

Earthworks Construction

1.1 Planning and Design



Road construction is a particularly important forestry operation to enable access to all stages of the forest cycle, from establishment through to tending and protection, and harvesting.

The construction of roads and *landings* can involve earthworks on steep, erosion prone terrain. These earthworks are recognised as a primary source of erosion and *sedimentation* from forests.

If not appropriately planned and managed, earthworks associated with plantation forestry can result in the following adverse environmental effects:

- Accelerated erosion due to slope instability and mass soil movements (e.g. collapse of slopes around cuts), and
- Excessive *sediment* discharges to sensitive areas (e.g. *rivers*) from exposed earth (e.g. through soil disturbance and slope failures).

Some natural slopes exist in a state of only marginal stability and relatively minor works such as trenching, excavation for roads or *landings*, or removal of scrub or vegetation can lead to failure.

This guide is provided as a reference document and does not constitute a statutory obligation under the Resource Management Act 1991 or the National Environmental Standards for Plantation Forestry.

Please refer to the 'how to use' section of the introduction at <http://docs.nzfoa.org.nz/forest-practice-guides/> for advice on how to use this guide.

Earthworks Construction

1.1 Planning and Design



Scope

This guide should be used for planning and designing all forest road earthworks. Users of this guide are also referred to the following useful references:

- National Environmental Standards for Plantation Forestry (regulations 22-35)
- New Zealand Forest Owners Association – New Zealand Forest Road Engineering Manual (2020)
- NZTA Standard Specification F/1 – Earthworks Construction
www.nzta.govt.nz/assets/resources/earthworks-const/docs/earthworks-const.pdf
- Guideline for the Field Classification and Description of Soils and Rock for Engineering Purposes: NZ Geotechnical Society, December 2005
www.nzgs.org/library/field-description-of-soil-and-rock-field-sheet



Earthworks Construction

1.1 Planning and Design



General planning and design considerations

Planning and design are important processes in mitigating the adverse effects of earthworks and ensuring cost effective, fit for purpose roading infrastructure is developed. These activities should be carried out by an experienced and/or qualified person, who can adequately address the following:

- 1. Road and landing design standards** – the first step in the design process is to confirm operating requirements and the design standards. Appropriate design standards will ensure fit for purpose infrastructure that is safe and efficient for road users and the harvesting operation, and is established whilst minimising the foot print (scale and extent) and environmental impact of the earthworks.
- 2. Site topography** – will influence the location/ position of road and *landing* infrastructure, and the earthworks construction techniques employed. Obtaining suitably detailed mapping and survey data is an essential step in the planning and design process. 1:5,000 scale topographical maps with 5 m contour are often used for planning, however more detailed topographical and engineering surveys may be necessary for the design of large scale and high risk earthworks.
- 3. Site geology** – the stability of steep slopes should be assessed during the planning phase and care taken to avoid, as far as practicable, locating infrastructure on high risk areas (terrain hazards) such as gully heads, landslide scarps (slips), earthflows or near *riparian margins*. Terrain models produced from LiDAR survey are particularly useful in identifying hazardous landforms and features such as hummocky surfaces and crescent shaped depressions. Field inspections will identify other signs, such as trees leaning uphill or downhill, *wetlands* or wet ground in elevated positions, plants such as rushes growing on a slope, and water seeping from the ground.
- 4. Water bodies and drainage** – avoiding *sediment* discharge to *water bodies* and protecting aquatic ecosystems is a critical element of road construction. The design process must consider the impact the construction and ongoing use of the road and *landing* infrastructure, will have on *water bodies*. The natural drainage patterns should be identified with roads positioned/ designed to cater for sensitive areas. During and post-construction drainage should aim to minimise stormwater *run-off* from exposed earth and cater for the safe disposal of stormwater.
- 5. Soil properties/geotechnical design** – soil classification and understanding slope stability are important factors in the design of earthworks. The Guideline for Field Classification and Description of Soils and Rocks for Engineering Purposes is a good reference document.

Earthworks Construction

1.1 Planning and Design



General planning and design considerations continued

- 6. Construction methodology (constructability)** – the design process should include a constructability review, considering the timing and sequencing of work, *road-line salvage* operations, the safe placement (disposal) of stumps and stripping, the disposal (dumping) of unsuitable material and cut to waste (end-haul). The review should be seen as a risk assessment.
- 7. Earthworks management** – effective earthworks projects include good production planning. The contractor needs to understand the designer's intention for the earthworks in order to plan and implement the earthworks successfully. This requires the designer to provide clear project specifications regarding the material and standard of workmanship required.




Earthworks Construction

1.1 Planning and Design




Recommended planning and design processes

 **Green zone: Low erosion susceptibility**

 **General**

Green zone areas are generally characterised by well-developed soils and stable geology. Green zones are not exclusive to flat and rolling contour and encroach into steeper hill country in some parts of the country. Whilst these steeper areas will typically be geologically stable, road and *landing* design needs to be managed carefully.

If good earthworks techniques are employed (FPGs Earthworks Construction), green zones should present a low erosion risk.

 **Forest engineering**

A basic understanding of local geology and soils is adequate.

 **Geometric design**

Not critical on flat to rolling contour. However, a simple road design may be necessary for an isolated section of road or *landing* located in difficult areas (i.e. adjacent to a *riparian margin*).

Note: green zone may reach into steep hill country. Detailed engineering design is recommended for green zone sites on steep slopes.

 **Construction specifications**

Operational prescriptions detailing the project requirements – including, but not limited to, material specifications and standards of workmanship – need to be provided to contractors and operators undertaking the work.

Earthworks prescriptions should specify the required cut and fill *batter* slopes, standards of *compaction*, and hold points for inspections and testing.

 **Survey and setting out**

The road centre-line or grade and *landing* locations should be flagged.

 **Yellow zone: Moderate erosion susceptibility**

 **General**

Yellow zone areas are generally characterised by rolling to moderately incised terrain, with well-developed soils and stable geology. If good earthworks techniques are employed (FPGs Earthworks Construction), yellow zones should present a low erosion risk.

Yellow zones encroach into steeper terrain in some parts of the country. Whilst these steeper areas will typically be geologically stable and present a reduced erosion risk than a red or orange zone, the design of roads and *landings* should be carefully managed on steep slopes.

 **Forest engineering**

A basic understanding of local geology and soils is adequate.

 **Geometric design**

Not critical on flat to rolling contour. However, a simple road design may be necessary for isolated sections of road or *landings* located in difficult areas (i.e. adjacent to a *riparian margin*).

Note: yellow zone may reach into steep hill country. Detailed engineering design is recommended for green zone sites on steep slopes.

 **Construction specifications**

Operational prescriptions detailing the project requirements – including, but not limited to, material specifications and standards of workmanship – need to be provided to contractors and operators undertaking the work. Earthworks prescriptions should specify the required cut and fill *batter* slopes, standards of *compaction*, and hold points for inspections and testing.

 **Survey and setting out**

The road centre-line or grade and *landing* locations should be flagged.

Earthworks Construction

1.1 Planning and Design



Recommended planning and design processes continued

Orange zone: High erosion susceptibility

General

Orange zones are characterised by rolling steep to incised terrain, with shallow soils and a shallow landslide risk. Soils become increasingly susceptible to slipping as the hill slope increases. Carrying out earthworks in an orange zone on slopes < 25 degrees represents a moderate but manageable risk, if good earthworks construction techniques are implemented.

Where the slopes are > 25 degrees the erosion susceptibility is higher and there are limits on the scale of earthworks that are permitted (refer to NES-PF regulation 24 (2) (c)). Resource Consent (Restricted Discretionary) will be required where the permitted activity thresholds will be exceeded – in these situations specialist advice should be sought. Consent applications will typically need to be supported by engineering design appropriate for the level of risk.

Forest /Geotechnical engineering

Soil classification and slope stability should be assessed. This information is required for the design of cut and fill *batter* slopes, specifying *compaction* standards for structural *fills*.

Geometric design

Geometric design is critical in orange zones with slopes > 25 degrees in order to confirm the scale and extent of earthworks meets NES-PF regulation 24 (2) (c). Designs developed using appropriate engineering design processes and tools (RoadEng, Civil 3D or similar) will optimise the road alignments.

Construction specifications

Operational prescriptions detailing the project requirements – including, but not limited to, material specifications and standards of workmanship – need to be provided to contractors and operators undertaking the work.

Earthworks prescriptions should specify the required cut and fill *batter* slopes, standards of *compaction*, and hold points for inspections and testing.

Survey and setting out

Consider pegging or flagging the extent of the earthworks at regular intervals (typically 20 m).

Red zone: Very high erosion susceptibility

General

Red zones are characterised by a combination of fragile, highly erodible soils and steep slopes. Carrying out earthworks in a red zone represents a significant risk. Resource Consent (Restricted Discretionary) will be required. Where earthworks in a red zone are necessary, seeking specialist advice should be considered. Consent applications will typically need to be supported by engineering design appropriate for the level of risk.

Forest/Geotechnical engineering

Soil classification and slope stability should be assessed. This information is required for the design of cut and fill *batter* slopes, specifying *compaction* standards for structural *fills*.

Geometric design

Geometric designs confirming the optimum road alignment and the extent and scale (volume) of the earthworks should be developed using appropriate engineering design processes and tools (RoadEng, Civil 3D or similar).

Construction specifications

Operational prescriptions detailing the project requirements – including, but not limited to, material specifications and standards of workmanship – need to be provided to contractors and operators undertaking the work.

Earthworks prescriptions should specify the required cut and fill *batter* slopes, standards of *compaction*, and hold points for inspections and testing.

Survey and setting out

The extent of the earthworks should be pegged or flagged at regular intervals (typically 20 m). The top of cut and the toe of *fill* slopes should be marked with *batter* pegs. Setting out should give consideration of the *road-line salvage* requirements and, where necessary, the extent of tree clearance marked.

Earthworks Construction

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Contact



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Other Practice Guides in this series



1.1 Planning and Design



1.2 Clearing and Stripping



1.3 Bulk Earthworks



1.4 Fill Placement and Compaction

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