| Eskom | Terms of Reference | Technology |
|---|---|---|

Title: **ESSELEN SUBSTATION GROUNDWATER MONITORING STATION SCOPE AND SPECIFICATION**

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# 1. INTRODUCTION

Esselen Transmission Substation is located in Esselen Park, Tembisa; an area which is underlain by Malmani Subgroup dolomitic rocks of the Chuniespoort Group (1: 250 000 Geological Series, 2628 East Rand). A dolomitic stability investigation (DSI) was conducted by a geo-professional and the site was classified as follows:

- C3 type development in terms of SANS 1936:2012.
- IHC 3/4/6/7 with a D3 dolomite area designation.
- IHC 8 with a D4 dolomite area designation.

The DSI reported further details that the groundwater draw down has little to none impact on the dolomitic stability in the subsurface; however, a ground water monitoring station must be implemented at Esselen Substation as part of compliance to regulations and a safety measure based on the Inherent Hazard Classification (IHC) of the site.

# 2. SUPPORTING CLAUSES

## 2.1 SCOPE

The document provides the procedure to be followed for the rehabilitation of the sinkholes that have formed at the Esselen substation.

This document does not provide design cost, schedule or other project management type information.

### 2.1.1 Purpose

This document covers the scope of work and specification for the deliverables of the groundwater monitoring station for Esselen Substation.

### 2.1.2 Applicability

The document is applicable to the installation of groundwater monitoring stations at Esselen Substation.

## 2.2 NORMATIVE / INFORMATIVE REFERENCE

### 2.2.1 Normative

[1] ISO 9001 Quality Management System

[2] SANS 1936-1:2012 Development of dolomite land Part 1: General principles and requirements.

[3] SANS 1936-2:2012 Development of dolomite land Part 2: Geotechnical investigations and determinations.

[4] SANS 1936-3:2012 Development of dolomite land Part 3: Design and construction of buildings, structures and infrastructure.

[5] SANS 1936-4:2012 Development of dolomite land Part 4: Risk management.

[6] SANS 2001-BE3:2012 Construction works Part BE3: Repair of sinkholes and subsidence's in dolomite land.

### 2.2.2 Informative

[7] Dolomite Stability Investigation report: Eskom Esselen Substation, Esselen, Tembisa, Gauteng, South Africa.

[8] Site Specific Dolomite Risk Management Strategy Report for Esselen Substation.

[9] Consultants Guide: Approach to sites on dolomite land, Council for Geoscience, Pretoria.

[10] 1:250 000 Geological Map Series 2628 EAST RAND, published by Council for Geoscience.

## 2.3 DEFINITIONS

| Definition | Description |
|---|---|
| C3 | Commercial developments < 3 storeys, including railway stations, shops, wholesale stores, offices, places of worship, theatrical, indoor sports or public assembly venues, other institutional land uses such as universities, schools, colleges, libraries, exhibition halls and museums, light (dry) industrial developments, dry manufacturing, commercial uses such as warehousing, packaging, and electrical substations, filling stations |
| Competent person | Person who is qualified by virtue of his experience, qualifications, training and in-depth contextual knowledge of development on dolomite. (Refer to [6] for definition in its entirety). |
| Contractor | A person or party who is appointed to execute the works specified herein. |
| 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. |
| Dolomite | Rock composed of the mineral dolomite, which is a carbonate of calcium and magnesium |
| D4 | Additional site-specific precautionary measures are required. |
| | |
| Excavator | Tractor-Loader-Backhoe |
| Factual report | A document that is concerned with facts or contains facts |
| Geophysical Survey | Ground-based physical or remote sensing techniques to produce a detail image or map of an area; it is a destructive method of testing. |
| Interpretive report | Documents which contain interpretation of analysis of results including factual and desktop reporting, ultimately reaching objective recommendations based on the interpretation of results and background information of the geotechnical field. |
| Liquefaction | Process of or state of having been made liquid |
| Lithology | The general composition of a rock or rock sequence |
| Self-compacting concrete | self-compacting concrete shall comprise a pumpable concrete mix that requires no external vibration to achieve consolidation, with a cube strength greater than 5 MPa. |
| Seismic | Related to, or caused by an earthquake or other vibration of the earth |
| Stratigraphy | The layering of deposits, with newer remains overlaying older ones, forming a chronology of the site |

### 2.3.1 Classification

**Controlled disclosure:** controlled disclosure to external parties (either enforced by law, or discretionary).

## 2.4 ABBREVIATIONS

| Abbreviation | Description |
|---|---|
| CBR | California Bearing Ratio |
| DSI | Dolomitic Stability Investigation |
| EA | Engineer Assistant |
| FPI | Footprint Investigation |
| GWMS | Groundwater Monitoring Station |
| HV | High voltage |
| IHC | Inherent hazard classification |
| MTS | Major transmission substation |
| MVA | Mega volt ampere |
| NGL | Natural ground level |
| OMC | Optimum moisture content |
| SAICE | South African Institution of Civil Engineering |
| SAIEG | South African Institute for Engineering and Environmental Geologists |
| SANS | South African National Standards |
| SHE | Safety, Health & Environment |
| TLB | Tractor-Loader-Backhoe |
| TMH | Technical Methods for Highways |
| TRH | Technical Recommendations for Highways |

# 3. DESIGN INFORMATION

The recommendations from the DSI report stipulate that a groundwater monitoring station shall be installed at Esselen Substation to manage the risk of groundwater level variation and its effects on the underlying dolomite. The existing geohydrological data shall be assessed by the appointed contractors competent person to ensure that the correct system is installed.

## 3.1 KEY DESIGN ASSUMPTIONS AND FINDINGS

The following are the assumptions and findings that have been considered based on the site visit and the previous reports and works that have been conducted pertaining to the Esselen Substation sinkhole problem:

1. Existing geohydrological data.
2. Gravity survey: Bouger Map

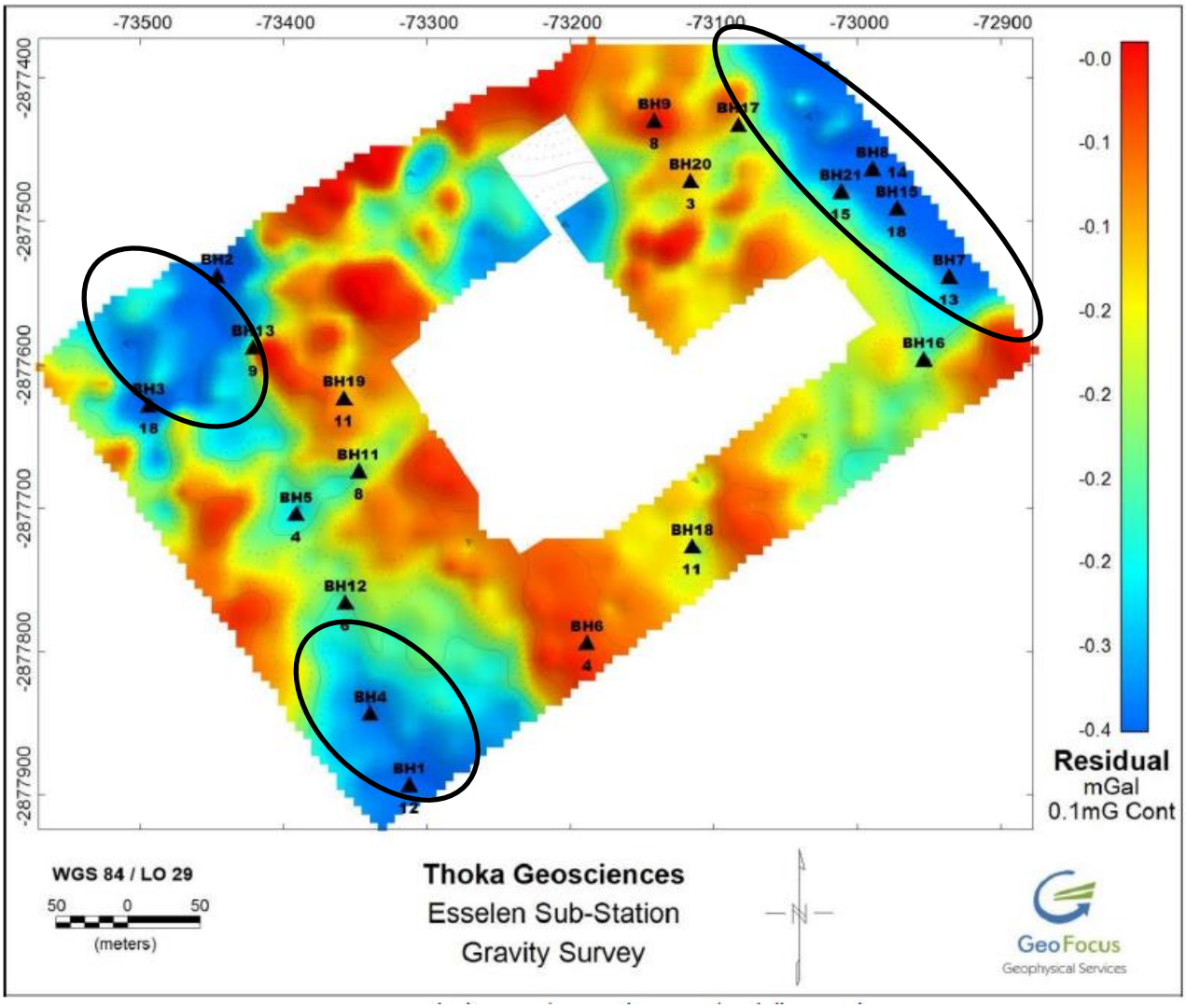


**Figure 1: Gravity Survey: Bouger Map**

The encircled regions in the map have low gravity anomalies indicating that the low density bedrock.

The appointed contractor shall undertake to install the groundwater monitoring system at Esselen Substation at the following positions:

**Table 1: GWMS Positions**

| Monitoring Station | Latitude (S) | Longitude (E) |
|---|---|---|
| GWMS 1 | 26º00'18.73" | 28º15'57.67" |
| GWMS 2 | 26º00'25.91" | 28º16'03.57" |
| GWMS 3 | 26º00'14.64" | 28º16'14.80" |

The positions were determined based on the gravity survey that was conducted. The bouger anomaly provides the subsurface density. Low (negative) values of bouger anomaly indicate lower density beneath

measurement point and high (positive) values of bouger anomaly indicate higher density beneath measurement point.

### 3.1.1 Site Description

The site is located in Esselen Park, approximately 13 km north of Kempton Park and the site is adjacent R21 road. The site is accessible through Long Ave, a gravel round leading to the substation. The centre coordinates of the site are 26º 00' 17.53"S longitude and 28º 16' 06.56" E latitude. The predominant land use in the region is agricultural

### 3.1.2 Location

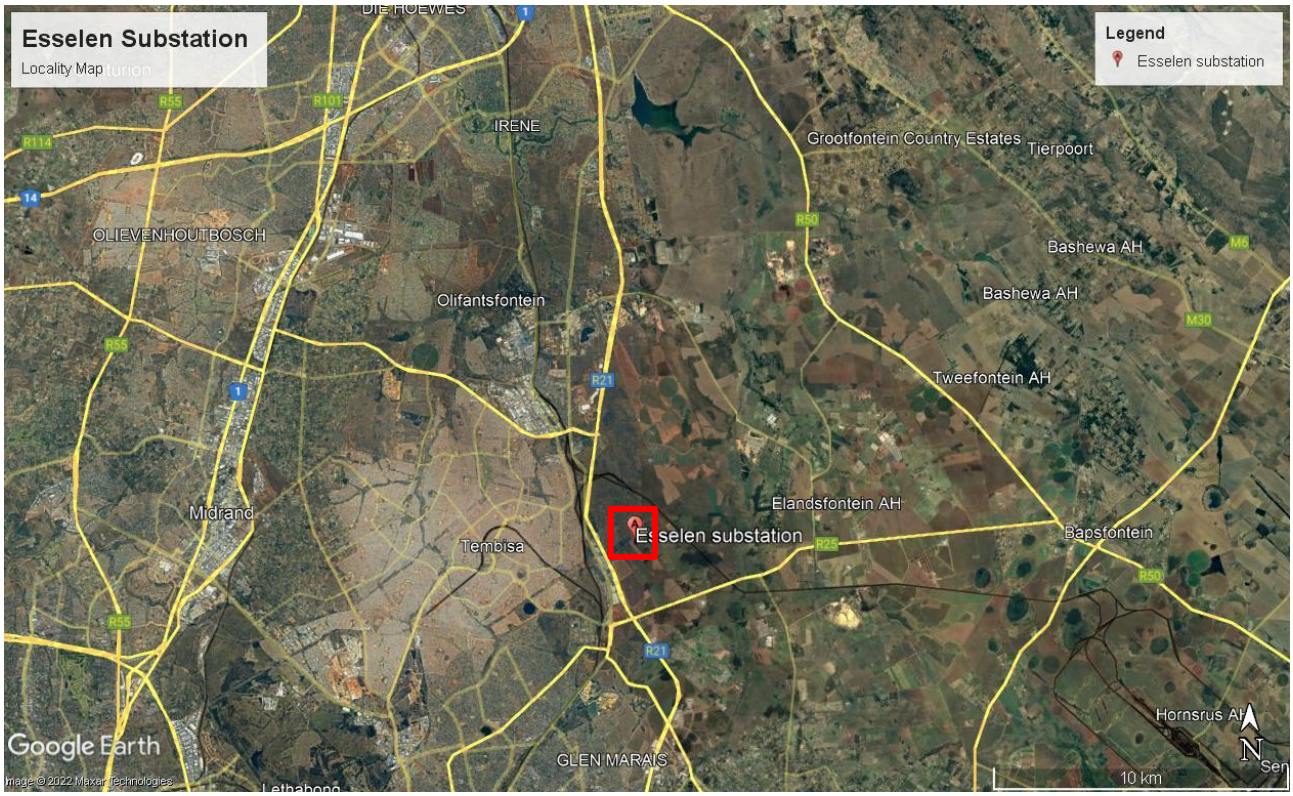


**Figure 2: Satellite imagery – Esselen Substation**

### 3.1.3 Regional Geology

The regional geology of the area is underlain by the Malmani Subgroup dolomitic rocks of the Chuniespoort Group (1: 250 000 Geological Series, 2628 East Rand). The Malmani Subgroup is comprised of the Oaktree Formation as the oldest formation followed by the Monte Christo, Lyttelton, Eccles and Frisco Formation in chronological order from oldest to youngest of age. The subdivision of the Malmani Subgroup is based on the differences in chert content, stromatolite morphology, intercalated shales and erosion surfaces (Button, 1973b).

Dolomite is a Calcium/Magnesium Carbonate rock which is soluble in the presence of a weak acid water, such as rain water. This occurs when the weak acid erodes away the calcium carbonate structure of the mineral/rock, percolating through fissures and fault zones, eventually resulting in large cavities or a sudden collapse of the surface ground, known as a sinkhole. During this dissolution, the dolomite dissociates into low strength insoluble manganese oxides, chert an iron oxides.

- $CaMg(CO_3)_2 + 2H_2CO_3 \longrightarrow Ca(HCO_3)_2 + Mg(HCO)_2$

### 3.1.4 Regional Geohydrology

According to the DSI conducted the, site is located within the Sterkfontein Dolomite Compartment in the A21A Groundwater Management Unit in the Crocodile West and Marico Water Management Area. The hydrogeological properties of the compartment are characterised by the karst nature of dolomite aquifers.

The DSI conducted by Thoka Geosciences at Esselen substation for the hydrogeology of the site indicates that the groundwater levels may be expected to be a maximum depth of approximately 30 m from the natural ground level. The contractor to be appointed should note that Thoka Geosciences recommends ODEX drilling systems to be implemented specifically for securing groundwater monitoring points.

### 3.1.5 Information Available

The following information is available and is attached:

1. Dolomitic Stability Investigation
2. Site Layout

## 3.2 DESIGN APPROACH

The GWMS will be installed in three different positions of low density bedrock to monitor the groundwater levels. The system to be installed must provide the following data/information:

- Groundwater level.
- Groundwater flow rate and direction.
- Groundwater recharge.
- Groundwater quality; to check for any chemical contamination that may dissolve the dolomite.

The contractor shall ensure that adequate casing is used for the stability of the borehole for the purposes of groundwater monitoring. A concrete base around the borehole at natural ground level shall be constructed.

## 3.3 KEY DESIGN DRIVERS

The design is based on the recommendations DSI and the geohydrological data presented therein.

## 3.4 SCOPE OF WORK

The contractor shall perform the following:

1. Study the existing geohydrological data presented in the DSI and supplement that information with information from local authorities and organisations dealing with groundwater
2. Establish site as required for purposes of installation of GWMS
3. Drill boreholes at specified positions. Ensure that the borehole is stable and provides required adequate casing for borehole stability for the purposes of monitoring groundwater. the
4. Construct concrete base at the mouth of the borehole for stability in the NGL. Refer to drawing ESS22P15-SE-E94, Concrete Base Detail.

5. The GWMS should be adequately housed/covered to protect from adverse climatic conditions; i.e. rain, sun, etc.
6. Liaise with the relevant authorities regarding the undertaking of the project and ensure compliance with relevant authorities.
7. Prepare a report containing all the relevant information pertinent to the project; this should include the following but not limited to:
    a. Type of groundwater monitoring system used.
    b. As-built drawings presented in (dgn format).
    c. Operational Manual.
    d. Maintenance Manual.
    e. Precautionary procedures: i.e. proactive and reactive measures based on data reading.

### 3.5 MAINTENANCE REQUIREMENTS

The maintenance of the GWMS is important to ensure optimal functionality; therefore, the contractor shall provide a maintenance manual for the system to be installed. Typical problems and risks associated with the GWMS should also be listed that may affect the safety and environment of the substation with risk mitigation plan.

### 3.6 OPERATIONAL REQUIREMENTS

The contractor shall provide an operational manual, and as a minimum, the manual should provide the following:

- Detailed routine inspections, with routine inspection form or template. Optimal frequency for this should be clearly stated as well in the routine form.
- Required competence for person inspecting and operating the GWMS.
- Training should be provided for the operation of the GWMS (data capturing, analysis and reporting)
- Emergency situation and procedure to be followed (based on the readings of the GWMS)
- Contact list of relevant and applicable authorities
- Provide processes to be followed for chemical testing of the groundwater and relevant stakeholders for chemical testing and types of tests to be undertaken indicating analysis, reporting and reactions measures to be taken.

### 3.7 SAFETY ASSESSMENT

All work shall be carried out in accordance with the requirements of the Occupational Health and Safety Act (Act 85 of 1993) and the regulations accompanying this act will be adhered to where applicable and comply with Eskom's SHE specification. All employees shall be provided with adequate training for the tasks that they are required to perform including an awareness of the risks involved in the execution of their duties and the methods available for the mitigation of these risks. Safety induction and security

clearance will have to be done prior to establishment of site. A safety file shall be prepared for the project and medicals might have to be carried out and cost thereof should be included in the quote.

### 3.8 SITE ACCESSIBILITY

The following is excluded from the contractor's responsibility:

- Arranging access (To be provided by the EA on site/ Eskom land development)
- Excavation permits (To be organised through an environmental officer when necessary)

## 4. AUTHORISATION

This document has been seen and accepted by:

| Name and surname | Designation |
|---|---|
| Nkosazana Leseka | Senior Geologist, Pr.Sci.Nat |
| Abdullah Kaka | Civil Engineer, PrEng |
| Andile Maneli | Middle Manager: Substation Engineering |
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## 5. REVISIONS

| Date | Rev. | Compiler | Remarks |
|---|---|---|---|
| October 2022 | 0 | Sithembiso Mabena | First Draft |
| November 2022 | 1 | Sithembiso Mabena | Changes to the following:<br>3.1.4 Addition of paragraph<br>3.5 Detailed specification of Maintenance Requirements<br>3.6 New section added: Operational Requirements |

## 6. DEVELOPMENT TEAM

The following people were involved in the development of this document:

- Sithembiso Mabena
- Nkosazana Leseka
- Abdullah Kaka

## 7. ACKNOWLEDGEMENTS

N/A

## ANNEXURE A: DOLOMITIC STABILITY INVESTIGATION

## ANNEXURE B: SITE LAYOUT