

REPORT TO

MLALA EMAZWENI ENGINEERS

ON A PRELIMINARY

GEOTECHNICAL INVESTIGATION

OF THE PROPOSED

TOWNSHIP DEVELOPMENT AT

PTN OF REM OF BEZWENI FARM NO. 18223

UMZIMKHULU LOCAL MUNICIPALITY

KWAZULU-NATAL

Ref № 33992

SEPTEMBER 2023

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EXECUTIVE SUMMARY

This report describes the results of the Preliminary geotechnical investigations for the proposed township development on portion of Bezweni Farm № 18223 within Umzimkhulu Local Municipality in KwaZulu-Natal.

The geotechnical investigations were undertaken in accordance with the requirements of the Department of Housing's Generic Specification GFSH-2, preliminary Geotechnical Site Investigations for Housing Developments, and the NHBRC, and the report can be used to accompany applications for subsidised low cost housing.

Topographically, the study area has a general planar conformation falling moderately steep in an easterly direction, but flattening out in the eastern boundary. The Nyenyezi, Mvubukazi and Mzimkulu Rivers are the major river draining this area.

The study area is underlain by Ecca Group Shale bedrock and associated soils. The weathered bedrock is generally overlain by residual subsoils, pedogenic horizon in places and colluvial.

Strong subsurface seepage flows characterize the site. Should this development proceed, precautions will, however, need to be made for potential sidewall collapse and water ingress. surface and sub-soil drains and damp proofing should be implemented as a matter of course.

It is anticipated that most sites will require some degree of earthwork to produce a platform to construct a house on. Notwithstanding this, general recommendations with regard to cutting and filling of the site for development have been given in Section 2.5. The classes of excavatability across the site is expected to range from slight (hand dugged) to moderate (back-actor (TLB/excavator is required)

Foundation type will depend largely on the platforms constructed and is expected to range from R to H3NHBRC Classification.

The following geotechnical characteristics of the site are expected to have an impact on subsidy housing development and subsidy variations:-

- a) Potentially expansive founding conditions in the clayey residual shale/dolerite areas of the site.
- b) Strong seepage occurring near surface
- c) Difficulty in the excavation of hard rock occurring on surface

The shale/dolerite derived soils and weathered rock do not have good percolation properties for on-site effluent disposal.

Stormwater runoff should be controlled by piping or, carrying in lined surface drains to be discharged into an approved discharge point downslope of buildings. Erosion protection measures must be implemented at all outlets. Dwellings should be guttered or at minimum have a 1.0m wide concrete apron leading water away from the foundations.

Though the report has highlighted some development constraints, however these do not amount to any fatal flaws which would preclude the proposed development of this area.

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**REPORT TO MLALA EMAZWENI ENGINEERS - PRELIMINARY
GEOTECHNICAL INVESTIGATION FOR THE PROPOSED TOWNSHIP
DEVELOPMENT ON PORTION OF REM OF BEZWENI FARM NO.18223,
UMZIMKHULU LOCAL MUNICIPALITY,
KWAZULU-NATAL**

1. INTRODUCTION AND TERMS OF REFERENCE

Drennan Maud Pty Ltd undertook a preliminary geotechnical study of the proposed township development in Ward 19 of Umzimkhulu Municipality. The main aim was to obtain a broad understanding of the anticipated prevailing topography, drainage, geology, geotechnical conditions and constraints.

We confirm that the investigation was carried out as per our cost estimate and work proposal letter Ref. 91 dated 24th August 2023.

It should be noted that this assessment is only applicable for the proposed initial planning purposes. Once a site usage and development plan has been finalised it will be necessary to carry out a suitably more detailed geotechnical investigation to provide appropriate development recommendations for the design and construction of the proposed development.

2. INFORMATION

2.1 Description and list of the information assimilated and used in the study.

The following information sources were used in the investigation: -

- a) Google Maps imagery from various years.
- b) 1:250 000 scale Kokstad (3028) Geological Map published by the Council for Geoscience (1998),
- c) Brink (1985) Vol 1- 4
- d) 1:250 000 scale Topographic map - Kokstad (Published by the Council for Geoscience (1998))
- e) 1:50 000 scale Geohydrological map - (Dept of Water Affairs & Forestry)
- f) Various geotechnical reports, covering smaller sites with a radius of 10km
- g) The National Department of Housing: Geotechnical site Investigation for housing development (GENERIC Specification GFSH - 2 : September 2002)
- h) SAIGE South African Institute of Civil Engineering , Geotechnical Division(1990)
- i) A walkover survey of the site, as far as access would allow, for ground truthing and confirming site features and zones of seepage

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2.2 General location and description of the site

2.2.1 General location

The site is located approximately 3km north west of Umzimkhulu CBD in ward 19 within Umzimkhulu local Municipality in the KwaZulu-Natal province, under Harry Gwala District Municipality, central coordinates (long/lat) -30.252473/29.923987. It covers some 240.0 hectares.

The central portion of the site is currently vacant and is used for public livestock grazing. Access to the study area is gained off the P749 and was mostly possible by car, where as a few of the areas could only be accessed by foot paths. Enclosed herewith are Plates № 1-10 that illustrate site condition at the time of the investigation.



Figure 1: Aerial Photo of site

2.2.2 Proposed Development

It is understood that the local authority wishes to develop a minimum of 250 units in the central portion of the study area.

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Figure 2: Developmental plan

2.2.3 Topography

It has a general planar conformation falling moderately steep in an easterly direction, but flattening out towards the eastern boundary(Figure 3 refers). Elevation in the area varies from about 825m to 732m above mean sea level as furnished in Figure 4 below.



Figure 3 : Topography map

**PHASE 1 - PRELIMINARY GEOTECHNICAL INVESTIGATION FOR THE PROPOSED
BEZWENI TOWNSHIP DEVELOPMENT**

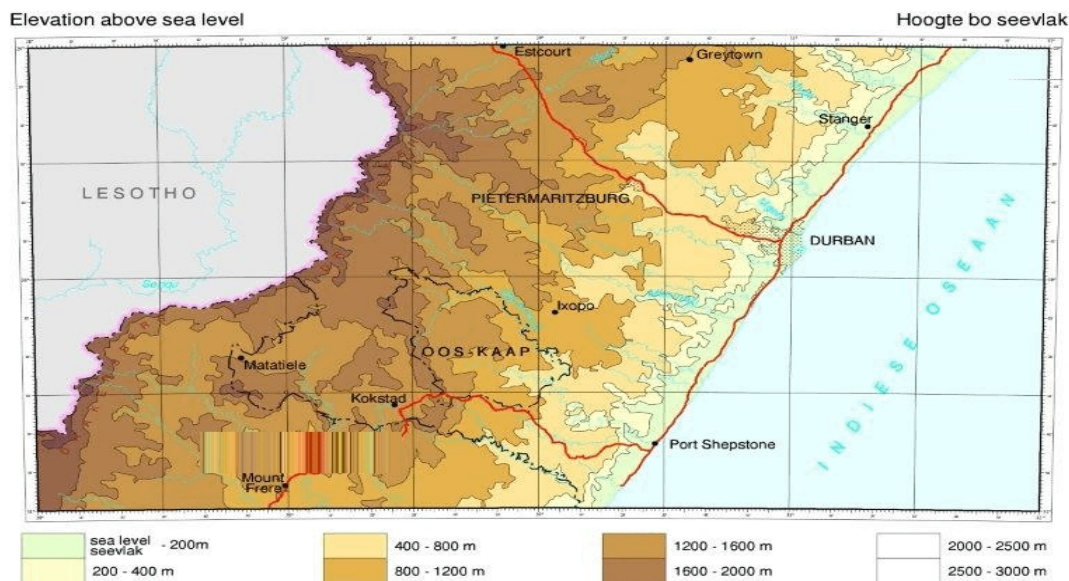


Figure 4 : Elevation above sea level

2.3 Evaluation procedures used in the investigation

The following evaluation procedures have been used: -

- A survey of available literature.
- A broad assessment of aerial photography and surface and underlying geology and geohydrology from available maps and reports.
- Interpretation of aerial photographs and imagery to delineate landforms
- A walkover survey of the site to confirm initial interpretations

2.4 Geology and Hydrogeology of the site

2.4.1 Site Geology

Based on observations made on site and the consultation of the 1:250 000 geological series map, sheet 3028 Kokstad. The geological formations occurring in the area are as follows :-

- Dolerite Karoo Dolerite
- Shale Pietermaritzburg Formation (Pp) Eccca Group
- Shale Vryheid Formation (Pv) Eccca Group & Sandstone

The Eccca Group shale was generally encountered as completely through highly to moderately weathered pale yellow orange to olive, laminated to thinly bedded, closely jointed, very soft to medium hard rock with iron-oxide on the joints and bedding planes(Figure 5). However where in close proximity to dolerite intrusions the shale was often 'baked' (indurated) and therefore ranged from moderately to slightly weathered, close to medium jointed, medium hard to hard rock in places.

PHASE 1 - PRELIMINARY GEOTECHNICAL INVESTIGATION FOR THE PROPOSED
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On elevated ridges the shale was generally encountered at shallow depths below the surface (typically <1.0m).



Figure 5 - Moderately Weathered Shale

These sediments are overlain by a pedogenic horizon and colluvium of varying thickness. Alluvial deposits are evident on some of the rivers and drainage lines.

The distribution of the above mentioned formations within the study area is shown in figure 6 below.



Figure 6: Geology of the Study Area

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2.4.2 Hydrogeology of the site

As part of the geotechnical investigation, a broad geohydrological assessment has been undertaken.

The census has been carried out within a one kilometer radius of the proposed development site to assess water abstraction and usage therein.

- **Surface Water Bodies**

Mvubukazi River is located some 100m south of the site whereas Nyenyezi forms the northern boundary of the site and both flow in a north easterly direction where it joins (tributary) the Mzimkulu River as shown in figure 7 below;

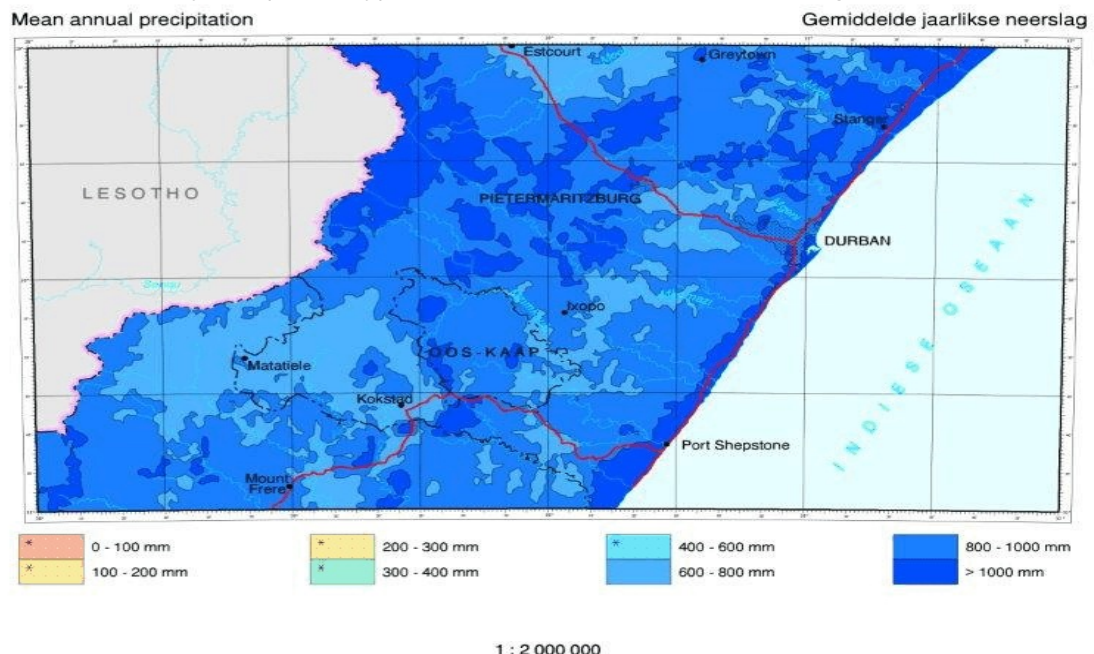


Figure 7: Rivers and Drainage lines

- **Ground Water**

The geology of the surrounding area comprises shale of the Ecca Group which have been intruded by Karoo dolerite. , neither of which are particularly good ground water aquifers in this area. These rock types are hydro-geologically classified as a fractured (secondary) aquifer and generally falls within the poor yielding class '1F'.

- **Existing Water Boreholes**

Data obtained from National Groundwater Archive (NGA) database revealed a total of 20No. boreholes exist within a 10km radius of the site (figure 8 refers). Boreholes drilled in areas underlain by shale have yields typically ranging between 0.5 – 2.0l/s (poor to moderate).

**PHASE 1 - PRELIMINARY GEOTECHNICAL INVESTIGATION FOR THE PROPOSED
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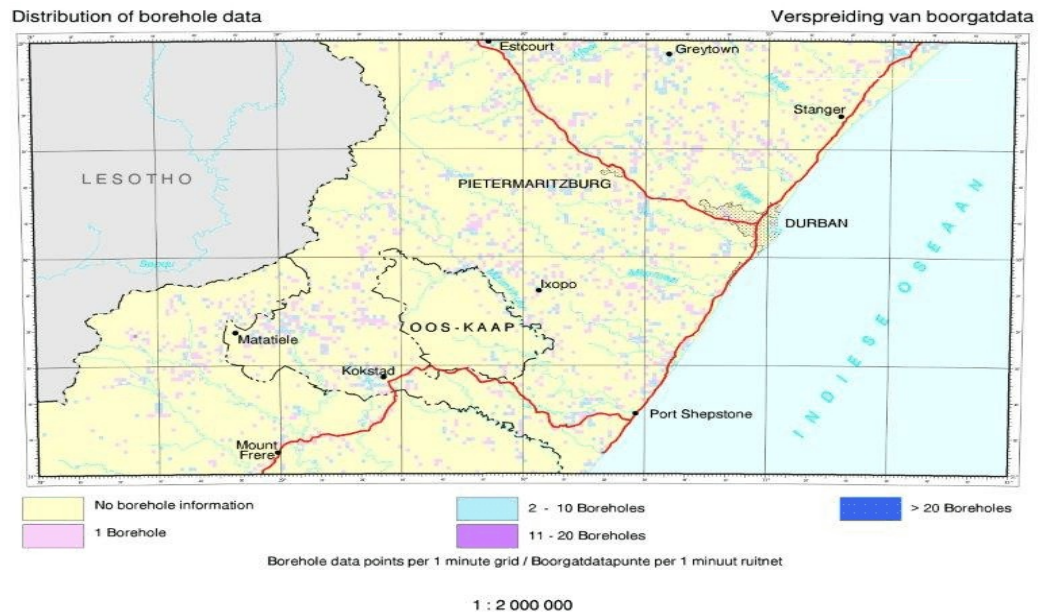


Figure 8: Existing Boreholes

- **Current Ground and Surface Water Usage**

This town is supplied by piped municipal water and it is considered unlikely that there would be any users of ground or river water for any purpose other than for livestock and irrigation in this area.

- **Ground Water Contamination Potential**

Given the very low subsoil permeability in the residual shale/dolerite, it would appear that the risk of shallow ground water contamination is relatively limited.

- **Drainage**

The drainage pattern in the study area is strongly dendritic with almost all runoff toward the north eastward flowing Nyenyezi and Mvubukazi Rivers which ultimately drain into the Mzimkulu River.

The valley bottoms are generally poorly drained with characteristic alluvial vle conditions for much of the year until the onset of the seasonal rains when the streams flow again in response to the precipitation.

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2.5 Geotechnical conditions and constraints

2.5.1 Geotechnical conditions

- **Slope Stability**

During the site drive over no signs of slope instability was observed. However, thinly bedded shale present within the study area are likely to become saturated and result in shallow slips or sloughs during periods of high rainfall. This can be reduced to manageable levels if the cut slopes are flattened sufficiently and correct building practices are employed during construction phase.

- **Surface and Sub-Surface Seepage**

Strong subsurface seepage flows characterize the site. Groundwater can be expected to be encountered in the range 0.5m to 1.5 m and it would generally coincide with the contact of the upper colluvial sand and pedogenic horizon and underlying residual shale/dolerite or completely weathered shale.

Should this development proceed, surface and sub-soil drains and damp proofing should be implemented as a matter of course.

- **Excavation**

The excavatability of the site is assessed according to the SABS 1200 D earth works specifications (Table 1, overleaf).

It is assumed the excavation in the colluvium, residual soils and completely weathered materials classifies as “soft excavation” in terms of the SABS 1200 D Earthworks Specification. Excavation within moderately weathered materials classifies as “Intermediate” excavation and may require the use of heavier plant. Excavation within dolerite core-stones will be classified as “Boulder Class B” excavation. However, hard rock conditions are not expected to cover any significant proportion of the site.

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Table 1 :SANS 1200 D Earthworks Classification

| Classification | Description |
|--|--|
| <u>Restricted Excavations</u> | |
| Soft | Material which can be efficiently removed by a back-acting excavator of fly wheel power >0.10 kW for each mm of tined bucket width |
| Intermediate | Material which can be removed by a back-acting excavator of fly wheel power >0.10 kW for each mm of tined bucket width or with the use of pneumatic tools before removal by a machine capable of removing soft material |
| Hard rock | Material that cannot be removed without blasting or wedging and splitting |
| Classification | Description |
| <u>Non-restricted Excavations</u> | |
| Soft | Material which can be efficiently removed or loaded, without prior ripping, by any of the following plant: A bulldozer or a track-type front end loader having an approximate mass of 22 tonne and fly wheel power of 145 kW A tractor-scraper unit having an approximate mass of 28 tonne and fly wheel power of 245 kW pushed during loading by a bulldozer equivalent to that described above |
| Intermediate | Material which can be efficiently ripped by a bulldozer having an approximate mass of 35 tonne and a fly wheel power of 220 kW |
| Hard rock | Material that cannot be efficiently ripped by a bulldozer having an approximate mass of 35 tonne and a fly wheel power of 220 kW |
| Boulder Class A | Material containing more than 40% by volume of boulders of size between 0.03 m ³ and 20 m ³ in a matrix of soft material or smaller boulders |
| Boulder Class B | Material containing 40% or less by volume of boulders of size between 0.03 m ³ and 20 m ³ in a matrix of soft material or smaller boulders |

- **Earthworks**

It is anticipated that most sites will require some degree of earthwork to produce a platform to construct a house on. The nature of the soils and the extent of the earthworks will determine what founding would be appropriate.

Limited earthworks, in the form of site preparation, will be required in areas of gentle topography. Where as the construction of cut to fill platforms will be required on the steeper areas. The construction of these platforms should not be difficult, provided that they are constructed correctly, i.e. as an engineered fill and at appropriate cut and fill batters on slopes not steeper than 1:3. It is recommended that the proposed dwellings be constructed in the cut portion of the platform to ensure long term stability.

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- **Cut Embankments**

All permanent cut slopes in sandy clayey to clayey sandy colluvium, clayey residuum or completely weathered bedrock should be restricted to a maximum batter of 1:2 (26°). Should cut embankments expose competent, tightly bedded, weathered bedrock batters may be increased to 1:1,5 (33°) or possibly steeper at the discretion of a responsible Engineer. The maximum height of any cut slope should not exceed 3.0m without being suitably retained.

Should it not be possible to accommodate the above mentioned slope angles, the slopes will need to be supported by retaining structures. In the same regard all foundation and service excavations which exceed 1.2m depth should be trimmed back to a batter of 1:2 (26°) or alternatively shored.

Building platforms should ideally be created entirely in cut.

All cut embankments must be protected against surface erosion by the planting of vegetation immediately after construction.

- **Fill Embankments**

Prior to the placement of any fill the in-situ subsoil materials containing vegetation should be grubbed clear.

Fills should be constructed of suitable granular material in layers with a maximum loose thickness of 300mm and compacted to 93% to 95% of the materials Max Mod AASHTO Density for more clayey and sandy materials respectively prior to placement of the next layer. The maximum particle size within the fill should be restricted to two thirds of the layer thickness.

Permanent fill batters should be laid back to a batter no steeper than 1:1,75(30°) and should not exceed a maximum vertical height of about 3m.

In general, for well constructed engineered fills, settlements of up to 1% of the fill thickness should be anticipated. As such, settlements across the cut/fill line or from natural ground to maximum fill, depending on the thickness of fill, may vary across the platform.

- **Foundation Measures**

The foundation design assessment is therefore considered to be generalized until a detailed geotechnical investigation is carried out. Due to the majority of housing platforms being constructed on cut/fill platforms, it is believed that founding measures will have to include both shallow founding and deep founding. Foundation type will depend largely on the platforms constructed.

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Where the new dwelling is located on the top of spurs and ridges, on flat surfaces and the foundations area taken into weathered shale, then normal strip (R to H NHBRC Classification) foundations would be suitable. Over clayey gritty residual shale, raft foundation (H1/H2 - NHBRC Classification) would be preferred.

The soils occurring along the lower valley slopes and in the valley bottoms are likely to exhibit seasonal moisture change movements and therefore would also require stiffened foundations (H3 - NHBRC Classification) to counteract the active materials.

All foundations should be ideally placed entirely in cut, however where the raft layout encroaches onto the fill portion of the site (in accordance with NHBRC Classification it will fall into a S1/S2 or S/Fill classification). Therefore, among factors which need to be considered in the design of the raft foundations, differential settlements should be included across the prick of cut to fill on platforms. Normal long-term settlement should be expected and needs to be catered for. In the event that the depth of fill exceeds 1m below any platform, pads may be needed to be introduced to modify and stiffen the vertical dimensional stability of the fill. Such pads are not necessarily taken through the full depth of the fill, but through only a predetermined proportion of the depth.

Due to the likely expansive nature of the active clayey soils, in general the use of these materials as fill beneath the surface bed or beneath foundations should be avoided if possible. Suitable granular material is preferred for this purpose.

For foundations placed in unconsolidated material a general allowable bearing pressure of 80kPa can be used for design purposes. Should foundation levels intersect weathered bedrock the bearing pressures can be increased to between 150 - 250 kPa depending on the relative weathering and hardness of the bedrock material.

It must be taken into account that the above foundation types (and NHBRC Classification) should be used as a guide only at this stage until a detail 'Brown Field' geotechnical investigation has been undertaken for NHBRC project registration (Phase 1 of GFSH-2002) followed by site classification of dwellings and pit latrines during construction for NHBRC site registration (Phase 2 of GFSH-2002).

- **Percolation Characteristics**

No percolation tests were conducted. However, the shale/dolerite derived soils and associated weathered bedrock, generally have low permeability and are classified as unsuitable for on-site subsoil percolation disposal of septic tank waste water and stormwater.

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If waterborne sanitation cannot be considered at this stage, a consideration should be given to placing the entire development onto a suitably sized package treatment plants or mini treatment works. The cost of such systems are quite high but running costs are relatively low. The treated water could then be disposed into a reed bed.

- **Road Making Properties**

The Eccra Group shales, siltstones and sandstones are not expected to produce any good road making materials. However the presence of dolerite in the greater area should present an opportunity to locate suitable borrow material i.e. probably up to a G5/6 quality.

Crushed stone will have to be brought in from the nearest commercial quarry.

Sand winning from the rivers and streams for plaster and building sand is not considered feasible given the fine nature of the prevailing alluvial soils and environmental regulations.

- **Drainage**

Seepage as alluded to above will occur, on the contacts between the colluvial and residual soils overlying the weathered bedrock and in the lower lying areas along the streams, during periods of high rain falls and the rainy summer months.

Seepage should be dealt with symptomatically as and when it occurs and may include local installation of subsoil drains at the discretion of the Engineer. Allowance will need to be made for the installation of subsoil drainage systems where severe seepage may be encountered in the low lying areas.

Stormwater runoff must be controlled by piping or, carrying in lined surface drains to be discharged into the natural drainage paths in the valley bottoms. Stormwater volumes can be controlled with attenuation structures. Erosion protection measures must be implemented at all outlets. Dwellings should be guttered or at minimum have a 1.0m wide concrete apron leading water away from the foundations.

After construction the site must be properly graded to facilitate the runoff of storm water and prevent ponding.

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2.5.2 Geotechnical constraint

On the basis of the desk study and the available geotechnical information, the following points relating to site geotechnical conditions and constraints, may be made:-

- **Seepage**

As alluded to above, the site is characterized by strong seepage. Such groundwater conditions will make excavation difficult and tedious with the continuous collapse of trench and foundation sidewalls.

- **Erodibility Potential**

The site drive over has highlighted the fact that the soils of the Pietermaritzburg Formation and Karoo Aged Dolerite are prone to erosion to a lesser or greater degree. According to table 7 (page № 22) in the National Housing Code, the site falls under Category 1.

The soils are considered to be very susceptible to sheet and channeled water flow erosion and thus proper storm water drainage measures must be provided during the construction phase, to limit erosion of the platforms and after the construction phase, to prevent erosion and ponding around the completed house.

2.5.3 Problem Soils

- **Active Soils**

The potential expansiveness of a soil depends upon its clay content, the type of clay mineral present, its chemical composition and mechanical character. A material is potentially expansive if it exhibits the following properties (van der Merwe, 1964):

- Clay content of more than 12 %
- Plasticity index of more than 12 %
- Linear shrinkage of more than 8 %

The residual materials of the Eccra Group are typically not considered to be potentially moderately to highly active in the sense that the material will undergo significant volume change with variations in the materials natural moisture content (swell when wet and shrink when dry). However, the relatively high clay content would be an indication of the activity of these materials.

As such certain design measures should be considered where foundations are placed within residual horizons to mitigate potential cracking due to differential movement.

**PHASE 1 - PRELIMINARY GEOTECHNICAL INVESTIGATION FOR THE PROPOSED
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3. Impact of the Geotechnical Character of the site on Subsidy Development

3.1 *General Impact*

The following geotechnical characteristics of the site are expected to have an impact on subsidy housing development and subsidy variations:-

- a) Potentially expansive founding conditions in the clayey residual shale/dolerite areas of the site.
- b) Strong seepage occurring near surface
- c) Difficulty in the excavation of hard rock occurring on surface

3.2 *Land Usage*

The central portion of the site is used for public livestock grazing and the remainder is covered by thick bush and rock outcrop of the Eccia Group. Impacts of the geotechnical character of the site on land usage include shallow rock outcrop, which could limit development in some areas, and the character of the near-surface talus soils, which will impact on the type of foundations that can be economically employed and installed.

3.3 *Installation of Services*

Negative impacts of the character of the site on installation of services are foreseen as being sidewall collapse of excavations due to shallow groundwater, difficult excavation of trenches in some areas and selection of trench back-fill materials (including pipe-bedding) and difficult compaction of on-site back-fill material.

3.4 *House Construction*

Impacts of the geotechnical character of the site on house construction are expected to be limited to the installation of foundations and services.

A schedule of generic subsidy variations applicable to the site is outlined in Table 2, below and overleaf.

Table 2: Site Specific Subsidy Variations

| Geotechnical Conditions | Category or Type | Criteria | Precautionary Measures | Applicable areas | Comment |
|--------------------------------|-------------------------|--|---|-------------------------|--|
| Seepage / groundwater | Category 1 | Permanent or perched water tables less than 1.0m below ground surface | Subsurface drainage / improved damp-proofing measures to houses, service trenches to be dewatered during construction | None | Across the majority of the site and Near the streams |
| | Category 2 | Permanent or perched water tables more than 1m but less than 1.5m below ground level | Service trenches to be dewatered during construction | None | Near valley lines |

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| Erodability of soil | Category 1 | High risk (Erodability index 1-8) | Retaining walls & earthworks to reduce slopes & surface drainage | None | |
|------------------------------------|------------------|---|--|------------------|---------------|
| | Category 2 | Medium risk (Erodability index 9-15) | Retaining walls and earthworks to reduce slopes | Yes | Certain areas |
| Hard excavation | Category 1 | Hard rock excavation to a depth of 1.5m | Additional cost of trench and foundation excavation | Yes | Certain areas |
| | Category 2 | Boulder excavation to a depth of 1.5m | Additional cost of trench, foundation & road excavation | None | |
| Dolomite | Category 1 | Risk class 1 & 2 (Dolomite area class D2) | Additional cost of foundations | None | |
| | Category 2 | Risk class 3 & 4 (Dolomite area class D3) | Additional cost of foundations | None | |
| Geotechnical Conditions | Category or Type | Criteria | Precautionary Measures | Applicable areas | Comment |
| Expansive Clays | Category 1 | H1 | Foundation design, building procedures and precautionary measures: Modified normal | Yes | Certain areas |
| | Category 2 | H2 | Foundation design, building procedures and precautionary measures: Light/medium raft | Yes | Certain areas |
| | Category 3 | H3 | Foundation design, building procedures and precautionary measures: Heavy raft | Yes | Certain areas |
| Compressible and Collapsible soils | Category 1 | C1 | Foundation design, building procedures and precautionary measures: Modified normal | None | |
| | Category 2 | C2 | Foundation design, building procedures and precautionary measures: Light or heavy raft | None | |
| Geotechnical Conditions | Category or Type | Criteria | Precautionary Measures | Applicable areas | Comment |
| Compressible soils | Category 1 | S1 | Foundation design, building procedures and precautionary measures: Modified normal | | |
| | Category 2 | S2 | Foundation design, building procedures and precautionary measures: Light or heavy raft | None | |
| Mining subsidence | Category 1 | Old undermining to a depth of between 90- 240m below surface where slope closure has ceased | Additional cost of foundations: Compaction below footings or raft | None | |
| | Category 2 | Old undermining to a depth of between 90- 240m below surface where total extraction has taken place | Additional cost of foundations: additional earthworks or soil reinforcement | None | |

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| Geotechnical Conditions | Category or Type | Criteria | Precautionary Measures | Applicable areas | Comment |
|------------------------------|------------------|--|--|------------------|-----------|
| Seismic activity | Category 1 | Mining induced seismic activity > 100cm/s ² | Additional cost of foundations: Stiffened strip footings or raft | None | |
| | Category 2 | Natural seismic activity > 100cm/s ² | Additional cost of foundations: Stiffened strip footings or raft | None | |
| Topography | Category 1 | Grade ground slope flatter than 1:20 | Increase depth of sewer and provision of pump station | None | |
| | Category 2 | Average ground slope of between 1:11 and 1:20 | Terracing for houses and additional earthworks to roads & storm water control measures | None | |
| | Category 3 | Average ground slope of between 1:7.5 and 1:10 | Terracing for houses and additional earthworks to roads & storm water control measures | None | |
| | Category 4 | Average ground slope of between 1:5 and 1:7.4 | Terracing for houses and additional earthworks to roads & storm water control measures | None | |
| | Category 5 | Average ground slope steeper than 1:5 | Terracing for houses and additional earthworks to roads & storm water control measures | Yes | All areas |
| Location of development site | | Site less than 20km from major centres | Additional cost of transportation | No | |

4. CONCLUSIONS

This geotechnical desktop study report indicates that farm Bezweni no. 18223 is broadly suitable for development. The present assessment has highlighted certain development constraints, however these do not amount to any fatal flaws which would preclude the proposed development of this area. This preliminary geotechnical site investigation indicates that the site is broadly suitable for project linked subsidy housing development, provided that aspects of concern relating to the geotechnical character of the site are addressed. These aspects are highlighted in the report.



M J HADLOW Pr.Sci.Nat.

**REFERENCE 33992
SEPTEMBER 2023
/gn/kjvr**



G. NTAKA Cert.Sci.Nat.

**DRENNAN MAUD (PTY) LTD
68 Peter Mokaba Ridge, Tollgate,
DURBAN, 4001**

APPENDIX A

Plates 1 - 10



Plate 1.jpg



Plate 2.jpg



Plate 3.jpg



Plate 4.jpg



Plate 5.jpg



Plate 6.jpg



Plate 7.jpg

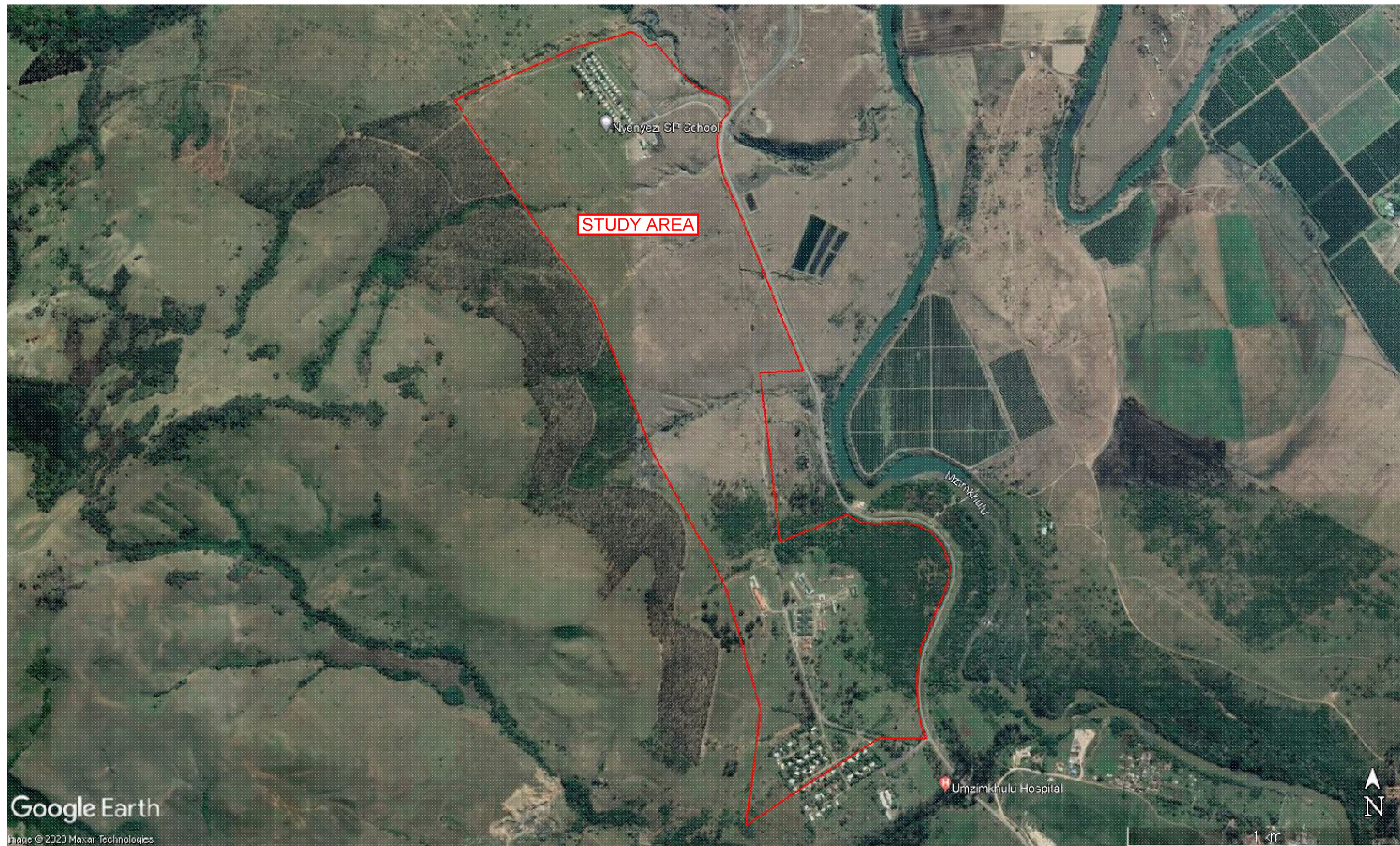


Plate 9.jpg




Plate 10.jpg

Areal view of the site




EXCERPT FROM GOOGLE EARTH

| | | | |
|--|--|---|---|
| <p>DRENNAN MAUD (PTY) LTD Geotechnical Engineers & Engineering Geologists</p> <p>68 Peter Mokaba Ridge Tollgate DURBAN 4001 Telephone 031-201-8992</p>  <p>P.O. Box 30464 MAYVILLE 4058 Telefax 031-201-7920 e-mail: info@drennanmaud.com</p> | <p>DESIGNED : G.N.</p> <p>DRAWN : S.P.</p> <p>DATE : 8-9-2023</p> <p>SCALE : N.T.S.</p> <p>CHECKED :</p> | <p>PRELIMINARY GEOTECHNICAL INVESTIGATION MLALA EMANZWENI - BEZWENI FARM AERIAL VIEW OF THE SITE</p> | <p>DRAWING NO.</p> <p>33992-01</p> |
|--|--|---|---|

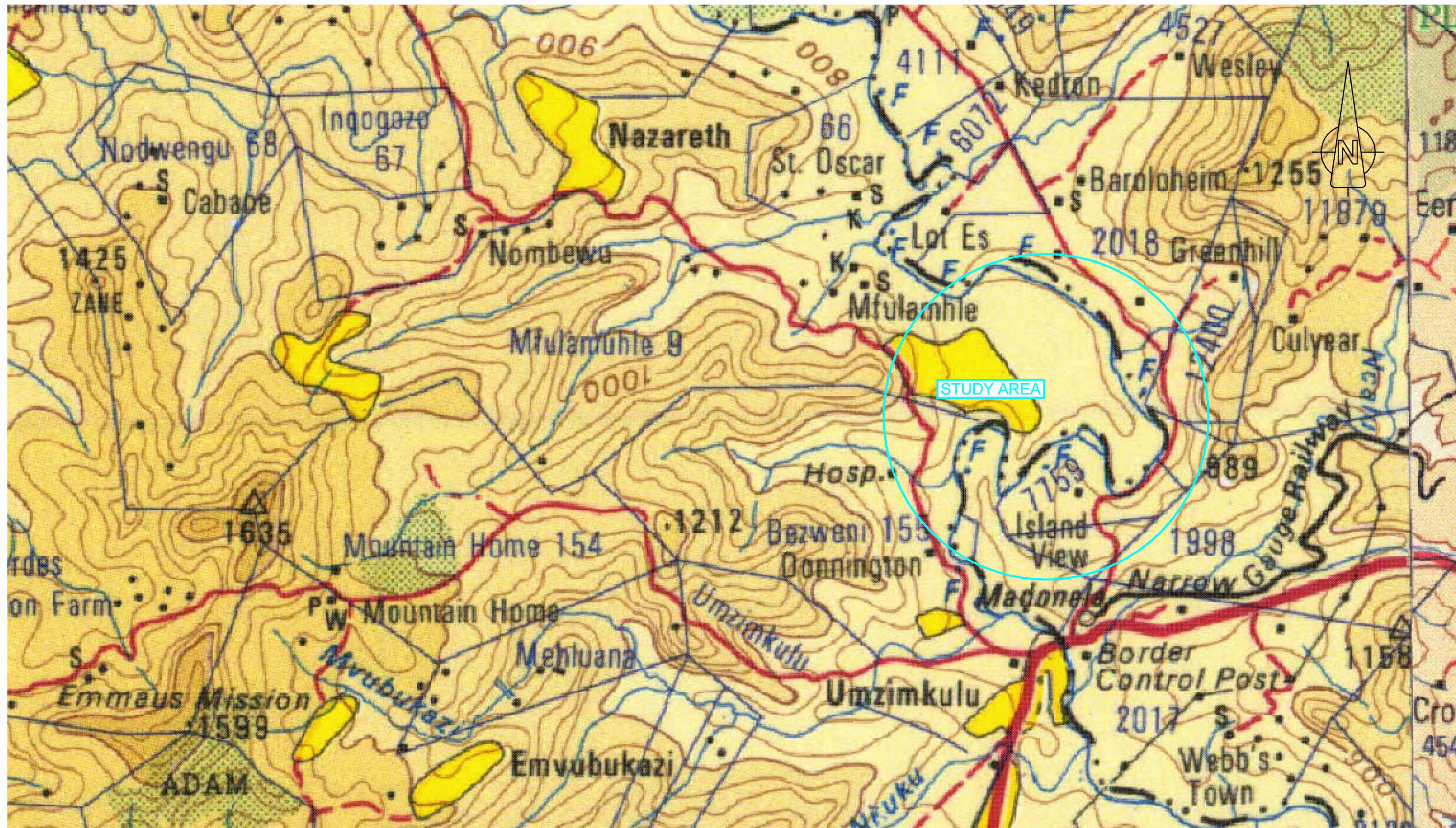
Geological Plan



EXCERPT FROM GEOLOGICAL SERIES
3028 - KOKSTAD

| | | | | | | | | | | | | | | | | |
|---|----------|---|--|------------|------|---------|------|--------|----------|---------|--------|-----------|--|---|--|--|
| <div><div><div>DRENNAN MAUD (PTY) LTD</div><div>Geotechnical Engineers & Engineering Geologists</div><div><div>68 Peter Mokaba Ridge Tollgate DURBAN 4001 Telephone 031-201-8992</div><div></div><div><div>P.O. Box 30464 MAYVILLE 4058 Telefax 031-201-7920 e-mail:info@drennanmaud.com</div></div></div></div></div> | | <table><tr><td>DESIGNED :</td><td>G.N.</td></tr><tr><td>DRAWN :</td><td>S.P.</td></tr><tr><td>DATE :</td><td>8-9-2023</td></tr><tr><td>SCALE :</td><td>N.T.S.</td></tr><tr><td>CHECKED :</td><td></td></tr></table> | | DESIGNED : | G.N. | DRAWN : | S.P. | DATE : | 8-9-2023 | SCALE : | N.T.S. | CHECKED : | | <div><div>PRELIMINARY GEOTECHNICAL INVESTIGATION</div><div>MLALA EMANZWENI - BEZWENI FARM</div><div>GEOLOGICAL PLAN</div></div> | | <div>DRAWING NO.</div> <div>33992-02</div> |
| DESIGNED : | G.N. | | | | | | | | | | | | | | | |
| DRAWN : | S.P. | | | | | | | | | | | | | | | |
| DATE : | 8-9-2023 | | | | | | | | | | | | | | | |
| SCALE : | N.T.S. | | | | | | | | | | | | | | | |
| CHECKED : | | | | | | | | | | | | | | | | |

Topographic Plan



**EXCERPT FROM TOPOGRAPHICAL SHEET
3028 - KOKSTAD**

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e-mail: info@drennanmaud.com

DESIGNED : G.N.

DRAWN : S.P.

DATE : 8-9-2023

SCALE : N.T.S.

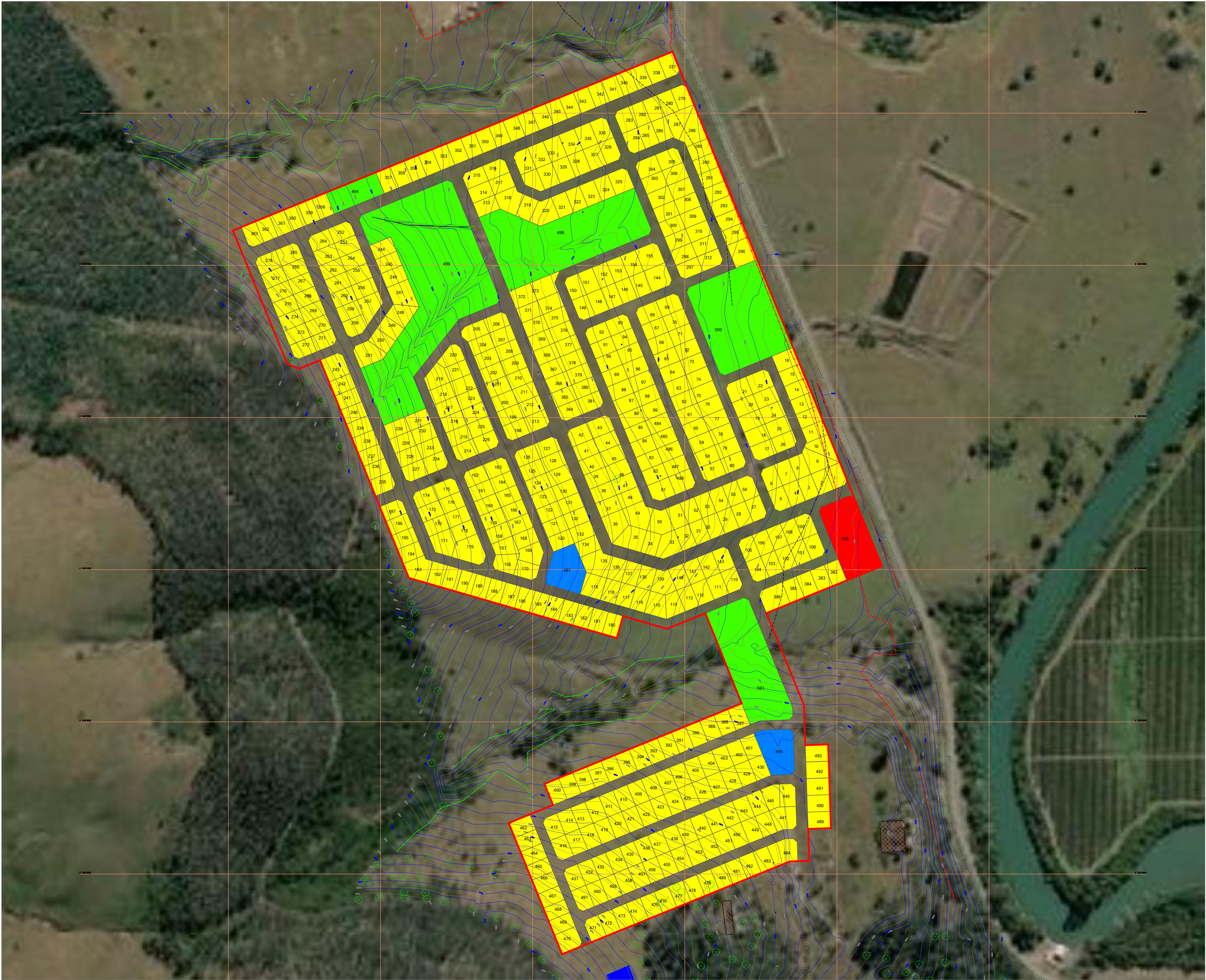
CHECKED :

**PRELIMINARY GEOTECHNICAL INVESTIGATION
MLALA EMANZWENI - BEZWENI FARM
TOPOGRAPHICAL PLAN**

DRAWING NO.

33992-03

Developmental Plan



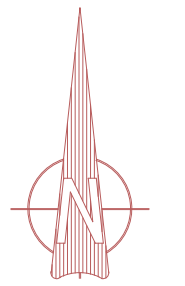
TOWNSHIP ESTABLISHMENT ON PORTION OF
REMAINDER FOR BEZWENI FARM NO. 18223

LAND USE

| ZONING | LAND USE | NO. OF STANDS | AREA Ha. | % OF AREA |
|-------------------|-------------|---------------|------------|------------|
| RESIDENTIAL 1 | RESIDENTIAL | 491 | 31.095279 | 63.231619 |
| BUSINESS 1 | BUSINES | 1 | 0.5076 | 1.032142 |
| EDUCATIONAL | CRECHE | 2 | 0.4914 | 0.999234 |
| PUBLIC OPEN SPACE | PARK | 5 | 0.98030946 | 1.993439 |
| STREETS | * | * | 16.1022 | 32.743565 |
| TOTAL | * | 499 | 49,1768 | 100.000000 |

LEGEND

××× FENCE



- GENERAL NOTES
- 1) CADASTRAL BOUNDARIES _____
 - 2) GEODETIC SYSTEM WGS 84
 - 3) ALL INTERNAL ROADS ARE 15 AND 12 M WIDE UNLESS INDICATED OTHERWISE
 - 4) ALL DIMENSIONS AND AREAS ARE APPROXIMATE & SUBJECT TO FINAL SURVEY BY PROFESSIONAL LAND SURVEYORS
 - 5) BUILDING LINE ARE SUBJECT TO APPLICABLE SCHEME
 - 6) ZONING ARE SUBJECT TO APPLICABLE ZONING SCHEME
 - 7) CONTOUR NOTE: THE CONTOUR SURVEY IS IN ACCORDANCE WITH THE STANDARD LAID DOWN BY THE REGULATIONS RELATING TO TOWNSHIP ESTABLISHMENT AND LAND USE

FLOODLINE NOTE

IT IS HEREBY CERTIFIED IN TERMS OF ARTICLE 144 OF THE NATIONAL WATER ACT (ACT No. 36 OF 1998 THAT THE TOWNSHIP SHOWN ON THIS PLAN IS NOT AFFECTED BY FLOODLINES REPRESENTING THE MAXIMUM LEVEL LIKELY TO BE REACHED BY FLOODWATERS IN A DEFINED WATER COURSE ON AVERAGE ONCE IN EVERY 50 /100 YEARS.

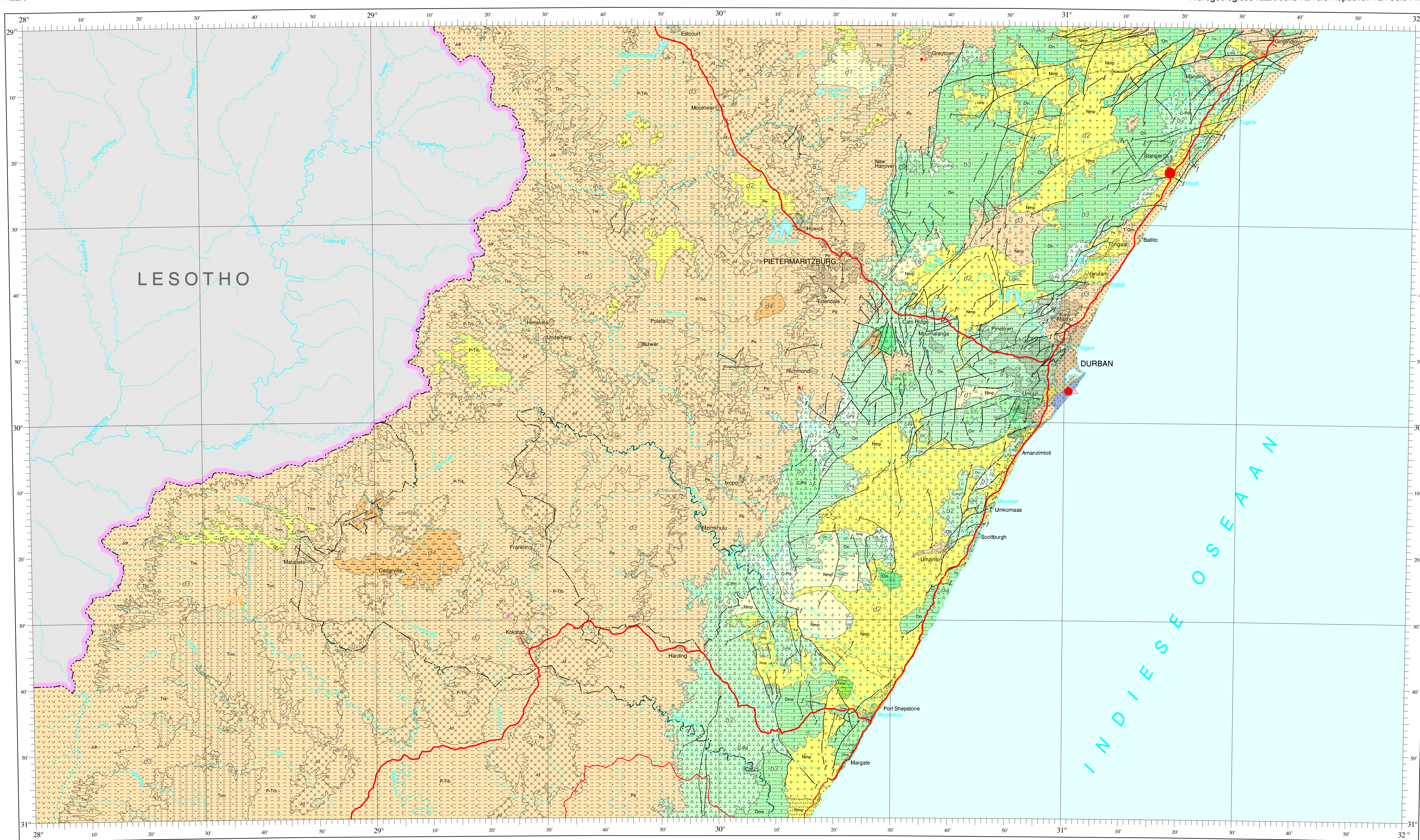
SIGNATURES

| | | |
|--------------|---------------|----------|
| TOWN PLANNER | LAND SURVEYOR | ENGINEER |
| FIRM: | FIRM: | FIRM: |
| DATE: | DATE: | DATE: |

| | |
|-------------|----------------|
| DATE | 16/03/2023 |
| DRAWING NO. | BEZ/01/2023 |
| REVISION | 01 |
| DRAWN BY | R SELEPE |
| CHECKED BY | LIBERTY BALOYI |



Hydrogeological Plan



G. King - Map Author / Kaartskrywer
E. Maritz - GIS Specialist / GIS Spesialis
E. Maritz / F. Jonck - Cartographer / Kartograaf

Assisted by / Bygestaan deur:
Mapping Management Team / Kaartbestuurspan:
P. Searat, P. S. Meyer, J. Baron, H. Mullin, F. Jonck and A.E. Corley
Editorial Board / Redigeraad:
E. Braune, W.R.G. Open, Z.M. Dzimbowski and F. Coetsee (Consultant / Konsultant)

This map was approved by the Director-General of the Department of Water Affairs and Forestry.

The groundwater occurrence and groundwater quality maps, and the conceptual illustration of groundwater occurrence, were compiled by G. King. The lithology was adapted by G. King from the 1:500 000 scale geological map series. Permission from the Council for Geoscience to make use of their information is gratefully acknowledged. E. Maritz was responsible for the compilation of the borehole distribution map. Borehole data were obtained from the National Groundwater Data Base (NGDB). Precipitation and elevation data were obtained from the Consulting Centre for Water Research, University of Natal, and compiled by H. Mullin. Data of roads, rivers, towns, the coastline, international and provincial boundaries were obtained from the Chief Directorate: Surveys and Land Information, Department of Land Affairs and edited by the Department of Water Affairs and Forestry. Acknowledgment is accorded to: E. Martini & Associates, Groundwater Consulting Services; Doreen Lynn & Partners, Groundwater Development Services and Stefan Robertson & Kistner, for collecting and collating groundwater related information for the Tswalu-Natal Hydrogeological Mapping Project from 1992 to 1995, much of which has been used in the compilation of this map. This project was co-ordinated by Dr. R.H. Maud of Drennan, Maud & Partners.

Hierdie kaart is goedgekeur deur die Direkteur-Generaal van die Departement van Waterreëls en Bosbou.

Die grondwatervoorkoms- en grondwaterkwaliteitskaarte, en die konseptuele illustrasie van grondwatervoorkoms is deur G. King saamgestel. Die litologie is deur G. King vanaf die 1:500 000 skaal geïntegreer. Toestemming van die Raad vir Geowetenskap vir die gebruik van hulle inligting word met dank erken. E. Maritz was verantwoordelik vir die saamstelling van die boorgatverspreidingskaart. Boorgatdata is verkry vanaf die Nasionale Grondwaterdatabank (NGDB). Die reënval- en hoogte data is verkry vanaf die Konsultasiesentrum vir Wateronderzoek, Universiteit van Natal, en saamgestel deur H. Mullin. Data van paaie, riviere, dorpe, die kuslyn, internasionale en provinsiale grense is verkry vanaf die Hoofdirekteur: Surveys and Land Information, Departement van Landreëls en Bosbou. Die Departement van Waterreëls en Bosbou. Erkennings word verleen aan: E. Martini & Associates, Grondwater Konsulting Diens; Doreen Lynn & Partners, Grondwater Ontwikkeling Diens en Stefan Robertson & Kistner, vir die insameling en verwerking van grondwaterverwante inligging vir die Tswalu-Natal Hidrogeologiese Kaartprojek van 1992 tot 1995, waarvan 'n groot gedeelte gebruik is vir die saamstelling van hierdie kaart. Hierdie projek is gekoördineer deur Dr. R.H. Maud van Drennan, Maud & Partners.

Principal groundwater occurrence / Hoof grondwatervoorkoms

Borehole yield class (median l/sec) / Boorgatleweringsklas (median l/sec)
(excluding dry boreholes) / (bevoelings uitgesluit)

| | 0.0 - 0.1 | 0.1 - 0.5 | 0.5 - 2.0 | 2.0 - 5.0 | > 5.0 |
|--|-----------|-----------|-----------|-----------|-------|
| Intergranular / Tussenkorrelig | a1 | a2 | a3 | a4 | a5 |
| Fractured / Gespleet | b1 | b2 | b3 | b4 | b5 |
| Karst / Karst | c1 | c2 | c3 | c4 | c5 |
| Intergranular and Fractured / Tussenkorrelig en gespleet | d1 | d2 | d3 | d4 | d5 |

Borehole yield boundary / Boorgatleweringsgrens

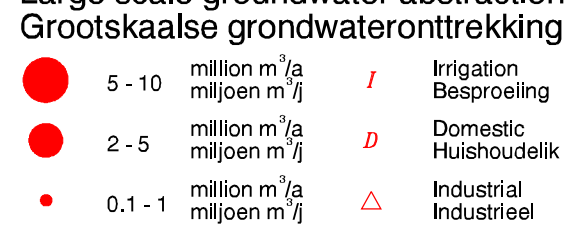
Note: Groundwater occurrence depicts the aquifer types with the highest borehole yield which does not always correlate with surface lithology.

Nota: Grondwatervoorkoms weerspieël die watervlaasies met die hoogste boorgatlewerings, wat nie noodwendig ooreenstem met die oppervlakkige litologie nie.

Surface lithology / Oppervlakkige litologie

| | | |
|--|--|---|
| Aluvium (clay, sand, gravel and boulders) Aluvium (klei, sand, gruis en rotsblokke) | Agglutaceous and arenaceous rocks (approximately equal proportions) Agglutiese en arenitiese gesteentes (benoedig gelyk verhouding) | Predominantly meta-arenaceous rocks (quartzite, gneiss, migmatite and granulite) Oorwegend meta-arenitiese gesteentes (kwartsiet, gneis, migmatiet en granuliet) |
| Undifferentiated coastal deposits (unconsolidated to semi-consolidated sediments including sand, calcarenite, conglomerate, clay and siltstone) Ongeïndifferensieerde kusafsettings (ongesolidatiseerde tot half gesolidatiseerde sedimente waaronder sand, kalkarene, konglomerat, klei en siltesteen) | Predominantly diamictite (siltite) Oorwegend diamiktiet (siltiet) | Predominantly calcareous rocks (caliche, dolomite marble) Oorwegend kalkhoudende gesteentes (kalkiet en dolomiet marmer) |
| Mafic intrusive rocks (dolerite) Mafiese intrusiewe gesteentes (doleriet) | Acid/intermediate/alkaline intrusive rocks (various granitoids) Suur/intermediaal/alkaliese intrusiewe gesteentes (verskeie granitiese rots) | Undifferentiated rocks and various mixed lithologies Ongeïndifferensieerde gesteentes en verskeie gemengde litologie |
| Predominantly argillaceous rocks (shale, carbonaceous shale, mudstone and siltstone) Oorwegend argillitiese gesteentes (skalie, koolstofhoudende skalie, moddersteen en siltesteen) | Mafic extrusive rocks (basalt) Mafiese ekstrusiewe gesteentes (basalt) | Lithological / stratigraphical boundary Litologiese / stratigrafiese grens |
| Predominantly arenaceous rocks (sandstone, feldspathic sandstone, arkose, sandstone becoming quartzite) Oorwegend arenitiese gesteentes (sandsteen, feldspaat-sandsteen, arkose, sandsteen wordend kwartsiet) | Predominantly meta-argillaceous rocks (phyllite, meta-siltite, schist, amphibolite) Oorwegend meta-argillitiese gesteentes (siltiet, meta-siltiet, skis, amphiboliet en amfiboliet) | Fault / Versuiweling |

Large scale groundwater abstraction / Groot skaalse grondwateronttrekking



Spring / Inoor springs (< 1 l/s) are wide spread and not shown on this map.
Fontein (kleiner fontein (< 1 l/s)) is wyd verspreid en word nie op hierdie kaart aangetoon nie.

City / Town area / Stads- / dorpsgebied
Inset map: Town / Insetkaart: Dorp

National road / Nasionale pad
Inset map: National road / Insetkaart: Nasionale pad

Main road / Inset map: Main road / Hoofpad / Insetkaart: Hoofpad

International boundary / Internasionale grens

Provincial boundary / Provinsiale grens

Not applicable to this map / Nie van toepassing op hierdie kaart nie

Chronostratigraphy / Chronostratigrafie

| 1 | 2 | 3 | 4 | 5 | 6 |
|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Quaternary / Kwaternêr | Quaternary / Kwaternêr | Quaternary / Kwaternêr | Quaternary / Kwaternêr | Quaternary / Kwaternêr | Quaternary / Kwaternêr |
| Tertiary / Tertiêr | Tertiary / Tertiêr | Tertiary / Tertiêr | Tertiary / Tertiêr | Tertiary / Tertiêr | Tertiary / Tertiêr |
| Cretaceous / Kretasies | Cretaceous / Kretasies | Cretaceous / Kretasies | Cretaceous / Kretasies | Cretaceous / Kretasies | Cretaceous / Kretasies |
| Jurassic / Jura | Jurassic / Jura | Jurassic / Jura | Jurassic / Jura | Jurassic / Jura | Jurassic / Jura |
| Triassic / Triaas | Triassic / Triaas | Triassic / Triaas | Triassic / Triaas | Triassic / Triaas | Triassic / Triaas |
| Permian / Perm | Permian / Perm | Permian / Perm | Permian / Perm | Permian / Perm | Permian / Perm |
| Carboniferous / Karbon | Carboniferous / Karbon | Carboniferous / Karbon | Carboniferous / Karbon | Carboniferous / Karbon | Carboniferous / Karbon |
| Devonian / Devon | Devonian / Devon | Devonian / Devon | Devonian / Devon | Devonian / Devon | Devonian / Devon |
| Silurian / Silur | Silurian / Silur | Silurian / Silur | Silurian / Silur | Silurian / Silur | Silurian / Silur |
| Ordovician / Ordovisie | Ordovician / Ordovisie | Ordovician / Ordovisie | Ordovician / Ordovisie | Ordovician / Ordovisie | Ordovician / Ordovisie |
| Cambrian / Kambrum | Cambrian / Kambrum | Cambrian / Kambrum | Cambrian / Kambrum | Cambrian / Kambrum | Cambrian / Kambrum |

This general hydrogeological map is part of the 1:500 000 Hydrogeological map series of the Republic of South Africa.

This map is not to be used for the purpose of local borehole siting. Simplified lithology may be considered as guidelines only. Further geological information can be obtained from the Council for Geoscience. This map series is produced by ACR/IO software.

Digital data, copies of this map and accompanying brochure are available from:

Directorate: Geo-hydrology
Department of Water Affairs and Forestry
Private Bag X313
Pretoria 0001

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Associated Printing
Cape Town

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Hierdie algemene hidrogeologiese kaart is deel van die 1:500 000 Hidrogeologiese kaartreks van die Republiek van Suid-Afrika.

Hierdie kaart moet nie gebruik word vir plaaslike boorgatlewerings nie. Vereenvoudigde litologie kan slegs as riglyne beskou word. Verdere geologiese inligting kan vanaf die Raad vir Geowetenskap verkry word. Die kaartreks is vervaardig met ACR/IO programmatuur.

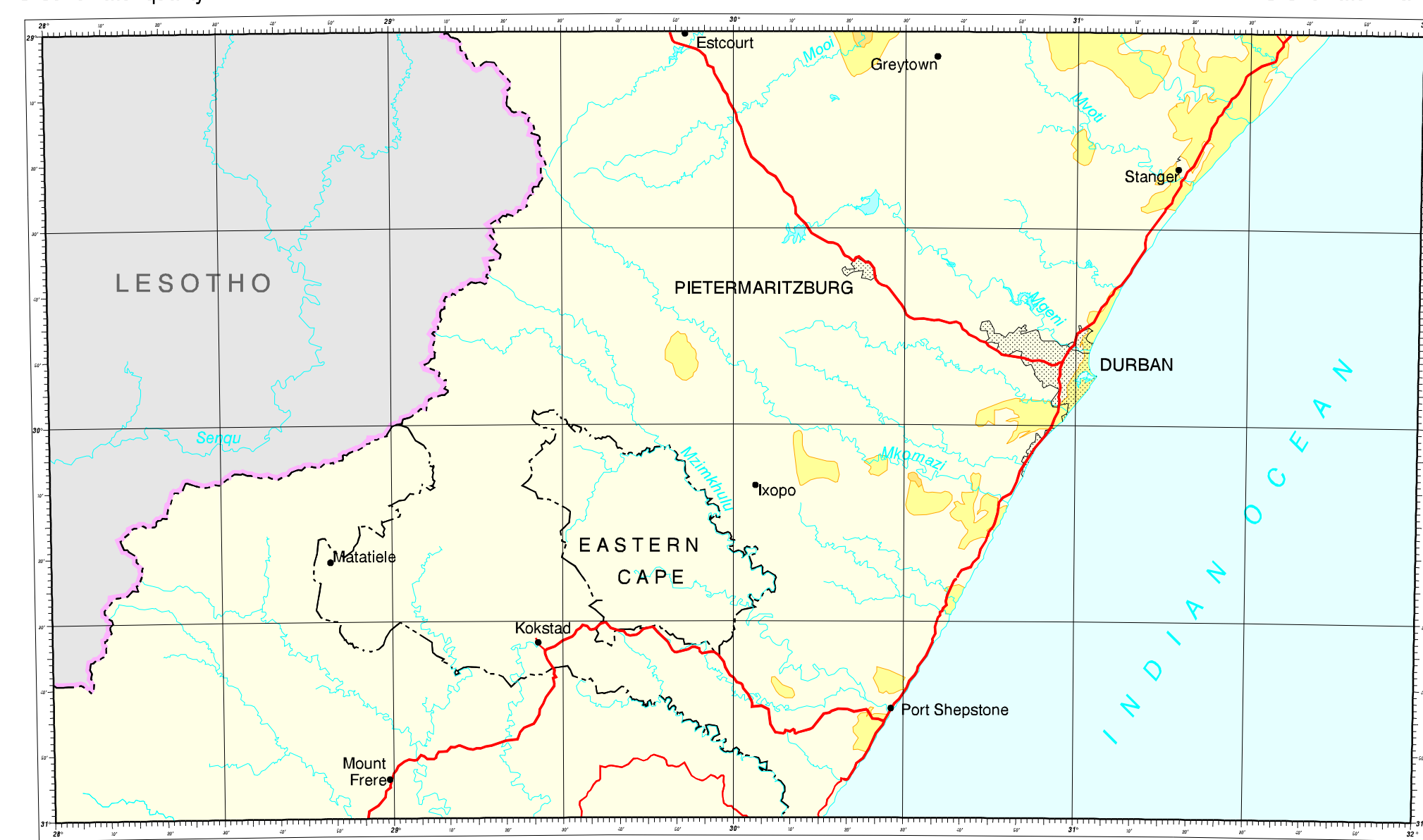
Digitaal data, kopie van die kaart en meegangende brosjure kan verkry word vanaf:

Geologiese Direkteur
Departement van Waterreëls en Bosbou
Private Sak X313
Pretoria 0001

Getruksaai deur:
Assosieerde Drukkery
Kaapstad

Staatsreëls 1999

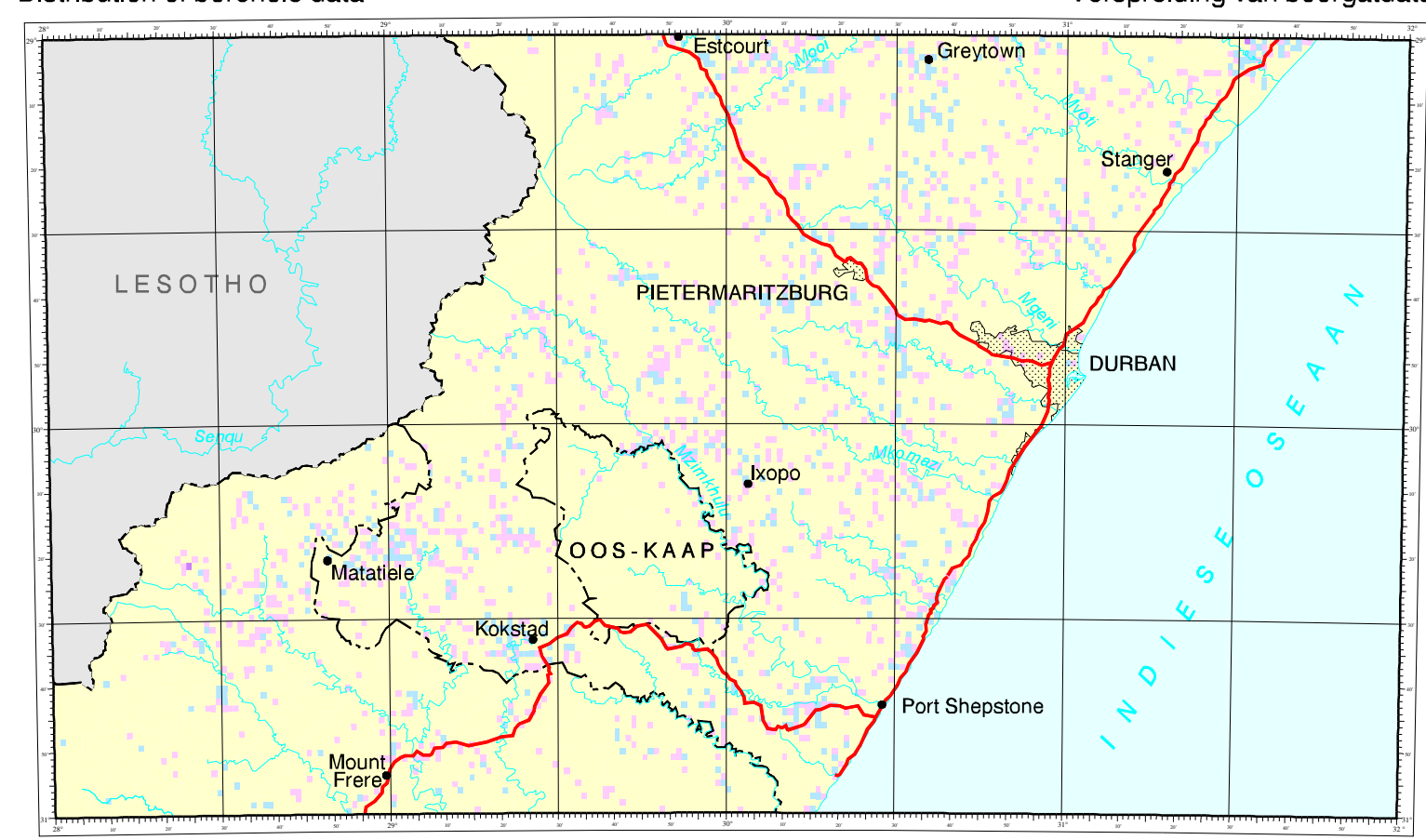
Groundwater quality



Electrical conductivity contour / Elektriese geleidingsvermoë/kontour

0 - 70 µS/cm, 70 - 300 µS/cm, 300 - 1000 µS/cm, > 1000 µS/cm

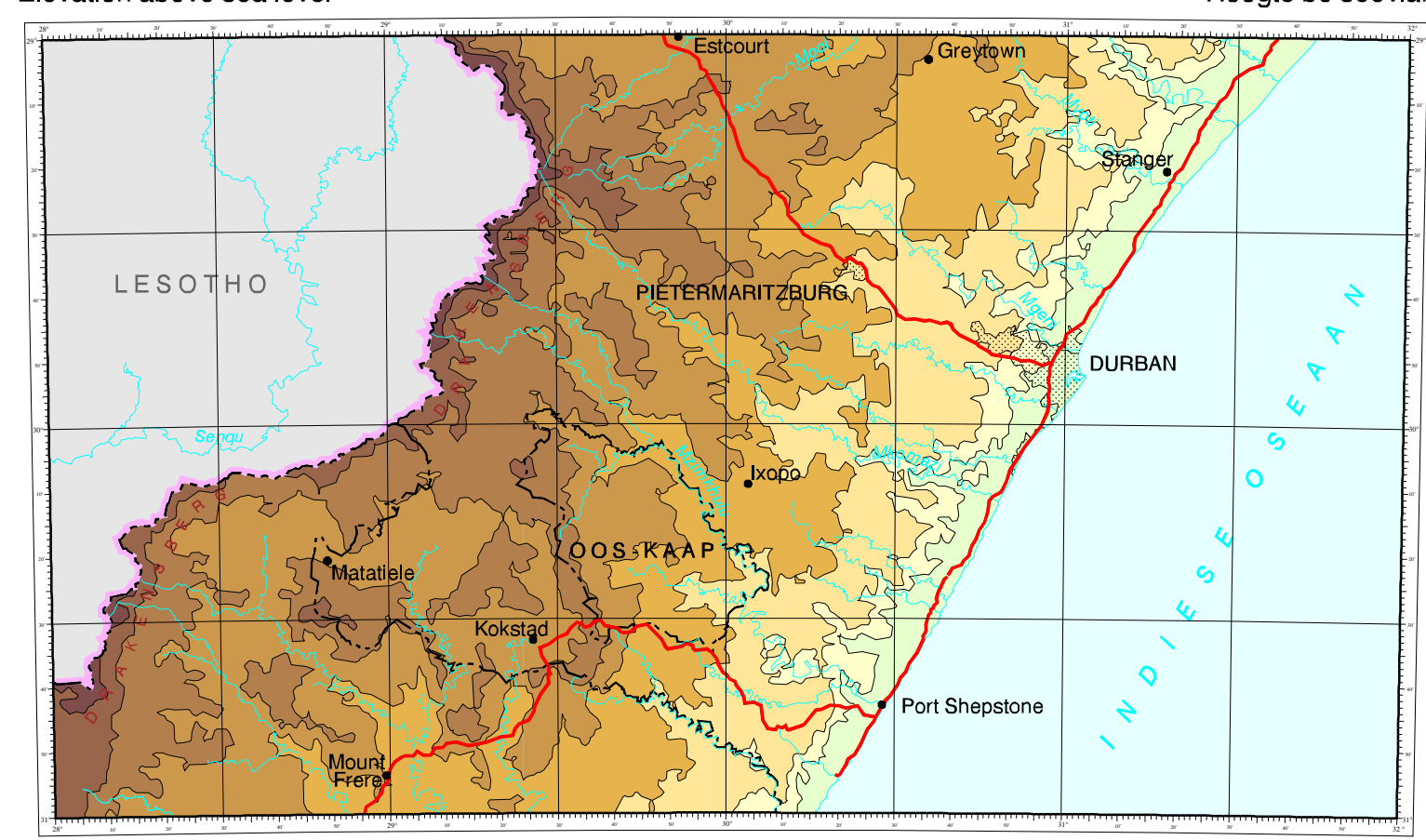
Distribution of borehole data



No borehole information, 1 Borehole, 2 - 10 Boreholes, 11 - 20 Boreholes, > 20 Boreholes

Borehole data points per 1 minute grid / Boorgatdata-punte per 1 minuut rooster

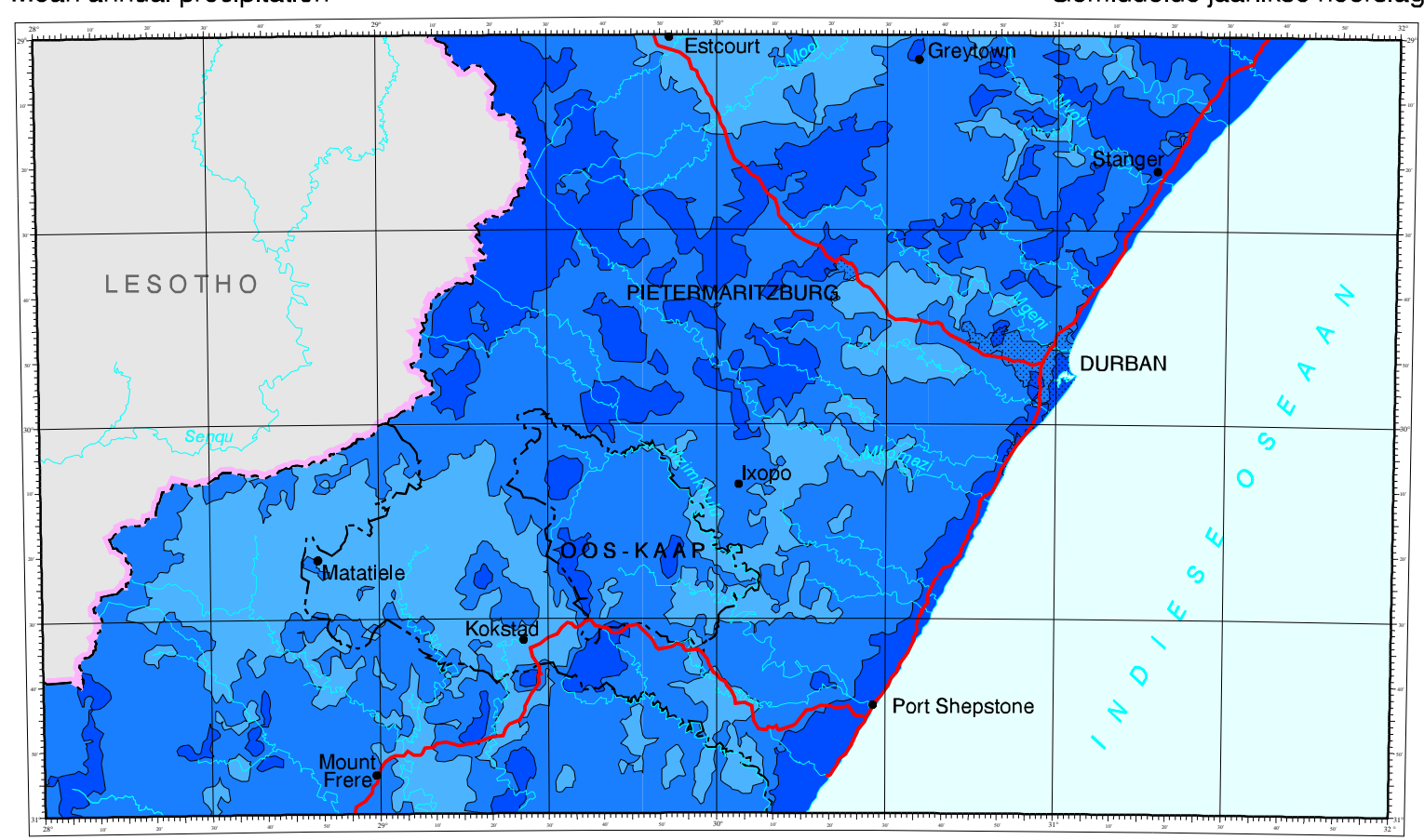
Elevation above sea level



Sea level - 200m, 200 - 400 m, 400 - 800 m, 800 - 1200 m, 1200 - 1600 m, 1600 - 2000 m, 2000 - 2500 m, 2500 - 3000 m

Hoogte bo seevlak

Mean annual precipitation



0 - 100 mm, 100 - 200 mm, 200 - 300 mm, 300 - 400 mm, 400 - 600 mm, 600 - 800 mm, 800 - 1000 mm, > 1000 mm

Gemiddelde jaarlikse neerslag