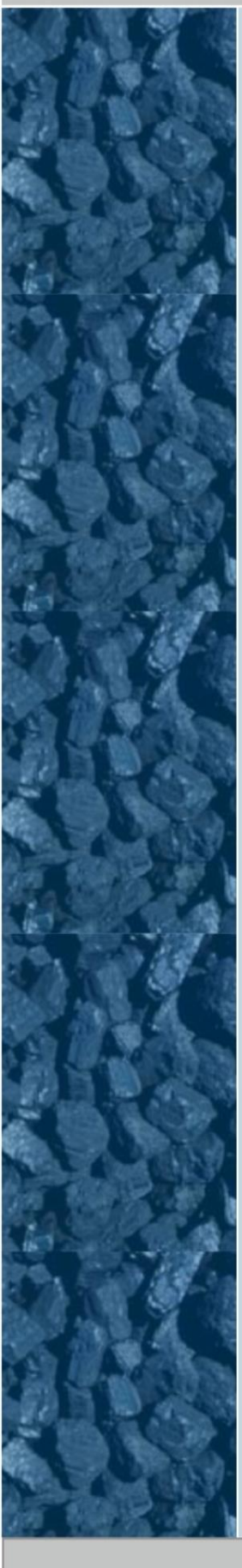
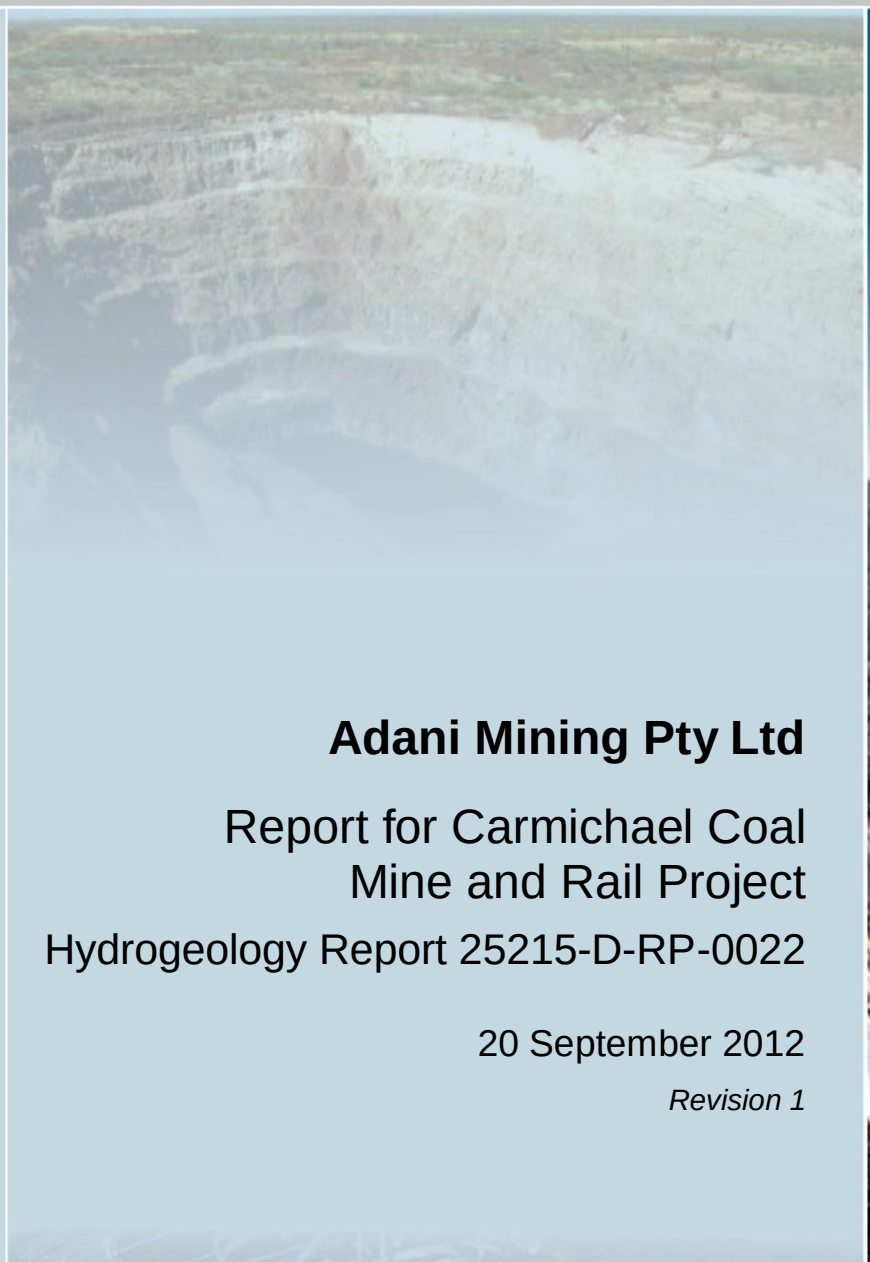
Adani Mining Pty Ltd





Adani Mining Pty Ltd

Report for Carmichael Coal Mine and Rail Project

Hydrogeology Report 25215-D-RP-0022

20 September 2012

Revision 1

GHD

This Carmichael Coal Mine and Rail Project: Rail Hydrogeology Report ("the Report") has been prepared by GHD Pty Ltd ("GHD") on behalf of and for Adani Mining Pty Ltd ("Adani") in accordance with an agreement between GHD and Adani.

The Report may only be used and relied on by Adani for the purpose of informing environmental assessments and planning approvals for the proposed Carmichael Coal Mine and Rail Project (Purpose)and may not be used by, or relied on by any person other than Adani.

The services undertaken by GHD in connection with preparing the Report were limited to those specifically detailed in Section 1 of the Report.

The Report is based on conditions encountered and information reviewed, including assumptions made by GHD, at the time of preparing the Report.

To the maximum extent permitted by law GHD expressly disclaims responsibility for or liability arising from:

- *any error in, or omission in connection with assumptions, or*
- *reliance on the Report by a third party, or use of this Report other than for the Purpose.*

Contents

Table Index

Figure Index

Appendices

Page intentionally left blank

Abbreviations and Glossary

Project Specific Terminology	
Abbreviation	**Term**
the EIS	Carmichael Coal Mine and Rail Project Environmental Impact Statement- refers to the particular document that GHD is preparing to facilitate approval of the Project
the Proponent	Adani Mining Pty Ltd
the Project	Carmichael Coal Mine and Rail Project
the Project (Mine)	Carmichael Coal Mine and Rail Project: Mine Component
the Project (Rail)	Carmichael Coal Mine and Rail Project: Rail Component
Generic Terminology	
Abbreviation	**Term**
100K	1:100,000 scale (in relation to geological mapping)
ANRA	Australian Natural Resource Atlas
ANZECC	Australian and New Zealand Environment and Conservation Council
bgl	Below ground level
BoM	Bureau of Meteorology
CEMP	Construction and Environmental Management Plan
DEHP	Department of Environment and Heritage Protection
DERM	Former Department of Environment and Resource Management
DEWHA	Former Department of Environment, Water, Heritage and the Arts
DNRM	Department of Natural Resources and Mines
EC	Electrical conductivity (in relation to water quality)
GAB	Great Artesian Basin
GMA	Groundwater management area
GMU	Groundwater management unit
GSQ	Geological Society Queensland
L/sec	Litres per second
ML/yr	Mega litre per year
µS/cm	Micro Siemens per centimetre (measure of electrical conductivity in water)

Project Specific Terminology	
QWQG	Queensland Water Quality Guidelines 2009
RN	Registration number (in relation to DERM registered bores)
ROP	Resource operations plan
SWL	Standing water level
TDS	Total dissolved solids (in relation to water quality)
UA	Unincorporated area
WRP	Water resource plan

Executive Summary

Adani is proposing to develop a 60 million tonne (product) per annum (Mtpa) thermal coal mine in the north Galilee Basin approximately 160 kilometres (km) north-west of the town of Clermont, Central Queensland. All coal will be railed via a privately owned rail line connecting to the existing QR National rail infrastructure, and shipped through coal terminal facilities at the Port of Abbot Point and the Port of Hay Point (Dudgeon Point expansion). The Carmichael Coal Mine and Rail Project (the Project) will have an operating life of approximately 90 years.

The Project comprises of two major components:

- The Project (Mine): a greenfield coal mine over EPC1690 and the eastern portion of EPC1080, which includes both open cut and underground mining, on mine infrastructure and associated mine processing facilities (the Mine) and the Mine (offsite) infrastructure including:
  - A workers accommodation village and associated facilities
  - A permanent airport site
  - Water supply infrastructure
- The Project (Rail): a greenfield rail line connecting the Mine to the existing Goonyella and Newlands rail systems to provide for the export of coal via the Port of Hay Point (Dudgeon Point expansion) and the Port of Abbot Point, respectively; including:
  - Rail (west): a 120 km dual gauge portion from the Mine site running west to east to Diamond Creek
  - Rail (east): a 69 km narrow gauge portion running east from Diamond Creek connecting to the Goonyella rail system south of Moranbah

The Project has been declared a 'significant project' under the *State Development and Public Works Organisation Act 1971* (SDPWO Act) and as such, an Environmental Impact Statement (EIS) is required for the Project. The Project is also a 'controlled action' and requires assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Project EIS has been developed with the objective of avoiding or mitigating all potential adverse impacts to environmental, social and economic values and enhancing positive impacts. Detailed descriptions of the Project are provided in Volume 2 Section 2 Project Description (Mine) and Volume 3 Section 2 Project Description (Rail).

This report has been prepared for the purpose of providing information on the potential impacts of the Project (Rail) on hydrogeology within a 10 km buffer of the Project (Rail) and mitigation measures to address such impacts. Requirements listed within Section 3.4 of the Terms of Reference for the Project EIS have been provided as part of this report. Potential impacts on groundwater resources (hydrogeology) due to the construction and operation of the Project (Rail) have been assessed through a desktop study of publically available data. For an assessment of the impact of the Project (Mine) on hydrogeology refer to Volume 4 Appendix R Mine Hydrogeology Report.

In order to establish the existing environment of the Project Area this report accounts for key elements such as Groundwater Management Units defined in the *2000-2002 National Land and Water Resource Audit*, geological units, standing water levels, yields and water quality, groundwater

flow direction and interaction with surface water, existing bores and groundwater users, and other sensitive receptors such as spring complexes and groundwater dependent ecosystems.

The potential impacts of the Project (Rail) on these key elements were assessed against relevant legislation and plans, including the *Water Resources (Burdekin Basin) Plan, 2007 Water Resources (Fitzroy Basin) Plan, 2011* and associated Resource Operations Plans. Aspects of the Project (Rail) with potential impact to hydrogeology were primarily civil works, blasting, and the construction of tracks, quarries, borrow areas, watercourse crossings and construction camps. The potential impacts of the Project (Rail) identified through this assessment can be summarised as follows.

- Degradation of groundwater by introduction of drilling muds, chemicals or machinery fluids
- Intersection of groundwater during excavation of borrow areas or other earthworks
- Reduced groundwater levels due to water demand during construction and operation
- Increased aquifer permeability due to fracturing from blasting
- Localised increases in groundwater levels (i.e. water logging) as a result of pre-loading or construction of embankments

Potential impacts identified in this report will be mitigated/managed as follows.

- Potential contaminants will be stored and handled in a controlled manner to prevent impacts to creeks, rivers, bores or groundwater dependent ecosystems
- Shallow aquifers will be avoided during excavation activities
- Environmentally neutral or biodegradable fluids will be used during boring
- Plant will be maintained to reduce the risk of breakdown or chemical leakage
- Pylon structures, culverts and filling activities are designed and will be constructed to minimise the loading and compaction of alluvial sediments

If blasting of rock is required for construction of the Project (Rail) (or for quarrying activities), a census (physically finding and detailing bore properties) of all existing groundwater bores and spring complexes within a one km radius will be undertaken. A search of the Queensland Groundwater Database (DERM, 2010), the Department of Natural Resources and Mines (DNRM) Water Entitlement Registration Database, enquiries with the local council and liaison with local landholders will inform the census. Any bores and springs that are located will be monitored pre and post blasting to assess any actual impacts and determine any mitigation measures that may be needed, including capture of excess water and make-good reparations.

Water supply options are currently being investigated. The main purpose of the study is to identify suitable water supply sources to accommodate the water supply for construction purposes whilst minimising impacts on stakeholders and the environment. If the need to undertake extended dewatering is identified during detailed design and major drawdown of the alluvial aquifer is expected, a groundwater management plan may be required. The management plan will include objectives and targets to be met and detail monitoring requirements.

No significant impacts on groundwater resources and groundwater quality are expected given:

- No long-term lowering of groundwater levels due to construction dewatering activities is anticipated
- The majority of the Project (Rail) area does not contain well developed or extensive alluvial aquifers. Groundwater in the area is therefore not considered threatened or vulnerable as a resource
- Outside of the main river corridors groundwater and surface water connectivity is thought to be limited
- Only a small number of shallow cuttings are included in the preliminary rail design and hence no significant permanent lowering of groundwater levels due to drainage of cutting areas is anticipated
- River crossing points will be designed such that compaction of alluvial sediments and upstream ponding of surface water flow is minimised.

Page intentionally left blank

1. Introduction

1.1 Project Overview

Adani Mining Pty Ltd (Adani) is proposing to develop a 60 million tonne (product) per annum (Mtpa) thermal coal mine in the north Galilee Basin approximately 160 kilometres (km) north-west of the town of Clermont, Central Queensland. All coal will be railed via a privately owned rail line connecting to the existing QR National rail infrastructure, and shipped through coal terminal facilities at the Port of Abbot Point and the Port of Hay Point (Dudgeon Point expansion). The Carmichael Coal Mine and Rail Project (the Project) will have an operating life of approximately 90 years.

The Project comprises of two major components:

- The Project (Mine): a greenfield coal mine over EPC1690 and the eastern portion of EPC1080, which includes both open cut and underground mining, on mine infrastructure and associated mine processing facilities (the Mine) and the Mine (offsite) infrastructure including:
  - A workers accommodation village and associated facilities
  - A permanent airport site
  - Water supply infrastructure
- The Project (Rail): a greenfield rail line connecting the Mine to the existing Goonyella and Newlands rail systems to provide for the export of coal via the Port of Hay Point (Dudgeon Point expansion) and the Port of Abbot Point, respectively; including:
  - Rail (west): a 120 km dual gauge portion from the Mine site running west to east to Diamond Creek
  - Rail (east): a 69 km narrow gauge portion running east from Diamond Creek connecting to the Goonyella rail system south of Moranbah

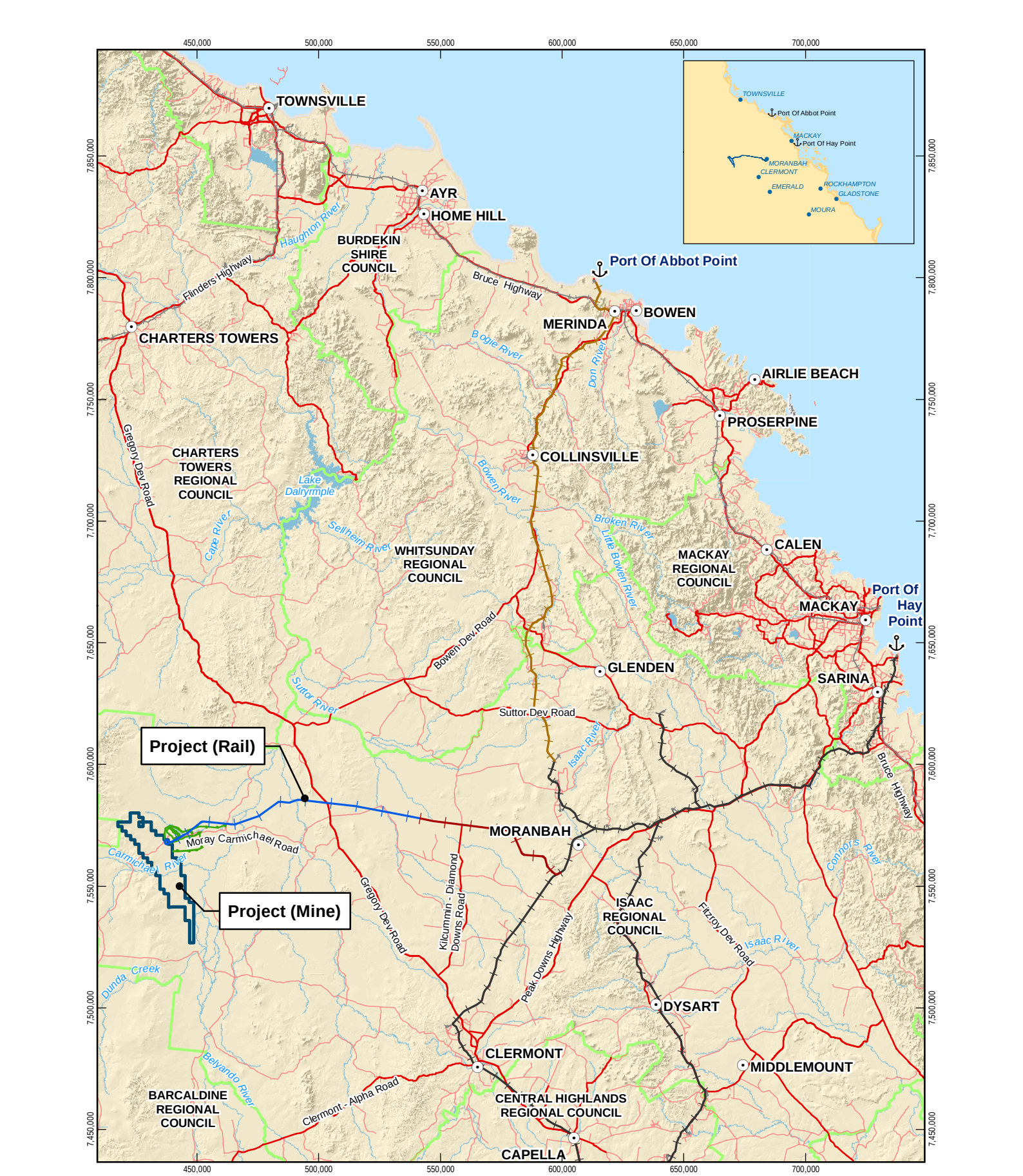
The Project has been declared a 'significant project' under the *State Development and Public Works Organisation Act 1971* (SDPWO Act) and as such, an Environmental Impact Statement (EIS) is required for the Project. The Project is also a 'controlled action' and requires assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Project EIS has been developed with the objective of avoiding or mitigating all potential adverse impacts to environmental, social and economic values and enhancing positive impacts. Detailed descriptions of the Project are provided in Volume 2 Section 2 Project Description (Mine) and Volume 3 Section 2 Project Description (Rail). Figure 1-1 shows the Project location.

1.2 Scope of Reporting

Potential impacts on groundwater resources (hydrogeology) due to the construction and operation of the Project (Rail) have been assessed through a desktop study of publically available data. The objectives of the desktop study were to describe the existing hydrogeological environment, and to determine what impacts the Project (Rail) may have on groundwater resources, including the identification of appropriate management and mitigation measures.

A summary of compliance with the terms of reference of the Project EIS is provided in Table 1-1. Full details are provided in Appendix A.



LEGEND

- Town
- Major Port
- Other Rail Network
- Goonyella System
- Newlands System
- State Road
- Local Road
- Watercourse
- Local Government Area
- Project (Rail)
- Rail (West)
- Rail (East)
- Project (Mine)
- Mine (Offsite)

1:2,000,000 (at A4)

0 10 20 30 40 50

Kilometres

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

N

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

Job Number 41-25215
Revision L
Date 28-08-2012

Project Location

Figure: 1-1

G:\41\25215\GIS\Maps\MXD\100_Planning\41-25215_117_rev_l.mxd

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: © Commonwealth of Australia (Geoscience Australia): Town, Railways, Watercourses (2007); DERM: LGA, (2011), Hillshade (2009); DMR: State Roads (2008); Gassman/Hyder: Mine (Offsite) (2012); DME: EPC1690 (2010), EPC1080 (2011); Adani: Alignment Opt9 Rev3 (2012). Created by: BW, JVC

Table 1-1 Terms of Reference Cross Reference

Terms of Reference Requirement/Section Number	Section of this report
Section 3.4 Water Resources	
Section 3.4.1 Description of environmental values	
Describe the existing water resources that may be affected by the project in the context of environmental values as defined in such documents as the EP Act, Environmental Protection (Water) Policy 2009 (EPP (Water)), Australia and New Zealand Guidelines for Fresh and Marine Water Quality and the Queensland Water Quality Guidelines.	Section 1.4 Figure 1-3
Describe present and potential users and uses of water in areas potentially affected by the project, including municipal, agricultural, industrial and recreational uses of water, and reference to any licences held by users. Describe the environmental values of the surface waterways of the affected area in terms of existing and other potential surface and groundwater users	Section 2.2 Figure 2-1
Provide a detailed description of the quality and quantity of surface and groundwater resources in the area potentially affected by the project.	Sections 2.3 and 1.4.1
Describe existing groundwater in terms of physical, chemical and biological characteristics. Describe the groundwater quality considering seasonal variations in depth and flow and all times of natural flow in ephemeral streams. Parameters should include a broad range of water quality indicators.	Sections 2.3 and 1.4.1
Investigate the relationship between groundwater and surface water to assess the nature of any interaction between the two resources and any implications of the proposed mine that would affect the interaction.	Sections 2.5 and 2.6
Describe the environmental values of the surface waterways and groundwater	Sections 1.4.3, 2.3 and 2.3
◗ Aquifer type—such as confined and unconfined ◗ Depth to and thickness of the aquifers	Section 2.3
If the project is likely to use or affect local sources of groundwater, describe the groundwater resources in the area.	Sections 1.4, 2.2 and 2.3
Section 3.4.2 – Potential Impacts and Mitigation Measures	
Address and describe the following matters, including provision of maps: ◗ potential impacts on the flow and the quality of surface and groundwater from all phases of the ◗ Measures to prevent, mitigate and remediate any impacts on existing users or groundwater-dependent ecosystems ◗ How extracted groundwater will be managed in the surface water management system to minimise the likelihood of discharging highly saline water ◗ All likely impacts on groundwater depletion or recharge regimes	Section 3 Volume 2 Section 6

Terms of Reference Requirement/Section Number	Section of this report
Section 3.4 Water Resources	
Address and describe the following matters, including provision of maps: ◗ The potential environmental impact caused by the project (and its associated project components) to local groundwater resources, including the potential for groundwater-induced salinity. ◗ The project's impact on the local groundwater regime caused by the altered porosity and permeability of any land disturbance ◗ The potential to contaminate surface and groundwater resources and measures to prevent, mitigate and remediate such contamination.	Section 3.2
Assess any potential surface water and groundwater interaction as a result of subsidence of a watercourse. Also assess the potential impacts on the groundwater regime in alluvial and deeper aquifers due to altered porosity, permeability and interconnectivity from any land disturbance, including subsidence.	Section 2.5
The EIS should outline all of the approvals required under the Water Act 2000, Water Regulation 2002	Section 1.4

1.3 Approach and Methodology

The spatial extent of the Project (Rail) is depicted in Figure 1-1. The groundwater assessment area is defined by a 10 km radius buffer placed around the proposed Project (Rail). To define the groundwater environmental values for the Project (Rail) a desktop assessment was undertaken. A number of information sources in the public domain were identified and relevant data was collated and reviewed. Data sources included:

- Department of Environment and Resource Management (DERM) Queensland Groundwater Database, December 2010:
  - A 10 km radius buffer from the Project (Rail) was applied to the Queensland Groundwater Database (DERM, 2010) dataset. Records were extracted from the database and have been summarised for inclusion at Appendix B.
- Geological Society of Queensland (GSQ) digital geology mapping, 2007
- Bureau of Meteorology rainfall data (stations 36071 and 34015, accessed 9 June 2011)
- Australian Natural Resource Atlas (DSEWPaC, 2009) interactive website, 2009
- Burdekin Basin Resource Operations Plan, explanatory notes, 2009
- Queensland Government, *Water Resources (Burdekin Basin) Plan, 2007*
- Fitzroy Basin Resource Operations Plan, 2011
- Queensland Government, *Water Resources (Fitzroy Basin) Plan, 2011*
- Hancock Prospecting Pty Ltd, Alpha Coal Project Environmental Impact Statement Volume 3, Railway Corridor, 2010

- Waratah Coal, Galilee Coal Project Environmental Impact Statement Volume 3 – Rail, August 2011
- Environmental Protection (Water) Policy 2009 Isaac River Sub-basin Environmental Values and Water Quality Objectives

The collated data were used to:

- Develop a description of baseline hydrogeological conditions within the Project (Rail) area buffer (Section 2)
- Identify potential impacts, mitigation measures and monitoring (where appropriate) (Section 3)

For the purposes of analysing large groundwater and geology datasets, the Project (Rail) has been divided into three sections described in Table 1-2 and shown in Figure 2-1.

This division is primarily based on the geological / hydrogeological characteristics of the different areas and on availability of groundwater data.

Table 1-2 Project (Rail) Groundwater Assessment Sections

Section	Location Name	Geological Setting	Number of Registered Bores (10 km radius)
1	Project (Mine) to Mistake Creek	Floodplain alluvium and Tertiary sediments overlying Permian sedimentary bedrock	24
2	Mistake Creek to Diamond Creek	Outcropping units of metamorphic, igneous and sedimentary bedrock with overlying colluvial and alluvial deposits in low-lying areas	10
3	Diamond Creek to the Goonyella rail system tie in	Alluvium to the west and outcropping Tertiary / Permian sedimentary units to the east	9

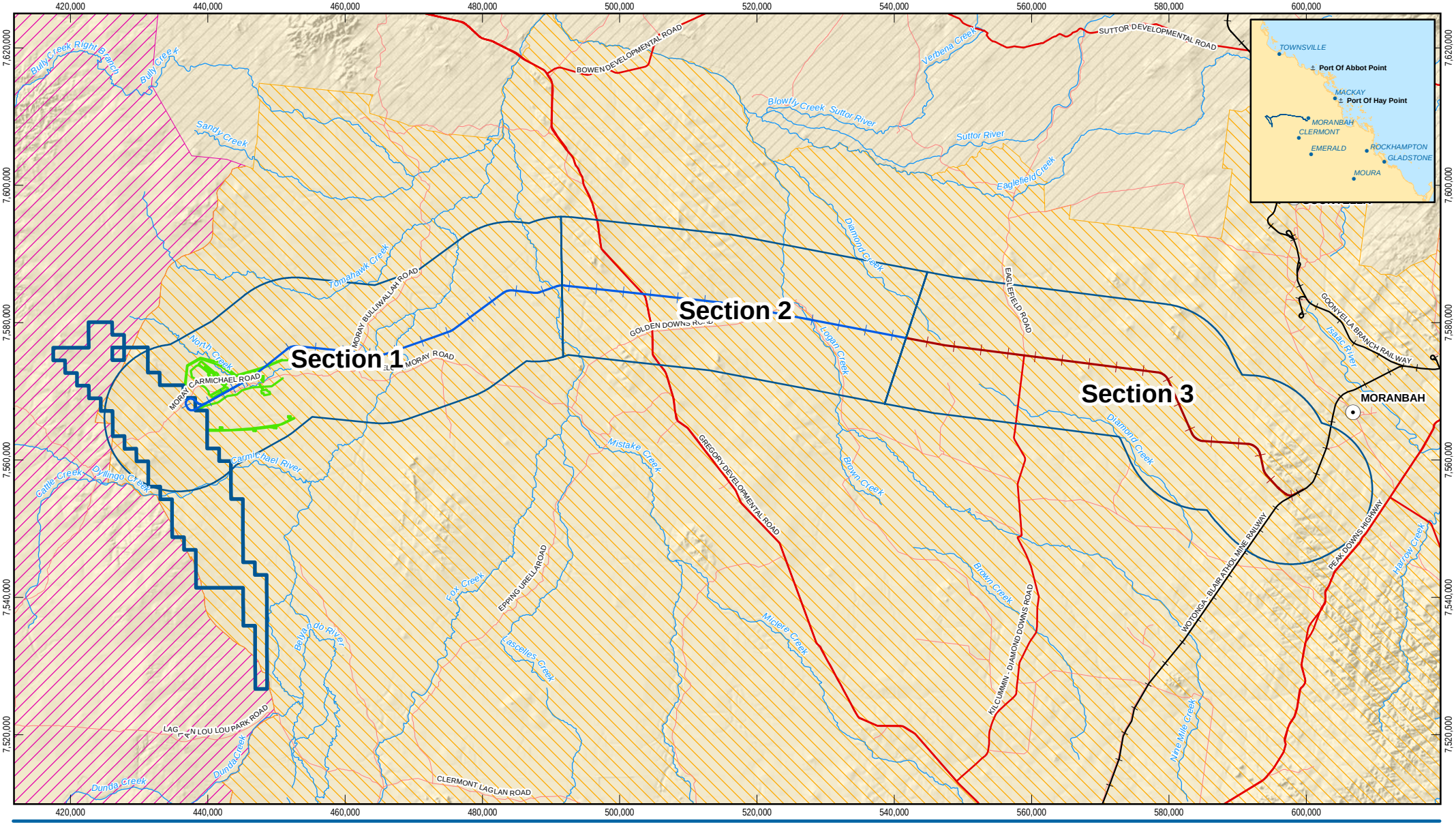
1.4 Legislative Framework

1.4.1 Water Act 2000

In Queensland the *Water Act 2000* (Water Act) is enacted through the *Water Regulation 2002* (Water Regulation), which provides for a range of matters required by the Water Act (e.g. declaring catchment areas and administration of water allocations etc.). The Water Regulation further provides a framework under which catchment-based water resource plans (WRPs) are developed in Queensland. The WRPs are then activated through resource operation plans. A WRP provides a framework for sustainable management of water resources in the plan area, including the establishment of Groundwater Management Areas (GMA), or regulated groundwater areas.

In Queensland, regulated groundwater areas, otherwise known as declared sub-artesian areas, have been established to protect groundwater resources. Water resources within these regulated groundwater areas are subject to management requirements activated through either a WRP, a Local Water Management Policy or as defined by Schedule 11 of the Water Regulation. In regulated groundwater areas a water licence or development permit is required to take or interfere with groundwater. The requirements for taking of groundwater for certain purposes are defined under a WRP, Local Water Management Policy or by the Water Regulation.

An authorisation to take sub-artesian water is only required in (1) a declared sub-artesian area as defined under Schedule 11 of the Water Regulation; or (2) a GMA established under a WRP.



1:750,000 (at A4)

0 5 10 15 20

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)
- Study Corridor

Declared Sub-Artesian Areas

- Great Artesian Basin
- Highlands
- Non Artesian Area

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Regional Hydrogeology
Groundwater Management Areas

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

Figure: 1-2

G:\41\25215\GIS\Maps\MXD\300_Hydrogeology\41-25215_327_rev_c.mxd 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),Declared Sub-Artesian Areas (2009); DME: EPC1690 (2011), EPC1080 (2010); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads, Watercourses (2007); Adani: Alignment Opt9 Rev3 (2012); GHD: Study Corridor (2012), Gassman/Hyder: Mine (Offsite) (2012). Created by: AJ, CA

The Project (Rail) falls mostly within the Burdekin Basin Catchment, where there is an existing WRP and Resource Operations Plan, namely the Water Resource (Burdekin Basin) Plan 2007 and Burdekin Basin Resource Operations Plan 2010, respectively. The WRP for the Burdekin Basin Catchment does not have management requirements for groundwater. A small portion at the eastern end of the Project (Rail) falls within the Isaac-Connors Catchment (which forms part of the Fitzroy River catchment), and is subject to the Water Resource (Fitzroy Basin) Plan 2011. This plan outlines the objectives for groundwater in the Fitzroy Basin and defines the GMAs. The Fitzroy Basin Resource Operations Plan 2011 does not have management requirements for groundwater. The whole of the Project (Rail) also falls entirely within the Highlands Sub-artesian Area (see Figure 1-2), a declared GMA under the Water Regulation. According to Schedule 11 of the Water Regulation, all bores within the Highlands Sub-artesian Area require a licence for abstraction; with the exception of bores utilising groundwater for stock or domestic purposes.

There are no current water resource moratorium notices for the Project (Rail) area.

The Project (Rail) lies outside of and is not expected to impact upon the Great Artesian Basin.

1.4.2 Queensland Environmental Protection Act 1994

The aim of the *Environmental Protection Act 1994* (the EP Act) is to protect Queensland's environment while allowing for development that improves the quality of life as well as maintaining the ecological processes on which it depends.

The EP Act also imposes a general environmental duty on all persons (including corporations) such that they must not conduct any activity that causes, or is likely to cause, environmental harm, unless they take all reasonable and practicable measures to prevent or minimise the harm.

The EP Act permits the Department of Environment and Heritage Protection to prepare Environmental Protection Policies. Environmental Protection Policies are subordinate legislation which contain detailed requirements for protecting a part of the environment or controlling a type of activity.

1.4.3 Queensland Environmental Protection (Water) Policy 2009

The *Environmental Protection (Water) Policy 2009* seeks to achieve the object of the EP Act in relation to protecting Queensland's waters while allowing for ecologically sustainable development. The *Environmental Protection (Water) Policy 2009* schedules areas where Environmental Values and Water Quality Objectives for waters are defined. The process of identifying Environmental Values to determine Water Quality Objectives and water quality guidelines are based on the National Water Quality Management Strategy (DSEWPaC, 2000) and are further outlined in the Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000) . The first 40 km of the rail line is located within Grosvenor Creek sub-catchment of the Isaac River, which is a tributary of the Fitzroy River. This area is covered by the Environmental Protection (Water) Policy 2009 Isaac River Sub-basin Environmental Values and Water Quality Objectives. Currently the scheduling for the Burdekin Basin is proposed by December 2013, therefore the majority of the Project (Rail) does not have assigned Environmental Values or Water Quality Objectives for waters

Groundwater quality in Queensland is assessed through the *Queensland Water Quality Guidelines 2009*. The guidelines are consistent with and are an extension of the National Water Quality

Management Strategy (DSEWPaC, 2000) and the Australian and New Zealand Environment and Conservation Council Guidelines for Fresh and Marine Water Quality (ANZECC, 2000.

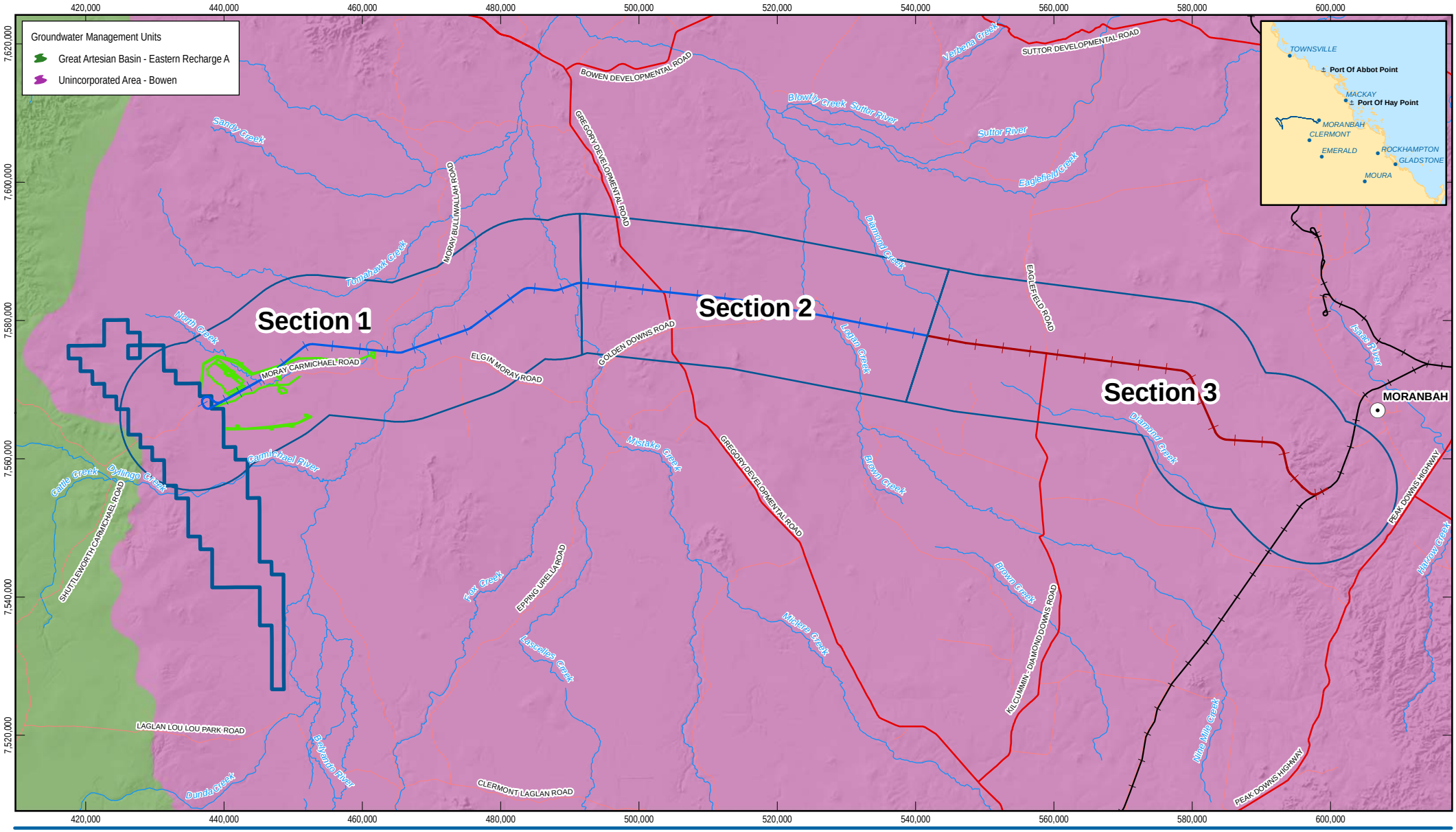
1.4.4 National Land and Water Resource Audit 2000-2002

Groundwater management units (GMUs) have been identified for the whole of Australia as part of the Australian Water Resources Assessment 2000 (DSEWPaC, 2009). The assessment forms part of the *2000-2002 National Land and Water Resource Audit* (the Audit).

GMUs used in the Audit are loosely based on surface water catchment areas or significant groundwater aquifers (e.g. Great Artesian Basin) (see Figure 1-3). The Audit determined broad scale groundwater resource conditions within each unit to give an overall estimate of quantity and sustainable yields.

The Audit determined that there are certain GMUs that rely extensively on groundwater for water supply and have comprehensive data from monitoring the resource. Other areas, referred to as Unincorporated Areas (UAs), had limited data to be able to inform groundwater conditions within that GMU. Groundwater resources and exploitation of the resource within UAs is typically not well developed (DSEWPaC, 2009).

GMUs defined in the Audit are separate to GMAs, which are defined by the Water Regulation. GMAs have specific legislative requirements in regards to interference with or take of groundwater. GMAs are discussed in Section 1.4 of this Report.



1:750,000 (at A4)

0 5 10 15 20

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)
- Study Corridor

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

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

Groundwater Management Units

Figure: 1-3

G:\41\25215\GIS\Maps\MXD\300_Hydrogeology\41-25215_322_rev_c.mxd 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) Groundwater Management Units, Declared Sub-Artesian Areas (2009); DME: EPC1690 (2011), EPC1080 (2010); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads, Watercourses (2007); Adani: Alignment Opt9 Rev3 (SP1&2) (2012); Gassman/Hyder: Mine (Offsite) (2012); GHD: Study Corridor (2012). Created by: AJ, CA

2. Description of Environmental Values

2.1 Introduction

A detailed description of soils and geology within the Project (Rail) area are presented in Volume 3 Section 4. The following groundwater resource section provides a description of the current groundwater resource environmental values, as they relate to the proposed Project (Rail).

2.2 Existing Groundwater Resources

2.2.1 Bowen Unincorporated Area Groundwater Resources

The proposed Project (Rail) traverses the Bowen UA, which is bound to the west by the Great Artesian Basin GMU and the Isaac River GMU to the north-west (see Figure 1-3).

The Bowen UA consists of several groundwater resources that are being utilised to much less than their full potential (DSEWPaC, 2009). The major aquifers within the Bowen UA are Quaternary-aged alluvium, the sand and gravel horizons of the Tertiary-aged sediments and the Tertiary-aged basalts. The achievable bore yields are generally below 5 L/sec and consequently most groundwater development would be limited to stock and domestic supplies.

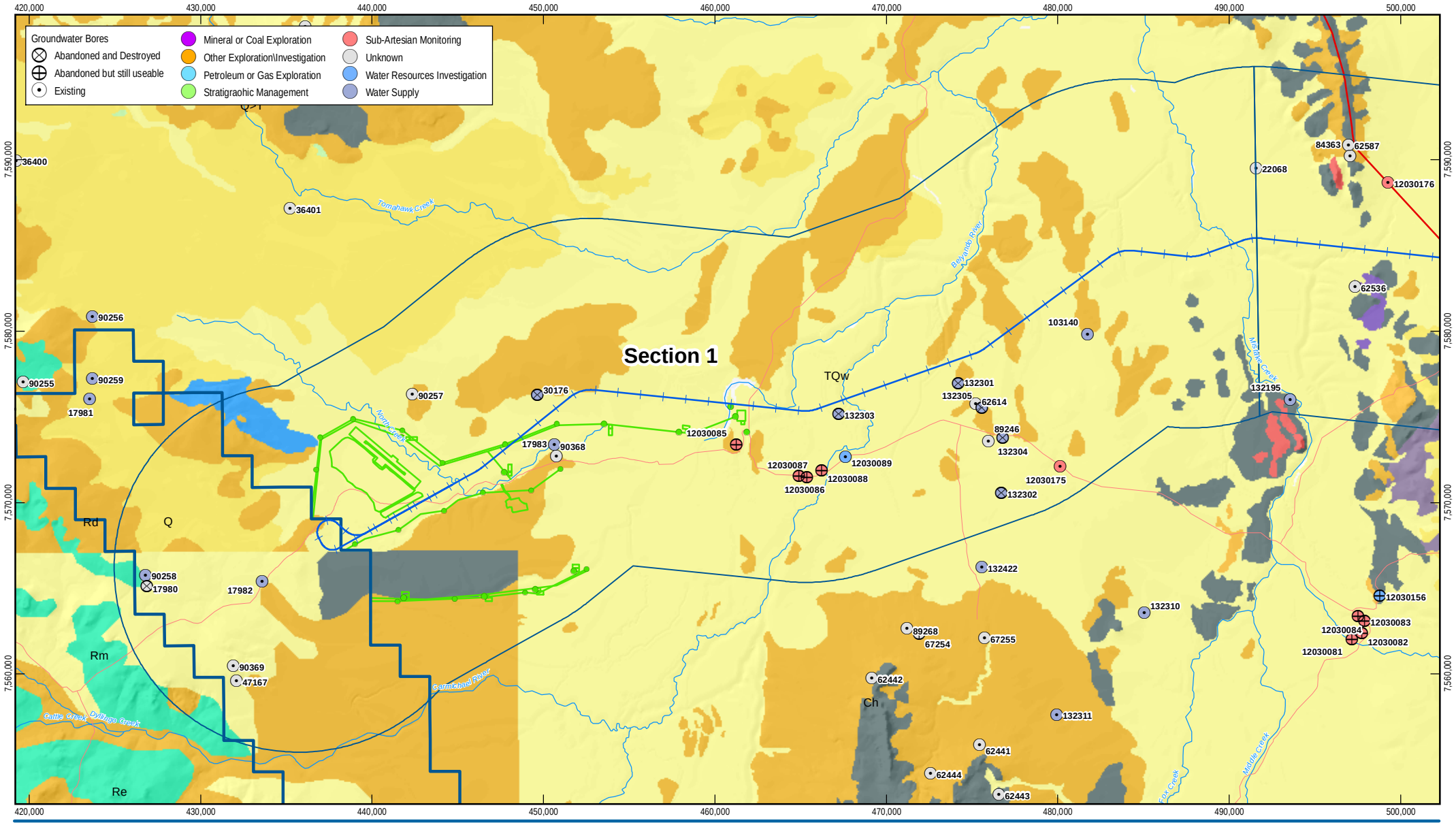
The extent of groundwater resources within the Bowen UA is not well studied and limited information within the Project (Rail) area is available. A sustainable yield has not been assessed for the entire Bowen UA, however, preliminary estimates of the sustainable yield were calculated for the Bowen UA sub-catchments of Mackenzie, Nogoa, Comet and Isaac resulting in a total for all sub-catchments of 260,000 ML/yr, which was applied to the entire UA (DSEWPaC, 2009).

Groundwater abstraction at the time of the Audit was well under the calculated total sustainable yield. Predicted abstraction rates within the Bowen UA for 2020 and 2050 of 15,000 ML/yr and 20,000 ML/yr, respectively, remain well below the sustainable yield of 260,000 ML/yr (DSEWPaC, 2009). Groundwater abstraction for stock and domestic use are generally not recorded, however the amount of groundwater take is considered to be low overall. The Audit determined that major abstractions are for agricultural and mining activities.

The Bowen UA is not considered a major priority and therefore does not require active management in the form of a resource plan (DSEWPaC, 2009). The groundwater resources in the Bowen UA are not heavily exploited. Subsequently, it was concluded that the resource is under no immediate threat that would require management plans for groundwater protection (DSEWPaC, 2009). While currently underexploited, demand for groundwater is increasing with the expansion of the coal mining industry within the Bowen and Galilee Basin.

2.2.2 Current and Potential Users

A total of 43 registered bores occur within a 10 km radius buffer of the Project (Rail). The location of all registered bores is shown in Figure 2-1. The reported facility roles (or bore type) are detailed in Table 2-1.



1:300,000 (at A4)

0 2 4 6 8 10

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
- Rail (West)
- Rail (East)
- Study Corridor
- Mine (Onsite)
- Mine (Offsite)
- Mine (Offsite)

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

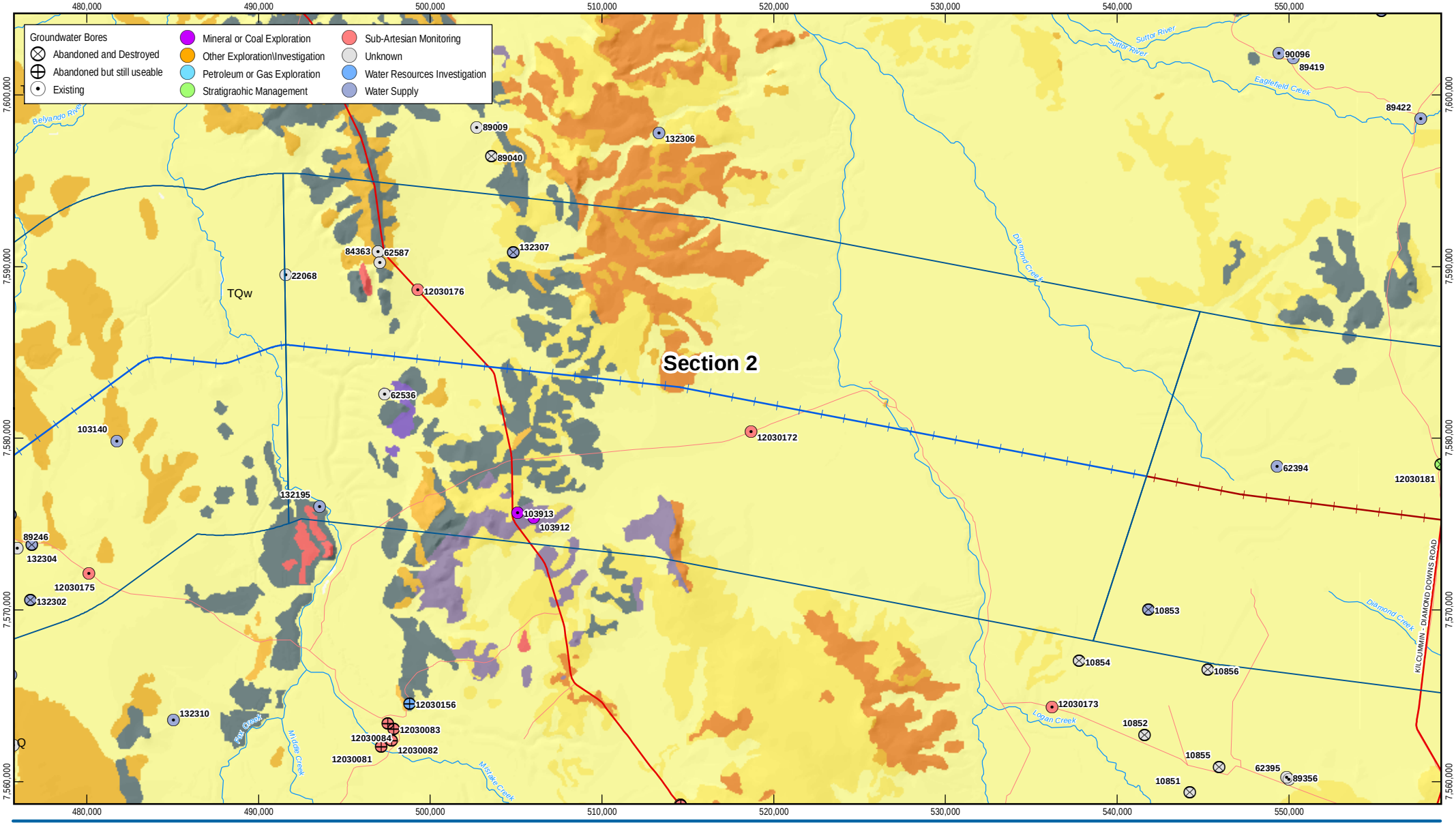
Registered Groundwater Bores

Job Number 41-25215
Revision C
Date 05-09-2012

Figure: 2-1
Sheet 1 of 4

G:\41\25215\GIS\Maps\MXD\300_Hydrogeology\41-25215_321_rev_c.mxd 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: Groundwater Bores (2010); DME: EPC1690 (2011), EPC1080 (2010); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads (2007), 100k Geology (2007), 250k Geology (2008); Adani: Alignment Opt9 Rev3 (SP1&2) (2012); Gassman/Hyder: Mine (Offsite); GHD: Study Corridor (2012). Created by: AJ, CA



1:300,000 (at A4)
0 2 4 6 8 10
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
Rail (West)
Rail (East)
Study Corridor
Mine (Onsite)
Mine (Offsite)
Mine (Offsite)

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

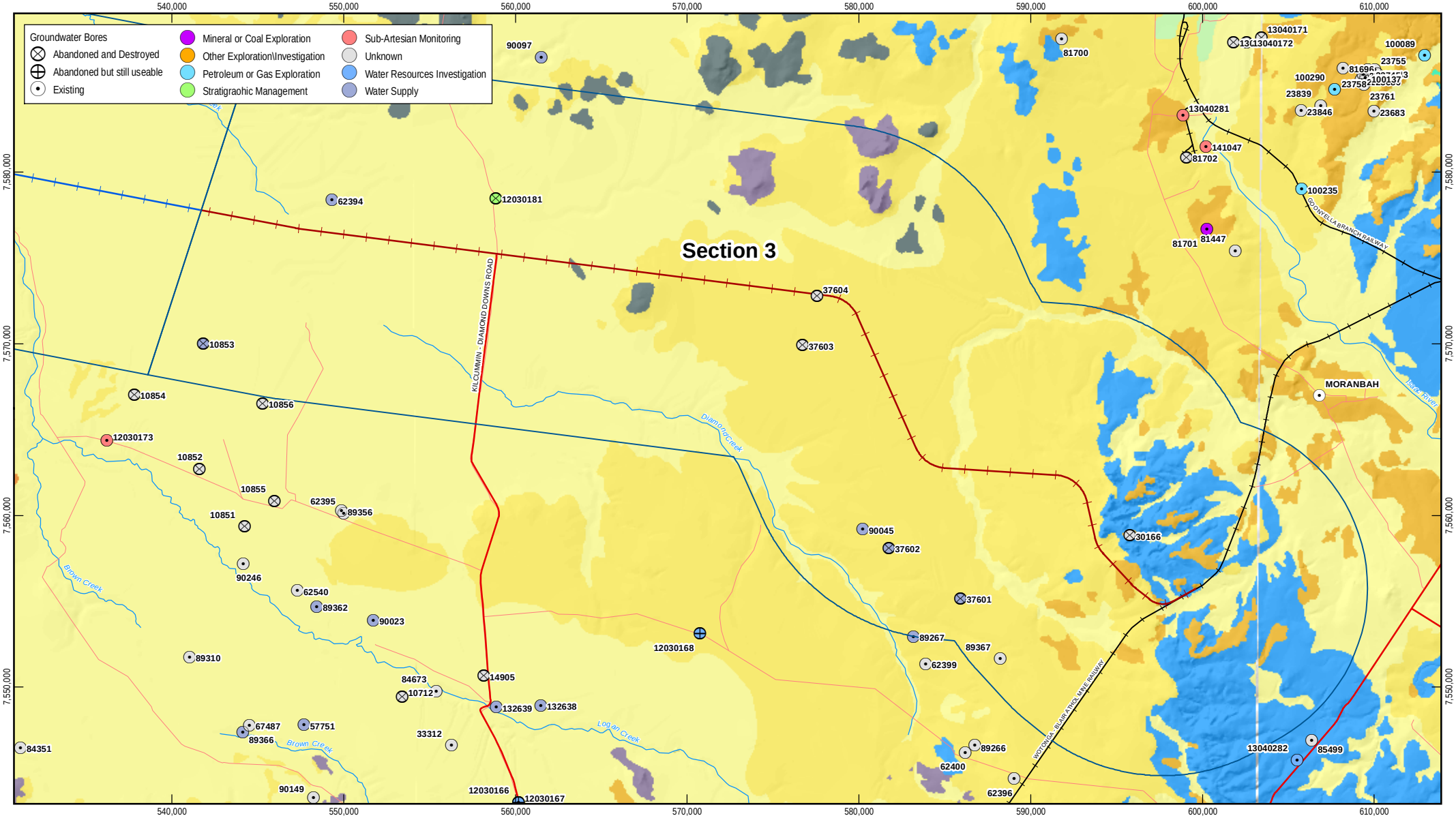
Registered Groundwater Bores

Job Number 41-25215
Revision C
Date 05-09-2012

Figure: 2-1
Sheet 2 of 4

G:\41\25215\GIS\Maps\MXD\300_Hydrogeology\41-25215_321_rev_c.mxd 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: Groundwater Bores (2010); DME: EPC1690 (2011), EPC1080 (2010); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads (2007), 100k Geology (2007), 250k Geology (2008); Adani: Alignment Opt9 Rev3 (SP1&2) (2012); Gassman/Hyder: Mine (Offsite); GHD: Study Corridor (2012). Created by: AJ, CA



1:300,000 (at A4)

0 2 4 6 8 10

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
- Rail (West)
- Rail (East)
- Study Corridor
- Mine (Onsite)
- Mine (Offsite)
- Mine (Offsite)

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

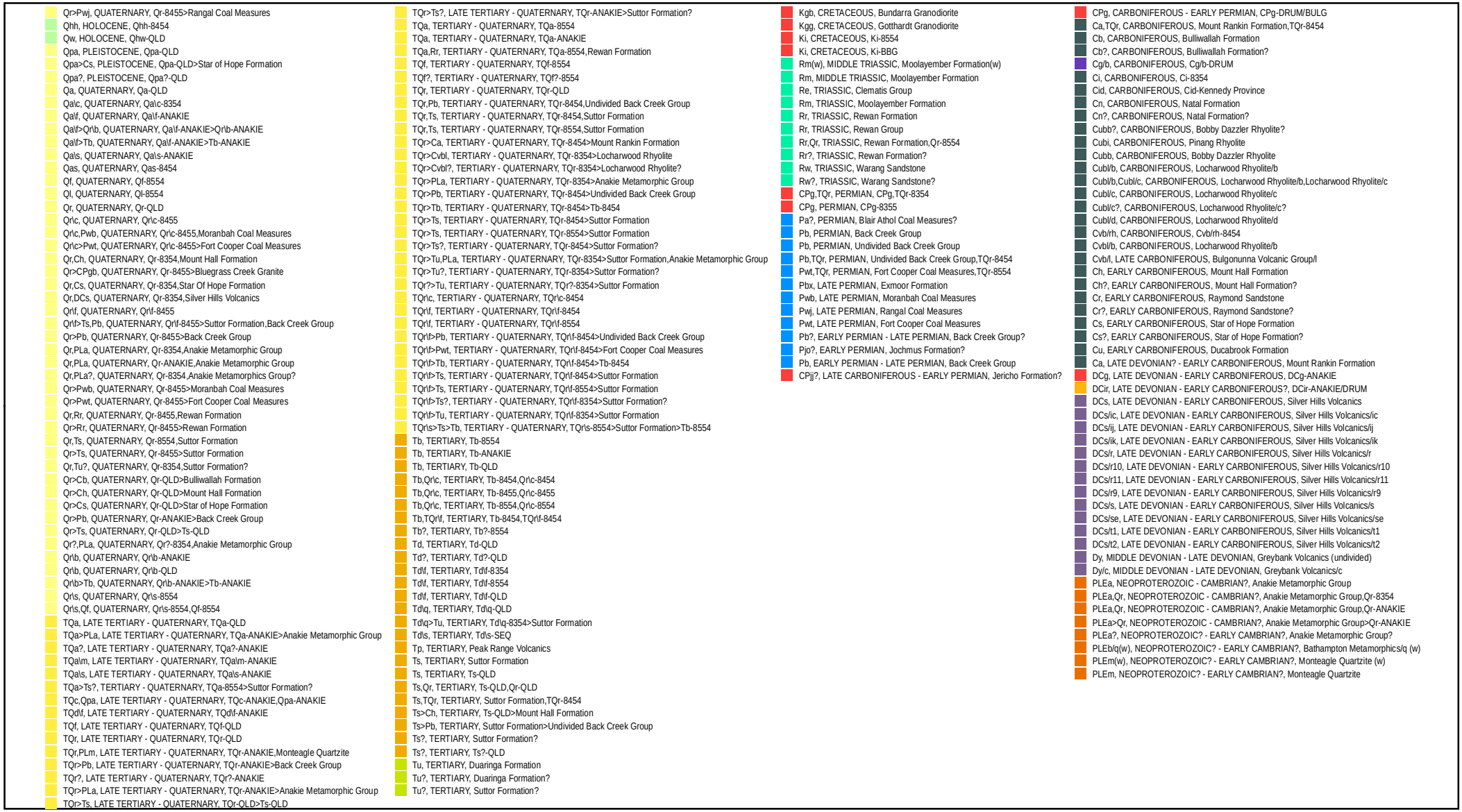
Registered Groundwater Bores

Job Number	41-25215
Revision	C
Date	05-09-2012

Figure: 2-1
Sheet 3 of 4

G:\41\25215\GIS\Maps\MXD\300_Hydrogeology\41-25215_321_rev_c.mxd 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: Groundwater Bores (2010); DME: EPC1690 (2011), EPC1080 (2010); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads (2007), 100k Geology (2007), 250k Geology (2008); Adani: Alignment Opt9 Rev3 (SP1&2) (2012); Gassman/Hyder: Mine (Offsite); GHD: Study Corridor (2012). Created by: AJ, CA



1:250,000 (at A4)

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

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

Registered Groundwater Bores

Job Number	41-25215
Revision	B
Date	04-09-2012

Figure: 2-1
Sheet 4 of 4

G:\41\25215\GIS\Maps\MXD\300_Hydrogeology\41-25215_326_rev_b.mxd 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: 250k Geology (2008); © Commonwealth of Australia (Geoscience Australia). Created by: A.J.

Table 2-1 Registered Bores and Facility Roles

Facility Role / Type	Existing	Abandoned (useable)	Abandoned and destroyed	Total
Unknown	11	-	4	15
Water supply	7	-	10	17
Stratigraphic investigation	-	-	1	1
Mineral or coal exploration	2	-	-	2
Sub-artesian monitoring	3	1	-	4
Groundwater investigation & sub-artesian monitoring	1	3	-	4
TOTAL	**24**	**4**	**15**	**43**

Abandoned bores total 19, of which 15 are no longer useable (and reported as abandoned and destroyed). The remaining 24 bores are assumed to still 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.

Table 2-2 provides detail on each registered existing water supply bore located within 10 km of the Project (Rail), as discussed below:

- Project (Rail) Section 1 – Four existing water supply bores are situated between 1.7 km and 10 km from the Project (Rail) Section 1. Three of these bores are indicated to penetrate Tertiary-aged sedimentary bedrock. Bore RN 90258 is located 10 km from the proposed Project (Rail) and is screened within a Triassic –aged sedimentary aquifer at a depth of 75.0 to 79.3 m below ground level (bgl).
- Project (Rail) Section 2 – One registered bore (RN 132195) is recorded as an existing water supply facility within 4.6 km of the Project (Rail) Section 2. This bore appears to abstract groundwater from weathered shale within the Star of Hope Formation.
- Project (Rail) Section 3 – Two registered bores (RN 62394 and RN 90045) are located 1.7 km and 9.8 km away from the of the Project (Rail) Section 3. These bores abstract groundwater from the Suttor Formation and from fine sand within the Blenheim Subgroup, respectively.

Table 2-2 Registered Existing Water Supply Bores

Project (Rail) Section	RN	Formation	Yield (L/s)	Distance from Project (Rail) (km)
1	17982	Sediments (interpreted Dunda Beds)	-	1.7
	90258	Undifferentiated (interpreted Dunda Beds)	1.89	10
	90368	Tertiary – Undefined	3.9	1.5
	103140	No lithology details (interpreted Tertiary Sediments)	0.5	2.9
2	132195	Star of Hope Formation	0.75	9.1
3	62394	Suttor Formation	1.0	1.9
	90045	Blenheim Sub Group (Undifferentiated)	0.75	5.6

2.3 Hydrogeological Description

Analysis of the data extracted from the Queensland Groundwater Database (DERM, 2010) and the available 1:100,000 scale geological mapping indicates four distinct geology types present in the vicinity of the Project (Rail) subset of which are as follows:

- Major hydrogeological units:
  - Alluvium, colluvium and miscellaneous sediments (Quaternary to Tertiary)
  - Sedimentary units (Tertiary, Carboniferous and Permian)
- Minor outcropping units within the Project (Rail) area buffer:
  - Igneous units (Tertiary and Carboniferous to Late Devonian)
  - Metamorphic unit (Neoproterozoic to Cambrian)

Quaternary to Tertiary-aged alluvium and colluvium occur within the majority of the Project (Rail) area with some minor miscellaneous sediment. The alluvial sediments are most prevalent, particularly in low-lying areas and have been typically deposited by adjacent rivers and creeks and associated floodplains. The alluvium mostly consists of sand, silt, clay and gravel. Miscellaneous sediments typically occur distal to watercourses consisting of sand, silt, clay and gravel, originating from alluvial, colluvial and residual sources.

The low-lying Quaternary to Tertiary-aged alluvial, colluvial and miscellaneous sediments are typically underlain by Carboniferous-aged sedimentary bedrock units in Project (Rail) Section 1; Carboniferous-aged volcanic and Neoproterozoic to Cambrian aged metamorphic units in Project (Rail) Section 2; and Permian-aged sedimentary bedrock units in Project (Rail) Section 3.

A detailed description of the major geological units and structural features underlying the Project area are presented in Volume 4, Appendix Y Rail Soils Assessment. Hydrogeological characteristics of the major geological units are summarised below.

2.3.1 Project (Rail) Section 1

2.3.1.1 Hydrogeological Units

Shallow Quaternary-aged alluvial hydrogeological units (Qa and Qpa) in Project (Rail) Section 1 are located in the vicinity of major rivers and creeks (refer to Figure 2-1) with depths ranging from 10.1 m bgl (RN 12030086) to 37.7 m bgl (RN 90368). Standing water levels (SWL) for bores within the Belyando River alluvium (total of five bores) have mostly been reported as dry (except for RN 12030085), indicating that alluvial aquifers with significant groundwater resources is not typical of the region.

Aquifers within Section 1 predominately occur in Tertiary-aged arenite and mudrock (Ts) with depth to top of the Tertiary aquifer ranging from 35.6 m bgl (RN 90369) to 60.0 m bgl (RN 89246). SWL for Tertiary-aged sediments is approximately 18.3 m bgl (RN 17983) to 39.6 m bgl (RN 90258).

Deeper bedrock aquifers also occur within Carboniferous-aged sandstone in some locations (possibly of the Mt Hall Formation) at a depth of ranging 39.0 m bgl (RN 12030175). The deeper bedrock aquifer reports SWL ranging from 27 m bgl (RN 90257) to greater than 153 m bgl (RN 132302 and RN 132304, which report as a dry hole).

Groundwater level hydrographs for all bores with recorded water level data in Project (Rail) Section 1 are presented in Figure 2-3, and indicate that the alluvial bore is more responsive with a change in groundwater levels up to 3.7 m between the minimum and maximum. There appears to be no direct relationship with rainfall recharge.

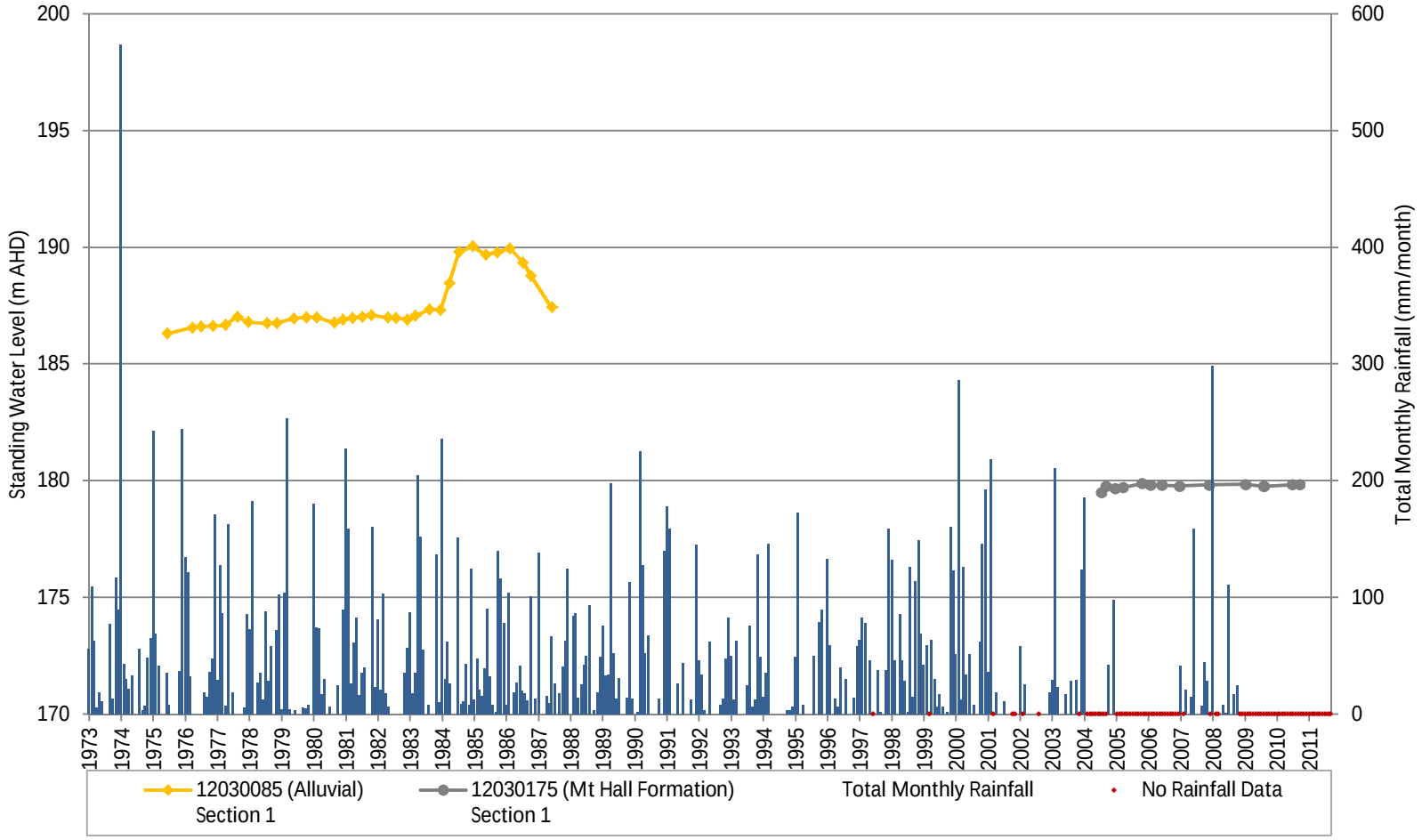
2.3.1.2 Yields and Water Quality

No data is available on yields from the Tertiary aquifer. A yield of up to 11 L/sec was recorded from RN 30176 through possibly the Mt Hall Formation. Data for the alluvial aquifers suggests yields ranging from 0 L/s to 3.9 L/s (RN 90368).

Electrical conductivity (EC) of the groundwater is variable with values ranging from 373 µS/cm (RN 17980) in Tertiary sediments and up to 15,500 µS/cm (RN 12030175) in the Mt Hall Formation.

pH values range from slightly acidic to basic with pH levels of 6.7 (RN 17983) to 8.5 (RN 12030175), from Tertiary sediments and the Mt Hall Formation, respectively. No pH values are available for the alluvial sediments.

Figure 2-2 Standing Groundwater Level Hydrographs from Registered Bores in Project (Rail) Section 1



2.3.2 Project (Rail) Section 2

2.3.2.1 Hydrogeological Units

A number of outcropping volcanic, sedimentary and metamorphic bedrock units are present within the buffer zone of Project (Rail) Section 2. Colluvium is mapped on the slopes and toward the base of the outcropping units and alluvial deposits dominate the low-lying areas in the vicinity of Mistake Creek, Logan Creek and Diamond Creek.

Depth to top of the Carboniferous-aged bedrock aquifer ranges from 54.9 m bgl (Mt Hall Formation) to 96 m bgl (Star of Hope Formation). The Tertiary-aged sedimentary aquifer top is reported at 85 m bgl (RN103912).

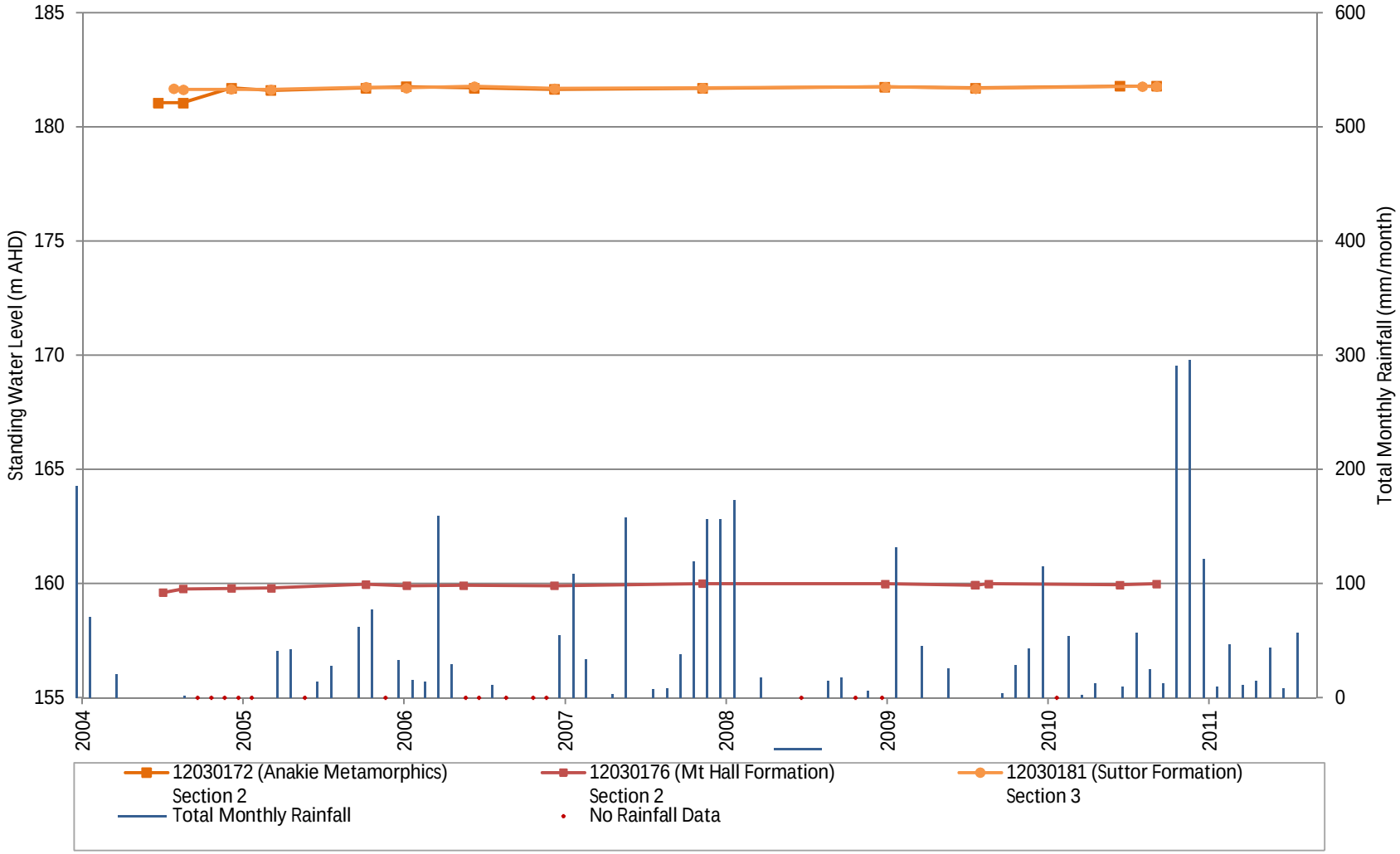
There are four bores situated within the alluvial deposits of Mistake Creek, which are south of the 10 km study area and the data therefore has not been summarised, however these bores are instrumental in determining the characteristics of the Mistake Creek alluvium. These bores range in depths of up to 13.6 m bgl, and according to the Groundwater Database (DERM, 2010), records all have reported dry during monitoring, indicating that shallow alluvial groundwater resources are not extensive in the region.

Groundwater level hydrographs for all registered bores in Project (Rail) Section 2 and Project (Rail) Section 3 with some water level data are presented in Figure 2-3. Water levels in the Anakie Metamorphics (RN 12030172), the Mt Hall Formation (RN 12030176) and the Suttor Formation (RN 12030181) have remained relatively static and appear to not be subject to rainfall recharge. This lack of response indicates that there is limited hydraulic connection or a large response lag-time between surface waters and groundwater.

2.3.2.1 Yields and Water Quality

Bores within the Mistake Creek alluvium have remained dry therefore there is no yield data available for the shallow alluvial deposits. Yields of up to 3.43 L/s have been recorded in the Tertiary-aged sedimentary aquifer. Yields in the bedrock aquifers are typically lower and range from 0.4 L/s to 0.75 L/s of slightly brackish water (up to 2,000 µS/cm). Saline water was reported in two bores with EC values of 45,500 µS/cm (Anakie Metamorphic Group) and 53,100 µS/cm (Mt Hall Formation). Only RN 12030176 reported a pH with a value of 7.5.

Figure 2-3 Standing Groundwater Level Hydrographs from Registered Bores in Project (Rail) Sections 2 and 3



2.3.3 Project (Rail) Section 3

2.3.3.1 Hydrogeological Units

Much of the Project (Rail) Section 3 is underlain by alluvium associated with Diamond Creek to the west and Late Tertiary- to Quaternary-aged unconsolidated sediments to the east. Outcropping Tertiary volcanics or durricrust and Permian sedimentary units (Back Creek Group) are also present towards the eastern limit of the search area.

There is very little or no information on aquifer properties within this area. The Groundwater Database (DERM, 2010) indicates that the top of the Blenheim Subgroup (part of the Back Creek Group) ranges in depths of 79.2 to 85.3 m bgl with SWL ranging 51.2 to 61.0 m bgl; and the top of the Suttor Formation from 36.6 to 55 m bgl with a SWL of 27.4 m bgl.

Groundwater level hydrographs for all registered bores in Project (Rail) Section 2 and Project (Rail) Section 3 with some water level data are presented in Figure 2-3.

2.3.3.2 Yields and Water Quality

Information on groundwater yields are only available for two bores within Project (Rail) Section 3 and range from 0.75 L/s (Blenheim Subgroup) to 1.0 L/s (Suttor Formation). Limited water quality data are also available, with two bores reporting 'brackish' water and two bores reporting an EC with values of 9,600 µS/cm (Blenheim Subgroup) and 18,010 µS/cm (Suttor Formation), which may be characterised as saline. pH in the Suttor Formation was reported as slightly basic with a value of 8.0.

2.4 Groundwater Quality

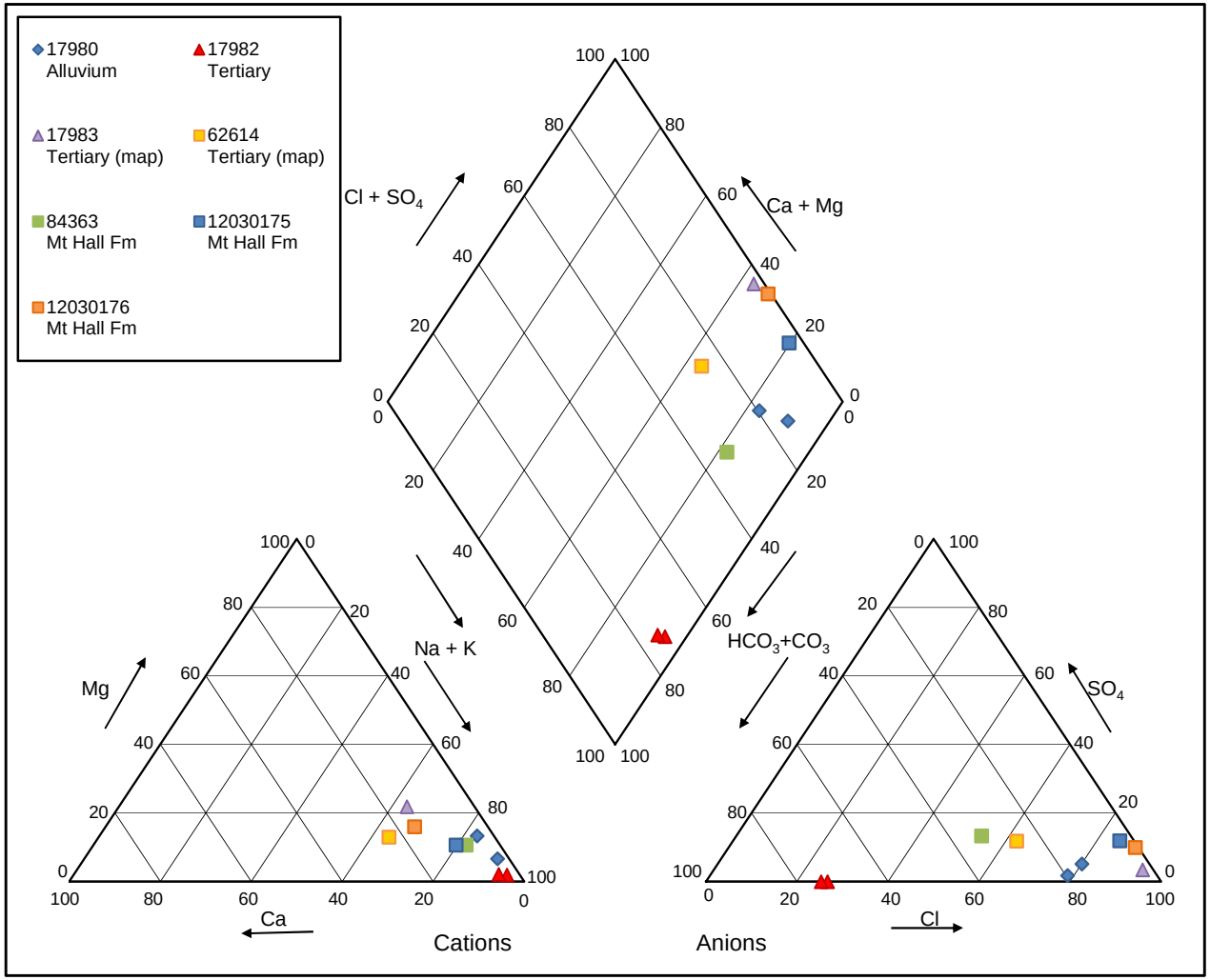
Limited water quality data are available from the Groundwater Database (DERM, 2010). Of the data extracted, some pH, EC and/or total dissolved solids data are available for up to 21 bores within the search area. These data are summarised in Table 2-3. The table indicates the number (count) of datum available in each Project (Rail) Section. Some bores have each recorded multiple readings through regular monitoring and other bores have a single reading (usually at the time the bore was installed). The table details the minimum, median (middle value) and maximum recorded value in each Project (Rail) Section.

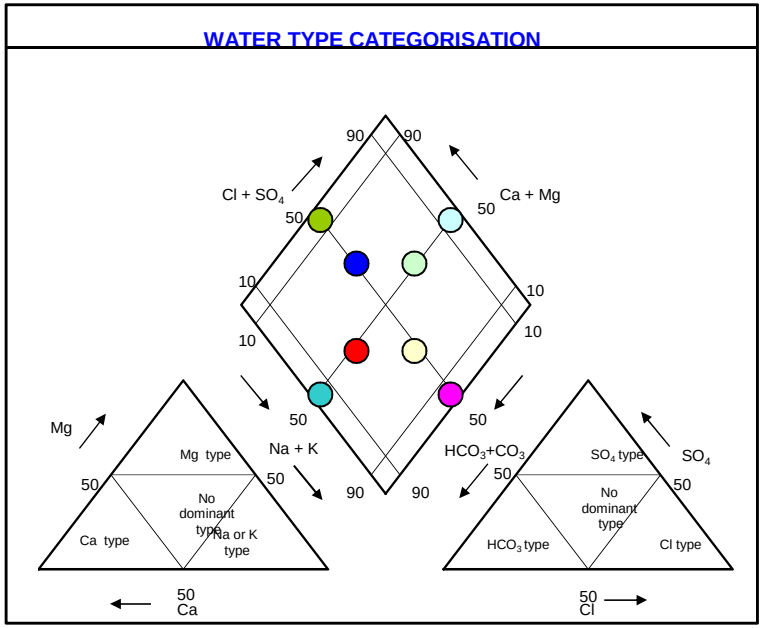
Table 2-3 Groundwater Quality Data from Registered Bores on Project (Rail) Sections

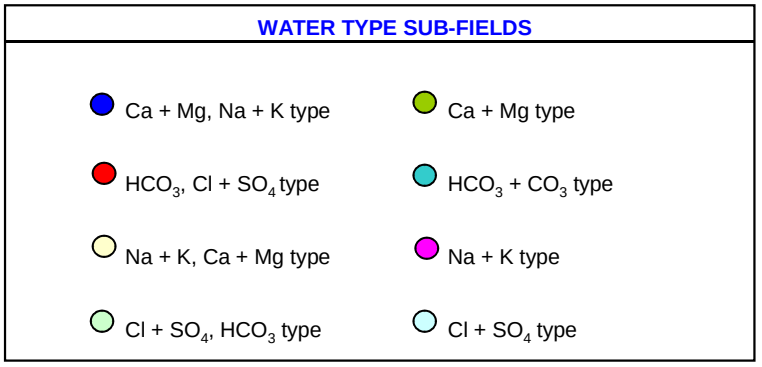
Parameter	Statistical Parameter	Section 1	Section 2	Section 3
pH	Minimum	6.4	7.3	8.0
	Median	7.85	7.55	8.0
	Maximum	8.5	7.7	8.0
	Datum Count	12	4	1
EC (µS/cm)	Minimum	320	495	9600
	Median	2080	45,500	17,500
	Maximum	17,750	53,100	18,010
	Datum Count	20	9	3
Total dissolved solids (mg/L)	Minimum	0	316	10,360
	Median	972	27,656	10,360
	Maximum	11,070	32,845	10,360
	Datum Count	12	3	1

Source: Queensland Groundwater Database (DERM, 2010).

Laboratory data is also available for major ions for some of the bores in Project (Rail) Section 1. A piper plot of the major ion data is shown in Figure 2-1. The piper plot indicates that groundwater is typically a sodium/potassium-chloride type water (with the exception of RN 17982, which can be classified as sodium/potassium-bicarbonate type water). The same data are also shown on an expanded durov plot (Figure 2-5), which suggests that the majority of the groundwater samples are end-product water meaning that the groundwater has long residence times and groundwater that is not actively recharged from rainfall or infiltration from surface water bodies.







CLIENTS | PEOPLE | PERFORMANCE

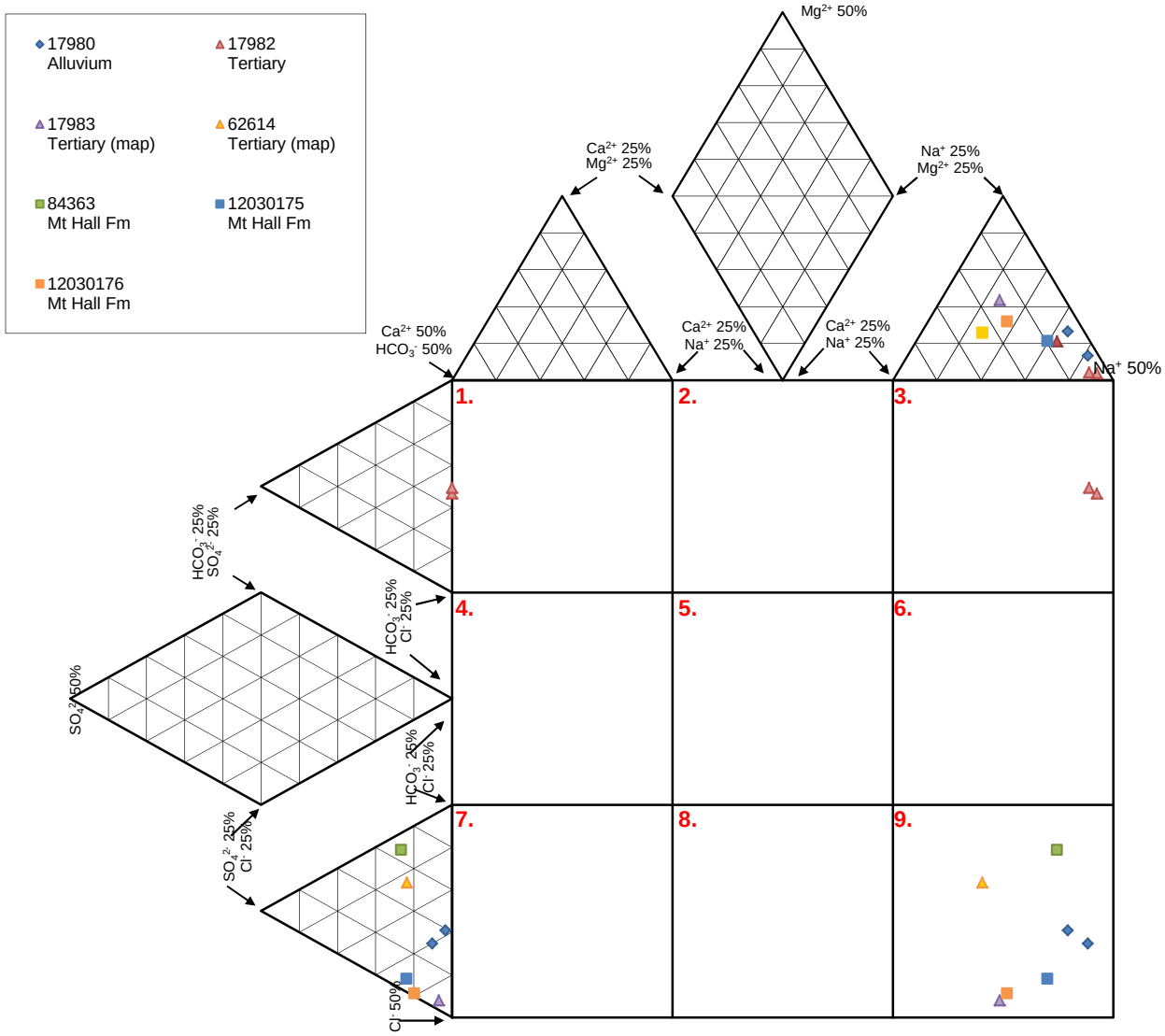
Piper diagram of major ions from DERM registered bores – Section 1

Figure 2-4

Date: 15/01/12

Data Source: Queensland Groundwater Database (DERM, 2010)

Project: Carmichael Coal Project EIS
Project No: 41-23244-45
Description: Rail Component: Groundwater
Client: Adani Mining Pty Ltd



WATER TYPE SUB-FIELDS

1. HCO_3^- and Ca^{2+} dominant, frequently indicates recharging waters in limestone, sandstone and many other aquifers.

2. HCO_3^- dominant and eight Mg^{2+} dominant or cations indiscriminant, with Mg^{2+} dominant or Ca^{2+} and Mg^{2+} important, indicates waters often associated with dolomites; where Ca^{2+} and Na^+ are important partial ion exchange may be indicated.

3. HCO_3^- and Na^+ dominant, normally indicates ion-exchanged waters although the generation of CO_2 at depth can produce HCO_3^- where Na^+ is dominant under certain circumstances.

4. SO_4^{2-} dominant or anions indiscriminant and Ca^{2+} dominant, Ca^{2+} and SO_4^{2-} dominant frequently indicates a recharge water in lavas and gypiferous deposits; otherwise a mixed water or a water exhibiting simple dissolution may be indicated.

5. No dominant anion or cation, indicates waters exhibiting simple dissolution or mixing.

6. SO_4^{2-} dominant or anions indiscriminant and Na^+ dominant, is a water type not frequently encountered and indicates probable mixing influences.

7. Cl^- and Ca^{2+} dominant, is infrequently encountered unless cement pollution is present in a well; otherwise the waters may result from reverse ion exchange of Na^+ - Cl^- waters.

8. Cl^- dominant and no dominant cation indicates that the groundwaters may be related to reverse ion exchange of Na^+ - Cl^- waters.

9. Cl^- and Na^+ dominant frequently indicates end-point waters. The Durov diagram does not permit much distinction between Na^+ - Cl^- waters.

GHD CLIENTS | PEOPLE | PERFORMANCE

Expanded durov diagram of DERM registered bores – Section 1

Figure 2-5

Date: 15/01/12

Data Source: Queensland Groundwater Database (DERM, 2010)

Project: Carmichael Coal Project EIS **Description:** Rail Component: Groundwater

Project No: 41-23244-45 **Client:** Adani Mining Pty Ltd

2.5 Interaction between Groundwater and Surface Water

Other than the Belyando River, all the watercourses in the Project (Rail) search area are highly intermittent or ephemeral. The Belyando River typically sustains flow for several months after rainfall ceases. The remaining creeks, following heavy rainfall typically stop flowing and retract into a few small water holes within a few days to weeks. Peak surface water flow is likely to occur between November and May, with February producing the highest average flow.

The ephemeral nature of the watercourses within the Project (Rail) area suggests little to no significant groundwater base-flow during dry periods. The Belyando River sustains permanent water holes in some sections of the river, indicating that there is some base-flow, although this would be highly reduced during the dry season.

Recharge of alluvium underlying the creeks and rivers likely occurs during the wet season when surface water levels are highest. Recharge of Tertiary-aged aquifers is via rainfall recharge at outcrop areas and from percolation through alluvial deposits during peak flow of surface water. The underlying Permian and Cambrian aquifers are recharged through leakage from alluvial and Tertiary sediments and via direct recharge at outcrop areas.

2.6 Groundwater Flow Direction

Determination of groundwater flow direction allows the assessment of potential impacts on sensitive receptors (i.e. potential migration of any contaminants that may enter the groundwater, drawdown/flow-through extent etc.).

There is insufficient data to be able to definitively determine groundwater flow direction. However, groundwater will generally follow broad-scale topographical features. The low-lying topography of the Project (Rail) study area is dominated by the Belyando River basin and the Suttor River basin (refer to Volume 3 Section 5). A ridge of outcropping bedrock in the middle of the Project (Rail) study area forms a natural ridge between the Belyando and the Suttor basins. Groundwater is thought to flow toward the low-lying rivers with the ridge forming a possible groundwater divide.

2.7 Sensitive Receptors

2.7.1 Spring Complexes

According to the Springs of Queensland dataset (EPA, 2005) there are no reported spring complexes within the Project (Rail) study area. Doongmabulla Springs are listed under the Directory of Important Wetlands and located approximately 11 km west of Project (Mine) (refer Volume 4, Appendices N, O and R describing Mine ecology and hydrogeology), some 20 km distant from the western extent of the Project (Rail).

Reference to Queensland Spring Database also suggest the presence of two further springs around 10 km south of the mine lease area to the north of Mellaluka. These springs are identified as non-GAB Eastern Desert Upland springs typically associated with outcropping Dunda Beds.

2.7.2 Groundwater Dependant Ecosystems

Much of the landscape surrounding the Study Area has experienced broad-scale vegetation clearing, and as such, remnant vegetation coverage is fragmented. Connectivity of remnant vegetation at a landscape level is maintained by tracts of remnant vegetation often associated with major watercourses including the Belyando River and Mistake Creek.

Open cleared land is the most common and widespread fauna habitat type within the study area. This habitat type typically provides a low diversity of suitable resources for fauna (including threatened species), as compared to the higher ecological value of remnant vegetation.

Flows in the major watercourses including the Belyando River and Mistake Creek are understood to be relatively persistent and even during extended dry periods these systems are thought to maintain a series of semi-permanent to permanent waterholes. This suggests that the major water courses and the associated remnant riparian vegetation are groundwater dependent to a degree. Consequently the fauna which are attracted to these areas are also thought likely to be dependent on groundwater to a degree, albeit indirectly.

Outside of the riparian areas associated with the main watercourses then groundwater dependant ecosystems are unlikely to be present within the Project (Rail) study area. The other minor creeks and rivers are typically ephemeral and are not associated with areas of remnant vegetation. This is understood to be related to elevated depths to water table away from the main river systems and little or no groundwater contribution to vegetation demands and/or river flows.

2.7.3 Groundwater Users

There are a number of existing water supply bores within the Project (Rail) study area (that is, within 10 km radius of the Project (Rail)). These bores are typically utilised for stock and domestic purposes. There are also a number of bores listed in the Groundwater Database (DERM, 2010) as having an ‘unknown’ facility role. These bores may also be utilised for local water supply. It should be noted that prior to 1998 there was no requirement for registration of private bores therefore it is possible that there are additional water supply bores that are being utilised that have not been identified in this desktop review.

All groundwater bores within the nominal 10 km radius are considered sensitive receptors for Project (Rail) construction activities, however, due to the nature of the proposed development the risk to groundwater supplies is considered low.

Groundwater bores located in close proximity to the Project (Rail) have the highest risk of being impacted (i.e. bores within 1 km of the construction zone). There are two registered bores, namely RN 132303 and RN 37604, within 1 km of the Project (Rail) Section 1 and Section 3 respectively. Both are reported to be abandoned and destroyed (DERM, 2010). Bores that are greater than 1 km from the Project (Rail) have a very low risk of being impacted from construction or operational activities.

2.8 Hydrogeology Conceptualisation

The Project (Rail) falls within an area for which there is little to no data on groundwater resources.

Assessing data obtained from the Groundwater Database (DERM, 2010), Bureau of Meteorology long-term average rainfall data, stream flow data and considering the hot central Queensland climate during the wet season (i.e. elevated evaporation) it is considered that recharge to groundwater is low and limited to heavy rainfall periods during the wet season.

A number of water supply exploration bores were historically installed into the alluvium of Belyando River and Mistake Creek. Data from monitoring of these bores (DERM, 2010) show that the bores have remained dry during monitoring periods and the bores have subsequently been abandoned. This indicates that alluvial aquifers are not extensive nor a source for significant local groundwater abstractions. The majority of abstractions within the Project (Rail) study area are therefore from the underlying Tertiary and Permian sedimentary units. Information on observed depth to groundwater in these bores suggests that groundwater is typically encountered between around 15 and 75 m bgl. Interaction between surface water and groundwater resources in the project area is therefore thought likely to be limited to major watercourses including the Belyando River and Mistake Creek. Flows in these major river systems are relatively persistent and permanent to semi-permanent waterholes are maintained year-round suggesting a degree of groundwater support. This is supported by ecological data which confirms the presence of mature remnant riparian vegetation including River Red Gums and Paperbarks associated with these water courses. Conversely the remaining minor water courses are typically highly ephemeral and are not associated with mature riparian vegetation suggesting little or no groundwater support.

While some minor recharge of shallow aquifers may occur during the wet season, it is not likely to be significant, as indicated by the very low groundwater yields achieved in most bores (typically less than 1 L/s) and the brackish to saline quality of the groundwater. The piper and durov plots (Figure 2-4 and Figure 2-5, respectively) indicate that the groundwater is an ‘end-point water’ (i.e. is not actively recharged directly from surface waters and has a long residence time).

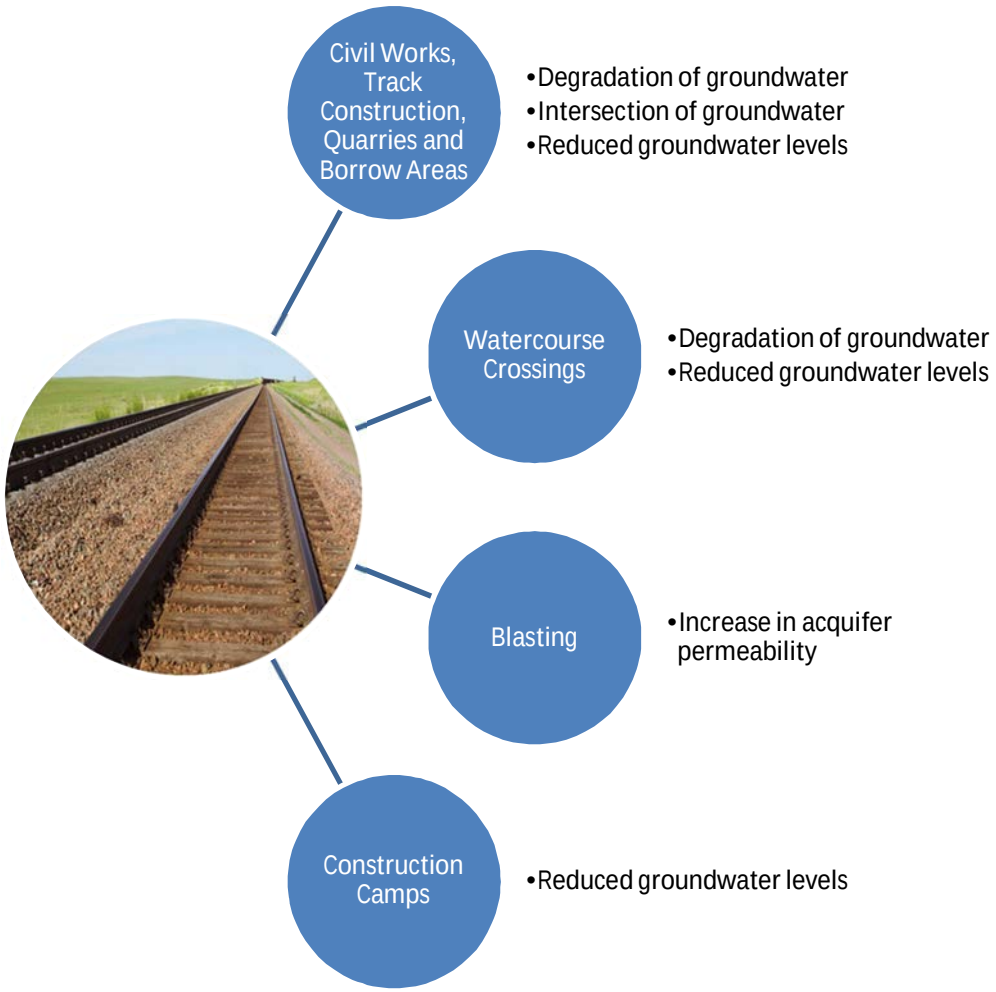
3. Potential Impacts and Mitigation Measures

3.1 Overview

The construction and operation of the Project (Rail) have the potential to cause impacts on groundwater resources.

Potential construction impacts have been identified and discussed on the basis of a desktop analysis considering the construction activities and methods proposed to be used. Figure 3-1 provides a conceptual overview of the potential construction impacts of the Project (Rail) on groundwater resources.

Figure 3-1 Conceptual Overview of Potential Construction Impacts



Construction activity for the Project (Rail) will primarily consist of minor cut and fill activities and sourcing of construction materials (possibly quarrying of rock and borrowing of sand). Cuttings for the construction of the rail are anticipated to be a maximum of 5.7 m below the natural ground surface (Aarvee Associates, 2011) the deepest of which is on the eastern section at approximately 12 km from the tie in with the Goonyella rail system. The cuttings are not in the immediate vicinity of major water courses. Construction of the rail embankments will reach a nominated maximum height of 9.3 m above natural ground surface. Built-up embankments are typically indicated within the low-lying alluvial floodplains associated with the Belyando River, Mistake Creek and Logan Creek (Aarvee Associates, 2011).

Deeper disturbances of the ground may occur at creek and river crossing where piles for bridge structures and culverts may be required, and within quarry and borrow areas. Depending on the construction method temporary dewatering may be necessary. This would include areas to be developed as quarries and/or borrow areas. A number of quarry and borrow locations have been identified for investigation within and in the vicinity of the Project (Rail). Geotechnical investigations are underway to better determine the nature of the potential resource and the quantity of resource available. The number and size of pits developed within each borrow area will vary depending on the volume of borrow material required for each section of the railway formation. The final locations will be identified during detailed design as the results of onsite geotechnical and environmental investigations become finalised.

The greatest potential for any impact to groundwater is therefore in the vicinity of shallow alluvial aquifers, mostly found near major creeks and rivers, which could be impacted by temporary dewatering for Project (Rail) construction activities.

Potential operational impacts have been identified and discussed on the basis of a desktop analysis. Embankment infrastructure may result in retention of water (pooling/ponding, water logging) thereby locally increasing groundwater levels. Extraction of groundwater may form part of a water supply solution for Project (Rail).

Table 3-1 lists the watercourse crossings, where the potential for interaction between surface and groundwater is likely to be the greatest.

Table 3-1 Major Creek and River Crossings in or near Project (Rail)

Project (Rail) Section	Rail Corridor Chainage (km)	Watercourse Name	Status / Notes
1	170.4 km	North Creek	Ephemeral
	149.0 km	Belyando River (Anabranch)	Ephemeral Maintains permanent waterholes
	146 km	Belyando River	
2	120.8 km	Mistake Creek	Ephemeral
	82.7 km	Logan Creek	Ephemeral
3	62.7 km	Diamond Creek	Ephemeral; does not cross the rail corridor

3.2 Civil Works, Track Construction, Quarries and Borrow Areas

3.2.1 Potential Impact

Construction activities, such as civil works, including: earthworks, drainage construction, haul road and access track construction and maintenance, track laying and excavation of quarry and sand materials, have the potential to adversely impact on groundwater resources.

Specifically, potential impacts on groundwater resources may include;

- The degradation of groundwater resources
- The intersection of groundwater resources
- A decrease in groundwater levels at a local scale

Storage of chemicals, fuels, machinery and waste has the potential to impact groundwater quality where spills and leaks could occur. Contaminants have the potential to enter groundwater through infiltration and/or runoff. If the spill/leak is up-gradient of a sensitive receptor (i.e. groundwater bore or groundwater dependant ecosystems) there may be potential for degradation of water quality and impact on groundwater users.

Excavations of construction material from borrow pits, quarries and sand pits have the potential to intersect groundwater resources. Potential dewatering of pits and quarries may be required.

Excavation of construction materials is considered most likely to occur in bedrock area to provide ballast and/or fill material. The desktop study has shown that groundwater within the bedrock is relatively deep (greater than 30 m bgl) and hence is not likely to be intersected during extractive activities. Sourcing of sand is likely to be in alluvial areas and has the potential to impact on shallow aquifers.

Construction water demand is dependent on geotechnical properties and quantities of fill and capping materials (Aarvee Associates, 2011) yet to be determined.

A number of construction water supply options are however available and are currently being investigated, for example, water and rainfall harvesting, use of farm dams, recycling, etc. In addition, there is potential for the development of water bores in the Project (Rail) area. It is not likely that water usage will rely solely on groundwater sources (refer Volume 3, Section 2 Rail Project Description). Further it is not likely that establishment of groundwater bores and abstraction of groundwater for construction purposes will result in a decrease in the local resource for other users.

3.2.2 Management Measures

- Laydown areas for vehicles and machinery and storage areas for chemicals, oils and fuels will be contained in appropriately designed facilities. Containment may include: sealed/lined surfaces and hard stand areas; bunded areas; containerised storage. In addition, chemicals, oils, fluids and other hazardous substances will be stored in accordance with the specifications of the material safety data sheet, as appropriate. Containment and correct storage will prevent spills, leaks, infiltration and surface runoff and hence prevent contaminants from entering aquifers, waterways and the general environment.
- Laydown and storage areas will not be placed in the vicinity of creeks or rivers or close-by to sensitive receptors (i.e. groundwater bores or groundwater dependant ecosystems).

- Spill kits will be available to all personnel in the event of a spill or leak. Booms and spill kits will be on-site at refuelling facilities. Refuelling will only occur at designated sites away from watercourse and sensitive receptors. All machinery will have its own designated spill kit.
- Where sources of sand are required, this will, as far as is practicably possible, be obtained from borrow pits where shallow aquifers are not present (e.g. older alluvial palaeochannels). Importing sources of construction materials will also be investigated where necessary.
- Where dewatering of pits/quarries/excavations is required, opportunities for reinjection of the groundwater down-gradient will be explored. Engineered cut-offs for pits and excavations may also be an option; however this is dependent on the size of the pits and groundwater inflows.
- During detailed design, fill and capping material details will be defined and water demand curves formulated. A range of water sources will be investigated and developed.

3.3 Watercourse Crossings Construction

3.3.1 Potential Impact

Activities, such as drilling and piling, associated with the construction of bridges and culverts have the potential to adversely impact on groundwater resources. Potential impacts may include:

- Degradation of groundwater quality
- A decrease in groundwater levels

Drilling and piling operations have the potential to degrade the quality of groundwater as a result of direct contamination through the introduction of drilling muds, chemicals and machinery fluids.

Dewatering may be required to facilitate drilling and piling operations within and near creeks and rivers during the construction of bridge pylons and/or culverts. Dewatering has the potential to reduce shallow groundwater levels in the vicinity of creeks and rivers. However, given the short-term duration, expected low volumes and localised nature of potential dewatering, it is unlikely that significant or long-term impacts will result.

3.3.2 Management Measures

- Any boring or similar activity during construction will utilise drilling fluids and chemicals that are environmentally neutral and biodegradable. Machinery and equipment will be maintained in accordance with manufacturer requirements and regularly maintained to minimise breakdown and decrease risk of contamination.
- Dewatering of shallow groundwater, if required for bridge pylons and/or culverts 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. The management plan will include objectives and targets to be met and detail monitoring requirements.

3.4 Blasting

3.4.1 Potential Impact

Blasting has the potential to impact on groundwater through fracturing of bedrock changing its permeability and altering localised groundwater regimes. This may impact on local groundwater users and/or discharge from local spring complexes, through the fracturing of rock. Fracturing of previously component rock may increase flow through the rock aquifer and potentially dewater adjacent aquifers.

3.4.2 Management Measures

Blasting during the construction of the Project (Rail) is not considered necessary at the present time, but will be determined following further geotechnical investigations. Blasting potentially associated with borrow (quarry) areas away from the Project (Rail) area will be assessed separately.

If blasting of rock is required for construction of the Project (Rail) (or for quarrying activities), a census (physically finding and detailing bore properties) of all groundwater bores and spring complexes within a one km radius will be undertaken. A search of the Queensland Groundwater Database (DERM, 2010), the Department of Natural Resources and Mines Water Entitlement Registration Database, enquires with the local council and liaison with local landholders will inform the census. Any bores and springs that are located will be monitored to assess pre and post blasting impacts and determine any mitigation measures that may be needed. Measures may include make-good reparations, capture of water if there is increased flow etc.

3.5 Construction Camps

3.5.1 Potential Impacts

It is expected that four construction camps will be established for the Project (Rail), approximately evenly spaced along the alignment, with one camp combined with the Project (Mine) workers accommodation village.

Potable water use is estimated at 84,000 litres of water per day per camp. A number of supply options exist for the provision of potable and non-potable water. This may include, water and rainfall harvesting, use of farm dams, recycling, etc.

There is potential for the development of water bores in the Project (Rail) area. It is not likely, however, that water usage will rely solely on groundwater sources. Further is not likely that establishment of groundwater bores and abstraction of groundwater for construction purposes will result in a decrease in the local resource for other users.

3.5.2 Management Measures

Water supply and demand options are currently being investigated and will be further developed during the detailed design phase when additional site investigation and testing will take place along with the formulation of the detailed water demand curves. A range of water sources are being investigated and developed.

3.6 Operations

3.6.1 Potential Impact

There is potential for localised increases in groundwater levels (i.e. water logging) as a result of pre-loading or construction of embankments, where the groundwater is close to the ground surface. This is particularly relevant in the vicinity of the Belyando River. Pre-loading of sediments reduces pore space within sediments, thereby decreasing any groundwater flow through the aquifer and decreasing recharge of the aquifer from surface waters.

3.6.2 Management Measures

Culverts and filling activities are designed and will be constructed to minimise the loading and compaction of alluvial sediments, which may alter shallow groundwater regimes and recharge.

The current design allows for openings in the embankment (through culverts and bridge spans) in the vicinity of creeks and rivers to facilitate flow.

If extensive loading or compaction of alluvium at watercourse crossings is required for construction, alternative design concepts will be explored to minimise this (e.g. piles).

It is anticipated that little impact to groundwater regimes is likely to result from pre-loading, since the area of the loading will be comparatively small and shallow alluvial aquifers are not extensive within the Project (Rail) study area.

4. Conclusion

Groundwater resources are likely to be most vulnerable to impact in the vicinity of major creeks/rivers and other areas characterised by relatively shallow depths to groundwater. Temporary construction dewatering may be required in such areas and there is therefore the greatest potential for both direct and indirect contamination and other impacts due to the lack of any significant saturated zone between the ground surface and water table. However, given the short-term duration, expected low volumes and localised nature of potential dewatering, it is unlikely that significant or long-term impacts will result. Based on the available data such areas are thought likely to be limited to crossing points of the Belyando River and the Mistake, Logan and Diamond creeks.

In general therefore no significant impacts on groundwater resources and/or quality are anticipated based on:

- Available information on baseline groundwater conditions
- Current understanding of proposed rail construction and operational activities including the limited number of shallow cuttings included in the preliminary rail design
- Adoption of the mitigation measures outlined in Section 3

Construction of new infrastructure such as culverts, cuttings, embankments and bridge structures has the potential to result in short-term, localised impacts on shallow groundwater, such as increases or decreases in groundwater levels, however no significant impacts on groundwater resources and groundwater quality are expected given:

- No long-term lowering of groundwater levels due to construction dewatering activities is anticipated
- The majority of the Project (Rail) area does not contain well developed or extensive alluvial aquifers. Groundwater in the area is therefore not considered threatened or vulnerable as a resource.
- Outside of the main river corridors groundwater and surface water connectivity is thought to be limited

Similarly no significant long term impacts on groundwater resources and groundwater quality are anticipated during operation of the rail line given that:

- Only a small number of shallow cuttings are included in the preliminary rail design and hence no significant permanent lowering of groundwater levels due to drainage of cutting areas is anticipated.
- River crossing points will be designed such that compaction of alluvial sediments and upstream ponding of surface water flow is minimised References

Page left intentionally blank

5. References

Aarvee Associates, 2011, Carmichael Rail Line Concept Design, Stage A – Report Volume 1 of 2, 17 November 2011

Australia and New Zealand Environment Conservation Council (ANZECC), 2000, Guidelines for Fresh and Marine Water Quality, Australian Government

Bureau of Meteorology (BoM), Climate Data: Australia V2.2, Monthly Rainfall Data, Stations 36071 and 34015, accessed 9 June 2011, Commonwealth of Australia.

Department of Environment and Resource Management (DERM), 2007, Water Resource (Burdekin Basin) Plan 2007 – explanatory notes for SL 2007 No. 189, Queensland Government

Department of Environment and Resource Management (DERM), 2009, Burdekin Basin resource operations plan – explanatory notes, December 2009, Queensland Government

Department of Environment and Resource Management (DERM), 2009, Queensland Water Quality Guidelines, Version 3 September 2009, Queensland Government

Department of Environment and Resource Management (DERM), 2010, Queensland Groundwater Database, accessed December 2010, Queensland Government

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC), National Water Quality Management Strategy (NWQMS), 2000, Australian Government

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC), 2009, Australian Natural Resources Atlas interactive website, last updated 13 May 2009, accessed 6 July 2011, http://www.anra.gov.au/index.htlm , Australian Government

Environmental Protection Agency (EPA), 2005, Spring of Queensland – Distribution and Assessment, Version 4, digital dataset, Queensland Government

Hancock Prospecting Pty Ltd, Alpha Coal Project Environmental Impact Statement Volume 3, Railway Corridor, 2010.

National Land and Water Resources Audit, 2001, Surface water and groundwater – availability and quality. In Australian Water Resources Assessment 2000, Land and Water Australia, Commonwealth of Australia

Geological Society of Queensland (GSQ), 2007, Digital Geoscience Dataset, DEEDI, Brisbane

Geoscience Australia, Digital Watercourse Features Dataset, accessed March 2010, from www.ga.gov.au

Waratah Coal, Galilee Coal Project Environmental Impact Statement Volume 3 – Rail, August 2011.

Page intentionally left blank

Appendix A

Terms of Reference Cross-reference

Terms of Reference Requirement/Section Number	Section of this report
Section 3.4 Water Resources	
Section 3.4.1 Description of environmental values	
Describe the existing water resources that may be affected by the project in the context of environmental values as defined in such documents as the EP Act, Environmental Protection (Water) Policy 2009 (EPP (Water)), Australia and New Zealand Guidelines for Fresh and Marine Water Quality and the Queensland Water Quality Guidelines.	Section 1.4 Figure 1-3Figure 1-3
Describe present and potential users and uses of water in areas potentially affected by the project, including municipal, agricultural, industrial and recreational uses of water, and reference to any licences held by users. Describe the environmental values of the surface waterways of the affected area in terms of existing and other potential surface and groundwater users	Section 2.2 Figure 2-1
Provide a detailed description of the quality and quantity of surface and groundwater resources in the area potentially affected by the project.	Sections 2.3 and 1.4.1
Describe existing groundwater in terms of physical, chemical and biological characteristics. Describe the groundwater quality considering seasonal variations in depth and flow and all times of natural flow in ephemeral streams. Parameters should include a broad range of water quality indicators including, but not necessarily limited to: ◗ Electrical conductivity ◗ Major cations and anions ◗ Dissolved metals (including Al, Ag, As, B, Br, Ca, Co, Cr, Cu, Fe, Hg, Mo, Mn, Ni, Pb, Se, U, V, Zn) ◗ Minor ions (such as ammonia, nitrite, nitrate, fluoride) ◗ Hydrocarbons ◗ Any other potential toxic or harmful substances ◗ Turbidity ◗ Suspended sediments ◗ pH. All sampling should be performed in accordance with the Monitoring and Sampling Manual 2009 or the most current edition. The description of water quality should include medians, ranges and percentiles appropriate for comparison with appropriate trigger levels and guidelines for the protection of aquatic ecosystems and downstream users.	Sections 2.3 and 1.4.1
Investigate the relationship between groundwater and surface water to assess the nature of any interaction between the two resources and any implications of the proposed mine that would affect the interaction. If the project is likely to use or affect local sources of groundwater, describe the groundwater resources in the area in terms of: ◗ Interaction with surface water	Sections 2.5 and 2.6

Terms of Reference Requirement/Section Number	Section of this report
Section 3.4 Water Resources	
Describe the environmental values of the surface waterways and groundwater of the affected area in terms of :	Section 1.4.3
◗ Values identified in the EPP (Water)	
◗ Physical integrity, fluvial processes and morphology, including riparian zone vegetation and form, if relevant	Volume 3 Appendix AB
◗ Any impoundments (e.g. dams, levees, weirs etc.)	Volume 3 Appendix AB
◗ Sustainability, including both quality and quantity	Section 2.3
◗ Dependent ecosystems	Section 2.7.2
◗ Hydrology of waterways and groundwater	Section 2.3
◗ Details of any proposed buffer widths between project activities and waterways (e.g. rivers, streams, creeks, other bodies of water and wetlands) and other fisheries values, as well as any potential temporary and/or permanent impacts to aquatic flora and fauna (if any).	Volume 3 Appendix AB
If the project is likely to use or affect local sources of groundwater, describe the groundwater resources in the area in terms of:	
◗ A comprehensive hydrogeological description covering: the coal seams and surrounding aquifers, both artesian and sub-artesian (including the Great Artesian Basin); inter-aquifer connectivity; flow of water; recharge and discharge mechanisms; and hydrogeological processes at work	Section 2.3 Volume 2 Section 6
◗ Geology/stratigraphy	
◗ Depth to water level and seasonal changes in levels	
◗ Groundwater flow directions (defined from water level contours)	
◗ Possible sources of recharge	
◗ Aquifer type—such as confined and unconfined	Section 2.3
◗ Depth to and thickness of the aquifers	
◗ Current extraction regime	
◗ Potential exposure to pollution	
The groundwater assessment should also be consistent with relevant guidelines for the assessment of acid sulfate soils, including spatial and temporal monitoring, to accurately characterise baseline groundwater characteristics.	Sections 1.4 and 2.2
For the taking of groundwater, the EIS should review the significance of groundwater in the project area, together with groundwater use in neighbouring areas. Specific reference should be made to relevant legislation or water resource plans for the region. The review should also	

Terms of Reference Requirement/Section Number	Section of this report
Section 3.4 Water Resources	
assess the potential take of water from the aquifer and how current users and the aquifer itself and any connected aquifers will be affected.	
If the project is likely to use or affect local sources of groundwater, describe the groundwater resources in the area in terms of: ◗ Current access to groundwater resources in the form of bores, springs, ponds, including quantitative yield of water and locations of access. The review should include a survey of existing groundwater supply facilities (bores, wells, or excavations) to the extent of any environmental harm. Information gathered for analysis should include: ◗ Location, type and status of existing water entitlements and associated infrastructure (bores, wells or excavations) ◗ Pumping parameters ◗ Draw down and recharge at normal pumping rates ◗ Seasonal variations (if records exist) of groundwater levels. ◗ Any water resource plans relevant to the affected catchments. ◗ Develop a network of observation points that would satisfactorily monitor groundwater resources both before and after commencement of operations. The data obtained from the groundwater survey should be sufficient to enable specification of the major ionic species present in the groundwater, pH, electrical conductivity and total dissolved solids.	Sections 2.2 and 2.3 Section 1.4
Section 3.4.2 – Potential Impacts and Mitigation Measures	
Address and describe the following matters, including provision of maps: ◗ potential impacts on the flow and the quality of surface and groundwater from all phases of the project, with reference to their suitability for the current and potential downstream uses and discharge licences ◗ Measures to prevent, mitigate and remediate any impacts on existing users or groundwater-dependent ecosystems ◗ The likely volume of groundwater to be dewatered during the operations, and its likely quality characteristics, including salinity ◗ How extracted groundwater will be managed in the surface water management system to minimise the likelihood of discharging highly saline water ◗ All likely impacts on groundwater depletion or recharge regimes ◗ The response of the groundwater resource to the progression and finally cessation of the proposal	Section 3 Volume 2 Section 6

Terms of Reference Requirement/Section Number	Section of this report
Section 3.4 Water Resources	
◗ The impacts on groundwater resources in each aquifer of any take of groundwater or dewatering as a result of the mine's operation, including any potential migration and risks associated with the inter-basin transfer of water. ◗ Any potential for the project to impact on groundwater-dependent vegetation, including avoidance and mitigation measures	
Address and describe the following matters, including provision of maps: ◗ The potential environmental impact caused by the project (and its associated project components) to local groundwater resources, including the potential for groundwater-induced salinity. ◗ The project's impact on the local groundwater regime caused by the altered porosity and permeability of any land disturbance ◗ The potential to contaminate surface and groundwater resources and measures to prevent, mitigate and remediate such contamination.	Section 3.2
Assess any potential surface water and groundwater interaction as a result of subsidence of a watercourse. Also assess the potential impacts on the groundwater regime in alluvial and deeper aquifers due to altered porosity, permeability and interconnectivity from any land disturbance, including subsidence.	Section 2.5
Describe management strategies in adequate detail to demonstrate best practice management and the environmental values of receiving waters will be maintained to nominated water quality objectives	Section 3
Identify the principles and objectives of the proposed monitoring in the coal seams and surrounding aquifers and include a supporting rationale for the monitoring.	Volume 2 Section 6
The EIS should outline all of the approvals required under the Water Act 2000, Water Regulation 2002 Works that would normally require a riverine protection permit can be completed by following the Mining "Entities Guidelines" Guideline - Activities in a Watercourse, Lake or Spring associated with Mining Operations WAM/2008/3435 – Version 2. Address where there will be a requirement for a Quarry Material Allocation and an associated Development Approval under the Sustainable Planning Act.	Section 1.4

Appendix B

Groundwater Database Summary Tables

Section 1 – Adani Mine Lease to Mistake Creek

Section 2 – Mistake Creek to Diamond Creek

Section 3 – Diamond Creek to Goonyella Rail Line

Bore Details		Location		Condition	Aquifer Properties				Screen Details			Lithology				Laboratory Results					Field Results			
RN	Drilled Date	Easting	Northing	TypeAndStatus	Top	Base	MaxYield(l/s)	SWL (mbgl)	Description	Top	Base	Top	Base	Description	Formation Description	Depth	Date	EC	pH	TDS	Date	EC	pH	Temp
17980	19680419	426849	7565142	, Abandoned and Destroyed				18.3									11/10/1973	400	7.7	0.00				
17980																	21/06/1993	373	7.4	183.63				
17982	19680419	433592	7565399	Water Supply , Existing				29.5				0	0.91	TOP SOIL	SEDIMENTS	58	19/04/1968	795	7	0.00				25.5
17982												0.91	9.44	CLAY		58	11/10/1973	865	8.2	0.00				
17982												9.44	32.3	SANDSTONE			21/06/1993	812	8.2	490.81				26.5
17982												32.3	36.57	SANDSTONE										24.6
17982												36.57	42.06	CHALK										23.6
17982												42.06	42.67	ROCK										
17982												42.67	48.76	CHALK										26.2
17982					48	57						48.76	52.73	WHITE SANDSTONE										
17982												52.73	57.91	COARSE SANDSTONE										
17982												57.91	61.26	BLACK SANDSTONE										
17983	19680419	450752	7572717	, Existing				18.3									21/06/1993	6990	6.7	3914.19				
22068	19560630	491586	7589541	, Existing																				
30176	19680903	449650	7576288	Water Supply, Abandoned and Destroyed	43	48						0	0.3	TOP SOIL	SEDIMENTS									
30176					80	80.9	11	-12.2				0.3	1.82	GRAVEL	SEDIMENTS									
30176												1.82	41.14	SLIPPERY BACK										
30176												41.14	41.75	SILT SOAK										
30176												41.75	43.28	BROWN MUDSTONE										
30176												43.28	48.15	SANDSTONE WATER BEARING								POTABLE		
30176												48.15	53.34	MUDSTONE										
30176												53.34	67.05	WHITE CLAY										
30176												67.05	80.77	SANDSTONE										
30176												80.77	80.92	DRIFT WATER BEARING								UNSUITABLE		
47167	19750715	432099	7559599	, Existing				22.1				0	47.24	NO STRATA DETAILS AVAILABLE										
62614	19000101	475217	7575751	, Existing													31/05/1993	2272	8.2	1300.34				
89246	19930629	475963	7573614	, Existing				33				0	1.5	SOIL	UNDIFFERENTIATED							2060		
89246												1.5	57	SANDSTONE										
89246					60	150			PERF	84	150	57	150	GREY SANDSTONE										
90257	19930726	442360	7576313	, Existing				-27				0	3	SOIL										
90257												3	40	CLAY										
90257												40	75	SOFT SANDSTONE WITH HARD BANDS										
90257									PERF	96	120	75	90	SANDSTONE										
90257					92	126			OPEN	120	126	90	126	SANDSTONE AND SHALE BROKEN AND	UNDIFF.							17750.00		
90258	19920905	426775	7565785	Water Supply , Existing				39.6				0	1.22	TOPSOIL AND SOFT ROCK	UNDIFFERENTIATED							320		
90258												1.22	17.98	SANDY CLAY										
90258												17.98	35.66	SILTY CLAY										
90258												35.66	44.81	SOFT ROCK										
90258												44.81	62.79	MUDSTONE										
90258												62.79	64.31	SILTY CLAY										
90258												64.31	67.06	CLAY AND SAND BANDS *										
90258												67.06	74.98	SAND AND CLAY										
90258					74.98	76.5	1.89		SCRN	75.3	76.2	74.98	76.5	SAND *										
90258									OPEN	76.2	79.3	76.5	79.25	CLAY										
90368	19950603	450622	7573363	Water Supply , Existing				15				0	1	TOP SOIL & SAND	ALLUVIUM						3/06/1995	2100		
90368												1	37.7	MULTICOLOURED CLAYS										
90368					37.7	40	3.9		SCRN	38.5	40	37.7	40	SAND	TERTIARY - UNDEFINED									
90369	19950604	431919	7560469	, Existing				21				0	1.2	TOP SOIL & CLAY	TERTIARY SEDIMENTS						4/06/1995	400		
90369					35.6	39.3	1.6		PERF	33.5		1.2	39.3	SANDSTONE & CLAY BANDS										
90369												39.3	64.3	CLAYS										
90369												64.3	65.5	SANDSTONE										
103140	19920520	481754	7579837	Water Supply, Existing	0	152	0.5	-33.5				0	152	NO DETAILS										
132301	20030706	474206	7576992	Water Supply, Abandoned and Destroyed								0	2	SANDY TOP SOIL										
132301												2	9	WEATHERING										
132301												9	12	RED AND GREY MUDSTONE										
132301												12	22	WEATHERING										
132301												22	25	GREY SILTSTONE										
132301												25	27	YELLOW AND ORANGE SILT										
132301												27	29	MUDSTONE										
132301												29	38	SILTSTONE										
132301												38	40	SANDSTONE COARSE										
132301												40	110	FINEGRAIN SANDSTONE (DRY HOLE)										
132302	20030707	476719	7570565	Water Supply , Abandoned and Destroyed								0	1	BLACKSOIL										
132302												1	3	RED CLAY										
132302												3	23	CLAY RED AND GREY										
132302												23	57	MUDSTONE										
132302												57	77	SILTSTONE										
132302												77	153	SANDSTONE (DRY HOLE)										

Bore Details		Location		Condition	Aquifer Properties				Screen Details			Lithology				Laboratory Results					Field Results			
RN	Drilled Date	Easting	Northing	TypeAndStatus	Top	Base	MaxYield(l/s)	SWL (mbgl)	Description	Top	Base	Top	Base	Description	Formation Description	Depth	Date	EC	pH	TDS	Date	EC	pH	Temp
132303	20030708	467217	7575175	Water Supply , Abandoned and Destroyed								0	1	BLACK SOIL										
132303												1	3	CLAY										
132303												3	6	SAND										
132303												6	11	RED WEATHERING										
132303												11	19	CLAYS REDS AND GREYS										
132303												19	45	MUDSTONES										
132303												45	48	CLAYS										
132303												48	56	SANDY CLAYS										
132303												56	62	WEATHERED SANDSTONE RED AND WHITE										
132303												62	69	SANDSTONE SALT										
132303												69	74	MUDSTONE										
132303												74	75	WEATHERED COAL (BLACK)										
132303												75	78	WEATHERED SANDSTONE										
132303												78	92	SANDSTONE (DRY HOLE)										
132304	20030709	476801	7573804	Water Supply , Abandoned and Destroyed								0	1	BLACK SOIL										
132304												1	20	CLAY										
132304												20	74	WEATHERED SANDSTONE										
132304												74	104	SANDSTONE COARSE										
132304												104	138	MUDSTONE GREEN AND BROWN										
132304												138	153	SANDSTONE FINE GRAIN (DRY HOLE)										
132305	20030709	475568	7575537	Water Supply , Abandoned and Destroyed				30				0	1	RED SANDY TOP SOIL								1980		
132305												1	5	WEATHERING										
132305												5	7	GRAVEL										
132305												7	10	WEATHERING										
132305					53	63	0.48		PERF	53		10	63	WEATHERED SANDSTONE *	TERTIARY - UNDEFINED									
132305											120	63	120	GREY GREENY SANDSTONE										
132305												120	125	FINE GRAINED SANDSTONE										
12030085	19750506	461241	7573393	Sub-Artesian Monitoring , Abandoned but still useable				12.22				0	0.2	SILTY TOP SOIL	BELYANDO R. ALLUV									
12030085												0.2	0.6	SANDY SILT										
12030085												0.6	1.5	SILTY SANDY CLAY										
12030085												1.5	3.8	SILTY SAND										
12030085												3.8	4.8	SAND										
12030085												4.8	7.7	CLAYEY SAND										
12030085												7.7	7.8	SANDY CLAY										
12030085												7.8	9.1	CLAYEY SAND										
12030085												9.1	9.8	SANDY CLAY										
12030085												9.8	13.5	CLAY										
12030085					13.5	16.9						13.5	16.9	SAND										
12030085												16.9	23	CLAY										
12030086	19750506	464900	7571578	Water Resources Investigation , Abandoned but still useable								0	0.1	SILTY TOP SOIL	BELYANDO R ALLUV									
12030086												0.1	2.2	CLAY										
12030086												2.2	4.8	SILTY CLAY										
12030086												4.8	6.9	CLAYEY SILT										
12030086												6.9	7.5	SILTY CLAY										
12030086												7.5	9.2	CLAYEY SILTY SAND										
12030086												9.2	10.1	CLAYEY SANDY SILT										
12030086					10.1	11.8	0					10.1	11.8	CLAYEY SAND AND GRAVEL										
12030086												11.8	13.9	CLAY										
12030087	19750502	465361	7571505	Water Resources Investigation , Abandoned but still useable								0	0.2	SILTY TOPSOIL	BELYANDO R ALLUV									
12030087												0.2	2.6	SILTY CLAY										
12030087												2.6	6.5	SAND										
12030087												6.5	9	CLAYEY SAND										
12030087					9	11.4	0					9	11.4	CLAYBOUND SAND										
12030087												11.4	12.5	CLAY										
12030088	19750502	466231	7571863	Water Resources Investigation , Abandoned but still useable								0	0.3	SILTY TOPSOIL	BELYANDO R ALLUV									
12030088												0.3	2.6	SILTY CLAY										
12030088												2.6	4.1	SILTY SANDY CLAY										
12030088												4.1	5.8	SAND										
12030088												5.8	7.8	SAND AND GRAVEL										
12030088												7.8	9.8	CLAYEY SAND										
12030088					9.8	11.4	0					9.8	11.4	SAND AND GRAVEL										
12030088												11.4	13.9	CLAY										

Bore Details		Location		Condition	Aquifer Properties				Screen Details			Lithology				Laboratory Results					Field Results			
RN	Drilled Date	Easting	Northing	TypeAndStatus	Top	Base	MaxYield(l/s)	SWL (mbgl)	Description	Top	Base	Top	Base	Description	Formation Description	Depth	Date	EC	pH	TDS	Date	EC	pH	Temp
12030089	19750418	467627	7572668	Water Resources Investigation , Existing				11.3				0	0.2	SILTY TOP SOIL	BELYANDO R ALLUV									
12030089												0.2	2.7	SILTY CLAY										
12030089												2.7	3.5	SILTY SANDY CLAY										
12030089												3.5	7.3	SAND										
12030089												7.3	11.9	CLAYEY SAND										
12030089					11.9	12.6						11.9	12.6	CLAYEY SAND AND GRAVEL										
12030089												12.6	15.4	CLAY										
12030089												15.4	18.3	SILTSTONE										
12030089												18.3	29.3	CLAY										
12030089												29.3	31	SILTY CLAY										
12030089												31	34.8	CLAY										
12030089												34.8	37	SILTY CLAY										
12030089												37	47.5	CLAY										
12030089												47.5	50.3	SILTY CLAY										
12030089												50.3	54.4	SANDY CLAY										
12030089												54.4	73.1	WEATHERED SANDSTONE										
12030175	20040710	480019	7571954	Sub-Artesian Monitoring , Existing				39				0	3	BROWN CLAY SOIL	QUATERNARY - UNDEFINED	62	10/07/2004	13500	8.1	7588.63	17/11/2004	14010		
12030175												3	5	RED BROWN CLAY SOIL							28/05/2006	15500	8.5	
12030175												5	9	GREYSIH BROWN SANDY CLAY	TERTIARY - UNDEFINED						12/07/2004	13760		
12030175												9	13	BROWNISH GREY CLAY RED BROWN MOTTLING										
12030175												13	17	LIGHT BROWN CLAYEY SAND, RUST-RED BROWN MOTTLING										
12030175												17	18	CLAYEY IRONSTONE GRAVEL										
12030175												18	25	GREENISH BROWN DECOMPOSED CLAYEY VF-F SANDSTONE, OXIDISED	MOUNT HALL CONGLOMERATE FORMATION									
12030175												25	39	OLIVE GREEN DECOMPOSED CLAYEY VF-F SANDSTONE										
12030175												39	42	PALE GREY WEATHERED CLAYEY VF-F LITHIC SANDSTONE										
12030175												42	54	OLIVE GREEN WEATHERED CLAYEY VF-F LITHIC SANDSTONE										
12030175									PERF	62.52	64.02	54	67	GREY CLAYEY VF-F LITHIC SANDSTONE										

Bore Details		Location		Condition	Aquifer Properties				Screen Details			Lithology				Laboratory Results					Field Results				
RN	Drilled Date	Easting	Northing	TypeAndStatus	Top	Base	MaxYield(l/s)	SWL (mbgl)	Material	Top	Base	Top	Base	Description	Formation Description	Depth	Date	EC	pH	TDS	Date	Depth	EC	pH	Temp
10853	19000101	541830	7570024	Water Supply , Abandoned and Destroyed								0	121.92	NO STRATA DETAILS AVAILABLE											
62536	19640101	497345	7582582	, Existing				27.4				0	45.72	NO STRATA DETAILS AVAILABLE							30263		BRACKISH		
62587	19000101	496972	7590885	, Existing				60.96	OPEN	91.4	97.5	0	97.5	NO STRATA DETAILS AVAILABLE							30340		GOOD		
84363	19880901	497065	7590239	, Existing								0	0.91	SHALE AND QUARTZ ROCK AND SANDY CLAYS							32945		495		
84363												0.91	54.86	SANDSTONE & BANDS OF GRAVEL CEMENTED IN SOME ROCKS OF ALTERED SHALES											
84363					54.9	88						54.9	82.3	YELLOW TO GREY SANDSTONE *	MOUNT HALL CONGLOMERATE FORMATION											
84363												82.3	88.39	GREY SANDSTONE *											
84363												88.4	94.49	MUDSTONE											
84363												94.5	109.73	GREY SANDSTONE											
84363					110	119						110	118.87	GREY TO YELLOW SANDSTONE *	MOUNT HALL CONGLOMERATE FORMATION										
84363												119	121.92	GREY SANDSTONE											
84363					122	126						122	126.49	COARSE QUARTZ CEMENTED GRAVEL *	MOUNT HALL CONGLOMERATE FORMATION										
84363												126	128.02	BLUE SHALE											
103912	20060509	506032	7575395	Mineral or Coal Exploration , Existing				65				0	3	SURFACE SOIL RED	TERTIARY - UNDEFINED										
103912												3	7	LIGHT RED OXIDISED CLAYS											
103912												7	9	BLEACHED CREAMY CLAY											
103912												9	39	RED 70 PINK OXIDISED CLAYS											
103912									PERF	67		39	85	CREAM CLAYS OXIDISED											
103912					85	97	3.43				97	85	97	DARK GREY SILICIFIDD SILTSTONE *											
103913	20060429	505108	7575663	Mineral or Coal Exploration , Existing				75				0	0.1	TOP SOIL	STAR OF HOPE FORMATION										
103913												0.1	3	RED SANDY CLAY											
103913												3	39	SILTITION/SANDSTONE											
103913												39	54	WEATHERED SILTITION SANDSTONE											
103913												54	72	SILTITION CLAYS											
103913									PERF	91		72	96	SILTITION MINOR SANDSTONE BARS											
103913					96	145	0.4					96	132	MEDIUMOR SANDSTONE *											
103913												132	141	TRACHYTO DUKE											
103913												141	142	MED GRAINED DARK GREY SANDSTONE *											
103913											145	142	145	TRACHYTO DYKE HARD											
132195	20050605	493569	7576026	Water Supply , Existing				53				0	6	SANDY CLAY	STAR OF HOPE FORMATION							75 - 83	2000		
132195												6	33	CLAY											
132195												33	75	HARD SANDY CLAY											
132195					75	83	0.75		PERF	75	80	75	83	HARD SHALE WITH SOFT SEAMS *											
132307	20030712	504842	7590828	Water Supply, Abandoned and Destroyed								0	1	BLACK FILL CLAY AND ROCK											
132307												1	2	GRAVEL											
132307												2	9	WEATHERING											
132307												9	12	CLAY											
132307												12	36	WEATHERING											
132307												36	63	SHALE											
132307												63	71	WEATHERED SANDSTONE											
132307												71	81	COARSE SANDSTONE											
132307												81	87	FINE GRAIN SANDSTONE											
132307												87	134	DARK BROWN HARD ROCK (DRY HOLE)											
12030172	20040703	518563	7580207	Sub-Artesian Monitoring , Existing								0	2	BROWNISH GREY CLAYEY SOIL	QUATERNARY - UNDEFINED	84	03-Jul-04	44000	7.6	27655.68	02-Dec-03	90.5	45500		
12030172												2	6	GREEN GREY SANDY CLAY GYPSUM CRYSTALS							16-Sep-10		45400		
12030172												6	8	DARK GREY CLAY, GYPSUM CRYSTALS, RUST BROWN MOTTLING											
12030172												8	11	LIGHT GREY CLAY, GYPSUM CRYSTALS, RUST BROWN AND PURPLE MOTTLING											
12030172												11	13	DARK GREY CLAY, PURPLE MOTTLING											
12030172												13	20	DARK GREY CLAY											
12030172												20	22	GREY CLAYSTONE											
12030172												22	27	OFF WHITE CLAYSTONE	ANAKIE METAMORPHICS										
12030172												27	29.5	OFF WHITE SANDY CLAYSTONE											
12030172												29.5	33	OFF WHITE CLAYSTONE											
12030172												33	36	OFF WHITE SANDY CLAYSTONE											
12030172												36	38	OFF WHITE CLAYSTONE											
12030172												38	40	CLAYSTONE, MAUVE MOTTLING											
12030172												40	44	CLAYSTONE, PINKISH PURPLE MOTTLING											
12030172												44	50	OFF WHITE CLAYSTONE, RUST BROWN MOTTLING											
12030172												50	55	OFF WHITE CLAYSTONE, RUST BROWN & PURPLE MOTTLING											
12030172												55	62	GREYISH WHITE CLAYSTONE, RUST BROWN MOTTLING											
12030172												62	65	OFF WHITE SANDY CLAYSTONE, RUST BROWN MOTTLING											
12030172												65	75	OFF WHITE CLAYSTONE, RUST BROWN MOTTLING											
12030172												75	77	OFF WHITE SANDY CLAYSTONE, RUST BROWN											
12030172												77	80	OFF WHITE CLAYSTONE, PURPLE MOTTLING											
12030172									PERF	84.48	87.48	80	88	BROWNISH GREY WEATHERED PHYLLITE, FRACTURED QTZ VEINS											
12030172												88	97.8	OLIVE GREY WEATHERED PHYLLITE, FRACTURED QTZ VEINS, BROWN MOTTLING											

Bore Details		Location		Condition	Aquifer Properties				Screen Details			Lithology				Laboratory Results					Field Results				
RN	Drilled Date	Easting	Northing	TypeAndStatus	Top	Base	MaxYield(l/s)	SWL (mbgl)	Material	Top	Base	Top	Base	Description	Formation Description	Depth	Date	EC	pH	TDS	Date	Depth	EC	pH	Temp
12030176	20040713	499284	7588660	Sub-Artesian Monitoring, Existing				43.26				0	4	GREY BROWN CLAY SOIL	QUATERNARY - UNDEFINED						13-Jul-04		52700		
12030176												4	6.5	DARK GREY CLAY, RED BROWN MOTTLING							17-Nov-04	69	53100		24.4
12030176												6.5	9	DARK GREY CLAY, GYPSUM CRYSTALS, RED BROWN MOTTLING							27-May-06		52200	7.5	24.6
12030176												9	11	GREY CLAY, RUST BROWN MOTTLING											
12030176												11	13	PALE PURPLE CLAY, RUST BROWN MOTTLING											
12030176												13	17	CREAM OFF WHITE CLAYSTONE, RUST BROWN MOTTLING	MOUNT HALL CONGLOMERATE FORMATION										
12030176												17	21	PURPLISH OFF WHITE CLAYSTONE											
12030176												21	26	OFF WHITE SANDY CLAYSTONE											
12030176												26	30	OFF WHITE CLAYSTONE											
12030176												30	33	OFF WHITE CLAYSTONE, RUST BROWN & PURPLE MOTTLING											
12030176												33	40.5	OFF WHITE SANDY CLAYSTONE, RUST BROWN MOTTLING											
12030176												40.5	45	PALE GREY & PURPLE CLAYSTONE, RUST BROWN MOTTLING											
12030176												45	51	PALE GREY SANDY CLAYSTONE, RUST BROWN & PURPLE MOTTLING											
12030176									PERF	67.5	69.5	51	66	DARK PURPLISH BROWN SHALE, FRACTURED, ALTERED, WEAKLY SILICIFIED, BLEACHING ALONG FRACTURES											
12030176												66	70.2	PALE GREEN CREAM SILTY CLAYSTONE											

Bore Details		Location		Condition	Aquifer Properties				Screened Details			Lithology				Laboratory Results					Field Results				
RN	Drilled Date	Easting	Northing	TypeAndStatus	Top	Base	MaxYield(l/s	SWL (mbgl	Material	Top	Base	Top	Base	Description	Formation Description	Depth	Date	EC	pH	TDS	Date	Depth	EC	pH	Temp
30166		595767	7558845	, Abandoned and Destroyed																					
37601	19711030	585905	7555170	Water Supply , Abandoned and Destroyed								0	1.22	BLACK SOIL DRILLED FOR THE LAC											
												1.22	2.74	BROWN CLAY ON WUTHUNG HOLDING											
												2.74	3.66	SANDY BROWN CLAY PARISH OF MARTYR											
												3.66	4.27	BROWN CLAY AND LIME NODULES											
												4.27	7.92	BROWN CLAY											
												7.92	21.03	MOTTLED CLAYS ISSUED WITH OFFICE											
												21.03	22.86	GREYWACKE LICENSE											
												22.86	29.26	MUDSTONE											
												29.26	33.22	BROWN SANDY CLAY											
												33.22	34.75	GREY SANDSTONE											
												34.75	36.58	MUDSTONE											
												36.58	37.8	COARSE GRAINED GREYWACKE											
												37.8	39.32	MUDSTONE											
												39.32	40.23	COARSE GRAINED GREYWACKE											
												40.23	86.26	MUDSTONE											
												86.26	86.56	CARBONACEOUS MUDSTONE											
												86.56	89.31	BANDS OF COAL AND GREYWACKE											
												89.31	102.11	COARSE GRAIN GREYWACKE WITH QUARTZ											
												102.11	117.04	WEATHERED ANDESITE											
37602	19711120	581751	7558103	Water Supply , Abandoned and Destroyed								0	2.13	BROWN CLAY											
												2.13	7.32	REDDISH BROWN CLAY											
												7.32	25.91	MOTTLED CLAY											
												25.91	26.82	GREYWACKE DRILLED FOR THE L.A.C.											
												26.82	28.96	MUDSTONE ON WUTHUNG HOLDING											
												28.96	30.18	GREYWACKE PARISH OF MARTYR											
												30.18	41.45	MUDSTONE											
												41.45	43.28	GREYWACKE											
												43.28	119.79	MUDSTONE											
												119.79	123.14	WEATHERED ANDESITE											
												123.14	125.58	FRESH ANDESITE											
												125.58	127.1	WEATHERED AND JOINTED ANDESITE											
												127.1	129.54	ANDESITE											
												129.54	131.37	BASALT											
												131.37	152.1	ANDESITE WITH WEATHERED ZONES											
37603	19711031	576712	7569924	, Abandoned and Destroyed								0	0.61	BROWN SOIL DRILLED FOR THE L.A.C.											
												0.61	3.05	BROWN CLAY ON WUTHUNG HOLDING											
												3.05	3.66	SANDY BROWN CLAY PARISH OF MARTYR											
												3.66	5.79	TIGHT BROWN CLAY ISSUED WITH OFFICE											
												5.79	6.4	CLAYBOUND GRAVEL LICENSE											
												6.4	7.32	CLAY AND BASALT STONES											
												7.32	16.76	BROWN CLAY											
												16.76	17.98	SANDSTONE											
												17.98	22.86	GREY CLAY											
												22.86	100.59	MUDSTONE											
												100.59	105.16	WEATHERED ANDESITE											
37604	19711107	577545	7572803	, Abandoned and Destroyed								0	1.52	BLACK SOIL											
												1.52	24.38	CLAYS											
												24.38	36.58	MUDSTONE											
												36.58	38.71	VERY SOFT RED COARSE GRAIN SANDSTONE											
												38.71	41.15	MUDSTONE											
												41.15	41.76	SANDSTONE											
												41.76	53.34	MUDSTONE											
												53.34	53.65	GREYWACKE											
												53.65	120.4	MUDSTONE											
												120.4	131.07	WEATHERED ANDESITE											
62394	19000101	549313	7578374	Water Supply , Existing	0	42.6	1	27.4	OPEN	36.6	42.7	0	42.6	NO STRATA DETAILS AVAILABLE	SUTTOR FORMATION								BRACKISH		
89367	19920906	588221	7551654	, Existing				61				0	0.3	SANDY CLAY	BLENHEIM SUBGROUP								BRACKISH		
												0.3	2.44	CLAY											
												2.44	3.05	WEATHERED SANDSTONE BAND											
												3.05	6.1	CLAY											
												6.1	7.62	WEATHERED SANDSTONE BAND											
												7.62	8.53	CLAY											
												8.53	9.14	SAND AND GRAVEL											
												9.14	32	CLAY											
												32	41.15	SANDY CLAY											
												41.15	79.25	CLAY											
					79.2	85.3			PERF	79.2	85.3	79.25	85.34	SAND (FINE GRAINED) *											
												85.34	87.48	CLAY											
90045	19930101	580225	7559216	Water Supply , Existing				51.2				0	85.3	MULTICOLOURED CLAYS WITH SAND BANDS	BLENHEIM SUBGROUP (UNDIFF.)								9600		
					85.3	90	0.75		PERF	88.4	90	85.3	90	FINE SAND *											

Bore Details		Location		Condition	Aquifer Properties				Screened Details			Lithology				Laboratory Results					Field Results				
RN	Drilled Date	Easting	Northing	TypeAndStatus	Top	Base	MaxYield(l/s	SWL (mbgl	Material	Top	Base	Top	Base	Description	Formation Description	Depth	Date	EC	pH	TDS	Date	Depth	EC	pH	Temp
12030181	20040807	559022	7578643	Stratigraphic Investigation , Abandoned and Destroyed								0	4	DARK CHOCOLATE TO RED BROWN CLAY	QUATERNARY - UNDEFINED	59	07-Aug-04	17500	8	10359.71	07-Aug-04	63	18010		
												4	13	LIGHT GREY AND MAROON SILTY CLAY	SUTTOR FORMATION										
												13	26	LIGHT GREY BROWN SILTY CLAY WITH YELLOW AND MAROON FE OXIDE											
												26	29	LIGHT GREY FINE TO MEDIUM SEMI-CONSOLIDATED SAND/SANDSTONE:SLIGHTLY DAMP IN THIS INTERVAL											
												29	33	BROWN TO ORANGE BROWN STIFF SLIGHTLY SILTY CLAY											
												33	55	VERY LIGHT GREY TO LIGHT PINK SLIGHTLY SILTY CLAY WITH MINOR YELLOW BROWN FE OXIDE											
					55							55	58	LIGHT GREY CLAYEY FINE SEMI-CONSOLIDATED SAND :DAMP FROM 56; WET FROM 57	TERTIARY - UNDEFINED (SUTTOR FORMATION)										
									PERF	59.35		58	61	LIGHT CREAM GREY FINE TO MEDIUM DESCR SEMI-CONSOLIDATED CLAYEY SAND											
						69					63.35	61	69	DIRTY CREAM CLAYS WITH FINE TO COARSE 2MM QUARTZ. POOR SAMPLE											

Page intentionally left blank

GHD

145 Ann Street Brisbane QLD 4000
GPO Box 668 Brisbane QLD 4001
T: (07) 3316 3000 F: (07) 3316 3333 E: bnemail@ghd.com.au

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	V Dear M Prskalo	K Phillipson G Squires	On file	J Scott	On file	20/02/2012
1	M Prskalo	G Squires		J Keane		18/09/2012