



CODE OF PRACTICE - VOLUME TWO - TRAIN SYSTEM [CP2] TRANSADELAIDE INFRASTRUCTURE SERVICES		
PART 9: FORMATION AND EARTHWORKS		DOC. NO. CP-TS-959
Issue: 2	Date: 26/09/08	Page: 1 of 18

TRACK AND CIVIL INFRASTRUCTURE

CODE OF PRACTICE

VOLUME TWO - TRAIN SYSTEM [CP2]

FORMATION AND EARTHWORKS



CODE OF PRACTICE - VOLUME TWO - TRAIN SYSTEM [CP2] TRANSADELAIDE INFRASTRUCTURE SERVICES		
PART 9: FORMATION AND EARTHWORKS		DOC. NO. CP-TS-959
Issue: 2	Date: 26/09/08	Page: 2 of 18

TABLE OF CONTENTS

1.0 PURPOSE AND SCOPE3

1.1 PURPOSE3

1.2 PRINCIPLES.....3

1.3 SCOPE3

1.4 REFERENCES.....3

2.0 DESIGN AND RATING5

2.1 DESIGN CODES.....5

2.2 DESIGN PROFILES.....5

2.3 DESIGN OF EARTHWORKS.....5

2.4 EARTHWORKS MATERIALS7

2.5 EARTHWORKS CONSTRUCTION.....10

2.6 DEFINED EVENTS AND SPECIAL LOCATIONS15

3.0 MONITORING AND MAINTENANCE.....17

3.1 SPECIAL LOCATIONS17

3.2 INSPECTION, ASSESSMENT AND MAINTENANCE ACTIONS17

3.3 INDICATORS OF TRACK INSTABILITY18

4.0 DOCUMENTATION20

4.1 REGISTER OF GEOTECHNICAL SPECIAL LOCATIONS20

4.2 SCHEDULE OF GEOTECHNICAL STRUCTURES.....20

4.3 INSPECTION REPORTS20



CODE OF PRACTICE - VOLUME TWO - TRAIN SYSTEM [CP2] TRANSADELAIDE INFRASTRUCTURE SERVICES		
PART 9: FORMATION AND EARTHWORKS		DOC. NO. CP-TS-959
Issue: 2	Date: 26/09/08	Page: 3 of 18

1.0 PURPOSE AND SCOPE

1.1 PURPOSE

The purpose of this part is to set standards to ensure that:

- a) earthworks meet the safety risk profile determined by TransAdelaide;
- b) by inspection, earthworks are maintained safely;
- c) in the event of earthworks becoming unstable or failing, precautions and actions are taken to ensure safety of train operations.

1.2 PRINCIPLES

This part complies with the principles set out in the "Code of Practice for the Defined Interstate Rail Network", volume 4, part 2, section 8.

1.3 SCOPE

This part specifies general procedures for:

- a) the design/rating, monitoring and maintenance of new earthworks and geotechnical structures;
- b) the identification of existing geotechnical special locations; and
- c) the determination of defined events which may lead to unsafe conditions at those locations.

1.4 REFERENCES

1.4.1 Australian Standards

AS 5100 Bridge Design

AS1289 Method of testing soils for engineering purposes

1.4.2 Industry codes of practice

Code of Practice for the Defined Interstate Rail Network, volume 4 (Track, Civil and Electrical Infrastructure), part 2 (Infrastructure Principles), section 8: Earthworks

1.4.3 TransAdelaide documents

a) CP2

CP-TS-953: Part 3, Infrastructure management and principles

b) TransAdelaide/Infrastructure Procedures

QP-IS-501: Document and Data Control

CPRD/PRC/046 Records Management:

1.4.4 TransAdelaide drawings

304-A4-81-116: Design standard: typical cross sections - cut: rail reserve

304-A4-81-117: Design standard: typical cross sections - fill: rail reserve

1.4.5 DTEI Documents

Master Specification, Part 215: Supply of Pavement Materials

Master Specification, Part 215, Appendix 1.



CODE OF PRACTICE - VOLUME TWO - TRAIN SYSTEM [CP2] TRANSADELAIDE INFRASTRUCTURE SERVICES		
PART 9: FORMATION AND EARTHWORKS		DOC. NO. CP-TS-959
Issue: 2	Date: 26/09/08	Page: 4 of 18

TP134 – Particle Size Distribution, Standard Method of Analysis by Sieving



CODE OF PRACTICE - VOLUME TWO - TRAIN SYSTEM [CP2] TRANSADELAIDE INFRASTRUCTURE SERVICES		
PART 9: FORMATION AND EARTHWORKS		DOC. NO. CP-TS-959
Issue: 2	Date: 26/09/08	Page: 5 of 18

2.0 DESIGN AND RATING

2.1 DESIGN CODES

Design and rating of earthworks and geotechnical structures shall where necessary include geotechnical investigation and specialist geotechnical advice of the site and or materials. Geotechnical structures and their stability should be determined in accordance with the following documents:

- a) Railway loading shall be determined in accordance with the Australian Bridge Design Code.
- b) Geotechnical stability shall be determined in accordance with the appropriate Australian Standards.

2.2 DESIGN PROFILES

- a) Cuttings shall conform to the profile shown on drg no. 304-A4-81-116.
- b) Embankments shall conform to the profile shown on drg no. 304-A4-81-117.

2.3 DESIGN OF EARTHWORKS

2.3.1 Earthworks For New Construction And Major Upgrading Works

Earthworks for new mainlines and loops shall comply with the appropriate dimensions shown on Drawings 304-A4-81-116 and 304-A4-81-117.

The following elements shall be taken into account in design:

- Cess and sub surface drainage.
- Special requirements for drainage in multiple track areas.
- Top Drains above Cuttings
- Presence of contaminated material!

2.3.2 Formation

2.3.2.1 Formation types

- a) The formation is the surface on which the track (including ballast) is laid. Traditionally, it was the finished surface of the earthworks. However, present day practice requires the material in the finished earthworks to be analyzed for its ability to satisfactorily support the track whether wet or dry and if necessary carry out one of the following procedures to ensure the track is properly supported and drained:
 - i. cap the formation with 200mm to 300mm of selected material in accordance with Transport SA specification PM21;
 - ii. cement stabilize the top 200mm layer of the earthworks in accordance with geotechnical design; or
 - iii. finish the earthworks with a layer of geofabric or similar laid on the surface and covered with a 150mm layer of sand as protection from puncturing.
- b) Track built before the adoption of the present day methods in sub-clause (a) may shows signs of stress and necessitate the undertaking of remedial work. Where



CODE OF PRACTICE - VOLUME TWO - TRAIN SYSTEM [CP2] TRANSADELAIDE INFRASTRUCTURE SERVICES		
PART 9: FORMATION AND EARTHWORKS		DOC. NO. CP-TS-959
Issue: 2	Date: 26/09/08	Page: 6 of 18

the track shows signs of formation failure or signs of stress a geotechnical assessment should be carried out to design a capping along with treatment to the sub-grade, if required as a result of the geo-technical assessment.

When track is to be upgraded on existing formation, the formation should be free of identifiable defects such as:

- i. Excessively narrow shoulders;
- ii. Retained moisture;
- iii. Ballast settlement; or
- iv. Formation deformation.

2.3.2.2 Formation Crossfall Design

The finished formation for double track shall be graded to fall towards the sides of the track. On single track, the fall will be all to one side (whichever is the most convenient to accommodate drainage). The design of the fall in areas of multiple tracks (eg yards & platforms) shall be carried out in conjunction with the design of the stormwater drainage system to ensure that the formation is adequately drained. The degree of cross-fall shall range from 1 in 20 (preferred) to 1 in 45 depending on other influences (such as cuttings in solid rock, over bridges, etc.).

2.3.2.3 Formation depth design

Changes in formation level relative to top of rail may occur due to changes in rail type, sleeper type or structure type. At these locations, the change in depth shall occur over a relative grade of 1 in 200 without compromising the stormwater drainage system design for the location. Where this will create a low point in the formation, the stormwater drainage design shall incorporate suitable transverse drains to remove water from the formation.

2.3.3 Capping Design

Capping layer design shall;

- i. be undertaken by a suitably experienced geotechnical engineer taking into account the proposed operating regime for the line, expected ground movements and the existing subgrade and drainage requirements.
- ii. shall target a desirable formation design life of 50 years minimum by reducing subgrade stresses to an acceptable long term value.
- iii. Shall include drainage design to cater for run off

2.4 EARTHWORKS MATERIALS

2.4.1 Definition of Earth and Rock

Earth is defined to include all materials such as soil, clay, sand, gravel, weathered or loose rock which could normally be removed by ripping by a bulldozer of nominal 290-kilowatt brake power with heavy duty tynes.



**CODE OF PRACTICE - VOLUME TWO - TRAIN SYSTEM [CP2]
TRANSADELAIDE INFRASTRUCTURE SERVICES**

PART 9: FORMATION AND EARTHWORKS		DOC. NO. CP-TS-959
Issue: 2	Date: 26/09/08	Page: 7 of 18

Rock is defined to include any material, which cannot be so removed and shall include boulders greater than 1 cubic metre in volume.

2.4.2 Topsoil

Topsoil shall be removed over the area to be occupied by the completed works plus a clearance of 2 metres either side, to a depth of 150 mm. Topsoil suitable for vegetation propagation shall be placed in a stockpile clear of the work to enable its re-use in landscaping and revegetation. Topsoil stockpiles shall be appropriately protected from erosion by either vegetating or covering.

2.4.3 Unsuitable Material

Unsuitable material includes topsoil, peat and other highly organic soils, logs, stumps, perishable material, refuse, stones, material susceptible to spontaneous combustion, free draining materials susceptible to scouring (e.g. very fine sand), silt clay lumps and organic clay and material with soaked CBR<1. Such material shall be excavated, to a minimum depth of 300 mm, and disposed off-site except for topsoil required for vegetation propagation.

Where unsuitable material exists in excessive depths the advice of a Geotechnical Engineer is required.

Dispersive soils can be used only in accordance with guidelines provided by a Geotechnical Engineer and with prior approval.

2.4.4 Free Draining Filter Material

Free draining filter material shall be crushed rock, river gravel or slag composed of hard, strong and durable particles from an approved quarry source, and complying with the following Table 2.1:

Table 2.1: Free Draining Filter Material Properties

Test Method Requirement	Description	Criteria	Min frequency of Testing
AS1289, 3.6.1	Particle Size Distribution % Passing 53.0mm sieve % Passing 37.5mm sieve % Passing 26.5mm sieve % Passing 19.0mm sieve	100 90-100 20-55 0-5	One per 1000t
AS1141, section 32	Soft and friable particles	Max. 5%	
AS1141, section 30	Clay Lumps	Max. 0.5%	
AS1141, section 23	Los Angeles Value (Grading A)	Max. 30%	
AS1141, section 6	Particle density	Min. 2.3t/m ³	

2.4.5 Embankment Material

The embankment shall consist of two zones of embankment material.

- 1) Structural Zone
- 2) General Fill



CODE OF PRACTICE - VOLUME TWO - TRAIN SYSTEM [CP2]		
TRANSADELAIDE INFRASTRUCTURE SERVICES		
PART 9: FORMATION AND EARTHWORKS		DOC. NO. CP-TS-959
Issue: 2	Date: 26/09/08	Page: 8 of 18

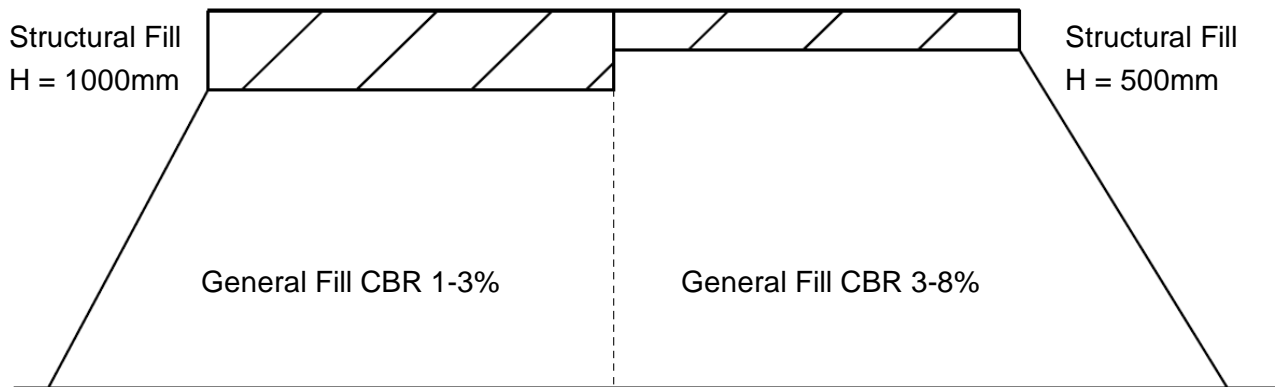
The zones of the embankment shall be defined by the thickness of the structural zone (H) at the top of the embankment as determined by the following relationship with the general fill:

General Fill CBR*3-8% - H = 500mm

General Fill CBR*1-3% - H = 1000mm

* (Soaked California Bearing Ratio, Standard Compaction).

Figure 2.1: Depth of Structural Fill Required



Material for use in the structural zone shall comply with the following Table 2.2:

Table 2.2: Structural Fill Material Properties

Test Method Requirement	Description	Criteria	Min frequency of Testing
AS1289, 3.6.1	Particle Size Distribution % Passing 53.0mm sieve % Passing 2.36mm, sieve % Passing 425um, sieve % Passing 75um, sieve	80-100 15-100 0-70 0-30	One per 1000t
AS1289, 3.1.2	Liquid Limit	Maximum 40	
AS1289, 3.3.1	Plasticity Index	Maximum 20	
AS1289, 5.2.1	Maximum dry density	Minimum 1.8t/m ³	
AS1289, Test 6.1.1	Soaked California Bearing Ratio (Standard compaction)	Minimum 8%	

Unsuitable material (refer 2.4.2) shall not be used as General Fill. General Fill shall have a Liquid Limit less than 40, and the product of the Liquid Limit and the percentage passing the 425 micron sieve shall not exceed 1800. Non-cohesive filling with a Plasticity Index less than



CODE OF PRACTICE - VOLUME TWO - TRAIN SYSTEM [CP2]		
TRANSADELAIDE INFRASTRUCTURE SERVICES		
PART 9: FORMATION AND EARTHWORKS		DOC. NO. CP-TS-959
Issue: 2	Date: 26/09/08	Page: 9 of 18

6 shall only be used with prior written approval and in accordance with such conditions as may be required to protect the filling from erosion.

Material not complying with the above requirements shall only be used with prior approval.

2.4.6 Formation Capping Material

The formation capping material shall have properties that conform to the requirements for PM1/20QG to DTEI Master Specification, Part 215: Supply of Pavement Materials as given below.

Table 2.3: PM1/20QG Material Properties

Test Method Requirement	Description	Criteria	Min frequency of Testing
TP134	Particle Size Distribution ⁽¹⁾ % Passing 26.5mm sieve % Passing 19mm sieve % Passing 13.2mm sieve % Passing 9.5mm sieve % Passing 4.75mm sieve % Passing 2.36mm, sieve % Passing 425um, sieve % Passing 75um, sieve	100 95-100 77-93 60-83 44-64 29-49 13-23 5-11	One per 1000m ³
AS1289.3.1.2	Liquid Limit	Max.25	
AS1289.3.3.1	Plasticity Index	Min 1% Max 6%	
AS1289.3.4.1	Linear Shrinkage	Max 3%	
AS1289.5.2.1	Maximum dry density	Min.2.0t/m ³	
AS1141.23	LA Abrasion Grading 'B'	Max 30%	
AS1289.6.1.1 ⁽²⁾	Soaked California Bearing Ratio (Standard compaction)	Min.50%	

Notes for Table 3

(1)The quarried pavement material shall have a uniform grading and shall not be graded from the coarse limit of the grading envelope to the fine limit of the grading envelope, or vice versa.

(2) Compacted to 95% (min) Maximum Dry Density obtained by AS.1289 5.2.1 & with 9 kg surcharge

2.4.7 Geofabrics and Geogrids

The use of geofabrics and geogrids should be considered by the geotechnical engineer carrying out the formation and capping design in the following situations:

- i. Where poor subgrade conditions exist (i.e. where CBR value is 10 or less);
- ii. Through road crossings, and
- iii. For the full length of passenger platforms.



CODE OF PRACTICE - VOLUME TWO - TRAIN SYSTEM [CP2] TRANSADELAIDE INFRASTRUCTURE SERVICES		
PART 9: FORMATION AND EARTHWORKS		DOC. NO. CP-TS-959
Issue: 2	Date: 26/09/08	Page: 10 of 18

Geofabrics shall be used to provide segregation of materials.

Geogrids shall be used to provide increased layer strength and to allow soft formation materials to be spanned..

2.5 EARTHWORKS CONSTRUCTION

2.5.1 Clearing and Grubbing

The whole area to be occupied by the completed works including ancillary earthworks for drains and diversion levees is to be cleared and grubbed plus a clearance of 2m from tops of cuttings and toes of embankments. Clearing includes removal and disposal of all trees, stumps, logs, timber, scrub, vegetation, minor structures, refuse and other material unsuitable for incorporation in the work.

Grubbing is to be carried out to the level of 0.5m below natural surface or 1.5m below finished earthworks level. Holes left after grubbing are to be filled with sound material and compacted in layers as for embankments.

If required by the environmental plan, fauna habitat logs shall be placed well clear of construction activities.

Disposal of all excess materials shall be managed in accordance with relevant regulations

2.5.2 Excavation for Cuttings

Excavation shall be carried out to the lines, levels, dimensions and slopes as designed. The excavated faces shall be neatly trimmed and the top edges of the cuttings neatly rounded. Under cutting of the slopes will not be permitted under any circumstances. Batter slopes in rock cuttings in excess of 3m high and closer than 6m from the track centreline shall be determined on the advice of a Geotechnical Engineer or Geologist.

Unless otherwise specified, cutting slopes shall be in accordance with the following Table 2.4:

Table 2.4: Typical (Minimum) Cutting Slopes

Material	Slope Horizontal : Vertical
1 Sand	2 : 1
2 Wet clay, loose gravel	2 : 1
3 Sandy clay, boulders and clay, compact gravelly soils	1.75 : 1
4 Poor Rock (Fractured, friable)	1.5 : 1
5* Sound shale dipping sharply towards railway formation, tight cemented gravel	1 : 1
6* Ordinary Rock	1 : 1
7* Solid well bedded rock	0.25 : 1

* Maximum height without bench - 7m

* A Geotechnical Engineer or Geologist shall confirm batter slopes in rocks



CODE OF PRACTICE - VOLUME TWO - TRAIN SYSTEM [CP2] TRANSADELAIDE INFRASTRUCTURE SERVICES		
PART 9: FORMATION AND EARTHWORKS		DOC. NO. CP-TS-959
Issue: 2	Date: 26/09/08	Page: 11 of 18

Excavation shall be carried out in such a manner as to prevent erosion or slips, working faces shall be limited to safe heights and slopes, and the surface shall be drained to avoid ponding and erosion.

Slope design shall be reviewed following site inspection and investigation during excavation. Overhanging, loose or unstable material likely to slip should be cut back, removed or stabilised.

Rock cuttings and exposed rock surfaces shall be excavated so as to obtain smooth, uniformly trimmed surfaces. Batters in cuttings shall be carried around curves in an even and regular manner. Finished batters shall not have a slope steeper than designed.

Excavation at the base of the cutting shall be finished at a level to suit the capping thickness, and with crossfalls as designed. Compaction of the top 150mm layer in the base of cuttings or of material required to fill over-excavation shall be compacted to compaction standard A (refer to Clause 2.5.5), or shall be solid rock. In addition the finished surface shall not deviate from the bottom of a 3 metre straight edge laid in any direction by more than 25mm.

2.5.3 Preparation of Embankment Base

Preparation includes clearing, grubbing, and removal of topsoil and removal of unsuitable material and subsequent restoration under sections 2.4.2 and 2.5.1. It also includes cutting of terraces into slopes, scarifying and compaction of embankment base and provision of drainage works as specified below.

Where embankments are to be constructed on a natural slope or on the slope of an existing embankment steeper than 4 to 1 (horizontal to vertical), the existing slope is to be cut in horizontal terraces at least 1.5m wide. The terraces are to be cut progressively as the embankment is constructed. Suitable material excavated in cutting the terraces may be incorporated in the embankment but unsuitable material shall be removed.

The area of the base of the embankment shall be scarified to a depth of 100mm, parallel to the embankment axis. A layer of general fill 100mm thick shall be spread over the scarified area, and the whole shall be compacted to compaction standard B (refer to section 2.5.5).

Where designed, a drainage blanket is to be provided at the base of the embankment. It shall comprise a geotextile fabric (as approved by a Geotechnical Engineer) laid along the base and around a layer of free draining filter material to a depth of 300mm, with spall protection at the outlet. Manufacturer's instructions concerning installation of the fabric shall be followed.

2.5.4 Placing Embankment Material

Embankments shall be constructed full width in horizontal layers. Layers shall not exceed 200mm thickness unless it can be shown that the specified compaction can be obtained for a thicker layer. Notwithstanding, maximum layer thickness shall be 300mm. Layers or pockets of substantially varying material should be avoided. The maximum particle size should be less than 2/3 of the compacted layer thickness. Construction shall be carried out in such a manner as to ensure adequate drainage of the works, and to avoid scour and erosion. The top of the earthworks is to be trimmed in accordance with the requirements for preparation for capping.



**CODE OF PRACTICE - VOLUME TWO - TRAIN SYSTEM [CP2]
TRANSADELAIDE INFRASTRUCTURE SERVICES**

PART 9: FORMATION AND EARTHWORKS		DOC. NO. CP-TS-959
Issue: 2	Date: 26/09/08	Page: 12 of 18

2.5.5 Compaction on Embankment Material

Compaction shall be carried out at a moisture content, which will allow the specified compaction to be achieved.

Where necessary water shall be added uniformly or drying carried out. Bond between layers is to be ensured, if necessary by wetting or scarifying.

Compaction Standards shall be as follows:

- Compaction A Cohesive soils - Not less than 100% Relative Compaction as determined by AS.1289.5.1.1 (Standard Compaction)
 Rock fill or cohesion less soils - No visible deflection of surface under 10 tonne Vibratory rollers after 6 - 8 passes.
- Compaction B: Not less than 95% Relative Compaction as determined by AS.1289.5.1.1 (Standard Compaction).

Embankments shall be compacted to:

- General Fill: Below Structural Zone = Compaction B
 Structural Zone = Compaction A

2.5.6 Embankment Profile

Embankment batter slopes shall be as designed. Unless shown otherwise, the standard batter slope for embankments shall be 1.75:1 (horizontal:vertical). If stability is expected to be a problem, batters may be flattened to 2:1 or more. Advice shall be sought from a Geotechnical Engineer if there is any doubt concerning embankment stability.

2.5.7 Earthworks Near Structures

Care shall be exercised in constructing earthworks within 5m of structures to avoid damage to the structures. Non-vibratory equipment should be used within this distance and adjacent to the structure further limitations, as defined in Table 5, apply. Adjacent to weep-holes free draining filter material encapsulated in geofabric should be placed, horizontally for at least 300mm from, and vertically for 450mm above the weep – hole unless specified otherwise. Select back fill material complying with the requirement for capping material except that a minimum of 60% shall be retained on 2.36mm sieve, shall be used adjacent to structures as follows:

Table 2.5: Select Fill near Structures

Structure	Minimum width & height of selected fill	Compaction method
Bridge abutment and wing walls	2m wide for full height	Hand held compaction equipment for full structure height for a distance of 2/3 H (H=overall height of structure)
Pipe culverts	300mm width each side and above top pipes	Hand held compaction equipment for distance D from pipe to top pipe (D=diameter of pipe)
Box culverts and culvert wing and	H/3 wide for full height	Hand held compaction equipment for full structure height for a



CODE OF PRACTICE - VOLUME TWO - TRAIN SYSTEM [CP2] TRANSADELAIDE INFRASTRUCTURE SERVICES		
PART 9: FORMATION AND EARTHWORKS		DOC. NO. CP-TS-959
Issue: 2	Date: 26/09/08	Page: 13 of 18

retaining walls		distance of 2/3 H (H=overall height of structure)
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2.5.8 Tolerances For Earthworks

2.5.8.1 Vertical Tolerances

In Embankments

Top of structural zone: +0 to -50mm

Top of general fill zone: +40 to -40mm

In Cuttings

Other than rock

Floor of cut (top of common earthworks): +40 to -40mm

Top of structural Zone (Refer Clause 5): +0 to -50mm

Rock

Floor of cut (top of common earthworks): +0 to -80mm

At Transitions between cut and fill

Floor of cut to fill transition +0 to -50mm

Top of benches and berms

Top of benches and berms +50 to -50mm

Formation Crossfall

The constructed formation crossfall shall not be flatter than 1 in 40, or be flatter by more than one tenth of the design crossfall, whichever is steeper.

Table 2.6: Absolute minimum as-constructed crossfall

Design Crossfall	As-Constructed Crossfall Absolute Minimum
1 in 25	1 in 27.5
1 in 30	1 in 33
1 in 40	1 in 40

Formation capping material

Refer to section 2.5.9.3

2.5.8.2 Horizontal Tolerances

Base width, width to top of cuts and bottom of fills, widths of benches and berms – not to be less than designed.

Maximum positive tolerance 300mm, unless otherwise agreed.



CODE OF PRACTICE - VOLUME TWO - TRAIN SYSTEM [CP2] TRANSADELAIDE INFRASTRUCTURE SERVICES		
PART 9: FORMATION AND EARTHWORKS		DOC. NO. CP-TS-959
Issue: 2	Date: 26/09/08	Page: 14 of 18

2.5.9 Capping Material

2.5.9.1 Preparation for Capping

The earthworks in embankments shall be placed and compacted to a level 30mm above the base of the capping layer. Immediately prior to the placement of the capping, the fill shall be trimmed by grading to the final profile and compacted by a minimum of three passes of a smooth steel drum roller, which has a static mass not less than 10 tonnes.

The finished, rolled surface shall be true to profile to a tolerance of +0 to -40mm, and shall be free of depressions and ruts.

No traffic other than that required to place the capping shall be allowed on the finished surface.

The capping material shall be transported from the source to the work in vehicles which are so constructed that loss of material does not occur. It shall be suitably damp to prevent segregation during transit.

2.5.9.2 Spreading, Placing, Compaction and Trimming of Capping.

The capping layer shall be constructed in layers to a total compacted thickness of 150mm unless otherwise specified. The material shall be spread full width in uniform horizontal layers..

Spreading shall be undertaken by a method which will ensure segregation does not occur, and so as not to rut or disturb the compacted thickness.

Where required for compaction purposes, water shall be added as necessary to achieve optimum moisture content and mixed uniformly with the capping material by approved mechanical means. Compaction shall achieve a minimum density of 95 per cent relative compaction (modified) as determined by AS 1289.5.2.1.

Rock and rock fines shall be distributed throughout each layer so that all voids are filled. The top of the final layer shall be graded and trimmed, and material shall be added and compacted as necessary to produce an even surface.

2.5.9.3 Capping Layer Tolerances

The following tolerances shall apply.

2.5.9.3.1 Width

The width from the design centreline to the finished top of embankment slopes or toe of batters in cuttings shall in no case be less than the dimensions required by the design.

The finished surface of the formation shall be +/- 25mm of the design level and: -

- The difference of the deviations from the correct level for any two points 20 metres apart on the centreline shall not exceed 10mm.
- The deviation from a three (3) metre straight edge laid on the surface parallel to the centreline shall not exceed 10mm.



CODE OF PRACTICE - VOLUME TWO - TRAIN SYSTEM [CP2] TRANSADELAIDE INFRASTRUCTURE SERVICES		
PART 9: FORMATION AND EARTHWORKS		DOC. NO. CP-TS-959
Issue: 2	Date: 26/09/08	Page: 15 of 18

2.5.9.3.2 Transverse Slope

When tested with a three (3) metre straight edge laid perpendicular to the track centre line(s) the deviation from design profile shall not exceed 10mm concavity.

2.5.10 Track Reconstruction

In repairing and upgrading the track formation, the following shall be taken into account when preparing the design:

- Excessively narrow shoulders;
- Retained moisture;
- Ballast settlement; or
- Formation deformation (localized and global)
- Rectification of drainage deficiencies
- Removal and disposal of fouled ballast to the formation level.
- Removal and disposal of failed formation material.
- Provision of Capping Material on the original formation
- Provision of sub-surface drains
- Provision of surface drains
- Repair/rectification of degraded, ineffective, blocked or sagging culverts.

Reference should be made to CP2, Part 8 –Drainage for design of drainage systems.

2.6 DEFINED EVENTS AND SPECIAL LOCATIONS

- a) The defined events for sections of track potentially at high risk of geotechnical failure i.e. geotechnical special locations, shall be determined. Defined events in accordance with CP-TS-953 (Infrastructure management and principles) may include earth movement, rainstorms, thunderstorms, earthquake, blasting, or inundation.
- b) The defined events at geotechnical special locations may be determined and reviewed through detailed investigation in accordance with CP-TS-953 (Infrastructure management and principles) and analysis in accordance with the above manuals and codes. The analysis shall take into account the environmental conditions at the location and documentation relating to unscheduled inspections resulting from previous defined event occurrences.
- c) A register of geotechnical special locations and the defined events requiring actions should be established and maintained.



**CODE OF PRACTICE - VOLUME TWO - TRAIN SYSTEM [CP2]
TRANSADELAIDE INFRASTRUCTURE SERVICES**

PART 9: FORMATION AND EARTHWORKS**DOC. NO. CP-TS-959****Issue: 2****Date: 26/09/08****Page: 16 of 18****3.0 MONITORING AND MAINTENANCE****3.1 SPECIAL LOCATIONS**

Track sections prone to (e.g. with a history of) earthworks instability or vulnerability should be identified and managed as special locations until rectification or earthworks stabilization can be carried out. Detailed inspections may be necessary for this purpose.

3.2 INSPECTION, ASSESSMENT AND MAINTENANCE ACTIONS

Inspection, assessment and maintenance actions of earthworks shall include the specific conditions shown in table 3.1:

Table 3.1: Earthworks inspection, assessment and maintenance actions

Type of inspection	Specific actions or conditions to look for
Scheduled inspections	
Walking inspections	<ul style="list-style-type: none"> a) Identify visually, and report, obvious conditions which may affect, or indicate problems with, earthworks stability as listed in sub-section 3.3. b) Sections of track with suspected defects related to the stability of earthworks should be subject to a general inspection. c) Particular attention should be paid to conditions at special locations d) Intervals between walking inspections shall not exceed 31 days.
General inspections	<ul style="list-style-type: none"> a) Should be of sufficient detail to identify defects and conditions as for walking inspections including changes in condition that may affect their vulnerability to instability; b) To be scheduled at an interval appropriate to each location, dependent on its nature and condition, and other seasonal factors but shall not exceed 12 months. Earthworks protection (including that at geotechnical special locations) shall be inspected prior to the risk season appropriate to the area.
Unscheduled inspections	
Earthworks instability inspections at special locations	<ul style="list-style-type: none"> a) At earthworks nominated as special locations, the onset of a defined event exceeding a specific magnitude, including indications from remote ground movement sensors (where installed), should be subject to unscheduled general earthworks inspection until rectification or stabilizing work can be carried out. Track sections and associated earthworks with a history of instability should be nominated as special locations. b) These inspections should collect information on the physical condition of the earthworks to allow assessment of the stability and the actions to be taken. Detailed inspections may be necessary for this purpose. Operating restrictions may also be appropriate at some special locations prior and during the inspection. c) Records should be maintained showing the history of defined events and the results of unscheduled general earthworks instability inspections at special locations.



CODE OF PRACTICE - VOLUME TWO - TRAIN SYSTEM [CP2] TRANSADELAIDE INFRASTRUCTURE SERVICES		
PART 9: FORMATION AND EARTHWORKS		DOC. NO. CP-TS-959
Issue: 2	Date: 26/09/08	Page: 17 of 18

Table 3.1 (*continued*): Earthworks inspection, assessment and maintenance actions

Type of inspection	Specific actions or conditions to look for
Unscheduled inspections (<i>continued</i>)	
General inspections	<p>a) These inspections should be carried out to confirm the presence of suspected defects identified from walking inspections or in response to a reported movement, instability or failure of earthworks (e.g. by train crews) to allow necessary action to be determined. The condition of the earthworks at the location should be determined in terms of its impact on stability. Sections of track within identified earthworks instability should be nominated as special locations until rectification or earthworks stabilization can be carried out. Detailed inspections may be necessary for this purpose.</p> <p>b) Traffic may need to be restricted until the suspected defect or failure is inspected and the necessary actions assessed.</p>
Assessment, method of assessment, response and maintenance actions	
	<p>a) The integrity of earthworks shall be assessed to verify their capacity to safely perform their required function or determine the necessary actions.</p> <p>b) At special locations where significant changes in condition have been identified, reassessment of the defined event should be carried out.</p> <p>c) During defined or other events requiring inspection, assessments of the condition should be made to determine the actions necessary to maintain safety.</p>

3.3 INDICATORS OF TRACK INSTABILITY

Earthworks defects and conditions (i.e. indicators of a defect) that may affect, or indicate problems with, the stability of earthworks include the following:

- a) indications of recent movement including slippage, slumping, settlement or heaving;
- b) fissures and cracks in formation or earth batters;
- c) rock, earth or other debris falling on or near the track;
- d) loss of track geometry;
- e) track subsidence due to ground movements;
- f) earthwork scour and/or erosion including narrow formation leading to loss of ballast and undercutting of the toe of embankments and cuttings by water or wind;
- g) water seepage from embankments and cuttings;
- h) damage to embankments or cuttings including that caused by construction or vehicle access;
- i) conditions that may cause future slip, scour, slump, settlement including burning off or clearing of steep embankments and cuttings;
- j) any other occurrence likely to impact on the stability of earthworks.



CODE OF PRACTICE - VOLUME TWO - TRAIN SYSTEM [CP2] TRANSADELAIDE INFRASTRUCTURE SERVICES		
PART 9: FORMATION AND EARTHWORKS		DOC. NO. CP-TS-959
Issue: 2	Date: 26/09/08	Page: 18 of 18

4.0 DOCUMENTATION

4.1 REGISTER OF GEOTECHNICAL SPECIAL LOCATIONS

A register of geotechnical special locations and the defined events shall be established and maintained in accordance with QP-IS-501 (Document and Data Control). *REGISTER TO BE PREPARED*

4.2 SCHEDULE OF GEOTECHNICAL STRUCTURES

A schedule of cuttings and embankments shall be established and maintained in accordance with QP-IS-501 (Document and Data Control). *SCHEDULE TO BE PREPARED*

4.3 INSPECTION REPORTS

All inspection reports shall be maintained in accordance with CPRD/PRC/046 Records Management.