenches (R)

It has been assumed that an excavator will be used to excavate trenches for services rather than a TLB, since an excavator will be able to excavate harder materials more readily than a TLB.

For example, an excavator would be able to excavate further/deeper into soft rock material whereas a TLB would experience refusal. Based on this assumption, the three excavatability categories of materials identified from test pits, to a depth of 3,0m according to SABS 1200D can be made:

- Soft Excavation (Class A): All soil layers encountered to an anticipated maximum depth of 1.2m in profile.
- Intermediate Excavation (Class B): Soft rock conditions at depth of between 0.1m to 1.2 were encountered honeycomb calcrete tending to hardpan calcrete.
- Hard rock Excavation (Class C): No hard rock conditions were encountered.

Refusal of the excavator occurred at a depth of 0.1m to 1.2m on honeycomb calcrete tending to hardpan calcrete rock. Excavatability problems are therefore anticipated with the use of a TLB for the placing of subsurface services from a depth of 0.1m to 1.0m.

9.5. Seismic Activity

In terms of SANS 10160 (2012) and the seismic hazard map contained therein the site is not located in a Seismic Hazard Zone.

9.6. Materials for Road Construction Purposes (TRH14)

Test Pit No.	Sample Depth	Soil Origin	MDD	OMC	COLTO Classification
TP02/1	0-0.3	Calcrete	2016	7.6	G5
TP15/1	0-0,3	Calcrete	1824	10.8	G5
TP26/1	0-0,4	Calcrete	1880	7.4	G5
TP36/3	0.4-1.1	Calcrete	1880	9.7	G6

- G5 quality materials are suitable for the use for base layer, and G6 quality material are suitable for sub base in road construction. However G6 quality material can be improved to G5 quality by adding 20% to 30% gravels.

9.7. Re-Usability of Spoil: Bedding Material and Earthworks[3]

- Selected Granular Bedding – i.e. naturally occurring non-cohesive, free draining, singularly graded gravel-soils between 0.6mm and 19.0mm particle size are not available on this site and will need to be imported.

- Selected Fill – the laboratory tests results confirm that natural soils with a PI less than 6% and/or a stones content of <30mm are not available on this site.

- General Backfill – materials recovered from trench excavation works may be considered for general backfill purposes after removal or reduction of all the larger cobble and boulder size fractions.

- The selected calcrete materials, G5 and G6 quality materials are suitable for the construction of earth mattresses.

9.8. Drainage

A complete stormwater system that provides for drainage as well as the provision of drainage to control runoff from major stormwater events will need to be constructed on the site, according to Municipal specifications.

10. CONCLUSIONS

10.1. General

This investigation comprised the excavation, profiling and sampling of 38 test pits across the two proposed sites and the studying of existing, relevant Sishen Iron Ore Mine data.

Existing information indicates that the **Sims site** is underlain by very thick (57-117m) Kalahari Group material (calcrete, clay, pebble layers), overlying Gamagara Formation shale to 121->234m). No known/confirmed faults are indicated to transect the site. Most of the Sims site is located within the area significantly impacted by groundwater abstraction. The current groundwater elevation range is 1080m AMSL to 1120m AMSL, i.e. 80m to 120m below the OWL. The site is not judged to be on dolomite land.

[3] SANS 1200 DB: 1983 & LB: 1989

TABLES

Existing information indicates that the **Uitkoms site** is underlain by Banded Iron Formation at shallow (10m or less) and to great depth (in excess of 142m). The site is located in the area not impacted by large scale groundwater abstraction. The site is not judged to be on dolomite land.

10.2. Near Surface Soils Assessment

It follows from the test pits and laboratory test results that the sites can be described in terms of **two soil zones** of similar foundation conditions, namely:

Soil Zones	Designation
1	2[(H/C-C1/S-S1)R3]
2	2[(H/C2/S1-S2)R3]

10.2.1. Soil Zone 1: 2([H/C-C1/S-S1)R3]

All the soil layers (i.e. the colluvium, ferruginous pebble marker, pedogenic are of low expansiveness (H).

The colluvium and pedogenic layers comprise low density, collapsible and compressible material (C-C1/S-S1), to depths less than 0.5m. Settlement of up to 15mm may be anticipated if these materials are placed under load and/or if the moisture content increases.

Refusal occurred with a TLB at depths less than 1.5m (R3).

10.2.2. Soil Zone 2: 2[(H/C2/S1-S2)R3]

All the soil layers (i.e. the colluvium, ferruginous pebble marker, pedogenic are of low expansiveness (H).

The colluvium and pedogenic layers comprise low density collapsible and compressible materials to depths greater than 0.5m (C2/S1-S2). Major settlement (>15mm) may be anticipated if these materials are placed under load and/or if the moisture content increases.

Refusal occurred with a TLB at depths less than 1.5m (R3).

11. RECOMMENDATIONS

11.1. Foundation Design Requirements

The loose colluvial layer and medium dense nodular calcrete encountered in majority of the Test Pits from natural ground level to an anticipated maximum depth of 0.9m are not suitable for the founding.

Refusal of the TLB was encountered at a depth of 0.1m and 1.2m on honeycomb tending to hardpan calcrete (pedogenic) in all the test pits.

In Soil Zone 1, in terms of the 1999 Home Building Manual the following Foundation Design/ building procedures allowed for the identified design soil classes/single storey residential structures (Part 1, Section 2 Tables 6/7) are:

SITE CLASS	ESTIMATED TOTAL COLLAPSE (mm)	CONSTRUCTION TYPE	FOUNDATION DESIGN AND BUILDING PROCEDURES (Expected damage limited to Category 1)
C1	5-10	Modified normal	• Reinforced strip footings. • Articulation joints at some internal and all external doors. • Light reinforcement in masonry. • Site drainage and plumbing / service precautions. • Foundation pressure not to exceed 50kPa.
		Compaction of insitu soils below individual footings	• Remove insitu material below foundations to a depth and width of 1.5 times the foundation width or to a compacted 98% MOD AASHTO density at -1% to +2% of optimum moisture content. • Normal construction with lightly reinforced strip foundation and light reinforcement in masonry.
		Deep strip foundations	• Normal construction with drainage precautions. • Founding on competent horizon below the problem horizon.
		Soil raft	• Remove insitu material to 1.0m beyond perimeter of the building to a depth of 1.5 times the widest foundation or to a competent horizon and replace with material compacted to 98% MOD AASHTO density at -1% to +2% of optimum moisture content. • Normal construction with lightly reinforced strip footings and light reinforcement in masonry.
NOTE Differential settlements equals 75% of total settlement. The relaxation of some of these requirements, e.g. the reduction or omission of reinforcement or articulation joints, may result in a Category 2 level of expected damage.			

SITE CLASS	ESTIMATED TOTAL SETTLEMENT (mm)	CONSTRUCTION TYPE	FOUNDATION DESIGN AND BUILDING PROCEDURES (Expected damage limited to Category 1)
S1	10-20	Modified normal	• Reinforced strip footings. • Articulation joints at some internal and all external doors • Light reinforcement in masonry • Site drainage and service/plumbing precautions • Foundation pressure not to exceed 50kPa
		Compaction of insitu soils below individual footings	• Remove in situ material below foundations to a depth and width of 1,5 times the foundation width or to a competent horizon and replace with material compacted to 93% MOD AASHTO density at -1% to +2% of optimum moisture content. • Normal construction with lightly reinforced strip foundations and light reinforcement in masonry.
		Deep strip foundations	• Normal construction with drainage precautions. Founding on a competent horizon below the problem horizon.

SITE CLASS	ESTIMATED TOTAL SETTLEMENT (mm)	CONSTRUCTION TYPE	FOUNDATION DESIGN AND BUILDING PROCEDURES (Expected damage limited to Category 1)
		Soil Raft	• Remove insitu material to 1,0m beyond perimeter of building to a depth of 1,5m times the widest foundation or to a competent horizon and replace with material compacted to 93% MOD AASHTO density at -1% to + 2% of optimum moisture content. • Normal construction with lightly reinforced strip footings and light reinforcement in masonry.
NOTE 1) Differential settlement equals 50% of total settlement. 2) The relaxation of some of these requirements, e.g. the reduction or omission of reinforcement or articulation joints, may result in a Category 2 level of expected damage. 3) Account must be taken of sloping sites when differential fill heights may lead to greater differential settlements. 4) Settlements induced by loads imposed by deep filling beneath surface beds may necessitate the adoption of a construction type appropriate to a more severe site class.			

In Soil Zone 2, in terms of the 1999 Home Building Manual the following Foundation Design/ building procedures allowed for the identified design soil classes/single storey residential structures (Part 1, Section 2 Tables 6/7) are:

SITE CLASS	ESTIMATED TOTAL COLLAPSE (mm)	CONSTRUCTION TYPE	FOUNDATION DESIGN AND BUILDING PROCEDURES (Expected damage limited to Category 1)
C2	>10	Stiffened strip footings, stiffened or cellular raft	Stiffened strip footings or stiffened or cellular raft with lightly reinforced or articulated masonry. Bearing pressure not to exceed to 50kPa. Fabric reinforcement in floor slabs. Site drainage and plumbing / service precautions.
		Deep strip foundations	Normal construction with drainage precautions. Founding on competent horizon below the problem horizon. With fabric reinforcement in floor slabs.
		Compaction of insitu soils below individual footings	Remove insitu material below foundations to a depth and width of 1.5 times the foundation width or to a compacted 98% MOD AASHTO density at -1% to +2% of optimum moisture content. Normal construction with lightly reinforced strip foundation and light reinforcement in masonry.
		Piled or pier foundations	Reinforced concrete ground beams or solid slabs on piled or pier foundations. Ground slabs with fabric reinforcement. Good site drainage.
		Soft raft	Remove insitu material to 1.0m beyond perimeter of the building to a depth of 1.5 times the widest foundation or to a competent horizon and replace with material compacted to 98% MOD AASHTO density at -1% to +2% of optimum moisture content. Normal construction with lightly reinforced strip footings and light reinforcement in masonry.
NOTE Differential settlements equals 75% of total settlement. The relaxation of some of these requirements, e.g. the reduction or omission of reinforcement or articulation joints, may result in a Category 2 level of expected damage.			

SITE CLASS	ESTIMATED TOTAL SETTLEMENT (mm)	CONSTRUCTION TYPE	FOUNDATION DESIGN AND BUILDING PROCEDURES (Expected damage limited to Category 1)
S2	>20	Stiffened strip footings, stiffened	Stiffened strip footings or stiffened or cellular raft with lightly reinforced or articulated masonry. Bearing pressure not to exceed to 50kPa. Mesh reinforcement in floor slabs. Site drainage and service/plumbing precautions.
		Deep strip foundations	As for S1 but with mesh reinforcement in floor slabs
		Compaction of in situ soils below individual footings	Remove in situ material below foundations to a depth and width of 1,5 times the foundation width or to a competent horizon and replace with material compacted to 93% MOD AASHTO density at -1% to +2% of optimum moisture content. Normal construction with lightly reinforced strip foundations and light reinforcement in masonry.
		Piled or pier foundation	Reinforced concrete ground beams or solid slabs on piled or pier foundations. Ground slabs with fabric reinforcement. Ground site drainage.
		Soil raft	Remove insitu material to 1,0m beyond perimeter of building to a depth of 1,5m times the widest foundation or to a competent horizon and replace with material compacted to 93% MOD AASHTO density at -1% to + 2% of optimum moisture content. Normal construction with lightly reinforced strip footings and light reinforcement in masonry.

NOTE
1) Differential settlement equals 50% of total settlement.
2) The relaxation of some of these requirements, e.g. the reduction or omission of reinforcement or articulation joints, may result in a Category 2 level of expected damage.
3) Account must be taken of sloping sites when differential fill heights may lead to greater differential settlements.
4) Settlements induced by loads imposed by deep filling beneath surface beds may necessitate the adoption of a construction type appropriate to a more severe site class.

Where very dense honeycomb tending to hardpan calcrete is encountered within the standard footing depth, the structure can be placed directly on this material.

Where such material is not encountered within the standard footing depth, an engineered soil mattress should be constructed (on the very dense honeycomb tending to hardpan calcrete) to the required founding level as follows:

1) Remove all excavatable material (with an excavator) to a maximum depth of between 0.1m to 1.0m in the footprint area of the structure and up to 1m beyond the edge of the proposed foundation area.
2) Rip and compact the excavated floor area to 95% of Modified AASHTO maximum dry density at optimum moisture content.
3) Backfill in maximum 150mm thick layers with imported G5-quality material; each layer is to be compacted to at least 98% of Modified AASHTO maximum dry density at optimum moisture content.
4) This should also include the (minimum) 150mm freeboard, i.e. top of floor slab to top of natural ground level, as required by the NHBRC Guidelines.

11.2. Excavatability

It should be noted that if a backactor will be used for the excavation of services, excavatability problems may be experienced in both Soil Zones 1 and 2 from 0.1m depth (which is within the general excavation depth for services [1.5m]) due to the presence of shallow calcrete.

11.3. Trench Sidewall Stability

In the event that there is uncertainly with respect to shoring requirements in trenches deeper than 1m, a competent person should be consulted.

All excavation slopes must be inspected by a competent person during construction to assess stability and recommended stabilizing measures, where required.

11.4. Pipe Bedding Material and Backfill and Compaction Characteristics

- The materials tested in this investigation do not comply with the SABS 1200LB criteria for selected granular fill or selected fill. Selected granular fill and/or selected fill is not available on this site and will need to be imported.

- Selected Granular Bedding – i.e. naturally occurring non-cohesive, free draining, singularly graded gravel-soils between 0.6mm and 19.0mm particle size are not available on this site and will need to be imported.

- Selected Fill – the laboratory tests results confirm that natural soils with a PI less than 6% and/or a stones content of <30mm are not available on this site and will need to be imported.

- General Backfill – materials recovered from trench excavation works may be considered for general backfill purposes after removal or reduction of all the larger cobble and boulder size fractions.

- The selected calcrete materials, G5 and G6 quality materials are suitable for the construction of earth mattresses

11.5. Corrosivity

The selection of materials to be used for wet services placed below ground surface should take cognisance of a possible corrosive nature of the environment.

11.6. Road Construction

Calcrete classifying as G5 quality materials is suitable for the use for base layer.

G6 quality material is suitable for sub base in road construction. However G6 quality material can be improved to G5 quality by adding 20% to 30% gravels.

11.7. Groundwater Conditions

No seepage was indicated in the test pits excavated. However the soil/rock interface may give rise to water seepage during wet season.

Water runoff into open works may also occur during excavation and construction work, particularly in the wet season due natural slope. A pump should therefore be available during such work.

Structures could be impacted on by ‘rising damp’. Special attention to membrane/dampcourse measures is required (for example, the use of ‘waterproof’ concretes in slab/raft foundation designs).

12. GENERAL

12.1. Verification Process

The findings in this report are based upon our interpretation of the data recovered during these investigations.

While every effort has been made, within the limits of the project budget, time and present-day insight, to determine overall ground conditions on this site, poorer sub-areas may have been missed. For this reason, it is recommended that a competent specialist is always invited to inspect open works on this site in order to further confirm the findings described in this report.

12.2. Third Party Reviews

If this report is reviewed by third parties, it should be noted that dolomite hazard assessment and management is an empirical science and consequently such parties may formulate opinions concerning the findings, conclusions and recommendations of this investigation at variance with those contained in this report. This fact should be borne in mind when costs are incurred on this project prior to receipt of the comments of these parties. VGIconsult Projects Pty Ltd, its members and personnel cannot be held responsible for these divergent views or consequential damages.

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Borehole Number with collar elevation in m AMSL	Transported &Kalahari Group material (m-m)	Low mobilisation potential material (shale, lava, dolerite etc) (m-m)	Ghaap Group Chert		Ghaap Group Dolomite Residuum (m-m)	Soft and weathered dolomite rock (Ghaap Group) (m-m)	Dolomite Bedrock (Ghaap Group) m and m AMSL	Groundwater Strike (m bg) Rest (m bg) OWL (m bg) and m AMSL	Susceptibility Characterisation			
									Ingress Water		Groundwater Drawdown	
			Fines Subordi-nate (m-m)	Fines Predomi-nant (m-m)					Subsid-ence Formation	Sinkhole Formation	Subsidence Formation	Sinkhole Formation
SIMS SITE												
SW410E 1209	0-117 117-124 CAV?	-	-	-		-	> 124 < 1085	?	NO	NO	NO	NO
SIM430E 1204	0-57	57-70 TILL 70-84 GAM SH 84-100 GAM 100-121 SH	-	-	-	-	121-178 1083	?	NO	NO	NO	NO
KBH01/ SIM436 1209	0-92	92-150 GAM SH	-	-	-	-	> 150 < 1058	Strike 74 91 1117 OWL 8 1200	NO	NO	NO	NO
KU1E (KM7) 1211	0-92	92-112 BIF	-	-	-	-	> 112 < 1099	Strike – 27.82 1183.18 OWL 11 1200	NO	NO	NO	NO
KU11E (KM17) 1205	0-117	117-234 GAM SH?	-	-	-	-	> 234	?	NO	NO	NO	NO
BOROHOLES IN PROXIMITY TO SIMS SITE												

Table 1: Summarised Borehole Information and Inherent Susceptibility Characterisation

BIF	Banded Iron Formation	PEB	Pebble stone (rolstene)
CC	Calcrete	SH	Shale (Gamagara)
CL	Clay	TIL	Tillite
GM	No sample return	SST	Sandstone

Borehole Number with collar elevation in m AMSL	Transported &Kalahari Group material (m-m)	Low mobilisation potential material (shale, lava, dolerite etc) (m-m)	Ghaap Group Chert		Ghaap Group Dolomite Residuum (m-m)	Soft and weathered dolomite rock (Ghaap Group) (m-m)	Dolomite Bedrock (Ghaap Group) m and m AMSL	Groundwater Strike (m bg) Rest (m bg) OWL (m bg) and m AMSL	Susceptibility Characterisation			
									Ingress Water		Groundwater Drawdown	
			Fines Subordi-nate (m-m)	Fines Predomi-nant (m-m)					Subsid-ence Formation	Sinkhole Formation	Subsidence Formation	Sinkhole Formation
2382/ SIM435 1213	0-102	102-150 GAM SH	-	-	-	-	> 150 < 1062	Strike – 135 1077 OWL 12 1200	NO	NO	NO	NO
13316 SIM434E 1204	0-70	70-84 GAM SH	-	-	-	-	> 84 < 1120	Strike 19 Dry (rest) OWL 21 1225	NO	NO	NO	NO
UITKOMS SITE												
SW377E	NO LOG IN KUMBA MINE EXPLORATION DATABASE											
BOROHOLES IN PROXIMITY TO UITKOMS SITE												
4155/ UK9 1223	0-10	10-142 BIF	-	-	-	-	> 142 < 1081	Strike 53 1199 23.5 OWL 23 1200	NO	NO	NO	NO
5276/ UK13 1224	-	0-150 BIF	-	-	-	-	> 150 < 1073	Strike 72 26 1197 OWL 23 1200	NO	NO	NO	NO
KBH04/ BE1 1228	0-36	36-90 BIF	-	-	-	-	> 90 < 1138	Strike 83 22 1206 OWL 28 1200	NO	NO	NO	NO

Table 1: Summarised Borehole Information and Inherent Susceptibility Characterisation

BIF	Banded Iron Formation	PEB	Pebble stone (rolstene)
CC	Calcrete	SH	Shale (Gamagara)
CL	Clay	TIL	Tillite
GM	No sample return	SST	Sandstone

Borehole Number with collar elevation in m AMSL	Transported &Kalahari Group material (m-m)	Low mobilisation potential material (shale, lava, dolerite etc) (m-m)	Ghaap Group Chert		Ghaap Group Dolomite Residuum (m-m)	Soft and weathered dolomite rock (Ghaap Group) (m-m)	Dolomite Bedrock (Ghaap Group) m and m AMSL	Groundwater Strike (m bg) Rest (m bg) OWL (m bg) and m AMSL	Susceptibility Characterisation			
									Ingress Water		Groundwater Drawdown	
			Fines Subordi-nate (m-m)	Fines Predomi-nant (m-m)					Subsid-ence Formation	Sinkhole Formation	Subsidence Formation	Sinkhole Formation
KM9 (KU3E) 1230	0-16	16-41 BIF	-	-			41-142	Strike 24-44 16.86 OWL 30 1200	NO	NO	NO	NO
KM10 (KU4E) 1230	0-54	54-66 BIF	-	-	-	-	66-100	Strike 43-50 17.47 OWL 30 1200	NO	NO	NO	NO
KM11 (KU5E) 1230	0-12	12-48 BIF	-	-	-	-	48-60	47 16.73 OWL 30 1200	NO	NO	NO	NO

Table 1: Summarised Borehole Information and Inherent Susceptibility Characterisation

BIF	Banded Iron Formation	PEB	Pebble stone (rolstene)
CC	Calcrete	SH	Shale (Gamagara)
CL	Clay	TIL	Tillite
GM	No sample return	SST	Sandstone

TEST PIT NUMBER	DEPTH OF SOIL HORIZONS (m) – (m)			SOFT ROCK	MATERIAL AT THE BASE OF TEST PIT
	SOIL				
	FILL	COLLUVIUM	NODULAR CALCRETE		
TP01	–	0 – 0.3	–	+0.3	Honeycomb Calcrete +R
TP02	–	–	0 – 0.3	+0.3	Honeycomb Calcrete +R
TP03	–	–	0 – 0.3	+0.3	Honeycomb Calcrete +R
TP04	–	–	0 – 0.2	+0.2	Honeycomb Calcrete +R
TP05	–	–	0 – 0.4	+0.4	Honeycomb Calcrete +R
TP06	–	–	0 – 0.2	+0.2	Honeycomb Calcrete +R
TP07	–	0 – 0.3	–	+0.3	Honeycomb Calcrete +R
TP08	–	0 – 0.3	–	+0.3	Honeycomb Calcrete +R
TP09	–	0 – 0.2	–	+0.2	Honeycomb Calcrete +R
TP10	–	–	0 – 0.2	+0.2	Honeycomb Calcrete +R
TP11	0 – 0.6	–	0.6 – 1.0	+1.0	Honeycomb Calcrete +R
TP12	–	0 – 0.8	–	+0.8	Honeycomb Calcrete +R
TP13	–	0 – 0.4	–	+0.4	Honeycomb Calcrete +R
TP14	–	–	0 – 0.4	+0.4	Honeycomb Calcrete +R
TP15	–	–	0 – 0.3	+0.3	Honeycomb Calcrete +R
TP16	–	–	0 – 0.3	+0.3	Honeycomb Calcrete +R
TP17	–	–	0 – 0.3	+0.3	Honeycomb Calcrete +R
TP18	–	–	0 – 0.4	+0.4	Honeycomb Calcrete +R
TP19	–	–	0 – 0.1	+0.1	Honeycomb Calcrete +R
TP20	–	–	0 – 0.2	+0.2	Honeycomb Calcrete +R
TP21	–	–	0 – 0.3	+0.3	Honeycomb Calcrete +R
TP22	–	0 – 0.4	0.4 – 0.5	+0.5	Honeycomb Calcrete +R
TP23	–	–	0 – 0.3	+0.3	Honeycomb Calcrete +R
TP24	–	0 – 0.4	–	+0.4	Honeycomb Calcrete +R
TP25	–	–	0 – 0.2	+0.2	Honeycomb Calcrete +R
TP26	–	–	0 – 0.4	+0.4	Honeycomb Calcrete +R
TP27	–	–	0 – 0.2	+0.2	Honeycomb Calcrete +R
TP28	–	0 – 0.6	–	+0.6	Honeycomb Calcrete +R
TP29	–	0 – 0.5	–	+0.5	Honeycomb Calcrete +R
TP30	–	0 – 0.2	0.2 -1.2	+1.2	Honeycomb Calcrete +R

Table 2: Summarised Test Pit Profiles

Note: MR – Maximum Reach
R – Refusal
NR – No Refusal (Webb & Partners, 1986)
PR – Partial Refusal (Webb & Partners, 1986)

TEST PIT NUMBER	DEPTH OF SOIL HORIZONS (m) – (m)			SOFT ROCK	MATERIAL AT THE BASE OF TEST PIT
	SOIL				
	FILL	COLLUVIUM	NODULAR CALCRETE		
TP31	–	0 – 0.3	–	+0.3	Honeycomb Calcrete +R
TP32	–	0 – 0.2	0.2 -0.4	+0.4	Honeycomb Calcrete +R
TP33	–	0 – 0.5	–	+0.5	Honeycomb Calcrete +R
TP34	–	0 – 0.5	–	+0.5	Honeycomb Calcrete +R
TP35	–	0 – 0.4	–	+0.4	Honeycomb Calcrete +R
TP36	–	0 – 0.4	0.4 – 1.1	+1.1	Honeycomb Calcrete +R
TP37	–	0 – 0.9	–	+0.9	Honeycomb Calcrete +R
TP38	–	0 – 0.4	–	+0.4	Honeycomb Calcrete +R

Table 2: Summarised Test Pit Profiles

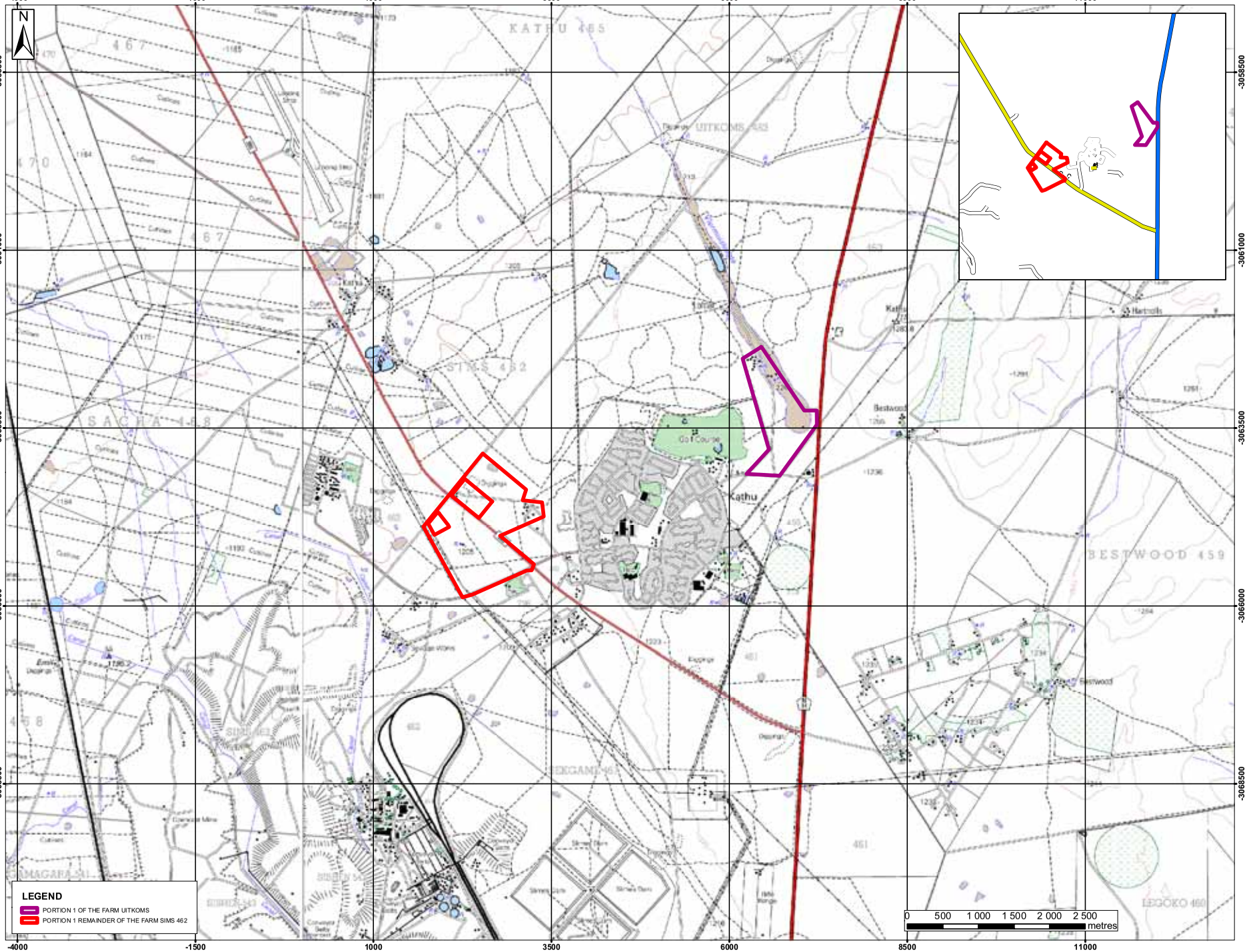
Note: MR – Maximum Reach
R – Refusal
NR – No Refusal (Webb & Partners, 1986)
PR – Partial Refusal (Webb & Partners, 1986)

Test Pit No.	SAMPLE DEPTH (m)	GRADING (% PASSING) SIEVE SIZE (mm)				ATTERBERG LIMITS (%)			POTENTIAL EXPANSIVE-NESS	USC	GM	CBR AT % COMPACTION			MODIFIED AASHTO COMPACTION		ORIGIN
		2,0	0,425	0,075	0,002	LL (%)	PI (%)	LS (%)				95	97	98	MDD (kg/m³)	OMC (%)	
TP02/1	0-0.3	48	44	7	1	0	NP	0	Low	GP-GM	2.01	39	59	69	2016	7.6	PEDOGENIC
TP11/1	0-0.6	53	44	11	2	0	NP	0	Low	SP-SM	1.92						FILL
TP13/1	0-0.4	99	89	11	3	0	NP	0	Low	SP-SM	1.01						COLLUVIUM
TP15/1	0-0,3	43	40	12	5	0	NP	0	Low	GP-GM	2.01	36	53	64	1824	10.8	PEDOGENIC
TP22/1	0-0.4	99	95	16	3	0	NP	0	Low	SM	0.90						COLLUVIUM
TP24/1	0-0,4	100	96	11	1	0	NP	0	Low	SP-SM	0.93						COLLUVIUM
TP26/1	0-0,4	56	53	13	1	0	NP	0	Low	SC	1.78	33	48	57	1880	7.4	PEDOGENIC
TP27/1	0-0,2	51	47	11	6	0	NP	0	Low	GP-GM	1.91						PEDOGENIC
TP36/1	0-0.4	95	90	17	3	0	NP	0	Low	SM	0.98						COLLUVIUM
TP36/3	0.4-1.1	73	70	26	9	22	6	2.5	Low	SC	1.31	38	53	64	1880	9.7	PEDOGENIC

Table 3: Summarised Laboratory Test Results

LL : Liquid Limit
PI : Plasticity Index
LS : Linear Shrinkage
GM : Grading Modulus
USC : Unified Soil Classification
MDD : Maximum Dry Density
OMC : Optimum Moisture Content
CBR : California Bearing Ratio
GC : Clayey Gravels
SC : Clayey Sands
CL : Sandy Clays
ML : Clayey Silts

FIGURES



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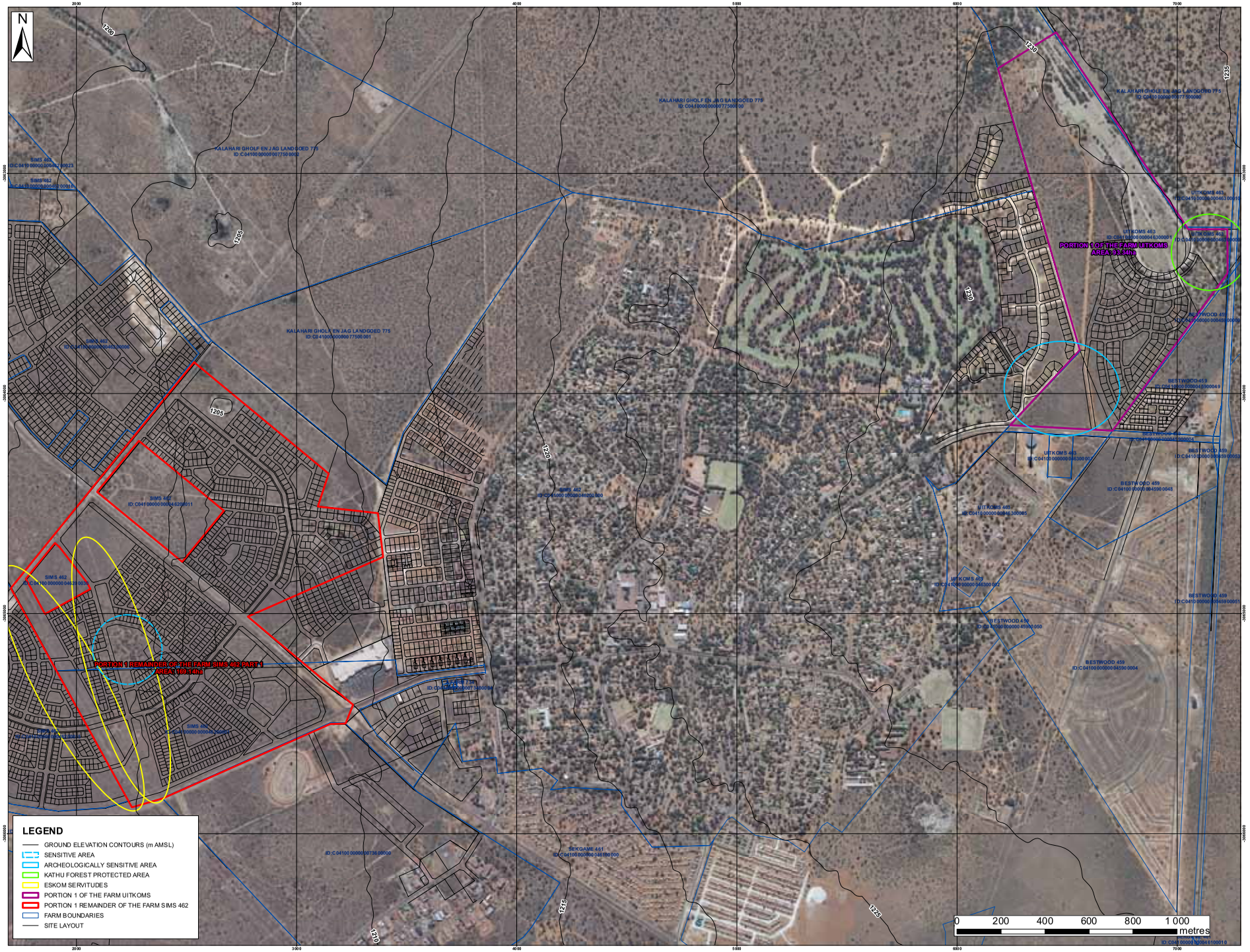

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SITE LAYOUT WITH
GROUND ELEVATION CONTOURS

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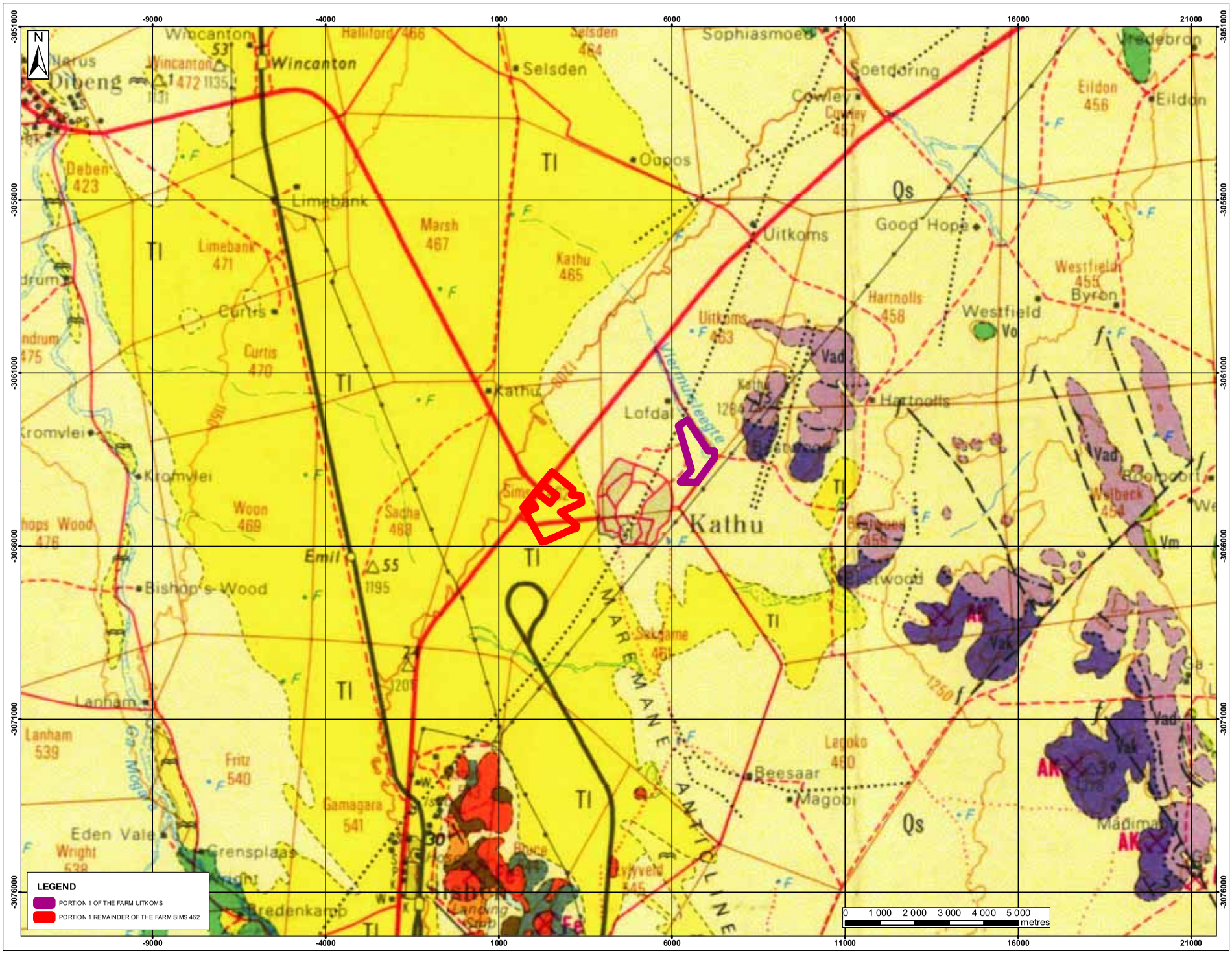
FIGURE 2



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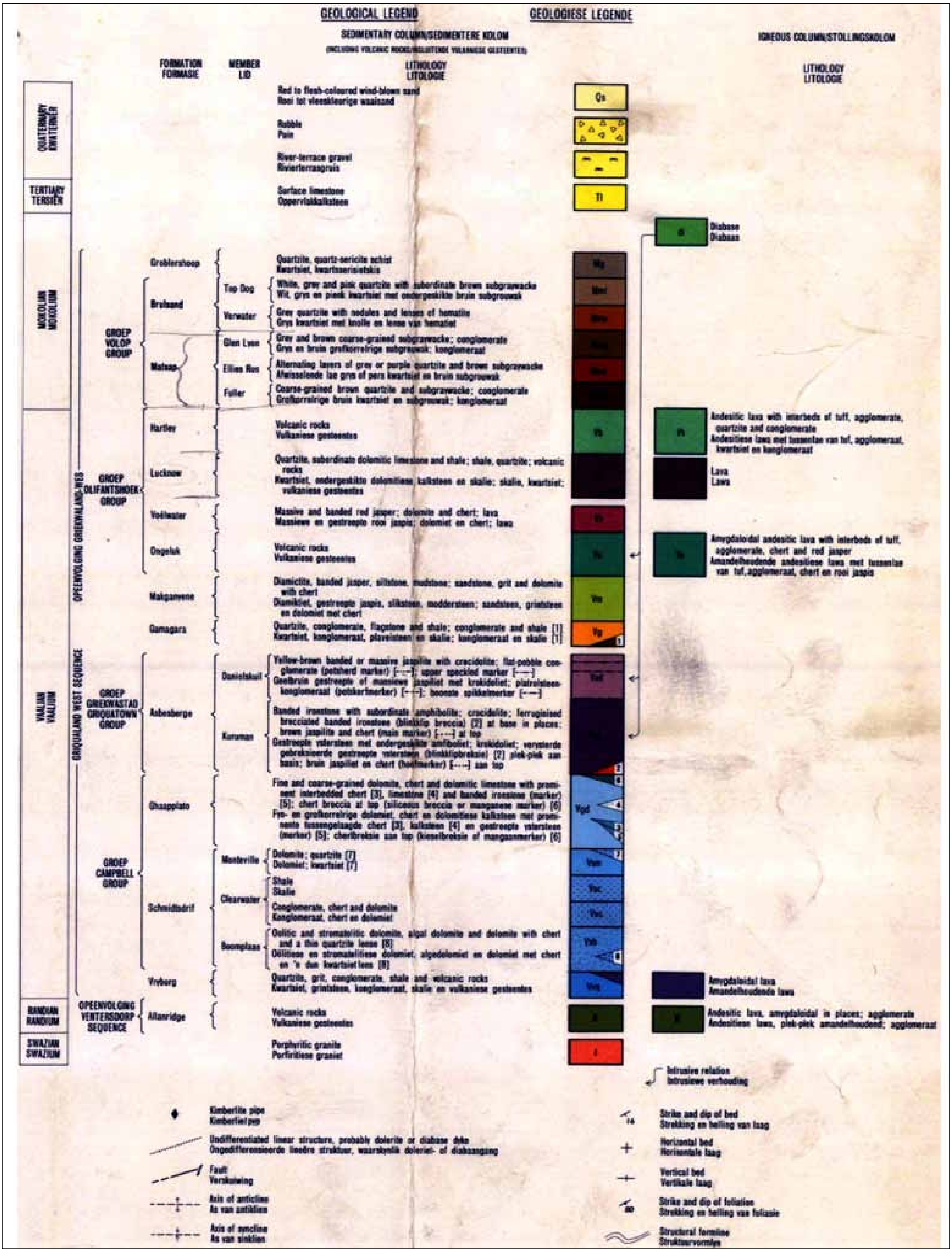

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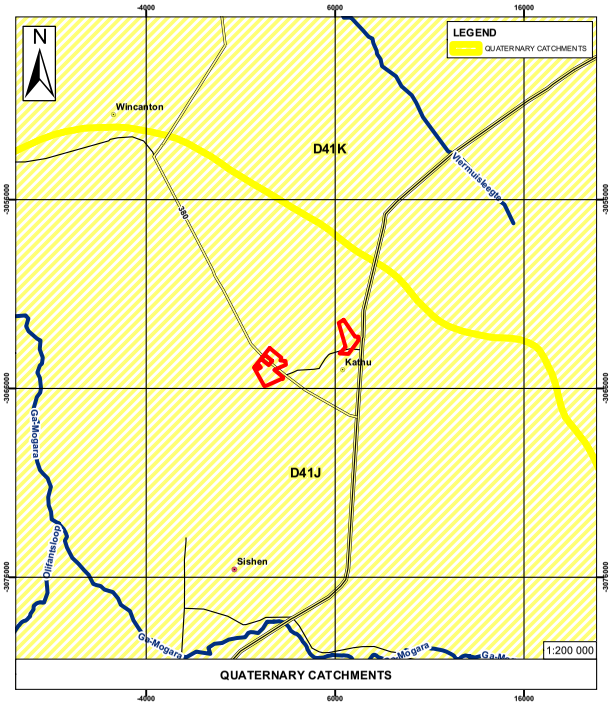

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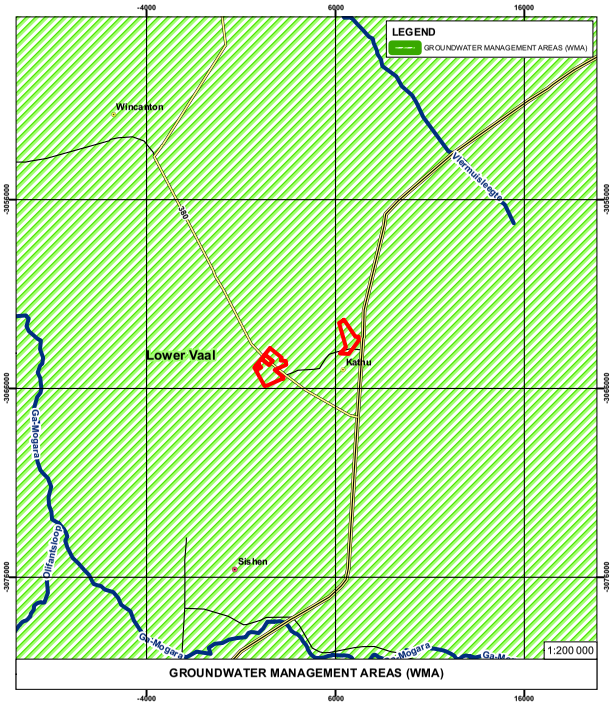
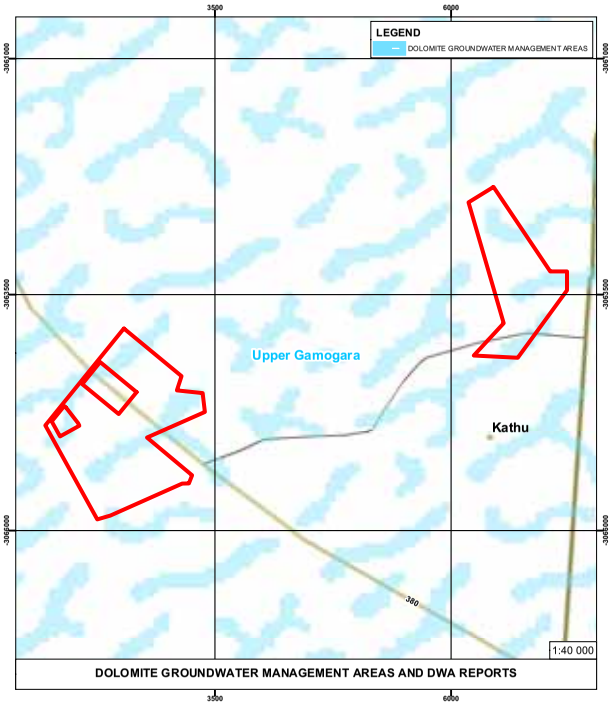
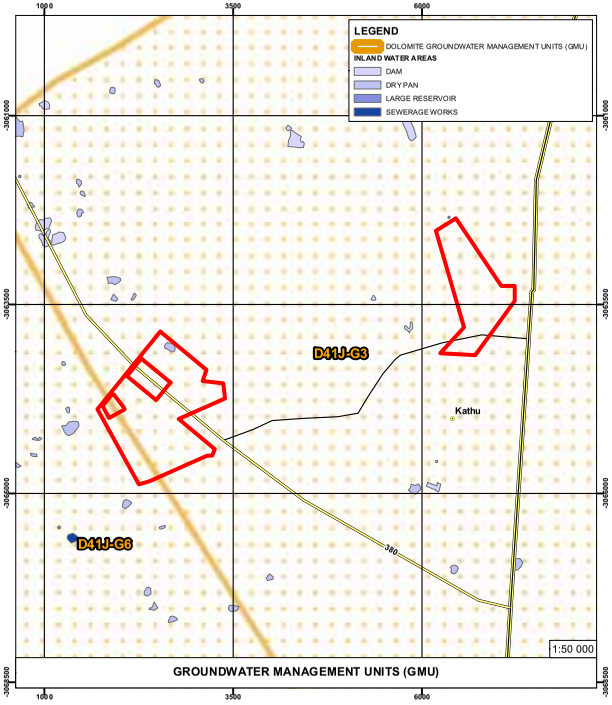


GROUNDWATER MANAGEMENT AREAS (WMA)



DOLOMITE GROUNDWATER MANAGEMENT AREAS AND DWA REPORTS



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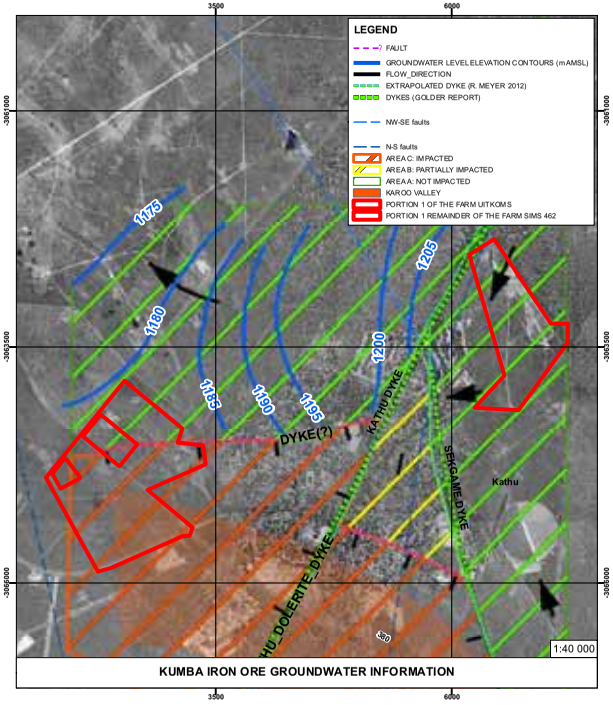
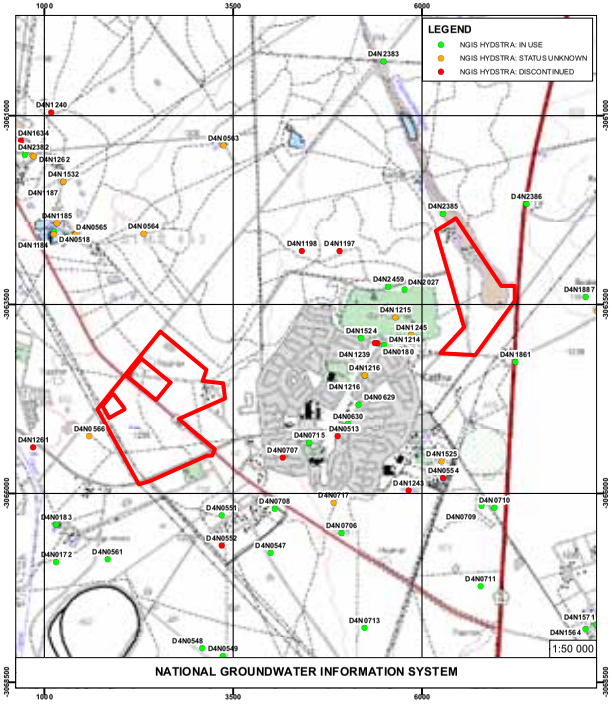


KUMBA IRON ORE GROUNDWATER INFORMATION



NATIONAL GROUNDWATER INFORMATION SYSTEM

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GENERAL LEGEND

PORTION 1 OF THE FARM UITKOMS
PORTION 1 REMAINDER OF THE FARM SIMS 462

RSA TOWNS
- CAPITAL / CITY
- CHIEF ADMINISTRATIVE TOWN
- MAJOR TOWN
- OTHER TOWN
- SECONDARY TOWN
- SETTLEMENT

FREEWAY ROADS
MAIN ROADS
NATIONAL ROADS
SECONDARY ROADS
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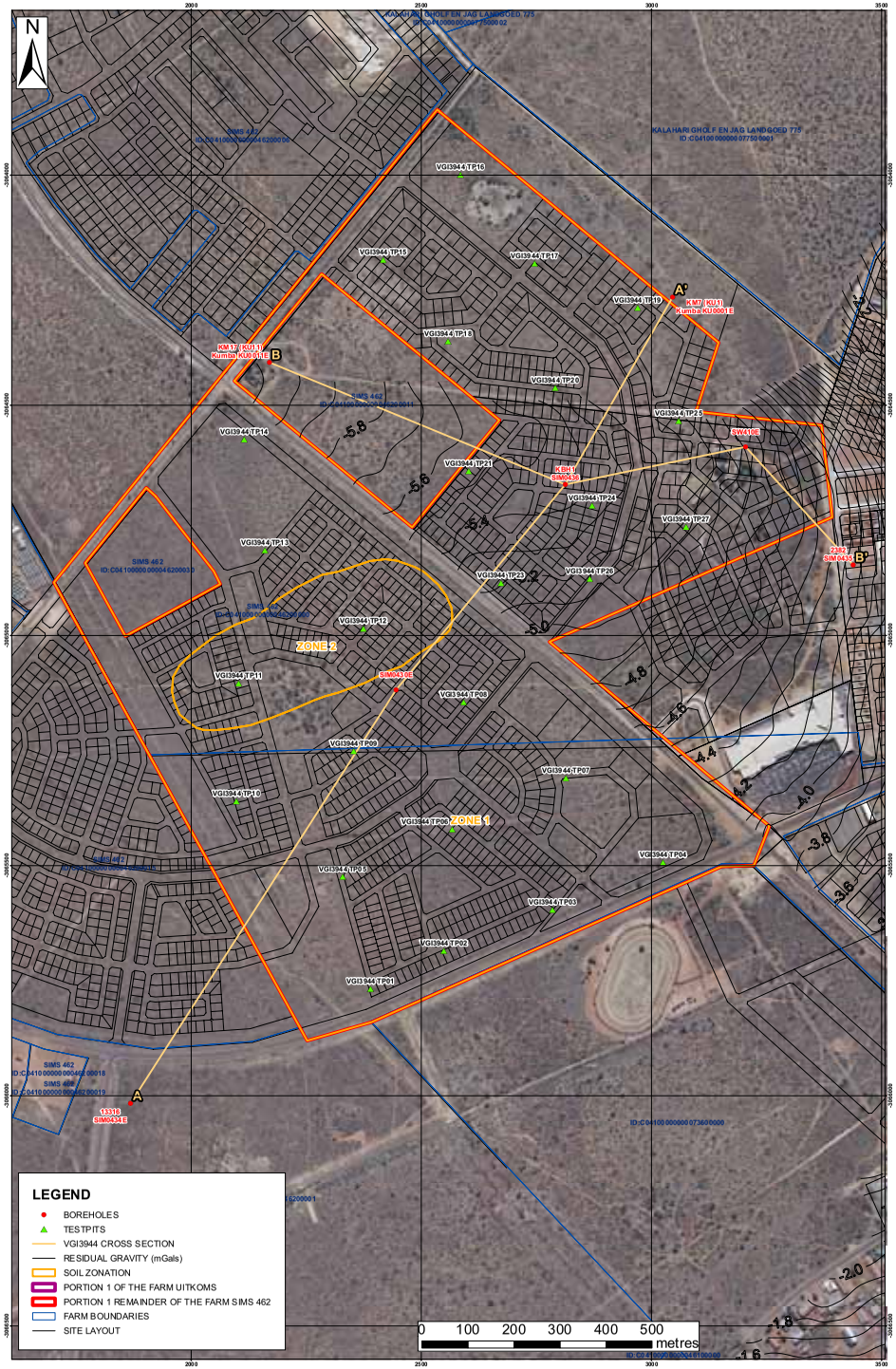
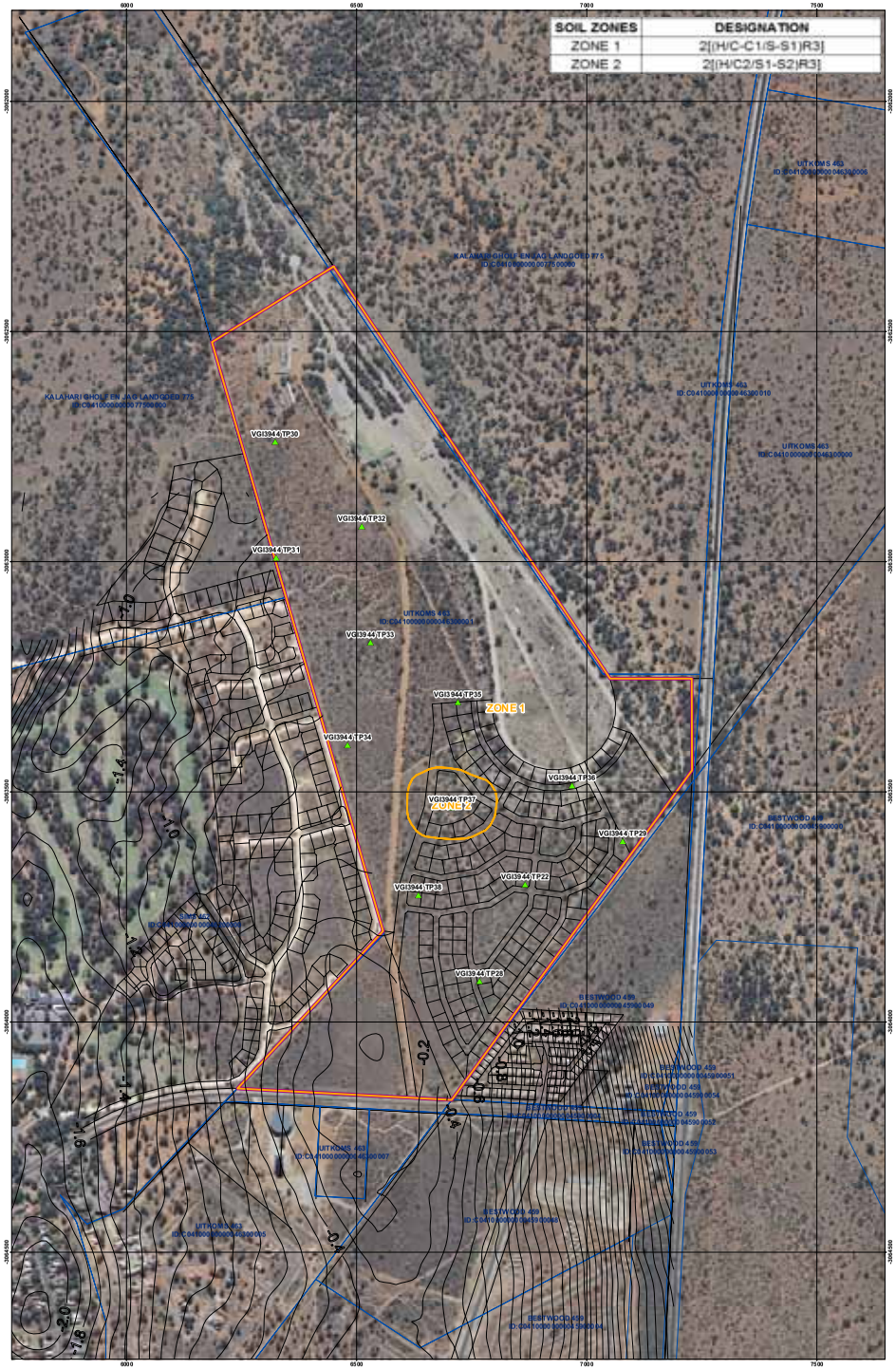
FIGURE 4

DRAWINGS





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BOREHOLE-, TEST PIT POSITIONS
AND SOIL ZONATION

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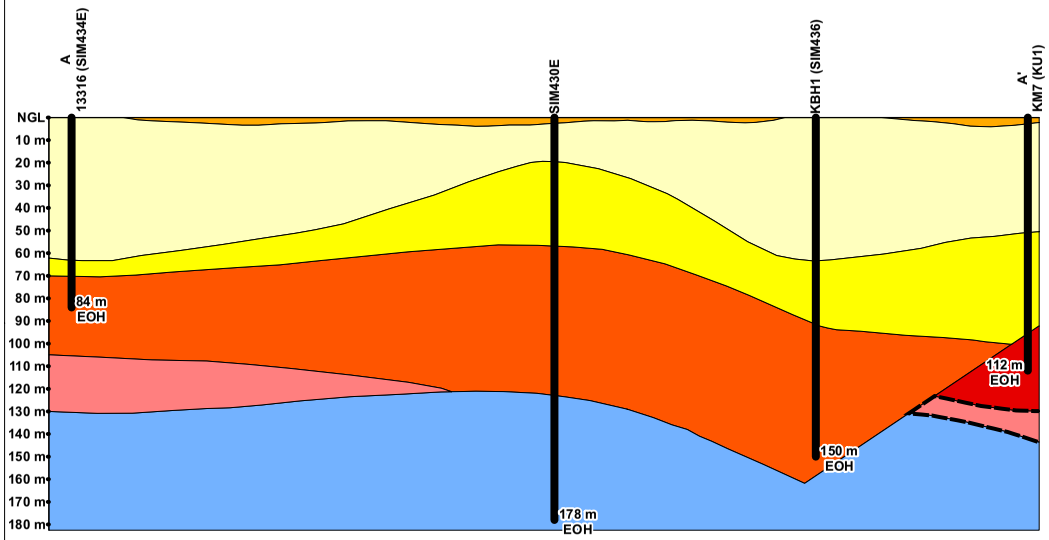

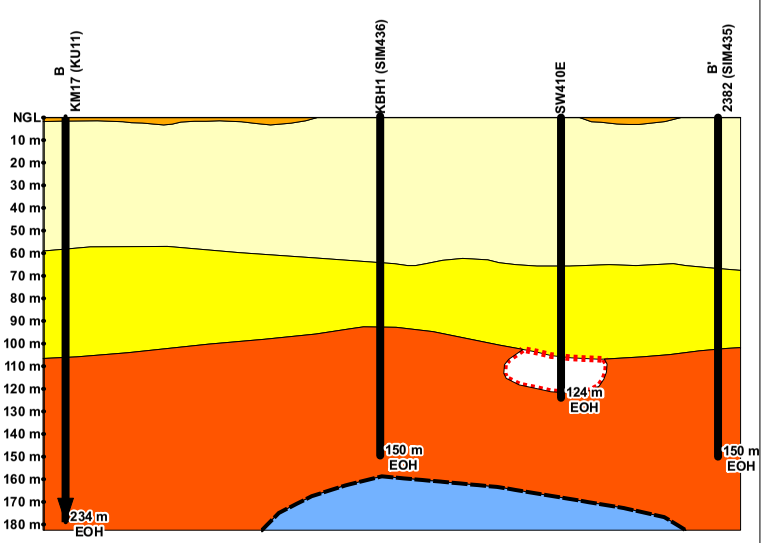

LEGEND

- BOREHOLES
- GORDONIA FORMATION, KALAHARI GROUP (SAND)
- MOKALANLEN FORMATION, KALAHARI GROUP (CALCRETE)
- WESSELS FORMATION, KALAHARI GROUP (GRAVELY CLAY)
- GAMAGARA FROMATION, OLIFANTSHOEK SUPERGROUP (SHALE, SILTSTONE)
- BANDED IRON FORMATION ASBESTOSHILLS SUBGROUP
- WOLHAARSKOP, ASBESTOSHILLS SUBGROUP (BRECCIA)
- GHAAP GROUP, CAMPBELLRAND SUBGROUP (DOLOMITE)
- CAVITY?

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APPENDICES

APPENDIX 1

BOREHOLE PROFILES

Sishen Geological Borehole Log

Verslag Datum: 2008/07/17

Plaas: WATERGATE **Finale Diepte:** 124.00 **XKoord:** 64295.67
Boorgat: 410 E **Diamant Geoloog:** **YKoord:** -53250.76
Eind Datum: **Aanvoor Geoloog:** **ZKoord:** 1209.96

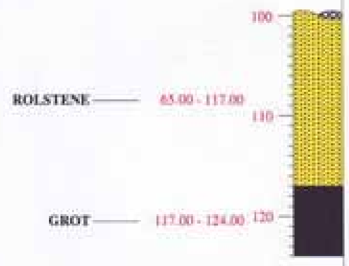
Geologiese Eienskappe	Analise: Fe	SiO2	Al2O3	K2O	P	S	Erts

Sishen Geological Borehole Log

Verslag Datum: 2008/07/17

Plaas: WATERGATE **Finale Diepte:** 124.00 **XKoord:** 64295.67
Boorgat: 410 E **Diamant Geoloog:** **YKoord:** -53250.76
Eind Datum: **Aanvoor Geoloog:** **ZKoord:** 1209.96

Geologiese Eienskappe	Analise: Fe	SiO2	Al2O3	K2O	P	S	Erts



0 - 117
C
124

Sishen Geological Borehole Log

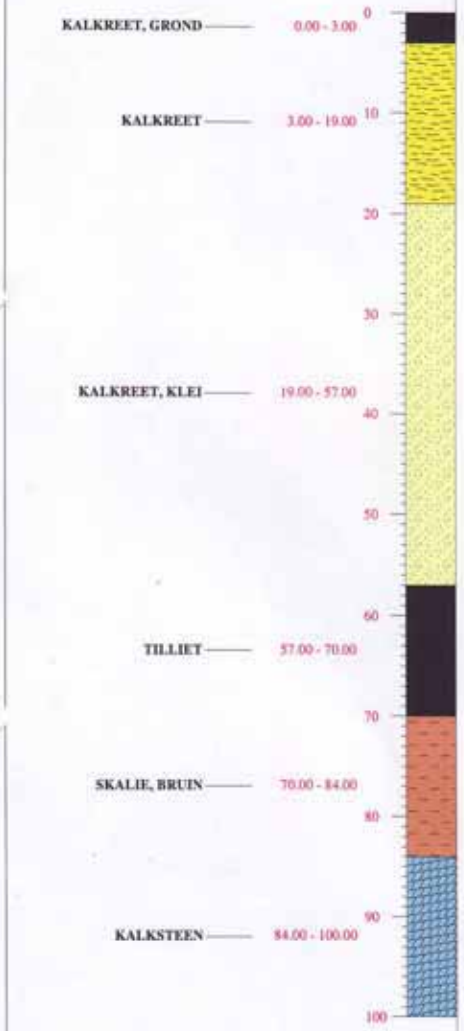
Verslag Datum: 2008/07/17

Plaas: SIMS
Boorgat: 430 E
Eind Datum:

Finale Diepte: 178.15
Diamant Geoloog:
Aanvoor Geoloog: HANNES VILJOEN

XKoord: 64822.99
YKoord: -52494.75
ZKoord: 1204.81

Geologiese Eienskappe		Analise						Erts
		Fe	SiO2	Al2O3	K2O	P	S	S PG
KALKREET, GROND	0.00 - 3.00	6						
KALKREET	3.00 - 19.00	4						
		57						
		5						
		121						
KALKREET, KLEI	19.00 - 57.00	10						
		178						
TILLIET	57.00 - 70.00							
SKALIE, BRUIN	70.00 - 84.00							
KALKSTEEN	84.00 - 100.00							



Sishen Geological Borehole Log

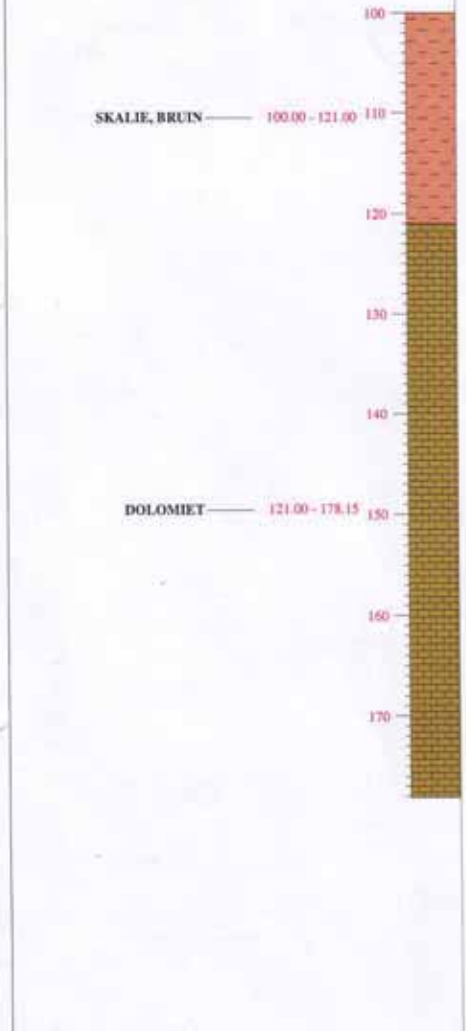
Verslag Datum: 2008/07/17

Plaas: SIMS
Boorgat: 430 E
Eind Datum:

Finale Diepte: 178.15
Diamant Geoloog:
Aanvoor Geoloog: HANNES VILJOEN

XKoord: 64822.99
YKoord: -52494.75
ZKoord: 1204.81

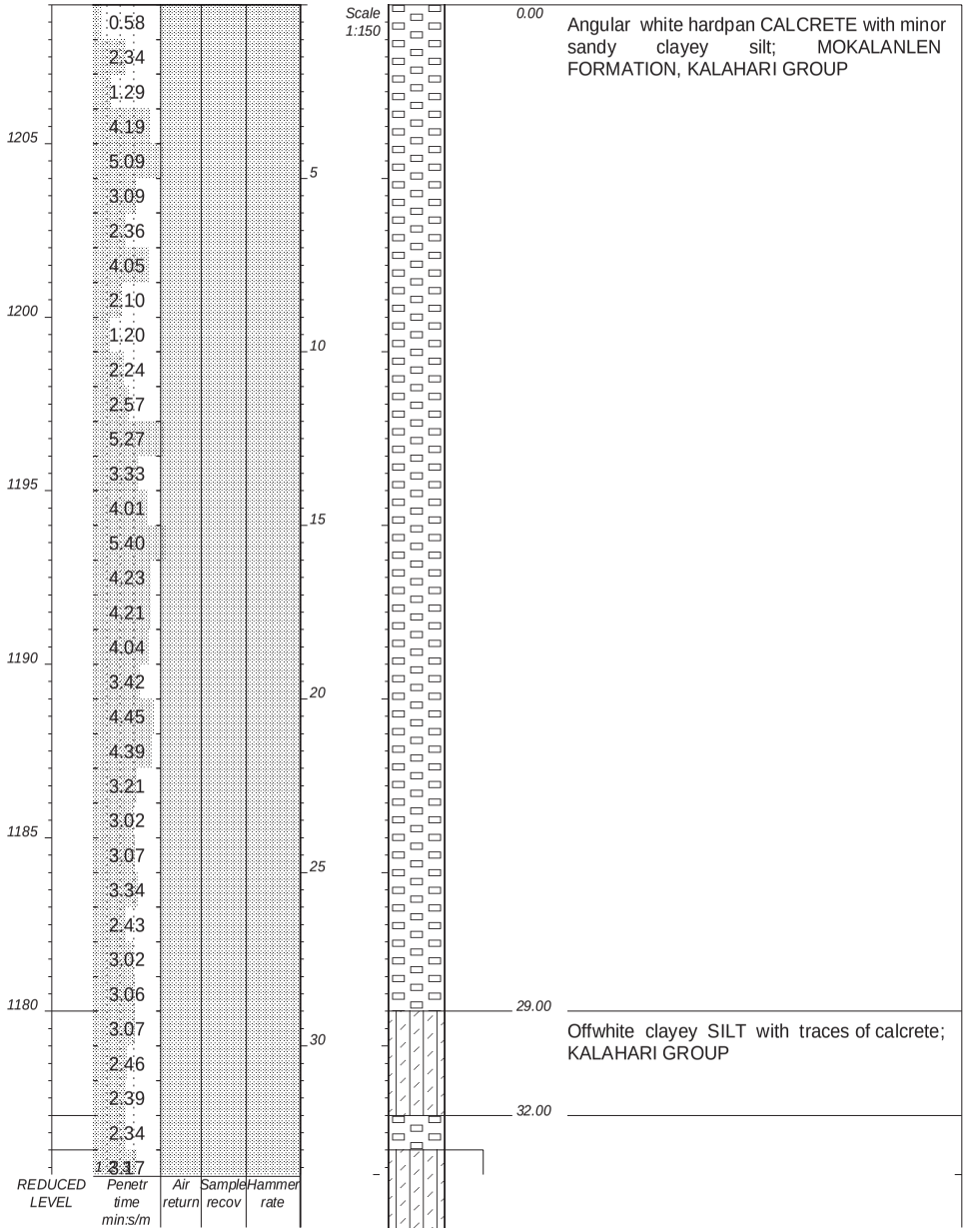
Geologiese Eienskappe		Analise						Erts
		Fe	SiO2	Al2O3	K2O	P	S	S PG
SKALIE, BRUIN	100.00 - 121.00							
DOLOMIET	121.00 - 178.15							



KUMBA
SISHEN GROUND WATER STUDY

HOLE No: KBH1
Sheet 1 of 5

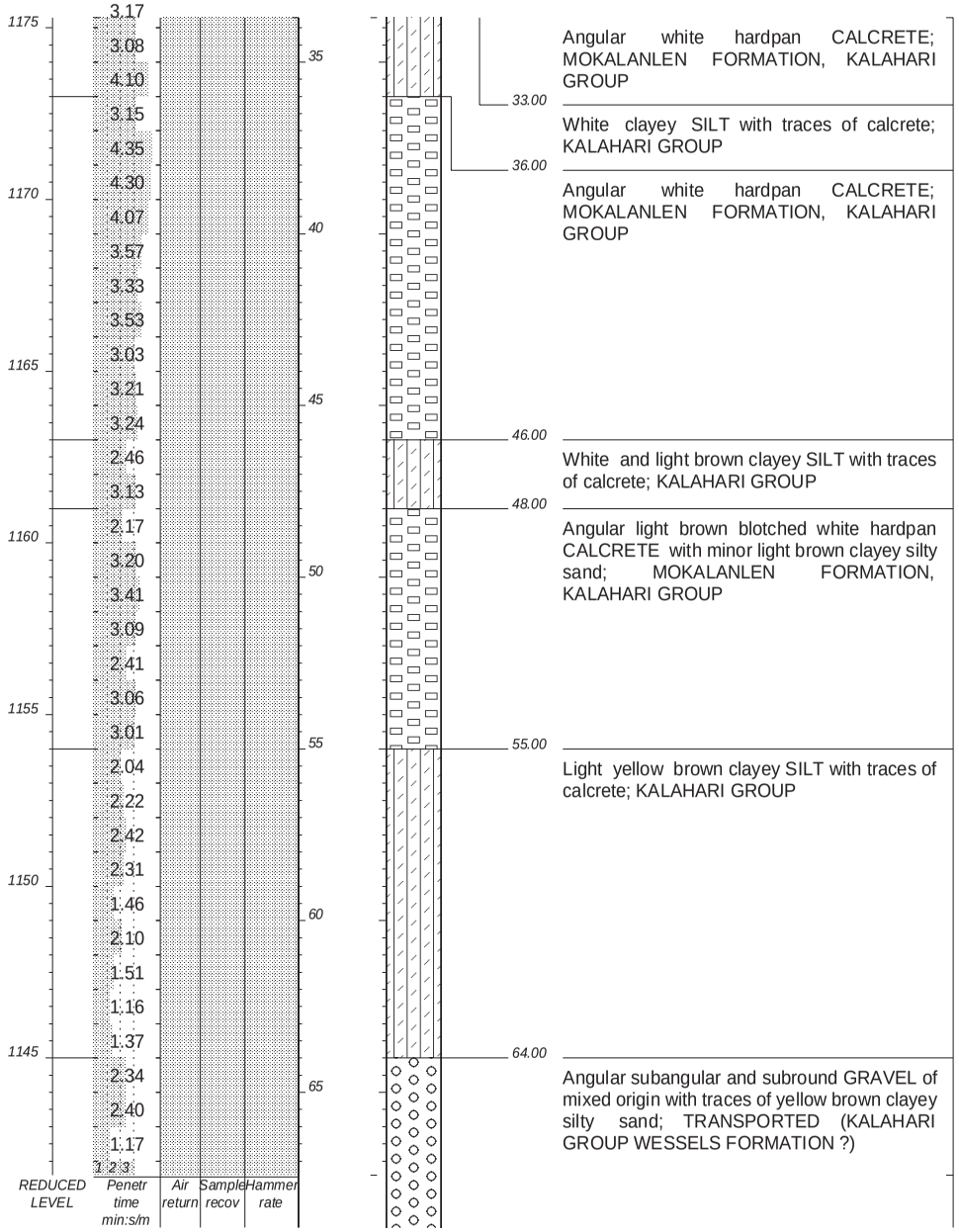
JOB NUMBER: VGI3193.3



KUMBA
SISHEN GROUND WATER STUDY

HOLE No: KBH1
Sheet 2 of 5

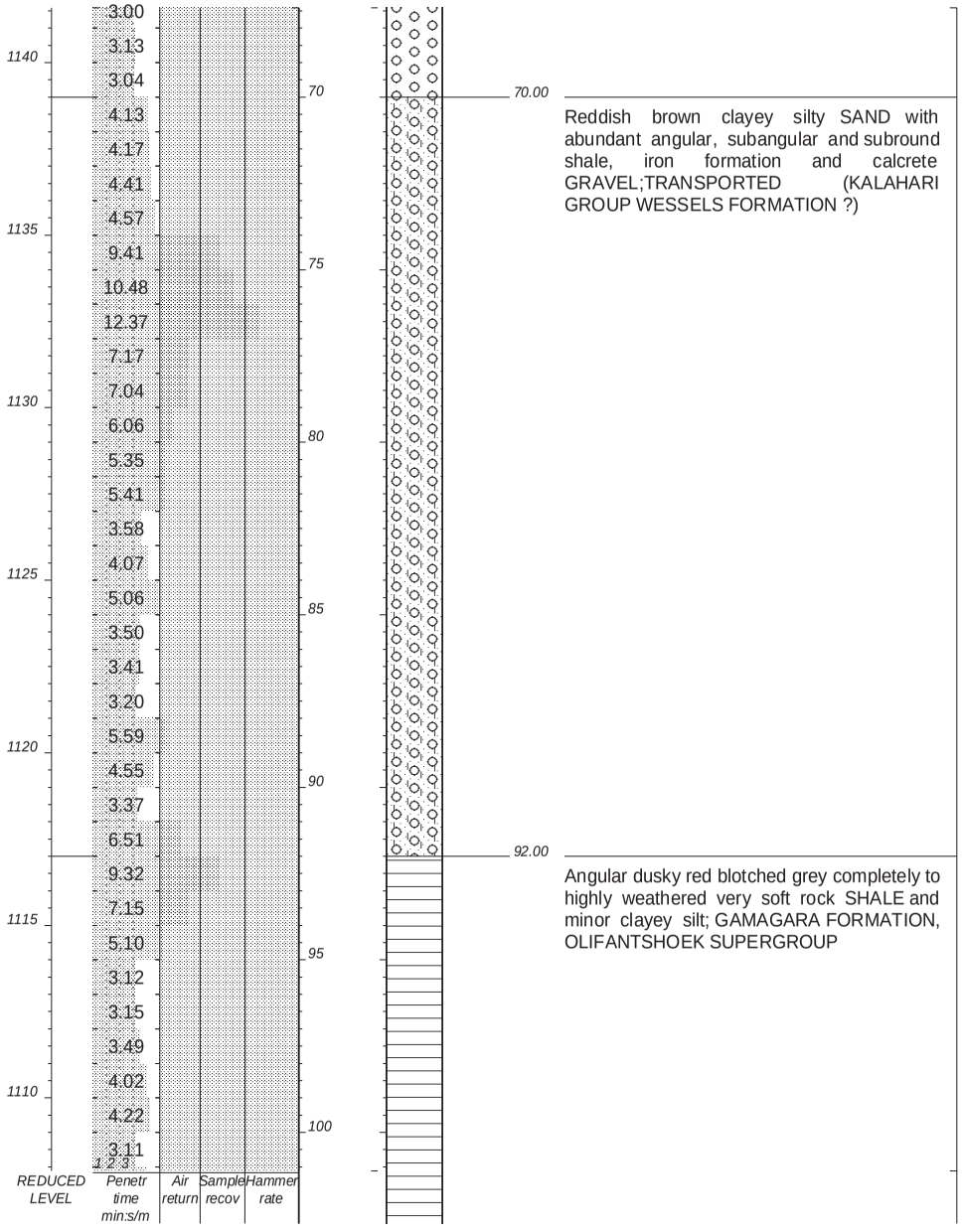
JOB NUMBER: VGI3193.3



KUMBA
SISHEN GROUND WATER STUDY

HOLE No: KBH1
Sheet 3 of 5

JOB NUMBER: VGI3193.3



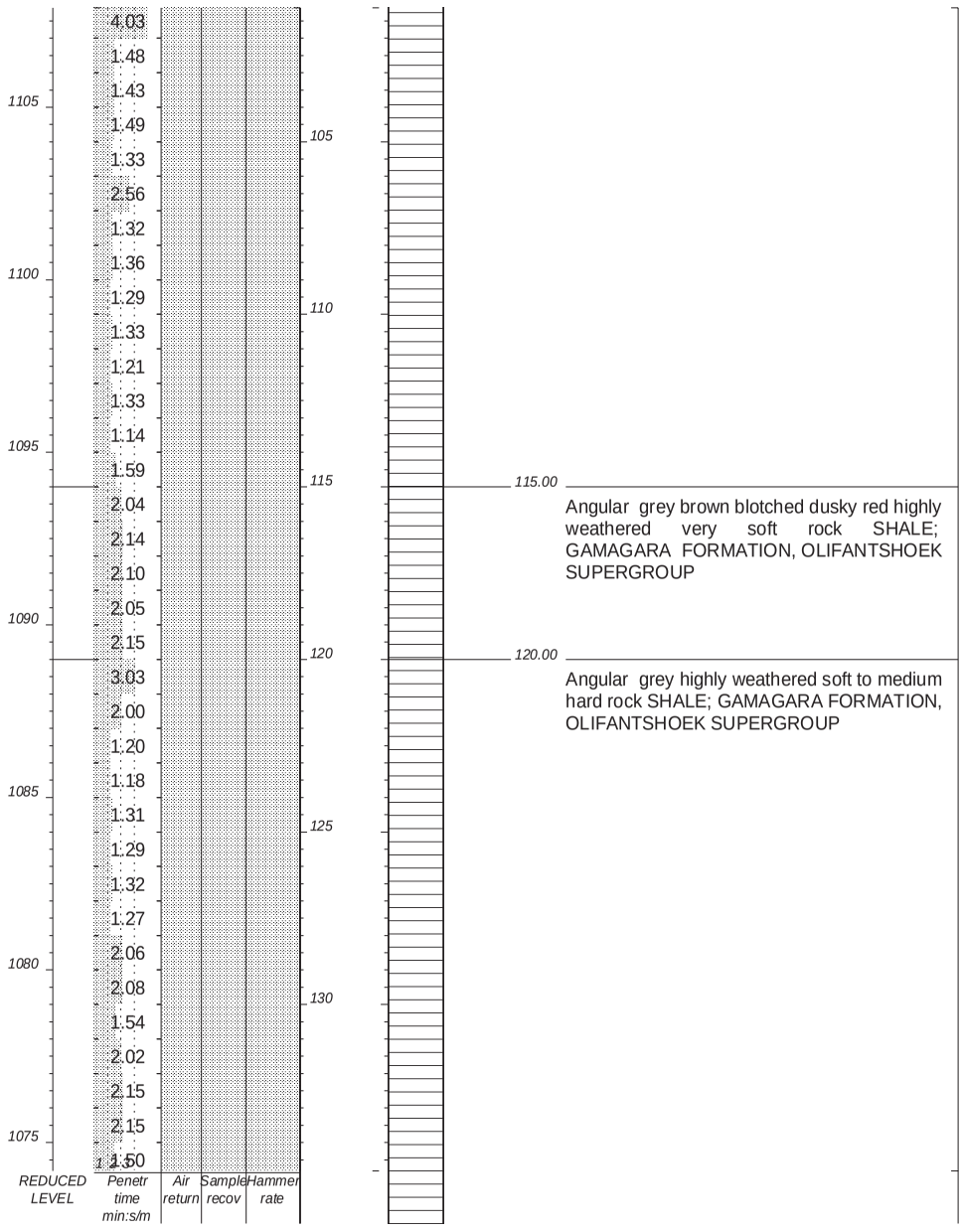
Reddish brown clayey silty SAND with abundant angular, subangular and subround shale, iron formation and calcrete GRAVEL;TRANSPORTED (KALAHARI GROUP WESSELS FORMATION ?)

Angular dusky red blotched grey completely to highly weathered very soft rock SHALE and minor clayey silt; GAMAGARA FORMATION, OLIFANTSHOEK SUPERGROUP

KUMBA
SISHEN GROUND WATER STUDY

HOLE No: KBH1
Sheet 4 of 5

JOB NUMBER: VGI3193.3



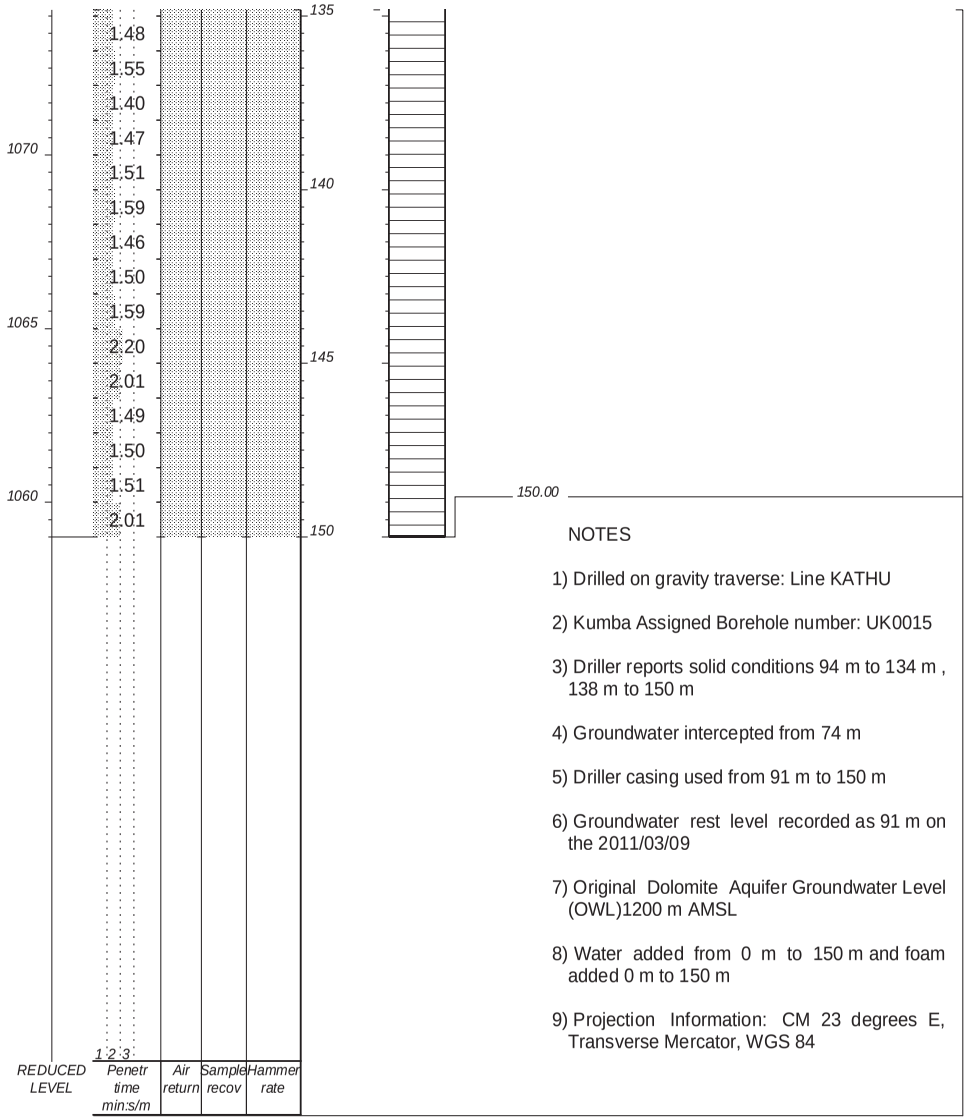
Angular grey brown blotched dusky red highly weathered very soft rock SHALE; GAMAGARA FORMATION, OLIFANTSHOEK SUPERGROUP

Angular grey highly weathered soft to medium hard rock SHALE; GAMAGARA FORMATION, OLIFANTSHOEK SUPERGROUP

KUMBA
SISHEN GROUND WATER STUDY

HOLE No: **KBH1**
Sheet 5 of 5

JOB NUMBER: VGI3193.3



NOTES

1) Drilled on gravity traverse: Line KATHU

2) Kumba Assigned Borehole number: UK0015

3) Driller reports solid conditions 94 m to 134 m , 138 m to 150 m

4) Groundwater intercepted from 74 m

5) Driller casing used from 91 m to 150 m

6) Groundwater rest level recorded as 91 m on the 2011/03/09

7) Original Dolomite Aquifer Groundwater Level (OWL)1200 m AMSL

8) Water added from 0 m to 150 m and foam added 0 m to 150 m

9) Projection Information: CM 23 degrees E, Transverse Mercator, WGS 84

CONTRACTOR : BOOYSEN BORE
MACHINE : HJB01 SCHRAMM (2100 kPa)
DRILLED BY : FRANS/HERMAN/APRIL
PROFILED BY : B BOLITHO

INCLINATION : 90 DEGREES
DIAM : 165 mm
DATE : 2011/03/03
DATE : 2011/05/05

ELEVATION : 1209 m AMSL
X-COORD : 3064659
Y-COORD : 2840

HOLE No: **KBH1**

TYPE SET BY : GARTH JORDAAN
SETUP FILE : SETUP.SET

DATE : 26/10/15 09:33
TEXT : ..C:\DOTFILES\201109~1.TXT

D055 DBB

dot.PLOT 5006 J&W

Sishen Geological Borehole Log

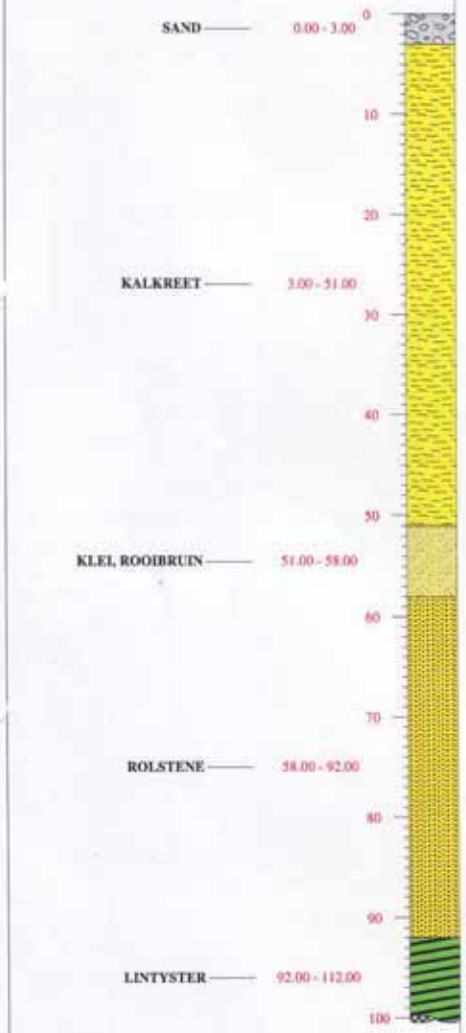
Verslag Datum: 2008/07/17

Plaas: KATHU
Boorgat: 1 E
Eind Datum:

Finale Diepte: 112.00
Diamant Geoloog:
Aanvoor Geoloog: FERDI GOUSSARD

XKoord: 63970.42
YKoord: -53092.25
ZKoord: 1211.06

Geologiese Eienskappe	Analise						Erts
	Fe	SiO2	Al2O3	K2O	P	S	S BIQ



Sishen Geological Borehole Log

Verslag Datum: 2008/07/17

Plaas: KATHU
Boorgat: 1 E
Eind Datum:

Finale Diepte: 112.00
Diamant Geoloog:
Aanvoor Geoloog: FERDI GOUSSARD

XKoord: 63970.42
YKoord: -53092.25
ZKoord: 1211.06

Geologiese Eienskappe	Analise						Erts
	Fe	SiO2	Al2O3	K2O	P	S	S BIQ

Borehole KM17:

Bh No	KM17	Lat	Long
	Start: 08/11/06 Stop: 14/11/06	-27.69287	23.02191

Depth (m.bgl.)	Geology	Water Strike	Yield (l/s)	EC (mS/m)	pH	Comments
0 - 1	Reddish brown topsoil					
-10	Pale white to yellow brown partially weathered calcrete					
-12	Reddish brown well weathered calcrete	25	Seep			
-37	Pale white to yellow brown partially weathered calcrete	34	0.1			
-43	Reddish brown clay - intensively weathered calcrete					
-46	Pale white to yellow brown partially weathered calcrete					
-48	Reddish brown clay - intensively weathered calcrete	48	0.3	89	8.34	
-58	Reddish brown to yellow brown weathered calcrete					
-67	Cobblestone and gravel - well rounded	60	0.5	83	8.25	
-73	Red clay with gravel and cobblestone					
-98	Cobblestone and gravel - well rounded					
-117	Red clay with gravel and cobblestone					
-234	Grey Dwyka tillite and shale					
WL =	18.96m.bgl. 15/11/06 08:35					

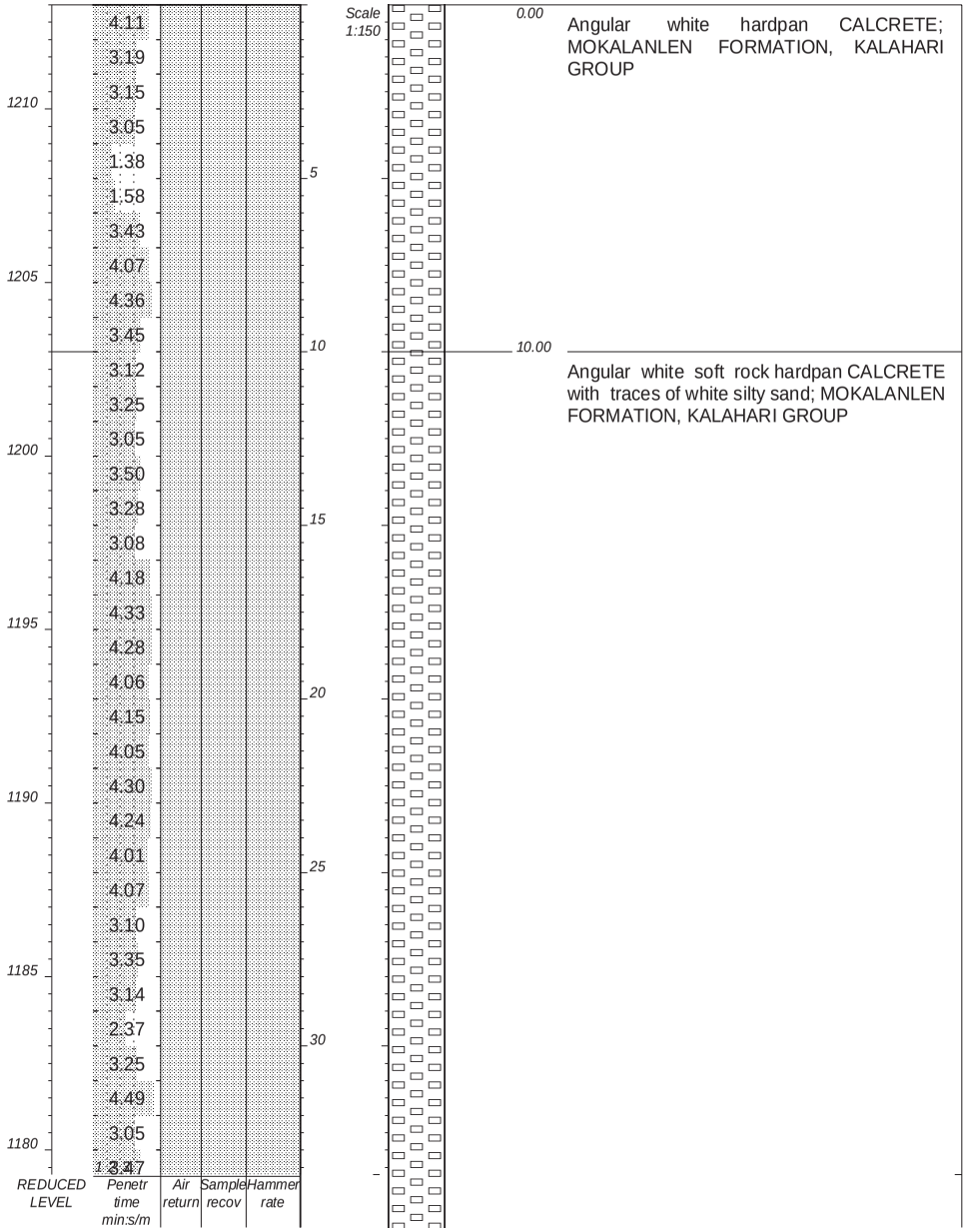
CONSTRUCTION

0 - 132m	203mm Air percussion drilling
126 - 234m	165mm Air percussion drilling
0 - 2m	260mm ID steel casing, 4mm wall
0 - 132m	165mm ID steel casing 4mm wall, Perforated 48-60m and 72-102m

KUMBA
SISHEN GROUND WATER STUDY

HOLE No: 2382
Sheet 1 of 5

JOB NUMBER: VGI3193.3



Angular white hardpan CALCRETE; MOKALANLEN FORMATION, KALAHARI GROUP

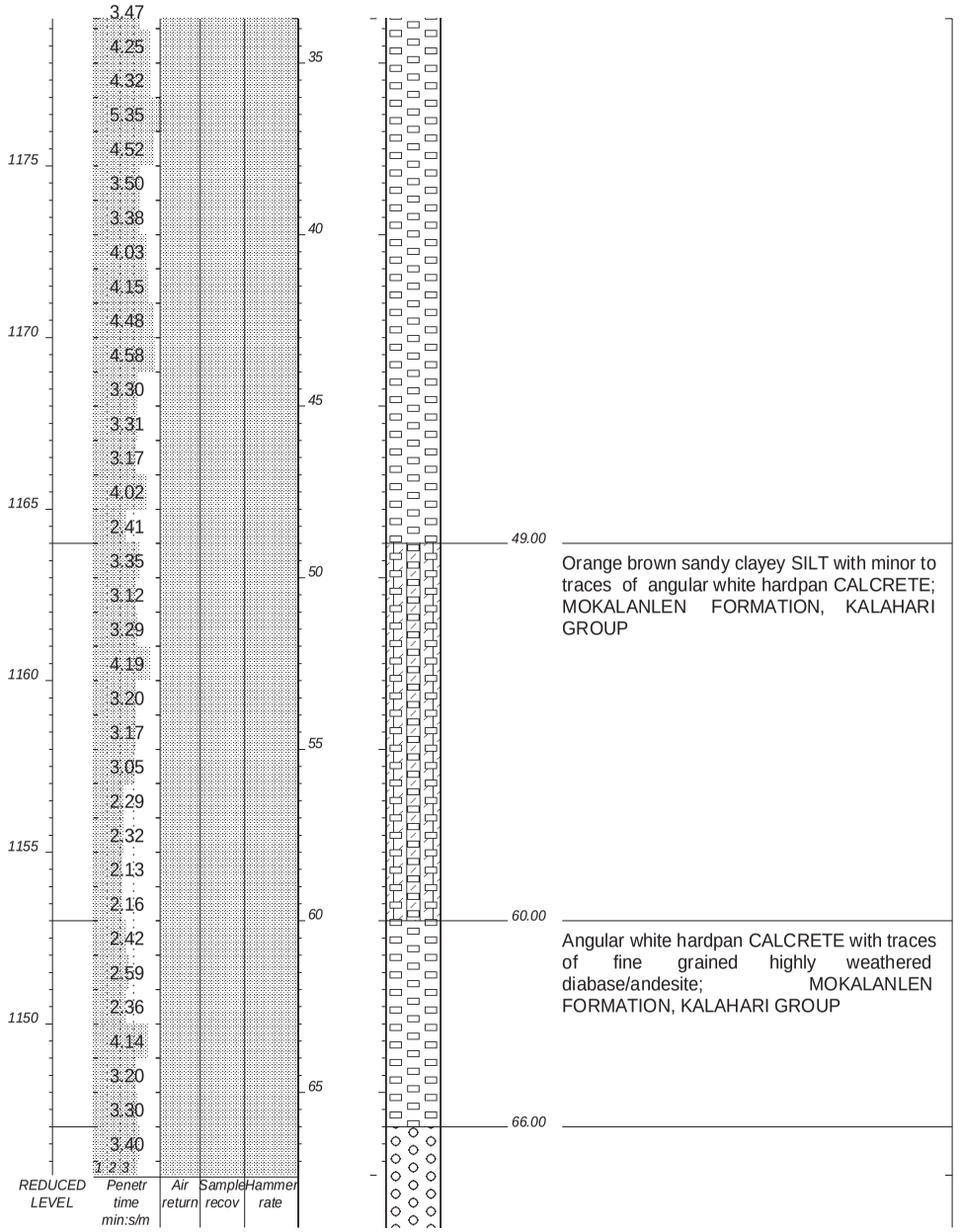
10.00

Angular white soft rock hardpan CALCRETE with traces of white silty sand; MOKALANLEN FORMATION, KALAHARI GROUP

KUMBA
SISHEN GROUND WATER STUDY

HOLE No: 2382
Sheet 2 of 5

JOB NUMBER: VGI3193.3



49.00

Orange brown sandy clayey SILT with minor to traces of angular white hardpan CALCRETE; MOKALANLEN FORMATION, KALAHARI GROUP

60.00

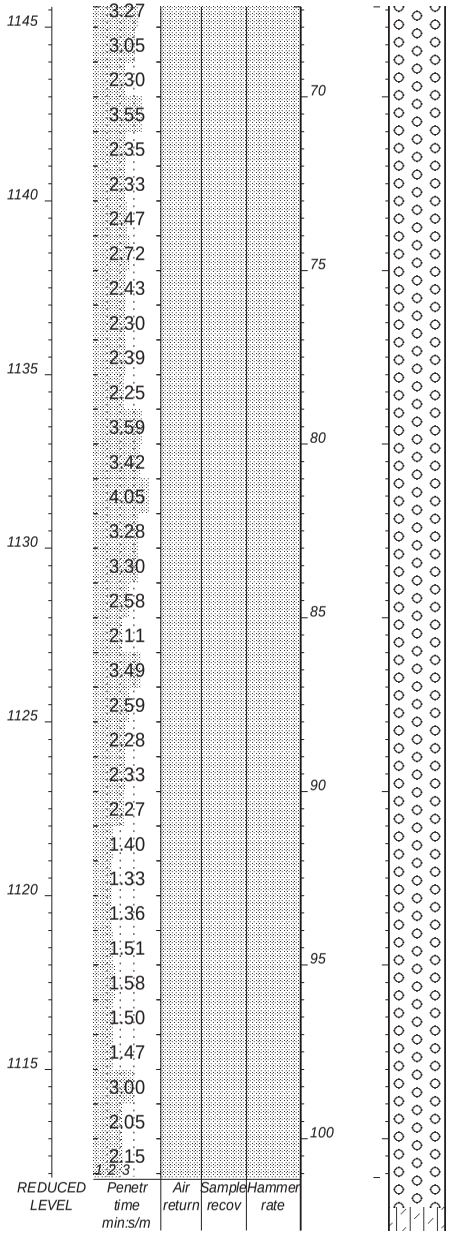
Angular white hardpan CALCRETE with traces of fine grained highly weathered diabase/andesite; MOKALANLEN FORMATION, KALAHARI GROUP

66.00

KUMBA
SISHEN GROUND WATER STUDY

HOLE No: 2382
Sheet 3 of 5

JOB NUMBER: VGI3193.3

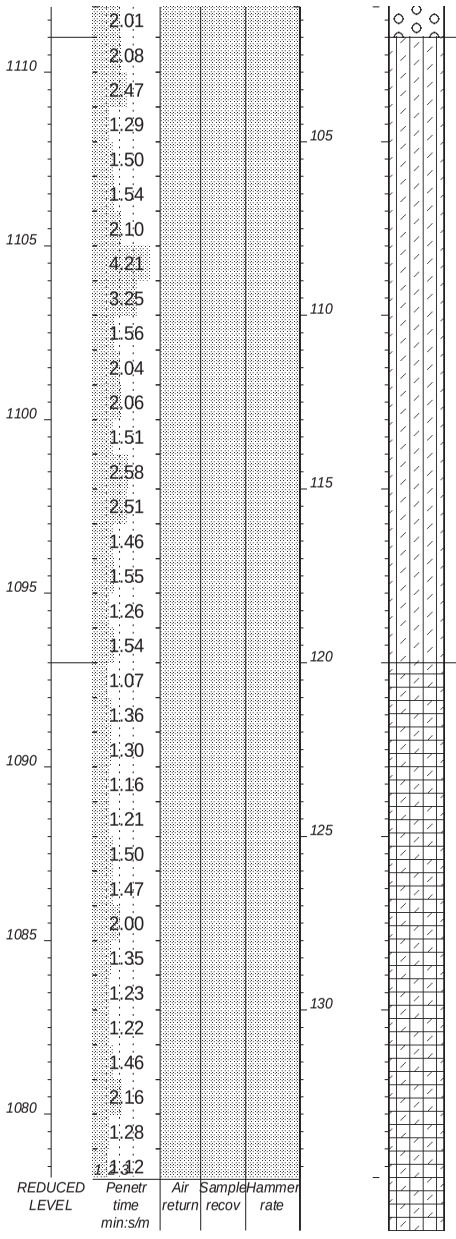


Subround, subangular and angular highly weathered GRAVEL of mixed origin; WESSELS FORMATION, KALAHARI GROUP

KUMBA
SISHEN GROUND WATER STUDY

HOLE No: 2382
Sheet 4 of 5

JOB NUMBER: VGI3193.3



102.00

Angular dusky brown completely weathered and shattered clayey SILT; GAMAGARA FORMATION, OLIFANTSHOEK SUPERGROUP

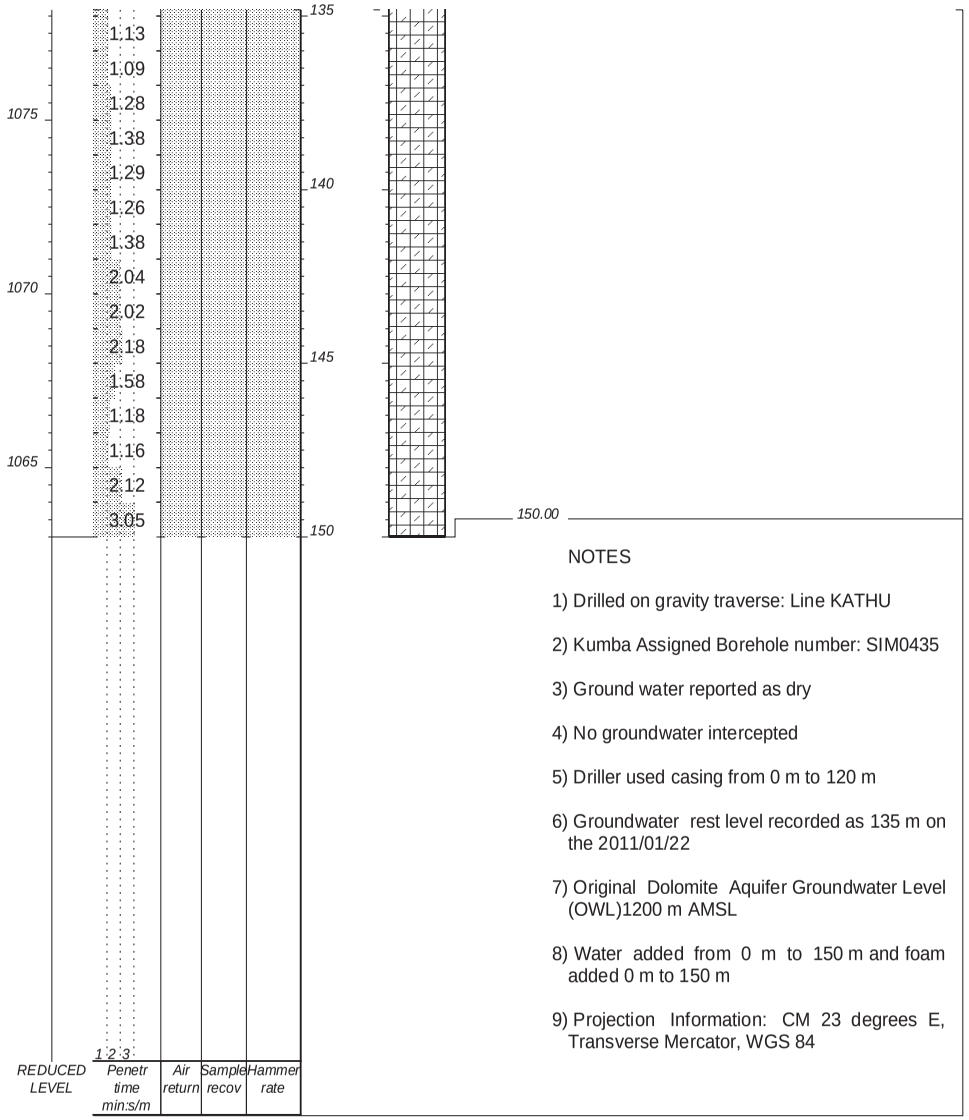
120.00

Angular light grey highly weathered very soft rock MUDROCK with abundant grey clayey SILT; GAMAGARA FORMATION, OLIFANTSHOEK SUPERGROUP

KUMBA
SISHEN GROUND WATER STUDY

HOLE No: 2382
Sheet 5 of 5

JOB NUMBER: VGI3193.3



NOTES

1) Drilled on gravity traverse: Line KATHU

2) Kumba Assigned Borehole number: SIM0435

3) Ground water reported as dry

4) No groundwater intercepted

5) Driller used casing from 0 m to 120 m

6) Groundwater rest level recorded as 135 m on the 2011/01/22

7) Original Dolomite Aquifer Groundwater Level (OWL)1200 m AMSL

8) Water added from 0 m to 150 m and foam added 0 m to 150 m

9) Projection Information: CM 23 degrees E, Transverse Mercator, WGS 84

CONTRACTOR : BOOYSEN BORE
MACHINE : HJB01 SCHRAMM (2100 kPa)
DRILLED BY : FRANS/HERMAN/APRIL
PROFILED BY : B BOLITHO

INCLINATION : 90 DEGREES
DIAM : 165 mm
DATE : 2011/01/19
DATE : 2011/02/11

ELEVATION : 1213 m AMSL
X-COORD : 3064835
Y-COORD : 3442

HOLE No: 2382

TYPE SET BY : GARTH JORDAAN
SETUP FILE : SETUP.SET

DATE : 26/10/15 09:32
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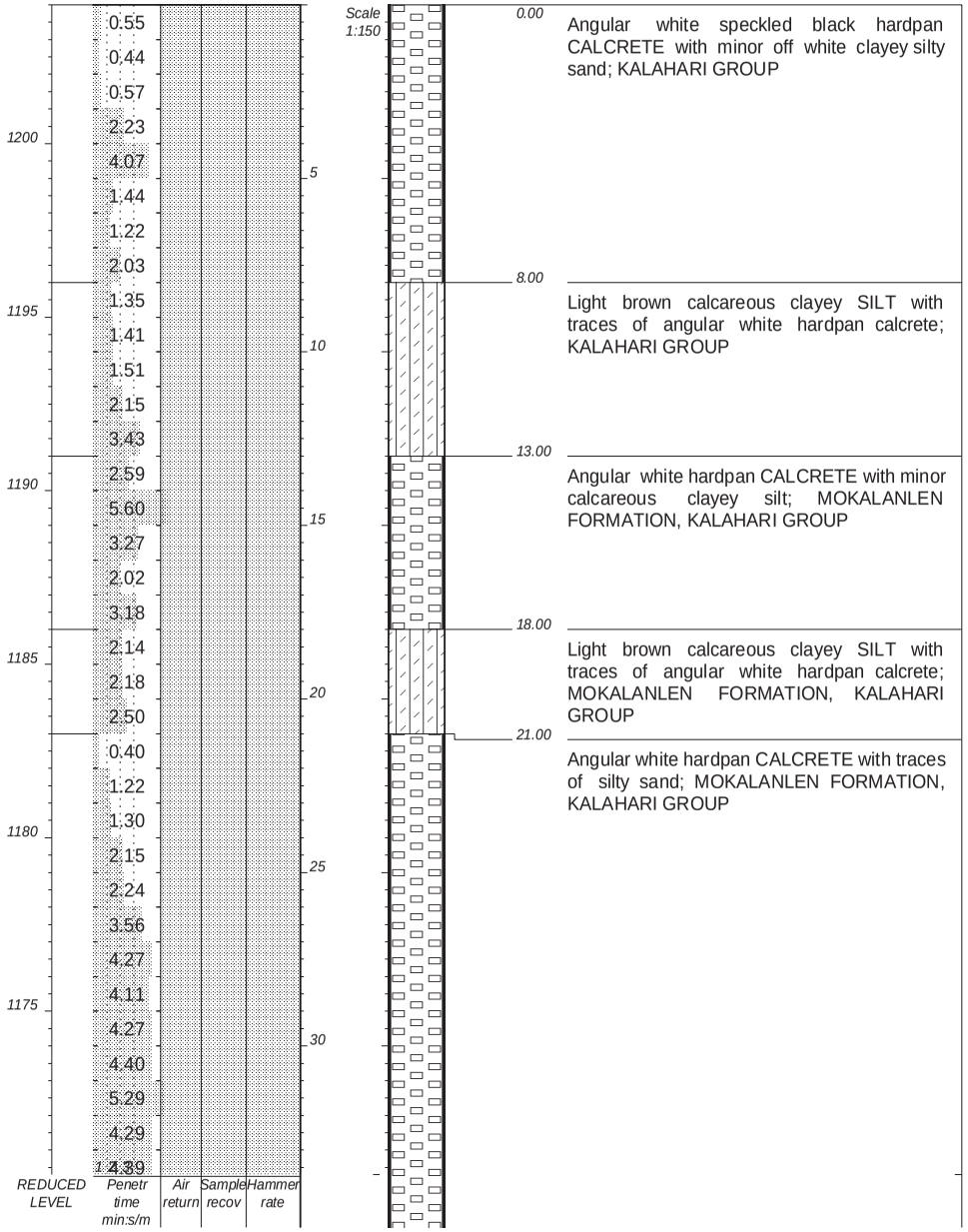
D055 DBB

dot.PLOT 5006 J&W

KUMBA
SISHEN GROUND WATER STUDY

HOLE No: 13316
Sheet 1 of 3

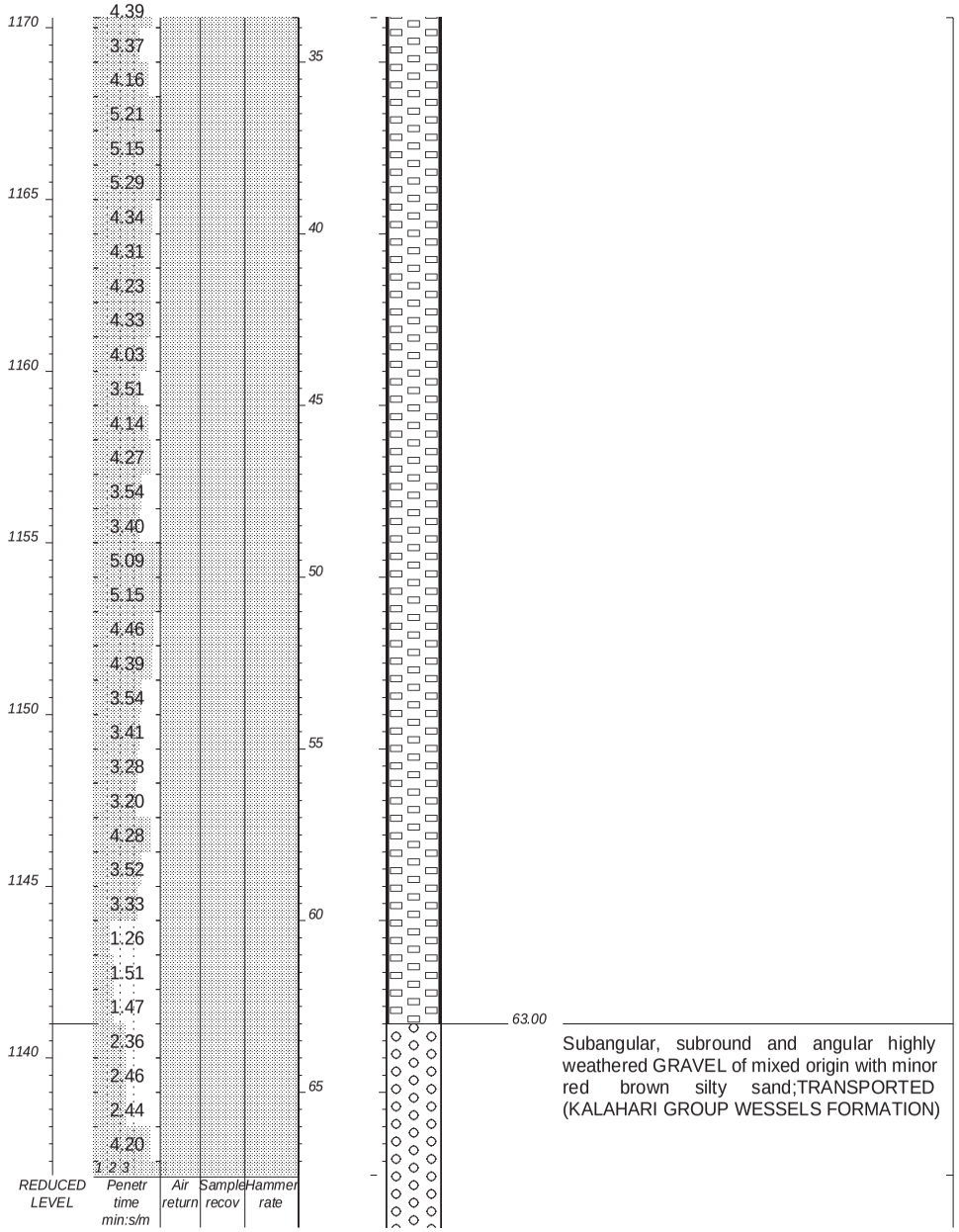
JOB NUMBER: VGI3193.3



KUMBA
SISHEN GROUND WATER STUDY

HOLE No: 13316
Sheet 2 of 3

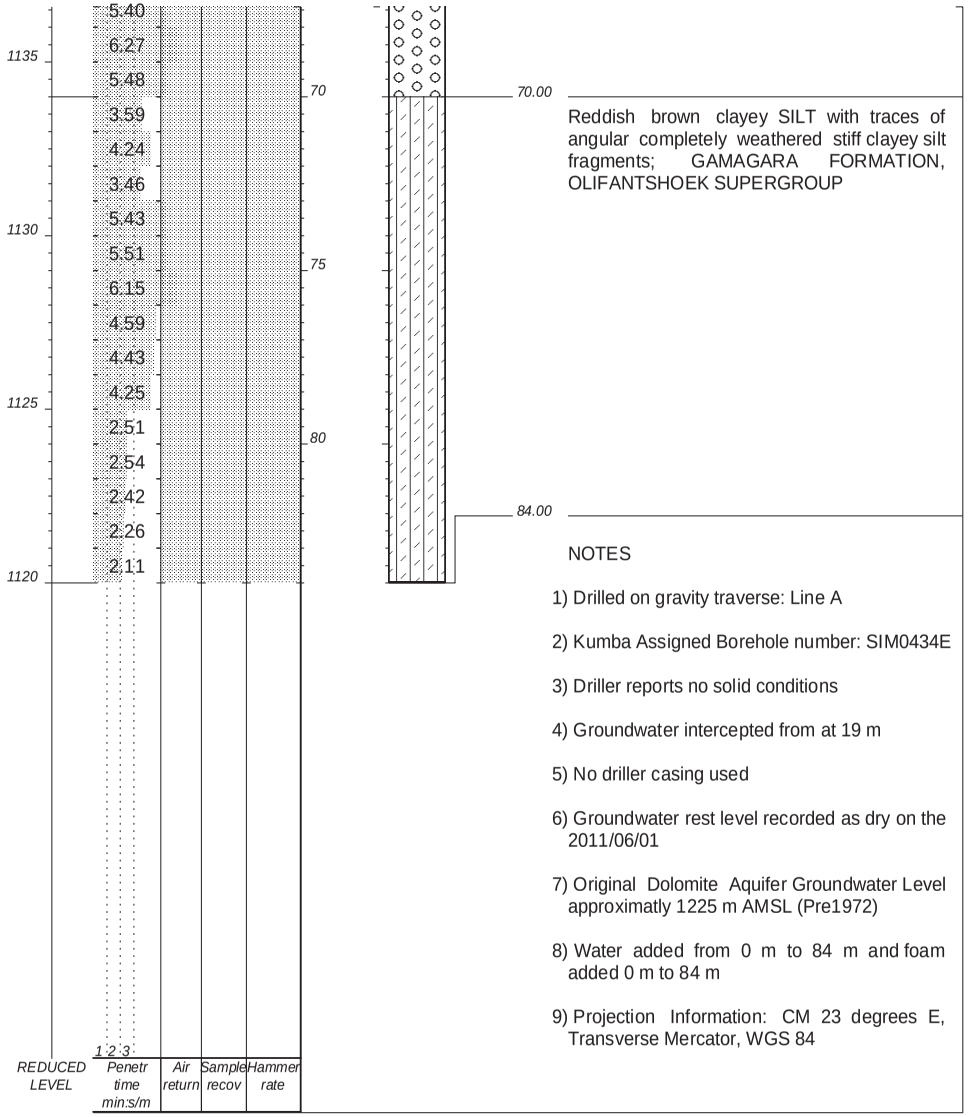
JOB NUMBER: VGI3193.3



KUMBA
SISHEN GROUND WATER STUDY

HOLE No: 13316
Sheet 3 of 3

JOB NUMBER: VGI3193.3



Reddish brown clayey SILT with traces of angular completely weathered stiff clayey silt fragments; GAMAGARA FORMATION, OLIFANTSHOEK SUPERGROUP

NOTES

1) Drilled on gravity traverse: Line A

2) Kumba Assigned Borehole number: SIM0434E

3) Driller reports no solid conditions

4) Groundwater intercepted from at 19 m

5) No driller casing used

6) Groundwater rest level recorded as dry on the 2011/06/01

7) Original Dolomite Aquifer Groundwater Level approximatly 1225 m AMSL (Pre1972)

8) Water added from 0 m to 84 m and foam added 0 m to 84 m

9) Projection Information: CM 23 degrees E, Transverse Mercator, WGS 84

CONTRACTOR : BOOYSEN BORE
MACHINE : HJB01 SCHRAMM (2100 kPa)
DRILLED BY : Frans/Herman/April
PROFILED BY : B BOLITHO

INCLINATION : 90 DEGREES
DIAM : 165 mm
DATE : 2011/05/30
DATE : 2011/07/01

ELEVATION : 1204m AMSL
X-COORD : 3065902
Y-COORD : 1770

HOLE No: 13316

TYPE SET BY : GARTH JORDAAN
SETUP FILE : SETUP.SET

DATE : 26/10/15 09:50
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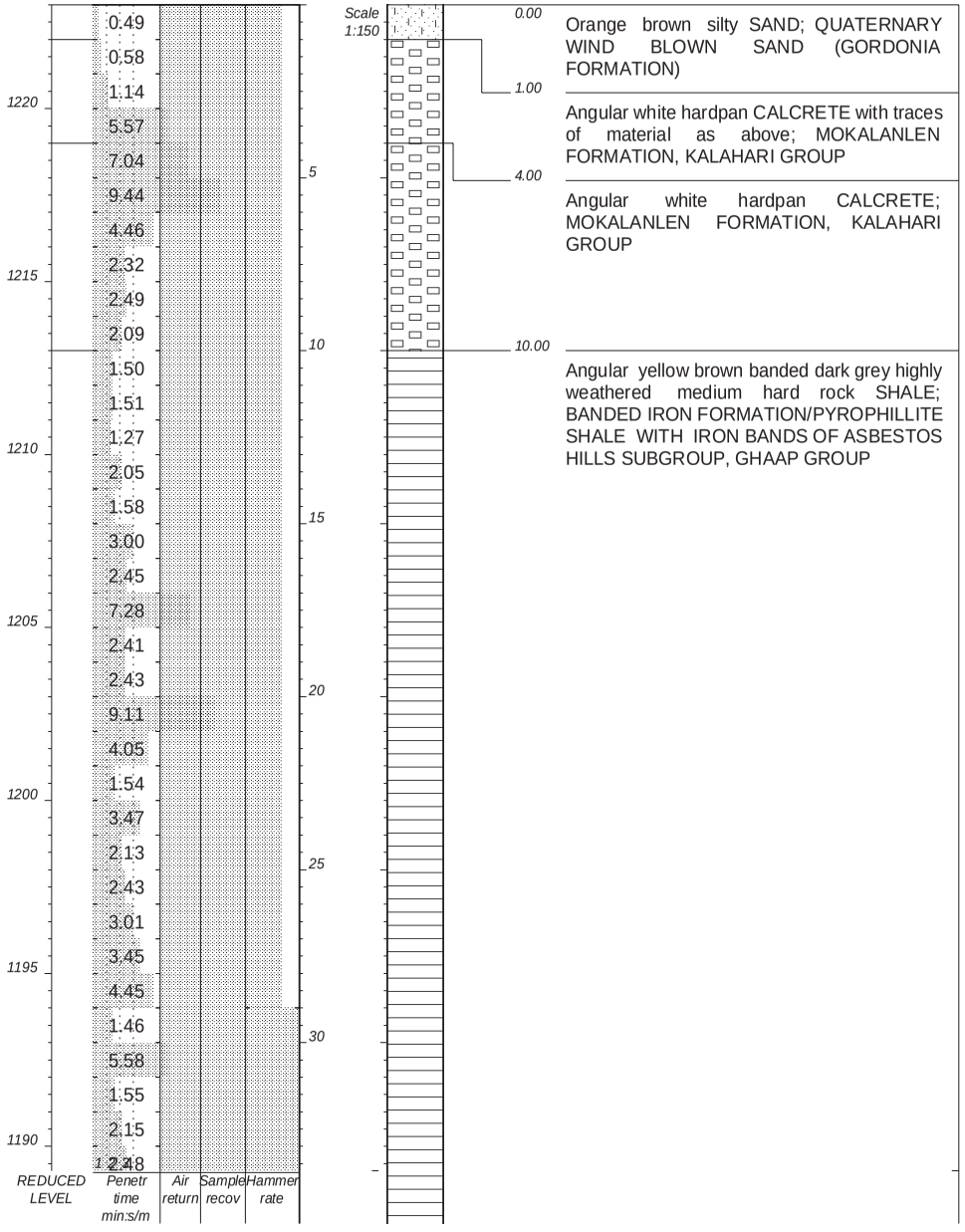
D055 DBB

dot.PLOT 5006 J&W

KUMBA
SISHEN GROUND WATER STUDY

HOLE No: 4155
Sheet 1 of 5

JOB NUMBER: VGI3193.3



Orange brown silty SAND; QUATERNARY WIND BLOWN SAND (GORDONIA FORMATION)

Angular white hardpan CALCRETE with traces of material as above; MOKALANLEN FORMATION, KALAHARI GROUP

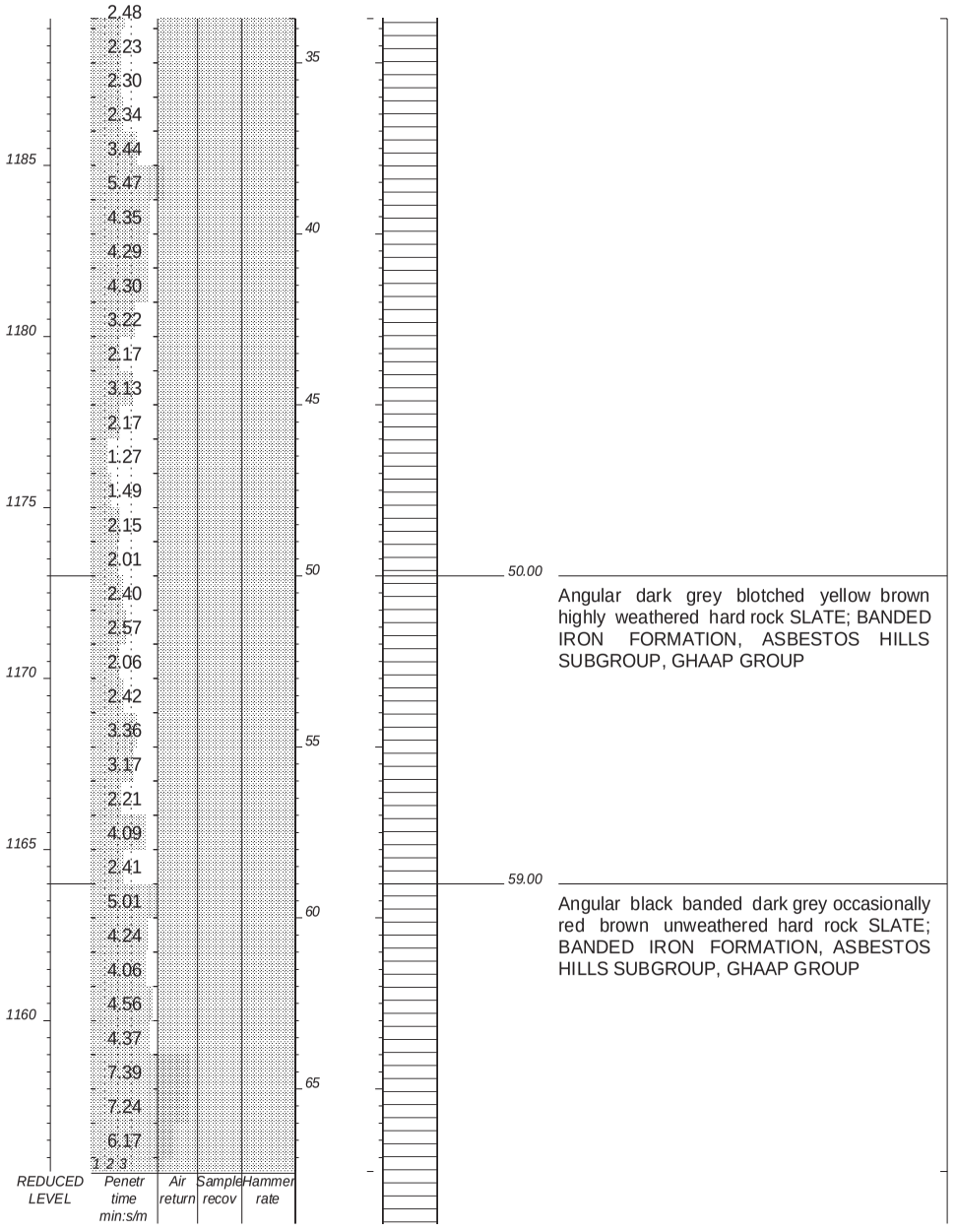
Angular white hardpan CALCRETE; MOKALANLEN FORMATION, KALAHARI GROUP

Angular yellow brown banded dark grey highly weathered medium hard rock SHALE; BANDED IRON FORMATION/PYROPHILLITE SHALE WITH IRON BANDS OF ASBESTOS HILLS SUBGROUP, GHAAP GROUP

KUMBA
SISHEN GROUND WATER STUDY

HOLE No: 4155
Sheet 2 of 5

JOB NUMBER: VGI3193.3



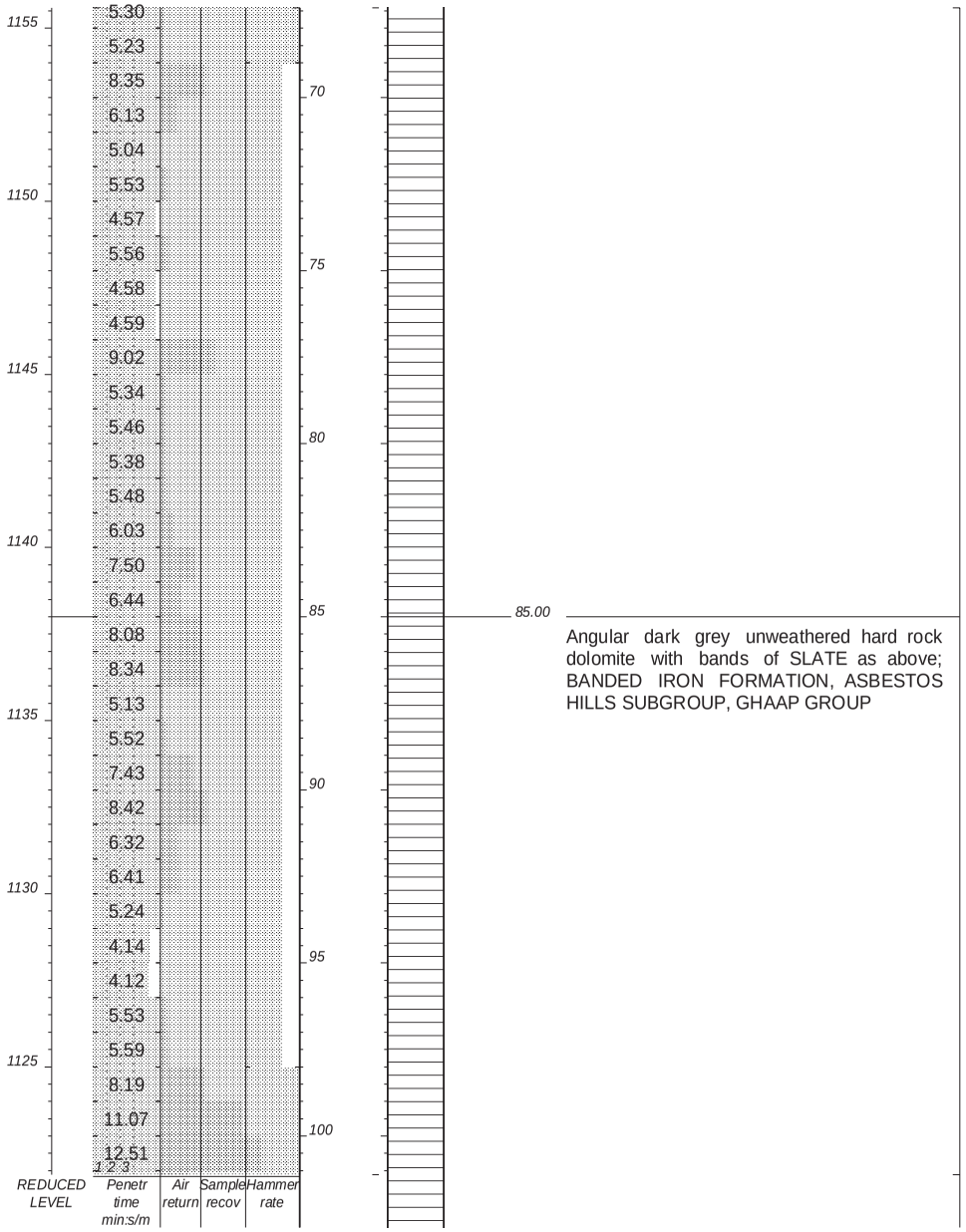
Angular dark grey blotched yellow brown highly weathered hard rock SLATE; BANDED IRON FORMATION, ASBESTOS HILLS SUBGROUP, GHAAP GROUP

Angular black banded dark grey occasionally red brown unweathered hard rock SLATE; BANDED IRON FORMATION, ASBESTOS HILLS SUBGROUP, GHAAP GROUP

KUMBA
SISHEN GROUND WATER STUDY

HOLE No: 4155
Sheet 3 of 5

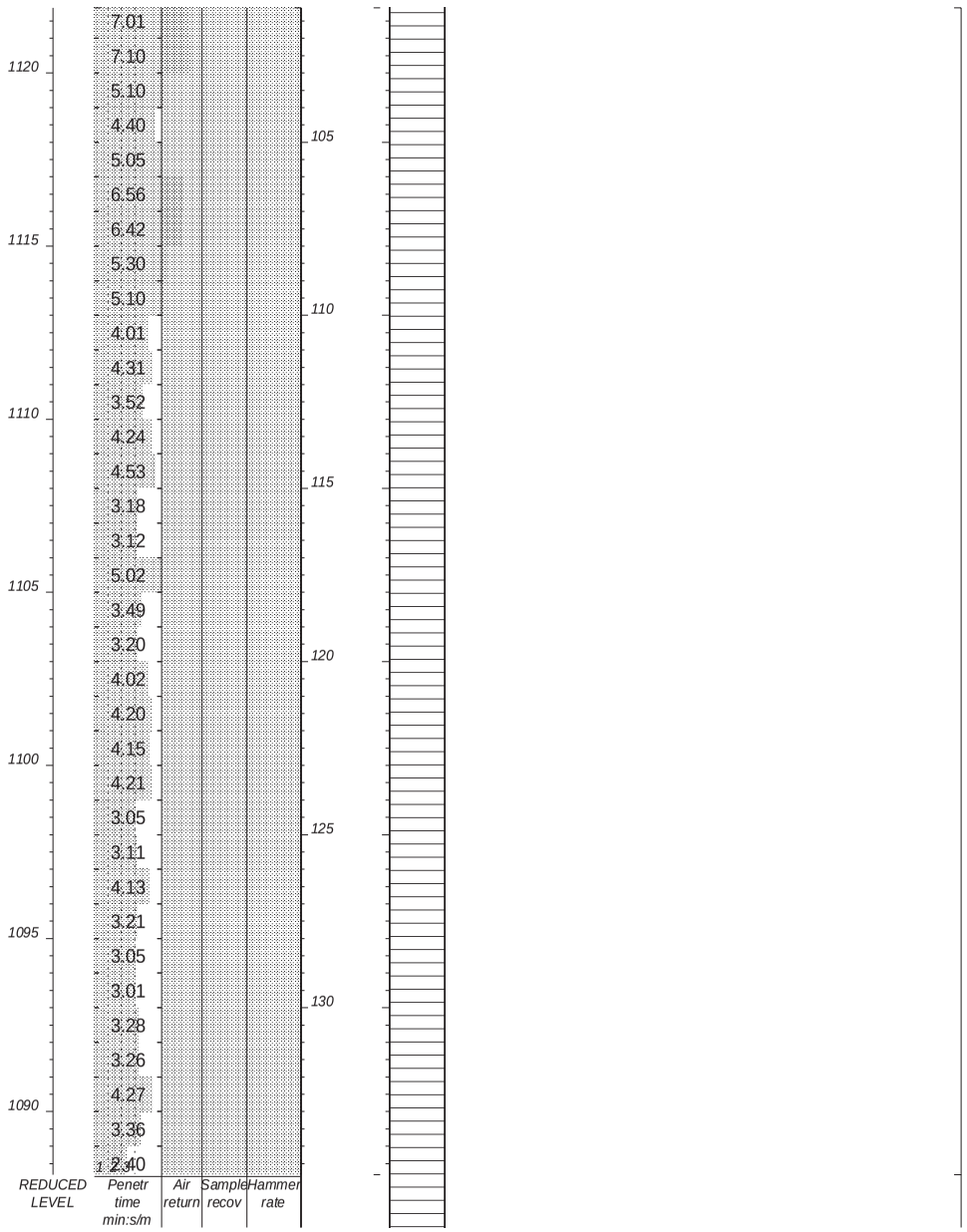
JOB NUMBER: VGI3193.3



KUMBA
SISHEN GROUND WATER STUDY

HOLE No: 4155
Sheet 4 of 5

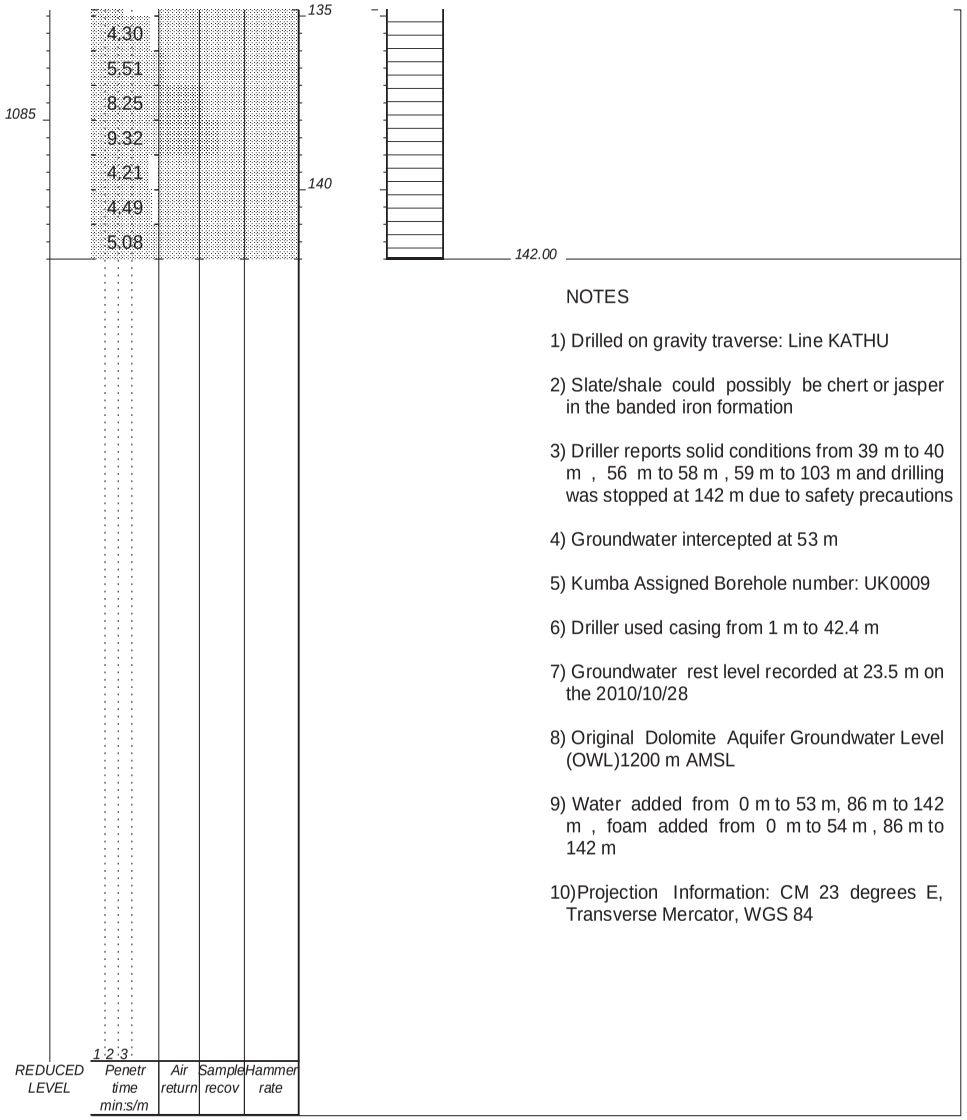
JOB NUMBER: VGI3193.3



KUMBA
SISHEN GROUND WATER STUDY

HOLE No: 4155
Sheet 5 of 5

JOB NUMBER: VGI3193.3



NOTES

1) Drilled on gravity traverse: Line KATHU

2) Slate/shale could possibly be chert or jasper in the banded iron formation

3) Driller reports solid conditions from 39 m to 40 m , 56 m to 58 m , 59 m to 103 m and drilling was stopped at 142 m due to safety precautions

4) Groundwater intercepted at 53 m

5) Kumba Assigned Borehole number: UK0009

6) Driller used casing from 1 m to 42.4 m

7) Groundwater rest level recorded at 23.5 m on the 2010/10/28

8) Original Dolomite Aquifer Groundwater Level (OWL)1200 m AMSL

9) Water added from 0 m to 53 m, 86 m to 142 m , foam added from 0 m to 54 m , 86 m to 142 m

10)Projection Information: CM 23 degrees E, Transverse Mercator, WGS 84

CONTRACTOR : BOOYSEN BORE
MACHINE : HJB01 SCHRAMM (2100 kPa)
DRILLED BY : FRANS/HERMAN/APRIL
PROFILED BY : B BOLITHO

INCLINATION : 90 DEGREES
DIAM : 165 mm
DATE : 2010/10/26
DATE : 2010/11/18

ELEVATION : 1223 m AMSL
X-COORD : 3063395
Y-COORD : 6383

HOLE No: 4155

TYPE SET BY : GARTH JORDAAN
SETUP FILE : SETUP.SET

DATE : 26/10/15 09:31
TEXT : ..C:\DOTFILES\201109~1.TXT

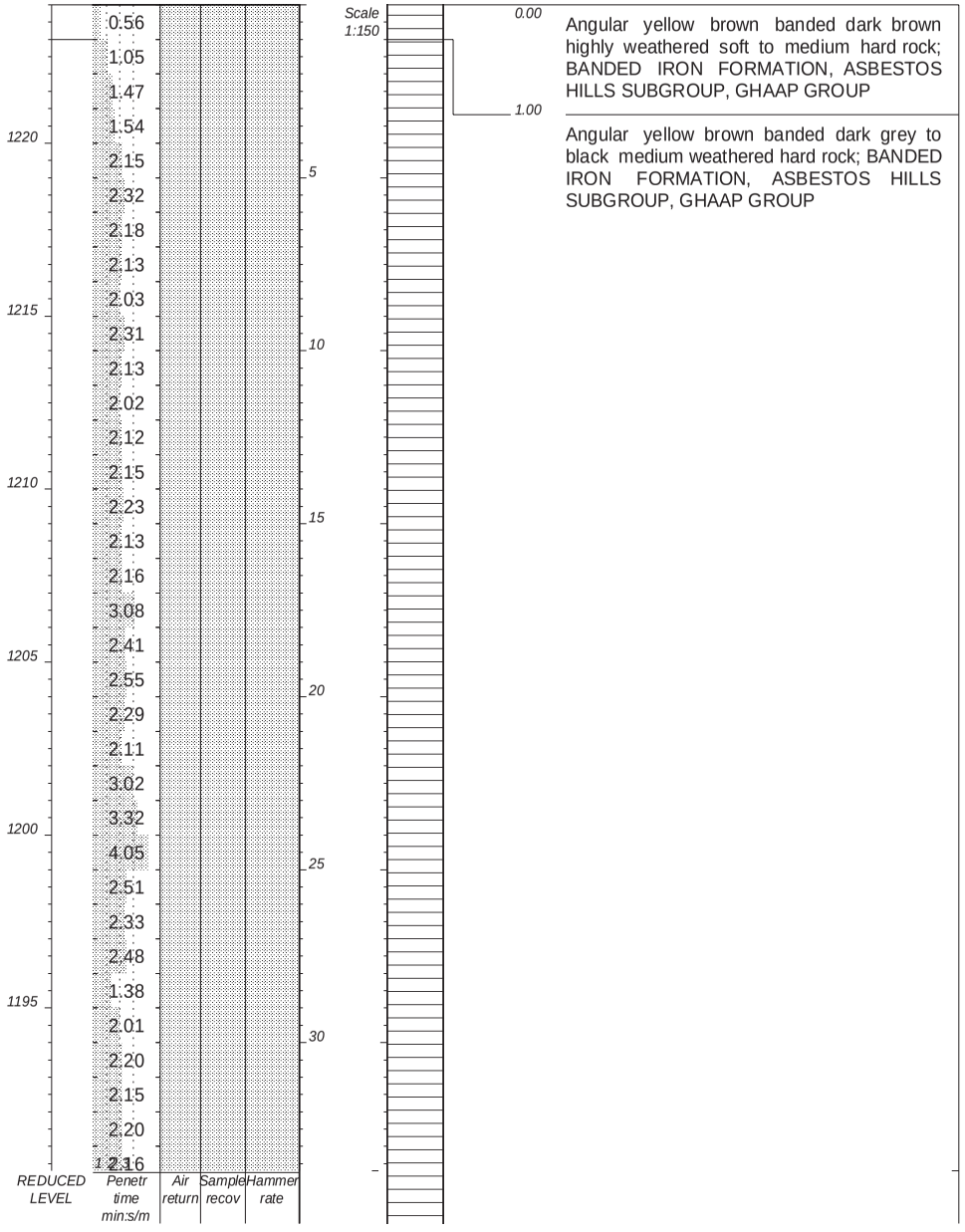
D055 DBB

dot.PLOT 5006 J&W

KUMBA
SISHEN GROUND WATER STUDY

HOLE No: 5276
Sheet 1 of 5

JOB NUMBER: VGI3193.3



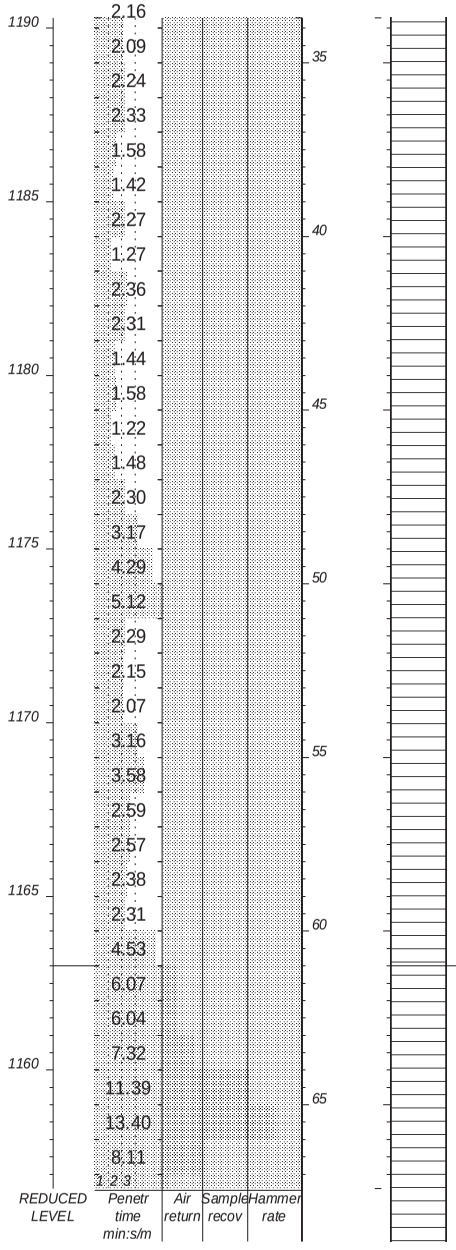
Angular yellow brown banded dark brown highly weathered soft to medium hard rock; BANDED IRON FORMATION, ASBESTOS HILLS SUBGROUP, GHAAP GROUP

Angular yellow brown banded dark grey to black medium weathered hard rock; BANDED IRON FORMATION, ASBESTOS HILLS SUBGROUP, GHAAP GROUP

KUMBA
SISHEN GROUND WATER STUDY

HOLE No: 5276
Sheet 2 of 5

JOB NUMBER: VGI3193.3

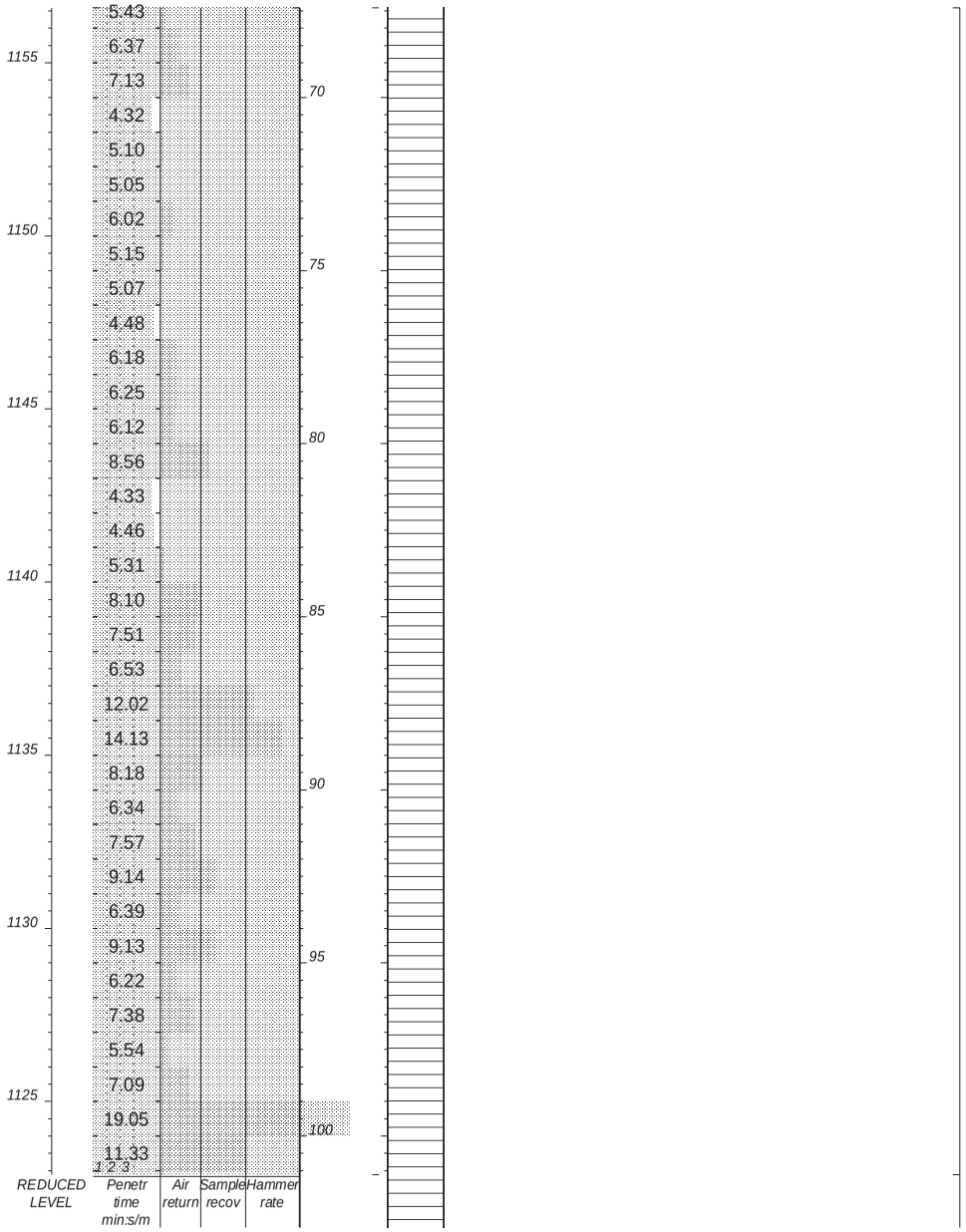


Angular grey banded dark grey to black slightly weathered hard rock SLATE/ SHALE; BANDED IRON FORMATION, ASBESTOS HILLS SUBGROUP, GHAAP GROUP

KUMBA
SISHEN GROUND WATER STUDY

HOLE No: 5276
Sheet 3 of 5

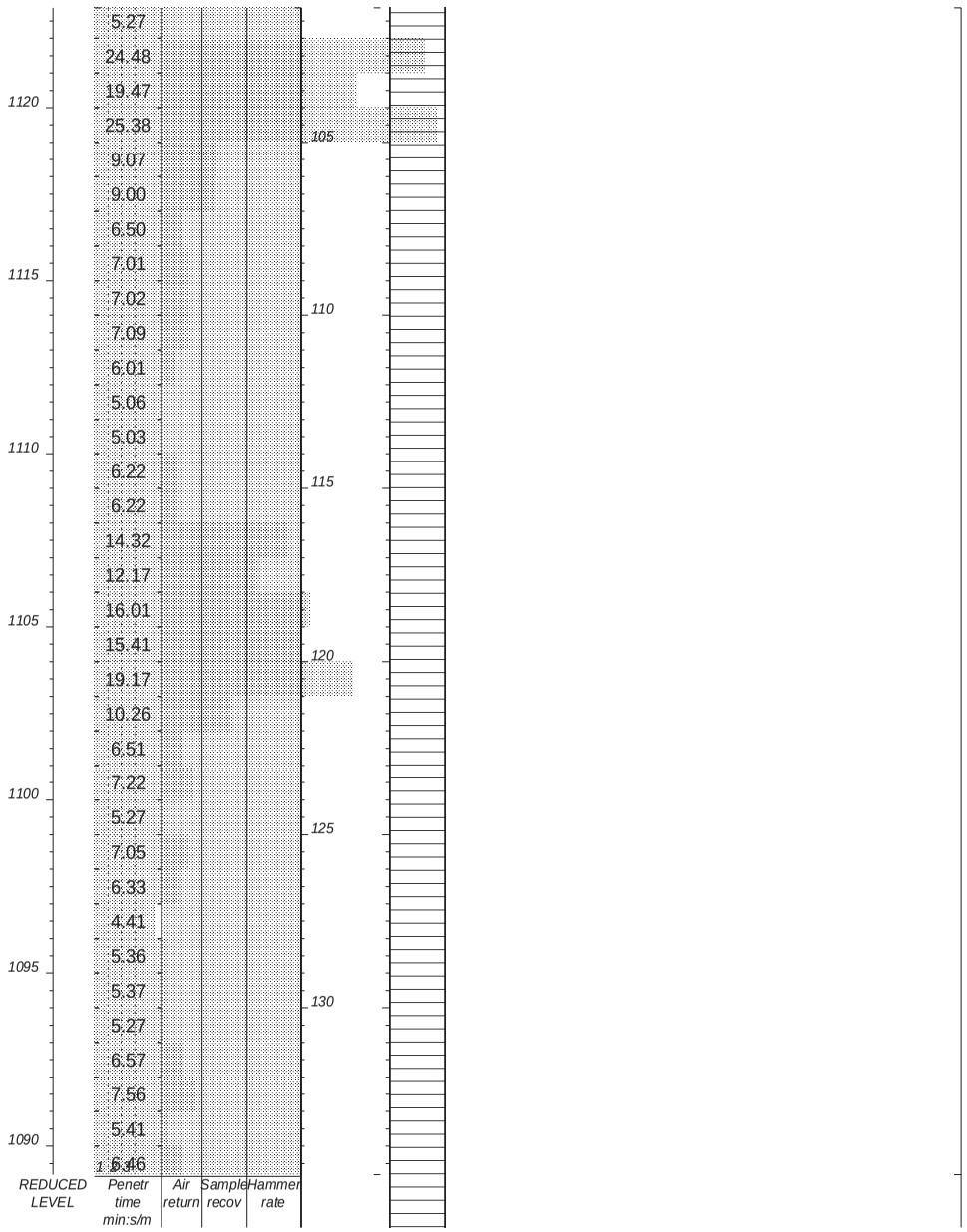
JOB NUMBER: VGI3193.3



KUMBA
SISHEN GROUND WATER STUDY

HOLE No: 5276
Sheet 4 of 5

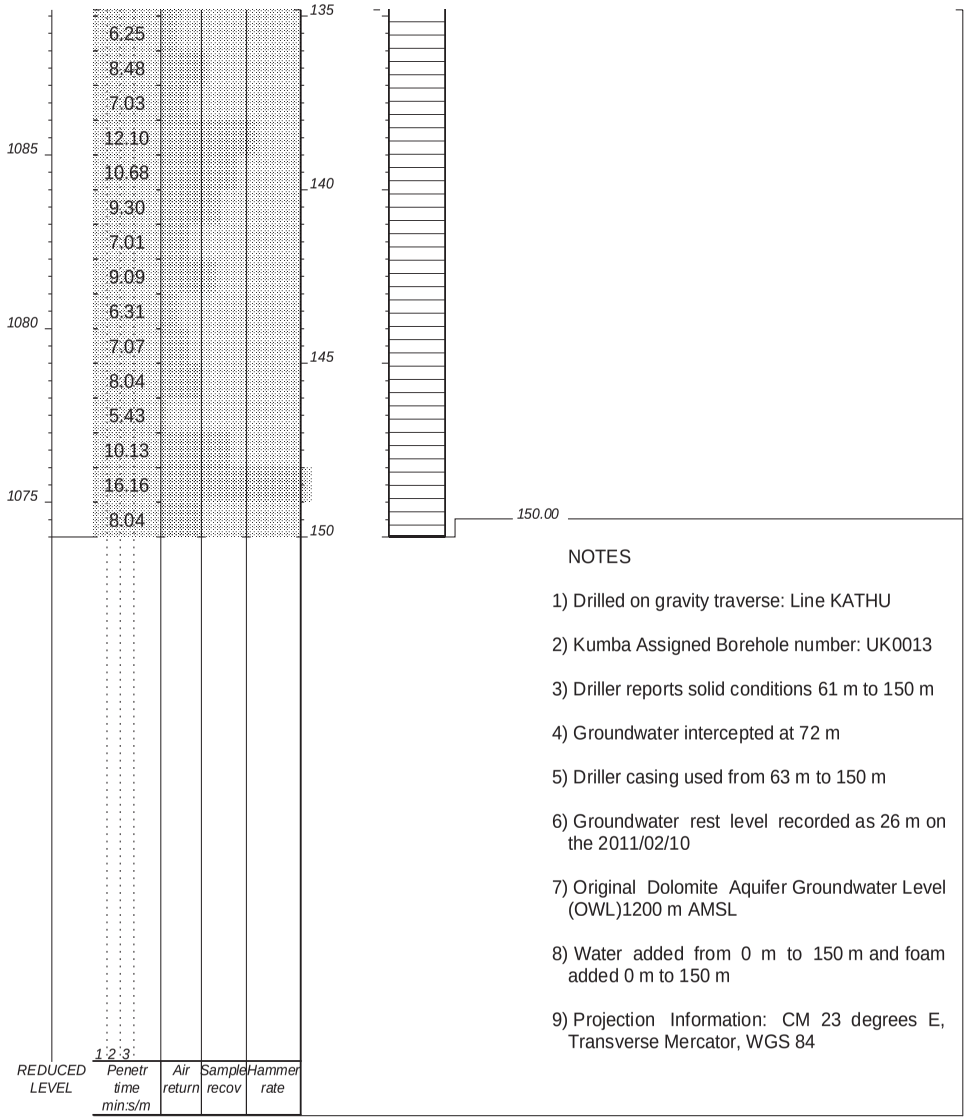
JOB NUMBER: VGI3193.3



KUMBA
SISHEN GROUND WATER STUDY

HOLE No: 5276
Sheet 5 of 5

JOB NUMBER: VGI3193.3



NOTES

1) Drilled on gravity traverse: Line KATHU

2) Kumba Assigned Borehole number: UK0013

3) Driller reports solid conditions 61 m to 150 m

4) Groundwater intercepted at 72 m

5) Driller casing used from 63 m to 150 m

6) Groundwater rest level recorded as 26 m on the 2011/02/10

7) Original Dolomite Aquifer Groundwater Level (OWL)1200 m AMSL

8) Water added from 0 m to 150 m and foam added 0 m to 150 m

9) Projection Information: CM 23 degrees E, Transverse Mercator, WGS 84

CONTRACTOR : BOOYSEN BORE
MACHINE : HJB01 SCHRAMM (2100 kPa)
DRILLED BY : FRANS/HERMAN/APRIL
PROFILED BY : B BOLITHO

INCLINATION : 90 DEGREES
DIAM : 165 mm
DATE : 2011/02/03
DATE : 2011/05/05

ELEVATION : 1224 m AMSL
X-COORD : 3064264
Y-COORD : 6503

HOLE No: 5276

TYPE SET BY : GARTH JORDAAN
SETUP FILE : SETUP.SET

DATE : 26/10/15 09:32
TEXT : ..C:\DOTFILES\201109~1.TXT

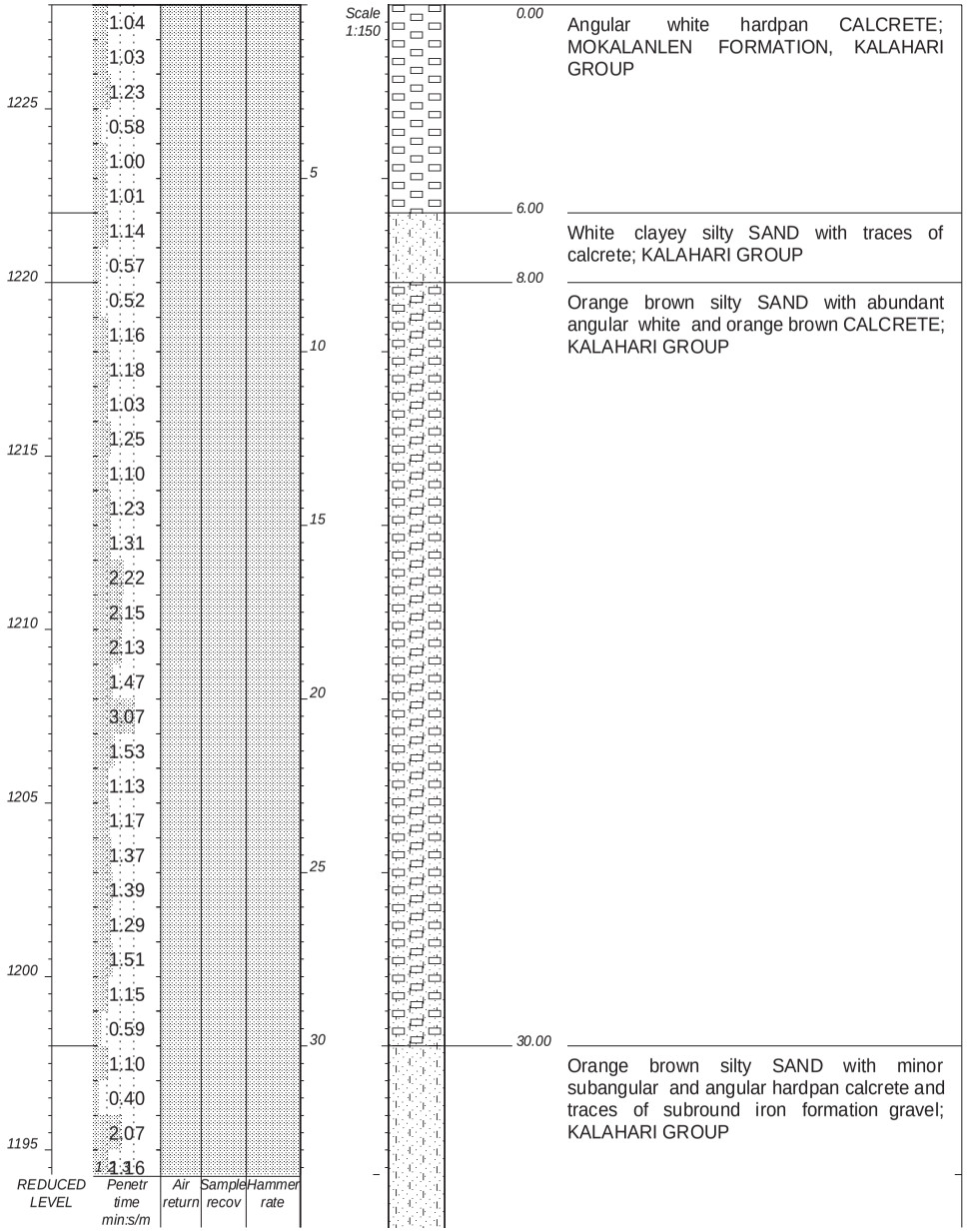
D055 DBB

dot.PLOT 5006 J&W

KUMBA
SISHEN GROUND WATER STUDY

HOLE No: KBH4
Sheet 1 of 3

JOB NUMBER: VGI3193.3



Angular white hardpan CALCRETE; MOKALANLEN FORMATION, KALAHARI GROUP

White clayey silty SAND with traces of calcrete; KALAHARI GROUP

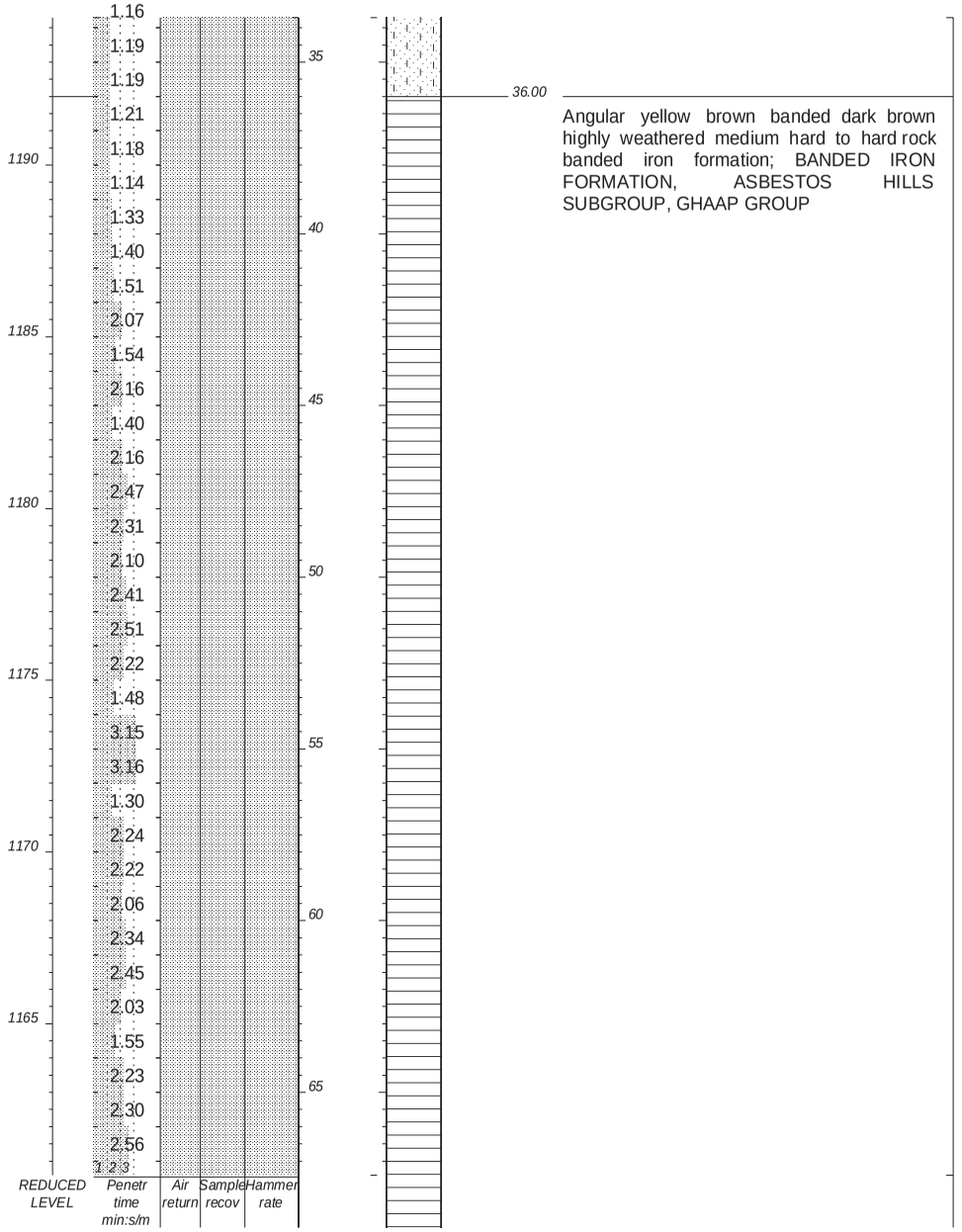
Orange brown silty SAND with abundant angular white and orange brown CALCRETE; KALAHARI GROUP

Orange brown silty SAND with minor subangular and angular hardpan calcrete and traces of subround iron formation gravel; KALAHARI GROUP

KUMBA
SISHEN GROUND WATER STUDY

HOLE No: KBH4
Sheet 2 of 3

JOB NUMBER: VGI3193.3

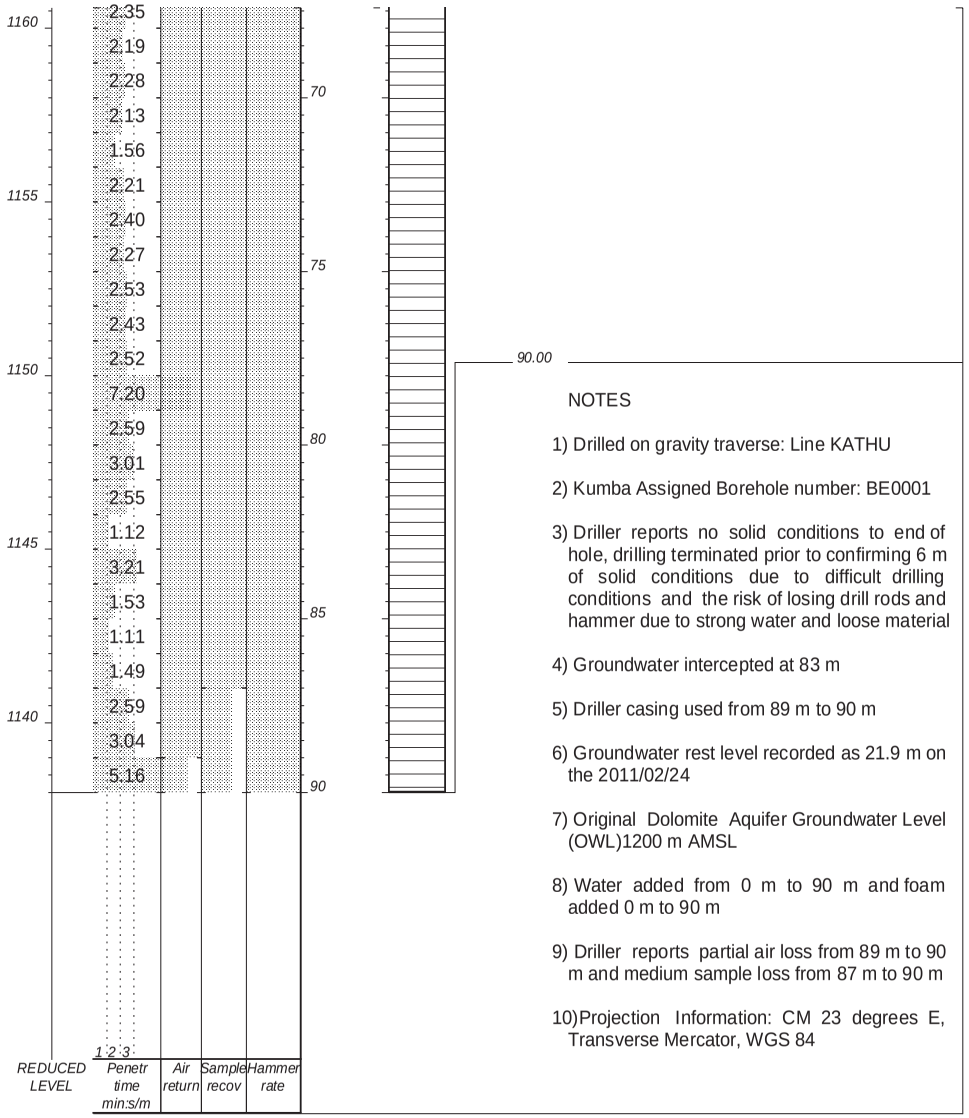


Angular yellow brown banded dark brown highly weathered medium hard to hard rock banded iron formation; BANDED IRON FORMATION, ASBESTOS HILLS SUBGROUP, GHAAP GROUP

KUMBA
SISHEN GROUND WATER STUDY

HOLE No: KBH4
Sheet 3 of 3

JOB NUMBER: VGI3193.3



NOTES

1) Drilled on gravity traverse: Line KATHU

2) Kumba Assigned Borehole number: BE0001

3) Driller reports no solid conditions to end of hole, drilling terminated prior to confirming 6 m of solid conditions due to difficult drilling conditions and the risk of losing drill rods and hammer due to strong water and loose material

4) Groundwater intercepted at 83 m

5) Driller casing used from 89 m to 90 m

6) Groundwater rest level recorded as 21.9 m on the 2011/02/24

7) Original Dolomite Aquifer Groundwater Level (OWL)1200 m AMSL

8) Water added from 0 m to 90 m and foam added 0 m to 90 m

9) Driller reports partial air loss from 89 m to 90 m and medium sample loss from 87 m to 90 m

10)Projection Information: CM 23 degrees E, Transverse Mercator, WGS 84

CONTRACTOR : BOOYSEN BORE
MACHINE : HJB01 SCHRAMM (2100 kPa)
DRILLED BY : FRANS/HERMAN/APRIL
PROFILED BY : B BOLITHO

INCLINATION : 90 DEGREES
DIAM : 165 mm
DATE : 2011/02/18
DATE : 2011/05/05

ELEVATION : 1228 m AMSL
X-COORD : 3064050
Y-COORD : 7200

HOLE No: KBH4

TYPE SET BY : GARTH JORDAAN
SETUP FILE : SETUP.SET

DATE : 26/10/15 09:33
TEXT : ..C:\DOTFILES\201109~1.TXT

D055 DBB

dot.PLOT 5006 J&W

Log KU3:

0 to 1	SAND light brown, medium grained
1 to 12	CALCRETE white, medium grained
12 to 16	CLAY red to brown, fine to medium grained
16 to 41	BANDED IRONSTONE brown, fine to medium grained
41 to 138	DOLOMITE bluish-grey, medium grained
138 to 142	DOLOMITE and chert, bluish-grey with white streaks, fine to medium grained

Log KU4:

0 to 3	SAND light brown, medium grained
3 to 12	CALCRETE white, medium grained
12 to 16	CLAY grayish-light brown, fine to medium grained
16 to 24	CONGLOMERATES brown, fine to medium grained
24 to 54	CLAY light brown, fine to medium grained
54 to 66	BANDED IRONSTONE brown, fine to medium grained
66 to 100	DOLOMITE bluish-grey, medium grained

Log KU5:

0 to 1	SAND light brown, medium grained
1 to 12	CALCRETE white, medium grained
12 to 48	BANDED IRONSTONE brown, fine to medium grained
48 to 60	DOLOMITE with traces of wad, grayish-blue, medium grained

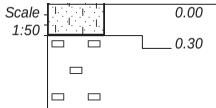
APPENDIX 2

TEST PIT PROFILES

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP01
Sheet 1 of 1

JOB NUMBER: VGI3944



Slightly moist light brown loose silty SAND; COLLUVIUM

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

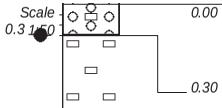
CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
SIZE : TRENCH
ELEVATION : 1205 m AMSL
X-COORD : 3065768
Y-COORD : -2390
PROFILED BY : J.C. MEINTJES
DATE : 2015/10/13
HOLE No: VGI3944 TP01
TYPE SET BY : J.C. MEINTJES
DATE : 05/11/15 16:50
SETUP FILE : TESTPITS.SET
TEXT : ..C:\DOTFILES\201511~1.TXT

D055 DBB
dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP02
Sheet 1 of 1

JOB NUMBER: VGI3944



White abundant(40% to 50%) NODULAR CALCRETE GRAVEL loosely packed in a light brown silty sand matrix, Overall consistency is medium dense; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) Large bag sample taken between 0 m to 0,3 m.

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

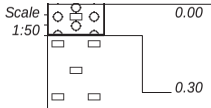
CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
SIZE : TRENCH
ELEVATION : 1205 m AMSL
X-COORD : 3065685
Y-COORD : -2549
PROFILED BY : J.C. MEINTJES
DATE : 2015/10/13
HOLE No: VGI3944 TP02
TYPE SET BY : J.C. MEINTJES
DATE : 05/11/15 16:50
SETUP FILE : TESTPITS.SET
TEXT : ..C:\DOTFILES\201511~1.TXT

D055 DBB
dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP03
Sheet 1 of 1

JOB NUMBER: VGI3944



White abundant(40% to 50%) NODULAR CALCRETE GRAVEL loosely packed in a light brown silty sand matrix, Overall consistency is medium dense; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/13
DATE : 05/11/15 16:50
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1205 m AMSL
X-COORD : 3065596
Y-COORD : -2785

HOLE No: VGI3944 TP03

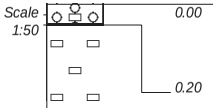
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP04
Sheet 1 of 1

JOB NUMBER: VGI3944



White abundant(40% to 50%) NODULAR CALCRETE GRAVEL loosely packed in a light brown silty sand matrix, Overall consistency is medium dense; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/13
DATE : 05/11/15 16:50
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1210 m AMSL
X-COORD : 3065493
Y-COORD : -3025

HOLE No: VGI3944 TP04

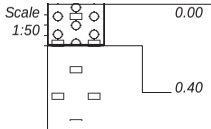
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP05
Sheet 1 of 1

JOB NUMBER: VGI3944



White abundant(40% to 50%) NODULAR CALCRETE GRAVEL loosely packed in a light brown silty sand matrix, Overall consistency is medium dense; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/13
DATE : 05/11/15 16:50
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1205 m AMSL
X-COORD : 3065524
Y-COORD : -2329

HOLE No: VGI3944 TP05

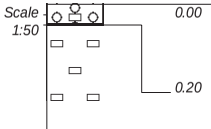
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP06
Sheet 1 of 1

JOB NUMBER: VGI3944



White abundant(40% to 50%) NODULAR CALCRETE GRAVEL loosely packed in a light brown silty sand matrix, Overall consistency is medium dense; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/13
DATE : 05/11/15 16:50
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1205 m AMSL
X-COORD : 3065421
Y-COORD : -2567

HOLE No: VGI3944 TP06

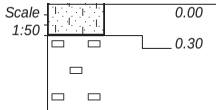
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP07
Sheet 1 of 1

JOB NUMBER: VGI3944



Slightly moist light brown loose silty SAND; COLLUVIUM

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT

PROFILED BY : J.C. MEINTJES

TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH

DATE : 2015/10/13

DATE : 05/11/15 16:50
TEXT : ..C:\DOTFILES\201511~1.TXT

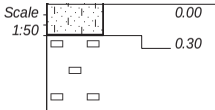
ELEVATION : 1205 m AMSL
X-COORD : 3065310
Y-COORD : -2814

HOLE No: VGI3944 TP07

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP08
Sheet 1 of 1

JOB NUMBER: VGI3944



Slightly moist light brown loose silty SAND; COLLUVIUM

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT

PROFILED BY : J.C. MEINTJES

TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH

DATE : 2015/10/13

DATE : 05/11/15 16:50
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1205 m AMSL
X-COORD : 3065145
Y-COORD : -2592

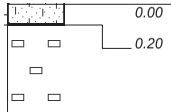
HOLE No: VGI3944 TP08

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP09
Sheet 1 of 1

JOB NUMBER: VGI3944

Scale 1:50



Slightly moist light brown loose silty SAND; COLLUVIUM

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/14
DATE : 05/11/15 16:50
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1205 m AMSL
X-COORD : 3065251
Y-COORD : -2353

HOLE No: VGI3944 TP09

D055 DBB

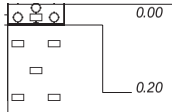
dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP10
Sheet 1 of 1

JOB NUMBER: VGI3944

Scale 1:50



White abundant(40% to 50%) NODULAR CALCRETE GRAVEL loosely packed in a light brown silty sand matrix, Overall consistency is medium dense; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/14
DATE : 05/11/15 16:50
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1205 m AMSL
X-COORD : 3065360
Y-COORD : -2098

HOLE No: VGI3944 TP10

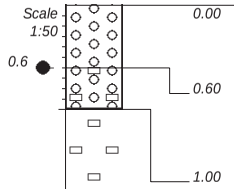
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP11
Sheet 1 of 1

JOB NUMBER: VGI3944



Reddish brown abundant(60% to 70%) MIXED GRAVEL loosely packed in a brown silty sand matrix, Overall consistency is medium dense; FILL

White abundant(40% to 50%) NODULAR CALCRETE GRAVEL loosely packed in a light brown silty sand matrix, Overall consistency is medium dense; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) Small bag sample taken between 0 m to 0,6 m.

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/14
DATE : 05/11/15 16:50
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1205 m AMSL
X-COORD : 3065104
Y-COORD : -2103

HOLE No: VGI3944 TP11

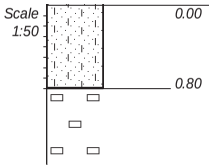
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP12
Sheet 1 of 1

JOB NUMBER: VGI3944



Slightly moist light brown loose silty SAND; COLLUVIUM

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/14
DATE : 05/11/15 16:50
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1205 m AMSL
X-COORD : 3064985
Y-COORD : -2374

HOLE No: VGI3944 TP12

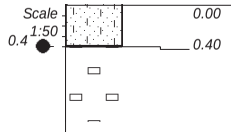
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP13
Sheet 1 of 1

JOB NUMBER: VGI3944



Slightly moist light brown loose silty SAND; COLLUVIUM

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) Small bag sample taken between 0 m to 0,4 m.

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/14
DATE : 05/11/15 16:50
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1205 m AMSL
X-COORD : 3064815
Y-COORD : -2160

HOLE No: VGI3944 TP13

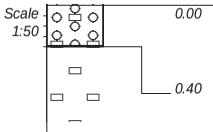
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP14
Sheet 1 of 1

JOB NUMBER: VGI3944



White abundant(40% to 50%) NODULAR CALCRETE GRAVEL loosely packed in a light brown silty sand matrix, Overall consistency is medium dense; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/14
DATE : 05/11/15 16:50
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1204 m AMSL
X-COORD : 3064574
Y-COORD : -2115

HOLE No: VGI3944 TP14

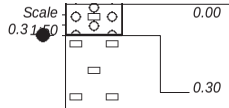
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP15
Sheet 1 of 1

JOB NUMBER: VGI3944



White abundant(40% to 50%) NODULAR CALCRETE GRAVEL loosely packed in a light brown silty sand matrix, Overall consistency is medium dense; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) Large bag sample taken between 0 m to 0,3 m.

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/14
DATE : 05/11/15 16:50
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1205 m AMSL
X-COORD : 3064184
Y-COORD : -2417

HOLE No: VGI3944 TP15

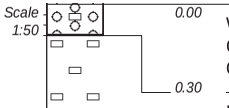
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP16
Sheet 1 of 1

JOB NUMBER: VGI3944



White abundant(40% to 50%) NODULAR CALCRETE GRAVEL loosely packed in a light brown silty sand matrix, Overall consistency is medium dense; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/14
DATE : 05/11/15 16:50
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1205 m AMSL
X-COORD : 3063999
Y-COORD : -2585

HOLE No: VGI3944 TP16

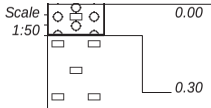
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP17
Sheet 1 of 1

JOB NUMBER: VGI3944



White abundant(40% to 50%) NODULAR CALCRETE GRAVEL loosely packed in a light brown silty sand matrix, Overall consistency is medium dense; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT

PROFILED BY : J.C. MEINTJES

TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH

DATE : 2015/10/14

DATE : 05/11/15 16:51
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1205 m AMSL
X-COORD : 3064192
Y-COORD : -2746

HOLE No: VGI3944 TP17

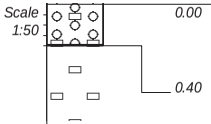
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP18
Sheet 1 of 1

JOB NUMBER: VGI3944



White abundant(40% to 50%) NODULAR CALCRETE GRAVEL loosely packed in a light brown silty sand matrix, Overall consistency is medium dense; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT

PROFILED BY : J.C. MEINTJES

TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH

DATE : 2015/10/14

DATE : 05/11/15 16:51
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1205 m AMSL
X-COORD : 3064361
Y-COORD : -2558

HOLE No: VGI3944 TP18

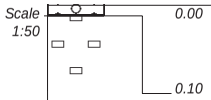
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP19
Sheet 1 of 1

JOB NUMBER: VGI3944



White abundant(40% to 50%) NODULAR CALCRETE GRAVEL loosely packed in a light brown silty sand matrix, Overall consistency is medium dense; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT

PROFILED BY : J.C. MEINTJES

TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH

DATE : 2015/10/14

DATE : 05/11/15 16:51
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1208 m AMSL
X-COORD : 3064288
Y-COORD : -2970

HOLE No: VGI3944 TP19

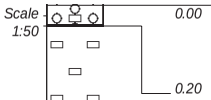
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP20
Sheet 1 of 1

JOB NUMBER: VGI3944



White abundant(40% to 50%) NODULAR CALCRETE GRAVEL loosely packed in a light brown silty sand matrix, Overall consistency is medium dense; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT

PROFILED BY : J.C. MEINTJES

TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH

DATE : 2015/10/14

DATE : 05/11/15 16:51
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1205 m AMSL
X-COORD : 3064462
Y-COORD : -2791

HOLE No: VGI3944 TP20

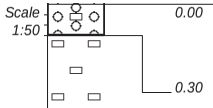
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP21
Sheet 1 of 1

JOB NUMBER: VGI3944



White abundant(40% to 50%) NODULAR CALCRETE GRAVEL loosely packed in a light brown silty sand matrix, Overall consistency is medium dense; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/14
DATE : 05/11/15 16:51
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1205 m AMSL
X-COORD : 3064643
Y-COORD : -2603

HOLE No: VGI3944 TP21

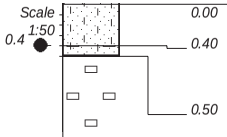
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP22
Sheet 1 of 1

JOB NUMBER: VGI3944



Slightly moist light brown loose silty SAND; COLLUVIUM

Slightly moist light brown medium dense silty SAND with minor (20%-30%) NODULAR CALCRETE; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) Small bag sample taken between 0 m to 0,4 m.

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/13
DATE : 05/11/15 16:51
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1230 m AMSL
X-COORD : 3063701
Y-COORD : -6866

HOLE No: VGI3944 TP22

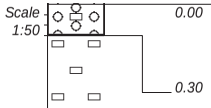
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP23
Sheet 1 of 1

JOB NUMBER: VGI3944



White abundant(40% to 50%) NODULAR CALCRETE GRAVEL loosely packed in a light brown silty sand matrix, Overall consistency is medium dense; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/14
DATE : 05/11/15 16:51
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1205 m AMSL
X-COORD : 3064886
Y-COORD : -2673

HOLE No: VGI3944 TP23

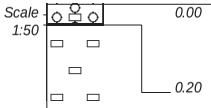
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP25
Sheet 1 of 1

JOB NUMBER: VGI3944



White abundant(40% to 50%) NODULAR CALCRETE GRAVEL loosely packed in a light brown silty sand matrix, Overall consistency is medium dense; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/14
DATE : 05/11/15 16:51
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1210 m AMSL
X-COORD : 3064534
Y-COORD : -3059

HOLE No: VGI3944 TP25

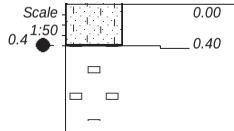
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP24
Sheet 1 of 1

JOB NUMBER: VGI3944



Slightly moist light brown loose silty SAND; COLLUVIUM

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) Small sample taken between 0 m to 0,4 m.

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/14
DATE : 05/11/15 16:51
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1205 m AMSL
X-COORD : 3064718
Y-COORD : -2871

HOLE No: VGI3944 TP24

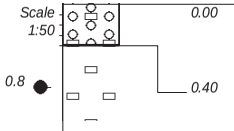
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP26
Sheet 1 of 1

JOB NUMBER: VGI3944



White abundant(40% to 50%) NODULAR CALCRETE GRAVEL loosely packed in a light brown silty sand matrix, Overall consistency is medium dense; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) Large bag sample taken between 0 m to 0,8 m.

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/14
DATE : 05/11/15 16:51
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1205 m AMSL
X-COORD : 3064877
Y-COORD : -2866

HOLE No: VGI3944 TP26

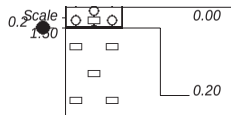
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP27
Sheet 1 of 1

JOB NUMBER: VGI3944



White abundant(40% to 50%) NODULAR CALCRETE GRAVEL loosely packed in a light brown silty sand matrix, Overall consistency is medium dense; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) Small bag sample taken between 0 m to 0,2 m.

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/14
DATE : 05/11/15 16:51
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1210 m AMSL
X-COORD : 3064764
Y-COORD : -3075

HOLE No: VGI3944 TP27

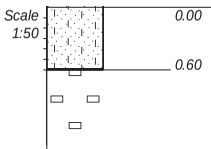
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP28
Sheet 1 of 1

JOB NUMBER: VGI3944



Slightly moist light brown loose silty SAND; COLLUVIUM

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/13
DATE : 05/11/15 16:51
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1230 m AMSL
X-COORD : 3063911
Y-COORD : -6767

HOLE No: VGI3944 TP28

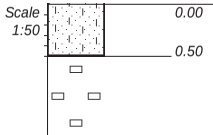
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP29
Sheet 1 of 1

JOB NUMBER: VGI3944



Slightly moist light brown loose silty SAND; COLLUVIUM

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/13
DATE : 05/11/15 16:51
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1230 m AMSL
X-COORD : 3063607
Y-COORD : -7078

HOLE No: VGI3944 TP29

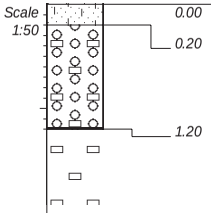
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP30
Sheet 1 of 1

JOB NUMBER: VGI3944



Slightly moist light brown loose silty SAND; COLLUVIUM

White abundant(60% to 80%) NODULAR CALCRETE GRAVEL densly packed in a white to light brown silty sand matrix, Overall consistency is dense; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/13
DATE : 05/11/15 16:51
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1230 m AMSL
X-COORD : 3062739
Y-COORD : -6323

HOLE No: VGI3944 TP30

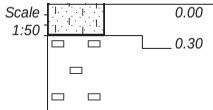
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP31
Sheet 1 of 1

JOB NUMBER: VGI3944



Slightly moist light brown loose silty SAND; COLLUVIUM

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/13
DATE : 05/11/15 16:51
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1230 m AMSL
X-COORD : 3062991
Y-COORD : -6325

HOLE No: VGI3944 TP31

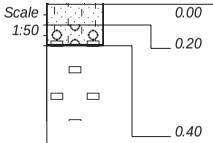
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP32
Sheet 1 of 1

JOB NUMBER: VGI3944



Slightly moist light brown loose silty SAND; COLLUVIUM

Slightly moist light brown medium dense silty SAND with minor (20%-30%) NODULAR CALCRETE GRAVEL and COBBLES; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/13
DATE : 05/11/15 16:51
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1230 m AMSL
X-COORD : 3062923
Y-COORD : -6511

HOLE No: VGI3944 TP32

D055 DBB

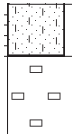
dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP33
Sheet 1 of 1

JOB NUMBER: VGI3944

Scale 1:50



0.00 Slightly moist light brown loose silty SAND; COLLUVIUM

0.50 Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/13
DATE : 05/11/15 16:51
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1230 m AMSL
X-COORD : 3063175
Y-COORD : -6530

HOLE No: VGI3944 TP33

D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP34
Sheet 1 of 1

JOB NUMBER: VGI3944

Scale 1:50

0.00 Slightly moist light brown loose silty SAND; COLLUVIUM

0.50 Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/13
DATE : 05/11/15 16:51
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1230 m AMSL
X-COORD : 3063398
Y-COORD : -6480

HOLE No: VGI3944 TP34

D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP35
Sheet 1 of 1

JOB NUMBER: VGI3944

Slightly moist light brown loose silty SAND; COLLUVIUM

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
SIZE : TRENCH
ELEVATION : 1230 m AMSL
X-COORD : 3063305
Y-COORD : -6720
PROFILED BY : J.C. MEINTJES
DATE : 2015/10/13
TYPE SET BY : J.C. MEINTJES
DATE : 05/11/15 16:51
SETUP FILE : TESTPITS.SET
TEXT : ..C:\DOTFILES\201511~1.TXT

HOLE No: VGI3944 TP35

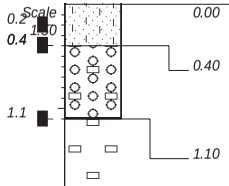
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP36
Sheet 1 of 1

JOB NUMBER: VGI3944



Slightly moist light brown medium dense silty SAND; COLLUVIUM

White abundant(60% to 80%) NODULAR CALCRETE GRAVEL densly packed in a white to light brown silty sand matrix, Overall consistency is dense; PEDOGENIC

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) Small bag sample taken bewteen 0 m to 0,4 m, undisturbed sample taken at 0.2 m and large bag sample taken between 0,4 m to 1,1 m.

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
SIZE : TRENCH
ELEVATION : 1230 m AMSL
X-COORD : 3063486
Y-COORD : -6968
PROFILED BY : J.C. MEINTJES
DATE : 2015/10/13
TYPE SET BY : J.C. MEINTJES
DATE : 05/11/15 16:51
SETUP FILE : TESTPITS.SET
TEXT : ..C:\DOTFILES\201511~1.TXT

HOLE No: VGI3944 TP36

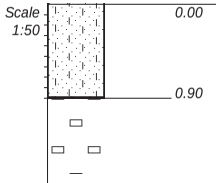
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP37
Sheet 1 of 1

JOB NUMBER: VGI3944



Slightly moist light brown loose silty SAND; COLLUVIUM

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/13
DATE : 05/11/15 16:51
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1230 m AMSL
X-COORD : 3063533
Y-COORD : -6708

HOLE No: VGI3944 TP37

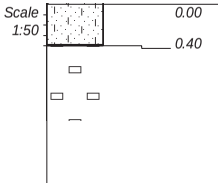
D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

HOLE No: VGI3944 TP38
Sheet 1 of 1

JOB NUMBER: VGI3944



Slightly moist light brown loose silty SAND; COLLUVIUM

Refusal on White very dense HONEYCOMB CALCRETE tending to hardpan calcrete.

NOTES

1) No sample taken

2) Stable sidewalls

3) No groundwater intercepted

4) Projection Information: CM 23 degrees E, WGS 84

5) Test pit coordinates according to South African Coordinate System

CONTRACTOR : BURMA PLANT HIRE
MACHINE : CAT
PROFILED BY : J.C. MEINTJES
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET

SIZE : TRENCH
DATE : 2015/10/13
DATE : 05/11/15 16:51
TEXT : ..C:\DOTFILES\201511~1.TXT

ELEVATION : 1230 m AMSL
X-COORD : 3063724
Y-COORD : -6634

HOLE No: VGI3944 TP38

D055 DBB

dot.PLOT 5006 J&W

MACROPLAN
NORTHERN CAPE: KATHU: PROPOSED HOUSING PROJECT

LEGEND
Sheet 1 of 1

JOB NUMBER: VGI3944

	GRAVEL	{SA02}
	SAND	{SA04}
	SILTY	{SA07}
	HONEYCOMB CALCRETE	{SA27}
	NODULAR CALCRETE	{SA27}
Name ■	UNDISTURBED SAMPLE	{SA37}
Name ●	DISTURBED SAMPLE	{SA38}

CONTRACTOR :
MACHINE :
SIZE :
ELEVATION :
X-COORD :
Y-COORD :
PROFILED BY :
DATE :
TYPE SET BY : J.C. MEINTJES
SETUP FILE : TESTPITS.SET
DATE : 05/11/15 16:51
TEXT : ..C:\DOTFILES\201511~1.TXT

LEGEND
SUMMARY OF SYMBOLS

D055 DBB
dot.PLOT 5006 J&W

APPENDIX 3

LABORATORY TEST RESULTS

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SUMMARY OF TEST RESULTS ON SOILS - REP COM 2

Client: VGI Consult Projects **Project:** Proposed Housing Project - Kathu **Project No:** VGI 3944 **Job No:** 2015-C-1332 **Date:** 16/11/2015

Sample No	Hole No / TP No	Depth (m)	Description	Percentage Passing Sieve (mm) - TMH1 A1, A5, MT1																	Atterberg Limits (TMH1 A2-A4) < 0.425 mm			Maximum Dry Density (kg/m³) & OMC (%) (TMH1 A7)		CBR (Modified AASHTO) TMH1 A8							pH + Conductivity (TMH A20 & A21T)	
				Sieve Analysis																						% Swell	90%	93%	95%	97%	98%	100%		
				53.0	37.5	26.5	19.0	13.2	9.5	4.75	2.00	0.425	0.250	0.150	0.075	0.060	0.050	0.020	0.005	0.002	GM	LL	PI	LS									pH	S/m
5/8834	TP 2/1	0 - 0.3		100	78	58	55	52	50	49	48	44	33	22	7	5	4	3	1	1	2.01		NP	0.0	2016	7.6	0.0	12	24	39	59	69	92	7.30	0.163
5/8835	TP 11/1	0 - 0.6		100	86	79	74	68	63	57	53	44	36	26	11	6	6	5	2	2	1.92		NP	0.0									7.89	0.139
5/8836	TP 13/1	0 - 0.4					100	99	99	99	99	89	62	41	11	7	6	5	3	3	1.01		NP	0.0									7.80	0.0701
5/8837	TP 15/1	0 - 0.3		100	71	62	58	53	51	45	43	40	35	27	12	10	9	7	6	5	2.05		NP	0.0	1824	10.8	0.0	13	24	36	53	64	94		
5/8838	TP 24/1	0 - 0.4									100	96	79	47	11	7	6	4	3	1	0.93		NP	0.0										
5/8839	TP 26/1	0 - 0.4		100	81	65	63	60	59	57	56	53	46	35	13	8	7	4	2	1	1.78		NP	0.0	1880	7.4	0.0	10	21	33	48	57	80	7.92	0.1133
5/8840	TP 27/1	0 - 0.2		100	88	74	66	60	57	52	51	47	41	31	11	8	8	7	6	6	1.91		NP	0.0										
5/8841	TP 36/1	0 - 0.4				100	97	96	95	95	95	90	74	53	17	10	9	7	5	3	0.98		NP	0.0									8.03	0.142
5/8843	TP 36/3	0.4 - 1.1		100	87	87	83	81	79	76	73	70	62	49	26	21	20	17	14	9	1.31	22	6	2.5	1880	9.7	0.4	14	26	38	53	64	90	8.35	0.154
5/8844	TP 22/1	0 - 0.4					100	99	99	99	99	95	81	57	16	7	7	7	5	3	0.90		NP	0.0									7.44	0.154

Remarks:

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FOUNDATION INDICATOR TEST RESULTS - REP COM 7

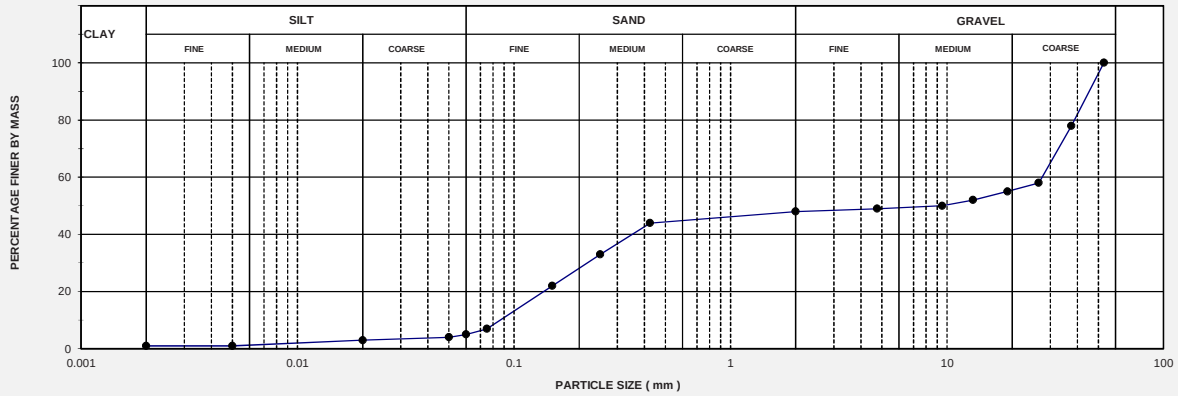
Client:	**VGI Consult Projects**	**Source/Location:**		**Job No:**	**2015-C-1332**
Project Name:	**Proposed Housing Project - Kathu**	**Layer:**		**Sample No:**	**5/8834**
Project No:	**VGI 3944**	**Lane:**		**Date:**	**16/11/2015**
Hole/TP No:	**TP 2/1**	**Stabilizing Agent:**		**Test Method:**	**TMH1 A1, A5 & MT1**
Depth (m):	**0 - 0.3**	**Section:**		**Client Ref No:**	
Description:		**Chainage:**		**GPS X:**	
Additional Info:		**Offset:**		**GPS Y:**	

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
75.0	**100**	0.425	**44**
63.0	**100**	0.250	**33**
53.0	**100**	0.150	**22**
37.5	**78**	0.075	**7**
26.5	**58**	0.060	**5**
19.0	**55**	0.050	**4**
13.2	**52**	0.020	**3**
9.5	**50**	0.005	**1**
4.75	**49**	0.002	**1**
2.00	**48**		

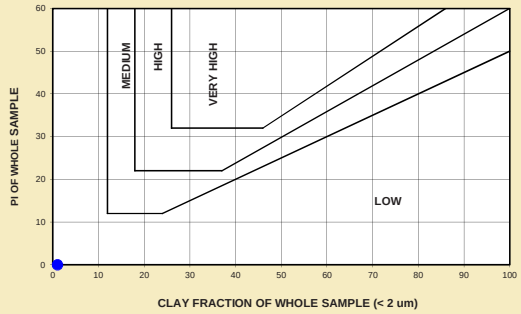
ATTERBERG LIMITS		
Liquid Limit (%)	**0**	
Plastic Limit (%)	**0**	
Plasticity Index (%)	**NP**	
Weighted PI (%)	**0**	
Linear Shrinkage (%)	**0.0**	
Grading Modulus	**2.01**	
Uniformity coefficient	**300**	
Coefficient of curvature	**0.0**	
Remarks:		

SOIL CLASSIFICATION	
% Gravel	**52**
% Sand	**43**
% Silt	**4**
% Clay	**1**
Activity	**0.0**
Unified Classification	**GP-GM**
TRB Classification	**A - 1 - b**

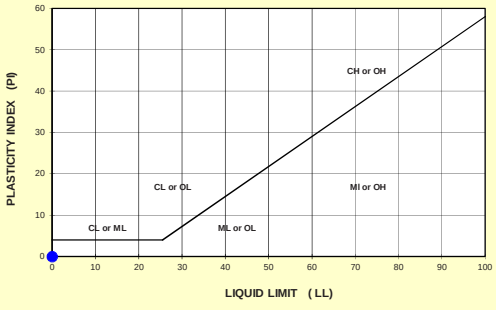
PARTICLE SIZE DISTRIBUTION



POTENTIAL EXPANSIVENESS
Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



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FOUNDATION INDICATOR TEST RESULTS - REP COM 7

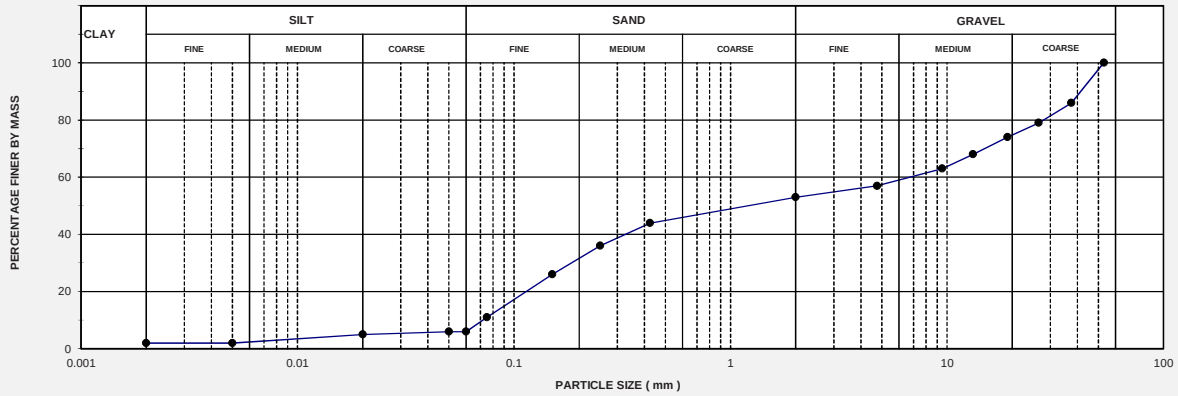
Client:	**VGI Consult Projects**	**Source/Location:**		**Job No:**	**2015-C-1332**
Project Name:	**Proposed Housing Project - Kathu**	**Layer:**		**Sample No:**	**5/8835**
Project No:	**VGI 3944**	**Lane:**		**Date:**	**16/11/2015**
Hole/TP No:	**TP 11/1**	**Stabilizing Agent:**		**Test Method:**	**TMH1 A1, A5 & MT1**
Depth (m):	**0 - 0.6**	**Section:**		**Client Ref No:**	
Description:		**Chainage:**		**GPS X:**	
Additional Info:		**Offset:**		**GPS Y:**	

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
75.0	**100**	0.425	**44**
63.0	**100**	0.250	**36**
53.0	**100**	0.150	**26**
37.5	**86**	0.075	**11**
26.5	**79**	0.060	**6**
19.0	**74**	0.050	**6**
13.2	**68**	0.020	**5**
9.5	**63**	0.005	**2**
4.75	**57**	0.002	**2**
2.00	**53**		

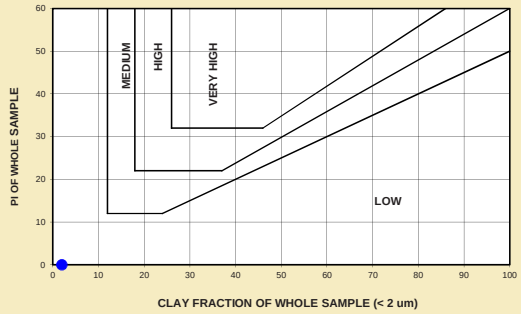
ATTERBERG LIMITS		
Liquid Limit (%)	**0**	
Plastic Limit (%)	**0**	
Plasticity Index (%)	**NP**	
Weighted PI (%)	**0**	
Linear Shrinkage (%)	**0.0**	
Grading Modulus	**1.92**	
Uniformity coefficient	**96**	
Coefficient of curvature	**0.1**	
Remarks:		

SOIL CLASSIFICATION	
% Gravel	**47**
% Sand	**47**
% Silt	**4**
% Clay	**2**
Activity	**0.0**
Unified Classification	**SP-SM**
TRB Classification	**A - 1 - b**

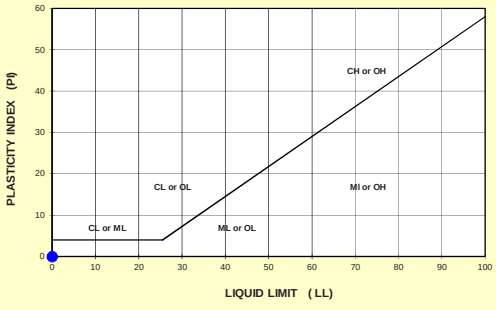
PARTICLE SIZE DISTRIBUTION



POTENTIAL EXPANSIVENESS
Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



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FOUNDATION INDICATOR TEST RESULTS - REP COM 7

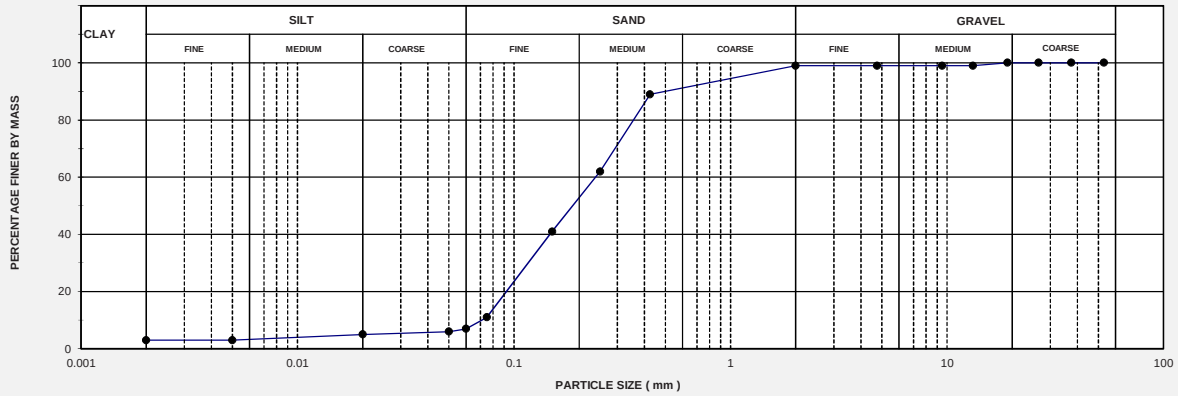
Client:	**VGI Consult Projects**	**Source/Location:**		**Job No:**	**2015-C-1332**
Project Name:	**Proposed Housing Project - Kathu**	**Layer:**		**Sample No:**	**5/8836**
Project No:	**VGI 3944**	**Lane:**		**Date:**	**16/11/2015**
Hole/TP No:	**TP 13/1**	**Stabilizing Agent:**		**Test Method:**	**TMH1 A1, A5 & MT1**
Depth (m):	**0 - 0.4**	**Section:**		**Client Ref No:**	
Description:		**Chainage:**		**GPS X:**	
Additional Info:		**Offset:**		**GPS Y:**	

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
75.0	**100**	0.425	**89**
63.0	**100**	0.250	**62**
53.0	**100**	0.150	**41**
37.5	**100**	0.075	**11**
26.5	**100**	0.060	**7**
19.0	**100**	0.050	**6**
13.2	**99**	0.020	**5**
9.5	**99**	0.005	**3**
4.75	**99**	0.002	**3**
2.00	**99**		

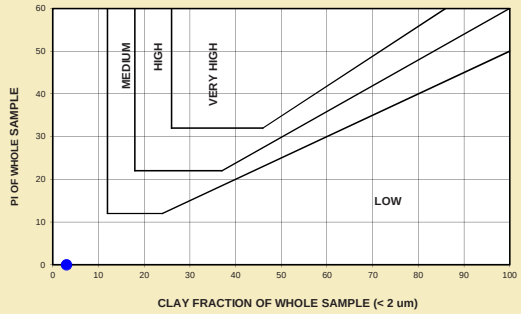
ATTERBERG LIMITS		
Liquid Limit (%)	**0**	
Plastic Limit (%)	**0**	
Plasticity Index (%)	**NP**	
Weighted PI (%)	**0**	
Linear Shrinkage (%)	**0.0**	
Grading Modulus	**1.01**	
Uniformity coefficient	**3**	
Coefficient of curvature	**0.9**	
Remarks:		

SOIL CLASSIFICATION	
% Gravel	**1**
% Sand	**92**
% Silt	**4**
% Clay	**3**
Activity	**0.0**
Unified Classification	**SP-SM**
TRB Classification	**A - 2 - 4**

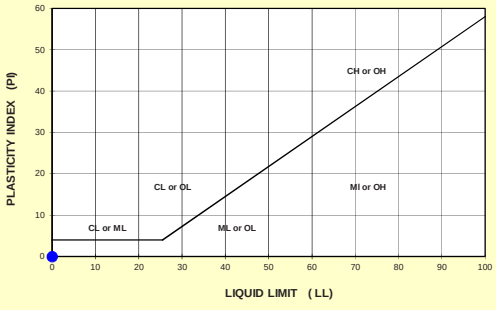
PARTICLE SIZE DISTRIBUTION



POTENTIAL EXPANSIVENESS
Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



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FOUNDATION INDICATOR TEST RESULTS - REP COM 7

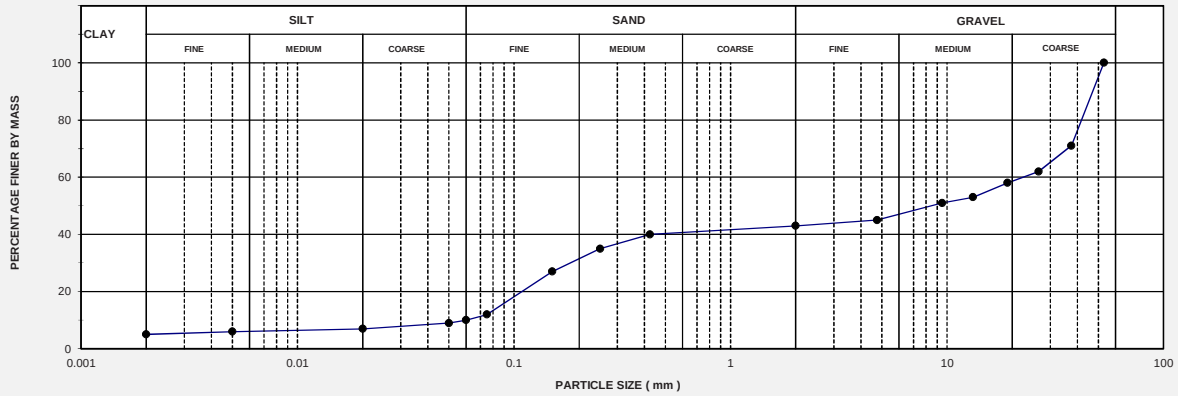
Client:	**VGI Consult Projects**	**Source/Location:**		**Job No:**	**2015-C-1332**
Project Name:	**Proposed Housing Project - Kathu**	**Layer:**		**Sample No:**	**5/8837**
Project No:	**VGI 3944**	**Lane:**		**Date:**	**16/11/2015**
Hole/TP No:	**TP 15/1**	**Stabilizing Agent:**		**Test Method:**	**TMH1 A1, A5 & MT1**
Depth (m):	**0 - 0.3**	**Section:**		**Client Ref No:**	
Description:		**Chainage:**		**GPS X:**	
Additional Info:		**Offset:**		**GPS Y:**	

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
75.0	**100**	0.425	**40**
63.0	**100**	0.250	**35**
53.0	**100**	0.150	**27**
37.5	**71**	0.075	**12**
26.5	**62**	0.060	**10**
19.0	**58**	0.050	**9**
13.2	**53**	0.020	**7**
9.5	**51**	0.005	**6**
4.75	**45**	0.002	**5**
2.00	**43**		

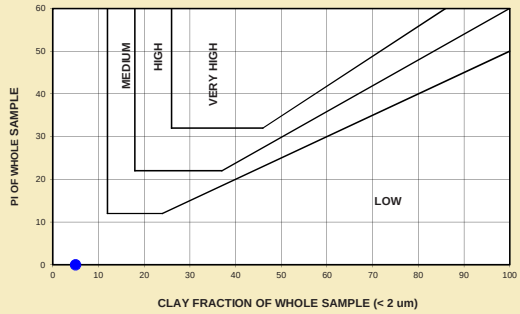
ATTERBERG LIMITS		
Liquid Limit (%)	**0**	
Plastic Limit (%)	**0**	
Plasticity Index (%)	**NP**	
Weighted PI (%)	**0**	
Linear Shrinkage (%)	**0.0**	
Grading Modulus	**2.05**	
Uniformity coefficient	**367**	
Coefficient of curvature	**0.0**	
Remarks:		

SOIL CLASSIFICATION	
% Gravel	**57**
% Sand	**33**
% Silt	**5**
% Clay	**5**
Activity	**0.0**
Unified Classification	**GP-GM**
TRB Classification	**A - 1 - b**

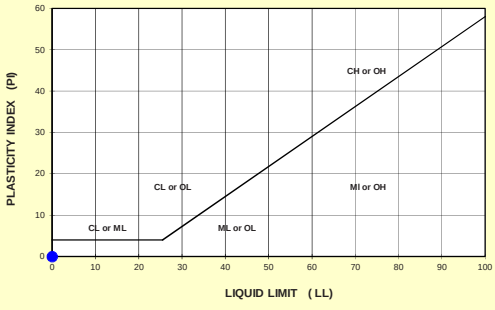
PARTICLE SIZE DISTRIBUTION



POTENTIAL EXPANSIVENESS
Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



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FOUNDATION INDICATOR TEST RESULTS - REP COM 7

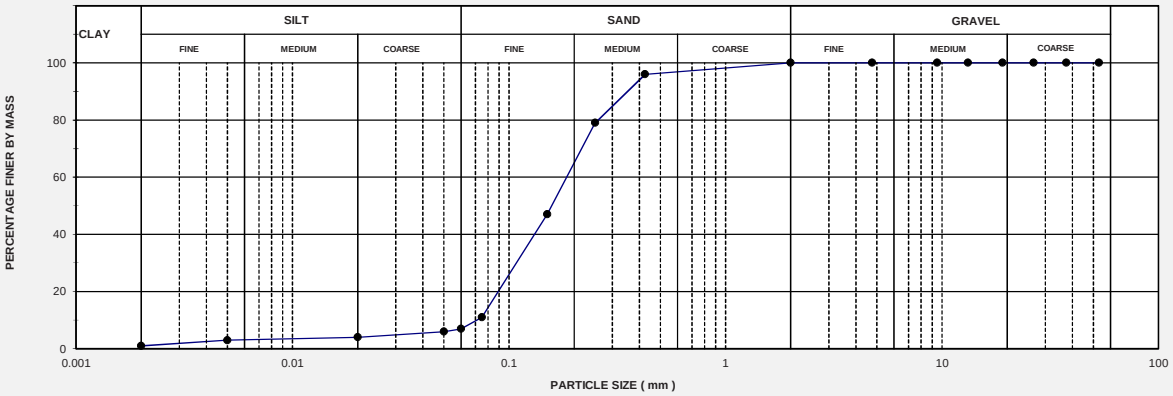
Client:	**VGI Consult Projects**	**Source/Location:**		**Job No:**	**2015-C-1332**
Project Name:	**Proposed Housing Project - Kathu**	**Layer:**		**Sample No:**	**5/8838**
Project No:	**VGI 3944**	**Lane:**		**Date:**	**16/11/2015**
Hole/TP No:	**TP 24/1**	**Stabilizing Agent:**		**Test Method:**	**TMH1 A1, A5 & MT1**
Depth (m):	**0 - 0.4**	**Section:**		**Client Ref No:**	
Description:		**Chainage:**		**GPS X:**	
Additional Info:		**Offset:**		**GPS Y:**	

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
75.0	**100**	0.425	**96**
63.0	**100**	0.250	**79**
53.0	**100**	0.150	**47**
37.5	**100**	0.075	**11**
26.5	**100**	0.060	**7**
19.0	**100**	0.050	**6**
13.2	**100**	0.020	**4**
9.5	**100**	0.005	**3**
4.75	**100**	0.002	**1**
2.00	**100**		

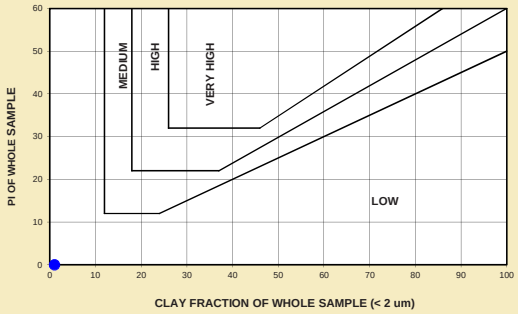
ATTERBERG LIMITS		
Liquid Limit (%)	**0**	
Plastic Limit (%)	**0**	
Plasticity Index (%)	**NP**	
Weighted PI (%)	**0**	
Linear Shrinkage (%)	**0.0**	
Grading Modulus	**0.93**	
Uniformity coefficient	**3**	
Coefficient of curvature	**1.0**	
Remarks:		

SOIL CLASSIFICATION	
% Gravel	**0**
% Sand	**93**
% Silt	**6**
% Clay	**1**
Activity	**0.0**
Unified Classification	**SP-SM**
TRB Classification	**A - 2 - 4**

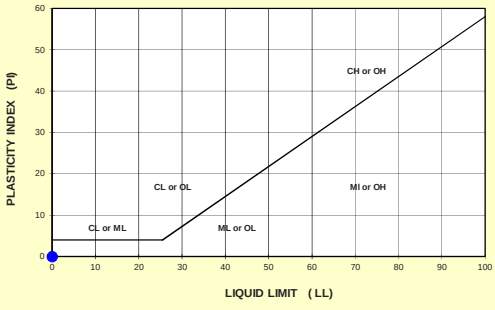
PARTICLE SIZE DISTRIBUTION



POTENTIAL EXPANSIVENESS
Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



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FOUNDATION INDICATOR TEST RESULTS - REP COM 7

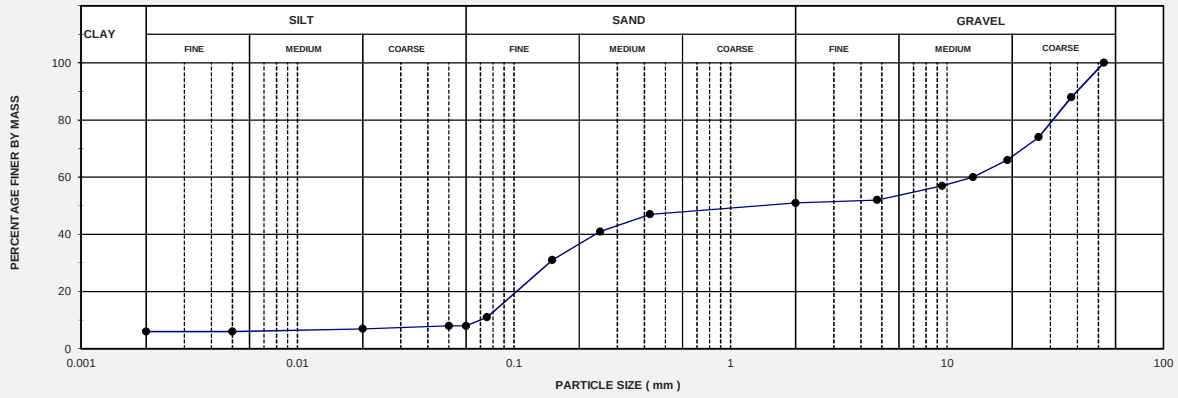
Client:	**VGI Consult Projects**	**Source/Location:**		**Job No:**	**2015-C-1332**
Project Name:	**Proposed Housing Project - Kathu**	**Layer:**		**Sample No:**	**5/8840**
Project No:	**VGI 3944**	**Lane:**		**Date:**	**16/11/2015**
Hole/TP No:	**TP 27/1**	**Stabilizing Agent:**		**Test Method:**	**TMH1 A1, A5 & MT1**
Depth (m):	**0 - 0.2**	**Section:**		**Client Ref No:**	
Description:		**Chainage:**		**GPS X:**	
Additional Info:		**Offset:**		**GPS Y:**	

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
75.0	**100**	0.425	**47**
63.0	**100**	0.250	**41**
53.0	**100**	0.150	**31**
37.5	**88**	0.075	**11**
26.5	**74**	0.060	**8**
19.0	**66**	0.050	**8**
13.2	**60**	0.020	**7**
9.5	**57**	0.005	**6**
4.75	**52**	0.002	**6**
2.00	**51**		

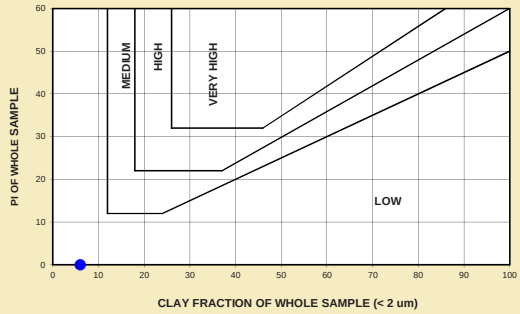
ATTERBERG LIMITS		
Liquid Limit (%)	**0**	
Plastic Limit (%)	**0**	
Plasticity Index (%)	**NP**	
Weighted PI (%)	**0**	
Linear Shrinkage (%)	**0.0**	
Grading Modulus	**1.91**	
Uniformity coefficient	**183**	
Coefficient of curvature	**0.0**	
Remarks:		

SOIL CLASSIFICATION	
% Gravel	**49**
% Sand	**43**
% Silt	**2**
% Clay	**6**
Activity	**0.0**
Unified Classification	**GP-GM**
TRB Classification	**A - 1 - b**

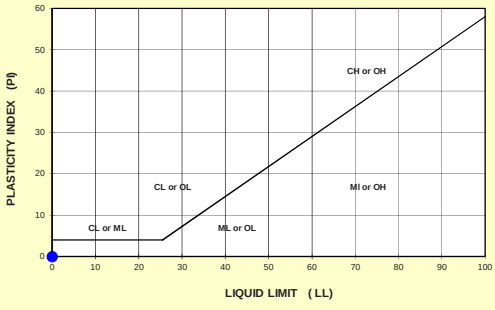
PARTICLE SIZE DISTRIBUTION



POTENTIAL EXPANSIVENESS
Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



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FOUNDATION INDICATOR TEST RESULTS - REP COM 7

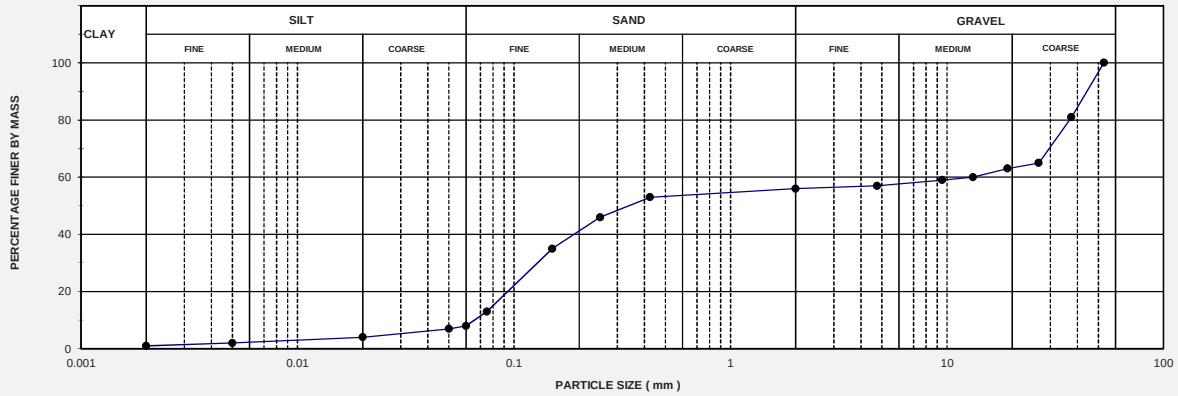
Client:	**VGI Consult Projects**	**Source/Location:**		**Job No:**	**2015-C-1332**
Project Name:	**Proposed Housing Project - Kathu**	**Layer:**		**Sample No:**	**5/8839**
Project No:	**VGI 3944**	**Lane:**		**Date:**	**16/11/2015**
Hole/TP No:	**TP 26/1**	**Stabilizing Agent:**		**Test Method:**	**TMH1 A1, A5 & MT1**
Depth (m):	**0 - 0.4**	**Section:**		**Client Ref No:**	
Description:		**Chainage:**		**GPS X:**	
Additional Info:		**Offset:**		**GPS Y:**	

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
75.0	**100**	0.425	**53**
63.0	**100**	0.250	**46**
53.0	**100**	0.150	**35**
37.5	**81**	0.075	**13**
26.5	**65**	0.060	**8**
19.0	**63**	0.050	**7**
13.2	**60**	0.020	**4**
9.5	**59**	0.005	**2**
4.75	**57**	0.002	**1**
2.00	**56**		

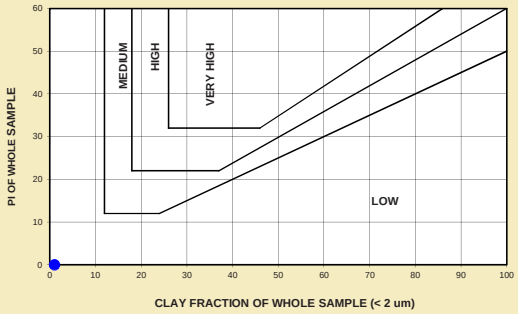
ATTERBERG LIMITS		
Liquid Limit (%)	**0**	
Plastic Limit (%)	**0**	
Plasticity Index (%)	**NP**	
Weighted PI (%)	**0**	
Linear Shrinkage (%)	**0.0**	
Grading Modulus	**1.78**	
Uniformity coefficient	**194**	
Coefficient of curvature	**0.0**	
Remarks:		

SOIL CLASSIFICATION	
% Gravel	**44**
% Sand	**48**
% Silt	**7**
% Clay	**1**
Activity	**0.0**
Unified Classification	**SC**
TRB Classification	**A - 2 - 4**

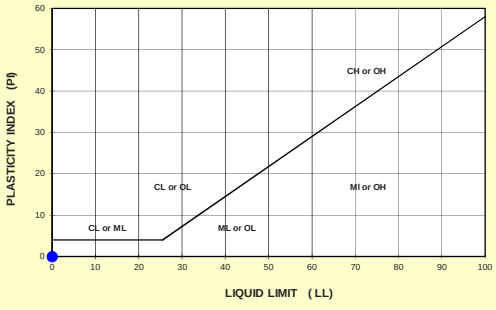
PARTICLE SIZE DISTRIBUTION



POTENTIAL EXPANSIVENESS
Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



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FOUNDATION INDICATOR TEST RESULTS - REP COM 7

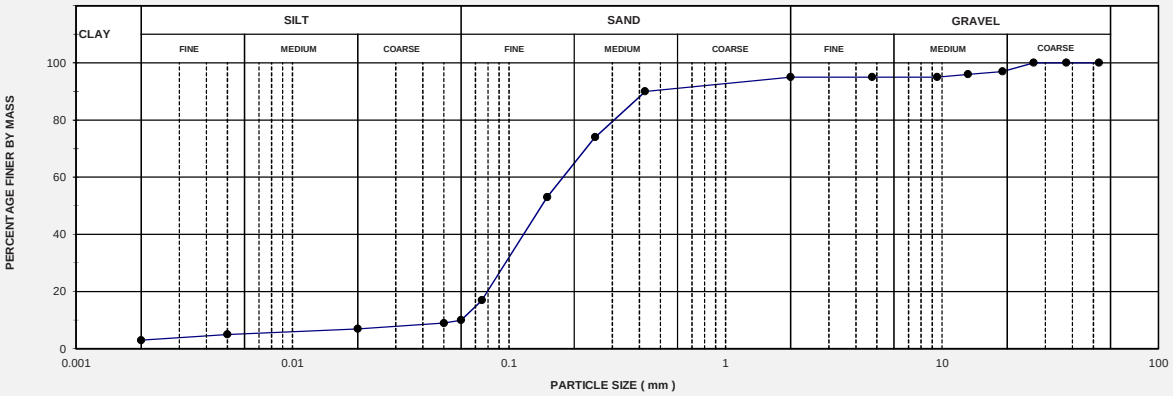
Client:	**VGI Consult Projects**	**Source/Location:**		**Job No:**	**2015-C-1332**
Project Name:	**Proposed Housing Project - Kathu**	**Layer:**		**Sample No:**	**5/8841**
Project No:	**VGI 3944**	**Lane:**		**Date:**	**16/11/2015**
Hole/TP No:	**TP 36/1**	**Stabilizing Agent:**		**Test Method:**	**TMH1 A1, A5 & MT1**
Depth (m):	**0 - 0.4**	**Section:**		**Client Ref No:**	
Description:		**Chainage:**		**GPS X:**	
Additional Info:		**Offset:**		**GPS Y:**	

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
75.0	**100**	0.425	**90**
63.0	**100**	0.250	**74**
53.0	**100**	0.150	**53**
37.5	**100**	0.075	**17**
26.5	**100**	0.060	**10**
19.0	**97**	0.050	**9**
13.2	**96**	0.020	**7**
9.5	**95**	0.005	**5**
4.75	**95**	0.002	**3**
2.00	**95**		

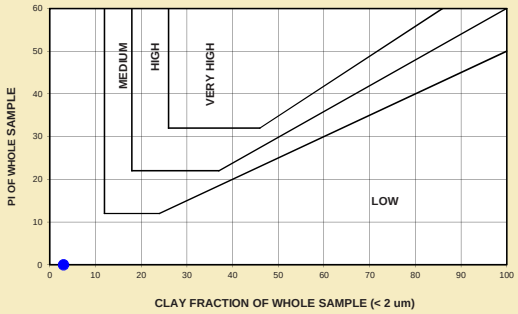
ATTERBERG LIMITS		
Liquid Limit (%)	**0**	
Plastic Limit (%)	**0**	
Plasticity Index (%)	**NP**	
Weighted PI (%)	**0**	
Linear Shrinkage (%)	**0.0**	
Grading Modulus	**0.98**	
Uniformity coefficient	**3**	
Coefficient of curvature	**1.0**	
Remarks:		

SOIL CLASSIFICATION	
% Gravel	**5**
% Sand	**85**
% Silt	**7**
% Clay	**3**
Activity	**0.0**
Unified Classification	**SM**
TRB Classification	**A - 2 - 4**

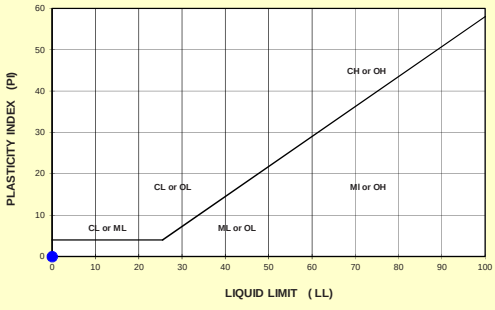
PARTICLE SIZE DISTRIBUTION



POTENTIAL EXPANSIVENESS
Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



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FOUNDATION INDICATOR TEST RESULTS - REP COM 7

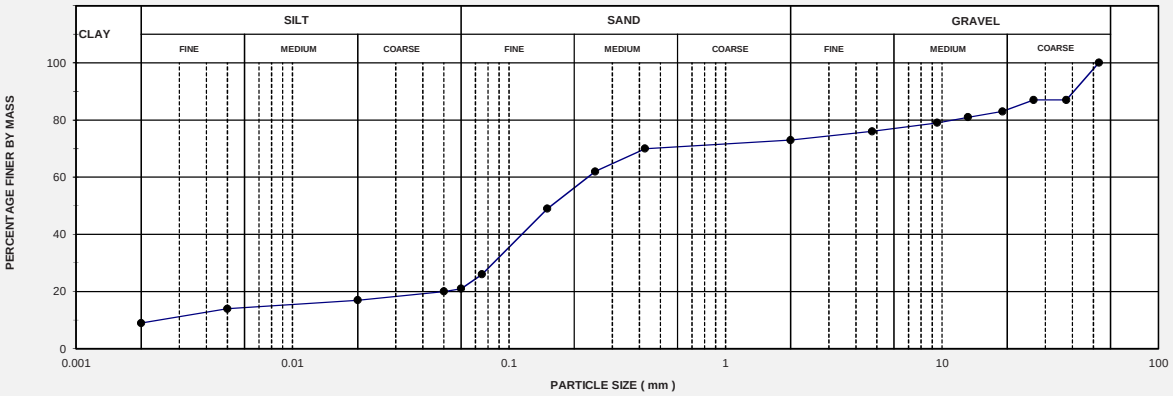
Client:	**VGI Consult Projects**	**Source/Location:**		**Job No:**	**2015-C-1332**
Project Name:	**Proposed Housing Project - Kathu**	**Layer:**		**Sample No:**	**5/8843**
Project No:	**VGI 3944**	**Lane:**		**Date:**	**16/11/2015**
Hole/TP No:	**TP 36/3**	**Stabilizing Agent:**		**Test Method:**	**TMH1 A1, A5 & MT1**
Depth (m):	**0.4 - 1.1**	**Section:**		**Client Ref No:**	
Description:		**Chainage:**		**GPS X:**	
Additional Info:		**Offset:**		**GPS Y:**	

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
75.0	**100**	0.425	**70**
63.0	**100**	0.250	**62**
53.0	**100**	0.150	**49**
37.5	**87**	0.075	**26**
26.5	**87**	0.060	**21**
19.0	**83**	0.050	**20**
13.2	**81**	0.020	**17**
9.5	**79**	0.005	**14**
4.75	**76**	0.002	**9**
2.00	**73**		

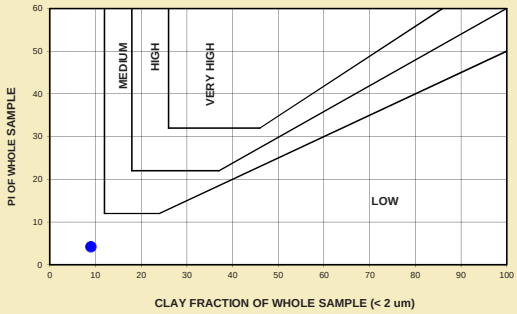
ATTERBERG LIMITS		
Liquid Limit (%)		**22**
Plastic Limit (%)		**16**
Plasticity Index (%)		**6**
Weighted PI (%)		**4**
Linear Shrinkage (%)		**2.5**
Grading Modulus		**1.31**
Uniformity coefficient		**90**
Coefficient of curvature		**13.3**
Remarks:		

SOIL CLASSIFICATION	
% Gravel	**27**
% Sand	**52**
% Silt	**12**
% Clay	**9**
Activity	**0.7**
Unified Classification	**SC**
TRB Classification	**A - 2 - 4**

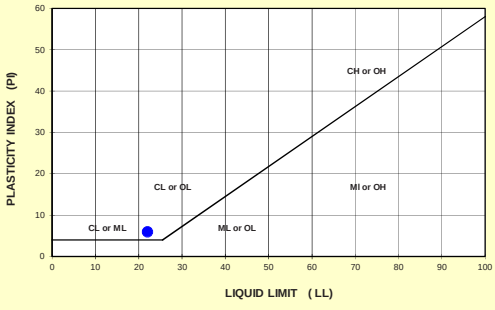
PARTICLE SIZE DISTRIBUTION



POTENTIAL EXPANSIVENESS
Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



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FOUNDATION INDICATOR TEST RESULTS - REP COM 7

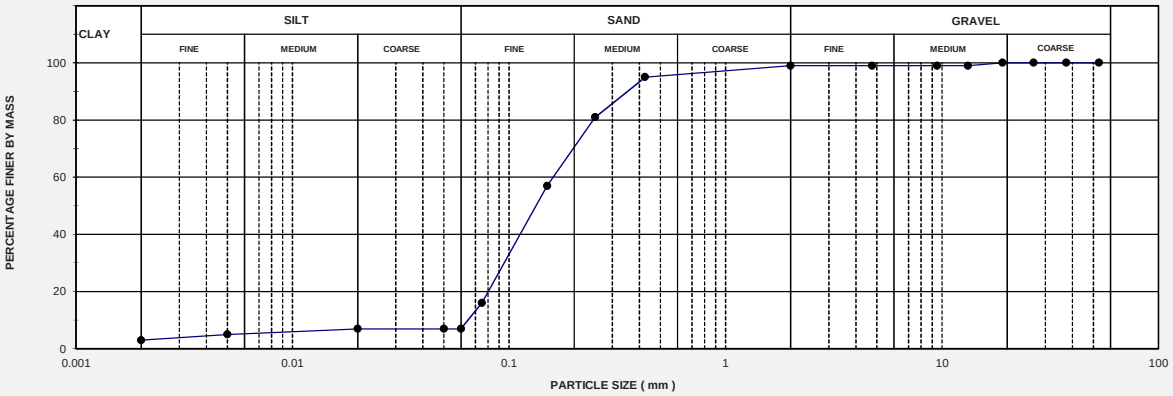
Client:	**VGI Consult Projects**	**Source/Location:**		**Job No:**	**2015-C-1332**
Project Name:	**Proposed Housing Project - Kathu**	**Layer:**		**Sample No:**	**5/8844**
Project No:	**VGI 3944**	**Lane:**		**Date:**	**16/11/2015**
Hole/TP No:	**TP 22/1**	**Stabilizing Agent:**		**Test Method:**	**TMH1 A1, A5 & MT1**
Depth (m):	**0 - 0.4**	**Section:**		**Client Ref No:**	
Description:		**Chainage:**		**GPS X:**	
Additional Info:		**Offset:**		**GPS Y:**	

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
75.0	**100**	0.425	**95**
63.0	**100**	0.250	**81**
53.0	**100**	0.150	**57**
37.5	**100**	0.075	**16**
26.5	**100**	0.060	**7**
19.0	**100**	0.050	**7**
13.2	**99**	0.020	**7**
9.5	**99**	0.005	**5**
4.75	**99**	0.002	**3**
2.00	**99**		

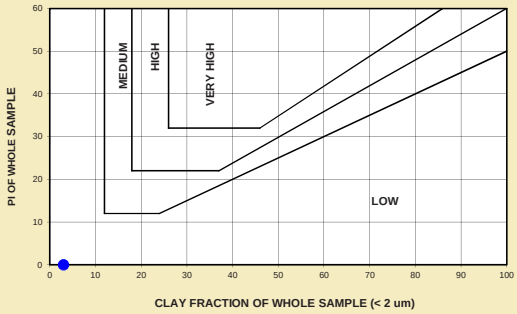
ATTERBERG LIMITS		
Liquid Limit (%)	**0**	
Plastic Limit (%)	**0**	
Plasticity Index (%)	**NP**	
Weighted PI (%)	**0**	
Linear Shrinkage (%)	**0.0**	
Grading Modulus	**0.90**	
Uniformity coefficient	**2**	
Coefficient of curvature	**1.0**	
Remarks:		

SOIL CLASSIFICATION	
% Gravel	**1**
% Sand	**92**
% Silt	**4**
% Clay	**3**
Activity	**0.0**
Unified Classification	**SM**
TRB Classification	**A - 2 - 4**

PARTICLE SIZE DISTRIBUTION



POTENTIAL EXPANSIVENESS
Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE