Eskom	Standard	Transmission

Title: **GEOTECHNICAL INVESTIGATION SPECIFICATION FOR ESKOM TELECOMMUNICATIONS TOWERS AND RELATED INFRASTRUCTURE**

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	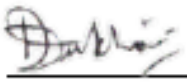	
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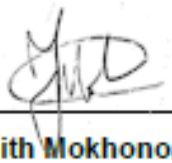

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Content

1. Introduction

Eskom Holdings SOC Ltd Telecommunications (the *Employer*) requires geotechnical investigations to be conducted for telecommunications towers, roadways and associated infrastructure (i.e. fencing, bund walls etc.). The geotechnical investigations must be conducted by a professionally registered engineering geologist/geotechnical engineer (registered with ECSA/SACNASP). The geotechnical investigation findings will provide pertinent ground information and inform the civil engineering designs.

2. Supporting clauses

2.1 Scope

This document outlines the minimum geotechnical scope of works required to conduct geotechnical investigations for telecommunications towers, roadways and associated infrastructure. The geotechnical investigations must be conducted to sufficient detail to provide pertinent soil/rock information for the civil engineering designs.

The *works* will comprise of a desk study, site walkover and geotechnical site investigation by means of intrusive and non-intrusive testing, and laboratory testing; as required. The findings of the geotechnical investigation will result in the production of a detailed geotechnical investigation report.

The successful tenderer (*Contractor*) provides all the equipment and resources required to execute the *works*.

2.1.1 Purpose

The Contractor will:

- Conduct desk top study and site walkovers for literary and upfront visual observation of the proposed site(s).
- Perform geotechnical investigations and gather all pertinent geotechnical, geological and geo-hydrological information for the proposed site(s).
- Gather sufficient and accurate data by means of field and laboratory testing to allow for the civil engineering design of the telecommunications towers, roadways and associated infrastructure.

2.1.2 Applicability

This specification is applicable to Eskom Telecommunication Division.

2.2 Normative/informative references

Parties using this document must apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] Site Investigation Code of Practice, 1st Edition, South African Institution of Civil Engineering - Geotechnical Division, January, 2010

[2] All laboratory testing is conducted in accordance with the latest standard methods and procedures as outlined by the appropriate authorities (S.A.N.S, B.S/ Euro Code equivalent, A.S.T.M, A.A.S.H.T.O, I.S.R.M, T.M.H)

[3] All Soil profiling is conducted in accordance with guidelines outlined in: Jennings, J.E, Brink, A.B.A, & Williams, A.A.B, (1973) “Revised Guide to Soil Profiling for Civil Engineering purposes in Southern Africa” Trans. S.A.I.C.E, Vol. 15, No. 1, pp 3 – 12.

[4] All works are conducted in accordance with the requirements of the Occupational Health and Safety Act (Act 85 of 1993) as amended

[5] The successful tenderer conforms to all relevant legislation, whether natural, social, cultural or technical, and shall liaise with the appropriate authorities if required.

2.2.2 Informative

[6] 240-80605256: Access to Private Property Standard

2.3 Definitions

2.3.1 General

None

2.3.2 Disclosure classification

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

2.4 Abbreviations

Abbreviation	Description
AASHTO	American Association of State Highway and Transport Officials
ASCII	American Standard Code for Information Interchange
ASTM	American Society for Testing and Materials
BS	British Standard
CAD	Computer Aided Design
DCP	Dynamic Cone Penetrometer
EASBP	Estimated Allowable Safe Bearing Pressure
ECSA	Engineering Council of South Africa
ISRM	International Society of Rock Mechanics
ITP	Inspection and Test Plan
LES	Lines Engineering Services
MCCSSO	Moisture Condition, Colour, Consistency, Structure, Soil Texture and Origin
OSH	Occupational Health and Safety
PPE	Personal Protective Equipment
QCP	Quality Control Plan
SACNASP	South African Council for Natural Scientific Professions
SAICE	South African Institute of Civil Engineers
SANAS	South African National Accreditation System
SANS	South African National Standards
SHEQ	Safety, Health, Environment and Quality
TLB	Tractor Loader Backhoe
TMH	Technical Methods for Highways
UCS	Uniaxial Compressive Strength

2.5 Roles and responsibilities

The *Contractors* lead for each phase:

- provides adequate resources including provision of equipment for required *Works*;
- manages cost and a scheduled time frame of work;
- ensures the scope is carried out in full;
- provides regular feedback on the status of this phase;
- ensures that all site work is conducted by a competent person;
- ensures that prior to any fieldwork, all parties working on site familiarized themselves with the *Employer's* safety requirements and the Occupational Health and Safety (OSH) Regulations act (85 of 1993);
- applies his discretion in conducting tests in as close an area to the desired location as possible, should access to testing areas be restricted and/or obstructed;
- ensures that, should the ground conditions exhibit notable changes, the *Employer* is informed promptly;
- notifies the *Employer*, if any impedance occurs as soon as the *Contractor* becomes aware of them.

2.6 Process for monitoring

The *Contractor* submits weekly progress updates; the format of which will be communicated by the *Employers Project Manager* on a project specific basis; and in additional allows for the following quality control measures:

- The *Contractor* exercises strict and adequate quality control during all phases of the *works.*
- Where required, the *Contractor* prepares suitable Quality Control Plans (QCP), Inspection and Test Plans (ITP) for all work carried out and submits to the *Employer* for acceptance as required.
    - The QCP is to be structured as per the agreed scope i.e. a) technical activities as per scope must undergo quality control and should be indicated in the QCP; b) Quality Standards and Procedures as stipulated in the contract must be indicated in the QCP along with linked activities.

2.7 Related/supporting documents

Not applicable.

2.8 Receivables upon contract award

The Employer provides the following upon contract award (where required):

- Proposed co-ordinates for the telecommunications towers, locations of proposed roadways and/or associated infrastructure.
- An authorized person to accompany the *Contractor* to site.
- The height(s) and loading(s) of the proposed infrastructure to be constructed.
- The tower builder's foundation specification for the proposed tower.

Note: The foundation may be changed or altered based of the geotechnical investigation findings.

2.9 Safety, Health, Environment and Quality (SHEQ)

The *Contractor* submits the following:

- Safety file for acceptance by *Employer* before commencement of the *Works*.
- Ensures that all personnel are familiar with the *Employers* Health and Safety induction, and Personal Protective Equipment (PPE) requirements before commencement of the *Works*.
- Identifies and submits strategic measures to execute fieldworks without contravening environmental compliances.
- The *Contractor* ensures that all SHEQ activities are incorporated into the schedule.
- The *Contractors* SHEQ file must contain as a minimum:
    - Qualification/training requirements
    - PPE as identified by site Health, Safety and Environment personnel
    - Prevention/mitigation measures
    - Emergency procedures
    - Access
    - Covid 19 Compliance Measures

2.10 Methodologies and Sampling

- Where geotechnical investigations are required for larger test areas/extents - Test layouts and proposed sampling plan with rationalised methodology are submitted for review and acceptance by the *Employer* prior to commencement on site.
    - The *Employer* will take a maximum of two (2) working days for review (technical hold point).
- Sampling is conducted on representative disturbed and undisturbed samples.
- Samples are collected, stored and labelled as per the relevant SAICE standards.
- The *Contractor* ensures that all samples are transported carefully to the SANAS accredited laboratory, such that the samples retain their sample integrity.
- No samples are to be misplaced, damaged or lost during transportation and testing.

3. Scope of Works

3.1 Desk Study

- The *Contractor* conducts a desk study review for all proposed infrastructure.
- The *Contractor* reviews all known literature, existing local and regional geotechnical information available for the proposed areas.
- The *Contractor* reviews pertinent soil maps and hydrological/climatological data where needed.
- The *Contractor* purchases all relevant information required.

3.2 Walkover

The *Contractor* conducts a site walkover of the proposed site(s).

- The *Contractor* identifies any areas which may require specified soil testing (example. erosive soils or indications of heave) and uses the walkover to identify proposed soil test positions, as well as flag any potential concerns i.e. access limitations, height restrictions etc.

- Identifiable landform features, adjacent land uses and contributing environmental factors are noted.

3.3 Geophysical Tests

The *Employer* will communicate if geophysical tests are required.

- Geophysical tests are conducted in highly populated areas and/or areas with dense infrastructure where sub-surface impedance is anticipated.
- Geophysical tests are aimed at locating sub-surface infrastructure i.e. pipelines/electrical cables which may impede excavations or may be damaged by the excavation processes.
- Geophysical test information will be used to finalise test positions and/or infrastructure positions (where applicable).

3.4 Access

Access to the required site(s) is provided in accordance to 240-80605256: Access to Private Property Standard. The *Employers Project Manager* will provide guidance to the *Contractor* regarding specific accesses. Conditions for access will be provided upon contract award.

3.5 Test Pits

- Excavation and supervision of a minimum of one (1) test pits per telecommunications tower.
- For roadways test pit numbers are based on the total road length, the Contractor makes use of the SAICE Code of Practice [1] document to identify test pit numbers.
    - Test pits for roadways will be used for soil classification and to advise removal and re-compaction efforts.
- For adjacent infrastructure, a minimum of one (1) test pit is conducted per structure.
- Per project - the total number of test pits required is based on the amount of proposed infrastructure provided by the *Employer* i.e. project specific.
- The number of test pits may be amended upon assessment of the ground condition. Should test numbers require amendment, the Contractor requests the amendment in writing and may only commence once acceptance is received from the Employer.
- Test pits are excavated by a TLB or Excavator depending on the prevalent soil conditions.
- Test pits are excavated to a minimum depth of 1.5m or refusal.
- All test pits are profiled by a professionally registered engineering geologist/ geotechnical engineer (SACNASP/ECSA) according to ‘Guidelines for Soil and Rock Logging in SA, 2nd Impression’ (Brink and Bruin, 2002).
- Test pits are profiled vertically and each soil layer is described in terms of Moisture Condition, Colour, Consistency, Structure, Soil Texture and Origin (MCCSSO).
- Soil profiling should be conducted before the soils have dried out (i.e. profiled shortly after test pit is opened). If there have been delays before soil profiling can occur, then the profiler must attempt to get to the fresh soil behind the exposed face, this may be done by scraping at soil locally using a geological pick. This is on condition that it is safe to enter the test pits.
- Where required, soil/rock samples are taken upon the discretion of the professionally registered engineering geologist/geotechnical engineer.
- Sample acquisition, storage, transportation and testing are done in accordance with applicable guidelines and standards.
- Sample management as per Section 2.10.

- If seepage is encountered, the seepage is noted and where possible the rate of water flow is determined.
- Test pit images must be taken in clear lighting with soil layers visible. A tape measure or surveyor's rod must be placed within the test pit which shows the soil layer depth correlation between the image and soil profile. A whiteboard (preferred) or sheet of paper showing the test pit name and project name must also be visible in the image.
- Observations are also made external to the test pit. Features such as land relief, proximity to water bodies, natural and man-made landforms, weather on day of test pit profiling and notable environmental impacts provide key information to soil behaviour with time.
- All test pits are reinstated using the soil removed from test pits following completion of soil profiling and sampling.
- Reinstated soils are adequately compacted to minimize differential settlements.

NB. The *Contractor* must (a) take reasonable and sufficient steps in order to prevent, as far as is reasonably practicable, any person from being buried or trapped by a fall or dislodgement of material in an excavation; (b) may not require or permit any person to work in an excavation which has not been adequately shored or braced as stipulated in Section 13 of Reference [4].

3.6 Dynamic Cone Penetrometer (DCP)

- DCP tests are conducted adjacent to or at the base of test pits should the *Contractor* require verifications of ground stiffness.
- A minimum of one (1) DCP test is conducted per telecommunications tower.
- DCP tests for roadways will be conducted every 250m or otherwise indicated by the *Employer*. Test numbers and frequencies may be amended based on the condition of the roadways.
- DCP test frequencies for adjacent infrastructural area will be based on the extent of the test area (i.e. project specific)
- The position of the DCP i.e. co-ordinates and proximity to/in test pit must be noted.
- DCP test apparatus must be at 90 degree angles/ perpendicular to natural ground level.
- The DCP must be calibrated, therefore the "zero" reading must be noted.
- DCP weight must be noted.
- Lifting of the hammer must be done slowly and released to allow a "free falling" action of the hammer.
- It must be noted that the DCP apparatus refuses on solid materials such as hardpan layers and will also refuse in gravels and pebbles. Therefore a DCP must not be used in areas where stiffness is needed for greater depths or in areas where hardpans and larger material are anticipated/present.
- DCP data is recorded and submitted with the test pit profile information.
- DCP data is correlated to Estimated Allowable Safe Bearing Pressure (EASBP) which is the factored bearing capacity of the soil.

3.7 Tests on Soil Samples

3.7.1 Identification Tests

- The *Contractor* conducts one (1) Foundation Indicator test per soil layer encountered in the test pit for the Telecommunications tower
- The *Contractor* conducts one (1) Road Indicator test per soil layer encountered in the test pit for roadways. Sampling frequency may be increased based on geotechnical findings.

3.7.2 State Tests

- The *Contractor* conducts in-situ moisture content tests.

3.7.3 Compaction Tests (as required)

- The *Contractor* conducts Moisture/Density relationship at Modified AASHTO compaction effort.
- The *Contractor* conducts California Bearing Ratio tests

3.7.4 Deformability Tests (as required)

- The *Contractor* conducts Double Oedometer tests for soil layers showing indication of heave or collapse
- The *Contractor* conducts dispersivity tests (both field indicator and laboratory)

3.7.5 Chemical Tests

- The *Contractor* conducts laboratory tests to determine the aggressiveness of soils toward concrete and metals (J.J. Basson, 1989) on the proposed sites including:
    - pH
    - Electrical Conductivity
    - Organic Content

3.8 Tests on Rock

3.8.1 Strength Tests

- The *Contractor* conducts site based Uniaxial Compressive Strength (UCS) tests on rock identified on site.

3.9 Electrical Resistivity

- Electrical resistivity testing is conducted for all proposed structures
- Electrical resistivity tests are conducted to obtain soil specific resistance to establish the design parameters for the grounding system and cathodic protection.

3.10 Deliverables

- After completion of the fieldworks and laboratory testing, the Contractor's professionally registered engineering geologist or geotechnical engineer (ECSA/SACNASP) prepares and submits a consolidated geotechnical report.
- Factual information, and interpretive results are clearly distinguished.
- The geotechnical report includes:
    - Site Location,
    - Site Description (this includes: observed relief, vegetation, drainage, manmade features etc.),
    - Project Description,
    - Proposed facility description and grading,
    - Geological Setting;
        - Regional Geology,

- Local Geology and Geo-hydrology;
  - ✓ At onset, all geotechnical information is sourced from the local municipality, adjacent geotechnical investigation finds, mining data (where available) and through accepted published literary works,
- Regional Geological Hazards,

- Description of fieldwork including equipment used for excavating and testing,
- Drawing/s depicting all testing locations and structural geological features (where applicable) superimposed onto the area layout,
- Surface and sub-surface conditions as determined by intrusive ground testing. This includes:
  - classification and description of all properties pertinent to the soil and rock strata,
  - any and all natural groundwater intersection, quantification and source thereof,
  - discussions on problem soils encountered within the proposed areas and the extent thereof,
- Based on the soil data derived from fieldworks: the proposed foundations for telecommunications towers and associated infrastructure are confirmed or new foundations types and details thereof are recommended.
- For roadways - the Contractor recommends adequate rip and re-compact measures to allow functionality of the road.
- Tables of laboratory test results;
- Discussions of all in situ and laboratory tests and classifications.
  - Analysis and Recommendations include the following:
    - Earthworks recommendations (as needed);
    - Backfills/Layerworks recommendations (as needed);
    - Recommendations of foundations types (as needed);
  - The following is included in the appendices:
    - All field data (i.e. raw data),
    - Detailed methodology of calculations used (with related assumptions) leading to the final recommendations.
    - All laboratory results are to be included in the appendices.
    - List of assumptions used for calculations and recommendation.
- Design reviews are conducted as per the Employer's governance procedures
- The Contractor's design reviews are supplemented with the Employer's governance procedures (240-53113685).
- Formal progress reports are submitted in the form of:
  - Weekly progress reports (electronic copies) and an overall geotechnical report once the Works have been carried out in full
  - Monthly/weekly progress meeting (timeline applicable)
- The priced proposal will include:
  - Resource(s), rate and price for Works highlighted above including the provision of an updated schedule is issued monthly to the *Employer.* This schedule identifies milestones outlining time allocation for desk study, excavation of test pits and logging of soil profile, execution of DCP testing, as well as samples acquisition and soil testing.

NB. Written consent must be received from the Employer for any and all deviations from the testing suite as outlined herein.

4. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Alicia Simbudayal	Senior Engineering Geologist, LES
Dan Dukhan	Chief Civil Engineer, LES
Ndangi Muthadi	Senior Mechanical Engineer, LES
Koos Radebe	Senior Civil Engineer, TE
Sibonelo Nzama	Structures, Civil and Hardware Cluster Middle Manager, LES
Faith Mokhonoana	Acting Senior Manager, LES

5. Revisions

Date	Rev	Compiler	Remarks
Jan 2022	3	A Simbudayal	Document updated to add further detail for geotechnical testing
Oct 2018	2	D Dukhan	Document added to new SCOT template with not content change
April 2012	1	A Hector	First issue

6. Development team

- Alicia Simbudayal

7. Acknowledgements

- Dan Dukhan