# 04 Geology

# Section 04 Geology

## 4.1 Introduction

A desktop review of available geological data relevant to the Alpha Coal Project (Rail) corridor (herein referred to as the Project) has been undertaken in order to assess the geological characteristics of the Project corridor.

The objectives of this review were to:

- describe the existing environment in relation to geological units and structural features found within the Project corridor;
- identify and assess the potential impacts of significant geological properties on construction activities and on operation of the Project;
- identify potential impacts on the geological environment from construction activities; and
- propose mitigation measures for each identified potential impact.

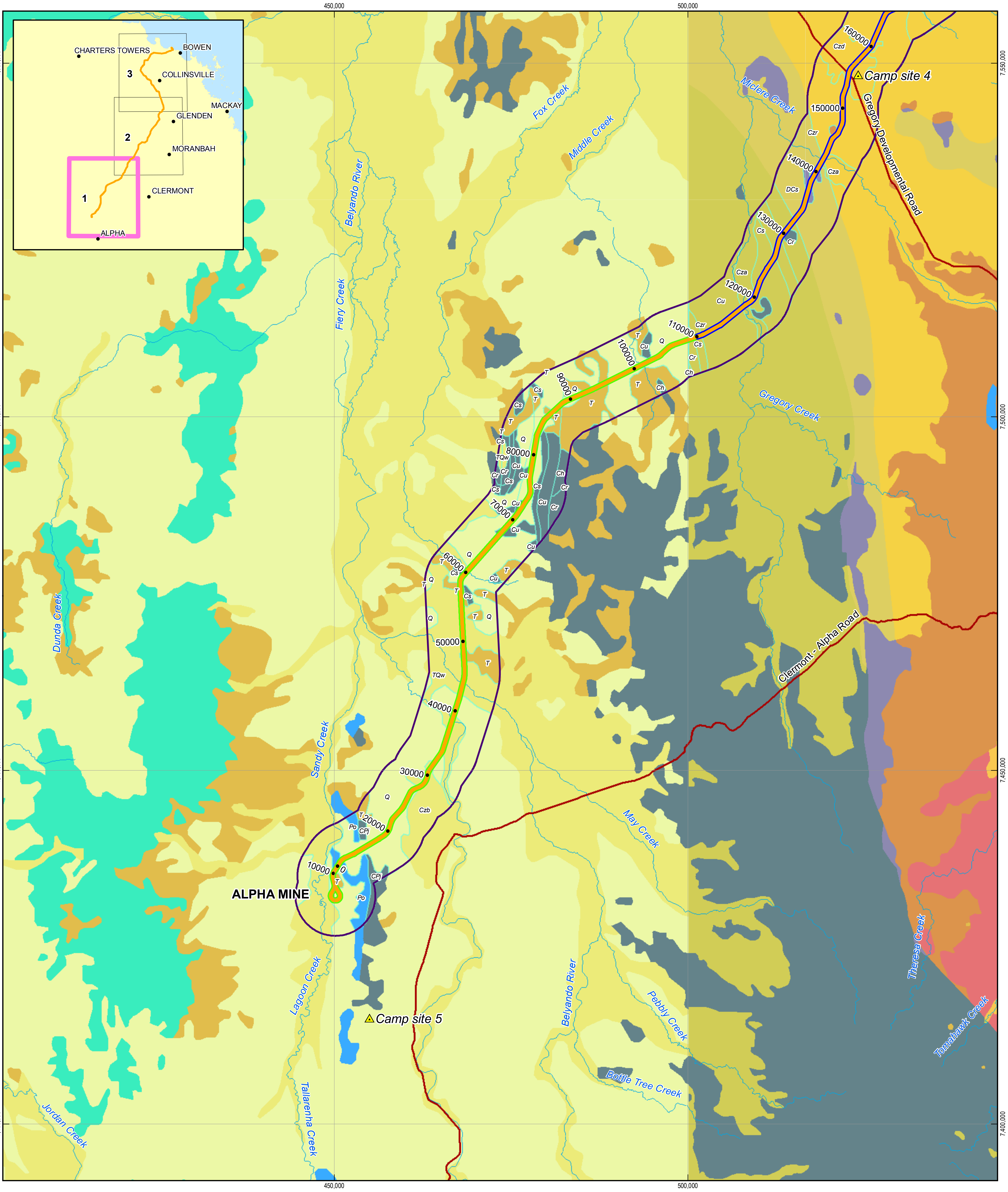
The following data resources have been used in the preparation of this desktop review:

- Geological Survey of Queensland (GSQ) published geological digital data, Regional 1:250,000 scale (GSQ, 2007);
- published hard copy lithological sheets, Australia 1:250,000 Geological Series (GSQ,1968-1971);
- GSQ Queensland Geology: A companion Volume to the 1:2,500,000 Scale Geological Map (GSQ, 1983);
- Geoscience Australia, geographical dataset and stratigraphic unit database (2010);
- Mining Leases for Queensland, Department of Employment, Economic Development and Infrastructure (DEEDI) (June 2010);
- Mineral Development License for Queensland, DEEDI (June 2010);
- CSIRO. Australian Soil Classification (ASC) mapping (Department of Environment and Resource Management (DERM), 2007); and
- GSQ major quarries and extractive industries database, (DEEDI, 2009).

For ease of describing geological features within the vicinity of the Project, the corridor has been divided into four sections, which are described in Table 4-1 and demonstrated in Figure 4-1. Each section corresponds to a chainage and contains discrete geological units, which are described in the following sections.

Table 4-1: Summary of sections based on chainages along the Project

| Section | Location Names | Chainages in kilometres (km) |
|---|---|---|
| 1 | Windaree to Clonmell | 0 – 110 |
| 2 | Clonmell to Newlands | 110 – 300 |
| 3 | Newlands to Bogie River | 300 – 430 |
| 4 | Bogie River to Willmington Station | 430 – 510 |




LEGEND

| | | | |
|---|---|---|---|
| Town | Proposed Alignment | Proposed Alignment Section | 5km Alignment Corridor |
| Camp | State Road | Section 1 | Geology Unit |
| Marshalling Yards | Existing Railway | Section 2 | Waterbody |
| Depot | Watercourse | Section 3 | |
| | | Section 4 | |



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1:500,000 (at A3)

0 2.5 5 10 15 20 25

Kilometers

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

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# REGIONAL GEOLOGY

Job Number | 41-22090
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**Figure: 4-1**
**Sheet 1 of 3**

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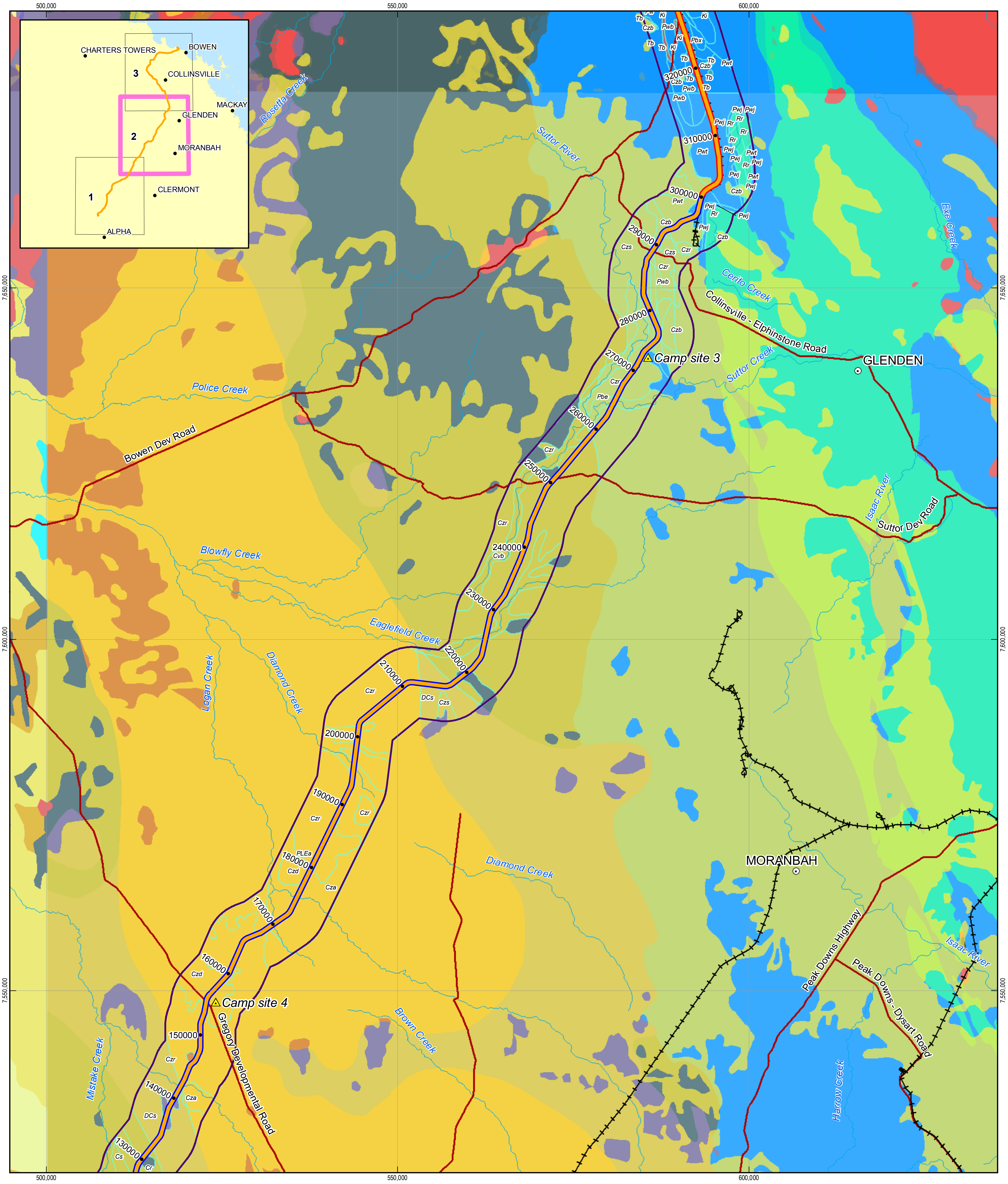


LEGEND

- Town
- Camp
- Marshalling Yards
- Depot
- Proposed Alignment
- State Road
- Existing Railway
- Watercourse

Proposed Alignment Section

- Section 1
- Section 2
- Section 3
- Section 4
- 5km Alignment Corridor
- Geology Unit
- Waterbody



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Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
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# REGIONAL GEOLOGY

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| Job Number | 41-22090 |
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Figure: 4-1
Sheet 2 of 3

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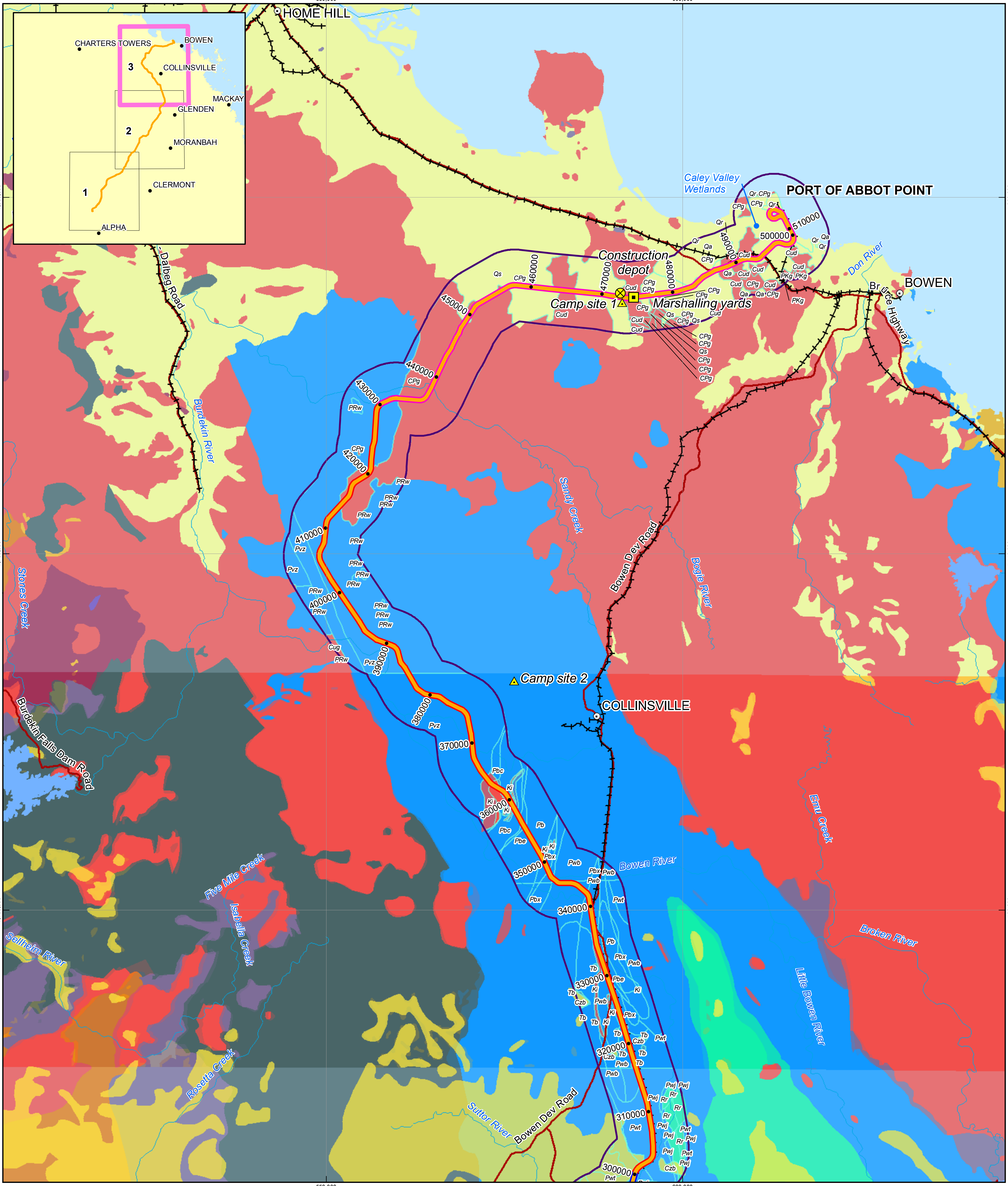


LEGEND

- Town
- Camp
- Marshalling Yards
- Depot
- Proposed Alignment
- State Road
- Existing Railway
- Watercourse
- Proposed Alignment Section
  - Section 1
  - Section 2
  - Section 3
  - Section 4
- 5km Alignment Corridor
- Geology Unit
- Waterbody



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1:500,000 (at A3)

0 2.5 5 10 15 20 25

Kilometers

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

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# REGIONAL GEOLOGY

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| Job Number | 41-22090 |
| Revision | A |
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Figure: 4-1
Sheet 3 of 3

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## 4.2 Description of Environmental Values

### 4.2.1 Regional Geology of the Project Corridor

The Project traverses the Galilee and Drummond Basins in the west, the Bowen Basin in the east and the Anakie Inlier geological unit in the central section.

The Anakie Inlier is a window of older a north-trending block of early to mid-Palaeozoic rocks surrounded by younger strata of the Drummond and Bowen Basins. The Anakie Metamorphics (Eoa) consist of two units, the older constituting low-grade regional basic metavolcanics originating in an oceanic environment. The second, younger unit overlying unconformably is composed of quartzose arenite and mudstone of varying thicknesses (GLNG, 2009).

The Early to Middle Devonian age strata of the Anakie Inlier was folded in the late Middle Devonian period and are unconformably overlain by Late Devonian period sediments and volcanics of the Drummond Basin.

The Drummond Basin contains Late Devonian and Early Carboniferous period sediments which were deposited mainly west but also on the east of the Anakie Inlier. Deposition was mainly continental. West of the Anakie Inlier, fluviatile clastic rocks (rock fragments derived from river sediments) were deposited in a narrow, subsiding basin by a north-flowing river system. Compression from the east ended sedimentation in the mid Carboniferous period and as a result, a zone of thrust faulting occurs immediately west of the Anakie Inlier.

The Bowen Basin is a north-south trending belt, which extends over approximately 60,000 km$^2$ of Central Queensland from the town of Collinsville in the north to Theodore in the south. The southern half of the Bowen Basin is overlain by the Surat Basin (GSQ, 1983).

A significant proportion of the sedimentary units in the Bowen Basin were laid down during the Permian (between 299 and 251 million years ago) and extended through to the Middle Triassic (between 244 and 321 million years ago). Andesitic volcanics (Lizzie Creek Volcanics and Camboon Andesite, Plv) form the eastern margin of the Bowen Basin (GSQ, 1983) and are a major part of the Camboon Volcanic Arc that runs along the east coast of northern central Queensland. Deposition of the Bowen Basin was concentrated in two centres, the Taroom Trough on the eastern edge and the Denison Trough on the western edge (GLNG, 2009).

The sea entered the Bowen Basin in the Early Permian period, and deposition was dominantly marine until the Middle Permian. The thickest sediments were laid down in the Denison Trough and the northern part of the basin, with the bulk of the sediments consisting of muddy deposits. A series of transgressive-regressive cycles produced inter-tonguing marine mudstones and deltaic and fluviatile (river derived) sandstone in the Denison Trough and on the Collinsville shelf, forming the Blenheim Subgroups (Pb). Withdrawal of the sea from the northern Bowen Basin in Middle Permian was followed by landward-side deposits and continental sedimentation forming the Moranbah Coal Measures (Puw) and German Creek Formation (Pb). Final sea withdrawal from the Bowen Basin in the Middle Permian resulted in extensive fluvio-lacustrine sediments being laid down and coal measures of the Blackwater Group (Puw) formed throughout the basin to the end of the Middle Triassic, where deposition was ended by uplift (GSQ, 1983).

### 4.2.2 Geological Units

With reference to the GSQ Digital Geology, three datasets of the 1:250,000 scale Geology maps were analysed:

- North Eromanga Basin;
- Bowen Basin; and
- Burdekin Basin.

A 5 km investigative corridor was studied along the Project and digital geological data that occurred within the corridor zone was extracted. The extracted geological units are presented in Volume 6, Appendix D (along with the geology legend), summarised in Table 4-2 and described in detail in the following sections.

A geological ground model with associated cross-sections will be created once the geotechnical investigation is completed. At this time there is insufficient subsurface data publicly available to create site-specific geological cross-sections.

Table 4-2: Geological units underlying the Project corridor

| Section | Map Symbol | Unit Name/Type | Geological Age | Lithological Summary |
|---|---|---|---|---|
| 1 (chainage 0 km – 110 km) | Q | ALLUVIUM | QUATERNARY | Alluvium of older flood plains, sand, gravel, soil |
| | TQw | Woondoola beds | TERTIARY - QUATERNARY | Silt, clay, sandy clay; minor sand and gravel; fluvial |
| | T | SEDIMENTARY ROCK | TERTIARY | Quartzose sandstone, conglomerate, siltstone |
| | Czb | BASALT | CAINOZOIC | Olivine basalt lava flows |
| | Po | Colinlea Sandstone | EARLY PERMIAN - LATE PERMIAN | Quartz sandstone, pebbly quartz sandstone, minor conglomerate and siltstone |
| | CPj | Joe Joe Group | CARBONIFEROUS - PERMIAN | Tillitic conglomerate, lithic sandstone, siltstone, minor mudstone and coal |
| | Cr | Raymond Sandstone | CARBONIFEROUS | Flaggy quartzose sandstone, siltstone and minor limestone |
| | Cs | Star of Hope Formation | CARBONIFEROUS | Lithic conglomerate, feldspatholithic sandstone, rhyolitic to dacitic ignimbrite and flows, tuffaceous siltstone and rare sinter |
| | Cu | Ducabrook Formation | CARBONIFEROUS | Feldspatholithic sandstone, mudstone, siltstone (commonly tuffaceous), minor algal and oolitic limestone |

| Section | Map Symbol | Unit Name/Type | Geological Age | Lithological Summary |
|---|---|---|---|---|
| | Ch | Mount Hall Formation | CARBONIFEROUS | Quartzose to feldspathic sublabile sandstone, quartz-pebble conglomerate, mudstone and red siltstone |
| 2 (chainage 110 km – 300 km) | Cza | ALLUVIUM | CAINOZOIC | Alluvium, mainly clay, silt, sand and gravel |
| | Czb | BASALT | CAINOZOIC | Olivine basalt lava flows |
| | Czd | FERRICRETE | CAINOZOIC | Laterite. |
| | Czr | MISCELLANEOUS UNCONSOLIDATED SEDIMENTS | CAINOZOIC | Soil, alluvium, gravel, scree, 'billy', sand, duricrust. |
| | Czs | COLLUVIUM | CAINOZOIC | Sandstone, claystone, siltstone, conglomerate, laterite, oil shale, brown coal, sandstone breccia. |
| | Ki | GRANITOID | EARLY CRETACEOUS | Gabbro, leuco-diorite, quartz hornblende diorite, biotite-hornblende granodiorite, microgranite, rhyolite, trachyte |
| | Rr | Rewan Formation | TRIASSIC | Lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanilithic pebble conglomerate (at base) |
| | PRw | Mount Wickham Rhyolite | PERMIAN - TRIASSIC | Rhyolite, rhyolitic breccia, trachyte, dacite |
| | Pbe | Blenheim Subgroup | LATE PERMIAN | Micaceous siltstone, pebbly in places, labile sandstone, quartzose lithic sandstone, coquinite, limestone |
| | Pbx | Exmoor Formation | LATE PERMIAN | Quartzose to sublabile sandstone, siltstone, mudstone, rare limestone |
| | Pwb | Moranbah Coal Measures | LATE PERMIAN | Labile sandstone, siltstone, mudstone, coal, conglomerate in the east |
| | Pbc | Collinsville Coal Measures | EARLY PERMIAN | Quartzose sandstone, conglomerate, siltstone, coal |
| | Pwj | Rangal Coal Measures, Bandanna Formation, Baralaba Coal Measures | PERMIAN | Sandstone, siltstone, mudstone, coal, tuff, conglomerate |

| Section | Map Symbol | Unit Name/Type | Geological Age | Lithological Summary |
|---|---|---|---|---|
| | Pvz | Lizzie Creek Volcanics | PERMIAN | Basaltic to andesitic lava and volcaniclastic rocks (including breccia and arenite), rhyolitic to dacitic lava and volcaniclastic rocks (including ignimbrite); local siltstone, shale and polymictic conglomerate |
| | Pwt | Fair Hill Formation, Fort Cooper Coal Measures | PERMIAN | Sandstone, conglomerate, mudstone, carbonaceous shale, coal, cherty tuff |
| | Cvb | Bulgonunna Volcanic Group | CARBONIFEROUS | Rhyolitic to dacitic ignimbrite and lava flows and domes |
| | Ch | Mount Hall Formation | CARBONIFEROUS | Quartzose to feldspathic sublabile sandstone, quartz-pebble conglomerate, mudstone and red and green siltstone |
| | Cu | Ducabrook Formation | CARBONIFEROUS | Feldspatholithic sandstone, mudstone, siltstone (commonly tuffaceous), minor algal and oolitic limestone |
| | Cr | Raymond Sandstone | CARBONIFEROUS | Flaggy quartzose sandstone, siltstone and minor limestone |
| | Cs | Star of Hope Formation | EARLY CARBONIFEROUS | Lithic conglomerate, feldspatholithic sandstone, rhyolitic to dacitic ignimbrite and flows, tuffaceous siltstone and rare sinter |
| | DCs | Silver Hills Volcanics | LATE DEVONIAN - EARLY CARBONIFEROUS | Rhyolite, dacite, rhyolitic ignimbrite, volcaniclastic sediments, sinter, minor sandstone and siltstone |
| | PLEa | Anakie Metamorphic Group | NEOPROTEROZOIC - CAMBRIAN | Siltstone, fine sandstone, phyllite, schist, commonly cleaved and multiply deformed |
| 3 (chainage 300 km – 430 km) | Tb | BASALT | TERTIARY | Olivine basalt |
| | Tn | SEDIMENTARY ROCK | TERTIARY | Clayey sandstone, sandy claystone, feldspathic sandstone, conglomerate, minor siltstone, rare oil shale |

| Section | Map Symbol | Unit Name/Type | Geological Age | Lithological Summary |
|---|---|---|---|---|
| | Ki | GRANITOID | CRETACEOUS | Granodiorite, diorite, rhyolite, porphyry, gabbro, microdiorite |
| | PKg | GRANITOID | PERMIAN - CRETACEOUS | Leucocratic granite, microgranite, adamellite; minor microadamellite, syenite, diorite, gabbro, rhyolite porphyry |
| | PTRr | Mount Wickham Rhyolite | PERMIAN - TRIASSIC | Rhyolite, rhyolitic breccia, trachyte, dacite |
| | Pb | Back Creek Group | EARLY PERMIAN - LATE PERMIAN | Quartzose to lithic sandstone, siltstone, carbonaceous shale, minor coal and sandy coquinite |
| | Plc | Collinsville Coal Measures | EARLY PERMIAN | Quartzose sandstone, conglomerate, siltstone, coal |
| | Plz | Lizzie Creek Volcanics | PERMIAN | Basaltic to andesitic lava and volcaniclastic rocks (including breccia and arenite), rhyolitic to dacitic lava and volcaniclastic rocks (including ignimbrite); local siltstone, shale and polymictic conglomerate |
| | CPg | GRANITOID | CARBONIFEROUS - PERMIAN | Adamellite, granodiorite, granite; minor microgranite, porphyry, quartz diorite, granophyre, microtrondhjemite |
| 4 (chainage 430 km – 510 km) | Qa | ALLUVIUM | QUATERNARY | Alluvium, coastal mud flats, minor evaporites, colluvium, soil |
| | Qs | COLLUVIUM | QUATERNARY | Residual and colluvial soil, sand, gravel, rubble, some semi-consolidated material |
| | Qr | COLLUVIUM | QUATERNARY | Clay, silt, sand, gravel and soil; colluvial and residual deposits |
| | CPg | GRANITOID | CARBONIFEROUS - PERMIAN | Adamellite, granodiorite, granite; minor microgranite, porphyry, quartz diorite, granophyre, microtrondhjemite |
| | Cud | GRANITOID | CARBONIFEROUS | Diorite, quartz diorite, tonalite, gabbro, granodiorite; rare adamellite, norite, monzonite, granite; abundant dykes |

Note: Unit Name/Type – If a geological unit is unnamed the major rock type is listed in capital letters (i.e. ALLUVIUM, BASALT, FERRICRETE, MISCELLANEOUS UNCONSOLIDATED SEDIMENTS, GRANITOID, COLLUVIUM, SEDIMENTARY ROCK).

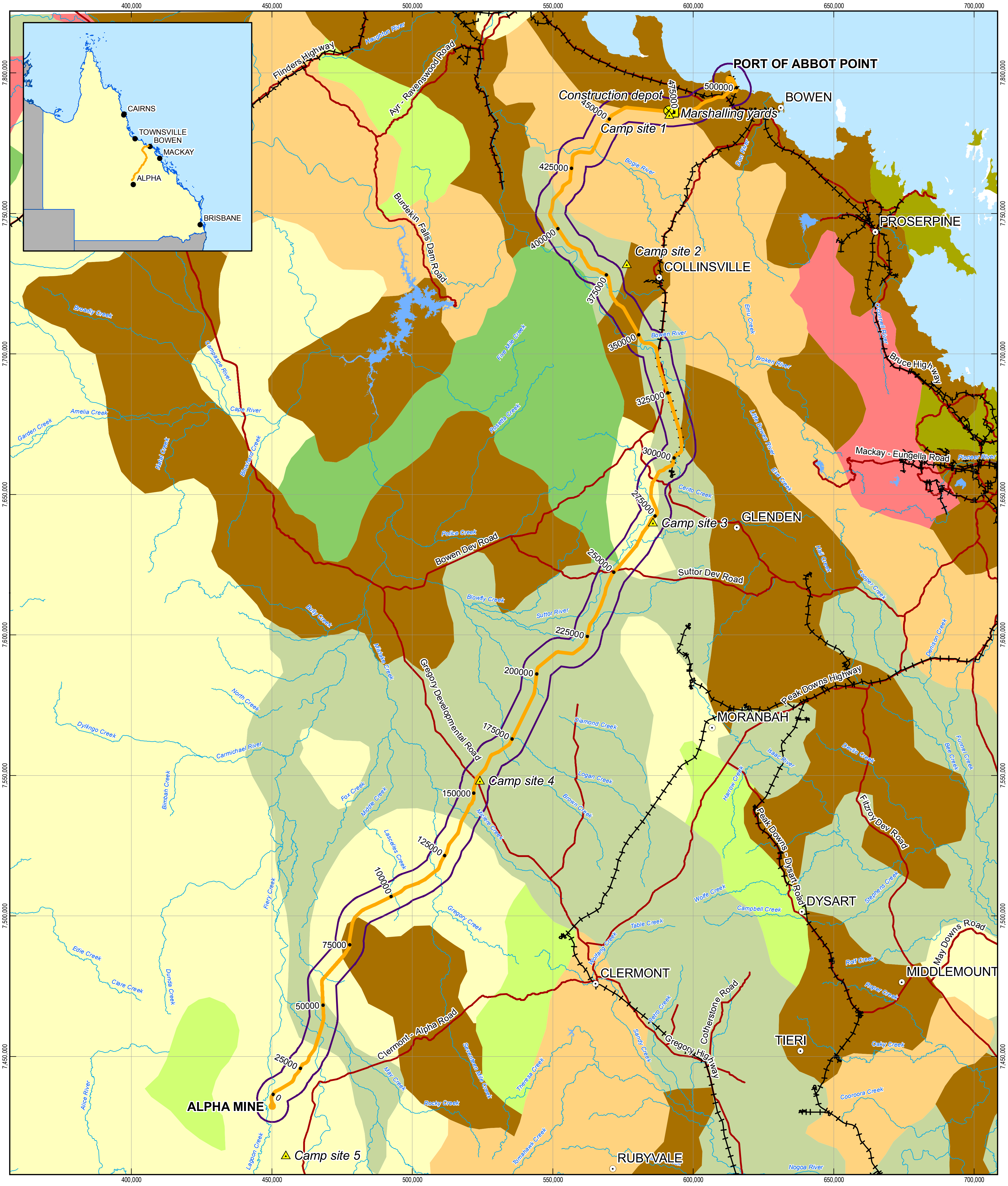
### 4.2.3 Dominant Soil Classification

Broad scale Commonwealth Scientific and Industrial Research Organisation (CSIRO) Australian Soils Classification (ASC) mapping is displayed in Figure 4-2. Main types of soils encountered along the Project are briefly described in Table 4-3. Vertosols, sodosols and chromosols have particular geotechnical properties that may impact on construction and operation of the Project. Detailed descriptions of soils encountered within the Project area can be found in Volume 3, Section 5 of this EIS.

Table 4-3: Broad-scale CSIRO Soils Intersected by the Project

| Australian Soil Classification | Description/Properties |
|---|---|
| Kandosol | This order accommodates those soils which lack strong texture contrast, have massive or only weakly structured *B horizons*, and are not *calcareous* throughout. Containing clay minerals.<br>Kandosol soils do not present any specific concerns in relation to engineering design of the Project. |
| Vertosol | Clay soils with shrink-swell properties that exhibit strong cracking when dry and at depth have slickensides and/or lenticular structural aggregates.<br>Vertosol soils have “shrink-swell” properties, which may require consideration in relation to engineering design of linear infrastructure projects. |
| Sodosol | Soils with strong texture contrast between A horizons and *sodic B horizons* which are not *strongly acid*. Influenced by sodium.<br>Sodosol soils are often dispersive and therefore highly susceptible to erosion when disturbed. |
| Chromosol | Soils with strong texture contrast between A horizons and *B horizons*. The latter are not *strongly acid* and are not *sodic*. Often bright coloured.<br>Chromosol soils are often dispersive and therefore highly susceptible to erosion when disturbed. |

Obtained from CSIRO, http://www.clw.csiro.au/aclep/asc_re_on_line/soilkey.htm




LEGEND

| | | | | | |
|---|---|---|---|---|---|
| Town | Alignment | 5km Alignment Corridor | ASC Orders | Hudrosols | Sodosols |
| Camp | State Road | Waterbody | Chromosols | Kandosols | Tenosols |
| Marshalling Yards | Existing Railway | | Dermosols | Podosols | Vertosols |
| Depot | Watercourse | | Ferrosols | Rudosols | Unknown |



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1:1,250,000 (at A3)

0 5 10 20 30 40 50

Kilometres

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

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# CSIRO AUSTRALIAN SOIL CLASSIFICATION MAPPING

Job Number 41-22090
Revision A
Date 21-09-2010

Figure: 4-2

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### 4.2.4 Local Geology and Structural Features

#### 4.2.4.1 Overview

The geology and structural features encountered within the five km buffer are described below. The following descriptions relate to geology units and structural features that underlie the infrastructure corridors for electricity easements, rail line, pipeline easements and any other associated infrastructure (if they fall within the five km buffer).

Structural features located within published hardcopy maps are included in the descriptions below and are displayed in Volume 6, Appendix D.

Topographical features, broad-scale soil classification and hydrology are discussed briefly in terms of the relationships of these characteristics to geology.

Detailed descriptions of environmental values relating to topography, soils and hydrology are covered in Volume 3, Section 5 of this EIS and surface water features are described in more detail in Volume 3, Section 11 of this EIS.

The Project corridor is divided into four sections. In each section the Project is subdivided into parts which briefly describe the terrain (relating to outcropping geological units), soils (that have specific geotechnical properties), geology units mapped at surface and geological structural features that may impact the Project. Chainages given below in relation to geological outcrop units is approximate as the scale of the geology maps is 1:250,000.

#### 4.2.4.2 Section 1

Section 1 of the Project occurs from the Alpha Coal Mine (chainage 0) to chainage 110 km (refer to Figure 4-3) and is subdivided into three parts, namely:

**Part 1 – Alpha Coal Mine to Chainage 60 km**

The topography of the area consists of gently undulating slopes associated with alluvial flats of Lagoon Creek moving into undulating with level to low hilly reliefs. Some knolls and breakaways are present to the west, low rises and ridges with undulating plains leading into alluvial plains of the Belyando River (a braided river system with broad channels), Native Companion Creek and Lestree Hill Creek before returning to level to very gently undulating slopes at chainage 60 km.

The dominant soil type indicates in this part of the Project is kandosol, however from approximately chainage 30 km to chainage 50 km the Project is underlain by vertosols, otherwise known as cracking clays. The vertosols appear to be associated with the alluvium of the Belyando River catchment.

According to the geology mapping, this part of the Project is predominately underlain by Quaternary-aged alluvium of older floodplains of the Belyando River Catchment area, which consists of sand, gravel and soil. The rivers and creeks however are underlain by Tertiary to Quaternary-aged fluvial sediments of the Woondoola beds (TQw) dominated by silt, clay and sandy clay with minor sand and gravel. Outcropping sedimentary rock (T, unnamed and CPj; Joe Joe Group) and sandstone (Po; Colinlea Sandstone) between chainage 15 km and chainage 30 km is associated with the steeper topographic profiles.

#### Part 2 – Chainage 60 km to Chainage 85 km

Moving north along the Project, the topography is described as gently undulating terrain of Quaternary floodplain alluvium, before entering an area of crests and rises with localised steeper slopes and rugged terrain associated with outcropping geological units of unnamed Tertiary-aged sedimentary rock and Carboniferous-aged arenite-mudrock (Cu; Ducabrook Formation).

Soils are mapped as dispersive (sodosols), which is a common residual product of weathered Carboniferous to Permian-aged sandstones.

#### Part 3 – Chainage 85 km to Chainage 110 km

The landscape returns to very gently undulating slopes with sporadic hills and scarps of incised valleys, including lateritic blocks at chainage 90 km before moving into lowlands and plains with shallow depressions.

The soils underlying the Project are mapped as kandosols derived from older alluvial floodplains which dominate the region. Outcropping units of the unnamed Tertiary-aged sedimentary rock occurs both north and south of the Project with the Carboniferous-aged Ducabrook Formation to the north and the Mount Hall Formation of the south of the Project. These outcropping bedrock units form the scarp and valley dominated terrain. At chainage 90 km the lateritic blocks are associated with weathered outcropping unnamed sedimentary rock (T).

At about chainage 88 km the mapping indicates a north-south trending concealed fault of the underlying basement bedrock between two geological units, the Carboniferous-aged Ducabrook Formation to the west and the Mount Hall Formation to the east.

### 4.2.4.3 Section 2

Section 2 of the Project occurs from chainage 110 km to chainage 300 km (refer to Figure 4-3) and is subdivided into three parts.

#### Part 1 – Chainage 110 km to Chainage 140 km

The topography of this part of the Project consists of plains and undulating lowlands with flatter alluvial floodplains where the Project intersects a creek-line. At chainage 120 km the terrain exhibits low relief, breakaways and depressions, and at about chainage 135 km rocky hills occur.

Soils in this part are broadly mapped as kandosols and are described geologically as miscellaneous unconsolidated sediments, consisting of soil, alluvium, gravel, scree, 'billy', sand and duricrust (Czr). Minor outcroppings of Drummond Basin units occur as follows:

- Ducabrook Formation to the east of chainage 120 km;
- Raymond Sandstone underlies the Project at about chainage 130 km; and
- Silver Hills Volcanics underlies the Project from about chainage 135 km to chainage 140 km.

Structurally, the Clermont Sheet SF55-1 (refer to Volume 6, Appendix D), shows the Mistake Creek Syncline (downward trending fault line), trending north-south, intersecting the Project at approximately chainage 122 km.

#### Part 2 – Chainage 140 km to Chainage 210 km

The topography in this part consists of plains, lowlands and depressions, grading into flat alluvial floodplains around creeks. Occasional rises, scarps, shallow valleys and lateritic blocks (chainage 205 km) occur.

The Project corridor is mapped as consisting of cracking clays (vertosols) that dominate this area and are associated with the geologically mapped alluvium, colluvium, durricrust and soil (Czr). This mixture of sediments is likely to be the result of various depositional processes and weathering of the underlying bedrock. Alluvium consisting of clay, silt, sand and gravel underlies the flat terrain of the floodplains associated with the creeks in the region. Laterite (weathered material of the underlying parent rock) is dominant between chainage 153 km to chainage 161 km, chainage 164 km to chainage 169 km and chainage 178 km to chainage 180 km. Minor outcropping Anakie Metamorphic Group occurs within the vicinity of the Project at chainage 145 km and chainage 208 km.

#### Part 3 – Chainage 210 km to Chainage 300 km

Topography is described as gently to moderately undulating and plain lowlands with intermittent crests, rises, breakaways and knolls. Alluvial flats are associated with the water pathways of the various creeks with the terrain returning to undulating country north of Suttor Creek.

The soils are chiefly cracking clays (vertosols) with kandosols underlying the Project between chainage 250 km and chainage 290 km.

The majority of this part of the Project (chainage 210 km to chainage 277 km) is underlain by miscellaneous deposits (Czr; soil, alluvium, gravel, scree, 'billy', sand and duricrust) with occasional outcroppings of the Bulgonunna Volcanic Group (Cb; rhyolitic to dacitic ignimbrite and lava flows and domes). After chainage 277 km through to chainage 286 km the Project is underlain by colluvium (Czs) and then olivine basalt lava flows (Czb) out-cropping between chainage 288 km and chainage 300 km.

Alluvial material (Cza) is mapped as underling the rivers and creeks of the region, and consists of clay, silt, sand and gravel.

### 4.2.4.4 Section 3

Section 3 of the Project occurs from chainage 300 km to chainage 430 km (refer to Figure 4-3) and is subdivided into three parts.

The topography and geology change noticeably after chainage 300 km as the Project enters the Bowen River Catchment area.

#### Part 1 – Chainage 300 km to Chainage 345 km

The Project traverses undulating terrain with some sharper rises and depressions associated with creeks and drainage lines.

The soils consist of cracking clays (vertosols) for most of this part of the Project until the Bowen River is intersected at chainage 345 km.

Outcropping units of the Upper Permian-aged Blackwater Group (Puw) and the Back Creek Group (Pb), which includes the major coal measures of the Bowen Basin dominate this part of the Project area. Within the vicinity of the Project (five km buffer), the following units are found:

- Unnamed Early Cretaceous intrusive granitoid (Ki) (chainage 320 km to chainage 340 km);
- Rewan Formation (TRr);
- Blackwater Group:
  - Moranbah Coal Measures (Pwb);
  - Fair Hill Formation and Fort Hill Coal Measures (Pwt); and
  - Rangal Coal Measures, Bandanna Formation, Baralaba Coal Measures (Pwj).
- Back Creek Group:
  - Blenheim Subgroup (Pbe); and
  - Exmoor Formation (Pbx).

Outcrops of the Blackwater Group and the Back Creek Group are common within the vicinity of the Project area associated with structural features including faults, synclines, anticlines and trend lines and granitoid intrusions. Many of these structural features are trending approximately north-south, inline with the geological boundaries between the various units.

### Part 2 – Chainage 345 km to Chainage 360 km

The Project crosses the Bowen River at chainage 345 km before running parallel with it to approximately chainage 388 km. The topography from chainage 345 km to chainage 360 km is described as gently sloping levee country with either side of the river consisting of a mixture of small crests and gentle slopes, alternating with low gently undulating hills.

Soils within the Bowen catchment area are mapped as sodosols and identified as being dispersive in nature.

This part of the Project is underlain by the Back Creek Group comprising Early to Middle Permian-aged units of the:

- Exmoor Formation (Pbx);
- Blenheim Subgroup (Pbe); and
- Collinsville Coal Measures (Pbc).

A minor outcropping of an unnamed Early Cretaceous intrusive granitoid (Ki) occurs at approximately chainage 360 km.

### Part 3 – Chainage 360 km to Chainage 430 km

The Project parallels the gentle sloping levee country of the Bowen River to chainage 388 km, after which it traverses gently undulating terrain with low hills, skirting rugged hills/ranges with steep slopes located to the east. The Project traverses flat terrain with some shallow depressions as it parallels the Bogie River before crossing at chainage 435 km.

Soils mapping indicates changes from sodic (dispersive) soils to cracking clays, with this change associated with a change in the underlying geology from sedimentary to volcanic origin.

The geology from chainage 360 km to chainage 430 km is dominated by the Lizzie Creek Volcanics. Minor intrusions of the Mount Wickham (PRw) unit occur within the five km buffer; however these do not intersect the Project. Part of the Project between chainage 412 km and chainage 417 km is underlain by an unnamed Permian- to Carboniferous-aged granitoid (CPg) unit.

A significant geological structural feature of Section 3 is the north-west to south-east trending Millaroo Fault Zone, which is situated to the west of the Project within the Lizzie Creek Volcanics. This fault zone is reported within the five km buffer of the Project between chainage 385 km to chainage 405 km (refer to Volume 6, Appendix D, Diagram 2).

#### 4.2.4.5 Section 4

Section 4 of the Project occurs from chainage 430 km to chainage 510 km (refer to Figure 4-3) and is subdivided into two parts.

##### Part 1 – Chainage 430 km to Chainage 455 km

The Project traverses flat terrain with some shallow depressions as it parallels the Bogie River before crossing this river at chainage 435 km. The topography re-enters undulating terrain with rugged ranges and hills located to the east, which are associated with outcropping unnamed intrusive granitoids (CPg).

Soils in the area are mapped as dispersive (chromosols).

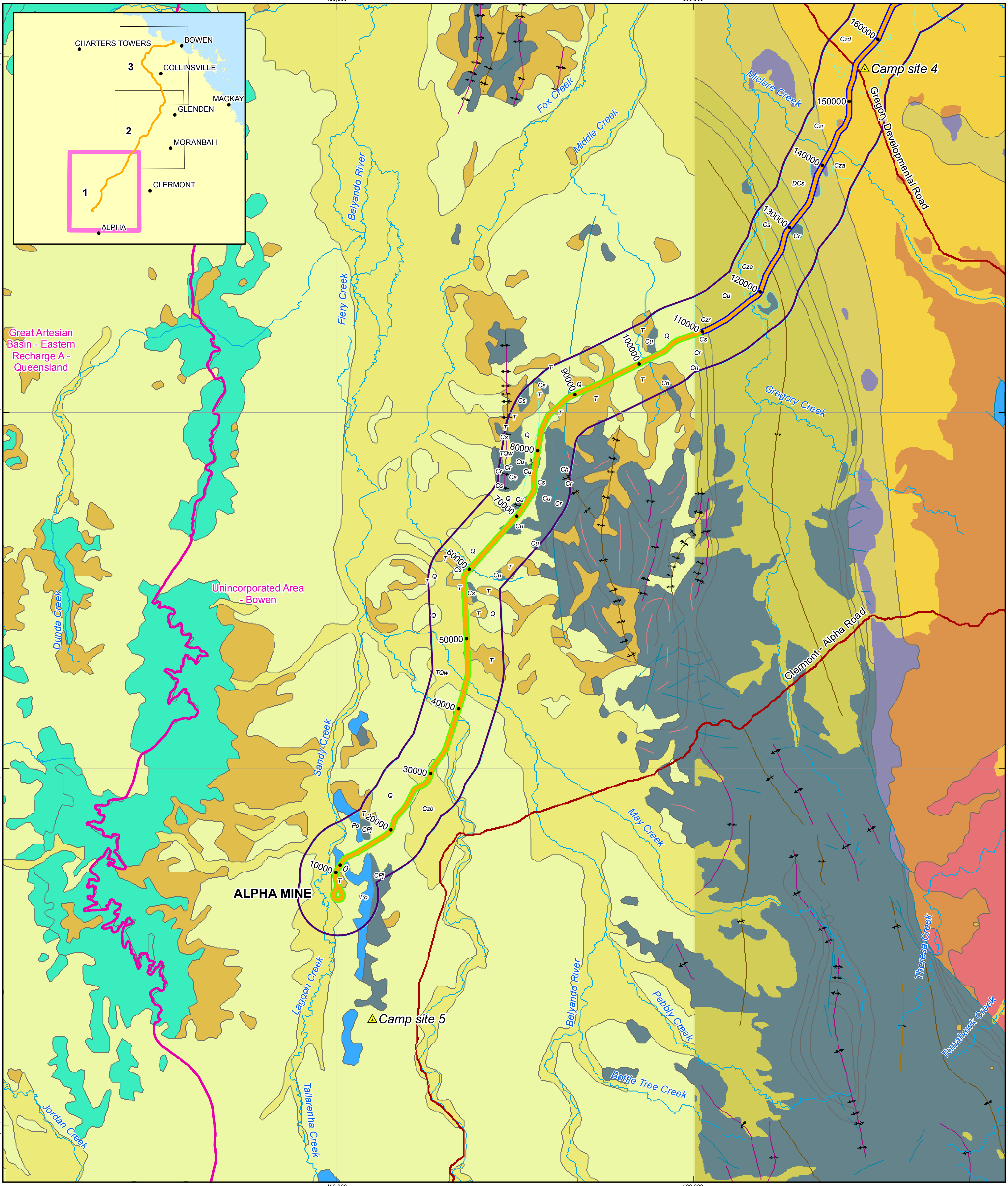
##### Part 2 – Chainage 455 km to Chainage 510 km

The topography is described as flat terrain with moderate undulations towards Abbot Point, which are naturally low lying salt flats. Small hilly areas protrude around the rail loop in an otherwise flat terrain.

Abbot Point is predominately underlain by coastal and alluvial sediments consisting of various compositions of clay, silt, sand, gravel and soil; originating from colluvial and residual deposits. These sediments are mapped as dispersive (sodosols).

Underlying the colluvial and residual material is the parent rock of Permian- to Carboniferous-aged unnamed granitoid intrusions (Cud and CPg). Moving away from the outcropping bedrock, further inland the landscape is underlain by some semi-consolidated material but predominately residual and colluvial soil consisting of sand, gravel and rubble (Qs).

In the vicinity of chainage 470 km to chainage 476 km, to the south of the Project, the granitoid intrusion (Cud) is mapped as containing the Glenore Shear Zone trending east-west and marks the boundary with the CPg unit to the south. A number of fault lines trending north west-south east, crosscut with two other faults trending north-south and north east-south west. This unit is mapped as containing an abundance of dykes containing felsite rocks.




LEGEND

| | | | | | | |
|---|---|---|---|---|---|---|
| Town | Proposed Alignment | Proposed Alignment Section | 5km Alignment Corridor | Anticline | Joint Pattern | Syncline |
| Camp | State Road | Section 1 | Geology Unit | Coastline | Lineament | Synform |
| Marshalling Yards | Existing Railway | Section 2 | Waterbody | Dyke or Vein | Miscellaneous | Trend Line |
| Depot | Watercourse | Section 3 | Groundwater Management Unit | Fault | Monocline | |
| | | Section 4 | | Geological Boundary | Shear Zone | |



Source: See Copyright Details below and for full disclosure please refer to the EIS ***Volume 4 - References***

1:500,000 (at A3)

0 2.5 5 10 15 20 25

Kilometers

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

N W E S

**HANCOCK PROSPECTING PTY LTD**

Alpha Coal Project
Environmental Impact Statement

# MAPPED GEOLOGY AND STRUCTURAL FEATURES

| | |
|---|---|
| Job Number | 41-22090 |
| Revision | A |
| Date | 20-09-2010 |

Figure: 4-3
Sheet 1 of 3

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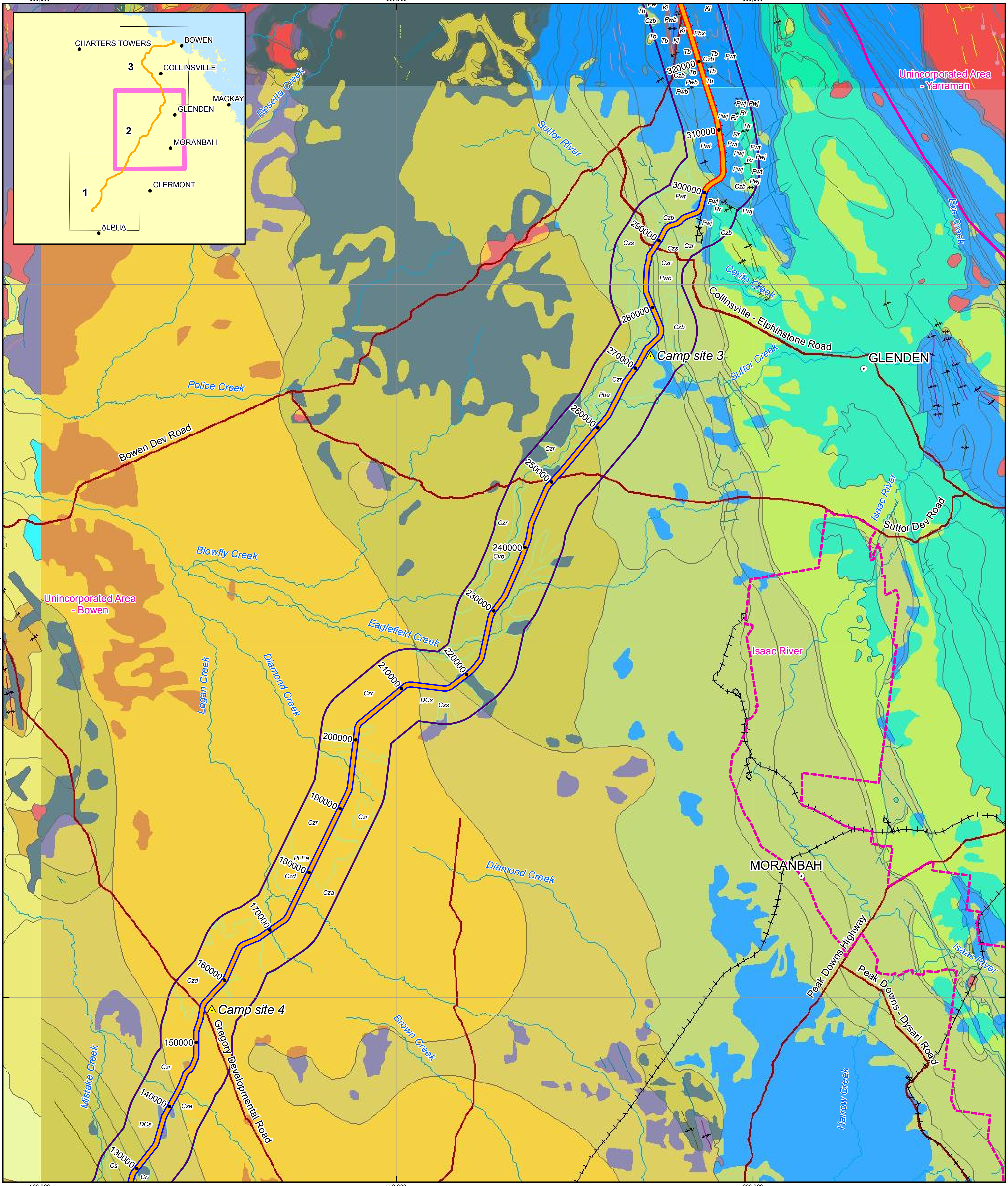


LEGEND

| | | |
|---|---|---|
| Town | Proposed Alignment | Proposed Alignment Section |
| Camp | State Road | Section 1 |
| Marshalling Yards | Existing Railway | Section 2 |
| Depot | Watercourse | Section 3 |
| | | Section 4 |

| | | | |
|---|---|---|---|
| 5km Alignment Corridor | Anticline | Joint Pattern | Syncline |
| Geology Unit | Coastline | Lineament | Synform |
| Waterbody | Dyke or Vein | Miscellaneous | Trend Line |
| Groundwater Management Unit | Fault | Monocline | |
| | Geological Boundary | Shear Zone | |



Source: See Copyright Details below and for full disclosure please refer to the EIS ***Volume 4 - References***

1:500,000 (at A3)

0 2.5 5 10 15 20 25

Kilometers

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

N W E S

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Alpha Coal Project
Environmental Impact Statement

# MAPPED GEOLOGY AND STRUCTURAL FEATURES

Job Number: 41-22090
Revision: A
Date: 20-09-2010

Figure: 4-3
Sheet 2 of 3

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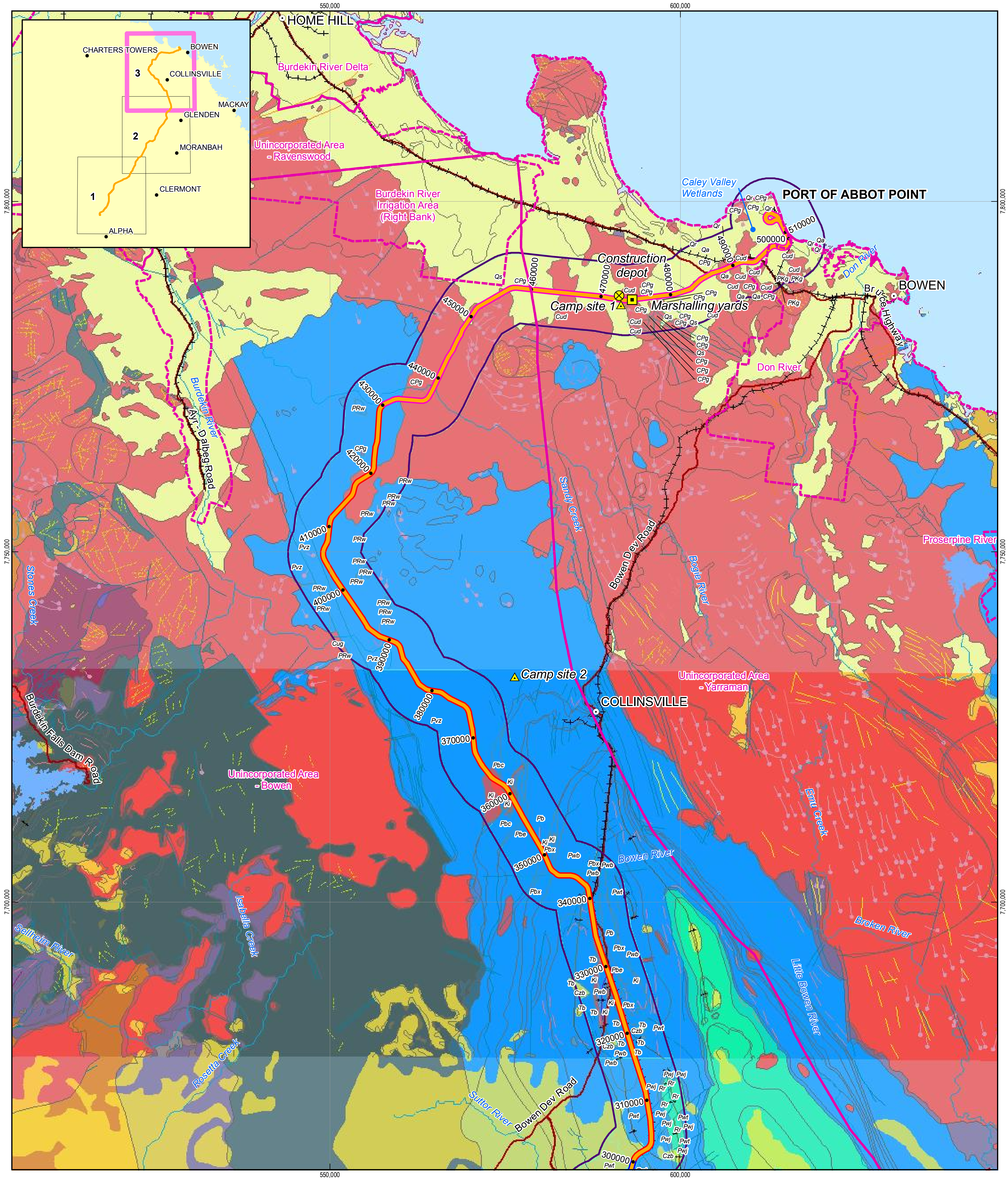


LEGEND

| | | | | | | |
|---|---|---|---|---|---|---|
| Town | Proposed Alignment | Proposed Alignment Section | 5km Alignment Corridor | Anticline | Joint Pattern | Syncline |
| Camp | State Road | Section 1 | Geology Unit | Coastline | Lineament | Synform |
| Marshalling Yards | Existing Railway | Section 2 | Waterbody | Dyke or Vein | Miscellaneous | Trend Line |
| Depot | Watercourse | Section 3 | Groundwater Management Unit | Fault | Monocline | |
| | | Section 4 | | Geological Boundary | Shear Zone | |



Source: See Copyright Details below and for full disclosure please refer to the EIS ***Volume 4 - References***

1:500,000 (at A3)

0 2.5 5 10 15 20 25

Kilometers

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

N W E S

HANCOCK PROSPECTING PTY LTD

Alpha Coal Project
Environmental Impact Statement

# MAPPED GEOLOGY AND STRUCTURAL FEATURES

Job Number 41-22090
Revision A
Date 20-09-2010

Figure: 4-3
Sheet 3 of 3

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#### 4.2.4.6 Water Courses/Pathways

The Project crosses or comes in close proximity to a number of creeks and rivers. Creek and river crossings will necessitate geotechnical investigations for design of footings/piles for the bridge structures. A list of the major creeks and rivers that have been identified in the vicinity of the Project are given in Table 4-4. Other seasonal surface water pathways may occur during periods of wet weather that are not identified on the available mapping and will require hydrological analysis during detailed design.

Table 4-4: Watercourse in the vicinity and crossings of the Project

| Section | Approx Chainages | Water Course Name | Status/Notes |
|---|---|---|---|
| 1<br>Chainage 0 km – chainage 110 km | - | Lagoon Creek | Ephemeral, does not cross the Project |
| | - | Sandy Creek | Ephemeral, does not cross the Project |
| | 38.8 | Native Companion Creek | Ephemeral |
| | 43.5 | Belyando River | Ephemeral |
| | 60.6 | Lestree Hill Creek | Ephemeral |
| | 101.3 | Lascelles Creek | Ephemeral |
| 2<br>Chainage 110 km – chainage 300 km | 118.0 | Mistake Creek | Ephemeral |
| | 142.0 | Miclere Creek | Ephemeral |
| | 170.0 | Brown Creek | Ephemeral |
| | 175.3 | Logan Creek | Ephemeral |
| | 195.9 | Diamond Creek | Ephemeral |
| | 223.7 | Eaglefield Creek | Ephemeral |
| | 262.7 | Suttor Creek | Ephemeral |
| | - | Suttor River | Ephemeral, does not cross the Project |
| 3<br>Chainage 300 km – chainage 430 km | 301.7 | Kangaroo Creek | Ephemeral, does not cross the Project |
| | ~ 345 | Rosella Creek | Ephemeral, intersects Option 2 & 3 |
| | ~ 345 | Bowen River | Perennial, intersects Option 1A & 2 |
| | 375.0 | Pelican Creek | Ephemeral |
| 4<br>Chainage 430 km – chainage 495 km | 436.2 | Bogie River | Ephemeral |

### 4.2.5 Coal, Petroleum and Mineral Resources

The Drummond and Bowen Basins are rich in coal resources. There are a number of mining lease applications (MLA) and mineral development licences (MDL) within the five kilometre investigative corridor for the Project (refer to Figure 4-4) and are listed in Table 4-5.

Table 4-5: Mining Lease Applications and Mineral Development Licenses within five km of the Project

| Section | Type | Principal Holder | Tenure Reference | Site Name | Status |
|---|---|---|---|---|---|
| 1 | MDL | Hancock Coal Pty Ltd | MDL 285 | - | Granted |
| | ML | Hancock Coal Pty Ltd | ML 70,426 | Alpha | Application |
| | MDL | Hancock Prospecting Pty Ltd | MDL 333 | Kevin's Corner | Granted |
| | ML | Hancock Galilee Pty Ltd | ML 70,425 | Kevin's Corner | Application |
| 2 | ML | Xstrata Coal Queensland Pty Ltd | ML 4,761 | Suttor Creek | Granted |
| | ML | Xstrata Coal Queensland Pty Ltd | ML 4,748 | Newlands | Granted |
| | MDL and ML | Byerwen Coal Pty Ltd | MDL 443, ML 10355, ML 10356, ML 70434, ML 70435, ML 704346, ML 10357 | Byerwen, Byerwen 1, 2,3,4,5 and 6 | Application |
| 3 | ML | Xstrata Coal Queensland Pty Ltd | ML 10,336 | Sarum | Application |
| | ML | Xstrata Coal Queensland Pty Ltd | ML 1,064 | Scott-Denison West | Granted |
| | ML | Xstrata Coal Queensland Pty Ltd | ML 1,037 | Bowen Consolidated Coal Mine | Granted |
| | ML | Xstrata Coal Queensland Pty Ltd | ML 1,009 | Collinsville Open Cut | Granted |
| | ML | Drake Coal Pty Ltd | ML 10,349, ML 10,350, & ML 10,351 | Drake 1, Drake 2 & Drake 3 | Application |
| | MDL | QCoal Pty Ltd | MDL 392 | Drake East | Application |
| | ML | Conquest Mining Limited (CQT) | ML 10,343 | Mt Carlton | Application |
| | ML | Jax Coal Pty Ltd | ML 10346 | Jax | Application |

Obtained from the GSQ Tenures and Geoscience Digital Data, DEEDI, ML data (June 2010), MDL Data (June 2010).

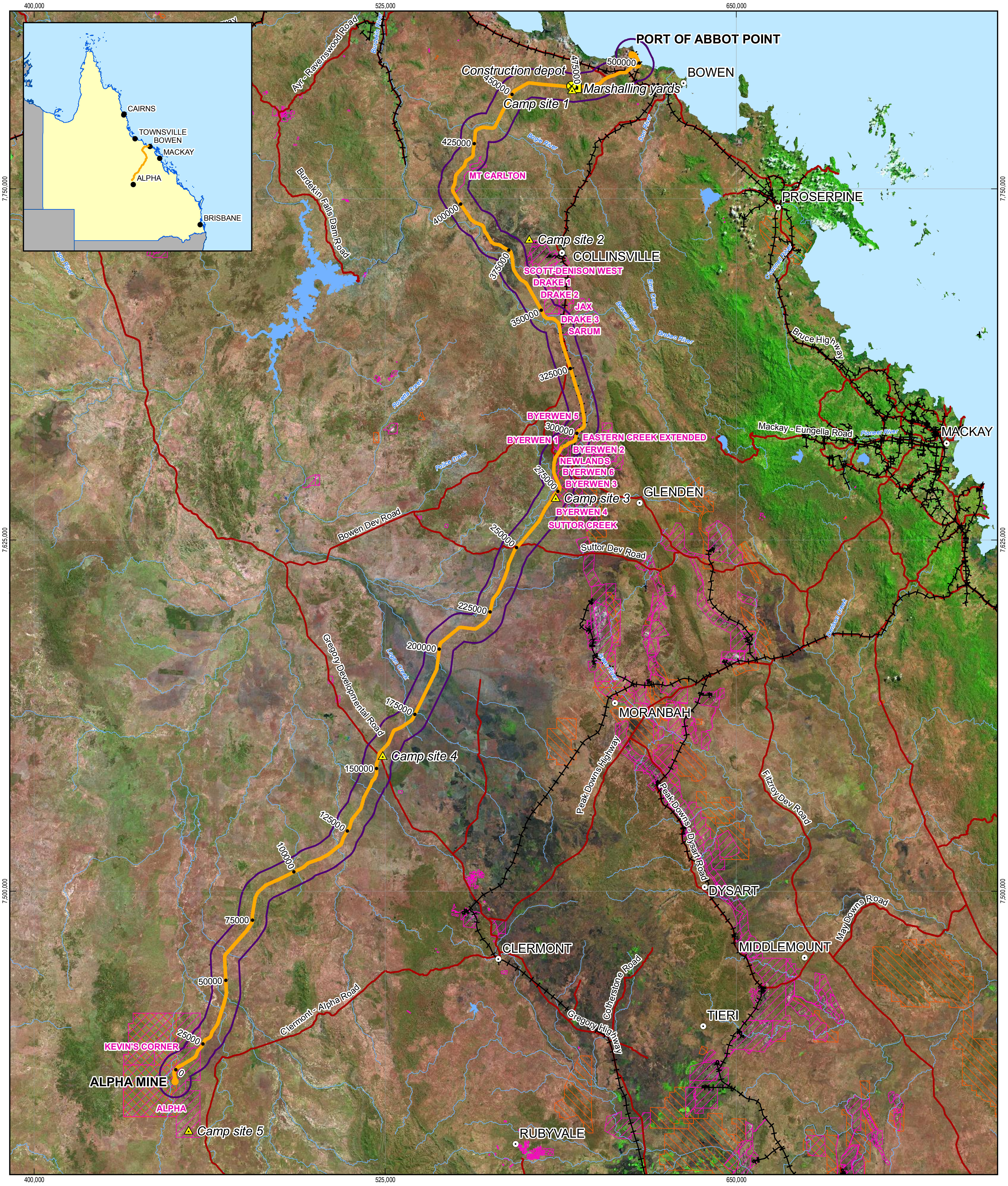
The Project passes over a number of geological units prospective for coal, minerals, petroleum (including coal seam gas) and possibly geothermal energy. In particular the Project corridor in Volume 3, Section 3 traverses large areas of the coal bearing Moranbah Coal Measures within the Bowen Basin rocks. Coal beds are pervasive in this geological structure although not all resources are economically extractable under current economic conditions.

### 4.2.6 Extractive Resources

Major extractive resources (i.e. hardrock quarries) are not extensive in Central Queensland and are mainly confined to the coastline. Sourcing materials for rail ballast and embankment fill may require use of material already available on site (e.g. excavated rock), or importing materials from the nearest quarry. A list of major hardrock quarries that are located in the vicinity of the Project area are as follows:

- Townsville – Bohle Quarry, Black River Quarry, Roseneath Quarry;
- Ayr – The Rocks Quarry;
- Bowen – North Gregory Quarry; and
- Mackay – Cedars Quarry, Farleigh Quarry.

Construction material sourcing is described in greater detail in Volume 3, Section 2 of this EIS and associated impacts area described in Volume 3, Section 5 of this EIS.




LEGEND

- Town
- Camp
- Marshalling Yards
- Depot
- Proposed Alignment
- State Road
- Existing Railway
- Watercourse
- 5km Alignment Corridor
- Waterbody
- Mining Lease
- Mineral Development Licences



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1:1,250,000 (at A3)

0 5 10 20 30 40 50

Kilometres

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

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Environmental Impact Statement

# MINING LEASES AND MINERAL DEVELOPMENT LICENSES

| | |
|---|---|
| Job Number | 41-22090 |
| Revision | A |
| Date | 21-09-2010 |

Figure: 4-4

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## 4.3 Potential Impacts and Mitigation Measures

### 4.3.1 Problematic Soils Characteristics

The geological properties outlined in the previous section pose potential impacts on the construction and operation of the Project; features that include outcropping granites and sharp topographic relief areas, concealed faults, fault zones, highly weathered lithological profiles and cracking and dispersive soils.

The geotechnical investigation will identify the physical, geo-mechanical and chemical properties of waste rock in both fresh and weathered lithologies, which will then allow the determination and design concepts for slope stability, rehabilitation and possible acid generation of waste rock and waste water management.

Once the geotechnical and chemical properties of the rocks and soils within the Project area are determined, then Occupational Health and Safety concerns may be identified and addressed as part of the Environmental Management Plan (EMP).

#### 4.3.1.1 Potential Impact

The Project crosses large areas of soil types that can be problematic in construction projects.

Vertosol soils also known as cracking clays, have shrink/swell properties that cause the soil to shrink and develop large cracks when dry, and then swell and close-up to form a tight impermeable mass when wet. The dry and wet stages of these soils exhibit different structural and behavioural properties. During construction, cracking clays can be difficult to excavate and handle when wet. Given that vertosol soils occur across a large proportion of the Project, it is unlikely to be practical to avoid constructing in this soil type during the wet season, and hence construction methods will need to take into account the need to handle wet cracking clays.

After construction, the swelling/shrinkage cycle can place strain on overlying structures, including linear infrastructure such as railway lines. These issues can be addressed through engineering design, provided that locations of cracking clays are identified. Geotechnical investigations will be undertaken as part of the detailed design phase of the Project and will allow the location and properties of cracking clays to be delineated so that design can allow for the changing properties when wet and dry.

Chromosol and sodosol soils also occur across quite significant parts of the Project and are classified as dispersive soils. When exposed to wetting, dispersive soils tend to quickly lose structure and collapse as the soil particles do not cling together. This property represents both an environmental and engineering issue.

From an environmental point of view, dispersive soils are highly erosive and erosion in turn results in releases of sediment to waterways. Impacts associated with erosion are discussed in more detail in Volume 3, Sections 5.3.3 and 11.3.1 of this EIS.

From an engineering point of view, highly erodible soils create a risk for the stability of the rail line as soils can be “washed out” from batters or from under the railway line itself. Dispersive soils are not easily compacted and may need treatment to become usable for construction.

#### 4.3.1.2 Mitigation Measures

For vertesol or cracking clays geotechnical studies will further delineate vertosol soils along the alignment and establish shrink/swell ratio to identify problematic soils. The shrink/swell properties of cracking clays will be addressed in detailed design and measures may include:

- allowing for expansion joints;
- encapsulating soils by placing and compacting swelling clays within embankment cores to minimize exposure to drying/wetting;
- incorporating moisture control barriers with foundation swelling clays to control lateral seasonal migration of moisture;
- applying lime stabilisation to reduce plasticity and shrinkage potential; and
- where the shrink/swell ratio is unacceptable, identifying appropriate disposal locations for these soils.

Similarly, geotechnical studies will also examine dispersivity of soils. Measures to be taken during design and construction may include:

- avoiding disturbance of highly dispersive soils where possible;
- implementing an erosion and sediment control plan during construction, and until post-construction rehabilitation has been completed, with a particular emphasis on controlling drainage across dispersive soils (refer to Volume 3, Section 5.3.5 of this EIS);
- chemically ameliorating through treatment of the soil with gypsum, hydrated lime or aluminium sulfate to promote bonding of soil particles to reduce dispersion potential;
- encapsulating, sealing or capping dispersive soils so that the soils are not exposed to running water;
- rehabilitating after construction, including replacement of topsoil and re-vegetation to minimise exposure of dispersive soils to erosive forces; and
- ongoing monitoring during operation and prompt response in the event of observed erosion.

With these mitigation measures in place, impacts associated with problematic soil characteristics are expected to be of low significance.

### 4.3.2 Geological Structural Features

#### 4.3.2.1 Potential Impact

Structural features occurring within the Bowen Basin and the Camboon Volcanic Arc consist of predominately north-south trending faults and folds (synclines and anticlines). Mapping by the GSQ, (2007) indicates major anticlines, synclines and fault lines that either intersect or pass close to the Project. The faults typically occur along adjoining individual geological units and may potentially comprise of zones of weakness and may be subject to movement over time. On a localised scale, old faults, joints and folded bedding planes of geological units have potential slip surfaces that may be activated during construction and operation of the Project.

Based on the available geological information it is not possible to determine any specific health and safety issues which may be present. These will be assessed during the detailed design phase.

The available information is insufficient at this stage to determine if the specific geology of the development area would have an adverse impact on rehabilitation of development areas or the influence the quality of waste water generated from disturbed areas. Given the area of disturbance it is anticipated that both rehabilitation and management of waste water can be effectively achieved.

Note that this does not directly relate to earthquake risk, which is discussed in Volume 3, Section 24.5.6 of this EIS.

#### 4.3.2.2 Mitigation Measures

Geological faults, shear zones and known instabilities will be mapped and further investigated during detailed geotechnical studies which will occur as part of the detailed design phase of the Project. Design and construction of the Project will conform to relevant standards for potential instability of the ground caused by movement, slips, erosion and weathering.

### 4.3.3 Terrain-based Issues

#### 4.3.3.1 Potential Impact

While topographical constraints along the alignment are limited, there are some areas where steeper slopes will require more extensive earthworks to allow access and construction to occur. Reducing slopes along the Project alignment during construction has operational benefits in terms of reduced haulage effort during operation.

A construction footprint of 60 m wide has been assumed for the Project as a basis for calculating impacts. This should allow for extra width where required due to topographical constraints and the need to minimise grades along the Project alignment.

Rocky outcrops also occur along the Project. Some heavy rock breaking and blasting may be required which in turn may give rise to additional impacts such as:

- noise and vibration. This is assessed in Volume 3, Section 15 of this EIS;
- dust. This is assessed in Volume 3, Section 13 of this EIS; and
- damage to existing infrastructure and services.

#### 4.3.3.2 Mitigation Measures

Terrain-based issues will be addressed through:

- minimising construction footprint wherever possible;
- achieving a cut full balance where possible (see also Section 4.3.4, below);
- avoiding rocky outcrops if possible;
- implementing management and mitigation measures identified in Volume 3, Section 13 and 15 of this EIS in relation to air quality and noise/vibration impacts;
- undertaking all blasting activities in accordance with regulatory requirements and relevant Australian standards; and
- prior to excavation and blasting, identify locations of all infrastructure and services and provide measures to protect from impacts.

## 4.3.4 Construction Materials and Resources

### 4.3.4.1 Potential Impact

It is anticipated that a considerable amount of construction material will be required in order to construct the Project. Materials such as fill and rail ballast will be of high demand for the duration of the construction. It is likely that fill material will be able to be sourced from some of the cuttings that will be required to be undertaken as part of the Project. The suitability of the cuttings for use as fill material is dependant on the geotechnical condition of the cut material and whether it meets the appropriate standards. Ideally only surplus cuttings will be used for fill materials and not be sourced from virgin ground where disturbance is not required as part of the Project. Fill material will not be sourced from soil types conducive to cropping and beneficial land uses such as higher class Good Quality Agricultural Land (GQAL) soil types.

Generation of waste rock will be minimised through the use of cuttings for fill materials wherever possible. Specialised materials are required for rail construction, particularly in relation to ballast (the crushed rock surface on which the sleepers and tracks are laid) as well as material for stable embankments and fill. Detailed design has not yet been undertaken, and it is not known what quantity of material will be able to be obtained from the Project footprint, whether material will need to be imported to the area for construction and whether there will be excess spoil that will require disposal.

Requirements for ballast are quite specific, and it is unlikely that all ballast requirements will be able to be met from within the Project footprint. Ballast material will probably need to be imported from hard rock quarries in the area. These quarries will need to hold development permits for operation of a quarry under the *Sustainable Planning Act 2009* (SPA).

Otherwise, detailed design will seek to achieve a balance between cut and fill to minimise both the need to import material and also the need to dispose of excess material. In particular, excess material will be incorporated into batter slopes wherever possible. Management of waste spoil is discussed in Volume 3, Section 16 of this EIS.

Traffic related impacts of material import are addressed in a preliminary traffic assessment provided in Volume 3, Section 17 of this EIS.

### 4.3.4.2 Mitigation Measures

The following mitigation measures will be undertaken in relation to construction materials and resources:

- geotechnical investigations include characterisation of the rock and soil materials that may potentially be used for fill, ballast or embankment compaction or for ground surface rehabilitation;
- geotechnical and geological properties of soils and rock will be considered during the detailed design such that good quality material is reused as much as possible in preference to import of material from other sources, and the need to dispose of material is limited; and
- where fill material is required, this will not be sourced from areas of land suitable for cropping or higher class GQAL soil types.

### 4.3.5 Palaeontology

#### 4.3.5.1 Potential Impact

Fossil records may exist in rocks along the Project. While there are no known fossil deposits within the Project footprint, there is potential for fossil deposits to be uncovered during excavation activities associated with construction. Fossils often contain important information on the evolution of plants and animals and, if fossils were uncovered and inadvertently destroyed, this information may be lost.

#### 4.3.5.2 Mitigation Measures

As part of the Construction Environmental Management Plan, a procedure will be developed in the event of inadvertent fossil finds. The procedure will include stopping work at protecting the area until further investigations can be carried out.

If it is discovered that the rock in the work area contains fossils, all work is to stop and the Project Environmental Representative notified of the find. The area will be sectioned off and personnel will not disturb the area any further. The Environmental Representative will notify the Department of Environment and Resource Management (DERM) as soon as is practical for further advice.

### 4.3.6 Economic Impacts on Surrounding Resources

#### 4.3.6.1 Overview of Potential Impacts

The current alignment passes over geological units that contain known coal reserves and are prospective for coal, mineral, petroleum, extractive (construction materials) and geothermal energy resources. As such, construction of the Project over these resources may result in sterilisation of these resources. In order to minimise this impact, the alignment has been examined and adjusted (with over 200 route modelling exercises in addition to on the ground considerations).

The extraction of geothermal and petroleum resources is highly unlikely to be affected by narrow linear infrastructure since the point of extraction (i.e. through wells) is flexible and extraction can be accomplished with minimal surface effects (subsidence may be a risk in some locations). Consequently impacts on these resources are not examined further.

Similarly, sterilisation of mineral (other than coal) and extractive resources has been avoided by previously undertaken minor relocations of the rail alignment (prior to declaration on 2$^{nd}$ July 2010).

Total avoidance of extensive planar, shallow-dipping coal beds is more problematic and the optimal alignment may be over lower quality coked or faulted coal or where the coal is deep and uneconomic or only able to be mined by underground methods to avoid impacts on surface infrastructure in the mid to long term future. In the future, it may be possible to find alternative approaches should they be appropriate to retrieve coal that becomes economic.

The implications of sterilising coal resources are economic, in that materials required to support economic activity and development may become scarce in future, and also through loss of revenue to Government from royalties and taxes.

The Project as constructed will have the potential for positive impacts on resource extraction and transport. For instance the Project will facilitate the extraction and export of the Galilee Basin thermal coals, enabling their utilisation to the world. The Project will also provide a transport alternative for a number of resources, particularly coal from the northern Bowen Basin to the Port of Abbot Point as an alternative to the existing Newlands line which may have capacity constraints.

#### 4.3.6.2 Direct Impacts and Mitigation Measures

The Proponent has considered the potential to sterilize known coal resources in route selection, using the following process:

- desktop studies of resources outlined in the Department of Employment, Economic Development and Innovation (DEEDI) Interactive Resource and Tenures Maps (IRTM) database;
- identification of tenures such as MDL, MLA, Exploration Permits for Coal (EPC), Exploration Permits for Mining (EPM) traversing the corridor and undertaking consultation with the holders of granted permits;
- adjustment of the corridor on the basis of feedback received on the corridor from submissions from the notification process undertaken during declaration of the Project as an Infrastructure Facility of Significance (IFS) under the *State Development and Public Works Organisation Act 1971* (SDPWOA);
- avoidance of MLAs and MDLs except where its was clear that lesser net sterilisation was likely than through the adjacent exploration permit areas;
- ongoing consultation with key tenure holders traversed by the IFS corridor; and
- co-siting the alignment with other infrastructure such as the established Northern Missing Link corridor.

Potential sterilisation by the Project has been assessed and identified as part of the IFS and EIS processes in three main areas:

- in areas of the Galilee Basin and Drummond Basin east of the proposed Alpha and Kevin's corner coal mines in exploration permits held by the Proponent or other companies to the east;
- in hardrock areas of the Anakie Inlier covered by EPMs and in some cases MLAs; and
- in areas of the northern Bowen Basin traversed by the corridor and particularly in MLA areas between the Newlands Mine and Collinsville.

Each of these is discussed in more detail below.

##### Galilee Basin and Drummond Basin

The Project traverses tenures held by the Proponent east of the proposed mine and, then passes into exploration permits held by other companies. The Project alignment was publicly advertised for a month from 20th February 2010 until 22nd March 2010. Submissions were received and reviewed as part of the IFS process. The proponent has written to MDL and MLA holders and applicants prior to the public advertisement period (in letters dated 5th February 2010).

There is limited information on coal resources in these EPCs. No concerns were raised by tenement holders. It is considered that any present coal seams would be deep and not amenable to open cut mining and that it may be possible to undertake underground mining underneath the proposed rail line.

Overall, impacts on coal reserves and resources in the Galilee and Drummond Basins are not likely to be economically significant.

### Anakie Inlier

This area traversing the Project includes a number of EPMs and MLAs including ML 10343 submitted on September 9th, 2009, for the Mount Carlton gold mine held by Conquest Mining Limited (CQT). This application has currently progressed to the Certificate of Application (COA) stage of approval.

Whilst a number of EPMs are traversed by the alignment, there are no resources identified on the IRTM database. In addition, none of the tenure holders raised issues in response to the advice provided or advertised publicly. The alignment avoids the proposed mine-site at Mount Carlton.

The Proponent will continue to liaise with CQT in the future to identify any opportunities for sharing infrastructure.

Otherwise, it does not appear that any known resources or reserves of economic significance are impacted by the proposed Project.

### Northern Bowen Basin

In traversing the Bowen Basin from southwest of Newlands and Collinsville, the Project passes through a number of EPCs, MDLs and MLAs. Tenures traversed are listed in

Table 4-5.

Hancock Prospecting Pty Ltd (HPPL) has identified potential issues in this section of Project after the corridor was initially identified and undertook consultation with key tenement holders prior to and during the IFS process. In particular, HPPL identified that the alignment may traverse potential coal resources in the Byerwen, Weetalaba and Rosella Creek deposits held by QCoal in exploration permits (EPCs 739, 768, 614 and 586). QCoal, in its submission to the IFS process, reported that the rail alignment sterilised significant resources of coal.

While recognising that coal is likely to underlie many areas in the Bowen Basin and that complete avoidance of coal resources may not be possible, the Proponent relocated the Project alignment in three main areas to minimise the potential for sterilisation of coal resources:

- in the vicinity of the Newlands Mine to abut the then proposed NML (now under construction).

  In response to representations from QCoal, HPPL relocated the rail alignment to abut NML as it passes through EPC 739. Whilst available data on drilling is limited, indications are that resources of mineable coal occur in this area, particularly in the Byerwen Project. The rationale behind the relocation was that the NML had already been subjected to a coal sterilisation investigation, and that sterilisation of mineable coal, if any, would be minimised by co-location of the two rail alignments by reducing the quantity of coal underlying the batters and buffers to the rail alignment.

  This relocation of the rail alignment diverts the line through the north-west corner of the Newland’s ML 4748 of Xstrata Coal. However, it is believed that mineable coal is not present underlying the NML in this area and that the optimal location is through the mining lease rather than through the QCoal EPC 739 to the west.

- from Newlands to the south of the Bowen River to abut the NML and avoid the deposits at Weetalaba.

  HPPL realigned the rail corridor to continue abutting the existing Newlands rail way line in this section, having relocated the line in the vicinity of the Newlands Mine. This effectively prevented potential sterilisation at the Weetalaba deposit. The rationale for the co-location of the two line routes is that the Newlands line was located in its current alignment because of the presence of an underlying fault which had rendered any coal present as effectively un-mineable.

Further consideration of sterilisation in this section is being carried out by HPPL.

- in the vicinity of the Bowen River to avoid the Rosella Creek deposit of QCoal and the Sarum Deposit of Xstrata south of the Bowen River and the QCoal's Drake deposit north of the Bowen River.

  HPPL examined in detail three alternative routes to cross the Bowen River as the alignment diverges from the Newlands line to pass to the west of Collinsville. The preferred alignment was developed in consultation with QCoal and Xstrata to pass between the Rosella Creek deposits of QCoal and the Sarum deposit and mining leases of Xstrata south of the river. To the north of the river the alignment had to avoid resources within the Drake mining lease applications of QCoal. The optimal route to avoid all resource areas in this area moved the alignment through the south western section of the Drake mining leases. However, this alignment is beyond the resource areas and does not sterilise coal resources. Further assessment of resources in other EPC areas is being carried out as part of the EIS process.

Given the geology and extent of the Bowen Basin in particular, it is impractical to completely avoid sterilisation of coal resources. Through consultation with tenement holders and realignment wherever possible, impacts on coal resources have been minimised. While the Project may have a minor effect on coal resources in the Bowen Basin, it also provides the means to make use of coal resources in the Galilee Basin and Drummond Basin which would not be possible otherwise. The presence of the Project may also provide some opportunities for future development of coal resources in the Galilee, Drummond and Bowen Basins by providing transportation.

Impacts on mineral resources and petroleum resources are minimal and are not likely to be significant.

## 4.4 Conclusions

The Project traverses a wide range of geological units and intersects a number of structural features. It passes over a number of geological units prospective for coal, minerals and petroleum and possibly geothermal energy. Whilst the extraction of petroleum (coal seam gas) and geothermal energy is unlikely to be impacted by narrow linear infrastructure due to flexibility of the extraction site, extraction of coal and minerals can be severely impaired by overlaying infrastructure and sterilisation from extraction for community benefits. In particular the Project traverses large areas of coal bearing Bowen Basin rocks, the Moranbah Coal Measures within which coal beds are almost pervasive. Consequently, a significant effort in development of the Project has already been directed towards identifying and eliminating potential sterilisation of coal and mineral resources. The resource sterilisation issue is dealt with in Section 4.3.6 above.

A geological and geotechnical investigation is being undertaken to characterise the geological units and their features in order to identify:

- geohazards;
- foundation conditions;
- excavation conditions;
- sources of construction materials;

- potential resource sterilisation; and
- optimal detailed engineering design for the Project.

In particular the geotechnical investigation focus on areas of difficult ground conditions such as cracking soil planes and rock cuttings requiring excavation/blasting and at locations of structures such as river crossings. A conceptual ground model will be developed with the data obtained from the geotechnical investigation to better understand the potential impacts and allow for detailed design. The identified impacts and mitigation measures will form part of the Construction Environment Management Plan (CEMP) for the Project.