PART 2 : EARTHWORKS AND LAND STABILITY

2.1 INTRODUCTION

This section of the Manual sets out the basic design requirements for earthworks that are to be carried out as part of the development. Some construction information is included for completeness. However detailed information on construction standards is set out in Volume 3 — Standard Technical Specifications.

2.2 STANDARDS

The following NZ Standards shall be read concurrently with and apply to this part of the Design Guide:

NZS 4402 - Methods of Testing Soils for Civil Engineering Purposes
NZS 4431 - Code of Practice for Earth Fill for Residential Development.

2.3 SCOPE

This part of the Manual sets out the requirements for the design of earthworks or preparation for foundations, or both, including:

- The excavation and filling of land to form new contours
- The assessment and protection of slope stability
- The suitability of both natural and filled ground for the founding of roads, buildings, services and other works.

Because of the wide range of soil types, physical conditions and environmental factors applying in different areas of the city, it is not often possible to lay down precise requirements which will be applicable in all cases. The criteria set out in this section will be subject to the judgement of the Developer or Geotechnical Engineer.

2.4 GENERAL

Earthmoving activities are subject to both Regional and District Council approvals. Resource consents shall be obtained before commencement of site work.

Choice of final landform is dependent on many factors which may be specific to the subdivision. These include:

- Relation with surrounding landscape
- Size
- Roading pattern
- Preservation of natural features
- Stability

- Damage by flood or other natural occurrences such as erosion by sea, river, or surface water run-off.

The intent is that every lot shall contain a safe building platform suitable for the erection of building types appropriate to the zoning of the land.

All resource consent applications for land subdivision, or any other type of development where land stability needs to be addressed to ensure that the requirements of Council are met, shall be accompanied by a Statement of Suitability for Development (see Volume 4) relevant to the site. Council may request that a more detailed geotechnical report be undertaken to prove the suitability of the site for its intended purpose after evaluating the engineer's statement.

2.5 TECHNICAL RESPONSIBILITIES

Where any urban land subdivision involves carrying out bulk earthworks, the assessment of slope stability, or the detailed evaluation of the suitability of natural ground for the foundations of buildings, streets, services or other works, then a geotechnical engineer shall be appointed by the developer to carry out the following functions:

a) Prior to detailed planning of any development, to undertake a site inspection and such investigations of subsurface conditions as may be required.

b) To review the drawings and specifications defining the earthworks proposed, and submit a written report to the Engineer on foundation and stability aspects and any proposed departures from this Manual and associated standards.

2.5.1 Preliminary Site Evaluation

Prior to any detailed planning or design, the Developer or geotechnical engineer, as applicable, shall undertake a preliminary evaluation of the general nature and character of the site in sufficient detail to determine the likely requirements for earthworks or the need for further investigations into the suitability of foundation conditions, or both, and the stability of the natural ground. The preliminary evaluations should be carried out in the context of the total surroundings of the site. In simple cases a visual appraisal may be sufficient. In other cases, depending on the nature of the project, its locality, the scale of development proposed and individual site characteristics, particular attention may need to be given to the following matters, which should normally be considered prior to preparing a scheme of subdivision.

a) **Drainage**
It is important to identify the existing natural drainage pattern of any area and to locate natural springs or seepage.

Where any natural drainage paths are interfered with or altered by earthworks, appropriate measures should be taken to ensure that sufficient adequate alternative drainage facilities are provided.

Note: sub-soil drainage is subject to approval under the Building Act 1991. Building Consents shall be obtained before commencement of site work.

b) **Slope stability**
Some natural slopes exist in a state of marginal stability and relatively minor works such as trenching, excavation for streets or building platforms, removal of scrub and vegetation, or the erection of buildings, can lead to failure. Signs of instability include cracked or hummocky surfaces, crescent shaped depressions, crooked fences, trees or power poles leaning uphill or downhill, uneven surfaces, swamps or wet ground in elevated positions, plants such as rushes growing on a slope or water seeping from the ground.

c) **Foundation stability**
A study of the general topography of the site and its surroundings may indicate areas which have previously been built up as a result of natural ground movement or by the deliberate placing of fill material. Unless such fill has been placed and compacted under proper control, long-term differential settlement could occur causing damage to superimposed structures, roads, services or other subdivision works.

2.5.2 Specialist Services

Where a soils report is required, then prior to or at the time of applying for a subdivision consent, the developer shall submit to Council a written report from a geotechnical engineer setting out the particulars of any investigations carried out. The report should include details of contours, natural features and modifications proposed thereto, and include a statement from the geotechnical engineer as to the suitability of the land for subdivision, with details of any special conditions that should be imposed. A suitable format for this statement of opinion is included as Checklist 2.1 in Volume 4 — Quality Systems Manual.

2.6 PLANNING AND DESIGN

2.6.1 Landform

The final choice of landform should represent the most desirable compromise between taking account of the factors referred to in Section 2.5 and the preservation of natural features and the natural quality of the landscape including the retention of natural watercourses.

The choice of a suitable landform is dependent on many factors which may be specific to a particular site. In general unnecessary earthworks should be avoided but considerations which may justify the carrying out of earth- works include:

a) Minimising the possibility of damage to property occurring through ground movement in the form of slips, subsidence, creep, erosion or settlement.

b) Minimising the possibility of damage to property occurring through flooding, or surface water run-off.

c) The development of a more desirable roading pattern with improved accessibility to and within the site and the creation of a better sense of orientation and identity for the area as a whole.

d) Efficient overall land utilisation including the quality of individual sites and amenity areas around buildings, the economics of providing engineering services, and the standard of roading and on-site vehicular access.

e) The need to create suitably graded areas for playing fields and other community facilities.

f) The enhancement of the general environmental character of the area by softening the landscape or by artificially creating or emphasising landforms of visual significance, particularly on flat sites or on areas devoid of landscape features.

g) The safety of the site by incorporating CPTED (Crime Prevention through Environmental Design) principles. Refer Part 7 : Street Landscaping, Clause 7.2.1 for details.

2.6.2 Soils Investigations

Where appropriate the general nature and shape of the ground should be studied and particular note taken of:

a) the geological nature and distribution of soils;
b) existing and proposed drainage conditions and the likely effects on ground water;
c) the previous history of ground movements in similar soils in the area;
d) the performance of comparable cuts and fills (if any) in adjacent areas;
e) the existence of peat soils including consistency, depth and extent.

Soil data should be obtained for areas which are intended to:

a) form in situ bases for fills;
b) yield material for construction of fills;
c) be exposed as permanent batters.

Sufficient borings, probings, or open cuts should be made to:

a) classify the soil strata by field and visual methods;
b) evaluate the likely extent and variation in depths of the principal soil types;
c) establish the natural ground water levels.

The soil information thus obtained should form the basis for:

a) further sampling and testing which may be required on representative soil types;
b) relating subsequent soil test properties to relevant strata over the site.

The appropriate test data for different areas shall be determined by the soils engineer.

2.6.3 Stability Criteria

Settlement

The most important factor in ensuring satisfactory performance of stable fills is the limiting of post-construction differential settlements. The design and construction of fills should be such that these settlements are kept within acceptable limits.

Bearing capacity

The strength of the ground resisting general shear failure (and resulting gross deformation) under the footings of a house is a local phenomenon distinct from settlement. Fill constructed to minimise settlement in accordance with this Manual will have adequate shear strength.

Shrinkage and expansion

Where peat soils are present in the area of the subdivision then special provisions shall be made to limit drainage of the peat which would lead to shrinkage.

Slope stability

In most cases, it is unnecessary or impracticable to measure quantitatively the factor of safety of a slope against shear failure. Maximum slopes of cuts and fills may be determined by the geotechnical engineer from experience and from observation of slopes in the vicinity which have a long-standing history of stability, are of similar height to the proposed slope, and are of apparently similar geological formation.

Where necessary or where a precedent is not available, a special soils engineering investigation should be carried out by the geotechnical engineer to determine acceptable limits to cut and fill slopes. In assessing slope stability, account should be taken of possible future changes in ground water level or other conditions.