APPENDIX Y

Spoil Management Strategy

INLAND RAIL—BORDER TO GOWRIE ENVIRONMENTAL IMPACT STATEMENT

IR_1534

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

Inland Rail Border to Gowrie EIS

Appendix Y – Spoil Management Strategy

Australian Rail Track Corporation

Reference: 3100

Document Number:
2-0001-310-EAP-10-RP-0221

Contents

1 Overview 1

1.1 Purpose and scope 1
1.2 Objectives 1
1.3 Further development 2

2 Spoil production 4

2.1 Spoil reduction 5
2.2 Earthworks material types and classification 5
2.2.1 Suitable material 5
2.2.2 Unsuitable material 7
2.3 Spoil re-use in engineered embankments 8
2.4 Spoil movement 9
2.5 Spoil re-use for rehabilitation and operational landfill purposes 10
2.6 Spoil disposal 11

3 Spoil management 12

3.1 Spoil storage and stockpile management 12
3.2 Spread of fire ant carriers 14
3.3 Weed hygiene 14
3.4 Archaeological potential 15

4 Transport 16

Appendices

Appendix A

ARTC Earthworks Material Specification (ETC-08-03)

Appendix B

Cut material generation and fill quantities

Appendix C

Total cut and total fill along the Project alignment

Figures

Figure 2.1 Decision process for spoil management and material fate
Figure 2.2 Schematic of zoned embankment cross section

Tables

Table 1.1 Spoil management hierarchy
Table 2.1 Summary of bulk earthworks for the Project
Table 2.2 Anticipated re-use potential for natural material encountered within the Project footprint
Table 2.3 Spoil re-use opportunities by material type
Table 2.4 Existing facilities in proximity to the Project that accept excess materials
Table 3.1 Laydown areas nominated for the Project

1 Overview

1.1 Purpose and scope

This Spoil Management Strategy (SMS) has been prepared to guide the decision-making process and intent for the management of spoil generated by the Border to Gowrie section (the Project) of the Inland Rail Program.

The SMS applies to the construction of the 216.2 kilometre (km) rail alignment, in addition to supporting infrastructure such as road works. The document has been written based on the Project in isolation from other adjoining sections of the Inland Rail Program.

This SMS should be read in conjunction with

- The Border to Gowrie Environmental Impact Statement (EIS), particularly the following chapters:
  - Chapter 5: Project description
  - Chapter 6: Sustainability
  - Chapter 8: Land resources
  - Chapter 18: Traffic, transport and access
  - Chapter 20: Waste management
  - Chapter 22: Outline environmental management plan
  - Appendix X: Traffic impact assessment
- ARTC Earthworks Material Specification (ETC-08-03) (refer Appendix A).

1.2 Objectives

This SMS seeks to identify options for the beneficial re-use of spoil, in consideration of social, economic and environmental aspects of the Project. Where practicable, the offsite (i.e. outside of the Project footprint) disposal of spoil will be avoided.

Key objectives of the SMS are to provide measures to manage soil:

- In accordance with *Waste Reduction and Recycling Act 2011* (Qld) (WWR Act) hierarchy
- In accordance with identified sustainability initiatives for the Project, consistent with the Inland Rail Environment and Sustainability Policy
- In a manner that minimises impacts on construction and operation activities and timing, as well as controlling costs.

The WRR Act provides a strategic framework for managing wastes by establishing a waste and resource management hierarchy, as follows:

1. Avoid or reduce
2. Re-use
3. Recycle
4. Recover energy
5. Treat
6. Dispose.

Table 1.1 details the fate options for spoil generated by the Project. The fate options are presented in order of preference.

For the purposes of this SMS, the generation, management, movement and use of spoil material has been considered for the Project in isolation of adjoining projects in the Inland Rail Program. In practical terms, this is unlikely to be the case and this SMS encourages the identification of opportunities to minimise wastage through the sharing of spoil between projects in the Inland Rail Program.

Table 1.1 Spoil management hierarchy

Rank	Options	Example
1	Avoid and reduce spoil	Reduce the amount of spoil generated by the Project by ensuring cuts are only to the extent required for safe and effective construction of the Project
2	Re-use within the rail corridor (with or without treatment)	Re-use within the Project footprint, subject to the material complying with the ARTC Earthworks Material Specification (refer Appendix A), to establish formation, fill embankments and mounds within short haulage distance of the source location.
3	Re-use for environmental works and land restoration (with or without treatment)	Re-use for environmental works, subject to the material complying with the required specifications intended for its purpose. Examples include: ■ Re-use in the rehabilitation of native vegetation ■ Re-use in flood mitigation works, e.g. modification of the Yelarbon levee ■ Re-use for land reinstatement, e.g. the end-of-use closure of borrow pits used by the Project or the reinstatement of laydown facilities ■ Re-use as landfill cover (day and intermediate covers) and final capping (where deemed suitable) at licenced facilities within a haulage route distance of 50 km from the Project
4	Re-use on other development (with or without treatment)	Re-use for fill embankments and mounds on projects within a reasonable haulage distance from the source location, subject to the material complying with the required specifications intended for its purpose. Other projects in the Inland Rail Program should be prioritised in the first instance.
5	Dispose offsite as waste	Disposal of excess spoil as waste at an approved facility licenced to receive the material. Offsite disposal to landfill should only occur if the material is considered unsuitable for other uses in this hierarchy, e.g. due to geotechnical, contamination or saturation reasons.

1.3 Further development

This SMS has been developed in response to the Project design as described in Chapter 5: Project description of the EIS. It will be reviewed and updated as the Project progresses through detail design to maintain validity. Such updates will be required in response to:

- Changes to the design and subsequent changes to the volumes of material produced from the works
- Changes or improvements in Project processes, including Project approvals
- Changes in Project scope
- Changes in applicable legislation, policy and guidelines
- Consultation with, and feedback from, landholders, stakeholders and regulators
- Outcomes from further geotechnical testing and site investigations, including for contamination and other problematic materials
- Confirmation of the construction methods and sequencing to be implemented for delivering the Project, including material haulage routes
- Continuous improvement and evaluation of environmental management performance against environmental policies, objectives and targets.

This SMS will require revision through detail design, prior to the commencement of construction, to account for the final quantities of spoil that will be produced through construction of the Project. Once revised, the SMS will be used as a supporting reference for the following:

- Revision of the Traffic Impact Assessment (refer Appendix X: Traffic impact assessment of the Border to Gowrie EIS)
- Development of the Road Use Management Plan. This will be developed in consultation with the Department of Transport and Main Roads (DTMR), emergency services (i.e. Queensland Police Service) and local government authorities.
- Development of the Traffic Management Plan. This will be developed as a joint effort between the Principal Contractor, DTMR, local government authorities and an accredited road safety auditor once preferred construction routes are confirmed.
- Development of the Soil Management Sub-plan, as a component of the Construction Environmental Management Plan (CEMP), to confirm site-specific soil management requirements. The CEMP will be submitted to the Environmental Monitor for the Project, an independent entity approved by the Coordinator-General.

The above-listed documentation will be prepared and finalised prior to the commencement of construction.

2 Spoil production

For the purpose of this SMS, spoil is defined as rock and material other than rock that is generated through earthworks for the Project which is either surplus to requirements or unsuitable for immediate re-use within the Project footprint without treatment.

The hierarchy of spoil management is largely driven by the cut and fill balance. The Project is anticipated to produce approximately 12,525,037 cubic metres (m^3) of cut material during construction, primarily from surface works. Approximately 12,376,132 m^3 of this cut material is estimated to be compliant, from source, with the ARTC Earthworks Material Specification (refer Appendix A) and suitable for immediate re-use as topsoil, general earth fill or structural fill without requiring treatment. This leaves an excess (spoil that is deemed to be unsuitable for use, without treatment) of approximately 148,905 m^3 of spoil to be managed and/or treated with the potential for re-use.

A summary of bulk earthwork quantities for the Project is presented in Table 2.1. A breakdown of the cut and fill volumes for the Project, by chainage, is provided in Appendix B. A graphical representation of the total volumes of cut and fill along the Project alignment is provided in Appendix C.

Table 2.1 Summary of bulk earthworks for the Project

Earthworks	Volume
Cut	
Unusable cut (without treatment)	148,905 m^3
Useable cut (without treatment)	12,376,132 m^3
Total cut	**12,525,037 m^3**
Fill	
General (rail)	9,595,807m^3
Structural (rail)	2,070,678 m^3
Capping (rail)	584,214 m^3
Fill requirement (rail)	**12,250,699 m^3**
Fill requirement (road)	**1,096,670 m^3**
Total fill requirement	**13,347,369 m^3**
Balance	**822,332 m^3 material deficit**

The total fill requirement for the Project (i.e. rail, road and supporting infrastructure) based on the reference design is 13,347,369 m^3. If all unusable cut material is able to be treated for re-use, then the total material deficit for the Project will be 822,332 m^3. However, this deficit may be up to 971,237 m^3 depending on the feasibility and success of material treatment options.

Where practicable, spoil will be re-used within the Project footprint through treatment, amelioration or drying. Offsite re-use options may also be considered subject to compliance with a current End of Waste code under the WWR Act. Material that cannot be treated for appropriate re-use may be disposed off-site. Off-site disposal to landfill will only occur if the material is considered unsuitable for other uses, e.g. due to geotechnical, contamination or saturation reasons.

The spoil management and material fate decision process is summarised in Figure 2.1.

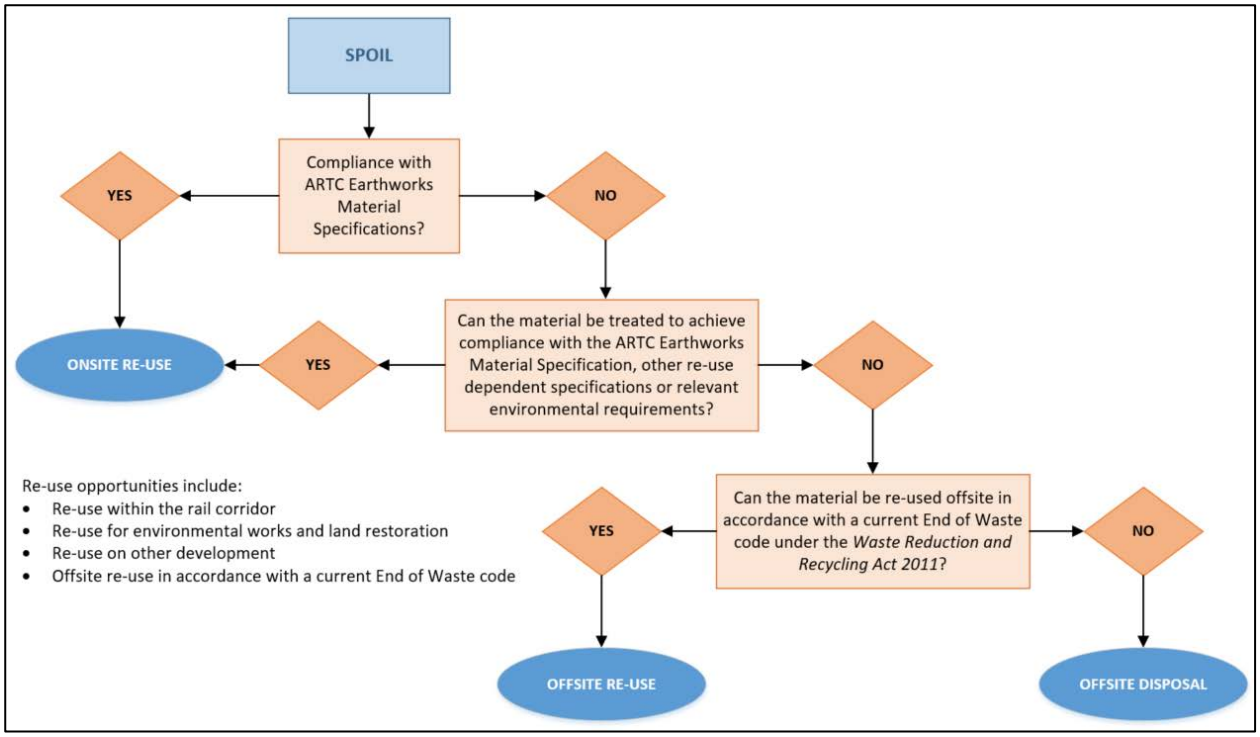


Figure 2.1 **Decision process for spoil management and material fate**

2.1 Spoil reduction

The quantity of spoil to be generated by the Project has been reduced through development of the reference design to achieve as close to a net balance in earthworks as is practicable. For the most part, this has been achieved through:

- Aligning the Project to avoid, where possible, steep terrain and topographical constraints to minimise earthworks and provide for more efficient track geometry and grade
- Considering the shape and size of batters to encourage cut and fill balancing
- Optimising the number, width and depth of cuts to avoid the generation of material that would be considered surplus to Project requirements.

Where practicable, spoil will continue to be reduced during detail design and development of the construction methodology.

2.2 Earthworks material types and classification

The ARTC Earthworks Material Specification (refer Appendix A) describes material types, associated compliance criteria and classification/suitability for use within earthworks for the Inland Rail Program. This section differentiates and summarises suitable and unsuitable material types.

2.2.1 Suitable material

The reference design for the Project is estimated to result in 12,376,132 m^3 of cut material that is expected to be compliant with the ARTC Earthworks Material Specification (refer Appendix A) and therefore be suitable for immediate re-use (without treatment) as topsoil, general earth fill and structural fill for the construction of zoned embankments. The material classes specified in ARTC Earthworks Material Specification are unique to ARTC.

Definitions for each material type are provided in Appendix A. A cross section schematic of a zoned embankment is provided in Figure 2.2.

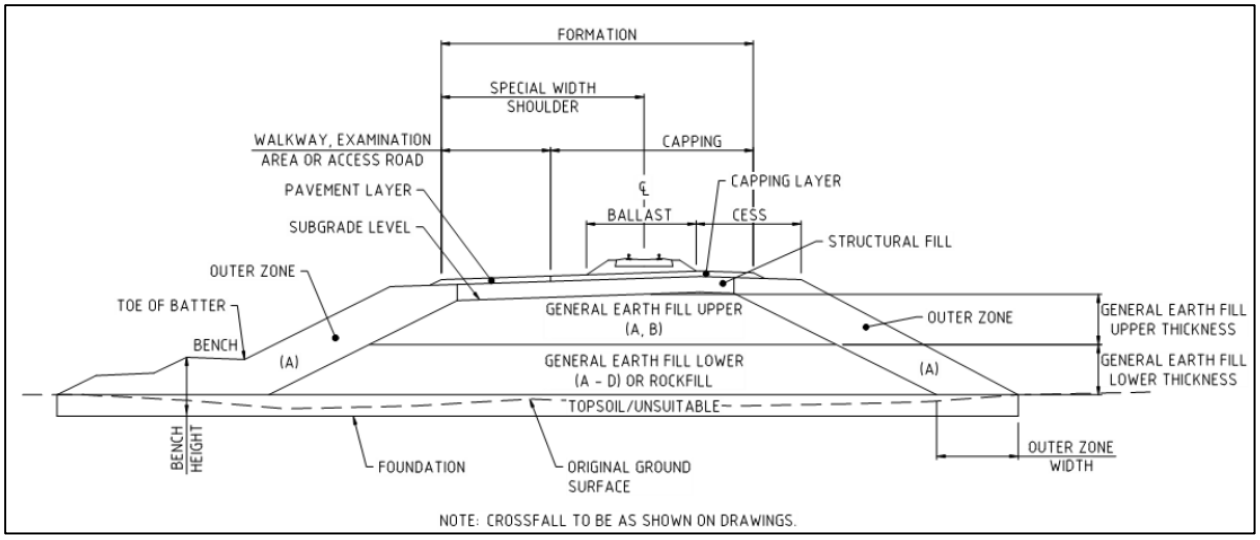


Figure 2.2 Schematic of zoned embankment cross section

The depth of topsoil is variable across the Project footprint. All topsoil from the Project will be stripped and stockpiled for re-use in the staged reinstatement of work fronts.

Where identified in cuttings, material class Type A will be selectively targeted, separated and re-incorporated into the outer part of zoned embankments, where durable and erosion resistant material is required (refer Figure 2.2).

The general earth fill upper zone of embankments must be general earth fill Type A and Type. The lower zone may be general earth fill Type A – D or rock fill in accordance with their respective placement depth criteria (refer Figure 2.2).

In general, Holocene age (Qa), Terrace alluvium (Qs), colluvium (TQr) and residual soils from the Walloon Coal Measures and basalts are expected to be reactive and subject to softening if allowed to become wet. These soils are likely to only be suitable for re-use as Type C and D material within zoned embankment construction (refer Appendix A and Figure 2.2). A summary of re-use potential for materials present within the Project footprint is shown in Table 2.2.

Table 2.2 Anticipated re-use potential for natural material encountered within the Project footprint

Geology	Lithology	Typical material re-use potential based on available laboratory test data[1]	
The Marburg subgroup rocks - Jmb	Weathered sandstone interbedded with siltstone and mudstone	Residual to extremely weathered	Type B – D
		Highly weathered or better	Bulk, select, structural fill, Type A/B
Walloon Coal Measures rocks - Jw	Deeply weathered and locally lateritised sandstone, siltstone and mudstone	Type B – D to unsuitable	
Main Range Volcanics - Tm	Basalt, basaltic tuff	Residual	Type B - D
		Extremely weathered or better	Bulk, select, structural fill, Type A/B
Colluvium/Tertiary sediments - TQr>Tm	Colluvium over basalt: clay, gravelly clay, cobbles and boulders and lateritised residual or colluvial deposits	Type C to unsuitable *Potential for bulk/select/structural fill depending on deposit type.	
Active Alluvium – Qa	Clay and Sandy Clay	Type C to unsuitable	
Terrace alluvium - Qs	Sandy Clay and Clay	Type B to unsuitable	

Table note:

1 Material classes specified in ARTC Earthworks Material Specification (refer Appendix A)

2.2.2 Unsuitable material

The Project is estimated to result in the generation of approximately 148,905 m^3 of spoil that is not appropriate for immediate re-use without treatment. The ARTC Earthworks Material Specification (refer Appendix A) classifies unsuitable material (without treatment) based on the following properties:

- **Moisture content:** Based on the natural moisture content, the material may either be too wet or too dry in its current condition to meet the required specifications or consistency.
- **Organic content:** Materials with organic content are typically considered unsuitable due to being highly compressible, degradable and susceptible to collapse.
- **Dispersive:** The material is found to be dispersive and therefore highly prone to erosion and piping. Dispersive materials are typically unsuitable as usage can compromise the structural integrity of the earthworks and lead to long-term maintenance issues. Dispersive materials that can meet Type C/D requirements as per ARTC Earthworks Material Specification may potentially be incorporated into the core of an embankment.
- **Compaction requirements:** Material is unable to be re-compacted to achieve the minimum compaction requirements – nominally 95 per cent Relative Dry Density (RDD).
- **Reactivity:** Highly reactive materials with significant shrink-swell characteristics that may lead to movement within the fill. There is no soil ameliorant available for shrink/swell soils, instead, engineering solutions are required. Reactive materials that can meet Type C/D fill requirements as per ARTC Earthworks Material Specification may potentially be incorporated into the core of a zoned embankment.
- **Contamination:** Contaminants may be present in spoil material due to a number of factors including historical land use and activities. Contamination will not always be present at a concentration that presents a risk of harm through exposure to receptors, including workers. Based on the land uses within the Project footprint and the findings of initial desktop assessment, potential sources of contamination in the vicinity of the Project are considered to include:
  - Agricultural activities: hydrocarbons (fuel and oil storage and use), pesticides and herbicides, asbestos and lead paint, arsenic (cattle dips), landfilling
  - Quarries: hydrocarbons (fuel and oil storage and use), metals/metalloids, hazardous materials
  - Landfilling, waste disposal: hazardous materials, hydrocarbons, metals/metalloids, phenols, polychlorinated biphenyls, phthalates, volatiles and pesticides and herbicides
  - Existing rail corridor: metals, asbestos, hydrocarbons, pesticides/herbicides
  - Road crossings: metals and hydrocarbons
  - Unknown fill material: asbestos, metals/metalloids, hydrocarbons
- **Oversize materials:** Blasted or ripped rock with particles larger than 150 millimetres (mm) are typically excluded from earthworks, as they cannot be adequately compacted. The oversize material can be considered for use as rock fill or rip-rap.

Materials will be tested in accordance with AS 1289 - Methods of testing soil for engineering purposes and AS 4133 - Methods of testing rocks for engineering purposes. All materials with one or a combination of the above characteristics may be specified as ‘unsuitable’ without treatment. Geotechnically unsuitable materials are expected to occur within gullies and flat alluvial plains, as colluvium at the toe of hills and residual soils developed on sedimentary or basaltic rocks.

For the Project, unsuitable soils will predominantly include material from alluvium, residual soils from the Walloon Coal Measures and residual soils of the basalts or colluvium.

Section 11.161 of the Terms of Reference for the Border to Gowrie Project requires the quantity, and physical and chemical characteristics of waste rock to be described. In the context of this Project, the term “waste rock” describes a waste material. All rock generated through excavation works for the Project is expected to have a re-use value within the Project footprint. Therefore, rock is not regarded as a waste material for the Project.

2.3 Spoil re-use in engineered embankments

Table 2.3 details what are traditionally the most robust and technically feasible approaches to the treatment of unsuitable material to enable re-use. These opportunities will require further assessment during the detail design phase to define whether they are technically feasible and cost effective for the Project. Quantities of spoil material re-used by the Project will be recorded in order to track performance against sustainability targets.

Table 2.3 Spoil re-use opportunities by material type

Types of material	Reference design solution	Opportunity
Topsoil	The depth of topsoil is variable across the Project footprint. All topsoil is to be stripped and stockpiled for re-use in the staged reinstatement of work fronts. Dispersive topsoil is to be ameliorated to ensure suitability for re-use.	Further agronomic soils testing to be undertaken to confirm the suitability of soil chemistry for native plant growth and ameliorant requirements. Earthworks are to be balanced based on expected volumes of topsoil generated along the alignment.
Dispersive and Type B/C/D material recovered from cuttings	Assume that all this material can be incorporated into a zoned embankments, as per ARTC Earthworks Material Specification and Figure 2.2.	Further investigation and earthworks balancing between areas of cut and fill. Lime is a useful soil ameliorant for acidic soils; gypsum most useful for sodic soils. Soil that is to be stockpiled for later use is to be analysed to ensure material with high sodic subsoils can be appropriately treated, depending on where it is to be subsequently located. Further trials to determine if lime amelioration of Type B/C/D material can be adopted in the outer zone of the embankment in lieu of Type A (non-dispersive material). Similarly, amelioration in lieu of adopting Type B and C (low plasticity general fill) material is to be explored.
Potentially contaminated material	Extent and type of contamination has not been defined by geotechnical and soil investigations for the reference design. It is assumed that contaminated material, where encountered, can be treated, incorporated and/or encapsulated within existing earthworks.	Further investigations to determine the location and extent of contamination is required. Sampling, testing and compliance of materials will be undertaken in accordance with the appropriate contamination methods and criteria, e.g. National Environment Protection (Assessment of Site Contamination) Measure 1999 guidelines. Where appropriate, the feasibility of encapsulating contaminated material within zoned embankments will be investigated.
Acid sulfate soils	Initial assessment through reference to the Australian Soil Resource Information System indicates that acid sulfate soil is unlikely to be encountered within the Project footprint. Therefore acid sulfate soil has not been factored into the reference design. If encountered, soils can typically be treated with an amount of neutralising agent that will counter their existing plus potential acidity.	Not applicable
Acid sulfate rock	Initial assessment of available petrographic reports and the geological history of the rocks that occur within the Project footprint indicates that acid rock drainage is unlikely to be encountered. Therefore acid sulfate rock has not been factored into the reference design.	Not applicable

Types of material	Reference design solution	Opportunity
Structurally unsuitable material	Material that does not meet the requirements of ARTC Earthworks Material Specification for structural purposes will, where possible, be ameliorated on site for re-use back into Project earthworks.	Establish treatment pads within laydown areas in proximity to where unsuitable materials are likely to be encountered e.g. overly wet soils recovered from low floodplain areas are to be dried or ameliorated before being incorporated back into the works as general earth fill.

In addition to the material-specific treatment and re-use opportunities listed in Table 2.3, the following conceptual opportunities have been identified for the re-use of excess cut:

- Use excess rock material for scour protection at bridge and culverts, if suitable
- Use excess material for construction of temporary works, such as access roads, laydown areas etc.
- Construction of the rail maintenance access road at rail formation level
- Extension of the rail formation for future passing loops
- Supply of excess material to other developments near the Project for use as fill
- Supply of material to local waste facilities for use as daily cover
- Rehabilitate borrow sites.

A detailed mass haul assessment will be carried out during the detail design phase of the Project to assess the need for and viability of these opportunities.

2.4 Spoil movement

A preliminary assessment of spoil movement to, from and within the Project footprint has been summarised below. For the purpose of this preliminary spoil movement planning, earthwork quantities have been rounded to the closest thousand cubic metre.

The preliminary estimate of spoil movement requirements for each section of the Project is as follows:

- **Area 1:** Ch 30.6 km to Ch 39.9 (NS2B):
  - 312,000 m^3 import general fill (from borrow sites)
  - 56,000 m^3 import structural fill (from borrow sites)
- **Area 2:** Ch 0.0 km to Ch 40.0 km:
  - 32,000 m^3 cut to fill
  - 81,000 m^3 import general fill from Area 3 (Ch 40.0 km to 73.1 km)
  - 19,000 m^3 cut to spoil (unsuitable material, unless treated)
  - 441,000 m^3 import structural fill (from borrow sites)
- **Area 3:** Ch 40.0 km to 73.1 km:
  - 199,4000 m^3 cut to fill
  - 81,000 m^3 cut to fill to Area 2 (Ch 0.0 km to Ch 40.0 km)
  - 475,000 m^3 cut to fill to Area 4 (Ch 73.1 km to Ch 100.0 km)
  - 825,000 m^3 cut to spoil (unsuitable material, unless treated)
  - 299,000 m^3 import structural fill (from borrow sites)

- **Area 4:** Ch 73.1 km to Ch 100.0 km:
  - 276,000 m^3 cut to fill
  - 475,000 m^3 import general fill from Area 3 (Ch 40.0 km to Ch 73.1 km)
  - 36,000 m^3 cut to spoil
  - 304,000 m^3 cut/import to structural fill (from borrow sites)
- **Area 5:** Ch 100.0 km to Ch 148.8 km:
  - 1,025,000 m^3 cut to fill
  - 1,230,000 m^3 cut to spoil (unsuitable material, unless treated)
  - 451,000 m^3 import structural fill from Area 6 (cutting at Ch 160.0 km to Ch 184.0 km)
- **Area 6:** Ch 148.0 km to Ch 184.0 km:
  - 1,903,000 m^3 cut to fill
  - 361,000 m^3 cut to fill (rock)
  - 922,000 m^3 cut to fill to Area 8 (Ch 203.0 km to Ch 207.0 km)
  - 71,000 m^3 cut to spoil (unsuitable material, unless treated)
  - 322,000 m^3 cut to structural fill from Area 6 (cutting at Ch 160.0 km to Ch 184.0 km approx.)
- **Area 7:** Ch 184.0 km to Ch 203.0 km:
  - 2,032,000 m^3 cut to fill
  - 240,000 m^3 cut to fill (rock)
  - 66,000 m^3 cut to fill to Area 8 (Ch 203.0 km to Ch 207.0 km)
  - 40,000 m^3 cut to structural fill to Area 8 (Ch 203.0 km to Ch 207.0 km)
  - 168,000 m^3 cut to structural fill
- **Area 8:** Ch 203.0 km to Ch 207.0 km:
  - 922,000 m^3 import general fill from Area 6 (Ch 148.0 km to Ch 184.0 km)
  - 66,000 m^3 import general fill from Area 7 (Ch 184.0 km to Ch 203.0 km)
  - 40,000 m^3 import structural fill from Area 7 (Ch 184.0 km to Ch 203.0 km).

A detailed assessment of spoil movement will form part of the mass haul assessment which will be carried out in the detail design phase of the Project to assess need for and viability of opportunities for spoil re-use.

2.5 Spoil re-use for rehabilitation and operational landfill purposes

The Project will seek to optimise the amount of material that can be beneficially used within the Project footprint, thereby minimising the volume of excess spoil produced. Once material re-use opportunities within the Project footprint have been exhausted, the Project will seek to beneficially re-use spoil material for rehabilitation of borrow sites in proximity to the Project. The use of Project won materials for this purpose will be contingent on further discussions and negotiations with relevant landholders.

In addition to the above, Project won material may be re-used for operational landfill purposes. Potential localities for the beneficial re-use of material from the Project are identified in Table 2.4. These waste management facilities may accept clean fill for use as day and intermediate covers and/or final capping (where deemed suitable) and therefore could be considered a material re-use opportunity. Clean fill is defined as naturally occurring material that does not contain contaminants above adopted threshold levels, e.g. those published in the National Environment Protection (Assessment of Site Contamination) Measure 2013 guidelines.

The beneficial re-use of spoil for this purpose will require further negotiation and consultation with operators and will be informed by:

- Detailed design of the Project
- Final earthworks optimisation
- Detailed characterisation of the material
- Earthworks sequencing, staging and logistics
- End user requirements
- Commercial negotiations.

Table 2.4 Existing facilities in proximity to the Project that accept excess materials

Facility	Type	Operator	Contact details
Toowoomba Waste Management Centre	Landfill and transfer station	Toowoomba Regional Council	155-175 Hermitage Road, Cranley QLD (07) 13 18 72
Goondiwindi Transfer Facility and Landfill	Landfill and transfer station	Goondiwindi Regional Council (Proterra Group)	Rubbish Tip Road, Goondiwindi QLD (07) 4671 7400
Inglewood Landfill	Landfill	Goondiwindi Regional Council (Proterra Group)	Inglewood-Texas Road, Inglewood QLD (07) 4671 7440
Yelarbon Landfill	Landfill	Goondiwindi Regional Council (Proterra Group)	East of Sawmill Road, Yelarbon QLD (07) 4671 7440

2.6 Spoil disposal

Spoil disposal is considered to be the least beneficial option and will only be considered where material cannot be treated or otherwise re-used. The disposal of spoil material to licensed facilities is costly due to transportation and landfill costs; however, it should be noted that the Waste Reduction and Recycling Regulation 2011 prescribes certain waste streams (including clean soil) as exempt from landfill levy payment.

During detail design and construction, the Project will seek to re-use as much material as possible in accordance with the hierarchy of spoil management options specified in Table 1.1. Existing waste management facilities in proximity to the Project that have potential to accept waste from commercial operations are detailed in Table 2.4.

These facilities may also accept clean soil materials for use as day and intermediate covers and/or capping soils (if deemed suitable) and therefore could be considered a material re-use opportunity (refer Section 2.5). However, such acceptance is likely to attract a landfill gate fee.

3 Spoil management

3.1 Spoil storage and stockpile management

In the first instance, excess spoil will be directly transported to a point of re-use to avoid stockpiling and double handling. In the event that immediate transport is not possible, the material will be stockpiled along the right of way established for construction of the Project or within designated laydown areas. Stockpiles will be located as close as possible to the source of the excavated material or its intended destination and will be stockpiled by separable material type. Soil that is to be stockpiled for later use is to be analysed to ensure material with high sodic subsoils can be appropriately treated, depending on where it is to be subsequently located.

Several laydown areas have been identified along the length of the Project footprint and are listed in Table 3.1. These laydown areas are situated next to the rail corridor to facilitate direct access to/from the laydown to the rail corridor. The laydown areas have various primary functions, such as for the storage of plant and materials, establishment of site offices or as an area to be used in support of constructing structures, such as bridges. Regardless of primary function, laydown areas have potential to be used for the temporary stockpiling of spoil, if required.

Table 3.1 Laydown areas nominated for the Project

ID[1]	Location	Chainage (km)	Size (m^2)
NS2B-LDN031.0	Kildonan Road	31.0	184,000
NS2B-LDN032.5	Kildonan Road	32.5	160,000
NS2B-LDN033.2	Kildonan Road	33.2	7,000
NS2B-LDN035.6	Eukabilla Road	35.6	87,000
B2G-LDN000.9	Georges Road (extension)	0.9	126,000
B2G-LDN006.3	Yelarbon-Kurumbul Road	6.3	10,000
B2G-LDN016.0	Yelarbon-Kurumbul Road	16.0	26,000
B2G-LDN020.3	Yelarbon-Kurumbul Road	20.3	8,000
B2G-LDN025.9	Yelarbon (south)	25.9	21,000
B2G-LDN025.9	Yelarbon (north)	25.9	11,000
B2G-LDN030.0	Suttons Road	30.0	11,000
B2G-LDN037.6	Springborg Road	37.6	12,000
B2G-FBW045.0	Whetstone Access Road - South	45.0	125,000
B2G-LDN045.5	Whetstone Access Road - North	45.5	18,000
B2G-LDN050.1	McDougalls Crossing Road	50.1	32,000
B2G-LDN052.8	Cremascos Road	52.8	11,000
B2G-LDN054.2	Cremascos Road	54.2	54,000
B2G-LDN055.4	Cremascos Road	55.4	12,000
B2G-LDN060.4	Bybera Road	60.4	27,000
B2G-LDN065.8	Lovells Crossing Road	65.8	25,000
B2G-LDN067.6	Thornton Road	67.6	10,000
B2G-LDN069.0	Thornton Road	69.0	100,000
B2G-LDN073.0	Millmerran-Inglewood Road	73.0	10,000
B2G-LDN074.0	Millmerran-Inglewood Road	74.0	147,000
B2G-LDN081.0	Millmerran-Inglewood Road	81.0	27,000
B2G-LDN088.4	Cattle Creek	88.4	10,000

ID[1]	Location	Chainage (km)	Size (m^2)
B2G-LDN091.8	Millmerran-Inglewood Road	91.8	15,500
B2G-LDN093.8	Millmerran-Inglewood Road	93.8	12,800
B2G-LDN098.0	Millmerran-Inglewood Road	98.0	30,500
B2G-LDN100.6	Millmerran-Inglewood Road	100.6	3,500
B2G-LDN104.5	Nicol Creek	104.5	25,800
B2G-LDN112.1	Koorongara-Bull Creek Road	112.1	26,000
B2G-LDN115.6	Millmerran-Inglewood Road	115.6	14,000
B2G-LDN116.5	Millmerran-Inglewood Road	116.5	109,000
B2G-LDN120.2	Blackwell Road	120.2	90,000
B2G-LDN127.0	Millmerran-Inglewood Road	127.0	10,000
B2G-LDN127.8	Millmerran-Inglewood Road	127.8	10,000
B2G-LDN129.8	Owens Scrub Road	129.8	10,300
B2G-LDN133.5	Pfeffers-Lindenmeyers Road	133.5	26,000
B2G-LDN137.0	Yandilla	137.0	145,000
B2G-LDN138.5	Grasstree Creek Bridge	138.5	44,600
B2G-LDN140.2	Condamine River	140.2	76,000
B2G-LDN141.3	Condamine River Bridge	141.3	12,000
B2G-LDN143.0	Condamine River Main Branch #1 Rail Bridge	143.0	12,000
B2G-LDN144.6	Condamine River Main Branch #2 Rail Bridge	144.6	142,500
B2G-LDN147.1	Fysh Road	147.1	5,000
B2G-LDN149.0	Condamine River Bridge (North Branch)	149.0	45,400
B2G-LDN150.5	Dieckmann Road	150.5	129,000
B2G-LDN150.9	Gore Highway	150.9	5,000
B2G-LDN153.1	Gore Highway	153.1	90,600
B2G-LDN161.0	Pittsworth-Tummaville Road	161.0	65,500
B2G-LDN163.3	Roche Road	163.3	5,300
B2G-LDN164.3	Murlaggan Road	164.3	24,600
B2G-LDN165.6	Kahler Road	165.6	8,300
B2G-LDN169.6	Gore Highway	169.6	30,000
B2G-LDN171.0	Pittsworth	171.0	6,800
B2G-LDN172.0	Gore Highway	172.0	15,400
B2G-LDN172.6	Lochaber Road	172.6	27,000
B2G-LDN173.5	Gore Highway	173.5	17,000
B2G-LDN175.5	Linthorpe Road Bridge	175.5	72,000
B2G-LDN179.0	Linthrope Valley Road	179.0	22,000
B2G-LDN183.0	Bushy Lane	183.0	19,000
B2G-LDN183.8	Southbrook Rockview Road	183.8	15,000
B2G-LDN185.0	Gore Highway	185.0	32,000
B2G-LDN188.2	Athol School Road	188.2	81,000
B2G-LDN192.3	Off Berghofer Road	192.3	30,400
B2G-LDN196.2	Toowoomba-Cecil Plains Road	196.2	4,000
B2G-LDN197.0	Westbrook Creek	197.0	4,300

ID[1]	Location	Chainage (km)	Size (m^2)
B2G-LDN198.1	Dry Creek	198.1	4,000
B2G-LDN198.7	Brimblecombe Road	198.7	2,500
B2G-LDN203.0	Warrego Hwy	203.0	4,100
B2G-LDN204.2	Chamberlain Road	204.2	38,000
B2G-LDN206.3	Leesons Road	206.3	30,000
B2G-LDN206.9	Draper Road	206.9	80,500

Stockpile sites for spoil material will be established and managed in accordance with the following criteria:

- Located within the approved Project footprint
- Located a minimum of 50 m from areas of concentrated water flow and first order watercourses
- Located on level land above flood areas, unless measures are implemented to manage flooding
- Located to minimise the need for heavy vehicles to travel on the public road network and through residential areas
- Positioned in areas to minimise impacts on sensitive receptors (i.e. visual, air and noise impacts)
- Located on land to minimise impacts on threatened species or important habitat (other than that already permitted for the Project)
- Located on land to minimise impacts on heritage sites (other than that already permitted for the Project)
- Spoil materials will not be stockpiled within the tree protection zone of trees or native vegetation to be retained
- Contaminated materials will be separated, stockpiled and bunded or contained, in accordance with the Soil Management Sub-plan
- Erosion and sediment controls will be implemented, operated and maintained in accordance with a Soil Management Sub-plan
- Watering, vegetation or cover of long-term stockpiles to reduce the likelihood of erosional loss of materials.

3.2 Spread of fire ant carriers

Under the *Biosecurity Act 2014* (Qld) (Biosecurity Act), ARTC has a general biosecurity obligation to take all reasonable steps to ensure the spread of fire ant carriers does not occur. The Project is not located within a fire ant biosecurity zone. However, materials delivered to site may originate from a fire ant biosecurity zone.

3.3 Weed hygiene

Activities associated with the management of spoil may provide pathways for the spread of weed species. The Biosecurity Act mandates a general biosecurity obligation to prevent or minimise the risks of transferring weed species.

The following measures will be implemented through the CEMP for the Project:

- Identify major weed species in the area through pre-construction surveys and consultation with local government authority Pest Management Officers, local bush care groups and supporting landholders
- Ensure that weed impacted topsoil is not re-used in rehabilitation works, unless it is treated and sterilised in an appropriate manner
- Use designed access tracks for transportation of spoil material and avoid weed impacted areas, where practicable

- Clean equipment such as boots, vehicles, plant and machinery when leaving weed impacted areas
- Implement weed hygiene protocols and washdown procedures for construction vehicles
- Dispose of weed material in appropriate waste receptacles within designated locations.

Chapter 11: Flora and fauna further details mitigation measures for the prevention of the spread of weed species from the Project.

3.4 Archaeological potential

ARTC has completed early engagement with registered Aboriginal Parties in the establishment of approved Cultural Heritage Management Plans for the Project, in accordance with the *Aboriginal Cultural Heritage Act 2003*.

The requirements of the Cultural Heritage Management Plans will be implemented and adhered to for the duration of the Project. Stop work procedures, in response to chance finds, will also be incorporated into the CEMP.

4 Transport

The construction program will generally be based on the following worksite hours:

- General construction activities:
  - Monday to Friday – 6.30 am to 6.00 pm
  - Saturday – 6.30 am to 1.00 pm
  - No work planned on Sundays or public holidays
- Track possessions may occur on a 7 day/24 hour calendar basis, subject to agreement with Queensland Rail.

Track possession of Queensland Rail assets will generally be allocated over weekend periods, with extended track possession occurring over holiday periods.

There may be circumstances where work outside the above standard hours, including night works, will be required, for example, the delivery of materials. Work outside standard hours will only be undertaken where consultation with the local community has been undertaken.

Access roads will be required along the rail corridor to allow unhindered access for all construction and support traffic vehicles. During construction materials will be delivered and stockpiled/stored in designated construction laydown areas. Access roads to the rail corridor will be designed and constructed, or upgraded if existing tracks are to be used, with appropriate consideration to minimising disruption to landholders and public infrastructure. Access roads to the rail corridor will require restoration once the construction work has been completed, unless agreed otherwise with the relevant landholders.

There is no foreseeable need for material to be transported across the New South Wales-Queensland border.

Spoil material haulage routes for the Project are identified in Chapter 18: Traffic, Transport and Access of the NSW/QLD Border to Gowrie EIS.

APPENDIX Y

Spoil Management Strategy

Appendix A ARTC Earthworks Material Specification (ETC-08-03)

IR_1534

ARTC

Division / Business Unit: Inland Rail
Function: Earthworks (Construction)
Document Type: Specification

Earthworks Materials Specification

ETC-08-03

Applicability

NSW	QLD	VIC	SMS

Publication Requirement

Internal / External

Primary Source

0-9000-PEN-00-SP-1002 – Rev 2.1

Document Status

Version #	Date Reviewed	Prepared by	Reviewed by	Endorsed	Approved
1.3	08 Jul 20	Inland Rail & Technical Standards	Stakeholders	Manager Standards	General Manager Technical Standards 24/07/2020

Amendment Record

Amendment Version #	Date Reviewed	Clause	Description of Amendment
1.0	12 May 17		First Issue
1.1	23 Nov 17	All	Revision to align with issue of ETC-08-04. Addition of section for geotextile classification and compliance. Additional update to scope following ONRSR comments, as well as clauses 4.1, 4.7 & 4.11.
1.2	25 Sep 19	1.5	Add Procedure Owner section and remove ‘Confidential’ from title page.
1.3	08 Jul 20	All	Minor revision of Sections 1–7. Addition of section for geogrid classification and compliance. Added Earthworks Materials Management Framework to Section 4.1 and flowchart to Appendix B.

Table of Contents

1 Scope and Purpose 5
1.1 Purpose 5
1.2 Scope 5
1.3 Precedence 5
1.4 Project Documents 5
1.5 Document Owner 6
2 Definitions 7
3 Codes and Standards 15
4 Earthworks Materials 17
4.1 General 17
4.2 Capping Material 17
4.3 Structural Fill Material 19
4.4 General Earth Fill Material 20
4.5 Select Fill Adjacent to Structures 21
4.6 Bedding Sand 22
4.7 Rock Fill 22
4.8 Rock Protection 23
4.9 Drainage Blanket Material 23
4.10 Other Drainage Materials 24
4.11 Unsuitable Material 24
4.11.1 General 24
4.11.2 Inherently Unsuitable 24
4.11.3 Unsuitable Materials by Virtue of Position 25
4.11.4 Unsuitable by Moisture Content 25
4.12 Stabilised Material 25
5 Geosynthetics 26
5.1 General 26
5.2 Geotextiles 26
5.2.1 General 26
5.2.2 Strength Class 27
5.2.3 Filtration Class 27
5.3 Geogrids 28

5.3.1 General 28
5.3.2 Uniaxial/Biaxial Geogrid 29
5.3.3 Multiaxial Geogrid 30
6 Quality Plan 31
6.1 Contractor's Project Quality Plan 31
7 Variations 32
7.1 Variation to Material Tests, Methods and Compliance Criteria 32
7.2 Variation of Testing Frequencies 32
7.3 Alternative Test Methods 32
Appendix A – Specification Variation Compliance Forms 33
A1. Variance to Material Specification and Compliance 33
A2. Variance to Formation Geometry Specific Design Requirements 40
A3. Variance to Cutting Geometry Project Specific Design Requirements 41
Appendix B – Earthworks Materials Management Framework 42

List of Figures

Figure 1 Schematic of Homogeneous Embankment Cross Section 13
Figure 2 Schematic of Zoned Embankment Cross Section 13
Figure 3 Schematic of Cutting Cross Section 14
Figure 4 Schematic of Formation and Track 14

List of Tables

Table 1 Contractual Definitions 7
Table 2 Railway Earthworks Definitions 8
Table 3 Abbreviations 11
Table 4 Capping Material Requirements 18
Table 5 Structural Fill Material Requirements 19
Table 6 General Earth Fill Material Requirements 20
Table 7 Select Fill Material Requirements 21
Table 8 Bedding Sand Material Requirements 22
Table 9 Rock Fill Material Requirements 23
Table 10 Drainage Blanket Material Requirements 24
Table 11 Geotextile Strength Classifications 27
Table 12 Geotextile Filtration Classifications 28
Table 13 Geogrid Class Applications 29
Table 14 Uniaxial/biaxial Geogrid Classification 30
Table 15 Multiaxial Geogrid Classification 30
Table 16 Capping Material Variance 33
Table 17 Structural Fill Material Variance 34
Table 18 General Earth Fill Material Variance 35
Table 19 Select Fill Material Variance 36
Table 20 Bedding Sand Material Variance 37
Table 21 Rock Fill Material Variance 38
Table 22 Drainage Blanket Material Variance 39
Table 23 Design Specific Formation and Shoulder Geometry Requirements 40
Table 24 Design Specific Cutting Geometry Requirements 41

1 Scope and Purpose

1.1 Purpose

The purpose of this Specification is to provide earthworks material types and compliance requirements. Complying earthworks materials shall be used to construct a stable foundation and formation suitable for ballast and track to be constructed upon, along with associated earthworks for drainage elements, such that it maintains stability and meets safety and performance standards over the design life.

1.2 Scope

This Specification defines earthworks material properties for construction of railway earthworks for the Inland Rail Program (the Program).

This Specification is intended to be tailored to suit the materials available within the Program. The design information and values provided in the following sections are deemed to comply. Variation to this Specification requirements must be in accordance with Section 7. The proposed values must be consistent with design requirements and acceptance of the proposed values is at the sole discretion of the Superintendent.

This Specification allows for unconventional alternative engineered materials, such as use of stabilised materials, geosynthetics or other solutions. Proposals for use of alternative engineered materials and their compliance requirements must be in accordance with Section 7 and subject to appropriate ARTC review and acceptance. If an alternative material specification is accepted, material properties and other relevant information must be documented in a Project Specific Specification and on drawings approved by the Superintendent.

1.3 Precedence

The following order of precedence shall be adopted when undertaking construction of earthworks which form part of the Works:

1. the Drawings;
2. Project Specific Specifications;
3. this Specification;
4. ARTC standard drawings;
5. Australian Standard requirements, regulations and industry guidelines.

Where there is a discrepancy, the Contractor must request clarification in writing from the Superintendent prior to proceeding with the works containing the discrepancy.

1.4 Project Documents

The execution of earthworks in accordance with this Specification requires compliance to overarching Project and Program requirements. The Contractor’s attention is drawn to the following documents:

- The Project General Conditions of Contract.
- The Project Environmental Management Plan.
- The Project Primary Approval Document and Conditions of Approval.
- The Project Quality Plan.

1.5 Document Owner

The Manager Standards is the document owner and is the initial point of contact for all queries relating to this Specification.

2 Definitions

Unless defined otherwise in the relevant Contract, terms used in this Specification will have the following meanings assigned in Table 1 to Table 3 and Figure 1 to Figure 4.

Table 1 Contractual Definitions

Term	Definition
Approve(d)	Means approved in writing by the Superintendent.
Contract	Commercial document entered into between the Principal and the Contractor detailing the terms of the engagement of the Contractor by the Principal contractually obligated to perform the Works.
Contractor	Any partnership, joint venture, company, corporation, or trust who has entered into a Contract with the Principal to perform the Works prescribed in the Contract.
Designer	The company/individual engaged by the Principal or the Contractor to undertake design.
Design Services Agreement	Means the agreement entered in to, or to be entered in to, between the Principal and Designer for design works.
Drawing	The latest approved revision of the project drawings.
Geotechnical Engineer	A qualified geotechnical engineer, geologist or engineering geologist, with experience and knowledge in soil-structure interactions.
Principal	A client who awards a contract to a Contractor for completion of a job or project in accordance with terms of the contract.
Project	A package of works within a Program as determined by ARTC.
Program	Means the Inland Rail Program.
Project Quality Plan	Means the Contractor's Project Quality Plan (PQP) for the Project, prepared in accordance with the Program Quality Plan.
Project Specific Specification	Will mean a Specification developed by the Contractor for a project specific requirement that is not covered under the latest revisions of ARTC standards and specifications.
Quality System	A documented Quality System prepared by the Contractor in accordance with this Specification and Australian Standard for Quality System AS/NZ ISO 9001.
Rail Corridor	The rail corridor is the land on which the railway is built. It comprises all property typically bounded from fence line to fence line, or if there are no fences, everywhere within 15 m either side of the outermost parts of track, unless otherwise indicated.
Site	Means the location or portion of land related to the Project works. The site may include land both inside and outside of the rail corridor.
Specification	A Specification consists of a written document that delineates the requirements regarding the materials, products, equipment, systems, standards, workmanship and quality aspects involved with the execution of the work to be undertaken and fulfilment of the Contract. Reference to this specification document includes all other relevant documents referred to in this specification.
Standard	A consensus on what is required or should be done. A Standard consists of a written document that delineates the requirements regarding a particular material, product, process or service.

Term	Definition
Superintendent	Means the person(s) appointed by the Principal to act as the nominated Principal's Representative and includes the Superintendents Representative. In general, the Superintendent's role is to 'administer' the contract and ensure the contractual obligations are performed. Under a traditional construction contract, the superintendent has two separate and distinct roles: to act as agent for the principal; and to act as an independent certifier.
Works	Means the whole of the work to be executed in accordance with the Contract, including variations provided for by the Contract. Work includes the provision of materials unless agreed otherwise.

In addition to the definitions listed in Table 1 the following railway construction definitions appearing in this Specification will have the following meanings:

Table 2 Railway Earthworks Definitions

Term	Definition
Ballast	Ballast is a free draining coarse aggregate used to support railway tracks.
Batter	A constructed slope (cut or fill) commonly of uniform gradient.
Bench	Bench is a near horizontal break in a slope (cut or fill) to break the continuity of an otherwise long slope to improve its stability or to catch and arrest slide material. Bench crossfall and width configuration is determined by slope design.
Borrow Area/Pit	An area/pit where excavations are made for the procurement of additional material.
Bound Material	A granular material with sufficient stabilising agents added to produce a material with a significant tensile strength.
California Bearing Ratio	A measure of the load-bearing capacity of soils, typically in a re-compacted and saturated state, or in situ.
Capping Layer	A layer or layers of graded crushed rock or other engineered fill within the Formation, usually provided for the purpose of sealing the earthworks from surface water and structurally supporting the track.
Certified Materials	Materials certified as virgin materials, clean materials or suitable for the intended land use in accordance with the relevant regulatory waste classification or categorisation requirements.
Cess	The area from the edge of the ballast profile to either the crest of the embankment or the toe of the cutting.
Cess Drain	The surface drain outside the sleepers to drain water from the ballast.
Compaction	The process whereby the dry density of a material is increased by mechanical or other means.
Compacted Lift Thickness	The lift thickness of a placed fill material after compaction.
Contaminated Materials	Any material containing a chemical substance(s) at above background levels and posing, or potentially posing, a risk of harm to human health, the environment, water supply or agriculture, based on applicable legislation and standards.
Cut/Cutting	Earthworks constructed by excavation.
Design CBR	The Californian Bearing Ratio (CBR) determined by design for nominated test conditions using statistical analysis or other appropriate methods.

Term	Definition
Earth Excavation	Rippable or excavatable material. All materials such as earth, clay, sand, gravel, weathered or loose rocks which can be removed by ripping or excavation, without regard to stockpiling, loading or carting, as defined for bulk excavation and confined excavation non-rippable materials in the Earthworks Construction Specification ETC-08-04.
Earth Fill	Fill material consisting of fine and coarse particles evenly distributed throughout the layer filling voids so that when compacted produces a dense stable embankment. As larger sized rock fragments are added to an earth fill, at some point the "earth fill" becomes a "rock fill" with predominantly coarse-grained gravel, cobble and boulder sized rock fragments.
Earthworks Materials Management Framework	The framework for reuse of site won or generated earth and rock materials, where the reuse: • Is genuine, rather than a means of waste disposal. • Is beneficial or fit for purposes. • Will not cause harm to human health, the environment. • Will not adversely impact current and future rail infrastructure, maintenance or operations.
Embankment	Earthworks constructed by placement of fill for the purpose of constructing an overlying formation.
Fill	Earth or rock materials placed as a part of the construction process.
Formation	Earthworks constructed by material, usually capping and structural fill, placed between the Subgrade Level and Formation Level below the ballast (refer to Figure 4).
Formation Level	The level of the formation surface, also referred to as the top of formation.
Foundation	The soil or rock material immediately underlying and supporting any earthworks undertaken as part of the Works.
General Earth Fill	An earth fill material complying with Section 4.4 of this Specification.
General Earth Fill Lower	The bottom portion of a Zoned Embankment (refer to Figure 2).
General Earth Fill Upper	The top portion of a Zoned Embankment (refer to Figure 2).
Geocomposite	A product combining a geogrid layer overlaying a geotextile layer for reinforcement, separation and filtration applications.
Geosynthetics	The range of polymeric products comprising eight main categories: geotextiles, geogrids, geonets, geomembranes, geosynthetic clay liners, geofoam, geocells and geocomposites.
Geosynthetic Reinforced Embankment	An embankment that utilises geosynthetics to improves its stability. Geosynthetic reinforcement may be used for the following applications: • As embankment basal reinforcement (e.g. load transfer, piled embankments and platforms). • Within reinforced embankment (batter slope ≤ 70°).
Geosynthetic Reinforced Soil Structure	A structure that utilises geosynthetics in its design so as to form a stable composite structure. Geosynthetic reinforcement may be used for the following applications: • Retaining walls. • Within Reinforced Soil Structure with batter slope ≥ 70°.
Homogenous Embankment	Earthworks constructed by placement of a uniform fill material. Not a Zoned Embankment.
Layer	One or more uniformly compacted lifts of a given material.

Term	Definition
Land Use Criteria	The maximum concentration of contaminants recommended for safe use under a generic land use scenario applicable to the site as outlined in the National Environment Protection (Assessment of Site Contamination) Measure 1999 Amendment 2013.
Lift	The placement of a fill material within the compacted thickness limits in this Specification.
Loose Lift Thickness	The thickness of a placed fill material prior to compaction.
Lot	A portion of material or a section of the Works which has been constructed and supplied under uniform conditions and contains material of uniform quality and is homogeneous with only minor and random variation in characteristics (such as density, moisture, thickness, material type, colour, and finish) or a single finished item of work which includes several materials or work types (e.g. construction of a culvert in place).
Main line	The line normally used for running trains through and between locations.
Maximum Dry Density	The dry density which can be achieved under a specified compaction effort at the Optimum Moisture Content.
Moisture Ratio	The ratio of moisture content to Optimum Moisture Content.
Optimum Moisture Content	The percentage of moisture in a soil at which the soil can be compacted to its greatest density for a specified amount and type of compaction effort.
Outer Zone	The portion of a Zoned Embankment encapsulating structural fill and general earth fill (refer to Figure 2).
Reinforcement	The improvement of the earthworks by introducing a geosynthetic to enhance lateral restraint or bearing capacity using interlocking of particles.
Rock Fill	A material, meeting the requirements of Section 4.7, which when placed, produces an embankment deriving its stability from the mechanical interlock of the coarser particles, rather than from the compaction of finer material around the coarser particles. Rock fill may contain large open voids.
Select Fill	Material for use adjacent to structures or in other distinct applications that require specific properties defined for that purpose.
Siding	A section of railway track, connected to a running line or another siding, on which rolling stock can be placed clear of the running line and normally used for purposes such as stabling, loading, rolling stock maintenance or passing of trains.
Spoil	Material surplus to the Contract requirements which must be managed onsite or disposed of off the Site, as per Earthworks Materials Management Framework (Appendix B).
Stabilisation	The permanent physical and chemical alteration of materials to enhance their physical properties. Stabilisation binders include, but are not limited to, granular, salts, organic and polymer compounds, hydrated lime, Portland Cement, slag, fly ash, bitumen, and combinations thereof.
Stripped Surface Level	The ground surface after clearing and grubbing and topsoil stripping operations have been completed.
Structural Fill Layer	A layer or layers of engineered fill, usually placed to provide a gradational structural support zone between the Subgrade Level and Capping Layer.
Subgrade Level	The finished surface of an embankment or cutting upon which the formation is constructed.
Surplus	That which remains when use or need is satisfied.

Term	Definition
Topsoil	The upper most layer of the soil usually dark in colour and rich in organic material.
Track	The infrastructure upon which rolling stock travels. Track can be designated as uni-directional or bi-directional. Track is formed through the combination of rails, rail connectors, sleepers, ballast, points, crossings, and substitute devices where used. Also referred to as the Track Structure (refer to Figure 4).
Unsuitable Material	All material identified as unsuitable, as defined in Section 4.11, for use as a foundation for earthworks or structures or for use as fill material in its present position or condition in consideration of both geotechnical and environmental aspects.
Waste	Waste means any: (a) discarded, rejected, unwanted, surplus or abandoned matter; or (b) otherwise discarded, rejected, unwanted, surplus or abandoned matter intended for: (i) recycling, reprocessing, recovery, reuse, or purification by a separate operation from that which produced the matter; or (ii) sale, whether of any value or not (National Environment Protection (Movement of Controlled Waste between States and Territories) Measure 1998).
Weighted Plasticity Index	Defined as the value of the Plasticity Index (PI) times the percent passing the 0.425 mm sieve.
Zoned Embankment	An embankment comprised of zones of different types of fill materials (refer to Figure 2).

The abbreviations listed below where used in the Specification, will have the following meaning:

Table 3 Abbreviations

Abbreviation	Meaning
ARTC	Australian Rail Track Corporation
AS	Australian Standard
ASTM	American Society for Testing and Materials
BoD	Basis of Design
BS	British Standard
CBR	California Bearing Ratio
D_{50}	Particle size represented by the 50% passing, AS 1289.3.6.1
D_{85}	Particle size represented by the 85% passing, AS 1289.3.6.1
EN	European Standard
EOS	Equivalent Opening Size, AS 3706.1, AS 3706.7 or EN ISO 12956
EOTA	European Organisation for Technical Assessment
G Rating	Geotextile strength rating = $(L \times h_{50})^{1/2}$
h_{50}	Drop cone puncture resistance (mm) of the geotextile material, AS 3706.5
HDPE	High Density Polyethylene
ISO	International Standard
ITP	Inspection Test Plan

Abbreviation	Meaning
L	Burst strength (N) of geotextile material, AS 3706.4
MDD	Maximum Dry Density
MR	Moisture Ratio
NATA	National Association of Testing Authorities
NEPM	National Environmental Protection (Assessment of Site Contamination) Measure
OMC	Optimum Moisture Content
PET	Polyester (polyethylene terephthalate)
PI	Plasticity Index
PP	Polypropylene (also known as polypropene)
PQP	Project Quality Plan
Q_{100}	Flow rate through the geotextile material, in $l/m^2/s$, under 100 m constant head conditions, AS 3706.9
R_c	Reduction factor for creep
R_d	Resistance to installation damage
R_m	Reduction factor for manufacture
R_{uv}	Resistance to UV
RMS	Roads and Maritime Services - NSW
SMDD	Standard Maximum Dry Density
T_s	Tensile Strength
UTS	Ultimate Tensile Strength
Ψ	Permittivity of the geotextile material, in S^{-1}, under 100 m constant head conditions, AS 3706.9

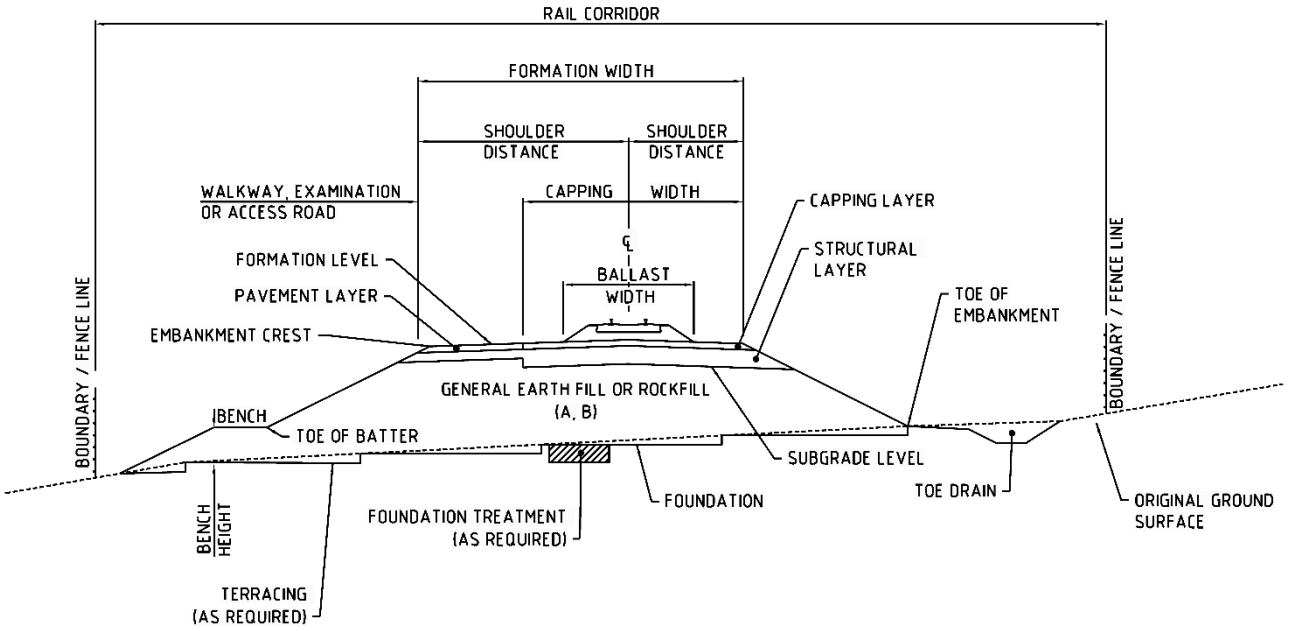


Figure 1 Schematic of Homogeneous Embankment Cross Section

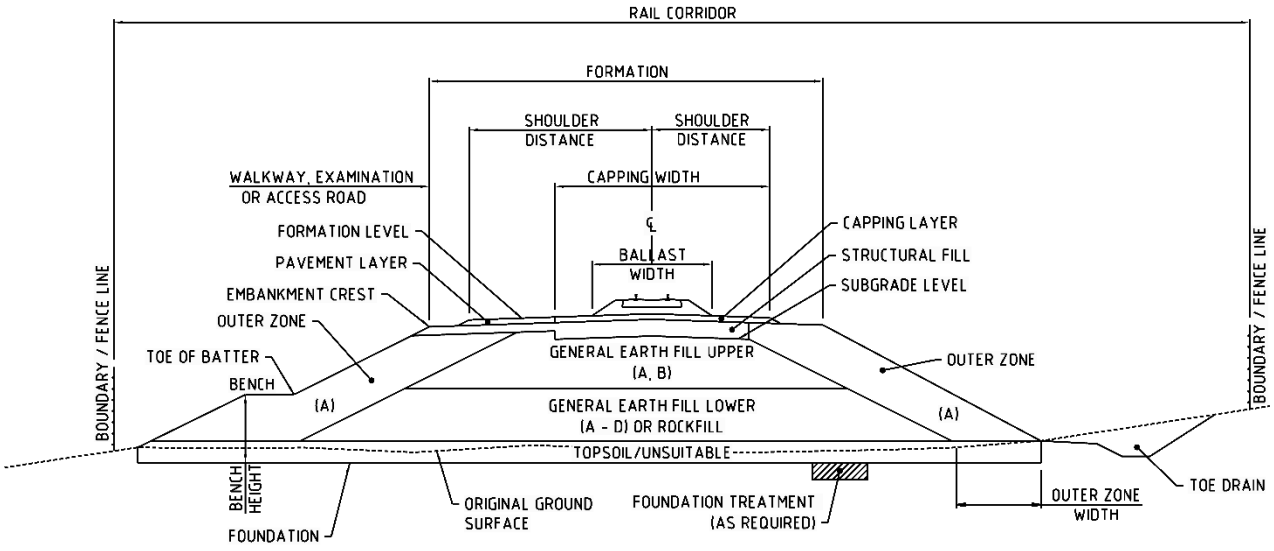


Figure 2 Schematic of Zoned Embankment Cross Section

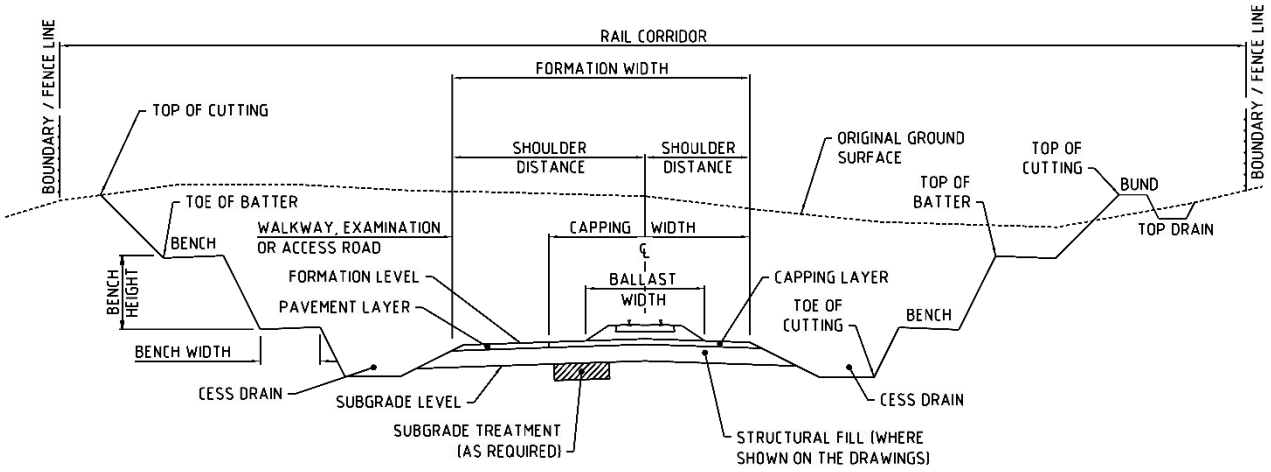


Figure 3 Schematic of Cutting Cross Section

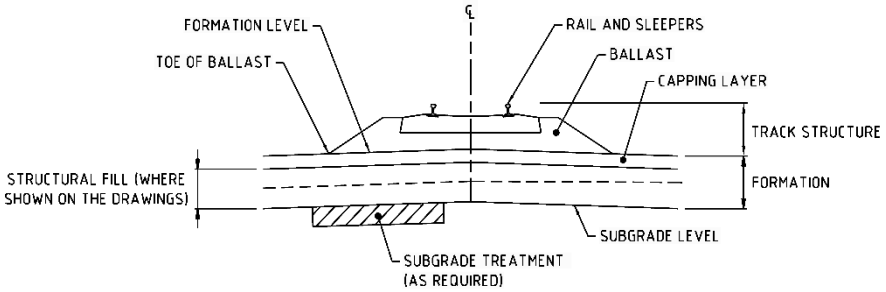


Figure 4 Schematic of Formation and Track

3 Codes and Standards

All design, materials, equipment, workmanship and installations must comply with the latest revision of the Project Standards and Specifications, ARTC Engineering Standards, relevant rail authorities and Australian Standards (AS) relating to the relevant element or component of Works unless otherwise noted in this Specification.

The following codes and standards apply for the Project, and any discrepancy between standards and this Specification must be referred to the Superintendent for clarification.

AS 1012	Methods of testing concrete
AS 1141	Methods for sampling and testing aggregates
AS 1289	Methods of testing soil for engineering purposes
AS 1672	Building Limes
AS 1726	Geotechnical Site Investigations
AS 2001	Methods of test for textiles
AS/NZS 2041	Buried Corrugate Metal Structures
AS 2159	Piling—Design and Installation
AS 2758	Aggregates and rock for engineering purposes
AS 3705	Geotextiles—Identification, marking and general data
AS 3706	Geotextiles—Methods of test
AS/NZS 3725	Design for installation of buried concrete pipes
AS 3972	General purpose and blended cements
AS 4133	Methods of testing rocks for engineering purposes
AS 4489	Test Methods for Limes and Limestones
AS 5101	Methods for preparation and testing of stabilised materials
AS 7638	Railway Earthworks
AS/NZS ISO 9001	Quality management systems - requirements
ASTM D1603	Standard Test Method for Carbon Black Content in Olefin Plastics
ASTM D4355	Standard Test Method for Determination of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc-Type Apparatus
ASTM D4595	Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM D5321	Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear
ASTM D5818	Standard Practice for Exposure and Retrieval of samples to Evaluate Installation Damage of Geosynthetics
ASTM D6637	Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method

ASTM D7737	Standard Test Method for Individual Geogrid Junction Strength
BS 8006-1	Code of practice for strengthened/reinforced soils and other fills
EN ISO 10319	Geosynthetics—Wide-width tensile test
EN ISO 12956	Geotextiles and geotextile-related products—Determination of the characteristic opening size
EOTA TR41	Non-reinforcing hexagonal geogrid for the stabilization of unbound granular layers by way of interlock with the aggregate
RMS T102	Pre-treatment of road construction materials by compaction
RMS T103	Pre-treatment of road construction materials by artificial weathering

The latest ARTC Engineering Standards and Codes of Practice are available from www.artc.com.au/.

4 Earthworks Materials

4.1 General

The Contractor must:

- Only use earthworks materials approved for use by the Superintendent. Earthworks materials may include site won earthworks materials and waste material that has been confirmed as suitable for the proposed use in accordance with relevant state authority environmental requirements, in consideration of requirements relating to waste minimisation and classification, geotechnical and environmental properties.
- All earthworks materials must comply with relevant landuse criteria for contaminants.
- Stockpile, test (to Australian Standards) and gain approval of all materials in accordance with their classification prior to placement.
- Ensure all earth fill materials have a uniform grading and must not be gap graded between the coarse limit of the grading envelope to the fine limit of the grading envelope, or vice versa, unless specified otherwise.
- Undertake appropriate testing of all construction material sources to confirm compliance to this Specification.
- Where surplus earthworks materials are proposed to be reused, comply with the requirements of the Earthworks Materials Management Framework in Appendix B.
- Evaluate the suitability of non-potable water by field and laboratory testing at the discretion of and approved by the Superintendent.
- Ensure saline water with chemical composition exceeding the limits specified in AS 2159 is not used in fill material where steel elements or steel reinforced concrete are buried, or where vegetation is to be established.

Subgrade materials must be tested in accordance with General Earth Fill CBR requirements.

Prior to construction, all compliance tests must be completed for each material type and source. Test reports must not be older than 12 months. Classification conformance criteria must be determined by sampling of sources, stockpiles and Lots. Placement conformance criteria must be determined by appropriate test methods post placement.

Embankments must be comprised of materials derived from excavated cuts, borrow pits, quarries and other approved sources.

All variations from the material requirements outlined in Section 4.2 to Section 4.10 must be specified in accordance with Section 7.

4.2 Capping Material

Capping material must be a well-graded natural or artificially blended gravel/soil. It is required to have sufficient fines to allow for compacting to high densities by static or vibratory steel-tyred rollers or by ballasted pneumatic-tyred rollers. Capping material must be capable of providing structural support to the ballast layer and shedding water from the ballast away from the formation.

Capping material must comply with the following Table 4 requirements unless varied by design.

Table 4 Capping Material Requirements

Criteria	Test Method[4]	Compliance
Classification		
Artificial Weathering[1,5]	RMS T103	Pre-treatment
Repeated Compaction[1,5]	RMS T102	Pre-treatment
Particle Size Distribution	AS 1289.3.6.1	
% Passing 26.5 mm sieve		100
% Passing 19.0 mm sieve		80–100
% Passing 9.5 mm sieve		55–100
% Passing 2.36 mm sieve		30–70
% Passing 425 μm sieve		12–40
% Passing 75 μm sieve		5–25
Particle Shape	AS 1141.14	< 30% passing 2:1 caliper ratio
Flakiness Index	AS 1141.15	≤ 40
Wet/Dry Strength	AS 1141.22	≥ 85 kN wet < 35% variation
Liquid Limit	AS 1289.3.1.1 or 3.1.2	≤ 30 (35 for arid areas)
Plastic Limit	AS 1289.3.2.1	≤ 20
Plasticity Index	AS 1289.3.3.1 or 3.3.2	6–12 (6–15 for arid areas)
Linear Shrinkage	AS 1289.3.4.1	3.0–7.5
Weighted Plasticity Index	AS 1289.3.6.1/3.3.1	140–360
Maximum Dry Density	AS 1289.5.1.1	≥ 2.0 t/m^3
California Bearing Ratio[2]	AS 1289.6.1.1/5.1.1 4 day soaked, 9 kg surcharge, to 100% SMDD at OMC	≥ 50%
Classification test frequency[3]		1 test per 1,000 t
Permeability		
Permeability	AS 1289.6.7.1	< 5 × 10^{-7} m/s
Permeability test frequency[3]		Min. 2 tests per source material

Notes:

1 *Material that is susceptible to break down or fracturing during compaction must be subject to pre-treatment. Tests performed post placement for conformity with this table do not require pre-treatment.*

2 *CBR to be determined by design.*

3 *Refer to Section 7.2 for variations to test frequencies.*

4 *Refer to Section 7.3 for alternative test methods.*

5 *These tests to be completed prior to construction works (classification conformance) and may be applied during the construction works at the discretion of the Superintendent.*

4.3 Structural Fill Material

Structural fill must be a material with properties which when placed, provides a gradational support zone over the underlying material. Structural fill is typically used to provide a stable formation for the support of the track infrastructure and a stable construction platform for the placement, compaction and maintenance of the capping layer and track.

Structural fill material must comply with the following Table 5 requirements unless varied by design.

Table 5 Structural Fill Material Requirements

Criteria	Test Method[6]	Compliance
Classification		
Repeated Compaction[1,7]	RMS T102	Pre-treatment
Particle Size Distribution	AS 1289 Clause 3.6.1	
% Passing 75 mm sieve		100
% Passing 53.0 mm sieve		80–100
% Passing 2.36 mm sieve		15–100
% Passing 425 μm sieve		10–70
% Passing 75 μm sieve		5–30
Liquid Limit	AS 1289.3.1.2	≤ 40
Plasticity Index	AS 1289.3.3.1	≤ 20
Wet/Dry Strength[7,8]	AS 1141.22	≥ 85 kN wet < 35% variation
Emerson Class[7]	AS 1289.3.8.1	≥ 3
Weighted Plasticity Index	AS 1289.3.6.1/3.3.1	≤ 800
Maximum Dry Density[7]	AS 1289.5.1.1	≥ 1.8 t/m^3
California Bearing Ratio[2]	AS 1289.6.1.1/5.1.1 4-day soaked[3], 9 kg surcharge[4], to 100% SMDD @ OMC	≥ 8%
Classification test frequency[5]		1 test per 2,000 t

Notes:

1 *Material that is susceptible to break down or fracturing during compaction must be subject to pre-treatment. Tests performed post placement for conformity with this table do not require pre-treatment.*
2 *CBR to be determined by design.*
3 *Period (number of days) of CBR soaking may be varied according to climatic and drainage conditions and the embankment design.*
4 *Surcharge may be increased in accordance with AS 1289.6.1.1.*
5 *Refer to Section 7.2 for variations to test frequencies.*
6 *Refer to Section 7.3 for alternative test methods.*
7 *These tests to be completed prior to construction works (classification compliance) and may be applied during the construction works at the discretion of the Superintendent.*
8 *Wet/dry Strength to be tested when 9.5 mm fraction exceeds 30%.*

4.4 General Earth Fill Material

The purpose of general earth fill is to provide a stable embankment for the support of the track infrastructure and a stable construction platform for the placement, compaction and maintenance of the structural fill layer, capping layer and track superstructure.

Selection of fill materials must be appropriate to the adopted design and performance expectations. General earth fill materials must comply with the following Table 6 requirements unless varied by design.

The outer zone material for a zoned embankment (Figure 2) must be durable, erosion resistant material (General Earth Fill Type A). The general earth fill upper zone must be general earth fill Type A and Type B. The lower zone may be general earth fill (Type A–D) or rockfill in accordance with their respective placement depth criteria.

General earth fill materials are to be compacted using the compacted layer method with density compliance measured using relative compaction tests or using a project specific method specification where the performance is demonstrated by a compaction trial. The thickness of a single stone must be not less than one-third its length and the maximum size of a single stone must not exceed two-thirds of the layer thickness.

Table 6 General Earth Fill Material Requirements

Criteria	**Test Method[5]**	**Compliance**				
		Homogenous Embankment	**Zoned Embankment**			
			A	**B**	**C**	**D**
Classification						
Particle Size Distribution	AS 1289.3.6.1					
% Passing 150 mm sieve		100	100	100	100	100
% Passing 75.0 mm sieve		100	100	80–100	80–100	80–100
% Passing 37.5 mm sieve		60–100	80–100	60–100	60–100	
% Passing 75 μm sieve		15–30	15–30	8–40	< 50	
Plasticity Index	AS 1289.3.3.1	7–30	7–30	7–30	≤ 50	≤ 50
Weighted Plasticity Index	AS 1289.3.6.1 /3.3.1	500–1200	500–1200	< 2200	< 3200	< 4000
Emerson Class	AS 1289.3.8.1	≥ 3	≥ 3	≥ 3	No criteria	
California Bearing Ratio	AS 1289.6.1.1 /5.1.1 4-day soaked[1], 9 kg surcharge[2], to equivalent compaction level[6] of 95% SMDD @ OMC	≥ 3%			≥ 1%	

Criteria	Test Method[5]	Compliance				
		Homogenous Embankment	Zoned Embankment			
			A	B	C	D
Classification test frequency[3]		1 test per 5,000 t			1 test per 10,000 t	
Closest depth below Formation Level (m)[4]		0.35	0.35	1.0	1.5	2.0

Notes:

1 *Period (number of days) of CBR soaking may be varied according to climatic and drainage conditions and the embankment design.*
2 *Surcharge may be increased in accordance with AS 1289.6.1.1.*
3 *Refer to Section 7.2 for variations to test frequencies.*
4 *Closest depth below Formation Level may be varied by geotechnical design and supporting documentation.*
5 *Refer to Section 7.3 for alternative test methods.*
6 *Equivalent Compaction Level is provided as coarse materials may not be able to be tested using standard test methods, alternative test methods (Note 5) are to be nominated to demonstrate general compliance to these compaction levels.*

4.5 Select Fill Adjacent to Structures

Compacted select fill material must be placed adjacent to structures where the fill depth is greater than 3 m. The select fill must be durable and not disintegrate in water or when exposed to the weather, and must comply with Table 7 requirements unless varied by design. At depths equal to or less than 3 m, fill material must comply with Table 5 of this Specification.

Table 7 Select Fill Material Requirements

Criteria	Test Method[3]	Compliance
Classification		
Artificial Weathering[1,4]	RMS T103	Pre-treatment
Repeated Compaction[1,4]	RMS T102	Pre-treatment
Particle Size Distribution	AS 1289.3.6.1	
% Passing 53.0 mm sieve		100
% Passing 2.36 mm sieve		< 50
% Passing 75 μm sieve		< 15
Liquid Limit	AS 1289.3.1.2	≤ 30
Plasticity Limits	AS 1289.3.2.1	≤ 20
Plasticity Index	AS 1289.3.3.1	6–15
Weighted Plasticity Index	AS 1289.3.6.1/3.3.1	180–300
Maximum Dry Density[4]	AS 1289.5.1.1	≥ 2.0 t/m^3
California Bearing Ratio	AS 1289.6.1.1/5.1.1 4-day soaked, 9 kg surcharge, to 100% SMDD @ OMC	≥ 50%

Criteria	Test Method[3]	Compliance
Particle Density[4]	AS 1141.6.1	≥ 2.6 t/m^3
Wet/dry Strength[4,5]	AS 1141.22	≥ 85 kN wet < 35% variation
Aggregate Crushing Value[4]	AS 1141.21	≤ 30%
Aggregate Flakiness Index[4]	AS 1141.15	≤ 40%
Degradation Factor[4]	AS 1141.25	≥ 50
Weak Particles[4]	AS 1141.32	≤ 0.5%
Classification test frequency[2]		1 test per 500 t

Notes:

1 Material that is susceptible to break down or fracturing during compaction must be subject to pre-treatment. Tests performed post placement for conformity with this table do not require pre-treatment.

2 Refer to Section 7.2 for variations to test frequencies.

3 Refer to Section 7.3 for alternative test methods.

4 These tests to be completed prior to construction works (classification compliance) and may be applied during the construction works at the discretion of the Superintendent.

5 Wet/dry Strength to be tested when 9.5 mm fraction exceeds 30%.

4.6 Bedding Sand

Bedding sand for pipes, culverts and other miscellaneous structures must be well graded natural or crushed quarry product sands sourced from designated sources, free from organic or other materials harmful to pipes, concrete, structures and the environment and be complying with Table 8 requirements unless varied by design.

Table 8 Bedding Sand Material Requirements

Criteria	Test Method[2]	Compliance
Classification		
Particle Size Distribution	AS 1289.3.6.1	
% Passing 6.7 mm sieve		100
% Passing 0.075 mm sieve		0–20
Plasticity Index	AS 1141.23	≤ 30%
Test frequency[1]		Two per source

Notes:

1 Refer to Section 7.2 for variations to test frequencies.

2 Refer to Section 7.3 for alternative test methods.

4.7 Rock Fill

Rock fill derives its stability from mechanical interlock and requires a method specification for compliance. Rock fill must be strong, hard durable rock obtained from sources approved by the Superintendent and must comply with Table 9 requirements unless varied by design.

Table 9 Rock Fill Material Requirements

Criteria	Test Method[2]	Compliance
Classification		
Particle Size Distribution	Visual assessment for mechanical interlock and size distribution.	
% Passing 600 mm		100
% Passing 4.75 mm		0–10
Point Load Test	AS 4133.4.1	≥ 1.0 MPa
Particle Density	AS 1141.6.1	≥ 2.3 t/m
Wet/dry Strength	AS 1141.22	≥ 85 kN wet < 35% variation
Secondary Mineral Content	AS 1141.26	< 20%
Particle Shape	Visual Assessment	The thickness of a single stone must be not less than one-third its length
Test frequency[1]		1 test per 5,000 t
Closest depth below Formation Level (m)[3]		1.5

Notes:

1 Refer to Section 7.2 for variations to test frequencies.

2 Refer to Section 7.3 for alternative test methods.

3 Closest depth below Formation Level may be varied by geotechnical design and supporting documentation.

4.8 Rock Protection

Rock protection must be clean, sound, dense and durable rock that will not disintegrate in water or when exposed to the weather. Rock protection is to comply with the requirements of Table 9 Rock Fill Material Requirements, with the exception of grading and particle shape. Rock protection should be non-acid forming, angular, blocky and well graded with dimensions ranging nominally from 100 mm to 1000 mm. The thickness of a single stone must be not less than one-third its length. Rock protection may be used for protecting embankments and structures from scour and erosion. Rock protection must be obtained from sources approved by the Superintendent.

4.9 Drainage Blanket Material

Drainage blanket material must be durable, not disintegrate in water or when exposed to the weather, and must comply with Table 10 requirements unless varied by design. The drainage blanket material must be spread in uniform lifts to achieve the specified compacted layer thickness in such a manner as to avoid damage to geosynthetics or structures.

Table 10 Drainage Blanket Material Requirements

Criteria	Test Method[2]	Compliance
Classification		
Particle Size Distribution	AS 1141.11, AS 1141.12	
% Passing 63.0 mm sieve		100
% Passing 37.5 mm sieve		20–100
% Passing 26.5 mm sieve		0–55
% Passing 19.0 mm sieve		0–5
% Passing 75 μm sieve		0–0.5
Los Angeles Value (Grading A)	AS 1141.23	≤ 30%
Particle Shape	AS 1141.14	< 30% passing 2:1 caliper ratio
Flakiness Index	AS 1141.15	≤ 40
Particle Density	AS 1141.6.1	≥ 2.3 t/m^3
Water Absorption	AS 1141.6.1	≤ 2%
Wet/dry Strength	AS 1141.22	≥ 100 kN wet < 25% variation
Test frequency[1]		One per source

Notes:

1 Refer to Section 7.2 for variations to test frequencies.

2 Refer to Section 7.3 for alternative test methods.

4.10 Other Drainage Materials

All other drainage materials, including controlled low strength materials (CLSM, Appendix A of AS 3725), filter material and lean mix concrete (e.g. 5 MPa concrete), must be specified in accordance with the relevant Australian Standards (such as AS 2041 and AS 3725).

4.11 Unsuitable Material

4.11.1 General

The following materials are deemed unsuitable materials and must not be used in the constructed works unless otherwise treated and approved by the Superintendent in accordance with the Earthworks Construction Specification ETC-08-04.

4.11.2 Inherently Unsuitable

Inherently unsuitable materials are:

- Materials susceptible to piping, such as fine single sized sand, windblown sand and non-cohesive silt.
- Materials containing high organic content, vegetable matter, large rocks, gypsum, debris, or other materials that could cause the fill not to compact to specification.
- Organic soils with Unified Soil Classifications of Pt, OH, or OL (AS 1726).
- Contaminated materials or prescribed waste materials as classified by relevant legislation, with the exception of materials deemed suitable from a contamination and geotechnical perspective.

4.11.3 Unsuitable Materials by Virtue of Position

Unsuitable materials by virtue of position are soil having insufficient strength to carry the loads that will be superimposed on the completed fill without excessive settlement, swell, erosion or loss of stability.

4.11.4 Unsuitable by Moisture Content

Unsuitable materials by moisture content will be materials not meeting the specified moisture requirements or having a moisture content that may adversely impact the Works.

4.12 Stabilised Material

A Project Specific Specification for the use of stabilised materials must be developed which includes, but not limited to:

- Results and details of laboratory testing (test methods to demonstrate short and long term performance criteria).
- Stabilisation method (plant mixed or in situ).
- Stabilisation trial sections and Quality Assurance / Quality Control procedures to meet requirements of this Specification and the Earthworks Construction Specification ETC-08-04.
- Alternative test methods (Section 6.3) for stabilised material may be nominated as part of the Project Quality Plan (PQP).

The Project Specific Specification for stabilisation must be submitted to the Superintendent for approval prior to any stabilising work commencing.

Materials may be chemically stabilised by an approved binder(s) to produce a stabilised material. The design criteria for stabilised fill must be determined based on meeting the long-term design performance criteria. Chemical stabilisation may include lime, cement, bitumen, polymers or other proprietary products. In addition to CBR strength requirements, Uniaxial Compressive Strength (AS 1141.51 or AS 5101.4) must be < 1.5 MPa at minimum 28-days curing and 4-hour soak using standard compactive effort to prevent cracking and preclude bound materials from within the formation.

The stabilising agent must be determined based on laboratory mix design testing to confirm the percentage of binders added to a material to meet the specified design criteria.

Bulk lime for stabilisation must comply with requirements of hydrated or quick lime (AS 1672) with a minimum Calcium Hydroxide ($Ca(OH)_2$) of 85% (AS 4489.6.1).

Bulk cement for stabilisation must comply with requirements of AS 3972, Type GP (General Purpose) or GB (General Blended) cement.

Water used for stabilisation must be of potable standard unless the chemical composition of non-potable water is demonstrated to not adversely affect stabilisation.

5 Geosynthetics

5.1 General

The requirements of this section are applicable to geosynthetics for use as separation, filtration, stiffening and reinforcing elements in earthworks and miscellaneous structures (such as culverts, pipe trenches and drainage blankets). This section does not apply to geosynthetic reinforced embankments or geosynthetic reinforced soil structures (RSS) which require compliance to detailed designs for those elements.

Geosynthetics shall not be placed less than 400 mm below the Formation Level, with the possible exception at stations, turnouts, and other discrete sections of track not likely to be subject to rail bound (mechanised) formation renewal.

Where geocomposites or both geogrids and geotextiles are specified at the same level, geotextiles must be placed below geogrids, and the geotextile layer shall be compliant with Strength Class C and Filtration Class I or II in accordance with Tables 11 and 12 respectively.

A certificate demonstrating compliance with this Specification shall be provided by the Contractor to the Superintendent prior to use for each geosynthetic used. All test results on which the test certificates are based shall not be more than one year old, measured from the date of supply.

A lot size for geosynthetics shall be 10,000 m^2 or part thereof. The Superintendent or the Design Drawings may require additional conformance testing of representative samples from lots by the Contractor.

5.2 Geotextiles

5.2.1 General

The requirements of this section are applicable to geotextiles for use as separation or filtration elements in earthworks.

Unless specified otherwise on the Drawings, geotextiles must meet the following requirements:

- The fibres of the geotextile and thread used in joining lengths must consist of long chain synthetic polymers composed of at least 95% by mass of polyolefins or polyesters.
- The geotextile filaments must be rot-proof, chemically stable and must have low water absorbency.
- Filaments must resist delamination and maintain their relative dimensional stability in the geotextile.
- Non-woven geotextiles must have filaments bonded by needle punching, heat or chemical bonding processes.
- Woven geotextiles must have filaments interlaced in two sets, mutually at right angles. One set must be parallel to the longitudinal direction of the geotextile.
- Geotextiles must be free of any flaws which may have an adverse effect on the physical and mechanical properties of the geotextile.
- Geotextiles must be stabilised against ultraviolet radiation such that when tested in accordance with AS 3706.11 they must have retained strength of at least 50% after 672 hours of test exposure. A certificate not more than a year old must be provided by the manufacturer.
- Testing of geotextiles must be undertaken using test methods in accordance with AS 3706.

5.2.2 Strength Class

Geotextiles, where required for separation or filtration, are referenced by a Strength Class which must meet the requirements of Table 11.

Where a Strength Class is specified on the Drawings for a specific installation, a geotextile with a Strength Class at least equal to that stated must be used and the Contractor must check the strength requirements for the specific application complies with the requirements of the Earthworks Construction Specification.

Table 11 Geotextile Strength Classifications

Strength Class	Elongation[1] AS 3706.4	Grab Strength (N) AS 2001.2.3.2	Tear Strength (N) AS 3706.3	G Rating AS 3706.4
A	≥ 30%	500	180	900
	< 30%	800	300	1350
B	≥ 30%	700	250	1350
	< 30%	1100	400	2000
C	≥ 30%	900	350	2000
	< 30%	1400	500	3000
D	≥ 30%	1200	450	3000
	< 30%	1900	700	4500
E	≥ 30%	1600	650	4500

Notes:

1 Elongation to differentiate woven from non-woven geotextiles must be the elongation % at puncture corresponding to maximum puncture strength determined in accordance with AS 3706.4. In general, woven geotextiles will puncture at elongations less than 30% and non-woven geotextiles will puncture at elongations equal to or greater than 30%.

5.2.3 Filtration Class

Geotextiles, where required for separation or filtration, are referenced by a Filtration Class which must meet the requirements of Table 12.

Table 12 Geotextile Filtration Classifications

Filtration Class	Flow Rate Q_{100} ($L/m^2/s$)[1] AS 3706.9	Permittivity ψ (s^{-1})[1] AS 3706.9	Equivalent Opening Size EOS (mm)[1] AS 3706.1, AS 3706.7 or EN ISO 12956
I	≥ 50	≥ 0.5	≤ 0.12
II	≥ 50	≥ 0.5	≤ 0.25
III	≥ 30	≥ 0.3	≤ 0.12
IV	≥ 20	≥ 0.2	≤ 0.25
V	≥ 10	≥ 0.1	≤ 0.12
VI	≥ 10	≥ 0.1	≤ 0.25
VII	≥ 5	≥ 0.05	≤ 0.3
VIII	≥ 5	≥ 0.05	≤ 0.6

Notes:

1 Slit film woven type geotextile is not permitted for Filtration Classes I, II, III, IV, V and VI.

2 Additional technical advice on EOS, Q_{100} and Ψ is required where water flow may undergo reverse flow characteristics.

3 Additional technical advice on EOS is required for highly dispersive clay soils, gap graded soils, fine silt soils or artificially derived soils such as fly ash. Combined soil/geotextile testing may be required, and additional granular filters may be appropriate.

4 The Superintendent may direct additional testing of geotextiles where unforeseen conditions are encountered which may impede the function of the geotextile. These may include locations where water flow may undergo reverse flow characteristics or where high dispersive clay soils, gap graded soils, fine silt soils or artificially derived soils such as fly ash are encountered.

5.3 Geogrids

5.3.1 General

The requirements of this section are applicable to geogrids (and geocomposites) for use as reinforcement and increasing shear strength by constraining the movement of aggregates in the shear zone of ballast, capping, structural, general fill and subgrade materials in earthworks.

Geogrids are polymeric geogrids formed by a regular network of connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock or earth particles to function primarily as reinforcement.

Geogrids (and geocomposites) may be used for the following applications (Table 13), subject to compliance to Section 5.1:

- Stiffen capping and structural layers to control uneven formation movements and cracking over stabilised or expansive layers.
- Reinforce structural fill layer to improve bearing capacity, reduce layer thickness, reduce vertical deformation and control differential settlement.
- Reinforce subgrades to improve bearing capacity and foundation treatments (E3 and C4, ETC-08-04).
- Reinforce/stabilise the ballast layer to reduce ballast movements, breakage, control differential settlement and reduce maintenance costs.

Table 13 Geogrid Class Applications

Geogrid Class	Grid structure	Application
GC1	Uniaxial or biaxial	Capping, structural, general fill and subgrade CBR > 3%
GC2	Multiaxial	Capping, structural, general fill and subgrade CBR > 2%
GC3	Uniaxial or biaxial	Ballast, general fill and subgrade CBR ≤ 3%
GC4	Multiaxial	General fill and subgrade CBR ≤ 2%
GC5	Multiaxial	Ballast

When the geogrid reinforcement is to be placed directly onto general fill or subgrade, then a geotextile layer compliant with Strength Class C and Filtration Class I or II shall be placed below the geogrid.

The Contractor must provide design documents that include numerical simulation to demonstrate performance of each geogrid and geocomposite used in the earthworks, and test results to demonstrate interlocking and interaction between granular particles and geogrids. Additional performance-based evidence may be provided by the Contractor, or directed by the Superintendent, including but not limited to, large scale triaxial testing and rail based field and/or laboratory trials to determine deformations measured at reinforcement level, subgrade level and sleeper level.

5.3.2 Uniaxial/Biaxial Geogrid

Uniaxial geogrids shall have elongated structure and biaxial shall have a square structure, with polymer bars orientated in two directions.

A uniaxial or biaxial geogrid may be formed by either stretching and drawing a punched sheet of polymer bars, by welding together highly orientated discrete bars of polymer or by weaving together discrete polymer bars into a network that can be coated if necessary to protect the polymer strips. Uniaxial or biaxial geogrids shall be manufactured using High Density Polyethylene (HDPE), polypropylene (PP) and/or polyester (PET).

Uniaxial and biaxial geogrids, where required for reinforcement, are referenced by a Geogrid Class which must meet the requirements of Table 14.

Table 14 Uniaxial/biaxial Geogrid Classification

Geogrid Class	Junction Strength (mm) 2% strain ASTM D7737-11	T_s [1] (kN/m) 2% strain ASTM D6637-11, D4595 or EN ISO 10319	R_d [2] (%) ASTM D5818-11	R_{uv} (%) ASTM D4355-07	Coefficient of direct shear[3] (%) ASTM D5321-14, D5321M-14
GC1	≥ 9.5	≥ 10.5	≥ 85	≥ 90	≥ 75
GC3	≥ 12.5	≥ 14	≥ 85	≥ 90	≥ 75

Notes:

1 *Minimum tensile strength (T_s) in principal direction for uniaxial and both directions for biaxial grids. T_s @ 2% ≤ UTS × R_d × R_{uv} × R_c × R_m.*

2 *Particle size grading used for the installation damage test ASTM D5818 to be the overlying material layer.*

3 *Direct shear test shall apply vertical stress of 50 kPa, 100 kPa and 150 kPa. Base layer shall consist of granular material with friction angle of 30°.*

5.3.3 Multiaxial Geogrid

Multiaxial geogrid shall have a hexagonal structure with ribs orientated in three directions. The resulting triangular-shaped apertures are defined by ribs of rectangular cross section having a high degree of molecular orientation which is continuous through the node. Welded or woven junctions shall not be accepted.

A multiaxial geogrid is formed by stretching and drawing a punched sheet of polymer into a network of hexagonal ribs. Multiaxial geogrids shall be manufactured using PP with a minimum of 2% finely divided carbon black, well dispersed in the polymer matrix to inhibit attack by ultraviolet light, determined in accordance with ASTM D1603-06. Multiaxial geogrids manufactured using HDPE or PET shall not be accepted.

Multiaxial geogrids, where required for reinforcement, are referenced by a Geogrid Class which must meet the requirements of Table 15.

Table 15 Multiaxial Geogrid Classification

Geogrid Class	Hexagon Pitch (mm) EOTA TR41 B.4	Radial Secant Stiffness (kN/m) 0.5% strain EOTA TR41 B.1	Radial Secant Stiffness (kN/m) 2% strain EOTA TR41 B.1	Radial Secant Stiffness Ratio EOTA TR41 B.1	Junction Efficiency (%) EOTA TR41 B.2	Weight (kg/m²) EOTA TR41 B.3
GC2	80 (±4)	390 (-75)	290 (-65)	0.80 (-0.15)	100 (-10)	0.220 (-0.035)
GC4	80 (±4)	480 (-90)	360 (-65)	0.80 (-0.15)	100 (-10)	0.270 (-0.035)
GC5	120 (±6)	540 (-90)	400 (-100)	0.80 (-0.15)	100 (-10)	0.300 (-0.035)

Notes:

1 *Tolerances presented in brackets represent 99.7% tolerance criteria.*

6 Quality Plan

6.1 Contractor's Project Quality Plan

The Contractor's PQP must detail how the Contractor will manage, test and control the quality of the materials under this Specification. The Contractor may develop appropriate statistical techniques to support any request to the Superintendent for variance in the number of samples per Lot or minimum testing frequency for the materials as specified in this Specification using the method for statistical analysis presented in the Earthworks Construction Specification ETC-08-04.

All materials must be tested in accordance with this Specification, Australian Standards and the Earthworks Construction Specification unless approved otherwise by the Superintendent. Samples of material proposed for use must be tested and results considered in the final selection of material and its use within the earthworks.

7 Variations

7.1 Variation to Material Tests, Methods and Compliance Criteria

All variations to ET-08-03 must be documented in Specification Variation Compliance Forms (Appendix A1) and are subject to approval by the Superintendent.

Statistical analysis and criteria for reducing Classification Conformance and Placement Conformance compliance testing must be in accordance with the Project Quality Plan and ETC-08-04.

7.2 Variation of Testing Frequencies

If consistent test results can be demonstrated, the Contractor may apply to the Superintendent for a reduction in test frequency for that particular quality control test method and source. The frequency of testing may be increased at the discretion of the Superintendent if the test results demonstrate a high degree of variability which could affect the design assumptions or the quality of the completed construction.

7.3 Alternative Test Methods

Alternative test methods may be proposed by the Designer or Contractor to confirm the parameters of the earthworks materials.

The Designer or Contractor must obtain approval from the Superintendent prior to using any alternative test methods; and provide a detailed report on trials conducted using the alternative test methods and correlation factors to the compliance test requirements of the applicable materials specification. The report must also include statistical analysis and criteria for reducing compliance testing, in accordance with the Program Quality Plan.

Appendix A – Specification Variation Compliance Forms

A1. Variance to Material Specification and Compliance

Compliant material criteria are specified in Section 4. The forms below are to be completed where there is a deviation from compliant values.

Table 16 Capping Material Variance

Criteria	Test Method[4]	Variance
Classification		
Artificial Weathering[1,5]	RMS T103	
Repeated Compaction[1,5]	RMS T102	
Particle Size Distribution	AS 1289.3.6.1	
% Passing 26.5 mm sieve		
% Passing 19.0 mm sieve		
% Passing 9.5 mm sieve		
% Passing 2.36 mm sieve		
% Passing 425 μm sieve		
% Passing 75 μm sieve		
Particle Shape	AS 1141.14	
Flakiness Index	AS 1141.15	
Wet/Dry Strength	AS 1141.22	
Liquid Limit	AS 1289.3.1.1 or 3.1.22	
Plastic Limit	AS 1289.3.2.1	
Plasticity Index	AS 1289.3.3.1 or 3.3.2	
Linear Shrinkage	AS 1289.3.4.1	
Weighted Plasticity Index	AS 1289.3.6.1/3.3.1	
Maximum Dry Density	AS 1289.5.1.1	
California Bearing Ratio[2]	AS 1289.6.1.1/5.1.1 4-day soaked, 9 kg surcharge, to 100% SMDD at OMC	
Classification test frequency[3]		
Permeability		
Permeability	AS 1289.6.7.1	
Permeability test frequency[3]		

Notes:

1 *Material that is susceptible to break down or fracturing during compaction must be subject to pre treatment. Tests performed post placement for conformity with this table do not require pre-treatment.*

2 *CBR to be determined by design.*

3 Refer to Section 7.2 for variations to test frequencies.
4 Refer to Section 7.3 for alternative test methods.
5 These tests to be completed prior to construction works (classification conformance) and may be applied during the construction works at the discretion of the Superintendent.

Table 17 Structural Fill Material Variance

Criteria	Test Method[6]	Variance
Classification		
Artificial Weathering[1,7]	RMS T103	
Repeated Compaction[1]	RMS T102	
Particle Size Distribution	AS 1289 Clause 3.6.1	
% Passing 53.0 mm sieve		
% Passing 2.36 mm sieve		
% Passing 425 μm sieve		
% Passing 75 μm sieve		
Liquid Limit	AS 1289.3.1.2	
Plasticity Index	AS 1289.3.3.1	
Wet/Dry Strength[7,8]	AS 1141.22	
Emerson Class[7]	AS 1289.3.8.1	
Weighted Plasticity Index	AS 1289.3.6.1/3.3.1	
Maximum Dry Density[7]	AS 1289.5.1.1	
California Bearing Ratio[2]	AS 1289.6.1.1/5.1.1 4-day soaked[3], 9 kg surcharge[4], to 100% SMDD @ OMC	
Classification test frequency[5]		

Notes:
1 Material that is susceptible to break down or fracturing during compaction must be subject to pre-treatment. Tests performed post placement for conformity with this table do not require pre-treatment.
2 CBR to be determined by design.
3 Period (number of days) of CBR soaking may be varied according to climatic and drainage conditions and the embankment design.
4 Surcharge may be increased in accordance with AS 1289.6.1.1.
5 Refer to Section 7.2 for variations to test frequencies.
6 Refer to Section 7.3 for alternative test methods.
7 These tests to be completed prior to construction works (classification compliance) and may be applied during the construction works at the discretion of the Superintendent
8 Wet/dry Strength to be tested when 9.5 mm fraction exceeds 30%.

Table 18 General Earth Fill Material Variance

Criteria	Test Method[5]	Homogenous Embankment	Zoned Embankment			
			A	B	C	D
Classification						
Particle Size Distribution	AS 1289.3.6.1					
% Passing 150 mm sieve						
% Passing 75.0 mm sieve						
Passing 37.5 mm sieve						
% Passing 75 μm sieve						
Plasticity Index	AS 1289.3.3.1					
Weighted Plasticity Index	AS 1289.3.6.1/3.3.1					
Emerson Class	AS 1289.3.8.1					
California Bearing Ratio	AS 1289.6.1.1/5.1.1 4-day soaked[1], 9 kg surcharge[2], to equivalent compaction level[6] of 95% SMDD @ OMC					
Classification test frequency[3]						
Closest depth below Formation Level (m)[4]						

Notes:

1 *Period (number of days) of California Bearing Ratio (CBR) soaking may be varied according to climatic and drainage conditions and the embankment design.*
2 *Surcharge may be increased in accordance with AS 1289.6.1.1.*
3 *Refer to Section 7.2 for variations to test frequencies.*
4 *Closest depth below Formation Level may be varied by geotechnical design and supporting documentation.*
5 *Refer to Section 7.3 for alternative test methods.*
6 *Equivalent Compaction Level is provided as coarse materials may not be able to be tested using standard test methods, alternative test methods (Note 5) are to be nominated to demonstrate general compliance to these compaction levels.*

Table 19 Select Fill Material Variance

Criteria	Test Method[3]	Variance
Classification		
Artificial Weathering[1,4]	RMS T103	Pre-treatment
Repeated Compaction[1,4]	RMS T102	Pre-treatment
Particle Size Distribution	AS 1289.3.6.1	
% Passing 53.0 mm sieve		
% Passing 2.36 mm sieve		
% Passing 75 μm sieve		
Liquid Limit	AS 1289.3.1.2	
Plasticity Limits	AS 1289.3.2.1	
Plasticity Index	AS 1289.3.3.1	
Weighted Plasticity Index	AS 1289.3.6.1/3.3.1	
Maximum Dry Density[4]	AS 1289.5.1.1	
California Bearing Ratio[4,5]	AS 1289.6.1.1/5.1.1 4-day soaked, 9 kg surcharge, to 100% SMDD @ OMC	
Particle Density[4]	AS 1141.6.1	
Wet/dry Strength[4,5]	AS 1141.22	
Aggregate Crushing Value[4]	AS 1141.21	
Aggregate Flakiness Index[4]	AS 1141.15	
Degradation Factor[4]	AS 1141.25	
Weak Particles[4]	AS 1141.32	
Classification test frequency[2]		

Notes:

1 *Material that is susceptible to break down or fracturing during compaction must be subject to pre-treatment. Tests performed post placement for conformity with this table do not require pre-treatment.*

2 *Refer to Section 7.2 for variations to test frequencies.*

3 *Refer to Section 7.3 for alternative test methods.*

4 *These tests to be completed prior to construction works (classification compliance) and may be applied during the construction works at the discretion of the Superintendent.*

5 *Wet/dry Strength to be tested when 9.5 mm fraction exceeds 30%.*

Table 20 Bedding Sand Material Variance

Criteria	Test Method[2]	Variance
Classification		
Particle Size Distribution	AS 1289.3.6.1	
% Passing 6.7 mm sieve		
% Passing 0.075 mm sieve		
Plasticity Index	AS 1141.23	
Test frequency[1]		

Notes:

1 Refer to Section 7.2 for variations to test frequencies.

2 Refer to Section 7.3 for alternative test methods.

Table 21 Rock Fill Material Variance

Criteria	Test Method[2]	Variance
Classification		
Particle Size Distribution	Visual assessment for mechanical interlock and size distribution.	
% Passing 600 mm		
% Passing 4.75 mm		
Point Load Test	AS 4133.4.1	
Particle Density	AS 1141.6.1	
Wet/dry Strength	AS 1141.22	
Secondary Mineral Content	AS 1141.26	
Particle Shape	Visual Assessment	
Test frequency[1]		
Closest depth below Formation Level (m)[3]		

Notes:

1 Refer to Section 7.2 for variations to test frequencies.

2 Refer to Section 7.3 for alternative test methods.

3 Closest depth below Formation Level may be varied by geotechnical design and supporting documentation.

Table 22 Drainage Blanket Material Variance

Criteria	Test Method[2]	Variance
Classification		
Particle Size Distribution	AS 1141.11, AS 1141.12	
% Passing 63.0 mm sieve		
% Passing 37.5 mm sieve		
% Passing 26.5 mm sieve		
% Passing 19.0 mm sieve		
% Passing 75 μm sieve		
Los Angeles Value (Grading A)	AS 1141.23	
Particle Shape	AS 1141.14	
Flakiness Index	AS 1141.15	
Particle Density	AS 1141.6.1	
Water Absorption	AS 1141.6.1	
Wet/dry Strength	AS 1141.22	
Test frequency[1]		

Notes:

1 Refer to Section 7.2 for variations to test frequencies.

2 Refer to Section 7.3 for alternative test methods.

A2. Variance to Formation Geometry Specific Design Requirements

Track configurations, including minimum layer thicknesses, track centres and shoulder distances, must comply with those dimensions detailed in Table 20 below. All crossfalls to the formation are 1:30, unless otherwise shown on the Drawings.

Table 23 Design Specific Formation and Shoulder Geometry Requirements

Item	Minimum Value	Design Value
	mm	
Formation Geometry		
Capping layer thickness	150	
Capping width (from track centreline)	3500	
Structural Fill layer thickness	200	
Structural Fill width (from track centreline)	3500	
General Earth Fill A compacted layer thickness	150	
General Earth Fill B-D compacted layer thickness	150	
Outer Zone width	1000	
Distance from toe of embankment to toe drain	2000	
Distance from toe of cutting to cess drain	0	
Formation Shoulder Geometries (from track centreline)		
Main Line and Passing Loops	3500	
Siding	3000	
Special Width Requirements Shoulder Geometries (from track centreline)		
Shunters and guards parallel walkways	4250	
Train examination areas	5500	
Train examination areas with parallel access road	7750	
Clear Access Road Geometry		
Clear access road width	3000	

Requirements of EGH-20-01 shall apply to formation geometry.

A3. Variance to Cutting Geometry Project Specific Design Requirements

Batter slopes in cuttings in excess of 3 m high and closer than 6 m from the track centreline must be determined on the advice of a geotechnical engineer. Variations to the typical geometry values provided must be supported by a geotechnical risk assessment and geotechnical design.

Table 24 Design Specific Cutting Geometry Requirements

Material		**Slope**			
		Typical		**Design**	
		Horizontal	**Vertical**	**Horizontal**	**Vertical**
1	Sand	2	1		
2	Wet clay, loose gravel	2	1		
3	Sandy clay, boulders and clay, compacted gravelly soil, General Earth Fill A and rockfill, talus	1.75	1		
4	Residual soil to extremely weathered, very low strength, highly fractured rock	1.5	1		
5[1]	Sound shale dipping sharply towards railway formation, tight cemented gravel	N/A	N/A		
6[1]	Distinctly weathered, low strength, well developed, closely spaced bedding or fractured rock	N/A	N/A		
7[1]	Slightly weathered, medium strength, massive to widely spaced bedding or fractured rock	N/A	N/A		

Notes:

1 A geotechnical engineer must confirm batter slope design.

Requirements of EGH-20-01 shall apply to cutting geometry.

Appendix B – Earthworks Materials Management Framework

Page B-1

EARTHWORKS MATERIALS REUSE (Cont.)

NOTES TO CHART 1

1. General

All sampling and analysis date/reports (geotechncial, contamination & hydrological) must be tracked and registered to teh material movements and stockpile locations for the duration of the project, and following project handover particularly where permanent spoil mounds are built.

2. Reference Material

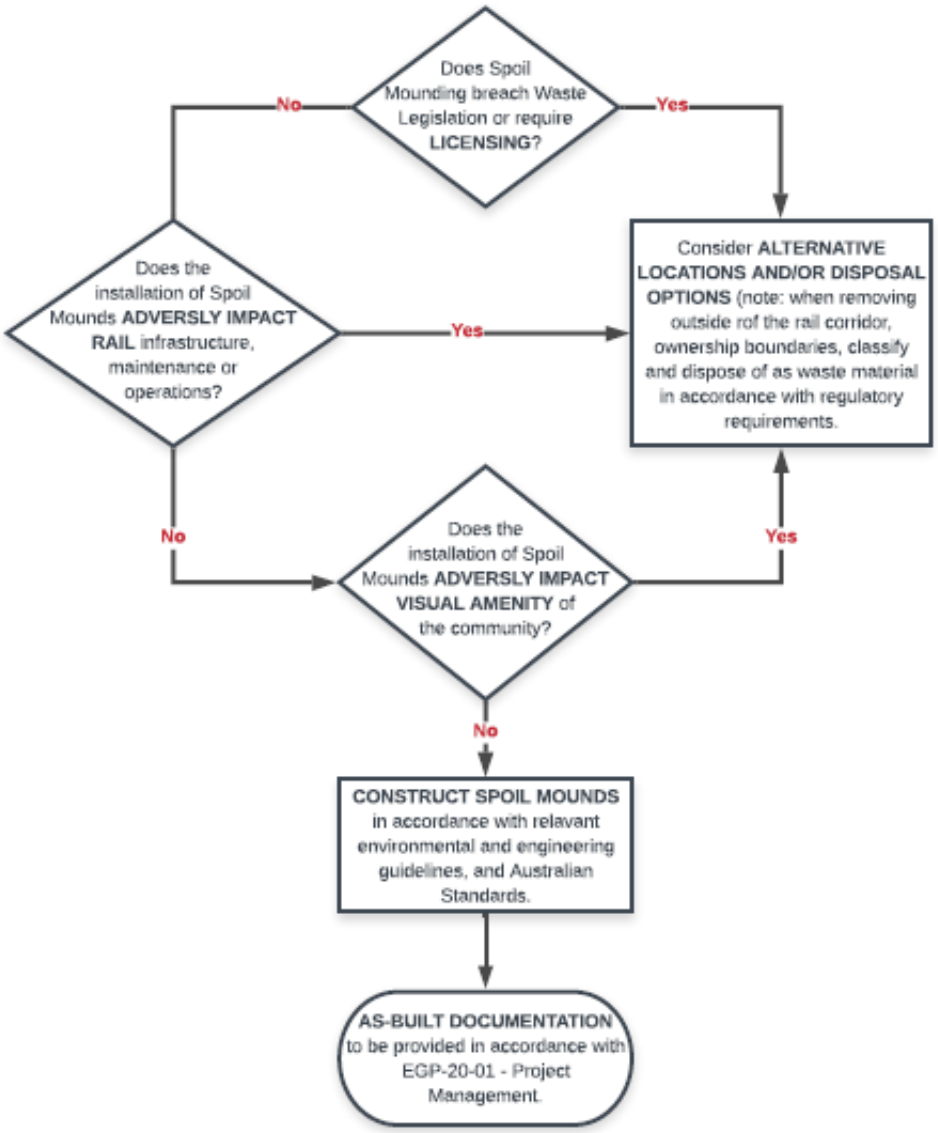
- National Environmental Protection (Assesment of Site Contamination) Measure 1999 Amendment 2013 (NEPM 2013).
- Earthworks Materials Specification ETC-08-03 and Earthworks Construction Specification ETC-08-04.
- Wastem Contamination and/or Hazardous Materials Assessment Management Plans.
- Hydrological Investigations and Plans.
- All applicable Approval Conditions, Environmental Impact Assessments, and Hydrology and Flooding Programmes.

3. Potentially Contaminating Activities

- Acid / alkali plant and formulation
- Acid sulfate soils sites
- Acid sulfate rock sites
- Ammunition manufacture and usage (e.g. shooting ranges)
- Any land registered on ARTC Contaminated Land Database or any state regulatory authority's database
- Asbestos production, handling or disposal
- Asphalt/bitumen manufacturing
- Commercial engine and machinery repair sites
- Battery manufacturing or recycling
- Boat/ship building, marinas, slip ways and associated boat yards
- Boiler or kiln usage
- Chemical manufacture and formulation (e.g. fertilisers, paints, pesticides, photography, plastics, solvents)
- Chemical pesticide and storage usage
- Defence use
- Drum conditioning works
- Dry cleaning establishments
- Environmental incidents or spills
- Electrical transformers
- Ethanol production plant
- Explosives industries
- Fertiliser manufacturing plants
- Fill material imported onto a site from a potentially contaminated source
- Foundry Operations
- Gas works
- Herbicide manufacture
- High salinity areas
- Illegal dumping
- Industrial activities involving hazardous chemicals in significant quantities
- Iron and steel works
- Landfill sites, including on-site waste disposal and refuse pits
- Depots - machinery, vehicle, locomotive maintenance
- Metal treatments (e.g. electroplating) and abrasive blasting
- Firefighting training and use of firefighting foam
- Metal smelting, refining or finishing
- Mineral processing
- Mine sites involving waste rock or tailings deposits
- Naturally occurring asbestos
- Oil or gas production or refining
- Paint formulation and manufacture
- Pesticide manufacture and formulation sites
- Petroleum product or oil and chemical storage (including Underground Petroleum Storage Systems)
- Pharmaceutical manufacture and formulation
- Power stations
- Printing Radio-active material usage (e.g. hospitals)
- Railway yards
- Refuelling locations (including Direct into Locomotive - DIL refuelling)
- Scrap yards and recycling facilities
- Sewage treatment plant
- Sheep and cattle dips
- Sites of fires involving hazardous materials, including fire fighting foam use
- Sites of incidents involving release of hazardous materials
- Spray storage and mixing sites (e.g. for orchards)
- Spray painting industries
- Tanning and associated trades
- Textile operations
- Tyre manufacturing and retreading works
- Wood preservation and storage or cutting of treated timber
- Wool scouring

EARTHWORKS MATERIALS SPOIL MOUNDING

CHART 2



APPENDIX Y

Spoil Management Strategy

Appendix B Cut Material Generation and Fill Quantities

INLAND RAIL—BORDER TO GOWRIE ENVIRONMENTAL IMPACT STATEMENT

IR_1534

Appendix B

Cut material generation and fill quantities

Chainage		Length of section (m)	Anticipated topsoil stripping (m)	Total cut (m^3)	General fill (m^3)	Structural fill (m^3)	Capping (m^3)		
From	To						Capping (CBR50%)	Sub-capping 2 (CBR30%)	Sub-capping 2 (CBR20%)
30.60	39.86/0	9,260	0.2	119	180,344	34,396	12,564	14,687	16,799
39.86/0	10.47	10,470	0.2	1,876	7,407	112,158	28,089		
10.47	10.87	400	0.2			4,103	917		
10.87	11.23	360	0.2			3,250	825		
11.23	12.53	1,300	0.2		2,074	14,207	2,996		
12.53	17.84	5,310	0.2	16,780	11,226	75,716	17,891		
17.84	18.00	160	0.2		3,878	1,537	306	230	252
18.00	18.45	450	0.2	2,988	385	9,065	2,196	33	36
18.45	19.28	830	0.2		12,955	17,493	4,150		
19.28	19.96	680	0.2		1,287	6,917	1,629		
19.96	20.44	480	0.2		3,925	5,464	1,090		
20.44	22.17	1,730	0.2		1,174	16,004	3,967		
22.17	22.54	370	0.2		1,808	4,212	848		
22.54	22.87	330	0.2		1,342	3,744	757		
22.87	23.24	370	0.2		2,429	4,212	848		
23.24	24.88	1,640	0.2		5,109	17,545	3,760		
24.88	25.27	390	0.2		3,143	4,440	894		
25.27	30.41	5,140	0.2	1,288	10,568	42,084	7,623	8,397	9,216
30.41	30.90	490	0.2		3,101	5,489	1,107	33	36
30.90	33.52	2,620	0.2		8,356	26,406	6,007		
33.52	33.78	260	0.2	274	4,752	2,960	596		
33.78	34.00	220	0.2	114	597	2,133	504		

Chainage		Length of section (m)	Anticipated topsoil stripping (m)	Total cut (m^3)	General fill (m^3)	Structural fill (m^3)	Capping (m^3)		
From	To						Capping (CBR50%)	Sub-capping 2 (CBR30%)	Sub-capping 2 (CBR20%)
34.00	34.80	800	0.2	27,686		7,126	1,834		
34.80	34.83	30	0.2			267	69		
34.83	35.99	1,160	0.2		10,730	12,796	2,660		
35.99	37.58	1,590	0.2		4,999	16,478	3,646		
37.58	37.99	410	0.2		2,112	4,500	940		
37.99	38.73	740	0.2	224	256	6,595	1,697		
38.73	39.18	450	0.2		2,313	4,665	1,032		
39.18	40.88	1,700	0.2		15,770	18,473	3,898		
40.88	41.48	600	0.2		15,111	6,805	1,376		
41.48	41.50	20	0.2			178	46		
41.50	42.60	1,100	0.2	44,401		9,793	2,522		
42.60	42.91	310	0.2	119	1,188	2,549	475	476	522
42.91	44.57	1,660	0.2		43,231	13,571	2,457	2,722	2,988
44.57	45.80	1,230	0.2		26,137	10,055	1,820	2,017	2,214
45.80	46.40	600	0.2	14,484		5,330	1,359	33	36
46.40	46.44	40	0.2	255	85	375	92		
46.44	46.56	120	0.2		1,365	1,341	275		
46.56	46.60	40	0.2		96	375	92		
46.60	48.08	1,480	0.2	359,646		802	357		
48.08	48.80	720	0.1	1,571	160,177	7,948	1,662		
48.80	49.80	1,000	0.1	240,260		489	252		
49.80	50.04	240	0.2	1,493	479	2,203	553		
50.04	51.15	1,110	0.2	245,583		22,787	5,644		
51.15	53.95	2,800	0.2	4,737	342,401	49,788	10,931		
53.95	54.61	660	0.2	1,494	1,558	6,204	1,513		

Chainage		Length of section (m)	Anticipated topsoil stripping (m)	Total cut (m^3)	General fill (m^3)	Structural fill (m^3)	Capping (m^3)		
From	To						Capping (CBR50%)	Sub-capping 2 (CBR30%)	Sub-capping 2 (CBR20%)
54.61	56.50	1,890	0.3		433,946	18,930	3,813		
56.50	60.00	3,500	0.2	1,758,967	301	787	1,186		
60.00	60.65	650	0.2	2,204	302,758	7,254	1,464		
60.65	61.30	650	0.2	242,004	775	1,647	151		
61.30	62.08	780	0.2	829	260,573	8,854	1,788		
62.08	62.66	580	0.1	235,065	1,144	412	141		
62.66	63.60	940	0.1	4,003	242,529	9,989	2,021		
63.60	64.40	800	0.2	125,803		8,116	1,834		
64.40	64.66	260	0.2	1,718	827	2,607	596		
64.66	65.60	940	0.2	383	6,408	9,877	2,155		
65.60	66.08	480	0.2	6,403	9	4,391	1,104		
66.08	66.96	880	0.2		42,323	13,154	2,477		
66.96	67.20	240	0.2	6,497	300	2,015	499		
67.20	69.91	2,710	0.2		81,888	32,045	5,686		
69.91	71.30	1,390	0.2		15,390	11,470	2,076	2,247	2,466
71.30	71.50	200	0.2	3,647		1,766	442	33	36
71.50	73.49	1,990	0.2	74,260	9,643	19,475	4,574		
73.49	74.28	790	0.2	14,289	19,807	7,760	1,800		
74.28	74.55	270	0.2	30,073		2,448	631		
74.55	75.10	550	0.2	8,463	5,848	5,520	1,261		
75.10	77.80	2,700	0.2	54,225	17,690	27,004	6,179		
77.80	78.20	400	0.2	11,084	516	3,687	917		
78.20	78.65	450	0.2	2,882	890	4,144	1,032		
78.65	78.91	260	0.2		1,797	2,774	596		
78.91	79.16	250	0.2		4,705	2,697	573		

Chainage		Length of section (m)	Anticipated topsoil stripping (m)	Total cut (m^3)	General fill (m^3)	Structural fill (m^3)	Capping (m^3)		
From	To						Capping (CBR50%)	Sub-capping 2 (CBR30%)	Sub-capping 2 (CBR20%)
79.16	79.30	140	0.2	3,457		1,247	321		
79.30	80.00	700	0.2	516	17,601	7,393	1,623		
80.00	80.50	500	0.2	34,744		4,385	1,129		
80.50	80.52	20	0.2	455		178	46		
80.52	80.80	280	0.2	711	1,759	2,841	642		
80.80	81.00	200	0.2	2,787	16	1,781	459		
81.00	81.00		0.2						
81.00	81.66	660	0.2	122	19,776	7,005	1,513		
81.66	82.70	1,040	0.2	10,042	15,335	10,578	2,385		
82.70	83.30	600	0.2	16,233	88	5,477	1,376		
83.30	83.30		0.2						
83.30	83.51	210	0.2	368	583	2,013	482		
83.51	85.40	1,890	0.2		64,611	20,509	4,348		
85.40	85.67	270	0.2	3,081	66	2,379	613		
85.67	87.00	1,330	0.2	105,324		11,813	3,041		
87.00	88.64	1,640	0.2		138,038	16,833	3,398		
88.64	89.47	830	0.2	7,967	5,755	13,637	3,190		
89.47	91.11	1,640	0.2	5,540	103,805	39,294	9,377		
91.11	92.22	1,110	0.2		59,817	19,314	4,524		
92.22	94.19	1,970	0.2		28,803	19,304	4,061		
94.19	94.42	230	0.2		1,465	2,417	527		
94.42	94.65	230	0.2		1,070	2,249	527		
94.65	96.16	1,510	0.2		2,319	12,311	2,236	2,452	2,691
96.16	98.96	2,800	0.2	159	198,518	32,191	5,931	33	36
98.96	99.22	260	0.2		7,732	2,233	403	394	432

Chainage		Length of section (m)	Anticipated topsoil stripping (m)	Total cut (m^3)	General fill (m^3)	Structural fill (m^3)	Capping (m^3)		
From	To						Capping (CBR50%)	Sub-capping 2 (CBR30%)	Sub-capping 2 (CBR20%)
99.22	99.35	130	0.2		2,083	1,063	192	213	234
99.35	99.53	180	0.2		5,137	1,472	266	295	324
99.53	100.41	880	0.2	97	25,409	4,357	789	874	959
100.41	101.02	610	0.2		7,433	8,781	1,662	1,051	1,154
101.02	101.65	630	0.2		10,294	7,115	1,433		
101.65	102.10	450	0.2		12,789	5,085	1,032		
102.10	104.14	2,040	0.2	15,540	1,174	18,285	4,689		
104.14	104.15	10	0.2			89	23		
104.15	104.56	410	0.2		5,721	2,952	672		
104.56	104.98	420	0.2		6,085	4,781	963		
104.98	105.80	820	0.2		16,585	9,134	1,880		
105.80	106.40	600	0.2	40,102	8	5,344	1,376		
106.40	106.50	100	0.2	748	209	940	229		
106.50	107.60	1,100	0.2	390	23,414	12,027	2,522		
107.60	107.80	200	0.2	3,590		1,781	459		
107.80	108.80	1,000	0.2	263	71,999	11,148	2,293		
108.80	109.30	500	0.2	55,447		4,454	1,146		
109.30	109.34	40	0.2	1,159		356	92		
109.34	110.20	860	0.2	1,851	4,906	8,193	1,972		
110.20	110.90	700	0.2	47,566		6,235	1,605		
110.90	111.00	100	0.2	248	301	940	229		
111.00	112.20	1,200	0.2	84,998	96	10,879	2,751		
112.20	112.40	200	0.2	603	928	2,017	459		
112.40	112.90	500	0.2	80,522	33	4,460	1,146		
112.90	113.12	220	0.2		13,303	2,498	504		

Chainage		Length of section (m)	Anticipated topsoil stripping (m)	Total cut (m^3)	General fill (m^3)	Structural fill (m^3)	Capping (m^3)		
From	To						Capping (CBR50%)	Sub-capping 2 (CBR30%)	Sub-capping 2 (CBR20%)
113.12	114.20	1,080	0.2	28,561	12,028	10,616	2,476		
114.20	114.40	200	0.2		2,247	2,265	470		
114.40	114.85	450	0.2	113,795	415	4,046	1,020		
114.85	115.10	250	0.2	119	3,441	2,685	573		
115.10	115.24	140	0.2	4,459		1,291	332		
115.24	115.80	560	0.2	135	65,788	5,269	1,066		
115.80	117.10	1,300	0.2	252,186		11,620	2,969		
117.10	117.28	180	0.2	528	2,117	2,058	413		
117.28	120.52	3,240	0.2	4,479	24,692	33,347	7,429		
120.52	120.58	60	0.1		241	565	138		
120.58	120.80	220	0.1		1,737	2,381	504		
120.80	123.80	3,000	0.1	1,489,426	414	988	848		
123.80	123.84	40	0.1	197	61	267	66		
123.84	126.10	2,260	0.1	525	201,802	25,553	5,193		
126.10	126.50	400	0.1	8,359		3,577	906		
126.50	128.37	1,870	0.1		227,040	16,212	3,285		
128.37	130.29	1,920	0.2	15,858	26,570	27,996	6,541		
130.29	130.74	451	0.2	729	8,806	11,989	2,719		
130.74	131.25	510	0.2		32,427	10,904	2,592		
131.25	131.63	380	0.2		44,887	8,617	1,977		
131.63	136.37	4,740	0.2	2,741	48,202	58,096	12,505		
136.37	145.07	8,700	0.2		130,968	61,695	11,505		
145.07	146.45	1,380	0.2		5,232	10,517	1,904	2,110	2,316
146.45	149.75	2,700	0.2		14,007	26,896	4,869	5,396	5,922
149.15	157.78	8,630	0.2	1,334	40,308	81,922	14,831	16,434	18,038

Chainage		Length of section (m)	Anticipated topsoil stripping (m)	Total cut (m^3)	General fill (m^3)	Structural fill (m^3)	Capping (m^3)		
From	To						Capping (CBR50%)	Sub-capping 2 (CBR30%)	Sub-capping 2 (CBR20%)
157.78	164.40	6,620	0.2	66,829	779,026	66,943	13,858	33	36
164.40	164.80	420	0.2	100,100			154		
164.80	164.82	980	0.2	2,117			8		
164.82	165.80	100	0.2	592,406			479		
165.80	165.90	1,700	0.2	604	81		19		
165.90	167.60	40	0.2	368,487	4	3,490	396		
167.60	167.64	70	0.2	547		340	88		
167.64	167.71	450	0.2	249	60	682	172		
167.71	168.16	170	0.2	2,047	1,906	4,437	1,020		
168.16	168.33	430	0.2		3,441	1,935	390		
168.33	168.76	440	0.2		37,293	5,094	1,008		
168.76	169.20	200	0.2	56,582	60	4,389	998		
169.20	169.40	200	0.2		11,533	2,259	459		
169.40	169.60	1,760	0.2	5,560		1,734	447		
169.60	171.36	640	0.2	843	305,500	18,801	3,831		
171.36	172.00	2,400	0.2	80,297		6,484	1,467		
172.00	174.40	1,100	0.2	100,818	398,990	12,668	2,060		
174.40	175.50	300	0.2	951,085		9,341	91		
175.50	175.80	500	0.2	85	19,362	6,679	1,541		
175.80	176.30	600	0.2	87,678		10,361	2,552		
176.30	176.90	100	0.2		52,306	17,804	4,126		
176.90	177.00	2,300	0.2	1,290	1,001	2,896	624		
177.00	179.30	1,000	0.2	1,556,378	4,097	13,946	6,104		
179.30	180.30	510	0.2		297,989	11,383	2,293		
180.30	180.81	91	0.2		85,941	5,853	1,181		

Chainage		Length of section (m)	Anticipated topsoil stripping (m)	Total cut (m^3)	General fill (m^3)	Structural fill (m^3)	Capping (m^3)		
From	To						Capping (CBR50%)	Sub-capping 2 (CBR30%)	Sub-capping 2 (CBR20%)
180.81	180.90	360	0.2		196	835	206		
180.90	181.26	2,700	0.2	5,829		3,237	835		
181.26	183.96	740	0.2	4,740	224,531	27,661	5,794		
183.96	184.70	300	0.2	132,675		6,591	1,697		
184.70	185.00	700	0.2	1,556	5,549	3,172	688		
185.00	185.70	640	0.2	114,627		6,235	1,605		
185.70	186.34	480	0.2	647	103,129	7,186	1,467		
186.34	186.82	380	0.2	30,664		4,318	1,112		
186.82	187.20	920	0.2	549	2,513	3,959	871		
187.20	188.12	40	0.2	145,029		8,212	2,116		
188.12	188.16	700	0.2	492		331	85		
188.16	188.86	1,540	0.2	412	38,071	7,598	1,594		
188.86	190.40	1,800	0.2	1,372,374		387	487		
190.40	192.20	1,100	0.2	398	808,110	20,517	4,127		
192.20	193.30	100	0.2	424,092	110	3,139	379		
193.30	193.40	1,240	0.2	2,390		939	227		
193.40	194.64	4,350	0.2	174,600		12,585	2,841		
194.64	198.99	180	0.2	586	1,137,421	44,499	8,599		
198.99	199.17	830	0.2		36,601	2,435	432		
199.17	200.00	200	0.2	1,572	9,049	8,757	1,918		
200.00	200.20	1,600	0.2	4,358	3	1,781	459		
200.20	201.80	950	0.2	1,659	104,986	17,715	3,669		
201.80	202.75	2,000	0.2	133,832	183	1,047	84		
202.75	204.75	160	0.2		488,185	17,364	3,497		
204.75	204.91	900	0.2		162,542	1,415	255	230	252

Chainage		Length of section (m)	Anticipated topsoil stripping (m)	Total cut (m^3)	General fill (m^3)	Structural fill (m^3)	Capping (m^3)		
From	To						Capping (CBR50%)	Sub-capping 2 (CBR30%)	Sub-capping 2 (CBR20%)
204.91	205.81	1,190	0.2		358,585	12,067	2,142	33	36
205.81	206.90	1,190	0.2	1,703	5,024	12,186	2,746		
Totals				12,525,037	9,595,807	2,070,678	456,727	60,456	67,031

Table note:

CBR = California Bearing Ratio

APPENDIX Y

Spoil Management Strategy

Appendix C Total Cut and Total Fill along the Project Alignment

INLAND RAIL—BORDER TO GOWRIE ENVIRONMENTAL IMPACT STATEMENT

IR_1534

Appendix C

Total cut and total fill along the Project alignment