

Engineering Geological models provide a detailed understanding of the geological, geotechnical and hydrological conditions of a site. This information is used to characterise the site and identify any potential hazards and risks.

1. PRELIMINARY ASSESSMENT

Proposed Development Review

- Review available development plan (earthworks, civil drawings etc)
- Develop an understanding of overall project objectives and elements

Desktop Study

- Review existing topographical models (Council contours, LiDAR etc)
- Review Regional Council Hazard and Heritage maps (GIS Maps)
- Review published geological maps (GNS Qmaps)
- Review recent and historical aerial imagery (Retrolens, Google Earth, National and Local Library's)
- Review services in the area (DBYD.co.nz)
- Review existing Geotechnical Investigation Data (NZGD, in-house archives)
- Review knowledge/experience of land owners

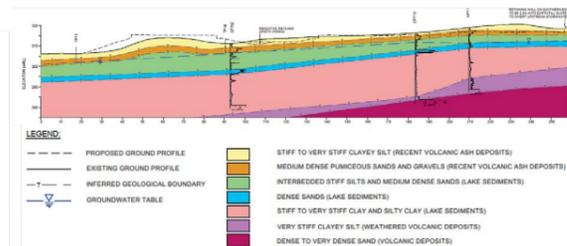
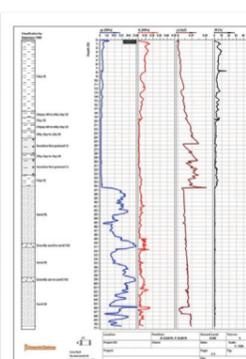
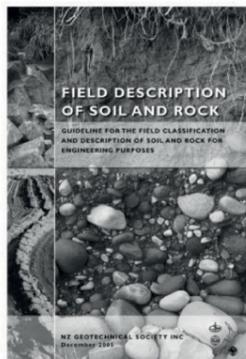
Development of Site Specific Assessment

- Are there areas identified within the desktop study that need to be targeted? (e.g. soft soils, tomos, unusual features, depressions, landslides/head scarps, springs, historic uncontrolled fills)
- What engineering understanding is required for the proposed development? (e.g. bearing capacity, settlement, groundwater, permeability, slope stability, seismic, liquefaction, reuse of material during earthworks)

Conceptual Ground Model

- Based on the desktop information develop a conceptual engineering geological model to anticipate what may be encountered during investigation. Consider the engineering significance of the conceptual model to the proposed development and from this identify key issues and uncertainties requiring investigation.
- Depending on the size and complexity of the project and the amount and quality of existing available data, a conceptual model may range from a simple sketch to a digital model. The conceptual model should clearly highlight areas of uncertainty.

DISCLAIMER: This reference guide is not a standard. It is a 'rough guide' based on common practice in New Zealand. The recommended calculation process/analytical methods within this document are not intended to be codified nor does the document hold any legal requirement/standing in New Zealand. The accuracy of the process described below depends highly on the expertise of the geotechnical engineer, the understanding of various soil models and their limitations, the selection of material parameters, and the ability to judge the results.
NOTE: Bold, underlined text contain hyperlinks to external sources. These hyperlinks are subject to failure should these posters be reviewed in print form.



NOTE: Figures sourced from Google Images or internal projects.
USEFUL REFERENCES: Baynes, F. J. and Parry, S. 2022. Guidelines for the Development and Application of Engineering Geological Models on Projects. IAEG Commission 25 Publication No. 1, 129pp. <https://www.iaeg.info/c25egmguidelines> Fookes et al. (2001). Total geological history: A model approach to understanding site conditions.

Investigation Requirements

- Use the conceptual ground model to design the site investigation. Consider what information will be required to be obtained to evaluate the uncertainties identified and information required to inform geotechnical analysis and design
- Investigations may include:
 - Topographic survey, drone surveys and remote sensing
 - Geological and geomorphological mapping
 - Intrusive techniques such as boreholes, test pits, hand augers
 - In-situ testing such as DCP, HSV, SPT, CPT, DMT, shear wave velocity
 - Geophysical methods such as MASW, GPR, Seismic
 - Instrumentation (piezometers, inclinometers)
 - Laboratory testing
 - Groundwater and surface water measurements

Rock & Soil Logging

- Logging in accordance with NZGS 2005 Guidelines

Onsite Mapping (geological and geomorphological mapping)

- How has the landform developed? Are there clues from current and historical geological and climatic processes?
- Regressive or progressive features / processes e.g. gullies, foreshore, aeolian, fluvial, alluvial.
- Evidence of groundwater (seepage; surface water features (open drains, swales, water bodies such as ponds, lakes, rivers, sea)
- Signs of instability e.g. landslip, tension cracks, tunnel gully erosion, ground subsidence, disturbed or rejuvenating vegetation, recent landform modifications, piping erosion / erosion, disturbed or rejuvenating vegetation, landform modifications.

3. DATA PROCESSING AND VERIFICATION

Laboratory Testing

- The testing required will depend on the specific geotechnical assessment requirements but will typically include but are not limited to: Soil classification, strength, compressibility, expansivity and compaction.

Processing Geological and Engineering Data

- Parametric assessment of investigation data.
- Process and publish the data in an effective format i.e. Geotechnical software (in AGS format).

Review Results

- Review of all investigation data to validate field interpretations of geological units, bedding, lithologies, weathering soil/rock strengths
- Identify any irregularities or uncertainties
- Review and validate laboratory and monitoring data to identify any irregularities or uncertainties

Cross Reference with Field Interpretation

- Cross reference field investigation data/interpretation with geological maps/literature (QMaps) and any other relevant information obtained during the desk study.

4. OBSERVATIONAL GROUND MODEL

Develop your Engineering Geological Model

Combine your conceptual model with your site investigation data to develop your observational ground model. This requires collation, interpretation and interpolation of all data, drawing on your observations of topography, geomorphology, geology, lithology and groundwater.

- To develop your engineering geological model requires you to identify the appropriate engineering geological units that reflect the interpreted ground conditions relevant to your project.
- Engineering geological units will vary depending on the significance to the project, but may be defined based on such things as lithology, strength/consistency, compressibility, weathering, alteration, and rock or soil mass conditions.
- When preparing your ground model, be sure to include all relevant ground information including groundwater levels, inferred/monitored or observed ground deformation zones/slip planes
- Engineering geological models may also present relevant geotechnical or geophysical information such as in-situ testing data, strength, shear wave velocity measurements.
- Where appropriate to do so, engineering ground models could be used to highlight specific layers and geotechnical risk such as identifying liquefiable soils, soft soils; and/or key geomorphological features such as tunnel gullies/tomos and tension cracks.
- An engineering geological model may also include relevant project information such as proposed design levels and structures, that illustrate how the development interacts with the ground.

Modelling

A variety of software tools are available to prepare your ground model. These will be selected based on the complexity of the model and the project and designers requirements.

- Simplistic 2D sections may be developed using AutoCAD, based on fence diagrams exported from logging software, or from hand drawn or digitised topographical cross sections (Inkscape, Adobe etc).
- 3D ground models are often selected for complex projects, where large data sets exist, and where there may be a large number of design elements and iterations required to be interrogated through exploring the ground model.
- 2D sections may be generated from the 3D ground models and are often transferable to analytical models.

- Ideally all ground models should show the relevant testing undertaken (showing the test labels and sticks, insitu test data, and offset distance (m) from the line of section drawn.) The sections should be developed to an appropriate scale, minimising vertical exaggeration where possible. Each cross section should be uniquely labeled and its location shown on investigation plan.
- Additional information may be necessary in order to supplement the geological model and sections in order to support, explain or highlight specific geological and geotechnical risks and uncertainties, such as:
 - Geomorphological Maps
 - Site investigation test location plans
 - Isopach maps (i.e. showing fill thickness, compressible soils, groundwater)
 - Block diagrams (i.e. to illustrate active surface and ground processes/stratigraphic relationships etc in a 3D perspective)
 - Geophysical data and sections
 - Historical imagery, drawings draped over a DEM to emphasise historical conditions or constraints.

Communicating ground risk and uncertainty

- All ground models are approximations, developed on the basis of interpretation of a finite amount of information and investigation data collected at discrete locations, applying knowledge and interpolation.
- It is the role of the engineering geologist and/or geotechnical engineer to identify, emphasise and communicate areas of ground uncertainty in the ground model such that appropriate risk management measures can be implemented during design and construction of a project.
- A project risk assessment should be conducted to evaluate the risk to the project from the identified ground uncertainties. The geotechnical risk assessment is typically undertaken by the project wide design team, involving the geologist and/or geotechnical engineer, and all client/stakeholders.
- Mitigation measures are developed based on the level of acceptable project risk, which may vary for each project, or for specific project elements.
- Ground uncertainties assessed as high risk may justify the need for further site investigation, whilst those assessed as lower risk may be managed through design (sensitivity analysis) or during construction.
- The risk assessment criteria should be developed based on the project specific requirements.