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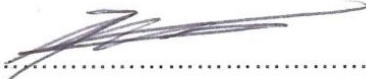
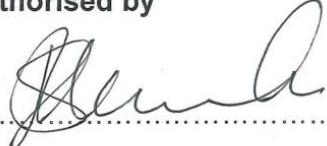
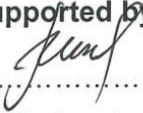
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1. INTRODUCTION

This document outlines the requirements for a geotechnical investigation to achieve a client specified deliverable. In the planning of a geotechnical site investigation, it is essential that the objectives of the investigation are clearly understood. This requires the geotechnical consultant obtaining clear terms of reference from the client regarding phase, scope and detail required for the intended project. From these the consultant can plan the geotechnical investigation.

The planning of an investigation is dependent upon a number of factors including:

- nature and complexity of the development,
- stage of development e.g. detailed
- size of the area to be investigated,
- the regional geology and geo-hydrology

These factors determine the type and extent of investigative methods to be used and form the basis for geotechnical design.

2. SUPPORTING CLAUSES

2.1 SCOPE

2.1.1 Purpose

The purpose of this document is to describe the processes followed in carrying out a geotechnical investigation.

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

2.2 NORMATIVE/INFORMATIVE REFERENCES

2.2.1 Normative

Parties using this specification shall apply the most recent edition of laws and practices listed below:

- [1] Soil profiling by 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
- [2] All laboratories testing by TMH-1 standards. All laboratory testing shall be conducted in accordance with the latest standard methods and procedures as outlined by the proper authorities (BS/ EuroCode equivalent, ASTM, AASHTO, ISRM, SABS /SANS).
- [3] GPS in accordance with WGS84 coordinate system
- [4] All work shall be conducted in accordance with Occupational Health and Safety Act (Act 85 of 1993) as amended
- [5] ISO 9001 Quality Management Systems
- [6] SAICE Site Investigation Code: 2010
- [7] Drilling in accordance with CSRA: Standard Specification for Sub-Surface Investigations, 2010?
- [8] Rock core logging conducted in accordance with: Brink, A.B.A, & Bruin, R.M.H, (2002) Second Impression: "Guidelines for Soil and Rock Logging in South Africa, Proceedings of Geoterminology Workshop 1990"

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[9] Franki Africa : A Guide To Practical Geotechnical Engineering in Southern Africa - Fourth Edition 2008

2.2.2 Informative

N/A

2.3 DEFINITIONS

Definition	Description
N/A	

2.3.1 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
AEG	Association of Engineering Geologists
ASTM	American Society of Testing and Materials
BH	Borehole
BS	British Standard
CBR	California Bearing Ratio
CPT	Cone Penetration Test
CSRA	Committee of State Road Authorities
DMS	Document Management System
DPL	Dynamic Probe Light
DPSH	Dynamic Probe Super Heavy
DTM	Digital Terrain Model
EM	Electrical conductivity Meter, Geophysics
GIS	Geographical Information System
GPS	Geographical Positioning System
ISRM	International Society of Rock Mechanics
RMC	Rock mass classification
ROC	Required Operational Capability
SABS	South African Bureau of Standards
SAICE	South African Institute of Civil Engineers
SAIEG	South African Institute of Engineering Geologists
SANS	South African National Standards
SoW	Scope Of Works
SPT	Standard Penetration Test
SRS	Stakeholder requirement specification

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Abbreviation	Description
TLB	Backhoe Loader
TMH	Technical Methods for Highways, CSIR
TRH	Technical Recommendations For Highways, CSRA
UCS	Unconfined Compressive Strength
URS	User requirement specification

2.5 ROLES AND RESPONSIBILITIES

2.5.1 The Role of a CoE

The role of the Engineering Centres of Excellence is provided below:

- Apply its expertise, skill and processes to produce a high quality output of exceptional standards in line with the organizational requirement.
- Assist in providing project activities and man hours for project preplanning
- Provide engineering resources to perform the engineering effort

2.5.2 The Engineering Design Work Lead

- The EDWL has the following reporting lines:
- Accountable for the strategy and all design related activities to the Plant Engineering General Manager. The Centre of Excellence Engineering Manager will prepare, review, assess and score the performance contract of the EDWL.
- The EDWL is appointed by the Engineering Work Delivery Unit Manager in conjunction with the relevant Centres of Engineering Excellence (CoE's) and Authorised by the Plant Engineering General Manager (GM).
- Reports to the Project Engineering Practitioner for technical delivery achieved to baseline scope, schedule and cost.

2.6 RELATED/SUPPORTING DOCUMENTS

[10] 240-98349953 Check sheet for Geotechnical Investigations

3. GEOTECHNICAL INVESTIGATION REQUIREMENTS

3.1 MINIMUM REQUIREMENTS

3.1.1 Client's objective

The aim of the investigation is to describe the nature of the geotechnical properties of the site. The geotechnical parameters will be used as an aid in the design of structures, and as an aid in determining the construction methodology. The type of structure is; in most projects; identified by the client e.g. roads, rails, pipelines, power stations etc. The size of the structure should also be specified in terms of magnitude and extent.

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3.1.2 ROC

Before a site investigation has been initiated a signed Required Operational Capability (ROC) must be submitted. The ROC will cover the purpose of the investigation, appropriate time frames and budget requirements.

3.1.3 Site accessibility

The client shall be responsible to obtain the necessary permissions to access the site for the proposed geotechnical investigation. This may include obtaining the necessary permissions to work within or in close proximity to existing road/rail servitudes, as well as permission from private land owners.

3.1.4 Health, Safety and the Environment

Geotechnical investigations have to comply with legislation, mostly the requirements of the Occupational Health and Safety Act (Act 85 of 1993). It is the responsibility of the client to obtain any site specific SHEQ/ HSE specifications and to make these available in the ROC/URS. Safety inductions; in most instances; are site specific and the client will therefore be responsible for arranging the relevant safety inductions.

3.1.5 Presence of existing services

It is the client's responsibility to indicate the presence of existing services on the site. This may include fuel lines, gas lines, telecommunication lines, power lines and water lines. It is also the client's responsibility to apply for and obtain the necessary excavation permits. The structural layout of existing services should be provided by the client.

3.1.6 Socio-political considerations

A site may be located in an area which is populated by local communities. The client needs to inform the local community of the nature and extent of the investigation; as well as any disturbances which may be incurred by the local community [where applicable].

3.1.7 Environmental considerations

The investigation must conform to national and provincial environmental laws. The necessary environmental permits and/or interfaces with the necessary authorities needs to be obtained by the client.

4. LEVELS OF THE INVESTIGATION

4.1 PRE-FEASIBILITY

This level of the investigation includes a desk study of available information and information obtained from a site walkover.

4.2 FEASIBILITY

This level of an investigation involves a comprehensive desk study and limited investigations (as deemed required by size of project).

4.3 DETAILED

Detailed investigations are carried out including in-situ testing and laboratory testing. Interpretive and factual reports are compiled, geotechnical recommendations are made. Geological hazards are identified

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5. INVESTIGATION METHODOLOGY

5.1 DESK STUDY

Desk study should be done using geological maps, aerial photo interpretation, and available previous geotechnical works in the region of interest.

- Data on the adjacent existing structures i.e. foundation types, cracking [where applicable] etc.
- Data on bodies of groundwater levels in the surrounds of the proposed site.
- Data on seismic aspects, such as ground motion.

5.2 GEOTECHNICAL FIELD INVESTIGATION

Refer to 240-57127951: Standard for the Execution of Site Investigations

- Test pits to be excavated using a TLB controlled by a licensed TLB operator. For excavation through rock, an excavator may be used. The required provision of plant shall be the responsibility of the contractor unless otherwise agreed upon by the client.
- All test pits shall be profiles by a registered geotechnical engineer or geologist
- Soil profiling shall be conducted in accordance to the SAICE code of practice (after Jennings et al.1973)
- All positions of test pits should be coordinated with a valid calibrated hand-held GPS.
- The type of soil samples taken and additional soil parameters recorded shall be outlined within the geotechnical SoW and is specific to the requirement.
- Representative disturbed and undisturbed samples should be collected and labelled correctly, care shall be taken not to mislabel / misplace or avoid loss of samples.
- N.B. in densely populated areas where there may be a risk of intersection of existing underground utilities, it is crucial that GPR testing be adopted to locate these sub-surface utilities prior to excavation. This allows for onset mitigation of Eskom risk.

5.3 Laboratory Testing

The following table shows the field and laboratory tests should be carried out where applicable to the investigation. Test should be carried according the relevant applicable standards.

Table 1: Planning Soil Investigations on Stable Soil Profiles above the water table

Parameter	Field test	Laboratory test
Description of Soil Profile	Test pits Auger Trial Holes Boreholes with SPT Seismic survey	
Consistency of soil profile	In suit tests – DCP /DPSH/ SPT/CPTU In-situ profiling of trial holes/test pits Sand replacement tests	Density of undisturbed samples (oedometer)
Undrained Shear Strength	Undisturbed samples from auger holes/test pits/borehole Vane shear tests in boreholes/trial	Undrained triaxial Unconfined compression

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	hole	
Effective angle of friction/effective cohesion	Undisturbed samples from auger holes/test pits/borehole	Drained triaxial Drained shearbox Undrained triaxial with measure of pore water pressure
Modulus of compressibility (stiffness at appropriate strain level)	Cross-hole jacking/plate load/pressure meter Small strain stiffness – SASW dilatometer	Oedometer Triaxial with local strain measurement Bender element
Index properties	Disturbed samples from auger holes/test pits/borehole	Grading analysis Atterberg Limits Moisture content Foundation Indicator
Permeability	Undisturbed samples from auger holes/test pits/borehole CPTU Lugeon testing	Falling or constant head permeability
Collapse	Undisturbed samples from auger holes/test pits/borehole	Double oedometer/collapse potential
Heave	Undisturbed samples from auger holes/test pits/borehole	Double oedometer swell under load/index testing (including hydrometer) on disturbed samples
Level of water table	Percolation test – in situ	Degree of saturation
Soil suction pressure	Filter paper test	

6. DELIVERABLES

Hardcopy and soft copy reports with appended maps and cross sections as well as an electronic/digital G.I.S data on disc or CD. All relevant factual test data, borehole logs and profiles inclusive of all field recorded data and hand sketches should be included in the factual report. A Sample of the check sheet is provided in Appendix A (information purposes only) for the geotechnical requirements from the client. Please always use the latest revision of **240-98349953 Check sheet for Geotechnical Investigations** for completion as downloaded from the Eskom Document Management System

6.1 INTERPRETIVE REPORT

The interpretive report should include the following –

- Available construction materials sources / location for borrow pit and associated cut and fill specification
- Proposed road construction materials
- Seismic risk assessments
- Rock stability
- Proposed site earthworks
- Drainage recommendations

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- Site Location
- Site description
- Facility description and grading
- Geological setting
- Regional and local geology and geo-hydrology
- Classification of pertinent rock and soil stratum
- Discussions of bearing capacity and long and short term settlements
- Groundwater intersections, quantification and sources
- Soil remediation and backfill requirements [where applicable]
- Foundation recommendations and related hazards
- Amendments to licensing's [where applicable]
- For piling – pile load capacity and pile load responses

7. AUTHORISATION

This document has been seen and accepted by:

Name & Surname	Designation
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8. REVISIONS

Date	Rev.	Compiler	Remarks
February 2015	0.1	K. Jungbahadur	None
April 2015	0.2	K. Jungbahadur	Draft Document for Comments Review
May 2015	0.3	K. Jungbahadur	Updated Draft after Comments Review Process
July 2015	1	K. Jungbahadur	Final Document for Authorisation and Publication

9. DEVELOPMENT TEAM

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

- Keshia Jungbahadur
- Alicia Simbudayal

10. ACKNOWLEDGEMENTS

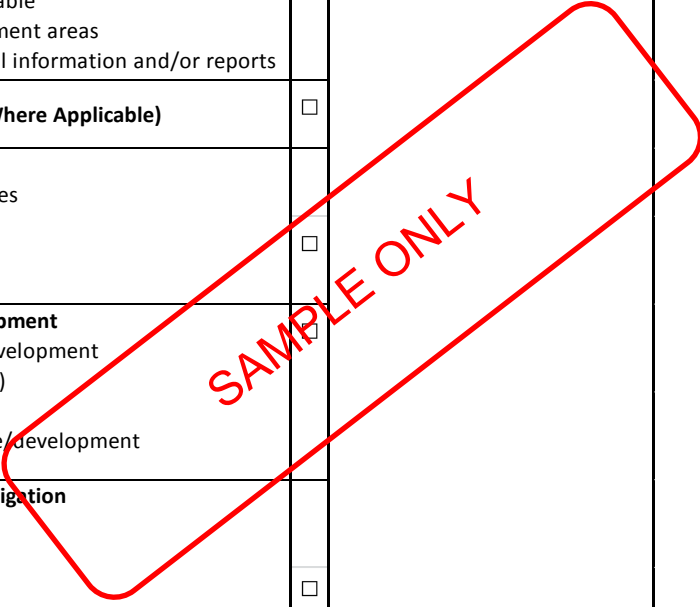
- Bruno Marrai
- Alicia Simbudayal

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APPENDIX A

Please refer to **240-98349953 Check sheet for Geotechnical Investigations** and always use the latest revision as supplied by the Eskom DMS

Geotechnical Engineering CoE	Technology	
Geotechnical Investigations Checksheet - Requirements from the client		
Signed ROC	☐	
Safety and health specifications	☐	
Site Description: - General location - Co-ordinates if available - Existing structures (temporary and permanent) - Vegetation - General climate, rainfall data/average temperatures if available - Drainage and catchment areas - Existing geotechnical information and/or reports	☐	
Previous Land Use (Where Applicable)	☐	
Adjacent land uses - Pollution control sites - Municipal - Recreational	☐	
Nature of the development - Size of structure/development - Loading (if available) - Design life - Purpose of structure/development	☐	
Purpose of the investigation - Site selection - Feasibility - Detailed design	☐	
Site Accessibility	☐	
Preliminary (Factual) report if applicable Final (Interpretive) report Eskom Engineering Review	☐	
Proposed time frames	☐	
Budget Allocation	☐	
Access Requirements (inductions, permits, medicals)	☐	

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