DLV Engineers
144 Mark Street
Vryheid
3100

Attention: Mr. Sashin Inderjeeth BSc. Eng. (Civil)

RE: Magobela Gravel Road: Geotechnical Report

Dear Sir,

Please find herewith some comments and recommendations, following the site visit to inspect the current road conditions and potential borrow material at Magobela, Umzinyathi DM.

Yours Faithfully

Mark Meyer
Pr. Sci. Nat.
REPORT ON A GEOTEchnical INVESTIGATION OF MAGOBELA ROAD, UMZINyATHI, northern kwazuL-NAtal.

Project: LL3335
Date: July 2019
M Meyer
Pr.Sci.Nat.
REPORT ON A GEOTECHNICAL INVESTIGATION OF MAGOBELOA ROAD, 
UMZINYATHI, NORTHERN KWAZULU-NATAL.

1. GENERAL SITE INFORMATION

1.1 Introduction

The findings of a geotechnical investigation on Magobela Road road roughly 15km north-west of Tugela Ferry are given in this report. The road, as well as the test pit positions are indicated on the Locality Plan, Figure 1, below.

The scope of work for the investigation specified amongst others the following investigation procedures:

i) Determine the site geology.

ii) Establish the soil, weathered rock and outcrop profiles across the site and evaluate their engineering properties and influence on the proposed roads.

iii) Assess the groundwater conditions and comment on the presence of perched or permanent water tables.

iv) Assess the layer works of the existing road.

v) Locate suitable surfacing material.

vi) Establish the founding conditions at the water-course crossings.

Figure 1: Locality plan, indicating the approximate test pit positions.
This report is based on information obtained from:

- Dundee geological map, sheet 2830 to scale of 1:250 000.
- Profiles of 15 test pits excavated at predetermined positions.
- Soil test results of a number of road indicator and compaction tests of representative disturbed soil samples taken during the field investigation from test pits as well as at the borrow pit.
- Aerial photographic data from Google Earth.
- Topographical survey of the site in digital format.

### 1.2 Site Observations

The investigation underlined the following important aspects encountered along the proposed road:

i) No seepage was encountered in any of the test pits (except at the two major stream crossings).

ii) Generally medium dense to dense consistencies were observed in the majority of test pits with shallow (<1m) bedrock along most of the road.

iii) Generally soft excavation is envisaged down to depths achieved during the investigation.

iv) No problem soils impeding further development were observed.

### 1.3 Topography

The road has a generally moderate gradient becoming steep in places towards the stream crossings. The route crosses three minor and two significant water-courses.

### 1.4 Geology and Soils

According to the *Geological Sheet, 2830 Vryheid*, the proposed road is primarily underlain by Pietermaritzburg Formation shale with a short section underlain by intrusive dolerite between E1 and E2 and Vryheid Formation sandstone on the higher lying areas at E5-E7. An extract of the published geological map with the overlain test pit positions is shown below in *Figure 2*.
2. METHODS OF INVESTIGATION

2.1 Test Pitting and Profiling

Fifteen test pits were excavated by means of pick and shovel intervals on the proposed road to depths of around 1.0m below existing ground level or earlier refusal in order to expose the existing layer works (if any) and underlying soils. The test pits were inspected and the excavation progress was observed to estimate the consistency of the soil profile. The profile assessments were done by a qualified, registered practitioner and the materials were described in terms of moisture, colour, consistency, structure, soil type and origin in accordance with the methods of Jennings et al. The soil profiles are included in Appendix A.

DCP tests adjacent to the test pits were completed adjacent to the test pits to confirm the in situ consistencies; all DCP tests (except DCP 10) refused at depths at less than 1.0m, and confirmed the medium dense to dense consistencies.
2.2 Soil Sampling and Laboratory Testing

Small, disturbed indicator samples and bulk CBR samples were selected during the profiling of the test pits as well as the borrow areas to confirm the in-field assessments of the engineering properties of the various representative soil horizons. The disturbed and bulk soil samples were submitted to Soilco Material Testing Laboratories in Vryheid, for grading, classification and compaction tests, as detailed below. Copies of the laboratory test results are appended to this report and summarised in Table 2.2 below for convenience.

The following tests were carried out on the samples:

i) Six road indicator tests comprising particle size distribution analysis and Atterberg Limit tests. *These tests permit a basic classification of the soils and group them according to typical engineering properties.*

ii) CBR and Compaction tests were completed on samples obtained from the borrow pit.

Table 2.2(A) Results of the Foundation Indicator Tests

<table>
<thead>
<tr>
<th>Test Pit</th>
<th>Depth</th>
<th>Origin</th>
<th>Liquid Limit</th>
<th>P. Index</th>
<th>L. shrinkage</th>
<th>Grading M</th>
<th>CBR at 95% MOD AASHTO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borrow Pit (Shale)</td>
<td>2.5-7m</td>
<td>Shale</td>
<td>28</td>
<td>10</td>
<td>5</td>
<td>2.31</td>
<td>7</td>
</tr>
<tr>
<td>Borrow Pit (Dolerite)</td>
<td>0-4m</td>
<td>Dolerite</td>
<td>31</td>
<td>10</td>
<td>5.5</td>
<td>2.62</td>
<td>20</td>
</tr>
<tr>
<td>TP2</td>
<td>0-1.1m</td>
<td>Weathered Sandstone</td>
<td>27</td>
<td>9</td>
<td>4.6</td>
<td>1.64</td>
<td></td>
</tr>
<tr>
<td>TP3</td>
<td>1-0.13m</td>
<td>Colluvium</td>
<td>CBD</td>
<td>NP</td>
<td>0</td>
<td>1.54</td>
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</tr>
<tr>
<td>TP5</td>
<td>0-0.3m</td>
<td>Colluvium</td>
<td>26</td>
<td>11</td>
<td>5.5</td>
<td>0.86</td>
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</tr>
<tr>
<td>TP10</td>
<td>0-0.8m</td>
<td>Alluvium</td>
<td>22</td>
<td>9</td>
<td>4.4</td>
<td>0.58</td>
<td></td>
</tr>
</tbody>
</table>

3. GEOTECHNICAL ASPECTS

3.1 Workability of Site Materials

3.1.1 Excavation Characteristics

TLB mechanical excavation operations will be adequate to excavate through the colluvium and residuum. Refusal was experienced in most test pits at depths of less than 1m, mostly on bedrock but also on boulders (TP6)
3.1.2 Compactability of Site Materials

As shown above the route traverses at least four geological units. Most of the underlying soils most likely conform to G9-G10 type material. The entire road has recently been graded and no imported surfacing material was noted.

3.1.3 Stability of Excavations

No collapse or imminent collapse of the test pit sidewalls was recorded in any of the test pits, further indicating the generally medium dense to dense soil conditions.

3.1.4 Problem soils

The majority of soils were at least medium dense to dense with no obvious problems. Soil cover is generally thin to no existent with the exception of the alluvial plain.

3.1.5 Seepage

No groundwater seepage was noted in any of the test pits. Good surface drainage measures should be in place.

3.1.6 Borrow Material

There is an existing borrow-pit roughly 1.5km north of the start of the road. Both shale and dolerite material has been used extensively from this borrow pit but there is still ample room for extension, primarily towards the east. The material from this borrow pit has been used to surface the gravel road accessing the Magobela area and seems to be performing satisfactorily, with minimal dirt in summer but slightly dusty in winter. Erosion channels were noted in some places on the road surfaced with this material, proper drainage measures and a maintenance programme would prevent further degradation. Both the shale and dolerite gravel is most useful, however, the dolerite material does have some oversized hard material that can not be used for surfacing as it is unlikely to be broken to medium gravel.
3.1.7 **Current Layerworks**

The entire road had recently been graded; no evidence of imported gravel was noted in any of the test pits.
### 3.1.8 Stream crossings

The route crosses three minor and two significant waterways

<table>
<thead>
<tr>
<th>Crossing</th>
<th>Test pit</th>
<th>Founding of culvert</th>
<th>Condition at time of investigation (June 2019)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crossing 1</td>
<td>TP3</td>
<td>0.2m on carbonaceous shale bedrock.</td>
<td>Dry</td>
</tr>
<tr>
<td>Crossing 2</td>
<td>TP4</td>
<td>1.2m on sandstone bedrock.</td>
<td>Dry</td>
</tr>
<tr>
<td>Crossing 3</td>
<td>TP9</td>
<td>Depending on design, alluvial boulder (0.3m diam average) bed at 0.7m.</td>
<td>Small stream</td>
</tr>
<tr>
<td>Crossing 4</td>
<td>TP11</td>
<td>1.0m on dolerite bedrock (undulating, not horizontal).</td>
<td>Small stream</td>
</tr>
<tr>
<td>Crossing 5</td>
<td>TP14</td>
<td>0.3m on shale bedrock.</td>
<td>Dry</td>
</tr>
</tbody>
</table>

![Magobela Gravel Road Figure 4: Stream Crossings](image)
CONCLUSIONS AND RECOMMENDATIONS

The site is stable for development provided that the recommendations given in this report are implemented.

Significant factors pertaining to the final design are as follows:

- Soft excavation (i.e. TLB) is anticipated for the majority of the site to depths as achieved in the test pits, Medium excavation is required if deeper excavation is required.
- Generally moderate slopes with only isolated short sections with steep inclines are anticipated.
- No imported surfacing material was noted in any of the test pits.
- No significant problem soils were observed.
- No Groundwater was encountered in any of the test pits.
- Five water-crossings are traversed by the route with generally shallow bedrock at all crossings, except crossing 3 where refusal occurred on a bed of alluvial boulders.

Every effort was made during the site investigation to ensure that generally accepted practices of our profession were used in the sub-surface evaluation of the site, and that the sampling and testing was representative of the soil/rock conditions observed on-site. However it is impossible under the constraints of a restricted investigation of this nature to guarantee that zones of poorer geological materials were not identified that could have a significant bearing on the outcomes of this investigation. The investigation has therefore attempted, through interpolation and extrapolation at known test locations, to identify problem issues of a geotechnical nature on which this report is based. Variances in soil and rock quality and quantity from those predicted may be encountered during construction and these should be recorded, however no warranty against these variations is expressed or implied, due to the geological changes that can occur over time due to natural processes, or human activity.
BIBLIOGRAPHY


Appendix A

Test Pit Profiles
Slightly moist, yellowish brown with grey and black, loose, silty sand; Fine alluvium.

Alluvial cobbles and boulders, with fine infill as above.

Dolerite bedrock (undulating)
Dry, reddish brown, dense, intact, gravelly sand; Colluvium.

NOTES
1) Refusal on sandstone bedrock.
Dry, light grey and yellowish, dense, intact, gravelly sand; Disturbed weathered Sandstone.

NOTES
1) Sampled as follows: DS2A at 0.0m--0.1m.
<table>
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<tr>
<th>Depth (m)</th>
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<td>0.00</td>
<td>Dry, light grey speckled yellowish and black, very loose, silty Sand; Alluvial deposit.</td>
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<tr>
<td>0.15</td>
<td></td>
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</table>

**NOTES**

1) Refusal on Carbonaceous Shale.
Dry, light grey-brown, dense, silty sandy matrix with abundant gravel supported gravel and cobbles; Fill.

**NOTES**

1) Refusal on Sandstone bedrock.
Dry, light grey, dense, intact, silty Sand; Colluvium/Fill.

Highly weathered, dark grey stained reddish, extremely closely jointed, soft-rock Shale.

NOTES
1) Refusal on Shale bedrock.
2) Sampled as follows: DS5A at 0.0m--0.3m

CONTRACTOR: Hand Excavated
MACHINE: Hand Excavated
DRILLED BY: M Meyer
PROFILED BY: M Meyer
TYPE SET BY: A Nolan
SETUP FILE: STANDARD_SET
ELEVATION: S28 39' 44.7"
INCLINATION: 0.00
DIAM: 0.30
DATE: 12 June 2019
X-COORD: E30 20' 29.9"
Y-COORD: S18 00' 00.0"
TEXT: AccessRoadJune2019mm.txt
HOLE No: TP05
Dry, light grey, dense, intact, silty Sand; Colluvium/Fill.

NOTES

1) Refusal on large Sandstone boulders (not bedrock).
Highly weathered, grey-brown speckled grey and stained red-orange brown, very closely jointed, hard rock dolerite with abundant silty infill along joints.

NOTES
1) Excavated as medium gravel material.
2) Slow excavation
3) No refusal
4) Scattered corestone boulders
Yellowish brown, very closely jointed, Shale outcrop.

NOTES
1) Refusal on shale outcrop.

CONTRACTOR: Hand Excavated
MACHINE: Hand Excavated
DRILLED BY: M Meyer
PROFILED BY: A Nolan
TYPE SET BY: A Nolan
SETUP FILE: STANDARD.SET

ELEVATION: S28°39'21.57"
X-COORD: E30°19'54.98"
DIAM: 0.20
DATE: 12 June 2019

TEXT: ..AccessRoadJune2019mm.txt
Moist, grey-brown, loose to medium, silty sand; Alluvium.

NOTES
1) Refusal on bed of alluvial boulders (>0.3m).
Dry to slightly moist, greyish brown, firm to stiff, microshattered, slightly clayey silty sand; Colluvium.

NOTES
1) No refusal
2) No seepage
Dry, grey-brown, medium dense to dense, microshattered, slightly clayey silty sand. Colluvium.

NOTES
1) No refusal
2) No seepage
3) Sandstone outcrop 30m further on road.
Highly weathered, grey-brown speckled grey and stained red-orange brown, very closely jointed, hard rock dolerite with abundant silty infill along joints.
Shale outcrop.

CONTRACTOR: Hand Excavated
MACHINE: Hand Excavated
DRILLED BY: M Meyer
PROFILED BY: A Nolan
TYPE SET BY: A Nolan
SETUP FILE: STANDARD.SET

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Y-COORD: E3018'48.89"
DATE: 02/07/2019 09:47
TEXT: ../AccessRoadJune2019mm.txt

HOLE No: TP14
Sheet 1 of 1
JOB NUMBER: LL3335

DLV Engineers & Project Managers
Magobela Access Road
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Appendix B

Laboratory Test Results
# MATERIALS TEST REPORT

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## Sieve Analysis (Wet Preparation) SANS 3001 - GR 1

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## Mechanical Analysis - SANS 3001 - GR 1

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## Atterberg Limits - SANS 3001 - GR 10 and GR 12

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## Classification

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## Maximum Dry Density and Optimum Moisture Content - SANS 3001 - GR 30

| Maximum Dry Density ( kg/m³ ) | 1922 |
| Optimum Moisture Content (%)  | 11.3 |

## California Bearing Ratio - SANS 3001 - GR 40

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Remarks:
The Colto / TRH 14 Classifications are only based on the above results. Further testing may be required.
## MATERIALS TEST REPORT

**Laboratory Number**  
V1168

**Field Number**  
-

**Position in field**  
Dolerite Quarry

**Depth (mm)**  
-

**Sample Description**  
Br. Speckled Black Weathered Dolerite.

**Stabilising Agent**  
Natural

### Sieve Analysis (Wet Preparation) SANS 3001 - GR 1

<table>
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<tr>
<th>Percentage Passing</th>
<th>100.0 mm</th>
<th>75.0 mm</th>
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### Mechanical Analysis - SANS 3001 - GR 1

- **Coarse Sand** (%): 50
- **Coarse - Fine Sand** (%): 2
- **Medium - Fine Sand** (%): 2
- **Fine - Fine Sand** (%): 3
- **Silt and Clay** (%): 44

### Atterberg Limits - SANS 3001 - GR 10 and GR 12

- **Liquid Limit** (%): 31
- **Plasticity Index** (%): 10
- **Linear Shrinkage** (%): 5.5

### Classification

- **Classification Group Index**: A - 2 - 4
- **COLTO Classification**: #
- **TRH 14 Classification (1965)**: # G8

### Maximum Dry Density and Optimum Moisture Content - SANS 3001 - GR 30

- **Maximum Dry Density** (kg/m³): 2115
- **Optimum Moisture Content**: 8.5

### California Bearing Ratio - SANS 3001 - GR 40

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### Remarks:

The Coito/TRH 14 Classifications are only based on the above results. Further testing may be required.
**MATERIALS TEST REPORT**

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<td>Position in Field</td>
<td>TP2</td>
<td>TP3</td>
<td>TP5</td>
<td>TP10</td>
</tr>
<tr>
<td>Depth (mm)</td>
<td>0 - 0.1</td>
<td>0 - 0.13</td>
<td>0 - 0.3</td>
<td>0 - 0.8</td>
</tr>
<tr>
<td>Stabilising Agent</td>
<td>Natural</td>
<td>Natural</td>
<td>Natural</td>
<td>Natural</td>
</tr>
</tbody>
</table>

**Sieve Analysis (Wet Preparation) SANS 3001 - GR 1**

<table>
<thead>
<tr>
<th>Percentage Passing</th>
<th>100.0 mm</th>
<th>75.0 mm</th>
<th>63.0 mm</th>
<th>50.0 mm</th>
<th>42.8 mm</th>
<th>37.5 mm</th>
<th>28.0 mm</th>
<th>20.0 mm</th>
<th>14.0 mm</th>
<th>10.0 mm</th>
<th>5.0 mm</th>
<th>2.0 mm</th>
<th>0.425 mm</th>
<th>0.075 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100</td>
<td>98</td>
<td>92</td>
<td>87</td>
<td>89</td>
<td>82</td>
<td>70</td>
<td>64</td>
<td>63</td>
<td>47</td>
<td>25</td>
</tr>
<tr>
<td>Grading Modulus</td>
<td>SANS 3001 PR 5</td>
<td></td>
<td></td>
<td>1.64</td>
<td>1.54</td>
<td>0.96</td>
<td>0.58</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Mechanical Analysis - SANS 3001 - GR 1**

- Coarse Sand (%): 26, 53, 19, 10
- Coarse - Fine Sand (%): 14, 24, 10, 13
- Medium - Fine Sand (%): 14, 13, 12, 13
- Fine - Fine Sand (%): 8, 5, 7, 11
- Silt and Clay (%): 39, 5, 51, 53

**Atterberg Limits - SANS 3001 - GR 10 and GR 12**

- Liquid Limit (%): 27, CSD, 26, 22
- Plasticity Index (%): 9, N/P, 11, 9
- Linear Shrinkage (%): 4.8, 0.0, 5.5, 4.4

**Classification**

- Classification Group Index: A-2 - A-4
- COLTO Classification: #
- TRH 14 Classification (1985): #

**Maximum Dry Density and Optimum Moisture Content - SANS 3001 - GR 30**

- Maximum Dry Density (kg/m³): 
- Optimum Moisture Content (%): 

**California Bearing Ratio - SANS 3001 - GR 40**

- CBR @ 100 % Compaction
- CBR @ 98 % Compaction
- CBR @ 95 % Compaction
- CBR @ 93 % Compaction
- CBR @ 90 % Compaction
- Swell @ 100 % Compaction

**Remarks:** The Colto / TRH 14 Classifications are only based on the above results. Further testing may be required.
MOISTURE / DENSITY RELATIONSHIP - SANS 3001 - GR30

<table>
<thead>
<tr>
<th>Moisture Content; (%)</th>
<th>6.3</th>
<th>7.3</th>
<th>8.3</th>
<th>9.3</th>
<th>10.3</th>
<th>Maximum Dry Density</th>
<th>2115 kg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Density (kg/m³)</td>
<td>2024</td>
<td>2084</td>
<td>2115</td>
<td>2099</td>
<td>2039</td>
<td>Optimum Moisture Content</td>
<td>8.5 %</td>
</tr>
</tbody>
</table>

The above test results are pertinent only to the samples received and tested at the laboratory. This report shall not be reproduced, except in full, without the prior consent of Soilco Materials Investigations (Pty) Ltd.

Remarks:

Method of Preparation: Scalping Process

For Soilco: [Signature]

Technical Signatory
SOILCO MATERIALS INVESTIGATIONS (PTY) LTD
CIVIL ENGINEERING MATERIALS TESTING LABORATORY

Reg. No.: 1965 / 009585 / 07

NOOIGEDATCH FARM - LOUPSBURG ROAD - P.O. BOX 761 - VRYHEID - 3100 - KWAZULU - NATAL
TELEPHONE: 034 - 982 6012 : TELEFAX 034 - 982 6013 - email: soilco@vhd.dorea.co.za

Client: Engeolab
Project: Magobela Road
Sampling Process: Samples Delivered by Customer

Job Card No.: 223090
Date Received: 2019-06-13
Date Tested: 2019-06-18
Date Reported: 2019-06-19

Laboratory Number: V1169
Field Reference No.: 
Position in field: 
Depth (mm): 
Material Description: Dark Grey Shale + Dolerite

**MOISTURE / DENSITY RELATIONSHIP - SANS 3001 - GR30**

<table>
<thead>
<tr>
<th>Moisture Content; (%)</th>
<th>9.2</th>
<th>10.2</th>
<th>11.2</th>
<th>12.2</th>
<th>13.2</th>
<th>Maximum Dry Density</th>
<th>1922 kg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Density (kg/m³)</td>
<td>1832</td>
<td>1892</td>
<td>1922</td>
<td>1904</td>
<td>1848</td>
<td>Optimum Moisture Content</td>
<td>11.3 %</td>
</tr>
</tbody>
</table>

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Remarks:

Method of Preparation: Scalping Process

For Soilco: [Signature]

Technical Signatory:

2019-04-08

Rev: 2

Soilco SF 34