DRAFT SOUTH AFRICAN STANDARD (DSS):
PUBLIC ENQUIRY STAGE

Document number  SANS 634

Reference  7135/634/SP

Date of circulation  2011-12-20  Closing date  2012-02-21

Number and title:
SANS 634: GEOTECHNICAL INVESTIGATIONS FOR TOWNSHIP DEVELOPMENT

Remarks:

PLEASE NOTE:

- The technical committee, SABS SC 59P: Construction standards – Geotechnical standards responsible for the preparation of this standard has reached consensus that the attached document should become a South African standard. It is now made available by way of public enquiry to all interested and affected parties for public comment, and to the technical committee members for record purposes. Any comments should be sent by the indicated closing date, either by mail, or by fax, or by e-mail to

  SABS Standards Division
  Attention: Compliance and Development department
  Private Bag X191
  Pretoria
  0001

  Fax No.: (012) 344-1568 (for attention: dsscomments)
  E-mail: dsscomments@sabs.co.za

  Any comment on the draft must contain in its heading the number of the clause/subclause to which it refers. A comment shall be well motivated and, where applicable, contain the proposed amended text.

- The public enquiry stage will be repeated if the technical committee agrees to significant technical changes to the document as a result of public comment. Less urgent technical comments will be considered at the time of the next amendment.

THIS DOCUMENT IS A DRAFT CIRCULATED FOR PUBLIC COMMENT. IT MAY NOT BE REFERRED TO AS A SOUTH AFRICAN STANDARD UNTIL PUBLISHED AS SUCH.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT SOUTH AFRICAN STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN LAW.
SOUTH AFRICAN NATIONAL STANDARD

Geotechnical investigations for township development
Acknowledgement

The SABS Standards Division wishes to acknowledge the work of the National Department of Housing, the National Department of Public Works, the South African Civil, Geological and Geotechnical Engineering Fraternity, and the National Dolomite Risk Management Working Committee established on instruction of the Cabinet Committee on Governance and Administration in developing this document.

Foreword

This South African standard was approved by National Committee SABS SC 59P, Construction standards – Geotechnical standards, in accordance with procedures of the SABS Standards Division, in compliance with annex 3 of the WTO/TBT agreement.

This document was published in xxxx 2012.

Reference is made in 3.2 to the “relevant national authority”. In South Africa, this means the South African National Accreditation System (SANAS)

Reference is made in 3.6(a) to the “relevant national legislation”. In South Africa, this means the Engineering Profession Act, 2000 (Act No. 46 of 2006).

Reference is made in 3.6(b) to the “relevant national legislation”. In South Africa, this means the Natural Scientific Professions Act, 2003 (Act No. 27 of 2003).

A reference is made in 4.1.6 to the “relevant national legislation”. In South Africa, this means the National Nuclear Regulator Act, 1999 (Act No. 47 of 1999) and the Mine Health and Safety Act, 1996 (Act No. 29 of 1996).

Reference is made in 4.1.7 to the “relevant national authority”. In South Africa, this means the Chief Inspector of Mines.

Reference is made in 4.2.3(a)(6), to the “relevant national authority”. In South Africa, this means the Chief Inspector of Mines or the Department of Mineral Resources and Department of Energy Affairs.

Reference is made in 4.2.3(a)(7), to the “relevant national department”. In South Africa, this means the Council for Geoscience, the Department of Land Affairs, the Department of Water Affairs, and the National Home Builders Registration Council.

Reference is made in 4.2.4 and 4.3.2.5 to the “relevant national authority”. In South Africa, this means the Government Mining Engineer.

Reference is made in 4.4.1(a) to the “relevant national legislation”. In South Africa, this means the Housing Consumers Protection Measures Act, 1998 (Act No. 95 of 1998).
Contents

Acknowledgement
Foreword

1 Scope ...................................................................................................................................... 3
2 Normative references.............................................................................................................. 3
3 Definitions ............................................................................................................................... 4
4 Requirements.......................................................................................................................... 7
   4.1 General ........................................................................................................................ 7
   4.2 Preliminary investigation............................................................................................... 8
   4.3 Phase 1 detailed investigation..................................................................................... 11
   4.4 Phase 2 detailed investigation...................................................................................... 16

Bibliography .............................................................................................................................. 18
Geotechnical investigations for township development

1 Scope

This standard establishes requirements applicable to a preliminary and two-phase detailed geotechnical site investigation on land including dolomite land, where unoccupied land or undeveloped parcels of land are to be utilized for township development purposes.

NOTE 1 The geotechnical site investigations described in this standard are suitable for housing schemes or developments involving a number of housing units. This standard might require some adaptation to make it appropriate for geotechnical site investigations relating to a single house or very small parcels of land or other types of development.

NOTE 2 This standard may be used to form the basis of the scope of work for services rendered by an investigator to a client for all or any of the phases that are provided for.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. Information on currently valid national and international standards can be obtained from the SABS Standards Division.

SANS 633, Soil profiling and rotary percussion borehole logging on dolomite land in Southern Africa for engineering purposes.

SANS 1921-5, Construction and management requirements for works contracts – Part 5: Earthworks activities which are to be performed by hand.


SANS 1936-2, Development of dolomite land – Part 2: Geotechnical investigations and determinations.


3 Definitions

3.1 acceptable
acceptable to the authority administering this standard, or to the parties concluding the purchase contract, as relevant

3.2 accredited testing laboratory
laboratory that has been accredited by the relevant national authority (see foreword)

3.3 Atterberg limit
transition points between various states of soil consistency, namely the liquid limit, plastic limit and shrinkage limit

3.4 client
individual or organization that commissions the geotechnical site investigation

3.5 collapsible soil
soil with a high void ratio and with a low density that, when subjected to a combination of direct actions and an increase in soil moisture content, experiences sudden or rapid settlement

3.6 competent person
person who

a) is registered in terms of the relevant national legislation (see foreword) as either a Professional Engineer or a Professional Engineering Technologist, and has a tertiary qualification (degree or diploma) in civil engineering, or

b) is registered as a Professional Natural Scientist in terms of the relevant national legislation (see foreword), and has a BSc (Hons) degree or higher qualification in engineering geology, and

c) has suitable experience in geotechnical site investigations

3.7 compressible soil
soil that, when subjected to direct actions, undergoes a gradual settlement as volume changes occur

3.8 contaminated land
any land in a condition, by reason of substances in, or under the land, which presents an unacceptable risk to the health and safety of occupants of buildings constructed on such land

3.9 data
facts collected and assembled during the geotechnical site investigation

3.9.1 factual data
materials, statistics and properties that can be seen, measured or identified by means of accepted or standardized criteria, classifications and tests
3.9.2 interpretative data
information derived from factual data using accepted and proven techniques, or from reasonable judgement exercised in the assessment of geological and geotechnical conditions or processes evident at the site

3.10 dolomite land
land underlain by dolomite or limestone residuum or bedrock (or both), within the Malmani Subgroup and Campbell Rand Subgroup, typically at depths of no more than

a) 60 m in areas where no de-watering has taken place and the local authority has jurisdiction, is monitoring and has control over the groundwater levels in the areas under consideration; or

b) 100 m in areas where de-watering has taken place or where the local authority has no jurisdiction or control over groundwater levels

NOTE For more information on dolomite land in South Africa, see annex B of SANS 1936-1:2012.

3.11 expansive soil
fine-grained soil the clay mineralogy of which is such that it changes in volume to varying degrees in response to changes in moisture content, i.e. the soil increases in volume (heaves or swells) upon wetting up and decreases in volume (shrinks) upon drying out

3.12 foundation indicator test
classification test based on the basic physical characteristics of disturbed samples, comprising the determination of Atterberg Limits and the grain size distribution (including the clay fraction)

3.13 geotechnical
pertaining to the nature, condition and physical properties of the earth’s crust (whether soil or rock and including water and gases therein) which affect its performance in civil engineering and building works

3.14 geotechnical site investigation
process of evaluating the geotechnical character of a site in the context of existing or proposed works or land usage, which may include one or more of the following:

a) evaluation of the geology and hydrogeology of the site;

b) examination of existing geotechnical information pertaining to the site;

c) excavating or boring in soil or rock and systematic description of the soil and rock profiles;

d) determining the depth of any fill that might be present;

e) field assessment of geotechnical properties of materials;

f) recovery of samples of soil or rock for examination, identification, recording, testing or display;

g) testing of soil or rock samples to quantify properties relevant to the purpose of the investigation;

h) evaluation of geotechnical properties of tested soils;
SANS 634:2012
Edition 1

i) reporting of the results; and

j) solutions (where relevant) and conclusions

3.15 hazard
source of potential harm

NOTE   A hazard can be a risk source, i.e. an element which alone or in combination has the intrinsic potential to give rise to risk.

3.16 heave
anticipated (vertical) surface movement produced by an expansive soil horizon caused by an increase in moisture content within the horizon

3.17 inherent hazard
potential for an event (sinkhole or subsidence) to develop in a particular ground profile on dolomite land

NOTE   For further details, see SANS 1936-1.

3.18 investigator
natural or juristic person responsible for performing the geotechnical site investigation (including its reporting), or for that part of the geotechnical site investigation which is relevant in a particular context

3.19 liquid limit
empirically established moisture content of a soil at the boundary between the plastic and liquid states

3.20 opinion
conclusions or recommendations derived by a competent person from consideration of factual and interpretative data, and from the exercise of judgement

3.21 parcel of land
tract of land, comprising one or more farm portions or properties registered in a deeds registry, and identified for the purpose of township development

3.22 plastic limit
empirically established moisture content of a soil at the boundary between the plastic and semi-solid states

3.23 settlement
one of the following

a) downward movement of the foundations of a structure due to the application or re-distribution of loads on the foundations;

b) downward movement of foundations due to a change in stiffness or vertical movement of the supporting ground; or
c) vertical decrease in soil volume that occurs in a soil under an applied static load owing to the slow time-related reduction in the volume of the voids, primarily due to a reduction in pore pressure (consolidation settlement)

3.24 shrinkage limit
empirically established moisture content of a soil at the boundary between the semi-solid and solid states

3.25 soil profile
record of the vertical succession of the different soil horizons as they occur at any particular location on site

3.26 suitable
capable of fulfilling or having fulfilled the intended function, or fit for its intended purpose

3.27 type 1 masonry building
building not used for storage or industrial purposes, and with masonry walls that are not supported by steel, concrete or reinforced masonry columns

NOTE Masonry walls in a type 1 masonry building rely on returns and cross walls for their stability, i.e. a cellular construction.

4 Requirements

4.1 General

4.1.1 Geotechnical site investigations shall, as necessary, be conducted in the following sequence:
a) preliminary investigation;
b) phase 1 detailed investigation; and
c) phase 2 detailed investigation.

4.1.2 Geotechnical site investigations shall be undertaken under the direction of one or more competent persons. Such persons shall be intimately involved in the design of the investigation, the gathering of data, the evaluation of factual data, the determination of interpretative data, the drafting of reports, and any interaction with the statutory councils and authorities that may be required.

4.1.3 Competent persons shall document and formulate all opinions and do so in such a manner that a peer review, if conducted on the same data, will arrive at substantially similar opinions.

4.1.4 Soil profiling and percussion chip logging on dolomite land shall be undertaken in accordance with the requirements of SANS 633.

4.1.5 Sites on dolomite land, which are recommended for township development, shall comply with the requirements of all the relevant parts of SANS 1936.

4.1.6 Sites on former mine land shall comply with the relevant national legislation (see foreword).

4.1.7 A competent person shall, in the case of contaminated land, demonstrate that the risk to the health and safety of occupants of all building types is acceptable and, where relevant, provide the relevant national authority (see foreword) with the distance and accompanying restrictions and conditions for comment relating to developments in close proximity to contaminated land and the workings of a mine.
4.2 Preliminary investigation

4.2.1 The preliminary investigation is commissioned by the client to establish whether or not a parcel of land is suitable for township development.

4.2.2 The investigator shall, with respect to a parcel of land identified by the client, make an initial determination during the preliminary investigation as to whether or not such land is acceptable for the development of a township.

4.2.3 The investigator shall, where necessary, as a minimum, in order to make the initial determination required in 4.2.2:

a) approach the following organizations, as necessary, in order to gather data:
   1) mining houses;
   2) the District Councils;
   3) the local authority or regional databank of geotechnical data;
   4) the Surveyor General;
   5) consultants who have previously worked in the area;
   6) the relevant national authority (see foreword); and
   7) the relevant national department (see foreword).

b) gather and assimilate available data pertaining to the site from the following sources, as necessary:
   1) orthophotographic coverage (scale 1 : 10 000) or satellite imagery (or both);
   2) aerial photographic coverage;
   3) geological data and mapping concerning the site and immediate environs;
   4) topographic maps;
   5) geohydrological data (regional and local in the case of dolomite land);
   6) mining data;
   7) geotechnical reports from surrounding developments, infrastructure, etc.;
   8) geotechnical problems previously recorded in the area, e.g. sinkholes in dolomite land, and seismic activity;
   9) any available regional geophysical data, such as regional gravity surveys, and aeromagnetic surveys; and
   10) seismological data.

c) review published geotechnical literature for the region;
d) analyse data and identify and categorize terrain types in accordance with the descriptions for designation and constraint given in table 1;

e) verify terrain types in the field and examine all visible data, including ground profile exposures, and the results of large scale ground excavation or alteration by means of borrow pits (or both), quarrying, mining, construction and related remedial works and rehabilitation that can be viewed and reasonably annotated on orthophotographs or aerial photographs;

f) indicate appropriate land uses; and

g) comment on potential sources of construction materials.

4.2.4 The investigator shall, where the land ownership history includes a mining operator, provide a properly documented record or site plan in which the surface footprint of the mining or quarrying or material borrow area (opencast pit) or the (underground) mining plan is indicated. The data should be presented on fully coordinated drawings, on aerial photographs or orthomapping, as relevant, based on the records of the relevant national authority (see foreword), other databases or mining sources.

4.2.5 The investigator shall document and report all findings and opinions in a written report that contains an executive summary followed by the standard section headings given in table 2, as relevant.

4.2.6 The report shall

a) include a discussion of the process followed to arrive at the terrain mapping units as outlined and defined in table 1;

b) include a locality plan of the site, complete with site boundaries, coordinates and property descriptions;

c) indicate topographic and geological conditions clearly on appropriately coordinated and scaled maps with superimposed or overlaid property boundaries;

d) discuss ground conditions in terms of the presence of outcrop and likely cover soils, the origin of which may be initially interpreted from maps, aerial photographs, orthophotographs, available information and observations from the walk-over survey or inspection;

e) provide a physical description of the surface soil condition, e.g. in alluvial floodplains, side gullies, undrained depressions or talus slopes, supported with photographic documentation of features of significance;

f) contain appropriate comments on the presence of prominent watercourses and preferred drainage routes;

g) present interpretations of groundwater seepage indications;

h) contain comments on the structural conditions of any buildings or improvements on the land as an indicator of the influence of ground conditions; and

i) include a drawing of the site showing terrain mapping units in accordance with the provisions of table 1, complete with approximate coordinates.

4.2.7 The report and all drawings shall be presented to the client in hard copy or electronic format (or both).
### Table 1 — Geotechnical constraints in urban development

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Letter</strong></td>
<td><strong>Description</strong></td>
</tr>
<tr>
<td>A</td>
<td>Collapsible soil</td>
</tr>
<tr>
<td>B</td>
<td>Seepage</td>
</tr>
<tr>
<td>C</td>
<td>Active soil</td>
</tr>
<tr>
<td>D</td>
<td>Highly compressible soil</td>
</tr>
<tr>
<td>E</td>
<td>Erodability of soil</td>
</tr>
<tr>
<td>F</td>
<td>Difficulty of excavation to 1.5 m depth</td>
</tr>
<tr>
<td>G</td>
<td>Undermined ground</td>
</tr>
<tr>
<td>H</td>
<td>Stability (dolomite land)</td>
</tr>
<tr>
<td>I</td>
<td>Steep slopes</td>
</tr>
<tr>
<td>J</td>
<td>Areas of unstable natural slopes</td>
</tr>
<tr>
<td>K</td>
<td>Areas subject to seismic activity</td>
</tr>
<tr>
<td>L</td>
<td>Areas subject to flooding</td>
</tr>
</tbody>
</table>

**NOTE 1** Areas should be designated by the numeral associated with the most appropriate descriptor in columns 3 to 5 followed by the letter associated with the constraint. For example, an area designated as Zone 2BF would be an intermediate class with anticipated seepage and excavation problems while an area designated as Zone 3B would be least favourable and not recommended for development due to surface water inundation.

**NOTE 2** More detailed information on undermined land can be obtained from Stacey, T.R. and Bakker, D. *The erection or construction of buildings and other structures on undermined ground.*

**NOTE 3** Undermining assessments should be carried out by persons with expert knowledge of such conditions.

<sup>a</sup> These areas are designated as 1A, 1C, 1D, or 1F where localized occurrences of the constraint might arise.
Table 2 — Standard headings associated with the reporting of preliminary investigations

<table>
<thead>
<tr>
<th>1 Section headings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Introduction</td>
</tr>
<tr>
<td>2 Terms of reference</td>
</tr>
<tr>
<td>3 Information</td>
</tr>
<tr>
<td>3.1 Sources of information</td>
</tr>
<tr>
<td>3.2 General location and description of site</td>
</tr>
<tr>
<td>3.3 Evaluation procedures used in the investigations</td>
</tr>
<tr>
<td>3.4 Geology and geohydrology of the site</td>
</tr>
<tr>
<td>3.5 Geotechnical conditions and constraints</td>
</tr>
<tr>
<td>3.6 Terrain mapping units</td>
</tr>
<tr>
<td>4 Impact of the geotechnical character of the site on township development</td>
</tr>
<tr>
<td>4.1 Land usage</td>
</tr>
<tr>
<td>4.2 Installation of services</td>
</tr>
<tr>
<td>4.3 Building construction</td>
</tr>
<tr>
<td>4.4 Other*</td>
</tr>
<tr>
<td>5 Conclusions</td>
</tr>
<tr>
<td>6 Recommendations</td>
</tr>
</tbody>
</table>

* Insert suitable additional headings here, as required.

### 4.3 Phase 1 detailed investigation

#### 4.3.1 General

The phase 1 detailed investigation comprises a stability investigation (if underlain by dolomite, limestone or undermined ground, or in undulating terrain where there is a potential for slope instability), and an investigation into the foundation characteristics of the near surface horizons.

The investigator shall, with respect to a parcel of land identified by the client during the phase 1 detailed geotechnical site investigation,

a) identify any potential hazards;

b) define the ground conditions, including detailed soil profile and groundwater occurrences within the zone of influence of foundation work;

c) broadly classify the land which is to be developed in accordance with the site class designations for single-storey and double-storey type 1 masonry buildings contained in SANS 10400-H;

d) determine the suitability of dolomite land for township developments and designate any dolomite land in accordance with the requirements of SANS 1936-1;

e) provide the geotechnical basis for safe and suitable land use planning, infrastructure design, type 1 masonry buildings, and the formulation of precautionary measures and risk management procedures; and

f) gather factual data which has a bearing on the installation of township services and the construction of type 1 masonry buildings.
4.3.2 Near surface soil horizons investigations

4.3.2.1 The investigator shall, as a minimum in non-dolomite land or dolomite land where the risk of sinkhole and doline formation is acceptable,

a) conduct a detailed geotechnical site investigation wherever feasible involving an in-situ evaluation of the ground profile to a minimum depth of 3.0 m or to the machine refusal depth at a frequency derived from table 3, representative sampling, laboratory testing and the analysis of physical and (basic) chemical properties of all representative soil horizons which can be expected to influence improvements to the land with regard to township development, at a frequency not less than that derived from table 4, including:

1) foundations and the structural nature of single-storey and double-storey type 1 masonry buildings;
2) construction of roads (surfaced and gravel);
3) excavations for and construction of buried services, including suitable trench backfills;
4) landslip (slope instability); and
5) present and past mining activities;

b) judge, in mine-related land, the long-term prognosis for excessive settlement and particularly differential settlement, which has the potential to compromise or negatively impact on a development due to factors such as:

1) water-bearing service disruptions arising from the loss of positive gradients or rupture due to ground settlement;
2) loss of positive stormwater run-off from zones of substantial settlement and resulting flooding, infiltration and exacerbated water-induced settlement;
3) loss of serviceability in structures due to rotation, tilt or settlement (or any combination thereof) even where structural distress is controlled by suitable foundation stiffness; and
4) restrictions that will inevitably be placed on housing development to mitigate the negative impacts of the settlement process;

c) prepare a comprehensive geotechnical report that

1) provides a description of the township and defines the extent and boundaries of the township;
2) describes the local geology;
3) presents the soil profiles encountered;
4) provides geotechnical interpretation of each soil profile type that is encountered;
5) provides provisional site class designation for single-storey and double-storey type 1 masonry buildings;
6) contains foundation recommendations in respect of each site class designation;
7) contains earthworks (materials) and excavation classifications in accordance with those contained in table 5 (machine excavation) or SANS 1921-5 (hand excavation) (or both), if so required by the client;
8) assesses the stability and related (geotechnical) parameters;

9) identifies conditions and constraints, such as mining-related problems, areas of outcrop, slope instability, contaminated land, unconsolidated fill, etc.; and

10) provides information on the drainage of the site.

NOTE The minimum extent of fieldwork and laboratory testing required is intended to give a minimum requirement of input data on the basis of which realistic engineering judgements can be made and site classification boundaries, which provide the client with a realistic sampling of the ground conditions, can be drawn. Obviously, where complex geological and topographic conditions exist, e.g. in mine-related land, uncontrolled fills (made-up ground without controlled compaction), or unstable slopes, or where soils are highly variable, supplementary work requiring additional input, deeper drilling or subsequent supplementary investigations can be anticipated.

<table>
<thead>
<tr>
<th>Study area ha</th>
<th>1.0</th>
<th>2.0</th>
<th>4.0</th>
<th>6.0</th>
<th>10.0</th>
<th>50.0</th>
<th>100.0</th>
<th>500.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum number of holes per hectare</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>0.5</td>
<td>0.35</td>
<td>0.5</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Table 3 — Minimum frequency of exploratory holes in near surface soil horizons

<table>
<thead>
<tr>
<th>Study area ha</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation indicator</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Consolidometer/swell(^a)</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Chemistry (see 4.3.2.2)</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 4 — Minimum test samples for different sizes of study areas

<table>
<thead>
<tr>
<th>Study area ha</th>
<th>Foundation indicator</th>
<th>Consolidometer/swell(^a)</th>
<th>Chemistry (see 4.3.2.2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 ≤ 20</td>
<td>6</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>21 ≤ 50</td>
<td>10</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>501 ≤ 1000</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

\(^a\) When physically feasible
Table 5 — Classification of material for machine excavation

<table>
<thead>
<tr>
<th>Excavation</th>
<th>Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restricted</td>
<td>Soft</td>
<td>Material which can be efficiently removed by a back-acting excavator of flywheel power &gt; 0,10 kW for each millimetre of tined bucket width.</td>
</tr>
<tr>
<td></td>
<td>Intermediate</td>
<td>Material which can be removed by a back-acting excavator of flywheel power &gt; 0,10 kW for each millimetre of tined bucket width, or with the use of pneumatic tools, before removal by a machine capable of removing soft material.</td>
</tr>
<tr>
<td></td>
<td>Hard rock</td>
<td>Material that cannot be removed without blasting or wedging and splitting.</td>
</tr>
<tr>
<td>Non-restricted</td>
<td>Soft</td>
<td>Material which can be efficiently removed or loaded, without prior ripping, by any of the following: a) a bulldozer or a track-type front-end loader with an approximate mass of 22 tonnes and 145 kW flywheel power. b) a tractor-scraper unit with an approximate mass of 28 tonnes and 245 kW flywheel power, pushed during loading by a bulldozer equivalent to that described in (a) above.</td>
</tr>
<tr>
<td></td>
<td>Intermediate</td>
<td>Material that can be efficiently ripped by a bulldozer with an approximate mass of 35 tonnes and 220 kW flywheel power.</td>
</tr>
<tr>
<td></td>
<td>Hard rock</td>
<td>Material that cannot be efficiently ripped by a bulldozer with an approximate mass of 35 tonnes and 220 kW flywheel power.</td>
</tr>
<tr>
<td></td>
<td>Boulder class A</td>
<td>Material containing more than a volume fraction of 40 % of boulders of size between 0,03 m$^3$ and 20 m$^3$, in a matrix of soft material or smaller boulders.</td>
</tr>
<tr>
<td></td>
<td>Boulder class B</td>
<td>Material containing a volume fraction of 40 % or less of boulders of size between 0,03 m$^3$ and 20 m$^3$, in a matrix of soft material or smaller boulders.</td>
</tr>
</tbody>
</table>

4.3.2.2 The investigator shall, as a minimum, arrange for laboratory test procedures (a), (b), (c) and (f) outlined below to be undertaken by an accredited testing laboratory on representative bulk, disturbed or undisturbed samples (or both) of all significant ground profile variants, in order to provide interpretative data for judging ground response to foundations, earthworks construction, excavation stability, chemical aggressiveness towards buried services, etc.:

a) particle size distribution or grading;
b) Atterberg limits;
c) moisture content;
d) compressibility or potential collapse;
e) swell under load;
f) pH and conductivity;
g) compaction (moisture:density relationship); and
h) California bearing ratio (CBR).

NOTE 1 Where aggressive environments are suspected or encountered, such soils should be evaluated in terms of the relevant test methods described in BS 1377-3, BRE Report 279, and BRE Special Digest 1.

NOTE 2 In-situ or geophysical testing (or both), as relevant, may be carried out in addition to laboratory tests at the discretion of the investigator.
4.3.2.3 The investigator shall document and report all findings and opinions in a written report containing an executive summary followed by the standard section headings given in Table 6.

Table 6 — Suggested headings associated with the reporting of phase 1 investigations

<table>
<thead>
<tr>
<th>Section heading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Introduction</td>
</tr>
<tr>
<td>2 Terms of reference</td>
</tr>
<tr>
<td>3 Information used in the study</td>
</tr>
<tr>
<td>4 Site description</td>
</tr>
<tr>
<td>5 Nature of investigation</td>
</tr>
<tr>
<td>6 Site geology and geohydrology</td>
</tr>
<tr>
<td>6.1 General</td>
</tr>
<tr>
<td>6.2 Soil profile</td>
</tr>
<tr>
<td>6.3 Groundwater table</td>
</tr>
<tr>
<td>7 Geotechnical evaluation</td>
</tr>
<tr>
<td>7.1 Engineering and material characteristics</td>
</tr>
<tr>
<td>7.2 Slope stability and erosion</td>
</tr>
<tr>
<td>7.3 Excavation classification with respect to services</td>
</tr>
<tr>
<td>7.4 Other&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>8 Site class designations</td>
</tr>
<tr>
<td>9 Foundation recommendations and solutions</td>
</tr>
<tr>
<td>10 Drainage</td>
</tr>
<tr>
<td>11 Special precautionary measures</td>
</tr>
<tr>
<td>12 Conclusions</td>
</tr>
<tr>
<td>13 Recommendations</td>
</tr>
<tr>
<td>– Appendices</td>
</tr>
</tbody>
</table>

<sup>a</sup> Insert suitable additional headings here, as required.

4.3.2.4 The report shall

a) describe and list the information assimilated and used in the study in section 3 (see Table 6);

b) provide particulars of site boundaries and a description of the property in section 4 (see Table 6);

c) describe the field investigation procedures used and laboratory tests undertaken in section 5 (see Table 6);

d) state engineering and material characteristics that will affect the development and construction, including the identification of conditions and constraints, such as mining-related problems, areas of outcrop, slope instability, contaminated land, and unconsolidated fill in subsection 7.1 (see Table 6);

e) evaluate and establish the potential for lateral soil movement arising from surface erosion, soil creep, talus movement and slope instability in subsection 7.2 (see Table 6);

f) establish the presence and extent of

1) permanent or perched groundwater;
2) the material likely to be encountered in service trenches, if so required by the client;

3) other properties of the material encountered on the site, if so required by the client;

g) assess, in accordance with SANS 1921-5, the suitability of the material in the upper 1.5 m of the site for excavation by hand in subsection 7.3 (see table 6), if so required by the client;

h) broadly classify the land which is to be developed in accordance with the site class designations for single-storey and double-storey type 1 masonry buildings given in SANS 10400-H;

i) discuss foundation recommendations in relation to SANS 10400-H, and provide geotechnical engineering data associated with the design of such foundations;

j) discuss the effect of both surface water (flooding and ponding) and groundwater (marshy conditions, underground erosion, hydrostatic pressure and fluctuating water levels) on the development, and comment on whether or not the groundwater will be potentially harmful with respect to buried concrete and steel;

k) contain all soil profiles and the results of laboratory and in-situ field tests, including penetrometer test results in an orderly manner in the appendices (see table 6);

l) include the following drawings:

   1) a locality plan of the site;

   2) a site plan showing positions of exploratory holes; and

   3) a soil map defining approximate boundaries of areas with common site class designations.

4.3.2.5 The investigator shall, where the land ownership history includes a mining operator, provide in the report details of depths of shallowest mining, backfill method and materials, the requirements of the relevant national authority (see foreword) or conditions of future land use and development (or both) and any investigation studies required to proceed with the development of such township.

4.3.2.6 Drawings shall be to a common scale, legible and easily reviewed. All drawings shall be correctly referenced with a clear indication of coordinates.

4.3.2.7 The report and all drawings shall be presented to the client in hard copy or electronic format (or both).

4.3.3 Stability investigations on dolomite land

The investigator shall undertake stability investigations of dolomite land in accordance with the requirements of SANS 1936-2 for a phase 1 detailed investigation.

Critical outcomes of the phase 1 investigations are the site class designations for single-storey and double-storey type 1 masonry buildings and, where applicable, dolomite area designations in respect of the site and individual erven, respectively.

4.4 Phase 2 detailed investigation

4.4.1 General

The phase 2 detailed investigation is commissioned by the client during the installation of township services to confirm the findings of the phase 1 investigations after the township has been pegged.
The investigator shall, with respect to a parcel of land identified by the client during this phase of the geotechnical site investigations,

a) confirm and refine the site class designations in respect of each stand so that, where so required by the client, the necessary documentation required for the enrolment of houses in terms of the relevant national legislation (see foreword) may take place; and

b) confirm the stability zoning in sites with D2, D3 and D4 dolomite area designations (see SANS 1936-1) and confirm that the mandatory precautions outlined in the phase 1 report have been observed.

4.4.2 Near surface soil horizons investigations

4.4.2.1 The investigator shall, as a minimum in non-dolomite land or dolomite land where the risk of sinkhole and doline formation is acceptable:

a) establish formal profiling procedures with the person responsible for the installation of township services so that the available trenching is optimally utilized within the construction framework and programme for profiling purposes;

b) coordinate activities associated with the profiling procedures;

c) observe and record soil profiles in exposed service trenches at not more than 100 m intervals or wherever soil type changes occur;

d) undertake, where justified, supplementary geotechnical site investigations;

e) arrange for undisturbed samples to be taken for a set of foundation indicator tests at a frequency of not more than one set for every five points profiled; and

f) record data on field sheets and record the points in the trenches which were profiled on a site layout plan.

4.4.2.2 The investigator shall prepare a brief report, as an addendum to the phase 1 report, which shall contain

a) a drawing indicating the location of the points profiled in the service trenches;

b) records of all profiles and tests; and

c) a marked up township layout drawing which confirms the site class designations of each individual stand.

4.4.2.3 The report and all drawings shall be presented to the client in hard copy or electronic format (or both).

4.4.3 Stability investigations on dolomite land

The investigator shall undertake stability investigations on dolomite land in accordance with the requirements of SANS 1936-2 for a phase 2 detailed investigation.

Critical outcomes of the phase 2 investigations are the site class designations for single-storey and double-storey type 1 masonry buildings and, where applicable, dolomite area designations in respect of the site and individual stands, respectively.
Bibliography

Standards

BS 1377-3, Methods of test for soils for civil engineering purposes – Chemical and electro-chemical tests.

Other publications


