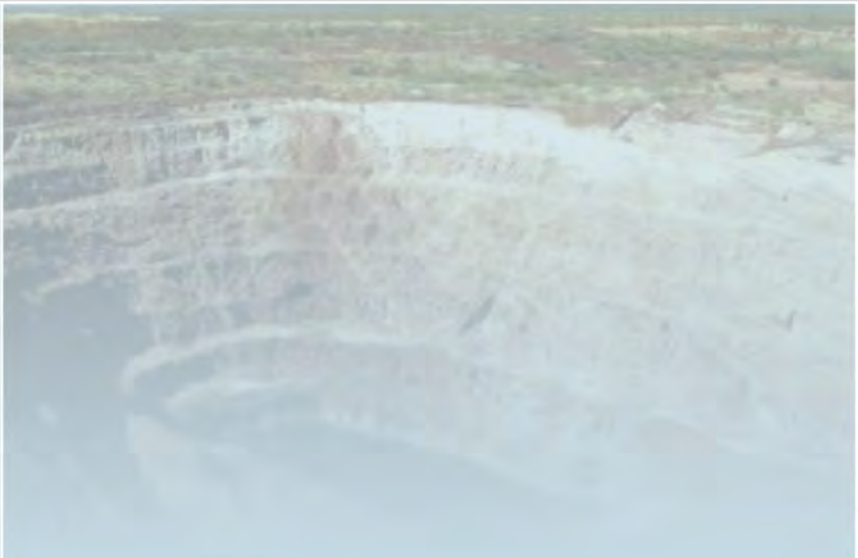
Adani Mining Pty Ltd



Carmichael Coal Mine and Rail Project SEIS

Report for Mine Hydrogeology Report

13 November 2013

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

The services undertaken by GHD in connection with preparing the Report were limited to those specifically detailed in Section 1 of the Report and did not include GHD undertaking testing at some parts of the site.

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

Contents

Table index

Figure index

Appendices

Abbreviations and glossary

Project specific terminology	
Abbreviation	Term
the EIS	Carmichael Coal Mine and Rail Project Environmental Impact Statement
the SEIS	Carmichael Coal Mine and Rail Project Suplementary 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DERM	Department of Environment and Resource Management (Qld) – now superseded by DEHP and DNRM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	MODFLOW 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	MODFLOW 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

Generic terminology	
Abbreviation	Term
LoR	Limit of Reporting
mAHD	Metre 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, the Proponent), commenced an Environmental Impact Statement (EIS) process for the Carmichael Coal Mine and Rail Project (the Project) in 2010. On 26 November 2010, the Queensland (Qld) Office of the Coordinator General declared the Project a ‘significant project’ and the Project was referred to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (referral No. 2010/5736). The Project was assessed to be a controlled action on 6 January 2011 under section 75 and section 87 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The controlling provisions for the Project include:

- World Heritage properties (sections 12 & 15A)
- National Heritage places (sections 15B & 15C)
- Wetlands (Ramsar) (sections 16 & 17B)
- Listed threatened species and communities (sections 18 & 18A)
- Listed migratory species (sections 20 & 20A)
- The Great Barrier Reef Marine Park (GBRMP) (sections 24B & 24C)
- Protection of water resources (sections 24D & 24E)

The Qld Government’s EIS process has been accredited for the assessment under Part 8 of the EPBC Act (1999) in accordance with the bilateral agreement between the Commonwealth of Australia and the State of Queensland.

The Proponent prepared an EIS in accordance with the Terms of Reference (ToR) issued by the Qld Coordinator-General in May 2011 (Qld Government, 2011). The EIS process is managed under section 26(1) (a) of the *State Development and Public Works Act 1971* (SDPWO Act), which is administered by the Qld Government’s Department of State Development, Infrastructure and Planning (DSDIP).

The EIS, submitted in December 2012, assessed the environmental, social and economic impacts associated with developing a 60 million tonne (product) per annum (Mtpa) thermal coal mine in the northern Galilee Basin, approximately 160 kilometres (km) north-west of Clermont, Central Queensland, Australia. Coal from the Project will be transported by rail to the existing Goonyella and Newlands rail systems, operated by Aurizon Operations Limited (Aurizon). The coal will be exported via the Port of Hay Point and the Port of Abbot Point over the 60 year (90 years in the EIS) mine life.

Project components are as follows:

- The Project (Mine): a greenfield coal mine over EPC 1690 and the eastern portion of EPC 1080, which includes both open cut and underground mining, on mine infrastructure and associated mine processing facilities (the Mine) and the Mine (offsite) infrastructure including a workers accommodation village and associated facilities, a permanent airport site, an industrial area and water supply infrastructure

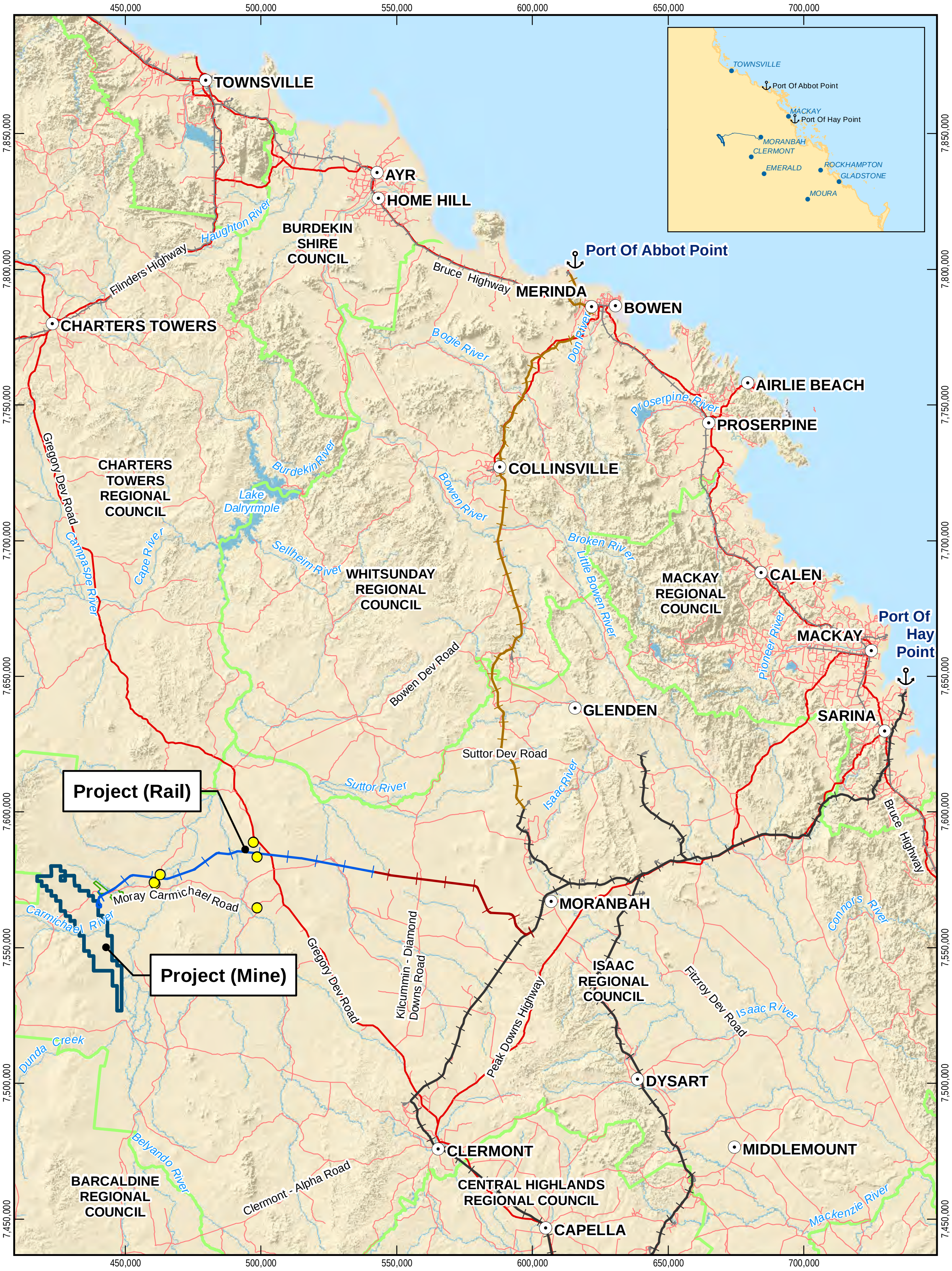
- The Project (Rail): a greenfield rail line connecting the mine to the existing Goonyella and Newlands rail systems to provide for the export of coal via the Port of Hay Point (Dudgeon Point expansion) and the Port of Abbot Point, respectively including:
  - Rail (west): a 120 km dual gauge portion running west from the Mine site 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
  - Quarries: The use of five local quarries to extract quarry materials for construction and operational purposes.

The project location is shown in Figure 1.

1.2 Report purpose

This hydrogeological study has been prepared as part of the Supplementary Environmental Impact Statement (SEIS) for the Project (Mine). The primary purpose of this hydrogeological study is to update assessments based on the revised Mine Plan as contained in Volume 4, Appendix B of the SEIS and additional information gathered since completion of the EIS. The report also addresses submissions received on the Hydrogeology Report, Appendix R of the Project EIS (GHD, 2012) and provides further information and comments as requested by the Coordinator-General.

An addendum to this report has been developed in response to comments received from a number of agency consultees including the DNRM, DEHP, DotE and URS, who conducted a peer review of the numerical groundwater flow modelling component of the SEIS report. This addendum has been included within SEIS Volume 4 Appendix K6.



LEGEND

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

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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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GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number	41-26422
Revision	2
Date	14-10-2013

Project Location

Figure 1

G:\41\26422\GIS\Maps\MXD\0000_Overview\41-26422_117_rev_2.mxd

Level 9, 145 Ann 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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Data Source: © Commonwealth of Australia (Geoscience Australia): Town, Railways, Watercourses (2007); DNRM: LGA, (2011), Hillshade (2009); DMR: State Roads (2008);
Adani: Project Rail 1 (Opt11 Rev2) & 2 (Opt9 Rev3), Offsite, Quarry (2013). Created by: MS

1.3 Scope

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

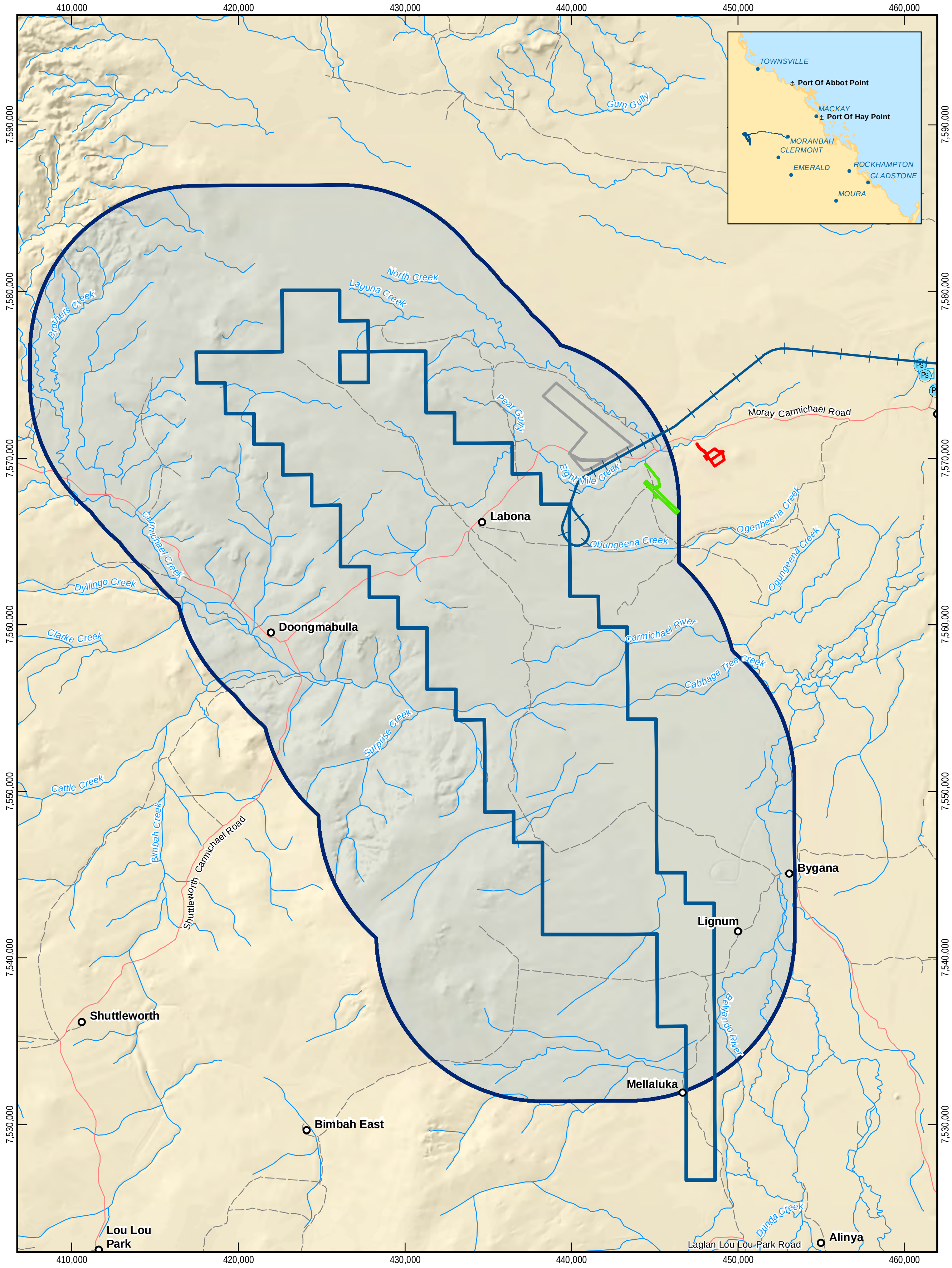
- Desktop review of geology, hydrogeology and groundwater bores
- Installation of a groundwater monitoring bore network
- Groundwater monitoring and hydrogeological testing of the installed monitoring bores
- Description of the existing hydrogeological conditions and environmental values
- Development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

This report represents a full revision of the previous Hydrogeology Technical Appendix to the EIS which was completed in November 2012 (GHD, 2012). Additional groundwater work completed for the SEIS and summarised in the current report includes:

- Extension of the groundwater monitoring network to include a number of additional bores south of the Carmichael River and in the area between the proposed mine area and the Great Artesia Basin (GAB) to the west
- One further round of groundwater quality sampling
- Updated groundwater level monitoring data
- Ecological survey and water chemistry sampling of the Doongmabulla and Mellaluka Spring complexes
- Revision of the groundwater flow modelling work based on a revised geological model (provided by Xenith), additional packer test results and groundwater level data and simulation of a revised 59 year mine plan
- The revised modelling work undertaken for the SEIS also included improved simulation of surface water / groundwater interactions along the Carmichael River.

1.4 Study and Mine Area definition

A 10 km radius extending outwards from the boundary of exploration lease EPC 1690 and incorporating the adjacent parts of EPC 1080 to the east defines the Hydrogeology Study Area (the Study Area) of the desktop review. Figure 2 shows the Study Area. The Mine Area is defined by the combined boundary of exploration lease EPC 1690 and exploration lease EPC 1080.



LEGEND

○ Homestead	Hydrogeology Study Area	Mine (Offsite)
Local Road	Project (Rail)	Ⓟ Pump Station
Track	Project (Mine)	▨ Storage Facility (Offstream)
Watercourse		

🟩 Airport
☐ Industrial Area
🟥 Accommodation Village

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 SEIS

Job Number 41-26422
Revision C
Date 15-10-2013

Hydrogeology Study Area

Figure 2

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Level 9, 145 Ann 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 2 shows the Hydrogeology Study Area (the Study Area), encompassing the Mine Area 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)

The following data from Project (Mine) specific field investigations has been collated and reviewed:

- Geological data (borehole logs from hydrogeology field investigations undertaken by GHD and from Adani Mining exploration programs, mine geological model provided in March 2013 (Xenith Consulting))
- Groundwater levels and quality (monitoring data)
- Hydrogeological testing results

Information related to the revised mine plan has been taken from:

- Volume 4, Appendix B, Updated Mine Project Description

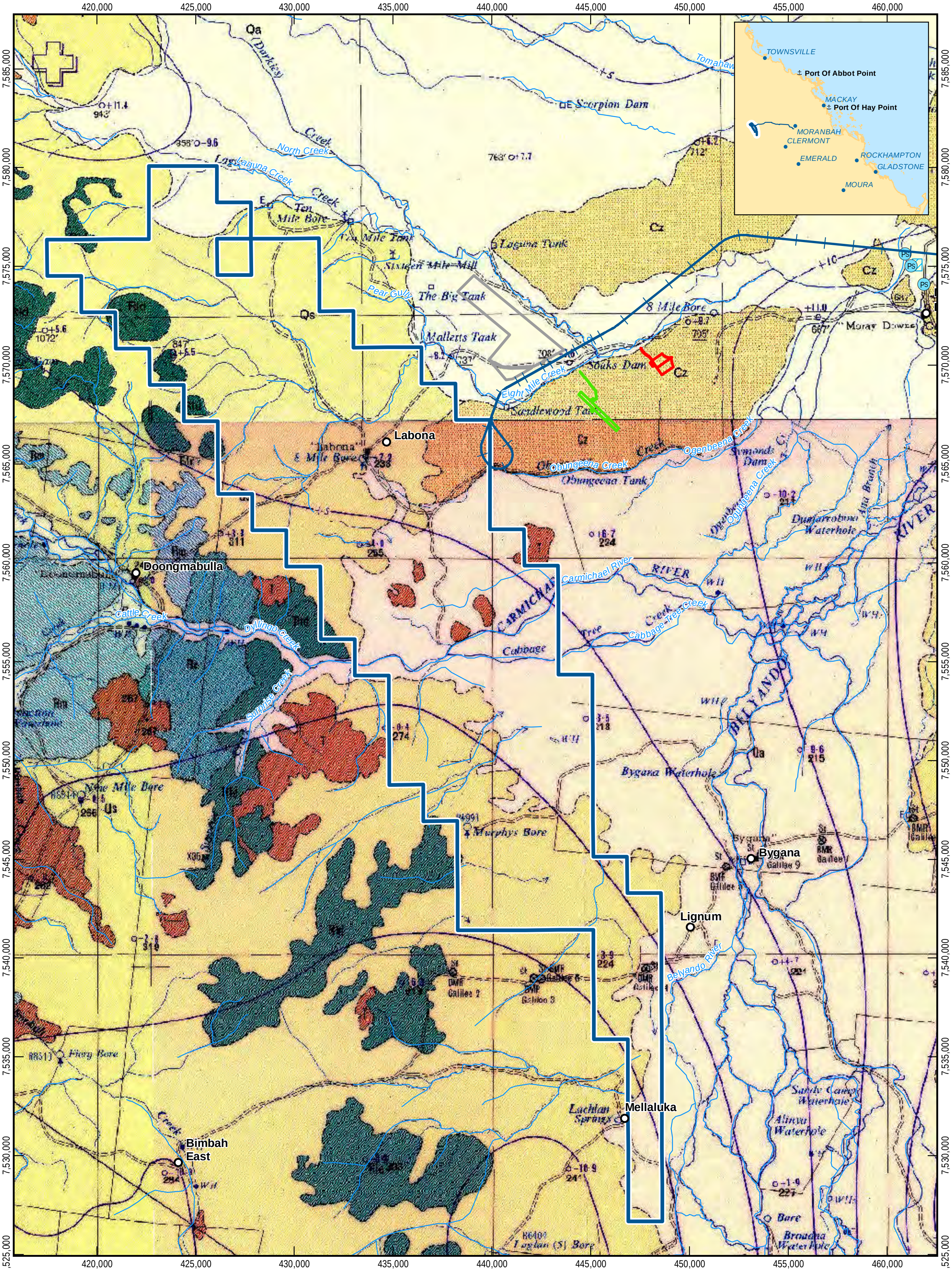
2.2.2 Geological setting

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)
- Memorandum, Carmichael Coal Project – Changes to geological interpretation of overburden in EPC 1690 (Xenith Consulting and Geotechnical Consulting Services, 2012)
- Borehole logs from ongoing Adani Mining exploration drilling programs incorporated into a geological model of the mine site most recently provided to GHD by Xenith Consulting in March 2013
- Published geological maps for the area

Published 1:250,000 scale geological mapping is shown in Figure 3.

Available digital geological mapping is shown in Figure 4. Figure 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 the Mine Area is shown in Figure 6.



LEGEND

- ○ Homestead
- — Local Road
- – – Track
- ┼ Project (Rail)
- ▭ Project (Mine)
- Mine (Offsite)
- Ⓟ Pump Station
- ▨ Storage Facility (Offstream)
- 🟩 Airport
- ▭ Industrial Area
- 🟥 Accommodation Village

Refer to Figure 5 for the legend to the geology mapping

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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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Carmichael Coal Mine and Rail Project SEIS

Job Number	41-26422
Revision	C
Date	15-10-2013

Mapped Geology
(1:250,000)

Figure 3

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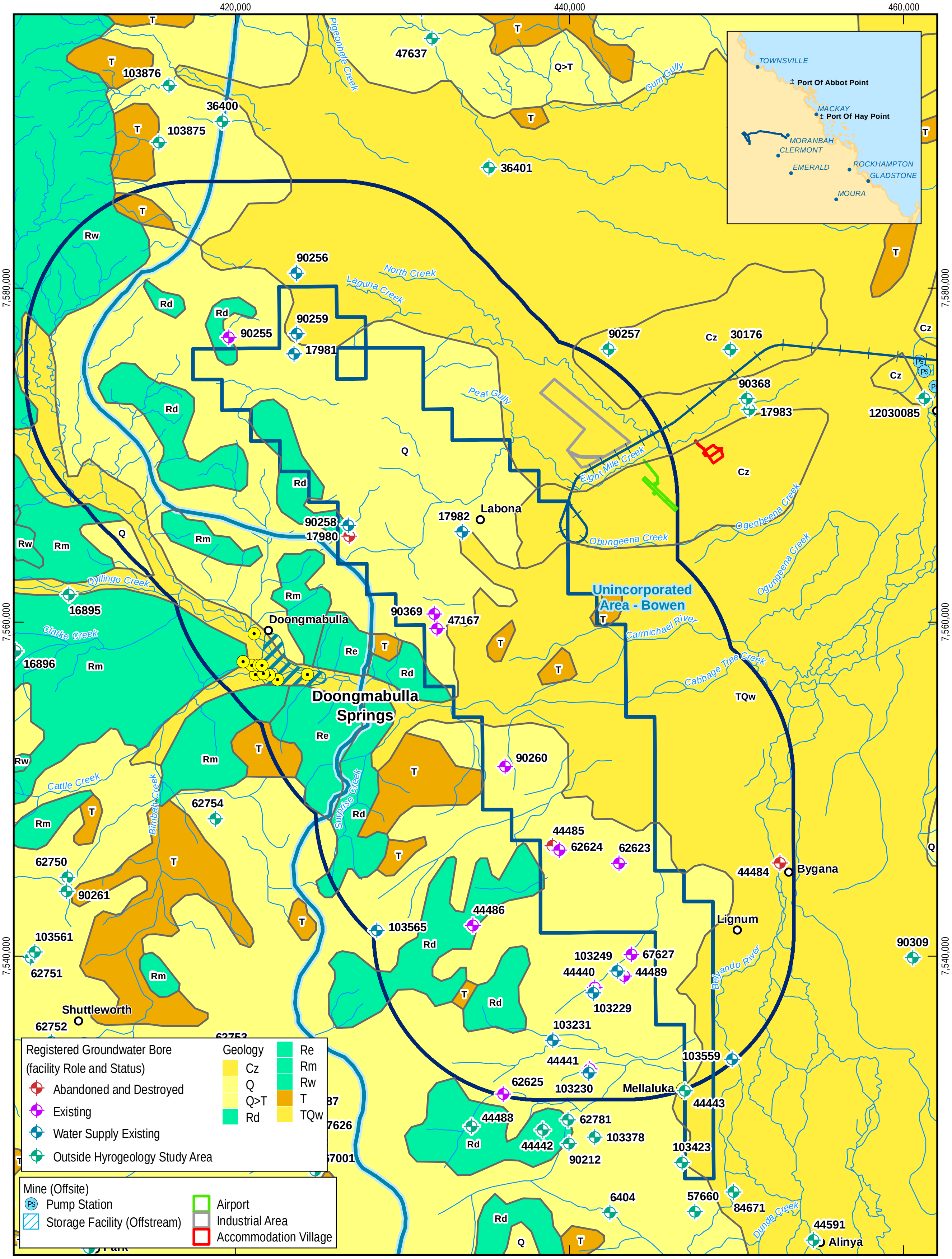
Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

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

- Hydrogeology Study Area
- Groundwater Management Unit boundary
- Directory of Important Wetlands
- Project (Rail)
- Project (Mine)

Refer to Figure 5 for the legend to the geology mapping

Based on or contains data provided by the State of QLD (DNRM) [2013]. 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.

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 SEIS

Published Digital Mapped Geology and Registered Groundwater Bores

Job Number	41-26422
Revision	F
Date	15-10-2013

Figure 4

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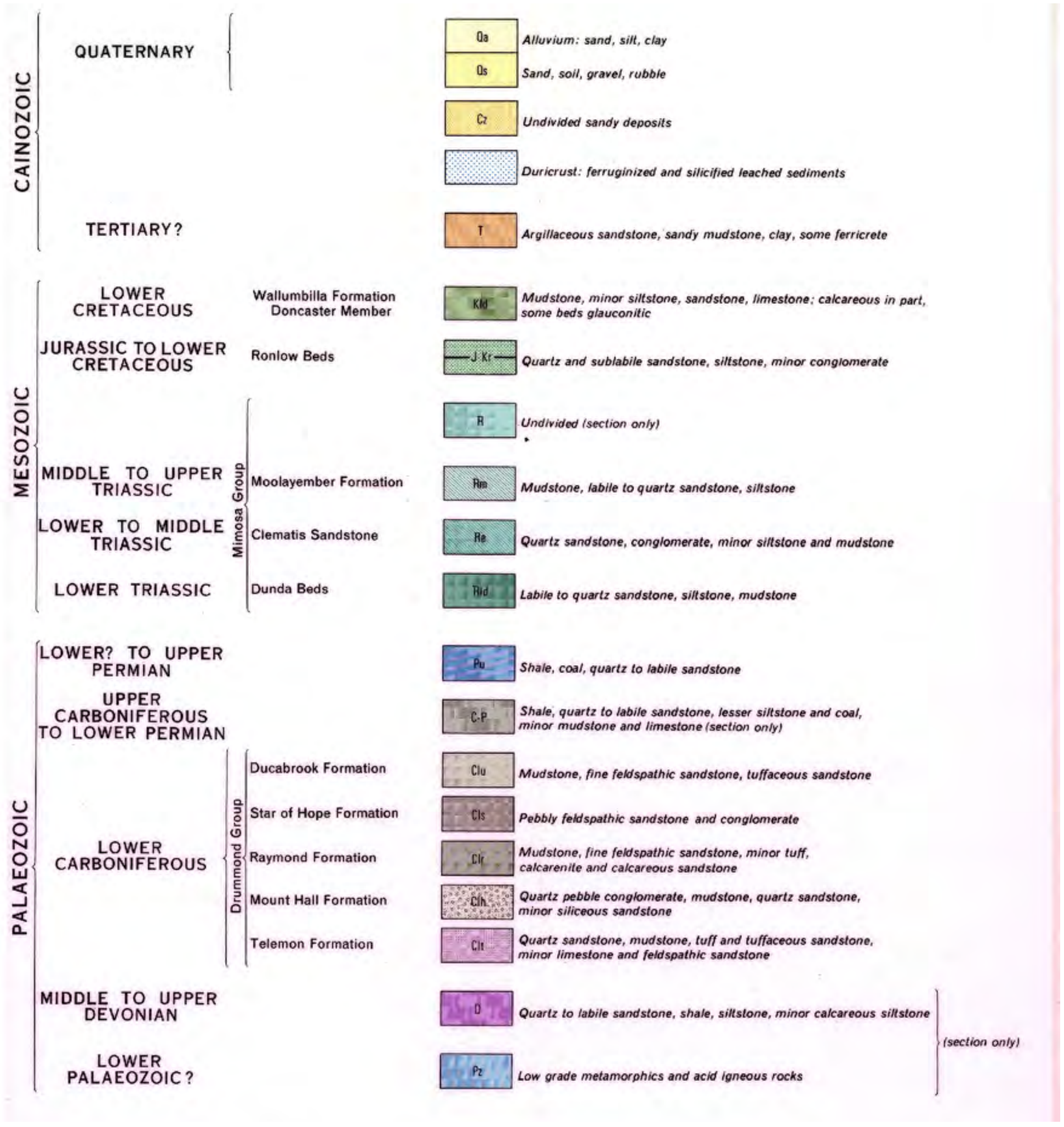
Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: DNRM: Registered Groundwater Bores (2010), DOI Wetlands (2011); DME: Regional Geology 1:1000000 (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: Project Rail 1 (Opt11 Rev2) & 2 (Opt9 Rev3), Facilities (2013). Created by: BW, CA

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



CAINOZOIC	QUATERNARY			Qa	*Alluvium: sand, silt, clay*
				Qs	*Sand, soil, gravel, rubble*
				Cz	*Undivided sandy deposits*
					Duricrust: ferruginized and silicified leached sediments
	TERTIARY?			T	*Argillaceous sandstone, sandy mudstone, clay, some ferricrete*
MESOZOIC	LOWER CRETACEOUS		Wallumbilla Formation Doncaster Member	Kld	*Mudstone, minor siltstone, sandstone, limestone; calcareous in part, some beds glauconitic*
	JURASSIC TO LOWER CRETACEOUS		Ronlow Beds	J Kr	*Quartz and sublabile sandstone, siltstone, minor conglomerate*
		Mimosa Group		R	*Undivided (section only)*
	MIDDLE TO UPPER TRIASSIC	Mimosa Group	Moolayember Formation	Rm	*Mudstone, labile to quartz sandstone, siltstone*
	LOWER TO MIDDLE TRIASSIC	Mimosa Group	Clematis Sandstone	Re	*Quartz sandstone, conglomerate, minor siltstone and mudstone*
	LOWER TRIASSIC	Mimosa Group	Dunda Beds	Rd	*Labile to quartz sandstone, siltstone, mudstone*
PALAEOZOIC	LOWER? TO UPPER PERMIAN			Pu	*Shale, coal, quartz to labile sandstone*
	UPPER CARBONIFEROUS TO LOWER PERMIAN			C-P	*Shale, quartz to labile sandstone, lesser siltstone and coal, minor mudstone and limestone (section only)*
	LOWER CARBONIFEROUS	Drummond Group	Ducabrook Formation	Clu	*Mudstone, fine feldspathic sandstone, tuffaceous sandstone*
		Drummond Group	Star of Hope Formation	Cls	*Pebbly feldspathic sandstone and conglomerate*
		Drummond Group	Raymond Formation	Clr	*Mudstone, fine feldspathic sandstone, minor tuff, calcarenite and calcareous sandstone*
		Drummond Group	Mount Hall Formation	Clh	*Quartz pebble conglomerate, mudstone, quartz sandstone, minor siliceous sandstone*
		Drummond Group	Telemon Formation	Clt	*Quartz sandstone, mudstone, tuff and tuffaceous sandstone, minor limestone and feldspathic sandstone*
	MIDDLE TO UPPER DEVONIAN			D	*Quartz to labile sandstone, shale, siltstone, minor calcareous siltstone* (section only)
	LOWER PALAEOZOIC?			Pz	*Low grade metamorphics and acid igneous rocks* (section only)

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.

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

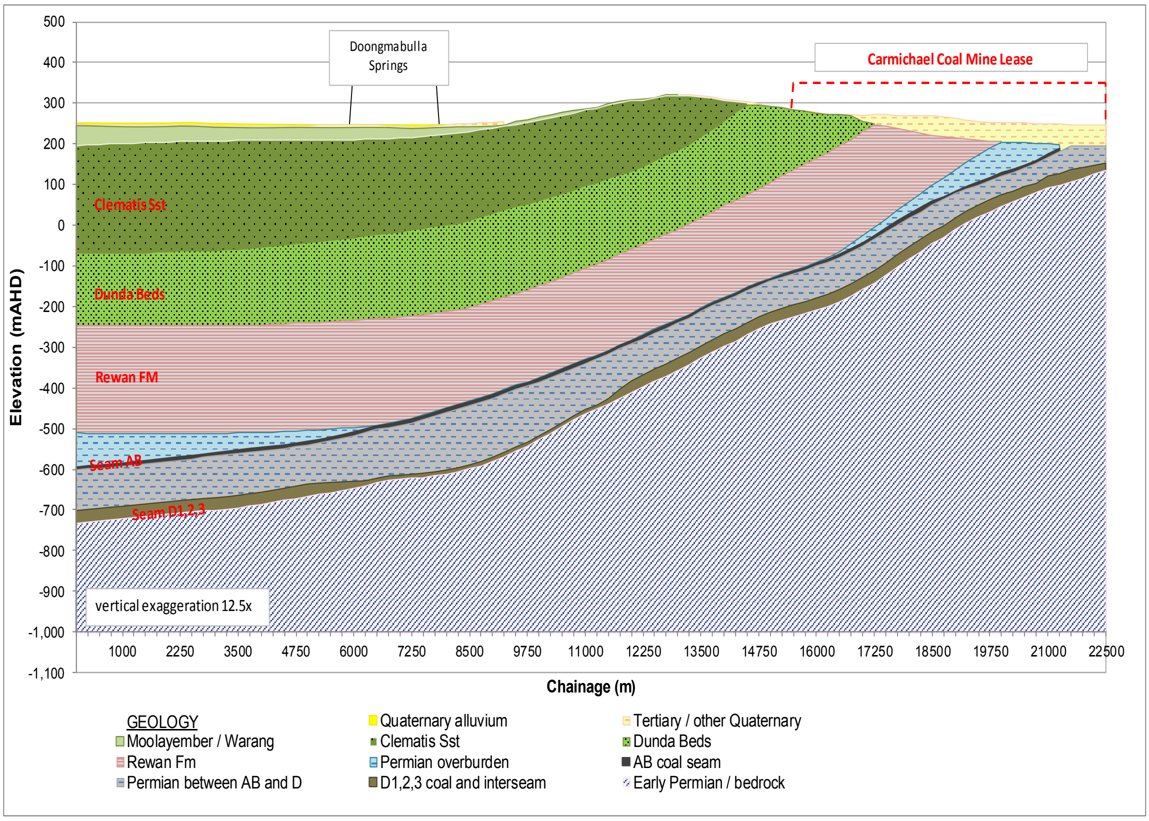
Job Number	41-26422
Revision	E
Date	31-07-2013

Geology Index Sheet

Figure 5

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

Figure 6 Sketch geological cross-section through the Project (Mine) lease



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 the Mine Area 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) in the west. However, an extensive drilling program has continued throughout the EIS and SEIS period which culminated in a detailed review of all the available geological information by Xenith Consulting and Geotechnical Consulting Services (GCS). The results of this review are summarised in Appendix G 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 EIS which also suggests 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 (geological mapping unit Rd) occupy the largest portion of the Mine Area.

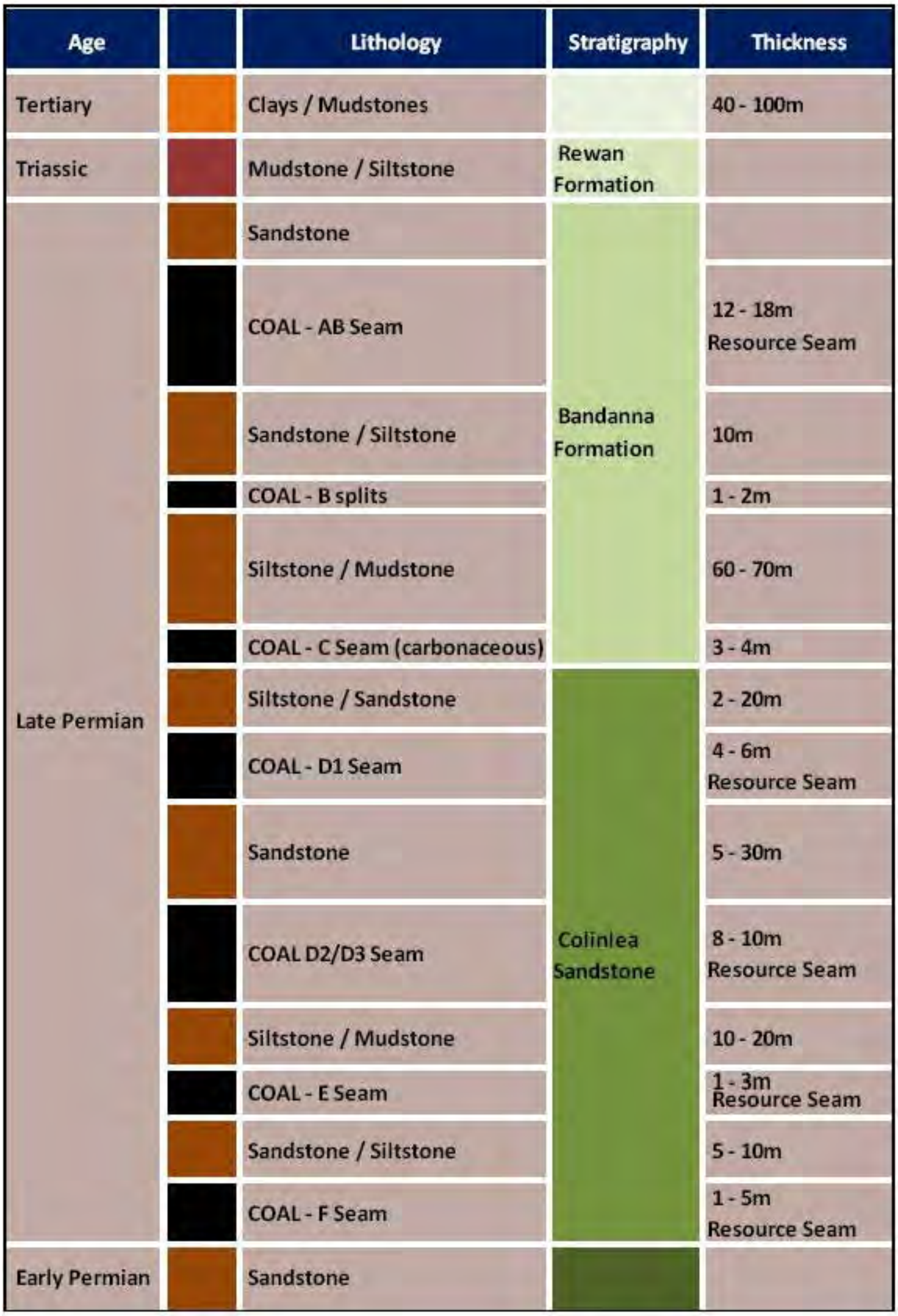
The recent review of the available geological information also suggests that where they are present the Tertiary strata are typically thinner than previously thought since the lower Tertiary horizons have now been re-interpreted as weathered Permian age strata.

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 the Mine Area 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.

A stratigraphic column to illustrate the main geological units within the lease area is summarised in Figure 7 from the *Carmichael Macro-Conceptual Mine Study* (Runge, May 2011). Quaternary-age strata (which lie stratigraphically above Tertiary-age strata) are not shown in this Figure.

Figure 7 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 Hydrogeological setting

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 spatial relationship between the GAB boundary and the Mine Area boundary is discussed below.

The base of the GAB is defined by the top of the Rewan Group which is present within the Mine Area. Definition of the precise boundaries of the GAB in the Mine 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 8. This mapping shows:

- The Great Artesian Basin Declared Sub-artesian Area and the Great Artesian Basin Water Resource Plan (GABWRP) boundary intermittently intersect the western boundary of the Mine Area and pass through the northern part of the Mine Area.
- The GAB Eastern Recharge Groundwater Management Unit boundary just intersects the western boundary of the Mine Area at two points, but predominantly lies to the west of the Mine Area.

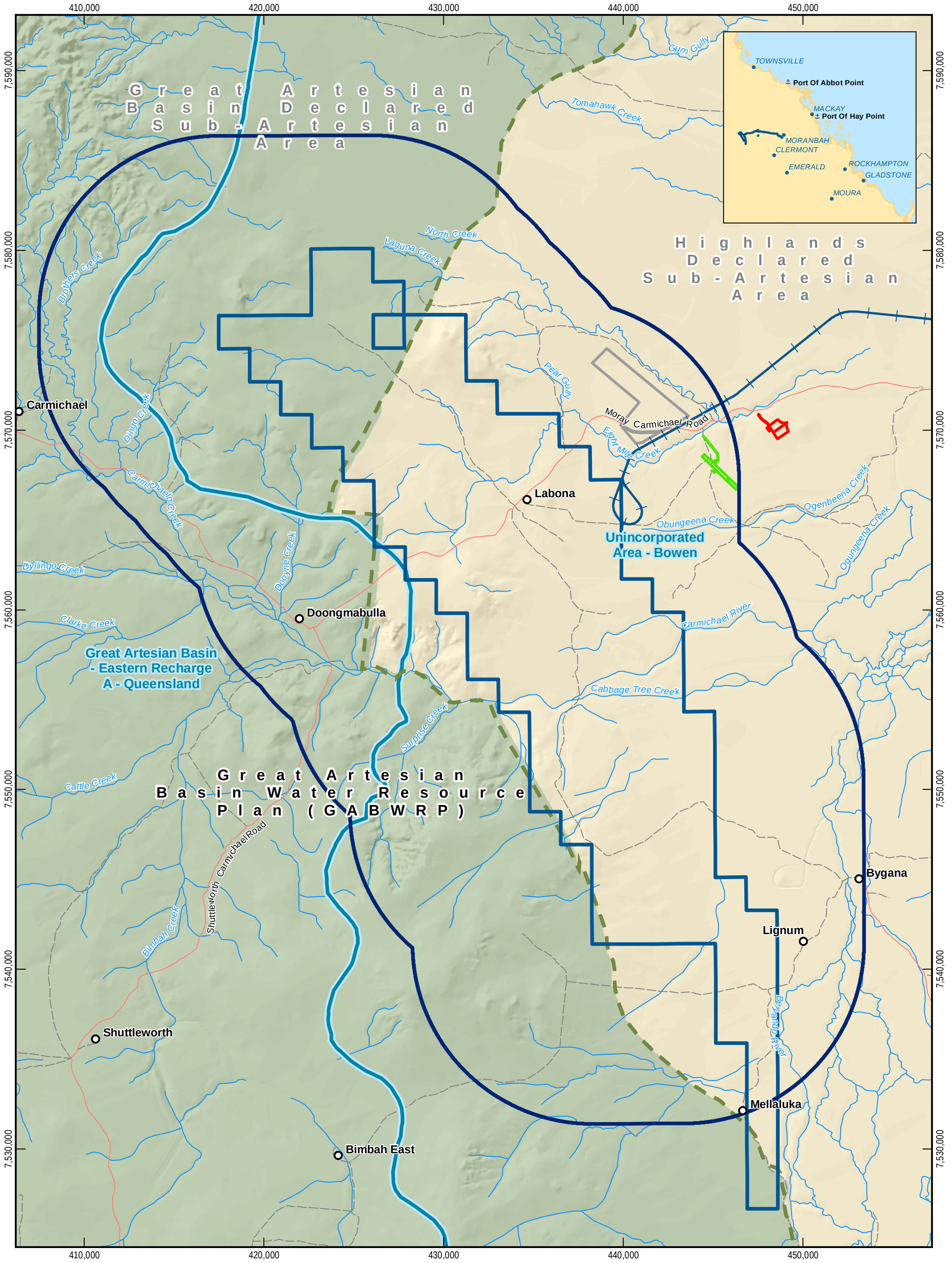
Irrespective of where the precise boundary of the GAB lies it should be noted that:

- The coal resources of the Project (which occur within Permian-age strata) are not part of the GAB; however the base of the GAB is defined by the base of the Rewan Group which is present within the Mine Area.
- None of the main GAB aquifer units are understood to be present within the Mine Area. The Clematis Sandstone is mapped at outcrop to the west of the Mine Area and dips to the west.
- The Permian-age Bandanna Coal Formation and Colinlea Sandstone which represent the target coal resources for the Project (Figure 7) are separated from the Clematis Sandstone GAB aquifer by the intervening aquitards of the Rewan Group (present on the Mine Area).

Areas where the outcrop geology is dominated by the Clematis Sandstone and other permeable units along the northern and eastern margins of the GAB typically act as recharge areas to the main body of the GAB to the south and west. The Project (Mine) 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).

Two spring complexes are located in the vicinity of the Mine Area (Figure 4):

- The Doongmabulla spring complex (located just inside the GAB around 8 km west of the Mine Area).
- The Mellaluka spring complex (located adjacent to and a few kilometres north of Mellaluka Homestead in the vicinity of the southern extent of the Mine Area).



LEGEND

- ○ Homestead
- Local Road
- Track
- Watercourse
- Declared Sub-Artesian Areas
- Great Artesian Basin Water Resource Plan
- Groundwater Management Unit boundary
- Project (Rail)
- Project (Mine)
- Mine (Offsite)
- PS Pump Station
- ▨ Storage Facility (Offstream)
- 🟩 Airport
- ☐ Industrial Area
- 🟥 Accommodation Village

1:300,000 (at A4)

0 2 4 6 8 10

Kilometres

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

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Revision	F
Date	15-10-2013

Groundwater Management

Figure 8

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Data Source: DERM: Elevation (2011), 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); Adani: Project Rail 1 (Opt11 Rev2) & 2 (Opt9 Rev3), Facilities (2013); GHD: Hydrogeology Study Area. Created by: BW.

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. 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 A.

Of the 26 registered bores identified 23 were recorded as existing (facility status) of which 11 were recorded as being for water supply (facility role). Four of the 11 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 as 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 the Mine Area, 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.

Publicly 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 western boundary of the Mine Area 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 the Mine Area. 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 Mine Area were not visited because they are located on properties controlled by the same landowner.

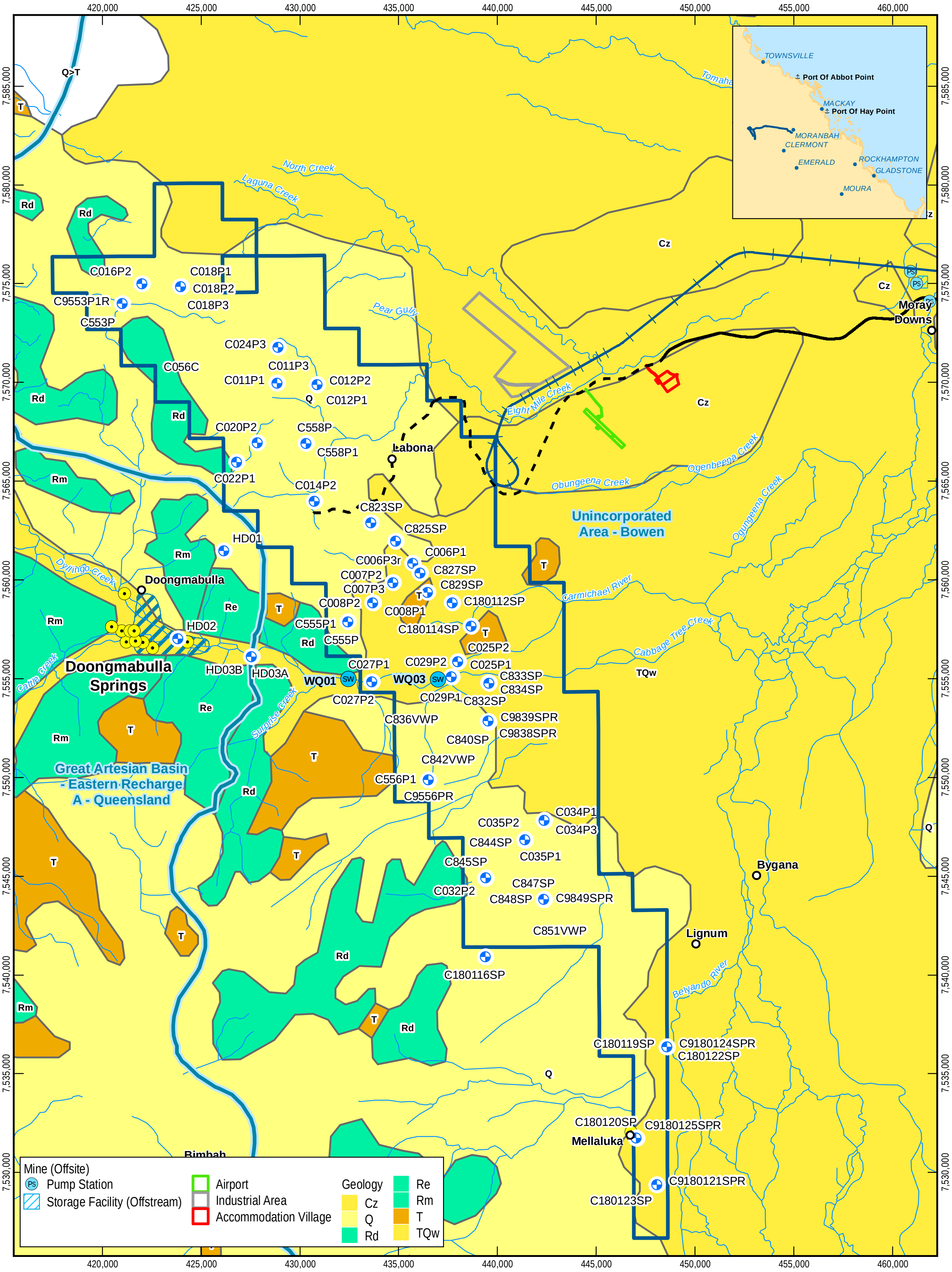
The limited information collected from the bore site inspection is summarised in Appendix A. Headworks were observed on six out of seven of the bores (one of the bores was hidden by the bore shed), with infrastructure in place for operation of a pump (diesel, electric or solar) and pipes for transfer of pumped water to storage tanks or a dam. All of the bores sighted appeared 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 publicly available groundwater level and quality data available for the site, a groundwater monitoring network was progressively established within and in the near vicinity of the Mine Area during 2011, 2012 and 2013 to collect hydrogeological data for the purposes of the EIS comprising:

- 57 standpipe piezometers at 33 sites (Mine Area)
- 24 nested vibrating wire piezometers (VWP) at eight sites (Mine Area)
- Three standpipe piezometers at two sites (between Mine Area and Doongmabulla Springs)
- Two standpipe piezometers at two sites (west of Mine Area).

Figure 9 shows the monitoring bore and VWP locations. Relevant information including the purpose of monitoring at each site is summarised in Table 1.



LEGEND

○ Homestead
Groundwater Monitoring Bore
SW Surface Water Quality Monitoring
● Springs
Watercourse
Structure
Anticline
Fault
Geological Boundary
Joint Pattern
Monocline
Syncline
Trend Line
Groundwater Management Unit boundary
▨ Directory of Important Wetlands
Project (Rail)
☐ Project (Mine)

Refer to Figure 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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Job Number	41-26422
Revision	G
Date	15-10-2013

Figure 9

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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: Project Rail 1 (Opt11 Rev2) & 2 (Opt9 Rev3), Facilities (2013). Created by: BW, CA, MS

Table 1 Groundwater monitoring network summary

Groundwater monitoring sites	Monitored unit	Monitoring purpose
C006P1 C006P3r	Interburden D Seam	Levels, quality, vertical gradients between strata
C007P2 C007P3	AB Seam D Seam	Levels, quality, vertical gradients between strata
C008P1 C008P2	Permian Overburden AB Seam	Levels, quality, vertical gradients between strata
C011P1 C011P3	Interburden D Seam	Levels, quality, vertical gradients between strata
C012P1 C012P2	Permian Overburden Tertiary/Permian	Levels, quality, vertical gradients between strata
C014P2	AB Seam	Levels, quality (no groundwater encountered in Tertiary-age strata)
C016P2	AB Seam	Levels, quality
C018P1 C018P2 C018P3	Permian Overburden AB Seam D Seam	Levels, quality, vertical gradients between strata
C020P2	AB Seam	Levels, quality
C022P1	Dunda Beds	Levels, quality, geological unit within the Great Artesian Basin
C024P3	D Seam	Levels, quality
C025P1 C025P2	Tertiary Tertiary	Levels, quality, potential connectivity between groundwater and the Carmichael River, vertical gradients
C027P1 C027P2	Alluvium Dunda Beds	Levels, quality, potential connectivity between groundwater and the Carmichael River, vertical gradients
C029P1 C029P2	Alluvium Tertiary	Levels, quality, potential connectivity between groundwater and the Carmichael River, vertical gradients
C032P2 C9845SPR	AB Seam Rewan Group	Levels, quality
C034P1 C034P3	Interburden D Seam	Levels, quality, vertical gradients between strata
C035P1 C035P2 C844SP	Rewan Group AB Seam Interburden	Levels, quality, vertical gradients between strata
C9553P1R C553P_V01 C553P_V02 C553P_V03	Dunda Beds D1 Seam AB1 Seam Permian Overburden	Levels, vertical gradients between strata

Groundwater monitoring sites	Monitored unit	Monitoring purpose
C555P1 C555P_V01 C555P_V02 C555P_V03	Rewan Group D Seam AB1 Seam Rewan Group	Levels, vertical gradients between strata
C556P1 C9556P_V01 C9556P_V02 C9556P_V03	Rewan Group D2 Seam AB1 Seam Rewan Group	Levels, vertical gradients between strata
C558P1 C558P_V01 C558P_V02 C558P_V03	Tertiary / Permian Overburden D1 Seam Interburden AB1 Seam	Levels, vertical gradients between strata
C056C_V01 C056C_V02 C056C_V03	D1 Seam AB1 Seam Rewan Group	Levels, vertical gradients between strata
HD01	Dunda Beds	Levels (west of the Mine Area)
HD02	Clematis Sandstone	Levels (between the Mine Area and Doongmabulla Springs)
HD03A HD03B	Dunda Beds Alluvium	Levels, vertical gradients between strata (between the Mine Area and Doongmabulla Springs)
C823SP	C Seam	Levels
C825SP	Below D Seam	Levels
C827SP	E Seam	Levels
C829SP	Colinlea sandstone	Levels
C180112SP	Colinlea sandstone	Levels
C180114SP	D Seam	Levels
C832SP C833SP C834SP	C Seam D Seam Below D Seam	Levels, quality, vertical gradients between strata
C836VWP_V01 C836VWP_V02 C836VWP_V03	Interburden AB Seam Overburden	Levels, quality, vertical gradients between strata
C9838SPR C9839SPR C840SP	Overburden Interburden Interburden	Levels, quality, vertical gradients between strata
C842VWP_V01 C842VWP_V02	Interburden AB Seam	Levels, quality, vertical gradients between strata

Groundwater monitoring sites	Monitored unit	Monitoring purpose
C842VWP_V03	Rewan Group	
C847SP C848SP C9849SPR	Interburden D Seam Below D Seam	Levels, quality, vertical gradients between strata
C851VWP_V01 C851VWP_V02 C851VWP_V03	Interburden AB3 Permian Overburden	Levels, quality, vertical gradients between strata
C180116SP	Dunda Beds	Levels, quality
C180120SP C9180125SPR	Clay/sandy clay Clayey sand	Levels, quality, vertical gradients between strata
C180119SP C180122SP C9180124SPR	Claystone Claystone Clayey sand	Levels, quality, vertical gradients between strata
C180123SP C9180121SPR	Siltstone and claystone Mudstone	Levels, quality, vertical gradients between strata

A combination of Rotary Wash Bore and Percussion Air-hammer drilling techniques were used to advance the standpipe piezometers 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 2 mm 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 for each of the installed monitoring bores are included in Appendix B.

2.3.3 Groundwater monitoring

Four rounds of groundwater monitoring have been conducted (October and November 2011, June 2012 and May 2013), to measure groundwater levels and to collect groundwater samples for water quality analysis (October 2011, November 2011 and May 2013 only). In addition, automatic level loggers have been installed in many of the standpipe piezometers across the Mine Area to provide a more continuous record of groundwater levels. Groundwater monitoring of the newest parts of the network (i.e. bores installed during the period April to June 2013) has recently commenced. Groundwater level data collected to date are summarised in Section 4.3 and in Appendix C and groundwater quality results are summarised in Section 4.4 and presented in Appendix D.

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 this initial sampling round which was completed in October 2011. This had the added benefit of leaving the monitoring bores free of sampling equipment for the subsequent 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 C_6 – C_{40}).

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 eight 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 the Mine Area, 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 this data was carried out using the Bouwer-Rice analytical solution using AQTESOLV software (developed by HydroSOLVE Incorporated). Packer testing was carried out using either single packer tests (downstage test method) or 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 (slug and packer tests) and in Table 3 (pumping tests). Refer to Figure 10 for the test locations. The results of the testing are summarised in Section 4.6.

Additional hydraulic testing is being conducted during 2013 as follows:

- Packer testing at three locations to the south of the Carmichael River (completed)
- Pumping tests at two locations to the south and three locations to the north of the Carmichael River (in progress).

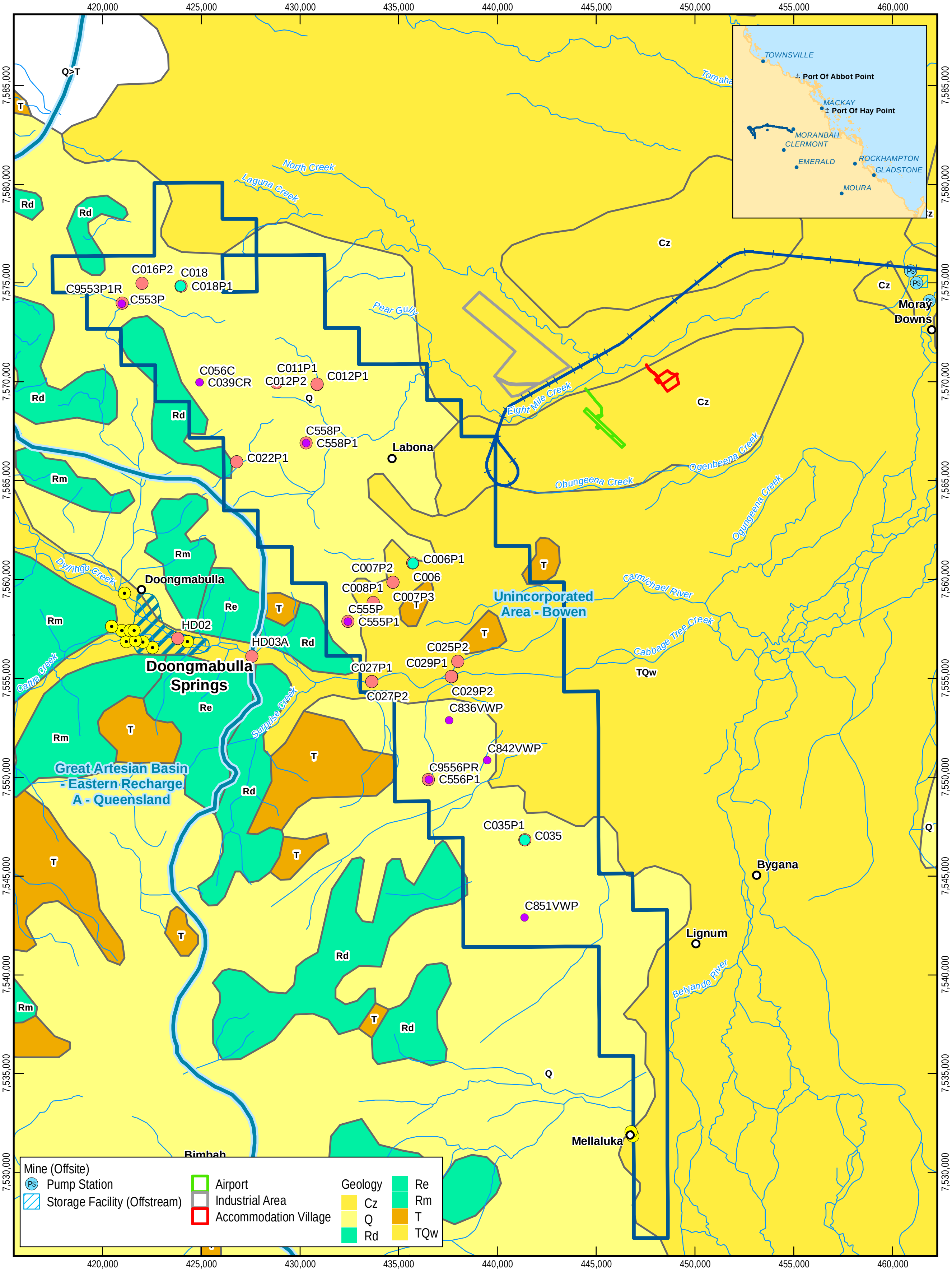
Table 2 Summary of slug and packer testing

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
Rewan Group	C035P1 C555P1 C556P1	12	Falling head slug (6) Rising head slug (6)
	C056 C9956PR C842VWP C836VWP	5	Packer
Overburden (Permian)	C008P1 C012P1 C012P2 C018P1	9	Falling head slug (6) Rising head slug (3)
	C039 C056 C555P C9556PR C836VWP C842VWP	6	Packer
AB Seam (Permian)	C007P2	2	Rising head slug (1)

Strata tested	Location ID	Total number of tests (by strata and test type)	Test type
	C016P2		Falling head slug (1)
	C039 C056 C555P C558P C9556PR C836VWP C842VWP	9	Packer
Interburden (Permian)	C006P1 C011P1	7	Falling head slug (4) Rising head slug (3)
	C056 C558P C836VWP C842VWP C851VWP	8	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 C851VWP	6	Packer
D Seam (Permian) and older strata	CC558P	1	Packer
Older Permian strata	C056 C555P C558P C9556PR C851VWP	5	Packer

Table 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
● Springs
— Watercourse
● Packer Test
● Pumping Test
● Slug Test
Structure
┼ Anticline
— Fault
— Geological Boundary
--- Joint Pattern
┼ Monocline
┼ Syncline
— Trend Line
▣ Groundwater Management Unit boundary
▨ Directory of Important Wetlands
— Project (Rail)
□ Project (Mine)

Refer to Figure 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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Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Published Digital Mapped Geology and Test Locations

Job Number	41-26422
Revision	D
Date	15-10-2013

Figure 10

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Level 9, 145 Ann 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: 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,Test Locations (2012); Adani: Project Rail 1 (Opt11 Rev2) & 2 (Opt9 Rev3), Facilities (2013). Created by: BW, CA, MS

2.3.5 Doongmabulla and Mellaluka Spring water quality sampling

Additional post EIS investigations have been conducted to confirm the ecological value and water quality of the Doongmabulla Spring complex (the complex of Moses, Little Moses and Joshua Spring groups and their associated wetlands) and the Mellaluka Spring complex (which includes the Mellaluka, Lignum and Stories spring groups and associated wetlands). The locations of the springs, as identified in the Queensland Spring Database, are represented on Figure 4.

Doongmabulla Spring complex

Water quality sampling and analysis of springs within the Doongmabulla Spring complex and nearby creeks was undertaken in May/June 2012 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
- The spring complex and nearby creeks.

As a result of the study, one set of baseline water quality data for the sampled springs and creeks has been collected.

Water samples were collected from a total of 14 springs and two creeks (Dylingo Creek and Cattle Creek) during May/June 2012 and analysed for major ions, alkalinity and selected dissolved metals. The results of the sampling are summarised in Section 4.9.1.

Mellaluka Spring complex

Water quality sampling was undertaken in April 2013 to:

- Provide information on potential water sources to the springs
- Collect a set of baseline water quality data for the springs.

For the study, water samples were collected from four spring sites and also from seven nearby groundwater extraction bores owned by third parties during April 2013 and analysed for major ions, alkalinity and selected dissolved metals. The resuls of the sampling are summarised in Section 4.9.2.

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 application for a Site-Specific Environmental Authority has been lodged for the Project (Mine).

3.2 Environmental Protection (Water) Policy 2009

The *Environmental Protection (Water) Policy 2009* (EPP (Water)) seeks to protect Queensland's water 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 these 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
- 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) regulates the process of development and its effects on the environment. Under the SPA, works to allow the taking or interfering with water (i.e. extraction of groundwater or dewatering) require a Development Permit (DP) to be obtained, which 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 set 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 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 water 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 the Mine Area are managed under the *Water Resource (Burdekin Basin) Plan 2007,* however, this WRP does not include management of groundwater. Groundwater resources within central and southern parts of the Mine Area are therefore managed as part the Highlands Declared Sub-Artesian Area as shown inFigure 8. Groundwater resources within the far northern part of the Mine Area 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 8). 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 those purposes 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 3.4 the majority of the Mine Area lies 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 8). 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 3.4 and Section 3.5, groundwater resources within the Mine Area 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 taking 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. There are currently no proposals to extract groundwater for construction purposes (refer to Section 6.1.1), however, mine dewatering will be required and pumping tests have already been carried out. 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 the SPA 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. Given the proximity of the Mine Area to the Clematis Sandstone (a GAB aquifer) licences for the take of groundwater for the Project (Mine) (i.e. from Permian-age strata to the east of the GAB) such as for the purposes of mine dewatering and extraction of groundwater for construction or consumption may be required under the GAB WRP and ROP.

4. Description of environmental values

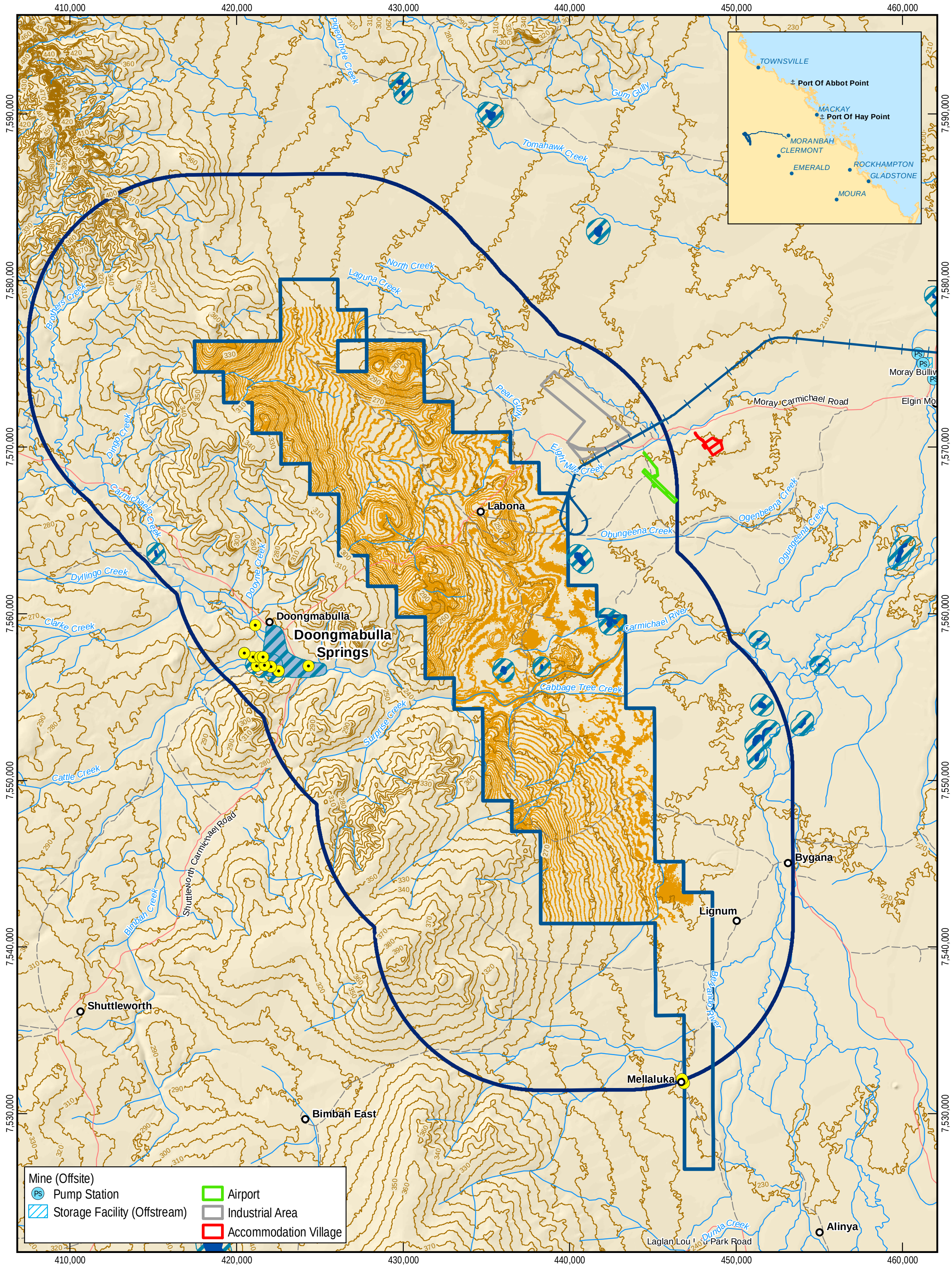
4.1 Topography and drainage

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 Mine Area boundary and running parallel to it (Figure 11). 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 the Mine Area, 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 and lies approximately 8 to 10 km to the east of the mine area 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 Volume 4, Appendix K5, Revised Mine Hydrology Impact Assessment Report,).

Two surface water monitoring stations were established as part of the EIS within the Study Area on the Carmichael River, one close to the upstream boundary of the lease (Station No. 333301) and one approximately midway between the upstream and downstream boundary of the lease. (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. Adani Mining has already established a number of permanent gauging and sampling sites, including the two previously monitored gauging sites, to address this particular data gap (see Section 7.6.6 for further information).



LEGEND

○ Homestead	— Watercourse	▨ Directory of Important Wetlands	▭ Hydrogeology Study Area
● Springs	— Contour - 2m	▨ Great Barrier Reef Wetland Protection Trigger Area	┼ Project (Rail)
— Local Road	— Contour - 10m	● Great Barrier Reef Wetland Protection Area	▭ Project (Mine)
-- Track			

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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Job Number	41-26422
Revision	C
Date	15-10-2013

Topography, Drainage and Wetlands Figure 11

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Level 9, 145 Ann 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 and the digital published geology in Figure 4 and. Figure 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)
- Tertiary-age clay, sandstones and siltstones (map symbol T,Figure 4)
- Numerous underlying Triassic-age units which form part of the GAB including the Warang Sandstone (a lateral equivalent of the Clematis 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.

4.2.1 Unconsolidated alluvial and colluvial deposits

Unconsolidated alluvium and colluvium 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 G) suggests that strata that have previously been considered lower Tertiary-age 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 2.1×10^{-4} m/d for the Tertiary-age clay strata (see Table 6). 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 the 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 the 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 the Mine Area 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. Investigations undertaken for the Alpha Coal Project EIS (JBT, 2010), however, suggests relatively high yields from the coarse sandstone units of the Colinlea Sandstone below the D seam (seeFigure 7).

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 publicay 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 Summary of hydrogeological units identified for the Study Area

Description	Map symbol	Age	Type	Typical thickness1	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 the Mine Area 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 the Mine Area 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 the Mine Area.
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 the Mine Area.
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 the Mine Area, 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

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[1] Within EPC 1690 lease area

Description	Map symbol	Age	Type	Typical thickness1	Comments
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 parts of the Mine Area; Sandstone and coal seams yield estimates <0.1 to 1 L/s

4.3 Groundwater levels and flows

4.3.1 Overview

Groundwater levels collected from the groundwater monitoring network established within Study Area in May/June 2013 are shown in plan view in Figure 12. Interpreted groundwater level contours and groundwater flow directions are shown for the Triassic-age strata (Figure 13 and Figure 14), overburden (Figure 15), AB seam (Figure 16), interburden (Figure 17), D seam (Figure 18) and older Permian-age strata (Figure 19). 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 12) suggests flow from west to east (i.e. downriver). Time series of groundwater elevations are included in Appendix C.

The groundwater elevations calculated for the D seam at vibrating wire piezometer (VWP) C056 (of between around 130 and 140 mAHD) are considered to be erroneous since groundwater levels are around 80 m lower than levels recorded in nearby monitoring bores installed in the D seam. Pressure data downloaded from two other VWPs, C9556P_V01 and C553P_V01, gave unexpectedly large fluctuations in groundwater levels of between around 10 and 800 m. All of the data downloaded for C553P_V01 and all of the data from 1 January 2013 onwards for C9556P_V01 are considered erroneous. The erroneous groundwater level data from these piezometers have therefore been excluded from all subsequent analysis although monitoring of groundwater level pressures in these bores is ongoing.

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 in the south of the Mine Area where the piezometric head has been measured close to ground surface at around 3 mBGL at borehole C035P2 (AB Seam), around 4.5 mBGL at C848SP (D Seam) 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 at the following locations:

- Exploration bore C066 (exploration site 180-35 just north of the Carmichael River close to the western boundary of the Mine Area)
- C832SP, C833SP and C834SP (south of the Carmichael River)
- C180119SP and C180122SP (north of Mellaluka)
- C180120SP and C9180125SPR (east of Mellaluka)
- C9180121SPR, C180123SP and C9180124SPR (south of Mellaluka).

Measured groundwater levels in the Dunda Beds at the two monitored locations towards the north of the Mine Area 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 the Mine Area (C555P1 and C556P1), around 3 to 4 mBGL in the south-east (C035P1) and around 20 mBGL in the south-west (C845SP).

As would normally be expected groundwater levels in the majority of strata close to the Carmichael River are close to ground surface. Groundwater levels measured within the Tertiary-age strata in the vicinity of the Carmichael River range therefore from around 2 mBGL at C029P2 to around 11 mBGL at C025P1. Similarly groundwater levels in the alluvium range from close to ground surface to around 11 mBGL at C027P1 and C029P1 respectively.

4.3.3 Groundwater flow directions

Interpretation of the groundwater elevation data for the monitoring network, collected in May/June 2013, for selected monitored units is shown in Figure 13, Figure 14, Figure 15, Figure 16, Figure 17, Figure 18 and Figure 19. These maps suggest that groundwater flow is typically towards the south-east across the northern and central parts of the Mine Area and towards the north across southern part of the Mine Area (i.e. towards the Carmichael River within the various monitored units). However, interestingly the groundwater level data typically show minimum elevations in an area located between around 4 and 10 km north of the Carmichael River (monitoring sites C006, C007, C008, C555, C825SP, C827SP and C829SP) rather than the Carmichael River itself.

4.3.4 Vertical gradients

A comparison of average groundwater levels (from observed data) and estimated river bed elevations (based on LIDAR data) at three locations where monitoring bores have been installed close to the Carmichael River are provided in Table 5.

Average groundwater level data at site CO27 close to the upstream limit of the mine area suggest upward gradients of around 2 m from the Dunda Beds (C027P2) to the overlying alluvium (C027P1) and of around 0.5 m from the alluvium to the river, indicating gaining conditions at this location. However, time series water level data at the same site (see Appendix C) suggest levels in the alluvium do fall below the estimated river level (224 mAHD) for large parts of the year, indicating periodic losing conditions.

Average groundwater levels at monitoring sites C027 and C029 which are located further downstream suggest consistent upward gradients of up to around 5 m from the Tertiary-age strata (C029P2) to the overlying alluvium (C029P1) but similar downward gradients from the river to the alluvium, indicating losing conditions at these locations.

Further discussion on groundwater and surface water interactions based on this and other data can be found in Section 4.7.

Table 5 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*

Site	Borehole	Strata monitored	Average groundwater / River bed level (mAHD)
	P1	Tertiary	216.6
	P2	Tertiary	217.9

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

The following comments on head gradients between the different strata away from the Carmichael River are drawn from interpretation of the groundwater level contour plots and time series charts:

- Data indicate upward gradients within the Permian-age strata (i.e. D to AB seam, D seam to interburden and AB to overburden) typically in the order 0.1 to 3.5 m head in the south of the Mine Area (nested sites C034, C848SP / C9849SP and C556V1 / C556V2) and in the order 1 to 4.5 m head in the central part of the Mine Area (nested sites C006, C007, C008 and C555, north of Carmichael River and south of Moray Carmichael Road).
- Conversely data indicate predominantly downward gradients within the Permian-age strata in northern parts of the Mine Area (nested sites C011, C018, C558, C9553 and C056, north of Moray Carmichael Road).
- Data indicate downward gradients in the order of 2 to 4 m head from the Dunda Beds in the west of the Mine Area to the underlying Permian-age strata (C845SP to C032P2 in the south and C9553P1R to C553PV3 in the north).
- Data indicate predominantly downward gradients of 4 to 6 m head from the Rewan Group to underlying Permian-age strata (VWP C056CV3 to C056CV2 towards the north of the Mine Area and VWP C9556PV3 to C9556PV2 towards the south of the Mine Area). However an upward gradient of around 1 m head is observed at site C035 towards the south of the Mine Area from the AB seam (C035P2) to the Rewan Group (C035P1).
- Data indicate a downward gradient of 4 to 5 m head within the Rewan Group (nested site C556P1 to C9556PV3 and nested site C555P1 to C555PV3) towards the west of the Mine Area.

4.3.5 Seasonal fluctuations

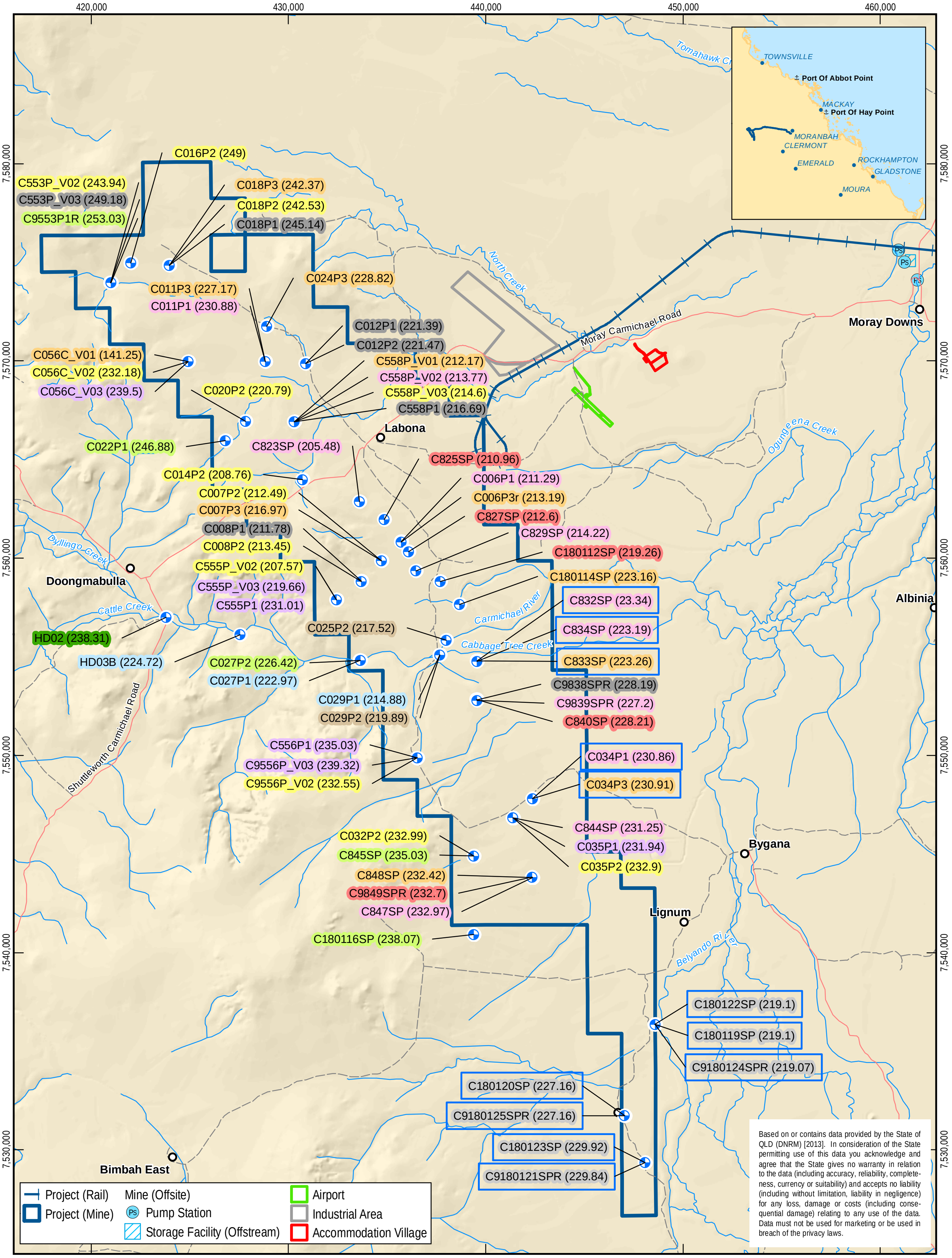
Groundwater level data for the monitoring network bores installed in 2011 and 2012 are currently available for the period July 2011 to May 2013. Time series monitoring data are not yet available for HD03A for which monitoring commenced in May 2013 or for the monitoring locations installed in 2013.

The available data (see Appendix C) suggest that across the majority of the Mine Area, 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 between around 0.3 and 0.5 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. Groundwater level time series data for monitoring boreholes completed along the Carmichael River corridor show fluctuations of up to around 3 m in some cases (e.g.C029P2, see Appendix C), compared

to less than 0.2 m in most other bores. This is thought to be related to enhanced river leakage derived recharge along the Carmichael River corridor and is discussed further in Section 4.8.

Across the Mine Area, 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, C006P1, C006P3r, C007P2, C007P3, C008P1, C008P2 and C029P2) or show a declining trend (for example C014P2, C016P2, C020P2, C025P2, C27P1, C27P2, C032P2, C034P1, C034P2, C035P1 and C035P2).



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LEGEND

- ○ Homestead
- Local Road
- Track
- Watercourse
- Artesian
- 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) - Permian Interburden
- Groundwater Monitoring Bore (SWL in AHD) - D Seam
- Groundwater Monitoring Bore (SWL in AHD) - Overburden
- Groundwater Monitoring Bore (SWL in AHD) - Permian below D Seam
- Groundwater Monitoring Bore (SWL in AHD) - Clematis Sandstone

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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Job Number 41-26422
Revision H
Date 15-10-2013

Groundwater Levels May/June 2013

Figure 12

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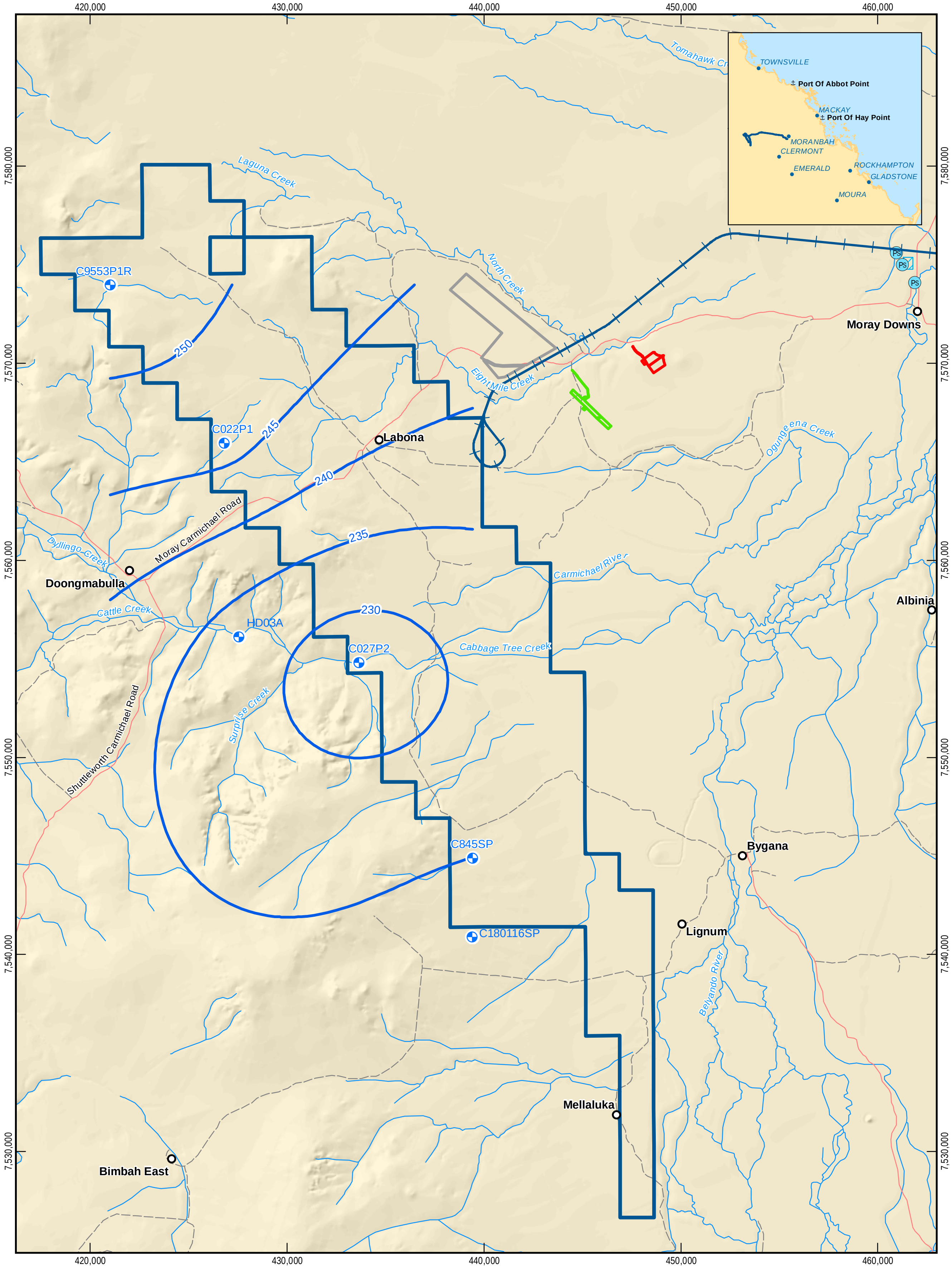
GHD: Monitoring Bores (2011, 2012, 2013); Adani: Project Rail 1 (Opt11 Rev2) & 2 (Opt9 Rev3), Facilities (2013). Created by: BW, MS



LEGEND

○	Homestead	- -	Track	🟩	Airport
●	Groundwater Monitoring Bore (SWL in mAHD - May/June 2013)	—	Watercourse	☐	Industrial Area
—	Interpreted Groundwater Level Contour (mAHD)	┥	Project (Rail)	🟥	Accommodation Village
—	Local Road	☐	Project (Mine)		
			Mine (Offsite)		
		PS	Pump Station		
		▨	Storage Facility (Offstream)		

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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

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Interpreted Groundwater Contours
Dunda Beds

Job Number	41-26422
Revision	J
Date	15-10-2013

Figure 13

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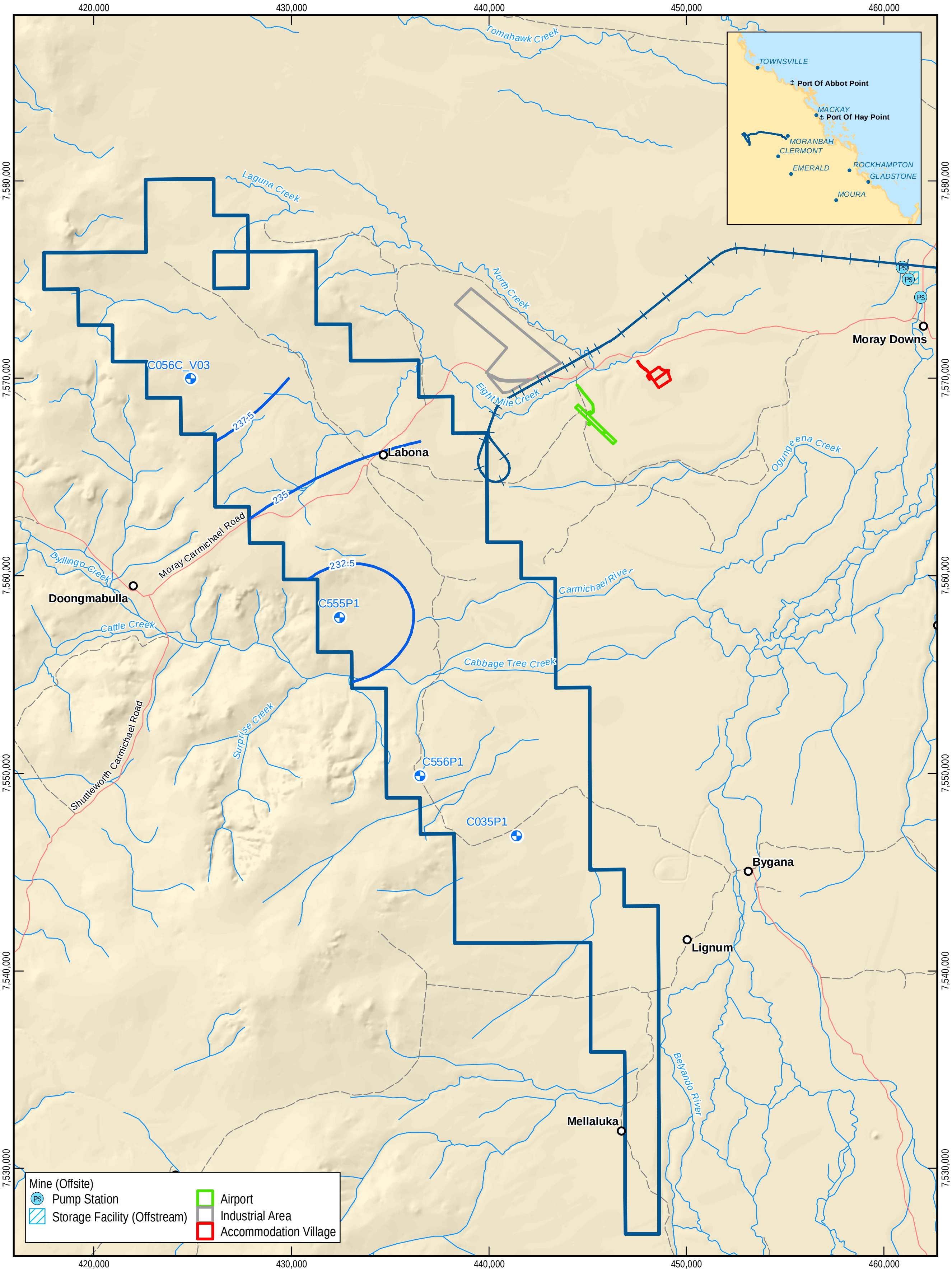

LEGEND

○ Homestead

● Groundwater Monitoring Bore (SWL in mAHD - May/June 2013)

— Local Road

- - Track

— Watercourse

— Interpreted Groundwater Level Contour (mAHD)

—| Project (Rail)

☐ Project (Mine)

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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 SEIS

Interpreted Groundwater Contours
Rewan Group

Job Number	41-26422
Revision	E
Date	15-10-2013

Figure 14

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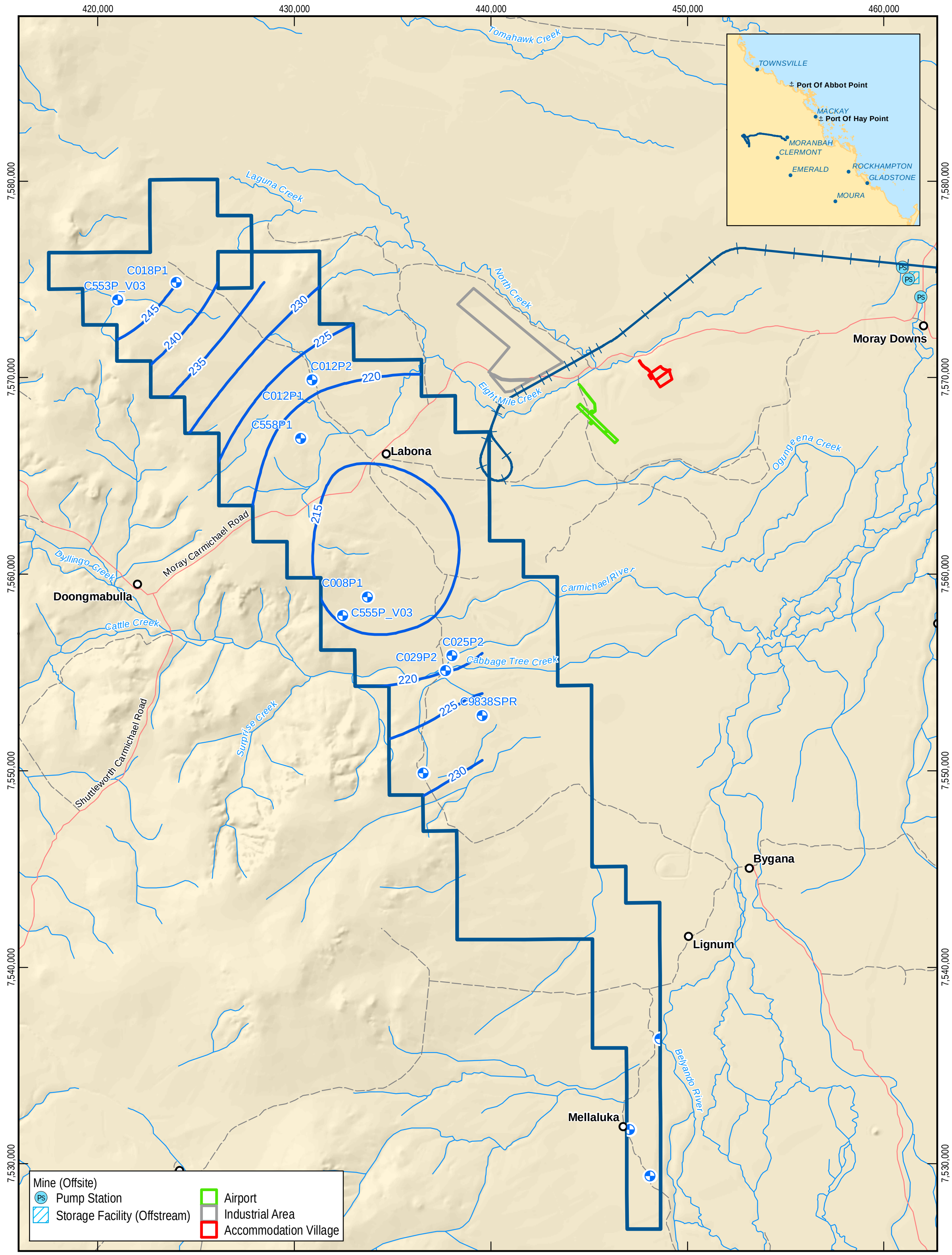

LEGEND

○ Homestead

⊕ Groundwater Monitoring Bore (SWL in mAHD - May/June 2013)

Local Road

Track

Watercourse

Interpreted Groundwater Level Contour (mAHD)

Project (Rail)

Project (Mine)

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Kilometres

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

N

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Interpreted Groundwater Contours Overburden

Job Number	41-26422
Revision	D
Date	15-10-2013

Figure 15

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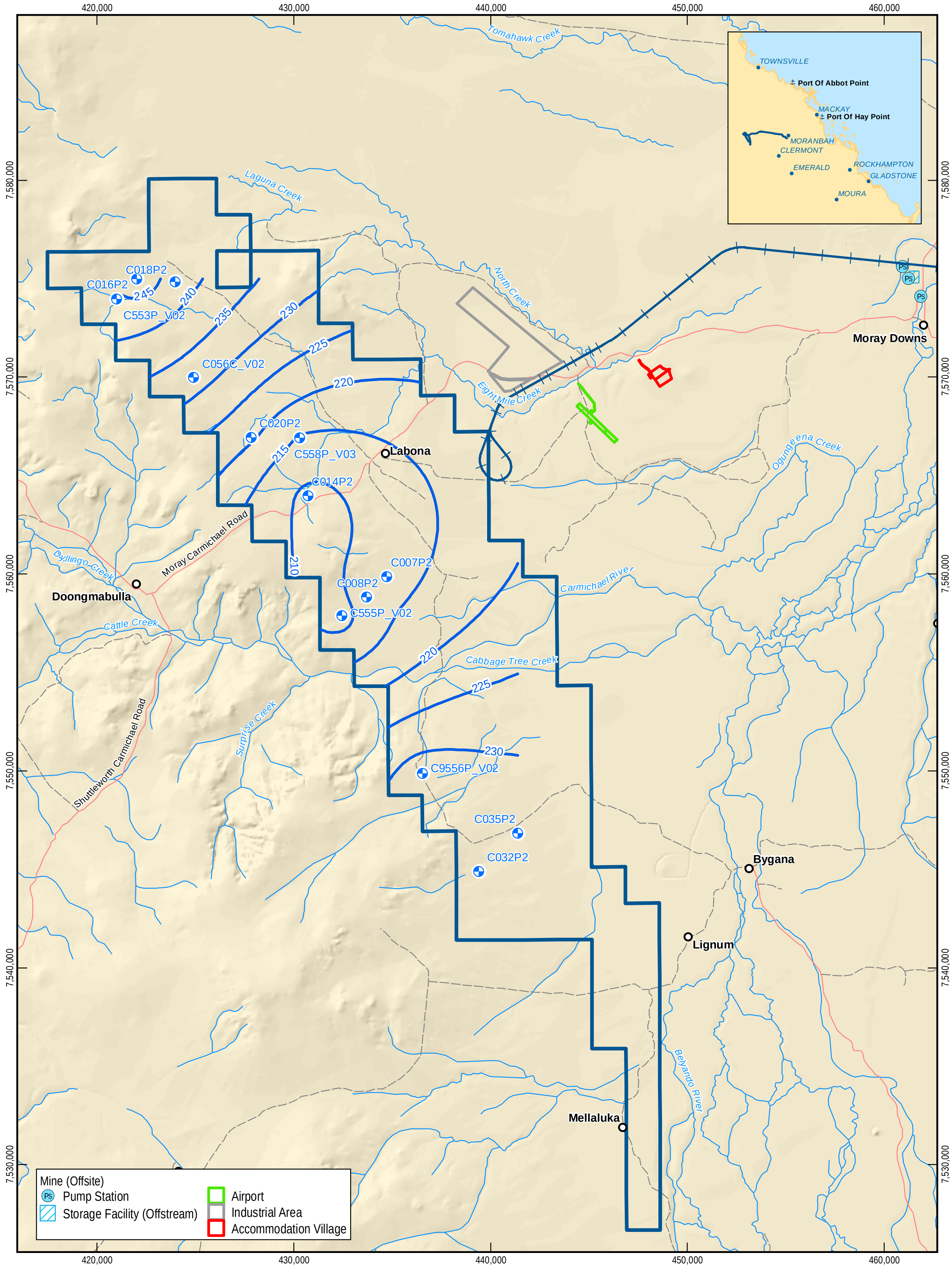

LEGEND

○ Homestead
● Groundwater Monitoring Bore (SWL in mAHD - May/June 2013)
— Local Road
- - Track
— Watercourse
— Interpreted Groundwater Level Contour (mAHD)
— Project (Rail)
▢ Project (Mine)

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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 SEIS

Interpreted Groundwater Contours
AB Seam

Job Number | 41-26422
Revision | I
Date | 15-10-2013

Figure 16

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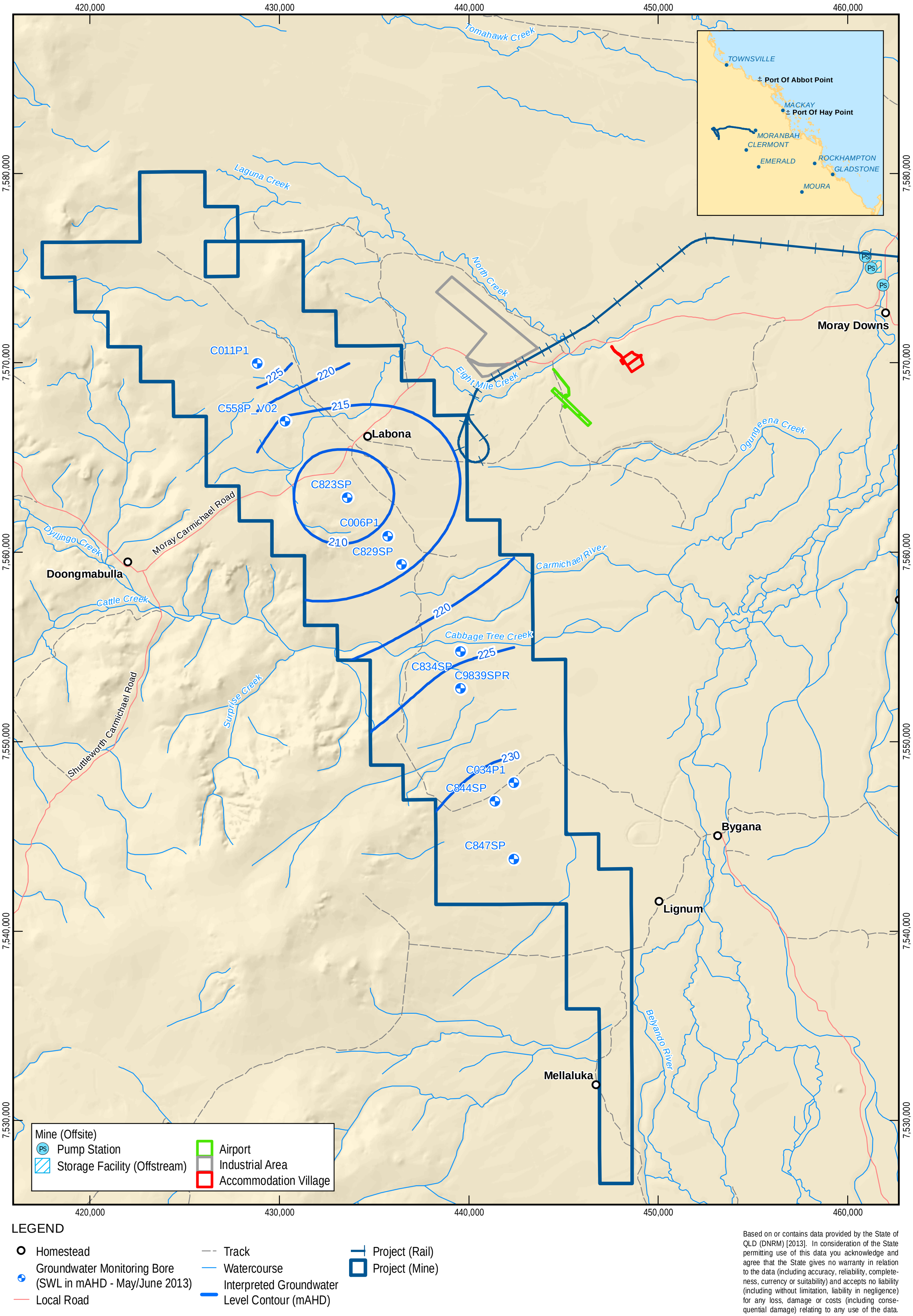
GHD: Monitoring Bores, Interpreted Groundwater Level Contour (2013); Adani: Project Rail 1 (Opt11 Rev2) & 2 (Opt9 Rev3), Facilities (2013). Created by: BW, MS



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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 SEIS

Interpreted Groundwater Contours Interburden

Job Number	41-26422
Revision	E
Date	15-10-2013

Figure 17

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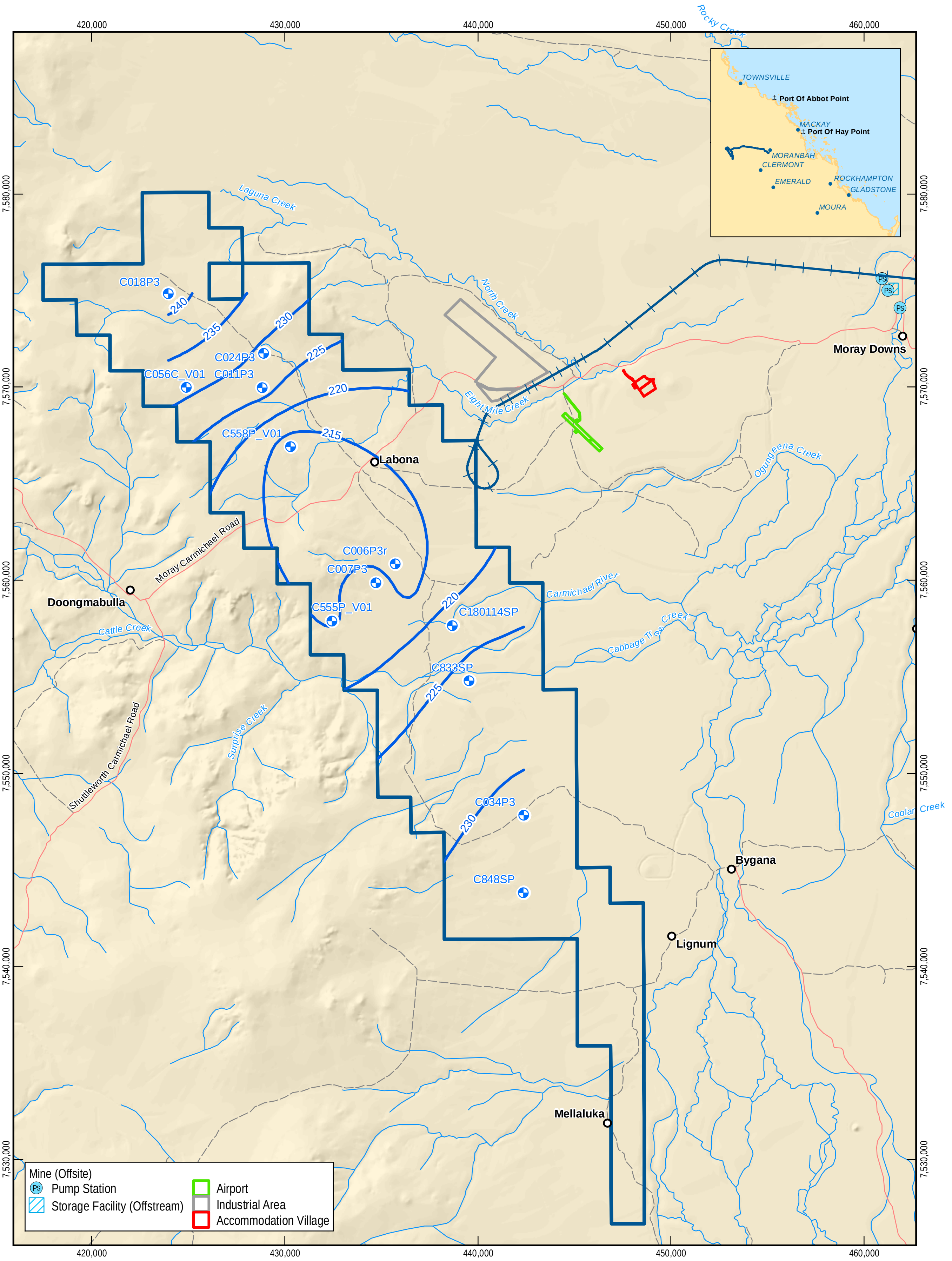
GHD: Monitoring Bores, Interpreted Groundwater Level Contour (2013); Adani: Project Rail 1 (Opt11 Rev2) & 2 (Opt9 Rev3), Facilities (2013). Created by: BW, MS



LEGEND

○ Homestead	Track	Project (Rail)
Groundwater Monitoring Bore (SWL in mAHD - May/June 2013)	Watercourse	Project (Mine)
Local Road	Interpreted Groundwater Level Contour (mAHD)	

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Kilometres

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

N

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Interpreted Groundwater Contours
D Seam

Job Number	41-26422
Revision	I
Date	15-10-2013

Figure 18

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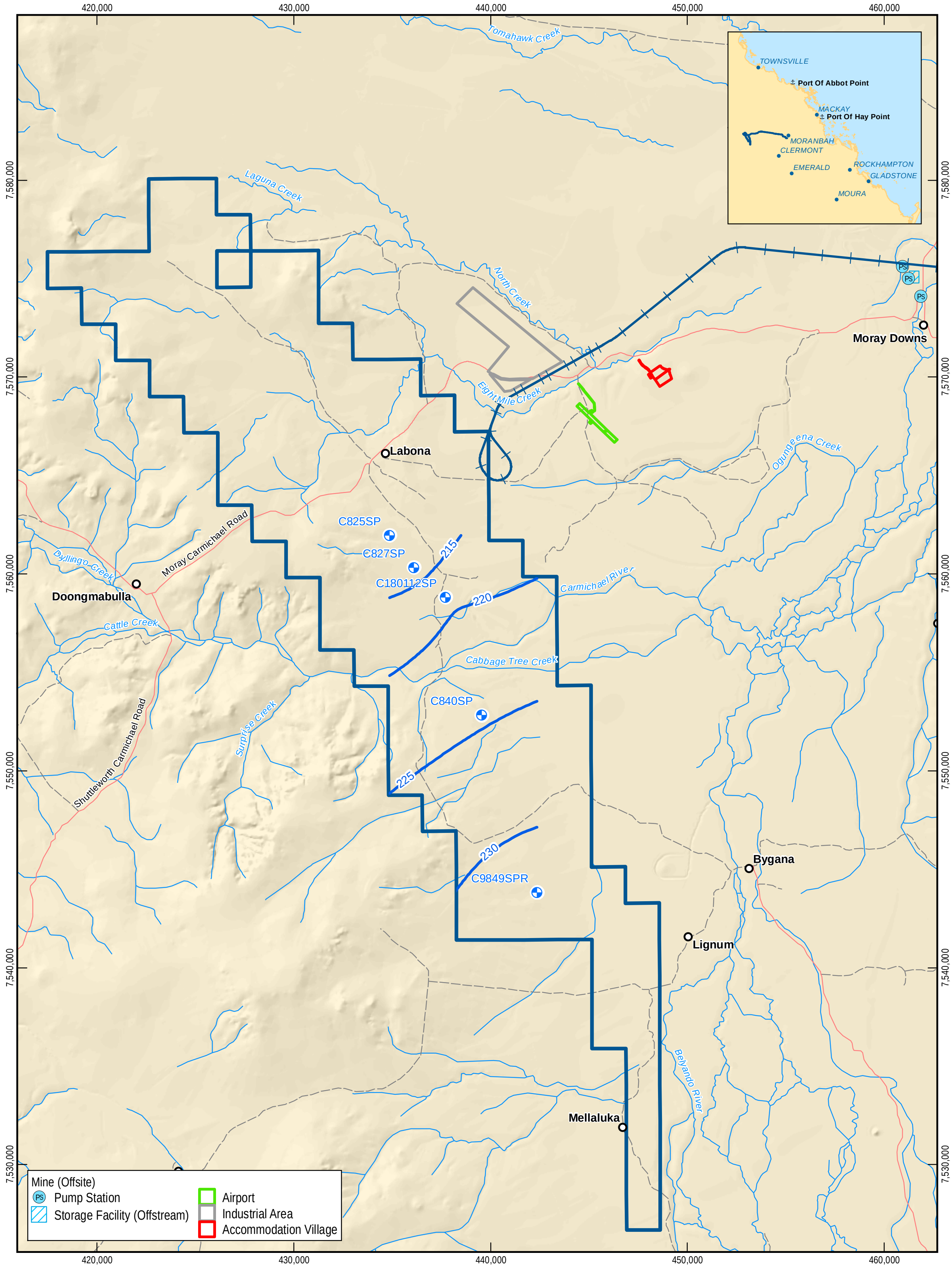
GHD: Monitoring Bores, Interpreted Groundwater Level Contour (2013); Adani: Project Rail 1 (Opt11 Rev2) & 2 (Opt9 Rev3), Facilities (2013). Created by: BW, MS



LEGEND

- ○ Homestead
- ⊕ Groundwater Monitoring Bore (SWL in mAHD - May/June 2014)
- Local Road
- Track
- Watercourse
- Interpreted Groundwater Level Contour (mAHD)
- Project (Rail)
- ☐ Project (Mine)

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Kilometres

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

N

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number	41-26422
Revision	D
Date	15-10-2013

Interpreted Groundwater Contours Permian-age Below D Seam

Figure 19

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4.4 Groundwater quality

4.4.1 Overview

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

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 20 and Figure 21) 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 20). 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 21 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 9 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 2012 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 2012 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.

Concentrations of sodium in groundwater samples detected above the laboratory LoR ranged from 47 to 6,710 mg/L and exceeded the long-term irrigation guidelines of 460 mg/L (ANZECC 2000) in 12 boreholes monitoring the alluvium, Tertiary-age strata, Rewan Group, overburden, interburden and the AB seam (i.e. all units monitored except the Dunda Beds and D Seam). Concentrations of chloride in groundwater ranged from 35 to 9,520 mg/L also exceeded the long-term irrigation guidelines of 700 mg/L in 13 boreholes monitoring all strata except the Dunda Beds and D seam. Sulphate concentrations in groundwater only exceeded the drinking water guideline (500 mg/L, ADWG 2011) 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 20 Piper diagram – groundwater

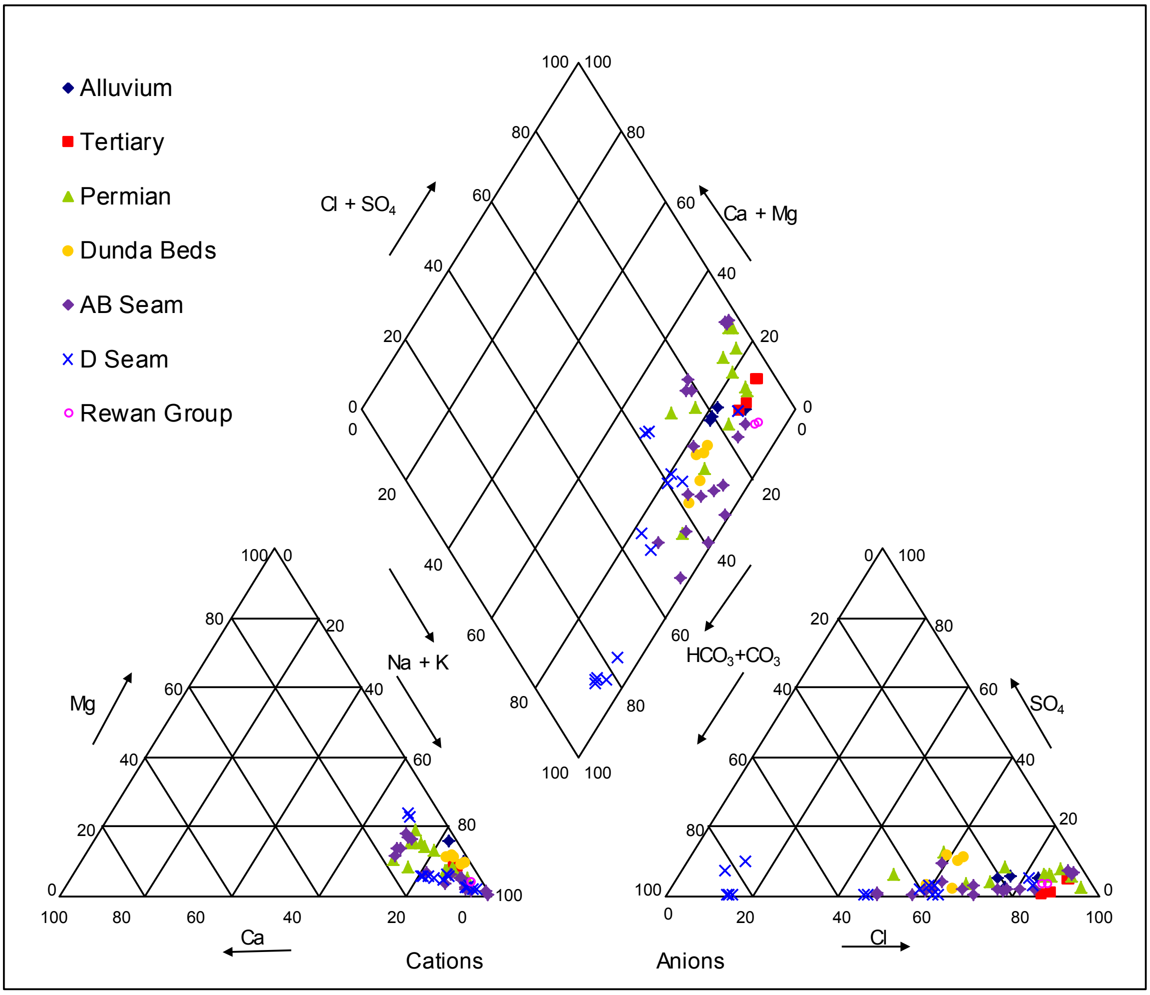
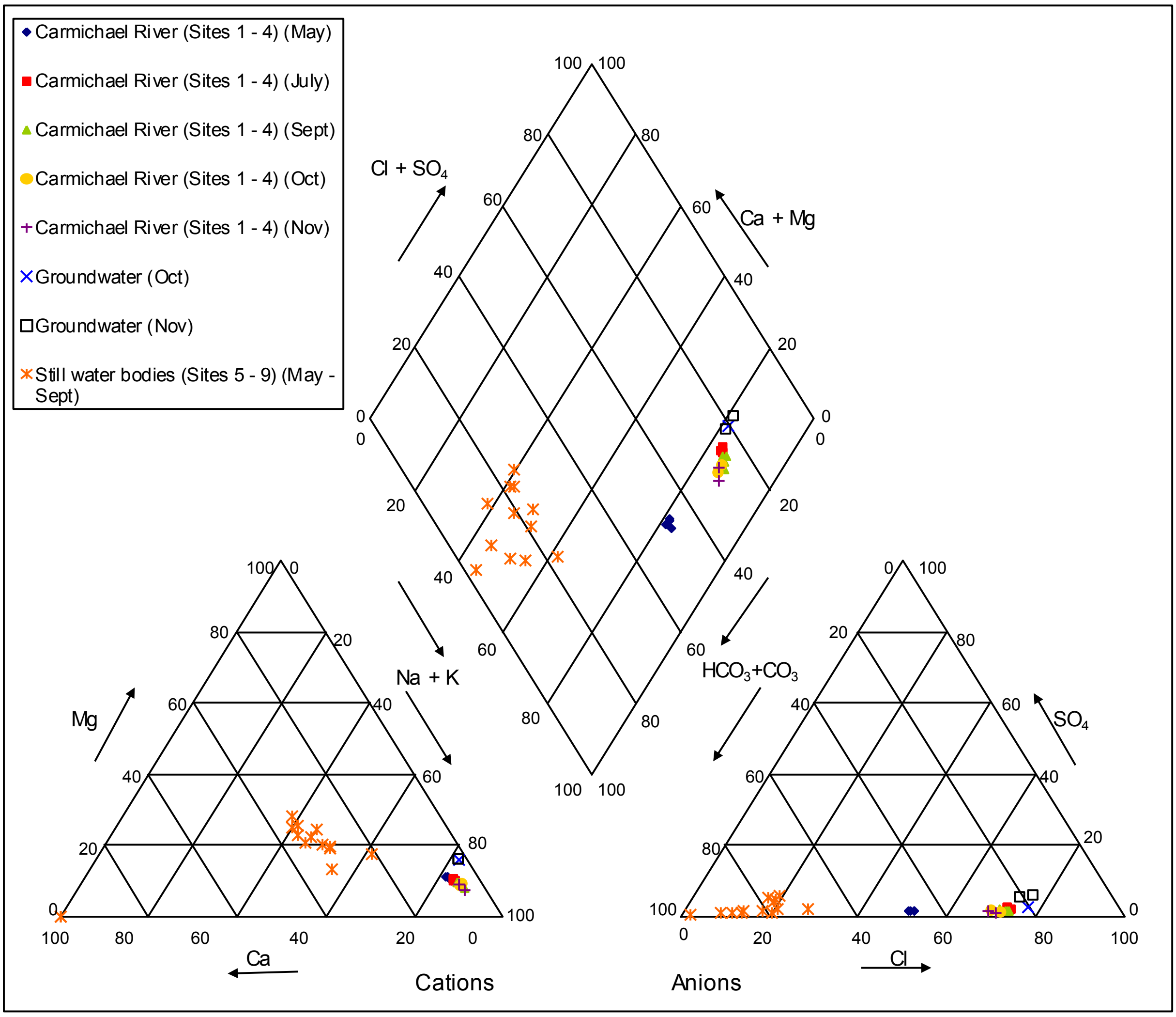


Figure 21 Piper diagram – groundwater and Carmichael River



4.4.3 Nutrients

Concentrations of ammonia (as N) in groundwater exceeded the ANZECC (2000) fresh water (95 per cent level of protection) guideline value of 0.9 mg/L at nine of the sampled locations and exceeded the drinking water guidelines of 0.5 mg/L at 12 of the sampled locations on one or more occasions. These exceedences of ammonia were identified in samples taken from monitoring bores installed in the alluvium, Tertiary-age strata, Clematis Sandstone, Permian interburden, the AB seam and the D seam (i.e. all units monitored except the Dunda Beds, the Rewan Group and the Permian interburden). 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, overburden, interburden, AB seam and D seam).

Nitrate (as N) concentrations of up to 0.2 mg/L and nitrite (as N) 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 11.7 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 hardness corrected dissolved chromium, copper, nickel and zinc along with concentrations of dissolved aluminium, boron, manganese, selenium and silver also typically exceeded the ANZECC (2000) fresh water (95 per cent level of protection) guidelines, in more than one location for all of the units monitored.

Concentrations of dissolved metals in all units tested were generally below the guideline concentrations for livestock, with the exception of manganese. Manganese concentrations at 25 sampled locations 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 (3 locations), boron (13 locations), iron (26 locations), manganese (20 locations), molybdenum (5 locations), selenium (2 locations) and uranium (3 locations). 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, overburden, interburden, AB seam and D seam).

Drinking water guidelines were exceeded for arsenic (7 locations), molybdenum (1 location), manganese (10 locations), nickel (3 locations), selenium (2 locations) and uranium (2 locations). Exceedences of one or more of these metals species were detected in all units monitored.

4.4.5 Hydrocarbons

Low concentrations of BTEX (benzene, toluene, ethylbenzene and xylene), comprising toluene (six locations in 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) in the first two monitoring rounds. Exceedences of the LoR were detected in the Dunda Beds, Tertiary-age strata, the AB seam and the D seam. No concentrations of BTEX compounds were reported above the LoR for the third monitoring round.

Low concentrations of total petroleum hydrocarbons (TPH) typically 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 (C008P2 in one out of three samples). 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 Mine Area indicated the following:

- Local groundwater is dominated by extraction for Stock & Domestic and Irrigation use
- To the west of Hydrogeology 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 the Mine Area extraction is generally thought to occur from Tertiary 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 be suitable for drinking (based on the elevated observed concentrations of arsenic, manganese and uranium detected), not suitable for long term irrigation (based on elevated 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 monitoring bores does not appear to be suitable for long-term irrigation given significantly elevated concentrations (above guideline values) of dissolved iron (0.72 to 24.5 mg/L), manganese (0.45 to 3.01 mg/L) and boron (0.9 to 1.22 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 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 concentrations for the bores tested typically fall into the ‘good’ palatability category (0 to 600 mg/L TDS) for drinking water (ADWG, 2011). However, the elevated iron concentrations present in the samples taken (0.5 to 24.9 mg/L) would make the groundwater unsuitable for long term irrigation and the results also indicate borderline suitability for livestock on the basis of dissolved manganese (up to 1.78 mg/L).
- AB seam. Potential for industrial use only. Generally not suitable for drinking water on the basis of palatability (aesthetic), given that 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 0.6 mg/L) in some bores suggest that in some areas groundwater could also be unsuitable for livestock. Elevated concentrations of sodium (up to >2000 mg/L) and chloride (up to >5000 mg/L) in some monitoring bores of the AB seam suggest that the groundwater from some areas would also be unsuitable for irrigation.
- D seam. Potential for industrial use only. Generally also suitable for drinking water, however fluoride concentrations exceeded drinking water guideline values at two monitoring bores sampled. 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 30.1 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 6, Table 7, and Table 8 respectively. Summary statistics are presented in Table 9. Slug test analysis data sheets are included in Appendix E and a summary of the pumping test analysis is included in Appendix F.

4.6.1 Permian-age coal measures

The majority (53 out of 69) of tests undertaken in the Mine 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-age strata are typically characterised by:

- Relatively low hydraulic conductivity and hence the median hydraulic conductivity for the different strata tested vary between $9.5x10^{-3}$ m/d for the D Seams to $1.3x10^{-3}$ m/d for the ‘interburden’ units between the AB and D seams (Table 9)
- A relatively high degree of variability. For the Permian-age strata tested (overburden, interburden and coal seams) 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 (Table 9)
- Packer testing results (Table 7) suggest little or no apparent difference between tests undertaken in adjacent sandstone and siltstone units although relatively high hydraulic conductivity values were recorded for sandstone units between or immediately below some of the main coal seams.

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

Pumping test results (Table 8), which suggest hydraulic conductivity values for the tested coal seams which vary from 0.1 to 3.5 m/d, are also comparable to values quoted in the Groundwater Technical Report for the Alpha Coal Project EIS (JBT, 2010). Pumping test derived hydraulic conductivity values for similar Permian-age Sandstone, coal seams and interburden at the Alpha Coal site vary from 0.14 to 1.56 m/d.

4.6.2 Rewan Group

Eight tests have also been completed in the Rewan Group. This is considered to be a particularly important unit since it separates the overlying Triassic age GAB units, which include the Clematis Sandstone, from the underlying Permian strata, which include the target coal seams. The median hydraulic conductivity returned by these test results of $3.1x10^{-4}$ m/d is consistent with regional data sets which indicate a median hydraulic conductivity of $3.6x10^{-4}$ m/d for the Rewan Group (QWC, 2012). The relatively high hydraulic conductivity values of up to $2.9x10^{-1}$m/d returned by slug tests undertaken in three monitoring bores completed into the Rewan Group (Table 6) is surprising given that regional data set suggest that 95 percent of tests in the Rewan return values of less than $5.1x10^{-2}$ m/d (QWC, 2012). However, it should be noted that these bores specifically targeted relatively permeable parts of the Rewan, in order to

reduce the potential of a dry bore, and hence are considered likely to be a less reliable indicator of the typical rock mass hydraulic conductivity of the Rewan Group than the packer test results (Table 7).

4.6.3 Other units

Only a small number of test results are available for the remaining strata present within the Project (mine) area.

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. However, as for the bores completed in the Rewan Group, it should be noted that these bores specifically targeted relatively permeable parts of the Tertiary, in order to reduce the potential of a dry bore, and hence are considered likely to represent an over-estimate of typical bulk hydraulic conductivity values for the clay dominated Tertiary-age strata. Laboratory testing of six Tertiary clay samples collected from shallow trial pits as part of geotechnical investigations indicates values of between 2.6×10^{-6} to 6.9×10^{-4} m/d (4DG, 2013) which are considered to more representative given the observed clay dominated nature of these strata.

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 6 Summary of estimated hydraulic conductivity from slug tests

Bore ID	Hydraulic conductivity K (m/d)	Hydraulic conductivity K (m/s)	Tested unit
C027P1	2.5x10-02	2.9×10^{-07}	Alluvium (sand with gravel)
C029P1	1.2x10-01	1.4×10^{-06}	Alluvium (sand and clayey sand)
HD03B	1.1x10+00	1.3×10^{-05}	Alluvium (clay)
C025P2	1.7x10-01	2.0×10^{-06}	Tertiary (leached, fine grained rock)
C029P2	5.3x10-02	6.1×10^{-07}	Tertiary (ferricrete)
C558P1	2.1x10-04	2.5×10^{-09}	Tertiary / Permian overburden (sandy clay)
HD02	1.5x10+01	1.7×10^{-04}	Clematis Sandstone
C022P1	3.0x10+00	3.4×10^{-05}	Dunda Beds (weathered sandstone)
C027P2	2.5x10-01	2.9×10^{-06}	Dunda Beds (ferricrete)
C035P1	2.3x10-02	2.7×10^{-07}	Rewan Group (weathered sandstone)
C9553P1R	2.2x10-03	2.6×10^{-08}	Dunda Beds (clayey sand)
C555P1	1.0x10-01	1.2×10^{-06}	Rewan Group (sandy clay)
C556P1	2.9x10-01	3.4×10^{-06}	Rewan Group (sandy clay)
C008P1	2.3x10-03	2.7×10^{-08}	Permian overburden (weathered

Bore ID	Hydraulic conductivity K (m/d)	Hydraulic conductivity K (m/s)	Tested unit
			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 7 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}
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}

Bore	Test type	Test interval (mbgl)	Formation tested	Estimated hydraulic conductivity (m/d)
C039 Test 3	Straddle	306 - 314.7	Permian overburden (Sandstone & siltstone, fractured zone 306 to 308 m)	$8.6\text{x}10^{-05}$
C558P Test 1	Single	182 - 222	Below D Seam (Sandstone, some siltstone)	$1.2\text{x}10^{-03}$
C558P Test 2	Straddle	161.7 - 167.7	D Seam (Coal)	$1.6\text{x}10^{-02}$
C558P Test 3	Single	161.7 - 222	D Seam & below D Seam (Coal & sandstone)	$8.7\text{x}10^{-03}$
C558P Test 4	Straddle	104.7 - 110.7	Interburden (Sandstone, some siltstone)	$8.6\text{x}10^{-05}$
C558P Test 5	Single	83.8 - 222	Interburden, D Seam, below D Seam (Sandstone, some siltstone)	$9.7\text{x}10^{-04}$
C558P Test 6	Straddle	77.4 - 82.4	AB2 & AB3 Seam (Coal)	$1.4\text{x}10^{-02}$
C555P Test 1	Single	441.5 - 473	Below D Seam (Sandstone, some siltstone)	$1.3\text{x}10^{-03}$
C555P Test 2	Straddle	435 - 441	D1 & D2 Seam (Coal & siltstone)	$2.8\text{x}10^{-03}$
C555P Test 3	Single	360 - 473	Interburden to below D Seam (Sandstone with siltstone, coal)	$3.3\text{x}10^{-04}$
C555P Test 4	Straddle	342 - 348	AB Seam (Coal)	$1.2\text{x}10^{-03}$
C555P Test 5	Straddle	330 - 336	Permian overburden (Sandstone)	$5.8\text{x}10^{-05}$
C9556PR Test 1	Single	410.7 - 444.7	Below D Seam (Sandstone)	$7.0\text{x}10^{-04}$
C9556PR Test 2	Straddle	404.5 - 410.5	D Seam (Coal)	$1.3\text{x}10^{-04}$
C9556PR Test 3	Single	329.7 - 444.7	Interburden to below D Seam (Sandstone, coal)	$1.3\text{x}10^{-03}$
C9556PR Test 4	Straddle	311.7 - 318.7	AB Seam (Coal)	$1.5\text{x}10^{-04}$
C9556PR Test 5	Straddle	303.1 - 309.1	Permian overburden (Sandstone)	$2.3\text{x}10^{-04}$
C9556PR Test 6	Straddle	243.1 - 249.1	Rewan Group (Sandstone & siltstone)	$2.3\text{x}10^{-04}$
C851VWP Test 1	Single	258 - 260.2	Below D Seam (Sandstone)	$2.2\text{x}10^{-02}$
C851VWP Test 2	Straddle	241.4 - 246.4	Within D Seam (Sandstone)	$1.5\text{x}10^{-02}$
C851VWP Test 3	Straddle	231.8 - 236.8	Within D Seam (Sandstone)	$9.5\text{x}10^{-03}$
C851VWP Test 4	Straddle	224.9 - 229.9	D Seam (Coal)	$9.5\text{x}10^{-03}$
C851VWP Test 5	Straddle	210.6 - 215.6	Interburden between C2 and C3 Seam (Sandstone)	$2.2\text{x}10^{-03}$
C851VWP Test 6	Straddle	186.6 - 191.6	Interburden between AB3	$8.6\text{x}10^{-04}$

Bore	Test type	Test interval (mbgl)	Formation tested	Estimated hydraulic conductivity (m/d)
			and C1 Seam (Sandstone)	
C842VWP Test 1	Single	240 - 246.8	Interburden between C3 and D1 Seam (tuff)	$1.7x10^{-03}$
C842VWP Test 2	Straddle	167.1 - 172.1	AB1 to AB3 (Coal)	$2.8x10^{-03}$
C842VWP Test 3	Straddle	152.7 - 157.7	Permian Overburden (Siltstone and sandstone)	$3.5x10^{-03}$
C842VWP Test 4	Straddle	138 - 143	Permian Overburden (Sandstone)	$4.8x10^{-04}$
C842VWP Test 5	Straddle	131.7 - 136.7	Rewan Group (Siltstone and sandstone)	$9.5x10^{-05}$
C836VWP Test 1	Single	294.9 - 299.4	Interburden between C3 and D1 Seam (Siltstone/mudstone)	$2.5x10^{-03}$
C836VWP Test 2	Straddle	285.8 - 290.8	Interburden between C2 and C3 Seam (Sandstone)	$5.1x10^{-03}$
C836VWP Test 3	Straddle	228.8 - 233.8	AB2 and AB3 (Coal)	$4.8x10^{-02}$
C836VWP Test 4	Straddle	192.8 - 197.8	Permian Overburden (Sandstone)	$9.5x10^{-04}$
C836VWP Test 5	Straddle	132.8 - 137.8	Rewan Group (Siltstone/mudstone)	$3.7x10^{-04}$
C836VWP Test 6	Straddle	105.8 - 110.8	Rewan Group (Siltstone)	$2.4x10^{-04}$

Table 8 Summary of estimated transmissivity, storage and hydraulic conductivity from pumping tests

Pumping test site ID	Formation tested	Adopted transmissivity1 (m2/d)	Adopted storativity 1 (Dimensionless)	Estimated hydraulic conductivity1 (m/d)
C006	D Seam	12	0.005	$2.0x10^{-01}$
C018	D Seam	9	0.001	$1.0x10^{-01}$
C035	AB Seam	60	0.005	$3.5x10^{+00}$

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

Table 9 Summary of estimated hydraulic conductivity by formation tested

		Estimated hydraulic conductivity (m/d)			
Formation	Dominant lithology	Minimum	Median	Maximum	Number of tests
Quaternary Alluvium	Sand and Clayey Sand	$2.3x10^{-02}$	$7.1x10^{-02}$	$1.2x10^{-01}$	2
Tertiary	Sandy Clay	$2.1x10^{-04}$	$5.3x10^{-02}$	$1.7x10^{-01}$	3

		Estimated hydraulic conductivity (m/d)			
Dunda Beds	Sandstone / Siltstone / Mudstone	$2.2x10^{-03}$	$2.5x10^{-01}$	$3.0x10^{+00}$	3
Rewan Group	Mudstone / Siltstone	$9.5x10^{-05}$	$3.1x10^{-04}$	$2.9x10^{-01}$	8
Permian overburden	Weathered Sandstone / Siltstone	$5.8x10^{-05}$	$1.7x10^{-03}$	$1.4x10^{+00}$	12
AB Seam	Coal and Siltstone	$8.6x10^{-05}$	$4.0x10^{-03}$	$3.5x10^{+00}$	13
Permian interburden	Sandstone / Siltstone	$8.6x10^{-05}$	$1.3x10^{-03}$	$5.1x10^{-03}$	8
D Seam	Coal and Siltstone	$1.3x10^{-04}$	$9.5x10^{-03}$	$2.0x10^{-01}$	11
Older Permian strata	Sandstone / Siltstone	$3.3x10^{-04}$	$1.2x10^{-03}$	$2.2x10^{-02}$	9

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 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
- 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 Mine Area suggests:

- An upward gradient from the Dunda Beds to the overlying alluvium

- 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 5 and also to Chart 14 of Appendix C).

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)
- 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 on the Carmichael River, one close to the upstream boundary of the Mine Area (Station No. 333301) and one further to the east (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 2011 to 15 August 2012, is shown in Figure 22. 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.

Nevertheless, the limited available flow data 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 this is consistent with the upward gradient observed at site C027 close to the western margin of the Mine Area.

- 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 Mine Area.

One 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 the Mine Area but that direct groundwater discharge to the river itself on and in the near vicinity of the Mine Area is negligible. Further monitoring of flows and water quality discharging from the springs is required to further explore this hypothesis. Adani Mining has already established a number of permanent gauging and sampling sites to provide this information (see Section 7.6.6 for further information).

Flow duration data and estimated flow losses between the upstream and downstream gauges based on the short period between July and November 2011, a relatively dry period when data are available for both gauges, are shown in Table 10. Of particular interest is the estimated loss of 620 m^3/d between the two gauges at the 70th percentile. This is considered to represent the best available estimate of actual losses to groundwater and/or evapotranspiration over the gauged reach since flows at the 70th percentile exceed zero at both gauges and are unlikely to include any significant surface water runoff.

Figure 22 Surface water flows and losses, Carmichael River

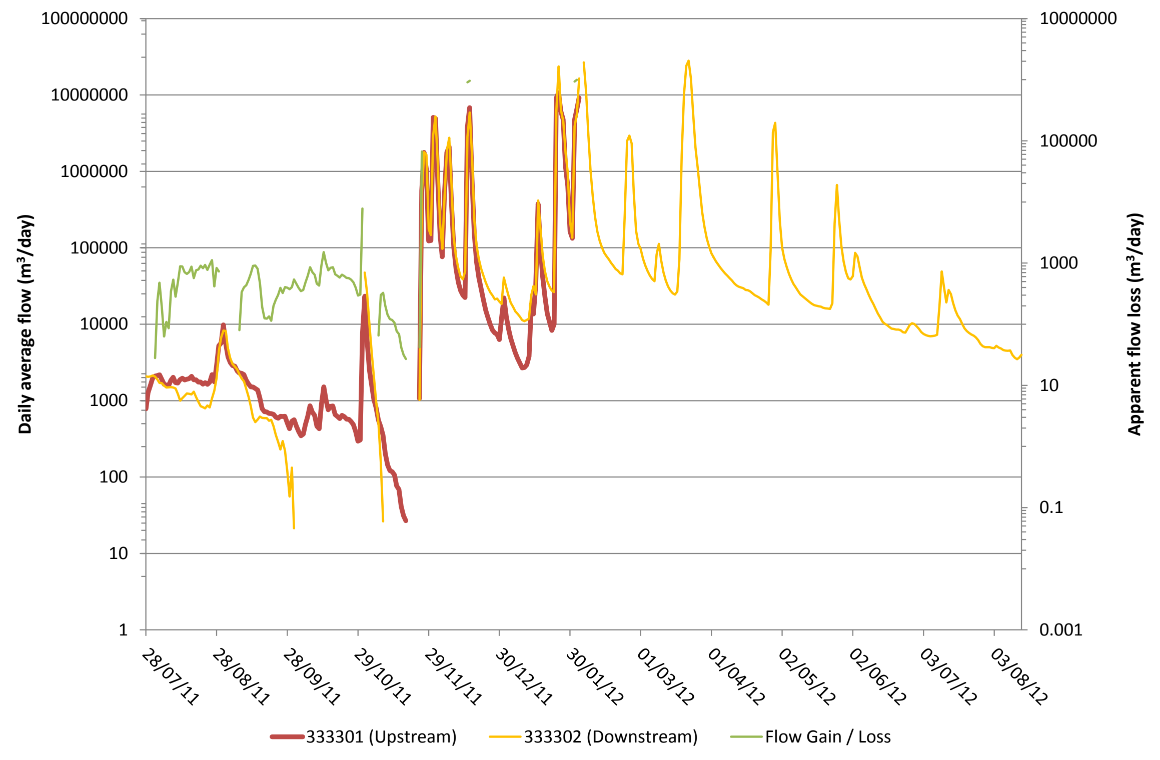


Table 10 Flow duration data and observed losses – Carmichael River (July to November 2011)

Percent time flow exceeded	Flow upstream gauge, 333301 (m3/d)	Flow downstream gauge, 333302 (m3/d)	Flow gain/loss (m3/d)
0	23274	46081	-22807
10	2802	2910	-109
20	2067	1949	118
30	1858	1422	436
40	1650	1090	560
50	1440	711	729
60	796	456	340
70	643	24	620
80	575	0	575
90	460	0	460
100	294	0	294

4.8 Groundwater recharge

4.8.1 Previous studies

Detailed investigations of recharge to the GAB aquifer outcrop areas in Queensland carried out by Kellet *et al.,* (2003) suggests three major recharge mechanisms. These are:

1. Diffuse rainfall recharge
2. Preferred pathway flow (or bypass recharge)
3. Localised recharge (or river leakage)

Diffuse rainfall recharge occurs as the direct infiltration of rainfall into outcropping aquifer units via the slow percolation of water though the soil zone to the water table. Although this is likely to occur over large areas, Kellet *et al.,* (2003) suggest that this mechanism is likely to be volumetrically less important than bypass recharge.

Preferred pathway flow (or bypass recharge) is a mechanism by which recharge can occur to the water table during heavy rainfall events irrespective of soil moisture conditions at the time. Kellet *et al.,* (2003) suggest that incident rainfall infiltrates through vertical fissures and fractures existing in the sandstone layers in the overlying soils reaching the water table relatively rapidly and effectively bypassing the soil zone. Volumetrically Kellet *et al.,* (2003) suggest that this recharge mechanism is likely to be more important than diffuse rainfall recharge.

Localised recharge occurs as leakage of water from surface water courses to the underlying water table.

Given the proximity of the site to the GAB to the west these same recharge mechanisms are expected to be equally relevant to the current Study Area.

Based predominantly on chloride mass balance calculations for boreholes located in GAB aquifer intake beds to the south of the Carmichael Coal Project area Kellet *et al.,* (2003) estimated the following long-term average recharge rates:

- Diffuse rainfall recharge: 0.03 – 2.4 millimetres per year (mm/yr)
- Preferred pathway flow (or bypass recharge): 0.5 – 28.2 mm/yr
- River leakage: up to 30 mm/yr.

Based on the same chloride mass balance calculations Kellet et al (2003) also provide the following typical long term average rainfall derived recharge rates(i.e. diffuse rainfall recharge plus preferred pathway flow) for individual aquifers:

- Kumbarilla Beds and Mooga Sandstone, less than 0.5 mm/yr
- Mooga Sandstone, less than 0.5 mm/yr
- Gubberamunda Sandstone, 1-2 mm/yr
- Hooray Sandstone and equivalent units, 1-2 mm/yr
- Hutton Sandstone, 2-4 mm/yr.

Given that the Kumbarilla Beds and the Mooga Sandstone are typically considered to be relatively poor aquifers whist the Gubberamunda, Hooray and Hutton are generally more reliable, then these estimates suggest typical rates or less than 0.5 mm/yr for minor GAB

aquifers and 1-4 mm/yr for major GAB aquifer units. No estimates are provided for aquitard units, due to the general lack of representative borehole data for such strata. However, where data were available then rates of less than 0.5 mm/yr must be expected given the generally low permeability of units such as the Rewan Formation and Moolayember Formation. Hence, based on this previous work, and given that the Clematis Sandstone is typically considered to represent a relatively poor GAB aquifer, long term average rainfall derived recharge (i.e. diffuse rainfall recharge plus preferred pathway flow) for the Project (Mine) area is expected to be less than 4 mm/yr. These recharge rates may be significantly enhanced in areas where leakage from surface water courses to the underlying water table is occurring.

Recharge mechanisms and estimated quantities for each hydrogeological unit present within the Project (Mine) area are discussed further in Sections 4.8.2 to 4.8.5.

4.8.2 Unconsolidated alluvial and colluvial deposits

All three of the recharge mechanisms described by Kellet *et al.,* (2003) are considered likely to contribute recharge to outcropping unconsolidated alluvial and colluvial deposits. Rainfall recharge is therefore likely to be significantly enhanced by leakage from the Carmichael River, and any other water courses which are underlain by the sand dominated Quaternary units observed along the Carmichael River. Groundwater level data for two shallow bores (C027P1 and C029P1) installed into the Quaternary alluvium along the Carmichael River indicate longer term seasonal fluctuations (i.e. ignoring water that is relatively rapidly returned to the river) of up to around 2.8 m, compared to less than 0.2 in most other bores (Appendix C). This tends to confirm a significant component of river leakage derived recharge to these bores, as might be expected given the variability of flows in the adjacent Carmichael River, and equates to an average recharge rate of up to 150 mm/yr based on the single year of available data. Expected total long term average recharge to unconsolidated alluvial and/or colluvial deposits along the Carmichael River may therefore approach or even exceed 60 mm/yr i.e. the upper range of values suggested by Kellet *et al.,* (2003).

4.8.3 Tertiary-age clay, sandstone and siltstones

Diffuse rainfall and bypass recharge to Tertiary-age clay, sandstones and siltstones which dominate the outcrop geology within the Project (Mine) area may also be enhanced by river leakage. However, the generally low expected hydraulic conductivity of these units will tend to limit river leakage and hence total recharge. Analysis of groundwater level data for seven bores monitoring Tertiary aged units around 30 km east of the lease area using the water table fluctuation method (Healy and Cook, 2002) suggest typical rates of 1-5 mm/year (Table 11). Data for these seven bores suggest typical seasonal fluctuations of less than 0.3 m which is broadly consistent with fluctuations seen in the relatively short period of record available for bores completed into the Tertiary in the proposed Mine Area (e.g. C029P2 and C025P5, see Appendix C).

Table 11 Estimates of groundwater recharge using the water table fluctuation method

Bore ID	Observed annual water level range (m)	Recharge² (range)	Specific yield (Sy)¹ (best estimate)	Recharge² (best estimate)
12030090_A	0.23	N/A	0.01- 0.05	2 to 11
12030120_A	0.13-0.28	1 to 14	0.01- 0.05	2 to 11
12030124_A	0.07-0.20	0.7 to 10	0.01- 0.05	1 to 7
12030133_A	0.10	N/A	0.01- 0.05	1 to 5
12030158_A	0.10	N/A	0.01- 0.05	1 to 5
12030170_A	0.07	N/A	0.01- 0.05	0.7 to 3
12030175_A	0.08	N/A	0.01- 0.05	0.8 to 4
			Median	1 to 5

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

4.8.4 Triassic-age Great Artesian Basin units

Effective recharge to the various GAB units which outcrop to the west of the site will vary significantly according to the permeability of the outcropping units. For relatively permeable units such as the Dunda Beds and Clematis Sandstone, recharge to outcrop units close to the Carmichael River and other water courses could approach or even exceed 60 mm/yr i.e. the upper range of values suggested by Kellet *et al.,* (2003). Data for bores completed into the Dunda Beds as part of the current project (e.g. C022P1, C027P2 and C9553P1R, Appendix C) suggest seasonal groundwater level fluctuations of up to 0.7 m which equates to an estimated average recharge rate to the Dunda Beds of up to around 35 mm/yr.

Conversely, effective recharge to aquitard units such as the Moolayember and Rewan Formation is likely to be limited by the generally low permeability of these units. Similar recharge rates to those calculated above for Tertiary aged strata are therefore anticipated (i.e. less than 5 mm/yr). This estimate is consistent with observed data for bores completed into the Rewan Formation as part of the current project (e.g. C035P1 see Appendix C) which suggest seasonal groundwater level fluctuations of less than 0.1 m which equates to an estimated average recharge rate to the Rewan of less than 5 mm/yr.

4.8.5 Permian-age coal measures

The Permian-age Coal Measures are confined beneath the overlying Tertiary-age deposits throughout the Mine Area and hence will not receive any direct recharge via incident rainfall or river leakage. Recharge will be limited to leakage through the overlying Tertiary strata which are typically clay dominated, and hence relatively low recharge rates are therefore expected. The available groundwater level data tends to confirm this hypothesis. Responses to individual rainfall events of up to 0.2 m can be seen in some cases (e.g. C020P2, see Appendix C) which equates to an estimated average recharge rate to Permian-age strata of up to 10 mm/yr. There is also some evidence of longer term fluctuations also of around 0.2 m in some bores including C020P2. However, many bores show little or no seasonal or other fluctuations which suggests

that recharge through the overlying Tertiary-age deposits is limited at most locations. It is interesting to note that where groundwater level fluctuations can be observed in the Permian-age strata there appears to be little or no lag between rainfall and recharge. This relatively rapid response in some locations may be related to:

- Spatial variability in the permeability of the overlying Tertiary-age strata leading to enhance leakage in some places
- A pressure response to increased groundwater levels in the overlying strata
- Bypass recharge due to weathering of the Tertiary-age strata present at outcrop.

4.8.6 Long term average areal recharge

It should be noted that the water table fluctuation method used to derive the recharge estimates discussed in Sections 4.8.2 to 4.8.5 is likely to over-estimate recharge in relatively dry areas such as the Mine Area since individual recharge events can be separated by several months or even years of low or zero recharge. The chloride mass balance method described by Cook and Healy (2002) is considered to provide a better guide to long term average recharge in the project area. This method, which was also used to derive the values quoted by Kellet *et al.,* (2003) 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
- Chloride borne in runoff or from stream leakage will contain chloride, and this should be accounted for in any assessment.

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. Based on these deposition rates and observed average chloride in groundwater of 1,397 and 3,283 mg/L, as derived from bores in and surrounding the lease area in the DNRM, chloride mass balance calculations suggest estimated recharge rates of 0.1 to 4 mm/year. These rates are very similar to the typical aquifer values quoted by Kellet *et al* (2003, Section 4.8.1) and are significantly lower than the water table fluctuation estimates described above in Sections 4.8.2 to 4.8.5. Of the two approaches the chloride mass balance method is considered to provide the most reliable estimate of long term average rainfall derived recharge and have therefore been used to guide subsequent modelling work (Section 5.3.2).

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 independent chemical and physical estimates of baseflow indicate average annual recharge rates of 0.1 to 4 mm/year for the Mine 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 rainfall derived recharge rates are expected to be enhanced in areas where leakage from overlying surface water courses is occurring.

4.9 Groundwater dependent ecosystems

As mentioned previously in Section 1.1.1 additional post EIS investigations have now also been conducted to confirm the ecological value and baseline water quality of the Doongmabulla and Mellaluka spring complexes.

A summary of the relevant water quality results and a description of the types of springs present in each complex is provided below. Further detail on the investigations undertaken at each spring can be found in Volume 4 Appendix Q Mine Water Quality Report and in Volume 4 Appendix I3 Springs Ecological Assessment Report.

4.9.1 Doongmabulla Spring complex

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 the Mine Area. The Doongmabulla Spring complex is 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 spring complex comprises 11 separate springs (Figure 11).

Further field investigations and water quality sampling undertaken by GHD during May/June 2012 and March/April 2013 (refer to Volume 4, Appendix J3 Springs Ecological Assessment Report) suggests that the Doongmabulla Springs complex consists of the following three separate springs or areas (see Figure 23):

- Little Moses – a possible incipient mound spring beside the Carmichael River with limited wetland
- Moses – a cluster of mounding and non-mounding artesian springs with large associated wetland areas
- Joshua – a large, modified spring, now a turkeys nest dam with associated wetland.

The Doongmabulla Springs complex and associated wetlands are listed as being of national significance in the Directory of Important Wetlands as they meet the following criteria:

- It is a good example of a wetland type occurring within a biogeographic region in Australia
- It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail (DSEWPaC, 2010).

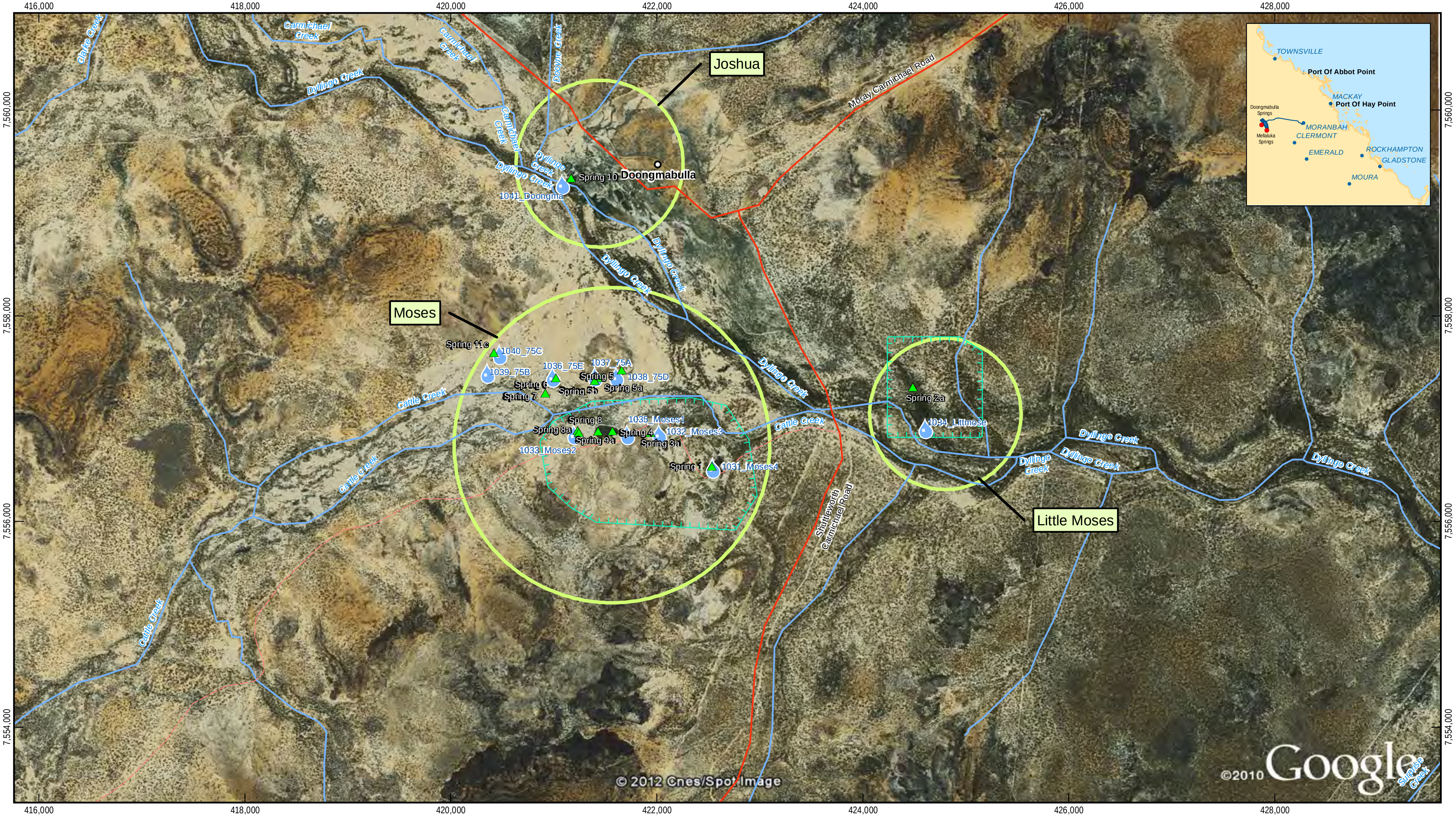
The Doongmabulla Springs complex is currently (and was historically) used for watering livestock, which directly impacts the springs through trampling, pugging, fouling of water and compaction. In addition, a large number of bores drilled historically in this area of the GAB has resulted in a lowering of hydrological pressure across the aquifer (the GAB in this region). Consequently, the springs are considered under threat (Mitchell et al., 2002).

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).

A piper plot of the major ion chemistry for all of the sampled springs and creeks is shown in Figure 23. Samples collected from the Little Moses Spring and the Moses Spring group have similar major ion chemistry but with variable proportions of chloride. This suggests that the groundwater feeding these springs is likely to be from the same source and has been subject to similar conditions below the surface. The samples from Joshua Spring (DS10) have proportionally more calcium and magnesium than the samples collected from Little Moses and the Moses Spring group. This spring has been modified to a turkeys nest to contain the spring water and is therefore physically very different to the mound springs of the Moses Spring group. The differences in major ion chemistry of Joshua Spring to the Moses Spring group suggests either a different source of water (which given the geological setting is considered unlikely) or a different pathway and hence contact with different lithological units before discharging to surface. However, modification to Joshua Spring could also play a part in the observed water chemistry differences.

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.



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Metres

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

N

LEGEND

○ Homestead

● Spring (Geoscience Australia)

▲ Spring water quality sample

— Minor Road

- - Track

— Watercourse

▢ Spring Groups

▨ Doongmabulla Mound Springs Nature Refuge

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Doongmabulla Springs Complex

Job Number	41-26422
Revision	D
Date	01-08-2013

Figure 23

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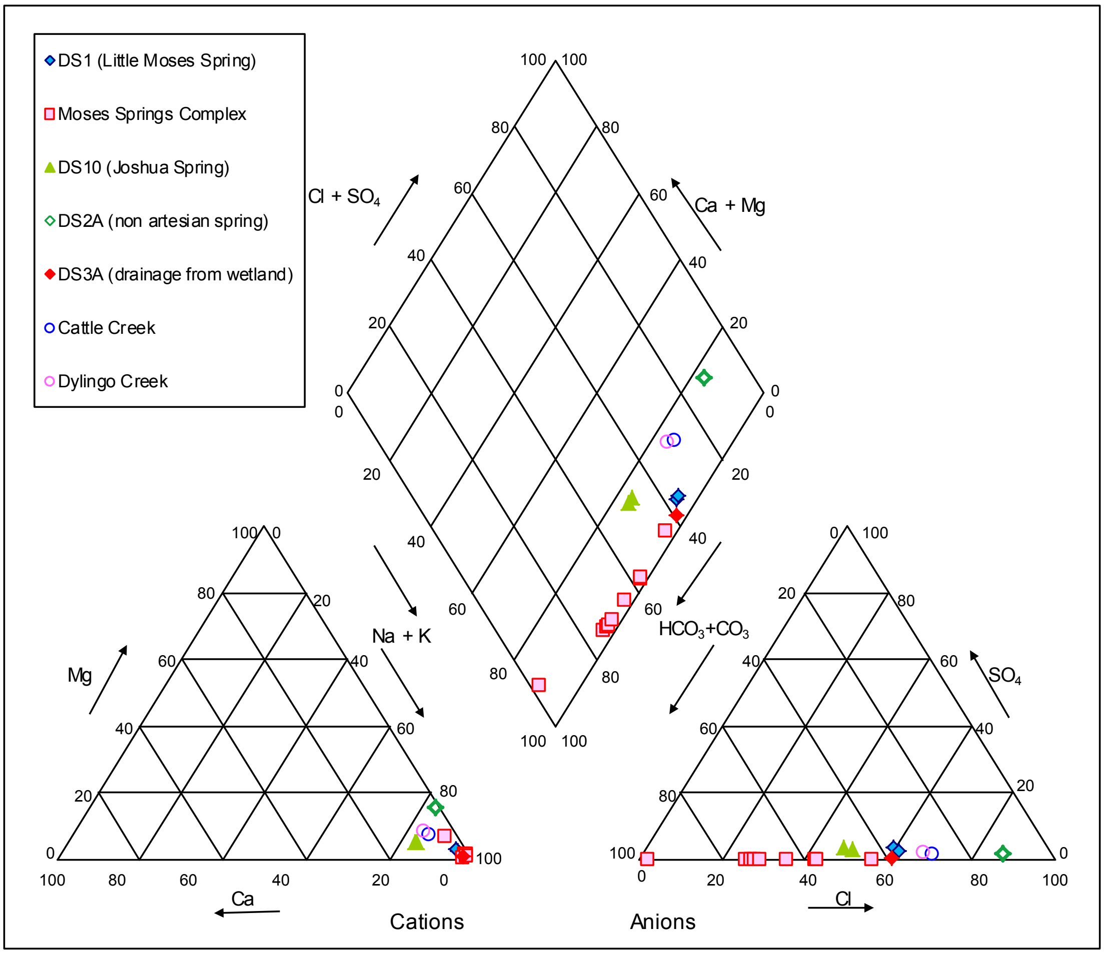
Level 9 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: GHD: Spring Complex/2012, Springs/2012; GA: Watercourses, Roads, Homesteads (2007); DNRM: Nature Refuge (2010); DME: Carmichael Mine Site; Google: Imagery (2012). Created by: SB,MS

Figure 24 Piper diagram – Doongmabulla Spring complex



4.9.2 Mellaluka spring complex

The Mellaluka wetland is a relatively unknown spring complex, with limited information within the scientific literature. While the Mellaluka spring complex is identified by DERM's wetland mapping tool and two springs are mapped close to the Mellaluka homestead (Figure 11), it is not listed in the Directory of Important Wetlands and is not considered to be a GAB spring complex.

Based on field investigations undertaken by GHD during March/April 2013 (refer to Volume 4, Appendix J3, Springs Ecological Assessment Report) the Mellaluka Springs complex appears to comprise the following three separate springs (see Figure 25):

- Mellaluka Spring – a large mound spring with several vents
- Stories Spring – a discrete non-mounding artesian spring
- Lignum Spring – a discrete non-mounding artesian spring.

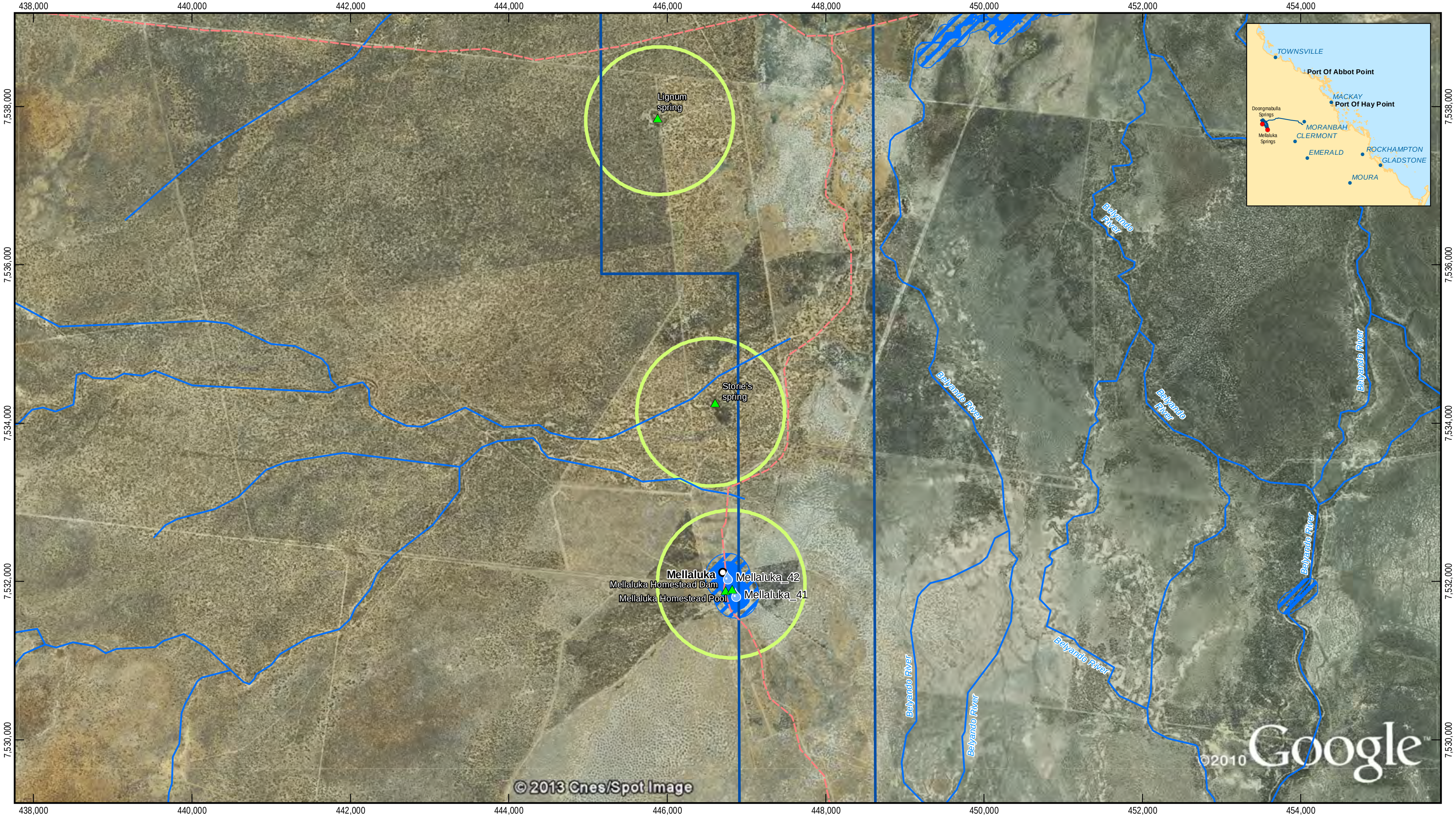
The Mellaluka Spring complex is located at Mellaluka station, almost 30 km south east of Doongmabulla Springs, and 20 km south of the Carmichael River. The spring groups are located in a line running north-south, with Stories Spring located in the middle, 3.6 km south of Lignum Spring and 2.3 km north of Mellaluka Spring. The northern two spring groups have only one spring or outlet each, and are relatively simple springs consisting of a shallow pond that appears to seep water. They are both situated within broad, level to gently undulating sand plains. By contrast, Mellaluka Spring is situated within a clay plain and has three or four springs (due to the dense overgrowing vegetation, it is not possible to be precise). The main spring has formed a peat mound approximately 3 – 4 m taller than the surrounding plain, and about 100 m in diameter. Immediately to the south of this large mound, two further springs are located, both approximately 20 – 30 m diameter, but neither having formed a mound. This spring group appears to have created its own small alluvial plain, exhibiting the same pale, very fine powdery sandy soil around the edges of the springs as seen at the Moses Spring at the Doongmabulla spring complex.The Mellaluka and Storie’s spring groups are located immediately to the west of the southern extent of the Mine Area and Lignum spring is located within the Mine Area close to the western boundary. The GHD ecological field survey found groundwater bores installed at each of the three spring groups which provide water for domestic use (Mellaluka springs) and water for livestock (Storie’s and Lignum springs).

The Mellaluka springs are not listed in the Directory of Important Wetlands and 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. In addition, standpipe piezometers recently installed around 250 m east of Mellaluka springs and also those installed to the north and south of Mellaluka springs within the Mine Area did not encounter any lithology resembling the Dunda Beds. The lithology encountered typically comprised clay dominated strata underlain by mudstone and/or claystone and/or siltstone and/or sandstone strata. Furthermore, groundwater modelling of the area to the south of the Carmichael River suggests groundwater flow typically in a north – north-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 laterally through the younger Permian and Tertiary strata present to the east at the Mellaluka springs. Alternatively the source aquifer for the springs could be Permian-age sandstone units or even relatively permeable strata of Tertiary-age. It is considered unlikely that these springs are sourced directly from the Dunda Beds.

A piper plot of the major ion chemistry for all the sampled springs is shown inFigure 26. The plot indicates that samples collected from the springs are of sodium-chloride type with similar proportions of major ions. Whilst no significant differences between the major ion chemistry were reported for samples collected from the Mellaluka spring group (dam 3-MSHD, and pool 4-MSHD), Lignum spring (6-LS) or Stories spring (7-SS), the sample collected from Stories spring (7-SS) reported a slightly lower proportion of chloride in comparison to the results for the other springs. Comparison of the spring major ion chemistry with groundwater data collected from other locations across the Mine Area (refer Figure 20) suggests that the Mellaluka spring complex major ion chemistry is:

- Similar to some of the samples drawn from Tertiary-age strata and various Permian-age units including interburden and AB and D coal seams
- Noticeably different from samples drawn from boreholes monitoring the Dunda Beds.

The major ion chemistry results therefore tend to confirm Tertiary or Permian-age strata, rather than the Dunda Beds, as the most likely source for the Melluka spring complex.



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Kilometres

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

N

LEGEND

○	Homestead	- -	Track	■	Wetland Management Area (WMA)
💧	Spring (Geoscience Australia)	—	Watercourse	▨	Wetland Management Area (WMA) - Trigger
▲	Spring water quality sample	☐	(Project) Mine	☐	Spring Groups

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Job Number	41-26422
Revision	C
Date	31-07-2013

Mellaluka Spring Complex

Figure 25

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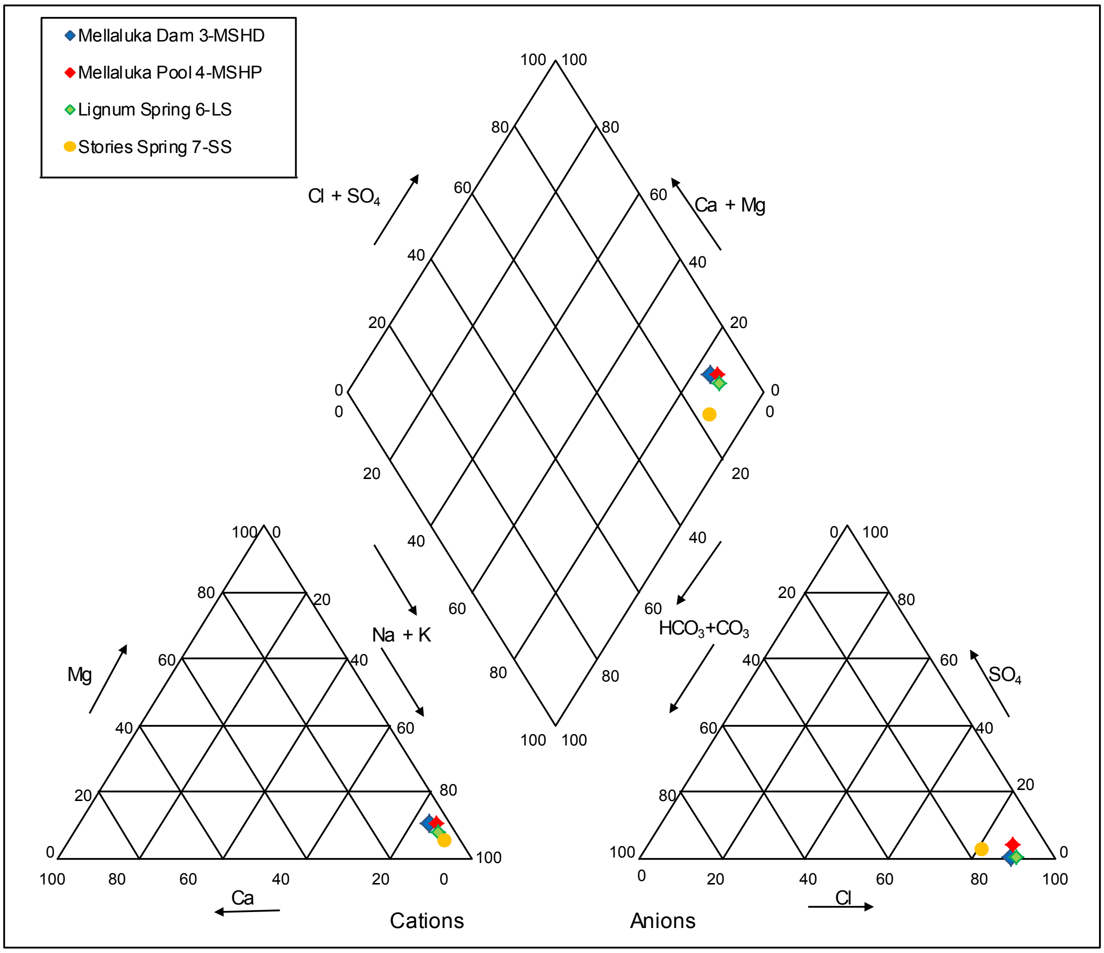
Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: GHD: Spring Complex and Groups/2013; GA: Watercourses, Roads, Homesteads (2007); DME: Carmichael Mine Site; Google: Imagery -2004 (2012); DNRM: WMA, WMA Trigger (2010), Springs (2012). Created by:MS

Figure 26 Piper diagram –Mellaluka Spring complex



Mg

50

Ca type

4.9.3 Riparian vegetation

Much of the landscape surrounding the Mine 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*), Paper Bark (*Melaleuca leucadendra*) and Waxy Cabbage Palms *(Livistona lanuginose)* (refer to Volume 4, Appendix J4 Waxy Cabbage Palm Assessment Report) 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 Volume 4, Appendix J1 Revised Ecological Assessment Report).

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 Volume 4, Appendix K5 Revised Mine Hydrology Impact Assessment Report). 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 Mine Area, although River Red Gums have also been identified next to an un-named ephemeral creek passing through the southern part of the Mine Area. The other minor creeks and rivers within the Study Area are understood to be ephemeral (refer to Volume 4, Appendix K5 Revised Mine Hydrology Impact Assessment Report) 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
- 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 twelve layers for groundwater modelling purposes as shown in Table 12. 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 before being further revised in March 2013. 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 March 2013 geological model used the same extent, i.e. effectively restricted to the Mine Area, but 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 summarised in Appendix G.

As shown in Table 12 five layers have been assigned to represent the various Permian-age strata present. Consideration was given to using more layers to represent laterally persistent sandstone units. However, packer testing results of adjacent sandstone and siltstone units (Table 7) did not suggest that the various sandstone units were typically characterised by higher hydraulic conductivity values than the other interburden units. A relatively simple layering system was therefore adopted using single layers for the various Permian-age over, inter and under-burden strata.

The spatial extent of each of the geological units within the Mine 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.

Similarly there are little or no data on coal seam extent and geometry outside of the Mine Area and hence it was also necessary to extrapolate the modelled coal seams outwards. 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.
- 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).

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 6.

Table 12 Groundwater model layering

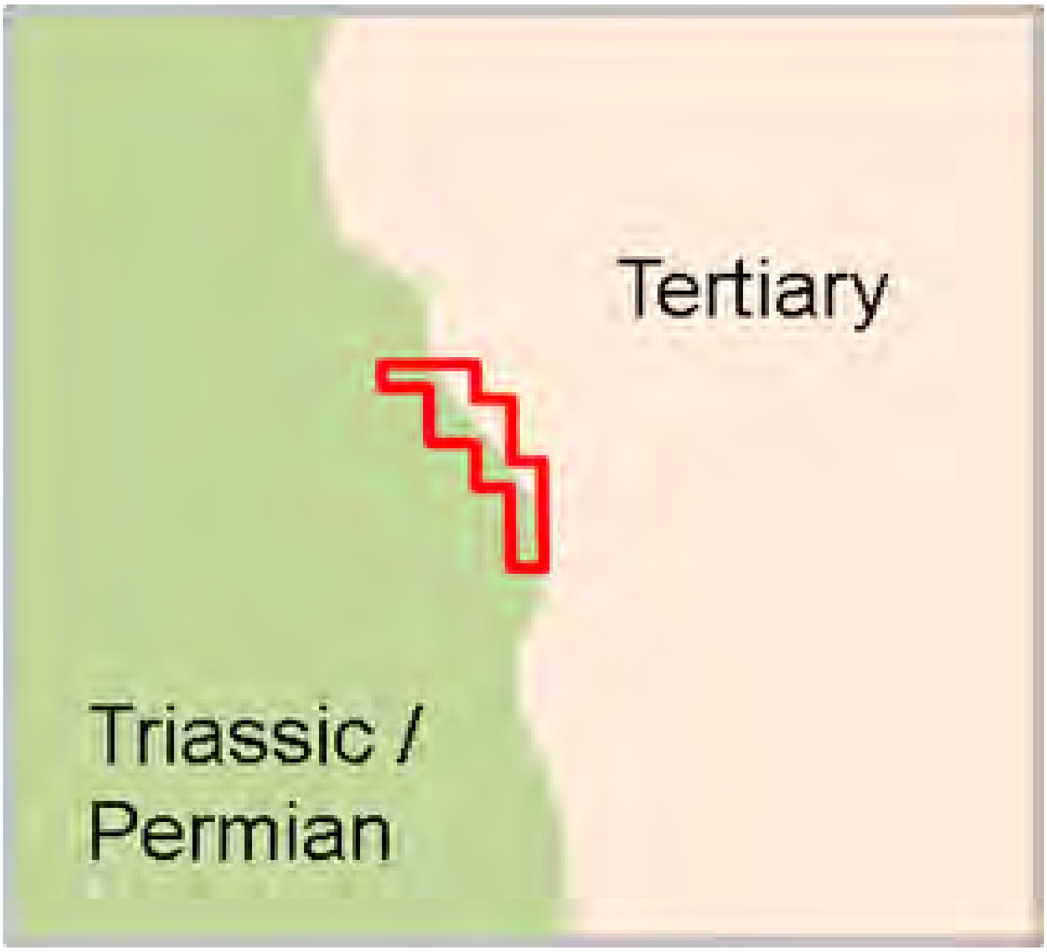
Layer formation	Groundwater model layer No.	Geological model layer code
Quaternary Alluvium	1	-
Tertiary age units and older Quaternary deposits	2	BUTE
Moolayember Formation / Warang Sandstone	3	-
Clematis Sandstone	4	-
Dunda Beds	5	BUDE
Rewan Formation	6/7	BURE
Permian units overlying AB Seam coals	8	-
AB Seam Coal	9	AB1/AB2/AB3 Roof/Floor
Permian units between the AB and D1 Seam Coals	10	C1/C2/C3/C4 Roof/Floor
D1 Seam Coal	11	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	12	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 11). The top of groundwater model Layer 11 is therefore defined by the roof of the D1 seam whilst the bottom of this layer was calculated by subtracting the total thickness of D seam coals from the roof of the D1 Seam.

The other major difference is the groundwater model's subdivision of the units overlying the AB Coal into the overlying Permian units (Layer 8), Rewan Group (Layers 6 and 7), 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 Area – their eastern extent corresponds roughly with the north-south trending geological outcrop of the Clematis Sandstone, Dunda Beds and Moolayember Formation (), and the eastern edge of the Mine Area. Hence, in the east, the Tertiary geological unit is subdivided evenly across ten numerical model layers (2 through 11), 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 12. Figure 27 illustrates the zonation between Permian-Triassic and Tertiary geology within each of model layers 3-11.

Figure 27 Zonation between Permian –Triassic and tertiary geology



As shown in Table 12 a minimum of two layers have been used in the current SEIS model to represent the Quaternary alluvium and the underlying Tertiary units. This allows representation of an observed contrast in the lithology encountered within boreholes within the Mine Area, 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:

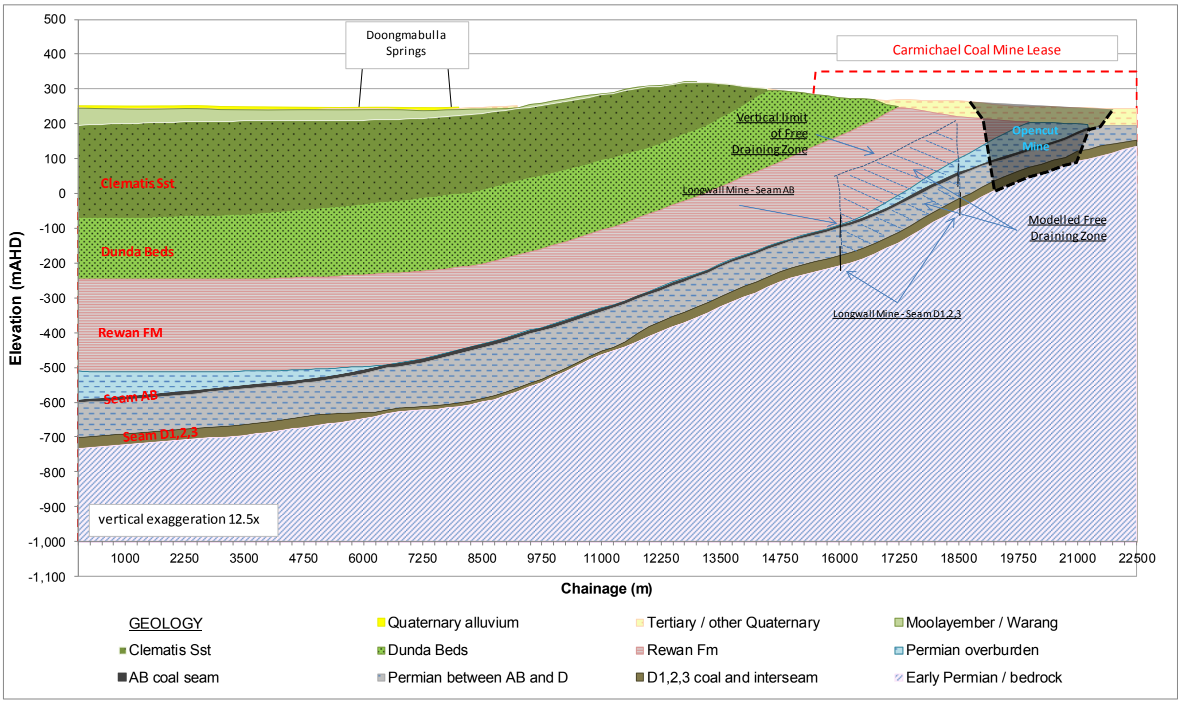
- The extent of the Quaternary alluvium was assumed to coincide with the mapped extent of the Wondoola Beds, which lie along the current drainage lines, including the Carmichael River. The Wondoola Beds are recorded as being Tertiary to Quaternary, however for the purposes of this study they have been 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 Mine Area (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).

In the earlier version of the groundwater model reported in the EIS (GHD 2012) the Rewan Group was simulated as a single model layer (model layer 6) and thus the historic model used for steady-state calibration comprised eleven layers. Model layer 6 was then split into two separate layers to allow better representation of the horizons within the Free Draining Zone which is likely to develop above the proposed longwall panels (MSEC, 2012, see Figure 28). The current SEIS groundwater model instead includes two layers for the Rewan Group in the historic steady state model and thus no structural changes are required for the subsequent predictive modelling work.

Figure 28 Geological cross-section and extent of free draining zone



Layer 12 (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 been 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 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 Mine 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 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

Initial long term average rainfall recharge estimates for use in subsequent groundwater flow modelling were estimated through development of a separate transient recharge-runoff model using PERFECT (Littleboy et al., 1989) guided by the estimates made using available groundwater level and chemistry data (Section4.8). The recharge-runoff modelling work relied on the following key input data sets:

- 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 and Bureau of Meteorology gauge at Bulliwallah for the period 1950 to 2011
- Interflow estimation using the method of Rassam and Littleboy (2003)
- 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. This 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. These values are considered to be broadly consistent with those calculated and discussed in Section 4.8, based on observed groundwater level fluctuations and chloride mass balance calculations. Based on these results an initial long term rainfall recharge rate of 1 mm/yr was applied throughout the modelled domain, although this value was subsequently allowed to vary during modelled calibration in the range 0.1 to 5 mm/yr. This modelled range is consistent with typical aquifer specific values calculated by Kellet *et al* (2003) and chloride mass balance and water balance calculations undertaken for the current study (Sections 4.8.1 and 4.8.6)

Enhanced recharge due to leakage from the Carmichael River has been simulated in the groundwater model using the MODFLOW stream package (Section 5.4.2). The recharge values quoted above therefore relate to rainfall recharge and therefore exclude leakage from the Carmichael River. The use of the MODFLOW stream package to calculate leakage, based on modelled head differences between the surface water course and the underlying aquifer, is seen as the best available methodology for representing this process.

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 in shallow groundwater areas
- 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 5.6.3.

5.4.2 Model extent and boundary conditions

The spatial extent of the numerical model and its specified boundary conditions are shown in Figure 29, and the modelled geological (model layer) outcrop is shown in Figure 30. For the most part modelled outcrop corresponds with the mapped geological outcrop (Figure 30). However, as discussed previously in Section 2.2.2 a revised interpretation of the extent of the Tertiary deposits was developed for the modelling based on information provided by Xenith and summarised in Appendix G.

The model grid varies in resolution, with refinement down to 50 m cell sizes over the Mine Area, and gradual coarsening outward to a maximum of one kilometre at the margins of the modelled

area. Given that there are twelve model layers, and the grid extends 93 km in the east-west direction, and 108 km in the north-south direction, there are 4,023,288 model cells, 3,318,470 of which are set as active (flow) cells. This is a relatively large model.

Figure 29 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:

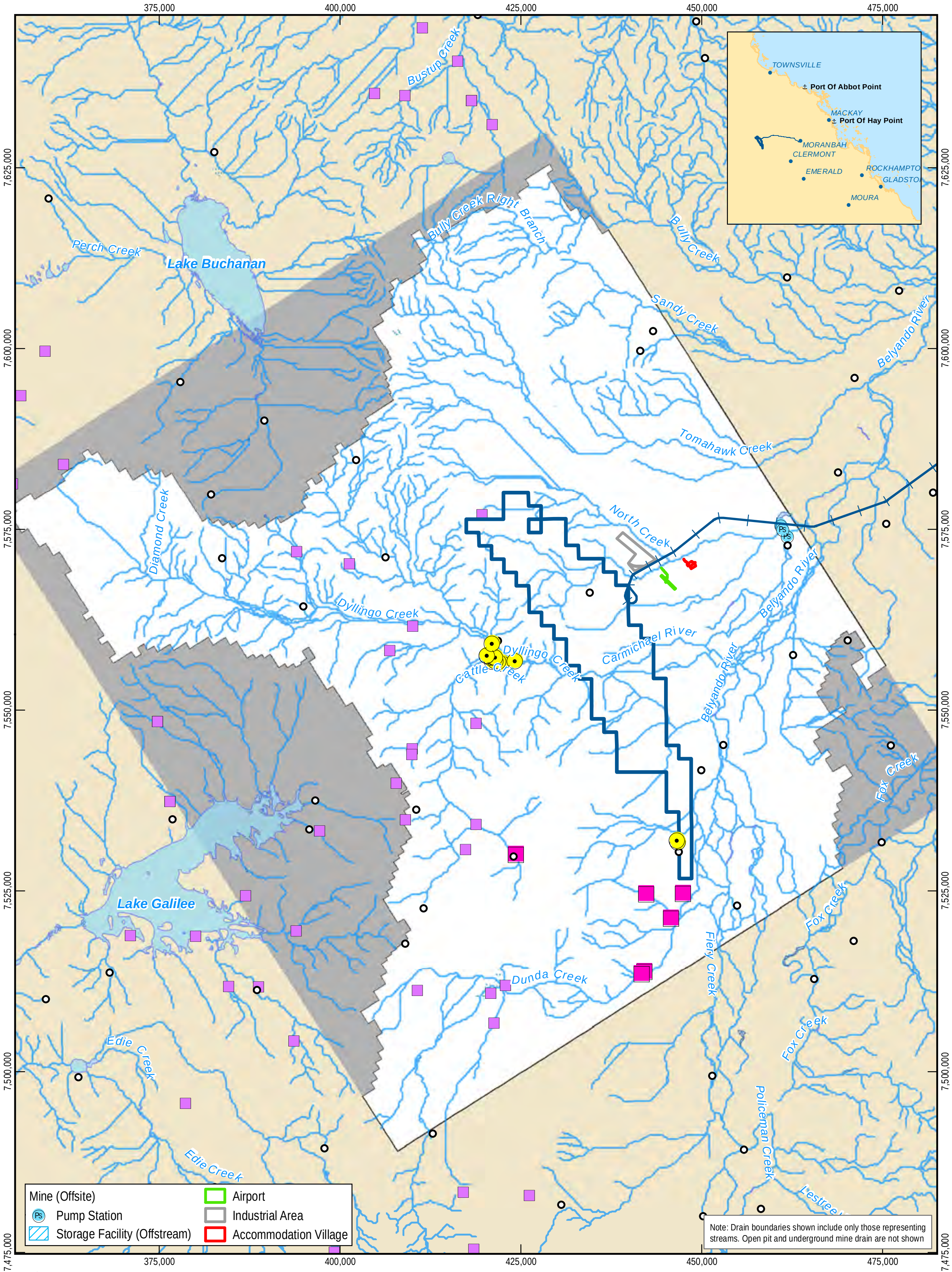
- River (RIV) Boundaries - Representing surface drainage (creeks and rivers) excluding the Carmichael River, all of which are mapped as ephemeral in the Bureau of Meteorology's Geospatial Hydrology Fabric (Figure 29). River conductance has been set to vary depending on the largest horizontal cell direction. River conductance therefore varies between 50 and around 1400 m^2/d and it is generally high enough so that the aquifer properties control baseflows rather than the conductance of the River boundary itself. The MODFLOW river stage and river bed levels have both been set to the same value, 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, particularly near riverside monitoring bores installed within the Mine Area, in order to better reflect surveyed ground levels in these areas.
- Stream (STR) Boundaries – Initial modelling for the EIS suggested significant groundwater discharge to the Carmichael River but little or/no discharge to the other surface water courses present in the area. Revised modelling for the SEIS therefore included simulation of a section of the Carmichael River between the Doongmabullla Springs and the Confluence with Cabbage Tree Creek to the east of the Mine Area using the MODFLOW stream package. This package enables a more realistic representation of surface water / groundwater interaction across the site since it can simulate both gains and losses from surface water systems, unlike the Drain package which only simulates flow from groundwater to surface water. Furthermore, the stream package also routes flow along the modelled stream network thereby limiting any calculated losses to the flow volume gained upstream, unlike the river package which does not include routing and therefore does not limit the amount of leakage. Stream conductance and stream stage elevations were set in a similar fashion as for river cell boundaries. Stream bed top and stream bed bottom were set at 0.1 m and 0.2 m from the stream stage, respectively.
- 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 29), with the attribution of GHBs to particular layers based on whether the layer is classified as one of the main aquifer units (see Table 14), 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 13 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 12 (early Permian/bedrock).
Layer 2, 3, 6, 7, 10 and 12 (south only) – 'aquitards'	Layer 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 (east)
Layer 4, 5, 9, and 11 (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 1.1).
- Evapotranspiration (EVT) package was used to simulate evaporation losses from areas, such as the Carmichael River, where high water table conditions are expected. Evaporation has been modelled from Layer 1 (i.e. Quaternary alluvium) only and assumed to occur only in areas where modelled groundwater levels are within 1 m of the ground surface. Evaporation rates were set based on a long term average potential evaporation rate of 5.9 mm/d for the nearby Bureau of Meteorology Bulliwallah station (Ref No. 36010). To avoid conflicts with other boundary conditions and thus the possibility for model instability, a zero evapotranspiration rate was applied at river and stream boundary locations.
- 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
● Springs
— Watercourse
Lake
Reservoir
Swamp

Model Boundary Cells
🟧 General Head Boundaries
Drain Boundary

Groundwater Users
Domestic Supply, Stock; Stock
Irrigation

Active Model Extent
☐ Active
Noflow

Rail (West)
Mine (Onsite)

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 SEIS

Groundwater Model Grid
and Boundary Conditions

Job Number	41-26422
Revision	D
Date	25-10-2013

Figure 29

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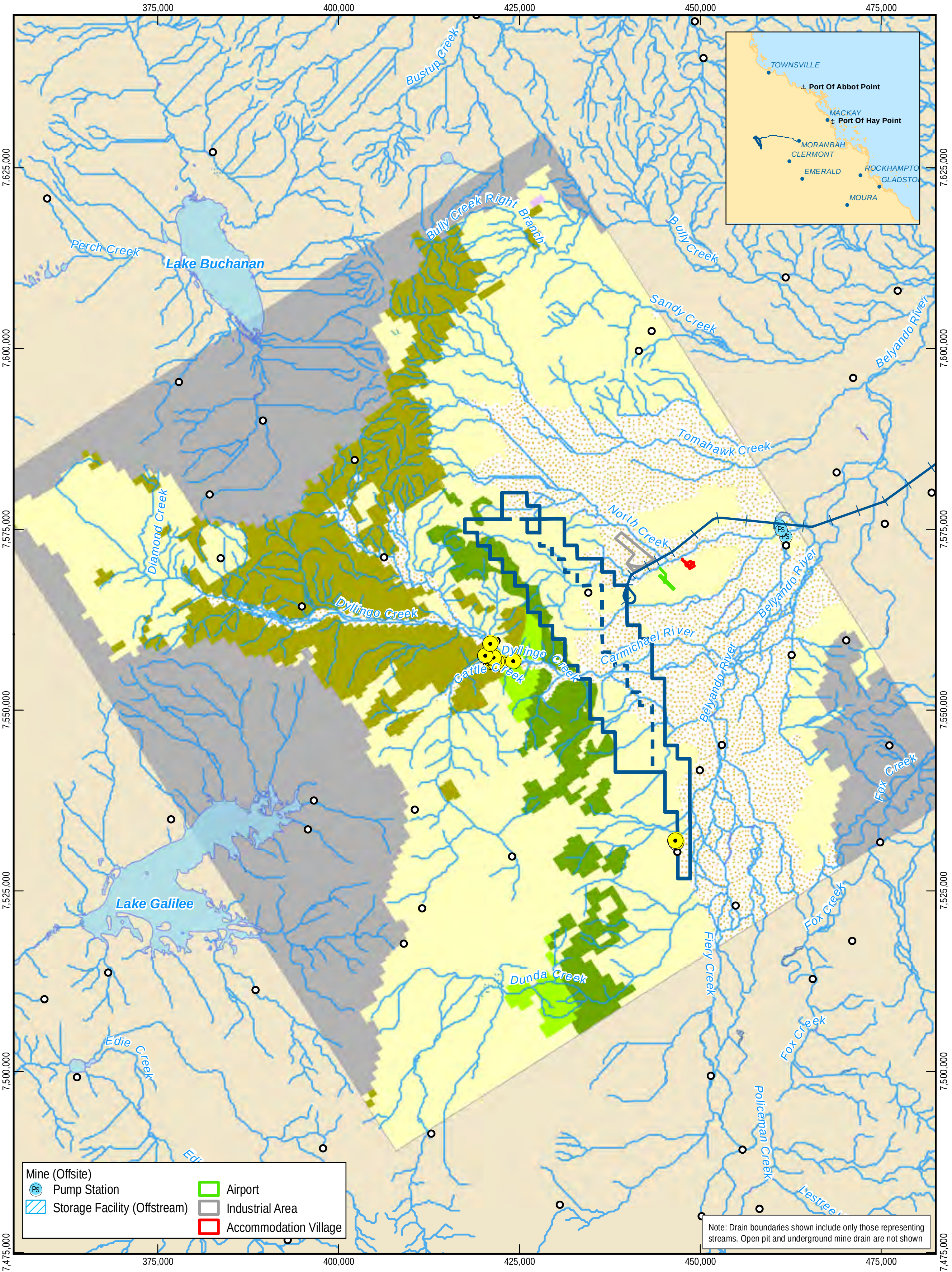
Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: DNRM: 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, Offsite (2013). Created by: MR, CA



Note: Drain boundaries shown include only those representing streams. Open pit and underground mine drain are not shown

LEGEND

○ Homestead
● Springs
— Watercourse
Lake
Reservoir
Swamp
Model Boundary Cells
🟧 General Head Boundaries
Drain Boundary

Active Model Extent
☐ Active
Noflow
Layer 1: Quaternary alluvium
Layer 2: Tertiary and Quaternary

Layer 3: Moolayamber / Warang Sst
🟩 Layer 4: Clematis Sst
🟩 Layer 5: Dunda Beds
Layer 11: Bedrock, early Permian

Rail (West)
Mine (Onsite)

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.

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 SEIS

Modelled Outcrop

Figure 30

Job Number	41-26422
Revision	B
Date	15-10-2013

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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

5.5 Model calibration

5.5.1 Calibration approach

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.

An additional transient calibration would ideally also have been carried out since this enables calibration of modelled storage parameters. For a green field site such as the Carmichael Coal Project area then a transient simulation would typically involve generating a time varying recharge time series and calibrating to observed groundwater level responses by adjusting the modelled specific storage (or confined storage) and the specific yield (or unconfined storage) parameters. However, in this case a transient calibration was considered to be of only limited value since:

- Only a relatively short groundwater level record was available for most monitoring bores
- Few of the monitoring bores completed into the deeper Permian-age Strata show any significant rainfall related fluctuations in groundwater levels (Appendix C). This is consistent with the confined nature of these strata and the generally very low rainfall recharge rates expected in the area (Section 4.8). Given that the proposed development is for extraction of coal from Permian-age strata then it is the storage parameters of these strata that will govern the initial rate of the development of groundwater level impacts.

Rather than complete a transient calibration of limited use storage parameters were instead assumed in the first instance, based on previous modelling experience, before assessing the sensitivity of model predictions to a range of different of likely storage values (see Section 5.8).

Data loggers have been installed in many of the onsite monitoring network bores so that detailed information on groundwater level fluctuations can be acquired prior to any development of the site. As the length of the monitored period increases then a transient calibration may become worthwhile, particularly where significant recharge events occur and/or the aquifers are stressed in other ways (e.g. by long term pumping tests or development of a starter pit or box-cut).

Of the data available for calibration the most reliable records are considered to be provided by bores drilled specifically for this project within the Mine Area, 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 (Appendix C), 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 31) 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 (i.e. a single recharge zone was assigned to each layer where it was present at outcrop). Recharge was applied to the uppermost active layer in all cells and hence the modelled recharge zones are essentially the same as the modelled outcrop layer shown in Figure 30.

5.5.2 Initial parameter values and permissible ranges

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, 4, 5, 6 and 7 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
- For layers 8-11 (including the coal seams) 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 14.

For the initial round of numerical modelling work presented in the EIS (GHD, 2012) initial parameter values for model calibration purposes were based (wherever possible) on median values from site specific field test results which were available at the time. Note that in the original EIS model Quaternary and Tertiary deposits were simulated as one combined unit with an initial value of $5.00\text{x}10^{-01}$. For the SEIS modelling work, rather than return to the pre-modelling parameter estimates used as initial values, the calibrated parameter values from the EIS model were used as initial values for the SEIS re-calibration. These values were then optimised further using PEST to fit the groundwater level calibration data set. It should be stressed that this parameter optimisation (or calibration) process is almost entirely automated and hence objective. Furthermore, initial parameter values are only adjusted by PEST where necessary to improve the modelled fit to the observed data. Hence, where there is little or no data available for a particular parameter then PEST tends to retain the adopted initial value. Initial values used for the both the EIS and SEIS modelling are summarised in Table 14.

Relatively widely spaced upper and lower bounds were also adopted for most parameters for model calibration purposes, based on a combination of recharge modelling, literature values and/or site specific field test results as summarised in Table 14. In most cases both the adopted upper and lower bounds are based on recently published regional summary statistics included in the Surat Cumulative Management Area Underground Water Impact Report (QWC, 2012). The use of regionally derived minimum and maximum acceptable values was considered preferable to the use of generally narrower ranges based on site specific values alone since:

- Allowing a relatively wide range of parameter values during the calibration reduces the risk that the adopted upper and lower bounds will constrain or bias the final calibrated parameters.

- Only a relatively small number of site specific values are inevitably available and hence upper and lower parameter bounds derived using this data alone are more likely to under-estimate the actual variability.

In the absence of any actual data on vertical hydraulic conductivity values a ratio of 1:10 between vertical and horizontal hydraulic conductivity has been assumed for all modelled layers. Given the relatively high variability evident in the lithology logged in each bore (Appendix B) actual ratios between vertical and hydraulic conductivity are considered likely to exceed this value. The adopted ratio of 1:10 is therefore considered to represent a conservative assumption.

5.5.3 Calibration results

Various calibration statistics are presented in Figure 31. 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). The statistical distribution of modelled head error is approximately normal, with the greatest density of errors within the +/- 5 m error band (Figure 31), and relatively evenly spread positive and negative head errors either side of that. The mean absolute head error is 7.94 m, with the majority of the Carmichael Mine Area bores showing head errors of less than 10 m (Figure 31).

The larger head errors are typically associated with single reading groundwater levels obtained from the DNRM Bore Database 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 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 32 and Table 15.

As shown in Figure 32 and Table 15 most, although not all, calibrated hydraulic conductivity parameters are within observed ranges from the combined slug, packer and pumping test results. As discussed in Section 5.5.2 in most cases regional values were used to set acceptable ranges, rather than site specific data. It was therefore expected that the final calibrated values would in some cases fall outside the range of values observed at the site. In the event two modelled hydraulic conductivity values fall outside the currently available site data as follows:

- The calibrated hydraulic conductivity for model layer 1 which represents the Quaternary sand unit underlying the Carmichael River, of 20 m/d exceeds the maximum estimated site value of 0.12 m/d. In this case it is considered likely that the site specific estimate represents an underestimate of the actual hydraulic conductivity. Only two falling head tests have been undertaken so far in the Quaternary sands and geological logs (Appendix B) suggest a fine to coarse grained sand. Domencio and Schwartz (1990) suggest typical values of up to around 500 m/d for similar strata.
- The calibrated hydraulic conductivity for model layers 6 and 7, which represent the Rewan Group, of 7.4x10^{-5} m/d is slightly below the minimum estimated site value of 9.5 x10^{-5} m/d. In this case eight site specific test results are currently available and hence it is less likely that the site data is under-estimating the variability of this strata, nevertheless the possibility cannot be discounted.

Whilst the adopted calibration approach, which used site derived intial values but regional and/or literature values to define upper and lower bounds for modelling purposes is considered to be optimal (Section 5.5.2) one alternative approach would have been to only allow parameters to vary within the range of hydraulic conductivity values ‘observed’ in the Mine Area. However, adopting this alternative approach using site results to constrain modelled values would have resulted in an un-realistically low modelled value for the Quaternary Alluvium and a very slightly higher value for the Rewan Group and had little or no impact on the model predictions. The sensitivity of the both the model calibration and model predictions to these two parameters is discussed further in Section 5.8.2.

The original intention was to vary modelled hydraulic conductivity values only during the calibration process, and hence to leave recharge at 1 mm/year (or 2.74×10^{-6} m/d) 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 nRMS of the calibration could not be improved below around 10 percent 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 14.

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 (0.1 mm/yr) of the calibration permissible range in most of the modelled area except for the Clematis Sandstone outcrop where model results suggest a higher recharge rate of 1.1 mm/yr. It is recognised that these recharge values are towards the lower end of the typical values calculated by Kellet et al (2003). However, it should be noted that the majority of the GAB and other units present at outcrop in the Project (Mine) area are either poor aquifers or aquitards. Kellet *et al* (2003) do not provide estimates for Gab aquitard units but suggest rates of less than 0.5 mm/yr for relatively poor aquifers such as the Kumbarilla Beds and the Mooga Sandstone. The model calibrated rates of around 0.1 mm/yr for most units are therefore considered to be consistent with the estimates provided by Kellet *et al*. Furthermore, the relatively high calibrated recharge value for the Clematis Sandstone is consistent with the generally higher expected permeability of this unit and is similar to the typical value of Kellet *et al* quote for the Gubberamunda Sandstone.

Modelled results suggest an upward head gradient from Permian-age units to the overlying Quaternary/Tertiary-age units in the vicinity of the Carmichael River and upstream of the proposed mining area. This general pattern is reflected in the modelled baseflow accretion profile for the Carmichael River (Figure 33) which confirms that the majority of the modelled baseflow is intercepted upstream of the mine lease before being lost again as leakage through the bed of the river.

As discussed previously in Section 4.3.4 this general modelled pattern of discharge to the Carmichael River upstream of the lease and natural flow losses across the proposed mine site is considered to be consistent with a number of field 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 and suggest actual losses of around 620 m^3/d across the lease area
- Major ion data for groundwater and surface samples which show 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.

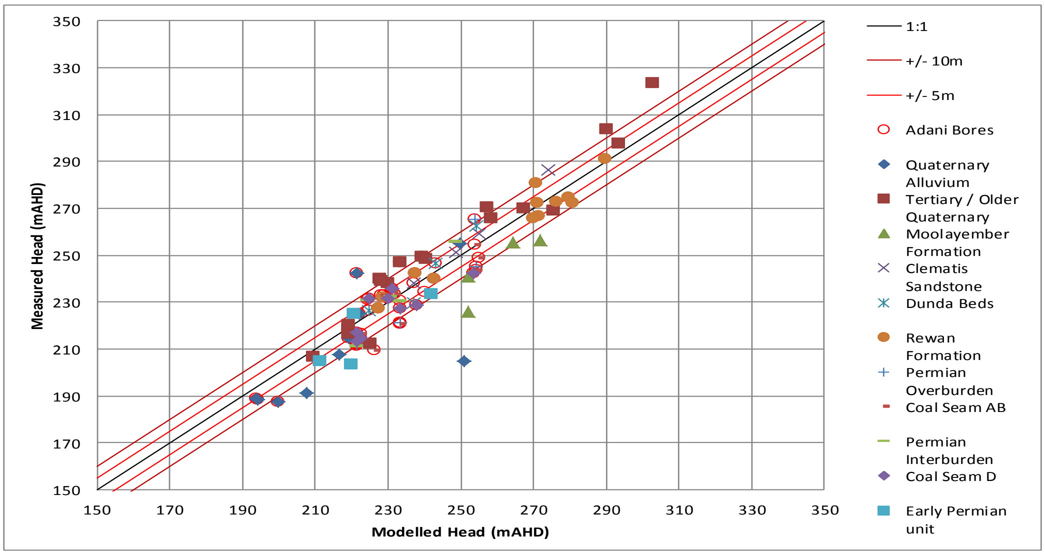
The modelled rate of loss from the Carmichael River to the underlying alluvial strata of 456 m^3/d between the upstream and downstream gauges is also comparable to the estimated dry period losses of 620 m^3/d between these two gauges (Table 10). Given the short period of record available for these gauges, compared to the long term average nature of the historic model, and the current lack of sufficient check gauging data (Section 4.7.4) no attempt was made to obtain a more precise match between ‘observed’ and modelled flow losses. However, the similarity of the two values gives some confidence that the model is capable of simulating surface water groundwater interaction along the river with a reasonable degree of accuracy.

Table 14 Initial values and permissible ranges

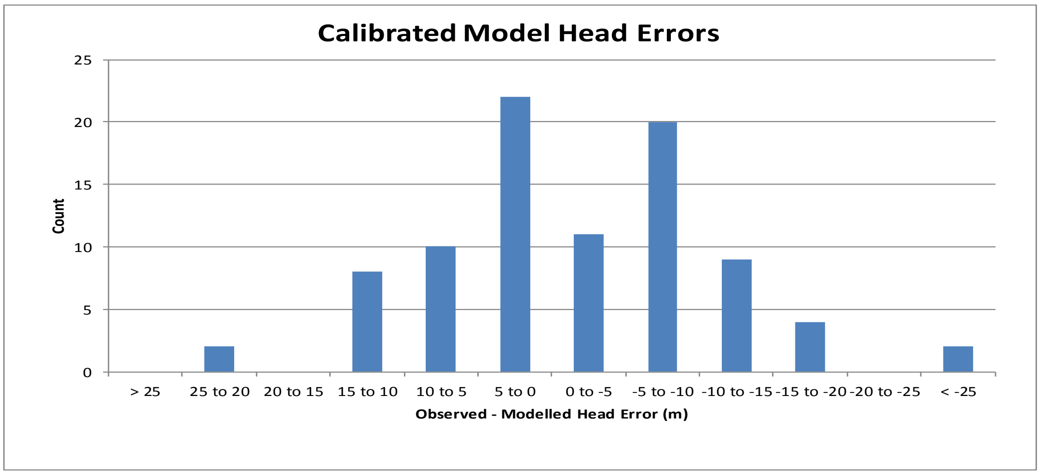
Dominant unit / zone	Calibrated parameter	Initial value EIS (m/d)	Initial value SEIS(m/d)	Lower bound (m/d)	Upper bound (m/d)	Source
Quaternary Alluvium	Recharge	2.74x10^{-06}	3.80x10^{-07}	2.74x10^{-07}	1.37x10^{-05}	Recharge modelling and previous studies
Tertiary / Old Quaternary	Recharge	2.74x10^{-06}	2.74x10^{-07}	2.74x10^{-07}	1.37x10^{-05}	Recharge modelling and previous studies
Moolayember Formation	Recharge	2.74x10^{-06}	1.76x10^{-06}	2.74x10^{-07}	1.37x10^{-05}	Recharge modelling and previous studies
Clematis Sandstone	Recharge	2.74x10^{-06}	8.04x10^{-07}	2.74x10^{-07}	1.37x10^{-05}	Recharge modelling and previous studies
Dunda Beds	Recharge	2.74x10^{-06}	5.13x10^{-07}	2.74x10^{-07}	1.37x10^{-05}	Recharge modelling and previous studies
Quaternary Alluvium	Kx	N/A	1.00x10^{+02}	1.00x10^{-02}	1.00x10^{+02}	Literature values
Tertiary (outcrop)	Kz	N/A	1.66x10^{-05}	1.00x10-05	1.00x10^{-03}	Literature values
Tertiary (sub-crop)	Kz	N/A	1.00x10^{-03}	1.00x10^{-05}	1.00x10^{-03}	Literature values

Dominant unit / zone	Calibrated parameter	Initial value EIS (m/d)	Initial value SEIS(m/d)	Lower bound (m/d)	Upper bound (m/d)	Source
Moolayember Formation	Kx	$1.0x10^{-01}$	$9.99x10^{-01}$	$4.00x10^{-05}$	$1.00x10^{+00}$	Regional summary stats (QWC, 2012)
Clematis Sandstone	Kx	$2.0x10^{-01}$	$5.00x10^{+00}$	$4.00x10^{-05}$	$5.00x10^{+00}$	Site tests and regional summary stats (QWC, 2012)
Dunda Beds	Kx	$2.0x10^{-01}$	$1.15x10^{-01}$	$4.00x10^{-05}$	$5.00x10^{+00}$	Site tests and regional summary stats (QWC, 2012)
Rewan Group	Kz	$1.73x10^{-04}$	$1.38x10^{-05}$	$2.00x10^{-07}$	$1.00x10^{-03}$	Site tests and regional summary stats (QWC, 2012)
Permian Overburden	Kz	$5.36x10^{-04}$	$3.00x10^{-04}$ (median value)	$4.00x10^{-06}$	$1.00x10^{-01}$	Site tests and regional summary stats (QWC, 2012)
Coal Seam AB	Kx	$1.84x10^{-02}$	$1.43x10^{-02}$ (median value)	$1.00x10^{-04}$	$5.00x10^{+00}$	Site tests and regional summary stats (QWC, 2012)
Permian Interburden	Kz	$4.69x10^{-04}$	$1.12x10^{-04}$ (median value)	$4.00x10^{-06}$	$1.00x10^{-03}$	Site tests and regional summary stats (QWC, 2012)
Coal Seam D	Kx	$2.69x10^{-02}$	$1.81x10^{-02}$ (median value)	$1.00x10^{-04}$	$1.00x10^{+00}$	Site tests and regional summary stats (QWC, 2012)
Early Permian	Kx	$6.31x10^{-04}$	$3.50x10^{-05}$	$3.50x10^{-07}$	$3.50x10^{-03}$	Site tests and regional summary stats (QWC, 2012)

Figure 31 Steady state groundwater level calibration statistics



No Calibration Bores	88	Root Mean Square Error	6.2	Adani Bores Scaled RMS Error	5.9%
Sum of Square Errors	3356	Correlation Coefficient	0.93	Overall Scaled RMS Error	4.5%



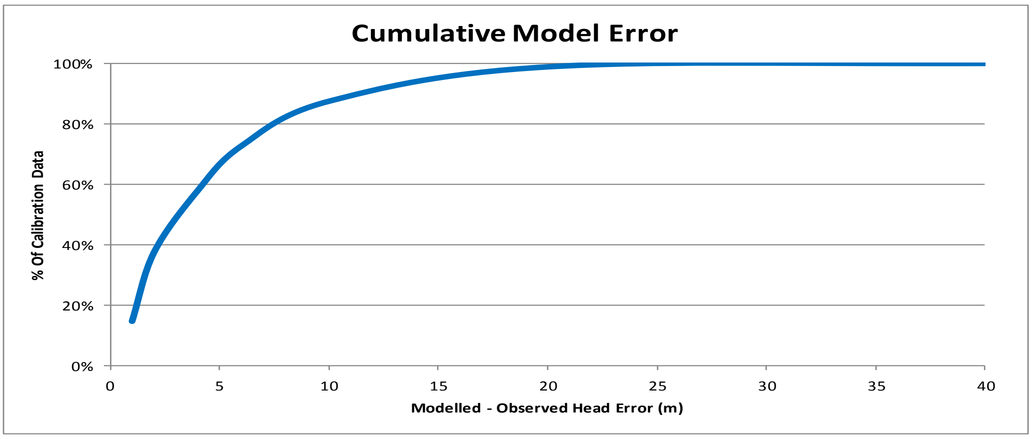


Figure 32 Steady state historic calibration model –calibrated parameters

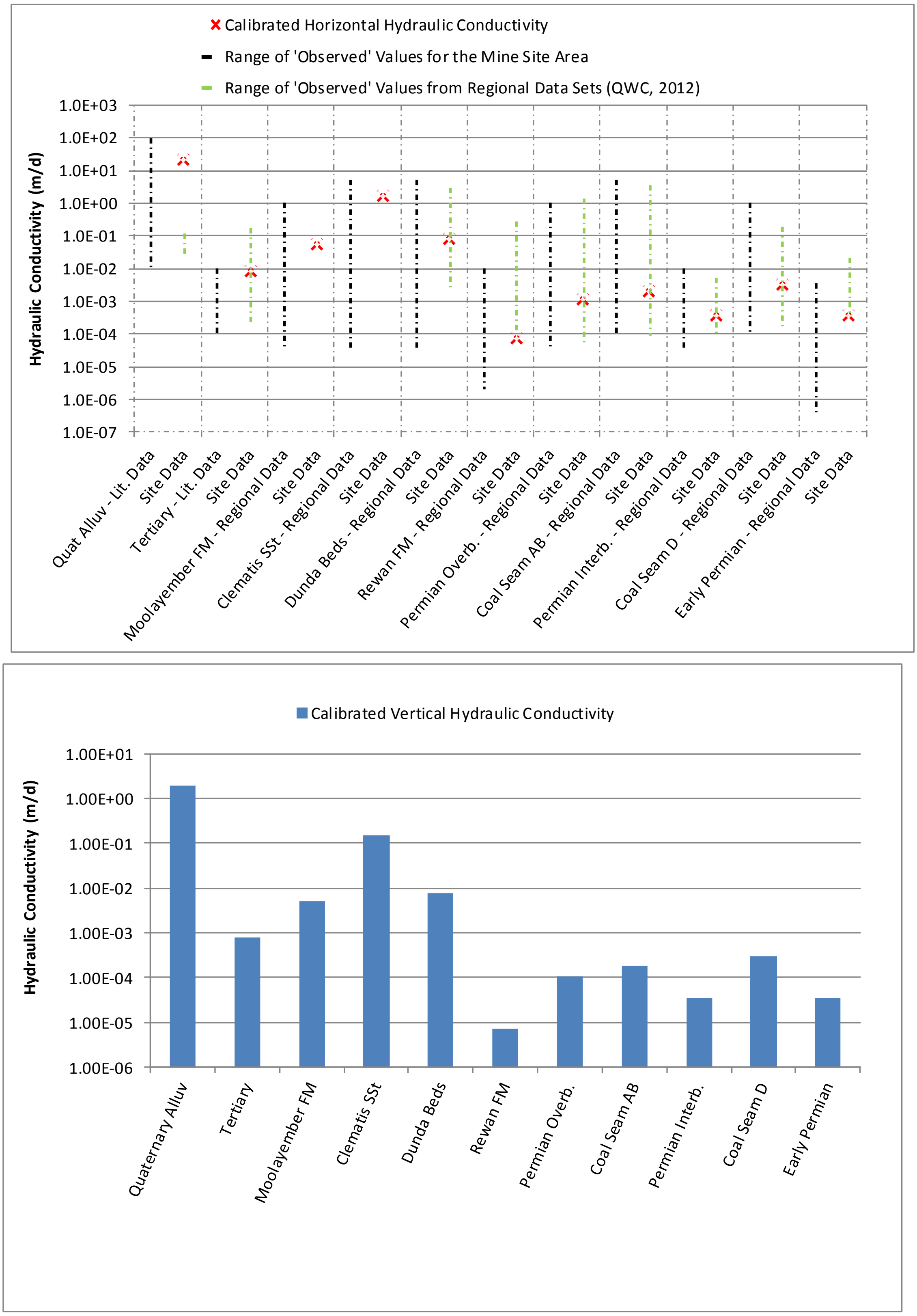


Figure 33 Carmichael River modelled accretion profile

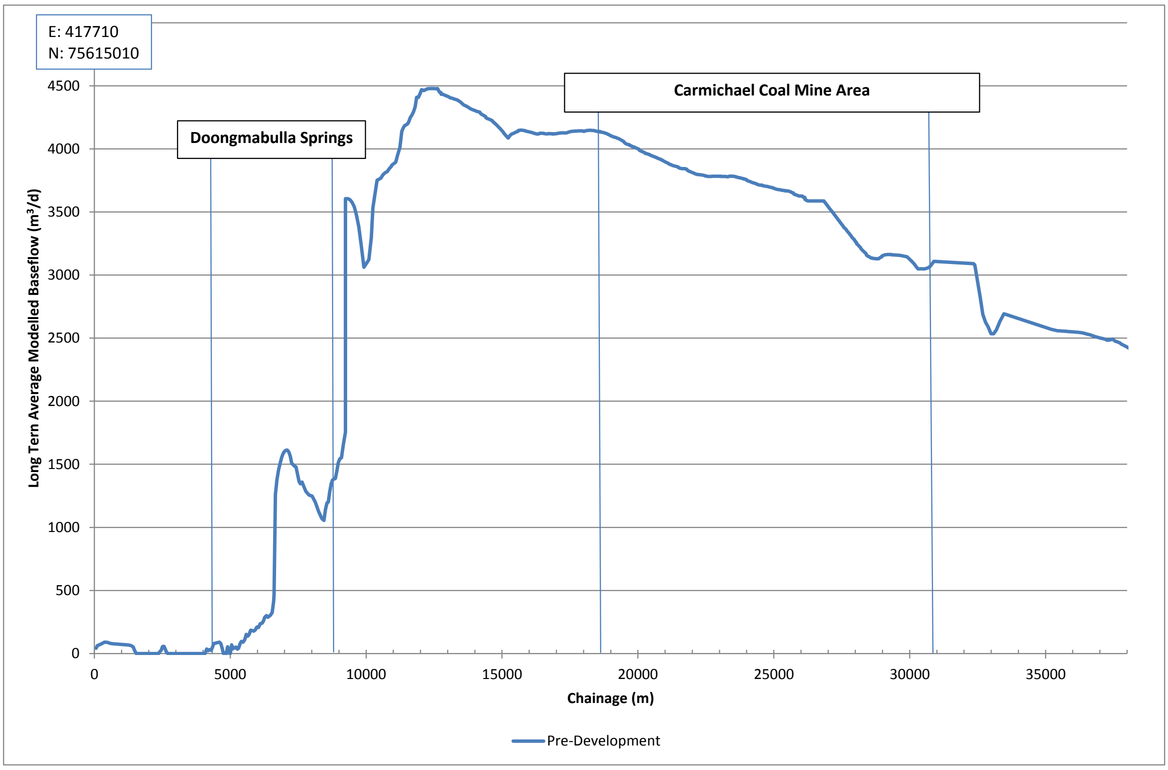


Table 15 Calibrated model parameters vs measured parameters

Zone / layer	Dominant geological unit	Calibrated parameter values (m/d)		Measured parameter values (m/d)			
		Kh	Kz	Minimum	Median	Maximum	Count
1	Quaternary alluvium	2.0x10^{+01}	2.0x10^{+00}	2.3x10^{-0}2	7.1x10^{-02}	1.2x10^{-01}	2
2	Tertiary units	1.0x10^{-02}	1.0x10^{-03}	2.1x10^{-04}	5.3x10^{-02}	1.7x10^{-01}	3
*3-10	Tertiary units in lower model layers	1.0x10^{-04} to 1.0x10^{-02}	1.0x10^{-05} to 1.0x10^{-03}				
3	Moolayember Formation	5.18x10^{-02}	5.18x10^{-03}	-	-	-	-
4	Clematis Sandstone	1.55x10^{+00}	1.55x10^{-01}	-	-	-	-
5	Dunda Beds	7.90x10^{-02}	7.90x10^{-03}	2.2x10^{-03}	2.5x10^{-01}	3.0	3
6	Rewan Formation	7.38x10^{-05}	7.38x10^{-06}	9.5x10^{-05}	3.1x10^{-04}	2.9x10^{-01}	8
7	Upper Permian	1.07x10^{-03}	1.07x10^{-04}	5.8x10^{-05}	1.7x10^{-03}	1.4	12
8	AB Coal Seam	1.89x10^{-03}	1.89x10^{-04}	8.6x10^{-05}	4.0x10^{-03}	3.5	13
9	Interburden	3.49x10^{-04}	3.49x10^{-05}	8.6x10^{-05}	1.3x10^{-03}	5.1x10^{-03}	8
10	D Coal Seams and Interburden	3.05x10^{-03}	3.05x10^{-04}	1.3x10^{-04}	9.5x10^{-03}	2.0x10^{-01}	11
11	Early Permian & Older Basement	Variable k, constant T = 0.015m2/d)	3.60x10-05	3.3x10^{-04}	1.2x10^{-03}	2.2x10^{-02}	9

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

5.5.4 Model validation

Additional groundwater level data for 12 recently installed bores, predominantly located to the south of the Carmichael River, became available following completion of the model calibration process. Standing water levels for each of these bores are summarised in Table 16. This data therefore provides a useful further model validation data set. Modelled groundwater levels and calculated model 'errors' or residuals are also shown in Table 16. Whilst there is an apparent tendency for the model to underestimate groundwater levels at these sites modelled errors are comparable to errors at other sites which were included in the calibration. This was confirmed by calculating the model nRMS with and without these additional residuals. Inclusion of the additional data in the calculation leads to a marginal reduction in the nRMS from 4.54 to 4.48 percent which suggests that the model fit to the validation data set is actually slightly better than to the calibration data set. Further re-calibration of the model including the validation data set was therefore not considered to be required.

Table 16 Model validation data set

Bore ID	Strata monitored	Model layer	Observed groundwater level (mAHD)	Modelled groundwater level (mAHD)	Model error (m)
C180116SP	Dunda Beds	5	238.07	240.88	-2.81
C832SP	Permian Overburden	8	223.34	217.99	5.35
C833SP	Seam D	11	223.26	218.06	5.20
C834SP	Early Permian Unit	12	223.19	219.35	3.84
C9838SPR	Permian Overburden	8	228.19	218.60	9.59
C9839SPR	Permian Interburden	10	227.20	218.61	8.59
C840SP	Early Permian Unit	12	228.21	220.66	7.55
C844SP	Permian Interburden	10	231.25	227.77	3.48
C9845SPR	Rewan Formation	6	234.21	233.01	1.20
C847SP	Permian Overburden	8	231.98	228.85	3.13
C848SP	Seam D	11	231.45	228.66	2.79
C9849SPR	Early Permian Unit	12	231.54	226.95	4.59
				Average Model Error	4.37

5.5.5 Water balance

A water balance for the entire area of calibrated steady-state historic or pre-development model is summarised in Table 17.

Modelled water balance results suggest that the primary modelled flow inputs are recharge, stream leakage from the Carmichael River to the underlying groundwater system and groundwater inflows from adjacent areas. Modelled groundwater inputs are balanced by evapotranspiration, groundwater discharge to the Carmichael River and other local water courses and groundwater outflow to adjacent areas.

Table 17 Calibrated steady state model – water balance

Component	Flow IN (m^3/d)	Flow OUT (m^3/d)	IN - OUT
Recharge	2,533	0	2,533
Evapotranspiration	0	4,001	-4,001
Discharge from/to Adjoining Areas	44,680	41,466	3,214
Groundwater Extraction	0	152	-152
Carmichael River Leakage	6,662	7,084	-421
Discharge to Other Water Courses	0	1,200	-1,200
TOTAL	53,876	53,904	-28 (-0.05%)

5.6 Model predictions – operational phase

5.6.1 Overview and important note on numerical model predictions

The primary purpose of developing a groundwater flow model for the Project (Mine) area was 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;
- 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
  - Two further non-GAB springs known as the Storie's and Lignum and which are located between the proposed mining area and the Mellaluka springs to the south

  - 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
  - 20 licensed extraction bores within the modelled area
  - A further 25 other registered bores which are within 10 km of the Study Area.

Reference to the typical stratigraphic profile shown in Figure 7 and the geological borehole logs shown in Appendix B suggests that the majority of the strata present at the site comprise alternating sequences of coal, siltstones, sandstones and mudstones. In general the more variable the strata which separate the unit to be de-watered (the Permian-age coal measures in this case) from the receptor of any impact (e.g. the Carmichael River) then the more significant attenuation of any impacts will be. Unfortunately it is typically not possible to accurately represent the complexity of these natural strata in a regional scale groundwater flow model and all models of this type therefore represent simplifications of a significantly more complex reality. For instance accurate simulation of the stratigraphy of the Permian-age strata shown in Figure 7, which has already been simplified for presentation purposes, would have required 15 model layers alone.

Furthermore, and as discussed in Section 5.5.2, given the highly stratified nature of the majority of the units present in the area the ratio of 1:10 between vertical and horizontal hydraulic conductivity assumed for all modelled layers is also considered to be conservative.

The predicted operational and post closure impacts summarised in the remainder of Section 5.6 and in 5.7 are therefore considered to be a conservative and hence in most cases actual impacts are likely to be less than those predicted.

It should also be noted that the timing of many of the impacts described below in Sections 5.6.5 to 5.6.7 are not predicted to occur until after the end of the proposed 59 year mine life (i.e. after completion of the operational phase of the mine development). However, irrespective of their timing, all of the predicted impacts discussed in these sections are related to operation of the mine, rather than long term post closure impacts, and hence are considered to be operational impacts.

5.6.2 Operational phase predictive model set-up

The predictive model simulates a 59 year period starting in 2013 (Year 1) and terminating with the completion of the mining operational phase in 2071 (Year 59). Open cut mining is currently scheduled to start in 2015 (Year 3) and will proceed throughout the 59 years mining period whilst the underground mining operations are scheduled to start in 2018 (Year 6) and be completed in 2058 (Year 46).

It should be noted that annual mine plans are available for the period 2015 to 2019 but are only available at five year increments up to year 2049. Two additional mine stages for years 2061 and 2071 and a final landform with partial backfilling are also available. Hence, some assumptions were necessary to develop the complete mine development time series required for predictive modelling purposes.

Starting conditions (i.e. initial groundwater levels) for the predictive simulation were extracted from the historic model, which represents long-term average pre-development conditions i.e. prior to commencement of the mining activities. 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 2015 to 2019, every five years up to 2049 and around every 10 years thereafter.

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 15 for the duration of the predictive simulation. Modelled river and stream elevations and conductance values were also assumed to be constant for the duration of the predictive simulation.

5.6.3 Operational phase predictive model parameterisation

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 15). Predicted hydraulic conductivity changes to the Rewan Group, 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, 2013 and with reference to the Subisdence Management Report, Volume 4, Appendix I) suggests 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 overlying layers 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 50 for the lower 50 percent of the zone and by a factor of 10 in the upper 50 percent. 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 (model layer 8), Rewan Group (model layers 6 and 7) and in the Permian interburden (model layer 10) follow the underground mining schedule (as described in Section 5.6.4).

Storage

Modelled storage values adopted for predictive modelling purposes are summarised in Table 18. It should be noted that given that a transient calibration of the groundwater model was not undertaken at this stage, for the reasons outlined in Section 5.5.1, 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 model 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 18 Predictive modelling – adopted storage values

Dominant unit	Layer	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 Group	6/7	1.0x10^{-06}	1.0x10^{-06} – 4.3x10^{-04}	1.0x10^{-0}2
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}

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.

Open cut mine workings

The open-cut mining involves the development of six open pits (pit B to pit G) with areal extent ranging from around 3770 hectares (pit B) to 1810 hectares (pit E). Pit B to pit E are located to the north of the Carmichael River whilst pit F and pit G are located to the south of the river.

The open cut stage plans provided by Adani represent a yearly snapshot of the open cut mine development for the period 2015 to 2019 and every five years up to 2049. Snapshots for years 2061 and 2071 were also provided. These plans were used to define the active mining areas in the numerical model at each corresponding model stress period.

Given that for numerical modelling purposes a continuous time series of open cut mine development is required a constant active mine area was assumed from one five year plan to the next. The same assumption was used for the 2061 and 2071 mine stages.

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 model 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 modelled drain conductance.

Open cut mining commences in 2015 with the excavation of pits B, D and E. 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. Open cut mining activities terminate in 2071.

Based on the modelled depth of the base of the D seam, at the western limit of the proposed open cut mining areas, the proposed open cut pits will extend to depths in excess of 300 m below ground level.

Underground longwall mining operations

The underground mine stage plans provided enabled an annual time series of active drains spanning the mine development period from 2018 (Year 6) to 2058 (Year 46) to be developed for predictive modelling purposes. The underground mining comprises the development of five mines extending in a north-south direction across the site to the west of the open-cut pits.

Underground mining operations start with longwall mining of seam D in 2018 and seam AB in 2019 in Mine 1 located in the northern part of the Mine Area. Longwall mining of seam AB in the southern part of the Mine Area commences in 2026 with Mine 5 and 2027 with Mine 4. Underground mining of the central part of the mine lease starts in 2036 (Mine 3) and 2040 (Mine 2) with longwall mining of Seam AB.

Completion of a single longwall panel ranges from one to three years with the majority of panels completed within two years from the commencement of works in any specific panel. For modelling purposes, 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. Drain elevations were set to 2.7 m and 3.25 m from the top of model layer 9 and 11, respectively (i.e. the average thickness of the AB1 and D1 seams in the proposed underground mining area). Based on the modelled depth of the top of the D seam, at the western limit of the proposed underground mining areas, the underground mine workings will extend to depths in excess of around 500 m below ground level.

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 mine inflows – operational phase

Predicted open-cut and underground mine inflows are presented in Figure 34. Model results suggest a peak total mine inflow of around 26 ML/d occurring in 2029 of which around 60 percent is associated with underground mining and the remaining 40 percent with open-cut mining. The predicted peak mine inflow in 2029 is consistent with the underground mining

schedule which includes a relatively large number of active underground developments in that specific year.

Predicted total mine inflows recede gradually from 2029 to 2061 to around 6.5 ML/d at the end of the proposed 59 year mine life. Longwall mining terminates in 2058 thus the total mine inflows in 2061 and 2071 are exclusively associated with open-cut mining activities.

5.6.6 Predicted groundwater level impacts – operational phase

Water table impacts

Maximum predicted water table impact in response to the proposed open cut and underground mine workings are shown in Figure 35. It should be stressed that this is a composite plot showing maximum "all-time" 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 Area itself and maximum impacts in excess of 300 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.

Predicted maximum water table impacts in the underground mining area (i.e. towards the west of the Mine Area) 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.

Groundwater level impacts at sites of specific interest

Predicted groundwater level impacts at specific sites of environmental or economic interest are listed in Table 19, Table 20 and Table 21.

Given the proximity of the Carmichael River to the proposed open cut and underground mine workings potentially significant impacts on groundwater levels in the vicinity of the river are anticipated. Groundwater model predictions suggest water table drawdowns of up to around 4 m in the vicinity of the river during the operational phase although impacts of less than 1 m are predicted along most of the river corridor. It should be noted that these impacts are considered to represent 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. As discussed previously in Section 5.6.1, where further layers were included to better simulate the complexity of the Quaternary, Tertiary and Permian-age strata present in the area then the predicted impacts on the water table would tend to be reduced.

The Doongmabulla springs are located around eight kilometres west of the proposed mining area and are permanent artesian springs which also 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 0.19 m (Table 19). Figure 36 shows a time series plot of predicted impacts at each mapped spring site.

The Mellaluka springs are located approximately four to ten kilometres south of the proposed mining area. Relatively little is known about the Mellaluka spring system and geological data is generally more limited towards the southern limit of the proposed mining area. The geology at the spring location is thought to comprise shallow near surface Quaternary and or Tertiary age strata (i.e. model layers 1 and 2) overlying older Permian-age units (i.e. model layer 12 in the predictive model). Model results suggest predicted maximum drawdowns at the Mellaluka Springs of between <0.05 and 8.22 m (Table 19) depending on the proximity of the individual spring to the Mine Area and whether the source aquifer of the springs is near surface Tertiary/Quaternary strata (model layers 1 and 2) or older Permian Units (model layer 12). Highest impacts (between 0.06 and 8.22 m) are therefore predicted at Lignum spring given its proximity (around 4km) to the southern boundary of the proposed mining area.

The significance or otherwise of these levels of drawdowns at the Doongmabulla and Mellaluka spring complexes is assessed in Section 7.

Predicted groundwater level impacts at each of the 20 licensed extractions understood to be present within the modelled area are summarised in Table 20. Little or no impact is predicted at these locations, less than 0.05 m of drawdown is predicted at 10 of the 20 locations, less than 0.2 m at a further 9 locations and 0.8 m at the only remaining bore RN 90255 despite the proximity of this bore to the underground mine workings.

Table 19 Predicted water table impacts at spring locations – operational phase

Spring number and name	Spring system	Sub-System	Predicted drawdown in source aquifer(m)
1031_Moses4	Doongmabulla	Moses	<0.05*
1032_Moses3	Doongmabulla	Moses	<0.05*
1033_Moses2	Doongmabulla	Moses	0.08*
1034_Littmose	Doongmabulla	Little Moses	<0.05*
1035_Moses1	Doongmabulla	Moses	0.06*
1036_75E	Doongmabulla	Moses	0.09*
1037_75A	Doongmabulla	Moses	0.08*
1038_75D	Doongmabulla	Moses	0.07*
1039_75B	Doongmabulla	Moses	0.12*
1040_75C	Doongmabulla	Moses	0.12*
1041_Doongma	Doongmabulla	Joshua	0.19*
41_(no name recorded)	Mellaluka	Mellaluka	<0.05 – 1.03**
42_(no name recorded)	Mellaluka	Mellaluka	<0.05 – 1.14**
Storie’s	Mellaluka	Storie’s	<0.05 – 2.34**
Lignum	Mellaluka	Lignum	0.06 – 8.22**
	* predicted drawdown in the Clematis Sandstone ** predicted drawdowns in the uppermost aquifer and Older Permian units since source aquifer has yet to be confirmed		

Table 20 Predicted groundwater level impacts at licensed extraction bores – operational phase

Site	Feature type	Model layer	Target formation	Maximum predicted drawdown in target formation (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	0.1
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	0.1
RN 90255	Stock Extraction	4	Clematis Sandstone / Dunda Beds	0.8
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	0.2
RN 62750	Stock Abstraction	4	Clematis Sandstone	0.1
RN 16897	Stock Abstraction	4	Clematis Sandstone	0.1
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 Mine Area are summarised in Table 21. 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 Mine Area predicted maximum drawdowns exceed 1 m at:

- Nine bore locations to the south of the lease
- Two bore locations to the north of the lease.

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

Table 21 Predicted groundwater level impacts at other registered bores – operational phase

Site	Model layer	Formation targeted	Maximum drawdown in target formation (m)	Notes
RN 17980	5	Dunda Beds	3.7	Inside lease area
RN 17981	10	Permian Sandstone	18.1	Inside lease area
RN 17982	12	Permian Sandstone	120.5	Inside lease area
RN 44440	2	Unconsolidated Quaternary / Tertiary Units	3.0	South of lease area
RN 44441	8	Permian Sandstone	0.4	South of lease area
RN 44484	2	Unconsolidated Quaternary / Tertiary Units	<0.05	East of lease area
RN 44485	5	Dunda Beds	16.8	Inside lease area
RN 44486	5	Dunda Beds	3.1	South-east of lease area
RN 44489	2	Unconsolidated Quaternary / Tertiary Units	1.1	South-east of lease area
RN 47167	5	Dunda Beds	1.4	Inside lease area
RN 62623	10	Permian Sandstone	74.0	Inside lease area
RN 62624	5	Dunda Beds	20.3	Inside lease area
RN 62625	5	Dunda Beds	1.1	South of lease area
RN 67627	10	Permian Sandstone	3.3	South of lease area
RN 90256	10	Permian Sandstone	1.3	North of lease area
RN 90258	5	Dunda Beds	3.8	Inside lease area
RN 90259	10	Permian Sandstone	1.3	North of lease area
RN 90260	5	Dunda Beds	4.9	Inside lease area
RN 90369	5	Dunda Beds	0.8	Inside lease area

Site	Model layer	Formation targeted	Maximum drawdown in target formation (m)	Notes
RN 103229	10	Permian Sandstone	8.6	South of lease area
RN 103230	8	Permian Sandstone	0.4	South of lease area
RN 103231	8	Permian Sandstone	4.5	South of lease area
RN 103249	10	Permian Sandstone	8.2	South of lease area
RN 103559	12	Permian Sandstone	0.8	South of lease area
RN 103565	5	Dunda Beds	1.7	South of lease area

5.6.7 Predicted groundwater flow impacts – operational phase

Base flow impacts

Given the predicted impacts on groundwater levels in the upstream area of the Mine Area there is also the potential for impact on flows in the Carmichael River and on other local water courses which are receiving groundwater base flow. Predicted operational baseflow impacts on the Carmichel River are shown in Figure 38 and Figure 39. 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). Impacts on the Carmichael River and any other local water courses which receive groundwater base flow are therefore possible.

Output from the calibrated pre-development steady state model suggests that long term average baseflow to the Carmichael River peaks at around 4,500 m^3/d around 7 km upstream of the site and around 3 km downstream of Doongmabulla Springs (Figure 38). Output from the predictive post development model suggests that total baseflow to this point could be reduced to around 4,300 m^3/d at the end of the mining operational phase (year 2071) which suggests a reduction in baseflow of around 200 m^3/d. This is equivalent to a predicted 5 percent reduction in modelled groundwater discharge to the Carmichael River upstream of the Mine Area.

Model results suggest a naturally occurring baseflow loss across the site. This is consistent with observations at the site. However, model predictions also suggest that mining induced drawdown within the mine area will increase the rate of loss across the site. Pre-development model results suggest a loss of around 1000 m^3/d across the Mine Area. Post development predictions suggest that losses would increase to around 1800 m^3/d at the end of the mine operational phase (2071) hence indicating around 800 m^3/d of additional baseflow losses due to mine dewatering activities.

Total impacts through a combination of reduced baseflow upstream and increased losses across the site are therefore around 1000 m^3/d (or 33 per cent of the long term average pre-development baseflow) at the end of the mine life.

The predicted reductions in baseflow will also affect the duration of low/zero flow periods at the downstream boundary of the site and are likely to cause the zero baseflow point to migrate

upstream. Extrapolation of the rate of baseflow decline at the end of the modelled profile (Figure 38) suggests that zero baseflow would occur around 25 km downstream under pre-development conditions but only around 15 km downstream post development, suggesting a 10 km migration of the zero baseflow point upstream.

Potential changes in the duration of zero flow periods can also be estimated based on the impacts identified above and using the small amount of available observed data at the upstream and downstream limits of the mine site. Maximum predicted baseflow impact at the upstream Mine Area boundary is 330 m^3/d, if we take this impact from the observed flow record at this location then results suggest an increase in the duration of zero flow periods from 0 per cent of the time pre-development (Table 10) to 5 percent post development (i.e. a 5 percent increase in no flow periods). Maximum predicted baseflow impact at the downstream boundary is 1000 m^3/d, taking this impact from the observed flow record at this location suggests an increase in the duration of zero flow periods from 30 per cent of the time pre-development to 60 per cent of the time post development (i.e a 30 per cent increase in no flow periods).

It should be noted that due to the lack of reliable flow data for the Carmichael River modelled river conductances, which regulate the rate of water gain/loss from the groundwater system to the river and vice versa, are currently largely assumed and have not been adjusted in the calibration process. Thus the accuracy of the predicted river flows and impacts could be enhanced in future modelling work by calibrating river conductance values against reliable baseflow targets for the Carmichael River. Adani Mining has already established a number of permanent gauging and sampling sites to obtain additional flow gauging data to address this particular data gap (see Section 7.6.6 for further information).

GAB groundwater resource impacts

Given that mining operations will dewater the Permian-age coal seams that dip in an easterly-westerly direction beneath the geological units of the Great Artesian Basin some indirect impact to the groundwater resources of the GAB is possible.

Output from the calibrated pre-development steady state model suggests around 100 m^3/d of net vertical leakage from the lowest unit of the GAB (the Rewan Group) to the underlying Permian units. This modelled long term average eastward flow from the GAB area to the underlying Permian-age strata is consistent with modelled groundwater levels which suggest a topographically controlled system with flow towards the Carmichael and/or the Belyando Rivers. Modelled flow within the GAB to the west of the Mine Area is not therefore towards the main GAB unit to the south/south-west of the area. This modelled flow direction is consistent with the available groundwater level data for GAB units to the west of the Mine Area and suggests that recharge to the outcropping Clematis Sandstone area does not provide recharge to the main GAB but instead provides recharge to the Carmichael/Belyando catchments to the east. Model results therefore suggest no impact on the groundwater resources of the overall GAB. Model predictions do, however, suggest that net leakage through the base of the Rewan Group to the underlying Permian-age strata will be increased from around 100 m^3/d to to around 2,200 m^3/d at the end of the mining operational phase (year 2071) due to mine dewatering induced drawdown on groundwater levels in the Permian-age Strata. An increase in net vertical leakage from the GAB units to the west to the Permian-age units to the east of up to around 2,100 m^3/d is therefore predicted. Model predictions suggest that around 73 percent or 1,600 m^3/d of this additional induced leakage will be derived from the Clematis Sandstone and Dunda Beds with storage releases from the Rewan comprising the remaining 500 m^3/d.

5.7 Model predictions - post closure

5.7.1 Post closure landform

Post closure impacts have been assessed based on a final post rehabilitation land surface provided by Adani. 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 74 m above the current ground surface in overburden areas. However, whilst the mining area which are active at the end of the mine life will be re-profiled and partially backfilled using redirected pre-strip waste from adjacent pits, it will not be possible to backfill all areas to pre-development levels. The final landform therefore also includes six final void areas (1 per pit), typically situated towards the west of the proposed open cut mining area. These final voids will be backfilled to the following elevations:

- Pit B, D and G to the top of Seam D
- Pit C, E and F to the top of Seam AB.

According to the final landform provided this equates to the following minimum elevations:

- Pit B, D and G: final minimum elevations at -22.1 m AHD, -7.6 m AHD and -20 m AHD respectively
- Pit C, E and F: final minimum elevations at 111.6 m AHD, 30.3 m AHD and 60.4 m AHD respectively.

The final ground surface within these voids will therefore be substantially below the pre-development ground surface and also below current 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 all 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 long term average annual evaporation totals 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 the provided final landform suggests a total final void area of around 3,346 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 theoretically exceed 124 ML/d.

Given that these potential losses significantly exceed the predicted 6.5 ML/d of groundwater 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 open cut 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.

5.7.2 Post closure predictive 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. Two models were set-up to assess the long term impact of the proposed development post closure:

- A long term transient model in order to estimate the time taken for groundwater levels to equilibrate post closure and verify the long term impacts calculated by the steady state post-closure model
- A steady state model to assess impacts once the groundwater system has re-equilibrated to steady-state post-closure conditions.

Initial groundwater levels for both runs were taken from the final stress period of the predictive operational run i.e. predicted groundwater levels at the end of the 59 year operational mine life.

As discussed in Section 5.7.1 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 therefore been undertaken through the use of the MODFLOW Drain package with drains set at the base of each final void. Drain cells covering the full extent of the final voids were assigned to all layers of the numerical model down to the base of model layer 10 in Pits B, D and G to simulate backfill up to the top of Seam D and to the base of model layer 8 in Pits C, E and F to simulate backfill up to the top of Seam AB.

5.7.3 Predicted pit inflows and water balance – post closure

Post closure model results indicate that groundwater inflow to final void areas via the modelled drain cells will fall gradually from 6.5 ML/d at the end of the operational period to 2.4 ML/d in the long term, i.e. significantly less than the 124 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 an ongoing groundwater extraction of 2.4 ML/d from the groundwater system.

A water balance for the post-closure steady-state model is summarised in Table 25.

Modelled water balance result suggests that the primary modelled flow inputs are recharge, stream leakage from the Carmichael River to the groundwater system and groundwater inflows from adjoining areas. Modelled groundwater inputs are balanced by evapotranspiration, groundwater discharge to the Carmichael River and other local water courses, groundwater outflow to adjoining areas and in-pit outflow (which as discussed earlier is expected to be lost as in-pit evaporation).

Table 22 Post-closure steady state model – water balance

Component	Flow IN (m^3/d)	Flow OUT (m^3/d)	IN – OUT (m^3/d)
Recharge	2,534	0	2,534
Evapotranspiration (Riparian Zone Only)	0	3,344	-3,344
Discharge from/to Adjoining Areas	44,825	41,301	3,523
Groundwater Extraction	0	151	-151
Carmichael River Leakage	6,436	6,436	0
Discharge to Other Water Courses	0	651	-6,51
In-pit Flow	0	2,402	-2,402
TOTAL	53,794	54,286	-491 (-0.91%)

5.7.4 Predicted groundwater level impacts – post closure

Predicted post closure groundwater levels impacts at the various Doongmabulla and Mellaluka spring complex locations are listed in Table 23.

Predicted drawdowns at the Doongmabulla spring complex to the west of the Mine Area are similar to maximum predicted drawdowns during the operational period. Hence predicted post closure impacts are a maximum of 0.16 m at the Doongma or Joshua spring and 0.1 m at two of the Moses springs (1039_75B and 1040_75C). Predicted post-closure impacts at the eight remaining Doongmabulla spring locations are less than 0.1 m.

Predicted post closure impacts at the Mellaluka spring system to the south of the Mine Area are between 1.6 and 25.6 m and hence are substantially higher than maximum predicted drawdowns of <0.05 and 8.22 m during the operational period (see Table 19).

Table 23 Predicted water table impacts at spring locations – post closure

Spring number and name	Spring system	Sub-system	Predicted drawdown in source aquifer (m)
1031_Moses4	Doongmabulla	Moses	<0.05*
1032_Moses3	Doongmabulla	Moses	0.05*
1033_Moses2	Doongmabulla	Moses	0.08*
1034_Littmose	Doongmabulla	Little Moses	<0.05*
1035_Moses1	Doongmabulla	Moses	0.06*
1036_75E	Doongmabulla	Moses	0.09*
1037_75A	Doongmabulla	Moses	0.07*
1038_75D	Doongmabulla	Moses	0.07*
1039_75B	Doongmabulla	Moses	0.11*
1040_75C	Doongmabulla	Moses	0.11*
1041_Doongma	Doongmabulla	Joshua	0.16*
41_(no name recorded)	Mellaluka	Mellaluka	1.6 -8.39**
42_(no name recorded)	Mellaluka	Mellaluka	2.9 -9.07**
Storie's	Mellaluka	Storie's	8.2 – 13.4**
Lignum	Mellaluka	Lignum	14.8 – 25.6**

* predicted drawdown in the Clematis Sandstone

** predicted drawdowns in the uppermost aquifer and Older Permian units since source aquifer has yet to confirmed

Predicted post closure groundwater level impacts at each of the 20 licensed groundwater bores within the groundwater model area are listed in Table 24. Predicted post closure drawdowns exceed 1 m at only one bore location (RN6404) to the north of the Mine Area. Predicted impacts at the remaining licensed extraction bores are less than 1 m and hence are considered unlikely to be significant.

Table 24 Predicted groundwater level impacts at licensed bores – post closure

Site	Feature type	Model layer	Target formation	Predicted drawdown in target formation (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	2.8
RN 62753	Stock Extraction	3	Moolayember Formation	0.3
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	0.15
RN 90255	Stock Extraction	4	Clematis Sandstone / Dunda Beds	0.8
RN 69443	Stock Extraction	4	Clematis Sandstone	0.15
RN 69442	Stock Abstraction	4	Clematis Sandstone	0.1
RN 69441	Stock Abstraction	4	Clematis Sandstone	0.1
RN 67626	Stock Abstraction	4	Clematis Sandstone	0.5
RN 62754	Stock Abstraction	4	Clematis Sandstone	0.2
RN 62750	Stock Abstraction	4	Clematis Sandstone	0.1
RN 16897	Stock Abstraction	4	Clematis Sandstone	0.2
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 25. Ten of these bores are located within the Mine Area and hence are likely to be decommissioned prior to the commencement of mining operations. Of the remaining 15 registered bores outside of the Mine Area predicted

maximum drawdowns exceed 1 m at all but one (RN44484) of the 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 25 Predicted groundwater level impacts at other registered bores – post closure

Site	Model layer	Formation targeted	Predicted drawdown (m)	Notes
RN 17980	5	Dunda Beds	2.6	Inside lease area
RN 17981	10	Permian Sandstone	23.6	Inside lease area
RN 17982	12	Permian Sandstone	92.6	Inside lease area
RN 44440	2	Unconsolidated Quaternary / Tertiary Units	42.3	South of lease area
RN 44441	8	Permian Sandstone	28.6	South of lease area
RN 44484	2	Unconsolidated Quaternary / Tertiary Units	0.7	East of lease area
RN 44485	5	Dunda Beds	29.7	Inside lease area
RN 44486	5	Dunda Beds	4.7	South-east of lease area
RN 44489	2	Unconsolidated Quaternary / Tertiary Units	39.8	South-east of lease area
RN 47167	5	Dunda Beds	6.3	Inside lease area
RN 62623	10	Permian Sandstone	111.3	Inside lease area
RN 62624	5	Dunda Beds	35.1	Inside lease area
RN 62625	5	Dunda Beds	3.7	South of lease area
RN 67627	10	Permian Sandstone	51.1	South of lease area
RN 90256	10	Permian Sandstone	3.7	North of lease area
RN 90258	5	Dunda Beds	2.8	Inside lease area
RN 90259	10	Permian Sandstone	13.6	North of lease area
RN 90260	5	Dunda Beds	5.6	Inside lease area
RN 90369	5	Dunda Beds	7.7	Inside lease area
RN 103229	10	Permian Sandstone	75.1	South of lease area
RN 103230	8	Permian Sandstone	28.6	South of lease area
RN 103231	8	Permian Sandstone	38.8	South of lease area
RN 103249	10	Permian Sandstone	85.9	South of lease area
RN 103559	12	Permian Sandstone	4.5	South of lease area
RN 103565	5	Dunda Beds	2.6	South of lease area

5.7.5 Predicted groundwater flow impacts – post closure

Base flow impacts

Predicted post closure (long-term) base flow impacts on the Carmichel River are shown in Figure 38.

Output from the calibrated pre-development steady state model suggests that long term average baseflow to the Carmichael River peaks at around 4,500 m^3/d around 7 km upstream of the Mine Area. Output from the predictive post closure model suggests that this baseflow could be reduced to around 4,200 m^3/d in the long term which suggests a reduction in baseflow of around 300 m^3/d. This is equivalent to a predicted 7 percent reduction in modelled groundwater discharge to the Carmichael River upstream of the mine lease.

Model results also suggest that naturally occurring baseflow losses across the Mine Area could increase as a result of mining induced drawdowns. Pre-development model results suggest a loss of around 1,000 m^3/d across the mine lease. Post closure predictions suggest that losses would increase to around 1,650 m^3/d post closure, hence indicating around 650 m^3/d of additional loss.

Total impacts through a combination of reduced baseflow upstream and increased losses across the site are therefore around 950 m^3/d (or 31 per cent of the long term average pre-development baseflow) post closure.

Post closure flow impacts on the Carmichael River are similar to those calculated at the end of the operational period (Section 5.6.3) and hence suggest little or no additional impact in the long term. Post closure results therefore also suggest:

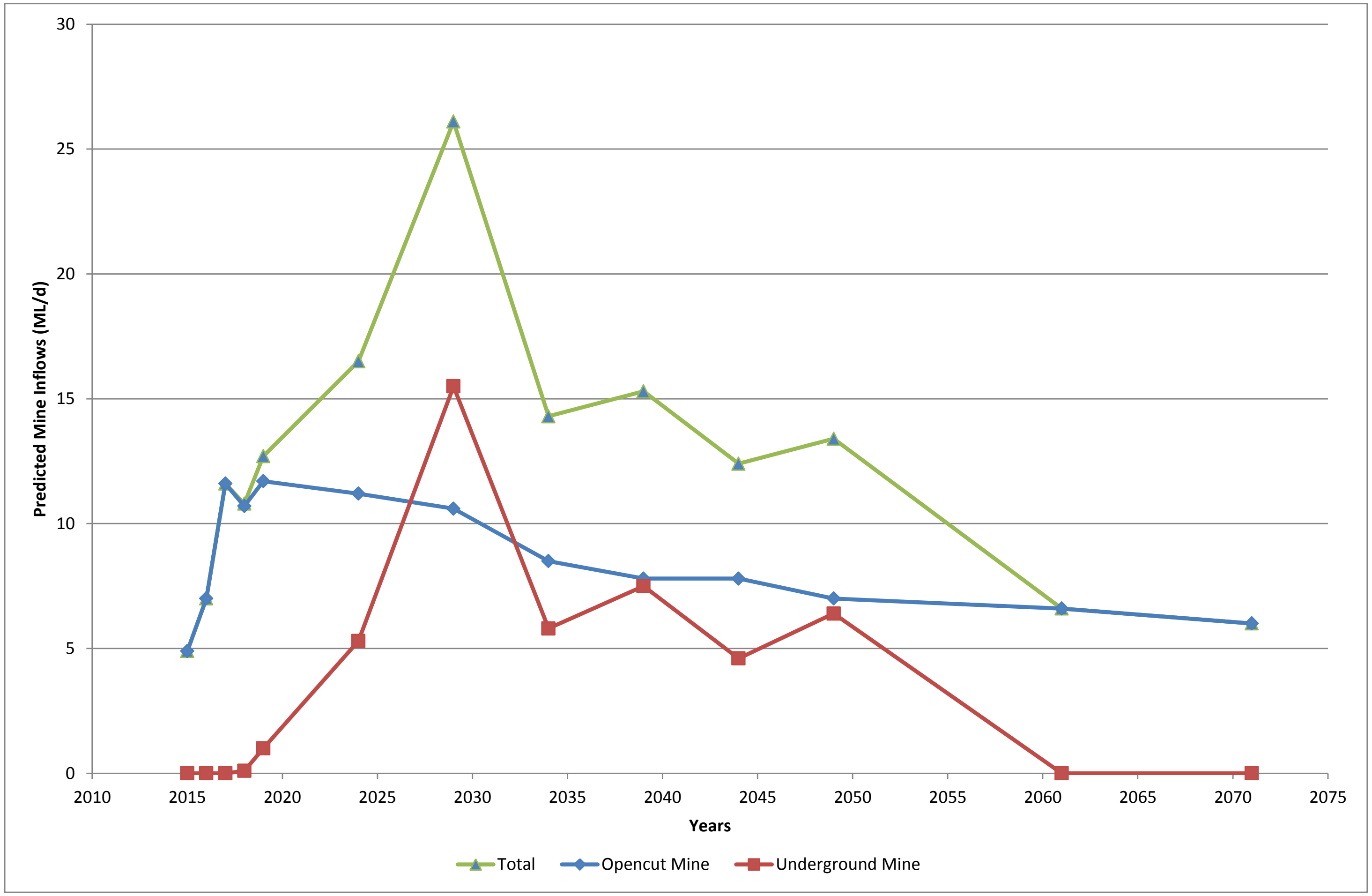
- A 10 km upstream migration of the estimated zero baseflow point from 25km downstream of the Mine Area pre-development to 15 km downstream post closure
- A 5 percent increase in the duration of no-flow periods at the upstream boundary of the Mine Area and a 30 percent increase at the downstream boundary.

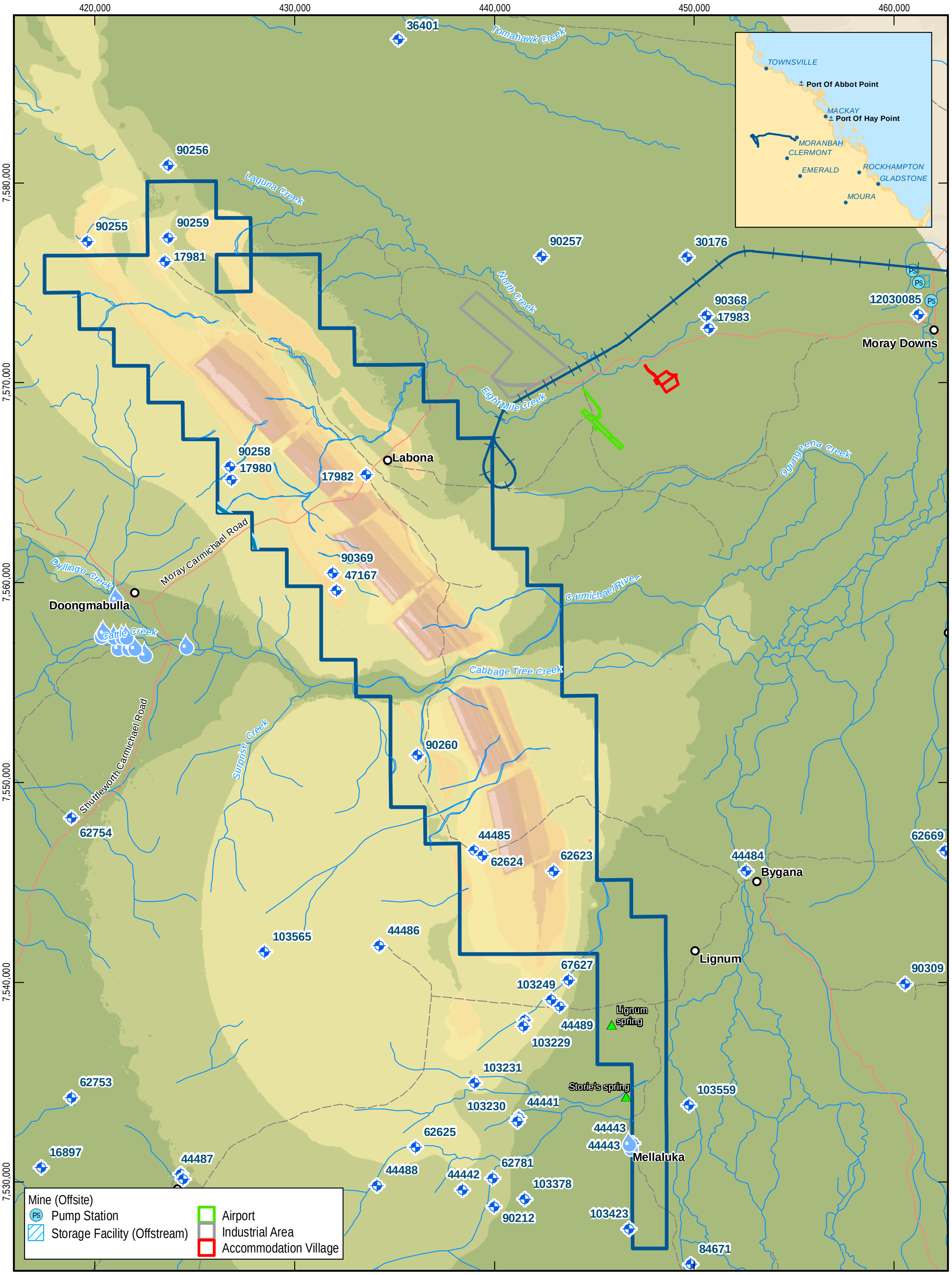
GAB groundwater resource impacts

As explained in Section 5.7.2, although some of the opencut pits will be backfilled up to the top of Seam AB and others up to the top of Seam D, deep un-remediated voids will remain towards the west of the proposed open cut mining area post closure. Therefore some long term impact to the groundwater resources of the GAB is possible.

Output from the calibrated pre-development steady state model suggests around 100 m^3/d of net vertical leakage from the lowest unit of the GAB (the Rewan Group) to the underlying Permian-age units. Model predictions suggest that net leakage through the base of the Rewan Group to the underlying Permian-age strata will be increased from around 100 m^3/d currently to around 1,000 m^3/d post closure due to ongoing evaporation from the final voids, and hence long term groundwater level drawdown. A long term increase in net vertical leakage from the GAB to the adjacent Permian-age units of up to around 900 m^3/d is therefore predicted. Model predictions suggest that all of this additional induced leakage will be derived from the Clematis Sandstone and Dunda Beds.

Figure 34 Predicted mine inflows





LEGEND

- ○ Homestead
- Spring (Geoscience Australia)
- Registered Groundwater Bore
- ▲ Spring
- Local Road
- Track
- Watercourse

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

- Project (Rail)
- ☐ Project (Mine)

Based on or contains data provided by the State of QLD (DNRM) [2013]. 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.

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

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number	41-26422
Revision	G
Date	15-10-2013

Predicted Maximum Water Table Drawdowns - Operational Phase

Figure 35

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Data Source: DME: EPC 1690 (2010)/EPC 1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road,Spring Locations, Watercourse (2007); GHD: Monitoring Bores, Interpreted Groundwater Level Contour (2012); Adani: Project Rail 1 (Opt11 Rev2) & 2 (Opt9 Rev3), Facilities (2013), Mine Layout (2013). Created by: BW, MS

Figure 36 Predicted Doongmabulla spring impacts – operational phase

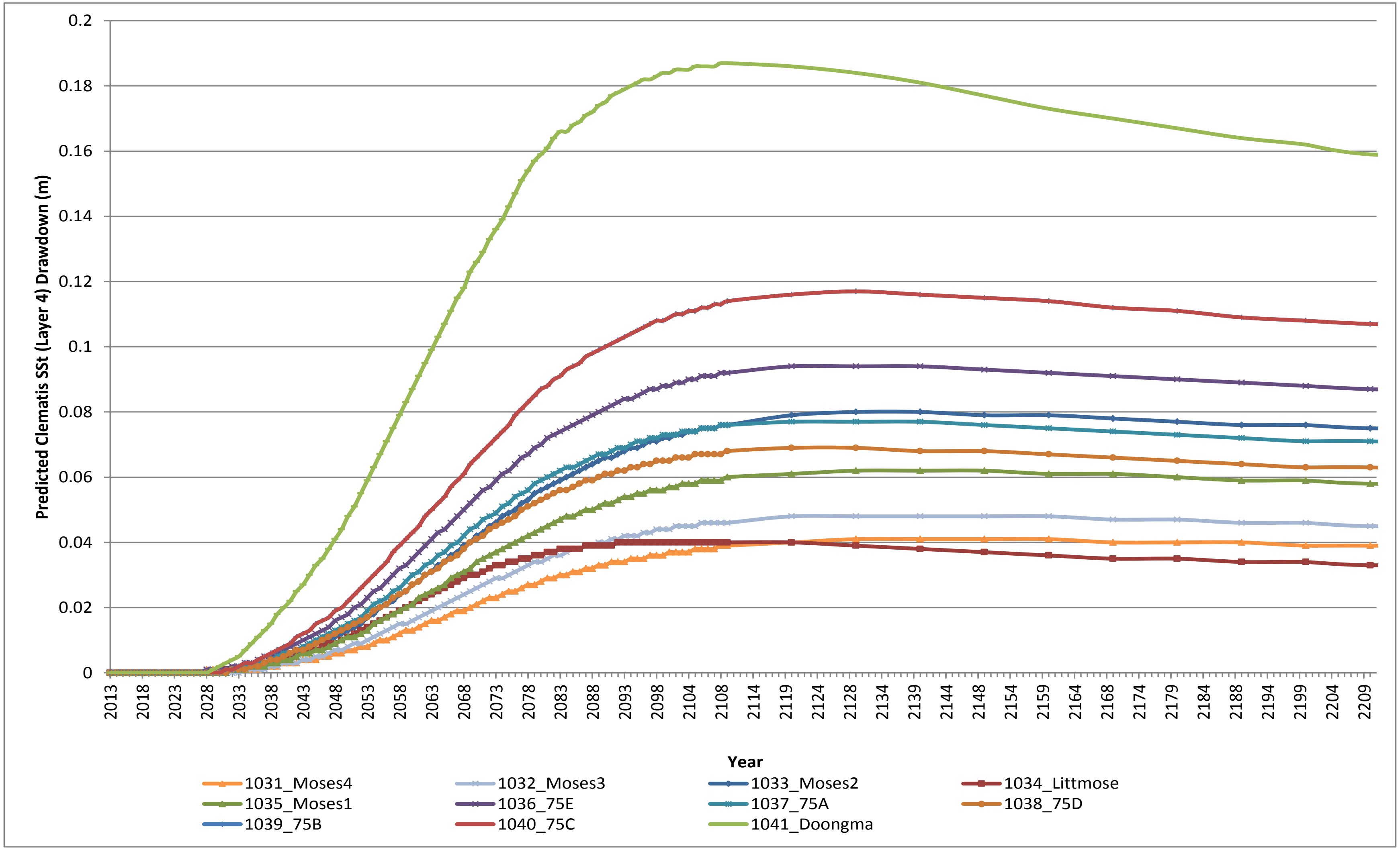


Figure 37 Predicted Mellaluka Spring impacts – operational phase

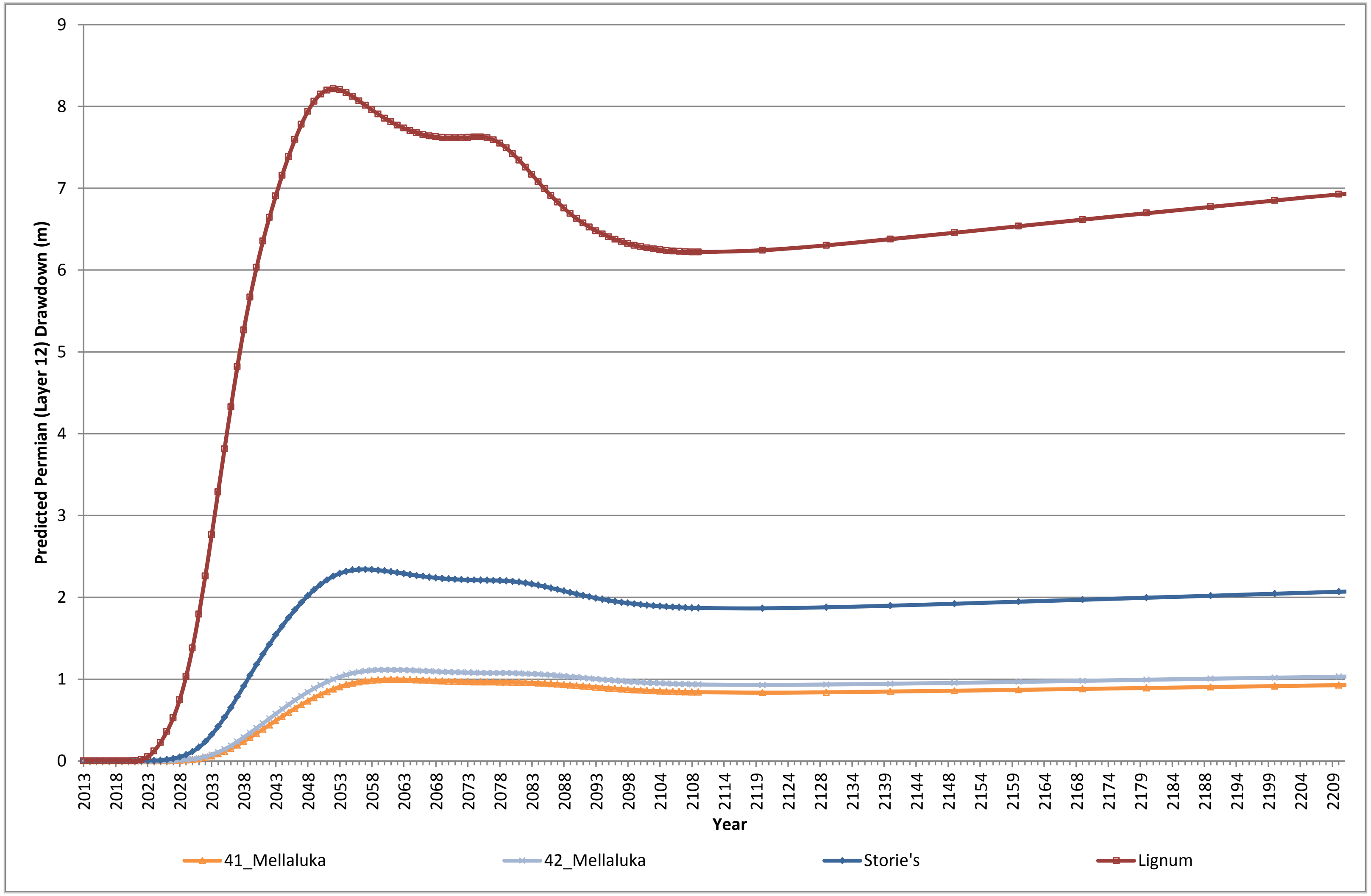


Figure 38 Predicted base flow impacts – pre and post development

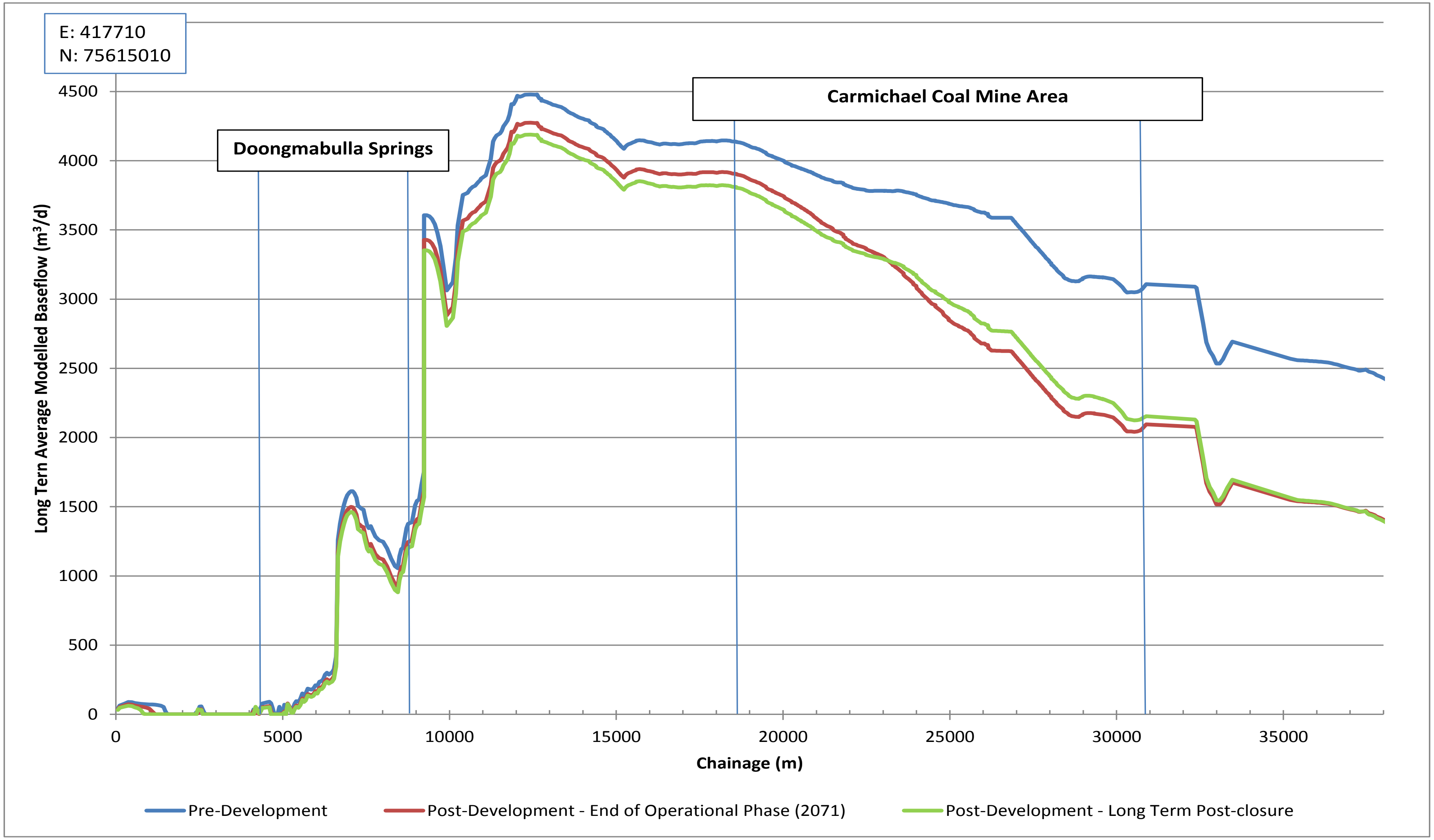
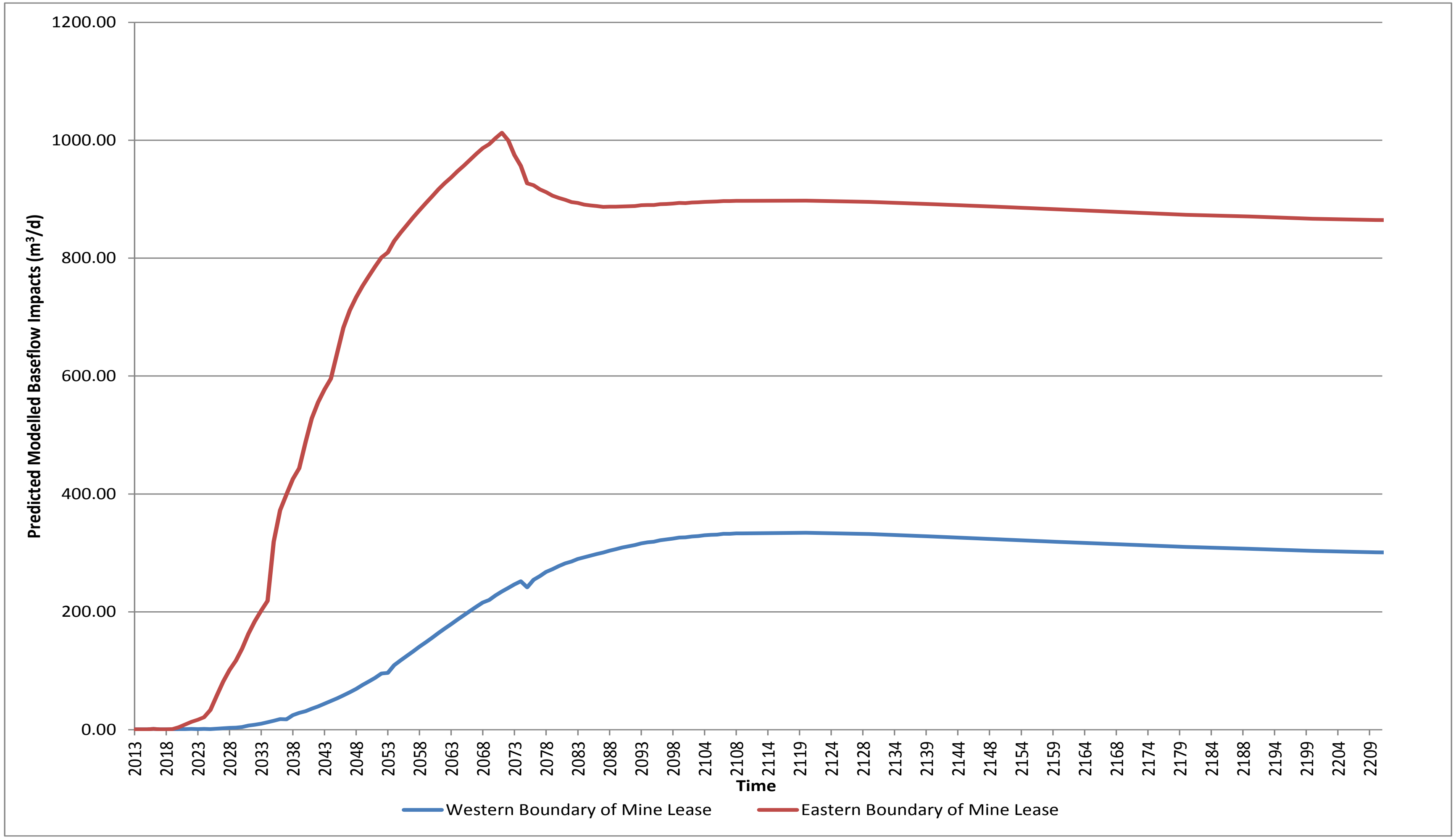
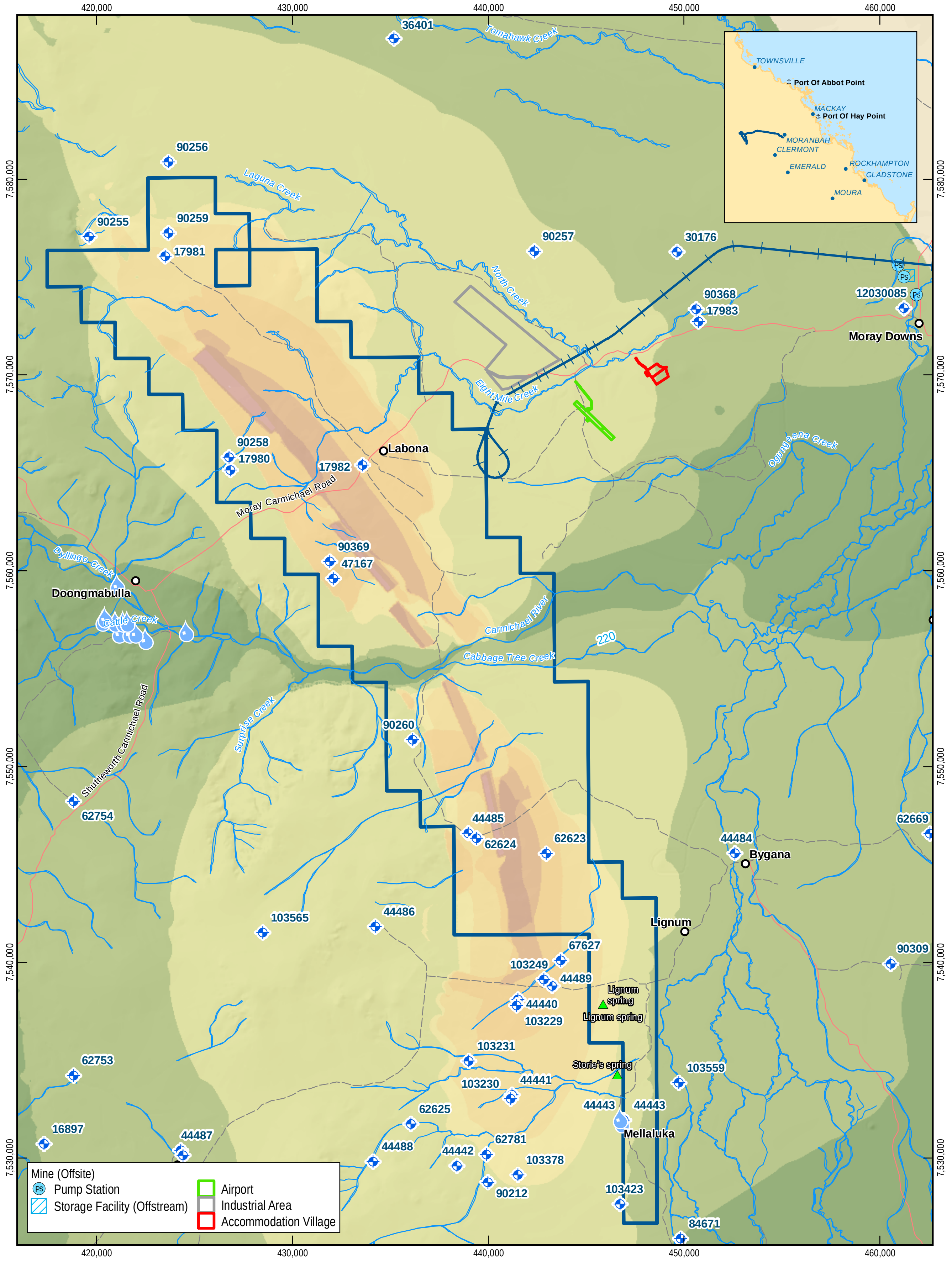


Figure 39 Predicted base flow impacts at specific locations – pre and post development





LEGEND

○ Homestead
Spring (Geoscience Australia)
Registered Groundwater Bore
▲ Spring

Local Road
Track
Watercourse

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

Project (Rail)
Project (Mine)

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 SEIS

Job Number 41-26422
Revision G
Date 15-10-2013

Predicted Long Term Water Table Drawdowns - Post Closure

Figure 40

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Level 9, 145 Ann 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, Spring Locations, Watercourse (2007);
GHD: Monitoring Bores, Interpreted Groundwater Level Contour (2012); Adani: Project Rail 1 (Opt11 Rev2) & 2 (Opt9 Rev3), Facilities (2013), Mien Layout (2013). Created by: BW, MS

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 both the model calibration and predictions to variations in selected key parameters. In total a further 179 runs of the calibration and predictive models were undertaken as follows:

- 85 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/stream conductance
- 91 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/stream and drain conductance
- 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)
- A further sensitivity run of the post closure steady state model was also carried out to confirm the contribution of the hypothesised development of a free draining fracture zone above the abandoned underground workings to the predicted impacts.

Further information on the modelled parameters varied during the sensitivity analysis and the range of parameter multipliers considered are provided in Table 27.

Table 26 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	7	7	0.1,0.2,0.5,2,5,10
K – Permian OB	8	8	0.1,0.2,0.5,2,5,10
K – AB Coal Seam	9	9	0.1,0.2,0.5,2,5,10
K – Permian IB	10	10	0.1,0.2,0.5,2,5,10
K – D Coal Seams	11	11	0.1,0.2,0.5,2,5,10
K – Older Permian Units	12	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 / Stream 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
K - underground mine goaf area	Layer 7, 8 and 10	Layer 7, 8 and 10	No Factorisation of pre-development calibrated K values

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
- Type IV Parameters. Parameters which have an insignificant impact on the model calibration but a significant 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 27.

Table 27 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 minimum 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	> 1.8 m change in predicted drawdown	Predictions based on the calibrated parameter set suggest up to around 9 m of impact post closure, a variation of 1.8 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 spring complex

Sensitivity analysis results relating to predicted post closure impacts at the Doongmabulla spring complex are presented in Figure 40. This plot suggests that whilst the predicted impacts on the springs are relatively sensitive to some parameters, such as the hydraulic conductivity of the Clematis Sandstone and the Moolayember Formation, the calibration is also sensitive to these same parameters. None of the parameters tested have therefore been classified as Type IV parameters.

Perhaps importantly given that the calibrated hydraulic conductivity value for the Rewan Group of 7.4x10^{-5} m/d is slightly below the minimum estimate site value of 9.5 x10^{-5} m/d (as discussed in 5.5.3) results suggest that predicted impacts at the Doongmabulla Springs are relatively insensitive to this parameter. Results indicate that increasing the modelled hydraulic conductivity of the Rewan Group by a factor of ten to 8.4x10^{-5} m/d (i.e. within the range of values measured on the site) would increase predicted impacts at the springs by less than 0.04 m. Similarly predicted impacts at Doongmabulla Springs are almost insensitive to the relatively high calibrated value for the Quaternary alluvium. Results indicate that decreasing the modelled hydraulic conductivity of the Quaternary alluvium by a factor of 10 to 2.0 m/d would increase the predicted impacts at the springs by less than 0.02 m.

As would be expected sensitivity analysis results also suggest that the timing of impacts may be affected where the actual storage values are different from those assumed for modelling purposes. Storage sensitivity analysis results for the Joshua Spring indicate that the timing of peak impact could be delayed by to 70 years or brought forward by to up to 30 years if storage parameters were multiplied or divided by a factor of two, respectively. Storage sensitivity analysis results also suggest that the magnitude of the maximum impact could also be affected slightly if storage parameters were altered from their assumed values suggesting that predicted maximum impacts of 0.19 m would be reduced slightly by around 0.04 m to 0.15 m if actual storage parameters are twice those modelled, and increased slightly by around 0.05 m to 0.24 m if the modelled storage parameters are halved.

Finally sensitivity analysis results suggest that impacts related to the simulated development of a free draining fracture zone above the abandoned mine workings represents a minor component of the total predicted impacts on the Doongmabulla Springs. Results suggest that less than 4 percent of the predicted post closure mining impact at the springs can be attributed to the modelled 150m thick free draining fracture zone.

Mellaluka Springs

Sensitivity analysis results relating to predicted post closure impacts on groundwater levels in Permian-age strata at the Mellaluka Springs are presented in Figure 42. This plot suggests that the predicted impacts on the springs are relatively sensitive to the hydraulic conductivity (K) of the Dunda Beds/Tertiary, the Rewan Group/Tertiary and the Permian Interburden/Tertiary (i.e. model layers 5, 6, 7 and 8). However, the model calibration is also relatively sensitive to two of these three parameters and hence only the hydraulic conductivity of the Rewan Group/Tertiary (i.e. model layers 6/7) is considered to be a Type IV parameter in this case. It should be noted that since the Rewan Group is not actually present in the vicinity of the Mellaluka Springs model layers 6 and 7 therefore represent Tertiary strata at this location, as discussed in Section 5.2. The type IV sensitivity of the hydraulic conductivity of these layers is considered to be related to the general lack of calibration data for the Tertiary strata in this area.

Unlike the Doongmabulla spring complex peak impacts at the Mellaluka spring complex are simulated by the long term post closure predictive run, rather than during the operational period. Maximum predicted impacts at the Mellaluka Springs are therefore not sensitive to the storage values assumed for the transient model of the operational period.

As at the Doongmabulla spring complex sensitivity analysis results also suggest that impacts related to the simulated development of a free draining fracture zone above the abandoned mine workings represents a minor component of the total predicted impacts on the Mellaluka Springs. Results suggest that less than 1 percent of the predicted post closure mining at the springs can be attributed to the modelled 150m thick free draining fracture zone.

Post closure baseflow impacts

Sensitivity analysis results relating to predicted post closure impacts on baseflow in the Carmichael River are presented in Figure 43. This plot suggests that whilst the predicted baseflow impacts are relatively sensitive to some parameters, such as the hydraulic conductivity of the Clematis Sandstone and the Quaternary Alluvium the calibration is also sensitive to these same parameters. None of the parameters tested have therefore been classified as Type IV parameters.

The sensitivity of baseflow impact predictions to the modelled river/stream bed conductance is also of particular interest in this case. In situ river bed conductivity is difficult to estimate in the field and hence bed conductance is typically treated as a calibration parameter. For this model, in the absence of a reliable time series of observed gains and/or losses from the Carmichael River from which to calibrate this parameter, river/stream bed conductance has been assumed based on a relatively high hydraulic conductivity value of 0.4 m/d. Fortunately predicted baseflow impacts are relatively insensitive to river/stream bed conductance since increasing the bed conductance tends to increase the volume of flow gained in the Carmichael River upstream of the site, whilst at the same time increasing by a similar volume flow losses across the site

Storage sensitivity analysis results suggest slightly lower predicted baseflow impacts and substantially delayed impacts where modelled storage parameters are multiplied by two.

Sensitivity analysis results also suggest that impacts related to the simulated development of a free draining fracture zone above the abandoned mine workings represents a minor component of the predicted total baseflow impacts. Results suggest that less than 4 percent of the predicted baseflow impacts can be attributed to the modelled 150m thick free draining fracture zone.

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 final voids to the parameters shown in Table 27. The results are summarised in Figure 43 and suggest that predicted inflows are relatively sensitive to:

- KL1 Quaternary Alluvium
- KL2 Tertiary
- KL11 D Coal Seams/Tertiary
- KL10 Permian Interburden/Tertiary
- KL12 Older Permian Units
- Recharge.

Predicted groundwater inflows appear to be particularly sensitive to the modelled hydraulic conductivity of the older Permian units. Results suggest that groundwater discharge to the final voids could be as high as 4,000 m^3/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 final voids are predicted to be around 2,400 m^3/d. Sensitivity analysis results therefore suggest an upper bound inflow of around 4,000 m^3/d or 1,600 m^3/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 mine workings may vary by up to around + 30 percent and -25 percent on average for the 59 year mine life.

Finally sensitivity analysis results suggest that predicted inflows would be reduced by around 10 percent in the event that a free draining fracture zone did not develop post development.

Figure 41 Sensitivity analysis results – Doongmabulla Springs

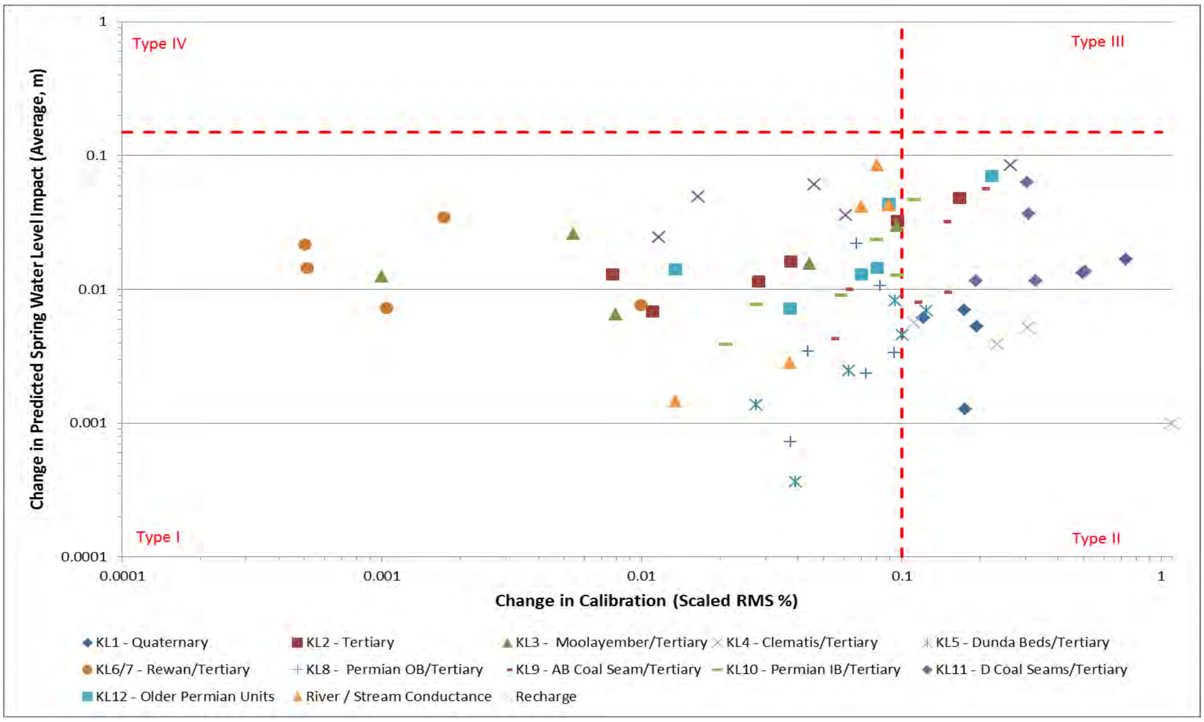


Figure 42 Sensitivity analysis results – Mellaluka Springs

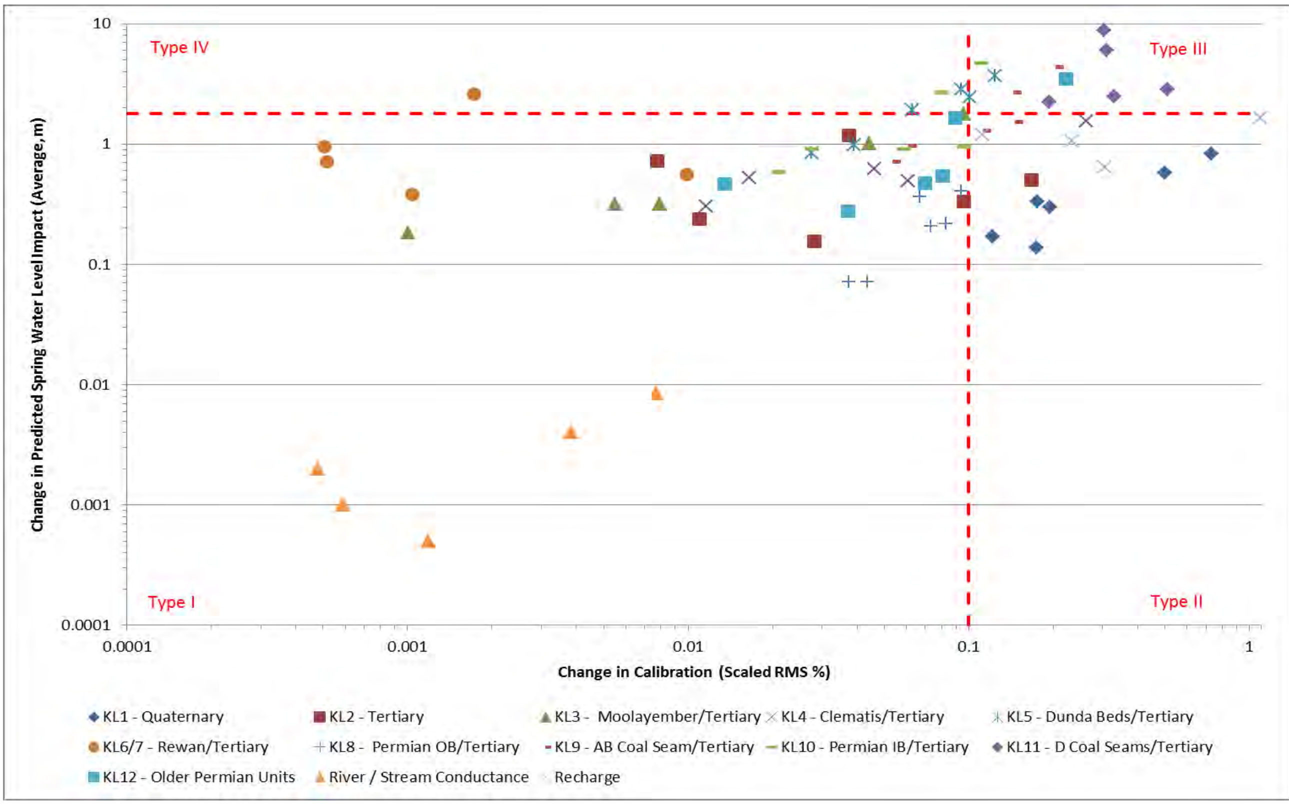


Figure 43 Sensitivity analysis results – baseflow impact

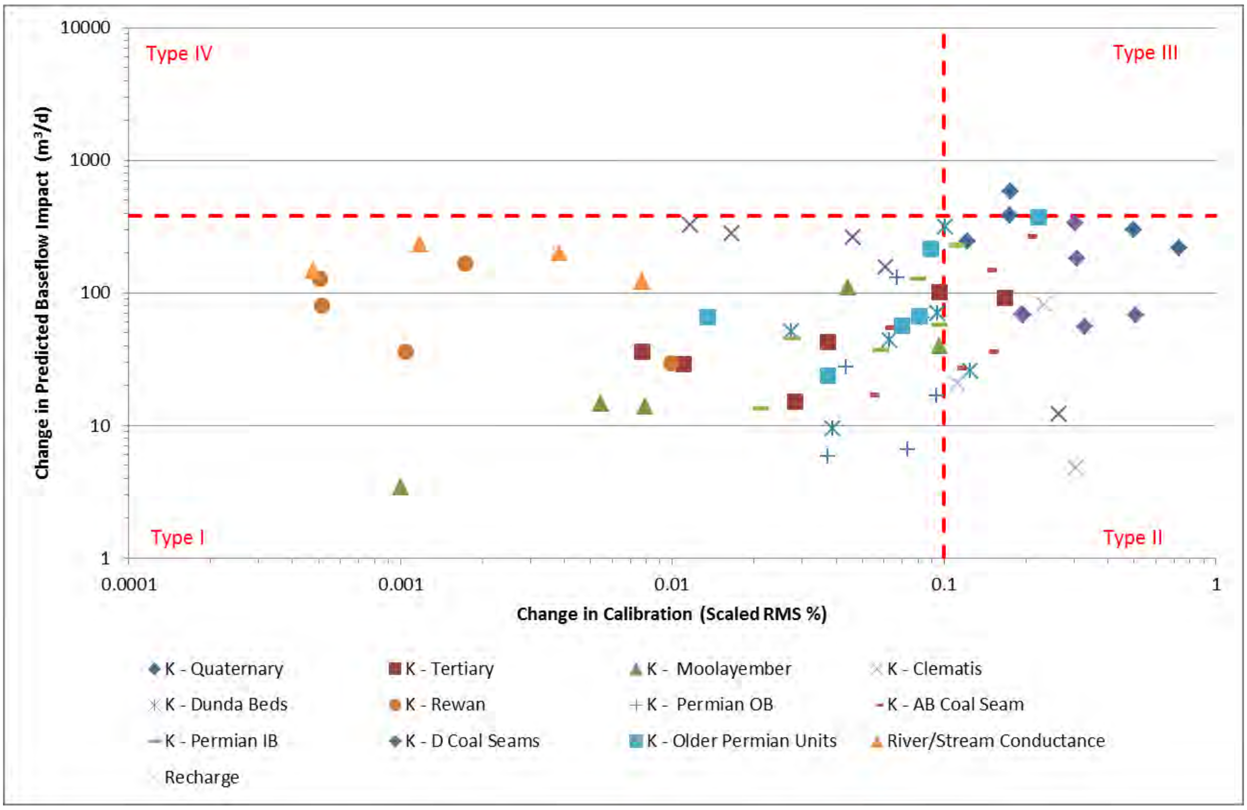
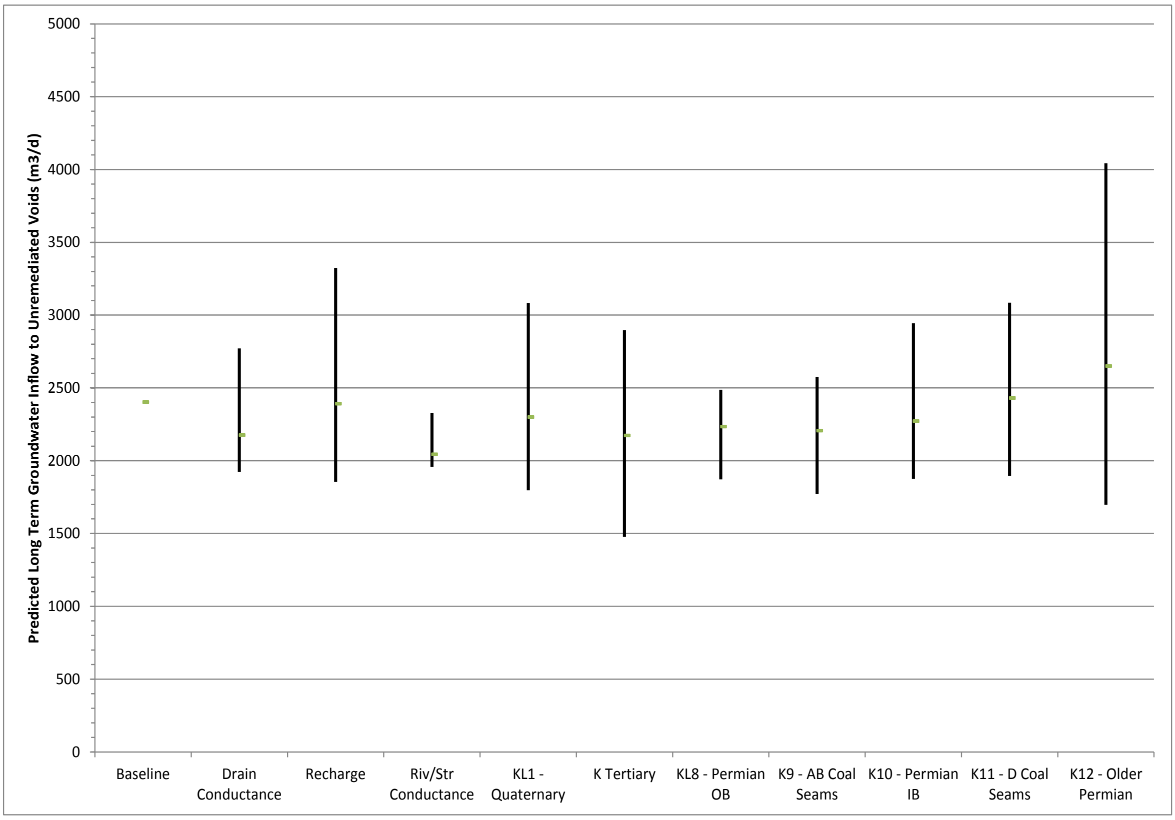


Figure 44 Sensitivity analysis results – final void inflows



5.8.3 Sensitivity analysis conclusions

Sensitivity analysis results suggest that the predicted impacts on the Doongmabulla and Mellaluka Springs and baseflow in the Carmichael River are sensitive to a range of different parameters. However, for the most part the model calibration is also sensitive to these same parameters and hence only one parameter, the hydraulic conductivity of Tertiary Clay in the vicinity of the Mellaluka Spring, has been classified as a type IV parameter (i.e. a parameter which has an insignificant impact on the model calibration but a significant impact on model predictions).

Sensitivity analysis results for the Mellaluka spring suggest that the hydraulic conductivity of model layer 6/7, which at this location represents Tertiary Clay (rather than the Rewan Group), is a type IV parameter. This reflects a general lack of calibration data and information on the strata present in this area. This particular gap in the monitoring network has already been filled by the drilling and installation of three additional monitoring network bores in the area close to the Mellaluka Springs (Figure 9).

Perhaps importantly given that the calibrated value for the hydraulic conductivity of the Rewan Group of 7.4x10^{-5} m/d is slightly below the minimum estimate site value of 9.5 x10^{-5} m/d (as discussed in 5.5.3) results suggest that predicted impacts on the nearby GAB Doongmabulla Springs are relatively insensitive to the variations of up to an order of magnitude in this parameter.

As would be expected storage sensitivity analysis results tend to confirm that any variation from the assumed modelled storage values will have an effect on the timing of predicted impacts, but relatively little impact on the magnitude of predicted impacts.

Sensitivity analysis runs carried out with and without inclusion of a free draining fracture zone also suggest the only a relatively minor component (less than 4 percent) of the total predicted impacts can be attributed to the modelled 150m thick free draining fracture zone.

6. Potential impacts and mitigation measures – construction phase

6.1 Potential impacts of construction activities

6.1.1 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 has not been considered in the impact assessment.

6.1.2 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. 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.

6.1.3 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 6.2 then no significant impacts on groundwater quality are anticipated during the construction phase.

6.2 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 containment of 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 reasonably practicabe, 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 minimised 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 cells
- Operation and processing and storage facilities and plant
- The diversion of minor ephemeral creeks along the western boundary of the Study Area
- 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 therefore not been considered in the impact assessment since it does not form part of the current project description (Volume 4 Appendix B, Updated Mine Project Description).

7.1.1 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 the 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 35 for a map of predicted water table decline).

7.1.2 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 the 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 surface water discharge has been assessed through the development and application of a water balance model (refer to Volume 4 Appendix K2, Water Balance Report). The impacts of predicted surface water discharges on the receiving environment are assessed as part Revised Mine Hydrology Impact Assessment Report (Volume 4 Appendix K5).

7.1.3 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 24 of the 35 licensed and other registered bores, outside of the Mine 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 11 registered bores (see Table 28). 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 28   Summary of significant impacts at registered groundwater bores

Site	Model layer	Formation targeted	Maximum drawdown in target formation m)	Notes
RN 44440	2	Unconsolidated Quaternary / Tertiary Units	3.0	South of lease area
RN 44486	5	Dunda Beds	3.1	South-east of lease area
RN 44489	2	Unconsolidated Quaternary / Tertiary Units	1.1	South-east of lease area
RN 62625	5	Dunda Beds	1.1	South of lease area
RN 67627	10	Permian Sandstone	3.3	South of lease area
RN 90256	10	Permian Sandstone	1.3	North of lease area
RN 90259	10	Permian Sandstone	1.3	North of lease area
RN 103229	10	Permian Sandstone	8.6	South of lease area
RN 103231	8	Permian Sandstone	4.5	South of lease area
RN 103249	10	Permian Sandstone	8.2	South of lease area
RN 103565	5	Dunda Beds	1.7	South of lease area

7.1.4 Potential for indirect impacts on the Great Artesian Basin

The proposed open cut mining pits are located towards the east of the Mine 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 Mine Area but only the older underlying Permian-age units will be actively dewatered in this area. Furthermore the Dunda Beds are separated from the underlying Permian units by the Rewan Group aquitard which is around 200 m thick in the underground mining area (see Figure 28). No direct impacts on groundwater resources in the GAB are therefore anticipated. However, groundwater modelling results suggest that some indirect impact on the GAB is possible via inducing:

- Drawdown in the near-surface Tertiary and Quaternary-age units which are present throughout the majority of the modelled area and hence also extend into the GAB area to the west; and/or
- Additional leakage from the overlying GAB units through the Rewan Group.

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 35 the area to the west of the Mine 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 overall 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 is towards the east i.e. away from the main body of the GAB rather than towards it. Where this eastward groundwater flow direction is confirmed by further monitoring then no impacts on the wider GAB groundwater resources would occur as a result of dewatering.

Model results do however suggest that net leakage through the base of the Rewan Group to the underlying Permian-age strata will be increased from around 100 m^3/d to around 2,200 m^3/d at the end of the mining operational phase (year 2071). An increase in net vertical leakage through the Rewand Group to the adjacent Permian-age units of up to around 2,100 m^3/d is therefore predicted. Model predictions suggest that around 73 percent or 1,600 m^3/d of this additional induced leakage will be derived from the Clematis Sandstone and Dunda Beds with the remaining 600 m^3/d from the Rewan Group. The hydrogeological impacts of this additional extraction of up to around 2.1 ML/d from the Clematis Sandstone / Dunda Beds on the nearby Doongmabulla GAB springs and Carmichael River are described in Sections 7.1.5 and 7.1.6.

7.1.5 Potential impact on local spring systems

Doongmabulla spring complex

The GAB Doongmabulla spring complex to the west of the Project (Mine) site lies close to the limit of the predicted cone of influence of mine dewatering and hence less than 0.05 m of aquifer drawdown is predicted at three of the 11 mapped spring sites. Predicted drawdown impacts of less than 0.05 m (or 5cm) are considered to be insignificant on the basis that:

- Impacts of less than 5 cm are likely to be practically difficult to measure on the ground
- 5 cm represents less than 10 percent of the observed natural fluctuation in monitoring borehole HD03 which has been completed in the Clematis Sandstone close to the Doogmabulla Springs.

However, minor impacts of up to around 0.19 m drawdown are predicted at the Joshua Spring and impacts of between 0.06 and 0.12 m are predicted at seven of the nine mapped Moses springs. It should be stressed that these drawdowns relate to predicted pressure reductions in the Clematis Sandstone which is thought to represent the source aquifer for these springs.

Actual impacts on the spring heads themselves are considered likely to be attenuated to some degree by the potentially highly variable strata which separate the source aquifer from the springs. Furthermore, and as discussed in Section 5.6.1, due to practical limitations on the number of layers that can be included in numerical models of this type, additional attenuation is likely to occur within the 200 m thick Rewan Group and other strata which separate the dewatered strata (i.e. the Permian Coal Measures) from the Doongmabulla spring complex. The predicted operational and post closure impacts on the Doognmabulla spring complex are therefore considered to be a conservative and hence in most cases actual impacts are likely to be less than those predicted.

Notwithstanding the conservative nature of the predicted impacts any assessment of the sensitivity of the springs to modelled reductions in pressure is complicated by the general lack of information on current pressures in either the source aquifer in the immediate vicinity of the springs or at the spring head themselves. Whilst it may be possible, with the right safeguards and permissions, to install some shallow driven piezometers to monitor near surface pressures, the installation of deeper monitoring bores to confirm pressures in the source aquifer is unlikely to be possible. Without information on current pressures in both the source aquifer and the spring head, including information on natural variations, it will remain difficult to assess the significance of the predicted drawdowns on the various springs. Some indication of current pressures and hence the sensitivity of the springs to water level decline can, however, be derived from an understanding of the physical form of each spring.

For instance as discussed in Section 4.9.1 the Joshua Spring is a large, modified spring surrounded by a 1.5 m high ‘turkeys nest’ type dam which discharges continually via an overflow pipe set near the top of the dam into a surrounding wetland. The height of the overflow pipe through the turkey nest dam suggests that average pressures at the spring head are currently at or around 1.5 m above ground level at this location. The potential impacts of the predicted 0.19 m of drawdown at this location could therefore be largely mitigated by reducing the elevation of overflow pipe by a similar distance which should act to maintain discharge from the spring at current levels.

Similarly a number of the Moses springs are characterised by natural mounds which range in height from around 0.4 to 1.5 m. The height of these mounds suggests that average pressures at the spring head currently fall within the range 0.4 to 1.5 m. The predicted impacts of between 0.06 and 0.12 m will not therefore lead to any of these mound springs drying up but could act to reduce current pressures and therefore flows by between 4 and 30 percent.

Non-mound springs are likely to be more sensitive to any groundwater level drawdowns since the current pressures may be at or close to ground surface. However, even at these springs some natural fluctuation in levels and flows is expected. Data for the nearby HD03 monitoring bore which is completed into the likely source aquifer for the springs, the Clematis Sandstone, suggests groundwater level fluctuations of up to 0.5 m (see Figure 9 and Appendix C). Hence, if we assume that actual pressures in non-mound springs vary seasonally between 0 and 0.5 m above ground then a drawdown of 0.12 m equates to a 24 percent increase in the cease to flow period rather than a permanent drying up of the spring.

Based on the above discussion predicted impacts on the Doongmabulla spring complex can be summarised as follows:

- Joshua spring, no significant impact anticipated

- Mound springs, 4 to 30 percent reduction in flows
- Non-Mound springs, up to a 25 percent increase in the cease to flow period.

Whilst it does not model individual springs the pre-development groundwater model suggests significant baseflow gain to the Carmichael River in the vicinity of the Doongmabulla springs, which is therefore consistent with the observed high density of springs in the area. Model results suggest a long term average baseflow to the Carmichael River upstream of the Mine Area of 4,500 m^3/d (Figure 38). Output from the predictive post development model suggests that total baseflow to this point could be reduced to around 4,300 m^3/d at the end of the mining operational phase (year 2071) which suggests a reduction in baseflow from the general area of the springs of around 200 m^3/d. This is equivalent to a predicted 5 percent reduction in modelled groundwater discharge to the Carmichael River upstream of the mine lease.

Mellaluka spring complex

The Mellaluka springs are located approximately four to ten kilometres south of the proposed mining area. Relatively little is known about the Mellaluka spring complex and geological data is generally more limited towards the southern limit of the proposed mining area. The geology in this general location typically comprises shallow near surface Quaternary and Tertiary age strata overlying older Permian-age units. Model results suggest predicted maximum drawdowns at the two Mellaluka Springs of between less than 0.05 and 1.11 m depending on whether the source aquifer for the springs is near surface Tertiary/Quaternary strata or the underlying Permian-age Units. Substantially higher impacts of between 0.05 and 2.3 m are predicted at the Stories Spring and between 0.06 and 8.2 m at the Lignum Spring, depending on the source aquifer, since these springs are located closer to the Mine Area.

Of these four springs only the main Mellaluka springs, which is characterised by a 3-4 m mound, can be described as mounding and hence the Lignum, Stories and the remaining Mellaluka springs could all be significantly impacted during the operational phase of the development if they are sourced from Permian-age aquifers. Data for the nearby monitoring bores installed into the Permian suggests typical groundwater level fluctuations of up to 0.5 m (see Figure 9 and Appendix C). Hence, if we assume that actual pressures in non-mound springs vary seasonally between 0 and 0.5 m above ground then any drawdowns of more than 0.5 m may lead to permanent drying of these springs.

Conversely the height of the mound observed at the main Mellaluka Spring suggests that average pressures at the spring head are currently 3 – 4 m above ground level. Hence the predicted impact of less than 1.1 m at this location will not lead to this mound spring drying up, but could act to reduce current pressures and therefore flows by up to 36 percent. It should be noted that natural pressures and flows from these springs are already likely to be being affected by ongoing extraction from adjacent groundwater bores installed at each of the three spring groups which provide water for domestic use (Mellaluka springs) and water for livestock (Storie's and Lignum springs).

7.1.6 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 the Carmichael River upstream of the mine site, will be reduced by up to 200 m^3/d or 5 per cent of pre-development discharge during the operational phase. Predictions also suggest that mining induced drawdown within the mine area will increase observed flow losses across the site by up to 800 m^3/d. Total impacts, through a combination of reduced baseflow upstream and increased losses across the site, are therefore around 1000 m^3/d (or 33 per cent of the long term average pre-development baseflow) at the end of the mine life.

The predicted reductions in baseflow will also affect the duration of low/zero flow periods at the downstream boundary of the site and are likely to cause the zero baseflow point in the Carmichael River to migrate upstream. Model predictions suggest:

- A 10 km migration of the zero baseflow point upstream
- A 5 percent increase in no flow periods at the upstream boundary of the Mine Area
- A 30 percent increase in no flow periods at the downstream boundary of the Mine Area.

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

7.1.7 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, Paper Bark and Waxy Cabbage Palm 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 J1, Revised Ecological Assessment Report and Volume 4, Appendix J4, Waxy Cabbage Palm Assessment Report.

7.2 Potential impacts of spoil and tailings disposal

Based on information provided in the conceptual mine plan (refer to Volume 4, Appendix B, Updated Mine Project Description), 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 managed in tailingscells adjacent to the MIA and will be disposed into out of spoil dumps.. 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 (refer to Volume 4, Appendix O1, Mine Waste Characterisation Report). This assessment is based on an assumption that the management, mitigation and monitoring activities outlined in Section 7.6.8 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.

Assessment of the potential for excavated material to produce acid and metalliferous drainage has been assessed (refer to Volume 4 Appendix O1, Mine Waste Characterisation Report). In summary, the geochemical assessment has identified the following:

- The majority of the overburden and interburden materials (not immediately adjacent to the coal seams) and roof and floor wastes are not likely to be a source of acid immediately after mining.
- The majority of the overburden and interburden waste from all lithological groups is likely to be non-acid forming in the longer term
- Some carbonaceous mudstone, carbonaceous sandstone, carbonaceous siltstone, clay, claystone, mudstone, sandstone, sandy clay, siltstone and tuff may be acid forming in the long term. There may be a requirement to manage these materials to prevent or limit the longer-term development of AMD.
- Some portion of the roof, floor and coal could be expected to be acid forming in the long term
- Testing of washed coal wastes would be required to assess the AMD risks associated with these materials. Kinetic testing of 10 samples to estimate rates of acid production and neutralisation and rates of metals release commenced in May 2013.

7.3 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 biggest 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 7.6.9 (see below) then no significant impacts on groundwater quality are anticipated during the construction phase.

7.4 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 Mine Area.. 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 7.6.10.

7.5 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 a separate study undertaken by MSEC (MSEC, 2013). 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, 2013; 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. However, additional runs of the predictive groundwater model carried out with and without inclusion of a free draining fracture zone suggest only a relatively minor component (less than 4 percent) of the predicted total impact can be attributed to longwall mining induced fracturing of the overlying strata.

As illustrated in Volume 4, Appendix B, Updated Mine Project Description Report 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 (refer to Volume 4, Appendix I , Subsidence Management Report).

Based on subsidence contours included within Appendix C of Volume 4, Appendix I, Subsidence Management Report surface cracking is 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 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.

7.6 Management, mitigation and monitoring activities – operational phase

7.6.1 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 K3 Mine Water Quality Report and Appendix K2 Water Balance Report. Operation of the mine water management system will be documented as part of the overall Environmental Management Plan (EMP) developed for the construction and operational phases of the Project.

7.6.2 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), including the bores installed close to the Mellaluka, Storie's and Lignum springs, 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 further 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 SEIS Volume 4 Appendix Q1, Environmental Management Plan - Mine). 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.

7.6.3 Great Artesian Basin aquifers

Groundwater model predictions suggest the potential for some minor indirect impacts on groundwater levels and leakage from Triassic-age units, which form part of the GAB system. Given the importance of the GAB from a national water resource perspective additional groundwater monitoring bores have already been installed in the area to the west of the Mine Area close to the Carmichael River, between the Mine Area and the Doongmabulla spring complex (refer toFigure 9), as follows:

- HD02 (standpipe piezometer installed in the Clematis sandstone, approximately 1.5 km west of the Moses spring group)
- HD03A and HD03B (nested standpipe piezometers installed in the Dunda Beds and Alluvium respectively, approximately 6 km west of the Moses spring group).

Initial results from these bores have already been incorporated into the SEIS and associated modelling as described above.

In addition, three standpipe piezometers are currently being installed into the Dunda Beds at locations immediately west of the Mine Area boundary (to the south (2 standpipes) and north of Doongmabulla springs complex).

The primary purpose of these facilities is to:

- Confirm pre-development groundwater levels and 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 through monitoring of groundwater levels during operation of the Project (Mine).

Monitoring of these additional bores and other parts of the extensive installed groundwater monitoring network is described in the Environmental Management Plan (refer to Volume 4 Appendix Q1, Environmental Management Plan – Mine).

7.6.4 Local spring systems – Doongmabulla spring complex

Groundwater model predictions also suggest the potential for some minor impacts at eight of the 11 mapped GAB springs at Doongmabulla. For instance impacts of up to 0.19 m are predicted after 90-120 years at the Joshua Spring. Limited data is currently available on pre-development flow rates, pressures and/or water chemistry at any of these springs.

Baseline water quality sampling of selected springs of the Doongmabulla spring complex was conducted in May and June 2012 (refer to Section 1.1.1). Two baseline ecological surveys were also conducted in May 2012 and March/April 2013 (refer to Volume 4 Appendix J3 Springs Ecological Assessment Report). Baseline monitoring of standpipe piezometers HD02 and HD03B commenced in late 2012 and of HD03A in June 2013. Given the importance of these springs from an ecological and cultural perspective, regular groundwater and spring water monitoring will continue prior to commencement of mining operations, to establish a reliable baseline data set of water conditions at the springs and also of groundwater levels between the springs and the Project (Mine) site. The following baseline monitoring of groundwater and the

springs is proposed in order to establish any seasonal variations in water levels, water quality and discharge flows from the springs:

- Monitoring of selected springs of the Doongmabulla spring complex on four occasions approximately once every three months over a twelve month period, to commence and continue at least one year prior to commencement of mining operations. This would involve water quality sampling and estimation of discharge flows from the springs selected for monitoring.
- Monitoring of groundwater levels and groundwater quality on at least four occasions at HD02, HD03A and HD03B standpipe piezometers, approximately once every three months over a twelve month period, to commence and continue at least one year prior to commencement of mining operations.
- Where possible the installation of shallow driven piezometers to enable monitoring of groundwater level pressures at selected spring heads should also be undertaken.

7.6.5 Local spring systems – Mellaluka spring complex

Drawdowns of up to 8.2 m are predicted after around 40-50 years at the location of the four non-GAB springs which comprise the Mellaluka spring complex and hence it is possible that these springs could be significantly affected. Initial water quality sampling of the Mellaluka spring complex (refer to Section 1.1.1) and an ecological survey (refer to SEIS Volume 4 Appendix J3 Springs Ecological Assessment Report) were conducted in April 2013 to confirm their environmental values, current status and the likely source aquifer(s) for the springs.

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
- ‘Making good’ any residual impacts on the springs and/or local water supply bores which cannot be otherwise mitigated.

It should be stressed that significant drawdowns are not expected in the Mellaluka spring complex area until after around 40 years of mine operation. There will therefore be ample opportunity to collect further data and develop management and mitigation measures before any actual impacts eventuate.

7.6.6 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 upstream and downstream level monitoring sites so that a reliable pre-development flow record can be developed for these gauges. Adani has recently established a number of permanent gauging and sampling sites for this purpose as detailed in Table 29.

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 into the river.

Table 29 Surface water monitoring locations

Latitude	Longitude	Station ID	Station Name	Location Desciption
-21.9594600	+146.6568190	BEL01	Belyando River at Carmichael/Moray Rd	
-22.1620320	+146.5285470	BEL02	Belyando River at Bygana Waterhole	Belyando/Bygana Waterhole Gauging Station
-22.0740740	+146.4675990	CAR01	Carmichael River far DS. Below 1080	Carmichael Downstream Gauging Station
-22.0975750	+146.4055550	CAR02	Carmichael River at Mid GS	Carmichael Mid Gauging Station
-22.1071410	+146.3957890	CAR03	Carmichael River at Main Crossing	
-22.1087960	+146.3527180	CAR04	Carmichael River at Upstream Gauging Station	Carmichael Upstream Gauging Station
-22.0906570	+146.2562410	CCK01	Cattle Creek upstream of Dyllingo confluence	
-22.1067830	+146.4139080	CT01	Cabbage Tree Creek approx 2.5km downstream of Mine Area	
-22.0888320	+146.2606000	DCK01	Dylingo Ck at Carmichael/Moray Rd	
-21.9691720	+146.3987390	ECK02	Eight Mile Creek at Carmichael/Moray Rd	
-21.9661140	+146.4865360	NCK01	North Creek at Carmichael/Moray Rd	

7.6.7 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, Paper Bark and Waxy Cabbage Palm communities, ecological monitoring before, during and after mine dewatering operations would be undertaken in addition to the hydrological monitoring outlined above (Section 7.6.6). There is evidence that these communities are reliant to some extent on ongoing groundwater discharge to the Carmichael River. Potential mitigation measures to protect these communities are therefore essentially the same as those identified above in Section 7.6.6 and include the diversion of minor creeks that currently flow across the mine footprint and/or the discharge of suitably treated inflows to the proposed mine workings into the river.

7.6.8 Spoil and tailings disposal siting and operation

Mitigation and monitoring measures are proposed as follows:

- Design and operation of the above ground tailings cells in accordance with appropriate legislation to minimise impacts on groundwater resources
- 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).

7.6.9 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. Refer to Volume 4, Appendix K1, Water Balance Report and Appendix K2, Water Quality Report for further information on potential discharges from the project area.

7.6.10 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 may 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. A preliminary diversion drain layout and impact assessment is provided in Volume 4, Appendix K5, Revised Mine Hydrology Impact Assessment Report. For the most part the proposed diversion drains are in the immediate vicinity of the proposed open cut pits and therefore do not encroach on the GAB area. Whilst minor impacts on local groundwater flow patterns are possible depending on the final diversion drain design no additional impacts on the GAB are anticipated as a result of diversion drain construction.

7.6.11 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 7.6.1 to 7.6.10 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.

8.2 Potential impacts related to creation of voids

Information on the final landform provided by Adani confirms that the final ground surface in part of each of the final pits will be below pre-development ground surface and current groundwater level elevations. Whilst there is the potential for these final voids to gradually fill with water once dewatering operations have ceased, potential evaporation losses from the voids significantly exceed predicted groundwater inflow 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 various impacts related to dewatering of the mine during the operational period will persist post-closure. In some 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 75 m are predicted at one out of 20 licensed registered bores and 14 of the 15 other registered bores (i.e. 15 bores in total) located outside of the Mine 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 is 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 wider GAB groundwater resources are expected to occur as a result of dewatering.

Model results do however suggest that net leakage through the base of the Rewan Group to the underlying Permian-age strata will be increased from around 100 m^3/d pre-development to around 1,000 m^3/d post closure. A long term increase in net vertical leakage through the Rewan Group to the adjacent Permian-age units of up to around 900 m^3/d is therefore predicted. Model predictions suggest that all of this additional induced leakage will be derived from the Clematis Sandstone and Dunda Beds.

8.2.3 Potential for impacts on local springs

Minor impacts on the Joshua Spring (1041) and seven of the other mapped Moses springs, are predicted to continue post-closure of the mining operations. No significant impact on the remaining three springs in the Doongmabulla complex are predicted during the operational or post closure period.

At the Mellaluka Spring complex site, however, predictions suggest ongoing drawdown post closure may result in drawdowns of up around 26 m at Lignum spring which is the closest mapped spring to the Mine Area, assuming that Permian-age strata represents the source aquifer for these springs. Predicted impacts at the four mapped springs are substantially reduced to between 1.6 and 15 m if it is instead assumed that these springs are supported by discharge from shallow Quaternary/Tertiary deposits. It should also 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 7.1.5 our understanding of the areas to the south of the Mine Area 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
- Entering into make good agreements with neighbouring landholders where residual impacts cannot be mitigated
- Offsetting impacts to MNES and SSBV under relevant policies where residual impacts cannot be mitigated.

It should also be stressed that significant drawdowns are not expected in the Mellaluka Springs area until at least 10 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

Total impacts through a combination of reduced baseflow upstream and increased losses across the site are predicted to be around 950 m^3/d (or 31 per cent of the long term average pre-development baseflow) post closure. Predictions also suggest:

- A 10 km migration of the zero baseflow point upstream

- A 5 percent increase in no flow periods at the upstream boundary of the Mine Site
- A 30 percent increase in no flow periods at the downstream boundary of the Mine Site.

This represents a similar level of impact to that predicted during the operational phase.

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.

Further information on pre-development flows in the Carmichael River and on discharges from the Doongmabulla Springs is required to confirm these estimated impacts.

In the event ongoing monitoring confirms significant impacts during the operational period then Adani Mining Pty Ltd is committed to taking any further steps necessary to reduce the post closure 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
- Reviewing the backfilling level of final voids in order to minimise or prevent ongoing losses due to evaporation
- Entering into make good agreements with neighbouring landholders where residual impacts cannot be mitigated
- Offsetting impacts to MNES and SSBV under relevant policies where residual impacts cannot be mitigated.

8.3 Potential impacts related to tailings and spoil disposal

If disposal of tailings and spoil 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 Final voids

Significant potential impacts on groundwater levels, groundwater extractions and on the groundwater regime within and in the vicinity of Mine Area are predicted as a result of partial backfilling of final voids and in some cases are predicted to be greater than during the operational phase of the Project (Mine). It should be stressed that the predicted impacts on groundwater levels included within this report during both the operational and post-closure phases are considered to be conservative estimates, actual impacts in most cases are therefore expected to be less than those predicted. In this case the post closure impact assessment effectively assumes that the final voids will remain dry in perpetuity. Whilst this is considered the most likely outcome at the current time higher than anticipated groundwater and/or surface water flows and lower than anticipated evaporation losses could all lead to significant groundwater level recovery in the final voids. As stated previously in the event that the significant impacts do become evident during the operational period then Adani Mining Pty Ltd is committed to taking any further steps necessary to reduce post closure impacts on

groundwater levels and/or flows 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
- Reviewing the backfilling level of final voids in order to minimise or prevent ongoing losses due to evaporation
- Entering into ‘make good’ agreements with neighbouring landholders where residual impacts cannot be mitigated
- Offsetting impacts to MNES and SSBV under relevant policies where residual impacts cannot be mitigated.

8.4.2 Tailings and spoil disposal, 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 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.

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Appendices

Appendix A – Registered groundwater bores

Table A1: Registered Bore Summary

Table A2: Bore Census Results

Summary of Groundwater Bores Sighted Within Mine Aea

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

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

Data source: Queensland Groundwater Bore Database (NRM), extracted December 2010

Appendix B – Survey data and borehole logs

Table B1: Monitoring bore survey data

Borehole logging notes

Draft borehole logs

Summary of Groundwater Monitoring Bore and Vibrating Wire Piezometer Survey Data

Notes
SP - Standpipe piezometer; VWP - Vibrating Wire Piezometer
* denotes value taken from LiDAR
** denotes 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

Monitoring Location ID	Type	Easting (GDA 1994, MGA Zone 55)	Northing (GDA 1994, MGA Zone 55)	Ground Elevation RL (mAHD)	Top of Casing RL (mAHD)	Survey Date	Surveyor
C006P1	SP	435726.146	7560833.182	233.71	234.333	14/11/2011	Wilson Survey Group
C006P3r	SP	435733.591	7560825.82	233.867	234.355	14/11/2011	Wilson Survey Group
C007P2	SP	434726.28	7559864.482	238.11	238.797	14/11/2011	Wilson Survey Group
C007P3	SP	434727.969	7559861.908	238.117	238.966	14/11/2011	Wilson Survey Group
C008P1	SP	433710.221	7558830.229	238.141	238.685	14/11/2011	Wilson Survey Group
C008P2	SP	433707.789	7558826.807	238.117	238.848	14/11/2011	Wilson Survey Group
C011P1	SP	428842.528	7569952.912	254.46	255.105	14/11/2011	Wilson Survey Group
C011P3	SP	428845.625	7569954.926	254.396	255.096	14/11/2011	Wilson Survey Group
C012P1	SP	430887.597	7569874.426	247.333	247.982	14/11/2011	Wilson Survey Group
C012P2	SP	430887.426	7569876.797	247.252	247.958	14/11/2011	Wilson Survey Group
C014P2	SP	430730.902	7563976.225	255.987	256.78	14/11/2011	Wilson Survey Group
C016P2	SP	422017.42	7574974.28	294.453	295.126	14/11/2011	Wilson Survey Group
C018P1	SP	423981.852	7574849.963	281.269	281.949	14/11/2011	Wilson Survey Group
C018P2	SP	423988.081	7574849.148	281.295	282.044	14/11/2011	Wilson Survey Group
C018P3	SP	423977.524	7574853.22	281.212	281.945	14/11/2011	Wilson Survey Group
C020P2	SP	427845.604	7566931.847	263.057	263.78	14/11/2011	Wilson Survey Group
C022P1	SP	426812.614	7565961.716	273.763	274.275	14/11/2011	Wilson Survey Group
C024P3	SP	428909.131	7571761.206	258.586	259.069	14/11/2011	Wilson Survey Group
C025P1	SP	438015.576	7555845.846	227.543	228.145	14/11/2011	Wilson Survey Group
C025P2	SP	438010.253	7555844.706	227.478	228.279	14/11/2011	Wilson Survey Group
C027P1	SP	433643.076	7554818.391	226.95	227.672	21/09/2012	Wilson Survey Group
C027P2	SP	433648.209	7554818.544	227.558*	227.859	21/09/2012	Wilson Survey Group
C029P1	SP	437691.058	7555082.374	225.438	226.079	14/11/2011	Wilson Survey Group
C029P2	SP	437687.554	7555080.918	225.373	225.994	14/11/2011	Wilson Survey Group
C032P2	SP	439404.358	7544896.018	256.221*	256.318	21/09/2012	Wilson Survey Group
C034P1	SP	442385.586	7547815.692	227.441	228.139	21/09/2012	Wilson Survey Group
C034P3	SP	442388.717	7547813.986	227.384	228.138	21/09/2012	Wilson Survey Group
C035P1	SP	441403.586	7546823.808	236.312*	236.667	21/09/2012	Wilson Survey Group
C035P2	SP	441401.683	7546827.747	236.24*	236.568	21/09/2012	Wilson Survey Group
C555P1	SP	432449.639	7557880.783	241.154^	241.874	11/10/2012	Wilson Survey Group
C556P1	SP	436524.082	7549881.547	260.634	261.553	11/10/2012	Wilson Survey Group
C558P1	SP	430311.546	7566903.059	250.054^	250.724	11/10/2012	Wilson Survey Group
C9553P1R	SP	421010.111	7573974.87	294.114^	294.414	11/10/2012	Wilson Survey Group
HD01	SP	426146.035	7561467.856	-	312.025	11/10/2012	Wilson Survey Group
HD02	SP	423823	7557008	240**	241.02^^	24/10/2012	Adani Mining
HD03A	SP	427565.2	7556119.6	229.41	-	3/11/2012	Adani Mining
HD03B	SP	427559.2	7556119.4	229.41	230.21	3/11/2012	Adani Mining
C553P	VWP	420992.731	7573965.334	294.562	-	11/10/2012	Wilson Survey Group
C555P	VWP	432449.639	7557880.783	241.154	- -		C555P within 10m of C555P1. Coordinates and ground RL for C555P1
C9556PR	VWP	436542.639	7549884.872	260.398	-	11/10/2012	Wilson Survey Group
C056C	VWP	424920	7569970	283.86	-	4/11/2011	Adani Mining
C558P	VWP	430311.546	7566903.059	250.054	- -		C558P within 10m of C558P1. Coordinates and ground RL for C558P1
C823SP	SP	433605.2	7562874.8	245.916	-	24/05/2013	Adani Mining
C825SP	SP	434868	7561960.4	238.056	-	08/07/2013	Adani Mining
C827SP	SP	436101.2	7560333.6	231.685	-	08/07/2013	Adani Mining
C829SP	SP	436462.8	7559356.4	238.101	-	08/07/2013	Adani Mining
C180112SP	SP	437715.2	7558820.2	226.206	-	08/07/2013	Adani Mining
C180114SP	SP	438686.6	7557649.2	224.961	-	08/07/2013	Adani Mining
C832SP	SP	439570.4	7554788.2	223.14	-	24/05/2013	Adani Mining
C833SP	SP	439559	7554779	223.06	-	24/05/2013	Adani Mining
C834SP	SP	439576.8	7554763.8	223.09	-	24/05/2013	Adani Mining
C836VWP	VWP	437566.6	7552868.8	236.757	-	08/07/2013	Adani Mining
C9838SPR	SP	439558.4	7552813.2	228.6	-	24/05/2013	Adani Mining

Summary of Groundwater Monitoring Bore and Vibrating Wire Piezometer Survey Data

Notes

SP - Standpipe piezometer; VWP - Vibrating Wire Piezometer
* denotes value taken from LiDAR
** denotes 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

Monitoring Location ID	Type	Easting (GDA 1994, MGA Zone 55)	Northing (GDA 1994, MGA Zone 55)	Ground Elevation RL (mAHD)	Top of Casing RL (mAHD)	Survey Date	Surveyor
C9839SPR	SP	439567	7552796.6	228.3	-	24/05/2013	Adani Mining
C840SP	SP	439545.6	7552839	228.7	-	24/05/2013	Adani Mining
C842VWP	VWP	439501.8	7550838.6	238.848	-	08/07/2013	Adani Mining
C844SP	SP	441391.8	7546840	235.57	-	24/05/2013	Adani Mining
C9845SPR	SP	439411.8	7544903.8	255.18	-	08/07/2013	Adani Mining
C847SP	SP	442384.6	7543809.2	236.8	-	24/05/2013	Adani Mining
C848SP	SP	442364.2	7543814.8	236.73	-	24/05/2013	Adani Mining
C9849SPR	SP	442356.8	7543819.4	236.85	-	24/05/2013	Adani Mining
C851VWP	VWP	441383.4	7542878.4	244.748	-	08/07/2013	Adani Mining
C180119SP	SP	448587.2	7536354.4	218.998	-	08/07/2013	Adani Mining
C180122SP	SP	448580.8	7536351.2	218.998	-	08/07/2013	Adani Mining
C9180124SPR	SP	448600	7536357.8	218.965	-	08/07/2013	Adani Mining
C180120SP	SP	447056.6	7531730	227.107	-	08/07/2013	Adani Mining
C9180125SPR	SP	447040.4	7531739	227.107	-	08/07/2013	Adani Mining
C9180121SPR	SP	448085.6	7529363.8	229.785	-	08/07/2013	Adani Mining
C180123SP	SP	448079	7529358	229.862	-	08/07/2013	Adani Mining
C180116SP	SP	439394.4	7540910.8	260.7	-	24/05/2013	Adani Mining
C180117SP	SP	435917.4	7547522.6	278.579	-	04/09/2013	Adani Mining
C180118SP	SP	423798.6	7568089.4	305.571	-	04/09/2013	Adani Mining

GENERAL NOTES

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.

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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.

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Ref: DS5.5.1 Issue 1.6 Date: 28/07/2009

GLOSSARY OF SYMBOLS

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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
CI	Closed
TI	Tight

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.

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.

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

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 : RB
Date Started : 24/06/11
Date Completed : 24/06/11
Logged by : MLW
Date : 16/8/'13

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, 5 1/8 inch)	Nil						No Returns			0.0 m - 36.0 m; Tertiary		Completed with steel monument
2													
4													
6					6.00 (227.71)		CH	CLAY with trace sand, greenish-grey, high plasticity, fine grained sand, stiff		St			
8													
10													
12													
14													
16													50mm PVC casing, with cement-bentonite grout
18													
20													
22			GNO										
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 : EPC 1690

HOLE No. C006P1

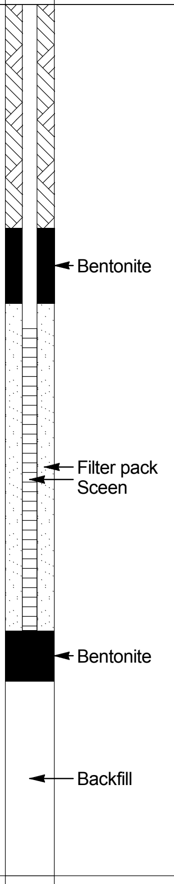
SHEET 2 OF 2

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 :** RB
Date Started : 24/06/11	**Date Completed :** 24/06/11	**Logged by :** MLW	**Date :** 16/8/'13

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
Rotary Wash Boring (bit, 5 1/8 inch)	Nil				▨		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.			

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

PIEZOMETER



See standard sheets for details of abbreviations & basis of descriptions

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C006P3

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 :** RB
Date Started : 21/06/11 **Date Completed :** 22/06/11 **Logged by :** MLW **Date :** 16/8/'13

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**
0–30	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		

See standard sheets for details of abbreviations & basis of descriptions

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C006P3

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 :** RB
Date Started : 21/06/11 **Date Completed :** 22/06/11 **Logged by :** MLW **Date :** 16/8/'13

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 34 36	Rotary Wash Boring (bit, 6 inch)	Nil						CLAY, as previous.		VSt	7.0 m - 38.0 m; Tertiary		
38 40 42 44 46 48					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		
50 52 54 56 58 60					49.00 (184.87)		CH	CLAY, white, high plasticity, very stiff. At 54 m; becoming pale brown with patches of pale grey		VSt			

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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. C006P3

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 :** RB
Date Started : 21/06/11 **Date Completed :** 22/06/11 **Logged by :** MLW **Date :** 16/8/13

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**
								CLAY, as previous.		VSt	38.0 m - 179.0 m; Permian		
62													50mm PVC casing, with cement-bentonite grout
64													
66													
68													
					69.00 (164.87)			SILTSTONE, dark grey, trace fine grained sand, trace carbonaceous material.					
70													
72											C Seam		
74	Rotary Wash Boring (bit, 6 inch)	Nil											
76													
78													
80													
82													
84													
86											D1 Seam		
88													
90													

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GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C006P3

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 :** RB
Date Started : 21/06/11	**Date Completed :** 22/06/11	**Logged by :** MLW	**Date :** 16/8/'13

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 94 96 98 100 102 104 106	Rotary Wash Boring (bit, 6 inch)	Nil						SILTSTONE, as previous.			38.0 m - 179.0 m; Permian		
108 110 112 114 116					108.00 (125.87)			COAL with silt, black to dark grey, dull.			D2 Seam D3 Seam		
118 120					117.00 (116.87)			SILTSTONE, pale grey, trace fine grained sand, some carbonaceous material					

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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. C006P3

SHEET 5 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 : RB
Date Started : 21/06/11
Date Completed : 22/06/11
Logged by : MLW
Date : 16/8/13

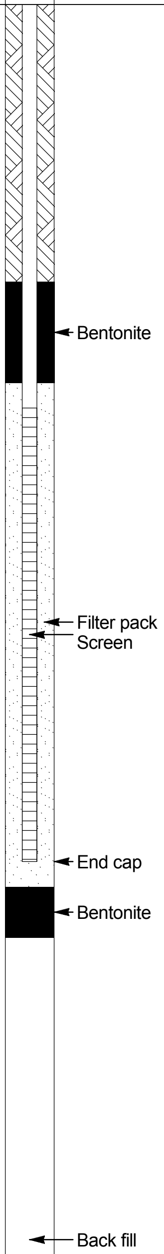
DRILLING

Drilling Method: Rotary Wash Boring (bit, 6 inch)

Hole Support \ Casing: Nil

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

PIEZOMETER



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GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C006P3

SHEET 6 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 : RB
Date Started : 21/06/11
Date Completed : 22/06/11
Logged by : MLW
Date : 16/8/13

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		
					155.00 (78.87)			COAL,dark grey/black, dull					
156 158 160 162 164 166 168 170 172 174 176 178					156.00 (77.87)			SILTSTONE with some COAL, pale grey. Returning as clayey SILT with some coal					Back fill Cave in
180					179.00 (54.87)			End of borehole at 179 m. Piezometer Installed.					

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C006P3r

SHEET 1 OF 4

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

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 : RB
Date Started : 11/07/11
Date Completed : 11/07/11
Logged by : MLW
Date : 16/8/13

DRILLING

Drilling Method: Rotary Wash Boring (bit, 6 inch)

Hole Support \ Casing: Nil

Water: GNO

Samples & Tests:

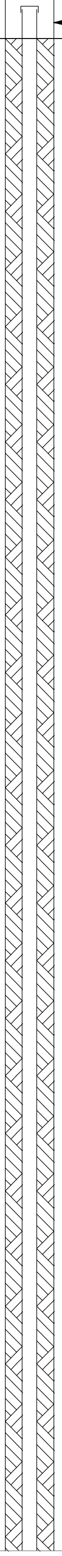
MATERIAL

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
			Silty CLAY, dark brown (TOPSOIL)			0 m - 6.0 m; Alluvium
1.00 (232.87)			CLAY, dark reddish-brown, trace fine grained sand, soft		S	
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
			From 26.0m; grey, very stiff		VSt	

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

PIEZOMETER

Piezometer Log



Components

Completed with steel monument

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 : EPC 1690

HOLE No. C006P3r

SHEET 2 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 :** RB
Date Started : 11/07/11 **Date Completed :** 11/07/11 **Logged by :** MLW **Date :** 16/8/13

Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	USC Symbol	Description	Moisture Condition	Consistency / Density Index	Comments/ Observations	Components
Rotary Wash Boring (bit, 6 inch)	Nil					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				50mm PVC casing, with cement-bentonite grout
				55.00 (178.87)		CLAYSTONE, orange-brown with some patches or dark red, low to medium strength				

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

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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. C006P3r

SHEET 3 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 : RB
Date Started : 11/07/11
Date Completed : 11/07/11
Logged by : MLW
Date : 16/8/13

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**
60–67	Rotary Wash Boring (bit, 6 inch)	Nil						From 60.0m; becoming orange with grey mottling From 63.0m; pale white-grey From 66.0m; pale brown			36.0 m - 118.4 m; Tertiary		
67–72					67.00 (166.87)			CARBONACEOUS MUDSTONE, dark grey and black, returned as carbonaceous clay, firm					
72–83					72.00 (161.87)			COAL AND MUDSTONE, interbedded, dark grey and black, returned as clay (60%) with coal (40%), coal very weak			C Seam		
83–87					83.00 (150.87)			CARBONACEOUS MUDSTONE, dark grey with patches of black, returned as CLAY, very stiff					
87–90					87.00 (146.87)			CARBONACEOUS MUDSTONE AND COAL, interbedded, dark grey and black, returned as clay (70%) and coal (30%)			D1 Seam		
90					90.00								

See standard sheets for details of abbreviations & basis of descriptions

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C006P3r

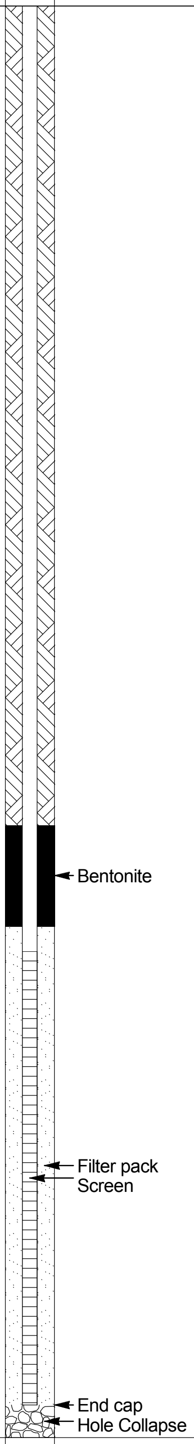
SHEET 4 OF 4

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 : RB
Date Started : 11/07/11
Date Completed : 11/07/11
Logged by : MLW
Date : 16/8/'13

DRILLING | **MATERIAL** | **PIEZOMETER**

Drilling Method	Hole Support \ Casing	Depth / (RL) metres	Description	Comments/ Observations
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	
		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
		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		**HOLE No. C007P2**	
Project : Carmichael Coal Mine Project			
Location : EPC 1690		**SHEET 1 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 :** RB
Date Started : 03/07/11	**Date Completed :** 04/07/11	**Logged by :** MP	**Date :** 16/8/'13

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**
	Air Hammer (bit, 5 1/8 inch)						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
					1.00 (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)		St-VSt			
2													
4													
6								From 6.0 m; trace red/orange mottling, trace dark grey carbonaceous clay.					
								From 7.0 m; no iron nodules.					
8													
10													
12													
14	Rotary Wash Boring (bit, 5 1/8 inch)	Nil											
16													
18													
20								From 20.0 m; decrease in orange mottling, increase in strength with depth (very stiff).		VSt			
22			GNO										
24													
26													
								From 27.0 m; little to no orange mottling, increase in strength with depth (very stiff to hard).		VSt to H			
28													
30													

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GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C007P2

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 :** RB
Date Started : 03/07/11 **Date Completed :** 04/07/11 **Logged by :** MP **Date :** 16/8/13

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 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.		
38 40 42 44 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 Group Inferred from reinterpretation of geology.		
48 50 52 54 56 58 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.					

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

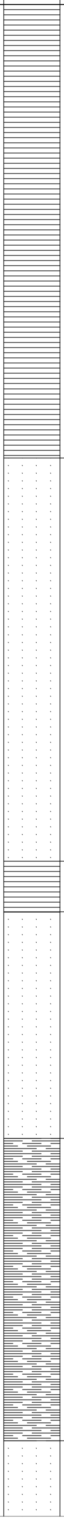
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

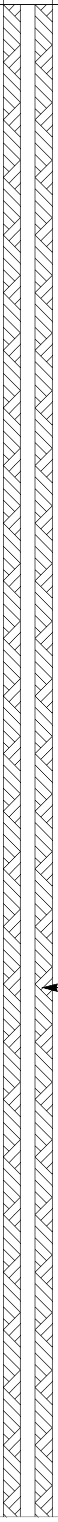
HOLE No. C007P2

SHEET 3 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 :** RB	
Date Started :	03/07/11	**Date Completed :** 04/07/11	**Logged by :** MP	**Date :** 16/8/13	

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





Depth / (RL) metres	Description	Comments/ Observations	Components
	CLAYSTONE, as previous.	36.5 m - 128.5 m; Rewan Group 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
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C007P2

SHEET 4 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 :** RB
Date Started : 03/07/11	**Date Completed :** 04/07/11	**Logged by :** MP	**Date :** 16/8/13

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 94	Rotary Wash Boring (bit, 5 1/8 inch)	Nil						supported. SANDSTONE, as previous.			36.5 m - 128.5 m; Rewan Group Inferred from reinterpretation of geology.		
96 98 100 102 104 106 108 110 112 114 116 118 120					95.00 (143.11)			SILTSTONE and SANDSTONE, interbedded . SANDSTONE (predominantly); grey, fine to medium grained sand, matrix SILTSTONE; grey, trace fine grained sand.					

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GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C007P2

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 : RB
Date Started : 03/07/11
Date Completed : 04/07/11
Logged by : MP
Date : 16/8/'13

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**
122 124 126 128 130 132 134 136 138 140 142 144 146 148 150	Rotary Wash Boring (bit, 5 1/8 inch)	Nil						SILTSTONE and SANDSTONE interbedded, as previous.			36.5 m - 128.5 m; Rewan Group Inferred from reinterpretation of geology. 128.5 m - 179.5 m; Permian. Inferred from reinterpretation of geology.		

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C007P2

SHEET 6 OF 7

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690
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 : RB
Date Started : 03/07/11
Date Completed : 04/07/11
Logged by : MP
Date : 16/8/13

DRILLING

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

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

Hole Support \ Casing: Nil

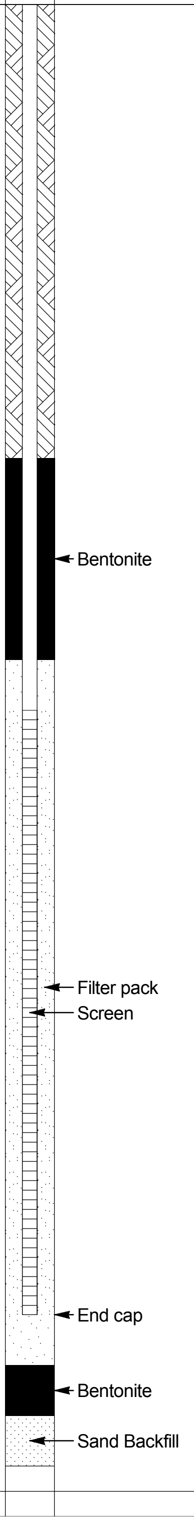
Water:

Samples & Tests:

MATERIAL

Depth / (RL) metres	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Comments/ Observations
	SILTSTONE and SANDSTONE interbedded, as previous.	128.5 m - 179.5 m; Permian. Inferred from reinterpretation of geology.
161.00 (77.11)	COAL, black. From 165 to 167 m; interbedded with SILTSTONE, grey, trace fine grained sand. From 167 to 169m; increase in SILTSTONE material (50% / 50%). From 171 to 173 m; interbedded COAL and SILTSTONE (50% / 50%). From 176 to 177 m; interbedded COAL and SILTSTONE (50% / 50%).	AB1, AB2, AB3 Seams
178.00 (60.11)	SANDSTONE, dark grey, fine grained sand, trace medium grained sand, matrix supported.	
179.50 (58.61)		

PIEZOMETER



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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C007P2

SHEET 7 OF 7

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

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 :**	RB
Date Started :	03/07/11	**Date Completed :**	04/07/11	**Logged by :**	MP	**Date :**	16/8/'13

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**
								End of borehole at 179.5 m. Piezometer installed.					
182													
184													
186													
188													
190													
192													
194													
196													
198													
200													
202													
204													
206													
208													
210													

See standard sheets for details of abbreviations & basis of descriptions

Job No.

41-23244

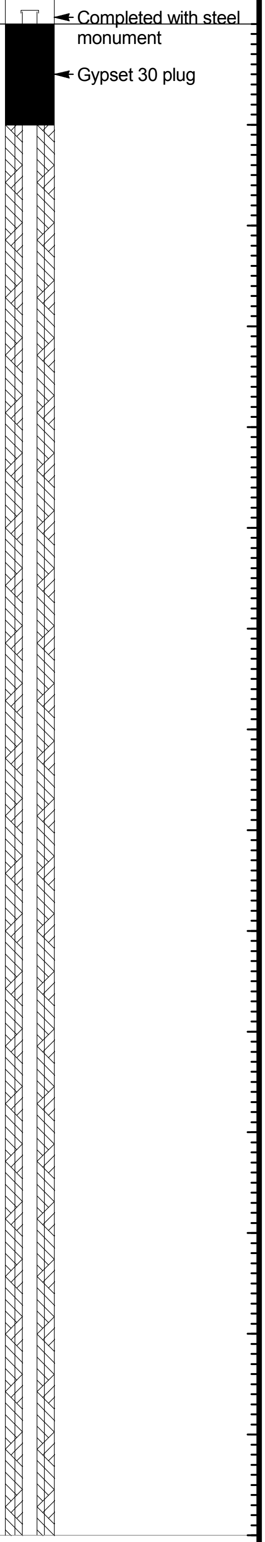
BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C007P3

SHEET 1 OF 9

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690
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 :** RB
Date Started : 29/06/11 **Date Completed :** 30/06/11 **Logged by :** MLW **Date :** 16/8/13

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	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		
2													
					3.00 (235.12)			Silty CLAY, dark red with pale brown mottling, very stiff, dry, high plasticity	D	VSt			
4													
6													
8													
10													
12													
14													
16													
18													
20													
			GNO										
22													
24													
26													
28													
30													



See standard sheets for details of abbreviations & basis of descriptions

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

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Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C007P3

SHEET 2 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 :** RB
Date Started : 29/06/11 **Date Completed :** 30/06/11 **Logged by :** MLW **Date :** 16/8/13

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		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 Group		
				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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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C007P3

SHEET 3 OF 9

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

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 : RB
Date Started : 29/06/11
Date Completed : 30/06/11
Logged by : MLW
Date : 16/8/'13

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 66 68 70 72 74 76 78 80 82	Rotary Wash Boring	PVC casing 150mm						CLAY, as previous From 72.0 m; reddish - brown		St	37.0 m - 129.0 m; Rewan Group		
84 86 88 90					83.00 (155.12)			MUDSTONE, dark greenish-grey, returned as CLAY, high plasticity					
					90.00								

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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. C007P3

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 : RB
Date Started : 29/06/11
Date Completed : 30/06/11
Logged by : MLW
Date : 16/8/13

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 94 96	Rotary Wash Boring	PVC casing 150mm			(148.12)			SANDSTONE, pale greenish-grey, fine grained			37.0 m - 129.0 m; Rewan Group		
98 100 102 104 106 108		Nil			97.00 (141.12)			MUDSTONE, dark grey. Returned as CLAY, high plasticity					
110 112 114 116					110.00 (128.12)			SANDSTONE, pale brownish-grey, fine grained					
118 120					117.00 (121.12)			MUDSTONE, dark grey. Returned as CLAY, high plasticity, slightly weathered					

See standard sheets for details of abbreviations & basis of descriptions

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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. C007P3

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 :** RB
Date Started : 29/06/11		**Date Completed :** 30/06/11		**Logged by :** MLW	**Date :** 16/8/13

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**
122–128	Rotary Wash Boring	Nil						MUDSTONE, as previous			37.0 m - 129.0 m; Rewan Group		50mm PVC casing, with cement-bentonite grout
130–150					129.00 (109.12)			SANDSTONE, pale grey, fine grained. Very high strength			129.0 m - 259.2 m; Permian		

See standard sheets for details of abbreviations & basis of descriptions

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GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C007P3

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 :** RB
Date Started : 29/06/11	**Date Completed :** 30/06/11	**Logged by :** MLW	**Date :** 16/8/13

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**
150–161	Rotary Wash Boring	Nil						SANDSTONE, as previous			129.0 m - 259.2 m; Permian		
161–178					161.00 (77.12)			COAL, dark grey to black, dull			AB 1 Seam		
178–180					178.00 (60.12)			SANDSTONE and Carbonaceous MUDSTONE, interbedded, pale grey with patches of dark grey					

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
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C007P3

SHEET 7 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 :** RB
Date Started : 29/06/11 **Date Completed :** 30/06/11 **Logged by :** MLW **Date :** 16/8/'13

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**
								SANDSTONE and Carbonaceous MUDSTONE, interbedded, as previous			129.0 m - 259.2 m; Permian		
182													
184													
186													
188													
190													
192													
194	Rotary Wash Boring	Nil											
196					196.00 (42.12)			COAL, black to dark grey, dull			C Seam		
198													
200					200.00 (38.12)			CARBONACEOUS MUDSTONE, dark grey					
202													
204													
206													
208													
210													

See standard sheets for details of abbreviations & basis of descriptions

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

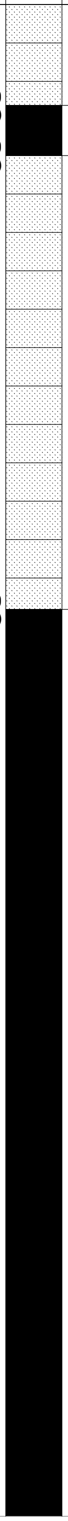
HOLE No. C007P3

SHEET 8 OF 9

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690
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 :** RB
Date Started : 29/06/11 **Date Completed :** 30/06/11 **Logged by :** MLW **Date :** 16/8/13

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
	Rotary Wash Boring	Nil						CARBONACEOUS MUDSTONE, as previous			129.0 m - 259.2 m; Permian		
212					212.00 (26.12)			COAL, black, dull					
213					213.00 (25.12)			CARBONACEOUS MUDSTONE, dark grey					
222					222.00 (16.12)			COAL, dark grey to black, dull					
236											D1 Seam		

Scale: 212, 214, 216, 218, 220, 222, 224, 226, 228, 230, 232, 234, 236, 238, 240



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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

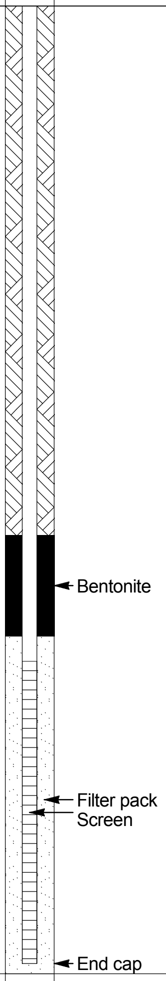
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C007P3

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 : RB
Date Started : 29/06/11
Date Completed : 30/06/11
Logged by : MLW
Date : 16/8/13

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**	Components
242	Rotary Wash Boring	Nil				■		COAL, as previous.			129.0 m - 259.2 m; Permian	
244 246 248 250					242.00 (-3.88)	▨		CARBONACEOUS MUDSTONE, dark grey				
252 254 256 258					252.00 (-13.88)	■		COAL, black, dull			D2 Seam	Bentonite Filter pack Screen End cap
260 262 264 266 268 270					259.20 (-21.08)							



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GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

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 : RB
Date Started : 14/07/11
Date Completed : 15/07/11
Logged by : MLW
Date : 16/8/13

DRILLING				MATERIAL							PIEZOMETER
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		Components
Air Hammer (bit, 6 inch)	Nil			0.00	MI	Clayey SILT, dark orange, dry, trace organic material	D		0.0 m - 29.0 m; Tertiary		Completed with steel monument
				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)					
		GNO									50mm PVC casing, with cement-bentonite grout
									29.0 m - 56.0 m; Rewan Group		

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

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GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

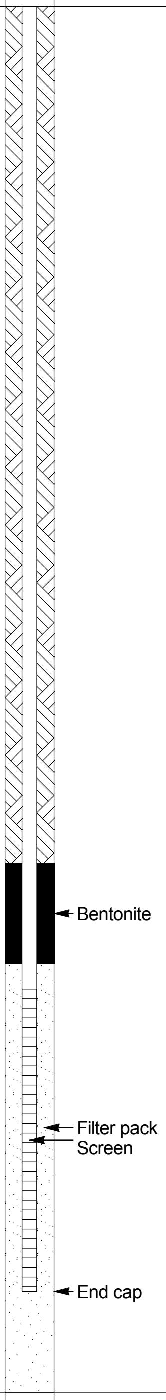
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C008P1

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 :** RB
Date Started : 14/07/11	**Date Completed :** 15/07/11	**Logged by :** MLW	**Date :** 16/8/13

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 34 36 38 40 42 44 46	Air Hammer (bit, 6 inch)	Nil				▨		CLAY, as previous.			Inferred from reinterpretation of geology.	
48 50 52 54 56					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 : EPC 1690

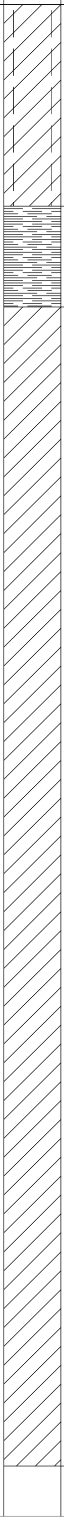
HOLE No. C008P2

SHEET 1 OF 10

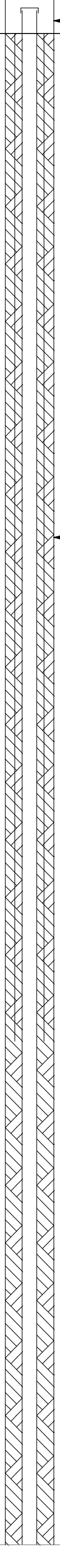
Position : 433711.0 E 7558827.0 N **Surface RL:** 238.1m **Angle from Horiz. :** 90° **Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck **Contractor :** Watson Drilling **Driller :** Snickers/ Dave **Checked :** RB
Date Started : 15/07/11 **Date Completed :** 17/07/11 **Logged by :** MLW **Date :** 16/8/13

DRILLING				MATERIAL							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	Comments/ Observations	Components
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
				4.00 (234.12)			SILTSTONE, dark grey, some orange staining, returned as Clayey GRAVEL				
				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
		GNO									
				29.00 (209.12)		CH	CLAY, dark greenish-grey, stiff to very stiff, high plasticity		ST - VSt	29.0 m- 212.0 m; Rewan Group	

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



Piezometer Log



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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. C008P2

SHEET 2 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 : RB
Date Started : 15/07/11
Date Completed : 17/07/11
Logged by : MLW
Date : 16/8/13

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 34 36 38 40 42 44	Rotary Wash Boring (bit, 6 inch)	PVC casing 150mm						From 34.0m; pale grey From 36.0m; dark purple-grey From 39.0 - 40.0m; Colour change to pale grey		ST - VSt			
46 48 50					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 54 56 58 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					

See standard sheets for details of abbreviations & basis of descriptions

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C008P2

SHEET 3 OF 10

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690
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 :** RB
Date Started : 15/07/11 **Date Completed :** 17/07/11 **Logged by :** MLW **Date :** 16/8/13

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 Group		
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													

See standard sheets for details of abbreviations & basis of descriptions

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. C008P2

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 :** RB
Date Started : 15/07/11 **Date Completed :** 17/07/11 **Logged by :** MLW **Date :** 16/8/13

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
92 94 96 98 100 102 104 106 108 110 112 114 116 118 120	Rotary Wash Boring (bit, 6 inch)							SILTSTONE, as previous			29.0 m- 212.0 m; Rewan Group		

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C008P2

SHEET 5 OF 10

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690
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 :** RB
Date Started : 15/07/11 **Date Completed :** 17/07/11 **Logged by :** MLW **Date :** 16/8/13

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
122	Rotary Wash Boring (bit, 6 inch)							SILTSTONE, as previous			29.0 m- 212.0 m; Rewan Group		
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													

See standard sheets for details of abbreviations & basis of descriptions

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C008P2

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 :** RB
Date Started : 15/07/11 **Date Completed :** 17/07/11 **Logged by :** MLW **Date :** 16/8/'13

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**
152 154 156 158 160 162 164 166 168 170 172 174 176	Rotary Wash Boring (bit, 6 inch)							SILTSTONE, as previous			29.0 m- 212.0 m; Rewan Group		
178 180					178.00 (60.12)			SILTSTONE and SANDSTONE interbedded, blue-grey, very fine- to fine-grained sandstone, low					

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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. C008P2

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 :** RB
Date Started : 15/07/11 **Date Completed :** 17/07/11 **Logged by :** MLW **Date :** 16/8/'13

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**
182 184 186 188 190 192 194 196 198 200	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 Group		
202								From 201.0 - 202.0m; purple-grey					
204 206 208								From 203.0 to 205.0m; pale grey, increased sandstone content (50% siltstone, 50% sandstone).					
210					210.00								

See standard sheets for details of abbreviations & basis of descriptions

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C008P2

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 :** RB
Date Started : 15/07/11 **Date Completed :** 17/07/11 **Logged by :** MLW **Date :** 16/8/13

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)				(28.12)			SANDSTONE, pale blue-grey, very fine to fine grained, low strength, returned as Silty SAND.					
212 214 216 218 220 222 224 226					212.00 (26.12)			SILTSTONE, pale grey, lenses of sandstone, very fine to fine grained, low strength.			212.0 m - 271.5m; Permian		
					227.00 (11.12)			SANDSTONE, pale grey, very fine to fine grained, matrix supported, low strength.					
228 230 232 234					228.00 (10.12)			SILTSTONE, pale grey, lenses of sandstone, very fine to fine grained, low strength.					
					234.50 (3.62)			SANDSTONE, pale grey, very fine to fine grained, matrix supported, low strength.					
236 238 240					235.50 (2.62)			SILTSTONE, pale grey, lenses of sandstone, very fine- to fine-grained, low strength					

See standard sheets for details of abbreviations & basis of descriptions

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

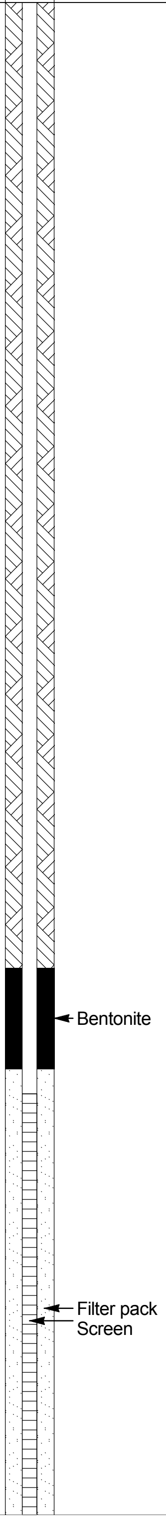
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C008P2

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 : RB
Date Started : 15/07/11
Date Completed : 17/07/11
Logged by : MLW
Date : 16/8/13

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**
242 244	Rotary Wash Boring (bit, 6 inch)							SILTSTONE, as previous			212.0 m - 271.5m; Permian		
246 248 250 252					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%)					
254 256 258 260 262 264 266 268 270					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
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C008P2

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 : RB
Date Started : 15/07/11
Date Completed : 17/07/11
Logged by : MLW
Date : 16/8/13

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
					271.50 (-33.38)	■		COAL, as previous.					End cap Backfill
272								End of borehole at 271.5 m. Piezometer installed.					
274													
276													
278													
280													
282													
284													
286													
288													
290													
292													
294													
296													
298													
300													

See standard sheets for details of abbreviations & basis of descriptions

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C011P1

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 :** RB
Date Started : 21/07/11	**Date Completed :** 22/07/11	**Logged by :** RB	**Date :** 16/8/'13

DRILLING

SCALE (m): 0 – 30

Drilling Method: Air Hammer (bit,6 1/2 inch)

Hole Support \ Casing: Nil

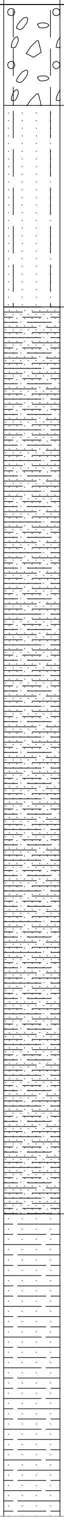
Water: GNO

Samples & Tests:

MATERIAL

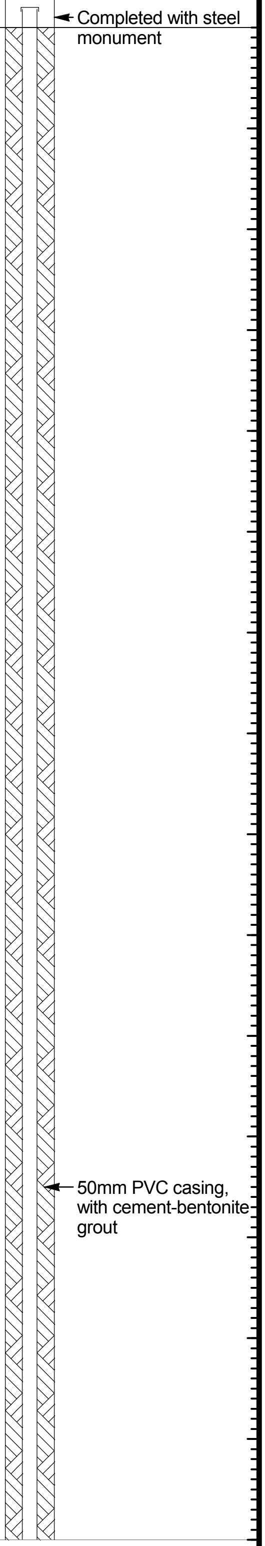
Depth / (RL) metres	USC Symbol	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations
	GP-GM	Silty GRAVEL, orange-brown, trace pale brown clay, fine gravel, orange-brown, fine grained sandstone, some fine to medium grained quartz sand.			0.0 m - 2.0 m; Alluvium
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
6.00 (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.			
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

Graphic Log



PIEZOMETER

Piezometer Log / Components



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Job No.
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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. C011P1

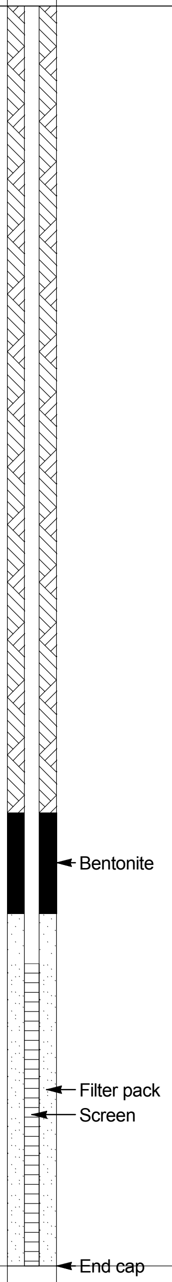
SHEET 2 OF 2

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 :** RB
Date Started : 21/07/11 **Date Completed :** 22/07/11 **Logged by :** RB **Date :** 16/8/13

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
Air Hammer (bit,6 1/2 inch)	Nil					SANDSTONE and SILTSTONE interbedded, as previous.			
				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.			
				38.50 (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.			
				55.00 (199.46)		End of borehole at 55.0 m. Piezometer installed.			

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

PIEZOMETER



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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

GEO BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD GEO TEMPLATE.GDT 02/08/13

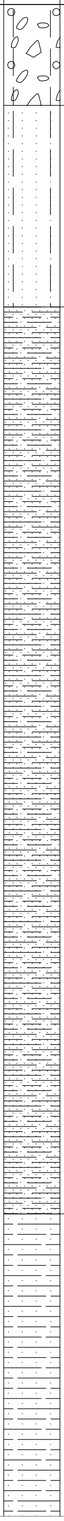
HOLE No. C011P3

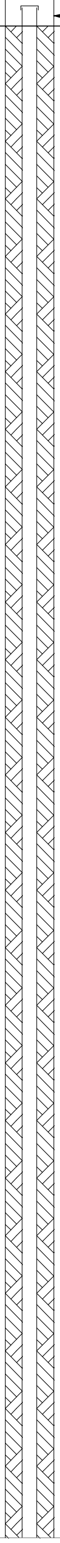
SHEET 1 OF 4

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

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 :**	RB
Date Started :	22/07/11	**Date Completed :**	22/07/11	**Logged by :**	RB	**Date :**	16/8/13

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	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.					
17								From 17.0 to 20.0 m; trace iron staining.					
20								From 20.0 to 24.0 m; green-grey.					
24					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		
28			GNO										
30													





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GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C011P3

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 : RB
Date Started : 22/07/11
Date Completed : 22/07/11
Logged by : RB
Date : 16/8/'13

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
	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
53					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.					

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

HOLE No. C011P3

SHEET 3 OF 4

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690
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 : RB
Date Started : 22/07/11
Date Completed : 22/07/11
Logged by : RB
Date : 16/8/13

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		Piezometer Log	Components
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

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GEO BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD GEO TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

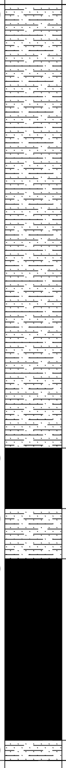
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

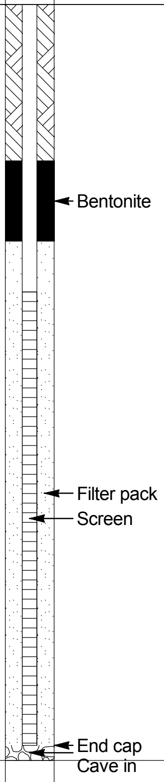
HOLE No. C011P3

SHEET 4 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 :** RB
Date Started : 22/07/11	**Date Completed :** 22/07/11	**Logged by :** RB	**Date :** 16/8/'13

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**
92	Rotary Wash Boring (bit, 6 inch)	Nil			(164.40)			material Carbonaceous SILTSTONE, dark grey, fine grained, some soft clay From 95.0m; grey			24.0 m - 104.5m; Permian		Bentonite
94													
96													
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 Cave in
106					105.00 (149.40)			End of borehole at 105 m. Piezometer installed.					
108													
110													
112													
114													
116													
118													
120													





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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. C012P1

SHEET 1 OF 2

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 : RB
Date Started : 24/07/11
Date Completed : 24/07/11
Logged by : RB
Date : 16/8/13

DRILLING — SCALE (m): 0–30; Drilling Method: Air Hammer (bit, 6 inch); Hole Support \ Casing: Nil; Water: GNO (at approx. 26 m); 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	SP-SM	Silty Gravelly SAND, orange-red, medium to coarse grained sub-rounded to sub-angular sand, fine sub-rounded to sub-angular gravel.			0.0 m - 32.0 m; Tertiary
1.00 (246.33)	GP-GC	Clayey GRAVEL, orange-brown, fine- to medium-sized sub-rounded gravel, orange-red staining. (LATERITE)			
4.00 (243.33)		SANDSTONE, pink/orange/white, medium grained sand, predominately quartz, trace silt and clay, highly weathered.			
6.50 (240.83)		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 (236.33)		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 (230.53)		SILTSTONE, fine grained, brittle, white/pink leached.			
23.00 (224.33)		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 (221.33)		SANDSTONE and SILTSTONE, Interbedded. SANDSTONE; brown-orange-pink, fine grained sand, some silt, trace clay, highly weathered.	VM-W		

PIEZOMETER — Components:

- Completed with steel monument
- 50mm PVC casing, with cement-bentonite grout

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

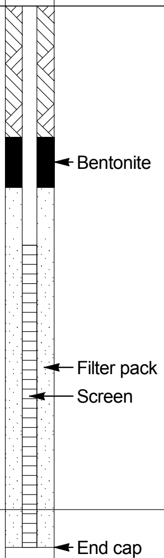
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C012P1

SHEET 2 OF 2

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 :** RB
Date Started : 24/07/11 **Date Completed :** 24/07/11 **Logged by :** RB **Date :** 16/8/'13

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	Air Hammer (bit, 6 inch)	Nil			32.00 (215.33)			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				
34					35.00 (212.33)			SILTSTONE, orange, fine grained, slightly sandy.			32.0 m - 40.0 m; Permian		Bentonite
36 38 40					40.00 (207.33)			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
42 44 46 48 50 52 54 56 58 60								End of borehole at 40 m. Piezometer installed.					End cap



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Job No.
41-23244

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C012P2

SHEET 1 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 :** RB
Date Started : 23/07/11 **Date Completed :** 24/07/11 **Logged by :** RB **Date :** 16/8/'13

DRILLING				MATERIAL								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	Comments/ Observations	Piezometer Log	Components	
Rotary Wash Boring (PCD, 6 inch bit)	Nil						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		Completed with steel monument	
				3.50 (243.75)			SANDSTONE, white, brown-orange and pink, medium grained sand.						
				5.00 (242.25)			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 (236.25)			QUARTZITE, returning as orange-brown, medium to coarse grained sub-angular quartz, trace silt, iron stained.						
		GNO		12.50 (234.75)			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.					50mm PVC casing, with cement-bentonite grout	
				29.00 (218.25)			MUDSTONE (?), pink, leached, silicified, very fine						

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GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

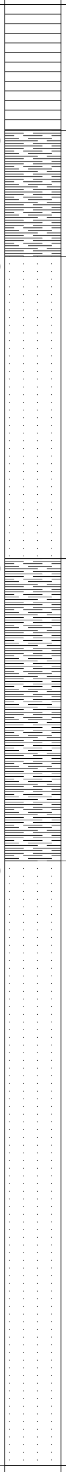
BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

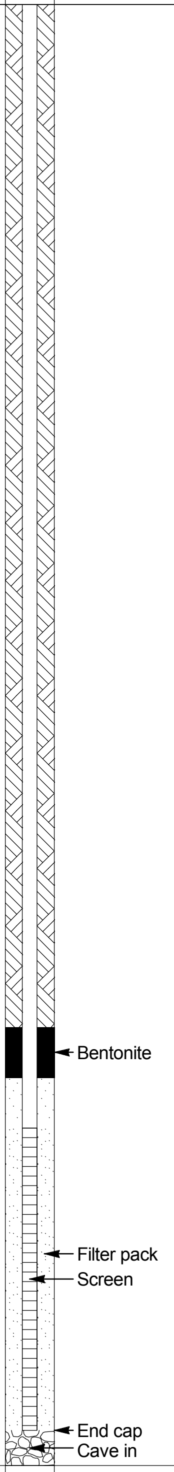
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C012P2

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 : RB
Date Started : 23/07/11
Date Completed : 24/07/11
Logged by : RB
Date : 16/8/13





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	Rotary Wash Boring (PCD, 6 inch bit)	Nil						grained. MUDSTONE, as previous					
34					32.50 (214.75)			SILTSTONE, orange-brown, fine grained, highly weathered, trace silt, slight foliation.			32.5 m - 59.0 m; Permian		
36 38 40					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.					
42 44 46					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.					
48 50 52 54 56 58					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
60					59.00 (188.25)			End of borehole at 59.0 m. Piezometer installed.					

See standard sheets for details of abbreviations & basis of descriptions

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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. C014P2

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 : RB
Date Started : 25/07/11
Date Completed : 26/07/11
Logged by : RB
Date : 16/8/13

Drilling Method: Air Hammer
Hole Support \ Casing: PVC casing 150mm

Depth / (RL) metres	Description	Comments/ Observations
0.00 – 1.00 (254.99)	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
1.00 (254.99) – 13.00 (242.99)	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.	
13.00 (242.99) – 18.00 (237.99)	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.	
18.00 (237.99) – 22.00 (233.99)	SILTSTONE, pink-brown, returning as clay chips, brittle, fine grained texture. From 20.0 to 22.0 m; pale yellow, trace orange (iron staining).	
22.00 (233.99) – 25.00 (230.99)	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.	
25.00 (230.99) – 27.00 (228.99)	CLAY, pale pink-brown, high plasticity, returns as powder. (MUDSTONE)	
27.00 (228.99) – 29.00 (226.99)	Sandy CLAY, pale pink-brown, fine grained (black, orange and pale grey grains), returns as powder	
29.00 (226.99) –	SILTSTONE, yellow-orange, returning as clay chips, brittle,	29.0 m - 178.1 m; Rewan Group

PIEZOMETER – Components: Completed with steel monument

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Job No. 41-23244

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C014P2

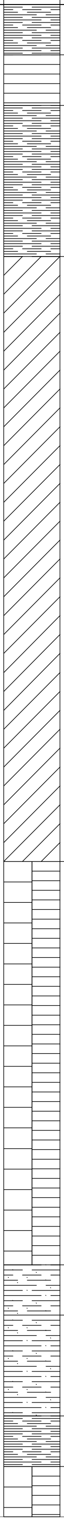
SHEET 2 OF 7

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 :** RB
Date Started : 25/07/11	**Date Completed :** 26/07/11	**Logged by :** RB	**Date :** 16/8/13

DRILLING — Drilling Method: Air Hammer; Hole Support \ Casing: PVC casing 150mm; Water: GNO; Samples & Tests

MATERIAL

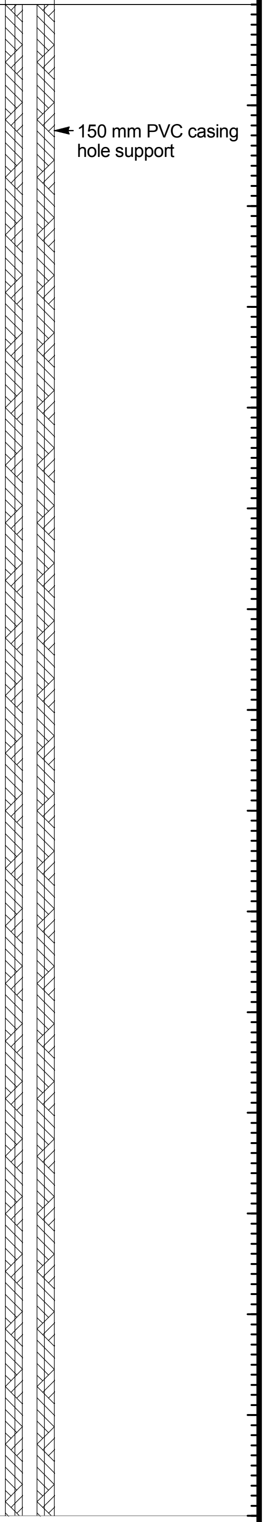
Depth / (RL) metres	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)
31.00 (224.99)	high plasticity, slightly grainy texture, extremely weathered. SILTSTONE, as previous
32.00 (223.99)	MUDSTONE, pale green-brown, returning as clay chips, high plasticity, smooth, extremely weathered.
35.00 (220.99)	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.
47.00 (208.99)	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
55.00 (200.99)	MUDSTONE/CLAYSTONE, blue-grey, leached, high plasticity, smooth, returns as powder. From 52.0 to 53.0 m; SILTSTONE, grey, leached, slightly grainy.
56.00 (199.99)	Sandy SILTSTONE, brown-pink and pink-brown, high plasticity, returns as powder, fine grained sand, extremely weathered.
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	



Comments/ Observations

29.0 m - 178.1 m; Rewan Group

PIEZOMETER



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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. C014P2

SHEET 3 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 : RB
Date Started : 25/07/11
Date Completed : 26/07/11
Logged by : RB
Date : 16/8/13

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**
	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 Group		
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											
68								From 67.0 to 68.0 m; grey-pink.					
70													
72													
74													
76													
					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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GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

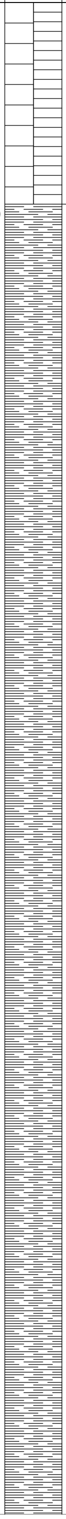
BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C014P2

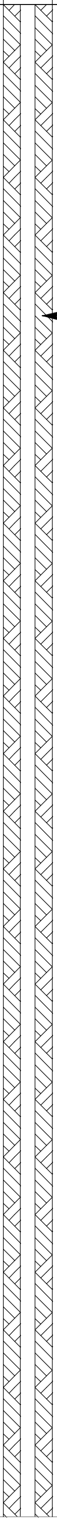
SHEET 4 OF 7

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690
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 :** RB
Date Started : 25/07/11 **Date Completed :** 26/07/11 **Logged by :** RB **Date :** 16/8/13

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	Components
92	Air Hammer	Nil				MUDSTONE/CLAYSTONE, as previous			29.0 m - 178.1 m; Rewan Group	
94					94.00 (161.99)	SILTSTONE, grey-blue, leached, high plasticity, trace fine grained black carbonaceous material, returns as powder				50mm PVC casing, with cement-bentonite grout
96										
98										
100										
102										
104										
106										
108						From 107.0 to 122.0 m; brown-grey.				
110										
112										
114										
116										
118										
120										

Graphic Log


USC Symbol

Piezometer Log


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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. C014P2

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 :** RB
Date Started : 25/07/11		**Date Completed :** 26/07/11		**Logged by :** RB	**Date :** 16/8/13

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**
								SILTSTONE, as previous			29.0 m - 178.1 m; Rewan Group		
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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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C014P2

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 :** RB
Date Started : 25/07/11 | **Date Completed :** 26/07/11 | **Logged by :** RB | **Date :** 16/8/13

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**
								SILTSTONE, as previous From 151.0 to 155.0 m; pale grey			29.0 m - 178.1 m; Rewan Group		
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													

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 : EPC 1690

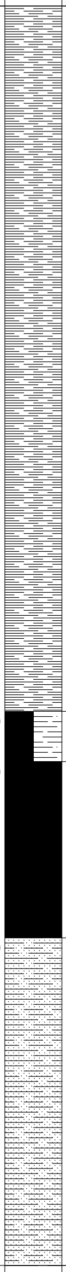
HOLE No. C014P2

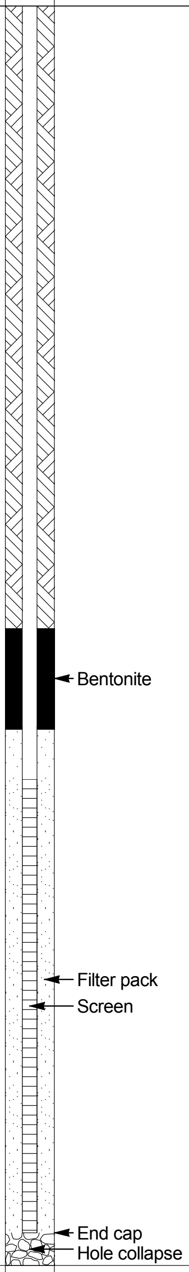
SHEET 7 OF 7

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 :** RB
Date Started : 25/07/11 **Date Completed :** 26/07/11 **Logged by :** RB **Date :** 16/8/13

DRILLING		MATERIAL		COMMENTS	PIEZOMETER
Drilling Method	Hole Support \ Casing	Depth / (RL) metres	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Comments/ Observations	Components
Air Hammer	Nil		SILTSTONE, as previous	178.1 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.		
		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.	AB Seam	
		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





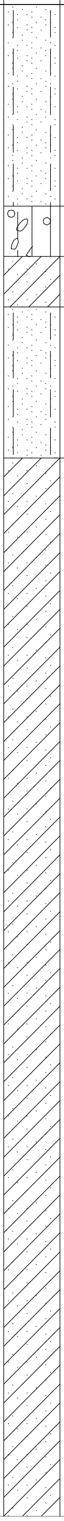
BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

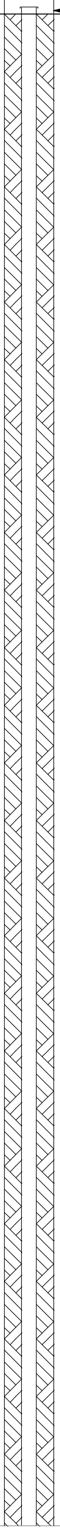
HOLE No. C016P2

SHEET 1 OF 8

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690
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 : RB
Date Started : 29/07/11
Date Completed : 30/07/11
Logged by : RB
Date : 16/8/13

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	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					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					5.00 (289.45)			Sandy CLAY, pale grey, some orange spots, medium plasticity, fine grained sand.					
6					6.00 (288.45)			Silty SAND, orange-brown, medium to coarse grained sand (quartz and orange fine-grained highly weathered rock).					
9					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.			9.0 m - 68.0 m; Tertiary		
24								From 24.0 m; high plasticity					
30													





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Job No.
41-23244

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C016P2

SHEET 2 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 :** RB
Date Started : 29/07/11		**Date Completed :** 30/07/11		**Logged by :** RB	**Date :** 16/8/13

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 34 36 38 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.			9.0 m - 68.0 m; Tertiary		
42 44					41.00 (253.45)			Sandy CLAY, dark orange-brown, medium plasticity, with silt, fine to medium grained sand, predominately quartz.					
46 48 50 52					46.00 (248.45)			Sandy CLAY, white, some yellow-orange mottling, high plasticity, fine to medium grained sand, predominately quartz, trace carbonaceous material.					
54 56 58 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.
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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. C016P2

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 : RB
Date Started : 29/07/11
Date Completed : 30/07/11
Logged by : RB
Date : 16/8/13

DRILLING				MATERIAL							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	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.					
				68.00 (226.45)			CLAY, brown-orange with trace pink-brown mottling, high plasticity, smooth. From 71.0 m; green-brown From 77.0 to 79.0 m; brown, trace fine grained sand, fine grained carbonaceous material From 79.0 to 85.5 m; green-brown, grey mottling From 83.0 to 85.5 m; with trace fine sand.			68.0 m - 91.0 m; Rewan Group		
				86.00 (208.45)			Sandy CLAY, brown-pink, high plasticity, fine grained sand, dark grey pockets of carbonaceous rich sandy clay.					
				89.50 (204.95)			CLAY, green-brown, high					

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

See standard sheets for details of abbreviations & basis of descriptions

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C016P2

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 : RB
Date Started : 29/07/11
Date Completed : 30/07/11
Logged by : RB
Date : 16/8/13

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**
								plasticity, smooth.					
	Rotary Wash Boring (Step, 6 inch bit)	Nil			90.50 (203.95)			CLAY, blue-grey,(MUDSTONE/CLAYSTONE, leached ?).			90.5 m - 233.0 m; Permian		
92													
94													
96													
98													
								From 99.0 m; trace silt, trace fine grained sand sized black carbonaceous material. (SILTSTONE ?)					
100													
102													
104													
106													
108													50mm PVC casing, with cement-bentonite grout
110													
112													
114													
116													
118													
120													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C016P2

SHEET 5 OF 8

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

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 :**	RB
Date Started :	29/07/11	**Date Completed :**	30/07/11	**Logged by :**	RB	**Date :**	16/8/13

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**
122 124 126 128 130 132 134	Rotary Wash Boring (Step, 6 inch bit)	Nil				▨		CLAY, as previous			90.5 m - 233.0 m; Permian	▨	
136 138 140 142 144 146 148 150					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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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C016P2

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 : RB
Date Started : 29/07/11
Date Completed : 30/07/11
Logged by : RB
Date : 16/8/13

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 (Step, 6 inch bit)	Nil						SANDSTONE with interbeds of SILTSTONE, as previous			90.5 m - 233.0 m; Permian		
152													
154													
156													
158													
160													
162													
164													
166													
168													
170													
172													
174													
176													
178					178.00 (116.45)			Interbedded SILTSTONE and SANDSTONE Siltstone, blue-grey and dark grey, fine grained.					
180													

See standard sheets for details of abbreviations & basis of descriptions

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C016P2

SHEET 7 OF 8

Client :	Adani Mining Pty Ltd				
Project :	Carmichael Coal Mine Project				
Location :	EPC 1690				
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 :** RB	
Date Started :	29/07/11	**Date Completed :** 30/07/11	**Logged by :** RB	**Date :** 16/8/13	

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.					
196								From 195.0 m; interbedded with SANDSTONE, pale grey, fine grained quartz, fine sand sized/silt black carbonaceous material.					
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
Project : Carmichael Coal Mine Project
Location : EPC 1690

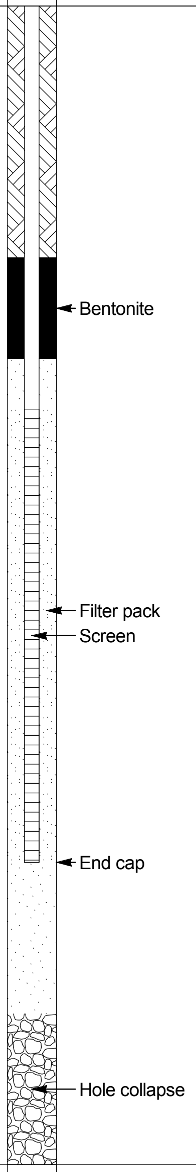
HOLE No. C016P2

SHEET 8 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 :** RB
Date Started : 29/07/11		**Date Completed :** 30/07/11	**Logged by :** RB		**Date :** 16/8/13

DRILLING				MATERIAL							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	Comments/ Observations	Components
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
				218.00 (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
				224.00 (70.45)			Carbonaceous SILTSTONE, dark grey, fine-grained, trace calcite, with interbeds of coal, returns include high plasticity clay.				
				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
				233.00 (61.45)			End of borehole at 233.0 m. Piezometer installed.				

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



See standard sheets for details of abbreviations & basis of descriptions

Job No. 41-23244

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

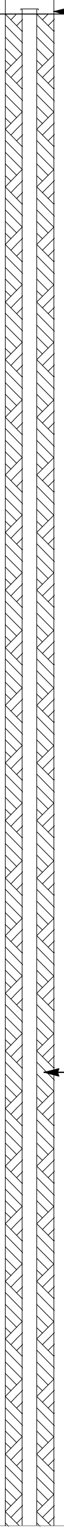
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C018P1

SHEET 1 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 : RB
Date Started : 01/08/11
Date Completed : 01/08/11
Logged by : RB
Date : 16/8/13

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		Components
	Air Hammer	Nil						Silty SAND, orange-brown, fine grained quartz sand, slightly moist. (TOPSOIL)	SM		0.0 m - 42.0 m; Tertiary	Completed with steel monument
2					1.00 (280.27)			SILTSTONE, orange-brown, fine grained, trace fine grained sand, trace silt, slight foliation, returns as high plasticity clays, extremely weathered.				
4					4.00 (277.27)			SANDSTONE, orange, fine grained, sub-rounded to rounded quartz sand, silt, trace clay, highly to extremely weathered.				
6												
8								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).				
10												
12								From 11.0 m; pale brown-orange, fine to medium grained sand.				
14												
16												
18												
20												
22								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
24												
26												
28												
30												



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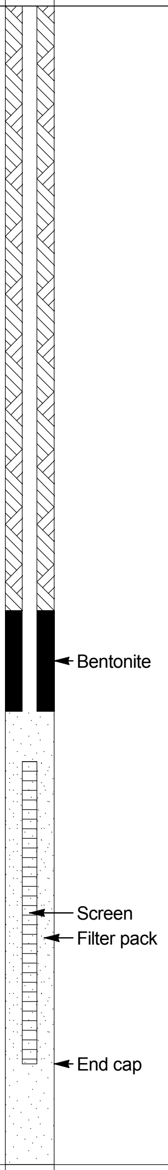
BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C018P1

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 :** RB
Date Started : 01/08/11 **Date Completed :** 01/08/11 **Logged by :** RB **Date :** 16/8/13

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 34 36 38 40	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 44 46 48 50 52					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
54 56 58 60					53.00 (228.27)			End of borehole at 53 m. Piezometer installed.					

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C018P2

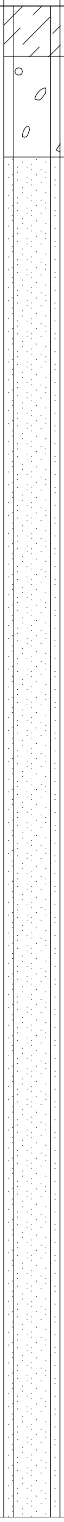
SHEET 1 OF 4

Client :	Adani Mining Pty Ltd				
Project :	Carmichael Coal Mine Project				
Location :	EPC 1690				
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 :**	RB
Date Started :	4/8/11	**Date Completed :** 5/8/11	**Logged by :** MP	**Date :**	16/8/13

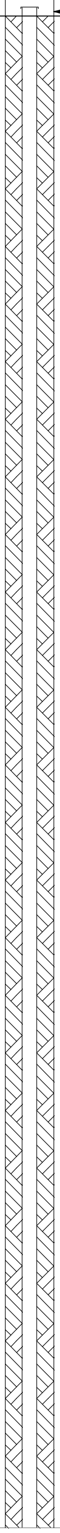
DRILLING | **MATERIAL** | **PIEZOMETER**

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	Components
0–1.00	Rotary Wash Boring (PCD, 6 inch bit)	Nil			1.00 (280.30)		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
1.00–3.00					3.00 (278.30)		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.				
3.00–30							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.				
16							From 16.0 m; grey with brown-red staining, red mottling, trace yellow/orange/dark brown mottling.				
23–24							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.				

Graphic Log



Piezometer Log



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 : EPC 1690

HOLE No. C018P2

SHEET 2 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 :** RB
Date Started : 4/8/11	**Date Completed :** 5/8/11	**Logged by :** MP	**Date :** 16/8/13

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 34 36 38	Rotary Wash Boring (PCD, 6 inch bit)	Nil	SWL					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 42 44 46 48 50 52 54 56 58 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; Permian		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 : EPC 1690

HOLE No. C018P2

SHEET 3 OF 4

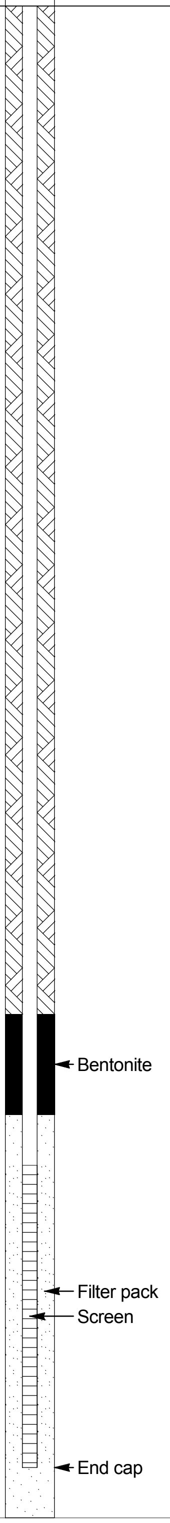
Position : 423991.0 E 7574848.0 N	**Surface RL:** 281.3m	**Angle from Horiz. :** 90°	**Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Shawn	**Checked :** RB
Date Started : 4/8/11	**Date Completed :** 5/8/11	**Logged by :** MP	**Date :** 16/8/13

DRILLING: Drilling Method: Rotary Wash Boring (PCD, 6 inch bit); Hole Support \ Casing: Nil

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

Depth / (RL) metres	Description	Comments/ Observations
	stained brown-orange with yellow/orange/red mottling.	40.0 m - 90.0 m; Permian
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
89.00 (192.30)	SILTSTONE, dark grey, returning as CLAY (ribbons),	
90.00		

PIEZOMETER



See standard sheets for details of abbreviations & basis of descriptions

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C018P2

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 :** RB
Date Started : 4/8/11 **Date Completed :** 5/8/11 **Logged by :** MP **Date :** 16/8/13

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**
					(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													

See standard sheets for details of abbreviations & basis of descriptions

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C018P3

SHEET 1 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 :** RB
Date Started : 02/08/11		**Date Completed :** 03/08/11		**Logged by :** MP	**Date :** 16/8/13

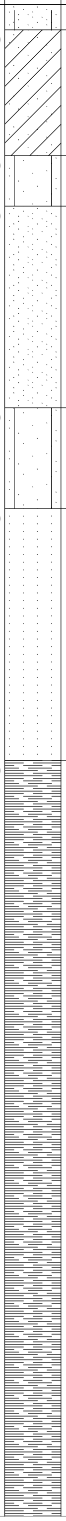
DRILLING — Drilling Method: Rotary Wash Boring (Bit, 6 inch); Hole Support \ Casing: Nil; Water; Samples & Tests

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

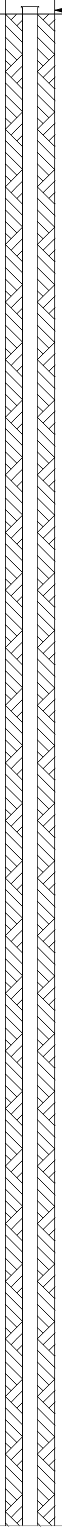
MATERIAL

Depth / (RL) metres	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	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. Interbedded with SAND, brown, medium to coarse grained sand, trace fine grained sand, trace fine sub-angular to angular gravel.	
15.00 (266.21)	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.	

Graphic Log / USC Symbol / Moisture Condition / Consistency / Density Index



PIEZOMETER — Piezometer Log / Components


Completed with steel monument

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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. C018P3

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 :** RB
Date Started : 02/08/11 **Date Completed :** 03/08/11 **Logged by :** MP **Date :** 16/8/'13

DRILLING
Drilling Method: Rotary Wash Boring (Bit, 6 inch)
Hole Support \ Casing: Nil
Water: GNO (at approx. 39 m)

Depth / (RL) metres	Description (MATERIAL)	Comments/ Observations
	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
41.00 (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
47.00 (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.	
51.00 (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	

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

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

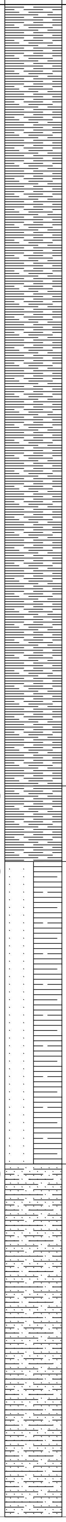
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

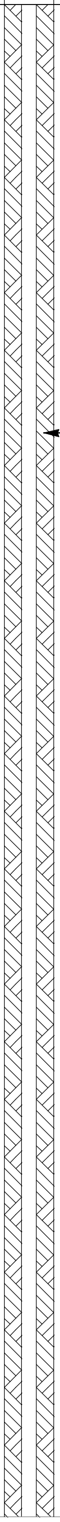
HOLE No. C018P3

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 :** RB
Date Started : 02/08/11 **Date Completed :** 03/08/11 **Logged by :** MP **Date :** 16/8/13

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	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.				
					90.00					





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GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C018P3

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 :** RB
Date Started : 02/08/11		**Date Completed :** 03/08/11		**Logged by :** MP	**Date :** 16/8/13

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 94 96	Rotary Wash Boring (Bit, 6 inch)	Nil			(191.21)			SILTSTONE, dark grey, trace orange mottling, trace fine grained sand.			41.0 m -161.0 m; Permian		
98 100 102					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		
104 106					103.00 (178.21)			SILTSTONE, dark grey, very fine to fine grained sand.					
108 110 112					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.					
114 116 118					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		
120					118.50 (162.71)			Interbedded SILTSTONE and COAL SILTSTONE, pale grey,					

See standard sheets for details of abbreviations & basis of descriptions

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C018P3

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 : RB
Date Started : 02/08/11
Date Completed : 03/08/11
Logged by : MP
Date : 16/8/13

DRILLING

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

Drilling Method: Rotary Wash Boring (Bit, 6 inch)

Hole Support \ Casing: Nil

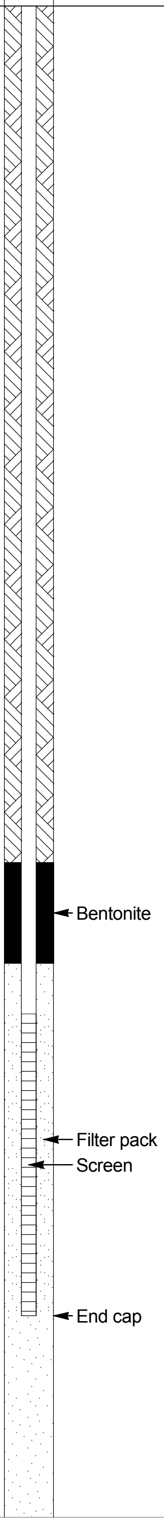
MATERIAL

Depth / (RL) metres	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Comments/ Observations
	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
132.00 (149.21)	COAL, brown-black, dull, chips into small shards.	
137.50 (143.71)	SILTSTONE, medium plasticity, pale grey.	
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.	
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.	
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	

Graphic Log

PIEZOMETER

Piezometer Log / Components



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GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C018P3

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 :** RB	
Date Started :	02/08/11	**Date Completed :** 03/08/11	**Logged by :** MP	**Date :** 16/8/'13	

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**
152 154 156 158 160	Rotary Wash Boring (Bit, 6 inch)	Nil						grained sand. At 152.5 m; dark grey, interbedded with thin carbonaceous siltstone bands. From 154.0 m; fining up to fine grained sand, trace medium to coarse grained sand, increase in fines content, grain supported. From 156.0 m; matrix supported (silt), fine grained sand, carbonaceous siltstone present. From 159.0 m; grain supported, fine to medium grained sand, coarsening with depth. From 160.0 m; medium to coarse grained sand, trace fine grained sand, <10% fines.			41.0 m -161.0 m; Permian		
162 164 166 168 170 172 174 176 178 180					161.00 (120.21)			End of borehole at 161 m. Piezometer installed.					

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GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

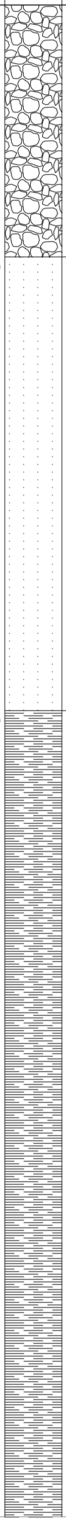
BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

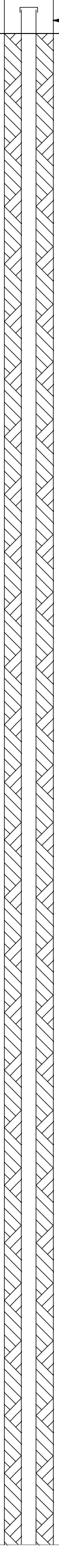
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C020P2

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 : RB
Date Started : 08/08/11
Date Completed : 10/08/11
Logged by : MP
Date : 16/8/13





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
													◄ Completed with steel monument
2 4	Rotary Wash Boring	Nil						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		
6 8 10 12					5.00 (258.06)			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 16 18 20 22 24 26 28 30					14.00 (249.06)			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.					

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GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C020P2

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 : RB
Date Started : 08/08/11
Date Completed : 10/08/11
Logged by : MP
Date : 16/8/13

Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	USC Symbol	Description	Moisture Condition	Consistency / Density Index	Comments/ Observations	Components
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	
				35.00 (228.06)		SANDSTONE, matrix supported, pale yellow-brown, very fine to fine grained sand.			35.0 m - 231.0 m; Rewan Group	
				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,				

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

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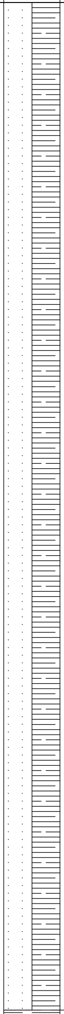
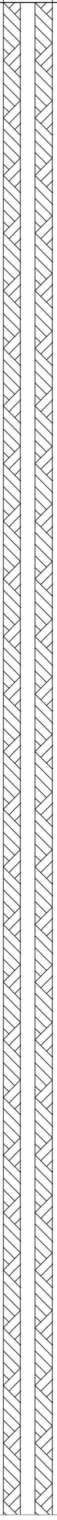
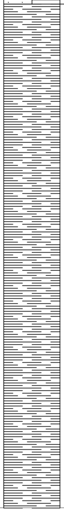
BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C020P2

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 : RB
Date Started : 08/08/11
Date Completed : 10/08/11
Logged by : MP
Date : 16/8/'13

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
62 64 66 68 70 72 74 76 78	Rotary Wash Boring	Nil						red/orange mottling. SILTSTONE / SANDSTONE, as previous			35.0 m - 231.0 m; Rewan Group		
80 82 84 86 88 90					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).					

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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. C020P2

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 :** RB
Date Started : 08/08/11 **Date Completed :** 10/08/11 **Logged by :** MP **Date :** 16/8/13

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
92 94 96 98 100 102	Rotary Wash Boring	Nil						SILTSTONE, as previous			35.0 m - 231.0 m; Rewan Group		
104 106 108 110 112 114 116 118 120					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.					

See standard sheets for details of abbreviations & basis of descriptions

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Job No.
41-23244

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

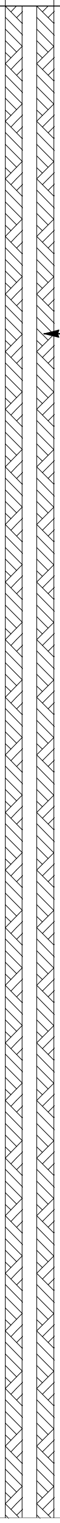
BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C020P2

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 : RB
Date Started : 08/08/11
Date Completed : 10/08/11
Logged by : MP
Date : 16/8/'13

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**
								SILTSTONE, as previous			35.0 m - 231.0 m; Rewan Group		
122													
124													
126													50mm PVC casing, with cement-bentonite grout
128													
130													
132													
134	Rotary Wash Boring	Nil											
136													
138													
140													
142													
144													
146													
148													
150													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C020P2

SHEET 6 OF 9

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

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 :** RB	
Date Started :	08/08/11	**Date Completed :** 10/08/11	**Logged by :** MP	**Date :** 16/8/13	

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**
								SILTSTONE, as previous			35.0 m - 231.0 m; Rewan Group		
152													
154													
156													
158													
160													
162													
164													
166	Rotary Wash Boring	Nil											
168													
170													
172													
174													
176													
178													
180													

See standard sheets for details of abbreviations & basis of descriptions

Job No.
41-23244

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C020P2

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 : RB
Date Started : 08/08/11
Date Completed : 10/08/11
Logged by : MP
Date : 16/8/13

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
182 184 186 188 190 192 194 196 198	Rotary Wash Boring	Nil				SILTSTONE, as previous			35.0 m - 231.0 m; Rewan Group		
200 202 204 206					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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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C020P2

SHEET 8 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 : RB
Date Started : 08/08/11
Date Completed : 10/08/11
Logged by : MP
Date : 16/8/13

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**
212 214	Rotary Wash Boring	Nil			(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 Group		
216 218 220					215.00 (48.06)			SILTSTONE, grey, very fine grained sand, trace fine to medium grained sand.					
222 224 226 228 230					221.00 (42.06)			SILTSTONE, dark grey, high plasticity fines, very fine grained sand, returning as shards.					
232 234					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		
236 238 240					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.					

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GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

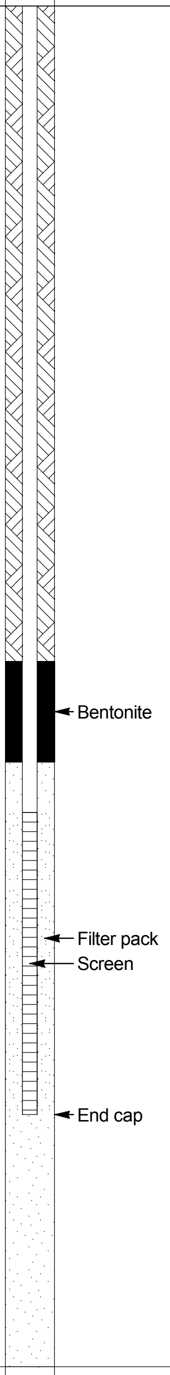
HOLE No. C020P2

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 :** RB
Date Started : 08/08/11	**Date Completed :** 10/08/11	**Logged by :** MP	**Date :** 16/8/13

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
242 244 246 248 250 252 254	Rotary Wash Boring	Nil						SILTSTONE, as previous			231.0 m - 267.0 m; Permian
256 258 260					255.00 (8.06)			COAL, black, vitreous, breaks into small shards.			AB Seam
262					261.00 (2.06)			SILTSTONE, grey, some carbonaceous material present.			
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.			

PIEZOMETER



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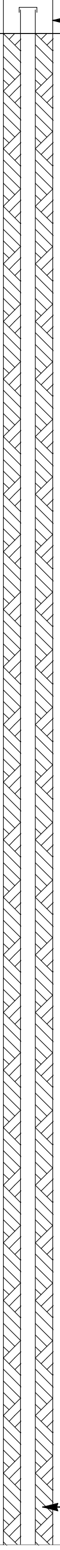
BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C022P1

SHEET 1 OF 3

Client :	Adani Mining Pty Ltd				
Project :	Carmichael Coal Mine Project				
Location :	EPC 1690				
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 :** RB	
Date Started :	11/08/11	**Date Completed :** 12/08/11	**Logged by :** MP	**Date :** 16/8/13	

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
	Percussion Air Hammer	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
2 4					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.					
6 8 10 12 14 16 18 20 22					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.					
24 26 28 30	Rotary Wash Boring		GNO										50mm PVC casing, with cement-bentonite



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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

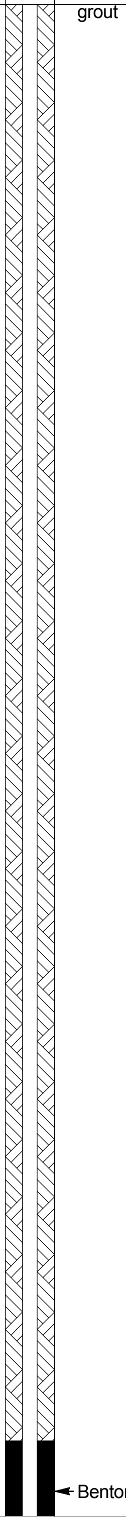
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C022P1

SHEET 2 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 :** RB	
Date Started :	11/08/11	**Date Completed :** 12/08/11	**Logged by :** MP	**Date :** 16/8/13	

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
32													
34													
36													
38													
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).					
42													
44													
46													
48								From 47.0 m; completely stained dark brown-red.					
50													
52													
54								From 54.0 m; orange-yellow red/orange mottling, decrease in staining, increase in coarse grained sand content.					
56													
58					58.00 (215.76)			SANDSTONE, grain supported, stained red-brown/orange, medium to coarse grained sand, trace fine					Bentonite
					59.00 (214.76)								
60													



See standard sheets for details of abbreviations & basis of descriptions

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

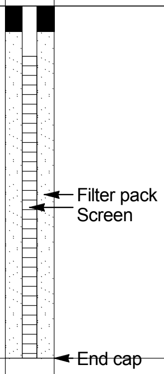
HOLE No. C022P1

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 : RB
Date Started : 11/08/11
Date Completed : 12/08/11
Logged by : MP
Date : 16/8/13

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**
60–67	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.					
					64.50 (209.26)			After 60.0 m - colour change to pale grey-yellow, very little fines.					Filter pack Screen
					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
								End of borehole at 67.0 m. Piezometer installed.					

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

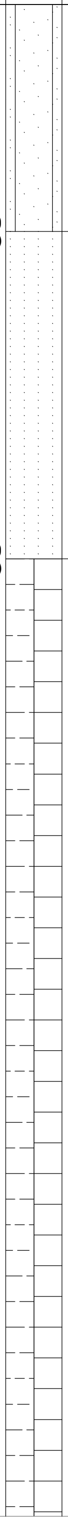
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

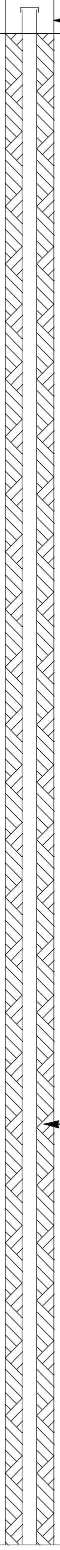
HOLE No. C024P3

SHEET 1 OF 2

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 : RB
Date Started : 15/08/11
Date Completed : 15/08/11
Logged by : MP
Date : 16/8/13

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
0–4.5	Rotary Wash Boring (bit, 6 inch)	Nil						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		Completed with steel monument
4.5–11.0					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.					
11.0–30					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. From 26.0 to 27.5 m; heavily stained dark orange, orange/yellow/red mottling.			19.0 m - 49.0 m; Permian. Inferred from reinterpretation of geology.		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 : EPC 1690

HOLE No. C024P3

SHEET 2 OF 2

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 : RB
Date Started : 15/08/11
Date Completed : 15/08/11
Logged by : MP
Date : 16/8/13

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 34 36	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.		
38 40 42					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 46					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					48.00 (210.59)			SILTSTONE, grey, trace fine grained sand, some carbonaceous material present (dark brown-black).					End cap Hole Collapse
50 52 54 56 58 60					49.00 (209.59)			End of borehole at 49.0 m. Piezometer installed.					

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

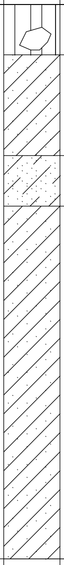
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

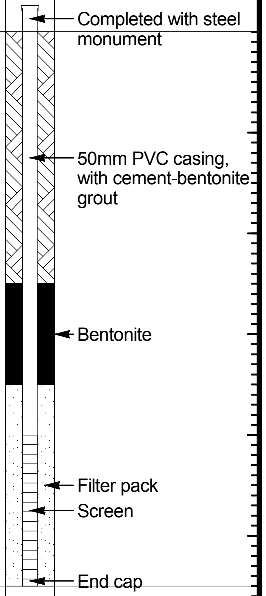
HOLE No. C025P1

SHEET 1 OF 1

Position : 438017.0 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 :** RB
Date Started : 17/08/11	**Date Completed :** 17/08/11	**Logged by :** RB	**Date :** 16/8/13

DRILLING				MATERIAL								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	Comments/ Observations	Piezometer Log	Components
Rotary Wash Boring (Step bit, 6 inch)	Nil	GNO		0.00 – 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 Bentonite Filter pack Screen End cap
				1.00 – 3.00 (224.54)		CH	Sandy CLAY, orange, yellow-orange and pale grey mottled, trace fine grained sand. High plasticity. (Extremely weathered SANDSTONE).					
				3.00 – 4.00 (223.54)		SC	Clayey SAND, Orange, yellow-orange and pale grey mottled, fine grained sand. (Extremely weathered SANDSTONE)					
				4.00 – 11.00 (216.54)		CH	Sandy CLAY, fine grained sand, high plasticity. (Extremely weathered SANDSTONE)					
				11.00 (216.54)			End of borehole at 11 m. Piezometer installed.					





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 : EPC 1690

HOLE No. C025P2

SHEET 1 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 :** RB
Date Started : 17/08/11 **Date Completed :** 17/08/11 **Logged by :** RB **Date :** 16/8/13

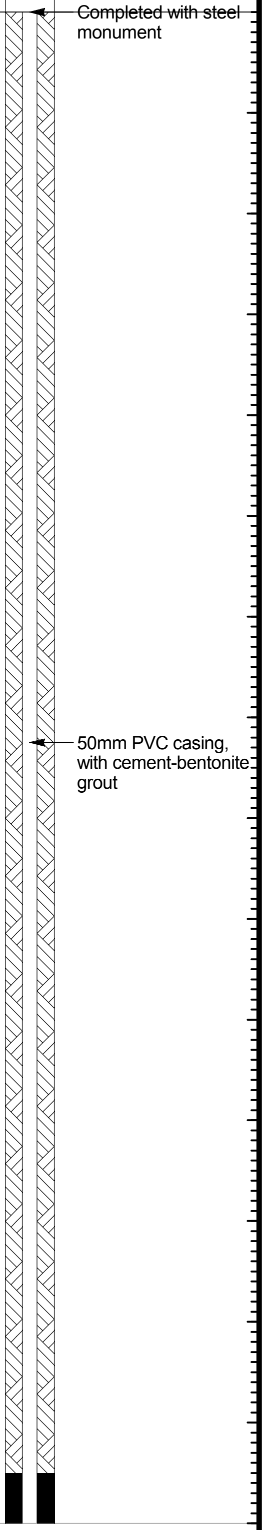
DRILLING
Drilling Method: Rotary Wash Boring (Step bit, 6 inch)
Hole Support \ Casing: Nil
Water: GNO
Samples & Tests:

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
		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



See standard sheets for details of abbreviations & basis of descriptions

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

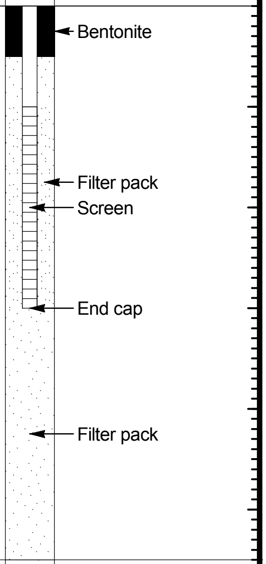
HOLE No. C025P2

SHEET 2 OF 2

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690
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 :** RB
Date Started : 17/08/11 **Date Completed :** 17/08/11 **Logged by :** RB **Date :** 16/8/13

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
	Rotary Wash Boring (Step bit, 6 inch)	Nil					From 30 m; trace carbon			0.0 m- 41.0 m; Tertiary
32					32.00 (195.48)		Leached rock, pale grey-brown, fine grained (silt sized), silicified chips in clay matrix. Returns as gravelly 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.			
34										
36										
38										
					39.00 (188.48)		FERRICRETE, pink brown, hard fine grained chips (iron rich), some clay.			
40										
					41.00 (186.48)		End of borehole at 41 m. Piezometer installed.			
42										
44										
46										
48										
50										
52										
54										
56										
58										
60										

PIEZOMETER



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Job No.
41-23244

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

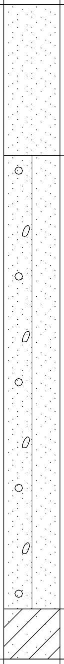
HOLE No. C027P1

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 : RB
Date Started : 21/08/11
Date Completed : 21/08/11
Logged by : RB
Date : 16/8/'13

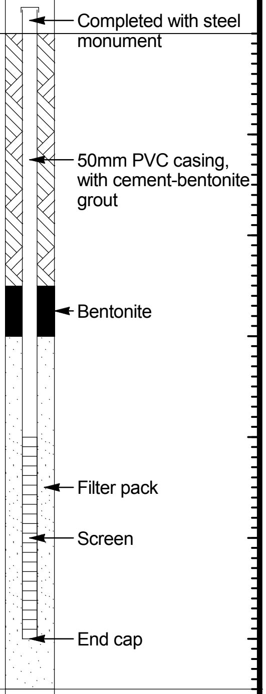
DRILLING					MATERIAL							
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	
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	
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				
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					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



PIEZOMETER

Piezometer Log | Components



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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. C027P2

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 : RB
Date Started : 20/08/11
Date Completed : 20/08/11
Logged by : RB
Date : 16/8/'13

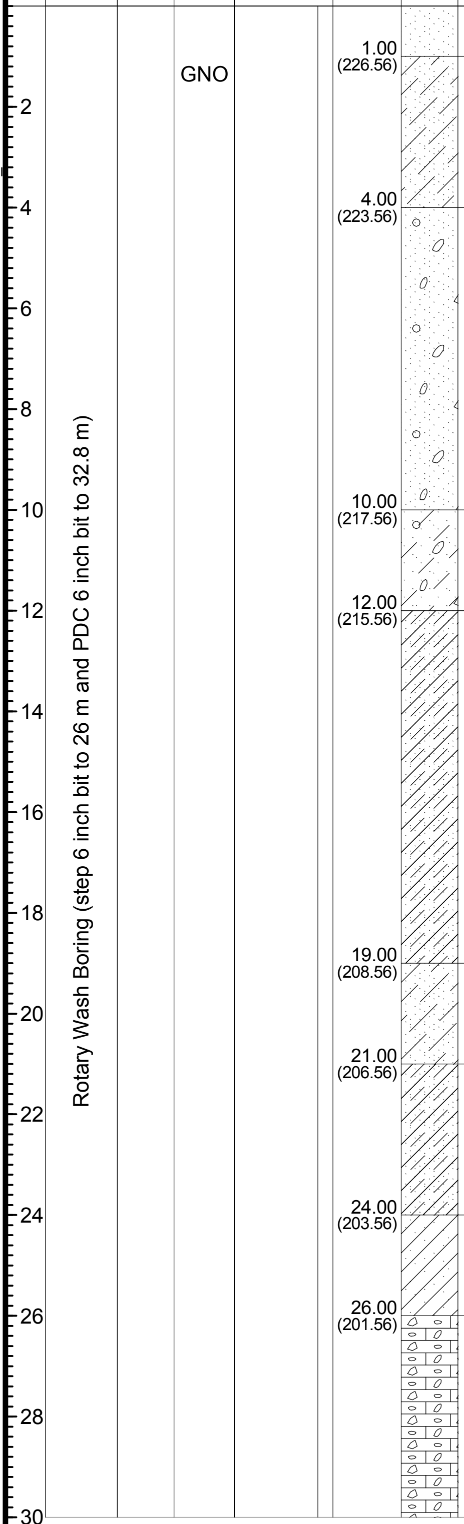
DRILLING

Drilling Method: Rotary Wash Boring (step 6 inch bit to 26 m and PDC 6 inch bit to 32.8 m)

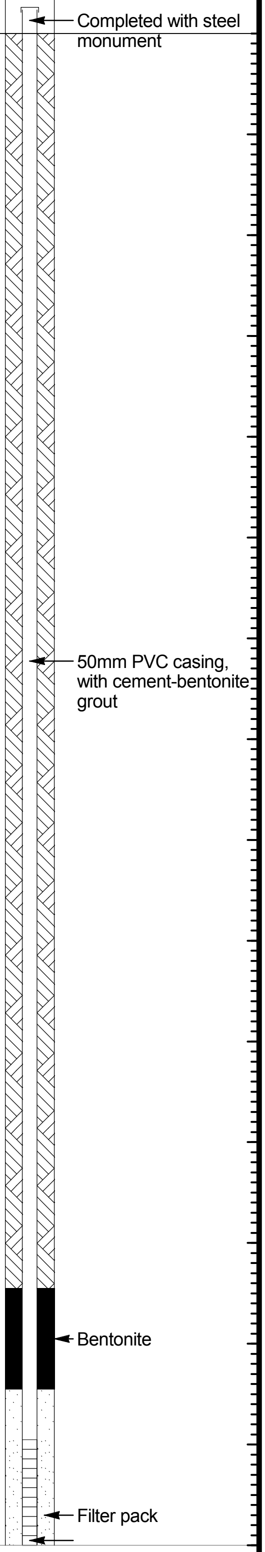
Water: GNO

MATERIAL

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



PIEZOMETER



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Job No.
41-23244

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C027P2

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 :** RB
Date Started : 20/08/11 **Date Completed :** 20/08/11 **Logged by :** RB **Date :** 16/8/13

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
32								sandstone and siltstone. (SANDSTONE and SILTSTONE) Iron rich Hardpan, as previous			12.0 m - 32.8 m; Dunda Beds		Screen End cap Hole Collapse
					32.80 (194.76)			End of borehole at 32.8 m. Piezometer installed.					
34													
36													
38													
40													
42													
44													
46													
48													
50													
52													
54													
56													
58													
60													

See standard sheets for details of abbreviations & basis of descriptions

Job No.
41-23244

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C029P1

SHEET 1 OF 1

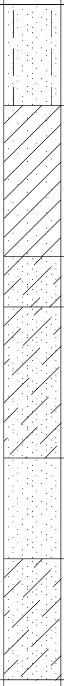
Position : 437695.0 E 7555078.0 N **Surface RL:** 225.4m **Angle from Horiz. :** 90° **Processed :** VLD
Rig Type : Bourne 1000 **Mounting:** Truck **Contractor :** Watson Drilling **Driller :** Stacey **Checked :** RB
Date Started : 21/08/11 **Date Completed :** 21/08/11 **Logged by :** RB **Date :** 16/8/13

DRILLING

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

MATERIAL

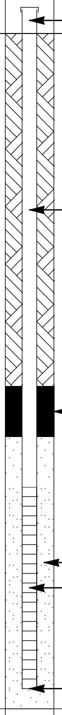
Depth / (RL) metres	USC Symbol	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index
	SP-SM	Silty SAND, orange-brown, fine grained, trace clay. (ALLUVIUM)		
2.00 (223.44)	CH	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 (220.44)	SC	Clayey SAND, orange and pale grey mottled, fine and medium grained sand. (ALLUVIUM)		
6.00 (219.44)	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 (216.44)	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 (214.44)	SC	SAND with Clay, as above with clay. (ALLUVIUM)		
13.40 (212.04)		End of borehole at 13.4 m. Piezometer installed.		



Comments/ Observations

0.0 m - 13.4 m; Alluvium

PIEZOMETER



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GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C029P2

SHEET 1 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 : RB
Date Started : 21/08/11
Date Completed : 21/08/11
Logged by : RB
Date : 16/8/13

DRILLING				MATERIAL							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	Comments/ Observations	Piezometer Log	Components
Rotary Wash Boring (Step bit, 6 inch)	Nil	GNO				SM	Silty SAND, orange-brown, fine and medium grained sand, trace clay. (ALLUVIUM)			0.0 m - 37.8 m; Alluvium		Completed with steel monument
				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)					50mm PVC casing, with cement-bentonite grout
				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.					

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GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

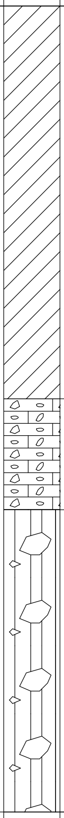
HOLE No. C029P2

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 : RB
Date Started : 21/08/11
Date Completed : 21/08/11
Logged by : RB
Date : 16/8/13

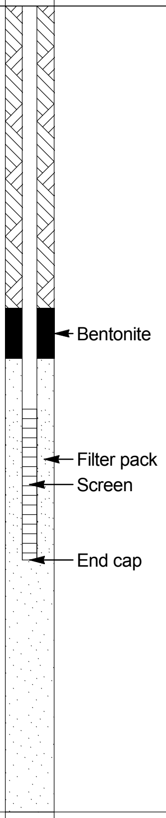
DRILLING					MATERIAL					Comments/ Observations
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	USC Symbol	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	
32 34 36	Rotary Wash Boring (Step bit, 6 inch)	Nil			37.80 (187.57)		From 30 to 31 m; dark brown colour. From 31 to 38 m; grey-brown colour.			0.0 m - 37.8 m; Alluvium
38 40					40.00 (185.37)		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
42 44 46					46.00 (179.37)		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
48 50 52 54 56 58 60							End of borehole at 46 m. Piezometer installed.			

Graphic Log



PIEZOMETER

Piezometer Log | Components



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Job No. 41-23244

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C032P2

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 :** RB
Date Started : 23/08/11	**Date Completed :** 23/08/11	**Logged by :** RB	**Date :** 16/8/13

DRILLING | **MATERIAL** | **PIEZOMETER**

Drilling Method: Rotary Wash Boring (PDC 6 inch bit)
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	Comments/ Observations
	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
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
7.00 (249.22)		SANDSTONE, pale green, fine and medium grained in very fine grained/no visible grains matrix. Brittle. Leached.	
8.00 (248.22)		SANDSTONE, pale green, fine and medium grained in clay matrix, high plasticity. Extremely weathered.	
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.	
22.00 (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.	
30.00			

Piezometer Components: Completed with steel monument

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 : EPC 1690

HOLE No. C032P2

SHEET 2 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 : RB
Date Started : 23/08/11
Date Completed : 23/08/11
Logged by : RB
Date : 16/8/13

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 (PDC 6 inch bit)	Nil			(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		
32													
34													
					35.00 (221.22)			FERRICRETE, orange-pink, fine grained, iron-rich. Silt. (SILTSTONE)					
36													
					38.00 (218.22)			SILTSTONE, dark orange-pink, fine grained, gritty (black and orange-pink), iron-rich. Disintegrates to clay. Extremely weathered.					
38													
40													
42								From 42m; Pink and white mottled with marble effect, slightly grainy. Returns as CLAY, high plasticity.					
44													
46													
48													
50													
52											52.0m - 243.5m; Rewan Group		
54													
56								Interbedded SILTSTONE and SANDSTONE. Sandstone is orange, fine and medium grained. Siltstone is dark orange-pink. Extremely weathered.					
58													
60													

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C032P2

SHEET 3 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 : RB
Date Started : 23/08/11
Date Completed : 23/08/11
Logged by : RB
Date : 16/8/13

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 66 68 70	Rotary Wash Boring (PDC 6 inch bit)	Nil				▤					52.0m - 243.5m; Rewan Group	▧	
72 74 76 78 80					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.				▧	
82 84 86 88 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)				▧	

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C032P2

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 : RB
Date Started : 23/08/11
Date Completed : 23/08/11
Logged by : RB
Date : 16/8/13

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 94 96 98 100 102 104 106 108 110 112 114 116 118 120	Rotary Wash Boring (PDC 6 inch bit)	Nil						CLAY, as previous			52.0m - 243.5m; Rewan Group		

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GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C032P2

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 :** RB
Date Started : 23/08/11 **Date Completed :** 23/08/11 **Logged by :** RB **Date :** 16/8/13

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								CLAY, as previous From 122 to 135m; with dark brown-red mottles			52.0m - 243.5m; Rewan Group		
124													50mm PVC casing, with cement-bentonite grout
126													
128													
130													
132													
134	Rotary Wash Boring (PDC 6 inch bit)	Nil											
136													
138													
140													
142								From 141 to 145m; with dark brown-red mottles					
144													
146													
148													
150													

See standard sheets for details of abbreviations & basis of descriptions

Job No.
41-23244

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C032P2

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 :** RB
Date Started : 23/08/11		**Date Completed :** 23/08/11		**Logged by :** RB	**Date :** 16/8/13

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	Rotary Wash Boring (PDC 6 inch bit)	Nil						CLAY, as previous			52.0m - 243.5m; Rewan Group		
154													
156													
158													
160													
162													
164													
166													
168													
170								From 169m; with chips of SILTSTONE/CLAYSTONE. Dark grey, very fine grained, brittle.					
172													
174													
176													
178													
180													

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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. C032P2

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 :** RB
Date Started : 23/08/11		**Date Completed :** 23/08/11		**Logged by :** RB	**Date :** 16/8/'13

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**
182 184 186 188 190 192 194 196 198 200 202 204 206	Rotary Wash Boring (PDC 6 inch bit)	Nil						CLAY, as previous			52.0m - 243.5m; Rewan Group		
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
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C032P2

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 : RB
Date Started : 23/08/11
Date Completed : 23/08/11
Logged by : RB
Date : 16/8/13

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 (PDC 6 inch bit)	Nil						sugary texture) SANDSTONE and SILTSTONE interbedded, as previous			52.0m - 243.5m; Rewan Group		
212													
214													
216													
218													
220													
222													
224													
226													
228													
230													
232													
234													
236													
238								From 238m; grey.					
240													

See standard sheets for details of abbreviations & basis of descriptions

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

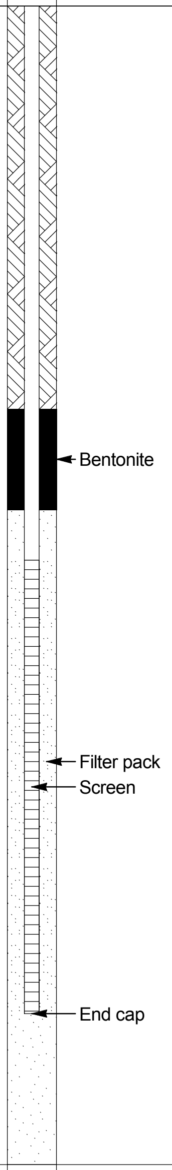
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C032P2

SHEET 9 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 :** RB
Date Started : 23/08/11 **Date Completed :** 23/08/11 **Logged by :** RB **Date :** 16/8/13

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
242	Rotary Wash Boring (PDC 6 inch bit)	Nil			243.50 (12.72)			SANDSTONE and SILTSTONE interbedded, as previous			52.0m - 243.5m; Rewan Group		
244 246 248 250 252 254 256 258 260 262					263.00 (-6.78)			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. From 253 to 257m: trace to some COAL interbeds.			243.5m - 263.0m; Permian AB Seam		Bentonite Filter pack Screen End cap
264 266 268 270								End of borehole at 263m. Piezometer installed.					



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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. C034P1

SHEET 1 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 : RB
Date Started : 29/08/11
Date Completed : 29/08/11
Logged by : RB
Date : 16/8/13

DRILLING

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

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	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

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 : EPC 1690

HOLE No. C034P1

SHEET 2 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 :** RB
Date Started : 29/08/11 **Date Completed :** 29/08/11 **Logged by :** RB **Date :** 16/8/13

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
32 / 34 / 36 / 38 / 40 / 42	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 / 46 / 48 / 50 / 52					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		
54 / 56 / 58					53.00 (174.59)		CH	CLAY, brown-grey trace orange-red mottle, high plasticity, firm, smooth. (MUDSTONE/ PRE-CONSOLIDATED MUDSTONE)					Bentonite
60					59.00 (168.59)			SANDSTONE, pale pink, pink and pale grey, fine and					

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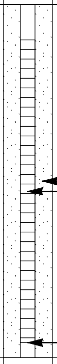
BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C034P1

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 :** RB
Date Started : 29/08/11 **Date Completed :** 29/08/11 **Logged by :** RB **Date :** 16/8/13

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 66	Rotary Wash Boring (bit, 6 inch)	Nil			67.00 (160.59)			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 70 72 74 76 78 80 82 84 86 88 90								End of borehole at 67 m. Piezometer installed.					

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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. C034P3

SHEET 1 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 : RB
Date Started : 27/08/11
Date Completed : 27/08/11
Logged by : RB
Date : 16/8/'13

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

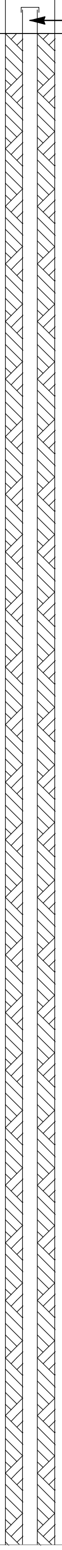
Comments/ Observations

PIEZOMETER – Piezometer Log | Components

Drilling Method: Rotary Wash Boring (Chevron bit)

Hole Support \ Casing: Nil

Depth / (RL) metres	USC Symbol	Description	Comments/ Observations
	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)	


Completed with steel monument

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

See standard sheets for details of abbreviations & basis of descriptions

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C034P3

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 :** RB
Date Started : 27/08/11 **Date Completed :** 27/08/11 **Logged by :** RB **Date :** 16/8/13

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 34 36 38 40 42 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		
46 48 50 52 54 56 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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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C034P3

SHEET 3 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 :** RB
Date Started : 27/08/11	**Date Completed :** 27/08/11	**Logged by :** RB	**Date :** 16/8/13

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 66 68	Rotary Wash Boring (Chevron bit)	Nil						medium grained sand (quartz, sub-rounded, some angular shards and needles, pale grey and pink). Returning as Sandy CLAY. Extremely weathered. From 64 to 66m; with some brown-green clay; high plasticity, smooth, soft.			45.0m - 113m; Permian		
70					69.00 (158.53)		CH	CLAY, brown-green, high plasticity, smooth, soft.					
72 74 76 78 80 82 84 86 88					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					
90					89.00 (138.53) 90.00		CH	CLAY, pale pink and white, high plasticity.					

See standard sheets for details of abbreviations & basis of descriptions

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Job No.
41-23244

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C034P3

SHEET 4 OF 4

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690
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 : RB
Date Started : 27/08/11
Date Completed : 27/08/11
Logged by : RB
Date : 16/8/13

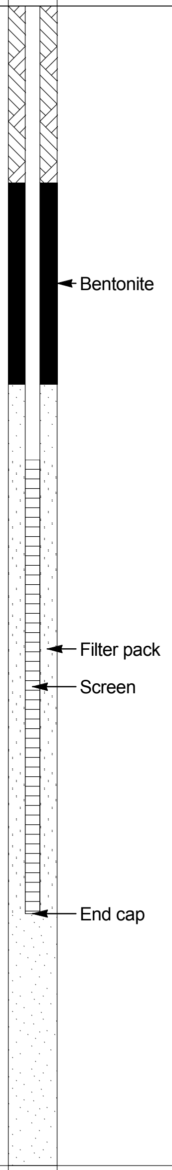
DRILLING

Drilling Method: Rotary Wash Boring (Chevron bit)
Hole Support \ Casing: Nil
Water: ▸ at 92 m

MATERIAL

Depth / (RL) metres	Description	Comments/ Observations
(137.53)	CARBONACEOUS MUDSTONE with COAL and MUDSTONE. MUDSTONE; Pale brown-green. CARBONACEOUS MUDSTONE; Black. COAL; Black. 90 to 92m; 25% coal, 25% carbonaceous mudstone, 50% mudstone.	45.0m - 113m; Permian Groundwater inflow at approximately 92.0 m, estimated at 3-4 L/s
92.00 (135.53)	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.	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



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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. C035P1

SHEET 1 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 :** RB
Date Started : 28/08/11		**Date Completed :** 28/08/11		**Logged by :** RB	**Date :** 16/8/13

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.					Completed with steel monument
2					1.00 (235.31)		CH	Sandy CLAY, pale grey-brown and orange mottled, (high plasticity). Medium and coarse grained, trace fine sand (quartz).			0.0 m - 50.0 m; Tertiary		
4 6 8 10					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.					
12 14 16 18 20 22 24 26 28 30					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 From 27 to 30 m; with pink mottling					50mm PVC casing, with cement-bentonite grout
					30.00								

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41-23244

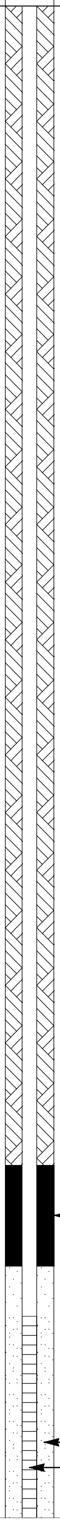
BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C035P1

SHEET 2 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 :** RB
Date Started : 28/08/11 **Date Completed :** 28/08/11 **Logged by :** RB **Date :** 16/8/13

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 34 36 38	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 42 44 46 48					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 52 54 56 58 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 Group		Bentonite Filter pack Screen

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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. C035P1

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 : RB
Date Started : 28/08/11
Date Completed : 28/08/11
Logged by : RB
Date : 16/8/13

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
		Nil						SANDSTONE, as previous			50.0 m - 62.0 m; Rewan Group		
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													

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41-23244

GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C035P2

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 :** RB
Date Started :	27/08/11		**Date Completed :** 28/08/11		**Logged by :** RB		**Date :** 16/8/13

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					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
2 4 6					1.00 (235.24)			Sandy CLAY, pale grey and orange mottled, high plasticity. Medium and coarse grained sand, trace fine gravel (quartz, sub-rounded and sub-angular).					
8 10					8.00 (228.24)			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.					
12 14 16 18 20 22 24 26 28 30					12.00 (224.24)			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.					

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GEO_BOREHOLE 41-23244-MINE-HYDROGEOLOGY.GPJ GHD_GEO_TEMPLATE.GDT 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C035P2

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 :** RB
Date Started : 27/08/11 **Date Completed :** 28/08/11 **Logged by :** RB **Date :** 16/8/'13

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			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
					50.00 (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; Rewan Group	▨	

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 02/08/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C035P2

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 : RB
Date Started : 27/08/11
Date Completed : 28/08/11
Logged by : RB
Date : 16/8/13

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 66 68 70	Rotary Wash Boring (bit, 6 inch)	Nil						SANDSTONE, as previous			50.0 m - 86.5 m; Rewan Group		
72 74 76 78 80 82 84 86					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).					
88 90					86.50 (149.74)			CLAY, Grey-brown, high plasticity, smooth. (Mudstone/ Pre-consolidated mudstone)			86.5 m - 110 m; Permian		

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C035P2

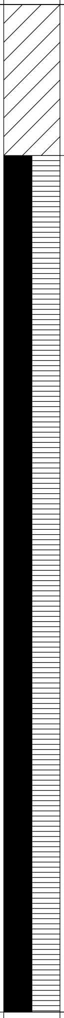
SHEET 4 OF 4

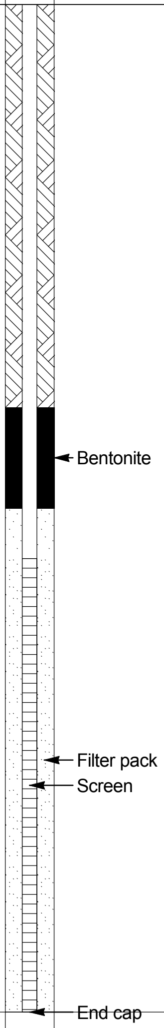
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

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 :** RB	
Date Started : 27/08/11	**Date Completed :** 28/08/11		**Logged by :** RB	**Date :** 16/8/'13	

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
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.			
100							From 100 to 101m; Coal.			AB1 Seam
102							From 101 to 107m; Coal with mudstone.			
108							From 107 to 110m; Mudstone with trace coal.			
110					110.00 (126.24)		End of borehole at 110m. Piezometer installed.			

Scale: 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
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C555P1

SHEET 1 OF 2

Position : 436146.0 E 7561468.0 N
Surface RL: 241.2m
Angle from Horiz. : 90°
Processed : CMM
Rig Type : Bourne 1000 **Mounting:** Truck
Contractor : Watson Drilling
Driller : Leigh
Checked : RB
Date Started : 26/9/12
Date Completed : 26/9/12
Logged by : DK
Date : 22/10/13

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" step bit	Nil	GNO			▨		Silty CLAY, pale brown, high plasticity			0 m - 75 m; Rewan Group	▨	Completed with steel monument
4						▨		From 4m; pale grey with pale brown banding at 20m and 30m				▨	
5						▨						▨	
10						▨						▨	
15						▨						▨	
20						▨						▨	
25						▨						▨	
30					30.00 (211.15)	▨		CLAY, pale grey, stiff		St		▨	50mm PVC casing in bentonite/cement grout
35						▨						▨	
40													

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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

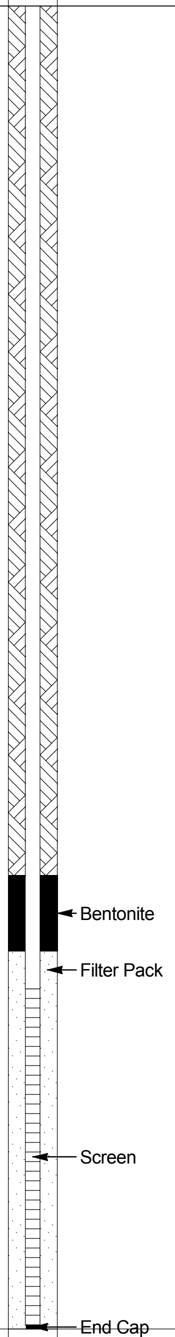
HOLE No. C555P1

SHEET 2 OF 2

Position : 436146.0 E 7561468.0 N	**Surface RL:** 241.2m	**Angle from Horiz. :** 90°	**Processed :** CMM
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Leigh	**Checked :** RB
Date Started : 26/9/12	**Date Completed :** 26/9/12	**Logged by :** DK	**Date :** 22/10/13

DRILLING				MATERIAL							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	**Comments/ Observations**	**Components**
Mud Rotary Wash Boring 6" step bit	Nil						From 42m; becoming dark grey From 45m; dark grey and white lensing From 49m; white with trace fine sand		St	0 m - 75 m; Rewan Group	
				69.00 (172.15)			Gravelly CLAY, yellow, fine to medium gravel, angular to subangular, trace fine to medium grained sand				
				73.00 (168.15)			CLAY with Sand, yellow and white, fine grained				
				75.00 (166.15)			End of Hole at 75 m				

SCALE (m): 45, 50, 55, 60, 65, 70, 75, 80



See standard sheets for details of abbreviations & basis of descriptions

Job No. 41-24415-46

GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 18/10/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C556P1

SHEET 1 OF 3

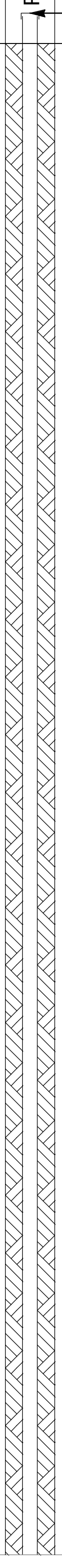
Position : 436524.1 E 7549882.0 N **Surface RL:** 260.6m **Angle from Horiz. :** 90° **Processed :** CMM
Rig Type : Bourne 1000 **Mounting:** Truck **Contractor :** Watson Drilling **Driller :** Leigh **Checked :** RB
Date Started : 28/9/12 **Date Completed :** 28/9/12 **Logged by :** DK **Date :** 22/10/13

DRILLING | **MATERIAL** | **PIEZOMETER**

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
0 – 20	Mud Rotary Wash Boring 6" step bit	Nil	GNO				Silty CLAY, pale orange - brown, soft From 4m; Low plasticity From 12m; with fragmented rock From 16m; pale grey		S	0 m - 83 m; Rewan Group
20 – 28					20.00 (240.63)		CLAY, pale grey, stiff, high plasticity		St	
28 – 30					28.00 (232.63)		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

Piezometer Log | **Components**



Completed with steel monument

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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

SHEET 2 OF 3

Position : 436524.1 E 7549882.0 N		**Surface RL:** 260.6m	**Angle from Horiz. :** 90°		**Processed :** CMM
Rig Type : Bourne 1000	**Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Leigh		**Checked :** RB
Date Started : 28/9/12	**Date Completed :** 28/9/12		**Logged by :** DK		**Date :** 22/10/13

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									0 m - 83 m; Rewan Group		
32													
								From 33m; Increase in Silt					
34													50mm PVC casing in bentonite/cement grout mix
36													
					37.00 (223.63)			Clayey SAND, white, medium and coarse grained sand, subangular, minor iron stone inclusion/ iron staining					
38													
40													
42					42.00 (218.63)			Sandy CLAY, pale grey, fine to medium sand, subangular, minor orange clay fragments					
44													
46													
					47.00 (213.63)			Silty CLAY, orange, high plasticity					
48													
50													
52													
54								From 54m; pale grey			Hole "collaring up"		
56													
58													
60													

See standard sheets for details of abbreviations & basis of descriptions

Job No.

41-24415-46

GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 18/10/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

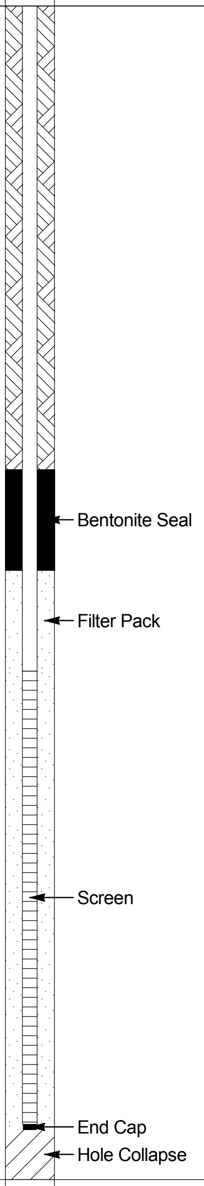
HOLE No. C556P1

SHEET 3 OF 3

Position : 436524.1 E 7549882.0 N	**Surface RL:** 260.6m	**Angle from Horiz. :** 90°	**Processed :** CMM
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Leigh	**Checked :** RB
Date Started : 28/9/12	**Date Completed :** 28/9/12	**Logged by :** DK	**Date :** 22/10/13

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
60 – 70	Mud Rotary Wash Boring 6" step bit	Nil									0 m - 83 m; Rewan Group		
70 – 83.3	Mud Rotary Wash Boring 6" blade bit	Nil			70.00 (190.63)			Sandy CLAY, pale brown, high plasticity, fine sand From 78m; pale grey - white, angular to subangular sand			Slow drilling, hard ground		Bentonite Seal Filter Pack Screen End Cap Hole Collapse
					83.30 (177.33)			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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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 18/10/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C558P1

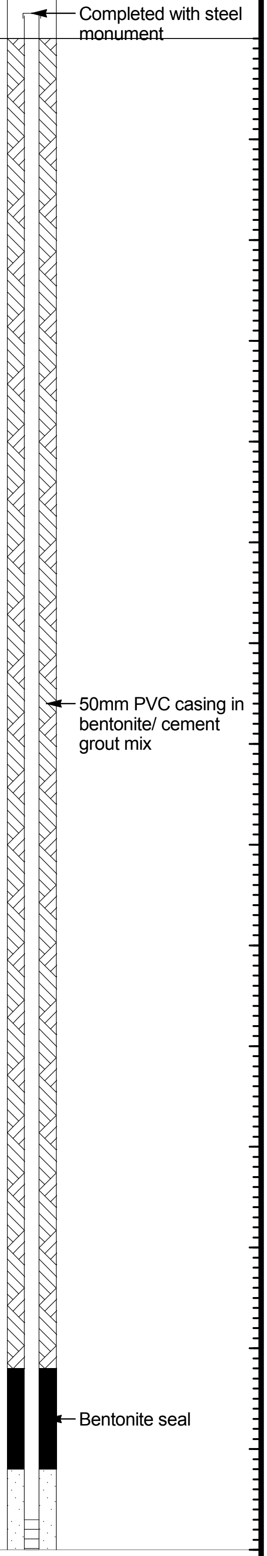
SHEET 1 OF 2

Position : 430311.5 E 7566903.0 N
Surface RL: 250.1m
Angle from Horiz. : 90°
Processed : CMM
Rig Type : Bourne 1000 **Mounting:** Truck
Contractor : Watson Drilling
Driller : Leigh
Checked : RB
Date Started : 21/9/12
Date Completed : 21/9/12
Logged by : RB
Date : 22/10/13

DRILLING — Drilling Method: Mud Rotary Wash Boring 6" step bit; Hole Support \ Casing: Nil; Water: GNO

Depth / (RL) metres	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Comments/ Observations
	SAND with Clay, orange - brown, medium grained sand	0.0 m - 41.4 m; Tertiary / Permian age strata
1.00 (249.05)	Clayey SAND, yellow-green, medium grained From 3m; brown and pale grey From 6m; red-brown From 9m; with pale grey mottling From 12m; with ferricrete bands, red-brown, fine grained, iron rich	
15.00 (235.05)	Sandy CLAY, pale grey - pink, fine and medium grained sand, trace to some ferricrete From 23m; red with brown clay	
25.00 (225.05)	CLAY, red - brown, trace fine sand From 27m; with ferricrete	
29.00 (221.05)	Sandy CLAY, red - brown and pale grey, fine grained sand	

PIEZOMETER



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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 18/10/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C558P1

SHEET 2 OF 2

Position : 430311.5 E 7566903.0 N
Surface RL: 250.1m
Angle from Horiz. : 90°
Processed : CMM
Rig Type : Bourne 1000 **Mounting:** Truck
Contractor : Watson Drilling
Driller : Leigh
Checked : RB
Date Started : 21/9/12
Date Completed : 21/9/12
Logged by : RB
Date : 22/10/13

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 34 36	Mud Rotary Wash Boring 6" step bit	Nil				▨		with ferricrete (red - brown and purple, fine grained) From 31m; pale grey - white with ferricrete From 35m; ferricrete absent			0.0 m - 41.4 m; Tertiary / Permian age strata		Screen
38 40					38.00 (212.05)	▨		CLAY, pale grey - white with purple - pink, trace sand, high plasticity					
42 44 46 48 50 52 54 56 58 60					41.40 (208.65)			End of Hole at 41.4m					End Cap

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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 18/10/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C9553P1R

SHEET 1 OF 2

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

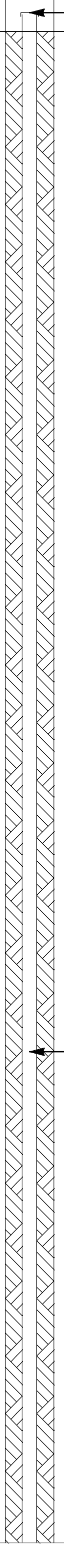
Position :	421010.1 E 7573975.0 N	**Surface RL:**	294.1m	**Angle from Horiz. :**	90°	**Processed :**	CMM
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :**	Watson Drilling	**Driller :**	Leigh	**Checked :**	RB
Date Started :	20/9/12	**Date Completed :**	21/9/12	**Logged by :**	RB	**Date :**	22/10/13

DRILLING					**MATERIAL**						**Comments/ Observations**
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	
0	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			0.0 m - 66.0 m; Dunda Beds
5					5.00 (289.11)			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					10.00 (284.11)			Sandy CLAY, pale grey and red - brown, medium plasticity, fine and medium grained sand, trace of silt			
15											
20											
					22.00 (272.11)			Clayey SAND, red - brown, orange - brown and pale grey, medium and coarse grained (quartz)			
25											
30											
35					36.00 (258.11)			Sandy CLAY, red - brown and pale grey mottle, medium grained and trace coarse grained sand (quartz)			
40											

PIEZOMETER

Piezometer Log

Components


Completed with Steel Monument

50mm PVC casing in bentonite / cement grout mix

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

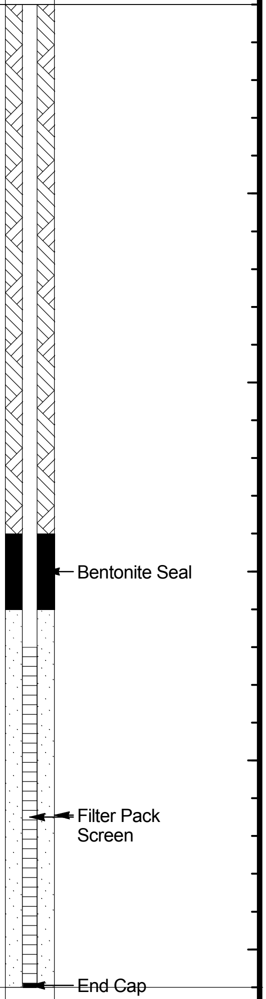
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : EPC 1690

HOLE No. C9553P1R

SHEET 2 OF 2

Position : 421010.1 E 7573975.0 N
Surface RL: 294.1m
Angle from Horiz. : 90°
Processed : CMM
Rig Type : Bourne 1000 **Mounting:** Truck
Contractor : Watson Drilling
Driller : Leigh
Checked : RB
Date Started : 20/9/12
Date Completed : 21/9/12
Logged by : RB
Date : 22/10/13

DRILLING				MATERIAL							PIEZOMETER
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**	**Components**
45 50	Mud Rotary Wash Boring 6" step bit	Nil			54.00 (240.11)		From 42m; pale grey - white From 51m; pink and pale grey - white, with fine quartz gravel			0.0 m - 66.0 m; Dunda Beds	
55 60 65					66.00 (228.11)		Clayey SAND, pale pink, coarse grained sand with fine quartz gravel From 60m; fine and medium grained, with trace coarse sand, trace fine quartz gravel				Bentonite Seal Filter Pack Screen End Cap
70 75 80							End of hole at 66m				



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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 6/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : West of EPC 1690,

HOLE No. HD01

SHEET 1 OF 2

Position : 426146.0 E 7561468.0 N
Surface RL: 312.0m
Angle from Horiz. : 90°
Processed : CMM
Rig Type : Bourne 1000 **Mounting:** Truck
Contractor : Watson Drilling
Driller : Jarrod Freeman
Checked : RB
Date Started : 8/9/12
Date Completed : 11/9/12
Logged by : DK
Date : 16/8/13

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**
	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
								From 2m; grained sand, fine to medium					
5								From 4m; no sand evident			Chips 1-2mm diameter		
								From 8m; minor hard clay gravel, rounded			Powder returns		
10								From 10m; pale red - brown claystone inclusion					
15								From 14m; pale brown - yellow					
20													50mm PVC casing in cement grout slurry
25													
30								31m - 32m; iron stone banding					
					32.00 (280.03)			From 32m; trace sand					
35													
40													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

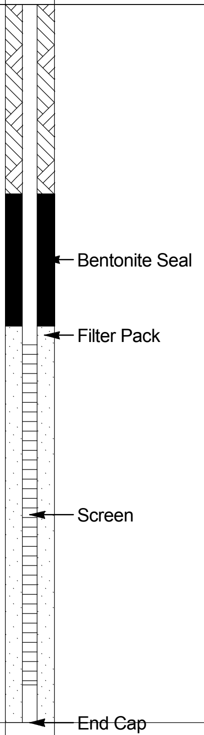
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : West of EPC 1690,

HOLE No. HD01

SHEET 2 OF 2

Position : 426146.0 E 7561468.0 N	**Surface RL:** 312.0m	**Angle from Horiz. :** 90°	**Processed :** CMM
Rig Type : Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Jarrod Freeman	**Checked :** RB
Date Started : 8/9/12	**Date Completed :** 11/9/12	**Logged by :** DK	**Date :** 16/8/13

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**
	Air Hammer 6" bit (reamed to 10")							From 42m; pale brown - orange, no sand			0-59m; Dunda Beds		
45					45.00 (267.03)			CLAY, orange, trace silt, trace fine and medium grained sand					Bentonite Seal
					48.00 (264.03)			Silty CLAY, orange, fragments of claystone					Filter Pack
50													
55													Screen
					59.00 (253.03)			End of Borehole at 59.0m					End Cap
60													
65													
70													
75													
80													



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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 6/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : West of EPC 1690,

HOLE No. HD02

SHEET 1 OF 2

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 :** RB
Date Started : 19/10/12 **Date Completed :** 19/10/12 **Logged by :** DK **Date :** 16/8/13

DRILLING

Drilling Method: Air Hammer 4-3/4" bit (reamed to 10 ")

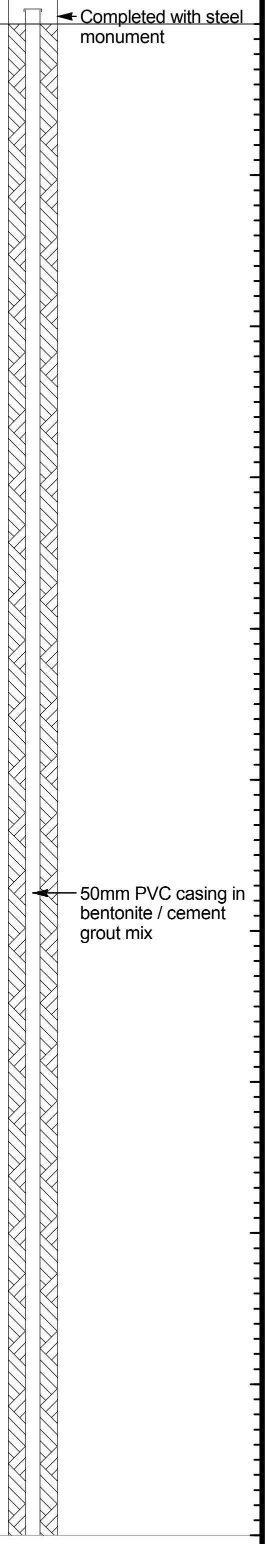
Hole Support \ Casing: 6" steel surface casing (pressure grouted)

Water: ▶ 4

MATERIAL

Depth / (RL) metres	USC Symbol	Description	Moisture Condition	Comments/ Observations
0.00		Silty CLAY, brown with a trace of fine sand 1.00m - 2.00m; slightly moist	D	0-2m; Alluvium
2.00 (238.00)	SP	SAND, white, fine, poorly graded. 3.00m; slightly yellow in colour	D M	2-32m; Clematis Sandstone
4.00 (236.00)		SAND, yellow, angular to subangular, fine grained quartz with a trace of clay. From 5.00m; with a trace of fine to medium gravel.	W W	
10.00 (230.00)		SAND, white, angular to subangular, fine to medium grained	W	
11.00 (229.00)	SC	Clayey SAND, yellow, angular to subangular fine to medium grained		
12.00 (228.00)	SW	SAND, white, angular to subangular, fine to coarse grained. Well graded but becoming coarser with depth		
16.00 (224.00)		SAND, yellow - orange, angular to subangular, fine to medium grained		
17.00 (223.00)		SAND, white, fine to medium grained with a trace of fine to medium gravel		

PIEZOMETER



SCALE (m): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

See standard sheets for details of abbreviations & basis of descriptions

Job No. 41-24415-46

GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 6/8/13

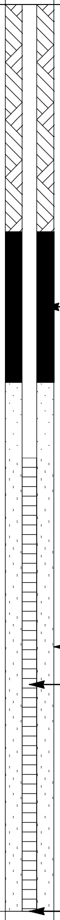
BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Mine Project
Location : West of EPC 1690,

HOLE No. HD02

SHEET 2 OF 2

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 : RB
Date Started : 19/10/12
Date Completed : 19/10/12
Logged by : DK
Date : 16/8/13

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**
											2-32m; Clematis Sandstone		
22													
24	Mud Rotary Wash Boring 6" bit												Bentonite Seal
					25.00 (215.00)			SAND, white, angular to subangular, fine to medium. Interbedded with black micaceous conglomerate					
26													
					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 Screen
30													
					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
34													
36													
38													
40													

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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. HD03A

SHEET 1 OF 2

Position :	427560.0 E 7556126.0 N	**Surface RL:** 229.4m	**Angle from Horiz. :** 90°	**Processed :**	CH
Rig Type :	Bourne 1000 **Mounting:** Truck	**Contractor :** Watson Drilling	**Driller :** Jarrod Freeman	**Checked :**	RB
Date Started :	23/10/12	**Date Completed :** 25/10/12	**Logged by :** DK	**Date :**	16/8/13

DRILLING

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests
0–11	Air Hammer 4 3/4 bit (reamed to 10" with mud rotary wash boring)	6" steel surface casing (pressure grouted)	▸ 6	
11–20	Mud Rotary Wash Boring 4-3/4" bit (reamed to 10")			

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
		CLAY, pale brown with a trace of sand			0-17m; Alluvium
2.00 (227.41)		CLAY, dark brown, with minor lenses of light brown/grey colour.			
4.00 (225.41)		CLAY, pale brown, grey and dark-brown mottled			
6.00 (223.41)	CI	Silty CLAY, pale grey, medium plasticity			
9.00 (220.41)	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.			
10.00 (219.41)	CH	CLAY, pale grey, high plasticity.			
11.00 (218.41)		CLAY, pale brown, with a trace of fine sand.			
16.00 (213.41)		Sandy CLAY, pale brown, sand is subangular to rounded medium to coarse and occasionally fine.			
17.00 (212.41)		Clayey SAND and GRAVEL, pale brown, red and white mottled. Sand is coarse. Gravel is subangular to subrounded and fine.			17-37m; Dunda Beds
19.00 (210.41)	GC	Clayey GRAVEL, white, with a trace of red, orange and black, subangular, fine to coarse of			

PIEZOMETER

Components

- Completed with steel headworks for artesian bore
- 50mm PVC casing in bentonite / cement grout mix

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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. HD03A

SHEET 2 OF 2

Position : 427560.0 E 7556126.0 N
Surface RL: 229.4m
Angle from Horiz. : 90°
Processed : CH
Rig Type : Bourne 1000 **Mounting:** Truck
Contractor : Watson Drilling
Driller : Jarrod Freeman
Checked : RB
Date Started : 23/10/12
Date Completed : 25/10/12
Logged by : DK
Date : 16/8/13

DRILLING — Drilling Method: Mud Rotary Wash Boring 6" bit

Depth / (RL) metres	USC Symbol	Description	Comments/ Observations	Piezometer Components
		quartz.	17-37m; Dunda Beds	
21.00 (208.41)		Sandy CLAY, white with a trace of orange, red and pink. Sand is subangular to angular, fine to medium of quartz.		
23.00 (206.41)		CLAY, purple, with a trace of pale grey mottling, high plasticity		
24.00 (205.41)		CLAY, mottled pale grey and purple with occasional bands of hard claystone.		
25.00 (204.41)	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
29.30 (200.11)		SAND, white, subangular to rounded, fine (10 - 20%) and coarse (80 - 90%). With a trace of gravel (possible contamination from above).	29.30m: Artesian groundwater encountered. Groundwater noted to be flowing 'very slowly'. 30.00m: Temporary casing installed to 30.00m.	Filter Pack Screen
37.00 (192.41)		End of Borehole at 37.0m		End Cap

SCALE (m): 22, 24, 26, 28, 30, 32, 34, 36, 38, 40

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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,

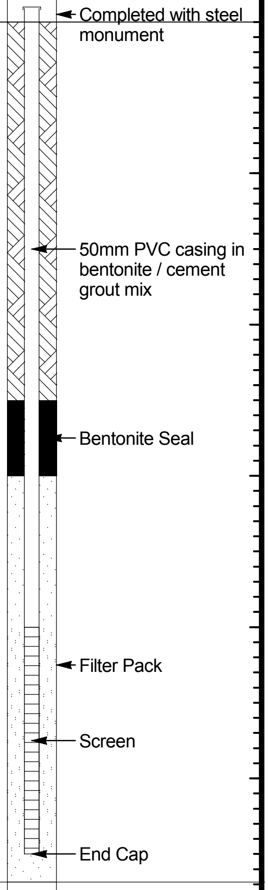
HOLE No. HD03B

SHEET 1 OF 1

Position : 427559.0 E 7556122.0 N
Surface RL: 229.4m
Angle from Horiz. : 90°
Processed : CH
Rig Type : Bourne 1000 **Mounting:** Truck
Contractor : Watson Drilling
Driller : Jarrod Freeman
Checked : RB
Date Started : 25/10/12
Date Completed : 26/10/12
Logged by : DK
Date : 16/8/13

DRILLING				MATERIAL						Comments/ Observations
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	
Mud rotary wash boring (6" bit)	Nil	GNO				CH	CLAY, pale brown, high plasticity.			0 m - 11.37 m; Alluvium
				2.00 (227.41)		CH	CLAY, dark brown with a trace of pale grey, high plasticity			
				4.00 (225.41)		CI	CLAY, pale brown, medium plasticity			
				6.00 (223.41)		CH	CLAY, pale grey, high plasticity			
				11.37 (218.04)			End of borehole 11.37m			

PIEZOMETER



SCALE (m): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

See standard sheets for details of abbreviations & basis of descriptions

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Job No.
41-24415-46

GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1080

HOLE No. C180112SP

SHEET 1 OF 3

Position : 437715.2 E 7558820.2 N	**Surface RL:** 226.2m	**Angle from Horiz. :** 90°	**Processed :** KS
Rig Type : Sandvick 650 **Mounting:** Truck	**Contractor :** Nitro Drilling	**Driller :** Kwan	**Checked :** RR
Date Started : 2/5/13	**Date Completed :** 4/5/13	**Logged by :** DK	**Date :** 16/8/13

DRILLING — SCALE (m) | Drilling Method | Hole Support \ Casing: 150mm PVC | Water | Samples & Tests

SCALE (m): 5, 10, 15, 20, 25, 30, 35, 40

PIEZOMETER — Piezometer Log | Components

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
	CL	CLAY; dark brown, hard and compacted	D		0-16m; Tertiary
3.00 (223.21)	CL	Sandy CLAY; pale yellow, very fine grained sand, yellow powdered clay	D		
5.00 (221.21)	CL	Silty CLAY; pale brown-orange, cohesive	D		Samples contaminated by yellow sandy clay powder from previous sample
16.00 (210.21)	CL	CLAY; dark brown-grey, with minor fine to medium grained sand (<10%), very cohesive		St	16-97m; Permian
28.00 (198.21)	ML	Clayey SILT; yellow, minor sand (<2%), fine to medium grained, gravel / sand inclusion towards base of unit, intact gravel, subangular to rounded, poorly sorted, not cohesive, very soft		S	
39.00 (187.21)		CLAYSTONE / SILTSTONE; in			

See standard sheets for details of abbreviations & basis of descriptions

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Job No.
41-24415-64

GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1080

HOLE No. C180112SP

SHEET 2 OF 3

Position : 437715.2 E 7558820.2 N
Surface RL: 226.2m
Angle from Horiz. : 90°
Processed : KS
Rig Type : Sandvick 650 **Mounting:** Truck
Contractor : Nitro Drilling
Driller : Kwan
Checked : RB
Date Started : 2/5/13
Date Completed : 4/5/13
Logged by : DK
Date : 16/8/13

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
		150mm PVC					pale grey-brown silt matrix, rounded chips, very soft / weathered, low strength, broken				50mm PVC casing with bentonite / cement grout
45											
50											
55											
60					60.00 (166.21)		SILTSTONE; dark grey, rounded chips, minor hard bands, minor silt, medium strength				
65					65.00 (161.21)		COAL; dark grey-black			65-75m; D seam	
70											
75					75.00 (151.21)	SM	Silty SAND; pale to moderate grey, subangular to angular medium sized quartz grains, in grey fine silt				
80											

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

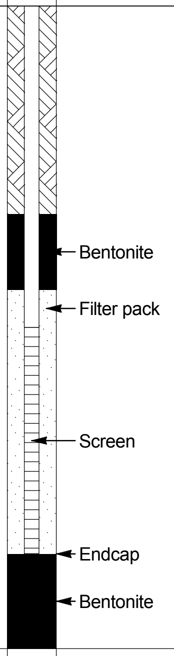
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1080

HOLE No. C180112SP

SHEET 3 OF 3

Position : 437715.2 E 7558820.2 N **Surface RL:** 226.2m **Angle from Horiz. :** 90° **Processed :** KS
Rig Type : Sandvick 650 **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** Kwan **Checked :** RB
Date Started : 2/5/13 **Date Completed :** 4/5/13 **Logged by :** DK **Date :** 16/8/13

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
85													Bentonite Filter pack
90													Screen
95					97.00 (129.21)			From 96 to 97m; decrease in silt and increase in sand End of borehole at 97m, standpipe piezometer installed					Endcap Bentonite
100													
105													
110													
115													
120													



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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1080

HOLE No. C180114SP

SHEET 1 OF 2

Position : 438686.6 E 7557649.2 N
Surface RL: 225.0m
Angle from Horiz. : 90°
Processed : AG/DM
Rig Type : Sandvick 650 **Mounting:** Truck
Contractor : Nitro Drilling
Driller : Gerry
Checked : RB
Date Started : 29/4/13
Date Completed : 30/4/13
Logged by : MP
Date : 16/8/13

DRILLING

Depth (m)	Drilling Method	Hole Support \ Casing
0–3	Air Blade 250 mm	
3–40	Mud Rotary 7 7/8" bit	150mm PVC

MATERIAL

Depth / (RL) metres	USC Symbol	Description	Comments/ Observations
	MI	Sandy SILT; grey-brown with trace orange mottles, trace fine grained sands, trace angular to sub-rounded medium grained quartz sands From 1 to 3m; yellow-brown grey	
3.00 (221.96)	SP	SAND; grey, fine grained From 4 to 5m; yellow-orange-red, fine to coarse grained, sub angular to sub rounded semi-spherical and semi smooth quartz grains	
6.00 (218.96)	MH	SILT; pale grey, trace orange stained fine grained sands	
10.00 (214.96)		CLAYSTONE; pale grey-white with brown-orange mottle From 13 to 17m; significant orange and brown staining	10-71m; Permian
32.00 (192.96)	SP	SAND; grey, medium to coarse grained sands, angular to sub rounded quartz sand with fine sand and silt matrix	
36.00 (188.96)		CLAYSTONE; grey, mottled brown-orange-yellow, trace fine sand	
40.00			

PIEZOMETER

Components

50mm PVC casing with 3% bentonite / cement grout

See standard sheets for details of abbreviations & basis of descriptions

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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1080

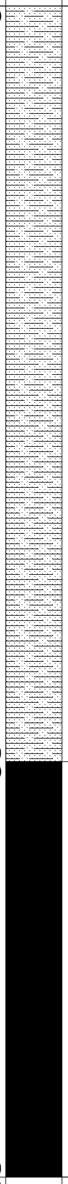
HOLE No. C180114SP

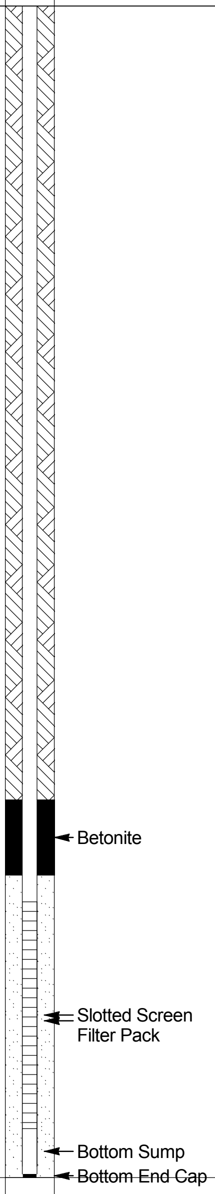
SHEET 2 OF 2

Position : 438686.6 E 7557649.2 N **Surface RL:** 225.0m **Angle from Horiz. :** 90° **Processed :** AG/DM
Rig Type : Sandvick 650 **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** Gerry **Checked :** RR
Date Started : 29/4/13 **Date Completed :** 30/4/13 **Logged by :** MP **Date :** 16/8/13

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
41–45		150mm PVC			(184.96)		Carbonaceous SILTSTONE; dark grey and pale grey, trace fine sand, soft dull coal and black vitreous chips present			
45–71	Mud Rotary 5 5/8" bit				60.00 (164.96)		COAL; black, soft and dull, hard and vitreous, bands of siltstone present, grey			60-71m; D Seam
					71.00 (153.96)		End of borehole at 71 m, standpipe piezometer installed			

SCALE (m): 45, 50, 55, 60, 65, 70, 75, 80





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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C180116SP

SHEET 1 OF 2

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : West of EPC 1690
Position : 439394.4 E 7540910.8 N
Surface RL: 260.7m
Angle from Horiz. : 90°
Processed : KS
Rig Type : Sandvick 650 **Mounting:** Truck
Contractor : Nitro Drilling
Driller :
Checked : RR
Date Started : 9/5/13
Date Completed : 9/5/13
Logged by : LE
Date : 16/8/13

DRILLING

Drilling Method: Air Hammer 5 5/8" bit

Water: 1 L/s estimate (at approx. 36–37 m)

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 – 1.00 (259.70)	CL	CLAY; orange-brown, medium grained sand	M	MD	0-1m; Tertiary
1.00 – 12.00 (248.70)	SP	SAND; pale orange, fine silt, gravels of rounded quartz	D	L	1-71m; Dunda Beds
12.00 – 21.00 (239.70)	SM	SILT; low-plasticity, pale orange-brown, soft, trace fine to coarse grained sand, trace fine gravel			
21.00 – 24.00 (236.70)	CL	CLAY / SILT; low plasticity, pale brown-grey, soft			
24.00 – 29.00 (231.70)		SANDSTONE; red-orange with pale tan grains, fine to medium grained sand, highly weathered / lateritic	M		
29.00 – 40			W		At 29m; no water flow 1-71m; Dunda Beds

PIEZOMETER

Components

- 50mm PVC casing, bentonite / cement grout (0 – approx. 37.5 m)
- Bentonite (approx. 37.5 – 39 m)

SCALE (m): 5, 10, 15, 20, 25, 30, 35, 40

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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : West of EPC 1690

HOLE No. C180116SP

SHEET 2 OF 2

Position :	439394.4 E 7540910.8 N	**Surface RL:** 260.7m	**Angle from Horiz. :** 90°	**Processed :** KS	
Rig Type :	Sandvick 650 **Mounting:** Truck	**Contractor :** Nitro Drilling	**Driller :**	**Checked :** RR	
Date Started :	9/5/13	**Date Completed :** 9/5/13	**Logged by :** LE	**Date :** 16/8/13	

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

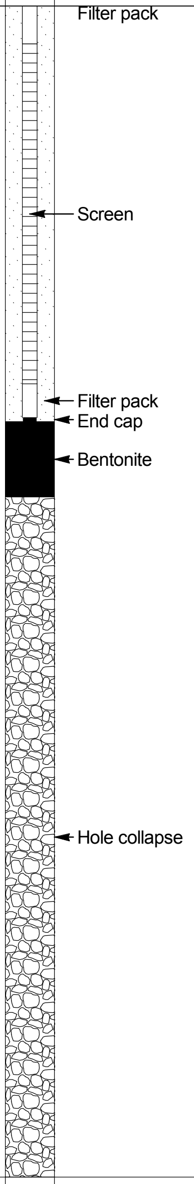
MATERIAL — Depth / (RL) metres | Graphic Log | USC Symbol | Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength | Moisture Condition | Consistency / Density Index

Comments/ Observations

PIEZOMETER — Piezometer Log | Components

Drilling Method	Water	Depth / (RL) metres	Description	Moisture Condition	Comments/ Observations
Air Hammer 5 5/8" bit				W	
	2.5 L/s estimate	41.00 (219.70)	SANDSTONE; pale orange-brown with red grains / bands, fine to medium grained sands and silts, moderately weathered		1-71m; Dunda Beds
	3 L/s estimate	51.00 (209.70)	Clay-rich MUDSTONE; high plasticity, pink, very highly weathered		
		56.00 (204.70)	SANDSTONE; orange, with coarse grained sands, fine silt, sand matrix		
		57.00 (203.70)	Clay-rich SANDSTONE and MUDSTONE; high plasticity, pink-red, highly weathered		
	4 L/s estimate	59.00 (201.70)	SANDSTONE; pale tan, moderately weathered		
	4 L/s estimate	61.00 (199.70)	MUDSTONE; pink-tan, bedded, clay with trace fine sand, highly weathered		
	4 L/s estimate	71.00 (189.70)	End of borehole at 71m, standpipe piezometer installed		

SCALE (m): 45, 50, 55, 60, 65, 70, 75, 80



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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

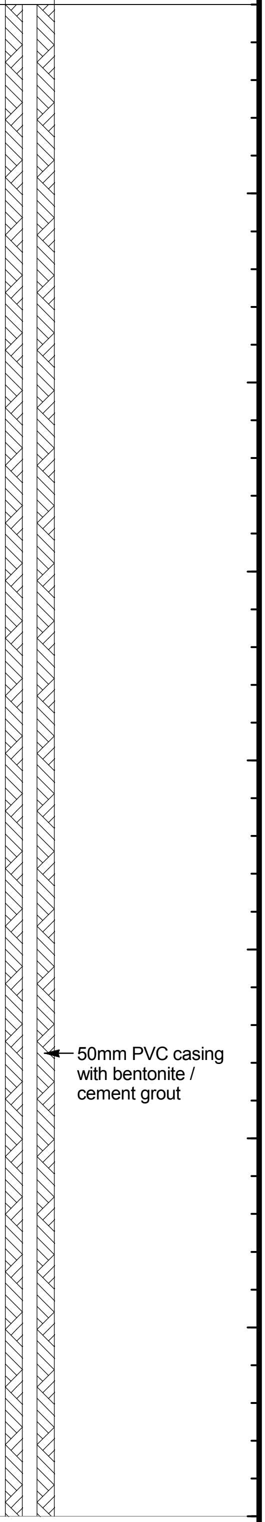
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1080

HOLE No. C180119SP

SHEET 1 OF 3

Position : 448587.2 E 7536354.4 N
Surface RL: 219.0m
Angle from Horiz. : 90°
Processed : KS
Rig Type : Sandvick 650 **Mounting:** Truck
Contractor : Nitro Drilling
Driller : Alan
Checked : RB
Date Started : 11/5/13
Date Completed : 13/5/13
Logged by : LE/ADW
Date : 16/8/13

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**	**Components**
0	Air Hammer	150mm PVC					SP	SAND; orange, (alluvial)	D			
					1.00 (218.00)		CL	CLAY; orange, trace to minor sand (fine to medium grained)			Difficult drilling (collaring)	
5	Mud Rotary 7 7/8" bit											
					7.00 (212.00)		CL	Clay / MUDSTONE; tan, clay / silt size with abundant fine, medium and coarse sand grains, very highly weathered, abundant quartz (coarse) fragments between 14 and 18 m				
10												
15												
					18.00 (201.00)		CL	CLAY; grey and dark brown, uniform throughout, hard		MD		
20												
25												50mm PVC casing with bentonite / cement grout
30												
					34.00 (185.00)			CLAYSTONE; brown-purple, trace quartz, sticky				
35												
40												



See standard sheets for details of abbreviations & basis of descriptions

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1080

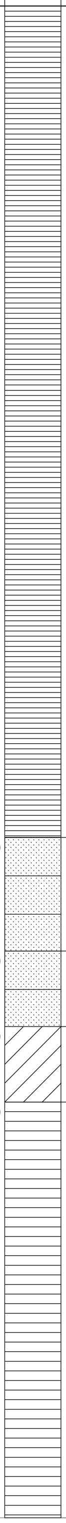
HOLE No. C180119SP

SHEET 2 OF 3

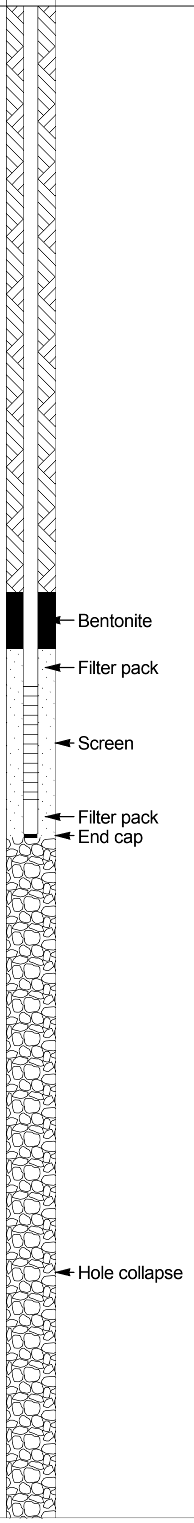
Position : 448587.2 E 7536354.4 N **Surface RL:** 219.0m **Angle from Horiz. :** 90° **Processed :** KS
Rig Type : Sandvick 650 **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** Alan **Checked :** RR
Date Started : 11/5/13 **Date Completed :** 13/5/13 **Logged by :** LE/ADW **Date :** 16/8/13

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	USC Symbol	Description	Moisture Condition	Consistency / Density Index	Comments/ Observations
45 50	Mud Rotary 7 7/8" bit	150mm PVC								Geologist interpreted as Jockmus FM to the east of coal measures
55	Mud Rotary 5 5/8" bit									Driller casing off (6"), hard
										No rods in hole. Flowing at 10 L/min, EC = 6.64 mS/cm, pH = 6.16, Temperature = 26.7 degrees celsius
60							Trace hard 'rock' fragments, grey-purple, can be crumbled / balled into clay, hard (59-62 m)			
					62.00 (157.00)	CL	Clay and CARBONACEOUS MUDSTONE; black chips in clayey matrix, very fine grained, occasionally vitreous, generally hard but some can be balled into a carbonaceous mud, occasional red-purple tinge, clay is grey-purple			
65					65.00 (154.00)	CL	Clay and CARBONACEOUS MUDSTONE; grey-purple and black			
					67.00 (152.00)	CI	CLAY; grey and purple streaks, plastic / sticky, trace carbonaceous mudstone and coal fragments			
70 75					69.00 (150.00)		MUDSTONE; dark grey / purple, bedded with white siltstones, moderately weathered			
80					80.00					

Graphic Log



PIEZOMETER



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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1080

HOLE No. C180119SP

SHEET 3 OF 3

Position : 448587.2 E 7536354.4 N **Surface RL:** 219.0m **Angle from Horiz. :** 90° **Processed :** KS
Rig Type : Sandvick 650 **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** Alan **Checked :** RB
Date Started : 11/5/13 **Date Completed :** 13/5/13 **Logged by :** LE/ADW **Date :** 16/8/13

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
					(139.00)			SANDSTONE; white, coarse grains, dominant quartz rounded to sub rounded					
85					85.00 (134.00)			End of borehole at 85 m, standpipe piezometer installed					
90													
95													
100													
105													
110													
115													
120													

See standard sheets for details of abbreviations & basis of descriptions

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C180120SP

SHEET 1 OF 2

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1080

Position : 447056.6 E 7531730.0 N
Surface RL: 227.1m
Angle from Horiz. : 90°
Processed : VD
Rig Type : Sandvick
Mounting: Truck
Contractor : Nitro Drilling
Driller : Darryl
Checked : RB
Date Started : 26/5/13
Date Completed : 27/5/13
Logged by : RB
Date : 16/8/13

DRILLING

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests
0–2	Mud Rotary 7 7/8"	Steel 8 inch		
2–30		PVC casing 150mm		
30–40	Mud Rotary 5 5/8"			

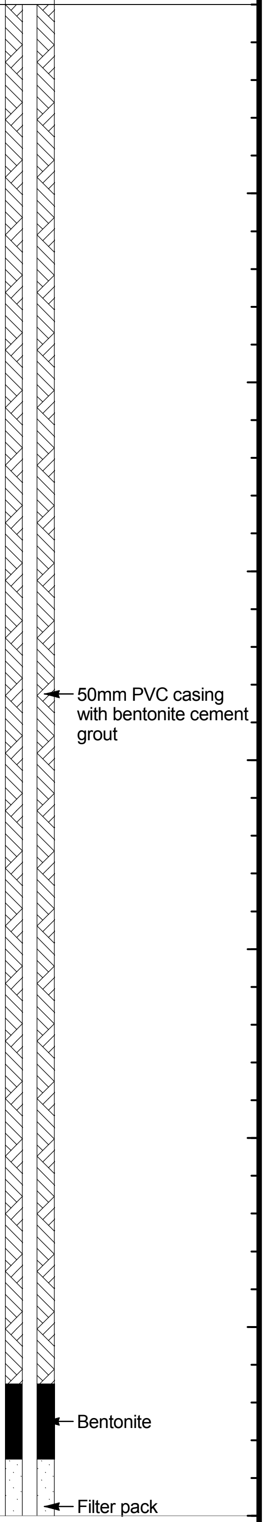
MATERIAL

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
	MI	Sandy SILT; pale brown, fine grained sand	D	
1.00 (226.11)	CH	Sandy CLAY; brown, high plasticity, fine grained sand, trace medium grained sand	SM	
4.00 (223.11)	CH	CLAY with Sand; brown-green, high plasticity, fine grained sand		
6.00 (221.11)	CH	CLAY; brown-green, high plasticity, trace sand From 8 m; no sand		
12.00 (215.11)	CH	CLAY; brown-green with red mottling, high plasticity		
18.00 (209.11)	CH	CLAY; pale greyish brown, high plasticity		
33.00 (194.11)	CH	CLAY; reddish brown and grey, high plasticity, trace ferruginous fine grained rock, hard		
37.00 (190.11)	CH	CLAY; pale pinkish brown, high plasticity, some medium grained sand		
39.00 (188.11)	CH	CLAY and Sandy CLAY; pale		

Comments/ Observations

PIEZOMETER

Piezometer Log / **Components**



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CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. **41-24415-64**

GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

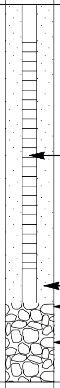
BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1080

HOLE No. C180120SP

SHEET 2 OF 2

Position : 447056.6 E 7531730.0 N
Surface RL: 227.1m
Angle from Horiz. : 90°
Processed : VD
Rig Type : Sandvick
Mounting: Truck
Contractor : Nitro Drilling
Driller : Darryl
Checked : RB
Date Started : 26/5/13
Date Completed : 27/5/13
Logged by : RB
Date : 16/8/13

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**
45	Mud Rotary 5 5/8"				48.00 (179.11)	▨		pinkish brown (Sandy CLAY) greyish brown (CLAY), high plasticity. Sand fine to medium grained with trace coarse grained, sub-angular of quartz (yellow, pink, white and grey), trace fine gravel. Possibly interbedded CLAY and Sandy CLAY (very similia to lithology seen at C027 on lease).			At 42 m; stopped drilling at 22:00, driller noted water production at 23:15.		Screen Filter pack End Cap
					50.00 (177.11)			No sample returns			Hole collapsed back to 36 m, driller tripped back in to clean out hole and new EOH at 50 m. Thicker muds were used to condition hole.		Hole collapse
50 55 60 65 70 75 80								End of hole at 50 m, piezometer installed.					

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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : West of EPC 1080

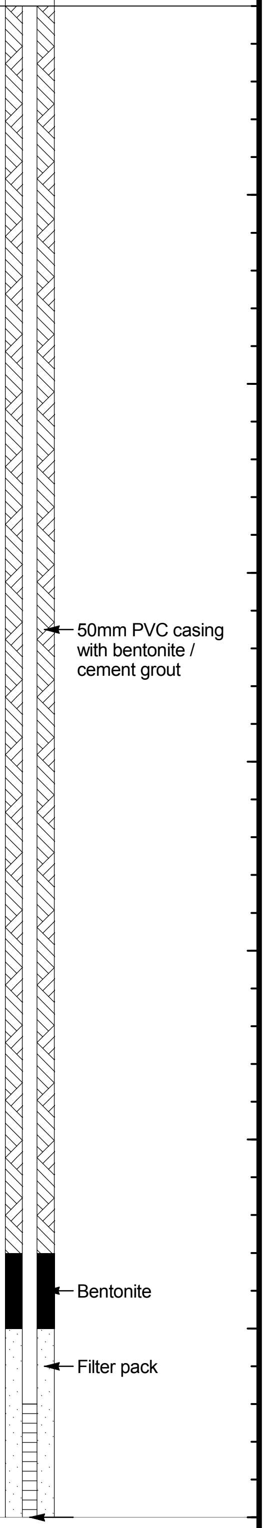
HOLE No. C9180121SPR

SHEET 1 OF 2

Position : 4488085.6 E 7529363.8 N
Surface RL: 229.8m
Angle from Horiz. : 90°
Processed : VD
Rig Type : Sandvick DE81
Mounting: Truck
Contractor : Nitro Drilling
Driller : Alan/Darryl
Checked : RB
Date Started : 21/5/13
Date Completed :
Logged by : Adani
Date : 16/8/13

Depth / (RL) metres	USC Symbol	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Drilling Method
0.00	ML	SILT; orange-brown with trace pale yellow mottling, low plasticity, trace fine grained sand, trace organic matter (rootlets)	Air 10" bit
2.50 (227.26)	MI	Clayey SILT; pale grey-white with stained red-brown layers, mottled yellow and orange, trace carbonaceous material, trace fine grained sand, highly weathered	Air 5 5/8" bit
6.00 (223.76)	CH	Silty CLAY; pale brown-grey, trace dark red-brown mottling, high plasticity, trace fine grained sand	Mud Rotary 5 5/8 bit
18.00 (211.76)	ML	SILT; pale grey-pink, mottled red, yellow and brown, low plasticity, trace fine grained sand	
23.00 (206.76)		CLAYSTONE; pale grey, trace orange and yellow mottling plus dark grey streaking in places (carbonaceous ?), trace silt	
36.00 (193.76)		MUDSTONE; dark grey, mottled dark red-brown with a trace of orange and yellow mottling, trace carbonaceous material From 37 to 39m; heavily to	

PIEZOMETER



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Job No. 41-24415-64

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

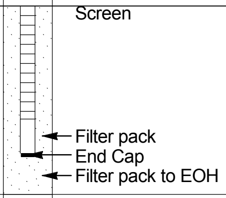
HOLE No. C9180121SPR

SHEET 2 OF 2

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : West of EPC 1080

Position :	4488085.6 E 7529363.8 N	**Surface RL:** 229.8m	**Angle from Horiz. :** 90°	**Processed :**	VD
Rig Type :	Sandvick DE810 **Mounting:** Truck	**Contractor :** Nitro Drilling	**Driller :** Alan/Darryl	**Checked :**	RR
Date Started :	21/5/13	**Date Completed :**	**Logged by :** Adani	**Date :**	16/8/13

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
								completely iron stained dark red-brown then returning to slightly mottled From 43m; CLAYSTONE chips, pale brown-pale grey, soft, iron stained (possibly contamination from above lithology)					Screen Filter pack End Cap Filter pack to EOH
45					45.00 (184.76)			End of hole at 45 m, standpipe piezometer installed					
50													
55													
60													
65													
70													
75													
80													



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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1080

HOLE No. C180122SP

SHEET 1 OF 2

Position : 448580.8 E 7536351.2 N
Surface RL: 219.0m
Angle from Horiz. : 90°
Processed : VD
Rig Type : Sandvick
Mounting: Truck
Contractor : Nitro Drilling
Driller : Paul
Checked : RR
Date Started : 14/5/13
Date Completed : 15/5/13
Logged by : MP
Date : 16/8/13

DRILLING

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests
0–6	Air Hammer	150mm PVC		
6–40	Mud Rotary 5 5/8" bit			

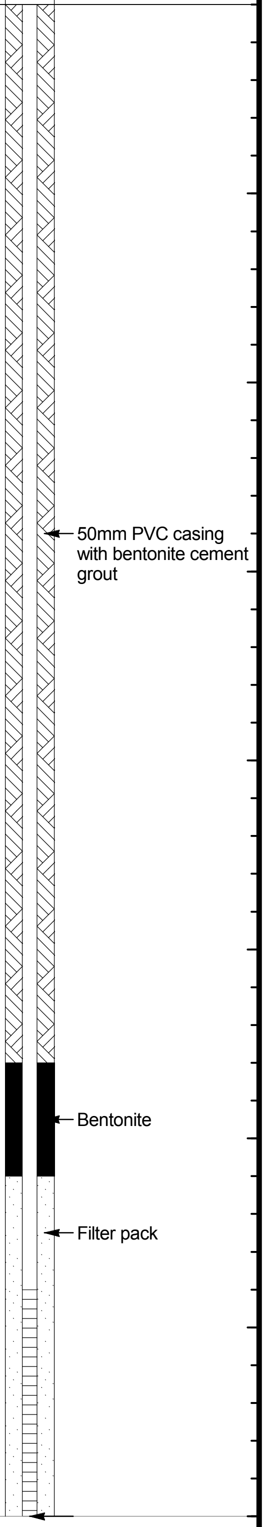
MATERIAL

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
0.00		SM	Silty SAND; dark orange, very fine to fine grained and trace medium grained sand, medium plasticity fines			
2.00 (217.00)			SANDSTONE; yellow mottled and streaked dark orange and red, very fine to fine grained sand, silt matrix supported, completley weathered to extremely weathered			
8.00 (211.00)		MI	Clayey SILT; pale grey with yellow-orange mottling and streaks, very fine grained sand, trace fine grained sand			
10.00 (209.00)		SP-SM	SAND; yellow grey with orange mottling, fine grained sand, silt fines, trace medium grained sand			
14.00 (205.00)			Gravelly SAND; predominantly medium grained sand, some coarse rounded to sub-angular quartz sand, fine sub-rounded semi-polished quartz gravel, silt matrix			
16.00 (203.00)		CH	CLAY; pale brown-grey, trace of orange and yellow mottling, high plasticity, trace fine grained sand, trace silt in parts			
33.00 (186.00)		CI-CH	CLAY; dark brown, medium to high plasticity			
40.00						

PIEZOMETER

Piezometer Log

Components



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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1080

HOLE No. C180122SP

SHEET 2 OF 2

Position : 448580.8 E 7536351.2 N **Surface RL:** 219.0m **Angle from Horiz. :** 90° **Processed :** VD
Rig Type : Sandvick **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** Paul **Checked :** RR
Date Started : 14/5/13 **Date Completed :** 15/5/13 **Logged by :** MP **Date :** 16/8/13

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 5 5/8" bit				(179.00)			CLAYSTONE; pale grey-white in places heavily stained dark reddish brown, Completley weathered to extremely weathered, weak, altered, bleached					Screen
45					43.00 (176.00)		CI	CLAY; dark greyish brown with a trace of orange mottling, medium plasticity, trace of fine grained sand			At 43 m, artesian Flow observed		Filter pack End Cap
50					47.00 (172.00)			End of hole at 47 m, standpipe piezometer installed					
55													
60													
65													
70													
75													
80													

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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 3/9/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1080

HOLE No. C180123SP

SHEET 1 OF 4

Position : 448079.0 E 7529358.0 N
Surface RL: 229.9m
Angle from Horiz. : 90°
Processed : VD
Rig Type : Sandvick 650 **Mounting:** Truck
Contractor : Nitro Drilling
Driller :
Checked : RB
Date Started : 23/5/13
Date Completed : 24/5/13
Logged by : Adani
Date : 5/9/13

Depth / (RL) metres	USC Symbol	Description	Comments/ Observations
0.00	ML	SILT; orange-brown with trace pale yellow mottling, low plasticity, trace fine grained sand, trace organic matter (rootlets)	0-45m; lithology assumed to be as per C180121SP
2.50 (227.36)	MI	Clayey SILT; pale grey-white with stained red-brown layers, mottled yellow and orange, trace carbonaceous material, trace fine grained sand, highly weathered	
6.00 (223.86)	CH	Silty CLAY; pale brown-grey, trace dark red-brown mottling, high plasticity, trace fine grained sand	
18.00 (211.86)	ML	SILT; pale grey-pink, mottled red, yellow and brown, low plasticity, trace fine grained sand	
23.00 (206.86)		CLAYSTONE; pale grey, trace orange and yellow mottling plus dark grey streaking in places (carbonaceous ?), trace silt	
36.00 (193.86)		MUDSTONE; dark grey, mottled dark red-brown with a trace of orange and yellow mottling, trace carbonaceous material From 37 to 39m; heavily to	

SCALE (m): 5, 10, 15, 20, 25, 30, 35, 40

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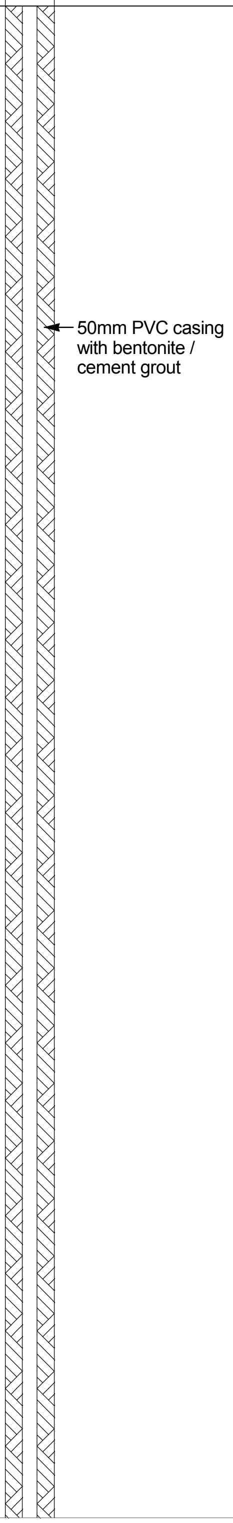
Job No. **41-24415-64**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client :	Adani Mining Pty Ltd				
Project :	Carmichael Coal Project			**HOLE No. C180123SP**	
Location :	EPC 1080			**SHEET 2 OF 4**	
Position :	448079.0 E 7529358.0 N	**Surface RL:** 229.9m	**Angle from Horiz. :** 90°	**Processed :**	VD
Rig Type :	Sandvick 650 **Mounting:** Truck	**Contractor :** Nitro Drilling	**Driller :**	**Checked :**	RB
Date Started :	23/5/13	**Date Completed :** 24/5/13	**Logged by :** Adani	**Date :**	5/9/13

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**
								completely iron stained dark red-brown then returning to slightly mottled					
								From 43m; CLAYSTONE chips, pale brown-pale grey, soft, iron stained (possibly contamination from above lithology)					
45					45.00 (184.86)			CLAYSTONE; pale grey to grey, minor lateritic fragments, moderately weathered					50mm PVC casing with bentonite / cement grout
50													
55								From 56 to 58m; interbedded with sandstone					
								From 58 to 62m; ferruginous					
60													
65													
70													
75													
80													



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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 3/9/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1080

HOLE No. C180123SP

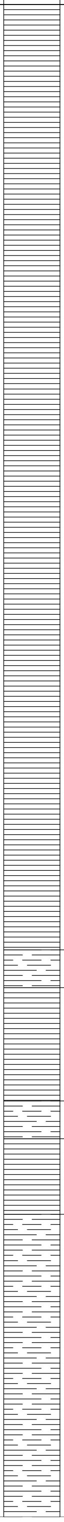
SHEET 3 OF 4

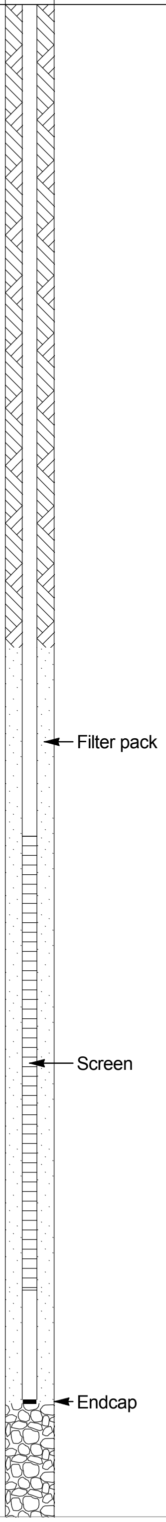
Position : 448079.0 E 7529358.0 N
Surface RL: 229.9m
Angle from Horiz. : 90°
Processed : VD
Rig Type : Sandvick 650 **Mounting:** Truck
Contractor : Nitro Drilling
Driller :
Checked : RB
Date Started : 23/5/13
Date Completed : 24/5/13
Logged by : Adani
Date : 5/9/13

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

SCALE (m)	Depth / (RL) metres	Description	Comments/ Observations
		From 82 to 89m; some sandstone fragments	
85			
90		From 89 to 102m; colour change to pale yellow	
95			
100			
105	105.00 (124.86)	SILTSTONE; grey, clayey in parts, trace ferruginous fragments	45-130m; lithology summarised from Adani borehole log
	106.00 (123.86)	CLAYSTONE; reddish grey, some siltstone fragments, ferruginous in parts, moderately weathered	
	109.00 (120.86)	SILTSTONE; grey, clayey in parts, trace ferruginous fragments	
110	110.00 (119.86)	CLAYSTONE; grey, some siltstone fragments, ferruginous in parts, trace sandstone fragments moderately weathered	
	112.00 (117.86)	SILTSTONE; grey, clayey in parts, trace ferruginous fragments, sandstone in parts, slightly weathered	
115			
120			





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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1080

HOLE No. C180123SP

SHEET 4 OF 4

Position : 448079.0 E 7529358.0 N
Surface RL: 229.9m
Angle from Horiz. : 90°
Processed : VD
Rig Type : Sandvick 650 **Mounting:** Truck
Contractor : Nitro Drilling
Driller :
Checked : RB
Date Started : 23/5/13
Date Completed : 24/5/13
Logged by : Adani
Date : 5/9/13

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
													Hole collapse
125								From 125 to 127m; grades to fine grained sandstone					
130					130.00 (99.86)			End of borehole at 130m, standpipe iezometer installed					
135													
140													
145													
150													
155													
160													

See standard sheets for details of abbreviations & basis of descriptions

GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1080

HOLE No. C9180124SPR

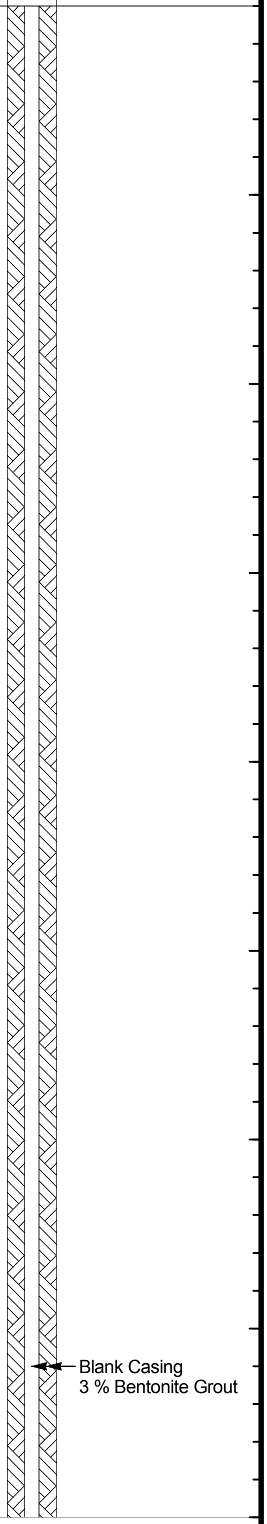
SHEET 1 OF 3

Position : 448600.0 E 7536357.8 N
Surface RL: 219.0m
Angle from Horiz. : 90°
Processed : VD
Rig Type : Sandvick
Mounting: Truck
Contractor : Nitro Drilling
Driller : Darryl
Checked : RB
Date Started : 25/5/13
Date Completed : 26/5/13
Logged by : RB
Date : 16/8/13

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
	Air Blade	150mm PVC (pressure grouted)				SM	Silty SAND; red-brown, fine grained sand	D		
	Mud Rotary 7 7/8 bit				2.00 (216.97)	CH	Silty CLAY; pale brown, high plasticity			
5					4.00 (214.97)	CH	CLAY; pale brown, high plasticity			
10					10.00 (208.97)	CI	Sandy CLAY; pale brown with orange mottling, fine grained sand			
					11.00 (207.97)	SM	Silty SAND; pale brown and orange, medium grained sand, trace of fine and coarse grained sand From 14-15 m; with fine and medium sub-rounded gravel From 17-19 m; with fine sub-rounded gravel			
15										
20					19.00 (199.97)	CH	CLAY; green-brown, high plasticity			
25										
30										
35					34.00 (184.97)	CL	CLAY; dark brow-purple with red mottling (possible iron staining), low plasticity			
40										

PIEZOMETER

Piezometer Log | Components



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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1080

HOLE No. C9180124SPR

SHEET 2 OF 3

Position : 448600.0 E 7536357.8 N **Surface RL:** 219.0m **Angle from Horiz. :** 90° **Processed :** VD
Rig Type : Sandvick **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** Darryl **Checked :** RB
Date Started : 25/5/13 **Date Completed :** 26/5/13 **Logged by :** RB **Date :** 16/8/13

DRILLING

SCALE (m)	Drilling Method	Hole Support \ Casing
43–65.5	Mud Rotary 7 7/8 bit	150mm PVC (pressure grouted)
65.5–80	Mud Rotary 5 5/8 bit	

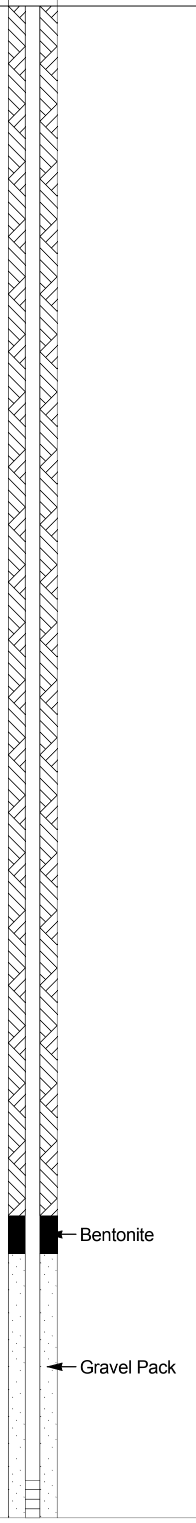
Scale: 45, 50, 55, 60, 65, 70, 75, 80

MATERIAL

Depth / (RL) metres	USC Symbol	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength
43.00 (175.97)	CI	CLAY; dark grey-brown
54.00 (164.97)	CH	CLAY; grey and purple, high plasticity
64.00 (154.97)	CH	CLAY; pale brown-grey, high plasticity From 74 m; with sand, orange, coarse grained
77.00 (141.97)	CH	Sandy CLAY; pale brown, high plasticity, medium and coarse grained sub-angular and sub-rounded sand
78.00 (140.97)	SW-SC	

Comments/ Observations

PIEZOMETER



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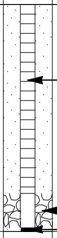
BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1080

HOLE No. C9180124SPR

SHEET 3 OF 3

Position : 448600.0 E 7536357.8 N **Surface RL:** 219.0m **Angle from Horiz. :** 90° **Processed :** VD
Rig Type : Sandvick **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** Darryl **Checked :** RB
Date Started : 25/5/13 **Date Completed :** 26/5/13 **Logged by :** RB **Date :** 16/8/13



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
	Mud Rotary 5 5/8 bit							SAND with clay; pale brown, medium to coarse grained sub-rounded quartz sand, with pale brown high plasticity clay From 79 m; colour grading to pale grey					Slotted Screen
85					82.00 (136.97)		CH	Sandy CLAY; pale grey, high plasticity, medium to coarse grained sub-rounded quartz sand					Hole collapse in annulus around sump
90 95 100 105 110 115 120					86.00 (132.97)			End of hole at 86 m, standpipe piezometer installed.			Bore not flowing at end of drilling		Bottom End Cap

See standard sheets for details of abbreviations & basis of descriptions

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Job No.
41-24415-64

GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1080

HOLE No. C180125SP

SHEET 1 OF 4

Position : 447040.4 E 7531739.0 N
Surface RL: 227.1m
Angle from Horiz. : 90°
Processed : VD
Rig Type : Sandvick
Mounting: Truck
Contractor : Nitro Drilling
Driller : Alan
Checked : RR
Date Started : 30/5/13
Date Completed : 31/5/13
Logged by : VD
Date : 16/8/13

Drilling Method	Hole Support \ Casing	Depth / (RL) metres	USC Symbol	Description	Moisture Condition
Air Hammer	Steel 9 7/8"		MI	Sandy SILT; pale brown, fine grained sand	D
		1.00 (226.11) 2.00 (225.11)	CH	Sandy CLAY; brown, high plasticity, fine grained sand, trace medium grained sand	SM
Mud Rotary 6 1/4" bit		4.00 (223.11)	CH	CLAY with Sand; brown-green, high plasticity, fine grained sand	
		6.00 (221.11)	CH	CLAY; brown-green, high plasticity, trace sand From 8 m; no sand	
		12.00 (215.11)	CH	CLAY; brown-green with red mottling, high plasticity	
		18.00 (209.11)	CH	CLAY; pale grey-brown, high plasticity	
		33.00 (194.11)	CH	CLAY; red-brown and grey, high plasticity, trace ferruginous fine grained rock, hard	
		37.00 (190.11)	CH	CLAY; pale pink-brown, high plasticity, some medium grained sand	
		39.00 (188.11)	CH	CLAY and Sandy CLAY; pale	

SCALE (m): 5, 10, 15, 20, 25, 30, 35, 40

Columns: 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: Piezometer Log | Components

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 Project
Location : EPC 1080

HOLE No. C180125SP

SHEET 2 OF 4

Position : 447040.4 E 7531739.0 N
Surface RL: 227.1m
Angle from Horiz. : 90°
Processed : VD
Rig Type : Sandvick
Mounting: Truck
Contractor : Nitro Drilling
Driller : Alan
Checked : RB
Date Started : 30/5/13
Date Completed : 31/5/13
Logged by : VD
Date : 16/8/13

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 6 1/4" bit							pink-brown (Sandy CLAY) grey-brown (CLAY), high plasticity. Sand fine to medium grained with trace coarse grained, sub-angular of quartz (yellow, pink, white and grey), trace fine gravel. Possibly interbedded CLAY and Sand					
45													50mm PVC casing with bentonite cement grout
					48.00 (179.11)		CH	Sandy CLAY; pale cream-grey, high plasticity, occasional ferruginous sandstone chips, red-purple low strength, fine to medium grained sub-angular sand					
50													
55					55.00 (172.11)		CH	Sandy CLAY; red-orange, high plasticity, stiff increasing to very stiff towards base of unit, red fine grained sand		St-VSt			
60													
					63.00 (164.11)		CH	CLAY; yellow-brown, high plasticity, stiff, minor sand From 67 to 69 m; pale cream-grey mottling		St			
65													
70													
					72.00 (155.11)		CL-CI	Sandy CLAY; yellow-brown with pale grey mottling in parts, low to medium plasticity, sand increasing towards base of unit		F			
75													
80													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1080

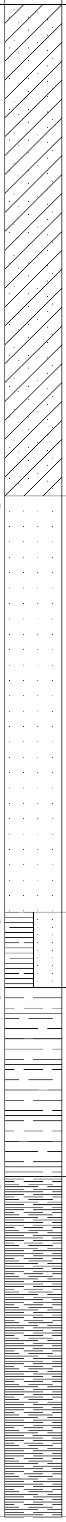
HOLE No. C180125SP

SHEET 3 OF 4

Position : 447040.4 E 7531739.0 N		**Surface RL:** 227.1m		**Angle from Horiz. :** 90°	**Processed :** VD
Rig Type : Sandvick	**Mounting:** Truck	**Contractor :** Nitro Drilling		**Driller :** Alan	**Checked :** RB
Date Started : 30/5/13		**Date Completed :** 31/5/13		**Logged by :** VD	**Date :** 16/8/13

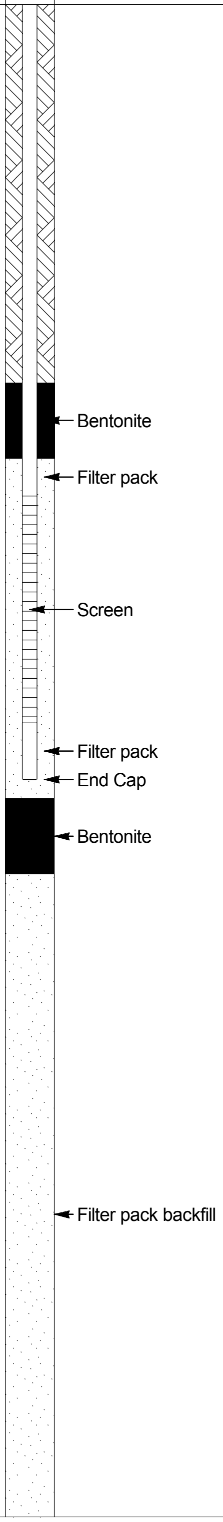
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	USC Symbol	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations
85 90	Mud Rotary 6 1/4" bit								F	
95 100					93.00 (134.11)		SANDSTONE; pale grey, clayey matrix, fine to medium grained, slightly weathered, low strength			Base of weathering
105					104.00 (123.11)		SILTSTONE / SANDSTONE; pale grey, fine to medium grained sandstone, very fine grained siltstone, fresh, low to medium strength			
110					106.00 (121.11)		SILTSTONE / CLAYSTONE; grey to dark grey, very fine grained siltstone, fresh, low to medium strength			
115 120	Mud Rotary 5 5/8" bit				111.00 (116.11)		SILTSTONE; grey to dark grey, very fine grained, hard, fresh			Driller encountered harder drilling, tripped out and changed to PCD bit.

Graphic Log



PIEZOMETER

Piezometer Log / **Components**



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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1080

HOLE No. C180125SP

SHEET 4 OF 4

Position : 447040.4 E 7531739.0 N **Surface RL:** 227.1m **Angle from Horiz. :** 90° **Processed :** VD
Rig Type : Sandvick **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** Alan **Checked :** RR
Date Started : 30/5/13 **Date Completed :** 31/5/13 **Logged by :** VD **Date :** 16/8/13

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**
					121.00 (106.11)								
125													
130													
135													
140													
145													
150													
155													
160													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C823SP

SHEET 1 OF 3

Position : 433605.2 E 7562874.8 N **Surface RL:** 245.9m **Angle from Horiz. :** 90° **Processed :** KS
Rig Type : Sandvick 650 **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** Gerry/Daryl **Checked :** RR
Date Started : 30/4/13 **Date Completed :** 1/5/13 **Logged by :** LE/DK **Date :** 16/8/13

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

- Drilling Method: Air Hammer (0 – 24 m); Mud Rotary (24 – 40 m)
- Hole Support \ Casing: 150 mm PVC

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
0.00	FERRICRETE; orange and white, clay	D		0-55m; Tertiary
3.00 (242.92)	SILT; orange, clay			
7.00 (238.92)	FERRICRETE; dark orange			
9.00 (236.92)	SILT; orange, minor clay in parts			
11.00 (234.92)	Clayey SAND; yellow-orange, fine grained			
13.00 (232.92)	SILT; orange			
14.00 (231.92)	CLAY; yellow			
15.00 (230.92)	Clayey SAND; yellow-orange, fine grained			
16.00 (229.92)	Sandy CLAY; yellow			
20.00 (225.92)	CLAY; orange, minor sand	D		
24.00 (221.92)				
25.00 (220.92)	CLAY; orange			
31.00 (214.92)	Sandy CLAY; yellow-white			
36.00 (209.92)	CLAY; yellow, soft, very cohesive		S	

SCALE (m): 5, 10, 15, 20, 25, 30, 35, 40

PIEZOMETER — Piezometer Log | Components

See standard sheets for details of abbreviations & basis of descriptions

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C823SP

SHEET 2 OF 3

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690
Position : 433605.2 E 7562874.8 N **Surface RL:** 245.9m **Angle from Horiz. :** 90° **Processed :** KS
Rig Type : Sandvick 650 **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** Gerry/Daryl **Checked :** RB
Date Started : 30/4/13 **Date Completed :** 1/5/13 **Logged by :** LE/DK **Date :** 16/8/13

Drilling Method	Hole Support \ Casing	Depth / (RL) metres	Graphic Log	Description	Consistency / Density Index	Comments/ Observations	Components
Mud Rotary	150 mm PVC				S		
		41.00 (204.92)		CLAY; pale yellow-white		0-55m; Tertiary	
		45.00 (200.92)		CLAY; pale cream			
		48.00 (197.92)		Silty CLAY; white-cream, silt very friable / powder, minor very fine sand (5%) From 51m; pale brown-yellow, no sand From 53m; white-cream, extremely fine rock powder			50 mm PVC casing with bentonite / cement grout
		55.00 (190.92)	■	COAL; fresh rock, minor clay inclusion at base		55-111m; Permian 55-58m; AB3 Seam	
		58.00 (187.92)		CLAY; pale grey			
		75.00 (170.92)		CLAY; pale grey, very soft, very sticky, very cohesive, no fines, minor hard bands	S		
		76.00 (169.92)		CLAY; pale grey, very soft, very sticky, very cohesive, no fines, minor hard bands	S		

SCALE (m): 45, 50, 55, 60, 65, 70, 75, 80

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C823SP

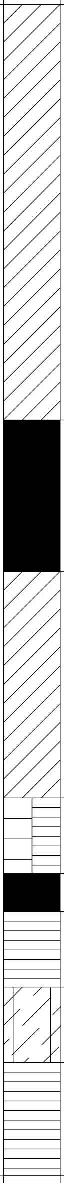
SHEET 3 OF 3

Position : 433605.2 E 7562874.8 N
Surface RL: 245.9m
Angle from Horiz. : 90°
Processed : KS
Rig Type : Sandvick 650 **Mounting:** Truck
Contractor : Nitro Drilling
Driller : Gerry/Daryl
Checked : RR
Date Started : 30/4/13
Date Completed : 1/5/13
Logged by : LE/DK
Date : 16/8/13

DRILLING | **MATERIAL** | **PIEZOMETER**

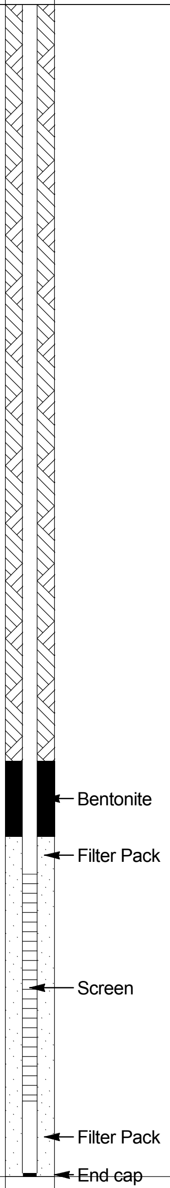
SCALE (m): 85, 90, 95, 100, 105, 110, 115, 120

Drilling Method: Mud Rotary



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
		S	55-111m; Permian
91.00 (154.92)	COAL / CARBONACEOUS MUD; highly weathered		91-95m; C1 Seam
95.00 (150.92)	CLAY; pale grey and grey, high plasticity, sticky		
101.00 (144.92)	CLAYSTONE / MUDSTONE; dark grey, hard, no sand		
103.00 (142.92)	COAL; minor mudstone inclusion		103-104; C2 Seam
104.00 (141.92)	MUDSTONE / CLAY; clay dark brown, very soft	VS	
106.00 (139.92)	Clayey SILT; pale grey, very sticky / soft	VS	
108.00 (137.92)	MUDSTONE / COAL; mudstone dark grey, coal extremely weathered		
111.00 (134.92)	SILTSTONE / MUDSTONE; dark grey		

End of borehole at 111 m, standpipe piezometer installed



See standard sheets for details of abbreviations & basis of descriptions

Job No. 41-24415-64

GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C825SP

SHEET 1 OF 4

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690
Position : 434868.0 E 7561960.4 N **Surface RL:** 238.1m **Angle from Horiz. :** 90° **Processed :** KS
Rig Type : Sandvick 650 **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** **Checked :** RB
Date Started : 2/5/13 **Date Completed :** 3/5/13 **Logged by :** MP **Date :** 16/8/13

DRILLING | **MATERIAL** | **PIEZOMETER**

Hole Support \ Casing: 150mm PVC

Depth / (RL) metres	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Comments/ Observations
0.00	Sandy SILT; pale grey, trace orange and brown mottling, very fine to fine grained sand, trace medium to coarse sand	0-44m; Tertiary
11.00 (227.06)	CLAY; pale grey-white, high plasticity, trace fine grained sand From 13.0 m; trace orange and red mottling	
15.00 (223.06)	Sandy SILT; medium plasticity, grey with orange and red mottling, fine to medium grained sand, trace clay	
17.50 (220.56)	Sandy SILT; pale grey-brown, with clay, fine grained sand, trace medium sand From 21.0 m; significantly mottled / stained red and orange	
30.00 (208.06)	Sandy CLAY; pale grey, trace orange and yellow mottling, fine grained sand	

SCALE (m): 5, 10, 15, 20, 25, 30, 35, 40

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C825SP

SHEET 2 OF 4

Position : 434868.0 E 7561960.4 N
Surface RL: 238.1m
Angle from Horiz. : 90°
Processed : KS
Rig Type : Sandvick 650 **Mounting:** Truck
Contractor : Nitro Drilling
Driller :
Checked : RR
Date Started : 2/5/13
Date Completed : 3/5/13
Logged by : MP
Date : 16/8/13

Hole Support \ Casing	Depth / (RL) metres	Description	Comments/ Observations	Components
150mm PVC		From 42.0 m, heavily stained red	0-44m; Tertiary	
	44.00 (194.06)	CLAYSTONE; grey, heavily stained orange	44-134m; Permian	
	60.00 (178.06)	Carbonaceous SILTSTONE; brown-grey, black carbonaceous material, trace very fine grained sand		50mm PVC casing with bentonite / cement grout
	64.00 (174.06)	SANDSTONE; pale grey, very fine to fine grained sand, matrix supported		
	66.00 (172.06)	Carbonaceous SILTSTONE; grey-dark and grey, trace fine grained sand		
	71.00 (167.06)	COAL; black	71-75m; C1 Seam	
	75.00 (163.06)	Carbonaceous SANDSTONE; grey-dark grey, fine grained, matrix supported		

SCALE (m): 45, 50, 55, 60, 65, 70, 75, 80

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Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C825SP

SHEET 3 OF 4

Position : 434868.0 E 7561960.4 N	**Surface RL:** 238.1m	**Angle from Horiz. :** 90°	**Processed :** KS
Rig Type : Sandvick 650 **Mounting:** Truck	**Contractor :** Nitro Drilling	**Driller :**	**Checked :** RB
Date Started : 2/5/13	**Date Completed :** 3/5/13	**Logged by :** MP	**Date :** 16/8/13

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**
											44-134m; Permian		
					81.00 (157.06)			COAL; black			81-82m; C2 Seam		
					82.00 (156.06)			Carbonaceous SANDSTONE; dark grey, hard					
85					84.00 (154.06)			COAL; black, dull and soft, hard and vitreous, interbedded with bands of carbonaceous siltstone			84-108m; C3 and D1 Seams		
90													
95													
100													
105													
110					108.00 (130.06)			Interbedded SILTSTONE and SANDSTONE; grey, very fine to fine grained sand, matrix supported					
115					113.00 (125.06)			Interbedded COAL and Carbonaceous SILTSTONE; grey-dark grey siltstone, black coal, trace fine grained sand, vitreous, hard, abundant pyrite (<1 cm in size)			113-125m; D2 and D3 Seams		
120													

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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

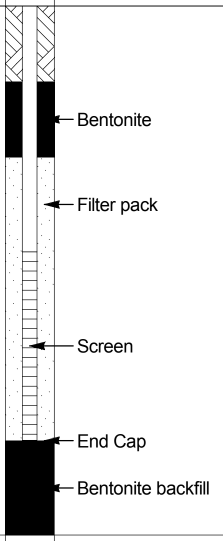
HOLE No. C825SP

SHEET 4 OF 4

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690
Position : 434868.0 E 7561960.4 N **Surface RL:** 238.1m **Angle from Horiz. :** 90° **Processed :** KS
Rig Type : Sandvick 650 **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** **Checked :** RB
Date Started : 2/5/13 **Date Completed :** 3/5/13 **Logged by :** MP **Date :** 16/8/13

SCALE (m)	Depth / (RL) metres	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Comments/ Observations
			44-134m; Permian
125	125.00 (113.06)	SANDSTONE; pale grey, fine grained sand, grain supported, hard, fine to coarse sand present in layers (sub angular to sub rounded), quartz, trace of fine grained rounded to sub rounded quartz gravel	
130			
	132.00 (106.06)	COAL; black, vitreous, hard, pyrite present	132-134m; F1 Seam
	134.00 (104.06)	End of hole at 134 m, standpipe piezometer installed	
135			
140			
145			
150			
155			
160			

PIEZOMETER



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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C827SP

SHEET 1 OF 4

Position : 436101.2 E 7560333.6 N
Surface RL: 231.7m
Angle from Horiz. : 90°
Processed : KS
Rig Type : Sandvick
Mounting: Truck
Contractor : Nitro Drilling
Driller : Jason
Checked : RR
Date Started : 6/5/13
Date Completed : 7/5/13
Logged by : ADW
Date : 16/8/13

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	150mm PVC						CLAY; brown and dark brown, dry, hard, streaks of grey throughout	D	H	0-18m; Tertiary		
4					4.00 (227.69)			CLAY; pale brown and brown, dry and hard, silty at 6.0 and 7.0 m					
7					7.00 (224.69)			Silty CLAY; grey, dry and hard, approximately 50% larger clay fragments in silty material					
18					18.00 (213.69)			CLAY; grey-black, uniform throughout Red tinges at 28.29 m Dark red at 30.0 m, sticky			Water injected 18-138m; Permian		
34					34.00 (197.69)			Sandy SILT; various colours but mostly pale yellow-white, fine grained silt and sand					
40													

See standard sheets for details of abbreviations & basis of descriptions

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CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No.
41-24415-64

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C827SP

SHEET 2 OF 4

Position : 436101.2 E 7560333.6 N
Surface RL: 231.7m
Angle from Horiz. : 90°
Processed : KS
Rig Type : Sandvick
Mounting: Truck
Contractor : Nitro Drilling
Driller : Jason
Checked : RR
Date Started : 6/5/13
Date Completed : 7/5/13
Logged by : ADW
Date : 16/8/13

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	Components
45	Air Hammer	150mm PVC								18-138m; Permian	
50							Becoming grey				
					52.00 (179.69)		Lateritic CLAY; red coarse grained to gravelly lateritic (iron stained fragments) in moist clay From 52 to 54m; pink From 57.0m; pink From 58 to 60m; tan-brown				
55											
60											
					62.00 (169.69)		CLAY; brown and red-brown, sticky				50mm PVC casing with bentonite / cement grout
65											
					67.00 (164.69)		CLAY; dark grey-black with streaks of pale brown				
					69.00 (162.69)		CLAY; carbonaceous "muddy clay", black clay and coal fragments mostly sticky, coal fragments vitreous when broken, laminar			C Seam	
70											
75										Driller / geotech report water at 75.0 m	
80											

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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C827SP

SHEET 3 OF 4

Position : 436101.2 E 7560333.6 N
Surface RL: 231.7m
Angle from Horiz. : 90°
Processed : KS
Rig Type : Sandvick
Mounting: Truck
Contractor : Nitro Drilling
Driller : Jason
Checked : RR
Date Started : 6/5/13
Date Completed : 7/5/13
Logged by : ADW
Date : 16/8/13

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
82–87	Air Hammer	150mm PVC						From 82.0 to 83.0m; slight brown tinge			18-138m; Permian		
								Coal fragments increasing			D1 seam		
87					87.00 (144.69)			SANDSTONE; pale grey, fine to medium grained, soft / low strength, minor clay bands and red clay banding					
96								From 96m; pale grey surface shearing banding, dark grey fragments, minor red-pale grey clay					
102								From 102m; pale grey, pale grey and red clay banding, fine to medium grained, low strength, minor clay fragments					
110					110.00 (121.69)			SILTSTONE; dark grey, minor sandstone and red clay fragments (most likely contaminants from above)			Noted very high water flow.		
								Tending carbonaceous towards base					
118					118.00 (113.69)			COAL; black, contaminants from above			118-123m; D2 and D3 Seams Water flow		

Scale marks: 85, 90, 95, 100, 105, 110, 115, 120

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

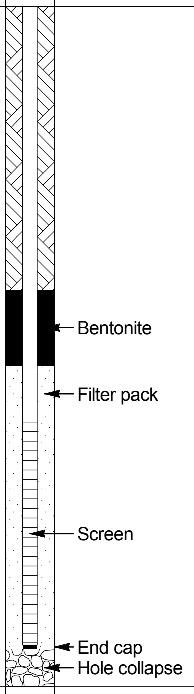
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C827SP

SHEET 4 OF 4

Position : 436101.2 E 7560333.6 N **Surface RL:** 231.7m **Angle from Horiz. :** 90° **Processed :** KS
Rig Type : Sandvick **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** Jason **Checked :** RB
Date Started : 6/5/13 **Date Completed :** 7/5/13 **Logged by :** ADW **Date :** 16/8/13

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
	Air Hammer					■					increased through coal seam, most coal probably washed out of sample due to water flow 18-138m; Permian		
125 130					123.00 (108.69)			SAND; coarse grained, minor fine to medium grained gravel, quartz, minor fine to medium grained sand, minor supported component, suggest weak strength					Bentonite Filter pack
					133.00 (98.69)	■		COAL; contaminants from above, sand, angular and coarse			133-135m; E Seam		Screen
135					135.00 (96.69)			SANDSTONE; pale grey, fine to medium grained support, medium strength, predominantly sub angular to angular quartz					End cap Hole collapse
140 145 150 155 160					138.00 (93.69)			End of borehole at 138 m, standpipe piezometer installed					



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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C829SP

SHEET 1 OF 4

Position : 436462.8 E 7559356.4 N
Surface RL: 238.1m
Angle from Horiz. : 90°
Processed : DM
Rig Type : Sandvick 650 **Mounting:** Truck
Contractor : Nitro Drilling
Driller : Jason
Checked : RR
Date Started : 5/5/13
Date Completed : 6/5/13
Logged by : ADW
Date : 16/8/13

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**
	Air Hammer						CH	Silty CLAY; dark red-brown, trace quartz gravel	D	H	0-42m; Tertiary		
5					3.00 (235.10)		SP-SM	Silty SAND; pale brown - yellow, traces of red and grey					
10					9.00 (229.10)		CH	CLAY; dark red-brown, sticky and plastic, trace gravel From 12m; dark grey From 14m; no gravel					
15													
20	Mud Rotary	150mm PVC											
25													
30													
35													
40													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C829SP

SHEET 2 OF 4

Position : 436462.8 E 7559356.4 N
Surface RL: 238.1m
Angle from Horiz. : 90°
Processed : DM
Rig Type : Sandvick 650 **Mounting:** Truck
Contractor : Nitro Drilling
Driller : Jason
Checked : RR
Date Started : 5/5/13
Date Completed : 6/5/13
Logged by : ADW
Date : 16/8/13

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**
											0-42m; Tertiary 42-147m; Permian		
	Mud Rotary	150mm PVC			42.00 (196.10)			LATERITE; grey-red, mixture of sandstone, iron stained gravel and quartz grains, trace clay, fine to medium grained					
45					45.00 (193.10)		CH	Gravelly CLAY; white - pale grey, fine sticky clay which often consolidates into larger (1 - 2 cm) plastic/breakable fragments					
50													
55													
60													
					62.00 (176.10)		CH	Gravelly CLAY; red-pink					
65													
					66.00 (172.10)		CH	CLAY; pale brown-yellow, very fine grained, sticky					50mm PVC casing with 3 % Bentonite Grout
70													
75													
					78.00 (160.10)			CLAY and COAL; dark brown-black, very fined grained					
80													

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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C829SP

SHEET 3 OF 4

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690
Position : 436462.8 E 7559356.4 N
Surface RL: 238.1m
Angle from Horiz. : 90°
Processed : DM
Rig Type : Sandvick 650 **Mounting:** Truck
Contractor : Nitro Drilling
Driller : Jason
Checked : RR
Date Started : 5/5/13
Date Completed : 6/5/13
Logged by : ADW
Date : 16/8/13

Drilling Method	Hole Support \ Casing	Depth / (RL) metres	Description	Moisture Condition	Comments/ Observations
Mud Rotary	150mm PVC	81.00 (157.10)	COAL; black, very fine grained, some carbonaceous mudstone / claystone, brittle		42-147m; Permian
		84.00 (154.10)	SILTSTONE; pale grey, brittle, minor clay inclusion, soft and sticky	D	
Mud Rotary 5 5/8 bit		94.00 (144.10)	COAL; black, powder	D	94-117m; C Seams
		97.00 (141.10)	SILTSTONE / Carbonaceous CLAYSTONE	M	
		99.00 (139.10)	Carbonaceous MUDSTONE; dark grey, very soft and sticky	W	
		113.00 (125.10)	Carbonaceous MUDSTONE; dark grey-black		
		116.00 (122.10)	COAL		
		117.00 (121.10)	Carbonaceous MUDSTONE; dark grey		
		120.00			

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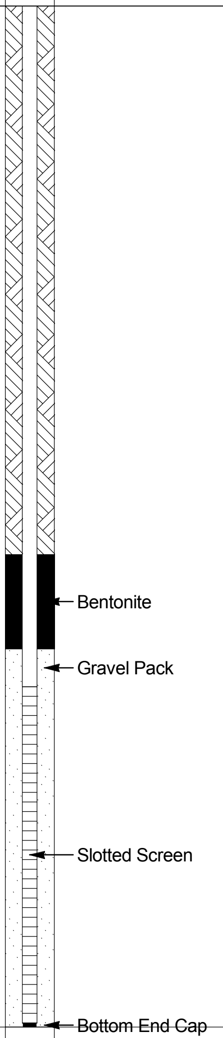
BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C829SP

SHEET 4 OF 4

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690
Position : 436462.8 E 7559356.4 N **Surface RL:** 238.1m **Angle from Horiz. :** 90° **Processed :** DM
Rig Type : Sandvick 650 **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** Jason **Checked :** RR
Date Started : 5/5/13 **Date Completed :** 6/5/13 **Logged by :** ADW **Date :** 16/8/13

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 5 5/8 bit				(118.10)			COAL; black, fresh			42-147m; Permian 120-123m; D1 Seam		
125					123.00 (115.10)			Carbonaceous SILTSTONE; minor claystone bands with hard sandstone bands					
					125.00 (113.10)			SANDSTONE; pale grey, fine to medium grained, hard, very brittle					
130					132.00 (106.10)			SANDSTONE; pale grey, fine to medium grained, angular to sub-angular quartz, minor coal contamination					
135					135.00 (103.10)			SANDSTONE; pale grey, coarse grained sand, fine to medium grained gravel, angular to sub-angular					Bentonite
140					137.00 (101.10)			SANDSTONE; pale grey, fine to medium grained support, fine with minor (<5%) very fine grained, sub-angular to angular with silt inclusion towards base					Gravel Pack Slotted Screen
145					147.00 (91.10)			End of borehole at 147 m, standpipe piezometer installed					Bottom End Cap
150													
155													
160													



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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

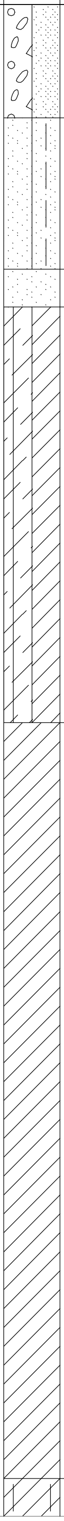
HOLE No. C832SP

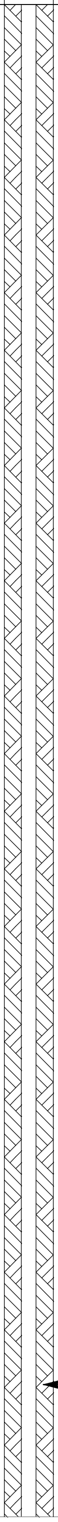
SHEET 1 OF 3

Position : 439570.4 E 7554788.2 N **Surface RL:** 223.1m **Angle from Horiz. :** 90° **Processed :** DM
Rig Type : Sandvick 650 **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** Gerry **Checked :** RR
Date Started : 11/5/13 **Date Completed :** 12/5/13 **Logged by :** ADW/LE **Date :** 16/8/13

DRILLING				MATERIAL							PIEZOMETER
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	Components
Air Hammer	150mm PVC				SP-SM	Silty gravelly SAND; dark red-brown and purple, fine to coarse grained			0-19m; Tertiary	
Mud Rotary				3.00 (220.14)	GP-GM	Silty SAND; pale brown-yellow, very fine grained silt to medium quartz sand				
				7.00 (216.14)	SP	SAND; pale red, fine to medium grained, sub angular quartz, trace silt				
				8.00 (215.14)		Clayey SILT; grey, very fine grained silt with sticky clay				
				19.00 (204.14)	CH	CLAY; grey, high plasticity, sticky From 27 m; trace red colouring From 29 m; Dark red-brown colouring From 31 m; Grey with trace of red colouring			19-102m; Permian	3 % Bentonite Grout
				39.00 (184.14)		Silty CLAY; grey-white, very				

SCALE (m): 5, 10, 15, 20, 25, 30, 35, 40

Graphic Log


Piezometer Log


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Job No. **41-24415-64**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C832SP

SHEET 2 OF 3

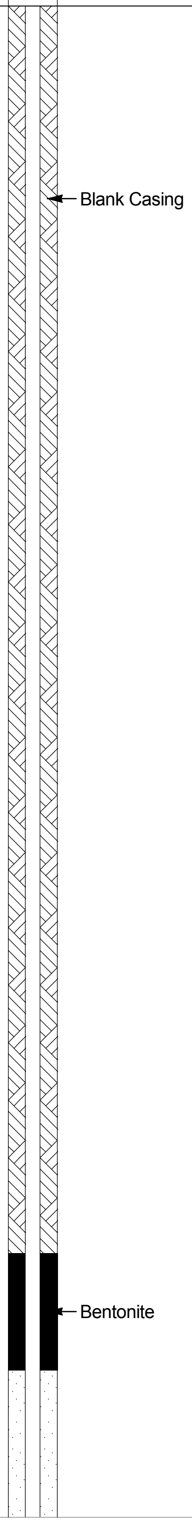
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690
Position : 439570.4 E 7554788.2 N
Surface RL: 223.1m
Angle from Horiz. : 90°
Processed : DM
Rig Type : Sandvick 650 **Mounting:** Truck
Contractor : Nitro Drilling
Driller : Gerry
Checked : RB
Date Started : 11/5/13
Date Completed : 12/5/13
Logged by : ADW/LE
Date : 16/8/13

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
45	Mud Rotary	150mm PVC						fine to fine grained, minor quartz			19-102m; Permian
50											
55											
60					57.00 (166.14)			CLAY/MUDSTONE; pink-white, very highly weathered From 59m; orange, very highly weathered			
65											
70											
75					72.00 (151.14)			Carbonaceous MUDSTONE; trace coal			
80											

PIEZOMETER

Piezometer Log

Components



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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C832SP

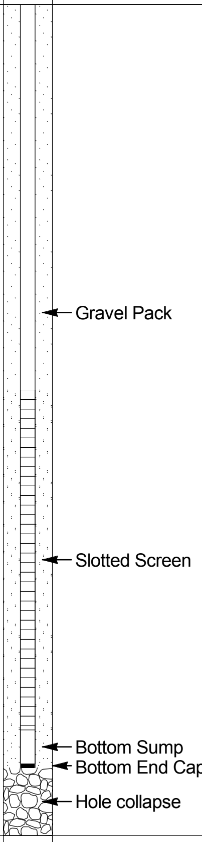
SHEET 3 OF 3

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690
Position : 439570.4 E 7554788.2 N **Surface RL:** 223.1m **Angle from Horiz. :** 90° **Processed :** DM
Rig Type : Sandvick 650 **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** Gerry **Checked :** RB
Date Started : 11/5/13 **Date Completed :** 12/5/13 **Logged by :** ADW/LE **Date :** 16/8/13

DRILLING					MATERIAL						Comments/ Observations
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	
	Mud Rotary	150mm PVC				▒					19-102m; Permian
85					83.00 (140.14)	■		COAL; black, minor mudstone, slightly weathered, low strength			83-88m; C1 Seam
					88.00 (135.14)	☰		CLAY/MUDSTONE; tan, highly weathered, low strength			
90					89.00 (134.14)	■		COAL; black, minor mudstone, slightly weathered	W		89-96m; C2 Seam
95					96.00 (127.14)	▒		Carbonaceous MUDSTONE; grey, minor coal, moderately weathered, low strength			
100					102.00 (121.14)			End of borehole at 102 m, standpipe piezometer installed			
105											
110											
115											
120											

PIEZOMETER

Piezometer Log | Components



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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C833SP

SHEET 1 OF 4

Position : 439559.0 E 7554779.0 N **Surface RL:** 223.1m **Angle from Horiz. :** 90° **Processed :** KS
Rig Type : Sandvick **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** Kwan **Checked :** RR
Date Started : 1/5/13 **Date Completed :** 5/5/13 **Logged by :** DK/ADW **Date :** 16/8/13

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							CLAY; yellow-orange, broken / powder	D		0-23m; Tertiary		
5	Mud Rotary 7 7/8" bit	150mm PVC			2.00 (221.06)			SAND; yellow-orange, fine grained, minor clay in matrix minor yellow clay at base					
10					10.00 (213.06)			Silty CLAY; pale grey, minor red mottling		St			
15 20 25					12.00 (211.06)			CLAY; pale grey, very cohesive, no sand inclusion From 23m; with minor red clay mottling, grading to a darker shade of grey CLAY; dark brown, minor red clay inclusion		 VSt	23-135m; Permian		
30 35					27.00 (196.06)			CLAY; pale grey, stiff, no fines, minor soft / sticky banding From 33m; pale grey-white and stiff pale grey (assume banding of soft / hard clay) no sand / fines		St			
40					37.00 (186.06)			Clayey SILT; white, very sticky, minor sand inclusion (10-15%), fine to medium grained (predominantly medium grained) sub angular to sub		VS			

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C833SP

SHEET 2 OF 4

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690
Position : 439559.0 E 7554779.0 N **Surface RL:** 223.1m **Angle from Horiz. :** 90° **Processed :** KS
Rig Type : Sandvick **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** Kwan **Checked :** RR
Date Started : 1/5/13 **Date Completed :** 5/5/13 **Logged by :** DK/ADW **Date :** 16/8/13

Drilling Method	Hole Support \ Casing	Depth / (RL) metres	Description	Consistency / Density Index	Comments/ Observations
Mud Rotary 7 7/8" bit	150mm PVC		rounded quartz	VS	23-135m; Permian
		51.00 (172.06)	Silty CLAY; pale grey-white, no fines, sticky, mottling pink-red bands that are slightly harder		
		55.00 (168.06)	CLAY; pale brown-dark grey, with yellow and white silty clay mottling, stiff	St	
		63.00 (160.06)	CLAY; dark grey, stiff		
		64.00 (159.06)	Carbonaceous MUDSTONE / CLAY; dark grey stiff clay		
Mud Rotary 5 5/8" bit		69.00 (154.06)	CLAY; dark grey, minor silt, no fines, very sticky	VS	

SCALE (m): 45, 50, 55, 60, 65, 70, 75, 80

PIEZOMETER – Components: 50mm PVC casing with bentonite cement grout

See standard sheets for details of abbreviations & basis of descriptions

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CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. **41-24415-64**

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C833SP

SHEET 3 OF 4

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690
Position : 439559.0 E 7554779.0 N
Surface RL: 223.1m
Angle from Horiz. : 90°
Processed : KS
Rig Type : Sandvick
Mounting: Truck
Contractor : Nitro Drilling
Driller : Kwan
Checked : RR
Date Started : 1/5/13
Date Completed : 5/5/13
Logged by : DK/ADW
Date : 16/8/13

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 5 5/8" bit									VS			
					81.00 (142.06)			CLAY; black with trace grey streaks, very fine grained, sticky, minor fragments of carbonaceous material, fragments broken easily, laminar			23-135m; Permian 81-104m; C seams		
85													
90													
95								From 98m; pale to moderately grey, abundance of coal fragments (>2 mm) throughout					
100													
					104.00 (119.06)			CLAY; black					
105													
110													
					114.00 (109.06)			Gravelly CLAY; grey-black, sticky, gravel sized carbonaceous fragments in sticky fine clay			Hard drilling		
115													
120					120.00								

See standard sheets for details of abbreviations & basis of descriptions

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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

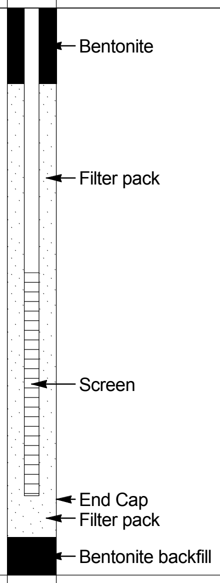
BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C833SP

SHEET 4 OF 4

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690
Position : 439559.0 E 7554779.0 N **Surface RL:** 223.1m **Angle from Horiz. :** 90° **Processed :** KS
Rig Type : Sandvick **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** Kwan **Checked :** RB
Date Started : 1/5/13 **Date Completed :** 5/5/13 **Logged by :** DK/ADW **Date :** 16/8/13

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 5 5/8" bit				(103.06)	■		COAL; black, generally hard, some friable to sticky clay, slight organic odour			D seam 23-135m; Permian		Bentonite
125						■							Filter pack
130						■		From 29m; grey-black colouring			Hard drilling		Screen End Cap Filter pack Bentonite backfill
135					135.00 (88.06)			End of hole at 135m, standpipe piezometer installed					
140													
145													
150													
155													
160													



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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C834SP

SHEET 1 OF 4

Position : 439576.8 E 7554763.8 N
Surface RL: 223.1m
Angle from Horiz. : 90°
Processed : AG
Rig Type : Sandvick 650 **Mounting:** Truck
Contractor : Nitro Drilling
Driller : David
Checked : RB
Date Started : 29/4/13
Date Completed : 1/5/13
Logged by : LE/DK
Date : 16/8/13

DRILLING				MATERIAL							PIEZOMETER
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		Components
Air Hammer 9" bit	Steel Collar				MH	SILT; orange, bedded, with fine grained sand	D		0-36m; Tertiary		
				4.00 (219.09)	MI	SILT; pale brown-white, with fine grained sand	-				
Mud Rotary 5 5/8" reamed to 7 7/8" bit	150mm PVC			6.00 (217.09)	MI	SILT; orange, with coarse grained polished quartz sand					
				12.00 (211.09)	CH	CLAY; brown, high plasticity					
				36.00 (187.09)	ML	SILT; white, low plasticity			36-151.5m; Permian		

SCALE (m): 5, 10, 15, 20, 25, 30, 35, 40

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C834SP

SHEET 2 OF 4

Position : 439576.8 E 7554763.8 N **Surface RL:** 223.1m **Angle from Horiz. :** 90° **Processed :** AG
Rig Type : Sandvick 650 **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** David **Checked :** RB
Date Started : 29/4/13 **Date Completed :** 1/5/13 **Logged by :** LE/DK **Date :** 16/8/13

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 5 5/8" reamed to 7 7/8" bit	150mm PVC									36-151.5m; Permian		
45													
50													
55													
60													
65													
					68.00 (155.09)		MI	SILT; orange, medium plasticity, trace clay					
					69.00 (154.09)			CARBONACEOUS MUDSTONE; dark brown, with trace coal					50 mm PC casing with bentonite cement grout
70													
75													
80													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C834SP

SHEET 3 OF 4

Position : 439576.8 E 7554763.8 N
Surface RL: 223.1m
Angle from Horiz. : 90°
Processed : AG
Rig Type : Sandvick 650 **Mounting:** Truck
Contractor : Nitro Drilling
Driller : David
Checked : RR
Date Started : 29/4/13
Date Completed : 1/5/13
Logged by : LE/DK
Date : 16/8/13

Drilling Method: Mud Rotary 5 5/8"

Depth / (RL) metres	USC Symbol	Description	Moisture Condition	Consistency / Density Index	Comments/ Observations
81.00 (142.09)	CL	CLAY; pale grey, minor white clay bedding towards base of unit			36-151.5m; Permian
82.00 (141.09)	CL	CLAY/CARBONACEOUS MUDSTONE; dark grey			
89.00 (134.09)		CARBONACEOUS MUDSTONE; dark grey-black, very sticky			
90.00 (133.09)	CH	CLAY; light grey-brown, high plasticity, trace hard banded claystone		VS	
98.00 (125.09)		CARBONACEOUS MUDSTONE; cohesive, clay content increasing with depth		VS	
104.00 (119.09)	ML	SILT; pale grey-white, low plasticity			
108.00 (115.09)	ML	SILT; dark grey, very sticky			
115.00 (108.09)	ML	SILT; dark grey, very sticky, minor hard bands			
120.00					

See standard sheets for details of abbreviations & basis of descriptions

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C834SP

SHEET 4 OF 4

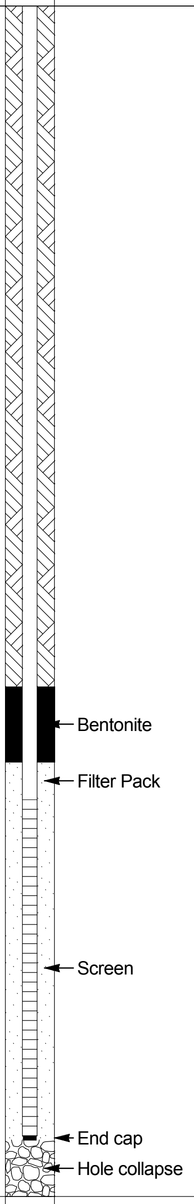
Position : 439576.8 E 7554763.8 N		**Surface RL:** 223.1m		**Angle from Horiz. :** 90°	**Processed :** AG
Rig Type : Sandvick 650	**Mounting:** Truck	**Contractor :** Nitro Drilling		**Driller :** David	**Checked :** RB
Date Started : 29/4/13		**Date Completed :** 1/5/13		**Logged by :** LE/DK	**Date :** 16/8/13

DRILLING — Drilling Method: Mud Rotary 5 5/8"

Depth / (RL) metres	USC Symbol	Description	Comments/ Observations
(103.09)		COAL/CARBONACEOUS MUDSTONE; extremely weathered	120-136m; D Seam 36-151.5m; Permian
134.00 (89.09)		COAL; minor clay band	
136.00 (87.09)	CL	CLAY; pale grey, with coal	
137.00 (86.09)		COAL; black	
138.00 (85.09)	CL	CLAY/SILT; pale grey, with fine to medium grained quartz, coal flecks, minor sandstone fragments	
144.00 (79.09)		CARBONACEOUS SILTSTONE; dark grey with fine to medium grained quartz, coal flecks, minor sandstone fragments	
151.00 (72.09)	CI	CLAY; pale grey, with fine to medium grained sub-angular-subrounded milky quartz sand	
151.50 (71.59)		End of borehole at 151.5 m, standpipe piezometer installed	

SCALE (m): 125, 130, 135, 140, 145, 150, 155, 160

PIEZOMETER



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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C9838SPR

SHEET 1 OF 3

Position : 439558.4 E 7552183.2 N
Surface RL: 228.6m
Angle from Horiz. : 90°
Processed : VD
Rig Type : Sandvick 650 **Mounting:** Truck
Contractor : Nitro Drilling
Driller :
Checked : RR
Date Started :
Date Completed :
Logged by : Adani
Date : 16/8/13

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
5								Sandy SILT; brown-grey, fine to medium sand (quartz), trace coarse quartz sand, medium plasticity fines From 3.0m; iron stained and hardened significantly in places to 6m	D	MD-D	0-20m; Tertiary		
10 15					7.00 (221.60)			SILT; grey, trace orange mottling, medium plasticity, with sand, fine to medium quartz sand From 16m; significant red, dark red and red-brown staining to 20m		St			
20 25 30 35 40					20.00 (208.60)			CLAY; brown-grey, colour gradually darkening with depth to dark brown-grey at 44.0 m, high plasticity, appears slightly fissured		St	20-98; Permian		50mm PVC casing with bentonite / cement grout

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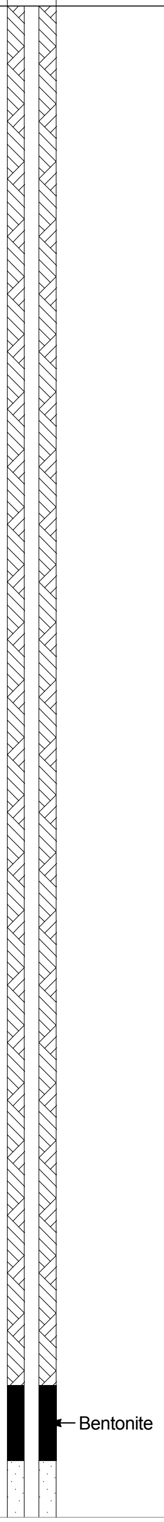
BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C9838SPR

SHEET 2 OF 3

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690
Position : 439558.4 E 7552183.2 N **Surface RL:** 228.6m **Angle from Horiz. :** 90° **Processed :** VD
Rig Type : Sandvick 650 **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** **Checked :** RR
Date Started : **Date Completed :** **Logged by :** Adani **Date :** 16/8/13

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**
										St	20-98; Permian		
45					44.00 (184.60)			SAND; dark grey matrix, red and orange mottling, with medium plasticity clay, fine to medium grained sand, trace coarse sand, predominantly quartz, trace fine to medium grained lithic gravel, rounded to sub rounded and smooth					
50					46.00 (182.60)			CLAYSTONE; dark grey-brown, returning as small sand sized shards, weak					
55													
60													
65					63.00 (165.60)			SANDSTONE; dark grey matrix, gradual colour change from dark grey to pale grey with depth to 99.0 m, fine to medium grained sand (predominantly quartz), matrix supported, becoming gradually grain supported with depth					
70													
75													
80													



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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C9838SPR

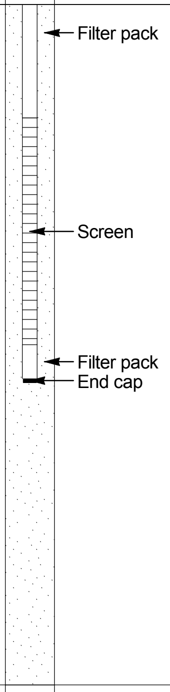
SHEET 3 OF 3

Position : 439558.4 E 7552183.2 N **Surface RL:** 228.6m **Angle from Horiz. :** 90° **Processed :** VD
Rig Type : Sandvick 650 **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** **Checked :** RR
Date Started : **Date Completed :** **Logged by :** Adani **Date :** 16/8/13

DRILLING					MATERIAL						
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**
											20-98; Permian
85											
90											
								From 91.0 to 99.0m; trace orange and red mottling			
								From 93.0m; grain supported, medium grained sub rounded to sub angular quartz sand, trace fine grained sand			
95											
					98.00 (130.60)			End of borehole at 98 m, standpipe piezometer installed			
100											
105											
110											
115											
120											

PIEZOMETER

Piezometer Log | **Components**



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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C9839SPR

SHEET 1 OF 5

Position : 439567.0 E 7552796.6 N		**Surface RL:** 228.3m	**Angle from Horiz. :** 90°	**Processed :** KS
Rig Type : Sandvick DE810	**Mounting:** Truck	**Contractor :** Nitro Drilling	**Driller :** Dave/Kwan	**Checked :** RR
Date Started : 22/4/13	**Date Completed :**		**Logged by :** MP	**Date :** 16/8/13

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
0	Air Blade 10"	Steel Casing				Sandy SILT; brown-grey, fine to medium sand (quartz), trace coarse quartz sand, medium plasticity fines From 3.0m; iron stained and harden significantly in places to 6m	D	MD-D	0-20m; Tertiary
5	Air Blade 8"	150mm PVC							
					7.00 (221.30)	SILT; grey, trace orange mottling, medium plasticity, with sand, fine to medium quartz sand	D	St	
10									
					14.00 (214.30)			St	Water injected from 14 m during drilling
15						From 16m; significant red, dark red and red-brown staining			
20					20.00 (208.30)	CLAY; brown-grey, colour gradually darkening with depth to dark brown-grey, high plasticity, appears slightly fissured at base of unit		St	20-173m; Permian
25									
30									
35									
40									

PIEZOMETER

Piezometer Log	Components

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 Project
Location : EPC 1690

HOLE No. C9839SPR

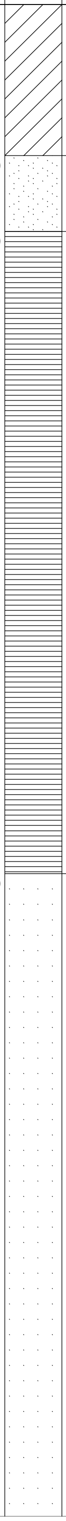
SHEET 2 OF 5

Position : 439567.0 E 7552796.6 N	**Surface RL:** 228.3m	**Angle from Horiz. :** 90°	**Processed :** KS
Rig Type : Sandvick DE81 **Mounting:** Truck	**Contractor :** Nitro Drilling	**Driller :** Dave/Kwan	**Checked :** RR
Date Started : 22/4/13	**Date Completed :**	**Logged by :** MP	**Date :** 16/8/13

DRILLING | **MATERIAL** | **PIEZOMETER**

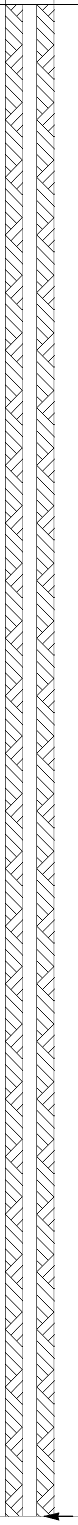
SCALE (m) | Drilling Method | Hole Support \ Casing | Water | Samples & Tests | Depth / (RL) metres | Graphic Log | USC Symbol | Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength | Moisture Condition | Consistency / Density Index | Comments/ Observations | Piezometer Log | Components

Drilling Method: Rotary Mud 8"
Hole Support \ Casing: 150mm PVC
Water: ∇



Depth / (RL) metres	Description	Consistency / Density Index	Comments/ Observations
		St	20-173m; Permian
44.00 (184.30)	SAND; dark grey matrix, red and orange mottling, with medium plasticity clay, fine to medium grained sand, trace coarse sand, predominantly quartz, trace fine to medium grained lithic gravel, rounded to sub rounded and smooth		
46.00 (182.30)	CLAYSTONE; dark grey-brown, returning as small sand sized shards, weak		
63.00 (165.30)	SANDSTONE; dark grey matrix, gradual colour change from dark grey to pale grey with depth to 99.0 m, fine to medium grained sand (predominantly quartz), matrix supported, becoming gradually grain supported with depth		Lots of claystone chips present until 69.0 m, possible entrainment in muds due to drilling not clearing hole properly between runs

SCALE (m): 45, 50, 55, 60, 65, 70, 75, 80



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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C9839SPR

SHEET 3 OF 5

Position : 439567.0 E 7552796.6 N
Surface RL: 228.3m
Angle from Horiz. : 90°
Processed : KS
Rig Type : Sandvick DE810
Mounting: Truck
Contractor : Nitro Drilling
Driller : Dave/Kwan
Checked : RB
Date Started : 22/4/13
Date Completed :
Logged by : MP
Date : 16/8/13

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
85 90	Rotary Mud 8"	150mm PVC						From 91.0 to 99.0m trace orange and red mottling From 93.0m; grain supported, medium grained sub rounded to sub angular quartz sand, trace fine grained sand			20-173m; Permian		50mm PVC casing with bentonite / cement grout
95	Rotary Mud 5 5/8"												
100					99.00 (129.30)			SANDSTONE; dark grey, fine to medium grained sand, quartz, coal / carbonaceous mudstone present					
105 110					102.00 (126.30)			Carbonaceous SANDSTONE / MUDSTONE; dark grey, fine to medium grained quartz sand, sub rounded to sub angular, trace coarse sub rounded to sub angular quartz sand From 109.0 to 115.0m; bands of coal, dull, black			Not sure if interbedded sandstone / mudstone, or if sand is contaminant (fall-in from above) 109-118m; AB Seam		
115					114.00 (114.30)			COAL; black, hard, vitreous, soft, dull, interbedded with fine to medium grained sandstone					
120					118.00 (110.30)			SILTSTONE; dark grey, very hard, very fine grained sand, trace fine grained sand,					

See standard sheets for details of abbreviations & basis of descriptions

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Job No.
41-24415-64

GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C9839SPR

SHEET 4 OF 5

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

Position :	439567.0 E 7552796.6 N	**Surface RL:**	228.3m	**Angle from Horiz. :**	90°	**Processed :**	KS
Rig Type :	Sandvick DE810 **Mounting:** Truck	**Contractor :**	Nitro Drilling	**Driller :**	Dave/Kwan	**Checked :**	RR
Date Started :	22/4/13	**Date Completed :**		**Logged by :**	MP	**Date :**	16/8/13

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
	Rotary Mud 5 5/8"					carbonaceous material			20-173m; Permian
125									
130									
135									
140									
145									
					147.00 (81.30)	COAL; black, dull, soft			C Seam
					149.00 (79.30)	SILTSTONE; dark grey, very hard, very fine grained sand present, trace fine grained sand, carbonaceous material present			
150									
					153.00 (75.30)	CARBONACEOUS SILTSTONE; dark grey, very fine grained sand present, trace fine grained sand			
155									
160					160.00				

PIEZOMETER — Piezometer Log | Components

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 Project
Location : EPC 1690

HOLE No. C9839SPR

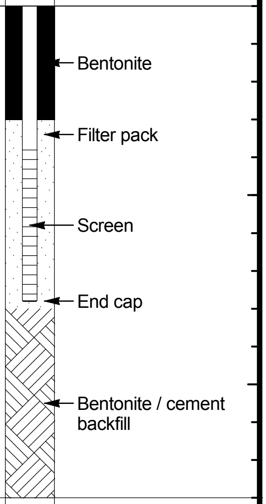
SHEET 5 OF 5

Position : 439567.0 E 7552796.6 N
Surface RL: 228.3m
Angle from Horiz. : 90°
Processed : KS
Rig Type : Sandvick DE810
Mounting: Truck
Contractor : Nitro Drilling
Driller : Dave/Kwan
Checked : RR
Date Started : 22/4/13
Date Completed :
Logged by : MP
Date : 16/8/13

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
	Rotary Mud 5 5/8"				(68.30)			COAL; black, dull, soft			160-162m; C Seam 20-173m; Permian
					162.00 (66.30)			CARBONACEOUS SILTSTONE; dark grey, trace very fine to fine grained sand			
165 170					164.00 (64.30)			SANDSTONE; grey, fine grained sand, hard, trace carbonaceous black material, trace medium grained angular to sub rounded sand (quartz)			No sample collection from 170.0 to 173m
175 180 185 190 195 200					173.00 (55.30)			End of borehole at 173 m, standpipe piezometer installed			

PIEZOMETER

Piezometer Log | **Components**



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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C840SP

SHEET 1 OF 6

Position : 439545.6 E 7552839.0 N **Surface RL:** 228.7m **Angle from Horiz. :** 90° **Processed :** KS
Rig Type : Sandvick **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** **Checked :** RB
Date Started : **Date Completed :** 20/4/13 **Logged by :** DK **Date :** 16/8/13

Depth / (RL) metres	Description	Comments/ Observations
0.00	Silty CLAY; pale brown, minor coarse grained sand (<5%)	0-19m; Tertiary
6.00 (222.70)	CLAY; dark red-brown, sticky, very cohesive	
7.00 (221.70)	CLAY, grey-brown, minor coarse sand, sticky, very cohesive	
10.00 (218.70)	CLAY; pale brown, minor white mottling, no fines	
19.00 (209.70)	CLAY; pale red, minor mottling of white clay, no fines	19-212m; Permian
21.00 (207.70)	CLAY; grey, sticky, very cohesive, minor stiffness, no fines	

Column headings: 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

SCALE (m): 5, 10, 15, 20, 25, 30, 35, 40

Hole Support \ Casing: 150mm PVC

See standard sheets for details of abbreviations & basis of descriptions

GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C840SP

SHEET 2 OF 6

Position : 439545.6 E 7552839.0 N
Surface RL: 228.7m
Angle from Horiz. : 90°
Processed : KS
Rig Type : Sandvick
Mounting: Truck
Contractor : Nitro Drilling
Driller :
Checked : RR
Date Started :
Date Completed : 20/4/13
Logged by : DK
Date : 16/8/13

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	Components
45		150mm PVC								19-212m; Permian	
50					49.00 (179.70)		CLAYSTONE; pale grey, no fines, chip size 5 mm diameter				
55					54.00 (174.70)		CLAYSTONE; pale grey, minor white clay mottling				
					56.00 (172.70)		CLAYSTONE; pale grey, claystone chip with white clay mottling				
60											
65											
70											
					72.00 (156.70)		CLAYSTONE; chip and white mottled, with coarse grain sand to fine grained gravel, predominantly coarse grained sand with 10-20% fine grained gravel.				
75											
80											

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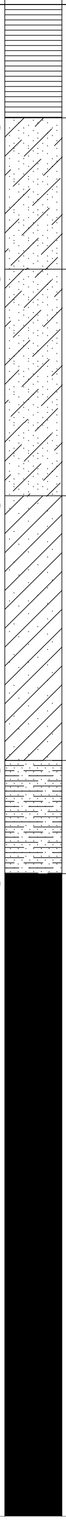
BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C840SP

SHEET 3 OF 6

Position : 439545.6 E 7552839.0 N
Surface RL: 228.7m
Angle from Horiz. : 90°
Processed : KS
Rig Type : Sandvick
Mounting: Truck
Contractor : Nitro Drilling
Driller :
Checked : RB
Date Started :
Date Completed : 20/4/13
Logged by : DK
Date : 16/8/13



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
											19-212m; Permian		
85		150mm PVC			83.00 (145.70)			Clayey SAND; predominately coarse grained sand with 10-20% fine gravel, Sub-angular to sub-rounded poorly sorted predominantly cloudy quartz (ground up sandstone?).			83-93 m; would suggest drilling method, mud and sample method have resulted in less clay / silt being sampled.		
90					87.00 (141.70)			Clayey SAND; coarse to medium grained, well sorted, sub angular, with minor claystone From 90m; decreasing clay					
95					93.00 (135.70)			Sandy CLAY; white-yellow clay, minor siltstone chips / fragments, fine sand (contamination from above?)					
100					100.00 (128.70)			Carbonaceous SILTSTONE; minor white-yellow clay					50mm PVC casing with bentonite / cement grout
105 110 115 120					103.00 (125.70)			COAL; weathered top of coal (very poor quality), clayey with minor white sticky fragments from 117; with minor white and pale grey soft clay			103-121m; AB Seam		

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C840SP

SHEET 4 OF 6

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690
Position : 439545.6 E 7552839.0 N **Surface RL:** 228.7m **Angle from Horiz. :** 90° **Processed :** KS
Rig Type : Sandvick **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** **Checked :** RR
Date Started : **Date Completed :** 20/4/13 **Logged by :** DK **Date :** 16/8/13

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**
					121.00 (107.70)			CLAY; pale grey-white, soft, minor silt		S	19-212m; Permian		
					123.00 (105.70)			CLAYSTONE; dark grey, brittle					
125													
130													
					133.00 (95.70)			CLAYSTONE; dark grey, brittle, with banded black carbonaceous siltstone					
135													
					136.00 (92.70)			CLAYSTONE; pale grey, hard, chips 5-10 mm					
140													
145													
					146.00 (82.70)			COAL; black, minor white-pale grey claystone lensing					
150													
155					155.00 (73.70)			CARBONACEOUS MUDSTONE / extremely weathered COAL					
					156.00 (72.70)			MUDSTONE; dark grey, hard chips					
160													

See standard sheets for details of abbreviations & basis of descriptions

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C840SP

SHEET 5 OF 6

Client :	Adani Mining Pty Ltd				
Project :	Carmichael Coal Project				
Location :	EPC 1690				
Position :	439545.6 E 7552839.0 N	**Surface RL:** 228.7m		**Angle from Horiz. :** 90°	**Processed :** KS
Rig Type :	Sandvick	**Mounting:** Truck	**Contractor :** Nitro Drilling	**Driller :**	**Checked :** RR
Date Started :		**Date Completed :** 20/4/13		**Logged by :** DK	**Date :** 16/8/13

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**
					161.00 (67.70)			COAL; black, brittle, minor mudstone (extremely weathered coal) lensing at 163 m			19-212m; Permian 161-164m; AB3 Seam		
165					164.00 (64.70)			SILTSTONE; pale grey, brittle, minor clay content (5%)					
					166.00 (62.70)			Clayey SILT; very pale grey-white, with brittle mudstone chips					
170					170.00 (58.70)			Clayey SILT; very pale grey-white, minor brittle mudstone chips, with minor (10-15%) large coarse rounded gravel, quartz cloudy-milky white, some quartz iron stained (yellow-orange cloudy colour)					
175					174.00 (54.70)			SAND; fine to medium grained, slight cohesion, minor silty clay component					
					177.00 (51.70)			CLAYSTONE; extremely weathered, white, with minor fresh dark grey chips					
180					179.00 (49.70)			MUDSTONE; extremely weathered, with coarse grained sand (~10%), sub angular grained quartz, milky colour					
185					182.00 (46.70)			MUDSTONE / COAL; no fines, very sticky, extremely weathered					
190					189.00 (39.70)			COAL; with mudstone			189-205m; D Seam		
195					192.00 (36.70)			COAL; with minor clay lensing					
200													

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

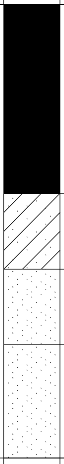
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C840SP

SHEET 6 OF 6

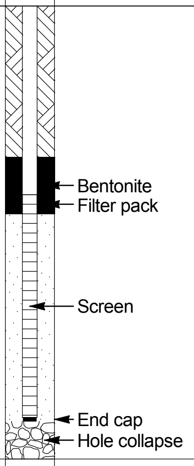
Position : 439545.6 E 7552839.0 N
Surface RL: 228.7m
Angle from Horiz. : 90°
Processed : KS
Rig Type : Sandvick
Mounting: Truck
Contractor : Nitro Drilling
Driller :
Checked : RR
Date Started :
Date Completed : 20/4/13
Logged by : DK
Date : 16/8/13

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
											19-212m; Permian
205					205.00 (23.70)			Sandy CLAY; dark grey, cohesive, sand predominately fine to medium grained, sub angular			
					207.00 (21.70)			SAND; pale grey, fine to medium grained, sub angular, cloudy quartz, minor iron stained (orange) quartz			
					209.00 (19.70)			SAND; medium to coarse grained, coarse sub angular to angular quartz, cloudy / milky in colour, well sorted sandstone			
210											
					212.00 (16.70)			End of borehole at 212 m, piezometer standpipe installed			
215											
220											
225											
230											
235											
240											



PIEZOMETER

Piezometer Log | **Components**



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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C844SP

SHEET 1 OF 5

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690
Position : 441391.8 E 7546840.0 N
Surface RL: 235.6m
Angle from Horiz. : 90°
Processed : KS
Rig Type : Sandvick DE810
Mounting: Truck
Contractor : Nitro Drilling
Driller : Darryl
Checked : RB
Date Started : 9/4/13
Date Completed :
Logged by : TC
Date : 16/8/13

DRILLING | **MATERIAL** | **PIEZOMETER**

Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength

Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	USC Symbol	Description	Moisture Condition	Consistency / Density Index	Comments/ Observations	Components
Air Hammer	150mm PVC				SP	Silty SAND; pale brown-yellow, fine grained			0-53m; Tertiary	
				6.00 (229.57)		IRONSTONE / FERRECRETE; brown-orange, hard				
				7.00 (228.57)	SP	SANDSTONE (SAND); pink-pale brown, fine grained, sandstone (residual soil)				
				12.00 (223.57)	CH	Silty CLAY (CLAYSTONE); brown-orange and brown, with grey and orange mottling, claystone residual soil From 22m; grading to sand, fine grained				
				25.00 (210.57)		CLAYSTONE; pale pink, with sand, claystone, highly weathered				
				28.00 (207.57)		CLAYSTONE; grey, trace silt, claystone (residual soil) From 31m; with minor residual sandstone				

SCALE (m): 5, 10, 15, 20, 25, 30, 35, 40

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 Project
Location : EPC 1690

HOLE No. C844SP

SHEET 2 OF 5

Position : 441391.8 E 7546840.0 N
Surface RL: 235.6m
Angle from Horiz. : 90°
Processed : KS
Rig Type : Sandvick DE81 **Mounting:** Truck
Contractor : Nitro Drilling
Driller : Darryl
Checked : RR
Date Started : 9/4/13
Date Completed :
Logged by : TC
Date : 16/8/13

Drilling Method	Hole Support \ Casing	Depth / (RL) metres	USC Symbol	Description	Comments/ Observations
Air Hammer	150mm PVC				0-53m; Tertiary
		44.00 (191.57)		CLAYSTONE; purple-brown, with minor residual sandstone From 50m; with trace fine grained sand	
		53.00 (182.57)	CH	Silty CLAY; yellow-brown, trace fine grained sand (weathered siltstone)	53-89m; Rewan Group
		54.00 (181.57)	SP	Clayey SAND; yellow-brown, fine grained (weathered sandstone)	
		60.00 (175.57)		Residual SANDSTONE; pale brown-yellow, fine grained	
		71.00 (164.57)	SW	Clayey SAND; brown-yellow, fine to medium grained, slightly weathered	
		77.00 (158.57)		MUDSTONE; grey-pale brown, with fine grey sand, moderately weathered	

SCALE (m): 45, 50, 55, 60, 65, 70, 75, 80

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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C844SP

SHEET 3 OF 5

Position : 441391.8 E 7546840.0 N **Surface RL:** 235.6m **Angle from Horiz. :** 90° **Processed :** KS
Rig Type : Sandvick DE810 **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** Darryl **Checked :** RR
Date Started : 9/4/13 **Date Completed :** **Logged by :** TC **Date :** 16/8/13

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: Air Hammer

Hole Support \ Casing: 150mm PVC (to approx. 93m)

Water: High flows

Scale (m): 85, 90, 95, 100, 105, 110, 115, 120

Depth / (RL) metres	Description	Comments/ Observations
		53-89m; Rewan Group
89.00 (146.57)	MUDSTONE; dark grey, slightly to moderately weathered	89-179m; Permian
		Driller drilled through base of casing due to hole deviation
94.00 (141.57)	MUDSTONE; dark grey, fresh	
95.00 (140.57)	COAL / MUDSTONE; black	AB Seam Lots of water gains, very high flows, mud pits full
98.00 (137.57)	SANDSTONE / SILTSTONE; grey-brown, fine grained	
99.00 (136.57)	MUDSTONE / COAL; black	1:27 pm: mud pits full, drilling paused, verifying use of flex pump to manage flows
112.00 (123.57)	COAL / CLAYSTONE; tuffaceous and carbonaceous, fresh	AB Seam
113.00 (122.57)	COAL; black	
115.00 (120.57)	SILTSTONE; grey, fresh	
117.00 (118.57)	SANDSTONE; grey, fine grained	

Piezometer Components: 50mm PVC casing with bentonite / cement grout

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C844SP

SHEET 4 OF 5

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690
Position : 441391.8 E 7546840.0 N **Surface RL:** 235.6m **Angle from Horiz. :** 90° **Processed :** KS
Rig Type : Sandvick DE810 **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** Darryl **Checked :** RR
Date Started : 9/4/13 **Date Completed :** **Logged by :** TC **Date :** 16/8/13

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										89-179m; Permian		
125					123.00 (112.57)			SILTSTONE; grey, trace fine grained sand					
130					126.00 (109.57)			SANDSTONE; grey, fine grained, trace very fine grained bands, fresh					
					132.00 (103.57)			TUFF; grey					
					134.00 (101.57)			COAL; black					
135					135.00 (100.57)			CLAYSTONE; grey, tuffaceous and carbonaceous, fresh					
140					139.00 (96.57)			SANDSTONE; grey, fine grained, fresh					
145 150 155 160					142.00 (93.57)			SANDSTONE; grey, fine grained, grading to medium and coarse grained, fresh From 151m; with minor dark grey siltstone lenses From 154m; fine to medium grained, minor clay content, fresh					

See standard sheets for details of abbreviations & basis of descriptions

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CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No.
41-24415-64

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

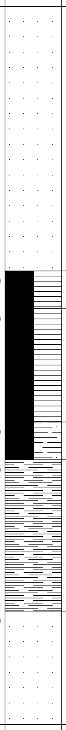
HOLE No. C844SP

SHEET 5 OF 5

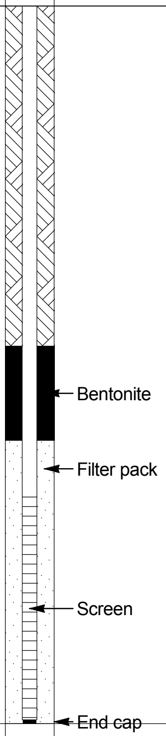
Position : 441391.8 E 7546840.0 N
Surface RL: 235.6m
Angle from Horiz. : 90°
Processed : KS
Rig Type : Sandvick DE810
Mounting: Truck
Contractor : Nitro Drilling
Driller : Darryl
Checked : RR
Date Started : 9/4/13
Date Completed :
Logged by : TC
Date : 16/8/13

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
165	Air Hammer						From 165m; medium grained, chips exhibit some very fine sand in matrix, fresh			89-179m; Permian
					167.00 (68.57)		TUFF / COAL; pale grey, very sticky clay, no sand			
					168.00 (67.57)		COAL / TUFF; pale grey, very sticky clay, no sand, increasing coal			C Seam
170					171.00 (64.57)		COAL / SILTSTONE; black coal, pale grey siltstone, minor very fine sheared surface chips, fresh			
					172.00 (63.57)		SILTSTONE; pale grey, minor very fine sandstone chips, fresh rock			
175					176.00 (59.57)		SANDSTONE; pale grey, very fine sand			
					179.00 (56.57) 179.01 (56.56)		At 179m; predominantly medium grained, some coarse grains, minor black flecks (possibly contamination from overlying coal) fresh End of hole at 179 m, standpipe piezometer installed.			
180										
185										
190										
195										
200										

Graphic Log



PIEZOMETER



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Job No.
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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C9845SPR

SHEET 1 OF 2

Position : 439411.8 E 7544903.8 N	**Surface RL:** 255.2m	**Angle from Horiz. :** 90°	**Processed :** KS
Rig Type : Sandvick DE810 **Mounting:** Truck	**Contractor :** Nitro Drilling	**Driller :**	**Checked :** RR
Date Started : 8/4/13	**Date Completed :** 9/4/13	**Logged by :** TC	**Date :** 16/8/13

DRILLING — Drilling Method: Air Blade; Water: ∇ at approx. 38 m

MATERIAL

Depth / (RL) metres	USC Symbol	Description	Moisture Condition	Consistency / Density Index	Comments/ Observations
0.00	SP	Silty SAND; pale brown-yellow, fine grained sand			0-23m; Tertiary
6.00 (249.18)	CL	CLAY; pale grey, low plasticity, with silt			
23.00 (232.18)	SP	SAND; pale brown, fine grained			23-45m; Dunda Beds
25.00 (230.18)	SP	SAND; pale pink-pale brown, fine grained, with ferricrete gravels, fine grained orange-brown-red gravels, hard, <10%	SM		
27.00 (228.18)	SW	Clayey SAND; pale brown, fine grained 80%, trace quartz fragments, <2 mm diameter, with clay	SM		
32.00 (223.18)	SW	Clayey SAND; brown-purple, grading to medium and coarse grained sand, with ferricrete (approximately 20%) hard			
33.00 (222.18)	SW	Gravelly SAND; pale brown-orange, medium to coarse grained sand, ferricrete gravels (approximately 20%), residual SANDSTONE			
36.00 (219.18)		SANDSTONE; red-brown, fine grained, lateritic (high iron content), trace ferricrete gravels, <4mm diameter, highly			Borehole wet

PIEZOMETER — Components:

- 50mm PVC casing with bentonite / cement grout (0 to approx. 32 m)
- Bentonite (approx. 32 to 35.4 m)
- Filter pack (approx. 35.4 m to 40 m)

SCALE (m): 5, 10, 15, 20, 25, 30, 35, 40

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

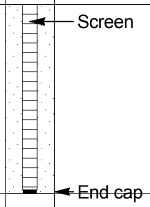
Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C9845SPR

SHEET 2 OF 2

Position : 439411.8 E 7544903.8 N
Surface RL: 255.2m
Angle from Horiz. : 90°
Processed : KS
Rig Type : Sandvick DE810
Mounting: Truck
Contractor : Nitro Drilling
Driller :
Checked : RR
Date Started : 8/4/13
Date Completed : 9/4/13
Logged by : TC
Date : 16/8/13

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 Blade							weathered			23-45m; Dunda Beds		Screen
					42.00 (213.18)			FERRICRETE / LATERITE; orange-pink, fine grained, with mostly clay, trace sand					
45					45.00 (210.18)			End of borehole at 45 m, standpipe piezometer installed			Groundwater yield: 0.4 L/sec estimate. Groundwater quality: pH = 6.49, EC = 1946 uS/cm, ORP = 86 mV, Temperature = 28 degrees celcius, DO = 6.5 mg/L		End cap
50													
55													
60													
65													
70													
75													
80													



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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C847SP

SHEET 1 OF 3

Position : 442384.6 E 7543809.2 N
Surface RL: 236.8m
Angle from Horiz. : 90°
Processed : DM
Rig Type : Sandvick 650 **Mounting:** Truck
Contractor : Nitro Drilling
Driller : Michael/Tony
Checked : RB
Date Started : 9/5/13
Date Completed : 11/5/13
Logged by : ADW
Date : 16/8/13

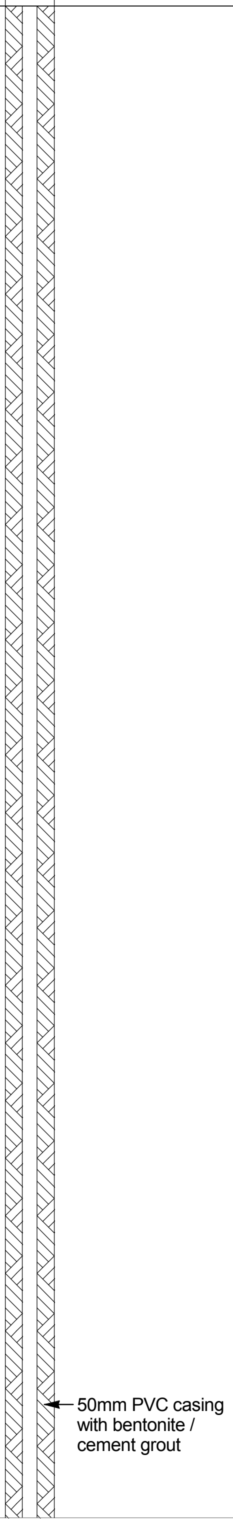
DRILLING

Depth (m)	Drilling Method	Hole Support \ Casing
0–2	Air Hammer	Steel
2–40	Mud Rotary	

MATERIAL

Depth / (RL) metres	USC Symbol	Description	Comments/ Observations
	SP-SM	Silty SAND; pale brown and orange, streaks of grey, quartz sand, fine to medium grained sand	0-34m; Tertiary
7.00 (229.80)		Silty CLAY; brown-orange	
9.00 (227.80)	CH	CLAY; grey and grey-brown, plastic and sticky, uniform throughout	
25.00 (211.80)	CH	CLAY; red and grey, plastic and sticky	
34.00 (202.80)	CH	CLAY; pale grey, sticky, hard, plastic, uniform throughout	34-87m; Permian

PIEZOMETER


50mm PVC casing with bentonite / cement grout

SCALE (m): 5, 10, 15, 20, 25, 30, 35, 40

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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

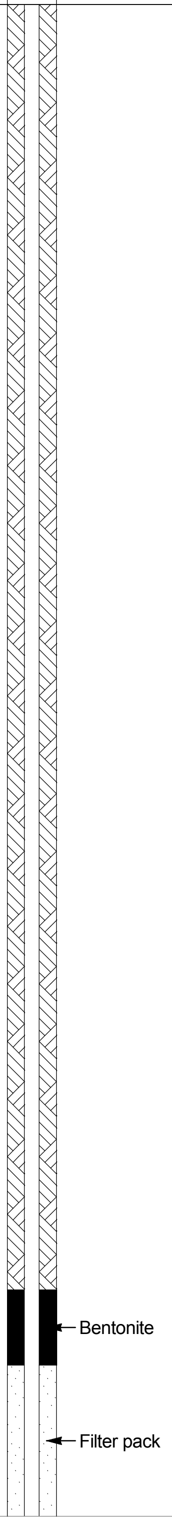
HOLE No. C847SP

SHEET 2 OF 3

Position : 442384.6 E 7543809.2 N
Surface RL: 236.8m
Angle from Horiz. : 90°
Processed : DM
Rig Type : Sandvick 650 **Mounting:** Truck
Contractor : Nitro Drilling
Driller : Michael/Tony
Checked : RR
Date Started : 9/5/13
Date Completed : 11/5/13
Logged by : ADW
Date : 16/8/13

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
45 50	Mud Rotary									34-87m; Permian
55 60 65					53.00 (183.80)		Sandy SILT; grey, 5-10 % sub rounded to sub angular quartz (medium grained) sand in sticky, very fine grained silt			
70 75					66.00 (170.80)	SM	Silty SAND; grey-white, medium grained quartz sand in very fine grained silt, quartz is sub rounded to sub angular, generally well sorted, 60-70 % quartz From 72m; quartz content lower, estimated at 40-50 % From 74m; quartz content 70-90 %, fine to medium grained, sub rounded			
80					79.00 (157.80)	SP	SAND; grey, medium to coarse			

PIEZOMETER



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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

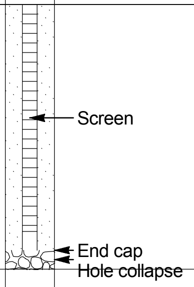
BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C847SP

SHEET 3 OF 3

Position : 442384.6 E 7543809.2 N
Surface RL: 236.8m
Angle from Horiz. : 90°
Processed : DM
Rig Type : Sandvick 650 **Mounting:** Truck
Contractor : Nitro Drilling
Driller : Michael/Tony
Checked : RR
Date Started : 9/5/13
Date Completed : 11/5/13
Logged by : ADW
Date : 16/8/13

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
85	Mud Rotary				87.00 (149.80)			quartz grains, sub angular to sub rounded, moderately sorted, trace silt			34-87m; Permian		Screen End cap Hole collapse
90 95 100 105 110 115 120								End of borehole at 87 m, standpipe piezometer installed					

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C848SP

SHEET 1 OF 3

Position : 442364.2 E 7543814.8 N
Surface RL: 236.7m
Angle from Horiz. : 90°
Processed : DM
Rig Type : Sandvick 650 **Mounting:** Truck
Contractor : Nitro Drilling
Driller :
Checked : RR
Date Started : 4/5/13
Date Completed :
Logged by : ADW
Date : 16/8/13

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
		150mm PVC					SP	SAND; pale yellow-brown, medium to coarse grained, 5 % angular quartz fragments throughout			0-33m; Tertiary		
5					2.00 (234.73)		SC	Clayey SAND; brown-yellow, fine to coarse grained From 14m; increase in clay content					
10													
15					15.00 (221.73)			CLAY; olive-green, trace sand, sand is medium grained with quartz fragments					
20													
25													
30					28.00 (208.73)			CLAY; olive with red streaks / patches					
35					33.00 (203.73)			CLAY; pale brown, sticky / plastic			33-140m; Permian		
40													
45													
50													

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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C848SP

SHEET 2 OF 3

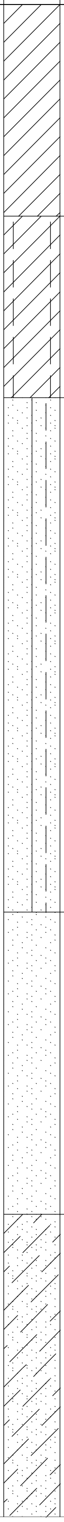
Position : 442364.2 E 7543814.8 N
Surface RL: 236.7m
Angle from Horiz. : 90°
Processed : DM
Rig Type : Sandvick 650 **Mounting:** Truck
Contractor : Nitro Drilling
Driller :
Checked : RB
Date Started : 4/5/13
Date Completed :
Logged by : ADW
Date : 16/8/13

Depth / (RL) metres	USC Symbol	Description	Comments/ Observations
			33-140m; Permian
57.00 (179.73)		Silty CLAY; pale brown-tan, trace fine grained sand	
63.00 (173.73)	SP-SM	SAND with silt; tan-yellow, fine to medium grained sand with very fine grained silt, sub rounded grains (> 1 mm)	
80.00 (156.73)	SP	SAND; pale yellow-brown, quartz grains (>2 mm) at 81 - 83 m	
90.00 (146.73)	SC	Clayey SAND; grey-brown. Abundant quartz grains grading to clay at 100-104 m	

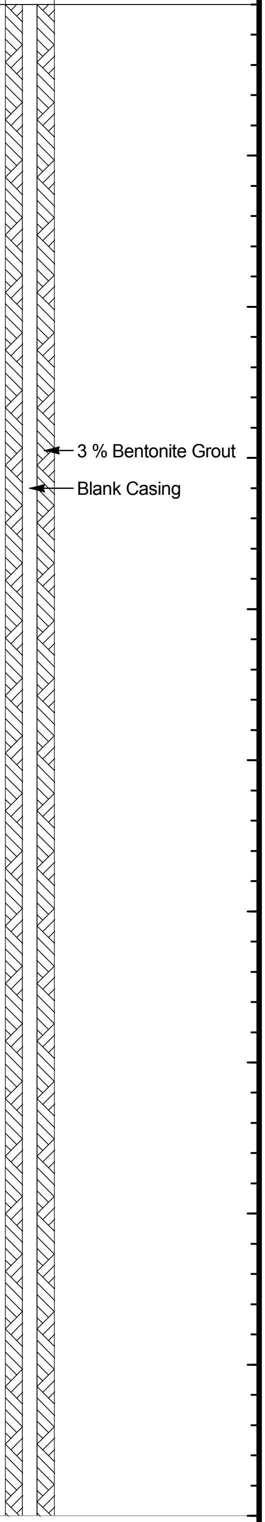
SCALE (m): 55 – 100

Hole Support \ Casing: 150mm PVC

Graphic Log



Piezometer Log



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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C848SP

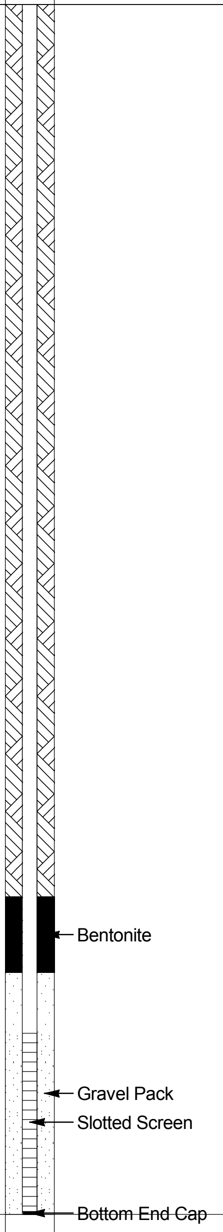
SHEET 3 OF 3

Position : 442364.2 E 7543814.8 N	**Surface RL:** 236.7m	**Angle from Horiz. :** 90°	**Processed :** DM
Rig Type : Sandvick 650 **Mounting:** Truck	**Contractor :** Nitro Drilling	**Driller :**	**Checked :** RR
Date Started : 4/5/13	**Date Completed :**	**Logged by :** ADW	**Date :** 16/8/13

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
		150mm PVC			102.00 (134.73)	CH	CLAY; olive-green, sticky / plastic. Tan to brown at 105 m		D	33-140m; Permian
					111.00 (125.73)		CLAY: grey, trace silt, very fine grained			
					114.00 (122.73)	GC	Carbonaceous MUD and CLAY; grey-black, abundant quartz gravel (> 2 m), sub angular to sub rounded			
					117.00 (119.73)		Silty CLAY; dark grey, very fine grained silt			
					129.00 (107.73)		COAL and muddy coal; black, vitreous in places, very fine grained, some clay (grey and sticky)			129-140m; D Seam
					140.00 (96.73)		End of borehole at 140 m, standpipe piezometer installed			

SCALE (m): 105, 110, 115, 120, 125, 130, 135, 140, 145, 150

PIEZOMETER



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GEO_BOREHOLE ADANI-CARMICHAEL COAL PROJECT.GPJ GHD_GEO_TEMPLATE.GDT 15/8/13

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C9849SPR

SHEET 1 OF 5

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690
Position : 442356.8 E 7543819.4 N **Surface RL:** 236.9m **Angle from Horiz. :** 90° **Processed :** AG
Rig Type : Sandvick 650 **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** Gerry/Dave **Checked :** RR
Date Started : 24/4/13 **Date Completed :** 28/4/13 **Logged by :** LE **Date :** 16/8/13

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 Log	Components
Blade	200mm Steel				SM	SAND; yellow-cream, with silt, intact	D	L	0-31m; Tertiary		
				2.00 (234.85)	MH	SILT; yellow-cream, with sand	D	L			
Mud Rotary 5 5/8" reamed to 7 7/8"	150mm PVC			6.00 (230.85)	CI	CLAY; yellow-cream, with silt		VSt	Drilling difficult (collaring clays)		
				15.00 (221.85)	CH	CLAY; grey-cream, very high plasticity			Improved drilling		
				26.00 (210.85)	CL	CLAY; red-cream, very high plasticity			Collaring clays		
				31.00 (205.85)	CL	CLAY; cream, very high plasticity			31-170m; Permian		

SCALE (m): 5, 10, 15, 20, 25, 30, 35, 40

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C9849SPR

SHEET 2 OF 5

Position : 442356.8 E 7543819.4 N	**Surface RL:** 236.9m	**Angle from Horiz. :** 90°	**Processed :** AG
Rig Type : Sandvick 650 **Mounting:** Truck	**Contractor :** Nitro Drilling	**Driller :** Gerry/Dave	**Checked :** RR
Date Started : 24/4/13	**Date Completed :** 28/4/13	**Logged by :** LE	**Date :** 16/8/13

DRILLING

- Drilling Method: Mud Rotary 5 5/8" reamed to 7 7/8"
- Hole Support \ Casing: 150mm PVC
- SCALE (m): 45, 50, 55, 60, 65, 70, 75, 80

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
					31-170m; Permian
43.00 (193.85)	CL	CLAY; pale pink-grey, high plasticity		St-VSt	Improved drilling
53.00 (183.85)		SANDSTONE; pale yellow-grey, with clay, with fine to coarse grained sand, moderately weathered			
75.00 (161.85)	SP	SAND; pale yellow, fine to coarse grained, angular to semi-rounded, clear polished quartz grains, silt matrix			Driller note extra water
80.00					

PIEZOMETER

Components: 50 mm PVC casing with bentonite cement grout

See standard sheets for details of abbreviations & basis of descriptions

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BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

HOLE No. C9849SPR

SHEET 3 OF 5

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690
Position : 442356.8 E 7543819.4 N **Surface RL:** 236.9m **Angle from Horiz. :** 90° **Processed :** AG
Rig Type : Sandvick 650 **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** Gerry/Dave **Checked :** RR
Date Started : 24/4/13 **Date Completed :** 28/4/13 **Logged by :** LE **Date :** 16/8/13

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 5 5/8" reamed to 7 7/8"	150mm PVC			(156.85)		SW	SAND; white-yellow, sub rounded and uniformly graded, polished coarse grained quartz			31-170m; Permian		
85													
90													
95					95.00 (141.85)			SILTSTONE; yellow-white, moderately weathered					
100													
105					105.00 (131.85)			SILTSTONE; grey-brown, slightly weathered					
110	Mud Rotary 5 5/8"												
					113.00 (123.85)			COAL; black-grey, with silt, bedded fresh			113-114m; C Seam		
					114.00 (122.85)			CARBONACEOUS MUDSTONE; grey, silt, bedded, fresh					
115													
120													

See standard sheets for details of abbreviations & basis of descriptions

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CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No.
41-24415-64

BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

HOLE No. C9849SPR

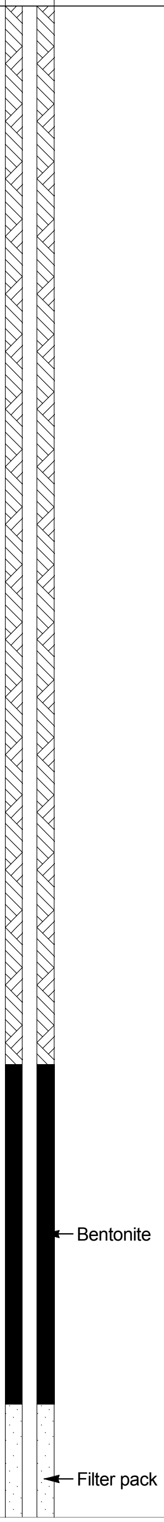
SHEET 4 OF 5

Position : 442356.8 E 7543819.4 N	**Surface RL:** 236.9m	**Angle from Horiz. :** 90°	**Processed :** AG
Rig Type : Sandvick 650 **Mounting:** Truck	**Contractor :** Nitro Drilling	**Driller :** Gerry/Dave	**Checked :** RR
Date Started : 24/4/13	**Date Completed :** 28/4/13	**Logged by :** LE	**Date :** 16/8/13

DRILLING: Drilling Method	Depth / (RL) metres	MATERIAL: Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Comments/ Observations
Mud Rotary 5 5/8"			31-170m; Permian
	125.00 (111.85)	SANDSTONE; white-grey, coarse grained fresh	
	127.00 (109.85)	CARBONACEOUS MUDSTONE and COAL; grey-black, with silt, fresh	
	132.00 (104.85)	COAL; black, with silt, fresh, coal seam	132-141m; D1 and D2 Seams
	141.00 (95.85)	SANDSTONE; grey, fine grained, bedded, fresh (micaceous), silt matrix	
	156.00 (80.85)	COAL; black-grey, silt, bedded, fresh (D Seam)	156-159m; D3 Seam
	159.00 (77.85)	CARBONACEOUS	Geophysics

SCALE (m): 125, 130, 135, 140, 145, 150, 155, 160

Columns: SCALE (m) | Drilling Method | Hole Support \ Casing | Water | Samples & Tests | Depth / (RL) metres | Graphic Log | USC Symbol | Description | Moisture Condition | Consistency / Density Index | Comments/ Observations | PIEZOMETER: Piezometer Log | Components



See standard sheets for details of abbreviations & basis of descriptions

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Job No. **41-24415-64**

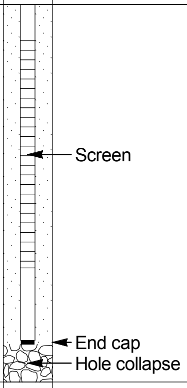
BOREHOLE LOG SHEET WITH STANDPIPE PIEZOMETER

Client : Adani Mining Pty Ltd
Project : Carmichael Coal Project
Location : EPC 1690

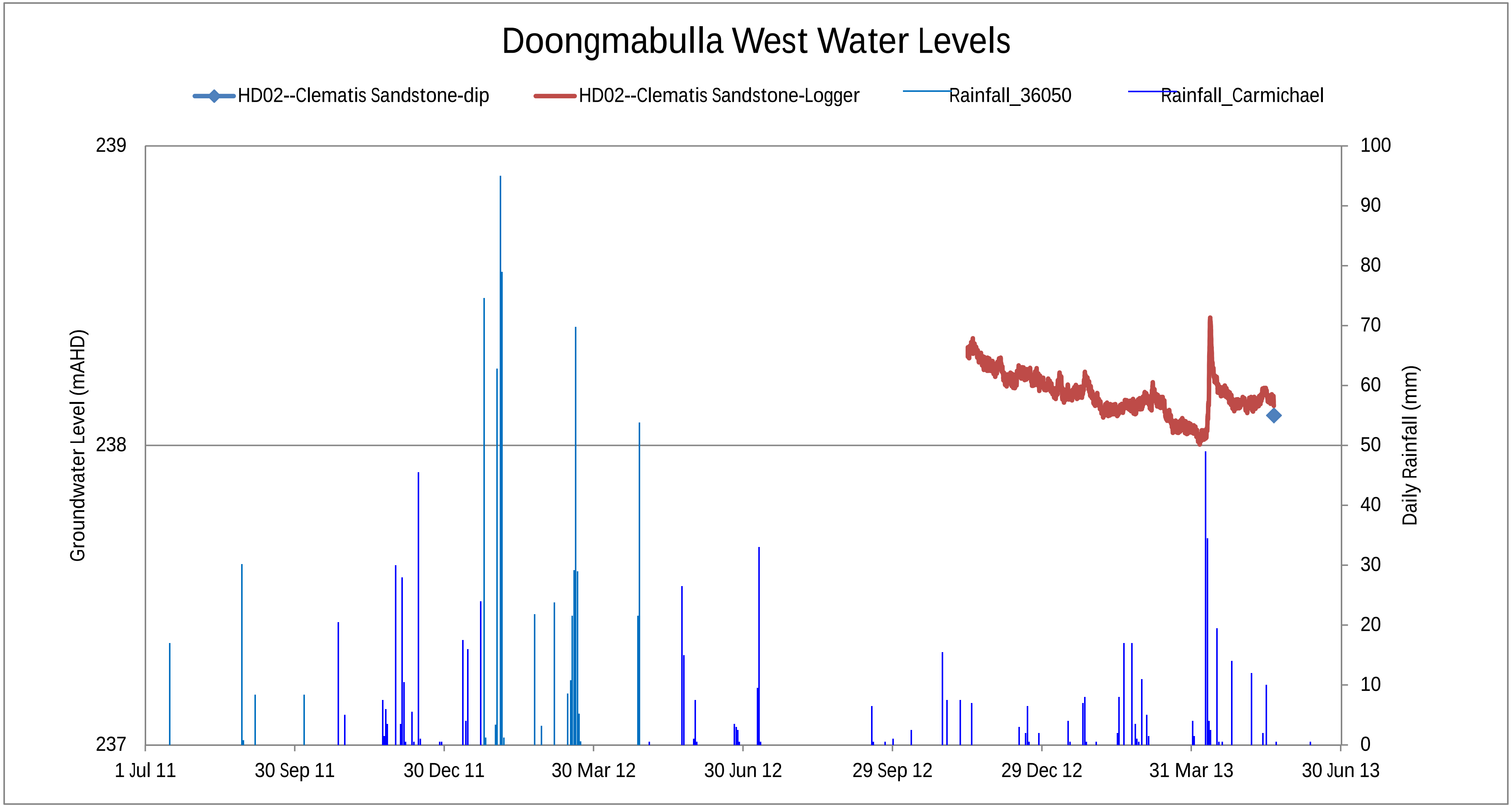
HOLE No. C9849SPR

SHEET 5 OF 5

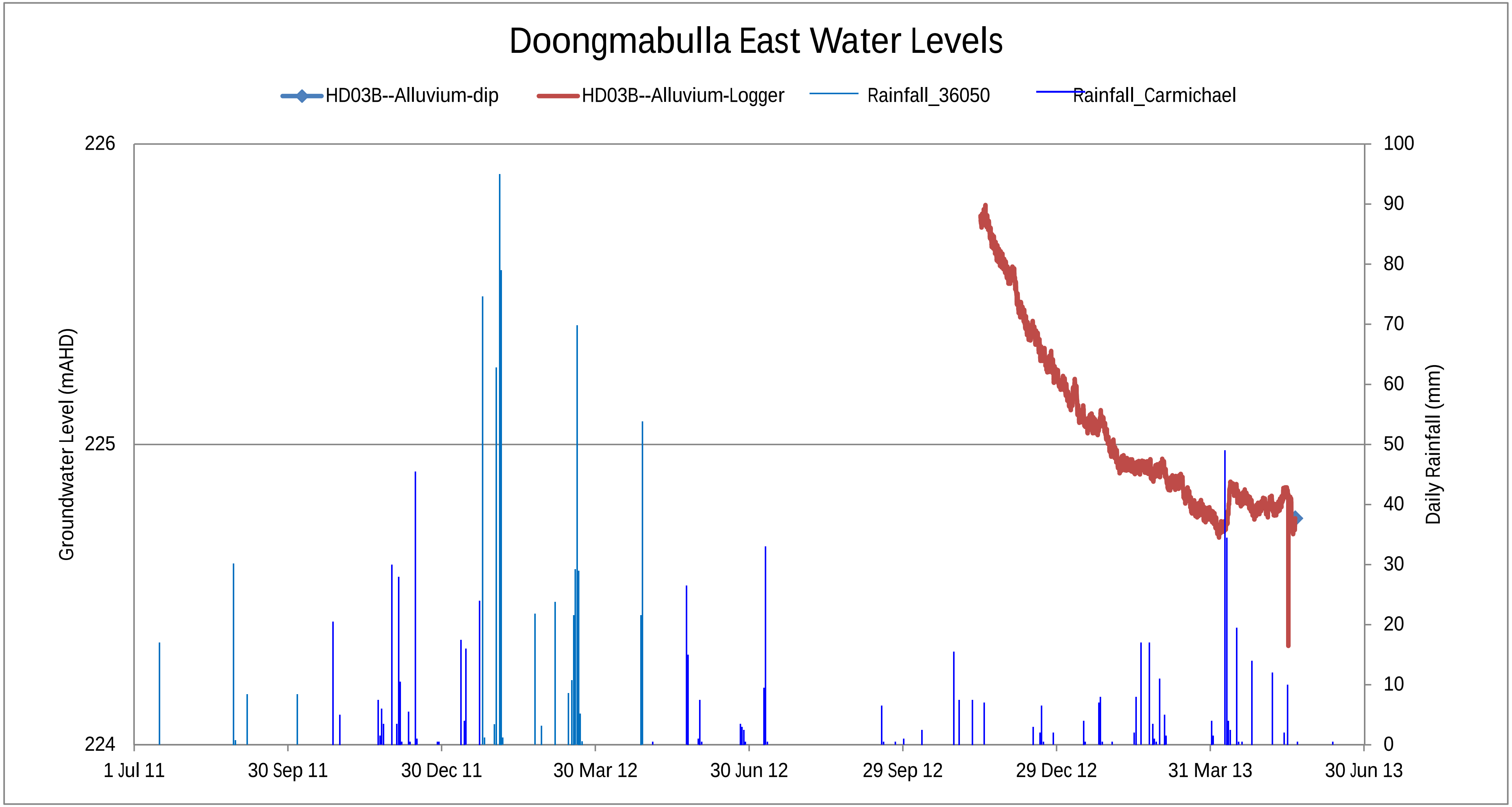
Position : 442356.8 E 7543819.4 N **Surface RL:** 236.9m **Angle from Horiz. :** 90° **Processed :** AG
Rig Type : Sandvick 650 **Mounting:** Truck **Contractor :** Nitro Drilling **Driller :** Gerry/Dave **Checked :** RR
Date Started : 24/4/13 **Date Completed :** 28/4/13 **Logged by :** LE **Date :** 16/8/13

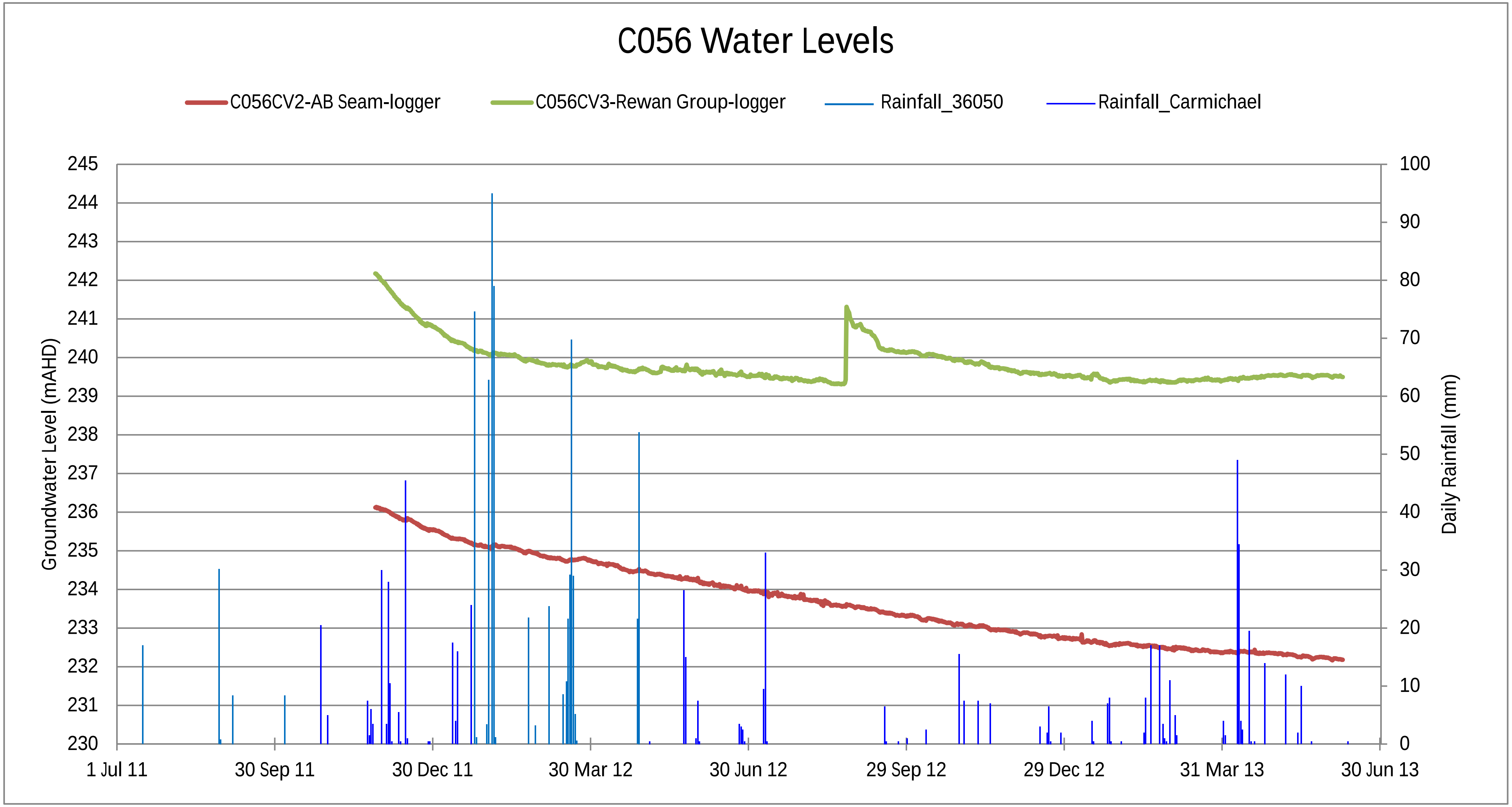
DRILLING					MATERIAL							PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	**Description** SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	**Comments/ Observations**	Piezometer Log	**Components**
	Mud Rotary 5 5/8"							MUDSTONE; grey, silt, bedded, fresh			indicated the colinlea sandstone at 159.5 m 31-170m; Permian		Screen
165					163.00 (73.85)			SANDSTONE; grey, coarse grained, fresh (colinlea sandstone)					End cap Hole collapse
170					170.00 (66.85)			End of borehole at 170 m, standpipe piezometer installed					
175													
180													
185													
190													
195													
200													

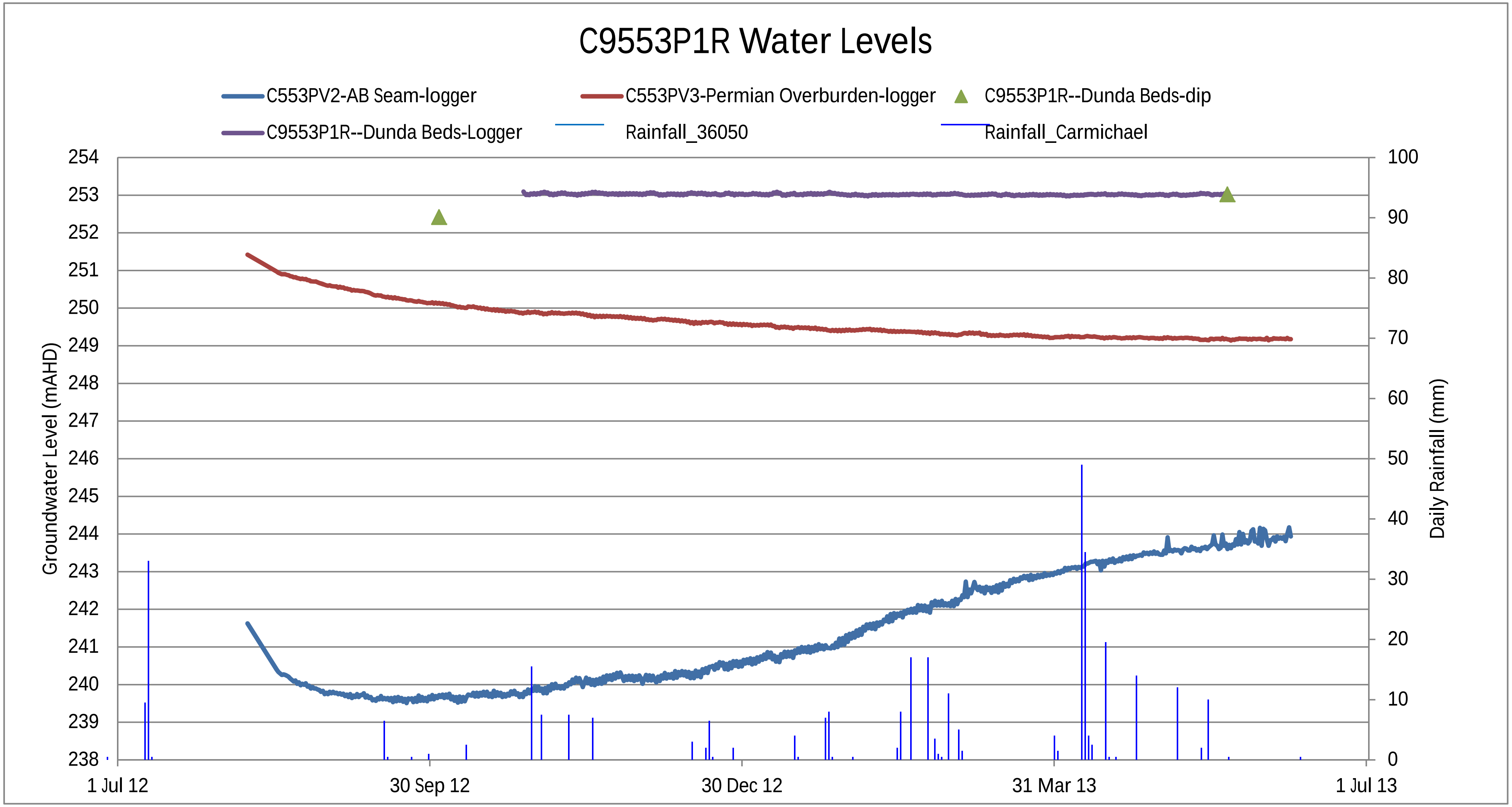
Appendix C – Groundwater levels

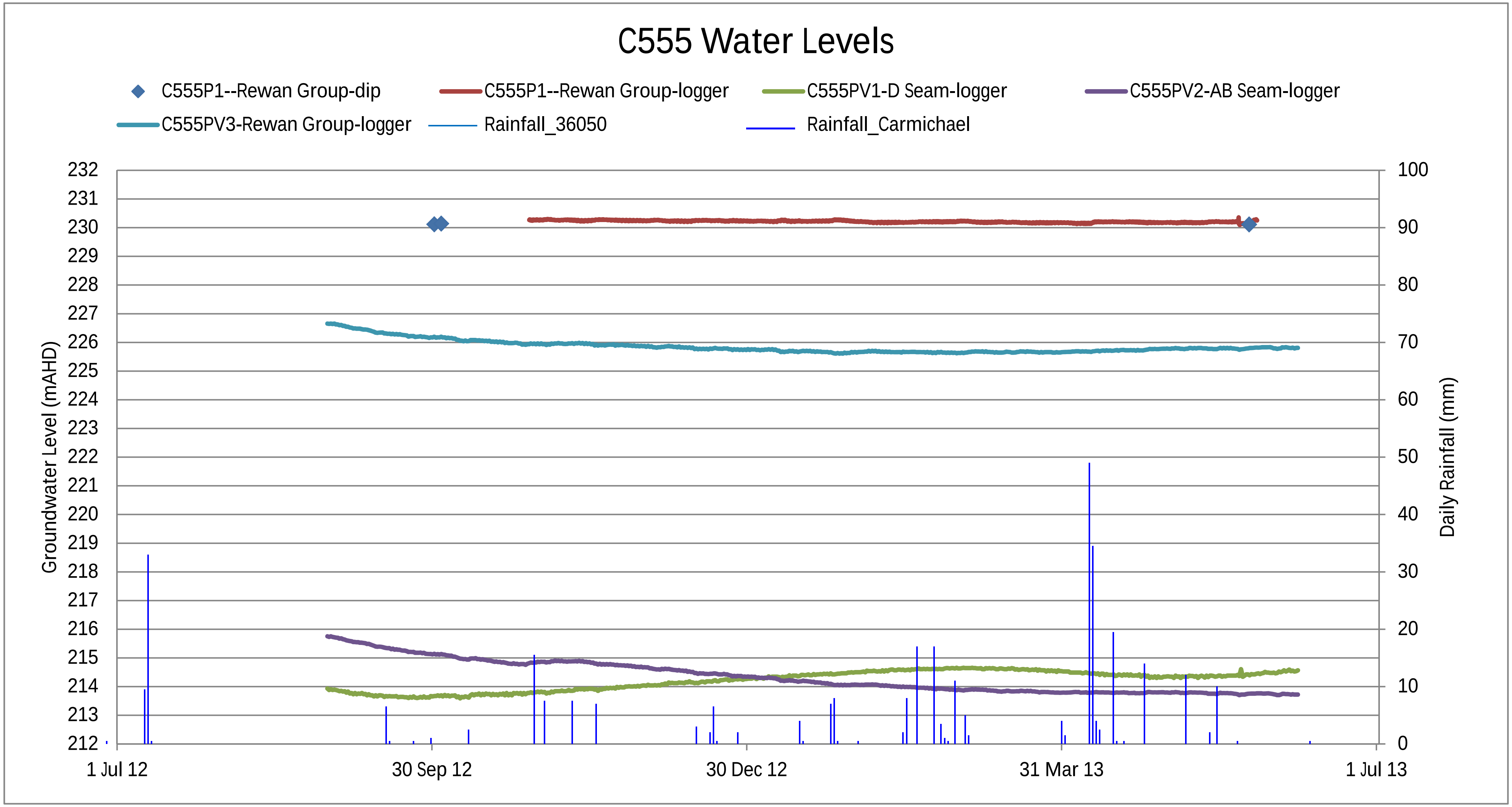


Carmichael Coal (Mine)

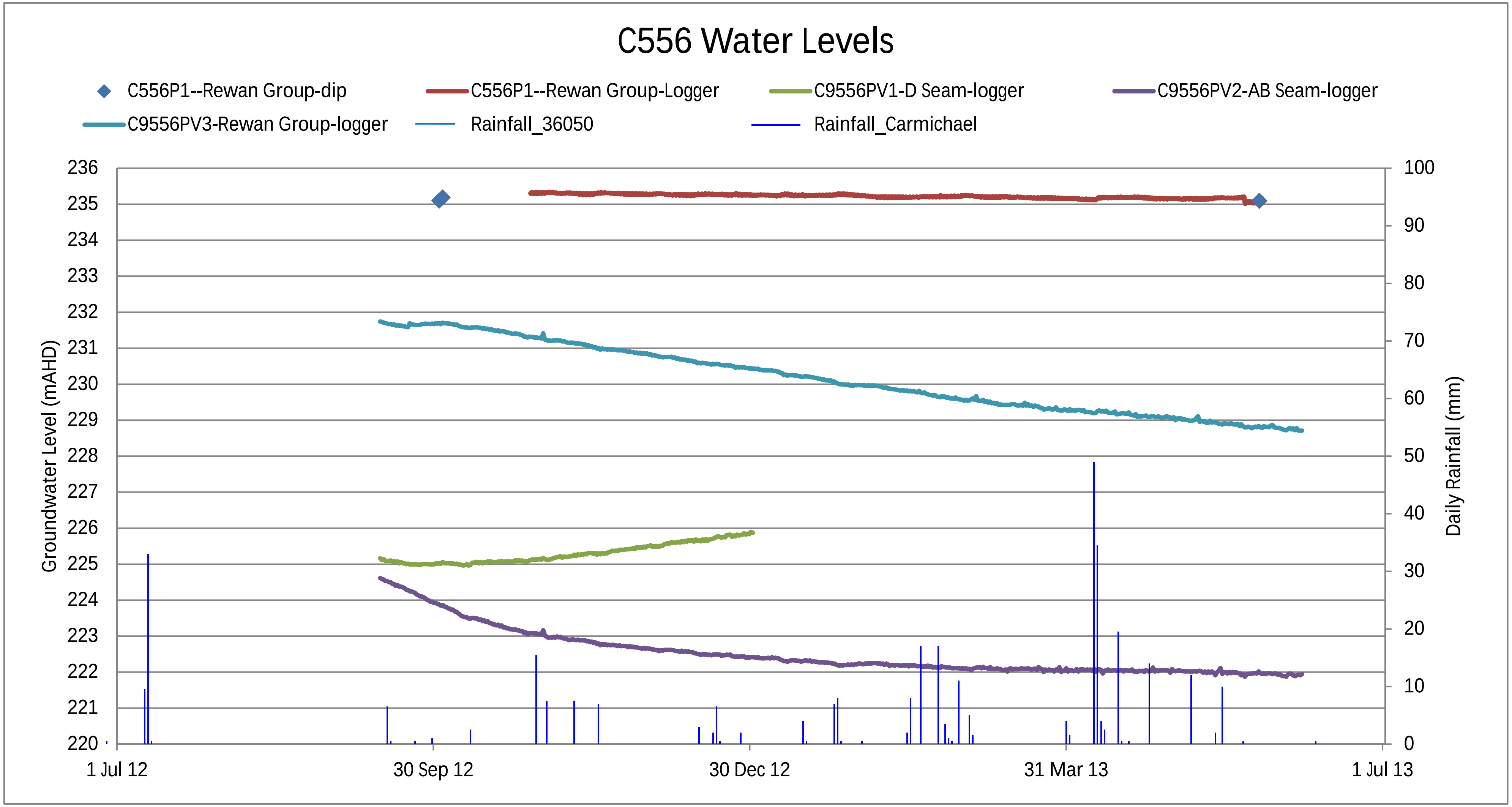

Doongmabulla East Water Levels
HD03B--Alluvium-dip
HD03B--Alluvium-Logger
Rainfall_36050
Rainfall_Carmichael
Groundwater Level (mAHD)
226
225
224
Daily Rainfall (mm)
100
90
80
70
60
50
40
30
20
10
0
1 Jul 11
30 Sep 11
30 Dec 11
30 Mar 12
30 Jun 12
29 Sep 12
29 Dec 12
31 Mar 13
30 Jun 13


C056 Water Levels
C056CV2-AB Seam-logger
C056CV3-Rewan Group-logger
Rainfall_36050
Rainfall_Carmichael
Groundwater Level (mAHD)
245
244
243
242
241
240
239
238
237
236
235
234
233
232
231
230
Daily Rainfall (mm)
100
90
80
70
60
50
40
30
20
10
0
1 Jul 11
30 Sep 11
30 Dec 11
30 Mar 12
30 Jun 12
29 Sep 12
29 Dec 12
31 Mar 13
30 Jun 13

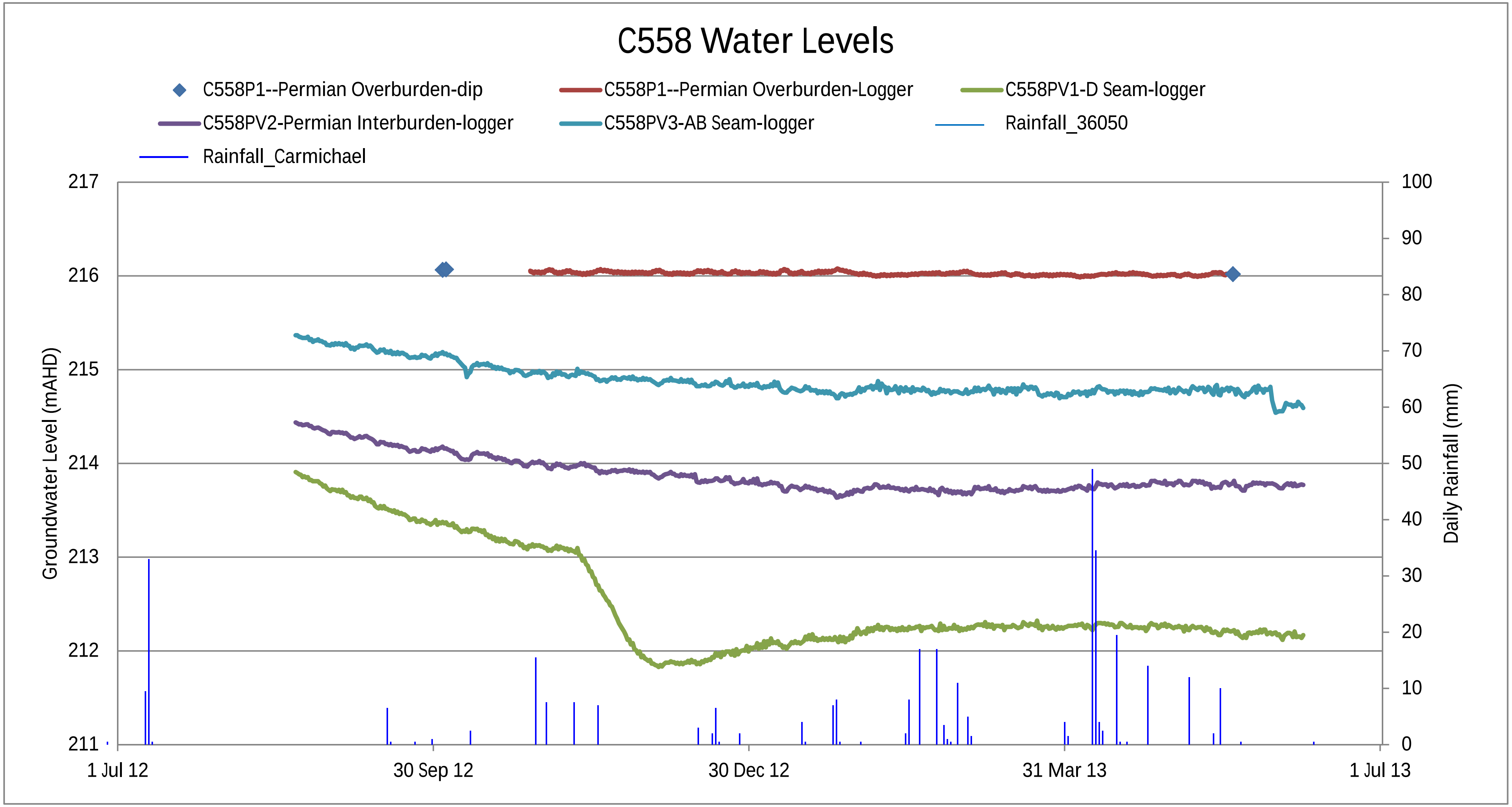

C9553P1R Water Levels
C553PV2-AB Seam-logger
C553PV3-Permian Overburden-logger
C9553P1R--Dunda Beds-dip
C9553P1R--Dunda Beds-Logger
Rainfall_36050
Rainfall_Carmichael
Groundwater Level (mAHD)
Daily Rainfall (mm)
254
253
252
251
250
249
248
247
246
245
244
243
242
241
240
239
238
100
90
80
70
60
50
40
30
20
10
0
1 Jul 12
30 Sep 12
30 Dec 12
31 Mar 13
1 Jul 13

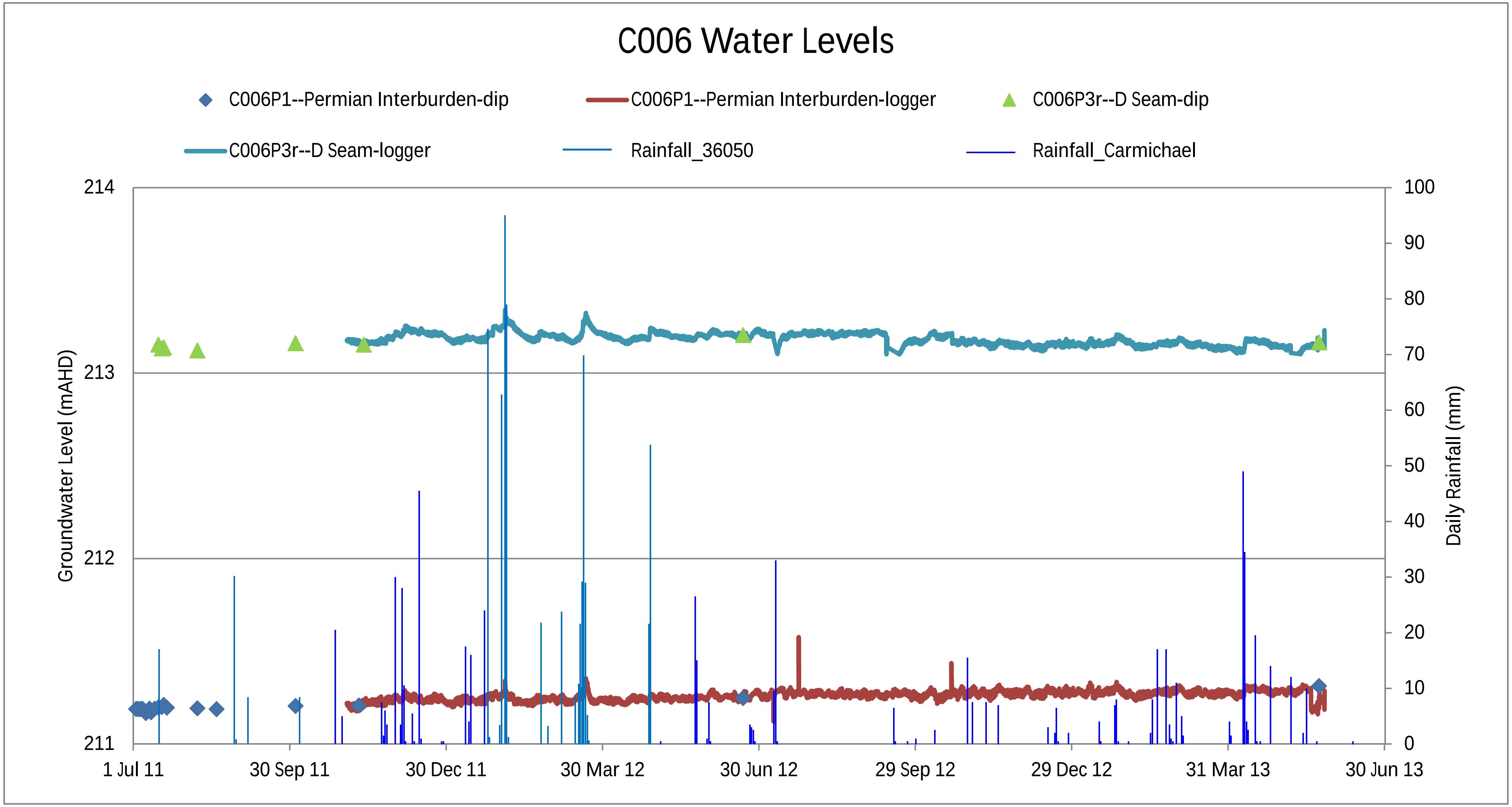


C555 Water Levels
C555P1--Rewan Group-dip
C555P1--Rewan Group-logger
C555PV1-D Seam-logger
C555PV2-AB Seam-logger
C555PV3-Rewan Group-logger
Rainfall_36050
Rainfall_Carmichael
Groundwater Level (mAHD)
232
231
230
229
228
227
226
225
224
223
222
221
220
219
218
217
216
215
214
213
212
Daily Rainfall (mm)
100
90
80
70
60
50
40
30
20
10
0
1 Jul 12
30 Sep 12
30 Dec 12
31 Mar 13
1 Jul 13

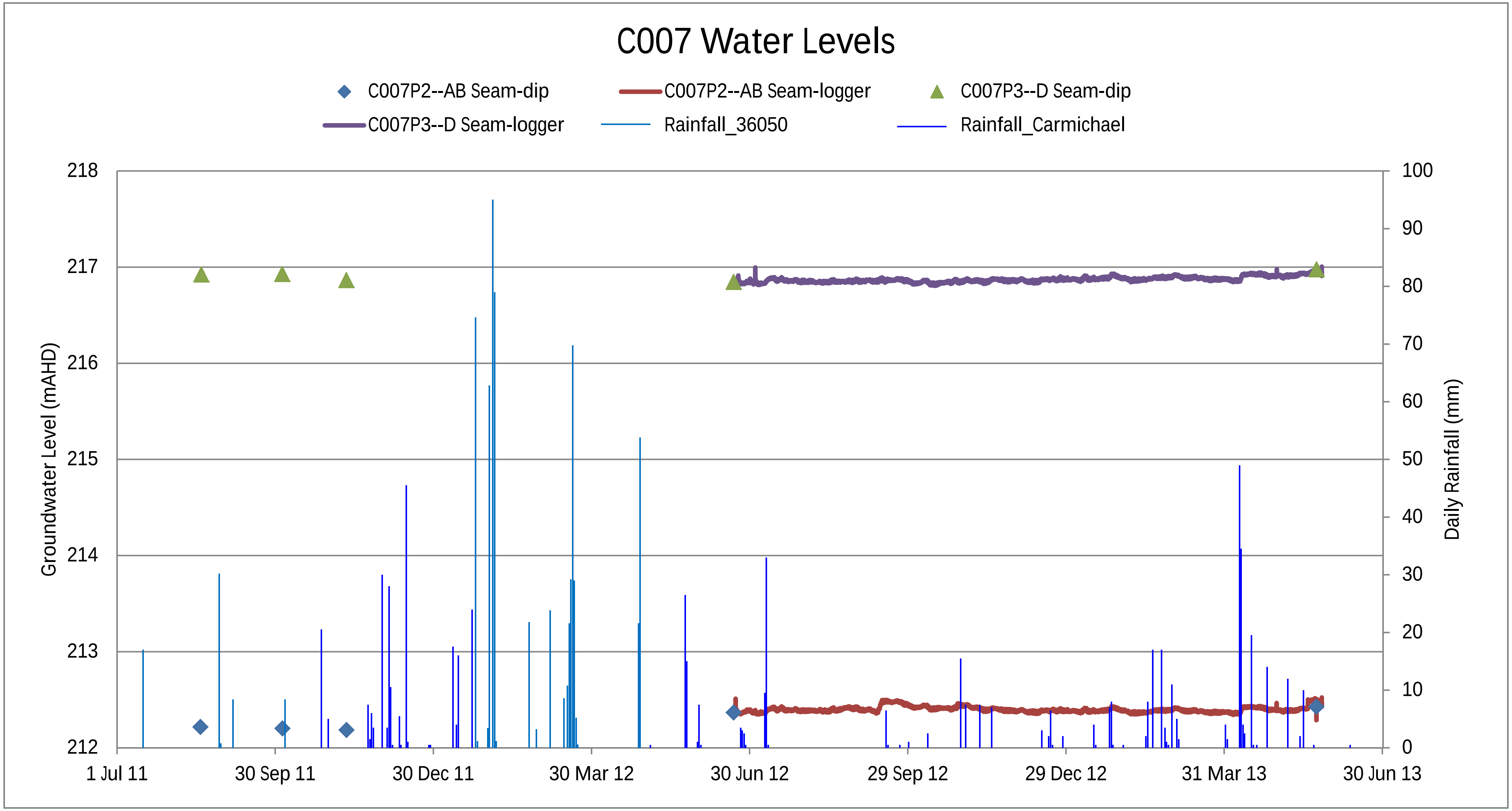


Carmichael Coal (Mine)

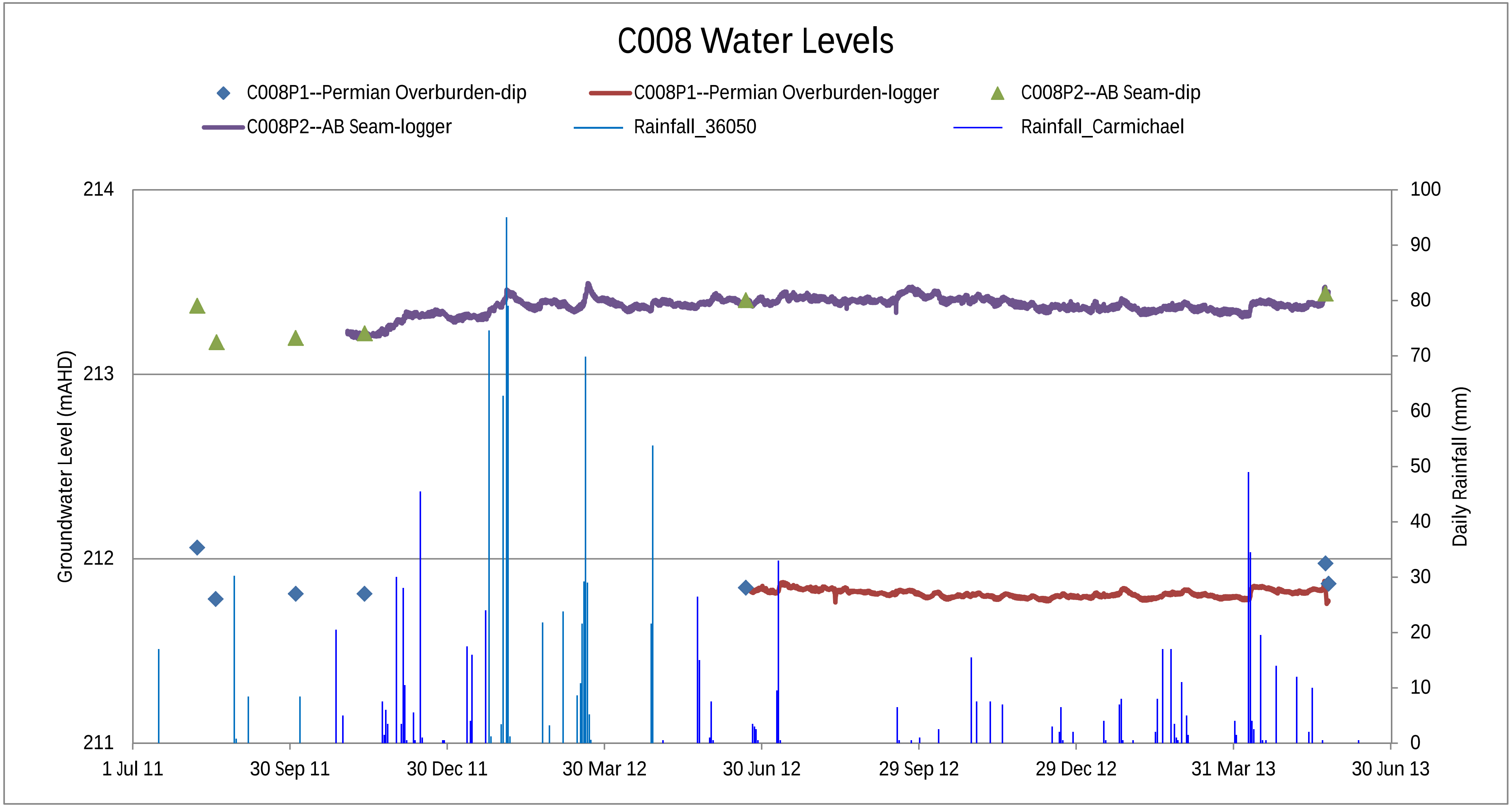

C558 Water Levels
C558P1--Permian Overburden-dip
C558P1--Permian Overburden-Logger
C558PV1-D Seam-logger
C558PV2-Permian Interburden-logger
C558PV3-AB Seam-logger
Rainfall_36050
Rainfall_Carmichael
Groundwater Level (mAHD)
217
216
215
214
213
212
211
Daily Rainfall (mm)
100
90
80
70
60
50
40
30
20
10
0
1 Jul 12
30 Sep 12
30 Dec 12
31 Mar 13
1 Jul 13

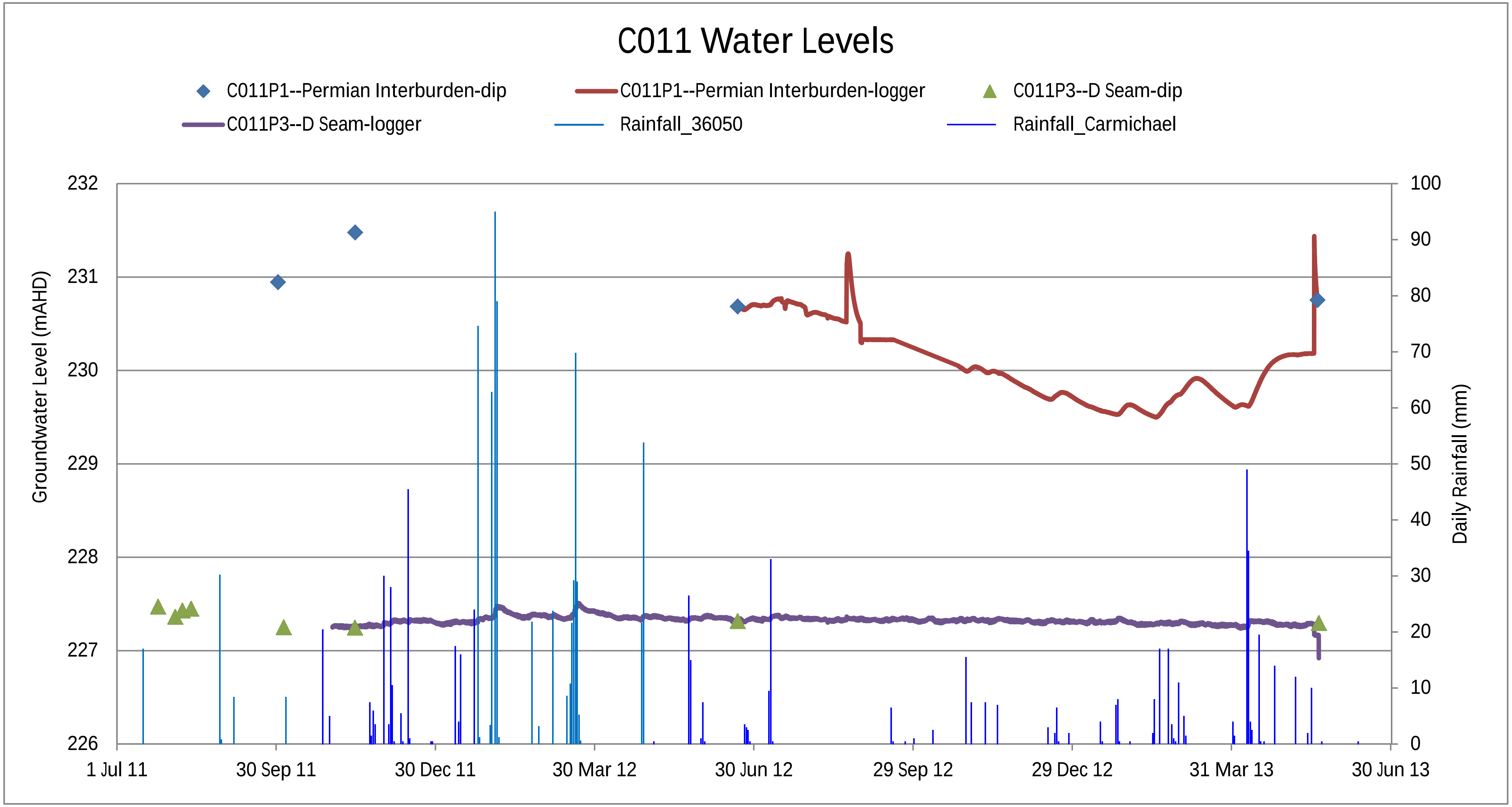


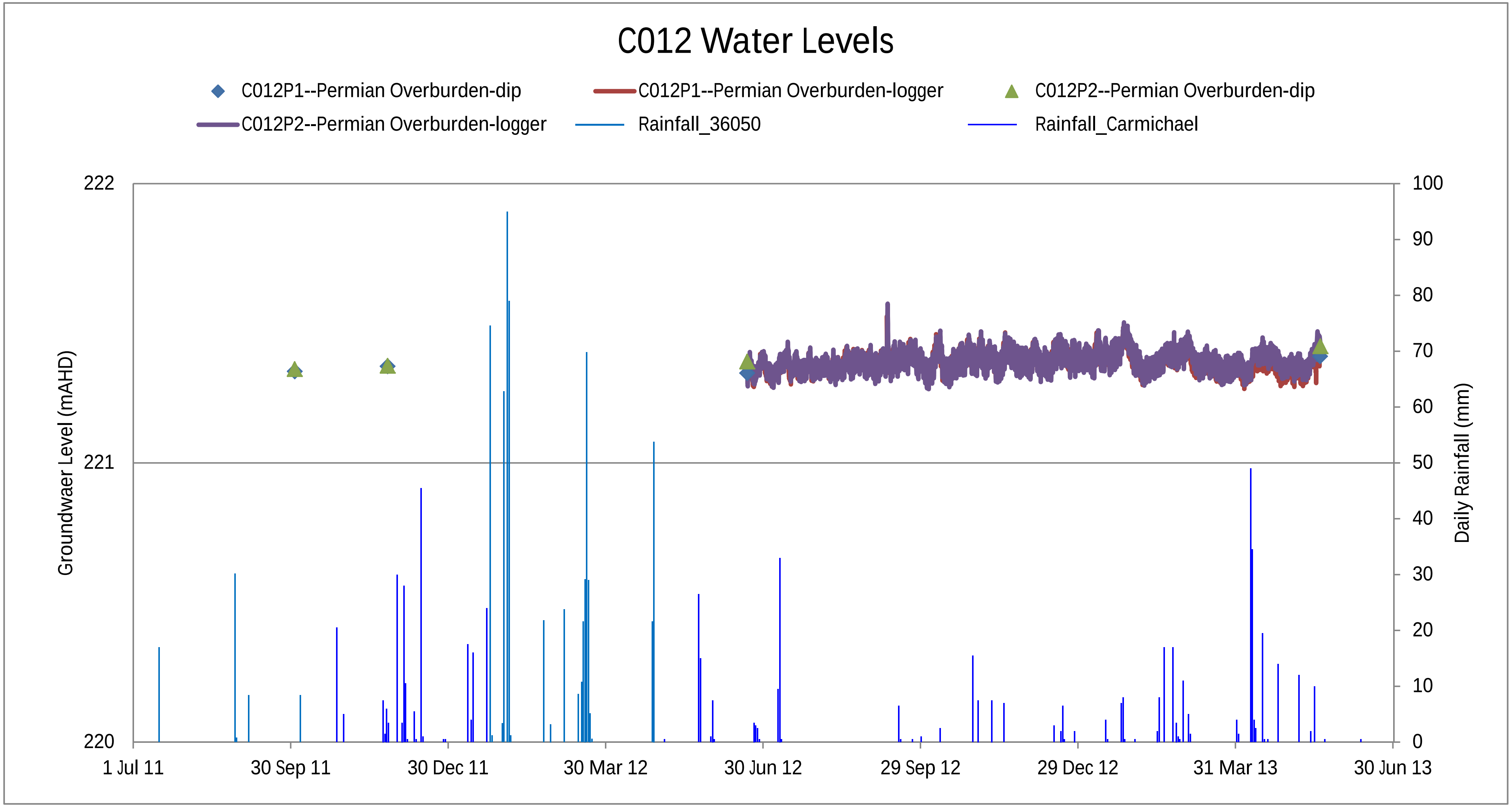
Carmichael Coal (Mine)

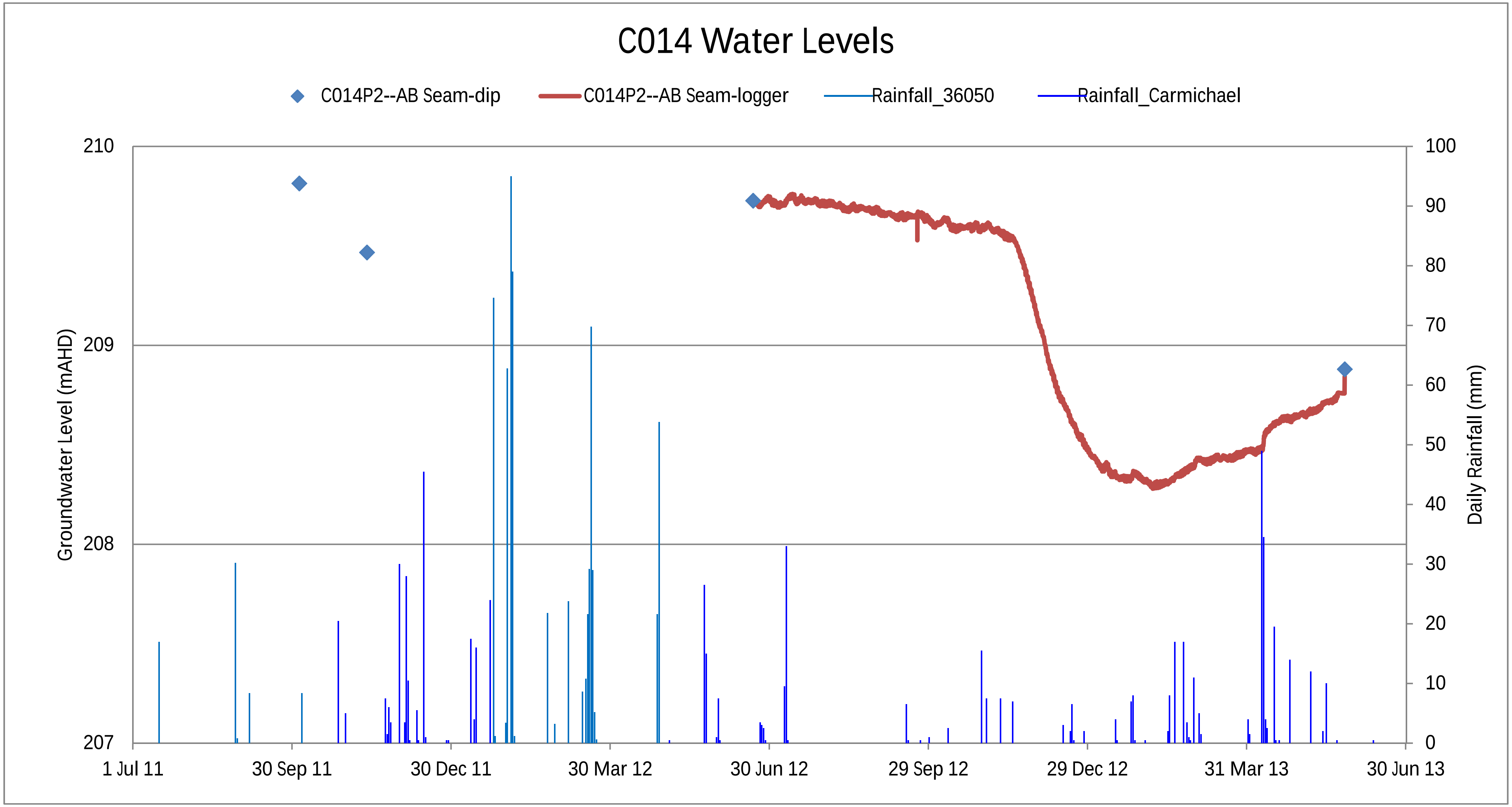


Carmichael Coal (Mine)

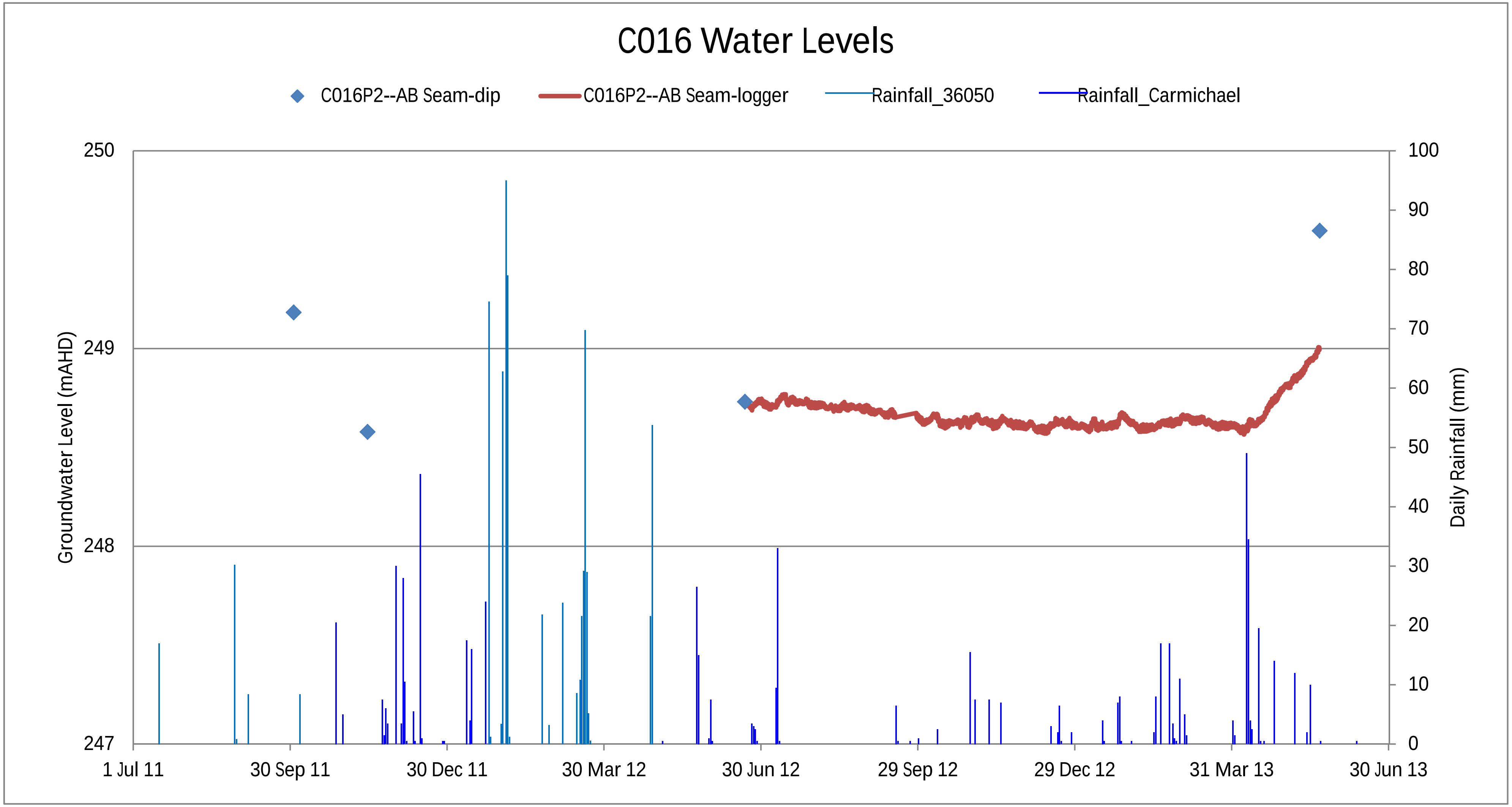

C008 Water Levels
C008P1--Permian Overburden-dip
C008P1--Permian Overburden-logger
C008P2--AB Seam-dip
C008P2--AB Seam-logger
Rainfall_36050
Rainfall_Carmichael
Groundwater Level (mAHD)
214
213
212
211
Daily Rainfall (mm)
100
90
80
70
60
50
40
30
20
10
0
1 Jul 11
30 Sep 11
30 Dec 11
30 Mar 12
30 Jun 12
29 Sep 12
29 Dec 12
31 Mar 13
30 Jun 13

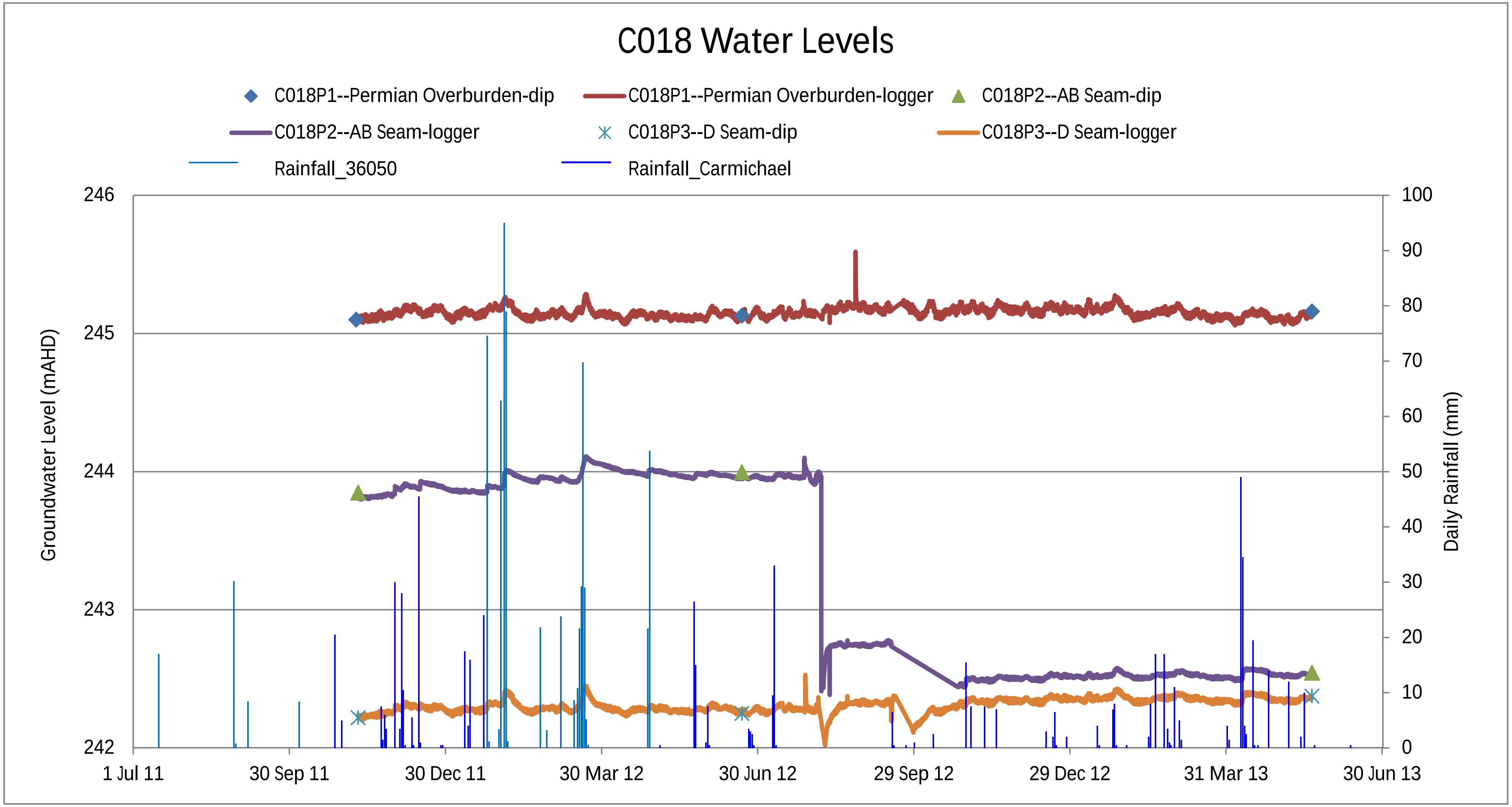

C011 Water Levels
C011P1--Permian Interburden-dip
C011P1--Permian Interburden-logger
C011P3--D Seam-dip
C011P3--D Seam-logger
Rainfall_36050
Rainfall_Carmichael
Groundwater Level (mAHD)
232
231
230
229
228
227
226
Daily Rainfall (mm)
100
90
80
70
60
50
40
30
20
10
0
1 Jul 11
30 Sep 11
30 Dec 11
30 Mar 12
30 Jun 12
29 Sep 12
29 Dec 12
31 Mar 13
30 Jun 13


C012 Water Levels
C012P1--Permian Overburden-dip
C012P1--Permian Overburden-logger
C012P2--Permian Overburden-dip
C012P2--Permian Overburden-logger
Rainfall_36050
Rainfall_Carmichael
Groundwaer Level (mAHD)
222
221
220
Daily Rainfall (mm)
100
90
80
70
60
50
40
30
20
10
0
1 Jul 11
30 Sep 11
30 Dec 11
30 Mar 12
30 Jun 12
29 Sep 12
29 Dec 12
31 Mar 13
30 Jun 13

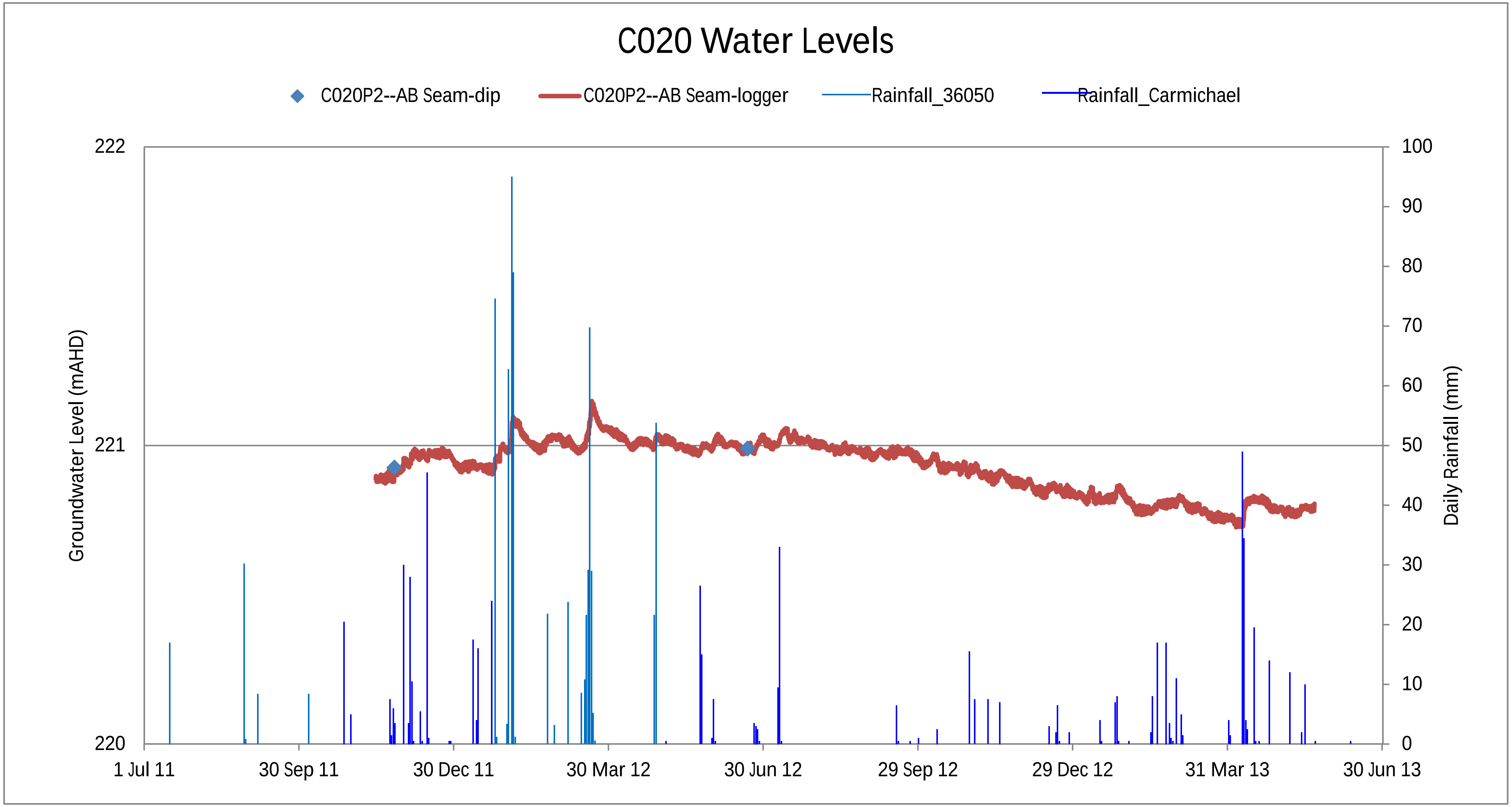


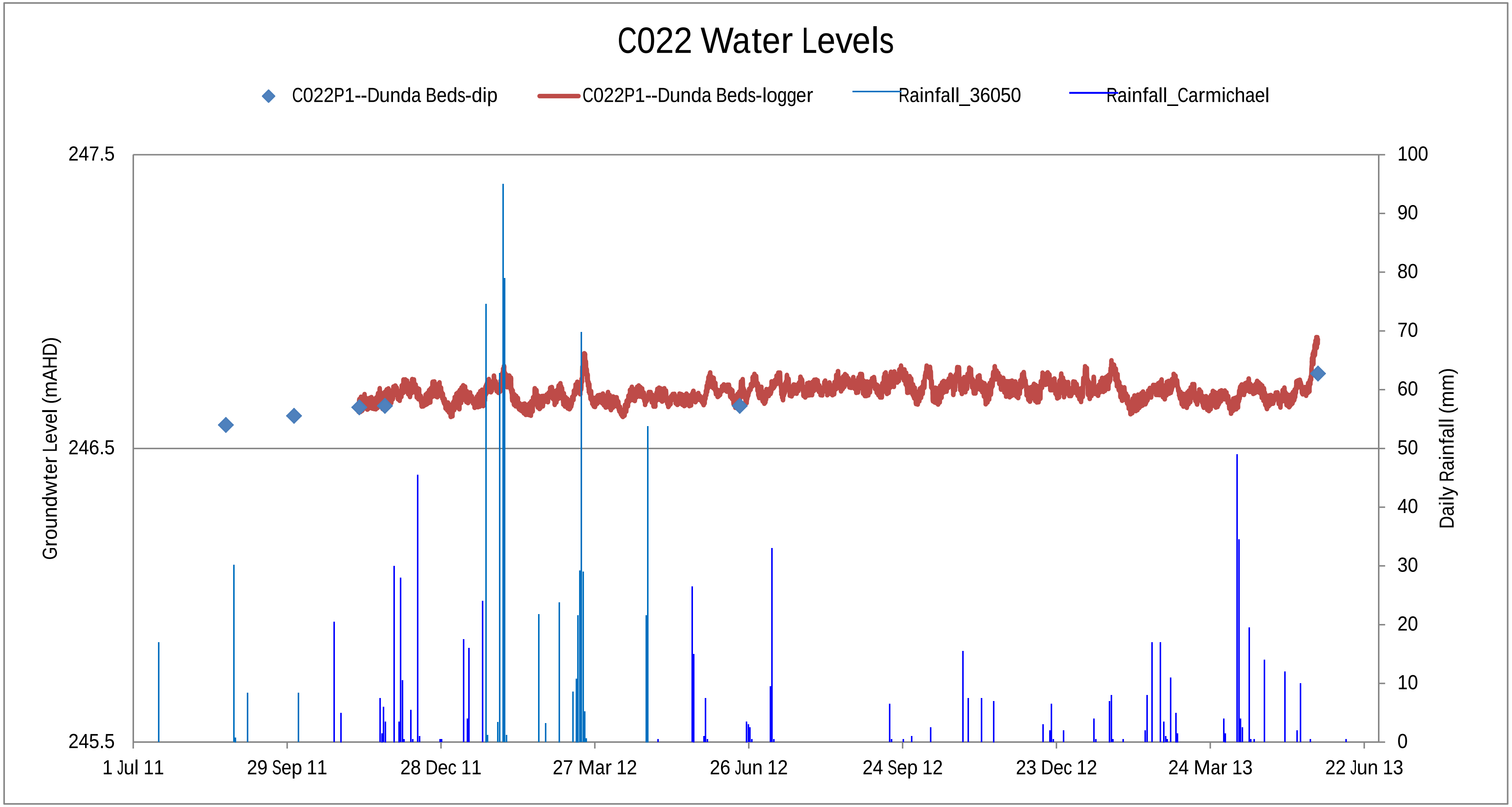
Carmichael Coal (Mine)


C016 Water Levels
C016P2--AB Seam-dip
C016P2--AB Seam-logger
Rainfall_36050
Rainfall_Carmichael
Groundwater Level (mAHD)
250
249
248
247
Daily Rainfall (mm)
100
90
80
70
60
50
40
30
20
10
0
1 Jul 11
30 Sep 11
30 Dec 11
30 Mar 12
30 Jun 12
29 Sep 12
29 Dec 12
31 Mar 13
30 Jun 13

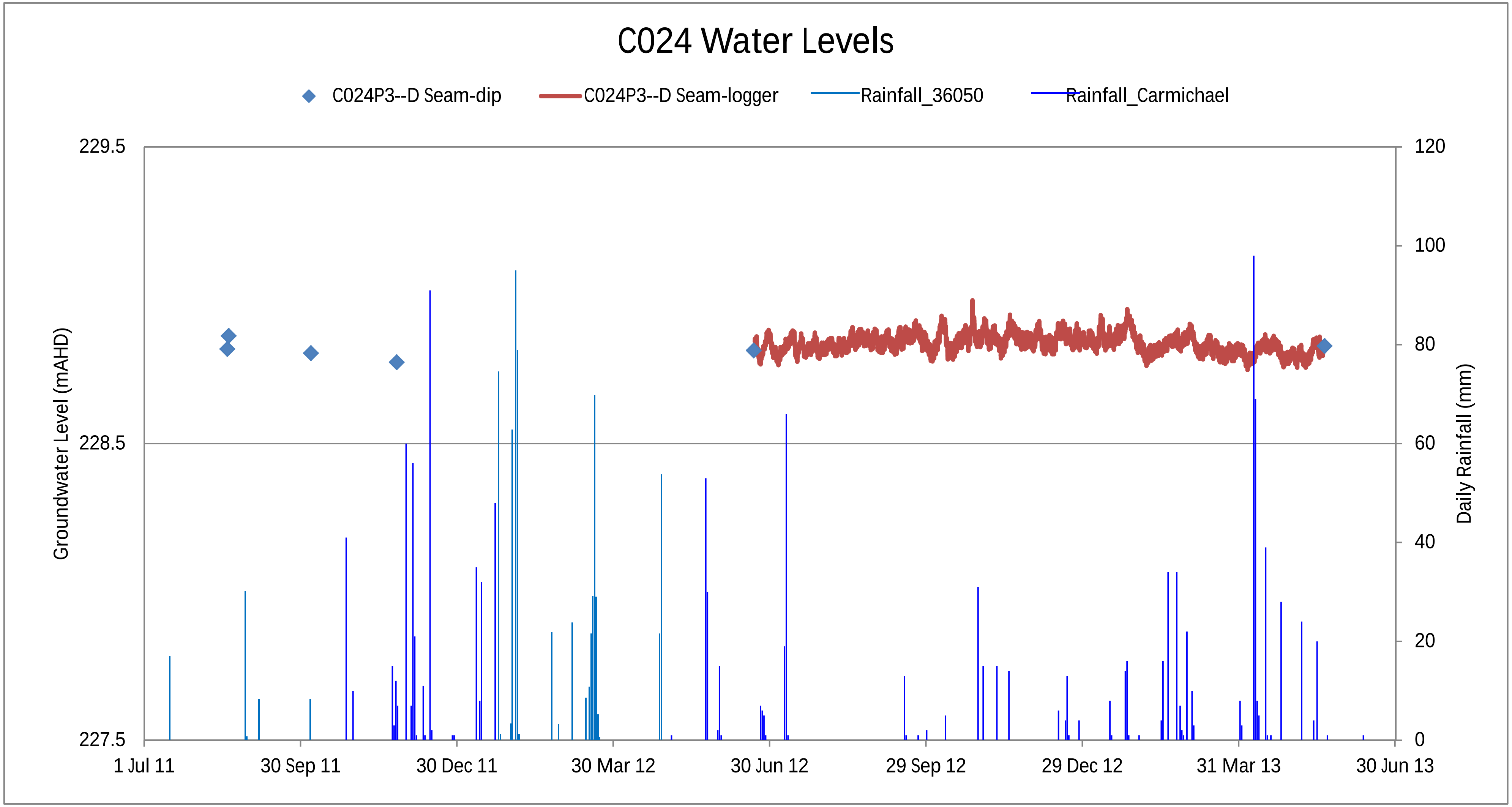


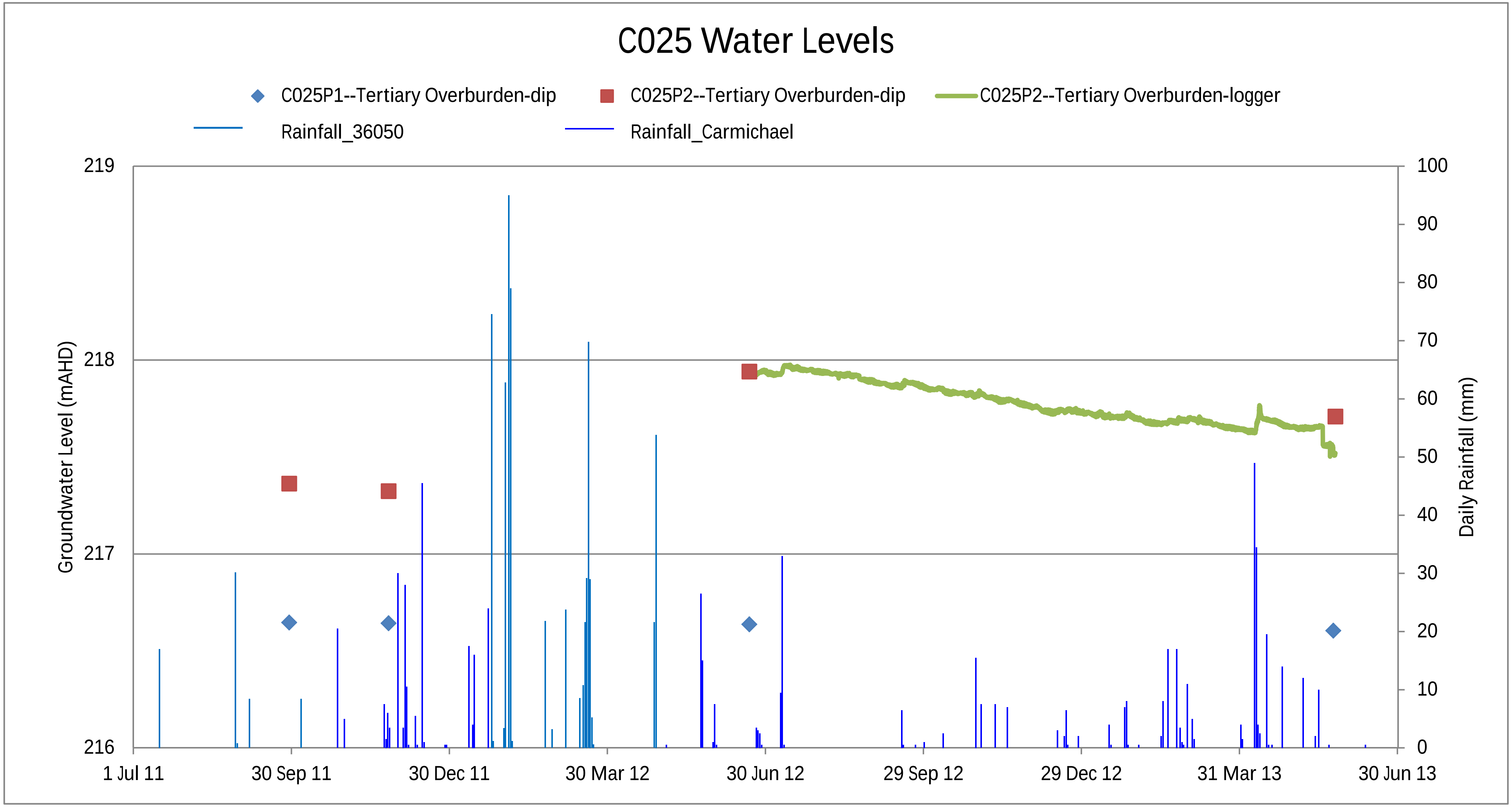
Carmichael Coal (Mine)


C020 Water Levels
C020P2--AB Seam-dip
C020P2--AB Seam-logger
Rainfall_36050
Rainfall_Carmichael
Groundwater Level (mAHD)
222
221
220
Daily Rainfall (mm)
100
90
80
70
60
50
40
30
20
10
0
1 Jul 11
30 Sep 11
30 Dec 11
30 Mar 12
30 Jun 12
29 Sep 12
29 Dec 12
31 Mar 13
30 Jun 13

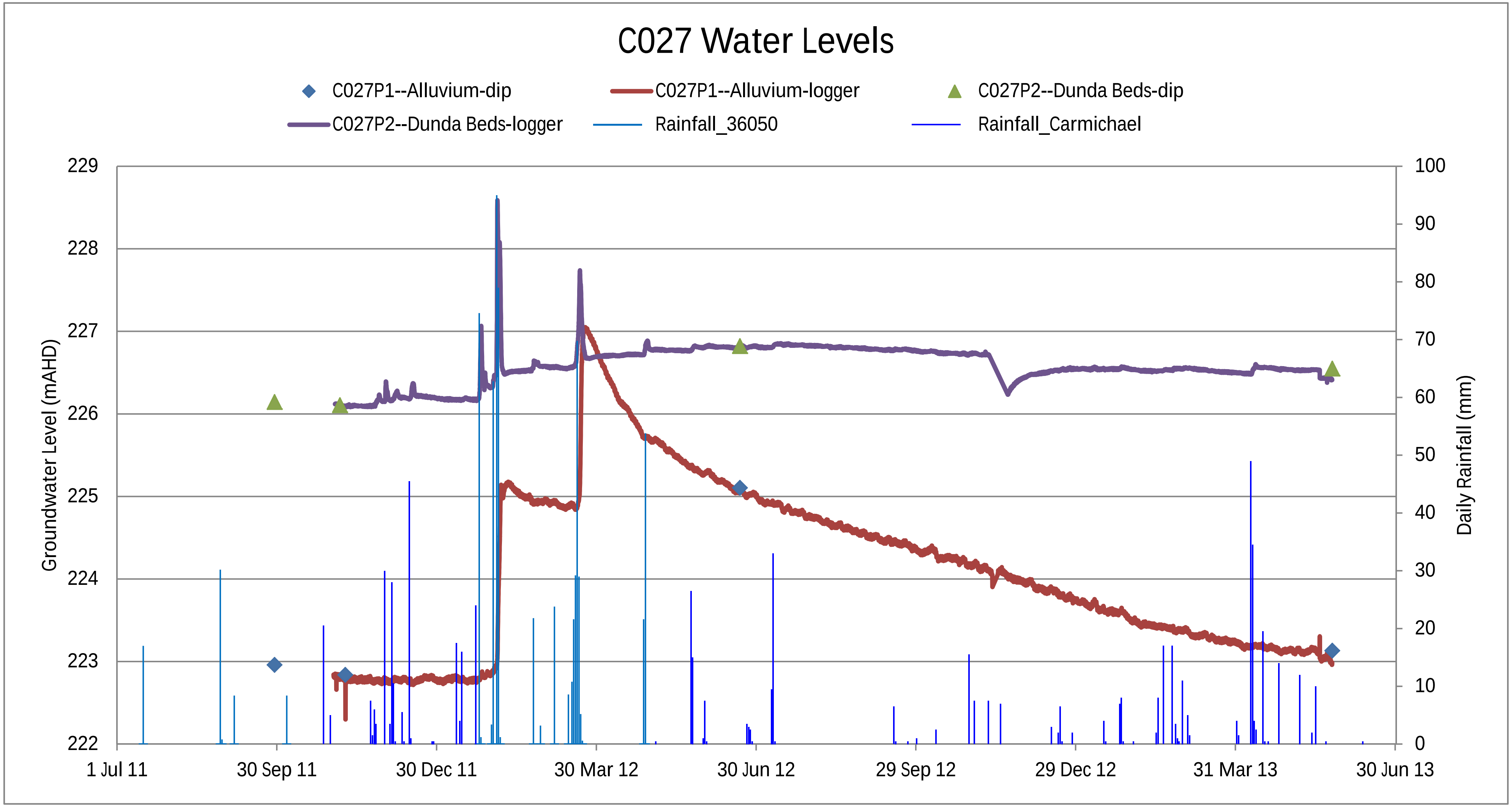


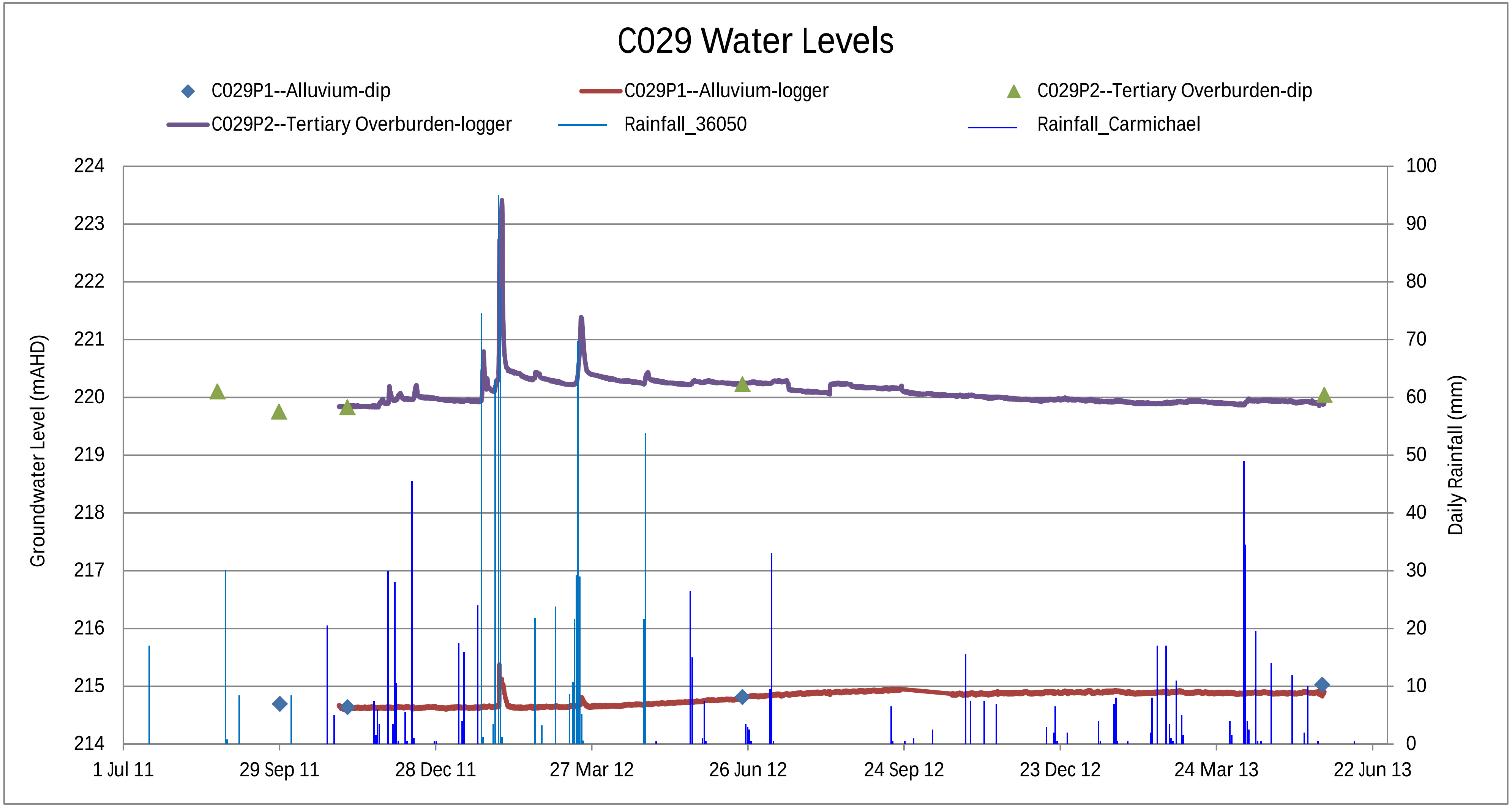
Carmichael Coal (Mine)

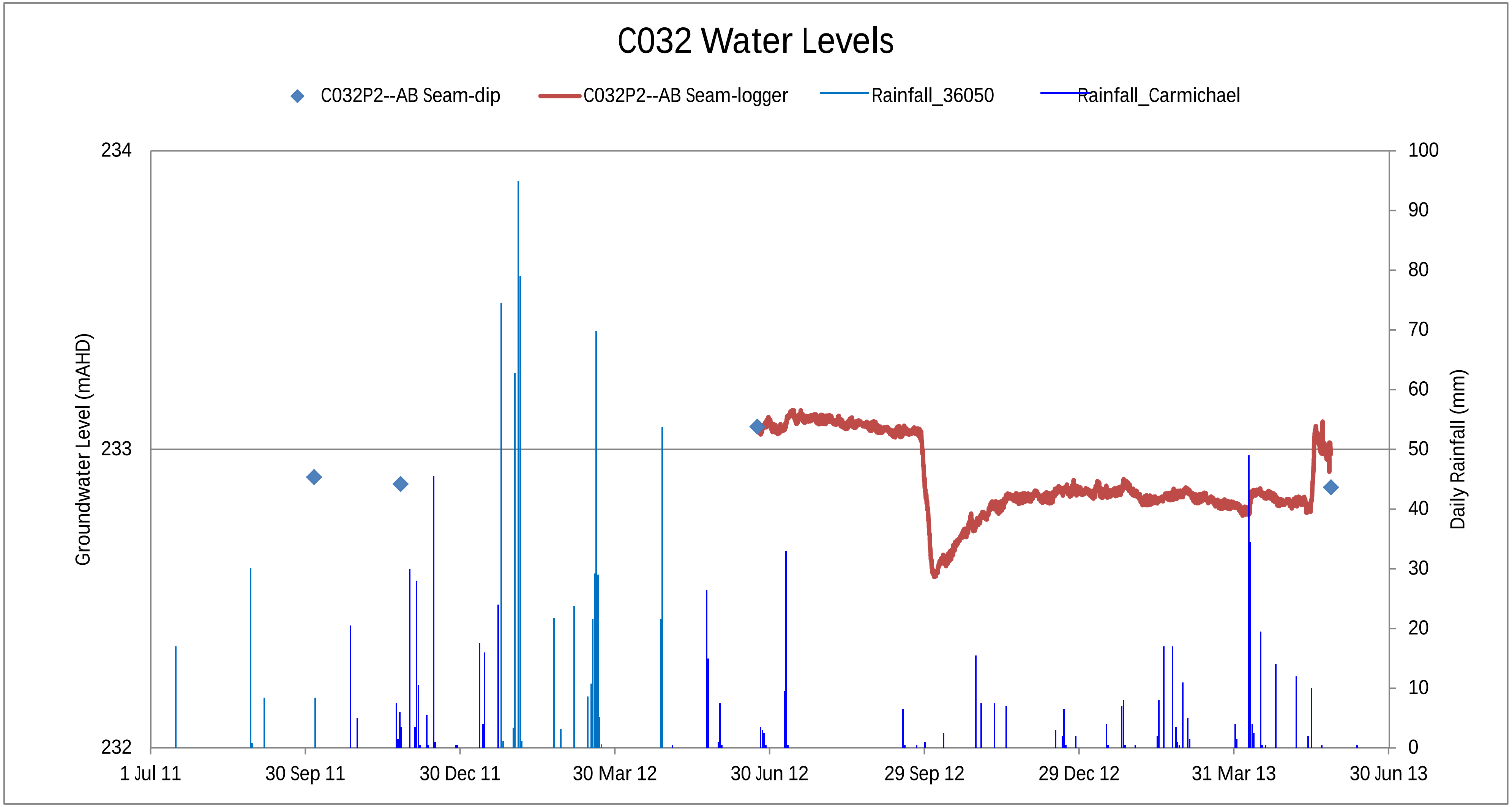

C024 Water Levels
C024P3--D Seam-dip
C024P3--D Seam-logger
Rainfall_36050
Rainfall_Carmichael
Groundwater Level (mAHD)
229.5
228.5
227.5
Daily Rainfall (mm)
120
100
80
60
40
20
0
1 Jul 11
30 Sep 11
30 Dec 11
30 Mar 12
30 Jun 12
29 Sep 12
29 Dec 12
31 Mar 13
30 Jun 13

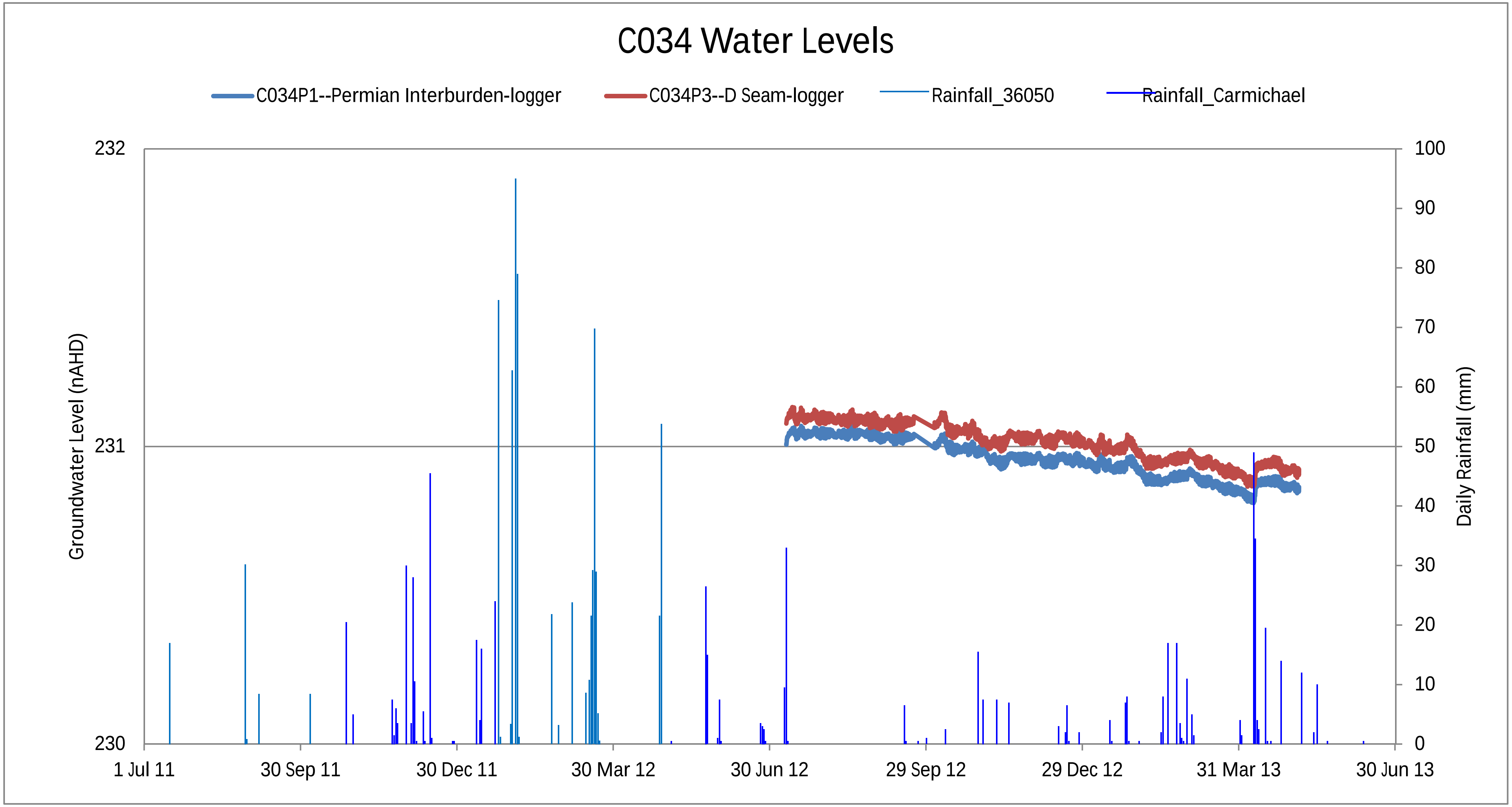


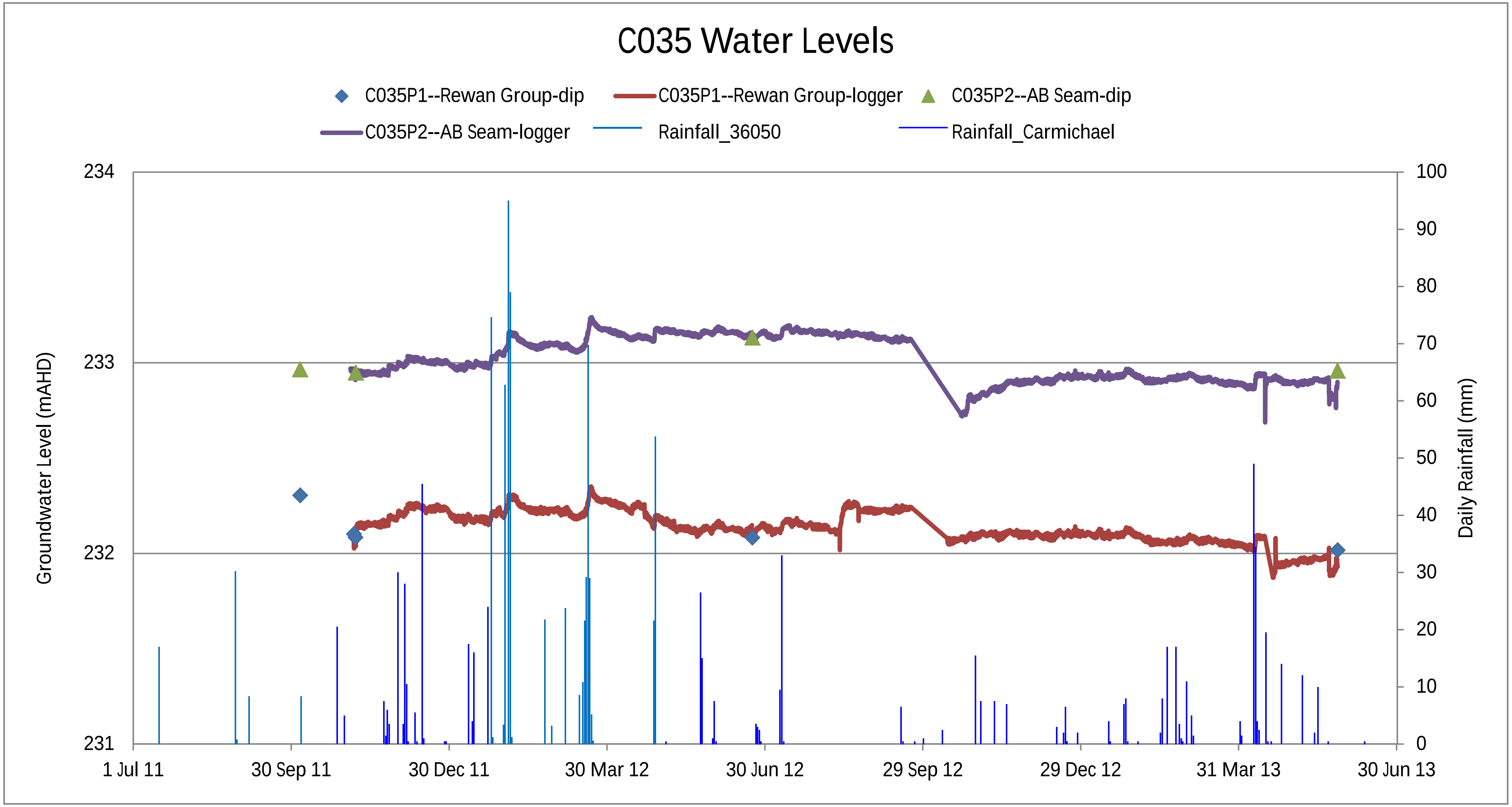
C025 Water Levels
C025P1--Tertiary Overburden-dip
C025P2--Tertiary Overburden-dip
C025P2--Tertiary Overburden-logger
Rainfall_36050
Rainfall_Carmichael
Groundwater Level (mAHD)
219
218
217
216
Daily Rainfall (mm)
100
90
80
70
60
50
40
30
20
10
0
1 Jul 11
30 Sep 11
30 Dec 11
30 Mar 12
30 Jun 12
29 Sep 12
29 Dec 12
31 Mar 13
30 Jun 13


C027 Water Levels
C027P1--Alluvium-dip
C027P1--Alluvium-logger
C027P2--Dunda Beds-dip
C027P2--Dunda Beds-logger
Rainfall_36050
Rainfall_Carmichael
Groundwater Level (mAHD)
229
228
227
226
225
224
223
222
Daily Rainfall (mm)
100
90
80
70
60
50
40
30
20
10
0
1 Jul 11
30 Sep 11
30 Dec 11
30 Mar 12
30 Jun 12
29 Sep 12
29 Dec 12
31 Mar 13
30 Jun 13


C029 Water Levels
◆ C029P1--Alluvium-dip
C029P1--Alluvium-logger
▲ C029P2--Tertiary Overburden-dip
C029P2--Tertiary Overburden-logger
Rainfall_36050
Rainfall_Carmichael
Groundwater Level (mAHD)
224
223
222
221
220
219
218
217
216
215
214
Daily Rainfall (mm)
100
90
80
70
60
50
40
30
20
10
0
1 Jul 11
29 Sep 11
28 Dec 11
27 Mar 12
26 Jun 12
24 Sep 12
23 Dec 12
24 Mar 13
22 Jun 13


C032 Water Levels
C032P2--AB Seam-dip
C032P2--AB Seam-logger
Rainfall_36050
Rainfall_Carmichael
Groundwater Level (mAHD)
234
233
232
Daily Rainfall (mm)
100
90
80
70
60
50
40
30
20
10
0
1 Jul 11
30 Sep 11
30 Dec 11
30 Mar 12
30 Jun 12
29 Sep 12
29 Dec 12
31 Mar 13
30 Jun 13


C034 Water Levels
C034P1--Permian Interburden-logger
C034P3--D Seam-logger
Rainfall_36050
Rainfall_Carmichael
Groundwater Level (nAHD)
232
231
230
Daily Rainfall (mm)
100
90
80
70
60
50
40
30
20
10
0
1 Jul 11
30 Sep 11
30 Dec 11
30 Mar 12
30 Jun 12
29 Sep 12
29 Dec 12
31 Mar 13
30 Jun 13



C035 Water Levels
C035P1--Rewan Group-dip
C035P1--Rewan Group-logger
C035P2--AB Seam-dip
C035P2--AB Seam-logger
Rainfall_36050
Rainfall_Carmichael
Groundwater Level (mAHD)
234
233
232
231
Daily Rainfall (mm)
100
90
80
70
60
50
40
30
20
10
0
1 Jul 11
30 Sep 11
30 Dec 11
30 Mar 12
30 Jun 12
29 Sep 12
29 Dec 12
31 Mar 13
30 Jun 13

Appendix D – Groundwater quality

Laboratory Analysis Summary Tables

Field Chemistry Summary Tables

Laboratory QA Certificates

			Field							Inorganics								Nutrients						Alkalinity					
			Dissolved Oxygen (% saturated) (Field)	Dissolved Oxygen (Field)	Electrical Conductivity (Field)	Oxygen Redox Potential (Field)	pH (Field)	TDS (Field)	Temp (Field)	Bromide	Electrical conductivity *(lab)	Fluoride	Kjeldahl Nitrogen Total	pH (Lab)	Sulphide	TOC	Total Dissolved Solids	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
			%S	mg/L	uS/cm	mV	pH_Units	PPM	oC	mg/L	uS/cm	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
EQL										0.005	1	0.1	0.1	0.01	0.1	1	5	0.01	0.01	0.01	0.01	0.1	0.01	1	1	1	1		
ADWG 2011 Health												1.5							11.3[#5]	0.68[#4]									
ANZECC (2000) Ecosystems Fresh Water (95%)																		0.9[#1]	0.158[#5]										
ANZECC (2000) Irrigation LTV							**6-8.5**					**1**										**5**	**0.05**						
ANZECC (2000) Livestock												2					5000[#3]		90[#5]	9[#6]									
LocCode	**Sampled_Date-Time**	**MonitoringUnit_2**																											
C006P1	3/10/2011	Permian Interburden	12.5	1.04	8250	-	**4.47**	5290	27.2	7.9	14,100	0.7	0.5	7.74	0.2	58	8960	0.46	0.02	<0.01	0.02	0.5	0.04	365	365	<1	<1	445.3	<1.2
C006P1	10/11/2011	Permian Interburden	8.2	0.61	16,020	-61	6.78	10,350	30.3	14.1	19,000	0.6	0.2	7.16	0.2	18	11,900	0.27	0.02	<0.01	0.02	0.2	<0.01	338	338	<1	<1	412.4	<1.2
C006P1	23/05/2013	Permian Interburden	77.2	-	38,310	-65.5	6.9	-	26.5	-	18,400	0.5	0.2	7.54	<0.1	<1	11,900	0.09	0.02	<0.01	0.02	-	<0.01	294	294	<1	<1	358.7	<1.2
C006P3r	3/10/2011	D Seam	11	0.8	999	-40	**4.71**	585	21.2	0.17	1000	**2.2**	0.4	8.32	<0.1	12	587	0.34	0.02	<0.01	0.02	0.4	**0.08**	491	485	6	<1	591.7	7.201
C006P3r	12/11/2011	D Seam	8	0.61	987	-120	7.71	566	29.2	0.16	1020	**2.4**	0.4	8.18	<0.1	<1	620	0.31	<0.01	<0.01	<0.01	0.4	**0.21**	454	454	<1	<1	553.9	<1.2
C006P3R	23/05/2013	D Seam	28.5	-	2364	-132.7	7.82	-	26.6	-	973	**2.3**	0.6	8.24	<0.1	3	541	0.4	0.01	<0.01	0.01	-	**0.08**	430	430	<1	<1	524.6	<1.2
C006P3r	10/11/2011	D Seam	12.3	0.91	980	31	7.78	563	34.9	0.18	1030	**2.2**	0.5	8.04	<0.1	13	568	0.33	0.02	<0.01	0.02	0.5	0.02	458	458	<1	<1	558.8	<1.2
C007P2	4/10/2011	AB Seam	14.6	1.1	14,210	-39	**4.41**	9310	26.1	8.3	17,100	0.4	6.2	7.56	<0.1	13	10,300	3.07	0.03	<0.01	0.03	**6.2**	**1.73**	205	205	<1	<1	250.1	<1.2
C007P2	10/11/2011	AB Seam	59.5	4.2	13,350	-153	7.9	8610	31	-	16,100	0.4	2	7.95	5.3	36	10,700	2.43	0.02	<0.01	0.02	2	<0.01	264	264	<1	<1	322.1	<1.2
C007P2	23/05/2013	AB Seam	28.5	-	27,300	-177.3	7.42	-	28.4	-	16,100	0.3	3	7.81	<0.1	<1	10,300	3.67	0.01	<0.01	0.01	-	**0.06**	211	211	<1	<1	257.4	<1.2
C007P2	10/11/2011	AB Seam	19.7	1.23	13,150	-192	7.49	8420	31.8	13	16,500	0.4	2.1	7.73	6.2	38	10,800	2.48	0.01	<0.01	0.01	2.1	0.04	251	251	<1	<1	306.2	<1.2
C007P3	4/10/2011	D Seam	9.9	0.9	1246	-82	**5.04**	737	28.8	0.14	1230	**2.6**	0.7	8.23	0.2	33	809	0.3	0.01	<0.01	0.01	0.7	**0.14**	487	487	<1	<1	594.1	<1.2
C007P3	10/11/2011	D Seam	74.9	5.92	1233	-192	8.34	713	31.8	0.2 - 11.7	1220	**2.6**	0.4	8.31	1.3	38	760	0.43	0.02	<0.01	0.02	0.4	0.05	548	538	9	<1	656.4	10.8
C007P3	23/05/2013	D Seam	29.7	-	2178	-215.3	8.11	-	27.7	-	1080	**2.3**	0.1	8.35	0.1	4	627	0.41	0.01	<0.01	0.01	-	0.02	488	477	12	<1	581.9	14.4
C008P1	3/10/2011	Permian Overburden	21.6	1.73	20,630	41	**5.58**	13,830	28.1	14.7	22,900	0.5	0.2	7.65	<0.1	3	14,900	0.14	0.02	<0.01	0.02	0.2	0.04	316	316	<1	<1	385.5	<1.2
C008P1	12/11/2011	Permian Overburden	10.4	0.79	19,900	129	6.65	13,030	30.6	20.4	23,000	0.6	0.2	7.23	<0.1	<1	17,200	0.15	<0.01	<0.01	<0.01	0.2	<0.01	298	298	<1	<1	363.6	<1.2
C008P1	25/05/2013	Permian Overburden	40.05	-	68,190	55.3	7.03	-	26.1	-	21,200	0.5	0.2	7.5	<0.1	<1	13,600	0.3	<0.01	<0.01	<0.01	-	0.05	284	284	<1	<1	346.5	<1.2
C008P2	3/10/2011	AB Seam	11.6	0.75	3290	-137	**5.92**	2020	31.1	1.35	3330	0.8	0.9	8.52	5.3	54	1920	0.9	0.02	<0.01	0.02	0.9	**0.18**	552	515	36	<1	628.3	43.21
C008P2	12/11/2011	AB Seam	71.6	5.4	3040	-116	8.03	1820	29.8	1.74	3260	0.9	1	8.27	0.9	37	1920	0.85	0.01	<0.01	0.01	1	<0.01	585	585	<1	<1	713.7	<1.2
C008P2	23/05/2013	AB Seam	24.3	-	7434	-192.8	8.06	-	25.5	-	3110	0.8	1.2	8.25	<0.1	18	1710	1.52	<0.01	<0.01	<0.01	-	**0.13**	414	414	<1	<1	505.1	<1.2
C011P1	13/11/2011	Permian Interburden	14.4	0.92	2880	-57	7.63	1720	40.8	1.51	2980	0.8	0.2	8.17	<0.1	31	1900	0.12	0.05	<0.01	0.05	0.2	<0.01	669	669	<1	<1	816.2	<1.2
C011P1	19/05/2013	Permian Interburden	51	-	5422	-149.5	7.87	-	29.9	-	2810	0.6	0.2	7.94	<0.1	28	1670	0.04	<0.01	<0.01	<0.01	-	<0.01	597	597	<1	<1	728.3	<1.2
C011P3	20/05/2013	D Seam	-	-	-	-	-	-	-	-	881	**1.1**	0.5	7.82	<0.1	<1	598	0.29	<0.01	<0.01	<0.01	-	0.03	220	220	<1	<1	268.4	<1.2
C011P3	4/10/2011	D Seam	14.6	1.2	980	35	**5.86**	5860	31.8	0.42	1020	**1.2**	1.1	8.45	<0.1	8	568	0.21	0.03	<0.01	0.03	1.1	**0.57**	258	245	13	<1	298.9	15.6
C011P3	13/11/2011	D Seam	46.7	3.42	982	-86	7.75	982	31.4	-	1030	**1.2**	0.3	8.01	<0.1	<1	608	0.29	0.02	<0.01	0.02	0.3	<0.01	278	278	<1	<1	339.2	<1.2
C011P3	28/11/2011	D Seam	-	-	-	-	-	-	-	0.61	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C011P3	20/05/2013	D Seam	62.1	-	1857	-110.7	7.68	-	27.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C012P1	2/10/2011	Permian Overburden	31.8	2.43	1839	78	**5.59**	1109	27.6	1.04	2010	0.3	0.5	7.32	<0.1	-	1170	0.2	0.03	0.01	0.04	0.5	**0.33**	84	84	<1	<1	102.5	<1.2
C012P1	4/10/2011	Permian Overburden	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-
C012P1	8/11/2011	Permian Overburden	17	1.43	1996	76	6.26	1180	28.4	1.89	2080	0.3	<0.1	6.43	<0.1	6	1350	0.02	0.05	<0.01	0.05	<0.1	<0.01	82	82	<1	<1	100	<1.2
C012P1	19/05/2013	Permian Overburden	11.1	-	3313	162.9	6.2	-	27.7	-	1940	0.3	<0.1	6.5	<0.1	<1	1140	0.02	0.06	<0.01	0.06	-	**0.7**	79	79	<1	<1	96.38	<1.2
C012P2	2/10/2011	Permian Overburden	19	1.38	2179	-15	**5.52**	1318	-	1.3	2580	0.5	<0.1	7.86	-	-	1680	0.04	0.02	<0.01	0.02	<0.1	<0.01	276	276	<1	<1	336.7	<1.2
C012P2	4/10/2011	Permian Overburden	-	-	-	-	-	-	-	-	-	-	-	-	0.3	58	-	-	-	-	-	-	-	-	-	-	-	-	-
C012P2	13/11/2011	Permian Overburden	10	0.75	2440	-119	7.19	1450	30.3	1.56	2660	0.4	0.1	7.75	0.1	32	1560	0.04	0.02	<0.01	0.02	0.1	<0.01	369	369	<1	<1	450.2	<1.2
C012P2	19/05/2013	Permian Overburden	9.2	-	6709	-181.2	7.29	-	28.2	-	2470	0.4	0.2	7.58	0.2	14	1810	0.04	0.01	<0.01	0.01	-	**0.06**	295	295	<1	<1	359.9	<1.2
C014P2	4/10/2011	AB Seam	8.6	0.63	1960	-9	**5.48**	5480	31.3	0.72	2020	1	1.1	8.61	<0.1	29	1110	0.82	0.02	<0.01	0.02	1.1	<0.01	390	360	30	<1	439.2	36.01
C014P2	12/11/2011	AB Seam	16.5	1.25	1980	-129	**9.86**	1169	30.9	1.15	2030	1	1.6	9.5	<0.1	23	1340	0.98	0.02	<0.01	0.02	1.6	**0.28**	406	216	190	<1	263.5	228
C014P2	26/05/2013	AB Seam	43.2	-	13,970	-382	-	-	26.4	-	5950	0.4	3.1	12	<0.1	134	2390	2.21	0.01	<0.01	0.01	-	**0.22**	1320	<1	664	653	<1.22	796.9
C016P2	2/10/2011	AB Seam	10.9	0.72	3070	-146	**10.12**	1880	25.2	1.36	3000	0.2	8.3	10.4	4.7	-	1660	4.93	0.02	<0.01	0.02	**8.3**	**0.51**	314	<1	274	40	<1.22	328.9
C016P2	6/10/2011	AB Seam	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-
C016P2	13/11/2011	AB Seam	33.1	2.46	4080	-199	**12.03**	4080	30.8	1.85	3840	0.3	11.7	11.5	1.9	28	1840	4.32	0.02	<0.01	0.02	**11.7**	<0.01	527	<1	306	221	<1.22	367.3
C016P2	21/05/2013	AB Seam	79.7	-	8166	-350.2	**11.88**	-	27.8	-	2810	0.2	18.4	11.5	<0.1	18	1440	6.02	<0.01	<0.01	<0.01	-	0.02	318	<1	122	196	<1.22	146.4
C018P1	2/10/2011	Permian Overburden	49.8	3.66	754	41	**5.63**	433	29.3	0.21	765	0.6	2.7	7.53	<0.1	-	486	0.1	0.03	0.06	0.09	2.8	**0.07**	100	100	<1	<1	122	<1.2
C018P1	6/10/2011	Permian Overburden	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-
C018P1	8/11/2011	Permian Overburden	43.8	3.27	782	58	6.33	444	29.3	0.52	810	0.4	<0.1	6.5	<0.1	<1	541	0.03	0.08	<0.01	0.08	<0.1	<0.01	83	83	<1	<1	101.3	<1.2
C018P1	20/05/2013	Permian Overburden	77.1	-	1144	182.2	6.24	-	28	-	721	0.3	0.1	6.51	<0.1	<1	540	0.01	0.12	<0.01	0.12	-	0.02	68	68	<1	<1	82.96	<1.2
C018P2	2/10/2011	AB Seam	17.9	1.61	1390	-57	**5.41**	828	30.8	1.27	2490	0.4	0.6	7.63	0.6	-	1420	0.03	0.02	<0.01	0.02	0.6	**0.3**	221	221	<1	<1	269.6	<1.2
C018P2	6/10/2011	AB Seam	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-
C018P2	9/11/2011	AB Seam	11	0.86	2310	-72	6.87	1370	29.3	2.15	2580	0.4	<0.1	7.18	0.4	28	1360	0.1	0.02	<0.01	0.02	<0.1	**0.21**	239	239	<1	<1	291.6	<1.2
C018P2	20/05/2013	AB Seam	28	-	3148	-92.9	7.34	-	28	-	1550	0.4	0.2	7.56	<0.1	<1	1260	0.08	<0.01	<0.01	<0.01	-	0.02	256	256	<1	<1	312.3	<1.2
C018P2	9/11/2011	AB Seam	14.5	1.02	2225	-31	6.96	1321	33.4	1.75	2320	0.5	0.4	7.26	0.9	16	1210	0.31	0.02	<0.01	0.02	0.4	**0.23**	246	246	<1	<1	300.1	<1.2

			Field							Inorganics								Nutrients						Alkalinity					
			Dissolved Oxygen (% saturated) (Field)	Dissolved Oxygen (Field)	Electrical Conductivity (Field)	Oxygen Redox Potential (Field)	pH (Field)	TDS (Field)	Temp (Field)	Bromide	Electrical conductivity *(lab)	Fluoride	Kjeldahl Nitrogen Total	pH (Lab)	Sulphide	TOC	Total Dissolved Solids	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
			%S	mg/L	uS/cm	mV	pH_Units	PPM	oC	mg/L	uS/cm	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
EQL										0.005	1	0.1	0.1	0.01	0.1	1	5	0.01	0.01	0.01	0.01	0.1	0.01	1	1	1	1		
ADWG 2011 Health												1.5							$11.3^{\#5}$	$0.68^{\#4}$									
ANZECC (2000) Ecosystems Fresh Water (95%)																		$0.9^{\#1}$	$0.158^{\#5}$										
ANZECC (2000) Irrigation LTV							**6-8.5**					**1**										**5**	**0.05**						
ANZECC (2000) Livestock												2					$5000^{\#3}$		$90^{\#5}$	$9^{\#6}$									
LocCode	**Sampled_Date-Time**	**MonitoringUnit_2**																											
C018P3	2/10/2011	D Seam	21.1	1.89	1020	-20	**5.81**	594	29.8	0.48	1050	**1.2**	0.8	7.81	<0.1	-	651	0.32	0.03	<0.01	0.03	0.8	**0.09**	179	179	<1	<1	218.4	<1.2
C018P3	6/10/2011	D Seam	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-
C018P3	9/11/2011	D Seam	23.1	1.61	991	-60	7.06	568	-	0.7	1040	**1.2**	0.2	7.35	<0.1	2	523	0.21	0.02	<0.01	0.02	0.2	0.05	188	188	<1	<1	229.4	<1.2
C018P3	19/05/2013	D Seam	-	-	-	-	-	-	-	-	948	**1.1**	0.4	7.36	<0.1	<1	653	0.16	<0.01	<0.01	<0.01	-	**0.12**	169	169	<1	<1	206.2	<1.2
C018P3	20/05/2013	D Seam	52.3	-	2438	-46.1	7.11	-	28.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C018P3	9/11/2011	D Seam	6.9	0.61	996	32.6	7.23	569	31.7	0.68	1040	**1.2**	0.3	7.51	0.1	5	554	0.06	0.02	<0.01	0.02	0.3	**0.07**	204	204	<1	<1	248.9	<1.2
C020P2	3/10/2011	AB Seam	13.5	1.13	1694	42	**4.5**	1019	30.1	0.84	1780	0.6	0.6	8.21	-	-	1050	0.04	0.03	<0.01	0.03	0.6	**0.23**	225	225	<1	<1	274.5	<1.2
C020P2	6/10/2011	AB Seam	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
C020P2	14/11/2011	AB Seam	19.4	1.49	1620	-189	8.06	949	29.1	1.33	1740	0.6	0.6	8.2	1.5	<1	970	0.52	0.02	<0.01	0.02	0.6	<0.01	257	257	<1	<1	313.5	<1.2
C022P1	3/10/2011	Dunda Beds	22.6	1.67	338	23	**4.9**	188	24	0.14	332	0.3	<0.1	6.76	-	-	301	0.02	0.03	<0.01	0.03	<0.1	**0.07**	36	36	<1	<1	43.92	<1.2
C022P1	6/10/2011	Dunda Beds	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	<1	-	-	-	-	-	-	-	-	-	-	-	-	-
C022P1	10/11/2011	Dunda Beds	-	-	-	-	-	-	-	0.23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C022P1	14/11/2011	Dunda Beds	9.7	0.78	347	9	6.02	190	28.6	0.21	357	0.3	<0.1	6.73	<0.1	2	233	0.04	0.03	<0.01	0.03	<0.1	<0.01	47	47	<1	<1	57.34	<1.2
C022P1	26/05/2013	Dunda Beds	80	-	8295	-136.7	-	-	26.7	-	275	0.1	0.4	6.57	<0.1	1	183	0.01	0.2	<0.01	0.2	-	**0.36**	24	24	<1	<1	29.28	<1.2
C022P1	10/11/2011	Dunda Beds	17.1	1.48	343	-6	6.04	187	31.1	-	395	0.3	0.1	6.39	<0.1	<1	209	0.05	0.02	<0.01	0.02	0.1	<0.01	45	45	<1	<1	54.9	<1.2
C024P3	6/10/2011	D Seam	10	0.71	1720	-72	**4.72**	1033	31.2	1.28	1710	0.4	0.8	6.52	0.4	108	1150	<0.01	<0.01	<0.01	<0.01	0.8	**0.07**	307	307	<1	<1	374.5	<1.2
C024P3	14/11/2011	D Seam	10.5	0.8	1602	-120	6.49	938	31.1	1.09	1720	0.4	0.4	7.12	1	47	1050	0.02	<0.01	<0.01	<0.01	0.4	<0.01	307	307	<1	<1	374.5	<1.2
C024P3	20/05/2013	D Seam	39	-	3979	-113.5	6.72	-	27	-	1520	0.6	1.2	6.86	<0.1	11	1110	1.19	0.01	<0.1	0.01	-	**0.18**	254	254	<1	<1	309.9	<1.2
C025P2	29/09/2011	Tertiary Overburden	6.6	0.67	11,500	-291	**5.56**	7500	30.5	6.1	14,000	0.8	3.3	7.52	0.4	1	8180	0.63	0.03	<0.01	0.03	3.3	**0.38**	746	746	<1	<1	910.1	<1.2
C025P2	7/11/2011	Tertiary Overburden	10.3	0.84	13,020	70	6.92	8350	28.5	11	14,700	0.6	1.8	7.07	<0.1	<1	8660	1.38	0.16	<0.01	0.16	2	**0.12**	763	763	<1	<1	930.9	<1.2
C025P2	25/05/2013	Tertiary Overburden	27.2	-	4023	-182	6.94	-	26.7	-	12,700	0.5	0.5	7.73	<0.1	<1	7780	0.72	<0.01	<0.01	<0.01	-	<0.01	605	605	<1	<1	738.1	<1.2
C027P1	29/09/2011	Alluvium	16.9	1.19	5940	-64	**5.97**	3710	28.9	-	6260	0.9	2.1	7	<0.1	52	3850	0.53	0.01	0.02	0.03	2.1	**0.21**	582	582	<1	<1	710	<1.2
C027P1	8/11/2011	Alluvium	26.4	2.07	5980	-55	6.64	3690	29.3	4.94	6590	0.6	1.1	6.77	<0.1	<1	4370	0.88	0.01	<0.01	0.01	1.1	<0.01	460	460	<1	<1	561.2	<1.2
C027P1	25/05/2013	Alluvium	7.4	-	19,600	-87.6	6.67	-	27.4	-	6910	0.5	0.5	7.16	<0.1	<1	4080	0.69	0.01	<0.01	0.01	-	**0.1**	257	257	<1	<1	313.5	<1.2
C027P1	8/11/2011	Alluvium	16.4	1.18	6140	-72	6.68	3810	33.2	4.4	6430	0.7	1.1	6.91	<0.1	<1	4260	0.93	0.02	<0.01	0.02	1.2	<0.01	480	480	<1	<1	585.6	<1.2
C027P2	29/09/2011	Dunda Beds	11.5	0.95	1161	-60	**5.77**	680	28.5	-	855	0.5	2	7.25	<0.1	106	805	0.97	0.01	<0.01	0.01	2	**0.19**	128	128	<1	<1	156.2	<1.2
C027P2	5/11/2011	Dunda Beds	6.2	0.46	1008	-90	6.71	576	27.5	0.6	992	0.4	0.6	6.79	<0.1	<1	949	0.42	0.02	<0.01	0.02	0.6	0.02	180	180	<1	<1	219.6	<1.2
C027P2	25/05/2013	Dunda Beds	40.7	-	2735	-54.2	6.72	-	27	-	821	0.2	0.1	7	<0.1	<1	488	0.09	0.03	<0.01	0.03	-	**0.09**	62	62	<1	<1	75.64	<1.2
C027P2	29/09/2011	Dunda Beds	-	-	-	-	-	-	-	0.32	1030	0.5	-	6.79	-	-	914	-	-	-	-	-	-	216	216	<1	<1	263.5	<1.2
C029P1	29/09/2011	Alluvium	8.4	0.51	20,770	-101	**5.82**	13,910	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C029P1	7/11/2011	Alluvium	38.6	2.86	27,600	-70	7.19	18,400	32.5	22	29,900	0.9	1.7	7.28	<0.1	<1	20,100	1.35	0.01	<0.01	0.01	1.7	**0.15**	1590	1590	<1	<1	1940	<1.2
C029P1	24/05/2013	Alluvium	33.6	-	31,670	-175.1	8.4	-	26.8	-	28,100	1	1.9	7.97	<0.1	<1	19,200	0.28	0.05	<0.01	0.05	-	**0.39**	1980	1980	<1	<1	2416	<1.2
C029P2	25/05/2013	Tertiary Overburden	17.9	-	33,190	-97.4	6.99	-	26.4	-	10,900	0.5	<0.1	7.47	<0.1	<1	6810	0.07	0.01	<0.01	0.01	-	<0.01	227	227	<1	<1	276.9	<1.2
C029P2	29/09/2011	Tertiary Overburden	16.6	1.46	7890	-176	6.38	5850	33.4	4.95	11,600	0.6	-	7.23	0.3	13	6960	-	-	-	-	-	-	259	259	<1	<1	316	<1.2
C029P2	7/11/2011	Tertiary Overburden	4.2	0.34	10,360	-165	6.77	6580	30.7	10	12,100	0.6	0.7	6.96	<0.1	<1	7780	0.42	0.01	<0.01	0.01	0.7	**0.21**	274	274	<1	<1	334.3	<1.2
C032P2	5/10/2011	AB Seam	12.5	0.84	1354	-26	**4.34**	800	31.6	0.42	1400	0.6	0.4	8.09	0.2	36	951	0.05	0.03	<0.01	0.03	0.4	**0.12**	336	336	<1	<1	409.9	<1.2
C032P2	7/11/2011	AB Seam	47.5	3.48	1563	-71	7.29	915	29.3	0.54	1580	0.7	2	7.49	<0.1	<1	1540	0.71	0.01	<0.01	0.01	2	**0.74**	535	535	<1	<1	652.7	<1.2
C032P2	27/05/2013	AB Seam	21.9	-	3721	-343	-	-	28.4	-	1590	0.9	0.7	10.1	<0.1	4	798	0.64	0.02	<0.01	0.02	-	0.03	414	98	316	<1	119.6	379.3
C034P1	5/10/2011	Permian Interburden	16.2	1.35	4960	32	**4.88**	3100	32	2.78	5180	0.7	0.2	7.03	<0.1	1	2870	0.06	0.06	<0.01	0.06	0.3	0.05	165	165	<1	<1	201.3	<1.2
C034P1	6/11/2011	Permian Interburden	36.1	2.92	4590	12	7.5	2800	29.6	3.9	4950	0.7	<0.1	7	<0.1	<1	2810	0.08	0.01	<0.01	0.01	<0.1	<0.01	159	159	<1	<1	194	<1.2
C034P1	24/05/2013	Permian Interburden	47	-	4838	-42.2	7.02	-	28.3	-	4420	0.7	<0.1	7.5	<0.1	<1	2320	0.12	<0.01	<0.01	<0.01	-	<0.01	156	156	<1	<1	190.3	<1.2
C034P3	5/10/2011	D Seam	-	-	-	-	-	-	-	1.29	2410	0.5	0.2	7.23	<0.1	<1	1260	0.14	0.08	<0.01	0.08	0.3	**0.07**	137	137	<1	<1	167.1	<1.2
C034P3	6/11/2011	D Seam	37.7	2.59	1608	13	7.5	943	30.1	1.43	1770	0.3	<0.1	6.96	<0.1	<1	1020	0.09	0.02	<0.01	0.02	<0.1	<0.01	108	108	<1	<1	131.8	<1.2
C034P3	24/05/2013	D Seam	71.9	-	2199	-67.7	7.16	-	29.1	-	1970	0.3	<0.1	7.61	<0.1	<1	1010	0.17	<0.01	<0.01	<0.01	-	0.05	114	114	<1	<1	139.1	<1.2
C035P1	27/05/2013	Rewan Group	-	-	-	-	-	-	-	-	4030	0.7	0.3	7.87	<0.1	53	2170	0.07	<0.01	<0.01	<0.01	-	**0.09**	159	159	<1	<1	194	<1.2
C035P1	5/10/2011	Rewan Group	17	1.04	4100	-57	**4.84**	2550	31	2.42	4260	0.7	0.6	7.22	<0.1	<1	2290	0.1	0.05	<0.01	0.05	0.6	**0.15**	175	175	<1	<1	213.5	<1.2
C035P1	6/11/2011	Rewan Group	6.2	0.4	3820	-28	7.5	2310	30.6	3.48	4010	0.6	3.9	7.24	<0.1	<1	2990	0.12	0.02	<0.01	0.02	3.9	**1.99**	171	171	<1	<1	208.6	<1.2
C035P1	27/05/2013	Rewan Group	14.1	-	6343	-107.7	-	-	28.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C035P2	27/05/2013	AB Seam	-	-	-	-	-	-	-	-	1610	0.3	0.2	7.83	<0.1	23	782	0.06	0.02	<0.01	0.02	-	0.05	118	118	<1	<1	144	<1.2
C035P2	5/10/2011	AB Seam	14.4	1.2	1561	-78	**4.71**	928	29.9	0.76	1560	0.3	0.2	7.15	0.1	1	851	0.04	0.05	<0.01	0.05	0.2	**0.06**	119	119	<1	<1	145.2	<1.2
C035P2	6/11/2011	AB Seam	15	1.53	1527	-30	-	2310	28.6	1.08	1550	0.3	<0.1	7.02	<0.1	11	1180	0.07	0.03	<0.01	0.03	<0.1	<0.01	120	120	<1	<1	146.4	<1.2
C035P2	27/05/2013	AB Seam	9.8	-	3595	-239.4	-	-	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C555P1	25/05/2013	Rewan Group	-	-	2224	-162.6	-	-	26	-	860	0.8	0.2	7.97	<0.1	<1	467	0.19	<0.01	<0.01	<0.01	-	0.04	161	161	<1	<1	196.4	<1.2
C555P1	30/09/2012	Rewan Group	-	5.28	455	90	7	-	26.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C556P1	26/05/2013	Rewan Group	28	-	248	-78.4	-	-	27.1	-	290	0.4	<0.1	7.15	<0.1	<1	248	0.03	0.02	<0.01	0.02	-	<0.01	59	59	<1	<1	71.98	<1.2
C556P1	1/10/2012	Rewan Group	-	5.08	156.3	106	6.32	-	29.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

			Field							Inorganics								Nutrients						Alkalinity					
			Dissolved Oxygen (% saturated) (Field)	**Dissolved Oxygen (Field)**	**Electrical Conductivity (Field)**	**Oxygen Redox Potential (Field)**	**pH (Field)**	**TDS (Field)**	**Temp (Field)**	**Bromide**	**Electrical conductivity *(lab)**	**Fluoride**	**Kjeldahl Nitrogen Total**	**pH (Lab)**	**Sulphide**	**TOC**	**Total Dissolved Solids**	**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**
			%S	mg/L	uS/cm	mV	pH_Units	PPM	oC	mg/L	uS/cm	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
EQL										0.005	1	0.1	0.1	0.01	0.1	1	5	0.01	0.01	0.01	0.01	0.1	0.01	1	1	1	1		
ADWG 2011 Health												1.5							11.3[#5]	0.68[#4]									
ANZECC (2000) Ecosystems Fresh Water (95%)																		0.9[#1]	0.158[#5]										
ANZECC (2000) Irrigation LTV							**6-8.5**					**1**										**5**	**0.05**						
ANZECC (2000) Livestock												2					5000[#3]		90[#5]	9[#6]									
LocCode	**Sampled_Date-Time**	**MonitoringUnit_2**																											
C558P1	19/05/2013	Permian Overburden	-	-	-	-	-	-	-	-	4820	0.3	35.3	7.03	<0.1	8	2940	0.88	0.04	<0.01	0.04	-	**0.14**	195	195	<1	<1	237.9	<1.2
C558P1	19/05/2013	Permian Overburden	79.2	-	13.8	-62.5	7.04	-	23.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C558P1	1/10/2012	Permian Overburden	-	3.39	247	87	7.05	-	29.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C9553P1R	21/05/2013	Dunda Beds	60.9	-	891	-112.8	6.97	-	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C9553P1R	2/10/2012	Dunda Beds	-	2.56	561	86	7.52	-	27.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C9553P1R	21/05/2013	Dunda Beds	-	-	-	-	-	-	-	-	522	0.8	3.2	7.34	<0.1	14	891	1.71	<0.01	<0.01	<0.01	-	**0.96**	208	208	<1	<1	253.8	<1.2
HD02	20/05/2013	Clematis Sandstone	32.7	-	1572	-73.8	7.58	-	26.7	-	588	0.3	0.2	7.78	<0.1	2	426	0.15	<0.01	<0.01	<0.01	-	**0.14**	126	126	<1	<1	153.7	<1.2
HD02	27/10/2012	Clematis Sandstone	-	9.89	606	10	7.24	-	26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HD03A	27/05/2013	Dunda Beds	41	-	872	-172	-	-	26.6	-	759	0.3	0.3	8.09	<0.1	<1	380	0.24	0.01	<0.01	0.01	-	**0.09**	118	118	<1	<1	144	<1.2
HD03A	27/10/2012	Dunda Beds	-	1.89	722	15	6.49	-	26.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HD03B	20/05/2013	Alluvium	33.8	-	1779	-89.4	7.24	-	27.3	-	839	0.4	0.3	7.53	<0.1	1	608	0.14	<0.01	<0.01	<0.01	-	**0.21**	141	141	<1	<1	172	<1.2
HD03B	27/10/2012	Alluvium	-	7.8	1152	63	8.2	-	26.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WQ01	6/10/2011	Surface Water	52.4	4.3	855	56	**5.25**	510	27.4	0.931	1290	0.5	0.3	7.79	<0.1	11	703	0.03	0.02	<0.01	0.02	0.3	0.05	178	178	<1	<1	217.2	<1.2
WQ01	8/11/2011	Surface Water	44.8	2.97	1463	32	7.99	839	32.2	0.65	1460	0.6	0.5	7.91	<0.1	5	1340	0.04	0.01	<0.01	0.01	0.5	<0.01	211	211	<1	<1	257.4	<1.2
WQ03	5/10/2011	Surface Water	-	-	-	-	-	-	-	0.55	1560	0.5	0.5	8.07	<0.1	8	859	0.03	0.04	<0.01	0.04	0.5	0.04	190	190	<1	<1	231.8	<1.2
WQ03	8/11/2011	Surface Water	45.1	3.7	1430	85	8.15	833	31.4	0.63	1430	0.5	0.6	8.04	<0.1	1	1350	0.03	0.02	<0.01	0.02	0.6	<0.01	193	193	<1	<1	235.5	<1.2

Comments

#1 pH of <8
#2 Guideline value for cattle
#3 Guideline value for beef cattle
#4 Guideline value calculated by dividing Nitrite (as NO2) value by 4.427
#5 Guideline value calculated by dividing Nitrate (as NO3) value by 4.427
#6 Guideline value calculated by dividing Nitrate (as NO3) value by 3.29

			Major Ions										BTEX & MAH								TPH												PAH	
			Calcium (Filtered)	Chloride	Anions Total	Magnesium (Filtered)	Cations Total	Ionic Balance	Potassium (Filtered)	Sodium (Filtered)	Sulphate	Sulphate (Filtered)	Benzene	BTEX (Sum of Total) - Calc	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Xylene Total	Xylenes (Sum of Total) - Calc	F1 minus BTEX (C6-C10)	C10 - C14 Fraction	C10 - C16 Fraction	C10 - C36 (Sum of Total) - Calc	C10 - C40 (Sum of Total) - Calc	C15 - C28 Fraction	C16 - C34 Fraction	C29 - C36 Fraction	C34 - C40 Fraction	C6 - C 9 Fraction	C6 - C10 Fraction	TPH C6 - C10 Fraction minus BTEX	Naphthalene	PAHs (Sum of Total) - Calc
			mg/L	mg/L	meq/L	mg/L	meq/L	%	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/Lf	µg/L	µg/L	µg/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	µg/L	µg/L
EQL			1	1	0.01	1	0.01	0.01	1	1	1	1	1		2	2	2	2	2		0.02	0.05	0.1			0.1	0.1	0.05	0.1	0.02	0.02	0.02	5	
ADWG 2011 Health											500	500	1		300	800			600	600														0.01
ANZECC (2000) Ecosystems Fresh Water (95%)													950					350															16	
ANZECC (2000) Irrigation LTV				**700**						**460**																								
ANZECC (2000) Livestock			1000								1000	1000																						
LocCode	**Sampled_Date-Time**	**MonitoringUnit_2**																																
C006P1	3/10/2011	Permian Interburden	244	**4800**	155	246	144	3.41	27	**2560**	-	573	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	0.04	0.04	0.04	<5	<5
C006P1	10/11/2011	Permian Interburden	311	**6240**	-	429	-	-	66	**3080**	497	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C006P1	23/05/2013	Permian Interburden	337	**6720**	206	454	198	2.02	64	**3270**	-	516	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C006P3r	3/10/2011	D Seam	9	58	11.5	4	11.6	0.44	4	246	-	1	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C006P3r	12/11/2011	D Seam	9	59	-	3	-	-	5	209	<1	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C006P3R	23/05/2013	D Seam	8	55	10.1	3	9.8	1.8	4	208	-	<1	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C006P3r	10/11/2011	D Seam	9	56	-	3	-	-	5	197	<1	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C007P2	4/10/2011	AB Seam	558	**5460**	170	234	168	0.6	52	**2740**	-	554	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	0.755	1.21	0.23	0.79	0.5	0.37	<0.02	<0.02	<0.02	<5	<5
C007P2	10/11/2011	AB Seam	453	**5230**	-	267	-	-	66	**2590**	465	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	0.02	0.02	0.02	<5	<5
C007P2	23/05/2013	AB Seam	547	**5880**	181	312	168	3.96	60	**2600**	-	545	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	0.125	<0.3	<0.1	<0.1	0.05	<0.1	<0.02	<0.02	-	<5	<5
C007P2	10/11/2011	AB Seam	486	**4350**	-	270	-	-	66	**2620**	473	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C007P3	4/10/2011	D Seam	10	61	12.7	3	13.8	4.05	4	297	-	59	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	0.05	0.05	0.05	<5	<5
C007P3	10/11/2011	D Seam	6	49	-	3	-	-	6	253	45	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C007P3	23/05/2013	D Seam	6	40	11.4	3	11	1.85	4	237	-	23	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	0.11	0.11	0.185	0.21	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C008P1	3/10/2011	Permian Overburden	505	**7950**	236	402	221	3.46	90	**3680**	-	282	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C008P1	12/11/2011	Permian Overburden	468	**7530**	-	442	-	-	115	**3810**	275	-	<1	<7	<2	<2	<2	<2	<2	<2	-	0.13	<0.1	0.205	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C008P1	25/05/2013	Permian Overburden	499	**7870**	233	420	226	1.59	131	**3740**	-	245	<1	<7	<2	<2	<2	<2	<2	<2	0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	0.02	0.02	-	<5	<5
C008P2	3/10/2011	AB Seam	35	**755**	33.7	19	35.7	2.8	20	**732**	-	66	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C008P2	12/11/2011	AB Seam	38	683	-	21	-	-	20	**577**	31	-	2	9	<2	5	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	0.02	0.03	0.02	<5	<5
C008P2	23/05/2013	AB Seam	27	**742**	31	18	29.2	2.97	19	**596**	-	87	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	0.06	<0.1	0.135	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C011P1	13/11/2011	Permian Interburden	18	539	-	17	-	-	14	**565**	91	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C011P1	19/05/2013	Permian Interburden	17	576	30.1	14	27.8	4.05	11	**586**	-	92	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C011P3	20/05/2013	D Seam	22	155	8.89	4	8.63	1.5	8	161	-	6	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C011P3	4/10/2011	D Seam	17	164	9.82	5	9.52	1.57	17	180	-	2	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	0.02	0.03	0.03	<5	<5
C011P3	13/11/2011	D Seam	22	173	-	6	-	-	14	165	<1	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C011P3	28/11/2011	D Seam	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C011P3	20/05/2013	D Seam	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C012P1	2/10/2011	Permian Overburden	26	549	18.3	29	18.5	0.43	11	334	-	56	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C012P1	4/10/2011	Permian Overburden	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C012P1	8/11/2011	Permian Overburden	31	551	-	33	-	-	13	301	51	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C012P1	19/05/2013	Permian Overburden	28	587	19.2	30	18.1	2.88	10	322	-	51	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C012P2	2/10/2011	Permian Overburden	78	631	24.3	25	25.5	2.29	12	442	-	49	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C012P2	4/10/2011	Permian Overburden	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C012P2	13/11/2011	Permian Overburden	84	614	-	30	-	-	18	384	43	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C012P2	19/05/2013	Permian Overburden	75	656	25.2	26	23.9	2.64	13	407	-	39	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C014P2	4/10/2011	AB Seam	20	398	19.1	6	20.2	2.77	25	415	-	3	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	0.17	0.18	0.18	<5	<5
C014P2	12/11/2011	AB Seam	3	406	-	3	-	-	33	374	<1	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	0.05	0.06	0.06	<5	<5
C014P2	26/05/2013	AB Seam	28	442	39.7	<1	40.1	0.42	319	**702**	-	43	<1	<7	<2	<2	<2	<2	<2	<2	0.32	0.11	0.1	0.185	0.2	<0.1	<0.1	<0.05	<0.1	0.37	0.32	-	<5	<5
C016P2	2/10/2011	AB Seam	5	**735**	30.2	<1	28.2	3.4	119	**573**	-	153	<1	10.5	<2	8	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	0.04	0.04	0.03	<5	<5
C016P2	6/10/2011	AB Seam	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C016P2	13/11/2011	AB Seam	4	659	-	<1	-	-	182	**520**	21	-	<1	5.5	<2	3	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	0.03	0.03	0.03	<5	<5
C016P2	21/05/2013	AB Seam	56	661	25.2	<1	26.1	1.71	64	**499**	-	12	<1	<7	<2	<2	<2	<2	<2	<2	0.03	0.06	<0.1	0.135	<0.3	<0.1	<0.1	<0.05	<0.1	0.03	0.03	-	<5	<5
C018P1	2/10/2011	Permian Overburden	7	141	6.83	6	6.72	0.85	12	128	-	41	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C018P1	6/10/2011	Permian Overburden	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C018P1	8/11/2011	Permian Overburden	7	255	-	7	-	-	10	134	39	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C018P1	20/05/2013	Permian Overburden	3	168	6.7	5	6.76	0.41	6	139	-	29	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C018P2	2/10/2011	AB Seam	45	578	21	43	21.9	1.97	18	359	-	14	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C018P2	6/10/2011	AB Seam	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C018P2	9/11/2011	AB Seam	47	659	-	47	-	-	25	337	20	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C018P2	20/05/2013	AB Seam	46	456	18.1	26	17.2	2.58	16	284	-	6	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C018P2	9/11/2011	AB Seam	43	586	-	40	-	-	25	306	17	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5

			Major Ions										BTEX & MAH								TPH												PAH	
			Calcium (Filtered)	Chloride	Anions Total	Magnesium (Filtered)	Cations Total	Ionic Balance	Potassium (Filtered)	Sodium (Filtered)	Sulphate	Sulphate (Filtered)	Benzene	BTEX (Sum of Total) - Calc	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Xylene Total	Xylenes (Sum of Total) - Calc	F1 minus BTEX (C6-C10)	C10 - C14 Fraction	C10 - C16 Fraction	C10 - C36 (Sum of Total) - Calc	C10 - C40 (Sum of Total) - Calc	C15 - C28 Fraction	C16 - C34 Fraction	C29 - C36 Fraction	C34 - C40 Fraction	C6 - C 9 Fraction	C6 - C10 Fraction	TPH C6 - C10 Fraction minus BTEX	Naphthalene	PAHs (Sum of Total) - Calc
			mg/L	mg/L	meq/L	mg/L	meq/L	%	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/Lf	µg/L	µg/L	µg/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	µg/L	µg/L
EQL			1	1	0.01	1	0.01	0.01	1	1	1	1	1		2	2	2	2	2		0.02	0.05	0.1			0.1	0.1	0.05	0.1	0.02	0.02	0.02	5	
ADWG 2011 Health											500	500	1		300	800			600	600														0.01
ANZECC (2000) Ecosystems Fresh Water (95%)													950					350															16	
ANZECC (2000) Irrigation LTV				**700**						**460**																								
ANZECC (2000) Livestock			1000								1000	1000																						
LocCode	**Sampled_Date-Time**	**MonitoringUnit_2**																																
C018P3	2/10/2011	D Seam	22	213	9.86	6	10	0.92	9	189	-	13	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C018P3	6/10/2011	D Seam	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C018P3	9/11/2011	D Seam	24	211	-	6	-	-	12	156	15	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C018P3	19/05/2013	D Seam	23	213	9.7	6	9.41	1.5	8	174	-	15	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C018P3	20/05/2013	D Seam	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C018P3	9/11/2011	D Seam	23	211	-	6	-	-	13	158	10	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C020P2	3/10/2011	AB Seam	15	411	16.6	3	17.4	2.26	4	374	-	24	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	0.05	0.05	0.05	<5	<5
C020P2	6/10/2011	AB Seam	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C020P2	14/11/2011	AB Seam	16	406	-	3	-	-	5	310	16	-	<1	6.5	<2	4	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	0.04	0.05	0.05	<5	<5
C022P1	3/10/2011	Dunda Beds	2	67	2.94	4	2.87	-	2	55	-	16	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	0.04	0.04	0.04	<5	<5
C022P1	6/10/2011	Dunda Beds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C022P1	10/11/2011	Dunda Beds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C022P1	14/11/2011	Dunda Beds	3	70	-	4	-	-	3	56	18	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C022P1	26/05/2013	Dunda Beds	1	65	2.46	3	2.39	-	2	47	-	7	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C022P1	10/11/2011	Dunda Beds	2	77	-	4	-	-	3	57	16	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	0.02	0.02	0.02	<5	<5
C024P3	6/10/2011	D Seam	27	351	16.1	51	17.7	4.85	17	270	-	2	<1	7.5	<2	5	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	0.46	0.49	0.48	<5	<5
C024P3	14/11/2011	D Seam	23	374	-	42	-	-	17	232	<1	-	<1	6.5	<2	4	<2	<2	<2	<2	-	0.09	<0.1	0.165	<0.3	<0.1	<0.1	<0.05	<0.1	0.34	0.36	0.36	<5	<5
C024P3	20/05/2013	D Seam	18	388	16.3	38	14.8	4.69	10	234	-	13	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C025P2	29/09/2011	Tertiary Overburden	107	**4570**	145	134	136	3.26	79	**2700**	-	54	<1	18.5	<2	16	<2	<2	<2	<2	-	0.06	<0.1	0.135	<0.3	<0.1	<0.1	<0.05	<0.1	0.31	0.33	0.31	<5	<5
C025P2	7/11/2011	Tertiary Overburden	130	**3670**	-	130	-	-	74	**2680**	10	-	<1	8.5	<2	6	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	0.06	0.06	0.05	<5	<5
C025P2	25/05/2013	Tertiary Overburden	114	**4710**	148	117	138	3.55	79	**2780**	-	165	<1	<7	<2	<2	<2	<2	<2	<2	0.07	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	0.08	0.07	-	<5	<5
C027P1	29/09/2011	Alluvium	27	**1580**	57.6	111	58.4	0.65	52	**1070**	-	66	<1	<7	<2	<2	<2	<2	<2	<2	-	1.45	<0.1	1.525	<0.3	<0.1	<0.1	<0.05	<0.1	0.35	0.34	0.34	<5	<5
C027P1	8/11/2011	Alluvium	26	**1420**	-	114	-	-	58	**1080**	141	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	0.09	0.1	0.1	<5	<5
C027P1	25/05/2013	Alluvium	24	**1770**	63.2	140	66.2	2.27	83	**1180**	-	391	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C027P1	8/11/2011	Alluvium	26	**1210**	-	113	-	-	57	**1080**	107	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	0.16	<0.3	0.11	<0.1	<0.05	<0.1	0.06	0.07	0.07	<5	<5
C027P2	29/09/2011	Dunda Beds	4	186	7.97	9	8.2	1.38	10	161	-	8	<1	<7	<2	<2	<2	<2	<2	<2	-	0.1	<0.1	0.175	<0.3	<0.1	<0.1	<0.05	<0.1	0.09	0.1	0.1	<5	<5
C027P2	5/11/2011	Dunda Beds	3	199	-	10	-	-	12	175	14	-	<1	19.5	<2	17	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	0.03	0.04	0.02	<5	<5
C027P2	25/05/2013	Dunda Beds	1	213	7.83	5	7.65	1.18	9	160	-	28	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C027P2	29/09/2011	Dunda Beds	5	200	10.1	12	10.4	1.46	10	204	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C029P1	29/09/2011	Alluvium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C029P1	7/11/2011	Alluvium	87	**8430**	-	362	-	-	177	**5960**	686	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C029P1	24/05/2013	Alluvium	69	**9520**	327	368	331	0.59	229	**6710**	-	928	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C029P2	25/05/2013	Tertiary Overburden	94	**4060**	125	122	118	2.86	83	**2320**	-	269	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C029P2	29/09/2011	Tertiary Overburden	100	**3950**	122	118	115	2.81	58	**2280**	-	259	<1	<7	<2	<2	<2	<2	<2	<2	-	0.11	<0.1	0.185	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C029P2	7/11/2011	Tertiary Overburden	95	**3740**	-	122	-	-	75	**2180**	246	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C032P2	5/10/2011	AB Seam	24	229	13.3	6	13.4	0.36	20	257	-	5	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	0.04	0.05	0.05	<5	<5
C032P2	7/11/2011	AB Seam	37	**934**	-	13	-	-	11	294	<1	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C032P2	27/05/2013	AB Seam	1	232	14.8	<1	15.2	1.26	50	319	-	<10	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	0.09	<0.1	0.165	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C034P1	5/10/2011	Permian Interburden	62	**1220**	40.2	39	43.2	3.58	11	**842**	-	120	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C034P1	6/11/2011	Permian Interburden	59	**1200**	-	38	-	-	12	**862**	108	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C034P1	24/05/2013	Permian Interburden	54	**1220**	39.7	34	41	1.55	11	**810**	-	106	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C034P3	5/10/2011	D Seam	32	601	20.8	14	21.6	1.93	15	424	-	51	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C034P3	6/11/2011	D Seam	22	478	-	11	-	-	14	295	24	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C034P3	24/05/2013	D Seam	26	563	18.8	11	17.3	4.18	14	338	-	29	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C035P1	27/05/2013	Rewan Group	16	**1100**	35.4	16	38.4	4.04	5	**830**	-	55	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C035P1	5/10/2011	Rewan Group	21	**1070**	34.9	18	38.4	4.76	6	**822**	-	60	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C035P1	6/11/2011	Rewan Group	20	**909**	-	18	-	-	6	**744**	50	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C035P1	27/05/2013	Rewan Group	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C035P2	27/05/2013	AB Seam	11	441	15.2	8	14.1	3.8	6	293	-	20	<1	<7	<2	<2	<2	<2	<2	<2	0.09	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	0.09	0.09	-	<5	<5
C035P2	5/10/2011	AB Seam	12	404	14	8	13.6	1.52	6	280	-	11	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C035P2	6/11/2011	AB Seam	13	535	-	8	-	-	7	276	17	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
C035P2	27/05/2013	AB Seam	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C555P1	25/05/2013	Rewan Group	5	191	8.6	7	8.4	1.24	7	170	-	<1	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C555P1	30/09/2012	Rewan Group	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C556P1	26/05/2013	Rewan Group	2	45	2.7	3	2.77	-	3	54	-	12	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C556P1	1/10/2012	Rewan Group	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

			Major Ions										BTEX & MAH								TPH												PAH	
			Calcium (Filtered)	Chloride	Anions Total	Magnesium (Filtered)	Cations Total	Ionic Balance	Potassium (Filtered)	Sodium (Filtered)	Sulphate	Sulphate (Filtered)	Benzene	BTEX (Sum of Total) - Calc	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Xylene Total	Xylenes (Sum of Total) - Calc	F1 minus BTEX (C6-C10)	C10 - C14 Fraction	C10 - C16 Fraction	C10 - C36 (Sum of Total) - Calc	C10 - C40 (Sum of Total) - Calc	C15 - C28 Fraction	C16 - C34 Fraction	C29 - C36 Fraction	C34 - C40 Fraction	C6 - C 9 Fraction	C6 - C10 Fraction	TPH C6 - C10 Fraction minus BTEX	Naphthalene	PAHs (Sum of Total) - Calc
			mg/L	mg/L	meq/L	mg/L	meq/L	%	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/Lf	µg/L	µg/L	µg/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	µg/L	µg/L
EQL			1	1	0.01	1	0.01	0.01	1	1	1	1	1		2	2	2	2	2		0.02	0.05	0.1			0.1	0.1	0.05	0.1	0.02	0.02	0.02	5	
ADWG 2011 Health											500	500	1		300	800			600	600														0.01
ANZECC (2000) Ecosystems Fresh Water (95%)													950					350															16	
ANZECC (2000) Irrigation LTV				**700**						**460**																								
ANZECC (2000) Livestock			1000								1000	1000																						
LocCode	**Sampled_Date-Time**	**MonitoringUnit_2**																																
C558P1	19/05/2013	Permian Overburden	35	**1370**	44.9	83	43.1	2.11	17	**783**	-	114	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
C558P1	19/05/2013	Permian Overburden	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C558P1	1/10/2012	Permian Overburden	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C9553P1R	21/05/2013	Dunda Beds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C9553P1R	2/10/2012	Dunda Beds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C9553P1R	21/05/2013	Dunda Beds	4	35	5.73	8	5.57	1.42	4	106	-	28	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
HD02	20/05/2013	Clematis Sandstone	2	114	5.82	1	5.8	0.21	12	122	-	4	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
HD02	27/10/2012	Clematis Sandstone	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HD03A	27/05/2013	Dunda Beds	4	158	7.06	2	6.99	0.53	16	143	-	12	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
HD03A	27/10/2012	Dunda Beds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HD03B	20/05/2013	Alluvium	2	192	8.5	2	8.42	0.55	16	178	-	13	<1	<7	<2	<2	<2	<2	<2	<2	<0.02	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	-	<5	<5
HD03B	27/10/2012	Alluvium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WQ01	6/10/2011	Surface Water	13	305	12.4	13	12.7	1.36	26	237	-	9	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
WQ01	8/11/2011	Surface Water	14	343	-	12	-	-	30	253	9	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
WQ03	5/10/2011	Surface Water	14	361	14.1	15	14.2	0.38	27	267	-	7	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5
WQ03	8/11/2011	Surface Water	14	341	-	14	-	-	30	234	6	-	<1	<7	<2	<2	<2	<2	<2	<2	-	<0.05	<0.1	<0.2	<0.3	<0.1	<0.1	<0.05	<0.1	<0.02	<0.02	<0.02	<5	<5

Comments

#1 pH of <8

#2 Guideline value for cattle

#3 Guideline value for beef cattle

#4 Guideline value calculated by dividing Nitrite (as NO2) value by

#5 Guideline value calculated by dividing Nitrate (as NO3) value by

#6 Guideline value calculated by dividing Nitrate (as NO3) value by

			Hardness corrected metals							Metals																	
			Cadmium -Calculated by Hardness (Filtered)	Chromium -Calculated by Hardness (Filtered)	Copper -Calculated by Hardness (Filtered)	Hardness Calculated (Filtered)	Lead -Calculated by Hardness (Filtered)	Nickel -Calculated by Hardness (Filtered)	Zinc -Calculated by Hardness (Filtered)	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)
			µg/L	µg/L	µg/L	mg/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	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
ADWG 2011 Health											0.01	4	0.002			2		0.01	0.5	0.001	0.05	0.02	0.01	0.1	0.017		
ANZECC (2000) Ecosystems Fresh Water (95%)			0.2	1	1.4		3.4	11	8	0.055		0.37	0.0002	0.001		0.0014		0.0034	1.9	0.00006		0.011	0.005	0.00005			0.008
ANZECC (2000) Irrigation LTV										**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**		**0.01**	**0.1**	**2**
ANZECC (2000) Livestock										5	0.5	5	0.1	1	1	$1^{\#2}$		0.1		0.002	0.15	1	0.02		0.2		20
LocCode	**Sampled_Date-Time**	**MonitoringUnit_2**																									
C006P1	3/10/2011	Permian Interburden	<0.009973	0.4782	<0.1106	1622	<0.03727	0.2212	0.6637	<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
C006P1	10/11/2011	Permian Interburden	<0.009973	0.4782	0.1106	2542	<0.03727	0.4424	0.8849	<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
C006P1	23/05/2013	Permian Interburden	<0.04986	<0.5978	<0.5531	2710	<0.1863	<0.5531	2.876	<0.05	<0.005	1.71	<0.0005	<0.005	<0.005	<0.005	1.33	<0.005	0.179	<0.0001	0.008	<0.005	<0.05	<0.005	0.013	<0.05	0.026
C006P3r	3/10/2011	D Seam	<0.0793	<0.8076	<0.8013	38.93	<0.7182	<0.8013	<4.006	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
C006P3r	12/11/2011	D Seam	<0.08759	0.885	<0.8811	34.82	<0.8277	2.643	7.93	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	23/05/2013	D Seam	<0.09358	<0.9407	1.877	32.32	<0.9097	1.877	9.386	<0.01	0.002	0.17	<0.0001	<0.001	<0.001	0.002	0.27	<0.001	0.032	<0.0001	0.001	0.002	<0.01	<0.001	<0.001	<0.01	0.01
C006P3r	10/11/2011	D Seam	<0.08759	2.655	<0.8811	34.82	<0.8277	<0.8811	<4.405	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
C007P2	4/10/2011	AB Seam	<0.009973	0.1196	0.2212	2356	<0.03727	<0.1106	<0.5531	<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
C007P2	10/11/2011	AB Seam	<0.009973	0.2391	0.1106	2230	<0.03727	<0.1106	0.5531	<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
C007P2	23/05/2013	AB Seam	<0.009973	0.2391	0.1106	2650	<0.03727	<0.1106	<0.5531	<0.01	0.002	0.51	<0.0001	0.002	<0.001	0.001	0.76	<0.001	0.592	<0.0001	0.001	<0.001	<0.01	<0.001	0.001	<0.01	<0.005
C007P2	10/11/2011	AB Seam	0.009973	0.2391	0.1106	2325	<0.03727	<0.1106	<0.5531	<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
C007P3	4/10/2011	D Seam	<0.08235	<0.8362	3.323	37.32	<0.758	<0.8307	<4.154	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
C007P3	10/11/2011	D Seam	<0.1087	<1.08	<1.083	27.33	<1.126	<1.083	10.83	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
C007P3	23/05/2013	D Seam	<0.1087	<1.08	<1.083	27.33	<1.126	<1.083	<5.413	0.02	0.002	0.23	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	0.054	<0.0001	0.005	<0.001	<0.01	<0.001	0.001	<0.01	<0.005
C008P1	3/10/2011	Permian Overburden	0.02992	0.4782	0.2212	2915	<0.03727	0.8849	1.549	<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
C008P1	12/11/2011	Permian Overburden	0.01995	0.1196	1.217	2987	<0.03727	1.659	13.05	<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
C008P1	25/05/2013	Permian Overburden	<0.04986	<0.5978	6.858	2974	<0.1863	3.54	6.969	<0.05	<0.005	1.59	<0.0005	<0.005	0.016	0.062	<0.25	<0.005	2.56	<0.0001	<0.005	0.032	<0.05	<0.005	0.018	<0.05	0.063
C008P2	3/10/2011	AB Seam	<0.02186	<0.2464	<0.2341	165.6	<0.1142	<0.2341	<1.17	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
C008P2	12/11/2011	AB Seam	<0.02017	0.2287	0.2167	181.3	<0.1018	0.4335	4.118	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
C008P2	23/05/2013	AB Seam	<0.02515	<0.2803	<0.2676	141.5	<0.1395	0.2676	<1.338	<0.01	0.003	0.27	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	0.102	<0.0001	0.002	0.001	<0.01	<0.001	<0.001	<0.01	<0.005
C011P1	13/11/2011	Permian Interburden	<0.03027	0.665	<0.3194	114.9	<0.1817	2.874	7.345	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
C011P1	19/05/2013	Permian Interburden	<0.03423	<0.3724	0.3592	100.1	<0.2166	1.078	2.874	0.02	0.003	0.87	<0.0001	<0.001	<0.001	0.001	<0.05	<0.001	0.064	<0.0001	0.006	0.003	<0.01	<0.001	0.003	<0.01	0.008
C011P3	20/05/2013	D Seam	<0.04623	<0.4912	<0.4786	71.39	<0.3325	0.4786	6.221	0.01	<0.001	0.38	<0.0001	<0.001	<0.001	<0.001	0.2	<0.001	0.05	<0.0001	0.001	0.001	<0.01	<0.001	<0.001	<0.01	0.013
C011P3	4/10/2011	D Seam	<0.05165	<0.5441	<0.5321	63.02	<0.3896	<0.5321	<2.66	<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
C011P3	13/11/2011	D Seam	<0.04195	<0.4491	<0.4362	79.62	<0.2895	0.4362	4.362	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
C012P1	2/10/2011	Permian Overburden	<0.01988	<0.2257	<0.2138	184.3	<0.09974	0.2138	2.565	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
C012P1	8/11/2011	Permian Overburden	<0.01746	0.2003	0.3777	213.2	<0.08287	1.133	6.987	<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
C012P1	19/05/2013	Permian Overburden	<0.01904	<0.217	2.462	193.4	0.09381	<0.2052	1.436	<0.01	<0.001	0.37	<0.0001	<0.001	<0.001	0.012	0.06	0.001	0.019	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	0.007
C012P2	2/10/2011	Permian Overburden	<0.01297	<0.1523	<0.1422	297.6	<0.05424	<0.1422	<0.711	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
C012P2	13/11/2011	Permian Overburden	<0.01173	0.1389	<0.1292	333.2	<0.047	0.3876	4.393	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
C012P2	19/05/2013	Permian Overburden	<0.01311	<0.1538	<0.1436	294.3	<0.05504	0.1436	2.01	0.02	0.003	0.4	<0.0001	<0.001	<0.001	<0.001	0.65	<0.001	0.458	<0.0001	0.002	0.001	<0.01	<0.001	<0.001	<0.01	0.014
C014P2	4/10/2011	AB Seam	<0.04444	<0.4736	<0.4609	74.63	<0.3143	1.383	<2.304	<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
C014P2	12/11/2011	AB Seam	<0.1445	1.404	<1.421	19.84	<1.691	2.843	9.95	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
C014P2	26/05/2013	AB Seam	<0.04589	<0.4879	1.426	71.97	<0.3291	27.57	4.278	15.8	<0.001	0.1	<0.0001	<0.001	<0.001	0.003	0.12	<0.001	<0.001	<0.0001	0.202	0.058	<0.01	<0.001	<0.001	<0.01	0.009
C016P2	2/10/2011	AB Seam	<0.1905	<1.811	<1.851	14.54	<2.508	<1.851	11.1	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
C016P2	13/11/2011	AB Seam	<0.2253	<2.113	<2.172	12.05	<3.186	<2.172	10.86	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
C016P2	21/05/2013	AB Seam	<0.02508	<0.2797	<0.2669	141.9	<0.139	<0.2669	1.335	2.23	0.001	0.27	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	<0.001	<0.0001	0.008	<0.001	<0.01	<0.001	<0.001	<0.01	0.005
C018P1	2/10/2011	Permian Overburden	<0.07386	<0.7564	<0.7487	42.17	<0.6489	<0.7487	8.984	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
C018P1	8/11/2011	Permian Overburden	<0.06798	2.102	<0.6917	46.28	<0.5766	2.075	21.44	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
C018P1	20/05/2013	Permian Overburden	<0.1061	2.112	32.81	28.07	<1.088	5.291	16.93	<0.01	<0.001	0.23	<0.0001	0.002	<0.001	0.031	<0.05	<0.001	0.004	<0.0001	<0.001	0.005	<0.01	0.001	<0.001	<0.01	0.016
C018P2	2/10/2011	AB Seam	<0.01331	<0.1559	<0.1457	289.3	<0.05624	<0.1457	1.02	<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
C018P2	9/11/2011	AB Seam	<0.01248	0.4411	<0.1371	310.8	<0.05135	0.4113	1.234	<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
C018P2	20/05/2013	AB Seam	<0.01685	<0.1939	0.1826	221.9	<0.07879	0.1826	2.738	<0.01	<0.001	0.48	<0.0001	<0.001	<0.001	0.001	0.61	<0.001	0.08	<0.0001	<0.001	0.001	<0.01	<0.001	<0.001	<0.01	0.015
C018P2	9/11/2011	AB Seam	<0.01406	0.4921	<0.1535	272	<0.06083	<0.1535	<0.7677	<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
C018P3	2/10/2011	D Seam	<0.04195	<0.4491	<0.4362	79.62	<0.2895	<0.4362	<2.181	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
C018P3	9/11/2011	D Seam	<0.03974	0.8546	<0.4142	84.62	<0.268	0.8284	5.799	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
C018P3	19/05/2013	D Seam	<0.04081	<0.4379	<0.4249	82.12	<0.2783	<0.4249	<2.124	<0.01	0.001	0.3	<0.0001	<0.001	0.001	<0.001	0.46	<0.001	0.055	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005
C018P3	9/11/2011	D Seam	<0.04081	0.8758	<0.4249	82.12	<0.2783	<0.4249	<2.124	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
C020P2	3/10/2011	AB Seam	<0.06369	<0.66	<0.65	49.8	<0.5254	<0.65	<3.25	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
C020P2	14/11/2011	AB Seam	<0.06098	<0.634	<0.6235	52.3	<0.4937	<0.6235	<3.118	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
C022P1	3/10/2011	Dunda Beds	<0.1348	<1.316	<1.33	21.45	<1.531	7.979	14.63	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
C022P1	14/11/2011	Dunda Beds	<0.1222	<1.203	<1.211	23.95	<1.331	7.266	33.91	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
C022P1	26/05/2013	Dunda Beds	<0.1871	<1.781	18.19	14.84	<2.444	9.094	41.83	0.08	<0.001	0.13	<0.0001	<0.001	0.024	0.01	<0.05	<0.001	0.034	<0.0001	<0.001	0.005	<0.01	<0.001	<0.001	<0.01	0.023
C022P1	10/11/2011	Dunda Beds	<0.1348	2.633	<1.33	21.45	<1.531	7.979	18.62	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
C024P3	6/10/2011	D Seam	<0.01382	<0.1615	<0.151	277.3	<0.05935	<0.151	<0.7552	<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
C024P3	14/11/2011	D Seam	<0.0163	0.188	0.3537	230.3	<0.07515	1.592	7.782	<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
C024P3	20/05/2013	D Seam	<0.01837	<0.2099	<0.1983	201.3	<0.08913	0.9913	3.172	<0.01	0.001	0.28	<0.0001	<0.001	0.004	<0.001	7.94	<0.001	0.239	<0.0001	<0.001	0.005	<0.01	<0.001	<0.001	<0.01	0.016
C025P2	29/09/2011	Tertiary Overburden	<0.009973	0.5978	<0.1106	818.6	<0.03727	<0.1106	0.6637	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
C025P2	7/11/2011	Tertiary Overburden	<0.009973	<0.5978	0.2212	859.6	<0.03727	0.1106	0.6637	<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
C025P2	25/05/2013	Tertiary Overburden	<0.009973	0.4782	<0.1106	766.1	<0.03727	<0.1106	0.6637	<0.01	0.002	1.22	<0.0001	0.004	<0.001	<0.001	4.11	<0.001	3.01	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	0.006
C027P1	29/09/2011	Alluvium	-	<0.1196	<0.1106	524.2	<0.03727	<0.1106	0.6637	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
C027P1	8/11/2011	Alluvium	<0.009973	0.4782	0.1106	534	<0.03727	1.327	2.102	<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
C027P1	25/05/2013	Alluvium	<0.009973	<0.1196	0.2212	636	<0.03727	0.2212	0.8849	<0.01	0.005	0.73	<0.0001	<0.001	0.002	0.002	17.9	<0.001	3.34	<0.0001	<0.001	0.002	<0.01	<0.001	<0.001	<0.01	0.008
C027P1	8/11/2011	Alluvium	<0.009973	0.4782	<0.1106	529.9	<0.03727	1.659	1.106	<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

			Hardness corrected metals							Metals																	
			Cadmium -Calculated by Hardness (Filtered)	**Chromium -Calculated by Hardness (Filtered)**	**Copper -Calculated by Hardness (Filtered)**	**Hardness Calculated (Filtered)**	**Lead -Calculated by Hardness (Filtered)**	**Nickel -Calculated by Hardness (Filtered)**	**Zinc -Calculated by Hardness (Filtered)**	**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)**
			µg/L	µg/L	µg/L	mg/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	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
ADWG 2011 Health											0.01	4	0.002			2		0.01	0.5	0.001	0.05	0.02	0.01	0.1	0.017		
ANZECC (2000) Ecosystems Fresh Water (95%)			0.2	1	1.4		3.4	11	8	0.055		0.37	0.0002	0.001		0.0014		0.0034	1.9	0.00006		0.011	0.005	0.00005			0.008
ANZECC (2000) Irrigation LTV										**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**		**0.01**	**0.1**	**2**
ANZECC (2000) Livestock										5	0.5	5	0.1	1	1	$1^{\#2}$		0.1		0.002	0.15	1	0.02		0.2		20
LocCode	**Sampled_Date-Time**	**MonitoringUnit_2**																									
C027P2	29/09/2011	Dunda Beds	-	<0.6917	<0.6825	47.02	<0.5651	2.73	6.142	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
C027P2	5/11/2011	Dunda Beds	<0.06504	1.346	<0.6631	48.64	<0.5413	6.631	6.631	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
C027P2	25/05/2013	Dunda Beds	<0.1263	<1.24	2.5	23.07	<1.396	2.5	22.5	0.01	0.004	0.2	<0.0001	<0.001	<0.001	0.002	**2.08**	<0.001	**0.234**	<0.0001	<0.001	0.002	<0.01	<0.001	<0.001	<0.01	0.018
C027P2	29/09/2011	Dunda Beds	-	-	-	61.87	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C029P1	7/11/2011	Alluvium	<0.009973	<0.1196	0.6637	1707	<0.03727	8.407	1.438	<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
C029P1	24/05/2013	Alluvium	<0.04986	<0.5978	<0.5531	1687	<0.1863	1.659	<2.765	<0.05	<0.005	**3.49**	<0.0005	<0.005	0.007	<0.005	**0.72**	<0.005	**0.942**	<0.0001	0.006	0.015	**<0.05**	<0.005	**0.15**	<0.05	<0.025
C029P2	25/05/2013	Tertiary Overburden	<0.009973	0.1196	0.1106	736.7	<0.03727	<0.1106	1.659	<0.01	0.001	**0.94**	<0.0001	0.001	<0.001	0.001	**0.72**	<0.001	0.19	<0.0001	<0.001	<0.001	<0.01	<0.001	0.002	<0.01	0.015
C029P2	29/09/2011	Tertiary Overburden	-	-	-	735.3	-	-	-	<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
C029P2	7/11/2011	Tertiary Overburden	<0.009973	0.2391	0.1106	739.2	<0.03727	0.5531	1.217	<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
C032P2	5/10/2011	AB Seam	<0.03974	<0.4273	<0.4142	84.62	<0.268	<0.4142	<2.071	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
C032P2	7/11/2011	AB Seam	<0.02447	0.8201	<0.2607	145.9	<0.1342	0.5214	1.304	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
C032P2	27/05/2013	AB Seam	<0.5353	<4.692	<4.965	4.555	<10.96	4.965	44.68	0.41	0.005	0.32	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	<0.001	<0.0001	**0.016**	0.001	<0.01	<0.001	<0.001	<0.01	0.009
C034P1	5/10/2011	Permian Interburden	<0.01232	<0.1453	<0.1354	315.3	<0.05042	<0.1354	<0.677	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
C034P1	6/11/2011	Permian Interburden	<0.01274	0.1498	<0.1398	303.7	<0.05288	0.1398	1.398	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
C034P1	24/05/2013	Permian Interburden	<0.01393	<0.1627	<0.1522	274.7	<0.06005	0.1522	2.131	<0.01	0.002	**0.63**	<0.0001	<0.001	<0.001	<0.001	**0.73**	<0.001	0.116	<0.0001	<0.001	0.001	<0.01	<0.001	<0.001	<0.01	0.014
C034P3	5/10/2011	D Seam	<0.02579	<0.2869	<0.2741	137.5	<0.1446	<0.2741	<1.371	<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
C034P3	6/11/2011	D Seam	<0.03419	<0.372	<0.3588	100.2	<0.2162	<0.3588	<1.794	<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
C034P3	24/05/2013	D Seam	<0.03142	<0.3441	0.3309	110.2	<0.1916	<0.3309	6.288	<0.01	<0.001	0.24	<0.0001	<0.001	<0.001	0.001	**1.4**	<0.001	0.184	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	0.019
C035P1	27/05/2013	Rewan Group	<0.03257	<0.3558	<0.3426	105.8	<0.2018	0.6852	2.741	<0.01	0.002	**0.7**	<0.0001	<0.001	0.001	<0.001	**0.38**	<0.001	0.12	<0.0001	<0.001	0.002	<0.01	<0.001	<0.001	<0.01	0.008
C035P1	5/10/2011	Rewan Group	<0.02778	<0.3073	<0.2943	126.5	<0.1608	<0.2943	<1.471	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
C035P1	6/11/2011	Rewan Group	<0.02828	0.3123	<0.2993	124	<0.1649	<0.2993	1.796	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
C035P2	27/05/2013	AB Seam	<0.05365	<0.5635	0.5518	60.39	<0.4113	<0.5518	7.173	0.01	<0.001	0.27	<0.0001	<0.001	<0.001	0.001	**0.46**	<0.001	0.102	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	0.013
C035P2	5/10/2011	AB Seam	<0.05175	<0.5451	1.066	62.88	<0.3907	<0.5331	<2.665	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
C035P2	6/11/2011	AB Seam	<0.04999	2.64	0.5157	65.38	<0.3718	1.547	5.157	**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
C555P1	25/05/2013	Rewan Group	<0.07526	<0.7696	<0.7622	41.29	<0.6665	6.098	10.67	0.02	0.005	0.28	<0.0001	<0.001	0.002	<0.001	**0.97**	<0.001	**0.67**	<0.0001	0.003	0.008	<0.01	<0.001	<0.001	<0.01	0.014
C556P1	26/05/2013	Rewan Group	<0.1629	<1.568	9.562	17.34	<2.006	15.94	22.31	0.07	0.002	0.1	<0.0001	<0.001	0.004	0.006	**0.27**	<0.001	**0.211**	<0.0001	0.001	0.01	<0.01	<0.001	<0.001	<0.01	0.014
C558P1	19/05/2013	Permian Overburden	<0.009973	<0.1196	3.208	428.9	<0.03727	0.7743	0.7743	0.03	0.001	0.38	<0.0001	<0.001	0.004	0.029	**0.48**	<0.001	**0.332**	<0.0001	<0.001	0.007	<0.01	<0.001	<0.001	<0.01	0.007
C9553P1R	21/05/2013	Dunda Beds	<0.07272	<0.7457	0.7377	42.91	<0.6348	4.426	8.853	0.02	0.01	0.1	<0.0001	<0.001	<0.001	0.001	**6.6**	<0.001	**0.498**	<0.0001	0.001	0.006	<0.01	<0.001	<0.001	<0.01	0.012
HD02	20/05/2013	Clematis Sandstone	<0.2889	<2.658	<2.754	9.109	<4.544	<2.754	30.3	<0.01	0.003	0.09	<0.0001	<0.001	<0.001	<0.001	0.05	<0.001	0.09	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	0.011
HD03A	27/05/2013	Dunda Beds	<0.1559	<1.505	3.056	18.22	<1.884	<1.528	140.6	0.03	<0.001	0.14	<0.0001	<0.001	<0.001	0.002	**0.64**	<0.001	**0.402**	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	0.092
HD03B	20/05/2013	Alluvium	<0.2073	<1.958	2.006	13.22	<2.83	<2.006	30.09	<0.01	<0.001	0.15	<0.0001	<0.001	<0.001	0.001	**0.53**	<0.001	0.157	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	0.015
WQ01	6/10/2011	Surface Water	<0.03919	<0.4218	<0.4087	85.96	<0.2627	<0.4087	<2.044	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
WQ01	8/11/2011	Surface Water	<0.03985	0.8569	<0.4154	84.34	<0.2691	0.4154	9.138	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	Surface Water	<0.03529	<0.383	1.109	96.68	<0.2262	0.3698	<1.849	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
WQ03	8/11/2011	Surface Water	<0.03668	<0.397	0.7675	92.57	<0.2391	0.3838	<1.919	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

Comments

#1 pH of <8
#2 Guideline value for cattle
#3 Guideline value for beef cattle
#4 Guideline value calculated by dividing Nitrite (as NO2) value by 4.427
#5 Guideline value calculated by dividing Nitrate (as NO3) value by 4.427
#6 Guideline value calculated by dividing Nitrate (as NO3) value by 3.29

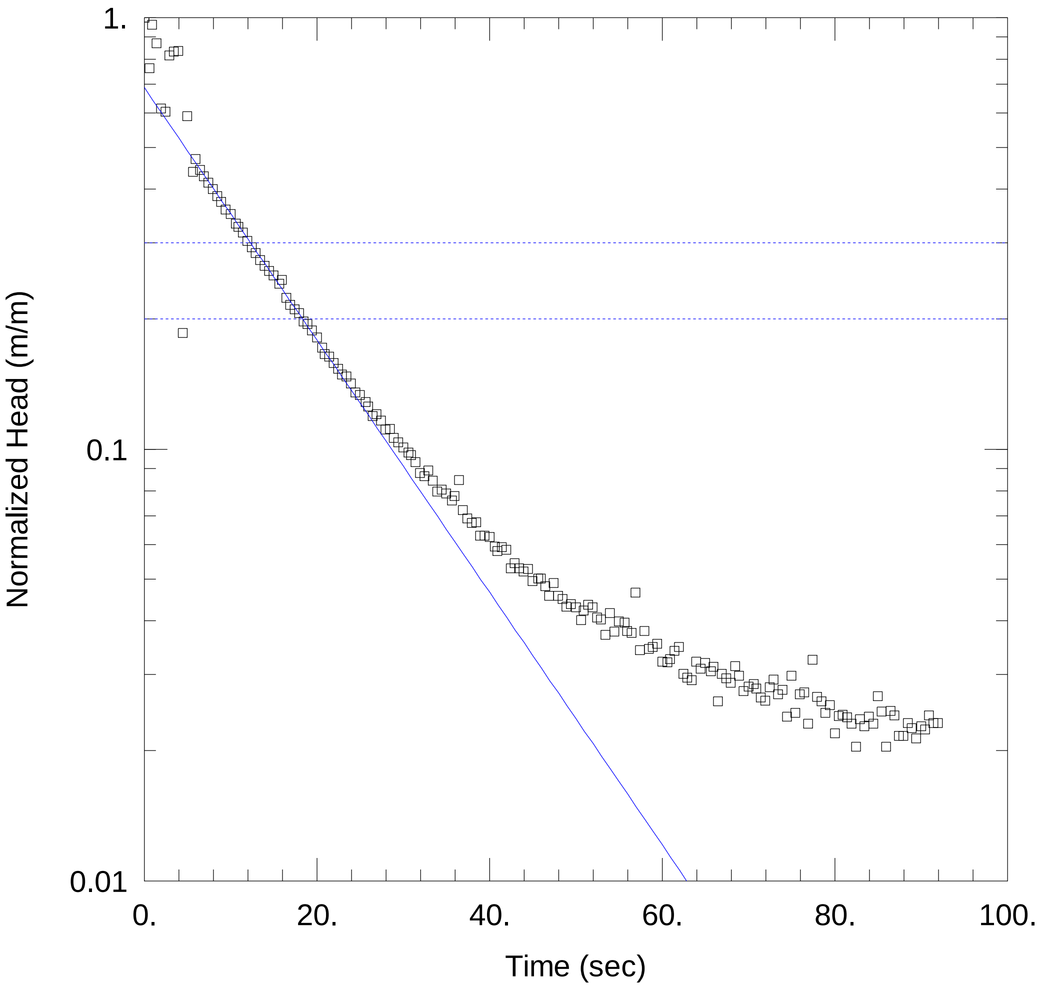
			Hardness corrected metals						Metals																		
			Cadmium -Calculated by Hardness	**Chromium -Calculated by Hardness**	**Copper -Calculated by Hardness**	**Lead -Calculated by Hardness**	**Nickel -Calculated by Hardness**	**Zinc -Calculated by Hardness**	**Aluminium**	**Arsenic**	**Boron**	**Cadmium**	**Chromium (III+VI)**	**Cobalt**	**Copper**	**Iron**	**Lead**	**Manganese**	**Mercury**	**Molybdenum**	**Nickel**	**Selenium**	**Silver**	**Uranium**	**Vanadium**	**Zinc**
			µg/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	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
ADWG 2011 Health										0.01	4	0.002			2		0.01	0.5	0.001	0.05	0.02	0.01	0.1	0.017		
ANZECC (2000) Ecosystems Fresh Water (95%)			0.2	1	1.4	3.4	11	8	0.055		0.37	0.0002	0.001		0.0014		0.0034	1.9	0.00006		0.011	0.005	0.00005			0.008
ANZECC (2000) Irrigation LTV									**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**		**0.01**	**0.1**	**2**
ANZECC (2000) Livestock									5	0.5	5	0.1	1	1	1$^{\#2}$		0.1		0.002	0.15	1	0.02		0.2		20
LocCode	**Sampled_Date-Time**	**MonitoringUnit_2**																								
C011P1	19/05/2013	Permian Interburden	<0.03423	0.3724	2.514	0.4332	3.233	8.262	0.28	0.003	**1.04**	<0.0001	0.001	<0.001	0.007	**0.36**	0.002	0.085	<0.0001	0.007	0.009	<0.01	<0.001	0.004	<0.01	0.023
C011P3	20/05/2013	D Seam	<0.04623	0.9824	6.221	1.33	1.914	9.571	1.83	0.002	0.45	<0.0001	0.002	0.003	0.013	**4.35**	0.004	0.127	<0.0001	<0.001	0.004	<0.01	<0.001	<0.001	<0.01	0.02
C012P1	19/05/2013	Permian Overburden	<0.01904	<0.217	3.488	<0.09381	0.4104	<1.026	0.11	<0.001	0.43	<0.0001	<0.001	<0.001	0.017	0.14	<0.001	0.025	<0.0001	<0.001	0.002	<0.01	<0.001	<0.001	<0.01	<0.005
C012P2	19/05/2013	Permian Overburden	<0.01311	<0.1538	3.733	<0.05504	0.5744	<0.718	0.3	0.004	0.49	<0.0001	<0.001	0.001	0.026	**1.26**	<0.001	**0.572**	<0.0001	0.002	0.004	<0.01	<0.001	<0.001	<0.01	<0.005
C018P1	20/05/2013	Permian Overburden	<0.1061	2.112	43.39	2.177	2.117	5.291	0.53	<0.001	0.27	<0.0001	0.002	<0.001	0.041	**0.21**	0.002	0.01	<0.0001	<0.001	0.002	<0.01	<0.001	<0.001	<0.01	0.005
C018P2	20/05/2013	AB Seam	<0.01685	0.9693	2.008	0.3151	1.46	3.651	1.94	<0.001	**0.56**	<0.0001	0.005	0.002	0.011	**3.26**	0.004	0.103	<0.0001	<0.001	0.008	<0.01	<0.001	<0.001	<0.01	0.02
C018P3	19/05/2013	D Seam	<0.04081	<0.4379	2.974	0.5567	0.8498	4.249	0.46	0.001	0.36	<0.0001	<0.001	0.002	0.007	**1.59**	0.002	0.066	<0.0001	<0.001	0.002	<0.01	<0.001	<0.001	<0.01	0.01
C024P3	20/05/2013	D Seam	<0.01837	<0.2099	1.388	<0.08913	1.983	25.18	0.17	0.019	0.33	<0.0001	<0.001	0.004	0.007	**33.3**	<0.001	**0.255**	<0.0001	<0.001	0.01	<0.01	<0.001	<0.001	<0.01	0.127
C024P3	20/05/2013	D Seam	<0.01907	<0.2172	1.233	<0.09398	2.054	2.054	0.13	0.019	0.34	<0.0001	<0.001	0.004	0.006	**33**	<0.001	**0.256**	<0.0001	<0.001	0.01	<0.01	<0.001	<0.001	<0.01	0.01
C032P2	27/05/2013	AB Seam	<0.5353	<4.692	<4.965	<10.96	<4.965	<24.82	0.04	0.007	0.31	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	<0.001	<0.0001	**0.025**	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005
C035P1	27/05/2013	Rewan Group	<0.03257	4.981	6.509	0.8071	4.111	6.509	**5.02**	0.003	**0.7**	<0.0001	0.014	0.006	0.019	**6.25**	0.004	0.164	<0.0001	<0.001	0.012	<0.01	<0.001	<0.001	0.01	0.019
C035P2	27/05/2013	AB Seam	<0.05365	1.127	29.24	<0.4113	5.518	8.276	0.46	<0.001	0.25	<0.0001	0.002	<0.001	0.053	**1.01**	<0.001	0.119	<0.0001	<0.001	0.01	<0.01	<0.001	<0.001	<0.01	0.015
C558P1	19/05/2013	Permian Overburden	<0.009973	1.076	25.66	0.7453	1.991	2.544	**5.68**	0.008	0.46	<0.0001	0.009	0.008	**0.232**	**7.53**	0.02	**0.469**	<0.0001	<0.001	0.018	<0.01	<0.001	0.002	0.02	0.023
HD02	20/05/2013	Clematis Sandstone	<0.2889	<2.658	<2.754	<4.544	<2.754	<13.77	0.04	0.004	0.11	<0.0001	<0.001	<0.001	<0.001	0.14	<0.001	0.106	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005
HD03A	27/05/2013	Dunda Beds	<0.1559	<1.505	18.34	3.768	<1.528	1030	0.04	<0.001	0.13	<0.0001	<0.001	<0.001	0.012	**0.96**	0.002	**0.46**	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	0.674
HD03B	20/05/2013	Alluvium	<0.2073	<1.958	4.013	<2.83	<2.006	<10.03	0.23	<0.001	0.18	<0.0001	<0.001	<0.001	0.002	**0.83**	<0.001	0.182	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.005
Statistical Summary																										
Number of Results			16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Number of Detects			0	7	14	8	12	11	16	10	16	0	7	8	14	15	8	15	0	3	12	0	0	2	2	11
Minimum Concentration			<0.009973	<0.1538	1.233	<0.05504	0.4104	<0.718	0.04	<0.001	0.11	<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			ND	0.3724	1.233	0.3151	0.4104	2.054	0.04	0.001	0.11	ND	0.001	0.001	0.002	0.14	0.002	0.01	ND	0.002	0.002	ND	ND	0.002	0.01	0.005
Maximum Concentration			<0.5353	4.981	43.39	<10.96	5.518	1030	5.68	0.019	1.04	<0.0001	0.014	0.008	0.232	33.3	0.02	0.572	<0.0001	0.025	0.018	<0.01	<0.001	0.004	0.02	0.674
Maximum Detect			ND	4.981	43.39	3.768	5.518	1030	5.68	0.019	1.04	ND	0.014	0.008	0.232	33.3	0.02	0.572	ND	0.025	0.018	ND	ND	0.004	0.02	0.674
Average Concentration			0.05	1.1	9.7	1.2	2	71	1.1	0.0046	0.4	0.00005	0.0025	0.0021	0.028	5.9	0.0028	0.19	0.00005	0.0025	0.0058	0.005	0.0005	0.00081	0.0063	0.06
Median Concentration			0.01876	0.97415	3.6105	0.651	1.9485	5.9	0.29	0.0025	0.35	0.00005	0.0005	0.00075	0.0115	1.135	0.00125	0.123	0.00005	0.0005	0.004	0.005	0.0005	0.0005	0.005	0.0125
Standard Deviation			0.071	1.2	13	1.5	1.4	256	1.8	0.0061	0.23	0	0.0038	0.0023	0.056	11	0.0048	0.17	0	0.0062	0.0053	0	0	0.00093	0.0039	0.17
Number of Guideline Exceedances			3	8	14	3	0	8	13	2	7	0	6	0	14	13	4	5	16	1	2	16	16	0	0	10
Number of Guideline Exceedances(Detects Only)			0	4	12	1	0	5	13	2	7	0	6	0	14	13	4	5	0	1	2	0	0	0	0	10

Comments

#1 pH of <8
#2 Guideline value for cattle
#3 Guideline value for beef cattle
#4 Guideline value calculated by dividing Nitrite (as NO2) value by 4.427
#5 Guideline value calculated by dividing Nitrate (as NO3) value by 4.427
#6 Guideline value calculated by dividing Nitrate (as NO3) value by 3.29

Appendix E – Slug testing

Slug Testing Analysis Data Sheets



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

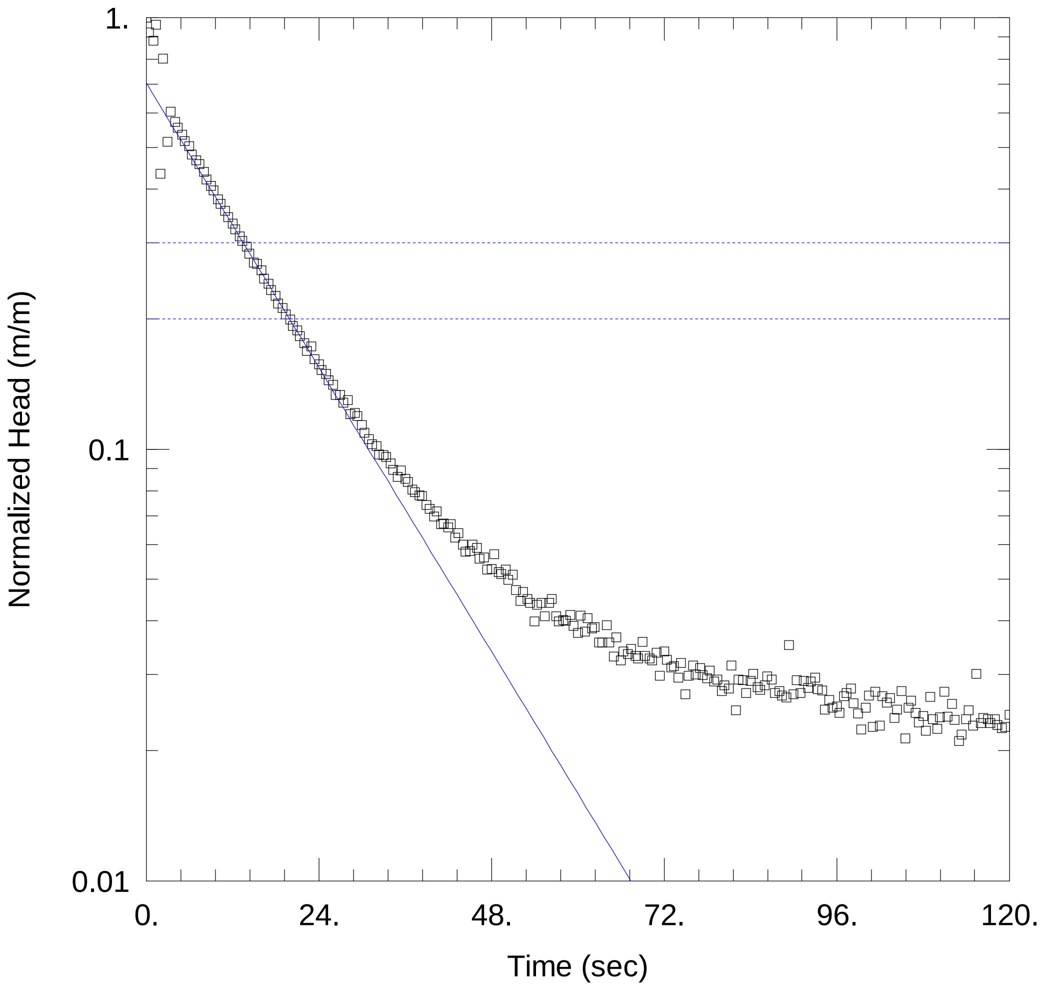
WELL DATA (C006P1)

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

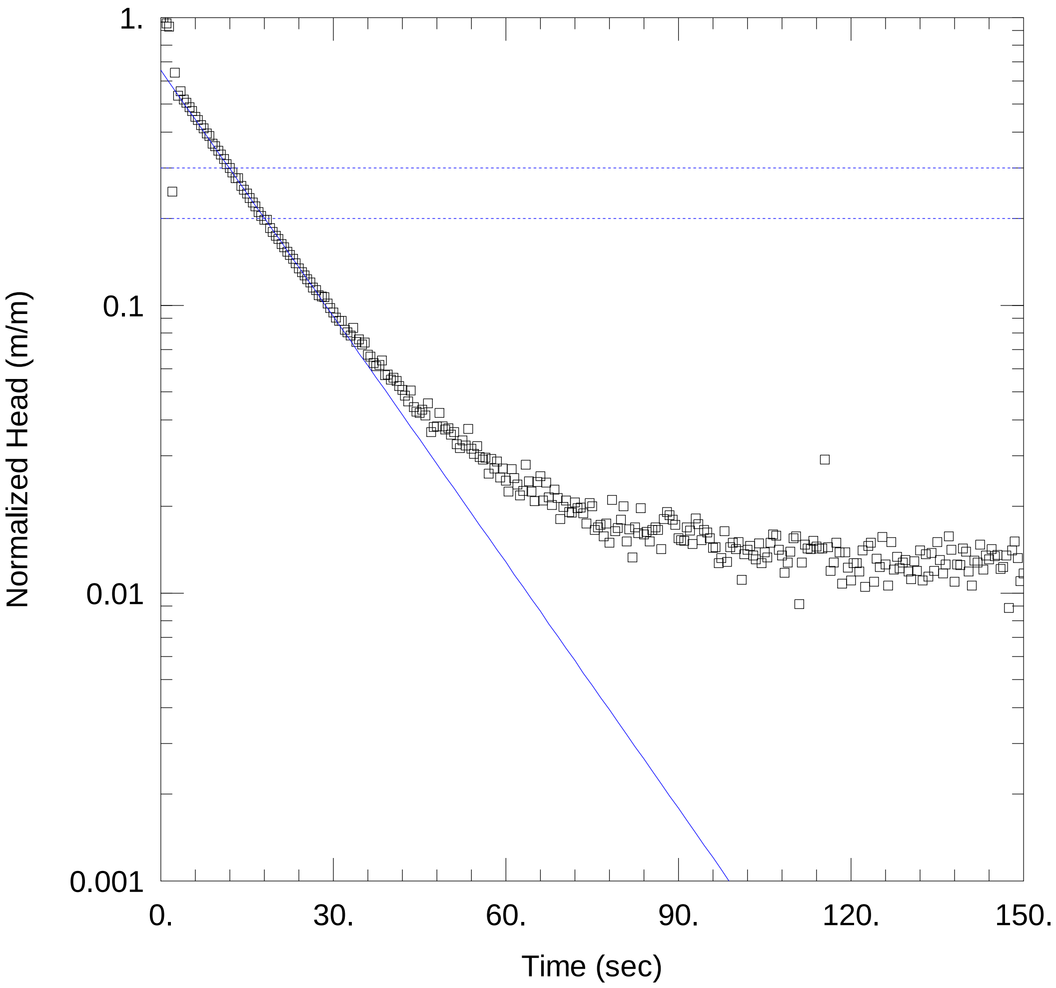
WELL DATA (C006P1)

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

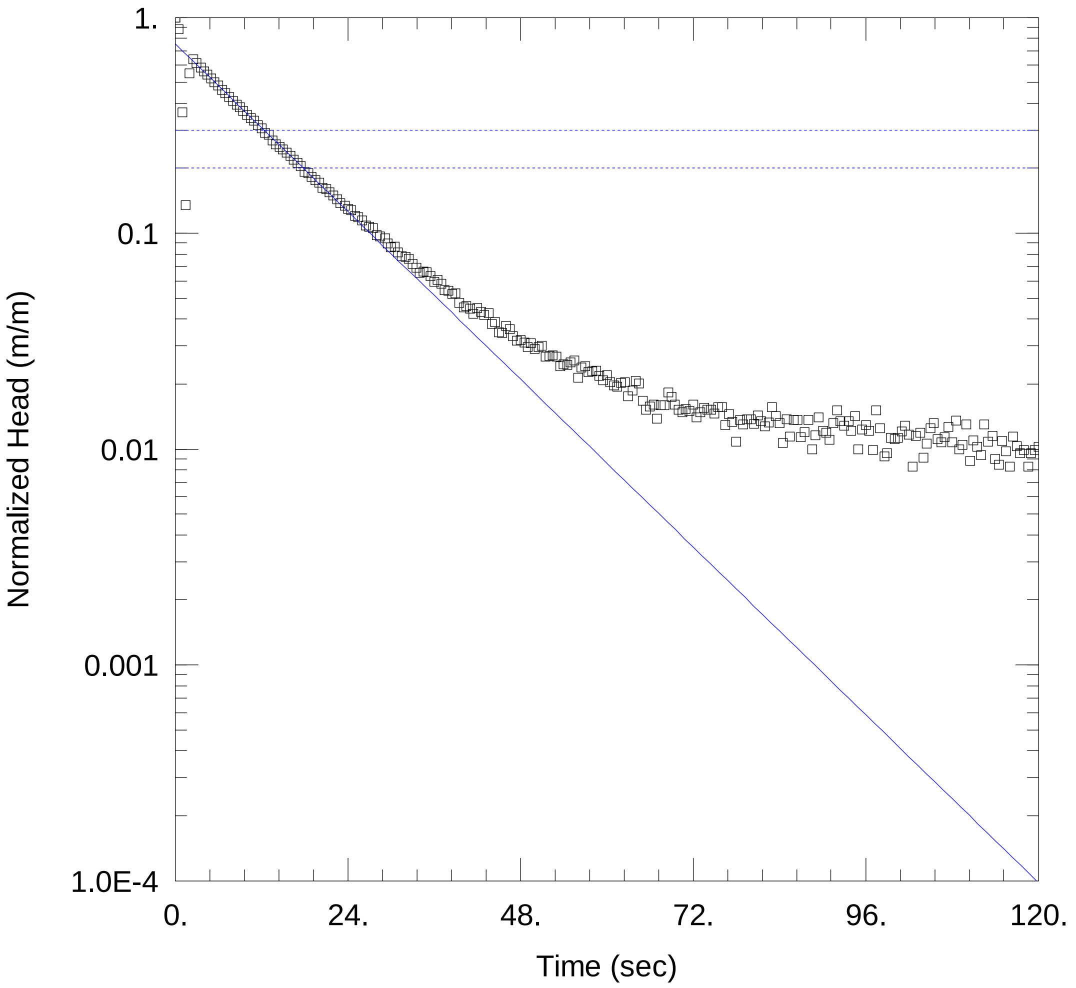
WELL DATA (C006P1)

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

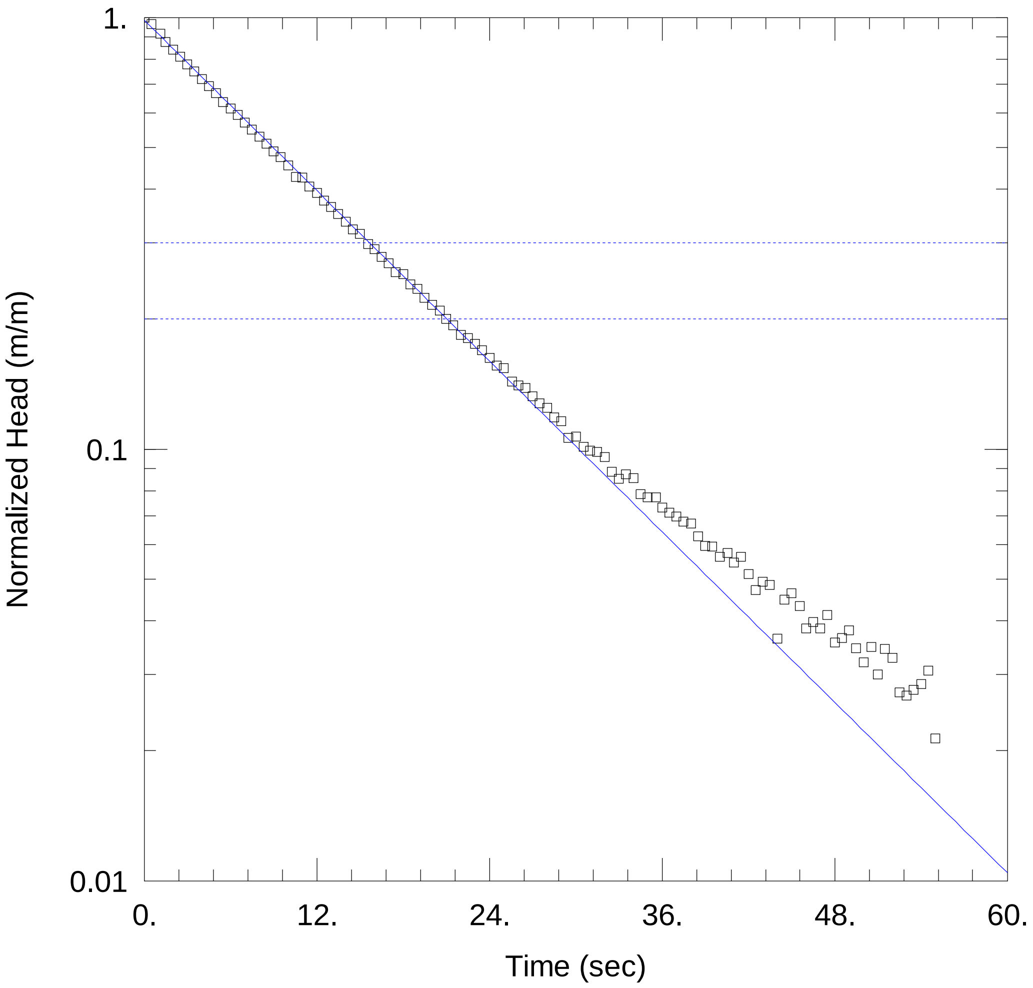
WELL DATA (C006P1)

Initial Displacement: 1.461 m
Static Water Column Height: 23.93 m
Total Well Penetration Depth: 19.88 m
Screen Length: 6. m
Casing Radius: 0.025 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 1.724 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

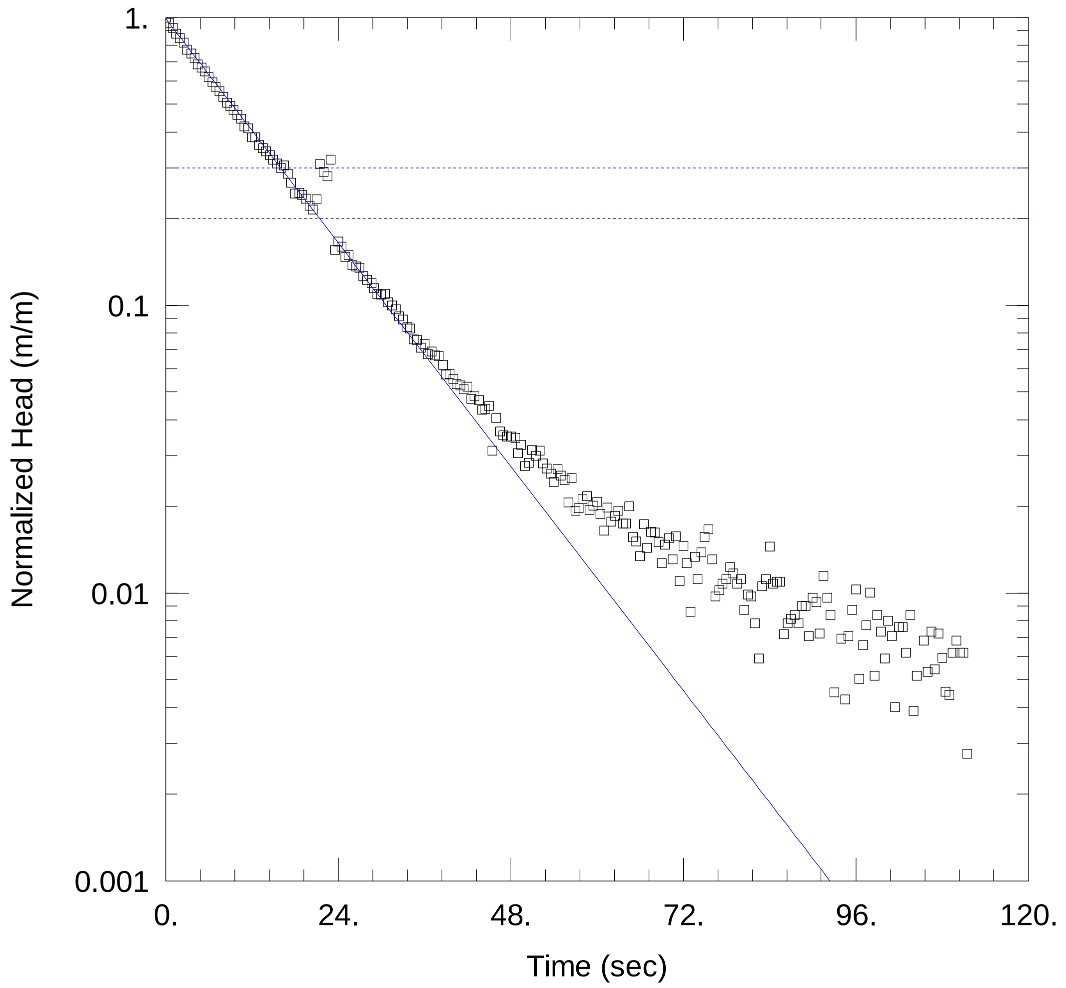
Saturated Thickness: 6. m	Anisotropy Ratio (Kz/Kr): 0.1

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

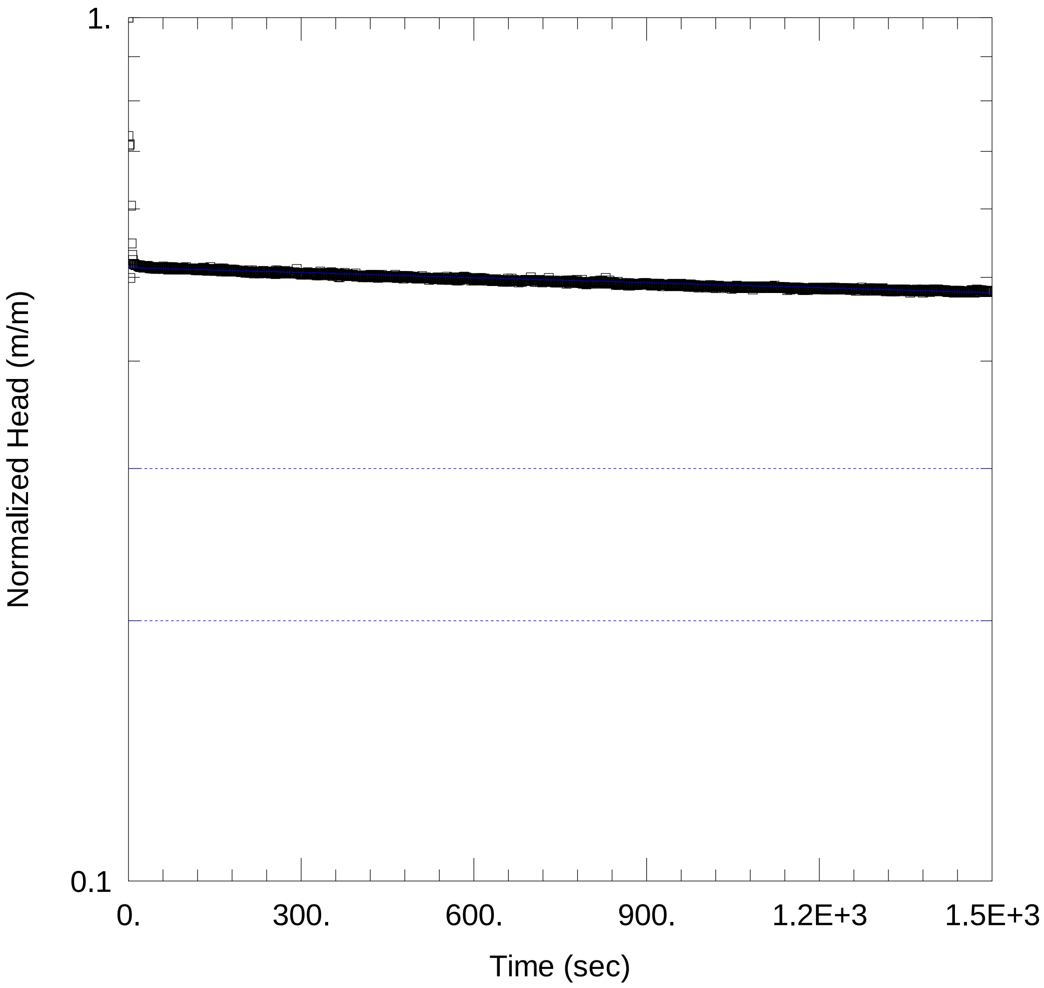
WELL DATA (C006P1)

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

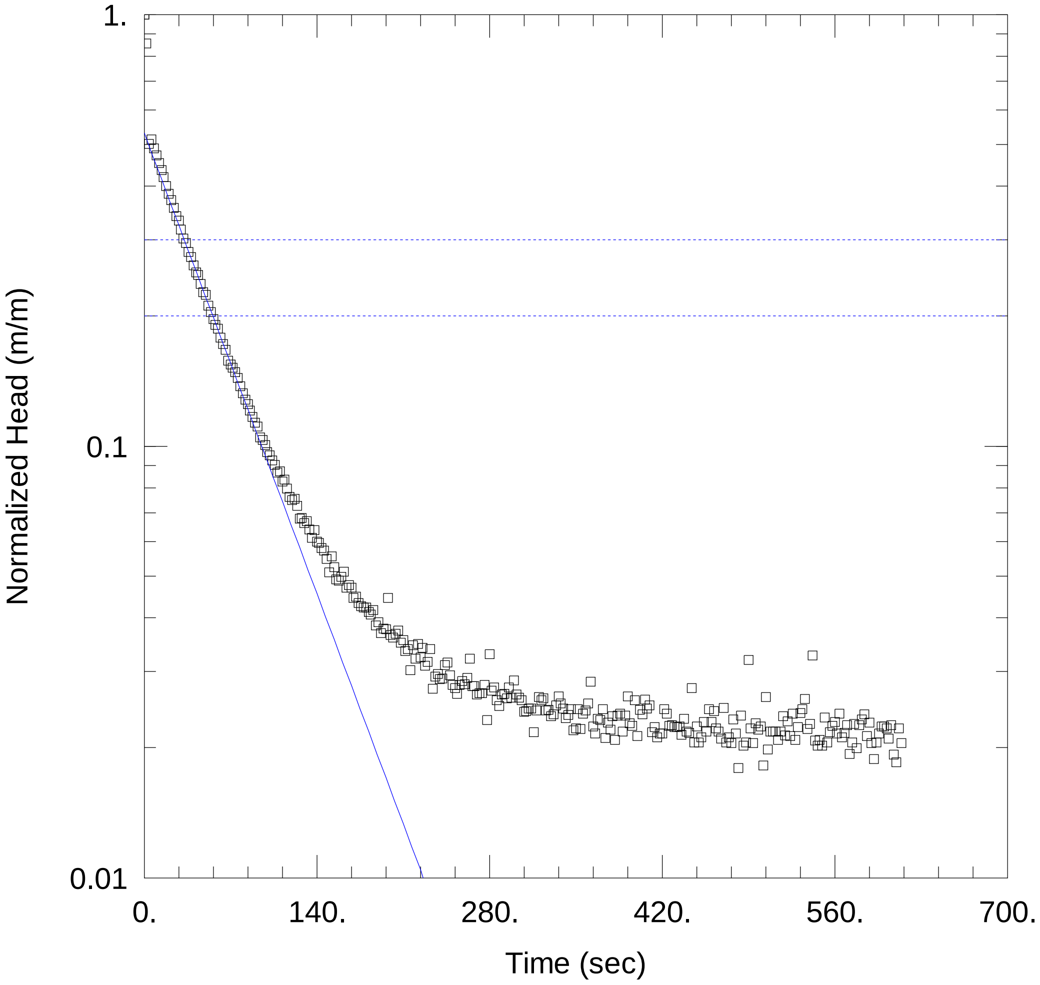
WELL DATA (C011P1)

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

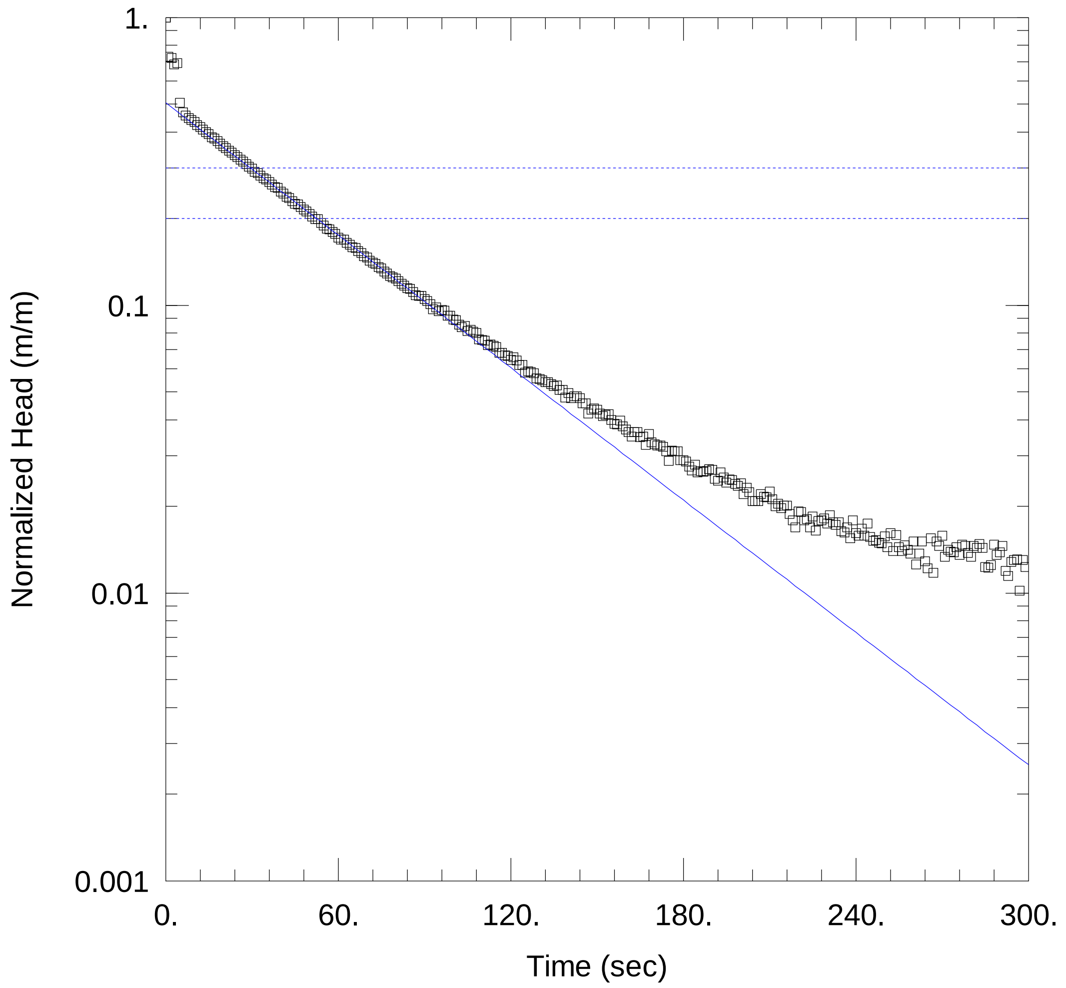
WELL DATA (C012P1)

Initial Displacement: 1.304 m
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 = 0.3883 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

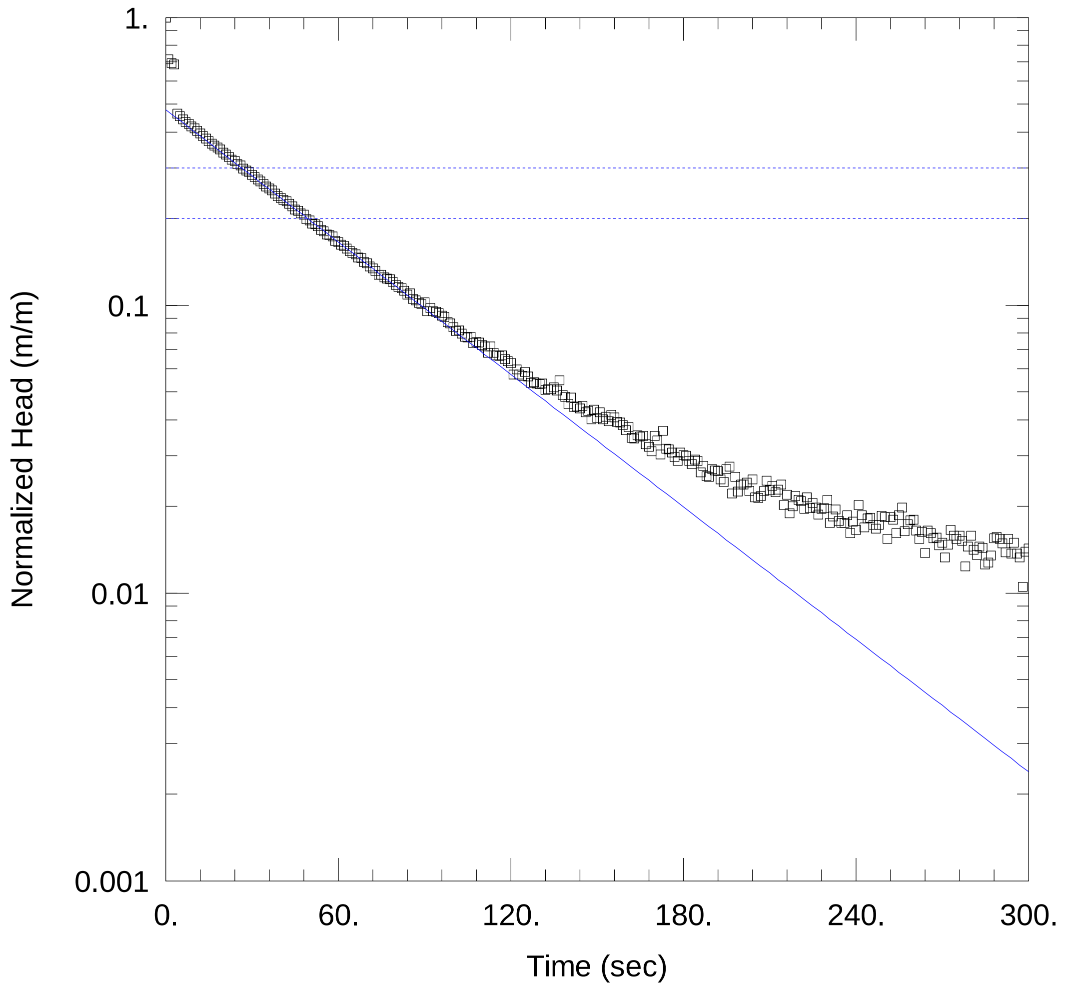
Saturated Thickness: 14.13 m
Anisotropy Ratio (Kz/Kr): 0.1

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

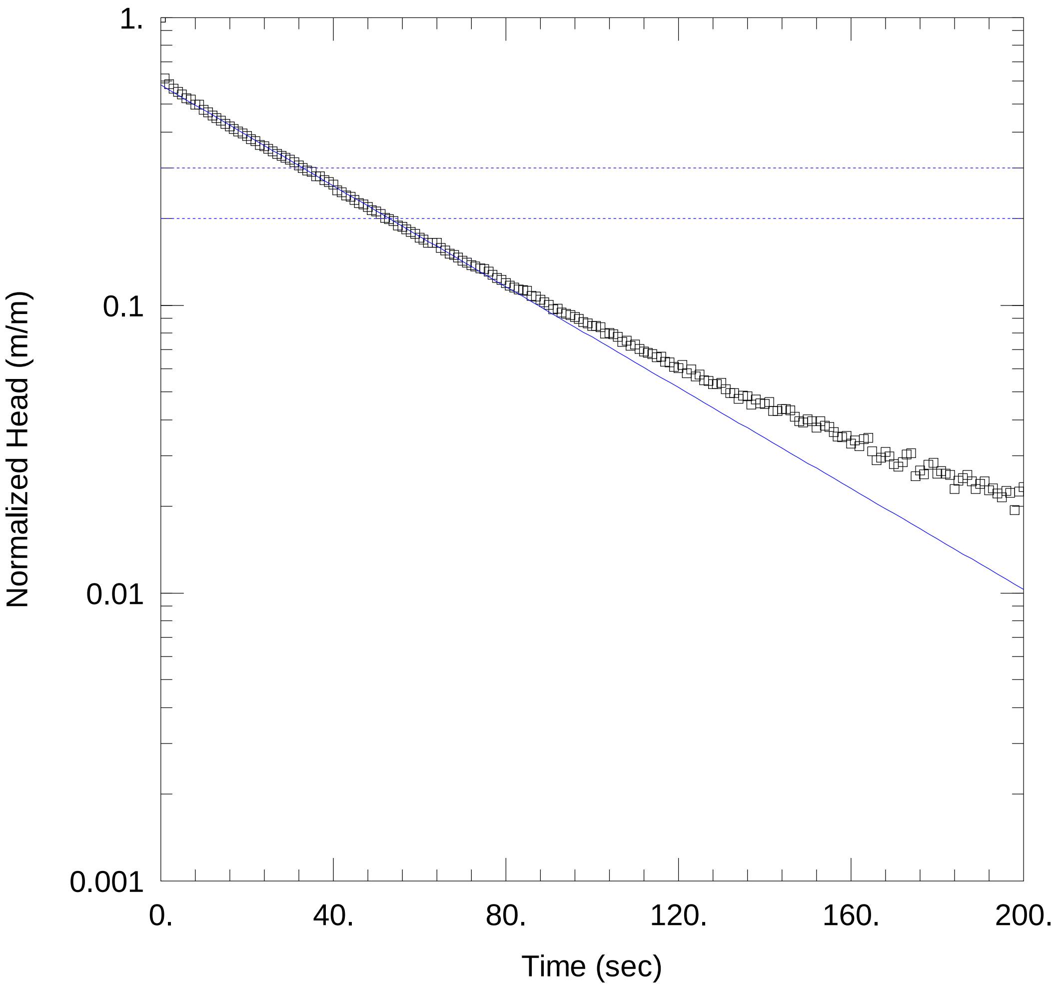
WELL DATA (CP012P1)

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

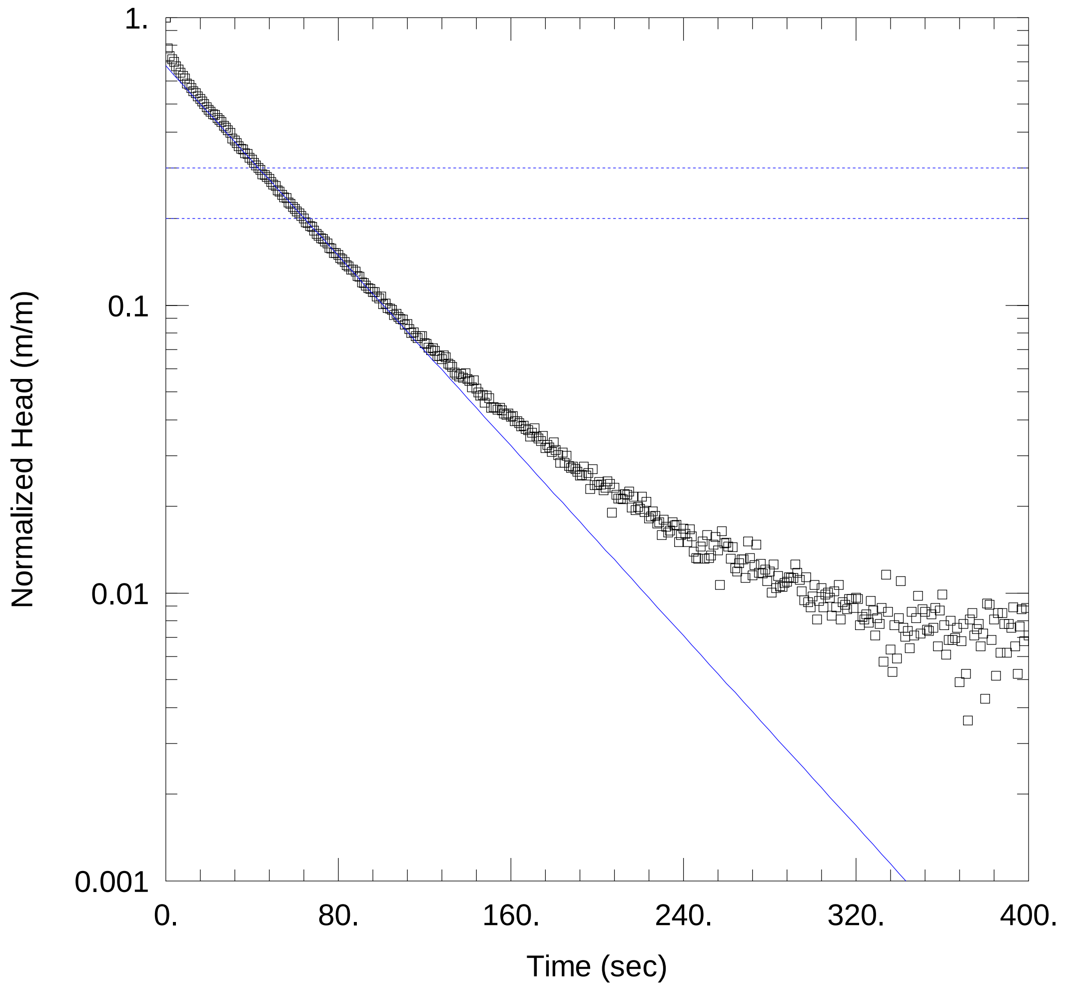
WELL DATA (C012P1)

Initial Displacement: 1.766 m
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 = 0.4466 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

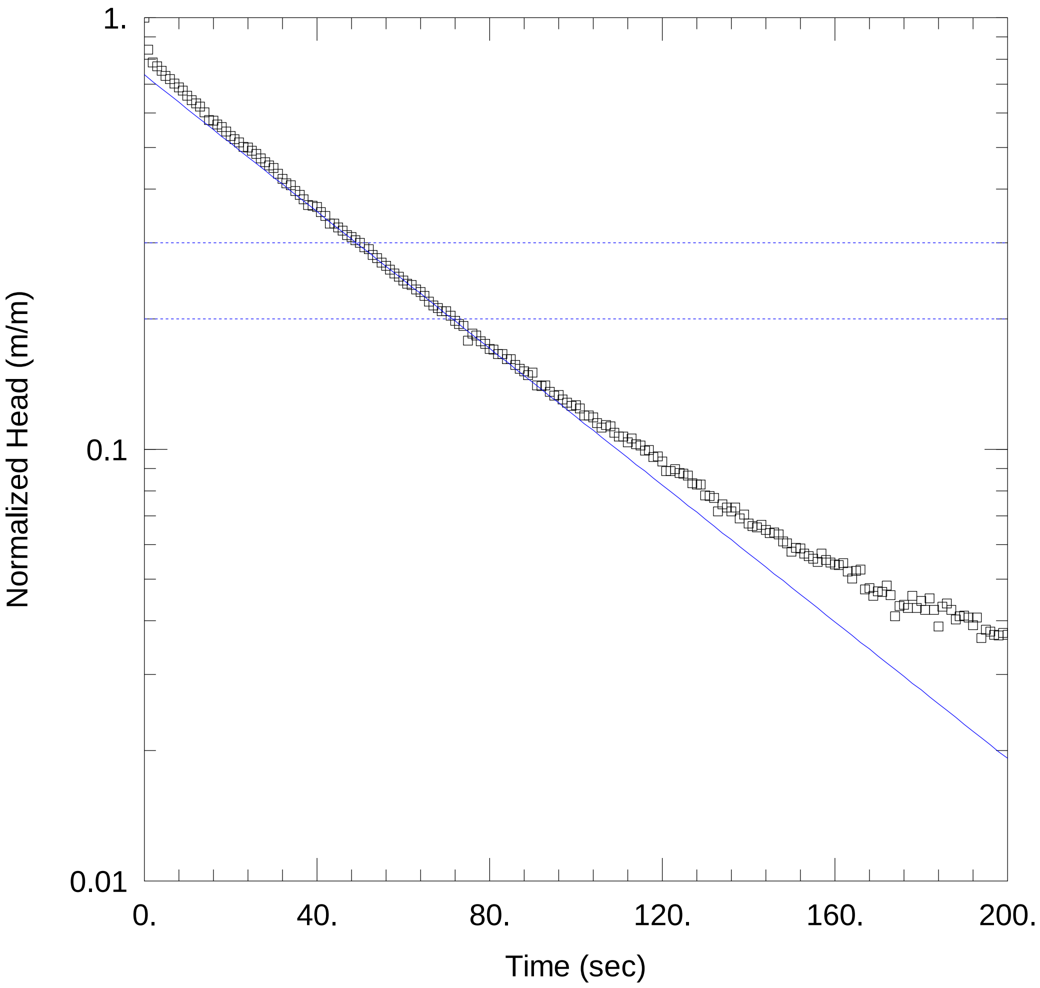
Saturated Thickness: 14.13 m
Anisotropy Ratio (Kz/Kr): 0.1

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

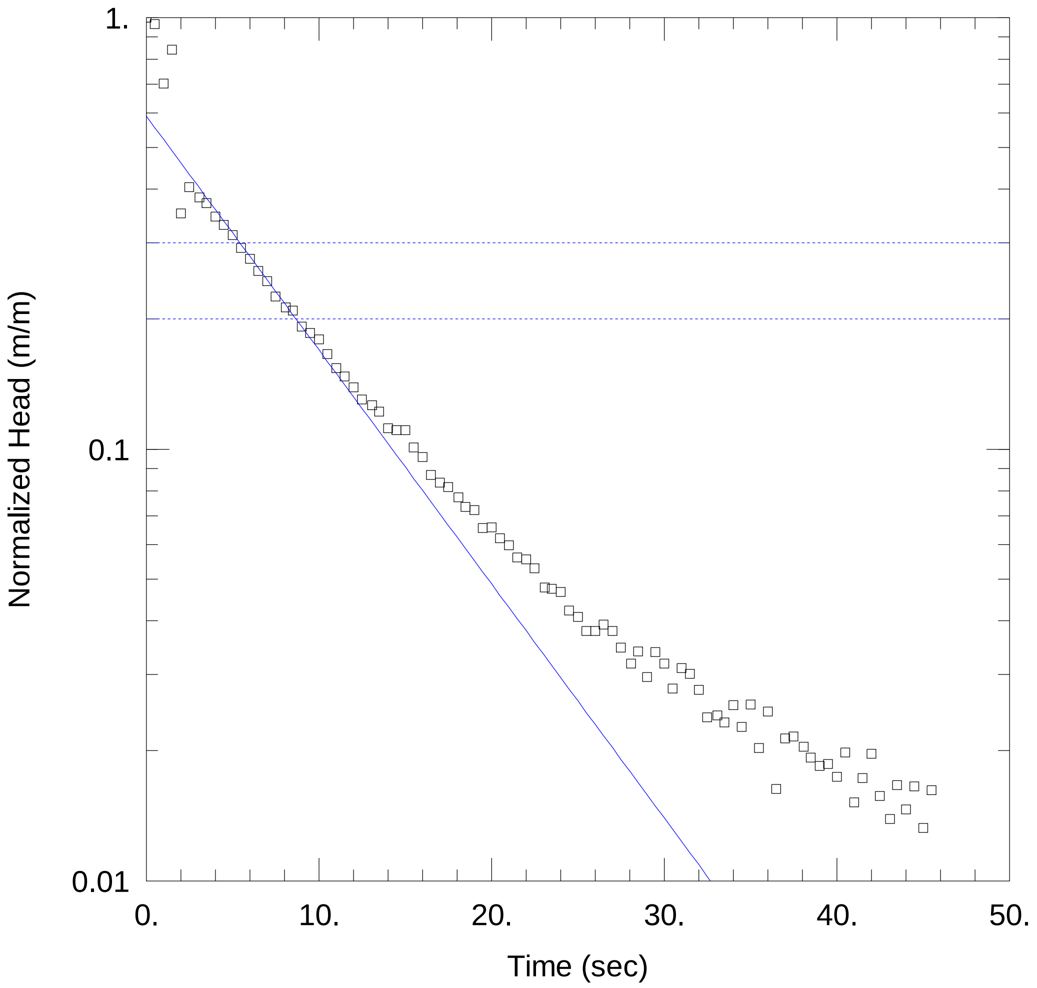
WELL DATA (C012P1)

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

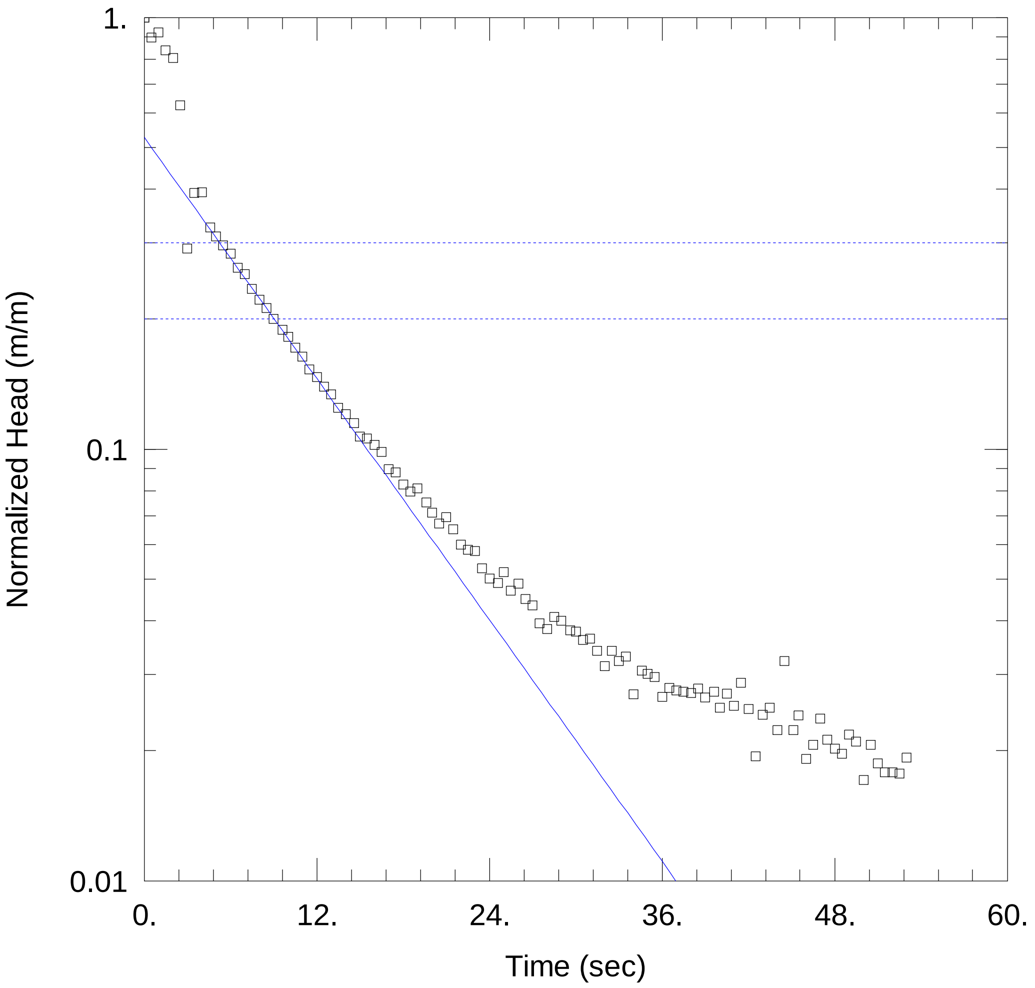
WELL DATA (C022P1)

Initial Displacement: 1.162 m
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 = 3.129 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

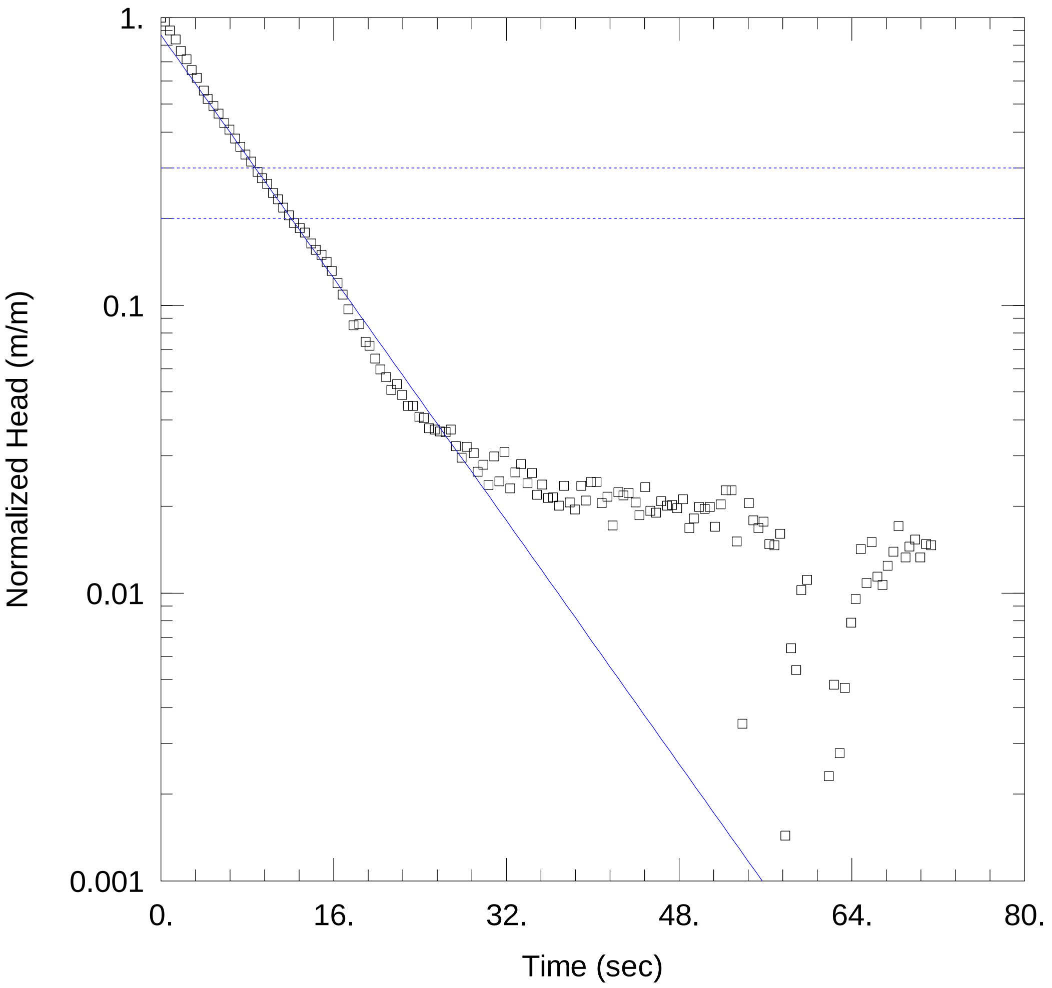
WELL DATA (C022P1)

Initial Displacement: 1.015 m
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 = 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

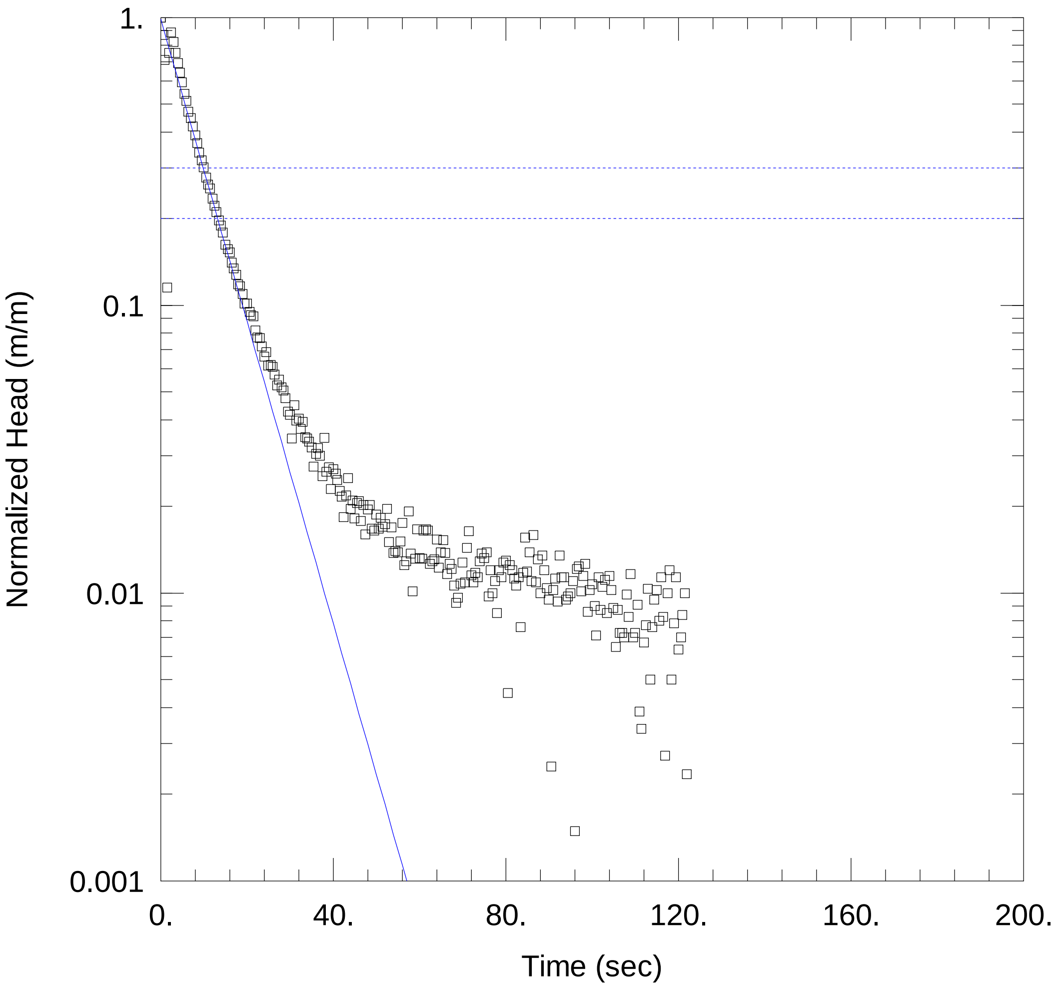
WELL DATA (C022P1)

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

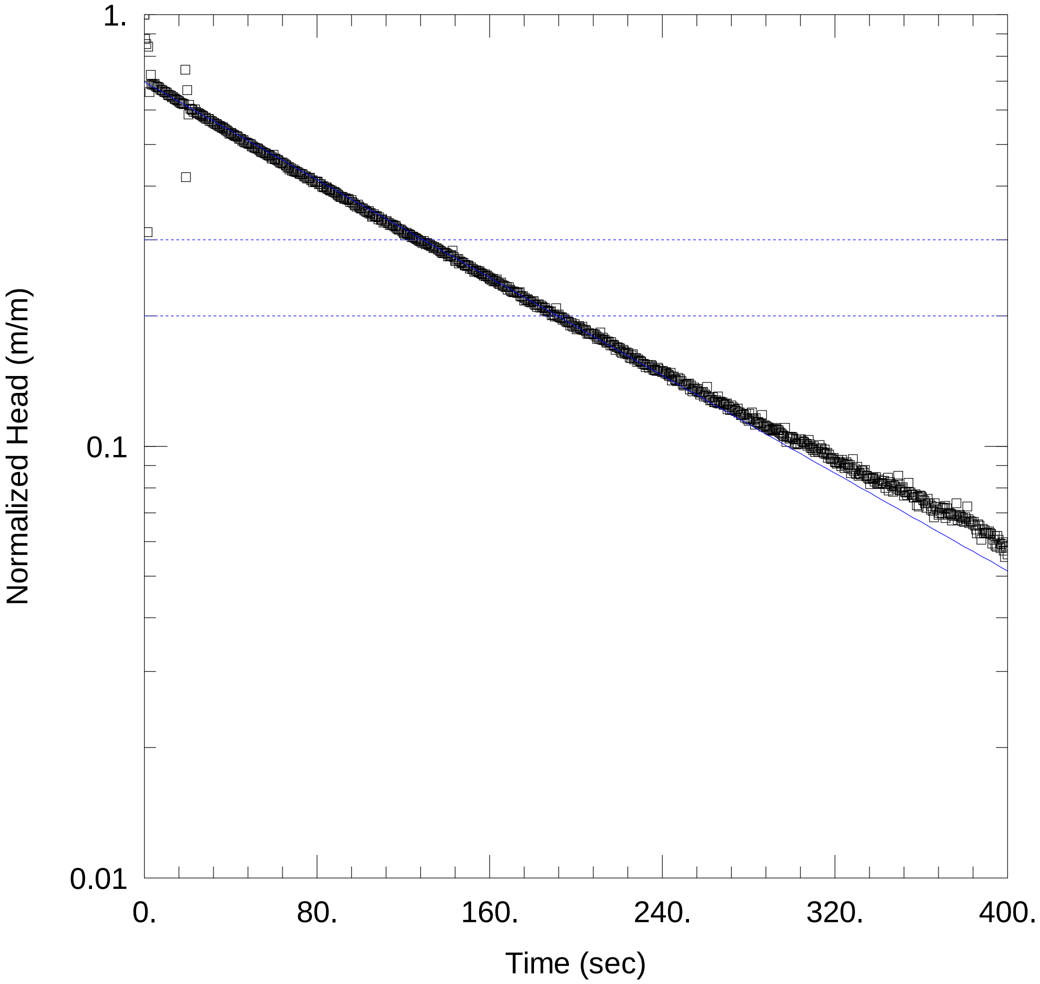
WELL DATA (C022P1)

Initial Displacement: 0.9791 m
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 = 3.031 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

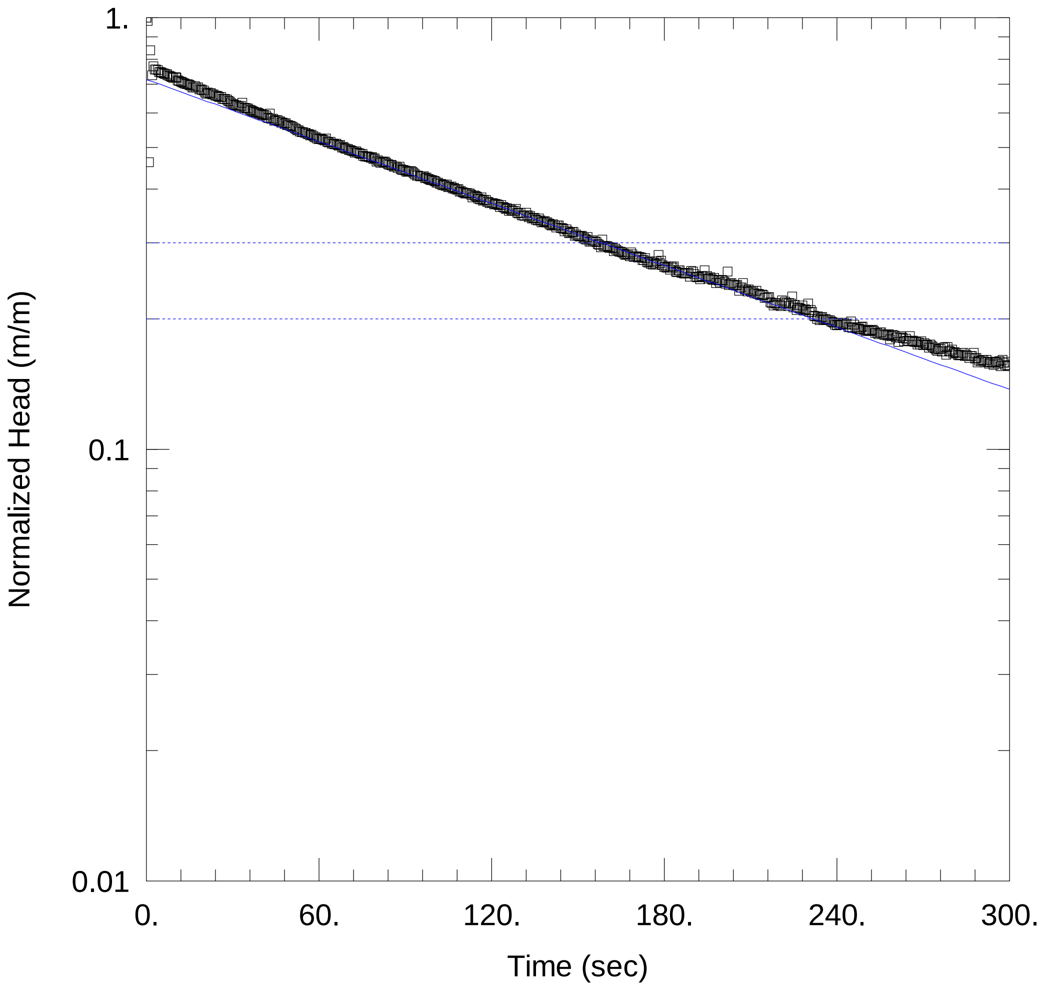
WELL DATA (C025P2)

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

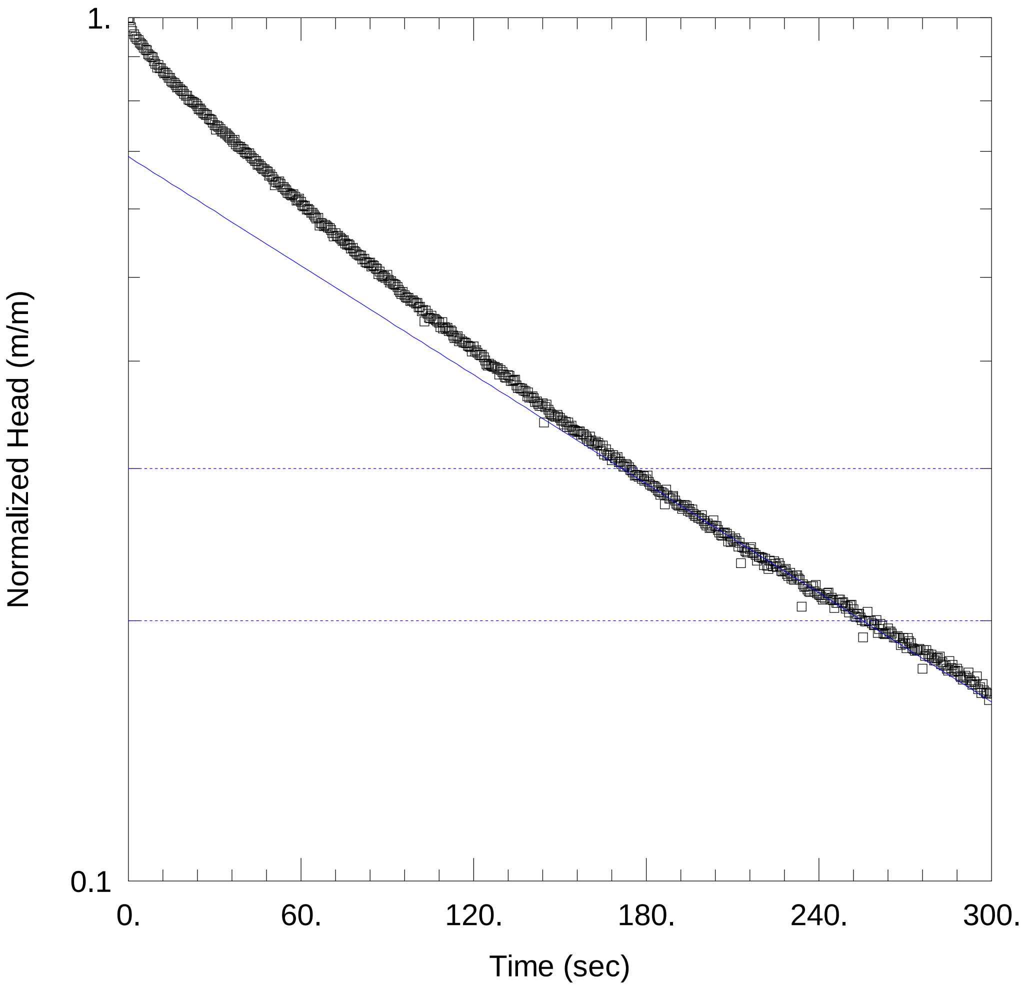
WELL DATA (C025P2)

Initial Displacement: 1.315 m
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 = 0.1663 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

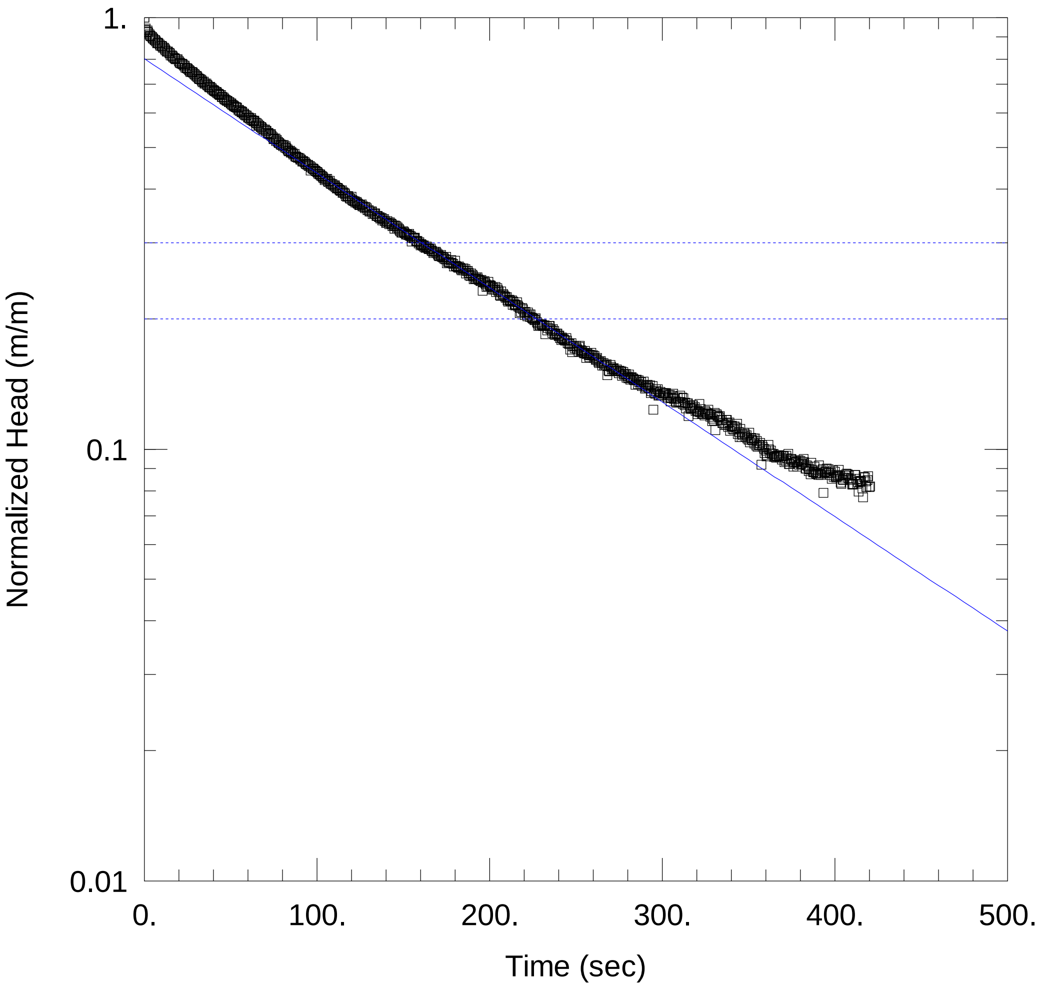
Saturated Thickness: 30.64 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (C025P2)

Initial Displacement: 1.083 m
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 = 0.1463 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

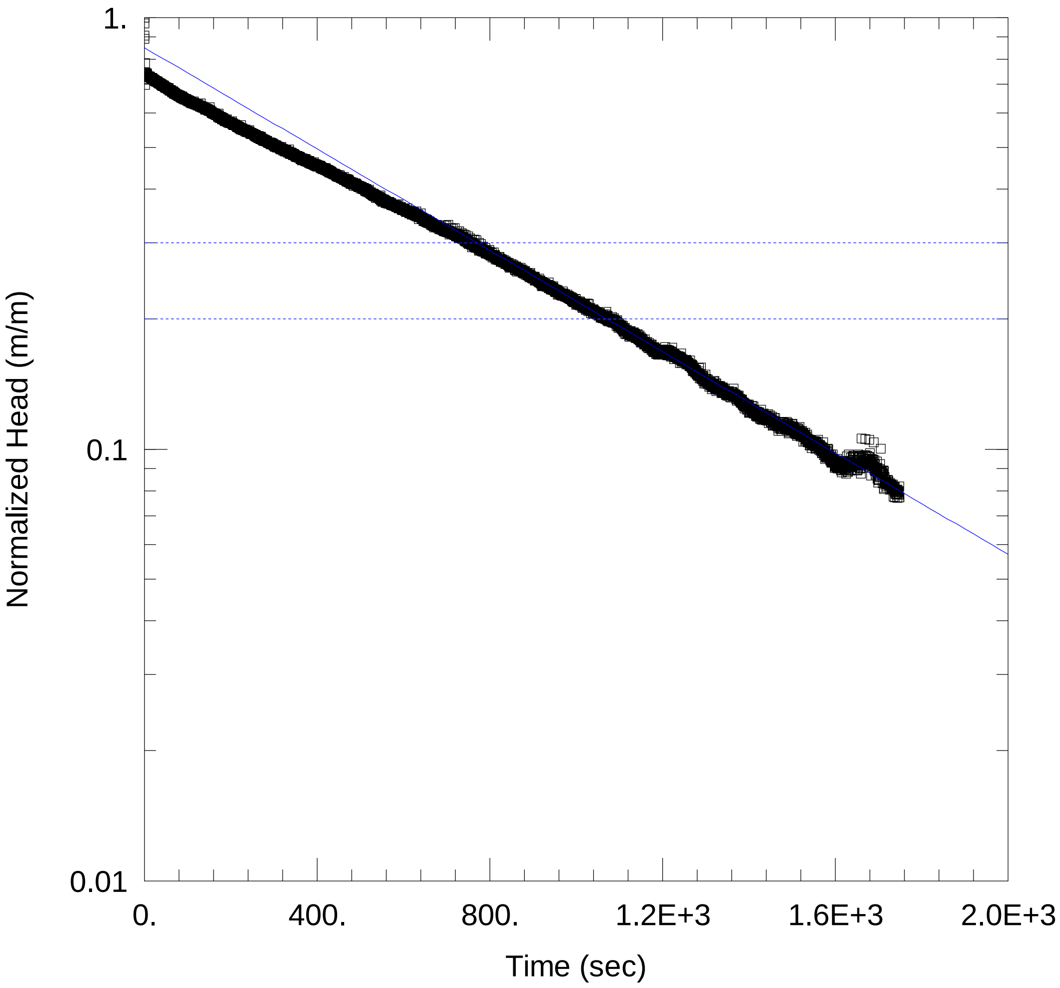
WELL DATA (C025P2)

Initial Displacement: 1.054 m
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 = 0.1843 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
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

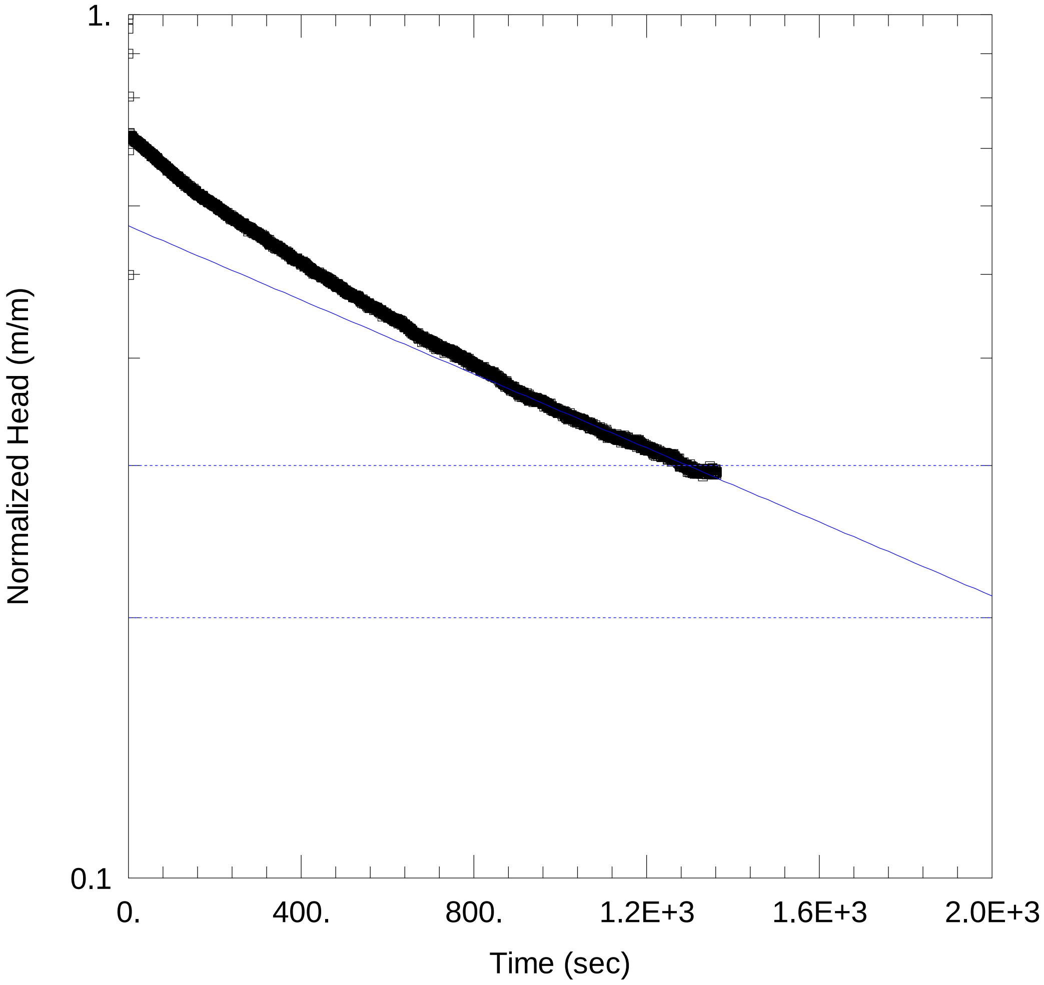
SOLUTION

Aquifer Model: Confined

Solution Method: Bouwer-Rice

K = 0.03529 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

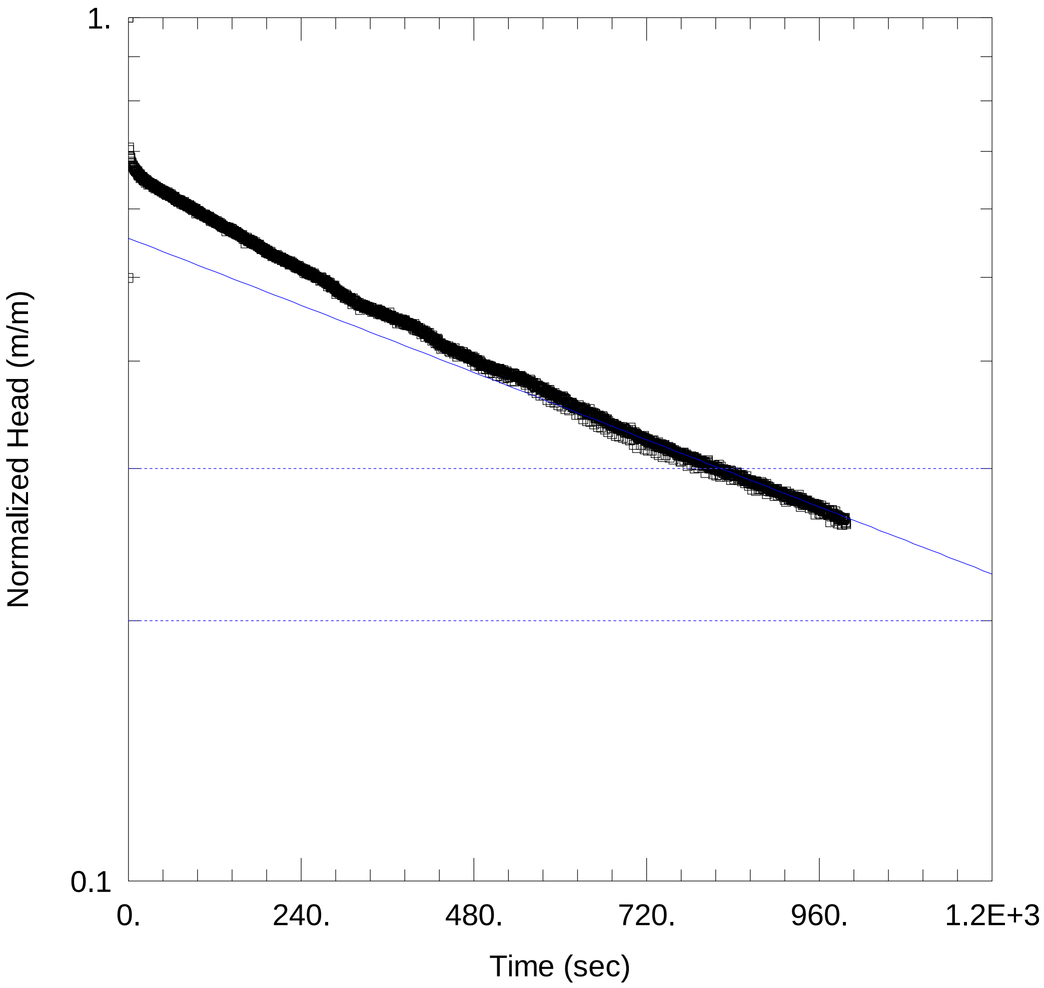
WELL DATA (C035P1)

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

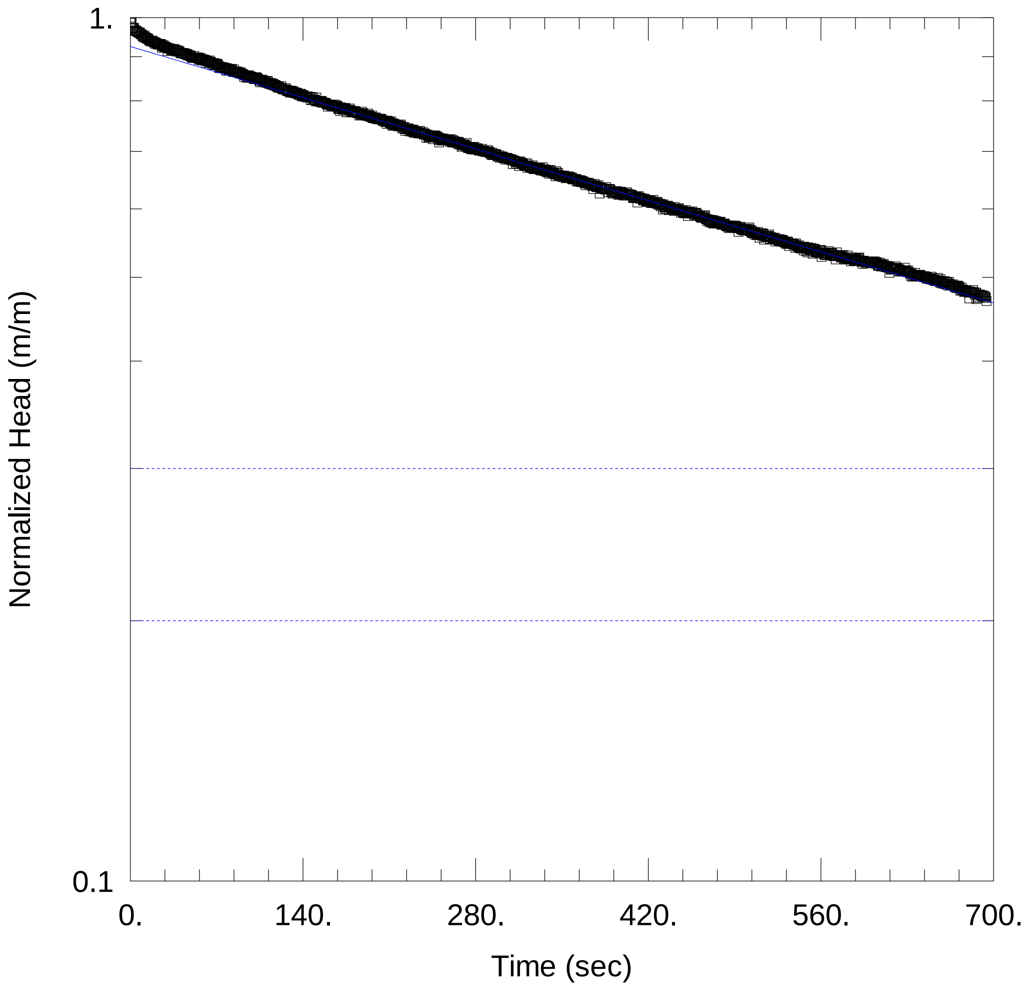
Saturated Thickness: 12. m	Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (C035P1)

Initial Displacement: 1.59 m	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 = 0.01949 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

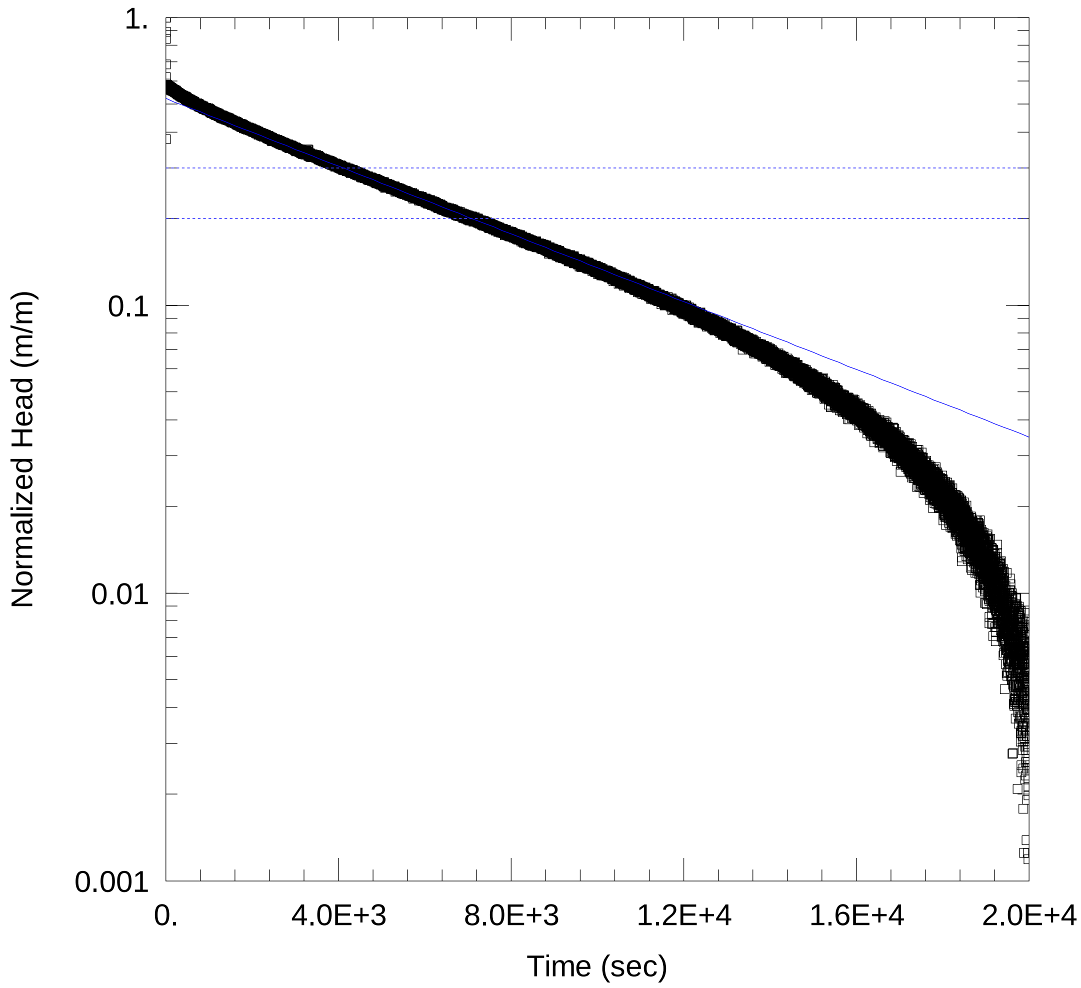
WELL DATA (C035P1)

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

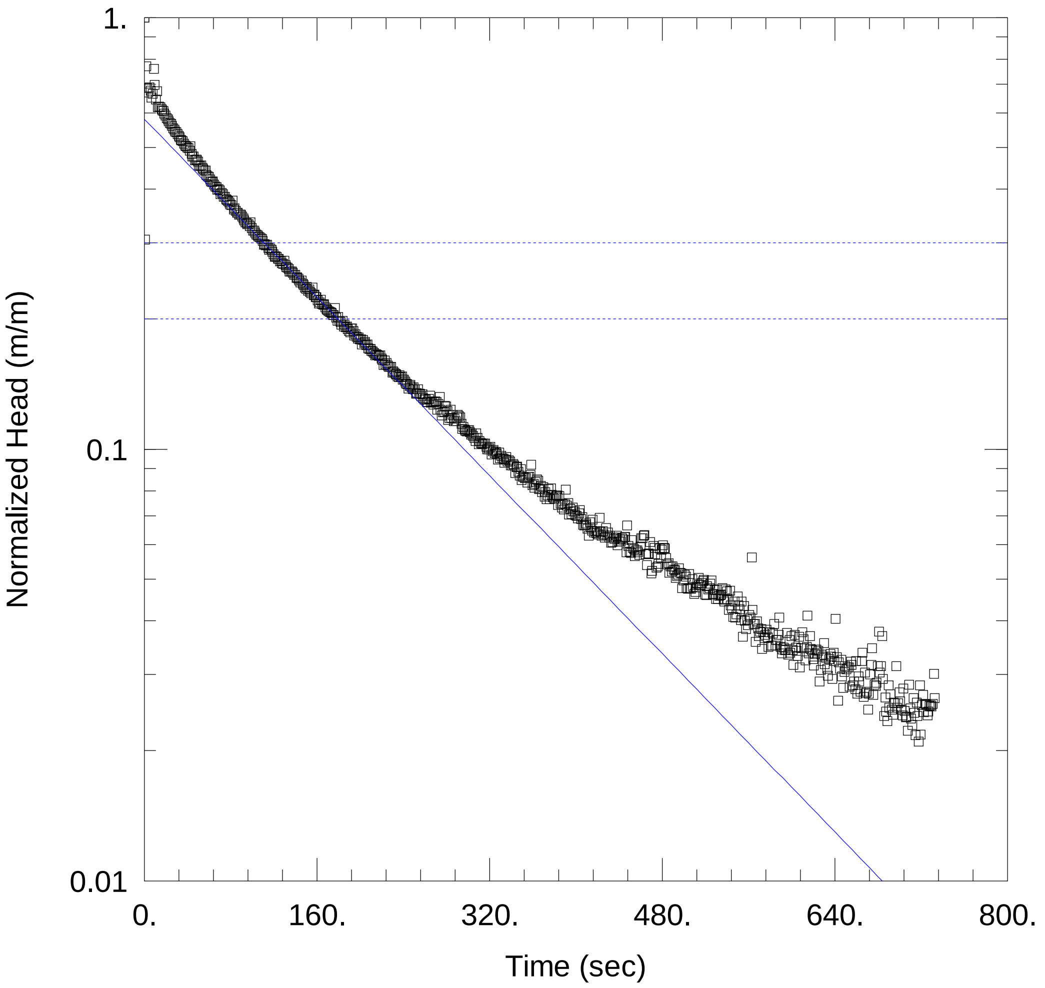
WELL DATA (C553P1)

Initial Displacement: 1.829 m
Static Water Column Height: 25.27 m
Total Well Penetration Depth: 25.27 m
Screen Length: 9. m
Casing Radius: 0.025 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.002221 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

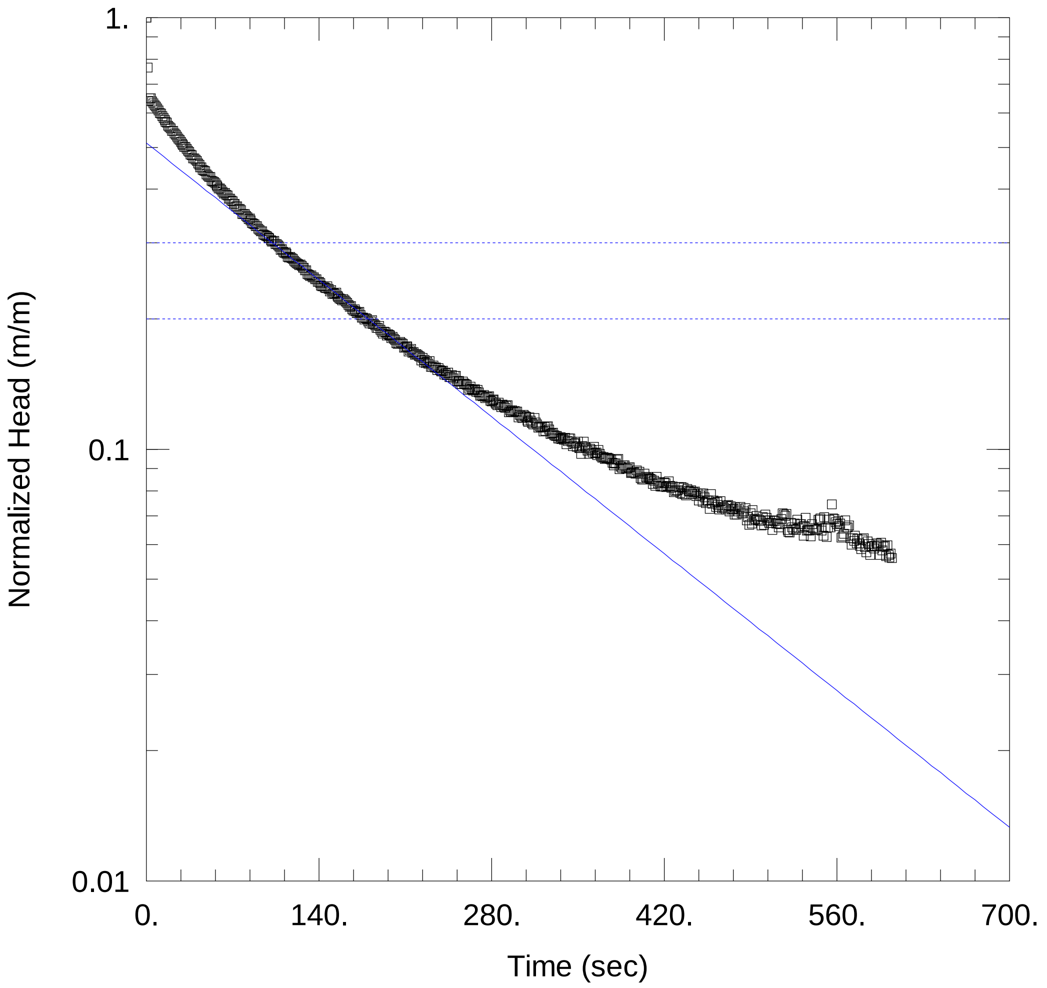
WELL DATA (C555P1)

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

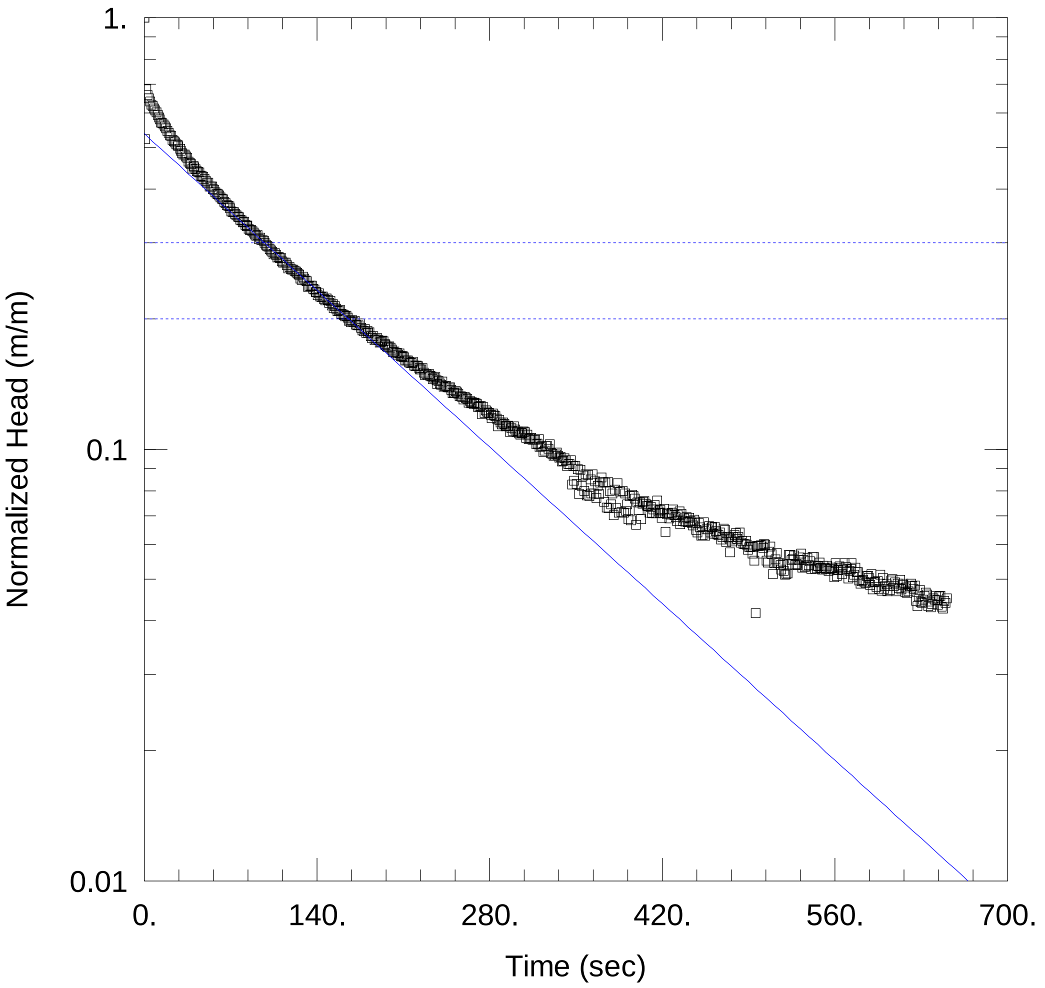
WELL DATA (C555P1)

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

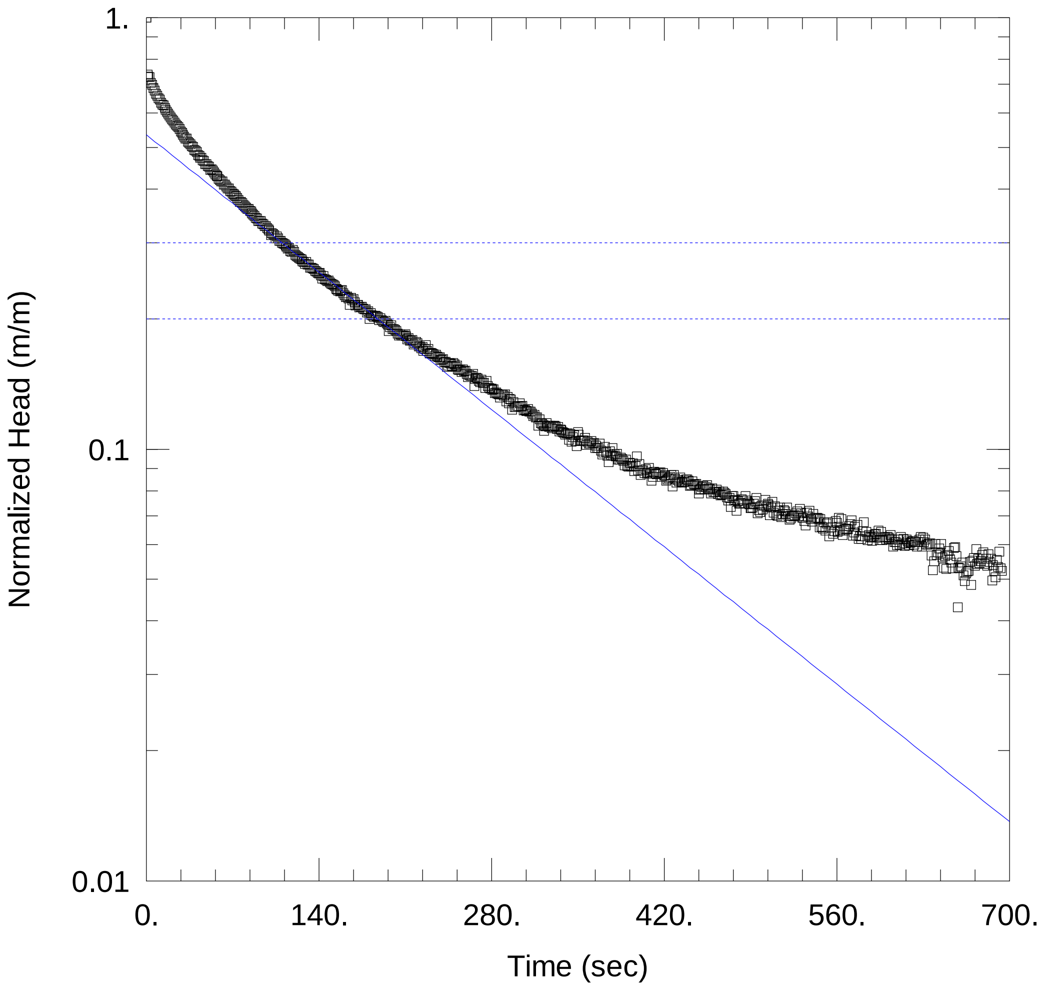
WELL DATA (C0555P1)

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

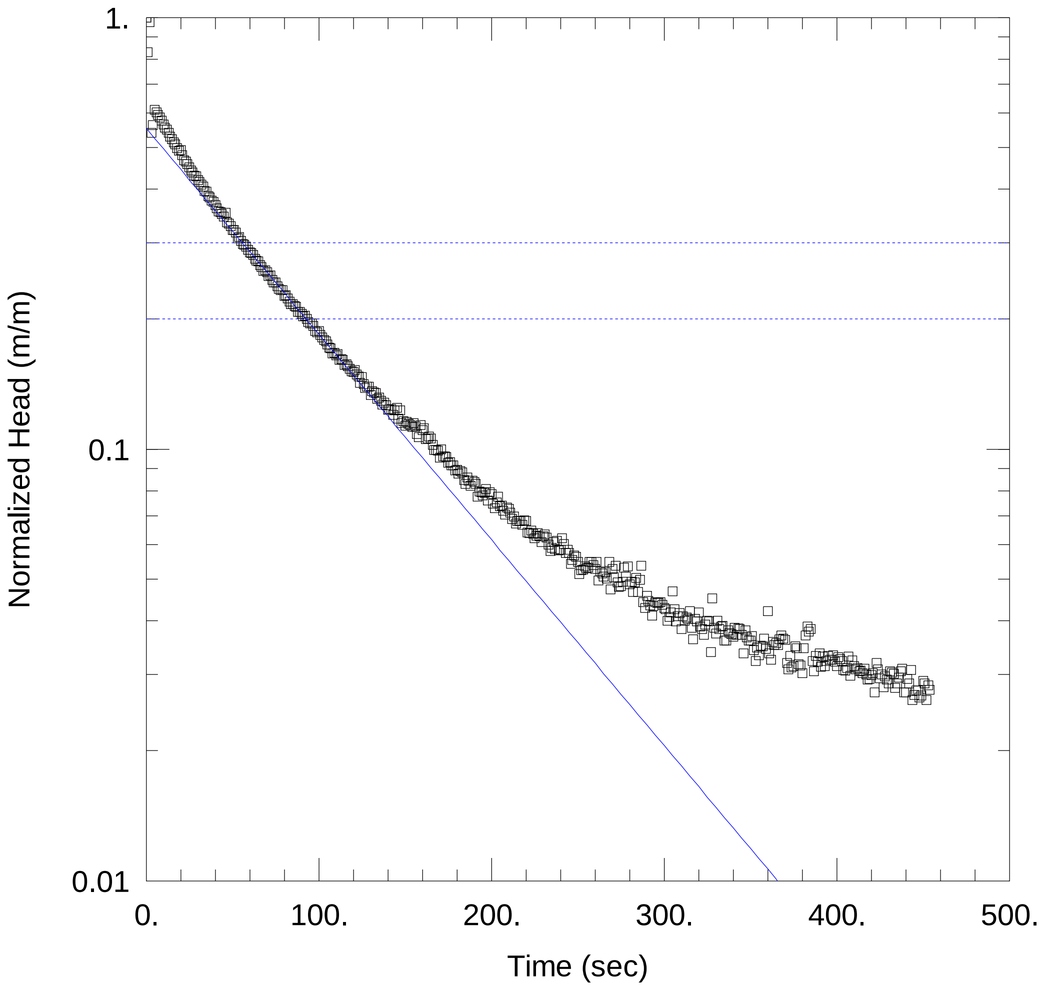
WELL DATA (C555P1)

Initial Displacement: 1.44 m
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 = 0.09538 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

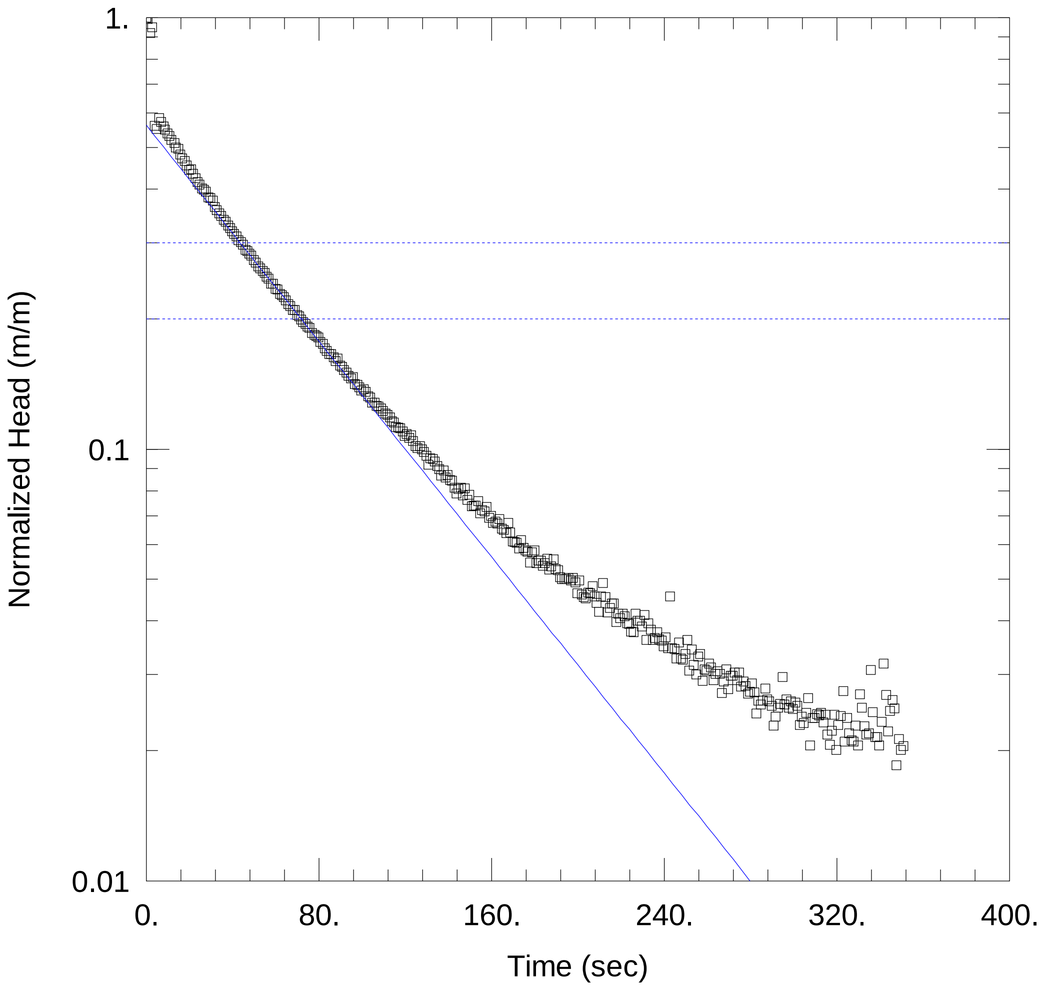
WELL DATA (C556P1)

Initial Displacement: 1.412 m
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 = 0.1788 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

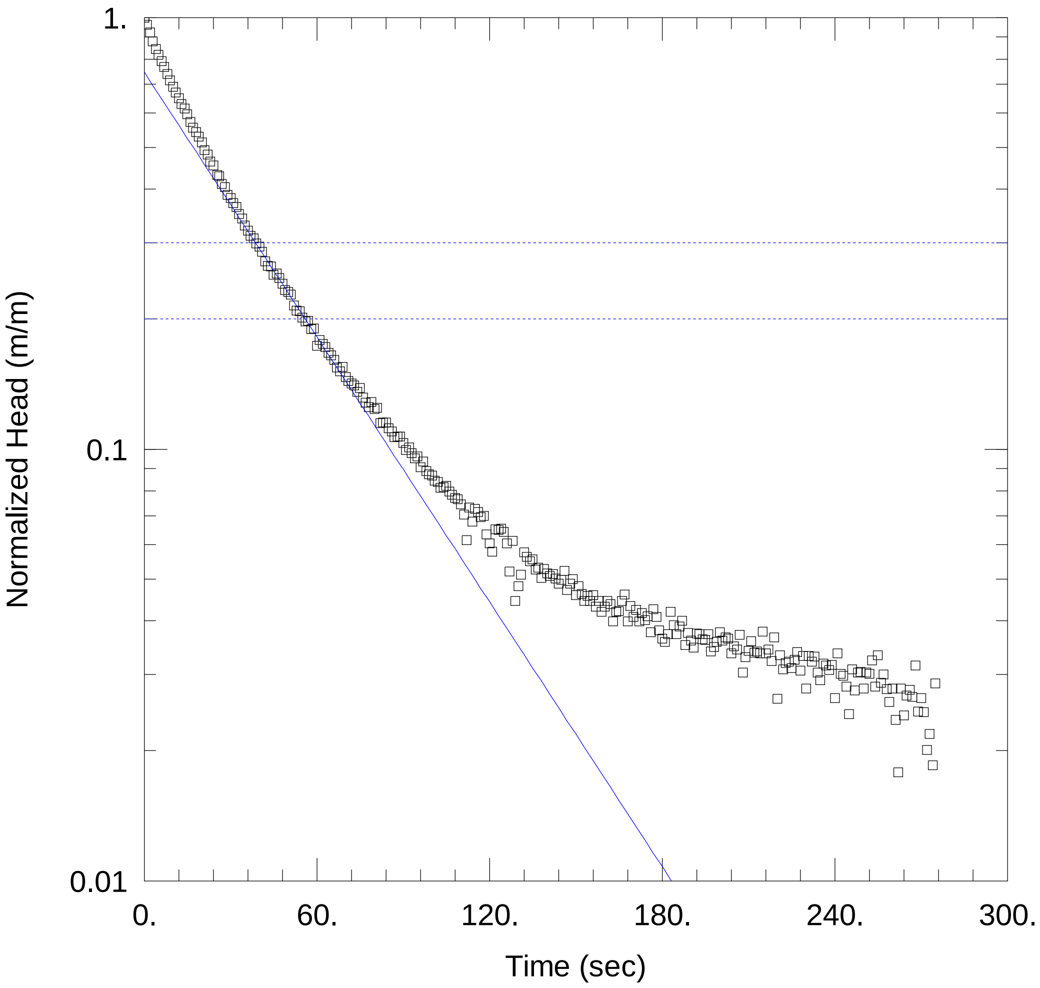
WELL DATA (C556P1)

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

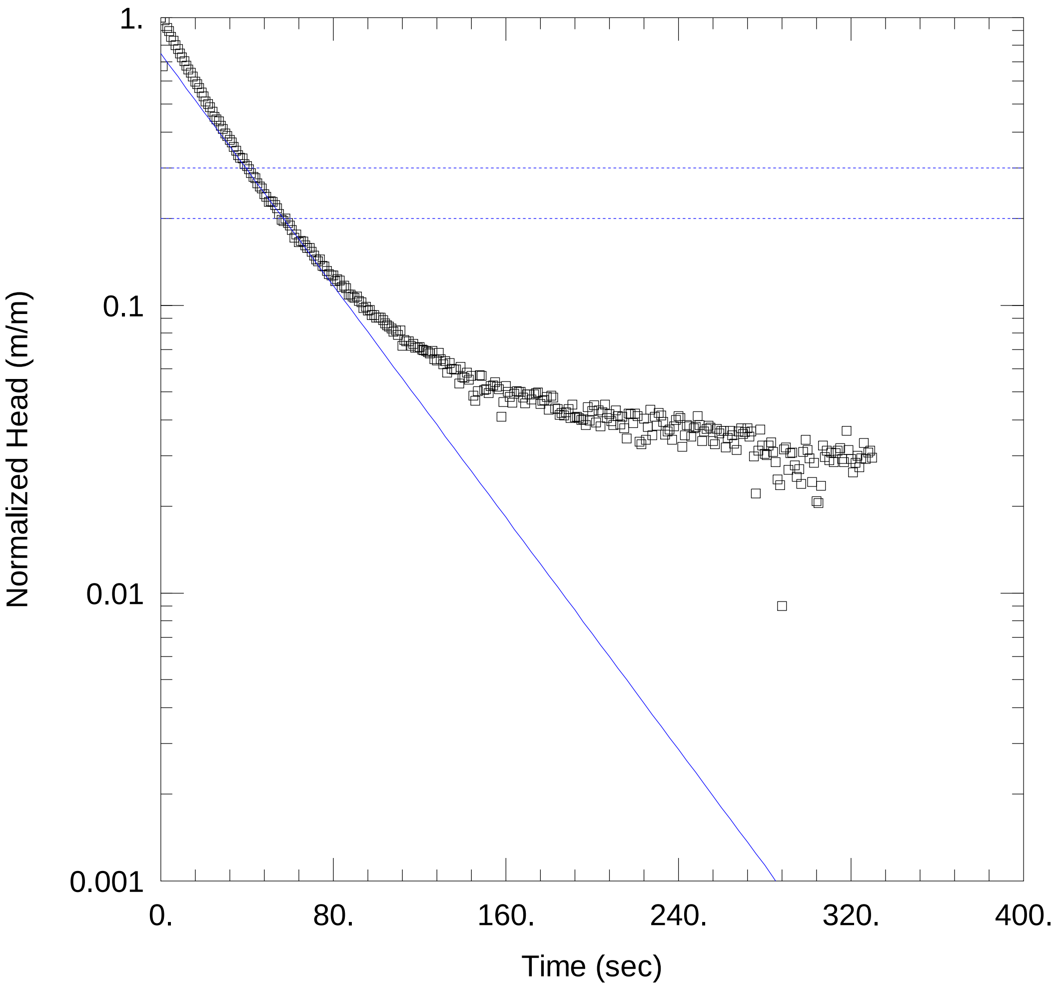
WELL DATA (C556P1)

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

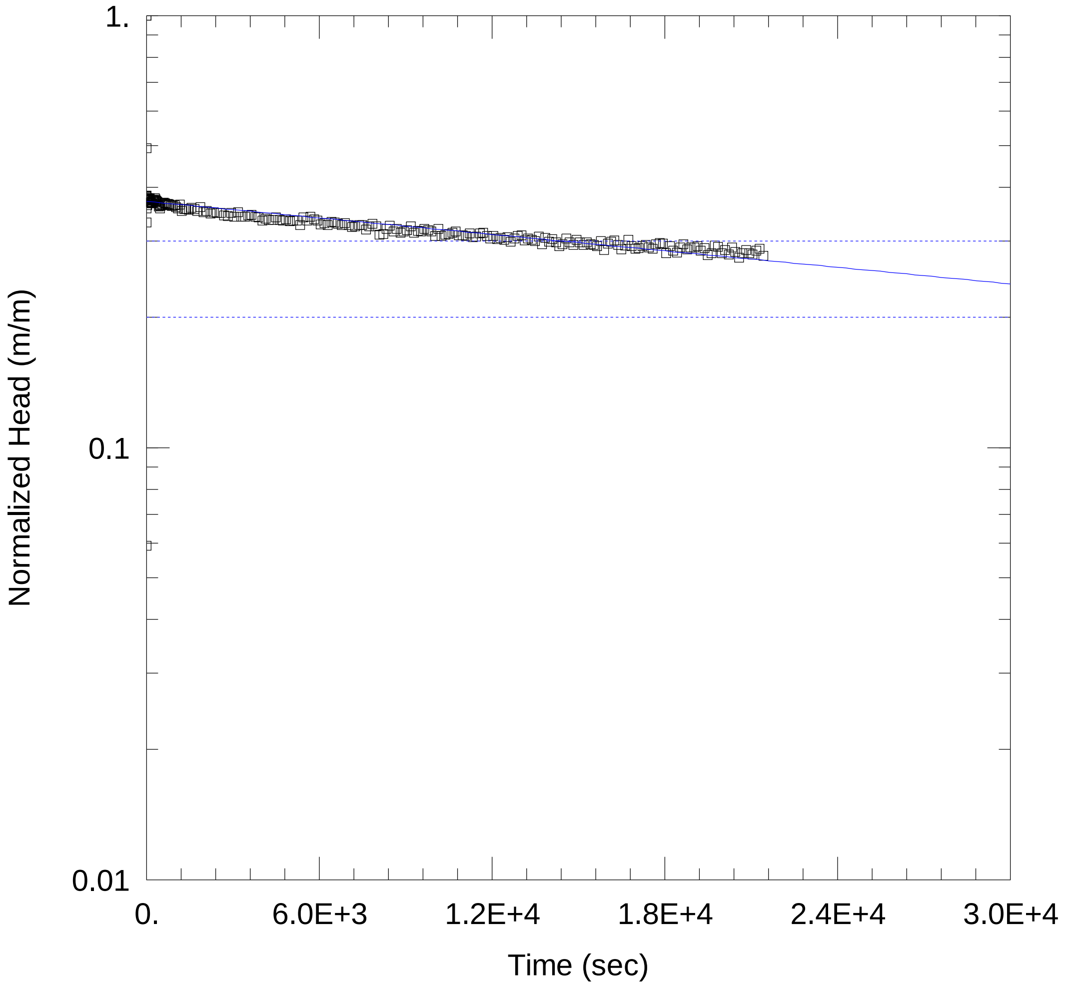
WELL DATA (C556P1)

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

Appendix F – Pumping test results

Table F1: Pumping Test Details

Table F2: Pumping Test Results Summary

Summary of Pumping Test Details (2012)

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

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 G – Revised geological interpretation memo

Xenith

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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.

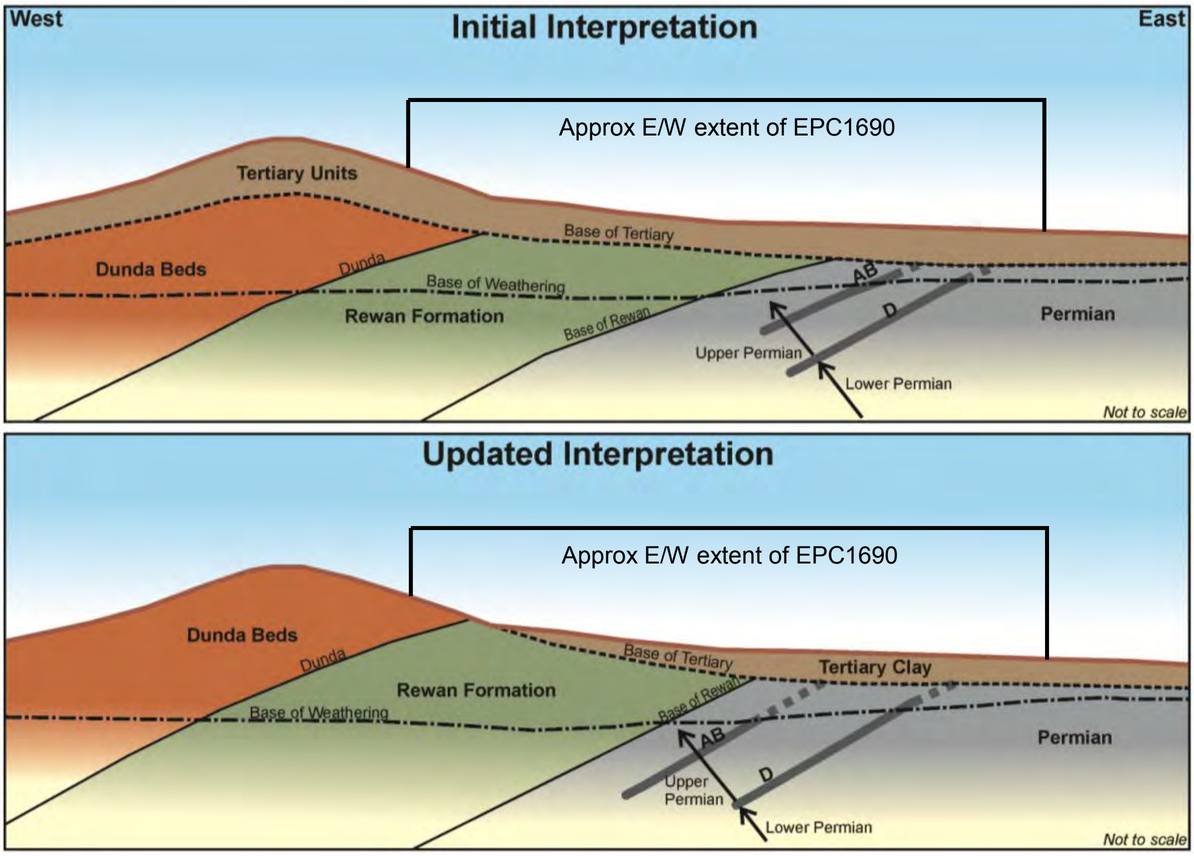
The increased number of drill holes and additional studies has lead to reinterpretation of the stratigraphy overlaying the Permian coal measures in the CCP area.

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'

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