4. Land

This section provides a summary of the scenic amenity assessment undertaken, and the potential impacts identified, in regards to the Project (Rail) during construction and operation. The assessment was undertaken in accordance with the requirements of the Terms of Reference (ToR) and a table cross-referencing these requirements is provided in Volume 4 Appendix C ToR Cross Reference Table. A detailed landscape and visual assessment, soils assessment and land use report are included in Volume 4 Appendix X, Appendix Y and Appendix Z1, respectively.

4.1 Scenic Amenity and Lighting

4.1.1 Introduction

A landscape and visual impact assessment has been conducted that included a combination of two separate but closely related aspects. The first is impact upon the landscape character, that is, the extent of change to the existing landscape character. The second is visual impact, that is, the extent to which new developments can be seen within a visual catchment and the responses that are felt by sensitive visual receptors towards the visual effects of the new development.

Sensitive receptor locations were chosen to represent a range of typical views possible from that locality, to the Project (Rail). In addition, the viewpoints were selected to:

- Represent views of particular landscape and /or visual features of importance.
- Represent views from key visual receptors (residents and road users) where a potentially significant change in view may occur as a result of the Project (Rail).

The Study Area in relation to scenic amenity assessment is defined as the visual catchment, i.e. the area from within which the Project (Rail) may be seen. The Project (Rail) corridor comprises a 95 m wide corridor within which the rail line is to be located.

4.1.2 Assessment of Impacts

4.1.2.1 Overview

Impacts are defined as the relative capacity of the landscape to accommodate changes to the physical landscape of the type and scale proposed that would occur as a direct result of the Project (Rail).

The level of the impact is evaluated considering:

- Landscape character
- Visual modification
- Visual sensitivity

Definitions are provided in Volume 4 Appendix X Landscape and Visual Assessment, and their use in identifying severity of the impacts is outlined.

Assessment of landscape and visual impacts is necessarily both quantitative and qualitative. The qualitative values of a particular landscape and the sensitivity of the visual receptors to change have

been assessed based on desktop studies, site surveys (of publicly and privately accessible points) and discussions with the Isaac Regional Council (IRC).

4.1.2.2 Zone of Theoretical Visibility

A zone of theoretical visibility is the theoretical assessment of visibility to or from a designated point in the landscape, using elevation data such as a Digital Elevation Model (DEM) to calculate the extent of visibility of that point from anywhere in the Study Area. The mapping does not take account of buildings or vegetation screening and hence reflects a lunar landscape, which for the visual impact assessment process represents the "worst case scenario". The zone of theoretical visibility generated for this assessment is based on 10 m contour intervals and an observer eye height of 1.7 m.

4.1.2.3 Visual Modification

Visual modification refers to the extent of change to the landscape, and therefore impact upon visual amenity, that would occur as a direct result of the Project (Rail) from a given viewpoint.

For the purposes of this assessment the level (magnitude of change) of visual modification is defined as:

- Large
- Moderate
- Small
- Not perceivable

4.1.2.4 Visual Sensitivity

Visual sensitivity refers to visual receptors and their sensitivity to their visual environment. Visual sensitivity is defined as the perception of viewers. Visual impacts relate to the changes that arise in composition of available views as a result of changes to the existing landscape, people's responses to these changes, and the overall impacts with respect to visual amenity. Visual sensitivity is described as being high, medium, low or neutral.

Key visual receptors comprise residents, users of transport routes (road and rail) as well as users of public recreation spaces and all have differing sensitivities to their visual environment. Generally, sensitivity is derived from a combination of factors including:

- Receptors' interest in the visual environment i.e. high, medium or low interest in their everyday visual environment, and the duration of the effect
- Receptors' duration and viewing opportunity i.e. prolonged, regular viewing opportunities
- Number of viewers and their distance / angle of view from the source of the effect, extent of screening / filtering of the view, where relevant
- Magnitude of change in the view (i.e. loss/addition of features that change the view's composition) and integration of changes within the existing view (form, mass, height, colour and texture)
- Effectiveness of proposed mitigation

4.1.2.5 Duration of Impact

Duration of impact has been defined for the purposes of this assessment as temporary, short term, medium term, long term or permanent.

4.1.2.6 Impact Type

Impact type (i.e. quality of the impact) is defined as positive, neutral or negative.

4.1.2.7 Significance of Impact

The significance (or severity) of impact has been assessed in accordance with the impact significance criteria described in Table 4-1.

Only impacts of major or high significance in the context of this assessment have been considered. These impacts will require further refinement through mitigation or scheme design.

Table 4-1 Significance of Impact

		Landscape Impact			
		Large	**Moderate**	**Small**	**Negligible**
Visual Sensitivity	**High**	Major significance	High significance	Moderate significance	Minor significance
	Medium	High significance	Moderate significance	Minor significance	Not significant
	Low	Moderate significance	Minor significance	Not significant	Not significant
	Negligible	Minor significance	Not significant	Not significant	Not significant

4.1.3 Mitigation

Preliminary evaluation of Project (Rail) alignment options and siting of depots has been guided by the need to avoid or reduce potential adverse effects on landscape character and visual receptors (refer Volume 1 Section 3 Introduction).

Where impacts have been deemed adversely significant, site specific mitigation measures have been proposed in order to lessen the impact on the landscape character and visual amenity.

The hierarchy of strategies for impact mitigation include:

- **Avoidance** - Avoid developments in sensitive or prominent landscapes, and avoid insensitive or visually intrusive designs. Prevention of adverse effects at source
- **Reduction** – Reduction of adverse effects that cannot be eliminated by avoidance. The significance of adverse impacts is lessened. Seeks to limit the exposure of the sensitive visual receptor. Reduce the visual intrusiveness of the design and reduce the visibility of the Project (Rail) (e.g. by installing barriers between the location(s) of likely receptors and the source of the impact)

- **Remedy** – Remedy serves to improve adverse conditions by carrying out further works which seek to restore the environment e.g. increased planting of trees/shrubs to offset unavoidable loss of vegetation

If it is not possible or practical to mitigate an impact (e.g. felling mature trees) this is described as a residual impact.

4.1.4 Description of Environmental Values

The following section provides an overview of the existing land use, landform, vegetation, landscape character areas and viewpoints in the vicinity of the Project (Rail) corridor. Site wide land use, topography and landscape features are largely similar and contribute directly to landscape character and visual amenity. Figure 4-1 provides a location overview and shows the viewing locations selected within the Study Area for specific consideration.

The Project (Rail) predominantly transverses a rural (agricultural) landscape, primarily used for cattle grazing. The Project (Rail) corridor is located in a remote region. The town of Moranbah is situated approximately 15 km from the eastern extent of the Project (Rail). Clermont is located to the south at approximately 160 km (western extent). Charters Towers is located to the north at approximately 200 km. The principal road connecting these towns is the Gregory Developmental Road and which intersects the Project (Rail) corridor. There are nine minor roads which dissect the corridor. There are three identified stock routes which intersect the Project (Rail) corridor.

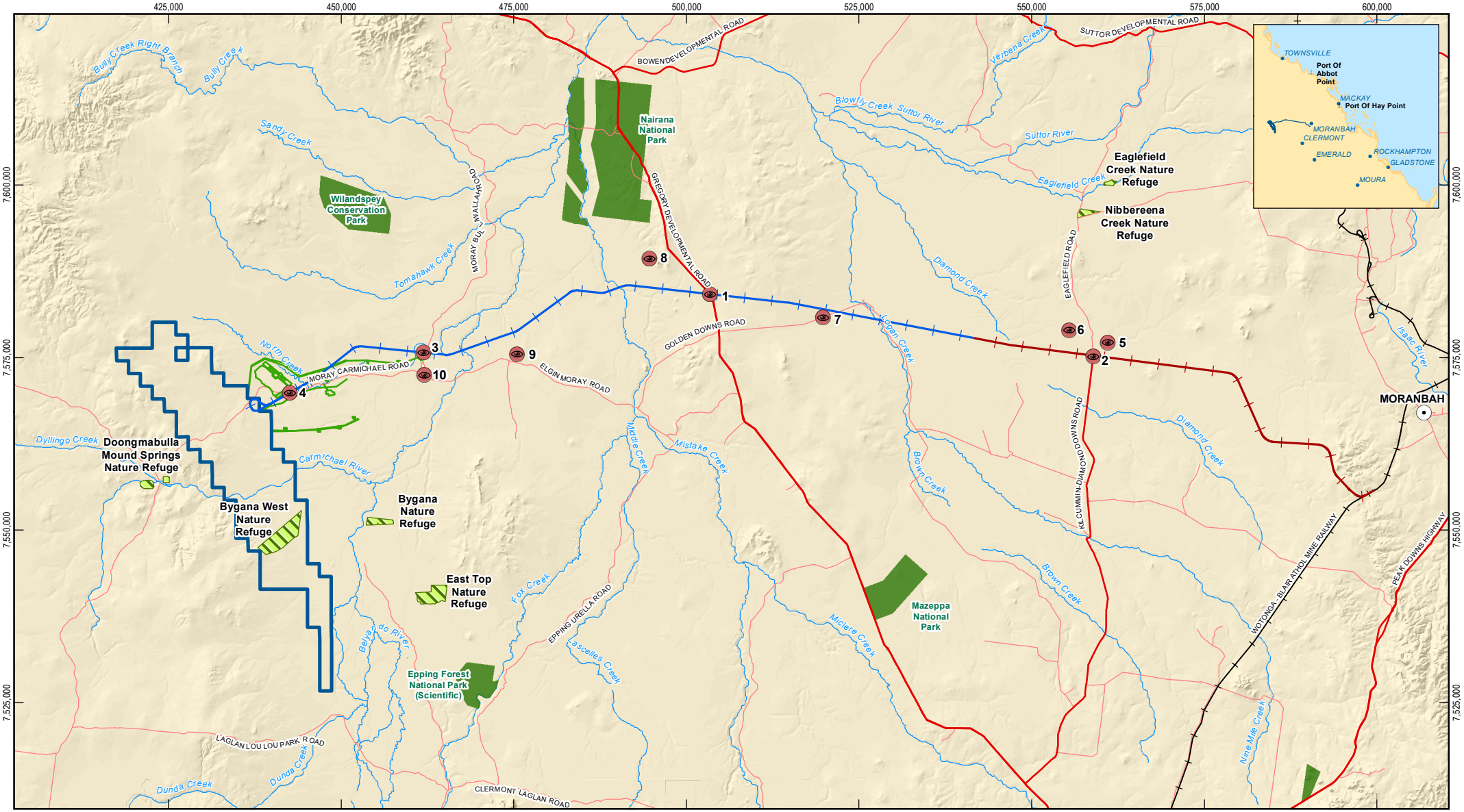
Topography within the Project (Rail) corridor is generally flat to undulating, without distinctive topographical features. There are a number of small hills to the north and south of the Project (Rail) corridor. The land form often provides open views across flat plains, sometimes to distant hills. However, vegetation dominates and provides short, middle and long views within the Study Area.

A river and a number of creeks dissect the Project (Rail) corridor, predominately in a north-south direction, including the Belyando River, Mistake Creek, Eight Mile Creek, North Creek and Logan Creek. There are also a number of unnamed ephemeral creeks.

Additional landscape features include Wilandspey Conservation Park and Nairana National Park, located approximately 17 km and 10 km north from the Project (Rail) corridor respectively.

The presence of vegetation within the Study Area strongly influences the rural (agricultural) landscape character. There are two distinct vegetation patterns that dominate. The first type displays modification to the natural landscape through open, broad acre paddocks of rough native grass and scattered acacias/ eucalypt clumps and woodlands. Native stands of trees are also evident between paddocks. The second type exhibits dense and open acacia woodlands, with understories of native grasses.

The vegetation structure, height and form are valuable in contributing to landscape character within the context of a relatively flat and featureless landscape.



1:750,000 (at A4)

0 5 10 15 20 25

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Town
- Viewing Location
- Watercourse
- Other Rail Network
- Northern Missing Link
- State Road
- Local Road
- Rail (West)
- Rail (East)
- Mine (Onsite)
- Mine (Offsite)
- Nature Refuge
- National Park

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

Job Number 41-25215
Revision B
Date 31-08-2012

Viewing Locations

Figure 4-1

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Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: DERM: DEM (2008), Nature Refuge (2011); DME: EPC1690 (2010), EPC1080 (2011): © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012); GHD: Northern Missing Link (2011), View Locations (2012). Created by: NR, CA

4.1.5 Viewing Locations and Sensitive Receptors

People are mobile and therefore could potentially experience views of the Project (Rail) from many different locations. In order to undertake an assessment of visual impacts, a series of key viewing locations have been selected to represent the points from which the Project (Rail) is likely to be viewed by the greatest number of visual receptors and from where the most sensitive visual receptors are likely to perceive the Project (Rail).

Residential properties likely to be impacted by the Project (Rail) have also been identified through desktop study, generation of a zone of theoretical visibility and site assessment. Residential properties, within 5 km of the Project (Rail) corridor, have been identified.

Representative sensitive receptor locations (viewing locations) are illustrated on Figure 4-1 above and described in Table 4-2 through Table 4-11 below.

Table 4-2 Viewing Location 1: Gregory Developmental Road

Viewing Location 1	
Plate 4-1 View looking east on the Gregory Developmental Road	**Plate 4-2 View looking south-east on the Gregory Developmental Road**
	
Landscape/ Visual Element	**Baseline Description**
Location	Digital Elevation Model (DEM) 1, Gregory Developmental Road.
Landform and Significant Landscape Features	The topography is flat in the vicinity of the view location gently rising to high points in the north, east and south.
Vegetation	A combination of broad acre pastures of rough native grassland with scattered shrubs, and areas of dense acacia woodlands.
Water	Low lying plains, may be flooded in wet season. Creeks are located approximately 2 km to the north-east and south-west of the road.
Land Use	Primarily agricultural, used for broad acre cattle grazing. The road is a State controlled (primary) road, used for travel between Clermont (south) and Charters Towers (north).
Visual Context	The scattered vegetation allows for long and wide views to low lying hills. The dense woodlands provide enclosed, immediate views. Views are experienced by regional and local road users.

Table 4-3 Viewing Location 2: Kilcummin Diamond Downs Road

Viewing Location 2	
Plate 4-3 View north on Kilcummin Diamond Downs Road. Note tall stands of trees along road.	**Plate 4-4 Short views across pastures, north-east on Kilcummin Diamond Downs Road**
	
Landscape/ Visual Element	**Baseline Description**
Location	Kilcummin Diamond Downs Road (an Isaac Regional Council local road running north to south across the Project (Rail)).
Landform and Significant Landscape Features	Topography ranges from flat to undulating.
Vegetation	Scattered and clumped eucalypts species and shrubs, surrounded by rough native grassland. Road edge often boarded by dense native stands of trees.
Water	Low lying flat plains, may be flooded in wet season.
Land Use	Primarily agricultural used for cattle grazing. There is one homestead within 4 km of this intersection.
Visual Context	Views from the road are short to native hedge rows and/wire fences adjacent to lot boundaries. There are intermittent long sweeping views through to agricultural broad acre paddocks of native grasslands and sparsely scattered trees. Views are experienced by local road users.

Table 4-4 Viewing Location 3: Moray Bulliwallah Road

Viewing Location 3	
Plate 4-5 View looking north, on the Moray Bulliwallah Road	
	
Landscape/ Visual Element	**Baseline Description**
Location	Moray Bulliwallah Road (running north-south across the Project (Rail).
Landform and Significant Landscape Features	The topography is generally flat to gently sloping.
Vegetation	There is a combination of broad acre pastures of rough native grassland with scattered shrubs (foreground) and areas of dense acacia woodlands (middle ground).
Water	Riparian wooded (native/indigenous) drainage lines and/or degraded non-wooded drainage lines.
Land Use	Primarily agricultural use, broad acre grazing for cattle.
Visual Context	Closed, short to middle views consisting of vegetation. Electricity poles and wires in view along the road. Views are experienced by local road users.

Table 4-5 Viewing Location 4: Moray Carmichael Road

Viewing Location 4	
Plate 4-6 View looking south-east on Moray Carmichael Road (minor road)	**Plate 4-7 View looking east on Moray Carmichael Road (minor road)**
	

Landscape/ Visual Element	Baseline Description
Location	Moray Carmichael Road (a minor road running north-west/south-east)
Landform and Significant Landscape Features	The topography is flat.
Vegetation	Open paddocks of native grassland with scattered/ clumped trees and shrubs.
Water	Low lying plains, may be flooded in wet season.
Land Use	Primarily agricultural use for cattle grazing and unmodified natural areas.
Visual Context	Views from this viewpoint are experienced by local road users, which include: ◗ Flat topography and sparse vegetation allows open, long views over broad pastures to low woodlands. ◗ Some short, intermediate vistas to nearby shrubs.

Table 4-6 Viewing Location 5: Residential Property

Viewing Location 5	
Plate 4-8 View south at homestead.	
	
Landscape/ Visual Element	**Baseline Description**
Location	Approximately 2 km east of Kilcummin Diamond Downs Road. VL5 is a residential property accessed by private track from Kilcummin Diamond Downs Road. This property was not directly accessible at the time of the site investigation. Views have been estimated from the desk study, assessment from the nearest publicly accessible area and discussions with GHD's noise technical team who accessed the site.
Landform and Significant Landscape Features	Low flat to sloping topography. The residential property is located at approximately 220 m Australian Height Datum (AHD).
Vegetation	Primarily open paddock of native grassland with scattered/ clumps of shrubs or trees. Ornamental and native planting around homestead.
Water	The non-perennial Sullivan Creek is located to the immediate south of this residential property. Riparian wooded (native/indigenous) drainage lines and/or degraded non-wooded drainage lines.
Land Use	Farming and agricultural use, primarily broad acre cattle grazing.
Visual Context	Views are generally characterised by the topography and presence of local vegetation. Vistas range from short to middle distance and are of clumped vegetation or views across lowland cleared pasture land. Views experienced by residents.

Table 4-7 Viewing Location 6: Residential Property

Viewing Location 6	
Landscape/ Visual Element	**Baseline Description**
Location	Approximately 3.2 km west of Kilcummin Diamond Downs Road. VL6 is a residential property accessed by private track from Kilcummin Diamond Downs Road. This property was not directly accessible and views have been estimated from the desktop study and assessment from the nearest publicly accessible area (hence no plate provided).
Landform and Significant Landscape Features	Topography is flat to undulating. The residential property is located at approximately 216 m AHD.
Vegetation	Primarily open pastures of native grassland with scattered/ clumps of shrubs or trees.
Water	The non-perennial Sullivan creek is located in the immediate vicinity of this residential property. Riparian wooded (native/indigenous) drainage lines and/or degraded non-wooded drainage lines.
Land Use	Farming and agricultural use, primarily broad acre cattle grazing.
Visual Context	Views are generally characterised by the topography and presence of local vegetation. Vistas range from short to middle distance and are of clumped vegetation or open views across lowland cleared pasture land. Views experienced by residents.

Table 4-8 Viewing Location 7: Residential Property

Viewing Location 7

Plate 4-9 View looking south to Homestead

Landscape/ Visual Element	Baseline Description
Location	The residential property is located on Golden Downs Road It is situated at approximately 209 m AHD.
Landform and Significant Landscape Features	Low flat landscape, slightly sloping to the north-north-west.
Vegetation	Primarily open pastures of native grassland with clumps or isolated shrubs/ trees.
Water	Riparian wooded (native) drainage lines and/or degraded non-wooded drainage lines.
Land Use	Farming and agricultural use, primarily broad acre cattle grazing.
Visual Context	Views are generally characterised by the topography and limited presence of local vegetation. Vistas range from middle to long distance and are of clumped vegetation to open views across lowland cleared pasture land. Views experienced by residents and road users for local access.

Table 4-9 Viewing Location 8: Residential Property

Viewing Location 8	
Landscape/ Visual Element	**Baseline Description**
Location	A residential property located approximately 3.2 km west of Gregory Developmental Road. This property was not directly accessible at the time of the site investigation and therefore views have been estimated from the desktop study, assessment from the nearest publicly accessible area and discussions with GHD noise technical team who had accessed the site. No plate is therefore available to demonstrate the viewing location.
Landform and Significant Landscape Features	Topography is flat to the south with raised hilly areas to the north and east. The residential property is located at approximately 205 m AHD.
Vegetation	Primarily native grassland with low storey clumps or isolated shrubs/ trees.
Water	Riparian wooded (native/indigenous) drainage lines and/or degraded non-wooded drainage lines.
Land Use	Farming and agricultural use, primarily broad acre cattle grazing.
Visual Context	Views are generally characterised by the topography and presence of local vegetation. Vistas range from middle to long distance and are of clumped vegetation to open views across lowland cleared pasture land. Views experienced by residents.

Table 4-10 Viewing Location 9: Residential Property

Viewing Location 9	
Plate 4-10 View looking north from Elgin Moray Road. This is south-west of the property.	
	
Landscape/ Visual Element	**Baseline Description**
Location	A residential property 1.4 km north of Elgin Moray Road. This property was not directly accessible and therefore views have been estimated from the desktop study and assessment from the nearest publicly accessible area.
Landform and Significant Landscape Features	Topography is flat to undulating. The residential property is located on the north-western slope of a hill. The residential property is located at approximately 210 m AHD.
Vegetation	Primarily native grassland with low storey clumps or isolated shrubs/ trees.
Water	Riparian wooded (native/indigenous) drainage lines and/or degraded non-wooded drainage lines.
Land Use	Farming and agricultural use, primarily broad acre cattle grazing.
Visual Context	Views are generally characterised by the topography and presence of local vegetation. Vistas range from middle to long distance and are of clumped vegetation to open views across lowland cleared pasture land. Views experienced by residents.

Table 4-11 Viewing Location 10: Residential Property

Viewing Location 310

Plate 4-11 View looking south, north of the residential property on Elgin Moray Road.

Landscape/ Visual Element	Baseline Description
Location	Residential property on Elgin Moray Road approximately 1.5 km south of road intersection. This property was not directly accessible and therefore views have been estimated from the desktop study and assessment from the nearest publicly accessible area.
Landform and Significant Landscape Features	Topography is flat to undulating. The residential property is located at approximately 203 m AHD.
Vegetation	Primarily native grassland with low storey clumps or isolated shrubs/ trees. Denser vegetation along the drainage line to the north. A mix of exotic and native vegetation surrounds the homestead.
Water	Riparian wooded (native/indigenous) drainage lines and/or degraded non-wooded drainage lines.
Land Use	Farming and agricultural use, primarily broad acre cattle grazing.
Visual Context	Views are generally characterised by the topography and presence of scattered vegetation. Vistas range from middle distance of clumped vegetation to open views across low cleared pasture land. Views experienced by residents and road users.

4.1.6 Potential Impacts and Mitigation Measures

4.1.6.1 Potential Impacts

The potential visual impacts of the construction and operation of the Project (Rail) are considered in the context of the sensitivity of the surrounding visual environment and the potential for viewing of the Project (Rail) during the construction and operating phases. The impacts of the Project (Rail) at each viewing location is assessed in Table 4-12 to Table 4-21.

Table 4-12 Viewing Location 1 Potential Impacts

Viewing Location 1 (Gregory Developmental Road)	
Key visual factors	**Description of potential impacts during construction and operation stages**
Visible Project Elements	The elements of the Project (Rail) that are likely to be seen during the construction and operational phases include: **Construction Phase** ◗ Clearing of vegetation prior to construction ◗ Earthworks ◗ Large machinery, trucks and other vehicles in and around construction zone ◗ Fence surrounding construction zone ◗ Lighting from construction camps and presence of construction personnel **Operational Phase** ◗ A grade separated (rail under road) crossing and associated infrastructure ◗ Freight trains carrying coal ◗ Fence surrounding Project (Rail) area.
Landscape and visual Impact	The receptor sensitivity is assessed as low due to short term views experienced by road users. During the construction phase the magnitude of change in landscape character was assessed as being moderate due to the scale of the construction activities and contrast to the receiving environment. The construction works are expected to be short term. The type of the impact would be negative. During the operational phase there would be a small magnitude of change in the landscape character. A graded separated treatment (rail under road) is proposed for this location. The operation phase is expected to be long term. The type of impact would be negative. Regrowth of vegetation and the implementation of mitigation measures would reduce the impact.
Significance of Impact	Construction Phase: Minor significance Operational Phase: Not significant

Table 4-13 Viewing Location 2 Potential Impacts

Viewing Location 2 (Kilcummin Diamond Downs Road)	
Key visual factors	**Description of potential impacts during construction and operation stages**
Visible Project Elements	**Construction Phase** ◗ Clearing of vegetation prior to construction ◗ Earthworks ◗ Large machinery, trucks and other vehicles in and around construction zone ◗ Fence surrounding construction zone ◗ Construction personnel **Operational Phase** ◗ At grade road (active) crossing and associated infrastructure ◗ Freight trains carrying coal ◗ Fence surrounding Project (Rail) area.
Landscape and visual Impact	The receptor sensitivity is assessed as low due to short term views experienced by road users. During the construction phase the magnitude of change in the landscape character was assessed as being moderate due to the scale of the construction activities and contrast to the receiving environment. The construction works are expected to be short term. The type of impact would be negative. During the operational phase there would be a small magnitude of change in the landscape character. An at-grade crossing is proposed at this location. The operational phase is expected to be long term. The type of impact would be negative. Regrowth of vegetation and the implementation of mitigation measures would reduce the impact over time.
Significance of Impact	Construction Phase: Minor significance Operational Phase: Not significant

Table 4-14 Viewing Location 3 Potential Impacts

Viewing Location 3 (Moray Bulliwallah Road)	
Key visual factors	**Description of potential impacts during construction and operation stages**
Visible Project Elements	The elements of the Project (Rail) likely to be seen during the construction and operational phases include: **Construction Phase** ◗ Clearing of vegetation prior to construction ◗ Earthworks ◗ Large machinery, trucks and other vehicles in and around construction zone ◗ Fence surrounding construction zone ◗ Construction personnel **Operational Phase** ◗ At grade rail crossing and associated infrastructure ◗ Freight trains carrying coal ◗ Fence surrounding Project (Rail) area ◗ Lighting associated with the maintenance facility
Landscape and visual Impact	The receptor sensitivity is assessed as low due to short term views experienced by road users. During the construction phase the magnitude of change in the landscape character was assessed as being moderate due to the scale of the construction activities and contrast to the receiving environment. The construction works are expected to be short term. The type of impact would be negative. During the operational phase there would be a small magnitude of change in the landscape character. An at-grade crossing is proposed at this location. The operational phase is expected to be long term. The type of the impact would be negative. Regrowth of vegetation and the implementation of mitigation measures would reduce the impact over time.
Significance of Impact	Construction Phase: Minor significance Operational Phase: Not significant

Table 4-15 Viewing Location 4 Potential Impacts

Viewing Location 4 (Moray Carmichael Road)	
Key visual factors	**Description of potential impacts during construction and operation stages**
Visible Project Elements	The elements of the Project (Rail) likely to be seen during the construction and operation phase include: **Construction Phase** ◗ Clearing of vegetation prior to construction ◗ Earthworks ◗ Large machinery, trucks and other vehicles in and around construction zone ◗ Fence surrounding construction zone ◗ Construction personnel **Operational Phase** ◗ Freight Trains carrying coal ◗ Fence surrounding Project (Rail) area ◗ Lighting associated with the maintenance facility
Landscape and visual Impact	The receptor sensitivity is assessed as low due to short term views experienced by road users. During the construction phase the magnitude of change in the landscape character was assessed as being moderate due to the scale of the construction activities and contrast to the receiving environment. The construction works are expected to be short term. The type of impact would be negative. During the operational phase there would be a small magnitude of change in the landscape character. An at-grade crossing is proposed at this location. The operational phase is expected to be long term. The type of the impact would be negative. Regrowth of vegetation and the implementation of mitigation measures would reduce the impact over time.
Significance of Impact	Construction Phase: Minor significance Operational Phase: Not significant

Table 4-16 Viewing Location 5 Potential Impacts

Viewing Location 5 (Residential Property)	
Key visual factors	**Description of potential impacts during construction and operation stages**
Visible Project Elements	No elements of the Project (Rail) are likely to be seen during the construction and operational phases.
Landscape and visual Impact	The impact on sensitive receptors was assessed as negligible due to the fact that there will be no views from this location. During the construction and operational phases the magnitude of change in the landscape character was assessed as negligible having no perceivable change to the baseline conditions. The type of impact would be neutral.
Significance of Impact	Not Significant

Table 4-17 Viewing Location 6 Potential Impacts

Viewing Location 6 (Residential Property)	
Key visual factors	**Description of potential impacts during construction and operation stages**
Visible Project Elements	No elements of the Project (Rail) are likely to be seen during the construction and operation phase.
Landscape and visual Impact	The impact on sensitive receptors was assessed as negligible due to the fact that there will be no views from this location. During the construction and operational phase the magnitude of change in the landscape character was assessed as negligible having no perceivable change to the baseline conditions. The type of impact would be neutral.
Significance of Impact	Not Significant

Table 4-18 Viewing Location 7 Potential Impacts

Viewing Location 7 (Residential Property)	
Key visual factors	**Description of potential impacts during construction and operation stages**
Visible Project Elements	No elements of the Project (Rail) are likely to be seen during the construction and operational phases.
Landscape and visual Impact	The receptor sensitivity is assessed as medium, as views are from a place of residence and the Project (Rail) is unlikely to be visible. During the construction and operational phase the magnitude of change in the landscape character was assessed as negligible, having no perceivable change to the baseline conditions. The type of impact would be neutral.
Significance of Impact	Not Significant

Table 4-19 Viewing Location 8 Potential Impacts

Viewing Location 8 (Residential Property)	
Key visual factors	**Description of potential impacts during construction and operation stages**
Visible Project Elements	The elements of the Project (Rail) that are likely to be seen during the construction and operational phases, include: **Construction Phase** ◗ Clearing of vegetation prior to construction ◗ Earthworks ◗ Large machinery, trucks and other vehicles in and around construction zone ◗ Fence surrounding construction zone ◗ Construction camp lighting and presence of construction personnel **Operational Phase** ◗ Freight trains carrying coal ◗ Fence surrounding Project (Rail) area
Landscape and visual Impact	The receptor sensitivity is assessed as medium as there may be views of the Project (Rail) albeit at a distance of approximately 4 km. During the construction phase the magnitude of change in landscape character was assessed as being moderate due to the scale of the construction activities and contrast to the receiving environment. The construction works are expected to be short term. The type of impact would be negative. During the operational phase there would be a moderate magnitude of change in the landscape character. The operational phase is expected to be long term. The type of impact would be negative. Regrowth of vegetation and the implementation of mitigation measures would reduce the impact over time.
Significance of Impact	Construction Phase: Moderate significance Operational Phase: Moderate significance

Table 4-20 Viewing Location 9 Potential Impacts

Viewing Location 9 (Residential Property)	
Key visual factors	**Description of potential impacts during construction and operation stages**
Visible Project Elements	VL9 is located approximately 3.2 km south of the proposed rail alignment at 210 AHD. The area between VL9 and the Project (Rail) consists of flat terrain with open paddocks of native grassland with scattered/ clumped trees and shrubs. The Project (Rail) is likely to be seen during the construction and operational phases.
Landscape and visual Impact	The receptor sensitivity is assessed as being medium. The Project (rail) is potentially visible from an elevated location due to the topographical features within the area. LV9 is located at 210 AHD while the Project (Rail) runs on land that is approximately 200 AHD. During the construction and operational phases the magnitude of change to landscape character was assessed as moderate due to the activities of both phases The type of impact would be negative.
Significance of Impact	Construction: Moderate significance Operation: Moderate significance

Table 4-21 Viewing Location 10 Potential Impacts

Viewing Location 10 (Residential Property)	
Key visual factors	**Description of potential impacts during construction and operation stages**
Visible Project Elements	No elements of the Project (Rail) are likely to be seen during the construction and operational phases.
Landscape and visual Impact	The impact on sensitive receptors was assessed as negligible due to the fact that there will be no views from this location. The magnitude of change in the landscape character was assessed as negligible having no perceivable change to the baseline conditions due to the activities of both phases. The type of impact would be neutral.
Significance of Impact	Not Significant

4.1.6.2 Mitigation Measures

The aim of this section is to identify mitigation measures that will reduce and / or manage potential adverse impacts of both the construction and operation stages of the Project (Rail) on the landscape character and visual amenity.

4.1.6.3 Construction Phase

The Project (Rail) would aim to achieve construction without causing undue visual disruption to existing receptors. The following controls will facilitate the reduction and management of impacts:

- Only necessary vegetation clearing is to be undertaken with all areas not required for site operations remaining uncleared
- Temporary boardings, barriers, traffic management and signage to be removed when no longer required

- Develop and implement a Dust Management Plan
- Materials and machinery to be stored tidily during the works
- Minimise security lighting to reduce additional sky glow
- Limit night time activities as far as is practicably possible
- Co-locate construction facilities as far as is practicably possible with the Project (Mine), for example the western construction camp
- Co-locate temporary activities, for example, construction camps, batch plants and laydown areas
- Roads providing access to the site and work areas to be maintained free of dust and mud as far as reasonably practicable
- Develop and implement a traffic management plan to control road usage routes and traffic speed to reduce the visual impact of vehicle movements and dust generation
- Progressive rehabilitation of temporary infrastructure sites and non-operational areas. This will assist in providing texture and contrast in the visual landscape

4.1.6.4 Operational Phase

Mitigation of landscape and visual impacts as a result of the Project (Rail) seeks to achieve a balance between the site use requirements and achieving an optimal visual outcome. The mitigation strategy for the Project (Rail) is to minimise the detrimental effects on the landscape and visual character. Operation phase mitigation measures are:

- Removal of boardings, barriers, traffic management and signage when no longer required.
- Co-locate infrastructure together with the Project (Mine), where possible, for example, maintenance yards, balloon loop/terminus facility
- Designate access points to the rail corridor to minimise direct access and therefore disturbance to properties
- Vegetation plantings around maintenance facilities and adjacent the Project (Rail) corridor in sensitive locations where landowner permission is granted

4.1.7 Lighting Impacts and Mitigation Measures

It is noted that the assessment of lighting has not been undertaken as part of this assessment as the Project (Rail) will have a very limited need for lighting. Potential impacts of lighting during construction and operation are outlined below.

4.1.7.1 Construction

Potential impacts of lighting during construction may include:

- Lighting may be required for night works during construction of the Project (Rail) which will result in localised and temporary light pollution
- The construction camps will require night-lighting which will result in localised and temporary light pollution

- Construction vehicles required to travel at night will result in periodic increased illumination on the roads between the Project (Rail) and the construction camps

Mitigation measures for lighting impacts during construction include:

- Where works will create light that will impact on light sensitive places, works will as far as possible be conducted during daylight hours (between 6:00 am and 6:00 pm from Monday to Saturday)
- Light spillage from artificial night-lighting used during night works will be designed such that the site is not over-lit unnecessarily and light spillage into adjacent areas is minimised
- Directional lighting will be used and shields provided to minimise spill outside the working area. This includes the sensitive placement and specification of lighting to minimise any potential increase in light pollution
- Fauna-sensitive lighting will be considered during construction camp design

4.1.7.2 Operation

Potential impacts of lighting during operation include:

- The operation of the Project (Rail) will result in localised and temporary light pollution, including direct glare, periodic increased illumination and temporary unexpected fluctuations in lighting associated with passing trains
- The rail line and level crossings will not require lighting
- Maintenance activities required to be carried out at night will result in localised and temporary light pollution

Mitigation measures for lighting impacts during operation include:

- Light spillage from artificial night-lighting used at the maintenance facility and during night works will be designed such that the site is not over-lit unnecessarily and light spillage into adjacent areas is minimised
- Directional lighting will be used and shields provided to minimise spill outside the working area. This includes the sensitive placement and specification of lighting to minimise any potential increase in light pollution

Train lighting is required for safety purposes and is unable to be mitigated.

4.1.8 Summary of Landscape and Visual Impact Assessment

In summary, the mitigated landscape and visual impacts of the Project (Rail) are of moderate and / or minor significance to not significant for the ten viewing locations assessed. The remaining receptors are at a reasonable distance (between 1.6 and 4 km) from and the majority have good screens of vegetation / topography in the direction of the view to the Project (Rail). Due to the nature of the Project (Rail) there will be a permanent impact on the visual landscape and amenity for some viewing locations within the Project (Rail) area.

The landscape and visual impacts of the Project (Rail) will occur during both the construction and operational phases and measures to minimise these impacts will be required.

A summary of the outcomes of this assessment are detailed in Table 4-22 and Table 4-23 for the construction and operational phases, respectively.

Classifications are presented as:

- Negligible Landscape Impact / Negligible Visual Sensitivity / No Significant Impact
- Small landscape Impact / Low Visual Sensitivity / Minor Significance of Impact
- Moderate Landscape Impact / Medium Visual Sensitivity / Moderate Significance of Impact
- Large Landscape Impact / High Visual Sensitivity / High Significance of Impact
- Major Significance of Impact

Table 4-22 Summary of Landscape and Visual Impacts – Construction Phase

Viewing Location (VL)	Visual Modification	Visual Sensitivity	Significance of Impact
VL1 (Gregory Developmental Road)	Moderate	Low	Minor
VL2 (Kilcummin Diamond Downs Road)	Moderate	Low	Minor
VL3 (Moray Bulliwallah Road)	Moderate	Low	Minor
VL4 (Moray Carmichael Road)	Moderate	Low	Minor
VL5 (Residential Property)	Negligible	Negligible	None
VL6 (Residential Property)	Negligible	Negligible	None
VL7 (Residential Property)	Negligible	Negligible	None
VL8 (Residential Property)	Moderate	Medium	Moderate
VL9 (Residential Property)	Moderate	Medium	Moderate
VL10 (Residential Property)	Negligible	Negligible	None

Table 4-23 Summary of Landscape and Visual Impacts – Operation Phase

Viewing Location (VL)	Visual Modification	Visual Sensitivity	Significance of Impact
VL1 (Gregory Developmental Road)	Small	Low	None
VL2 (Kilcummin Diamond Downs Road)	Small	Low	None
VL3 (Moray Bulliwallah Road)	Small	Low	None
VL4 (Moray Carmichael Road)	Small	Low	None
VL5 (Residential Property)	Negligible	Negligible	None
VL6 (Residential Property)	Negligible	Negligible	None
VL7 (Residential Property)	Negligible	Negligible	None
VL8 (Residential Property)	Small	Medium	Minor
VL9 (Residential Property)	Moderate	Medium	Moderate
VL10 (Residential Property)	Negligible	Negligible	None

4.2 Topography, Geology and Soils

4.2.1 Introduction

This assessment details the existing environmental values for soils and land within the area potentially impacted on by the Project (Rail), and describes the potential for the construction and operation of the rail and associated infrastructure to change existing land uses.

4.2.2 Description of Environmental Values

4.2.2.1 Topography

The Project (Rail) has an east-west orientation, starting in the west at the juncture with the Project (Mine) at approximately 240 m AHD (Figure 4-2). Moving eastward, the slope gently leads down onto a plain before rising to 220 m AHD near the Gregory Developmental Road, approximately 75 km east of the Mine site. The Project (Rail) crosses another plain for approximately 50 km, before rising to a crest (360 m AHD), to the south of Moranbah. The Project (Rail) connects in the east with the existing Goonyella system at an elevation of approximately 280 m AHD.

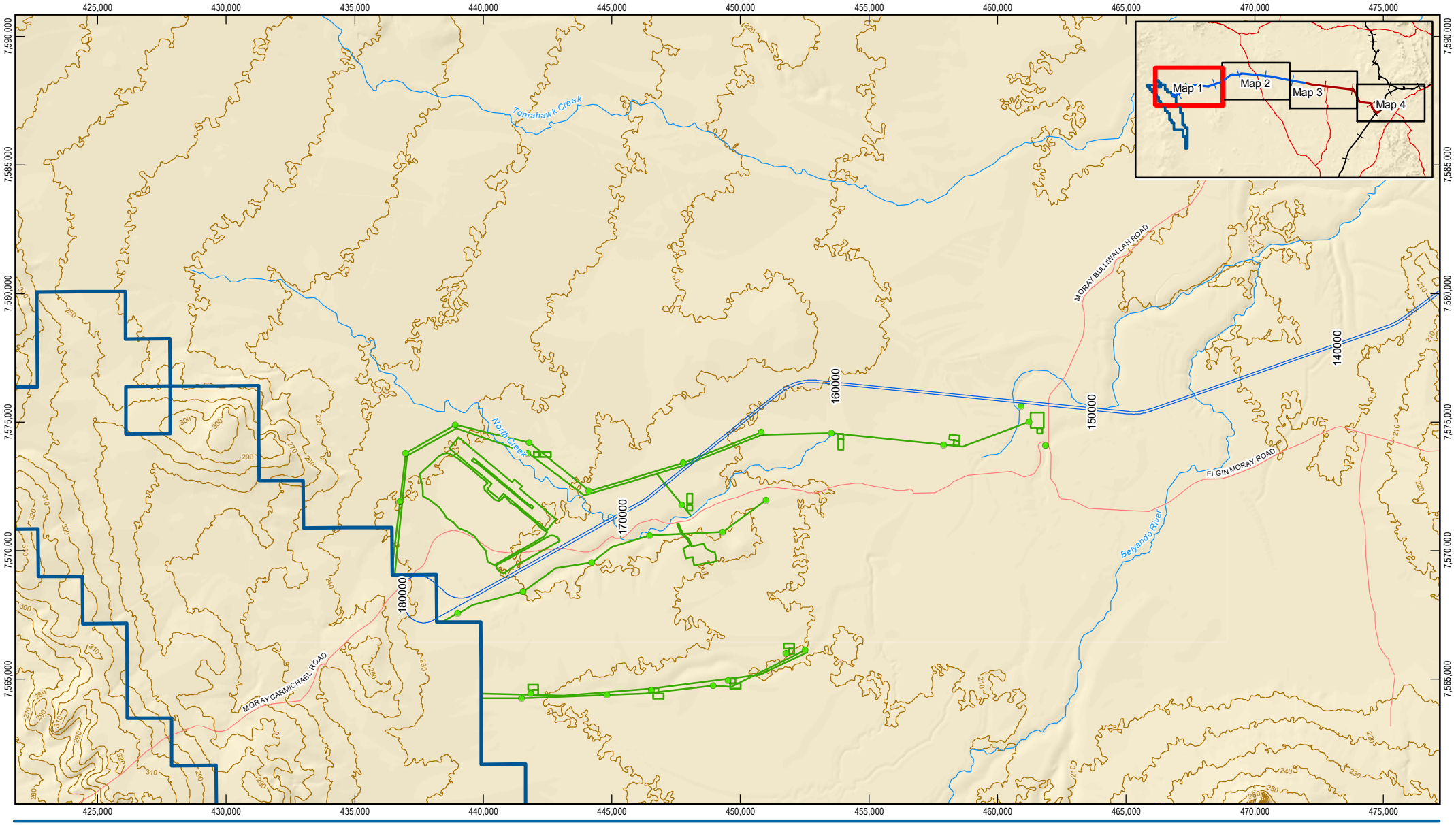
The Project (Rail) is predominantly within the Belyando River / Suttor River sub catchment (crossing the main stems of the Belyando River, Mistake Creek and Logan Creek). The last 27 km of the rail corridor (in the east) enters the Isaac River catchment via Grosvenor Creek. A number of ephemeral tributaries of these main waterways along with farm dams (created within the tributaries) and several non-perennial watercourses are also traversed.

All the watercourses flow in a general northward direction towards the Suttor River. Stream flows reflect rainfall variability and seasonality, flooding occurs in summer and it is not uncommon for an absence of flow between May and November.

The rail corridor is likely to intersect 10 broad landforms (Atlas of Australian Soils Database). These include:

- Broadly undulating or level plains
- Gently undulating plains
- Level plains with moderate to strong gilgai microrelief
- Level or very gently undulating outwash plains dissected by numerous small shallow prior stream channels, some of which are sand-filled
- Undulating low rises that are old levees of major streams
- Alluvial plains associated with major streams; numerous braided channels may occur and many areas are subject to irregular flooding
- Undulating lands, often with high gravelly ridges
- Gently to moderately undulating lands with some high ridges
- Extensive level old alluvial plains that have a very slight (few inches) gilgai microrelief
- Level or very gently undulating clay plains with slight to moderate (0.5 m) gilgai microrelief, occasionally stronger (1 m). Where the unit is adjacent to major streams many small braided channels occur and the area is subject to flooding

- Gently undulating lands with broad ridge crests and low rises
- Hilly deeply dissected plateaux consisting of level stony plateau surfaces, high bluffs and cliffs bordering narrow valleys, and some undulating colluvial slopes and alluvial flats; massive sandstone outcrop is common



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Town
- State Road
- Local Road
- Existing Railway
- Watercourse
- Contour - 10m
- Rail (West)
- Rail (East)
- Mine (Onsite)
- Mine (Offsite)
- Mine (Offsite)

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Carmichael Coal Mine and Rail Project

Topography

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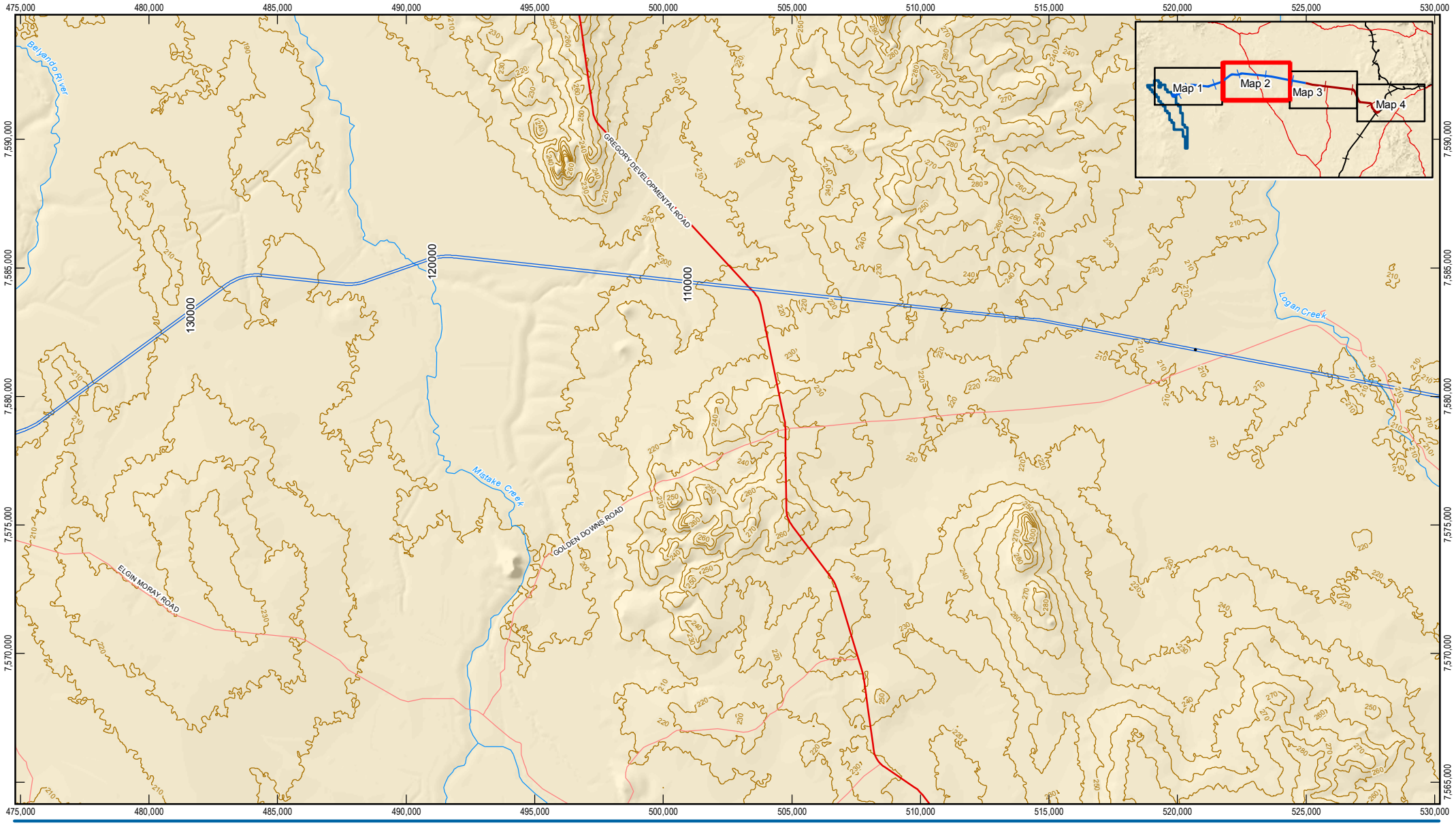

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Kilometres

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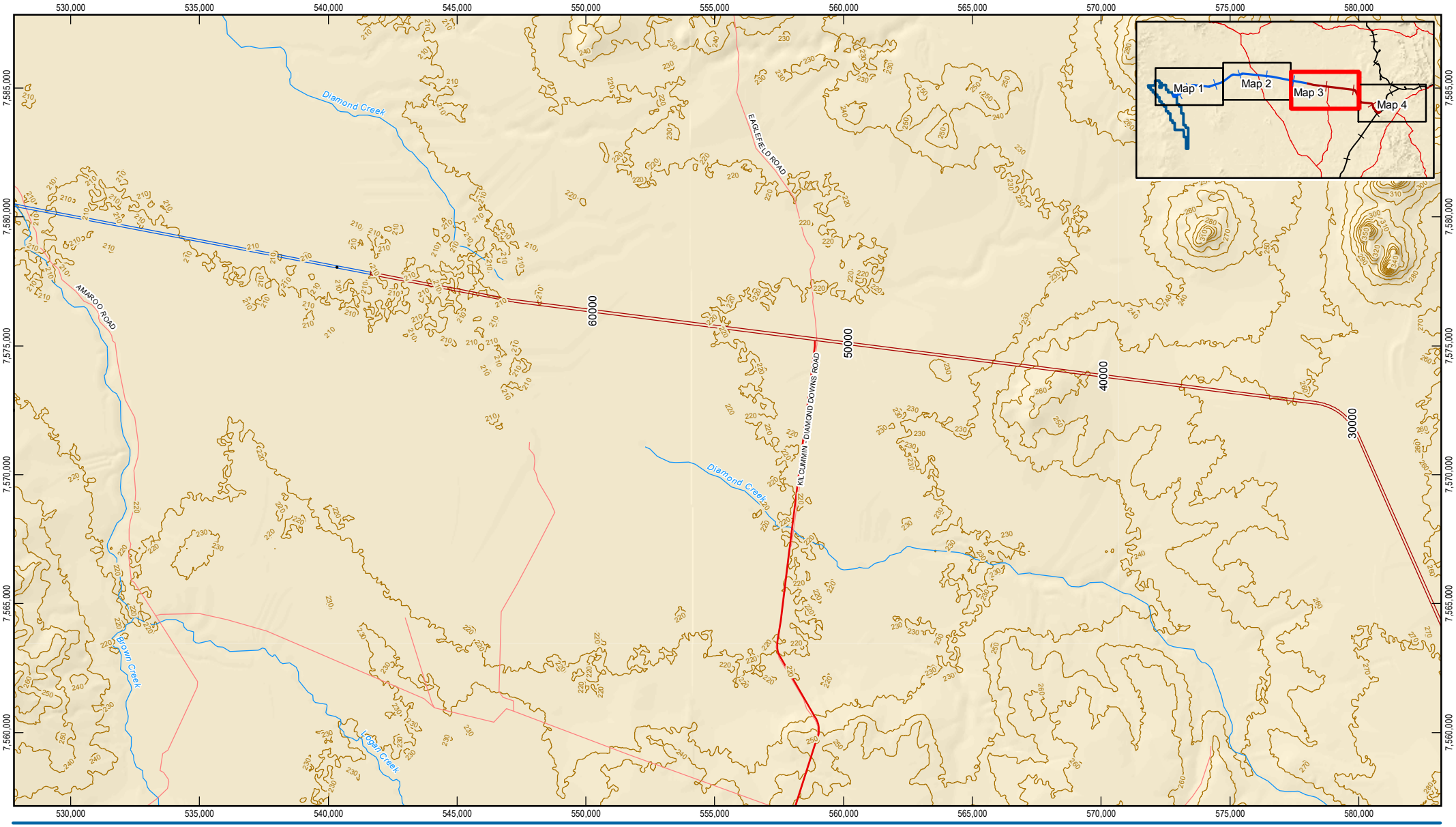

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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

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- Mine (Offsite)

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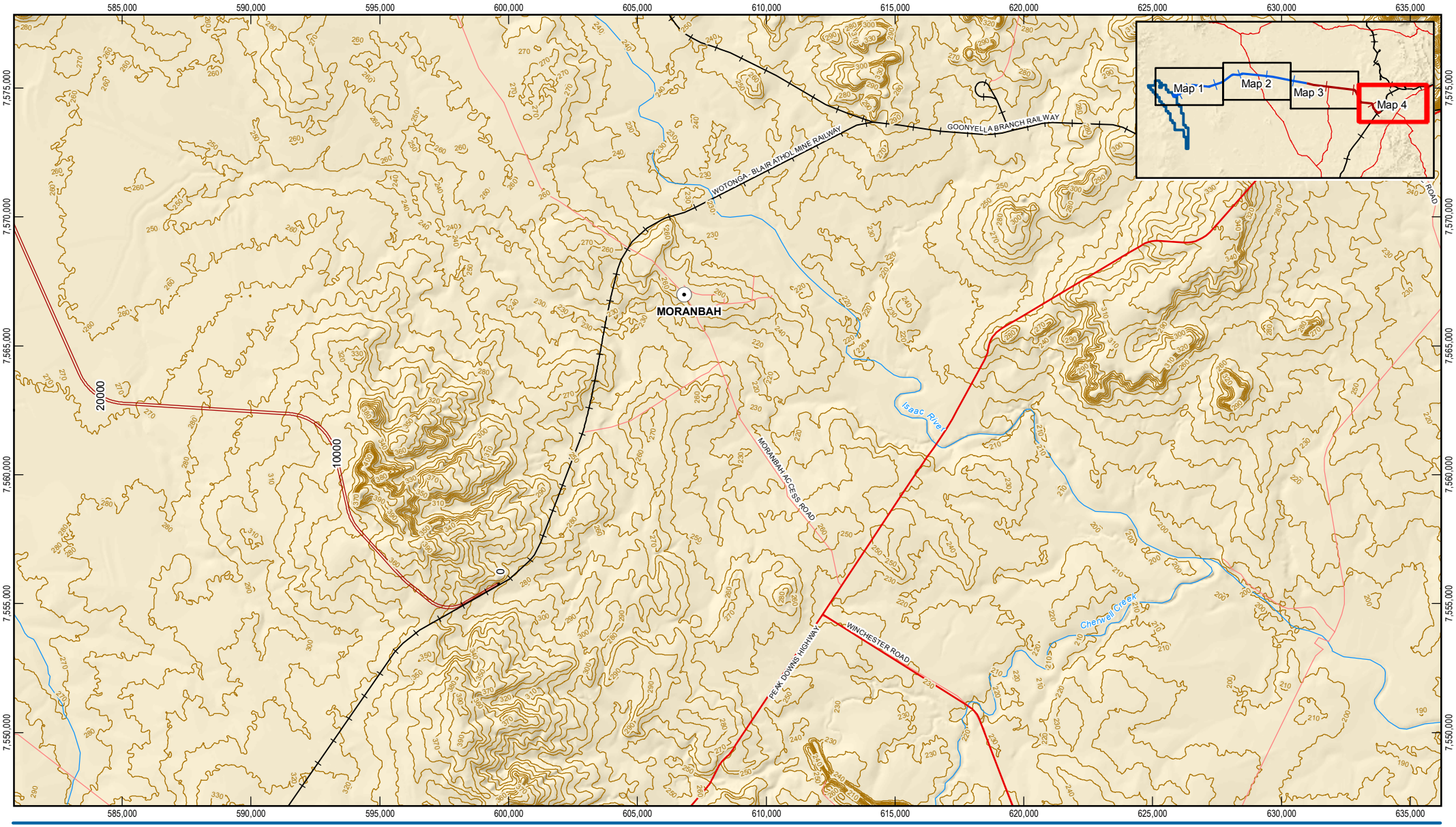

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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Town
- State Road
- Local Road
- Existing Railway
- Watercourse
- Contour - 10m
- Rail (West)
- Rail (East)
- Mine (Onsite)
- Mine (Offsite)
- Mine (Offsite)

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Topography

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The Project (Rail) is predominantly located within gently inclined areas, with the exception of those areas around major drainage lines. Figure 4-3 depicts the slope variation within the Study Area[1].

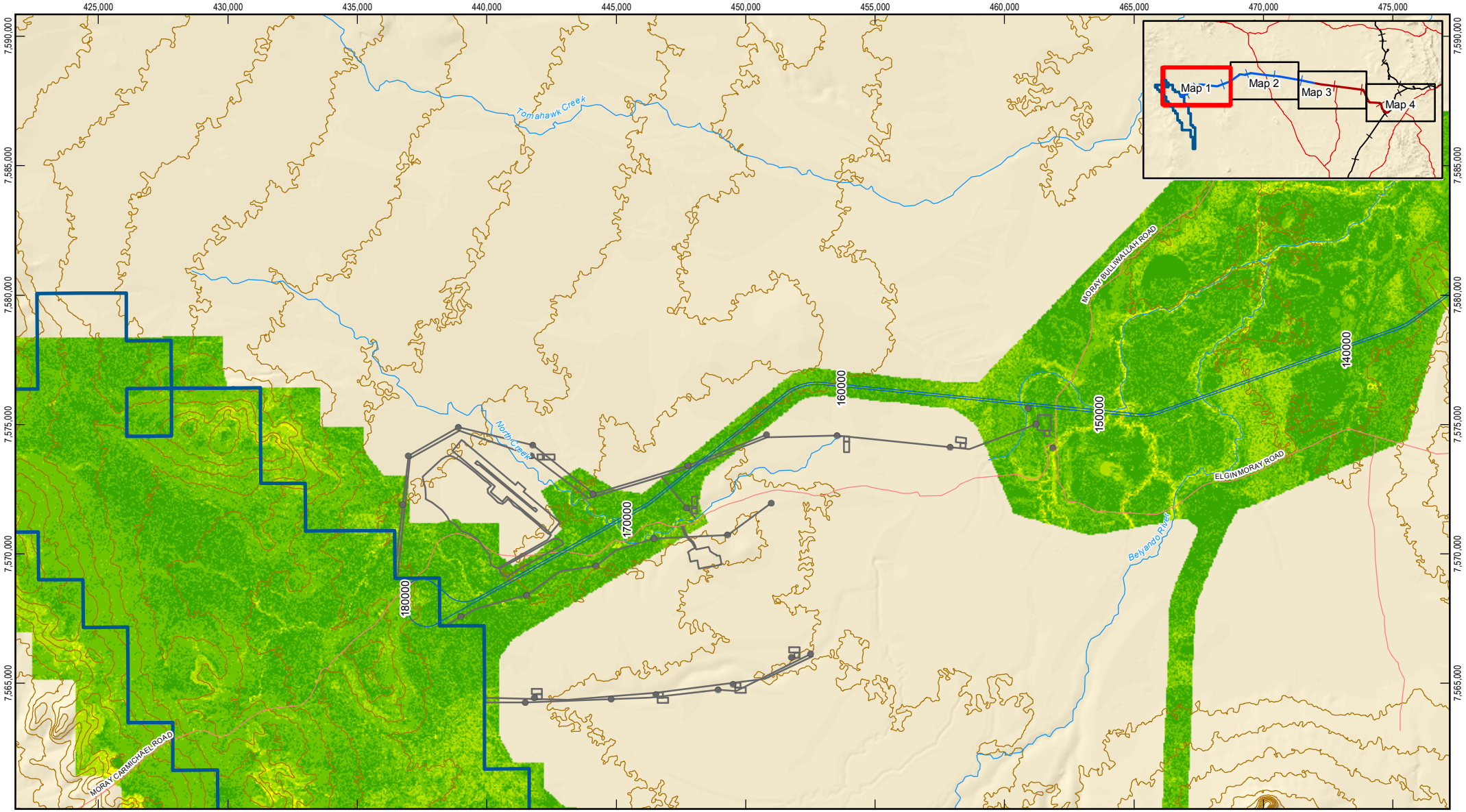
Areas of steep and long slopes are at risk of erosion and landslides under wet weather conditions. Erosion in regards to topography is a factor of both the slope gradient and slope length.

The Project (Rail) alignment traverses areas of sustained slope length (>100 m) regarded as a very high erosion risk, but with very low to moderate modal slope rating. An overall risk rating for the Project based on both aspects of slope is considered to be moderate. However specific management practices will be prescribed in an Erosion and Sediment Control Plan (ESCP) for those short distances of steep to precipitous slope as they are generally associated with the water crossings and drainage lines.

4.2.2.2 Geology

The geology within the Study Area consists predominantly of Tertiary to Quaternary deposits (Quaternary Alluvium) comprising sands, silts, clays and alluvium. There are 14 geological units underlying the proposed Project (Rail), displayed in Figure 4-4. The properties of these units are summarised in Volume 4 Appendix Y Rail Soils Assessment. No fault lines, or fossils were identified on the available geological maps as being present under the proposed Project (Rail).

[1] A slope hazard analysis is not currently possible at or about chainage 65 km to 100 km as a result of realignment to outside of the area previously covered by LIDAR survey.



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Kilometres

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Horizontal Datum: Geocentric Datum of Australia (GDA)
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N

LEGEND

- Town
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- Local Road
- Watercourse
- Existing Railway
- Contour - 10m
- Rail (West)
- Rail (East)
- Mine (Onsite)
- Mine (Offsite)
- Mine (Offsite)

Slope Classification

- <=1%
- >1% - <=3%
- >3% - <=10%
- >10% - <=32%
- >32% - <=56%
- >56% - <=100%
- >100%

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Slope Hazard

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Figure: 4-3
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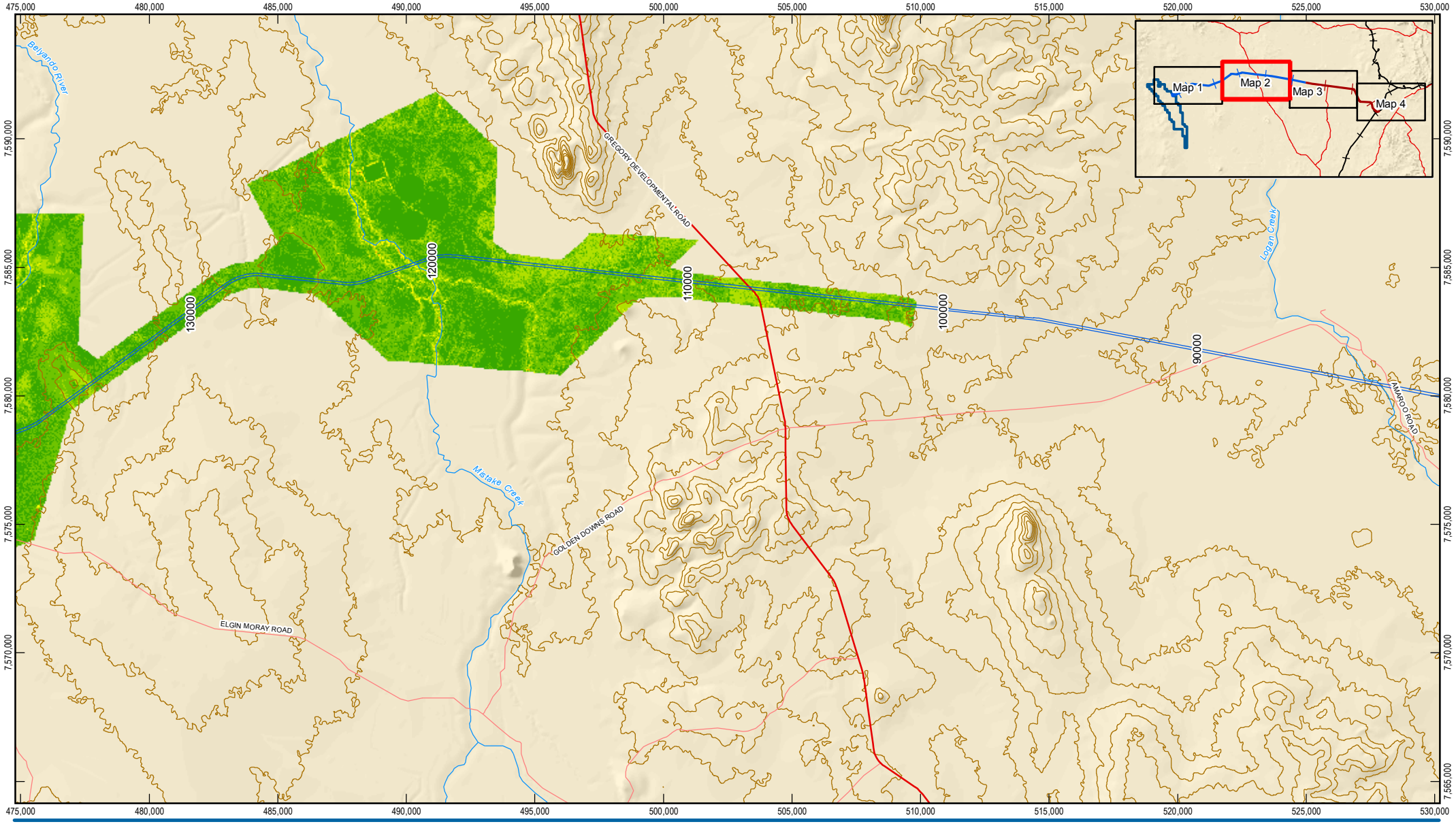

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Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
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N

LEGEND

- Town
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- Watercourse
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- Contour - 10m
- Rail (West)
- Rail (East)
- Mine (Onsite)
- Mine (Offsite)
- Mine (Offsite)

Slope Classification

- <=1%
- >1% - <=3%
- >3% - <=10%
- >10% - <=32%
- >32% - <=56%
- >56% - <=100%
- >100%

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Carmichael Coal Mine and Rail Project

Slope Hazard

Job Number	41-25215
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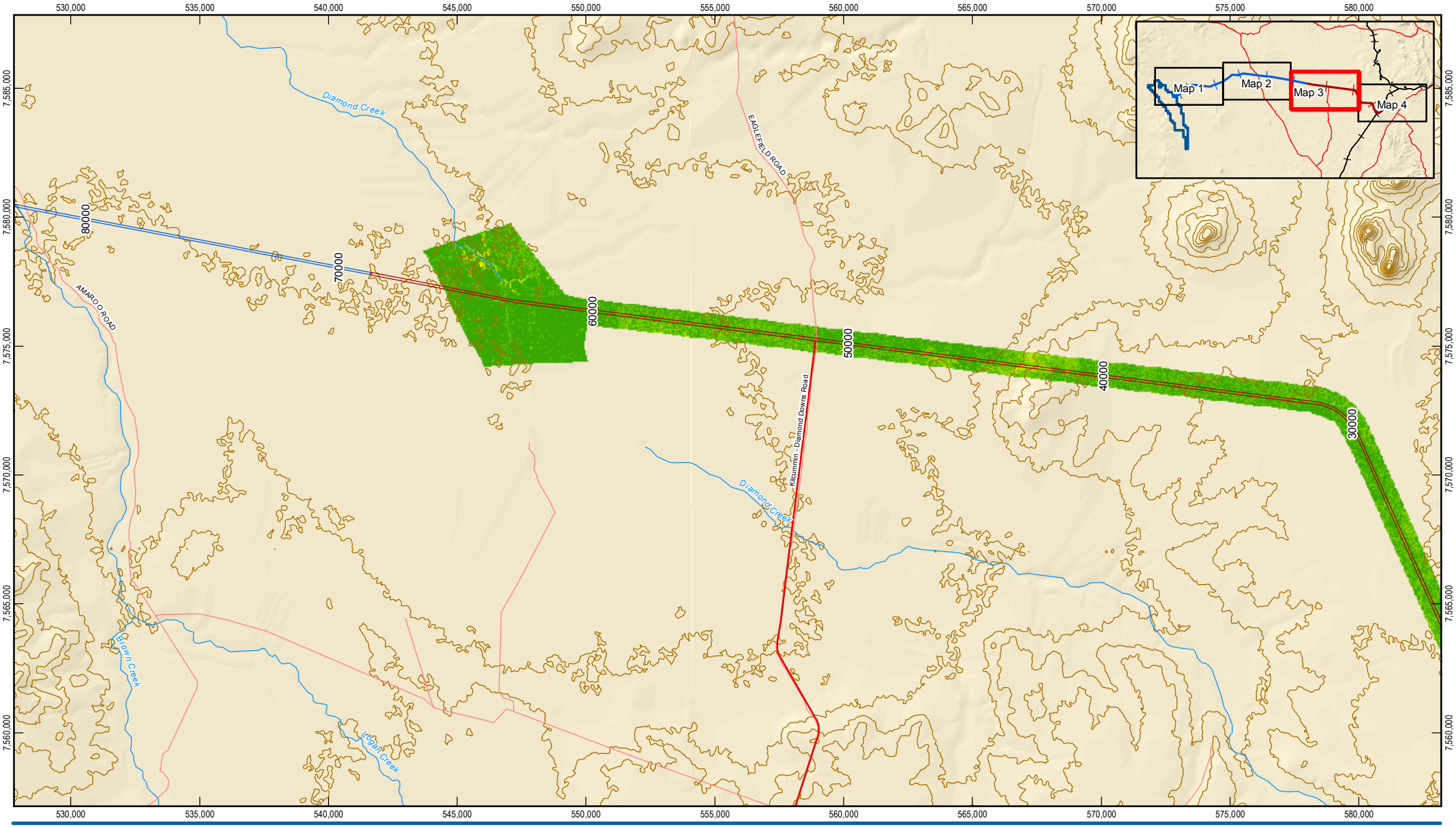

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Kilometres
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Horizontal Datum: Geocentric Datum of Australia (GDA)
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- Mine (Onsite)
- Mine (Offsite)
- Mine (Offsite)

Slope Classification

- <=1%
- >1% - <=3%
- >3% - <=10%
- >10% - <=32%
- >32% - <=56%
- >56% - <=100%
- >100%

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Slope Hazard

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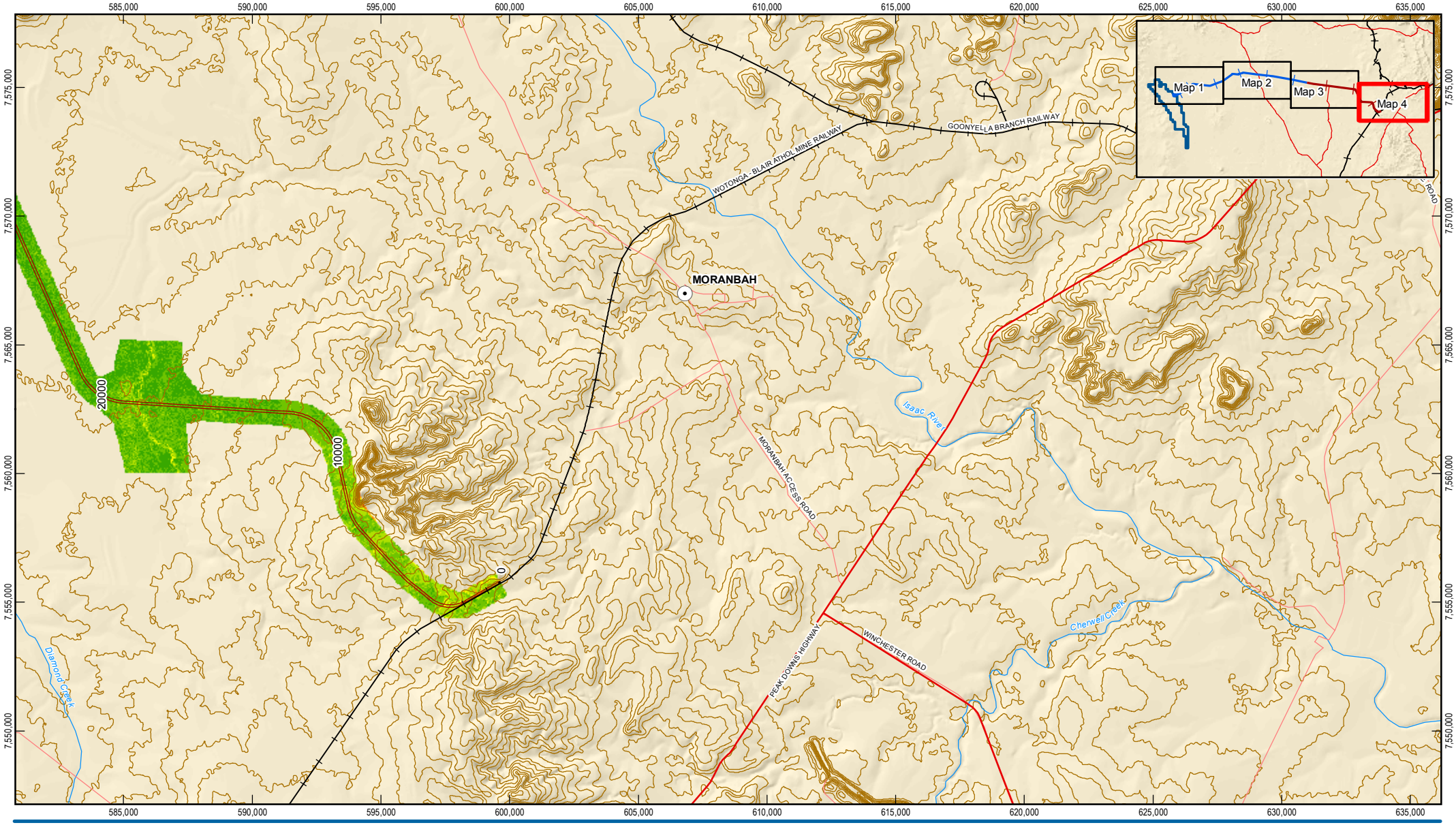

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Kilometres
Map Projection: Universal Transverse Mercator
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- Mine (Offsite)
- Mine (Offsite)

Slope Classification

- <=1%
- >1% - <=3%
- >3% - <=10%
- >10% - <=32%
- >32% - <=56%
- >56% - <=100%
- >100%

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Slope Hazard

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Figure: 4-3
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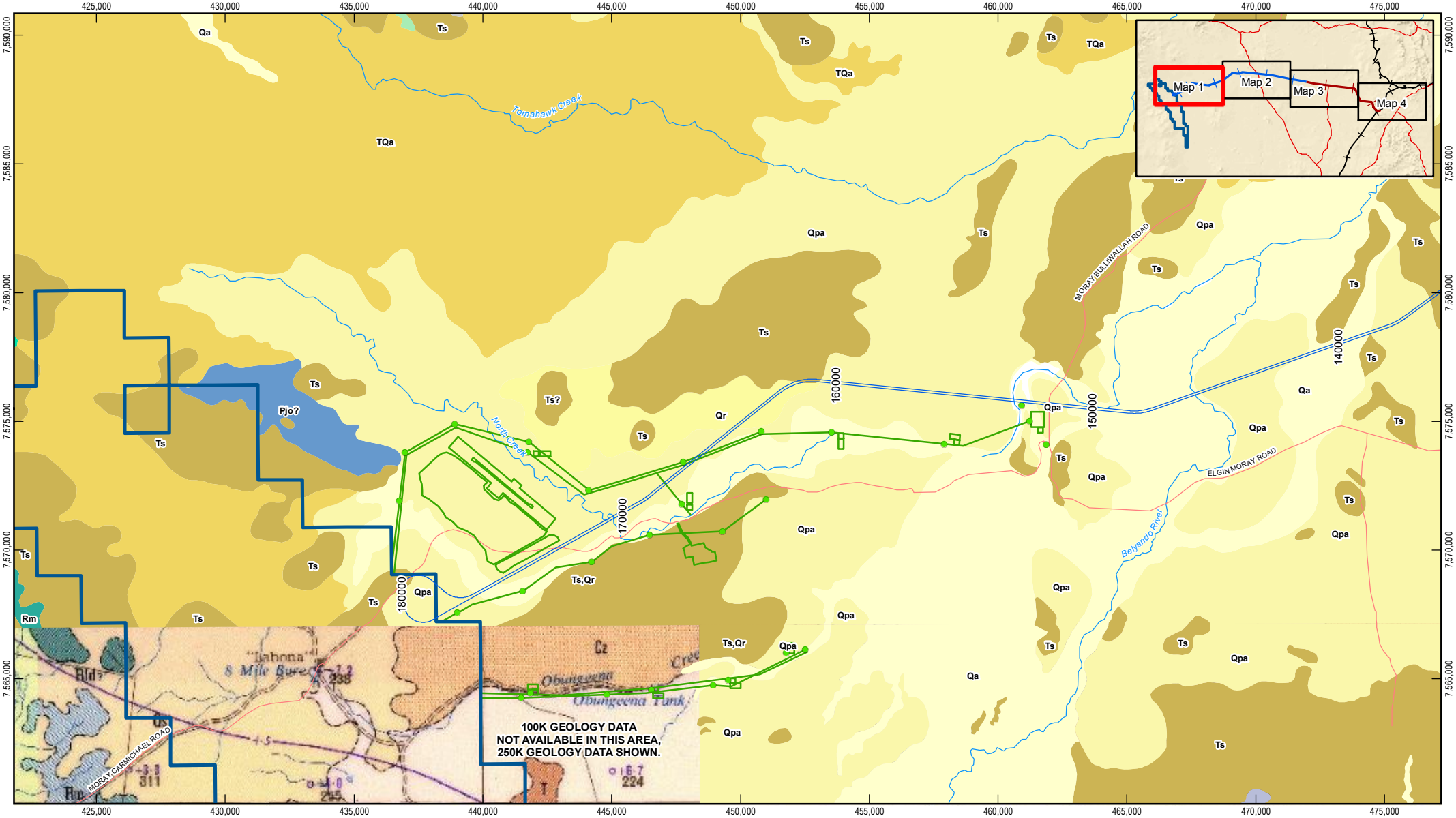

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0 1 2 3 4 5

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Town
- State Road
- Local Road
- Other Rail Network
- Watercourse
- Rail (West)
- Rail (East)
- Mine (Onsite)
- Mine (Offsite)
- Mine (Offsite)

NOTE: Detailed Geological Unit Information is included on Sheet 5

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

1:100,000 Mapped Geology

Job Number	41-25215
Revision	C
Date	11-09-2012

Figure: 4-4
Sheet 1 of 5

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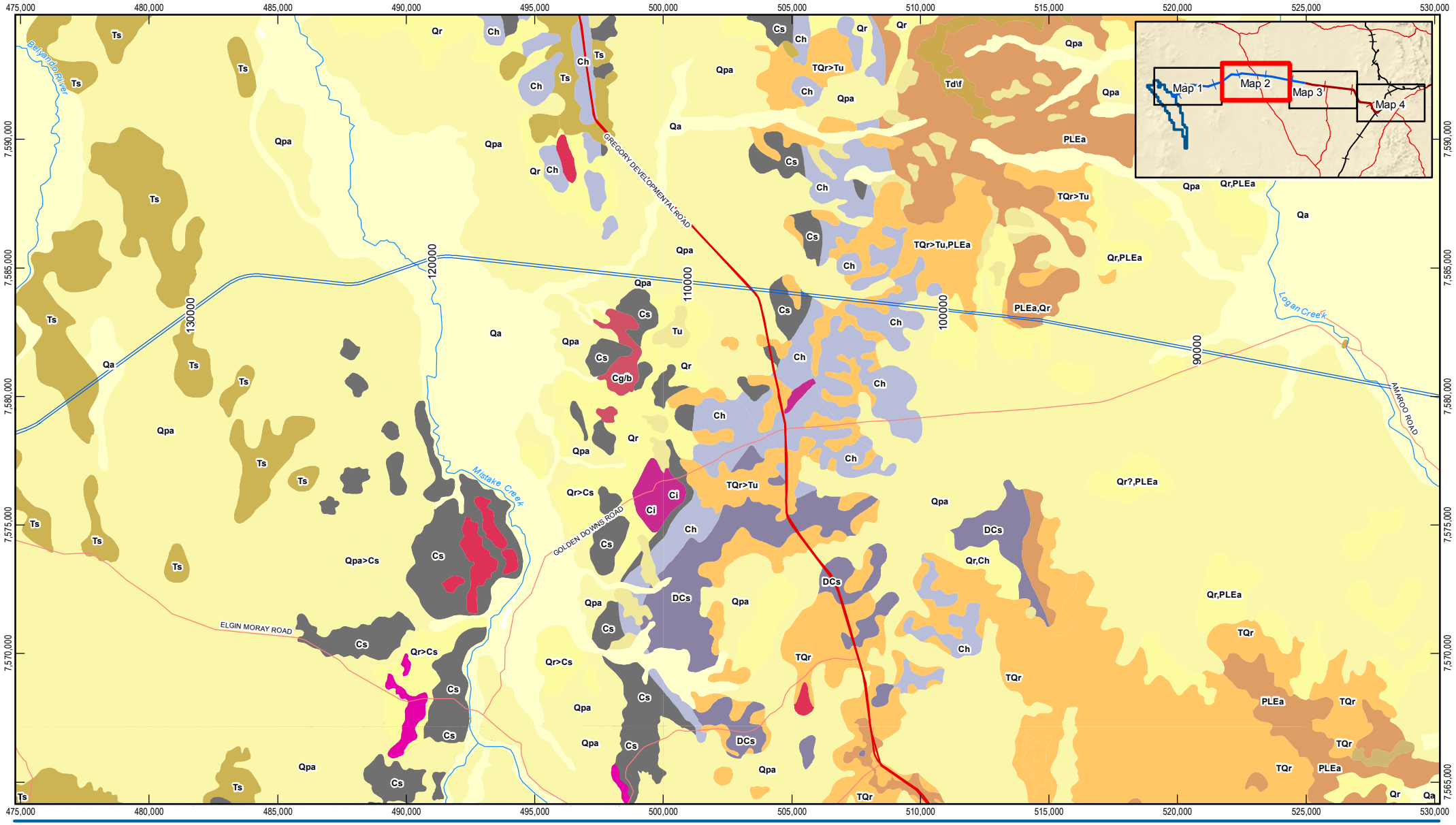

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Kilometres

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N

LEGEND

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Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

1:100,000 Mapped Geology

Job Number	41-25215
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Figure: 4-4
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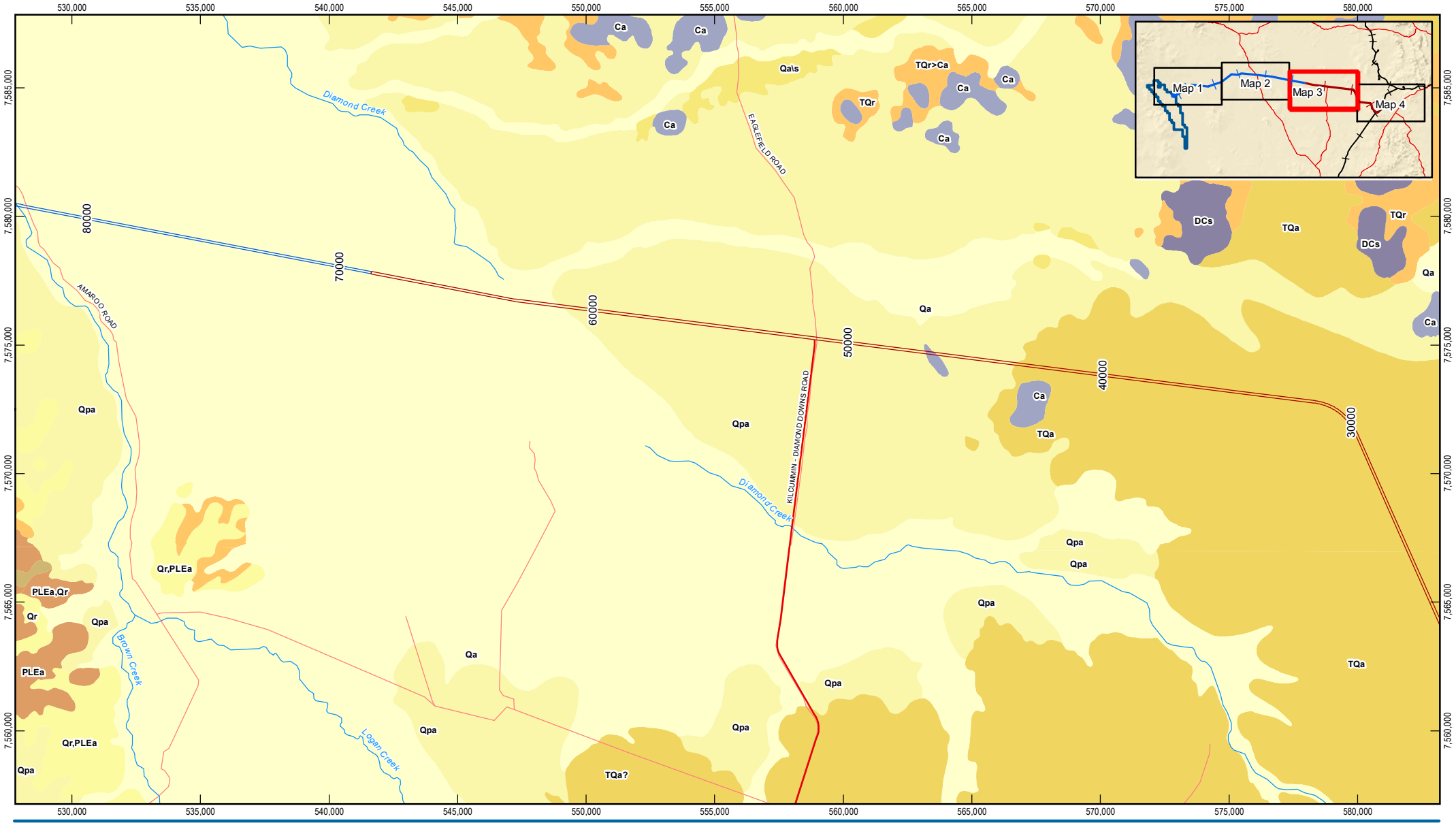

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Kilometres

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Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

1:100,000 Mapped Geology

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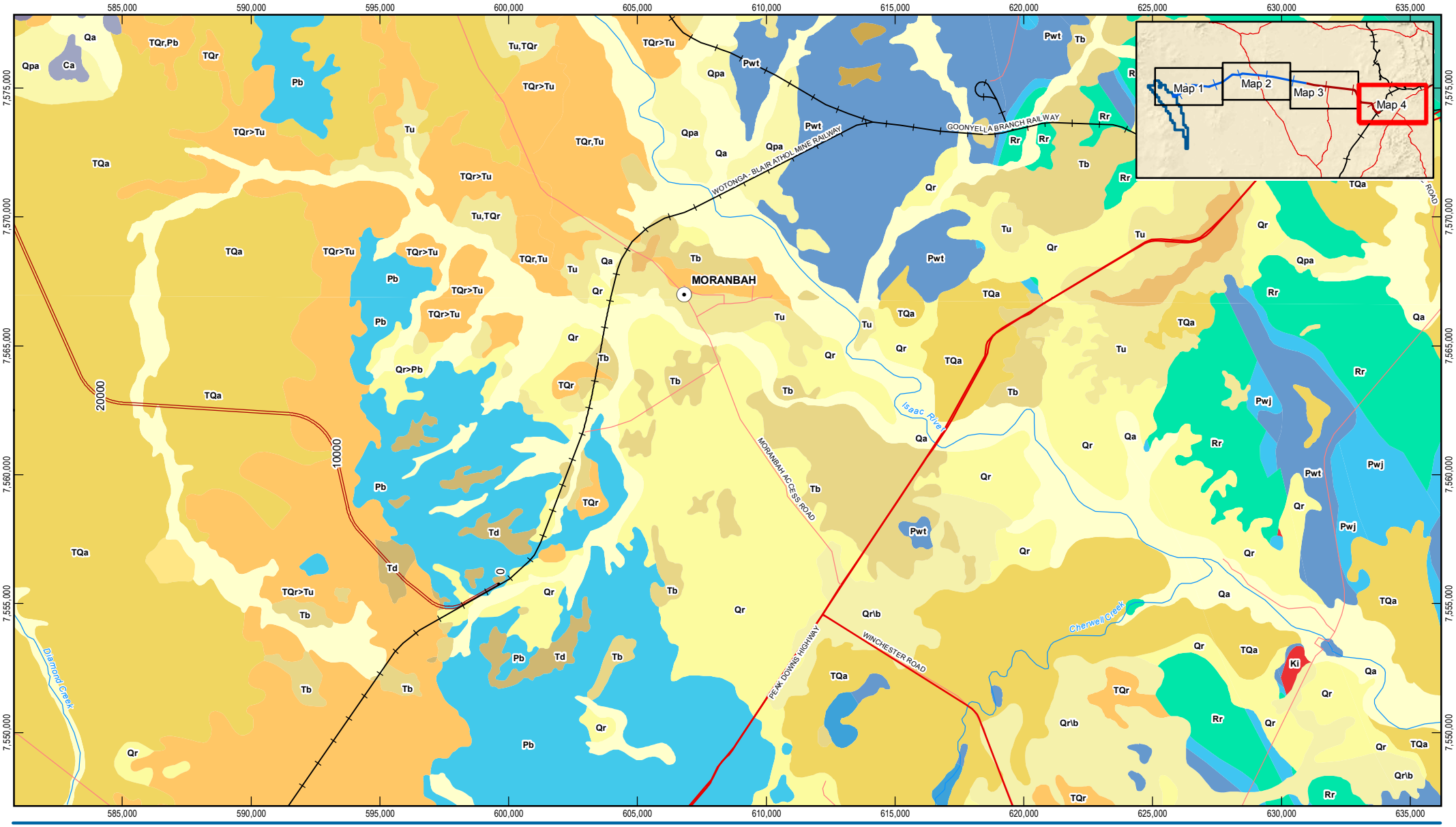
Data source: DME: EPC1690 (2010), EPC1080 (2011), 100k Geology (2011), 250k Geology Raster (2009); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW, CA



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0 1 2 3 4 5

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Town
- State Road
- Local Road
- Other Rail Network
- Watercourse
- Rail (West)
- Rail (East)
- Mine (Onsite)
- Mine (Offsite)
- Mine (Offsite)

NOTE: Detailed Geological Unit Information is included on Sheet 5

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Carmichael Coal Mine and Rail Project

1:100,000 Mapped Geology

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Figure: 4-4
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Data source: DME: EPC1690 (2010), EPC1080 (2011), 100k Geology (2011), 250k Geology Raster (2009); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW, CA

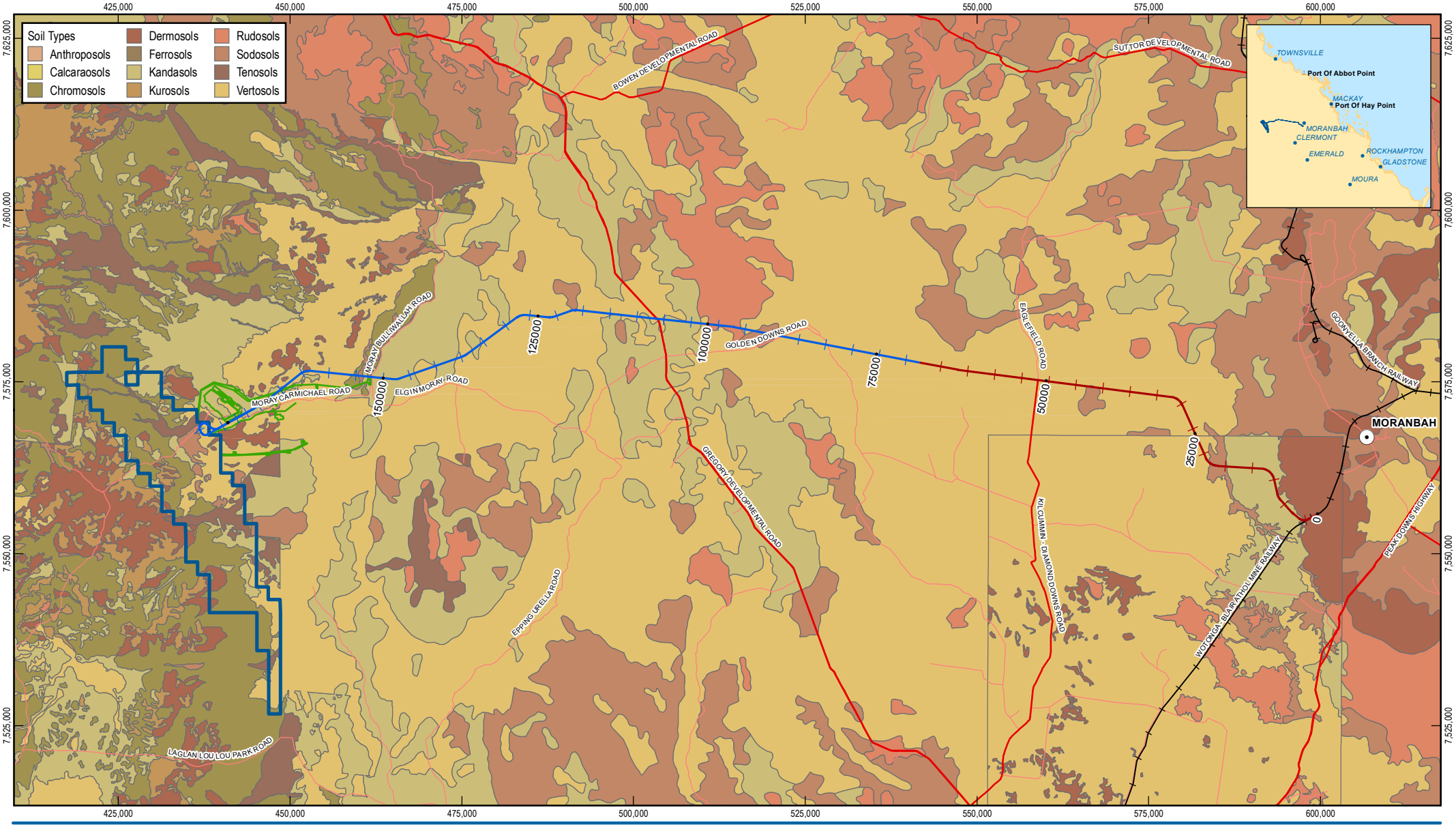
4.2.2.3 Soils

The Project (Rail) traverses land systems as defined in:

- Lorimer, MS 2005, The Desert Uplands: an overview of the Strategic Land Resource Assessment Project, Technical Report, Environmental Protection Agency, Queensland, herein referred to as DUSLARA. The Project (Rail) traverses the DUSLARA land resource study area for approximately 30 km commencing from the Mine site heading east. Within this section are five land systems, divided further into nine land units, as follows:
  - The Bulliwallah land system represents an outlier of the Desert Uplands plateau, comprising land units BH1 and BH2
  - The Belyando River land system represents the Belyando River floodplain between "Forrester" and "Bulliwallah" and comprises four land units. The Project (Rail) traverses only land unit BR4, being the actual streambeds and channels
  - The Beenboona land system is situated within the lower slopes of the landscape which results in the land system having a complex arrangement of soils types. The BB2 land unit comprises the gently undulating plains within the land system through which the Project (Rail) traverses
  - The Willandspey land system is characterised by an extensive plain of deep, grey and red brown clay soils. Land units WY1, WY2, WY3 and WY4 apply
  - The Plain Creek land system represents the steep hill landform on folded bedrock normally found in the Brigalow Belt bioregion. Land unit PK3 on lower slopes applies to the Project (Rail)
- Gunn, R.H. Galloway, R.W. Pedley, L and Fitzpatrick, E.A, 1967. Lands of the Nogoa - Belyando Area, Queensland - Land Research Series No. 18, Commonwealth Scientific and Industrial Research Organisation, Australia, Melbourne, Victoria, herein referred to as ZCQ2. The ZCQ2 study predominates along the length of the Project (Rail) and comprises the following land systems:
  - The Islay land system (five land units), associated with gidgee plains with gilgaied clay soils on acid clay exposed within the tertiary weathered zone
  - The Blackwater land system (five land units) is associated with brigalow plains with cracking clay soils on acid clay exposed within the tertiary weathered zone, which is similar to that of the Islay land system
  - The Ulcanbah land system (four land units) comprises clay plains with Gidgee and cracking clay soils on shales and acid clay exposed within the tertiary weathered zone
  - The Somerby land system (six land units) is associated with brigalow and cracking clay soils on acid clay exposed within the tertiary weathered zone, similar to that of above land systems
  - The Avon land system (four land units) is associated with gently undulating grassland with cracking clay soils on alkaline clays deposited within the Tertiary weathered zone
  - The Funnel land system (five land units) is a post tertiary land system associated with flooded alluvial plains with coolibah and cracking clay soils
  - The Moray land system (four land units) is described as comprising plains and lowlands with gidgee and cracking clay soils on alkaline clay deposited within the Tertiary weathered zone
  - The Loudon land system (six land units) is described as low hills with lancewood and some ironbark on weathered volcanics and Drummond basin sediments plus intervening lowlands with box, brigalow, and blackwood. The soil types are generally shallow rocky soils

  - The Disney land system is characterised by small lateritic mesas with ironbark and red or yellow earths on Tertiary sandstone; surrounding lowlands with box and brigalow and texture contrast soils on weathered Drummond Basin sediments
  - The Monteagle land system is described as lowlands with box and texture contrast soils on slightly stripped Tertiary land surface
  - The Banchory land system is described as alluvial plains with Gidgee and cracking clay soils. The land system is within a post tertiary alluvial system, within the lower alluvial plains
  - The Lennox land system is associated with the plains and lowlands with silver leaved ironbark and yellow and red earths on intact tertiary surfaces
  - The Alpha land system is associated with alluvial plains with box vegetation and texture contrast soils in non-basaltic alluvium
- The Shields, P.G, Chamberlain H.J., and Booth N.J., 1993. Soils and Agricultural Use, in the Kilcummin Area, Central Queensland, Project Report Series: QO93011, Department of Natural Resources and Mines, Brisbane Queensland, herein referred to as KCM. The KCM dataset covers the eastern 25 km portion of the Project (Rail). The KCM Project (Rail) section descends westwards from a ridge at 360 m to approximately 260 m. The soils in this section of the Project (Rail) are reported as being Vertosols (Kenmar melonhole soil type), Sodosols (Heyford and Lebanon soil types), Rudosols (Cherwell soil type) and Kandosols (Fletcher and Villafranca soil types).

A number of soil types have been mapped within the Study Area. Vertosols are mapped as dominating, while Chromosols and Sodosols occupy large expanses as shown in Figure 4-5. Other soil types mapped as present are Kurosols, Kandosols, Rudosols and Tenosols. The soils mapping conducted at a preliminary desktop level, is suitable for the purposes of the EIS and providing an overview of expected soil types within the Project (Rail) area. More detailed surveys will be required, to distinguish changes in landscape and soil types particularly in areas mapped at 1:500,000. This is currently underway.



1:750,000 (at A4)

0 5 10 15 20 25

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Town
- State Road
- Local Road
- Existing Railway
- Rail (West)
- Rail (East)
- Mine (Onsite)
- Mine (Offsite)

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Carmichael Coal Mine and Rail Project

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Australian Soil Classification

Figure 4-5

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Data source: DERM: Combined Soils (2010); DME: EPC1690 (2010), EPC1080 (2011); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012); GHD: Northern Missing Link (2011). Created by: BW, CA

The State Planning Policy 2/02: Planning and Management of Development Involving Acid Sulfate Soils (ASS) states that ASS occurs along coastal areas, generally where land elevation is less than 5 metres AHD. However, ASS is known to also occur in some inland areas within river and lake beds, irrigation channels, and in saline seepage areas. As the Project (Rail) is located at approximately 200 m AHD, ASS is not deemed to be a risk in the Study Area. Acid generating geologies may be present within the corridor; however these were not identified during the desktop assessment.

Soil erodibility is determined by the rate of infiltration at the surface, permeability of the soil profile, coherence of the soil particles, lack of vegetative cover, loss of soil organic matter and surface sealing (DMR, 2002). Soil types most susceptible to erosion, are the texture contrast soils (duplex soils), particularly soils that are highly sodic as the higher sodium content results in soil particles being easily separated and hence, more easily mobilised by wind and water.

One soil type was identified on the Project (Rail) area with a high to very high erodibility rating. The other seven soil types identified have a very low to moderate erodibility ratings (refer Volume 4 Appendix Y Rail Soils Assessment).

Good Quality Agricultural Land (GQAL) is land that is capable of sustainable use for agriculture with a reasonable level of inputs and without causing degradation of land or other natural resources.

There are four Agricultural Land Classes (A to D) defined for Queensland as detailed in Table 4-24. GQAL is defined as Class A agricultural land, and in some cases includes Class B agricultural land, under the Agricultural Land Class ranking.

Table 4-24 Agricultural Land Classes

Class	Description
Class A	**Crop land** – land that is suitable for current and potential crops with limitations to production which range from none to moderate levels.
Class B	**Limited crop land** – land that is marginal for current and potential crops due to severe limitations; and suitable for pastures. Engineering and/or agronomic improvements may be required before the land is considered suitable for cropping.
Class C	**Pasture land** – land that is suitable only for improved or native pastures due to limitations which preclude continuous cultivation for crop production; but some areas may tolerate a short period of ground disturbance for pasture establishment.
C1	Land suitable for sown pastures with moderate limitations
C2	Land suitable for sown pastures with severe limitations
C3	Land suitable for light grazing of native pastures in inaccessible areas
Class D	**Non-agricultural land** – land not suitable for agricultural uses due to extreme limitations. This may be undisturbed land with significant habitat, conservation and/or catchment values or land that may be unsuitable because of very steep slopes, shallow soils, rock outcrop or poor drainage.

Source: DPI and DHLGP, 1993

Figure 4-6 details the extent of mapped GQAL classes along the study corridor. The Belyando Shire Planning Scheme recognises GQAL classes A, B and C1 as GQAL land and only these classes are shown in Figure 4-6.

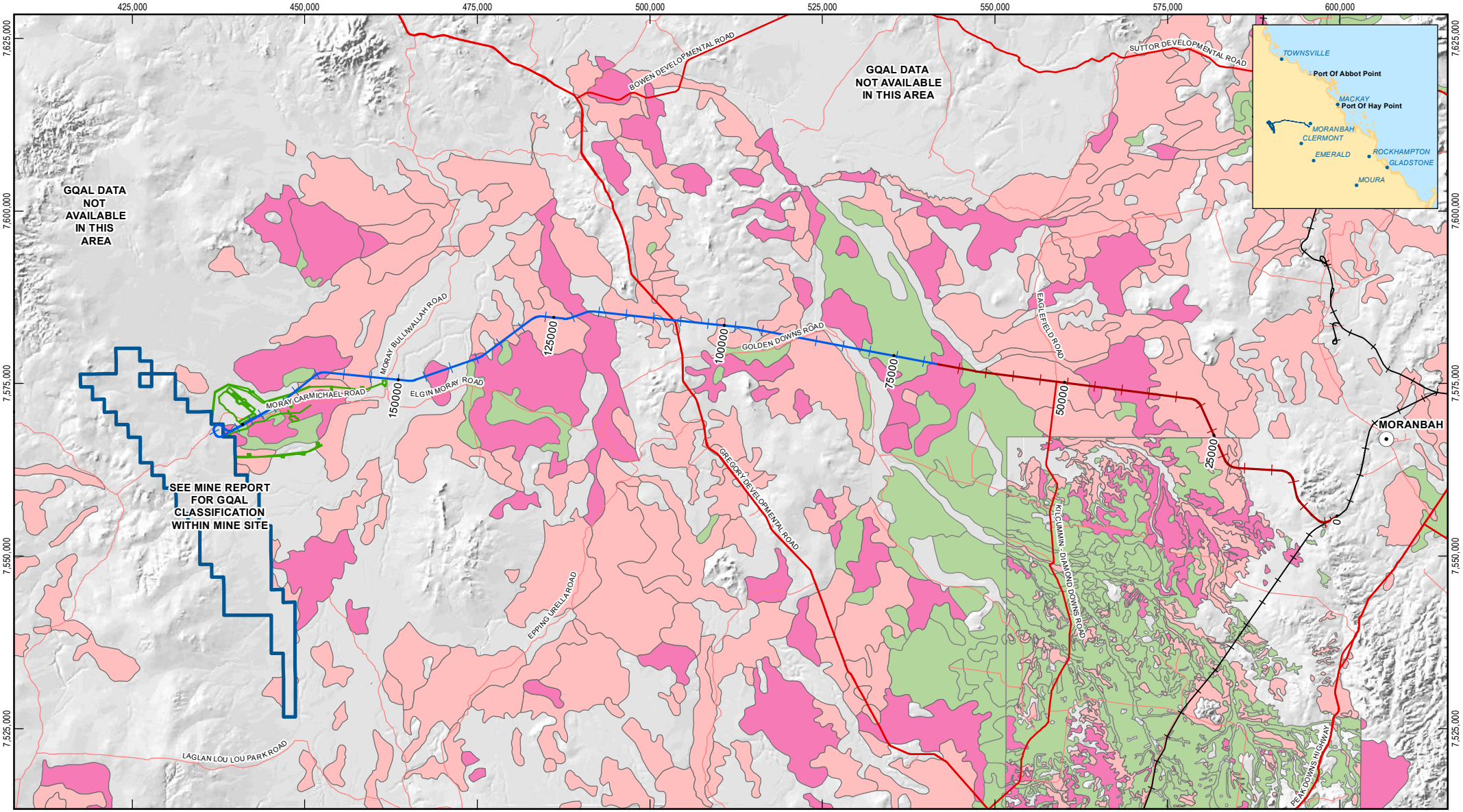
Land mapped as suitable for cropping (Class A) is limited within the Project (Rail) area. Land considered marginal for cropping (Class B) is more widespread along the Project (Rail) corridor albeit still limited in extent. Class C1 agricultural land, land considered suitable only for sown pastures with moderate limitations, dominates the landscape in the vicinity of the Project (Rail). The Project (Rail) also traverses through pockets of non-agricultural land, particularly at the intersections of roads, creeks and at the Goonyella rail system connection.

The Queensland Government considers that the best cropping land, defined as strategic cropping land , is a finite resource that must be conserved and managed for the longer term. As a general aim, planning and approval powers should be used to protect such land from those developments that would lead to its permanent alienation or diminished productivity. Two types of strategic cropping land are identified under government, namely Protection Areas and Management Areas.

Trigger maps published by the former Department of Environment and Resource Management (DERM) (2010) were reviewed and approximately 120 km of the Project (Rail) corridor traverses the western extent of the strategic cropping land Management Area in the western cropping zone. There are no strategic cropping land Protection Areas within the Project (Rail) vicinity.

Strategic cropping land is limited in extent within the Project (Rail) area and occurs in fragmented parcels. The Project (Rail) corridor traverses areas mapped as strategic cropping land within the western cropping zone. Figure 4-7 shows the extent of mapped strategic cropping land within the vicinity of the Project (Rail).

As this is a desktop assessment, the mapped strategic cropping land is yet to be confirmed against the eight criteria prescribed in the legislation. If necessary, the land may be assessed for a history of cropping.



1:750,000 (at A4)

0 5 10 15 20 25

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Town
- State Road
- Local Road
- Existing Railway
- Rail (West)
- Rail (East)
- Mine (Onsite)
- Mine (Offsite)

Good Quality Agricultural Land

- A
- B
- C1

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Good Quality Agricultural Land

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Figure 4-6

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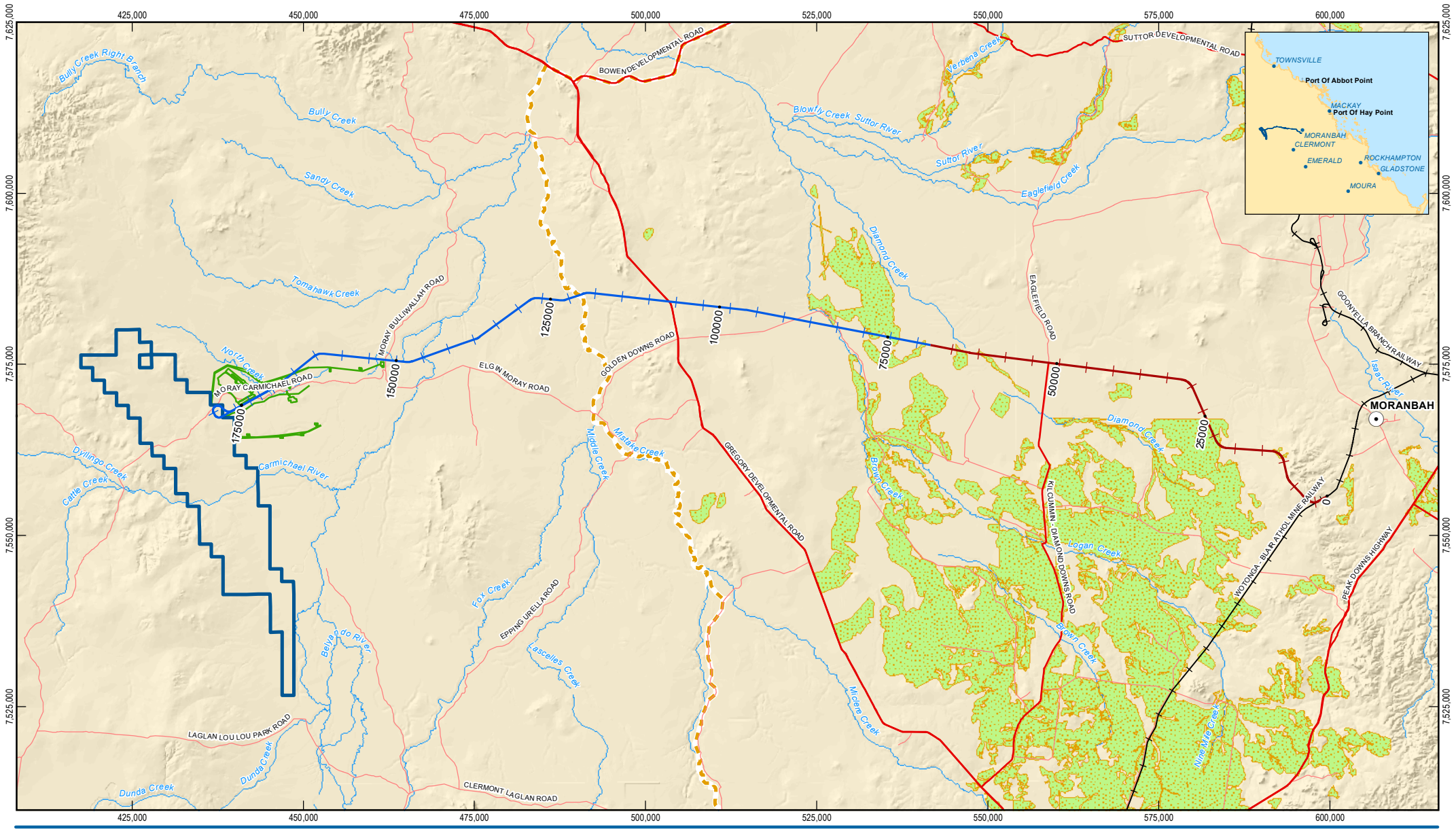
Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: Belyando Shire Council Planning Scheme: GQAL (2009); (DME: EPC1690 (2010), EPC1080 (2011); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW, CA



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0 5 10 15 20 25

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Town
- State Road
- Local Road
- Watercourse
- Existing Railway
- Rail (West)
- Rail (East)
- Mine (Onsite)
- Mine (Offsite)
- Strategic Cropping Land
- Western Cropping Boundary

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Carmichael Coal Mine and Rail Project

Strategic Cropping Land Overview Western Cropping Only

Job Number	41-25215
Revision	D
Date	11-09-2012

Figure 4-7

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Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

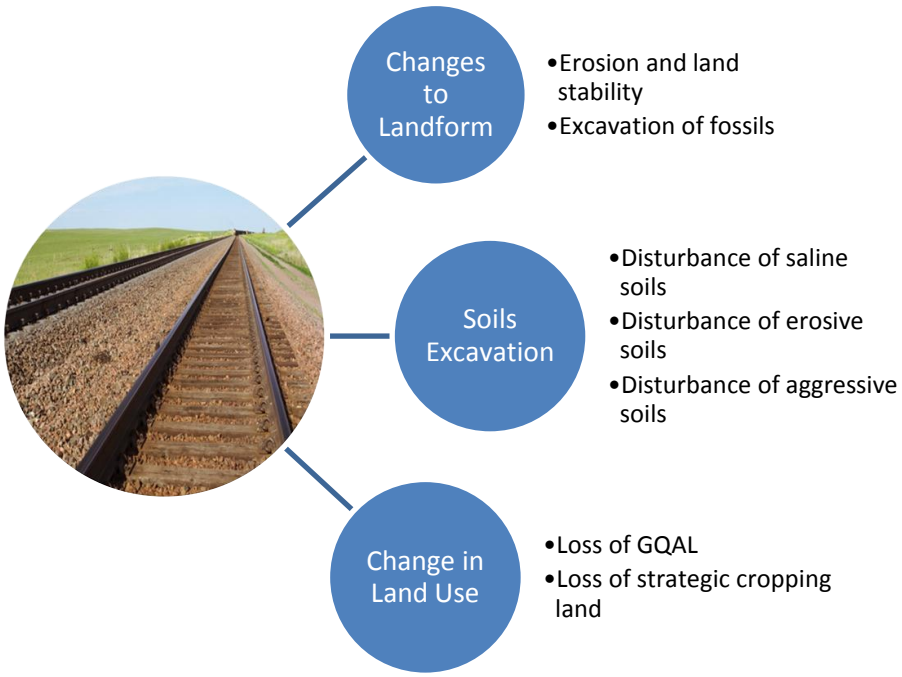
Data source: DERM: Strategic Cropping Land, Western Cropping Boundary (2011); DME: EPC1690 (2010), EPC1080 (2011); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012); GHD: Northern Missing Link (2011). Created by: BW, CA

4.2.3 Potential Impacts and Mitigation Measures

Potential impacts associated with the development of the Project (Rail) relevant to soils principally relate to the construction phase works and permanent alteration of land form.

Figure 4-8 provides a conceptual overview of the potential impacts.

Figure 4-8 Conceptual Diagram of Potential Impacts



4.2.3.1 Changes to Landform – Erosion and Land Suitability

Potential Impact

The potential impacts of the Project (Rail) include erosion risk and land slip based on slope. The construction of the Project (Rail) may impact topography particularly in areas associated with the Belyando River crossing, cuttings in the vicinity of the Goonyella system connection and the balloon loop near the Mine site.

A localised change to landform will be an unavoidable result of the Project (Rail). In order to construct the Project (Rail) there will be requirements to fill and cut within the current landscape. While the Project (Rail) will be confined to a 95 m wide corridor, the nature of the Project (Rail) will result in the final contours after construction differing from the original landform.

Topographically the land traversed by the Project (Rail) is considered to be relatively flat (elevations range between 200 m and 360 m AHD) and no significant landforms have been identified as present within the Project (Rail) area.

Landform, hydrology and hydrogeological conditions are closely connected (refer Volume 4 Appendix AB Rail Hydrology Report and Volume 4 Appendix AC Rail Hydrogeology Report, respectively). It is likely that drainage, including groundwater infiltration, sheet flow and creeks / streams will be altered to varying

degrees as a result of this Project (Rail). This may result in impacts on downstream ecosystems due to increases or decreases in runoff and redirection of drainage lines.

Management Measures

In general, works within topographical features that pose a risk to the environment from erosion due to slope length and gradient (e.g. the Belyando River crossing), are to be avoided, where possible, and carefully managed during wet weather periods and erosive rainfall events.

Managing the landforms in a way that will not alter the overall catchment behaviour is an important part in reducing the impacts on the change to landform. The following matters will be addressed to facilitate that this aspect is managed:

- Maintain drainage flows and pathways in the catchments that will be affected by the Project (Rail) (refer to Volume 4 Appendix AB Rail Hydrology Report for discussion on afflux and surface water flows)
- Maintain the integrity of topsoil resources (associated with construction and temporary disturbances outside of the rail corridor) as close to pre-disturbance conditions as possible, which may require the addition of ameliorants
- Maintain the overall catchment gradients as close to that of pre-disturbance condition
- Carefully manage (through appropriate erosion and sediment controls, amongst others) areas of steep slopes and areas that will require significant landform change

4.2.3.2 Changes to Landform – Excavation of Fossils

Potential Impact

There is limited potential for fossils to be encountered during the Project (Rail) construction. Rail construction is anticipated to include generally shallow earthworks with lower potential to intersect weathered rocks with intact fossils. Available 1:250,000 geology mapping of the Project (Rail) area, does not indicate the presence of recorded fossils.

Management Measures

Not applicable.

4.2.3.3 Soil Excavations – Soil Salinity

Potential Impact

Removal of vegetation from some environments results in a rise of the water table which in turn can lead to the accumulation of soluble salts on the soil surface. This process is known as secondary salinisation. Salt accumulation in soils can have a profound effect on development and catchment health. It can lead to die back in non-salt-tolerant vegetation and result in increased erosion hazard due to loss of groundcover and soil structural decline causing increased levels of runoff. Secondary salinisation can also affect infrastructure causing damage to building foundations, the breaking up of road pavements, and the corrosion of pipes and underground services.

Interaction between surface water and groundwater resources in the Project (Rail) area is limited to major watercourses including the Belyando River and Mistake Creek. Flows in these river systems are

relatively persistent and permanent to semi-permanent waterholes are maintained year-round suggesting a degree of groundwater support. As such in the unlikely event that high risk saline areas are identified they will be localised.

Management Measures

Management measures will reduce the potential to increase salinity of soils and groundwater within the Project (Rail) area, these include:

- Further geotechnical investigations undertaken during detailed design will refine data with regard to soil salinity level, substrate lithology and other geological features.
- Dewatering of shallow groundwater, if required for bridge pile and/or culvert construction, will be of a short duration and no long-term impacts are expected. However, if extended dewatering is identified during detailed design and major drawdown of the alluvial aquifer is expected, a groundwater management plan may be required (refer Volume 4 Appendix AC Rail Hydrogeology Report).
- Clearing will be confined to the Project (Rail) corridor and infrastructure areas and minimised wherever possible, particularly in areas where temporary infrastructure is to be established. Existing trees and shrubs, particularly in discharge and just above the discharge areas, will be retained as far as is practicable. Retention of vegetation assists in maintaining groundwater levels at sufficient depths below ground level. This prevents salt accumulation from occurring in the topsoil by preventing capillary rise from occurring.
- Temporarily disturbed areas will be stabilised as soon as practical by reinstating topsoil and subsoil and compacting replaced soils.
- Any bare ground associated with temporary infrastructure (e.g. construction camps) after the completion of the Project will be re-vegetated in line with pre clearing conditions, such as suitable pasture or native vegetation.

4.2.3.4 Soil Excavations – Soil Erosion

Potential Impact

The construction and operation of the Project (Rail) will result in a range of changes to the landscape that will increase the risk of erosion, these include:

- Clearing of vegetative cover
- Changes in topography, drainage patterns and localised concentration of storm water flows due to construction of both access tracks and the rail corridor
- Excavation and stockpiling of material
- Construction during high rainfall events, particularly erosive rainfall events
- Constructing through areas with high soil erodibility risks
- Constructing in areas of high risk slope gradient and length

Sediments that are entrained in runoff have the potential to collect in the surface waters. The coarser soil particles such as sands and silts will deposit as the velocity of water slows down, whilst the suspended clays will remain in suspension until the water becomes still or mixes with saline waters.

Deposition of elevated levels of coarse and fine sediments can cause adverse effects on aquatic and estuarine ecosystems. For example benthic communities can be smothered from sediments settling. Smothering can reduce the transmission of light through the water column which can in turn impact on aquatic plants ability to function and hence impact on organisms that rely on these plants for food and shelter.

Loss of topsoil and to a lesser extent subsoil from the construction area is important in terms of rehabilitation success. Topsoil is the most valuable resource in relation to rehabilitation and needs to be retained onsite and in a good re-usable condition.

Management Measures

Progressive rehabilitation will be undertaken to stabilise temporarily disturbed areas as quickly as practical and to limit erosion. Erosion and sediment control measures employed will be consistent with the practices described in the International Erosion Control Association (IECA), Best Practice Erosion and Sediment Control Guideline, 2008.

Prior to commencing construction an Erosion Sediment and Control Plan ESCP will be developed in accordance with IECA for use during construction (refer Volume 3 Section 13 Environmental Management Plan). The ESCP will address all aspects of construction and include performance criteria for all controls to be implemented across the Project. The ESCP will be adopted when developing the onsite detailed ESCPs.

4.2.3.5 Soil Excavations – Sodic, Dispersive and Aggressive Soils

Potential Impact

A soil is considered sodic when sodium reaches a concentration where it starts to impact soil structure (Isbell, *et al* 1996). When sodic soils are wetted the sodium weakens the bonds between soil particles resulting in clay swelling causing slaking or dispersion (Rengasamy and Walters, 1994). Such dispersion may occur in sodic soils without any disturbance at all. The dispersed clay particles can be easily moved by water or wind and can migrate through the soil clogging soil pores and reducing infiltration and drainage which causes higher run-off volumes. Dispersed clay particles may also be entrained in water and can contribute to water pollution. This may lead to a range of problems for construction sites including high water run-off and erosion rates, water pollution, tunnel formation, reduced workability, difficulty with vegetation establishment, and reduced vegetation growth due to low water holding capacity and root penetration (Raine and Loch, 2003).

It is important to note that not all sodic soils are dispersive and not all dispersive soils are sodic. Other factors such as salinity, texture, clay mineralogy, and organic matter can all influence soil dispersion. Dispersive soils can be problematic for construction and maintenance activities if not managed well and therefore will be investigated so that their constraints can be addressed in design and project planning.

Aggressive soils are those that have chemical or physical properties that are restrictive to plant growth. Such properties include elevated sodicity, salinities, or acidities (and less commonly high alkalinities). Inversion of these soils during excavation and reinstatement may result in ongoing maintenance issues and costs due to the formation of soil surfaces that are restrictive to vegetation establishment and plant growth.

Areas of Sodosols have been identified along the Project (Rail) route. Sodosols are characterised as being texture contrast soils (i.e. the topsoil is of a lighter texture than the subsoil) in which the subsoil is sodic and not strongly acidic.

Sodic subsoils exposed to the surface may result in highly erodable surfaces with surface crusting and hard setting issues effecting vegetation establishment and growth.

Management Measures

For Project (Rail) areas associated with temporary activities (e.g. construction camps) the reinstatement of acidic or saline soils may be problematic due to reduced capacity to re-establish vegetation and stabilise surfaces. Whilst sodic soils and acidic soils may be managed (gypsum for sodic soils, and lime for acidic soils) the costs and resource required can be large. Saline soils are more difficult to manage and need to generally be capped with non-aggressive soil, especially if vegetation is to be established.

A Soil Management Plan (SMP) will be developed detailing treatment and management requirements for sodic, dispersive and aggressive soils within the Project (Rail) area.

4.2.3.6 Soil Excavations – Acid Sulfate Soils

Potential Impact

Mapping indicates the ASS is unlikely to be present within the Project (Rail) Study Area.

Management Measures

Not applicable.

4.2.3.7 Change in Land Use – Good Quality Agricultural Land

Potential Impact

The Project (Rail) has the potential to impact areas mapped as GQAL and the potential to fragment land parcels leading to a reduction and loss of access to agricultural land. GQAL mapping indicates that approximately 1,334 ha of GQAL will potentially be impacted as a result of the Project (Rail), as detailed in Table 4-25. Class C1 land or pasture land classified as suitable only for improved or native pastures (due to limitations which preclude continuous cultivation for crop production) comprises 54 per cent of the potentially impacted area.

Table 4-25 Good Quality Agricultural Land within the Project (Rail)

GQAL Class	Area within the Project (Rail) (ha)*
A	157.7
B	454.2
C1	721.7
Total	1,333.6

*Total area calculation based on 95 m Project (Rail) corridor.

Management Measures

Potential impacts on GQAL have been avoided and minimised through route selection whereby GQAL constraints (amongst others) were considered.

The Project (Rail) alignment largely avoids land mapped as being Class A GQAL and attempts to traverse the outer extremes of Class B mapped areas to avoid and minimise fragmentation (refer Figure 4-6).

Management measures to further avoid and/or minimise potential impacts on agricultural productivity of soils will include:

- Continued consultation with directly affected landowners in relation to the limiting effects of fragmentation, for example by providing stock crossings and other crossings as necessary and the provision of compensation
- Maintain surface drainage patterns through design of culverts and cut/fill areas. Where changes in flows cannot be avoided, soil stabilisation to prevent salinisation or other forms of soil degradation will be considered
- Limiting overall areas of disturbance during construction
- Limiting vehicle movements to designated access tracks during construction
- Setting aside stripped topsoil for use in reinstatement. Topsoil stockpiles will be managed to maintain soil fertility and other soil properties
- Develop and implement an ESCP (refer Volume 3 Section 13 Environmental Management Plan).
- Erosion control structures to remain in place until reinstatement is complete
- Reinstating all temporarily disturbed areas progressively during and after construction. Reinstatement will be as close as possible to pre-construction conditions. If soils have been impacted then reinstatement will include measures like fertilizer to restore soils to pre-construction productivity
- Ripping soils in areas where compaction may have occurred
- Develop a soils survey methodology with the Department of Natural Resources and Mines (DNRM) for the Project (Rail) to better define the presence and nature of GQAL within the Project (Rail) and developing additional management measures as required

4.2.3.8 Change in Land Use – Strategic Cropping Land

Potential Impact

In accordance with the *Strategic Cropping Land Act 2011* (SCL Act), a permanent impact (in relation to the Project (Rail)) is defined as development that impedes the land from being cropped for at least 50 years and results in the land being unable to be restored to its pre-development condition.

Six individual polygons of strategic cropping land mapped within the strategic cropping land Management Area, western cropping zone will be traversed by the Project (Rail) (Figure 4-7). Strategic cropping land mapping indicates that out of the total Project (Rail) footprint approximately 115 ha will potentially be impacted by the Project (Rail) (as detailed in Table 4-26 and illustrated on Figure 4-7).

Table 4-26 Strategic Cropping Land (management) within the Project (Rail)

Chainage Start (km)	Chainage Finish (km)	Total SCL Polygon Area (ha)	Area of SCL within the Project (Rail) (ha)*
10.7	12.4	124	15.2
20.2	24.6	37431	42.4
60.3	61.3	280	9.1
63.6	64.9	476	12.3
69.5	70.1	1281	5.1
73.5	75.2	9395	16.1
76.3	77.8	9395	14.9

*Total area calculation based on 95 m wide Project (Rail) corridor.

Assessment of impacts on strategic cropping land is based on desktop data and mapping. Areas currently mapped as strategic cropping land within the Project (Rail) have not been assessed against the eight criteria to confirm that the mapped strategic cropping land is strategic cropping land. Furthermore, potentially impacted areas have not been assessed for cropping history due to land access constraints.

It is understood that past cropping activities within the Project (Rail) area have been limited, whereby one single area adjacent to the Project (Rail) has and is currently irrigated for cropping.

Management Measures

Potential impacts on strategic cropping land have been avoided and minimised through route selection. Where mapped strategic cropping land is unable to be avoided, the route selection process has considered (amongst other environmental, social, cultural, economic and technical constraints), the placement of the Project (Rail) such that it traverses around or as close as possible to, the edges of polygons to minimise fragmentation.

The SCL Act provides for a number of alternatives in dealing with strategic cropping land. A financial contribution commensurate with the area of impact on all mapped potential strategic cropping land is a common and reasonable management approach to minimise potential strategic cropping land impacts. Alternatively, measures to further avoid or minimise potential impacts include:

- Develop and agree a soil survey methodology with DNRM for the Project (Rail) to determine the actual presence of strategic cropping land prior to construction. This survey methodology will consider evaluation of soils within the western cropping zone and in particular those mapped as strategic cropping land against the eight criteria (as prescribed in the legislation)
- Ongoing consultation with landowners and consideration of compensatory measures where there are unavoidable impacts to strategic cropping land areas
- If areas are confirmed as strategic cropping land, a cropping history assessment will be undertaken
- Limiting disturbance during construction
- Reinstating temporarily disturbed areas progressively during and after construction. Where possible reinstatement will be close to pre-construction conditions. Where soils may have been impacted

reinstatement will include management measures like fertiliser to restore soils to pre-construction productivity

- Ripping soils in areas where compaction may have occurred
- If areas are confirmed as strategic cropping land, then mitigation will be required for infrastructure and activities considered permanent (i.e. rail and service road infrastructure, and powerline tower footprint). A Deed of Agreement will be established between Adani and the Department of Agricultural, Fisheries and Forestry (DAFF) to facilitate mitigation.

4.2.3.9 Decommissioning and Rehabilitation

The transport of coal product will be required until the closure of the Mine Site, which is estimated to have an operational lifetime of 90 years. Decommissioning of the Project (Rail) will most likely occur after that event, unless in use by third parties.

As per the TI Act, decommissioning is the responsibility of the Railway Manager, in this case, Adani.

Decommissioning will generally consist of:

- The removal of above ground and in ground structures
- The reinstatement of a natural landform and the stabilisation of soils on the site via plantings or other erosion and sediment controls

A Decommissioning and Rehabilitation Plan will be required to be developed with the overall aim of minimising the amount of land disturbed at any one time during the life of the Project (Rail). It will be required to be developed in accordance with the current Queensland legislative requirements (refer Volume 4 Appendix D), particularly DERM's Guideline 18 – Rehabilitation Requirements for Mining Projects, which provides information on progressive and final rehabilitation for mining projects in Queensland.

The Project (Rail) Decommissioning and Rehabilitation Plan (Rail) will include the following:

- Relevant permits and approvals that may be required for the removal of facilities
- Timing and methodology for the decommissioning
- The intended use of the sites after decommissioning
- Details of any structures or facilities that remain in place after decommissioning
- Erosion and sediment controls during and after decommissioning
- Rehabilitation details
- Reuse, recycling or disposal options for removed facilities, structures and materials, including community legacy opportunities

4.2.4 Summary of Topography, Geology and Soils Assessment

The main impacts associated with the Project (Rail) will be impacts to agricultural land and increased risk of erosion in areas of construction and operation. The presence of problematic soils will also pose risks for successful rehabilitation.

The following will be undertaken prior to construction:

- Develop and agree a soil survey methodology with DNRM for the Project (Rail) recognising the guidelines as follows:
  - Australian Soil and Land Survey: Guidelines for Survey Soil and Land Resources (McKenzie *et al*, 2008)
  - Land Suitability Assessment Techniques. (DME, 1995)
  - Australian Soil Classification (Isbell, 2002)
  - Australian Soil survey and Land Survey Field Handbook. (National Committee on Soil and Terrain, (NCTS) 2009)
  - Protecting Queensland's Strategic Cropping Land – Guidelines for Applying the Proposed Strategic Cropping Land Criteria (DERM, 2011)
  - Planning Guidelines: the Identification of Good Quality Agricultural Land. Department of Primary Industries and Department of Housing, Local Government and Planning Queensland, (DPI/DHLGP) 1993)
- The soil survey methodology will determine methods to confirm the GQAL status of land impacted, the location of major soil types, the strategic cropping land status of mapped strategic cropping land areas, the presence of aggressive soils, and topsoil stripping depths
- Development of an ESCP in accordance with the Best Practice Erosion and Sediment Control (IECA, 2008) guidelines
- Field works to record the current salinity status of risk areas

4.3 Land Contamination

4.3.1 Introduction

Land can become contaminated when hazardous chemical substances are released into soils, groundwater or surface water. Contaminated land may pose a threat to human or environmental health. Contaminated land is recorded by the Department of Environment and Heritage Protection (DEHP) Contaminated Land Register (CLR), while activities likely to cause land contamination are recorded in the DEHP Environmental Management Register (EMR).

A desktop land contamination study identified one potentially contaminated lot in the Project (Rail) area based on searches of the CLR and EMR. The study also identified potential sources, impacts and mitigation measures of land contamination during the construction and operational phases of the Project (Rail). It is recognised that contaminated lots not registered or that are notifiable in the EMR or CLR may be later identified. A detailed survey of potentially contaminated land will be undertaken during the detailed design phase of the Project (Rail), when defined areas of impact are finalised.

4.3.2 Legislative Requirements

The legislative requirements covering contaminated land in Queensland are primarily contained in the *Environmental Protection Act 1994* (EP Act) and subordinate legislation and policies. Schedule 3 of the EP Act lists a number of Notifiable Activities related to land contamination. Furthermore, it is an offence under the EP Act to remove soils from a site registered on the CLR or EMR without a permit.

Levels at which contaminants may be considered harmful have been set based on toxicity data and other hazardous properties. In Queensland, contaminant levels are set in:

- National Environment Protection (Assessment of Site Contamination) Measure (NEPM) (National Environment Protection Council, 1999).
- Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland, (DoE 1998; now administered by DEHP).

4.3.3 Methodology

The desktop study area included the lots traversed by the Project (Rail) area (refer Section 4.4) and involved:

- A search and review of the EMR and CLR
- A review of land uses in the study area
- Identification of potential offsite sources of contamination
- Identification of potential environmentally sensitive receptors

4.3.4 Description of Environmental Values

4.3.4.1 Land Use

The predominant land use in the study area is cattle grazing (breeding and fattening) (refer Section 4.4).

4.3.4.2 Contaminated Land Register and Environmental Management Register

Lot 637 on PH1980 is listed on the EMR for Livestock Dip or Spray Race as notified to DERM in 1999. No other lots in the Study Area were recorded on the CLR or EMR. Two parcels of land Lot 12 on SP151669 and Lot 1 on RP616897 have reported Extractive Land Use activities, however there two lots were not identified on the EMR.

4.3.4.3 Contaminants of Concern

Potential contaminants of concern associated with livestock dips or spray races are presented in Table 4-27 (Kimber et al., 2002; McDougall and Macoun, 1996). Contamination by these and other agricultural chemicals may occur in localised areas associated with storage of the chemicals and the dip process itself. In general, contamination is restricted to localised areas of use but may become more widespread if chemicals reach the groundwater table.

Table 4-27 Potential Contaminants Associated with Livestock Dips or Spray Races

Pesticide	Period of Use
Arsenic (Trioxide)	Pre-1900s to 1955
DDT	1955 - 1962
BHC	1955 - 1962

Pesticide	Period of Use
Carbaryl	1963 - 1970
Caoumpahos	1962 - 1970
Carophenothion	1962
Bromos ethyl	1969 - 1974
Dioxothion	1969
Ethion	1962 - 1976
Chlordimeform	1973 - 1976
Amitraz	1976 - present
Promacy	1977 - 1992
Cypermethrin + Chlorfenvinphos	1979 - present
Flumethrin	1986 - present

4.3.4.4 Sensitive Receptors

Sensitive receptors within the Study Area are major watercourses and groundwater resources. Major watercourses include Mistake Creek, Logan Creek, Belyando River and the Suttor River sub-catchment (refer to EIS Volume 4 Appendix AB Rail Hydrology Report). Watercourses are used as sources of stock water, either directly during the wet season or indirectly from impoundments during the dry season. Ground water resources are used for water extraction. A search of the relevant DERM Groundwater Database identified 43 registered bores within 10 km of the Project (Rail) area. Of the 24 bores still in use, seven are used to for water extraction and a further eleven are unclassified. The remaining bores are used for mineral or coal exploration, sub-artesian monitoring and groundwater investigation.

4.3.5 Potential Impacts and Mitigation Measures

4.3.5.1 Overview of Potential Impacts

The potential impacts from land contamination may arise in two ways. Firstly, construction and operation activities could disturb land containing contaminants deposited through previous land use activities and release these contaminants into the environment. Secondly, construction and operation activities may release new contaminants into the environment as a result of unintended spillages or accidents. Without appropriate management, the release of contaminants could impact on existing environmental qualities (e.g. air, soil, surface and groundwater) and human health. Appropriate management measures for these potential impacts are discussed in the following subsections.

It is not intended that the Project (Rail) will lead to land contamination requiring registration in the CLR. Any Notifiable Activities under Schedule 3 of the EP Act, such as the storage of hazardous material, associated with the Project (Rail) will be reported to DEHP.

4.3.5.2 Management Overview for Contaminated Sites

If contamination occurs as a result of the Project (Rail), including the potential for the disturbance of a previously contaminated site, then management will be carried out in accordance with the contaminated land provisions of the EP Act, National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPM, 1999) and Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland (DoE, 1998; now administered by DEHP). Broadly, the management measures will include:

- A site contamination assessment (SCA) will be undertaken in accordance with the National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPM, 1999)
- Management and remediation will adhere to a Site Management Plan or Remediation Action Plan approved by DEHP
- Validation sampling will be conducted to verify that remediation is successful
- Any required long term monitoring will be provided for in operational plans

Typically, spills are the source of most contamination incidents. The following measures will be implemented to mitigate the potential impacts of spills during the construction and operational phases of the Project (Rail). More particular mitigation measures providing for the control of specific substances are described in the following subsections.

- A spill response plan will be prepared and incorporated into an incident response plan, including requirements for spills to be reported, contained and cleaned
- Procedures for storing, handling, refuelling and using fuels, oils and other chemicals will also be developed and all staff will be trained accordingly
- Spill response kits and personal protective equipment will be placed in readily available locations wherever spills may occur. Material Safety Data Sheets will be readily available
- A program of regular equipment inspection and testing will be implemented

4.3.5.3 Bulk Fuel and Oil Contamination

Storage, transportation and disposal of bulk fuel (up to 130,000 L) and oil during the construction phase may risk spillage and consequent contamination of soil, groundwater or surface water.

Mitigation Measures

The following mitigation measures will be implemented to minimise the risk associated with fuel or oil leaking from storage tanks:

- Adequate bunding will be constructed in accordance with Australian Standard AS 1940:2004
- Tank level indicators will be installed for monitoring fuel and oil levels
- Maintenance of tanks will be undertaken to ensure safe and effective operation
- Tanks will be designed in accordance with Australian Standard AS 1692:2006
- Dangerous goods and potential contaminants will be transported in accordance with Australian Code for Transport of Dangerous Goods by Road and Rail

Potential for spillage of hydrocarbons will be minimised through the observation of standard operating procedures for transport, handling and storage of hydrocarbons. All hydrocarbons will be stored and handled in accordance with the bunding requirements of AS 1940:2004.

4.3.5.4 Fuel Contamination

Refuelling by mobile fuel trucks during the construction phase may risk spillage and consequent contamination of soil, groundwater or surface water.

Mitigation Measures

The following mitigation measures will be implemented to minimise the risk associated with fuel or oil leakage during refuelling:

- Equipment will be regularly inspected and tested to ensure reliable performance
- Operators will be trained in the safe operation and emergency spillage procedures
- Spill containment equipment will be available at the unloading pad
- Sumps will be provided to collect any spillage and allow recovery in workshop areas
- Ignition sources will be strictly controlled
- Appropriate fire fighting materials and equipment will be available
- An approved fire protection system will be installed around hydrocarbon storage areas
- Dangerous goods and potential contaminants will be transported in accordance with Australian Code for Transport of Dangerous Goods by Road and Rail (Commonwealth of Australia, 2007)

Potential for spillage of hydrocarbons will be minimised through the observation of standard operating procedures for transport, handling and storage of hydrocarbons. All hydrocarbons will be stored and handled in accordance with the bunding requirements of AS 1940:2004.

4.3.5.5 Wastewater Contamination

Wastewater treatment operations during the construction phase may risk spillage and consequent contamination of soil, groundwater or surface water.

Mitigation Measures

Minor quantities of chemicals required for water and wastewater treatment will be stored in bunded areas such as self-bunded pallets, within workshops or in a bunded container.

Waste products such as oil and water separator waste, sludges and residues will be contained within weatherproofed, sealed and bunded areas.

4.3.5.6 Sewage Contamination

Operation of the temporary sewage treatment plant during the construction phase can lead to spillage of wastewater and consequently result in nutrient contamination of soil, groundwater or surface water. Sewage poses a risk to human health due to potential infection from bacteria and viruses.

Mitigation Measures

Sewage will be treated onsite in a package sewage treatment plant. Disposal options will be assessed during the design phase of the Project (Rail).

4.3.5.7 Fertilisers and Soil Ameliorants Contamination

Storage and handling of fertilisers or soil ameliorants during the construction phase can lead to spillage and subsequent nutrient contamination of soil, groundwater or surface water.

Mitigation Measures

Chemical storage areas will be suitably bunded and constructed to minimise the potential for leaks. Chemicals will be stored, handled and used in accordance with the Material Safety Data Sheets. Small quantities of chemicals, fuels and oils will be stored within a bunded area within workshops or in a bunded container.

4.3.5.8 Contamination by Other Chemicals and Hazardous Substances

Storage and handling of other chemicals and hazardous substances during the construction phase can lead to spillage and subsequent contamination of soil, groundwater or surface water. These include chemicals for water treatment, cleaning products, solvents and degreasers.

Mitigation Measures

Chemical storage areas will be bunded and constructed to minimise the potential for leaks. All chemicals will be stored, handled and used in accordance with the Material Safety Data Sheets. Small quantities of chemicals, fuels and oils will be stored within a bunded area within workshops or in a bunded container.

4.3.5.9 Plant and Equipment

The operation of plant and equipment during the construction phase can lead to spillage and subsequent contamination of soil, groundwater or surface water. Breakage of hydraulic hoses is one such scenario that could provide the source of a spillage.

Mitigation Measures

All vehicles, plant and machinery will be routinely inspected and maintained to minimise the risks of leaking or spilling contaminants.

4.3.5.10 Pesticides

The use of pesticides to control weeds along the rail alignment during the operational phase can lead to residues and subsequent contamination of soil, groundwater or surface water.

Mitigation Measures

Low residue pesticides such as glyphosate will be used by licensed operators.

4.3.5.11 Diesel

Accidents involving locomotives or maintenance vehicles during the operational phase can lead to spillage of diesel and subsequent contamination of soil, groundwater or surface water.

Mitigation Measures

All diesel spills will be managed in accordance with spill response procedures.

4.3.5.12 Coal

Haulage of coal by train during the operational phase can lead to spillage of coal. Coal is relatively inert but can cause physical smothering of flora. Air quality issues in relation to coal dust are considered in EIS Volume 3 Section 7 Air Quality.

Mitigation Measures

Coal spillage adjacent to the rail line will be managed in accordance with spill response procedures.

4.3.5.13 Maintenance Facilities

Operation of maintenance facilities, associated fuel and chemical storage and waste oil facilities during the operational phase can result in a spillage and subsequent contamination of soil, groundwater or surface water.

Mitigation Measures

Chemical storage areas will be suitably bunded and constructed to minimise the potential for leaks. Chemicals will be stored, handled and used in accordance with the Material Safety Data Sheets.

Potential for spillage of hydrocarbons will be minimised through implementation of standard operating procedures for transport, handling and storage of hydrocarbons. Hydrocarbons will be stored and handled in accordance with the bunding requirements of AS 1940:2004.

4.3.6 Summary of Contamination Assessment

A desktop land contamination study identified the potential impacts of contaminated land in the study area. The study did not identify any lots registered on the CLR. One lot is registered on the EMR. The construction and operation of the Project (Rail) may increase human exposure to pre-existing contaminated land, or mobilise those contaminants into the water column and sediments, or may release contaminants into soil, groundwater or surface water. It is intended that neither phase of the Project (Rail) will lead to land contamination requiring registration in the CLR. Any potential impacts can be managed effectively by implementing the appropriate mitigation measures.

4.4 Land Use and Tenure

4.4.1 Introduction

The Land Use and Report prepared for the present EIS (refer to EIS Volume 4 Appendix Z Rail Land Use Report) identified existing land uses and land tenures in and around the 95 m wide Project (Rail) corridor. The predominant land uses in and around this area are:

- Agricultural Land
- Residential and recreational areas and facilities
- Nature reserves, wetlands and Regional Ecosystems
- Waterways and water storage
- Transport infrastructure
- Stock routes
- Other infrastructure
- Extractive Resource Areas

The following sections of this Chapter describes in further detail the existing land use activities of the Project (Rail) area, potential impacts of the Project (Rail) on these uses and mitigation measures developed to minimise potential impacts.

4.4.2 Description of Existing Values

4.4.2.1 Overview

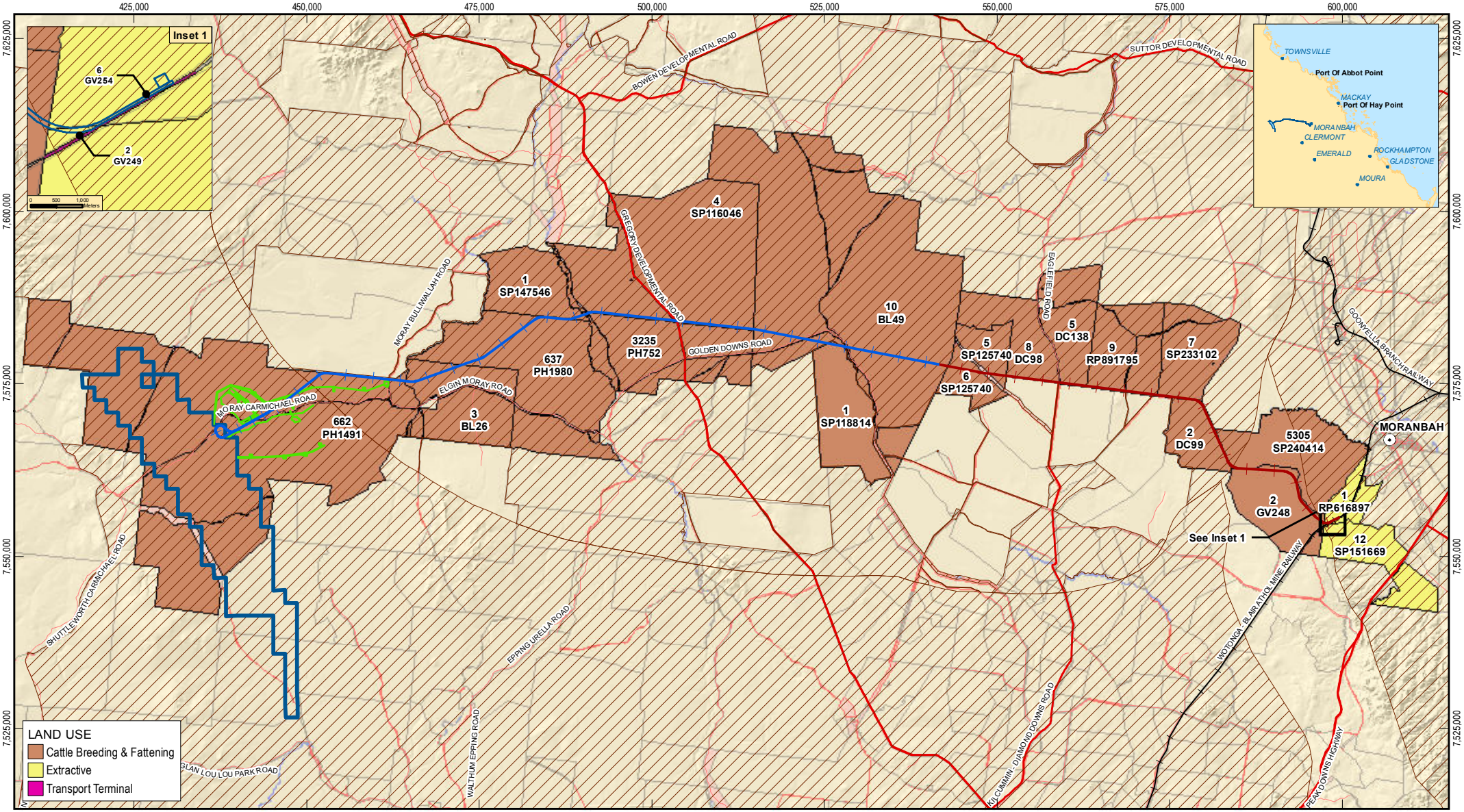
The Project (Rail) is located within the Regional Landscape and Rural Production Area (RLRPA) of the Mackay, Isaac and Whitsunday Regional Plan (MIWRP). The RLRPA as defined by the MIWRP includes land with significant biodiversity values, GQAL, cultural and landscape heritage values, extractive resources of economic significance, water catchments, native forests, coastal wetlands, land unsuitable for urban/rural residential purposes and rural towns and associated activities (DLGP 2011a). Land uses that the Project (Rail) crosses are classified in Table 4-28.

The Project (Rail) crosses 11 leasehold lots and 10 freehold lots, refer to Table 4-28 and Figure 4-9.

Table 4-28 Lots Sharing Land with the Project (Rail) Area

Lot on Plan	Area (ha) of lot affected by rail corridor	Current Tenure	Land Use
Project (Rail) - West			
Lot 662 PH1491	333.32	Leasehold	Cattle Breeding and Fattening
Lot 3 BL26	86.08	Freehold	Cattle Breeding and Fattening
Lot 637 PH1980	167.98	Leasehold	Cattle Breeding and Fattening
Lot 1 SP147546	17.32	Leasehold	Cattle Breeding and Fattening

Lot on Plan	Area (ha) of lot affected by rail corridor	Current Tenure	Land Use
Lot 3235 PH752	22.04	Leasehold	Cattle Breeding and Fattening
Lot 4 SP116046	206.41	Leasehold	Cattle Breeding and Fattening
Lot 10 BL49	234.37	Leasehold	Cattle Breeding and Fattening
Lot 1 SP118814	24.39	Leasehold	Cattle Breeding and Fattening
Project (Rail) -East			
Lot 6 SP125740	52.22	Freehold	Cattle Breeding and Fattening
Lot 5 SP125740	23	Freehold	Cattle Breeding and Fattening
Lot 8 DC98	73.45	Freehold	Cattle Breeding and Fattening
Lot 5 DC138	37.16	Freehold	Cattle Breeding and Fattening
Lot 9 RP891795	96.84	Freehold	Cattle Breeding and Fattening
Lot 7 on SP233102	37.59	Freehold	Cattle Breeding and Fattening
Lot 2 DC99	116.77	Freehold	Cattle Breeding and Fattening
Lot 5305 SP240414	9.27	Leasehold	Cattle Breeding and Fattening
Lot 2 GV248	161.86	Leasehold	Cattle Breeding and Fattening
Lot 1 RP616897	9.74	Freehold	Extractive
Lot 12 SP151669	5.67	Freehold	Extractive
Lot 2 GV249	0.37	Leasehold	Rail Development
Lot 6 GV254	2.44	Leasehold	Rail Development



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0 5 10 15 20 25

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Town
- State Road
- Local Road
- Other Rail Network
- Native Title Register
- Cadastral Parcel
- Road Reserve
- Watercourse Reserve
- Rail (West)
- Rail (East)
- Mine (Onsite)
- Mine (Offsite)

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Job Number 41-25215
Revision E
Date 06-12-2012

Project (Rail) Land Use

Figure: 4-9

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Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: DERM: DEM (2008), DCDB (2010); DME: EPC1690 (2010), EPC1080 (2011); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads (2007), Native Title (2010); Gassman/Hyder: Mine (Offsite) (2012), Subject Properties; Adani: Alignment Opt9 Rev3 (SP1& 2) (2012); RP Data: Land Use (2011). Created by: AF,MS

4.4.2.2 Cultural Heritage and Native Title

A cultural heritage assessment of the Project (Rail) was undertaken. The assessment located 39 culturally significant sites. The cultural heritage assessment of the Project (Rail) identified the following Native Title claims:

- The Project (Mine) and first 17 km of the Project (Rail) are located within the external boundaries of the Wangan and Jagalingou People registered native title claim (QUD85/04, QC04/6)
- Approximately 145 km of the Project (Rail) is located within the external boundaries of the Jangga People, registered native title claim (QUD6230/98, QC98/10)
- Approximately 17 km of the Project (Rail) is located within the external boundaries of the Barada Barna Kabalbara and Yetimarla People #4 (BBKY #4) former registered native title claim (QUD6023/01, QC01/25)
- Approximately 3 km of the Project (Rail) is located within the external boundaries of the Barada Barna People, registered native title claim (QUD380/08, QC08/11).

Cultural Heritage details are provided in EIS Volume 1 Section 5 Indigenous and Non-indigenous Cultural Heritage.

4.4.2.3 Residential and Recreational Areas

The main residential areas surrounding the Project (Rail) are Clermont, Moranbah and Belyando. None of these residential areas are in close proximity to the Project (Rail). Moranbah is the closest residential area to the Project (Rail), located approximately 15 km northeast of the easternmost extent of the Project (Rail).

Eight homesteads were identified within 5 km of the Project (Rail) (refer to Table 4-29). Two camping reserves were identified: one on Elgin Moray Road approximately 4.5 km south of the Project (Rail), and another on Elgin Road approximately 11 km south from the Project (Rail). Mazeppa National Park off Gregory Developmental Road is located approximately 30 km south from the Project (Rail).

Table 4-29 Homesteads Surrounding the Project (Rail)

Homestead	Easting	Northing	Approximate Distance from Project (Rail)	Description/Comment
Moray Downs	462027	7572602	3.3 km	Homestead
Cassiopeia	475674	7575617	3.0 km	Homestead
Twelve Mile Outstation	482139	7579957	3.0 km	Homestead
Disney	494429	7589482	4.2 km	Homestead
Avon Downs	525174	7583086	2.2 km	Homestead
Lambing Lagoon	546218	7578704	1.6 km	Homestead
Myra	555680	7578811	3.0 km	Homestead

Homestead	Easting	Northing	Approximate Distance from Project (Rail)	Description/Comment
Mullawa	561038	7577015	1.9 km	Homestead

4.4.2.4 Nature Refuges

Nature refuges in close proximity to the Project (Rail) are as follows:

- Doongmabulla Mound Springs Nature Refuge located approximately 14 km west of the Project (Rail)
- Bygana West Nature Refuge located 17 km south of the Project (Rail)
- Bygana Nature Refuge located 23 km south of the Project (Rail)
- Nibbereena Creek Nature Refuge located 20 km north of the Project (Rail)
- Eaglefield Creek Nature Refuge located 25 km north of the Project (Rail)
- East Top Nature Refuge located approximately 35 km south of the Project (Rail)

Information on the nature refuges and other protected areas in proximity of the Project (Rail) is included in Volume 4 Appendix AA Rail Ecology Report.

4.4.2.5 Wetlands

Doongmabulla Mound Springs is a wetland of national significance located approximately 14 km west of the Project (Rail). The wetland supports a distinct habitat type within the surrounding region (DERM, 2010). No further wetlands of national significance or Great Barrier Reef wetland protection areas are located in close proximity to the Project (Rail) (refer to Volume 4 Appendix AA Rail Ecology Report).

4.4.2.6 Regional Ecosystems

A number of Endangered, Of Concern and Least Concern Regional Ecosystems (REs) are situated in the Project (Rail) (refer to Volume 4 Appendix AA Rail Ecology Report, Volume 4 Appendix AA2 Property Map of Assessable Vegetation SP1 (Rail (west) and Volume 4 Appendix AA3 Property Map of Assessable Vegetation SP1 (Rail (east)).

4.4.2.7 Waterways and Storage

The Project (Rail) is located predominantly:

- In the Burdekin River catchment
- Partly within the Fitzroy River catchment
- Within the Belyando River and Suttor River sub-catchments of the Burdekin River
- Partly within the Grosvenor Creek sub-catchment of the Isaac River, a tributary of the Fitzroy River catchment

The Project (Rail) crosses minor waterways at 76 points and the Belyando River at 12 locations (refer to EIS Volume 4 Appendix AB Rail Hydrology Report).

The Burdekin Falls Dam is 60 km downstream of the Project (Rail). The Teviot Dam is located approximately 30 km north-east of the Project (Rail). A number of smaller dams used primarily for farm

and stock watering are located in close proximity to the Project (Rail) (refer to EIS Volume 4 Appendix AB Rail Hydrology Report).

4.4.2.8 Agricultural Land

GQAL and strategic cropping land are mapped as present within the Project (Rail) and have been addressed in Section 4.2.2.3.

4.4.2.9 Rail Infrastructure

QR National's Goonyella System services more than 30 coal mines in the northern and central areas of the Bowen Basin. The nearest existing railway to the Project (Rail) is the Blair Athol Branch of the Goonyella Rail System (refer to EIS Volume 4 Appendix AG Rail Transport Report). Two proposed rail lines by Alpha Coal and Waratah Coal also will cross the Project. The rail line proposed by Alpha Coal has received approval and, if constructed, is likely to impact on or be impacted by the Project (Rail). Waratah Coal's proposal is still being assessed. If progressed, it may impact on or be impacted by the Project (Rail).

4.4.2.10 Airport Infrastructure

Airports are located at Townsville, Moranbah, Mackay, Proserpine, Clermont, Bowen, Collinsville and Emerald. Moranbah is the closest airport in the immediate vicinity of the Project (Rail) (Aarvee Associates, 2011) (refer to EIS Volume 4 Appendix AG Rail Transport Report). Upgrades to Moranbah airport are proposed to allow for use of the airport by other airlines. Clermont Airport has two runways, one 1,068 m (gravel) and the other 1,311 m (asphalt). Both are unable to service the Project. Emerald Airport services the Central Queensland region via the Qantas link regional airline.

Adani is proposing to construct an airstrip to the north-east of the Project (Mine). The proposed airstrip will service the fly in-out workforce. The airstrip will be 2.2 km long and located approximately 12.5 km east of the Project (Rail) on Lot 662 on PH1491. No other airports are proposed to be constructed in close proximity to the Project (Rail). Refer to Volume 2 Section 2 for further information.

4.4.2.11 Road Infrastructure

The Project (Rail) crosses seven public roads, including one State controlled road (SCR) and a number of Isaac Regional Council (IRC) local roads:

- Moray Carmichael Boundary Road (IRC local road)
- Moray – Bulliwallah Road (IRC local road)
- Mistake Creek Crossing
- Gregory Developmental Road (SCR)
- Avon Road (IRC local road)
- Amaroo Road (IRC local road)
- Kilcummin-Diamond Downs / Eaglefield Road (IRC local road)

A number of minor roads also cross the proposed rail alignment. None of the roads in or around the Project (Rail) have been nominated for upgrade in the Queensland Infrastructure Plan 2011 (QI Plan) (DLGP, 2011b).

4.4.2.12 Stock Routes

The Stock Route Network is used for transporting stock in Queensland. A stock route may also be a transport corridor for vehicles, an infrastructure corridor or an area of land with rich biodiversity (DERM, 2009a). The land that makes up the Stock Route Network may have additional economic, environmental, cultural and social values beyond the transport of stock.

The Project (Rail) crosses three stock routes at:

- Kilcummin Diamond Downs Road (M399BELY03)
- Amaroo Road (U402BELY03)
- Mistake Creek Crossing (Y401BELY02)

4.4.2.13 Gas and Water Infrastructure

The QI Plan (DLGP, 2011b) identifies the following proposed water pipelines and pipeline upgrades in the Mackay, Isaac and Whitsunday region:

- Burdekin to Moranbah pipeline augmentation
- Arrow to Bowen Gas Pipeline

DERM Groundwater Resource Information (DERM, 2010) identified 43 bores within 10 km of the Project (Rail) and 24 bores are assumed to be in use. Seven of the existing bores are defined as ‘water supply’ bores. However it is possible that some or all of the 11 existing bores with an ‘unknown’ facility role may also abstract groundwater for water supply. The remaining bores that are still in use are used for mineral or coal exploration, sub-artesian monitoring and groundwater investigation.

4.4.2.14 Energy Infrastructure

The existing power supply in Moranbah comprises of Powerlink Queensland’s T34 Moranbah substation which has three 132/66/11 kV transformers supplying Moranbah town and the coal mine customers in the surrounding Bowen Basin coalfields (Ergon Energy, 2011). Ergon Energy owns and operates the 66 kV switchyard in T34 Moranbah substation which connects four privately-owned and two Ergon Energy-owned 66 kV feeders which supply the coal mines in the area (Ergon Energy, 2011).

The nearest electricity line to the proposed Project (Rail) is an existing high voltage electricity line, which runs parallel to the existing Blair Athol Branch of the Goonyella Rail System. No electricity easements traverse the Project (Rail).

4.4.2.15 Telecommunications Infrastructure

Telecommunications services in the Mackay, Isaac and Whitsunday region are currently provided by Telstra with towers located at the following locations:

- Within Lot 2 on SP119925, approximately 6 km north of the Project (Rail)
- Within Lot 4 on SP116046, approximately 5.5 km north of the Project (Rail)

- Within Lot 1 on SP210553, approximately 12 km south of the Project (Rail)

No telecommunications easements traverse the Project (Rail).

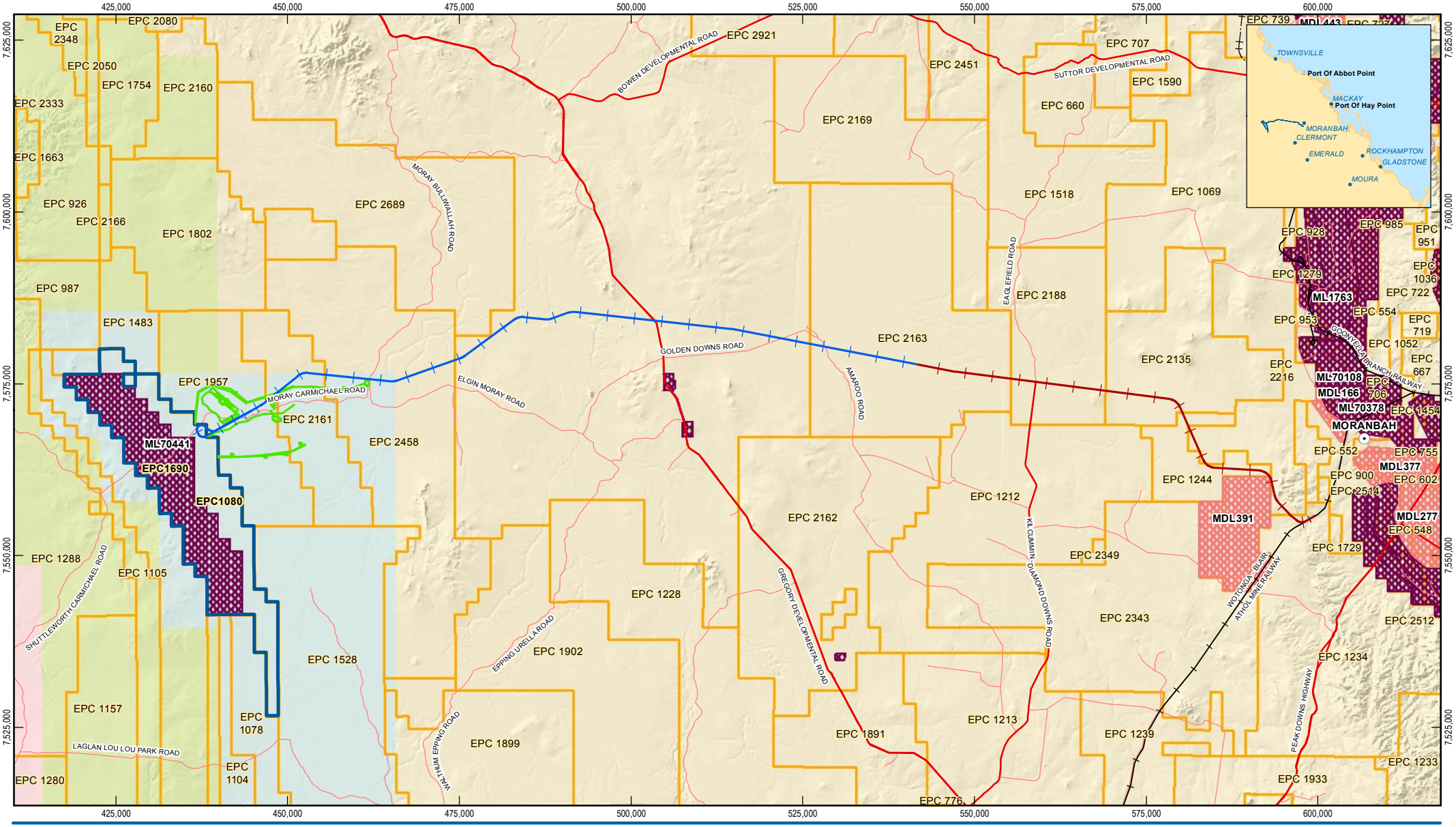
4.4.2.16 Mining Tenure

The Project (Rail) does not traverse any land subject to a Mining Lease or Mineral Development Licence. However, the Project (Rail) does traverse a number of areas subject to an Exploration Permit for Coal (EPC) or an Exploration Permit for Petroleum (EPP). Table 4-30 lists mining tenure near the Project (Rail), while Figure 4-10 demonstrates mining tenures traversed directly by the Project (Rail).

The Project undertook a review of historical exploration activities within the Project (Rail) corridor to assess the likelihood of significant deposits in the area (refer Volume 4, Appendix Z1 Xenith Rail Easement Study). The report concludes that the potential for substantial economic coal and/or petroleum deposits within the vicinity of the Project (Rail) is low.

Table 4-30 Mining and Petroleum Tenures near the Project (Rail)

Tenure	Holder	Status
EPC2163	Queensland Coal Investments Pty Ltd	Granted
EPC2135	Carabella Resources Limited	Application
EPC2458	Civil and Mining Resources Pty Ltd	Application
EPC2161	Rem Resources Pty Ltd	Application
EPC1957	Mining Investments One Pty Ltd	Application
EPC1069	Carabella Resources Limited	Granted
EPC2188	Carabella Resources Limited	Granted
EPC1080	Waratah Coal Pty Ltd	Granted
EPC1690	Adani Mining Pty Ltd	Granted
EPC1244	Energy Minerals Pty Ltd	Granted
EPC1234	Queensland Coking Coal Pty Ltd	Granted
EPP1044	Queensland Energy Resources Limited	Granted
EPP793	Diamond Creek Coal Pty Ltd	Granted
EPP814	Eureka Petroleum Pty Ltd	Granted



1:750,000 (at A4)

0 5 10 15 20 25

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Town
- State Road
- Local Road
- Other Rail Network
- Mining Lease
- Mineral Development License
- EPC Boundary
- EPP 744
- EPP 1015
- EPP 1044
- Rail (West)
- Rail (East)
- Mine (Onsite)
- Mine (Offsite)

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Project (Rail)
Mining and Petroleum Tenure

Job Number 41-25215
Revision D
Date 11-09-2012

Figure: 4-10

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Data source: DERM: DEM (2008), DCDB (2010); DME: EPC1690 (2010), EPC1080 (2011), Mining Leases, Mineral Development Licences, EPC, EPP (2012);

4.4.3 Potential Impacts and Mitigation Measures

The construction and operation of the Project (Rail) has potential to result in direct and permanent changes to the land use and tenure of the Project (Rail). Management measures to mitigate these potential impacts are provided in this section in accordance with a management hierarchy.

Potential impacts to Native Title and Cultural Heritage are matters for a Native Title Strategy and Cultural Heritage Management Plan (CHMP). A Native Title Strategy to manage Indigenous Land Use Agreements (ILUA) is being developed by Adani. Four CHMPs for the Project have been approved by Native Title claimants and DERM.

4.4.3.1 Fragmentation and Intrusion on Agricultural Property

The construction and operation of the Project (Rail) may fragment or intrude upon properties in the Project (Rail) (refer to Table 4-28). This may in turn affect stock movements, maintenance of access tracks and other existing operations on these properties.

The Project (Rail) has the potential to impact areas mapped as GQAL and strategic cropping land. These have been addressed in Sections 4.2.3.7 and 4.2.3.8.

Mitigation Measures

The Project (Rail) has been designed to maximise the distance of the Project (Rail) from homesteads and associated improvements such as sheds. The Project (Rail) also follows cadastral boundaries to avoid fragmentation or intrusion of properties. The design preserves access tracks within and between properties where possible. Private tracks will be joined to local roads or grade separated where possible to preserve their utility. Occupational crossings will be constructed to provide access typically under the Project (Rail). The design of the Project (Rail) may be further modified based on the outcomes from Adani's consultation with landholders.

4.4.3.2 Altered Overland Water Flow

The construction and operation of the Project (Rail) may alter overland water flow and increase flood height and duration. Afflux has the potential to impact pasture species and facilitate weed invasion. Afflux may also erode or otherwise degrade soil. Infrastructure across a floodplain like roads and farm tracks may be severed or degraded by flooding (refer to EIS Volume 4 Appendix AB Rail Hydrology).

Mitigation Measures

Surface drainage patterns will be preserved (where possible) with the design of culverts and cut/fill areas. The rail corridor design will incorporate acceptable afflux levels in order to mitigate potential impacts to property and infrastructure (refer to EIS Volume 4 Appendix AB Rail Hydrology). Considerations such as the raising of farm roads and additional bridges or culverts will be informed by the iterative design process in order to reduce the impacts of afflux. Impacted soils may be stabilised to prevent salinization or other forms of degradation. Compensation will be considered for owners of land or infrastructure adversely impacted by residual afflux.

4.4.3.3 Clearing of Remnant Vegetation

Remnant vegetation will be cleared during the construction and operation of the Project. Clearing of REs will comprise about 9.4 per cent of the total clearing extent in the Project (Rail) Area. No impacts on nature refuges will arise from the Project (Rail).

Mitigation Measures

Potential impacts on remnant vegetation have been avoided and minimised through the route selection process. Furthermore (where possible) activities will be undertaken on previously cleared land instead of land with remnant vegetation. Clearing of REs with Threatened Ecological Communities or REs of special conservation significance will be avoided where possible. Where clearing of REs in unavoidable, vegetation offsets may apply (refer to EIS Volume 3 Appendix AA Rail Ecology Report).

4.4.3.4 Degradation of water quality in waterways and water storages

The construction and operation of the Project (Rail) may lead to contamination and increased turbidity of water in waterways and storages near the Project (Rail). Poor quality water may lead to poor health and impaired fertility among livestock.

Mitigation Measure

Consultation with landholders was undertaken to determine where water storages will be required to be relocated. The Project will develop and implement ESCPs and Construction Management Plan (CMPs) to minimise erosion and avoid sedimentation of existing water storages. Appropriate contamination management measures will also be provided (refer section 4.3.5).

4.4.3.5 Increased traffic and damage of road infrastructure

The construction and operation of the Project (Rail) may increase the volume of traffic and subsequent wear on roads in and around the Project (Rail). Traffic will increase on Gregory Developmental Road and Kilcummin Diamond Downs Road due to the high number of personnel movements to and from construction camps. Some local roads are likely to have significant wear and haven't been designed for heavy and wide loads. Road crossings over the Project (Rail) may impact traffic and safety.

Mitigation Measures

Traffic management impacts will be managed through a Traffic Management Plan (TMP) and will address safety risks relating to crossings, heavy vehicle traffic and single-lane local roads (refer to EIS Volume 4 Section AG Rail Transport Report).

Table 4-31 lists proposed treatments at road crossings based on preliminary discussions with DTMR and IRC.

Table 4-31 Roads and Stock Routes Crossings and Proposed Treatments

ID	Road/Crossing Name	Chainage	Proposed Treatment Type*	Description
1	Eaglefield Road / Kilcummin Diamond Downs Road	Ch. 51.2	◗ At grade active crossing ◗ Stock crossing separately by culvert	IRC local road State Controlled Road (south of the Project (Rail)) Stock route (M399BELY03)
2	Amaroo Road	Ch. 82.1	◗ Grade separated (rail over road)	IRC local road Stock route

ID	Road/Crossing Name	Chainage	Proposed Treatment Type*	Description
			◗ Stock route along road	(U402BELY03)
3	Avon Road	Ch. 88.7	Grade separated (rail over road)	IRC local road
4	Gregory Developmental Road	Ch. 107.4	Grade separated (rail under road)	State controlled road
5	Mistake Creek Crossing	Ch. 120.4	Provide sufficient clearance for stock under the waterway bridge over creek	Stock route (Y401BELY02)
6	Moray Bulliwallah Road	Ch. 151.6	At grade active crossing	IRC local road
7	Moray Carmichael Road	Ch. 173.1	Realigned to run parallel on the southern side of the Project (Rail). No crossing treatment required.	IRC local road

4.4.3.6 Disruption of stock movement through Stock Route Network

The disruption of stock movement during construction and operation of the Project (Rail) may lead to stock distress, reduced pastoral productivity and higher stock transportation costs. Constraints to stock movement may also prevent stock from reaching important areas of pasture or water during drought and thereby potentially increase stock mortality.

Mitigation Measures

Table 4-31 lists proposed treatments at stock route crossings based on preliminary discussions with DTMR and IRC. Holding yards will be established at either side of stock crossings as necessary. Disused stock crossings may be reopened during the operation of the Project (Rail).

4.4.3.7 Interference with water pipelines

Earthworks undertaken during the construction of the Project (Rail) may interfere with water pipelines. The Queensland Infrastructure Plan identifies a number of proposed water pipelines in the Mackay, Isaac and Whitsunday region. There are no proposed pipelines in the vicinity of the Project (Rail).

Mitigation Measures

It is unlikely that the construction and operation of the Project (Rail) will impact any future proposed pipelines. Ongoing discussions with the proponents of proposed pipelines will seek to identify and mitigate any potential interactions between the Project (Rail) and proposed water pipelines.

4.4.3.8 Temporary raising or realignment of power lines

No electricity or telecommunications easements traverse the Project (Rail) area however the transport of large loads during the construction and operation of the Project (Rail) may necessitate that power lines be temporarily raised or realigned along existing road networks.

Mitigation Measure

Measures to mitigate the potential impacts of the construction and operation of the Project (Rail) on power lines will be addressed in the CMP for the Project (Rail).

4.4.4 Summary of Land Use Assessment

The extent of the land through which the Project (Rail) traverses is classified as production from relatively natural environments and is used predominantly for cattle grazing and fattening. It has been identified through this assessment that the construction and operation of the Project (Rail) has potential to result in direct permanent changes to the land use in the Project (Rail).

The construction and operation of the Project (Rail) has the following potential impacts:

- Fragmentation and intrusion of agricultural property, GQAL and strategic cropping land
- Altered overland water flow
- Clearing of endangered REs
- Reduction of water quality in waterways and water storages
- Increased traffic and damage of road infrastructure
- Disruption of stock movement through the Stock Route Network
- Temporary raising or realignment of power lines
- Restriction of access to mineral resources

Measures are provided to mitigate these potential impacts. Further mitigation may occur through the refinement of management plans. The assessment process Project (Rail) has been subject to multiple iterations based on feedback from landholders and key stakeholders. Adani will continue to work with landowners, key stakeholders and state and local governments to minimise potential impacts on land use.

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