APPENDIX V

INLAND RAIL

Spoil Management Strategy

CALVERT TO KAGARU ENVIRONMENTAL IMPACT STATEMENT

IR_1381

ARTC

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

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1. Overview

1.1 Purpose and scope

This Spoil Management Strategy (SMS) has been developed to guide the decision-making process for the management of spoil material generated by the Calvert to Kagaru Project (the Project). The Project is one of 13 projects that make up the Inland Rail Program for the delivery of 1,700 kilometre (km) rail line. It is one of five Inland Rail projects in Queensland (QLD). The Project connects to the Helidon to Calvert (H2C) in the north-west and Kagaru to Acacia Ridge and Bromelton (K2ARB) in the south-east (refer Figure 1.1).

The scope of this SMS extends to the construction of an approximately 53 km railway and supporting infrastructure such as roadworks. This SMS should be read in conjunction with the Australian Rail Track Corporation (ARTC) Earthworks Material Specification (ETC-08-03) version 1.2 (refer Appendix A).

While the document provides the overall strategy for the management of spoil material generated by the Project, a Construction Environmental Management Plan (CEMP) and associated Waste Management Plan will be prepared following detailed design to confirm site-specific requirements in accordance with the Draft Outline Environmental Management Plan (refer EIS Chapter 23).

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.

Key objectives of the SMS are to provide measures to:

- Manage spoil in accordance with *Waste Reduction and Recycling Act 2011* (Qld) (WRR Act) hierarchy
- Manage spoil in accordance with identified sustainability initiatives for the Project
- Manage spoil in a manner that minimises adverse impacts on construction activities, timing and costs.

The WRR Act provides a strategic framework for managing waste by establishing a waste and resource management hierarchy, which is in the order of preference:

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

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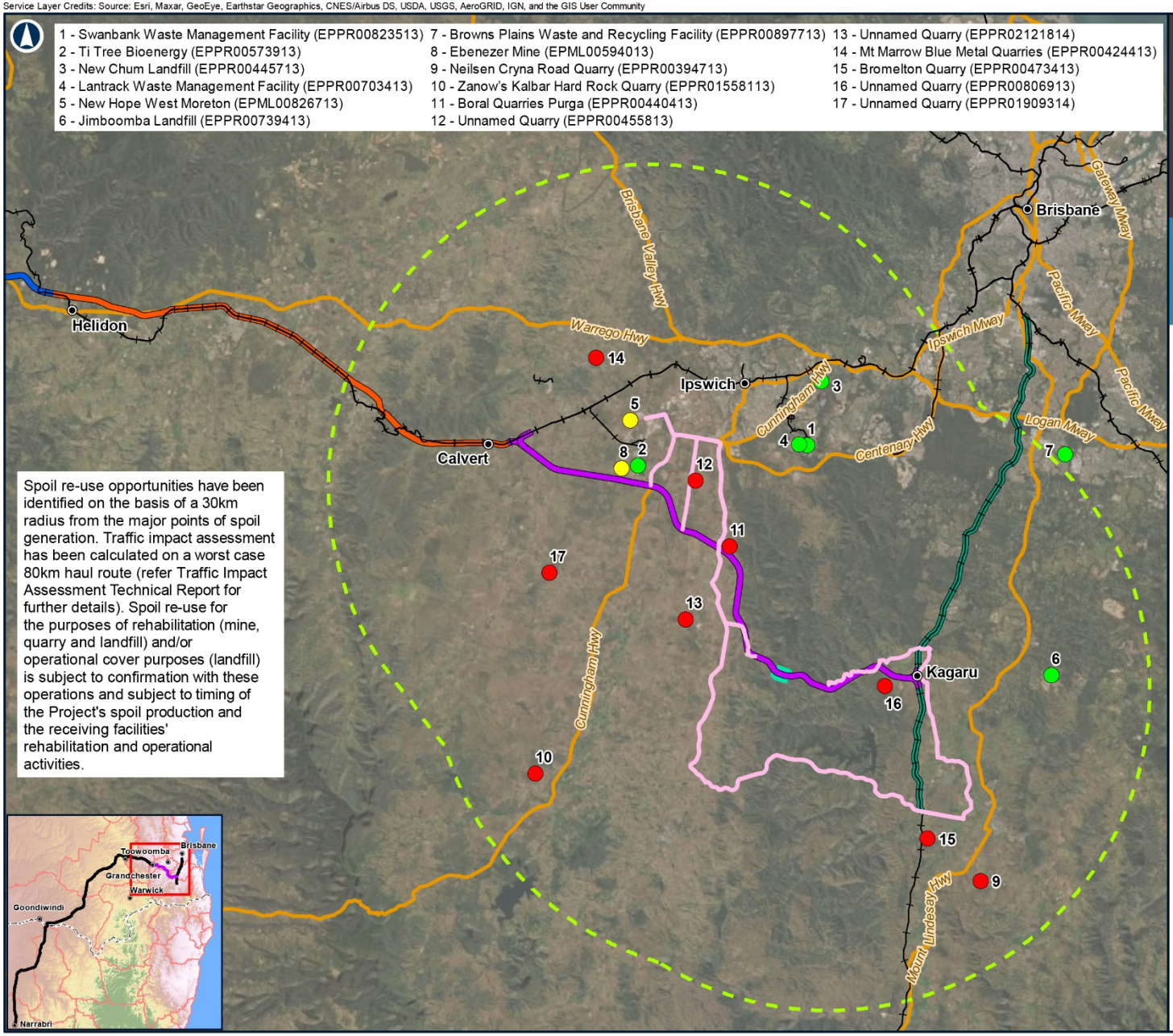

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CALVERT TO KAGARU

Figure 1.1:
Project context and spoil re-use opportunities

LEGEND

- Localities
- Quarry (>100,000tpa) - Quarry site rehabilitation
- Mine site rehabilitation
- Landfill - day, interim and final (cap) cover
- Spoil material haulage route (worst case)
- Existing rail
- G2H project alignment
- H2C project alignment
- C2K project alignment
- K2ARB project alignment
- Major roads
- Tunnel
- 30km radius from the major points of spoil generation

0 10 20 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 21/09/2020
Author: FFJV GIS
Data Sources: FFJV

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Scale: 1:500,000

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

For the purposes of the Environmental Impact Statement (EIS) assessment and the preparation of this SMS, production and management of spoil has been assumed to be limited to the rail corridor and associated construction works depicted on the design and quantified in the bill of quantities for the Project. However, in practical terms, this is unlikely to be the case and this SMS encourages the identification of opportunities to use spoil from the Project on adjacent and proximal Inland Rail projects, including the H2C and K2ARB.

TABLE 1.1: SPOIL MANAGEMENT HIERARCHY

Rank	Options	Example
1	Avoid and reduce spoil	Reduce the amount of spoil generated by the Project by reducing the extent and scale of cut where an immediate re-use opportunity in proximity to the source location does not exist, e.g. sections of the Project where a surplus of material will be generated
2	Re-use within the rail corridor	Re-use within the Project, subject to the material complying with the ARTC Earthworks Material Specification, to establish formation, fill embankments and mounds within short haulage distance of the source location
3	Re-use for environmental works and land restoration	Examples include: ▸ Re-use in the rehabilitation of native vegetation ▸ Re-use for landscaping ▸ Re-use for land re-instatement, including end-of life mines currently proposed for alternate use as waste and recycling facilities (Ebenezer Mine and New Hope West Moreton), subject to outcomes of planning applications ▸ Re-use for landfill covers (day and interim covers) and final capping (where deemed suitable)
4	Re-use on other development	Re-use for fill embankments and mounds on projects within a reasonable haulage distance (less than 80 km) from the site, prioritising other components of the Inland Rail Program
5	Dispose offsite as waste	Disposal of excess spoil as waste at an approved facility licensed to receive the material. Offsite disposal to landfill should only occur if the material is considered unsuitable without treatment for other uses, e.g. due to contamination

1.3 Further development

This version of the SMS has been developed in support of the EIS for the Project. It will be reviewed and updated as the Project progresses through detailed design and into construction, in order to remain valid. 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 processes, including approvals
- Changes in applicable legislation, policy and guidelines
- Consultation with stakeholders
- Outcomes from further geotechnical testing and site investigations, including for contamination
- Confirmation of contractual and commercial models for the execution of the Project, including the nature and scope of incentives and key performance indicators (KPIs) associated with spoil production and its management
- Greater certainty of the construction methods to be implemented for delivering the Project
- Continuous improvement and evaluation of environmental management performance against environmental policies, objectives and targets.

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 without treatment on the Project. The production and management of spoil for the Project has been limited to the disturbance footprint. The disturbance footprint includes the rail corridor and other permanent works associated with the Project (e.g. where changes to the road network are required) as well as the construction footprint where only temporary disturbance is proposed (e.g. laydown areas and compound sites).

The hierarchy of spoil management is largely driven by the cut and fill balance. The Project design calculates that 5,859,671 m^3 of cut material will be produced during construction, primarily from surface works. A calculated 4,237,167 m^3 of this cut material (including 824,534 m^3 of rock) is estimated to be suitable for immediate re-use as general earth fill for the construction of zoned embankments. A calculated excess of approximately 1,622,504 m^3 of spoil will be managed or treated with the potential for re-use.

Where practicable, spoil will be re-used within the disturbance footprint through treatment, amelioration or drying, and any material that cannot be treated for appropriate re-use may then be disposed offsite. Offsite disposal to landfill should only occur if the material is considered unsuitable without treatment for other uses e.g. due to geotechnical, contamination or saturation reasons. The spoil management decision process is summarised in Figure 2.1. The opportunity to use excess suitable material on adjacent Inland Rail projects will be explored as the highest priority and best option for the use of surplus material from the Project, as depicted in Figure 2.1.

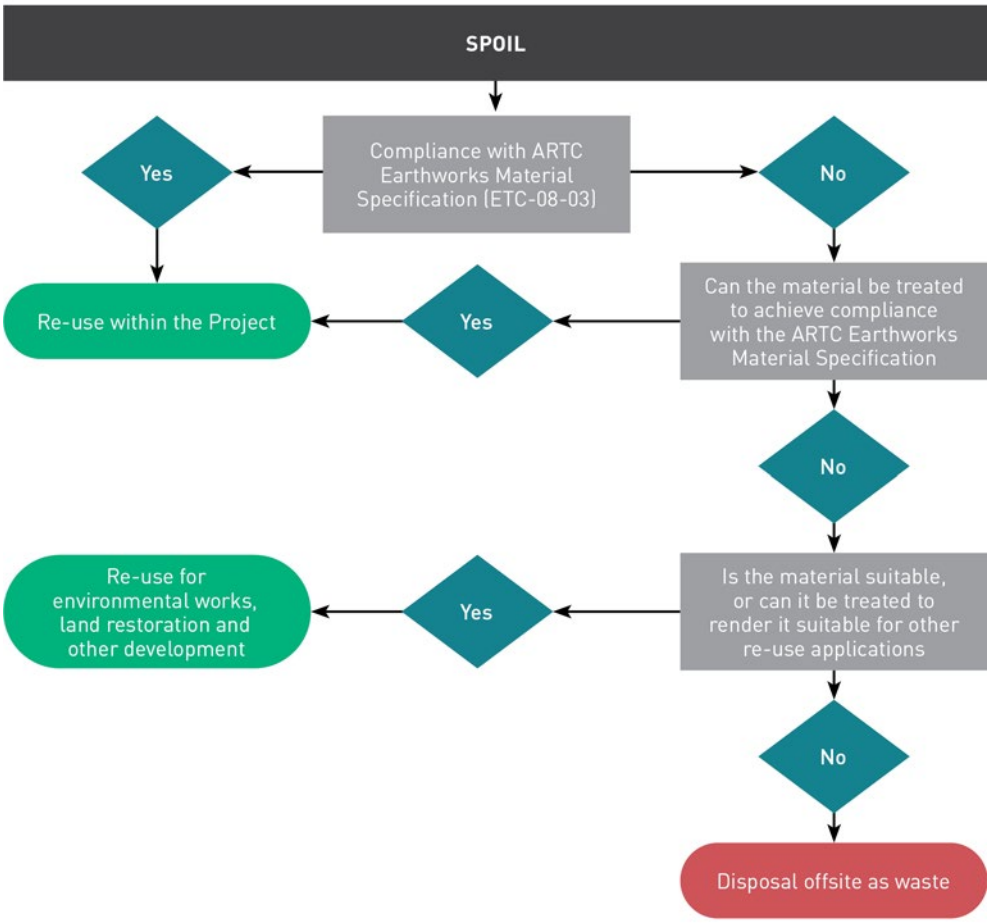

FIGURE 2.1: DECISION PROCESS FOR SPOIL MANAGEMENT

2.1 Spoil reduction

The anticipated spoil material generation associated with the construction of the Teviot Range tunnel has been reduced by using a roadheader rather than drill and blast methods. Roadheaders have a diverse cutting range, which results in a more accurate cut and therefore generation of less spoil.

Wherever practical, spoil material generation will continue to be minimised as the Project progresses through the detailed design and construction phases.

2.2 Earthworks material types and classification

The ARTC Earthworks Material Specification (ETC-08-03) version 1.2 (refer Appendix A) describes material types, associated compliance criteria and classification/suitability of materials for use within the Inland Rail Program.

In line with this specification, the following sections identify both suitable and unsuitable material for use as a foundation for earthworks structures or for use as fill material within the disturbance footprint.

2.2.1 Suitable material

The Project is expected to produce 4,237,167 m^3 of cut material (including 824,534 m^3 of rock) that is compliant with the ARTC Earthworks Material Specification (refer Appendix A) and therefore suitable for immediate re-use as Type A, B, C or D general earth fill for the construction of zoned embankments.

All topsoil from the Project will be stripped and stockpiled for re-use in the staged reinstatement of work fronts.

Type A material (where identified in cuttings) can 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 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 (refer Figure 2.2).

The differentiation of the fill types is dependent on their particle size distribution, which determines the compaction ability of the general earth fill. This then determines the material's suitability for use as general earth fill during the construction of zone embankments as discussed below (refer Figure 2.2). Type A or Type B fill have a minimum California Bearing Ratio (CBR) of 3 per cent whereas Type C and D fill have a minimum CBR of 1 per cent.

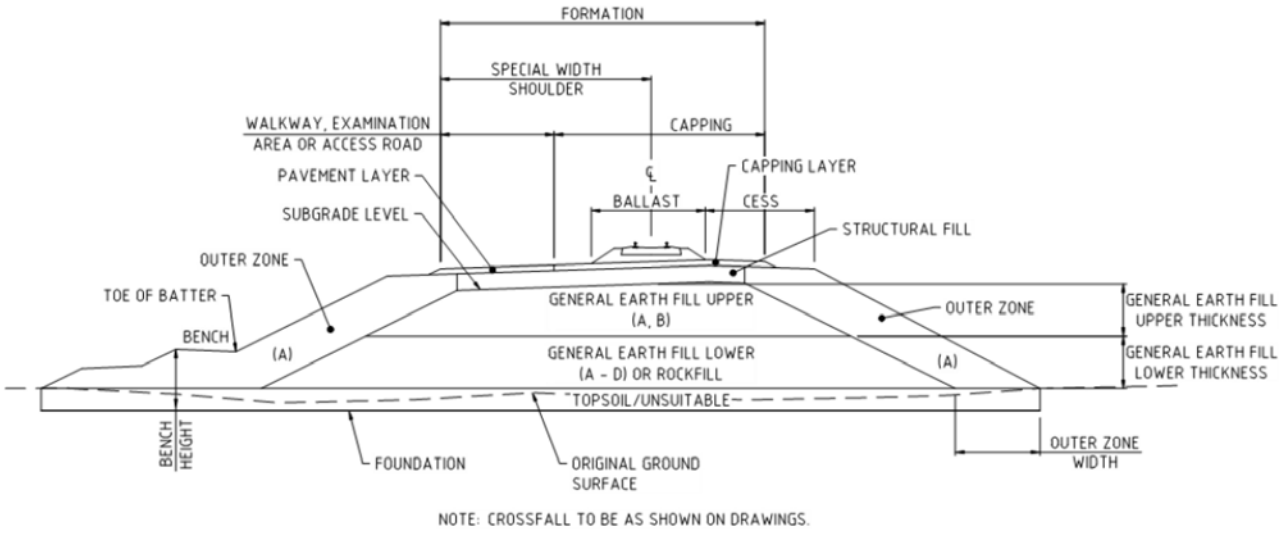

FIGURE 2.2: SCHEMATIC OF ZONED EMBANKMENT CROSS SECTION

2.2.2 Unsuitable material

The Project design has calculated 1,622,504 m^3 of material that will be produced that is not appropriate for immediate re-use (without treatment) within the engineered embankments. The ARTC Earthworks Material Specification (refer Appendix A) classifies material as unsuitable 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 (noting that in-situ treatments can be undertaken to modify the moisture content and consistency).
- Organic content: Materials with organic content are typically considered unsuitable for construction purposes due to being highly compressible, degradable and susceptible to collapse. These materials may be suitable for use in topsoil and vegetation rehabilitation applications with blending.
- Dispersive: Dispersive materials (Emerson Class < 4) have a high potential for erosion; therefore, it is recommended their usage be restricted to areas where they are not exposed to free water. Dispersive materials that can meet Type C/D requirements may potentially be incorporated into the core of a zoned embankment or used with due consideration for the associated risks. Alternatively, the dispersive characteristics of materials can be potentially reduced using chemical additives.
- Compaction requirements: Materials that are unsuitable to be re-compacted to a suitable density to achieve the minimum CBR design requirements (nominally CBR 3 per cent) or to achieve the required engineering design characteristics.
- Reactivity: Reactive materials with significant shrink swell potential may lead to excessive movement within the fill. Reactive materials that can meet Type C/D fill requirements may potentially be incorporated into the core of a zoned embankment or used where they are protected from significant moisture variations. Alternatively, chemical treatment could be considered to modify the reactivity of the clayey materials. Reactive soils up to swelling indices of 7 per cent have been found present along the Project alignment.
- Acidity: Acidic soils such as the surface layers of kurosols expected to be encountered generally with a pH less than 5.5. It is noted that in-situ treatments, such as the addition of lime, can be a successful method of ameliorating soil acidity. While the acidity of the soils has no impact on the engineering characteristics of the materials, the reusability of the stripped topsoil can be improved if the acidity is managed. Due to the topographic position of the Project, no acid sulfate soils (ASS) are anticipated to occur.
- Contamination: Contaminants may be present in the material due to several factors. Based on the land uses of the Project and the findings of a desktop assessment, potential sources of contamination for 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
  - Queensland Raceway, Willowbank: hydrocarbons (fuel and oil storage and use)
  - Landfilling and 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 mm are typically excluded from earthworks, as they cannot be adequately compacted. The oversize material can be considered for use as rock fill or riprap. The oversize sedimentary rock fragments are typically broken down to approximately 150 mm size particles by tracking with a tracked earthmoving machinery, such as excavators and dozers.
- Atterberg Limits or weighted plasticity index values exceeding the maximum limits stated in the Project specification (refer Appendix A).

All materials with one or a combination of the above characteristics may be specified as 'unsuitable' without treatment for use within the Project's engineered embankments. Unsuitable materials are expected to occur within gullies, the alluvial plains, as colluvium at the toe of hills, and residual soils developed on sedimentary rocks. Unsuitable materials within the Project will predominantly include material from alluvium and residual soils from the Walloon Coal Measures (WCM) or Koukandowie Formation.

For the purposes of this SMS, anticipated material re-use potential has been based on the main geological units identified in the disturbance footprint.

Waste rock

Waste rock is a term typically derived from the resources industry, where waste rock sometimes has pyritic qualities. EIS Chapter 9: Land Resources provides information on the physical and chemical characteristics of rock generated from the Project, including management requirements in the event that acidic materials are encountered during Project activities. Based on the assessment of desktop information and field investigations, rock with acid producing qualities has not been identified within the Project. Therefore, all rock that is won through excavation has been assumed to be re-used on the Project and is not defined as a waste (refer EIS Chapter 21: Waste and Resource Management). This is subject to the material being tested to determine the waste classification and suitability for re-use, in accordance with the guidelines, specifications and CEMP adopted for the Project.

If rock is not contaminated it may be crushed and re-used onsite as aggregate for fill, construction pads/laydown areas or road base. Under the Environmental Protection Regulation 2019 (EP Regulation), an approval for Environmentally Relevant Activity (ERA) 33 is not required for the extraction of material from a place for constructing a road or railway at the place. An approval for ERA 33 will only be required for the crushing, milling, grinding or screening of material exceeding 5,000 tonnes per year if the activity is undertaken outside of the Project. It has been assumed that such activities would be undertaken by a third-party commercial operation and they would be responsible for obtaining the requisite ERA to allow this activity to occur. As such, these places are not included within this assessment.

In accordance with the Draft Outline Environmental Management Plan (Draft Outline EMP) (refer EIS Chapter 23), soil conditions across the disturbance footprint will be appropriately characterised at a suitable scale through additional geotechnical surveys during the detailed design phase of the Project to inform design and environmental management measures.

Contaminated material

A Tier 1 Preliminary Site Investigation (contaminated land assessment) has been undertaken for the Project (refer EIS Chapter 9: Land Resources), in line with the processes and guidance detailed in the National Environment Protection (Assessment of Site Contamination) Measure 1999 (Cth) (ASC NEPM). As per EIS Chapter 9: Land Resources, the disturbance of existing contaminated land at the construction phase of the Project has been identified as presenting a medium (mitigated) risk. It should be noted that the extent and type of contamination has not yet been defined for the Project.

In accordance with the Draft Outline EMP, a targeted contaminated land investigation will be undertaken during the detailed design phase (post-EIS) to determine the likelihood of contaminated land, potential risks to human health/environment and required management measures. A contaminated land management strategy has also been prepared for the Project (refer EIS Chapter 9: Land Resources). Any contaminated land encountered as a result of project activities will be segregated and stockpiled separately in accordance with regulatory requirements and procedures identified in the Project's CEMP, including Soil Management Sub-plan. Prior to construction, the contractor must ensure that the requirements of Chapter 5, Division 1 and Division 2, of the EP Regulation are adhered to, including the testing and characterisation of regulated wastes and their intended treatment or disposal.

EIS Chapter 20: Hazard and Risk further details contaminated land that may arise as a result of the Project, providing an assessment of impacts and mitigation measures.

2.3 Spoil treatment and re-use in engineered embankments

Table 2.1 details technically feasible treatment options for unsuitable material that would allow re-use within the Project's engineered embankments. The proposed additional mitigations will require further investigation post-EIS. Quantities of spoil material re-used should be monitored, in order to track performance against sustainability targets.

TABLE 2.1: SPOIL RE-USE

Types of material	Initial mitigations	Proposed additional mitigations
Topsoil	All topsoil is to be stripped and stockpiled and re-incorporated back into the works. 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 of the Project.
Dispersive and Type B/C/D material recovered from cuttings	Assume all this material can be incorporated into a zoned embankment (as per ARTC Earthworks Material Specification). Type A material (where identified in cuttings) can be selectively won and re-incorporated into the outer part of zoned embankments. Type B and C material is to be selectively won and incorporated into the upper parts of zoned embankments.	Further investigation and earthworks balancing between areas of cut and fill. 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 EIS investigations—assume this can be incorporated/encapsulated within existing earthworks.	Further investigations to define contamination and encapsulation requirements required. Compliance of materials with the appropriate contamination criteria (e.g. *National Environment Protection (Assessment of Site Contamination) Measure 1999 (Cth) guidelines*).
Acid sulfate soils (ASS)	Initial assessment indicates ASS is unlikely to be encountered over the Project. 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 indicates that acid rock drainage is unlikely to be encountered in the Project. Assume not required.	Not applicable
Structurally unsuitable material	Unsuitable material to be sent to spoil and ameliorated on site suitable for re-use back into the Project.	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 flood plain areas are to be dried or ameliorated before being incorporated back into the works as general earth fill.

Sustainability considerations with regards to spoil management are included in EIS Chapter 7: Sustainability. ARTC also has an Inland Rail Environmental and Sustainability Policy (2018), which provides sustainability-related commitments throughout design, construction and operation of the Project.

A summary of the re-use potential for the main geological units of the Project is presented in Table 2.2.

TABLE 2.2: ANTICIPATED MATERIAL RE-USE - MAIN GEOLOGICAL UNITS OF THE PROJECT

Geology	Lithology	Description/weathering	Anticipated typical potential material re-use
Alluvium	Clay, clayey sands and gravelly clay	Typically, dark coloured, high plasticity clay	Type C to Unsuitable
Walloon Coal Measures	Sandstone, siltstone, mudstone and coal	Residual/extremely weathered	Type C to Unsuitable
		Highly Weathered or Better	Type B fill (subject to dispersivity) Type C/D fill
Koukandowie Formation	Lithofeldspathic labile and sublabile to quartzose sandstone, siltstone, shale, minor coal	Residual/extremely weathered	Type B to Unsuitable
		Highly/moderately weathered	Type A/B fill (subject to dispersivity and % passing 0.075 mm) Type C/D fill
		Slightly weathered/fresh	Bulk, select, rockfill, Type A–B (subject to dispersivity and % passing 0.075 mm)
Gatton Sandstone	Lithic labile and feldspathic labile sandstone	Residual/extremely weathered	Type AB fill (subject to dispersivity and % passing 0.075 mm) Type C/D fill
		Highly/moderately weathered	Rock fill (subject to % passing 0.075 mm) Type B Fill (subject to dispersivity)
		Slightly weathered/fresh	Bulk and select fill, rockfill, Type A/B (subject to dispersivity)
Tertiary age volcanics	Alkali basaltic volcanics	Residual to highly weathered	Type A to D
		Moderately/slightly weathered/fresh	Select, structural fill, rockfill, Type A/B

A summary of the re-use potential for major cuttings of the Project is presented in Table 2.3. EIS Chapter 9: Land Resources (Figure 9.4) shows the main surface geology intersected by the Project.

TABLE 2.3: ANTICIPATED MATERIAL RE-USE OPPORTUNITIES FOR ENGINEERED EMBANKMENTS - CUTTINGS

Area ID	Chainage start (km)	Chainage end (km)	Cut volume (m^3)	Estimated suitability of cut material for re-use	Anticipated rock/soil type intersected	Potential additional mitigations
340-C1	3.8	4.41	101,385	20% unsuitable 60% general fill C/D 20% general fill A/B	Shallow cut, mainly in high plasticity clays from residual to XW soils (WCM).	Lime treatment may allow reduction of Unsuitable
340-C2	9.14	11.03	871,815	10% unsuitable 50% general fill C/D 40% general fill A/B	High plasticity and dispersive residual soil (sandy clay, clay); sedimentary rocks (WCM) from approximately 5 m to 15 m depth (mudstone/siltstone/sandstone/coal).	Lime treatment may increase Type A/B over C/D
340-C3	12.14	12.83	47,131	10% unsuitable 60% general fill C/D 30% general fill A/B	High plasticity and dispersive clays from residual soils; XW-HW sandstone and interbedded sedimentary (WCM) from approximately 2 to 5 m depth (mudstone/siltstone/sandstone/coal).	Lime treatment may increase Type A/B over C/D
340-C4	15.08	16.85	965,615	10% unsuitable 50% general fill C/D 40% general fill A/B	Deep residual high plasticity clay (5 m to 15 m) over Tertiary age intrusions, flows and sedimentary (sandstone, siltstone, mudstone, coal, dolomite).	Lime treatment may increase Type A/B over C/D
340-C5	18.63	19.32	34,806	10% unsuitable 60% general fill C/D 30% general fill A/B	High plasticity and dispersive clays from residual to XW soils (WCM).	Lime treatment may increase Type A/B over C/D
340-C6	19.62	20.24	17,992	10% unsuitable 60% general fill C/D 30% general fill A/B	High plasticity and dispersive clays from residual to XW soils (WCM).	Lime treatment may increase Type A/B over C/D
340-C7	20.86	21.23	18,172	10% unsuitable 60% general fill C/D 30% general fill A/B	High plasticity and dispersive clays from residual to XW soils (WCM).	Lime treatment may increase Type A/B over C/D
340-C8	21.87	22.83	216,147	10% unsuitable 60% general fill C/D 30% general fill A/B	High plasticity and dispersive clays, consisting of alluvium and/or colluvium clayey soil over residual soil; Sedimentary from depths of 2 to 5 m (WCM—predominantly claystone/mudstone), possibly lenses of Amberley Basin sedimentary rocks.	Lime treatment may increase Type A/B over C/D
340-C9	26.11	26.95	246,026	60% general fill C/D 40% general fill A/B	High plasticity and dispersive residual soil (clay); from 2 m to 3 m depth weathered basalt flow over residual clay and weathered WCM rock.	Lime treatment may increase Type A/B over C/D
340-C10	28.93	29.16	3,235	10% unsuitable 60% general fill C/D 30% general fill A/B	High plasticity and dispersive clays from residual to XW soils (WCM).	Lime treatment may increase Type A/B over C/D

Area ID	Chainage start (km)	Chainage end (km)	Cut volume (m^3)	Estimated suitability of cut material for re-use	Anticipated rock/soil type intersected	Potential additional mitigations
340-C11	29.41	29.71	17,742	60% general fill C/D 40% general fill A/B	High plasticity and dispersive clays from residual to XW soils (WCM)	Lime treatment may increase Type A/B over C/D
340-C12	29.98	31.12	322,469	10% unsuitable 60% general fill C/D 30% general fill A/B	High plasticity and dispersive clays, clay dominated alluvium. Interbedded sedimentary rock (KOUKF) from approximately 5 m to 15 m depth (mudstone/siltstone/ sandstone/coal).	Lime treatment may increase Type A/B over C/D
340-C13	31.34	32.01	19,443	10% unsuitable 60% general fill C/D 30% general fill A/B	High plasticity and dispersive clays from residual soils. Sedimentary from approximately 12 m depth (KOUKF: mudstone/siltstone/sandstone/ coal).	Lime treatment may increase Type A/B over C/D
340-C14	32.36	33.15	157,093	10% unsuitable 60% general fill C/D 30% general fill A/B	High plasticity and dispersive soils: Alluvial (clay) or residual (clay and sand bands); underlain by sedimentary WCM (sandstone, mudstone, siltstone) and KOUKF (sandstone, siltstone, mudstone) from approximately 5 m to 10 m depth.	Lime treatment may increase Type A/B over C/D
340-C15	33.46	33.65	40,165	60% general fill C/D 40% general fill A/B	High plasticity and dispersive clay, some sand bands from residual KOUKF. Sedimentary (sandstone) from approximately 5 m to 10 m depth.	Lime treatment may increase Type A/B over C/D
340-C16	34.47	35.14	357,100	30% general fill C/D 50% general fill A/B 20% structural fill	High plasticity and dispersive clay from residual KOUKF. sedimentary (sandstone) from approximately 1 m to 3 m depth.	Lime treatment may increase Type A/B over C/D
340-C17	37.32	37.48	9,713	50% general fill C/D 50% general fill A/B	High plasticity and dispersive clay from residual to XW soils.	Lime treatment may increase Type A/B over C/D
340-C18	39.15	41.35	689,798	20% general fill C/D 80% general fill A/B	Residual (clays/sandy clays). HW and better Gatton Sandstone from approximately 2 m to 3 m depth.	N/A
340-C19	42.35	42.47	14,786	20% general fill C/D 80% general fill A/B	Residual (clays/sandy clays). HW and better Gatton Sandstone from approximately 2 m to 4 m depth.	N/A
340-C20	43.85	44.07	112,640	20% general fill C/D 80% general fill A/B	Residual (clays/sandy clays). HW and better Gatton Sandstone from approximately 2 m to 4 m depth	N/A
340-C21	44,.57	45.45	539,440	20% general fill C/D 80% general fill A/B	Residual soil to extremely weathered (clays/sandy clays); HW-MW Sandstone (from approximately 1.5 m depth), MW-SW from 6.5 m depth, becoming SW from 18 m. Coal recorded within the SW sandstone.	N/A

Area ID	Chainage start (km)	Chainage end (km)	Cut volume (m^3)	Estimated suitability of cut material for re-use	Anticipated rock/soil type intersected	Potential additional mitigations
340-C22	46.67	46.90	53,696	10% general fill C/D 90% general fill A/B	Residual (clays/sandy clays). HW and better Gatton Sandstone from approximately 3 m to 7 m depth.	N/A
340-C23	47.11	47.51	168,250	10% general fill C/D 90% general fill A/B	Residual (clays/sandy clays). HW and better Gatton Sandstone from approximately 2 m to 4 m depth. Possibly alluvium (sand gravel and cobbles) from adjacent creek.	N/A
340-C24	47.78	48.27	166,057	10% general fill C/D 90% general fill A/B	Residual (clays/sandy clays). HW and better Gatton Sandstone from approximately 2 m to 4 m depth.	N/A
340-C25	48.45	48.85	117,936	20% general fill C/D 80% general fill A/B	Residual (clays/sandy clays). HW and better Gatton Sandstone from approximately 2 m to 3 m depth.	N/A
340-C26	49.03	49.26	61,554	20% general fill C/D 80% general fill A/B	Residual soils (silty sand). HW and better Gatton Sandstone from approximately 3 m to 5 m depth.	N/A
340-C27	51.51	51.72	48,586	20% general fill C/D 80% general fill A/B	Residual soils (silty sand/sand, some clay) HW or better Interbedded Sedimentary Rock (KOUKF) from approximately 3 m to 5 m depth.	N/A
340-C28	51.87	52.22	67,305	30% general fill C/D 70% general fill A/B	High plasticity and dispersive clay from residual soils. HW or better interbedded sedimentary rock (KOUKF) from approximately 4 m to 6 m.	Lime treatment may increase Type A/B over C/D
340-C29	53.62	53.83	14,639	30% general fill C/D 70% general fill A/B	High plasticity and dispersive clay from residual soils (WCM).	Lime treatment may increase Type A/B over C/D
340-C30	54.27	54.62	16,257	30% general fill C/D 70% general fill A/B	High plasticity and dispersive clays from residual to XW soils (WCM).	Lime treatment may increase Type A/B over C/D

Table notes:

E = Embankment, C=Cut, RS = Residual Soil, XW = Extremely Weathered, HW = Highly Weathered, MW = Moderately Weathered, SW = Slightly Weathered, GWL = Ground Water Level, BGL = Below Ground Level, WCM = Walloon Coal Measures, KOUKF = Koukandowie Formation, GATTO = Gatton Sandstone, HEIFERCK = Heifer Creek Sandstone

2.4 Spoil re-use for rehabilitation and operational landfill purposes

The Project will seek to optimise earthworks to reduce the quantum of spoil produced in addition to optimising the amount of material that can be beneficially used within the Project (and adjacent projects) footprints. Once these mitigations have been exhausted, the project will seek to beneficially re-use spoil material for the rehabilitation of mines and quarries in proximity to the Project.

The re-use of Project won materials for this purpose will be contingent on further discussions and negotiations with the operators/owners of these facilities to ensure that the timing and quantum of the material and its physical/chemical properties are suitable for this purpose. Furthermore, operational requirements and resource sterilisation aspects will form part of the considerations of these entities before accepting the materials generated by the Project.

In addition to the above, Project-won material may be re-used for operational landfill purposes (application of day and interim covers) and for the capping and closure of landfill cells (final capping soils). Similar to the mines and quarries above, the re-use of this material will be contingent on the landfill operator's requirement for the material, its timing and whether this coincides with infrastructure development on the site.

Potential localities for the beneficial re-use of material are presented on Figure 1.1.

The beneficial re-use of spoil for the above purposes 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.

2.5 Spoil disposal

Spoil disposal is considered to be the least preferable option for material generated by the Project. Spoil re-use, as opposed to spoil disposal, is preferable from a social, environmental and financial perspective. 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 detailed design and construction, the Project should seek to re-use as much material as possible in accordance with the hierarchy of material management options specified in Table 1.1. Existing waste management facilities in proximity to the Project that have potential to accept spoil include:

- Swanbank Waste Management Facility: Swanbank Road, Swanbank QLD 4305
- Ti Tree Bioenergy: Champions Way, Willowbank QLD 4306
- New Chum Landfill: 100 Chum St, New Chum QLD 4303
- Lantrack Waste Management Facility: 1 Memorial Drive, Swanbank QLD 4306
- Jimboomba Landfill: 356 Mundoolun Road, Jimboomba QLD 4280
- Browns Plains Waste and Recycling Facility: 41 Recycle Way, Heritage Park QLD 4118
- Candy Soil: 237–239 Mount Crosby Rd, Tivoli QLD 4305.

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. However, such acceptance is likely to attract a landfill gate fee, which at current commercial rates is in the order of $\$75/m^3$. The location of the existing waste facilities is shown on Figure 1.1.

ARTC will continue to engage with relevant parties prior to the construction of the Project to confirm these potential spoil disposal sites. Consultation undertaken with operators is further described in EIS Appendix C: Consultation Report.

3. Spoil onsite handling

3.1 Spoil storage and stockpile management

In the first instance, excess spoil should 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 should be stockpiled along the right-of-way established for construction of the Project. Stockpiles should be located as close as possible to the source of the excavated material and will be stockpiled by separable material type. It is noted that the proposed construction laydown areas have sufficient capacity to accommodate stockpiled materials.

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

- Located within the disturbance footprint
- Located away from areas of concentrated water flow and watercourses
- Accessibility requirements are met, i.e. within proximity to access tracks and/or existing roads
- 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 local streets and through residential areas
- Located to reduce impacts on sensitive receptors (i.e. visual, air and noise impacts)
- Located on land that does not require the removal of remnant vegetation, threatened species, important habitat, wetlands or other environmentally sensitive areas (other than already permitted)
- Located away from the tree protection zone of trees or native vegetation to be retained. The tree protection zone is an area around a tree trunk that must be protected to ensure stability of the tree in the ground and can be calculated using Australian Standard AS 4970-2009
- Located on land that does not impact on heritage sites (other than already permitted)
- Erosion and sediment controls will be implemented, operated and maintained in accordance with the Project's CEMP and Soil Management Sub-plan
- The CEMP and Erosion and Sediment Control Plans will detail soil and water management measures consistent with the International Erosion Control Association Best Practice Erosion and Sediment Control
- Watering, vegetation or cover of long-term stockpiles to reduce the likelihood of erosional loss of materials. Profiling and stabilisation of all stockpiles to occur.

Segregated stockpiles should be constructed to avoid cross-contamination of topsoil, spoil material requiring treatment or disposal (i.e. asbestos/hazardous waste) and material for re-use. Topsoil stockpiles should be managed so they retain their biological function and seed bank for re-use. Contaminated materials will be segregated and stockpiled separately, in accordance with relevant legislative requirements and procedures identified in the Project's CEMP, including a Soil Management Sub-plan.

3.2 Tunnel spoil stockpiles

A single-track tunnel is proposed for the Project (the tunnel) through a ridge on the western side of the Teviot Range. Vertically, the tunnel falls from east to west for drainage with a high point in the vertical alignment exists at the eastern portal. Horizontally, the tunnel is mostly straight, with large radii curves at the western and eastern portal locations. Material generated from the excavation of the tunnel will be stored on a stockpile with ready access to the road network and construction corridor. Ongoing tunnel stockpile sites will be managed in accordance with Section 3.1

3.3 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 ants does not occur. The majority of the Project traverses through fire ant biosecurity zone 2 and a portion of the Project is also located within fire ant biosecurity zone 1, as per the Fire Ant Biosecurity Zone Map—RIFA02 (Department of Agriculture and Fisheries 2018).

The Biosecurity Regulation 2016 (Qld) prescribes procedures that must be undertaken when moving or storing a fire ant carrier. To move soil from areas of the Project within fire ant biosecurity zone 2, ARTC must have a biosecurity permit and the Construction Contractor will also need to have an approved Environmental Management Plan (in this case the CEMP) from the Department of Agriculture and Fisheries prior to carrying out activities, unless:

- The soil remains within zone 2 or is moved to zone 1, or
- The soil is moved to a waste facility within zone 1 or 2.

To move soil from areas of the Project within fire ant biosecurity zone 1 ARTC must have a biosecurity permit, unless:

- The soil remains within zone 1, or
- The soil is moved to a waste facility within zone 1 or zone 2.

3.4 Spread of weeds

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. Local councils also undertake inspections to ensure weeds are being controlled in accordance with local laws and state legislation.

The following information should be considered to meet ARTC's general biosecurity obligation:

- Identify major weed species in the area through pre-construction surveys and consultation with Council 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.

3.5 Archaeological potential

Two Cultural Heritage Management Plans (CHMPs) under Part 7 of the Aboriginal Cultural Heritage Act 2003 (ACH Act) have been developed and approved with the Yuggera Ugarapul People and Jagera People #2 (CLH071009). Together the CHMPs cover the entire EIS investigation corridor. Adherence to the requirements of these CHMPs will ensure that the proponent complies with the cultural heritage duty of care and avoids committing any of the other offences prescribed by the ACH Act while undertaking Project activities.

A Construction Heritage Management Plan will be developed by the Construction Contractor as part of the CEMP prior to construction, which complies with the Project conditions of approval, relevant regulatory requirements and references the above ARTC approved CHMPs as applicable. Stop work procedures will also be prepared for unexpected cultural heritage finds during excavation.

4. Spoil transport

4.1 Haulage routes

Spoil material haulage is anticipated to occur six days a week and will be restricted to standard construction hours where possible to minimise environmental harm and public amenity nuisance. Proposed work hours, presented in EIS Chapter 6: Project Description, are as follows:

Construction will typically be undertaken during the following primary Project construction hours:

- Monday to Friday 6.30 am to 6.00 pm
- Saturday 6.30 am to 1.00 pm
- No work Sundays and public holidays.

Track possessions, when the construction contractor has control over an operating railway, will proceed on a 7 day/24-hour period. Track possession of Queensland Rail assets will generally be allocated over weekend periods, with extended track possession occurring over holiday periods.

Works outside of primary Project construction hours may occur throughout the duration of the construction program and will involve:

- Delivery of concrete, steel, and other construction materials delivered to site by heavy vehicles
- Movements of heavy plant and materials
- Spoil haulage
- Tunnelling activities
- Arrival and departure of construction staff during shift change-overs
- Roadworks to arterial roads
- Traffic control crews, including large truck mounted crash attenuator vehicles, medium rigid vehicles, and lighting towers
- Incident response including tow-trucks for light, medium, and heavy vehicles.

Spoil will be transported by registered road trucks, with temporary construction access roads provided along the Project. These access roads would be used to transport tunnel spoil from the portals to embankment zones. Local spoil haulage may also involve transport on public roads. EIS Appendix U: Traffic Impact Assessment technical report provides detailed information on the haulage routes user for the Project, assuming a worst-case scenario of 1,622,504 m^3 of spoil to be transported by road to end-of-life mines located along Ipswich-Rosewood Road (Ebenezer Mine and New Hope West Moreton) approximately 80 km from the point of generation. Both the Ebenezer Mine and New Hope West Moreton are the subject of current development proposals to allow the end-of-life mines to be used as waste and recycling facilities in future. ARTC will continue to engage with relevant parties prior to the construction of the Project to confirm these potential spoil disposal sites. Consultation undertaken with operators is further described in EIS Appendix C: Consultation Report.

5. Review and improvement

5.1 Update and amendment

This SMS will be reviewed during the construction period based on results from monitoring, observations or complaints. Ongoing evaluation of environmental management performance against compliance requirements, environmental policies, objectives and targets will also be undertaken, in order to identify opportunities for continuous improvement in spoil management practices.

6. References

Department of Agriculture and Fisheries (2018). Fire ant biosecurity zone map. Queensland Government. Available from: **daf.qld.gov.au/__data/assets/pdf_file/0006/1384476/Fire_Ant_Biosecurity_Zone_Map.pdf** [Accessed 28 August 2019].

Department of Natural Resources, Mine and Energy (2017). Mapping and data. Queensland Government. Available from: **dnrm.qld.gov.au/mapping-data/maps** [Accessed 31 May 2018].

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APPENDIX V

Spoil Management Strategy

Appendix A ARTC Earthworks Material Specification

CALVERT TO KAGARU ENVIRONMENTAL IMPACT STATEMENT

IR_1381

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.

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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

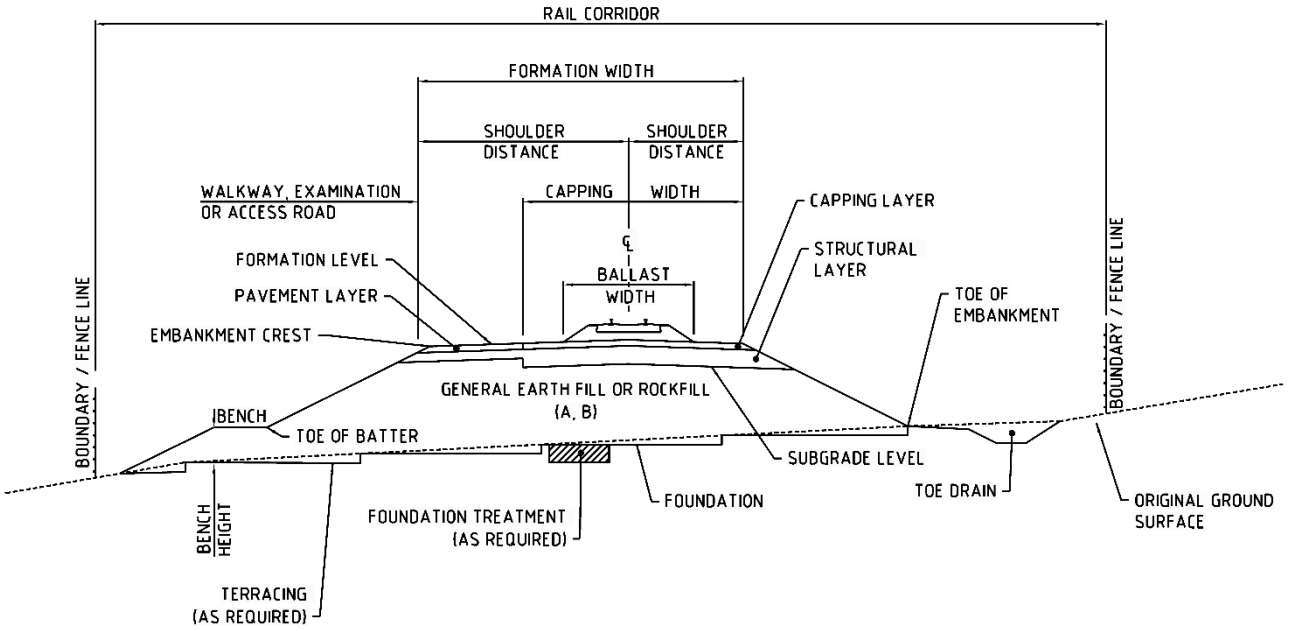

Figure 1 Schematic of Homogeneous Embankment Cross Section

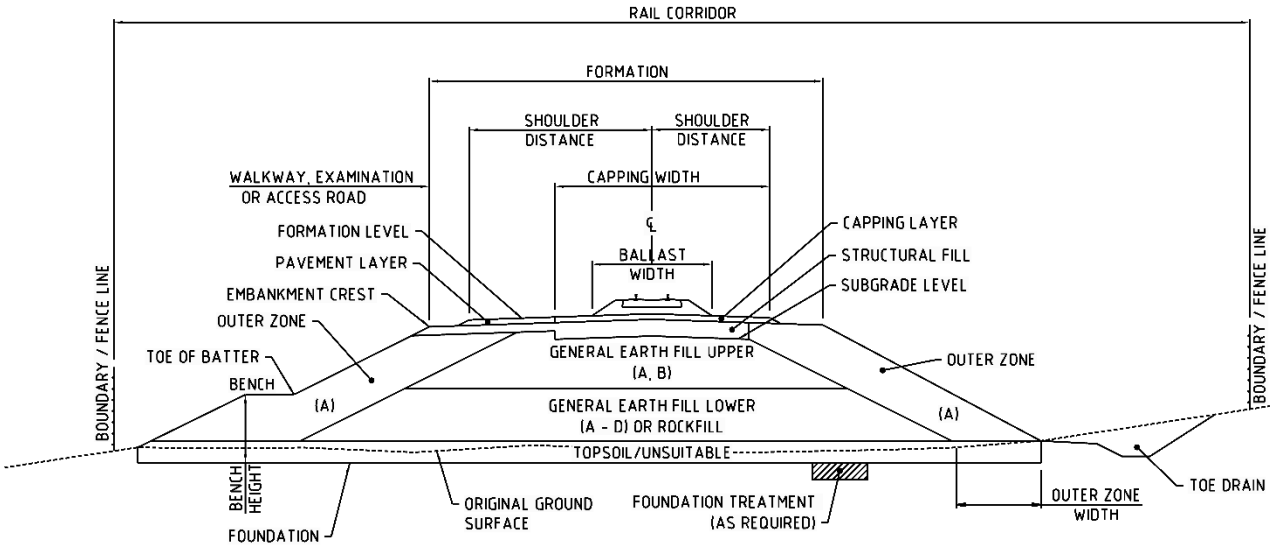

Figure 2 Schematic of Zoned Embankment Cross Section

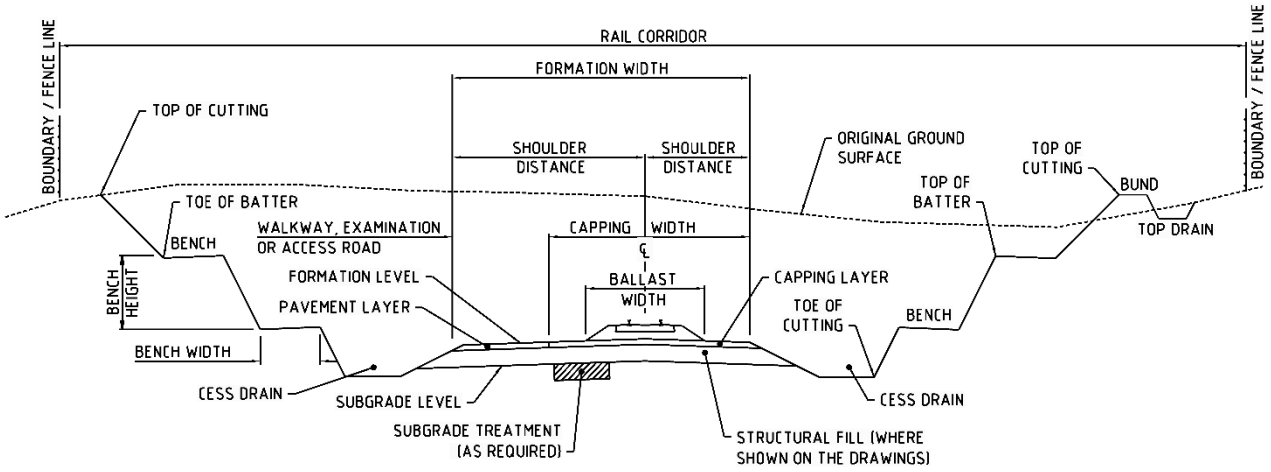

Figure 3 Schematic of Cutting Cross Section

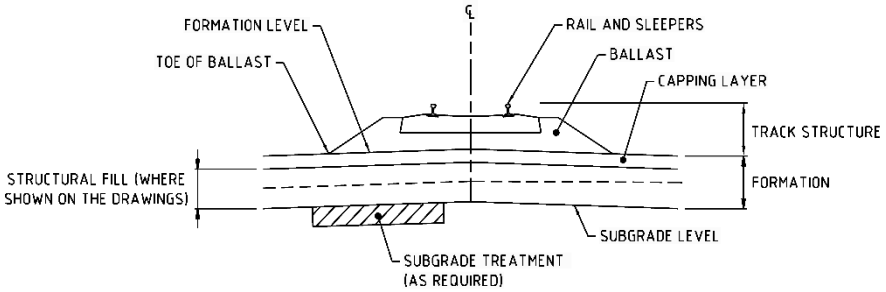

Figure 4 Schematic of Formation and Track

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

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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