

Superseded

Technical Specification

**Transport and Main Roads Specifications
MRTS04 General Earthworks**

April 2017

Superseded

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1 Introduction

1.1 General

This Technical Specification applies to the construction of earthworks in roadworks and bridgeworks.

This Technical Specification shall be read in conjunction with MRTS01 *Introduction to Technical Specifications*, MRTS50 *Specific Quality System Requirements* and other Technical Specifications as appropriate.

Specific Earthwork requirements covered elsewhere are:

- a) Reinforced Soils Structures which are specifically covered by MRTS06 *Reinforced Soils Structures*
- b) cast-in-place piles which are specifically covered by MRTS63 *Cast-In-Place Piles*, and
- c) footings for poles which are specifically covered by MRTS92 *Traffic Signal and Road Lighting Footings*.

This Technical Specification forms part of the Transport and Main Roads Specifications Manual.

1.2 Scope

Earthworks refers to all operations involved in loosening, removing, depositing, shaping and compacting soil or rock, and is also used to describe the structure resulting from these operations. The aim of the earthworks is to facilitate construction of other components such as pavements and structures, and to provide a long-term stable platform of sufficient strength to enable these components to function for their intended life. Earthworks is undertaken using materials won from the site or (if suitable or sufficient materials are not available within the site), using suitable materials from offsite.

The earthwork formation comprises a series of earth or rock structures, which must be constructed by the controlled excavation and placement of materials, and the use of associated structural treatments. Better quality materials are typically used in the upper portion of the earthworks.

The execution of earthworks involves safety and environmental risks and attention is drawn to the requirements of the relevant specifications.

2 Definition of terms

The terms used in this Technical Specification shall be as defined in Clause 2 of MRTS01 *Introduction to Technical Specifications*. Additional terms used in this Technical Specification shall be as defined in Table 2.

Table 2 – Definition of terms

Term	Definition
Acid Sulfate Soils (ASS)	Materials which contain iron sulfides in concentrations which have the potential to produce acidic conditions in the earthworks if left untreated. Acid sulfate soils shall include all materials which are actual acid sulfate soils or potential acid sulfate soils as indicated by the testing regime described in Clause 10.

Term	Definition
Assigned CBR	The CBR assigned to a source or stockpile of earth fill material in accordance with this Technical Specification.
Assigned swell	The swell (%) assigned to a source or stockpile of earth fill material based on the values obtained from swell test values obtained in conjunction with the soaked CBR test in accordance with this Technical Specification.
Backfill	Material placed in confined excavations for culverts, structures, conduits, pits, etc or, in some instances, to fill excavations of Unsuitable Material. Backfill includes bedding material and materials placed in the foundation bedding, haunch, side and overlay zones during culvert backfill.
Bedding Material	Material suitable for use in the foundation bedding zone of culverts and for bedding of pipes, conduits, pits, and so on.
Borrow Area	An area: <ul style="list-style-type: none"> a) on the Site outside the excavation lines, or b) an area off the Site which can be developed by the Contractor as a source of borrow material.
Borrow Material	Material, sourced from borrow areas, which is used to supplement a shortage of material sourced from excavations.
Cement Stabilised Unbound Granular Material	Unbound granular material stabilised with cement.
Cohesive / Cohesion-less Soil	<p>This definition applies for compaction purposes only. This definition does not apply for general geotechnical descriptions, where cohesive material is considered as > 35% passing the 75 µm sieve.</p> <p>Cohesive soil is a material which has a well-defined moisture density relationship when tested accordance with Q142A. Typically over 12% fines (passing the 75 µm sieve, by weight), but may still apply to above 5% fines in some cases. Whilst cohesive soils are typically clayey in nature, for the purpose of this definition only, these may also include well-graded granular materials such as crushed rock.</p> <p>Cohesion-less (non-cohesive) soils typically have less than 5% fines, are non-plastic and does not exhibit a well-defined moisture density relationship.</p>
Confined Earthworks	Any earthworks behind structures, in trenches, backfilling or repair works.
Confined Excavation	An excavation for a culvert, pipe or conduit trench or an excavation for a structure which requires the use of an excavator or similar machine fitted with a bucket. An excavation shall not be classed as a confined excavation where the excavation is of sufficient size to allow the operation of a crawler tractor of Class 150C or larger, as determined in Table 3.3.2 of MRS04.
Core Zone	The central zone of an embankment.
Cutting	Earthworks constructed by excavation to the lines shown on the drawings.
Diversion Channel	An open channel that diverts or redirects a given water flow from its natural flow path.
Drainage Layer	A layer of permeable material placed within the subgrade in wet cuttings.

Term	Definition
Earth Backfill Material	Earth fill material Class A or B predominantly less than 25 mm stone size used as backfill.
Earth Fill Material	Fill material for an embankment that can be placed using the compacted layer method.
Embankment	Earthworks constructed by placement of fill material to the shapes and dimensions shown on the drawings.
Fill Material	Material making up an embankment to subgrade level, used to backfill subgrade treatments or to replace unsuitable material. Includes both earth fill and rock fill. Fill material used in embankments may be interchangeable described as 'Embankment Fill' in this Technical Specification.
Foundation Bedding Zone	The layer of material forming the bedding for culverts as shown on Standard Drawing 1359.
Foundation Surface	The level of an excavation for a structure at which the material with the required bearing capacity exists.
Free Draining Granular Material	Coarse graded backfill material used behind retaining walls.
Haunch Zone	The layer of material immediately above the foundation bedding zone for installation of pipe culverts as shown on Standard Drawing 1359.
Lean Mix Concrete	Low strength concrete used for backfill of over-excavation for structures and as otherwise directed.
Lot	An area of work that is essentially homogeneous in relation to material properties, moisture condition during compaction, rolling response and compaction technique, or A single finished item of work which includes several materials and/or work types (for example, a culvert in place).
Lot CBR	The CBR assigned to a Lot of untreated subgrade material in accordance with this Technical Specification.
Lot expansive nature classification	The expansive nature classification assigned to the untreated subgrade material in accordance with this Technical Specification, AGPT02 and the <i>Pavement Design Supplement</i> . The classification shall be one of the following: low, moderate, high or very high.
Lot swell	The swell (%) assigned to a Lot of untreated subgrade material based on the values obtained from swell test values obtained in conjunction with the soaked CBR test in accordance with this Technical Specification.
Monosulfidic Black Oozes (MBO)	Monosulfidic black oozes are highly reactive organic-rich gels with extremely high moisture contents. They are commonly enriched in ultra-fine grained reactive iron sulfides
Natural Ground Surface	The ground surface which exists prior to any work being carried out under the Contract.
Near-grade Embankment	Any part of an embankment with less than 300 mm of new fill material between the prepared ground surface and subgrade level.
Outer Zone	The outer zone of an embankment.
Overlay Zone	The layer of material placed above pipe culverts as shown on Standard Drawing 1359.

Term	Definition
Planting Media	Material used as a planting medium for landscaping as defined "Topsoil" in MRTS16 <i>Landscape and Revegetation Works</i> . In this Technical Specification Topsoil is the top layer of existing soil on the Site which supports vegetation.
Prepared Ground Surface	The ground surface after clearing and grubbing and topsoil stripping operations have been completed.
Relative Compaction	The ratio, expressed as a percentage, of the insitu density (wet or dry) of the material presented for compliance testing and the maximum density (dry or converted wet density) of a reference sample compacted in accordance with a specified procedure.
Road Excavation	All excavation except for confined excavation and excavation for open channels and drains.
Rock Fill	Fill material consisting predominantly of stones and rock. Stability is achieved by mechanical interlock.
RMS	Roads and Maritime Services, New South Wales.
Sand	Natural or manufactured material with more than 85% passing 2.36 mm AS sieve. No oversize shall be greater than 6 mm. Less than 5% and 10% passing 0.075 mm sieve for natural sand and manufactured sand respectively.
Select Backfill Material	Backfill comprising gravel and/or loam materials with specified properties used for backfilling to trenches and structures.
Side Zone	The layer of material placed adjacent to the centre of pipe culverts as shown on Standard Drawing 1359.
Confined Earthworks	Any earthworks behind structures, in trenches, backfilling or repair works.
Spoil	Material surplus to the Contract requirements which shall be disposed of on or off the Site.
Stabilised Sand	Backfill material comprising sand stabilised with cement.
Stone	Material including natural rock, natural gravel, processed crushed rock and construction rubble which does not break down significantly under compaction.
Structure Zone	As per Transport and Main Roads "Geotechnical Design Standard" is not less than 25 m within the approach to any structure (e.g. bridges, culverts, slabs used to support rigid inclusions, as well as embankments supported on rigid inclusions).
Subgrade	The trimmed or prepared portion of the formation on which the pavement is constructed.
Subgrade Level	The level of the top surface of the prepared subgrade on which a pavement is constructed. Refer Figures 2-A, 2-B and 2-C for the definition of subgrade levels at zoned embankment, homogeneous embankment and cut sections respectively.
Topsoil	The top layer of existing soil on the Site which supports vegetation. The definition of Topsoil is different in MRTS16. Refer definition of Planting Media in this Technical Specification.
Treated Subgrade	The subgrade in cuttings which has been either modified or replaced to improve its properties.
Upper Zone	The top zone of an embankment excluding subgrade, pavement and shoulders.

Term	Definition
Unsuitable Material	All material identified as unsuitable for use as a foundation for earthworks or structures and/or for use as fill or backfill material.
Untreated subgrade material	Natural unprocessed material that will form part of the subgrade, other than that moved from another location and/or compacted at the location. May include material placed and compacted as part of previous works, or material that is naturally occurring.

Figure 2-A – Embankment terminology – zoned

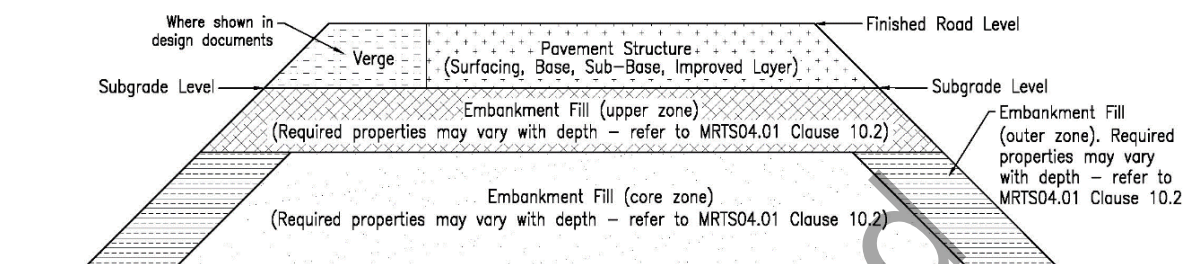


Figure 2-B – Embankment terminology – homogeneous

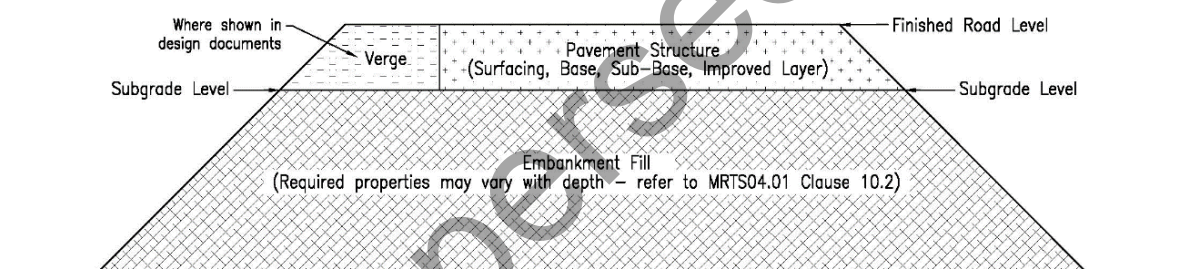
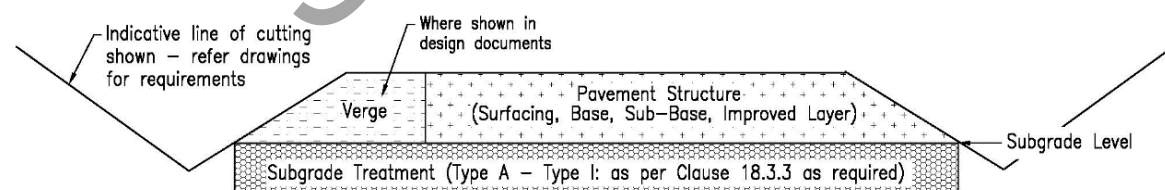


Figure 2-C – Cutting terminology



3 Referenced documents

Table 3 list documents referenced in this Technical Specification.

Table 3 – Referenced documents

Reference	Title
AGPT02	Austrroads Guide to Pavement Technology, Part 2: Pavement Structural Design

Reference	Title
AS 1289.1.2.1	<i>Methods of testing soils for engineering purposes - Sampling and preparation of soils - Disturbed samples - Standard method</i>
AS 3725	<i>Design for installation of buried concrete pipes</i>
Pavement Design Supplement	Transport and Main Roads Pavement Design Supplement
Acid Sulfate Soils Guidelines	"Queensland Acid Sulfate Soil Technical Manual – Soil Management Guidelines" published by the Queensland Government, Department of Science
Transport and Main Roads Geotechnical Design Standard	Manual, Geotechnical Design Standard – Minimum Requirements, Transport and Main Roads
Transport and Main Roads Geotechnical Terms and Symbols	Guideline - Geotechnical Terms and Symbols
MRTS01	<i>Introduction to Technical Specifications</i>
MRTS03	<i>Drainage Retaining Structures and Protective Treatments</i>
MRTS05	<i>Unbound Pavements</i>
MRTS06	<i>Reinforced Soils Structures</i>
MRTS07A	<i>Insitu Stabilised Subgrades Using Quicklime or Hydrated Lime</i>
MRTS07B	<i>Insitu Stabilised Pavements Using Cement or Cementitious Blends</i>
MRTS08	<i>Plant-Mixed Stabilised Pavements using Cements</i>
MRTS16	<i>Landscape and Revegetation Works</i>
MRTS27	<i>Geotextiles (Separation and Filtration)</i>
MRTS51	<i>Environmental Management</i>
MRTS52	<i>Erosion and Sediment Control</i>
MRTS58	<i>Subgrade Reinforcement using Pavement Geosynthetics</i>
MRTS63	<i>Cast-In-Place Piles</i>
MRTS70	<i>Concrete</i>
MRTS92	<i>Traffic Signal and Road Lighting Footings</i>
MRTS100	<i>High Strength Geosynthetic Reinforcement in Road Embankments</i>
Standard Drawing 1149	<i>Traffic Signals/Road Lighting/ITS – Installation of underground electrical and communications conduit</i>
Standard Drawing 1178	<i>Diversion of water – Diversion of water from roadway and table drains</i>
Standard Drawing 1359	<i>Culverts – Installation, bedding and filling/backfilling against/over culverts</i>
TN151	<i>Testing of Materials for Lime Stabilisation</i>
TN149	<i>Testing of Materials for Cement or Cementitious Blend Stabilisation</i>
QRS	Quarry Registration System as defined in MRTS50 Specific Quality System Requirements

Reference	Title
RMS R44, NSW	Roads and Maritime Services of New South Wales, QA Specification R44 Earthwork

4 Standard test methods

Testing of all work shall be undertaken in accordance with Clause 4 of MRTS01 *Introduction to Technical Specifications*.

Unless stated elsewhere herein, the standard test methods listed in Table 4 shall be used in this Technical Specification.

Table 4 – Test methods

Property to be Tested	Test Method
Acid Sulfate Soil Testing Field pH Tests (pH _F and pH _{FOX}) SPOCAS testing / Chromium Suite Monosulfidic Black Ooze (MBO)	Acid Sulfate Soils Laboratory Methods Guidelines in Queensland
California Bearing Ratio	Q113A, Q113C
Chloride Content	Q130A, Q130B
Density Index	AS 1289.5.5.1 and AS 1289.5.6.1
Dry Density – Moisture Relationship	Q142A, Q144A
Density – Moisture Relationship	Q142C
Degradation factor	Q208B
Electrical Conductivity / Resistivity	Q122A, Q122B
Emerson Class Number	AS 1289.3.8.1
Ferrous Oxide FeO content	Determination of ferrous iron by acid digestion
Insitu California Bearing Ratio (Dynamic Cone Penetrometer)	Q114B
Lime Content	AS 5101.3.2
Lime Demand	Q133
Linear Shrinkage	Q106
Liquid Limit	Q104A
Moisture Content	Q102A, Q102B, Q102D
Organic Content	Q120B
Particle Size Distribution	Q103A, Q103B, Q103C
pH	AS 1289.4.3.1
Plasticity Index	Q105
Point Load Index Test	AS 4133.4.1
Pretreatment of Road Construction Materials by Compaction	RMS T102
Pretreatment of Road Construction Materials by Artificial Weathering	RMS T103

Property to be Tested	Test Method
Proof Rolling Test	RMS T198
Relative Compaction and Moisture Content	Q140A, Q141A, Q141B
Selection of Sampling and Testing Location	Q050
Sulfate content	AS 1289.4.2.1
Unconfined Compressive Strength of Stabilised Materials	Q115
Water Absorption	AS 1141.6.1
Wet Strength (Ten percent fines value)	AS 1141.22
Wet/Dry Strength Variation	AS 1141.22
Working Time of Stabilised Materials	Q136
Petrographic Analysis	ASTM C295

5 Quality system requirements

5.1 Hold Points, Witness Points and Milestones

General requirements for Hold Points, Witness Points and Milestones are detailed in Clause 5.2 of MRTS01 *Introduction to Technical Specifications*.

The Hold Points, Witness Points and Milestones applicable to this Technical Specification are summarised in Table 5.1.

Table 5.1. – Hold Points, Witness Points and Milestones

Clause	Hold Point	Witness Point	Milestone
7.2.2	1. Trees etc to be left undisturbed marked by Contractor		
7.2.3	2. Trees required by Administrator marked by Contractor		
9.4	3. Treatment of unsuitable material		
10.4	4. Testing for acid sulfate potential		
13.3.2.1	5. Subgrade in cuttings treatment type		
13.3.4.1	6. Acceptance of foundation by Administrator	1. Inspection of foundation surface	
15.4		2. Rolling using mechanical interlock method of compaction	
18.2.5.4	7. Contractor to submit a mix design		
18.3.1	8. Subgrade testing prior to placement of pavement		

Clause	Hold Point	Witness Point	Milestone
18.3.2		3. Visible vertical movement of subgrade	
19.3.1		4. Backfill material compliance	
19.3.3	9. Backfill not placed before pipes, etc completed and inspected		
Appendix B B.2	10. Subgrade design verification		
Appendix B B.3		5. Sampling locations	
Appendix B B3.2			Sampling of fill materials
Appendix B B.4		6. Testing for subgrade and fill materials	
Appendix B B.5.1	11.Provision of relevant test results		

5.2 Construction procedures

Those construction procedures which are required to be prepared by the Contractor in accordance with the quality system requirements of the Contract are listed in Table 5.2.

Table 5.2 – Construction procedures

Clause	Procedure
5.2	Earthworks Construction Procedure
10.3	Acid Sulfate Soil Management Plan
11.2	Spoil Disposal Plan
Appendix B B2	Subgrade design verification construction procedure

The Earthwork Construction Procedure shall also include, but not be limited to:

- details of all plant associated with the work detailed in this Technical Specification
- source of fill and/or quarries to be used
- details regarding borrow site establishment, operation and finalisation
- testing frequencies to be adopted (where over and above minimum testing frequencies nominated)
- details of how services, utilities, buildings and drainage components shall be located and protected
- details of how services, utilities, buildings, drainage components, plant personnel shall be protected from damage, injury and so on.

5.3 Protection of earthworks

It shall be the responsibility of the contractor to provide protection of earthworks by (including but not limited to the following):

- a) Installing and maintaining effective erosion and sedimentation control measures.
- b) Maintaining drainage of all working areas at all times to ensure run-off of water without scour, except where ponding is off the formation and forms part of a planned erosion and sedimentation control system. Do not allow water to pond in the working areas resulting in wetting up of the existing pavement or formation or foundation material.
- c) When rain is likely or when work is not proposed to continue in a working area on the following day, take precautions to minimise ingress of water into earthworks material. Seal off ripped material remaining in cuttings and material placed on embankments with a smooth drum roller.
- d) Should earthworks material become over-wet (above the specified moisture content for compaction), the contractor is responsible for replacing and/or drying out the material, and for any consequent costs.
- e) Do not allow the earthworks material to dry out to the point where excessive shrinkage occurs in the embankment, and/or the surface is pulverised by traffic generating excessive dust.

5.4 Compliance testing

5.4.1 General

Compliance testing shall be carried out for each lot.

The Contractor is responsible for performing sufficient tests to ensure that the earthworks comply with the standards and requirements of the Contract.

However, the Contractor's testing program shall be such that the testing frequencies and number of tests are not less than those specified in Appendix A.

5.4.2 Geometrics

The geometric tolerances shall be as per Clause 6.

5.4.3 Compaction

For lots where the number of field density test results is five or more, the compaction standard for each lot shall be represented by the characteristic value of the relative compaction results. Unless stated otherwise, the characteristic value shall be calculated as shown in Clause 12 of MRTS01 *Introduction to Technical Specifications* using the individual relative compaction values determined from each lot.

For lots where the number of field density test results is less than five, no individual relative compaction result shall be less than the minimum compaction standard or greater than the maximum compaction standard (Refer Figure 15.1).

The location of each density test shall be chosen by a method of random stratified sampling as given in Test Method Q050.

The relative compaction shall be determined by Test Method Q140A, Q141A or Q141B. Reporting and correction for oversize material is mandatory as part of the test.

The density index of non-cohesive materials shall be determined using Test Methods AS 1289.5.5.1 and AS 1289.5.6.1.

5.4.4 Materials

The material properties for all materials used on the Works shall be checked using random stratified sampling as given in Test Method Q050.

5.5 Conformance requirements

The conformance requirements for compaction shall be to satisfy the characteristic values for relative compaction (except if the number of tests is less than five) and any maximum and minimum moisture content requirements for the appropriate material and location as defined in Clause 15.3.

All other conformance requirements for all materials shall be based on the characteristic value for the material properties defined in this Technical Specification.

5.6 Testing frequency

Unless otherwise stated in Clause 1.1 and/or Clause 1.2 of Annexure MRTS04.1, the minimum testing frequencies, the minimum number of tests and maximum lot sizes stated in Appendix A shall apply to the construction of work covered by this Technical Specification.

6 Geometrics

6.1 General

Earthworks shall be constructed so as not to depart from the widths, lengths, heights and shapes specified by more than the tolerances stated in Clause 6.

The widths, lengths, and heights for the surfaces of a layer other than the final layer shall be calculated from interpolation and extrapolation of the design lines shown on the drawings.

If the location of batter toe points specified are found not to lie on the existing ground surface, derived batter points shall be established by interpolating or extrapolating batters to ground surface.

6.2 Horizontal tolerances

The horizontal location of any point on a surface or interface between material types shall not differ from the corresponding point shown on the drawings, or determined in accordance with Clause 6.1, by more than ± 50 mm except for the following situations:

- a) for edges not adjacent to a structure the tolerance shall be -50 mm $+250$ mm (where the $+$ tolerance is in the direction which increases the width of the earthworks)
- b) the width of an embankment at subgrade level shall not be less than that specified, and
- c) where alignment of the pavement with an existing road structure is necessary, the new work shall be joined to the existing work in a smooth manner as shown on the drawings or, if not so shown, in a manner approved by the Administrator.

6.3 Vertical tolerances

6.3.1 Primary tolerances

The heights of earthworks measured anywhere on a layer surface shall not vary from those shown on the drawings, or calculated in accordance with Clause 6.1, by more than the tolerance stated in Table 6.3.1 unless specified otherwise.

Average tolerances shall apply to the results for a completed lot.

Table 6.3.1 – Primary vertical tolerances

Location	Tolerance (mm)
Subgrade level	± 25
Average subgrade level	± 10
Top of embankment, other than subgrade level	± 50
Top of insitu material below subgrade (in cuttings other than rock)	± 25
Top of insitu material below subgrade in cuttings that cannot be trimmed with a grader (Refer to Clause 18.3.3.1). Top of rock fill Top of high permeability drainage layer Top of insitu material below subgrade (in rock cuttings)	+ 25 / - 75
Inverts of drains	± 40
Top of benches and berms	± 35
Other interfaces between earthworks materials	± 50

6.3.2 Additional tolerances

The gap beneath a three metre long straight-edge placed anywhere on the surface at subgrade level shall not exceed 25 mm, due allowance being made for design shape where relevant.

All embankments, subgrade, benches, berms and drains shall not pond water and be free draining. Batters shall be finished in accordance with Clause 16.

7 Clearing and grubbing

7.1 General

Clause 7 applies to clearing and grubbing and bridge Site preparation where shown on the drawings or specified elsewhere in the Contract.

7.2 Construction

7.2.1 Areas to be cleared and grubbed

Clearing and grubbing operations shall be limited to those areas required to construct the Works and/or meet specified visibility requirements. As a minimum the following clearing and grubbing shall be carried out:

- where earthworks are to be constructed, the minimum width required to construct the Works, plus an additional width of not more than the distance stated in Clause 2.1 of Annexure MRTS04.1 or three metres where not so stated, or the property boundaries, whichever is the lesser
- where a bridge is to be constructed, the part of the area beneath the bridge required to construct the bridge plus a margin of not more than the distance stated in Clause 2.1 of Annexure MRTS04.1 or two metres beyond the plan limits of the bridge where not so stated, or the property boundaries, whichever is the lesser

- c) any areas specified for visibility, and
- d) other areas specified in Clause 2.2 of Annexure MRTS04.1.

7.2.2 Limitation on clearing operations

Any trees, shrubs and overhanging branches to be left undisturbed shall be clearly marked by the Contractor. This marking shall be carried out prior to clearing operations reaching the areas concerned. **Hold Point 1**

Clearing operations within streams and waterways shall not include removal of stumps and roots below ground surface. Beyond the areas to be cleared, only those trees, shrubs and overhanging branches which are shown on the drawings shall be removed or pruned, as necessary. Such removal or pruning shall only be carried out after consultation with the Administrator.

The Contractor shall take precautions to ensure that there is no unnecessary damage to stream beds or banks or any vegetation growing on them.

7.2.3 Trees required by the Administrator

Any trees required by the Administrator for use as marketable timber shall be as nominated in Clause 2.3 of Annexure MRTS04.1. Such trees shall be clearly marked by the Contractor prior to clearing operations reaching the areas concerned. **Hold Point 2**

Marked trees shall be felled and handled in a manner which avoids damaging the trunks. The trunks of these trees shall be trimmed of branches and the trunks stacked in neat manageable stockpiles at locations approved by the Administrator at spacings of not more than 500 metres.

7.2.4 Material suitable for organic mulch

Where site manufactured mulch is required in accordance with MRTS16 *Landscape and Revegetation Works* or MRTS52 *Erosion and Sediment Control*, processing of such material shall also be carried out in accordance with the Material and Construction requirements of MRTS16 *Landscape and Revegetation Works*.

Payment Note: Payment for the processing and stockpiling of the site manufactured mulch material can be nominated in the schedule of rates of Work Item 3854P as per MRS16. Payment for the spreading of mulch can be nominated in the schedule of rates of Work Item 3856 as per MRS16 and Work Item 1239P as per MRS52.

7.2.5 Fauna habitat logs

Hollow timber which is identified as being suitable for fauna habitat logs shall be relocated to areas clear of construction activities as follows:

- a) behind batters
- b) behind proposed safety barriers but not within any hazard free zone, and
- c) areas at least nine metres clear of carriageways.

Fauna habitat log density shall not exceed 20 metres length per 100 m² area. Logs shall not be placed in waterways or in any area where they are likely to be struck by errant vehicles.

7.2.6 Sugar cane and banana plants

Particular attention shall be taken to ensure that sugar cane and banana plant root systems are completely removed and disposed of.

Any regrowth of sugar cane and/or banana plants occurring during the Contract, including the Defects Liability Period, shall be removed.

7.2.7 Disposal of cleared and grubbed materials

Cleared and grubbed material other than that mulched under Clause 7.2.4 shall be disposed of in any areas stated in Clause 6 of Annexure MRTS04.1. If no such disposal instructions are stated, the cleared and grubbed material shall be removed from the Site and disposed of in accordance with all relevant Statutory Requirements including the requirements in MRTS51 *Environmental Management*.

Any burning of cleared and grubbed materials shall be carried out strictly in accordance with the requirements of the Contract.

7.2.8 Additional requirements

Within the limits of the clearing and grubbing, but clear of earthworks operations, any existing local irregularities of the natural surface shall be trimmed so as not to cause a hazard to errant vehicles. The surface shall be lightly compacted if necessary to provide a surface consistent with that existing prior to the Works.

Any requirements listed in Clause 2.4 of Annexure MRTS04.1 shall apply to clearing and grubbing operations in addition to all other requirements of Clause 7.

8 Stripping of topsoil

8.1 General

Clause 8 applies to stripping of existing topsoil where shown on the drawings.

8.2 Topsoil stripping dimensions

Where Site topsoil is required to be supplied in accordance with MRTS16 *Landscape and Revegetation Works*, topsoil shall be stripped from the Site at a 75 mm (\pm 25mm) depth, or from areas and depths as specified in Clause 3 of Annexure MRTS04.1.

Refer to the Soil Management Plan (as defined in MRTS16) – Planning in the environmental documents and/or schedule of rates for estimated topsoil volumes required and areas and depths for topsoil stripping for completing Clause 3.1 of Annexure MRTS04.1.

Payment Note: Payment for the stripping and stockpiling of topsoil can be nominated in the schedule of rates of Work Item 3103P.

8.3 Material considered suitable for use as topsoil

Soil stripped from the Site which is considered suitable for use as manufactured site topsoil shall be tested and ameliorated in accordance with in MRTS16 *Landscape and Revegetation Works*.

Payment Note: Payment for the testing of topsoil, supply of amelioration agents, incorporation of amelioration agent to topsoil and installation of topsoil can be nominated in the schedule of rates of Work Items 3803P, 3804P, 3807P to 3810P, 3828P and 3830 as per MRS16 *Landscape and Revegetation Works*.

8.4 Construction

8.4.1 Stripping to stockpile

Material considered suitable for use as topsoil in accordance with Clause 8.3 shall be stripped from the Site in a separate operation to any other clearing and/or stripping operation.

Stripped material shall be stockpiled in the locations shown on the drawings, as stated in Clause 3.2 of Annexure MRTS04.1. Material shall not be stockpiled within the drip lines of existing plants to be retained.

Consider testing and ameliorating the topsoil prior to stripping, for efficient and effective incorporation of amendments prior to stockpiling.

Refer to Soil Management Plan – Planning in the environmental documents for preliminary topsoil test data and recommendations

8.4.2 Surplus material

Surplus material and material considered to be not suitable for use as topsoil in accordance with Clause 8.3 shall be assessed for use as fill or deemed to be Unsuitable Material and disposed of in accordance with Clause 11.

8.4.3 Stripping limitations

Material shall not be removed from within drip lines of existing plants to be retained except where this would otherwise result in Unsuitable Material being left beneath embankments. The root systems of existing plants to be retained shall be preserved wherever practical.

8.4.4 Stockpiling of topsoil

Wherever practical, topsoil shall be transferred directly to placement as planting media. Where stockpiling of topsoil is required, it shall be carried out in a manner which ensures that the properties of the topsoil are not permitted to degrade such that it becomes unsuitable as topsoil. To assist preservation of topsoil, the Contractor shall include the following provisions in the management of topsoil stockpiles:

- a) limiting the height of stockpiles to three metres
- b) limiting the width of the base of stockpiles to 10 metres
- c) adopting batter slopes, protective covers and drainage which reduce potential for erosion and/or segregation
- d) limiting the period of stockpiling to a minimum practical time

- e) where stockpiling for greater than 12 months, the stockpile shall be revegetated with grass to provide erosion and preserve the physical and chemical properties of the topsoil, and
- f) carrying out herbicide spraying or other treatment of the stockpile at intervals required to prevent weed growth and ensure the stockpile faces are weed-free prior to use.

Manufactured of stripped topsoil into manufactured site topsoil shall be in accordance with MRTS16 *Landscape and Revegetation Works*.

Smaller linear projects, particularly in rural contexts, may consider grading the topsoil to the outer edge of the site to form a long linear topsoil stockpile, which can double as a catch bank during construction and maintain seed bank in the topsoil.

Consider testing and ameliorating the topsoil prior to stripping, for efficient and effective incorporation of amendments prior to stockpiling.

Payment Note: Payment for the testing of topsoil, supply of amelioration agents, incorporation of amelioration agent to topsoil and installation of topsoil can be nominated in the schedule of rates of Work Items 3803P, 3804P, 3807P to 3810P, 3828P and 3830 as per MRS16.

8.4.5 Finishing

All stripped areas, other than areas beneath road embankments or above road cuttings, shall be left in a neat, free-draining condition with side slopes not steeper than 1 in 4 unless otherwise specified.

They shall be treated so as to conform with the landscape, revegetation and environmental requirements of the Contract.

9 Unsuitable Material

9.1 General

Clause 9 applies to the identification, excavation and disposal of Unsuitable Material where encountered on the Site and the backfilling of the resulting excavation.

9.2 Identification of Unsuitable Material

Unsuitable Material shall include:

- a) material from swamps, marshes and bogs
- b) logs, stumps and perishable materials
- c) material susceptible to spontaneous combustion
- d) excavated material that has a WPI greater than 4200 and/or a PI greater than 50 (as stated in Clause 14.2)
- e) dry or wet material to a depth of 300 mm or the depth of subgrade treatment, whichever is greater, which in the opinion of the Administrator cannot be reasonably worked or conditioned to achieve specified requirements
- f) all material removed, where the material below the depth defined in Clause 9.2(e) is, in the opinion of the Administrator, unsuitable for compacting subsequent layers

- g) material forming the foundation for a structure which has an allowable bearing pressure less than that nominated on the drawings
- h) material forming the foundation for an embankment which has an allowable bearing pressure or CBR less than that stated in Clause 4 of Annexure MRTS04.1 or, where not so stated, a CBR less than three based on dynamic cone penetrometer using Test Method Q114B
- i) material containing biosecurity matter including noxious weeds and other matter which may adversely affect the local environment, except where these are treated in an appropriate manner. For management of contaminated land refer MRTS51 *Environmental Management*.
- j) acid sulfate soils from within the Site which cannot be treated or managed in accordance with Clause 10
- k) stripped topsoil which is deemed not suitable as planting media and is not suitable for use elsewhere in the Works
- l) building rubble including concrete, asphalt and other materials except where broken down or otherwise treated and proved to be suitable for use, and
- m) abandoned Public Utility Plant and any associated material.

9.3 Unsuitable material from inappropriate construction activities

If suitable material was to become unsuitable because of inappropriate construction activities or failure to adequately protect works, all costs associated with reworking or replacing such unsuitable material shall be borne by contractor.

Examples of inappropriate construction activities include, but are not limited to:

- poor surface drainage
- restricted or inoperative subsurface drains
- contamination
- excessive sized construction plant where the imposed load exceeds the material strength
- poorly maintained construction plant allowing leakage of oils and water onto the formation, and
- leaving the surface unsealed allowing moisture ingress during wet weather.

9.4 Construction requirements

It shall be the sole responsibility of the Contractor to prove that material is Unsuitable Material as defined in Clause 9.2.

Where Unsuitable Material or potentially Unsuitable Material is encountered on the Site, the Contractor shall, before proceeding to remove or cover such material, notify the Administrator and provide any test results required to justify such a claim. **Hold Point 3**

Within 24 hours of the above notification, the Administrator will advise the Contractor of the required treatment, if any, and the extent of such treatment.

Methods of excavation of Unsuitable Material shall be in accordance with the requirements of Clause 13. Excavated material shall be used or disposed of in accordance with Clause 11.

In general, backfilling of excavations of Unsuitable Material shall be carried out in accordance with the provisions of Clause 13.3.

10 Acid sulfate soils

10.1 General

Clause 10 applies to the identification, testing and treatment of acid sulfate soils where encountered on the Site and in imported materials. For the purposes of this clause, the term "Sampling and Analysis Procedure" shall mean the current revision of the "*Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils in Queensland*" published by the Queensland Acid Sulfate Soils Investigation Team and the Department of Natural Resources and Mines.

Acid Sulfate Soils are predominantly found in sediments of marine origin in coastal areas where the ground surface elevation is less than five metres above sea level. Any tidal swamp or wetland which was once tidal, and some inland marshes subject to saline seepage have the potential for the development of acid sulfate soils.

10.2 Initial assessment of acid sulfate soils on the Site

If acid sulfate soil has been identified on the Site, its presence shall be indicated in Clause 5.1 of Annexure MRTS04.1 and its location shall be stated in Clause 5.2 of Annexure MRTS04.1.

Where acid sulfate soil is likely to occur by reference to elevation, geology, geomorphology or as shown on Sulfate Soil Risk Maps compiled by the Department of Natural Resources and Mines, this shall be indicated in Clause 5.3 of Annexure MRTS04.1 and the likely locations shall be stated in Clause 5.4 of Annexure MRTS04.1.

10.3 Management of acid sulfate soils

Assessment of excavated materials, exposed subgrade and borrow sources shall be undertaken by testing as specified in Clause 10.4. Where additional site specific requirements are stated in Clause 5.5 of Annexure MRTS04.1, the additional requirements shall also be met.

Where potentially acid sulfate soils are discovered, detailed methods for the identification, assessment and treatment of acid sulfate soils shall be set out in an Acid Sulfate Soil Management Plan as part of the Environmental Management Plan. The Acid Sulfate Soil Management Plan shall comply with the Sampling and Analysis Procedure.

10.4 Testing and reporting of acid sulfate soils

Testing for acid sulfate potential and reporting of test results shall be carried out on all excavated material and exposed cuttings on the Site which could reasonably be expected to have a possible acid sulfate potential.

The testing frequency and reporting shall be as detailed below:

- a) visual testing undertaken by trained personnel shall be continuous throughout the earthwork phase of the Contract and shall be applied to all such areas on which work is performed including borrow areas

- b) field pH testing for both actual and potential acid sulfate soils shall be carried out (on the same soil sample) on all borrow material to be imported to the Works and all material excavated or exposed in the Works in areas specified as having acid sulfate potential. A minimum of one test per soil type shall be carried out. The results shall be documented and reported to the Administrator prior to such materials being used on the Site. **Hold Point 4**, and
- c) where materials test positive to actual or potential acid sulfate contamination in the field, the Administrator shall be notified immediately. Such soils shall not be used on the Site until the results of subsequent quantitative laboratory testing negates the results of the field testing. Recommended quantitative laboratory methods are the Suspension Peroxide Oxidation Combined Acidity and Sulfate method and Total Oxidisable Sulfur method, as specified in the Sampling and Analysis Procedure and "*Suspension Peroxide Oxidation – Combined Acidity and Sulfate (SPOCAS) Method*".

10.5 Assessment of potential acid sulfate soils

Visual assessment (as per Acid Sulfate Soil Guideline) followed by a soil pH test kit can be used to indicate the presence of actual acid sulfate soils. If the soil's field pH (pH_F) is less than four, oxidation of pyrite has probably occurred in the past, indicating that actual acid sulfate soil is present. The pH_F test shall only be used as an indicator.

All samples collected for laboratory analysis shall be placed in sealed sample containers which exclude air and the containers shall be placed in an insulated container packed with dry ice or in a refrigerator. The samples shall be transported to the laboratory within 24 hours of collection to reduce the possibility of biologically catalysed oxidation.

Specific soil sampling methods shall be outlined in the Contractor's Acid Sulfate Soil Management Plan.

10.6 Soil treatment

Acid sulfate soils encountered below the base of excavations which will not be subjected to a change in water and oxygen regime do not require treatment. However, the high water content of such materials can be an issue for load bearing and subsidence. Exposure of potential acid sulfate soil (above the water table) exceeding 24 hours requires treatment. During hot weather a covering may also be required. Actual acid sulfate soil and Monosulfidic Black Ooze (MBO) are not allowed to be exposed without treatment.

Acid sulfate soils encountered as part of excavated materials and left exposed in cuttings or otherwise subjected to a change in water and oxygen regime will require treatment by the methods detailed below.

The treatment of positively identified actual or potential acid sulfate soils shall be to neutralise their actual and potential acidity as specified in the Sampling and Analysis Procedure before use or transport off the Site. Methods of treatment shall be outlined in the Contractor's Acid Sulfate Soil Management Plan.

Acid sulfate soils from within the nominated excavation lines shall generally be treated with lime during placement in embankment as provided for in Clause 14.3.6. Acid sulfate soils which cannot practically be neutralised for use on Site, or which are classed as Unsuitable Material, shall be removed from the Site and treated in accordance with the Acid Sulfate Management Plan.

Acid sulfate soils outside the nominated excavation and drainage lines shall be treated by insitu stabilisation with lime in accordance with Clause 12.2.3.

10.7 Water treatment

Runoff from stockpiles of acid sulfate soil and exposed groundwater potentially contaminated by acid sulfate soils shall be contained and managed within the boundary of the Site or treated to acceptable levels before discharge to watercourses. Analysis shall be carried out for at least chloride, sulfate, aluminium, calcium and iron content, pH, and electrical conductivity. Water shall not be discharged unless it meets the standard specified in Clause 5.6 of Annexure MRTS04.1.

Treatment shall generally consist of introduction of a lime slurry to the contaminated water prior to discharge. Details of management and treatment methods and release parameters shall be included in the Contractor's Acid Sulfate Soil Management Plan.

11 Use of or disposal of surplus and unsuitable material

11.1 General

Clause 11 applies to the methods for use of and/or disposal of surplus material and Unsuitable Material. Material suitable for an alternative use shall be used for that purpose if possible. Disposal of material shall be either to on-site spoil areas or to spoil off the Site.

11.2 Disposal in areas on the Site

Disposal in areas on the Site shall be permitted only at the locations specified in Clause 6 of Annexure MRTS04.1. Where no such areas are specified in Clause 6 of Annexure MRTS04.1, all surplus material and/or Unsuitable Material shall be removed from the Site in accordance with Clause 11.3.

Placement of surplus material and/or Unsuitable Material in areas on the Site shall be conditional on it being placed in neat and uniform lines which will remain stable and free draining in the long term and compacted by traversing with construction machinery. The finished surface of the material shall be treated by topsoiling and grassing or other equivalent method so that it is not subject to erosion.

The following materials shall not be placed in disposal areas on the Site:

- a) material susceptible to spontaneous combustion
- b) untreated acid sulfate soils
- c) materials containing rubbish, construction materials, organic materials other than would be acceptable as planting media and other deleterious, odorous or unsightly materials, and
- d) contaminated materials and materials containing biosecurity matter including noxious weeds or other matter which may affect the local environment or are considered environmentally hazardous.

11.3 Spoil to off-site areas

Except as provided for in Clauses 11.1 and 11.2, materials excess to project requirements and Unsuitable Materials shall be disposed of off the Site.

Such material shall be removed from the Site and disposed of in accordance with all relevant Statutory Requirements. The Contractor must obtain a Deed of indemnity from the given landowner, stipulating that the Principal, Superintendent and any associated Officers, Contractors and Sub-Contractors for

the project will not be held liable for the physical, chemical and/or biological condition of the material accepted on the property.

12 Ground surface treatment

12.1 General

Clause 12 applies to ground surface treatment where shown on the drawings or specified elsewhere in the Contract. The requirements of Clause 12 shall apply following clearing and grubbing operations and the stripping of topsoil where appropriate.

12.2 Construction

12.2.1 Ground surface treatment, standard

12.2.1.1 Areas to be treated

The requirements specified in Clause 12.2.1 are those to be carried out on the ground surface in all areas beneath any part of a road embankment or road pavement, and any additional areas specified in Clause 7.1 of Annexure MRTS04.1, but excluding:

- a) any areas of excavation
- b) any areas where a special ground surface treatment or subgrade preparation is required, and
- c) any areas underlain by soft clay and disturbance to the crust may rise to construction issues (subject to confirm by the designer and agreed by the Administrator).

12.2.1.2 Filling holes and localised depressions

Any holes and localised depressions in the ground surface evident following clearing and grubbing and stripping of topsoil shall be filled to the level of the surrounding ground surface. Fill material shall be material similar to the surrounding ground material or material specified for the construction of embankments. The material shall be placed in the holes and depressions, and compacted in accordance with Clause 15.

12.2.1.3 Compaction of Insitu material below embankments

After any clearing and grubbing, stripping of topsoil and replacement of Unsuitable Material, the exposed ground surface on which an embankment is to be placed shall, as a minimum, be scarified and re-compacted to a depth of at least 150 mm in accordance with the requirements of Clause 15.

If the material below the ground surface on which an embankment is to be placed is too wet or too dry to compact in accordance with Clause 15 and the material does not meet the requirements for Unsuitable Material as specified in Clause 9, the moisture content shall be adjusted as necessary to the appropriate depth to a maximum of 300 mm. Material below this depth shall be assessed under Clause 9.2.

This work may include tining, adding water, mixing, draining, the addition of dry materials, removing and replacing and/or other appropriate treatments.

Alternatively, in the interests of expediency, the Contractor may elect to remove wet material and replace it with other material at their own expense.

12.2.2 Ground surface treatment, special

Project specific requirements for ground surface treatment shall be as specified in Clause 7.2 of Annexure MRTS04.1.

12.2.3 Ground surface treatment – Insitu treatment of acid sulfate soils

Where runoff or groundwater can leach from acid sulfate soils, it shall be tested and neutralised in accordance with Clause 10.7.

Testing of acid sulfate soils shall be in accordance with the requirements of Clause 10.

Lime shall to be added to neutralise acidity. Addition and mixing of lime shall be in accordance with the requirements of MRTS07A *Insitu Stabilised Subgrades Using Quicklime or Hydrated Lime* with verification of lime content carried out in accordance with the requirements of MRTS07A *Insitu Stabilised Subgrades Using Quicklime or Hydrated Lime*.

Compaction shall be in accordance with the requirements of Clause 15.

12.2.4 Removal of unsuitable material

Procedures and processes for the identification, removal and replacement of Unsuitable Material shall comply with the provisions of Clause 9.

13 Excavation

13.1 General

Clause 13 applies to excavation where shown on the drawings or specified elsewhere in the Contract.

13.2 Blinding concrete

Blinding concrete shall be concrete of minimum Class N20/20 complying with the requirements of MRTS70 *Concrete*.

13.3 Construction

13.3.1 All excavations

Excavations shall be constructed to the shapes, lines, dimensions and other requirements shown on the drawings.

The areas detailed in Clause 8 of Annexure MRTS04.1 shall be lightly tined.

The use of excavated material in the construction of embankments, subgrade treatments, or backfill shall be subject to the requirements of the specific clauses.

Material within the lines of cuttings which is identified as Unsuitable Material in accordance with the provisions of Clause 9.2 shall not be used in the construction of embankments, subgrade treatments or backfill.

Excavated material which is surplus to the project requirements shall be disposed of as stated in Clause 11.

All permanent excavation batters shall be finished in accordance with Clause 16.

The bottom of excavations shall be trimmed to the tolerances specified in Clause 6 and any loose material removed from the surface.

13.3.2 Special requirements for cuttings

13.3.2.1 Bottom of excavation

When the level of excavation has reached subgrade level, the Contractor shall carry out the requirements of the relevant provisions of Clause 18.3.3 and cease excavation until the subgrade treatment type has been determined in accordance with Clause 18.3.3. **Hold Point 5**

13.3.2.2 Unsuitable material below the lines of cuttings

Material below the finished lines and levels of cuttings, which is Unsuitable Material in accordance with the provisions of Clause 9.2, shall be removed and disposed of in accordance with the provisions of Clause 9.4.

Where Unsuitable Material has been removed, the excavation shall be backfilled to the finished surface level with appropriate fill material as specified on the drawings or in accordance with Clause 18 and 19.

13.3.2.3 Pre-splitting

Batters specified in Clause 9 of Annexure MRTS04.1 and batters of rock cuttings with a slope of 2 vertical to 1 horizontal or steeper shall be pre-split prior to burden blasts to ensure protection of the batters.

The spacing of pre-split drill holes shall not exceed 1000 mm centre to centre. The actual spacing shall be determined by the contractor.

13.3.2.4 Restoration of batters

If any section of a batter has been over-excavated beyond the tolerance limit specified, the Contractor shall re-form the batter to the average batter slope shown on the drawings using an approved rectification method.

13.3.2.5 Berm drains

Berm drains shall be constructed where shown on the drawings.

Unless shown otherwise, berm drains shall have a nominal depth of 100 mm and shall be two metres wide. Berm drains shall be concrete lined in accordance with the requirements of MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

13.3.3 Special requirements for confined excavations

13.3.3.1 Dimensions of excavations

Trench excavations and excavations for structures shall be carried out to the dimensions shown on the drawings or, where not so shown, to the minimum dimensions necessary to accurately and safely construct the work under the Contract.

13.3.3.2 Unsuitable material in confined excavations

Material which is Unsuitable Material in accordance with the provisions of Clause 9.2 shall not be reused in the Works but shall be removed and disposed of in accordance with the provisions of Clause 9.4.

13.3.3.3 Protection of excavations

The Contractor shall take all necessary precautions to protect an excavation and all personnel and equipment in or about an excavation, including provision of all necessary temporary Works and equipment. Upon completion of construction within an excavation, all temporary Works shall be removed in such a way as not to damage any finished structure and ensure the finished works meet the requirements of this Technical Specification in all regards.

13.3.3.4 Bottom of excavation

The material in the bottom of confined excavations shall comply with the density requirements of Clause 15. Where the insitu material does not comply, it shall be compacted to a depth of at least 150 mm in accordance with the requirements of Clause 15.

Where precast concrete items (end structures, walls, kerbs, kerb and channels etc) are to be placed in excavation, a 50 mm layer of bedding material complying with the requirements of Clause 19.2.6 shall be placed and compacted to provide continuous, even support to the structure.

13.3.4 Special requirements for structure foundations

13.3.4.1 Excavation for load bearing footings

Excavation for foundations of structures shall be carried out to the dimensions and depths shown on the drawings. All excavations for foundations shall be drained.

When competent material has been reached at or below the depth shown on the drawings, the foundation surface shall be trimmed to a generally horizontal plane or to generally horizontal steps as appropriate, completely dewatered and presented for final inspection by the Contractor's RPEQ geotechnical engineer. No work which will cover the surface of the foundation shall proceed until the foundation has been inspected and approved by the Contractor's RPEQ geotechnical engineer and approved by the Administrator **Hold Point 6**. The Contractor shall give the Administrator three days notice of such inspection **Witness Point 1**.

A report from the Contractor's Geotechnical Engineer confirming that the profile of ground water and the strength and stiffness characteristics of foundation soil comply with the design assumptions shall be forwarded to the Administrator.

Where shown on the drawings or specified elsewhere, a layer of blinding concrete shall be placed over the foundation material as soon as practical. The top surface of the blinding concrete shall be screeded neatly to the shape and levels shown on the drawings.

If the foundation surface has deteriorated since the time the foundation was approved and before blinding concrete or backfill material has been placed, additional material shall be removed until competent material is reached as described above and then **Hold Point 6** shall be re-released.

13.3.4.2 Excavation for pile caps

Excavation for pile caps shall be carried out to the dimensions and levels shown on the drawings.

13.3.5 Excavation to clear waterways

Excavation shall be carried out, where shown on the drawings, to clear the waterways at bridge abutments. The surface so formed shall be sealed by using a smooth drum roller.

13.3.6 Special requirements for culverts

The widths of excavations for culverts shall be the minimum necessary for their construction and placement of backfill against them, provided that nowhere shall such widths be more than those shown on Standard Drawing 1359.

The material in the bottom of an excavation shall comply with the density requirements of Clause 15. Where the insitu material does not comply, it shall be compacted to a depth of at least 150 mm in accordance with the requirements of Clause 15.

13.3.7 Special requirements for drains

13.3.7.1 Culvert inlet/outlet drains

Culvert inlet/outlet drains shall be constructed from the extremities of end structures to culverts and shall transition smoothly to existing adjacent natural drainage channels or to the boundary of the Site, whichever is closer.

13.3.7.2 Diversion channels

Diversion channels shall be constructed to the details shown on the drawings.

13.3.7.3 Diversion drains

Diversion drains shall be constructed to the details shown on the drawings or, where not shown, as detailed on Standard Drawing 1178 and to any cross-sectional areas shown on the drawings.

13.3.7.4 Catch drains

Catch drains shall be constructed before or during the early stages of construction of the adjacent roadworks and shall be located as close as practicable to the adjacent batter edges.

Where the transverse slope of the ground surface allows this, catch drains shall be turned out away from the roadworks at frequent intervals in a manner which will minimise the scouring effect of any surface flows. Catch drains shall, where practicable, be terminated at inlet/outlet drains to culverts.

13.3.7.5 Table drains

Where table drains cross accesses to private properties and details of the crossings are not specified, the drains shall be so constructed as to be trafficable to normal passenger vehicles.

13.3.7.6 Slope of drains

All drains shall have a continuous positive drainage slope in the required direction.

13.3.8 Dewatering of excavations

Where dewatering of excavations is required, it shall be carried out in compliance with the requirements of the Environmental Management Plan. Under no circumstances shall water be disposed of to sanitary sewers unless explicit permission to do so is granted by the relevant asset owner.

14 Embankments

14.1 General

Clause 14 applies to embankments constructed up to subgrade level or as otherwise shown on the drawings or specified elsewhere in the Contract.

14.2 Materials

14.2.1 Introduction

Fill material used in embankments shall be either earth fill material or rock fill, and shall be sourced from general excavations on the Site or from borrow.

Size limitations for stone shall apply where specified elsewhere in this Technical Specification.

Where fill material is required from borrow, borrow areas shall be developed, operated and reinstated in accordance with the provisions of Clause 17.

Where embankments are being constructed as the subgrade for pavements, the requirements of Clause 18 shall also apply in addition to the requirements of this Clause.

14.2.2 Earth fill material

Earth fill material shall comply with the properties and classes stated in Tables 14.2.2-A and 14.2.2-B modified in accordance with any requirements stated in Clause 10.1 of Annexure MRTS04.1. The requirements for percentage passing 0.075 mm AS sieve shall apply to the compacted material in place. The percentage passing 0.425 mm AS sieve and PI to estimate WPI shall also apply to the compacted material in place.

Table 14.2.2-A – Earth fill material properties

Earth Fill Material	WPI
Class A2	< 1200
Class B	$1200 \leq \text{WPI} < 2200$
Class C	$2200 \leq \text{WPI} < 3200$
Class D	$3200 \leq \text{WPI} < 4200$
Unsuitable	$\text{WPI} \geq 4200$

Notes:

- When used as outer zone and upper zone materials (refer Figure 14.3.1), Class A2 material shall have PI > 7%, passing 0.075 mm AS sieve between 15% and 30% and Emerson Class Number > 3. This is defined as Class A1 in Table 14.2.2-B.
- The final batter slope surface of the embankment shall be tested and ameliorated, as per MRTS16 (subsoil), to ensure material in the outer 200 mm is chemically stable and capable of supporting a long term vegetation cover.
- For embankments within the structure zone, Class A1 or A2 material shall be used with a maximum particle size of 75 mm. However, Class A2 material shall not be used in the outer zone or upper zone. The material shall be placed at a relative moisture content within the range of 60 to 80% and compacted to 98% minimum relative compaction (standard compaction).
- Class D material that has PI > 50% is unsuitable fill material (refer Clause 9.2 (d)).
- Where being used as backfill, earth fill material shall have all material passing the AS 25 mm sieve (refer Clause 19.2.2).

Payment Note: Payment for the testing of final batter slope surface material (subsoil), supply of amelioration agents, spreading of amelioration agent on subsoil and incorporation with ground preparation work operations can be nominated in the schedule of rates of Work Items 3805P, 3807P to 3809P, 3819 to 3822 as per MRS16.

Table 14.2.2-B – Additional earth fill material properties

Earth Fill Material	WPI	PI (%)	% Passing 0.075 mm AS sieve	Emerson Class Number
Class A1	< 1200	≥ 7	15 – 30	> 3

In humid, tropical regions, the development of concretions in lateritic soils governs their engineering properties. Performance based assessment applies. Details are required in the project specific Annexure based on local experience.

14.2.3 Rock fill

Rock fill shall consist of sound igneous, metamorphic or sedimentary rock or combination of these rock groups that will not disintegrate in water or when exposed to the weather. Rock fill shall be free from overburden, spoil, shale, clayey materials and organic matter. Rock fill shall comply with the properties stated in Table 14.2.3. Rock shall be angular in shape and the least dimension of the rock shall not be less than half its greatest dimension.

Table 14.2.3 – Properties of rock fill prior to placement

Property	Requirement
Particle Size Distribution <ul style="list-style-type: none"> Maximum particle size Percentage passing: <ul style="list-style-type: none"> 100 mm AS sieve 19 mm AS sieve 1.18 mm AS sieve 	Refer Table 15.4 < 20% < 10% < 5%
Wet / Dry strength variation (AS 1141.22)	35% (maximum)
Point load strength index $Is(50)$ (Test Method AS4133.4.1)	Percentage of +100 mm fraction with $Is(50)$ less than 1 MPa = 10% (max)
Water absorption (AS 1141.6.1)	< 5% < 2.5% in wet areas
Degradation Factor (Test Method Q208B) ¹	30 (minimum)
Petrographic Analysis	Interpretative report describing rock name, and strength and durability characteristics

Note:

1. Degradation Factor testing is only required if rock fill shall subject to inundation more than 12 hours.

Treat and shape the foundations under rock fill to maintain drainage and to ensure that erosion of the foundation will not occur. Place and spread the rock fill in such a way as to avoid segregation and to ensure that it is not contaminated with foreign material. The uncompacted rock fill layer thickness must not exceed the thickness given in Table 15.4.

Do not dump rock against the columns or retaining walls but built it up evenly by gradually placing it around or against such structures.

Compact the rock fill using the mechanical interlock method of construction as per Clause 15.4.

When rock fill is used in the core zone or outer zone (Figure 14.3.1), or within a homogeneous embankment, an upper zone of Class A1, A2 or B material is required as a capping layer immediately above the rock fill.

14.2.4 Verge material

Verge material shall be earth fill material Class A1 or Class B complying with the properties stated in Clause 14.2.2.

14.2.5 Water retaining embankments

Fill material used for the construction of levee banks, catch banks and other water retaining embankments shall be earth fill material which complies with the requirements for Class A1 or Class B material in accordance with Clause 14.2.2 and Tables 14.2.2-A and 14.2.2-B. However, the maximum particle size shall be limited to 50 mm.

The batter of the embankment subject to temporary or permanent inundation shall be protected from saturation and slumping failures. Any embankment batters subject to flood velocity greater than 2 m/s must be appropriately designed (not limited to scouring and embankment stability).

14.2.6 Geotextile

Geotextile shall be a material of the appropriate strength class and filtration class complying with the requirements of MRTS27 *Geotextiles (Separation and Filtration)*.

14.2.7 Geosynthetic reinforcement

Geosynthetic reinforcement in road embankments below subgrade level shall comply with the requirements of MRTS100 *High Strength Geosynthetic Reinforcement in Road Embankments*.

14.2.8 Special embankment materials

Where special embankment materials are required to be used, the material requirements are specified in Clause 10.2 of Annexure MRTS04.1.

14.3 Construction

14.3.1 General

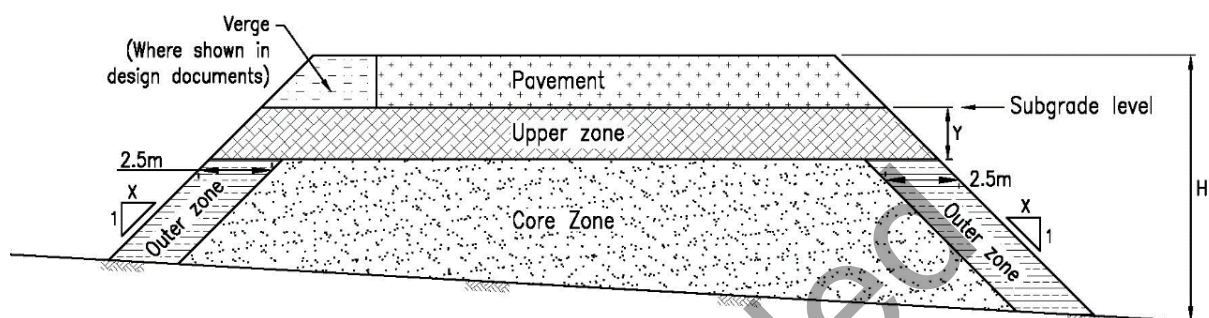
Embankments shall be constructed to the shapes, zones and other requirements shown on the drawings or as otherwise specified.

Where so stated in Clause 10.3 of Annexure MRTS04.1, fill material shall be placed in zones as shown in Figure 14.3.1. Where not shown as being placed in zones, fill material shall be homogeneous.

Notwithstanding any other specific requirement for fill material, material placed in an embankment within a height 600 mm below subgrade level shall consist of material suitable for placement using the compacted layer method.

Earth fill material requirements for both homogeneous and zoned embankments, and cover requirements for zoned embankments, depend on embankment height to subgrade level and rainfall zone. Unless shown otherwise in Clause 10.4 of Annexure MRTS04.1, the requirements shall be as given in Table 14.3.1. The zone definitions for the cross section and rainfall are shown in Figure 14.3.1 and Table 15.3-C respectively.

Figure 14.3.1 – Embankment zones



Note: It is preferred to construct the core zone and outer zone simultaneously in layers. If not, provide stepping as per Clause 14.3.3 between the core zone and outer zone.

Table 14.3.1 – Embankment fill properties

H	Batter Slope 'x' 1,6	Rainfall Zone ²	Zoned Cross-Section				Homogeneous Cross-Section ^{3,5}
			Upper Zone Thickness Y (m) ^{1,4}	Earth Fill Class ^{3,7}			
				Core ¹	Upper ¹	Outer ^{1,5}	
≤ 3 m	≥ 4	Low / Medium	1.0 m when Class C and 1.2 m when Class D in Core	A2, B, C, D	A1, B	A1, B, C	A1, B
		High	0.8 m when Class C and 1.0 m when Class D in Core				
≤ 10 m	≥ 2	Low / Medium	1.2 m when Class C and 1.5 m when Class D in Core			A1, B	
		High	1.0 m when Class C and 1.2 m when Class D in Core				
≤ 10 m	≥ 1.5	–	600 mm of Class A1 or B (refer note 8 below for additional requirements)	Rock fill, maximum rock size 300 mm (refer Table 15.4 for compaction)			
≤ 10 m				Rock fill, maximum rock size 400 mm (refer Table 15.4 for compaction)			

Notes:

1. Refer to Figure 14.3.1 for definitions of x, y and core, upper and outer zones.
2. Refer to Table 15.3-C for rainfall zone definitions.
3. Refer to Table 14.2.2-A for definitions of Earth Fill Classes A2, B, C and D and Table 14.2.2-B for Earth Fill Class A1.
4. As the upper zone (and core zone/outer zone) will form part of the pavement subgrade, additional requirements stated in Clause 10.2 of MRTS04.1, and/or in the pavement design documentation, must also be satisfied.
5. Emerson Class > 3, for outer zone and upper zone materials.
6. Minimum requirements are given in Figure 14.3.1 and Table 14.3.1. Embankments with H > 10 m need to be specifically geotechnically designed (example, outer zone thickness may need to be increased to satisfy the stability requirements).
7. For bridge approach embankments (structure zone), refer Clause 14.2.2, Note Number 3.
8. A geotextile separator as per Clause 14.3.2 shall be provided.

The required upper zone thickness in Table 14.3.1 is mainly to minimise shrink/swell effects of the core zone materials on the pavement. As the upper zone, core zone and outer zone contribute to pavement support, the additional requirements stated in Clause 13.2 of MRTS04.1, and/or in the pavement design documentation, must also be satisfied to meet the pavement design requirements.

Where excess fill material is available from general excavations on the Site, care shall be taken to ensure that material in classes with the highest WPI is disposed of progressively.

Care shall be taken when sourcing fill material so that sufficient Class A1 and Class B materials are available to complete the embankment in accordance with the requirements of this Technical Specification.

The method of construction employed shall be the compacted layer method and/or the mechanical interlock layer method in accordance with the requirements of Clause 15. Construction operations which involve tipping of material over the sides of a constructed section of embankment are not permitted.

Compaction standards shall be as specified in Clause 15.

Permanent embankment batters shall be finished in accordance with Clause 16.

14.3.2 Geotextile at changes in material type

Where fill material changes from material compacted by the mechanical interlock method to material compacted by the compacted layer method a geotextile complying with the requirements of MRTS27 *Geotextiles (Separation and Filtration)* shall be installed at the interface unless approved by the administrator.

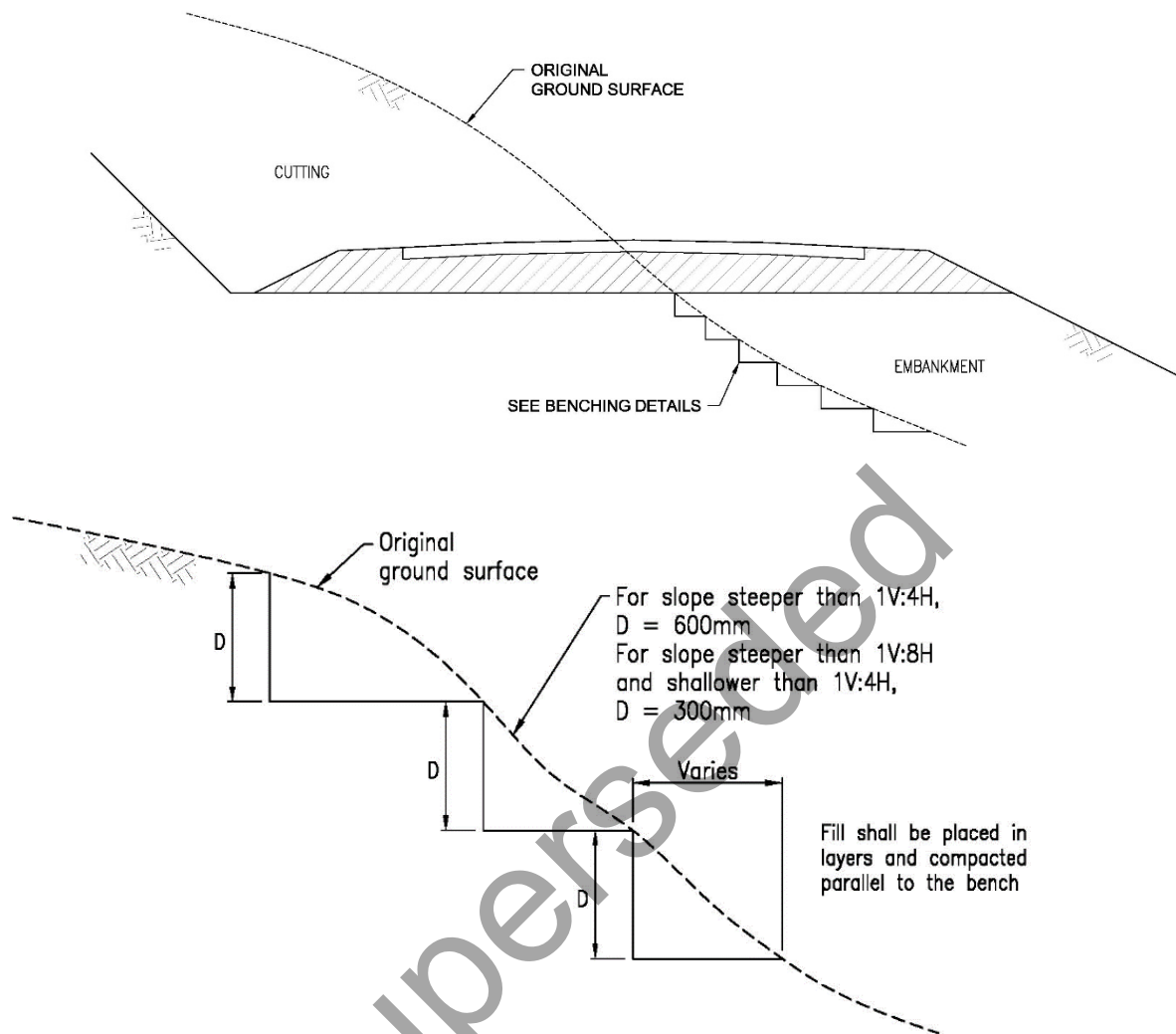
Prior to installing the geotextile, the surface voids in the material at the interface shall be completely filled with smaller stones and fines to provide effective support for the geotextile.

14.3.3 Stepping the ground surface on which embankments are to be constructed

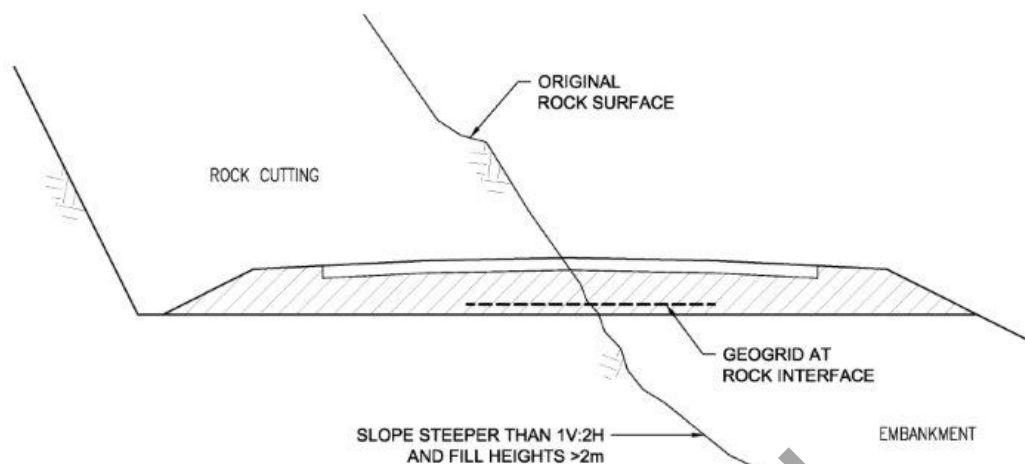
Where embankments are to be constructed on or against any slopes or batter of existing embankments (including batters resulting from the partial construction of embankment, e.g. Core Zone), steps shall be cut as follows:

- a) where the ground surface has a slope steeper than 1V to 8H and shallower than 1V to 4H, a series of horizontal steps not less than 300 mm high shall be cut into the ground surface to be covered by the embankment. Such steps shall be constructed both longitudinally and transversely (refer Figure 14.3.3.1)
- b) where the existing slope or batter has a slope steeper than 1V to 4H, a series of horizontal steps not less than 600 mm high shall be cut into the ground surface to be covered by the embankment. Such steps shall be constructed both longitudinally and transversely (refer Figure 14.3.3.1)

Figure 14.3.3.1 – Transverse transition in earth cutting (also applies to longitudinal transition)



- c) Where the material to be benched is hard rock, as a minimum a geogrid reinforcement (Type 2 as per MRTS58 *Subgrade Reinforcement using Pavement Geosynthetics*) shall be placed at least 2m either side of this interface at or below subgrade level (specific location to be nominated by the designer), (refer Figure 14.3.3.2).

Figure 14.3.3.2 – Transverse transition in hard rock (also applies to longitudinal transition)

Inspect the floor of each step in accordance with Clause 9 to check for any unsuitable material. Unless directed otherwise by the Administrator, incorporate the material thus excavated in embankments in accordance with Clause 14 or dispose of it as spoil in accordance with Clause 11.

No account will be taken of the material removed in stepping when determining the general earthworks excavated volume.

Additional requirements for side-long embankments are given in *Transport and Main Roads Geotechnical Design Standard*.

14.3.4 Special requirements for diversion blocks

Diversion blocks shall be constructed to the details shown on Standard Drawing 1178.

The volume of each diversion block shall be not less than 1 m³.

14.3.5 Special requirements for catch banks

Catch banks shall be constructed before or during the early stages of construction of the adjacent roadworks and shall be located as close as practicable to the adjacent batter edges of the roadworks.

Where the transverse slope of the ground surface allows this, catch banks shall be turned out away from the roadworks at frequent intervals in a manner which will minimise the scouring effect of any surface flows.

Catch banks shall be terminated at inlet drains to culverts.

14.3.6 Special requirements for acid sulfate soil materials

Testing of acid sulfate soils shall be in accordance with the requirements of Clause 10.

Where lime is to be added to fill material to neutralise acidity, the addition and mixing of lime shall be in accordance with the requirements of MRTS07A *In situ Stabilised Subgrades Using Quicklime or Hydrated Lime* with verification of lime content carried out in accordance with the requirements of MRTS07A *In situ Stabilised Subgrades Using Quicklime or Hydrated Lime*.

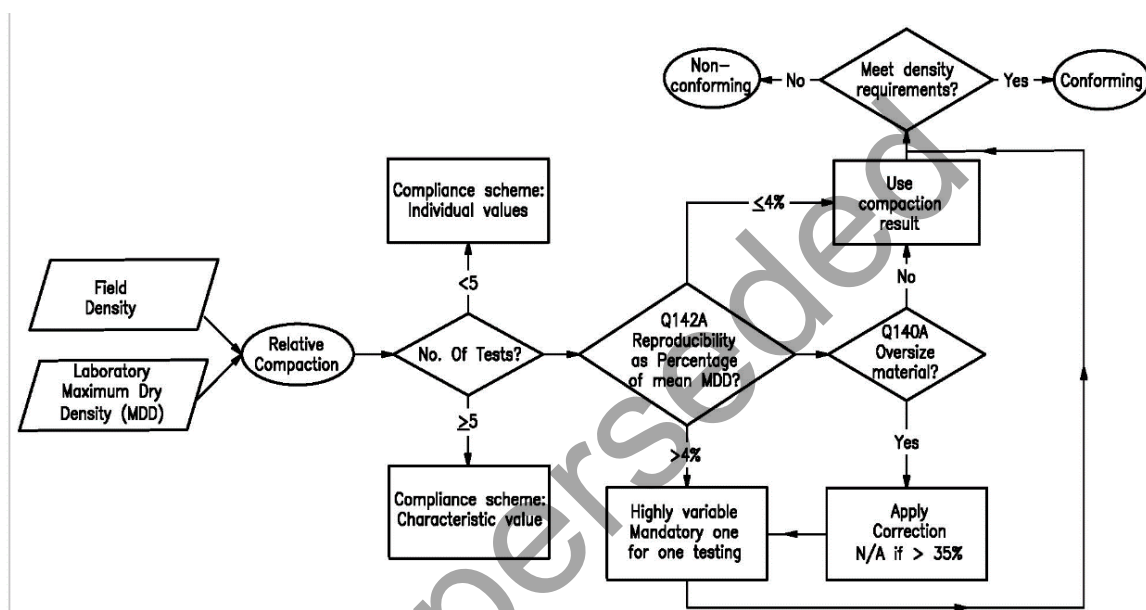
15 Compaction

15.1 General

Clause 15 applies to the requirements for compaction of all earthworks materials. Compaction compliance procedure is shown in Figure 15.1 to remind the following:

- Use of characteristic value versus individual value for density
- One to one test for highly variable material (i.e. reproducibility of Q142A test), and
- Apply oversize correction

Figure 15.1 – Compaction compliance procedure



15.2 Method of compaction and testing

The method of compaction and the required methods for verifying compliance with density requirements are dependent on the properties of the material being compacted. The categories of materials, their required method of compaction and the method for determination of density are summarised in Table 15.2.

Where the Contractor proposes to use materials other than those in the categories given in Table 15.2, the Contractor shall submit samples of the material and details of their proposed compaction and testing methods to the Administrator for acceptance.

Table 15.2 – Compaction method

Material Category	Compaction Method	Density Compliance Tests
Cohesionless sands	Compacted layer method	Density Index where maximum dry density test gives meaningless answers, otherwise relative compaction
Soils other than above which, after compaction, have less than 35% of stone retained on the 37.5 mm sieve	Compacted layer method	Relative compaction
Coarse grained soils with more than 35% of stone retained on the 37.5 mm sieve	Mechanical interlock method	Nil on material in general

15.3 Compacted layer method of construction

Where the compacted layer method of construction is employed, the provisions of Clause 15.3 shall apply.

Where the fill material contains stone, the stone shall be of size not greater than two-thirds of the uncompacted layer thickness.

All earth fill material shall be placed uniformly in layers. The allowable loose layer thickness for material compacted using the compacted layer method shall be as specified in Table 15.3-A.

The maximum allowable loose layer thickness for earth fill material in road embankment may be increased if the Contractor can demonstrate to the Administrator that the proposed compaction plant and work procedure will achieve the specified densities throughout the full depth of the compacted layer. Such trials for Earth fill and large earthworks projects are encouraged by Transport and Main Roads, who recognise that effective depth of compaction is dependent on the type of equipment being used. However, an equipment manufacturer's claim is not sufficient, and a quality control validation is required.

Table 15.3-A – Layer thickness for compaction

Material / Location	Loose Layer Thickness (mm)	
	Minimum	Maximum
Earth fill material in road embankment or subgrade treatments	150	300
Fill material in water retaining embankments	150	200
Backfill – except sand	100	100
Backfill – sand	150	300

In trenches and confined spaces, backfill shall be placed at the minimum layer thickness in Table 15.3-A.

Where the uncompacted thickness of a layer would otherwise be less than the minimum thickness specified in Table 15.3-A, a lesser thickness of newly placed fill material may be placed by loosening the underlying material to give a total depth equal to the minimum thickness.

Density requirements for materials compacted using the compacted layer method shall be as specified in Table 15.3-B. The characteristic value for relative compaction shall be calculated in accordance with the provisions of Clause 12 of MRTS01 *Introduction to Technical Specifications*.

Table 15.3-B – Density requirements

Application (Reference Clauses)	Material	Compaction Standard ¹	
		Minimum ²	Maximum ³
Embankment and Cutting			
Insitu material for placement of embankment fill (12.2.1.2, 12.2.1.3, 12.2.3)	Existing	95%	—
Bottom of excavations (13.3.3.4, 13.3.6)			
Top 300 mm below subgrade level	Existing	97%	
	Class A1, A2 or B		
	Unbound granular or stabilised material		
Greater than 300 mm below subgrade level	Class A1, A2, or B	95%	—
	Unbound granular or stabilised material		
	Class C or D (low or medium rainfall zone) ⁵	95%	—
	Class C or D (high rainfall zone) ⁵	90%	96%
Water retaining embankments	Class A1, A2 or B	97%	—
Other			
Backfill (19.3.1) (Excluding subgrade)	Cohesive	95%	—
	Cohesionless	70% (Density Index ⁴)	—
Non trafficked trench areas and ground surface treatment	Cohesive	90%	—
	Cohesionless	60% (Density Index ⁴)	—
Non trafficked landscaping areas ⁶	Cohesive	80%	90%

Notes:

1. The compaction standard shall be relative compaction except for sand where density index shall be used.
2. Lower characteristic value unless otherwise required (refer Clause 5.6)
3. Upper characteristic value unless otherwise required (refer Clause 5.6)
4. AS 1289.5.6.1.
5. Refer Table 15.3-C
6. Landscape area to be approved by Administrator. This recognises heavy compaction inhibits plant growth.

The embankment and any unbound granular material below subgrade level shall be placed and compacted at a moisture content within the range given in Table 15.3-C where the values given are the relative moisture content (standard compaction). The rainfall zone shall be as given in Clause 11 of Annexure MRTS04.1.

The OMC is the laboratory condition which considers the material properties to achieve the MDD, however the field moisture condition for optimal compaction is equipment and climate dependent for untreated materials in cut to fill operations. For processed material (e.g. imported gravels), the moisture content at or dry of OMC shall be adopted.

Where water is added to achieve the required moisture content, water shall be free from oil, acids, organic matter and any other matter which could be deleterious to earth fill properties.

The moisture content of the compacted material shall be maintained within the specified range until covered with subsequent layers.

At all times the Contractor shall ensure that no water is permitted to pond on or adjacent to an embankment and that the surface of the embankment is free draining. Any unsuitable materials due to wetting up shall be reworked or removed and replaced as per Clauses 9.3 and 9.4. Such unsuitable material must be excavated to the extent and depth directed by the Administrator.

Table 15.3-C – Moisture content range for embankment and unbound subgrade material

Rainfall Zone	Median Annual Rainfall (mm)	Earth Fill Material Relative Moisture Content (%)			
		Class A1/A2	Class B	Class C	Class D
High	> 1000	70 – 100	80 – 110	90 – 120*	100 – 130*
Medium	500 – 1000	70 – 90	70 – 100	80 – 110	80 – 110*
Low	< 500	60 – 80	60 – 90	60 – 90	60 – 90

* These limits apply to material without added water. Where water is added to achieve compaction, the limits shall be 80 – 110.

15.4 Mechanical interlock method of construction

The mechanical interlock method of construction shall be employed for coarse granular soils and rock fill as specified in Clause 15.2, where mechanical interlock is relied upon for stability. All fill material shall be placed and compacted uniformly in layers. The maximum thickness of an uncompacted layer shall be determined from Table 15.4 unless otherwise agreed with the Administrator.

The module weights specified in Table 15.4 shall apply to drawn rollers and self-propelled single drum rollers. The maximum layer thicknesses for module weights between the values listed shall be interpolated.

The layer thickness and compaction equipment shall be chosen such that the maximum stone size shall be less than or equal to half the uncompacted thickness.

Each layer shall be rolled without perceptible surface deformation or springing. **Witness Point 2**

Table 15.4 – Maximum thickness of uncompacted layers for mechanical interlock

Static Module Weight or Vibrating Drum Equivalent (tonnes)	Maximum Thickness of Uncompacted Layer (mm)	Maximum Rock Size (mm)
5	300	150
10	400	200
15	600	300
20	800	400

16 Finishing batters

Batters shall be free of loose material and shall be trimmed neatly to the shapes specified.

No portion of a batter shall project beyond the shape specified by more than 300 mm or one-third of the height of the batter, whichever is the lesser.

No portion of a rock batter shall overhang the outside edge of a table drain.

Batters shall continue in regular lines around curves.

Where vegetation treatments on cut or fill batters are shown on the drawings and/or specified, the batters shall be prepared in accordance with the following:

- batter slopes steeper than 1V : 4H shall be roughed in accordance with MRTS16 *Landscape and Revegetation Works*, and
- batter slopes flatter or equal to 1V : 4H shall be cultivated in accordance with MRTS16 *Landscape and Revegetation Works*

Vegetation treatment of batters shall commence as soon as practicable, but not later than 14 days after substantial completion of earthworks on each section of the Works.

Payment Note: Payment for the roughening and cultivation of cut and fill batters is included in the work operations of the Standard Work Items 3821 and 3822 of MRS16.

17 Borrow operations

17.1 General

Where material obtained from construction of excavations is insufficient for the construction of embankments and other fills, suitable material may be borrowed from areas on or off the Site.

17.2 Borrowing operations on the Site

Material may be borrowed on the Site from any areas stated in Clause 12.1 of Annexure MRTS04.1. Where no areas are stated in Clause 12.1 of Annexure MRTS04.1, material shall not be borrowed from the Site. Borrowing operations on the Site shall comply with any additional requirements stated in Clause 12.2 of Annexure MRTS04.1.

Borrow areas on the Site shall be developed, operated and reinstated in accordance with the following:

- borrow areas shall be cleared and grubbed in accordance with the provisions of Clause 7

- b) the area shall be stripped of topsoil in accordance with the requirements of Clause 8.2 and the resulting material shall be stockpiled in accordance with the requirements of Clause 8.4.4 for subsequent reinstatement of the borrow area
- c) the edges of the excavations shall be at least three metres clear of the Works, property boundaries, fences, Public Utility Plant, drainage lines and structures and any other installed components
- d) excavations shall not be deeper than 500 mm, shall have side slopes not steeper than 1 on 4, and shall be graded to drain away from roadworks, and
- e) on completion of borrowing operations, the area shall be trimmed to a neat and tidy shape that is able to freely drain. Previously stockpiled topsoil shall be spread uniformly over the area.

Development, operation and reinstatement of borrow areas shall comply with the environmental requirements of the Contract.

17.3 Borrowing operations off the Site

Borrowing operations off the Site shall be carried out in compliance with all Statutory Requirements.

Borrow material shall not be sourced from contaminated land as defined in the *Contaminated Land Act* 1991. Borrow material shall not contain acid sulfate soils.

18 Subgrade

18.1 General

Clause 18 applies to the preparation of subgrade below subgrade level in cuttings and embankment.

The depth of subgrade shall be defined as stated in Clause 13.1 of Annexure MRTS04.1. Where no depth is nominated in the Annexure the following shall apply:

- a) For untreated subgrade and subgrade in cuttings – 1.5 m below subgrade level, or
- b) For subgrade in embankments – 2.0 m below subgrade level.

Stabilised sand, lean mix concrete and sand shall not be used in the subgrade except as shown on the drawings or specified elsewhere in the Contract.

Subgrade is defined as the trimmed or prepared portion of the formation on which the pavement is constructed. The depth of subgrade is measured below 'subgrade level'.

For the purposes of pavement design, embankments and cuttings are required to be constructed to achieve the required support conditions at subgrade level adopted in the pavement design. These support conditions are typically specified using a minimum CBR (tested at the design moisture and density conditions).

The pavement designer should nominate (in MRTS04.1 Clause 13.2) material requirements for all materials below subgrade level that are expected to have an influence on pavement support.

18.2 Materials

18.2.1 Fill material

In addition to the requirements of Clause 14, fill material used for the construction of subgrade (to the depth nominated in Clause 18.1), shall comply with the requirements specified in Clause 13.2 of Annexure MRTS04.1 or elsewhere in the design documents.

These requirements shall apply to fill used in embankments, subgrade treatments and backfill.

18.2.2 Unbound granular material

Where unbound granular material is to be used for the construction of subgrade (including where it will be stabilised), it shall conform with the requirements of MRTS05 *Unbound Pavements* and shall be at least of the subtype specified in Clause 13.3 of Annexure MRTS04.1, or where no such subtype is specified, at least subtype 2.4.

18.2.3 Unbound granular drainage layer material

Where unbound granular drainage material is to be used for the construction of subgrade (including where it will be stabilised), it shall be subtype 2.4 conforming with the requirements of MRTS05 *Unbound Pavements* unless otherwise approved by the Administrator or shown elsewhere in the design documents. However, the particle size distribution of the material shall comply with the limits stated in Table 18.2.3.

Table 18.2.3 – Drainage layer – particle size distribution

As Sieve Size (mm)	Percent Passing by Mass
53	100
37.5	100
26.5	90 – 100
19.5	75 – 100
9.5	50 – 65
4.75	30 – 45
2.36	20 – 30
0.425	6 – 13
0.075	2 – 5

18.2.4 High permeability drainage material

18.2.4.1 General

The unbound granular drainage layer material specified in Clause 18.2.3 may not always be sufficient to ensure an adequately permeable material for all situations. A high permeability drainage layer may be required in some location where higher water flows are expected.

High permeability drainage material shall be rock fill complying with the requirements of Clause 14.2.3 and the additional and overriding requirements given in Table 18.2.4.2,

Table 18.2.4.1 – Additional properties for high permeability drainage layer

Property	Value
Particle size distribution	Refer Table 18.2.4.2
Wet Strength (Test Method AS 1141.22)	minimum 100 kN
Wet/dry strength variation (Test Method AS 1141.22)	maximum 35%
Degradation Factor (Test Method Q208B)	minimum 40
Water Absorption (Test Method AS 1141.6.11)	< 2.5%
Petrographic Analysis	Interpretative report describing rock name, and strength and durability characteristics

The intent of this material specification is to provide a free-draining, highly permeable material that is sufficiently durable to withstand prolonged periods of inundation. Therefore the high permeable drainage material shall be supplied by a quarry or any other sourcing sites registered and operated in accordance with the Department of Transport and Main Roads Quarry Registration System (QRS) requirements. The current Quarry Registration Certificate shall be submitted to the Administrator at least seven working days before a material's supply or use.

Table 18.2.4.2 – Particle size distribution for high permeability drainage layer

AS Sieve Size (mm)	Percent Passing by Mass
125*	100
19.0	0 – 15
2.36	0 – 5
0.075	0 – 1

* The maximum particle size of the rock fill may be increased to 150 mm where the high permeability drainage layer is at least 400 mm thick.

18.2.4.2 Material beneath high permeability drainage layer

The CBR of the material on which the high permeability drainage layer will be placed shall be determined by insitu dynamic cone penetrometer (DCP) testing at the time of construction of the high permeability drainage layer. Where the CBR of the material is less than 1.0%, a specific assessment to determine the required properties and placement method of the drainage layer material is necessary.

Where the CBR of the material is greater than or equal to 1.0% at the time of construction, the high permeability drainage layer should be a minimum thickness of 300 mm.

18.2.4.3 Cover over high permeability drainage layer

Where the maximum particle size of the rock fill exceeds 100 mm, the top surface of the placed rock fill shall be covered (prior to encapsulating with geotextile) by smaller particle size rock fill, with a maximum particle dimension of 75 mm, to “in fill” the voids in the surface of the high permeability drainage layer. The proof rolling test shall be undertaken after placement of the smaller particle size rock fill.

In addition, where the high permeability drainage layer is immediately below the pavement, it shall be covered by a minimum thickness of 150 mm of plant mixed stabilised material in accordance with Clause 18.2.6 or a lightly bound improved layer.

18.2.4.4 Construction requirements

The surface on which the drainage layer is placed shall be shaped in accordance with the design documents so that it does not pond water and is free draining.

High permeability drainage layer material must be placed and compacted to achieve stability of the layer. The Administrator may require that trial sections be constructed to verify that the proposed compaction procedure is acceptable.

High permeability drainage layers shall be compacted using the mechanical interlock method of construction as per Clause 15.4.

18.2.5 Stabilised subgrade material

18.2.5.1 General

The material to be stabilised may be existing subgrade materials, or imported material. Existing subgrade material may be stabilised insitu. Imported materials may be stabilised either insitu or through plant-mixed stabilisation.

Insitu or plant mixed stabilisation may be undertaken with either lime, cement or cementitious blends in accordance with the requirements of Clause 18.2.5.2 and 18.2.5.3.

The stabilising agent and its rate of application are nominated in Clause 13.4 of Annexure MRTS04.1.

The following guidance is provided on the suitability of materials for either lime or cement/cementitious blend stabilisation.

Material requirements for stabilisation:

Lime	Cement or Cementitious Blend
a) plasticity index > 10 b) weighted plasticity index (WPI) > 1200 c) maximum aggregate size of 75 mm d) lime reacts as determined by Q133 e) soluble sulfate ≤ 0.3% f) organic content* ≤ 1.0%, and g) ferric oxide* ≤ 2.0%.	a) plasticity index ≤ 10 b) percentage passing the 0.075 mm sieve ≤ 25, and c) maximum aggregate size of 75 mm.
Note: * These limits are a guide only; advice should be obtained before stabilising materials with ferric oxide contents greater than 2.0% or organic contents > 5.0%.	
UCS of 1.0 – 2.0 MPa at 28 days	UCS of 1.0 – 2.0 MPa at 7 days

18.2.5.2 Lime stabilised subgrade material

Unless otherwise directed by the Administrator, the material shall be stabilised with the amount of lime which satisfies all the mix design requirements given in Clause 4 of TN151 *Testing of Material for Lime Stabilisation*.

In doing so, the stabilised material shall achieve an unconfined compressive strength (UCS) of not less than 1.0 MPa and not greater than 2.0 MPa at 28 days.

Lime stabilisation is to be carried out in accordance with MRTS07A *In situ Stabilised Subgrades Using Quicklime or Hydrated Lime*.

Where construction conditions do not permit the time required to undertake UCS mix design testing, the Administrator may direct the Contractor as to the lime content to be used in the stabilisation process. Generally the value nominated in this circumstance would be the lime demand value plus two percent.

18.2.5.3 Cement or cementitious blend stabilised subgrade material

Unless otherwise directed by the Administrator, the material shall be stabilised with the amount of cement or cementitious blend which satisfies all of the mix design requirements given in Clause 4 of TN149 *Testing of Material for Cement or Cementitious Stabilisation*.

In doing so, the stabilised material shall achieve an unconfined compressive strength (UCS) of not less than 1.0 MPa and not greater than 2.0 MPa at seven days.

Insitu stabilisation is to be carried out in accordance with MRTS07B *Insitu Stabilised Pavements Using Cement or Cementitious Blends*.

Plant mix stabilisation shall be carried out in accordance with MRTS08 *Plant-Mixed Stabilised Pavements Using Cement or Cementitious Blends*.

Where construction conditions do not permit the time required to undertake UCS mix design testing, the Administrator may direct the Contractor on the stabilising agent content to be used in the stabilisation process. Generally in this circumstance, GB cement (60% cement /40% fly ash blend) at a target content of 2% (by mass) would be nominated.

18.2.5.4 Stabilised subgrade mix design submission

The Contractor shall submit a mix design at least 14 days prior to the commencement of stabilisation

Hold Point 7 The mix design shall use the same materials, including stabilising agent type and source, proposed for incorporation into the Works.

The mix design report shall include as a minimum:

- a) details of the stabilising agent type and source
- b) details of the material to be stabilised, including material type
- c) test results for the material to be stabilised, including requirements of Clauses 7.2 and 7.3
- d) seven day UCS test results (for cement or cementitious blend stabilised material) and 28 day UCS test results (for lime stabilised material) at a number of stabilising agent contents (minimum three) to cover the range of upper and lower UCS limits, and the design stabilising agent content (Note: in Q115, one UCS test result is the average of three specimens), and
- e) test results for determining the allowable working time in accordance with Q136

Where the properties of the material to be stabilised vary significantly at different locations in the project, a mix design shall be submitted for each unique set of material properties.

Where the administrator nominates the lime, cement or cementitious blend content to be used in the stabilisation process, the requirement for this mix design submission may be waived.

18.2.6 Geotextile filter fabric

Geotextile for use in a drainage layer shall be of the appropriate strength class and filtration class in accordance with the requirements specified in MRTS27 *Geotextiles (Separation and Filtration)*.

18.2.7 Geosynthetic reinforcement

Geosynthetic reinforcement in subgrade shall comply with the requirements of MRTS58 *Subgrade Reinforcement using Pavement Geosynthetics*.

18.3 Construction

18.3.1 General

The subgrade shall be constructed and tested to subgrade level in accordance with the requirements of this Technical Specification prior to construction of the pavement. **Hold Point 8**

18.3.2 Proof rolling

At the completion of earthworks to subgrade level, the Contractor shall test for perceptible surface deformation by undertaking proof rolling **Witness Point 3**

Testing shall be in accordance with RMS Test Method T198 unless otherwise approved by the Administrator. Testing for perceptible surface deformation is exempt from the requirement for NATA accreditation.

In areas where perceptible surface deformation is observed, the Contractor shall remove and replace the affected section, or take other corrective action to the satisfaction of the Administrator. In doing so, the Administrator may require the Contractor to carry out additional compliance testing to ensure that the affected section of pavement complies with the requirements of this Technical Specification. No additional payment will be made by the Principal for any such additional testing.

18.3.3 Subgrade treatment

18.3.3.1 General

Generally Clause 18.3.3 applies to the construction of subgrade in cuttings when excavation has progressed to subgrade level in accordance with Clause 13.3.2.1. Alternatively, where directed by the Administrator, specific subgrade treatments may be undertaken on embankments or at grade.

The subgrade treatments are nominated in Clause 13.5 of Annexure MRTS04.1. In considering authorisation to proceed past Hold Point 5 (refer to Clause 13.3.2.1), the Administrator will consider the actual subgrade material and the nominated treatments.

If subgrade treatment is not specifically nominated in Clause 13.5 of Annexure MRTS04.1 or the drawings, the Administrator will determine the subgrade treatment to be applied and such treatment shall be in accordance with the provisions of one of Clauses 18.3.3.4 to 18.3.3.12, inclusive. The Administrator's determination of the required subgrade treatment will be based on at least the following:

- a) the material encountered in the bottom of the excavation
- b) the results of testing of the insitu material, if ordered, and
- c) any adjustments to the pavement thickness considered necessary by the Administrator.

Where the Contractor is required to undertake material testing under the Contract, the period for determination by the Administrator of the subgrade treatment to be adopted shall commence from the time the test results are provided by the Contractor to the Administrator.

A summary of the various types of subgrade treatment is set out in Table 18.3.3.2.

Different subgrade treatments may be required in separate areas of any cutting or formation.

In general, material which is deemed to be Unsuitable Material, as defined in Clause 9, which is encountered in the zone below any treated subgrade in accordance with Clause 18.3.3, shall be dealt with in accordance with Clause 13.3.2.2.

The Contractor shall clean out any loose material and ensure the bottom of excavation is free draining. Alternatively, where a free draining state cannot be achieved, any undrained depressions shall be filled to provide a free draining surface with a suitable cross fall. Unless otherwise directed by the Administrator, depressions shall be filled with a plant mixed stabilised material in accordance with Clause 18.2.6, mixed and placed in accordance with the requirements of MRTS08 *Plant-Mixed Stabilised Pavements using Cement or Cementitious Blends*.

18.3.3.2 Subgrade treatment types

Acceptable subgrade treatments described in Table 18.3.3.2.

Table 18.3.3.2 – Summary of subgrade treatments

Treatment Type	Clause Reference	Description	Drainage Layer Required	Replacement Material	Stabilisation Method	Depth of Treatment (mm) † ¹
A	18.3.3.3	Compact existing	No	-	-	150
B	18.3.3.4	Replace with earth fill material	No	Earth fill material	-	150
C	18.3.3.5	Replace with unbound granular material	No	Unbound granular material	-	150
D	18.3.3.6	Insitu stabilise existing	No	-	Insitu	150
E	18.3.3.7	Replace with plant-mixed stabilised material	No	Stabilised granular material	Plant-mixed	200
F1	18.3.3.8	Plant-mixed stabilised upper layer and unbound drainage lower layer	Yes	Stabilised granular material	Plant-mixed	150
				Unbound granular drainage material		100
F2	18.3.3.8	Plant-mixed stabilised upper layer and high permeability drainage lower layer	Yes	Stabilised granular material	Plant-mixed	150
				High permeability drainage material		300
G	18.3.3.9	Insitu stabilised drainage layer	Yes	Stabilised granular drainage material	Insitu	150
H	18.3.3.10	Plant-mixed stabilised drainage layer	Yes	Stabilised granular drainage material	Plant-mixed	150

Treatment Type	Clause Reference	Description	Drainage Layer Required	Replacement Material	Stabilisation Method	Depth of Treatment (mm) † ¹
I	18.3.3.10	High Permeability Drainage Layer	Yes	High permeability drainage material	-	300
J	18.3.3.11	Bridging Layer	No	Rock Fill	-	-
K	18.3.3.12	Special	† ²	† ²	† ²	† ²

†¹ Unless otherwise specified on the drawings or Clause 13.5 of Annexure MRTS04.1.

†² As specified on the drawings.

18.3.3.3 Subgrade treatment Type A, compact existing

For Subgrade treatment Type A, excavation shall be completed to subgrade level in accordance with Clause 13.3.1.

The material below subgrade level shall be compacted as specified in Clause 15.3 to a characteristic value of relative compaction as specified in Table 15.3-B.

The depth of compaction shall be as specified in Clause 13.5 of Annexure MRTS04.1 or, where no such depth is specified, to a depth of 150 mm.

18.3.3.4 Subgrade treatment Type B, replace with fill material

For Subgrade treatment Type B, excavation shall be continued to a depth below subgrade level as specified in Clause 13.5 of Annexure MRTS04.1 or, where no such depth is specified, to a depth of 150 mm. Excavation shall comply with the requirements of Clause 13.3.1.

The excavation shall be backfilled to subgrade level with fill material in accordance with Clause 18.2.1 and compacted as specified in Clause 15.3 to a characteristic value of relative compaction as specified in Table 15.3-B.

18.3.3.5 Subgrade treatment Type C, replace with unbound granular material

For Subgrade treatment Type C, excavation shall be continued to a depth below subgrade level as specified in Clause 13.5 of Annexure MRTS04.1 or, where no such depth is specified, to a depth of 150 mm. Excavation shall comply with the requirements of Clause 13.3.1.

The excavation shall be backfilled to subgrade level with unbound granular material, in accordance with Clause 18.2.2, and shall be constructed as specified in MRTS05 *Unbound Pavements* to a characteristic value of relative compaction of not less than that specified in Table 15.3-B.

18.3.3.6 Subgrade treatment Type D, insitu stabilise existing

For Subgrade treatment Type D, excavation shall be completed to subgrade level in accordance with Clause 13.3.1.

The existing material below subgrade level shall be insitu stabilised in accordance with the requirements of Clause 18.2.5, to the depth below subgrade level specified in Clause 13.5 of Annexure MRTS04.1, or where no such depth is specified, 150 mm.

The stabilised material shall be compacted to a characteristic value of relative compaction not less than that specified in Table 15.3-B.

18.3.3.7 Subgrade treatment Type E, replace with plant-mixed stabilised material

For Subgrade treatment Type E, excavation shall be continued to a depth below subgrade level as specified in Clause 13.5 of Annexure MRTS04.1 or, where no such depth is specified, to a depth of 200 mm. Excavation shall comply with the requirements of Clause 13.3.1.

The excavation shall be backfilled to subgrade level with plant-mixed stabilised unbound granular material, in accordance with Clauses 18.2.2 and 18.2.5. The stabilised material shall be compacted to a characteristic value of relative compaction not less than that specified in Table 15.3-B.

18.3.3.8 Subgrade treatment Type F1 & F2, unbound granular drainage layer

For Subgrade treatment Type F1 & F2, excavation shall be continued to a depth below subgrade level as specified in Clause 13.5 of Annexure MRTS04.1 or, where no such depth is specified, as given in Table 18.3.3.8. Excavation shall comply with the requirements of Clause 13.3.1.

Table 18.3.3.8 – Subgrade treatment Type F requirements

Treatment Type	Unbound Drainage Layer Type	Depth of Excavation (mm)	Minimum Thickness of Unbound Drainage Layer (mm)
F1	Unbound granular drainage material (refer Clause 18.2.3)	250	100
F2	High permeability drainage material (refer Clause 18.2.4)	450	300

Unless otherwise specified in Clause 13.5 of MRTS04.1, the unbound drainage layer of the nominated type shall be constructed to the thickness given in Table 18.3.3.8. The drainage layer shall be wrapped in a non-woven geotextile (top, bottom and all sides) in accordance with MRTS27 *Geotextiles (Separation and Filtration)*.

The remainder of the excavation shall then be backfilled to subgrade level with plant mixed stabilised unbound granular material in accordance with Clauses 18.2.2 and 18.2.5.

The unbound granular drainage material and plant mixed stabilised material shall be compacted to a characteristic value of relative compaction not less than that specified in Table 15.3-B.

18.3.3.9 Subgrade treatment Type G, insitu stabilised drainage layer

For Subgrade treatment Type G, excavation shall be continued to a depth below subgrade level as specified in Clause 13.5 of Annexure MRTS04.1 or, where no such depth is specified, to a depth of 150 mm. Excavation shall comply with the requirements of Clause 13.3.1.

The excavation shall be backfilled to subgrade level with unbound granular drainage material, in accordance with Clause 18.2.3 and insitu stabilised in accordance with the requirements of Clause 18.2.5. The stabilised material shall be compacted to a characteristic value of relative compaction not less than that specified in Table 15.3-B.

18.3.3.10 Subgrade treatment Type H, plant-mixed stabilised drainage layer

For Subgrade treatment Type H, excavation shall be continued to a depth below subgrade level as specified in Clause 13.5 of Annexure MRTS04.1 or, where no such depth is specified, to a depth of 150 mm. Excavation shall comply with the requirements of Clause 13.3.1.

The excavation shall be backfilled to subgrade level with plant-mixed stabilised unbound granular drainage material, in accordance with Clause 18.2.3 and 18.2.5. The stabilised material shall be compacted to a characteristic value of relative compaction not less than that specified in Table 15.3-B.

18.3.3.11 Subgrade treatment Type I, high permeability drainage layer

For Subgrade treatment Type I, excavation shall be continued to a depth below subgrade level as specified in Clause 13.5 of Annexure MRTS04.1 or, where no such depth is specified, to a depth of 300 mm. Excavation shall comply with the requirements of Clause 13.3.1.

The excavation shall be backfilled to subgrade level with high permeability drainage layer material, in accordance with Clause 18.2.4. The drainage layer shall be wrapped in a non-woven geotextile (top, bottom and all sides) in accordance with MRTS27 *Geotextiles (Separation and Filtration)*.

Subgrade treatment Type I is primarily intended to be utilised where a stabilised or lightly bound layer (satisfying the requirements of Clause 18.2.4.3) will already be provided as part of the pavement design (for example as a lightly bound improved layer).

Placing pavement directly over a high permeability drainage layer without this overlying layer may lead to instability and difficulty achieving compaction in the structural pavement layers.

Furthermore, moisture may enter the pavement structure through the drainage layer leading to premature failure of the pavement.

18.3.3.12 Subgrade treatment Type J, bridging layer

Subgrade treatment Type J may be applied to subgrade in cuttings, at the base of embankments or otherwise as directed by the Administrator.

The Contractor shall place rock fill complying with Clause 14.2.3 to construct a stable bridging layer by using the mechanical interlock method of compaction in accordance with Clause 15.4.

Where directed by the Administrator:

- a) The bridge layer shall be wrapped in a non-woven geotextile (top, bottom and all sides) in accordance with MRTS27 *Geotextiles (Separation and Filtration)*, and/or
- b) The bridging layer shall be wrapped in a high strength geosynthetic reinforcement in accordance with MRTS100 *High Strength Geosynthetic Reinforcement in Road Embankments*.

18.3.3.13 Subgrade treatment Type K, special

Subgrade treatment Type K shall be in accordance with the provisions specified in Clause 13.6 of Annexure MRTS04.1.

18.3.4 Earthworks transition from cut to fill

18.3.4.1 General

At all such transitions from cut to fill or fill to cut, the embankment shall continue longitudinally and transversely up to the line where the subgrade level intercepts the prepared ground surface unless stated otherwise in Clause 18.3.4.2.

Earthworks transitions from cut to fill shall be benched in accordance with Clause 14.3.3.

18.3.4.2 Transition Treatment

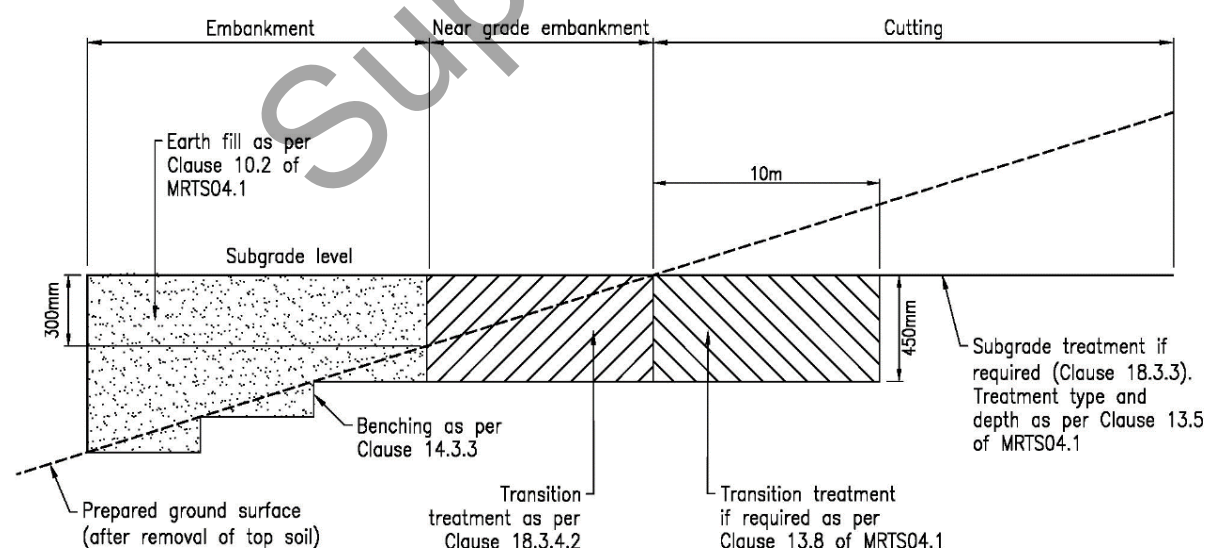
Where so stated in Clause 13.8 of Annexure MRTS04.1 or directed by the Administrator in accordance with Clause 13.7 of Annexure MRTS04.1, the properties of the existing foundation material beneath near-grade embankments below subgrade level shall be tested for compliance with the requirements in Clause 13.2 of Annexure MRTS04.1 to a depth of 450 mm. Existing foundation material which does not comply with these requirements shall be treated as Unsuitable Material.

Backfilling of Unsuitable Material excavations under near-grade embankments shall be carried out using material complying with the requirements of Clause 13.2 of Annexure MRTS04.1. Backfill shall be compacted to a characteristic value of relative compaction not less than that specified in Table 15.3-B for material below subgrade level.

Where nominated in Clause 13.7 of Annexure MRTS04.1, the transition treatment to test and replace unsuitable material shall be carried out 10 m into the cutting beyond the line where the subgrade level intercepts the prepared ground surface.

A schematic representation of the treatment required is shown in Figure 18.3.4.2. This treatment shall be carried out transversely and longitudinally, wherever applicable.

Figure 18.3.4.2 – Longitudinal section of earthworks transition from fill to cut



18.4 Subgrade testing

As stated in Clause 13.7 of Annexure MRTS04.1, the Contractor shall undertake testing of all subgrade material to the depth nominated in Clause 18.1.

Where the Contractor is responsible for completing the pavement design or testing of the subgrade is otherwise required to be undertaken by the Contractor as nominated in Clause 13.7 of Annexure MRTS04.1, the requirements of Appendix B of this Technical Specification shall apply.

Where testing of subgrade is only required to be undertaken by the Contractor as directed by the Administrator, as nominated in Clause 13.7 of Annexure MRTS04.1, the requirements of Appendix B of this Technical Specification shall apply, however the extents, frequency and location of these tests will be nominated by the Administrator.

For design and construction contracts, testing of untreated subgrades is typically required in all circumstances unless specifically nominated by the Principal.

For construct only contracts, testing of untreated subgrades is often not required as the subgrade has been tested and its strength taken into account during the design process. However where only limited subgrade testing has been undertaken, the Principal may elect for the Contractor to undertake additional verification testing during construction.

Where untreated subgrade testing is nominated 'as directed by the Administrator', it is intended this activity would be called up for specific activities such as determining subgrade treatment types and so on.

19 Backfill

19.1 General

Clause 19 applies to backfilling adjacent to structures, pipes, culverts, conduits, pits, access chambers, gullies, sumps, end walls, etc. where shown on the drawings or specified elsewhere in the Contract. Clause 19 also applies to the backfilling of some excavations of Unsuitable Material in accordance with Clause 9.4.

Large areas of filling not in the immediate vicinity of structures, culverts, pipes etc. shall be placed using the methods specified in Clause 14.

Where backfill will form part of the subgrade for pavements, the requirements of Clause 18 shall also apply in addition to the requirements of this clause.

19.2 Materials

19.2.1 General

All backfill materials shall be free of any high concentrations of soluble salts, organic matter and other deleterious matter.

19.2.2 Earth backfill material

Earth backfill material shall comply with the requirements of earth fill material Class A2 or Class B specified in Clause 14.2.2 except that 100% of the material shall pass an AS 25 mm sieve.

19.2.3 Select backfill material

Select backfill material shall be gravel or loam and shall have material properties as specified in Table 19.2.3.

Table 19.2.3 – Select backfill properties

AS Sieve Size (mm)	Percent (by Mass) Passing Sieve	
	Gravel [†]	Loam
37.5	100	100
9.5	60 – 85	100
2.36	25 – 70	70 – 100
0.425	25 – 70	10 – 40
0.075	3 – 30	3 – 30
Other Properties Linear Shrinkage	8 maximum	6 maximum

† Material of size greater than 2.36 mm shall be stone.

19.2.4 Free draining granular material

Free draining granular material shall be a non-cohesive well graded granular material comprising sound sand and stone particles which do not break down under compaction, wetting or exposure to air. The material properties shall comply with those specified in Table 19.2.4.

Table 19.2.4 – Free draining granular material properties

Property	Limit	Value
Stone size	maximum	20 min
Percent passing 0.15 mm	maximum	5%
Linear Shrinkage	maximum	3

19.2.5 Sand

Sand shall be natural sand, manufactured sand, or a blend of natural and manufactured sands comprising hard durable particles and with the properties specified in Table 19.2.5.

Table 19.2.5 – Sand properties

Property	Natural Sand	Blended and Manufactured Sand
Percent passing 2.36 mm AS sieve	85 – 100*	85 – 100*
Percent passing 0.075 mm AS sieve (maximum)	5	10
Linear Shrinkage (maximum)	3	6

* No oversize shall be greater than 6 mm.

19.2.6 Bedding material

Bedding material for foundation bedding and haunch zones of drainage structures and services shall be gravel, loam, sand or mixtures thereof and shall be free from soluble salts, organic matter and other deleterious matter. The material shall have properties as given in Table 19.2.6.

Table 19.2.6 – Bedding material properties

AS Sieve Size (mm)	Well Graded	20 mm Nominal	10 mm Nominal
19	100	85 - 100	100
9.5		25-55	100
2.36	50 – 100	0 – 5	85 – 100
0.6	20 – 90		0 - 10
0.075	0 – 10	0 – 2	0 – 2
Other Properties Linear Shrinkage	6 maximum	3 maximum	3 maximum

Where single size aggregate is used, a geotextile (as per Clause 14.2.7) is required to surround all bedding material. For pipes less than 250 mm in outside diameter, a 10 mm nominal sized material shall be used. The geotextile (and aggregate) shall not be exposed in any direction and shall be contained within wing walls or similar.

Compaction requirements as per Table 15.3-B applies for haunch and side support for all fills and trenches.

AS 3725, Type U and H supports are not typically used.

A controlled low strength material (CLSM) as per Appendix A of AS 3725 may provide a viable alternative to compacted bedding material where any or all of the following site conditions apply:

- a) work area access is limited by time or congestion
- b) where narrow trench width makes mechanical compaction of other types of bedding material in the haunch and side zone difficult
- c) difficult to get the bedding material locally
- d) trench fill subsidence needs to be minimised.

19.2.7 Filter material

Filter material shall be a natural or manufactured granular material free from organic matter with the particle size distribution limits as given in Table 19.2.7.

Additionally, where filter material is used adjacent to slotted drainage pipe or proprietary drainage media, 98% of the filter material shall be retained on the AS sieve size equal to or immediately greater than 1.5 times the slot width or opening diameter of the pipe or media.

Table 19.2.7 – Particle size distribution requirements for filter material

AS Sieve Size (mm)	Percent Passing by Mass
26.5	100
19	95 – 100
13.2	50 – 70
6.7	30 – 55
2.36	20 – 30
0.15	0 – 5

19.2.8 Cement stabilised unbound granular material

Cement stabilised unbound granular material used as backfill shall comply with the requirements of Clause 18.2.2 and 18.2.5.

19.2.9 Stabilised sand

Stabilised sand shall comprise sand meeting the requirements of Clause 19.2.5 in a mixture of 12 parts sand and 1 part of either Type GP or Type GB cement mixed with the minimum quantity of water sufficient to allow ease of placement and compaction using concrete placement techniques.

19.2.10 Dry stabilised sand

Dry stabilised sand shall comprise sand meeting the requirements of Clause 19.2.5 in a mixture of 12 parts sand and 1 part of either Type GP or Type GB cement mixed with the minimum quantity of water to obtain a moisture content which is optimum for field compaction using compacted layer techniques.

19.2.11 Lean mix concrete

Lean mix concrete used as a backfill material in confined excavations shall have a minimum strength of 5 MPa at 28 days and have nominal aggregate size of 20 mm in accordance with the provisions of MRTS70 *Concrete*. The target slump shall be consistent with compacted layer method of construction (that is, the lean mix concrete shall have nominally zero slump).

19.2.12 Backfill and bedding materials for steel culverts

Backfill and bedding materials for culverts fabricated from steel shall be in accordance with Clause 19.2.3 and Clause 19.2.6 respectively. Additionally, the material shall conform to the requirements for either Type 1 or Type 2 in Table 19.2.12.

Table 19.2.12 – Properties of backfill material for steel culverts

Property	Unit	Value	
		Type 1	Type 2
Electrical resistivity	ohm m	> 50	10 – 50
pH	-	5 – 10	5 – 10
Chloride content	mg/kg	-	< 200
Sulfate content	mg/kg	-	< 1000

19.2.13

Rock fill material used as backfill shall comply with the requirements of Clause 14.2.3.

19.3 Construction

19.3.1 Backfilling general

Material for backfill shall be as shown on the drawings or as specified elsewhere in the Contract. Where not so shown or specified, material shall be earth backfill material complying with the requirements of Clause 19.2.2. **Witness Point 4**

Unless specified otherwise in Clause 19.3 or elsewhere in the Contract, backfill shall be compacted using the compacted layer method of construction in accordance with the requirements of Clause 15, except as may be modified by the requirements of Clause 19.

Backfill which extends into the subgrade shall conform to the requirements of Clause 18.

Construction operations which involve puddling or jetting of material shall not be employed. Sand may be compacted by flooding and the use of immersion vibrators provided that the process does not cause damage to adjacent works.

Stabilised sand and lean mix concrete shall be compacted using the compacted layer method of construction in accordance with the requirements of Clause 15.

Compaction standards shall comply with the requirements of Clause 15.3.

Unless specified otherwise in the contract, conduit trenches shall be backfilled as per Standard Drawing 1149 (including trenches along the verge/shoulder).

19.3.2 Backfill beneath structure foundations

Backfill beneath structure foundations to replace over-excavation or excavation of Unsuitable Material shall generally be cement stabilised unbound granular material complying with the requirements of Clause 19.2.8 or lean mix concrete complying with the requirements of Clause 19.2.11 to satisfy the foundation requirements of Clause 13.3.4.

19.3.3 Backfilling to in-place units

Placement and compaction operations around and adjacent to in-place units (culverts, structures, pipes, conduits, pits, etc) shall not cause movement or damage to the units. Where backfill material is fluid, precautions shall be taken against flotation of the units.

Where the backfill material is placed against precast structures, the operations shall be carried out in accordance with the precast component manufacturer's recommendations except as otherwise provided for in the Contract.

Backfill material shall not be placed until culverts, structures, pipes, conduits, pits, etc have been completed and inspected, and any specified curing periods have elapsed. **Hold Point 9**

Where the material is placed on opposite sides of a culvert, structure, pipe, conduit, pit, etc, the difference in level of compacted material on the opposing sides shall not exceed 150 mm, unless shown otherwise on the drawings.

19.3.4 Backfill zones to concrete pipe culverts

Foundation bedding, haunch, side and overlay zones for concrete pipe culverts shall be constructed as shown on Standard Drawing 1359.

Materials for foundation bedding and haunch zones shall be bedding material complying with the requirements of Clause 19.2.6.

Material for side zones shall be select backfill material complying with the requirements of Clause 19.2.3.

For overlay zones, material within 300 mm of the structure, culvert, pipe, etc shall be earth backfill material complying with the requirements of Clause 19.2.2. Elsewhere, overlay zone material may contain stone size up to 150 mm maximum dimension.

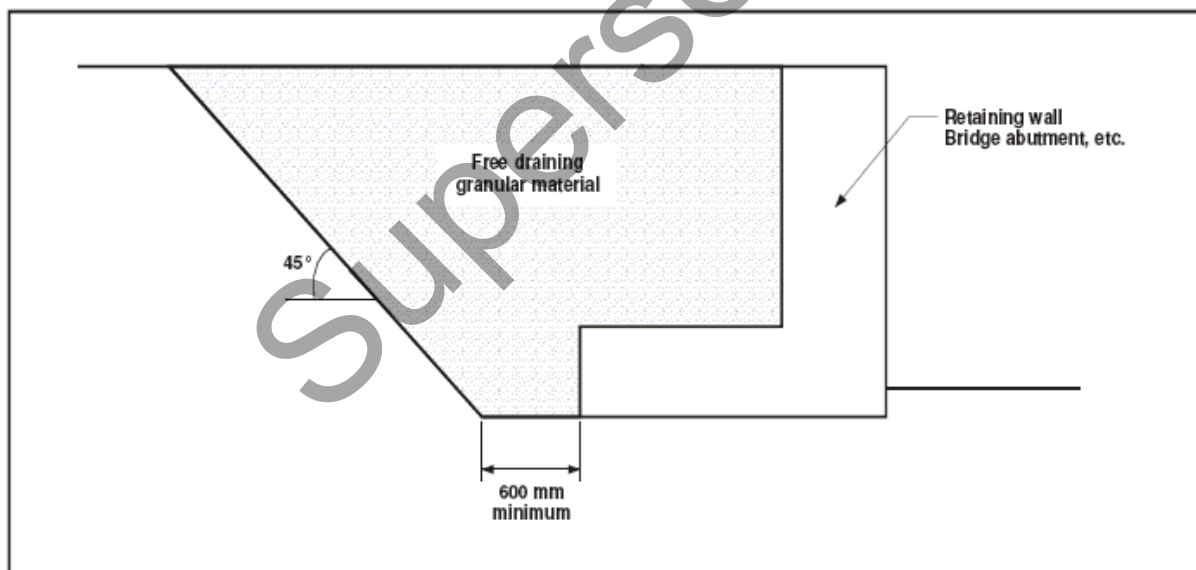
The construction loads which shall be placed on the culvert shall be as per Clause 12 of MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

19.3.5 Backfill to soil retaining structures

Unless otherwise shown on the drawings, backfilling to all soil retaining structures, including all retaining walls and bridge abutments, shall be carried out using free draining granular material complying with the requirements of Clause 19.2.4. Free draining backfill requirements for bridge abutments are shown in abutment protection Standard Drawings 2232 to 2238. Earthfill requirements for bridge approach embankments (structure zones) are given in Clause 14.2.2.

Backfilling to soil retaining structures shall be to the extent shown on the drawings or, where no such extent is shown on the drawings, to the minimum extent shown in Figure 19.3.5.

Figure 19.3.5 – Minimum extent of free draining granular material behind soil retaining structure



19.3.6 Special requirements for corrugated pipe, pipe-arch and arch culverts

Backfilling against corrugated pipe, pipe-arch and arch culvert components shall be carried out so as to not distort the components by more than 3% of the diameter, span or rise.

20 Turnouts, entrances and stopping places

20.1 General

Clause 20 applies to turnouts, entrances and pull-off areas where shown on the drawings or specified elsewhere in the Contract.

20.2 Materials

Materials employed in the construction of turnouts, entrances to private properties and stopping places shall comply with the relevant requirements specified in Clauses 13, 14 and 18.

20.3 Construction

Turnouts, entrances to private properties and stopping places shall be constructed to the shapes and other requirements shown on the drawings. The finished level and grade shall join smoothly with the new formation.

Construction of turnouts, entrances to private properties and stopping places shall comply with the provisions of the following Clauses:

- a) clearing and grubbing – Clause 7
- b) topsoil stripping – Clause 8
- c) ground surface treatment, standard – Clause 12
- d) excavation – Clause 13
- e) embankment construction – Clause 14, and
- f) subgrade – Clause 18.

21 Widening of existing formation to subgrade level

21.1 Introduction

Clause 21 applies to widening of the existing formation to subgrade level of the new pavement.

21.2 Description of work

The existing formation is to be widened as shown on the drawings.

General earthworks shall be constructed as shown on the drawings and shall include the following:

- a) ground surface treatment in accordance with Clause 12
- b) road excavation in accordance with Clause 13 including
 - i. excavation of existing shoulders to subgrade level shown on the drawings
 - ii. excavation below subgrade level, if necessary, to meet roadway embankment material quality requirements
 - iii. construction of table drains, diversion drains and catch drains, and
 - iv. cut batters
- c) roadway Embankment in accordance with Clause 14 and requirements shown on the drawings, and
- d) subgrade treatment Type A in accordance with Clause 18.

21.3 Construction

21.3.1 General

The formation is to be constructed as shown on the drawings for the entire length of the project.

Clearing and grubbing shall be carried out where earthworks are to be constructed, to the minimum width required to construct the works, plus a margin of not more than two metres.

Ground surface treatment (excluding the areas in Clause 12.2.1.1) is to be carried out on the existing ground surface in all areas beneath any part of road embankment or road pavement.

Cut batters are to be constructed to the details shown on the drawings.

Road excavation as required shall be constructed to the details shown on the drawings to achieve the required formation width.

Embankment material shall be placed to subgrade level as specified in Clause 15.3.

Table drains shall be constructed to the details shown on the drawings. Where details are not shown on the drawings, table drains shall be constructed parallel to the centreline of the road and evenly graded so as to prevent obstruction to the flow of water.

At all culverts and at intervals not exceeding 120 m on grades up to 2%, 60 m on grades 2% to 4%, 30 m on grades 4% to 8%, and 15 m on grades over 8% (except in cuttings) and at the ends of cuttings, the table drain shall be blocked by a diversion bank and the water diverted by means of a diversion drain as shown on the drawings.

21.3.2 Materials

Materials shall comply with Clause 14.2.2 and 18.2.1 plus any additional requirements shown on the drawings.

21.3.3 Horizontal location

The horizontal location shall comply with Clause 6.2.

21.3.4 Subgrade heights

Where control is by reduced level, the subgrade height shall be determined from the heights shown on the drawings.

Where control is by pavement depth and crossfall, the calculated subgrade level shall provide for a minimum total depth of pavement as shown on the drawings measured from the plane of the extension of the existing pavement surface, with due allowance for the specified crossfall.

21.3.5 Tolerances

The primary vertical tolerances for embankment and subgrade are defined in Clause 6.3.

In addition to the requirements of Clause 6.3.2, the shape of the prepared subgrade shall be such that the subgrade crossfalls shall not depart from the specified crossfalls by more than one-half of one per cent (0.5%) absolute.

21.4 Compliance testing

21.4.1 Materials

Testing of materials shall comply with Clause 5.5.4.

21.4.2 Geometrics

The horizontal location, vertical height and crossfall for the subgrade and all pavement layers shall be measured at the intervals shown on the drawings. The vertical height shall be measured and recorded adjacent to the cutback line for widening. The Contractor may use an approved and suitably calibrated automatic reading level (e.g. Smart-level) on a 3 m straight edge to measure crossfalls.

22 Supplementary requirements

The requirements of MRTS04 *General Earthworks* are varied by the supplementary requirements given in Clause 14 of Annexure MRTS04.1.

Superseded

Appendix A – Testing frequencies

Table A.1 – Testing frequencies

No	Construction Activity (Specification)	Quality Verification Requirements		Normal Testing Level			Reduced Testing Level		
		Description	Test Required	Maximum Lot Size	Minimum Testing Frequency	Minimum No. of Tests	Maximum Lot Size	Minimum Testing Frequency	Minimum No. of Tests
1	Clearing and Grubbing (Clause 7)	Geometrics	Clearance	500 m ²	1 test per 500 m ²	1 per lot	-	-	-
2	Ground Surface Treatment	Dry Density – Moisture Relationship	Q142A, Q144A, Q142C	Material Type	1 test per 2,000 m ²	2 tests per lot	-	-	-
		Relative Compaction	Q140A, Q141A, Q141B	500 m ²	1 test per 500 m ²	1 per lot	-	-	-
3	Subgrade Treatments (Clauses 13 and 18)	Compaction -Depth as per Clause 13.5 of MRTS04.1 or to a depth of 150 mm below subgrade level as per Clause 18	Q140A, Q141A, Q141B	single layer produced in a continuous operation in one day	1 test per 500 m ²	1 per lot	single layer produced in a continuous operation in one day	1 test per 1,000 m ²	1 per lot
		Geometrics	Horizontal	Not Applicable	All edges and interfaces (at 20 m intervals)	-	-	-	-

No	Construction Activity (Specification)	Quality Verification Requirements		Normal Testing Level			Reduced Testing Level		
		Description	Test Required	Maximum Lot Size	Minimum Testing Frequency	Minimum No. of Tests	Maximum Lot Size	Minimum Testing Frequency	Minimum No. of Tests
			Vertical		All edges and interfaces (at 20 m intervals)	-	-	-	-
			Deviation from a straight edge		1 test per 20 m (Left and Right)	-	-	-	-
			Cross fall		1 test per 10 m	-	-	-	-
4	Untreated subgrade material (Clause 18.4 & Appendix B)	Grading	Q103A	Refer Clause 6.4.1 in Appendix B	1 test per 500 m ²	5 per lot	-	-	-
		Plasticity Index	Q105						
		Liquid Limit	Q104A						
		Soaked CBR & Swell	Q113C						
		Insitu CBR, determined from DCP	Q114B						

No	Construction Activity (Specification)	Quality Verification Requirements		Normal Testing Level			Reduced Testing Level		
		Description	Test Required	Maximum Lot Size	Minimum Testing Frequency	Minimum No. of Tests	Maximum Lot Size	Minimum Testing Frequency	Minimum No. of Tests
		Insitu Moisture content	Q102A, Q102B, Q102D or Q141A						
		Lime Demand (where required)	Q133						
		Soluble Sulphate content (where required)	AS 1289.4.2.1						
5	Excavations culvert and/or end structures (Clause 13.3.6)	Compaction – to a depth of 150 mm below bottom of excavation	Q140A, Q141B	each culvert or end structure	1 test per 50 m ²	2 per lot	-	-	-
		Geometrics	Profile	each culvert or end structure	1 test per 100 m	1 test per lot	-	-	-
6	Excavations Channels and Drains (Clause 13.3.7)	Geometrics	Profile	Not applicable	1 test per 100 m	2 per lot	-	-	-
7A	Earth fill material - in confined earthworks (all areas including subgrade)	Dry Density – Moisture Relationship	Q142A, Q144A, Q142C	Material Type	1 test per 1,000 m ³	2 per lot	Material Type	1 test per 2,000 m ³	2 per lot
		Relative Compaction	Q140A, Q141A, Q141B	1,000 m ²	1 test per each compacted layer	1 test per 50 linear metres	2,000 m ²	1 test per each compacted layer	1 test per 100 linear metres
		Grading	Q103A	100 m ³	1 test per 50 m ³	2 per lot	200 m ³	1 test per 100 m ³	2 per lot
		Plasticity Index	Q105	100 m ³	1 test per 50 m ³	2 per lot	200 m ³	1 test per 100 m ³	2 per lot
7B	Earth fill material - in confined	Liquid Limit	Q104A	500 m ³	1 test per 250 m ³	4 tests per lot	1000 m ³	1 test per 500 m ³	4 tests per lot

No	Construction Activity (Specification)	Quality Verification Requirements		Normal Testing Level			Reduced Testing Level		
		Description	Test Required	Maximum Lot Size	Minimum Testing Frequency	Minimum No. of Tests	Maximum Lot Size	Minimum Testing Frequency	Minimum No. of Tests
	earthworks (additional requirements within subgrade only)	Soaked CBR & Swell	Q113C	500 m ³	1 test per 250 m ³	2 tests per lot	1000 m ³	1 test per 500 m ³	1 test per lot
8	Earth fill material - in subgrade (Clause 18.2.1 & Appendix B)	Dry Density – Moisture Relationship	Q142A, Q144A, Q142C	Material Type	1 test per 2,500 m ³	2 tests per lot	Material Type	1 test per 5,000 m ³	2 tests per lot
		Relative Compaction	Q140A, Q141A, Q141B	1000 m ²	1 test per 250 m ²	4 tests per lot	2,000 m ²	1 test per 500 m ²	4 tests per lot
		Grading	Q103A	1000 m ²	1 test per 500 m ²	4 tests per lot	2000 m ²	1 test per 1,000 m ²	4 tests per lot
		Plasticity Index	Q105	1000 m ²	1 test per 500 m ²	4 tests per lot	2000 m ²	1 test per 1,000 m ²	4 tests per lot
		Liquid Limit	Q104A	1000 m ²	1 test per 500 m ²	4 tests per lot	2000 m ²	1 test per 1,000 m ²	4 tests per lot
		Soaked CBR & Swell	Q113C	1000 m ²	1 test per 500 m ²	2 tests per lot	2000 m ²	1 test per 1,000 m ²	1 test per lot
		Emerson Class Number (Outer and Upper Zones – Figure 2-A)	AS 1289.3.8.1	400 m ²	1 test per 200 m ²	2 tests per lot	800 m ²	1 test per 400 m ²	2 tests per lot
9	Earth fill material – other than in confined earthworks or subgrade	Dry Density – Moisture Relationship	Q142A, Q144A, Q142C	Material Type	1 test per 5,000 m ³	2 tests per lot	Material Type	1 test per 10,000 m ³	2 tests per lot
		Relative Compaction	Q140A, Q141A, Q141B	2000 m ²	1 test per 500 m ²	4 tests per lot	4000 m ²	1 test per 1,000 m ²	4 tests per lot
		Grading	Q103A	2000 m ²	1 test per 1,000 m ²	4 tests per lot	4000 m ²	1 test per 2,000 m ²	4 tests per lot

No	Construction Activity (Specification)	Quality Verification Requirements		Normal Testing Level			Reduced Testing Level		
		Description	Test Required	Maximum Lot Size	Minimum Testing Frequency	Minimum No. of Tests	Maximum Lot Size	Minimum Testing Frequency	Minimum No. of Tests
		Plasticity Index	Q105	2000 m ²	1 test per 1,000 m ²	4 tests per lot	4000 m ²	1 test per 2,000 m ²	4 tests per lot
		Emerson Class Number (Homogeneous Embankment – Figure 2-B)	AS 1289.3.8.1	2000 m ²	1 test per 500 m ²	4 tests per lot	4000 m ²	1 test per 1,000 m ²	4 tests per lot
		Emerson Class Number (Outer and Upper Zones – Figure 2-A)		400 m ²	1 test per 200 m ²	2 tests per lot	800 m ²	1 test per 400 m ²	2 tests per lot
10	Verge (Clause 14.2.4)	Relative Compaction	Q140A, Q141A, Q141B	Single layer produced in a continuous operation in one day	1 test per 200 m ²	4 tests per lot	-	-	-
		Grading	Q103A	400 m ²	1 test per 200 m ²	2 tests per lot	800 m ²	1 test per 400 m ²	2 tests per lot
		Plasticity Index	Q105	400 m ²	1 test per 200 m ²	2 tests per lot	800 m ²	1 test per 400 m ²	2 tests per lot
		Emerson Class Number	AS 1289.3.8.1	400 m ²	1 test per 200 m ²	2 tests per lot	800 m ²	1 test per 400 m ²	2 tests per lot
		Geometric	Horizontal and Vertical	Single layer produced in a continuous operation in one day	All edges and interfaces at 20 m intervals	As per minimum testing frequency	-	-	-
11	Rock Fill (Clause 14.2.3)	Grading	Q103A	Stockpile	1 test per 2000 m ³	2 tests per lot	Stockpile	1 test per 4000 m ³	1 tests per lot
		Point Load Strength Index	AS 4133.4.1	Stockpile	1 test per 1000 m ³	4 tests per lot	Stockpile	1 test per 2000 m ³	2 tests per lot

No	Construction Activity (Specification)	Quality Verification Requirements		Normal Testing Level			Reduced Testing Level		
		Description	Test Required	Maximum Lot Size	Minimum Testing Frequency	Minimum No. of Tests	Maximum Lot Size	Minimum Testing Frequency	Minimum No. of Tests
		Wet/Dry Strength Variation	Q205C	Stockpile	1 test per 1000 m ³	2 tests per lot	Stockpile	1 test per 2000 m ³	1 tests per lot
		Degradation Factor	Q208B	Each Rock Type	1 test per 4000 m ³	2 tests per lot	Each Rock Type	1 test per 8000 m ³	2 tests per lot
		Water Absorption	Q214B						
		Petrographic Analysis	ASTM C295						
12	High Permeability Drainage Layer (Clause 18.2.4)	Grading	Q103A	As per Rock Fill Requirements above					
		Wet/Dry Strength Variation	Q205C	Refer to Clause 8.1.1 of MRTS50					
		Wet Strength	Q205B						
		Degradation Factor	Q208B						
		Water Absorption	Q214B						
		Petrographic Analysis	ASTM C295						
		Insitu CBR, determined from DCP (material below drainage layer)	Q114B	Each area of concerns	1 test per 200 m ²	5 per lot	-	-	-
13	Proof Rolling (Clause 18.3.2)	Proof Rolling	T198	Single layer produced in a continuous operation in one day					
14	Backfill Materials (Clause 19)	As per “Earth fill material - in confined earthworks” in item No. 7 above							

No	Construction Activity (Specification)	Quality Verification Requirements		Normal Testing Level			Reduced Testing Level		
		Description	Test Required	Maximum Lot Size	Minimum Testing Frequency	Minimum No. of Tests	Maximum Lot Size	Minimum Testing Frequency	Minimum No. of Tests
15	Acid Sulphate	Acid Sulfate Soil Testing	Field pH Tests (pH _F and pH _{FOX}) SPOCAS testing / Chromium Suite Monosulfidic Black Ooze (MBO)	As per Acid Sulfate Soils Laboratory Methods Guidelines in Queensland					

Notes:

1. Unless otherwise specified, compacted material in place shall satisfy the property requirements. Hence the material shall be tested from compacted material in place.
2. Reduced frequency can only be considered, if the fill material is homogeneous and good quality and approved by the Administrator. Also refer Clause 8.6 of MRTS50.

Appendix B – Subgrade testing requirements

B.1 Introduction

This appendix sets out the minimum requirements to verify that subgrade materials are of equal or better quality than that adopted in the pavement design. These requirements apply to the following subgrade materials:

- a) untreated subgrade materials
- b) fill material, and
- c) materials as nominated in the design documentation or by the Administrator.

Other subgrade materials, including but not limited to unbound pavement materials and stabilised materials, shall be assessed in accordance with the relevant Technical Specification for the particular material.

The intent of this Appendix is to provide a means by which the Contractor can demonstrate, and the Administrator can verify, that materials that support the pavement are of equal or better quality than adopted in the pavement design. It is particularly relevant when limited subgrade investigation and testing has been undertaken during the design stages of the project.

Due to the wide range in possible scenarios in relation to prior assessments of the relevant materials (such as local experience, source testing, geological data, previous project data, and test results from earlier project stages), which must be considered in conjunction with project alignment and project risk, it is not possible to provide standard requirements that will fit every project. Therefore, it may be necessary for the Administrator to vary the requirements to suit the specific project.

The Administrator may consider a reduction, or removal of some, or all, of the requirements of this Appendix where the Administrator deems the requirements unnecessary to meet the intent detailed above. For example, it might be possible to reduce the testing requirements when a detailed subgrade assessment was undertaken during the design stages of the project, or when fill materials from the same uniform source have been recently and extensively tested.

Generally, the pavement design engineer for the project should detail additional and/or alternative testing requirements for consideration by the Administrator.

The Administrator should implement an audit and surveillance plan. Typically a minimum of 10% of lots should be audited on Transport and Main Roads projects. An increased or reduced frequency may apply based on the Contractor's historical performance and the project's risk profile.

B.2 Subgrade design verification construction procedure

For contracts where the Contractor is responsible for completing the pavement design (such as Design and Construct, Alliance and other similar contracts) the Contractor shall submit a subgrade design verification construction procedure to the Administrator at least seven days prior to commencing the subgrade investigation and material sampling. **Hold Point 10**

The subgrade design verification construction procedure shall detail:

- a) Proposed lot locations and extents, in accordance with Clause B6.4.1 of this Technical Specification, and
- b) Any proposal by the Contractor to depart from the requirements of this Technical Specification.

The Administrator shall release the Hold Point if the Administrator deems that the subgrade design verification construction procedure meets the intent of this Technical Specification.

In assessing an alternative proposal, the Administrator should consider prior assessments of the relevant materials (such as local experience, source testing, geological data, previous project data, and test results from earlier project stages), in conjunction with project alignment and project risk. In this case this Appendix should be used as a framework for guidance.

B.3 Sampling requirements

All sampling shall be undertaken by the Contractor, in the presence of the Administrator, unless directed otherwise by the Administrator. **Witness Point 5**

Sampling locations shall be determined by a method of random stratified sampling as given in Q050.

Prior to the placement of any material over existing untreated subgrade materials, the untreated subgrade materials shall be assessed to determine the need for any one or more of the following elements:

- a) soft subgrade treatment
- b) expansive subgrade treatment
- c) drainage layer, and/or
- d) other subgrade treatments as per Clause 18.3.3, or the design documentation.

Unless otherwise directed by the Administrator, this clause applies to all untreated subgrade material and fill material to the minimum depth below subgrade level as defined in Clause 13.1 of Annexure MRTS04.1 (or Clause 18.4 where no value is otherwise nominated). Each different material encountered within this depth shall be sampled and tested in accordance with this Technical Specification unless otherwise approved by the Administrator.

The Contractor shall obtain sufficient samples of all required materials to satisfy the testing and assessment requirements of this Technical Specification.

B.3.1 Untreated subgrade materials

Untreated subgrade materials shall be sampled from their natural insitu location in accordance with AS 1289.1.2.1.

Untreated subgrade materials that break down under environmental and service conditions due to weathering (such as shales, claystones, siltstones and other soft laminated or jointed rocks), shall be pre-conditioned by artificial weathering in accordance with RMS Test Method T103.

Untreated subgrade materials which break down, degrade or fracture during construction, such as highly and extremely weathered rocks, shall be pre-conditioned prior to compacting the specimens for testing. Pre-conditioning shall simulate the effects of construction either by:

- a) laboratory pre-conditioning in accordance with RMS Test Method T102, or
- b) field compaction using the construction methods proposed for the works (including any loosening, repositioning, wetting, drying, compacting and proof rolling, and to meet the specified density).

The pre-conditioning method adopted shall be recorded in the submission of test results detailed in Clause B5.

Sampling of rock in rock cuttings is not required where the following conditions are satisfied:

1. the material is defined as “non-rippable” in accordance with Clause 3.3.2 of MRS04
2. the rock does not break down, degrade or fracture during construction, and
3. the Contractor has requested an exemption from testing, providing all relevant supporting information to the Administrator, and the exemption has been granted by the Administrator.

B.3.2 Fill materials

The Contractor shall sample fill materials by one or more of the following methods:

1. sampling from the source, where material is not stockpiled (refer Clause B3.2.1)
2. sampling from the source stockpile (refer Clause B3.2.1), or
3. sampling after field compaction has been completed (refer Clause B3.2.2).

Fill materials that break down under environmental and service conditions due to weathering (such as shales, claystones, siltstones and other soft laminated or jointed rocks), shall be pre-conditioned by artificial weathering in accordance with RMS Test Method 103. For such materials, sampling must be from the source or source stockpile.

The Contractor shall advise the Administrator in writing which sampling method will be adopted at least seven days prior to commencing material sampling. **Milestone**

B.3.2.1 Sampling from the source or sampling from the source stockpile

Samples shall be obtained from the source or source stockpile in accordance with AS 1289.1.2.1.

Materials which breakdown, degrade or fracture during construction, such as highly and extremely weathered rocks, shall be pre-conditioned prior to compacting the specimens for testing. Pre-conditioning shall simulate the effects of construction either by:

- a) laboratory pre-conditioning in accordance with RMS Test Method T102, or
- b) field compaction using the construction methods proposed for the works (including any loosening, repositioning, wetting, drying, compacting and proof rolling, and to meet the specified density).

The pre-conditioning method adopted shall be recorded in the submission of test results detailed in Clause B5.

B.3.2.2 Sampling after field compaction has been completed

Obtain samples from the completed fill (after compaction and proof rolling) in accordance with AS 1289.1.2.1. Samples shall be taken over the full depth of the compacted layer.

B.4 Testing requirements

All testing shall be undertaken by the Contractor, in the presence of the Administrator, unless directed otherwise by the Administrator. **Witness Point 6**

Each untreated subgrade material sample and each fill material sample shall be tested for:

- a) laboratory California Bearing Ratio (CBR)
- b) swell
- c) particle size distribution
- d) maximum aggregate size of fill materials
- e) liquid limit
- f) plastic limit
- g) plasticity index
- h) weighted plasticity index (WPI), which is the plastic index multiplied by the percent passing the AS 0.425 mm sieve, and
- i) insitu moisture content.

The laboratory CBR and swell test conditions shall be as defined in Clause 13.2 of Annexure MRTS04.1. Where test conditions are not nominated, the testing shall be on four day soaked samples with a target maximum dry density (MDD) of 95.0% and 100% optimum moisture content (OMC) using standard compactive effort.

Untreated subgrade material shall also be tested for insitu CBR, determined using the dynamic cone penetrometer (DCP).

Where laboratory pre-conditioning is undertaken, the plastic limit, liquid limit, Plasticity Index, WPI, CBR and swell shall be determined on the samples after pre-conditioning, and the particle size distribution shall be determined both before and after pre-conditioning.

Where it is proposed to lime stabilise the material, lime demand testing shall be undertaken on the material to determine lime reaction and demand in accordance with Q133.

Where it is proposed to either lime or cementitiously stabilise the material, the soluble sulfate content of the material shall be determined in accordance with AS 1289.4.2.1.

B.5 Reporting and pavement design requirements

B.5.1 General

The Contractor shall provide all the information to the Administrator as detailed in Clause B.5.2 or B.5.3 as relevant. **Hold Point 11** The Administrator will review the information submitted by the Contractor in considering authorisation to proceed past Hold Point 2.

B.5.2 Construct only contracts

For contracts where the Principal has supplied the pavement design (that is, construct-only or similar contracts) the Contractor shall provide all test results, including certified test certificates, to the Administrator.

In addition, the Contractor shall provide marked-up drawings to the Administrator accurately showing all test locations.

The Contractor shall allow a minimum period of 14 days for the Administrator to review the information prior to any subgrade treatment and the placement of any overlying materials.

B.5.3 Contracts which include pavement design

For contracts where the Contractor is responsible for completing the pavement design ((such as Design and Construct, Alliance and other similar contracts) the Contractor shall submit the following information to the Administrator:

- a) all test results, including certified test certificates
- b) marked up drawings accurately showing all test locations
- c) a written engineering report detailing the Contractor's interpretation of the test results for each lot, including lot CBR and lot expansive nature classification, and assigned CBR and assigned swell. The report shall fully detail all assumptions and calculations
- d) a table which compares the test results with the design values, and which highlights any situations where the quality is less than adopted in the pavement design (such as lot CBR or assigned CBR is less than the design CBR, or lot expansive nature classification or assigned swell is greater than adopted in the design), and
- e) Revised design documentation (where relevant).

The Contractor shall allow a minimum period of seven days for the Administrator to review the information prior to any subgrade treatment and the placement of any overlying materials.

The Contractor's interpretation of test results shall be in accordance with Clause B6 of this Technical Specification, unless otherwise approved by the Administrator.

Where the redesigned pavement and subgrade treatments require a significant change in the depth of the untreated subgrade in relation to the testing already completed, the sampling and testing shall be repeated at the new depth.

B.6 Determination of CBR, swell and expansive nature classification

B.6.1 General

For each untreated subgrade lot, the lot CBR, lot swell and lot expansive nature classification shall be determined in accordance with Clause B6.2.

For each source and type of fill material (materials with uniform properties), an assigned CBR and assigned swell shall be determined in accordance with Clause B6.3.

The percentile value for a set of test results shall be determined by plotting the cumulative frequency distribution and interpolating from the curve the relevant percentile value.

In accordance with the guide note in Clause B1, the Contractor may propose to vary the requirements for determining the CBR, swell and expansive nature classification in arid climates in low risk applications

B.6.2 Untreated subgrade material

For each lot, the lower 10th percentile of the laboratory CBR test results and, where relevant, the lower 10th percentile of the DCP test results shall be determined. The lot CBR is the minimum of these two values.

For each lot, the lot swell is the upper 10th percentile of the swell test results.

The lot swell and other material test results shall be used to determine the lot expansive nature classification in accordance with this Technical Specification, AGPT02 and Transport and Main Roads *Pavement Design Supplement*.

B.6.3 Fill material

For each source and type of fill material, the assigned CBR shall be the lower 10th percentile of the laboratory CBR test results. The assigned swell shall be the upper 10th percentile of the swell test results.

Where there are more than ten test results, the most recent ten results shall be used to determine the assigned CBR and assigned swell.

Where there are more than three, but less than ten test results, all of the available test results shall be plotted to determine the assigned CBR and assigned swell.

Where there are three or less test results, the assigned CBR shall be the minimum CBR test result, and the assigned swell shall be the maximum swell test result.

B.6.4 Lot size and test frequency

The lot size and testing frequency shall be as defined in Appendix A.

The test frequencies given in this Technical Specification are minimums only and should be increased by the Contractor where required.

B.6.4.1 Untreated subgrade material

The lot size shall be determined based on uniform sections including:

- a) topographical features including hills, valleys and the like
- b) pavement location, both horizontally and vertically (cut, side cut, fill)
- c) geological profile
- d) influence and/or presence of water
- e) material properties such as particle size distribution, plastic limit, liquid limit, insitu moisture content, plasticity index and WPI
- f) consistency of soil type, and

- g) In addition to the above, the maximum lot size for testing of material shall be:
 - i. for normal carriageway, no longer than 1000 m in carriageway length
 - ii. each roundabout, and
 - iii. each intersection.

Minimum testing frequency per lot is defined Appendix A.

B.6.4.2 Fill material

The lot size and minimum testing frequencies for assessing the subgrade strength of fill material shall be as detailed in Appendix A.

Superseded

Superseded