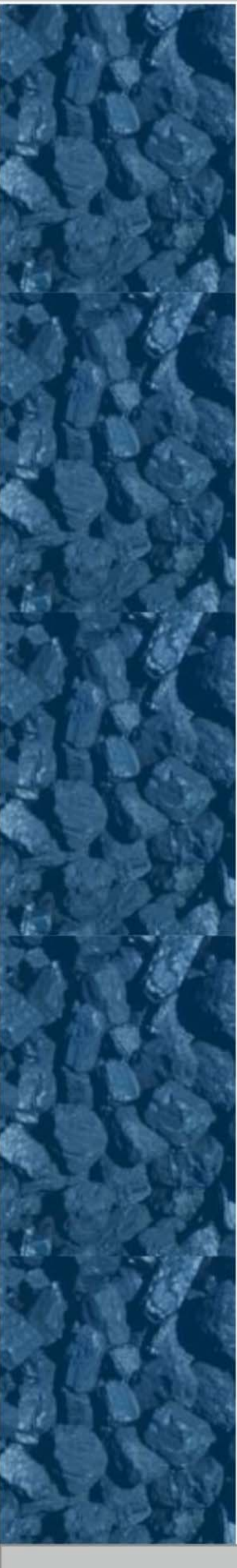
Adani Mining Pty Ltd



Adani Mining Pty Ltd

Report for Carmichael Coal Mine and Rail Project: Mine Technical Report

Hydrogeology Report 25215-D-RP-0026

15 November 2012

Revision 2

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Abbreviations and Glossary

Project Specific Terminology	
Abbreviation	**Term**
the EIS	Carmichael Coal Mine and Rail Project Environmental Impact Statement
the Proponent	Adani Mining Pty Ltd
the Project	Carmichael Coal Mine and Rail Project
Generic Terminology	
Abbreviation	**Term**
ADWG	Australian Drinking Water Guidelines
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
BOM	Bureau of Meteorology
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CEMP	Construction Environmental Management Plan
CSG	Coal Seam Gas
DEHP	Department of Environment and Heritage Protection (Qld)
DERM	Department of Environment and Resource Management (Qld) – now superseded by DEHP and DNRM
DNRM	Department of Natural Resources and Mines (Qld)
DO	Dissolved Oxygen
DRN	Drain boundary
EC	Electrical Conductivity
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EPC	Exploration Permit for Coal
EPP (Water)	Queensland Environmental Protection (Water) Policy 2009
EVs	Environmental Values
FWL	Fracture well
GAB	Great Artesian Basin

GABCC	Great Artesian Basin Consultative Council
GDE	Groundwater Dependent Ecosystem
GHB	General head boundary

Generic Terminology

Abbreviation	Term
GMA	Groundwater Management Area
GMU	Groundwater Management Unit
GWMP	Groundwater Management Plan
LIDAR	Light Detection and Ranging
LTV	Long-term trigger value
LoR	Limit of Reporting
mAHD	Metres Australian Height Datum
mBGL	Metres below ground level
MIA	Mine Infrastructure Area
Mtpa	Million tonnes per annum
PAHs	Polycyclic Aromatic Hydrocarbons
ROP	Resource Operations Plan
RSF	Recharge-seepage face
SPA	*Sustainable Planning Act 2009*
STV	Short-term trigger value
SWMP	Surface Water Management Plan
TDS	Total dissolved solids
TOC	Total organic carbon
ToR	Terms of reference
TPH	Total Petroleum Hydrocarbon
QWQG	Queensland Water Quality Guidelines
WERD	Water Entitlements Registered Database
WQGs	Water Quality Guidelines
WQOs	Water Quality Objectives
WRP	Water Resource Plan

1. Introduction

1.1 Background

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.

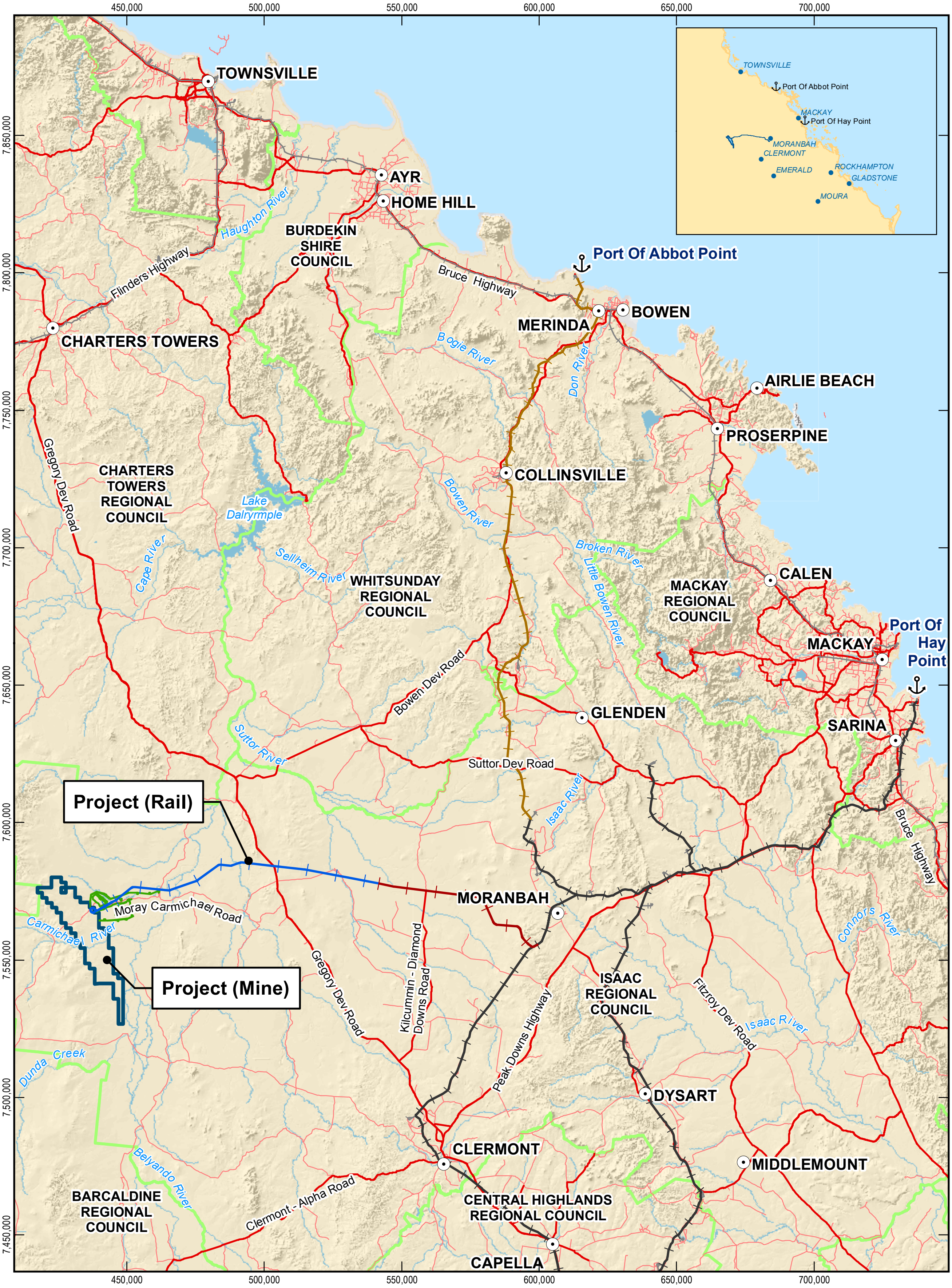
The Project comprises of two major components:

- 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
  - An industrial development area and 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) for which, an Environmental Impact Statement (EIS) is required for. 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.



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

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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

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

Data Source: © 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

1.2 Report Purpose

This hydrogeological study has been prepared as part of the Environmental Impact Statement (EIS) for the proposed Carmichael Coal Mine Project (the Project (Mine)). The primary purpose of this hydrogeological study is to:

- Address groundwater related parts of Section 3.4 (Water Resources) of the terms of reference (ToR) for the Project EIS, and specifically to:
  - Describe the existing environmental values of local groundwater resources using pre-existing published data and information collected from site specific field investigations
  - Assess the potential impacts of the proposed development on local groundwater resources
  - Identify mitigation and management options and ongoing groundwater monitoring requirements

Table 1-1 provides a summary of the terms of reference cross reference. Full details of each section are provided in Appendix A.

Table 1-1 Terms of Reference Cross Reference

Terms or Reference Section	Report Section
3.4. Water Resources	
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.	Volume 4 Appendix P
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.	Sections 2.2.4, 2.3.1
Describe the environmental values of the groundwater of the affected area in terms of existing and other potential surface and groundwater users	Section 4.5
Provide a detailed description of the quality and quantity of groundwater resources in the area potentially affected by the project.	Sections 4.4, 4.5
Describe the groundwater quality considering seasonal variations in depth and flow.	Sections 4.3, 4.4, Appendix E, Appendix D
All sampling should be performed in accordance with the Monitoring and Sampling Manual 2009 or the most current edition.	Section 2
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 4.3, 4.7

Terms or Reference Section	Report Section
3.4. Water Resources	
Describe the environmental values of the groundwater of the affected areas.	Sections 4, 6, 7
If the project is likely to use or affect local sources of groundwater, describe the groundwater resources in the area in terms of, current user, aquifer type, groundwater flows etc.	Section 4
The groundwater assessment should also be consistent with relevant guidelines for the assessment of acid sulphate soils, including spatial and temporal monitoring, to accurately characterise baseline groundwater characteristics.	Not Applicable (Acid Sulphate Soils are not anticipated) Volume 2 Section 4.2
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 assess the potential take of water from the aquifer and how current users and the aquifer itself and any connected aquifers will be affected.	(In relation to take of water from dewatering) Sections 2.2.4, 3.6, 4.5, 4.7, 4.8
The review should include a survey of existing groundwater supply facilities (bores, wells, or excavations) to the extent of any environmental harm.	Sections 2.2.4, 4.5
Develop a network of observation points that would satisfactorily monitor groundwater resources both before and after commencement of operations.	Section 2.3
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 2.3, 4.4
3.4.2 Potential Impacts and Mitigation Measures	
Assess potential impacts, including long-term indirect impacts of the project on water resource environmental values identified in the previous section. Define and describe the objectives and practical measures for protecting or enhancing water resource environmental values, to describe how nominated quantitative standards and indicators may be achieved, and how the achievement of the objectives will be monitored, audited and managed.	Section 5.6, 7.2, 7.3, 7.6, 7.8.6, 7.8.11, 8.2 Volume 2 Section 10 and Section 12, Volume 4 Appendix P
Describe and address the impacts of subsidence in relation to groundwater.	Sections 7.1, 7.7
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 7.7
Detail measures that would mitigate the impacts of subsidence.	Section 7.8.12

1.3 Scope

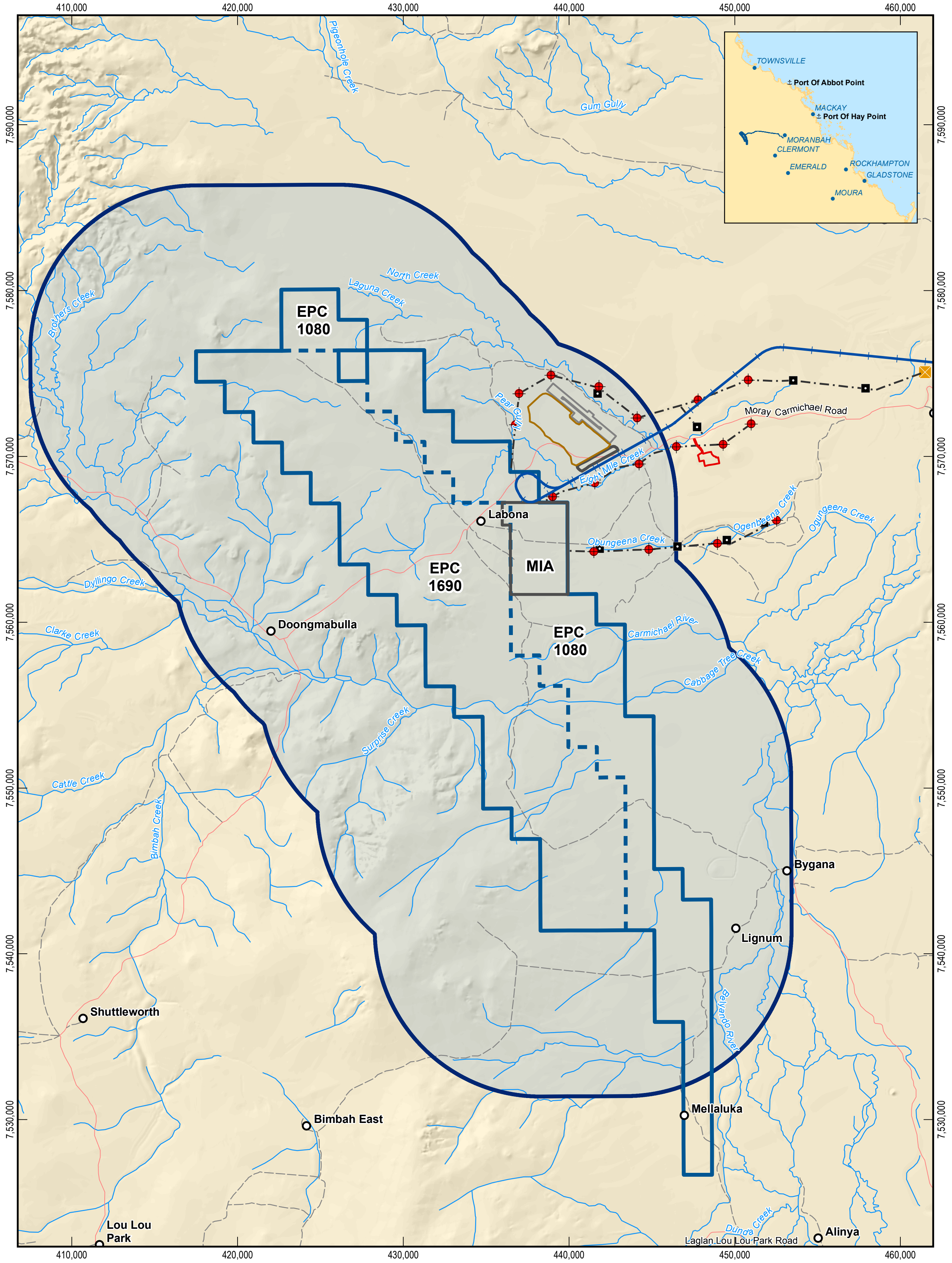
The following scope of works was undertaken, the results of which are summarised in this report:

- Desktop review of geology, hydrogeology and groundwater bores
- Installation of a groundwater monitoring bore network
- Groundwater monitoring and hydrogeological testing of the installed monitoring bores
- Description of the existing hydrogeological conditions and environmental values
- Development of a numerical groundwater model
- Identification of potential impacts and management and mitigation measures

1.4 Study Area

A 10 km radius extending outwards from the boundary of exploration lease EPC 1690 and the eastern portion of EPC 1080 defines the Hydrogeology Study Area (the Study Area).

Figure 1-2 shows the Study Area.



LEGEND

Homestead	Rail (West)	Mine (Offsite)	Airport Location
Local Road	Mine (Onsite)	Borehole	Rail Siding
Track	Mine Infrastructure Area	Storage Site (Instream)	Industrial Area
Watercourse	Hydrogeology Study Area	Storage Facility (Offstream)	Workers Accommodation Village
		Pipeline Network	

1:325,000 (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

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Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

Job Number | 41-25215
Revision | B
Date | 03-09-2012

Hydrogeology Study Area

Figure 1-2

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

Data Source: DME: EPC 1690 (2010)/EPC 1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); GHD: Hydrogeology Study Area (2011); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW, CA

2. Methodology

2.1 Overview

Figure 1-2 shows the Hydrogeology Study Area (the Study Area), encompassing the adjacent exploration leases EPC 1690 and the eastern portion of EPC 1080 and nearby surrounding areas.

Information and data obtained from a desktop review and hydrogeological field investigations have been used to appraise the hydrogeological conditions in the Study Area and to define the environmental values for groundwater resources. The potential impacts of the Project (Mine) on groundwater resources have been assessed in relation to the current baseline hydrogeological conditions as identified from the desktop review and field investigations. Mitigation measures and monitoring strategies have been identified to confirm any impacts of the proposed Project (Mine) on groundwater resources.

2.2 Desktop Review

The following activities have been carried out as part of the desktop review:

- Collation and review of existing reports, maps and data
- Review of records held on the Queensland Groundwater Bore Database (DERM, December 2010)
- Communications with DNRM (Rockhampton) and Isaac Regional Council

2.2.1 Data Review

The following published information has been used in the preparation of this report:

- Carmichael Macro-Conceptual Mine Study report (Runge Ltd, May 2011)
- Galilee Project – In situ Coal Resources Estimate report (Xenith Consulting Pty Ltd, November 2009)
- Galilee Project Technical Due Diligence report (GHD, August 2010)
- Borehole logs from previous exploration programs (Linc Energy, not dated and Carr, 1974)
- North Eromanga Basin map sheet (1:1 000 000) digital version (Queensland Department of Natural Resources, Mines and Energy, 2004)
- Geology map sheet SF55-10, Galilee, (1:250 000) (Bureau of Mineral Resources, Geology and Geophysics, 1972)
- Geology map sheet SF55-6, Buchanan, (1:250 000) (Bureau of Mineral Resources, Geology and Geophysics, 1982)
- Selected information from the Queensland Groundwater Database (DNRM), data extracted December 2010
- Australian Groundwater Management Units, Unincorporated Areas and Provinces (Geoscience Australia, 2000)
- Great Artesian Basin Resource Study (Great Artesian Basin Consultative Council, 1998)

In addition, the following data from Project (Mine) specific field investigations has been collated and reviewed:

- Geological data (borehole logs and mine geological model)

- Groundwater levels and quality (monitoring data)
- Hydrogeological testing results

2.2.2 Geology Overview

The following overview of geology has been compiled from a review of:

- The *Galilee Project – In situ Coal Resources Estimate* (Xenith Consulting, 2009) report
- The *Galilee Project Technical Due Diligence* report (GHD, 2010)
- Borehole logs from previous exploration programs within EPC 1690 (Linc Energy, not dated)
- The *Galilee Basin Exploratory Coal Drilling – Moray Downs Area* report (Carr, 1974)
- Published geological maps for the area

Published 1:250,000 scale geological mapping is shown in Figure 4-2.

Available digital geological mapping is shown in Figure 4-3 and Figure 4-4. Figure 4-5 provides the legend for the geological mapping and includes further information on each of the mapped units. A sketch cross section illustrating the stratigraphy within EPC 1690 is shown in Figure 2-1.

The Project (Mine) lies within the Galilee Basin, an intracratonic sedimentary basin deposited in the Permian and Triassic Periods.

Tertiary-age strata (including sandstones, mudstones and conglomerates) are mapped at outcrop over much of EPC 1690 and EPC 1080 and based on geological information available from the initial exploration program were typically thought to range in thickness from 45 to 100 m thick (Xenith Consulting, 2009) over EPC 1690. However, an extensive drilling program has continued throughout the EIS period which culminated in a detailed review of all the available geological information by Xenith Consulting and Geotechnical Consulting Services. The results of this review are summarised in Appendix H and suggest that the Tertiary cover is not as laterally extensive or as thick as previously thought. Based on the detailed geological information now available for the site it appears likely that the published mapping under-estimates the extent of the underlying Dunda Beds towards the western margin of the lease. This is broadly consistent with the results of soils mapping undertaken for the current study (see Volume 4 Appendix L, Section 2.2) which also suggest that:

- The extent of the Quaternary and underlying Tertiary units is over-estimated in the mapping; and
- That soils formed on the fine grained sandstones of the Dunda Beds (unit Rld) occupy the largest portion of the EPC1690 area.

The recent review of the available geological information also suggests that where they are present the Tertiary strata are typically thinner than previously thought since the lower Tertiary horizons have now been re-interpreted as weathered Permian age strata.

Along the Carmichael River and over much of the Belyando River system to the east of the Project (Mine) area, the Tertiary strata are indicated to be overlain by Quaternary-aged floodplain alluvium (sands, silts, gravels and clays). An unconformity defines the boundary between the Tertiary-age strata and the underlying Late Permian-age coal bearing strata (a sequence of siltstones, mudstones, sandstones, shales and coal of the Bandana Formation and Colinlea Sandstone). Geological cross sections (Geological Survey of Queensland) and modelled cross sections of the geology (GHD, 2010) indicate that the Late Permian-age strata dip at approximately 2-4° to the west, steepening slightly in the southern half of the lease.

Along the western margins of EPC 1690 a sequence of Triassic-age strata forms an angular unconformity with the overlying Tertiary-age strata and is mapped at outcrop as the Dunda Beds (predominantly sandstone). The Rewan Group (mudstone and sandstone) underlies the Dunda Beds (as shown in cross section and exploration borehole log NS16, BS17 and NS21, Geological Survey of Queensland, 1974) and overlies the Late Permian-age strata.

It has been reported that a fault has been interpreted through the middle of the lease but requires further drilling to confirm (Xenith Consulting, 2009).

A stratigraphic column to illustrate the main geological units within the lease area is summarised in Figure 2-2 from the *Carmichael Macro-Conceptual Mine Study* (Runge, May 2011). Quaternary-age strata (which lie stratigraphically above Tertiary-age strata) are not shown.

Figure 2-1 Geological Cross-section through the Project (Mine) Lease

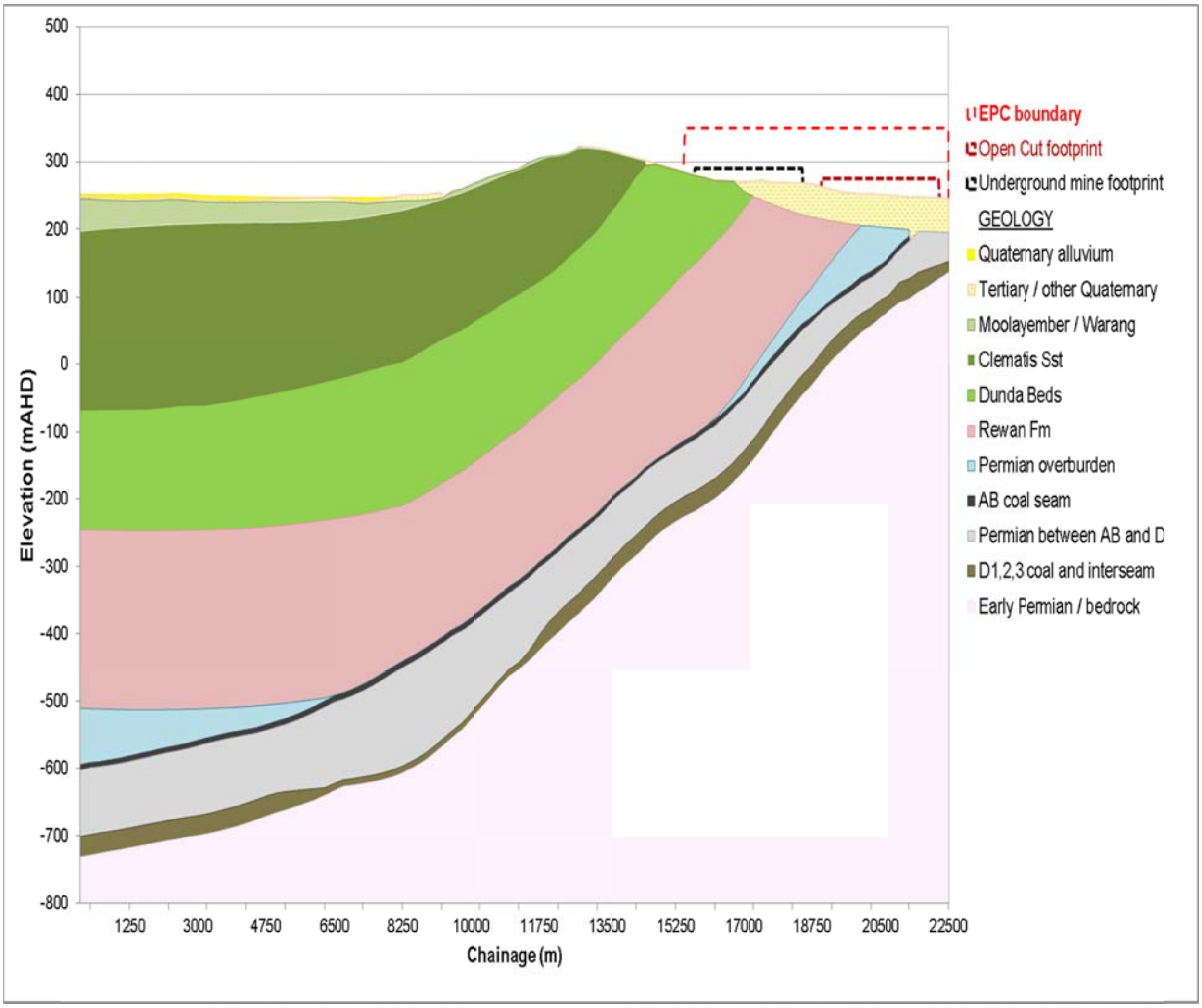


Figure 2-2 Stratigraphic Column (Runge, May 2011)

Age		Lithology	Stratigraphy	Thickness
Tertiary		Clays / Mudstones		40 - 100m
Triassic		Mudstone / Siltstone	Rewan Formation	
Late Permian		Sandstone	Bandanna Formation	
		COAL - AB Seam		12 - 18m Resource Seam
		Sandstone / Siltstone		10m
		COAL - B splits		1 - 2m
		Siltstone / Mudstone		60 - 70m
		COAL - C Seam (carbonaceous)		3 - 4m
		Siltstone / Sandstone	Colinlea Sandstone	2 - 20m
		COAL - D1 Seam		4 - 6m Resource Seam
		Sandstone		5 - 30m
		COAL D2/D3 Seam		8 - 10m Resource Seam
		Siltstone / Mudstone		10 - 20m
		COAL - E Seam		1 - 3m Resource Seam
		Sandstone / Siltstone		5 - 10m
		COAL - F Seam		1 - 5m Resource Seam
Early Permian		Sandstone		

2.2.3 Hydrogeology Overview

The Project (Mine) lies close to the eastern margin of the Great Artesian Basin (GAB). The GAB comprises Late Triassic to Middle Cretaceous-age strata which are bound by the Triassic-age Rewan Group at the bottom and the Winton Formation at the top (GABCC, 1998).

The coal resources of the Project (which occur within Permian-age strata) are therefore not part of the GAB; however the base of the GAB is defined by the top of the Rewan Group which is present within the EPC 1690 lease area. Definition of the precise boundaries of the GAB in the Project area is made difficult by the presence of younger Quaternary and Tertiary-age units at outcrop and this situation is complicated further by the delineation of a number of overlapping groundwater resource planning and management units which include different interpretations of the limit of the GAB. These different management units are shown in Figure 4-6. This mapping suggests that the boundary between the GAB Eastern Recharge Groundwater Management Unit and the Bowen Unincorporated area lies to the west of EPC 1690 and hence that the lease lies outside of the GAB. However, other mapping of the extent of the Great Artesian Basin Declared Sub-artesian Area and the Great Artesian Basin Water Resource Plan (GABWRP) boundary suggests that the northern part of the Project (Mine) lies within the GAB management areas.

Irrespective of where the precise boundary of the GAB lies it should be noted that:

- None of the main GAB aquifer units are understood to be present within the EPC 1690 or EPC 1080. The Clematis Sandstone is mapped at outcrop to the west of the Project site and dips to the west.
- No direct impacts on any GAB aquifer units are anticipated since the Permian aged Bandana Coal Formation and Colinlea Sandstone which represent the target coal resources for the Project (Figure 2-2) are separated from the Clematis Sandstone GAB aquifer by the intervening aquitards of the Rewan Group.

Areas where the outcrop geology is dominated by the Clematis Sandstone and other permeable units along the northern and eastern margins of the GAB act as recharge areas to the main body of the GAB to the south and west. The Project (Mine) therefore lies immediately east of one such recharge area, identified as the ‘GAB Eastern Recharge A – Queensland’ groundwater management unit (GMU) delineated by the GABCC in 1999 (Australian National Resources Atlas (ANRA) website, Australian Government).

2.2.4 Registered Groundwater Bore Review

A search of the Queensland Groundwater Database (DERM, 2010) identified 26 registered groundwater bores located within the Hydrogeology Study Area (i.e. within a 10 km radius of the EPC 1690 boundary). The locations of these registered bores are shown in Figure 4-3. Selected information (including facility type, facility role, yield, water level and selected water quality data) for these bores, from the database, is summarised in Appendix B.

In summary, 23 of the registered bores were recorded as existing (facility status) of which 11 were recorded as being for water supply (facility role). Four of the water supply bores were indicated to be for stock use (RN 17981, RN 90256, RN 90258 and RN 90259) and three bores were recorded as abandoned and destroyed. The use of the other four water supply bores was not recorded in the database.

A search of the Queensland Government Water Entitlements Registered Database (WERD) was also conducted for the registered bores identified to obtain any additional available information including groundwater abstraction rates and purpose of abstraction (such as stock watering). The search was conducted in December 2010. Records identified three of the registered bores at having a licence to take water (RN 62623, RN 67627 and RN 90255); although no allocation quantity is recorded in the database.

The proposed Carmichael Coal mining lease is located within the area administered by the Isaac Regional Council (IRC) (with the exception of 167 ha within the north-western corner of EPC1690, which is located within the Charters Towers Regional Council local government area). Communications with IRC confirmed that they do not hold information regarding privately owned unregistered bores and/or extraction rates.

Publically available groundwater data (such as groundwater levels, groundwater quality, yield estimates) are therefore limited to information extracted from the Queensland Groundwater Database (DERM, 2010) relating to registered bores within the Study Area. In summary these data indicate:

- Where geological and bore construction information are available, the registered bores typically intersect sandstone units (interpreted as being Tertiary, Triassic or Permian-age) with a smaller proportion intersecting alluvial deposits.
- Groundwater in the alluvium in the south of the Study Area appear to be generally brackish (electrical conductivity (EC) in the range 3,700 to 8,100 µS/cm) and slightly alkaline (pH in the range 8 to 9.4 pH units).
- Groundwater in sandstone units ranges from fresh to brackish (recorded EC in the range 155 to 3,800 µS/cm) and typically neutral pH (7.1 to 8.1 pH units).
- Groundwater levels in alluvial areas towards the south of the study area may be relatively close to ground surface, based on data for RN 44489 (interpreted to intersect alluvium) where groundwater was recorded at five metres below ground level (mBGL).

Conversely available records for the single bore with groundwater data completed in Permian age sandstone units (RN 90258) towards the west of EPC 1690 indicates a static groundwater water level of around 40 mBGL.

2.3 Field Investigations

2.3.1 Registered Bore Site Inspection

An attempt was made to visit each of the ten DNRM registered bores thought to be located within EPC 1690. Of these bores, only seven bores could be located and all were situated within fenced off areas on private property to which access could not be negotiated with the land owner. These bores could therefore only be observed from the fence line. Similarly registered bores outside of the areas of EPC 1690 and EPC 1080 were not visited because they are located on properties controlled by the same landowner.

The limited information collected from the bore site inspection is summarised in Appendix B. Headworks were observed on six out of seven of the bores (one of the bores was hidden by the bore shed), with infrastructure in place for operation of a pump (diesel, electric or solar) and pipes for transfer of pumped water to storage tanks or a dam. All of the bores sighted looked to be maintained and the presence of troughs at each location suggested that the primary use of the water was for stock watering.

2.3.2 Groundwater Monitoring Network Installation

Given the limited publically available groundwater level and quality data available for the site, a groundwater monitoring network was established within EPC 1690 to collect hydrogeological data for the purposes of the EIS comprising:

- 33 standpipe bores at 21 sites
- 15 nested vibrating wire piezometers (VWP) at five sites

Figure 2-3 shows the monitoring bore and VWP locations. Relevant information including the purpose of monitoring at each site is summarised in Table 2-1.

Table 2-1 Groundwater Monitoring Network Summary

Groundwater Monitoring Sites	Monitored Unit	Monitoring Purpose
C006P1 C006P3r	Interburden D Seam	Levels and quality, vertical gradients between strata
C007P2 C007P3	AB Seam D Seam	Levels and quality, vertical gradients between strata
C008P1 C008P2	Permian Overburden AB Seam	Levels and quality, vertical gradients between strata
C011P1 C011P3	Interburden D Seam	Levels and quality, vertical gradients between strata
C012P1 C012P2	Permian Overburden Tertiary/Permian	Levels and quality, vertical gradients between strata
C014P2	AB Seam	Levels and quality (no groundwater encountered in Tertiary-age strata)
C016P2	AB Seam	Levels and quality
C018P1 C018P2 C018P3	Permian Overburden AB Seam D Seam	Levels and quality, vertical gradients between strata
C020P2	AB Seam	Levels and quality
C022P1	Dunda Beds	Levels and quality, geological unit within the Great Artesian Basin
C024P3	D Seam	Levels and quality
C025P1 C025P2	Tertiary Tertiary	Levels and quality, potential connectivity between groundwater and the Carmichael River, vertical gradients
C027P1 C027P2	Alluvium Dunda Beds	Levels and quality, potential connectivity between groundwater and the Carmichael River, vertical gradients

Groundwater Monitoring Sites	Monitored Unit	Monitoring Purpose
C029P1	Alluvium	Levels and quality, potential connectivity between groundwater and the Carmichael River, vertical gradients
C029P2	Tertiary	
C032P2	AB Seam	Levels and quality
C034P1	Interburden	Levels and quality, vertical gradients between strata
C034P3	D Seam	
C035P1	Rewan Group	Levels and quality, vertical gradients between strata
C035P2	AB Seam	
C9553P1R	Dunda Beds	Levels, vertical gradients between strata
C553P_V01	D1 Seam	
C553P_V02	AB1 Seam	
C553P_V03	Permian Overburden	
C555P1	Rewan Group	Levels, vertical gradients between strata
C555P_V01	D Seam	
C555P_V02	AB1 Seam	
C555P_V03	Rewan Group	
C556P1	Rewan Group	Levels, vertical gradients between strata
C9556P_V01	D2 Seam	
C9556P_V02	AB1 Seam	
C9556P_V03	Rewan Group	
C558P1	Permian Overburden	Levels, vertical gradients between strata
C558P_V01	D1 Seam	
C558P_V02	Interburden	
C558P_V03	AB1 Seam	
C056C_V01	D1 Seam	Levels, vertical gradients between strata
C056C_V02	AB1 Seam	
C056C_V03	Rewan Group	
HD01	Dunda Beds	Levels (west of EPC 1690)
HD02	Clematis Sandstone	Levels (between EPC 1690 and Doongmabulla Springs)
HD03A	Dunda Beds	Levels, vertical gradients between strata (between EPC 1690 and Doongmabulla Springs)
HD03B	Alluvium	

A Bourne Drill 1000 rig and a combination of Rotary Wash Bore and Percussion Air-hammer drilling techniques were used to advance the monitoring bores and the VWPs. Each standpipe monitoring bore was installed with 50 mm diameter uPVC casing (glued and/or screwed), machine slotted screen and fitted with a lockable monument cover. The bore annulus of the screened interval was filled with washed two millimetre silica sand, sealed with a bentonite plug and grouted to surface with a cement-bentonite grout mix. Each bore was developed by airlifting.

Each group of VWPs were installed into a 32 mm diameter pvc carrier pipe and grouted into place with bentonite-cement grout. Borehole logs and a summary of survey data are included in Appendix C.

2.3.3 Groundwater Monitoring

Three rounds of groundwater monitoring have been conducted (October and November 2011 and June 2012), to measure groundwater levels and to collect groundwater samples for water quality analysis (October and November 2011 only). In addition, automatic level loggers have been installed in all of the monitoring bores across EPC 1690 to provide a more continuous record of groundwater levels. Groundwater level data collected to date are summarised in Section 4.3 and in Appendix D and groundwater quality results are summarised in Section 4.4 and presented in Appendix E.

The first round of groundwater monitoring was conducted prior to the stygofauna survey (which used a selection of the groundwater monitoring bores) conducted by ALS Water Resources Group (refer to Volume 2, Section 5.4). In order to meet the minimal disturbance criteria for the stygofauna survey, a passive sampling technique using HydraSleeves to collect samples from the screened interval of each borehole was used for the October 2011 round. This had the added benefit of leaving the monitoring bores free of sampling equipment for the stygofauna survey. Low-flow sampling was used to collect the groundwater samples for the second monitoring round (November 2011) and included collection of six duplicate samples using the HydraSleeve technique in order to validate the consistency of results between the two sampling methods. Again, sampling equipment was removed from the monitoring bores in preparation for another round of stygofauna sampling.

Duplicate samples were collected from randomly selected monitored sites at a rate of approximately 10 per cent for quality assurance purposes.

All groundwater samples were stored on ice in an insulated container immediately after collection and air freighted under chain of custody to a NATA accredited laboratory, Australian Laboratory Services (ALS) Brisbane, for analysis.

Groundwater samples were tested for a range of parameters in accordance with the ToR for the Project EIS and are summarised below. In addition, samples were collected from surface water sampling sites WQ1 and WQ3 on the Carmichael River at the same time as the groundwater monitoring samples to inform the assessment of groundwater – surface water interactions.

Field Parameters (measured at the bore prior to collection of samples for laboratory testing):

- Dissolved oxygen (DO), electrical conductivity (EC), pH, temperature, Total dissolved solids (TDS).

Laboratory Analysis:

- EC, pH, total organic carbon (TOC)
- Dissolved metals: Aluminium, arsenic, boron, cadmium, cobalt, copper, chromium, iron, manganese, mercury, molybdenum, nickel, lead, selenium, silver, uranium, vanadium, zinc
- Nutrients: Ammonia as N, nitrate as N, nitrite as N, total phosphorous as P

- Major and minor ions: Calcium, magnesium, sodium, potassium, chloride, sulphate, alkalinity (carbonate and bi-carbonate)
- Fluoride, sulphide
- BTEX (benzene, toluene, xylene, ethylbenzene)
- TPH (total petroleum hydrocarbons C6 – C36)

2.3.4 Hydraulic Testing

A combination of rising and falling head tests (also known as slug tests) have been conducted on 22 of the groundwater monitoring bores and packer testing has been conducted at five locations, to estimate the hydraulic conductivity of key hydrogeological units including the alluvium, Tertiary-age strata, AB seam, D seam, interburden, overburden, Rewan Group and Dunda Beds. Pumping tests have also been conducted at three locations within EPC 1690, to estimate bulk aquifer properties of the AB seam and the D seam.

For the rising and falling head tests, the standing water level (SWL) was displaced and level loggers were used to measure and record the recovery rate. Analysis of these data was carried out using the Bouwer-Rice analytical solution using AQTESOLV software (developed by HydroSOLVE Incorporated). The packer testing was carried out using a combination of single packer tests (downstage test method) and straddle packer tests (GHD, 2012) and interpreted using methods described in 'Routine Interpretation of the Lugeon Water-Test' (Houlsby, 1976). Each pumping test comprised a 48 hour constant rate test followed by a period of monitored recovery. Analyses were carried out for the appropriate analytical solutions using AQTESOLV software.

The locations tested are summarised in Table 2-2 (slug and packer tests) and in Table 2-3 (pumping tests). Refer to Figure 2-3 for the test locations. The results of the testing are summarised in Section 4.6.

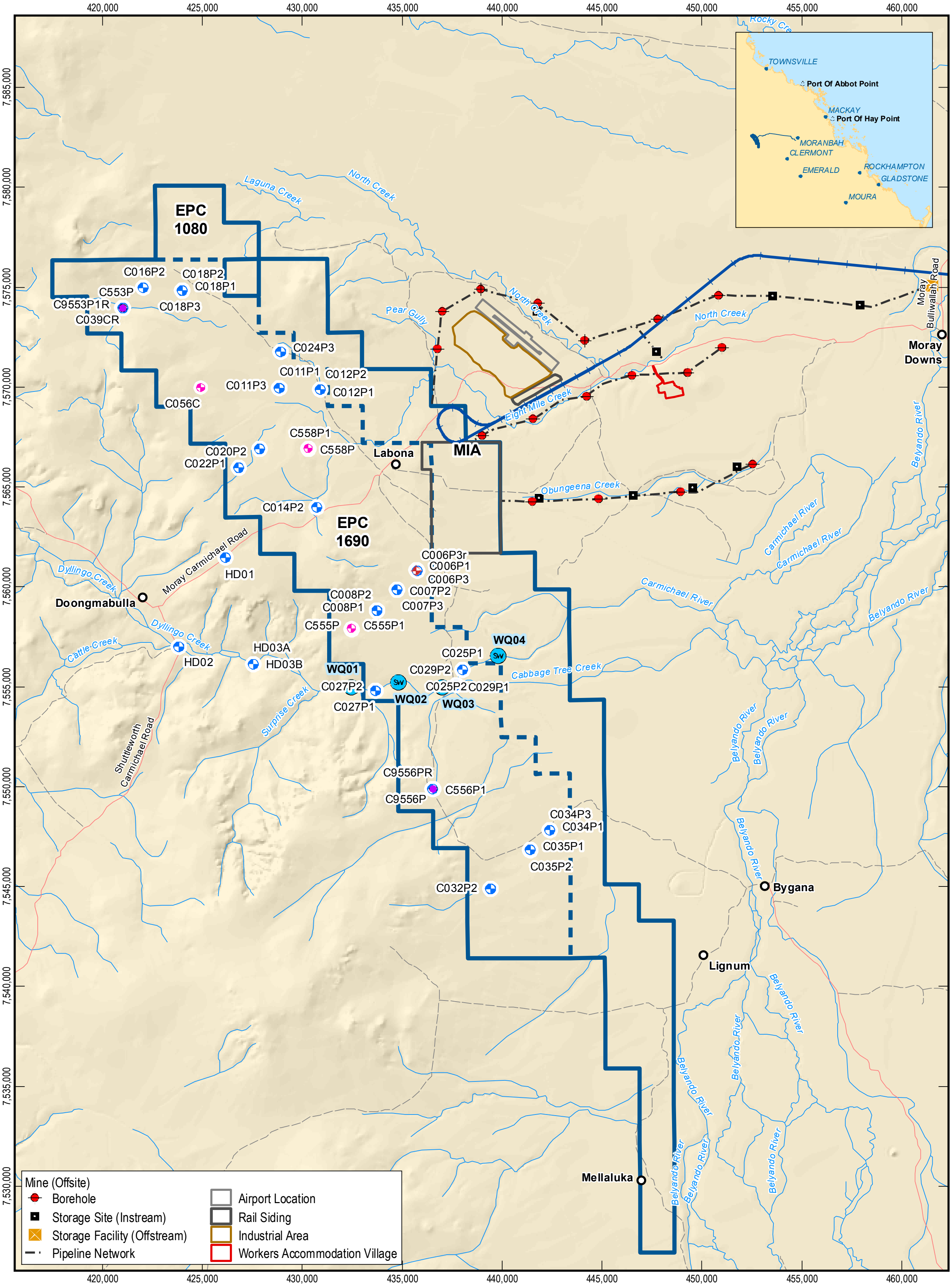
Table 2-2 Summary of Slug and Packer Testing

Strata Tested	Location ID	Total Number of Tests (by Strata and Test Type)	Test Type
Alluvium	C027P1 C029P1 HD03B	6	Falling head slug (4) Rising head slug (2)
Tertiary	C025P2 C029P2 C558P1	6	Falling head slug (4) Rising head slug (2)
Clematis Sandstone	HD02	2	Rising head slug
Dunda Beds	C22P1 C027P2 C9553P1R	6	Falling head slug (4) Rising head slug (2)
Overburden (Triassic)	C056	1	Packer

Strata Tested	Location ID	Total Number of Tests (by Strata and Test Type)	Test Type
Rewan Group	C035P1 C555P1 C556P1	12	Falling head slug (6) Rising head slug (6)
	C056 C9956PR	2	Packer
Overburden (Permian)	C008P1 C012P1 C012P2 C018P1	9	Falling head slug (6) Rising head slug (3)
	C039 C056 C555P C9556PR	4	Packer
AB Seam (Permian)	C007P2 C016P2	2	Rising head slug (1) Falling head slug (1)
	C039 C056 C555P C558P C9556PR	7	Packer
Interburden (Permian)	C006P1 C011P1	7	Falling head slug (4) Rising head slug (3)
	C056 C558P	3	Packer
Interburden, D Seam (Permian) and older Permian strata	C056 C555P C558P C9556PR	4	Packer
D Seam (Permian)	C007P3	1	Falling head slug
	C056 C555P C558P C9556PR	4	Packer
D Seam (Permian) and older strata	CC558P	1	Packer
Older Permian strata	C056 C555P C558P C9556PR	4	Packer

Table 2-3 Summary of Pumping Tests

Strata Tested	Pumping Test Site	Observation Bore ID	Test Flow Rate	Test Type
D Seam	C006	C006P1 C006P3r	0.3 L/s increased to 0.5 L/S after 24 hours	48 hour constant rate test, monitored recovery
D Seam	C018	C018P1 C018P2 C018P3	1 L/s	48 hour constant rate test, monitored recovery
AB Seam	C035	C035P1 C035P2	2.5 L/s	48 hour constant rate test, monitored recovery



LEGEND

Homestead	Abandoned and Destroyed	Local Road	Mine (Onsite)
Surface Water Quality Monitoring	Vibrating Wire Piezometer, Packer Testing	Track	Mine Infrastructure Area
Groundwater Monitoring Bore	Packer Testing	Watercourse	
		Rail (West)	

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Kilometres

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

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Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

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

Monitoring and Test Locations

Figure 2-3

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

Data Source: DERM: Registered Groundwater Bores (2010); DME: Carmichael Mine Site (2010); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); GHD: Monitoring Bores, Test Location (2012); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW, CA

3. Relevant Legislation

3.1 Queensland Environmental Protection Act 1994

The *Environment Protection Act 1994* (EP Act) provides a regulatory framework for the protection and management of the Queensland environment. The objective of the EP Act is to protect Queensland's environment while allowing for development that is ecologically sustainable. The environmental values of Queensland's waterways are protected under the EP Act and the subordinate Environmental Protection (Water) Policy 2009 (Section 3.2). Among other things, the EP Act provides for the authorisation of mining activities and an Environmental Authority (Mining Lease) will be required for the proposed mining activity.

3.2 Environmental Protection (Water) Policy 2009

The *Environmental Protection (Water) Policy 2009* (EPP (Water)) seeks to protect Queensland's waters while allowing for development that is ecologically sustainable, the objective identified by the *Environmental Protection Act 1994*.

This purpose is achieved within a framework that includes identifying environmental values (EVs) for Queensland waters (such as aquatic ecosystems, water for drinking, water supply, water for agriculture, industry and recreational use) and deciding and stating water quality guidelines (WQGs) and water quality objectives (WQOs) to enhance or protect the environmental values.

The EVs to be enhanced or protected under the EPP (Water), considered applicable to the Project in relation to groundwater are:

- Biological integrity of an aquatic ecosystem;
- Suitability for minimal treatment before supply as drinking water;
- Suitability for agricultural use; and
- The cultural and spiritual values of the water.

Groundwater resources within the Study Area are not listed in Schedule 1 of the EPP (Water) and therefore the EVs relevant to the study area are as described in Part 3 – 6 (2) of the EPP (Water). Site specific WQOs in order to enhance or protect the EVs can then be derived from relevant water quality guidelines, such as the *Queensland Water Quality Guidelines* 2009 (QWQG) and the *Australia and New Zealand Fresh and Marine Water Quality Guidelines* 2000 (ANZECC 2000).

3.3 Sustainable Planning Act 2009

The *Sustainable Planning Act 2009* (SPA) manages the process of development and the effects of development on the environment. Under SPA, construction works to take water (i.e. extraction of groundwater or dewatering) require a Development Permit (DP) and will be applicable if groundwater is to be taken for any purpose (other than groundwater monitoring) for the Project.

3.4 Water Act (2000)

The *Water Act 2000* provides a framework under which catchment based Water Resource Plans (WRPs) are developed in Queensland. The WRPs are then activated through related Resource

Operations Plans (ROPs) which provide detail on how the water resources will be managed to implement the strategies and objectives as set out in the WRP.

A WRP provides a framework for sustainable management of water resources in the plan area including establishment of Groundwater Management Areas (GMAs) and Groundwater Management Units (GMUs) which can be sub-divisions of a GMA. WRPs also define the availability of water and define water licensing and development permit requirements.

In Queensland, regulated groundwater areas, which is a general term used to include declared sub-artesian areas, sub-artesian areas, sub-artesian management areas and groundwater management areas, have been established by the Queensland Government to protect groundwater resources. The water resources in these regulated groundwater areas are subject to management and are either established through a WRP, a Local Water Management Policy or as defined by Schedule 11 of the Water Regulation 2002.

In order to take water from a regulated groundwater area for certain purposes, authorisation (such as a licence or development permit) is required. These purposes are defined under a WRP, Local Water Management Policy or by the Water Regulation 2002.

Water resources within the central and southern parts of EPC 1690 and within EPC 1080 are managed under the *Water Resource (Burdekin Basin) Plan 2007* however; this WRP does not include management of groundwater. The groundwater resources within central and southern parts of EPC 1690 and 1080 fall within and are therefore managed as part the Highlands Declared Sub-Artesian Area as shown in Figure 4-6. The groundwater resources within the far northern part of EPC 1690 and along its western margins (the Rewan Group and Dunda Beds) are not classed as GAB aquifers for management purposes and therefore fall within and are managed as part of the Great Artesian Basin Declared Sub-Artesian Area (refer to Figure 4-6). However, the Clematis Sandstone and Moolayember Formation are defined as GAB aquifers and are managed under the GAB WRP.

3.5 Water Regulation (2002)

The Water Regulation 2002 is subordinate to the *Water Act 2000* and defines sub artesian groundwater declared areas (i.e. regulated groundwater areas). It also details the purpose of use (such as stock / domestic use) that do not require authorisation to take water in regulated groundwater areas and, by omission, those purposes that do require authorisation.

As detailed in Section 3.3 the majority of EPC 1690 (and EPC 1080) lie within the Highlands Declared Sub-Artesian Area and the northern end and western margins lie within the Great Artesian Basin Declared Sub-Artesian Area (Figure 4-6). An authorisation to take water (a groundwater licence) is required for any purpose of use, with the exception of stock and domestic use, in both of these areas.

3.6 Groundwater Related Licensing and Permits Relevant to the Project (Mine)

As discussed in Section 3.3 and Section 3.5, groundwater resources within Project (Mine) site are managed within the Highlands Declared Sub-Artesian Area and the GAB Declared Sub-Artesian Area. Under these management regimes a licence will be required for any activity involving the take

of groundwater for the Project (Mine) such as for the purposes of mine dewatering, extraction of groundwater for construction or consumption, or conducting pumping tests. A licence is applied for under Section 206 of the *Water Act 2000* and submitted to the Department of Natural Resources and Mines (DNRM) for assessment under the provisions of the *Water Act* 2000. Each application is assessed on its merits. Currently there is no limit to the volume of water that can be applied for, to take from aquifers managed under the Highlands Declared Sub-Artesian Area and the GAB Declared Sub-Artesian Area.

The likely timeline indicated by DNRM for granting a licence under Section 206 of the *Water Act 2000* and a DP under *SPA 2009* is a minimum of six months.

Take of any groundwater from aquifers managed under the GAB WRP and ROP is subject to different permits and approvals. However, no aquifers managed under the GAB WRP are present within the Project (Mine) site and hence no direct extraction from such aquifers for dewatering or other purposes is proposed as part of the Project. The permitting requirements under the GAB WRP and ROP are therefore not considered to be relevant in this case.

4. Description of Environmental Values

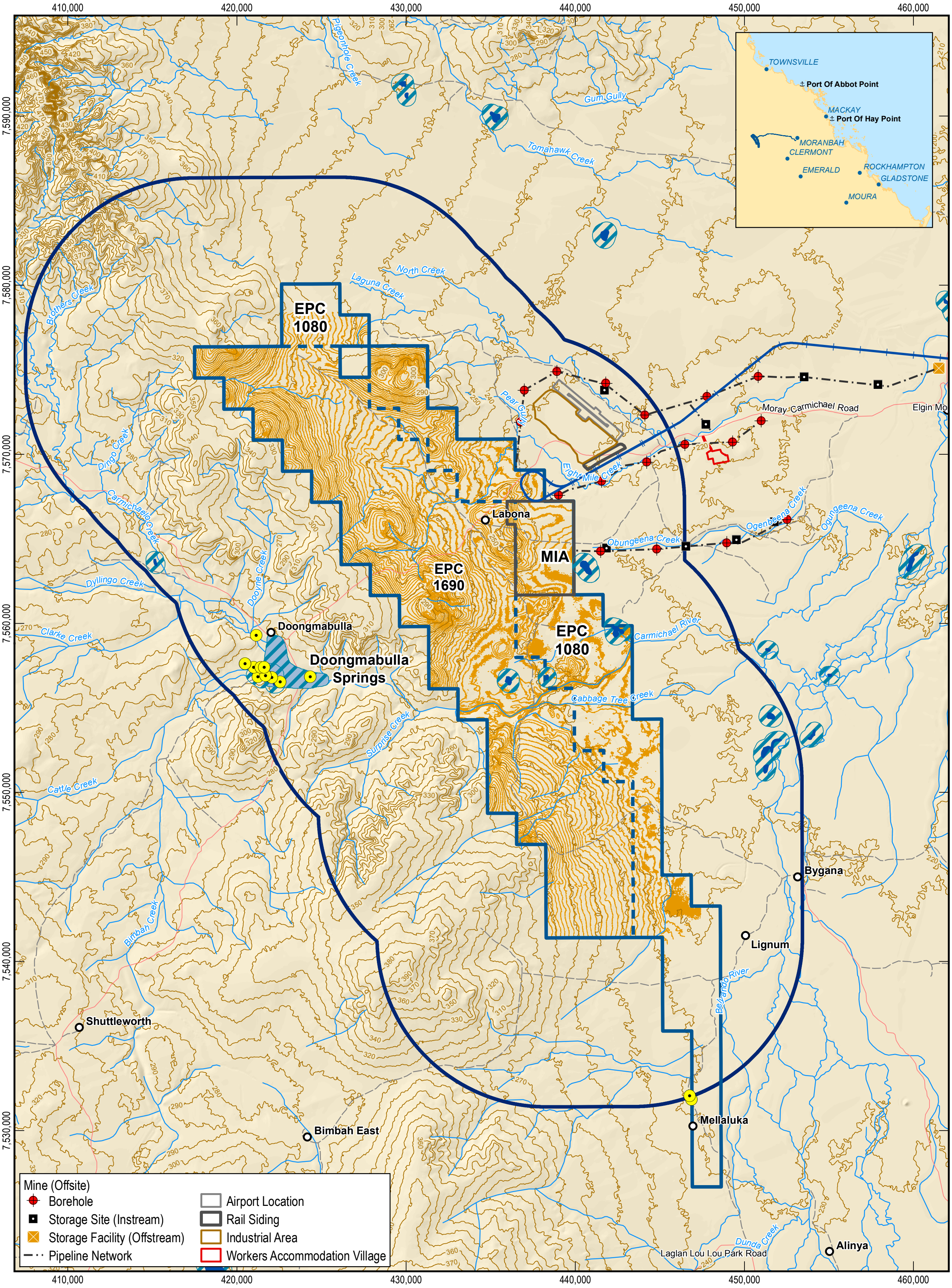
4.1 Topography and Drainage

Topography across the Study Area typically slopes towards the east and north-east from a north-west to south-east trending ridge line, west of the EPC1690 lease (lease) boundary and running parallel to it (Figure 4-1). The topographic gradient flattens out in the vicinity of the Carmichael River and in eastern parts of the Study Area.

The ridgeline is bisected by the Carmichael River, which flows west to east through the southern half of the Study Area. A number of tributaries to the west of the lease feed into the Carmichael River (including Surprise Creek, Carmichael Creek, Dingo Creek, Cattle Creek and Dooyne Creek) and the Carmichael River also receives discharge from the Doongmabulla Spring complex. Other ephemeral drainage lines also cross EPC 1690, north and south of the Carmichael River, and typically fall towards the east. The Carmichael River is a tributary of the Belyando River, which flows south to north past Study Area and lies approximately 8 to 10 km to the east of the exploration lease boundary.

The closest DNRM river gauging station to the Study Area is the Gregory Developmental Road Gauge on the Belyando River (No. 120301B) around 70 km to the northeast of the Project (Mine) (refer to Mine Hydrology Report, Volume 4, Appendix P, Section 3.3.1 and 3.3.2).

Two surface water monitoring stations have been established as part of the current study within the Study Area on the Carmichael River, one close to the upstream boundary of the lease (Station No. 333301) and one close to the downstream boundary (Station No. 333302). These stations provide information on surface water levels (or river stage) and estimated flows (or discharge) which have been used for various technical studies undertaken as part of the EIS. These gauging stations have been operational since July 2011, however no data for the upstream gauge has been recorded since 4 February 2012 due to damage. The current flow estimates for these gauges are understood to have been developed from a stage-discharge relationship based on a single flow gauging event. Flow gauging over a wide range of flows is typically required to develop an accurate stage-discharge relationship, as the cross sectional flow area at different river stages can vary significantly in natural channels. As such, the estimated flow data for these gauges should be treated with some caution.



LEGEND

- Homestead
- Springs
- Local Road
- Track
- Watercourse
- Contour - 2m
- Contour - 10m
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Hydrogeology Study Area
- Directory of Important Wetlands
- Great Barrier Reef Wetland Protection Trigger Area
- Great Barrier Reef Wetland Protection Area

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Kilometres

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

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Carmichael Coal Mine and Rail Project

Job Number	41-25215
Revision	C
Date	03-09-2012

Topography, Drainage and Wetlands

Figure 4-1

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

Data Source: DERM: GBR WPA (2009), DOI Wetlands (2011); DME: EPC 1690 (2010)/EPC 1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); EPA - Springs (2005); GHD: Hydrogeology Study Area (2011); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW, CA

4.2 Hydrogeological Units

Published 1:250,000-scale geology mapping for the Hydrogeology Study Area is shown in Figure 4-2 and the digital published geology in Figure 4-3 and Figure 4-4. Figure 4-5 provides the legend for each of the units mapped at outcrop. A description of the geology is also included in Volume 2, Section 4.3 of the Carmichael Coal Mine and Rail Project EIS.

Based on the current understanding of the geology for Project (Mine) site and Study Area the following hydrogeological units are considered of relevance to the Project:

- Cainozoic and Quaternary unconsolidated alluvial and colluvial deposits associated with the Carmichael River and other local water courses (map symbols Cz, Q, Q>T, Q>Rw, and TQw, Figure 4-3)
- Tertiary-age clay, sandstones and siltstones (map symbol T, Figure 4-3)
- Numerous underlying Triassic-age units which form part of the GAB including the Warang Sandstone (map symbol Rw), the Moolayember Formation (map symbol Rm), the Clematis Sandstone (map symbol Re), the Dunda Beds (map symbol Rd) and the Rewan Group (not mapped at outcrop)
- Permian-age siltstones, mudstones, sandstones and coals of the Bandanna Formation and the Colinlea Sandstone which form the target of the proposed mining operations (not mapped at outcrop)

Each of these units is described in Sections 4.2.1 to 4.2.4 below. Summary information on each unit is presented in Table 4-1.

4.2.1 Unconsolidated Alluvial and Colluvial Deposits

The unconsolidated alluvium and colluvium of Cainozoic and Quaternary typically form the uppermost hydrogeological unit within and in the vicinity of the Project (Mine). Along the Carmichael River these strata include sands, gravels and clay-dominated layers of variable thickness and lateral extent which form an unconfined aquifer, indicated to be between around 10 to 12 m thick. Alluvial aquifers are also likely to be associated with other main watercourses in the area, such as the Belyando River to the east of Study Area.

The permeability of these units will be governed primarily by the proportion of sands and gravels and the connectivity of the various materials, which is likely to vary both laterally and vertically. Yields appear to be in the region of 1 to 3 L/s, based on available records for two registered bores in the Study Area.

4.2.2 Tertiary-age Clay, Sandstones and Siltstones

Layered clay, sandstones and siltstones of Tertiary-age are mapped at outcrop and underlie the younger unconsolidated deposits over much of the Study Area.

Geological logging of the Tertiary-age units encountered during drilling of the monitoring network bores suggests a typical profile including around 16 m of clay overlying around 55 m of sandstones and siltstones which are often highly weathered and include significant clay-dominated material. These weathered sandstones and siltstones were originally interpreted as Tertiary-age strata, although they are typically difficult to differentiate from both the overlying Quaternary strata and underlying weathered Triassic and Permian-age strata. A more recent review of the available geological information (see Appendix H) suggests that these lower Tertiary horizons are in fact typically weathered Permian age strata.

Falling head test results for the three monitoring bores installed in Tertiary deposits suggest hydraulic conductivity values as low as 2.1 x 10^{-4} m/d for the Tertiary-age clay strata (see Table 4-3). Assuming that these results are typical of the wider study area and given the, often, significant thickness of clayey strata then it is considered unlikely that the Tertiary-age strata represent a locally important groundwater resource.

4.2.3 Triassic-age Great Artesian Basin Units

Triassic-age GAB units comprising, from oldest to youngest, the Rewan Group, Dunda Beds, Clematis Sandstone and Moolayember Formation lie within and to the west of Study Area. The Rewan Group (comprising layers of sandstone, mudstone and conglomerate) is considered to be a major confining bed of the GAB and bounds the base of the GAB aquifers (GABCC, 1998). Within Study Area the Rewan Group is indicated to be dominated by clays and mudstones with some interbeds of sandier lithology and is considered to be an aquitard. It separates the Project coal resource within the underlying Permian-age strata from the stratigraphically younger Dunda Beds (predominantly sandstones) and Clematis Sandstone (a GAB aquifer) to the west.

In the vicinity of the Project (Mine) the permeability of these sandstone aquifers is likely to be variable and dependent on the degree of fracturing and/or grain sizes. This is supported by the available yield data, which suggests yields from as low as 0.1 L/s to as high as 4 L/s for registered bores thought to be completed in Triassic-age units within the Study Area.

4.2.4 Permian-age Coal Measures

The coal resource of the proposed Project lies within the Late Permian-age Bandanna Formation and Colinlea Sandstone, which form part of the Galilee Basin. The coals dip from east to west across the Project area. Hence, towards the eastern boundary of EPC 1690 the coal seams can be present at subcrop directly beneath the Quaternary and Tertiary units, which dominate the outcrop geology. Conversely, towards the west of the Study Area, the Triassic-age sandstones and mudstones of the Rewan Group overlie the coals. Both the Triassic and Permian-age strata typically dip with a shallow gradient (2 to 4 degrees) towards the west and are unconformably overlain by Tertiary and Quaternary-age strata.

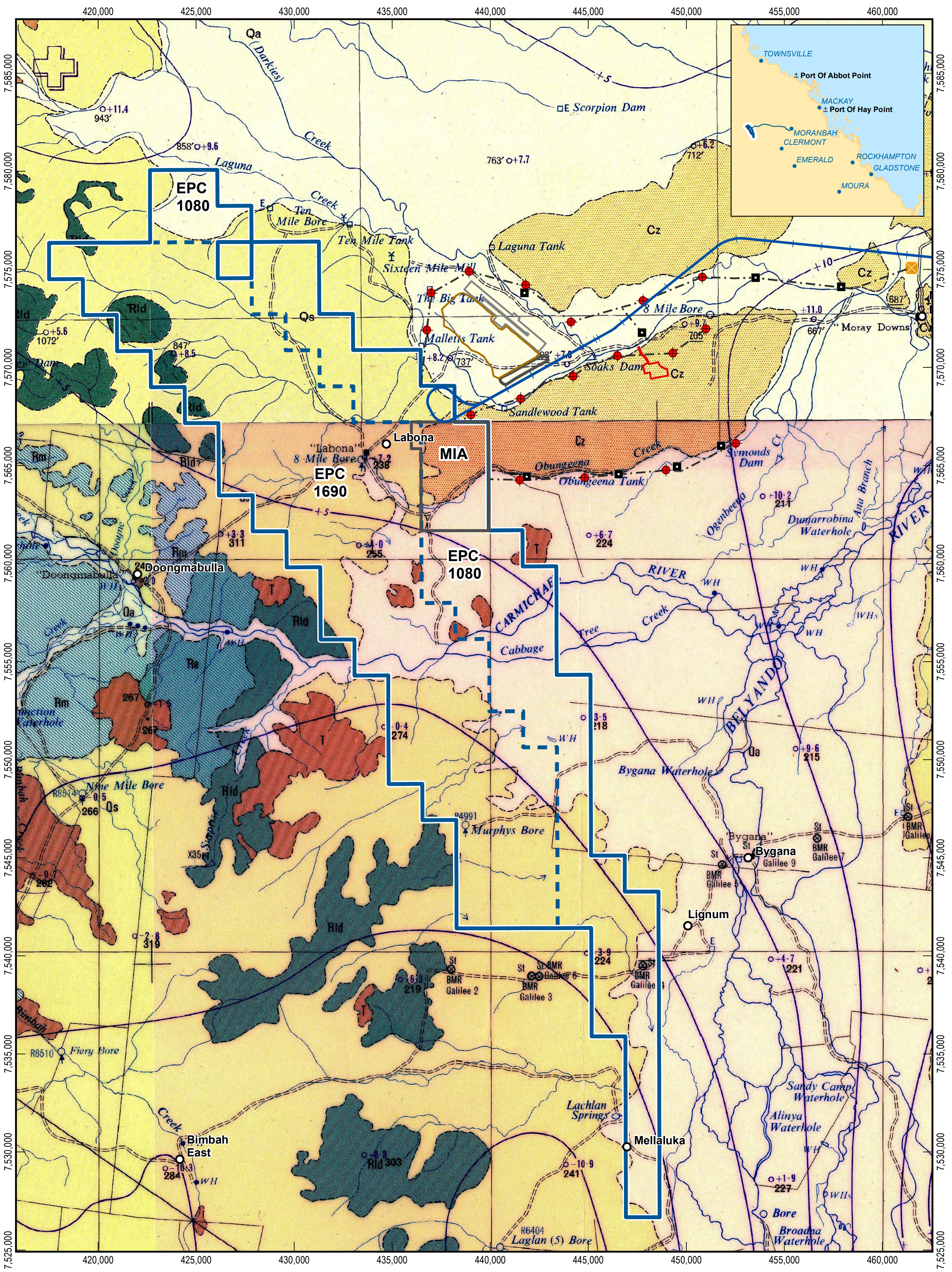
The Permian Coal Measures within the Bandanna Formation typically comprise a varied sequence of sandstones, siltstones, mudstones and coals. Primary porosity and permeability in each of these units is typically low and hence yields are generally governed by the degree to which secondary porosity and permeability has developed. Experience at locations within the nearby Bowen Basin suggests that coal seams are often the highest yielding and most permeable part of the sequence. This probably reflects the relatively low strength and hence high fracture potential of the coal seams, in comparison to other units present.

Yield estimates from short periods of airlifting (1 to 2 hours in length) conducted on the Project (Mine) groundwater monitoring network installed in coal seams ranged from <0.1 to 1.0 L/s (with a mean of 0.2 L/s and median of 0.12 L/s) and suggests that in general, relatively low yields should be anticipated from the coal seams. No publically available information on groundwater yields which can be attributed to Permian-age units within the Study Area was identified in the desktop review which suggests that the Bandanna Formation and/or the Colinlea Sandstone do not represent a locally important water resource.

Table 4-1 Summary of Hydrogeological Units Identified for the Study Area

Description	Map Symbol	Age	Type	Typical Thickness[1]	Comments
Alluvium (lenses of sand, sand and gravel, and clay)	Q, Cz	Quaternary/ Cainozoic	Unconfined local aquifer(s)	2 – 12 m (where present)	Predominantly in the vicinity of the Carmichael River within EPC 1690 and the Belyando River to the east of the Study Area.
Weathered sandstones and siltstones (often weathered to clays and sandy clays, including yellow, red, orange colourations)	T, TQw	Tertiary	Unconfined limited resources	20 - 50 m (where present), up to ~80 m in SE of EPC	Thought to occur at outcrop over central and eastern parts of EPC 1690 and the Study Area.
Moolayember Formation (sandstone and siltstone) and Warang Sandstone (sandstone, conglomerate, mudstone and siltstone)	Rm	Triassic	Aquitard / limited resources	Not present in EPC. ~50 m near Doongmabulla; and > 100 m further west	Mapped at outcrop approximately 2 km west of EPC 1690.
Clematis Sandstone (sandstone)	Re	Triassic	Confined GAB artesian aquifer	Not present in EPC. ~200 m near Doongmabulla; and > 250 m further west	Mapped at outcrop approximately 2 km west of EPC 1690.
Dunda Beds (typically orange-brown and red-brown quartzose sandstone)	Rd	Lower Triassic	Confined local aquifer	Up to 100 m at western limit of lease, typically ~150-200 m further west	Mapped at outcrop in western parts of EPC 1690, separated from the underlying Late Permian-age strata (bearing the coal) by the underlying Rewan Group
Rewan Group (typically red-brown and grey-green mudstone and green-grey sandstone)	NA	Lower Triassic	Aquitard	Up to 250 m at western limit of lease	Defined as the base of the Great Artesian Basin, separating the Dunda Beds (above) from the Permian-age (coal–bearing) strata below
Permian Coal Measures. Variable sequences of mudstone, siltstones, coals and sandstones including the target coal seams of the Bandanna Formation and Colinlea Sandstone.	NA	Late Permian	Variable. Aquitards / limited resources and confined local aquifers	90 to 180 m to base of target coals	Aquitard layers (typically siltstone, mudstone and clays) in central and western pars of EPC 1690; Sandstone and coal seams yield estimates <0.1 to 1 L/s

[1] Within EPC 1690 lease area



LEGEND

- Homestead
- Local Road
- Track
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area

Mine (Offsite)

- Borehole
- Storage Site (Instream)
- Storage Facility (Offstream)
- Pipeline Network
- Airport Location
- Rail Siding
- Industrial Area
- Workers Accommodation Village

Refer to Figure 4-5 for the legend to the geology mapping

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Kilometres

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

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GHD adani

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Mapped Geology
(1:250,000)

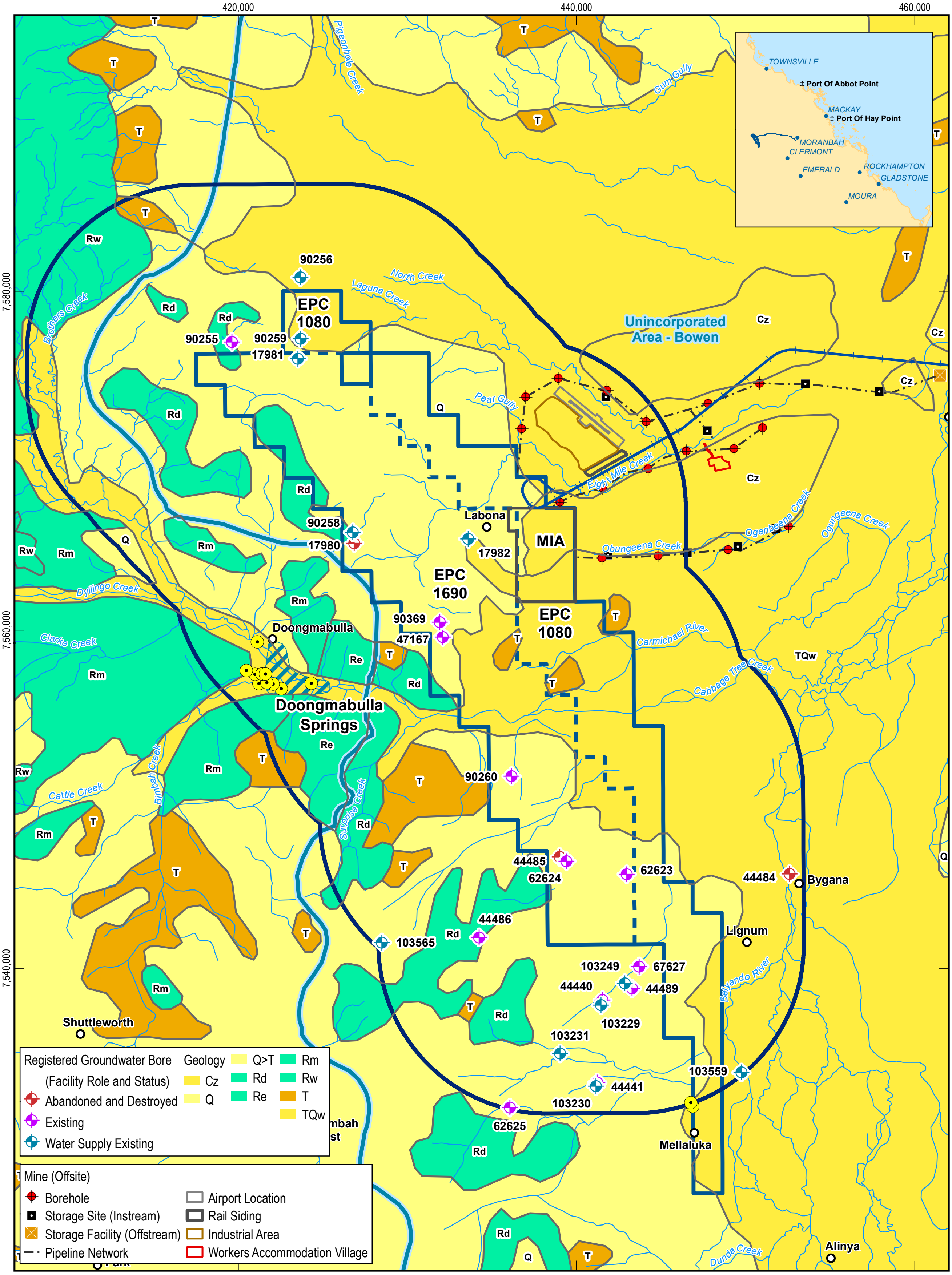
Job Number	41-25215
Revision	B
Date	03-09-2012

Figure 4-2

G:\41\25215\GIS\Maps\MXD\300_Hydrogeology\41-25215_310_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: DME: Mapped Geology 250k (2008),EPC 1690 (2010)/EPC 1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW, CA



LEGEND

- Homestead
- Springs
- Watercourse
- Structure
  - Anticline
  - Fault
  - Geological Boundary
- Joint Pattern
- Monocline
- Syncline
- Trend Line
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Hydrogeology Study Area
- Groundwater Management Unit boundary
- Directory of Important Wetlands

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Refer to Figure 4-5 for the legend to the geology mapping

1:325,000 (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

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GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Job Number	41-25215
Revision	B
Date	03-09-2012

Published Digital Mapped Geology and Registered Groundwater Bores

Figure 4-3

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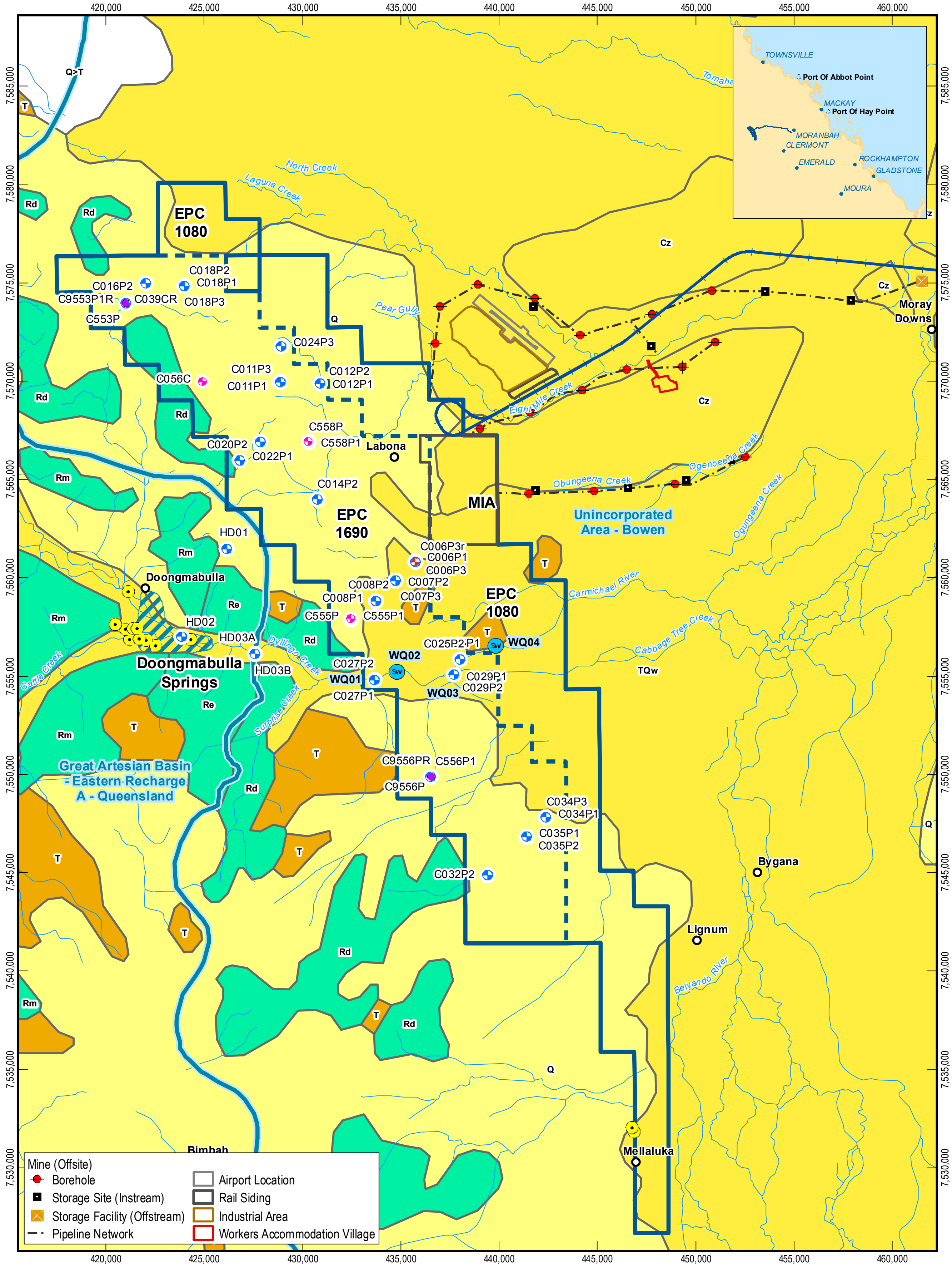
Data Source: DERM: Registered Groundwater Bores (2010), DOI Wetlands (2011); DME: Regional Geology 1:100000 (2004), EPC 1690 (2010),EPC 1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Watercourse (2007); BRS: Groundwater Management Unit Boundary (2009); EPA - Springs (2005); GHD: Hydrogeology Study Area (2011); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW, CA



LEGEND

Homestead
Surface Water Quality Monitoring
Groundwater Monitoring Bore (Surveyed)
Groundwater Monitoring Bore
Vibrating Wire Piezometer, Packer Testing
Packer Testing
Springs
Watercourse
Rail (West)
Directory of Important Wetlands
Mine (Onsite)
Mine Infrastructure Area

Structure
Anticline
Fault
Geological Boundary
Joint Pattern
Monocline
Syncline
Trend Line

Geology
Cz
Q
Rd
Re
Rm
T
TQw

Refer to Figure 4-5 for the legend to the geology mapping

1:275,000 (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

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GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Published Digital Mapped Geology and Monitoring/Test Locations

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

Figure 4-4

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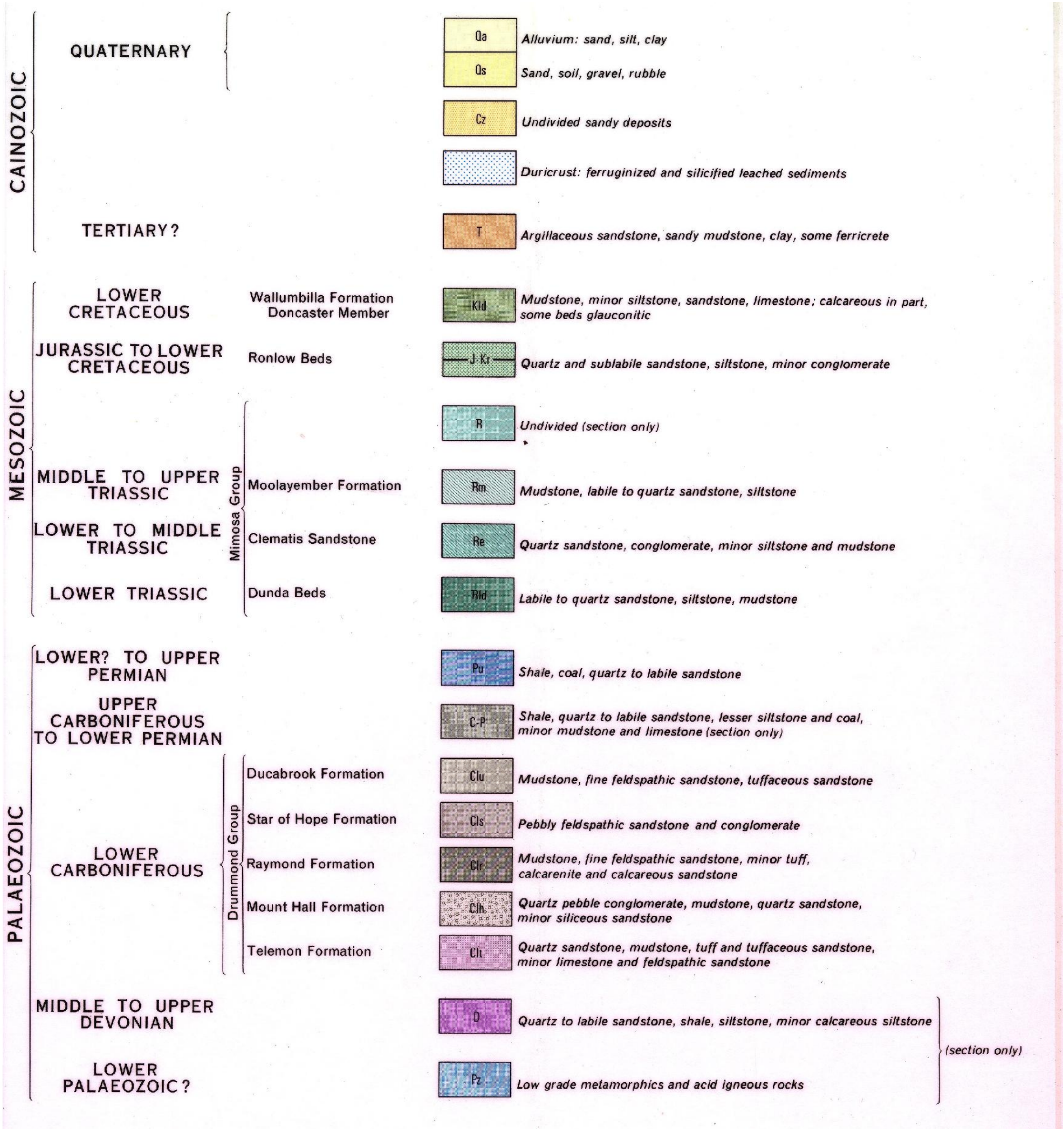
Data Source: DERM: Registered Groundwater Bores (2010),DOI Wetlands (2011); DME: EPC1690 (2010)/EPC1080 (2011), Regional Geology 1:1,000,000 (2004); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Watercourse (2007); BRS: GMU Boundary (2009); EPA - Springs (2005); GHD: Hydrogeology Study Area, Groundwater Monitoring Bores,Test Locations (2012); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW, CA, MS

1:250,000 North Eromanga Regional Geology Symbol Key

Geology Unit	Formation	Age	Lithology Summary
Cz		CAINOZOIC	Sand, silt, gravel: alluvial, colluvial and residual
Q		QUATERNARY	Alluvium of older flood plains, sand, gravel, soil
Q>Rw	Warang Sandstone	QUATERNARY	Alluvium of older flood plains, sand, gravel, soil
Q>T		QUATERNARY	Alluvium of older flood plains, sand, gravel, soil
TQw	Woondoola beds	TERTIARY - QUATERNARY	Silt, clay, sandy clay; minor sand and gravel; fluvial
T		TERTIARY	Quartzose sandstone, conglomerate, siltstone
Rw	Warang Sandstone	TRIASSIC	Kaolinitic quartz sandstone, conglomerate, variegated mudstone and siltstone
Rm	Moolayember Formation	TRIASSIC	Micaceous lithic sandstone, micaceous siltstone
Re	Clematis Sandstone	TRIASSIC	Medium to coarse-grained quartzose to sublabile, micaceous sandstone, siltstone, mudstone and granule to pebble conglomerate
Rd	Dunda beds	EARLY TRIASSIC	Lithic to quartzose sandstone, siltstone, mudstone
Cb	Bulliwallah Formation	CARBONIFEROUS	Fine to medium feldspathic quartz sandstone; minor olive mudstone, pebbly feldspathic quartz sandstone and algal limestone; poorly preserved plant fossils
Cu	Ducabrook Formation	CARBONIFEROUS	Feldspatholithic sandstone, mudstone, siltstone (commonly tuffaceous), minor algal and oolitic limestone
Cs	Star of Hope Formation	CARBONIFEROUS	Lithic conglomerate, feldspatholithic sandstone, rhyolitic to dacitic ignimbrite and flows, tuffaceous siltstone and rare sinter
Cr	Raymond Sandstone	CARBONIFEROUS	Flaggy quartzose sandstone, siltstone and minor limestone
Ch	Mount Hall Formation	CARBONIFEROUS	Quartzose to feldspathic sublabile sandstone, quartz-pebble conglomerate, mudstone and red siltstone
Cn	Natal Formation	CARBONIFEROUS	Alternating fine feldspathic quartz sandstone and olive siltstone; poorly preserved plant fossils

1:250,000 Mapped Geology Symbol Key



NOTE

Geological unit descriptions are limited to those shown in the map extent.
Additional geological units not described here may be present in surrounding areas.

N

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Job Number 41-25215
Revision B
Date 03-09-2012

Geology Index Sheet

Figure 4-5

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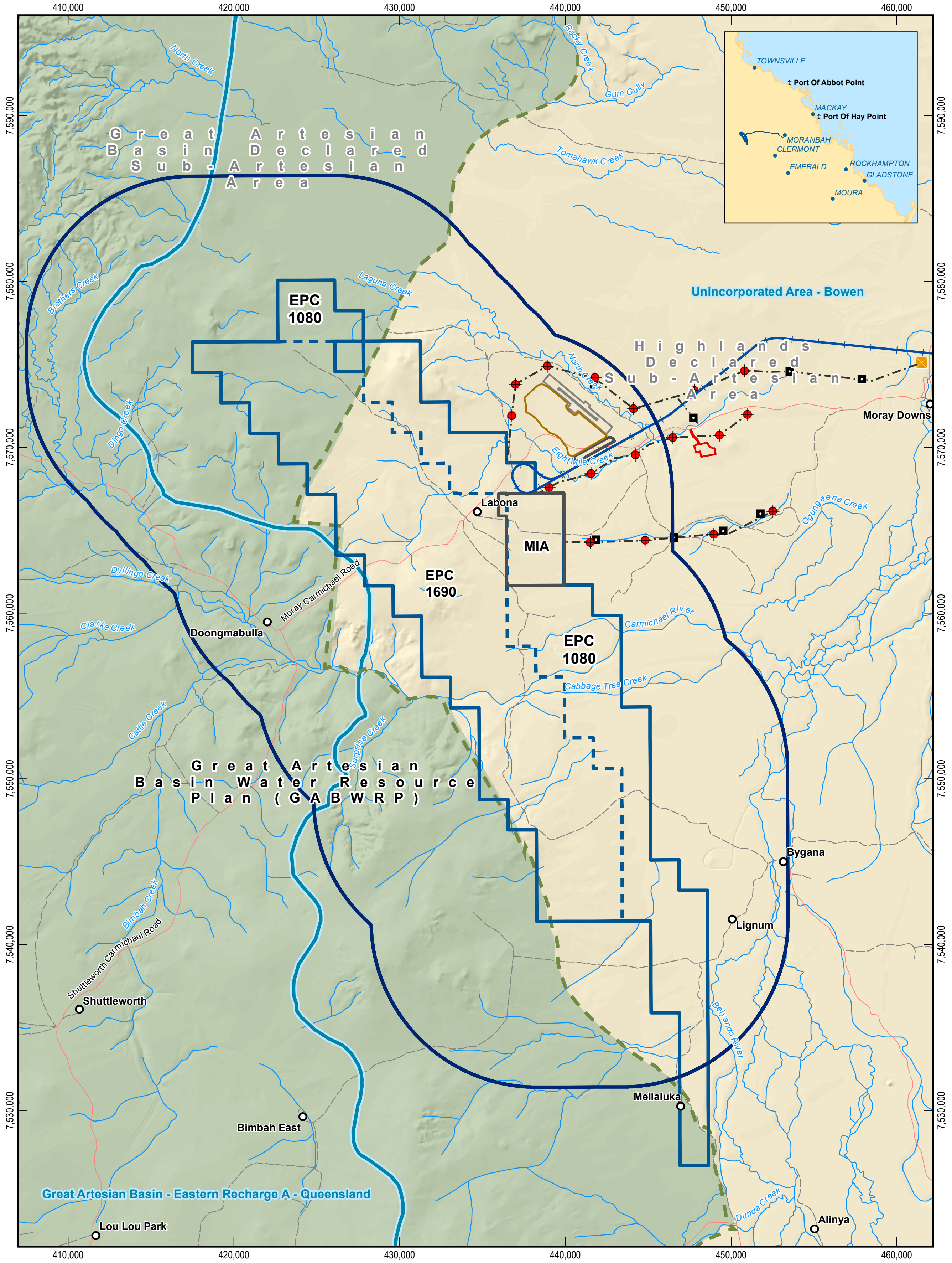
Data Source: DME: Regional Geology 250K (2007). Created by: BW, CA



LEGEND

Homestead	Rail (West)	Declared Sub-Artesian Areas	Mine (Offsite)
Local Road	Mine (Onsite)	Great Artesian Basin Water Resource Plan	Borehole
Track	Mine Infrastructure Area	Groundwater Management Unit Boundary	Storage Site (Instream)
Watercourse			Storage Facility (Offstream)
			Pipeline Network

- Airport Location
- Rail Siding
- Industrial Area
- Workers Accommodation Village

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1:325,000 (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

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Groundwater Management

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

Figure 4-6

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

Data Source: GABWRP, Declared Subartesian Area (2009); DME: EPC 1690 (2010)/EPC 1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); BRS: Groundwater Management Unit Boundary (2009); GHD: Hydrogeology Study Area (2011); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW, CA

4.3 Groundwater Levels and Flows

4.3.1 Overview

Groundwater levels collected from the groundwater monitoring network established within Study Area in November 2011 are shown in plan view in Figure 4-7. Interpreted groundwater level contours and groundwater flow directions for the Tertiary-age strata, AB seam and D seam are shown in Figure 4-8, Figure 4-9 and Figure 4-10 respectively. Insufficient data are available to develop meaningful groundwater level contours for the Quaternary alluvium and Tertiary-age strata although as would be expected the available data from the monitoring bores along the Carmichael River (Figure 4-7) suggests flow from west to east (i.e. downriver). Time series of groundwater elevations are included in Charts 1 to 23 in Appendix D.

4.3.2 Depth to Groundwater

The monitored piezometric head in the Permian-age strata including the coal seams generally falls within the range 20 to 47 m below ground level (BGL). Exceptions to this general rule include the far south of EPC 1690 where the piezometric head has been measured close to ground surface at around 3 mBGL at borehole C035P2 and almost 3 m above ground level (AGL) at nearby monitoring bores C034P3 (D seam) and C034P1 (which monitors overlying sandstone interburden). Piezometric heads above ground were also encountered in exploration bore C066 (at exploration site 180-35) just north of the Carmichael River close to the western boundary of the exploration lease.

Measured groundwater levels in the Dunda Beds at the two monitored locations in the north of EPC 1690 are within the range 27 to 42 mBGL (C022P1 and C9553P1R). Depth to groundwater at monitored locations within the Rewan Group are between around 11 and 26 m BGL in the north of EPC 1690 (C555P1 and C556P1) and around 3 to 4 mBGL in the south (C035P1).

Groundwater levels measured within the Tertiary-age strata in the vicinity of the Carmichael River range from around 2 mBGL at C029P2 to around 11 mBGL at C025P1. Groundwater levels have also been measured close to ground surface in the alluvium (ranging between ground surface and up to around 11 mBGL at C027P1 and C029P1 respectively) and in the Dunda Beds (from around 0.7 mAGL to around 3.6 mBGL at C027P2). These shallower depths to groundwater in the Tertiary-age strata and Dunda Beds are thought to be at least partly as a result of a lower topographic profile close to the river.

4.3.3 Groundwater Flow Directions

Interpretation of the groundwater elevation data for the monitoring network, collected in September 2012, for selected monitored units is shown in Figure 4-8, Figure 4-9, Figure 4-10, Figure 4-11 and Figure 4-12. It suggests that groundwater flow is typically towards the south-east across the northern and central parts of EPC 1690 in the Dunda Beds, Rewan Group, Permian-age sandstones and siltstones, the AB seam and the D seam. The groundwater level data typically show minimum groundwater level elevations at monitoring sites C006, C007, C008 and C555 rather than in the vicinity of the topographic low point the Carmichael River. Across southern areas of EPC 1690, interpretation of the data suggests groundwater flow is typically towards the north west in the Permian-age sandstones and siltstones and the AB and D seams (refer to Figure 4-10, Figure 4-11 and Figure 4-12).

The groundwater elevation calculated for the D seam at vibrating wire piezometer C056 (136.73 mAHD, 7 September 2012) is considered to be erroneous since it is around 80 m lower than levels recorded in nearby monitoring bores. Groundwater level data from this piezometer have therefore been excluded from all subsequent analysis although monitoring of groundwater level pressures data at C056 is ongoing.

4.3.4 Vertical Gradients

A comparison of observed groundwater levels and river bed elevations (note, survey of bed elevation may be +/- 2 m due to tree cover) at three locations where monitoring bores have been installed close to the Carmichael River are provided in Table 4-2. This data suggest an upward gradient of up to around six metres from the Tertiary-age strata, where present, to the overlying alluvium. Groundwater levels in the alluvium at C027P1 close to the western boundary of the lease are also above the bed of the adjacent Carmichael River, which suggests the potential for groundwater discharge to the river in this area. Data for sites C025 and C029 which are located closer to the eastern boundary of EPC 1690 suggest that the bed of the river is typically above the observed groundwater level in the alluvium, which suggests the potential for leakage from the river to groundwater in this area. Further discussion on groundwater and surface water interactions based on this and other data can be found in Section 4.7.

Table 4-2 Carmichael River Monitoring Bore Summary

Site	Borehole	Strata Monitored	Average Groundwater / River Bed Level (mAHD)
C027	NA	River Bed	224.0*
	P1	Alluvium	224.5
	P2	Dunda Beds	226.6
C029	NA	River Bed	220.0*
	P1	Alluvium	214.6
	P2	Tertiary	220.2
C025	NA	River Bed	221.0*
	P1	Tertiary	216.6
	P2	Tertiary	217.9

Note: * Survey of bed level may be +/- 2 m due to tree cover

Upward piezometric head gradients also appear to be present in central and southern parts of EPC 1690 within the Permian-age strata (as indicated by data for monitoring bore pairs C006P1 and C006P3r, C007P2 and C007P3, C008P1 and C008P2, C034P1 and C034P2, refer to Appendix D) and between the Permian-age strata and overlying Rewan Group (monitoring bore pair C035P1 and C035P2). The data for the VWPs installed at C9556P are also consistent with this upward gradient. However the data for the VWPs at C555P also within the central part of EPC 1690 show a downward gradient within the Permian-age strata and also from the Rewan Group to the Permian-age strata at this location.

In northern parts of the Study Area water level data for monitoring bores and VWPs indicate a downward gradient within the Permian-age strata and from the Rewan Group to the underlying Permian-age strata (Refer to Charts 5, 9, 19, 20 and 22 in Appendix D which related to monitoring bores C011P1 and C011P3, C018P1, C018P2 and C018P3 and VWPs at C553P, C056C and C558P).

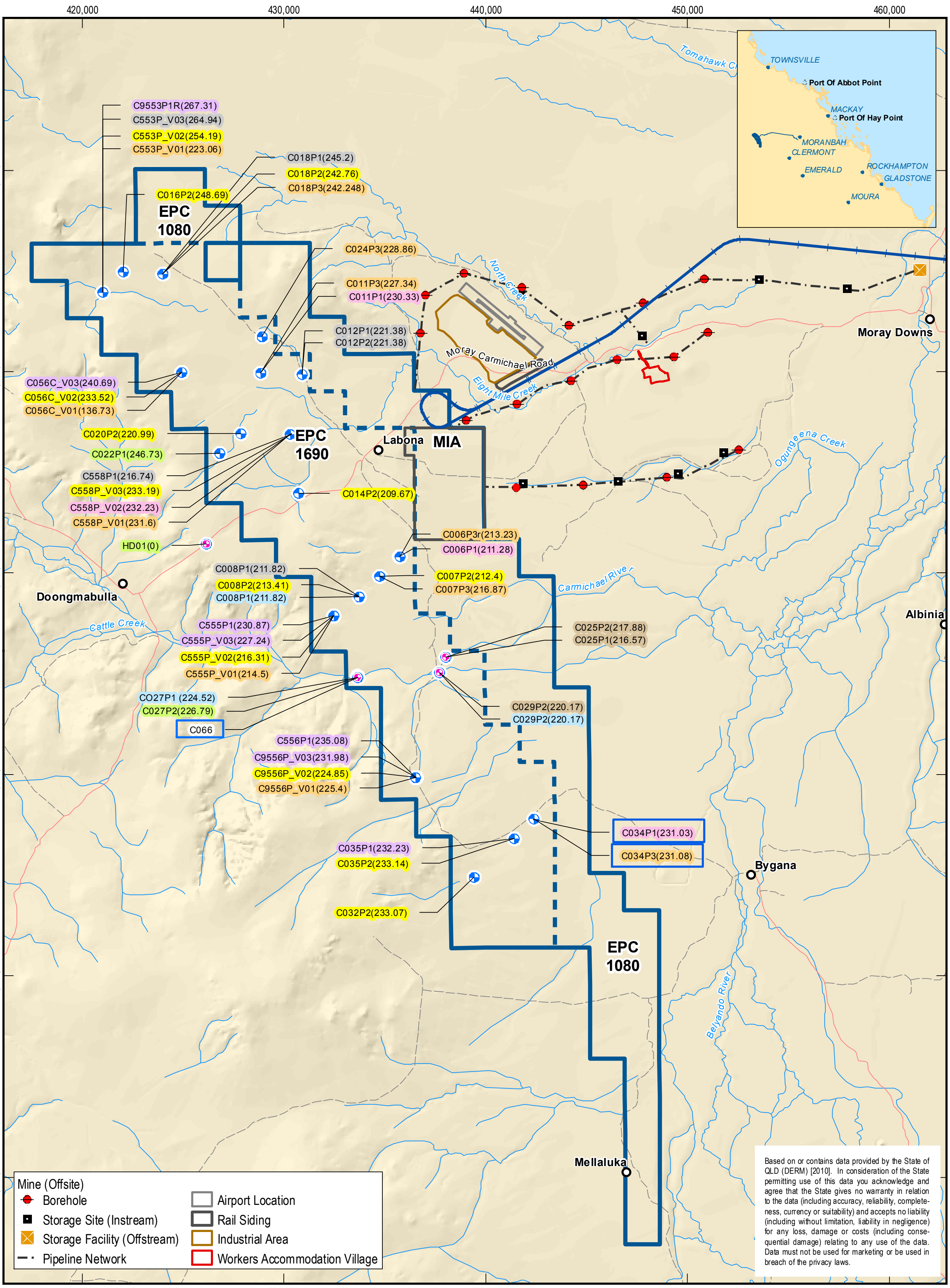
4.3.5 Seasonal Fluctuations

Groundwater level data for the installed monitoring network bores are currently available for July 2011 to September 2012. Monitoring data are not yet available for HD02, HD03A and HD03B which were installed in late October 2012.

The available data suggest that across the majority of EPC 1690, at monitored locations away from the Carmichael River, groundwater levels fluctuate between around 0.1 and 0.2 m in response to individual rainfall events with annual variations in groundwater levels of up to around 0.3 m. The degree of fluctuation is similar for all of the geological units monitored.

In the vicinity of the Carmichael River, groundwater levels typically fluctuate much more widely in response to rainfall events than observed for the rest of the monitoring network. In the alluvium, measured groundwater level increases of up to around 2 m were measured (C027P1) whereas further east at C029P1 response to rainfall was significantly less with an increase of up to around 0.6 m for the same two rainfall events. This may be due to the more clayey nature of the alluvium encountered at C029P1 in comparison to the sandier deposits encountered at C027P1. In the underlying Dunda Beds (C027P2) and Tertiary-age strata (C029P2) groundwater levels fluctuated between around 0.2 and 3 m in response to the same rainfall events.

Across EPC 1690, the lowest groundwater levels were typically recorded during August to October 2011 before the onset of the wet season and the highest groundwater levels recorded during February and March 2012 during the wet season. Since March 2012 groundwater levels have typically remained relatively steady (for example C011P3, C007P2, C007P3 and C029P2) or declined slightly (for example C014P2, C016P2, C020P2 and C025P2).



LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Artesian Bore
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Vibrating Wire Piezometer
- Groundwater Monitoring Bore (SWL in AHD) - Alluvium
- Groundwater Monitoring Bore (SWL in AHD) - Tertiary
- Groundwater Monitoring Bore (SWL in AHD) - Dunda Beds
- Groundwater Monitoring Bore (SWL in AHD) - Rewan Group
- Groundwater Monitoring Bore (SWL in AHD) - Permian overburden
- Groundwater Monitoring Bore (SWL in AHD) - AB Seam
- Groundwater Monitoring Bore (SWL in AHD) - Interburden
- Groundwater Monitoring Bore (SWL in AHD) - D Seam

1:275,000 (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

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Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

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

Groundwater Monitoring Bores
September 2012 Standing Water Levels

Figure 4-7

G:\41\25215\GIS\Maps\MXD\300_Hydrogeology\41-25215_316_rev_e.mxd

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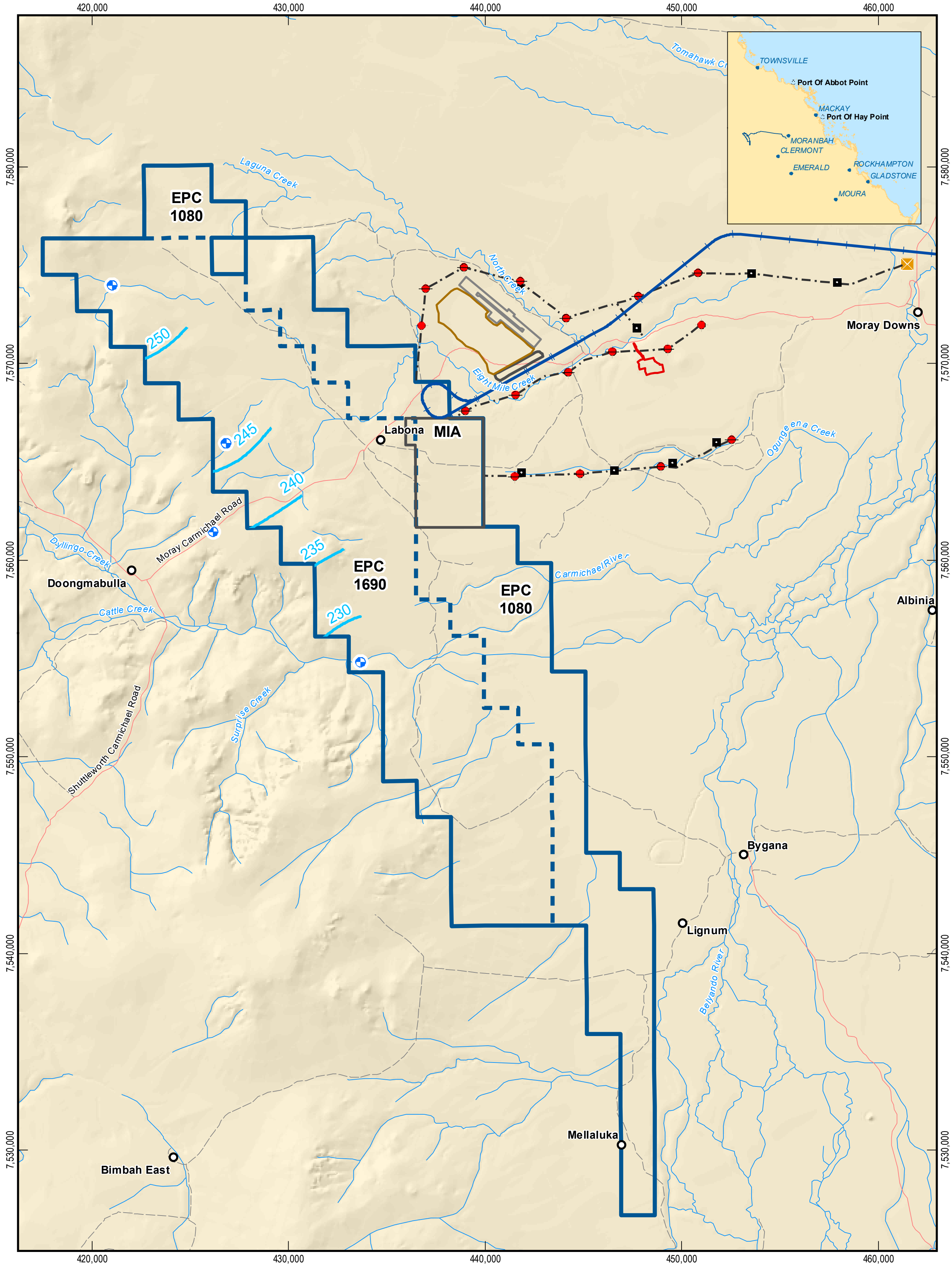
GHD: Monitoring Bores, River Bed Locations, Test Locations (2011); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW, CA



LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine Infrastructure Area
- Mine (Onsite)
- Groundwater Monitoring Bore (SWL in mAHD - September 2012)
- Interpreted Groundwater Level Contour (mAHD)
- Mine (Offsite)
- Borehole
- Storage Site (Instream)
- Storage Facility (Offstream)
- Pipeline Network
- Airport Location
- Rail Siding
- Industrial Area
- Workers Accommodation Village

1:275,000 (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

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GHD adani

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

Interpreted Groundwater Contours
Dunda Beds

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

Figure 4-8

G:\41\25215\GIS\Maps\MXD\300_Hydrogeology\41-25215_323_rev_f.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

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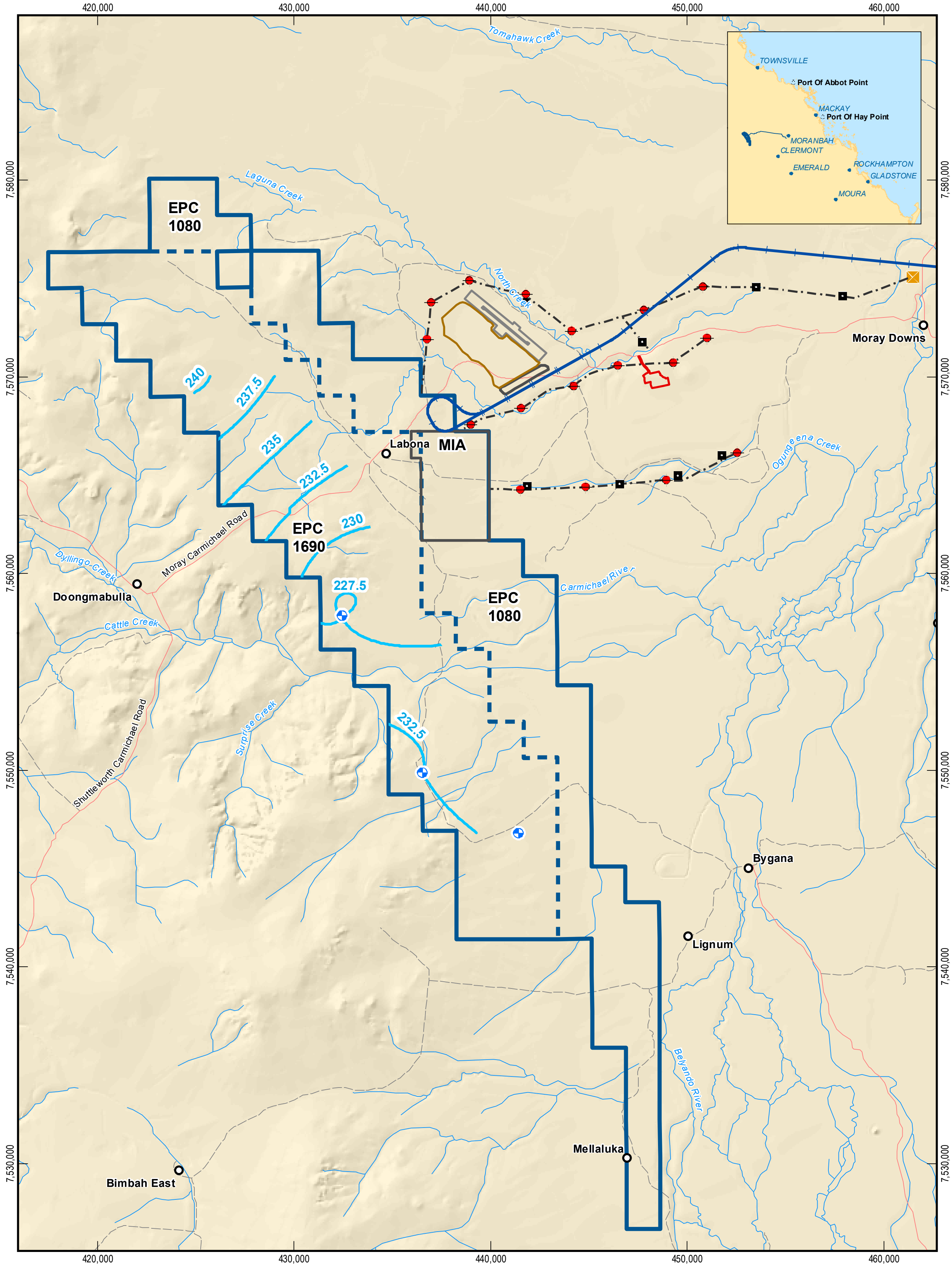
GHD: Monitoring Bores, Interpreted Groundwater Level Contour (2012); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW, MS



LEGEND

Homestead	Rail (West)	Mine (Offsite)	Airport Location
Local Road	Mine (Offsite)	Borehole	Rail Siding
Track	Mine Infrastructure Area	Storage Site (Instream)	Industrial Area
Watercourse	Groundwater Monitoring Bore (SWL in mAHD - September 2012)	Storage Facility (Offstream)	Workers Accommodation Village
	Interpreted Groundwater Level Contour (mAHD)	Pipeline Network	

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1:275,000 (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

GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Interpreted Groundwater Contours
Rewan Group

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

Figure 4-9

G:\41\25215\GIS\Maps\MXD\300_Hydrogeology\41-25215_336_rev_a.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

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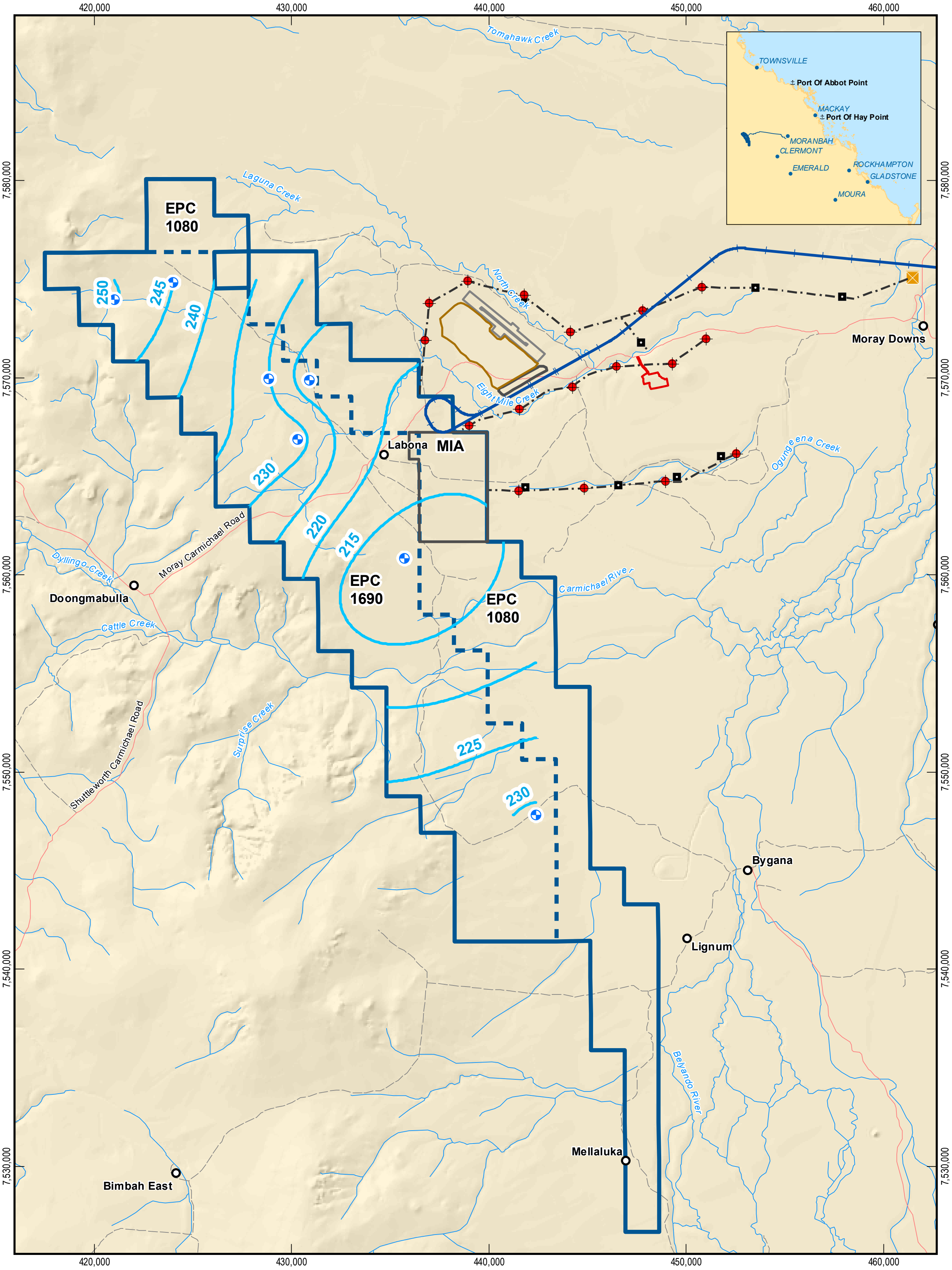
GHD: Monitoring Bores, Interpreted Groundwater Level Contour (2012); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW.



LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Offsite)
- Mine Infrastructure Area
- Groundwater Monitoring Bore (SWL in mAHD - September 2012)
- Interpreted Groundwater Level Contour (mAHD)

Mine (Offsite)
- Borehole
- Storage Site (Instream)
- Storage Facility (Offstream)
- Pipeline Network
- Airport Location
- Rail Siding
- Industrial Area
- Workers Accommodation Village

1:275,000 (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

GHD adani

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

Interpreted Groundwater Contours
Permian-age strata

Job Number 41-25215
Revision A
Date 08-11-2012

Figure 4-10

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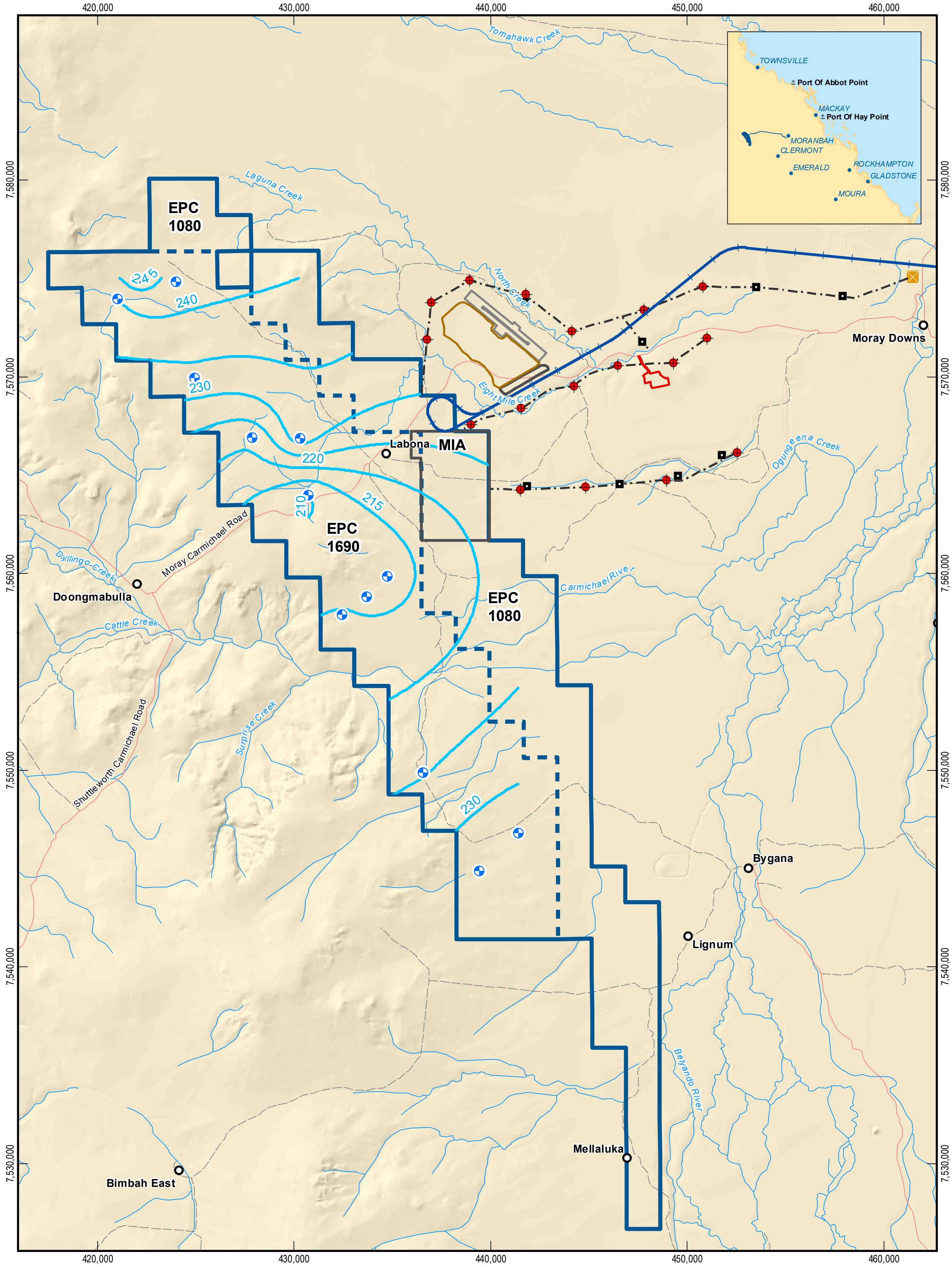
Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: DME: EPC 1690 (2010)/EPC 1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007);
GHD: Monitoring Bores, Interpreted Groundwater Level Contour (2012); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW, MS



LEGEND

Homestead	Rail (West)	Mine (Offsite)	Airport Location	Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.
Local Road	Mine (Offsite)	Borehole	Rail Siding	
Track	Mine Infrastructure Area	Storage Site (Instream)	Industrial Area	
Watercourse	Groundwater Monitoring Bore (SWL in mAHD - September 2012)	Storage Facility (Offstream)	Workers Accommodation Village	
	Interpreted Groundwater Level Contour (mAHD)	Pipeline Network		

1:275,000 (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

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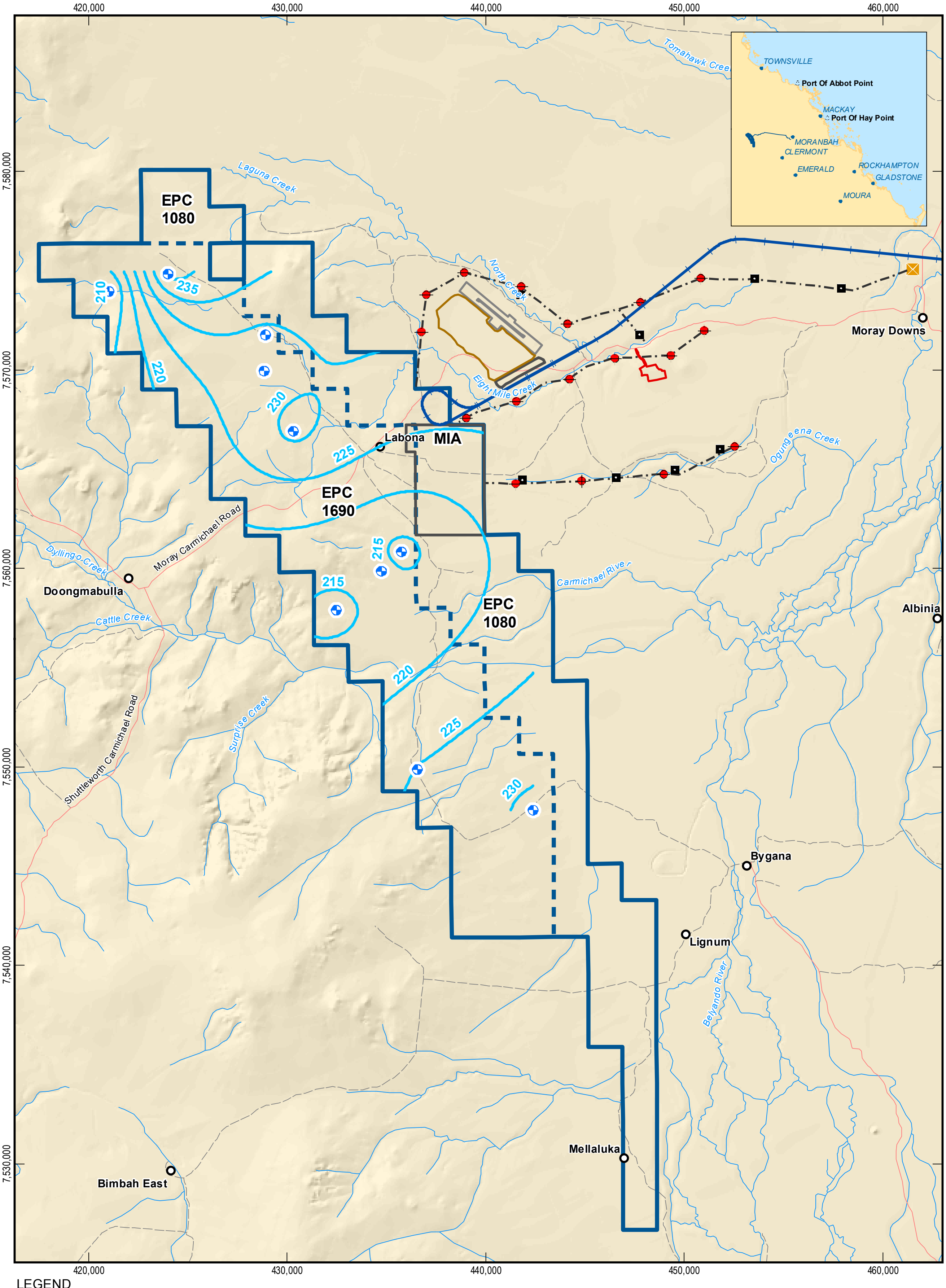
Carmichael Coal Mine and Rail Project

Interpreted Groundwater Contours
AB Seam

Job Number	41-25215
Revision	E
Date	07-11-2012

Figure 4-11

Data Source: DME: EPC 1690 (2010)/EPC 1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007);
GHD: Monitoring Bores, Interpreted Groundwater Level Contour (2012); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW.



LEGEND

Homestead	Mine (Onsite)
Local Road	Mine Infrastructure Area
Track	Groundwater Monitoring Bore (SWL in mAHD)
Watercourse	Interpreted Groundwater Level Contour (mAHD)
Rail (West)	

Mine (Offsite)	Airport Location
Borehole	Rail Siding
Storage Site (Instream)	Industrial Area
Storage Facility (Offstream)	Workers Accommodation Village
Pipeline Network	

1:275,000 (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

GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project
Interpreted Groundwater Contours
D Seam

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

Figure 4-12

G:\41\25215\GIS\Maps\MXD\300_Hydrogeology\41-25215_325_rev_e.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: DME: EPC 1690 (2010)/EPC 1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007);
GHD: Monitoring Bores, Interpreted Groundwater Level Contour, Test Locations (2012); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW, CA

4.4 Groundwater Quality

4.4.1 Overview

Groundwater samples were collected from 28 of the 29 monitoring bores installed at the time of sampling on two separate occasions for field testing and laboratory analysis (for further information on groundwater sampling refer to Section 2.3.3). Sampling of one of the bores (C025P1) was not possible since this bore was observed to be dry during both sampling rounds. The groundwater quality analysis results for samples collected from the monitoring network bores are summarised in Appendix E.

The laboratory analysis results for dissolved metals have been corrected for hardness where appropriate.

The major ion data are also shown on Piper diagrams (Figure 4-13 and Figure 4-14) in order to identify and make comment on differences in the major ion chemistry of the samples collected. As part of the review groundwater quality results have been compared to ANZECC (2000) fresh water quality guidelines (95 per cent level of protection) in order to identify any anomalous concentrations. Concentrations have also been compared to Australian Drinking Water Guidelines (ADWG, 2011) and ANZECC (2000) guidelines for livestock and for long-term irrigation in order to comment on potentially suitable uses for the groundwater.

4.4.2 Major Ions and Inorganics

A piper plot of the major ion chemistry for the sampled bores indicates that the groundwater is typically of sodium-chloride type in each of the strata monitored (Figure 4-13). For the most part there appears to be no clear difference between the major ion chemistry of the strata monitored, although the proportion of chloride and hence the final plotting position in most units is highly variable. A possible exception to this general rule is the D seam where some samples contain proportionally less chloride and more bicarbonate when compared to the overlying monitored units, i.e. some of the samples suggest a sodium-bicarbonate-chloride type rather than sodium-chloride type water.

Figure 4-14 shows a comparison of major ion chemistry for four surface water sampling sites along the Carmichael River (WQ1, WQ2, WQ3 and WQ4,) and two groundwater monitoring bores (C025P2 and C027P1) which are completed into the Quaternary/Tertiary alluvium close to the river (see Figure 4-4 for monitoring site locations). Information on surface water quality data for a number of still water bodies, predominantly local farm dams are also shown. Comparison of these data sets suggests that both the Carmichael River and groundwater samples can be classified as sodium-chloride type waters. In fact the Carmichael River samples appear to become progressively more similar to the groundwater samples as the dry season progresses. Hence, some difference can be observed between the major ion chemistry of the May surface water samples and the groundwater samples.

The main point of difference is the relatively low proportion of chloride present in the surface water samples, which suggests a higher rainfall/runoff component. However, by July the proportion of chloride in the surface water samples had increased to 70-80 per cent such that there is little apparent difference between the major ion chemistry of the groundwater and surface water samples. This suggests that groundwater discharge becomes an increasingly important component of flow in the river as the dry season progresses. This observation is supported by the groundwater level data, which suggest an upward gradient from the Tertiary units to the alluvium, throughout the EPC 1690 area, and from the alluvium to the Carmichael River towards the west of the lease.

Concentrations of sodium in groundwater samples detected above the laboratory LoR ranged from 55 to 5,960 mg/L and exceeded the long-term irrigation guidelines (ANZECC 2000) in 24 samples, collected from the alluvium, Tertiary-age strata and the AB seam. Concentrations of chloride in groundwater ranged from 49 to 8,430 mg/L also exceeded the long-term irrigation guidelines in 23 samples tested (collected from the alluvium, Tertiary-age strata and the AB seam). Sulphate concentrations in groundwater only exceeded the drinking water guideline (500 mg/L) in one sample with a concentration of 686 mg/L.

Fluoride concentrations ranged from 0.1 to 2.6 mg/L and exceeded the drinking water guideline (1.5 mg/L) and livestock guideline (2 mg/L) in five samples collected from two bores monitoring the D seam.

Figure 4-13 Piper Diagram – Groundwater

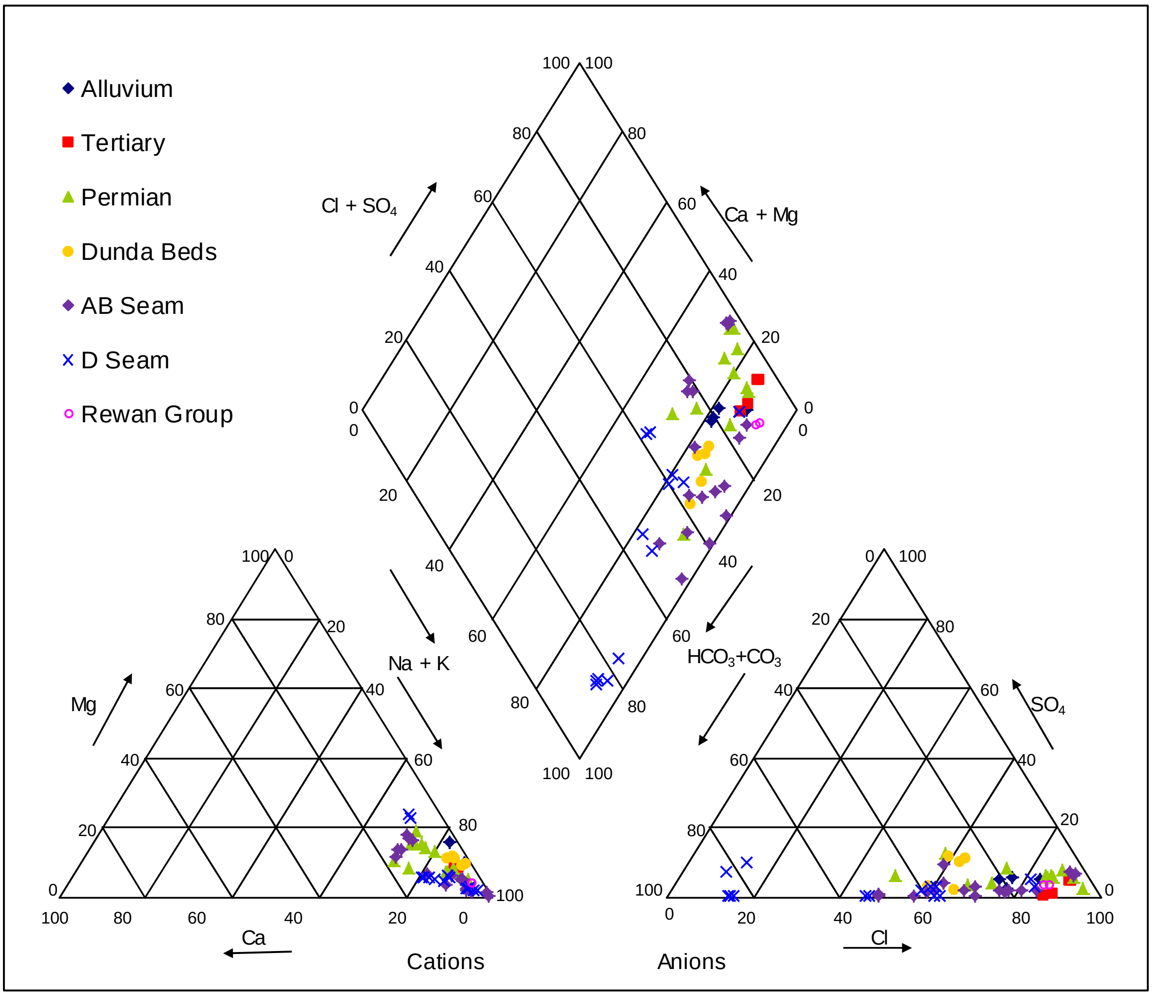
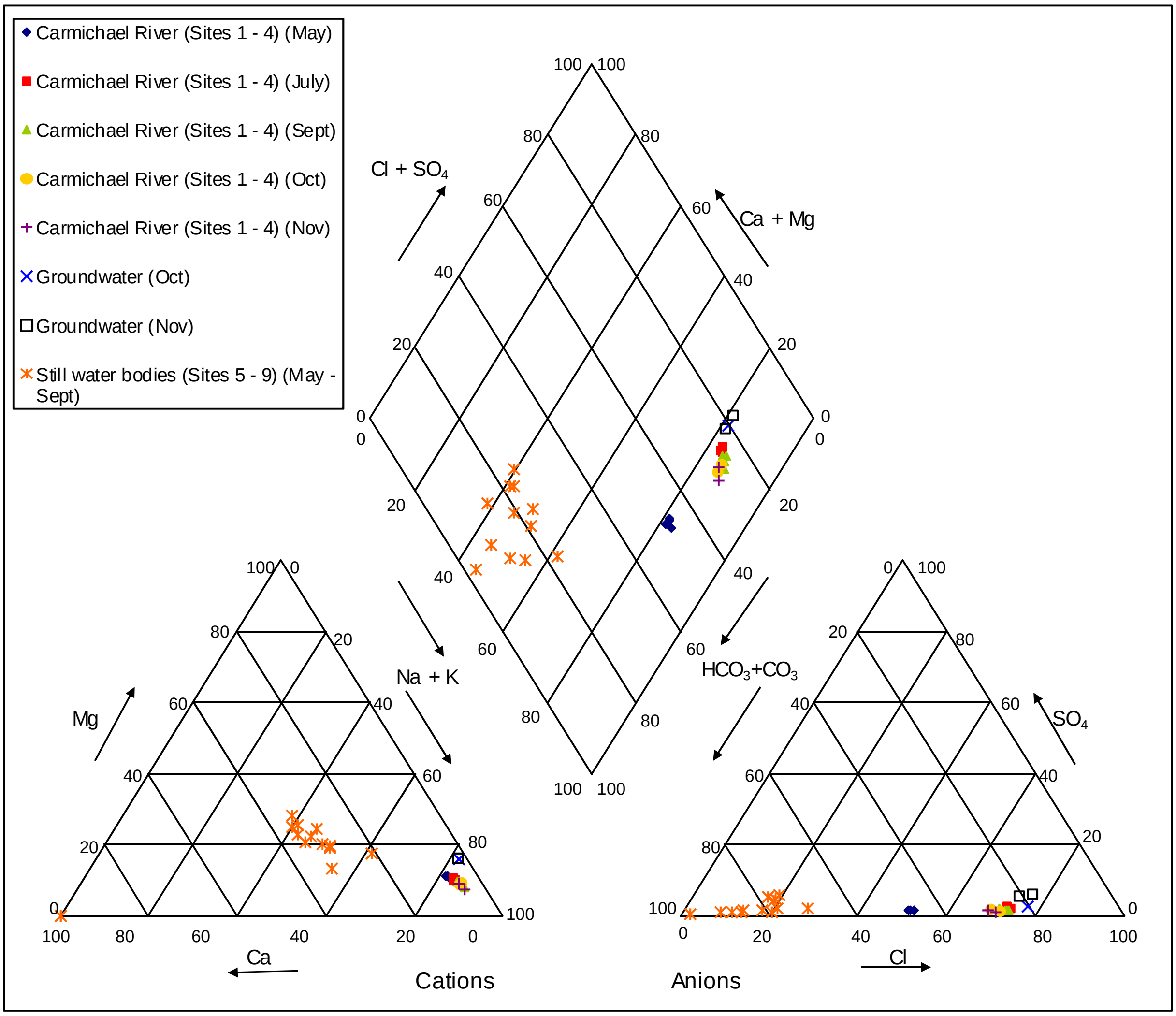


Figure 4-14 Piper Diagram – Groundwater and Carmichael River



4.4.3 Nutrients

Concentrations of ammonia in groundwater exceeded the ANZECC (2000) fresh water (95 per cent level of protection) guideline value of 0.9 mg/L in 10 samples and exceeded the drinking water guidelines of 0.5 mg/L in 18 samples. These exceedences of ammonia were identified in samples taken from monitoring bores installed in the alluvium, Tertiary-age strata and the AB seam. Samples collected from bores completed in the Dunda Beds and the D seam did not exceed these guideline values. Concentrations of total nitrogen, total dissolved nitrogen and phosphorous were also identified above the laboratory limit of reporting (LoR) in all of the monitored strata (i.e. the alluvium, Tertiary-age strata, Dunda Beds, AB seam and D seam).

Nitrate concentrations of up to 0.2 mg/L and nitrite concentrations of up to 0.06 mg/L were detected, which are below the guideline values for drinking water and livestock. Concentrations of total nitrogen (up to 12 mg/L) and phosphorous (up to 1.99 mg/L) were detected in the samples tested and exceeded the long-term irrigation guideline value.

4.4.4 Dissolved Metals

Concentrations of dissolved metals in all units tested were generally below the guideline concentrations for livestock, with the exception of manganese. Manganese concentrations in 48 out of 52 samples tested exceeded the guideline value (0.1 mg/L) with concentrations in groundwater detected up to 4.81 mg/L.

Guidelines for long-term irrigation were exceeded for aluminium (1 sample), boron (22 samples), iron (52 samples), manganese (32 samples), molybdenum (6 samples), selenium (1 sample) and uranium (6 samples). Exceedences of one or more of these metals species were detected in all of the units monitored (i.e. the alluvium, Tertiary-age strata, Dunda Beds, AB seam and D seam).

Drinking water guidelines were exceeded for arsenic (11 samples), manganese (14 samples), selenium (2 samples) and uranium (3 samples). Exceedences of one or more of these metals species were detected in all units monitored with the exception of the D seam.

4.4.5 Hydrocarbons

Low concentrations of BTEX (benzene, toluene, ethylbenzene and xylene), comprising toluene (nine samples with the range 3 to 17 µg/L) and benzene (one sample at 2 µg/L), were detected just above the laboratory LoR (2 µg/L toluene and 1 µg/L benzene) at six locations. Exceedences of the LoR were detected in Tertiary-age strata, the AB seam and the D seam.

Low concentrations of total petroleum hydrocarbons (TPH) in the fraction range C6 to C14 were detected above the laboratory LoR (i.e. the lighter more volatile fractions of TPH) in each of the monitored units (i.e. the alluvium, Tertiary-age strata, Dunda Beds, AB seam and D seam).

The guidelines for drinking water, livestock and long-term irrigation for benzene (1 µg/L) were exceeded in one sample (with a concentration of 2 µg/L) collected from monitoring in the AB seam. The guideline values for ethylbenzene (300 µg/L), toluene (800 µg/L) and total xylene (600 µg/L) were not exceeded.

4.5 Groundwater Suitability for Use

A review of the available data from the groundwater bore database (DERM, 2010) and site visits to registered bores within the EP 1690 lease area indicated the following:

- Local groundwater is dominated by extraction for Stock & Domestic and Irrigation use.
- To the west of Study Area, extraction is predominantly from the Triassic-age units of the GAB including the Moolayember Formation and the Clematis Sandstone.
- Within and to the east of EPC 1690 extraction is thought to occur from Tertiary, Triassic and/or Permian-age sandstone units.

Based on comparison of the available groundwater chemistry data collected for the current study with relevant groundwater quality guidelines (for long term irrigation, livestock and drinking water (health)) potential uses for groundwater from each hydrogeological unit tested are as follows:

- Alluvium. Potential for use for industrial purposes only. Monitoring results suggest that groundwater drawn from the Quaternary alluvium may not suitable be for drinking (based on the elevated observed concentrations of arsenic, manganese and uranium detected), not suitable for long term irrigation (based elevated on concentrations of chloride, sodium, dissolved boron, iron and manganese) and also not suitable for livestock (on the basis of the observed elevated manganese concentrations).

- Tertiary-age strata. Potentially only suitable for industrial purposes. TDS concentrations typically fall within the 'poor' (900 to 1,200 mg/L) and 'unacceptable' (>1,200 mg/L) palatability categories for drinking water making it generally not suitable for drinking. Groundwater in some areas does not appear to be suitable for long-term irrigation given significantly elevated concentrations of dissolved iron (0.29 to 24.9 mg/L), manganese (0.45 to 0.89 mg/L) and boron (0.9 to 1.29 mg/L) above the guideline values in some of the bores. TDS concentrations are also elevated above 8,100 mg/L (the guideline maximum TDS for irrigation) in some areas. The concentration of manganese is also generally above the guideline value for livestock (0.1 mg/L) and, in combination with elevated TDS in some areas, suggests that the water is generally unsuitable for livestock.
- Dunda Beds. Potentially suitable for use as drinking water and/or industrial purposes. The measured TDS concentration for the single bore tested falls into the 'good' palatability category (0 to 600 mg/L TDS) for drinking water (ADWG, 2011) and all other parameters tested are below guideline level. However, the elevated iron concentrations present in the samples taken would make the groundwater unsuitable for long term irrigation and the results also indicate borderline suitability for livestock on the basis of dissolved manganese and pH.
- AB seam. Potential for industrial use only. Generally not suitable for drinking water on the basis of palatability (aesthetic), given the measured TDS concentrations typically fall within the 'poor' (900 to 1,200 mg/L) and 'unacceptable' (>1,200 mg/L) palatability categories. The elevated observed concentrations of manganese (up to 0.9 mg/L) in somee bores suggest that in some areas groundwater could also be unsuitable for livestock. Elevated concentrations of sodium (up to >2000 mg/L) and chloride (>5000 mg/L) in some monitoring bores suggest that the groundwater from some areas would also be unsuitable for irrigation.
- D seam. Potential for industrial use only. Generally potentially suitable for drinking water, however fluoride concentrations exceeded drinking water guideline values at two monitoring bores sampled indicating localised areas could be unsuitable for drinking. TDS concentrations typically fall into the 'good' and 'fair' (600 to 900 mg/L TDS) palatability categories for aesthetic quality. Concentrations of iron (up to 14.8 mg/L) indicate the groundwater would not be suitable for long term irrigation. The elevated observed concentrations of manganese and fluoride suggest that the water would also be generally unsuitable for livestock.

4.6 Aquifer Properties

Hydraulic conductivity values estimated from slug tests, packer tests and pumping tests are summarised in Table 4-3, Table 4-4, and Table 4-5 respectively. Summary statistics are presented in Table 4-6. Slug test analysis data sheets are included in Appendix F and a summary of the pumping test analysis is included in Appendix G.

The majority (45 out of 58) of tests undertaken in the lease area were completed in Permian age strata since these units dominate the sub-surface geology and will largely control inflows to and the impacts of the proposed mine workings. The results of these tests suggest that the Permian strata are typically characterised by:

- Relatively low hydraulic conductivity and hence the median hydraulic conductivity for the different strata tested vary between 5.6x10-3 m/d for the D Seams to 5.0x10-4 m/d for the 'interburden' units between the AB and D seams;
- A relatively high degree of variability. Test results vary across 5 orders of magnitude from 3.5 m/d to 5.8x10-5 m/d;

- Generally higher hydraulic conductivity values are returned by tests undertaken in the coal seams, hence the highest median values are recorded in the AB and D Seams;

These observations are considered to be consistent with the findings of other similar analyses of similar Permian strata elsewhere in Queensland including summary statistics for Triassic and Permian age strata in the Surat and Bowen basin recently published by the Queensland Water Commission (QWC, 2012).

Only a small number of test results are available for the remaining strata present within the lease area and hence the results should be treated with some caution.

For instance tests undertaken on the Rewan Group within the site suggest a relatively high median hydraulic conductivity of 2.3×10^{-2} m/d. However, whilst it is recognised that the Rewan Group is highly variable, it is typically considered to be an aquitard (QWC, 2012). Regional data sets indicate a median hydraulic conductivity of 3.6×10^{-4} m/d and suggest that 95% of tests return values of less than 5.1×10^{-2} m/d (QWC, 2012).

Similarly based on the observed sandy lithology of the Quaternary alluvium the results of the two tests undertaken, which suggest hydraulic conductivity values of between 2.3×10^{-2} and 1.2×10^{-1} m/d, seem too low to be representative.

Conversely the hydraulic conductivity values returned by the three tests undertaken in Tertiary units, which suggest a median value of 5.3×10^{-2} m/d, seem relatively high given the clay dominated nature of this unit.

Results for the Dunda Beds suggest that the hydraulic conductivity of this unit is highly variable and vary from 2.2×10^{-3} to 3 m/d. This is considered to be consistent with the variable lithological nature of strata attributed to the Dunda Beds in borehole logs.

Table 4-3 Summary of Estimated Hydraulic Conductivity from Slug Tests

Bore ID	Hydraulic Conductivity K (m/d)	Hydraulic Conductivity K (m/s)	Tested Unit
C027P1	2.5×10^{-02}	2.7×10^{-07}	Alluvium (sand with gravel)
C029P1	1.2×10^{-01}	1.4×10^{-06}	Alluvium (sand and clayey sand)
HD03B	$1.1 \times 10^{+00}$	1.3×10^{-05}	Alluvium (clay)
C025P2	1.7×10^{-01}	2.0×10^{-06}	Tertiary (leached, fine grained rock)
C029P2	5.3×10^{-02}	6.1×10^{-07}	Tertiary (ferricrete)
C558P1	2.1×10^{-04}	2.5×10^{-09}	Tertiary and Rewan Group (sandy clay)
HD02	$1.5 \times 10^{+01}$	1.7×10^{-04}	Clematis Sandstone
C022P1	$3.0 \times 10^{+00}$	3.4×10^{-05}	Dunda Beds (weathered sandstone)
C027P2	2.5×10^{-01}	2.9×10^{-06}	Dunda Beds (ferricrete)
C035P1	2.3×10^{-02}	2.7×10^{-07}	Rewan Group (weathered sandstone)

Bore ID	Hydraulic Conductivity K (m/d)	Hydraulic Conductivity K (m/s)	Tested Unit
C553P1	2.2x10^{-03}	2.6x10^{-08}	Rewan Group (clayey sand)
C555P1	1.0x10^{-01}	1.2x10^{-06}	Rewan Group (sandy clay)
C556P1	2.9x10^{-01}	3.4x10^{-06}	Rewan Group (sandy clay)
C008P1	2.3x10^{-03}	2.7x10^{-08}	Permian overburden (weathered siltstone)
C012P1	4.1x10^{-01}	4.7x10^{-06}	Permian overburden (weathered sandstone and siltstone)
C012P2	2.5x10^{-03}	2.9x10^{-08}	Permian overburden (weathered sandstone)
C018P1	1.9x10^{-02}	2.2x10^{-07}	Permian overburden (weathered sandstone)
C007P2	5.6x10^{-02}	6.5x10^{-07}	AB Seam (coal)
C016P2	4.0x10^{-03}	4.6x10^{-08}	AB Seam (coal and carbonaceous siltstone)
C006P1	1.4x10^{+00}	1.6x10^{-05}	Permian interburden (siltstone)
C011P1	1.0x10^{-03}	1.2x10^{-08}	Permian interburden (weathered sandstone)
C007P3	6.9x10^{-02}	7.9x10^{-07}	D Seam (coal with siltstone)

Table 4-4 Summary of Hydraulic Conductivity from Packer Tests

Bore	Test Type	Test Interval (mbgl)	Formation Tested	Estimated Hydraulic Conductivity (m/d)
C056 Test 1	Single	302.8 - 315	AB1/AB2 Seam (Coal)	1.7x10^{-02}
C056 Test 2	Single	352 - 363	AB3 Seam (Coal)	1.2x10^{-02}
C056 Test 3	Single	402.8 - 420	D Seam (Coal)	6.5x10^{-03}
C056 Test 4	Single	368.8 - 420	D Seam & Interburden (Coal, siltstone & sandstone)	5.6x10^{-03}
		368.8 - 402.8	Calculated K value Interburden only	5.2x10^{-03}
C056 Test 5	Straddle	423.8 - 432.5	Below D Seam (Med-coarse sandstone, no fractures)	6.3x10^{-04}
C056 Test 6	Straddle	376 - 384	Interburden (Coarse sandstone)	6.8x10^{-04}
C056 Test 7	Straddle	331 - 341.5	Interburden (Coarse sandstone, no fractures)	9.5x10^{-05}
C056 Test 8	Straddle	278.8 - 292.5	Permian overburden (Siltstone, jointed)	5.4x10^{-04}
C056 Test 9	Straddle	268 - 276.5	Base of Rewan Group (Siltstone, fractured)	1.7x10^{-04}

Bore	Test Type	Test Interval (mbgl)	Formation Tested	Estimated Hydraulic Conductivity (m/d)
C039 Test 1	Straddle	429.3 - 433.4	AB3 Seam lower split (Coal)	$5.4x10^{-04}$
C039 Test 2	Straddle	417.8 - 422.8	AB3 Seam upper split (Coal)	$1.4x10^{-04}$
C039 Test 3	Straddle	306 - 314.7	Permian overburden (Sandstone & siltstone, fractured zone 306 to 308 m)	$8.6x10^{-05}$
C558P Test 1	Single	182 - 222	Below D Seam (Sandstone, some siltstone)	$1.2x10^{-03}$
C558P Test 2	Straddle	161.7 - 167.7	D Seam (Coal)	$1.6x10^{-02}$
C558P Test 3	Single	161.7 - 222	D Seam & below D Seam (Coal & sandstone)	$8.7x10^{-03}$
C558P Test 4	Straddle	104.7 - 110.7	Interburden (Sandstone, some siltstone)	$8.6x10^{-05}$
C558P Test 5	Single	83.8 - 222	Interburden, D Seam, below D Seam (Sandstone, some siltstone)	$9.7x10^{-04}$
C558P Test 6	Straddle	77.4 - 82.4	AB2 & AB3 Seam (Coal)	$1.4x10^{-02}$
C555P Test 1	Single	441.5 - 473	Below D Seam (Sandstone, some siltstone)	$1.3x10^{-03}$
C555P Test 2	Straddle	435 - 441	D1 & D2 Seam (Coal & siltstone)	$2.8x10^{-03}$
C555P Test 3	Single	360 - 473	Interburden to below D Seam (Sandstone with siltstone, coal)	$3.3x10^{-04}$
C555P Test 4	Straddle	342 - 348	AB Seam (Coal)	$1.2x10^{-03}$
C555P Test 5	Straddle	330 - 336	Permian overburden (Sandstone)	$5.8x10^{-05}$
C9556PR Test 1	Single	410.7 - 444.7	Below D Seam (Sandstone)	$7.0x10^{-04}$
C9556PR Test 2	Straddle	404.5 - 410.5	D Seam (Coal)	$1.3x10^{-04}$
C9556PR Test 3	Single	329.7 - 444.7	Interburden to below D Seam (Sandstone, coal)	$1.3x10^{-03}$
C9556PR Test 4	Straddle	311.7 - 318.7	AB Seam (Coal)	$1.5x10^{-04}$
C9556PR Test 5	Straddle	303.1 - 309.1	Permian overburden (Sandstone)	$2.3x10^{-04}$
C9556PR Test 6	Straddle	243.1 - 249.1	Rewan Group (Sandstone & siltstone)	$2.3x10^{-04}$

Table 4-5 Summary of Estimated Transmissivity, Storage and Hydraulic Conductivity from Pumping Tests

Pumping Test Site ID	Formation Tested	Adopted Transmissivity[1] (m^2/d)	Adopted Storativity [1] (Dimensionless)	Estimated Hydraulic Conductivity[1] (m/d)
C006	D Seam	12	0.005	$2.0\text{x}10^{-01}$
C018	D Seam	9	0.001	$1.0\text{x}10^{-01}$
C035	AB Seam	60	0.005	$3.5\text{x}10^{+00}$

Note [1] – Refer to Appendix G for a more detailed summary of results

Table 4-6 Summary of Estimated Hydraulic Conductivity by Formation Tested

Formation	Dominant Lithology	Estimated Hydraulic Conductivity (m/d)			Number of tests
		Minimum	Median	Maximum	
Quaternary Alluvium	Sand and Clayey Sand	$2.3\text{x}10^{-02}$	$7.1\text{x}10^{-02}$	$1.2\text{x}10^{-01}$	2
Tertiary	Sandy Clay	$2.1\text{x}10^{-04}$	$5.3\text{x}10^{-02}$	$1.7\text{x}10^{-01}$	3
Dunda Beds	Sandstone / Siltstone / Mudstone	$2.2\text{x}10^{-03}$	$2.5\text{x}10^{-01}$	$3.0\text{x}10^{+00}$	3
Rewan Group	Mudstone / Siltstone	$1.7\text{x}10^{-04}$	$2.3\text{x}10^{-02}$	$2.9\text{x}10^{-01}$	5
Permian overburden	Weathered Sandstone / Siltstone	$5.8\text{x}10^{-05}$	$2.3\text{x}10^{-03}$	$1.4\text{x}10^{+00}$	9
AB Seam	Coal and Siltstone	$8.6\text{x}10^{-05}$	$4.0\text{x}10^{-03}$	$3.5\text{x}10^{+00}$	11
Permian interburden	Sandstone / Siltstone	$8.6\text{x}10^{-05}$	$5.0\text{x}10^{-04}$	$1.3\text{x}10^{-03}$	6
D Seam	Coal and Siltstone	$1.3\text{x}10^{-04}$	$5.6\text{x}10^{-03}$	$2.0\text{x}10^{-01}$	11
Older Permian strata	Sandstone / Siltstone	$3.3\text{x}10^{-04}$	$1.1\text{x}10^{-03}$	$8.7\text{x}10^{-03}$	8

4.7 Interaction between Surface Water and Groundwater

4.7.1 Overview

A number of strands of evidence suggest that interaction between groundwater and surface water resources in the Carmichael River is likely to be occurring, including:

- An upward gradient from the underlying deposits (Tertiary-age strata and Dunda Beds) to the overlying alluvium next to the river (recorded at all three nested monitoring bore sites along the Carmichael River);
- Groundwater levels in the alluvium above the level of the river bed (recorded at one nested monitoring bore site, C027, next to the Carmichael River) showing a typical exponential decline in groundwater levels following a significant rainfall event;

- Similarities in major ion chemistry between groundwater next to the Carmichael River and surface water;
- Continuous flow recorded at the upstream gauge installed on the Carmichael River suggests groundwater discharge is occurring upstream of the gauge location; and
- Apparent flow losses between the upstream and downstream gauges suggest surface water leakage to groundwater is also occurring.

Further details are outlined in the Sections 4.7.2 to 4.7.4.

4.7.2 Groundwater Levels and Gradients

As described previously in Section 4.3.4 groundwater level data collected from monitoring boreholes located close to the Carmichael River confirm the potential for groundwater to discharge to the river upstream of the Study Area but potential losses to groundwater within and downstream of the lease.

Data for the riverside monitoring location C027 that includes monitoring in the Quaternary alluvium (C027P1) and underlying Dunda Beds (C027P2) and is located close to the western limit of the EPC 1690 lease suggests:

- An upward gradient from the Dunda Beds to the overlying alluvium; and
- Groundwater levels in the alluvium which are typically above the bed of the adjacent Carmichael River (based on a survey of the river bed elevation close to monitoring location C027 (refer to Table 4-2 and also to Chart 14 of Appendix D))

This suggests the potential for groundwater discharge from the underlying deposits to the Carmichael River in this area. Conversely, however,data for two further nested riverside monitoring sites further east, C025 and C029, show:

- Upward gradients from the Tertiary deposits to the overlying alluvium at C029 (i.e. between C029P1 and C029P2) and within the Tertiary deposits (i.e. between C025P1 and C025P2); but
- Groundwater levels in the alluvium at C029P1 and shallow Tertiary deposits at C025P1 which appear to be below the bed of the adjacent Carmichael River.

This suggests the potential for leakage from the river to groundwater in these areas.

Based on the groundwater level data alone it appears that the Carmichael River may switch from gaining flow from groundwater to losing flow to groundwater at or around the western limit of the site.

4.7.3 Groundwater and Surface Water Quality

As discussed in Section 4.4.2 analysis of the major ion chemistry of groundwater samples taken from the Quaternary alluvium and surface water samples taken from the Carmichael River suggests that groundwater discharge becomes an increasingly important component of flow in the river as the dry season progresses. This is considered to be consistent with the upward gradients from the alluvium to the river close to and potentially upstream of the western boundary of the Study Area.

4.7.4 Surface Water Flows

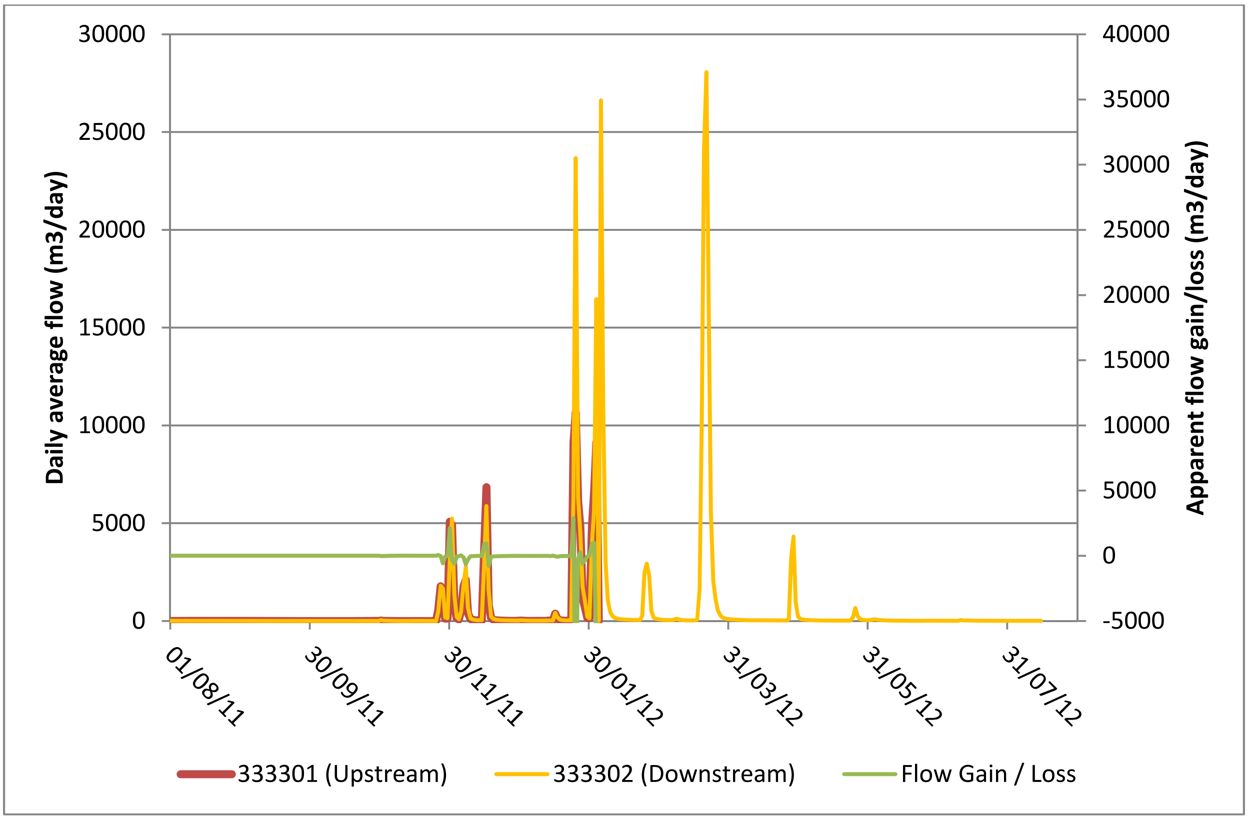
As discussed in Section 4.1 two surface water monitoring stations have been established as part of the current study within Study Area on the Carmichael River, one close to the upstream boundary of the lease (Station No. 333301) and one close to the downstream boundary (Station No. 333302). These stations provide information on surface water levels and flows for various technical studies for the EIS. A hydrograph of the flow data collected to date, 28 July to 15 August 2012, is shown in Figure 4-15. It should be noted, however, that the estimates of flow are understood to be based on a stage-discharge relationship derived from a single flow gauging event. Gauging over a range of flow events is typically required for accurate flow estimation. As such, observed flow data for these gauges should be treated with some caution.

Nevertheless, the limited available flow data are considered to suggest the following:

- Continuous flow has been recorded at the upstream gauge, except for the period 10 November to 25 November 2011 despite rainfall being limited to one event in mid-July, two events in late August and one event in mid-October 2011 prior to the onset of more significant rainfall from late November 2011. This suggests that groundwater discharge to the Carmichael River upstream of the Study Area is occurring and is consistent with the upward gradient observed at site C027 close to the western margin of the lease.
- Apparent flow losses between the upstream and downstream gauges during dry periods. This is consistent with the downward gradient observed from river bed to groundwater at sites C025 to C029 closer to the eastern margin of the lease.

One possible explanation for the observations is that dry season flows in the Carmichael River are supported primarily by discharges from the Doongmabulla Springs and potentially by direct groundwater discharge to the river upstream of EPC 1690 but that direct groundwater discharge to the river itself on and in the near vicinity of EPC 1690 is negligible. Further monitoring of flows and water quality discharging from the springs is required to further explore this hypothesis.

Figure 4-15 Surface Water Flows and Losses, Carmichael River



4.8 Groundwater Dependent Ecosystems

4.8.1 Doongmabulla Springs

Doongmabulla Springs are listed on the Directory of Important Wetlands. They are a group of permanent artesian, fresh water springs (based on information provided in the *Directory of Important Wetlands - Information Sheet* for Doongmabulla Springs, Australian Government Department of Sustainability, Environment, Water, Population and Communities), located approximately 8 km west of Study Area. Doongmabulla Springs are part of the Barcaldine spring supergroup (regional clusters of springs associated with the GAB), located on the eastern margin of the GAB within a recharge area to the GAB, the 'GAB Eastern Recharge A – Queensland' GMA. Reference to information held within the Queensland Spring Database which is understood to be largely based on the work of Fensham and Fairfax (2005) suggests that the Doongmabulla complex comprises 11 separate springs (Figure 4-1).

Based on a review of the mapped geology, the springs are likely to be a result of discharge from the Triassic-age Moolayember Formation and/or Clematis Sandstone which form part of the GAB.

Water sampling of the Doongmabulla Spring complex has been carried out as part of a separate study (see Volume 4 Appendix Q Mine Water Quality Report), in order to provide further information on potential water sources to the springs and to identify any similarities and/or variations in the water quality between:

- Individual springs of the springs complex
- Springs and nearby creeks

Fourteen springs and two nearby creeks were sampled and analysed for major ions, alkalinity and selected dissolved metals.

The results of the sampling are reported in Volume 4 Appendix Q Mine Water Quality Report and summarised here.

The mapped geology in the vicinity of the Doongmabulla Springs complex suggests that all of the springs are likely fed by groundwater from the Clematis Sandstone aquifer which in the case of most of the springs discharges through the overlying Moolayember Formation and/or Quaternary alluvium. This is consistent with available information on the physical features of Doongmabulla Springs (reference QLD081) which are described as 'derived from faults allowing water to flow from thin confining beds of the Great Artesian Basin aquifer' (in the *Australian Wetlands Database – Directory Wetland Information* (http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW&doiw_refcodelist=QLD081).

Despite the apparent single aquifer source some potentially significant differences can be observed in the hydrochemistry of samples taken from the springs. Based on the limited geological and major ion data currently available these observed differences could be related to:

- The proximity of the source aquifer to the surface and/or thickness of the overlying confining layer
- The discharge rate of the individual springs and hence potentially differences in flow pathways to the surface
- Differences in the degree of post discharge evaporation occurring between the various spring heads

4.8.2 Mellaluka Springs

Reference to the Queensland Spring Database also suggest the presence of two further springs around 10 km south of the Study Area lease area to the north of Mellaluka (Figure 4-1). These springs are identified as non-GAB Eastern Desert Upland springs typically associated with outcropping Dunda Beds. In this case, however, it is considered unlikely that the Dunda Beds are present in the vicinity of the Mellaluka Springs. The springs are mapped around 10 km east of the nearest area of Dunda Beds outcrop and the geology typically dips from east to west. However, groundwater modelling of the area to the south of the Carmichael River suggests groundwater flow typically in an easterly direction. It is therefore possible that these springs are fed by recharge to outcropping Dunda Beds close to the western margin of the lease which then discharges through the overlying Permian and Tertiary strata at the Mellaluka springs.

4.8.3 Riparian Vegetation

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 including mature River Red Gum (*Eucalyptus camaldulensis*) and Paper Bark (*Melaleuca leucadendra*) associated with major watercourses, including the Carmichael and Belyando Rivers. The open forest and woodland (remnant vegetation) fringing the Carmichael River is considered to be groundwater dependent (refer to the Mine Terrestrial Ecology Report, Volume 4, Appendix N).

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 Carmichael and Belyando River are understood to be relatively persistent, supported by flow data for the site (refer to the Mine Hydrology Report, Volume 4, Appendix P). 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 Carmichael River groundwater dependant ecosystems (GDEs) are unlikely to be present within the Study Area, although River Red Gums have also been identified next to an un-named ephemeral creek passing through the southern end of Study Area. The other minor creeks and rivers within the Study Area are understood to be ephemeral (refer to the Mine Hydrology Report, Volume 4, Appendix P1) and are not associated with areas of remnant vegetation. This lack of remnant vegetation around the ephemeral water courses is likely to be due to the greater depths to the water table away from the main river systems (which have been measured between around 20 and 40 m BGL away from the Carmichael River) and little or no groundwater contribution to vegetation demands and/or river flows.

5. Groundwater Modelling

5.1 Conceptual Model

A conceptual groundwater model is a representation of the behaviour of the groundwater system and its interactions with surface water within the catchment. Development of a conceptual model requires the compilation of detailed information on the geology, water quality, recharge, rivers, water levels, hydraulic parameters and groundwater usage. The key elements in a conceptual model are:

- The definition of the extent and hydraulic properties of the aquifers and aquitards;
- An understanding the groundwater flow directions; and
- An understanding of the groundwater recharge and discharge processes.

5.2 Geological Layers and Distribution

A conceptual hydrogeological model has been developed based on the current understanding of the distribution of the various geological formations, aquifer testing (packer, slug and pumping tests) and groundwater monitoring completed to date. Further discussion on the hydrogeological investigations, from which the conceptual model has been developed, is contained in Sections 2 and 4.

The stratigraphy has been divided into eleven layers for groundwater modelling purposes as shown in Table 5-1. These layers are based in part on the Xenith geological model, developed initially using exploration information available to October 2011 and then revised using exploration information available in September 2012. The 2011 version of the geological model focused on the detail of the coal units and only covered the lease area and hence some further work was required to extend and refine the model for groundwater impact assessment modelling purposes. The revised (2012) geological model used the same extent, i.e. effectively restricted to the lease area, however included additional surfaces defining the top of the Rewan Group and Dunda Beds in addition to the underlying Permian strata. The base of the Tertiary age strata was also revised based on the updated understanding on the thickness and extent of the Tertiary and is outlined in Appendix H.

The spatial extent of each of the geological units within the mine lease area was defined using the Xenith geological model, and extrapolated to areas outside of the lease area with reference to the regional geological structure and mapped outcrop. This extrapolation into the region surrounding the mine lease area used the following data:

- Previously existing stratigraphic interpretations in the DNRM Bore Database;
- Stratigraphic interpretation of lithological records in the DNRM Bore Database undertaken by GHD.

Where there were few data on coal seam extent and geometry outside the mine lease area, the Xenith geological model layers were extrapolated outward. The primary extrapolations in this regard were:

- The AB Coal unit was extrapolated towards the west assuming a constant thickness of eight metres, based on the Xenith geological model average thickness along the western edge of the model. The thickness of this layer was further revised in October 2012 to restrict it to a maximum thickness of 20 m; and

- The Permian 'interburden' between the AB Coal to D1 Coal was extrapolated towards the west using the average 70 m thickness of this unit in the Xenith geological model along the western edge of model;
- The D1, D2 and D3 coals and the respective interseams were modelled as a single layer in the model. The thickness of this layer was revised in October 2012 to restrict it to a maximum thickness of 30 m, as well as setting a minimum thickness of 10 m (except along the eastern edge where this layer is present at subcrop – here the thickness was allowed to follow the mapping and interpolation).

The hydrogeological conceptual model, geological model surfaces and aquifer test data have been used to develop a MODFLOW-SURFACT (HydroGeoLogic, 1996) groundwater model for the site. A geological cross section from the groundwater model is shown in Figure 2-1.

Table 5-1 Groundwater Model Layering

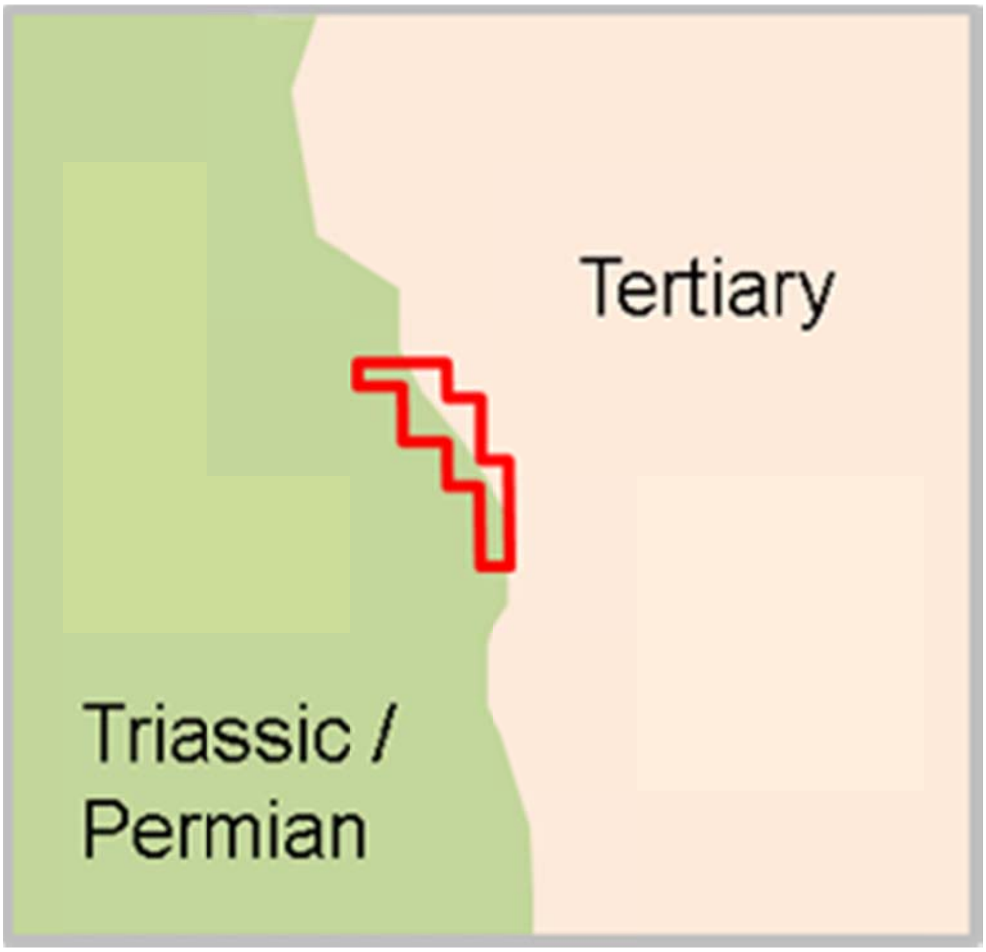
Layer Formation	Groundwater Model Layer No.	Geological Model layer Code
Quaternary Alluvium	1	**-**
Tertiary age units and older Quaternary deposits	2	BUTE
Moolayember Formation / Warang Sandstone	3	-
Clematis Sandstone	4	-
Dunda Beds	5	BUDE
Rewan Formation	6	BURE
Permian units overlying AB Seam coals	7	-
AB Seam Coal	8	AB1/AB2/AB3 Roof/Floor
Permian units between the AB and D1 Seam Coals	9	C1/C2/C3/C4 Roof/Floor
D1 Seam Coal	10	D1 Roof/Floor
Permian units between the D1 and D2/D3 Seam Coals		D23 Roof/Floor
D2/D3 seam Coal		D2/D3/D2L/D2U/ D3L/D3U Roof/Floor
Permian units underlying the D2/D3 seams	11	E/F Roof/Floor
Early Permian and older units		-

The most significant simplifying difference between the Xenith geological model and groundwater impact assessment model is the simplified representation of the D seam coals and interburden adopted for the groundwater model. Because of the intermittent presence of the individual D seams and interbeds (particularly the D1 seam coals and D2-D3 interburden), all D seam coal and interburden horizons have been grouped into a single groundwater model layer (Layer 10). The top and bottom of groundwater model Layer 10 are therefore defined by the roof of the D1 seam and the floor of the D3U seam respectively.

The other major difference is the groundwater model's subdivision of the units overlying the AB Coal into the overlying Permian units (Layer 7), Rewan Formation (Layer 6), Dunda Beds (Layer 5), Clematis Sandstone (Layer 4), and the Moolayember Formation / Warang Sandstone (Layer 3). These are significant hydrogeological units (aquifers/aquitards) with respect to predicting the impacts of the proposed mining development on regional groundwater levels and flows.

The Late Permian to Triassic aged units primarily occur within and to the west of the mine lease area – their eastern extent corresponds roughly with the north-south trending geological outcrop of the Clematis Sandstone, Dunda Beds and Moolayember Formation (Figure 4-2), and the eastern edge of the mine lease area. Hence, in the east, the Tertiary geological unit is subdivided evenly across nine numerical model layers (2 through 10), all of which are parameterised with Tertiary properties. In the west, these layers are parameterised as the aquifers/aquitards that they represent as specified in Table 5-1. Figure 5-1 illustrates the zonation between Permian-Triassic and Tertiary geology within each of model layers 3-10.

Figure 5-1 Zonation between Permian –Triassic and Tertiary Geology



In an earlier version of the groundwater flow model, all Quaternary and Tertiary units were considered in a single layer. In the current version of the model these have been split into two layers, as shown in Table 5-1. The Quaternary alluvium has been split out from the Tertiary units due to an observed contrast in the lithology encountered within boreholes within the EPC, for instance.

- Borehole logs for site C027 suggest around 12 m of sandy alluvium (interpreted to be of Quaternary in age) overlying sandy clay to around 33 mBGL (interpreted to be of Tertiary age);
- Similarly logs for site C029 indicate around 12 m of Quaternary sand overlying Tertiary sandy clay to 39 mBGL;

Therefore some simple rules for the defining the extent and thickness of this relatively permeable (sandy) Quaternary alluvium were developed as follows:

- The extent of the Quaternary alluvium was assumed to coincide with the mapped extent of the Wondoola Beds, which lie along the current drainage lines, including the Carmichael River. The Wondoola Beds are recorded as being Tertiary to Quaternary, however for the purposes of this study they have been modelled as sandy Quaternary alluvium.
- For modelling purposes a minimum thickness of 2 m has been assumed around the mapped margins of the Wondoola Beds, and a maximum thickness of 12 m assumed at the two bore sites described above. This maximum thickness has been reduced to 7 metres to the west of the EPC (i.e. in the upper parts of the Carmichael River catchment) based on an assumption that the thickness of such deposits will increase as one moves downslope away from the top of a catchment. Interpolation has been used to derive the layer thickness between the edge of the extent and the areas defined as having the maximum thickness.

The Tertiary unit (which could also include other Quaternary deposits not falling within the extent of the Wondoola Beds) has then been mapped as all other Tertiary or younger deposits, using information on the base of the Tertiary strata supplied by Xenith (within the EPC).

Layer 11 (Early Permian and older units) are simulated throughout the entire model domain with its base set at a constant elevation of -1,000 mAHD. The layer is therefore ‘flat-bottomed’ and roughly 100 m thick in the deepest part of the basin. Due to the layer’s flat bottom and hence variable thickness it has parameterised with variable hydraulic conductivity (k_h) so as to maintain a constant transmissivity, which was then adjusted during model calibration.

5.3 Groundwater Flow Systems

5.3.1 Flow Direction

Groundwater flow through the Permian-Triassic rock units is expected to be primarily via fractures and fissures, whereas flow through the overlying Tertiary and Quaternary units will be predominantly via pore spaces in these unconsolidated to poorly-consolidated sedimentary deposits.

Mapping of groundwater levels from the DNRM Bore Database indicates that the regional water table flow field forms a subdued replica of land surface elevations, with flow typically from the south-west to the north-east. Localised flow directions appear to vary, with a notable south-eastward flow direction in the north-west of the lease area. This latter flow direction appears to be related to the local land surface topography and surface drainage, particularly drainage towards the Carmichael River.

In the southern two-thirds of the mine lease area, vertical hydraulic gradients with the Permian-Triassic sequence are consistently upward from the older rocks into the Tertiary and Quaternary deposits, and this upward gradient is also observed between the Tertiary units and Quaternary-Recent alluvium in the southern area. Conversely, gradients are consistently downward in the northern third of the lease area.

The strongest upward head gradients are observed around the Carmichael River, with a maximum upward gradient of around 4.9 m from the Tertiary deposits into the Quaternary alluvials in bore C029, which is located immediately adjacent to the river channel. A similar situation and a 3.0 m upward gradient is observed slightly further upstream at bore C027. There is also a large upward gradient (4.1 m) observed in bore C007 from the D Seam into the AB Seam.

The downward gradients in the northern third of the lease area are typically in the range one to three metres. Interestingly, the downward gradient is maintained in this area even between deeper units: bore C018 (on the northern margin of the lease area) shows consistent downward gradients from the Tertiary into the AB Seam (around 1.0 m) and from the AB Seam into the D Seam (around 1.8 m).

5.3.2 Groundwater Recharge

Groundwater recharge appears to be minimal. Analysis of nearby bore hydrographs from the Queensland Bore Database (DNRM) and data for monitoring network bores installed within the lease show little fluctuation in groundwater levels (based on two to four records per year), including during wetter periods in the late 1970s and early 1980s. Typical recharge peaks are in the order of 0.2 m, but occur relatively infrequently and may represent a response to higher rainfall periods that is lagged and attenuated over multiple years if not longer. The apparent attenuation of recharge events and the relatively minor seasonal fluctuations suggests that the aquifers underlying the region are typically of low permeability and/or that there is little recharge to the groundwater system. This is consistent with the relatively high salinity recorded in many of the observation bores installed in the Project (Mine) area. Recharge rates estimated using the water table fluctuation method (Healy and Cook, 2002) using data for seven bores around 30 km east of the lease area suggest typical rates of one to 5 mm/year (Table 5-2). These bores monitor the Tertiary-Quaternary aquifer along the Belyando River floodplain. Hence these recharge estimates are considered likely to be at the higher end of the spectrum for the lease area and surrounds due to the dominance of low permeability bedrock at outcrop and shallow subcrop in this area.

A further estimate of groundwater recharge has been made using the chloride mass balance method described by Cook and Healy (2002). This method requires measurements of chloride in groundwater and chloride deposition rates from rainfall. Chloride mass balance recharge estimates are made assuming that:

- There is no ‘dry’ deposition of chloride (i.e. chloride is only deposited by rain, not by wind);
- Steady state conditions exist;
- All chloride in groundwater is derived from rainfall, and not from weathering of host rock or soil; and
- Chloride borne in runoff or from stream leakage will contain chloride, and this should be accounted for in any assessment.

Table 5-2 Estimates of Groundwater Recharge using the Water table Fluctuation Method

Bore ID	Recharge[2] (range)	Specific Yield (Sy)[1] (best estimate)	Recharge[2] (best estimate)
12030090_A	N/A	0.01- 0.05	2 to 11
12030120_A	1 to 14	0.01- 0.05	2 to 11
12030124_A	0.7 to 10	0.01- 0.05	1 to 7
12030133_A	N/A	0.01- 0.05	1 to 5
12030158_A	N/A	0.01- 0.05	1 to 5
12030170_A	0.7 to 3	0.01- 0.05	0.7 to 3
12030175_A	N/A	0.01- 0.05	0.8 to 4
		Median	***1 to 5***

[1] Sy is dimensionless; [2] Recharge estimates in millimetres / year

Chloride deposition is the factor with the greatest associated uncertainty (it varies spatially, and can vary seasonally or year-to-year), however recent work by the CSIRO provides Australia-wide estimates and an uncertainty assessment based on the available data (Crosby *et al*, 2009). From this paper, it is estimated that chloride deposition in rainfall for the Carmichael lease area may vary between approximately nil and 12 kg/ha/year, with a best estimate of 3 kg/ha/year. These deposition rates result in estimated recharge rates of 0.1 to 4 mm/year. These estimates are based upon median and average concentrations of chloride in groundwater of 1,397 and 3,283 mg/L, as derived from bores in and surrounding the lease area in the DNRM Bore Database.

Baseflow to streams can also be used as a proxy estimate of groundwater recharge minima in a given catchment. Baseflow analysis of the Belyando River gauge at Gregory Developmental Road using the Hysep method (Sloto and Crouse, 1996) indicates average annual base flow rates of around 1 mm/year. It is well known however that digital baseflow filters typically overestimate baseflows, when compared with chemical methods and numerical models, and therefore this recharge minima estimate is likely to also be an over-estimate.

These three independent chemical and physical estimates of baseflow all indicate average annual recharge rates of less than 1 to 5 mm/year for the Carmichael area and surrounds. This equates to around one per cent of the average annual rainfall for the region (550 mm, Bureau of Meteorology, 2011).

These recharge estimates were confirmed through recharge-runoff modelling using PERFECT (Littleboy *et al*, 1989). This relied on the following data:

- DNRM soils mapping and Northcote principal profile soil classifications;
- The Soil Hydrologic Properties of Australia database (Western and Mackenzie, 2006);
- Daily climatic data (rainfall and pan evaporation) from the SILO / Bureau of Meteorology gauge at Bulliwallah for the period 1950 to 2011;
- Interflow estimation using the method of Rassam and Littleboy (2003); and

- Leaf Area Indices from the mapping of Lu *et al*, (2001)

A low permeability bedrock layer was simulated in the soil profiles in areas of bedrock outcrop and shallow subcrop. The recharge-runoff modelling suggests recharge rates varying from 0 to as high as 44 mm/year, with an average of 6 mm/year and a median of 0 mm/year. The higher recharge rates are modelled for the more permeable soil types in areas where the Tertiary and Quaternary deposits occur at outcrop, whilst the lower rates were generally modelled for the Permian-Triassic bedrock outcrop areas.

5.4 Groundwater Model Design and Construction

5.4.1 Choice of Modelling Code

The numerical code selected for this model is MODFLOW-SURFACT v4 (HydroGeoLogic, 1996), a proprietary modification to the United States Geological Survey's open source MODFLOW-96 (finite difference) code. MODFLOW-SURFACT v4 provides several useful enhancements to MODFLOW-96 including:

- A more robust and flexible numerical solver (PCG5);
- Simulation of saturated and unsaturated zone flow, resolving many of the issues with cell drying and rewetting and associated numerical instabilities of standard MODFLOW;
- A more flexible and robust well boundary package (FWL4/5);
- A more flexible recharge package (RSF4), which allows for simulation of recharge rejection when groundwater levels are shallow; and
- A capability to model changing hydraulic conductivity with time using the Time-varying Properties (TMP) package which was used in this case to simulate the hydrogeological impacts of collapse into abandoned underground mine goaf areas. More detail on this aspect of the modelling work is provided in Section 5.6.

5.4.2 Model Extent and Boundary Conditions

The spatial extent of the numerical model and its specified boundary conditions are shown in Figure 5-2, and the modelled geological (model layer) outcrop is shown in Figure 5-3. For the most part modelled outcrop corresponds with the mapped geological outcrop (Figure 4-2). However, as discussed previously in Section 2.2.2 a revised interpretation of the extent of the Tertiary deposits was assumed for the modelled based on information provided by Xenith and summarised in Appendix H.

The model grid varies in resolution, with refinement down to 50 m cell sizes over the entire Carmichael lease area, and gradual coarsening outward to a maximum of one kilometre at the margins of the modelled area. Given that there are nine model layers, and the grid extends 93 km in the east-west direction, and 108 km in the north-south direction, there are 3,017,466 model cells, 2,720,066 of which are set as active (flow) cells. This is a relatively large model.

Figure 5-2 also shows the active and inactive extents of the model grid. The active extent has been specified as the surface water catchment flowing into the Carmichael River and Belyando River.

Modelled boundary conditions comprise:

- Rivers (RIV) Boundaries - Representing surface drainage (creeks and rivers), all of which are mapped as ephemeral in the Bureau of Meteorology's Geospatial Hydrology Fabric (Figure 5-2).

River conductance has been set to 1000 m^2/d – high enough so that the aquifer properties control baseflows rather than the River boundary itself. The River bed has been set to have a zero thickness, meaning that these River boundaries act in the same fashion as MODFLOW Drain boundaries, i.e. allowing baseflow out of the aquifer, but not allowing leakage from watercourse to aquifer. River elevation was set to the minimum of the 50 m DEM within each model grid cell, with some manual modification to certain areas of the drainage network, particularly near bores within the EPC, in order to better represent unconfined water levels near watercourses.

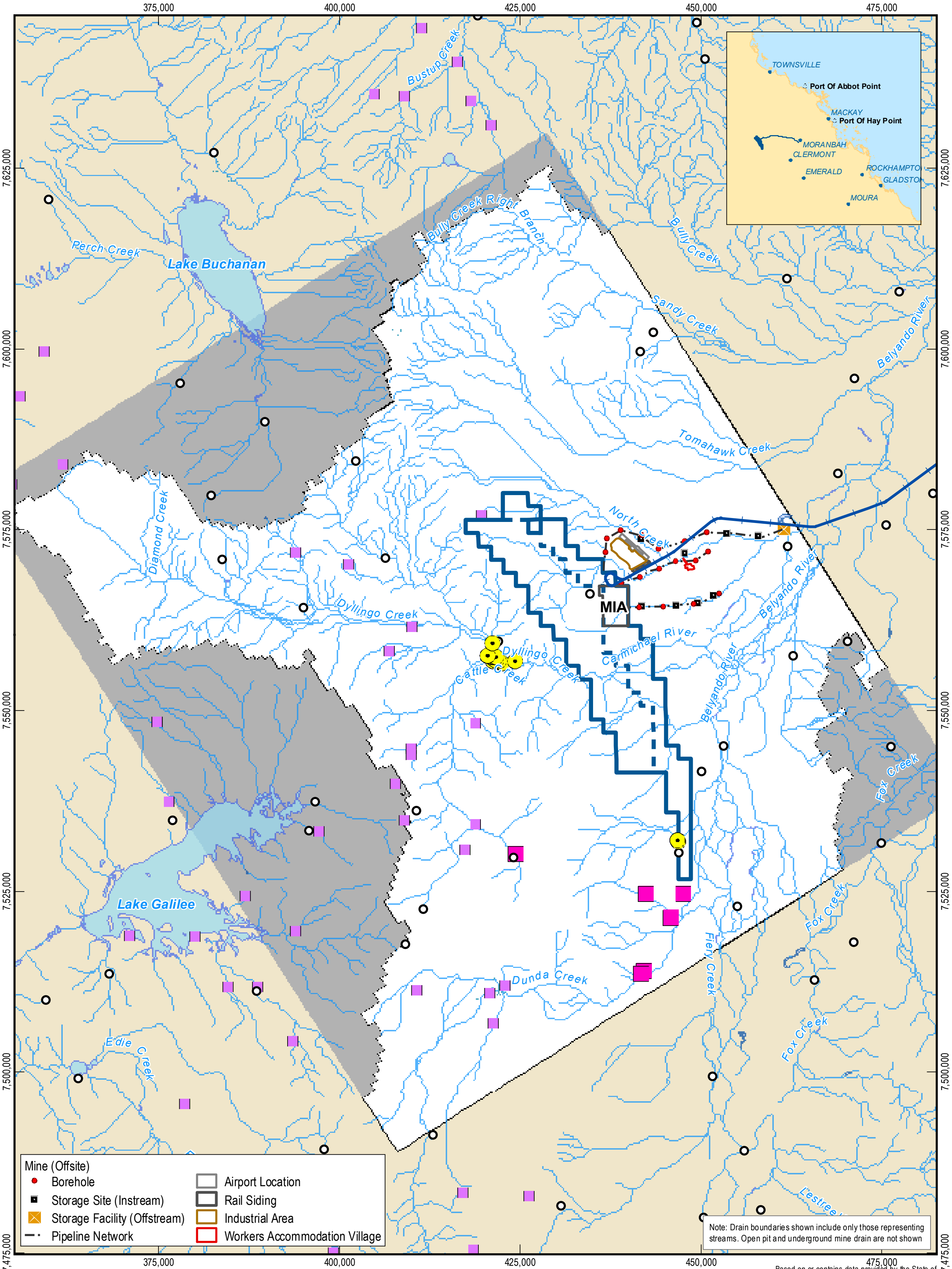
- Drains (DRN) were used in the predictive model to represent both the underground mine workings and open pits, according to the current mine plan regarding the location, timing, depth and methods of extraction to be adopted in the proposed open cut and underground mine workings.
- General Head Boundaries (GHB) – GHBs have been applied around the outer edge of the active model grid (Figure 5-2), with the attribution of GHBs to particular layers based on whether the layer is classified as one of the main aquifer units (see Table 5-3), and only where mapped groundwater levels indicated inflow (i.e. typically along much of the northern and western model margin, and parts of the southern margin) or outflow (along much of the eastern margin).

Table 5-3 General Head Boundaries

Inflow GHBs	Outflow GHBs
North, west – GHBs in the Triassic/Permian units. South – GHBs primarily located in the Tertiary horizons.	East –GHBs located within the Tertiary horizons, except for Layer 11 (early Permian/bedrock).
Layer 2, 3, 6, 7, 9 and 11 (south only) – 'aquitards'	Layer 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11 (east)
Layer 4, 5, 8, and 10 (north, west, south) – 'aquifers'	

- The specified head of these boundaries has been derived from the interpolated watertable potentiometric surface (i.e. based on existing bore data). If the mapped head was below a cell base in any given layer, a GHB was not specified for that cell. GHB conductance was set to 1000 m^2/d.
- GHBs have not been set in Layer 1 (Quaternary alluvium) as discharge from the modelled alluvium will be primarily via baseflow to watercourses, rather than as groundwater throughflow out of the model domain.
- Recharge-Seepage Faces (RSF) – RSFs were specified as active in the MODFLOW-SURFACT RSF package. Seepage face elevations were set to the top of the layer that is at outcrop in the model. Recharge rates to groundwater were initially set to a flat rate of 1 mm/year based upon the analysis presented in Section 5.3.2. This was later revised down during the calibration process, which suggested that a significantly better fit between observed and modelled heads could be achieved using lower recharge values of around 0.1 mm/yr (this reduced value remains consistent with the analysis of recharge, particularly the baseflow estimates, presented in Section 5.3.2).
- Fracture Wells (FWL4) – FWLs were specified according to the DNRM licensed groundwater bore data. It has been assumed that 30 per cent of the total licensed volumes is utilised on average (for irrigation bores), and that 2 ML/year is utilised from stock and domestic bores. All licensed volumes were apportioned equally across all bores associated with any given licence. Bores were assigned

to model layers based upon the aquifer unit noted for each bore in the DNRM licence database. FWL bore storage was set to 0.1 in all cases. Total estimated extraction from these bores is 0.195 ML/d which equates to less than one per cent of the total recharge applied to the modelled area. Extractions therefore represent a minor component of the modelled water balance.



LEGEND

Homestead	Mine (Onsite)	Model Boundary Cells	Groundwater Users	Active Model Extent
Springs	Mine Infrastructure Area	General Head Boundaries	Domestic Supply, Stock; Stock	Active
Watercourse	Lake	Drain Boundary	Irrigation	Noflow
Rail (West)	Reservoir			
	Swamp			

1:750,000 (at A4)

0 5 10 15 20 25

Kilometres

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

N

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

Groundwater Model Grid
and Boundary Conditions

Job Number	41-25215
Revision	C
Date	15-11-2012

Figure 5-2

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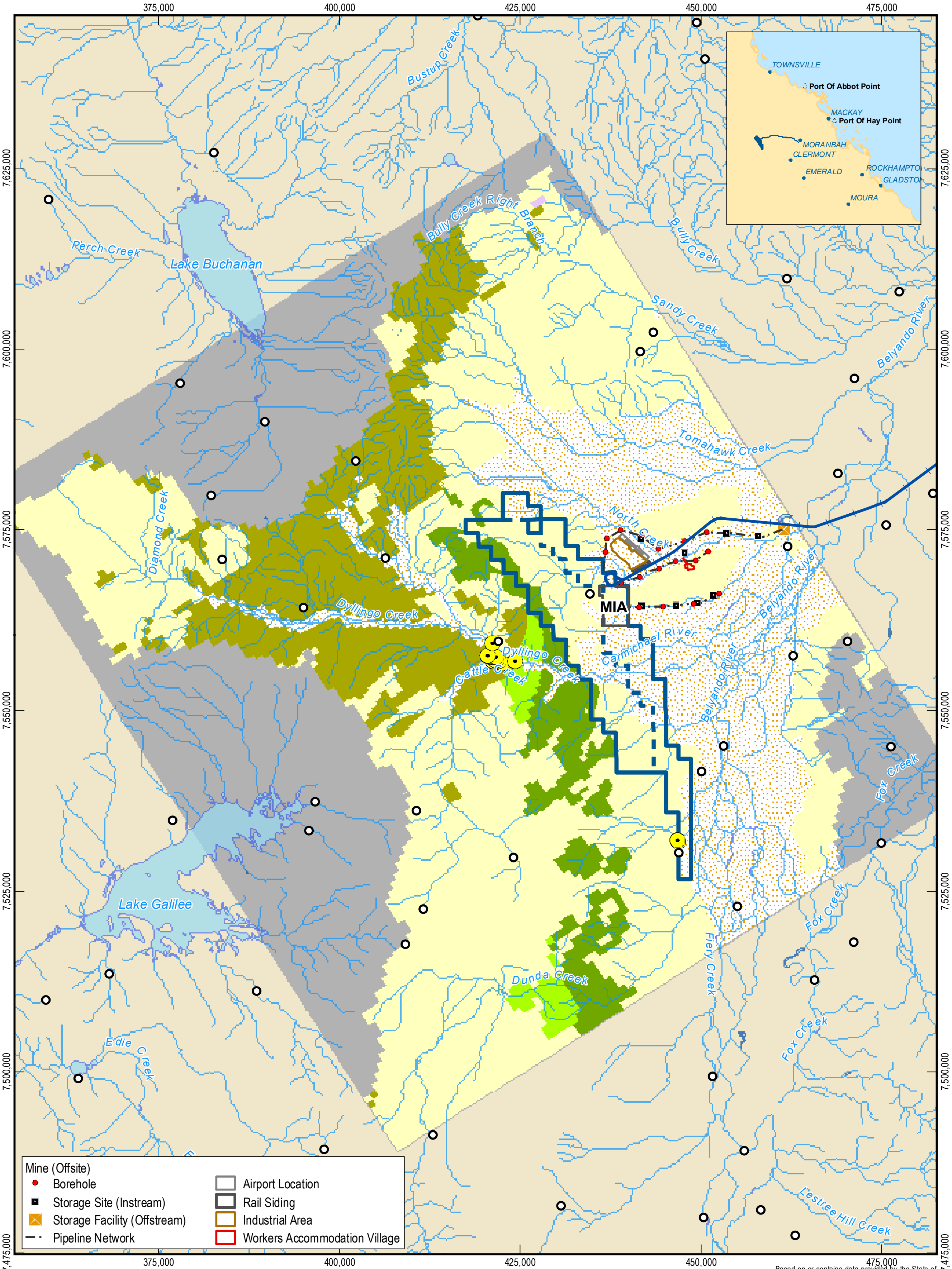
Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: DERM: Regional Outcrop, Towns, Groundwater users, EPA: Springs (2005), Bureau of Meteorology: Streams, © Copyright Commonwealth of Australia - Geoscience Australia: Road, Homestead, Watercourse (2007); GHD: Drain, GHB, Model extent, Layer Outcrop (2011); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: MR, CA



LEGEND

Homestead	Mine Infrastructure Area	Active model extent	Layer 2: Tertiary and Quaternary
Springs	Mine (Onsite)	Inactive	Layer 3: Moolayamber / Warang Sst
Watercourse	Lake	Active	Layer 4: Clematis Sst
Rail (West)	Reservoir	Model Layer outcrop	Layer 5: Dunda Beds
	Swamp	Layer 1: Quaternary alluvium	Layer 11: Bedrock, early Permian

1:750,000 (at A4)

0 5 10 15 20 25

Kilometres

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

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GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Job Number 41-25215
Revision D
Date 15-11-2012

Modelled Outcrop

Figure 5-3

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

Data Source: DERM: Regional outcrop, towns, Groundwater users, EPA: Springs (2005), Bureau of Meteorology: Streams, © Copyright Commonwealth of Australia - Geoscience Australia: Road, Homestead, Watercourse (2007); GHD: Drain, GHB, Model extent, Layer Outcrop (2012); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: MR, MS

5.5 Model Calibration

Calibration of the groundwater flow model was undertaken in steady state through comparison of observed and modelled groundwater levels at 88 borehole locations (43 bores within the Carmichael mine lease area, six DNRM State Observation bores with transient historical water level records, and 39 bores with time of drilling water levels recorded in the DNRM Bore Database). Time series data from the Carmichael lease bores and the DNRM State Observation bores were averaged for the purposes of the steady state model calibration.

Calibration in transient mode would have been preferable but it is currently considered that there is insufficient time series groundwater level data to make this worthwhile. Data loggers have however been installed at all of the monitoring network bores onsite in order to fill this data gap as soon as possible. The most reliable calibration data are provided by bores drilled specifically for this project within the lease area, whilst the least reliable are the time of drilling records from the DNRM database. The Carmichael lease bores were assigned to model layers according to the available detailed drilling and bore construction information, whereas the DNRM bores were assigned according to the bore construction or depth information where available. Where this information was not available in the DNRM database, bores were assumed to screen the model layer (aquifer) that is at outcrop at the supplied bore location.

A reasonable match between modelled and observed groundwater levels has been achieved (Figure 5-4) via automated calibration using PEST (Doherty, 2010). PEST was instructed to adjust either the horizontal or vertical hydraulic conductivity in each layer within specified limits depending on whether a layer was considered to be an aquifer or an aquitard. PEST was also allowed to vary recharge on a layer by layer basis. Modelled hydraulic conductivity values for each layer were assigned in the following manner:

- A single hydraulic conductivity value was assumed for the entire extent of model layers 1, 3, 5 and 6 i.e. the Quaternary and Triassic age units;
- Two hydraulic conductivity zones, one for outcrop areas and one for subcrop areas, was assigned to Tertiary age units modelled as Layer 2;
- Single hydraulic conductivity values were assumed for the Tertiary where it is represented as multiple model layers to the east of the proposed mining area; and
- For layers 7-10 (including the coal seams) single hydraulic conductivity values were applied outside of the mine lease, whilst within the lease the calibration software was allowed to assign interpolated hydraulic conductivity values (based on pilot points) in order to maximise the data ‘worth’ of the multiple monitoring bores installed within these strata.

Parameters used in the model calibration including the initial values and selected lower and upper bounds are listed in Table 5-4. Initial values were predominantly taken from a previous iteration of the modelling work completed in March 2012.

Various calibration statistics are presented in Figure 5-4. The normalised root mean square error (nRMS) is less than five per cent, which is within the typically accepted limits, as suggested in the Murray Darling Basin Commission’s Groundwater Flow Modelling Guideline (Middlemis, Merrick and Ross, 2002). Calibrated model water balance errors are well below one per cent, which is also within the guidelines’ suggested limits. The statistical distribution of modelled head error is approximately normal, with the greatest density of errors within the +/- 5 m error band (Figure 5-4), and relatively evenly spread positive and negative head errors either side of that. The mean absolute head error is 7.96 m, with the majority of the Carmichael lease bores showing head errors of less than 10 m (Figure 5-4).

The bigger head errors are typically associated with bores screened in the superficial units, specifically in model layers 1 and 2 (Quaternary and Tertiary units).

Given the limited monitoring data of variable quality, the steady state (rather than transient) model, complex geology and simple model parameter zonation, the overall level of modelled head error is considered reasonable. The calibrated model parameters and the corresponding field measurements are presented in Figure 5-5 and Table 5-5.

Most calibrated hydraulic conductivity parameters are within observed ranges from the combined slug, packer and pumping test results. In some cases wider ranges were adopted for model calibration purposes than evidenced by the site specific hydraulic test data e.g. where:

- Relatively few site test results were available; and/or
- A comparison of the test data for the site with regional data sets (e.g. QWC, 2012) suggested that the site specific data was considered likely to under-estimate likely ranges and hence potentially bias the calibration.

The original intention was to vary modelled hydraulic conductivity values only during the calibration process, and hence to leave recharge at 1 mm/year based on the recharge calculations described in Section 5.3.2. However, initial attempts to calibrate the model suggested that the recharge value adopted was significantly limiting the quality of the calibration, such that the SRMS of the calibration could not be improved below around 10% by altering the hydraulic conductivity values alone. Modelled recharge was therefore also allowed to vary between 0.1 and 5 mm/year or 2.74×10^{-7} and 1.37×10^{-5} m/d as shown in Table 5-5.

A two step calibration process was then adopted whereby modelled recharge only was optimised in the first instance before fixing recharge at the calibrated values and optimising the modelled hydraulic conductivity values. The final calibrated recharge values are generally towards the lower bound of the calibration permissible range and range between 0.1 and 0.6 mm/yr.

Modelled results suggest an upward head gradient from the Permian-aged units to the overlying Quaternary/Tertiary-aged units in the vicinity of the Carmichael River and upstream of the proposed mining area. This is consistent with observed groundwater data for the riverside monitoring bores installed in the lease area (see Section 4.3.4). In response to these upward gradients modelled results suggest around 15,300 m^3/d of groundwater discharges to surface water courses in the area. The majority of the baseflow is intercepted by the Carmichael River and tributaries upstream of the mine lease. This general modelled pattern of discharge to the Carmichael River upstream of the lease is considered to be consistent with a number of information sources including:

- Observed groundwater levels in the Quaternary alluvium which are above estimated river bed levels towards the upstream boundary of the Study Area;
- Field observations which confirm active flow in the Carmichael River throughout much of the dry period from June to November 2011;
- Major ion data for groundwater and surface samples which shows a tendency for surface water samples from the Carmichael River to become progressively more similar to groundwater samples during the dry period from June to November 2011;

- The presence of mature river red gum trees and other riparian zone vegetation along the banks of the Carmichael Creek.

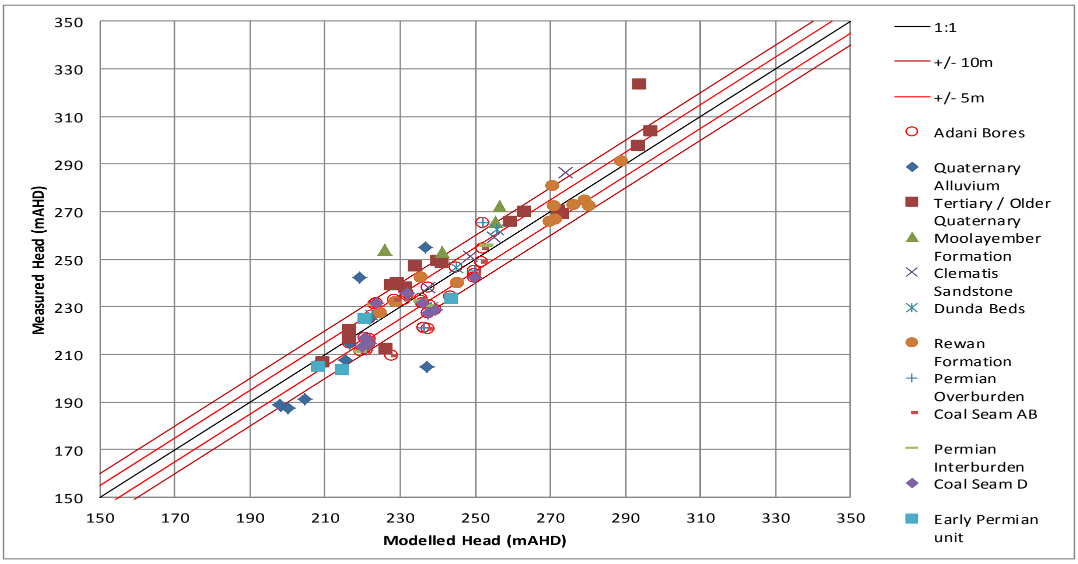
However, based on the limited surface water flow data available for flow gauges installed at the upstream and downstream (see Section 4.7.4) it is possible that the model is currently over-estimating the magnitude of baseflow to the upstream area. Further reliable flow data at the upstream boundary of the site and for the Doongmabulla Springs would be required to refine this. Once this additional flow data was available it could also be used as an additional target for re-calibration of the model to ensure that modelled baseflows were consistent with observations.

Table 5-4 Initial Values and Permissible Ranges

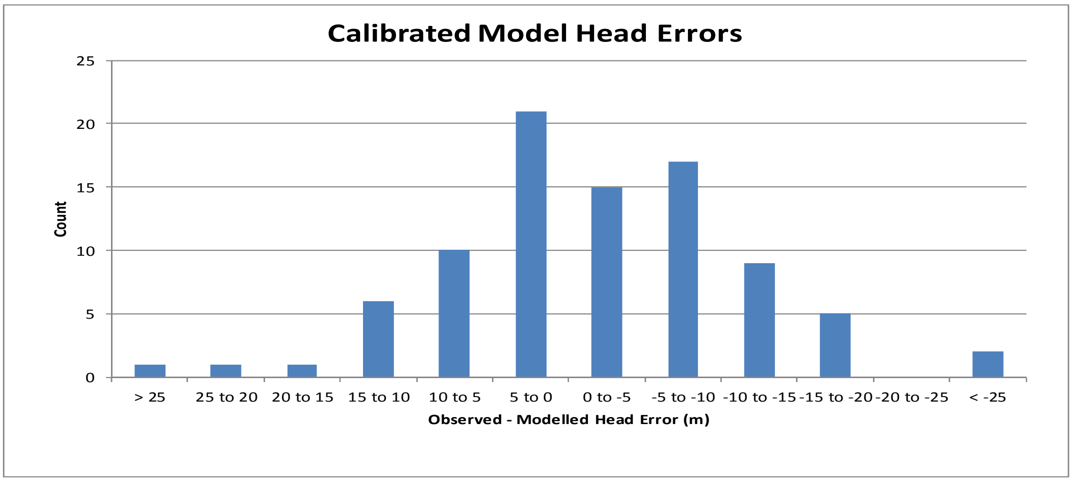
Dominant Unit / Zone	Calibrated Parameter	Initial Value (m/d)	Lower Bound (m/d)	Upper Bound (m/d)	Source
Quaternary Alluvium	Recharge	$2.74x10^{-06}$	$2.74x10^{-07}$	$1.37x10^{-05}$	Recharge modelling and previous studies
Tertiary / Old Quaternary	Recharge	$2.74x10^{-06}$	$2.74x10^{-07}$	$1.37x10^{-05}$	Recharge modelling and previous studies
Moolayember Formation	Recharge	$2.74x10^{-06}$	$2.74x10^{-07}$	$1.37x10^{-05}$	Recharge modelling and previous studies
Clematis SSt	Recharge	$2.74x10^{-06}$	$2.74x10^{-07}$	$1.37x10^{-05}$	Recharge modelling and previous studies
Dunda Beds	Recharge	$2.74x10^{-06}$	$2.74x10^{-07}$	$1.37x10^{-05}$	Recharge modelling and previous studies
Quaternary Alluvium	Kx	$1.00x10^{-01}$	$1.00x10^{-02}$	$1.00x10^{+02}$	Literature values
Tertiary_L2 (outcrop)	Kz	$1.00x10^{-04}$	$1.00x10^{-05}$	$1.00x10^{-03}$	Literature values
Tertiary_L2 (sub-crop)	Kz	$1.00x10^{-04}$	$1.00x10^{-05}$	$1.00x10^{-03}$	Literature values
Moolayember Formation	Kx	$3.09x10^{-01}$	$4.00x10^{-05}$	$1.00x10^{+00}$	Regional summary stats (QWC, 2012)
Clematis SSt	Kx	$4.77x10^{-02}$	$4.00x10^{-05}$	$5.00x10^{+00}$	Site tests and regional summary stats (QWC, 2012)
Dunda Beds	Kx	$4.77x10^{-02}$	$4.00x10^{-05}$	$5.00x10^{+00}$	Site tests and regional summary stats (QWC, 2012)
Rewan Formation	Kz	$1.00x10^{-05}$	$2.00x10^{-07}$	$1.00x10^{-03}$	Site tests and regional summary stats (QWC, 2012)

Dominant Unit / Zone	Calibrated Parameter	Initial Value (m/d)	Lower Bound (m/d)	Upper Bound (m/d)	Source
Permian Overburden	Kz	1.70×10^{-04}	4.00×10^{-06}	1.00×10^{-01}	Site tests and regional summary stats (QWC, 2012)
Coal Seam AB	Kx	2.04×10^{-02}	1.00×10^{-04}	$5.00\times10^{+00}$	Site tests and regional summary stats (QWC, 2012)
Permian Interburden	Kz	8.48E-05	4.00E-06	1.00×10^{-03}	Site tests and regional summary stats (QWC, 2012)
Coal Seam D	Kx	6.50E-03	1.00E-04	$1.00\times10^{+00}$	Site tests and regional summary stats (QWC, 2012)
Early Permian	Kx	3.50E-05	3.50E-07	3.50×10^{-03}	Site tests and regional summary stats (QWC, 2012)

Figure 5-4 Steady State Groundwater Level Calibration Statistics



No Calibration Bores	88	Root Mean Square Error	6.6	Adani Bores Scaled RMS Error	6.4%
Sum of Square Errors	3824.6	Correlation Coefficient	0.93	Overall Scaled RMS Error	4.9%



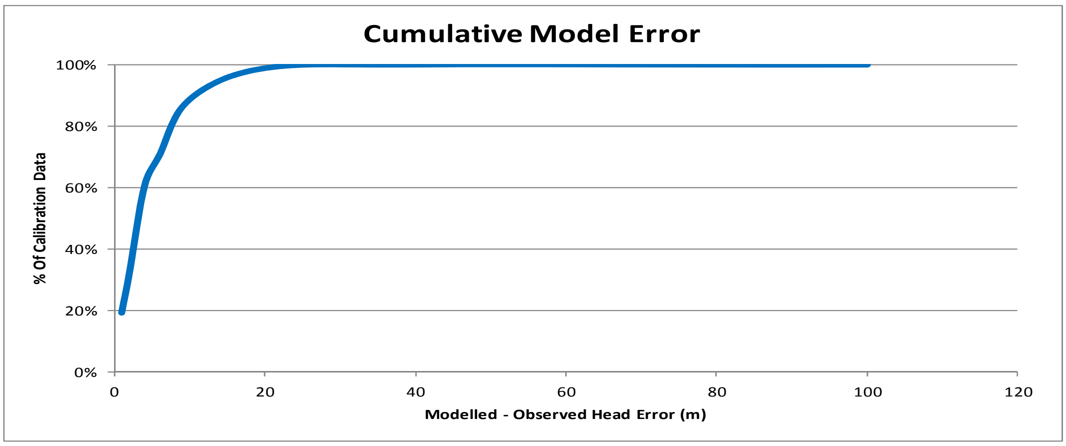


Figure 5-5 Groundwater Model Parameterisation

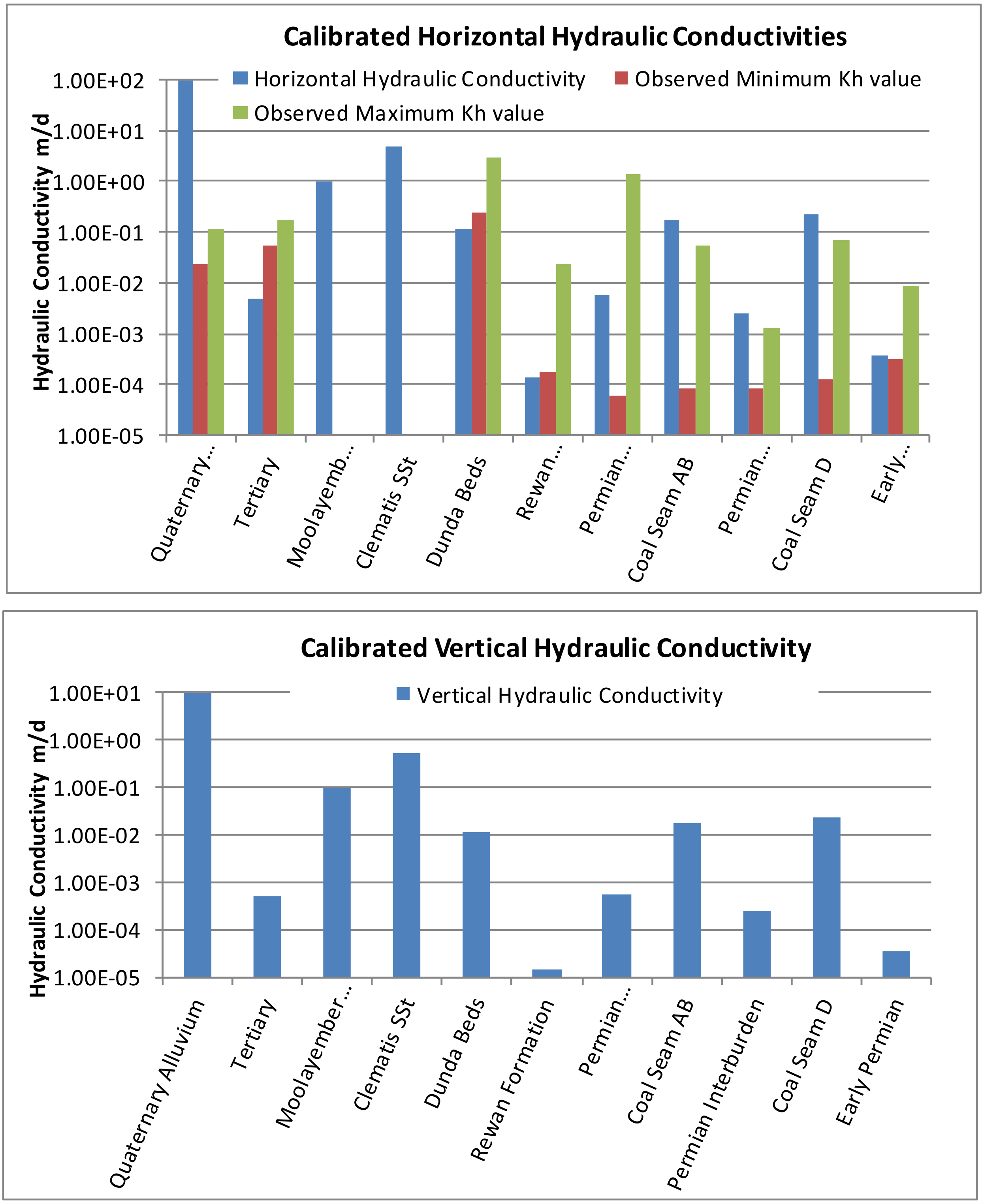


Table 5-5 Calibrated Model Parameters vs Measured Parameters

Zone / Layer	Dominant geological unit	Calibrated Parameter Values (m/d)		Measured Parameter values (m/d)			
		Kh	Kz	Minimum	Median	Maximum	Count
1	Quaternary alluvium	1.0x10^{+02}	1.0x10^{+01}	2.3x10^{-02}	7.1x10^{-02}	1.2x10^{-01}	2
2	Tertiary units	1.66x10^{-04} to 1.00x10^{-02}	1.66x10^{-05} to 1.00x10^{-03}	2.1x10^{-04}	5.3x10^{-02}	1.7x10^{-01}	3
*3-10	Tertiary units in lower model layers	1.82x10^{-04} to 1.00x10^{-02}	1.82x10^{-05} to 1.00x10^{-03}				
3	Moolayember Formation	9.99x10^{-01}	9.99x10^{-02}	-	-	-	-
4	Clematis Sandstone	5.00x10^{+00}	5.00x10^{-01}	-	-	-	-
5	Dunda Beds	1.15x10^{-01}	1.15x10^{-02}	2.2x10^{-03}	2.5x10^{-01}	3.0	3
6	Rewan Formation	1.38x10^{-04}	1.38x10^{-05}	1.7x10^{-04}	2.3x10^{-02}	2.9x10^{-01}	5
7	Upper Permian	5.62x10^{-03}	5.62x10^{-04}	5.8x10^{-05}	2.3x10^{-03}	1.4	9
8	AB Coal Seam	1.70x10^{-01}	1.70x10^{-02}	8.6x10^{-05}	4.0x10^{-03}	3.5	11
9	Interburden	2.41x10^{-03}	2.41x10^{-04}	8.6x10^{-05}	5.0x10^{-04}	1.3x10^{-03}	6
10	D Coal Seams and Interburden	2.23x10^{-01}	2.23x10^{-02}	1.3x10^{-04}	5.6x10^{-03}	2.0x10^{-01}	11
11	Early Permian & Older Basement	Variable *k*, constant T = 0.015m^2/d)	3.60x10^{-05}	3.3x10^{-04}	1.1x10^{-03}	8.7x10^{-03}	8

NOTES: Kh = horizontal hydraulic conductivity; Kz = Vertical hydraulic conductivity

5.6 Model Predictions

5.6.1 Overview

The primary purpose of developing a groundwater flow model for the Carmichael Coal Mine area is to provide a tool to predict:

- Groundwater inflows to the proposed open cut and underground mine workings for mine planning and water balance purposes;
- Groundwater level changes in the various hydrogeological units present within the area in response to dewatering of the proposed mine workings; and
- Potential baseflow impacts on local water courses.
- Impacts on local hydrological features of environmental or economic importance and which may be sensitive to groundwater level decline including:
  - The Carmichael River which bisects the site and other local watercourses;
  - A Great Artesian Basin spring system close to Doongmabulla around eight kilometres west of the lease area, which supports flow in the Carmichael River particularly during dry periods;
  - The two non-GAB springs which are mapped to the north of Mellaluka around 10 km south of the Study Area ;
  - The Clematis Sandstone which occurs at outcrop to the west of the site and as one of the main aquifers of the GAB forms an important regional aquifer;
  - 21 licensed extraction bores within the modelled area; and
  - A further 25 other registered bores which are within 10 km of the Study Area.

More details on the numerical representation of the mine workings are given below. It should be noted that currently only a limited amount of information is available regarding the development plans for the open cut and underground mines. For instance annual mine plans are available for the period 2013 to 2018 but are only available at ten year increments for the remainder of the 90 year mine life (i.e. 2027, 2037, 2047 etc.). Hence, although the predictive modelling is largely based on the Carmichael Macro-Conceptual Mining Study report (Runge, 2011) some assumptions were necessary to develop the complete mine development time series required for modelling purposes.

5.6.2 Predictive Model Setup

The predictive model simulates a 90 year period from the commencement of mining activities in the lease during early 2013 (nominally Year 1, but specified as 2013 in the Macro Conceptual Plan (Runge 2011)) until the completion of mining work in 2102 (Year 90). Open cut mining will proceed throughout this period whilst the underground mining operations are scheduled to start in 2014 (Year 2) and be completed in 2065 (Year 51).

Two key changes were made between the finalising the historic/calibration model and running the predictive model:

- Upgrading software from MODFLOW-SURFACT v3 to v4 in order to be able to implement the Time-Verying Properties (TMP) package. See Section 5.4.1. This upgrade in software required no other changes to the groundwater model.
- Splitting Layer 6 (primarily representing the Rewan Formation) in the historic model into two layers for the predictive scenarios. This was to allow better representation of the horizons within the Free Draining Zone which develops above longwall panels (MSEC, 2012). Because of the addition of a new layer (a new Layer 7), properties and boundary conditions were copied from Layer 6 to the new Layer 7, and boundary conditions pushed down a layer in all lower layers.

A further steady state model, this time using the 12-layer configuration of the predictive model was run using the relevant heads from the historic model (accounting for the additional layer), and this then represented long-term average pre-development conditions i.e. before the commencement of the mining activities. The starting conditions (initial groundwater levels) for the predictive simulation. were extracted from the 12-layer steady state model. Annual stress periods were adopted for the predictive simulation based on the frequency of the mine planning drawings available which are annual for the period 2013 to 2018 and every ten years thereafter (Runge, 2011).

The extension of boundary conditions developed for the steady state model for use in the transient predictive model was generally straight forward. Modelled GHB boundary cell elevations have been assumed to remain at the same level for the duration of the predictive simulation. The same conductance values used in the steady state model were used in the predictive simulation.

Modelled recharge has been assumed to remain constant at the calibrated model values shown in Table 5-5 for the duration of the predictive simulation. Modelled river elevations and riverbed conductance used to simulate major as well as minor watercourses were also assumed to be constant for the duration of the predictive simulation.

5.6.3 Predictive Model Parameterisation

5.6.3.1 Hydraulic Conductivity

Horizontal and vertical hydraulic conductivity values for predictive modelling purposes were taken from the final calibration run of the steady state model (see Table 5-5). Hydraulic conductivity changes to the Permian overburden and interburden associated with induced sub-surface fracturing caused by the underground mining were simulated using the TMP package.

A separate study of subsidence by MSEC (MSEC, 2012) suggests that a free draining fractured zone with a maximum height of approximately 150 meters above each of the mined seams is likely to develop above the underground longwall mine workings. This free draining fractured zone is characterized by intense vertical fracturing thus creating potential for direct groundwater inflows from the overburden to the workings. Conceptual models for the free draining fractured zone (MSEC, 2012; Guo et al., 2007) suggest an increase in vertical hydraulic conductivity whilst variation in horizontal hydraulic conductivity is generally considered likely to be negligible. Guo et al. (2007) suggest that the vertical hydraulic conductivity in the free draining fracture zone may be increased by a factor of up to 50. Furthermore the relative change in vertical hydraulic conductivity is likely to higher towards the base of the fracture zone that at the top.

For modelling purposes the free draining fractured zone has been simulated by increasing the natural (pre-mining) vertical hydraulic conductivity by a factor of fifty for the lower 50% of the zone and by a factor of 10 in the upper 50%. This is considered to be consistent with the factors suggested by Guo et al. (2007) and with the conceptual model of reducing hydraulic conductivity enhancement with vertical distance from the mined areas. The development of the free draining fractured zones in the Permian overburden and Rewan Formation (model layers 7 and 8) and in the Permian interburden (model layer 10) follow the underground mining schedule (as described in Section 5.6.4.2) for coal seam AB and D, respectively.

5.6.3.2 Storage

Modelled storage values adopted for predictive modelling purposes are summarised in Table 5-6. It should be noted that given that a transient calibration of the groundwater model was not possible at this stage then the adopted storage values are essentially assumed. The adopted values are however consistent with other modelling studies carried out for similar coal resource areas in the Surat and Bowen Basins (e.g. QWC, 2012).

Confined storage values for each model layer are input to MODFLOW-SURFACT in the form of total storativity (i.e. specific storage multiplied by the layer thickness). A further check was therefore applied on the input storativity values for relatively thick layers, including Layer 12 (early Permian/bedrock), to ensure that the modelled confined storage value (i.e. storativity) did not approach the modelled unconfined storage value (i.e. specific yield). A maximum storativity value of $1x10^{-4}$ was assumed i.e. two orders of magnitude less than the specific yield value of $1x10^{-2}$.

Table 5-6 Predictive Modelling – adopted Storage values

Dominant Unit	Layer / Zone*	Specific Storage (per m)	Storativity	Specific Yield
Quaternary	1	*NA*	NA	$1.0x10^{-01}$
Tertiary	2	$3.0x10^{-03}$	$2.0x10^{-02}$	$5.0x10^{-02}$
Moolayember Formation	3	$1.0x10^{-05}$	$1.0x10^{-05}$ - $1.0x10^{-03}$	$1.0x10^{-02}$
Clematis Sandstone	4	$1.0x10^{-05}$	$1.0x10^{-05}$ - $1.0x10^{-03}$	$1.0x10^{-02}$
Dunda Beds	5	$1.0x10^{-05}$	$1.0x10^{-05}$ - $1.0x10^{-03}$	$1.0x10^{-02}$
Rewan Formation	6-7*	$1.0x10^{-06}$	$1.0x10^{-06}$ – $4.3x10^{-04}$	$1.0x10^{-02}$
Upper Permian	8	$1.0x10^{-06}$	$1.0x10^{-06}$ – $2.3x10^{-04}$	$1.0x10^{-02}$
Coal Seam AB	9	$1.0x10^{-05}$	$1.0x10^{-05}$ – $2.5x10^{-04}$	$1.0x10^{-02}$
Coal AB – D interburden	10	$1.0x10^{-06}$	$1.0x10^{-06}$ – $2.2x10^{-04}$	$1.0x10^{-02}$
Coal Seam D	11	$1.0x10^{-05}$	$1.0x10^{-05}$ – $3.0x10^{-04}$	$1.0x10^{-02}$
Older Units	12	$1.0x10^{-07}$	$1.0x10^{-04}$	$1.0x10^{-02}$

* the predictive model has two layers for Rewan Formation, where historic model only has one.

5.6.4 Simulation of Mine Workings

The proposed open cut and underground mine workings have both been simulated in the model using the MODFLOW DRAIN package but in slightly different ways as described below.

5.6.4.1 Open Cut Mine Workings

The open cut stage plans included in Appendix H of the Runge report (Runge 2011) provide a yearly snapshot of the open cut mine development for the period 2013 to 2018 and every ten years thereafter. These plans were used to define the active mining areas in the numerical model at each corresponding model stress period.

Given that the mine develops incrementally between the decadal snapshots from 2018 onwards it was also necessary to estimate the extent of the open cut mine workings for each year. This was achieved by assuming a constant active area which gradually moved from the area shown in one decadal plan to the next. This methodology produced the continuous open cut mine development time series required for numerical modelling purposes.

Drain cells covering the full extent of the estimated open cut mine footprint in each year were assigned to all layers of the numerical model down to the base of Layer 11 i.e. Coal Seam D. Drain conductance for each drain cell was set to a relatively large value of 1000 m^2/d, which is equivalent to a vertical hydraulic conductivity value of 0.4 m/d. Thus the equivalent hydraulic conductivity value used for parameterisation of the MODFLOW drain cells is greater than the expected vertical hydraulic permeability of the modelled layers; hence the material properties of the modelled layer will tend to control the modelled flow to drain cells rather than the drain properties.

Open cut mining commences in 2013 with the excavation of pits G and J. As time progresses drain cells are turned on and off gradually depending on the areal extent of the active mined area in any specific stress period. Years with a relatively large number of active pits include:

- 2037, where six active mine areas are present in the northern part of the lease;
- 2067 with seven active areas in the southern part of the lease.

Open cut mining activities terminate in 2102.

Based on the modelled depth of the base of the D seam, at the western limit of the proposed open cut mining areas, the open cut pits will extend to depths of up to around 360 m below ground level. The model assumes no partial back fill of the voids so this is considered to a worst case scenario for post closure impacts.

5.6.4.2 Underground Longwall Mining Operations

Only very limited information on the proposed underground mine development are available from the Runge report (Runge, 2011). To create a time series of active drains spanning the whole model simulation period, the following data were used:

- Figures 6.8 and 6.9 Appendix D from the Runge (2011) report were used to define the start and end years for mining operations from the North, Central and South underground mines;
- Longwall production commences in Layer 9 (Seam AB) and is followed by production in Layer 11 (Seam D) with a lag time of up to five years;
- Mine layouts for Seam AB and Seam D are understood to be identical;

- Production from the Central mine will lag the starting operations from the North mine by one year. Operations in the South mine will not start before 2039 as per Figure 6.9 in the Runge report (Runge, 2011).

Information on the underground mine workings is therefore largely limited to the planned final extent of the workings and the start and end date of each mine. No information is therefore available on the extent of the active underground mine workings in any of the intervening years. Hence for modelling purposes it was necessary to estimate the extent of the active working area at any time assuming that the panels are worked from north-east to south-west and at a constant rate. Model drain cells defining each longwall panel are turned on and off as production from the underground mines progresses.

Drain cells are only assigned to modelled layers 9 and 11 (i.e. the AB and D coal seams) since the other under and overlying units are unlikely to be actively drained. Based on the modelled depth of the base of the D seam, at the western limit of the proposed underground mining areas, the underground mine workings will extend to depths of up to around 600 m below ground level. With reference to Runge (2011) the E and F seams are not planned to be mined and therefore simulation of dewatering of these seams has not been included in the model.

Drain conductance was assigned a value of 1,000 m^2/d as for the open cut mining area. The sensitivity of model predictions to this assumed value is discussed in Section 5.8.

5.6.5 Predicted Groundwater Level Impacts

5.6.5.1 Water Table Impacts

Maximum predicted water table impact in response to the proposed open cut and underground mine workings are shown in Figure 5-6. .It should be stressed that this is a composite plot showing maximum predicted drawdown in the water table at each location. Due to the transient nature of the mining operations maximum impacts will occur at different times at different locations.

As expected the largest water table impacts occur within the mine lease and maximum impacts of up to 350 m are predicted towards the west of the proposed open cut mining areas. Predicted impacts in the open cut mining areas increase from north-east to south-west in line with the observed dip of the coal seams to be mined, again this assumes no partial back fill of the pits or any other remediation.

Predicted maximum water table impacts in the underground mining area (i.e. towards the west of the lease) and outside of the proposed open cut areas are less pronounced since the near surface units will not be drained directly. Maximum water table impacts outside of the proposed open cut areas are typically between 20 and 50 m.

5.6.4.2 Groundwater Level Impacts at Sites of Specific Interest

Predicted groundwater level impacts at specific sites of environmental or economic interest are listed in Table 5-7, Table 5-8 and Table 5-9.

Given the proximity of the Carmichael River to the proposed open cut and underground mine workings significant impacts on groundwater levels in the vicinity of the river are anticipated. Groundwater model predictions suggest water table drawdowns of up to around 30 m in the vicinity of the river under the post closure scenario. It should be noted that these impacts are considered to be a conservative assessment since actual impacts are likely to be attenuated to some extent by the likely presence of clay or other low permeability strata underlying the river. The full detail of these strata are not represented in the numerical model, which includes two layers to represent the sandy near surface Quaternary strata and the underlying sandy clay dominated Tertiary strata. Where further layers were included then the predicted impacts on the water table would be reduced, although considering the scale of the impacts at this location even where this additional detail was modelled then significant groundwater level impacts are likely to remain.

The Doongmabulla springs are located around eight kilometres west of the mining lease and are permanent artesian springs which provide baseflow to the adjacent Carmichael River. Predicted maximum drawdown impacts in the Clematis Sandstone which is thought to represent the source aquifer for these springs range from <0.05 to 0.1 m (Table 5-7). Figure 5-7 shows a time series plot of predicted impacts at each spring site.

The Mellaluka springs are located approximately ten kilometres south of the mining lease. Little is known about the Mellaluka spring system and geological data is generally more limited at the southern extent of the proposed mine footprint. The geology at the spring location is thought likely to comprise shallow near surface Quaternary and or Tertiary age strata (i.e. model layers 1 and 2) overlying the older Permian units (i.e. model layer 12 in the predictive model). Thus the older Permian units have been assumed to be source aquifer in this case and predicted maximum drawdown impacts calculated by extracting modelled in groundwater levels in this unit. Model results suggest predicted maximum drawdowns at the Mellaluka Springs of between 0.7 and 0.8 m (Table 5-7).

Based on recent assessments of the potential for impacts on GAB springs in response to Coal Seam Gas (CSG) extractions carried out by DNRM and the Queensland Water Commission, drawdowns of over 0.2 m are considered to be potentially significant. Predicted drawdowns therefore exceed this 0.2 m threshold after around 60 years at the two mapped Mellaluka springs (Figure 4-1). Predicted drawdowns at all springs in the Doongmabulla system are less than 0.2 m throughout the operational period with the majority of predicted impacts lower than 0.05 m.

Predicted groundwater level impacts at each of the 21 licensed extractions understood to be present within the modelled area are summarised in Table 5-8. For the most part little or no impact is predicted at these locations, less than 0.05 m of drawdown is predicted at 14 of the 21 locations. Minor impacts of 0.1 m are predicted at RN 16896, RN 16895, RN 67626 and RN 62754 which are located to the west of the lease area. Impacts of over 1 m are predicted at a single bore RN 90255 which is located close to the northern lease boundary. Given the proximity of this bore to the underground mine workings it is not surprising that a significant impact is recorded at this location.

Table 5-7 Predicted Water Table Impacts at Spring Locations – Operational Phase

Spring Number and Name	Spring System	Predicted Drawdown (m)
1031_Moses4	Doongmabulla	<0.05 *
1032_Moses3	Doongmabulla	<0.05 *
1033_Moses2	Doongmabulla	<0.05 *
1034_Littmose	Doongmabulla	0.1 *
1035_Moses1	Doongmabulla	<0.05 *
1036_75E	Doongmabulla	<0.05 *

Spring Number and Name	Spring System	Predicted Drawdown (m)
1037_75A	Doongmabulla	<0.05 *
1038_75D	Doongmabulla	<0.05 *
1039_75B	Doongmabulla	<0.05 *
1040_75C	Doongmabulla	<0.05 *
1041_Doongma	Doongmabulla	0.1 *
41_(no name recorded)	Mellaluka?	0.7 **
42_(no name recorded)	Mellaluka?	0.8 **

* predicted drawdown in the Clematis Sandstone

** predicted drawdown in the Older Permian units

Table 5-8 Predicted Groundwater Level Impacts at Licensed Extraction Bores – Operational Phase

Site	Feature Type	Model Layer	Target Formation	Maximum Predicted Drawdown (m)
RN 62798	Irrigation Extraction	2	Unconsolidated Tertiary Units	<0.05
RN 57660	Irrigation Extraction	2	Unconsolidated Tertiary Units	<0.05
RN 57661	Irrigation Extraction	2	Unconsolidated Tertiary Units	<0.05
RN 44398	Irrigation Extraction	2	Unconsolidated Tertiary Units	<0.05
RN 6404	Irrigation Extraction	2	Unconsolidated Tertiary Units	<0.05
RN 62753	Stock Extraction	3	Moolayember Formation	<0.05
RN 39802	Stock Extraction	3	Moolayember Formation	<0.05
RN 39801	Stock Extraction	3	Moolayember Formation	0.1
RN 16896	Stock Extraction	3	Moolayember Formation	0.1
RN 16895	Stock Extraction	3	Moolayember Formation	0.1
RN 90261	Stock Extraction	4	Clematis Sandstone	<0.05
RN 90255	Stock Extraction	4	Clematis Sandstone / Dunda Beds	3.6
RN 69443	Stock Extraction	4	Clematis Sandstone	<0.05
RN 69442	Stock Abstraction	4	Clematis Sandstone	<0.05

Site	Feature Type	Model Layer	Target Formation	Maximum Predicted Drawdown (m)
RN 69441	Stock Abstraction	4	Clematis Sandstone	<0.05
RN 67626	Stock Abstraction	4	Clematis Sandstone	0.1
RN 62754	Stock Abstraction	4	Clematis Sandstone	0.1
RN 62750	Stock Abstraction	4	Clematis Sandstone	<0.05
RN 16897	Stock Abstraction	4	Clematis Sandstone	<0.05
RN 14217	Stock Abstraction	4	Clematis Sandstone	<0.05

Predicted maximum groundwater level impacts at the remaining 25 registered groundwater bores within 10 km of the lease are summarised in Table 5-9. Ten of these bores are located within the lease area and hence are likely to be decommissioned prior to the commencement of mining operations. Of the remaining 15 registered bores outside of the lease area predicted maximum drawdowns exceed 1 m at:

- Two bore locations to the south of the lease (RN 44486 and RN 103229).
- Two bore locations to the north of the lease (RN 90259 and RN 90256).

Predicted maximum impacts at the remaining registered bores are less than 1 m and hence are considered unlikely to be significant.

Table 5-9 Predicted Groundwater Level Impacts at Other Registered Bores – Operational Phase

Site	Model Layer	Formation Targeted	Maximum Drawdown (m)	Notes
RN 17980	5	Dunda Beds	7.2	Inside lease area
RN 17981	10	Permian Sandstone	149.6	Inside lease area
RN 17982	12	Permian Sandstone	80.5	Inside lease area
RN 44440	2	Unconsolidated Quaternary / Tertiary Units	<0.05	South of lease area
RN 44441	8	Permian Sandstone	<0.05	South of lease area
RN 44484	2	Unconsolidated Quaternary / Tertiary Units	<0.05	East of lease area
RN 44485	5	Dunda Beds	32.2	Inside lease area
RN 44486	5	Dunda Beds	1.7	South-east of lease area
RN 44489	2	Unconsolidated Quaternary / Tertiary Units	<0.05	South-east of lease area
RN 47167	5	Dunda Beds	6.1	Inside lease area

Site	Model Layer	Formation Targeted	Maximum Drawdown (m)	Notes
RN 62623	10	Permian Sandstone	135.1	Inside lease area
RN 62624	5	Dunda Beds	35.8	Inside lease area
RN 62625	5	Dunda Beds	0.3	South of lease area
RN 67627	10	Permian Sandstone	0.7	South of lease area
RN 90256	10	Permian Sandstone	2.2	North of lease area
RN 90258	5	Dunda Beds	7.5	Inside lease area
RN 90259	10	Permian Sandstone	19.8	North of lease area
RN 90260	5	Dunda Beds	7.8	Inside lease area
RN 90369	5	Dunda Beds	0.7	Inside lease area
RN 103229	10	Permian Sandstone	1.6	South of lease area
RN 103230	8	Permian Sandstone	<0.05	South of lease area
RN 103231	8	Permian Sandstone	0.2	South of lease area
RN 103249	10	Permian Sandstone	0.6	South of lease area
RN 103559	12	Permian Sandstone	0.6	South of lease area
RN 103565	5	Dunda Beds	0.9	South of lease area

5.6.4.3 Base Flow Impacts

Given the predicted impacts on groundwater levels in the vicinity of the mine there is also the potential for impact on flows in Carmichael River and on other local water courses which are receiving groundwater base flow. Information on observed surface water flows, groundwater levels and a comparison of groundwater and surface water quality data for the Carmichael River suggests that flows and/or water levels are at least partly supported by direct groundwater flow from the underlying units and/or by discharge from the Doongmabulla Springs. This is consistent with field observations which confirm active flow in the Carmichael River throughout much of the period from June to November 2011 (i.e. during the dry season). Some impact on the Carmichael River and any other local water courses which receive groundwater base flow are therefore anticipated. However, little or no groundwater flow is thought to be occurring currently to other minor ephemeral water courses in the area and hence no significant impacts are expected.

Output from the calibrated pre-development steady state model suggests around 15,300 m^3/d of groundwater flow to local watercourses, almost all of which is to the Carmichael River upstream of the site. This is consistent with groundwater level and surface water data for the site. Output from the predictive post development model suggests that this base flow could be reduced to around 14,300 m^3/d by the end of the mining period and hence impacts of up to around 1,000 m^3/d on base flows to the Carmichael River upstream of the site. This is equivalent to a predicted 7 per cent reduction in modelled groundwater discharges to local watercourses. During wet periods direct base flow and discharges from the Doongmabulla Springs will represent only a minor component of flow to the Carmichael River.

However, groundwater discharges will represent a progressively more important source of water during prolonged dry periods, as evidenced by comparison of the available surface water and groundwater quality data. Given that the predicted reduction of baseflow is only 7 per cent, it is considered unlikely that the mining workings will cause significant changes to the duration of zero flow and/or low flow periods in the Carmichael River. However, further reliable flow data is required to confirm the significance of this impact.

This relatively minor predicted impact on flows despite the relatively large groundwater level impacts described in Section 5.6.5 is related to the groundwater model predictions of flow losses from the Carmichael River to underlying groundwater under current i.e. pre-development conditions throughout the majority of the lease area. This is consistent with groundwater level and flow monitoring data for the site which suggests:

- Groundwater levels in the alluvium which are below the bed of the river (i.e. losing conditions) at both sites C025 and C029 located in the eastern part of the lease (Section 4.7.2); and
- Observed flow losses in the Carmichael River across the lease area between the upstream and downstream gauges (Section 4.7.4).

It should be noted that the current groundwater flow model effectively assumes dis-connection of groundwater and surface resources in areas where a downward gradient is calculated. Hence it has been assumed that any further drawdowns in areas where there is already a downward gradient (i.e. throughout the majority of the lease area) will not induce further losses from the river. This assumption is however considered to be consistent with groundwater level data for the riverside monitoring bores C025P1 and C029P1 both of which show only a limited response to significant increases (up to 4 m) in groundwater and surface water levels which occurred between December 2011 and March 2012. This suggests little or no connectivity between surface water and groundwater resources at these locations.

Figure 5-9 shows a time series plot charting the development of predicted base flow impacts in different creek catchments. This plot confirms that almost all of the predicted impact is to the Carmichael River upstream of the site and also suggests that impacts will take a number of years to develop. For instance impacts of over 100 m^3/d are not expected until around 15 years after the start of mining.

5.7 Post Closure Impacts

5.7.1 Post Closure Landform

Reference to the conceptual mining study (Runge, 2011) suggests that the majority of the proposed open pit areas will be backfilled and rehabilitated such that for the most part the final land surface will be at or above the current ground level (a result of bulking effects on the excavated overburden). On average the final land surface is anticipated to be 50 m above the current ground surface in backfilled areas (Runge, 2011). However, the final landform outlined in the concept design also includes a number of large final voids, typically situated towards the west of the proposed open cut mining area. Where possible these final voids will be backfilled using redirected pre-strip waste from adjacent pits. However, significant backfilling will not be possible in the nine pit areas including the western parts of the BE, DE, BW, DW, G, H, N, O and P pits. These pits will be remediated to some extent by re-profiling of the pit walls to ensure long term geotechnical stability and encourage re-vegetation. However, the final ground surface within these voids will be substantially below pre-development ground surface and groundwater level elevations. Hence once dewatering operations have ceased in each pit, there is the potential for groundwater levels to gradually rebound and permanent lakes could develop in the BE, DE, BW, DW, G, H, N, O and P pits.

A comparison of annual patched point rainfall and evaporation totals, extracted for the site from the Bureau of Meteorology (BOM) SILO website, indicates that evaporation totals on average exceed rainfall by around 1,350 mm/yr. Net actual evaporation losses from a flooded pit environment are likely to be less than these potential rates due to shadowing at the base of the pit, nevertheless evaporation losses from lakes which form in the closed open pits represent a potentially significant post-closure groundwater extraction. Reference to drawings included in the conceptual mining study (Runge, 2011) suggest a total un-remediated void area of around 1,500 hectares. Based on a net effective rainfall rate of -1,350 mm/yr and assuming, conservatively, that the external catchment to each void is zero, then potential evaporation losses from the final un-remediated voids could exceed 56 ML/d.

Given that these potential losses significantly exceed the predicted pit inflows at the end of the mine life (i.e. the potential evaporation losses exceed the capacity of the coal measures and other units to provide inflow) the pits are expected to remain dry except following heavy rainfall events. This also means that the potential long term post closure impacts associated with the BE, DE, BW, DW, G, H, N, O and P pits may exceed those calculated for the operational period since evaporation is likely to continue to control groundwater levels within the final un-remediated voids in perpetuity.

Further calculations have therefore been carried out using the groundwater model developed for the Project in order to assess the impact of evaporation losses from un-remediated voids on groundwater resources.

5.7.2 Post Closure Groundwater Model Set-up

Unlike dewatering impacts during the operational phase of mine development, which are transient, evaporation losses from un-remediated voids will continue in perpetuity following closure of the mine. The groundwater model developed for the operational period has therefor been run in steady state model to assess the long-term impact of the proposed development post closure. Initial groundwater levels for this run were taken from the final stress period of the predictive run i.e. predicted groundwater levels at the end of the 90 year operational mine life.

As discussed above, groundwater levels are anticipated to be at around the base of the voids post closure and the un-remediated voids are expected to remain dry except following heavy rainfall events. Predictive modelling, for this situation has been undertaken through the use of the MODFLOW Drain package. Drain cells covering the full extent of the un-remediated voids were assigned to all layers of the numerical model down to the base of Layer 11 i.e. Coal Seam D.

Post closure model results indicate around 2 ML/d of groundwater inflow to un-remediated void areas via the modelled drain cells, i.e. significantly less than the 56 ML/d of potential evaporation losses calculated in Section 5.7.1, see above. Modelling results therefore also suggest that:

- In the absence of significant external catchments the un-remediated void areas will tend to remain dry post closure
- Evaporation losses from the un-remediated void areas will represent a significant ongoing groundwater extraction of 2 ML/d from the system

5.7.3 Predicted Post-Closure Groundwater Level Impacts

Predicted post closure groundwater levels impacts at spring locations are listed in Table 5-10.

Predicted drawdowns at the Doongmabulla Springs to the west of the lease area are similar to maximum predicted drawdowns during the operational period. Hence predicted post closure impacts are a maximum of 0.1 m at the Littmose (Little Moses) and Doongma (Doongmabulla) springs and are less than 0.05 m at seven of the nine remaining springs. Predicted post closure impacts at the Mellaluka spring system to the south of the mining lease are between 4.8 and 5.3 m and hence are substantially higher than maximum predicted drawdowns of 0.7 and 0.8 m during the operational period (see Table 5-7).

Table 5-10 Predicted Water Table Impacts at Spring Locations – Post Closure

Spring Number and Name	Spring System	Predicted Drawdown (m)
1031_Moses4	Doongmabulla	<0.05 *
1032_Moses3	Doongmabulla	<0.05 *
1033_Moses2	Doongmabulla	<0.05 *
1034_Littmose	Doongmabulla	0.1 *
1035_Moses1	Doongmabulla	<0.05 *
1036_75E	Doongmabulla	<0.05 *
1037_75A	Doongmabulla	<0.05 *
1038_75D	Doongmabulla	<0.05 *
1039_75B	Doongmabulla	<0.05 *
1040_75C	Doongmabulla	<0.05 *
1041_Doongma	Doongmabulla	0.1 *
41_(no name recorded)	Mellaluka?	4.8 **
42_(no name recorded)	Mellaluka?	5.3 **

* predicted drawdown in the Clematis Sandstone

** predicted drawdown in the Older Permian unit

Predicted post closure groundwater level impacts at each of the 21 licensed groundwater bores within the groundwater model area are listed in Table 5-11. Predicted post closure drawdowns exceed 1 m at only one bore location (RN90255) to the north of the mine lease. Predicted impacts at the remaining licensed extraction bores are less than 1 m and hence are considered unlikely to be significant.

As discussed previously in Section 5.7.1, although still relatively minor, these predicted post closure impacts typically exceed the maximum predicted drawdowns during the operational period since evaporation from un-remediated void areas will continue in perpetuity, unlike operational dewatering impacts which will be transient.

Table 5-11 Predicted Groundwater Level Impacts at Licensed Bores – Post Closure

Site	Feature Type	Model Layer	Target Formation	Predicted Drawdown (m)
RN 62798	Irrigation Extraction	2	Unconsolidated Tertiary Units	<0.05
RN 57660	Irrigation Extraction	2	Unconsolidated Tertiary Units	<0.05
RN 57661	Irrigation Extraction	2	Unconsolidated Tertiary Units	<0.05
RN 44398	Irrigation Extraction	2	Unconsolidated Tertiary Units	<0.05
RN 6404	Irrigation Extraction	1	Unconsolidated Tertiary Units	0.9
RN 62753	Stock Extraction	3	Moolayember Formation	0.1
RN 39802	Stock Extraction	3	Moolayember Formation	<0.05
RN 39801	Stock Extraction	3	Moolayember Formation	<0.05
RN 16896	Stock Extraction	3	Moolayember Formation	<0.05
RN 16895	Stock Extraction	3	Moolayember Formation	0.1
RN 90261	Stock Extraction	4	Clematis Sandstone	<0.05
RN 90255	Stock Extraction	4	Clematis Sandstone / Dunda Beds	3.0
RN 69443	Stock Extraction	4	Clematis Sandstone	<0.05
RN 69442	Stock Abstraction	4	Clematis Sandstone	<0.05
RN 69441	Stock Abstraction	4	Clematis Sandstone	<0.05
RN 67626	Stock Abstraction	4	Clematis Sandstone	0.2
RN 62754	Stock Abstraction	4	Clematis Sandstone	0.1
RN 62750	Stock Abstraction	4	Clematis Sandstone	<0.05
RN 16897	Stock Abstraction	4	Clematis Sandstone	<0.05
RN 14217	Stock Abstraction	4	Clematis Sandstone	<0.05

Predicted post closure groundwater level impacts at the remaining 25 registered groundwater bores within 10 km of the lease are summarised in Table 5-12. Ten of these bores are located within the lease area and hence are likely to decommissioned prior to the commencement of mining operations. Of the remaining 15 registered bores outside of the lease area predicted maximum drawdowns exceed 1 m at all bores listed and hence could be significant depending on the status, rest water level and pump elevations at each location.

As discussed previously in Section 5.7.1 these predicted post closure impacts typically exceed the maximum predicted drawdowns during the operational period since evaporation from un-remediated void areas will continue in perpetuity, unlike operational dewatering impacts which will be transient.

Table 5-12 Predicted Groundwater Level Impacts at Other Registered Bores – Post Closure

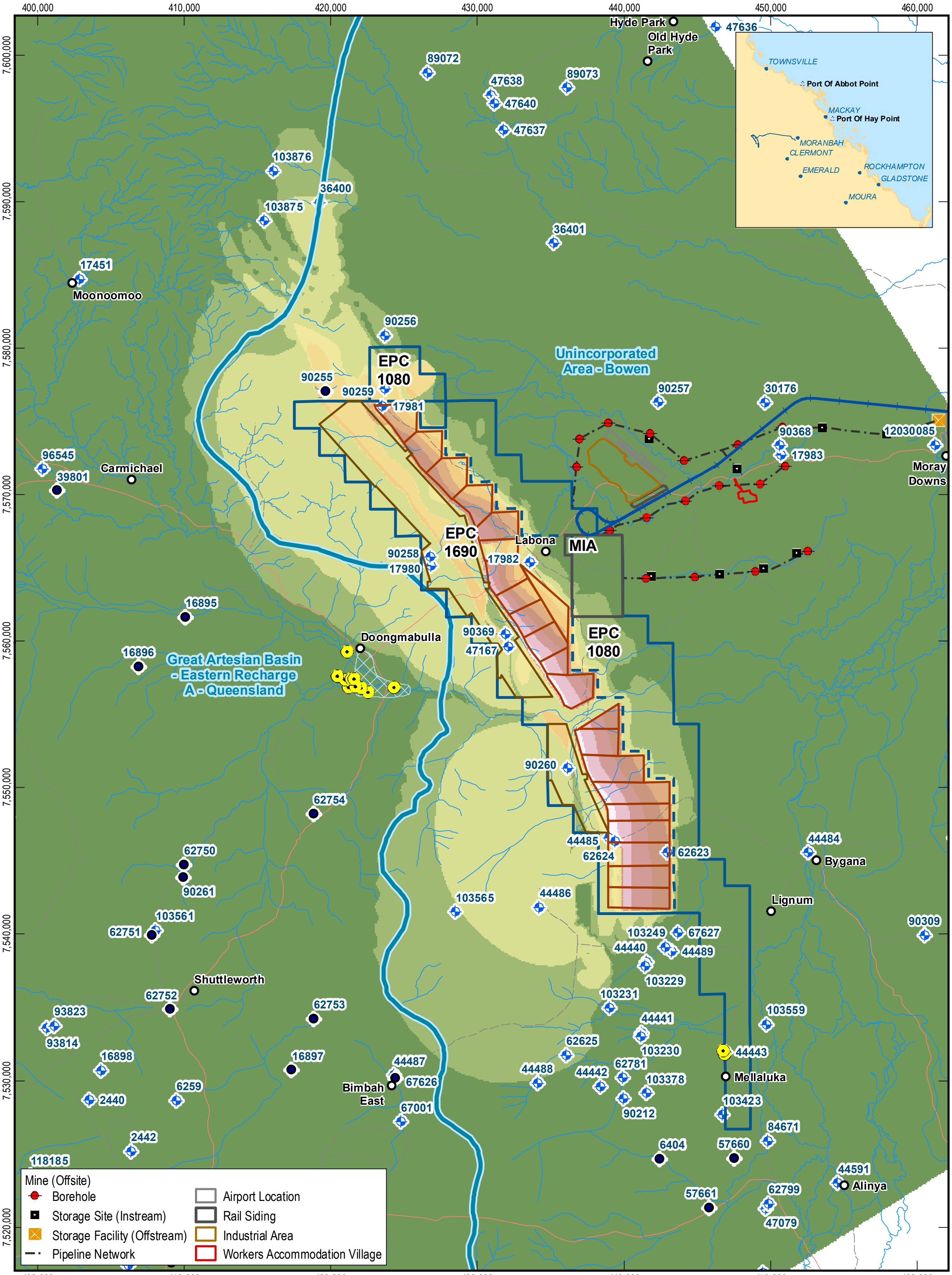
Site	Model Layer	Formation Targeted	Predicted Drawdown (m)	Notes
RN 17980	5	Dunda Beds	5.2	Inside lease area
RN 17981	10	Permian Sandstone	55.1	Inside lease area
RN 17982	12	Permian Sandstone	126.3	Inside lease area
RN 44440	2	Unconsolidated Quaternary / Tertiary Units	29.1	South of lease area
RN 44441	8	Permian Sandstone	10.8	South of lease area
RN 44484	2	Unconsolidated Quaternary / Tertiary Units	1.0	East of lease area
RN 44485	5	Dunda Beds	29.7	Inside lease area
RN 44486	5	Dunda Beds	3.8	South-east of lease area
RN 44489	2	Unconsolidated Quaternary / Tertiary Units	28.5	South-east of lease area
RN 47167	5	Dunda Beds	7.8	Inside lease area
RN 62623	10	Permian Sandstone	147.1	Inside lease area
RN 62624	5	Dunda Beds	36.2	Inside lease area
RN 62625	5	Dunda Beds	1.8	South of lease area
RN 67627	10	Permian Sandstone	45.7	South of lease area
RN 90256	10	Permian Sandstone	7.0	North of lease area
RN 90258	5	Dunda Beds	5.4	Inside lease area
RN 90259	10	Permian Sandstone	35.6	North of lease area
RN 90260	5	Dunda Beds	8.9	Inside lease area
RN 90369	5	Dunda Beds	12.5	Inside lease area
RN 103229	10	Permian Sandstone	39.1	South of lease area
RN 103230	8	Permian Sandstone	10.8	South of lease area
RN 103231	8	Permian Sandstone	12.1	South of lease area
RN 103249	10	Permian Sandstone	44.5	South of lease area

Site	Model Layer	Formation Targeted	Predicted Drawdown (m)	Notes
RN 103559	12	Permian Sandstone	3.2	South of lease area
RN 103565	5	Dunda Beds	2.0	South of lease area

5.7.4 Base Flow Impacts

Predicted post closure base flow impacts on each of the affected local watercourses are shown in Figure 5-11. In this case the predicted post closure impacts are comparable to those predicted during the operational period. This is due to the fact that predicted drawdowns in the area upstream of the mining lease are comparable during the operational and post closure scenarios (Figure 5-6 and Figure 5-10).

Output from the calibrated pre-development steady-state model suggests around 15,300 m^3/d of groundwater flow to local watercourses, predominantly the Carmichael River. Output from the post closure steady-state model suggests that this base flow could be reduced to around 14,300 m^3/d post closure and hence impacts of up to around 1,000 m^3/d on base flows to local watercourses are predicted. This is equivalent to a predicted 7 per cent reduction in modelled groundwater discharges to local watercourses. During wet periods, direct base flow and discharges from the Doongmabulla Springs will represent only a minor component of flow to the Carmichael River. However, groundwater discharges will represent a progressively more important source of water during prolonged dry periods, as evidenced by comparison of the available surface water and groundwater quality data. Given that the predicted reduction of baseflow is only 7 per cent, it is unlikely that the proposed mining development will cause significant changes to the duration of zero flow and/or low flow periods in the Carmichael River. However, further reliable flow data is required to confirm the significance of this impact.



LEGEND

- Homestead
- Licensed Groundwater Extraction
- Registered Groundwater Bore
- Springs
- Local Road
- Track
- Watercourse
- Doongmabulla Springs
- Underground Mine
- Open Cut Mine
- Groundwater Management Unit Boundary
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area

Water Table Drawdown (m)

0 - 0.2	20.0 - 50	200.0 - 250
0.2 - 1	50.0 - 100	250.0 - 300
1.0 - 10	100.0 - 150	300.0 - 350
10.0 - 20	150.0 - 200	

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Kilometres

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

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Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

Predicted Maximum Water Table Drawdowns – Operational Phase

Job Number 41-25215
Revision C
Date 15-11-2012

Figure 5-6

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

Data Source: DERM: Registered Groundwater Bores (2010); DME: EPC 1690 (2010)/EPC 1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); BRS: Groundwater Management Unit Boundary (2009); GHD: Maximum Drawdown (2012); EPA - Springs (2005); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW, MS

Figure 5-7 Predicted Doongmabulla Spring Impacts – Operational Phase

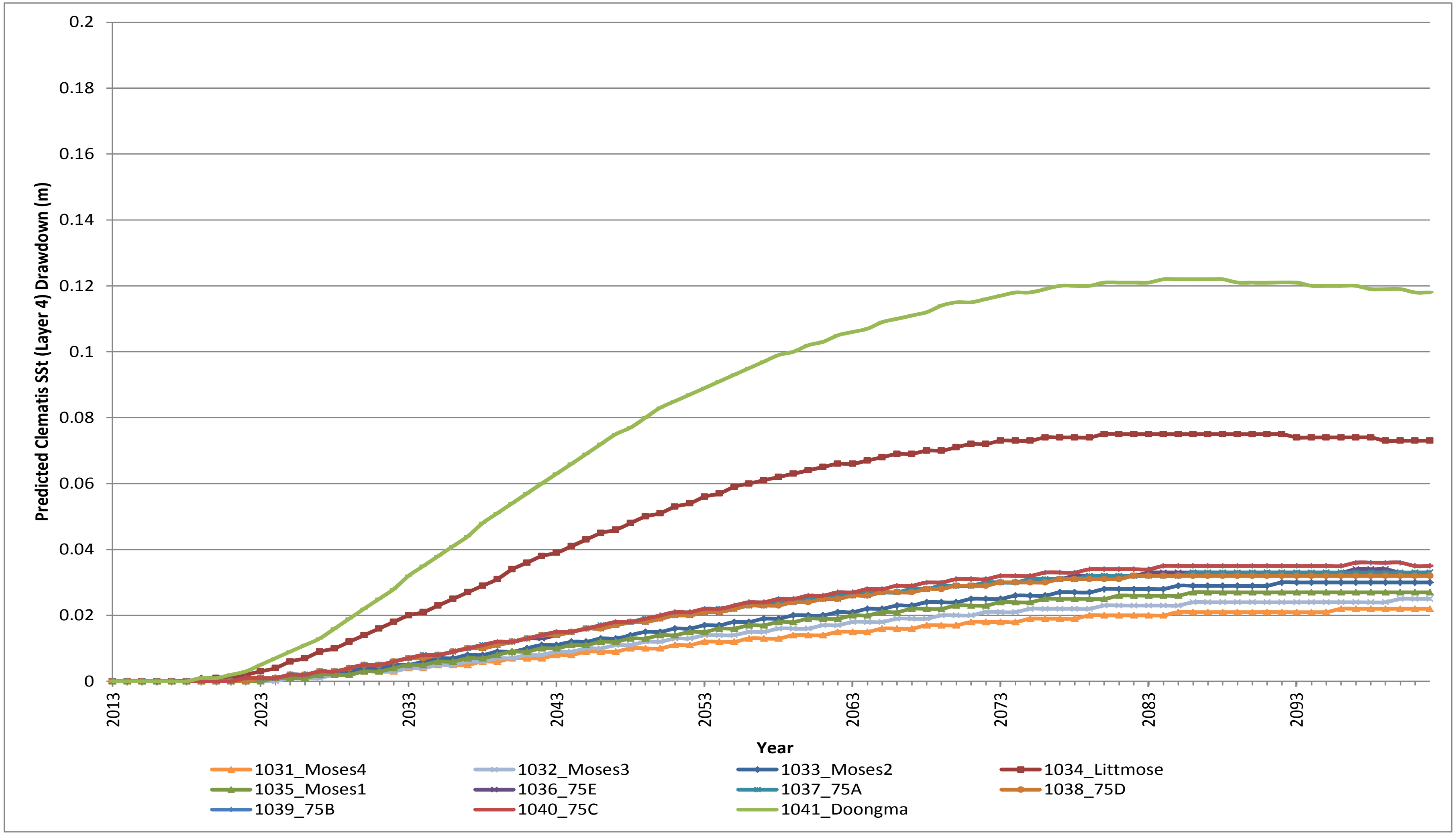


Figure 5-8 Predicted Mellaluka Spring Impacts – Operational Phase

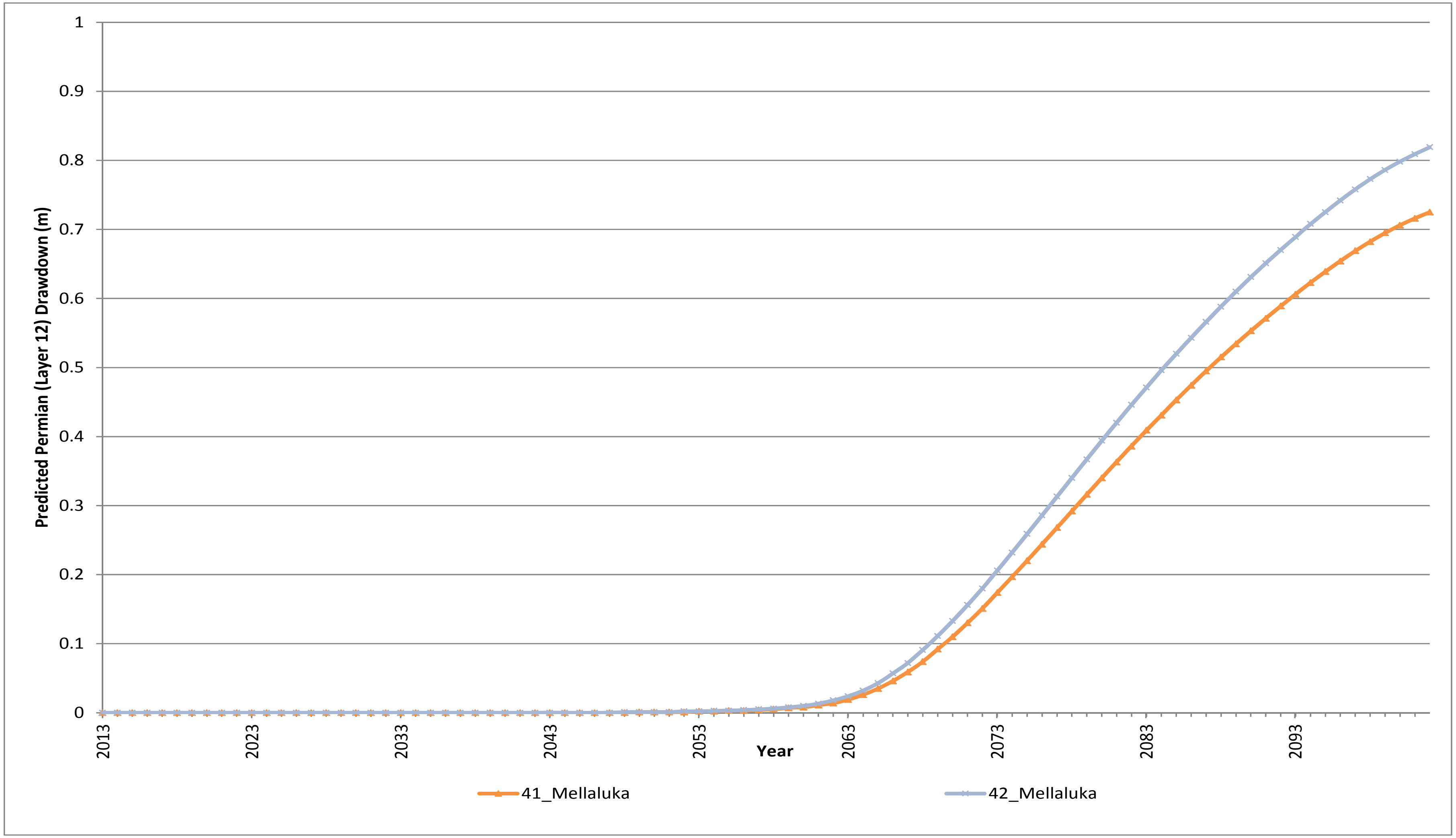
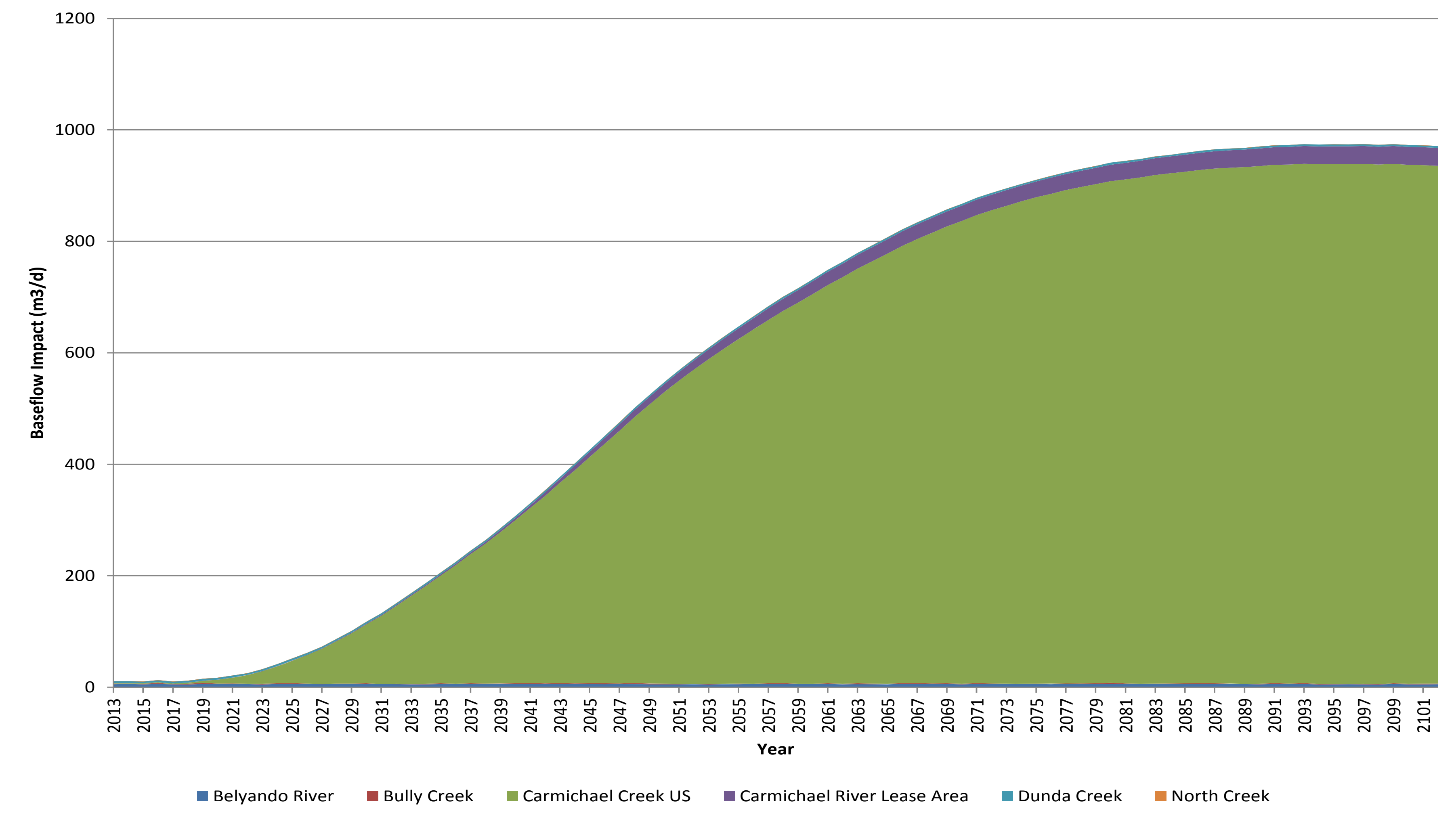
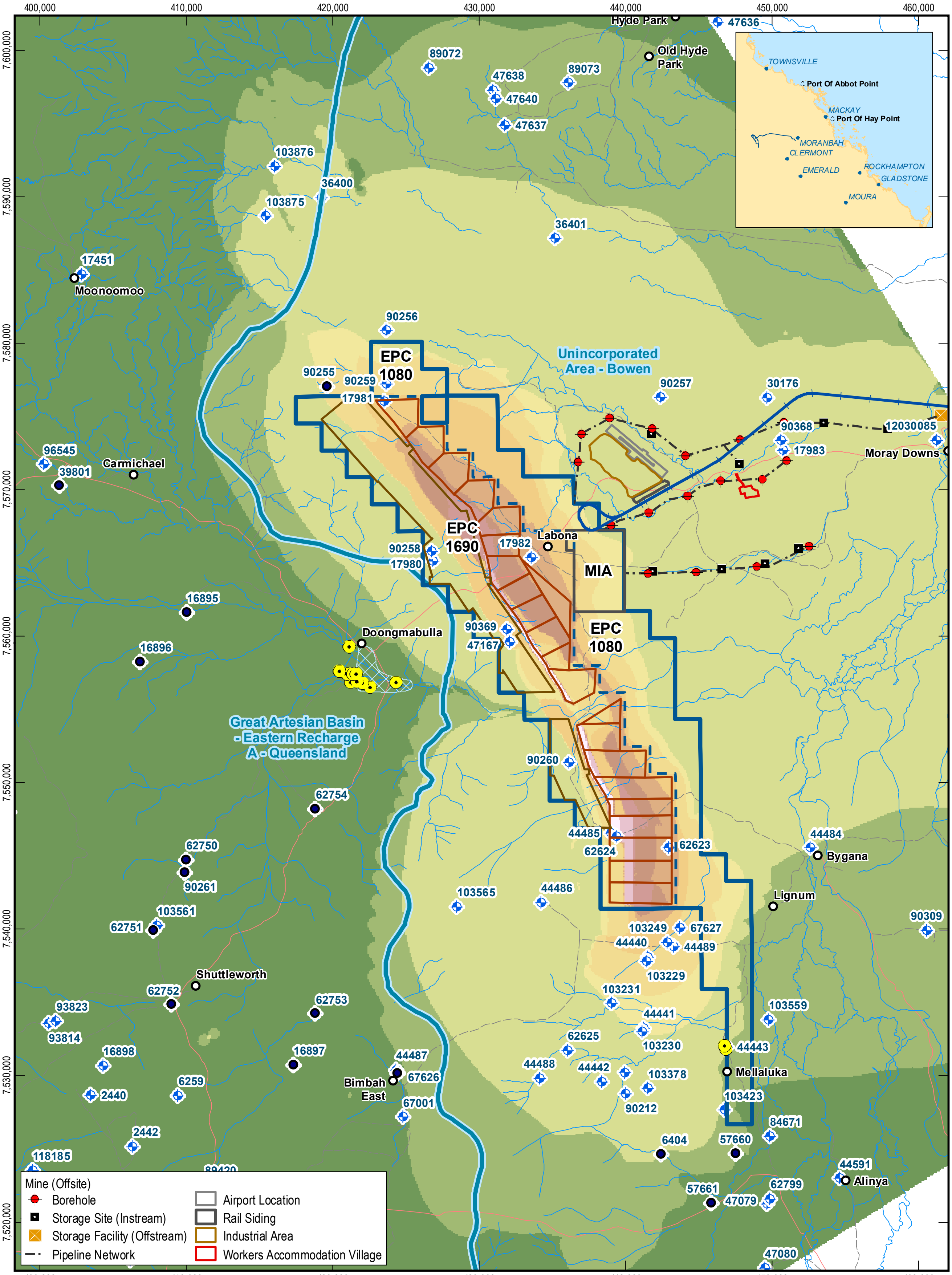


Figure 5-9 Predicted Base Flow Impacts – Operational Phase





LEGEND

- Homestead
- Licensed Groundwater Extraction
- Registered Groundwater Bore
- Springs
- Local Road
- Track
- Watercourse
- Doongmabulla Springs
- Underground Mine
- Open Cut Mine
- Groundwater Management Unit Boundary
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area

Water Table Drawdown (m)

- 0 - 0.2
- 0.2 - 1
- 1.0 - 10
- 10.0 - 20
- 20.0 - 50
- 50.0 - 100
- 100.0 - 150
- 150.0 - 200
- 200.0 - 250
- 250.0 - 300
- 300.0 - 350

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1:375,000 (at A4)

0 2.5 5 7.5 10

Kilometres

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

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GHD adani

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

Job Number 41-25215
Revision C
Date 15-11-2012

Predicted Long Term Water Table Drawdowns – Post Closure

Figure 5-10

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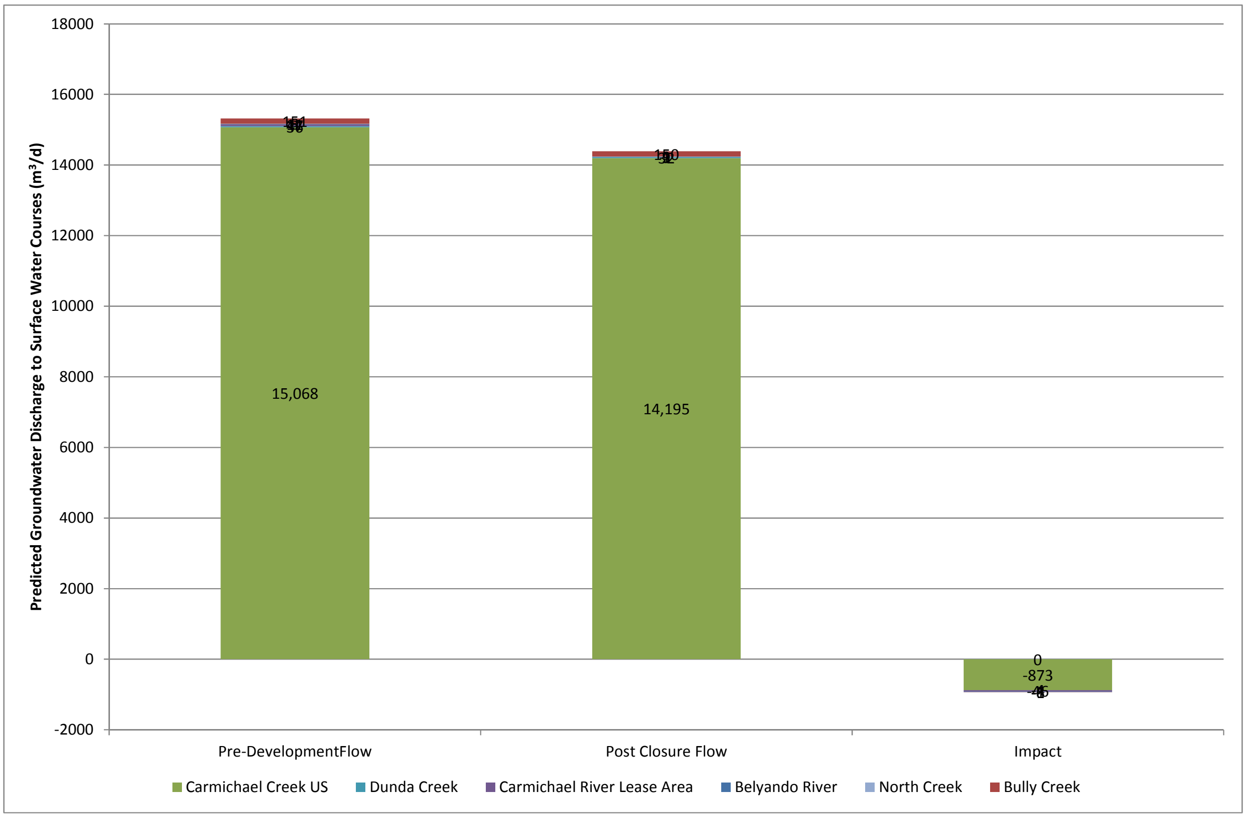
Data Source: DERM: Registered Groundwater Bores (2010); DME: EPC 1690 (2010)/EPC 1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); BRS: Groundwater Management Unit Boundary (2009); GHD: Maximum Drawdown (2012); EPA - Springs (2005); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW, MS

Figure 5-11 Predicted Base Flow Impacts – Post Closure



5.8 Sensitivity Analysis

5.8.1 Approach

A detailed post calibration sensitivity analysis has been carried out in order to assess the sensitivity of model calibration and predictions to variations in selected key parameters. In total a further 176 runs of the calibration and predictive models were undertaken as follows:

- 82 further runs of the steady state calibration model in order to assess the sensitivity of the model calibration to modelled hydraulic conductivity, recharge and river conductance;
- 92 further runs of the post closure steady state model in order to assess the sensitivity of key model predictions to modelled hydraulic conductivity, recharge and river and drain conductance; and
- 2 further runs of the transient predictive model in order to assess the sensitivity of key model predictions to modelled storage parameters (i.e. specific yield and storativity).

Further information on the modelled parameters varied during the sensitivity analysis and the range of parameter multipliers considered are shown in Table 5-13.

Table 5-13 Sensitivity Analysis– Parameters and Multipliers

Parameter	Calibration Model Layer	Predictive Model Layer	Parameter Multipliers
K – Quaternary	1	1	0.1,0.2,0.5,2,5,10
K – Tertiary	2	2	0.1,0.2,0.5,2,5,10
K – Moolayember Formation	3	3	0.1,0.2,0.5,2,5,10
K – Clematis Sandstone	4	4	0.1,0.2,0.5,2,5,10
K – Dunda Beds	5	5	0.1,0.2,0.5,2,5,10
K – Rewan Formation	6	6/7	0.1,0.2,0.5,2,5,10
K – Permian OB	7	8	0.1,0.2,0.5,2,5,10
K – AB Coal Seam	8	9	0.1,0.2,0.5,2,5,10
K – Permian IB	9	10	0.1,0.2,0.5,2,5,10
K – D Coal Seams	10	11	0.1,0.2,0.5,2,5,10
K – Older Permian Units	11	12	0.1,0.2,0.5,2,5,10
Recharge	Layers 1 - 5	Layers 1 – 5	0.1,0.2,0.5,2,5,10
River Conductance	Layers 1 – 5	Layers 1 – 5	0.1,0.2,0.5,2,5,10
Drain Conductance	Layers 1 – 10	Layers 1 – 10	0.1,0.2,0.5,2,5,10
Storage	Layers 1 – 11	Layers 1 – 12	0.5,2

The sensitivity analysis approach adopted is consistent with the approach outlined in Section 5.2 of the Murray Darling Basin Groundwater Flow Modelling Guidelines (Middlemis, Merrick and Ross, 2001) and enables identification of four different sensitivity types as follows:

- Type I Parameters. Parameters with an insignificant impact on either the calibration or model predictions;
- Type II Parameters. Parameters which have a significant impact on the model calibration but an insignificant impact on model predictions;
- Type III Parameters. Parameters which have a significant impact on the model calibration but an insignificant impact on model predictions; and
- Type IV Parameters. Parameters which have an insignificant impact on the model calibration but an insignificant impact on model predictions

For a calibrated model then Type IV parameters only are cause for concern since variations in these parameters can significantly affect predictions without affecting the calibration. Parameters are often classified as Type IV where there is limited calibration data. For instance where there are few calibration targets in a layer which proves critical to quantifying the impact.

It should be noted that this classification process requires a definition of 'significance' i.e. what magnitude of change in the model calibration and prediction is significant. Whilst this definition is subjective to some degree this does not typically affect the value of the analysis. Adopted definitions of significance for the calibration and various predictions are shown in Table 5-13.

Table 5-14 Sensitivity Analysis– Significance Definition

Model Output	Significant Impact	Justification
Calibration Quality (Scaled RMS)	> 0.1 % change in Scaled RMS	Changes of less than 0.1 in the Scaled RMS considered to be insignificant.
Predicted Drawdown at Doongmabulla Springs	> 0.15 m change in predicted drawdown	Predictions based on the calibrated parameter set suggest <0.05 m of impact post closure, an additional 0.15 m would therefore be sufficient for the impact to exceed the 0.2 m significant level adopted for other studies (e.g. QWC, 2012).
Predicted Drawdown at Mellaluka Springs	> 1 m change in predicted drawdown	Predictions based on the calibrated parameter set suggest around 5 m of impact post closure, a variation of 1 m or 20% is therefore considered to represent a significant change in prediction.
Predicted Baseflow Impact	> 20% change in predicted baseflow impact	Expected error in modelled flow predictions = + or - 20%.

5.8.2 Discussion of Results

Doongmabulla Springs

Sensitivity analysis results relating to predicted post closure impacts at the Doongmabulla Springs are presented in Figure 5-12. This plot suggests that the predicted impacts on the springs are relatively insensitive to all of the parameters tested.

Results suggest that slightly higher post closure impacts of around excess of 0.1 m (i.e. around 0.05 m higher than the predictions made using the calibrated parameter set) could occur at the springs if the actual hydraulic conductivity of the Clematis Sandstone was 10 times higher than the calibrated value for this layer.As would be expected sensitivity analysis results also that the timing of impacts may be affected where the actual storage values are different from those assumed for modelling purposes. However, in this case since maximum impacts on the Doongmabulla Springs occur during the steady state post closure run then maximum predicted drawdowns are not sensitive to storage variations. Storage sensitivity analysis results for the Littmose spring therefore indicate that the timing of peak impact at the spring may vary by around + or – 15 years depending on the actual aquifer storage but that the maximum impact of 0.1 m at this location will be unaffected.

Mellaluka Springs

Sensitivity analysis results relating to predicted post closure impacts on groundwater levels in Permian strata at the Mellaluka Springs are presented in Figure 5-13. This plot suggests that the predicted impacts on the springs are relatively sensitive to the hydraulic conductivity (K) of the Permian overburden, the Permian coal seams and the older Permian units but that the overall calibration quality is relatively insensitive to these same parameters i.e. the following parameters are classified as Type IV:

- K Permian Overburden;
- K AB Coal Seams;
- K D Seams; and
- K Older Permian Units.

The results also suggest that higher post closure impacts of up to around excess of 10 m (i.e. around 5 m higher than the predictions made using the calibrated parameter set) could occur at the springs if the actual hydraulic conductivity of the older Permian units was 10 times higher than the calibrated value for this layer.

As for the Doongmabulla Springs sensitivity analysis results for storage suggest that the timing of significant impacts (i.e. greater than 0.2 m) at the Mellaluka Springs may vary by around + or – 15 years depending on the actual aquifer storage values but that the maximum long term impact will be unaffected.

Post Closure Baseflow Impacts

Sensitivity analysis results relating to predicted post closure impacts on baseflow in local water courses are presented in Figure 5-14. This plot suggests that the predicted impacts on the springs are relatively sensitive to the hydraulic conductivity (K) of the older Permian units and River Conductance but that the overall calibration quality is relatively insensitive to these same parameters i.e. the following parameters are classified as Type IV:

- K Older Permian Units; and
- River Conductance.

The predicted baseflow are also relatively sensitive to the hydraulic conductivity of the Dunda Beds, the Rewan Formation and the coal seams to some extent although these parameters have been classified as Type III since the calibration is also relatively sensitive to these parameters.

Results suggest that predicted post closure baseflow impacts could be as high as 1440 m3/d if the actual hydraulic conductivity of the older Permian units was 10 times higher than the calibrated value for this layer. Based on the calibrated parameters post closure baseflow impacts are predicted to be around 920 m3/d. Sensitivity analysis results therefore suggest an upper bound impact of around 1440 m3/d or 520 m3/d higher than the 'best estimate' inflow based on the calibration.

The predicted baseflow impacts are therefore relatively insensitive to the hydraulic conductivity of the remaining layers and/or recharge.

Sensitivity analysis results for storage suggest that the timing of peak baseflow impact on the Carmichael River may vary by around + or – 20 years depending on the actual aquifer storage values but that the maximum long term impact will be unaffected.

Predicted Post Closure Mine Inflows

Since the proposed mine is not included in the historic calibration model then it is only possible to assess the sensitivity of predicted inflows to un-remediated voids to the parameters shown in Table 5-13. The results are summarised in Figure 5-15 and suggest that predicted inflows are relatively sensitive to:

- K Dunda Beds;
- K Rewan Formation;
- K Permian Overburden;
- K AB Coal Seams;
- K Permian Interburden;
- K Older Permian Units; and
- Recharge.

Predicted groundwater inflows appear to be particularly sensitive to the modelled hydraulic conductivity of the older Permian units. Results suggest that inflows could be as high as 4700 m3/d if the actual hydraulic conductivity of the older Permian units was 10 times higher than the calibrated value for this layer. Based on the calibrated parameters post closure groundwater inflows to unremediated voids are predicted to be around 1900 m3/d. Sensitivity analysis results therefore suggest an upper bound inflow of around 4700 m3/d or 1800 m3/d higher than the 'best estimate' inflow calculated using the calibrated parameter set.

Sensitivity analysis results for storage suggest that the predicted inflows to the proposed mineworkings may vary by up to around + or – 25% on average for the first 80 years of the 90 year mine life. However, during the final 10 years of the mine life flows appear to approach steady state and hence predicted inflows during the last 10 years of mining onwards do not appear to be sensitive to the assumed modelled storage values.

Figure 5-12 Sensitivity Analysis Results – Doongmabulla Springs

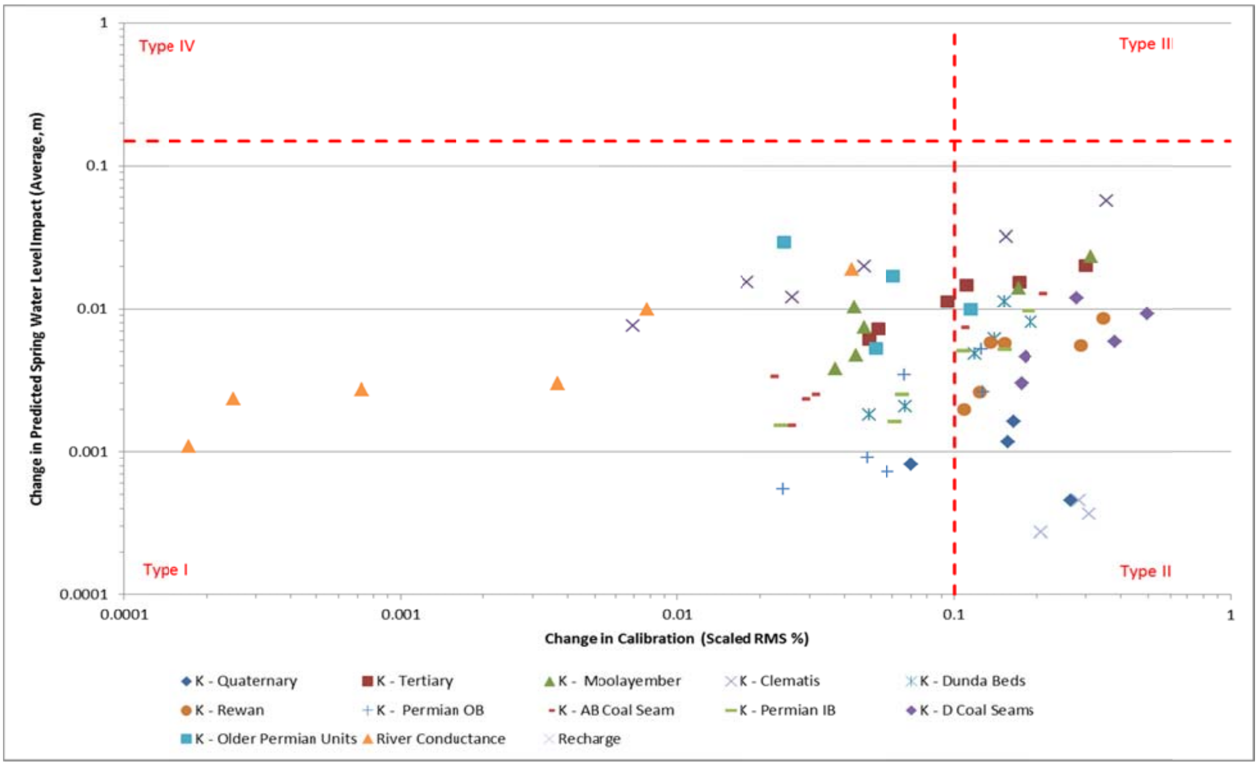


Figure 5-13 Sensitivity Analysis Results – Mellaluka Springs

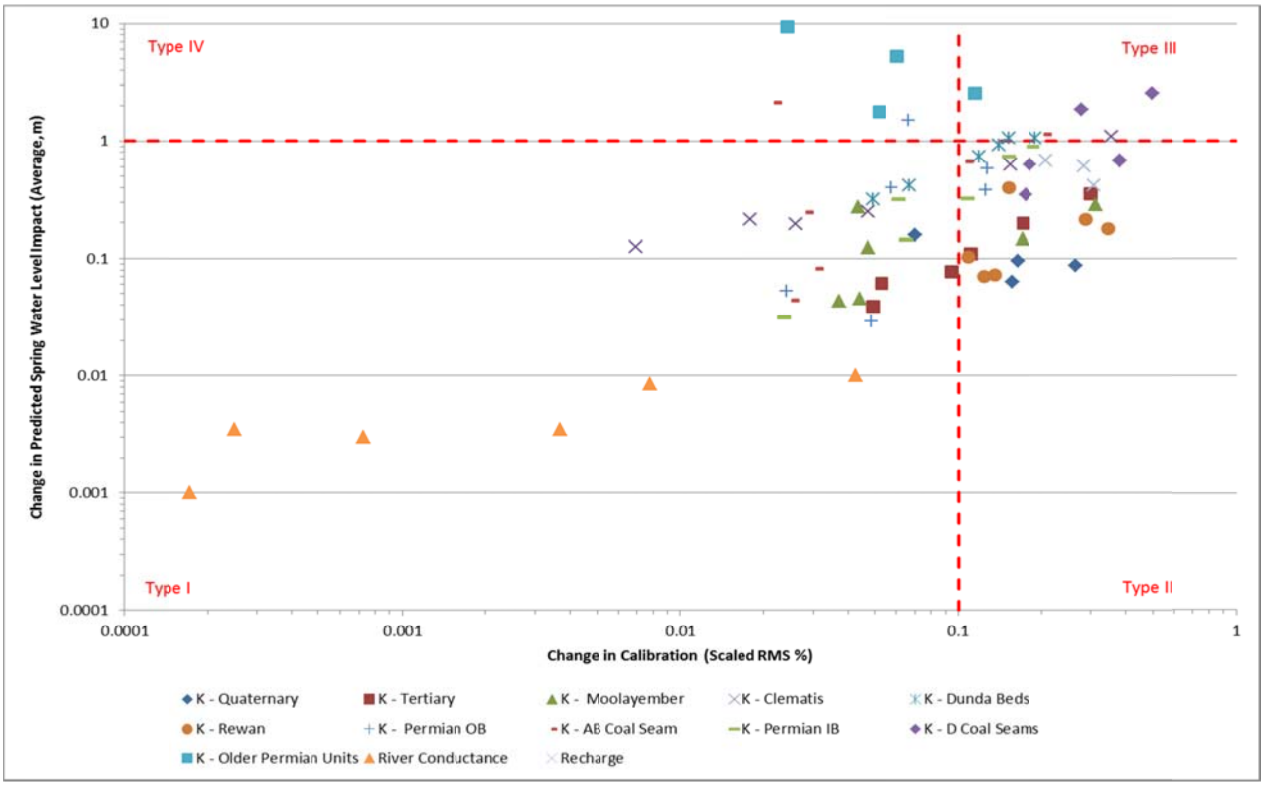


Figure 5-14 Sensitivity Analysis Results – Baseflow Impact

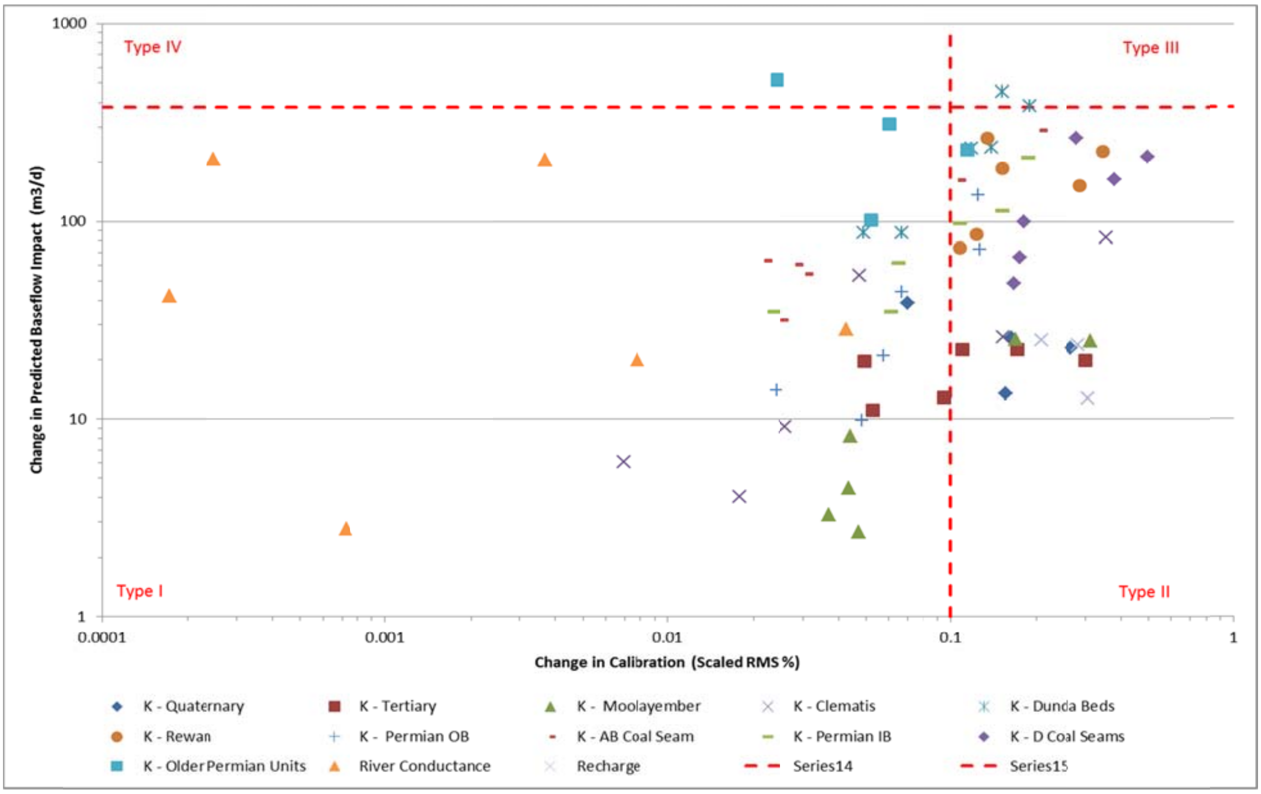
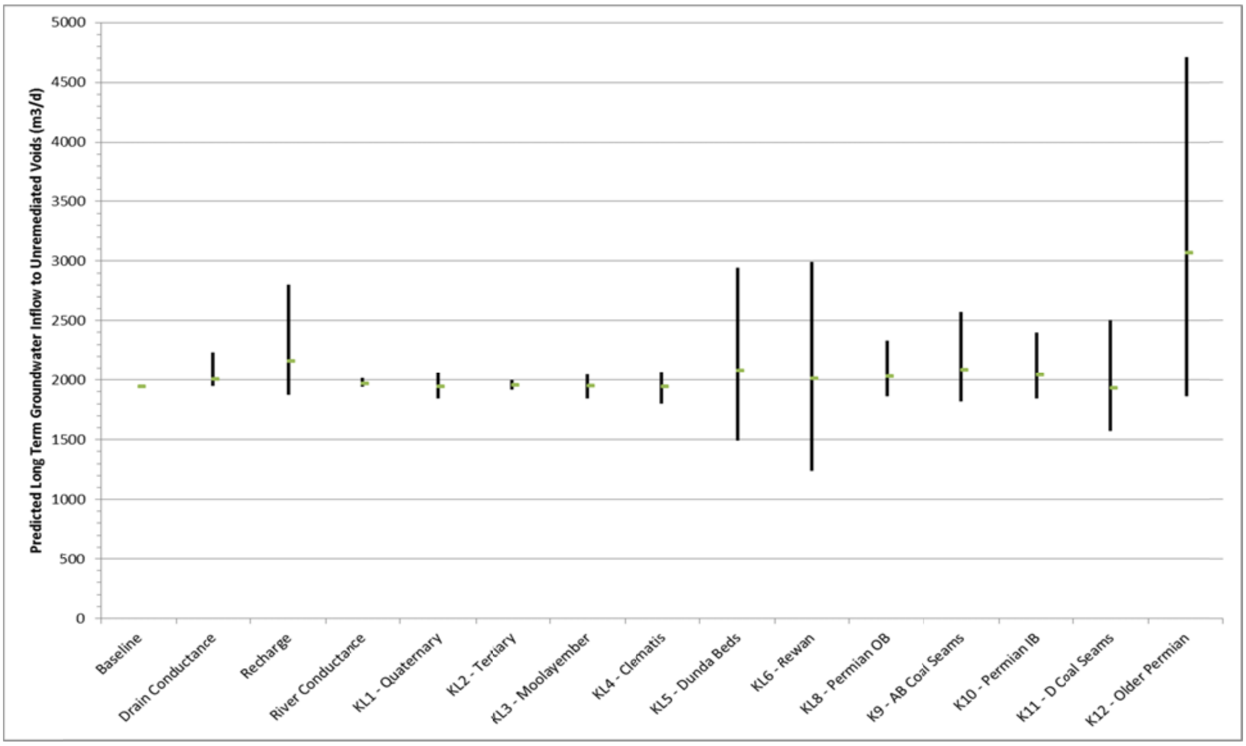


Figure 5-15 Sensitivity Analysis Results – Mine Inflows



5.7.1 Sensitivity Analysis Conclusion

Sensitivity analysis results suggest that the predicted impacts on the Doongmabulla and Mellaluka Springs, baseflow in the Carmichael River and predicted inflows to the proposed mine workings are all relatively sensitive to the modelled hydraulic conductivity of the basal model layer which represents older Permian units underlying the D Seams. Conversely, however, the model calibration is relatively in-sensitive to this parameter since there are few observations in this unit. Re-calibration of the model using additional groundwater level observation data for the older Permian units would therefore tend to reduce the current level uncertainty in a number of model predictions.

6. Potential Impacts and Mitigation Measures – Construction Phase

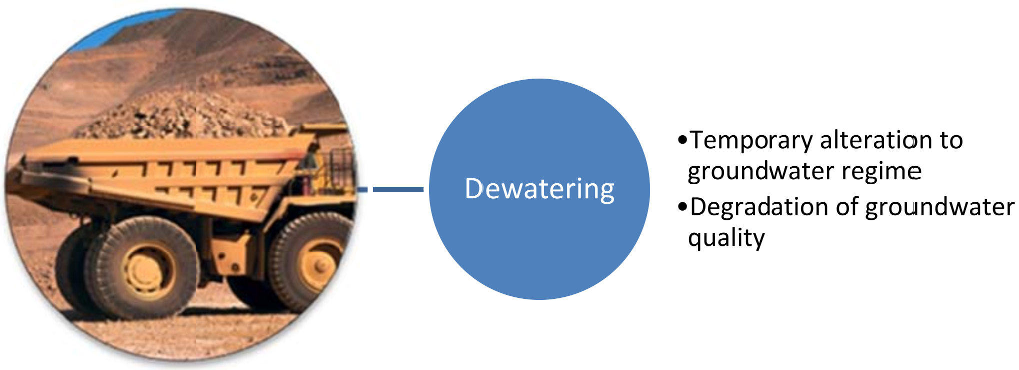
6.1 Overview

The principal activities during the construction phase of the Project (Mine) which may impact groundwater resources are considered to be:

- Temporary dewatering for construction of foundations for proposed infrastructure, including for:
  - Mine infrastructure including water and waste management facilities
  - Mine airport
  - Workers accommodation village
  - Creek crossings (if constructed during the wet season)
- Degradation of groundwater quality due to spills and leaks of hazardous materials such as oil and diesel or poor management of wastewater.

It is understood that all water required for construction will be sourced from offsite surface water resources; hence, groundwater extraction for use in construction use has not been considered in the impact assessment. Figure 6-1 provides an overview of potential impacts of the construction phase of the Project (Mine).

Figure 6-1 Summary of Potential Impacts, Construction Phase



6.2 Potential Impacts of Construction Activities

6.2.1 Overview

The potential impacts to groundwater resources from the principal construction activities are considered to be:

- Potential for localised and temporary changes to groundwater levels and flows as a result of temporary dewatering during construction of foundations and/or the general waste landfill.
- Potential to degrade the groundwater quality as a result of leaks and spills and/or uncontrolled discharges of site runoff occurring during construction works.

6.2.2 Potential Impacts to the Groundwater Flow Regime

Temporary dewatering is unlikely to be required for construction of foundations for infrastructure (including the village and airport) or for the construction of a general waste landfill, given that depth to groundwater is anticipated to be at least 20 m below ground surface away from the Carmichael River (i.e. within and in the vicinity of the Mine Infrastructure Area (MIA) where the majority of construction is proposed). The location of the proposed landfill has not been confirmed however, it has been assumed that it will also be close to the MIA for the purposes of this assessment.

Temporary dewatering is also considered unlikely to be required for construction of minor creek crossings, given that the minor surface watercourses in the Project area are understood to be ephemeral and located in areas where groundwater is anticipated to be at least 20 m below ground surface. A causeway construction, with culverts, is proposed for the short term low-level crossing of the Carmichael River; hence significant temporary dewatering is also unlikely to be required for this construction activity. The proposed bridge across the Carmichael River will also require minimal excavation.

6.2.3 Potential Impacts to Groundwater Quality

Construction vehicles and equipment will use diesel and oil, and diesel will be stored at the MIA and off-site infrastructure area for refuelling. Other potentially environmentally hazardous materials include waste oils and sewage.

The relatively high anticipated depths to groundwater (generally greater than 20 m below ground surface) and the clayey nature of much of the Tertiary-age strata encountered across the site is considered to provide significant potential for the attenuation of any contaminants from leaks and spills before they reach the groundwater table.

In addition, leaching of contaminants to groundwater is unlikely to occur unless moderate to large quantities are released over a long period of time. Provided that storage facilities are designed in accordance with Australian standards and standard practices for management of storage and handling activities are followed, large quantity, long term releases are not expected.

If treated sewage is to be disposed of by irrigation, this will be in accordance with an effluent disposal management plan that is informed by modelling to determine the application rates required to avoid leaching to groundwater.

Hence, the risk of degradation of the groundwater quality from construction activities is considered to be low.

The highest risks to groundwater quality therefore relate to any construction activities in the vicinity of the Carmichael River (such as construction of the crossing) since groundwater levels in this area are relatively close to ground surface (within five metres in places) and the shallow sub-surface materials are likely to be relatively sandy, i.e. permeable. Hence, any contaminants introduced at the ground surface in this area are likely to reach the water table relatively quickly and with little or no attenuation. Any impacts on groundwater quality in this area could also affect surface water quality as a component of flow in Carmichael River during dry periods is thought to be derived from local groundwater sources.

However, assuming that construction activities are managed and operated according to management and mitigation measures outlined in Section 6.3 then no significant impacts on groundwater quality are anticipated during the construction phase.

6.3 Management, Mitigation and Monitoring Activities – Construction Phase

Laydown areas for vehicles and machinery and storage areas for chemicals, oils and fuels must be appropriately designed and allow for full containment of any leaks and spills. Containment may include: sealed/lined surfaces and hard stand areas; bunded areas; containerised storage. In addition, chemicals, oils, fluids and other hazardous substances must be stored in accordance with the specifications of the material substance 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 must not be placed in the vicinity of creeks or rivers or near to sensitive receptors (i.e. groundwater bores or GDEs).

Spill kits must be available to all personnel in the event of a spill or leak. Booms and spill kits must be onsite at refuelling facilities. Refuelling must only occur at designated sites away from watercourses and other sensitive receptors. A spill kit must be present for any mobile refuelling and mobile refuelling must be supervised..

Where sources of sand are required, this must, as far as is practicably possible, be obtained from borrow pits in areas where shallow aquifers are not present (e.g. older alluvial palaeochannels) and should not be obtained from present-day creek beds. Importation of construction materials should also be investigated where necessary.

If temporary dewatering of excavations for construction of surface infrastructure is required, the quality of groundwater should first be ascertained and an appropriate means for managing and disposing of the groundwater determined in accordance with procedures in the Construction Environmental Management Plan (CEMP). Dewatering should be kept to a minimum by forward planning of construction activities requiring dewatering.

Potential impacts on groundwater quality due to the discharge of potentially contaminated runoff will be prevented through the development and operation of a suitable surface water management system and associated management plan (SWMP). The overall aim of the system and plan would be to ensure that all water leaving the construction site is captured, treated and recycled (where possible). Where discharge from the site is necessary then the effluent will be of a suitable quality and quantity to prevent any significant impacts on receiving water course.

7. Potential Impacts and Mitigation Measures – Operational Phase

7.1 Overview

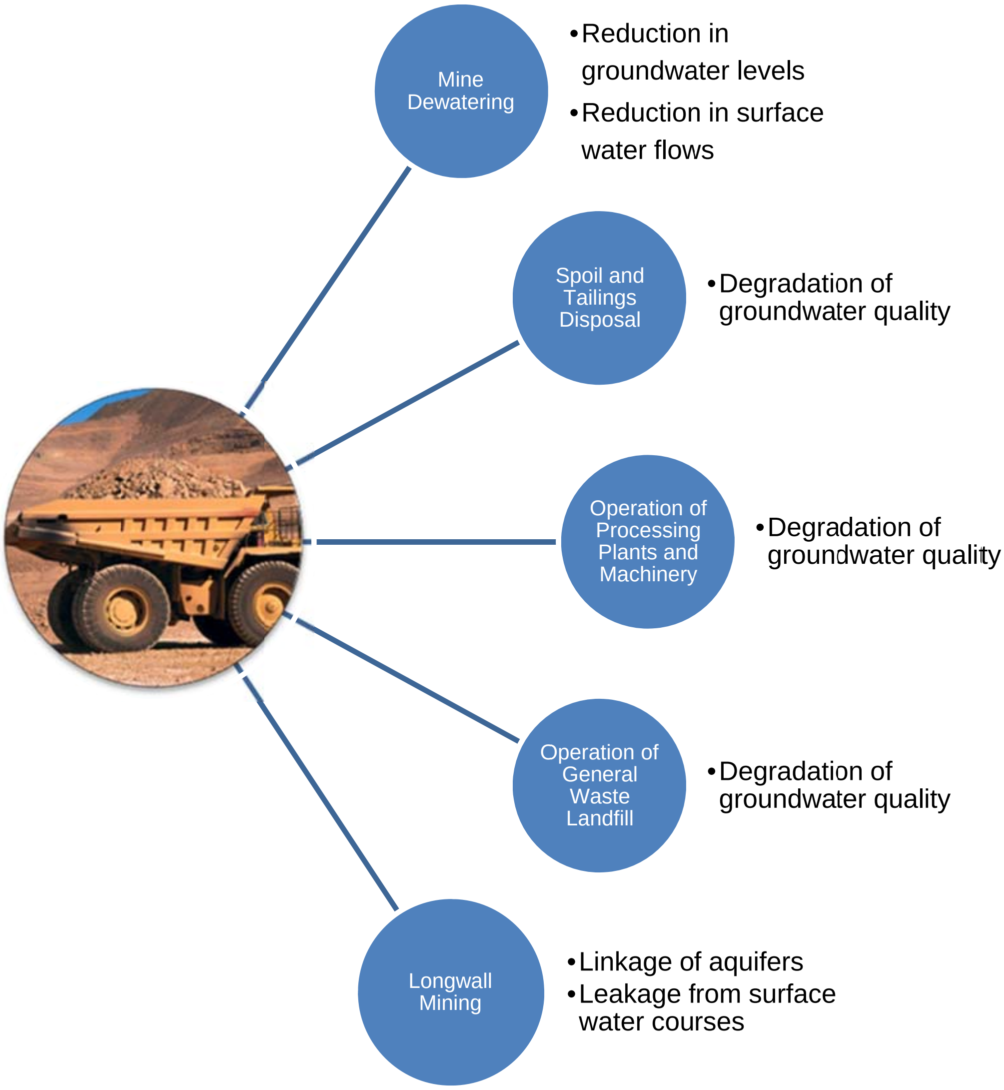
The principal activities during the operational phase of the Project (Mine) which may impact groundwater resources are considered to be:

- Dewatering of open cut pits;
- Dewatering of underground mine workings;
- Spoil and tailings disposal to pits and/or tailings dams;
- Operation and processing and storage facilities and plant;
- The diversion of minor ephemeral creeks along the western boundary of the Study Area;
- Operation of the general waste landfill;
- Longwall mining of the underground workings.

It is understood that the water demand for the operational phase of the Project (Mine) will be met from a combination of water from dewatering, stored surface water and water imported from offsite. The impact of additional groundwater extraction from boreholes, specifically for the purposes of meeting the operational water demand, has not been considered in the impact assessment.

Figure 7-1 provides an overview of the potential impacts during the operational phase.

Figure 7-1 Overview of Potential Impacts on Groundwater Resources, Operational Phase



7.2 Potential Impacts related to Mine Dewatering

7.2.1 Cone of Influence of Dewatering Operations

Dewatering will be required to lower groundwater levels to the base of the proposed workings for safe and efficient operation of the open cut and the underground mines. As a result, groundwater levels will decline within Study Area and are predicted to be drawn down by more than one metre up to around 10 km from the Project (Mine) site during the operational phase (refer to Figure 5-6 for a map of predicted water table decline).

7.2.2 Discharge of Excess Groundwater Inflow

Groundwater discharge to the proposed mine workings is expected to form one of the major inputs to the mine water management system, particularly during dry season, and will typically be re-cycled for use elsewhere within the mine, to meet processing and other water demands. The reuse of groundwater and the need for a discharge must be assessed through the development and application of a water balance model (see Volume 4 Appendix P2 Preliminary Water Balance).

7.2.3 Drawdown at Existing Groundwater Extraction Locations

Dewatering has the potential to reduce groundwater levels in existing groundwater bores that fall within the cone of influence of the proposed mine and hence has the potential to impact on existing groundwater users. It has been assumed that the ten registered bores located within the lease boundary will be decommissioned prior to commencement of mining and hence have been excluded from the impact assessment.

Potential impacts on 31 of the 36 licensed and other registered bores, outside of the lease area assessed by the model, are not anticipated to be significant, on the basis that the predicted drawdowns at these locations are less than one metre. In most cases it is likely that a 1 m drawdown will have little or no impact on the yield of an individual bore.

Potentially significant impacts on groundwater levels (i.e. a predicted drop in water levels of greater than one metre) are anticipated at five registered bores (see Table 7-1). It should be noted that the actual significance of these predicted drawdowns will depend on a range of factors including bore status, bore depth, rest water level and pump and screen elevations. It may be possible to maintain water production rates and quality with augmentation of bores and a detailed assessment of individual bores will be carried out prior to development and in consultation with landholders.

Table 7-1 Summary of Significant Impacts at Registered Groundwater Bores

Site	Model Layer	Formation Targeted	Maximum Drawdown (m)	Notes
RN 90255	4	Clematis Sandstone / Dunda Beds	3.6	North of lease area
RN 44486	5	Dunda Beds	6.4	South-east of lease area
RN 90256	10	Permian Sandstone	2.2	North of lease area
RN 90259	10	Permian Sandstone	19.8	North of lease area
RN 103229	10	Permian Sandstone	1.6	South of lease area

7.2.4 Potential for Indirect Impacts on the Great Artesian Basin

The proposed open cut mining areas are located towards the east of the EPC 1690 lease area. None of the Triassic-age strata which form part of the GAB (i.e. the strata overlying the Rewan Group) are present within the proposed open cut mining areas. Triassic-age strata including the Dunda Beds are present in the underground mining area towards the west of the lease but only the older underlying Permian units will be actively dewatered in this area. No direct impacts on groundwater resources in the GAB are anticipated. However, groundwater modelling results suggest that some indirect impact on the GAB is possible primarily via inducing drawdown in the near-surface Tertiary and Quaternary-age units which are present throughout the Project area and hence also extend into the GAB area to the west.

Groundwater model predictions suggest maximum groundwater table drawdowns of up to 10 m during the operation phase along the western boundary of the Study Area where Triassic-age Dunda Beds, Clematis Sandstone and/or the Moolayember Formation are mapped at outcrop. Predicted impacts decline relatively rapidly towards the west, away from Study Area, and hence maximum water table impacts of less than one metre at 10 km from the lease boundary are typically predicted.

As shown in Figure 5-6 the area to the west of Study Area is mapped as representing part of the Eastern Recharge area of the GAB. Hence, any impacts on groundwater levels in outcropping relatively permeable sandstone units such as the Dunda Beds and Clematis Sandstone has the potential to reduce the volume of recharge to the GAB. However, it should be noted that the topography, groundwater modelling results and the limited available groundwater level data all suggest that current groundwater flow in Triassic-age units to the west of the site may be towards the east i.e. away from the GAB rather than towards it. Where this eastward groundwater flow direction is confirmed by further monitoring then no impacts on the GAB groundwater resources would occur as a result of dewatering.

7.2.5 Potential Impact on Local Spring Systems

For the most part the predicted cone of influence of mine dewatering does not extend beneath the GAB Doongmabulla Spring complex to the west of the Project (Mine) site and hence less than 0.05 m of drawdown is predicted at 9 of the 11 mapped spring sites. However, minor impacts of up to around 0.1 m drawdown are predicted at the two springs closest to the lease, Little Moses (1034) and Doongmabulla or Joshua Spring (1041). There is the potential, therefore, for some minor impact on groundwater levels at two springs which in turn has the potential to reduce the rate of flow from the springs and to reduce the amount of water available for the ecological communities dependent on and associated with the springs. Any reduction in the flow from the springs will also impact flows in the Carmichael River downstream.

Based on recent assessments of the potential for impacts on GAB springs in response to Coal Seam Gas (CSG) extractions carried out by DNRM and the Queensland Water Commission, drawdowns of over 0.2 m at GAB spring locations are considered to be potentially significant. Predicted drawdowns at all of the mapped Doongmabulla Springs are below this threshold and are therefore considered to be insignificant.

Drawdowns of up to 0.7 to 0.8 m are predicted at the location of the two non-GAB springs mapped just north of Mellaluka (approximately 10 km south of the Project (Mine) site) during the operational phase and hence it is possible that these springs could be impacted. It should be noted, however, that limited data are currently available on the geology and hydrogeology of the area to the south of the Carmichael River and that little is known about the status or source of these springs. The Mellaluka springs are identified as non-GAB Eastern Desert Upland springs typically associated with outcropping Dunda Beds. In this case, however, it is considered unlikely that the Dunda Beds are present in the vicinity of the Mellaluka Springs. The springs are mapped around 10 km east of the nearest area of Dunda Beds outcrop and the geology typically dips from east to west. Further assessment of the ecology and hydrogeology of the springs themselves and of the area between the springs and the proposed mining area is required to better understand the potential for impact in this area. It should also be stressed that significant drawdowns are not expected in the Mellaluka Springs area until around 60 years into the proposed life time of the mine. There will therefore be ample opportunity to collect further data and develop management and mitigation measures before any impacts eventuate.

7.2.6 Potential Impacts on Surface Water Flows

The maximum predicted cone of influence of mine dewatering extends beneath the Carmichael River within, upstream and downstream of the Project (Mine) site. Given that groundwater discharge to the Carmichael River upstream of the site is thought to help maintain flow in the river during dry periods (along with discharge from Doongmabulla Springs), surface water flows in the river are likely to decline as a result of the predicted reduction in groundwater levels along the river. Groundwater modelling results suggest that groundwater discharges to local water courses, predominantly the Carmichael River, will be reduced by up to 1,000 m^3/d or 7 per cent of pre-development discharge during the operational phase. Where groundwater discharge is reduced by 7 per cent as predicted then this may have some impact on the duration of zero flow and/or low flow periods in the Carmichael River and also possibly the Belyando River downstream. Ongoing monitoring and measurement of flows in the Carmichael River and of discharges from the Doongmabulla Springs is required to quantify the magnitude of these impacts.

The Carmichael River also receives a proportion of its water from Doongmabulla Springs; hence any reduction in the rate of flow from the springs as a result of the minor predicted impacts on groundwater levels at two of the springs (Section 7.2.5) may also contribute to a reduction of flow in the river.

No significant impacts on flows in the various ephemeral minor creeks which drain the Project area are anticipated since these water courses are not thought to currently receive any substantial discharges from groundwater.

7.2.7 Potential Impacts on Riparian Vegetation

Direct groundwater discharge to the Quaternary alluvium underlying the river and discharge from the Doongmabulla springs is thought to represent a potentially significant water source to the stands of the mature River Red Gum and Paper Bark tree communities along the river, particularly during dry periods. Any significant reduction in groundwater levels and/or surface water flows in the Carmichael River during dry periods has the potential to impact the ecological health of these communities. This is assessed further in Volume 4 Appendix N1 Mine Terrestrial Ecology.

7.3 Potential Impacts of Spoil and Tailings Disposal

Based on information provided in the conceptual mine plan (Runge, 2011), a combination of in pit disposal (overburden, interburden, coarse reject, tailings and slimes) and out of pit disposal (overburden, interburden and coarse reject) will be employed. Tailings will initially be disposed of to a tailings dam adjacent to the MIA until the in pit disposal system becomes operational. Provided these facilities are operated to minimise discharges, either via surface water release and/or groundwater seepage and to manage any potential for materials to produce acid and metalliferous drainage (AMD), no significant impacts on groundwater resources in the area are anticipated (See Volume 2 Section 10.2 Acid Mine Drainage). This assessment is based on an assumption that the management, mitigation and monitoring activities outlined in Section 7.8.7 are adopted and taking into account the following considerations:

- Processing of the coal will be limited to a relatively simple washing process and hence the quality of any water leaching from the deposited tailings is expected to be relatively benign based on experience with similar plants. Testing of the tailings and spoil will also be conducted as part of the monitoring activities, which will identify any potential impacts on groundwater and inform the implementation of appropriate mitigation measures.

- An assumption that the material to be deposited in the proposed in pit disposal areas will be relatively dry on deposition (i.e. will not require substantial ponds to store process water that might drain from the spoil/tailings).
- The current quality of groundwater resources within the area is indicated to be relatively poor on the basis that the majority of the groundwater samples taken from the Project (Mine) monitoring network to date would not be suitable for drinking water, irrigation or livestock use.

Whilst significant impacts related to in-pit or above ground storage are not anticipated, it is understood that the proposed coal washing process involves the addition of magnetite. No tailings leachate trials have been undertaken to date and hence the potential impact of this part of the process on the quality of leachate is currently unknown.

Initial desktop (SRK 2012a) and geochemical assessments (SRK 2012b and c) of the potential for excavated material to produce acid and metalliferous drainage have been conducted (refer to the, Volume 4 Appendix V Acid Mine Drainage Report). The initial geochemical assessment has identified the potential for a proportion of the coal, roof, floor, interburden and overburden materials to be potentially acid forming. As detailed in the geochemistry report (SRK, 2012c), testing of tailings from coal washing would be required to assess the AMD risks associated with these materials. Initial testing using raw coal as a surrogate infers a small potential for the coal wastes to generate acid and/or slightly saline drainage. Additional sampling and geochemical testing to assess AMD risks in relation to excavated material are currently underway.

7.4 Potential Impacts Related to Operation of Plant and Storage Facilities

Leakages and spills from plant (such as for coal processing, vehicles and maintenance) during the course of day to day site operations and from any fuel and/or chemical storage facilities have the potential to degrade the quality of local groundwater resources.

The highest risks to groundwater quality relate to any operational activities carried out in the vicinity of the Carmichael River since groundwater levels in this area are relatively close to ground surface (within five metres in places) and shallow sub-surface materials are likely to be relatively sandy. Hence, any contaminants introduced at the ground surface (such as leaks and spills) in this area are likely to reach the water table relatively quickly, with little or no attenuation. However, operational activities in the immediate vicinity of the river are understood to be limited to mine vehicle traffic across the river via a specifically engineered structure. The risk of any significant leaks and spills in this area is therefore considered to be negligible.

Assuming that storage facilities and plant activities are managed and operated according to management and mitigation measures outlined in Section 7.8.8 (see below) then no significant impacts on groundwater quality are anticipated during the construction phase.

7.5 Potential Impacts Related to Stream Diversions

The final mine design will include the diversion of a number of minor ephemeral creeks which currently flow during heavy rainfall events from west to east across the EPC 1690. Preliminary design work for this diversion has identified a number of potential design options including the construction of a diversion channel along the western margin of Study Area to divert flow north and south into the Carmichael River. Further design work is required to confirm the location and elevation of the final diversion system and hence insufficient information is currently available to quantify the impacts of the diversion. Significant impacts on groundwater are considered unlikely given the elevated depths to groundwater observed across most of the site and the fact that any practical diversion design, which can be economically constructed, is considered unlikely to intersect the water table over the majority of its length. Consideration of depth to groundwater should however be incorporated as a key constraint in the final diversion design process, as outlined in Section 7.8.9.

7.6 Potential Impacts Related to Operation of a General Waste Landfill

It is proposed to locate a landfill at the off-site infrastructure area for putrescible wastes and other wastes that cannot be removed by contractor for recycling or disposal due to the distances involved. It has been assumed that this landfill will not be required to receive 'Regulated waste'(e.g. oils, batteries, tyres, solvents and chemicals and other waste types) which are regulated under Schedule 1 of the Environmental Protection (Waste Management) Regulation 2000.

As detailed in the Mine Waste Management Section (Volume 2 Section 10) the management of waste from the Project (Mine) will be in accordance with relevant legislation and the principles of the waste management hierarchy. The general waste landfill would be designed, constructed and operated in accordance with the appropriate waste management legislation and guidelines and as such would include appropriate measures to minimise any leachate leakage from the landfill to groundwater.

7.7 Potential Impacts Related to Longwall Mining

Longwall mining creates a void, or goaf, into which unsupported material typically collapses and this, can result in fracturing of the overlying material remaining in-situ and cause subsidence of the ground surface. The fracturing not only occurs directly above the goaf but can also radiate out at an angle although the intensity of fracturing typically decreases with increasing distance from the goaf.

The extent of this fracture zone and the potential for surface subsidence has been assessed in separate study undertaken by MSEC (MSEC, 2012). The results of this study suggest that a free draining fracture zone with a maximum height of approximately 150 meters above each of the mined seams is likely to develop above the underground longwall mine workings. This free draining fractured zone is likely to be characterized by intense vertical fracturing thus creating potential for direct groundwater inflows from the overburden to the workings. Conceptual models for the free draining fractured zone (MSEC, 2012; Guo et al., 2007) suggest potentially significant increases in vertical hydraulic conductivity in these areas. Guo et al. (2007) suggest that the vertical hydraulic conductivity in the free draining fracture zone may be increased by a factor of up to 50. Furthermore the relative change in vertical hydraulic conductivity is likely to be higher towards the base of the fracture zone than at the top.

The impact of these changes in the hydraulic conductivity in areas above the mine has been assessed as part of the groundwater modelling work through the introduction of time varying hydraulic conductivity to the predictive model. The hydraulic conductivity of the Permian and Triassic age strata which fall within the predicted free draining fracture zone has been increased for the modelled post-mining period. The predictions of impact on the GAB areas to the west of the mine therefore take account of this potentially important mining-induced change in hydrogeological properties.

As illustrated in the conceptual mine study (Runge, 2011) the longwalls will not be advanced beneath the Carmichael River and hence subsidence beneath the river itself should be avoided providing that the 'stand-off' distance between the river and the nearest panels is sufficient.

Based on subsidence contours included within Appendix C of the MSEC study (MSEC, 2012) less than 50 mm of subsidence is anticipated in the vicinity of the Carmichael River. Furthermore surface cracking it expected to be limited to areas immediately above the proposed longwall panels and hence no significant surface cracking is expected in the vicinity of the Carmichael River. The MSEC report also highlights that whilst surface cracking is often observed in exposed bedrock areas in NSW, similar types of cracking are not anticipated in the Carmichael Coal project area due to the presence of unconsolidated Quaternary and Tertiary sediments at outcrop across the underground mining area.

7.8 Management, Mitigation and Monitoring Activities – Operational Phase

7.8.1 Discharge of Excess Groundwater Inflows

All inflows to the operational mine area, including groundwater inflow to the proposed open cut and underground workings, would be directed into the mine water management system. It is proposed that the mine affected water (MAW), including dewatered water, will be reused for dust suppression and in the coal handling process where possible. Any discharges of MAW will be subject to appropriate levels of control and monitoring such that it can be discharged to receiving water courses without any significant detrimental impacts on water quality and flow. This is discussed further in Volume 4 Appendix Q Mine Water Quality Report and Appendix P2 Preliminary Water Balance.t. Operation of the mine water management system will be documented in the mine water management plan, which will form part of the overall Environmental Management Plan (EMP) developed for the construction and operational phases of the Project.

7.8.2 Drawdown at Existing Groundwater Extraction Locations

Prior to the commencement of construction activities the status of each of the existing registered bores that could be significantly affected by the proposed Project (Mine) should be confirmed and a baseline assessment undertaken at each of the active bores in order to establish their pre-operational condition. This assessment would include:

- Confirmation of the operational status, purpose of use of the bore and bore yield
- Measurement of pumping and rest water levels and pumping rates
- Sampling and laboratory analysis of water samples from each bore

Where operational registered bores are identified, which may be impacted by the development, then consideration would be given to incorporating them into the Project (Mine) monitoring network and/or installing observation bores in the area between the mine and the bores in order to identify the development of the mine cone of depression in the direction of the bores. This will be determined in consultation with landholders.

If an operational registered bore is found to be significantly impacted as a result of the Project (Mine) then losses/changes in the extracted groundwater will be ‘made good’, for example by supplementing the supply with imported water.

Any monitoring of registered bores will be incorporated into the Environmental Management Plan, (see Appendix 2 Section 15 of the EIS).

Should significant effects on registered bores used for water supply be identified, Adani will make good any loss in water availability in conjunction with the landholder.

7.8.3 Great Artesian Basin Aquifers

Groundwater model predictions suggest the potential for some minor indirect impacts on groundwater levels and recharge to Triassic-age units, which form part of the GAB system. Given the importance of the GAB from a national water resource perspective additional monitoring bores have already been installed in the area to the west of the Study Area including the installation and monitoring of two multi-level facilities at sites HD02 and HD03 close to the Carmichael River, upstream of Study Area but downstream of the Doongmabulla Spring complex. Initial results from these bores have already been incorporated into the EIS and associated modelling as described above.

The primary purpose of these facilities is to:

- Confirm pre-development groundwater flow directions in the Triassic-age units to the west of the site;
- Track the progression of any impacts on GAB units to the west of the site.

7.8.4 Local Spring Systems

Groundwater model predictions also suggest the potential for some minor impacts at two of the 11 mapped GAB springs at Doongmabulla. Impacts of up to 0.1 m are predicted after 40-70 years at the two closest springs to the proposed mining area, i.e. the Little Moses spring to the north and the Doongmabulla Spring to the east. Little or no data is currently available on the flow rate or chemistry of these springs and access was not possible during the majority of the current EIS monitoring period.

Given the importance of these springs from an ecological and cultural perspective, further investigations and monitoring will be undertaken prior to commencement of mining operations, to establish a reliable baseline data set of conditions at the springs and also of groundwater levels between the springs and the Project (Mine) site. The following investigations and monitoring are proposed at least 12 months prior to commencement of any dewatering operations:

- An ecological survey of the spring complex to establish its ‘health’ and to establish any seasonal variations. The survey would include measurement or estimation of discharge flows, assessment of the water quality and assessment of the ecology (for example extent, health and species present).
- The installation of two multi-level monitoring bores close to the Little Moses and Doongmabulla Springs. Data from these bores would be used to confirm the relative levels and quality of groundwater in the near surface and underlying Triassic-age strata. These facilities would complement similar monitoring bores/stationsalready installed along the Carmichael River downstream (refer to Section 7.8.3).

Access to the Doongmabulla Springs area was recently negotiated allowing this work to be commenced. The results of an initial ecological survey and sampling of the springs is described in Volume 4 Appendix Q of the EIS.

Drawdowns of up to 0.7 to 0.8 m are also predicted after around 60 years at the location of the two non-GAB springs mapped just north of Mellaluka during the operational phase and hence it is possible that these springs could also be affected. However, relatively little is currently known about these springs and is understood that they may be currently used for water supply purposes. Further assessment of the ecology and hydrogeology of the springs themselves is therefore proposed initially, in order to confirm their environmental values, current status and confirm likely source aquifers for the springs. Depending on the findings of these assessments Adani Mining Pty Ltd is committed to taking any further steps as necessary to reduce the predicted impacts at these springs to acceptable levels. Potential mitigation measures which may reduce and/or mitigate predicted impacts during the operational phase include:

- Reviewing and revising the extent, location and/or timing of the proposed mine workings; and/or
- Offsetting or ‘making good’ any residual impacts.

It should also be stressed that significant drawdowns are not expected in the Mellaluka Springs area until around 60 years into the proposed life time of the mine. There will therefore be ample opportunity to collect further data and develop management and mitigation measures before any actual impacts eventuate.

7.8.5 Surface Water Flows

Given the potential for a reduction in surface water flows in the Carmichael River, supported by numerical modelling, continued detailed monitoring of groundwater levels and flows in the Carmichael River corridor will be undertaken. In particular, further manual gauging will be undertaken at the existing upstream and downstream level monitoring sites so that a reliable pre-development flow record can be developed for these gauges. An assessment of ecological impacts associated with changes in flows is provided in Volume 4 Appendix O1 Mine Aquatic Ecology.

In the event that groundwater level and/or surface water flow impacts are identified post development then Adani would work with the relevant environmental authorities to manage the water balance for identified losses. Potential alternative sources of water which could be used to mitigate observed flow impacts on the Carmichael include the diversion of minor creeks that currently flow across the mine footprint and the discharge of suitably treated inflows to the proposed mine workings.

7.8.6 Riparian Vegetation

Given the potential for a reduction in groundwater levels in the vicinity of the Carmichael River and hence the potential to impact on the health of the mature River Red Gum and Paper Bark communities, ecological monitoring before, during and after mine dewatering operations would be undertaken in addition to the hydrological monitoring outlined above (Section 7.8.5). An assessment of ecological impacts associated with changes in groundwater levels is provided in Volume 4 Appendix N1 Mine Terrestrial Ecology Report.

7.8.7 Spoil and Tailings Disposal Siting and Operation

Mitigation and monitoring measures are proposed as follows:

- Design and operation of the above ground tailings dam in accordance with appropriate legislation to minimise impacts on groundwater resources (see Volume 2 Section 10.2).
- Establishment and operation of a dedicated groundwater monitoring network around the perimeter of the proposed above ground tailings dam, comprising a minimum of four locations, prior to commencement of the operation of the dam.
- Leach testing of tailings generated from coal washing (or other processing activities) and materials proposed for disposal in the in pit and above ground tailings facilities prior to the start of mining, in order to identify any contaminants that might leach to groundwater. This will assist with the development and implementation of suitable treatment and, or, management measures in order to minimise impacts on groundwater quality from disposal.

- Treatment of spoil and tailings prior to disposal, if necessary, in order to minimise acid generation from any materials with AMD potential.
- Post closure capping of in-pit and above ground tailings facilities.
- Location of in-pit and above ground facilities in the northern half and towards the eastern edge of the site and more than five kilometres from the Carmichael River (i.e. areas thought to be characterised by a relatively thick unsaturated zone and as far as possible from any Triassic-age GAB units).

7.8.8 Operation of Plant and Storage Facilities

Laydown areas for vehicles and machinery and storage areas for chemicals, oils and fuels must be appropriately designed facilities and allow for full containment of any leaks or spills. Containment may include sealed/lined surfaces and hard stand areas; bunded areas; containerised storage. In addition, chemicals, oils, fluids and other hazardous substances must be stored in accordance with the specifications of the material substance 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.

Spill kits must be available to all personnel in the event of a spill or leak. Spill kits must be onsite at refuelling facilities. Refuelling must only occur within pits or at the central MIA or underground MIAs.

Potential impacts on groundwater quality due to the discharge of potentially contaminated runoff will be prevented through the development and operation of a suitable surface water management system and associated management plan (SWMP). The overall aim of the system and plan would be to ensure that all water leaving the operational mine site is captured, treated and recycled (where possible). Where discharge from the site is necessary then the effluent will be of a suitable quality and quantity to prevent any significant impacts on receiving watercourse.

7.8.9 Diversion Channel Design

Given the proximity of the western boundary of the site to the eastern limit of the GAB the potential for long term impacts on groundwater levels will form a key constraint on the final diversion channel design. As far as possible, the location and elevation of the diversion system will be designed to minimise areas where the drain invert is below the current water table. Where this cannot be achieved, due to practical or other constraints, then the impacts of the final design will be assessed by completing further numerical modelling work and implementing additional mitigation measures to further reduce potential impacts on groundwater resources.

7.8.10 General Waste Landfill Siting and Operation

Whilst no significant impacts on groundwater from construction of a general waste landfill are anticipated, monitoring and mitigation measures to minimise the potential for any impacts from operation of the proposed landfill (refer to Section 7.6) are proposed as follows:

- Design, construction, management and operation of the general waste landfill in accordance with relevant legislation and guidelines (see Volume 2 Section 10.2)
- Establishment and operation of a dedicated groundwater monitoring network around the perimeter of the landfill, comprising a minimum of four locations, prior to commencement of the operation of the facility

- Post closure capping

7.8.11 Monitoring Network Review and Groundwater Management Plan

Once the final mine design and layout have been developed, a review of the adequacy of the current groundwater monitoring network and the additional monitoring proposals outlined above in Sections 7.8.1 to 7.8.9 will be undertaken. The findings of this review will form a key component of a groundwater management plan, which would be developed prior to commencement of construction of the Project (Mine).

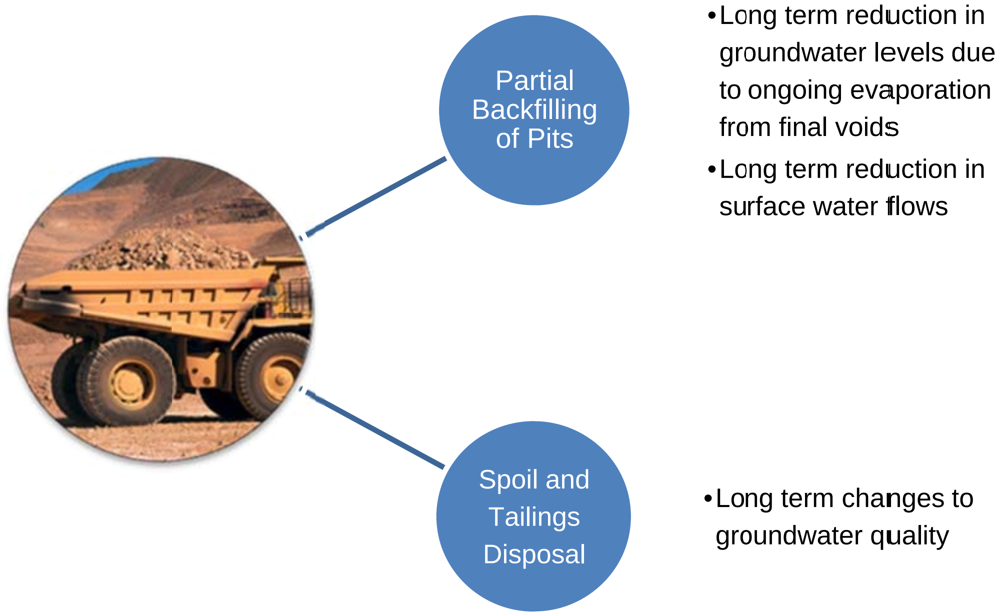
8. Potential Impacts and Mitigation Measures – Post Closure

8.1 Overview

The principal outcome of the post-closure phase of the Project (Mine) considered to have the potential to impact on groundwater resources is the proposed partial backfilling of some of the open cut pits. Long-term impacts on groundwater resources, principally of reduced groundwater levels and alterations to the groundwater regime due to ongoing evaporation from final void areas are anticipated.

Figure 8-1 shows a summary of the post-closure potential impacts.

Figure 8-1 Overview of Potential Impacts on Groundwater, Post-Closure Phase



8.2 Potential Impacts Related to Creation of Voids

The conceptual mining study (Runge, 2011) indicates that nine of the open cut pits will not be significantly backfilled and hence that the final ground surface within these voids will be substantially below pre-development ground surface and groundwater level elevations. Whilst there is the potential for these voids to gradually fill with water once dewatering operations have ceased, potential evaporation losses from the voids significantly exceed the predicted groundwater inflow to these pits and hence the voids are expected to remain dry, except following prolonged heavy rainfall events. In this case, ongoing evaporation from these voids will essentially act as long-term groundwater extractions from within the Project (Mine) area, with the potential to permanently reduce groundwater levels to the base of proposed final voids. As a result, the numerous impacts related to dewatering of the mine during the operational period (Section 7.2) will persist post-closure. Furthermore, in most cases predictions indicate that potential long-term post closure impacts may exceed those calculated for the operational period since evaporation is likely to continue to control groundwater levels within the final un-remediated voids in perpetuity, whereas dewatering of the proposed mine workings during the operational phase is only required for the life of the mine.

8.2.1 Drawdown at Existing Groundwater Extractions

There is the potential for significant reductions in groundwater levels at selected registered groundwater bores if the voids are only partially backfilled. Potentially significant post closure impacts of between one and 46 m are predicted at one out of 21 licensed registered bores and all of the 15 other registered bores outside of the Study Area.

8.2.2 Potential for Indirect Impacts on the Great Artesian Basin

As during the operational phase, the predicted post closure cone of influence extends to the west and includes areas where the Triassic-age Dunda Beds, Clematis Sandstone and/or the Moolayember Formation are mapped at outcrop. Hence, there is the potential for groundwater levels to remain lower than pre-development levels after cessation of mining activities and for a permanent reduction in the availability of recharge to the GAB in this area. However, it should be noted that the topography, groundwater modelling results and the available groundwater level data all suggest that current groundwater flow in Triassic-age units to the west of the site may be towards the east i.e. away from the GAB rather than towards it. If this eastward groundwater flow direction is confirmed by further monitoring then no impacts on the GAB groundwater resources are expected to occur as a result of dewatering.

8.2.3 Potential for Impacts on Local Springs

Minor impacts on groundwater levels at the two springs closest to the lease, Little Moses (1034) and Doongmabulla or Joshua Spring (1041), are predicted to continue to be impacted post-closure of the mining operations. No impact on the remaining nine springs in the Doongmabulla complex are predicted during the operational or post closure period.

At the Mellaluka Spring site, however, predictions suggest ongoing drawdown post closure result in drawdowns of around 5 m at these springs in the long term although it should be stressed that predictions also suggest that significant impacts will not occur until around 60 years into the proposed life time of the mine. Furthermore as previously discussed in Section 7.2.5 our understanding of the areas to the south of the lease and the springs themselves is currently limited. Further assessment of the ecology and hydrogeology of the springs themselves is therefore proposed initially. Depending on the findings of these assessments Adani Mining Pty Ltd is committed to taking any further steps as necessary to reduce the predicted impacts at these springs to acceptable levels. Potential mitigation measures which may reduce and/or mitigate impacts during the post closure phase include:

- Reviewing and revising the extent, location and/or timing of the proposed mine workings;
- Backfilling of final voids to above pre-development groundwater levels to prevent ongoing losses due to evaporation; and/or
- Offsetting any residual impacts.

It should also be stressed that significant drawdowns are not expected in the Mellaluka Springs area until around 60 years into the proposed life time of the mine. There will therefore be ample opportunity to collect further data and develop management and mitigation measures before any actual impacts eventuate.

8.2.4 Potential for Impacts on Surface Water Flows

There is potential for further reductions in base flow to local surface watercourses (including the Carmichael River and the Belyando River) during the post-closure phase, with long term impacts of around 1,00 m^3/d or 7 per cent of pre-development base flows predicted. Where groundwater discharge is reduced by 7 per cent as predicted then this may have some impact on the duration of zero flow and/or low flow periods in the Carmichael River and also possibly the Belyando River downstream. Further information on flows in the Carmichael River and on discharges from the Doongmabulla Springs is required to quantify the significance of these impacts.

Unlike during the operational period there is little opportunity for 'making good' any impacts since the mining operations will have been de-commissioned. In the event that significant post closure impacts are predicted then Adani Mining Pty Ltd is committed to taking any further steps necessary to reduce the impacts on levels and/or flow in the Carmichael River to acceptable levels. Potential mitigation measures which may reduce and/or mitigate impacts during the post closure phase include:

- Reviewing and revising the extent, location and/or timing of the proposed mine workings;
- Backfilling of final voids to above pre-development groundwater levels to prevent ongoing losses due to evaporation; and/or
- Offsetting any residual impacts.

8.3 Potential Impacts Related to Tailings and Spoil Disposal and General Waste Landfill

If disposal of tailings and spoil and the general waste landfill are not managed effectively at the operational stage there is potential for these wastes to be sources of long term contamination of groundwater post-closure of the mine, both within and down gradient of the Project (Mine) lease.

8.4 Management, Monitoring and Mitigation Measures – Post Closure

8.4.1 Open Pits

Significant potential impacts on groundwater levels, groundwater extractions and on the groundwater regime within and in the vicinity of Study Area are predicted as a result of partial backfilling of pits and in most cases are predicted to be greater than the operational phase of the Project (Mine).

The following mitigation measure is therefore proposed:

- Partial backfill all open cut pit voids such that the final ground surface within each of the pit areas is above the pre-development groundwater levels, to allow groundwater levels to rebound to pre-development elevations.

8.4.2 Tailings and Spoil Disposal, General Waste Landfill, Mine Infrastructure Area

In order to confirm no impact on groundwater quality from waste storage and former operational areas of the site (such as in pit and above ground disposal of tailings and spoil, seepage from the general waste landfill and coal processing facilities), continuation of monitoring of groundwater quality beyond the end of the operational phase will be undertaken. A staged approach to post-mining monitoring of tailings and spoil disposal areas is proposed in order to tie in with the various stages of mining as they are completed and rehabilitated.

The operational monitoring network for the Project (Mine) site would be reviewed and modified as appropriate in order to develop an appropriate post closure monitoring network. A post closure GWMP would be developed as part of the post closure EMP and include key components such as monitoring duration and frequency, chemical analyses, definition of trigger values and appropriate action plans.

9. References

Australian Drinking Water Guidelines (ADWG) 6, 2011, Volume 1, Commonwealth of Australia.

Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, the guidelines (Chapters 1 – 7), 2000, Australian and New Zealand Environment Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).

Australian National Resources Atlas (ANRA) website, Australian Government, available from: http://www.anra.gov.au/topics/water/overview/qld/gmu-great-artesian-basin-eastern-recharge-a-queensland.html.

Bureau of Mineral Resources, Geology and Geophysics, 1972, Australia 1:250 000 Geological Series, Galilee, Sheet SF55-10.

Bureau of Mineral Resources, Geology and Geophysics, 1982, Australia 1:250 000 Geological Series, Buchanan, Sheet SF55-6.

Carr, A.F., 1974, Galilee Basin Exploratory Coal Drilling – Moray Downs Area, Geological Survey of Queensland.

Cook, P.G, Healy R.W., 2002, 'Using Groundwater Levels to Estimate Recharge'. Hydrogeology Journal 10: pp. 91-109.Department of Environment and Resource Management (DERM), 2010, Queensland Groundwater Database.

Department of Environment and Resource Management (DERM), 2010, data download from Water Entitlements Registered Database (WERD) on 22 December 2010.

Department of Natural Resources and Water, 2007, Great Artesian Basin Resource Operations Plan, Queensland Government.

Doherty, J., 2010, PEST: Model-Independent Parameter Estimation, Watermark Numerical Computing, Brisbane, Australia.

Environmental Protection (Water) Policy 2009, Queensland Government.

Geoscience Australia, 2000, Australian Groundwater Management Units, Unincorporated Areas and Provinces.

GHD Pty Ltd, 2010, Galilee Project Technical Due Diligence report.

Great Artesian Basin Consultative Council, 1998, Great Artesian Basin Resource Study, Ed. Cox, R., Barron, A.

Guo, H., Adhikary, D. P. and Gabeva, D., 2007. Hydrogeological Response to Longwall Mining, ACARP project C14033. CSIRO Exploration and Mining Report P2007/692.Houlsby, 1976, Routine Interpretation of the Lugeon Water-Test, p303 – 313.

Hydrogeologic, 1996. MODHMS Software (Version 2.0) Documentation. Volume I: Groundwater Flow Modules.

Linc Energy, not dated, exploration borehole logs within EPC 1690.

Littleboy, M., Silburn, D.M., Freebairn, D.M., Woodruff, D.R. and Hammer, G.L., 1989. *PERFECT,* 'A computer simulation model of Productivity, Erosion, Runoff Functions to Evaluate Conservation Techniques'. Queensland Department of Primary Industries, Bulletin QB89005, 119 pp.

Lu, H., Raupach, MR., McVicar, TR., 2001, A robust model to separate remotely sensed vegetation indices into woody and non-woody cover and its large-scale application using AVHRR NDVI time series. CSIRO Technical Report 35/01, in preparation.

Middlemis, H., Merrick, N., Ross, J., 2000, Groundwater Flow Modelling Guideline, Murray Darling Basin Commission, Australia.

MSEC, Mine Subsidence Engineering Consultants, 2012. Carmichael Project – Subsidence Prediction Report. Report Number: MSEC575

Queensland Department of Natural Resources, Mines and Energy, 2004, North Eromanga Basin map sheet, digital version.

Queensland Environmental Protection Act 1994, Reprint 10C, Queensland Government.

Queensland Water Commission (QWC), 2012. Underground Water Impact Report for the Surat Cumulative Management Area. Coal Seam Gas Water – Queensland Water Commission.

Rassam, D. and Littleboy, M., 2003, 'Identifying vertical and lateral components of drainage flux in hillslopes'*.* MODSIM 2003 Proceedings, Vol1.

Runge Pty Ltd, 2011, Carmichael Macro-Conceptual Mine Study.

SCT Operations Pty Ltd, 30 November 2011, Memorandum 'Preliminary Estimates of Subsidence Associated with Longwall Extraction of AB and D Seams at the Carmichael Project'.

Sloto, R.A., Crouse, M.Y., 1996, 'HYSEP: A Computer Program for Streamflow Hydrograph Separation And Analysis'. U.S. Geological Survey Water-Resources Investigations Report 96-4040.

SRK Consulting, 2012a, Carmichael Project: Mine Waste and Metalliferous Drainage and Dispersive Materials Desktop Assessment.

SRK Consulting, 2012b, Carmichael Project: Mine Waste and Metalliferous Drainage and Dispersive Materials Assessment, Initial Laboratory Results.

SRK Consulting, 2012c, Carmichael Project: Mine Waste Acid and Metalliferous Drainage and Dispersive Materials Assessment.

Sustainable Planning Act 2009, Commonwealth Government.

Water Regulation 2002, Reprint 8F, Queensland Government.

Water Resource (Burdekin Basin) Plan 2007, Queensland Government.

Water Resource (Great Artesian Basin) Plan 2006, Reprint 1A, Queensland Government.

Western, A., McKenzie, N., 2006. 'Soil hydrologic Properties of Australia'. Rev. 1.01, Cooperative Research Centre for Catchment Hydrology, University of Melbourne, Victoria, Australia.

Xenith Consulting Pty Ltd, 2009, Galilee Project – MDLa 372 In situ Coal Resource Estimate.

Xenith Consulting Pty Ltd, exploration borehole logs for 2010 and 2011 within EPC 1690.

Xenith Consulting Pty Ltd, Geological Model, provided 26 October 2011.

Appendix A

Terms of Reference Cross Reference

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Terms of Reference Cross Reference

3.4. Water Resources	
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.	Volume 4 Appendix P
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.	Section 4.4.6
Describe the environmental values of the surface waterways of the affected area in terms of existing and other potential surface and groundwater users	Section 4.4.6,
Provide a detailed description of the quality and quantity of surface and groundwater resources in the area potentially affected by the project.	Sections 4.4
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	Appendix E
• Major cations and anions	Section 4.4.2 Appendix E
• Dissolved metals (including Al, Ag, As, B, Br, Ca, Co, Cr, Cu, Fe, Hg, Mo, Mn, Ni, Pb, Se, U, V, Zn)	Section 4.4.4 Appendix E
• Minor ions (such as ammonia, nitrite, nitrate, fluoride)	Appendix E
• Hydrocarbons	Section 4.4.5 Appendix E
• Any other potential toxic or harmful substances	Appendix E
• Turbidity	Appendix E
• Suspended sediments	Appendix E
• pH.	Appendix E
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.	Section 2
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	Section 4.3, 4.7
Describe the environmental values of the surface waterways and groundwater of the affected area in terms of:	
• values identified in the EPP	Section 4
• Physical integrity, fluvial processes and morphology	Volume 4 Appendix P
• Any impoundments	Volume 4 Appendix P
• Hydrology of waterways and groundwater	Section 4.1
• Sustainability (quality and quantity)	Section 4.3, 4.4
• Dependent ecosystems	Section 4.8
• Existing and other potential surface and groundwater users	Section 4.5
• Details of any proposed buffer widths between project activities and	Section 6, 7

3.4. Water Resources	
waterways • Any water resource plans relevant to the affected catchments	Volume 4 Appendix P
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; inter-aquifer connectivity; flow of water; recharge and discharge mechanisms; and hydrogeological processes at work	Section 4.2
• Current extraction regime	Section 4.5
• Geology/stratigraphy	Section 4.1, 4.2
• Aquifer type	Section 4.5
• Depth to and thickness of aquifers	Section 4.6
• Depth to water level and seasonal changes in levels	Section 4.3
• Groundwater flow directions	Section 4.3
• Interaction with surface water	Section 4.7
• Possible sources of recharge	Section 4.3
• Potential exposure to pollution	Section 4.4
• Current access to groundwater resources (bores, springs, ponds, etc)	Section 4.5, 4.8
The groundwater assessment should also be consistent with relevant guidelines for the assessment of acid sulphate soils, including spatial and temporal monitoring, to accurately characterise baseline groundwater characteristics.	Section 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 assess the potential take of water from the aquifer and how current users and the aquifer itself and any connected aquifers will be affected.	N/A No groundwater take is proposed.
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)	Section 4.5
• pumping parameters	Section 4.5
• draw down and recharge at normal pumping rates	Section 4.5
• seasonal variations (if records exist) of groundwater levels	Section 4.4
Develop a network of observation points that would satisfactorily monitor groundwater resources both before and after commencement of operations.	Section 2.3
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.	Section 2.3
3.4.2 Potential Impacts and Mitigation Measures	
Assess potential impacts, including long-term indirect impacts of the project on water resource environmental values identified in the previous section. Define and describe the objectives and practical measures for protecting or enhancing water resource environmental values, to describe how nominated quantitative standards and indicators may be achieved, and how the achievement of the objectives will be monitored, audited and managed. Address and describe the following matters, including provision of maps:	

3.4. Water Resources	
• 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	Section 5.6
• All likely impacts on groundwater depletion or recharge regimes	Section 5.6
• The likely volume of groundwater to be dewatered during the operations, and its likely quality characteristics, including salinity	Section 5.6
• 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	Section 5.6
• How extracted groundwater will be managed in the surface water management system to minimise the likelihood of discharging highly saline water	Section 5.6
• Measures to prevent, mitigate and remediate any impacts on existing users or groundwater-dependent ecosystems	Section 7.7.6
• The potential environmental impact caused by the project (and its associated project components) to local groundwater resources, including the potential for groundwater-induced salinity	Section 7.2
• Response of the groundwater resource to the progression and cessation of the proposal	Section 7, 8
• Impact on the local groundwater regime caused by the altered porosity and permeability of any land disturbance	Section 8.2
• Any potential for the project to impact on groundwater-dependent vegetation, including avoidance and mitigation measures	Section 7.2.7
• Potential impacts of surface water flow on existing infrastructure, with reference to the EPP (Water) and the Water Act 2000	Volume 4 Appendix P
• Chemical and physical properties of any wastewater including stormwater at the point of discharge into natural surface waters, including the toxicity of effluent to flora and fauna	Volume 4 Appendix P
• How contaminants and wastes are avoided, minimised, treated and managed in accordance with section 13 of EPP (Water)	Volume 2 Section 10
• Environmental monitoring to check the effectiveness of mitigation measures	Section 7.7.11
• Potential impacts on other downstream receiving environments, considering the available assimilative capacity of the receiving waters, if it is proposed to discharge water to a riverine system	N/A Uncontrolled releases not proposed
• If it is proposed to discharge water to a riverine system, mitigation measures for water treatment	N/A Volume 4 Appendix P
• The results of a risk assessment for uncontrolled releases to water due to system or catastrophic failure, implications of such emissions for human health and natural ecosystems, and strategies to prevent, minimise and contain impacts	Volume 2 Section 12
• The potential to contaminate surface and groundwater resources and measures to prevent, mitigate and remediate such contamination.	Section 7.3, 7.6
Describe and address the impacts of subsidence.	Volume 2 Section 4
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 5.7, 7.2.6, 8.2.4
Assess the potential impacts of subsidence on the sediment load within watercourses. Identify any existing Quarry Material Allocation Notice (QMAN) holders in, or downstream of, subsidence areas; and if there are any QMAN holders, assess whether there would be potential impacts on their resource or entitlement. Provide mitigation measures for any	Volume 2 Section 4

3.4. Water Resources	
impacts on any QMAN holders.	
Assess the impacts of subsidence on the ecological condition of the bed and banks, including fish passage	Volume 2 Section 4
Assess the impacts of subsidence effects on terrestrial ecosystems	Volume 2 Section 4
Detail measures that would mitigate the impacts of subsidence	Volume 2 Section 4
Outline impacts on all surface water resources by describing: • Local overland flow catchment characteristics and estimated change to mean and median (50th percentile) annual run off from local overland flow catchments • Change to flows including mean and median (50th percentile) annual flow, in watercourses immediately downstream of the site	Volume 4 Appendix P Volume 4 Appendix P
Describe the option for supplying water to the project, and assess the consequential impacts.	Volume 4 Appendix P
Reference the properties of the land disturbed and processing liquid wastes, the technology for settling suspended clays from contaminated water, and the techniques to be employed to ensure contaminated water is contained and successfully treated on site.	
Describe the proposed stormwater drainage system and proposed disposal arrangements. (Illustrate with figures and contours).	Volume 4 Appendix P
The EIS should outline all of the approvals required under the Water Act 2000, Water Regulation 2002 and subordinate legislation to complete the project, including construction and operational stages	Volume 4 Appendix P
Describe management strategies in adequate detail to demonstrate best practice management and environmental values of receiving waters will be maintained to nominated water quality objectives.	Volume 4 Appendix P
Address where there will be a requirement for a Quarry Material Allocation and an associated Development Approval under the Sustainable Planning Act.	N/A

Appendix B

Registered Groundwater Bores

Table B1: Registered Bore Summary

Table B2: Bore Census Results

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RN	Original Name	Easting	Northing	Facility Type Description	Facility Role	Facility Status	Comments	Interpreted Screened Lithology	Base of Screen or Open Section (m)	Bore Depth (m)	Conductivity (uS/cm)	Total Dissolved Solids (TDS)	pH	Measurement Method	Yield (L/s)
17980	-	426849	7565142	Sub-artesian Facility	-	Abandoned and Destroyed	-	-	-	-	400	0	7.7	Lab	-
17981	10 Mile Bore	423527	7576054	Sub-artesian Facility	Water Supply	Existing	Stock	Sandstone (Tertiary / Permian-age)	-	-	1400	0	7.5	Lab	-
17982	Labona Bore	433592	7565399	Sub-artesian Facility	Water Supply	Existing	-	Sandstone (Permian-age)	-	58	795	0	7	Lab	-
44440	New Bore	441533	7538108	Sub-artesian Facility	-	Existing	-	Alluvium	-	23	3700	1979.94	8	Lab	1
44441	Trickle Flow Bore	441226	7533240	Artesian Bore, Controlled Flow	-	Existing	-	Sandstone (Triassic-age, Dunda Beds)	-	-	-	-	-	-	-
44484	House Bore	452599	7545569	Sub-artesian Facility	-	Abandoned and Destroyed	-	Alluvium	7.6	8	8100	4702.22	9.4	Lab	-
44485	Murphys Bore	438998	7546581	Sub-artesian Facility	-	Abandoned and Destroyed	-	Trassic-age or Permian-age	-	67	155	85.21	7.7	Lab	1.3
44486	Desert Bore	434239	7541828	Sub-artesian Facility	-	Existing	-	Sandstone (Triassic-age, Dunda Beds)	-	92	200	106.8	7.5	Lab	0.76
44489	New Bore	443276	7538796	Sub-artesian Facility	-	Existing	-	Alluvium (loose sand)	25	25	3800	2098.37	8.2	Lab	2.78
47167	Humes Bore	432099	7559599	Sub-artesian Facility	-	Existing	-	-	-	-	-	-	-	-	-
62623	Gricks Corner Bore	442969	7545554	Artesian Bore, Controlled Flow	-	Existing	*LTW authorised	Sandstone (Triassic-age, Dunda Beds)	104	104	720	434.19	7.1	Lab	1
62624	Murphys Bore	439404	7546336	Sub-artesian Facility	-	Existing	-	Sandstone (Triassic-age or Permian-age)	61	54	440	335.73	7.2	Lab	2
62625	Soak Bore	436052	7531743	Sub-artesian Facility	-	Existing	-	Sandstone (Triassic-age, Dunda Beds)	85	84	375	212.49	7	Lab	4
67627	Dexter	443712	7540104	Artesian Bore, Controlled Flow	-	Existing	*LTW authorised	Permian-age	104	41	3400	1929.84	8.1	Lab	2.41
90255	Langlands Bore	419633	7577047	Sub-artesian Facility	-	Existing	*LTW authorised	Sandstone (Triassic-age or Permian-age)	97	-	-	-	-	-	-
90256	15 Mile Bore	423671	7580878	Sub-artesian Facility	Water Supply	Existing	Stock	Sandstone (Permian-age strata)	117	-	-	-	-	-	2.53
90258	4 Mile Bore Labona	426775	7565785	Sub-artesian Facility	Water Supply	Existing	Stock	Sandstone (Triassic-age or Permian-age)	79.3	-	-	-	-	-	1.89
90259	Ten Mile	423688	7577246	Sub-artesian Facility	Water Supply	Existing	Stock	Sandstone (Permian-age)	104	-	-	-	-	-	4.55
90260	Carmichael Bore	436157	7551360	Sub-artesian Facility	-	Existing	-	Sandstone (Triassic-age or Permian-age)	91	-	-	-	-	-	-
90369	New Humes Bore	431919	7560469	Sub-artesian Facility	-	Existing	-	Clay with Sandstone (Tertiary-age or Permian-age)	78	-	400	-	-	Field	1.6
103229	Desert Bore	441450	7537803	Sub-artesian Facility	Water Supply	Existing	-	Trassic-age or Permian-age	47.85	-	3800	-	-	Field	0.63
103231	Poison Bore	439028	7534951	Sub-artesian Facility	Water Supply	Existing	-	Sandstone (Triassic-age, Dunda Beds)	97.54	-	1561	-	-	Field	0.51
103230	3 Mile Bore	441156	7533012	Sub-artesian Facility	Water Supply	Existing	-	Sandstone (Triassic-age, Dunda Beds)	88 (base of hole)	-	945	-	-	Field	0.13
103249	New Bore	442857	7539117	Sub-artesian Facility	Water Supply	Existing	-	Sandstone (Tertiary or Permian-age)	46.94	-	-	-	-	-	8.21
103559	-	449748	7533830	Sub-artesian Facility	Water Supply	Existing	-	Trassic-age or Permian-age	-	-	-	-	-	-	-
103565	-	428493	7541524	Sub-artesian Facility	Water Supply	Existing	-	Sandstone (Triassic-age, Dunda Beds)	75	-	-	-	-	-	0.58

Interpretation of screend lithology based on bore depth, mapped geology and recorded lithology
* LTW - licence to take water

Appendix A, Summary of Groundwater Bores Sighted on EPC 1690

Registered Bore ID	Name of Registered Bore	Purpose	Condition	Remarks
17981	10 Mile Bore	Water supply, stock watering (DERM, 2010)	Looks maintained	Pump headworks, diesel generator, under cover, storage tank, turkeys nest dam, 2 x water troughs
17982	Labona bore	Water supply, stock watering (DERM, 2010)	Looks maintained	Electricity hookup, could not observe headworks, under cover, 1 x storage tank, water trough
Not confirmed	Murphys Bore	Assumed is for stock watering	Maintained	GPS 439149E 7546347N. Pump headworks, 2 x solar panels, 1 x tanks. Known as Middle Murphys Bore. Probably RN 62624
90260	Carmichael Bore	Assumed is for stock watering	Looks maintained	GPS 436383E 7551860N. Pump headworks, 1 x storage tank
Not confirmed	4 Mile Bore	Assumed is for stock watering	Looks maintained	GPS 427254E 7565148N. Pump headworks, diesel generator, under cover, 1 x storage tank. Probably RN 90258
Not confirmed	Humes Bore (assumed)	Assumed is for stock watering	Looks maintained	GPS 431999E 7559048N. Pump headworks, diesel generator, under cover, turkeys nest dam. Suspect is either RN 90369 or RN 47167
Not confirmed	Middle Murphys Bore	Assumed is for stock watering	Looks maintained	Known as Murphys Bore. Pump headworks, 1 x tank. Could not identifty a possible RN Bore ID

GPS coordinates GDA94 Zone 55

Appendix C

Survey Data and Borehole Logs

Table C1: Monitoring bore survey data

Borehole logging notes

Draft borehole logs

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Appendix C, Table C1
Summary of Groundwater Monitoring Bore and Vibrating Wire Piezometer Survey Data

Monitoring Bore ID	Easting	Northing	Ground Elevation RL (mAHD)	Top of Casing RL (mAHD)	Survey Date	Surveyor
C006P1	435726.146	7560833.182	233.71	234.333	14/11/2011	Wilson Survey Group
C006P3r	435733.591	7560825.82	233.867	234.355	14/11/2011	Wilson Survey Group
C007P2	434726.28	7559864.482	238.11	238.797	14/11/2011	Wilson Survey Group
C007P3	434727.969	7559861.908	238.117	238.966	14/11/2011	Wilson Survey Group
C008P1	433710.221	7558830.229	238.141	238.685	14/11/2011	Wilson Survey Group
C008P2	433707.789	7558826.807	238.117	238.848	14/11/2011	Wilson Survey Group
C011P1	428842.528	7569952.912	254.46	255.105	14/11/2011	Wilson Survey Group
C011P3	428845.625	7569954.926	254.396	255.096	14/11/2011	Wilson Survey Group
C012P1	430887.597	7569874.426	247.333	247.982	14/11/2011	Wilson Survey Group
C012P2	430887.426	7569876.797	247.252	247.958	14/11/2011	Wilson Survey Group
C014P2	430730.902	7563976.225	255.987	256.78	14/11/2011	Wilson Survey Group
C016P2	422017.42	7574974.28	294.453	295.126	14/11/2011	Wilson Survey Group
C018P1	423981.852	7574849.963	281.269	281.949	14/11/2011	Wilson Survey Group
C018P2	423988.081	7574849.148	281.295	282.044	14/11/2011	Wilson Survey Group
C018P3	423977.524	7574853.22	281.212	281.945	14/11/2011	Wilson Survey Group
C020P2	427845.604	7566931.847	263.057	263.78	14/11/2011	Wilson Survey Group
C022P1	426812.614	7565961.716	273.763	274.275	14/11/2011	Wilson Survey Group
C024P3	428909.131	7571761.206	258.586	259.069	14/11/2011	Wilson Survey Group
C025P1	438015.576	7555845.846	227.543	228.145	14/11/2011	Wilson Survey Group
C025P2	438010.253	7555844.706	227.478	228.279	14/11/2011	Wilson Survey Group
C027P1	433643.076	7554818.391	226.95	227.672	21/09/2012	Wilson Survey Group
C027P2	433648.209	7554818.544	227.558*	227.859	21/09/2012	Wilson Survey Group
C029P1	437691.058	7555082.374	225.438	226.079	14/11/2011	Wilson Survey Group
C029P2	437687.554	7555080.918	225.373	225.994	14/11/2011	Wilson Survey Group
C032P2	439404.358	7544896.018	256.221*	256.318	21/09/2012	Wilson Survey Group
C034P1	442385.586	7547815.692	227.441	228.139	21/09/2012	Wilson Survey Group
C034P3	442388.717	7547813.986	227.384	228.138	21/09/2012	Wilson Survey Group
C035P1	441403.586	7546823.808	236.312*	236.667	21/09/2012	Wilson Survey Group
C035P2	441401.683	7546827.747	236.24*	236.568	21/09/2012	Wilson Survey Group
C555P1	432449.639	7557880.783	241.154^	241.874	11/10/2012	Wilson Survey Group
C556P1	436524.082	7549881.547	260.634	261.553	11/10/2012	Wilson Survey Group
C558P1	430311.546	7566903.059	250.054^	250.724	11/10/2012	Wilson Survey Group
C9553P1R	421010.111	7573974.87	294.114^	294.414	11/10/2012	Wilson Survey Group
HD01	426146.035	7561467.856	-	312.025	11/10/2012	Wilson Survey Group
HD02	423823	7557008	240**	241.02^^	24/10/2012	Adani Mining
HD03A	427560	7556126	TBC	TBC	3/11/2012	Adani Mining
HD03B	427559	7556122	TBC	TBC	3/11/2012	Adani Mining
C553P	420992.731	7573965.334	294.562	-	11/10/2012	Wilson Survey Group
C555P	432449.639	7557880.783	241.154	-	-	Survey TBC. C555P within 10m of C555P1. Coordinates and ground RL for C555P1
C9556PR	436542.639	7549884.872	260.398	-	11/10/2012	Wilson Survey Group
C056C	424920	7569970	283.86	-	4/11/2011	Adani Mining
C558P	430311.546	7566903.059	250.054	-	-	Survey TBC. C558P within 10m of C558P1. Coordinates and ground RL for C558P1

* denotes value taken from LiDAR
** denots value from GPS
^ denotes value calculated from pvc stickup and top of casing RL survey
^^ denotes value calculated from pvc stickup and ground RL survey
TBC - to be confirmed

GENERAL NOTES

GHD GEOTECHNICS
Specialist Services in Geotechnical Engineering, Geology, Field/Laboratory Testing and Hydrogeology
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The report contains the results of a geotechnical investigation conducted for a specific purpose and client. The results should not be used by other parties, or for other purposes, as they may contain neither adequate nor appropriate information. In particular, the investigation does not cover contamination issues unless specifically required to do so by the client.

TEST HOLE LOGGING

The information on the test hole logs (boreholes, test pits, exposures etc.) is based on a visual and tactile assessment, except at the discrete locations where test information is available (field and/or laboratory results). The test hole logs include both factual data and inferred information. Moreover, the location of test holes should be considered approximate, unless noted otherwise (refer report). Reference should also be made to the relevant standard sheets for the explanation of logging procedures (Soil and Rock Descriptions, Core Log Sheet Notes etc.).

GROUNDWATER

Unless otherwise indicated, the water levels presented on the test hole logs are the levels of free water or seepage in the test hole recorded at the given time of measuring. The actual groundwater level may differ from this recorded level depending on material permeabilities (i.e. depending on response time of the measuring instrument). Further, variations of this level could occur with time due to such effects as seasonal, environmental and tidal fluctuations or construction activities. Confirmation of groundwater levels, phreatic surfaces or piezometric pressures can only be made by appropriate instrumentation techniques and monitoring programmes.

INTERPRETATION OF RESULTS

The discussion or recommendations contained within this report normally are based on a site evaluation from discrete test hole data, often with only approximate locations (e.g. GPS). Generalised, idealised or inferred subsurface conditions (including any geotechnical cross-sections) have been assumed or prepared by interpolation and/or extrapolation of these data. As such these conditions are an interpretation and must be considered as a guide only.

CHANGE IN CONDITIONS

Local variations or anomalies in the generalised ground conditions do occur in the natural environment, particularly between discrete test hole locations. Additionally, certain design or construction procedures may have been assumed in assessing the soil-structure interaction behaviour of the site. Furthermore, conditions may change at the site from those encountered at the time of the geotechnical investigation through construction activities and constantly changing natural forces.

Any change in design, in construction methods, or in ground conditions as noted during construction, from those assumed or reported should be referred to this firm for appropriate assessment and comment.

GEOTECHNICAL VERIFICATION

Verification of the geotechnical assumptions and/or model is an integral part of the design process - investigation, construction verification, and performance monitoring. Variability is a feature of the natural environment and, in many instances, verification of soil or rock quality, or foundation levels, is required. There may be a requirement to extend foundation depths, to modify a foundation system and/or to conduct monitoring as a result of this natural variability. Allowance for verification by appropriate geotechnical personnel must be recognised and programmed for construction.

FOUNDATIONS

Where referred to in the report, the soil or rock quality, or the recommended depth of any foundation (piles, caissons, footings etc.) is an engineering estimate. The estimate is influenced, and perhaps limited, by the fieldwork method and testing carried out in connection with the site investigation, and other pertinent information as has been made available. The material quality and/or foundation depth remains, however, an estimate and therefore liable to variation. Foundation drawings, designs and specifications should provide for variations in the final depth, depending upon the ground conditions at each point of support, and allow for geotechnical verification.

CLIMATE CHANGE

GHD Geotechnics acknowledges the occurrence of ongoing climate change. Cognisance is given to climate change issues as may be applicable to specific geotechnical investigations and assessments.

REPRODUCTION OF REPORTS

Where it is desired to reproduce the information contained in our geotechnical report, or other technical information, for the inclusion in contract documents or engineering specification of the subject development, such reproductions must include at least all of the relevant test hole and test data, together with the appropriate Standard Description sheets and remarks made in the written report of a factual or descriptive nature.

Reports are the subject of copyright and shall not be reproduced either totally or in part without the express permission of GHD.

GLOSSARY OF SYMBOLS

GHD GEOTECHNICS
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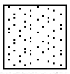
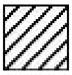
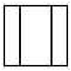
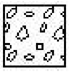
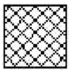
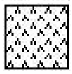
This standard sheet should be read in conjunction with all test hole log sheets and any idealised geological sections prepared for the investigation report.

GENERAL

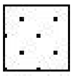
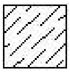
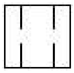
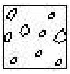
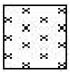
Symbol	Description	Symbol	Description
D	Disturbed Sample	PZ	Piezometer Installation
U	Undisturbed Sampled (suffixed by sample size or tube diameter in mm if applicable)	R	Rising Head Permeability Test
		F	Falling Head Permeability Test
C	Core Sample (suffixed by diameter in mm)	PBT	Plate Bearing Test
SV	Shear Vane Test (suffixed by value in kPa)	▶—	Water Inflow (make)
SPT	Standard Penetration Test (with blows per 0.15m)	—◀	Water Outflow (loss)
N	SPT Value	▽	Temporary Water Level
HB	SPT hammer bouncing	▼	Final Water Level
PM	Pressuremeter Test	●	Point Load Test (axial)
PP	Pocket Penetrometer (suffixed by value in kPa)	○	Point Load Test (diametric)
PK	Packer Test	IMP	Impression Device Test

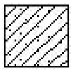
SOIL SYMBOLS

Main Components

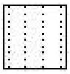
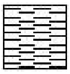
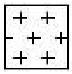
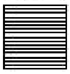
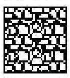
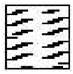
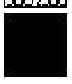
	SAND		CLAY		SILT
	GRAVEL		FILL		TOPSOIL

Minor Components

	sandy		clayey		silty
	gravelly		vegetation, roots		

Note: Natural soils are generally a combination of constituents, e.g.  sandy CLAY

ROCK SYMBOLS

Sedimentary				Igneous	
	SANDSTONE		SHALE		GRANITIC ROCK
	CLAYSTONE		CONGLOMERATE		IGNEOUS DYKE
	SILTSTONE		COAL		BASALTIC ROCK

Note: Additional rock symbols may be allocated for a particular project.

NATURAL FRACTURES (Coding)

Fracture Type

JT	Joint
BP	Bedding Plane
Cb	Cross Bed
SS	Sheared Surface
SM	Seam
CS	Crushed Seam
FZ	Fragmented Zone
SZ	Shear Zone
VN	Vein

Orientation

For vertical non-oriented core ... “Dip” angle (eg. 5°) measured relative to horizontal
For inclined non-oriented core ... “Angle” measured relative to core axis.
For inclined oriented core ... “Dip” angle and “Dip Direction” angle (eg. 45°/225° mag.)

VT	Vertical
HZ or 0°	Horizontal
d	degrees

Infilling or Coating

CN	Clean
X	Carbonaceous
CLAY	Clay
KT	Chlorite
CA	Calcite
FE	Iron Oxide
MI	Micaceous
Mn	Manganese
Py	Pyrite
QZ	Quartz
VE	Veneer

Shape

PLN	Planar
CU	Curved
UN	Undulating
ST	Stepped
IR	Irregular

Roughness

POL	Polished
SLK	Slickensided
SO	Smooth
RF	Rough
VR	Very Rough

Others

DIS	Discontinuous
OP	Open
CL	Closed
TI	Tight

Ref: DS6.5.1 Issue 1.7 Date: 20/09/2010

SOIL DESCRIPTION

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This procedure involves the description of a soil in terms of its visual and tactile properties, and relates to both laboratory samples and field exposures as applicable. A detailed soil profile description, in association with local geology and experience, will facilitate the initial (and often complete) site assessment for engineering purposes.

The method involves an evaluation of each of the items listed below and is in general agreement with both Australian Standard AS 1726 (the Site Investigation Code) and ASTM D2487 and D2488.

MOISTURE

The moisture condition of the soil is most applicable for cohesive soils as a precursor to the assessment of consistency and workability. The moisture condition is described as:-

Dry (dusty, dry to the touch) ***Slightly Moist*** ***Moist*** (damp, no visible water) ***Very Moist*** or ***Wet*** (visible free water, saturated condition)

In addition, the presence of any seepage or free water is noted on the testhole logs.

COLOUR

Colour is important for correlation of data between testholes and during subsequent excavation operations. The prominent colour is noted, followed by (spotted, mottled, streaked etc.) then secondary colours as applicable. Colour is usually described at as-received moisture condition, though both wet and dry colours may also be appropriate.

CONSISTENCY / DENSITY INDEX

This assessment is based on the effort required to penetrate and/or mould the soil, and is an indicator of shear strength.

Granular soils are generally described in terms of density index as listed in AS 1726. These soils are inherently difficult to assess and normally a penetration test procedure (SPT, DCP or CPT) is used in conjunction with published correlations. Alternatively, in-situ density tests can be conducted in association with minimum and maximum densities performed in the laboratory.

Term	Symbol	Density Index (%)
Very Loose	VL	< 15
Loose	L	15 - 35
Medium Dense	MD	35 - 65
Dense	D	65 - 85
Very Dense	VD	>85

Cohesive soils can be assessed by direct measurement (shear vane, CPT etc), or estimated approximately by tactile means and/or the aid of a geological pick as given on the following table. It is emphasised that a "design shear strength" must take cognisance of the mode of testing and the in-situ moisture content with the possible variations of moisture with time.

Term	Symbol	Tactile Properties	Undrained Strength S_u (kPa)
Very Soft	VS	Extrudes between fingers when squeezed in hand	<12
Soft	S	Easily penetrated by thumb about 30-40 mm. Pick head can be pushed in up to shaft.	12-25
Firm	F	Penetrated by thumb 20-30mm with moderate effort. Sharp end of pick pushed in 30-40mm.	25-50
Stiff	St	Indented by thumb about 5mm with moderate effort. Pick pushed in up to 10mm.	50-100
Very Stiff	VSt	Readily indented by thumb nail. Slight indentation produced by pushing pick into soil.	100-200
Hard	H	Difficult to indent with thumb nail. Requires power tools for excavation.	>200

STRUCTURE/OTHER FEATURES

The soil structure is generally applicable to cohesive soils and mainly refers to the presence or absence of joints and layering. Typical terms use are intact (no joints), fissured (closed joints), shattered (open joints), slickensided (polished joints indicative of movement), and stratified/laminated. In addition, the presence of other features (ferricrete nodules, timber inclusions) should also be noted as applicable.

For granular soils, an assessment of grading (well, uniform or poor), particle size (fine, medium etc.) and angularity and shape may also be given.

SOIL TYPE

The soil is described in terms of its estimated grain size composition and the tactile behaviour (plasticity of any fines (less than *0.06 mm)). This system does not differentiate on grading below 0.06 mm, in accordance with the Unified Soil Classification (USC) procedure.

However, in some situations a soil can exhibit different characteristics between the undisturbed and disturbed/remolded condition (eg. 'sand' sized particles which break down a clay). The Soil Type generally relates to the latter state but the former condition should be noted where applicable.

Furthermore, as most natural soils frequently are combinations of various constituents, the primary soil is described and modified by minor components. In brief, the system is as follows:-

Coarse Grained Soils		Fine Grained Soils	
% Fines	Modifier	% Coarse	Modifier
<5	omit, or use "trace"	<15	omit, or use "trace"
5-12	describe as "with clay/silt" as applicable	15-30	described as "with sand/gravel" as applicable
>12	prefix soil as "silty/clayey" as applicable	>30	prefix soil as "sandy/gravelly" as applicable

(*The 200# sieve (0.075 mm) is commonly used in practice to differentiate between fine and coarse grained soils).

Note: For soils containing both sand and gravel the minor coarse fraction is omitted if less than 15%, or described as "with sand/gravel" as applicable when greater than 15%.

The appropriate USC symbol may also be given after the soil type description in accordance with ASTM D2487 and D2488.

ORIGIN

An attempt is made, where possible, to assess origin (transported, residual, pedogenic, or fill etc.) since this assists in the judgement of probable engineering behaviour. This assessment is generally restricted to field logging activities. An interpretation of landform is a useful guide to the origin of transported soils (e.g. colluvium, talus, slide debris, slope wash, alluvium, lacustrine, estuarine, aeolian and littoral deposits) while local geology and remnant fabric will assist identification of residual soils.

Ref: DS6.5.1.1 Issue 1.6 Date: 19/11/2008

ROCK DESCRIPTION

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This method is based on Australian Standard AS 1726 and is orientated to the field logging of diamond drill core, but may be used for the profiling of natural exposures and cuttings, as applicable. The procedure involves a visual and tactile assessment of the rock mass and the nature of defects within it in order to facilitate a prediction of engineering behaviour.

DESCRIPTION: Rock Type is described on the basis of origin (sedimentary, metamorphic and igneous) with the common types listed below:-

Sedimentary				**Metamorphic**	**Igneous**				
Clastic	**Non clastic (chemical)**	**Non clastic (organic)**	**Pyroclastic**			**Acid**	**Intermediate**		**Basic**
Conglomerate Sandstone Siltstone Shale Claystone	Limestone Chert Gypsum Salt	Coal Some Limestone	Tuff Agglomerate Volcanic Breccia	Slate Phyllite Schist Quartzite Gneiss	Extrusive	Rhyolite	Trachyte	Andesite	Basalt
					Intrusive (medium grained)	Quartz Porphyry	Porphyry	Porphyrite	Dolerite
					(coarse grained)	Granite	Syenite	Diorite	Gabbro

Colour is given to assist in rock identification and the interpolation of field data. Colour is usually described at as-received moisture condition, though both wet and dry colours may also be appropriate.

Texture refers to the degree of crystallinity and granularity (grain size) and the fabric relationship between the constituents of a rock. Often only grain size is given for simplified descriptions of certain sedimentary rocks.

Structure and texture are commonly used synonymously in describing rocks since there is no clear delineation between terms. In general, structure refers to large-scale features recognisable in the field (banding, lineation, massive, porphyritic, schistose etc.). For sedimentary rocks in particular, the thickness of sedimentary layering (bedding) is described as:-

Thinly laminated	<6mm	very thinly bedded	20-60mm	medium bedded	0.2-0.6m	very thickly bedded	>2m
Laminated	6-20mm	thinly bedded	60-200mm	thickly bedded	0.6-2m		

In addition, mineral composition, hardness, alteration, cementation is given as applicable.

WEATHERING: The assignment of weathering is somewhat subjective. Weathering assists identification and does not imply engineering behaviour. No distinction is drawn between chemical weathering and alteration for most engineering purposes. These procedures are collectively described as "weathering" using the following terms which do not describe the related strength change. This system is general, and in this format may not apply to all rock types. Carbonate rocks generally do not conform to this classification.

Term	Symbol	Definition
Completely Weathered	CW	Residual soil with rock fabric not visible.
Extremely Weathered	EW	The rock exhibits soil-like properties though the texture of the original rock is still evident.
Highly Weathered	HW	Limonite staining or colour change affects the whole of the rock mass and other signs of chemical or physical decomposition are evident.
Moderately Weathered	MW	Staining extends throughout the whole of the rock mass and the original colour is no longer recognisable.
Slightly Weathered	SW	Partial staining or discolouration of the rock mass, usually by limonite, has taken place.
Fresh	Fr	Rock mass unaffected by weathering.

ESTIMATED STRENGTH: This refers to the strength of the rock substance and not that of the rock mass. The strength of the rock substance is estimated by the Point Load Strength Index $I_S(50)$ and refers to the strength measured in the direction normal to the bedding for sedimentary rocks. A field guide is given below:-

Term	Symbol	$I_S(50)$ MPa	Field Guide (The core refers to a 150mm long x 50mm dia. sample)
Extremely Low	EL	<0.03	Remoulded by hand to a material with soil properties.
Very Low	VL	0.03-0.1	May be crumbled in the hand. Sandstone is "sugary" and friable.
Low	L	0.1-0.3	The core may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.
Medium	M	0.3-1.0	The core may be broken by hand with considerable difficulty. Readily scored with knife.
High	H	1-3	The core cannot be broken by unaided hands, can be slightly scratched or scored with knife.
Very High	VH	3-10	The core may be broken readily with hand held hammer. Cannot be scratched with knife.
Extremely High	EH	>10	The core is difficult to break with hand held hammer. Rings when struck with a hammer.

DEFECTS: This important feature can control the overall engineering behaviour of a rock mass. All types of natural fractures across which the core is discontinuous are noted. These fractures include bedding plane partings, joints and other defects but exclude artificial fractures such as drilling breaks. The nature of the defects (joints, bedding partings, seams, zones and veins) is also noted with description, orientation, infilling or coating, shape, roughness, thickness, etc. given generally in accordance with AS 1726. The spacing of natural fractures excludes bedding partings unless there is evidence that they were separated prior to drilling. This notwithstanding, bedding partings maybe considered as planes of weakness in an engineering assessment.

Ref: DS6.5.2.1 Issue 1.6 Date: 04/06/2008

CORE LOG SHEET NOTES

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The intention of Core log Sheets is to present factual information measured from the core or as recorded in the field. Some interpretative information is inevitable in the location of core loss, description of weathering and identification of drilling induced fractures. This should be noted in the use of Core Log Sheets and remembered in their utilisation.

DRILLING AND CASING

The types of drilling used to advance the drill hole are recorded for relevant intervals. The types of drilling may include: NMLC coring, NQTT (NQ triple tube wire line), HW, HX, NW and NX casing, wash boring (tri-cone roller bit, TC drag bit, TC blade bit), or auger drilling (V-bit, TC drag bit).

The relevant progress is shown by abbreviated dates in the column.

WATER

Water lost or water made during drilling is recorded and subsequent readings of water levels in the borehole or piezometers are recorded here with dates of observation.

DRILL DEPTH AND CORE LOSS

Drilling intervals are shown by depth increments and horizontal marker lines. Core loss is measured as a percentage of the drill run. If the location of the core loss is known or strongly suspected, it is shown in a region of the column bounded by dashed horizontal lines. If unknown, core loss is assigned to the bottom of a coring run.

SAMPLES AND FIELD TESTS

The location of samples taken for testing or the location of field tests are indicated by the appropriate symbol from the GLOSSARY OF SYMBOLS Standard Sheet (or as applicable for the project) and are shown at the relevant location or over the relevant depth interval.

DEPTH (RL)

Changes in rock types or the locations of piezometer tips, samples, test intervals or other depths are shown as appropriate in terms of depth from the hole collar or in terms of RL.

For inclined holes the depths shown on the log refer to the drilled length along the borehole. The RL, where used, is the only transformed reference to true vertical depth.

STRATA

Rock types are presented graphically using the symbols shown on the GLOSSARY OF SYMBOLS Standard Sheet or as assigned for the project.

DESCRIPTION

The rock type is described in accordance with the ROCK DESCRIPTION Standard Sheet.

WEATHERING

Weathering is described, by code letters, in accordance with the ROCK DESCRIPTION Standard Sheet. A weathering term or range of terms is usually assigned to various strata.

It is noted, however, that the assignment of a term of weathering is subjective and is normally used for identification and does <u>not</u> imply engineering behaviour (such behaviour being controlled principally by rock substances strength and defect frequency - collectively, rock mass strength). Consequently, boundaries are often not shown and weathering may even not be reported where potentially misleading.

ESTIMATED STRENGTH

The strength of the rock substance is estimated by a combination of Point Load testing and tactile appraisal in accordance with the ROCK DESCRIPTION Standard Sheet. The estimated strength is presented in a histogram form. Both axial and diametric point load test results can be presented using the symbols on the GLOSSARY OF SYMBOLS Standard Sheet and the variation between axial and diametric values is indicative of anisotropy or fissility of the rock unit.

NATURAL FRACTURES

The identification of <u>natural</u> fractures requires an endeavour to exclude drilling induced breaks in the core and, as such, can be somewhat subjective. Natural fractures exist prior to coring the rock, whereas artificial fractures occur either during coring, during placing core in the core boxes, or during examination or transportation, or core after being boxed.

The log of Natural Fractures is presented as a combination of Fracture Spacing, Visual and Description columns. Coding is presented on the GLOSSARY OF SYMBOLS Standard Sheet.

ROCK QUALITY DESIGNATION (RQD) INDEX OPTION

The Core Log Sheet has an optional field column to record the RQD index. For certain projects, such as tunnelling or underground mining investigations, rock mass ratings or classifications can be required as part of the design process. The Rock Quality Designation (RQD) Index forms a component of these rock mass ratings and provides a quantitative estimate of rock mass quality from rock core logs. The core must be a minimum of 54.7mm diameter (although NMLC-sized core is probably OK) for derivation of an RQD index.

The RQD index is expressed as a <u>percentage of intact rock core</u> (excludes extremely weathered rock/residual soil) <u>greater than 100 mm in length over the total selected core length</u>. The total selected core length should be based on identifiable engineering geological domain characteristics. Should this not be practicable, RQD can be measured on a per run basis.

Ref: DS6.2.1 Issue 1.5 Date: 04/06/2008

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C006P1

SHEET 1 OF 2

Position : 435725.0 E 7560825.0 N	**Surface RL:** 233.7m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Dave	**Checked :**
Date Started : 24/6/11	**Date Completed :** 24/6/11	**Logged by :** MLW	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
0	Rotary Wash Boring (bit, 5 1/8 inch)	Nil						No Returns			0.0 m - 36.0 m; Tertiary		Completed with steel monument
6					6.00 (227.71)		CH	CLAY with trace sand, greenish-grey, high plasticity, fine grained sand, stiff		St			
17													50mm PVC casing, with cement-bentonite grout
23			GNO										
30													

DRAFT

See standard sheets for details of abbreviations & basis of descriptions

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C006P1

SHEET 2 OF 2

Client :	Adani Mining Pty Ltd				
Project :	Carmichael Coal Mine Project				
Location :	, EPC1690				
Position :	435725.0 E 7560825.0 N	**Surface RL:** 233.7m	**Angle from Horiz. :** 90°	**Processed :** VLD	
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Dave	**Checked :**	
Date Started :	24/6/11	**Date Completed :** 24/6/11	**Logged by :** MLW	**Date :**	

Depth / (RL) metres	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Consistency / Density Index	Comments/ Observations
	CLAY, as previous.	St	
36.00 (197.71)	SILTSTONE, pale grey, high strength, returned as Sandy GRAVEL.		36.0m - 47.3m; Permian
42.00 (191.71)	MUDSTONE, white, high plasticity, stiff, returned as Clayey SAND.	St	
47.30 (186.41)	End of borehole at 47.3 m. Piezometer Installed.		

DRILLING: Drilling Method: Rotary Wash Boring (bit, 5 1/8 inch); Hole Support \ Casing: Nil

SCALE (m): 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

PIEZOMETER – Components: Bentonite; Filter pack; Sceen; Bentonite; Backfill

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C006P3**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 1 OF 6**	
Position : 435730.0 E 7560830.0 N	**Surface RL:** 233.9m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Dave/Glen	**Checked :**
Date Started : 21/6/11	**Date Completed :** 22/6/11	**Logged by :** MLW	**Date :**

DRILLING: Drilling Method	Hole Support \ Casing	Water	Samples & Tests	MATERIAL: Depth / (RL) metres	USC Symbol	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations	PIEZOMETER: Components
Rotary Wash Boring (bit, 6 inch)	Nil	GNO			CL	CLAY, dark brown, very stiff, low plasticity.		VSt	0 m - 7.0 m; Alluvium Monitoring bore decommissioned due to suspected grout in monitoring bore.	Completed with steel monument
				3.00 (230.87)	CI-CH	CLAY with trace fine grained sand. Pale grey with pinkish-red mottling. Very stiff, medium to high plasticity.		VSt		
				7.00 (226.87)	CI-CH	CLAY, pale grey with patches of pale brown, very stiff, medium to high plasticity. From 25.0m; dark grey		VSt	7.0 m - 38.0 m; Tertiary	

SCALE (m): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

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Job No. **41-23244**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C006P3**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 2 OF 6**	
Position : 435730.0 E 7560830.0 N	**Surface RL:** 233.9m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Dave/Glen	**Checked :**
Date Started : 21/6/11	**Date Completed :** 22/6/11	**Logged by :** MLW	**Date :**

Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
Rotary Wash Boring (bit, 6 inch)	Nil						CLAY, as previous.		VSt	7.0 m - 38.0 m; Tertiary		
				38.00 (195.87)			SILTSTONE, pale grey, moderately weathered, returned as Sandy GRAVEL. From 43.0m; white with pink and dark red mottling			38.0 m - 179.0 m; Permian		
				49.00 (184.87)		CH	CLAY, white, high plasticity, very stiff. At 54 m; becoming pale brown with patches of pale grey		VSt			

SCALE (m): 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

See standard sheets for details of abbreviations & basis of descriptions	**GHD** GPO Box 668, Brisbane Qld 4001 T: 61 7 3316 3000 F: 61 7 3316 3333 E: bnemail@ghd.com CLIENTS | PEOPLE | PERFORMANCE	**Job No.** **41-23244**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd			**HOLE No. C006P3**
Project : Carmichael Coal Mine Project			
Location : , EPC1690			**SHEET 3 OF 6**
Position : 435730.0 E 7560830.0 N	**Surface RL:** 233.9m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Dave/Glen	**Checked :**
Date Started : 21/6/11	**Date Completed :** 22/6/11	**Logged by :** MLW	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
60–69	Rotary Wash Boring (bit, 6 inch)	Nil						CLAY, as previous.		VSt	38.0 m - 179.0 m; Permian		50mm PVC casing, with cement-bentonite grout
69–90					69.00 (164.87)			SILTSTONE, dark grey, trace fine grained sand, trace carbonaceous material.			C Seam (~72 m); D1 Seam (~86 m)		

Scale: 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90

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See standard sheets for details of abbreviations & basis of descriptions

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd			**HOLE No. C006P3**
Project : Carmichael Coal Mine Project			
Location : , EPC1690			**SHEET 4 OF 6**
Position : 435730.0 E 7560830.0 N	**Surface RL:** 233.9m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Dave/Glen	**Checked :**
Date Started : 21/6/11	**Date Completed :** 22/6/11	**Logged by :** MLW	**Date :**

Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
Rotary Wash Boring (bit, 6 inch)	Nil						SILTSTONE, as previous.			38.0 m - 179.0 m; Permian		
				108.00 (125.87)			COAL with silt, black to dark grey, dull.			D2 Seam D3 Seam		
				117.00 (116.87)			SILTSTONE, pale grey, trace fine grained sand, some carbonaceous material					

SCALE (m): 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C006P3

Position : 435730.0 E 7560830.0 N		**Surface RL:** 233.9m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000	**Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Dave/Glen	**Checked :**
Date Started : 21/6/11		**Date Completed :** 22/6/11	**Logged by :** MLW	**Date :**

Depth / (RL) metres	Graphic Log	Description	Comments/ Observations
	Siltstone	SILTSTONE, as previous.	38.0 m - 179.0 m; Permian
122.00 (111.87)	Coal	COAL,dark grey/black, dull	E Seam
123.00 (110.87)	Siltstone	SILTSTONE, pale grey, trace fine grained sand, some carbonaceous material	
128.00 (105.87)	Coal	COAL,dark grey/black, dull	F Seam
130.00 (103.87)	Siltstone	SILTSTONE with some COAL, pale grey. Returning as clayey SILT with some coal	
132.00 (101.87)	Coal	COAL, dark grey/black, dull	
133.00 (100.87)	Siltstone	SILTSTONE with some COAL, pale grey. Returning as clayey SILT with some coal	
134.00 (99.87)	Coal	COAL,dark grey/black, dull	
136.00 (97.87)	Siltstone	SILTSTONE with some COAL, pale grey. Returning as clayey SILT with some coal	
147.00 (86.87)	Coal	COAL,dark grey/black, dull	
149.00 (84.87)	Siltstone	SILTSTONE with some COAL, pale grey. Returning as clayey	

Drilling Method: Rotary Wash Boring (bit, 6 inch)
Hole Support \ Casing: Nil
Water:
Samples & Tests:
USC Symbol:
Moisture Condition:
Consistency / Density Index:

Scale (m): 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150

Piezometer Components: Bentonite (approx. 125.5–127.5 m); Filter pack; Screen (approx. 128–136.8 m); End cap; Bentonite (approx. 137.5–138.5 m); Back fill

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See standard sheets for details of abbreviations & basis of descriptions

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C006P3

Position : 435730.0 E 7560830.0 N		**Surface RL:** 233.9m		**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000	**Mounting:** Truck	**Contractor :** Watson Drilling		**Driller :** Dave/Glen	**Checked :**
Date Started : 21/6/11		**Date Completed :** 22/6/11		**Logged by :** MLW	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
152–154	Rotary Wash Boring (bit, 6 inch)	Nil						SILT with some coal SILTSTONE with some COAL, as previous.			38.0 m - 179.0 m; Permian		
155					155.00 (78.87)			COAL,dark grey/black, dull					
156–178					156.00 (77.87)			SILTSTONE with some COAL, pale grey. Returning as clayey SILT with some coal					Back fill Cave in
179–180					179.00 (54.87)			End of borehole at 179 m. Piezometer Installed.					

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Job No. **41-23244**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 7/11/12

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C006P3r

SHEET 1 OF 4

Position : 435727.0 E 7560835.0 N	**Surface RL:** 233.9m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Snickers	**Checked :**
Date Started : 11/7/11	**Date Completed :** 11/7/11	**Logged by :** MLW	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
0	Rotary Wash Boring (bit, 6 inch)	Nil	GNO					Silty CLAY, dark brown (TOPSOIL)			0 m - 6.0 m; Alluvium		Completed with steel monument
					1.00 (232.87)			CLAY, dark reddish-brown, trace fine grained sand, soft		S			
2													
4													
6					6.00 (227.87)			CLAY, grey with dark red mottling, stiff From 7.0m; greenish-grey with trace brown streaks, trace carbonaceous material		St	6.0 m - 36.0 m; Tertiary		
8													
10													
12													
14													
16													
18													
20													
22													
24													
26								From 26.0m; grey, very stiff		VSt			
28													
30													

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Job No. 41-23244

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 7/11/12

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C006P3r

Position : 435727.0 E 7560835.0 N		**Surface RL:** 233.9m		**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000	**Mounting:** Truck	**Contractor :** Watson Drilling		**Driller :** Snickers	**Checked :**
Date Started : 11/7/11		**Date Completed :** 11/7/11		**Logged by :** MLW	**Date :**

DRILLING: SCALE (m) 32–60; Drilling Method: Rotary Wash Boring (bit, 6 inch); Hole Support \ Casing: Nil; Water; Samples & Tests

Depth / (RL) metres	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations
	CLAY, as previous		St	6.0 m - 36.0 m; Tertiary
36.00 (197.87)	SILTSTONE, pale grey-white, very low strength, returned as Clayey SILT, stiff			36.0 m - 118.4 m; Permian
40.00 (193.87)	SILTSTONE AND MUDSTONE, interbedded, SILTSTONE; pale greyish-white, very low strength, MUDSTONE; orange, high strength			
43.00 (190.87)	SILTSTONE, pale grey-white, very low strength, returned as Clayey SILT, stiff			
46.00 (187.87)	CLAYSTONE, white, returned as silty CLAY, firm From 51.0m; pale grey with dark red and brown mottling. Becoming stiff			
52.00 (181.87)	SILTSTONE AND CLAYSTONE, interbedded, pale grey and dark orange, returned as clayey SILT/Silty CLAY, firm to stiff, trace dark red staining			
55.00 (178.87)	CLAYSTONE, orange-brown with some patches or dark red, low to medium strength			

PIEZOMETER: Components: 50mm PVC casing, with cement-bentonite grout

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C006P3r

Position : 435727.0 E 7560835.0 N	**Surface RL:** 233.9m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Snickers	**Checked :**
Date Started : 11/7/11	**Date Completed :** 11/7/11	**Logged by :** MLW	**Date :**

DRILLING: Drilling Method: Rotary Wash Boring (bit, 6 inch); Hole Support \ Casing: Nil; Water; Samples & Tests

Depth / (RL) metres	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations
	From 60.0m; becoming orange with grey mottling			36.0 m - 118.4 m; Tertiary
	From 63.0m; pale white-grey			
	From 66.0m; pale brown			
67.00 (166.87)	CARBONACEOUS MUDSTONE, dark grey and black, returned as carbonaceous clay, firm			
72.00 (161.87)	COAL AND MUDSTONE, interbedded, dark grey and black, returned as clay (60%) with coal (40%), coal very weak			C Seam
83.00 (150.87)	CARBONACEOUS MUDSTONE, dark grey with patches of black, returned as CLAY, very stiff			
87.00 (146.87)	CARBONACEOUS MUDSTONE AND COAL, interbedded, dark grey and black, returned as clay (70%) and coal (30%)			D1 Seam
90.00				

SCALE (m): 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90

PIEZOMETER: Piezometer Log; Components

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C006P3r

Position : 435727.0 E 7560835.0 N		**Surface RL:** 233.9m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000	**Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Snickers	**Checked :**
Date Started : 11/7/11		**Date Completed :** 11/7/11	**Logged by :** MLW	**Date :**

Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Components
Rotary Wash Boring (bit, 6 inch)	Nil			(143.87)			COAL, black, vitreous with some dull surfaces			36.0 m - 118.4 m; Permian	
				93.00 (140.87)			CARBONACEOUS MUDSTONE AND COAL, interbedded, dark grey and black, returned as clay (70%) and coal (30%)				
				95.00 (138.87)			SILTSTONE, dark grey, trace fine grained sand, trace carbonaceous material From 98.0 m - 99.0 m; pale grey				Bentonite
				108.00 (125.87)			COAL, black, vitreous			D2 Seam	
				111.00 (122.87)			SILTSTONE, pale grey, trace fine grained sand, some carbonaceous material				
				112.00 (121.87)			COAL, black, vitreous			D3 Seam	Filter pack Screen End cap Hole Collapse
				118.40 (115.47)			End of borehole at 119.4 m. Piezometer Installed.				

Scale (m): 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120

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Job No. 41-23244

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C007P2

Position : 434731.0 E 7559864.0 N	**Surface RL:** 238.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 3/7/11	**Date Completed :** 4/7/11	**Logged by :** MP	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
0–1	Air Hammer (bit, 5 1/8 inch) (0–5 m)	Nil					OL/ OH	Sandy SILT, medium plasticity, orange-brown, fine to medium grained sand, fine to medium sub-rounded to subangular lithic gravel. (TOPSOIL)			0.0 m - 36.5 m; Tertiary		Completed with steel monument
1–30	Rotary Wash Boring (bit, 5 1/8 inch) (from 5 m)		GNO		1.00 (237.11)		CI	CLAY, medium plasticity, grey, significant red mottling/streaking, trace iron nodules, fine grained sand (<10%), trace medium to coarse grained sand, stiff to very stiff. (Completley weathered CLAYSTONE) From 6.0 m; trace red/orange mottling, trace dark grey carbonaceous clay. From 7.0 m; no iron nodules.		St-VSt			
20								From 20.0 m; decrease in orange mottling, increase in strength with depth (very stiff).		VSt			
27								From 27.0 m; little to no orange mottling, increase in strength with depth (very stiff to hard).		VSt to H			

Scale marks: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

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Job No. 41-23244

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd			**HOLE No. C007P2**
Project : Carmichael Coal Mine Project			
Location : , EPC1690			**SHEET 2 OF 7**
Position : 434731.0 E 7559864.0 N	**Surface RL:** 238.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 3/7/11	**Date Completed :** 4/7/11	**Logged by :** MP	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
32–36	Rotary Wash Boring (bit, 5 1/8 inch)	Nil						CLAY, as previous.		St-VSt	0.0 m - 36.5 m; Tertiary. Inferred from reinterpretation of geology.		
36–46					36.50 (201.61)			SANDSTONE, grey, yellow/orange/red staining, fine grained sand, trace medium grained sand, high quartz sand content, matrix supported, brittle (chips into small shards at <5mm), highly weathered. From 38.0 m; slightly weathered, slight increase in strength with depth.			36.5 m - 128.5 m; Rewan Fmn. Inferred from reinterpretation of geology.		
46–60					46.00 (192.11)			CLAYSTONE, pale grey, orange/red/dark red mottling/staining, trace iron nodules, fine grained sand, friable. From 48.5 m (approx); complete dark red staining of sediments, iron nodules (<1mm). From 51.0 m; grey with orange/yellow mottling, trace red mottling. From 55.0 m (approx); orange-brown, decrease in sand content to trace fine and medium grained sand.					

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C007P2

Position : 434731.0 E 7559864.0 N		**Surface RL:** 238.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000	**Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 3/7/11	**Date Completed :** 4/7/11		**Logged by :** MP	**Date :**

DRILLING: Drilling Method	Hole Support \ Casing	Water	Samples & Tests	MATERIAL: Depth / (RL) metres	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations	PIEZOMETER: Components
Rotary Wash Boring (bit, 5 1/8 inch)	Nil				CLAYSTONE, as previous.			36.5 m - 128.5 m; Rewan Fmn. Inferred from reinterpretation of geology.	
				69.00 (169.11)	SANDSTONE, yellow-brown, orange mottling, very fine to fine grained sand, trace medium grained sand, matrix supported.				
				77.00 (161.11)	CLAYSTONE, pale grey, trace orange/red mottling, trace fine to medium grained sand.				
				78.00 (160.11)	SANDSTONE, grey, heavily stained orange/red/brown, fine grained sand, trace medium grained sand.				50mm PVC casing, with cement-bentonite grout
				82.50 (155.61)	SILTSTONE, medium plasticity, yellow/orange/brown, trace fine grained sand. From 83.0 m (approx); grey, high plasticity, trace fine to medium sand, slight increase in strength with depth.				
				88.50 (149.61)	SANDSTONE, grey, medium plasticity fines, fine to medium grained sand, matrix				

SCALE (m): 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd			**HOLE No. C007P2**
Project : Carmichael Coal Mine Project			
Location : , EPC1690			
Position : 434731.0 E 7559864.0 N	**Surface RL:** 238.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 3/7/11	**Date Completed :** 4/7/11	**Logged by :** MP	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
90–95	Rotary Wash Boring (bit, 5 1/8 inch)	Nil						supported. SANDSTONE, as previous.			36.5 m - 128.5 m; Rewan Fmn. Inferred from reinterpretation of geology.		
95–120					95.00 (143.11)			SILTSTONE and SANDSTONE, interbedded . SANDSTONE (predominantly); grey, fine to medium grained sand, matrix SILTSTONE; grey, trace fine grained sand.					

Scale marks: 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C007P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 5 OF 7**	
Position : 434731.0 E 7559864.0 N	**Surface RL:** 238.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 3/7/11	**Date Completed :** 4/7/11	**Logged by :** MP	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Rotary Wash Boring (bit, 5 1/8 inch)	Nil						SILTSTONE and SANDSTONE interbedded, as previous.			36.5 m - 128.5 m; Rewan Fmn. Inferred from reinterpretation of geology.		
122													
124													
126													
128											128.5 m - 179.5 m; Permian. Inferred from reinterpretation of geology.		
130													
132													
134													
136													
138													
140													
142													
144													
146													
148													
150													

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C007P2

Position : 434731.0 E 7559864.0 N	**Surface RL:** 238.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 3/7/11	**Date Completed :** 4/7/11	**Logged by :** MP	**Date :**

Drilling Method: Rotary Wash Boring (bit, 5 1/8 inch)

Hole Support \ Casing: Nil

Depth / (RL) metres	Description	Comments/ Observations	Piezometer Components
	SILTSTONE and SANDSTONE interbedded, as previous.	128.5 m - 179.5 m; Permian. Inferred from reinterpretation of geology.	
161.00 (77.11)	COAL, black.		Bentonite
	From 165 to 167 m; interbedded with SILTSTONE, grey, trace fine grained sand.		
	From 167 to 169m; increase in SILTSTONE material (50% / 50%).	AB1, AB2, AB3 Seams	Filter pack
			Screen
	From 171 to 173 m; interbedded COAL and SILTSTONE (50% / 50%).		
	From 176 to 177 m; interbedded COAL and SILTSTONE (50% / 50%).		End cap
			Bentonite
178.00 (60.11)	SANDSTONE, dark grey, fine grained sand, trace medium grained sand, matrix supported.		Sand Backfill
179.50 (58.61)			

Scale (m): 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C007P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 7 OF 7**	
Position : 434731.0 E 7559864.0 N	**Surface RL:** 238.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 3/7/11	**Date Completed :** 4/7/11	**Logged by :** MP	**Date :**

DRILLING					MATERIAL							PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	**Description** SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	**Comments/ Observations**	Piezometer Log	**Components**
								End of borehole at 179.5 m. Piezometer installed.					
182													
184													
186													
188													
190													
192													
194													
196													
198													
200													
202													
204													
206													
208													
210													

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Job No. **41-23244**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C007P3

Position : 434729.0 E 7559864.0 N		**Surface RL:** 238.1m		**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000	**Mounting:** Truck	**Contractor :** Watson Drilling		**Driller :** Ryan	**Checked :**
Date Started : 29/6/11		**Date Completed :** 30/6/11		**Logged by :** MLW	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
0 – 3.00	Rotary Wash Boring	PVC casing 150mm					SP-SM	SANDY SILT, brown, some rootlets, dry (TOPSOIL) From 2.0m; pale brown	D		0.0 m - 37.0 m; Tertiary		Completed with steel monument Gypset 30 plug
3.00 – 30			GNO (at ~21.5 m)		3.00 (235.12)			Silty CLAY, dark red with pale brown mottling, very stiff, dry, high plasticity	D	VSt			

Scale marks: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

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Job No. **41-23244**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C007P3

Position : 434729.0 E 7559864.0 N		**Surface RL:** 238.1m		**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000	**Mounting:** Truck	**Contractor :** Watson Drilling		**Driller :** Ryan	**Checked :**
Date Started : 29/6/11		**Date Completed :** 30/6/11		**Logged by :** MLW	**Date :**

DRILLING: Drilling Method	Hole Support \ Casing	Water	Samples & Tests	MATERIAL: Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	PIEZOMETER: Piezometer Log	Components
Rotary Wash Boring	PVC casing 150mm						Silty CLAY, as previous	D	VSt	0.0 m - 37.0 m; Tertiary		
				37.00 (201.12)			Clayey Silty SAND, pale grey/white			37.0 m - 129.0 m; Rewan Fmn		
				46.00 (192.12)			Sandy CLAY, dark red with pale grey mottling, stiff, high plasticity From 58.0 m; pale grey with dark red mottling		St			← 150 mm PVC casing hole support
				52.00 (186.12)			RESIDUAL CLAY, orange-brown, high plasticity, stiff, (MUDSTONE) completley weathered.		St			

SCALE (m): 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

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Job No. 41-23244

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C007P3**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 3 OF 9**	
Position : 434729.0 E 7559864.0 N	**Surface RL:** 238.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 29/6/11	**Date Completed :** 30/6/11	**Logged by :** MLW	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
62–82	Rotary Wash Boring	PVC casing 150mm						CLAY, as previous From 72.0 m; reddish - brown		St	37.0 m - 129.0 m; Rewan Fmn		
84–90					83.00 (155.12)			MUDSTONE, dark greenish-grey, returned as CLAY, high plasticity					
					90.00								

Client : Adani Mining Pty Ltd		**HOLE No. C007P3**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 4 OF 9**	
Position : 434729.0 E 7559864.0 N	**Surface RL:** 238.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 29/6/11	**Date Completed :** 30/6/11	**Logged by :** MLW	**Date :**

Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
Rotary Wash Boring	PVC casing 150mm (to 96.0)			(148.12)			SANDSTONE, pale greenish-grey, fine grained			37.0 m - 129.0 m; Rewan Fmn		
	Nil			97.00 (141.12)			MUDSTONE, dark grey. Returned as CLAY, high plasticity					
				110.00 (128.12)			SANDSTONE, pale brownish-grey, fine grained					
				117.00 (121.12)			MUDSTONE, dark grey. Returned as CLAY, high plasticity, slightly weathered					

Scale (m): 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120

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Job No. 41-23244

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C007P3**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 5 OF 9**	
Position : 434729.0 E 7559864.0 N	**Surface RL:** 238.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 29/6/11	**Date Completed :** 30/6/11	**Logged by :** MLW	**Date :**

DRILLING					MATERIAL							PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	**Description** SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	**Comments/ Observations**	Piezometer Log	**Components**
122	Rotary Wash Boring	Nil						MUDSTONE, as previous			37.0 m - 129.0 m; Rewan Fmn		
124													
126													50mm PVC casing, with cement-bentonite grout
128													
					129.00 (109.12)			SANDSTONE, pale grey, fine grained. Very high strength			129.0 m - 259.2 m; Permian		
130													
132													
134													
136													
138													
140													
142													
144													
146													
148													
150													

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Job No. **41-23244**

Client : Adani Mining Pty Ltd		**HOLE No. C007P3**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 6 OF 9**	
Position : 434729.0 E 7559864.0 N	**Surface RL:** 238.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 29/6/11	**Date Completed :** 30/6/11	**Logged by :** MLW	**Date :**

Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
Rotary Wash Boring	Nil						SANDSTONE, as previous			129.0 m - 259.2 m; Permian		
				161.00 (77.12)			COAL, dark grey to black, dull			AB 1 Seam		
				178.00 (60.12)			SANDSTONE and Carbonaceous MUDSTONE, interbedded, pale grey with patches of dark grey					

SCALE (m): 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd			**HOLE No. C007P3**
Project : Carmichael Coal Mine Project			
Location : , EPC1690			
Position : 434729.0 E 7559864.0 N	**Surface RL:** 238.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 29/6/11	**Date Completed :** 30/6/11	**Logged by :** MLW	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
182–196	Rotary Wash Boring	Nil						SANDSTONE and Carbonaceous MUDSTONE, interbedded, as previous			129.0 m - 259.2 m; Permian		
196–200					196.00 (42.12)			COAL, black to dark grey, dull			C Seam		
200–210					200.00 (38.12)			CARBONACEOUS MUDSTONE, dark grey					

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Job No. **41-23244**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C007P3**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 8 OF 9**	
Position : 434729.0 E 7559864.0 N	**Surface RL:** 238.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 29/6/11	**Date Completed :** 30/6/11	**Logged by :** MLW	**Date :**

DRILLING				MATERIAL						Comments/ Observations	PIEZOMETER
Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index		Components
Rotary Wash Boring	Nil						CARBONACEOUS MUDSTONE, as previous			129.0 m - 259.2 m; Permian	
				212.00 (26.12)			COAL, black, dull				
				213.00 (25.12)			CARBONACEOUS MUDSTONE, dark grey				
				222.00 (16.12)			COAL, dark grey to black, dull			D1 Seam	

SCALE (m): 212, 214, 216, 218, 220, 222, 224, 226, 228, 230, 232, 234, 236, 238, 240

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C007P3**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 9 OF 9**	
Position : 434729.0 E 7559864.0 N	**Surface RL:** 238.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 29/6/11	**Date Completed :** 30/6/11	**Logged by :** MLW	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Rotary Wash Boring	Nil						COAL, as previous.			129.0 m - 259.2 m; Permian		
242					242.00 (-3.88)			CARBONACEOUS MUDSTONE, dark grey					
244													
246													
248													
250													
252					252.00 (-13.88)			COAL, black, dull					Bentonite
254											D2 Seam		
256													Filter pack Screen
258					259.20 (-21.08)								End cap
260													
262													
264													
266													
268													
270													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C008P1

SHEET 1 OF 2

Position : 433713.0 E 7558829.0 N	**Surface RL:** 238.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Snickers	**Checked :**
Date Started : 14/7/11	**Date Completed :** 15/7/11	**Logged by :** MLW	**Date :**

DRILLING: SCALE (m) | Drilling Method | Hole Support \ Casing | Water | Samples & Tests

MATERIAL: Depth / (RL) metres | Graphic Log | USC Symbol | Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength) | Moisture Condition | Consistency / Density Index

Comments/ Observations

PIEZOMETER: Piezometer Log | Components

Drilling Method (0–30 m): Air Hammer (bit, 6 inch)
Hole Support \ Casing: Nil
Water: GNO

Depth / (RL) metres	USC Symbol	Description	Moisture Condition	Consistency / Density Index	Comments/ Observations
0.00	MI	Clayey SILT, dark orange, dry, trace organic material	D		0.0 m - 29.0 m; Tertiary
2.00 (236.14)	CL	Silty CLAY with trace sand, pale brown, low plasticity, fine grained sand, trace, fine to medium grained iron nodules.			
3.00 (235.14)	SC	Clayey SAND, pale grey, fine grained.			
5.00 (233.14)		SILTSTONE, pale grey, high strength, some veins of carbonaceous material, dry, slightly weathered.	D		
8.00 (230.14)		CLAY, brown and pale grey, low to medium plasticity, dry, very stiff, rock structure observed (pre-consolidated MUDSTONE, TERTIARY SEDIMENTS)			
					29.0 m - 56.0 m; Rewan Fmn.

Scale (m): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

Piezometer components:
- Completed with steel monument (0 m)
- 50mm PVC casing, with cement-bentonite grout (approx. 23 m)

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

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Client : Adani Mining Pty Ltd		**HOLE No. C008P1**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 2 OF 2**	
Position : 433713.0 E 7558829.0 N	**Surface RL:** 238.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Snickers	**Checked :**
Date Started : 14/7/11	**Date Completed :** 15/7/11	**Logged by :** MLW	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
32–46	Air Hammer (bit, 6 inch)	Nil						CLAY, as previous.			Inferred from reinterpretation of geology.		
47–57					47.00 (191.14)			SILTSTONE, pale grey-brown, trace fine grained sand.					Bentonite; Filter pack; Screen; End cap
58–60					57.50 (180.64)			End of borehole at 57.5 m. Piezometer installed.					

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Job No. **41-23244**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C008P2

Position : 433711.0 E 7558827.0 N	**Surface RL:** 238.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Snickers/ Dave	**Checked :**
Date Started : 15/7/11	**Date Completed :** 17/7/11	**Logged by :** MLW	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
0–4	Rotary Wash Boring (bit, 6 inch)	PVC casing 150mm					CI	Silty CLAY, yellow-brown, high plasticity, soft, trace sand and gravel, sand fine to medium grained, gravel of ironstone.		S	0.0 m - 29.0 m; Tertiary		Completed with steel monument
4–6					4.00 (234.12)			SILTSTONE, dark grey, some orange staining, returned as Clayey GRAVEL					
6–29			GNO		6.00 (232.12)		CH	CLAY, pale greenish-grey with some orange-brown staining, stiff, high plasticity, trace fine grained sand From 15.0 to 17.0m; Increase in orange-brown staining.		St			150 mm PVC casing hole support
29–30					29.00 (209.12)		CH	CLAY, dark greenish-grey, stiff to very stiff, high plasticity		ST - VSt	29.0 m- 212.0 m; Rewan Fmn		

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Job No. 41-23244

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C008P2

Position : 433711.0 E 7558827.0 N	**Surface RL:** 238.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Snickers/ Dave	**Checked :**
Date Started : 15/7/11	**Date Completed :** 17/7/11	**Logged by :** MLW	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
30–34	Rotary Wash Boring (bit, 6 inch)	PVC casing 150mm						From 34.0m; pale grey		ST - VSt			
36–44								From 36.0m; dark purple-grey From 39.0 - 40.0m; Colour change to pale grey					
45–52					45.00 (193.12)		CH	CLAY with ironstone, pinkish-red with patches of pale grey, firm, medium to high plasticity, fine to coarse nodules of ironstone From 48.0m; dark red with some white patches. From 49.0 to 51.0m; white with patches of dark red		F			
52–60					52.00 (186.12)			SILTSTONE, dark red with trace patches of pale grey, returned as Clayey SILT, extremely low strength. From 55.0m; yellow-brown					

Scale marks: 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

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Client :	Adani Mining Pty Ltd				**HOLE No. C008P2**		
Project :	Carmichael Coal Mine Project						
Location :	, EPC1690				**SHEET 3 OF 10**		
Position :	433711.0 E 7558827.0 N	**Surface RL:**	238.1m	**Angle from Horiz. :** 90°		**Processed :**	VLD
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :**	Watson Drilling	**Driller :** Snickers/ Dave		**Checked :**	
Date Started :	15/7/11	**Date Completed :**	17/7/11	**Logged by :** MLW		**Date :**	

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Rotary Wash Boring (bit, 6 inch)							SILTSTONE, as previous			29.0 m- 212.0 m; Rewan Fmn		
62													
64													
66													
68													
70													
72								From 73.0m; grey-brown					
74													
76								From 77.0m; pale brown					
78								From 79.0m; bluish-grey					
80													
82													
84													
86													
88													
90													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd			**HOLE No. C008P2**	
Project : Carmichael Coal Mine Project				
Location : , EPC1690			**SHEET 4 OF 10**	
Position : 433711.0 E 7558827.0 N	**Surface RL:** 238.1m		**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling		**Driller :** Snickers/ Dave	**Checked :**
Date Started : 15/7/11	**Date Completed :** 17/7/11		**Logged by :** MLW	**Date :**

DRILLING					MATERIAL							PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	**Description** SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	**Comments/ Observations**	Piezometer Log	**Components**
	Rotary Wash Boring (bit, 6 inch)							SILTSTONE, as previous			29.0 m- 212.0 m; Rewan Fmn		
92													
94													
96													
98													
100													
102													
104													
106													
108													
110													
112													
114													
116													
118													
120													

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Client :	Adani Mining Pty Ltd			**HOLE No. C008P2**	
Project :	Carmichael Coal Mine Project				
Location :	, EPC1690			**SHEET 5 OF 10**	
Position :	433711.0 E 7558827.0 N	**Surface RL:** 238.1m	**Angle from Horiz. :** 90°	**Processed :** VLD	
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Snickers/ Dave	**Checked :**	
Date Started :	15/7/11	**Date Completed :** 17/7/11	**Logged by :** MLW	**Date :**	

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Rotary Wash Boring (bit, 6 inch)							SILTSTONE, as previous			29.0 m- 212.0 m; Rewan Fmn		
122													
124													
126													
128								From 128.0 to 144.0m; Increased clay content					
130													50mm PVC casing, with cement-bentonite grout
132													
134													
136													
138													
140													
142													
144													
146													
148													
150													

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Client : Adani Mining Pty Ltd			**HOLE No. C008P2**
Project : Carmichael Coal Mine Project			
Location : , EPC1690			**SHEET 6 OF 10**
Position : 433711.0 E 7558827.0 N	**Surface RL:** 238.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Snickers/ Dave	**Checked :**
Date Started : 15/7/11	**Date Completed :** 17/7/11	**Logged by :** MLW	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
152	Rotary Wash Boring (bit, 6 inch)							SILTSTONE, as previous			29.0 m- 212.0 m; Rewan Fmn		
154													
156													
158													
160													
162													
164													
166													
168													
170													
172													
174													
176													
178					178.00 (60.12)			SILTSTONE and SANDSTONE interbedded, blue-grey, very fine- to fine-grained sandstone, low					
180													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd			**HOLE No. C008P2**	
Project : Carmichael Coal Mine Project				
Location : , EPC1690			**SHEET 7 OF 10**	
Position : 433711.0 E 7558827.0 N	**Surface RL:** 238.1m		**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling		**Driller :** Snickers/ Dave	**Checked :**
Date Started : 15/7/11	**Date Completed :** 17/7/11		**Logged by :** MLW	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Rotary Wash Boring (bit, 6 inch)							strength, 70% SILTSTONE 30% SANDSTONE, returned as Sandy Clayey SILT. SILTSTONE and SANDSTONE interbedded, as previous.			29.0 m- 212.0 m; Rewan Fmn		
182													
184													
186													
188													
190													
192													
194													
196													
198													
200								From 201.0 - 202.0m; purple-grey					
202								From 203.0 to 205.0m; pale grey, increased sandstone content (50% siltstone, 50% sandstone).					
204													
206													
208													
210					210.00								

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Job No. **41-23244**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd			**HOLE No. C008P2**	
Project : Carmichael Coal Mine Project				
Location : , EPC1690			**SHEET 8 OF 10**	
Position : 433711.0 E 7558827.0 N	**Surface RL:** 238.1m		**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling		**Driller :** Snickers/ Dave	**Checked :**
Date Started : 15/7/11	**Date Completed :** 17/7/11		**Logged by :** MLW	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Rotary Wash Boring (bit, 6 inch)				(28.12)			SANDSTONE, pale blue-grey, very fine to fine grained, low strength, returned as Silty SAND.					
212					212.00 (26.12)			SILTSTONE, pale grey, lenses of sandstone, very fine to fine grained, low strength.			212.0 m - 271.5m; Permian		
214													
216													
218													
220													
222													
224													
226													
					227.00 (11.12)			SANDSTONE, pale grey, very fine to fine grained, matrix supported, low strength.					
228					228.00 (10.12)			SILTSTONE, pale grey, lenses of sandstone, very fine to fine grained, low strength.					
230													
232													
234					234.50 (3.62)			SANDSTONE, pale grey, very fine to fine grained, matrix supported, low strength.					
					235.50 (2.62)			SILTSTONE, pale grey, lenses of sandstone, very fine- to fine-grained, low strength					
236													
238													
240													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd			**HOLE No. C008P2**
Project : Carmichael Coal Mine Project			
Location : , EPC1690			**SHEET 9 OF 10**
Position : 433711.0 E 7558827.0 N	**Surface RL:** 238.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Snickers/ Dave	**Checked :**
Date Started : 15/7/11	**Date Completed :** 17/7/11	**Logged by :** MLW	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
242–244	Rotary Wash Boring (bit, 6 inch)							SILTSTONE, as previous			212.0 m - 271.5m; Permian		
246–252					245.00 (-6.88)			SANDSTONE and SILTSTONE interbedded , pale grey, very fine to fine grained, matrix supported sandstone, very low strength (50/50) From 247.0m; increased siltstone content (80%)					
254–270					254.00 (-15.88)			COAL, black, vitreous surfaces.			AB Seam		Bentonite; Filter pack; Screen

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd			**HOLE No. C008P2**	
Project : Carmichael Coal Mine Project				
Location : , EPC1690			**SHEET 10 OF 10**	
Position : 433711.0 E 7558827.0 N	**Surface RL:** 238.1m	**Angle from Horiz. :** 90°		**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Snickers/ Dave		**Checked :**
Date Started : 15/7/11	**Date Completed :** 17/7/11	**Logged by :** MLW		**Date :**

DRILLING					MATERIAL							PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	**Description** SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	**Comments/ Observations**	Piezometer Log	**Components**
					271.50			COAL, as previous.					End cap Backfill
272					(-33.38)			End of borehole at 271.5 m. Piezometer installed.					
274													
276													
278													
280													
282													
284													
286													
288													
290													
292													
294													
296													
298													
300													

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C011P1**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 1 OF 2**	
Position : 428839.0 E 7569952.0 N	**Surface RL:** 254.5m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Dave	**Checked :**
Date Started : 21/7/11	**Date Completed :** 22/7/11	**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Components
0–2	Air Hammer (bit,6 1/2 inch)	Nil				GP-GM	Silty GRAVEL, orange-brown, trace pale brown clay, fine gravel, orange-brown, fine grained sandstone, some fine to medium grained quartz sand.			0.0 m - 2.0 m; Alluvium	Completed with steel monument
2–6					2.00 (252.46)		Silty SANDSTONE, orange-brown and pale grey-green mottled, fine grained sand, highly to extremely weathered. Returning as Clayey SAND. From 4.0 m; pale green-grey with some red.			2.0 m - 24.0 m; Tertiary	
6–24					6.00 (248.46)		Carbonaceous SILTSTONE, pale green-brown, black flecks (carbonaceous material), trace fine grained sand. Some carbonaceous mudstone, pale green-brown, black flecks (carbonaceous material). Highly weathered. From 17.0 to 20.0 m; trace iron staining From 20.0 to 24.0 m; green-grey.				50mm PVC casing, with cement-bentonite grout
24–30			GNO		24.00 (230.46)		SANDSTONE and SILTSTONE interbedded, SANDSTONE; pale green and white, medium grained sand, matrix supported (clay), extremely weathered. SILTSTONE; pale pink-white (leached), trace pink tabular flecks, distinctly weathered.			24.0 m - 55.0 m; Permian	

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C011P1

Position : 428839.0 E 7569952.0 N | **Surface RL:** 254.5m | **Angle from Horiz. :** 90° | **Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck | **Contractor :** Watson Drilling | **Driller :** Dave | **Checked :**
Date Started : 21/7/11 | **Date Completed :** 22/7/11 | **Logged by :** RB | **Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Air Hammer (bit,6 1/2 inch)	Nil						SANDSTONE and SILTSTONE interbedded, as previous.					
32					32.00 (222.46)			SANDSTONE, pink, pale pink/orange/white mottling, medium grained sand, predominately quartz and carbonaceous material (black), matrix supported (clay), extremely weathered. From 33.0 to 35.0 m; fine grained sand.					
38					38.50 (215.96)			SANDSTONE, orange-brown, fine to medium grained sand, predominately quartz and contains specks of carbonaceous material (black), grain supported, trace clay, extremely weathered, crumbles between the fingers.					Bentonite; Filter pack; Screen
55					55.00 (199.46)			End of borehole at 55.0 m. Piezometer installed.					End cap

SCALE: 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C011P3

Position : 428845.0 E 7569950.0 N	**Surface RL:** 254.4m		**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000	**Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Dave/ Troy	**Checked :**
Date Started : 22/7/11	**Date Completed :** 22/7/11		**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Components
0	Rotary Wash Boring (bit, 6 inch)	Nil				Silty GRAVEL, orange-brown, trace pale brown clay, fine gravel, orange-brown, fine grained sandstone, some fine to medium grained quartz sand.			0.0 m - 2.0 m; Alluvium	Completed with steel monument
2					2.00 (252.40)	Silty SANDSTONE, orange-brown and pale grey-green mottled, fine grained sand, highly to extremely weathered. Returning as Clayey SAND. From 4.0 m; pale green-grey with some red.			2.0 m - 24.0 m; Tertiary	
6					6.00 (248.40)	Carbonaceous SILTSTONE, pale green-brown, black flecks (carbonaceous material), trace fine grained sand. Some carbonaceous mudstone, pale green-brown, black flecks (carbonaceous material). Highly weathered. From 17.0 to 20.0 m; trace iron staining. From 20.0 to 24.0 m; green-grey.				
24			GNO (28 m)		24.00 (230.40)	SANDSTONE and SILTSTONE interbedded, SANDSTONE; pale green and white, medium grained sand, matrix supported (clay), extremely weathered. SILTSTONE; pale pink-white (leached), trace pink tabular flecks, distinctly weathered.			24.0 m - 104.5m; Permian	
30										

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

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Client : Adani Mining Pty Ltd		**HOLE No. C011P3**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 2 OF 4**	
Position : 428845.0 E 7569950.0 N	**Surface RL:** 254.4m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Dave/ Troy	**Checked :**
Date Started : 22/7/11	**Date Completed :** 22/7/11	**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Rotary Wash Boring (bit, 6 inch)	Nil						SANDSTONE and SILTSTONE interbedded, as previous.					
32					32.00 (222.40)			SANDSTONE, pink, pale pink/orange/white mottling, medium grained sand, predominately quartz and carbonaceous material (black), matrix supported (clay), extremely weathered. From 33.0 to 35.0 m; fine grained sand.					
38					38.50 (215.90)			SANDSTONE, orange-brown, fine to medium grained sand, predominately quartz and contains specks of carbonaceous material (black), grain supported, trace clay, extremely weathered, crumbles between the fingers.					50mm PVC casing, with cement-bentonite grout (at ~46.5 m)
52					53.00 (201.40)			SANDSTONE, pale grey, medium grained sand, predominately rounded quartz, trace lithic fragments, contains carbonaceous material (black, fine to medium grained), returning as sandy clay, low plasticity, extremely weathered.					
60													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C011P3**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 3 OF 4**	
Position : 428845.0 E 7569950.0 N	**Surface RL:** 254.4m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Dave/ Troy	**Checked :**
Date Started : 22/7/11	**Date Completed :** 22/7/11	**Logged by :** RB	**Date :**

Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations
Rotary Wash Boring (bit, 6 inch)	Nil				SANDSTONE, as previous.			24.0 m - 104.5m; Permian
				65.00 (189.40)	SILTSTONE, dark grey, returning as clay, low plasticity, extremely weathered.			
				69.00 (185.40)	COAL, black, shiny.			
				70.50 (183.90)	Carbonaceous SILTSTONE, dark grey, fine grained, trace coal.			
				73.00 (181.40)	COAL and SILTSTONE interbedded, COAL; black, shiny. SILTSTONE; dark grey, carbonaceous, fine grained.			
				76.00 (178.40)	Carbonaceous SILTSTONE, dark grey, fine grained, with clay.			
				77.00 (177.40)	Carbonaceous SANDSTONE, pale grey, fine grained sand, significant black specks and needles (carbonaceous material) and laminae. From 79.0 m; interbedded siltstone, soft, clay present indicating harder and softer bands of siltstone/mudstone. From 80.0 to 81.0 m; carbonaceous tuff, pale grey-brown, 'layers' of fine needles.			
				89.00 (165.40)	COAL, black, predominately disintegrates to clay-like			
				90.00				

Scale (m): 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90

PIEZOMETER — Piezometer Log | Components

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C011P3

Position : 428845.0 E 7569950.0 N	**Surface RL:** 254.4m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Dave/ Troy	**Checked :**
Date Started : 22/7/11	**Date Completed :** 22/7/11	**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Rotary Wash Boring (bit, 6 inch)	Nil			(164.40)			material					
92								Carbonaceous SILTSTONE, dark grey, fine grained, some soft clay			24.0 m - 104.5m; Permian		
94													Bentonite
96								From 95.0m; grey					
98					98.80 (155.60)			COAL, black, some disintegration in water to clay			D1 Seam		
100					100.00 (154.40)			Carbonaceous SILTSTONE, dark grey, fine grained, with clay and silt (grey).					Filter pack; Screen
102					101.00 (153.40)			COAL, black, little/no disintegration to clay					
104					104.60 (149.80)			Carbonaceous SILTSTONE, dark grey, fine grained.					End cap
					105.00 (149.40)			End of borehole at 105 m. Piezometer installed.					Cave in
106													
108													
110													
112													
114													
116													
118													
120													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

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Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C012P1

Position : 430890.0 E 7569875.0 N		**Surface RL:** 247.3m	**Angle from Horiz. :** 90°		**Processed :** VLD
Rig Type : Bourne 1000	**Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Dave		**Checked :**
Date Started : 24/7/11		**Date Completed :** 24/7/11	**Logged by :** RB		**Date :**

DRILLING: SCALE (m) 2–30; Drilling Method: Air Hammer (bit, 6 inch); Hole Support \ Casing: Nil; Water: GNO (at approx. 26 m); Samples & Tests: —

Depth / (RL) metres	USC Symbol	Description	Moisture Condition	Consistency / Density Index
0.00–1.00 (246.33)	SP-SM	Silty Gravelly SAND, orange-red, medium to coarse grained sub-rounded to sub-angular sand, fine sub-rounded to sub-angular gravel.		
1.00–4.00 (243.33)	GP-GC	Clayey GRAVEL, orange-brown, fine- to medium-sized sub-rounded gravel, orange-red staining. (LATERITE)		
4.00–6.50 (240.83)		SANDSTONE, pink/orange/white, medium grained sand, predominately quartz, trace silt and clay, highly weathered.		
6.50–11.00 (236.33)		SILTSTONE and SANDSTONE, SILTSTONE; pale pink, fine-grained, trace orange flecks, needles and laminae, weathered/altered organic matter (leached). SANDSTONE; pale pink, fine-grained sand. (leached)		
11.00–16.80 (230.53)		SANDSTONE, orange, trace pale grey mottling, grain supported, medium grained sub-rounded quartz sand, trace coarse grained sand, trace fine sub-rounded gravel, some silt, trace clay, highly weathered.		
16.80–23.00 (224.33)		SILTSTONE, fine grained, brittle, white/pink leached.		
23.00–26.00 (221.33)		SILTSTONE, orange-brown, fine grained, highly weathered, brittle. From 25.0 to 26.0 m; approximately 0.5 m of SANDSTONE, purple-pink, medium grained sand, some silt.		
26.00–		SANDSTONE and SILTSTONE, Interbedded. SANDSTONE; brown-orange-pink, fine grained sand, some silt, trace clay, highly weathered.	VM-W	

Comments/ Observations: 0.0 m - 32.0 m; Tertiary

PIEZOMETER – Components:
- Completed with steel monument
- 50mm PVC casing, with cement-bentonite grout

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C012P1

Position : 430890.0 E 7569875.0 N		**Surface RL:** 247.3m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000	**Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Dave	**Checked :**
Date Started : 24/7/11		**Date Completed :** 24/7/11	**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Air Hammer (bit, 6 inch)	Nil						SILTSTONE; brown-orange-pink, highly weathered. From 29.0 to 30.0 m; orange, specks of black/orange (weathered carbonaceous material?). From 30 to 32 m; dark purple-brown fine-grained silt and dark grey-purple medium grained highly weathered rock (iron rich ferricrete).	VM-W				
32					32.00 (215.33)						32.0 m - 40.0 m; Permian		Bentonite
34													
					35.00 (212.33)			SILTSTONE, orange, fine grained, slightly sandy.					
36								SANDSTONE, brown-orange and pale grey, fine and coarse grained, predominantly quartz, sub-rounded. Grain supported, iron stained quartz, trace silt, highly weathered.					Filter pack; Screen
38													
40					40.00 (207.33)			End of borehole at 40 m. Piezometer installed.					End cap
42													
44													
46													
48													
50													
52													
54													
56													
58													
60													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C012P2

Position : 430890.0 E 7569877.0 N	**Surface RL:** 247.3m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Troy	**Checked :**
Date Started : 23/7/11	**Date Completed :** 24/7/11	**Logged by :** RB	**Date :**

DRILLING: SCALE (m) | Drilling Method: Rotary Wash Boring (PCD, 6 inch bit) | Hole Support \ Casing: Nil | Water: GNO (at approx. 27 m) | Samples & Tests

Depth / (RL) metres	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Comments/ Observations
0.00 – 3.50 (243.75)	Clayey LATERITE,orange-brown, high plasticity clay, clayey fine to medium rounded to sub-rounded gravel, orange-red staining, trace sand.	0.0 m - 32.5 m; Tertiary
3.50 – 5.00 (242.25)	SANDSTONE, white, brown-orange and pink, medium grained sand.	
5.00 – 11.00 (236.25)	SILTSTONE, leached, white and pink, fine grained, brittle. Returning as gravelly CLAY, medium plasticity, orange flecks, spots and needles (resembles organic matter) From 10.0 to 11.0 m; trace clay.	
11.00 – 12.50 (234.75)	QUARTZITE, returning as orange-brown, medium to coarse grained sub-angular quartz, trace silt, iron stained.	
12.50 – 29.00 (218.25)	SILTSTONE, pink-orange, leached, very fine to fine grained, brittle, trace clay. From 15.0 m; colour change to white and pink. From 19.0 to 22.0 m; predominately pink. From 23.0 to 29.0 m; orange-brown in colour, highly weathered siltstone, interbedded with pink (leached) siltstone.	
29.00 –	MUDSTONE (?), pink, leached, silicified, very fine	

PIEZOMETER — Components:
- Completed with steel monument
- 50mm PVC casing, with cement-bentonite grout

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Job No. 41-23244

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd			**HOLE No. C012P2**
Project : Carmichael Coal Mine Project			
Location : , EPC1690			**SHEET 2 OF 2**
Position : 430890.0 E 7569877.0 N	**Surface RL:** 247.3m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Troy	**Checked :**
Date Started : 23/7/11	**Date Completed :** 24/7/11	**Logged by :** RB	**Date :**

DRILLING: Drilling Method	Hole Support \ Casing	Depth / (RL) metres	MATERIAL: Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Comments/ Observations	PIEZOMETER: Components
Rotary Wash Boring (PCD, 6 inch bit)	Nil		grained. MUDSTONE, as previous		
		32.50 (214.75)	SILTSTONE, orange-brown, fine grained, highly weathered, trace silt, slight foliation.	32.5 m - 59.0 m; Permian	
		35.00 (212.25)	SANDSTONE, pale brown-orange, fine to medium grained sub-angular quartz sand (white, iron stained), extremely to highly weathered. Siltstone laminae present, dark grey and orange-brown. From 37.0 m; no clay, highly weathered.		
		41.00 (206.25)	SILTSTONE, orange, fine grained, no clay, extremely to highly weathered. From 45.0 to 47.0 m; Interbedded with SANDSTONE, returning as orange-brown, medium to coarse grained quartz, leached pink.		
		47.00 (200.25)	SANDSTONE, high plasticity fines, orange-brown, fine to medium grained sand, extremely weathered, returning as Sandy CLAY. From 50.0 to 51.5 m; interbedded with siltstone, grey-orange, fine grained, slight foliation. From 55.0 - 59.0 m; interbedded with siltstone, grey-orange, fine grained, slight foliation.		Bentonite; Filter pack; Screen; End cap; Cave in
		59.00 (188.25)	End of borehole at 59.0 m. Piezometer installed.		

SCALE (m): 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

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Job No. 41-23244

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 7/11/12

Client :	Adani Mining Pty Ltd				**HOLE No. C014P2**
Project :	Carmichael Coal Mine Project				
Location :	, EPC1690				**SHEET 1 OF 7**
Position :	430733.0 E 7563976.0 N	**Surface RL:** 256.0m	**Angle from Horiz. :** 90°		**Processed :** VLD
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Dave/ Troy		**Checked :**
Date Started :	25/7/11	**Date Completed :** 26/7/11	**Logged by :** RB		**Date :**

DRILLING					MATERIAL							PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	**Description** SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	**Comments/ Observations**	Piezometer Log	**Components**
0–1	Air Hammer	PVC casing 150mm						SANDSTONE, orange, red/grey-green mottling, quartz, grain supported, medium grained sub-rounded quartz sand, trace silt, highly weathered, some iron staining of grains.			0.0 m - 29.0 m; Tertiary		Completed with steel monument
1–13					1.00 (254.99)			SILTSTONE and SANDSTONE interbedded , pink-red, green-grey/yellow/orange mottling, fine grained sand, trace quartz grains, some chips are brittle and others are hard, highly weathered.					
13–18					13.00 (242.99)			SILTSTONE/MUDSTONE, pale brown-orange, orange iron staining, returning as brittle clay chips, high plasticity fines, extremely weathered. From 15.0 to 17.0 m; pink-brown. From 17.0 to 18.0 m; brown with some yellow-orange mottling.					
18–22					18.00 (237.99)			SILTSTONE, pink-brown, returning as clay chips, brittle, fine grained texture. From 20.0 to 22.0 m; pale yellow, trace orange (iron staining).					
22–25					22.00 (233.99)			MUDSTONE, red-brown, returning as clay chips, smooth, brittle, medium plasticity fines, extremely weathered. From 23.0 to 24.0 m; colour change to orange-yellow.					
25–27					25.00 (230.99)			CLAY, pale pink-brown, high plasticity, returns as powder. (MUDSTONE)					
27–29					27.00 (228.99)			Sandy CLAY, pale pink-brown, fine grained (black, orange and pale grey grains), returns as powder					
29–30					29.00 (226.99)			SILTSTONE, yellow-orange, returning as clay chips, brittle,			29.0 m - 178.1 m; Rewan Fmn		

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Job No. **41-23244**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C014P2

Position : 430733.0 E 7563976.0 N	**Surface RL:** 256.0m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Dave/ Troy	**Checked :**
Date Started : 25/7/11	**Date Completed :** 26/7/11	**Logged by :** RB	**Date :**

DRILLING: Drilling Method: Air Hammer; Hole Support \ Casing: PVC casing 150mm; Water: GNO (at approx. 47 m)

Depth / (RL) metres	Description	Comments/ Observations	Piezometer Components
	high plasticity, slightly grainy texture, extremely weathered.		
31.00 (224.99)	SILTSTONE, as previous	29.0 m - 178.1 m; Rewan Fmn	
32.00 (223.99)	MUDSTONE, pale green-brown, returning as clay chips, high plasticity, smooth, extremely weathered.		150 mm PVC casing hole support
	SILTSTONE, pink-brown, returning as clay chips, high plasticity fines, stiff, slightly grainy, extremely weathered. From 33.0 to 35.0 m; pale green-brown and brown-orange.		
35.00 (220.99)	CLAY, high plasticity, orange, trace fine grained sand, returning as powder From 36.0 to 37.0 m; trace fine to medium grained sand. From 36.0 to 38.0 m; pale brown-orange. From 36.0 m; smooth. From 38.0 to 39.0 m; orange-red. From 39.0 to 42.0 m; pale brown-orange. From 42.0 to 43.0 m; pale pink-brown, slighty grainy From 43.0 to 44.0 m; yellow-orange, smooth From 44.0 to 47.0 m; pale pink-brown, returns as chips		
47.00 (208.99)	MUDSTONE/CLAYSTONE, blue-grey, leached, high plasticity, smooth, returns as powder. From 52.0 to 53.0 m; SILTSTONE, grey, leached, slightly grainy.		
55.00 (200.99)	Sandy SILTSTONE, brown-pink and pink-brown, high plasticity, returns as powder, fine grained sand, extremely weathered.		
56.00 (199.99)			
58.00 (197.99)	Sandy CLAY, brown-pink and pink-brown, high plasticity fines, fine grained sand, returns as powder, (extremely weathered Sandy SILTSTONE)		
59.00 (196.99)			
60.00			

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Job No. 41-23244

Client :	Adani Mining Pty Ltd			**HOLE No. C014P2**	
Project :	Carmichael Coal Mine Project				
Location :	, EPC1690				
Position :	430733.0 E 7563976.0 N	**Surface RL:** 256.0m	**Angle from Horiz. :** 90°	**Processed :** VLD	
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Dave/ Troy	**Checked :**	
Date Started :	25/7/11	**Date Completed :** 26/7/11	**Logged by :** RB	**Date :**	

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Air Hammer	PVC casing 150mm			(195.99)			SILTSTONE, orange-yellow, high plasticity, smooth, returning as powder, extremely weathered.			29.0 m - 178.1 m; Rewan Fmn		
62								MUDSTONE/CLAYSTONE, blue-grey, leached, high plasticity, smooth, returns as powder.					
64								SILTSTONE, grey-blue, leached, high plasticity, trace silt, trace fine grained black carbonaceous material, slightly grainy, returns as powder					
66		Nil											
67								From 67.0 to 68.0 m; grey-pink.					
68													
70													
72													
74													
76													
77					77.00 (178.99)			MUDSTONE/CLAYSTONE, blue-grey, leached, high plasticity, smooth, returns as powder.					
78													
80													
82													
84													
86													
88													
90													

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Job No. **41-23244**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C014P2

Position : 430733.0 E 7563976.0 N		**Surface RL:** 256.0m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000	**Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Dave/ Troy	**Checked :**
Date Started : 25/7/11		**Date Completed :** 26/7/11	**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Air Hammer	Nil						MUDSTONE/CLAYSTONE, as previous			29.0 m - 178.1 m; Rewan Fmn		
92													
94					94.00 (161.99)			SILTSTONE, grey-blue, leached, high plasticity, trace fine grained black carbonaceous material, returns as powder					
96													50mm PVC casing, with cement-bentonite grout
98													
100													
102													
104													
106													
108								From 107.0 to 122.0 m; brown-grey.					
110													
112													
114													
116													
118													
120													

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Job No. 41-23244

Client :	Adani Mining Pty Ltd			**HOLE No. C014P2**	
Project :	Carmichael Coal Mine Project				
Location :	, EPC1690			**SHEET 5 OF 7**	
Position :	430733.0 E 7563976.0 N	**Surface RL:** 256.0m	**Angle from Horiz. :** 90°	**Processed :** VLD	
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Dave/ Troy	**Checked :**	
Date Started :	25/7/11	**Date Completed :** 26/7/11	**Logged by :** RB	**Date :**	

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
								SILTSTONE, as previous			29.0 m - 178.1 m; Rewan Fmn		
122								From 122.0 to 151.0 m; grey.					
124													
126													
128													
130													
132								From 132.0 m; grey, chips of siltstone returning, fine grained.					
134	Air Hammer	Nil											
136													
138													
140													
142													
144													
146													
148													
150													

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Job No. **41-23244**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd			**HOLE No. C014P2**
Project : Carmichael Coal Mine Project			
Location : , EPC1690			**SHEET 6 OF 7**
Position : 430733.0 E 7563976.0 N	**Surface RL:** 256.0m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Dave/ Troy	**Checked :**
Date Started : 25/7/11	**Date Completed :** 26/7/11	**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
								SILTSTONE, as previous					
								From 151.0 to 155.0 m; pale grey			29.0 m - 178.1 m; Rewan Fmn		
152													
154													
								From 155.0 to 160.0 m; grey					
156													
158													
160								From 160.0 to 166.0 m; pale grey					
162													
164	Air Hammer	Nil											
166								From 166.0 to 168.0 m; grey					
168								From 168.0 to 194.0 m; pale grey					
170													
172													
174													
176													
178											178.1 m - 205.0 m; Permian		
180													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C014P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 7 OF 7**	
Position : 430733.0 E 7563976.0 N	**Surface RL:** 256.0m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Dave/ Troy	**Checked :**
Date Started : 25/7/11	**Date Completed :** 26/7/11	**Logged by :** RB	**Date :**

DRILLING: Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	USC Symbol	MATERIAL: Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations	PIEZOMETER: Components
Air Hammer	Nil					SILTSTONE, as previous			47.0 m - 205.0 m; Permian	Bentonite
				194.00 (61.99)		SILTSTONE and COAL, interbedded , SILTSTONE; dark grey to grey, fine grained, brittle. COAL; black, brittle.			AB Seam	
				195.00 (60.99)		COAL, black, slight sheen, brittle, trace interbeds of silicified mudstone (brown-green, no visible grains). From 195.5 to 198.5 m; siltstone.				
				198.50 (57.49)		Carbonaceous SILTSTONE/SILTSTONE and COAL interbedded; trace silicified mudstone, (brown-green, no visible grains). SILTSTONE; dark grey and grey, fine grained. COAL; black, brittle				Filter pack, Screen, End cap, Hole collapse
				205.00 (50.99)		End of borehole at 205.0 m. Piezometer installed.				

SCALE (m): 182, 184, 186, 188, 190, 192, 194, 196, 198, 200, 202, 204, 206, 208, 210

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C016P2

Client : Adani Mining Pty Ltd			
Project : Carmichael Coal Mine Project			
Location : , EPC1690			
Position : 422018.0 E 7574974.0 N	**Surface RL:** 294.5m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Jimmy	**Checked :**
Date Started : 29/7/11	**Date Completed :** 30/7/11	**Logged by :** RB	**Date :**

DRILLING					MATERIAL							PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
0–4	Rotary Wash Boring (Step, 6 inch bit)	Nil	GNO					Silty SAND, orange-brown, medium to coarse grained sub-rounded to sub-angular sand, predominately quartz, trace clay, trace fine sub-rounded to sub-angular gravel. From 2.0 to 3.0 m; green-grey with some orange spots. From 3.0 to 4.0 m; orange-pink with fine sub-rounded to sub-angular gravel, predominately quartz grains.			0.0 m - 9.0 m; Alluvium		Completed with steel monument
4–5					4.00 (290.45)			Silty GRAVEL, dark orange-brown, fine angular to sub-angular gravel, trace clay, gravel of highly weathered fine grained rock.					
5–6					5.00 (289.45)			Sandy CLAY, pale grey, some orange spots, medium plasticity, fine grained sand.					
6–9					6.00 (288.45)			Silty SAND, orange-brown, medium to coarse grained sand (quartz and orange fine-grained highly weathered rock).					
9–30					9.00 (285.45)			Sandy CLAY, pale grey, orange-brown and dark orange-brown mottling, medium plasticity, fine to medium grained sand (quartz and dark grey fine grained carbonaceous material), trace silt. From 24.0 m; high plasticity			9.0 m - 68.0 m; Tertiary		

Scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C016P2

Client :	Adani Mining Pty Ltd						
Project :	Carmichael Coal Mine Project						
Location :	, EPC1690						
Position :	422018.0 E 7574974.0 N	**Surface RL:**	294.5m	**Angle from Horiz. :**	90°	**Processed :**	VLD
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :**	Watson Drilling	**Driller :**	Jimmy	**Checked :**	
Date Started :	29/7/11	**Date Completed :**	30/7/11	**Logged by :**	RB	**Date :**	

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
32–40	Rotary Wash Boring (Step, 6 inch bit)	Nil						Sandy CLAY, as previous From 35.0 m; orange-brown and pale grey-pink in colour.					
42–44					41.00 (253.45)			Sandy CLAY, dark orange-brown, medium plasticity, with silt, fine to medium grained sand, predominately quartz.					
46–52					46.00 (248.45)			Sandy CLAY, white, some yellow-orange mottling, high plasticity, fine to medium grained sand, predominately quartz, trace carbonaceous material.			9.0 m - 68.0 m; Tertiary		
54–60					53.00 (241.45)			CLAY, white, trace yellow-orange mottling, high plasticity. From 54.0 to 55.0 m; pink-brown with white mottling From 57.0 to 61.0 m; pink-brown, orange-yellow/white mottling					

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Job No. 41-23244

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C016P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 3 OF 8**	
Position : 422018.0 E 7574974.0 N	**Surface RL:** 294.5m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Jimmy	**Checked :**
Date Started : 29/7/11	**Date Completed :** 30/7/11	**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Rotary Wash Boring (Step, 6 inch bit)	Nil			61.00 (233.45)			Sandy CLAY, pink-brown with pale grey/orange mottling, high plasticity, sand is fine grained sand, trace silt.					
62													
64													
66													
68					68.00 (226.45)			CLAY, brown-orange with trace pink-brown mottling, high plasticity, smooth.			68.0 m - 91.0 m; Rewan Group		
70													
72								From 71.0 m; green-brown					
74													
76													
78								From 77.0 to 79.0 m; brown, trace fine grained sand, fine grained carbonaceous material					
80								From 79.0 to 85.5 m; green-brown, grey mottling					
82													
84								From 83.0 to 85.5 m; with trace fine sand.					
86					86.00 (208.45)			Sandy CLAY, brown-pink, high plasticity, fine grained sand, dark grey pockets of carbonaceous rich sandy clay.					
88													
90					89.50 (204.95)			CLAY, green-brown, high					

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Job No. **41-23244**

Client :	Adani Mining Pty Ltd			**HOLE No. C016P2**	
Project :	Carmichael Coal Mine Project				
Location :	, EPC1690			**SHEET 4 OF 8**	
Position :	422018.0 E 7574974.0 N	**Surface RL:** 294.5m	**Angle from Horiz. :** 90°	**Processed :** VLD	
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Jimmy	**Checked :**	
Date Started :	29/7/11	**Date Completed :** 30/7/11	**Logged by :** RB	**Date :**	

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Rotary Wash Boring (Step, 6 inch bit)	Nil						plasticity, smooth.					
92					90.50 (203.95)			CLAY, blue-grey,(MUDSTONE/CLAYSTONE, leached ?).			90.5 m - 233.0 m; Permian		
94													
96													
98													
100								From 99.0 m; trace silt, trace fine grained sand sized black carbonaceous material. (SILTSTONE ?)					
102													
104													
106													
108													50mm PVC casing, with cement-bentonite grout
110													
112													
114													
116													
118													
120													

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C016P2

Position : 422018.0 E 7574974.0 N	**Surface RL:** 294.5m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Jimmy	**Checked :**
Date Started : 29/7/11	**Date Completed :** 30/7/11	**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
122–134	Rotary Wash Boring (Step, 6 inch bit)	Nil						CLAY, as previous			90.5 m - 233.0 m; Permian		
136–150					135.00 (159.45)			SILTSTONE, dark grey and grey-blue, trace fine gravel-sized chips of siltstone returning within the clay, fine grained, brittle and crumbly.					

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Job No. **41-23244**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd			**HOLE No. C016P2**
Project : Carmichael Coal Mine Project			
Location : , EPC1690			**SHEET 6 OF 8**
Position : 422018.0 E 7574974.0 N	**Surface RL:** 294.5m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Jimmy	**Checked :**
Date Started : 29/7/11	**Date Completed :** 30/7/11	**Logged by :** RB	**Date :**

DRILLING					MATERIAL						Comments/ Observations	PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	**Description** SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index		Piezometer Log	Components
152–178	Rotary Wash Boring (Step, 6 inch bit)	Nil						SANDSTONE with interbeds of SILTSTONE, as previous			90.5 m - 233.0 m; Permian		
178–180					178.00 (116.45)			Interbedded SILTSTONE and SANDSTONE Siltstone, blue-grey and dark grey, fine grained.					

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C016P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 7 OF 8**	
Position : 422018.0 E 7574974.0 N	**Surface RL:** 294.5m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Jimmy	**Checked :**
Date Started : 29/7/11	**Date Completed :** 30/7/11	**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
182	Rotary Wash Boring (Step, 6 inch bit)	Nil						Sandstone, pale grey, fine grained quartz, carbonaceous silt/fine sand sized, black. SANDSTONE with interbeds of SILTSTONE, as previous			90.5 m - 233.0 m; Permian		
184					183.00 (111.45)			SILTSTONE, blue-grey, fine grained, returns with high plasticity clay.					
186													
188													
190													
192													
194													
196								From 195.0 m; interbedded with SANDSTONE, pale grey, fine grained quartz, fine sand sized/silt black carbonaceous material.					
198													
200													
202													
204													
206													
208					208.00 (86.45)			SANDSTONE with interbeds of SILTSTONE SANDSTONE; pale grey, fine grained quartz sand, fine sand					
210													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client :	Adani Mining Pty Ltd			**HOLE No. C016P2**	
Project :	Carmichael Coal Mine Project				
Location :	, EPC1690				
Position :	422018.0 E 7574974.0 N	**Surface RL:** 294.5m	**Angle from Horiz. :** 90°	**Processed :** VLD	
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Jimmy	**Checked :**	
Date Started :	29/7/11	**Date Completed :** 30/7/11	**Logged by :** RB	**Date :**	

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
212–218	Rotary Wash Boring (Step, 6 inch bit)	Nil						sized/silt carbonaceous material, returns as high plasticity Sandy CLAY. SILTSTONE; grey. SANDSTONE with interbeds of SILTSTONE, as previous From 213.0 to 218.0 m; with interbeds of coal (black, slackes in water) and carbonaceous siltstone (dark grey-black, fine grained).			90.5 m - 233.0 m; Permian AB1 Seam		Bentonite
218–224					218.00 (76.45)			COAL, black, slakes in water, brittle, some interbeds of carbonaceous siltstone and sandstone. From 221.0 to 222.0 m; trace carbonaceous siltstone, sandstone and mudstone. Mudstone is milky brown with carbonaceous (black) laminae, no visible grains.			AB2 Seam		Filter pack Screen
224–227					224.00 (70.45)			Carbonaceous SILTSTONE, dark grey, fine-grained, trace calcite, with interbeds of coal, returns include high plasticity clay.					
227–233					227.00 (67.45)			SANDSTONE, pale grey, fine grained quartz sand, with silt/fine sand sized carbonaceous material. With trace interbeds of carbonaceous siltstone, returning with high plasticity sandy clay.					End cap Hole collapse
233–240					233.00 (61.45)			End of borehole at 233.0 m. Piezometer installed.					

Scale marks: 212, 214, 216, 218, 220, 222, 224, 226, 228, 230, 232, 234, 236, 238, 240

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Job No. **41-23244**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C018P1

Client :	Adani Mining Pty Ltd				
Project :	Carmichael Coal Mine Project				
Location :	, EPC1690				
Position :	423982.0 E 7574850.0 N	**Surface RL:** 281.3m	**Angle from Horiz. :** 90°	**Processed :** VLD	
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Snickers	**Checked :**	
Date Started :	1/8/11	**Date Completed :** 1/8/11	**Logged by :** RB	**Date :**	

DRILLING					**MATERIAL**							**PIEZOMETER**	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	**Description** SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	**Comments/ Observations**	Piezometer Log	**Components**
0–1	Air Hammer	Nil			1.00 (280.27)			Silty SAND, orange-brown, fine grained quartz sand, slightly moist. (TOPSOIL)	SM		0.0 m - 42.0 m; Tertiary		Completed with steel monument
1–4					4.00 (277.27)			SILTSTONE, orange-brown, fine grained, trace fine grained sand, trace silt, slight foliation, returns as high plasticity clays, extremely weathered.					
4–30								SANDSTONE, orange, fine grained, sub-rounded to rounded quartz sand, silt, trace clay, highly to extremely weathered. From 7.0 m; fine to coarse grained sand, some quartz is iron stained (orange), trace black fine grained carbonaceous material and orange brown angular fragments (fine to medium sand sized grains). From 11.0 m; pale brown-orange, fine to medium grained sand. From 21.0 to 22.0 m; interbedded with SILTSTONE, pale brown-orange, iron stained, fine grained, returning as clay, extremely weathered. From 23.0 m - orange-brown and pale grey-brown.					50mm PVC casing, with cement-bentonite grout

Scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 7/11/12

Client : Adani Mining Pty Ltd			**HOLE No. C018P1**		
Project : Carmichael Coal Mine Project					
Location : , EPC1690			**SHEET 2 OF 2**		
Position : 423982.0 E 7574850.0 N		**Surface RL:** 281.3m	**Angle from Horiz. :** 90°		**Processed :** VLD
Rig Type : Bourne 1000	**Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Snickers		**Checked :**
Date Started : 1/8/11		**Date Completed :** 1/8/11	**Logged by :** RB		**Date :**

Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Components
Air Hammer	Nil	GNO					SANDSTONE, as previous From 32.5 m; increase in clay content. Interbeds of sandy CLAY, pale grey-brown high plasticity, and medium-grained sandstone. Extremely weathered.			0.0 m - 42.0 m; Tertiary	
				42.00 (239.27)			SANDSTONE, pale yellow-brown, fine to medium grained sand, high plasticity fines, extremely weathered. Returns as very Sandy CLAY. From 45.0 to 47.0 m; orange-brown, fine to medium grained quartz sand, silt matrix, trace clay. From 47.0 to 50.0 m; pale yellow-brown, fine to medium grained sand, high plasticity fines. Returns as Sandy clay/clayey SAND.			42.0 m - 53.0 m; Permian	Bentonite Screen Filter pack End cap
				53.00 (228.27)			End of borehole at 53 m. Piezometer installed.				

SCALE (m): 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

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GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 7/11/12

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C018P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 1 OF 4**	
Position : 423991.0 E 7574848.0 N	**Surface RL:** 281.3m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Shawn	**Checked :**
Date Started : 4/8/11	**Date Completed :** 5/8/11	**Logged by :** MP	**Date :**

Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Description	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Components
Rotary Wash Boring (PCD, 6 inch bit)	Nil				Clayey SILT, orange-brown, medium plasticity, very fine grained sand, trace fine to medium grained sand.			0.0 m - 40.0 m; Tertiary	Completed with steel monument
				1.00 (280.30)	Sandy Gravelly SILT, grey, heavily stained brown-orange, red/yellow/orange mottling, fine to coarse grained sand, fine sized, sub-rounded to angular lithic gravel.				
				3.00 (278.30)	Sandy SILT, grey, heavily stained brown-orange, yellow/orange/red/dark brown mottling, medium to high plasticity, very fine to fine grained sand, trace medium to coarse grained sand.				
					From 16.0 m; grey with brown-red staining, red mottling, trace yellow/orange/dark brown mottling.				
					From 23.0 to 24.0 m; grey with orange staining, yellow/orange/red mottling. From 24.0 m; decrease in staining, yellow/orange/red/brown mottling.				

SCALE (m): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

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Job No. **41-23244**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C018P2

Position : 423991.0 E 7574848.0 N	**Surface RL:** 281.3m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Shawn	**Checked :**
Date Started : 4/8/11	**Date Completed :** 5/8/11	**Logged by :** MP	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
30–40	Rotary Wash Boring (PCD, 6 inch bit)	Nil	SWL (approx. 37.5)					Sandy SILT, as previous From 39.0 m; completely stained pale red with trace orange/yellow/red mottling.			0.0 m - 40.0 m; Tertiary		
40–60					40.00 (241.30)			SANDSTONE, pale grey-white, trace orange/yellow/red mottling, matrix supported, medium to high plasticity fines, fine grained sand, trace medium to coarse grained sub-angular to sub-rounded sand. Hard, coming up in chips in places. Decrease in mottling with depth. At 53.0 to 54.0 m; CONGLOMERATE, fine grained/silt matrix, fine to medium grained sub-rounded to rounded, quartz and lithic gravel (smooth and polished). At 54.0 to 56.0 m; pale grey with pale red staining in places, trace orange/yellow/red mottling. At 56.0 to 58.0 m; pale yellow-brown, yellow/red/orange/dark brown mottling. After 58.0 m; completely			40.0 m - 90.0 m; Tertiary		50mm PVC casing, with cement-bentonite grout

Scale marks: 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C018P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 3 OF 4**	
Position : 423991.0 E 7574848.0 N	**Surface RL:** 281.3m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Shawn	**Checked :**
Date Started : 4/8/11	**Date Completed :** 5/8/11	**Logged by :** MP	**Date :**

Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Components
Rotary Wash Boring (PCD, 6 inch bit)	Nil						stained brown-orange with yellow/orange/red mottling.			40.0 m - 90.0 m; Tertiary	
				76.50 (204.80)			SILTSTONE, dark grey, trace fine grained sand, returning as CLAY (ribbons), medium plasticity stiff.				
				81.00 (200.30)			COAL, black, dull, soft, some hard chips returning. Interbedded with thin bands SILTSTONE, pale brown-grey, returning as CLAY (ribbons), stiff.			AB3 Seam	Bentonite; Filter pack; Screen; End cap
				89.00 (192.30)			SILTSTONE, dark grey, returning as CLAY (ribbons),				
				90.00							

SCALE (m): 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd			**HOLE No. C018P2**
Project : Carmichael Coal Mine Project			
Location : , EPC1690			**SHEET 4 OF 4**
Position : 423991.0 E 7574848.0 N	**Surface RL:** 281.3m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Shawn	**Checked :**
Date Started : 4/8/11	**Date Completed :** 5/8/11	**Logged by :** MP	**Date :**

DRILLING					MATERIAL							Comments/ Observations	PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index			Piezometer Log	Components
					(191.30)			stiff. End of borehole at 90.0 m. Piezometer installed.						
92														
94														
96														
98														
100														
102														
104														
106														
108														
110														
112														
114														
116														
118														
120														

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Job No. **41-23244**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C018P3

Client :	Adani Mining Pty Ltd				
Project :	Carmichael Coal Mine Project				
Location :	, EPC1690				
Position :	423975.0 E 7574857.0 N	**Surface RL:** 281.2m	**Angle from Horiz. :** 90°		**Processed :** VLD
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Shawn		**Checked :**
Date Started :	2/8/11	**Date Completed :** 3/8/11	**Logged by :** MP		**Date :**

DRILLING: Drilling Method: Rotary Wash Boring (Bit, 6 inch); Hole Support \ Casing: Nil; Water; Samples & Tests

Depth / (RL) metres	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations
0.50 (280.71)	Silty SAND, low plasticity fines, grey-brown, fine to medium grained sand, trace organic matter (rootlets). (TOPSOIL)			0.0 m - 41.0 m; Tertiary
3.00 (278.21)	Sandy CLAY, pale brown, trace orange mottling medium plasticity, fine to medium grained sand.			
4.00 (277.21)	Sandy SILT, grey, significant orange-grey colouring, orange/yellow mottling, low plasticity, fine to medium grained sand.			
8.00 (273.21)	SAND, orange-brown, medium to coarse grained sand, trace fine grained sand, <15% fines returning, trace fine angular to sub-angular gravel. From 8.0 m; increase in fines content with depth.			
10.00 (271.21)	Sandy SILT, grey, heavily mottled red/orange/brown, fine grained sand, trace medium to coarse grained sand.			
15.00 (266.21)	Interbedded with SAND, brown, medium to coarse grained sand, trace fine grained sand, trace fine sub-angular to angular gravel. SANDSTONE, grey, yellow/red/orange mottling, matrix supported, fine grained sand, trace medium grained sand.			
	SILTSTONE, grey, stained orange-brown, orange/yellow/red mottling, high plasticity fines, very fine grained sand, trace fine grained sand. Interbedded with thin bands of SANDSTONE, fine grained sand, trace medium to coarse grained sand. From 27.0 m; decrease in staining and mottling.			

PIEZOMETER — Components: Completed with steel monument

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C018P3**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 2 OF 6**	
Position : 423975.0 E 7574857.0 N	**Surface RL:** 281.2m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Shawn	**Checked :**
Date Started : 2/8/11	**Date Completed :** 3/8/11	**Logged by :** MP	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
31–41	Rotary Wash Boring (Bit, 6 inch)	Nil	GNO			SILTSTONE, as previous At 33.0 m; thin beds of fine to medium grained sand, trace coarse grained sand.			0.0 m - 41.0 m; Tertiary		
41–47					41.00 (240.21)	SANDSTONE, grey, trace orange/red/yellow mottling, matrix supported, medium plasticity fines, fine grained sand, trace medium grained sand.			41.0 m -161.0 m; Permian		
47–51					47.00 (234.21)	CONGLOMERATE, grey, predominantly quartz, fine to medium sized sub rounded to rounded gravel, <10% fines returning, well sorted, trace fine to coarse grained sand. From 49.0 to 50.0 m; SANDSTONE, grey, matrix supported (silt), fine to medium grained sand, trace coarse grained sand.					
51–60					51.00 (230.21)	SILTSTONE, pale grey, heavily stained pale red-brown, trace yellow/orange mottling, low plasticity, fine-grained sand. From 53.0 m; decrease in pale red-brown staining, increase in orange/yellow mottling. From 59.0 m; completely stained brown-orange, trace					

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C018P3**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 3 OF 6**	
Position : 423975.0 E 7574857.0 N	**Surface RL:** 281.2m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Shawn	**Checked :**
Date Started : 2/8/11	**Date Completed :** 3/8/11	**Logged by :** MP	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Description	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Components
	Rotary Wash Boring (Bit, 6 inch)	Nil				red/dark brown mottling.				
						SILTSTONE, as previous			41.0 m -161.0 m; Permian	50mm PVC casing, with cement-bentonite grout
					75.50 (205.71)	SILTSTONE, dark grey, trace orange/yellow mottling, no sand.				
					77.00 (204.21)	SILTSTONE/SANDSTONE, grey, high plasticity fines, very fine grained sand, trace fine grained sand.				
					83.00 (198.21)	CARBONACEOUS SILTSTONE, grey, very fine grained sand, trace fine grained sand. Thin beds of COAL, black, dull, soft.				
90					90.00					

Scale (m): 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90

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Job No. 41-23244

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 7/11/12

Client : Adani Mining Pty Ltd		**HOLE No. C018P3**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 4 OF 6**	
Position : 423975.0 E 7574857.0 N	**Surface RL:** 281.2m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Shawn	**Checked :**
Date Started : 2/8/11	**Date Completed :** 3/8/11	**Logged by :** MP	**Date :**

DRILLING: Drilling Method: Rotary Wash Boring (Bit, 6 inch); Hole Support \ Casing: Nil; Water; Samples & Tests

Depth / (RL) metres	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations
(191.21)	SILTSTONE, dark grey, trace orange mottling, trace fine grained sand.			41.0 m -161.0 m; Permian
98.00 (183.21)	CARBONACEOUS SILTSTONE, dark grey-black, dull, very fine grained sand, soft, some hard vitreous coal. Interbedded with pale grey SILTSTONE, very fine grained sand.			AB3 Seam
103.00 (178.21)	SILTSTONE, dark grey, very fine to fine grained sand.			
107.00 (174.21)	SANDSTONE, grey, grain supported, fine to medium grained sand, coarsening slightly with depth, medium grained sand, trace fine grained sand. From 109.0 m; trace coarse grained sand, decrease in fines.			
113.00 (168.21)	COAL, black, dull, returning as small chips, hard, some soft carbonaceous material present. Thin beds of grey SILTSTONE.			113 m - 139 m; C Seam (interpreted from C017 ~ along strike) C Seam
118.50 (162.71)	Interbedded SILTSTONE and COAL SILTSTONE, pale grey,			

SCALE (m): 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120

PIEZOMETER: Piezometer Log; Components

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Job No. 41-23244

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C018P3**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 5 OF 6**	
Position : 423975.0 E 7574857.0 N	**Surface RL:** 281.2m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Shawn	**Checked :**
Date Started : 2/8/11	**Date Completed :** 3/8/11	**Logged by :** MP	**Date :**

DRILLING: Drilling Method: Rotary Wash Boring (Bit, 6 inch); Hole Support \ Casing: Nil; Water; Samples & Tests

Depth / (RL) metres	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Comments/ Observations	Piezometer Components
	medium plasticity, carbonaceous material present, trace fine grained sand. COAL, brown-black, dull, soft, some hard shards returning, almost carbonaceous siltstone.	41.0 m -161.0 m; Permian; C Seam (at 126 m)	
132.00 (149.21)	COAL, brown-black, dull, chips into small shards.		
137.50 (143.71)	SILTSTONE, medium plasticity, pale grey.		Bentonite
138.00 (143.21)	COAL, black, dull, carbonaceous material within siltstone present.		
139.00 (142.21)	CARBONACEOUS SILTSTONE, grey to dark grey, trace fine to medium grained sand.		Filter pack; Screen
143.00 (138.21)	COAL, black, soft, 50/50 shards/soft material.	D1 Seam	
145.50 (135.71)	CARBONACEOUS SILTSTONE, dark grey, trace mica grains.		End cap
147.00 (134.21)	SANDSTONE, grey, grain supported, fine to medium grained sand, coarsening with depth. From 154.0 m; grey, medium to coarse grained sand, trace fine		

SCALE (m): 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C018P3**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 6 OF 6**	
Position : 423975.0 E 7574857.0 N	**Surface RL:** 281.2m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Shawn	**Checked :**
Date Started : 2/8/11	**Date Completed :** 3/8/11	**Logged by :** MP	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Rotary Wash Boring (Bit, 6 inch)	Nil						grained sand.			41.0 m -161.0 m; Permian		
152								At 152.5 m; dark grey, interbedded with thin carbonaceous siltstone bands.					
154								From 154.0 m; fining up to fine grained sand, trace medium to coarse grained sand, increase in fines content, grain supported.					
156								From 156.0 m; matrix supported (silt), fine grained sand, carbonaceous siltstone present.					
158													
160								From 159.0 m; grain supported, fine to medium grained sand, coarsening with depth.					
					161.00 (120.21)			From 160.0 m; medium to coarse grained sand, trace fine grained sand, <10% fines.					
162								End of borehole at 161 m. Piezometer installed.					
164													
166													
168													
170													
172													
174													
176													
178													
180													

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Job No. **41-23244**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 7/11/12

Client : Adani Mining Pty Ltd			**HOLE No. C020P2**
Project : Carmichael Coal Mine Project			
Location : , EPC1690			**SHEET 1 OF 9**
Position : 427850.0 E 7566934.0 N	**Surface RL:** 263.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 8/8/11	**Date Completed :** 10/8/11	**Logged by :** MP	**Date :**

DRILLING					MATERIAL							PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	**Description** SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	**Comments/ Observations**	Piezometer Log	**Components**
0–5	Rotary Wash Boring	Nil			5.00 (258.06)			CONGLOMERATE, grain supported, grey (translucent) and white (opaque) quartz grains, fine grained angular to sub-rounded quartz gravel, coarse grained angular to sub-angular sand, matrix of sandy silt, very fine to fine grained sand, trace medium grained sand, iron stained and hardened, dark red-brown, dark red/orange mottling, trace gypsum crystals. From 3.0 m; pale brown-orange staining of quartz grains, no iron hardening of sediments.			0.0 m - 35.0 m; Tertiary		Completed with steel monument
5–14					14.00 (249.06)			SANDSTONE, grain supported, pale grey, fine to medium grained sand, predominately quartz, trace coarse grained sand. Increase in fines content with depth. From 7.0 to 9.0 m; pale yellow-orange From 9.0 m; matrix supported, silt, trace clay.					
14–30								SILTSTONE, completely stained pale brown-red, trace yellow/orange mottling, trace mica grains. From 16.0 to 19.0 m; colour change to pale grey, heavily stained pale yellow-brown. After 19.0 m; pale grey, stained pale brown-red in places, yellow/orange/red mottling.					

Scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

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Job No. **41-23244**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd			**HOLE No. C020P2**
Project : Carmichael Coal Mine Project			
Location : , EPC1690			**SHEET 2 OF 9**
Position : 427850.0 E 7566934.0 N	**Surface RL:** 263.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 8/8/11	**Date Completed :** 10/8/11	**Logged by :** MP	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
32–34	Rotary Wash Boring	Nil	GNO					SILTSTONE, as previous From 32.0 to 35.0 m; heavily stained dark red-brown.			0.0 m - 35.0 m; Tertiary		
36–52					35.00 (228.06)			SANDSTONE, matrix supported, pale yellow-brown, very fine to fine grained sand.			35.0 m - 231.0 m; Rewan Fmn		
54–60					53.00 (210.06)			SILTSTONE and SANDSTONE, completely stained dark brown-red, iron hardened in places, orange/yellow/red mottling. Siltstone; extremely weathered. Sandstone; matrix supported (silt), very fine to fine grained sand, trace medium grained sand. Decrease in staining with depth, becoming pale grey with pale yellow staining and iron hardening in places,					

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd			**HOLE No. C020P2**
Project : Carmichael Coal Mine Project			
Location : , EPC1690			**SHEET 3 OF 9**
Position : 427850.0 E 7566934.0 N	**Surface RL:** 263.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 8/8/11	**Date Completed :** 10/8/11	**Logged by :** MP	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Rotary Wash Boring	Nil						red/orange mottling. SILTSTONE / SANDSTONE, as previous			35.0 m - 231.0 m; Rewan Fmn		
80					80.00 (183.06)			SILTSTONE, grey, stained red-grey in places, trace fine grained sand, trace orange/red/brown mottling, iron hardened in places (dark red-brown).					

Scale: 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 7/11/12

Client : Adani Mining Pty Ltd		**HOLE No. C020P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 4 OF 9**	
Position : 427850.0 E 7566934.0 N	**Surface RL:** 263.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 8/8/11	**Date Completed :** 10/8/11	**Logged by :** MP	**Date :**

DRILLING					MATERIAL							PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
90–103	Rotary Wash Boring	Nil						SILTSTONE, as previous			35.0 m - 231.0 m; Rewan Fmn		
103–120					103.00 (160.06)			SILTSTONE, dark grey, high plasticity fines, no staining, very fine grained sand, trace fine grained sand, trace orange/yellow mottling, returning as shards.			35.0 m - 231.0 m; Rewan Fmn		

Scale marks: 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C020P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 5 OF 9**	
Position : 427850.0 E 7566934.0 N	**Surface RL:** 263.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 8/8/11	**Date Completed :** 10/8/11	**Logged by :** MP	**Date :**

DRILLING					MATERIAL							PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	**Description** SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	**Comments/ Observations**	Piezometer Log	**Components**
122 – 150	Rotary Wash Boring	Nil						SILTSTONE, as previous			35.0 m - 231.0 m; Rewan Fmn		50mm PVC casing, with cement-bentonite grout

Scale markings: 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C020P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 6 OF 9**	
Position : 427850.0 E 7566934.0 N	**Surface RL:** 263.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 8/8/11	**Date Completed :** 10/8/11	**Logged by :** MP	**Date :**

DRILLING					MATERIAL							PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	**Description** SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	**Comments/ Observations**	Piezometer Log	**Components**
152–180	Rotary Wash Boring	Nil						SILTSTONE, as previous			35.0 m - 231.0 m; Rewan Fmn		

Scale: 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C020P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 7 OF 9**	
Position : 427850.0 E 7566934.0 N	**Surface RL:** 263.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 8/8/11	**Date Completed :** 10/8/11	**Logged by :** MP	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
182–198	Rotary Wash Boring	Nil						SILTSTONE, as previous			35.0 m - 231.0 m; Rewan Fmn		
200–206					199.00 (64.06)			SANDSTONE, grey, trace orange mottling, matrix supported, (silt, medium plasticity fines), fine grained sand, trace medium grained sand. From 203.0 to 207.0 m; coarse grained sand, iron staining and hardening of some sediments, dark red-brown.					
208–210					208.00 (55.06)			SILTSTONE, grey trace orange/red/dark red-brown mottling, high plasticity, trace fine grained sand.					
					210.00								

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Job No. **41-23244**

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C020P2

Position : 427850.0 E 7566934.0 N	**Surface RL:** 263.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 8/8/11	**Date Completed :** 10/8/11	**Logged by :** MP	**Date :**

DRILLING — Drilling Method: Rotary Wash Boring; Hole Support \ Casing: Nil

SCALE (m): 212, 214, 216, 218, 220, 222, 224, 226, 228, 230, 232, 234, 236, 238, 240

Depth / (RL) metres	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Comments/ Observations
(53.06)	SANDSTONE, grey, matrix supported, high plasticity (clay/silt), very fine to fine grained sand, trace medium grained sand.	35.0 m - 231.0 m; Rewan Fmn
215.00 (48.06)	SILTSTONE, grey, very fine grained sand, trace fine to medium grained sand.	
221.00 (42.06)	SILTSTONE, dark grey, high plasticity fines, very fine grained sand, returning as shards.	
231.00 (32.06)	SANDSTONE, grey, matrix supported, medium plasticity fines (silt), fine grained sand, trace medium to coarse grained sand.	231.0 m - 267.0 m; Permian
236.00 (27.06)	SILTSTONE, grey, orange/dark red-brown mottling, some iron hardening in places, very fine to fine grained sand, trace medium to coarse grained sand.	

PIEZOMETER — Piezometer Log; Components

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C020P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 9 OF 9**	
Position : 427850.0 E 7566934.0 N	**Surface RL:** 263.1m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 8/8/11	**Date Completed :** 10/8/11	**Logged by :** MP	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
242–254	Rotary Wash Boring	Nil						SILTSTONE, as previous			231.0 m - 267.0 m; Permian		Bentonite
256–260					255.00 (8.06)			COAL, black, vitreous, breaks into small shards.			AB Seam		Filter pack; Screen
262					261.00 (2.06)			SILTSTONE, grey, some carbonaceous material present.					End cap
264					263.00 (0.06)			COAL, black, vitreous, breaks into small shards.					
266					264.50 (-1.44)			SILTSTONE, grey, trace orange/red mottling, trace fine grained sand, trace medium grained sand, some carbonaceous material present.					
268–270					267.00 (-3.94)			End of borehole at 267.0 m. Piezometer installed.					

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Job No. **41-23244**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C022P1

SHEET 1 OF 3

Client :	Adani Mining Pty Ltd				
Project :	Carmichael Coal Mine Project				
Location :	, EPC1690				
Position :	426816.0 E 7565958.0 N	**Surface RL:** 273.8m	**Angle from Horiz. :** 90°		**Processed :** VLD
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :**		**Checked :**
Date Started :	11/8/11	**Date Completed :** 12/8/11	**Logged by :** MP		**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
0–1	Percussion Air Hammer (0–23)	Nil						SANDSTONE, matrix supported, orange, fine grained sand, with medium to coarse grained sub-angular sand, completely weathered.			0.0 m - 67.0 m: Dunda Beds		Completed with steel monument
1–5					1.00 (272.76)			SANDSTONE, pale grey-brown, orange/red/dark brown mottling/staining in places, some iron hardening, very fine to fine grained sand.					
5–30	Rotary Wash Boring (23–30)		GNO		5.00 (268.76)			SANDSTONE, grain supported, pale orange-yellow, trace orange/red mottling, fine to medium grained sand, trace coarse grained sub-angular to sub-rounded sand, quartz and lithic grains. From 11.0 m; pale red-brown, increase in orange/yellow mottling. From 17.0 to 18.0 m; completely stained dark orange-brown, yellow/orange/red mottling. From 18.0 to 19.5 m; pale orange-yellow, yellow/orange/red mottling, staining of quartz grains. From 19.5 m; completely stained dark orange-brown, orange/red mottling.					50mm PVC casing, with cement-bentonite

Scale marks: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

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Job No. **41-23244**

Client : Adani Mining Pty Ltd			**HOLE No. C022P1**
Project : Carmichael Coal Mine Project			**SHEET 2 OF 3**
Location : , EPC1690			
Position : 426816.0 E 7565958.0 N	**Surface RL:** 273.8m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :**	**Checked :**
Date Started : 11/8/11	**Date Completed :** 12/8/11	**Logged by :** MP	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Rotary Wash Boring	Nil						SANDSTONE, as previous.			0.0 m - 67.0 m: Dunda Beds		grout
40								From 40.0 m; matrix/grains 50/50, high plasticity fines, stained dark red, orange/yellow/red mottling, fine angular to subangular quartz gravel (translucent, white/yellow).					
47								From 47.0 m; completely stained dark brown-red.					
54								From 54.0 m; orange-yellow red/orange mottling, decrease in staining, increase in coarse grained sand content.					
58					58.00 (215.76)			SANDSTONE, grain supported, stained					
59					59.00 (214.76)			red-brown/orange, medium to coarse grained sand, trace fine					Bentonite

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Job No. 41-23244

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C022P1**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 3 OF 3**	
Position : 426816.0 E 7565958.0 N	**Surface RL:** 273.8m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :**	**Checked :**
Date Started : 11/8/11	**Date Completed :** 12/8/11	**Logged by :** MP	**Date :**

DRILLING					MATERIAL							PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	**Description** SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	**Comments/ Observations**	Piezometer Log	**Components**
62–64	Rotary Wash Boring	Nil						grained sand, predominately quartz, trace fine angular to sub-angular gravel, hard capping/iron crust			0.0 m - 67.0 m: Dunda Beds		
								SANDSTONE, pale red, grain supported, well graded, medium grained sand, trace fine and coarse grained sand, predominately quartz grains, some volcanic grains.					Filter pack Screen
					64.50 (209.26)			After 60.0 m - colour change to pale grey-yellow, very little fines.					
					65.00 (208.76)			SANDSTONE, pale grey, matrix supported, high plasticity fines (silt), fine grained sand with medium to coarse grained sand.					
					67.00 (206.76)			SANDSTONE, pale grey, trace red mottling, grain supported (>25% fines), medium grained sand, with fine grained sand, trace coarse grained sand.					End cap
68–90								End of borehole at 67.0 m. Piezometer installed.					

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C024P3

SHEET 1 OF 2

Client :	Adani Mining Pty Ltd				
Project :	Carmichael Coal Mine Project				
Location :	, EPC1690				
Position :	428910.0 E 7571759.0 N	**Surface RL:** 258.6m	**Angle from Horiz. :** 90°		**Processed :** VLD
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Glen		**Checked :**
Date Started :	15/8/11	**Date Completed :** 15/8/11	**Logged by :** MP		**Date :**

DRILLING — SCALE (m); Drilling Method; Hole Support \ Casing; Water; Samples & Tests

MATERIAL — Depth / (RL) metres; Graphic Log; USC Symbol; **Description** (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength); Moisture Condition; Consistency / Density Index

Comments/ Observations

PIEZOMETER — Piezometer Log; **Components**

Drilling Method (0.0–30.0 m): Rotary Wash Boring (bit, 6 inch)

Hole Support \ Casing: Nil

Depth / (RL) metres	Description	Comments/ Observations
	Sandy SILT, orange-brown, yellow/orange/red mottling, iron nodules (<5mm), fine grained sand, trace medium grained sand, low plasticity fines. From 2.0 m; colour change to pale grey with significant pale brown-orange staining, yellow/orange/red mottling, medium to coarse grained angular to sub-angular sand.	0.0 m - 19.0 m; Tertiary
4.50 (254.09)	SANDSTONE, matrix supported (medium plasticity silt), pale grey, heavily stained pale yellow-brown, orange/yellow/red mottling, very fine to fine grained sand, trace medium grained sand. From 8.0 m; increase in medium to coarse grained sand content.	
11.00 (247.59)	CLAYSTONE/SILTSTONE, leached, white, trace orange-yellow staining, some silt, trace very fine to fine grained sand. From 13.0 m; significant orange/yellow/dark orange/red mottling.	
	From 15.0 to 17.0 m; heavily stained pale orange-brown and pale red-brown.	
	From 19.0 to 26.0 m; white, heavily stained pale grey-red (purple) and pale orange.	19.0 m - 49.0 m; Permian. Inferred from reinterpretation of geology.
	From 26.0 to 27.5 m; heavily stained dark orange, orange/yellow/red mottling.	

Piezometer Components:
- Completed with steel monument
- 50mm PVC casing, with cement-bentonite grout

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Job No. **41-23244**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C024P3

Position : 428910.0 E 7571759.0 N		**Surface RL:** 258.6m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000	**Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Glen	**Checked :**
Date Started : 15/8/11	**Date Completed :** 15/8/11		**Logged by :** MP	**Date :**

Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Components
Rotary Wash Boring (bit, 6 inch)	Nil	GNO					From 30.0 to 32.0 m; white, some staining of pale brown. From 32.0 to 33.0 m; pale brown, trace orange/yellow mottling. From 33.0 to 34.0 m; purple-brown. From 34.0 to 36.0 m; pale grey, trace pale red/orange mottling. From 36.0 to 37.5 m; dark grey, trace orange mottling.			19.0 m - 49.0 m; Permian. Inferred from reinterpretation of geology.	
				37.50 (221.09)			SILTSTONE, pale orange-brown, trace orange/yellow/red/dark brown-red mottling, very fine to fine grained sand, crumbles into powder. From 38.0 m; pale grey-red. From 41.0 to 42.0 m; pale yellow-brown. From 42.0 to 43.0 m; heavily stained pale orange-brown.				
				44.00 (214.59)			COAL, black-dark brown, dull, soft, some vitreous shards, interbedded with CARBONACEOUS SILTSTONE; dark brown.			D3 Seam	Bentonite; Filter pack; Screen
				48.00 (210.59)			SILTSTONE, grey, trace fine grained sand, some carbonaceous material present (dark brown-black).				End cap; Hole Collapse
				49.00 (209.59)			End of borehole at 49.0 m. Piezometer installed.				

SCALE (m): 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

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Job No. **41-23244**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C025P1**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 1 OF 1**	
Position : 438017.0 E 755846.0 N	**Surface RL:** 227.5m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Stacy	**Checked :**
Date Started : 17/8/11	**Date Completed :** 17/8/11	**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
0–11	Rotary Wash Boring (Step bit, 6 inch)	Nil			1.00 (226.54)			LATERITE, orange-brown, fine and medium sized sub-rounded nodules, iron rich, silt, trace fine grained sand.			0.0 m - 11.0 m; Tertiary		Completed with steel monument; 50mm PVC casing, with cement-bentonite grout
					3.00 (224.54)		CH	Sandy CLAY, orange, yellow-orange and pale grey mottled, trace fine grained sand. High plasticity. (Extremely weathered SANDSTONE).					
					4.00 (223.54)		SC	Clayey SAND, Orange, yellow-orange and pale grey mottled, fine grained sand. (Extremely weathered SANDSTONE)					Bentonite
			GNO		11.00 (216.54)		CH	Sandy CLAY, fine grained sand, high plasticity. (Extremely weathered SANDSTONE)					Filter pack; Screen; End cap
								End of borehole at 11 m. Piezometer installed.					

Scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C025P2

Position : 438013.0 E 7555846.0 N	**Surface RL:** 227.5m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Stacy	**Checked :**
Date Started : 17/8/11	**Date Completed :** 17/8/11	**Logged by :** RB	**Date :**

DRILLING — Drilling Method: Rotary Wash Boring (Step bit, 6 inch); Hole Support \ Casing: Nil; Water: GNO; Samples & Tests: –

MATERIAL

Depth / (RL) metres	USC Symbol	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations
0.00		LATERITE, brown-red, fine and medium gravel sized sub-rounded nodules of iron rich material, silt, trace fine grained sand. From 1-2 m; Orange - brown			0.0 m- 41.0 m; Tertiary
2.00 (225.48)	CH	Sandy CLAY, orange yellow-orange and pale grey mottled, fine grained sand. High plasticity. (Extremely weathered SANDSTONE)			
4.00 (223.48)	SC	Clayey SAND, Orange-red, yellow-orange and pale grey mottled, fine grained sand. (Extremely weathered SANDSTONE)			
5.00 (222.48)	CH	Very Sandy CLAY Pale grey with orange mottling, fine grained sand. (Extremely weathered SANDSTONE)			
11.00 (216.48)	CH	CLAY, pale green-grey trace brown-orange mottle, trace fine-grained sand, high plasticity. At 15 m; pale grey-green, smooth From 16 to 18 m; trace black brittle material (carbon) up to 8 mm length (elongate, flat) organic looking.			

SCALE (m): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

PIEZOMETER — Components:
- 0.0 m: Completed with steel monument
- approx. 14.5 m: 50mm PVC casing, with cement-bentonite grout

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 7/11/12

Client : Adani Mining Pty Ltd		**HOLE No. C025P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 2 OF 2**	
Position : 438013.0 E 7555846.0 N	**Surface RL:** 227.5m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Stacy	**Checked :**
Date Started : 17/8/11	**Date Completed :** 17/8/11	**Logged by :** RB	**Date :**

DRILLING					MATERIAL							PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	**Description** SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	**Comments/ Observations**	Piezometer Log	**Components**
30–32	Rotary Wash Boring (Step bit, 6 inch)	Nil						From 30 m; trace carbon			0.0 m- 41.0 m; Tertiary		Bentonite
32–39					32.00 (195.48)			Leached rock, pale grey-brown, fine grained (silt sized), silicified chips in clay matrix. Returns as gravely CLAY. (SILTSTONE?) From 33 to 35 m; pink-red, white with yellow and orange and pink-red staining, trace to some clay. From 35 to 39 m; significant clay.					Filter pack; Screen; End cap; Filter pack
39–41					39.00 (188.48)			FERRICRETE, pink brown, hard fine grained chips (iron rich), some clay.					
41					41.00 (186.48)			End of borehole at 41 m. Piezometer installed.					

Scale: 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

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GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 7/11/12

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C027P1**
Project : Carmichael Coal Mine Project		
Location : , EPC1690		**SHEET 1 OF 1**
Position : 433645.0 E 7554821.0 N	**Surface RL:** 227.6m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Stacey	**Checked :**
Date Started : 21/8/11	**Date Completed :** 21/8/11	**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
0–3	Rotary Wash Boring (Step, 6 inch bit)	Nil	GNO				SP	SAND, brown-orange, fine grained, trace silt, trace clay. From 2 to 3 m, fine and medium grained, no silt, no clay.			0.0 m - 13.0 m; Alluvium		Completed with steel monument; 50mm PVC casing, with cement-bentonite grout
3–12					3.00 (224.63)		SP	SAND with gravel, orange brown and pale grey mottled, medium and coarse grained sand, trace fine sand, trace clay. Gravel is fine grained, all grains are quartz (white, grey, pink-orange, pink, orange), sub-angular and sub-rounded. (ALLUVIUM) From 7 to 8 m; some CLAY From 7 m; trace ferricrete (dark orange-brown, angular and sub-angular, fine gravel sized, fine grained) From 8 to 10 m; no clay, some ferricrete as described above. From 10 to 12 m; clayey					Bentonite; Filter pack; Screen; End cap
12–13					12.00 (215.63)		CI	Sandy CLAY, pale grey with orange mottles, trace whisps orange-red in colour. Fine grained sand, trace medium grained sand. Fines include needles, specks and sub-rounded grains. Trace coarse angular sand sized extremely weathered to highly weathered siltstone (orange-brown, fine grained). Fines include needles, specks, and sub-rounded grains. Trace ferricrete (fine sized gravel), trace quartz (fine sized gravel), possibly contamination from above. (ALLUVIUM)					
					13.00 (214.63)			End of borehole at 13 m. Piezometer installed.					

Scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

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Client : Adani Mining Pty Ltd			**HOLE No. C027P2**	
Project : Carmichael Coal Mine Project				
Location : , EPC1690			**SHEET 1 OF 2**	
Position : 433649.0 E 7554820.0 N	**Surface RL:** 227.6m	**Angle from Horiz. :** 90°		**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Stacey		**Checked :**
Date Started : 20/8/11	**Date Completed :** 20/8/11	**Logged by :** RB		**Date :**

DRILLING — Drilling Method: Rotary Wash Boring (step 6 inch bit to 26 m and PDC 6 inch bit to 32.8 m); Water: GNO

MATERIAL

Depth / (RL) metres	USC Symbol	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Comments/ Observations
0.00	SP	SAND, orange-brown, fine grained, trace silt, trace clay. (ALLUVIUM)	
1.00 (226.56)	SP-SC	Clayey SAND, orange-brown, fine grained. (ALLUVIUM)	0.0 m - 12.0 m; Alluvium
4.00 (223.56)	SP	SAND with Gravel, brown-orange with pale grey mottle, trace fine grained sand, trace clay. Fine sub-rounded and sub-angular gravel, predominantly quartz. Trace fine grained iron rich material (ferricrete nodules). (ALLUVIUM) From 5 to 8 m; some clay From 7 to 8 m; trace fine gravel From 8 to 10 m; sand with gravel, trace clay (as at 4 m) (ALLUVIUM)	
10.00 (217.56)	SP-SC	Clayey SAND with Gravel, brown-orange with trace pale grey mottle, medium and coarse grained sand, trace fine sand. Gravel is fine and all grains sub-angular and sub-rounded, predominantly quartz, trace ferricrete. (ALLUVIUM)	
12.00 (215.56)	SC	Clayey SAND/Sandy CLAY, pale brown-grey and grey to orange, fine and medium grained sand, wisps of pink-red clay. Grains include grey quartz (sub-rounded) and grey needles and flecks of material. Trace fine sub-angular and sub-rounded quartz gravel (contamination?) and fine grained siltstone/ ferricrete (contamination?). (SANDSTONE)	12.0 m - 32.8 m; Dunda Beds
19.00 (208.56)	SC	SAND with Clay, pale grey-brown, fine and medium grained, trace coarse grains. Quartz (grey and pink-orange). Trace fine grained sub-angular and sub-rounded quartz (as sand grains, as 4 to 10 m) possible contamination. (SANDSTONE)	
21.00 (206.56)	SC	Clayey SAND/Sandy CLAY, as 19 to 21 m. (SANDSTONE)	
24.00 (203.56)	CI	Sandy CLAY, pale grey, fine and medium grained sand (as 19 to 21 m). (SANDSTONE)	
26.00 (201.56)		Iron rich Hardpan, pale green-grey-brown with orange-brown, yellow, red-brown and black staining and wisps of colour. Fine and medium grained (quartz)	

SCALE (m): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

PIEZOMETER — Components:
- Completed with steel monument
- 50mm PVC casing, with cement-bentonite grout
- Bentonite
- Filter pack

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Job No. 41-23244

Client : Adani Mining Pty Ltd		**HOLE No. C027P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 2 OF 2**	
Position : 433649.0 E 7554820.0 N	**Surface RL:** 227.6m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Stacey	**Checked :**
Date Started : 20/8/11	**Date Completed :** 20/8/11	**Logged by :** RB	**Date :**

DRILLING					MATERIAL							PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	**Description** SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	**Comments/ Observations**	Piezometer Log	**Components**
32					32.80 (194.76)			sandstone and siltstone. (SANDSTONE and SILTSTONE) Iron rich Hardpan, as previous			12.0 m - 32.8 m; Dunda Beds		Screen End cap Hole Collapse
34								End of borehole at 32.8 m. Piezometer installed.					
36													
38													
40													
42													
44													
46													
48													
50													
52													
54													
56													
58													
60													

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 7/11/12

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C029P1

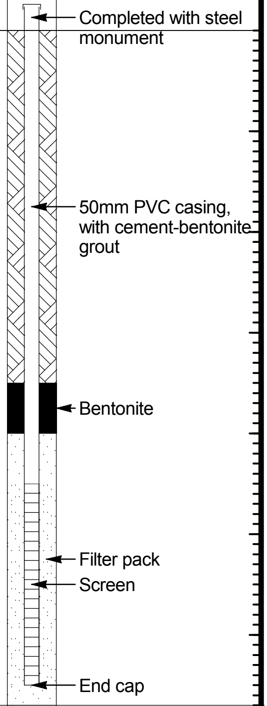
SHEET 1 OF 1

Position : 437695.0 E 7555078.0 N		**Surface RL:** 225.4m		**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000	**Mounting:** Truck	**Contractor :** Watson Drilling		**Driller :** Stacey	**Checked :**
Date Started : 21/8/11		**Date Completed :** 21/8/11		**Logged by :** RB	**Date :**

DRILLING: Drilling Method: Rotary Wash Boring (Step bit, 6 inch); Hole Support \ Casing: Nil; Water: GNO

Depth / (RL) metres	USC Symbol	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations
0.00 – 2.00 (223.44)	SP-SM	Silty SAND, orange-brown, fine grained, trace clay. (ALLUVIUM)			0.0 m - 13.4 m; Alluvium
2.00 – 5.00 (220.44)	CH	Sandy CLAY, orange-brown and pale pale grey mottled (high plasticity), Fine and medium grained sand. clay. Trace coarse sand and fine sized gravel of carbon rich material. (ALLUVIUM)			
5.00 – 6.00 (219.44)	SC	Clayey SAND, orange and pale grey mottled, fine and medium grained sand. (ALLUVIUM)			
6.00 – 9.00 (216.44)	SC	Sandy CLAY, orange-brown and pale pale grey mottled, trace brown mottle. Trace spots of dark grey (carbon rich) fine and medium grained sand. Some lumps of material appear semi-consolidated. (ALLUVIUM)			
9.00 – 11.00 (214.44)	SP-SC	SAND, orange and pale grey mottled, fine and medium grained, trace clay, trace coarse sand and fine gravel (sub-rounded and sub-angular, pink and grey). (ALLUVIUM)			
11.00 – 13.40 (212.04)	SC	SAND with Clay, as above with clay. (ALLUVIUM)			
13.40		End of borehole at 13.4 m. Piezometer installed.			

PIEZOMETER



SCALE (m): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

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Job No. 41-23244

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C029P2

Client :	Adani Mining Pty Ltd				
Project :	Carmichael Coal Mine Project				
Location :	, EPC1690				
Position :	437689.0 E 7555078.0 N	**Surface RL:** 225.4m	**Angle from Horiz. :** 90°	**Processed :** VLD	
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Stacey	**Checked :**	
Date Started :	21/8/11	**Date Completed :** 21/8/11	**Logged by :** RB	**Date :**	

DRILLING — Drilling Method: Rotary Wash Boring (Step bit, 6 inch); Hole Support \ Casing: Nil; Water: GNO; Samples & Tests: –

MATERIAL

Depth / (RL) metres	USC Symbol	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index
0.00	SM	Silty SAND, orange-brown, fine and medium grained sand, trace clay. (ALLUVIUM)		
3.00 (222.37)	CH	Sandy CLAY, orange-brown and pale grey mottled (high plasticity). Fine and medium grained sand. Trace black coarse sand and fine gravel sized carbonised material (disintegrates when rubbed), including elongated wood like piece. From 6 to 8 m; rare coarse grained sand and fine gravel (quartz sub-angular, pale pink and grey). (ALLUVIUM)		
8.00 (217.37)	SC	SAND with Clay, pale brown-grey with orange mottle. Some wavey laminations 1 to 5 mm width (orange, sand dominated). Fine and medium-grained sand. Trace dark grey spots (carbon rich). (ALLUVIUM)		
10.00 (215.37)	SP	SAND, as above, trace clay From 11 m to 12 m- trace coarse sand and fine gravel (quartz, grey, white, pale yellow). Trace ferricrete (coarse grained sand and fine gravel in size, fine grained, orange and brown, hard, sub-angular)		
12.00 (213.37)	CH	Sandy CLAY, grey-green-brown, high plasticity, fine and medium grained sand. Trace medium gravel of laterite nodules and ferricrete (orange and brown, fine grained, iron rich). (ALLUVIUM)		
13.00 (212.37)	CH	CLAY, grey trace red-brown. High plasticity, trace black smearing (carbonaceous), smooth. (ALLUVIUM) From 29 to 30 m; dark grey-brown colour.		

Comments/ Observations: 0.0 m - 37.8 m; Alluvium

PIEZOMETER — Components:
- Completed with steel monument
- 50mm PVC casing, with cement-bentonite grout

Scale (m): 0 – 30

See standard sheets for details of abbreviations & basis of descriptions

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Job No. 41-23244

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 7/11/12

Client : Adani Mining Pty Ltd		**HOLE No. C029P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 2 OF 2**	
Position : 437689.0 E 7555078.0 N	**Surface RL:** 225.4m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Stacey	**Checked :**
Date Started : 21/8/11	**Date Completed :** 21/8/11	**Logged by :** RB	**Date :**

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SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
32–36	Rotary Wash Boring (Step bit, 6 inch)	Nil						From 30 to 31 m; dark brown colour. From 31 to 38 m; grey-brown colour.			0.0 m - 37.8 m; Alluvium		Bentonite
38					37.80 (187.57)			FERRICRETE, grey with significant yellow, orange, black and dark red-pink staining, black-brown spider veining, trace medium grained rock. Trace chips with no visible grains.			37.8 m - 40.0 m; Tertiary		Filter pack; Screen
40–44					40.00 (185.37)			Bleached / Leached ROCK, pale grey with some yellow and orange staining, fine grained, hard. From 41 m; returning as CLAY medium plasticity with trace black specks / fines of carbon and fine sand (quartz). From 41 to 43 m; with fine gravel and coarse sand sized chips of bleached / leached rock			40.0 m - 46.0 m; Permian		End cap
46					46.00 (179.37)			End of borehole at 46 m. Piezometer installed.					
48													
50													
52													
54													
56													
58													
60													

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Job No. 41-23244

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C032P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 1 OF 9**	
Position : 439407.0 E 7544895.0 N	**Surface RL:** 256.2m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Stacey / Shaun	**Checked :**
Date Started : 23/8/11	**Date Completed :** 23/8/11	**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
0–5	Rotary Wash Boring (PDC 6 inch bit)	Nil					SM	Silty SAND, orange, yellow and pale brown mottled. Fine, medium and coarse grained sand (quartz, sub-angular and sub-rounded, pink, orange, grey). Some fine gravel (quartz, and laterite nodules). Trace clay from 1m. (ALLUVIUM)			0.0m - 5.0m; Alluvium		Completed with steel monument
5–7					5.00 (251.22)			Laterite GRAVEL, dark orange-brown with yellow-orange and red-pink mottles. Gravel is fine and medium grained rock. Some silt.			5.0m - 52.5m; Tertiary		
7–8					7.00 (249.22)			SANDSTONE, pale green, fine and medium grained in very fine grained/no visible grains matrix. Brittle. Leached.					
8–18.5					8.00 (248.22)			SANDSTONE, pale green, fine and medium grained in clay matrix, high plasticity. Extremely weathered.					
18.5–22					18.50 (237.72)			SANDSTONE, pale green-grey, fine grained, trace medium grained sand. Returning as sandy CLAY; high plasticity. Carbon pieces and grey patches; fine sand up to fine gravel sized. Extremely weathered.					
22–30			GNO		22.00 (234.22)			SANDSTONE, pale brown-green with orange mottles, medium grained. Returning as clayey SAND (quartz, sub-angular and sub-rounded, pink, orange, grey, colourless), black specs (carbon). Extremely weathered.					
30					30.00								

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Job No. 41-23244

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C032P2

Position : 439407.0 E 7544895.0 N	**Surface RL:** 256.2m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Stacey / Shaun	**Checked :**
Date Started : 23/8/11	**Date Completed :** 23/8/11	**Logged by :** RB	**Date :**

Depth / (RL) metres	Description	Comments/ Observations
(226.22)	SANDSTONE with Ferricrete, pale pink, cream and orange-brown mottled. Sandstone is medium grained, trace coarse grained sand, black specs (carbon) returning as clayey SAND. Ferricrete is pink-red with dark red and purple staining, hard, iron-rich.	5.0m - 52.5m; Tertiary
35.00 (221.22)	FERRICRETE, orange-pink, fine grained, iron-rich. Silt. (SILTSTONE)	
38.00 (218.22)	SILTSTONE, dark orange-pink, fine grained, gritty (black and orange-pink), iron-rich. Disintegrates to clay. Extremely weathered.	
	From 42m; Pink and white mottled with marble effect, slightly grainy. Returns as CLAY, high plasticity.	
		52.0m - 243.5m; Rewan Fmn
	Interbedded SILTSTONE and SANDSTONE. Sandstone is orange, fine and medium grained. Siltstone is dark orange-pink. Extremely weathered.	

Drilling Method: Rotary Wash Boring (PDC 6 inch bit)
Hole Support \ Casing: Nil

Scale (m): 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

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Job No. 41-23244

Client : Adani Mining Pty Ltd		**HOLE No. C032P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690			
Position : 439407.0 E 7544895.0 N	**Surface RL:** 256.2m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Stacey / Shaun	**Checked :**
Date Started : 23/8/11	**Date Completed :** 23/8/11	**Logged by :** RB	**Date :**

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SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
62–72	Rotary Wash Boring (PDC 6 inch bit)	Nil									5.0m - 81.5m; Tertiary		
72–81.5					72.00 (184.22)			SANDSTONE, brown-pink with trace orange-brown and orange-yellow mottles. Fine grained sand. Returning as sandy CLAY, high plasticity. Extremely weathered.					
81.5–90					81.50 (174.72)			CLAY, blue-grey, high plasticity, slightly grainy, trace carbon (black fine grained sand size). (Extremely weathered siltstone/claystone / pre-consolidated material)					

Scale (m): 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90

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Job No. 41-23244

Client : Adani Mining Pty Ltd		**HOLE No. C032P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 4 OF 9**	
Position : 439407.0 E 7544895.0 N	**Surface RL:** 256.2m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Stacey / Shaun	**Checked :**
Date Started : 23/8/11	**Date Completed :** 23/8/11	**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Rotary Wash Boring (PDC 6 inch bit)	Nil						CLAY, as previous			52.0m - 243.5m; Rewan Fmn		
92													
94													
96													
98													
100													
102													
104													
106													
108													
110													
112													
114													
116													
118													
120													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd				**HOLE No. C032P2**
Project : Carmichael Coal Mine Project				
Location : , EPC1690				**SHEET 5 OF 9**
Position : 439407.0 E 7544895.0 N	**Surface RL:** 256.2m		**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling		**Driller :** Stacey / Shaun	**Checked :**
Date Started : 23/8/11	**Date Completed :** 23/8/11		**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
122	Rotary Wash Boring (PDC 6 inch bit)	Nil						CLAY, as previous From 122 to 135m; with dark brown-red mottles			52.0m - 243.5m; Rewan Fmn		
124													50mm PVC casing, with cement-bentonite grout
126													
128													
130													
132													
134													
136													
138													
140								From 141 to 145m; with dark brown-red mottles					
142													
144													
146													
148													
150													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C032P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 6 OF 9**	
Position : 439407.0 E 7544895.0 N	**Surface RL:** 256.2m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Stacey / Shaun	**Checked :**
Date Started : 23/8/11	**Date Completed :** 23/8/11	**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
150–169	Rotary Wash Boring (PDC 6 inch bit)	Nil						CLAY, as previous			52.0m - 243.5m; Rewan Fmn		
169–180								From 169m; with chips of SILTSTONE/CLAYSTONE. Dark grey, very fine grained, brittle.					

Scale: 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180

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Client : Adani Mining Pty Ltd		**HOLE No. C032P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 7 OF 9**	
Position : 439407.0 E 7544895.0 N	**Surface RL:** 256.2m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Stacey / Shaun	**Checked :**
Date Started : 23/8/11	**Date Completed :** 23/8/11	**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
182–208	Rotary Wash Boring (PDC 6 inch bit)	Nil						CLAY, as previous			52.0m - 243.5m; Rewan Fmn		
208–210					208.00 (48.22)			SANDSTONE and SILTSTONE grey and pale grey, interbedded. Sandstone is fine grained (quartz, slightly					

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C032P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 8 OF 9**	
Position : 439407.0 E 7544895.0 N	**Surface RL:** 256.2m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Stacey / Shaun	**Checked :**
Date Started : 23/8/11	**Date Completed :** 23/8/11	**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Rotary Wash Boring (PDC 6 inch bit)	Nil						sugary texture) SANDSTONE and SILTSTONE interbedded, as previous			52.0m - 243.5m; Rewan Fmn		
212													
214													
216													
218													
220													
222													
224													
226													
228													
230													
232													
234													
236													
238								From 238m; grey.					
240													

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Job No. **41-23244**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C032P2

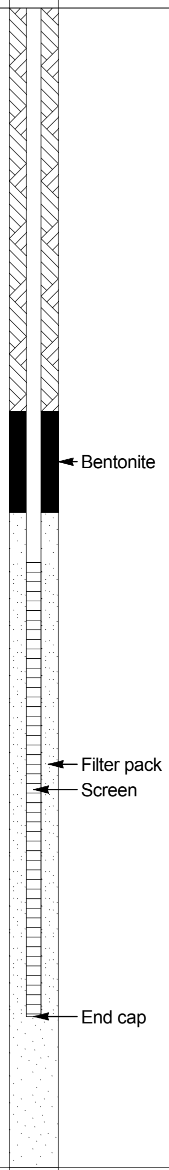
SHEET 9 OF 9

Client :	Adani Mining Pty Ltd				
Project :	Carmichael Coal Mine Project				
Location :	, EPC1690				
Position :	439407.0 E 7544895.0 N	**Surface RL:** 256.2m	**Angle from Horiz. :** 90°		**Processed :** VLD
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Stacey / Shaun		**Checked :**
Date Started :	23/8/11	**Date Completed :** 23/8/11	**Logged by :** RB		**Date :**

Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations
Rotary Wash Boring (PDC 6 inch bit)	Nil					SANDSTONE and SILTSTONE interbedded, as previous			52.0m - 243.5m; Rewan Fmn
				243.50 (12.72)		Carbonaceous MUDSTONE, dark grey, very fine grained/no visible grains. Trace to some interbeds of siltstone; grey, fine grained. Trace interbeds of mudstone; pale brown, no visible grains. 246 to 246m; with some COAL interbeds; black, disintegrates.			243.5m - 263.0m; Permian AB Seam
						From 253 to 257m: trace to some COAL interbeds.			
				263.00 (-6.78)		End of borehole at 263m. Piezometer installed.			

SCALE (m): 242, 244, 246, 248, 250, 252, 254, 256, 258, 260, 262, 264, 266, 268, 270

PIEZOMETER — Piezometer Log / Components



Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C034P1

Position : 442384.0 E 7547816.0 N	**Surface RL:** 227.6m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 29/8/11	**Date Completed :** 29/8/11	**Logged by :** RB	**Date :**

DRILLING: Drilling Method: Rotary Wash Boring (bit, 6 inch); Hole Support \ Casing: Nil; Water: GNO

Depth / (RL) metres	USC Symbol	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations
0.00	SC	Clayey SAND, brown-orange, fine and medium grained sand, trace coarse grained sand, (quartz, sub-rounded), silt. Completely weathered			0.0m - 3.0m; Alluvium
3.00 (224.59)	CI	Sandy CLAY, pale grey-green with orange mottle (3 to 4 m), pale grey-green with pink-orange mottle (4 to 6 m). Medium grained and trace coarse grained sand (quartz), grey, orange, pink, yellow, sub-rounded. Extremely to highly weathered. (SANDSTONE)			3.0m - 44.0m; Tertiary
6.00 (221.59)	CH	CLAY, pale green-gey with orange-brown, trace medium-grained sand, firm, high plasticity. (SILTSTONE)		F	SWL above top of casing after installation
15.00 (212.59)	CH	CLAY, brown-green with pink-red mottles, high plasticity, stiff. (MUDSTONE) From 17 to 19 m, predominantly pink-red.		St	
23.00 (204.59)	CH	CLAY, green- grey, firm, high plasticity, smooth. (MUDSTONE) From 29 to 33 m, pale grey		F	

PIEZOMETER Components:
- Completed with steel monument
- 50mm PVC casing, with cement-bentonite grout

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Job No. 41-23244

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C034P1

Position : 442384.0 E 7547816.0 N		**Surface RL:** 227.6m	**Angle from Horiz. :** 90°		**Processed :** VLD
Rig Type : Bourne 1000	**Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan		**Checked :**
Date Started : 29/8/11		**Date Completed :** 29/8/11	**Logged by :** RB		**Date :**

DRILLING					MATERIAL							PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
30–44	Rotary Wash Boring (bit, 6 inch)	Nil						CLAY, as previous From 35 m to 37 m; with dark pink-red mottles, iron rich layers/laminations (residual mudstone/siltstone) From 41 to 43 m; pale grey-yellow From 43 to 44 m; with orange mottle		F	3.0m - 44.0m; Tertiary		
44–53					44.00 (183.59)		CH	CLAY, brown-grey with variable amounts of pink-red mottle, high plasticity, slightly grainy. Iron rich layers/laminations, smooth. Red-brown fine grained rock, iron rich. (SILTSTONE/MUDSTONE) From 51 to 52 m; ~ 50 % ferricrete			44.0m - 67m; Permian		
53–59					53.00 (174.59)		CH	CLAY, brown-grey trace orange-red mottle, high plasticity, firm, smooth. (MUDSTONE/ PRE-CONSOLIDATED MUDSTONE)					Bentonite
59–60					59.00 (168.59)			SANDSTONE, pale pink, pink and pale grey, fine and					

Scale: 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

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Client : Adani Mining Pty Ltd		**HOLE No. C034P1**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 3 OF 3**	
Position : 442384.0 E 7547816.0 N	**Surface RL:** 227.6m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Ryan	**Checked :**
Date Started : 29/8/11	**Date Completed :** 29/8/11	**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
62–66	Rotary Wash Boring (bit, 6 inch)	Nil						medium grained, trace coarse grained (quartz, sub-rounded with some rounded needles and angular grains). Extremely weathered to highly weathered returning as Sandy CLAY, high plasticity, trace fine sized gravel (angular and sub-angular, quartz). From 66 to 67 m, returning as Clayey SAND			44.0m - 67m; Permian		Filter pack; Screen; End cap
68					67.00 (160.59)			End of borehole at 67 m. Piezometer installed.					

Scale: 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90

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Job No. 41-23244

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C034P3

Client :	Adani Mining Pty Ltd				
Project :	Carmichael Coal Mine Project				
Location :	, EPC1690				
Position :	442387.0 E 7547816.0 N	**Surface RL:** 227.5m	**Angle from Horiz. :** 90°	**Processed :** VLD	
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Glen	**Checked :**	
Date Started :	27/8/11	**Date Completed :** 27/8/11	**Logged by :** RB	**Date :**	

DRILLING — SCALE (m) | Drilling Method | Hole Support \ Casing | Water | Samples & Tests

MATERIAL — Depth / (RL) metres | Graphic Log | USC Symbol | Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength | Moisture Condition | Consistency / Density Index

Comments/ Observations

PIEZOMETER — Piezometer Log | Components

Drilling Method: Rotary Wash Boring (Chevron bit)

Hole Support \ Casing: Nil

Depth / (RL) metres	USC Symbol	Description	Comments/ Observations
0.00	SC	Clayey SAND, brown-orange, fine and medium grained, trace coarse grained sand (quartz, sub-rounded), silt.	0.0m - 3.0m; Quaternary Alluvium
3.00 (224.53)	CI	Sandy CLAY, 3 to 4m; Pale grey-green with orange mottles. 4 to 6m; Pale grey-green with pink-orange mottles. Medium grained, trace coarse grained sand (quartz, sub-rounded, grey, pink, orange, yellow). Extremely to highly weathered. (SANDSTONE)	3.0m - 45.0m; Tertiary SWL above top of casing after installation.
6.00 (221.53)	CI	CLAY, green-grey with orange-brown mottles. Some medium grained sand (quartz as 3 to 6m). (SILTSTONE) From 12m; trace medium grained sand From 14 to 16m; green-grey with red-brown mottles.	
16.00 (211.53)	CL	Sandy CLAY, red-brown and green-grey, medium and coarse grained sand (as 3 to 6m). Stiff to firm clay, low plasticity.	
18.00 (209.53)	CH	CLAY, red-brown, high plasticity, trace medium grained sand (quartz). (SILTSTONE)	
21.00 (206.53)	CH	CLAY, green-grey, high plasticity. (MUDSTONE)	

Piezometer Components: Completed with steel monument

Scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

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Job No. 41-23244

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C034P3**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 2 OF 4**	
Position : 442387.0 E 7547816.0 N	**Surface RL:** 227.5m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Glen	**Checked :**
Date Started : 27/8/11	**Date Completed :** 27/8/11	**Logged by :** RB	**Date :**

DRILLING					MATERIAL								PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations		Piezometer Log	Components
32–44	Rotary Wash Boring (Chevron bit)	Nil						CLAY, as previous 36 to 41m; with dark pink-red mottles. 44 to 45m; with dark grey and orange mottles.			3.0m - 45.0m; Tertiary			
45–58					45.00 (182.53)		CH	CLAY , brown-grey with trace to some (variable) dark pink-red mottles. Slightly grainy. (SILTSTONE)			45.0m - 113m; Permian			50mm PVC casing, with cement-bentonite grout
60					59.00 (168.53)			SANDSTONE, pale pink, pink and pale grey, fine and						

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Job No. 41-23244

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C034P3

Position : 442387.0 E 7547816.0 N	**Surface RL:** 227.5m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Glen	**Checked :**
Date Started : 27/8/11	**Date Completed :** 27/8/11	**Logged by :** RB	**Date :**

Depth / (RL) metres	USC Symbol	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Comments/ Observations
		medium grained sand (quartz, sub-rounded, some angular shards and needles, pale grey and pink). Returning as Sandy CLAY. Extremely weathered.	45.0m - 113m; Permian
		From 64 to 66m; with some brown-green clay; high plasticity, smooth, soft.	
69.00 (158.53)	CH	CLAY, brown-green, high plasticity, smooth, soft.	
71.00 (156.53)		SANDSTONE / SILTSTONE, SANDSTONE; pale pink and white, medium and coarse grained sand (quartz, sub-rounded and sub-angular, shards and needles).SILTSTONE; Grey, fine grained, trace iron staining, brittle. Extremely weathered.	
		77 to 83m; sandstone has some fine gravel (quartz, sub-rounded and sub-angular)	
		83 to 89m; sandstone is fine grained, returning as clay with some sand, high plasticity	
89.00 (138.53)	CH	CLAY, pale pink and white, high plasticity.	
90.00			

Drilling Method: Rotary Wash Boring (Chevron bit)
Hole Support \ Casing: Nil

SCALE (m): 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C034P3

Client :	Adani Mining Pty Ltd				
Project :	Carmichael Coal Mine Project				
Location :	, EPC1690				
Position :	442387.0 E 7547816.0 N	**Surface RL:** 227.5m	**Angle from Horiz. :** 90°	**Processed :** VLD	
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Glen	**Checked :**	
Date Started :	27/8/11	**Date Completed :** 27/8/11	**Logged by :** RB	**Date :**	

DRILLING: Drilling Method: Rotary Wash Boring (Chevron bit); Hole Support \ Casing: Nil; Water: groundwater level marker at 92 m.

Depth / (RL) metres	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Comments/ Observations
(137.53)	CARBONACEOUS MUDSTONE with COAL and MUDSTONE. MUDSTONE; Pale brown-green.	45.0m - 113m; Permian
92.00 (135.53)	CARBONACEOUS MUDSTONE; Black. COAL; Black. 90 to 92m; 25% coal, 25% carbonaceous mudstone, 50% mudstone. COAL with CARBONACEOUS MUDSTONE and MUDSTONE. MUDSTONE; Pale brown-green. CARBONACEOUS MUDSTONE; Black. COAL; Black. From 92 to 94m; 50% coal, 25% carbonaceous mudstone, 25% mudstone. From 94 to 95m; 98% coal, 1% carbonaceous mudstoneE, 1% mudstone. From 95 to 103m; 80% coal, 5% carbonaceous mudstone, 15% mudstone. From 103 to 106m; 98% coal, 1% carbonaceous mudstone, 1% mudstone.	Groundwater inflow at approximately 92.0 m, estimated at 3-4 L/s. D Seam
106.00 (121.53)	SILTSTONE, dark grey, fine grained. With interbeds of COAL (5%) and CARBONACEOUS MUDSTONE (5%); black.	
110.00 (117.53)	SANDSTONE, pale grey, coarse grained sand and fine gravel (quartz, sub-rounded and sub-angular). With trace interbeds of sandstone; grey, fine grained, and carbonaceous mudstone; dark grey.	
113.00 (114.53)	End of hole at 113m. Piezometer installed.	

PIEZOMETER Components: Bentonite; Filter pack; Screen; End cap

Scale (m): 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120

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Job No. 41-23244

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C035P1

Position : 441403.0 E 7546820.0 N	**Surface RL:** 236.3m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Shaun	**Checked :**
Date Started : 28/8/11	**Date Completed :** 28/8/11	**Logged by :** RB	**Date :**

DRILLING					MATERIAL							PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	**Description** SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Rotary Wash Boring (bit, 6 inch)	Nil	GNO				SP	SAND with Gravel, orange, medium and coarse grained sand (quartz, sub-angular and sub-rounded), fine gravel of quartz. Silt, trace clay.			0.0 m - 50.0 m; Tertiary		Completed with steel monument
					1.00 (235.31)		CH	Sandy CLAY, pale grey-brown and orange mottled, (high plasticity). Medium and coarse grained, trace fine sand (quartz).					
					5.00 (231.31)			SANDSTONE, pale grey and orange mottled, medium and coarse grained sand, trace fine gravel (quartz, sub-rounded and sub-angular). Returns as sandy clay. Extremely weathered.					
					10.50 (225.81)		CH	CLAY, green-grey and orange mottled, high plasticity. (Siltstone/ Mudstone)					
								From 23 to 26 m; with pink mottling					
								From 26 to 27 m; pink, trace grey-green colour					50mm PVC casing, with cement-bentonite grout
								From 27 to 30 m; with pink mottling					
30					30.00								

Scale (m): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : , EPC1690

HOLE No. C035P1

Position : 441403.0 E 7546820.0 N	**Surface RL:** 236.3m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Shaun	**Checked :**
Date Started : 28/8/11	**Date Completed :** 28/8/11	**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
30–40	Rotary Wash Boring (bit, 6 inch)	Nil			(206.31)		CH	CLAY, pale grey-green, high plasticity, stiff, smooth. (Pre-consolidated mudstone/ Siltstone)			0.0 m - 50.0 m; Tertiary		
40–50					40.00 (196.31)		CH	CLAY, brown-grey, high plasticity, firm, smooth. From 41 to 43 m; with red-brown clay, iron-rich layers / laminations. From 49 to 50 m; green-grey colour.					
50–60					50.00 (186.31)			SANDSTONE, pale brown-grey with orange mottles. Fine, medium and coarse grained sand (quartz, sub-angular, needles, pink, red, grey, yellow, white). Returns as sandy clay/clayey sand. Extremely weathered. Trace siltstone, highly weathered.			50.0 m - 62.0 m; Rewan Fmn		Bentonite; Filter pack; Screen

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Job No. 41-23244

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C035P1**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 3 OF 3**	
Position : 441403.0 E 7546820.0 N	**Surface RL:** 236.3m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Shaun	**Checked :**
Date Started : 28/8/11	**Date Completed :** 28/8/11	**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
		Nil						SANDSTONE, as previous			50.0 m - 62.0 m; Rewan Fmn		
62					62.00 (174.31)			End of borehole at 62 m Piezometer installed					End cap
64													
66													
68													
70													
72													
74													
76													
78													
80													
82													
84													
86													
88													
90													

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 7/11/12

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C035P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 1 OF 4**	
Position : 441405.0 E 7546827.0 N	**Surface RL:** 236.2m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Shaun	**Checked :**
Date Started : 27/8/11	**Date Completed :** 28/8/11	**Logged by :** RB	**Date :**

DRILLING				MATERIAL								PIEZOMETER	
SCALE (m) / Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations		Piezometer Log	Components
Rotary Wash Boring (bit, 6 inch)	Nil	GNO		1.00 (235.24)			SAND with Gravel, orange, medium and coarse grained sand, fine gravel (quartz, sub-rounded and sub-angular). Silt, trace clay			0.0 m - 50.0 m; Tertiary			Completed with steel monument
				8.00 (228.24)			Sandy CLAY, pale grey and orange mottled, high plasticity. Medium and coarse grained sand, trace fine gravel (quartz, sub-rounded and sub-angular).						
				12.00 (224.24)			SANDSTONE, pale grey and orange mottled, medium and coarse grained sand, trace fine gravel (quartz, sub-rounded and sub-angular). Returns as sandy clay. Extremely weathered.						
							CLAY, green-grey and orange mottled, high plasticity. (Siltstone/ mudstone)						
							From 17 to 22m; Green-grey with pink mottles.						
							From 26 to 31m; Pink with some green-grey mottles.						

Scale (m): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C035P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 2 OF 4**	
Position : 441405.0 E 7546827.0 N	**Surface RL:** 236.2m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Shaun	**Checked :**
Date Started : 27/8/11	**Date Completed :** 28/8/11	**Logged by :** RB	**Date :**

DRILLING					MATERIAL							PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	**Description** SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	**Comments/ Observations**	Piezometer Log	**Components**
32–48	Rotary Wash Boring (bit, 6 inch)	Nil			31.00 (205.24)			CLAY, pale grey-green, high plasticity, stiff, smooth.(Mudstone/ siltstone)			0.0m - 50.0 m; Tertiary		
					40.00 (196.24)			CLAY, brown-grey, high plasticity, firm, smooth. From 41 to 44m; With red-brown and orange clay (iron-rich layers/laminations). (Mudstone)					50mm PVC casing, with cement-bentonite grout
50–60					50.00 (186.24)			SANDSTONE, pale brown-grey with orange mottles. Fine, medium and coarse grained sand (quartz, sub-angular, needles, pink, red, grey, yellow, white). Returns as sandy clay/clayey sand. Extremely weathered. Trace siltstone, highly weathered.			50.0 m - 86.5 m; Permian		

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C035P2**	
Project : Carmichael Coal Mine Project			
Location : , EPC1690		**SHEET 3 OF 4**	
Position : 441405.0 E 7546827.0 N	**Surface RL:** 236.2m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Shaun	**Checked :**
Date Started : 27/8/11	**Date Completed :** 28/8/11	**Logged by :** RB	**Date :**

Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
Rotary Wash Boring (bit, 6 inch)	Nil						SANDSTONE, as previous			50.0 m - 86.5 m; Permian		
				72.00 (164.24)			CLAY, cream, high plasticity. Trace fine sand.					
							From 80 to 86.5m; Orange-brown with trace fine gravel size sandstone chips (orange, fine grained).					
				86.50 (149.74)			CLAY, Grey-brown, high plasticity, smooth. (Mudstone/ Pre-consolidated mudstone)			86.5 m - 110 m; Permian		

Scale (m): 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C035P2

Client :	Adani Mining Pty Ltd				
Project :	Carmichael Coal Mine Project				
Location :	, EPC1690				
Position :	441405.0 E 7546827.0 N	**Surface RL:** 236.2m	**Angle from Horiz. :** 90°		**Processed :** VLD
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Shaun		**Checked :**
Date Started :	27/8/11	**Date Completed :** 28/8/11	**Logged by :** RB		**Date :**

DRILLING | **MATERIAL** | **PIEZOMETER**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
92	Rotary Wash Boring (bit, 6 inch)	Nil						CLAY, as previous					
94					93.00 (143.24)			MUDSTONE and COAL, Grey-brown, high plasticity, smooth. (Mudstone/ Pre-consolidated mudstone) From 93 to 97m; Mudstone with coal.					
98								From 97 to 100m; coal with mudstone.					Bentonite
100								From 100 to 101m; Coal.			AB1 Seam		
102								From 101 to 107m; Coal with mudstone.					
106													Filter pack; Screen
108								From 107 to 110m; Mudstone with trace coal.					
110					110.00 (126.24)			End of borehole at 110m. Piezometer installed.					End cap
112													
114													
116													
118													
120													

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Job No. **41-23244**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C555P1

Position : 436146.0 E 7561468.0 N	**Surface RL:** 230.1m	**Angle from Horiz. :** 90°	**Processed :** CMM
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Leigh	**Checked :**
Date Started : 26/09/12	**Date Completed :** 26/09/12	**Logged by :** DK	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
0–4	Mud Rotary Wash Boring 6" step bit	Nil	GNO					Silty CLAY, pale brown, high plasticity					Completed with steel monument
4–25								From 4m; pale grey with pale brown banding at 20m and 30m					

Scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24

PRELIMINARY

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Job No. **41-24415-46**

GEO_BORE_PIEZO ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 08/11/12

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd			**HOLE No. C555P1**
Project : Carmichael Coal Mine Project			
Location : EPC 1690			**SHEET 2 OF 3**
Position : 436146.0 E 7561468.0 N	**Surface RL:** 230.1m	**Angle from Horiz. :** 90°	**Processed :** CMM
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Leigh	**Checked :**
Date Started : 26/09/12	**Date Completed :** 26/09/12	**Logged by :** DK	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
26–30	Mud Rotary Wash Boring 6" step bit	Nil											
30					30.00 (200.14)			CLAY, pale grey, stiff		St			
31.5													50mm PVC casing with bentonite/cement grout
42								From 42m; becoming dark grey					
45								From 45m; dark grey and white lensing					
49								From 49m; white with trace fine sand					

PRELIMINARY

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Client : Adani Mining Pty Ltd			**HOLE No. C555P1**
Project : Carmichael Coal Mine Project			
Location : EPC 1690			**SHEET 3 OF 3**
Position : 436146.0 E 7561468.0 N	**Surface RL:** 230.1m	**Angle from Horiz. :** 90°	**Processed :** CMM
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Leigh	**Checked :**
Date Started : 26/09/12	**Date Completed :** 26/09/12	**Logged by :** DK	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
52–68	Mud Rotary Wash Boring 6" step bit	Nil								St			Bentonite (approx. 63–65); Filter Pack
					69.00 (161.14)			Gravelly CLAY, yellow, fine to medium gravel, angular to subangular, trace fine to medium grained sand					Screen
					73.00 (157.14)			CLAY with Sand, yellow and white, fine grained					
					75.00 (155.14)			End of Hole at 75 m					End Cap
76													

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Job No. 41-24415-46

GEO_BORE_PIEZO ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 08/11/12

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C556P1

Position : 436524.1 E 7549882.0 N		**Surface RL:** 234.3m	**Angle from Horiz. :** 90°		**Processed :** CMM
Rig Type : Bourne 1000	**Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Leigh		**Checked :**
Date Started : 28/09/12	**Date Completed :** 28/09/12		**Logged by :** DK		**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Mud Rotary Wash Boring 6" step bit	Nil	GNO					Silty CLAY, pale orange - brown, soft		S			Completed with steel monument
4								From 4m; Low plasticity					
12								From 12m; with fragmented rock					
16								From 16m; pale grey					
20					20.00 (214.27)			CLAY, pale grey, stiff, high plasticity		St			
28					28.00 (206.27)			Silty CLAY pale white-grey, trace fine grained sand, angular					

Scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

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Job No. 41-24415-46

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C556P1

Position : 436524.1 E 7549882.0 N	**Surface RL:** 234.3m	**Angle from Horiz. :** 90°	**Processed :** CMM
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Leigh	**Checked :**
Date Started : 28/09/12	**Date Completed :** 28/09/12	**Logged by :** DK	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Components
32–36	Mud Rotary Wash Boring 6" step bit	Nil				From 33m; Increase in Silt				50mm PVC casing in bentonite/cement grout mix
38–40					37.00 (197.27)	Clayey SAND, white, medium and coarse grained sand, subangular, minor iron stone inclusion/ iron staining				
42–46					42.00 (192.27)	Sandy CLAY, pale grey, fine to medium sand, subangular, minor orange clay fragments				
48–52					47.00 (187.27)	Silty CLAY, orange, high plasticity				
54–60						From 54m; pale grey			Hole "collaring up"	

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

GEO_BORE_PIEZO ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 08/11/12

Client : Adani Mining Pty Ltd			**HOLE No. C556P1**	
Project : Carmichael Coal Mine Project				
Location : EPC 1690			**SHEET 3 OF 3**	
Position : 436524.1 E 7549882.0 N	**Surface RL:** 234.3m		**Angle from Horiz. :** 90°	**Processed :** CMM
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling		**Driller :** Leigh	**Checked :**
Date Started : 28/09/12	**Date Completed :** 28/09/12		**Logged by :** DK	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
62–70	Mud Rotary Wash Boring 6" step bit	Nil											
70	Mud Rotary Wash Boring 6" blade bit	Nil			70.00 (164.27)			Sandy CLAY, pale brown, high plasticity, fine sand			Slow drilling, hard ground		Bentonite Seal
72													Filter Pack
78								From 78m; pale grey - white, angular to subangular sand					Screen
82													End Cap
													Hole Collapse
83.3					83.30 (150.97)			End of Borehole at 83.3 m					

Scale (m): 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd			**HOLE No. C558P1**
Project : Carmichael Coal Mine Project			
Location : EPC 1690			**SHEET 1 OF 3**
Position : 430311.5 E 7566903.0 N	**Surface RL:** 216.1m	**Angle from Horiz. :** 90°	**Processed :** CMM
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Leigh	**Checked :**
Date Started : 21/09/12	**Date Completed :** 21/09/12	**Logged by :** RB	**Date :**

PRELIMINARY

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Mud Rotary Wash Boring 6" step bit	Nil	GNO					SAND with Clay, orange - brown, medium grained sand					Pipe stickup to 1.6m
					1.00 (215.07)			Clayey SAND, yellow-green, medium grained					
2													
								From 3m; brown and pale grey					
4													
6								From 6m; red-brown					
8													
								From 9m; with pale grey mottling					
10													
12								From 12m; with ferricrete bands, red-brown, fine grained, iron rich					
													50mm PVC casing in bentonite/ cement grout mix
14													
					15.00								

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Job No. **41-24415-46**

Client :	Adani Mining Pty Ltd			**HOLE No. C558P1**	
Project :	Carmichael Coal Mine Project				
Location :	EPC 1690			**SHEET 2 OF 3**	
Position :	430311.5 E 7566903.0 N	**Surface RL:** 216.1m	**Angle from Horiz. :** 90°	**Processed :** CMM	
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Leigh	**Checked :**	
Date Started :	21/09/12	**Date Completed :** 21/09/12	**Logged by :** RB	**Date :**	

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Mud Rotary Wash Boring 6" step bit	Nil			(201.07)			Sandy CLAY, pale grey - pink, fine and medium grained sand, trace to some ferricrete					
16													
18													
20													
22													
								From 23m; red with brown clay					
24													
					25.00 (191.07)			CLAY, red - brown, trace fine sand					
26													
								From 27m; with ferricrete					Bentonite seal
28													
					29.00 (187.07)			Sandy CLAY, red - brown and pale grey, fine grained sand with ferricrete (red - brown and purple, fine grained)					
30													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd			**HOLE No. C558P1**		
Project : Carmichael Coal Mine Project					
Location : EPC 1690			**SHEET 3 OF 3**		
Position : 430311.5 E 7566903.0 N		**Surface RL:** 216.1m	**Angle from Horiz. :** 90°		**Processed :** CMM
Rig Type : Bourne 1000	**Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Leigh		**Checked :**
Date Started : 21/09/12		**Date Completed :** 21/09/12	**Logged by :** RB		**Date :**

DRILLING					MATERIAL							PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	**Description** SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	**Comments/ Observations**	Piezometer Log	**Components**
	Mud Rotary Wash Boring 6" step bit	Nil						From 31m; pale grey - white with ferricrete					
32													
34													Screen
								From 35m; ferricrete absent					
36													
38					38.00 (178.07)			CLAY, pale grey - white with purple - pink, trace sand, high plasticity					
40													
					41.40 (174.67)			End of Hole at 41.4m					End Cap
42													
44													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C9553P1R

Position : 421010.1 E 7573975.0 N	**Surface RL:** 252.4m	**Angle from Horiz. :** 90°	**Processed :** CMM
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Leigh	**Checked :**
Date Started : 20/09/12	**Date Completed :** 21/09/12	**Logged by :** RB	**Date :**

DRILLING					MATERIAL								PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	**Description** SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	**Comments/ Observations**	Piezometer Log	**Components**
0–5	Mud Rotary Wash Boring 6" step bit	Nil	GNO					Clayey SAND, orange - brown with pale grey mottle, fine and medium grained sand with trace of silt					Completed with Steel Monument
5–10					5.00 (247.42)			SAND, red-orange brown with pale grey mottle, medium grained, trace clay, trace silt (Extremely weathered Sandstone) From 8m; ferricrete, orange - brown and purple - red, fine grained, iron rich					
10–22					10.00 (242.42)			Sandy CLAY, pale grey and red - brown, medium plasticity, fine and medium grained sand, trace of silt					
22–30					22.00 (230.42)			Clayey SAND, red - brown, orange - brown and pale grey, medium and coarse grained (quartz)					50mm PVC casing in bentonite / cement grout mix

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Job No. **41-24415-46**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C9553P1R

Position : 421010.1 E 7573975.0 N	**Surface RL:** 252.4m		**Angle from Horiz. :** 90°	**Processed :** CMM
Rig Type : Bourne 1000	**Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Leigh	**Checked :**
Date Started : 20/09/12	**Date Completed :** 21/09/12		**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
32–34	Mud Rotary Wash Boring 6" step bit	Nil											
36					36.00 (216.42)			Sandy CLAY, red - brown and pale grey mottle, medium grained and trace coarse grained sand (quartz)					
42								From 42m; pale grey - white					
51								From 51m; pink and pale grey - white, with fine quartz gravel					
54					54.00 (198.42)			Clayey SAND, pale pink, coarse grained sand with fine quartz gravel					Bentonite Seal
56–60													

SCALE (m): 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. C9553P1R**	
Project : Carmichael Coal Mine Project			
Location : EPC 1690		**SHEET 3 OF 3**	
Position : 421010.1 E 7573975.0 N	**Surface RL:** 252.4m	**Angle from Horiz. :** 90°	**Processed :** CMM
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Leigh	**Checked :**
Date Started : 20/09/12	**Date Completed :** 21/09/12	**Logged by :** RB	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
62, 64		Nil						From 60m; fine and medium grained, with trace coarse sand, trace fine quartz gravel					Filter Pack Screen
66					66.00 (186.42)			End of hole at 66m					End Cap
68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd	**HOLE No. HD01**
Project : Carmichael Coal Mine Project	
Location : West of EPC 1690	**SHEET 1 OF 3**
Position : 426146.0 E 7561468.0 N	**Surface RL:** n/r
Angle from Horiz. : 90°	**Processed :** CMM
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling
Driller : Jarrod Freeman	**Checked :**
Date Started : 08/09/12	**Date Completed :** 11/09/12
Logged by : DK	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
0	Air Hammer 6" bit (reamed to 10")	6" steel surface casing (pressure grouted)	GNO					Silty CLAY, red			0-59m; Dunda Beds		Completed with steel monument
2								From 2m; grained sand, fine to medium					
4								From 4m; no sand evident			Chips 1-2mm diameter		
6													
8								From 8m; minor hard clay gravel, rounded			Powder returns		
10								From 10m; pale red - brown claystone inclusion					
12													
14								From 14m; pale brown - yellow					
16													
18													
20													
22													50mm PVC casing in cement grout slurry
24													

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Job No. **41-24415-46**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. HD01

Client :	Adani Mining Pty Ltd				
Project :	Carmichael Coal Mine Project				
Location :	West of EPC 1690				
Position :	426146.0 E 7561468.0 N	**Surface RL:** n/r	**Angle from Horiz. :** 90°		**Processed :** CMM
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Jarrod Freeman		**Checked :**
Date Started :	08/09/12	**Date Completed :** 11/09/12	**Logged by :** DK		**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Components
26–31	Air Hammer 6" bit (reamed to 10")						31m - 32m; iron stone banding				
32					32.00		From 32m; trace sand				
42							From 42m; pale brown - orange, no sand				
45					45.00		CLAY, orange, trace silt, trace fine and medium grained sand				Bentonite Seal
48					48.00		Silty CLAY, orange, fragments of claystone				Filter Pack
50											

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. HD01**	
Project : Carmichael Coal Mine Project			
Location : West of EPC 1690		**SHEET 3 OF 3**	
Position : 426146.0 E 7561468.0 N	**Surface RL:** n/r	**Angle from Horiz. :** 90°	**Processed :** CMM
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Jarrod Freeman	**Checked :**
Date Started : 08/09/12	**Date Completed :** 11/09/12	**Logged by :** DK	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	**Description** SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	**Comments/ Observations**	Piezometer Log	**Components**
52	Air Hammer 6" bit (reamed to 10")												
54													Screen
56													
58													
					59.00			End of Borehole at 59.0m					End Cap
60													
62													
64													
66													
68													
70													
72													
74													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : West of EPC 1690

HOLE No. HD02

Position : 423823.0 E 7557008.0 N	**Surface RL:** 240.0m	**Angle from Horiz. :** 90°	**Processed :** CH
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Jarrod Freeman	**Checked :**
Date Started : 19/10/12	**Date Completed :** 19/10/12	**Logged by :** DK	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
0	Air Hammer 4-3/4" bit (reamed to 10 ")	6" steel surface casing (pressure grouted)						Silty CLAY, Brown with a trace of fine sand	D		0-2m; Alluvium		Completed with steel monument
1								1.00m - 2.00m; slightly moist					
2					2.00 (238.00)		SP	SAND, white, fine, poorly graded.	D		2-32m; Clematis Sandstone		
3								3.00m; slightly yellow in colour	M				
4			▶		4.00 (236.00)			SAND, yellow, angular to subangular, fine grained quartz with a trace of clay.	W				
5								From 5.00m; with a trace of fine to medium gravel.	W				
6													
7													
8													
9													
10					10.00								

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. HD02**	
Project : Carmichael Coal Mine Project			
Location : West of EPC 1690		**SHEET 2 OF 4**	
Position : 423823.0 E 7557008.0 N	**Surface RL:** 240.0m	**Angle from Horiz. :** 90°	**Processed :** CH
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Jarrod Freeman	**Checked :**
Date Started : 19/10/12	**Date Completed :** 19/10/12	**Logged by :** DK	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
	Air Hammer 4-3/4" bit (reamed to 10 ")	6" steel surface casing (pressure grouted)			(230.00)			SAND, white, angular to subangular, fine to medium grained	W				
11					11.00 (229.00)		SC	Clayey SAND, yellow, angular to subangular fine to medium grained					50mm PVC casing in bentonite / cement grout mix
12					12.00 (228.00)		SW	SAND, white, angular to subangular, fine to coarse grained. Well graded but becoming coarser with depth					
13													
14													
15													
16					16.00 (224.00)			SAND, yellow-orange, angular to subangular, fine to medium grained					
17					17.00 (223.00)			SAND, white, fine to medium grained with a trace of fine to medium gravel					
18													
19													
20													

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41-24415-46

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd			**HOLE No. HD02**
Project : Carmichael Coal Mine Project			
Location : West of EPC 1690			**SHEET 3 OF 4**
Position : 423823.0 E 7557008.0 N	**Surface RL:** 240.0m	**Angle from Horiz. :** 90°	**Processed :** CH
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Jarrod Freeman	**Checked :**
Date Started : 19/10/12	**Date Completed :** 19/10/12	**Logged by :** DK	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
21–24	Air Hammer 4-3/4" bit (reamed to 10 ")	6" steel surface casing (pressure grouted)											
24	Mud Rotary Wash Boring 6" bit												Bentonite Seal
25					25.00 (215.00)			SAND, white, angular to subangular, fine to medium. Interbedded with black micaceous conglomerate ????					
27					27.00 (213.00)			SAND, white, fine to medium grained, angular to subangular of quartz.					
28					28.00 (212.00)			SAND, pink, fine to medium grained, Interbedded with black micaceous conglomerate					Filter Pack
29													Screen
30													

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. HD02

Client :	Adani Mining Pty Ltd				
Project :	Carmichael Coal Mine Project				
Location :	West of EPC 1690				
Position :	423823.0 E 7557008.0 N	**Surface RL:** 240.0m	**Angle from Horiz. :** 90°	**Processed :** CH	
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Jarrod Freeman	**Checked :**	
Date Started :	19/10/12	**Date Completed :** 19/10/12	**Logged by :** DK	**Date :**	

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
31	Mud Rotary Wash Boring 6" bit				31.00 (209.00)			SAND, pink, angular to subangular, fine to medium with a trace of fine to medium quartz gravel					
32					32.00 (208.00)			End of Borehole at 32.0m					End Cap
33													
34													
35													
36													
37													
38													
39													
40													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. HD03A

Client : Adani Mining Pty Ltd			
Project : Carmichael Coal Mine Project			
Location : West of EPC 1690			
Position : 427560.0 E 7556126.0 N	**Surface RL:** n/r	**Angle from Horiz. :** 90°	**Processed :** CH
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Jarrod Freeman	**Checked :**
Date Started : 23/10/12	**Date Completed :** 25/10/12	**Logged by :** DK	**Date :**

Depth / (RL) metres	USC Symbol	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations
0.00–2.00		CLAY, pale brown with a trace of sand			0-17m; Alluvium
2.00–4.00		CLAY, dark brown, with minor lenses of light brown/grey colour.			
4.00–6.00		CLAY, pale brown, grey and dark-brown mottled			
6.00–9.00	CI	Silty CLAY, pale grey, medium plasticity			
9.00–10.00	SC	Clayey SAND, pale grey, subangular to rounded, fine to medium grained quartz with a trace of fine gravel and fragments of coal and organic matter.			

DRILLING

- Drilling Method: Air Hammer 4 3/4 bit (reamed to 10" with mud rotary wash boring)
- Hole Support \ Casing: 6" steel surface casing (pressure grouted)
- Water: level marked at 6 m
- Samples & Tests:

PIEZOMETER — Components: Completed with steel headworks for artesian bore

SCALE (m): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd			**HOLE No. HD03A**
Project : Carmichael Coal Mine Project			
Location : West of EPC 1690			**SHEET 2 OF 4**
Position : 427560.0 E 7556126.0 N	**Surface RL:** n/r	**Angle from Horiz. :** 90°	**Processed :** CH
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Jarrod Freeman	**Checked :**
Date Started : 23/10/12	**Date Completed :** 25/10/12	**Logged by :** DK	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
							CH	CLAY, pale grey, high plasticity.					
11	Mud Rotary Wash Boring 4-3/4" bit (reamed to 10")	6" steel surface casing (pressure grouted)			11.00			CLAY, pale brown, with a trace of fine sand.					
12													
13													50mm PVC casing in bentonite / cement grout mix
14													
15													
16					16.00			Sandy CLAY, pale brown, sand is subangular to rounded medium to coarse and occasionally fine.					
17					17.00			Clayey SAND and GRAVEL, pale brown, red and white mottled. Sand is coarse. Gravel is subangular to subrounded and fine.			17-37m; Dunda Beds		
18													
19					19.00		GC	Clayey GRAVEL, white, with a trace of red, orange and black, subangular, fine to coarse of quartz.					
20													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

GEO_BORE_PIEZO ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 08/11/12

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : West of EPC 1690

HOLE No. HD03A

SHEET 3 OF 4

Position : 427560.0 E 7556126.0 N	**Surface RL:** n/r	**Angle from Horiz. :** 90°	**Processed :** CH
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Jarrod Freeman	**Checked :**
Date Started : 23/10/12	**Date Completed :** 25/10/12	**Logged by :** DK	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
21	Mud Rotary Wash Boring 4-3/4" bit (reamed to 10")	6" steel surface casing (pressure grouted)			21.00			Sandy CLAY, white with a trace of orange, red and pink. Sand is subangular to angular, fine to medium of quartz.					
22–23					23.00			CLAY, purple, with a trace of pale grey mottling, high plasticity					
24	Mud Rotary Wash Boring 6" bit				24.00			CLAY, mottled pale grey and purple with occasional bands of hard claystone.					
25–29					25.00		GC	Clayey GRAVEL, white, subangular to subrounded, fine of quartz with fragments of fine grained sandstone and with a trace of quartz sand. With bands of white and purple hard clays and claystones.					Bentonite Seal
30					29.30			SAND, white, subangular to rounded, fine (10 - 20%) and coarse (80 - 90%). With a trace of gravel (possible contamination from			29.30m: Artesian groundwater encountered. Groundwater noted to be flowing 'very		

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GEO_BORE_PIEZO ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 08/11/12

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd		**HOLE No. HD03A**	
Project : Carmichael Coal Mine Project			
Location : West of EPC 1690		**SHEET 4 OF 4**	
Position : 427560.0 E 7556126.0 N	**Surface RL:** n/r	**Angle from Horiz. :** 90°	**Processed :** CH
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Jarrod Freeman	**Checked :**
Date Started : 23/10/12	**Date Completed :** 25/10/12	**Logged by :** DK	**Date :**

DRILLING					MATERIAL							PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	**Description** SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	**Comments/ Observations**	Piezometer Log	**Components**
	Mud Rotary Wash Boring 6" bit							above).			slowly'. 30.00m: Temporary casing installed to 30.00m.		
31													
32													
33													Filter Pack
34													Screen
35													
36													
37					37.00			End of Borehole at 37.0m					End Cap
38													
39													
40													

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : West of EPC 1690

HOLE No. HD03B

Position : 427559.0 E 7556122.0 N	**Surface RL:** n/r	**Angle from Horiz. :** 90°	**Processed :** CH
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Jarrod Freeman	**Checked :**
Date Started : 25/10/12	**Date Completed :** 26/10/12	**Logged by :** DK	**Date :**

DRILLING					MATERIAL								PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations		Piezometer Log	Components
0	Mud rotary wash boring (6" bit)	Nil	GNO				CH	CLAY, pale brown, high plasticity.			0 m - 11.37 m; Alluvium			Completed with steel monument
2					2.00		CH	CLAY, dark brown with a trace of pale grey, high plasticity						
3														50mm PVC casing in bentonite / cement grout mix
4					4.00		CI	CLAY, pale brown, medium plasticity						
5														Bentonite Seal
6					6.00		CH	CLAY, pale grey, high plasticity						
8														Filter Pack
9														Screen
10														

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd			**HOLE No. HD03B**	
Project : Carmichael Coal Mine Project				
Location : West of EPC 1690			**SHEET 2 OF 2**	
Position : 427559.0 E 7556122.0 N	**Surface RL:** n/r		**Angle from Horiz. :** 90°	**Processed :** CH
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling		**Driller :** Jarrod Freeman	**Checked :**
Date Started : 25/10/12	**Date Completed :** 26/10/12		**Logged by :** DK	**Date :**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	Piezometer Log	Components
11		Nil			11.37								End Cap
								End of borehole 11.37m					
12													
13													
14													
15													
16													
17													
18													
19													
20													

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Appendix D

Groundwater Levels

Charts 1 to 23

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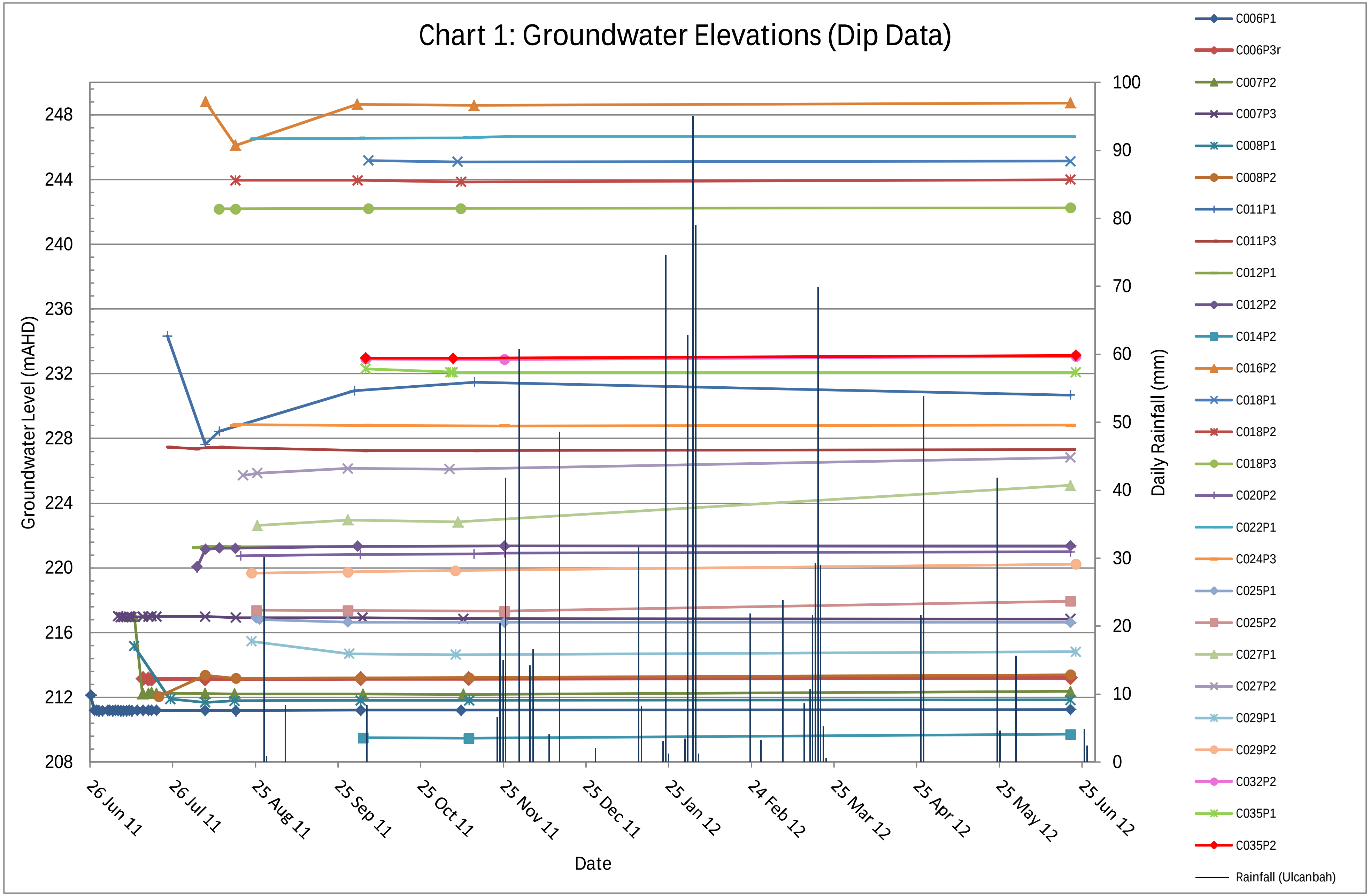
Chart 1: Groundwater Elevations (Dip Data)
Groundwater Level (mAHD)
Daily Rainfall (mm)
Date
208
212
216
220
224
228
232
236
240
244
248
0
10
20
30
40
50
60
70
80
90
100
26 Jun 11
26 Jul 11
25 Aug 11
25 Sep 11
25 Oct 11
25 Nov 11
25 Dec 11
25 Jan 12
24 Feb 12
25 Mar 12
25 Apr 12
25 May 12
25 Jun 12
C006P1
C006P3r
C007P2
C007P3
C008P1
C008P2
C011P1
C011P3
C012P1
C012P2
C014P2
C016P2
C018P1
C018P2
C018P3
C020P2
C022P1
C024P3
C025P1
C025P2
C027P1
C027P2
C029P1
C029P2
C032P2
C035P1
C035P2
Rainfall (Ulcanbah)

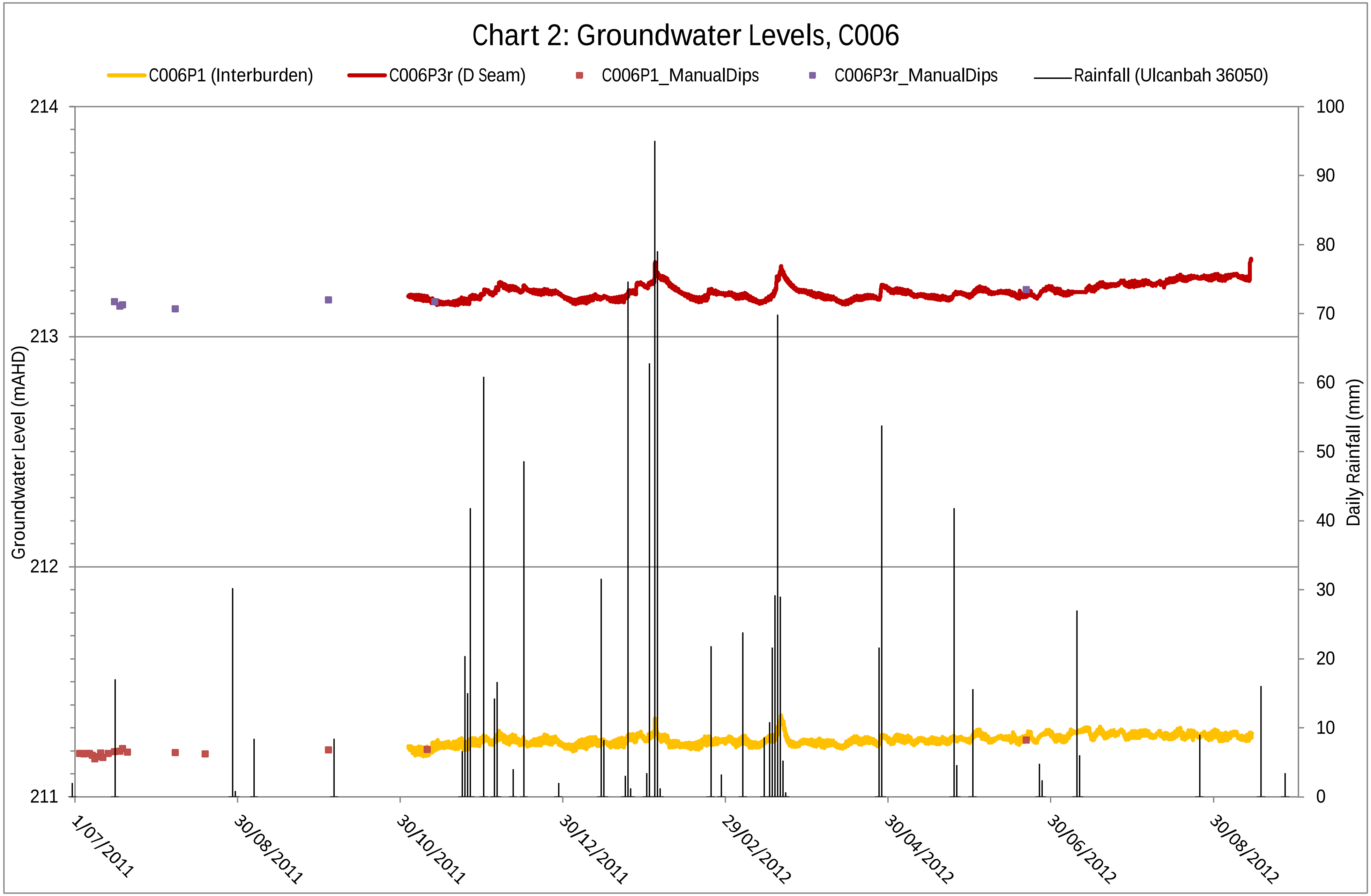
Chart 2: Groundwater Levels, C006
C006P1 (Interburden)
C006P3r (D Seam)
C006P1_ManualDips
C006P3r_ManualDips
Rainfall (Ulcanbah 36050)
Groundwater Level (mAHD)
Daily Rainfall (mm)
214
213
212
211
100
90
80
70
60
50
40
30
20
10
0
1/07/2011
30/08/2011
30/10/2011
30/12/2011
29/02/2012
30/04/2012
30/06/2012
30/08/2012

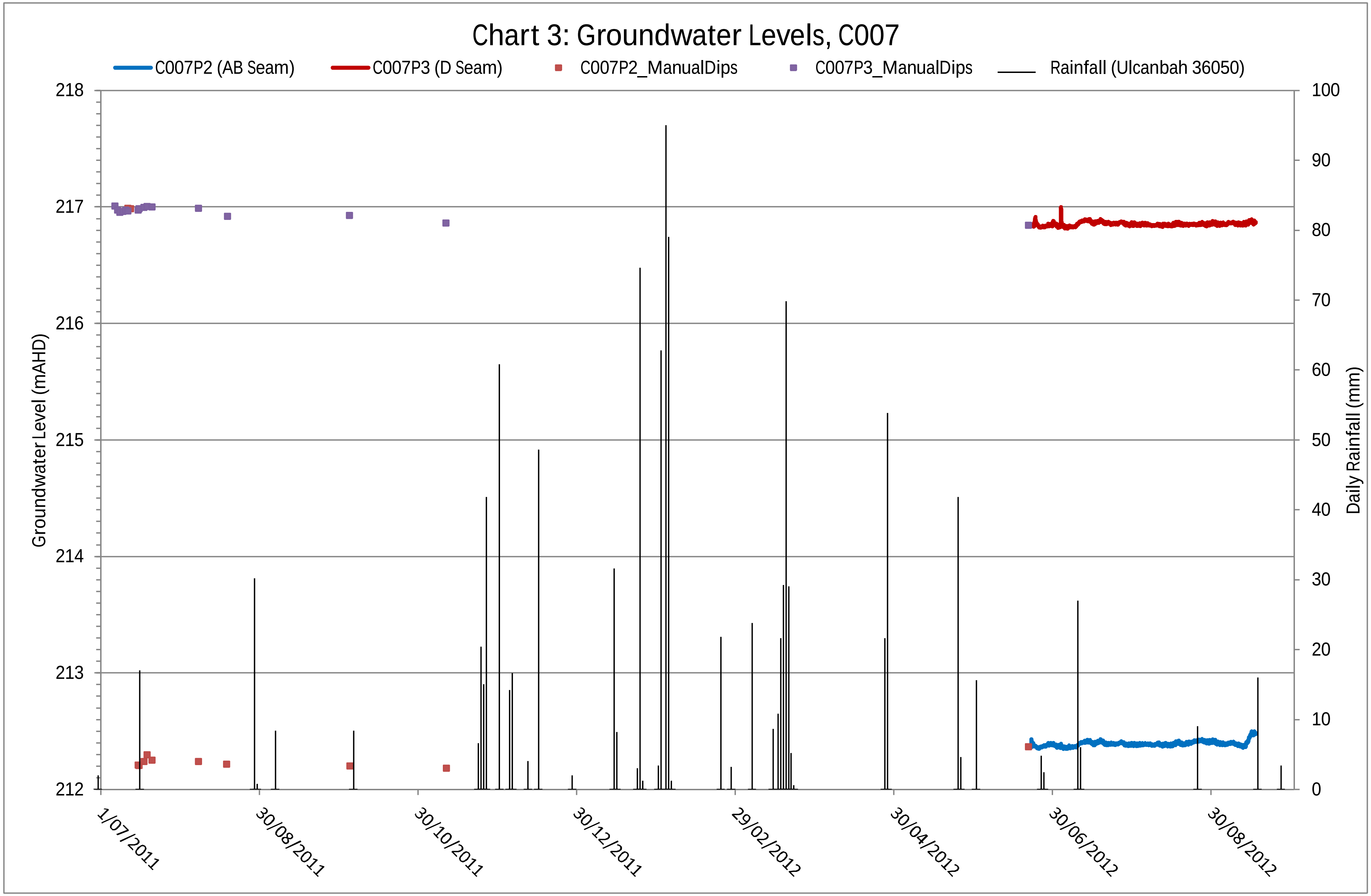

Chart 3: Groundwater Levels, C007
C007P2 (AB Seam)
C007P3 (D Seam)
C007P2_ManualDips
C007P3_ManualDips
Rainfall (Ulcanbah 36050)
Groundwater Level (mAHD)
Daily Rainfall (mm)
218
217
216
215
214
213
212
100
90
80
70
60
50
40
30
20
10
0
1/07/2011
30/08/2011
30/10/2011
30/12/2011
29/02/2012
30/04/2012
30/06/2012
30/08/2012

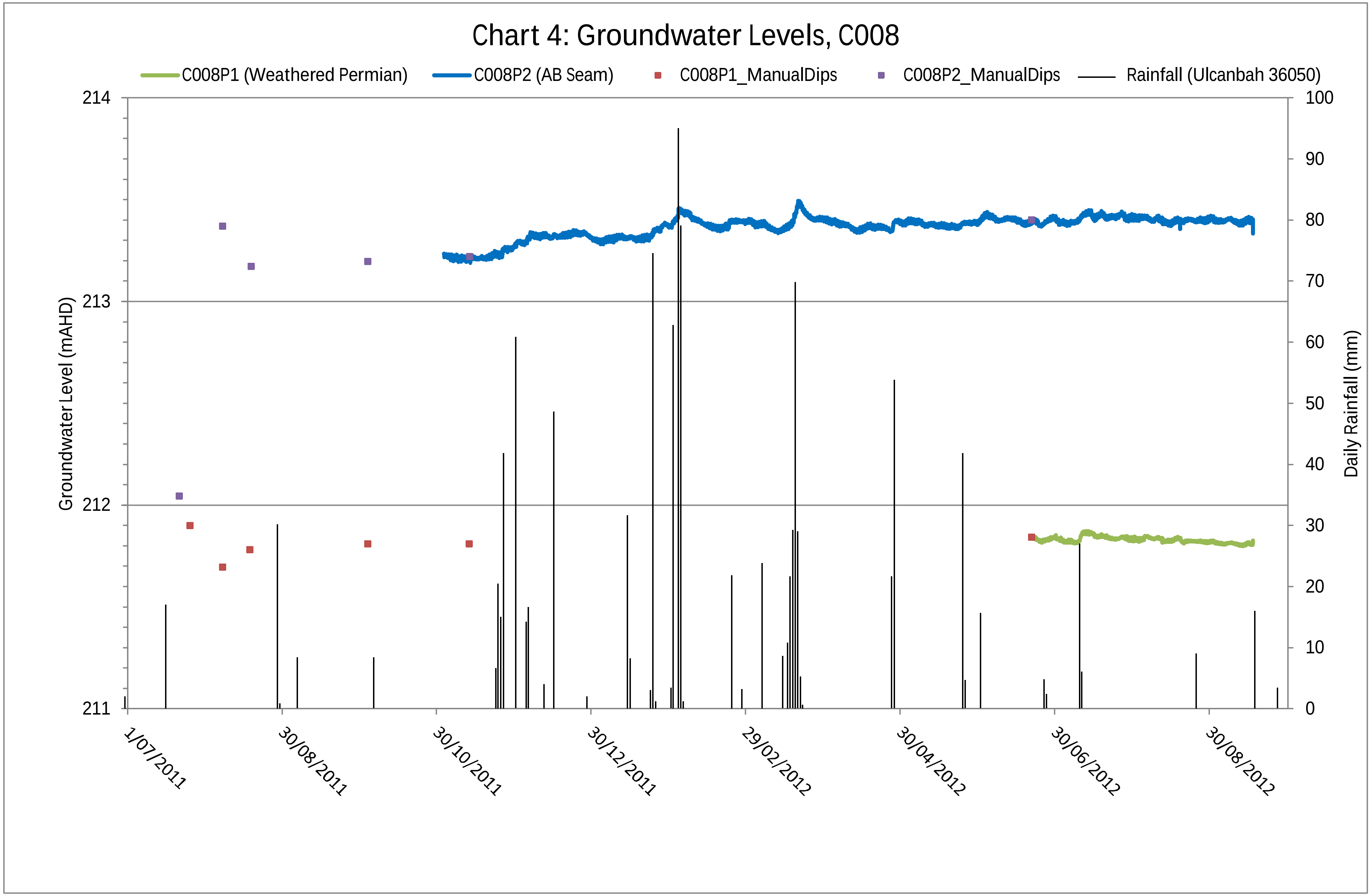

Chart 4: Groundwater Levels, C008
C008P1 (Weathered Permian)
C008P2 (AB Seam)
C008P1_ManualDips
C008P2_ManualDips
Rainfall (Ulcanbah 36050)
Groundwater Level (mAHD)
Daily Rainfall (mm)
214
213
212
211
100
90
80
70
60
50
40
30
20
10
0
1/07/2011
30/08/2011
30/10/2011
30/12/2011
29/02/2012
30/04/2012
30/06/2012
30/08/2012

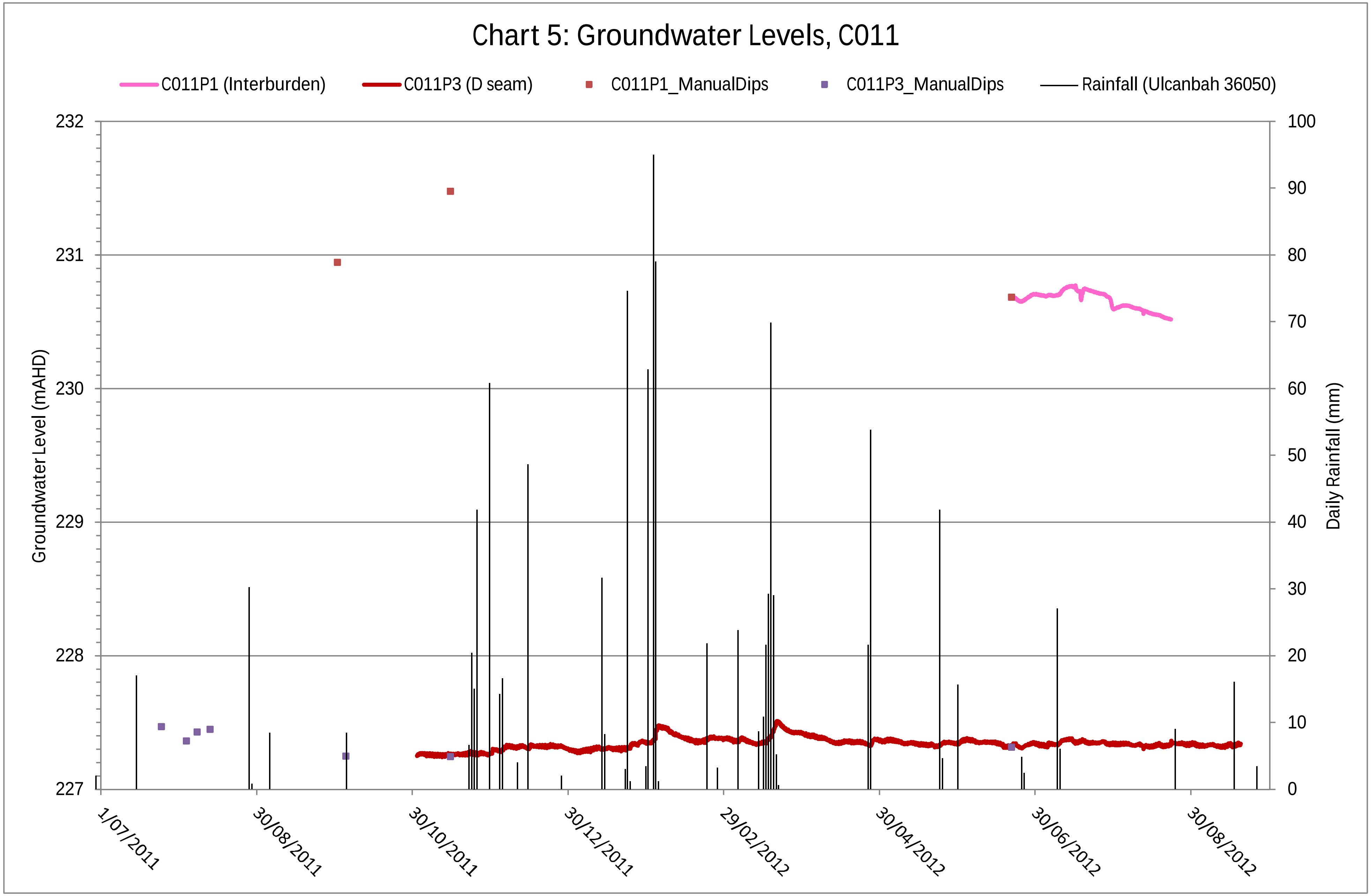

Chart 5: Groundwater Levels, C011
C011P1 (Interburden)
C011P3 (D seam)
C011P1_ManualDips
C011P3_ManualDips
Rainfall (Ulcanbah 36050)
Groundwater Level (mAHD)
Daily Rainfall (mm)
232
231
230
229
228
227
100
90
80
70
60
50
40
30
20
10
0
1/07/2011
30/08/2011
30/10/2011
30/12/2011
29/02/2012
30/04/2012
30/06/2012
30/08/2012

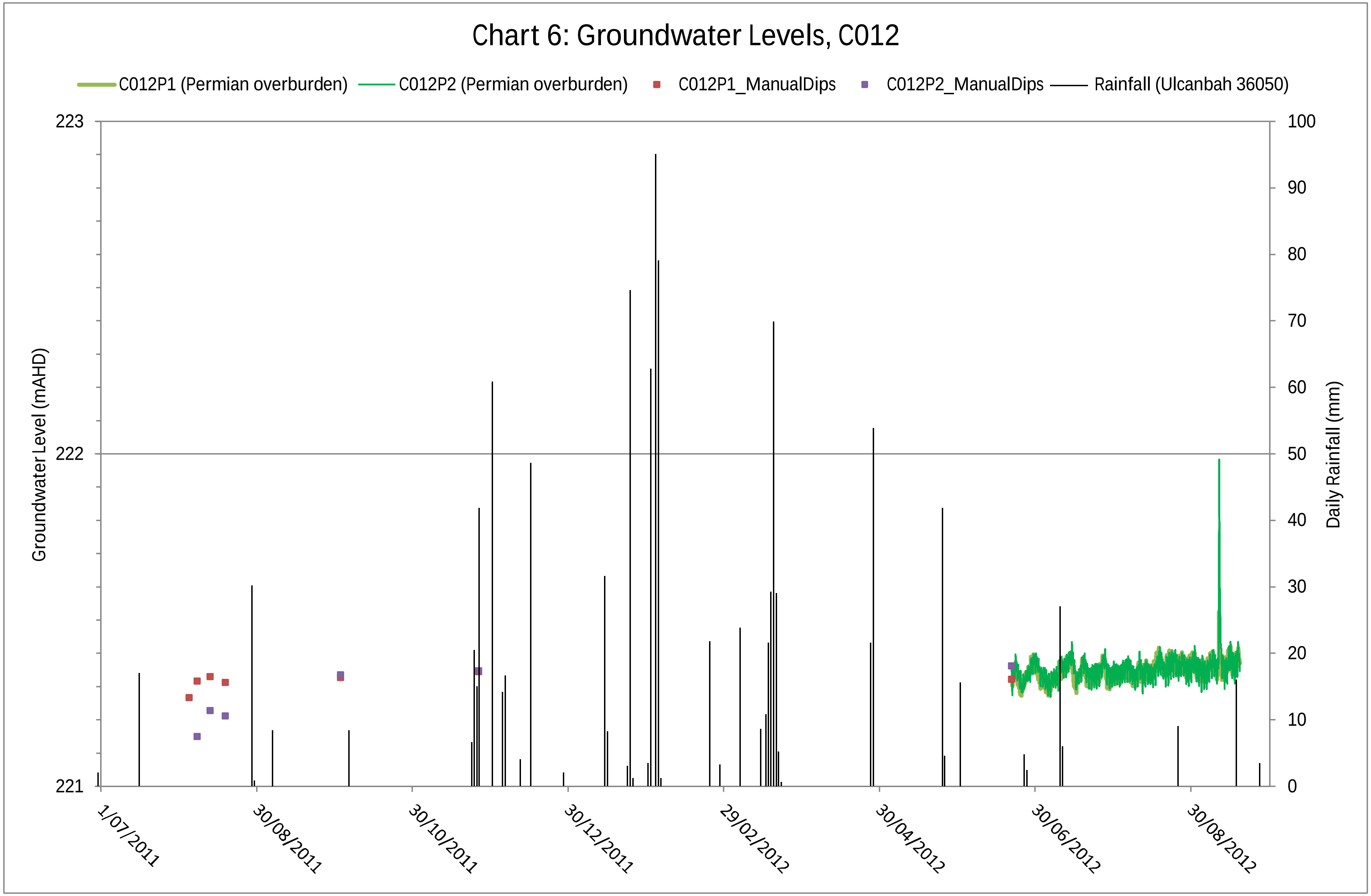
Chart 6: Groundwater Levels, C012
C012P1 (Permian overburden)
C012P2 (Permian overburden)
C012P1_ManualDips
C012P2_ManualDips
Rainfall (Ulcanbah 36050)
Groundwater Level (mAHD)
Daily Rainfall (mm)
223
222
221
100
90
80
70
60
50
40
30
20
10
0
1/07/2011
30/08/2011
30/10/2011
30/12/2011
29/02/2012
30/04/2012
30/06/2012
30/08/2012

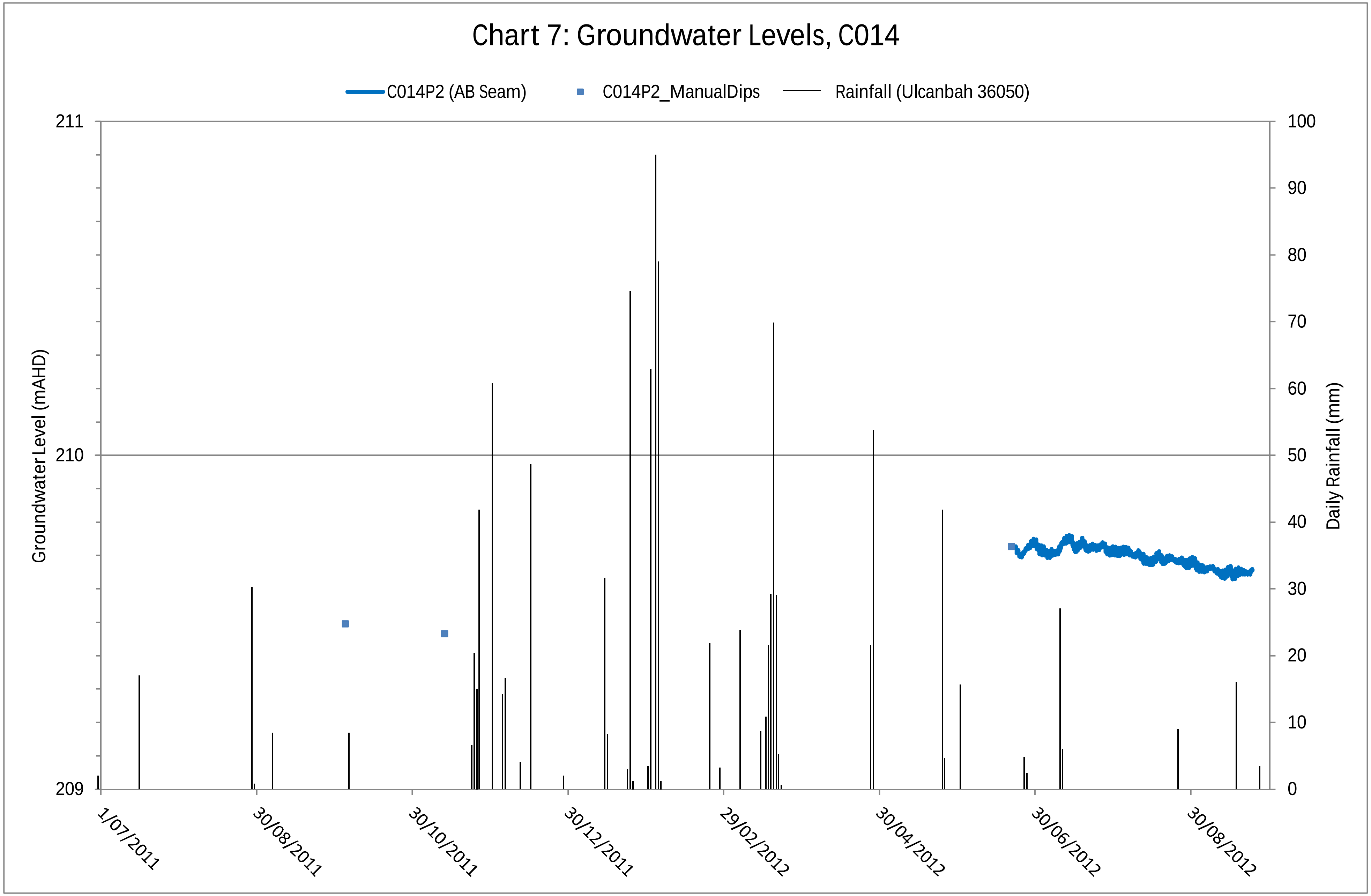

Chart 7: Groundwater Levels, C014
C014P2 (AB Seam)
C014P2_ManualDips
Rainfall (Ulcanbah 36050)
Groundwater Level (mAHD)
Daily Rainfall (mm)
211
210
209
100
90
80
70
60
50
40
30
20
10
0
1/07/2011
30/08/2011
30/10/2011
30/12/2011
29/02/2012
30/04/2012
30/06/2012
30/08/2012

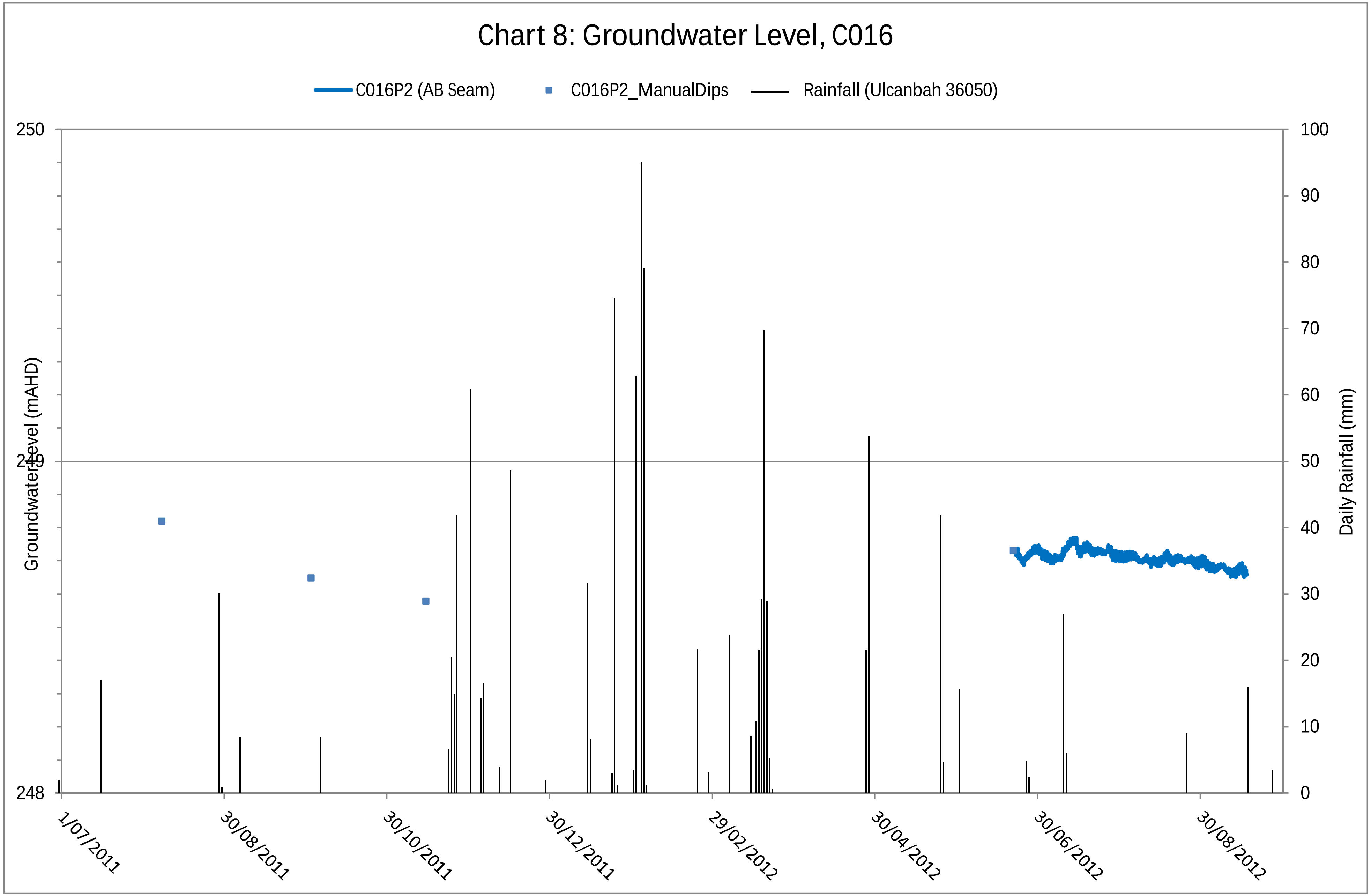

Chart 8: Groundwater Level, C016
C016P2 (AB Seam)
C016P2_ManualDips
Rainfall (Ulcanbah 36050)
Groundwater Level (mAHD)
Daily Rainfall (mm)
250
249
248
100
90
80
70
60
50
40
30
20
10
0
1/07/2011
30/08/2011
30/10/2011
30/12/2011
29/02/2012
30/04/2012
30/06/2012
30/08/2012

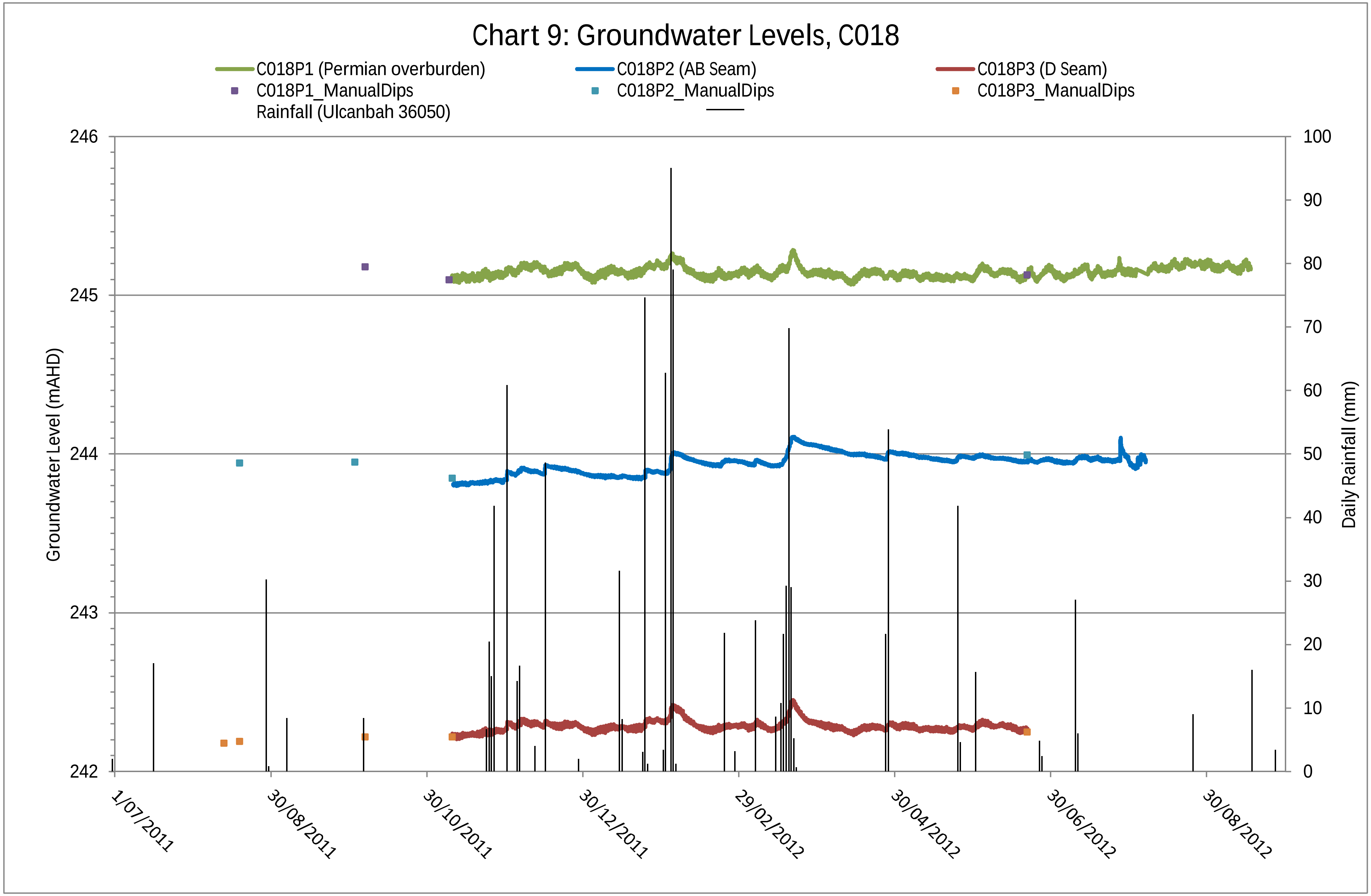

Chart 9: Groundwater Levels, C018
C018P1 (Permian overburden)
C018P2 (AB Seam)
C018P3 (D Seam)
C018P1_ManualDips
C018P2_ManualDips
C018P3_ManualDips
Rainfall (Ulcanbah 36050)
Groundwater Level (mAHD)
Daily Rainfall (mm)
246
245
244
243
242
100
90
80
70
60
50
40
30
20
10
0
1/07/2011
30/08/2011
30/10/2011
30/12/2011
29/02/2012
30/04/2012
30/06/2012
30/08/2012

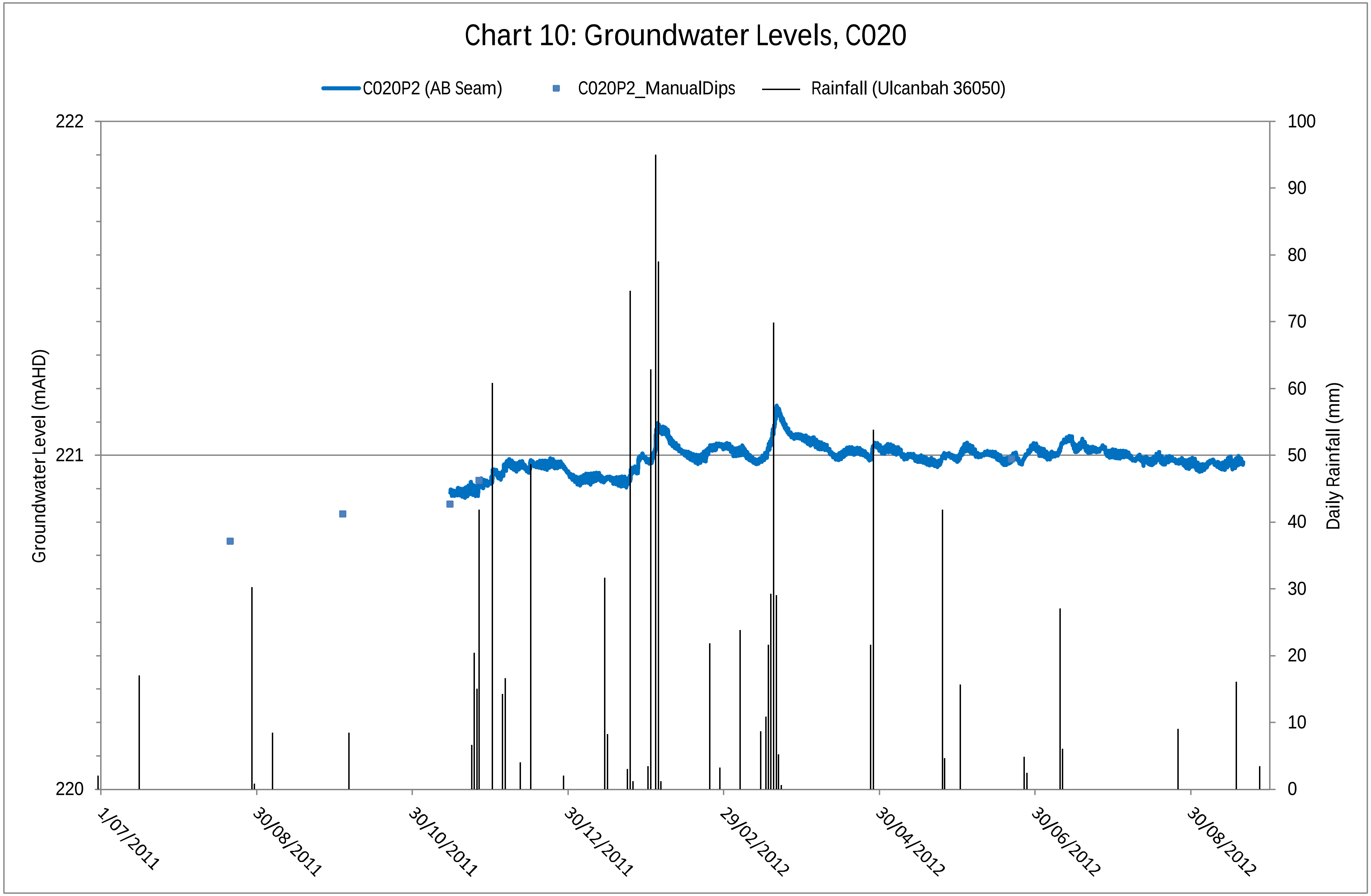

Chart 10: Groundwater Levels, C020
C020P2 (AB Seam)
C020P2_ManualDips
Rainfall (Ulcanbah 36050)
Groundwater Level (mAHD)
Daily Rainfall (mm)
222
221
220
100
90
80
70
60
50
40
30
20
10
0
1/07/2011
30/08/2011
30/10/2011
30/12/2011
29/02/2012
30/04/2012
30/06/2012
30/08/2012

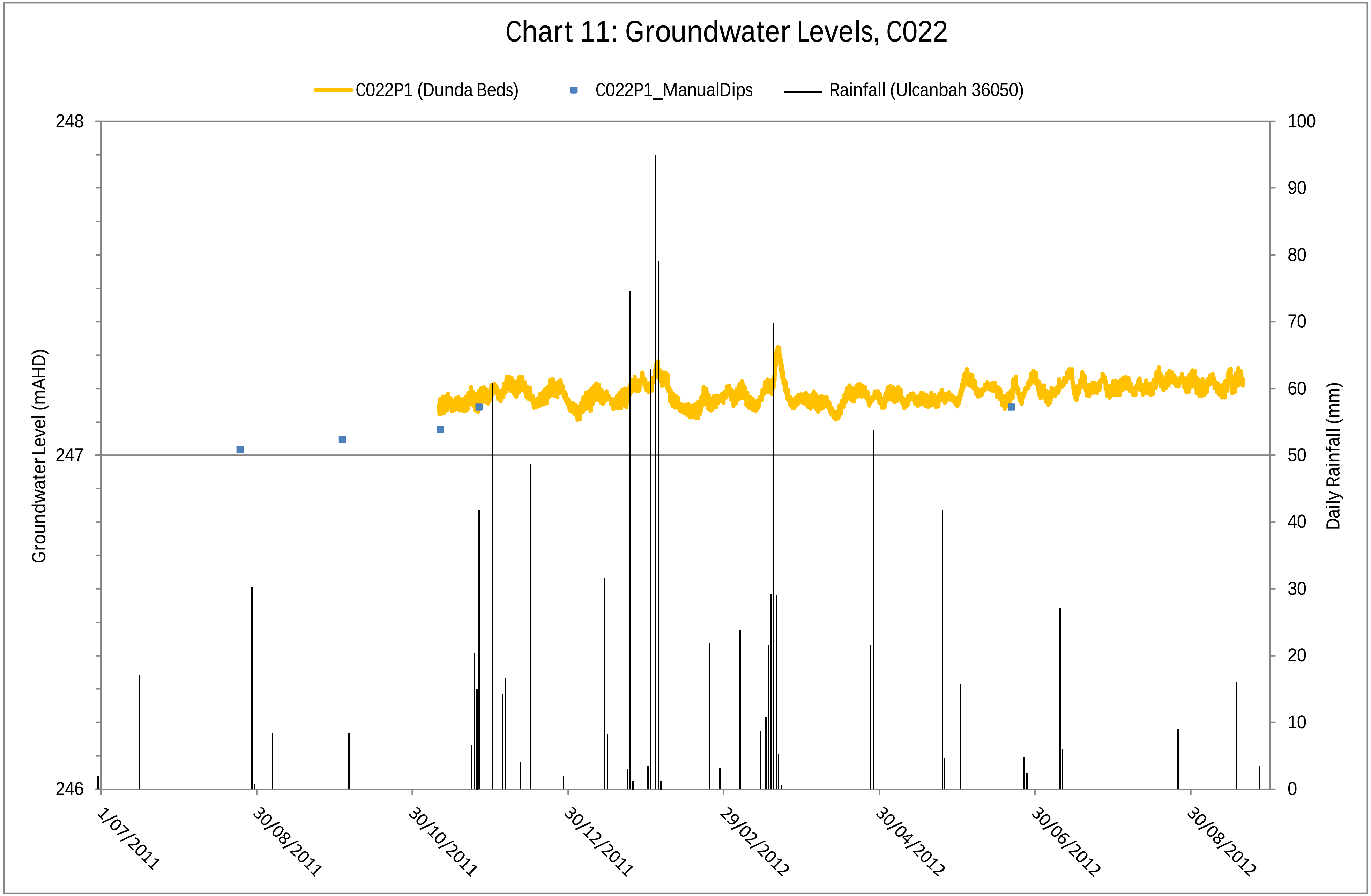
Chart 11: Groundwater Levels, C022
C022P1 (Dunda Beds)
C022P1_ManualDips
Rainfall (Ulcanbah 36050)
Groundwater Level (mAHD)
Daily Rainfall (mm)
248
247
246
100
90
80
70
60
50
40
30
20
10
0
1/07/2011
30/08/2011
30/10/2011
30/12/2011
29/02/2012
30/04/2012
30/06/2012
30/08/2012

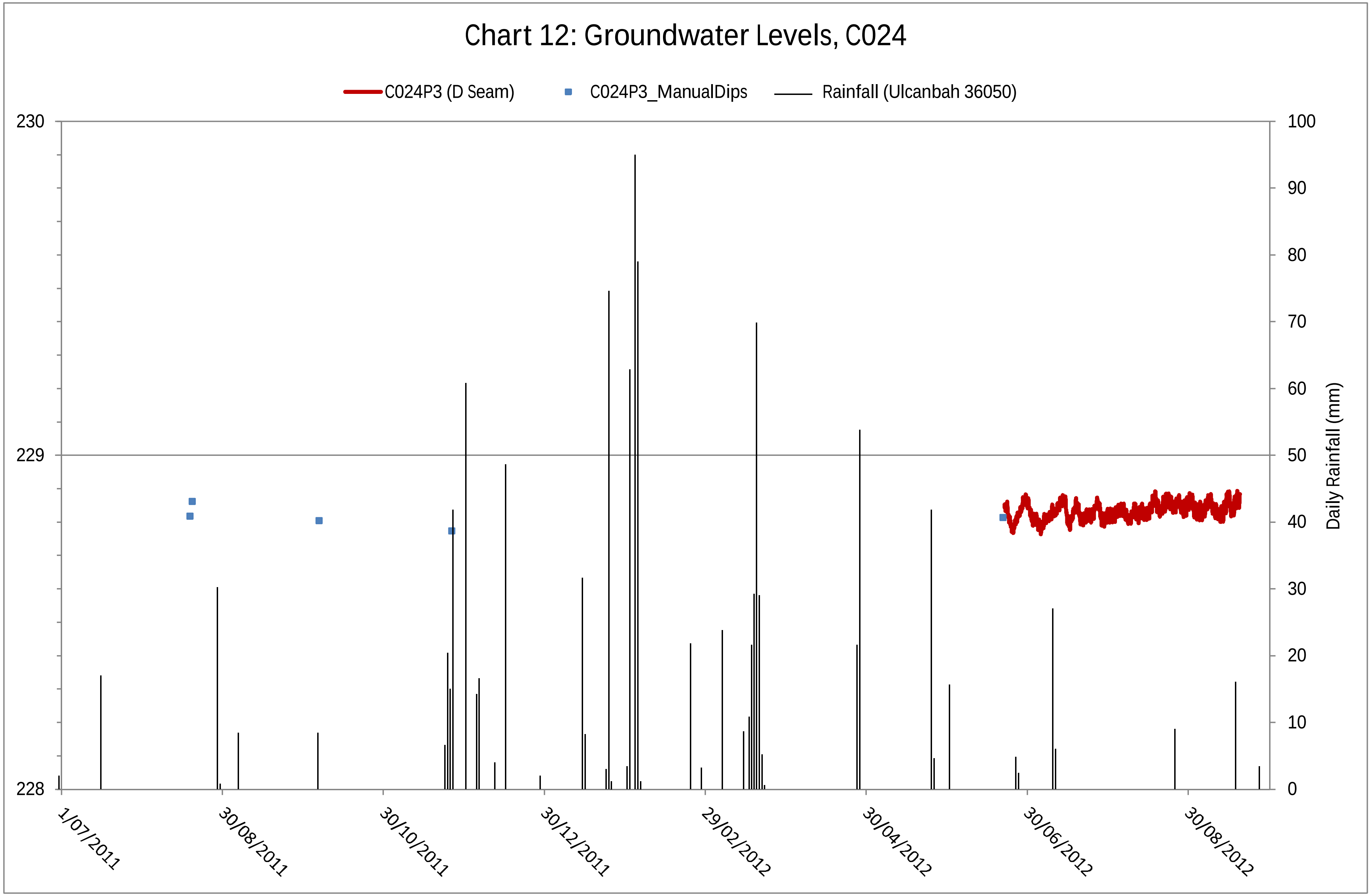

Chart 12: Groundwater Levels, C024
C024P3 (D Seam)
C024P3_ManualDips
Rainfall (Ulcanbah 36050)
230
229
228
100
90
80
70
60
50
40
30
20
10
0
Daily Rainfall (mm)
1/07/2011
30/08/2011
30/10/2011
30/12/2011
29/02/2012
30/04/2012
30/06/2012
30/08/2012

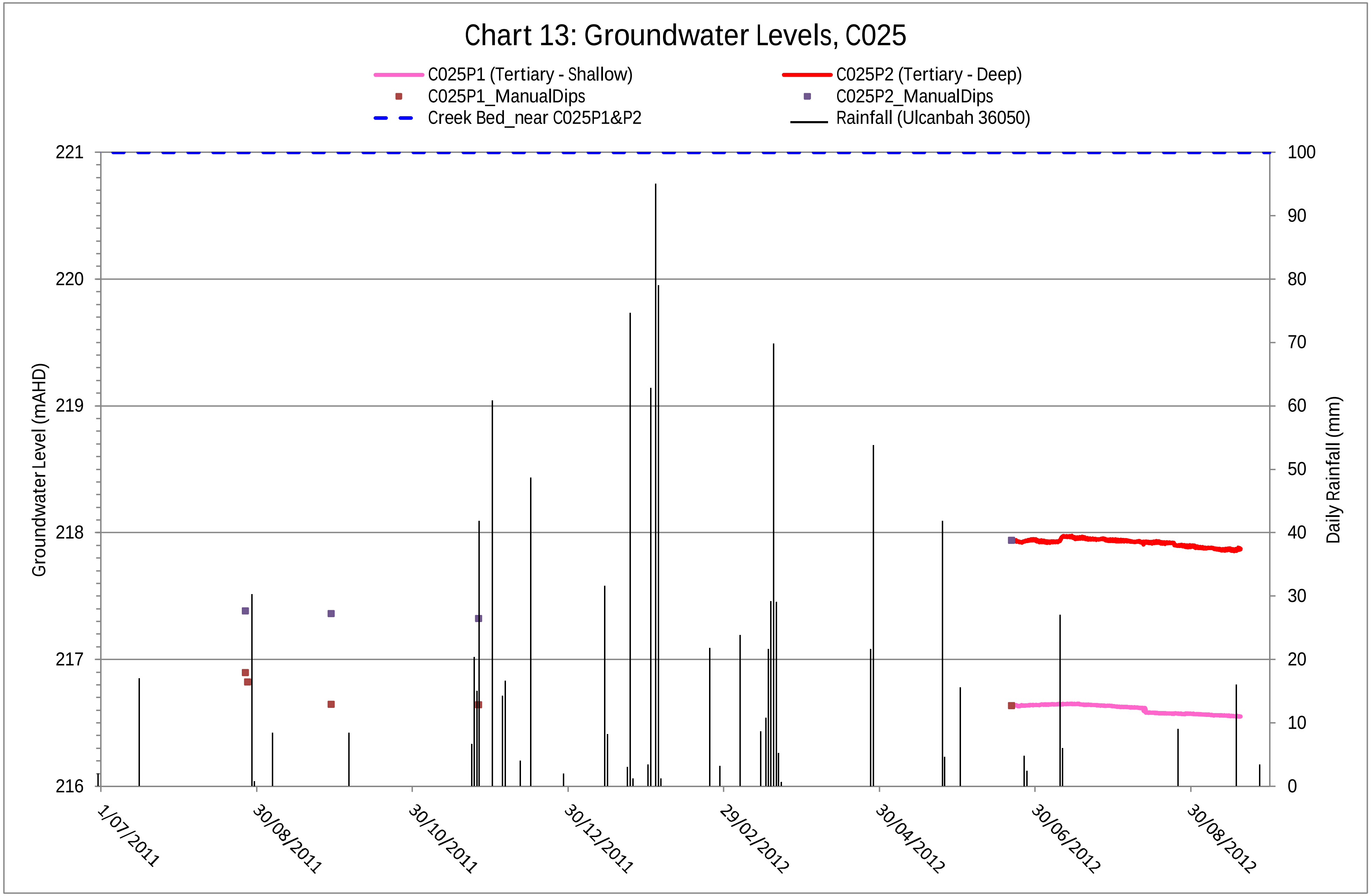
Chart 13: Groundwater Levels, C025
C025P1 (Tertiary - Shallow)
C025P2 (Tertiary - Deep)
C025P1_ManualDips
C025P2_ManualDips
Creek Bed_near C025P1&P2
Rainfall (Ulcanbah 36050)
Groundwater Level (mAHD)
Daily Rainfall (mm)
221
220
219
218
217
216
100
90
80
70
60
50
40
30
20
10
0
1/07/2011
30/08/2011
30/10/2011
30/12/2011
29/02/2012
30/04/2012
30/06/2012
30/08/2012

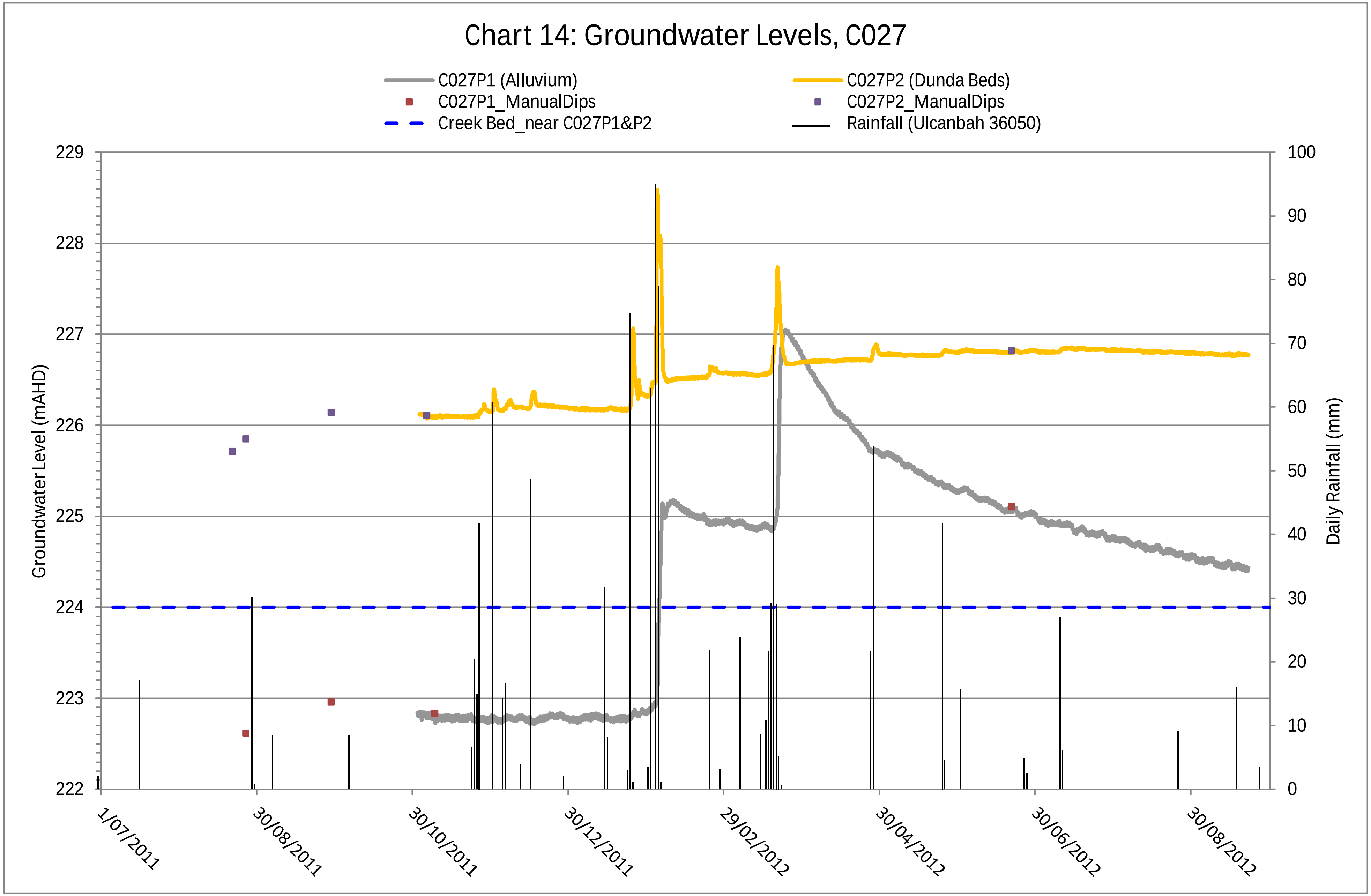

Chart 14: Groundwater Levels, C027
C027P1 (Alluvium)
C027P2 (Dunda Beds)
C027P1_ManualDips
C027P2_ManualDips
Creek Bed_near C027P1&P2
Rainfall (Ulcanbah 36050)
Groundwater Level (mAHD)
Daily Rainfall (mm)
229
228
227
226
225
224
223
222
100
90
80
70
60
50
40
30
20
10
0
1/07/2011
30/08/2011
30/10/2011
30/12/2011
29/02/2012
30/04/2012
30/06/2012
30/08/2012

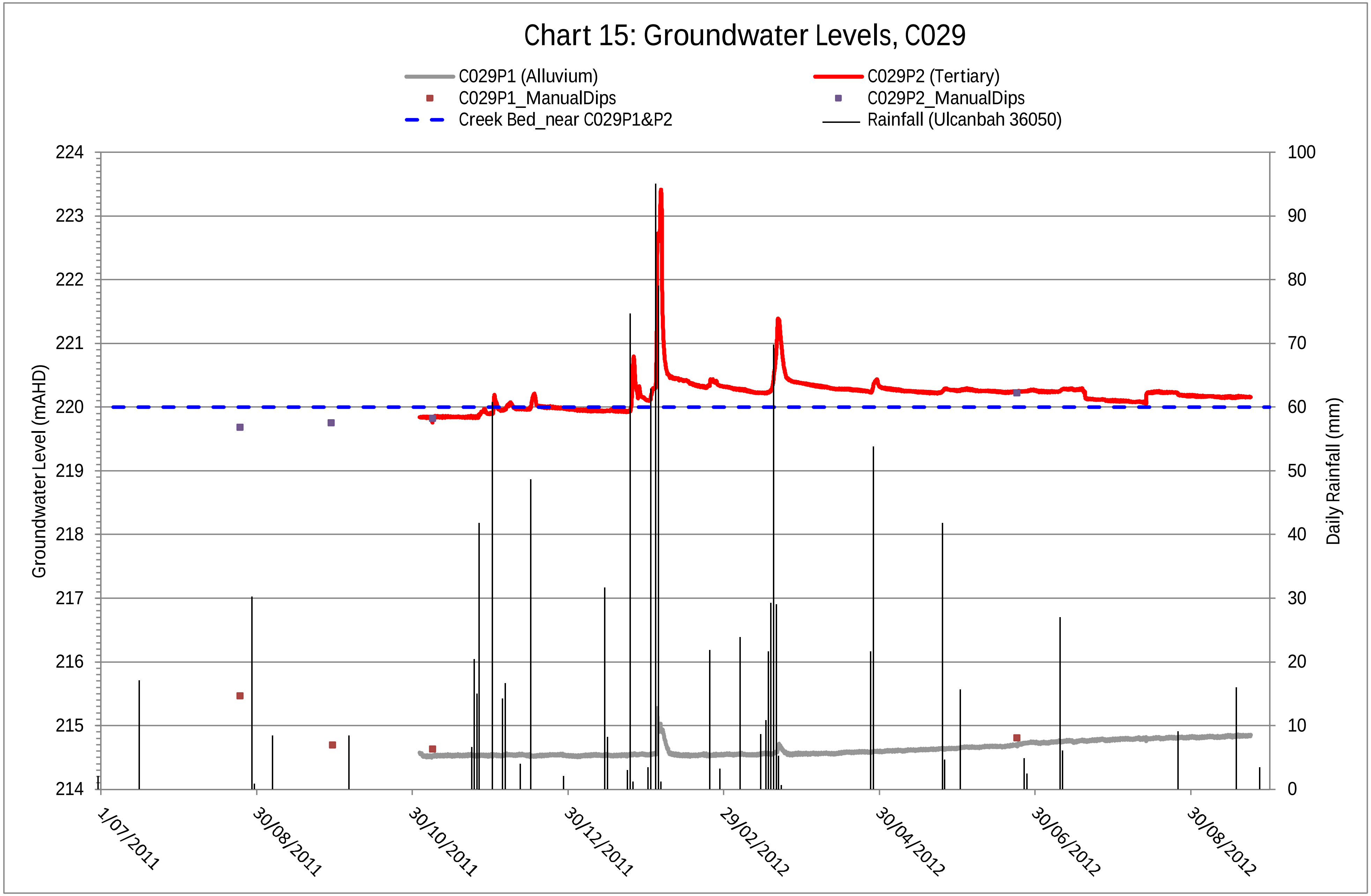
Chart 15: Groundwater Levels, C029
C029P1 (Alluvium)
C029P2 (Tertiary)
C029P1_ManualDips
C029P2_ManualDips
Creek Bed_near C029P1&P2
Rainfall (Ulcanbah 36050)
Groundwater Level (mAHD)
Daily Rainfall (mm)
224
223
222
221
220
219
218
217
216
215
214
100
90
80
70
60
50
40
30
20
10
0
1/07/2011
30/08/2011
30/10/2011
30/12/2011
29/02/2012
30/04/2012
30/06/2012
30/08/2012

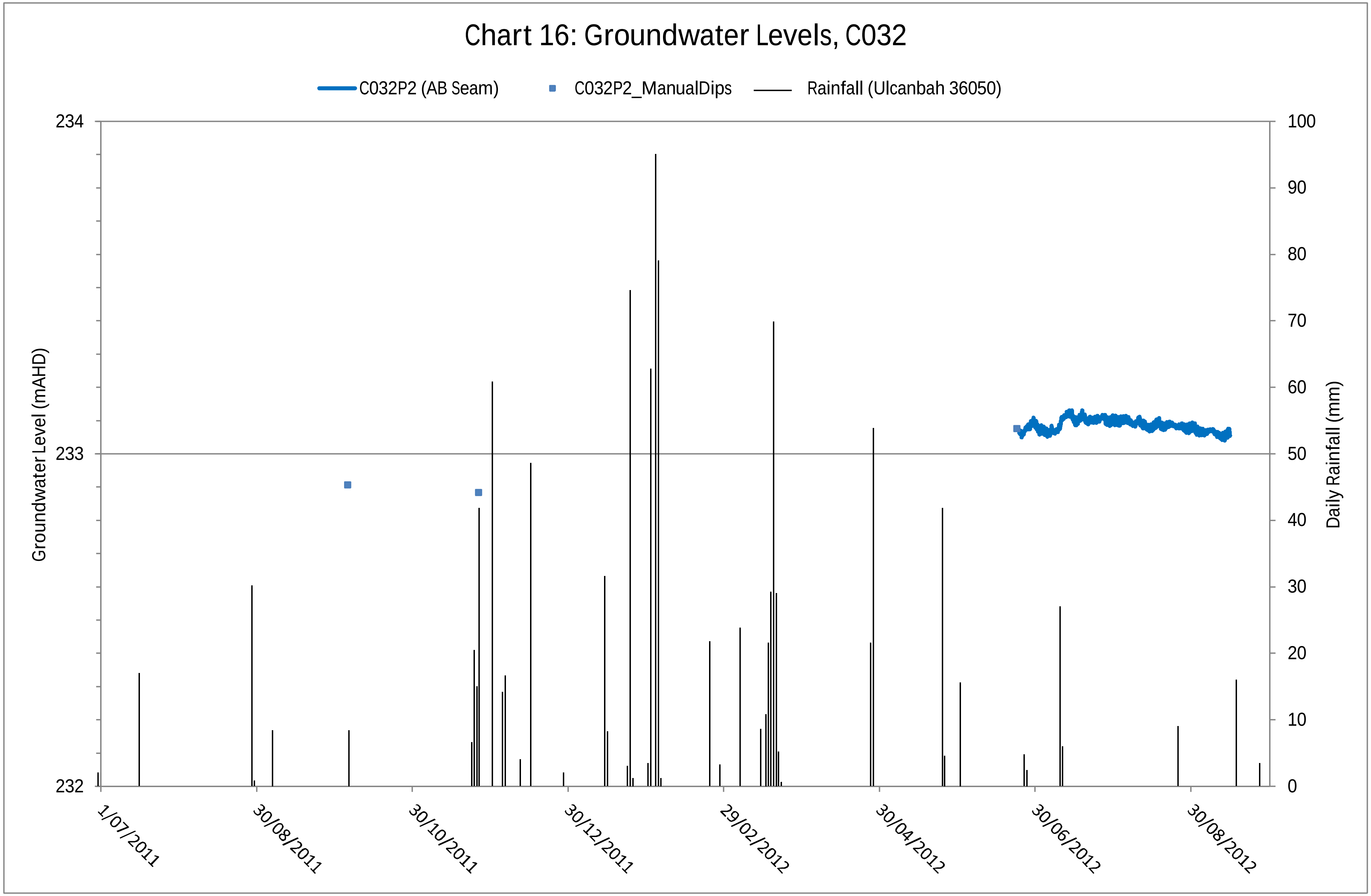

Chart 16: Groundwater Levels, C032
C032P2 (AB Seam)
C032P2_ManualDips
Rainfall (Ulcanbah 36050)
Groundwater Level (mAHD)
Daily Rainfall (mm)
234
233
232
100
90
80
70
60
50
40
30
20
10
0
1/07/2011
30/08/2011
30/10/2011
30/12/2011
29/02/2012
30/04/2012
30/06/2012
30/08/2012

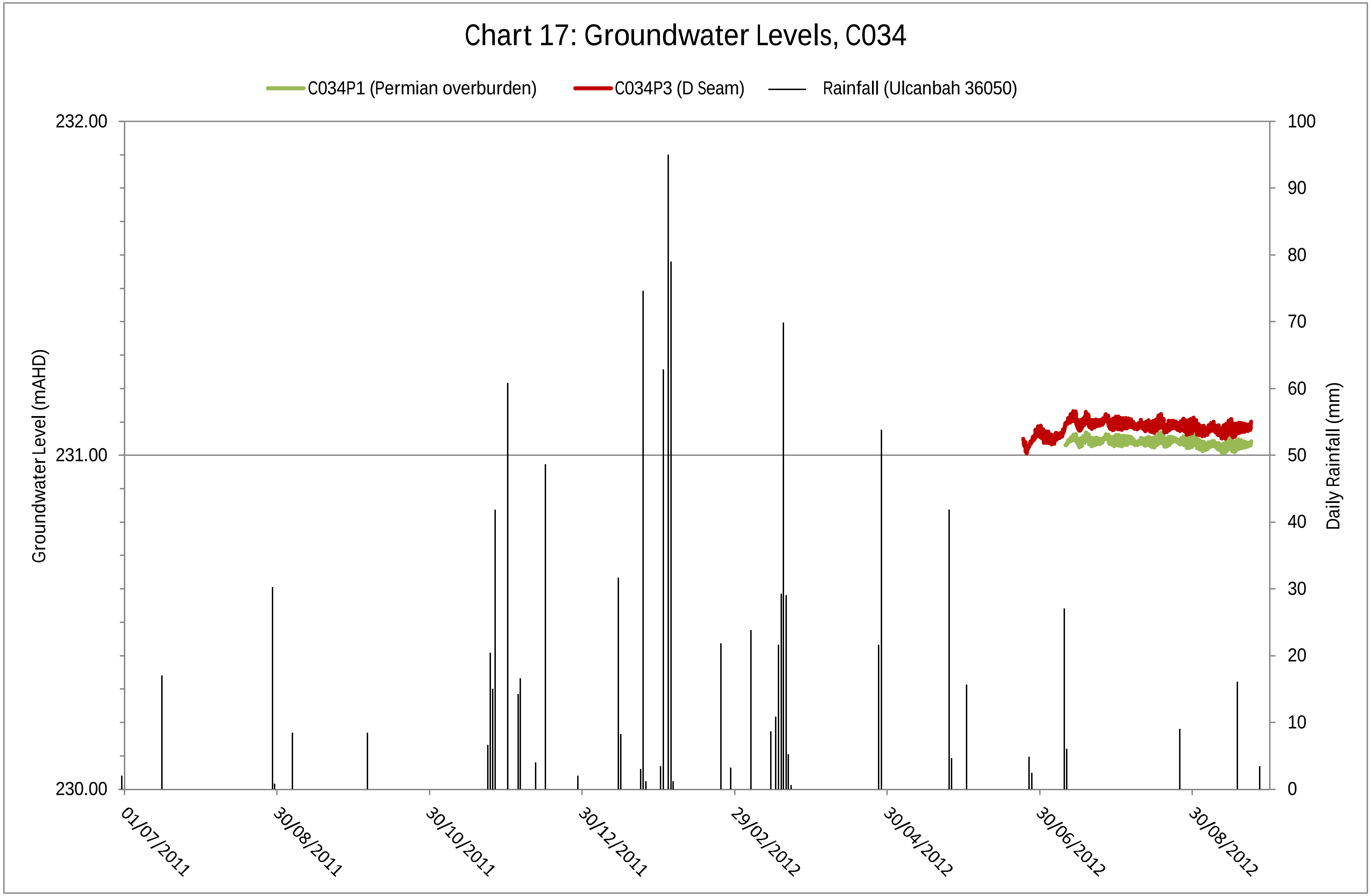

Chart 17: Groundwater Levels, C034
C034P1 (Permian overburden)
C034P3 (D Seam)
Rainfall (Ulcanbah 36050)
Groundwater Level (mAHD)
Daily Rainfall (mm)
232.00
231.00
230.00
100
90
80
70
60
50
40
30
20
10
0
01/07/2011
30/08/2011
30/10/2011
30/12/2011
29/02/2012
30/04/2012
30/06/2012
30/08/2012

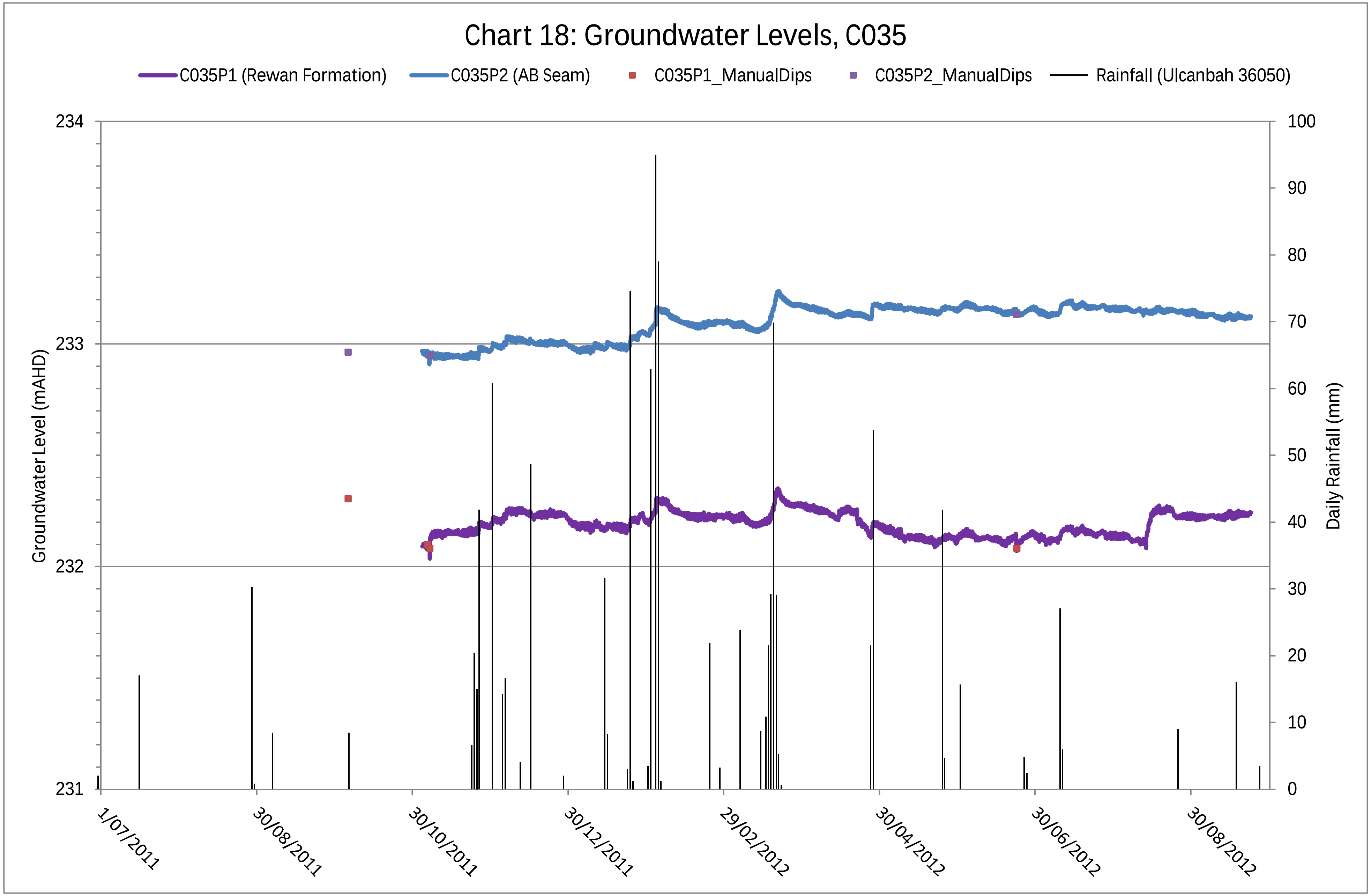
Chart 18: Groundwater Levels, C035
C035P1 (Rewan Formation)
C035P2 (AB Seam)
C035P1_ManualDips
C035P2_ManualDips
Rainfall (Ulcanbah 36050)
Groundwater Level (mAHD)
Daily Rainfall (mm)
234
233
232
231
100
90
80
70
60
50
40
30
20
10
0
1/07/2011
30/08/2011
30/10/2011
30/12/2011
29/02/2012
30/04/2012
30/06/2012
30/08/2012

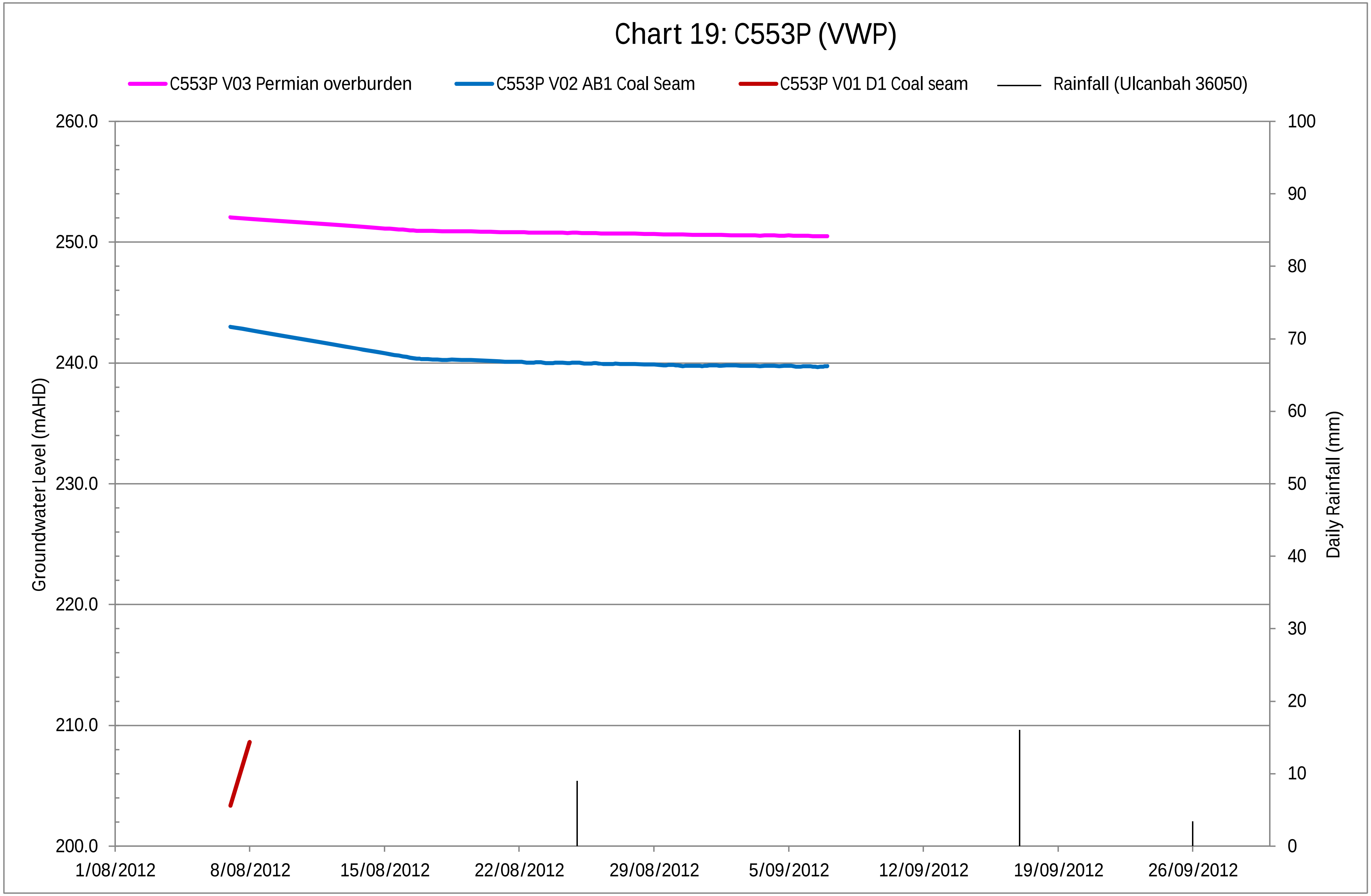

Chart 19: C553P (VWP)
C553P V03 Permian overburden
C553P V02 AB1 Coal Seam
C553P V01 D1 Coal seam
Rainfall (Ulcanbah 36050)
Groundwater Level (mAHD)
Daily Rainfall (mm)
260.0
250.0
240.0
230.0
220.0
210.0
200.0
100
90
80
70
60
50
40
30
20
10
0
1/08/2012
8/08/2012
15/08/2012
22/08/2012
29/08/2012
5/09/2012
12/09/2012
19/09/2012
26/09/2012

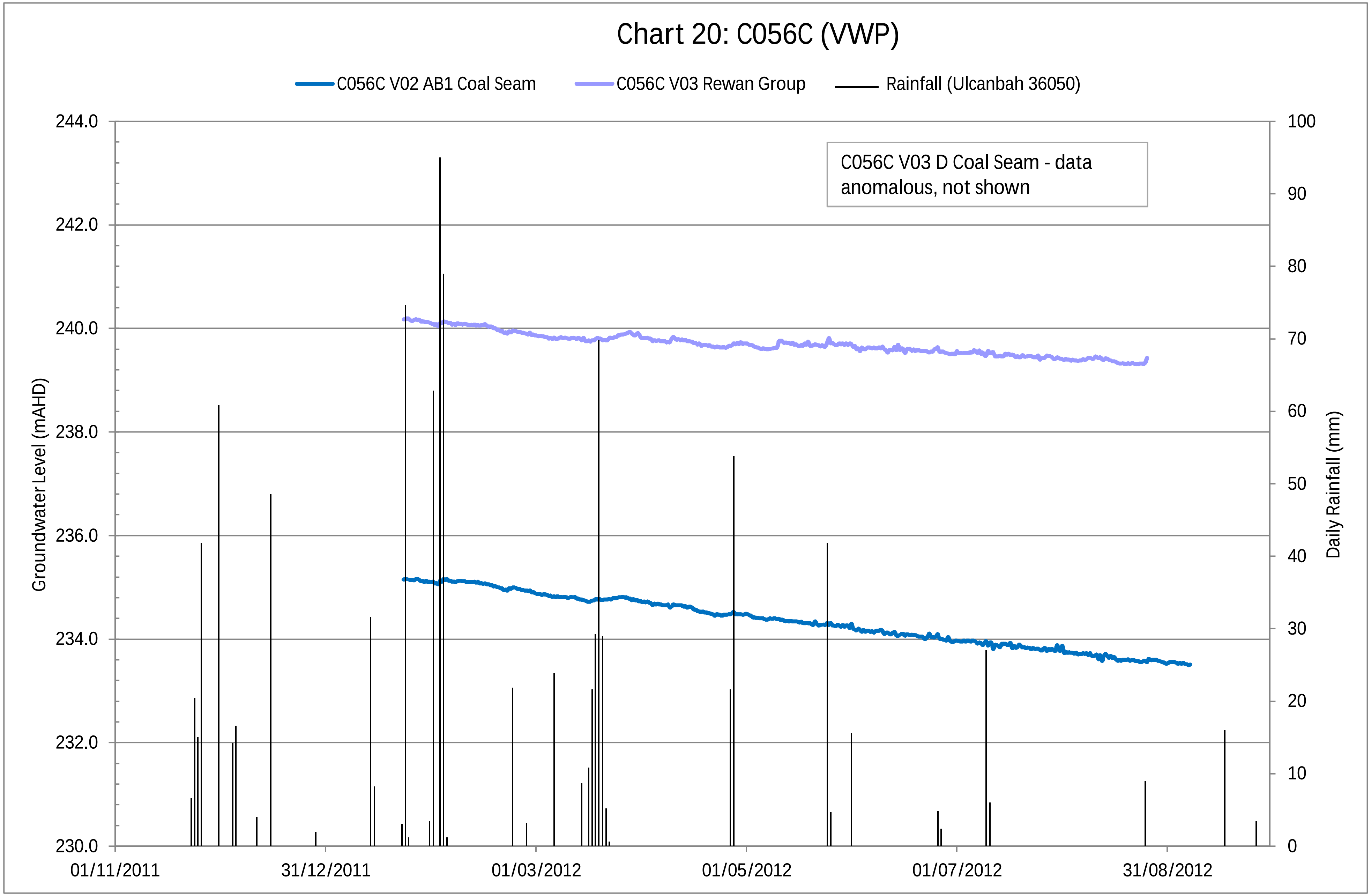

Chart 20: C056C (VWP)
C056C V02 AB1 Coal Seam
C056C V03 Rewan Group
Rainfall (Ulcanbah 36050)
C056C V03 D Coal Seam - data anomalous, not shown
Groundwater Level (mAHD)
Daily Rainfall (mm)
244.0
242.0
240.0
238.0
236.0
234.0
232.0
230.0
100
90
80
70
60
50
40
30
20
10
0
01/11/2011
31/12/2011
01/03/2012
01/05/2012
01/07/2012
31/08/2012

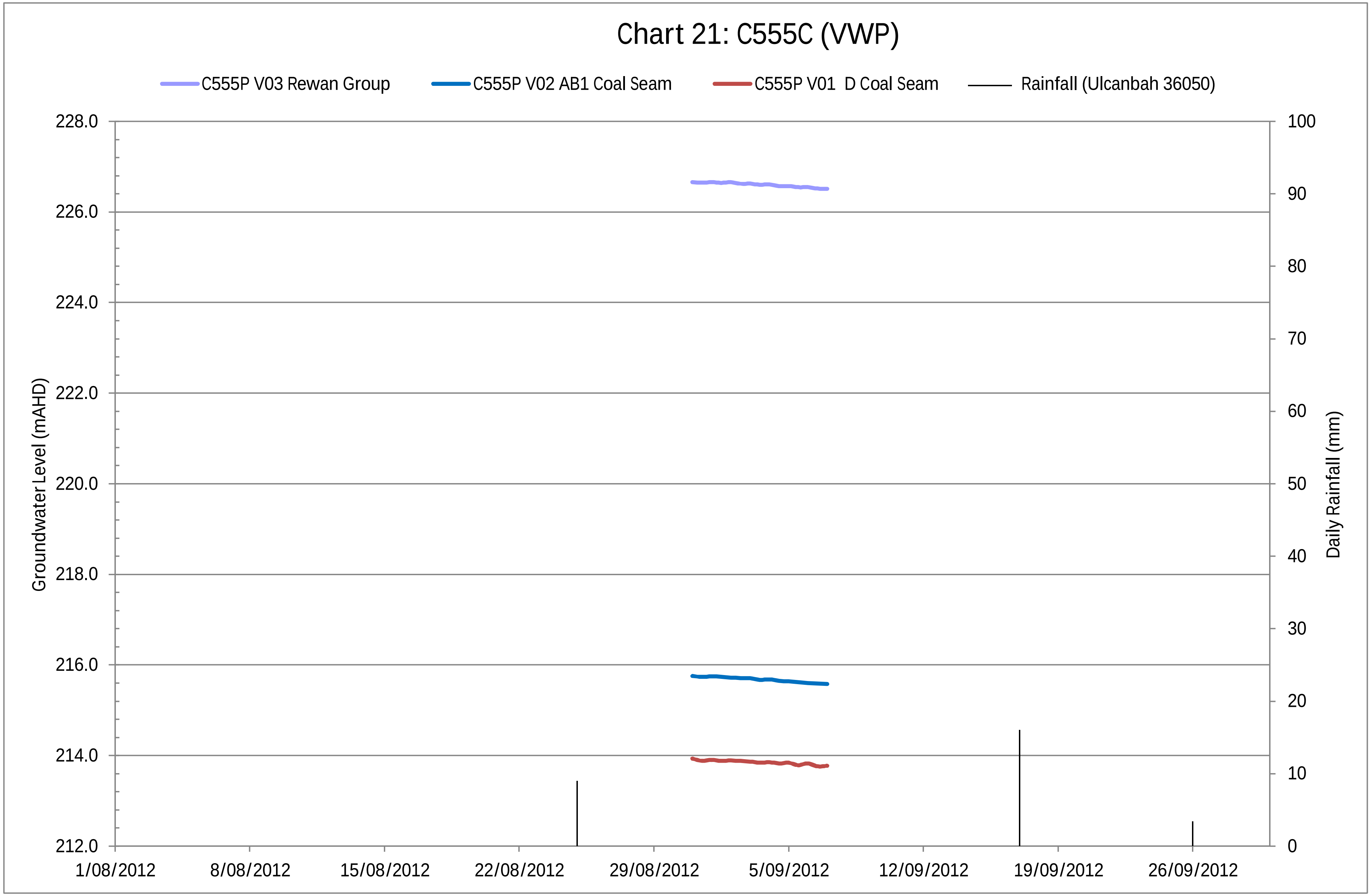
Chart 21: C555C (VWP)
C555P V03 Rewan Group
C555P V02 AB1 Coal Seam
C555P V01 D Coal Seam
Rainfall (Ulcanbah 36050)
Groundwater Level (mAHD)
Daily Rainfall (mm)
228.0
226.0
224.0
222.0
220.0
218.0
216.0
214.0
212.0
100
90
80
70
60
50
40
30
20
10
0
1/08/2012
8/08/2012
15/08/2012
22/08/2012
29/08/2012
5/09/2012
12/09/2012
19/09/2012
26/09/2012

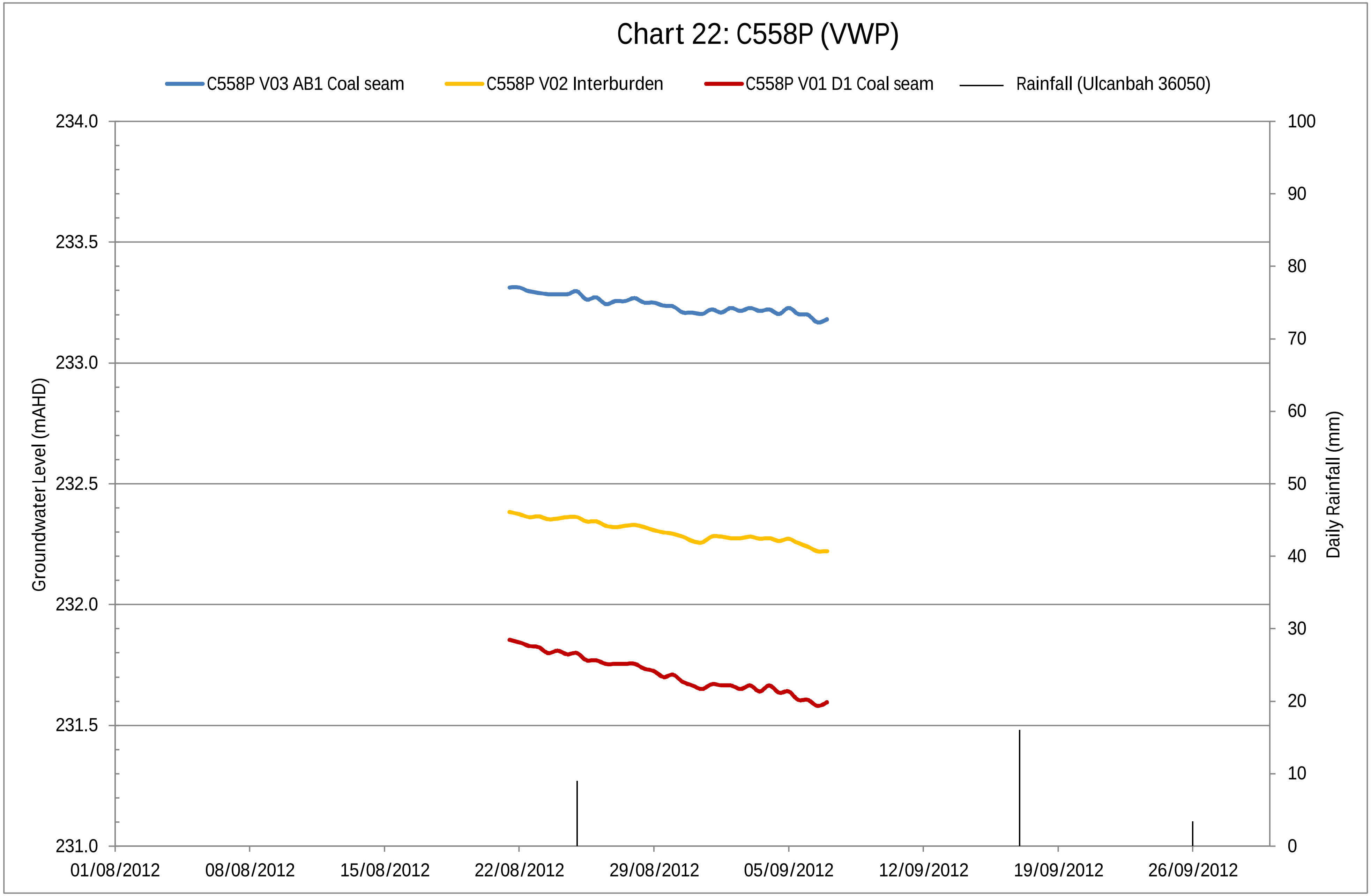
Chart 22: C558P (VWP)
C558P V03 AB1 Coal seam
C558P V02 Interburden
C558P V01 D1 Coal seam
Rainfall (Ulcanbah 36050)
Groundwater Level (mAHD)
Daily Rainfall (mm)
234.0
233.5
233.0
232.5
232.0
231.5
231.0
100
90
80
70
60
50
40
30
20
10
0
01/08/2012
08/08/2012
15/08/2012
22/08/2012
29/08/2012
05/09/2012
12/09/2012
19/09/2012
26/09/2012

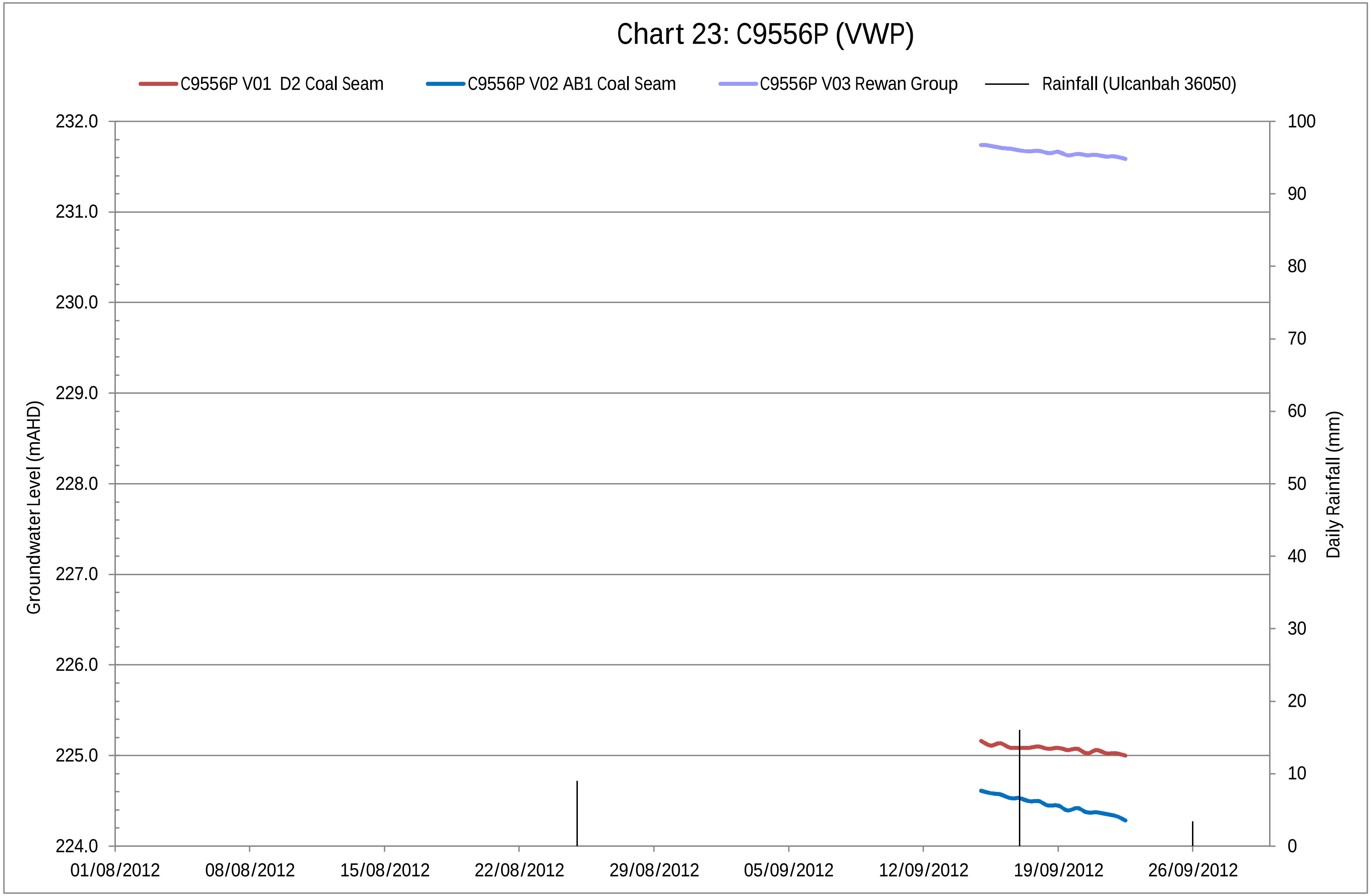

Chart 23: C9556P (VWP)
C9556P V01 D2 Coal Seam
C9556P V02 AB1 Coal Seam
C9556P V03 Rewan Group
Rainfall (Ulcanbah 36050)
Groundwater Level (mAHD)
Daily Rainfall (mm)
232.0
231.0
230.0
229.0
228.0
227.0
226.0
225.0
224.0
100
90
80
70
60
50
40
30
20
10
0
01/08/2012
08/08/2012
15/08/2012
22/08/2012
29/08/2012
05/09/2012
12/09/2012
19/09/2012
26/09/2012

Appendix E

Groundwater Quality

Laboratory Analysis Summary Tables

Field Chemistry Summary Tables

Laboratory QA Certificates

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Monitored Unit	LocCode	Sampled_ Date-Time	Field: Dissolved Oxygen (Field) mg/L	Field: Electrical Conductivity (Field) uS/cm	Field: Oxygen Redox Potential (Field) mV	Field: pH (Field) pH_Units	Field: TDS (Field) PPM	Field: Temp (Field) oC
Alluvium	C027P1	29/09/2011	1.19	5940	-64	5.97	3710	28.9
	C027P1	8/11/2011	2.07	5980	-55	6.64	3690	29.3
	C027P1	8/11/2011	1.18	6140	-72	6.68	3810	33.2
	C029P1	29/09/2011	0.51	20,770	-101	5.82	13,910	30
	C029P1	7/11/2011	2.86	27,600	-70	7.19	18,400	32.5
	HD03B	27/10/2012	7.8	1152	63	8.2	-	26.2
Tertiary	C025P2	29/09/2011	0.67	11,500	-291	5.56	7500	30.5
	C025P2	7/11/2011	0.84	13,020	70	6.92	8350	28.5
	C029P2	29/09/2011	1.46	7890	-176	6.38	5850	33.4
	C029P2	7/11/2011	0.34	10,360	-165	6.77	6580	30.7
Clematis Sandstone	HD02	27/10/2012	9.89	606	10	7.24	-	26
Dunda Beds	C022P1	3/10/2011	1.67	338	23	4.9	188	24
	C022P1	14/11/2011	0.78	347	9	6.02	190	28.6
	C022P1	10/11/2011	1.48	343	-6	6.04	187	31.1
	C027P2	29/09/2011	0.95	1161	-60	5.77	680	28.5
	C027P2	5/11/2011	0.46	1008	-90	6.71	576	27.5
	C9553P1R	2/10/2012	2.56	561	86	7.52	-	27.5
	HD03A	27/10/2012	1.89	722	15	6.49	-	26.8
Rewan Group	C035P1	5/10/2011	1.04	4100	-57	4.84	2550	31
	C035P1	6/11/2011	0.4	3820	-28	7.5	2310	30.6
	C555P1	30/09/2012	5.28	455	90	7	-	26.2
	C556P1	1/10/2012	5.08	156.3	106	6.32	-	29.4
Permian Overburden	C008P1	3/10/2011	1.73	20,630	41	5.58	13,830	28.1
	C008P1	12/11/2011	0.79	19,900	129	6.65	13,030	30.6
	C012P1	2/10/2011	2.43	1839	78	5.59	1109	27.6
	C012P1	8/11/2011	1.43	1996	76	6.26	1180	28.4
	C012P2	2/10/2011	1.38	2179	-15	5.52	1318	-
	C012P2	13/11/2011	0.75	2440	-119	7.19	1450	30.3
	C018P1	2/10/2011	3.66	754	41	5.63	433	29.3
	C018P1	8/11/2011	3.27	782	58	6.33	444	29.3
	C558P1	1/10/2012	3.39	247	87	7.05	-	29.5
AB Seam	C007P2	4/10/2011	1.1	14,210	-39	4.41	9310	26.1
	C007P2	10/11/2011	4.2	13,350	-153	7.9	8610	31
	C007P2	10/11/2011	1.23	13,150	-192	7.49	8420	31.8
	C008P2	3/10/2011	0.75	3290	-137	5.92	2020	31.1
	C008P2	12/11/2011	5.4	3040	-116	8.03	1820	29.8
	C014P2	4/10/2011	0.63	1960	-9	5.48	5480	31.3
	C014P2	12/11/2011	1.25	1980	-129	9.86	1169	30.9
	C016P2	2/10/2011	0.72	3070	-146	10.12	1880	25.2
	C016P2	13/11/2011	2.46	4080	-199	12.03	4080	30.8
	C018P2	2/10/2011	1.61	1390	-57	5.41	828	30.8
	C018P2	9/11/2011	0.86	2310	-72	6.87	1370	29.3
	C018P2	9/11/2011	1.02	2225	-31	6.96	1321	33.4
	C020P2	3/10/2011	1.13	1694	42	4.5	1019	30.1
	C020P2	14/11/2011	1.49	1620	-189	8.06	949	29.1
	C032P2	5/10/2011	0.84	1354	-26	4.34	800	31.6
	C032P2	7/11/2011	3.48	1563	-71	7.29	915	29.3
	C035P2	5/10/2011	1.2	1561	-78	4.71	928	29.9
	C035P2	6/11/2011	1.53	1527	-30	-	2310	28.6
Interburden	C006P1	3/10/2011	1.04	8250	-	4.47	5290	27.2
	C006P1	10/11/2011	0.61	16,020	-61	6.78	10,350	30.3
	C011P1	13/11/2011	0.92	2880	-57	7.63	1720	40.8
	C034P1	5/10/2011	1.35	4960	32	4.88	3100	32
	C034P1	6/11/2011	2.92	4590	12	7.5	2800	29.6
D Seam	C006P3r	3/10/2011	0.8	999	-40	4.71	585	21.2
	C006P3r	12/11/2011	0.61	987	-120	7.71	566	29.2
	C006P3r	10/11/2011	0.91	980	31	7.78	563	34.9
	C007P3	4/10/2011	0.9	1246	-82	5.04	737	28.8
	C007P3	10/11/2011	5.92	1233	-192	8.34	713	31.8
	C011P3	4/10/2011	1.2	980	35	5.86	5860	31.8
	C011P3	13/11/2011	3.42	982	-86	7.75	982	31.4
	C018P3	2/10/2011	1.89	1020	-20	5.81	594	29.8
	C018P3	9/11/2011	1.61	991	-60	7.06	568	-
	C018P3	9/11/2011	0.61	996	32.6	7.23	569	31.7
	C024P3	6/10/2011	0.71	1720	-72	4.72	1033	31.2
	C024P3	14/11/2011	0.8	1602	-120	6.49	938	31.1
	C034P3	6/11/2011	2.59	1608	13	7.5	943	30.1

			Inorganics						
			Bromide	Fluoride	Kjeldahl Nitrogen Total	pH (Lab)	Sulphide	TOC	Total Dissolved Solids
			mg/L	mg/L	mg/L	pH Units	mg/L	mg/L	mg/L
EQL			0.005	0.1	0.1	0.01	0.1	1	5
ANZECC (2000) Ecosystems Fresh Water (95%)									
MonitoringUnit	**WellCode**	**Sampled_Date-Time**							
ALLUVIUM	C027P1	29/09/2011	-	0.9	2.1	7	<0.1	52	3850
		8/11/2011	-	0.6	1.1	6.77	<0.1	<1	4370
		8/11/2011	-	0.7	1.1	6.91	<0.1	<1	4260
	C029P1	7/11/2011	-	0.9	1.7	7.28	<0.1	<1	20,100
TERTIARY	C025P2	29/09/2011	6.1	0.8	3.3	7.52	0.4	1	8180
		7/11/2011	-	0.6	1.8	7.07	<0.1	<1	8660
	C029P2	29/09/2011	4.95	0.6	-	7.23	0.3	13	6960
		7/11/2011	-	0.6	0.7	6.96	<0.1	<1	7780
DUNDA BEDS	C022P1	3/10/2011	0.14	0.3	<0.1	6.76	-	-	301
		6/10/2011	-	-	-	-	<0.1	<1	-
		14/11/2011	-	0.3	<0.1	6.73	<0.1	2	233
		10/11/2011	-	0.3	0.1	6.39	<0.1	<1	209
	C027P2	29/09/2011	-	0.5	2	7.25	<0.1	106	805
		5/11/2011	-	0.4	0.6	6.79	<0.1	<1	949
REWAN	C035P1	5/10/2011	2.42	0.7	0.6	7.22	<0.1	<1	2290
		6/11/2011	-	0.6	3.9	7.24	<0.1	<1	2990
PERMIAN OVERBURDEN	C008P1	3/10/2011	14.7	0.5	0.2	7.65	<0.1	3	14,900
		12/11/2011	-	0.6	0.2	7.23	<0.1	<1	17,200
	C012P1	2/10/2011	1.04	0.3	0.5	7.32	<0.1	-	1170
		4/10/2011	-	-	-	-	-	<1	-
		8/11/2011	-	0.3	<0.1	6.43	<0.1	6	1350
	C012P2	2/10/2011	1.3	0.5	<0.1	7.86	-	-	1680
		4/10/2011	-	-	-	-	0.3	58	-
		13/11/2011	-	0.4	0.1	7.75	0.1	32	1560
	C018P1	2/10/2011	0.21	0.6	2.7	7.53	<0.1	-	486
		6/10/2011	-	-	-	-	-	<1	-
		8/11/2011	-	0.4	<0.1	6.5	<0.1	<1	541
AB SEAM	C007P2	4/10/2011	8.3	0.4	6.2	7.56	<0.1	13	10,300
		10/11/2011	-	0.4	2	7.95	5.3	36	10,700
		10/11/2011	-	0.4	2.1	7.73	6.2	38	10,800
	C008P2	3/10/2011	1.35	0.8	0.9	8.52	5.3	54	1920
		12/11/2011	-	0.9	1	8.27	0.9	37	1920
	C014P2	4/10/2011	0.72	1	1.1	8.61	<0.1	29	1110
		12/11/2011	-	1	1.6	9.5	<0.1	23	1340
	C016P2	2/10/2011	1.36	0.2	8.3	10.4	4.7	-	1660
		6/10/2011	-	-	-	-	-	20	-
		13/11/2011	-	0.3	11.7	11.5	1.9	28	1840
	C018P2	2/10/2011	1.27	0.4	0.6	7.63	0.6	-	1420
		6/10/2011	-	-	-	-	-	<1	-
		9/11/2011	-	0.4	<0.1	7.18	0.4	28	1360
		9/11/2011	-	0.5	0.4	7.26	0.9	16	1210
	C020P2	3/10/2011	0.84	0.6	0.6	8.21	-	-	1050
		6/10/2011	-	-	-	-	<0.1	2	-
		14/11/2011	-	0.6	0.6	8.2	1.5	<1	970
	C032P2	5/10/2011	0.42	0.6	0.4	8.09	0.2	36	951
		7/11/2011	-	0.7	2	7.49	<0.1	<1	1540
	C035P2	5/10/2011	0.76	0.3	0.2	7.15	0.1	1	851
		6/11/2011	-	0.3	<0.1	7.02	<0.1	11	1180
INTERBURDEN	C011P1	13/11/2011	-	0.8	0.2	8.17	<0.1	31	1900
	C006P1	3/10/2011	7.9	0.7	0.5	7.74	0.2	58	8960
		10/11/2011	-	0.6	0.2	7.16	0.2	18	11,900
	C034P1	5/10/2011	2.78	0.7	0.2	7.03	<0.1	1	2870
		6/11/2011	-	0.7	<0.1	7	<0.1	<1	2810
D SEAM	C006P3r	3/10/2011	0.17	2.2	0.4	8.32	<0.1	12	587
		12/11/2011	-	2.4	0.4	8.18	<0.1	<1	620
	C006P3r	10/11/2011	-	2.2	0.5	8.04	<0.1	13	568
	C007P3	4/10/2011	0.14	2.6	0.7	8.23	0.2	33	809
		10/11/2011	-	2.6	0.4	8.31	1.3	38	760
	C011P3	4/10/2011	0.42	1.2	1.1	8.45	<0.1	8	568
		13/11/2011	-	1.2	0.3	8.01	<0.1	<1	608
	C018P3	2/10/2011	0.48	1.2	0.8	7.81	<0.1	-	651
		6/10/2011	-	-	-	-	-	<1	-
		9/11/2011	-	1.2	0.2	7.35	<0.1	2	523
		9/11/2011	-	1.2	0.3	7.51	0.1	5	554
	C024P3	6/10/2011	1.28	0.4	0.8	6.52	0.4	108	1150
		14/11/2011	-	0.4	0.4	7.12	1	47	1050
	C034P3	5/10/2011	1.29	0.5	0.2	7.23	<0.1	<1	1260
		6/11/2011	-	0.3	<0.1	6.96	<0.1	<1	1020
UNKNOWN	C066 (line 180-35)	11/11/2011	-	0.1	0.1	6.51	<0.1	-	396
SURFACE WATER	WQ01	6/10/2011	0.931	0.5	0.3	7.79	<0.1	11	703
		8/11/2011	-	0.6	0.5	7.91	<0.1	5	1340
	WQ03	5/10/2011	0.55	0.5	0.5	8.07	<0.1	8	859
		8/11/2011	-	0.5	0.6	8.04	<0.1	1	1350

Statistical Summary

Number of Results	26	66	65	66	66	65	66
Number of Detects	26	66	56	66	23	42	66
Minimum Concentration	0.14	0.1	<0.1	6.39	<0.1	<1	209
Minimum Detect	0.14	0.1	0.1	6.39	0.1	1	209
Maximum Concentration	14.7	2.6	11.7	11.5	6.2	108	20,100
Maximum Detect	14.7	2.6	11.7	11.5	6.2	108	20,100
Average Concentration	2.4	0.73	1.1	7.6	0.53	16	3150
Median Concentration	1.16	0.6	0.5	7.515	0.05	5	1300
Standard Deviation	3.4	0.55	1.9	0.86	1.3	23	4329
Number of Guideline Exceedances	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)	0	0	0	0	0	0	0

* Calculated in ESDAT (database management software)

			Metals																	
			Aluminium (Filtered)	Arsenic (Filtered)	Boron (Filtered)	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Cobalt (Filtered)	Copper (Filtered)	Iron (Filtered)	Lead (Filtered)	Manganese (Filtered)	Mercury (Filtered)	Molybdenum (Filtered)	Nickel (Filtered)	Selenium (Filtered)	Silver (Filtered)	Uranium (Filtered)	Vanadium (Filtered)	Zinc (Filtered)
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL			0.01	0.001	0.05	0.0001	0.001	0.001	0.001	0.05	0.001	0.001	0.0001	0.001	0.001	0.01	0.001	0.001	0.01	0.005
ANZECC (2000) Ecosystems Fresh Water (95%)			0.055	0.013	0.37	0.0002	0.001		0.0014		0.0034	1.9	0.00006		0.011	0.005	0.00005			0.008
MonitoringUnit	**WellCode**	**Sampled_Dat**																		
ALLUVIUM	C027P1	29/09/2011	0.01	0.013	0.63	-	<0.001	<0.001	<0.001	16	<0.001	4.49	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	0.01	0.006
		8/11/2011	<0.01	0.015	0.52	<0.0001	0.004	0.004	0.001	29.3	<0.001	4.43	<0.0001	<0.001	0.012	<0.01	<0.001	<0.001	<0.01	0.019
		8/11/2011	<0.01	0.013	0.52	<0.0001	0.004	<0.001	<0.001	27.4	<0.001	4.55	<0.0001	<0.001	0.015	<0.01	<0.001	<0.001	<0.01	0.01
	C029P1	7/11/2011	<0.01	0.028	2.56	<0.0001	<0.001	0.003	0.006	5.62	<0.001	4.81	<0.0001	0.001	0.076	<0.01	<0.001	0.05	0.02	0.013
TERTIARY	C025P2	29/09/2011	0.03	0.012	1.01	<0.0001	0.005	-	<0.001	-	<0.001	1.16	<0.0001	0.001	<0.001	0.05	<0.001	0.002	0.01	0.006
		7/11/2011	<0.01	0.013	1.01	<0.0001	<0.005	<0.001	0.002	24.5	<0.001	2.19	<0.0001	<0.001	0.001	0.01	<0.001	<0.001	0.01	0.006
	C029P2	29/09/2011	<0.01	0.006	0.92	-	<0.001	<0.001	<0.001	1.74	<0.001	0.448	<0.0001	0.001	0.001	<0.01	<0.001	<0.001	<0.01	0.006
		7/11/2011	<0.01	0.008	0.84	<0.0001	0.002	0.001	0.001	6.33	<0.001	0.655	<0.0001	<0.001	0.005	<0.01	<0.001	<0.001	<0.01	0.011
DUNDA BEDS	C022P1	3/10/2011	0.51	<0.001	0.15	<0.0001	<0.001	0.005	<0.001	0.5	<0.001	0.099	<0.0001	<0.001	0.006	<0.01	<0.001	<0.001	<0.01	0.011
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14/11/2011	0.23	0.002	0.07	<0.0001	<0.001	0.009	<0.001	2.67	<0.001	0.2	<0.0001	<0.001	0.006	<0.01	<0.001	<0.001	<0.01	0.028
		10/11/2011	0.63	0.001	0.11	<0.0001	0.002	0.007	<0.001	0.76	<0.001	0.083	<0.0001	<0.001	0.006	<0.01	<0.001	<0.001	<0.01	0.014
	C027P2	29/09/2011	0.09	0.019	0.22	-	<0.001	0.007	<0.001	24.9	<0.001	1.78	<0.0001	<0.001	0.004	<0.01	<0.001	<0.001	<0.01	0.009
		5/11/2011	0.14	0.012	0.16	<0.0001	0.002	0.002	<0.001	11.3	<0.001	0.883	<0.0001	<0.001	0.01	<0.01	<0.001	<0.001	<0.01	0.01
REWAN	C035P1	5/10/2011	0.08	0.008	0.64	<0.0001	<0.001	<0.001	<0.001	2.04	<0.001	0.256	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005
		6/11/2011	0.03	0.005	0.54	<0.0001	0.001	<0.001	<0.001	0.68	<0.001	0.218	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	0.006
PERMIAN OVERBURDEN	C008P1	3/10/2011	<0.01	0.002	1.14	0.0003	0.004	0.002	0.002	0.29	<0.001	0.181	<0.0001	<0.001	0.008	0.02	0.003	0.019	<0.01	0.014
		12/11/2011	<0.01	<0.001	1.29	0.0002	0.001	0.004	0.011	0.06	<0.001	1.6	<0.0001	<0.001	0.015	<0.01	0.003	0.018	<0.01	0.118
	C012P1	2/10/2011	0.01	<0.001	0.41	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	0.182	<0.0001	<0.001	0.001	<0.01	0.001	<0.001	<0.01	0.012
		4/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		8/11/2011	<0.01	<0.001	0.32	<0.0001	0.001	<0.001	0.002	0.05	<0.001	0.173	<0.0001	<0.001	0.006	<0.01	<0.001	<0.001	<0.01	0.037
	C012P2	2/10/2011	0.01	0.006	0.49	<0.0001	<0.001	<0.001	<0.001	1.62	<0.001	1.32	<0.0001	0.001	<0.001	<0.01	<0.001	0.001	<0.01	<0.005
		4/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		13/11/2011	0.01	0.006	0.4	<0.0001	0.001	<0.001	<0.001	1.26	<0.001	0.924	<0.0001	<0.001	0.003	<0.01	<0.001	<0.001	<0.01	0.034
	C018P1	2/10/2011	0.07	<0.001	0.19	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	0.006	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	0.012
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		8/11/2011	0.03	<0.001	0.18	<0.0001	0.003	<0.001	<0.001	<0.05	<0.001	0.013	<0.0001	<0.001	0.003	<0.01	<0.001	<0.001	<0.01	0.031
AB SEAM	C007P2	4/10/2011	<0.01	0.003	0.41	<0.0001	0.001	0.001	0.002	0.24	<0.001	0.445	<0.0001	0.008	<0.001	<0.01	0.004	0.003	<0.01	<0.005
		10/11/2011	<0.01	0.002	0.51	<0.0001	0.002	<0.001	0.001	0.1	<0.001	0.304	<0.0001	0.001	<0.001	<0.01	<0.001	0.002	<0.01	0.005
		10/11/2011	<0.01	0.003	0.49	0.0001	0.002	<0.001	0.001	0.16	<0.001	0.285	<0.0001	<0.001	<0.001	<0.01	0.003	0.002	<0.01	<0.005
	C008P2	3/10/2011	0.02	0.004	0.3	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	0.263	<0.0001	0.005	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005
		12/11/2011	0.06	0.008	0.3	<0.0001	0.001	<0.001	0.001	0.06	<0.001	0.361	<0.0001	<0.001	0.002	<0.01	<0.001	<0.001	<0.01	0.019
	C014P2	4/10/2011	<0.01	0.004	0.3	<0.0001	<0.001	0.002	<0.001	0.38	<0.001	0.084	<0.0001	0.009	0.003	<0.01	<0.001	<0.001	<0.01	<0.005
		12/11/2011	0.42	0.004	0.24	<0.0001	0.001	<0.001	<0.001	0.18	<0.001	0.002	<0.0001	0.012	0.002	<0.01	<0.001	<0.001	<0.01	0.007
	C016P2	2/10/2011	0.08	0.004	0.31	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	<0.001	<0.0001	0.01	<0.001	<0.01	<0.001	<0.001	<0.01	0.006
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		13/11/2011	0.02	0.003	0.23	<0.0001	<0.001	<0.001	<0.001	0.05	<0.001	0.001	<0.0001	0.013	<0.001	<0.01	<0.001	<0.001	<0.01	0.005
	C018P2	2/10/2011	<0.01	0.001	0.61	<0.0001	<0.001	<0.001	<0.001	1.13	<0.001	0.051	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	0.007
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		9/11/2011	<0.01	<0.001	0.5	<0.0001	0.003	<0.001	<0.001	0.98	<0.001	0.03	<0.0001	<0.001	0.003	<0.01	<0.001	<0.001	<0.01	0.009
		9/11/2011	<0.01	0.002	0.46	<0.0001	0.003	<0.001	<0.001	0.57	<0.001	0.06	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005
	C020P2	3/10/2011	0.1	0.002	0.48	<0.0001	<0.001	<0.001	<0.001	0.06	<0.001	0.037	<0.0001	0.004	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14/11/2011	0.04	0.001	0.41	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	0.041	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005
	C032P2	5/10/2011	0.02	0.005	0.3	<0.0001	<0.001	<0.001	<0.001	0.33	<0.001	0.264	<0.0001	0.018	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005
		7/11/2011	0.02	0.013	0.3	<0.0001	0.003	<0.001	<0.001	1.4	<0.001	0.464	<0.0001	0.01	0.002	<0.01	<0.001	<0.001	<0.01	0.005
	C035P2	5/10/2011	0.35	<0.001	0.24	<0.0001	<0.001	<0.001	0.002	1.01	<0.001	0.136	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005
		6/11/2011	5.66	<0.001	0.2	<0.0001	0.005	<0.001	0.001	2.24	<0.001	0.128	<0.0001	<0.001	0.003	<0.01	<0.001	<0.001	<0.01	0.01
INTERBURDEN	C011P1	13/11/2011	0.07	0.002	0.9	<0.0001	0.002	0.001	<0.001	<0.05	<0.001	0.113	<0.0001	0.007	0.009	<0.01	<0.001	0.004	<0.01	0.023
	C006P1	3/10/2011	<0.01	0.011	1.05	<0.0001	0.004	<0.001	<0.001	1.9	<0.001	0.891	<0.0001	0.029	0.002	<0.01	<0.001	0.014	<0.01	0.006
		10/11/2011	<0.01	0.01	1.3	<0.0001	0.004	0.005	0.001	3.85	<0.001	0.687	<0.0001	0.005	0.004	<0.01	<0.001	0.014	<0.01	0.008
	C034P1	5/10/2011	0.01	0.005	0.6	<0.0001	<0.001	0.001	<0.001	3.24	<0.001	0.204	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005
		6/11/2011	0.01	0.003	0.51	<0.0001	0.001	<0.001	<0.001	1.3	<0.001	0.141	<0.0001	<0.001	0.001	<0.01	<0.001	<0.001	<0.01	0.01
D SEAM	C006P3r	3/10/2011	0.14	0.004	0.18	<0.0001	<0.001	<0.001	<0.001	0.8	<0.001	0.046	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005
		12/11/2011	0.13	0.003	0.12	<0.0001	0.001	<0.001	<0.001	0.41	<0.001	0.038	<0.0001	0.002	0.003	<0.01	<0.001	<0.001	<0.01	0.009
	C006P3r	10/11/2011	0.1	0.003	0.13	<0.0001	0.003	<0.001	<0.001	0.44	<0.001	0.036	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005
	C007P3	4/10/2011	0.32	0.004	0.22	<0.0001	<0.001	<0.001	0.004	0.18	<0.001	0.052	<0.0001	0.019	<0.001	<0.01	<0.001	0.002	<0.01	<0.005
		10/11/2011	0.22	0.003	0.22	<0.0001	<0.001	<0.001	<0.001	0.12	<0.001	0.042	<0.0001	0.019	<0.001	<0.01	<0.001	0.002	<0.01	0.01
	C011P3	4/10/2011	<0.01	0.004	0.41	<0.0001	<0.001	0.002	<0.001	2.59	<0.001	0.218	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005
		13/11/2011	0.02	0.002	0.35	<0.0001	<0.001	<0.001	<0.001	0.88	<0.001	0.09	<0.0001	0.002	0.001	<0.01	<0.001	<0.001	<0.01	0.01
	C018P3	2/10/2011	0.05	0.002	0.35	<0.0001	<0.001	0.001	<0.001	0.59	<0.001	0.122	<0.0001	0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		9/11/2011	0.05	0.001	0.29	<0.0001	0.002	<0.001	<0.001	0.89	<0.001	0.09	<0.0001	<0.001	0.002	<0.01	<0.001	<0.001	<0.01	0.014
		9/11/2011	0.06	0.001	0.28	<0.0001	0.002	<0.001	<0.001	0.4	<0.001	0.109	<0.0001	0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005
	C024P3	6/10/2011	<0.01	0.007	0.3	<0.0001	<0.001	0.001	<0.001	14.8	<0.001	0.261	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005
		14/11/2011	<0.01	0.004	0.28	<0.0001	0.001	<0.001	0.002	8.37	<0.001	0.236	<0.0001	<0.001	0.009	<0.01	<0.001	<0.001	<0.01	0.044
	C034P3	5/10/2011	<0.01	0.002	0.26	<0.0001	<0.001	<0.001	<0.001	1.2	<0.001	0.23	<0.0001	0.006	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005
		6/11/2011	<0.01	<0.001	<0.05	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005
UNKNOWN	C066 (line 180-35)	11/11/2011	0.58	<0.001	0.05	<0.0001	<0.001	0.003	<0.001	0.32	<0.001	0.048	<0.0001	<0.001	0.004	<0.01	<0.001	<0.001	<0.01	0.026
SURFACE WATER	WQ01	6/10/2011	0.13	<0.001	0.13	<0.0001	<0.001	<0.001	<0.001	0.85	<0.001	0.184	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005
		8/11/2011	0.12	0.001	0.12	<0.0001	0.002	<0.001	<0.001	0.82	<0.001	0.2	<0.0001	<0.001	0.001	<0.01	<0.001	<0.001	<0.01	0.022
	WQ03	5/10/2011	0.1	<0.001	0.15	<0.0001	<0.001	<0.001	0.003	0.5	<0.001	0.055	<0.0001	<0.001	0.001	<0.01	<0.001	<0.001	<0.01	<0.005
		8/11/2011	0.17	<0.001	0.14	<0.0001	<0.001	<0.001	0.002	0.72	<0.001	0.298	<0.0001	<0.001	0.001	<0.01	<0.001	<0.001	<0.01	<0.005

Statistical Summary

	Aluminium (Filtered)	Arsenic (Filtered)	Boron (Filtered)	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Cobalt (Filtered)	Copper (Filtered)	Iron (Filtered)	Lead (Filtered)	Manganese (Filtered)	Mercury (Filtered)	Molybdenum (Filtered)	Nickel (Filtered)	Selenium (Filtered)	Silver (Filtered)	Uranium (Filtered)	Vanadium (Filtered)	Zinc (Filtered)
Number of Results	67	67	67	64	67	66	67	66	67	67	67	67	67	67	67	67	67	67
Number of Detects	44	52	66	3	31	20	19	58	0	65	0	28	36	3	5	13	4	42
Minimum Concentration	<0.01	<0.001	<0.05	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005
Minimum Detect	0.01	0.001	0.05	0.0001	0.001	0.001	0.001	0.05	ND	0.001	ND	0.001	0.001	0.01	0.001	0.001	0.01	0.005
Maximum Concentration	5.66	0.028	2.56	0.0003	0.005	0.009	0.011	29.3	<0.001	4.81	<0.0001	0.029	0.076	0.05	0.004	0.05	0.02	0.118
Maximum Detect	5.66	0.028	2.56	0.0003	0.005	0.009	0.011	29.3	ND	4.81	ND	0.029	0.076	0.05	0.004	0.05	0.02	0.118
Average Concentration	0.17	0.0047	0.45	5.7E-05	0.0014	0.0013	0.0011	3.3	0.0005	0.57	0.00005	0.0032	0.0037	0.006	0.0007	0.0024	0.005	0.011
Median Concentration	0.02	0.003	0.31	0.00005	0.0005	0.0005	0.0005	0.78	0.0005	0.195	0.00005	0.0005	0.001	0.005	0.0005	0.0005	0.005	0.006
Standard Deviation	0.69	0.0052	0.4	3.7E-05	0.0013	0.0018	0.0015	6.7	0	1.1	0	0.0056	0.0096	0.006	0.0007	0.007	0.002	0.016
Number of Guideline Exceedances	26	3	30	1	22	0	12	0	0	5	67	0	4	67	67	0	0	29
Number of Guideline Exceedances(Detects Only)	26	3	30	1	21	0	12	0	0	5	0	0	4	3	5	0	0	29

* Calculated in ESDAT (database management software)

MonitoringUnit	WellCode	Sampled_Date	Nutrients						Alkalinity						Major Ions									
			Ammonia as N	Nitrate (as N)	Nitrite (as N)	Nitrogen (Total Oxidised)	Nitrogen (Total)	Phosphorus	Alkalinity (total) as CaCO3	Alkalinity (Bicarbonate as CaCO3)	Alkalinity (Carbonate as CaCO3)	Alkalinity (Hydroxide) as CaCO3	Bicarbonate	Carbonate	Calcium (Filtered)	Chloride	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Sulphate	Sulphate (Filtered)	Anions Total	Cations Total	Ionic Balance
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	%
EQL			0.01	0.01	0.01	0.01	0.1	0.01	1	1	1	1			1	1	1	1	1	1	1	0.01	0.01	0.01
ANZECC (2000) Ecosystems Fresh Water (95%)			0.9		0.7																			
ALLUVIUM	C027P1	29/09/2011	0.53	0.01	0.02	0.03	2.1	0.21	582	582	<1	<1	710	<1.2	27	1580	111	52	1070	-	66	57.6	58.4	0.65
		8/11/2011	0.88	0.01	<0.01	0.01	1.1	<0.01	460	460	<1	<1	561.2	<1.2	26	1420	114	58	1080	141	-	-	-	-
		8/11/2011	0.93	0.02	<0.01	0.02	1.2	<0.01	480	480	<1	<1	585.6	<1.2	26	1210	113	57	1080	107	-	-	-	-
	C029P1	7/11/2011	1.35	0.01	<0.01	0.01	1.7	0.15	1590	1590	<1	<1	1940	<1.2	87	8430	362	177	5960	686	-	-	-	-
TERTIARY	C025P2	29/09/2011	0.63	0.03	<0.01	0.03	3.3	0.38	746	746	<1	<1	910.1	<1.2	107	4570	134	79	2700	-	54	145	136	3.26
		7/11/2011	1.38	0.16	<0.01	0.16	2	0.12	763	763	<1	<1	930.9	<1.2	130	3670	130	74	2680	10	-	-	-	-
	C029P2	29/09/2011	-	-	-	-	-	-	259	259	<1	<1	316	<1.2	100	3950	118	58	2280	-	259	122	115	2.81
		7/11/2011	0.42	0.01	<0.01	0.01	0.7	0.21	274	274	<1	<1	334.3	<1.2	95	3740	122	75	2180	246	-	-	-	-
DUNDA BEDS	C022P1	3/10/2011	0.02	0.03	<0.01	0.03	<0.1	0.07	36	36	<1	<1	43.92	<1.2	2	67	4	2	55	-	16	2.94	2.87	-
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14/11/2011	0.04	0.03	<0.01	0.03	<0.1	<0.01	47	47	<1	<1	57.34	<1.2	3	70	4	3	56	18	-	-	-	-
		10/11/2011	0.05	0.02	<0.01	0.02	0.1	<0.01	45	45	<1	<1	54.9	<1.2	2	77	4	3	57	16	-	-	-	-
	C027P2	29/09/2011	0.97	0.01	<0.01	0.01	2	0.19	128	128	<1	<1	156.2	<1.2	4	186	9	10	161	-	8	7.97	8.2	1.38
		5/11/2011	0.42	0.02	<0.01	0.02	0.6	0.02	180	180	<1	<1	219.6	<1.2	3	199	10	12	175	14	-	-	-	-
REWAN	C035P1	5/10/2011	0.1	0.05	<0.01	0.05	0.6	0.15	175	175	<1	<1	213.5	<1.2	21	1070	18	6	822	-	60	34.9	38.4	4.76
		6/11/2011	0.12	0.02	<0.01	0.02	3.9	1.99	171	171	<1	<1	208.6	<1.2	20	909	18	6	744	50	-	-	-	-
PERMIAN OVERBURDEN	C008P1	3/10/2011	0.14	0.02	<0.01	0.02	0.2	0.04	316	316	<1	<1	385.5	<1.2	505	7950	402	90	3680	-	282	236	221	3.46
		12/11/2011	0.15	<0.01	<0.01	<0.01	0.2	<0.01	298	298	<1	<1	363.6	<1.2	468	7530	442	115	3810	275	-	-	-	-
	C012P1	2/10/2011	0.2	0.03	0.01	0.04	0.5	0.33	84	84	<1	<1	102.5	<1.2	26	549	29	11	334	-	56	18.3	18.5	0.43
		4/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		8/11/2011	0.02	0.05	<0.01	0.05	<0.1	<0.01	82	82	<1	<1	100	<1.2	31	551	33	13	301	51	-	-	-	-
	C012P2	2/10/2011	0.04	0.02	<0.01	0.02	<0.1	<0.01	276	276	<1	<1	336.7	<1.2	78	631	25	12	442	-	49	24.3	25.5	2.29
		4/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		13/11/2011	0.04	0.02	<0.01	0.02	0.1	<0.01	369	369	<1	<1	450.2	<1.2	84	614	30	18	384	43	-	-	-	-
	C018P1	2/10/2011	0.1	0.03	0.06	0.09	2.8	0.07	100	100	<1	<1	122	<1.2	7	141	6	12	128	-	41	6.83	6.72	0.85
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		8/11/2011	0.03	0.08	<0.01	0.08	<0.1	<0.01	83	83	<1	<1	101.3	<1.2	7	255	7	10	134	39	-	-	-	-
AB SEAM	C007P2	4/10/2011	3.07	0.03	<0.01	0.03	6.2	1.73	205	205	<1	<1	250.1	<1.2	558	5460	234	52	2740	-	554	170	168	0.6
		10/11/2011	2.43	0.02	<0.01	0.02	2	<0.01	264	264	<1	<1	322.1	<1.2	453	5230	267	66	2590	465	-	-	-	-
		10/11/2011	2.48	0.01	<0.01	0.01	2.1	0.04	251	251	<1	<1	306.2	<1.2	486	4350	270	66	2620	473	-	-	-	-
	C008P2	3/10/2011	0.9	0.02	<0.01	0.02	0.9	0.18	552	515	36	<1	628.3	43.21	35	755	19	20	732	-	66	33.7	35.7	2.8
		12/11/2011	0.85	0.01	<0.01	0.01	1	<0.01	585	585	<1	<1	713.7	<1.2	38	683	21	20	577	31	-	-	-	-
	C014P2	4/10/2011	0.82	0.02	<0.01	0.02	1.1	<0.01	390	360	30	<1	439.2	36.01	20	398	6	25	415	-	3	19.1	20.2	2.77
		12/11/2011	0.98	0.02	<0.01	0.02	1.6	0.28	406	216	190	<1	263.5	228	3	406	3	33	374	<1	-	-	-	-
	C016P2	2/10/2011	4.93	0.02	<0.01	0.02	8.3	0.51	314	<1	274	40	<1.22	328.9	5	735	<1	119	573	-	153	30.2	28.2	3.4
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		13/11/2011	4.32	0.02	<0.01	0.02	11.7	<0.01	527	<1	306	221	<1.22	367.3	4	659	<1	182	520	21	-	-	-	-
	C018P2	2/10/2011	0.03	0.02	<0.01	0.02	0.6	0.3	221	221	<1	<1	269.6	<1.2	45	578	43	18	359	-	14	21	21.9	1.97
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		9/11/2011	0.1	0.02	<0.01	0.02	<0.1	0.21	239	239	<1	<1	291.6	<1.2	47	659	47	25	337	20	-	-	-	-
		9/11/2011	0.31	0.02	<0.01	0.02	0.4	0.23	246	246	<1	<1	300.1	<1.2	43	586	40	25	306	17	-	-	-	-
	C020P2	3/10/2011	0.04	0.03	<0.01	0.03	0.6	0.23	225	225	<1	<1	274.5	<1.2	15	411	3	4	374	-	24	16.6	17.4	2.26
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14/11/2011	0.52	0.02	<0.01	0.02	0.6	<0.01	257	257	<1	<1	313.5	<1.2	16	406	3	5	310	16	-	-	-	-
	C032P2	5/10/2011	0.05	0.03	<0.01	0.03	0.4	0.12	336	336	<1	<1	409.9	<1.2	24	229	6	20	257	-	5	13.3	13.4	0.36
		7/11/2011	0.71	0.01	<0.01	0.01	2	0.74	535	535	<1	<1	652.7	<1.2	37	934	13	11	294	<1	-	-	-	-
	C035P2	5/10/2011	0.04	0.05	<0.01	0.05	0.2	0.06	119	119	<1	<1	145.2	<1.2	12	404	8	6	280	-	11	14	13.6	1.52
		6/11/2011	0.07	0.03	<0.01	0.03	<0.1	<0.01	120	120	<1	<1	146.4	<1.2	13	535	8	7	276	17	-	-	-	-
INTERBURDEN	C011P1	13/11/2011	0.12	0.05	<0.01	0.05	0.2	<0.01	669	669	<1	<1	816.2	<1.2	18	539	17	14	565	91	-	-	-	-
	C006P1	3/10/2011	0.46	0.02	<0.01	0.02	0.5	0.04	365	365	<1	<1	445.3	<1.2	244	4800	246	27	2560	-	573	155	144	3.41
		10/11/2011	0.27	0.02	<0.01	0.02	0.2	<0.01	338	338	<1	<1	412.4	<1.2	311	6240	429	66	3080	497	-	-	-	-
	C034P1	5/10/2011	0.06	0.06	<0.01	0.06	0.3	0.05	165	165	<1	<1	201.3	<1.2	62	1220	39	11	842	-	120	40.2	43.2	3.58
		6/11/2011	0.08	0.01	<0.01	0.01	<0.1	<0.01	159	159	<1	<1	194	<1.2	59	1200	38	12	862	108	-	-	-	-
D SEAM	C006P3r	3/10/2011	0.34	0.02	<0.01	0.02	0.4	0.08	491	485	6	<1	591.7	7.201	9	58	4	4	246	-	1	11.5	11.6	0.44
		12/11/2011	0.31	<0.01	<0.01	<0.01	0.4	0.21	454	454	<1	<1	553.9	<1.2	9	59	3	5	209	<1	-	-	-	-
	C006P3r	10/11/2011	0.33	0.02	<0.01	0.02	0.5	0.02	458	458	<1	<1	558.8	<1.2	9	56	3	5	197	<1	-	-	-	-
	C007P3	4/10/2011	0.3	0.01	<0.01	0.01	0.7	0.14	487	487	<1	<1	594.1	<1.2	10	61	3	4	297	-	59	12.7	13.8	4.05
		10/11/2011	0.43	0.02	<0.01	0.02	0.4	0.05	548	538	9	<1	656.4	10.8	6	49	3	6	253	45	-	-	-	-
	C011P3	4/10/2011	0.21	0.03	<0.01	0.03	1.1	0.57	258	245	13	<1	298.9	15.6	17	164	5	17	180	-	2	9.82	9.52	1.57
		13/11/2011	0.29	0.02	<0.01	0.02	0.3	<0.01	278	278	<1	<1	339.2	<1.2	22	173	6	14	165	<1	-	-	-	-
	C018P3	2/10/2011	0.32	0.03	<0.01	0.03	0.8	0.09	179	179	<1	<1	218.4	<1.2	22	213	6	9	189	-	13	9.86	10	0.92
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		9/11/2011	0.21	0.02	<0.01	0.02	0.2	0.05	188	188	<1	<1	229.4	<1.2	24	211	6	12	156	15	-	-	-	-
		9/11/2011	0.06	0.02	<0.01	0.02	0.3	0.07	204	204	<1	<1	248.9	<1.2	23	211	6	13	158	10	-	-	-	-
	C024P3	6/10/2011	<0.01	<0.01	<0.01	<0.01	0.8	0.07	307	307	<1	<1	374.5	<1.2	27	351	51	17	270	-	2	16.1	17.7	4.85
		14/11/2011	0.02	<0.01	<0.01	<0.01	0.4	<0.01	307	307	<1	<1	374.5	<1.2	23	374	42	17	232	<1	-	-	-	-
	C034P3	5/10/2011	0.14	0.08	<0.01	0.08	0.3	0.07	137	137	<1	<1	167.1	<1.2	32	601	14	15	424	-	51	20.8	21.6	1.93
		6/11/2011	0.09	0.02	<0.01	0.02	<0.1	<0.01	108	108	<1	<1	131.8	<1.2	22	478	11	14	295	24	-	-	-	-
UNKNOWN	C066 (line 180-35)	11/11/2011	0.05	0.2	<0.01	0.2	0.3	<0.01	25	25	<1	<1	30.5	<1.2	3	158	10	6	82	10	-	-	-	-
SURFACE WATER	WQ01	6/10/2011	0.03	0.02	<0.01	0.02	0.3	0.05	178	178	<1	<1	217.2	<1.2	13	305	13	26	237	-	9	12.4	12.7	1.36
		8/11/2011	0.04	0.01	<0.01	0.01	0.5	<0.01	211	211	<1	<1	257.4	<1.2	14	343	12	30	253	9	-	-	-	-
	WQ03	5/10/2011	0.03	0.04	<0.01	0.04	0.5	0.04	190	190	<1	<1	231.8	<1.2	14	361	15	27	267	-	7	14.1	14.2	0.38
		8/11/2011	0.03	0.02	<0.01	0.02	0.6	<0.01	193	193	<1	<1	235.5	<1.2	14	341	14	30	234	6	-	-	-	-

Statistical Summary

Statistical Summary	Ammonia as N	Nitrate (as N)	Nitrite (as N)	Nitrogen (Total Oxidised)	Nitrogen (Total)	Phosphorus	Alkalinity (total) as CaCO3	Alkalinity (Bicarbonate as CaCO3)	Alkalinity (Carbonate as CaCO3)	Alkalinity (Hydroxide) as CaCO3	Bicarbonate	Carbonate	Calcium (Filtered)	Chloride	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Sulphate	Sulphate (Filtered)	Anions Total	Cations Total	Ionic Balance
Number of Results	65	65	65	65	65	65	66	66	66	66	65	65	66	66	66	66	66	38	28	28	28	27
Number of Detects	64	60	3	60	56	40	66	64	8	2	63	8	66	66	64	66	66	32	28	28	28	27
Minimum Concentration	<0.01	<0.01	<0.01	<0.01	<0.1	<0.01	25	<1	<1	<1	<1.22	<1.2	2	49	<1	2	55	<1	1	2.94	2.87	0.36
Minimum Detect	0.02	0.01	0.01	0.01	0.1	0.02	25	25	6	40	30.5	7.201	2	49	3	2	55	6	1	2.94	2.87	0.36
Maximum Concentration	4.93	0.2	0.06	0.2	11.7	1.99	1590	1590	306	221	1940	367.3	558	8430	442	182	5960	686	573	236	221	4.85
Maximum Detect	4.93	0.2	0.06	0.2	11.7	1.99	1590	1590	306	221	1940	367.3	558	8430	442	182	5960	686	573	236	221	4.85
Average Concentration	0.55	0.028	0.006	0.03	1.1	0.16	310	293	14	4.4	359	16	72	1389	64	32	860	94	91	46	45	2.2
Median Concentration	0.2	0.02	0.005	0.02	0.5	0.05	258	242	0.5	0.5	298.9	0.6	22.5	537	14	17	322	19	45	18.7	19.35	1.97
Standard Deviation	0.95	0.032	0.007	0.032	1.9	0.34	237	240	55	28	294	66	133	2094	110	38	1159	166	151	60	57	1.4
Number of Guideline Exceedances	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* Calculated in ESDAT (database management software)

			BTEX & MAH					TPH									PAH	
			Benzene	Ethylbenzene	Toluene	Xylene (o)	Xylene Total	TPH C10 - C14 Fraction	TPH C10 - C16 Fraction	TPH C15 - C28 Fraction	TPH C16 - C34 Fraction	TPH C29 - C36 Fraction	TPH C34 - C40 Fraction	TPH C6 - C 9 Fraction	TPH C6 - C10 Fraction	TPH C6 - C10 Fraction minus BTEX	Naphthalene	PAHs (Sum of Total) - Calc*
			µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L
EQL			1	2	2	2	2	0.05	0.1	0.1	0.1	0.05	0.1	0.02	0.02	0.02	5	
ANZECC (2000) Ecosystems Fresh Water (95%)			950			350											16	
MonitoringUnit	**WellCode**	**Sampled_Dat**																
ALLUVIUM	C027P1	29/09/2011	<1	<2	<2	<2	<2	1.45	<0.1	<0.1	<0.1	<0.05	<0.1	0.35	0.34	0.34	<5	<5
		8/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.09	0.1	0.1	<5	<5
		8/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	0.11	<0.1	<0.05	<0.1	0.06	0.07	0.07	<5	<5
	C029P1	7/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
TERTIARY	C025P2	29/09/2011	<1	<2	16	<2	<2	0.06	<0.1	<0.1	<0.1	<0.05	<0.1	0.31	0.33	0.31	<5	<5
		7/11/2011	<1	<2	6	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.06	0.06	0.05	<5	<5
	C029P2	29/09/2011	<1	<2	<2	<2	<2	0.11	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		7/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
DUNDA BEDS	C022P1	3/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.04	0.04	0.04	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		10/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.02	0.02	0.02	<5	<5
	C027P2	29/09/2011	<1	<2	<2	<2	<2	0.1	<0.1	<0.1	<0.1	<0.05	<0.1	0.09	0.1	0.1	<5	<5
		5/11/2011	<1	<2	17	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.03	0.04	0.02	<5	<5
REWAN	C035P1	5/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
PERMIAN OVERBURDEN	C008P1	3/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		12/11/2011	<1	<2	<2	<2	<2	0.13	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C012P1	2/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		4/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		8/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C012P2	2/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		4/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		13/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C018P1	2/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		8/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
AB SEAM	C007P2	4/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	0.23	0.79	0.5	0.37	<0.02	<0.02	<0.02	<5	<5
		10/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.02	0.02	0.02	<5	<5
		10/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C008P2	3/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		12/11/2011	2	<2	5	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.02	0.03	0.02	<5	<5
	C014P2	4/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.17	0.18	0.18	<5	<5
		12/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.05	0.06	0.06	<5	<5
	C016P2	2/10/2011	<1	<2	8	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.04	0.04	0.03	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		13/11/2011	<1	<2	3	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.03	0.03	0.03	<5	<5
	C018P2	2/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		9/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		9/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C020P2	3/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.05	0.05	0.05	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14/11/2011	<1	<2	4	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.04	0.05	0.05	<5	<5
	C032P2	5/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.04	0.05	0.05	<5	<5
		7/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C035P2	5/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
INTERBURDEN	C011P1	13/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C006P1	3/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.04	0.04	0.04	<5	<5
		10/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C034P1	5/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
D SEAM	C006P3r	3/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		12/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C006P3r	10/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C007P3	4/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.05	0.05	0.05	<5	<5
		10/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C011P3	4/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.02	0.03	0.03	<5	<5
		13/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C018P3	2/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		9/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		9/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C024P3	6/10/2011	<1	<2	5	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.46	0.49	0.48	<5	<5
		14/11/2011	<1	<2	4	<2	<2	0.09	<0.1	<0.1	<0.1	<0.05	<0.1	0.34	0.36	0.36	<5	<5
	C034P3	5/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
UNKNOWN	C066 (line 180-35)	11/11/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SURFACE WATER	WQ01	6/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		8/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	WQ03	5/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		8/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5

Statistical Summary

Number of Results	69	69	69	69	69	65	65	65	65	65	65	69	69	69	69	65
Number of Detects	1	0	9	0	0	6	0	2	1	1	1	23	23	23	0	0
Minimum Concentration	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
Minimum Detect	2	ND	3	ND	ND	0.06	ND	0.11	0.79	0.5	0.37	0.02	0.02	0.02	ND	ND
Maximum Concentration	2	<2	17	<2	<2	1.45	<0.1	0.23	0.79	0.5	0.37	0.46	0.49	0.48	<5	<5
Maximum Detect	2	ND	17	ND	ND	1.45	ND	0.23	0.79	0.5	0.37	0.46	0.49	0.48	ND	ND
Average Concentration	0.52	1	1.9	1	1	0.053	0.05	0.05	0.06	0.032	0.06	0.042	0.044	0.043	2.5	2.5
Median Concentration	0.5	1	1	1	1	0.025	0.05	0.05	0.05	0.025	0.05	0.01	0.01	0.01	2.5	2.5
Standard Deviation	0.18	0	2.9	0	0	0.18	0	0.02	0.09	0.059	0.04	0.086	0.09	0.088	0	0
Number of Guideline Exceedances	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* Calculated in ESDAT (database management software)

MonitoringUnit	LocCode	Sampled Date	Caculated Hardness	Dissolved Metals Hardness Corrected: Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Copper (Filtered)	Lead (Filtered)	Nickel (Filtered)	Zinc (Filtered)
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL									
ANZECC (2000) Ecosystems Fresh Water (95%)				0.0002	0.001	0.0014	0.0034	0.011	0.008
ALLUVIAL	C027P1	29/09/2011	524.184	-	4.79E-05	4.40E-05	1.32E-05	4.40E-05	5.27E-04
	C027P1	8/11/2011	529.917	3.88E-06	3.80E-04	4.35E-05	1.30E-05	1.13E-03	8.71E-04
	C029P1	7/11/2011	1706.869	1.37E-06	1.82E-05	1.93E-04	2.95E-06	2.45E-03	4.19E-04
TERTIARY	C025P2	29/09/2011	818.589	2.64E-06	3.32E-04	3.01E-05	7.50E-06	3.01E-05	3.61E-04
	C025P2	7/11/2011	859.56	2.52E-06	1.60E-04	1.15E-04	7.05E-06	5.77E-05	3.46E-04
	C029P2	29/09/2011	735.27	-	3.63E-05	3.30E-05	8.60E-06	6.59E-05	3.96E-04
	C029P2	7/11/2011	739.245	2.89E-06	1.44E-04	6.56E-05	8.54E-06	3.28E-04	7.22E-04
DUNDA BEDS	C027P2	29/09/2011	51.138	-	3.23E-04	3.18E-04	2.54E-04	2.54E-03	4.45E-03
	C027P2	5/11/2011	48.641	3.25E-05	1.35E-03	3.32E-04	2.71E-04	6.63E-03	6.63E-03
	C022P1	3/10/2011	21.454	6.74E-05	6.58E-04	6.65E-04	7.65E-04	7.98E-03	1.46E-02
	C022P1	10/11/2011	21.454	6.74E-05	2.63E-03	6.65E-04	7.65E-04	7.98E-03	1.86E-02
	C022P1	14/11/2011	23.951	6.11E-05	6.01E-04	6.05E-04	6.66E-04	7.27E-03	3.39E-02
PERMIAN OVERBURDEN	C008P1	3/10/2011	2907.724	5.12E-06	7.05E-05	4.10E-05	1.50E-06	1.64E-04	2.87E-04
	C008P1	12/11/2011	2987.426	3.33E-06	2.30E-05	2.20E-04	1.45E-06	3.00E-04	2.36E-03
	C012P1	2/10/2011	184.257	9.94E-06	1.13E-04	1.07E-04	4.99E-05	2.14E-04	2.57E-03
	C012P1	8/11/2011	213.202	8.73E-06	2.00E-04	3.78E-04	4.14E-05	1.13E-03	6.99E-03
	C018P1	2/10/2011	42.169	3.69E-05	3.78E-04	3.74E-04	3.24E-04	3.74E-04	8.98E-03
	C018P1	8/11/2011	46.284	3.40E-05	2.10E-03	3.46E-04	2.88E-04	2.08E-03	2.14E-02
	C012P2	2/10/2011	304.253	6.36E-06	7.48E-05	6.98E-05	2.64E-05	6.98E-05	3.49E-04
	C012P2	13/11/2011	333.198	5.87E-06	1.39E-04	6.46E-05	2.35E-05	3.88E-04	4.39E-03
REWAN	C035P1	5/10/2011	126.507	1.39E-05	1.54E-04	1.47E-04	8.04E-05	1.47E-04	7.36E-04
	C035P1	6/11/2011	124.01	1.41E-05	3.12E-04	1.50E-04	8.25E-05	1.50E-04	1.80E-03
AB SEAM	C007P2	4/10/2011	2356.236	1.03E-06	2.79E-05	4.90E-05	1.96E-06	1.23E-05	6.13E-05
	C007P2	10/11/2011	2251.44	1.07E-06	5.80E-05	2.55E-05	2.08E-06	1.27E-05	1.27E-04
	C008P2	3/10/2011	165.58	1.09E-05	1.23E-04	1.17E-04	5.71E-05	1.17E-04	5.85E-04
	C008P2	12/11/2011	181.301	1.01E-05	2.29E-04	2.17E-04	5.09E-05	4.33E-04	4.12E-03
	C014P2	4/10/2011	74.63	2.22E-05	2.37E-04	2.30E-04	1.57E-04	1.38E-03	1.15E-03
	C014P2	12/11/2011	19.836	7.23E-05	1.40E-03	7.11E-04	8.46E-04	2.84E-03	9.95E-03
	C016P2	2/10/2011	14.5425	9.52E-05	9.05E-04	9.25E-04	1.25E-03	9.25E-04	1.11E-02
	C016P2	13/11/2011	12.0455	1.13E-04	1.06E-03	1.09E-03	1.59E-03	1.09E-03	1.09E-02
	C018P2	2/10/2011	289.31	6.65E-06	7.80E-05	7.28E-05	2.81E-05	7.28E-05	1.02E-03
	C018P2	9/11/2011	297.54	6.49E-06	4.57E-04	7.11E-05	2.71E-05	2.84E-04	9.96E-04
	C020P2	3/10/2011	49.8	3.18E-05	3.30E-04	3.25E-04	2.63E-04	3.25E-04	1.62E-03
	C020P2	14/11/2011	52.297	3.05E-05	3.17E-04	3.12E-04	2.47E-04	3.12E-04	1.56E-03
	C032P2	5/10/2011	84.618	1.99E-05	2.14E-04	2.07E-04	1.34E-04	2.07E-04	1.04E-03
	C032P2	7/11/2011	145.884	1.22E-05	8.20E-04	1.30E-04	6.71E-05	5.21E-04	1.30E-03
	C035P2	5/10/2011	62.884	2.59E-05	2.73E-04	1.07E-03	1.95E-04	2.67E-04	1.33E-03
	C035P2	6/11/2011	65.381	2.50E-05	2.64E-03	5.16E-04	1.86E-04	1.55E-03	5.16E-03
INTERBURDEN	C006P1	3/10/2011	1621.558	1.43E-06	1.52E-04	1.68E-05	3.15E-06	6.73E-05	2.02E-04
	C006P1	10/11/2011	2541.902	9.62E-07	1.05E-04	2.30E-05	1.78E-06	9.19E-05	1.84E-04
	C011P1	13/11/2011	114.901	1.51E-05	6.65E-04	1.60E-04	9.08E-05	2.87E-03	7.35E-03
	C034P1	5/10/2011	315.299	6.16E-06	7.27E-05	6.77E-05	2.52E-05	6.77E-05	3.39E-04
	C034P1	6/11/2011	303.693	6.37E-06	1.50E-04	6.99E-05	2.64E-05	1.40E-04	1.40E-03
D SEAM	C006P3r	3/10/2011	38.933	3.96E-05	4.04E-04	4.01E-04	3.59E-04	4.01E-04	2.00E-03
	C006P3r	10/11/2011	34.818	4.38E-05	2.66E-03	4.41E-04	4.14E-04	4.41E-04	2.20E-03
	C006P3r	12/11/2011	34.818	4.38E-05	8.85E-04	4.41E-04	4.14E-04	2.64E-03	7.93E-03
	C007P3	4/10/2011	37.315	4.12E-05	4.18E-04	3.32E-03	3.79E-04	4.15E-04	2.08E-03
	C007P3	10/11/2011	27.327	5.43E-05	5.40E-04	5.41E-04	5.63E-04	5.41E-04	1.08E-02
	C011P3	4/10/2011	63.024	2.58E-05	2.72E-04	2.66E-04	1.95E-04	2.66E-04	1.33E-03
	C011P3	13/11/2011	79.624	2.10E-05	2.25E-04	2.18E-04	1.45E-04	4.36E-04	4.36E-03
	C018P3	2/10/2011	79.624	2.10E-05	2.25E-04	2.18E-04	1.45E-04	2.18E-04	1.09E-03
	C018P3	9/11/2011	82.121	2.04E-05	8.76E-04	2.12E-04	1.39E-04	4.25E-04	4.25E-03
	C024P3	6/10/2011	277.284	6.91E-06	8.07E-05	7.55E-05	2.97E-05	7.55E-05	3.78E-04
	C024P3	14/11/2011	230.261	8.15E-06	1.88E-04	3.54E-04	3.76E-05	1.59E-03	7.78E-03
	C034P3	5/10/2011	137.514	1.29E-05	1.43E-04	1.37E-04	7.23E-05	1.37E-04	6.85E-04
	C034P3	6/11/2011	100.199	1.71E-05	1.86E-04	1.79E-04	1.08E-04	1.79E-04	8.97E-04
SURFACE WATER	WQ01	6/10/2011	85.956	1.96E-05	2.11E-04	2.04E-04	1.31E-04	2.04E-04	1.02E-03
	WQ01	8/11/2011	84.338	1.99E-05	4.28E-04	4.15E-04	1.35E-04	4.15E-04	8.31E-03
	WQ03	5/10/2011	96.683	1.76E-05	1.92E-04	1.11E-03	1.13E-04	3.70E-04	9.25E-04
	WQ03	8/11/2011	92.568	1.83E-05	1.98E-04	7.68E-04	1.20E-04	3.84E-04	9.59E-04
UNKNOWN	C066	11/11/2011	48.641	3.25E-05	3.36E-04	3.32E-04	2.71E-04	2.65E-03	1.72E-02

Statistical Summary

Statistic	Caculated Hardness	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Copper (Filtered)	Lead (Filtered)	Nickel (Filtered)	Zinc (Filtered)
Number of Results	61	58	61	61	61	61	61
Minimum Concentration	12.0455	9.62E-07	1.82E-05	1.68E-05	1.45E-06	1.23E-05	6.13E-05
Maximum Concentration	2987.426	1.13E-04	2.66E-03	3.32E-03	1.59E-03	7.98E-03	3.39E-02
Average Concentration	426.24636	2.34E-05	4.76E-04	3.45E-04	2.09E-04	1.10E-03	4.39E-03
Median Concentration	100.199	1.74E-05	2.29E-04	2.17E-04	1.08E-04	3.70E-04	1.40E-03
Number of Guideline Exceedances		0	7	1	0	0	11

			Inorganics							Metals																		Nutrients					
			Bromide	Fluoride	Kjeldahl Nitrogen Total	pH (Lab)	Sulphide	TOC	Total Dissolved Solids	Aluminium (Filtered)	Arsenic (Filtered)	Boron (Filtered)	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Cobalt (Filtered)	Copper (Filtered)	Iron (Filtered)	Lead (Filtered)	Manganese (Filtered)	Mercury (Filtered)	Molybdenum (Filtered)	Nickel (Filtered)	Selenium (Filtered)	Silver (Filtered)	Uranium (Filtered)	Vanadium (Filtered)	Zinc (Filtered)	Ammonia as N	Nitrate (as N)	Nitrite (as N)	Nitrogen (Total Oxidised)	Nitrogen (Total)	Phosphorus
			mg/L	mg/L	mg/L	pH_Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL			0.005	0.1	0.1	0.01	0.1	1	5	0.01	0.001	0.05	0.0001	0.001	0.001	0.001	0.05	0.001	0.001	0.0001	0.001	0.001	0.01	0.001	0.001	0.01	0.005	0.01	0.01	0.01	0.01	0.1	0.01
ADWG (2011) Health				1.5							0.01	4	0.002	0.05		2		0.01	0.5	0.001	0.05	0.02	0.01	0.1	0.017				50	3			
MonitoringUnit	WellCode	Sampled_Date-Time																															
ALLUVIUM	C027P1	29/09/2011	-	0.9	2.1	7	<0.1	52	3850	0.01	0.013	0.63	-	<0.001	<0.001	<0.001	16	<0.001	4.49	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	0.01	0.006	0.53	0.01	0.02	0.03	2.1	0.21
		8/11/2011	-	0.6	1.1	6.77	<0.1	<1	4370	<0.01	0.015	0.52	<0.0001	0.004	0.004	0.001	29.3	<0.001	4.43	<0.0001	<0.001	0.012	<0.01	<0.001	<0.001	<0.01	0.019	0.88	0.01	<0.01	0.01	1.1	<0.01
		8/11/2011	-	0.7	1.1	6.91	<0.1	<1	4260	<0.01	0.013	0.52	<0.0001	0.004	<0.001	<0.001	27.4	<0.001	4.55	<0.0001	<0.001	0.015	<0.01	<0.001	<0.001	<0.01	0.01	0.93	0.02	<0.01	0.02	1.2	<0.01
	C029P1	7/11/2011	-	0.9	1.7	7.28	<0.1	<1	20,100	<0.01	0.028	2.56	<0.0001	<0.001	0.003	0.006	5.62	<0.001	4.81	<0.0001	0.001	0.076	<0.01	<0.001	0.05	0.02	0.013	1.35	0.01	<0.01	0.01	1.7	0.15
TERTIARY	C025P2	29/09/2011	6.1	0.8	3.3	7.52	0.4	1	8180	0.03	0.012	1.01	<0.0001	0.005	-	<0.001	-	<0.001	1.16	<0.0001	0.001	<0.001	0.05	<0.001	0.002	0.01	0.006	0.63	0.03	<0.01	0.03	3.3	0.38
		7/11/2011	-	0.6	1.8	7.07	<0.1	<1	8660	<0.01	0.013	1.01	<0.0001	<0.005	<0.001	0.002	24.5	<0.001	2.19	<0.0001	<0.001	0.001	0.01	<0.001	<0.001	0.01	0.006	1.38	0.16	<0.01	0.16	2	0.12
	C029P2	29/09/2011	4.95	0.6	-	7.23	0.3	13	6960	<0.01	0.006	0.92	-	<0.001	<0.001	<0.001	1.74	<0.001	0.448	<0.0001	0.001	0.001	<0.01	<0.001	<0.001	<0.01	0.006	-	-	-	-	-	-
		7/11/2011	-	0.6	0.7	6.96	<0.1	<1	7780	<0.01	0.008	0.84	<0.0001	0.002	0.001	0.001	6.33	<0.001	0.655	<0.0001	<0.001	0.005	<0.01	<0.001	<0.001	<0.01	0.011	0.42	0.01	<0.01	0.01	0.7	0.21
DUNDA BEDS	C022P1	3/10/2011	0.14	0.3	<0.1	6.76	-	-	301	0.51	<0.001	0.15	<0.0001	<0.001	0.005	<0.001	0.5	<0.001	0.099	<0.0001	<0.001	0.006	<0.01	<0.001	<0.001	<0.01	0.011	0.02	0.03	<0.01	0.03	<0.1	0.07
		6/10/2011	-	-	-	-	<0.1	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14/11/2011	-	0.3	<0.1	6.73	<0.1	2	233	0.23	0.002	0.07	<0.0001	<0.001	0.009	<0.001	2.67	<0.001	0.2	<0.0001	<0.001	0.006	<0.01	<0.001	<0.001	<0.01	0.028	0.04	0.03	<0.01	0.03	<0.1	<0.01
		10/11/2011	-	0.3	0.1	6.39	<0.1	<1	209	0.63	0.001	0.11	<0.0001	0.002	0.007	<0.001	0.76	<0.001	0.083	<0.0001	<0.001	0.006	<0.01	<0.001	<0.001	<0.01	0.014	0.05	0.02	<0.01	0.02	0.1	<0.01
	C027P2	29/09/2011	-	0.5	2	7.25	<0.1	106	805	0.09	0.019	0.22	-	<0.001	0.007	<0.001	24.9	<0.001	1.78	<0.0001	<0.001	0.004	<0.01	<0.001	<0.001	<0.01	0.009	0.97	0.01	<0.01	0.01	2	0.19
		5/11/2011	-	0.4	0.6	6.79	<0.1	<1	949	0.14	0.012	0.16	<0.0001	0.002	0.002	<0.001	11.3	<0.001	0.883	<0.0001	<0.001	0.01	<0.01	<0.001	<0.001	<0.01	0.01	0.42	0.02	<0.01	0.02	0.6	0.02
REWAN	C035P1	5/10/2011	2.42	0.7	0.6	7.22	<0.1	<1	2290	0.08	0.008	0.64	<0.0001	<0.001	<0.001	<0.001	2.04	<0.001	0.256	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.1	0.05	<0.01	0.05	0.6	0.15
		6/11/2011	-	0.6	3.9	7.24	<0.1	<1	2990	0.03	0.005	0.54	<0.0001	0.001	<0.001	<0.001	0.68	<0.001	0.218	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	0.006	0.12	0.02	<0.01	0.02	3.9	1.99
PERMIAN OVERBURDEN	C008P1	3/10/2011	14.7	0.5	0.2	7.65	<0.1	3	14,900	<0.01	0.002	1.14	0.0003	0.004	0.002	0.002	0.29	<0.001	0.181	<0.0001	<0.001	0.008	0.02	0.003	0.019	<0.01	0.014	0.14	0.02	<0.01	0.02	0.2	0.04
		12/11/2011	-	0.6	0.2	7.23	<0.1	<1	17,200	<0.01	<0.001	1.29	0.0002	0.001	0.004	0.011	0.06	<0.001	1.6	<0.0001	<0.001	0.015	<0.01	0.003	0.018	<0.01	0.118	0.15	<0.01	<0.01	<0.01	0.2	<0.01
	C012P1	2/10/2011	1.04	0.3	0.5	7.32	<0.1	-	1170	0.01	<0.001	0.41	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	0.182	<0.0001	<0.001	0.001	<0.01	0.001	<0.001	<0.01	0.012	0.2	0.03	0.01	0.04	0.5	0.33
		4/10/2011	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		8/11/2011	-	0.3	<0.1	6.43	<0.1	6	1350	<0.01	<0.001	0.32	<0.0001	0.001	<0.001	0.002	0.05	<0.001	0.173	<0.0001	<0.001	0.006	<0.01	<0.001	<0.001	<0.01	0.037	0.02	0.05	<0.01	0.05	<0.1	<0.01
	C018P1	2/10/2011	0.21	0.6	2.7	7.53	<0.1	-	486	0.07	<0.001	0.19	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	0.006	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	0.012	0.1	0.03	0.06	0.09	2.8	0.07
		6/10/2011	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		8/11/2011	-	0.4	<0.1	6.5	<0.1	<1	541	0.03	<0.001	0.18	<0.0001	0.003	<0.001	<0.001	<0.05	<0.001	0.013	<0.0001	<0.001	0.003	<0.01	<0.001	<0.001	<0.01	0.031	0.03	0.08	<0.01	0.08	<0.1	<0.01
	C012P2	2/10/2011	1.3	0.5	<0.1	7.86	-	-	1680	0.01	0.006	0.49	<0.0001	<0.001	<0.001	<0.001	1.62	<0.001	1.32	<0.0001	0.001	<0.001	<0.01	<0.001	0.001	<0.01	<0.005	0.04	0.02	<0.01	0.02	<0.1	<0.01
		4/10/2011	-	-	-	-	0.3	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		13/11/2011	-	0.4	0.1	7.75	0.1	32	1560	0.01	0.006	0.4	<0.0001	0.001	<0.001	<0.001	1.26	<0.001	0.924	<0.0001	<0.001	0.003	<0.01	<0.001	<0.001	<0.01	0.034	0.04	0.02	<0.01	0.02	0.1	<0.01
AB SEAM	C007P2	4/10/2011	8.3	0.4	6.2	7.56	<0.1	13	10,300	<0.01	0.003	0.41	<0.0001	0.001	0.001	0.002	0.24	<0.001	0.445	<0.0001	0.008	<0.001	<0.01	0.004	0.003	<0.01	<0.005	3.07	0.03	<0.01	0.03	6.2	1.73
		10/11/2011	-	0.4	2	7.95	5.3	36	10,700	<0.01	0.002	0.51	<0.0001	0.002	<0.001	0.001	0.1	<0.001	0.304	<0.0001	0.001	<0.001	<0.01	<0.001	0.002	<0.01	0.005	2.43	0.02	<0.01	0.02	2	<0.01
		10/11/2011	-	0.4	2.1	7.73	6.2	38	10,800	<0.01	0.003	0.49	0.0001	0.002	<0.001	0.001	0.16	<0.001	0.285	<0.0001	<0.001	<0.001	<0.01	0.003	0.002	<0.01	<0.005	2.48	0.01	<0.01	0.01	2.1	0.04
	C008P2	3/10/2011	1.35	0.8	0.9	8.52	5.3	54	1920	0.02	0.004	0.3	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	0.263	<0.0001	0.005	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.9	0.02	<0.01	0.02	0.9	0.18
		12/11/2011	-	0.9	1	8.27	0.9	37	1920	0.06	0.008	0.3	<0.0001	0.001	<0.001	0.001	0.06	<0.001	0.361	<0.0001	<0.001	0.002	<0.01	<0.001	<0.001	<0.01	0.019	0.85	0.01	<0.01	0.01	1	<0.01
	C014P2	4/10/2011	0.72	1	1.1	8.61	<0.1	29	1110	<0.01	0.004	0.3	<0.0001	<0.001	0.002	<0.001	0.38	<0.001	0.084	<0.0001	0.009	0.003	<0.01	<0.001	<0.001	<0.01	<0.005	0.82	0.02	<0.01	0.02	1.1	<0.01
		12/11/2011	-	1	1.6	9.5	<0.1	23	1340	0.42	0.004	0.24	<0.0001	0.001	<0.001	<0.001	0.18	<0.001	0.002	<0.0001	0.012	0.002	<0.01	<0.001	<0.001	<0.01	0.007	0.98	0.02	<0.01	0.02	1.6	0.28
	C016P2	2/10/2011	1.36	0.2	8.3	10.4	4.7	-	1660	0.08	0.004	0.31	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	<0.001	<0.0001	0.01	<0.001	<0.01	<0.001	<0.001	<0.01	0.006	4.93	0.02	<0.01	0.02	8.3	0.51
		6/10/2011	-	-	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		13/11/2011	-	0.3	11.7	11.5	1.9	28	1840	0.02	0.003	0.23	<0.0001	<0.001	<0.001	<0.001	0.05	<0.001	0.001	<0.0001	0.013	<0.001	<0.01	<0.001	<0.001	<0.01	0.005	4.32	0.02	<0.01	0.02	11.7	<0.01
	C018P2	2/10/2011	1.27	0.4	0.6	7.63	0.6	-	1420	<0.01	0.001	0.61	<0.0001	<0.001	<0.001	<0.001	1.13	<0.001	0.051	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	0.007	0.03	0.02	<0.01	0.02	0.6	0.3
		6/10/2011	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		9/11/2011	-	0.4	<0.1	7.18	0.4	28	1360	<0.01	<0.001	0.5	<0.0001	0.003	<0.001	<0.001	0.98	<0.001	0.03	<0.0001	<0.001	0.003	<0.01	<0.001	<0.001	<0.01	0.009	0.1	0.02	<0.01	0.02	<0.1	0.21
		9/11/2011	-	0.5	0.4	7.26	0.9	16	1210	<0.01	0.002	0.46	<0.0001	0.003	<0.001	<0.001	0.57	<0.001	0.06	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.31	0.02	<0.01	0.02	0.4	0.23
	C020P2	3/10/2011	0.84	0.6	0.6	8.21	-	-	1050	0.1	0.002	0.48	<0.0001	<0.001	<0.001	<0.001	0.06	<0.001	0.037	<0.0001	0.004	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.04	0.03	<0.01	0.03	0.6	0.23
		6/10/2011	-	-	-	-	<0.1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14/11/2011	-	0.6	0.6	8.2	1.5	<1	970	0.04	0.001	0.41	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	0.041	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.52	0.02	<0.01	0.02	0.6	<0.01
	C032P2	5/10/2011	0.42	0.6	0.4	8.09	0.2	36	951	0.02	0.005	0.3	<0.0001	<0.001	<0.001	<0.001	0.33	<0.001	0.264	<0.0001	0.018	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.05	0.03	<0.01	0.03	0.4	0.12
		7/11/2011	-	0.7	2	7.49	<0.1	<1	1540	0.02	0.013	0.3	<0.0001	0.003	<0.001	<0.001	1.4	<0.001	0.464	<0.0001	0.01	0.002	<0.01	<0.001	<0.001	<0.01	0.005	0.71	0.01	<0.01	0.01	2	0.74
	C035P2	5/10/2011	0.76	0.3	0.2	7.15	0.1	1	851	0.35	<0.001	0.24	<0.0001	<0.001	<0.001	0.002	1.01	<0.001	0.136	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.04	0.05	<0.01	0.05	0.2	0.06
		6/11/2011	-	0.3	<0.1	7.02	<0.1	11	1180	5.66	<0.001	0.2	<0.0001	0.005	<0.001	0.001	2.24	<0.001	0.128	<0.0001	<0.001	0.003	<0.01	<0.001	<0.001	<0.01	0.01	0.07	0.03	<0.01	0.03	<0.1	<0.01
INTERBURDEN	C006P1	3/10/2011	7.9	0.7	0.5	7.74	0.2	58	8960	<0.01	0.011	1.05	<0.0001	0.004	<0.001	<0.001	1.9	<0.001	0.891	<0.0001	0.029	0.002	<0.01	<0.001	0.014	<0.01	0.006	0.46	0.02	<0.01	0.02	0.5	0.04
		10/11/2011	-	0.6	0.2	7.16	0.2	18	11,900	<0.01	0.01	1.3	<0.0001	0.004	0.005	0.001	3.85	<0.001	0.687	<0.0001	0.005	0.004	<0.01	<0.001	0.014	<0.01	0.008	0.27	0.02	<0.01	0.02	0.2	<0.01
	C011P1	13/11/2011	-	0.8	0.2	8.17	<0.1	31	1900	0.07	0.002	0.9	<0.0001	0.002	0.001	<0.001	<0.05	<0.001	0.113	<0.0001	0.007	0.009	<0.01	<0.001	0.004	<0.01	0.023	0.12	0.05	<0.01	0.05	0.2	<0.01
	C034P1	5/10/2011	2.78	0.7	0.2	7.03	<0.1	1	2870	0.01	0.005	0.6	<0.0001	<0.001	0.001	<0.001	3.24	<0.001	0.204	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.06	0.06	<0.01	0.06	0.3	0.05
		6/11/2011	-	0.7	<0.1	7	<0.1	<1	2810	0.01	0.003	0.51	<0.0001	0.001	<0.001	<0.001	1.3	<0.001	0.141	<0.0001	<0.001	0.001	<0.01	<0.001	<0.001	<0.01	0.01	0.08	0.01	<0.01	0.01	<0.1	<0.01
D SEAM	C006P3r	3/10/2011	0.17	2.2	0.4	8.32	<0.1	12	587	0.14	0.004	0.18	<0.0001	<0.001	<0.001	<0.001	0.8	<0.001	0.046	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.34	0.02	<0.01	0.02	0.4	0.08
		12/11/2011	-	2.4	0.4	8.18	<0.1	<1	620	0.13	0.003	0.12	<0.0001	0.001	<0.001	<0.001	0.41	<0.001	0.038	<0.0001	0.002	0.003	<0.01	<0.001	<0.001	<0.01	0.009	0.31	<0.01	<0.01	<0.01	0.4	0.21
		10/11/2011	-	2.2	0.5	8.04	<0.1	13	568	0.1	0.003	0.13	<0.0001	0.003	<0.001	<0.001	0.44	<0.001	0.036	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.33	0.02	<0.01	0.02	0.5	0.02
	C007P3	4/10/2011	0.14	2.6	0.7	8.23	0.2	33	809	0.32	0.004	0.22	<0.0001	<0.001	<0.001	0.004	0.18	<0.001	0.052	<0.0001	0.019	<0.001	<0.01	<0.001	0.002	<0.01	<0.005	0.3	0.01	<0.01	0.01	0.7	0.14
		10/11/2011	-	2.6	0.4	8.31	1.3	38	760	0.22	0.003	0.22	<0.0001	<0.001	<0.001	<0.001	0.12	<0.001	0.042	<0.0001	0.019	<0.001	<0.01	<0.001	0.002	<0.01	0.01	0.43	0.02	<0.01	0.02	0.4	0.05
	C011P3	4/10/2011	0.42	1.2	1.1	8.45	<0.1	8	568	<0.01	0.004	0.41	<0.0001	<0.001	0.002	<0.001	2.59	<0.001	0.218	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.21	0.03	<0.01	0.03	1.1	0.57
		13/11/2011	-	1.2	0.3	8.01	<0.1	<1	608	0.02	0.002	0.35	<0.0001	<0.001	<0.001	<0.001	0.88	<0.001	0.09	<0.0001	0.002	0.001	<0.01	<0.001	<0.001	<0.01	0.01	0.29	0.02	<0.01	0.02	0.3	<0.01
	C018P3	2/10/2011	0.48	1.2	0.8	7.81	<0.1	-	651	0.05	0.002	0.35	<0.0001	<0.001	0.001	<0.001	0.59	<0.001	0.122	<0.0001	0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.32	0.03	<0.01	0.03	0.8	0.09
		6/10/2011	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		9/11/2011	-	1.2	0.2	7.35	<0.1	2	523	0.05	0.001	0.29	<0.0001	0.002	<0.001	<0.001	0.89	<0.001	0.09	<0.0001	<0.001	0.002	<0.01	<0.001	<0.001	<0.01	0.014	0.21	0.02	<0.01	0.02	0.2	0.05
		9/11/2011	-	1.2	0.3	7.51	0.1	5	554	0.06	0.001	0.28	<0.0001	0.002	<0.001	<0.001	0.4	<0.001	0.109	<0.0001	0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.06	0.02	<0.01	0.02	0.3	0.07
	C024P3	6/10/2011	1.28	0.4	0.8	6.52	0.4	108	1150	<0.01	0.007	0.3	<0.0001	<0.001	0.001	<0.001	14.8	<0.001	0.261	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	<0.01	<0.01	<0.01	<0.01	0.8	0.07
		14/11/2011	-	0.4	0.4	7.12	1	47	1050	<0.01	0.004	0.28	<0.0001	0.001	<0.001	0.002	8.37	<0.001	0.236	<0.0001	<0.001	0.009	<0.01	<0.001	<0.001	<0.01	0.044	0.02	<0.01	<0.01	<0.01	0.4	<0.01
	C034P3	5/10/2011	1.29	0.5	0.2	7.23	<0.1	<1	1260	<0.01	0.002	0.26	<0.0001	<0.001	<0.001	<0.001	1.2	<0.001	0.23	<0.0001	0.006	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.14	0.08	<0.01	0.08	0.3	0.07
		6/11/2011	-	0.3	<0.1	6.96	<0.1	<1	1020	<0.01	<0.001	<0.05	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.09	0.02	<0.01	0.02	<0.1	<0.01
UNKNOWN	C066 (line 180-35)	11/11/2011	-	0.1	0.1	6.51	<0.1	-	396	0.58	<0.001	0.05	<0.0001	<0.001	0.003	<0.001	0.32	<0.001	0.048	<0.0001	<0.001	0.004	<0.01	<0.001	<0.001	<0.01	0.026	0.05	0.2	<0.01	0.2	0.3	<0.01
SURFACE WATER	WQ01	6/10/2011	0.931	0.5	0.3	7.79	<0.1	11	703	0.13	<0.001	0.13	<0.0001	<0.001	<0.001	<0.001	0.85	<0.001	0.184	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.03	0.02	<0.01	0.02	0.3	0.05
		8/11/2011	-	0.6	0.5	7.91	<0.1	5	1340	0.12	0.001	0.12	<0.0001	0.002	<0.001	<0.001	0.82	<0.001	0.2	<0.0001	<0.001	0.001	<0.01	<0.001	<0.001	<0.01	0.022	0.04	0.01	<0.01	0.01	0.5	<0.01
	WQ03	5/10/2011	0.55	0.5	0.5	8.07	<0.1	8	859	0.1	<0.001	0.15	<0.0001	<0.001	<0.001	0.003	0.5	<0.001	0.055	<0.0001	<0.001	0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.03	0.04	<0.01	0.04	0.5	0.04
		8/11/2011	-	0.5	0.6	8.04	<0.1	1	1350	0.17	<0.001	0.14	<0.0001	<0.001	<0.001	0.002	0.72	<0.001	0.298	<0.0001	<0.001	0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.03	0.02	<0.01	0.02	0.6	<0.01

Statistical Summary

Number of Results	26	66	65	66	66	65	66	67	67	67	64	67	66	67	66	67	67	67	67	67	67	67	67	67	67	65	65	65	65	65	65
Number of Detects	26	66	56	66	23	42	66	44	52	66	3	31	20	19	58	0	65	0	28	36	3	5	13	4	42	64	60	3	60	56	40
Minimum Concentration	0.14	0.1	<0.1	6.39	<0.1	<1	209	<0.01	<0.001	<0.05	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	<0.01	<0.01	<0.01	<0.01	<0.1	<0.01
Minimum Detect	0.14	0.1	0.1	6.39	0.1	1	209	0.01	0.001	0.05	0.0001	0.001	0.001	0.001	0.05	ND	0.001	ND	0.001	0.001	0.01	0.001	0.001	0.01	0.005	0.02	0.01	0.01	0.01	0.1	0.02
Maximum Concentration	14.7	2.6	11.7	11.5	6.2	108	20,100	5.66	0.028	2.56	0.0003	0.005	0.009	0.011	29.3	<0.001	4.81	<0.0001	0.029	0.076	0.05	0.004	0.05	0.02	0.118	4.93	0.2	0.06	0.2	11.7	1.99
Maximum Detect	14.7	2.6	11.7	11.5	6.2	108	20,100	5.66	0.028	2.56	0.0003	0.005	0.009	0.011	29.3	ND	4.81	ND	0.029	0.076	0.05	0.004	0.05	0.02	0.118	4.93	0.2	0.06	0.2	11.7	1.99
Average Concentration	2.4	0.73	1.1	7.6	0.53	16	3150	0.17	0.0047	0.45	0.000057	0.0014	0.0013	0.0011	3.3	0.0005	0.57	0.00005	0.0032	0.0037	0.006	0.00067	0.0024	0.0054	0.011	0.55	0.028	0.0062	0.03	1.1	0.16
Median Concentration	1.155	0.6	0.5	7.515	0.05	5	1300	0.02	0.003	0.31	0.00005	0.0005	0.0005	0.0005	0.78	0.0005	0.195	0.00005	0.0005	0.001	0.005	0.0005	0.0005	0.005	0.006	0.2	0.02	0.005	0.02	0.5	0.05
Standard Deviation	3.4	0.55	1.9	0.86	1.3	23	4329	0.69	0.0052	0.4	0.000037	0.0013	0.0018	0.0015	6.7	0	1.1	0	0.0056	0.0096	0.0058	0.00067	0.007	0.0021	0.016	0.95	0.032	0.0071	0.032	1.9	0.34
Number of Guideline Exceedances	0	5	0	0	0	0	0	0	10	0	0	0	0	0	0	0	14	0	0	1	2	0	3	0	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)	0	5	0	0	0	0	0	0	10	0	0	0	0	0	0	0	14	0	0	1	2	0	3	0	0	0	0	0	0	0	0

			Alkalinity						Major Ions									
			Alkalinity (total) as CaCO3	Alkalinity (Bicarbonate as CaCO3)	Alkalinity (Carbonate as CaCO3)	Alkalinity (Hydroxide) as CaCO3	Bicarbonate	Carbonate	Calcium (Filtered)	Chloride	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Sulphate	Sulphate (Filtered)	Anions Total	Cations Total	Ionic Balance
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	%
EQL			1	1	1	1			1	1	1	1	1	1	1	0.01	0.01	0.01
ADWG (2011) Health														500				
MonitoringUnit	WellCode	Sampled_Date-T																
ALLUVIUM	C027P1	29/09/2011	582	582	<1	<1	710	<1.2	27	1580	111	52	1070	-	66	57.6	58.4	0.65
		8/11/2011	460	460	<1	<1	561.2	<1.2	26	1420	114	58	1080	141	-	-	-	-
		8/11/2011	480	480	<1	<1	585.6	<1.2	26	1210	113	57	1080	107	-	-	-	-
	C029P1	7/11/2011	1590	1590	<1	<1	1940	<1.2	87	8430	362	177	5960	686	-	-	-	-
TERTIARY	C025P2	29/09/2011	746	746	<1	<1	910.1	<1.2	107	4570	134	79	2700	-	54	145	136	3.26
		7/11/2011	763	763	<1	<1	930.9	<1.2	130	3670	130	74	2680	10	-	-	-	-
	C029P2	29/09/2011	259	259	<1	<1	316	<1.2	100	3950	118	58	2280	-	259	122	115	2.81
		7/11/2011	274	274	<1	<1	334.3	<1.2	95	3740	122	75	2180	246	-	-	-	-
DUNDA BEDS	C022P1	3/10/2011	36	36	<1	<1	43.92	<1.2	2	67	4	2	55	-	16	2.94	2.87	-
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14/11/2011	47	47	<1	<1	57.34	<1.2	3	70	4	3	56	18	-	-	-	-
		10/11/2011	45	45	<1	<1	54.9	<1.2	2	77	4	3	57	16	-	-	-	-
	C027P2	29/09/2011	128	128	<1	<1	156.2	<1.2	4	186	9	10	161	-	8	7.97	8.2	1.38
		5/11/2011	180	180	<1	<1	219.6	<1.2	3	199	10	12	175	14	-	-	-	-
REWAN	C035P1	5/10/2011	175	175	<1	<1	213.5	<1.2	21	1070	18	6	822	-	60	34.9	38.4	4.76
		6/11/2011	171	171	<1	<1	208.6	<1.2	20	909	18	6	744	50	-	-	-	-
PERMIAN OVERBURDEN	C008P1	3/10/2011	316	316	<1	<1	385.5	<1.2	505	7950	402	90	3680	-	282	236	221	3.46
		12/11/2011	298	298	<1	<1	363.6	<1.2	468	7530	442	115	3810	275	-	-	-	-
	C012P1	2/10/2011	84	84	<1	<1	102.5	<1.2	26	549	29	11	334	-	56	18.3	18.5	0.43
		4/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		8/11/2011	82	82	<1	<1	100	<1.2	31	551	33	13	301	51	-	-	-	-
	C018P1	2/10/2011	100	100	<1	<1	122	<1.2	7	141	6	12	128	-	41	6.83	6.72	0.85
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		8/11/2011	83	83	<1	<1	101.3	<1.2	7	255	7	10	134	39	-	-	-	-
	C012P2	2/10/2011	276	276	<1	<1	336.7	<1.2	78	631	25	12	442	-	49	24.3	25.5	2.29
		4/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		13/11/2011	369	369	<1	<1	450.2	<1.2	84	614	30	18	384	43	-	-	-	-
AB SEAM	C007P2	4/10/2011	205	205	<1	<1	250.1	<1.2	558	5460	234	52	2740	-	554	170	168	0.6
		10/11/2011	264	264	<1	<1	322.1	<1.2	453	5230	267	66	2590	465	-	-	-	-
		10/11/2011	251	251	<1	<1	306.2	<1.2	486	4350	270	66	2620	473	-	-	-	-
	C008P2	3/10/2011	552	515	36	<1	628.3	43.21	35	755	19	20	732	-	66	33.7	35.7	2.8
		12/11/2011	585	585	<1	<1	713.7	<1.2	38	683	21	20	577	31	-	-	-	-
	C014P2	4/10/2011	390	360	30	<1	439.2	36.01	20	398	6	25	415	-	3	19.1	20.2	2.77
		12/11/2011	406	216	190	<1	263.5	228	3	406	3	33	374	<1	-	-	-	-
	C016P2	2/10/2011	314	<1	274	40	<1.22	328.9	5	735	<1	119	573	-	153	30.2	28.2	3.4
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		13/11/2011	527	<1	306	221	<1.22	367.3	4	659	<1	182	520	21	-	-	-	-
	C018P2	2/10/2011	221	221	<1	<1	269.6	<1.2	45	578	43	18	359	-	14	21	21.9	1.97
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		9/11/2011	239	239	<1	<1	291.6	<1.2	47	659	47	25	337	20	-	-	-	-
		9/11/2011	246	246	<1	<1	300.1	<1.2	43	586	40	25	306	17	-	-	-	-
	C020P2	3/10/2011	225	225	<1	<1	274.5	<1.2	15	411	3	4	374	-	24	16.6	17.4	2.26
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14/11/2011	257	257	<1	<1	313.5	<1.2	16	406	3	5	310	16	-	-	-	-
	C032P2	5/10/2011	336	336	<1	<1	409.9	<1.2	24	229	6	20	257	-	5	13.3	13.4	0.36
		7/11/2011	535	535	<1	<1	652.7	<1.2	37	934	13	11	294	<1	-	-	-	-
	C035P2	5/10/2011	119	119	<1	<1	145.2	<1.2	12	404	8	6	280	-	11	14	13.6	1.52
		6/11/2011	120	120	<1	<1	146.4	<1.2	13	535	8	7	276	17	-	-	-	-
INTERBURDEN	C006P1	3/10/2011	365	365	<1	<1	445.3	<1.2	244	4800	246	27	2560	-	573	155	144	3.41
		10/11/2011	338	338	<1	<1	412.4	<1.2	311	6240	429	66	3080	497	-	-	-	-
	C011P1	13/11/2011	669	669	<1	<1	816.2	<1.2	18	539	17	14	565	91	-	-	-	-
	C034P1	5/10/2011	165	165	<1	<1	201.3	<1.2	62	1220	39	11	842	-	120	40.2	43.2	3.58
		6/11/2011	159	159	<1	<1	194	<1.2	59	1200	38	12	862	108	-	-	-	-
D SEAM	C006P3r	3/10/2011	491	485	6	<1	591.7	7.201	9	58	4	4	246	-	1	11.5	11.6	0.44
		12/11/2011	454	454	<1	<1	553.9	<1.2	9	59	3	5	209	<1	-	-	-	-
		10/11/2011	458	458	<1	<1	558.8	<1.2	9	56	3	5	197	<1	-	-	-	-
	C007P3	4/10/2011	487	487	<1	<1	594.1	<1.2	10	61	3	4	297	-	59	12.7	13.8	4.05
		10/11/2011	548	538	9	<1	656.4	10.8	6	49	3	6	253	45	-	-	-	-
	C011P3	4/10/2011	258	245	13	<1	298.9	15.6	17	164	5	17	180	-	2	9.82	9.52	1.57
		13/11/2011	278	278	<1	<1	339.2	<1.2	22	173	6	14	165	<1	-	-	-	-
	C018P3	2/10/2011	179	179	<1	<1	218.4	<1.2	22	213	6	9	189	-	13	9.86	10	0.92
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		9/11/2011	188	188	<1	<1	229.4	<1.2	24	211	6	12	156	15	-	-	-	-
		9/11/2011	204	204	<1	<1	248.9	<1.2	23	211	6	13	158	10	-	-	-	-
	C024P3	6/10/2011	307	307	<1	<1	374.5	<1.2	27	351	51	17	270	-	2	16.1	17.7	4.85
		14/11/2011	307	307	<1	<1	374.5	<1.2	23	374	42	17	232	<1	-	-	-	-
	C034P3	5/10/2011	137	137	<1	<1	167.1	<1.2	32	601	14	15	424	-	51	20.8	21.6	1.93
		6/11/2011	108	108	<1	<1	131.8	<1.2	22	478	11	14	295	24	-	-	-	-
UNKNOWN	C066 (line 180-35)	11/11/2011	25	25	<1	<1	30.5	<1.2	3	158	10	6	82	10	-	-	-	-
SURFACE WATER	WQ01	6/10/2011	178	178	<1	<1	217.2	<1.2	13	305	13	26	237	-	9	12.4	12.7	1.36
		8/11/2011	211	211	<1	<1	257.4	<1.2	14	343	12	30	253	9	-	-	-	-
	WQ03	5/10/2011	190	190	<1	<1	231.8	<1.2	14	361	15	27	267	-	7	14.1	14.2	0.38
		8/11/2011	193	193	<1	<1	235.5	<1.2	14	341	14	30	234	6	-	-	-	-

			BTEX & MAH					TPH									PAH	
			Benzene	Ethylbenzene	Toluene	Xylene (o)	Xylene Total	TPH C10 - C14 Fraction	TPH C10 - C16 Fraction	TPH C15 - C28 Fraction	TPH C16 - C34 Fraction	TPH C29 - C36 Fraction	TPH C34 - C40 Fraction	TPH C6 - C 9 Fraction	TPH C6 - C10 Fraction	TPH C6 - C10 Fraction minus BTEX	Naphthalene	PAHs (Sum of Total) - Calc*
			µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L
EQL			1	2	2	2	2	0.05	0.1	0.1	0.1	0.05	0.1	0.02	0.02	0.02	5	
ADWG (2011) Health			1.000	300	800		600											
MonitoringUnit	WellCode	Sampled_Date-T																
ALLUVIUM	C027P1	29/09/2011	<1	<2	<2	<2	<2	1.45	<0.1	<0.1	<0.1	<0.05	<0.1	0.35	0.34	0.34	<5	<5
		8/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.09	0.1	0.1	<5	<5
		8/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	0.11	<0.1	<0.05	<0.1	0.06	0.07	0.07	<5	<5
	C029P1	7/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
TERTIARY	C025P2	29/09/2011	<1	<2	16	<2	<2	0.06	<0.1	<0.1	<0.1	<0.05	<0.1	0.31	0.33	0.31	<5	<5
		7/11/2011	<1	<2	6	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.06	0.06	0.05	<5	<5
	C029P2	29/09/2011	<1	<2	<2	<2	<2	0.11	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		7/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
DUNDA BEDS	C022P1	3/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.04	0.04	0.04	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		10/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.02	0.02	0.02	<5	<5
	C027P2	29/09/2011	<1	<2	<2	<2	<2	0.1	<0.1	<0.1	<0.1	<0.05	<0.1	0.09	0.1	0.1	<5	<5
		5/11/2011	<1	<2	17	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.03	0.04	0.02	<5	<5
REWAN	C035P1	5/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
PERMIAN OVERBURDEN	C008P1	3/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		12/11/2011	<1	<2	<2	<2	<2	0.13	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C012P1	2/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		4/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		8/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C018P1	2/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		8/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C012P2	2/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		4/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		13/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
AB SEAM	C007P2	4/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	0.23	0.79	0.5	0.37	<0.02	<0.02	<0.02	<5	<5
		10/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.02	0.02	0.02	<5	<5
		10/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C008P2	3/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		12/11/2011	2	<2	5	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.02	0.03	0.02	<5	<5
	C014P2	4/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.17	0.18	0.18	<5	<5
		12/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.05	0.06	0.06	<5	<5
	C016P2	2/10/2011	<1	<2	8	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.04	0.04	0.03	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		13/11/2011	<1	<2	3	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.03	0.03	0.03	<5	<5
	C018P2	2/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		9/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		9/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C020P2	3/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.05	0.05	0.05	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14/11/2011	<1	<2	4	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.04	0.05	0.05	<5	<5
	C032P2	5/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.04	0.05	0.05	<5	<5
		7/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C035P2	5/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
INTERBURDEN	C006P1	3/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.04	0.04	0.04	<5	<5
		10/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C011P1	13/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C034P1	5/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
D SEAM	C006P3r	3/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		12/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		10/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C007P3	4/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.05	0.05	0.05	<5	<5
		10/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C011P3	4/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.02	0.03	0.03	<5	<5
		13/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C018P3	2/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		9/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		9/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C024P3	6/10/2011	<1	<2	5	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.46	0.49	0.48	<5	<5
		14/11/2011	<1	<2	4	<2	<2	0.09	<0.1	<0.1	<0.1	<0.05	<0.1	0.34	0.36	0.36	<5	<5
	C034P3	5/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
UNKNOWN	C066 (line 180-35)	11/11/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SURFACE WATER	WQ01	6/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		8/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	WQ03	5/10/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		8/11/2011	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5

Statistical Summary

	Alkalinity (total) as CaCO3	Alkalinity (Bicarbonate as CaCO3)	Alkalinity (Carbonate as CaCO3)	Alkalinity (Hydroxide) as CaCO3	Bicarbonate	Carbonate	Calcium (Filtered)	Chloride	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Sulphate	Sulphate (Filtered)	Anions Total	Cations Total	Ionic Balance
Number of Results	66	66	66	66	65	65	66	66	66	66	66	38	28	28	28	27
Number of Detects	66	64	8	2	63	8	66	66	64	66	66	32	28	28	28	27
Minimum Concentration	25	<1	<1	<1	<1.22	<1.2	2	49	<1	2	55	<1	1	2.94	2.87	0.36
Minimum Detect	25	25	6	40	30.5	7.201	2	49	3	2	55	6	1	2.94	2.87	0.36
Maximum Concentration	1590	1590	306	221	1940	367.3	558	8430	442	182	5960	686	573	236	221	4.85
Maximum Detect	1590	1590	306	221	1940	367.3	558	8430	442	182	5960	686	573	236	221	4.85
Average Concentration	310	293	14	4.4	359	16	72	1389	64	32	860	94	91	46	45	2.2
Median Concentration	257.5	242	0.5	0.5	298.9	0.6	22.5	537	14	17	322	19	45	18.7	19.35	1.97
Standard Deviation	237	240	55	28	294	66	133	2094	110	38	1159	166	151	60	57	1.4
Number of Guideline Exceedances	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Number of Guideline Exceedances(Detects Only)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0

	Benzene	Ethylbenzene	Toluene	Xylene (o)	Xylene Total	TPH C10 - C14 Fraction	TPH C10 - C16 Fraction	TPH C15 - C28 Fraction	TPH C16 - C34 Fraction	TPH C29 - C36 Fraction	TPH C34 - C40 Fraction	TPH C6 - C 9 Fraction	TPH C6 - C10 Fraction	TPH C6 - C10 Fraction minus BTEX	Naphthalene	PAHs (Sum of Total) - Calc*
Number of Results	69	69	69	69	69	65	65	65	65	65	65	69	69	69	69	65
Number of Detects	1	0	9	0	0	6	0	2	1	1	1	23	23	23	0	0
Minimum Concentration	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
Minimum Detect	2	ND	3	ND	ND	0.06	ND	0.11	0.79	0.5	0.37	0.02	0.02	0.02	ND	ND
Maximum Concentration	2	<2	17	<2	<2	1.45	<0.1	0.23	0.79	0.5	0.37	0.46	0.49	0.48	<5	<5
Maximum Detect	2	ND	17	ND	ND	1.45	ND	0.23	0.79	0.5	0.37	0.46	0.49	0.48	ND	ND
Average Concentration	0.52	1	1.9	1	1	0.053	0.05	0.054	0.061	0.032	0.055	0.042	0.044	0.043	2.5	2.5
Median Concentration	0.5	1	1	1	1	0.025	0.05	0.05	0.05	0.025	0.05	0.01	0.01	0.01	2.5	2.5
Standard Deviation	0.18	0	2.9	0	0	0.18	0	0.023	0.092	0.059	0.04	0.086	0.09	0.088	0	0
Number of Guideline Exceedances	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

MonitoringUnit	LocCode	Sampled Date		Dissolved Metals Hardness Corrected					
			Caculated Hardness	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Copper (Filtered)	Lead (Filtered)	Nickel (Filtered)	Zinc (Filtered)
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL									
ADWG (2011) Health				0.002	0.05	2	0.01	0.02	
ALLUVIAL	C027P1	29/09/2011	524.184	-	4.79E-05	4.40E-05	1.32E-05	4.40E-05	5.27E-04
	C027P1	8/11/2011	529.917	3.88E-06	3.80E-04	4.35E-05	1.30E-05	1.13E-03	8.71E-04
	C029P1	7/11/2011	1706.869	1.37E-06	1.82E-05	1.93E-04	2.95E-06	2.45E-03	4.19E-04
TERTIARY	C025P2	29/09/2011	818.589	2.64E-06	3.32E-04	3.01E-05	7.50E-06	3.01E-05	3.61E-04
	C025P2	7/11/2011	859.56	2.52E-06	1.60E-04	1.15E-04	7.05E-06	5.77E-05	3.46E-04
	C029P2	29/09/2011	735.27	-	3.63E-05	3.30E-05	8.60E-06	6.59E-05	3.96E-04
	C029P2	7/11/2011	739.245	2.89E-06	1.44E-04	6.56E-05	8.54E-06	3.28E-04	7.22E-04
DUNDA BEDS	C022P1	3/10/2011	21.454	6.74E-05	6.58E-04	6.65E-04	7.65E-04	7.98E-03	1.46E-02
	C022P1	10/11/2011	21.454	6.74E-05	2.63E-03	6.65E-04	7.65E-04	7.98E-03	1.86E-02
	C022P1	14/11/2011	23.951	6.11E-05	6.01E-04	6.05E-04	6.66E-04	7.27E-03	3.39E-02
	C027P2	29/09/2011	51.138	-	3.23E-04	3.18E-04	2.54E-04	2.54E-03	4.45E-03
	C027P2	5/11/2011	48.641	3.25E-05	1.35E-03	3.32E-04	2.71E-04	6.63E-03	6.63E-03
REWAN	C035P1	5/10/2011	126.507	1.39E-05	1.54E-04	1.47E-04	8.04E-05	1.47E-04	7.36E-04
	C035P1	6/11/2011	124.01	1.41E-05	3.12E-04	1.50E-04	8.25E-05	1.50E-04	1.80E-03
PERMIAN OVERBURDEN	C008P1	3/10/2011	2907.724	5.12E-06	7.05E-05	4.10E-05	1.50E-06	1.64E-04	2.87E-04
	C008P1	12/11/2011	2987.426	3.33E-06	2.30E-05	2.20E-04	1.45E-06	3.00E-04	2.36E-03
	C012P1	2/10/2011	184.257	9.94E-06	1.13E-04	1.07E-04	4.99E-05	2.14E-04	2.57E-03
	C012P1	8/11/2011	213.202	8.73E-06	2.00E-04	3.78E-04	4.14E-05	1.13E-03	6.99E-03
	C012P2	2/10/2011	304.253	6.36E-06	7.48E-05	6.98E-05	2.64E-05	6.98E-05	3.49E-04
	C012P2	13/11/2011	333.198	5.87E-06	1.39E-04	6.46E-05	2.35E-05	3.88E-04	4.39E-03
	C018P1	2/10/2011	42.169	3.69E-05	3.78E-04	3.74E-04	3.24E-04	3.74E-04	8.98E-03
	C018P1	8/11/2011	46.284	3.40E-05	2.10E-03	3.46E-04	2.88E-04	2.08E-03	2.14E-02
AB SEAM	C007P2	4/10/2011	2356.236	1.03E-06	2.79E-05	4.90E-05	1.96E-06	1.23E-05	6.13E-05
	C007P2	10/11/2011	2251.44	1.07E-06	5.80E-05	2.55E-05	2.08E-06	1.27E-05	1.27E-04
	C008P2	3/10/2011	165.58	1.09E-05	1.23E-04	1.17E-04	5.71E-05	1.17E-04	5.85E-04
	C008P2	12/11/2011	181.301	1.01E-05	2.29E-04	2.17E-04	5.09E-05	4.33E-04	4.12E-03
	C014P2	4/10/2011	74.63	2.22E-05	2.37E-04	2.30E-04	1.57E-04	1.38E-03	1.15E-03
	C014P2	12/11/2011	19.836	7.23E-05	1.40E-03	7.11E-04	8.46E-04	2.84E-03	9.95E-03
	C016P2	2/10/2011	14.5425	9.52E-05	9.05E-04	9.25E-04	1.25E-03	9.25E-04	1.11E-02
	C016P2	13/11/2011	12.0455	1.13E-04	1.06E-03	1.09E-03	1.59E-03	1.09E-03	1.09E-02
	C018P2	2/10/2011	289.31	6.65E-06	7.80E-05	7.28E-05	2.81E-05	7.28E-05	1.02E-03
	C018P2	9/11/2011	297.54	6.49E-06	4.57E-04	7.11E-05	2.71E-05	2.84E-04	9.96E-04
	C020P2	3/10/2011	49.8	3.18E-05	3.30E-04	3.25E-04	2.63E-04	3.25E-04	1.62E-03
	C020P2	14/11/2011	52.297	3.05E-05	3.17E-04	3.12E-04	2.47E-04	3.12E-04	1.56E-03
	C032P2	5/10/2011	84.618	1.99E-05	2.14E-04	2.07E-04	1.34E-04	2.07E-04	1.04E-03
	C032P2	7/11/2011	145.884	1.22E-05	8.20E-04	1.30E-04	6.71E-05	5.21E-04	1.30E-03
	C035P2	5/10/2011	62.884	2.59E-05	2.73E-04	1.07E-03	1.95E-04	2.67E-04	1.33E-03
	C035P2	6/11/2011	65.381	2.50E-05	2.64E-03	5.16E-04	1.86E-04	1.55E-03	5.16E-03
INTERBURDEN	C006P1	3/10/2011	1621.558	1.43E-06	1.52E-04	1.68E-05	3.15E-06	6.73E-05	2.02E-04
	C006P1	10/11/2011	2541.902	9.62E-07	1.05E-04	2.30E-05	1.78E-06	9.19E-05	1.84E-04
	C011P1	13/11/2011	114.901	1.51E-05	6.65E-04	1.60E-04	9.08E-05	2.87E-03	7.35E-03
	C034P1	5/10/2011	315.299	6.16E-06	7.27E-05	6.77E-05	2.52E-05	6.77E-05	3.39E-04
	C034P1	6/11/2011	303.693	6.37E-06	1.50E-04	6.99E-05	2.64E-05	1.40E-04	1.40E-03
D SEAM	C006P3r	3/10/2011	38.933	3.96E-05	4.04E-04	4.01E-04	3.59E-04	4.01E-04	2.00E-03
	C006P3r	10/11/2011	34.818	4.38E-05	2.66E-03	4.41E-04	4.14E-04	4.41E-04	2.20E-03
	C006P3r	12/11/2011	34.818	4.38E-05	8.85E-04	4.41E-04	4.14E-04	2.64E-03	7.93E-03
	C007P3	4/10/2011	37.315	4.12E-05	4.18E-04	3.32E-03	3.79E-04	4.15E-04	2.08E-03
	C007P3	10/11/2011	27.327	5.43E-05	5.40E-04	5.41E-04	5.63E-04	5.41E-04	1.08E-02
	C011P3	4/10/2011	63.024	2.58E-05	2.72E-04	2.66E-04	1.95E-04	2.66E-04	1.33E-03
	C011P3	13/11/2011	79.624	2.10E-05	2.25E-04	2.18E-04	1.45E-04	4.36E-04	4.36E-03
	C018P3	2/10/2011	79.624	2.10E-05	2.25E-04	2.18E-04	1.45E-04	2.18E-04	1.09E-03
	C018P3	9/11/2011	82.121	2.04E-05	8.76E-04	2.12E-04	1.39E-04	4.25E-04	4.25E-03
	C024P3	6/10/2011	277.284	6.91E-06	8.07E-05	7.55E-05	2.97E-05	7.55E-05	3.78E-04
	C024P3	14/11/2011	230.261	8.15E-06	1.88E-04	3.54E-04	3.76E-05	1.59E-03	7.78E-03
	C034P3	5/10/2011	137.514	1.29E-05	1.43E-04	1.37E-04	7.23E-05	1.37E-04	6.85E-04
	C034P3	6/11/2011	100.199	1.71E-05	1.86E-04	1.79E-04	1.08E-04	1.79E-04	8.97E-04
SURFACE WATER	WQ01	6/10/2011	85.956	1.96E-05	2.11E-04	2.04E-04	1.31E-04	2.04E-04	1.02E-03
	WQ01	8/11/2011	84.338	1.99E-05	4.28E-04	4.15E-04	1.35E-04	4.15E-04	8.31E-03
	WQ03	5/10/2011	96.683	1.76E-05	1.92E-04	1.11E-03	1.13E-04	3.70E-04	9.25E-04
	WQ03	8/11/2011	92.568	1.83E-05	1.98E-04	7.68E-04	1.20E-04	3.84E-04	9.59E-04
UNKNOWN	C066	11/11/2011	48.641	3.25E-05	3.36E-04	3.32E-04	2.71E-04	2.65E-03	1.72E-02

Statistical Summary

Number of Results	39	39	39	39	39	39	39
Number of Detects	39	39	39	39	39	39	39
Minimum Concentration	12.0455	9.61649E-07	2.79267E-05	1.68299E-05	1.77976E-06	1.225E-05	6.12501E-05
Minimum Detect	12.0455	9.61649E-07	2.79267E-05	1.68299E-05	1.77976E-06	1.225E-05	6.12501E-05
Maximum Concentration	2541.902	0.000112635	0.002655104	0.003322861	0.001593186	0.002874222	0.01724147
Maximum Detect	2541.902	0.000112635	0.002655104	0.003322861	0.001593186	0.002874222	0.01724147
Average Concentration	324	0.000025	0.00048	0.00041	0.00023	0.00065	0.0035
Median Concentration	84.618	1.98685E-05	0.000236821	0.00021809	0.000133979	0.000369833	0.001332705
Standard Deviation	655	0.000024	0.0006	0.00057	0.00033	0.00082	0.0041
Number of Guideline Exceedances	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)	0	0	0	0	0	0	0

				Dissolved Metals Hardness Corrected					
			Caculated Hardness	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Copper (Filtered)	Lead (Filtered)	Nickel (Filtered)	Zinc (Filtered)
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL									
ANZECC (2000) Irrigation (Long Term Value)				0.01	0.1	0.2	2	0.2	2
MonitoringUnit	**LocCode**	**Sampled Date**							
ALLUVIAL	C027P1	29/09/2011	5.24E+02	-	4.789E-05	4.395E-05	1.322E-05	4.395E-05	5.274E-04
	C027P1	8/11/2011	5.30E+02	3.882E-06	3.797E-04	4.355E-05	1.304E-05	1.132E-03	8.709E-04
	C029P1	7/11/2011	1.71E+03	1.371E-06	1.819E-05	1.933E-04	2.951E-06	2.449E-03	4.189E-04
TERTIARY	C025P2	29/09/2011	8.19E+02	2.636E-06	3.323E-04	3.009E-05	7.504E-06	3.009E-05	3.611E-04
	C025P2	7/11/2011	8.60E+02	2.524E-06	1.596E-04	1.155E-04	7.053E-06	5.773E-05	3.464E-04
	C029P2	29/09/2011	7.35E+02	-	3.628E-05	3.296E-05	8.601E-06	6.593E-05	3.956E-04
	C029P2	7/11/2011	7.39E+02	2.887E-06	1.445E-04	6.563E-05	8.542E-06	3.281E-04	7.219E-04
DUNDA BEDS	C022P1	3/10/2011	2.15E+01	6.739E-05	6.582E-04	6.649E-04	7.654E-04	7.979E-03	1.463E-02
	C022P1	10/11/2011	2.15E+01	6.739E-05	2.633E-03	6.649E-04	7.654E-04	7.979E-03	1.862E-02
	C022P1	14/11/2011	2.40E+01	6.110E-05	6.014E-04	6.055E-04	6.655E-04	7.266E-03	3.391E-02
	C027P2	29/09/2011	5.11E+01	-	3.229E-04	3.178E-04	2.540E-04	2.542E-03	4.449E-03
	C027P2	5/11/2011	4.86E+01	3.252E-05	1.346E-03	3.316E-04	2.707E-04	6.631E-03	6.631E-03
REWAN	C035P1	5/10/2011	1.27E+02	1.389E-05	1.536E-04	1.471E-04	8.039E-05	1.471E-04	7.357E-04
	C035P1	6/11/2011	1.24E+02	1.414E-05	3.123E-04	1.497E-04	8.246E-05	1.497E-04	1.796E-03
PERMIAN OVERBURDEN	C008P1	3/10/2011	2.91E+03	5.119E-06	7.051E-05	4.098E-05	1.500E-06	1.639E-04	2.869E-04
	C008P1	12/11/2011	2.99E+03	3.332E-06	2.299E-05	2.203E-04	1.450E-06	3.004E-04	2.363E-03
	C012P1	2/10/2011	1.84E+02	9.940E-06	1.129E-04	1.069E-04	4.987E-05	2.138E-04	2.565E-03
	C012P1	8/11/2011	2.13E+02	8.729E-06	2.003E-04	3.777E-04	4.143E-05	1.133E-03	6.987E-03
	C012P2	2/10/2011	3.04E+02	6.361E-06	7.481E-05	6.979E-05	2.638E-05	6.979E-05	3.489E-04
	C012P2	13/11/2011	3.33E+02	5.867E-06	1.389E-04	6.460E-05	2.350E-05	3.876E-04	4.393E-03
	C018P1	2/10/2011	4.22E+01	3.693E-05	3.782E-04	3.744E-04	3.245E-04	3.744E-04	8.984E-03
	C018P1	8/11/2011	4.63E+01	3.399E-05	2.102E-03	3.459E-04	2.883E-04	2.075E-03	2.144E-02
AB SEAM	C007P2	4/10/2011	2.36E+03	1.029E-06	2.793E-05	4.900E-05	1.960E-06	1.225E-05	6.125E-05
	C007P2	10/11/2011	2.25E+03	1.071E-06	5.798E-05	2.547E-05	2.076E-06	1.273E-05	1.273E-04
	C008P2	3/10/2011	1.66E+02	1.093E-05	1.232E-04	1.170E-04	5.712E-05	1.170E-04	5.852E-04
	C008P2	12/11/2011	1.81E+02	1.008E-05	2.287E-04	2.167E-04	5.090E-05	4.335E-04	4.118E-03
	C014P2	4/10/2011	7.46E+01	2.222E-05	2.368E-04	2.304E-04	1.571E-04	1.383E-03	1.152E-03
	C014P2	12/11/2011	1.98E+01	7.226E-05	1.404E-03	7.107E-04	8.456E-04	2.843E-03	9.950E-03
	C016P2	2/10/2011	1.45E+01	9.525E-05	9.054E-04	9.253E-04	1.254E-03	9.253E-04	1.110E-02
	C016P2	13/11/2011	1.20E+01	1.126E-04	1.057E-03	1.086E-03	1.593E-03	1.086E-03	1.086E-02
	C018P2	2/10/2011	2.89E+02	6.653E-06	7.796E-05	7.284E-05	2.812E-05	7.284E-05	1.020E-03
	C018P2	9/11/2011	2.98E+02	6.489E-06	4.571E-04	7.112E-05	2.713E-05	2.845E-04	9.957E-04
	C020P2	3/10/2011	4.98E+01	3.185E-05	3.300E-04	3.250E-04	2.627E-04	3.250E-04	1.625E-03
	C020P2	14/11/2011	5.23E+01	3.049E-05	3.170E-04	3.118E-04	2.469E-04	3.118E-04	1.559E-03
	C032P2	5/10/2011	8.46E+01	1.987E-05	2.136E-04	2.071E-04	1.340E-04	2.071E-04	1.035E-03
	C032P2	7/11/2011	1.46E+02	1.224E-05	8.201E-04	1.304E-04	6.708E-05	5.214E-04	1.304E-03
	C035P2	5/10/2011	6.29E+01	2.588E-05	2.725E-04	1.066E-03	1.953E-04	2.665E-04	1.333E-03
	C035P2	6/11/2011	6.54E+01	2.500E-05	2.640E-03	5.157E-04	1.859E-04	1.547E-03	5.157E-03
INTERBURDEN	C006P1	3/10/2011	1.62E+03	1.435E-06	1.518E-04	1.683E-05	3.150E-06	6.732E-05	2.020E-04
	C006P1	10/11/2011	2.54E+03	9.616E-07	1.050E-04	2.297E-05	1.780E-06	9.188E-05	1.838E-04
	C011P1	13/11/2011	1.15E+02	1.513E-05	6.650E-04	1.597E-04	9.085E-05	2.874E-03	7.345E-03
	C034P1	5/10/2011	3.15E+02	6.162E-06	7.265E-05	6.770E-05	2.521E-05	6.770E-05	3.385E-04
	C034P1	6/11/2011	3.04E+02	6.371E-06	1.498E-04	6.990E-05	2.644E-05	1.398E-04	1.398E-03
D SEAM	C006P3r	3/10/2011	3.89E+01	3.965E-05	4.038E-04	4.006E-04	3.591E-04	4.006E-04	2.003E-03
	C006P3r	10/11/2011	3.48E+01	4.379E-05	2.655E-03	4.405E-04	4.138E-04	4.405E-04	2.203E-03
	C006P3r	12/11/2011	3.48E+01	4.379E-05	8.850E-04	4.405E-04	4.138E-04	2.643E-03	7.930E-03
	C007P3	4/10/2011	3.73E+01	4.117E-05	4.181E-04	3.323E-03	3.790E-04	4.154E-04	2.077E-03
	C007P3	10/11/2011	2.73E+01	5.433E-05	5.398E-04	5.413E-04	5.629E-04	5.413E-04	1.083E-02
	C011P3	4/10/2011	6.30E+01	2.583E-05	2.720E-04	2.660E-04	1.948E-04	2.660E-04	1.330E-03
	C011P3	13/11/2011	7.96E+01	2.097E-05	2.246E-04	2.181E-04	1.447E-04	4.362E-04	4.362E-03
	C018P3	2/10/2011	7.96E+01	2.097E-05	2.246E-04	2.181E-04	1.447E-04	2.181E-04	1.090E-03
	C018P3	9/11/2011	8.21E+01	2.041E-05	8.758E-04	2.124E-04	1.392E-04	4.249E-04	4.249E-03
	C024P3	6/10/2011	2.77E+02	6.909E-06	8.073E-05	7.552E-05	2.968E-05	7.552E-05	3.776E-04
	C024P3	14/11/2011	2.30E+02	8.151E-06	1.880E-04	3.537E-04	3.757E-05	1.592E-03	7.782E-03
	C034P3	5/10/2011	1.38E+02	1.290E-05	1.435E-04	1.371E-04	7.231E-05	1.371E-04	6.853E-04
	C034P3	6/11/2011	1.00E+02	1.709E-05	1.860E-04	1.794E-04	1.081E-04	1.794E-04	8.969E-04
SURFACE WATER	WQ01	6/10/2011	8.60E+01	1.959E-05	2.109E-04	2.044E-04	1.313E-04	2.044E-04	1.022E-03
	WQ01	8/11/2011	8.43E+01	1.993E-05	4.285E-04	4.154E-04	1.345E-04	4.154E-04	8.307E-03
	WQ03	5/10/2011	9.67E+01	1.765E-05	1.915E-04	1.109E-03	1.131E-04	3.698E-04	9.246E-04
	WQ03	8/11/2011	9.26E+01	1.834E-05	1.985E-04	7.675E-04	1.195E-04	3.838E-04	9.594E-04
UNKNOWN	C066	11/11/2011	4.86E+01	3.252E-05	3.364E-04	3.316E-04	2.707E-04	2.653E-03	1.724E-02

Statistical Summary

Number of Results	34	39	39	39	39	39	39
Number of Detects	34	39	39	39	39	39	39
Minimum Concentration	12.0455	9.61649E-07	2.79267E-05	1.68299E-05	1.77976E-06	1.225E-05	6.12501E-05
Minimum Detect	12.0455	9.61649E-07	2.79267E-05	1.68299E-05	1.77976E-06	1.225E-05	6.12501E-05
Maximum Concentration	2356.236	0.000112635	0.002655104	0.003322861	0.001593186	0.002874222	0.01724147
Maximum Detect	2356.236	0.000112635	0.002655104	0.003322861	0.001593186	0.002874222	0.01724147
Average Concentration	228	0.000025	0.00048	0.00041	0.00023	0.00065	0.0035
Median Concentration	80.8725	1.98685E-05	0.000236821	0.00021809	0.000133979	0.000369833	0.001332705
Standard Deviation	532	0.000024	0.0006	0.00057	0.00033	0.00082	0.0041
Number of Guideline Exceedances	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)	0	0	0	0	0	0	0

				Dissolved Metals Hardness Corrected					
			Caculated Hardness	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Copper (Filtered)	Lead (Filtered)	Nickel (Filtered)	Zinc (Filtered)
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL									
ANZECC (2000) Livestock				0.01	1	0.5		1	20
MonitoringUnit	**LocCode**	**Sampled Date**							
ALLUVIAL	C027P1	29/09/2011	5.24E+02	-	4.79E-05	4.40E-05	1.32E-05	4.40E-05	5.27E-04
	C027P1	8/11/2011	5.30E+02	3.88E-06	3.80E-04	4.35E-05	1.30E-05	1.13E-03	8.71E-04
	C029P1	7/11/2011	1.71E+03	1.37E-06	1.82E-05	1.93E-04	2.95E-06	2.45E-03	4.19E-04
TERTIARY	C025P2	29/09/2011	8.19E+02	2.64E-06	3.32E-04	3.01E-05	7.50E-06	3.01E-05	3.61E-04
	C025P2	7/11/2011	8.60E+02	2.52E-06	1.60E-04	1.15E-04	7.05E-06	5.77E-05	3.46E-04
	C029P2	29/09/2011	7.35E+02	-	3.63E-05	3.30E-05	8.60E-06	6.59E-05	3.96E-04
	C029P2	7/11/2011	7.39E+02	2.89E-06	1.44E-04	6.56E-05	8.54E-06	3.28E-04	7.22E-04
DUNDA BEDS	C022P1	3/10/2011	2.15E+01	6.74E-05	6.58E-04	6.65E-04	7.65E-04	7.98E-03	1.46E-02
	C022P1	10/11/2011	2.15E+01	6.74E-05	2.63E-03	6.65E-04	7.65E-04	7.98E-03	1.86E-02
	C022P1	14/11/2011	2.40E+01	6.11E-05	6.01E-04	6.05E-04	6.66E-04	7.27E-03	3.39E-02
	C027P2	29/09/2011	5.11E+01	-	3.23E-04	3.18E-04	2.54E-04	2.54E-03	4.45E-03
	C027P2	5/11/2011	4.86E+01	3.25E-05	1.35E-03	3.32E-04	2.71E-04	6.63E-03	6.63E-03
REWAN	C035P1	5/10/2011	1.27E+02	1.39E-05	1.54E-04	1.47E-04	8.04E-05	1.47E-04	7.36E-04
	C035P1	6/11/2011	1.24E+02	1.41E-05	3.12E-04	1.50E-04	8.25E-05	1.50E-04	1.80E-03
PERMIAN OVERBURDEN	C008P1	3/10/2011	2.91E+03	5.12E-06	7.05E-05	4.10E-05	1.50E-06	1.64E-04	2.87E-04
	C008P1	12/11/2011	2.99E+03	3.33E-06	2.30E-05	2.20E-04	1.45E-06	3.00E-04	2.36E-03
	C012P1	2/10/2011	1.84E+02	9.94E-06	1.13E-04	1.07E-04	4.99E-05	2.14E-04	2.57E-03
	C012P1	8/11/2011	2.13E+02	8.73E-06	2.00E-04	3.78E-04	4.14E-05	1.13E-03	6.99E-03
	C012P2	2/10/2011	3.04E+02	6.36E-06	7.48E-05	6.98E-05	2.64E-05	6.98E-05	3.49E-04
	C012P2	13/11/2011	3.33E+02	5.87E-06	1.39E-04	6.46E-05	2.35E-05	3.88E-04	4.39E-03
	C018P1	2/10/2011	4.22E+01	3.69E-05	3.78E-04	3.74E-04	3.24E-04	3.74E-04	8.98E-03
	C018P1	8/11/2011	4.63E+01	3.40E-05	2.10E-03	3.46E-04	2.88E-04	2.08E-03	2.14E-02
AB SEAM	C007P2	4/10/2011	2.36E+03	1.03E-06	2.79E-05	4.90E-05	1.96E-06	1.23E-05	6.13E-05
	C007P2	10/11/2011	2.25E+03	1.07E-06	5.80E-05	2.55E-05	2.08E-06	1.27E-05	1.27E-04
	C008P2	3/10/2011	1.66E+02	1.09E-05	1.23E-04	1.17E-04	5.71E-05	1.17E-04	5.85E-04
	C008P2	12/11/2011	1.81E+02	1.01E-05	2.29E-04	2.17E-04	5.09E-05	4.33E-04	4.12E-03
	C014P2	4/10/2011	7.46E+01	2.22E-05	2.37E-04	2.30E-04	1.57E-04	1.38E-03	1.15E-03
	C014P2	12/11/2011	1.98E+01	7.23E-05	1.40E-03	7.11E-04	8.46E-04	2.84E-03	9.95E-03
	C016P2	2/10/2011	1.45E+01	9.52E-05	9.05E-04	9.25E-04	1.25E-03	9.25E-04	1.11E-02
	C016P2	13/11/2011	1.20E+01	1.13E-04	1.06E-03	1.09E-03	1.59E-03	1.09E-03	1.09E-02
	C018P2	2/10/2011	2.89E+02	6.65E-06	7.80E-05	7.28E-05	2.81E-05	7.28E-05	1.02E-03
	C018P2	9/11/2011	2.98E+02	6.49E-06	4.57E-04	7.11E-05	2.71E-05	2.84E-04	9.96E-04
	C020P2	3/10/2011	4.98E+01	3.18E-05	3.30E-04	3.25E-04	2.63E-04	3.25E-04	1.62E-03
	C020P2	14/11/2011	5.23E+01	3.05E-05	3.17E-04	3.12E-04	2.47E-04	3.12E-04	1.56E-03
	C032P2	5/10/2011	8.46E+01	1.99E-05	2.14E-04	2.07E-04	1.34E-04	2.07E-04	1.04E-03
	C032P2	7/11/2011	1.46E+02	1.22E-05	8.20E-04	1.30E-04	6.71E-05	5.21E-04	1.30E-03
	C035P2	5/10/2011	6.29E+01	2.59E-05	2.73E-04	1.07E-03	1.95E-04	2.67E-04	1.33E-03
	C035P2	6/11/2011	6.54E+01	2.50E-05	2.64E-03	5.16E-04	1.86E-04	1.55E-03	5.16E-03
INTERBURDEN	C006P1	3/10/2011	1.62E+03	1.43E-06	1.52E-04	1.68E-05	3.15E-06	6.73E-05	2.02E-04
	C006P1	10/11/2011	2.54E+03	9.62E-07	1.05E-04	2.30E-05	1.78E-06	9.19E-05	1.84E-04
	C011P1	13/11/2011	1.15E+02	1.51E-05	6.65E-04	1.60E-04	9.08E-05	2.87E-03	7.35E-03
	C034P1	5/10/2011	3.15E+02	6.16E-06	7.27E-05	6.77E-05	2.52E-05	6.77E-05	3.39E-04
	C034P1	6/11/2011	3.04E+02	6.37E-06	1.50E-04	6.99E-05	2.64E-05	1.40E-04	1.40E-03
D SEAM	C006P3r	3/10/2011	3.89E+01	3.96E-05	4.04E-04	4.01E-04	3.59E-04	4.01E-04	2.00E-03
	C006P3r	10/11/2011	3.48E+01	4.38E-05	2.66E-03	4.41E-04	4.14E-04	4.41E-04	2.20E-03
	C006P3r	12/11/2011	3.48E+01	4.38E-05	8.85E-04	4.41E-04	4.14E-04	2.64E-03	7.93E-03
	C007P3	4/10/2011	3.73E+01	4.12E-05	4.18E-04	3.32E-03	3.79E-04	4.15E-04	2.08E-03
	C007P3	10/11/2011	2.73E+01	5.43E-05	5.40E-04	5.41E-04	5.63E-04	5.41E-04	1.08E-02
	C011P3	4/10/2011	6.30E+01	2.58E-05	2.72E-04	2.66E-04	1.95E-04	2.66E-04	1.33E-03
	C011P3	13/11/2011	7.96E+01	2.10E-05	2.25E-04	2.18E-04	1.45E-04	4.36E-04	4.36E-03
	C018P3	2/10/2011	7.96E+01	2.10E-05	2.25E-04	2.18E-04	1.45E-04	2.18E-04	1.09E-03
	C018P3	9/11/2011	8.21E+01	2.04E-05	8.76E-04	2.12E-04	1.39E-04	4.25E-04	4.25E-03
	C024P3	6/10/2011	2.77E+02	6.91E-06	8.07E-05	7.55E-05	2.97E-05	7.55E-05	3.78E-04
	C024P3	14/11/2011	2.30E+02	8.15E-06	1.88E-04	3.54E-04	3.76E-05	1.59E-03	7.78E-03
	C034P3	5/10/2011	1.38E+02	1.29E-05	1.43E-04	1.37E-04	7.23E-05	1.37E-04	6.85E-04
	C034P3	6/11/2011	1.00E+02	1.71E-05	1.86E-04	1.79E-04	1.08E-04	1.79E-04	8.97E-04
SURFACE WATER	WQ01	6/10/2011	8.60E+01	1.96E-05	2.11E-04	2.04E-04	1.31E-04	2.04E-04	1.02E-03
	WQ01	8/11/2011	8.43E+01	1.99E-05	4.28E-04	4.15E-04	1.35E-04	4.15E-04	8.31E-03
	WQ03	5/10/2011	9.67E+01	1.76E-05	1.92E-04	1.11E-03	1.13E-04	3.70E-04	9.25E-04
	WQ03	8/11/2011	9.26E+01	1.83E-05	1.98E-04	7.68E-04	1.20E-04	3.84E-04	9.59E-04
UNKNOWN	C066	11/11/2011	4.86E+01	3.25E-05	3.36E-04	3.32E-04	2.71E-04	2.65E-03	1.72E-02

Statistical Summary

		Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Copper (Filtered)	Lead (Filtered)	Nickel (Filtered)	Zinc (Filtered)
Number of Results		39	39	39	39	39	39
Number of Detects		39	39	39	39	39	39
Minimum Concentration		9.61649E-07	2.79267E-05	1.68299E-05	1.77976E-06	1.225E-05	6.12501E-05
Minimum Detect		9.61649E-07	2.79267E-05	1.68299E-05	1.77976E-06	1.225E-05	6.12501E-05
Maximum Concentration		0.000112635	0.002655104	0.003322861	0.001593186	0.002874222	0.01724147
Maximum Detect		0.000112635	0.002655104	0.003322861	0.001593186	0.002874222	0.01724147
Average Concentration		0.000025	0.00048	0.00041	0.00023	0.00065	0.0035
Median Concentration		1.98685E-05	0.000236821	0.00021809	0.000133979	0.000369833	0.001332705
Standard Deviation		0.000024	0.0006	0.00057	0.00033	0.00082	0.0041
Number of Guideline Exceedances		0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)		0	0	0	0	0	0

			Inorganics							Metals																		Nutrients					
			Bromide	Fluoride	Kjeldahl Nitrogen Total	pH (Lab)	Sulphide	TOC	Total Dissolved Solids	Aluminium (Filtered)	Arsenic (Filtered)	Boron (Filtered)	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Cobalt (Filtered)	Copper (Filtered)	Iron (Filtered)	Lead (Filtered)	Manganese (Filtered)	Mercury (Filtered)	Molybdenum (Filtered)	Nickel (Filtered)	Selenium (Filtered)	Silver (Filtered)	Uranium (Filtered)	Vanadium (Filtered)	Zinc (Filtered)	Ammonia as N	Nitrate (as N)	Nitrite (as N)	Nitrogen (Total Oxidised)	Nitrogen (Total)	Phosphorus
			mg/L	mg/L	mg/L	pH_Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL			0.005	0.1	0.1	0.01	0.1	1	5	0.01	0.001	0.05	0.0001	0.001	0.001	0.001	0.05	0.001	0.001	0.0001	0.001	0.001	0.01	0.001	0.001	0.01	0.005	0.01	0.01	0.01	0.01	0.1	0.01
ANZECC (2000) Irrigation (Long Term Value)						6.5 - 8.5			8100	5	0.1	0.5	0.01	0.1	0.05	0.2	0.2	2	0.2	0.002	0.01	0.2	0.02		0.010	0.1	2					5	0.5
MonitoringUnit	**WellCode**	**Sampled_Date-Time**																															
ALLUVIUM	C027P1	29/09/2011	-	0.9	2.1	7	<0.1	52	3850	0.01	0.013	0.63	-	<0.001	<0.001	<0.001	16	<0.001	4.49	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	0.01	0.006	0.53	0.01	0.02	0.03	2.1	0.21
		8/11/2011	-	0.6	1.1	6.77	<0.1	<1	4370	<0.01	0.015	0.52	<0.0001	0.004	0.004	0.001	29.3	<0.001	4.43	<0.0001	<0.001	0.012	<0.01	<0.001	<0.001	<0.01	0.019	0.88	0.01	<0.01	0.01	1.1	<0.01
		8/11/2011	-	0.7	1.1	6.91	<0.1	<1	4260	<0.01	0.013	0.52	<0.0001	0.004	<0.001	<0.001	27.4	<0.001	4.55	<0.0001	<0.001	0.015	<0.01	<0.001	<0.001	<0.01	0.01	0.93	0.02	<0.01	0.02	1.2	<0.01
	C029P1	7/11/2011	-	0.9	1.7	7.28	<0.1	<1	20,100	<0.01	0.028	2.56	<0.0001	<0.001	0.003	0.006	5.62	<0.001	4.81	<0.0001	0.001	0.076	<0.01	<0.001	0.05	0.02	0.013	1.35	0.01	<0.01	0.01	1.7	0.15
TERTIARY	C025P2	29/09/2011	6.1	0.8	3.3	7.52	0.4	1	8180	0.03	0.012	1.01	<0.0001	0.005	-	<0.001	-	<0.001	1.16	<0.0001	0.001	<0.001	0.05	<0.001	0.002	0.01	0.006	0.63	0.03	<0.01	0.03	3.3	0.38
		7/11/2011	-	0.6	1.8	7.07	<0.1	<1	8660	<0.01	0.013	1.01	<0.0001	<0.005	<0.001	0.002	24.5	<0.001	2.19	<0.0001	<0.001	0.001	0.01	<0.001	<0.001	0.01	0.006	1.38	0.16	<0.01	0.16	2	0.12
	C029P2	29/09/2011	4.95	0.6	-	7.23	0.3	13	6960	<0.01	0.006	0.92	-	<0.001	<0.001	<0.001	1.74	<0.001	0.448	<0.0001	0.001	0.001	<0.01	<0.001	<0.001	<0.01	0.006	-	-	-	-	-	-
		7/11/2011	-	0.6	0.7	6.96	<0.1	<1	7780	<0.01	0.008	0.84	<0.0001	0.002	0.001	0.001	6.33	<0.001	0.655	<0.0001	<0.001	0.005	<0.01	<0.001	<0.001	<0.01	0.011	0.42	0.01	<0.01	0.01	0.7	0.21
DUNDA BEDS	C027P2	29/09/2011	-	0.5	2	7.25	<0.1	106	805	0.09	0.019	0.22	-	<0.001	0.007	<0.001	24.9	<0.001	1.78	<0.0001	<0.001	0.004	<0.01	<0.001	<0.001	<0.01	0.009	0.97	0.01	<0.01	0.01	2	0.19
		5/11/2011	-	0.4	0.6	6.79	<0.1	<1	949	0.14	0.012	0.16	<0.0001	0.002	0.002	<0.001	11.3	<0.001	0.883	<0.0001	<0.001	0.01	<0.01	<0.001	<0.001	<0.01	0.01	0.42	0.02	<0.01	0.02	0.6	0.02
	C022P1	3/10/2011	0.14	0.3	<0.1	6.76	-	-	301	0.51	<0.001	0.15	<0.0001	<0.001	0.005	<0.001	0.5	<0.001	0.099	<0.0001	<0.001	0.006	<0.01	<0.001	<0.001	<0.01	0.011	0.02	0.03	<0.01	0.03	<0.1	0.07
		6/10/2011	-	-	-	-	<0.1	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14/11/2011	-	0.3	<0.1	6.73	<0.1	2	233	0.23	0.002	0.07	<0.0001	<0.001	0.009	<0.001	2.67	<0.001	0.2	<0.0001	<0.001	0.006	<0.01	<0.001	<0.001	<0.01	0.028	0.04	0.03	<0.01	0.03	<0.1	<0.01
		10/11/2011	-	0.3	0.1	6.39	<0.1	<1	209	0.63	0.001	0.11	<0.0001	0.002	0.007	<0.001	0.76	<0.001	0.083	<0.0001	<0.001	0.006	<0.01	<0.001	<0.001	<0.01	0.014	0.05	0.02	<0.01	0.02	0.1	<0.01
REWAN	C035P1	5/10/2011	2.42	0.7	0.6	7.22	<0.1	<1	2290	0.08	0.008	0.64	<0.0001	<0.001	<0.001	<0.001	2.04	<0.001	0.256	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.1	0.05	<0.01	0.05	0.6	0.15
		6/11/2011	-	0.6	3.9	7.24	<0.1	<1	2990	0.03	0.005	0.54	<0.0001	0.001	<0.001	<0.001	0.68	<0.001	0.218	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	0.006	0.12	0.02	<0.01	0.02	3.9	1.99
PERMIAN OVERBURDEN	C008P1	3/10/2011	14.7	0.5	0.2	7.65	<0.1	3	14,900	<0.01	0.002	1.14	0.0003	0.004	0.002	0.002	0.29	<0.001	0.181	<0.0001	<0.001	0.008	0.02	0.003	0.019	<0.01	0.014	0.14	0.02	<0.01	0.02	0.2	0.04
		12/11/2011	-	0.6	0.2	7.23	<0.1	<1	17,200	<0.01	<0.001	1.29	0.0002	0.001	0.004	0.011	0.06	<0.001	1.6	<0.0001	<0.001	0.015	<0.01	0.003	0.018	<0.01	0.118	0.15	<0.01	<0.01	<0.01	0.2	<0.01
	C012P1	2/10/2011	1.04	0.3	0.5	7.32	<0.1	-	1170	0.01	<0.001	0.41	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	0.182	<0.0001	<0.001	0.001	<0.01	0.001	<0.001	<0.01	0.012	0.2	0.03	0.01	0.04	0.5	0.33
		4/10/2011	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		8/11/2011	-	0.3	<0.1	6.43	<0.1	6	1350	<0.01	<0.001	0.32	<0.0001	0.001	<0.001	0.002	0.05	<0.001	0.173	<0.0001	<0.001	0.006	<0.01	<0.001	<0.001	<0.01	0.037	0.02	0.05	<0.01	0.05	<0.1	<0.01
	C018P1	2/10/2011	0.21	0.6	2.7	7.53	<0.1	-	486	0.07	<0.001	0.19	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	0.006	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	0.012	0.1	0.03	0.06	0.09	2.8	0.07
		6/10/2011	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		8/11/2011	-	0.4	<0.1	6.5	<0.1	<1	541	0.03	<0.001	0.18	<0.0001	0.003	<0.001	<0.001	<0.05	<0.001	0.013	<0.0001	<0.001	0.003	<0.01	<0.001	<0.001	<0.01	0.031	0.03	0.08	<0.01	0.08	<0.1	<0.01
	C012P2	2/10/2011	1.3	0.5	<0.1	7.86	-	-	1680	0.01	0.006	0.49	<0.0001	<0.001	<0.001	<0.001	1.62	<0.001	1.32	<0.0001	0.001	<0.001	<0.01	<0.001	0.001	<0.01	<0.005	0.04	0.02	<0.01	0.02	<0.1	<0.01
		4/10/2011	-	-	-	-	0.3	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		13/11/2011	-	0.4	0.1	7.75	0.1	32	1560	0.01	0.006	0.4	<0.0001	0.001	<0.001	<0.001	1.26	<0.001	0.924	<0.0001	<0.001	0.003	<0.01	<0.001	<0.001	<0.01	0.034	0.04	0.02	<0.01	0.02	0.1	<0.01
AB SEAM	C007P2	4/10/2011	8.3	0.4	6.2	7.56	<0.1	13	10,300	<0.01	0.003	0.41	<0.0001	0.001	0.001	0.002	0.24	<0.001	0.445	<0.0001	0.008	<0.001	<0.01	0.004	0.003	<0.01	<0.005	3.07	0.03	<0.01	0.03	6.2	1.73
		10/11/2011	-	0.4	2	7.95	5.3	36	10,700	<0.01	0.002	0.51	<0.0001	0.002	<0.001	0.001	0.1	<0.001	0.304	<0.0001	0.001	<0.001	<0.01	<0.001	0.002	<0.01	0.005	2.43	0.02	<0.01	0.02	2	<0.01
	C007P2	10/11/2011	-	0.4	2.1	7.73	6.2	38	10,800	<0.01	0.003	0.49	0.0001	0.002	<0.001	0.001	0.16	<0.001	0.285	<0.0001	<0.001	<0.001	<0.01	0.003	0.002	<0.01	<0.005	2.48	0.01	<0.01	0.01	2.1	0.04
	C008P2	3/10/2011	1.35	0.8	0.9	8.52	5.3	54	1920	0.02	0.004	0.3	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	0.263	<0.0001	0.005	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.9	0.02	<0.01	0.02	0.9	0.18
		12/11/2011	-	0.9	1	8.27	0.9	37	1920	0.06	0.008	0.3	<0.0001	0.001	<0.001	0.001	0.06	<0.001	0.361	<0.0001	<0.001	0.002	<0.01	<0.001	<0.001	<0.01	0.019	0.85	0.01	<0.01	0.01	1	<0.01
	C014P2	4/10/2011	0.72	1	1.1	8.61	<0.1	29	1110	<0.01	0.004	0.3	<0.0001	<0.001	0.002	<0.001	0.38	<0.001	0.084	<0.0001	0.009	0.003	<0.01	<0.001	<0.001	<0.01	<0.005	0.82	0.02	<0.01	0.02	1.1	<0.01
		12/11/2011	-	1	1.6	9.5	<0.1	23	1340	0.42	0.004	0.24	<0.0001	0.001	<0.001	<0.001	0.18	<0.001	0.002	<0.0001	0.012	0.002	<0.01	<0.001	<0.001	<0.01	0.007	0.98	0.02	<0.01	0.02	1.6	0.28
	C016P2	2/10/2011	1.36	0.2	8.3	10.4	4.7	-	1660	0.08	0.004	0.31	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	<0.001	<0.0001	0.01	<0.001	<0.01	<0.001	<0.001	<0.01	0.006	4.93	0.02	<0.01	0.02	8.3	0.51
		6/10/2011	-	-	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		13/11/2011	-	0.3	11.7	11.5	1.9	28	1840	0.02	0.003	0.23	<0.0001	<0.001	<0.001	<0.001	0.05	<0.001	0.001	<0.0001	0.013	<0.001	<0.01	<0.001	<0.001	<0.01	0.005	4.32	0.02	<0.01	0.02	11.7	<0.01
	C018P2	2/10/2011	1.27	0.4	0.6	7.63	0.6	-	1420	<0.01	0.001	0.61	<0.0001	<0.001	<0.001	<0.001	1.13	<0.001	0.051	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	0.007	0.03	0.02	<0.01	0.02	0.6	0.3
		6/10/2011	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		9/11/2011	-	0.4	<0.1	7.18	0.4	28	1360	<0.01	<0.001	0.5	<0.0001	0.003	<0.001	<0.001	0.98	<0.001	0.03	<0.0001	<0.001	0.003	<0.01	<0.001	<0.001	<0.01	0.009	0.1	0.02	<0.01	0.02	<0.1	0.21
	C018P2	9/11/2011	-	0.5	0.4	7.26	0.9	16	1210	<0.01	0.002	0.46	<0.0001	0.003	<0.001	<0.001	0.57	<0.001	0.06	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.31	0.02	<0.01	0.02	0.4	0.23
	C020P2	3/10/2011	0.84	0.6	0.6	8.21	-	-	1050	0.1	0.002	0.48	<0.0001	<0.001	<0.001	<0.001	0.06	<0.001	0.037	<0.0001	0.004	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.04	0.03	<0.01	0.03	0.6	0.23
		6/10/2011	-	-	-	-	<0.1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14/11/2011	-	0.6	0.6	8.2	1.5	<1	970	0.04	0.001	0.41	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	0.041	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.52	0.02	<0.01	0.02	0.6	<0.01
	C032P2	5/10/2011	0.42	0.6	0.4	8.09	0.2	36	951	0.02	0.005	0.3	<0.0001	<0.001	<0.001	<0.001	0.33	<0.001	0.264	<0.0001	0.018	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.05	0.03	<0.01	0.03	0.4	0.12
		7/11/2011	-	0.7	2	7.49	<0.1	<1	1540	0.02	0.013	0.3	<0.0001	0.003	<0.001	<0.001	1.4	<0.001	0.464	<0.0001	0.01	0.002	<0.01	<0.001	<0.001	<0.01	0.005	0.71	0.01	<0.01	0.01	2	0.74
	C035P2	5/10/2011	0.76	0.3	0.2	7.15	0.1	1	851	0.35	<0.001	0.24	<0.0001	<0.001	<0.001	0.002	1.01	<0.001	0.136	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.04	0.05	<0.01	0.05	0.2	0.06
		6/11/2011	-	0.3	<0.1	7.02	<0.1	11	1180	5.66	<0.001	0.2	<0.0001	0.005	<0.001	0.001	2.24	<0.001	0.128	<0.0001	<0.001	0.003	<0.01	<0.001	<0.001	<0.01	0.01	0.07	0.03	<0.01	0.03	<0.1	<0.01
INTERBURDEN	C006P1	3/10/2011	7.9	0.7	0.5	7.74	0.2	58	8960	<0.01	0.011	1.05	<0.0001	0.004	<0.001	<0.001	1.9	<0.001	0.891	<0.0001	0.029	0.002	<0.01	<0.001	0.014	<0.01	0.006	0.46	0.02	<0.01	0.02	0.5	0.04
		10/11/2011	-	0.6	0.2	7.16	0.2	18	11,900	<0.01	0.01	1.3	<0.0001	0.004	0.005	0.001	3.85	<0.001	0.687	<0.0001	0.005	0.004	<0.01	<0.001	0.014	<0.01	0.008	0.27	0.02	<0.01	0.02	0.2	<0.01
	C011P1	13/11/2011	-	0.8	0.2	8.17	<0.1	31	1900	0.07	0.002	0.9	<0.0001	0.002	0.001	<0.001	<0.05	<0.001	0.113	<0.0001	0.007	0.009	<0.01	<0.001	0.004	<0.01	0.023	0.12	0.05	<0.01	0.05	0.2	<0.01
	C034P1	5/10/2011	2.78	0.7	0.2	7.03	<0.1	1	2870	0.01	0.005	0.6	<0.0001	<0.001	0.001	<0.001	3.24	<0.001	0.204	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.06	0.06	<0.01	0.06	0.3	0.05
		6/11/2011	-	0.7	<0.1	7	<0.1	<1	2810	0.01	0.003	0.51	<0.0001	0.001	<0.001	<0.001	1.3	<0.001	0.141	<0.0001	<0.001	0.001	<0.01	<0.001	<0.001	<0.01	0.01	0.08	0.01	<0.01	0.01	<0.1	<0.01
D SEAM	C006P3r	3/10/2011	0.17	2.2	0.4	8.32	<0.1	12	587	0.14	0.004	0.18	<0.0001	<0.001	<0.001	<0.001	0.8	<0.001	0.046	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.34	0.02	<0.01	0.02	0.4	0.08
		12/11/2011	-	2.4	0.4	8.18	<0.1	<1	620	0.13	0.003	0.12	<0.0001	0.001	<0.001	<0.001	0.41	<0.001	0.038	<0.0001	0.002	0.003	<0.01	<0.001	<0.001	<0.01	0.009	0.31	<0.01	<0.01	<0.01	0.4	0.21
	C006P3r	10/11/2011	-	2.2	0.5	8.04	<0.1	13	568	0.1	0.003	0.13	<0.0001	0.003	<0.001	<0.001	0.44	<0.001	0.036	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.33	0.02	<0.01	0.02	0.5	0.02
	C007P3	4/10/2011	0.14	2.6	0.7	8.23	0.2	33	809	0.32	0.004	0.22	<0.0001	<0.001	<0.001	0.004	0.18	<0.001	0.052	<0.0001	0.019	<0.001	<0.01	<0.001	0.002	<0.01	<0.005	0.3	0.01	<0.01	0.01	0.7	0.14
		10/11/2011	-	2.6	0.4	8.31	1.3	38	760	0.22	0.003	0.22	<0.0001	<0.001	<0.001	<0.001	0.12	<0.001	0.042	<0.0001	0.019	<0.001	<0.01	<0.001	0.002	<0.01	0.01	0.43	0.02	<0.01	0.02	0.4	0.05
	C011P3	4/10/2011	0.42	1.2	1.1	8.45	<0.1	8	568	<0.01	0.004	0.41	<0.0001	<0.001	0.002	<0.001	2.59	<0.001	0.218	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.21	0.03	<0.01	0.03	1.1	0.57
		13/11/2011	-	1.2	0.3	8.01	<0.1	<1	608	0.02	0.002	0.35	<0.0001	<0.001	<0.001	<0.001	0.88	<0.001	0.09	<0.0001	0.002	0.001	<0.01	<0.001	<0.001	<0.01	0.01	0.29	0.02	<0.01	0.02	0.3	<0.01
	C018P3	2/10/2011	0.48	1.2	0.8	7.81	<0.1	-	651	0.05	0.002	0.35	<0.0001	<0.001	0.001	<0.001	0.59	<0.001	0.122	<0.0001	0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.32	0.03	<0.01	0.03	0.8	0.09
		6/10/2011	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		9/11/2011	-	1.2	0.2	7.35	<0.1	2	523	0.05	0.001	0.29	<0.0001	0.002	<0.001	<0.001	0.89	<0.001	0.09	<0.0001	<0.001	0.002	<0.01	<0.001	<0.001	<0.01	0.014	0.21	0.02	<0.01	0.02	0.2	0.05
	C018P3	9/11/2011	-	1.2	0.3	7.51	0.1	5	554	0.06	0.001	0.28	<0.0001	0.002	<0.001	<0.001	0.4	<0.001	0.109	<0.0001	0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.06	0.02	<0.01	0.02	0.3	0.07
	C024P3	6/10/2011	1.28	0.4	0.8	6.52	0.4	108	1150	<0.01	0.007	0.3	<0.0001	<0.001	0.001	<0.001	14.8	<0.001	0.261	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	<0.01	<0.01	<0.01	<0.01	0.8	0.07
		14/11/2011	-	0.4	0.4	7.12	1	47	1050	<0.01	0.004	0.28	<0.0001	0.001	<0.001	0.002	8.37	<0.001	0.236	<0.0001	<0.001	0.009	<0.01	<0.001	<0.001	<0.01	0.044	0.02	<0.01	<0.01	<0.01	0.4	<0.01
	C034P3	5/10/2011	1.29	0.5	0.2	7.23	<0.1	<1	1260	<0.01	0.002	0.26	<0.0001	<0.001	<0.001	<0.001	1.2	<0.001	0.23	<0.0001	0.006	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.14	0.08	<0.01	0.08	0.3	0.07
		6/11/2011	-	0.3	<0.1	6.96	<0.1	<1	1020	<0.01	<0.001	<0.05	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.09	0.02	<0.01	0.02	<0.1	<0.01
UNKNOWN	C066 (line 180-35)	11/11/2011	-	0.1	0.1	6.51	<0.1	-	396	0.58	<0.001	0.05	<0.0001	<0.001	0.003	<0.001	0.32	<0.001	0.048	<0.0001	<0.001	0.004	<0.01	<0.001	<0.001	<0.01	0.026	0.05	0.2	<0.01	0.2	0.3	<0.01
SURFACE WATER	WQ01	6/10/2011	0.931	0.5	0.3	7.79	<0.1	11	703	0.13	<0.001	0.13	<0.0001	<0.001	<0.001	<0.001	0.85	<0.001	0.184	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.03	0.02	<0.01	0.02	0.3	0.05
		8/11/2011	-	0.6	0.5	7.91	<0.1	5	1340	0.12	0.001	0.12	<0.0001	0.002	<0.001	<0.001	0.82	<0.001	0.2	<0.0001	<0.001	0.001	<0.01	<0.001	<0.001	<0.01	0.022	0.04	0.01	<0.01	0.01	0.5	<0.01
	WQ03	5/10/2011	0.55	0.5	0.5	8.07	<0.1	8	859	0.1	<0.001	0.15	<0.0001	<0.001	<0.001	0.003	0.5	<0.001	0.055	<0.0001	<0.001	0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.03	0.04	<0.01	0.04	0.5	0.04
		8/11/2011	-	0.5	0.6	8.04	<0.1	1	1350	0.17	<0.001	0.14	<0.0001	<0.001	<0.001	0.002	0.72	<0.001	0.298	<0.0001	<0.001	0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.03	0.02	<0.01	0.02	0.6	<0.01

Statistical Summary

	Bromide	Fluoride	Kjeldahl Nitrogen Total	pH (Lab)	Sulphide	TOC	Total Dissolved Solids	Aluminium (Filtered)	Arsenic (Filtered)	Boron (Filtered)	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Cobalt (Filtered)	Copper (Filtered)	Iron (Filtered)	Lead (Filtered)	Manganese (Filtered)	Mercury (Filtered)	Molybdenum (Filtered)	Nickel (Filtered)	Selenium (Filtered)	Silver (Filtered)	Uranium (Filtered)	Vanadium (Filtered)	Zinc (Filtered)	Ammonia as N	Nitrate (as N)	Nitrite (as N)	Nitrogen (Total Oxidised)	Nitrogen (Total)	Phosphorus
Number of Results	30	72	70	72	71	70	72	72	72	72	68	72	71	72	71	72	72	72	72	72	72	72	72	72	72	70	70	70	70	70	70
Number of Detects	30	72	59	72	24	43	72	47	57	71	4	32	22	20	62	0	70	0	30	39	4	5	15	4	44	69	65	3	65	59	43
Minimum Concentration	0.14	0.1	<0.1	6.39	<0.1	<1	209	<0.01	<0.001	<0.05	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	<0.01	<0.01	<0.01	<0.01	<0.1	<0.01
Minimum Detect	0.14	0.1	0.1	6.39	0.1	1	209	0.01	0.001	0.05	0.0001	0.001	0.001	0.001	0.05	ND	0.001	ND	0.001	0.001	0.01	0.001	0.001	0.01	0.005	0.02	0.01	0.01	0.01	0.1	0.02
Maximum Concentration	14.7	2.6	11.7	11.5	6.2	108	20,100	5.66	0.028	2.56	0.0003	0.005	0.009	0.011	29.3	<0.001	4.81	<0.0001	0.029	0.076	0.05	0.004	0.05	0.02	0.118	4.93	0.2	0.06	0.2	11.7	1.99
Maximum Detect	14.7	2.6	11.7	11.5	6.2	108	20,100	5.66	0.028	2.56	0.0003	0.005	0.009	0.011	29.3	ND	4.81	ND	0.029	0.076	0.05	0.004	0.05	0.02	0.118	4.93	0.2	0.06	0.2	11.7	1.99
Average Concentration	2.4	0.71	1.1	7.6	0.51	16	3218	0.16	0.0047	0.46	0.00006	0.0013	0.0013	0.001	3.3	0.0005	0.57	0.00005	0.003	0.0036	0.006	0.00066	0.0025	0.0054	0.011	0.52	0.028	0.0061	0.03	1.1	0.15
Median Concentration	1.275	0.6	0.5	7.515	0.05	3.5	1340	0.02	0.003	0.335	0.00005	0.0005	0.0005	0.0005	0.8	0.0005	0.1895	0.00005	0.0005	0.001	0.005	0.0005	0.0005	0.005	0.006	0.145	0.02	0.005	0.02	0.5	0.05
Standard Deviation	3.3	0.53	1.9	0.84	1.3	24	4399	0.67	0.0051	0.39	0.000046	0.0012	0.0018	0.0015	6.7	0	1.1	0	0.0054	0.0093	0.0056	0.00064	0.0071	0.002	0.016	0.92	0.031	0.0068	0.032	1.9	0.33
Number of Guideline Exceedances	0	0	0	7	0	0	11	1	0	22	0	0	0	0	52	0	32	0	6	0	1	0	6	0	0	0	0	0	0	3	5
Number of Guideline Exceedances(Detects Only)	0	0	0	7	0	0	11	1	0	22	0	0	0	0	52	0	32	0	6	0	1	0	6	0	0	0	0	0	0	3	5

MonitoringUnit	WellCode	Sampled_Date-Time	Alkalinity (total) as CaCO3	Alkalinity (Bicarbonate as CaCO3)	Alkalinity (Carbonate as CaCO3)	Alkalinity (Hydroxide) as CaCO3	Bicarbonate	Carbonate	Calcium (Filtered)	Chloride	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Sulphate	Sulphate (Filtered)	Anions Total	Cations Total	Ionic Balance	Benzene	Ethylbenzene	Toluene	Xylene (o)	Xylene Total	TPH C10 - C14 Fraction	TPH C10 - C16 Fraction	TPH C15 - C28 Fraction	TPH C16 - C34 Fraction	TPH C29 - C36 Fraction	TPH C34 - C40 Fraction	TPH C6 - C 9 Fraction	TPH C6 - C10 Fraction	TPH C6 - C10 Fraction minus BTEX	Naphthalene	PAHs (Sum of Total) - Calc
			Alkalinity						Major Ions										BTEX & MAH					TPH									PAH	
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	%	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L
EQL			1	1	1	1			1	1	1	1	1	1	1	0.01	0.01	0.01	1	2	2	2	2	0.05	0.1	0.1	0.1	0.05	0.1	0.02	0.02	0.02	5	
ANZECC (2000) Irrigation (Long Term Value)										700			460						1.000	300	800		600											
ALLUVIUM	C027P1	29/09/2011	582	582	<1	<1	710	<1.2	27	1580	111	52	1070	-	66	57.6	58.4	0.65	<1	<2	<2	<2	<2	1.45	<0.1	<0.1	<0.1	<0.05	<0.1	0.35	0.34	0.34	<5	<5
		8/11/2011	460	460	<1	<1	561.2	<1.2	26	1420	114	58	1080	141	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.09	0.1	0.1	<5	<5
		8/11/2011	480	480	<1	<1	585.6	<1.2	26	1210	113	57	1080	107	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	0.11	<0.1	<0.05	<0.1	0.06	0.07	0.07	<5	<5
	C029P1	7/11/2011	1590	1590	<1	<1	1940	<1.2	87	8430	362	177	5960	686	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
TERTIARY	C025P2	29/09/2011	746	746	<1	<1	910.1	<1.2	107	4570	134	79	2700	-	54	145	136	3.26	<1	<2	16	<2	<2	0.06	<0.1	<0.1	<0.1	<0.05	<0.1	0.31	0.33	0.31	<5	<5
		7/11/2011	763	763	<1	<1	930.9	<1.2	130	3670	130	74	2680	10	-	-	-	-	<1	<2	6	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.06	0.06	0.05	<5	<5
	C029P2	29/09/2011	259	259	<1	<1	316	<1.2	100	3950	118	58	2280	-	259	122	115	2.81	<1	<2	<2	<2	<2	0.11	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		7/11/2011	274	274	<1	<1	334.3	<1.2	95	3740	122	75	2180	246	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
DUNDA BEDS	C027P2	29/09/2011	128	128	<1	<1	156.2	<1.2	4	186	9	10	161	-	8	7.97	8.2	1.38	<1	<2	<2	<2	<2	0.1	<0.1	<0.1	<0.1	<0.05	<0.1	0.09	0.1	0.1	<5	<5
		5/11/2011	180	180	<1	<1	219.6	<1.2	3	199	10	12	175	14	-	-	-	-	<1	<2	17	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.03	0.04	0.02	<5	<5
	C022P1	3/10/2011	36	36	<1	<1	43.92	<1.2	2	67	4	2	55	-	16	2.94	2.87	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.04	0.04	0.04	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14/11/2011	47	47	<1	<1	57.34	<1.2	3	70	4	3	56	18	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		10/11/2011	45	45	<1	<1	54.9	<1.2	2	77	4	3	57	16	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.02	0.02	0.02	<5	<5
REWAN	C035P1	5/10/2011	175	175	<1	<1	213.5	<1.2	21	1070	18	6	822	-	60	34.9	38.4	4.76	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/11/2011	171	171	<1	<1	208.6	<1.2	20	909	18	6	744	50	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
PERMIAN OVERBURDEN	C008P1	3/10/2011	316	316	<1	<1	385.5	<1.2	505	7950	402	90	3680	-	282	236	221	3.46	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		12/11/2011	298	298	<1	<1	363.6	<1.2	468	7530	442	115	3810	275	-	-	-	-	<1	<2	<2	<2	<2	0.13	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C012P1	2/10/2011	84	84	<1	<1	102.5	<1.2	26	549	29	11	334	-	56	18.3	18.5	0.43	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		4/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		8/11/2011	82	82	<1	<1	100	<1.2	31	551	33	13	301	51	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C018P1	2/10/2011	100	100	<1	<1	122	<1.2	7	141	6	12	128	-	41	6.83	6.72	0.85	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		8/11/2011	83	83	<1	<1	101.3	<1.2	7	255	7	10	134	39	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C012P2	2/10/2011	276	276	<1	<1	336.7	<1.2	78	631	25	12	442	-	49	24.3	25.5	2.29	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		4/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		13/11/2011	369	369	<1	<1	450.2	<1.2	84	614	30	18	384	43	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
AB SEAM	C007P2	4/10/2011	205	205	<1	<1	250.1	<1.2	558	5460	234	52	2740	-	554	170	168	0.6	<1	<2	<2	<2	<2	<0.05	<0.1	0.23	0.79	0.5	0.37	<0.02	<0.02	<0.02	<5	<5
		10/11/2011	264	264	<1	<1	322.1	<1.2	453	5230	267	66	2590	465	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.02	0.02	0.02	<5	<5
	C007P2	10/11/2011	251	251	<1	<1	306.2	<1.2	486	4350	270	66	2620	473	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C008P2	3/10/2011	552	515	36	<1	628.3	43.21	35	755	19	20	732	-	66	33.7	35.7	2.8	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		12/11/2011	585	585	<1	<1	713.7	<1.2	38	683	21	20	577	31	-	-	-	-	2	<2	5	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.02	0.03	0.02	<5	<5
	C014P2	4/10/2011	390	360	30	<1	439.2	36.01	20	398	6	25	415	-	3	19.1	20.2	2.77	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.17	0.18	0.18	<5	<5
		12/11/2011	406	216	190	<1	263.5	228	3	406	3	33	374	<1	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.05	0.06	0.06	<5	<5
	C016P2	2/10/2011	314	<1	274	40	<1.22	328.9	5	735	<1	119	573	-	153	30.2	28.2	3.4	<1	<2	8	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.04	0.04	0.03	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		13/11/2011	527	<1	306	221	<1.22	367.3	4	659	<1	182	520	21	-	-	-	-	<1	<2	3	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.03	0.03	0.03	<5	<5
	C018P2	2/10/2011	221	221	<1	<1	269.6	<1.2	45	578	43	18	359	-	14	21	21.9	1.97	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		9/11/2011	239	239	<1	<1	291.6	<1.2	47	659	47	25	337	20	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C018P2	9/11/2011	246	246	<1	<1	300.1	<1.2	43	586	40	25	306	17	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C020P2	3/10/2011	225	225	<1	<1	274.5	<1.2	15	411	3	4	374	-	24	16.6	17.4	2.26	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.05	0.05	0.05	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14/11/2011	257	257	<1	<1	313.5	<1.2	16	406	3	5	310	16	-	-	-	-	<1	<2	4	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.04	0.05	0.05	<5	<5
	C032P2	5/10/2011	336	336	<1	<1	409.9	<1.2	24	229	6	20	257	-	5	13.3	13.4	0.36	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.04	0.05	0.05	<5	<5
		7/11/2011	535	535	<1	<1	652.7	<1.2	37	934	13	11	294	<1	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C035P2	5/10/2011	119	119	<1	<1	145.2	<1.2	12	404	8	6	280	-	11	14	13.6	1.52	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/11/2011	120	120	<1	<1	146.4	<1.2	13	535	8	7	276	17	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
INTERBURDEN	C006P1	3/10/2011	365	365	<1	<1	445.3	<1.2	244	4800	246	27	2560	-	573	155	144	3.41	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.04	0.04	0.04	<5	<5
		10/11/2011	338	338	<1	<1	412.4	<1.2	311	6240	429	66	3080	497	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C011P1	13/11/2011	669	669	<1	<1	816.2	<1.2	18	539	17	14	565	91	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C034P1	5/10/2011	165	165	<1	<1	201.3	<1.2	62	1220	39	11	842	-	120	40.2	43.2	3.58	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/11/2011	159	159	<1	<1	194	<1.2	59	1200	38	12	862	108	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
D SEAM	C006P3r	3/10/2011	491	485	6	<1	591.7	7.201	9	58	4	4	246	-	1	11.5	11.6	0.44	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		12/11/2011	454	454	<1	<1	553.9	<1.2	9	59	3	5	209	<1	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C006P3r	10/11/2011	458	458	<1	<1	558.8	<1.2	9	56	3	5	197	<1	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C007P3	4/10/2011	487	487	<1	<1	594.1	<1.2	10	61	3	4	297	-	59	12.7	13.8	4.05	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.05	0.05	0.05	<5	<5
		10/11/2011	548	538	9	<1	656.4	10.8	6	49	3	6	253	45	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C011P3	4/10/2011	258	245	13	<1	298.9	15.6	17	164	5	17	180	-	2	9.82	9.52	1.57	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.02	0.03	0.03	<5	<5
		13/11/2011	278	278	<1	<1	339.2	<1.2	22	173	6	14	165	<1	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C018P3	2/10/2011	179	179	<1	<1	218.4	<1.2	22	213	6	9	189	-	13	9.86	10	0.92	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		9/11/2011	188	188	<1	<1	229.4	<1.2	24	211	6	12	156	15	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C018P3	9/11/2011	204	204	<1	<1	248.9	<1.2	23	211	6	13	158	10	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C024P3	6/10/2011	307	307	<1	<1	374.5	<1.2	27	351	51	17	270	-	2	16.1	17.7	4.85	<1	<2	5	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.46	0.49	0.48	<5	<5
		14/11/2011	307	307	<1	<1	374.5	<1.2	23	374	42	17	232	<1	-	-	-	-	<1	<2	4	<2	<2	0.09	<0.1	<0.1	<0.1	<0.05	<0.1	0.34	0.36	0.36	<5	<5
	C034P3	5/10/2011	137	137	<1	<1	167.1	<1.2	32	601	14	15	424	-	51	20.8	21.6	1.93	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/11/2011	108	108	<1	<1	131.8	<1.2	22	478	11	14	295	24	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
UNKNOWN	C066 (line 180-35)	11/11/2011	25	25	<1	<1	30.5	<1.2	3	158	10	6	82	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SURFACE WATER	WQ01	6/10/2011	178	178	<1	<1	217.2	<1.2	13	305	13	26	237	-	9	12.4	12.7	1.36	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		8/11/2011	211	211	<1	<1	257.4	<1.2	14	343	12	30	253	9	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	WQ03	5/10/2011	190	190	<1	<1	231.8	<1.2	14	361	15	27	267	-	7	14.1	14.2	0.38	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		8/11/2011	193	193	<1	<1	235.5	<1.2	14	341	14	30	234	6	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5

Statistical Summary

Number of Results	72	72	72	72	66	66	72	72	72	72	72	40	32	32	32	31	75	75	75	75	75	71	71	71	71	71	71	75	75	75	75	71
Number of Detects	72	70	8	2	64	8	72	72	70	72	72	34	32	32	32	31	1	0	10	0	0	7	0	2	1	1	1	25	25	25	0	0
Minimum Concentration	25	<1	<1	<1	<1.22	<1.2	2	49	<1	2	55	<1	1	2.94	2.87	0.36	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
Minimum Detect	25	25	6	40	30.5	7.201	2	49	3	2	55	6	1	2.94	2.87	0.36	2	ND	3	ND	ND	0.06	ND	0.11	0.79	0.5	0.37	0.02	0.02	0.02	ND	ND
Maximum Concentration	1590	1590	306	221	1940	367.3	558	8430	442	182	5960	686	573	238	221	4.85	2	<2	17	<2	<2	1.45	<0.1	0.23	0.79	0.5	0.37	0.46	0.49	0.48	<5	<5
Maximum Detect	1590	1590	306	221	1940	367.3	558	8430	442	182	5960	686	573	238	221	4.85	2	ND	17	ND	ND	1.45	ND	0.23	0.79	0.5	0.37	0.46	0.49	0.48	ND	ND
Average Concentration	304	288	12	4.1	357	16	75	1432	66	31	876	93	92	50	48	2.3	0.52	1	1.8	1	1	0.051	0.05	0.053	0.06	0.032	0.055	0.04	0.042	0.041	2.5	2.5
Median Concentration	257.5	242	0.5	0.5	295.25	0.6	22.5	544	14.5	14.5	335.5	19	46.5	19.95	20.9	1.97	0.5	1	1	1	1	0.025	0.05	0.05	0.05	0.025	0.05	0.01	0.01	0.01	2.5	2.5
Standard Deviation	228	231	53	26	292	66	137	2163	113	37	1163	162	146	66	62	1.4	0.17	0	2.8	0	0	0.17	0	0.022	0.088	0.056	0.038	0.083	0.087	0.085	0	0
Number of Guideline Exceedances	0	0	0	0	0	0	0	25	0	0	27	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)	0	0	0	0	0	0	0	25	0	0	27	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

MonitoringUnit	WellCode	Sampled_Date-Time	Bromide	Fluoride	Kjeldahl Nitrogen Total	pH (Lab)	Sulphide	TOC	Total Dissolved Solids	Aluminium (Filtered)	Arsenic (Filtered)	Boron (Filtered)	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Cobalt (Filtered)
			Inorganics							Metals					
			mg/L	mg/L	mg/L	pH_Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL			0.005	0.1	0.1	0.01	0.1	1	5	0.01	0.001	0.05	0.0001	0.001	0.001
ANZECC (2000) Livestock				2		6.5 - 8.5			5000	5	0.5	5	0.01	1	1
ALLUVIUM	C027P1	29/09/2011	-	0.9	2.1	7	<0.1	52	3850	0.01	0.013	0.63	-	<0.001	<0.001
		8/11/2011	-	0.6	1.1	6.77	<0.1	<1	4370	<0.01	0.015	0.52	<0.0001	0.004	0.004
		8/11/2011	-	0.7	1.1	6.91	<0.1	<1	4260	<0.01	0.013	0.52	<0.0001	0.004	<0.001
	C029P1	7/11/2011	-	0.9	1.7	7.28	<0.1	<1	20,100	<0.01	0.028	2.56	<0.0001	<0.001	0.003
TERTIARY	C025P2	29/09/2011	6.1	0.8	3.3	7.52	0.4	1	8180	0.03	0.012	1.01	<0.0001	0.005	-
		7/11/2011	-	0.6	1.8	7.07	<0.1	<1	8660	<0.01	0.013	1.01	<0.0001	<0.005	<0.001
	C029P2	29/09/2011	4.95	0.6	-	7.23	0.3	13	6960	<0.01	0.006	0.92	-	<0.001	<0.001
		7/11/2011	-	0.6	0.7	6.96	<0.1	<1	7780	<0.01	0.008	0.84	<0.0001	0.002	0.001
DUNDA BEDS	C027P2	29/09/2011	-	0.5	2	7.25	<0.1	106	805	0.09	0.019	0.22	-	<0.001	0.007
		5/11/2011	-	0.4	0.6	6.79	<0.1	<1	949	0.14	0.012	0.16	<0.0001	0.002	0.002
	C022P1	3/10/2011	0.14	0.3	<0.1	6.76	-	-	301	0.51	<0.001	0.15	<0.0001	<0.001	0.005
		6/10/2011	-	-	-	-	<0.1	<1	-	-	-	-	-	-	-
		14/11/2011	-	0.3	<0.1	6.73	<0.1	2	233	0.23	0.002	0.07	<0.0001	<0.001	0.009
		10/11/2011	-	0.3	0.1	6.39	<0.1	<1	209	0.63	0.001	0.11	<0.0001	0.002	0.007
REWAN	C035P1	5/10/2011	2.42	0.7	0.6	7.22	<0.1	<1	2290	0.08	0.008	0.64	<0.0001	<0.001	<0.001
		6/11/2011	-	0.6	3.9	7.24	<0.1	<1	2990	0.03	0.005	0.54	<0.0001	0.001	<0.001
PERMIAN OVERBURDEN	C008P1	3/10/2011	14.7	0.5	0.2	7.65	<0.1	3	14,900	<0.01	0.002	1.14	0.0003	0.004	0.002
		12/11/2011	-	0.6	0.2	7.23	<0.1	<1	17,200	<0.01	<0.001	1.29	0.0002	0.001	0.004
	C012P1	2/10/2011	1.04	0.3	0.5	7.32	<0.1	-	1170	0.01	<0.001	0.41	<0.0001	<0.001	<0.001
		4/10/2011	-	-	-	-	-	<1	-	-	-	-	-	-	-
		8/11/2011	-	0.3	<0.1	6.43	<0.1	6	1350	<0.01	<0.001	0.32	<0.0001	0.001	<0.001
	C018P1	2/10/2011	0.21	0.6	2.7	7.53	<0.1	-	486	0.07	<0.001	0.19	<0.0001	<0.001	<0.001
		6/10/2011	-	-	-	-	-	<1	-	-	-	-	-	-	-
		8/11/2011	-	0.4	<0.1	6.5	<0.1	<1	541	0.03	<0.001	0.18	<0.0001	0.003	<0.001
AB SEAM	C007P2	4/10/2011	8.3	0.4	6.2	7.56	<0.1	13	10,300	<0.01	0.003	0.41	<0.0001	0.001	0.001
		10/11/2011	-	0.4	2	7.95	5.3	36	10,700	<0.01	0.002	0.51	<0.0001	0.002	<0.001
		10/11/2011	-	0.4	2.1	7.73	6.2	38	10,800	<0.01	0.003	0.49	0.0001	0.002	<0.001
	C008P2	3/10/2011	1.35	0.8	0.9	8.52	5.3	54	1920	0.02	0.004	0.3	<0.0001	<0.001	<0.001
		12/11/2011	-	0.9	1	8.27	0.9	37	1920	0.06	0.008	0.3	<0.0001	0.001	<0.001
	C012P2	2/10/2011	1.3	0.5	<0.1	7.86	-	-	1680	0.01	0.006	0.49	<0.0001	<0.001	<0.001
		4/10/2011	-	-	-	-	0.3	58	-	-	-	-	-	-	-
	C012P2	13/11/2011	-	0.4	0.1	7.75	0.1	32	1560	0.01	0.006	0.4	<0.0001	0.001	<0.001
	C014P2	4/10/2011	0.72	1	1.1	8.61	<0.1	29	1110	<0.01	0.004	0.3	<0.0001	<0.001	0.002
		12/11/2011	-	1	1.6	9.5	<0.1	23	1340	0.42	0.004	0.24	<0.0001	0.001	<0.001
	C016P2	2/10/2011	1.36	0.2	8.3	10.4	4.7	-	1660	0.08	0.004	0.31	<0.0001	<0.001	<0.001
		6/10/2011	-	-	-	-	-	20	-	-	-	-	-	-	-
		13/11/2011	-	0.3	11.7	11.5	1.9	28	1840	0.02	0.003	0.23	<0.0001	<0.001	<0.001
	C018P2	2/10/2011	1.27	0.4	0.6	7.63	0.6	-	1420	<0.01	0.001	0.61	<0.0001	<0.001	<0.001
		6/10/2011	-	-	-	-	-	<1	-	-	-	-	-	-	-
		9/11/2011	-	0.4	<0.1	7.18	0.4	28	1360	<0.01	<0.001	0.5	<0.0001	0.003	<0.001
		9/11/2011	-	0.5	0.4	7.26	0.9	16	1210	<0.01	0.002	0.46	<0.0001	0.003	<0.001
	C020P2	3/10/2011	0.84	0.6	0.6	8.21	-	-	1050	0.1	0.002	0.48	<0.0001	<0.001	<0.001
		6/10/2011	-	-	-	-	<0.1	2	-	-	-	-	-	-	-
		14/11/2011	-	0.6	0.6	8.2	1.5	<1	970	0.04	0.001	0.41	<0.0001	<0.001	<0.001
	C032P2	5/10/2011	0.42	0.6	0.4	8.09	0.2	36	951	0.02	0.005	0.3	<0.0001	<0.001	<0.001
		7/11/2011	-	0.7	2	7.49	<0.1	<1	1540	0.02	0.013	0.3	<0.0001	0.003	<0.001
	C035P2	5/10/2011	0.76	0.3	0.2	7.15	0.1	1	851	0.35	<0.001	0.24	<0.0001	<0.001	<0.001
		6/11/2011	-	0.3	<0.1	7.02	<0.1	11	1180	5.66	<0.001	0.2	<0.0001	0.005	<0.001
INTERBURDEN	C006P1	3/10/2011	7.9	0.7	0.5	7.74	0.2	58	8960	<0.01	0.011	1.05	<0.0001	0.004	<0.001
		10/11/2011	-	0.6	0.2	7.16	0.2	18	11,900	<0.01	0.01	1.3	<0.0001	0.004	0.005
	C011P1	13/11/2011	-	0.8	0.2	8.17	<0.1	31	1900	0.07	0.002	0.9	<0.0001	0.002	0.001
	C034P1	5/10/2011	2.78	0.7	0.2	7.03	<0.1	1	2870	0.01	0.005	0.6	<0.0001	<0.001	0.001
		6/11/2011	-	0.7	<0.1	7	<0.1	<1	2810	0.01	0.003	0.51	<0.0001	0.001	<0.001
D SEAM	C006P3r	3/10/2011	0.17	2.2	0.4	8.32	<0.1	12	587	0.14	0.004	0.18	<0.0001	<0.001	<0.001
		12/11/2011	-	2.4	0.4	8.18	<0.1	<1	620	0.13	0.003	0.12	<0.0001	0.001	<0.001
		10/11/2011	-	2.2	0.5	8.04	<0.1	13	568	0.1	0.003	0.13	<0.0001	0.003	<0.001
	C007P3	4/10/2011	0.14	2.6	0.7	8.23	0.2	33	809	0.32	0.004	0.22	<0.0001	<0.001	<0.001
		10/11/2011	-	2.6	0.4	8.31	1.3	38	760	0.22	0.003	0.22	<0.0001	<0.001	<0.001
	C011P3	4/10/2011	0.42	1.2	1.1	8.45	<0.1	8	568	<0.01	0.004	0.41	<0.0001	<0.001	0.002
		13/11/2011	-	1.2	0.3	8.01	<0.1	<1	608	0.02	0.002	0.35	<0.0001	<0.001	<0.001
	C018P3	2/10/2011	0.48	1.2	0.8	7.81	<0.1	-	651	0.05	0.002	0.35	<0.0001	<0.001	0.001
		6/10/2011	-	-	-	-	-	<1	-	-	-	-	-	-	-
	C018P3	9/11/2011	-	1.2	0.2	7.35	<0.1	2	523	0.05	0.001	0.29	<0.0001	0.002	<0.001
		9/11/2011	-	1.2	0.3	7.51	0.1	5	554	0.06	0.001	0.28	<0.0001	0.002	<0.001
	C024P3	6/10/2011	1.28	0.4	0.8	6.52	0.4	108	1150	<0.01	0.007	0.3	<0.0001	<0.001	0.001
		14/11/2011	-	0.4	0.4	7.12	1	47	1050	<0.01	0.004	0.28	<0.0001	0.001	<0.001
	C034P3	5/10/2011	1.29	0.5	0.2	7.23	<0.1	<1	1260	<0.01	0.002	0.26	<0.0001	<0.001	<0.001
		6/11/2011	-	0.3	<0.1	6.96	<0.1	<1	1020	<0.01	<0.001	<0.05	<0.0001	<0.001	<0.001
UNKNOWN	C066 (line 180-35)	11/11/2011	-	0.1	0.1	6.51	<0.1	-	396	0.58	<0.001	0.05	<0.0001	<0.001	0.003
SURFACE WATER	WQ01	6/10/2011	0.931	0.5	0.3	7.79	<0.1	11	703	0.13	<0.001	0.13	<0.0001	<0.001	<0.001
		8/11/2011	-	0.6	0.5	7.91	<0.1	5	1340	0.12	0.001	0.12	<0.0001	0.002	<0.001
	WQ03	5/10/2011	0.55	0.5	0.5	8.07	<0.1	8	859	0.1	<0.001	0.15	<0.0001	<0.001	<0.001
		8/11/2011	-	0.5	0.6	8.04	<0.1	1	1350	0.17	<0.001	0.14	<0.0001	<0.001	<0.001

MonitoringUnit	WellCode	Sampled_Date-Time	Copper (Filtered)	Iron (Filtered)	Lead (Filtered)	Manganese (Filtered)	Mercury (Filtered)	Molybdenum (Filtered)	Nickel (Filtered)	Selenium (Filtered)	Silver (Filtered)	Uranium (Filtered)	Vanadium (Filtered)	Zinc (Filtered)	Ammonia as N	Nitrate (as N)	Nitrite (as N)	Nitrogen (Total Oxidised)	Nitrogen (Total)	Phosphorus
			Metals												Nutrients					
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL			0.001	0.05	0.001	0.001	0.0001	0.001	0.001	0.01	0.001	0.001	0.01	0.005	0.01	0.01	0.01	0.01	0.1	0.01
ANZECC (2000) Livestock			0.5			0.1	0.002	0.05	1	0.02		0.200		20		400	30			
ALLUVIUM	C027P1	29/09/2011	<0.001	16	<0.001	4.49	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	0.01	0.006	0.53	0.01	0.02	0.03	2.1	0.21
		8/11/2011	0.001	29.3	<0.001	4.43	<0.0001	<0.001	0.012	<0.01	<0.001	<0.001	<0.01	0.019	0.88	0.01	<0.01	0.01	1.1	<0.01
		8/11/2011	<0.001	27.4	<0.001	4.55	<0.0001	<0.001	0.015	<0.01	<0.001	<0.001	<0.01	0.01	0.93	0.02	<0.01	0.02	1.2	<0.01
	C029P1	7/11/2011	0.006	5.62	<0.001	4.81	<0.0001	0.001	0.076	<0.01	<0.001	0.05	0.02	0.013	1.35	0.01	<0.01	0.01	1.7	0.15
TERTIARY	C025P2	29/09/2011	<0.001	-	<0.001	1.16	<0.0001	0.001	<0.001	0.05	<0.001	0.002	0.01	0.006	0.63	0.03	<0.01	0.03	3.3	0.38
		7/11/2011	0.002	24.5	<0.001	2.19	<0.0001	<0.001	0.001	0.01	<0.001	<0.001	0.01	0.006	1.38	0.16	<0.01	0.16	2	0.12
	C029P2	29/09/2011	<0.001	1.74	<0.001	0.448	<0.0001	0.001	0.001	<0.01	<0.001	<0.001	<0.01	0.006	-	-	-	-	-	-
		7/11/2011	0.001	6.33	<0.001	0.655	<0.0001	<0.001	0.005	<0.01	<0.001	<0.001	<0.01	0.011	0.42	0.01	<0.01	0.01	0.7	0.21
DUNDA BEDS	C027P2	29/09/2011	<0.001	24.9	<0.001	1.78	<0.0001	<0.001	0.004	<0.01	<0.001	<0.001	<0.01	0.009	0.97	0.01	<0.01	0.01	2	0.19
		5/11/2011	<0.001	11.3	<0.001	0.883	<0.0001	<0.001	0.01	<0.01	<0.001	<0.001	<0.01	0.01	0.42	0.02	<0.01	0.02	0.6	0.02
	C022P1	3/10/2011	<0.001	0.5	<0.001	0.099	<0.0001	<0.001	0.006	<0.01	<0.001	<0.001	<0.01	0.011	0.02	0.03	<0.01	0.03	<0.1	0.07
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14/11/2011	<0.001	2.67	<0.001	0.2	<0.0001	<0.001	0.006	<0.01	<0.001	<0.001	<0.01	0.028	0.04	0.03	<0.01	0.03	<0.1	<0.01
		10/11/2011	<0.001	0.76	<0.001	0.083	<0.0001	<0.001	0.006	<0.01	<0.001	<0.001	<0.01	0.014	0.05	0.02	<0.01	0.02	0.1	<0.01
REWAN	C035P1	5/10/2011	<0.001	2.04	<0.001	0.256	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.1	0.05	<0.01	0.05	0.6	0.15
		6/11/2011	<0.001	0.68	<0.001	0.218	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	0.006	0.12	0.02	<0.01	0.02	3.9	1.99
PERMIAN OVERBURDEN	C008P1	3/10/2011	0.002	0.29	<0.001	0.181	<0.0001	<0.001	0.008	0.02	0.003	0.019	<0.01	0.014	0.14	0.02	<0.01	0.02	0.2	0.04
		12/11/2011	0.011	0.06	<0.001	1.6	<0.0001	<0.001	0.015	<0.01	0.003	0.018	<0.01	0.118	0.15	<0.01	<0.01	<0.01	0.2	<0.01
	C012P1	2/10/2011	<0.001	<0.05	<0.001	0.182	<0.0001	<0.001	0.001	<0.01	0.001	<0.001	<0.01	0.012	0.2	0.03	0.01	0.04	0.5	0.33
		4/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		8/11/2011	0.002	0.05	<0.001	0.173	<0.0001	<0.001	0.006	<0.01	<0.001	<0.001	<0.01	0.037	0.02	0.05	<0.01	0.05	<0.1	<0.01
	C018P1	2/10/2011	<0.001	<0.05	<0.001	0.006	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	0.012	0.1	0.03	0.06	0.09	2.8	0.07
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		8/11/2011	<0.001	<0.05	<0.001	0.013	<0.0001	<0.001	0.003	<0.01	<0.001	<0.001	<0.01	0.031	0.03	0.08	<0.01	0.08	<0.1	<0.01
AB SEAM	C007P2	4/10/2011	0.002	0.24	<0.001	0.445	<0.0001	0.008	<0.001	<0.01	0.004	0.003	<0.01	<0.005	3.07	0.03	<0.01	0.03	6.2	1.73
		10/11/2011	0.001	0.1	<0.001	0.304	<0.0001	0.001	<0.001	<0.01	<0.001	0.002	<0.01	0.005	2.43	0.02	<0.01	0.02	2	<0.01
		10/11/2011	0.001	0.16	<0.001	0.285	<0.0001	<0.001	<0.001	<0.01	0.003	0.002	<0.01	<0.005	2.48	0.01	<0.01	0.01	2.1	0.04
	C008P2	3/10/2011	<0.001	<0.05	<0.001	0.263	<0.0001	0.005	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.9	0.02	<0.01	0.02	0.9	0.18
		12/11/2011	0.001	0.06	<0.001	0.361	<0.0001	<0.001	0.002	<0.01	<0.001	<0.001	<0.01	0.019	0.85	0.01	<0.01	0.01	1	<0.01
	C012P2	2/10/2011	<0.001	1.62	<0.001	1.32	<0.0001	0.001	<0.001	<0.01	<0.001	0.001	<0.01	<0.005	0.04	0.02	<0.01	0.02	<0.1	<0.01
		4/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	C012P2	13/11/2011	<0.001	1.26	<0.001	0.924	<0.0001	<0.001	0.003	<0.01	<0.001	<0.001	<0.01	0.034	0.04	0.02	<0.01	0.02	0.1	<0.01
	C014P2	4/10/2011	<0.001	0.38	<0.001	0.084	<0.0001	0.009	0.003	<0.01	<0.001	<0.001	<0.01	<0.005	0.82	0.02	<0.01	0.02	1.1	<0.01
		12/11/2011	<0.001	0.18	<0.001	0.002	<0.0001	0.012	0.002	<0.01	<0.001	<0.001	<0.01	0.007	0.98	0.02	<0.01	0.02	1.6	0.28
	C016P2	2/10/2011	<0.001	<0.05	<0.001	<0.001	<0.0001	0.01	<0.001	<0.01	<0.001	<0.001	<0.01	0.006	4.93	0.02	<0.01	0.02	8.3	0.51
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		13/11/2011	<0.001	0.05	<0.001	0.001	<0.0001	0.013	<0.001	<0.01	<0.001	<0.001	<0.01	0.005	4.32	0.02	<0.01	0.02	11.7	<0.01
	C018P2	2/10/2011	<0.001	1.13	<0.001	0.051	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	0.007	0.03	0.02	<0.01	0.02	0.6	0.3
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		9/11/2011	<0.001	0.98	<0.001	0.03	<0.0001	<0.001	0.003	<0.01	<0.001	<0.001	<0.01	0.009	0.1	0.02	<0.01	0.02	<0.1	0.21
		9/11/2011	<0.001	0.57	<0.001	0.06	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.31	0.02	<0.01	0.02	0.4	0.23
	C020P2	3/10/2011	<0.001	0.06	<0.001	0.037	<0.0001	0.004	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.04	0.03	<0.01	0.03	0.6	0.23
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14/11/2011	<0.001	<0.05	<0.001	0.041	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.52	0.02	<0.01	0.02	0.6	<0.01
	C032P2	5/10/2011	<0.001	0.33	<0.001	0.264	<0.0001	0.018	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.05	0.03	<0.01	0.03	0.4	0.12
		7/11/2011	<0.001	1.4	<0.001	0.464	<0.0001	0.01	0.002	<0.01	<0.001	<0.001	<0.01	0.005	0.71	0.01	<0.01	0.01	2	0.74
	C035P2	5/10/2011	0.002	1.01	<0.001	0.136	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.04	0.05	<0.01	0.05	0.2	0.06
		6/11/2011	0.001	2.24	<0.001	0.128	<0.0001	<0.001	0.003	<0.01	<0.001	<0.001	<0.01	0.01	0.07	0.03	<0.01	0.03	<0.1	<0.01
INTERBURDEN	C006P1	3/10/2011	<0.001	1.9	<0.001	0.891	<0.0001	0.029	0.002	<0.01	<0.001	0.014	<0.01	0.006	0.46	0.02	<0.01	0.02	0.5	0.04
		10/11/2011	0.001	3.85	<0.001	0.687	<0.0001	0.005	0.004	<0.01	<0.001	0.014	<0.01	0.008	0.27	0.02	<0.01	0.02	0.2	<0.01
	C011P1	13/11/2011	<0.001	<0.05	<0.001	0.113	<0.0001	0.007	0.009	<0.01	<0.001	0.004	<0.01	0.023	0.12	0.05	<0.01	0.05	0.2	<0.01
	C034P1	5/10/2011	<0.001	3.24	<0.001	0.204	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.06	0.06	<0.01	0.06	0.3	0.05
		6/11/2011	<0.001	1.3	<0.001	0.141	<0.0001	<0.001	0.001	<0.01	<0.001	<0.001	<0.01	0.01	0.08	0.01	<0.01	0.01	<0.1	<0.01
D SEAM	C006P3r	3/10/2011	<0.001	0.8	<0.001	0.046	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.34	0.02	<0.01	0.02	0.4	0.08
		12/11/2011	<0.001	0.41	<0.001	0.038	<0.0001	0.002	0.003	<0.01	<0.001	<0.001	<0.01	0.009	0.31	<0.01	<0.01	<0.01	0.4	0.21
		10/11/2011	<0.001	0.44	<0.001	0.036	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.33	0.02	<0.01	0.02	0.5	0.02
	C007P3	4/10/2011	0.004	0.18	<0.001	0.052	<0.0001	0.019	<0.001	<0.01	<0.001	0.002	<0.01	<0.005	0.3	0.01	<0.01	0.01	0.7	0.14
		10/11/2011	<0.001	0.12	<0.001	0.042	<0.0001	0.019	<0.001	<0.01	<0.001	0.002	<0.01	0.01	0.43	0.02	<0.01	0.02	0.4	0.05
	C011P3	4/10/2011	<0.001	2.59	<0.001	0.218	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.21	0.03	<0.01	0.03	1.1	0.57
		13/11/2011	<0.001	0.88	<0.001	0.09	<0.0001	0.002	0.001	<0.01	<0.001	<0.001	<0.01	0.01	0.29	0.02	<0.01	0.02	0.3	<0.01
	C018P3	2/10/2011	<0.001	0.59	<0.001	0.122	<0.0001	0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.32	0.03	<0.01	0.03	0.8	0.09
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	C018P3	9/11/2011	<0.001	0.89	<0.001	0.09	<0.0001	<0.001	0.002	<0.01	<0.001	<0.001	<0.01	0.014	0.21	0.02	<0.01	0.02	0.2	0.05
		9/11/2011	<0.001	0.4	<0.001	0.109	<0.0001	0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.06	0.02	<0.01	0.02	0.3	0.07
	C024P3	6/10/2011	<0.001	14.8	<0.001	0.261	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	<0.01	<0.01	<0.01	<0.01	0.8	0.07
		14/11/2011	0.002	8.37	<0.001	0.236	<0.0001	<0.001	0.009	<0.01	<0.001	<0.001	<0.01	0.044	0.02	<0.01	<0.01	<0.01	0.4	<0.01
	C034P3	5/10/2011	<0.001	1.2	<0.001	0.23	<0.0001	0.006	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.14	0.08	<0.01	0.08	0.3	0.07
		6/11/2011	<0.001	<0.05	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.09	0.02	<0.01	0.02	<0.1	<0.01
UNKNOWN	C066 (line 180-35)	11/11/2011	<0.001	0.32	<0.001	0.048	<0.0001	<0.001	0.004	<0.01	<0.001	<0.001	<0.01	0.026	0.05	0.2	<0.01	0.2	0.3	<0.01
SURFACE WATER	WQ01	6/10/2011	<0.001	0.85	<0.001	0.184	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.03	0.02	<0.01	0.02	0.3	0.05
		8/11/2011	<0.001	0.82	<0.001	0.2	<0.0001	<0.001	0.001	<0.01	<0.001	<0.001	<0.01	0.022	0.04	0.01	<0.01	0.01	0.5	<0.01
	WQ03	5/10/2011	0.003	0.5	<0.001	0.055	<0.0001	<0.001	0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.03	0.04	<0.01	0.04	0.5	0.04
		8/11/2011	0.002	0.72	<0.001	0.298	<0.0001	<0.001	0.001	<0.01	<0.001	<0.001	<0.01	<0.005	0.03	0.02	<0.01	0.02	0.6	<0.01

Statistical Summary

	Bromide	Fluoride	Kjeldahl Nitrogen Total	pH (Lab)	Sulphide	TOC	Total Dissolved Solids	Aluminium (Filtered)	Arsenic (Filtered)	Boron (Filtered)	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Cobalt (Filtered)
Number of Results	26	65	64	65	65	64	65	65	65	65	62	65	64
Number of Detects	26	65	55	65	23	41	65	42	51	64	3	31	19
Minimum Concentration	0.14	0.1	<0.1	6.39	<0.1	<1	209	<0.01	<0.001	<0.05	<0.0001	<0.001	<0.001
Minimum Detect	0.14	0.1	0.1	6.39	0.1	1	209	0.01	0.001	0.05	0.0001	0.001	0.001
Maximum Concentration	14.7	2.6	11.7	11.5	6.2	108	20,100	5.66	0.028	2.56	0.0003	0.005	0.009
Maximum Detect	14.7	2.6	11.7	11.5	6.2	108	20,100	5.66	0.028	2.56	0.0003	0.005	0.009
Average Concentration	2.4	0.73	1.1	7.6	0.53	16	3181	0.17	0.0047	0.45	0.000057	0.0014	0.0013
Median Concentration	1.155	0.6	0.5	7.51	0.05	5	1340	0.02	0.003	0.31	0.00005	0.0005	0.0005
Standard Deviation	3.4	0.55	1.9	0.87	1.3	24	4356	0.71	0.0053	0.4	0.000037	0.0013	0.0018
Number of Guideline Exceedances	0	5	0	7	0	0	12	1	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)	0	5	0	7	0	0	12	1	0	0	0	0	0

	Copper (Filtered)	Iron (Filtered)	Lead (Filtered)	Manganese (Filtered)	Mercury (Filtered)	Molybdenum (Filtered)	Nickel (Filtered)	Selenium (Filtered)	Silver (Filtered)	Uranium (Filtered)	Vanadium (Filtered)	Zinc (Filtered)	Ammonia as N	Nitrate (as N)	Nitrite (as N)	Nitrogen (Total Oxidised)	Nitrogen (Total)	Phosphorus
Number of Results	65	64	65	65	65	65	65	65	65	65	65	65	64	64	64	64	64	64
Number of Detects	18	56	0	63	0	28	35	3	5	13	4	41	63	60	3	60	55	40
Minimum Concentration	<0.001	<0.05	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005	<0.01	<0.01	<0.01	<0.01	<0.1	<0.01
Minimum Detect	0.001	0.05	ND	0.001	ND	0.001	0.001	0.01	0.001	0.001	0.01	0.005	0.02	0.01	0.01	0.01	0.1	0.02
Maximum Concentration	0.011	29.3	<0.001	4.81	<0.0001	0.029	0.076	0.05	0.004	0.05	0.02	0.118	4.93	0.2	0.06	0.2	11.7	1.99
Maximum Detect	0.011	29.3	ND	4.81	ND	0.029	0.076	0.05	0.004	0.05	0.02	0.118	4.93	0.2	0.06	0.2	11.7	1.99
Average Concentration	0.0011	3.3	0.0005	0.58	0.00005	0.0033	0.0038	0.006	0.00068	0.0024	0.0055	0.011	0.55	0.029	0.0062	0.03	1.1	0.16
Median Concentration	0.0005	0.74	0.0005	0.184	0.00005	0.0005	0.001	0.005	0.0005	0.0005	0.005	0.006	0.205	0.02	0.005	0.02	0.5	0.05
Standard Deviation	0.0016	6.8	0	1.1	0	0.0057	0.0097	0.0059	0.00068	0.0071	0.0021	0.016	0.96	0.032	0.0071	0.032	1.9	0.34
Number of Guideline Exceedances	0	0	0	42	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)	0	0	0	42	0	0	0	1	0	0	0	0	0	0	0	0	0	0

			Alkalinity						Major Ions										BTEX & MAH					TPH									PAH	
			Alkalinity (total) as CaCO3	Alkalinity (Bicarbonate as CaCO3)	Alkalinity (Carbonate as CaCO3)	Alkalinity (Hydroxide) as CaCO3	Bicarbonate	Carbonate	Calcium (Filtered)	Chloride	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Sulphate	Sulphate (Filtered)	Anions Total	Cations Total	Ionic Balance	Benzene	Ethylbenzene	Toluene	Xylene (o)	Xylene Total	TPH C10 - C14 Fraction	TPH C10 - C16 Fraction	TPH C15 - C28 Fraction	TPH C16 - C34 Fraction	TPH C29 - C36 Fraction	TPH C34 - C40 Fraction	TPH C6 - C 9 Fraction	TPH C6 - C10 Fraction	TPH C6 - C10 Fraction minus BTEX	Naphthalene	PAHs (Sum of Total) - Calc
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	%	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L
EQL			1	1	1	1			1	1	1	1	1	1	1	0.01	0.01	0.01	1	2	2	2	2	0.05	0.1	0.1	0.1	0.05	0.1	0.02	0.02	0.02	5	
ANZECC (2000) Livestock									1000					1000					1.000	300	800		600											
MonitoringUnit	**WellCode**	**Sampled_Date-Time**																																
ALLUVIUM	C027P1	29/09/2011	582	582	<1	<1	710	<1.2	27	1580	111	52	1070	-	66	57.6	58.4	0.65	<1	<2	<2	<2	<2	1.45	<0.1	<0.1	<0.1	<0.05	<0.1	0.35	0.34	0.34	<5	<5
		8/11/2011	460	460	<1	<1	561.2	<1.2	26	1420	114	58	1080	141	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.09	0.1	0.1	<5	<5
		8/11/2011	480	480	<1	<1	585.6	<1.2	26	1210	113	57	1080	107	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	0.11	<0.1	<0.05	<0.1	0.06	0.07	0.07	<5	<5
	C029P1	7/11/2011	1590	1590	<1	<1	1940	<1.2	87	8430	362	177	5960	686	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
TERTIARY	C025P2	29/09/2011	746	746	<1	<1	910.1	<1.2	107	4570	134	79	2700	-	54	145	136	3.26	<1	<2	16	<2	<2	0.06	<0.1	<0.1	<0.1	<0.05	<0.1	0.31	0.33	0.31	<5	<5
		7/11/2011	763	763	<1	<1	930.9	<1.2	130	3670	130	74	2680	10	-	-	-	-	<1	<2	6	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.06	0.06	0.05	<5	<5
	C029P2	29/09/2011	259	259	<1	<1	316	<1.2	100	3950	118	58	2280	-	259	122	115	2.81	<1	<2	<2	<2	<2	0.11	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		7/11/2011	274	274	<1	<1	334.3	<1.2	95	3740	122	75	2180	246	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
DUNDA BEDS	C027P2	29/09/2011	128	128	<1	<1	156.2	<1.2	4	186	9	10	161	-	8	7.97	8.2	1.38	<1	<2	<2	<2	<2	0.1	<0.1	<0.1	<0.1	<0.05	<0.1	0.09	0.1	0.1	<5	<5
		5/11/2011	180	180	<1	<1	219.6	<1.2	3	199	10	12	175	14	-	-	-	-	<1	<2	17	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.03	0.04	0.02	<5	<5
	C022P1	3/10/2011	36	36	<1	<1	43.92	<1.2	2	67	4	2	55	-	16	2.94	2.87	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.04	0.04	0.04	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14/11/2011	47	47	<1	<1	57.34	<1.2	3	70	4	3	56	18	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		10/11/2011	45	45	<1	<1	54.9	<1.2	2	77	4	3	57	16	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.02	0.02	0.02	<5	<5
REWAN	C035P1	5/10/2011	175	175	<1	<1	213.5	<1.2	21	1070	18	6	822	-	60	34.9	38.4	4.76	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/11/2011	171	171	<1	<1	208.6	<1.2	20	909	18	6	744	50	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
PERMIAN OVERBURDEN	C008P1	3/10/2011	316	316	<1	<1	385.5	<1.2	505	7950	402	90	3680	-	282	236	221	3.46	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		12/11/2011	298	298	<1	<1	363.6	<1.2	468	7530	442	115	3810	275	-	-	-	-	<1	<2	<2	<2	<2	0.13	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C012P1	2/10/2011	84	84	<1	<1	102.5	<1.2	26	549	29	11	334	-	56	18.3	18.5	0.43	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		4/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		8/11/2011	82	82	<1	<1	100	<1.2	31	551	33	13	301	51	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C018P1	2/10/2011	100	100	<1	<1	122	<1.2	7	141	6	12	128	-	41	6.83	6.72	0.85	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		8/11/2011	83	83	<1	<1	101.3	<1.2	7	255	7	10	134	39	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
AB SEAM	C007P2	4/10/2011	205	205	<1	<1	250.1	<1.2	558	5460	234	52	2740	-	554	170	168	0.6	<1	<2	<2	<2	<2	<0.05	<0.1	0.23	0.79	0.5	0.37	<0.02	<0.02	<0.02	<5	<5
		10/11/2011	264	264	<1	<1	322.1	<1.2	453	5230	267	66	2590	465	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.02	0.02	0.02	<5	<5
		10/11/2011	251	251	<1	<1	306.2	<1.2	486	4350	270	66	2620	473	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C008P2	3/10/2011	552	515	36	<1	628.3	43.21	35	755	19	20	732	-	66	33.7	35.7	2.8	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		12/11/2011	585	585	<1	<1	713.7	<1.2	38	683	21	20	577	31	-	-	-	-	2	<2	5	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.02	0.03	0.02	<5	<5
	C012P2	2/10/2011	276	276	<1	<1	336.7	<1.2	78	631	25	12	442	-	49	24.3	25.5	2.29	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		4/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	C012P2	13/11/2011	369	369	<1	<1	450.2	<1.2	84	614	30	18	384	43	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C014P2	4/10/2011	390	360	30	<1	439.2	36.01	20	398	6	25	415	-	3	19.1	20.2	2.77	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.17	0.18	0.18	<5	<5
		12/11/2011	406	216	190	<1	263.5	228	3	406	3	33	374	<1	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.05	0.06	0.06	<5	<5
	C016P2	2/10/2011	314	<1	274	40	<1.22	328.9	5	735	<1	119	573	-	153	30.2	28.2	3.4	<1	<2	8	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.04	0.04	0.03	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		13/11/2011	527	<1	306	221	<1.22	367.3	4	659	<1	182	520	21	-	-	-	-	<1	<2	3	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.03	0.03	0.03	<5	<5
	C018P2	2/10/2011	221	221	<1	<1	269.6	<1.2	45	578	43	18	359	-	14	21	21.9	1.97	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		9/11/2011	239	239	<1	<1	291.6	<1.2	47	659	47	25	337	20	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		9/11/2011	246	246	<1	<1	300.1	<1.2	43	586	40	25	306	17	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C020P2	3/10/2011	225	225	<1	<1	274.5	<1.2	15	411	3	4	374	-	24	16.6	17.4	2.26	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.05	0.05	0.05	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14/11/2011	257	257	<1	<1	313.5	<1.2	16	406	3	5	310	16	-	-	-	-	<1	<2	4	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.04	0.05	0.05	<5	<5
	C032P2	5/10/2011	336	336	<1	<1	409.9	<1.2	24	229	6	20	257	-	5	13.3	13.4	0.36	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.04	0.05	0.05	<5	<5
		7/11/2011	535	535	<1	<1	652.7	<1.2	37	934	13	11	294	<1	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C035P2	5/10/2011	119	119	<1	<1	145.2	<1.2	12	404	8	6	280	-	11	14	13.6	1.52	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/11/2011	120	120	<1	<1	146.4	<1.2	13	535	8	7	276	17	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
INTERBURDEN	C006P1	3/10/2011	365	365	<1	<1	445.3	<1.2	244	4800	246	27	2560	-	573	155	144	3.41	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.04	0.04	0.04	<5	<5
		10/11/2011	338	338	<1	<1	412.4	<1.2	311	6240	429	66	3080	497	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C011P1	13/11/2011	669	669	<1	<1	816.2	<1.2	18	539	17	14	565	91	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C034P1	5/10/2011	165	165	<1	<1	201.3	<1.2	62	1220	39	11	842	-	120	40.2	43.2	3.58	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/11/2011	159	159	<1	<1	194	<1.2	59	1200	38	12	862	108	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
D SEAM	C006P3r	3/10/2011	491	485	6	<1	591.7	7.201	9	58	4	4	246	-	1	11.5	11.6	0.44	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		12/11/2011	454	454	<1	<1	553.9	<1.2	9	59	3	5	209	<1	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		10/11/2011	458	458	<1	<1	558.8	<1.2	9	56	3	5	197	<1	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C007P3	4/10/2011	487	487	<1	<1	594.1	<1.2	10	61	3	4	297	-	59	12.7	13.8	4.05	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.05	0.05	0.05	<5	<5
		10/11/2011	548	538	9	<1	656.4	10.8	6	49	3	6	253	45	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C011P3	4/10/2011	258	245	13	<1	298.9	15.6	17	164	5	17	180	-	2	9.82	9.52	1.57	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.02	0.03	0.03	<5	<5
		13/11/2011	278	278	<1	<1	339.2	<1.2	22	173	6	14	165	<1	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C018P3	2/10/2011	179	179	<1	<1	218.4	<1.2	22	213	6	9	189	-	13	9.86	10	0.92	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/10/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	C018P3	9/11/2011	188	188	<1	<1	229.4	<1.2	24	211	6	12	156	15	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		9/11/2011	204	204	<1	<1	248.9	<1.2	23	211	6	13	158	10	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	C024P3	6/10/2011	307	307	<1	<1	374.5	<1.2	27	351	51	17	270	-	2	16.1	17.7	4.85	<1	<2	5	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	0.46	0.49	0.48	<5	<5
		14/11/2011	307	307	<1	<1	374.5	<1.2	23	374	42	17	232	<1	-	-	-	-	<1	<2	4	<2	<2	0.09	<0.1	<0.1	<0.1	<0.05	<0.1	0.34	0.36	0.36	<5	<5
	C034P3	5/10/2011	137	137	<1	<1	167.1	<1.2	32	601	14	15	424	-	51	20.8	21.6	1.93	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		6/11/2011	108	108	<1	<1	131.8	<1.2	22	478	11	14	295	24	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
UNKNOWN	C066 (line 180-35)	11/11/2011	25	25	<1	<1	30.5	<1.2	3	158	10	6	82	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SURFACE WATER	WQ01	6/10/2011	178	178	<1	<1	217.2	<1.2	13	305	13	26	237	-	9	12.4	12.7	1.36	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		8/11/2011	211	211	<1	<1	257.4	<1.2	14	343	12	30	253	9	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
	WQ03	5/10/2011	190	190	<1	<1	231.8	<1.2	14	361	15	27	267	-	7	14.1	14.2	0.38	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
		8/11/2011	193	193	<1	<1	235.5	<1.2	14	341	14	30	234	6	-	-	-	-	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5

Statistical Summary

Number of Results	65	65	65	65	65	65	65	65	65	65	65	37	28	28	28	27	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64
Number of Detects	65	63	8	2	63	8	65	65	63	65	65	31	28	28	28	27	1	0	9	0	0	6	0	2	1	1	1	23	23	23	0	0
Minimum Concentration	25	<1	<1	<1	<1.22	<1.2	2	49	<1	2	55	<1	1	2.94	2.87	0.36	<1	<2	<2	<2	<2	<0.05	<0.1	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
Minimum Detect	25	25	6	40	30.5	7.201	2	49	3	2	55	6	1	2.94	2.87	0.36	2	ND	3	ND	ND	0.06	ND	0.11	0.79	0.5	0.37	0.02	0.02	0.02	ND	ND
Maximum Concentration	1590	1590	306	221	1940	367.3	558	8430	442	182	5960	686	573	236	221	4.85	2	<2	17	<2	<2	1.45	<0.1	0.23	0.79	0.5	0.37	0.46	0.49	0.48	<5	<5
Maximum Detect	1590	1590	306	221	1940	367.3	558	8430	442	182	5960	686	573	236	221	4.85	2	ND	17	ND	ND	1.45	ND	0.23	0.79	0.5	0.37	0.46	0.49	0.48	ND	ND
Average Concentration	311	294	14	4.5	359	16	73	1405	65	32	869	97	91	46	45	2.2	0.52	1	1.9	1	1	0.053	0.05	0.054	0.062	0.032	0.055	0.044	0.047	0.045	2.5	2.5
Median Concentration	258	245	0.5	0.5	298.9	0.6	23	539	14	17	334	20	45	18.7	19.35	1.97	0.5	1	1	1	1	0.025	0.05	0.05	0.05	0.025	0.05	0.01	0.01	0.01	2.5	2.5
Standard Deviation	238	241	55	28	294	66	133	2107	110	38	1165	168	151	60	57	1.4	0.19	0	3	0	0	0.18	0	0.024	0.092	0.059	0.04	0.089	0.093	0.091	0	0
Number of Guideline Exceedances	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix F

Slug Testing

Slug Testing Analysis Data Sheets

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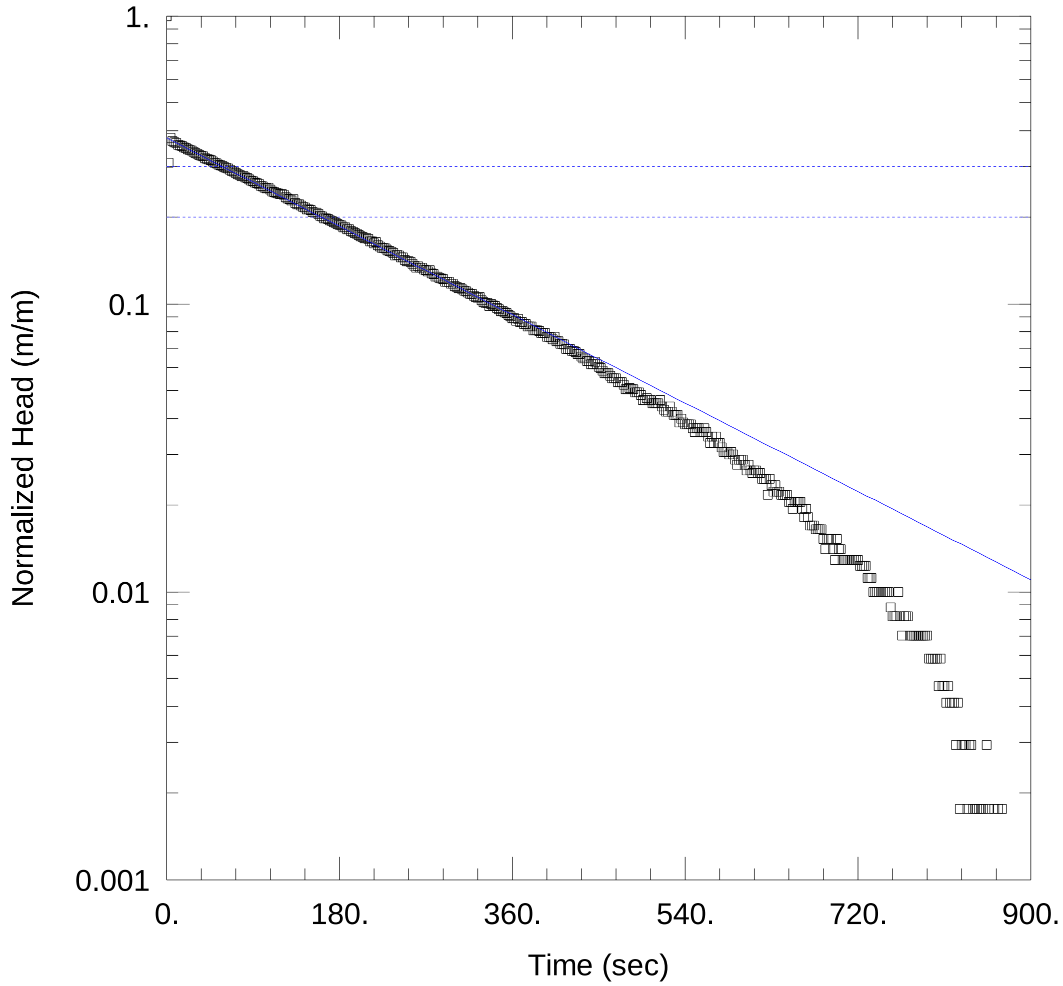


WELL TEST ANALYSIS

Data Set: G:\...\C007P2.aqt
Date: 11/23/11
Time: 09:28:41

PROJECT INFORMATION

Company: GHD
Client: Adani
Project: 41-23244-15
Location: Carmichael
Test Well: C007P2
Test Date: 2/11/2011

AQUIFER DATA

Saturated Thickness: 150.4 m
Anisotropy Ratio (Kz/Kr): 0.1

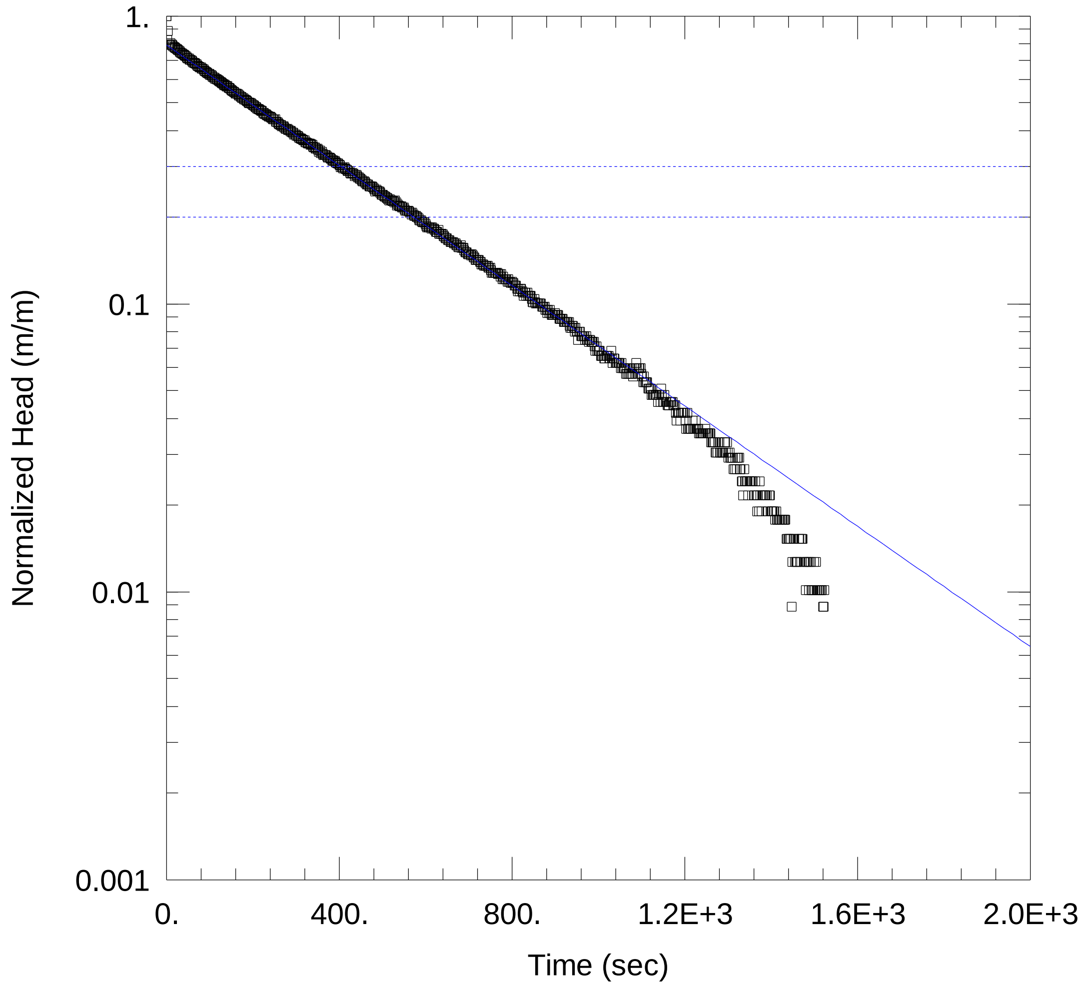
WELL DATA (C007P2)

Initial Displacement: 1.704 m
Static Water Column Height: 149.4 m
Total Well Penetration Depth: 149.4 m
Screen Length: 12. m
Casing Radius: 0.025 m
Well Radius: 0.076 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.05593 m/day
y0 = 0.6418 m



WELL TEST ANALYSIS

Data Set: G:\...\C007P3.aqt
Date: 11/23/11 Time: 09:43:05

PROJECT INFORMATION

Company: GHD
Client: Adani
Project: 41-23244-15
Location: Carmichael
Test Well: C007P3
Test Date: 30/09/2011

AQUIFER DATA

Saturated Thickness: 237.2 m Anisotropy Ratio (Kz/Kr): 0.1

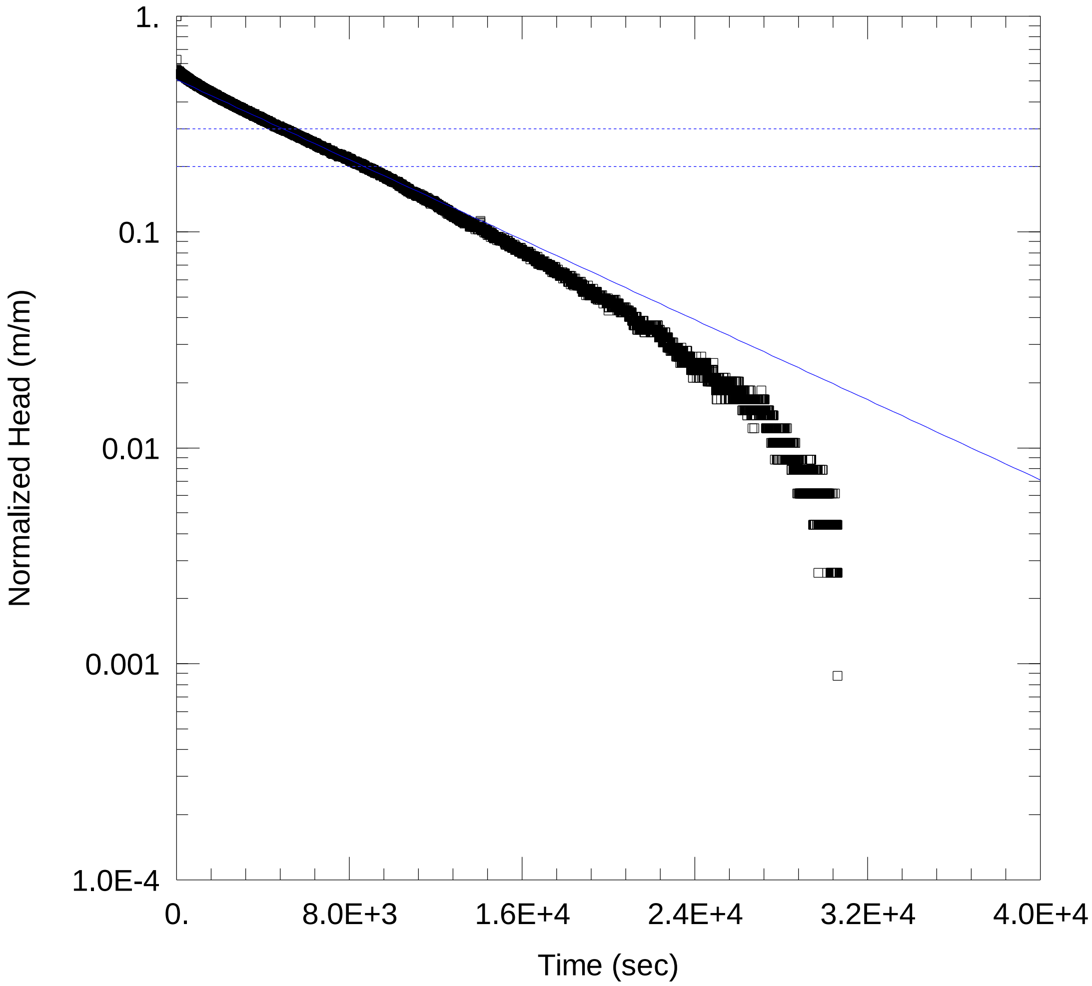
WELL DATA (C007P3)

Initial Displacement: 0.788 m Static Water Column Height: 237. m
Total Well Penetration Depth: 237. m Screen Length: 6. m
Casing Radius: 0.025 m Well Radius: 0.076 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.06864 m/day y0 = 0.6249 m



WELL TEST ANALYSIS

Data Set: G:\...\C008P1.aqt
Date: 11/23/11 Time: 09:33:45

PROJECT INFORMATION

Company: GHD
Client: Adani
Project: 41-23244-15
Location: Carmichael
Test Well: C008P1
Test Date: 2/11/2011

AQUIFER DATA

Saturated Thickness: 30.7 m Anisotropy Ratio (Kz/Kr): 0.1

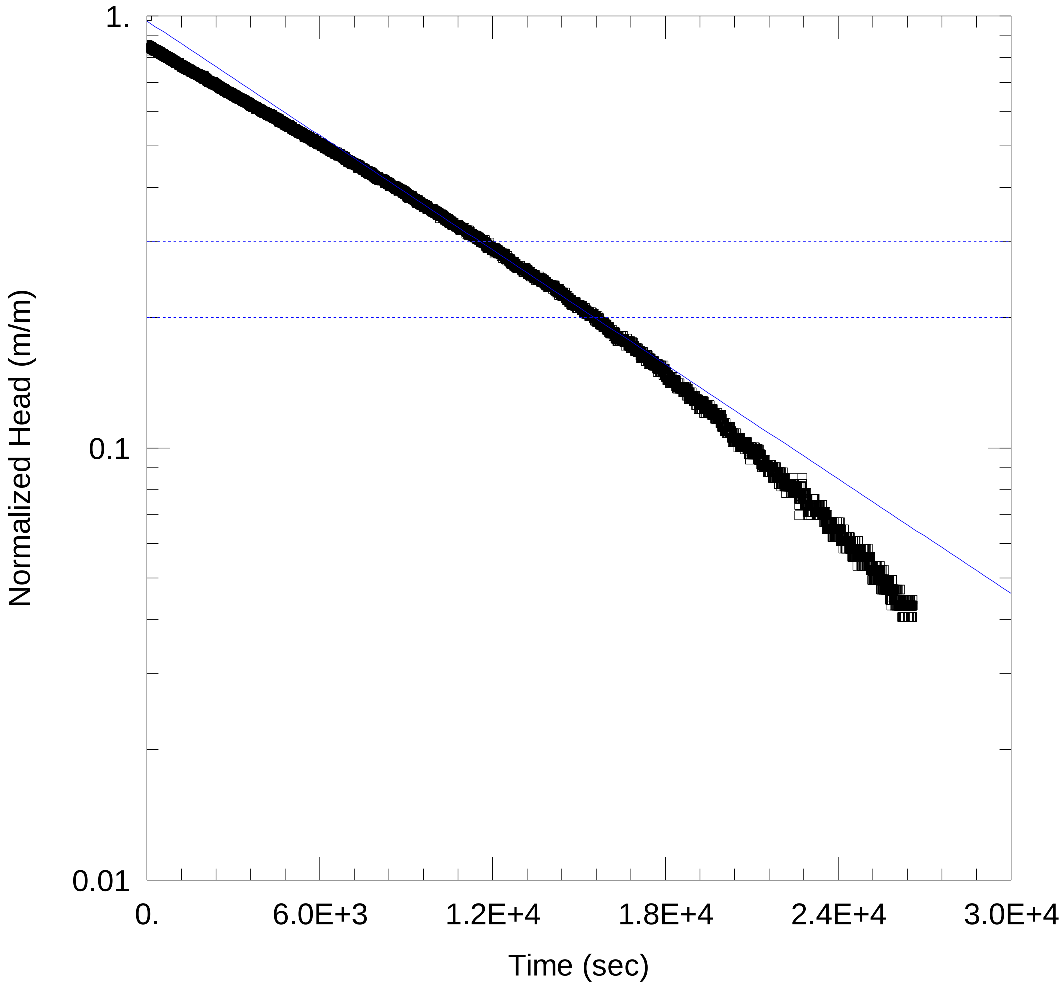
WELL DATA (C008P1)

Initial Displacement: 1.137 m Static Water Column Height: 28.7 m
Total Well Penetration Depth: 28.7 m Screen Length: 6. m
Casing Radius: 0.025 m Well Radius: 0.076 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.002333 m/day y0 = 0.5772 m



WELL TEST ANALYSIS

Data Set: G:\...\C012P2.aqt
Date: 11/23/11 Time: 09:27:08

PROJECT INFORMATION

Company: GHD
Client: Adani
Project: 41-23244-15
Location: Carmichael
Test Well: C012P2
Test Date: 01/10/2011

AQUIFER DATA

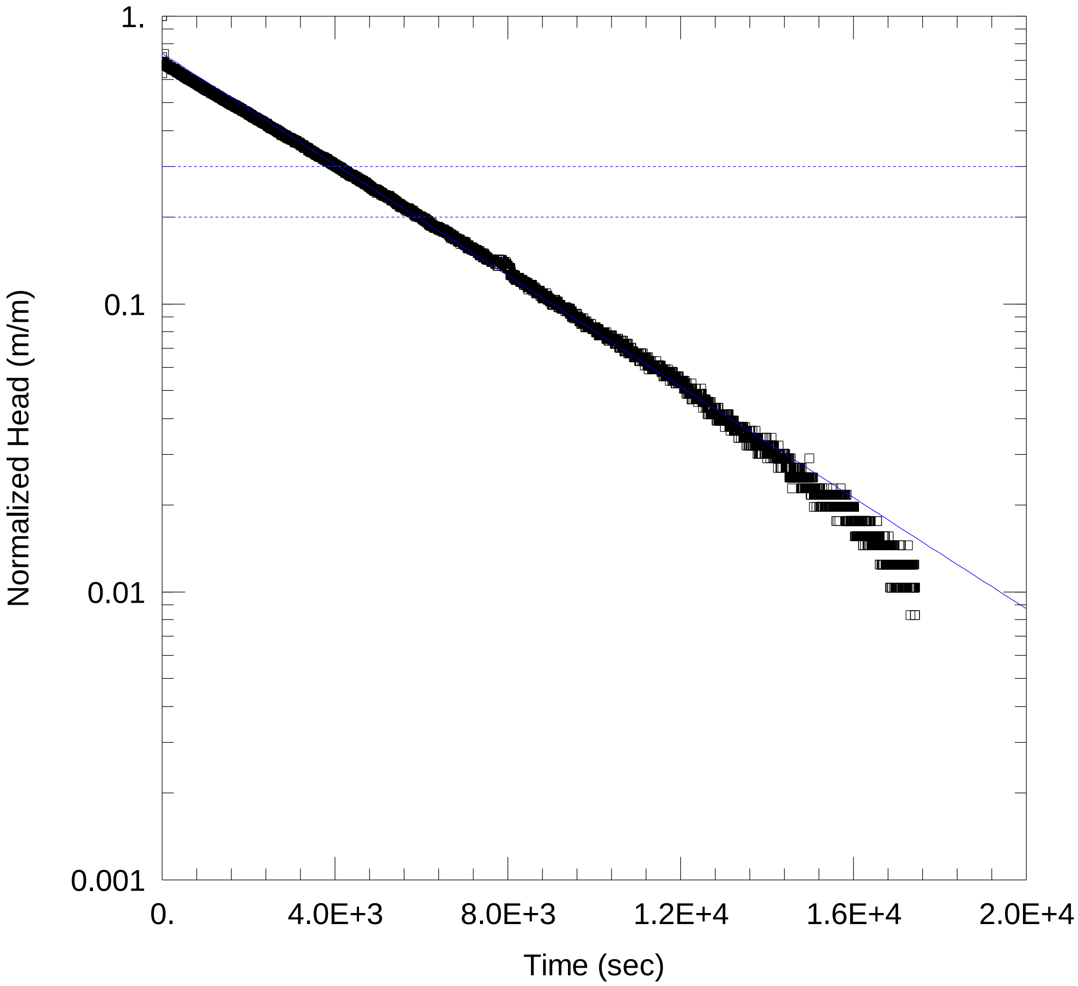
Saturated Thickness: 31.76 m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (C012P2)

Initial Displacement: 0.788 m Static Water Column Height: 31.76 m
Total Well Penetration Depth: 31.76 m Screen Length: 6. m
Casing Radius: 0.025 m Well Radius: 0.076 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice
K = 0.002481 m/day y0 = 0.7665 m



WELL TEST ANALYSIS

Data Set: G:\...\C016P2.aqt
Date: 11/23/11 Time: 09:32:05

PROJECT INFORMATION

Company: GHD
Client: Adani
Project: 41-23244-15
Location: Carmichael
Test Well: C016P2
Test Date: 30/09/2011

AQUIFER DATA

Saturated Thickness: 184.3 m Anisotropy Ratio (Kz/Kr): 0.1

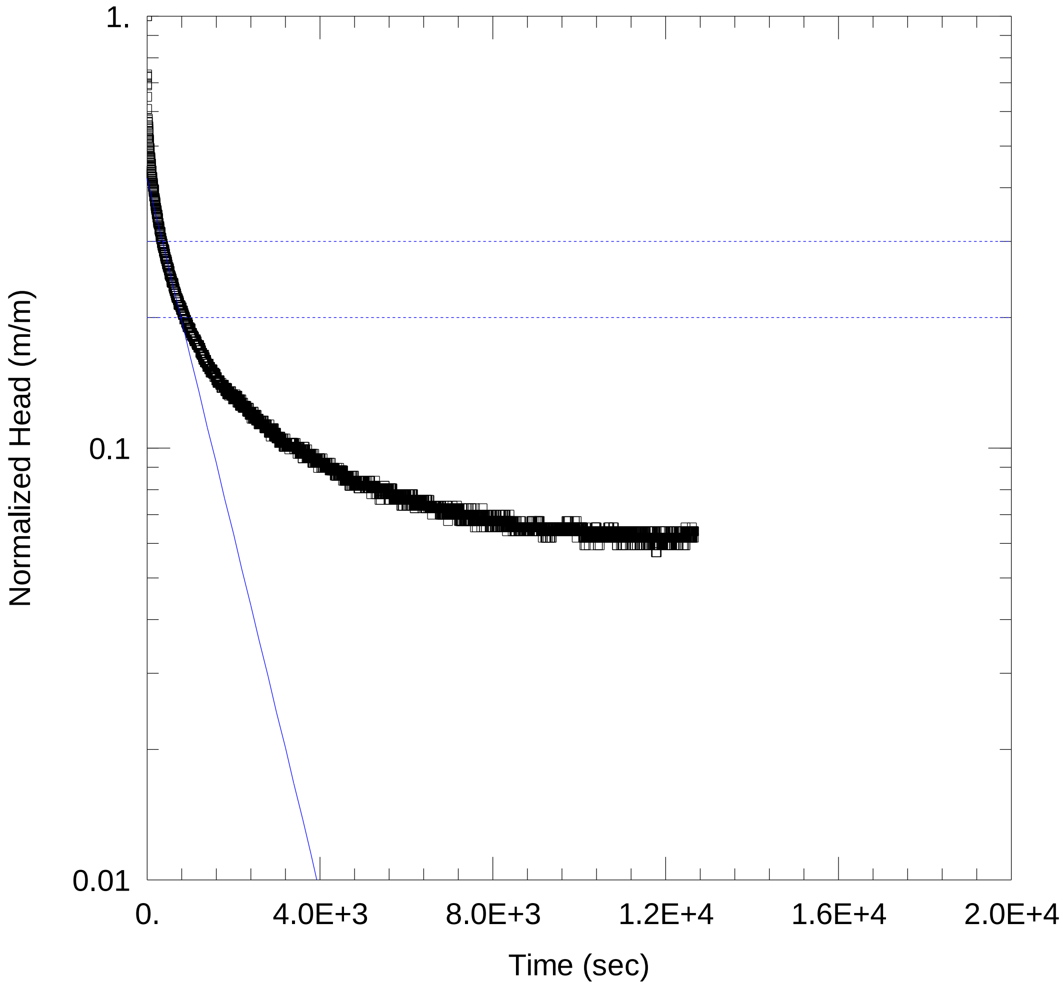
WELL DATA (C016P2)

Initial Displacement: 0.965 m
Total Well Penetration Depth: 181.3 m
Casing Radius: 0.025 m
Static Water Column Height: 181.3 m
Screen Length: 9. m
Well Radius: 0.076 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.004007 m/day y0 = 0.7153 m



WELL TEST ANALYSIS

Data Set: G:\...\C018P1.aqt
Date: 11/23/11 Time: 09:35:03

PROJECT INFORMATION

Company: GHD
Client: Adani
Project: 41-23244-15
Location: Carmichael
Test Well: C018P1
Test Date: 1/11/2011

AQUIFER DATA

Saturated Thickness: 16.78 m Anisotropy Ratio (Kz/Kr): 0.1

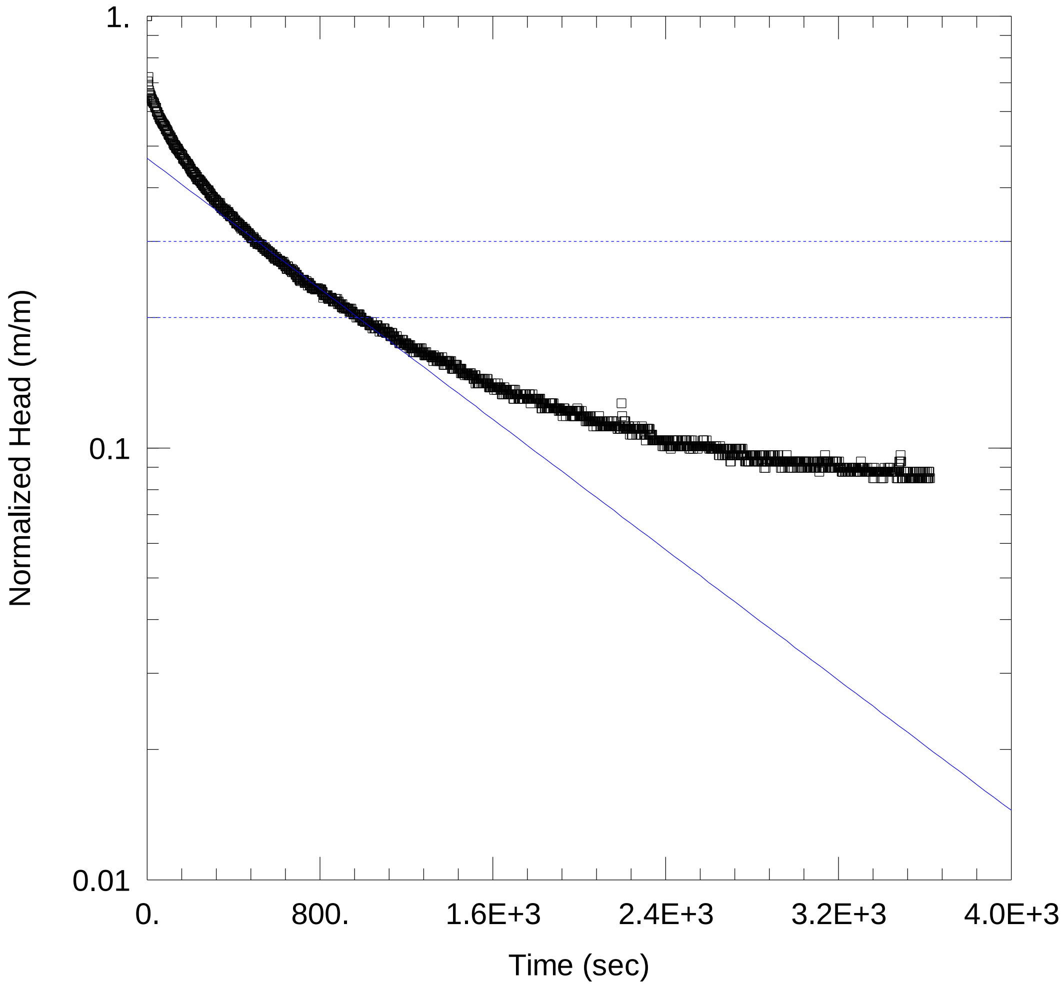
WELL DATA (C018P1)

Initial Displacement: 0.857 m
Total Well Penetration Depth: 14.78 m
Casing Radius: 0.025 m
Static Water Column Height: 14.78 m
Screen Length: 6. m
Well Radius: 0.076 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.01925 m/day
y0 = 0.361 m



WELL TEST ANALYSIS

Data Set: G:\...\C027P1.aqt
Date: 11/23/11 Time: 09:36:23

PROJECT INFORMATION

Company: GHD
Client: Adani
Project: 41-23244-15
Location: Carmichael
Test Well: C027P1
Test Date: 3/11/2011

AQUIFER DATA

Saturated Thickness: 8.109 m Anisotropy Ratio (Kz/Kr): 0.1

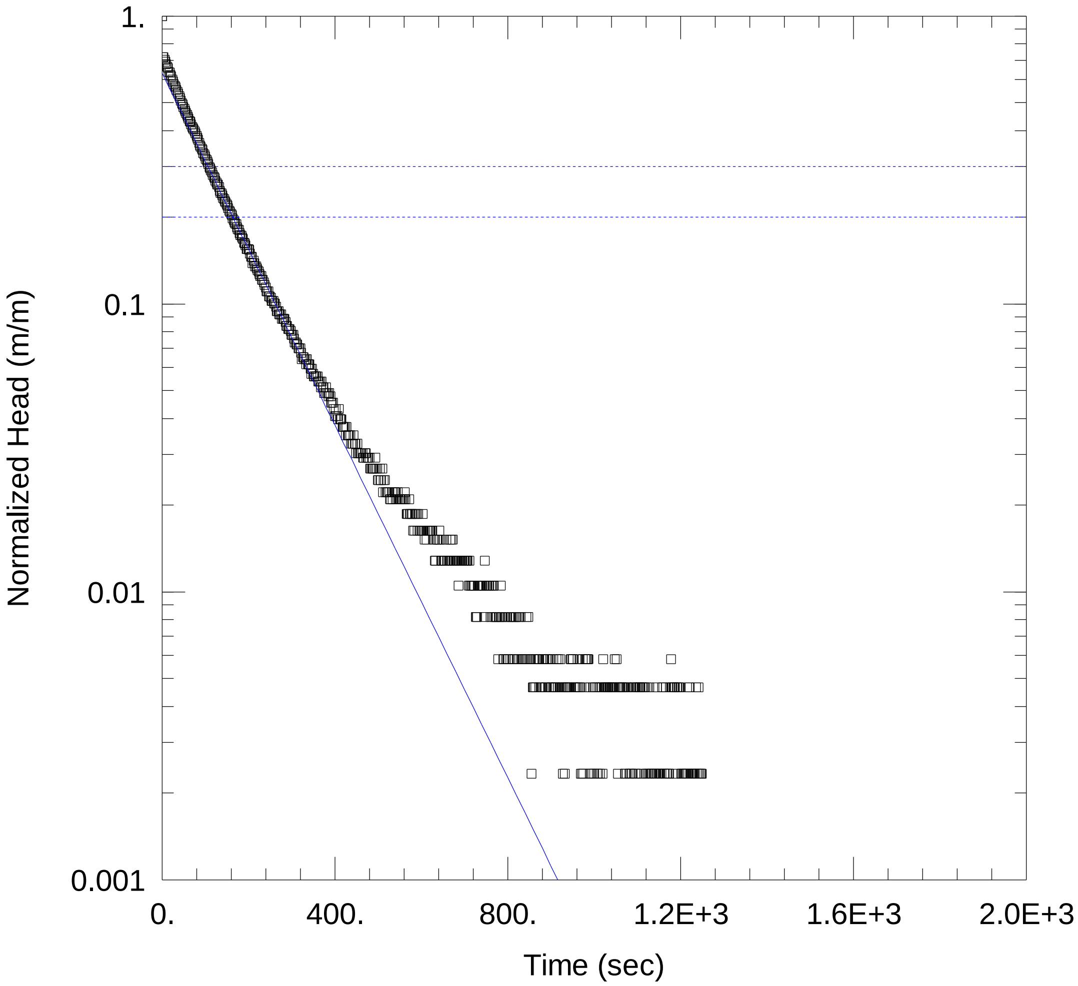
WELL DATA (C027P1)

Initial Displacement: 0.624 m Static Water Column Height: 7.109 m
Total Well Penetration Depth: 7.109 m Screen Length: 4. m
Casing Radius: 0.025 m Well Radius: 0.076 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.02348 m/day y0 = 0.2922 m



WELL TEST ANALYSIS

Data Set: G:\...\C027P2.aqt
Date: 11/23/11 Time: 09:38:15

PROJECT INFORMATION

Company: GHD
Client: Adani
Project: 41-23244-15
Location: Carmichael
Test Well: C027P2
Test Date: 3/11/2011

AQUIFER DATA

Saturated Thickness: 30.16 m Anisotropy Ratio (Kz/Kr): 0.1

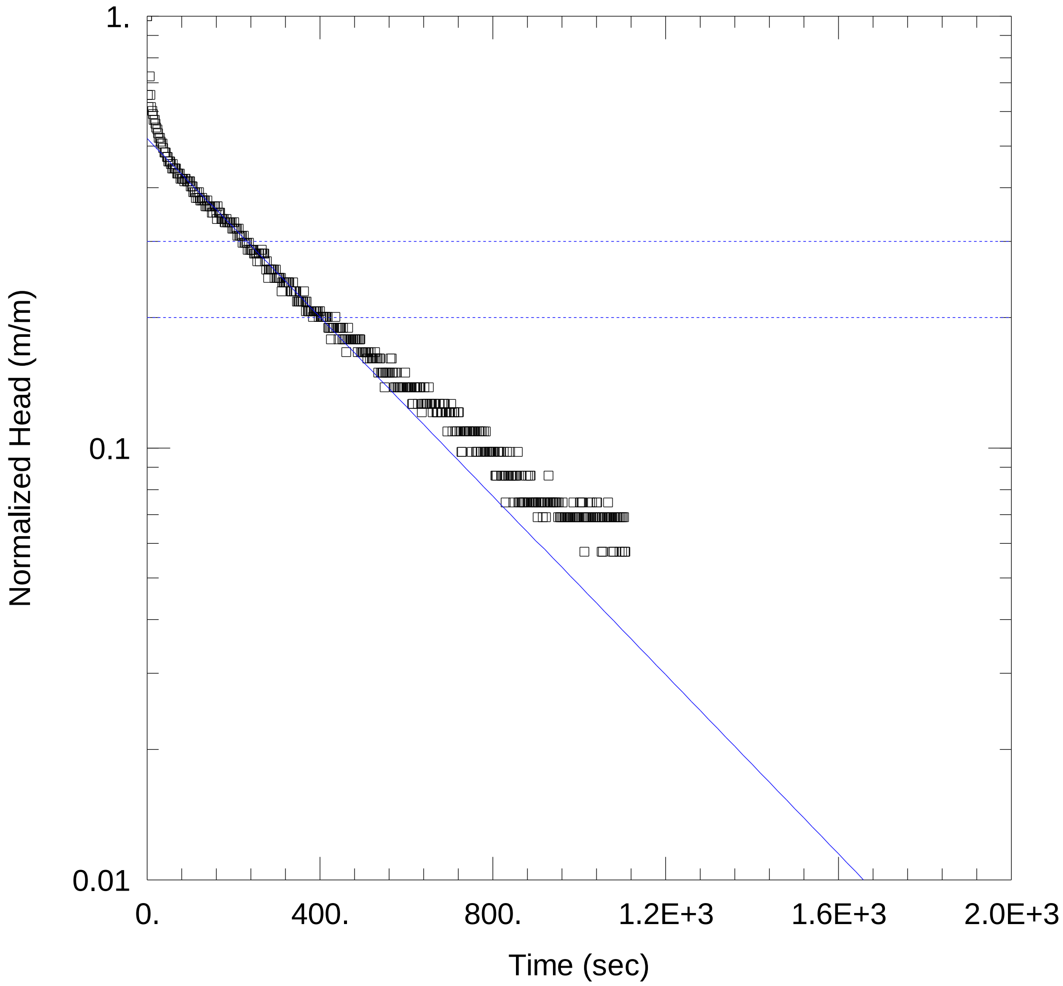
WELL DATA (C027P2)

Initial Displacement: 0.858 m Static Water Column Height: 30.16 m
Total Well Penetration Depth: 30.16 m Screen Length: 4. m
Casing Radius: 0.025 m Well Radius: 0.076 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.2486 m/day y0 = 0.543 m



WELL TEST ANALYSIS

Data Set: G:\...\C029P1.aqt
Date: 11/23/11 Time: 09:39:25

PROJECT INFORMATION

Company: GHD
Client: Adani
Project: 41-23244-15
Location: Carmichael
Test Well: C029P1
Test Date: 3/11/2011

AQUIFER DATA

Saturated Thickness: 1.996 m Anisotropy Ratio (Kz/Kr): 0.1

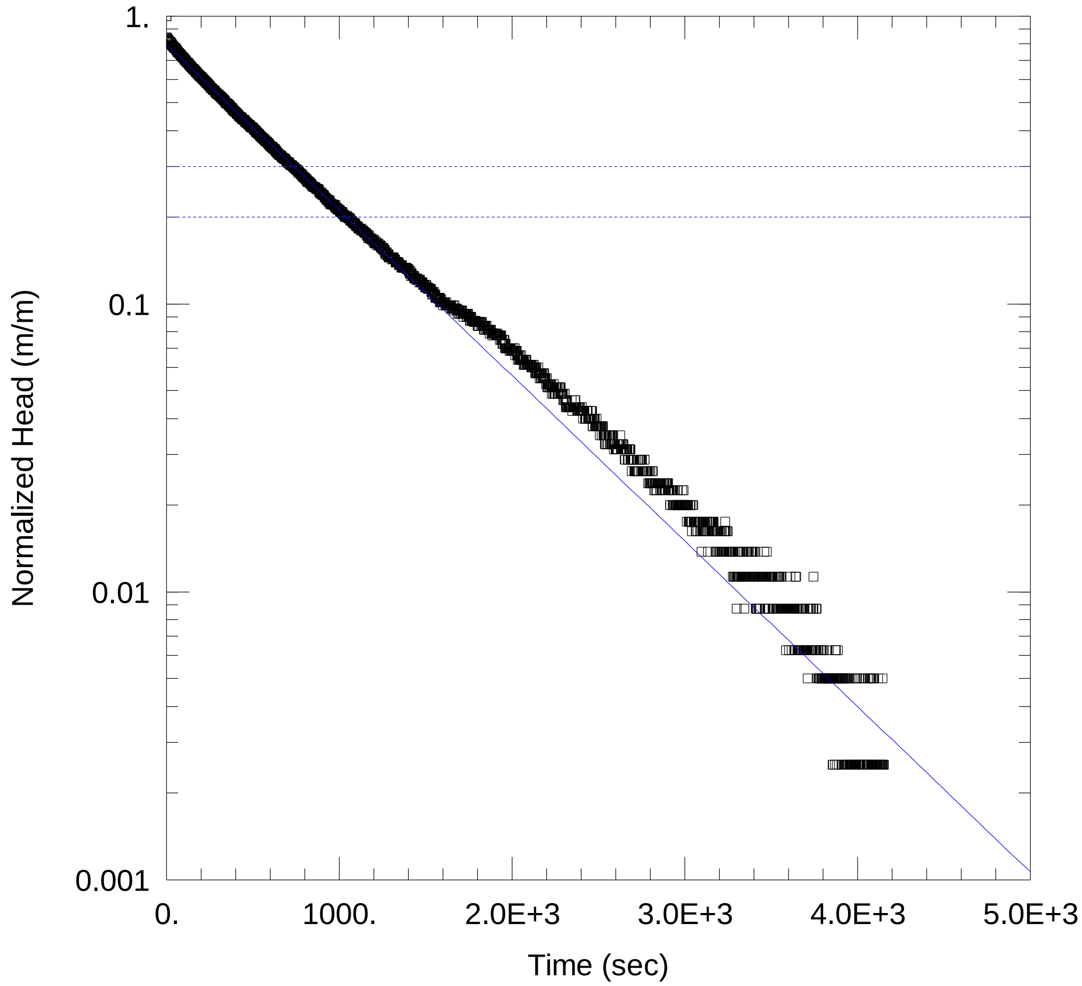
WELL DATA (C029P1)

Initial Displacement: 0.174 m Static Water Column Height: 1.596 m
Total Well Penetration Depth: 1.596 m Screen Length: 1.596 m
Casing Radius: 0.025 m Well Radius: 0.076 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.1186 m/day y0 = 0.09063 m



WELL TEST ANALYSIS

Data Set: G:\...\C029P2.aqt
Date: 11/23/11 | Time: 09:40:42

PROJECT INFORMATION

Company: GHD
Client: Adani
Project: 41-23244-15
Location: Carmichael
Test Well: C029P2
Test Date: 3/11/2011

AQUIFER DATA

Saturated Thickness: 39.87 m | Anisotropy Ratio (Kz/Kr): 0.1

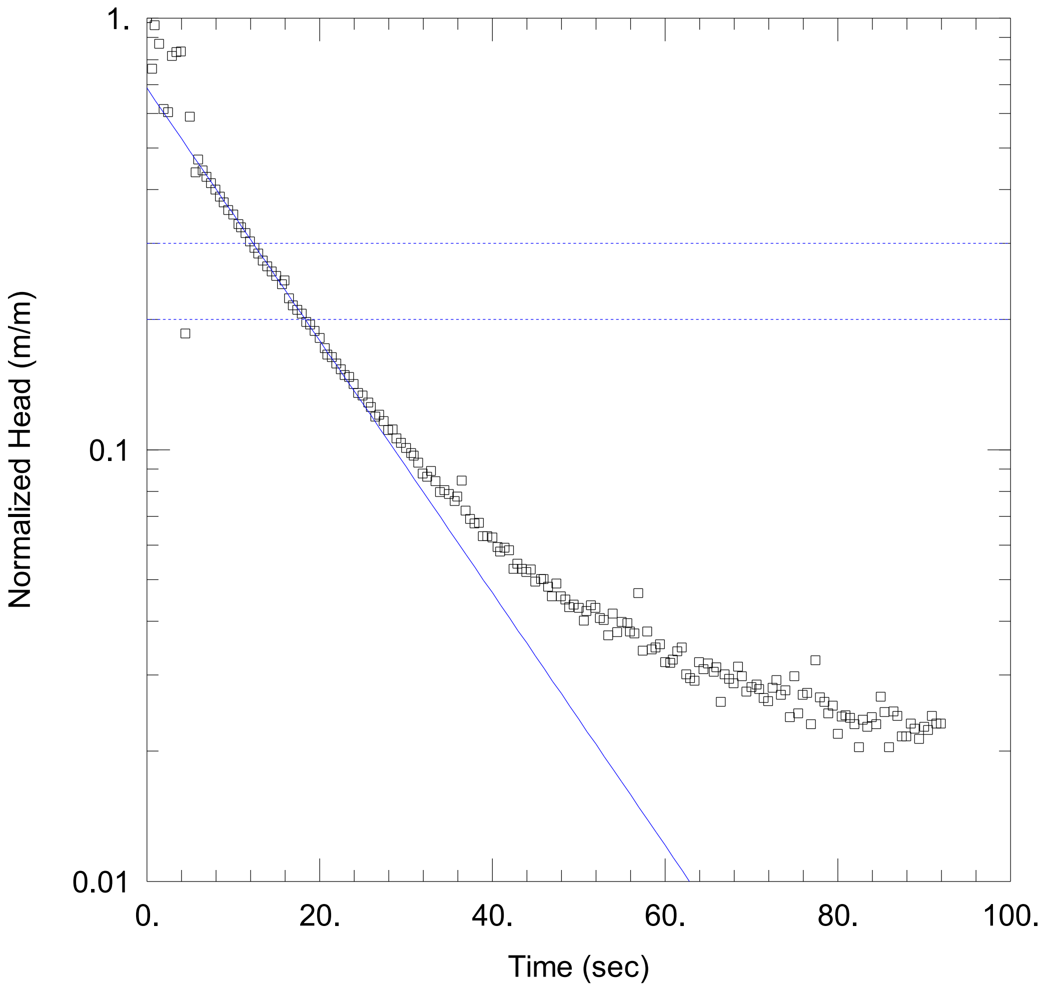
WELL DATA (C029P2)

Initial Displacement: 0.8 m | Static Water Column Height: 34.87 m
Total Well Penetration Depth: 34.87 m | Screen Length: 3. m
Casing Radius: 0.025 m | Well Radius: 0.076 m

SOLUTION

Aquifer Model: Unconfined | Solution Method: Bouwer-Rice

K = 0.05265 m/day | y0 = 0.6364 m



FALLING HEAD 1

Data Set: N:\...\C006P1_FH1.aqt
Date: 10/03/12 Time: 15:37:21

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C006P1
Test Date: 21/8/2012

AQUIFER DATA

Saturated Thickness: 6. m
Anisotropy Ratio (Kz/Kr): 0.1

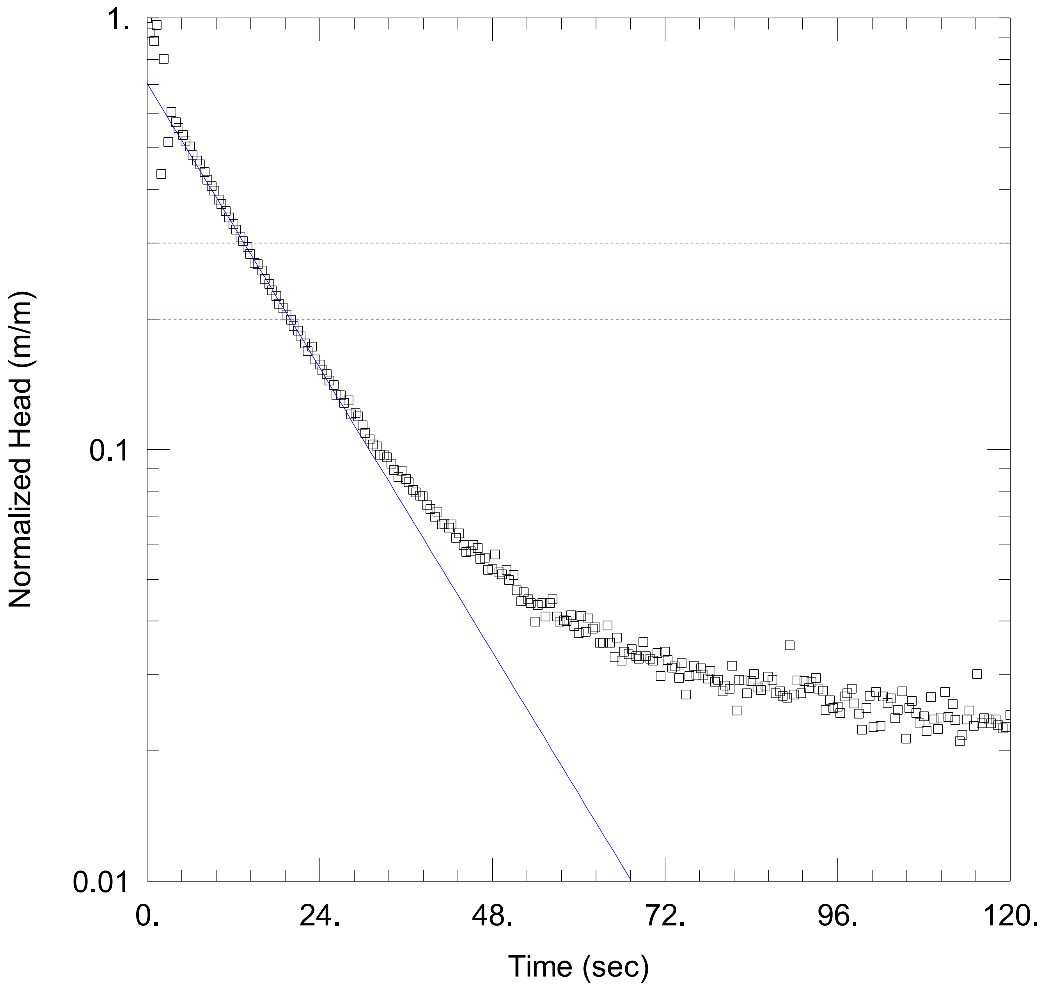
WELL DATA (C006P1)

Initial Displacement: 1.208 m
Static Water Column Height: 23.93 m
Total Well Penetration Depth: 19.91 m
Screen Length: 6. m
Casing Radius: 0.025 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 1.246 m/day
y0 = 0.8313 m



RISING HEAD 2

Data Set: N:\...\C006P1_FH2.aqt
Date: 10/03/12 Time: 15:38:25

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C006P1
Test Date: 21/8/2012

AQUIFER DATA

Saturated Thickness: 6. m Anisotropy Ratio (Kz/Kr): 0.1

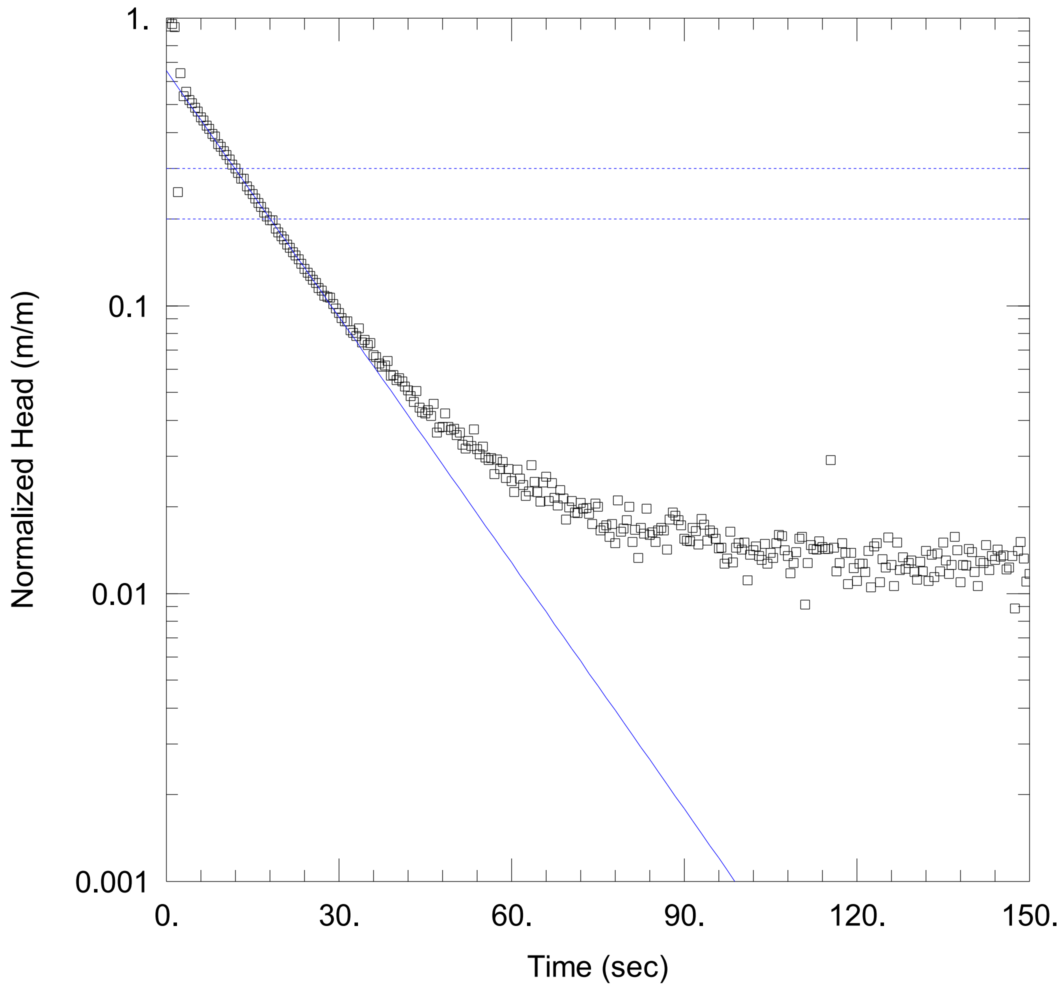
WELL DATA (C006P1)

Initial Displacement: 1.213 m Static Water Column Height: 23.93 m
Total Well Penetration Depth: 19.9 m Screen Length: 6. m
Casing Radius: 0.025 m Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 1.17 m/day y0 = 0.8544 m



RISING HEAD 3

Data Set: N:\...\C006P1_FH3.aqt
Date: 10/03/12 Time: 15:38:33

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C006P1
Test Date: 21/8/2012

AQUIFER DATA

Saturated Thickness: 6. m Anisotropy Ratio (Kz/Kr): 0.1

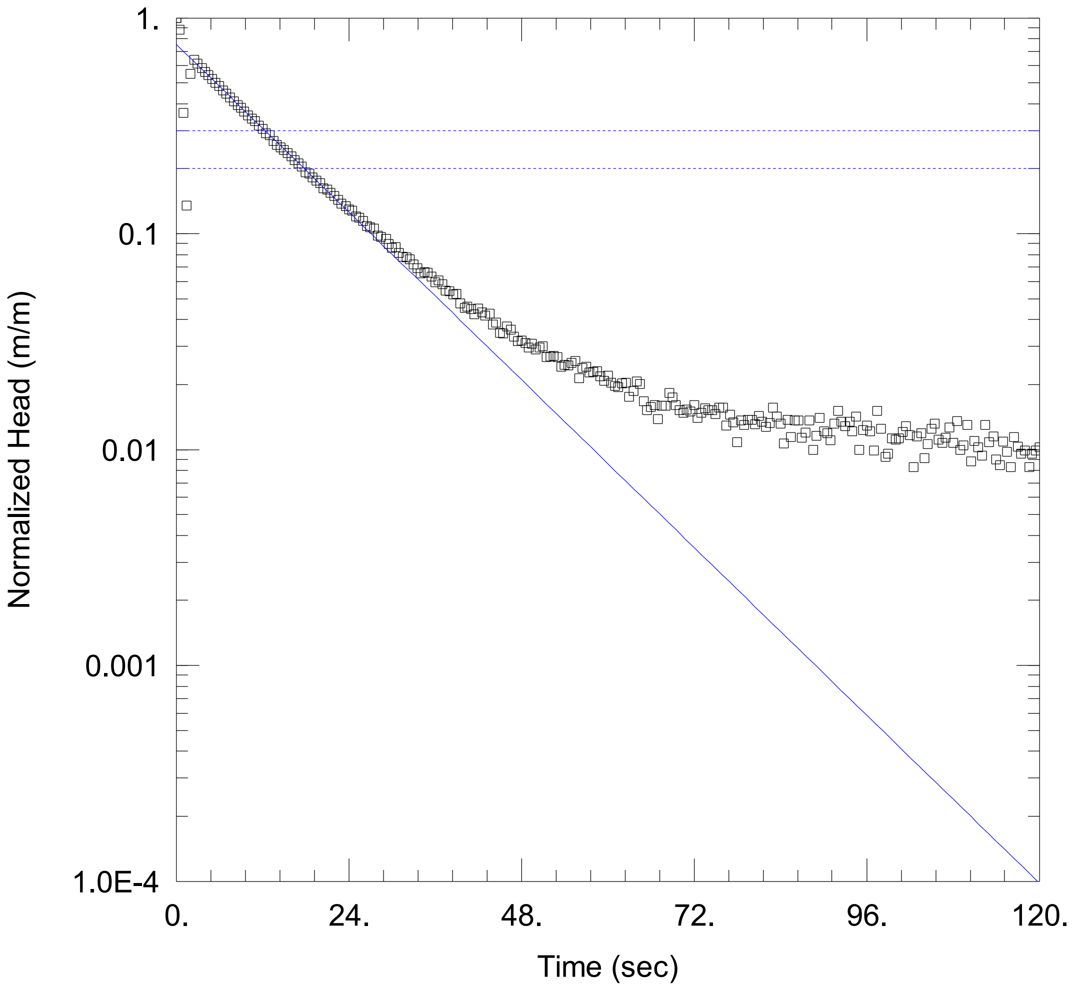
WELL DATA (C006P1)

Initial Displacement: 1.362 m Static Water Column Height: 23.93 m
Total Well Penetration Depth: 19.91 m Screen Length: 6. m
Casing Radius: 0.025 m Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 1.215 m/day y0 = 0.8918 m



FALLING HEAD 1

Data Set: N:\...\C006P1_RH1.aqt
Date: 10/03/12 Time: 15:38:41

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C006P1
Test Date: 21/8/2012

AQUIFER DATA

Saturated Thickness: 6. m
Anisotropy Ratio (Kz/Kr): 0.1

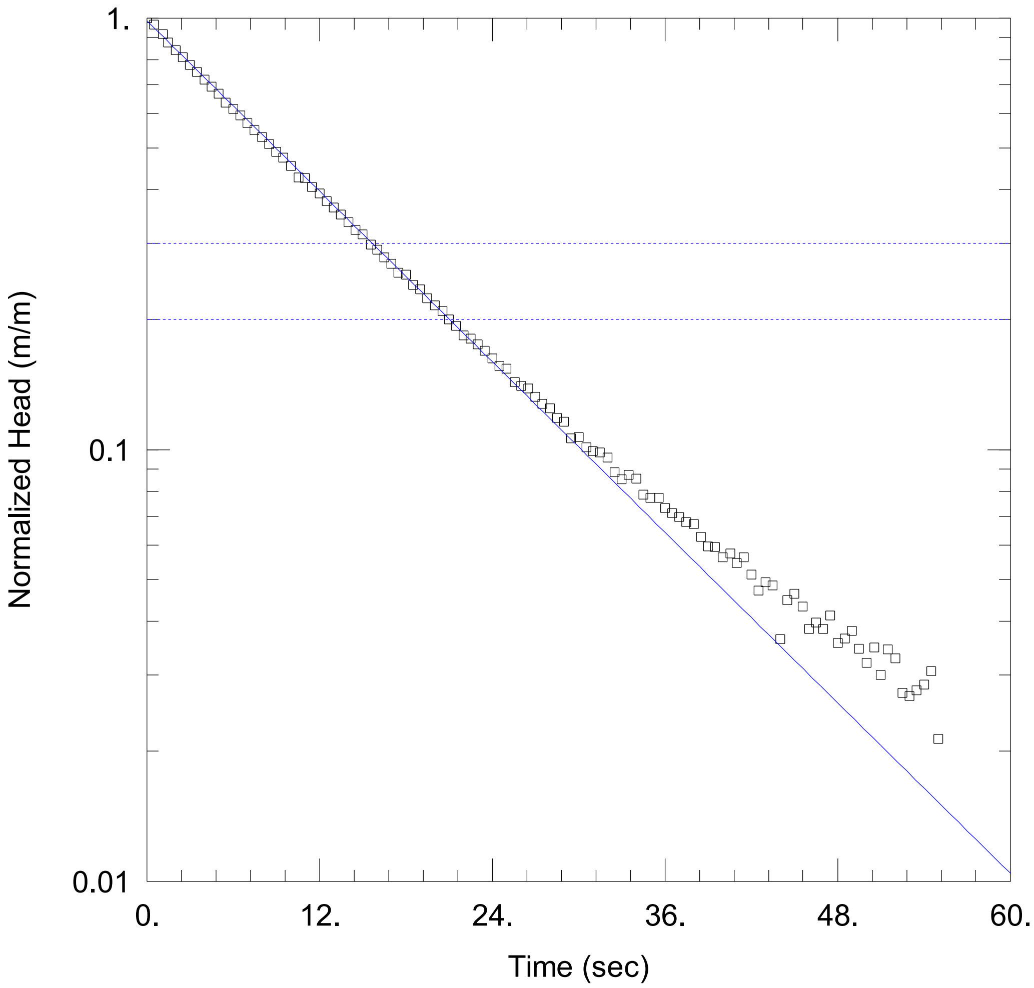
WELL DATA (C006P1)

Initial Displacement: 1.461 m
Total Well Penetration Depth: 19.88 m
Casing Radius: 0.025 m
Static Water Column Height: 23.93 m
Screen Length: 6. m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 1.724 m/day
y0 = 1.103 m



FALLING HEAD 2

Data Set: N:\...\C006P1_RH2.aqt
Date: 10/03/12 Time: 15:38:49

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C006P1
Test Date: 21/8/2012

AQUIFER DATA

Saturated Thickness: 6. m
Anisotropy Ratio (Kz/Kr): 0.1

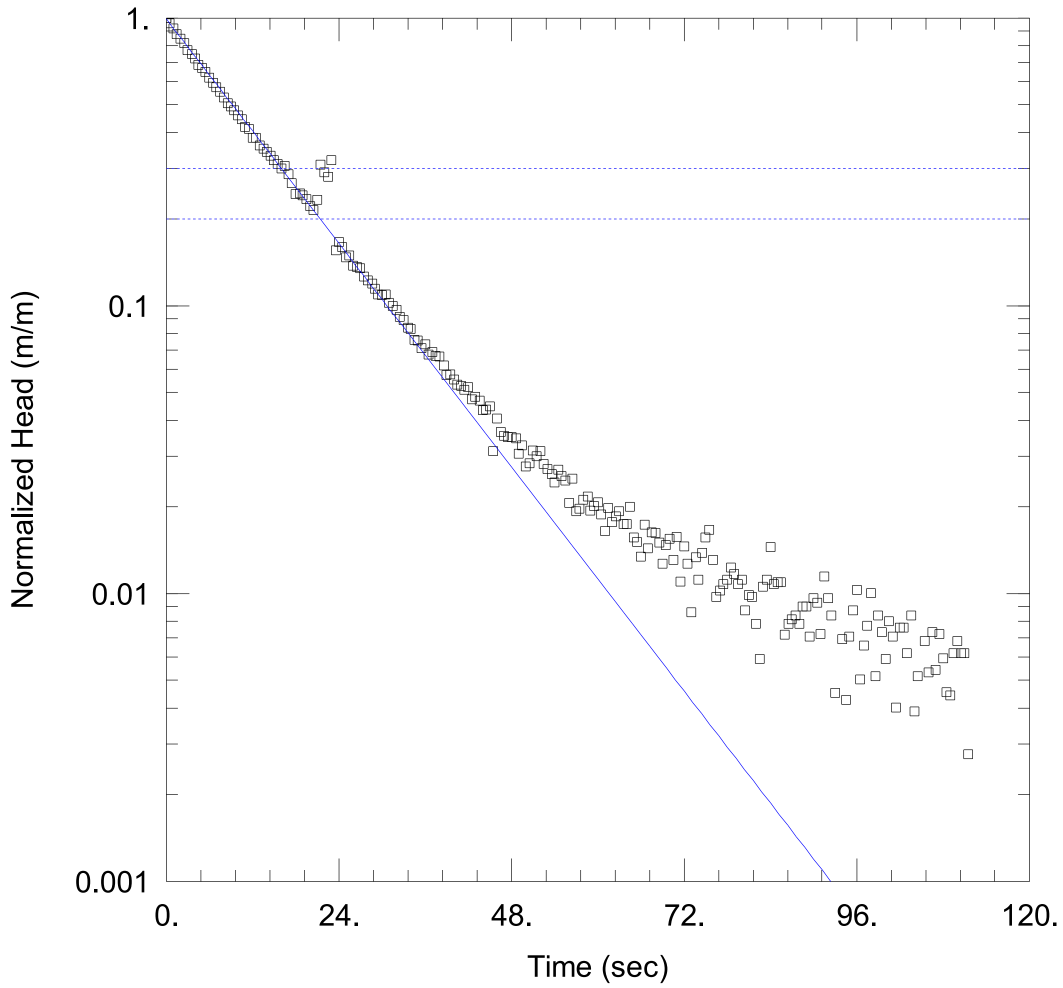
WELL DATA (C006P1)

Initial Displacement: 0.9835 m
Static Water Column Height: 23.93 m
Total Well Penetration Depth: 19.91 m
Screen Length: 6. m
Casing Radius: 0.025 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 1.404 m/day
y0 = 0.9692 m



FALLING HEAD 3

Data Set: N:\...\C006P1_RH3.aqt
Date: 10/03/12 Time: 15:38:57

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C006P1
Test Date: 21/8/2012

AQUIFER DATA

Saturated Thickness: 6. m Anisotropy Ratio (Kz/Kr): 0.1

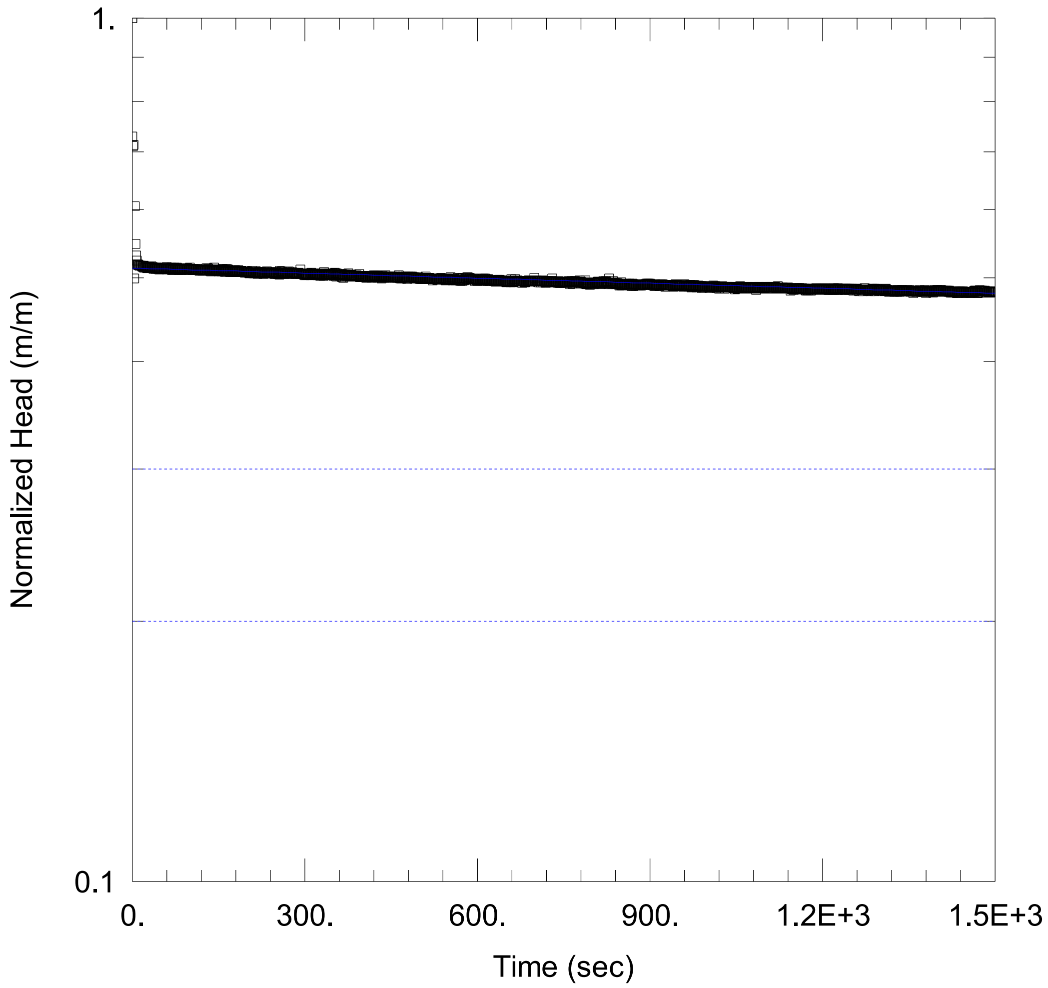
WELL DATA (C006P1)

Initial Displacement: 0.9594 m Static Water Column Height: 23.93 m
Total Well Penetration Depth: 19.91 m Screen Length: 6. m
Casing Radius: 0.025 m Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 1.382 m/day y0 = 0.9504 m



FALLING HEAD 1

Data Set: N:\...\C011P1_FH1.aqt
Date: 10/03/12 | Time: 15:39:17

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C011P1
Test Date: 30/8/2012

AQUIFER DATA

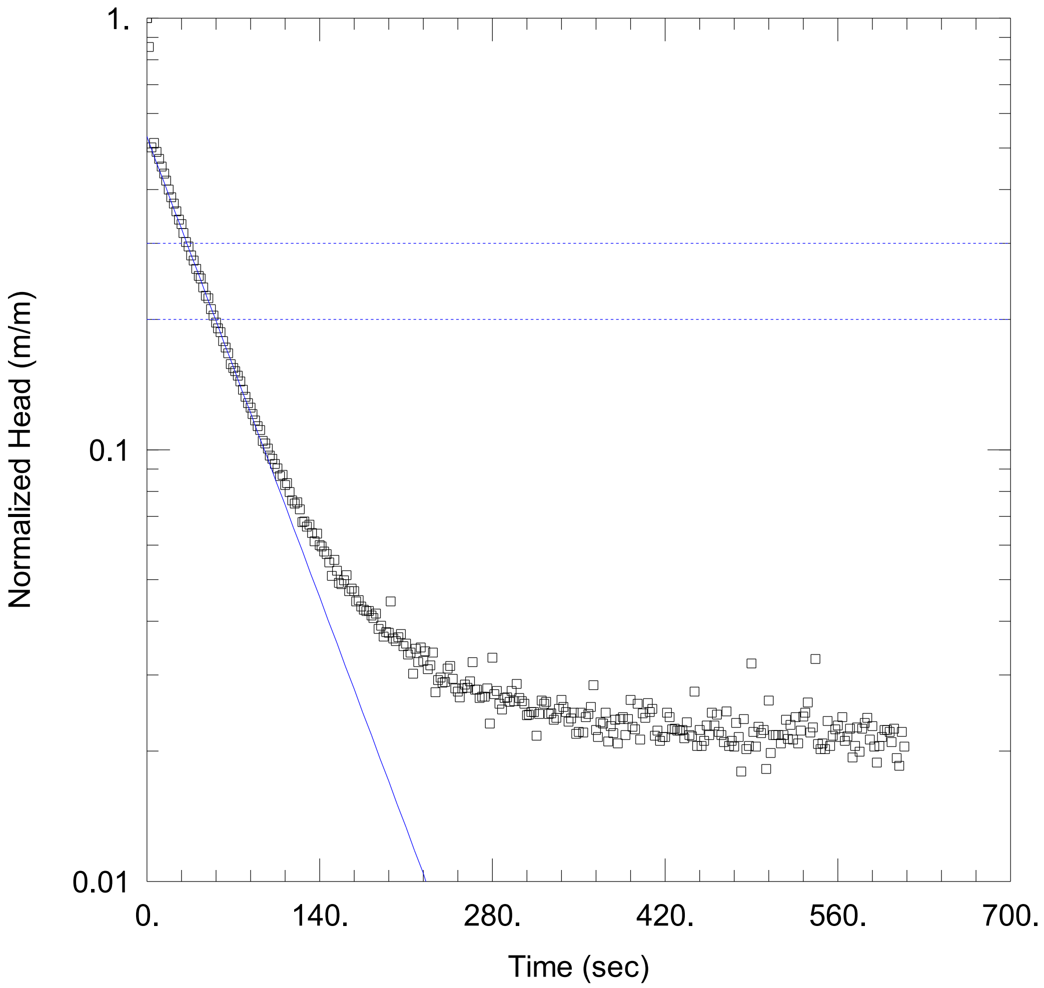
Saturated Thickness: 30.75 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (C011P1)

Initial Displacement: 2.05 m
Static Water Column Height: 30.41 m
Total Well Penetration Depth: 30.41 m
Screen Length: 6. m
Casing Radius: 0.025 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.001038 m/day
y0 = 1.052 m



FALLING HEAD 1

Data Set: N:\...\C012P1_FH1.aqt
Date: 10/03/12 Time: 15:39:32

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C012P1
Test Date: 30/8/2012

AQUIFER DATA

Saturated Thickness: 14.13 m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (C012P1)

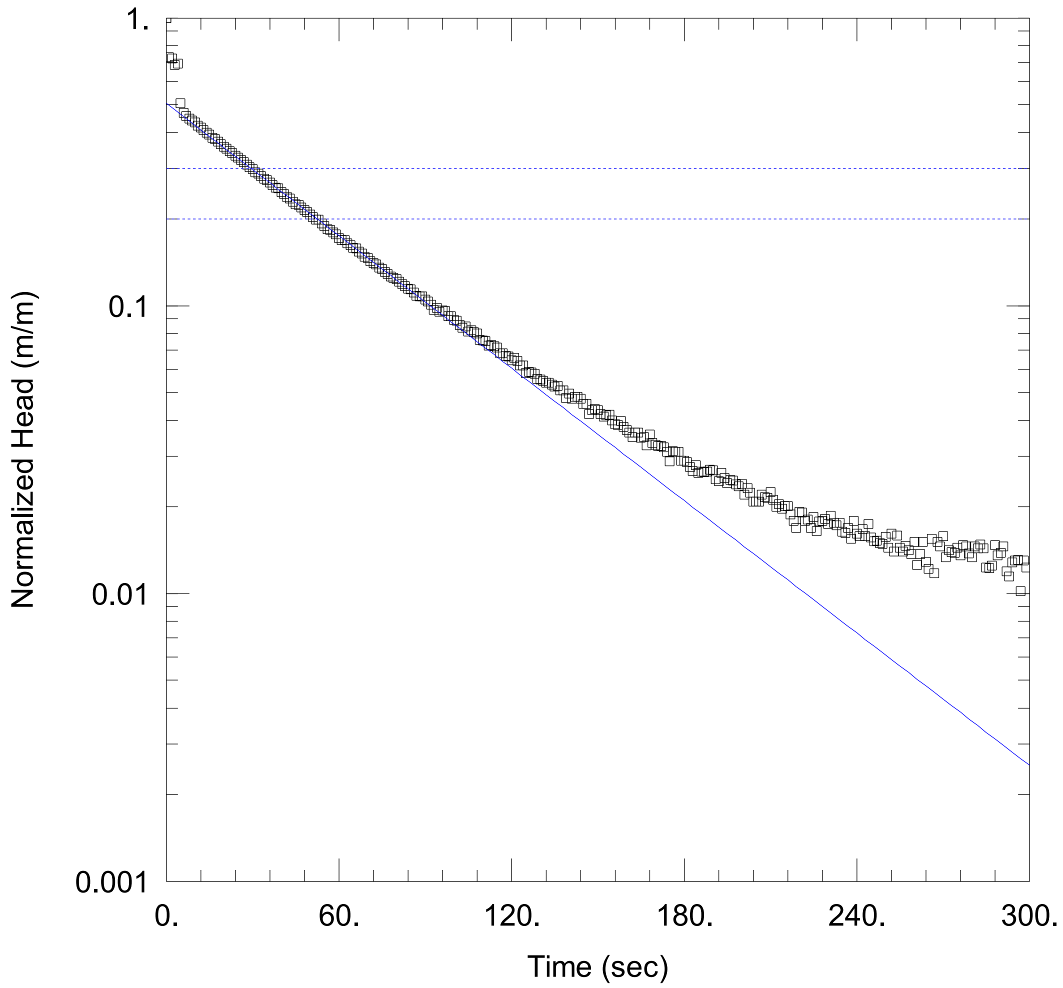
Initial Displacement: 1.304 m
Total Well Penetration Depth: 14.13 m
Casing Radius: 0.025 m

Static Water Column Height: 14.13 m
Screen Length: 6. m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.3883 m/day
y0 = 0.6929 m



FALLING HEAD 2

Data Set: N:\...\C012P1_FH2.aqt
Date: 10/03/12 Time: 15:39:50

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C012P1
Test Date: 30/8/2012

AQUIFER DATA

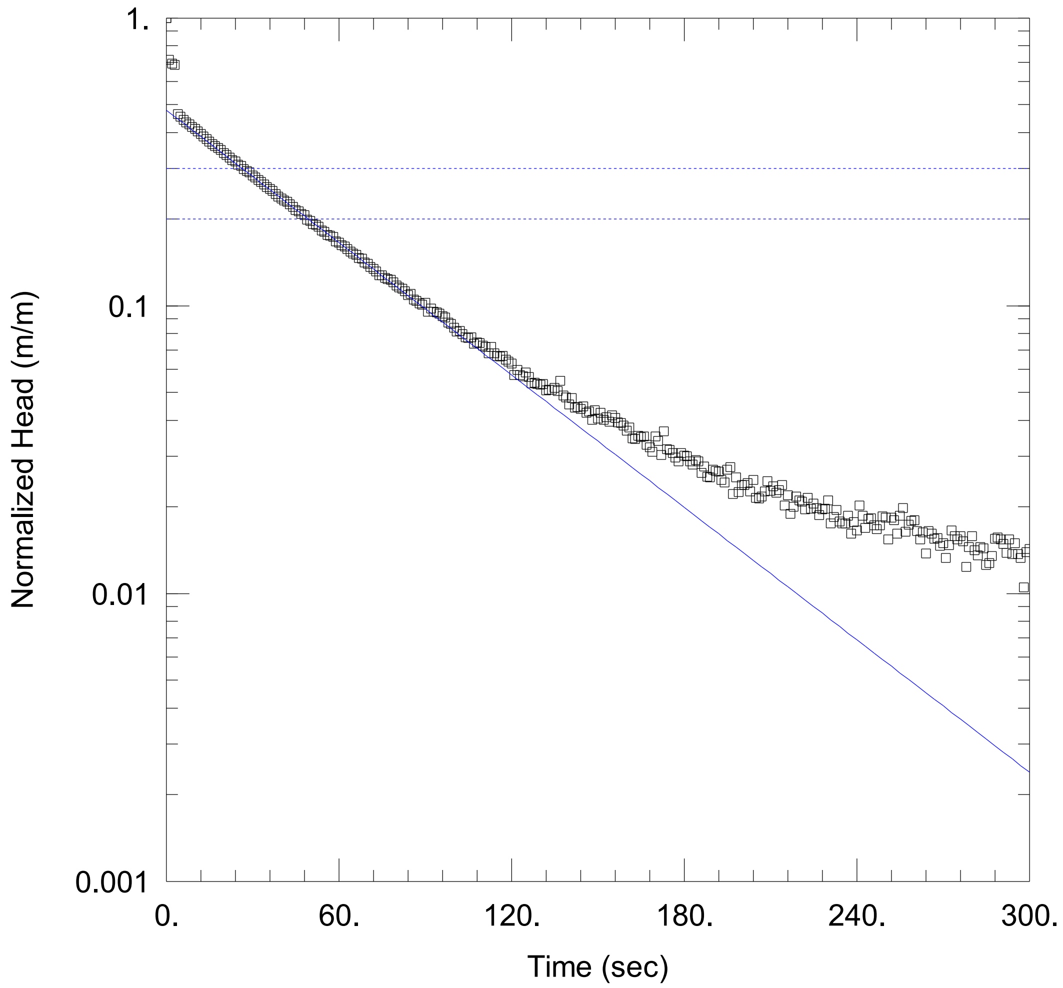
Saturated Thickness: 14.13 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (C012P1)

Initial Displacement: 1.933 m
Static Water Column Height: 14.13 m
Total Well Penetration Depth: 14.13 m
Screen Length: 6. m
Casing Radius: 0.025 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.3907 m/day
y0 = 0.9757 m



FALLING HEAD 3

Data Set: N:\...\C012P1_FH3.aqt
Date: 10/03/12 Time: 15:40:08

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C012P1
Test Date: 30/8/2012

AQUIFER DATA

Saturated Thickness: 14.13 m
Anisotropy Ratio (Kz/Kr): 0.1

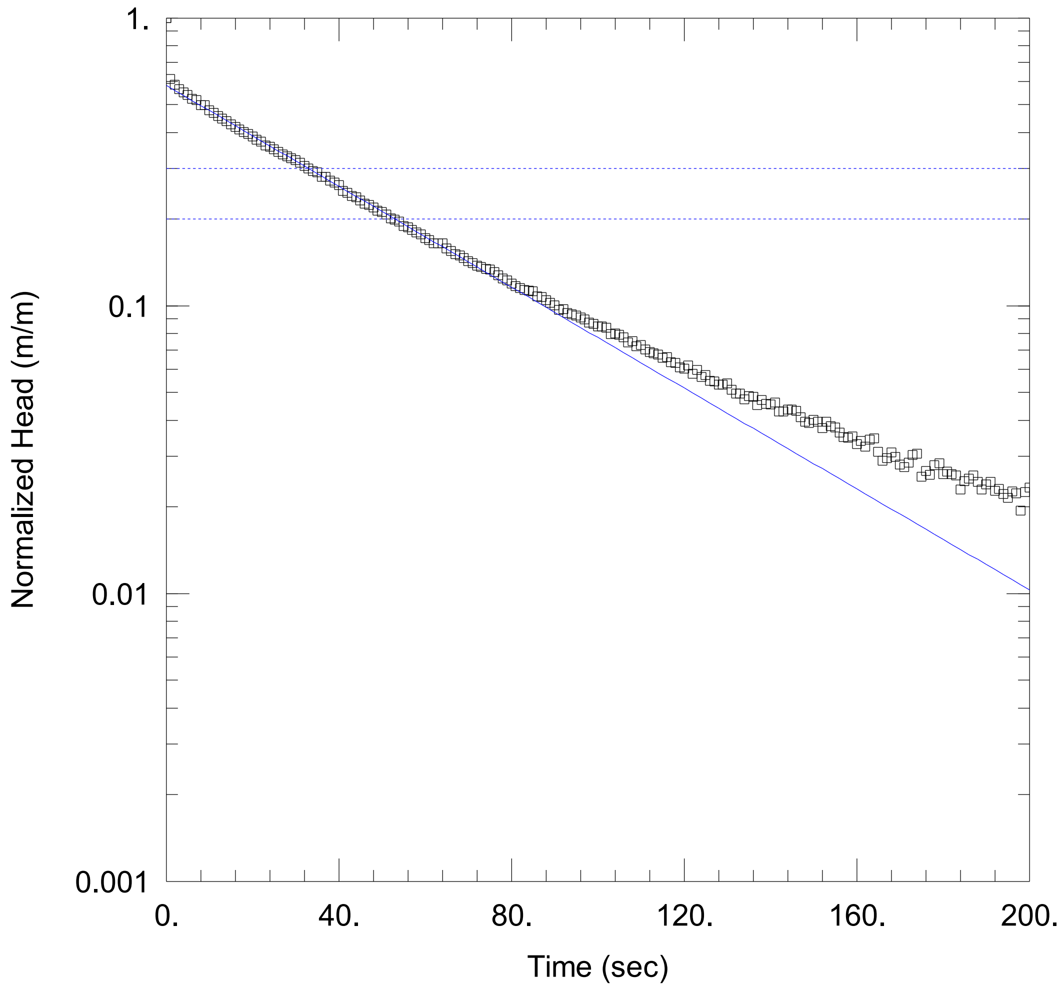
WELL DATA (CP012P1)

Initial Displacement: 1.88 m
Static Water Column Height: 14.13 m
Total Well Penetration Depth: 14.13 m
Screen Length: 6. m
Casing Radius: 0.025 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.3907 m/day
y0 = 0.8985 m



RISING HEAD 1

Data Set: N:\...\C012P1_RH1.aqt
Date: 10/03/12 Time: 15:40:24

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C012P1
Test Date: 30/8/2012

AQUIFER DATA

Saturated Thickness: 14.13 m Anisotropy Ratio (Kz/Kr): 0.1

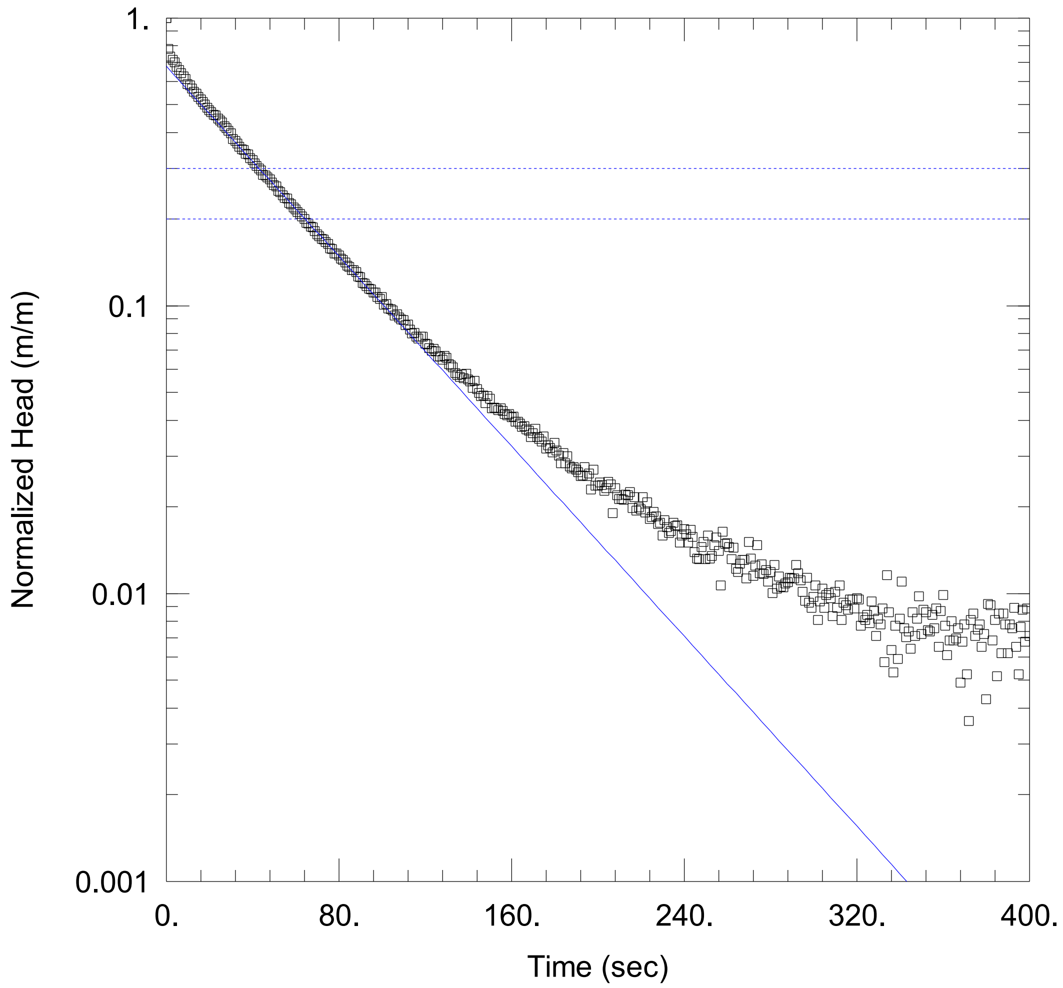
WELL DATA (C012P1)

Initial Displacement: 1.766 m Static Water Column Height: 14.13 m
Total Well Penetration Depth: 14.13 m Screen Length: 6. m
Casing Radius: 0.025 m Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.4466 m/day y0 = 1.029 m



RISING HEAD 2

Data Set: N:\...\C012P1_RH2.aqt
Date: 10/03/12 Time: 15:40:40

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C012P1
Test Date: 30/8/2012

AQUIFER DATA

Saturated Thickness: 14.13 m
Anisotropy Ratio (Kz/Kr): 0.1

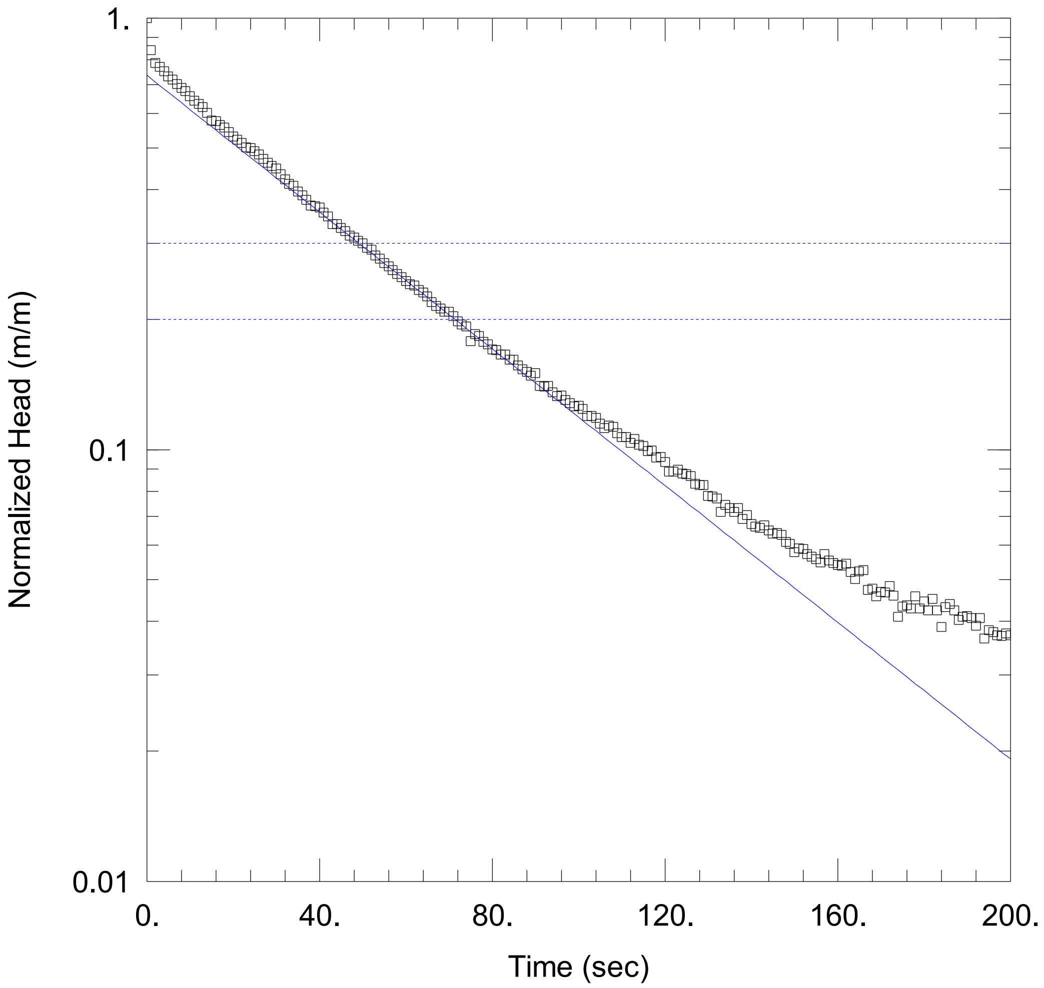
WELL DATA (C012P1)

Initial Displacement: 1.436 m
Static Water Column Height: 14.13 m
Total Well Penetration Depth: 14.13 m
Screen Length: 6. m
Casing Radius: 0.025 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.4205 m/day
y0 = 0.9754 m



RISING HEAD 3

Data Set: N:\...\C012P1_RH3.aqt
Date: 10/03/12 Time: 15:40:56

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C012P1
Test Date: 30/8/2012

AQUIFER DATA

Saturated Thickness: 14.13 m
Anisotropy Ratio (Kz/Kr): 0.1

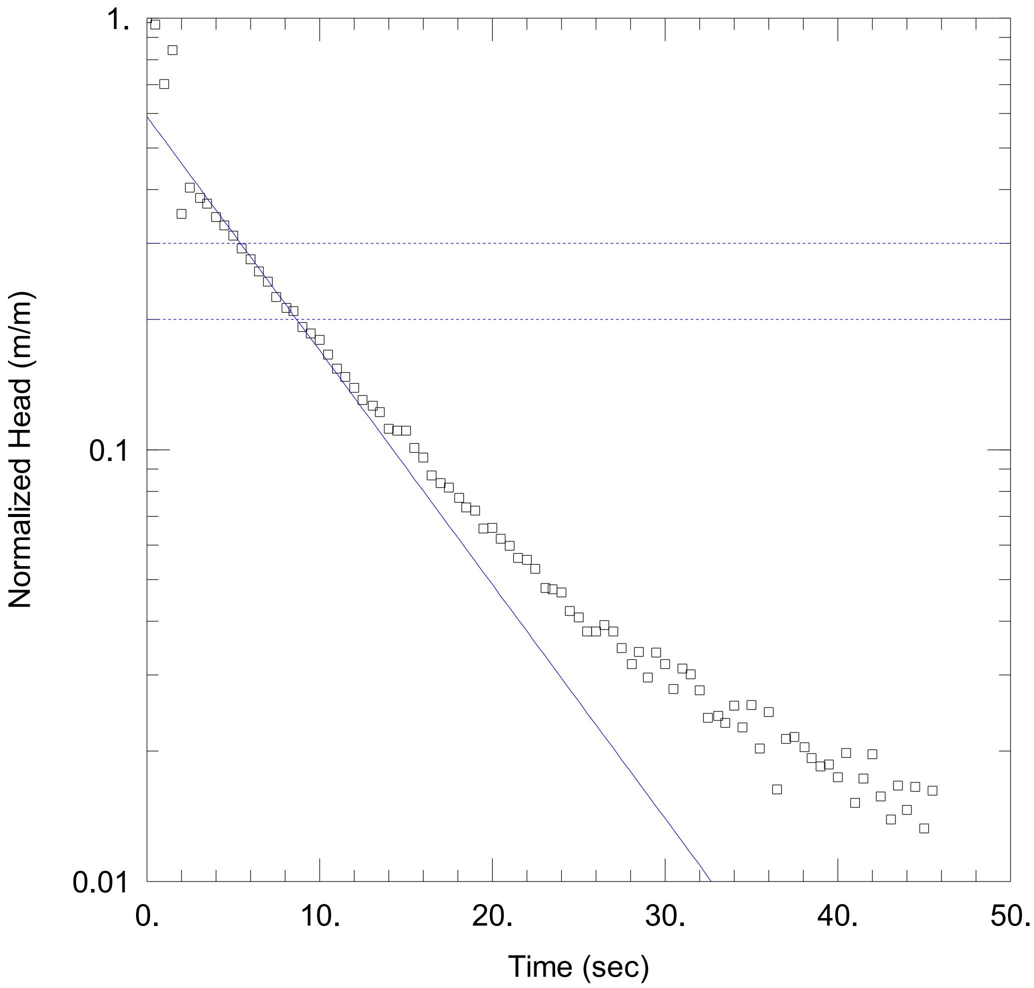
WELL DATA (C012P1)

Initial Displacement: 1.282 m
Static Water Column Height: 14.13 m
Total Well Penetration Depth: 14.13 m
Screen Length: 6. m
Casing Radius: 0.025 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.4035 m/day
y0 = 0.9432 m



FALLING HEAD 1

Data Set: N:\...\C022P1_FH1.aqt
Date: 10/03/12 Time: 15:41:16

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C022P1
Test Date: 22/08/2012

AQUIFER DATA

Saturated Thickness: 39.41 m Anisotropy Ratio (Kz/Kr): 0.1

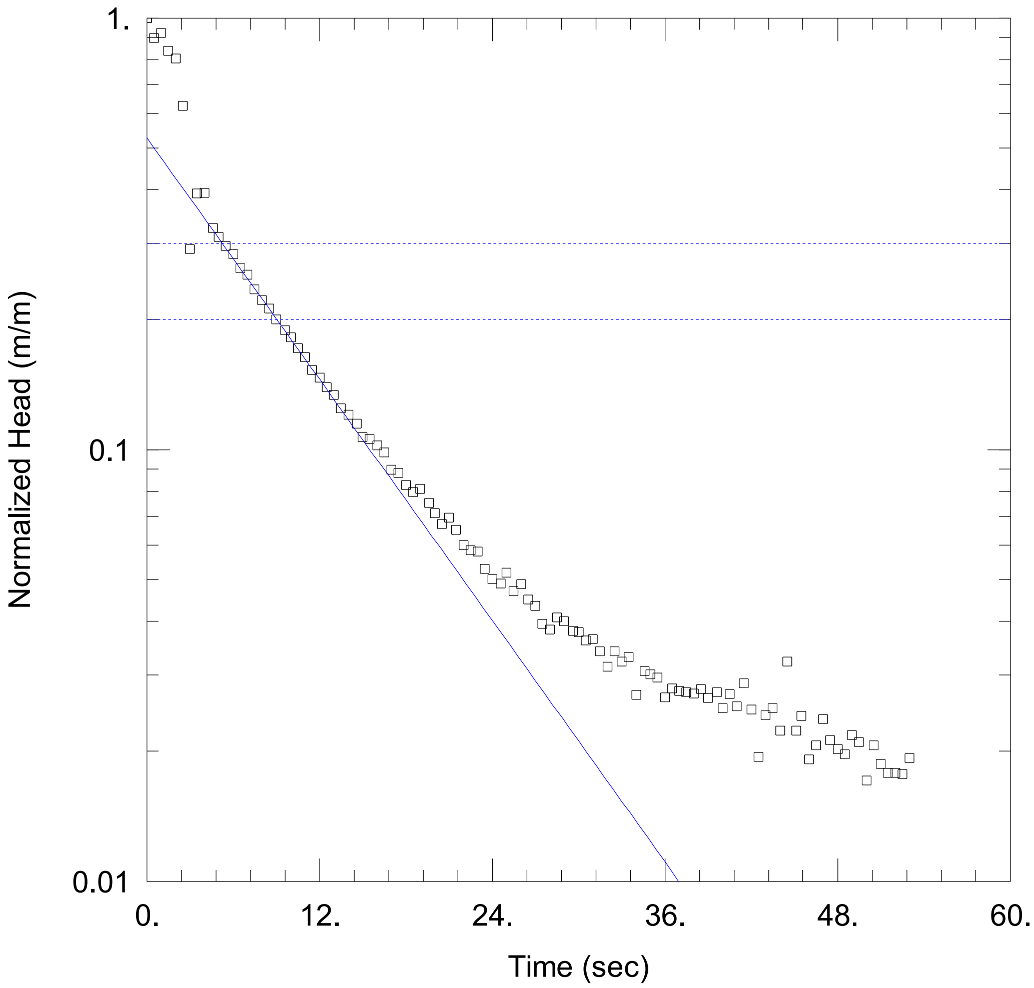
WELL DATA (C022P1)

Initial Displacement: 1.162 m
Total Well Penetration Depth: 39.41 m
Casing Radius: 0.025 m
Static Water Column Height: 39.41 m
Screen Length: 6. m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 3.129 m/day y0 = 0.6869 m



FALLING HEAD 2

Data Set: N:\...\C022P1_FH2.aqt
Date: 10/03/12 Time: 15:41:31

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C022P1
Test Date: 22/08/2012

AQUIFER DATA

Saturated Thickness: 39.41 m
Anisotropy Ratio (Kz/Kr): 0.1

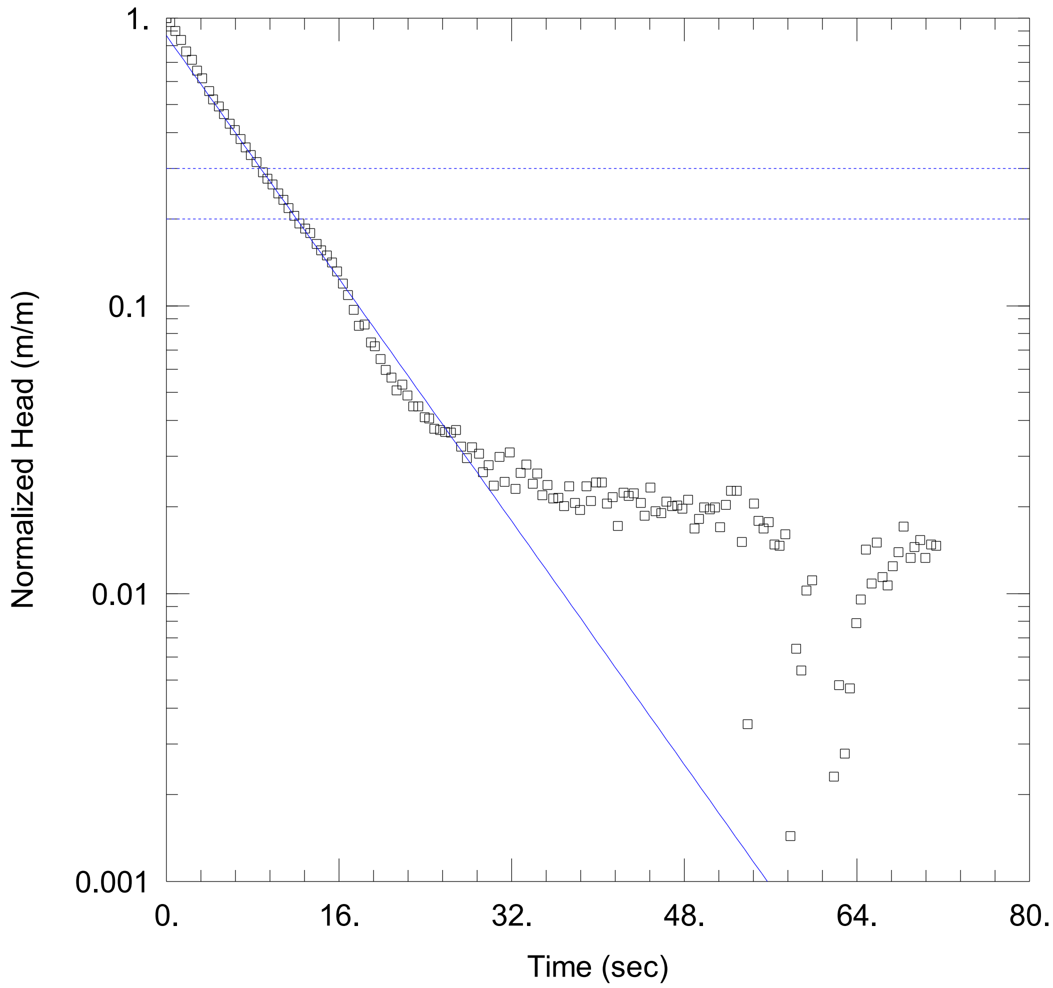
WELL DATA (C022P1)

Initial Displacement: 1.015 m
Static Water Column Height: 39.41 m
Total Well Penetration Depth: 39.41 m
Screen Length: 6. m
Casing Radius: 0.025 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 2.688 m/day
y0 = 0.5349 m



RISING HEAD 1

Data Set: N:\...\C022P1_RH1.aqt
Date: 10/03/12 Time: 15:41:48

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C022P1
Test Date: 22/08/2012

AQUIFER DATA

Saturated Thickness: 39.41 m
Anisotropy Ratio (Kz/Kr): 0.1

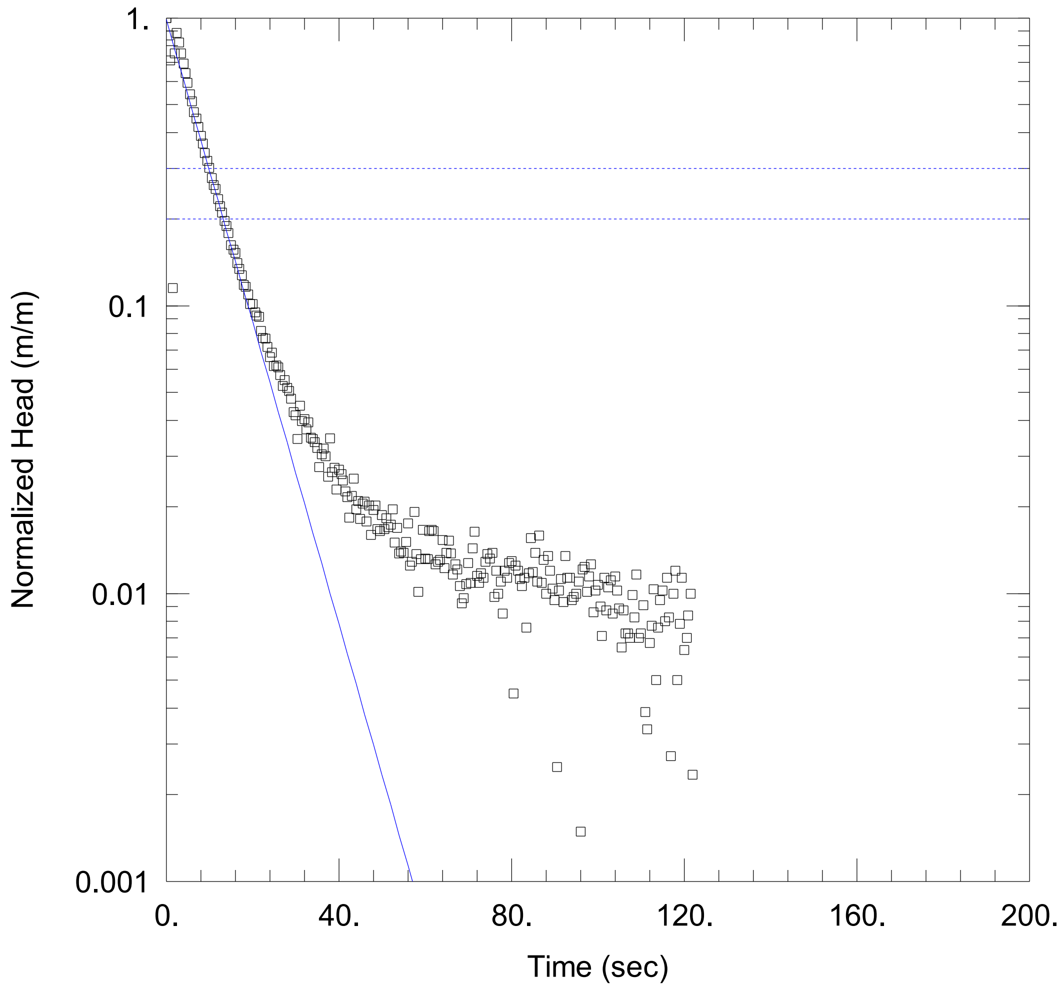
WELL DATA (C022P1)

Initial Displacement: 0.8358 m
Total Well Penetration Depth: 39.41 m
Casing Radius: 0.025 m
Static Water Column Height: 39.41 m
Screen Length: 6. m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 3.042 m/day
y0 = 0.725 m



RISING HEAD 2

Data Set: N:\...\C022P1_RH2.aqt
Date: 10/03/12 Time: 15:42:04

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C022P1
Test Date: 22/08/2012

AQUIFER DATA

Saturated Thickness: 39.41 m Anisotropy Ratio (Kz/Kr): 0.1

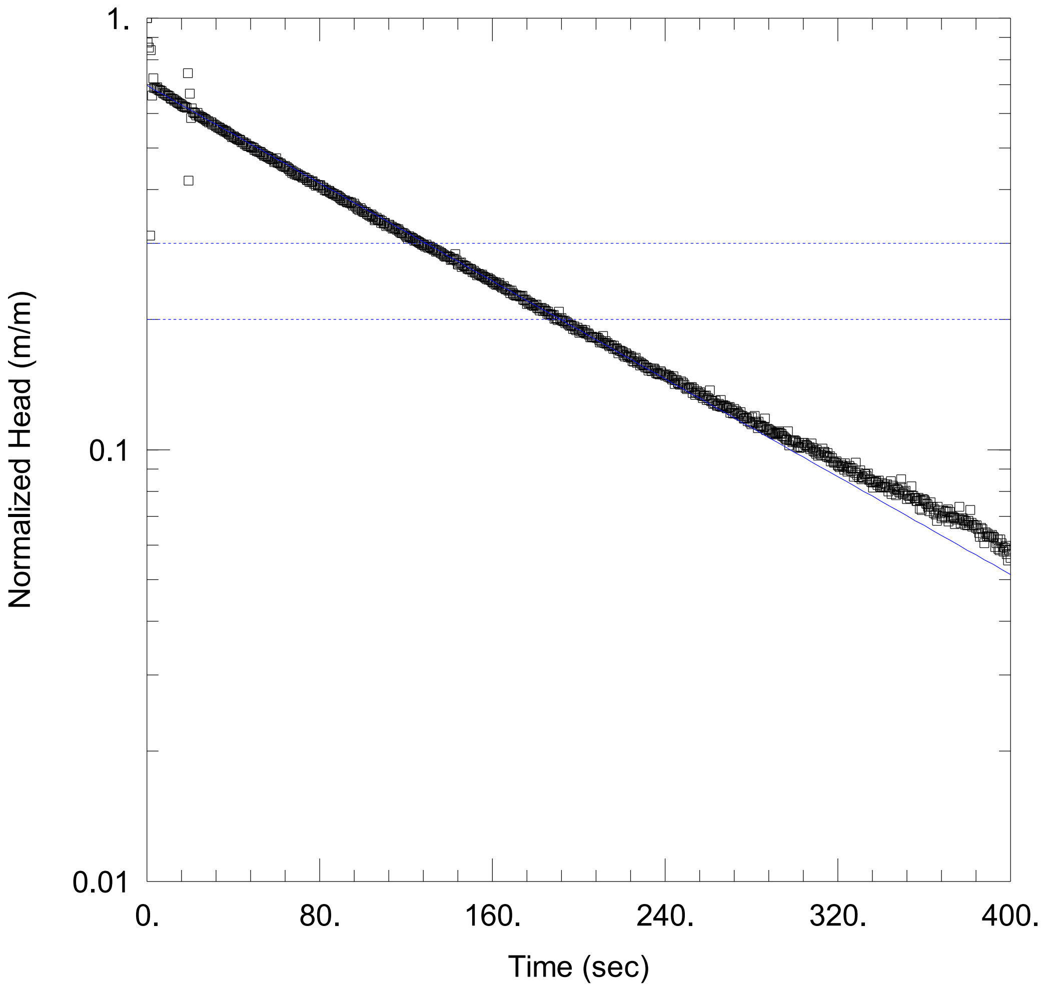
WELL DATA (C022P1)

Initial Displacement: 0.9791 m Static Water Column Height: 39.41 m
Total Well Penetration Depth: 39.41 m Screen Length: 6. m
Casing Radius: 0.025 m Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 3.031 m/day y0 = 0.9681 m



FALLING HEAD 1

Data Set: N:\...\C025P2_FH1.aqt
Date: 10/03/12 Time: 15:42:23

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C025P2
Test Date: 22/8/2012

AQUIFER DATA

Saturated Thickness: 30.64 m Anisotropy Ratio (Kz/Kr): 0.1

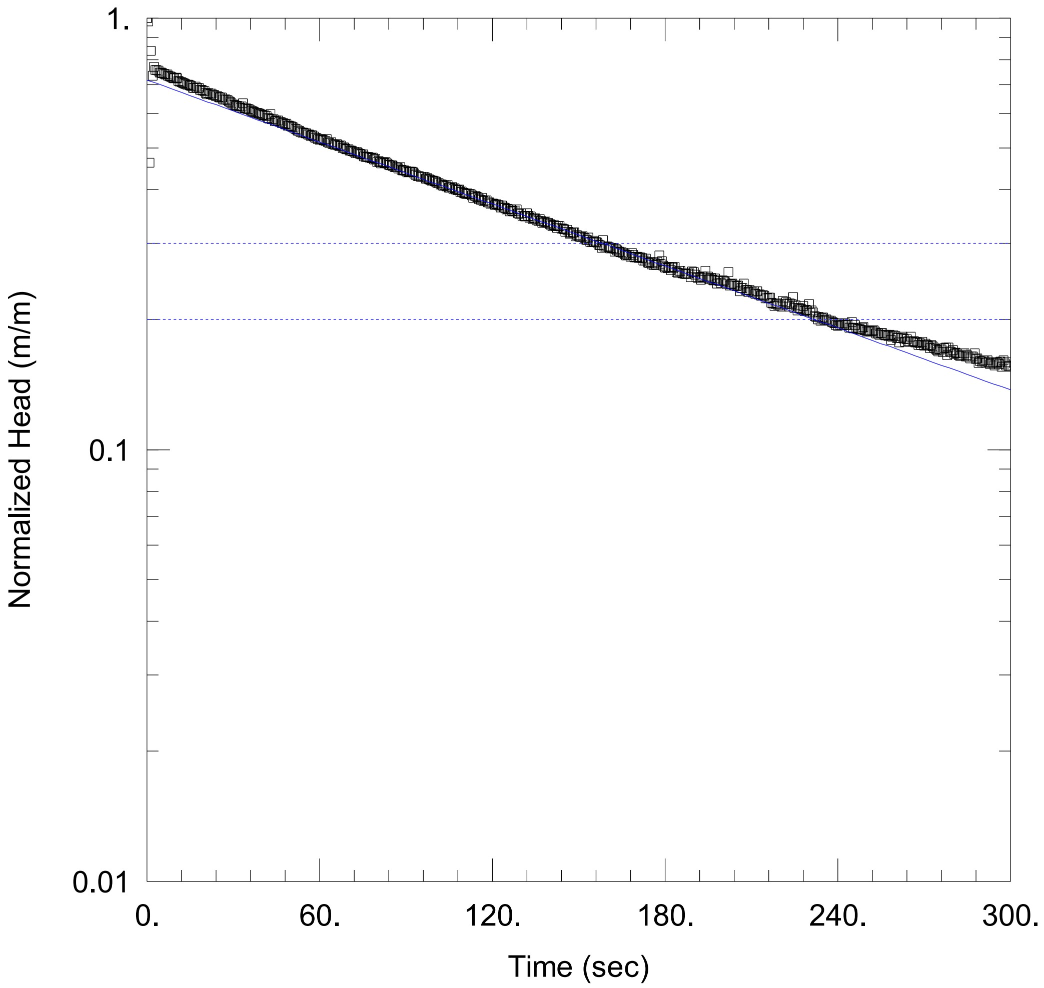
WELL DATA (C025P2)

Initial Displacement: 1.433 m Static Water Column Height: 30.64 m
Total Well Penetration Depth: 25.64 m Screen Length: 4. m
Casing Radius: 0.025 m Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.1968 m/day y0 = 0.9995 m



FALLING HEAD 2

Data Set: N:\...\C025P2_FH2.aqt
Date: 10/03/12 Time: 15:42:40

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C025P2
Test Date: 22/8/2012

AQUIFER DATA

Saturated Thickness: 30.64 m Anisotropy Ratio (Kz/Kr): 0.1

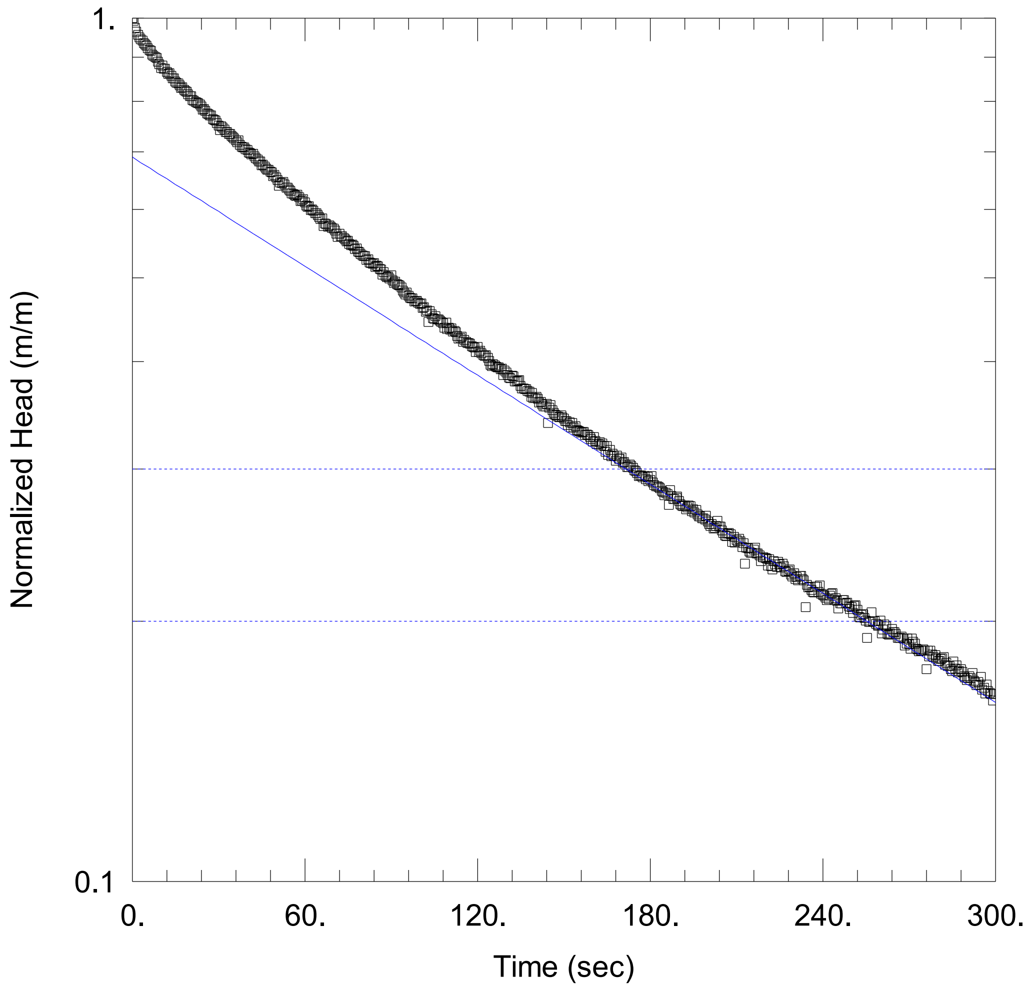
WELL DATA (C025P2)

Initial Displacement: 1.315 m
Total Well Penetration Depth: 25.64 m
Casing Radius: 0.025 m
Static Water Column Height: 30.64 m
Screen Length: 4. m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.1663 m/day y0 = 0.9443 m



RISING HEAD 1

Data Set: N:\...\C025P2_RH1.aqt
Date: 10/03/12 Time: 15:42:58

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C025P2
Test Date: 22/8/2012

AQUIFER DATA

Saturated Thickness: 30.64 m
Anisotropy Ratio (Kz/Kr): 0.1

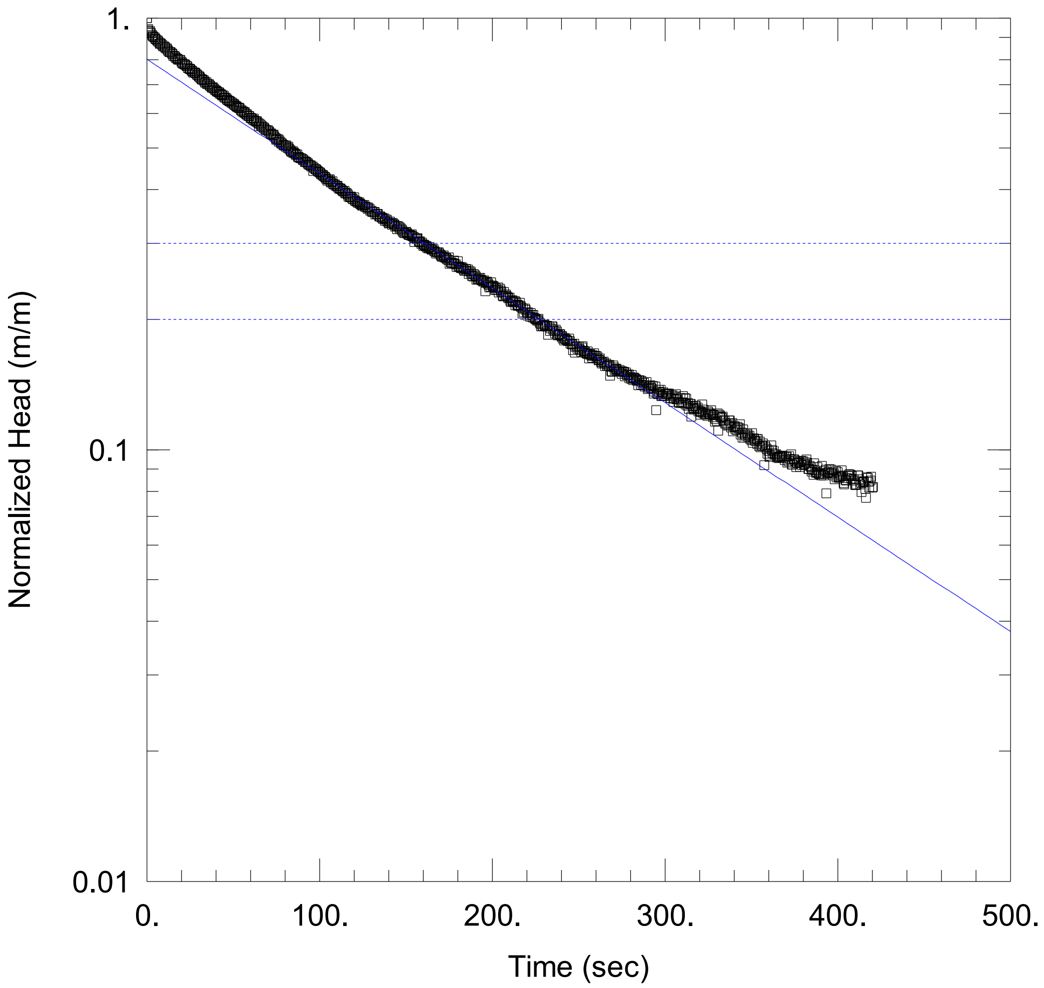
WELL DATA (C025P2)

Initial Displacement: 1.083 m
Total Well Penetration Depth: 25.64 m
Casing Radius: 0.025 m
Static Water Column Height: 30.64 m
Screen Length: 4. m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.1463 m/day
y0 = 0.7469 m



RISING HEAD 2

Data Set: N:\...\C025P2_RH2.aqt
Date: 10/03/12 Time: 15:43:15

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C025P2
Test Date: 22/8/2012

AQUIFER DATA

Saturated Thickness: 30.64 m
Anisotropy Ratio (Kz/Kr): 0.1

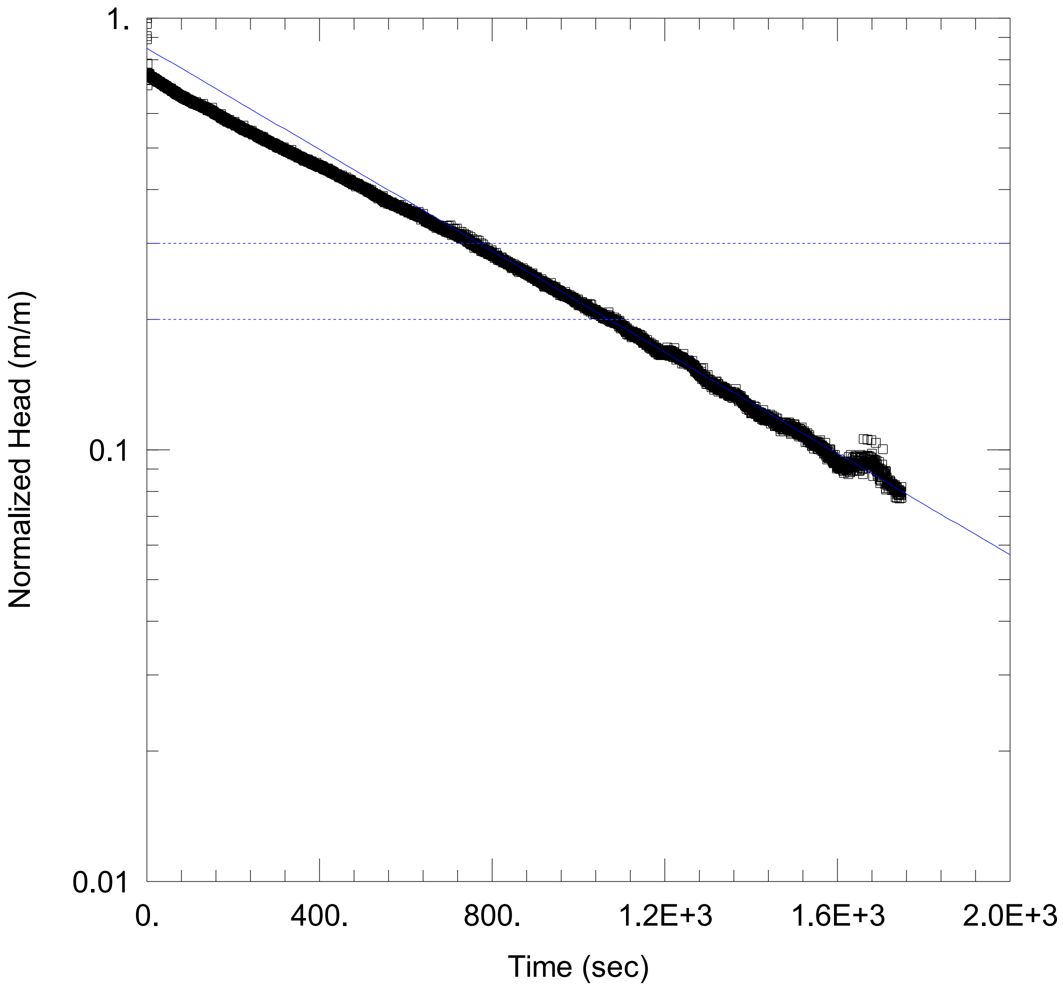
WELL DATA (C025P2)

Initial Displacement: 1.054 m
Total Well Penetration Depth: 25.64 m
Casing Radius: 0.025 m
Static Water Column Height: 30.64 m
Screen Length: 4. m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.1843 m/day
y0 = 0.8454 m



FALLING HEAD 1

Data Set: N:\...\C035P1_FH1.aqt
Date: 10/03/12 Time: 16:03:27

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C035P1
Test Date: 23/8/2012

AQUIFER DATA

Saturated Thickness: 12. m
Anisotropy Ratio (Kz/Kr): 0.1

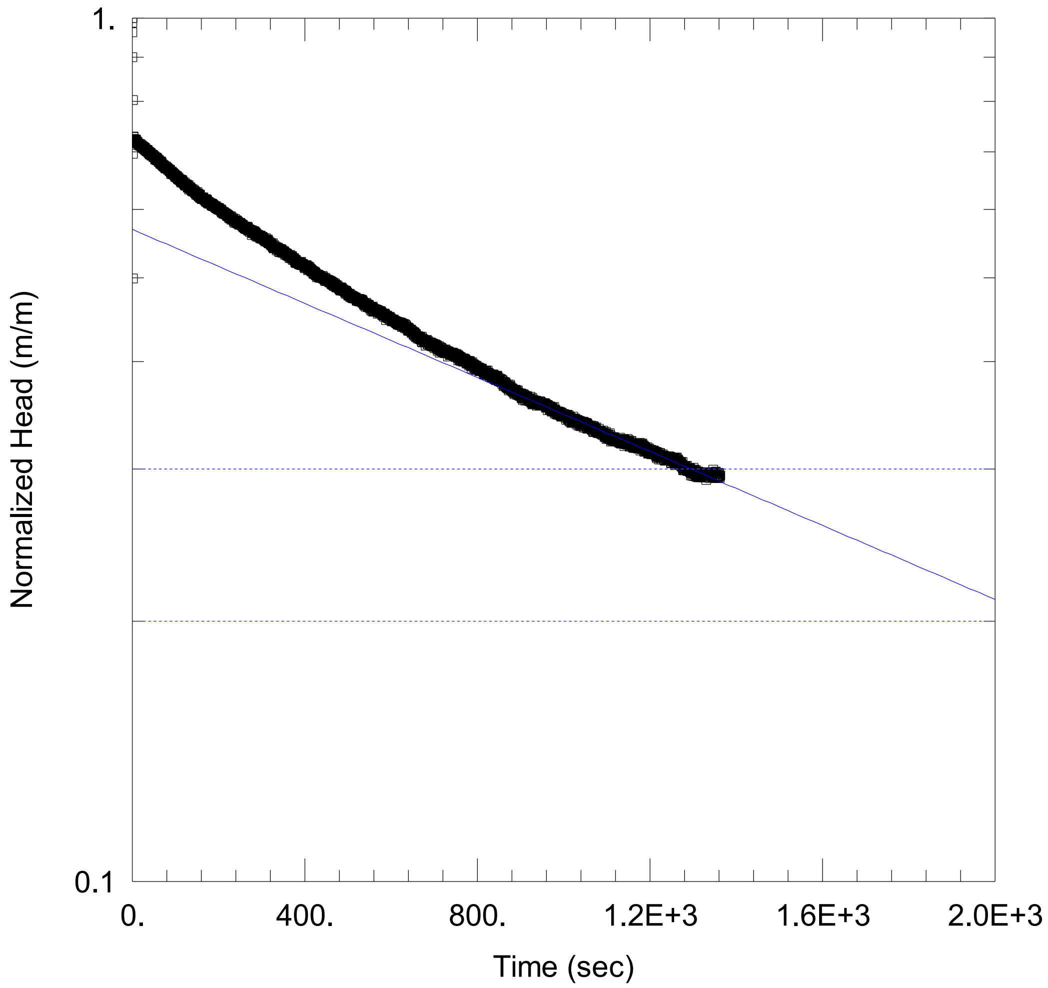
WELL DATA (CP035P1)

Initial Displacement: 1.42 m
Static Water Column Height: 57.56 m
Total Well Penetration Depth: 57.56 m
Screen Length: 6. m
Casing Radius: 0.025 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.03529 m/day
y0 = 1.209 m



FALLING HEAD 2

Data Set: N:\...\C035P1_FH2.aqt
Date: 10/03/12 Time: 15:44:00

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C035P1
Test Date: 23/8/2012

AQUIFER DATA

Saturated Thickness: 12. m
Anisotropy Ratio (Kz/Kr): 0.1

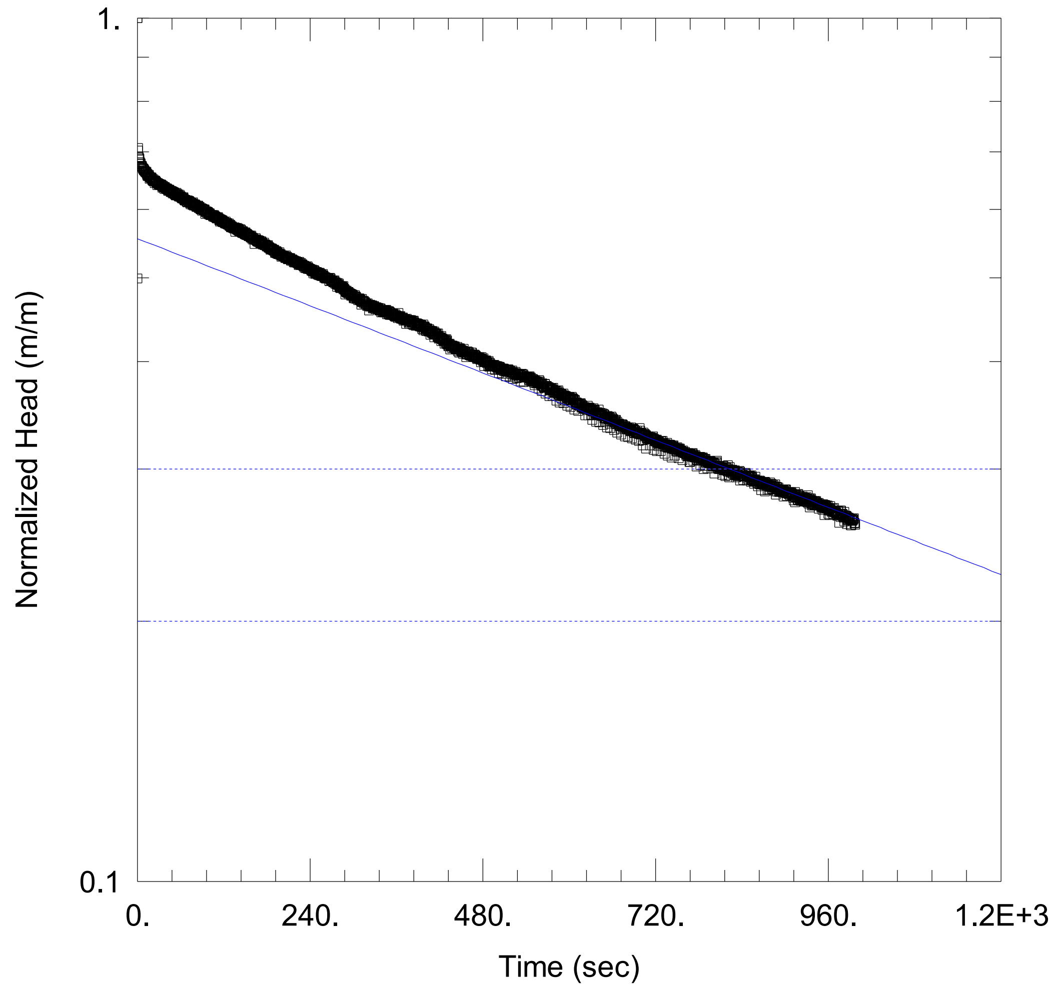
WELL DATA (C035P1)

Initial Displacement: 1.451 m
Static Water Column Height: 57.56 m
Total Well Penetration Depth: 57.56 m
Screen Length: 6. m
Casing Radius: 0.025 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.01289 m/day
y0 = 0.8252 m



RISING HEAD 1

Data Set: N:\...\C035P1_RH1.aqt
Date: 10/03/12 Time: 16:02:40

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C035P1
Test Date: 23/8/2012

AQUIFER DATA

Saturated Thickness: 12. m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (C035P1)

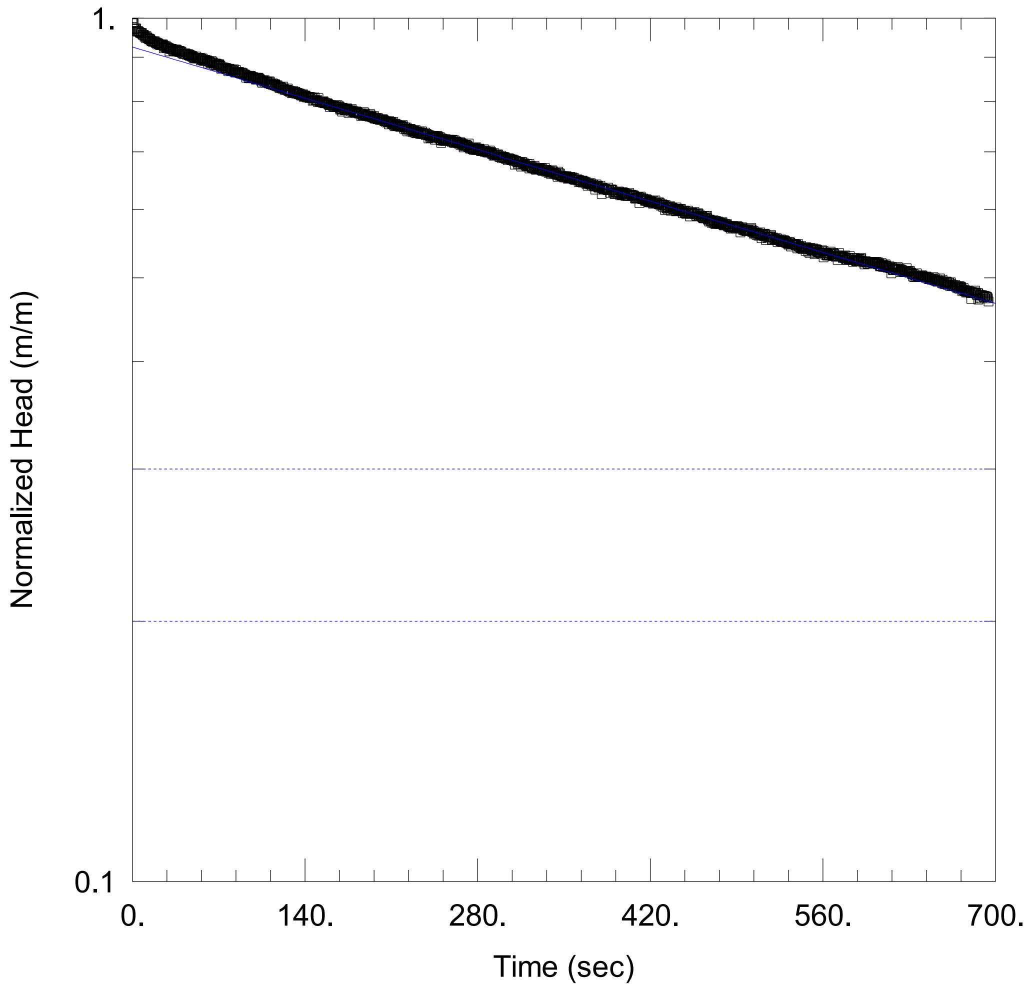
Initial Displacement: 1.59 m
Total Well Penetration Depth: 57.56 m
Casing Radius: 0.025 m

Static Water Column Height: 57.56 m
Screen Length: 6. m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.01949 m/day y0 = 0.8823 m



RISING HEAD 2

Data Set: N:\...\C035P1_RH2.aqt
Date: 10/03/12 Time: 15:43:30

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C035P1
Test Date: 23/8/2012

AQUIFER DATA

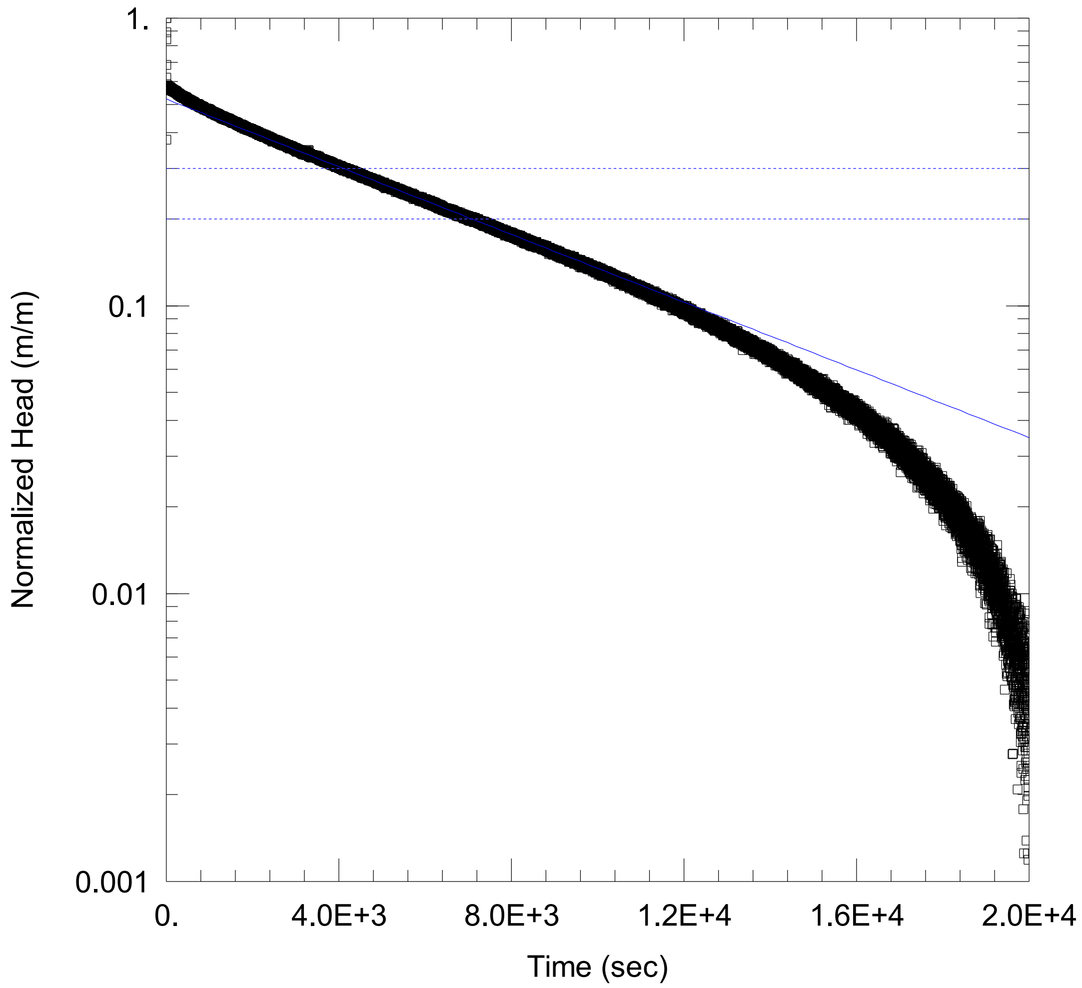
Saturated Thickness: 12. m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (C035P1)

Initial Displacement: 1.101 m
Static Water Column Height: 57.56 m
Total Well Penetration Depth: 57.56 m
Screen Length: 6. m
Casing Radius: 0.025 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.02556 m/day
y0 = 1.019 m



FALLING HEAD TEST

Data Set: N:\...\C553P1_FH.aqt
Date: 10/10/12 Time: 10:01:15

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C553P1
Test Date: 3/10/2012

AQUIFER DATA

Saturated Thickness: 12. m
Anisotropy Ratio (Kz/Kr): 0.1

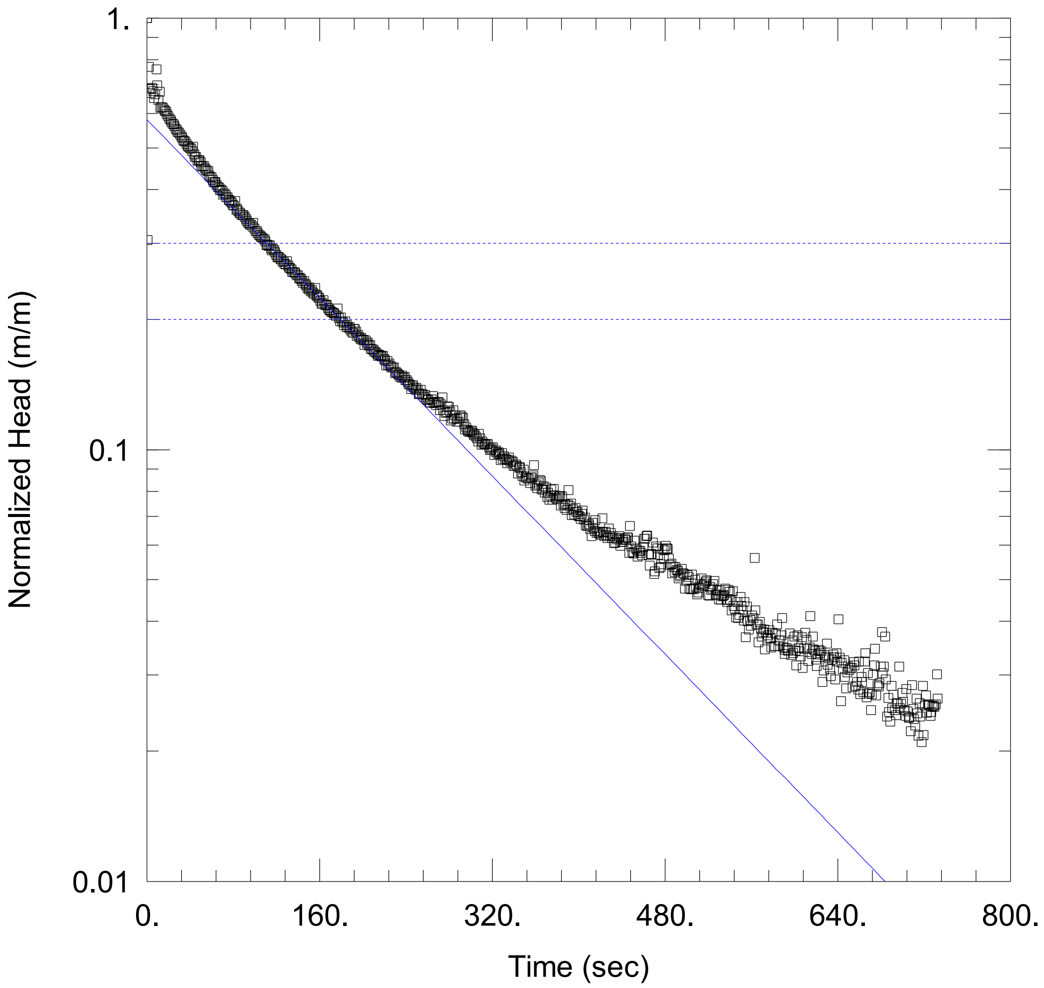
WELL DATA (C553P1)

Initial Displacement: 1.829 m
Total Well Penetration Depth: 25.27 m
Casing Radius: 0.025 m
Static Water Column Height: 25.27 m
Screen Length: 9. m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.002221 m/day
y0 = 0.9564 m



FALLING HEAD TEST 1

Data Set: N:\...\C555P1_FH1.aqt
Date: 10/10/12 Time: 10:02:59

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C555P1
Test Date: 3/10/2012

AQUIFER DATA

Saturated Thickness: 26. m Anisotropy Ratio (Kz/Kr): 0.1

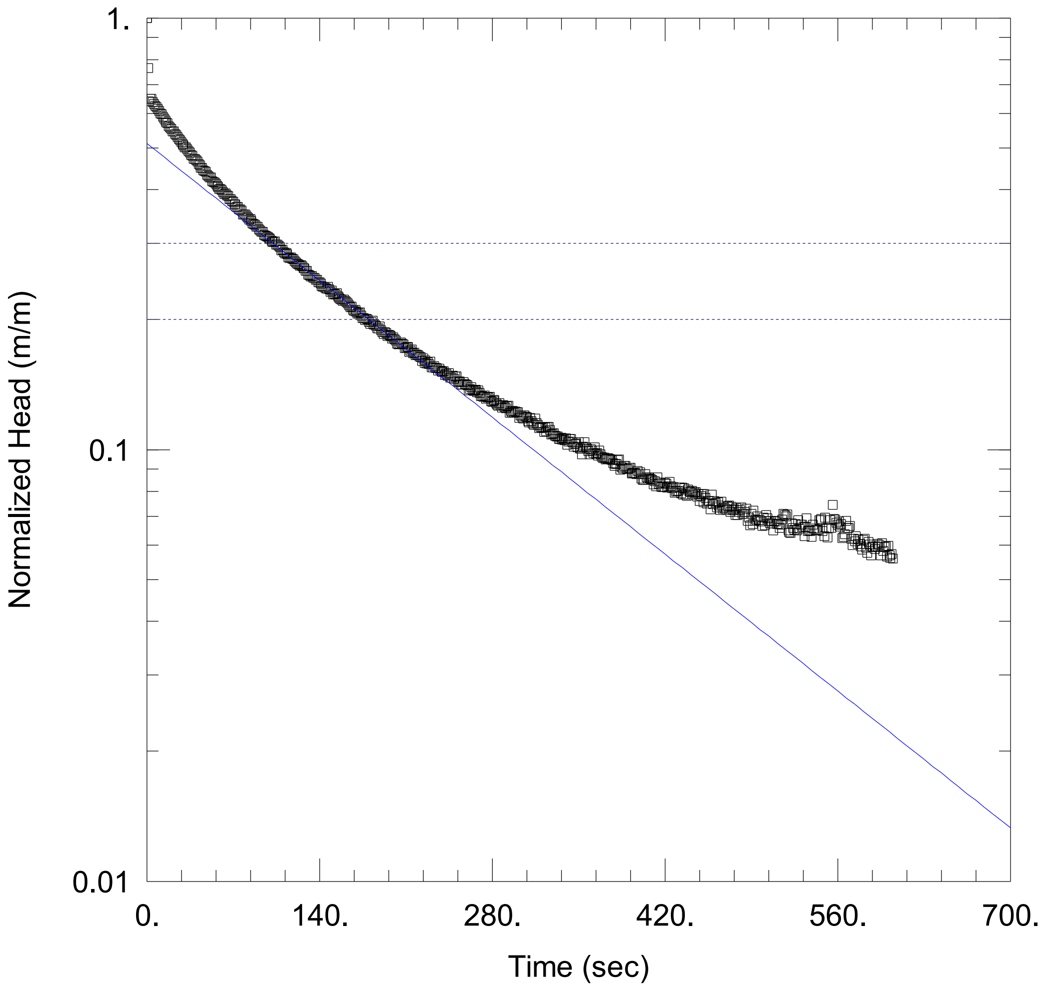
WELL DATA (C555P1)

Initial Displacement: 1.384 m Static Water Column Height: 63.31 m
Total Well Penetration Depth: 63.31 m Screen Length: 9. m
Casing Radius: 0.025 m Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.1082 m/day y0 = 0.8047 m



FALLING HEAD TEST 2

Data Set: N:\...\C555P1_FH2.aqt
Date: 10/10/12 Time: 10:03:20

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C555P1
Test Date: 3/10/2012

AQUIFER DATA

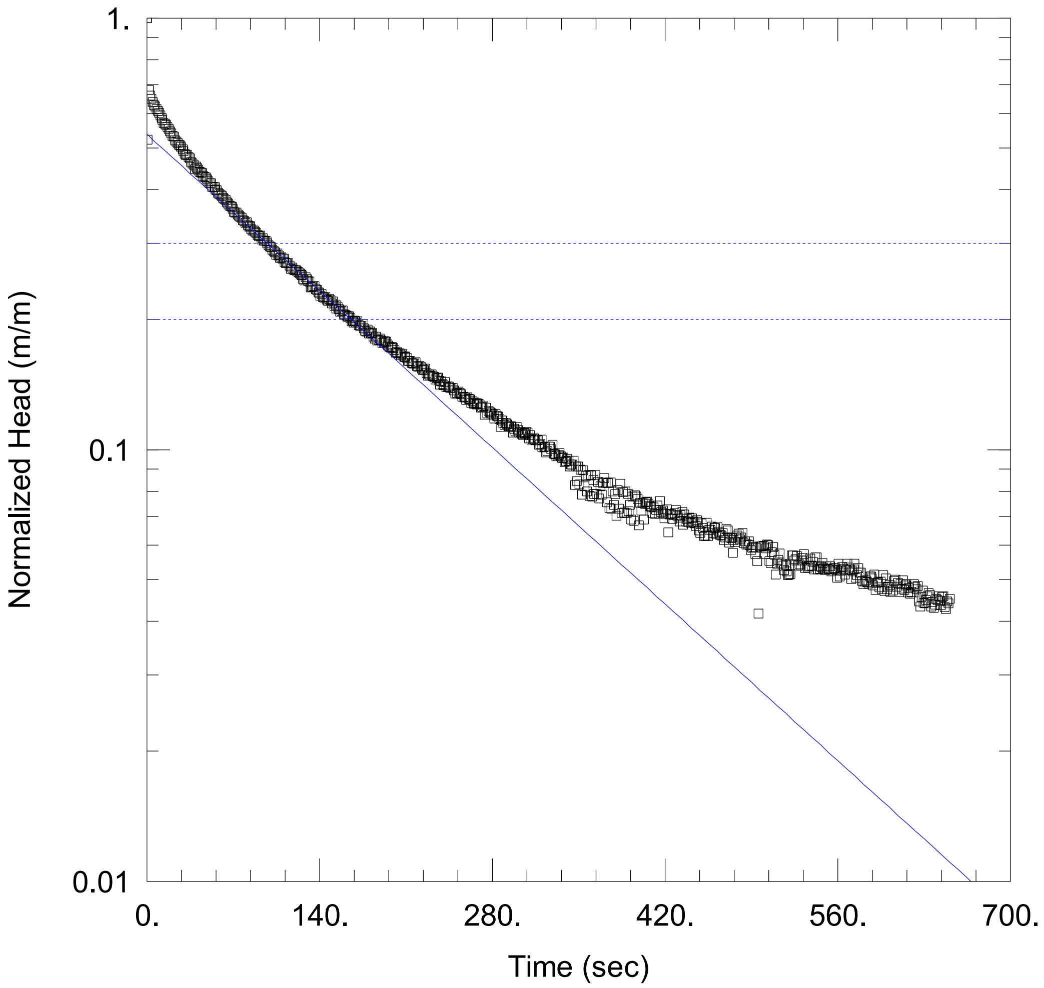
Saturated Thickness: 26. m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (C555P1)

Initial Displacement: 1.483 m
Static Water Column Height: 63.31 m
Total Well Penetration Depth: 63.31 m
Screen Length: 9. m
Casing Radius: 0.025 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.09505 m/day
y0 = 0.7593 m



RISING HEAD TEST 1

Data Set: N:\...\C555P1_RH1.aqt
Date: 10/10/12 Time: 10:03:50

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C555P1
Test Date: 3/10/2012

AQUIFER DATA

Saturated Thickness: 26. m
Anisotropy Ratio (Kz/Kr): 0.1

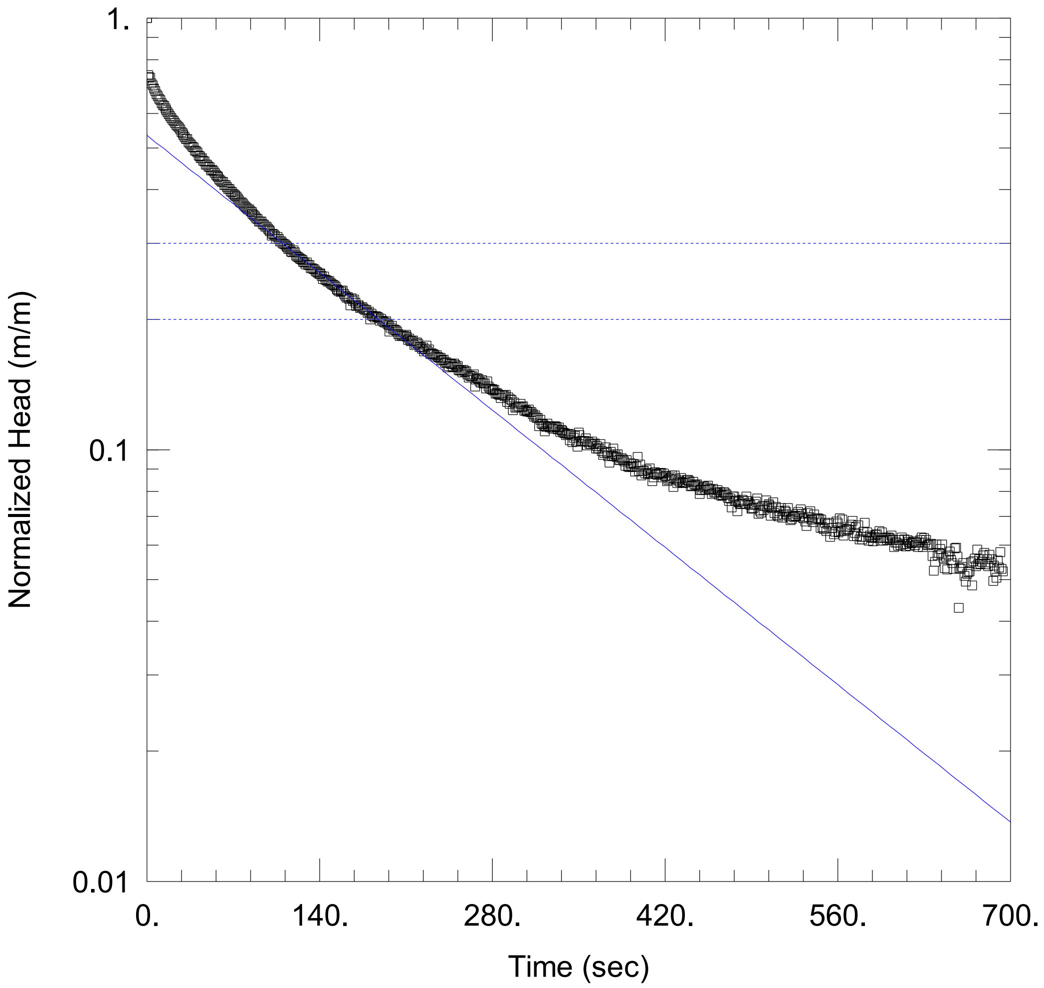
WELL DATA (C0555P1)

Initial Displacement: 1.58 m
Static Water Column Height: 63.31 m
Total Well Penetration Depth: 63.31 m
Screen Length: 9. m
Casing Radius: 0.025 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.1087 m/day
y0 = 0.8495 m



RISING HEAD TEST 2

Data Set: N:\...\C555P1_RH2.aqt
Date: 10/10/12 Time: 10:04:21

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C555P1
Test Date: 3/10/2012

AQUIFER DATA

Saturated Thickness: 26. m
Anisotropy Ratio (Kz/Kr): 0.1

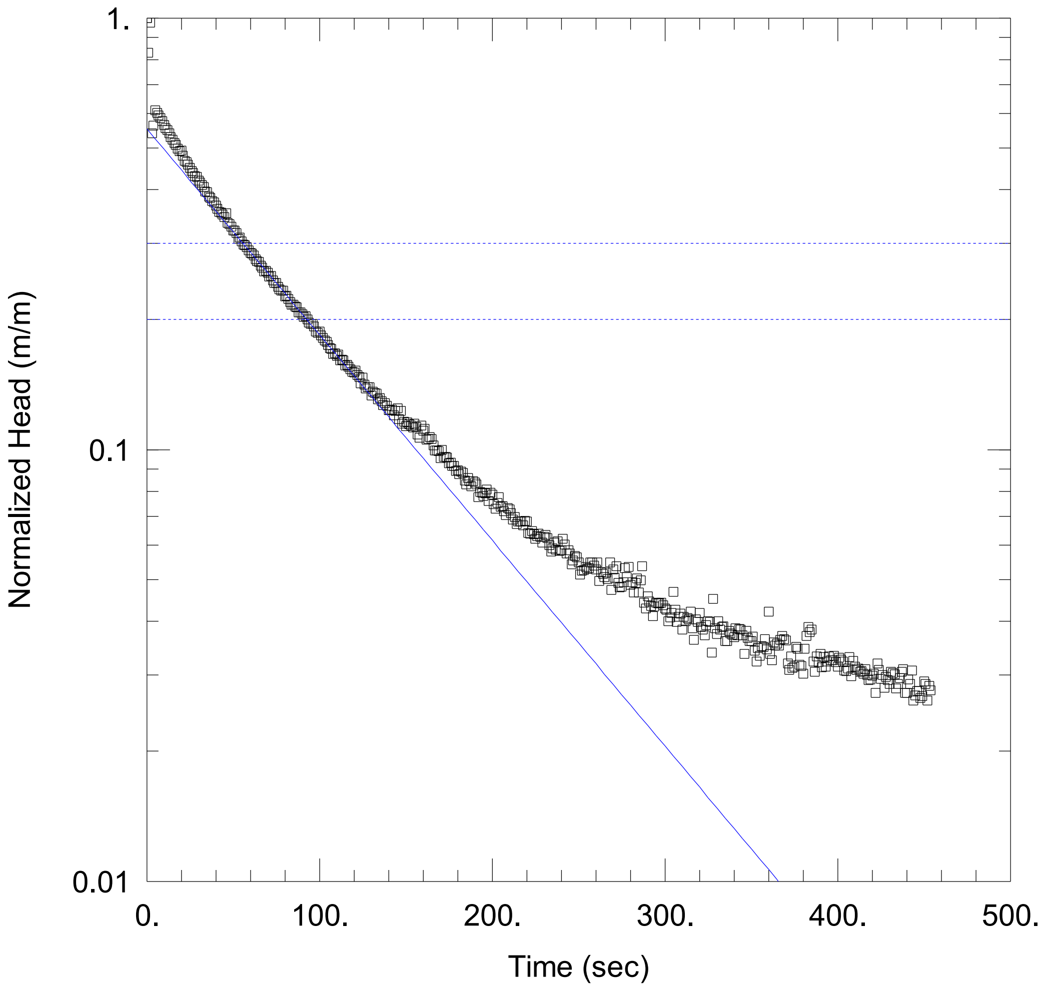
WELL DATA (C555P1)

Initial Displacement: 1.44 m
Total Well Penetration Depth: 63.31 m
Casing Radius: 0.025 m
Static Water Column Height: 63.31 m
Screen Length: 9. m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.09538 m/day
y0 = 0.7703 m



FALLING HEAD TEST 1

Data Set: N:\...\C556P1_FH1.aqt
Date: 10/10/12 Time: 10:01:52

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C556P1
Test Date: 3/10/2012

AQUIFER DATA

Saturated Thickness: 58.63 m Anisotropy Ratio (Kz/Kr): 0.1

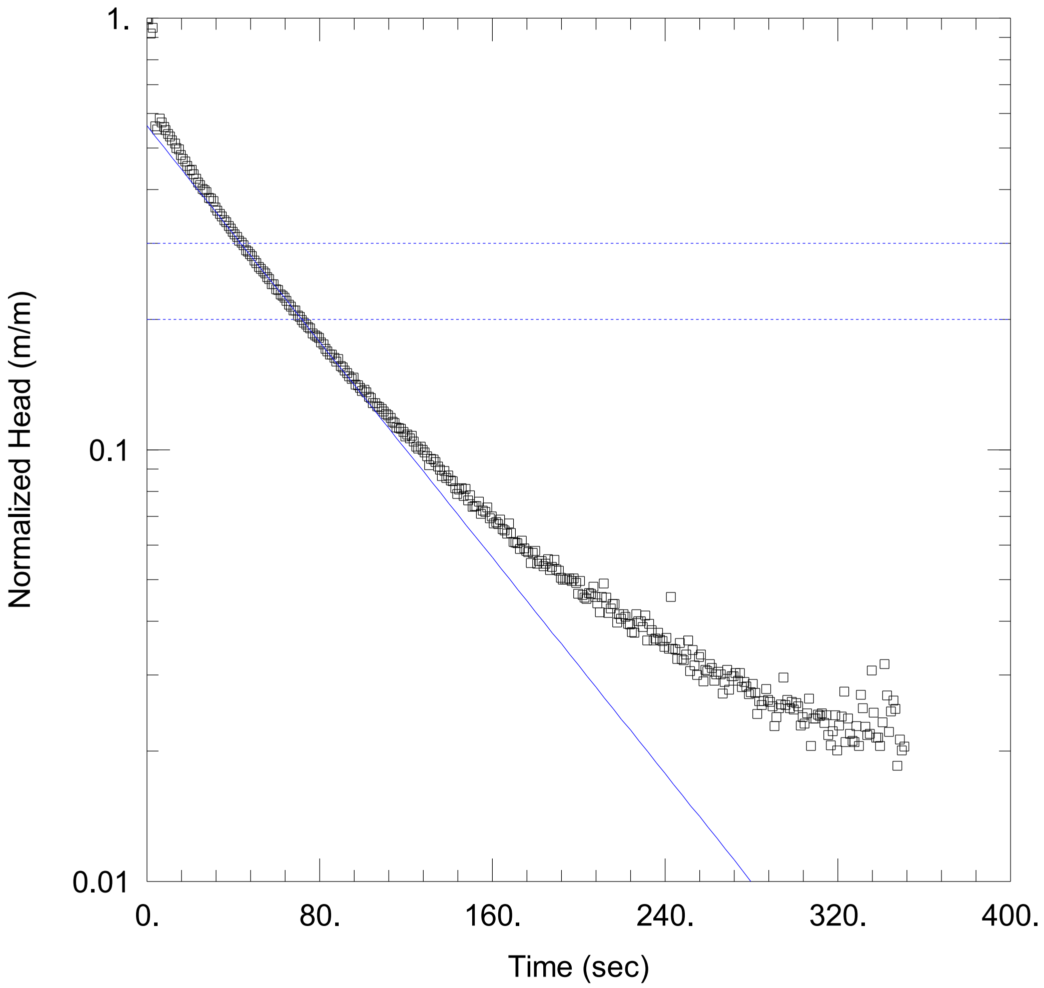
WELL DATA (C556P1)

Initial Displacement: 1.412 m
Total Well Penetration Depth: 55.84 m
Casing Radius: 0.025 m
Static Water Column Height: 55.84 m
Screen Length: 9. m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.1788 m/day y0 = 0.7808 m



FALLING HEAD TEST 2

Data Set: N:\...\C556P1_FH2.aqt
Date: 10/10/12 Time: 10:02:07

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C556P1
Test Date: 3/10/2012

AQUIFER DATA

Saturated Thickness: 58.63 m Anisotropy Ratio (Kz/Kr): 0.1

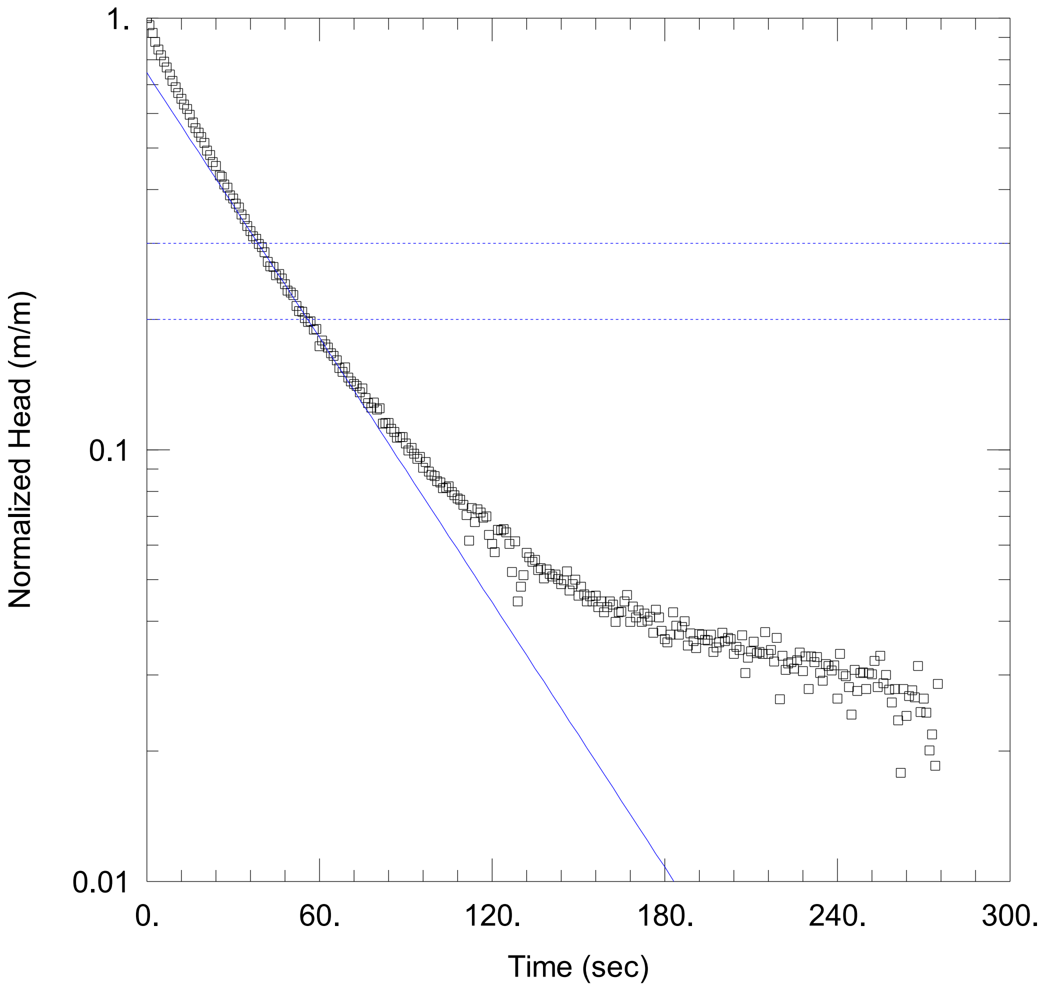
WELL DATA (C556P1)

Initial Displacement: 1.436 m Static Water Column Height: 55.84 m
Total Well Penetration Depth: 55.84 m Screen Length: 9. m
Casing Radius: 0.025 m Well Radius: 0.075 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.2345 m/day y0 = 0.8076 m



RISING HEAD TEST 1

Data Set: N:\...\C556P1_RH1.aqt
Date: 10/10/12 Time: 10:02:22

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C556P1
Test Date: 3/10/2012

AQUIFER DATA

Saturated Thickness: 58.63 m Anisotropy Ratio (Kz/Kr): 0.1

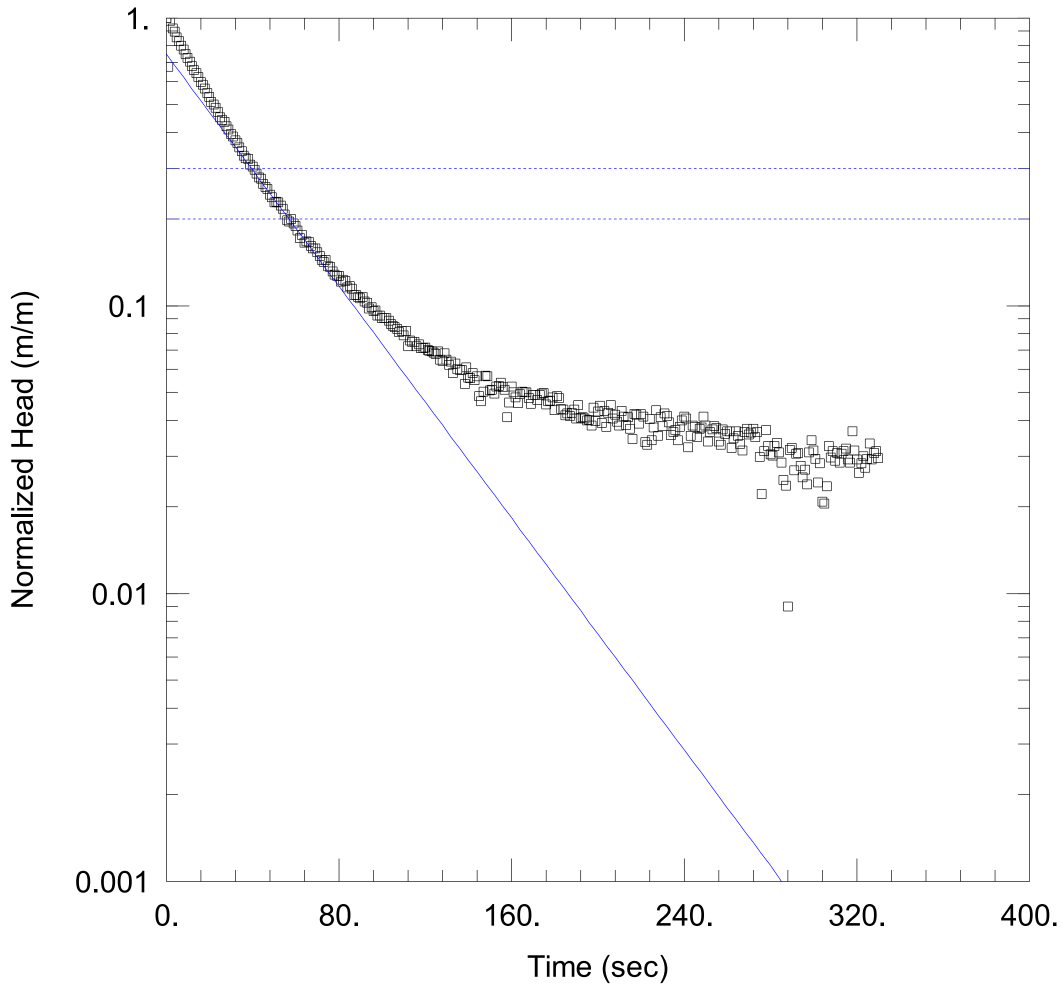
WELL DATA (C556P1)

Initial Displacement: 1.024 m Static Water Column Height: 55.84 m
Total Well Penetration Depth: 55.84 m Screen Length: 9. m
Casing Radius: 0.025 m Well Radius: 0.075 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.3835 m/day y0 = 0.7643 m



RISING HEAD TEST 2

Data Set: N:\...\C556P1_RH2.aqt
Date: 10/10/12 Time: 10:02:39

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C556P1
Test Date: 3/10/2012

AQUIFER DATA

Saturated Thickness: 58.63 m
Anisotropy Ratio (Kz/Kr): 0.1

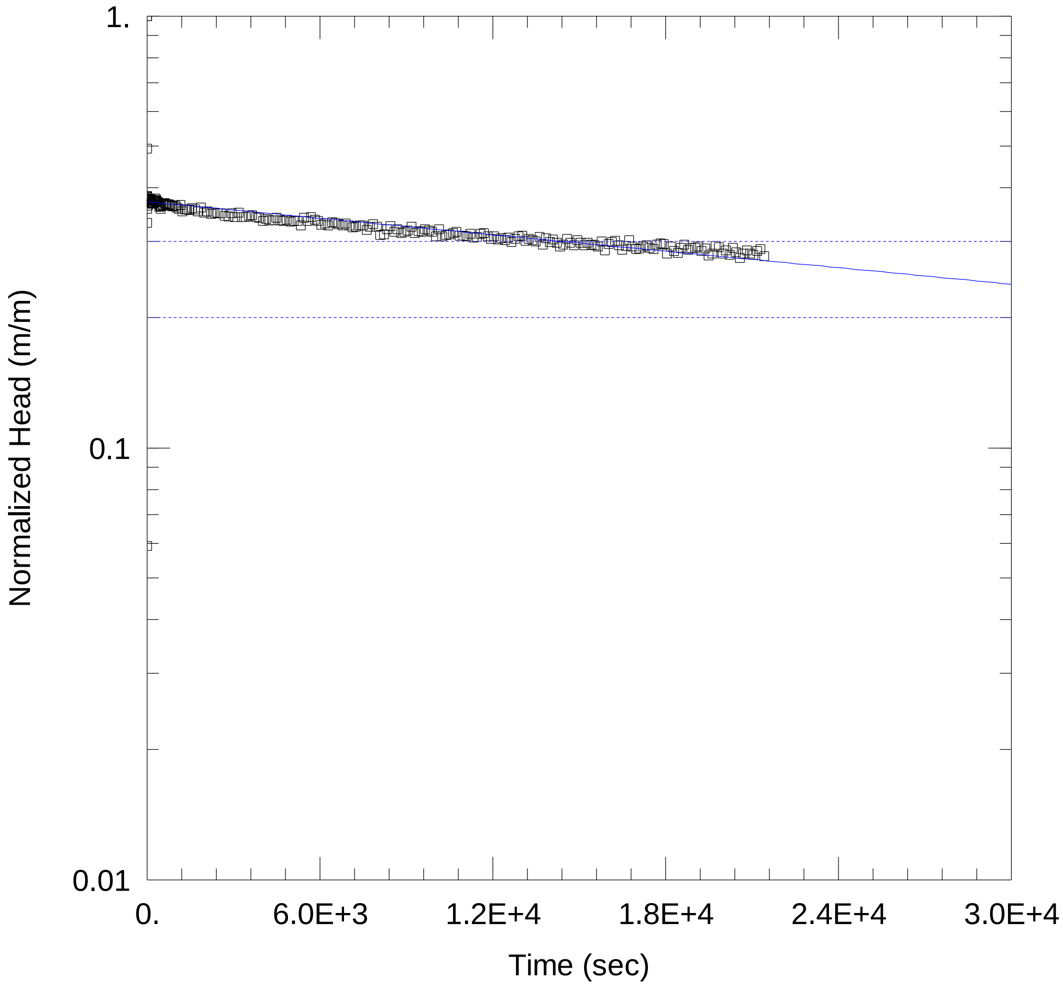
WELL DATA (C556P1)

Initial Displacement: 1.035 m
Static Water Column Height: 55.84 m
Total Well Penetration Depth: 55.84 m
Screen Length: 9. m
Casing Radius: 0.025 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.3779 m/day
y0 = 0.7746 m



FALLING HEAD TEST

Data Set: G:\41\24415\07 Additional Hydrogeology 2012\06 Slug Tests\C558P1_FH_RevA.aqt
Date: 10/17/12 Time: 12:46:39

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: C558P1
Test Date: 4/10/2012

AQUIFER DATA

Saturated Thickness: 6.79 m Anisotropy Ratio (Kz/Kr): 0.1

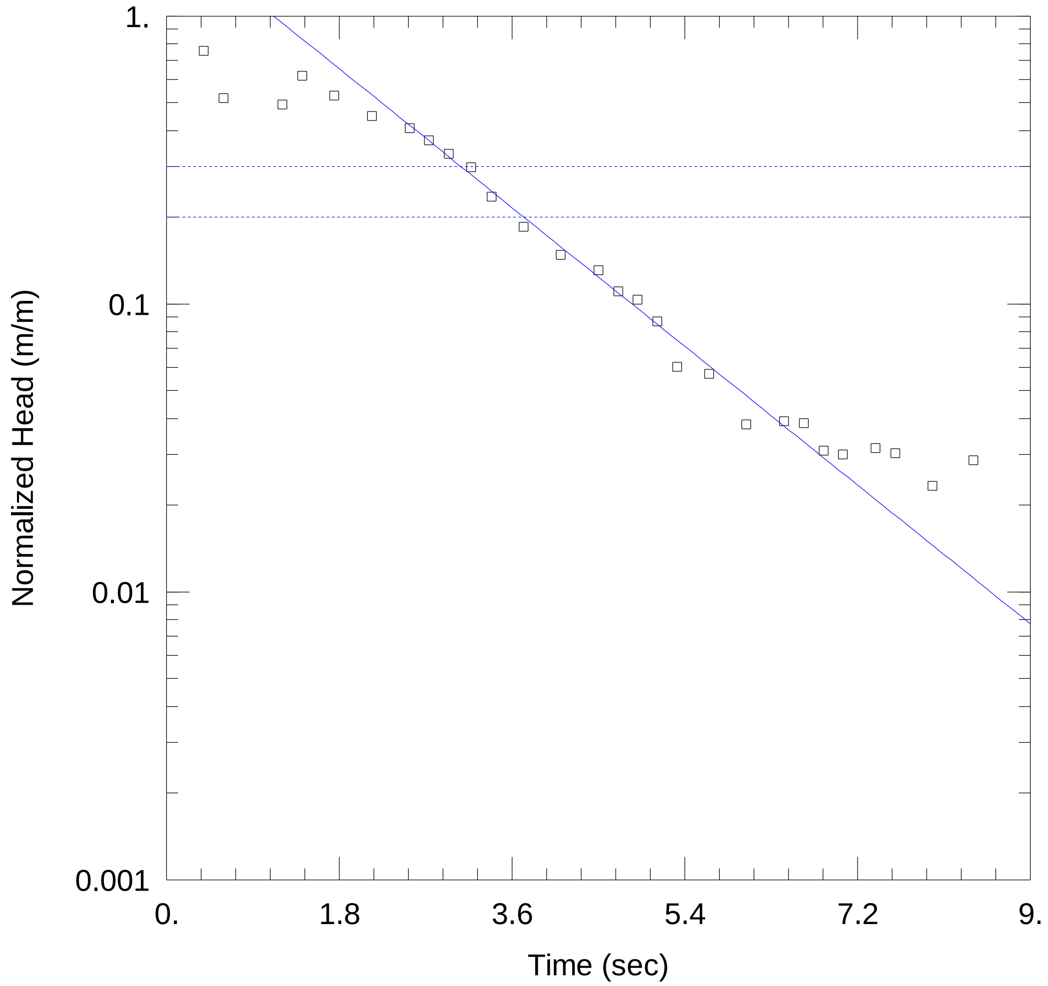
WELL DATA (C558P1)

Initial Displacement: 0.7436 m Static Water Column Height: 6.79 m
Total Well Penetration Depth: 9. m Screen Length: 9. m
Casing Radius: 0.025 m Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.0002123 m/day y0 = 0.276 m



HD02 TEST 1, RISING HEAD (1)

Data Set: G:\41\24415\07 Additional Hydrogeology 2012\06 Slug Tests\HD02_RH1.aqt
Date: 11/01/12 Time: 12:36:43

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: HD02
Test Date: 28/10/2012

AQUIFER DATA

Saturated Thickness: 29.21 m
Anisotropy Ratio (Kz/Kr): 0.1

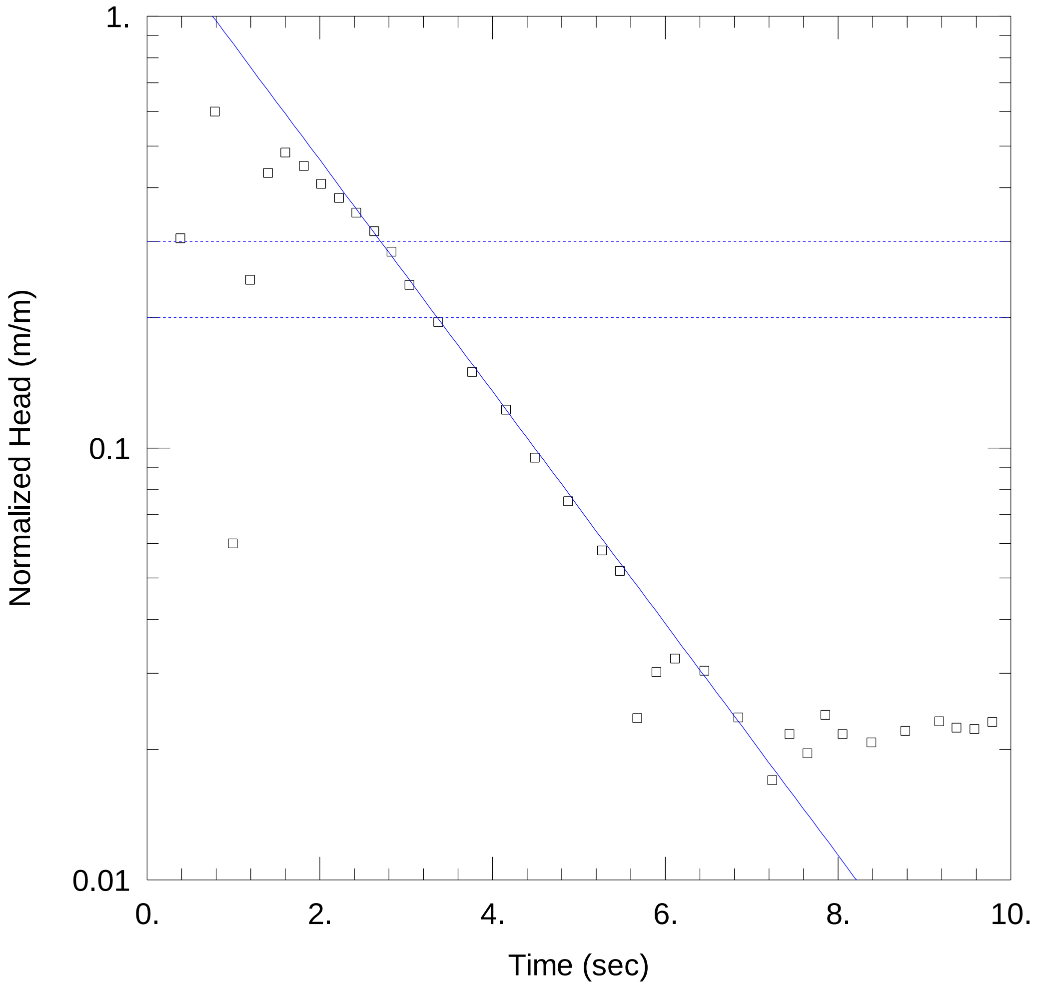
WELL DATA (HD02)

Initial Displacement: -0.805 m
Static Water Column Height: 23.21 m
Total Well Penetration Depth: 29.21 m
Screen Length: 6. m
Casing Radius: 0.025 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 14.93 m/day
y0 = -1.601 m



HD02 TEST 3, RISING HEAD (2)

Data Set: G:\41\24415\07 Additional Hydrogeology 2012\06 Slug Tests\HD02_RH2.aqt
Date: 11/01/12 Time: 12:36:21

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: HD02
Test Date: 28/10/2012

AQUIFER DATA

Saturated Thickness: 29.21 m
Anisotropy Ratio (Kz/Kr): 0.1

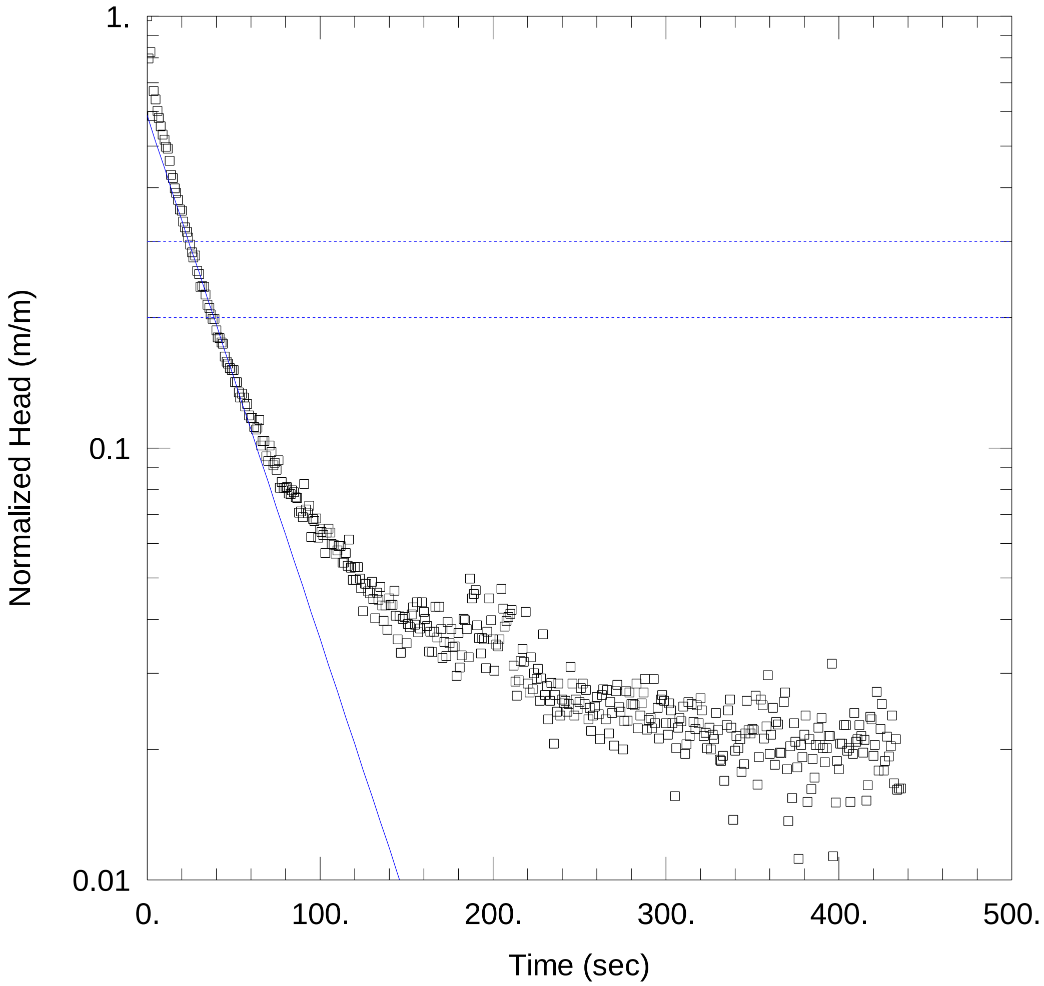
WELL DATA (HD02)

Initial Displacement: -1.033 m
Total Well Penetration Depth: 29.21 m
Casing Radius: 0.025 m
Static Water Column Height: 29.21 m
Screen Length: 6. m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 14.96 m/day
y0 = -1.649 m



HD03B TEST 1, FALLING HEAD (1)

Data Set: G:\41\24415\07 Additional Hydrogeology 2012\06 Slug Tests\HD03B_FH1.aqt
Date: 11/01/12 Time: 12:37:16

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: HD03B_FH1
Test Date: 28/10/2012

AQUIFER DATA

Saturated Thickness: 7.055 m
Anisotropy Ratio (Kz/Kr): 0.1

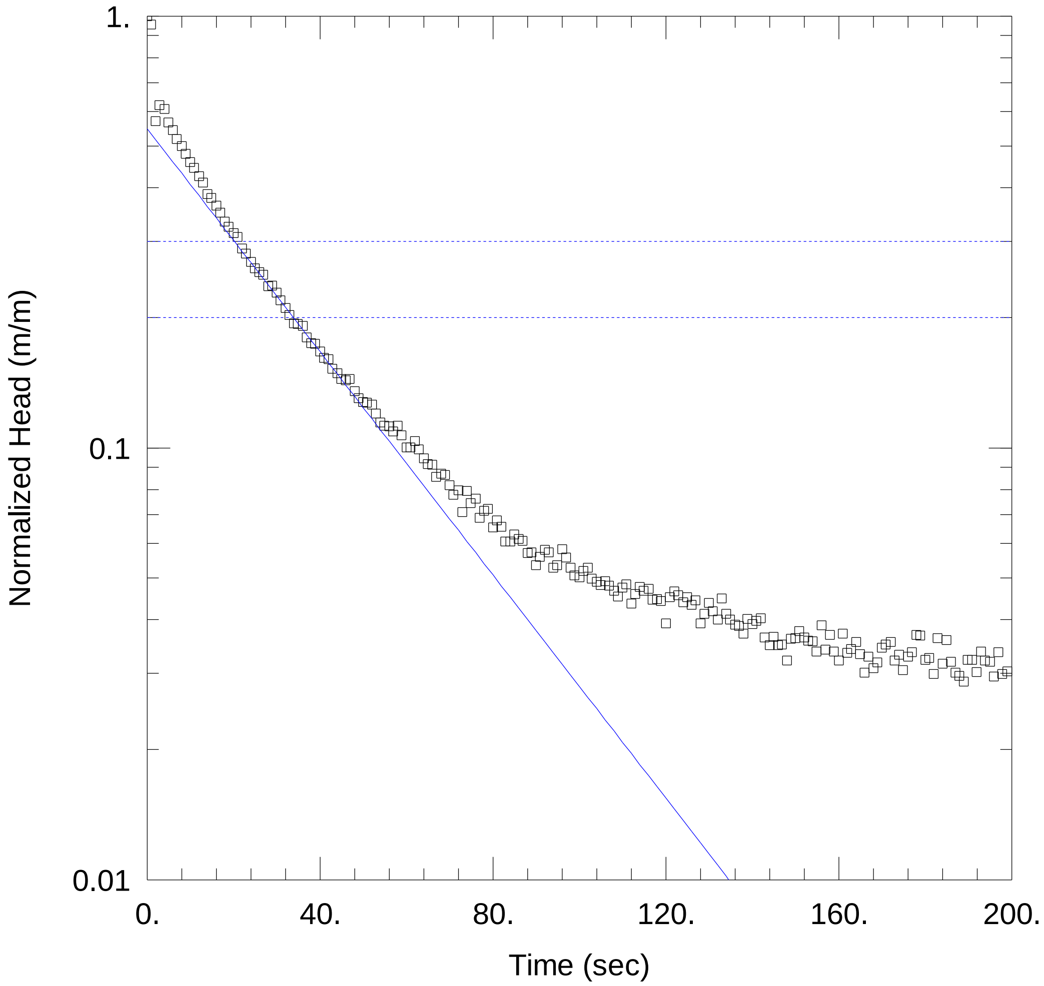
WELL DATA (HD03B)

Initial Displacement: 0.739 m
Total Well Penetration Depth: 7.055 m
Casing Radius: 0.025 m
Static Water Column Height: 7.055 m
Screen Length: 3. m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.075 m/day
y0 = 0.4348 m



HD03B TEST 3, FALLING HEAD (2)

Data Set: G:\41\24415\07 Additional Hydrogeology 2012\06 Slug Tests\HD03B_FH2.aqt
Date: 11/01/12 Time: 12:37:41

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: HD03B_FH2
Test Date: 28/10/2012

AQUIFER DATA

Saturated Thickness: 7.053 m
Anisotropy Ratio (Kz/Kr): 0.1

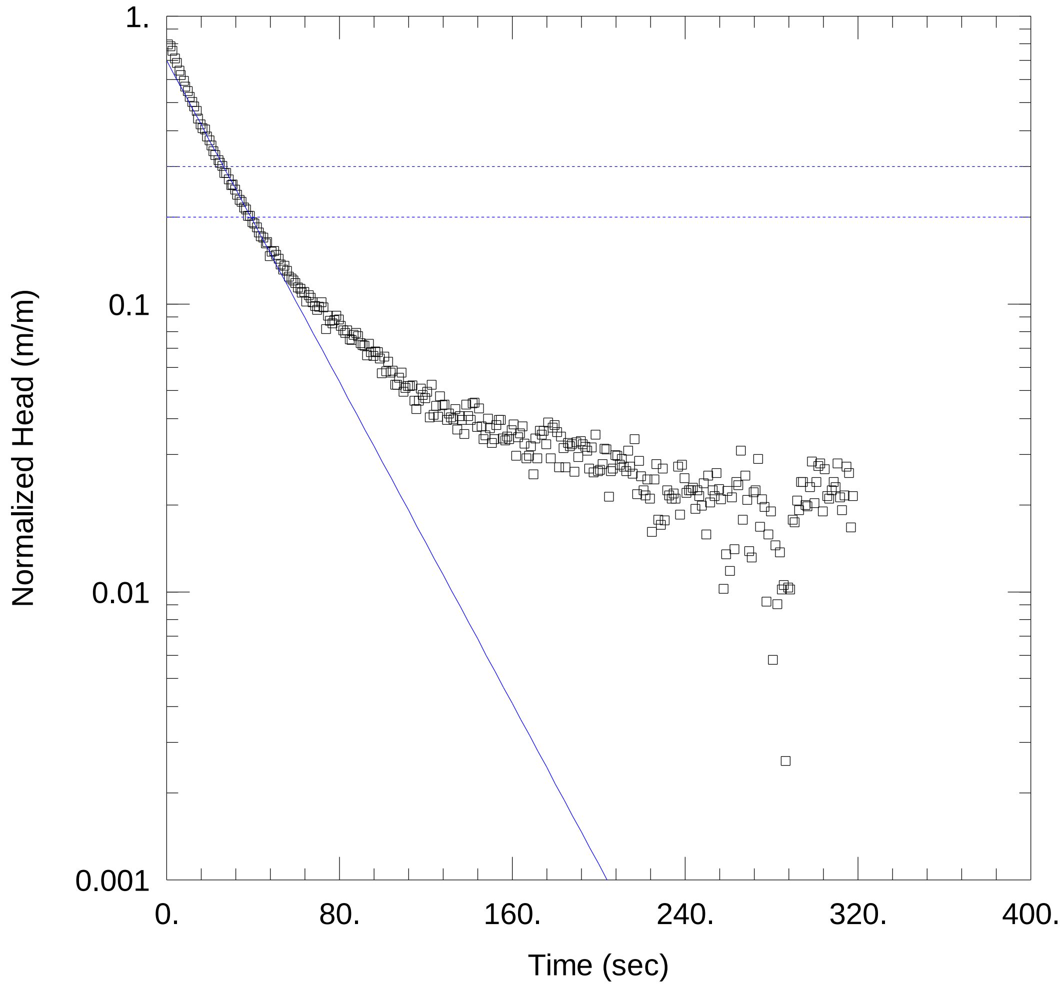
WELL DATA (HD03B)

Initial Displacement: 0.802 m
Total Well Penetration Depth: 7.053 m
Casing Radius: 0.025 m
Static Water Column Height: 7.053 m
Screen Length: 3. m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.146 m/day
y0 = 0.4396 m



HD03B TEST 2, RISING HEAD (1)

Data Set: G:\41\24415\07 Additional Hydrogeology 2012\06 Slug Tests\HD03B_RH1.aqt
Date: 11/01/12 Time: 12:38:06

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: HD03B
Test Date: 28/10/2012

AQUIFER DATA

Saturated Thickness: 7.067 m
Anisotropy Ratio (Kz/Kr): 0.1

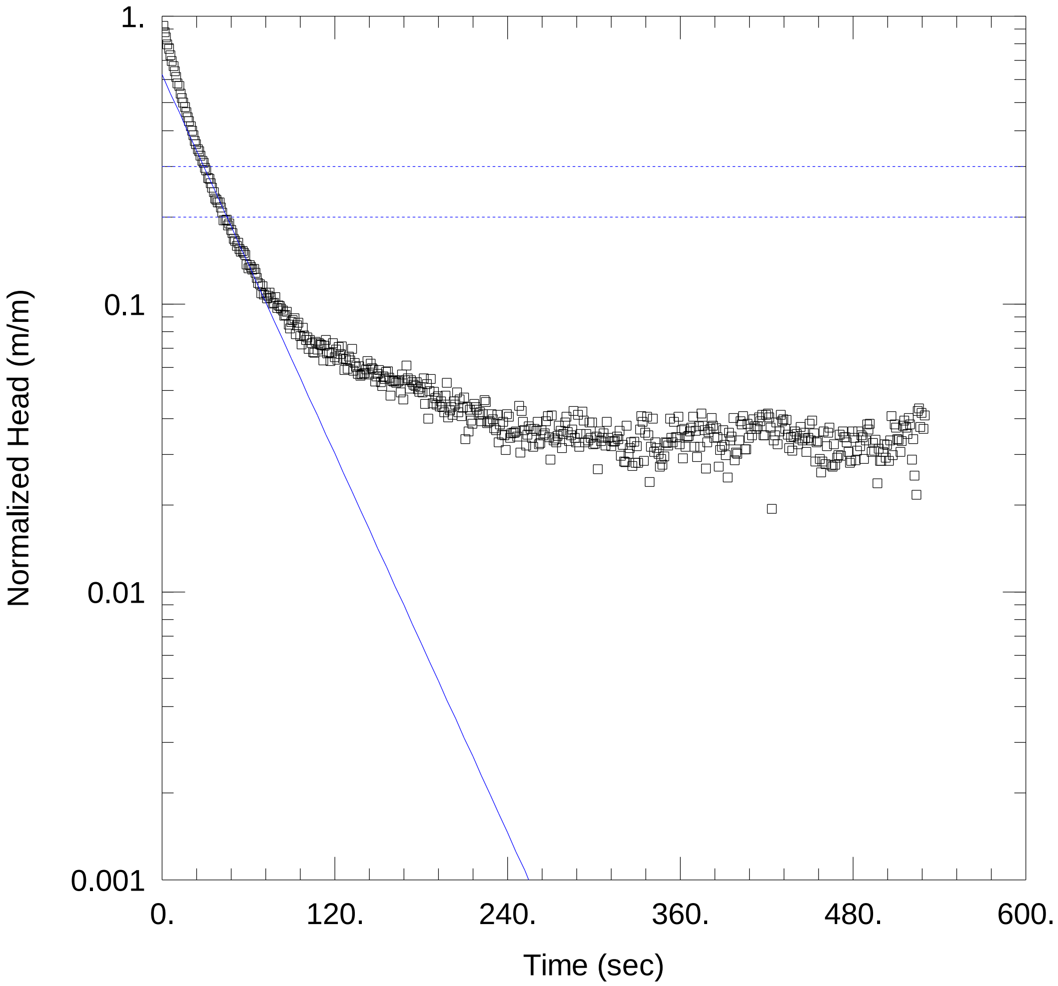
WELL DATA (HD03B)

Initial Displacement: -0.66 m
Static Water Column Height: 7.067 m
Total Well Penetration Depth: 7.067 m
Screen Length: 3. m
Casing Radius: 0.025 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.239 m/day
y0 = -0.4628 m



HS03B TEST 4, RISING HEAD (2)

Data Set: G:\41\24415\07 Additional Hydrogeology 2012\06 Slug Tests\HD03B_RH2.aqt
Date: 11/01/12 Time: 12:38:29

PROJECT INFORMATION

Company: GHD
Client: Adani Mining Pty Ltd
Project: 4124415
Location: Carmichael Coal Project, Mine
Test Well: HD03B_RH2
Test Date: 28/10/2012

AQUIFER DATA

Saturated Thickness: 7.077 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (HD03B)

Initial Displacement: -0.574 m
Static Water Column Height: 7.077 m
Total Well Penetration Depth: 7.077 m
Screen Length: 3. m
Casing Radius: 0.025 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.9737 m/day
y0 = -0.3594 m

Appendix G

Pumping Test Results

Table G1: Pumping Test Details

Table G2: Pumping Test Results Summary

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Table G1
Summary of Pumping Test Details

Pumping Test Bore	Pumped / Screened Unit of Pump Bore	Test Flow Rate	Test Type	Estimated Aquifer Thickness (m) used in analysis
C006	D Seam	0.3 increased to 0.5 L/S after 24 hours	48 hour constant rate test, recovery test	50
C0018	D Seam	1L/S	48 hour constant rate test, recovery test	70
C035	AB Seam	2.5L/s	48 hour constant rate test, recovery test	17

Table G2
Summary of Pumping Test Results

Observation Bore ID	Tested / Monitored Unit	Observation Data Matched	Analytical Solutions Applied	Solution Aquifer Type	Calculated Transmissivity, T (m^2/d)	Calculated Storage, S	Calculated S/S' (ratio storativity during pumping to storativity during recovery)	Calculated Ss (fracture specific storage)	Calculated Hydrauclic Conductivity, K (m/d)	Calculated Hydrauclic Conductivity, K (m/s)	Remarks
Test 1 (C006)											
C006P1	Weathered Permian Overburden	Drawdown & recovery	-	-	-	-	-	-	-	-	No drawdown response evident
C006P3r	D Seam	Drawdown	Hantush	leaky	4.81	5.02E-05	-	-	9.61E-02	1.11E-06	-
C006P3r	D Seam	Recovery	Hantush	leaky	2.08	1.84E-04	-	-	4.15E-02	4.80E-07	-
C006P3r	D Seam	Drawdown	Moench	leaky	9.88	5.41E-03	-	-	1.98E-01	2.29E-06	-
C006P3r	D Seam	Recovery	Moench	leaky	5.11	1.94E-03	-	-	1.02E-01	1.18E-06	-
C006P3r	D Seam	Drawdown	Neuman	leaky	4.20	5.87E-05	-	-	8.40E-02	9.72E-07	-
C006P3r	D Seam	Drawdown & recovery	Barker	confined	6.59	-	-	3.81E-04	1.32E-01	1.52E-06	-
C006P3r	D Seam	Drawdown	Papadopolus-Cooper	confined	12.56	5.02E-03	-	-	2.51E-01	2.91E-06	Good fit of solution curve to data
C006P3r	D Seam	Recovery	Papadopolus-Cooper	confined	7.10	1.50E-02	-	-	1.42E-01	1.64E-06	Good fit of solution curve to data
C006P3r	D Seam	Recovery	Theis (late time data)	confined	12.83	-	4.18E-01	-	2.57E-01	2.97E-06	Good fit of solution curve to data
C006P3r	D Seam	Recovery	Theis (all data)	confined	21.68	-	1.02E-01	-	4.34E-01	5.02E-06	-
C006P3r	D Seam	Drawdown	Cooper-Jacob	confined	12.61	5.25E-03	-	-	2.47E-01	2.86E-06	Good fit of solution curve to data
C006P3r	D Seam	Drawdown	Dougherty-Babu	confined	12.60	8.79E-01	-	-	2.52E-01	2.92E-06	-
Test 2 (C018)											
C018P1	Weathered Permian Overburden	Drawdown & recovery	-	-	-	-	-	-	-	-	No drawdown response evident
C018P2	AB Seam	Drawdown & recovery	Moench	leaky	4.60	2.46E-04	-	-	6.57E-02	7.60E-07	Response to pumping greater at P2 than at P3, indicates fractured rock aquifer across AB seam, interburden
C018P3	D Seam	Drawdown	Hantush	leaky	9.41	1.42E-03	-	-	1.34E-01	1.56E-06	Good fit of solution curve to data
C018P3	D Seam	Recovery	Hantush	leaky	8.04	2.71E-03	-	-	1.15E-01	1.33E-06	Good fit of solution curve to data
C018P3	D Seam	Ddown & recovery	Moench	leaky	9.32	1.51E-03	-	-	1.33E-01	1.54E-06	Good fit of solution curve to data
C018P3	D Seam	Recovery	Theis (early time data)	confined	9.41	-	8.64E-01	-	1.34E-01	1.56E-06	Good fit of solution curve to data
C018P3	D Seam	Drawdown	Cooper-Jacob	confined	10.08	1.09E-03	-	-	1.44E-01	1.67E-06	Good fit of solution curve to data
Test 3 (C035)											
C035P1	Rewan	Drawdown & recovery	-	-	-	-	-	-	-	-	No drawdown response evident
C035P2	AB Seam	Recovery	Cooper-Jacob (late time data)	confined	55.95	5.80E-03	-	-	3.29E+00	3.81E-05	Good fit of solution curve to data
C035P2	AB Seam	Drawdown	Dougherty-Babu	confined	68.79	4.46E-03	-	-	4.05E+00	4.68E-05	Good fit of solution curve to data
C035P2	AB Seam	Drawdown	Papadopolus-Cooper	confined	58.75	4.99E-03	-	-	3.46E+00	4.00E-05	Good fit of solution curve to data
C035P2	AB Seam	Recovery	Papadopolus-Cooper	confined	26.53	4.15E-02	-	-	1.56E+00	1.81E-05	-
C035P2	AB Seam	Drawdown	Theis	confined	60.15	8.04E-03	-	-	3.54E+00	4.10E-05	Good fit of solution curve to data

Appendix H

Revised Geological Interpretation Memo

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ABN: 73 112 994 715

MEMO

To: Martin Watkinson, Adani Mining Pty Ltd

CC: Barry Ward, GCS Pty Ltd

From: Troy Turner, Xenith Consulting Pty Ltd

Date: 18 October 2012

Re: Carmichael Coal Project – Changes to geological interpretation of overburden in EPC1690

Adani Mining Pty Ltd ('Adani') requested that Xenith Consulting Pty Ltd ('Xenith') undertake a review of the stratigraphic relationships of the formations present in EPC 1690, the area known as the Carmichael Coal Project (CCP) area. Xenith's works were carried out with the input of Barry Ward of Geotechinical Consulting Services Pty Ltd ('GCS') in September 2012.

Project Background

In late 2011, Xenith provided a geological model to GHD Pty Ltd, dated November 2011 to use as the basis of a hydro-geological study. The geological model contained a total of 77 data points, collected from the Adani 2010 and 2011 drilling programmes, and 2009 Linc Energy Data.

In 2012 Adani have, and continue to conduct an extensive drilling programme in the CCP area and have significantly increased the data points within the model (324 total drill holes September 2012). In parallel to this studies have been carried out by external consultants to better understand and characterise the relationships between and behaviour of the geological units in the CCP area, particularly those in the overburden of the Permian coal measures.

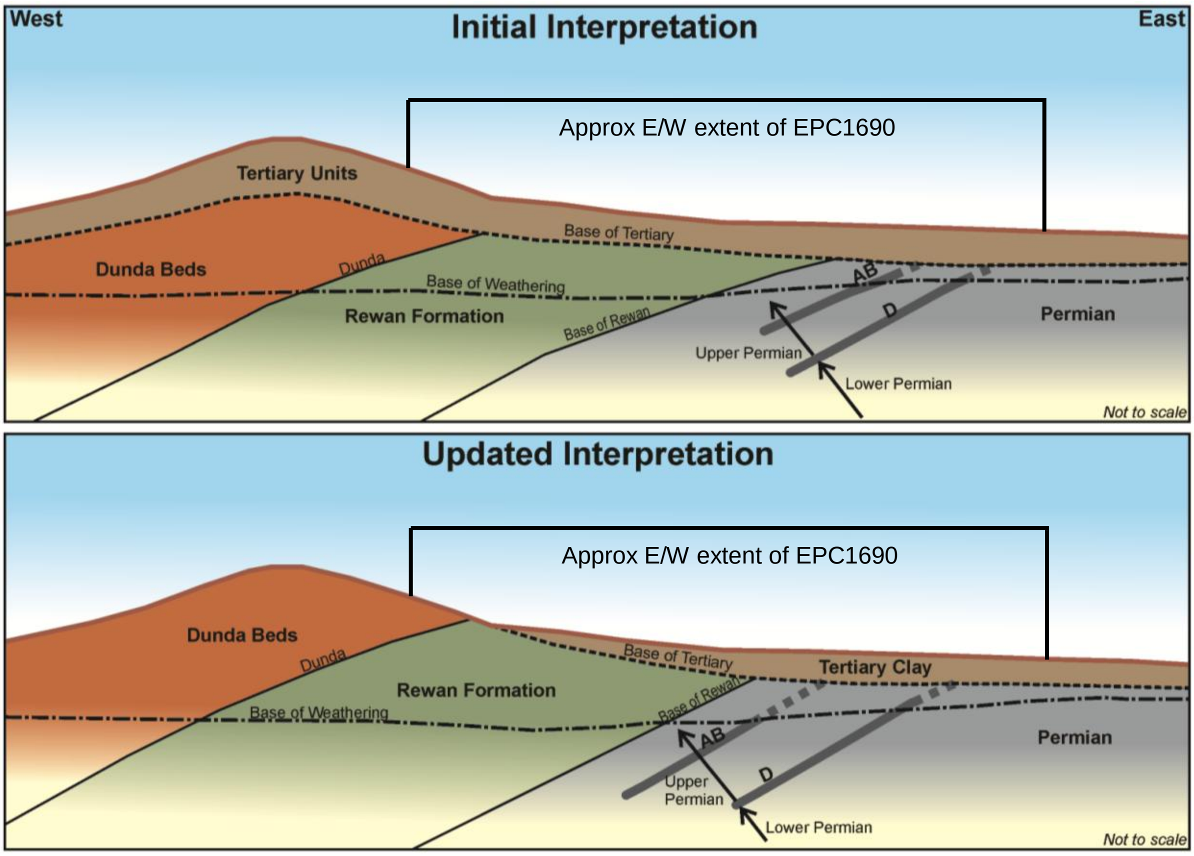
The increased number of drill holes and additional studies has lead to reinterpretation of the stratigraphy overlaying the Permian coal measures in the CCP area.

Methodology

The review of the stratigraphic units that overlay the Permian coal in the CCP area was undertaken in September 2012 by Barry Ward of GSC. GCS reviewed the core photos, lithological and geophysical logs of the drill holes from the 2011 drill programme, selected data from the 2012 drilling programme and geotechnical reports produced by other consultants. From this data GCS were able to pick the base of Dunda Beds (Triassic), base of Rewan Formation (Triassic) and base of Tertiary age units. A detailed methodology of this process can be found in the extract of the GCS report in Attachment 1.

Xenith updated the current (September 2012) geological model, created in Ventyx's Minescape software, with the data produced by GCS. Figure 1 shows a schematic of the interpretation in initial interpretation, November 2011 and the updated interpretation, September 2012.

Figure 1: East/west cross section of interpretation of overburden relationships in CCP area in November 2011 (top) and September 2012 (lower)



The review concluded that the Tertiary cover was not laterally extensive across (east/west) the CCP area as previously thought, and the substantial thickness of clay that was originally interpreted in the west of the deposit due to a deeper weathering profile in Rewan Formation. It should also be noted that Triassic age strata are present at surface in the west of the lease.

Kind regards

Troy Turner

Xenith Consulting

Attachment 1: Extract from GCS report 'Geotechnical Report –Open Cut Mining'

GHD

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	R Brown	K Phillipson	On File	J Keane	On File	20/02/2012
1	R Brown	J Keane		J Keane		07/09/2012
2	R Brown L Traverso	W Minchin		K Phillipson		09/11/2012