

Main Roads Technical Standard

MRTS04

General Earthworks

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GENERAL EARTHWORKS

1 INTRODUCTION

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

The technical requirements of this Standard shall apply to excavation and filling operations for all work under the Contract except for excavation for –

- a) cast-in-place piles which is specifically covered by MRTS63 *Cast-In-Place Piles*; and
- b) footings for poles which is specifically covered by MRTS92 *Traffic Signal and Road Lighting Footings*.

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

This Technical Standard forms part of the Main Roads Specifications and Technical Standards Manual.

2 DEFINITION OF TERMS

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

Table 2 – Definition of Terms

Term	Definition	Clause Reference
acid sulfate soils	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.	10
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.	9.3 and 19
bedding material	Material suitable for use in the foundation bedding zone of culverts and for bedding of pipes, conduits, pits, etc.	19.2.6
borrow area	An area – 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.	17
borrow material	Material, sourced from borrow areas, which is used to supplement a shortage of material sourced from excavations.	17
cement stabilised pavement material	Backfill material comprising unbound pavement material stabilised with cement.	19.2.8
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 for any culvert, pipe or conduit trench or any structure 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 accordance with the provisions of Table 10.1 of AS 2868.	-
core zone	The central zone of an embankment.	14.2.2

Term	Definition	Clause Reference
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 below the subgrade in wet cuttings.	
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.	14.2.1
foundation bedding zone	The layer of material forming the bedding for culverts as shown on DMR Standard Drawing Number 1359.	-
foundation surface	The level of an excavation for a structure at which the material with the required bearing capacity exists.	13.3.4.1
free draining granular material	Coarse graded backfill material used behind retaining walls.	19.2.4
general backfill material	General fill material Class A or B predominantly less than 25 mm stone size used as backfill.	19.2.2
general fill material	Fill material for an embankment that can be placed using the compacted layer method	14.2.2
haunch zone	The layer of material immediately above the foundation bedding zone for installation of pipe culverts as shown on DMR Standard Drawing Number 1359.	-
lean mix concrete	Low strength concrete used for backfill of over-excavation for structures and as otherwise directed.	19.2.11
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 between the prepared ground surface and subgrade level.	-
outer zone	The outer zone of an embankment.	14.2.2
overlay zone	The layer of material placed above pipe culverts as shown on DMR Standard Drawing number 1359.	-
planting media	Material used as a planting medium for landscaping as defined in MRTS16 <i>Landscape and Revegetation Works</i> .	-
prepared ground surface	The ground surface after clearing and grubbing and topsoil stripping operations have been completed.	-
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	14.2.3
sand	Natural or manufactured material with 100% passing 6.7 mm AS sieve and a low plasticity index	19.2.5
select backfill material	Backfill comprising gravel and/or loam materials with specified properties used for backfilling to trenches and structures.	19.2.3
side zone	The layer of material placed adjacent to the centre of pipe culverts as shown on DMR Standard Drawing number 1359.	-

Term	Definition	Clause Reference
spoil	Material surplus to the Contract requirements which shall be disposed of on or off the Site.	11
stabilised sand	Backfill material comprising sand stabilised with cement.	19.2.9
stone	Material including natural rock, natural gravel, processed crushed rock and construction rubble which does not break down significantly under compaction.	-
subgrade	The top portion of prepared earthworks immediately below the pavement.	18
subgrade level	The top surface of the prepared subgrade on which a pavement is constructed.	-
topsoil	The top layer of existing soil on the Site which supports vegetation.	-
treated subgrade	The subgrade in cuttings which has been either modified or replaced to improve its properties.	18.3.2
upper zone	The top zone of an embankment excluding subgrade, pavement and shoulders.	14.3.1
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.	9

3 REFERENCED DOCUMENTS

Table 3 lists documents referenced in this Technical Standard.

Table 3 – Referenced Documents

Reference	Title
AS 1152	Specification for test sieves
AS 2868	Classification of machinery for earthmoving, construction, surface mining and agricultural purposes
AS 1289.3.8.1	Methods of testing soils for engineering purposes – Soil classification tests – Dispersion – Determination of Emerson class number of a soil

4 STANDARD TEST METHODS

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

Unless stated elsewhere herein, the standard test methods listed in Table 4 shall be used in this standard. Where not shown, the relevant test methods shall be as listed in Clause 1.2 of Annexure MRTS04.1.

Table 4 – Test Methods

Property to be Tested	Method No. ¹
Acid Sulfate Soil Testing Field pH Tests (pH _F and pH _{FOX}) SPOCAS testing Total oxidisable sulfur method (S _{TOS})	Acid Sulfate Soils Laboratory Methods Guidelines in Queensland
California bearing ratio	Q113C
Chloride content	Q130A
Density index	Q142E and Q140B
Electrical conductivity / resistivity	Q122A

Property to be Tested	Method No.¹
Emerson class number	AS 1289.3.8.1
Insitu California bearing ratio (Dynamic Cone Penetrometer)	Q114B
Lime content	Q117A
Lime Demand	Q133
Linear shrinkage	Q106
Liquid limit	Q104A
Moisture content	Q102A, Q102B, Q102C, Q102D, Q102E, Q102F, Q141A
Particle size distribution	Q103A
pH	Q121
Plasticity index	Q105
Relative compaction	Q142A, Q144A, Q141B, Q143, Q140A, Q141A
Relative moisture content	Q140A, Q102A, Q142A, Q141A, Q141B
Selection of Sampling and Testing Location	Q050
Sulfate content	Q131A
Unconfined compressive strength	Q115

¹ Refer to the department's 'Materials Testing Manual'

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 Standards*.

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

Table 5.1 – Hold Points, Witness Points and Milestones

Clause	Hold Point	Witness Point
7.2.2	1. Trees etc to be left undisturbed marked by Contractor.	-
7.2.3	2. Trees required by Principal marked by Contractor.	-
9.3	3. Treatment of Unsuitable Material.	-
10.4.1	4. Testing for acid sulfate potential.	-
13.3.2.1	5. Subgrade in cuttings treatment type.	-
13.3.4.1	6. Determination by Administrator of competent material in footing excavation.	-
13.3.4.1	7. Inspection of foundation surface by Administrator.	-
13.3.4.1	8. Re-presentation inspection of foundation surface.	-
15.4		Rolling using mechanical interlock method of compaction.
18.3.1	9. Subgrade testing prior to placement of pavement.	Visible vertical movement of subgrade.
19.3.1		Backfill material compliance.

Clause	Hold Point	Witness Point
19.3.3	10. Backfill not placed before pipes, etc completed and inspected.	-

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
10.3	Acid Sulfate Soil Management Plan.
11.2	Spoil Disposal Plan.

5.3 Lots

In addition to the any other requirements of the Contract, the maximum size of a lot shall be within the limits given in Clause 1.1 of Annexure MRTS04.1.

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 Clause 5.6.

5.4.2 Geometrics

The geometric tolerances shall be checked at the locations nominated in Clause 1.2 of Annexure MRTS04.1.

5.4.3 Compaction

The compaction standard for each lot shall be represented by the characteristic value of the relative compaction test results. Unless stated otherwise, the characteristic value shall be calculated as shown in Clause 13 of MRTS01 *Introduction to Technical Standards* using the individual relative compaction values determined from each lot.

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

The density shall be determined by Test Method Q141B or Q143 and the maximum dry density of a reference sample shall be determined by Test Method Q142A or Q144A. The density index of non-cohesive materials shall be determined using Test Methods Q142E and Q140B.

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 relative compaction values and any maximum and minimum moisture content requirements for the appropriate material and location as defined in Clause 15.

Conformance requirements for all materials shall be based on the characteristic value for the material properties defined in this standard.

5.6 Testing Frequency

The minimum test frequencies and minimum numbers of tests as stated in Clause 1.2 of Annexure MRTS04.1 shall apply to the construction of work covered by this standard.

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 batter points specified are found not to lie on the 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 –

- 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);
- the width of an embankment at subgrade level shall not be less than that specified; and
- 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 Contract 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 distances 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 the subgrade level.	± 50
Top of insitu material below subgrade in cuttings in 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).	+ 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 3 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 –

- a) 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 3 metres where not so stated, or the property boundaries, whichever is the lesser;
- b) 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 2 metres beyond the plan limits of the bridge where not so stated, but not beyond the property boundaries;
- c) any areas specified for visibility; and
- d) other areas or specific requirements given 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 protection on them.

7.2.3 Trees Required by the Principal

Any trees required by the Principal 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 Mulching

Where organic mulch is required to be supplied and placed in accordance with MRTS16B *Vegetation Ground Works*, processing of such material shall be carried out in accordance with the requirements of MRTS16B *Vegetation Ground Works*.

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 9 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.

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

In the areas specified in Clause 3.1 of Annexure MRTS04.1, topsoil shall be stripped from the Site.

The average depth of topsoil to be excavated from each designated area shall be as specified in Clause 3.1 of Annexure MRTS04.1.

8.3 Material Considered Suitable for Use as Planting Media

Soil stripped from the Site which is considered suitable for use as planting media shall comply with the requirements for planting media specified in MRTS16B *Vegetation Ground Works*.

8.4 Construction

8.4.1 Stripping to Stockpile

Material considered suitable for use as planting media 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.

8.4.2 Surplus Material

Surplus material and material considered to be not suitable for use as planting media 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 planting media. To assist preservation of planting media, the Contractor shall include the following provisions in the management of topsoil stockpiles –

- a) limiting the height of stockpiles to 3 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; and
- e) 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.

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 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 4000 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 3 based on dynamic cone penetrometer using Test Method Q114B;
- i) material containing noxious weeds and other matter which may adversely affect the local environment, except where these are treated in an appropriate manner;
- 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 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. **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.

In the interests of expediency, the Contractor may elect to remove Unsuitable Material and replace it with material complying with this specification without reference to the Administrator.

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.

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, 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. It shall be developed in conjunction with a laboratory experienced in acid sulfate soil analysis.

10.4 Testing and Reporting

10.4.1 General

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. This shall include all materials from coastal areas below 5 metres above sea level and all areas with visual indications of acid sulfate potential in accordance with Clause 10.4.2 and all areas identified as specified in Clause 10.2.

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 1 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".

10.4.2 Visual Assessment of Potential Acid Sulfate Soils

Acid Sulfate Soils are predominantly found in sediments of marine origin in coastal embayments where the ground surface elevation is less than 5 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.

Possible visual indications of acid sulfate soils are as follows –

- a) iron staining or iron flocculation lining stream banks and water surfaces;
- b) presence of dark grey clays, sands or peats;
- c) soil profiles showing yellow mottles of jarosite and red and brown iron staining;
- d) excessively clear or blue-green water in drains or streams;
- e) poor plant growth or acid scalds;
- f) the presence of acid resistant vegetation such as mangroves, ti-tree, marine couch, melaleuca, casuarina and phragmites;
- g) soil cracking;
- h) badly corroded metal and concrete fixtures; and/or
- i) fish kills.

10.4.3 Field pH Testing for Actual Acid Sulfate Soils

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 4, 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. Errors in this test procedure can occur due to the severity of the soil acidity, the influence of salts in the soil and/or contamination of the indicator chemicals.

A calibrated electronic pH probe can be inserted directly into moist soil to measure the in situ pH of actual acid sulfate soil or into dry soil moistened with deionised water.

Small samples can give a large variation in pH due to the uneven distribution of pyrite in the soil. The field test therefore shall include at least 5 pH measurements in any one area to gauge the distribution of the actual acid sulfate soil.

Saturated potential acid sulfate may exist below the actual acid sulfate soil layer. These field tests do not account for any pyrite that has not yet been oxidised.

10.4.4 Field pH Testing for Potential Acid Sulfate Soils

The field test for determining the presence or absence of potential acid sulfate soils shall be performed as follows –

- a) the soil sample shall be oxidised with 30% laboratory grade hydrogen peroxide, the pH of which has been adjusted to 4.5 – 5.5;
- b) if on oxidation there is an effervescent reaction with the soil, the pH after oxidation (pH_{FOX}) is below the pH_F for the sample, and the pH_{FOX} is less than 3, then the presence of potential acid sulfate soils is indicated (the more exaggerated these effects, the more positive the presence of sulfides); and

- c) if the pH_{FOX} is greater than 3 but the other two conditions still apply, further quantitative laboratory assessment shall still be carried out (particularly in areas previously specified as having acid sulfate soil problems, or potential areas identified by the Contractor during visual inspections).

10.4.5 Soil Sample Collection, Handling and Transport

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.

If samples cannot be transported to the laboratory within 24 hours, they shall be managed to reduce the oxidation of pyrite before laboratory analysis. Methods of minimising the oxidation of pyrite in soil include –

- a) oven drying at 80°C to 85°C in a forced draft, high capacity oven for 48 hours;
- b) freezing the sample; and
- c) refrigeration and storage in a sealed container (this is for short term only as oxidation still occurs).

Despite these precautions, samples taken from the actively oxidising layer of acid sulfate soil profiles can contain ferrous iron which undergoes chemical oxidation. Laboratory determinations of the pH of these samples will always show a significant decrease from the field determination.

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

10.5 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.

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 in situ stabilisation with lime in accordance with Clause 12.2.3.

10.6 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 and 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.

10.7 Contractor's Duty of Care

Nothing contained in this standard shall negate the Contractor's general environmental duty of care if acid sulfate soils are discovered on the Site or in borrow areas. In such cases, the Contractor shall immediately notify the Administrator and take all appropriate action to limit any potential environmental effects.

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 use 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 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.

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 any areas of excavation and excluding any areas where a special ground surface treatment or subgrade preparation is required.

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 tyning, adding water, mixing, draining, the addition of dry materials, removing and replacing and/or other appropriate treatment.

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

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 – In Situ 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 12.2.3

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 *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*.

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 provisions 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 tyned.

The use of excavated material in the construction of embankments shall be subject to the requirements of Clause 14.

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.

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 plus 100 mm, 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 9.3.

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 the provisions of Clause 14 or Clause 19 as appropriate (refer to Clause 9.3).

13.3.2.3 Pre-splitting

Where so stated in Clause 9 of Annexure MRTS04.1, 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 2 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 9.3.

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.

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 in situ 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 the excavation has been carried out to the depth shown on the drawings (including blinding concrete where appropriate), the Contractor shall notify the Administrator who will determine whether or not material meeting the required bearing capacity has been reached. This material is defined as **undisturbed natural material** which will safely carry the foundation bearing pressures shown on the Drawings. **Hold Point 6**

Excavation below the lines shown on the drawings shall be treated as excavation for Unsuitable Material in accordance with Clause 13.3.3.2. Where Unsuitable Material has been removed, the excavation shall be backfilled to foundation level with appropriate backfill material as specified on the drawings or directed by the designer in accordance with the provisions of Clause 19.

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 Designer'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 Designer's RPEQ geotechnical engineer. **Hold Point 7**

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. The foundation shall be represented for further inspection and approval by the Administrator. **Hold Point 8**

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 DMR Standard Drawing number 1359.

The material in the bottom of an excavation shall comply with the density requirements of Clause 15. Where the in situ 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 the lesser.

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 DMR Standard Drawing number 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.

14 EMBANKMENTS

14.1 General

Clause 14 applies to embankments to the underside of the subgrade where shown on the drawings or specified elsewhere in the Contract.

14.2 Materials

14.2.1 Introduction

Fill material used for the construction of road embankments shall be material sourced from general excavations on the Site or from borrow.

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

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

14.2.2 General Fill Material

General fill material shall comply with the properties stated in Table 14.2.2 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. General fill material shall be classified into classes in accordance with the properties listed in Table 14.2.2.

Where it is suspected that general fill might be sodic, the Contractor shall test a representative sample of the proposed fill as detailed in AS 1289.3.8.1 to obtain the Emerson Class Number. The proposed fill shall not be used when the Emerson Class Number is 3 or lower except that it may be used in the core zone of a zoned cross section.

Table 14.2.2. – Embankment Material Properties

Material Description	WPI	PI (%)	% passing 0.075 mm AS Sieve
General fill material Class A	< 1200	≥ 7	15 – 30
General fill material Class B	1200 < 2200	-	-
General fill material Class C	2200 < 3200	-	-
General fill material Class D*	3200 < 4000	≤ 50	-

* Material that is inferior to Class D is unsuitable material as per Clause 9.2 (d)

14.2.3 Rock Fill

Rock fill shall comply with the properties stated in Table 14.2.3, in addition to Clause 19.2.13.

Table 14.2.3 – Properties of Rock Fill

% Passing	Sieve Aperture Size, mm
100	500
95 – 100	300
0 – 10	4.75

Notes:

Ten percent fines value (wet) as per Test Method Q205B shall be a minimum of 50 kN.

Coefficient of Uniformity ($C_u = D_{60}/D_{10}$) shall be greater than or equal to 5.

14.2.4 Subgrade Fill Material

The material used for the construction of subgrade in road embankments and for treatment of subgrade in cuttings, where directed, shall be general fill material which satisfies the following additional material properties –

- a) the material shall be general fill material of Class A or Class B in accordance with the requirements of Table 14.2.2 and shall comply with the additional requirements specified in Clause 10.2 of Annexure MRTS04.1;
- b) the material shall be suitable for placement using the compacted layer method in accordance with the requirements of Clause 15.3; and
- c) the maximum stone size shall be 75 mm.

14.2.5 Verge Material

Verge material shall be general fill material Class A complying with the properties stated in Clause 14.2.2.

14.2.6 Water Retaining Embankments

Fill material used for the construction of levee banks, catch banks and other water retaining embankments shall be general fill material which complies with the requirements for Class A or Class B material in accordance with Clause 14.2.2 and Table 14.2.2.

14.2.7 Geotextile

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

14.2.8 Special Embankment Materials

Where special embankment materials are required to be used, the material requirements are specified in Clause 10.3 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 otherwise as specified.

Where so stated in Clause 10.4 of Annexure MRTS04.1, general fill material shall be placed in zones as shown in Figure 14.3.1. Where not shown as being placed in zones, general fill material shall be homogeneous.

Embankment fill material shall be either general fill material or rock fill. Notwithstanding any other specific requirement for fill material, material placed in an embankment above a height 600 mm below subgrade level shall consist of material suitable for placement using the compacted layer method.

General 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 10.5 of Annexure MRTS04.1, requirements shall be as shown 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.

Table 14.3.1 – Embankment Fill Properties (For embankments not containing any bound layers in pavement)

H (m)	Batter Slope 'x' ¹	Rainfall Zone ²	Zoned Cross-Section				Homogeneous Cross-Section ^{3,5}
			Upper Zone Thickness Y (m) ¹	General Fill Class ³			
				Core ¹	Upper ₁	Outer _{1,5}	
Less than or equal to 1.5	Greater than or equal to 4	Low/Medium	--	A, B, C, D	A, B, C, D	A, B, C	A, B, C, D ⁴
		High	0.6		A, B, C	A, B, C	A, B, C
	Greater than or equal to 2 & less than 4	Low/Medium	0.6		A, B, C	A, B	A, B
		High	1.0				
Greater than 1.5 and Less than or equal to 6	Greater than or equal to 2.5	Low/Medium	1.0	A, B, C, D	A, B, C		
		High	0.6 m when Class C and 1.0 m when Class D in core				
	Greater than or equal to 2 & less than 2.5	Low/Medium	0.6 m when Class C and 1.0 m when Class D in core		A, B	A, B	A, B
		High	1.0 m when Class C and 1.5 m when Class D in core				
Greater than 6 and Less than or equal to 10	Greater than or equal to 2	Low/Medium	1.5 m when Class C and 2.0 m when Class D in core	A, B, C, D	A, B	A, B	A, B
		High			A, B	A	A
Less than or equal to 10	Greater than or equal to 1.5	Low – High	ROCK FILL				
Greater than 10	To be geotechnically designed						

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.

³ Refer to Table 14.2.2 for definitions of Fill Classes A, B C and D.

⁴ Specific pavement design requirements shall dictate the material class for the upper 300 mm across the entire embankment cross section.

⁵ Where it is suspected that general fill may be sodic, the Contractor shall test a representative sample of the proposed fill as detailed in AS 1289.3.8.1 to obtain the Emerson Class Number. The proposed fill shall not be used when the Emerson Class Number is 3 or lower except that it may be used in the core zone of a zoned cross-section.

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.

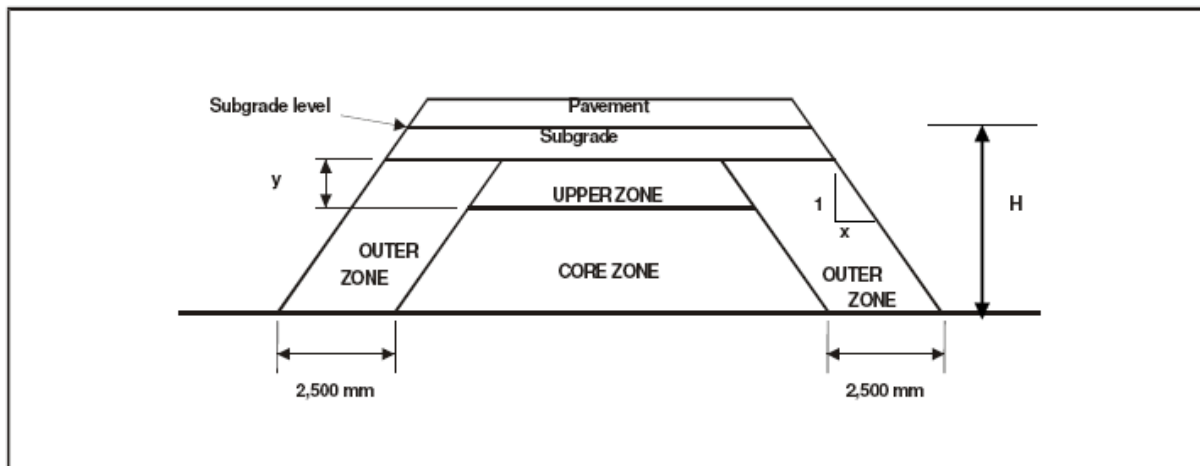
Care shall be taken when sourcing fill material so that sufficient Class A and Class B materials are available to complete the embankment in accordance with the requirements of this standard.

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 shall not be permitted.

Compaction standards shall be as specified in Clause 15.

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

Figure 14.3.1 – Embankment Zones



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 and the voids in the previously placed coarse material are not completely filled with fines (refer to Clause 15.4), a geotextile membrane shall be installed at the interface between the coarse and fine fill materials.

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

Installation of the geotextile shall comply with the provisions of MRTS27 *Geotextiles (Separation and Filtration)*.

14.3.3 Stepping the Ground Surface on Which Embankments are to be Constructed

Where the ground surface on which an embankment is to be constructed and the earthworks operations are such that the uncompacted thickness of a layer is less than the minimum thickness specified in Clause 15.3 or 15.4, horizontal steps shall be cut into the ground surface –

- where the ground surface has a transverse slope steeper than 1 in 8, a horizontal step not less than 300 mm high shall be cut into the ground surface at the toe of the embankment on the low side; and
- where the ground has a transverse slope steeper than 1 on 4, 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 continuous longitudinally and contiguous transversely.

14.3.4 Special Requirements for Diversion Blocks

Diversion blocks shall be constructed to the details shown on DMR Standard Drawing number 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 embankment 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 materials.

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 shall be as 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 the material and special compaction and testing methods to the Administrator for acceptance.

Table 15.2 – Compaction Method

Material	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 20% of stone retained on the 37.5 mm sieve	Compacted layer method	Relative compaction
Coarse grained soils with more than 70% of stone retained on the 37.5 mm sieve	Mechanical interlock method	Nil on material in general;
Soils other than above which, after compaction, have more than 20%, but less than 70% of stone retained on the 37.5 mm sieve	Compacted layer method or Mechanical interlock method	Relative compaction Relative compaction where appropriate on materials completely infilling voids

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 depth.

All general 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 general fill material in road embankment may be increased if the Contractor can demonstrate that the proposed compaction plant and work procedure will achieve the specified densities throughout the full depth of the compacted layer.

Table 15.3-A – Layer Thickness for Compaction

Material / Location	Loose Layer Thickness (mm)	
	Minimum	Maximum
General fill material in road embankment	150	300
Fill material in water retaining fills	150	200
Subgrade	100	200
Backfill – except sand	-	100
Backfill – sand	150	300

Where the uncompacted thickness of a layer would otherwise be less than the minimum thickness specified in Clause 15.3, a lesser thickness of newly placed fill material may be employed 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 13 of MRTS01 *Introduction to Technical Standards*.

Table 15.3-B – Density Requirements

Location and Referenced Clauses	Material	Characteristic Value of Relative Compaction ¹
Insitu material for placement of fill (other than subgrade) (12.2.1.2, 12.2.1.3, 12.2.3)	All materials	95% minimum
Bottom of excavations (other than subgrade) (13.3.3.4, 13.3.6)	All materials	95% minimum
Subgrade in cuttings (full treatment depth) (18.3.3)	Class A or B Class C or D	97% minimum 90% minimum ² 96% maximum ³
	Class C or D Low and medium rainfall zones	95% minimum
Subgrade on embankments	Class A or B	97% minimum
	Class C or D High rainfall zone	95% minimum
Road embankment (other than subgrade) (14.3.1)	Class A or B	95% minimum
	Class C or D High rainfall zone	90% minimum ² 96% maximum ³
	Class C or D Low and medium rainfall zones	95% minimum
Levee embankment and other water retaining fills (14.3.1)	Class A or B	97% minimum
Backfill (other than subgrade) (19.3.1)	Sand	70% minimum Density Index ⁴
	Other than sand	95% minimum

Notes:

¹ The density compliance test shall be relative compaction except for sand where density index shall be used.

² Lower characteristic value.

³ Upper characteristic value.

⁴ Q142E.

The embankment and unbound subgrade material 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 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.

Table 15.3-C – Moisture Content Range for Embankment and Unbound Subgrade Material

Rainfall Zone	Median Annual Rainfall (mm)	General Fill Material Relative Moisture Content (%)			
		Class A	Class B	Class C	Class D
High	> 800	50 – 80	60 – 90	100 – 140*	100 – 140*
Medium	500 – 800	50 – 80	60 – 90	80 – 100	80 – 100
Low	< 500	50 – 80	60 – 80	60 – 80	60 – 80

* These limits apply to material without added water. Where water is added to achieve compaction, the limits shall be 85 – 110.

15.4 Mechanical Interlock Method of Construction

The mechanical interlock layer method of construction shall be employed for coarse granular soils 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.

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 minimum thickness of uncompacted layers is not less than one and a half times the maximum size of stone in the layer or 150 mm, whichever is greater.

Each layer shall be rolled until no further reduction of the layer surface height occurs. **Witness Point**

Where the proportion of finer grained material is such as to completely fill the voids between rocks, the finer grained portion shall be compacted to a characteristic value of the relative compaction as specified in Clause 15.3.

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)	
	Voids not filled	Voids filled
5	400	300
10	600	400
15	900	600
20	1200	800

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 treatment of batters with planting media or vegetation is shown on the drawings or specified, the batters shall be prepared in accordance with the following –

- a) where planting media is specified, cut batters shall be stepped to allow retention of planting media to the depth specified;
- b) where planting media is not specified, cut batters shall be stepped as shown on Standard Drawing number 1045; and
- c) fill batters shall be roughened.

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.

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 –

- a) 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 3 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 and the 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 in cuttings and in embankment where shown on the drawings or specified elsewhere in the Contract.

18.2 Materials

18.2.1 Subgrade Fill Material

Subgrade fill material used for the construction of subgrade in road embankments and for treatment of subgrade in cuttings shall comply with Clause 14.2.4.

18.2.2 Unbound Pavement Material

Unbound pavement material shall conform with the requirements of MRTS05 *Unbound Pavements* and shall be at least of the subtype specified in Clause 13.1 of Annexure MRTS04.1, or where no such subtype is specified, at least subtype 2.4.

18.2.3 Unbound Drainage Layer Material

Material for an unbound drainage layer shall conform with the requirements of MRTS05 *Unbound Pavements* and shall be at least of the subtype specified in Clause 13.2 of Annexure MRTS04.1, or where no such subtype is specified, at least subtype 2.4. 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	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 Stabilising Agent for In Situ Stabilisation

The stabilising agent for in situ stabilisation of the existing subgrade material shall be one of the following –

- a) lime complying with the requirements of MRTS23 *Supply of Quicklime and Hydrated Lime for Road Stabilisation*; or
- b) Type GB cement.

18.2.5 Stabilising Agent for Plant-Mixed Stabilisation

The stabilising agent for plant-mixed stabilisation shall be as specified in Clause 13.3 of Annexure MRTS04.1. Where no such specification is provided, the stabilising agent shall be Type GB cement incorporated at a rate of the greater of 2% or that which will achieve an unconfined compressive strength of at least 2 MPa in 7 days.

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)*.

18.3 Construction

18.3.1 General

The subgrade shall be constructed and tested to subgrade level in accordance with all standard requirements prior to placement of the pavement. **Hold Point 9**

The material at subgrade level shall provide a stable, dense surface which displays no visible vertical movement under the construction equipment nominated in Clause 13.4 of Annexure MRTS04.1.

Witness Point

18.3.2 Subgrade Treatment Type A

Subgrade treatment Type A applies to cuttings and embankments where the subgrade material is to be trimmed and compacted in accordance with Clauses 18.3.3.4 and 18.3.5 respectively.

18.3.3 Subgrade in Cuttings

18.3.3.1 General

The provisions of Clause 18.3.3 shall apply to the construction of subgrade in cuttings when excavation has progressed to subgrade level plus 100 mm in accordance with Clause 13.3.2.1.

The subgrade treatments are nominated in Clause 13.5 of Annexure MRTS04.1. In considering authorisation to proceed past **Hold Point 6** (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 in situ material, if ordered; and
- c) any adjustments to the pavement thickness considered necessary by 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.

Unless stated otherwise in Clause 18, the vertical tolerance on the bottom of any excavation required as part of a subgrade treatment shall be ± 25 mm.

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.

Where the floor of the cutting cannot be trimmed with a grader to the specified tolerance for subgrade, the allowable tolerance may be increased to + 25, - 75 mm. 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 plant mixed stabilised material in accordance with Clauses 18.2.2 and 18.2.5, mixed and placed in accordance with the requirements of MRTS08 *Plant-Mixed Stabilised Pavements*. The material shall be compacted adequately.

18.3.3.2 Testing

Where so stated in Clause 13.6 of Annexure MRTS04.1, the Administrator may direct the Contractor to select samples from the subgrade consistent with the testing frequency stated in Clause 13.7 of Annexure MRTS04.1 and test each sample for –

- a) plastic limit;
- b) liquid limit;
- c) percent passing the AS 0.425 mm sieve;
- d) WPI;
- e) linear shrinkage; and
- f) soaked or unsoaked CBR as appropriate.

The results of the testing described above shall be submitted to the Administrator to assist in determining the need for any subgrade treatment.

Where subgrade treatment Type D in accordance with Clause 18.3.3.7 or Type G in accordance with Clause 18.3.3.10 are to be used, the Contractor shall test the subgrade material or drainage layer material, as applicable, to determine lime reaction and demand in accordance with Test Method Q133.

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	18.3.3.4	Compact existing	No	–	–	150
B	18.3.3.5	Replace with general fill material	No	General fill material	–	150
C	18.3.3.6	Replace with unbound pavement material	No	Unbound pavement material	–	150
D	18.3.3.7	In situ stabilise existing	No	–	In situ	150
E	18.3.3.8	Replace with plant-mixed stabilised material	No	Unbound pavement material	Plant-mixed	200
F	18.3.3.9	Plant-mixed stabilised upper layer and unbound drainage lower layer	Yes	Unbound pavement material	Plant-mixed	200
				Unbound drainage material		100
G	18.3.3.10	In situ stabilised drainage layer	Yes	Unbound drainage material	In situ	150
H	18.3.3.11	Plant-mixed stabilised drainage layer	Yes	Unbound drainage material	Plant-mixed	150
I	18.3.3.12	Special	† ²	† ²	† ²	† ²

†¹ Unless otherwise specified on the drawings.

†² As specified on the drawings.

18.3.3.3 Period for Determination of Subgrade Treatment

Unless stated otherwise in Clause 18, the Contractor shall allow a period of 2 working days from the time when the excavation reached subgrade level plus 100 mm for the Administrator to make a determination regarding the subgrade treatment to be adopted.

Where subgrade testing has been directed in accordance with Clause 18.3.3.2, 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.

18.3.3.4 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 constructed as specified in Clause 15.3 to a characteristic value of relative compaction as specified in Table 15.3B.

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.

18.3.3.5 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 provisions of Clause 13.3.1.

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

18.3.3.6 Subgrade Treatment Type C, Replace with Unbound Pavement 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 provisions of Clause 13.3.1.

The excavation shall be backfilled to subgrade level with unbound pavement 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 15.3B.

18.3.3.7 Subgrade Treatment Type D, In Situ Stabilise Existing

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

The depth below subgrade level as specified in Clause 13.5 of Annexure MRTS04.1, or, where no such depth is specified, 150 mm below subgrade level shall be stabilised in accordance with the requirements of the following –

- a) If lime reacts with the material, as determined by testing described in Clause 18.3.3.2, the stabilising agent shall be lime, in accordance with Clause 18.2.4, at an application rate of the greater of 3% by mass or the amount of lime required to satisfy lime demand. The material shall be stabilised as specified in MRTS07A *In situ Stabilised Subgrades using Quicklime or Hydrated Lime*; or
- b) If lime does not react with the material, as determined by testing described in Clause 18.3.3.2, the stabilising agent shall be Type GB cement, in accordance with Clause 18.2.4, incorporated at a rate of the greater of 1.5% or that which will achieve an unconfined compressive strength of at least 1 MPa in 7 days. The material shall be stabilised as specified in MRTS07B *In situ Stabilised Pavements Using Cement or Cementitious Blends*.

The material shall be constructed to a characteristic value of relative compaction not less than that specified in Table 16.3B.

18.3.3.8 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 provisions of Clause 13.3.1.

The excavation shall be backfilled to subgrade level with plant-mixed stabilised pavement material, in accordance with Clauses 18.2.2 and 18.2.5, mixed and placed in accordance with the requirements of MRTS08 *Plant-Mixed Stabilised Pavements*. The material shall be compacted to a characteristic value of relative compaction not less than that specified in Table 15.3B.

18.3.3.9 Subgrade Treatment Type F, Unbound Drainage Layer

For Subgrade treatment Type F, 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 provisions of Clause 13.3.1.

A 100 mm thick unbound drainage layer shall be constructed using material as specified in Clause 18.2.3. A layer of geotextile as specified in Clause 18.2.6 shall be installed above and below the granular layer. Installation of the geotextile shall comply with the provisions of MRTS27 *Geotextiles (Separation and Filtration)*.

The remainder of the excavation shall then be backfilled to subgrade level with plant mixed stabilised material in accordance with Clauses 18.2.2 and 18.2.5 mixed and placed in accordance with MRTS08 *Plant Mixed Stabilised Pavements*. The material shall be compacted to a characteristic value of relative compaction not less than that specified in Table 15.3B.

18.3.3.10 Subgrade Treatment Type G, In Situ 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 provisions of Clause 13.3.1.

The excavation shall be backfilled to subgrade level with granular material, in accordance with Clause 18.2.3 placed and stabilised in accordance with the requirements of MRTS07A *In situ Stabilised Subgrades using Quicklime or Hydrated Lime* and the following –

- a) If lime reacts with the material, as determined by testing described in Clause 18.3.3.2, the stabilising agent shall be lime, in accordance with Clause 18.2.4, at an application rate of the greater of 3% by mass or the amount of lime required to satisfy lime demand. The material shall be stabilised as specified in MRTS07A *In situ Stabilised Subgrades using Quicklime or Hydrated Lime*; or
- b) If lime does not react with the material, as determined by testing described in Clause 18.3.3.2, the stabilising agent shall be Type GB cement, in accordance with Clause 18.2.4, incorporated at a rate of the greater of 1.5% or that which will achieve an unconfined compressive strength of at least 1 MPa in 7 days. The material shall be stabilised as specified in MRTS07B *In situ Stabilised Pavements Using Cement or Cementitious Blends*.

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

18.3.3.11 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 provisions of Clause 13.3.1.

The excavation shall be backfilled to subgrade level with plant-mixed stabilised granular material, in accordance with Clause 18.2.2 and 18.2.5, mixed and placed in accordance with the requirements of MRTS08 *Plant-Mixed Stabilised Pavements*. The material shall be compacted to a characteristic value of relative compaction not less than that specified in Table 15.3B.

18.3.3.12 Subgrade Treatment Type I, Special

Subgrade treatment Type I shall be in accordance with the provisions specified in Clause 13.8 of Annexure MRTS04.1.

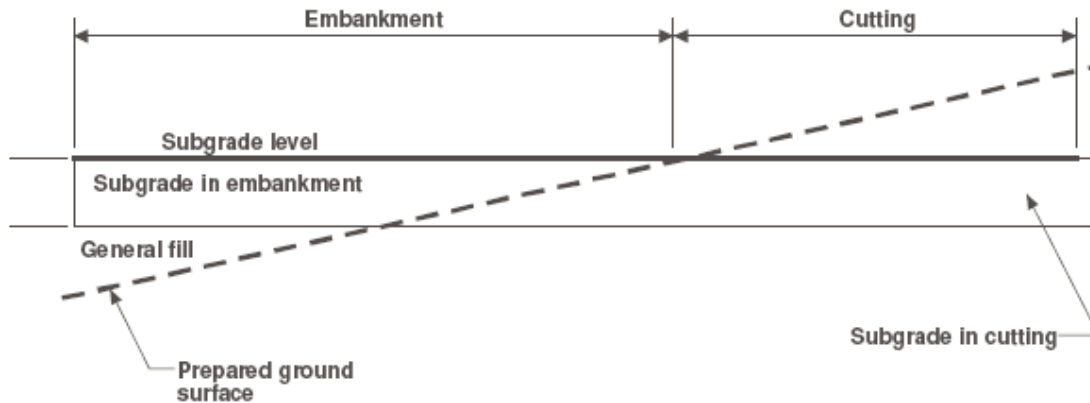
18.3.4 Earthworks Transition from Cut to Fill

18.3.4.1 General

At all such transitions, the embankment subgrade shall continue longitudinally up to the line where the subgrade level intercepts the prepared ground surface unless stated otherwise in Clauses 18.3.4.2 and 18.3.4.3.

A schematic representation of the treatment required is shown in Figure 18.3.4.1.

Figure 18.3.4.1 – Longitudinal Section of Earthworks Transition from Fill to Cut



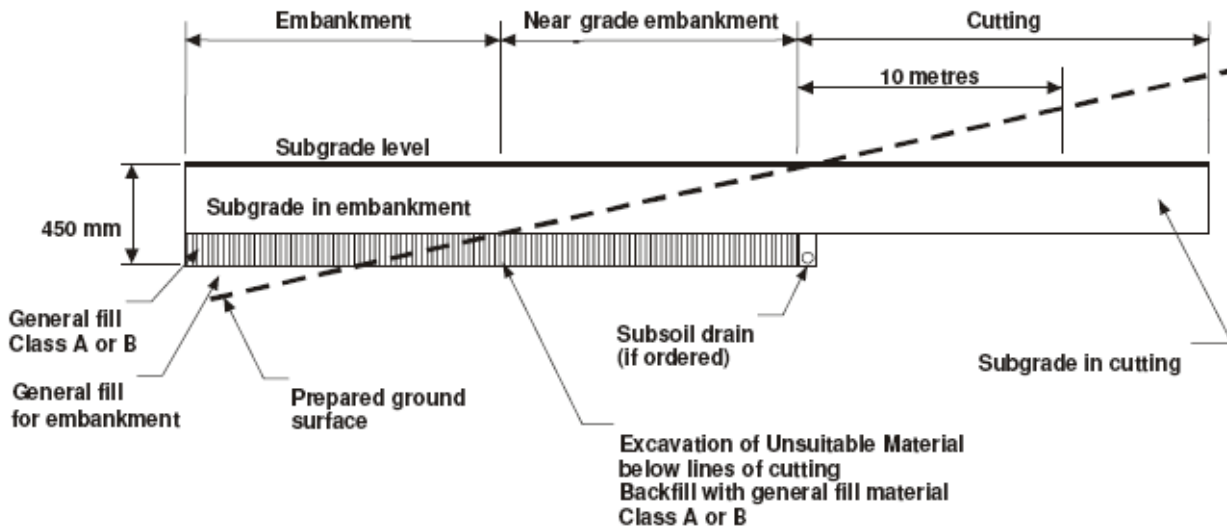
18.3.4.2 Near Grade Embankments

Where so stated in Clause 13.9 of Annexure MRTS04.1, the properties of the existing foundation material beneath near-grade embankments shall be tested for compliance with the requirements of general fill material Class A or B, as specified in Clause 14.2.2, within 450 mm of subgrade level. 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 general fill material Class A or B, as specified in Clause 14.2.2. Backfill shall be compacted to a characteristic value of relative compaction not less than that specified in Table 15.3B for subgrade.

A schematic representation of the treatment required is shown in Figure 18.3.4.2.

Figure 18.3.4.2 – Longitudinal Section of Earthworks Transition from Fill to Cut



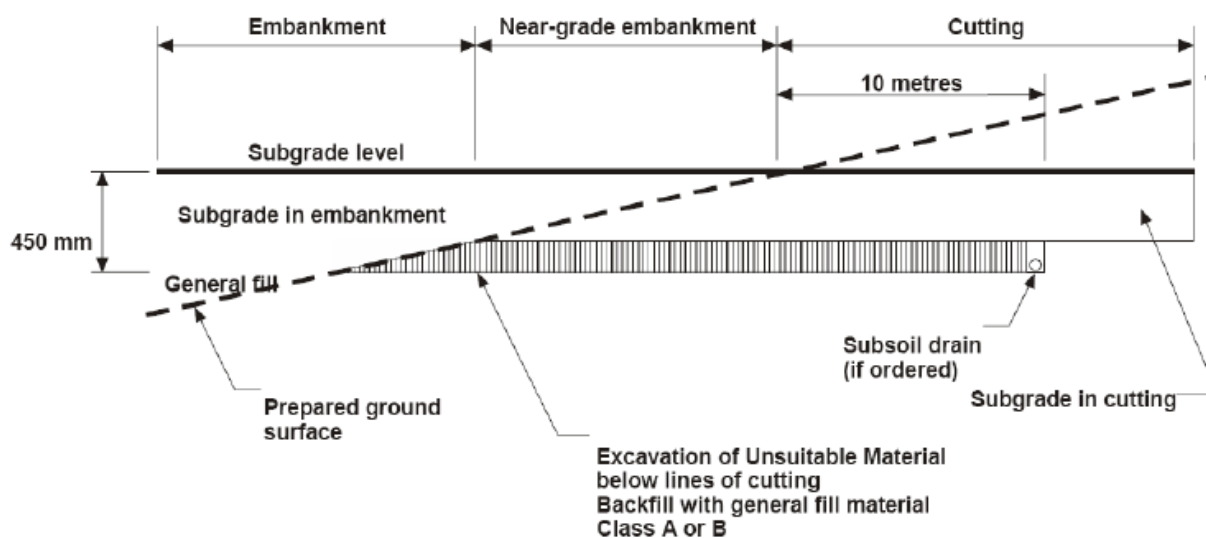
18.3.4.3 Additional Requirements

Where so stated in Clause 13.9 of Annexure MRTS04.1, the construction of transitions between cuttings and embankments shall include the additional requirements specified in Clause 18.3.4.3.

Construction as a near-grade embankment in accordance with Clause 18.3.4.2 shall continue for a distance of 10 metres from the line of transition, transversely and longitudinally, where the transition line is determined at subgrade level.

A schematic representation of the treatment required is shown in Figure 18.3.4.3.

Figure 18.3.4.3 – Longitudinal Section of Earthworks Transition from Fill to Cut



18.3.5 Subgrade on Embankment

Subgrade on embankment shall be constructed from material complying with the requirements of Clause 18.2.1.

Subgrade on embankment shall be placed and compacted using the compacted layer method as specified in Clause 15.3. Subgrade depth shall be 150 mm unless stated otherwise on the drawings.

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

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.

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 9.3.

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

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 General Backfill Material

General backfill material shall comply with the requirements of general fill material Class A 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	10 – 40	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 mm
Percent passing 0.15 mm sieve	maximum	5%
Plasticity index	maximum	8

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	100	100
Percent passing 0.075 mm AS sieve (maximum)	5	10
Plasticity Index (maximum)	5	10

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 set Table 19.2.6.

Table 19.2.6 – Bedding Material Properties

AS Sieve Size (mm)	% Passing By Mass
19	100
2.36	30 – 100
0.425	15 – 70
0.075	3 – 30

AS Sieve Size (mm)	% Passing By Mass
Other Properties Linear Shrinkage	6 maximum

19.2.7 Filter Material

Filter material shall be a natural or manufactured granular material free from organic matter with the grading limits as set out 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 – Grading Requirements for Filter Material

AS Sieve Size (mm)	% 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 Pavement Material

Cement stabilised pavement material shall consist of at least subtype 2.3 unbound pavement material, Grading C or D, as specified in MRTS05 *Unbound Pavements*. The material shall be stabilised with either Type GP or Type GB cement at a rate of 3% by mass.

Cement stabilised pavement material shall be plant mixed in accordance with the requirements of MRTS08 *Plant-Mixed Stabilised Pavements*.

19.2.9 Stabilised Sand

Stabilised sand shall comprise sand meeting the requirements of Clause 19.2.5 in an intimate 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 an intimate 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 be Class 5 MPa/40 concrete in accordance with the provisions of MRTS70 *Concrete*. The target slump shall be consistent with compacted layer method of construction.

19.2.12 Backfill Material for Steel Culverts

Backfill material for culverts fabricated from steel shall be select backfill material in accordance with Clause 19.2.3. 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

Rock fill material shall consist of sound igneous, metamorphic or sedimentary rock that will not disintegrate in water or when exposed to the weather. Rock fill shall be free from overburden, spoil, shale and organic matter. The largest dimension of any stone shall not be greater than 500 mm.

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 general backfill material complying with the requirements of Clause 19.2.2. **Witness Point**

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 placed in accordance with the provisions of MRTS70 *Concrete* and compacted using an immersion vibrator.

Compaction standards shall comply with the requirements of Clause 15.3.

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 pavement 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 10**

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 DMR Standard Drawing Number 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.

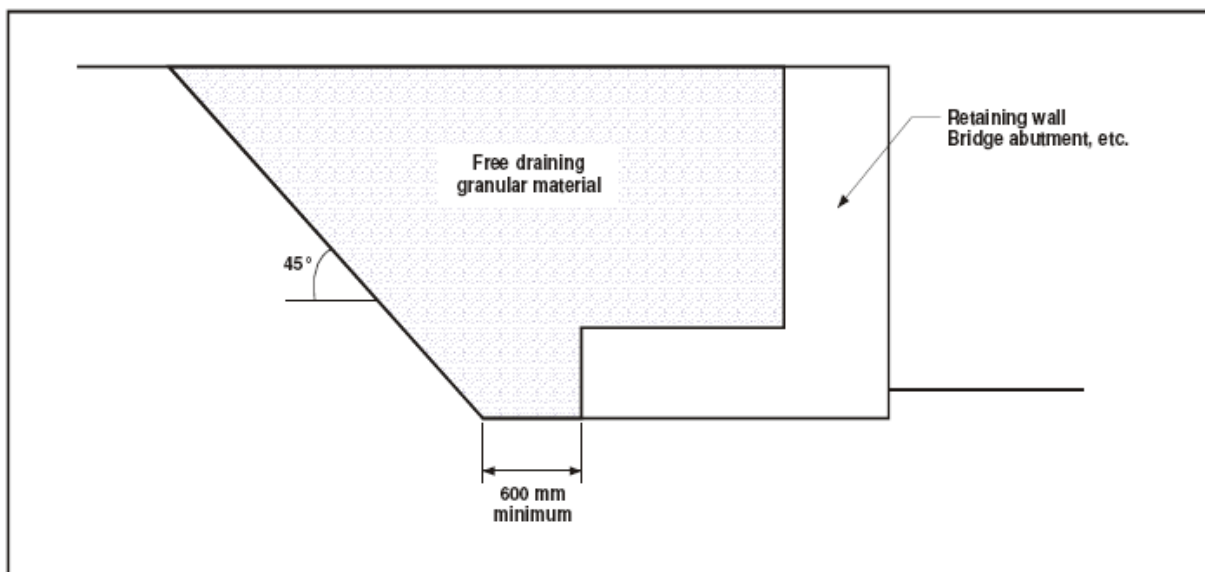
For overlay zones, material within 300 mm of the structure, culvert, pipe, etc shall be general backfill material complying with the requirements of Clause 19.2.2. Elsewhere, overlay zone material may contain stone size up to 150 mm maximum dimension.

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.

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 —
 - Excavation of existing shoulders to subgrade level shown on the drawings;
 - Excavation below subgrade level, if necessary, to meet roadway embankment material quality requirements;
 - Construction of table drains, diversion drains and catch drains; and
 - 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 (2) metres.

Ground surface treatment 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. The depth of subgrade shall be 150 mm unless shown otherwise on the drawings.

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 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 height, 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 5.4.

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.