

Preliminary Geotechnical Investigation Phase 1 and 2

Executive Summary

Soil and rock provide foundations for structures and natural construction materials, but their inherent variability can create significant project risks and construction challenges. Geotechnical investigations help maximise their benefits by identifying geotechnical constraints and informing practical, cost-effective foundation and construction solutions.

The Eastern Cape Department of Transport appointed BMK to provide additional geotechnical services for the proposed upgrade of the Gali River crossing. The works include constructing a major culvert bridge to improve the road link between the R410 and DR08592 in the Chris Hani District Municipality and villages beyond the crossing.

Climatic Data (Obtained from the weather bureau)

Temperature Averages

- Hottest month: January, with an average high around 28°C (83°F).
- Coldest month: July, with an average low dropping to around 2°C (37°F).
- Midday ranges: Average daily maximums range from about 16.8°C in June to 27.6°C in January

Rainfall Patterns

- Total annual rain: ~399 mm per year.
- Highest rainfall: Mostly during the summer months, peaking in March at approximately 67 mm.
- Lowest rainfall: Winter, bottoming out in July at approximately 3 mm.

These figures are indicative only and should be interpreted with caution due to significant climatic variability.

Landscape and Hydrogeology

- **Topography:** The landscape transitions from flat to gently rolling, low-lying Karoo scrubland and river valleys in the south-west to high plateaus, steep escarpments, and rugged mountain ranges in the north and east.
- **Hydrogeology and Soils:** Groundwater systems are typically secondary aquifers hosted within fractured, jointed sedimentary rocks and along the contact zones of dolerite intrusions, which often act as barriers or conduits for groundwater movement.

Map of Chris Hani District



Map of the Eastern Cape
with municipalities named and
districts shaded (2016)



Emalahleni Map



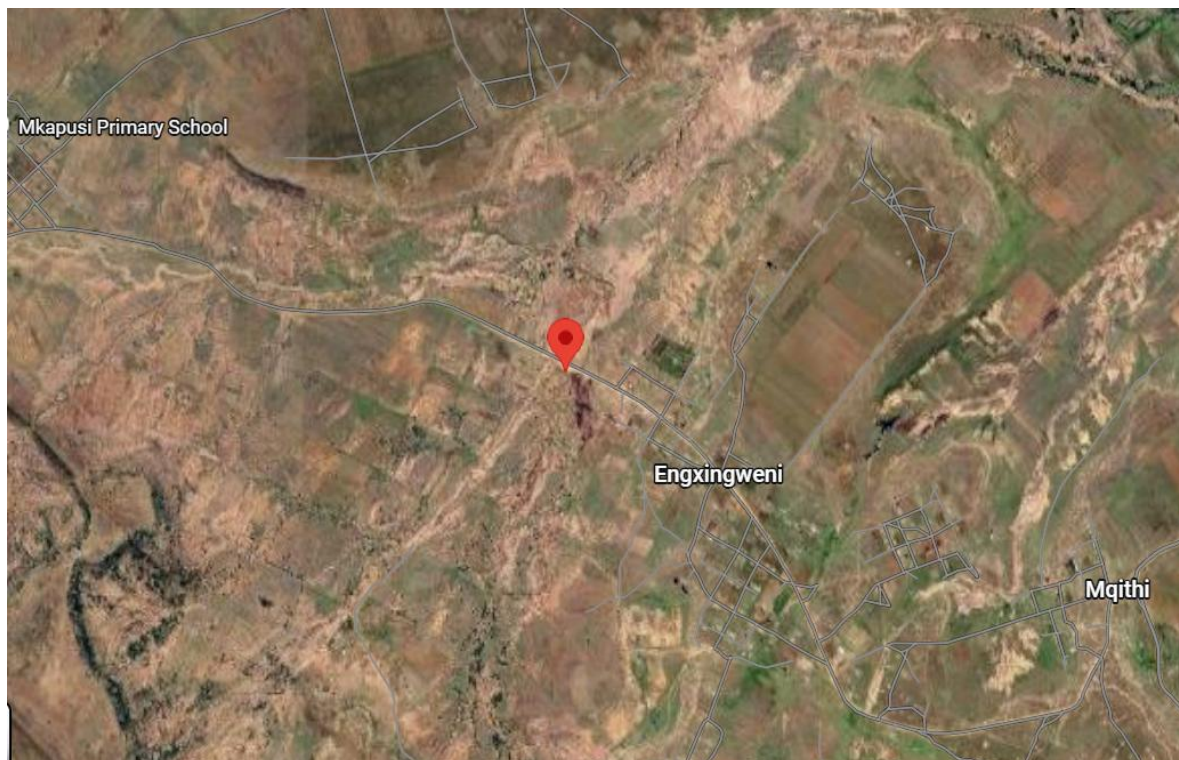
Locality of the Project

Location

The Gali Bridge project is located in the Chris Hani District Municipality, within the Emalahleni Local Municipality in Lady Frere. The crossing is situated on District Road DR08592.



Locality of Gali Bridge with coordinates: 31°36'10.37"S 27°07'53.00"E





Topography

The 100 square km of the crossing features a diverse landscape that slopes down from the southern Drakensberg Mountains through eastern grasslands into the arid Great Karoo. Upstream are high mountains that provide a massive water catchment that is evident with the characteristic of the riverbed.

Vegetation

Vegetation in the Chris Hani District Municipality comprises mainly Grassland, Nama-Karoo, and Savanna biomes, transitioning from moist uplands to arid scrubland.

Geology

The geology of the Chris Hani District Municipality in the Eastern Cape is dominated by sedimentary strata of the Karoo Supergroup that have been extensively intruded by Jurassic Karoo dolerites.

Major Stratigraphic Units

- **Beaufort Group**

Distribution: Covers much of the southern and central areas toward Queenstown.

Lithology: Comprises mainly continental mudstone, shale, and sandstone.

Stratigraphy: Includes the Adelaide and Tarkastad subgroups, such as the Katberg Formation.

- **Stormberg Group**

Distribution: Occurs in the higher-lying northern areas, particularly towards the Stormberg Plateau and Emalahleni.

Stratigraphy and depositional setting: Includes the Molteno, Elliot, and Clarens formations, which record ancient fluvial, floodplain, and desert environments.

- **Karoo Dolerite Suite:** Resilient, dark igneous sills, dykes, and sheets of Jurassic age that intruded the older sedimentary layers. These weather to form the prominent ridges, mesas, caps, and mountainous topography (such as the Winterberg and Stormberg ranges) seen across the district.

Extent of the Site



Measure distance

Click on the map to add to your path

Total area: 140,612.91 m² (1,513,544.75 ft²)

Total distance: 1.54 km (5,060.17 ft)

The Preliminary Geotechnical Investigation

The geotechnical investigation for the project is conducted in three phases:

- Phase 1 an initial visual assessment during the feasibility stage,
- Phase 2 investigation during design, and a Phase 3 detailed investigation to be conducted during construction.
- This report covers only the Phase 1 and 2 geotechnical investigation of the bridges and culvert, collectively referred to as the major structures.

Phase 1 Investigation Scope

The Phase 1 investigation included the following activities:

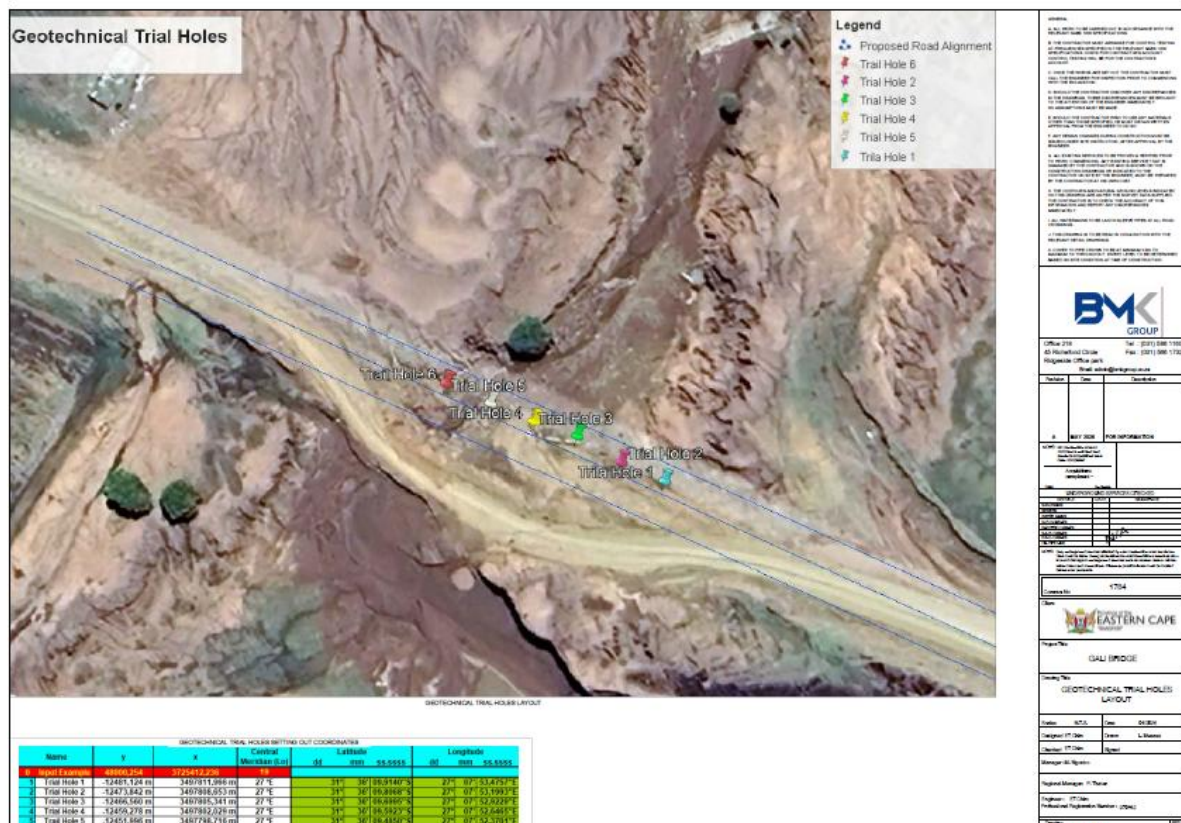
- **Site visit:** Visual assessment which included river banks profile visual assessment, Catchment viewing, Riverbed behaviour, and constructability.
- **Desktop Study:** Desktop study of the general geological formations.

- **Review** of the Hydrology and Hydraulic analysis

Phase 2 Investigation Scope

The Phase 2 investigation included the following activities:

- **Rotary coring:** Six boreholes were drilled at the bridge and culvert locations to characterise the deeper ground profile and determine the depth to bedrock.
- **Drilling and logging:** A specialist drilling contractor completed the boreholes, which were logged in accordance with the relevant standards and guidelines.
- **Sample review:** Representative soil and rock samples recovered from the boreholes were reviewed.



The recovered materials indicate broadly similar subsurface profiles at the bridge sites. The sequence generally comprises occasional sand fill identified in the test

pits, underlain by colluvium (hill wash), alluvial soil and boulder deposits, and residual soils overlying either Karoo dolerite or Adelaide Formation sandstone and siltstone bedrock. Bedrock was encountered at depths of approximately 4–6 m, transported sand and boulders extended from the surface to about 1.5 m, and hard to very hard rock was intersected at depths of approximately 2–8 m.

Overall, the ground conditions are suitable for the proposed development, with no geotechnical constraints that would prevent construction. Raft foundations on engineered fills are recommended, along with scour protection and upstream riverbed management.

The Eastern Cape Department of Transport appointed BMK to conduct a preliminary geotechnical investigation for the proposed upgrade of the Gali River crossing in the Cacadu District.

Additionally, the upgrade will involve:

- A new low-level temporary crossing to be demolished after commissioning new crossing.
- Construction of layer-works (materials planned to be obtained from borrow pits and hard rock quarry/s on site);
- Construction of subsoil drains.
- Construction of storm water drainage.
- Demolition of 4 existing single-span bridges and one culvert; and
- Construction of new major bridge culvert.
- Riverbed management.
- Erosion and scour control.

The investigation assessed ground conditions for the proposed structures, identified geotechnical constraints that could restrict development or increase foundation risks and costs, and developed general foundation design recommendations. The work

included rotary coring of six boreholes at the bridge site, followed by laboratory testing of the recovered soil and rock samples.

This report sets out the methodology and findings from the investigation as well as recommendations for geotechnical and foundation works. The report is prepared in accordance with the requirements of the relevant Codes of Practice as noted.

The objectives of the study were to:

- To identify relevant ground-related features and determine the variability of ground conditions and other geotechnical factors that may influence the design and alignment of the structures (bridges and culvert);
- Provide generalised recommendations for geotechnical works; and
- Provide foundation recommendations for the proposed new bridge structure

The following methodology was used to achieve the study objectives:

- A general site walk-over along with a review of available geological and geotechnical records;
- A preliminary site investigation involving the excavation of test pits using a tractor-loader-backhoe (TLB);
- Visual analysis of geotechnical conditions

This report is based on data from investigation points distributed across the structure footprints and may not capture all subsurface conditions, such as variations in bedrock levels, that become apparent during construction. Further investigations should therefore be undertaken during construction to identify variations in the materials encountered.

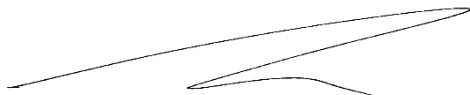
The key findings and recommendations are as follows:

- Transported sandy material and rock fragments were encountered alongside loamy soils from the collapsed riverbank.

- The underlying layers from a meter deep are stable varying requiring a need for geotechnical lab on site to assist with quality and sound engineering information that may result in either strengthening or reduction of engineered fills
- Scour and riverbed alignment risks require appropriate riverbed and flood management.
- Scouring is also a risk due to loose top material requiring scour protection.
- Although anchoring or piling is unlikely to be required, the need should be quantified as a precaution to minimise excessive variation orders.
- A raft foundation with aprons extending beyond both the upstream and downstream ends is recommended.
- Additional protection of gabion mattresses are also recommended together with gabion baskets for riverbed flow management

Borrow Materials

There are existing borrow pits that need further investigation in terms of quality and possible improvement in terms of stabilization. There are available rocks which can be selected and stockpiled for rockfill use. Furthermore aggregates available from commercial source within 50km (Queenstown) and within 100km Eliot



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