# Brisbane City Council

# Reference Specifications for Engineering Work

# S140 EarthworksB

## Amendment Register

|  |  |  |  |
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| 3.4 | Requirement to protect existing services |
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## TABLE OF CONTENTS

1.0 GENERAL 1

1.1 SECTION CONTENT 1

1.2 Standards 1

1.3 References 2

1.4 Definitions 2

1.5 Measurement 3

2.0 QUALITY 3

2.1 Inspection 3

2.2 Samples 3

2.3 Contractor’s Submissions 4

3.0 SITE MANAGEMENT 4

3.1 Tree Protection 4

3.2 Trees to Be Retained 4

3.3 Work Near Trees 5

3.4 Existing Services 5

3.5 Dewatering 5

3.6 Site Restoration 6

4.0 SITE CLEARING 6

4.1 Site Clearing 6

4.2 Removal Of Topsoil 6

4.3 Stockpiles 6

5.0 TOLERANCES 6

6.0 Compaction 7

6.1 Method of Compaction and Testing 7

6.2 Compacted Layer Method Of Construction 7

6.3 Mechanical Interlock Method Of Construction 8

6.4 Density and Moisture Requirements 8

7.0 EXCAVATION 9

7.1 General 9

7.2 Surface Drainage 10

7.3 Provisional Depths 10

7.4 Explosives 10

7.5 Bearing Surfaces 10

7.6 Reinstatement of Excavation 10

7.7 Adjacent Structures 11

7.8 Non-Rippable Material 11

8.0 FILLING 12

8.1 Fill Material 12

8.2 Preparation for Filling 12

8.3 Geogrids 13

8.4 Placing Fill 13

9.0 SUBGRADE PREPARATION 13

10.0 DRAINAGE AND OTHER SERVICETRENCHES 14

11.0 service conduit installation 14

12.0 Geotextiles 14

13.0 GABIONS AND MATTRESSES 16

13.1 Materials 16

13.2 Execution 16

14.0 ROCK SCOUR PROTECTION 17

15.0 ROCK FILLING 17

16.0 Barriers and membranes 18

17.0 RETAINING WALLS 18

17.1 Crib Walls 18

17.2 Earth Reinforcement 18

18.0 GROUND ANCHORS 19

18.1 General 19

18.2 Execution 19

## GENERAL

### SECTION CONTENT

Ground works generally, protection of trees, site clearing, excavation, placing and compacting fill, installation of geotextile, gabions and mattresses, sluiced rock fill, crib walls, earth reinforcement and ground anchors.

Drainage and service trenches and installation of service conduits is now contained in *S145 Installation and Maintenance of Utility Services*,

### Standards

|  |  |  |  |
| --- | --- | --- | --- |
| Australian Standard | AS 1141.22 | Methods for sampling and testing aggregates - Wet/dry strength variation | |
| Australian Standard | AS 1289.5.8.1 | Methods of testing soils for engineering purposes – Soil compaction and density tests – Determination of field density and field moisture content of a soil using a nuclear surface moisture – Density gauge – Direct transmission mode | |
| Australian Standard | AS 1289.5.1.1 | Methods of testing soils for engineering purposes – Soil compaction and density tests – Determination of the dry density/moisture content relation of a soil using standard compactive effort | |
| Australian Standard | AS 1289.5.3.5 | Methods of testing soils for engineering purposes – Soil compaction and density tests – Determination of the field dry density of a soil – Water replacement method | |
| Australian Standard | AS 1289.5.4.1 | Methods of testing soils for engineering purposes – Soil compaction and density tests – Compaction control test – Dry density ratio, moisture variation and moisture ratio | |
| Australian Standard | AS 1289.5.5.1 | Methods of testing soils for engineering purposes - Soil compaction and density tests – Determination of the minimum and maximum dry density of a cohesionless material – Standard method | |
| Australian Standard | AS 1289.5.6.1 | Methods of testing soils for engineering purposes – Soil compaction and density tests – Compaction control test – Density index method for a cohesionless material | |
| Australian/New Zealand Standard | AS 1289.5.8.4 | Methods of testing soils for engineering purposes - Soil compaction and density tests - Nuclear surface moisture-density gauges - Calibration using standard blocks | |
| Australian/New Zealand Standard | AS/NZS 1594 | Hot-rolled steel flat products | |
| Australian Standard | AS 1726 | Geotechnical site investigations | |
| Australian Standard | AS 1744 | Standard alphabets for road signs | |
| Australian Standard | AS 2423 | Coated steel wire fencing products for terrestrial, aquatic and general use | |
| Australian Standard | AS 2868 | Classification of machinery for earthmoving, construction, surface mining and agricultural purposes | |
| Australian Standard | AS 3600 | Concrete structures | |
| Australian Standard | AS 3706 | Geotextiles – Methods of test | |
| Australian/New Zealand Standard | AS/NZS 4534 | Zinc and zinc/aluminium-alloy coatings on steel wire | |
| Australian Standard | AS 4678 | Earth-retaining structures | |
| Australian Standard | AS 4680 | Hot-dip galvanized (zinc) coatings on fabricated ferrous articles | |
| Australian Standard | AS 5100.3 | Bridge design - Part 3: Foundation and soil-supporting structures | |
| Australian/New Zealand Standard, International Standards Organization | AS/NZS ISO 9001 | | Quality management systems – Requirements |

### References

|  |  |  |  |
| --- | --- | --- | --- |
| Queensland Department of Transport and Main Roads | Technical Specification | MRTS06 | Reinforced Soil Structures |
| Queensland Department of Transport and Main Roads | Technical Specification | MRTS58 | Subgrade Reinforcement using Pavement Geosynthetics |
| Brisbane City Council |  |  | Standard Drawings; |
| Brisbane City Council | Procedure | OS21 | Tree Removal and Replacement Procedure |

Refer to the following other Reference Specifications for Engineering Work:

|  |  |
| --- | --- |
| S110 | General Requirements |
| S120 | Quality: Process |
| S145 | Installation and Maintenance of Utility Services |
| S150 | Roadworks |
| S160 | Drainage |
| S170 | Stonework |
| S180 | Unit Paving |
| S190 | Landscaping |
| S200 | Concrete Work |
| S300 | Quarry Products |

### Definitions

Description and classification of soils: To *AS 1726*.

Bad ground: Ground unsuitable for the purposes of the Works, including filling liable to subsidence; ground full of vegetative matter; ground containing cavities, faults or fissures; ground contaminated by harmful substances including oil, cement and chemicals; ground containing acid sulphate soil; or ground which is or becomes soft, wet and unstable; and the like.

Non-rippable material: As defined in *Clause* *7.8*.

Line of influence: A line extending downward and outward from the bottom edge of a footing, slab or pavement and defining the extent of foundation material having influence on the stability or support of the footings, slab or pavement.

Subgrade: The prepared formation on which a pavement or slab is constructed or the top portion of earthworks immediately below the pavement or slab. Subgrade is considered to be the top 150 mm in cuttings and the top 300 mm in embankment unless stated otherwise.

Subgrade level: The top surface of the prepared subgrade on which a pavement or slab is constructed.

Relative compaction: The ratio between the field bulk density and the bulk density of the material when compacted in the laboratory.

Critical zone (trees): The area described by the greater of the vertical projection of the canopy or a radius of ten times the tree trunk diameter and extending to a depth of 750 mm below the ground.

### Measurement

General

If provisional quantities are specified, or there have been variations to the contract dimensions of excavations, do not commence backfilling or place any permanent work in excavations until the quantities of excavation and backfilling have been agreed and recorded.

Measurement of non-rippable material

If payment is to be claimed for excavation in non-rippable material, do not remove the material until the level and (if applicable) class of material have been determined.

## QUALITY

### Inspection

Witness points

*Refer annexure*. Give sufficient notice so that inspection may be made of the following stages:

* Protection measures in place for trees to be retained.
* Areas to be cleared and/or stripped of topsoil marked out.
* Excavation completed to contract levels or founding material.
* Subgrade material opened up so that its nature can be assessed.
* Geotextile in place prior to backfilling.
* Reinforced earth wall faces at the factory ready for delivery to site.
* At the commencement of installing reinforced earth wall faces.

**Hold points**

*Refer annexure*. Do not proceed without approval. Give sufficient notice so that inspection may be made at the following stages:

* Subgrade ready to receive sub base, base, working base, geotextile or membrane, as applicable.
* Proof rolling of the completed subgrade surface.

Immediate notice

If rock or bad ground is encountered, give notice immediately and obtain instructions.

### Samples

General

*Refer annexure*. Submit to the testing authority samples of the following:

* Each type of imported fill.
* Each type of excavated material, which is to be re-used as select fill or embankment fill in the Works.

Identification

Attach a tag to each sample showing relevant information including description, source and nominal size of material.

Earth reinforcement

Provide samples of the following, before fabrication commences:

* Facing unit (at the approval of the Superintendent, facing units of the same design installed at a nearby project may be used in lieu of the facing unit sample).
* Reinforcing anchor to facing unit joint

### Contractor’s Submissions

Design

Ground anchors: Submit all details of the proposed ground anchor system prior to commencement of work.

Crib walls: Submit an engineer's certificate confirming stability of the completed design.

Earth reinforcement: Submit an engineer's certificate confirming compliance with Queensland Department of Transport and Main Roads standard specification *MRTS* *06 Reinforced Soil Structures* and this specification.

Materials

Imported materials: Notify the supplier, source and suppliers description of all imported materials.

Recycled products: Notify the nature, source, proportions and method of incorporation of any added fillers or binders.

Imported fill: Submit certification or test results, which establish the compliance of imported fill.

## SITE MANAGEMENT

### Tree Protection

Warning sign

General: Display a sign, in a prominent position at each entrance to the site, warning that trees and planting are to be protected during construction. Remove on completion.

Lettering: Road sign type sans serif letters, 100 mm high, in red on a white background, to *AS 1744*.

### Trees to Be Retained

Requirement

Retain all trees outside the site. Retain all trees within the site that are shown on the Drawings to be retained and any others that it is not necessary to remove. *Refer annexure*.

Marking

Mark trees to be retained within the site by visible, durable tags lettered to conform with the tree number (if any) on the Drawings. Secure the tag to the tree by a loose band of yellow plastic “barrier tape”. Remove the tags on completion.

Protection and repair

Protection: Protect from damage the trees and shrubs that are to be retained, including those beyond the site area, both above and below ground.

Repair: Repair trees damaged during the work by a certified arborist.

Tree enclosure

Location: Erect fence around trees to be retained within the site, and around trees outside the site but within the operating range of machinery.

Fencing: Provide a minimum 1.8 m high rigid fence. Install protective device before commencement of work and remove on completion.

Large ovate tree canopy: Erect fence at the tree drip line perimeter.

Column type tree canopy: Erect fence at varying distances from the stem, depending on the tree diameter in terms of depth breast height. Provide minimum clear distances of 3 m for tree diameter up to 30 cm, 4 m for tree diameter greater than 30 cm and up to 50 cm, and 5 m for diameter larger than 50 cm.

Removal

If repair work is impracticable, or is attempted and is rejected, remove the tree (including the root system if directed), make good, and either replace the tree with a replacement tree of the same species and similar size, or pay damages. Calculate the value of any tree removed in accordance with Council’s *OS21 Tree Removal and Replacement Procedure*. *Refer annexure.*

### Work Near Trees

Harmful materials

Do not store or place harmful materials under or near trees. Prevent wind-blown materials such as cement from harming trees and plants.

Damage

Prevent damage to tree bark. Do not attach stays, guys and the like to trees.

Work under trees

General: Do not add or remove topsoil within the drip line of trees. Do not place temporary fill against tree trunks.

Excavation: Open up excavations under tree canopies for as short a period as possible.

Hand methods: Use hand methods to locate, expose and cleanly remove the roots on the line of excavation. If it is necessary to excavate within the critical zone, use hand methods such that root systems are preserved intact and undamaged.

Roots

Where it is necessary to cut tree roots in excess of 50 mm diameter, use means such that the cutting does not unduly disturb the remaining root system. Immediately after cutting, apply a bituminous fungicidal sealant to the cut surface.

Backfilling

Backfill excavations around tree roots with a mixture consisting of three parts (by volume) of topsoil and one part of well rotted compost with a neutral pH value, free from weed growth and harmful materials. Place the backfill in layers each of 300 mm maximum depth and compact to a dry density similar to that of the surrounding soil. Immediately after backfilling, thoroughly water the root zone surrounding the tree.

Compacted ground

Avoid unnecessary compaction of the ground under trees. Do not stockpile materials within the drip line. Do not permit vehicles or machinery to be parked within the drip line. Do not permit vehicles or machinery to pass under trees if practicable alternatives exist. If compaction (of areas within the drip line but not occupied by the Works) nevertheless occurs, seek instructions.

### Existing Services

Approval: Obtain approval from service owner to undertake excavation near to their services.

Marking: Before commencing ground works, locate, mark and identify existing underground services in the areas that will be affected by the earthworks operations. Hand excavation of trial holes may be necessary to determine the alignment and depth of services prior to excavating with machinery.

Protection: Protect existing services from damage during the works.

Completion: Prior to completion of surface reinstatement, remove any temporary marks (eg paint) used to locate, mark and identify underground services.

### Dewatering

Keep earthworks free of surface water. Provide and maintain slopes, crowns and drains on excavations and embankments to ensure satisfactory drainage. Place construction including filling, paving, structures and services, on ground from which surface water has been removed. Protect freshly laid work from water damage.

### Site Restoration

Requirement

Where existing ground surfaces are not required to be varied as part of the Works, restore them to the condition existing at the commencement of the work under the Contract.

## SITE CLEARING

### Site Clearing

Timing

Do not clear any area until commencement of other work in the area is imminent.

Extent

General: Clear only the site areas to be occupied or affected by the Works and any other areas that the Contract specifically requires to be cleared.

Contractor's site areas: If not included within the areas specified above, clear generally only to the extent necessary for the performance of the Works.

Clearing operations

General clearing: Remove everything on or above the site surface, including rubbish, vegetable matter and organic debris, scrub, trees, timber, stumps, boulders and rubble. Remove standing grass to a depth just sufficient to include the root zone. Strip surface grasses with the topsoil.

Grubbing: Grub out stumps and roots over 75 mm diameter to a minimum depth of 500 mm below subgrade of buildings and pavement, or 300 mm below finished surface in other areas.

Old works: Remove old slabs, foundations, retaining walls, paving, abandoned services and the like to a depth of 300 mm below existing or finished surface or 500 mm below subgrade level (whichever is lower).

Refilling: Unless otherwise specified, refill grub holes and the like with material similar to the surrounding soil.

### Removal Of Topsoil

Extent

Remove topsoil to a depth of 100 mm from site areas to be occupied or affected by Works such as structures, paving, excavations, embankments and regrading and any other areas the Contract requires. If topsoil extends to a depth greater than 100 mm, obtain direction.

### Stockpiles

Wherever practical, transfer topsoil directly for use as planting media. Where stockpiling of topsoil is required, establish stockpiles in approved locations, to heights not exceeding 1.5 m. Provide adequate drainage and erosion protection. Do not burn off to remove plant growth that may occur during storage. Do not allow traffic on stockpiles. If a stockpile of topsoil is to remain for more than four weeks, sow with temporary grass.

## TOLERANCES

Surface level

General: Provide finished subgrade that is evenly graded between level points, free draining and conform to the required tolerances.

Smoothness: As normally produced by a grader blade (except for batters without topsoil).

Tolerances: The limits in the Table 5.1 apply to the finished surface unless overridden by the requirements for the finished level and thickness of the surfacing.

Table 5.1 – Tolerances

| Item | Level tolerance | |
| --- | --- | --- |
| Absolute | Relative to a 3 m straightedge\* |
| Cut subgrade level in earth and fill subgrade level | +0 mm  -50 mm | 15 mm |
| Cut subgrade in rock | +0 mm  -75 mm | Unspecified |

\* Limits to incorporate due allowance for design shape where relevant

Other ground surfaces

Absolute level tolerance: ±50 mm, provided the area matches adjacent construction.

Horizontal surfaces

Absolute tolerance: ±50 mm, except where alignment with an existing road structure is necessary. Join new construction to the existing work in a smooth manner.

Batters

Slope: Average slope not steeper than shown on the Drawings nor more than 10 flatter, provided that flatter slopes do not encroach on abutting property.

Absolute level tolerance: For cut batters in earth, ±150 mm and for cut batters in rock and for fill batters, ±300 mm; both measured from the average slope plane.

Topsoil to batters: Absolute level tolerance ±50 mm, provided the area matches adjacent construction.

## COMPACTION

### Method of Compaction and Testing

Requirement: Select the methods of compaction and compliance testing to suit the material category listed in Table 6.1.

Table 6.1 – Compaction method

|  |  |  |
| --- | --- | --- |
| Material category | Compaction method | Density compliance tests |
| 1. Cohesionless sand | Compacted layer method | Relative dry density or density index (if RDD gives meaningless answers) |
| 1. Soils other than 1 above which, after compaction, have less than 20% of stone retained on the 37.5 mm sieve | Compacted layer method | Relative dry density |
| 1. Coarse granular soils with more than 70% of stone retained on the 37.5 mm sieve | Mechanical interlock method | Nil on material in general |
| 1. Soils other than 3 above which, after compaction, have 20%-70% of stone retained on the 37.5 mm sieve | Compacted layer method; or | Relative dry density |
| Mechanical interlock method | RDD where appropriate on the finer grained materials which completely fill the voids between rocks |

### Compacted Layer Method Of Construction

Stone size: Limit stone size in fill material to less than two-thirds of the uncompacted layer depth.

Execution: Place and compact fill material uniformly in layers.

Compaction layer thickness: Comply with Table 6.2 for the allowable loose layer thickness for the location and properties of the material being compacted. Where the uncompacted thickness of a layer would otherwise be less than the specified minimum thickness, a lesser thickness of newly placed material may be employed by loosening the underlying material to give a total depth equal to the minimum thickness.

Table 6.2 – Layer thickness for compaction

|  |  |  |
| --- | --- | --- |
| Material/ location | Loose layer thickness (mm) | |
| Minimum | Maximum |
| General fill in road embankment | 150 | 300 |
| Clay fill in water retaining structures | 150 | 200 |
| Subgrade | 100 | 200 |
| Backfill other than sand | - | 100 |
| Sand backfill | 150 | 300 |

### Mechanical Interlock Method Of Construction

Execution: Place and compact coarse granular fill material uniformly in layers. Roll each layer until no permanent visible lowering of the surface occurs.

Minimum thickness of uncompacted layers: Greater of 150 mm or 1.5 times the maximum rock size in the layer.

Maximum thickness of uncompacted layers: Comply with Table 6.3 for the specified module weights, which apply to both drawn and self-propelled single drum rollers. Interpolate layer thickness for module weights between the listed values.

Table 6.3 – Maximum thickness of uncompacted layers

|  |  |  |
| --- | --- | --- |
| Static module weighty or vibrating drum equivalent (tonnes) | Maximum thickness of uncompacted layer (mm) | |
| Voids not filled | Voids filled\* |
| 5 | 400 | 300 |
| 10 | 600 | 400 |
| 15 | 900 | 600 |
| 20 | 1200 | 800 |

\* Proportion of finer grained materials to completely fill the voids between rocks

### Density and Moisture Requirements

Density requirements: Compact fill and unbound subgrade material to the relevant standards specified in Table 6.4.  *Refer annexure*.

Moisture content: Unless specified otherwise in the annexure, adjust moisture content of fill and unbound subgrade material as necessary to within 80-100% of the optimum moisture content (determined by *AS 1289.5.1.1*) to achieve the required compaction. Maintain moisture content of the compacted material within the specified range until covered with subsequent layers. *Refer annexure*.

Table 6.4 – Minimum density schedule

| Location | Minimum relative compaction (standard)  (Cohesive soils generally)  (see Notes 1, 2, 3, 4) | Minimum density index  (Cohesionless soils)  (see Notes 1, 5) |
| --- | --- | --- |
| Single one or two storey residential dwelling sites |  |  |
| 1. Allotment fill | 95% | 65% |
| 1. Building pad (see Note 6) | 100% | 80% |
| Commercial, industrial and multi unit residential developments |  |  |
| 1. Allotment fill | 98% | 70% |
| 1. Building pad (see Note 6) | 100% | 80% |
| Road and structural (other than building) formations including embankments, footpaths, paved areas and shoulders (see Note 7) |  |  |
| 1. >0.3 m below subgrade level | 95% | 65% |
| 1. ≤0.3 m below subgrade level | 100% | 80% |
| All other areas e.g. parks |  |  |
| 1. >0.3 m below design level | 90% | 62% |
| 1. ≤0.3 m below design level | 95% | 65% |
| Replacement of unsuitable or over-excavated subgrade material | 100% | 80% |
| Backfilling of grub holes | 100% | 80% |

Notes:

1. Field dry density to *AS 1289.5.3.1*, *AS 1289.5.3.5* or *AS 1289.5.8.1*. If using *AS 1289.5.8.1*, calibrate the surface moisture-density gauge in accordance with *AS 1289.5.8.4* before use on site.
2. Standard maximum dry density to *AS 1289.5.1.1*.
3. Relative compaction (% of maximum dry density) to *AS 1289.5.4.1*.
4. For plastic soils, compact soils designated under the unified classifications system as OH CH MH to not less that 92% nor greater than 96% of standard maximum dry density at moisture contents of between 90% and 120% of optimum moisture content.
5. Density index to *AS 1289.5.6.1*. Maximum and minimum dry densities to *AS 1289.5.5.1*.
6. Average imposed bearing pressure of floor slab not to exceed 20 kPa. Imposed bearing pressures of strip and pad footings not to exceed 100 kPa.
7. In the context of this specification, road formation is deemed to include all the area within the designated road reserve. Structural formation is deemed to include the area under the paving plus a nominal 1 m from the edge of the paved area.

## EXCAVATION

### General

Extent

Site surface: Excavate over the site to give correct levels and profiles as the basis for construction, paving, filling, landscaping and the like. Make allowance for compaction or settlement.

Footings: Excavate for footings, pits, wells, shafts and the like, to the required sizes and depths. Confirm that the bearing capacity is as specified.

**Preparation**

Prior to excavating, cut any pavement wearing surface, concrete footpath, kerb and channel or the like by saw or other approved means to give a clean break line along the edge of excavation.

Existing footings, slabs and pavements

If excavation is required below the line of influence of an existing footing, slab or pavement, use methods that maintain the support of the footing, slab or pavement and ensure that the structure and finishes supported by the footing are not damaged. *Refer annexure*.

### Surface Drainage

Catch drains

Construct catch drains at the top of cuttings. Grade and trim the catch drains to ensure the free flow of water and connect to the drainage system. Install erosion protection measures where necessary.

Table drains

Profile: Neatly trim earth table drains to the required profile, grade and alignment. Install erosion protection measures where necessary.

Grading: Construct table drains with a minimum grade of 0.5% and with a maximum length of 50 m before diversion to drainage system.

### Provisional Depths

Contract depths

The footing or pier depths shown on the Drawings are only a basis for measurement of quantities. Actual excavation levels will be determined on the basis of material encountered.

### Explosives

Do not use explosives.  *Refer annexure*.

### Bearing Surfaces

General

Provide horizontal bearing surfaces for load bearing elements including footings. Step to accommodate level changes. Make the steps to the appropriate courses if supporting masonry.

Deterioration

If the bearing surface deteriorates after approval, excavate further to a sound surface before placing the load bearing element.

### Reinstatement of Excavation

General

Where excavation exceeds the required extent, whether as a result of bad ground (and where footing levels or the like are not varied) or as a result of excess excavation, reinstate to the correct depth and required bearing value.

Particular

Within the ‘line of influence’ of footings, beams or other structural elements: Refill over-excavation with concrete of strength appropriate to the loading, minimum 15 MPa. *Refer annexure*.

Below slabs or pavements: Refer to *Clause* *9.0*.

### Adjacent Structures

Temporary supports

General: Provide supports to adjacent structures where necessary, sufficient to prevent damage arising from the works.

Lateral supports: Provide lateral support using shoring.

Vertical supports: Provide vertical support where necessary using piling or underpinning or both.

Permanent supports

If permanent supports for adjacent structures are necessary and are not described, give notice and obtain instructions.

Encroachments

If encroachments from adjacent structures are encountered and are not shown on the drawings, give notice and obtain instructions.

Rock bolting

Provide proprietary high strength steel bars or tubes anchored into holes drilled in the rock and tensioned against plates bearing on the rock face to provide temporary or permanent support for the rock face. Refer *Clause* *18.0*.

### Non-Rippable Material

General

Where the methods of measurement require differentiation of non-rippable material, the following criteria apply. Machine classification to *AS 2868*.

Confined excavation

Definition: Excavation of trenches and to broader areas less than 1000 m2 in extent.

Classification: Classify material as non-rippable if any of the nominated classes of crawler excavator fitted with a heavy-duty bucket, cannot rip at a production rate (in situ volume) exceeding the nominated values. Fit bucket teeth with high penetration boots, approved by the machine manufacturer for use on the particular machine in rock.

Class 55 crawler excavator fitted with a maximum 450 mm wide bucket: Maximum production rate 1.5 m3 per hour.

Class 85 crawler excavator fitted with a maximum 600 mm wide bucket: Maximum production rate 3 m3 per hour.

Class 115 crawler excavator fitted with a maximum 750 mm wide bucket: Maximum production rate 4.5 m3 per hour.

Class 155 crawler excavator fitted with a maximum 900 mm wide bucket: Maximum production rate 7 m3 per hour.

Class 200 crawler excavator fitted with a maximum 1050 mm wide bucket: Maximum production rate 10 m3 per hour.

Other excavation

Classification: Classify material as non-rippable if the nominated classes of crawler tractor, equipped with a heavy duty, single tine parallelogram ripper (approved by the machine manufacturer for use on the particular machine in rock), cannot rip at a production rate (in situ volume) exceeding the nominated values.

Class 150C crawler tractor: Maximum production rate of 50 m3 per hour.

Class 200C crawler tractor: Maximum production rate of 75 m3 per hour.

Class 300C crawler tractor: Maximum production rate of 90 m3 per hour.

Class 400C crawler tractor: Maximum production rate of 105 m3 per hour.

Class 500C crawler tractor: Maximum production rate of 120 m3 per hour.

Class 600C crawler tractor: Maximum production rate of 135 m3 per hour.

## FILLING

### Fill Material

General

Material type: Inorganic, non-perishable material.

Sulphur content: Do not use filling with sulphur content exceeding 0.5% within 0.5 m of cement bound elements (for example concrete structures or masonry), unless such elements are protected by impermeable membranes or by other suitable means.

Sources

Where directed, re-use material recovered from excavations on the site. Dry out recovered material as necessary prior to use.

**Recycled Material**

Various products derived from resource recovery of construction and demolition waste from building waste; reclaimed asphalt pavement (RAP) from maintenance and rehabilitation activities; and reclaimed glass from the glass disposal industry blended to produce fill types meeting the requirement of this clause.

Low density foreign materials such as plastic, rubber, plaster, clay lumps and other friable material shall not exceed 3% by mass. Wood and other vegetable or decomposable matter shall be limited to a maximum of 0.5% by mass.

Crushed glass used in any recycled material blends shall be crushed to a cubic shape and able to pass the 4.75 mm AS sieve. It must be cleaned and free of any putrid odour.

Any blend of recycled materials shall be able to be classified as ‘clean fill’ or ‘clean earthen materials’ in accordance with *Environmental Protection (Waste Management) Regulation 2008*.

Fill types

General fill: Well graded material, maximum particle size 75 mm, plasticity index ≤ 55%.

Select fill: Granular material complying with the following properties.

* Particle size: 75 mm maximum.
* Proportion passing 0.075 mm sieve: 25% maximum.
* Plasticity index: ≥2%, ≤ 15%.
* Soaked CBR: Not less than 15.

Road embankment fill: Well graded material with maximum plasticity index 35% and maximum particle size determined by location and layer thickness, but not exceeding two-thirds of the uncompacted layer thickness.

Fill subgrade: Use Class 3 material or select fill.

Special fill: *Refer annexure*.

### Preparation for Filling

General

Remove loose material, debris and organic matter.

Benching

If filling is to be placed against a ground surface that slopes more than 1V:4H, bench into the natural surface for at least 1 m at every 1 m change of level to form a key for the filling.

Under ground slabs, pavements and other load bearing elements

Under filling that will support slabs, pavements and other load-bearing elements, compact the stripped surface as for filling. If necessary loosen the material to a depth of 200 mm and adjust the moisture content.

Under earth mounds

Cultivate the ground by ripping to a depth of 200 mm before mound formation.

Rock

Remove any overhanging rock ledges. Remove any loose or unstable blocks of rock.

### Geogrids

Approval: Obtain approval before incorporating geogrids.

Comply with Queensland Department of Transport and Main Roads Standard Specification *MRTS* *58 Subgrade Reinforcement using Pavement Geosynthetics.*

### Placing Fill

General

Layers: Place and compact fill in accordance with the compacted layer method of construction specified in *Clause 6.2* to achieve the density specified in *Clause 6.4*.

Placing at structures

General: Place and compact filling in layers simultaneously on both sides of structures, culverts and pipelines to avoid differential loading. Commence compaction of each layer at the structure and proceed away from it.

Placing against concrete: Do not place fill against concrete until the concrete strength is more than 80% of the specified strength.

Supports: Remove any temporary supports to excavations progressively as backfilling proceeds.

## SUBGRADE PREPARATION

General

Trim the subgrade to an even surface free from loose material.

Compaction

Compact, or recompact, subgrade material to obtain the density specified in *Clause 6.4*.

Subgrade affected by moisture

Where the subgrade is unable to support construction equipment, or it is not possible to compact the overlying pavement because of high subgrade moisture content, perform one or more of the following:

* Allow the subgrade to dry until it will support equipment and allow compaction.
* Scarify the subgrade to a depth of 150 mm, work as necessary to accelerate drying, and recompact when the moisture content approximates the optimum.
* Excavate the wet material and replace with Class 3 material or select fill.
* Treat the material with lime mixed in by approved specialised plant.

Side drain, mitre drain and blanket course

General: Construct pavement drainage system to comply with *Standard Drawing BSD-2041*. For roads, construct side drains on both sides unless directed otherwise.

Material: Conform to the filter material requirements of *S300 Quarry Products Clause 4.4*.

Construction: Do not allow construction equipment to travel or stand directly on constructed subsoil drains.

Springs or seeps

If springs or seeps are found, provide drainage as directed.

Draining depressions

If subgrade is replaced, grade depressions in the native material to drain to the subsoil drainage system or connect by mitre drains.

In rock subgrades, drain depressions with subgrade drains at least 150 mm wide, backfilled with coarse filter, and connected to the subsoil drainage system.

Unsuitable material

Remove roots, boulders, silt, organic matter and other unsuitable materials.

Remove or lime treat subgrade with a soaked CBR less than 3 to an approved depth which shall not be less than 150 mm. If removed, replace with Class 3 material or select fill.

Backfilling

Reinstate over-excavation, including excavation for grub holes to the correct level with class 3 material or select fill and compact to comply with *Clause 6.4*.

Rectification

If a section of subgrade material fails to meet the required density after compaction, rework or rectify as follows:

* Fill subgrades: Remove the non-complying material, replace with Class 3 material or select fill and recompact.
* Cut subgrades: Rework the material or replace with Class 3 material or select fill and recompact.

Proof rolling

Requirement: Test the finished base for perceptible surface deformation or instability by proof rolling in the presence of the Superintendent.

Test method: Use a truck with a single rear axle with dual tyres with a loaded axle mass of 9 tonnes or a truck with tandem rear axles with dual tyres with a total loaded mass on the tandem axles of 16.5 tonnes. Use a minimum 600 kPa tyre pressure. Testing for perceptible surface deformation is exempt from the requirement for NATA accreditation.

Corrective Action: In areas of perceptible surface deformation or instability, remove and replace the material, or undertake other corrective action to the satisfaction of the Superintendent.

## DRAINAGE AND OTHER SERVICETRENCHES

Refer to *Reference Specification S145 Installation and Maintenance of Utility Services.*

## SERVICE CONDUIT INSTALLATION

Refer to *Reference Specification S145 Installation and Maintenance of Utility Services.*

## GEOTEXTILES

General

Testing: To *AS 3706*.

Base materials: Polyamide, polyolefines, polyester and polyvinyl materials, either singly or in combination.

Filament properties: Rot-proof, chemically stable and with low water absorbency. Non-woven geotextiles must have the filaments bonded by needle punching, heat or chemical bonding processes. Woven geotextiles must have the filaments interlaced in two sets, mutually at right angles. One set must be parallel to the longitudinal direction of the geotextile.

Ultraviolet radiation resistance

Exposed conditions: For use such as silt fence, retain 90% of its original strength after three months exposure to sunlight.

Unexposed conditions: Retain 90% of its original strength after one month exposure to sunlight.

Applications

Type 1, non woven: Material properties to comply with Table 12.1. Suitable for filter drain in granular soils subject to light compaction equipment. Limit the maximum aggregate size in contact with the geotextile to 37.5 mm.

Type 2, non woven: Material properties to comply with Table 12.1. Suitable for filter drain for side drains in roadwork and general non-roadwork applications. Limit the maximum aggregate size in contact with the geotextile to 75 mm.

Type 3, non woven: Material properties to comply with Table 12.1. Suitable for general use in roadwork (other than side drains), crib walls, and gabions. Limit the maximum aggregate size in contact with the geotextile to 200 mm.

Type 4, non woven: Material properties to comply with Table 12.1. Suitable for scour protection works, where the maximum rock size exceeds 200 mm.

Table 12.1 – Material properties

| Designation/type | Wide Strip Tensile Strength  5 percentile value (kN/m) | Trapezoidal Tear Strength  5 percentile value (N) | G Rating (Note) | Pore Size EOS (μm) | Permittivity (s-1) |
| --- | --- | --- | --- | --- | --- |
| Type 1, non woven | >5.0 | >180 | >1000 | <250 | >1.00 |
| Type 2, non woven | >9.0 | >270 | >2000 | <180 | >1.00 |
| Type 3, non woven | >13.0 | >360 | >3000 | <180 | >1.00 |
| Type 4, non woven | >20.0 | >550 | >5000 | <160 | >1.00 |

Note:

G Rating = Geotextile Strength Rating = (H50 x L)0.5

H50 =Normalised drop height (mm), as determined using the Drop Cone Test procedure in *AS 3706.5*

L = Plunger failure load (N), as determined using the CBR Plunger Test procedure in *AS 3706.4*.

Filter tube: Non woven or woven geotextile suitable for sump protection boom. Minimum weight 285 g/m2, pore size EOS < 75 μm, permittivity >0.2 s-1.

Silt fence: Non woven or woven geotextile. G rating >2500, wide strip tensile strength (5 percentile value) >4 kN/m, permittivity >0.2 s-1.

Storage

Store geotextile under protective cover or wrapped with a waterproof and ultraviolet protective sheering. Do not store geotextile directly on the ground or expose them to excessive heat.

Preparation

Before placing geotextile, trim the ground to a smooth surface free from cavities and projecting rocks.

Placing

Fixing: Lay the material flat, but not stretched tight, and secure it with anchor pins. Overlap joints by 300 mm minimum.

Traffic: Do not allow vehicles and construction equipment on the geotextile until it has been covered with a layer of fill or pavement material at least 150 mm thick.

Sunlight: Do not expose the material to sunlight for more than 14 days.

## GABIONS AND MATTRESSES

### Materials

Wire, gabions and mattresses

General: Comply with *AS 2423*. Galvanise all wire to *AS/NZS 4534*. Coat all components with polyvinyl chloride to a minimum thickness of 0.5 mm.

Gabions: Use mesh with a wire diameter not less than 2 mm. Provide appropriate mesh size to retain the rock filling. Provide selvedge wires with a diameter not less the 3.15 mm and binding wire with a diameter not less than 2.5 mm.

Mattress: Use mesh with a wire diameter not less than 2 mm. Provide appropriate mesh size to retain the rock filling. Provide selvedge wires with a diameter not less than 2.5 mm and binding wire with a diameter not less than 1.6 mm.

Rock fill

General: Clean, hard, durable crushed rock, rock spalls or river gravel, with minimum size larger than the maximum opening size of the mesh or fabric forming the basket. Rocks must be cubical where possible. The smallest dimension must not be less than half the greatest dimension.

Properties: Wet/dry strength variation tested in accordance with *AS 1141.22* must not exceed 35%. Ten percent fines value tested in accordance with *AS 1141.22* must not be less than 150 kN.

Gabions: Provide rock of nominal size between 120 mm and 200 mm. Rock must be uniformly graded, with greater than 80% by number exceeding the 150 mm nominal size.

Mattresses: Provide rock of nominal size between 75 mm and 150 mm. Rock must be uniformly graded, with greater than 80% by number exceeding the 100 mm nominal size.

Anchor plates, bolts and pickets (mattresses)

Anchor plates: Grade 250 steel to *AS/NZS 1594*. Smooth all sharp edges and curves prior to galvanising. Galvanise to comply with *AS 4680* after fabrication.

Anchor bolts: Supply hot dip galvanised anchor bolts to secure the anchor plates to the concrete.

Anchor pickets: Supply star pickets 1.8 m long.

### Execution

Gabions

General: Construct gabion protection work in the locations and in accordance with the details shown on the drawings.

Surface preparation: Trim areas on which gabions are to be positioned to the specified shapes within a tolerance of ±50 mm. Trimmed surfaces must be free of roots, stumps, brush, rocks and the like protrusions.

Geotextile fabric: Place Type 3 geotextile behind all gabions.

Assembly: Assemble to comply with the drawings and recommendations of the manufacturer.

Positioning: Position assembled gabions empty in the works. Securely position the first row of gabions and fill before gabions in other rows are positioned.

Rock fill: Hand pack the exposed faces of the basket. The remainder may be filled using machine methods. Place the rock to produce a dense, evenly distributed filling with a minimum of voids. Maintain the tolerances and shape specified. Tie together the outer and inner panels of the gabions during the placing operation to minimise distortions where necessary.

Damage: During the placing, do not damage the gabion mesh or geotextile.

Mattresses

General: Construct mattress protection work in the locations and in accordance with the details shown on the drawings.

Surface preparation: Trim areas on which gabions are to be positioned to the specified shapes within a tolerance of +50 mm to -50 mm, except where the provision of such tolerances will not permit the tops of the mattresses to join neatly to the inverts of adjacent culverts. Trimmed surfaces must be free of roots, stumps, brush, rocks and the like protrusions.

Geotextile fabric: Place Type 3 geotextile behind all mattresses.

Assembly: Assemble to comply with the drawings and recommendations of the manufacturer.

Positioning: Position assembled mattresses empty in the works. Fix the upstream edge (if any) and the top edge of each mattress using star pickets at 1 m centres. Make neatly cut openings for the pickets in the geotextile. Drive pickets to refusal or full depth. Finish the pickets level with the tops of the mattresses.

Rock fill: Fill each row of mattresses before following rows are placed. Tension the mattresses before filling. Place fill to produce a dense evenly distributed filling with minimum voids and distortion of the mattress shape. Release tension on the mattress when the mattress has sufficient rock filling to prevent the mesh from slacking after release.

Damage: During the placing, do not damage the mattress or any geotextile under the mattresses.

Construction tolerances

General: Construct gabions and mattresses in the locations and in accordance with the details shown on the Drawings.

## ROCK SCOUR PROTECTION

Application

Ungrouted rock lining to provide scour protection to open channels and other areas as specified. *Refer annexure.*

Rock

Use clean, hard, durable, well graded rock spalls with a nominal size of 200 mm or more. At least 50% of rocks must be larger than a size twice the specified nominal size. Wet/dry strength variation tested in accordance with *AS 1141.22* must not exceed 35%. Ten percent fines value tested in accordance with *AS 1141.22* must not be less than 150 kN. The breadth and thickness of a single stone must not less than one-third its length. *Refer annexure.*

Thickness

The thickness of the rock facing must be at least twice the nominal rock size. *Refer annexure.*

Excavation

Excavate the area to be rock faced so the final rock surface finishes level with the surrounding ground level.

Placing

Minimise the chances of rocks running loose and damaging adjacent areas. Recover any rocks deposited outside the rock protection zone. Place rocks in a manner that ensures that the larger rocks are uniformly distributed throughout the protection works, and that the smaller rocks effectively fill the spaces between the large rocks without leaving any large voids. Layers of placed rock must have even thickness and even grading.

Geotextile

Install Type 4 geotextile over the area to be rock-faced. Place rock to avoid damage to the geotextile.

## ROCK FILLING

Application

Rock filling to provide low settlement at structures and other areas as specified.

Rock

Use clean, hard, durable, well graded rock spalls with a nominal size of 200 mm. Wet/dry strength variation tested in accordance with *AS 1141.22* must not exceed 35%. Ten percent fines value tested in accordance with *AS 1141.22* must not be less than 150 kN. Rocks of length greater than 100 mm must have breadth and thickness not less than one-third of the length.

Placing

Layering: Place rock in layers no deeper than 750 mm. Construct layers horizontally. At structures, avoid differences in surface levels that would cause horizontal loading on the structure.

Exposed faces: Hand pack all exposed faces with selected aggregate. Place the rocks with their greatest dimension perpendicular to the face, breaking the joints vertically.

Compaction

General: During the placing of the rock, continuously sluice with water pumped from a 50 mm pump through a 50 mm hose and nozzle and compact with a vibrating roller of static weight 5 tonnes to ensure rock to rock contact throughout.

Confined spaces: Where the use of a 5 tonne roller is impracticable, use a 1 tonne vibratory roller or, if necessary, a mechanical rammer.

## BARRIERS AND MEMBRANES

Protective covering: Do not disturb or damage the protective covering of membranes during backfilling.

## RETAINING WALLS

### Crib Walls

Proprietary system of interlocking precast concrete or preservative treated timber cribs with backfill as specified by the manufacturer, placed and compacted progressively with the crib to form a retaining wall. *Refer annexure.*

### Earth Reinforcement

Scope

Reinforced soil structures consisting of proprietary systems of reinforcing strips placed in layers with compacted select fill and connected to precast concrete facing panels to form vertical retaining walls. *Refer annexure*.

Design

Standard: To Queensland Department of Transport and Main Roads standard specification *MRTS 06 Reinforced Soil Structures*.

Design life: 120 years. *Refer annexure.*

Wall movement: The maximum long term incremental lateral deflection of any part of the wall facing, occurring at any time, must not exceed 20 mm. *Refer annexure.*

Facing units: Concrete Grade N40 to *AS 3600* with surface finish to Class 2 to comply with *AS 3610*.

Fill

Comply with Queensland Department of Transport and Main Roads standard specification *MRTS 06 Reinforced Soil Structures*.

Accessories

Provide the necessary accessories including levelling pad, bearing pads and joint fillers or covers to keep the fill material out of the panel joints. *Refer annexure.*

Construction

Comply with Queensland Department of Transport and Main Roads standard specification *MRTS 06 Reinforced Soil Structures*.

Completion

Provide as constructed drawings, including sections at 5 m centres.

## GROUND ANCHORS

### General

Application: Permanent or temporary ground anchors, placed in any aspect, which use a prestressing tendon anchored in rock or soil at one end and stressed at the other end. *Refer annexure.*

Materials and design: To *AS 4678 & AS 5100.3*.

### Execution

Soft ground

Temporarily line holes in soft or loose ground to prevent collapse. Do not use wrapped tendons.

Stressing

Stress each anchor to a test load of 85% of the ultimate strength of the tendon, hold for a minimum of five minutes, and then reduce the stress to the lock-off load. If the anchor fails to maintain the load for five minutes, replace it. *Refer annexure*.

Tendon protection

Grout the free length of tendon inside sheath of permanent anchors as soon as possible after they have been stressed.

Protection of stressing anchorages

Protect the stressing anchorage of permanent anchors by filling the anchorage block-out with concrete after final stressing. Trim tendons to give a cover of 50 mm. If no block-out is provided, construct concrete protection to give a minimum cover of 50 mm to all steel components.

Temporary anchors

De-stress tendons and remove wedges on completion of use of the anchor.

Completion

Provide as constructed drawings showing the lock-off load, position, direction and length of permanent ground anchors.