# Earthworks

DIPL Roadworks Master – March 2022

## General

Gravel obtained from Pastoral Leasehold land is to be supplied at no cost to the Principal.

## Standards and Publications

Conform to the following Standard and Publication unless specified otherwise:

AS 1289 (set) Methods of testing soils for engineering purposes.

NTMTM NT Materials Testing Manual accessible via <https://dipl.nt.gov.au/industry/technical-standards-guidelines-and-specifications/materials-testing-manual>.

NTTM NT Test Methods

## Definitions

| **Table - Definitions - Earthworks** | |
| --- | --- |
| **TERM** | **DEFINITION** |
| **Carriageway** | That portion of a road for the use of vehicles including shoulders and auxiliary lanes. |
| **Formation** | The surface of finished earthworks on which a road pavement is constructed. It includes the earthworks (cut and fill), subgrade and the general shaping of the drainage. The formation width is therefore the distance of cut or fill including table drain(s), out to the points of any batters. |
| **Material Properties** | Intrinsic properties of the sourced material. These may differ from the properties required when the material is incorporated into the works. |
| **Offlet Drain** | Also described as a Table Drain Offlet. Provides relief at regular intervals of run off concentration in Table Drain. Drains water from Table Drain away from formation for dispersal into catchments. Also extends under footpaths, kerb and gutter, and surface structures. Includes the associated drain block to direct flow from the table drain into the offlet drain. |
| **Subgrade** | Top 150 mm of material below subgrade surface. Also known as subgrade layer. Subgrade placed against an existing pavement is to be compacted to 98% MMDD.  [Amend if different thickness of layer is to be specified] |
| **Subgrade Surface** | The prepared surface immediately beneath the pavement and shoulder layers. |
| **Surface Formation** | A road formation constructed from material generally cut from the table drains. |
| **Unpaved Areas** | Those areas within the road reserve boundary which are not part of the road pavement, including any medians not paved, but excluding footpaths and vehicle access strips. |
| **Unsuitable Material** | Any material that does not conform to the properties specified for the replacement materials to be used. If properties of the replacement materials to be used are not specified, then **Unsuitable Materials** are materials which do not conform to the properties specified for standard fill. |

## Earthworks In Cut

### Description

Operations necessary for excavation, irrespective of the type of material and subsurface conditions, including:

* working cuttings so that material meeting standard fill requirements is used for the subgrade;
* disposal of excess excavated material;
* trim and compact exposed surfaces – refer to the **Trim and Compact Unpaved Areas** clause in this work section;
* compaction of material below the subgrade surface; and
* shaping and trimming of formation within cuttings.

### Excess Material – Hold Point

Haul and dump and/or spread excess material at the following site(s): [enter data]

[If some excess material is to be spread and some to be stockpiled specify sites, indicating if they are for stockpiles or for spreading of excess material]

The material is to be; - Spread and sheeted with topsoil

- Stockpiled

[Delete option not required.]

Haul and dump and spread excess material:

* Not less than 125 metres from the new road centre line.
* To spoil dump sites specified. Clear site of organic material/topsoil prior to stockpiling material.

[If option two is used, ensure that site is specified. Delete option not required]

* Spread excess material and sheet with topsoil as specified.

[Delete if material is to be stockpiled]

Dumped material remains the property of the Principal.

Ensure dumps shall not dam surface water and streams or damage the works or other property.

Ensure dumping is not in streams.

Haul, dump and spread the materials in legally acceptable locations using legal methods.

Comply with AAPA clearances.

Comply with Environmental Management approvals, including within the road reserve.

**Hold Point -** Obtain approval from Superintendent prior to hauling, dumping and spreading excess material.

### Rock in Subgrade – Hold Point

**Hold point** - Obtain agreement from the Superintendent to the extent of the excavation.

Excavate rock encountered in the subgrade.

Avoid forming pockets of shattered material below the level of the excavation.

Remove all loose material.

Trim the excavation to shed water.

Replace excavated material with select fill compacted to 95% relative compaction.

### Unsuitable Material Below Subgrade Surface other than Rock – Hold Point

**Hold point** - Obtain directions from the Superintendent before works commence.

Excavate subgrade material which does not conform to the properties of standard fill as specified.

Dry out material with excessive moisture content to achieve a moisture content which permits specified compaction.

Replace excavated material with standard fill compacted to 95% relative compaction.

Floodways: Replace unsuitable material with material conforming with the following:

Angular or broken rock, free from organic matter and lumps of clay, complying with the ***Table – Grading - Suitable Fill Material Properties for Floodways*.**

|  |  |
| --- | --- |
| **Table – Grading - Suitable Fill Material Properties for Floodways** | |
| Maximum size: | 100 mm. |
| Plasticity Index: | 10 maximum. |
| Linear Shrinkage | 5.0 maximum. |
|  | |
| **AS Sieve (Mm)** | **Percentage Passing** |
| 75.0 | 40 ‑ 100 |
| 19.0 | 15 ‑ 50 |
| 2.36 | 0 ‑ 25 |

### Blasting and Overbreak

Ensure blasting is not excessive. There will be no payment for overbreak beyond the limits of excavation specified.

### Stability of Works, Rock Cuttings

Remove all loose material and rock which has been rendered unstable.

## Earthworks In Fill

### Description

Earthworks in fill includes preparation prior to filling, winning, hauling, placing, compacting, and trimming material on all prepared areas including holes, pits and other depressions.

### Preparation Prior to Filling – Hold Point

Subsequent to stripping of top layer apply a minimum of three passes with maximum mass compaction equipment.

**Hold Point -** Once moisture conditioned and compacted, subject each lot to a proof roll, with the Superintendent in attendance, as specified in the Proof Rolling sub-clause of the Conformance clause in this work section.

### Benching

Cut a bench at the toe of the lower side batter when natural surface inclines at steeper than eight horizontal to one vertical.

Ensure the bench slopes downwards towards the centre line of the road and is 3 metres wide to provide a sound key for the toe of the fill.

Terrace the existing surface where side slopes are steeper than three horizontal to one vertical to provide a key for the fill.

### Unsuitable Material Beneath Fill – Hold point

**Hold point** - Obtain directions from the Superintendent before works commence.

Remove unsuitable foundation material as directed before the fill is placed.

Replace excavated material with standard fill compacted to 95% relative compaction.

### Construction Methods

Fill by either the "Compacted Layer", "Rocky Material" or "Rock Fill" method.

Select appropriate method(s).

#### Compacted Layer Method

Use where material generally does not contain cobbles, boulders or broken rock.

* Deposit and spread the material in uniform level layers to a maximum thickness of 250 mm loose measurement for the full width of fill.
* Compact each layer to the specified compaction (refer ***Table - Dry Density Ratios for Conformance*** in CONFORMANCE TESTING) before placing the next layer.
* Use standard fill for the subgrade layer.

[Ensure this method is specified. Delete non‑relevant sentences where this is the only method specified]

#### Rocky Material Method

Use where material contains some cobbles and boulders (maximum size 600 mm) with sufficient fines for the work to be free of voids.

* Break up rocks bridging between adjacent material to prevent cavities being formed.
* Maximum rock dimension: 600 mm or one‑half the height of fill at the section where the rock is placed.
* Spread material in layers approximately equal to the maximum rock size.
* Work the rocky material in each layer until it is firm and unyielding.
* Construct to the bottom of the subgrade layer.
* Use standard fill for the subgrade layer

#### Rockfill Method

Use where material is predominantly cobbles or boulders with insufficient fines to fill voids.

* Place and work the material until interlock is achieved.
* Advance the fill by full width construction. Side dumping shall not be undertaken. The construction face shall be concave, with the shoulder face well in advance of the centre, except when filling in swamps or soft material when the advancing face ends shall be convex.
* Rock Dimensions;
  + Maximum vertical dimension: one‑third of the height of fill being placed.
  + Maximum horizontal dimension: one‑half of the height of the fill being placed.
* Construct to 300 mm below the bottom of the subgrade layer. Within 300 mm of the bottom of the subgrade layer use the Compacted Layer Method or Rocky Material Method, with a maximum particle size of 150 mm.
* Use standard fill for the subgrade layer.

[Delete Rocky Material and/or Rockfill Method where not required]

## Fill Material

The following material properties are the properties intrinsic to the materials and may differ from the properties required when the materials are incorporated into the works.

### General Fill

Use the best locally available material.

Use fill material, whether cut or borrow, that is free of organic matter and has a minimum soaked CBR at 95% MMDD of 20%, to AS 1289, and a plasticity index between 2% and 15%.

[To AS 1289. Ensure specified minimum CBR is consistent with locally available materials and the proposed pavement design]

### Standard Fill

Must be free of organic matter and conform to the following properties:

[Typical values]

|  |  |  |  |
| --- | --- | --- | --- |
| **Table - Standard fill properties** | | | |
| **Property** | | **Column 2** | **Default if no value shown in Column 2** |
| CBR 4 day soaked at 95% MMDD to AS 1289: | | [enter information] min. | 20 min. |
| Maximum Particle Size: | For subgrade layers | [enter information] mm | 50mm |
| For other than subgrade layers | [enter information] mm | 100 mm |
| Plasticity Index: | | [enter information] | 2% ‑ 15% |

[Determine in relation to locally available materials and proposed pavement design]

### Select Fill

[Do not delete this section without first ensuring that other sections of the Specification, such as the DRAINAGE WORKS Section are not referenced to it]

Select fill shall be comprised of gravel, decomposed rock or broken rock, free from organic matter and lumps of clay.

Conform to the following:

| **Table - Grading - Select fill** | |
| --- | --- |
| **AS SIEVE (mm)** | **% PASSING (DRY WEIGHT)** |
| 75.00 | 100 |
| 9.50 | 30 ‑ 100 |
| 2.36 | 15 ‑ 65 |
| 0.075 | 5 ‑ 25 |

|  |  |
| --- | --- |
| **Table – Select Fill Properties** | |
| CBR, 4 day soaked at 95% MMDD to AS 1289: | 30 minimum. |
| Plasticity Index: | 2 ‑ 15% maximum. |
| Linear Shrinkage: | 2 ‑ 6%. |

### Sand Clay Fill

[Delete subsection if it is not a permissible alternative]

Sand clay (clayey sand) may be used as an alternative to Select Fill.

Must be free of organic matter and conform to the following properties and grading:

|  |  |
| --- | --- |
| **Table – Sand Clay Fill Properties** | |
| CBR: 4 day soaked and 95% MMDD to AS 1289: | 30 minimum |
| Plasticity Index | 15% maximum |
| Linear Shrinkage | 1 ‑ 8% |

|  |  |
| --- | --- |
| **Table – Grading – Sand Clay Fill** | |
| **AS Sieve (mm)** | **% Passing (Dry Weight)** |
| 4.75 | 80 ‑ 100 |
| 2.36 | 60 ‑ 100 |
| 0.425 | 30 ‑ 60 |
| 0.075 | 14 ‑ 28 |

## Preparation And Maintenance Of Subgrade Surface

Trim, prepare, and maintain, subgrade surface to the required tolerances specified in this worksection, free of depressions, cracking, laminations, organic inclusions, and other defects. Surface to be formed and maintained to be free draining, and suitable for proof rolling.

Maintain and repair any damage to the prepared surface prior to placing further material.

## Earthworks For Drainage

Comply with the requirements of the Standard Specification for Environmental Management.

Gradients shown are in the ratio of Rise:Run.

### Stream Diversions

Excavate stream diversions as shown on the drawings.

[Delete if the drawings do not define the work]

Fill existing watercourses as shown on the drawings.

[Delete if the drawings do not define the work]

Divert streams temporarily where it is necessary for the construction of the work.

Ensure that existing waterways are not filled, altered, or diverted except where specified.

### Levees/Stop berms

Construct and trim levees/stop berms at locations to divert the water flow from the table drains into a stream or culvert or other approved location.

Construct using standard fill with a Plasticity Index of 6% minimum for all areas.

Compact in layers not exceeding 150 mm compacted thickness.

Construct in locations, and to dimensions shown on the drawings.

[Delete the last line if the drawings do not define the work]

### Table Drains

Construct to the dimensions shown on the drawings.

Grade to prevent ponding of water.

Trim and compact as specified in the **Trim and Compact Unpaved Areas** clause in this work section.

Discharge into culverts, offlet drains or watercourses.

### Table Drain Offlets

Divert table drains into offlet drains at intervals not exceeding 150 m [OR enter data] m, or as shown on the design drawings.

[Default 150 m. Enter information applicable]

Extend drains as far as is required to prevent ponding in the table drains, with the length to be a minimum of 50 m.

Ensure the capacity of the offlet is not less than the capacity of the table drain, and is of similar cross section and dimensions.

Align and grade offlet so that the water drains away without scour and damage to disperse as sheet flow or into natural watercourses. Gradient not to exceed 1:40 (1.5%).

Table drain offlets shall be trapezoidal in shape with not less than 2m flat bottom and batters shall not be steeper than 1 vertical to 3 horizontal.

Divert table drain offlets neatly around natural obstacles such as large rocks, and trees.

### Table Drain Blocks

Construct, or rehabilitate, and trim, table drain blocks at offlets.

Construct blocks from standard fill conforming to the following requirements:

* Plasticity Index 6% minimum for all areas.
* Length: To extend from edge of shoulder to top of outer table drain batter.
* Width: 3 metre minimum measured parallel to the road centre line.
* Height: To edge of shoulders.
* Compaction: Layers not exceeding 150 mm compacted thickness.

### Catch Drains

Construct catch drains prior to earthworks in cut.

Depth: 500 mm (minimum) into solid ground.

Gradients: Ensure free flow, prevent ponding of water, prevent scour.

Outlets: As terrain permits construct at frequent intervals to reduce scour. Construct a block on continuous grades to divert water into culverts or drains.

Offset: 2 m (minimum) and 4 m (maximum) beyond the edge of the cutting.

Divert the drain neatly around large rocks and trees.

## Widening Of Existing Formation

Cut back the existing formation and pavement as shown on the drawings by not less than 150 mm on each edge to sound densely compacted material to form a uniform edge (curved or straight where applicable).

Construct the widening by cutting and filling as specified.

## Trim And Compact Unpaved Areas

Shape, grade and compact as specified.

Unpaved areas include, but are not limited to, areas beyond the shoulders, and table drains.

Refer to ***Table – Test Frequencies for Soils – Part 3 of 3*** in CONFORMANCE TESTING.

Refer to ***Table – Dry Density Ratios for Conformance*** in CONFORMANCE TESTING.

## Surface Formation

### General

Form the road generally with material cut from the table drains, in accordance with the typical cross section.

Mix to a homogeneous material before compacting.

Allow for construction to the specified height above natural surface, either by local widening of table drains or importation of standard fill.

### Pastoral Access Roads

For in situ pavement materials comply with the following:

CBR 4 day soaked at 95% MMDD to AS 1289: 30 minimum.

Maximum particle size: 37.5 mm.

Plasticity Index: 4 ‑ 12%.

Alternatively sheet the in situ material with 150 mm imported material complying with the above, compacted to 95% relative compaction.

## Batter Protection By Grassing

For batter protection by grassing by hydroseeding method refer to LANDSCAPE.

Fill batters to have a surface layer 100 mm minimum thickness of stripped material.

[Indicate on cross sections and add note that this surface layer is additional to the specified cross section]

### Grassing

Batters to be treated from chainage [enter information] to chainage [enter information].

[Insert chainages or delete if indicated on drawings]

### Seed Mixture and Fertiliser

Provide certified seed complying with the requirements in the LANDSCAPE Section.

[Define which seed mix is to be used]

Fertiliser to comply with the ***Table - Fertilisers*** in the LANDSCAPE Section.

Apply at rate of [enter information] kg/ha.

[NPWS will only allow Rhodes grass seeds and seeds native to the parks. Ensure the LANDSCAPING Section is included]

### Grass Seed Application Technique

Conform to the LANDSCAPE Section.

Fabric protection to be used for all slopes steeper than 3:1. Fabric protection may consist of using jute mesh or equivalent in conjunction with hydromulching or the use of matting.

Smooth batters.

Form drains to control stormwater and prevent erosion until batter is grassed.

Place "top layer" soil from clearing operations over the batters to a depth of 50 mm.

Apply seed mixture, fertiliser, and protection. Establish grass and keep damp by watering until flowering stage is reached.

Repair any erosion.

Reseed areas until establishment is achieved.

### Acceptance

The minimum quality of grassing required for acceptance is;

* Establishment shall be uniform.
* Coverage rate: 98% minimum of total area.

## Bridge Foundations

### Conditions

The data shown on the drawings as to the character and depths of the various strata are approximate only, and no warranty, expressed or implied, is given by the Principal that the same or similar materials will be encountered during the progress of work.

Tenderers are advised to inspect copies of the bore logs and the original core samples.

Original samples are available for inspection at [enter information].

[Insert location]

### Excavation

#### GENERAL

The extent of foundations is specified by dimension and reduced level.

[Ensure that levels are given]

Excavate to the required lines and levels.

Dispose of excess material in accordance with the sub-clause ***Excess Material*** in the clause ***Earthworks in Cut*** in this worksection.

#### PREPARATION – Hold Point

Inspect and record the condition of all structures and services in the adjacent area prior to using pile drivers.

**Hold point** - Obtain Superintendent’s agreement with inspection record of current conditions.

Cut foundation to a firm surface either stepped or roughened, as directed.

Remove loose material.

**Hold point** - Obtain the Superintendent’s approval for the foundation surface before placing the blinding concrete.

Place a 50 mm thick layer of blinding concrete.

[Include if foundation is not homogeneous sound rock]

#### COFFER‑DAMS SHORING AND SHEETING

Design any coffer‑dams required for the execution of the works.

Construct coffer‑dams to adequate height and depth and as waterproof as necessary for proper performance.

Provide adequate clearance for:

* construction of forms;
* inspection of interiors; and
* pumping from outside the forms.

Remove shoring and sheeting from inside the excavation.

Remove coffer‑dams, sheeting and the like from the site when no longer required.

Do not damage the finished structure or disturb adjacent in situ material.

Remove obstructions from waterways.

### Backfilling

Backfill the excavation up to natural surface level with excavated material or select fill.

The excavated material may be used for backfill provided it is free of wood, other organic and other extraneous or deleterious material.

Mix to a homogeneous material before compacting.

Place in horizontal layers not exceeding 150 mm compacted thickness.

Compact to the density ratio specified in the ***Table - Dry Density Ratios for Conformance*** in the CONFORMANCE TESTING section.

Compact using equipment that will not damage the bridge substructure.

## Fill Adjacent To Bridge Structures

GENERAL

Fill includes preparation of the fill area, supply, placing and compacting fill, drainage layers and piping, disposal of unsuitable material and trimming and protection of batters.

[Delete processes not required]

Place select fill against structures after 14 days from date of casting or after test results confirm 70% of characteristic concrete strength achieved.

Avoid unbalanced loading on structures.

Do not operate mechanically driven vibrating rollers exceeding 1 tonne within 3 metres of the structures.

ABUTMENTS AND WINGWALLS

Prepare the area as specified.

Compact select fill in horizontal layers not exceeding 150 mm compacted thickness in areas adjacent to abutments and wing walls extending horizontally a distance equal to two times the height of the adjacent structure, or as specified.

Prevent water from ponding behind abutments and wing walls.

Provide weep holes and drain pipes as specified.

## Compaction

[Delete items not required. Edit specified compaction as required]

Mix to a homogeneous material and compact with no compaction planes and free of cracking to conform to the Dry Density Ratios specified in the ***Table - Dry Density Ratios For Conformance*** in the CONFORMANCE TESTING section and the following conformance clause.

## Conformance

### Existing Surface Levels – Witness Point

**Witness point** - Obtain inspections of any disputed existing surface levels with the Superintendent prior to any stripping or earthworks operations.

Quantities are based on the existing surface levels prior to the stripping of the top layer.

Allow for suitable material to replace the stripped layer (Cut and Fill) in the items for the EARTHWORKS Section.

[Delete when there is no stripping of topsoil]

### Tolerances

Finish earthworks to a smooth compacted and uniform surface within the following limits:

Formation Width: Not less than specified.

Subgrade Surface: Maximum 25 mm below and not above specified level.

Subgrade Width: Not less than specified. Extend 150 mm minimum beyond the back of kerb.

Delete when there is no kerbing]

Batter: Not steeper than the specified slope.

Maximum variation at any point from specified plane of batter shall be 150 mm in earth and 300 mm in rock.

Unpaved Areas/ Table Drain Invert:

Maximum 75 mm above or below specified level, free of depressions capable of ponding water. Maximum 40 mm adjacent to kerbs.

Works must also conform to the requirements in***Table – Relative height tolerances for new works abutting existing works*** in PAVEMENTS AND SHOULDERS.

### Proof Rolling – Hold point – Witness Point

Proof roll all areas to the satisfaction of the Superintendent.

**Hold point** - Submit a proof rolling procedure to the Superintendent for approval including the proposed method of preparing the areas, the extent of proof rolling, and details of the plant and / or equipment proposed to be used.

**Plant Requirements**

Use plant in proof rolling procedures that comply with the following requirements:

* For urban areas only, fully loaded water cart, minimum size 12tonne, on standard pneumatic road tyres, fully inflated.
* Fully loaded, minimum single trailer articulated heavy vehicle, on standard pneumatic road tyres, fully inflated.
* Pneumatic tyred compaction plant with a mass of not less than 20 tonnes and with a ground contact pressure under either the front or rear wheels of not less than 450 kPa per tyre and a ground contact area of not less than .035 m2 per tyre.
* Do not use flat drum rollers.

**Witness point** - Give the Superintendent not less than 24 hours notice of the location and commencement time for the proof rolling. Give 48hrs notice for remote work (greater than 5hrs travel one way from regional centre).

Check areas for level tolerance and layer thickness before proof rolling.

Proof roll each layer immediately following completion of compaction. If proof rolling is carried out at a later time, water the surface and roll with the test roller prior to commencement of proof rolling.

Compliance; the proof rolling requirements are deemed to comply when an area withstands proof rolling without visible deformation or springing.

Provide uniform and stable support for rear wheel loads when at walking pace.

Remedial work; remove and reconstruct areas that deform or break up.

### Conformance Testing – Hold point

Ordering procedures; refer to the CONFORMANCE TESTING section for testing requirements and test ordering procedures.

**General Fill**

Conformance testing will be carried out on each layer of fill.

**Subgrade**

Subgrade surface will be tested only when it is within level tolerance and conforms to proof rolling.

Check subgrade surface levels prior to testing.

**Hold Point** – Obtain the Superintendent’s approval of subgrade conformance prior to placing further material.