

## **PART B. EARTHWORKS DESIGN AND CONSTRUCTION**

### **CONTENTS**

<b>OBJECTIVES</b>	<b>2</b>
<b>B.1 DESIGN BASIS</b>	<b>2</b>
<b>B.2 SILT, SEDIMENT, EROSION AND STORMWATER CONTROL</b>	<b>3</b>
<b>B.3 DUST CONTROL</b>	<b>5</b>
<b>B.4 SITE PREPARATION</b>	<b>5</b>
<b>B.5 SITE WATER MANAGEMENT</b>	<b>7</b>
<b>B.6 FILL BATTERS</b>	<b>7</b>
<b>B.7 FILL MATERIAL</b>	<b>8</b>
<b>B.8 COMPACTION OF FILL</b>	<b>8</b>
<b>B.9 INSPECTION OF FILL</b>	<b>9</b>
<b>B.10 TESTING OF FILL</b>	<b>10</b>
<b>B.11 CUTS</b>	<b>11</b>
<b>B.12 WALLS</b>	<b>12</b>
<b>B.13 LOADING AND SPILLAGE</b>	<b>12</b>
<b>B.14 HOURS OF WORK</b>	<b>12</b>
<b>B.15 DURATION OF EARTHWORKS</b>	<b>13</b>
<b>B.16 PLANTING</b>	<b>13</b>
<b>B.17 CERTIFICATION OF SUITABILITY OF EARTH FILL</b>	<b>14</b>
<b>B.18 AS-BUILT REQUIREMENTS</b>	<b>14</b>

## OBJECTIVES

Earthworks are the removal, relocation or deposit of earth (which includes any substance constituting the land such as soil, clay, sand and rock) from a natural or constructed land formation. Topsoil stripping, turf farming, ground cultivation and quarrying are excluded from the definition of earthworks.

The objective of this chapter of the code is to ensure the following criteria are achieved:

- stability of land,
- geotechnical soundness and resilience of any development,
- control of the sediment generated by the works,
- restriction of erosion and run off from the works,
- control of the amount of sediment entering receiving environments,
- control of surface water flows both during and after construction,
- no undue nuisance from silt, dust, noise or disposal of vegetation,
- preservation of the natural land form and its features.

Developers shall comply with the earthworks provisions in the District Plan and the provisions of the Subdivision Design Guide. It should be noted that this may have an impact on the extent of earthworks which may be permitted.

### B.1 DESIGN BASIS

The design and construction of mass earthworks shall be in accordance with the requirements of NZS 4431:1989, "Code of Practice for Earth Fill for Residential Development" guided by, but not limited to NZS 4404:2010 Land Development and Subdivision Engineering and SNZ HB 44:2001, Subdivision for People and the Environment.

All works shall have regard for the following GWRC documents especially when watercourses and / or large scale earthwork are involved;

- Regional Freshwater Plan
- Regional Plan for Discharges to Land
- Regional Soil Plan
- Regional Air Quality Management Plan

## **B.2 SILT, SEDIMENT, EROSION AND STORMWATER CONTROL**

Erosion and sedimentation are two related processes:

- Erosion is the wearing away of the land surface by running water, wind, ice, or other agents, including processes such as gravitational creep. Any reduction of erosion will reduce the quantity of sediment generated.
- Sedimentation is the settling of sediment out of the water column as a result of sediment entering waterways.

Erosion and sediment control measures are used to minimise the effects of earthworks on receiving environments.

Principles of Erosion and Sediment Control;

1. Appropriately integrate the development into the site.
2. Integrate erosion and sediment control issues into site and construction planning.
3. Develop effective and flexible Erosion and Sediment Control (ESC) Plans based on anticipated soil, weather and construction conditions.
4. Minimise the extent and duration of soil disturbance.
5. Control water movement through the site.
6. Minimise soil erosion.
7. Promptly stabilise disturbed areas.
8. Maximise sediment retention on the site.
9. Maintain all ESC measures in proper working order at all times.
10. Monitor the site and adjust ESC practices to maintain the required performance standard.

A significant reduction in erosion on a site will result in less sediment being generated, requiring treatment and/or lost through the control measures than if reliance is solely placed on sediment control.

The erosion of soil and sediment from vegetation and earthworks is a problem throughout the Wellington Region.

All projects involving land disturbance should incorporate erosion and sediment controls as an integral part of land development. Activities in waterbodies require a range of control measures.

Adequate approved erosion and sediment controls shall be in place before earthworks commence, be maintained during the construction and only be removed once the site is fully stabilised to protect it from erosion.

Due to the increased rate of runoff brought about by the removal of vegetation and earthworks particular care must be taken to control surface water including stormwater.

Muddy or dirty water must be captured and treated before it drains into any watercourse or stormwater system.

Silt and sediment entering a waterbody can cause problems several kilometres downstream. The most obvious being colour change. Sediment can change flow patterns, cause flooding and also affect the health of aquatic ecosystems by smothering insects and other creatures.

It is required that best management practices are in place during the construction period of the development, including at site entrances and exits, to control all dust, silt and sediment generated by the works as to not discharge and cause nuisance away from the site or enter a water body or to Councils stormwater system.

To reduce the risk of erosion, the maximum area of vegetation stripped land being earthworked at any one time (including both cut and fill areas) must be kept to a minimum.

Land must be stabilised be it through revegetation or sealed as soon as possible.

All earthworked surfaces must be hydro-seeded as soon as practicably possible. No bare earth shall be left exposed longer than absolutely necessary.

Appropriate controls must be in place to cope with anticipated run off when the land is exposed to erosion. This must include suitable controls over any stockpiled topsoil or other fill material.

Adequate measures must be taken during the construction period to prevent excessive water logging of surface materials yet to be worked and to prevent fill material from being eroded and re-deposited at lower levels.

Greater Wellington Regional Council's documents, "Erosion and Sediment Control Guidelines for the Wellington Region" (September 2002) and "Small Earthworks: Erosion and sediment control for small sites" (June 2006), shall be used as guidelines.

### **B.3 DUST CONTROL**

All areas of major dust source including roads shall be kept damp during dry periods, or hydro-seeded in advance of anticipated dry periods, to minimise public nuisance from dust.

### **B.4 SITE PREPARATION**

Reference must be made to Greater Wellington Regional Council's Erosion and Sediment Control Guidelines for the Wellington Region before any earthworks are commenced.

Before any earthworks commence Site Management Plans which include plan drawings, timelines and layouts must be produced to the satisfaction of the Council. These are to be updated regularly with the details of the controls that are in place, and must be available upon request. All areas of cut and fill should be clearly defined in the Site Management Plans and marked on site.

It is favoured that a combination of control measures are investigated and used for optimum management of erosion and siltation. Adequate provision should be made for the control of erosion, surface water runoff and siltation prior to, during and after construction, as covered in section B.2 "Silt, Sediment, Erosion and Stormwater Control".

Avoid earthworks during autumn and winter. Avoid vegetation clearance during wet periods (between May and August in Wellington)

Large projects shall be programmed for earthworks in self contained stages which can be largely completed within one earthworks season.

Adequate fencing or barriers should also be provided around trees or other features that are to be protected.

Earthworks shall only commence after permission is granted from Council.

The site is to be adequately fenced / barricaded to safeguard other persons and private (or public) property both above and / or below the site and to prevent sediment from leaving the site.

All rubbish, vegetation, debris etc., must be removed from earthwork areas prior to topsoil stripping.

All earthwork areas must be stripped of all topsoil and any soft or organic material.

Special care should be taken to ensure that organic materials and areas of old uncompacted fill are not overlain by other soils.

Stripping shall be carried out as a specific operation with areas being stripped in large enough increments to ensure that there is an adequate margin of stripped ground beyond any current cutting or filling operation.

All stripped material must be deposited in temporary stockpiles or permanent dumps, in locations where there is no possibility of these materials being unintentionally covered over or incorporated into structural fills.

Stockpiles and building materials must not be stored on the footpath or within the road reserve without permission from Council.

All temporary stockpiles must be covered with tarps or similar to minimise losses.

Stockpiles must not be located within an overland flow path.

## **B.5 SITE WATER MANAGEMENT**

You can control surface water flows using swales, ponds, perimeter bunds, pipes or pumps.

Where possible, the permanent stormwater system should be designed so it can be constructed at an early stage in the project and be used to collect runoff from the site during construction in conjunction with silt and sediment control measures. This includes creating ponds for sediment control during construction which are used for on going stormwater quantity and quality control after development.

Where surface water could erode batters or affect their internal instability through soakage into the soil, open interceptor drains shall be constructed in permanent materials. Benches in batter faces shall be sloped back and graded longitudinally to reduce spillage of stormwater over the batter.

Water from stormwater systems shall not flow into a fill or onto ground near the toe or sides of fill or cut batters.

To prevent the problems of surface springs, scouring at the toe of fills, and saturated soil stability problems, it is essential that permanent subsoil drains be constructed in the valley floor and to other potential wet areas prior to fill being placed.

These drains shall be constructed as a public drain in accordance with Section D.

## **B.6 FILL BATTERS**

All fill batters shall be not steeper than 2 horizontal to 1 vertical with a bench of a minimum width of 2 metres every 8 metres of vertical height, with a fall inwards of 1 in 10 and longitudinally along the bench of 1 in 100 minimum to 1 in 20 maximum discharging to a point clear of the filling in such a manner as to prevent scouring. The top or toe of the batter shall be at least 3 metres from a boundary or building. This is in accordance with NZS4431: 1989 Code of Practice For Earth Fill For Residential Development.

Fill batters steeper than this will require specific design, e.g. high strength rockfill, reinforced earth.

The top edge of batters shall also be at least 1 metre from the kerb face or back edge of sealed path or 2 metres where it is anticipated that individual paths will be cut down the batter. The total height of fill batters shall generally be not higher than 15 metres.

## **B.7 FILL MATERIAL**

The quality of fill material shall be checked for suitability before the placing of fill commences.

The majority of soil types, other than organic materials, are potentially suitable for fillings under controlled conditions. However, because some clay soils are likely to undergo shrinkage and swelling when subjected to seasonal or other changes in water content, special examination of swelling and shrinkage characteristics shall be made in the case of highly plastic soils.

## **B.8 COMPACTION OF FILL**

Fill shall be placed in a systematic and uniform manner with near horizontal layers of uniform thickness (not greater than 225 mm) of material being deposited and compacted progressively across the fill area.

Before any loose layer of fill is compacted, the water content shall be suitable for the compaction required and shall be as uniform as possible.

Fill batter faces should be compacted as a separate operation, or alternatively, overfilled and cut back.

Where testing shows that the compaction achieved is below the specified minimum, all material represented by the test shall be further compacted or removed as necessary and re-compacted, until the required standard has been met.

Any compacted layer which has deteriorated after an interruption in the earth moving operation shall be re-compacted before further material is placed over it.

The minimum acceptable dry densities shall be as shown in *Table 1: Minimum Acceptable Dry Densities*.



Position of fill	Minimum acceptable dry density (As a percentage of the Maximum Dry Density <sup>1</sup> )
Within 0.6 metres (vertical measurement) of the road subgrade and extending to the outer edges of the footpaths.	100
Within 1 metre (vertical measurement) of the finished surface of all fill areas and within 3 metres (horizontal measurement) of all batter faces.	97
Elsewhere in the fill	95

**Table 1: Minimum Acceptable Dry Densities**

If cohesion-less soils are encountered and another test method would be more appropriate NZS 4431:1989 shall be used as a guide.

## B.9 INSPECTION OF FILL

Visual inspections shall be made and documented for inclusion with the application for Council certification under the RMA.

Work is to be signed off by the Council at least at the following times:

- a) After any part of the existing ground has been finally stripped and prepared and before the placing of any fill on that ground,
- b) After any drain has been installed and before the drain is covered by fill,
- c) Such other times as the Engineer considers necessary to enable an assessment of the general standard of earthworks and to be reasonable satisfied that:

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<sup>1</sup> The maximum dry density shall be determined by NZS 4402 Test 4.1.1 except that the soil water content shall be adjusted directly from the material water content to the compaction water content without prior drying.

- i) Fill is not placed over soft or organic material
- ii) All areas of existing ground showing seepage or potential seepage emission have relief drains provided
- iii) Unsuitable material is not incorporated into the fill
- iv) The compaction operations are systemic, the moisture content of the fill material appears on visual inspection to be suitable and the degree of compaction appears to be consistent and satisfactory.

## **B.10 TESTING OF FILL**

Testing shall be carried out and documented with respect to the following considerations and in accordance with the following times:

- a) During the construction of earth fills some or all of the following quality control tests shall be made on the fill material:
  - i) Tests to determine whether the moisture content is suitable for the type of material being used to achieve optimum density
  - ii) In-situ density tests to determine whether the degree of compaction is up to the specific minimum
  - iii) Where appropriate, test to determine the maximum dry density for the soil tested in each in-situ field density test.
  
- b) Once the filling work is progressing as a steady and acceptable operation with uniform construction methods the minimum frequency of control testing shall generally be one in-situ density test (or equivalent) for each 2,000 m<sup>3</sup> or 1.0 m lift of fill.

However, testing shall be more frequent under any of the following circumstances:

- i) During the first 4,000 m<sup>3</sup> of filling carried out on the project
- ii) On the final layer of not less than 1.0 m depth
- ii) When soil type or conditions are variable
- iv) When there is any doubt about the adequacy of construction methods or soil properties

- v) When relatively small quantities of fills are concentrated in localised areas or placed discontinuously over a long period of time.
- c) The location of tests shall generally be in a random manner to cover the whole area of the fill.
- d) All field and laboratory test data shall be recorded in a systematic manner that will allow the results to be identified and allow the calculations to be checked at a later date, if necessary. All control tests results shall have recorded the time, date, location and reduced level. Test results relating to sections of fill that have been subsequently removed or reworked and recompacted shall be noted accordingly.
- e) All field and laboratory test data shall be provided with the application for Council certification.

## **B.11 CUTS**

Cut batters shall be stable except for minor fretting and shall generally be not steeper than 1.0 horizontal to 1.5 vertical with a minimum width of 2.0 metres benching every 8 metres of vertical height. Steeper cut batters are generally not acceptable.

An area shall be provided at the top of cut batters that are steeper than 1 to 1 for the softer surface material to be cut back to a 1 to 1 batter.

The extent of this area shall be as follows:

- a) 1 m for batters up to 5 m in height
- b) 2 m for batters between 5 and 10 m in height
- c) 3 m for batters between 10 and 20 m in height

The top or toe of a cut batter shall be at least 2 metres from a boundary or building.

Buildings at the top of a cut batter shall be beyond a 45° line from the toe of the batter and buildings at the toe of a cut batter shall be beyond a 45° line from the top of the batter or side of the hill unless there is adequate walling or a qualified engineer certifies otherwise. The toe of a cut batter shall also be at least 0.3 metres from the kerb face or back edge of sealed footpath but additional allowance may be required for sight distance on a curve.

Cut batters shall generally be not higher than 20 metres, but if required, higher batters will be given special consideration and will require geological investigation.

## **B.12 WALLS**

All walls will require specific approval of the Council before construction, whether or not a Building Consent is required for the work.

All wall structures shall be designed for a 50 year or indefinite life period. All wall structures shall meet the New Zealand Building Code requirements for their design life.

Any sea walls shall be designed and constructed with future sea level rise taken into consideration.

## **B.13 LOADING AND SPILLAGE**

All loading shall be carried out on the Subdivider's land.

Special measures shall be taken to keep the streets safe and clear of mud and debris.

Adequate washing facilities or properly designed vehicle rumble pads shall be provided at all times on the construction site so that all vehicles are free from mud and debris when they pass onto the public streets. Where considered necessary properly formed, sealed or paved exit ways shall be constructed from the washing-down facilities to the public streets.

Any wash water, or other muddy water, must not be discharged to the stormwater system or waterbody without effective pre-treatment.

## **B.14 HOURS OF WORK**

The normal working hours for the carrying out of the earthworks on the site and the transport of excavated material from the site, are to be limited to:

- Monday to Saturday 7:30am to 6pm

- Quiet setting up of site (not including running of plant or machinery) may start at 6.30am
- No work is to be carried out on Sundays or public holidays.

These hours are taken from NZS 6803:1984 Acoustics: Construction Control. The measurement and assessment of noise from construction, maintenance and demolition work, which will also apply.

Where the noise is unlikely to cause a nuisance the Council may give approval to extend the hours of work. This approval will lapse should a nuisance be caused.

## **B.15 DURATION OF EARTHWORKS**

The work shall be programmed so that the duration of earthworks, between commencing and finishing, on any one stage/area shall not exceed six months.

## **B.16 PLANTING**

Areas of fill including batters and areas of cut but not including cut batters shall be prepared with topsoil. Minimum depth for topsoil is 300mm. This will depend on soil and species to be planted.

Those areas along with any other areas that have been disturbed, including cut batter faces, shall then as a minimum be sown or preferably hydro-seeded with grass as soon as a satisfactory strike is achieved.

Ideally the site will also be planted with native species. See section F for guidance on this matter.

Weeds must be controlled in an appropriate manner. Advice must be sought from Council for the best methods of control. Any spraying should be kept to a minimum near stormwater treatment devices, water courses and riparian margins.

Specific planting may be required for certain locations e.g. riparian planting in drainage situations and adjacent to open space. See section F.1 for guidance on this matter.

## **B.17 CERTIFICATION OF SUITABILITY OF EARTH FILL**

The Council requires certification of suitability of earth fill for residential development. Certification must be submitted and approved by the Council upon completion of the earthworks – refer to appendix B for a copy of certificate.

## **B.18 AS-BUILT REQUIREMENTS**

Council requires the following information concerning earthworks construction.

- 1) Extent and depth of fill in the form of lines joining all points of equal depth of fill at appropriate vertical intervals of 1 metre or as appropriate.
- 2) Plans shall also show the type of fill material and any areas where buildings or foundations will require specific design together with any fill areas of low density not complying with this Code.
- 3) The position, type and size of all subsoil drains and their outlets shall also be shown.
- 4) Where earthworks have been carried out a certificate of land suitability for residential development shall be supplied along with a report of the inspections and testing carried out. A recommended form of the certificate, Standard Form A/1, is in Appendix A. The type of residential development that earth fills shall be capable of properly supporting are residential buildings of timber or concrete block work conforming with the requirements of NZS 3604 or NZS 4229.

Dimensions and other information relating to the earthworks shall be provided.