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Carmichael Coal Project Groundwater Monitoring Program

Draft Groundwater Monitoring Program

3 March 2014

Adani Mining Pty Ltd

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ABBREVIATIONS

Abbreviation	Description
Adani	Adani Mining Pty Ltd
BTEX	Benzene, toluene, xylene, ethylbenzene
CCP	Carmichael Coal Project
DERM	Department of Environment and Resources Management (now EHP and NRM)
DO	Dissolved oxygen
EA	Environmental Authority
EC	Electrical conductivity
EIS	Environmental Impact Statement
EHP	Department of Environment and Heritage Protection
EMP	Environmental Management Plan
EPC	Permit for coal exploration
EPP (Water)	Environmental Protection (Water) Policy 2009
EVs	Environmental Values
GAB	Great Artesian Basin
GDEs	Groundwater Dependent Ecosystems
GMP	Groundwater Management Program
L/s	Litre per second
m/day or m/d	Metres per day
m^3/day	Metres cubed per day
mg/L	milligrams per litres
MIA	Mine infrastructure area
MLA	Mine Lease Application
mtpa	Million tonnes per annum
NRM	Department of Natural Resources and Mines
TDS	Total dissolved solids
TPH	Total petroleum hydrocarbons
UG	Underground mine
VWPs	Vibrating wire piezometers
WQGs	Water quality guidelines

1 INTRODUCTION

1.1 Overview

Adani Mining Pty Ltd (Adani) proposes to develop 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 (Figure 1-1).

The Carmichael Coal Project (CCP) mining component includes 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, 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 purpose of this document is to provide a framework and details of the existing baseline groundwater monitoring program. The program has been developed to characterise the baseline groundwater conditions and provide monitoring points to evaluate the potential effects on; local groundwater resources, local landholder bores, aquifers of the Great Artesian Basin, overlying alluvium, and surface water resources (Carmichael River baseflow, Doongmabulla Springs, and Mellaluka Springs) resulting from the proposed coal mining.

This groundwater monitoring program is intended for the long-term monitoring of these potential effects. A plan showing the CCP and tenements is provided in Figure 1-1.

1.2 Groundwater Management Framework

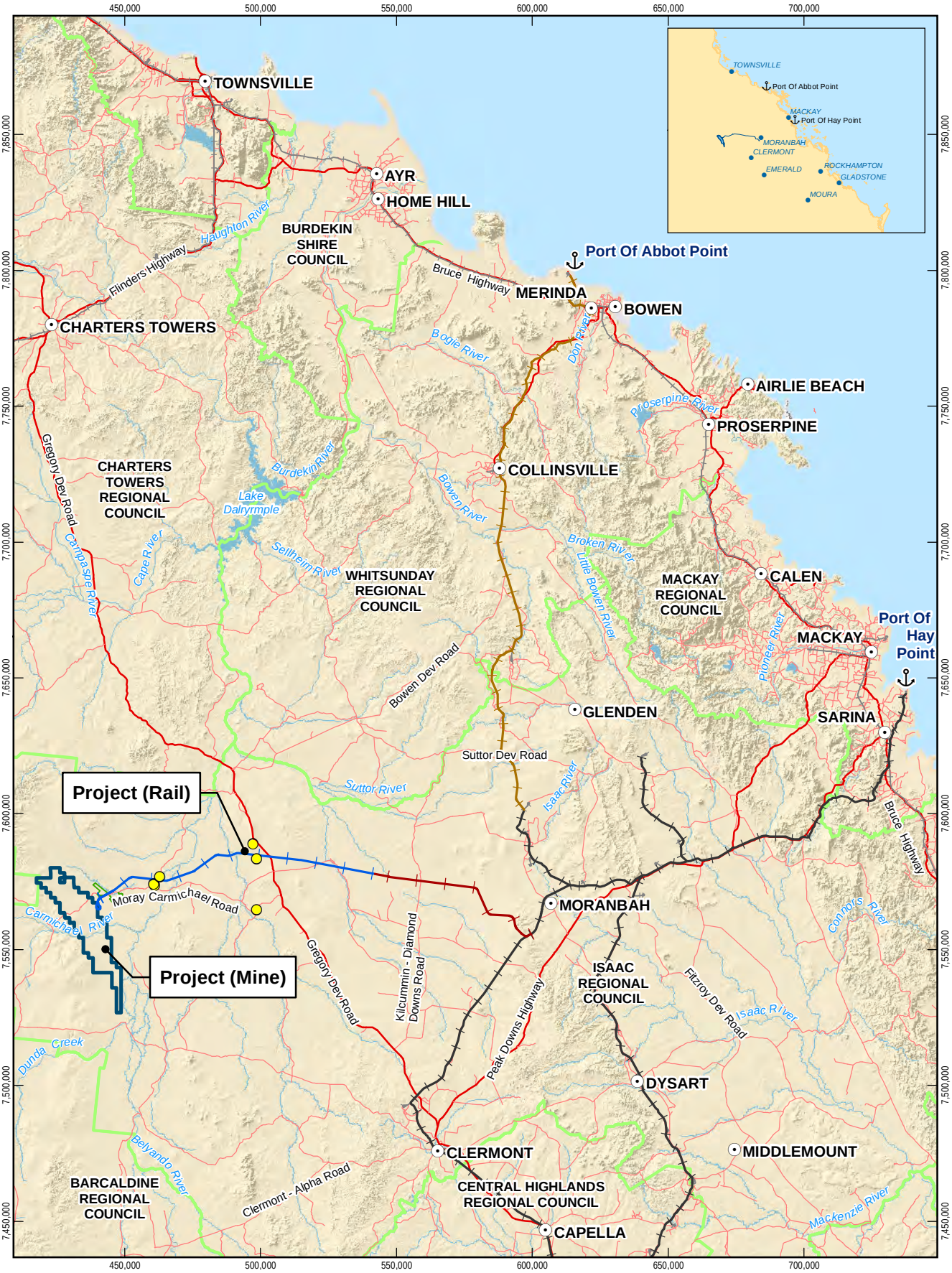
The groundwater monitoring framework is based on the principles of performance assessment and adaptive management. Adaptive management is a structured, iterative process of decision-making with a focus on reducing uncertainty over time via systems monitoring and continuous improvement to achieve the desired environmental and operational outcomes of the project.

The adaptive management process is shown schematically in Figure 1-2. Monitoring, evaluation and reporting are required to ensure operational and environmental outcomes are being met. If not, a feedback loop into management actions addresses the issues that are preventing the outcomes from being met. Adaptive management principles allow for adjustments in outcomes, indicators and limits, as well as associated monitoring and reporting approaches.

A number of elements associated with the framework are:

Outcomes: the environmental state to be achieved. Outcomes need to reflect project requirements, regulatory requirements and societal values and perceptions. Outcomes must be pragmatic, realistic and measurable (using relevant indicators).

Parameter: a measured variable or state of resource condition used to verify that established outcomes are being met.



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

1:2,000,000 (at A4)

0 10 20 30 40 50

Kilometres

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

N

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project SEIS

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

Project Location

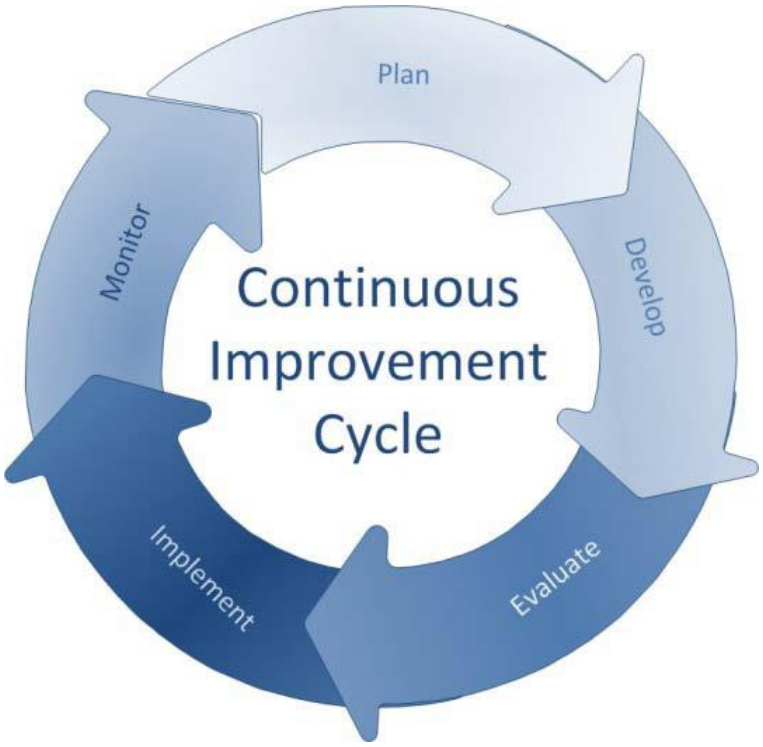
Figure 1

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

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

Figure 1-2 **Adaptive Management and Continuous Improvement Process**



Limit (or trigger): a desired condition or range for a given indicator to be maintained below, above or within. Limits must consider natural variability and background conditions for an aquifer with respect to both quality and quantity.

Threshold: a value not to be exceeded, such that resource health and associated resources may be maintained (that is, significantly exceeding the established natural variability at a given location or an agreed-upon published criterion).

Receptor: a natural discharge point (spring/watercourse) or user (landholder) of environment or health value which is interconnected to the groundwater system and is influenced by changes to aquifer physical and chemical characteristics

The development of targets and thresholds for the relevant indicators is discussed further in Section 4.

Using adaptive management, as new groundwater quality and quantity knowledge is generated, models can be updated and water management decisions adapted accordingly. This particular framework is therefore a living document and will be updated as required. More frequent during initial implementation, i.e. not more than 3 years and then less frequent at a later date, i.e. every five years.

1.3 Groundwater Monitoring Objectives

The desired outcomes for groundwater management associated with the CCP are to minimise potential impacts to surrounding landholders and environmental values. These outcomes need to be balanced with coal production requirements.

Effects from mine dewatering (drawdown) to provide safe dry working conditions are likely to manifest themselves on a more regional scale. Groundwater quality impacts may occur adjacent to mine water and waste storage facilities but due to drawdown are not predicted to migrate (within groundwater) off site. The monitoring system has been developed to effectively address the potential effects on identified groundwater environmental values (EVs). Understanding the potential pathways and effects on EVs assisted in developing the CCP groundwater management program (GMP).

The objectives of this CCP groundwater monitoring program are to:

- Establish an appropriate monitoring regime, both in space and time;
- Develop a high quality background dataset against which potential impacts can be assessed and gain a better understanding of natural groundwater (level and quality) variability in the region;
- Ensure CCP mining does not detrimentally impact on the availability and suitability of groundwater for domestic and agricultural use (stock watering);
- Identify potential impacts from the proposed mining activities with sufficient time to implement management (i.e. make-good agreements, etc.) and/or mitigation measures;
- Water and waste storage facilities to minimise the potential for impact on shallow groundwater aquifers during the life of the mine and after mining ceases;
- Ensure no impact on the major recharge mechanism;
- Recycle and reuse groundwater intersected during mining for mining activities and operations, so as to limit the need to import or diminish water resources outside of the mine area;
- Enable detection of long-term trends and potential cumulative effects from the CCP and other future coal mining operations;
- Generate data against which model predictions can be verified; and
- Obtain high quality (repeatable and representative) data to develop trigger levels and contaminant limits for each aquifer / groundwater unit that could be impacted using the adaptive management process.

1.4 Groundwater Monitoring Program Approach

The establishment and implementation of a groundwater monitoring program will, based on experience, need to evolve and respond to the various stages of the mining project, i.e. the groundwater monitoring program will be different depending on the different phases on mining including baseline, construction, operations, and closure.

In order to develop the optimum groundwater monitoring plan Adani proposes a phased approach, which will allow for the correct scientific development of the program and allow for variation over time to suit the site / mining phases.

This groundwater monitoring program includes for detailed procedures and processes required to determine and assess the baseline hydrogeological regimes and develop trigger levels, contaminant limits, and water level thresholds, which will be used to assess the mining activities potential impacts on groundwater resources.

The baseline stage of the GMP involves:

- A draft groundwater monitoring program (this document);
- Obtain approval from the administering authority on the GMP;
- Inclusion of this groundwater monitoring program in the mine's Environmental Approval Conditions;
- Compilation of representative groundwater quality samples from each aquifer or groundwater unit identified as potentially impacted (directly and indirectly) by mining activities;
- Compilation of baseline dataset, comprising at least 12 sampling events prior to coal excavation in order to obtain a statistically representative background groundwater quality dataset;
- Determine trigger levels and contaminant limits prior to commencement of coal mining activities;
- The identification of natural fluctuations and trends in groundwater levels and hydrochemistry; and
- Develop groundwater level threshold levels[1], in specific representative aquifers or groundwater units, which will act as "early warning" monitoring points, prior to predicted impacts of groundwater quantity that could lead to environmental harm and/or groundwater supply reduction in landholder bores.

The GMP includes recommendations and considerations for the remaining phases of mining, which will be implemented, through the revision and approval from the administering authority of the GMP over time.

1.5 Current Monitoring Program

Adani currently has a large existing groundwater monitoring network (Section 3), which allows for the compilation of baseline groundwater level and quality data from all identified aquifers and groundwater units within and down dip of the proposed mine. The current monitoring program allows for:

- Undertaking regular baseline monitoring which is aimed at determining limits for comparison to assess achieving objectives;
- Finalising the baseline phase of the GMP prior to any mining activities; and
- Providing details of investigation to be instigated should monitoring indicate values and levels in excess of the trigger levels and water level thresholds.

[1] The GMP currently includes proposed threshold values (early warning level drawdown values) based on the predictive groundwater modelling conducted during the CCP EIS and SEIS groundwater studies.

1.6 Monitoring Performance Indicators

The GMP allows for the assessment of the management and mitigation of potential impacts to groundwater resources as a result of mining activities. In order to assess the effectiveness of the management and mitigation measures to be employed by Adani during the life of mine (as compiled in the Carmichael Coal Project Environmental Management Plan) the performance criteria to be assessed based on the data compiled during the GMP include:

- There will be no migration of poor quality seepage into the surface water bodies;
- No alteration of the diffuse GAB recharge areas so as to ensure recharge during the life of the mine and after mining ceases;
- Landholders concerns over impacts on their water supplies are dealt with in a timely and prompt manner;
- Compile groundwater monitoring reports to validate environmental protection performance; and
- Final voids will remain at the end of mining to ensure the zone of influence, both in terms of groundwater level change and hydrochemistry, will be managed and maintained after mining ceases.

2 HYDROGEOLOGICAL REGIME

An understanding of the groundwater system(s) that could potentially be impacted by the proposed mining activities is essential for the development of an appropriate monitoring program.

Adani have developed a conceptual groundwater model based on the groundwater information compiled during the drilling and monitoring bore network construction and groundwater assessments conducted for the CCP Environmental Impact Statement (EIS). This conceptualisation was used to construct and calibrate a numerical groundwater model, which was used to predict groundwater impacts as a result of the proposed mining activities.

This impact assessment was the basis of developing the optimum groundwater monitoring program.

2.1 Geology / Hydrogeology

2.1.1 Geology

Regional Geology

The proposed CCP mine is located along the eastern limb of the Galilee Basin, which is a Late Carboniferous to Mid-Triassic extensional intracratonic terrestrial basin of predominantly fluvial sediment infill.

The stratigraphic units which are relevant to the proposed mine are the conformable interval between the coal-bearing Colinlea Sandstone-Bandanna Formation and the overlying Rewan Group with an unconformable and variable veneer of Tertiary sediments, which covers the deposit.

Colinlea Sandstone

This sequence comprises of dominantly quartz sandstone and conglomerate with minor shale and a number of low rank sub-bituminous and sub-hydrous coal seams. The Colinlea Sandstone sequence represents fluvial deposition with sandy braided channel and flood plain deposits associated with coal seam development. Three coal seams, namely seams D to F are laterally persistent and correlated regionally.

Bandanna Formation

The Bandanna Formation comprises of calcareous, lithic sandstone, siltstone and a number of low rank sub-bituminous and sub-hydrous coal seams. This sequence represents fluvial deposition with sandy braided channel and flood plain deposits associated with mire and coal seam development.

Three coal seams, namely seems A, B and C, are laterally present and correlated regionally.

Rewan Group

The Rewan Group comprises of monotonous sequence labile sandstone and multi-coloured argillaceous sediments, which are continuous across the Nebine Ridge and extensive throughout the Bowen and Surat basins.

Site Geology

Tertiary-age strata (i.e. sandstone, mudstone and conglomerate) are mapped at outcrop over much of EPC1690 and are typically in the range 45 to 100 m thick. Along the Carmichael River and over much of the Belyando River system to the east of EPC1690, these strata are indicated to be overlain by Quaternary-aged floodplain alluvium (i.e. sands, silts, gravels and clays).

Beneath much of EPC1690 an unconformity defines the boundary between the Tertiary-age strata and the underlying Late Permian-age coal bearing strata (a sequence of siltstone, mudstone, sandstone, shale and coal of the Bandanna Formation and Colinlea Sandstone).

The Late Permian-age strata dip at approximately 2-4 degrees to the west, steepening slightly in the southern half of the lease. Along the western margins of EPC1690, 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 and overlies the Late Permian-age strata.

A site specific stratigraphic column is included in Figure 2-1.

Figure 2-1 Stratigraphic column

Age	Stratigraphic unit		Lithology	Thickness	Comment
Quaternary			Alluvium	2 – 12 m	Unconfined aquifer along rivers
Tertiary			Argillaceous saprolite and clay	20 – 50 m	Unconfined aquifer, altered Permian units during the Tertiary period
Triassic	Clematis Sandstone		Quartz sandstone, minor siltstone and mudstone	Not on site	Unconfined at outcrop and confined to the west of the site, major GAB aquifer
	Rewan Group	Dunda Beds	Sandstone, siltstone, mudstone	Up to 100 m on CCP	Confining unit, basal unit of the GAB, Rewan Formation grades into Dunda beds
		Rewan Formation	Grey-green mudstone, siltstone, and sandstone	Up to 250 m on CCP	
Late Permian	Bandanna Formation		Sandstone		Permian 90 to 180 m to base of target coals
			Coal - AB Seam	12 – 18 m	Resource target
			Sandstone / siltstone	10 m	Aquitard
			Coal – B splits	1 – 2 m	Coal
			Siltstone / mudstone	60 – 70 m	Aquitard
			Coal – C Seam	3 – 4 m	Carbonaceous
	Colinlea Sandstone		Siltstone / sandstone	2 – 20 m	
			Coal – D1 Seam	4 – 6 m	Resource target
			Sandstone	5 – 30 m	
			Coal – D2/D3 Seam	8 – 10 m	Resource seam
			Siltstone / mudstone	10 – 20 m	
			Coal – E Seam	1 – 3 m	Resource seam
			Sandstone / siltstone	5 – 10 m	
			Coal – F Seam	1 – 5 m	Resource seam
Early Permian	Drummond Group		Bedrock		Low permeability unit

2.1.2 Hydrogeology

Based on the current understanding of the geology for the mine site the following hydrogeological units are considered of relevance to CCP:

- Quaternary unconsolidated alluvial deposits associated with the Carmichael River and other local water courses;
- Tertiary-age clay and saprolite (Altered Permian units during the Tertiary period);
- Triassic-age units which form part of the GAB including the Clematis Sandstone, the Dunda Beds and the Rewan Formation (not mapped at outcrop); and

- Permian-age siltstone, mudstone, sandstone and coal seams of the Bandanna Formation and the Colinlea Sandstone which form the target of the proposed mining operations (not mapped at outcrop).

Alluvial Deposits

Unconsolidated alluvium typically forms the uppermost hydrogeological unit within and in the vicinity of the mine. Along the Carmichael River these strata include sand, gravel 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.

The permeability of these units will be governed primarily by the proportion of sand and gravel and the connectivity of the various materials, which vary both laterally and vertically. Bore yields appear to be in the region of 1 to 3 L/s, based on available records.

Tertiary Sediments

Layered clay, sandstone and siltstone of Tertiary-age are mapped at outcrop and underlie the younger unconsolidated deposits over much of the CCP tenures. 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 sandstone and siltstone which are often highly weathered (saprolite) and include significant clay-dominated material. This saprolite is considered to be Permian age strata weathered during the Tertiary period.

Falling head test results in Tertiary deposits suggest hydraulic conductivity values as low as 2.1×10^{-4} m/d for the Tertiary-age clay strata. The Tertiary-age strata are not considered to represent a locally important groundwater resource.

Triassic Great Artesian Basin (GAB) units

Triassic-age GAB units comprise the Rewan Formation, Dunda Beds, and Clematis Sandstone , which lie within and to the west of CCP.

The Rewan Group (comprising the Rewan Formation and Dunda Beds) is recognised as the regional basal confining bed of the GAB (GABCC, 1998). Within the CCP the Rewan Formation is indicated to be dominated by clays and mudstone with some interbeds of sandier lithology and is considered to be an aquitard. It separates the Permian target coal seams from the stratigraphically younger Dunda Beds (predominantly sandstone) and Clematis Sandstone (a GAB aquifer) to the west.

In the vicinity of the mine the permeability of these Dunda Beds sandstone units 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.

Permian Coal Measures

The target coal seams lie 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 CCP tenure. Hence, the coal seams subcrop directly beneath the Quaternary and Tertiary units to the east of the CCP tenure. Conversely, the Triassic-age sandstone and mudstone of

the Rewan Group overlie the coal seams to the west. Both the Triassic and Permian-age strata typically dip with a shallow gradient (2 to 4 degrees) towards the west across the mine lease and are unconformably overlain by Tertiary and Quaternary-age strata.

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

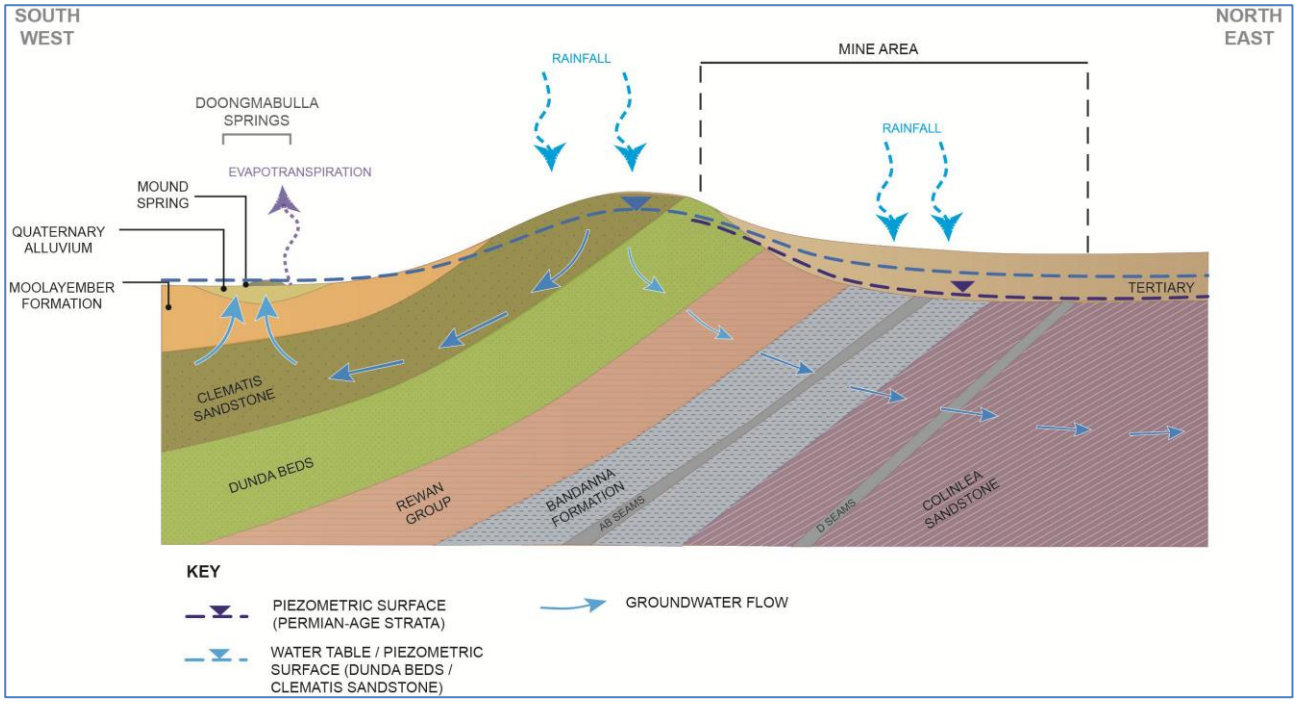
Yield estimates from short periods of airlifting (1 to 2 hours in length) conducted across CCP from groundwater monitoring bores installed in the coal seams ranged from <0.1 to 1.0 L/s (with a mean of 0.2 L/s and median of 0.12 L/s) and suggests that in general, relatively low yields.

The available data suggests that the Bandanna Formation and/or the Colinlea Sandstone do not represent a locally important water resource.

Hydrogeological conceptualisation

A review of available information allowed for the conceptualisation of the geological units and the groundwater resources. Figure 2-2 presents a cross-sketch through CCP.

Figure 2-2 **Hydrogeological Conceptualisation**



The proposed mining location indicates that mining will directly impact (due to open cut mining, longwall goaf, and dewatering) on the groundwater resources associated with the units within the mine footprint, namely:

- The Colinlea Sandstone;
- The Bandanna Formation;
- The Rewan Formation; and
- The Dunda Beds.

Mine dewatering and associated coal seam depressurisation, required to mine safely (dry conditions), can potentially have indirect impacts, due to induced flow, on the overlying Clematis Sandstone unit. This is dependent on the alteration of the vertical hydraulic conductivity in the Triassic Rewan Group units.

2.1.3 Environmental Values

Environmental Protection (Water) Policy 2009

The Environmental Protection (Water) Policy 2009 (EPP (Water)) applies to all waters including tidal, non-tidal, lakes, wetlands and groundwater. This purpose is achieved within a framework that includes identifying environmental values (EVs) such as aquatic ecosystems, water for drinking, water supply, water for agriculture, industry and recreational use for Queensland waters and stating corresponding water quality guidelines (WQGs) and water quality objectives (WQOs) to enhance or protect the environmental values.

The EVs considered applicable to the CCP mining to be particularly enhanced or protected under the EPP (Water) are the following:

- Biological integrity of an aquatic ecosystem;
- Suitability for agricultural use; and
- The cultural and spiritual values of the water.

In particular, the environmental values include:

- The Great Artesian Basin (GAB) spring system close to Doongmabulla around eight kilometres west of the lease area;
- Two non (GAB) springs which are mapped to the north of Mellaluka around 10 km south of the Study Area;
- Groundwater dependent ecology along Carmichael River;
- Existing extraction bores and registered bores within the study area; and
- Recharge zones of the Clematis Sandstone (a major aquifer within the GAB).

2.2 Mining Activities

The CCP mine comprises a greenfield coal mine over exploration permit for coal (EPC) 1690 and the eastern portion of EPC 1080, which includes both open cut and underground mining. The mine proposes six open cut pits and five multi-seam underground mines producing up to

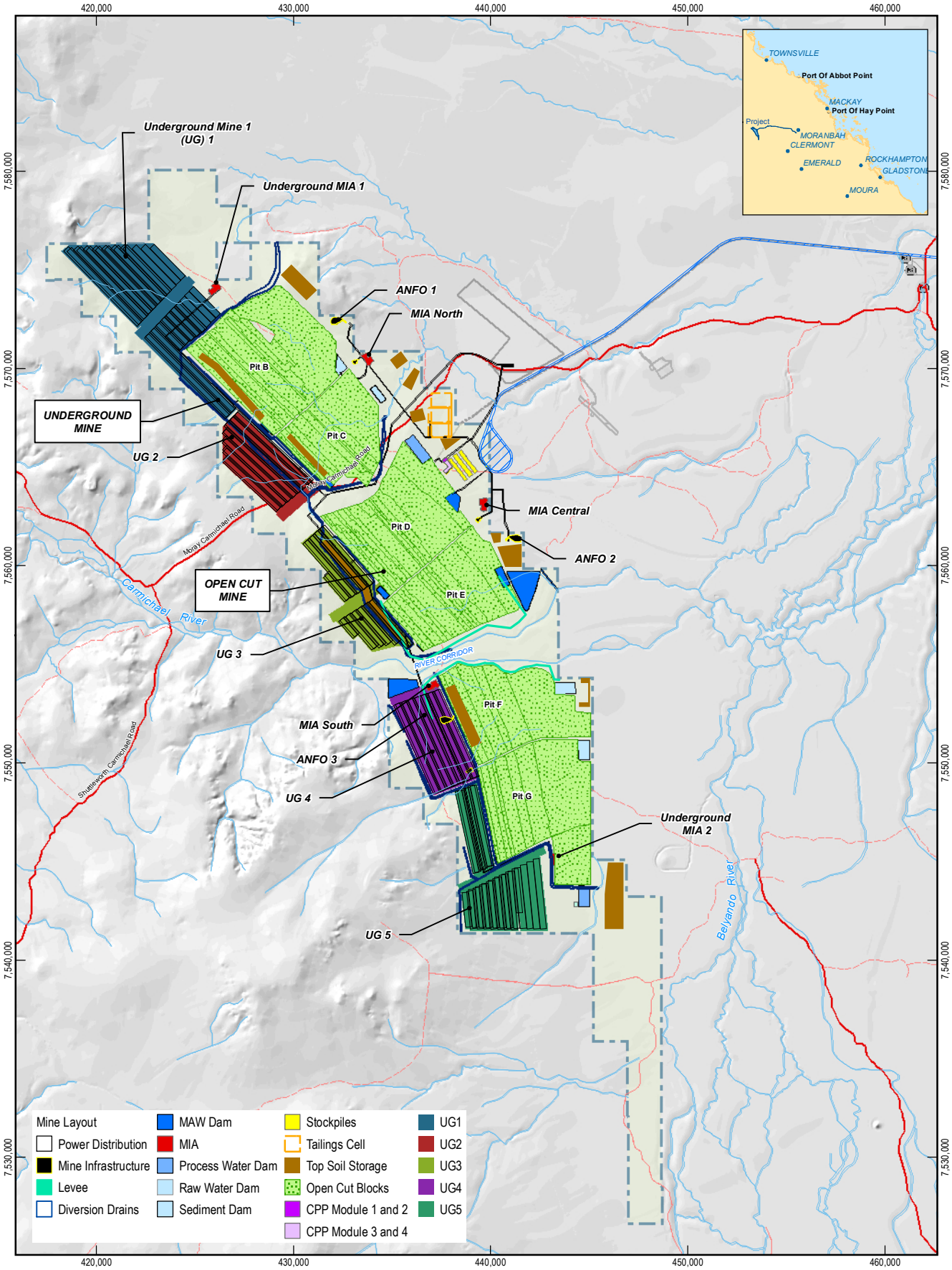
74 million tonnes per annum (Mtpa) of raw coal, equating to ~ 60 Mtpa of thermal coal over a 60 year mine life.

The mine footprint is over 200 km^2 and includes mine infrastructure and associated mine processing facilities, and the offsite infrastructure including a workers accommodation village and associated facilities, a permanent airport site, an industrial area and water supply infrastructure. The proposed mine layout is presented in Figure 2-3.

The geological characteristics of the CCP mine define the location of open cut and underground mining operations. This in turn determines the optimal location of mine infrastructure and associated interdependencies including site access, services and other infrastructure required to access offsite infrastructure and third party service providers. The layout of the infrastructure has subsequently been designed and located to minimise the likelihood of resource sterilisation. In particular, the main infrastructure area is located outside the sub-crop line of the identified economic seams. The out-of pit dumps are located to minimise handling of material and also to avoid the sterilisation of coal resources.

The proposed mining and associated mine infrastructure was reviewed to allow for the identification of mining infrastructure that can potentially impact on groundwater, these include:

- Mine service areas;
- Fuel supply and storage;
- Water supply and management;
- Mine water management; and
- Waste disposal facilities.



LEGEND

Minor Road
Track
Watercourse
Rail Corridor
Mine Site
Mine (Offsite)
Pump Station
Storage Facility
Accomodation Village
Airport
Industrial Area

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 28-10-2013

Mine Layout and Infrastructure

Figure 2-1

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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: GA: Road, River / Watercourse (2007); DME:EPC1690 (2010), EPC1080 (2011); Adani: Mine Layout / Infrastructure (2013), Mine (Offsite) (2013). Created by: MS

2.3 Potential Impacts

A summary of potential impacts of mining activities on the groundwater resources has been compiled based on the data compiled during the EIS and post EIS groundwater studies.

2.3.1 Construction

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; and
- Degradation of groundwater quality due to spills and leaks of hazardous materials such as oil and diesel or poor management of wastewater.

Dewatering

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). 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.

Spills

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.

2.3.2 Operations

The principal activities during the operational phase of the mine, which may impact groundwater resources, are considered to be:

- Dewatering of open cut pits and 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; and
- Longwall mining of the underground workings.

Mine Dewatering

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 are predicted to be drawn down by more than one metre up to around 10 km from the mine site during the operational phase.

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.

GAB Impacts

No direct impacts on groundwater resources in the Great Artesian Basin groundwater units are 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.

Spring Impacts

The source aquifer for the GAB Doongmabulla spring complex is thought to be the Clematis Sandstone and/or the underlying Dunda Beds. Recharge to the Clematis Sandstone / Dunda Beds discharges through the overlying Moolayember Formation and Quaternary Alluvium, which form a confining layer in the area of the springs, leading to artesian head pressures. Predicted impacts on groundwater levels within the Clematis Sandstone extend westward from the mine site in the direction of the dipping strata and tend to be relatively minor. Model predictions suggest maximum drawdowns generally between 0.2 and 1 meter for the Clematis Sandstone. Predictive modelling projects a maximum drawdown of up to 180 mm at the Doongmabulla springs.

The most likely source aquifer for the Mellaluka spring complex is thought to be the underlying Permian-age units of the Colinlea Sandstone. Predictive modelling 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.

River Impacts

Mine dewatering is predicted to result in a cone of influence extending beneath the Carmichael River. 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/day or 5 per cent of pre-development discharge during the operational phase.

Riparian Impacts

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 have the potential to impact the ecological health of these communities.

Tailings

Mine waste will be managed through a combination of in pit disposal (overburden, interburden, coarse reject, tailings and slimes) and out of pit disposal (overburden, interburden and coarse reject). These can potentially impact on shallow groundwater resources.

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.

Creek 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.

Goaf

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 fracturing can alter the aquifer hydraulic parameters in the units above the goaf.

2.3.3 Post Closure

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.

Final voids can gradually fill with water once dewatering operations have ceased, potential evaporation losses from the voids are considered to 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 mine area, with the potential to permanently reduce groundwater levels to the base of proposed final voids.

Continued Drawdown

There is the potential for marked reductions in groundwater levels at selected registered groundwater bores if the voids are only partially backfilled. Potentially significant post closure impacts of between 1 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 CCP area.

GAB Indirect Impacts

There is the potential for groundwater levels to remain lower than pre-development levels after cessation of mining activities providing potential for induced flow from the GAB.

Impacts on Local Springs

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

With regards to the Mellaluka springs complex, the predicted reduction in pressure at the two northern springs, Lignum and Stories, will be between 8.2 – 25.6 m post closure, whereas the Mellaluka Spring is predicted to have between 1.6 – 9.07 m post closure.

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/day (or 31 per cent of the long term average pre-development baseflow) post closure.

Storage Facilities

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 mine lease.

3 GROUNDWATER MONITORING NETWORK

The objective of the groundwater monitoring network is to monitor potential effects of the proposed mining on overlying and underlying aquifers, as recognised in Section 2, such that informed management decisions can be made.

The current groundwater monitoring network provides lateral and vertical coverage of the potentially impacted groundwater resources, taking into account the hydrogeological regimes and groundwater users.

The network provides an early warning of potential impacts, so that early intervention can be implemented to ensure water security to landholders and reduce potential environmental harm. Should monitoring indicate an undesirable trend, the requirement for additional monitoring bores, both in other aquifers and laterally away from the CCP tenure will be assessed, and actioned if deemed necessary.

3.1 Existing Baseline Monitoring Bores

Locations of groundwater monitoring were based on:

- Exploration bores allowing access to all potentially impacted units within the CCP area;
- GAB units outside of the CCP tenure;
- Predicted groundwater impacts;
- Identified environmentally sensitive areas (Spring complexes and Carmichael River corridor); and
- Existing landholder bores (groundwater extraction).

A summary of the current groundwater monitoring network is presented per monitoring unit, in Table 3-1. Appendix A provides locality figures showing all the bore locations.

Table 3-1 Existing bore network

Bore ID	Easting	Northing	Depth
QUATERNARY ALLUVIAL DEPOSITS			
C027P1	433646	7554820	12.72
C029P1	437693	7555082	13.54
HD03B	427559	7556120	11.75
C971SP	426590.06	7572994.56	20.00
C973SP	426707.25	7573188.29	37.00
TERTIARY AGE SEDIMENTS			
C025P1	438016	7555845	11.60
C025P2	438012	7555844	36.80
C029P2	437691	7555082	41.62
C558P1	430311.546	7566903.059	42.07
C012P2	430887.426	7569876.797	59.06
TRIASSIC AGE UNITS (GAB Units)			
Clematis Sandstone			
HD02	423821	7557008	32.75
Dunda Beds			
C022P1	426816	7565958	67.51
C027P2	433645	7554819	32.30
C9553P1R	430752	7563929	66.3
HD01	426146.035	7561467.856	Redrilling required
HD03A	427559	7556120	37.7
C9845SPR	439411.8	7544904	45.0
C180116SP	439394.4	7540911	50.0
C180117SP	435917.4	7547523	81.0
C180118SP	423798.6	7568089	126.0
Rewan Group			
C842VWP_V03	437566.6	7552869	130.0
C035P1	441398	7546824	62.3
C555P1	432450	7557893	75.7
C556P1	436537	7549880	81.2
C966VWP_VWP4	423982.8	7571921.1	240.0
C9845SPR	439411.8	7544904	45.0
C842VWP_V03	439501.8	7550838.6	130.0
C555 P_V3	432449.639	7557880.783	75.0
C9556P_V3	436544	7549883	216.0
C056_V3	424920	7569970	81.0
C9845SPR	439411.8	7544904	45.0

Bore ID	Easting	Northing	Depth
PERMIAN AGE UNITS			
Overburden			
C966VWP_P3	423982.89	7571921	260
C968VWP_P4	424873.59	7570989	258
C836VWP_V03	437566.6	7552869	130
C008P1	433710.221	7558830	56.044
C012P1	430887.597	7569874	41.399
C018P1	423981.852	7574850	51.68
C9838SPR	439558.4	7552813	89
C851VWP_V03	441383.4	7542878	103.7
C553P_V3	420992.731	7573965	265.43
C 974 SP	426765.59	7572908	60
C 975 SP	426834.24	7573002	60
C972SP	426601.1	7573122	63
C966VWP_P3	423982.89	7571921	260
Interburden			
C 966 VWP_P1	423982.89	7571921	278
C006P1	435726.146	7560833	43.053
C011P1	428842.528	7569953	55.645
C034P1	442385.586	7547816	67.698
C558P_V2	430311.546	7566903	120.1
C840SP	439545.6	7552839	211
C836VWP_V01	437566.6	7552869	296
C842VWP_V01	439501.8	7550839	235
C851VWP_V01	441383.4	7542878	209.7
C829SP	436462.8	7559356	147
C832SP	439570.4	7554788	99.2
C9839SPR	439567	7552797	167.8
C844SP	441391.8	7546840	179
C847SP	442384.6	7543809	86
C834SP	439576.8	7554764	150
Below D Seam			
C834SP	439576.8	7554764	150
C968VWP_P1	424873.59	7570989	355
C825SP	434868	7561960	131.5
C827SP	436101.2	7560334	137
C180112SP	437715.2	7558820	94.5
C9849SPR	442356.8	7543819	166.98

Bore ID	Easting	Northing	Depth
Coal Seams			
AB Seam			
C007P2	434726.3	7559864	176.69
C008P2	433707.8	7558827	271.38
C014P2	430730.9	7563976	205.14
C016P2	422017.4	7574974	227.67
C018P2	423988.1	7574849	89.749
C020P2	427845.6	7566932	262.72
C032P2	439404.4	7544896	260.1
C035P2	441401.7	7546828	110.33
C836VWP_V02	437566.6	7552869	237
C842VWP_V02	439501.8	7550839	177.5
AB1/AB3 Seam			
C056C_V2	424920	7569970	312
C553P_V2	420992.7	7573965	348.43
C555P_V2	432449.6	7557881	260.5
C558P_V3	430311.5	7566903	73.1
C9556P_V2	436544	7549883	316
C966 VWP_P2	423982.9	7571921	268
C968 VWP_P5	424873.6	7570989	244
C851VWP_V02	441383.4	7542878	145.7
C Seam			
C823SP	433605.2	7562875	109
C968VWP _P3	424873.6	7570989	302.5
D/D1/D2 Seam			
C555P_V1	432449.6	7557881	346
C006P3r	435733.6	7560826	118.24
C007P3	434728	7559862	259.85
C011P3	428845.6	7569955	105.4
C018P3	423977.5	7574853	146.73
C024P3	428909.1	7571761	49.283
C034P3	442388.7	7547814	108.75
C180114SP	438686.6	7557649	69.7
C833SP	439559	7554779	133
C848SP	442364.2	7543815	140
C056C_V1	424920	7569970	408
C553P_V1	420992.7	7573965	467.43
C558P_V1	430311.5	7566903	178.1
C968VWP_P2	424873.6	7570989	348.5
C9556P_V1	436544	7549883	410.5

Available Groundwater Monitoring Data

The baseline groundwater monitoring network, as described herein, focuses on obtaining representative monitoring data from all potentially affected aquifers and groundwater units within and adjacent to the CCP project area.

As there are currently no coal mining activities on or adjacent to the CCP baseline monitoring locations are located within the CCP tenements, taking advantage of bores drilled during the exploration drilling. Bores have been constructed outside of the mine lease application area (MLA) adjacent to springs.

The early implementation of the groundwater monitoring program allows for better characterisation of natural variability (temporal and spatial) in the groundwater system, prior to potential effects of the coal mining overprint the natural variation.

Early implementation of the monitoring program some years in advance of mining is considered to be the most practical approach to understanding the range of natural variability in the hydrogeological environment.

The transient water level and chemistry data compiled to date is included in the following appendices:

- **Appendix B** - Water level information
- **Appendix C** - Groundwater quality

3.2 Augmentation

The existing baseline groundwater monitoring network will be augmented over time and to ensure the following:

- Determine groundwater level responses and compare water level decline to selected thresholds (Section 5) so as to identify groundwater resources which may be unduly affected by mine dewatering, where unduly affected is where drawdown is projected to be greater than 5 m in the consolidated aquifers and 2 m in the unconsolidated aquifers (the trigger thresholds set in the amendments to the *Water Act 2000*);
- The extent and magnitude of drawdown in each aquifer is adequately monitored for comparison to modelled projections over time, which takes into account the envisaged alteration of the geological units above the coal seam units in response to longwall mining, particularly the intervening aquitards (Rewan Group) which control projected drawdown (induced flow) from the Clematis Sandstone; and
- Any potential impacts on surface water – groundwater interaction.

The groundwater monitoring network will act as an early warning system for potential drawdown impacts which could impact current groundwater use or have potential environmental harm. It is considered that the groundwater monitoring network will be modified as; mining extends to the west, existing monitoring points are lost during mining, and as mine activities change (i.e. operations or closure).

New monitoring bores will be constructed in optimum locations away from mine activities and local landholder groundwater extraction. It is recommended that current landholder production

bores are not monitored as this extraction, as recognised in the Labona Homestead area, can impact on groundwater levels. New monitoring points between the mine and the existing extraction will provide the assessment of the groundwater resource away from pumping effects.

3.2.1 New Monitoring Bores

The overarching design requirements for the construction of the new monitoring bores are:

- The ability to continuous monitor groundwater levels/pressures; and,
- The ability to collect a groundwater quality sample.

3.2.2 Bore design and Drilling

Bores will be drilled using a water bore drilling rig, using mud-rotary or air-percussion techniques.

Groundwater monitoring bores have been designed in accordance with the Minimum Construction Requirements for Water Bores in Australia, 3rd Edition (NWC, 2012) and the Minimum Standards for the Construction and Reconditioning of Water Bores that Intersect the Sediments of Artesian Basins in Queensland (NRM, 2013a). Particular consideration has been given to casing and annular seal requirements to ensure that no pathway is provided for the movement of water between aquifers.

To date the groundwater monitoring bores have been constructed using a combination of Rotary Wash Bore and Percussion Air-hammer drilling techniques were used to drill the standpipe monitoring bores and the vibrating wire piezometers (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.

3.2.2.1 Artesian Bores

It is noted that artesian bores have been constructed on neighbouring properties, within the GAB units and near the Mellaluka Springs complex. In areas where there are potential artesian conditions the bore design, drilling, and construction will be conducted according to the requirements for artesian bores, including the requirement to use a Class 3 driller, as detailed in the following guidelines:

- Minimum standards for the construction and reconditioning of the water bores that intersect the sediments of artesian basins in Queensland (NRM, 2013a);
- Minimum Construction Requirements for Water Bores in Australia, 3rd Edition (NRM, 2012); and
- Water bore driller's licensing handbook (NRM, 2013b).

3.2.3 Bore Nomenclature

New monitoring bores will be named using Adani bore naming convention, which reflects location and bore type.

3.3 Landholder Bores

Adani have, in their EIS, committed to enter into “make good” agreements with surrounding landholders prior to the commencement of mining.

The ability to assess the validity of make good claims made by landholders against Adani is reliant on knowledge of particular bore and local groundwater conditions before coal mining commences. Therefore, regardless of the legislative requirement it is considered prudent to undertake an inventory of the existing landholder bores.

During the compilation of the EIS several landholder bores, located adjacent to the CCP tenements, have been identified and a summary of the data compiled is included in Table 3-2. Note that the table below is not final. Adani will continue to liaise with surrounding landholders to ensure that all landholder bores with potential to be impacted by the mine are accounted for and included in the GMP.

Table 3-2 Landholder bore summary

Bore ID	RN	Easting	Northing	Owner	Comment
Mellaluka homestead bore		446688	7532130	Bruce Cobb	Installed pump
3 mile bore		441717	7532436	Bruce Cobb	Installed pump/artesian
Storie's bore		446258	7534429	Bruce Cobb	Artesian
Ironbark bore		441487	7528898	Bruce Cobb	Installed pump/artesian
Middle bore		443924	7534892	Bruce Cobb	Installed pump/artesian
Blue's bore #1		446121	7549416	David Luke	Artesian
Blue's bore #2		444270	7542867	David Luke	Artesian
Cockatoo Bore	44488	434139	7529822		
Soak Bore	62625	436052	7531743		Dunda Beds sandstone 85 m
Poison bore	62781	439933	7530187		
Gidgea Bore	103483	446741	7527650		
Laglan bore	6404	442438	7524648		
Laglan Bore	57660	447527	7524685		
Laglan bore	84671	449836	7525877		
Desert Bore Lignum	44486	434238	7541828		92 m
Desert Bore Mellaluka		442859	7538545		
Dexter Bore		445659	7540045		

Adani has combined the make-good agreement groundwater monitoring into this GMP. The methodology to be followed, based on the Coal Seam Gas industry guidelines, details are included in Section 5.

3.4 Doongmabulla and Mellaluka Springs and Carmichael River Baseflow

A number of monitoring points have been identified across and adjacent to the CCP lease to ensure the baseline data for the identified sensitive groundwater dependent ecosystems are compiled. Table 3-3 provides a summary of these current baseline monitoring points.

Table 3-3 Summary of current GDE monitoring points

Bore ID	Date Sampled	Monitoring Unit	Overall Unit	Area
1-MSHB	1/04/2013			Mellaluka homestead bore
3-MSHD	1/04/2013			Mellaluka homestead dam
4-MSHP	1/04/2013			Mellaluka homestead pool
6-LS	1/04/2013			Lignum Spring
C025P2	29/09/2011	Tertiary Overburden	Tertiary	River Bank
	7/11/2011			
	25/05/2013			
C027P1	29/09/2011	Alluvium	Alluvium	River Bank
	8/11/2011			
	25/05/2013			
	25/05/2013			
C027P2	29/09/2011	Dunda Beds	Dunda	River Bank
	5/11/2011			
	25/05/2013			
C029P1	29/09/2011	Alluvium	Alluvium	River Bank
	7/11/2011			
	24/05/2013			
C029P2	29/09/2011	Tertiary Overburden	Tertiary	River Bank
	7/11/2011			
	25/05/2013			
C180119SP	2/06/2013	Overburden	Bandanna	Mellaluka North
C180120SP	1/06/2013	Overburden	Bandanna	Mellaluka Middle
C180122SP	2/06/2013	Overburden	Bandanna	Mellaluka North
C180123SP	1/06/2013	Overburden	Bandanna	Mellaluka South
C9180121SPR	1/06/2013	Overburden	Bandanna	Mellaluka South
C9180124SPR	2/06/2013	Overburden	Bandanna	Mellaluka North
C9180125SPR	5/06/2013	Overburden	Bandanna	Mellaluka Middle
HD02	27/10/2012	Clematis Sandstone	Clematis	Doongmabulla
	20/05/2013			
HD03A	27/10/2012	Dunda Beds	Dunda	Doongmabulla
	27/05/2013			
HD03B	27/10/2012	Alluvium	Alluvium	Doongmabulla
	20/05/2013			

3.5 Monitoring Bores outside the Mine Lease

It is noted that several current and proposed monitoring points, comprising standpipe and vibrating wire piezometer designs, will be located outside mine lease application areas MLA70506 and MLA70505. These monitoring points, including the proposed additional monitoring bores (Section 5.3), are included in Table 3-4. The locations are included on the maps presented in Appendix A.

Table 3-4 Monitoring Bores outside of the Mine Lease Areas

Bore ID	Easting	Northing
Alluvium		
HD03B	427559	7556120
AGWB 20	443585	7559330
AGWB 19	444975	7558325
Tertiary		
AGWB 1_01	442467	7561194
AGWB 8_01	440152	7567059
AGWB 2 _01	443641	7556541
AGWB 11_01	444256	7552781
AGWB 021_01	445182	7548569
Bandanna Formation		
AGWB 18_03	418124	7566791
AGWB 17_03	429841	7550930
Clematis Sandstone		
HD02	423821	7557008
AGWB 3R_01	426391	7561598
AGWB 4_01	423759	7559744
AGWB 18_01	418124	7566791
AGWB 17_01	429841	7550930
AGWB 16_01	430030	7543903
Dunda Beds		
HD01	426146	7561467
HD03A	427559	7556120
C180116SP	439394	7540911
C180117SP	435917	7547523
C180118SP	423798	7568089
AGWB 3R_02	426391	7561598
AGWB 4_02	423759	7559744
AGWB 18_02	418124	7566791
AGWB 17_02	429841	7550930
AGWB 16_02	430030	7543903
Early Permian		
AGWB 1_02	442467	7561194

AGWB 8_02	440152	7567059
AGWB 2_02	443642	7556541
AGWB 11_02	444256	7552781
AGWB-009	44810	7541470
AGWB-010	448521	7533368
AGWB-012	445317	7536101
AGWB-013	448600	7527457
AGWB-014	440389	7533410
AGWB-021_02	445182	7548569

Adani will undertake the necessary negotiations and approvals to construct and monitor these off lease points. Monitoring at these points will be conducted with due care and process to reduce disturbance off lease and minimise any potential impacts due to frequent (repeat) monitoring events.

Mitigations, dependent on the site, landholder requirements, and environmental sensitivity, could potentially include automated data collection (to limit the number of visit to the site), telemetry, and single track access to and from these points, etc. The mitigation measures will be included to minimise potential environmental harm associated with data collection.

4 MONITORING REQUIREMENTS

This section describes the minimum monitoring that will be undertaken before, during, and after the proposed mining activities. In accordance with the adaptive management approach, these monitoring requirements will be modified on an on-going basis to ensure optimal understanding of the groundwater regimes and the envisaged mining impacts.

4.1 Parameters

Optimum parameter selection allows for the measure of the cause and effect relationship between mining activities and the environmental response to those activities. Suitable indicators include those:

- Commonly found in the environment;
- Relatively easy to measure;
- Sensitive to environmental change; and,
- Specific to disturbance impacts.

The selected parameters allow for the description of the groundwater resource, the physical, chemical and biological aspects of the groundwater system, while other selected parameters relate to anthropogenic activities.

The groundwater monitoring program allows for the evaluation of both groundwater quantity (levels) and quality parameters.

4.2 Groundwater Level Monitoring

Groundwater level monitoring is the key parameter for assessing changes to the groundwater regime, particularly as the ‘make good’ agreements with the landholders is predicated on a water level change.

4.2.1 Frequency and Duration

Groundwater level monitoring has started and will continue until the start of mining activities, which could potentially alter groundwater levels to ensure that pre-mining groundwater levels are characterised, and the range of natural variability is understood prior to any potential effects associated with mining.

At a minimum, groundwater levels within the baseline groundwater monitoring network will be measured monthly. It is intended that the majority of monitoring bores will have permanent groundwater level monitoring devices (e.g. pressure transducer and dataloggers) installed. These will log at a minimum of 12 hour intervals, with the data being downloaded and assessed on a monthly basis.

Groundwater level monitoring will continue through construction, operations, and post closure at selected representative groundwater monitoring points (providing representative assessment of groundwater level changes in the various groundwater units). During post closure it is envisaged that the groundwater level data will provide recovery data, which will be compared to long-term model predictions.

The details of the monitoring bores, units to be monitored, and monitoring frequency details for each of the mine phases are included in Section 5.

4.2.2 Instrumentation and Control

Groundwater levels are measured manually with an electronic water level probe each time a bore is visited. The probe is decontaminated between bores.

Permanent water level monitoring devices are and will be installed in the key monitoring bores (Section 5). This will comprise a pressure transducer or vibrating wire piezometer for water level measurement, and a datalogger for recording the measurements.

4.2.3 Groundwater Quantity Indicators

Changes in quantity of groundwater (or availability of groundwater), flow volumes in aquifers and interaction between groundwater and surface water features are primarily determined based on groundwater level/pressure levels and related changes in these levels. Natural fluctuations in groundwater levels occur (depending on aquifer type, depth, etc.) in response to daily, seasonal, and long term climate cycles. The duration of these fluctuations range from short-term (for example, shallow monitoring bores in unconfined aquifers responding to individual precipitation events) to long-term (multi-year variations in climate and basin water balance).

Mining-induced changes in groundwater levels can be caused by removal of groundwater from an aquifer, changes in groundwater balances (due to land cover changes including construction of ponds, dumps, etc.) and pressure effects due to depressurisation of aquifers. More localised effects can occur as a result of leakage from tailings storage or mine water dams (i.e. artificial recharge impacts resulting in groundwater level increase).

The primary indicator for groundwater quantity is, therefore, defined as the temporal change to groundwater level/pressure in a defined aquifer interval at an established monitoring location.

As a result, groundwater levels at established locations will be monitored until sufficient background data have been collected to compare and assess future trends. Characterisation of expected natural fluctuations in groundwater elevation in each monitored groundwater unit will be compiled to establish baseline conditions and variability, which will be used to assess for mine related influences.

4.3 Groundwater Quality Monitoring

Groundwater samples have and will be obtained from representative groundwater monitoring points within each monitored groundwater unit. The baseline groundwater monitoring that has been undertaken to date since the commencement of the EIS process forms part of the sampling data sets utilised to establishing representative groundwater chemistry trigger levels and contaminant levels.

The groundwater units monitored on site, based on the potential for mine activities to impact on these units, includes:

- Unconfined alluvium and Tertiary units;
- The Colinlea Sandstone;

- The Bandanna Formation;
- The Clematis Sandstone;
- The Rewan Formation;
- The Dunda Beds; and
- The Early Permian sediments.

4.3.1 Groundwater Quality Indicators

To determine relevant regional groundwater quality, baseline sampling will include for a wide range of parameters to gain an understanding of the specific aquifer hydrochemistry. Review of these results will be conducted to identify suitable chemistry parameters, which will allow for the identification of conditions which fall outside of a well-established range of natural variability or baseline conditions.

It is noted that baseline parameters (i.e. large suite of analytes) will be collected until sufficient measurements are available to demonstrate (statistically) the range of natural variability within the target groundwater unit. These baseline background conditions will be used for comparison to future samples.

Following the establishment of baseline conditions, it is considered that the suite of parameters will be reduced unless significant variations are observed.

4.3.2 Methods

Given the range in depths and diameters of the monitoring bores several methods of sampling are used to collect groundwater samples. Sampling methods selected minimise the volume of purge water to be managed while ensuring that samples collected are representative of the aquifer or groundwater unit.

Where samples are collected through more traditional purging methods (using dedicated low-flow systems), samples are collected when field parameters have stabilised as per Table 4-1.

Table 4-1 Field Parameter Stabilisation Criteria prior to sample collection

Measurement	Variability	Recording
pH	± 0.1 pH unit	Continuous readings until stabilised, i.e. three to five consecutive readings within the variability range
Temperature	± 0.2°C	
Electrical Conductivity	± 3%	
Dissolved oxygen	± 0.3 mg/L	
Redox potential (Eh)	± 5%	

Groundwater Sampling

Historic and current groundwater sampling is undertaken in accordance with the current edition of the Department of Environment and Heritage Protection's Water Quality Sampling Manual, which allows for the collection of repeatable representative groundwater data.

Sampling Springs

For sampling purposes all springs are treated similarly to a bore, except for two differences. Firstly, as the spring flows are continuous no purging is required. The second difference is a quality issue; during spring sampling, special care should be made not to allow contamination of the representative flowing water with standing water (especially where cattle has access to spring discharge).

Adani's approach to reduce contamination is to use a borehole sampling pump, which is lowered into the flowing water as close to the spring outlet as possible. Field parameters are measured and recorded, and after rinsing the sample bottles samples are collected as for a bore. Electrode measurements are made from little pools close to the spring outflow where the water velocity is not too great to cause distortion of the electrode readings.

Note: It is considered that Adani may utilise, depending on discussions with landholders and authorities, to install a stainless steel well screen with a point at the end connected to a length of metal casing into the spring. The well screen spear can be pushed into the source and the sampling pump lowered down the inside, and a sample can be collected without problems of grit jamming or damaging the sampling pump.

As the monitoring program is planned to continue for a long period it is proposed to install temporary shallow piezometers up dip of the spring complexes. These sample points will allow for the assessment of the groundwater resources considered to supply groundwater to the springs and provide early warning of potential impacts on springs. The use of remote sample points allows for the limitation of damage to sensitive ecosystems (groundwater dependent ecosystems, vegetation communities) that are associated with springs which could be damaged by sampling (walking to and working around springs can cause damage).

4.3.3 Parameters

The ongoing baseline groundwater quality monitoring, required to increase current hydrochemistry dataset, includes:

- Field parameters: Dissolved oxygen (DO), pH, temperature, and electrical conductivity (EC) - calculated total dissolved solids (TDS);
- Major cations and ions: Calcium, magnesium, potassium, sodium, chloride, sulphate, alkalinity (carbonate and bi-carbonate), sulphide, and fluoride;
- Dissolved[2] Metals/metalloids: Aluminium, arsenic, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, silver, uranium, vanadium, zinc, and mercury;
- Nutrients: Ammonia (as N), nitrate (as N), nitrite (as N), and total phosphorous (as P); and
- Total Petroleum Hydrocarbons (TPH) (C_6 –C_{40}) and BTEX (benzene, toluene, xylene, ethylbenzene).

[2] Dissolved concentrations will be analysed as this is representative of the water that flows through the aquifer, rather than analysis of total concentrations which may be affected by bore conditions.

These parameters were selected to obtain a large encompassing suite of analyses to ensure accurate evaluation of baseline hydrochemistry, allowing for comparison with groundwater quality data compiled during mining.

It is anticipated that the parameter list will be modified after the compilation of the baseline data, for different project stages.

4.3.4 Quality Assurance / Quality Control Sampling

Field monitoring equipment such as electrical conductivity and pH meters are calibrated on a daily basis using appropriately ranged and preserved calibration solutions.

Quality assurance/quality control laboratory samples will be collected at 1 duplicate sample for every ten samples collected, or if less than ten samples in a sampling event, one duplicate sample per batch. The duplicate sample will be sent to the primary analytical laboratory.

Duplicate samples will be analysed for the full suite of parameters for which the primary sample is analysed.

Collected samples will be transported under chilled conditions to the laboratory without compromising the sample holding limits.

4.4 Data Management

4.4.1 Data Collation

All data collected and compiled as part of the GMP is stored in a CCP specific database. This database includes:

- Bore location details, aquifer and construction details (including pumping infrastructure and instrumentation);
- Records of landholder bore visits, issues and complaints;
- Groundwater level and chemistry data;
- Geological and geophysical logs; and
- Bore construction details.

The database has the ability to check the integrity of laboratory water quality reports, and provides automated statistical analyses as required for the development of trigger values and contaminant limits (baseline data only), charting and trend determination.

4.4.2 Data Dissemination

Interpreted data will be disseminated through the agreed (Environmental Authorisation condition) reporting requirements (Section 4.6 below).

Geological logs and construction details of monitoring bores constructed on site (existing and in future) will be provided for inclusion in the groundwater database as required under the *Water Act 2000*.

Appropriate groundwater data will be made available to the public through the Adani website, these publically available data will include:

- Groundwater quality monitoring data, trend analyses, and interpretation;
- Groundwater level data trends and comparison to model predictions;
- Details regarding the groundwater monitoring network; and
- Other information as required.

4.5 Data Analysis

4.5.1 Data Analysis Process

Different methods exist for the assessment of groundwater monitoring data, one of which is the use of statistical tests for the development of indicator parameter limits. It is recognised that alternative methods exist, however, statistics honour natural data variability and facilitate tracking of quality and quantity trends. Adani will, in discussion with the regulator, define groundwater chemistry trigger levels and contaminant limits and groundwater level thresholds, based on statistics, against which monitoring data is to be assessed.

Hydrochemistry

As groundwater data becomes available through the monitoring of the regional network, it will become possible to assess statistical trends for representative parameters within each groundwater unit monitored.

Once sufficient groundwater quality data (from a statistical perspective) has been compiled trigger levels will be determined. These trigger levels will be based on arithmetic mean and standard deviations, set to support in assessing possible mine related impacts on the groundwater resources.

Trends can be identified and follow-up investigations initiated per the established approach outlined in Section 4.5.2. The intent of the investigative follow-up is to identify natural exceptions to established trigger levels and facilitate revision of the targets as per the adaptive management approach (i.e. an assessment of potential for environmental harm will be conducted and if it is found that the trigger levels are exceeded due to natural conditions (not mine related) then the limits are to be re-evaluated).

Water Level

It is recognised that drawdown, as a result of mine dewatering or depressurisation, in excess of 5 m in confined fractured rock aquifers and 2 m in unconfined aquifers can impact on groundwater production bore yields (e.g. reduced available drawdown or dewatering of fractures) and potentially cause environmental harm (e.g. water decline below root depths). In order to ensure to assess potential impacts prior to these drawdown thresholds being met, the groundwater monitoring at CCP allows for several of the monitoring points to act as early warning and model prediction validation points, when assessing mine dewatering drawdown.

Drawdown thresholds in units between the mine and the sensitive ecosystems (GDEs, spring complexes, and riparian vegetation) and landholder supply bores have been determined

based on predictive modelling. Once monitoring indicates that these thresholds have been reached then it is considered that this will pre-empt the investigation and response process (Section 4.5.2) and instigate make-good agreements allowing for water security.

The proposed units and water level thresholds will be revised over time, based on model refinement conducted using site specific monitoring data (every two years for first ten years and then every five years). Section 5 includes for early warning water level thresholds over the different mine life phases.

4.5.2 Investigation and Response Process

Hydrochemistry

Should groundwater quality trigger levels be exceeded, investigations will be undertaken to establish:

- Whether actual environmental harm has occurred;
- If required, immediate measures that should be taken to reduce the potential for environmental harm; and
- Long-term mitigation measures required to address any existing contamination, and to prevent recurrence of contamination.

Should hydrochemical monitoring data results greater than the trigger levels specified for the relevant aquifer (Section 5) be recorded, then the following will be conducted:

- The relevant monitoring point(s) will be resampled and the samples analysed for major cations and anions, and selected dissolved metals, including aluminium (Al), arsenic (As), antimony (Sb), boron (B), cadmium (Cd), chromium (Cr) (total), cobalt (Co), copper (Cu), iron (Fe), lead (Pb), mercury (Hg), manganese (Mn), molybdenum (Mo), nickel (Ni), selenium (Se), silver (Ag), uranium (U), vanadium (V), and zinc (Zn);
- If elevated concentrations (above trigger levels) are recorded on two consecutive sampling events then an investigation into cause, optimum response, and the potential for environmental harm must be conducted; and
- If elevated concentrations are recorded on two consecutive sampling events then the administering authority will be notified within 1 month of receiving the analysis results;
- Should hydrochemical monitoring data results greater than the contaminant limits specified for the relevant aquifer (Section 5) be recorded, then an investigation into potential environmental harm, required mitigation, and rehabilitation plans will be instigated and discussed with the administering authority.

Water Levels

Should water level threshold values (for sensitive or groundwater dependent ecosystems), defined through predictive modelling, be reached then the following could occur:

- Revise groundwater model and reassess model predictions;
- Re-run groundwater model to test drawdown effects on sensitive receptors;

- Implement make-good agreements with landholders; and
- Instigate mitigation measures to reduce environmental harm.

4.6 Reporting

Monitoring results, both groundwater levels and water quality, is verified and stored in the monitoring database. Review of the data will be undertaken on an annual basis and will be reported to the relevant regulator on an agreed-upon basis (i.e. annual environmental returns).

At a minimum, these annual reports will identify and provide comment on:

- Changes to the proposed monitoring network from the previous report (for example, new monitoring bores coming online);
- Most recent and historical monitoring results, trends, changes in trends in comparison with interim or adopted trigger levels, contaminant limits, and groundwater level thresholds;
- Differences between the actual development sequence and that included in the most recent version of the predictive numerical groundwater model;
- Comparisons between the monitoring results and the numerical model predictions;
- Revisions to the groundwater model (when applicable);
- Histories of complaints regarding water level drawdown or groundwater chemistry in private water bores; and
- The results of investigation(s) into potential environmental harm, details of mitigation and / or rehabilitation plans, and results.

The reporting conditions include:

- Data collected under the monitoring program will be forwarded to the administering authority on a quarterly basis within 30 business days of the end of each quarter and compiled in an annual motioning report in a format approved by the administering authority;
- Adani will undertake an assessment of the impacts of mining on groundwater after the first 12 months of dewatering commencing and thereafter every subsequent calendar year. To be included in the annual report;
- The annual monitoring report will be forwarded to the relevant authority by the first of March each calendar year; and
- The annual monitoring report will include an assessment of impacts, any mitigation strategies as well as any recommendations for changes to the approved monitoring program.

It is considered that Adani will submit a single annual groundwater report in compliance with both the EA Conditions and the envisaged condition issued under a water license under the *Water Act 2000*.

Adani will also consider options for making the groundwater data collected throughout the monitoring life available for the public through posting data on a webpage dedicated to sharing monitoring information in its website.

5 MONITORING PROGRAM DETAILS

The site specific GMP for CCP includes detailed procedures currently undertaken to develop a robust baseline groundwater dataset. This GMP includes envisaged changes and focus of the groundwater monitoring in response to differing phases over the life of mine.

The baseline monitoring has been compiled before the commencement of mining activities to ensure representative data is collected for comparison during the later stages of mine activities. The GMP includes the monitoring program details agreed with the administering authorities. This is to be completed once available (refer to typical EA Conditions and obligations presented in Appendix D).

5.1 Overview

The current GMP allows for the compilation of baseline data for aquifers that may be directly or indirectly impacted by the proposed mining activities. On completion of the compilation of sufficient (taking into consideration already available hydrochemistry and water level data) baseline data to assess natural fluctuations, seasonal variation, and ambient groundwater quality, trigger levels, contaminant limits, and threshold levels will be determined to be used for assessment purposes over the life of mine.

The levels, limits, and thresholds will be finalised prior to the commencement of coal mining extraction activities, such that it will include sufficient baseline water quality and level data to make informed decisions regarding groundwater quality trigger levels, groundwater quality contaminant limits, and water level thresholds to be adopted for the appropriate aquifers.

These trigger levels, contaminant limits, and thresholds are drafted in this document for discussion with the administering authority. The baseline groundwater quality sampling currently being conducted is for the purpose of obtaining a statistically representative number of samples sufficient for determining baseline condition trigger levels for groundwater in the different aquifers.

The draft trigger levels for each of the potentially impacted aquifers will be discussed with the administering authority and submitted 28 days prior to commencing coal extraction.

5.2 Baseline GMP

The groundwater monitoring program (monitoring point, target, parameter and frequency) compiled for collecting data prior to being disturbed by mining activities is included in Table 5-1. **Appendix A** presents the location of these bores.

Table 5-1 Groundwater monitoring network bores and frequency

Bore ID	Geology	Overall Unit	Monitoring Location						Monitoring Required		
			Carmichael River	Doongmabulla Springs	Mellaluka Springs	Landholder Early Warning Bores	Open Cut Mine Area	Underground Mine Area	Water Level - Logger 12hrly	Water Quality – Once every 2 months for first 12 events	Make Good
3 mile bore		Clematis									✓
Blue's bore #1		Early Permian									✓
Blue's bore #2		Early Permian									✓
C006P1	Interburden	Bandanna					✓		✓	✓	
C006P3r	D Seam	Colinlea					✓		✓	✓	
C008P1	Permian Overburden	Bandanna	✓					✓	✓	✓	
C008P2	AB Seam	Bandanna	✓					✓	✓	✓	
C012P2	Permian Overburden	Bandanna					✓	✓	✓	✓	
C025P1	Tertiary	Tertiary	✓						✓	✓	
C025P2	Tertiary	Tertiary	✓						✓	✓	
C027P1	Alluvium	Alluvium	✓	✓					✓	✓	
C027P2	Dunda	Dunda	✓	✓					✓	✓	
C029P1	Alluvium	Alluvium	✓						✓	✓	
C029P2	Tertiary	Tertiary	✓						✓	✓	
C032P2	AB Seam	Bandanna				✓		✓	✓	✓	
C034P1	D Seam	Colinlea				✓	✓		✓	✓	
C034P3	D Seam	Colinlea				✓	✓		✓	✓	
C035P1	Rewan	Rewan				✓	✓		✓	✓	
C035P2	AB Seam	Bandanna				✓	✓		✓	✓	
C056C_V1	D1 Seam	Colinlea						✓	✓		
C056C_V2	AB1 Seam	Bandanna						✓	✓		
C056C_V3	Interburden (sandstone)	Rewan						✓	✓		
C180112SP	Permian below D Seam	Early Permian	✓				✓		✓	✓	
C180114SP	D Seam	Colinlea	✓				✓		✓	✓	
C180116SP	Dunda	Dunda				✓			✓	✓	
C180117SP	Dunda Beds	Dunda				✓			✓	✓	
C180118SP	Dunda Beds	Dunda				✓			✓	✓	
C180119SP	Overburden	Early Permian			✓	✓			✓	✓	

Bore ID	Geology	Overall Unit		Monitoring Location								Monitoring Required		
				Carmichael River	Doongmabulla Springs	Mellaluka Springs	Landholder Early Warning Bores	Open Cut Mine Area	Underground Mine Area		Water Level - Logger 12hrly	Water Quality – Once every 2 months for first 12 events	Make Good
C180120SP	Overburden	Early Permian				✓	✓				✓	✓	
C180122SP	Overburden	Early Permian				✓	✓				✓	✓	
C180123SP	Overburden	Early Permian				✓	✓				✓	✓	
C553P_V1	D1 Seam	Colinlea							✓		✓		
C553P_V2	AB1 Seam	Bandanna							✓		✓		
C553P_V3	Overburden Sandstone	Rewan							✓		✓		
C555P_V1	D Seam	Colinlea		✓	✓				✓		✓		
C555P_V2	AB1 Seam	Bandanna		✓	✓				✓		✓		
C555P_V3	Overburden	Rewan		✓	✓				✓		✓		
C558P_V1	D1 Seam	Colinlea						✓			✓		
C558P_V2	Sandstone	Bandanna						✓			✓		
C558P_V3	AB1 Seam	Bandanna						✓			✓		
C829SP	Permian Interburden	Colinlea						✓			✓	✓	
C832SP	Permian Interburden	Colinlea		✓				✓			✓	✓	
C833SP	D Seam	Colinlea		✓				✓			✓	✓	
C834SP	Permian Interburden	Colinlea		✓				✓			✓	✓	
C836VWP_V01	Interburden (Below C Seam)	Colinlea		✓					✓		✓		
C836VWP_V02	AB Seam	Bandanna		✓					✓		✓		
C836VWP_V03	Rewan	Rewan		✓					✓		✓		
C840SP	Permian below D Seam	Early Permian		✓				✓			✓	✓	
C842VWP_V01	Interburden (within C Seam)	Bandanna						✓			✓		
C842VWP_V02	AB Seam	Bandanna						✓			✓		
C847SP	Permian Interburden	Colinlea					✓				✓	✓	
C848SP	D Seam	Colinlea					✓				✓	✓	
C851VWP_V01	Interburden (within C Seam)	Bandanna							✓		✓		
C851VWP_V02	AB3 Seam	Bandanna							✓		✓		
C851VWP_V03	Permian Overburden	Bandanna							✓		✓		
C9180121SPR	Overburden	Early Permian				✓	✓				✓	✓	

Bore ID	Geology	Overall Unit		Monitoring Location								Monitoring Required		
				Carmichael River	Doongmabulla Springs	Mellaluka Springs	Landholder Early Warning Bores	Open Cut Mine Area	Underground Mine Area		Water Level - Logger 12hrly	Water Quality – Once every 2 months for first 12 events	Make Good
C9180124SPR	Overburden	Early Permian				✓	✓				✓	✓	
C9180125SPR	Overburden	Early Permian				✓	✓				✓	✓	
C9556P_V1	D2 Seam	Colinlea							✓		✓		
C9556P_V2	AB1 Seam	Bandanna							✓		✓		
C9556P_V3	Overburden	Rewan							✓		✓		
C965PT	AB Seam	Bandanna							✓		✓	✓	
C966VWP_01	Below AB1	Bandanna							✓		✓		
C966VWP_02	AB1 Seam	Bandanna							✓		✓		
C966VWP_03	AB1 Overburden	Bandanna							✓		✓		
C966VWP_04	Rewan	Rewan							✓		✓		
C968VWP_01	Below D1 Seam	Early Permian							✓		✓		
C968VWP_02	D1 Seam	Colinlea							✓		✓		
C968VWP_03	C Seam	Bandanna							✓		✓		
C968VWP_04	Below AB3 Seam	Bandanna							✓		✓		
C968VWP_05	AB1 Seam	Bandanna							✓		✓		
C970PT	D Seam	Colinlea							✓		✓	✓	
C9838SPR	Permian Overburden	Bandanna		✓				✓			✓	✓	
C9839SPR	Permian Interburden	Colinlea		✓				✓			✓	✓	
C9845SPR	Dunda	Dunda					✓		✓		✓	✓	
C9849SPR	Permian below D Seam	Early Permian					✓		✓		✓	✓	
Cockatoo Bore													✓
Desert Bore Lignum													✓
Desert Bore Mellaluka													✓
Dexter Bore													✓
Gidgea Bore													✓
HD02	Clematis	Clematis			✓						✓	✓	
HD03A	Dunda	Dunda			✓						✓	✓	
HD03B	Alluvium	Alluvium			✓						✓	✓	
Ironbark bore													✓

Bore ID	Geology	Overall Unit		Monitoring Location								Monitoring Required		
				Carmichael River	Doongmabulla Springs	Mellaluka Springs	Landholder Early Warning Bores	Open Cut Mine Area	Underground Mine Area		Water Level - Logger 12hrly	Water Quality – Once every 2 months for first 12 events	Make Good
Laglan Bore 57660													✓
Laglan bore 6404													✓
Laglan bore 84671													✓
Mellaluka homestead bore													✓
Middle bore													✓
Poison bore													✓
Soak Bore													✓
Storie's bore													✓

Groundwater quality trigger levels and contaminant limits have been derived for each of the groundwater units potentially (directly or indirectly) impacted by the proposed mining activities based on statistical evaluation of existing datasets compiled during the EIS and SEIS. The groundwater units monitored included:

- Unconfined alluvium and Tertiary units;
- The Colinlea Sandstone;
- The Bandanna Formation;
- The Clematis Sandstone;
- The Rewan Formation;
- The Dunda Beds; and
- The Early Permian sediments.

The groundwater contaminant limits and trigger levels are included in Tables 5-2 to 5-9. These levels and limits are to be included, as per the Environmental Authority Conditions, once sufficient data, from a statistical perspective, has been collected.

Table 5-2 Groundwater trigger levels and contaminant limits for Alluvium

Parameter	Units	Trigger Levels (80th percentile of background data)	Contaminant Limits (99th percentile of background data)	No Samples greater than LOR
Dissolved Metals:				
Aluminium (Al)	mg/L			1
Arsenic (As)				5
Boron (B)				7
Cadmium (Cd)				1
Chromium (Cr)				1
Cobalt (Co)				5
Copper (Cu)				5
Iron (Fe)				7
Lead (Pb)				0
Manganese (Mn)				7
Mercury (Hg)				0
Molybdenum (Mo)				2
Nickel (Ni)				5
Selenium (Se)				0
Silver (Ag)				0
Uranium (U)				2
Vanadium (V)				2
Zinc (Zn)				6
Electrical Conductivity	µS/cm			7
Total Dissolved Solids	mg/L			7
Major Ions				
Calcium (Ca)	mg/L			7
Magnesium (Mg)				7
Potassium (K)				7
Sodium (Na)				7
Chloride (Cl)				7
Sulphate (SO_4)				2
Fluoride (F)				7
Nutrients				
Ammonia (N)	mg/L			7
Nitrate (N)				6
Nitrite (N)				1
Total phosphorous (P)				5
Hydrocarbons				
TPH (C_6-C_{40})	ppb			0
BTEX				0
pH	pH units	6.5-8.5	± 1 pH unit from highest/lowest readings	

Table 5-3 Groundwater trigger levels and contaminant limits for Tertiary

Parameter	Units	Trigger Levels	Contaminant Limits	No Samples (greater than LOR)
Dissolved Metals:				
Aluminium (Al)	mg/L			1
Arsenic (As)				6
Boron (B)				6
Cadmium (Cd)				0
Chromium (Cr)				4
Cobalt (Co)				1
Copper (Cu)				3
Iron (Fe)				5
Lead (Pb)				0
Manganese (Mn)				6
Mercury (Hg)				0
Molybdenum (Mo)				2
Nickel (Ni)				3
Selenium (Se)				2
Silver (Ag)				0
Uranium (U)				2
Vanadium (V)				2
Zinc (Zn)				6
Electrical Conductivity	µS/cm			6
Total Dissolved Solids	mg/L			6
Major Ions				
Calcium (Ca)	mg/L			6
Magnesium (Mg)				6
Potassium (K)				6
Sodium (Na)				6
Chloride (Cl)				6
Sulphate (SO_4)				2
Fluoride (F)				6
Nutrients				
Ammonia (N)	mg/L			5
Nitrate (N)				4
Nitrite (N)				0
Total phosphorous (P)				3
Hydrocarbons				
TPH (C_6-C_{40})	ppb			0
BTEX				0
pH	pH units	6.5-8.5	± 1 pH unit from highest/lowest readings	

Table 5-4 Groundwater trigger levels and contaminant limits for Bandanna Formation (AB Coal and Overburden)

Parameter	Units	Trigger Levels	Contaminant Limits	No Samples (greater than LOR)
Dissolved Metals:				
Aluminium (Al)	mg/L			17
Arsenic (As)				20
Boron (B)				25
Cadmium (Cd)				1
Chromium (Cr)				9
Cobalt (Co)				3
Copper (Cu)				10
Iron (Fe)				18
Lead (Pb)				0
Manganese (Mn)				21
Mercury (Hg)				0
Molybdenum (Mo)				18
Nickel (Ni)				10
Selenium (Se)				0
Silver (Ag)				2
Uranium (U)				4
Vanadium (V)				0
Zinc (Zn)				14
Electrical Conductivity	µS/cm			25
Total Dissolved Solids	mg/L			25
Major Ions				
Calcium (Ca)	mg/L			25
Magnesium (Mg)				20
Potassium (K)				25
Sodium (Na)				25
Chloride (Cl)				25
Sulphate (SO_4)				7
Fluoride (F)				24
Nutrients				
Ammonia (N)	mg/L			25
Nitrate (N)				23
Nitrite (N)				0
Total phosphorous (P)				18
Hydrocarbons				
TPH (C_6-C_{40})	µg/L			2
BTEX				5
pH	pH units	6.5-8.5	± 1 pH unit from highest/lowest readings	

Table 5-5 Groundwater trigger levels and contaminant limits for Colinlea Sandstone (D Seam and interburden)

Parameter	Units	Trigger Levels	Contaminant Limits	No Samples (greater than LOR)
Dissolved Metals:				
Aluminium (Al)	mg/L			15
Arsenic (As)				26
Boron (B)				29
Cadmium (Cd)				0
Chromium (Cr)				9
Cobalt (Co)				10
Copper (Cu)				7
Iron (Fe)				26
Lead (Pb)				0
Manganese (Mn)				29
Mercury (Hg)				0
Molybdenum (Mo)				17
Nickel (Ni)				14
Selenium (Se)				0
Silver (Ag)				0
Uranium (U)				8
Vanadium (V)				0
Zinc (Zn)				16
Electrical Conductivity	µS/cm			30
Total Dissolved Solids	mg/L			29
Major Ions				
Calcium (Ca)	mg/L			29
Magnesium (Mg)				30
Potassium (K)				30
Sodium (Na)				29
Chloride (Cl)				30
Sulphate (SO_4)				7
Fluoride (F)				30
Nutrients				
Ammonia (N)	mg/L			28
Nitrate (N)				22
Nitrite (N)				0
Total phosphorous (P)				19
Hydrocarbons				
TPH (C_6-C_{40})	µg/L			0
BTEX				2
pH	pH units	6.5-8.5	± 1 pH unit from highest/lowest readings	

Table 5-6 Groundwater trigger levels and contaminant limits for Rewan Formation

Parameter	Units	Trigger Levels	Contaminant Limits	No Samples (greater than LOR)
Dissolved Metals:				
Aluminium (Al)	mg/L			4
Arsenic (As)				5
Boron (B)				5
Cadmium (Cd)				0
Chromium (Cr)				1
Cobalt (Co)				3
Copper (Cu)				1
Iron (Fe)				5
Lead (Pb)				0
Manganese (Mn)				5
Mercury (Hg)				0
Molybdenum (Mo)				2
Nickel (Ni)				3
Selenium (Se)				0
Silver (Ag)				0
Uranium (U)				0
Vanadium (V)				0
Zinc (Zn)				4
Electrical Conductivity	µS/cm			6
Total Dissolved Solids	mg/L			6
Major Ions				
Calcium (Ca)	mg/L			6
Magnesium (Mg)				6
Potassium (K)				6
Sodium (Na)				6
Chloride (Cl)				6
Sulphate (SO_4)				1
Fluoride (F)				6
Nutrients				
Ammonia (N)	mg/L			6
Nitrate (N)				4
Nitrite (N)				0
Total phosphorous (P)				5
Hydrocarbons				
TPH (C_6-C_{40})	ppb			0
BTEX				0
pH	pH units	6.5-8.5	± 1 pH unit from highest/lowest readings	

Table 5-7 Groundwater trigger levels and contaminant limits for Dunda Beds

Parameter	Units	Trigger Levels	Contaminant Limits	No Samples (greater than LOR)
Dissolved Metals:				
Aluminium (Al)	mg/L			10
Arsenic (As)				7
Boron (B)				10
Cadmium (Cd)				0
Chromium (Cr)				2
Cobalt (Co)				7
Copper (Cu)				4
Iron (Fe)				9
Lead (Pb)				0
Manganese (Mn)				10
Mercury (Hg)				0
Molybdenum (Mo)				1
Nickel (Ni)				9
Selenium (Se)				0
Silver (Ag)				0
Uranium (U)				0
Vanadium (V)				0
Zinc (Zn)				10
Electrical Conductivity	µS/cm			8
Total Dissolved Solids	mg/L			8
Major Ions				
Calcium (Ca)	mg/L			9
Magnesium (Mg)				9
Potassium (K)				9
Sodium (Na)				8
Chloride (Cl)				8
Sulphate (SO_4)				3
Fluoride (F)				9
Nutrients				
Ammonia (N)	mg/L			9
Nitrate (N)				8
Nitrite (N)				0
Total phosphorous (P)				7
Hydrocarbons				
TPH (C_6-C_{40})	ppb			0
BTEX				0
pH	pH units	6.5-8.5	± 1 pH unit from highest/lowest readings	

Table 5-8 Groundwater trigger levels and contaminant limits for Clematis Sandstone

Parameter	Units	Trigger Levels	Contaminant Limits	No Samples (greater than LOR)
Dissolved Metals:				
Aluminium (Al)	mg/L			0
Arsenic (As)				1
Boron (B)				1
Cadmium (Cd)				0
Chromium (Cr)				0
Cobalt (Co)				0
Copper (Cu)				0
Iron (Fe)				1
Lead (Pb)				0
Manganese (Mn)				1
Mercury (Hg)				0
Molybdenum (Mo)				0
Nickel (Ni)				0
Selenium (Se)				0
Silver (Ag)				0
Uranium (U)				0
Vanadium (V)				0
Zinc (Zn)				1
Electrical Conductivity	µS/cm			1
Total Dissolved Solids	mg/L			1
Major Ions				
Calcium (Ca)	mg/L			1
Magnesium (Mg)				1
Potassium (K)				1
Sodium (Na)				1
Chloride (Cl)				1
Sulphate (SO_4)				0
Fluoride (F)				1
Nutrients				
Ammonia (N)	mg/L			1
Nitrate (N)				0
Nitrite (N)				0
Total phosphorous (P)				1
Hydrocarbons				
TPH (C_6-C_{40})	ppb			0
BTEX				0
pH	pH units	6.5-8.5	± 1 pH unit from highest/lowest readings	

Table 5-9 Groundwater trigger levels and contaminant limits for Early Permian

Parameter	Units	Trigger Levels	Contaminant Limits	No Samples (greater than LOR)
Dissolved Metals:				
Aluminium (Al)	mg/L			0
Arsenic (As)				0
Boron (B)				0
Cadmium (Cd)				0
Chromium (Cr)				0
Cobalt (Co)				0
Copper (Cu)				0
Iron (Fe)				0
Lead (Pb)				0
Manganese (Mn)				0
Mercury (Hg)				0
Molybdenum (Mo)				0
Nickel (Ni)				0
Selenium (Se)				0
Silver (Ag)				0
Uranium (U)				0
Vanadium (V)				0
Zinc (Zn)				0
Electrical Conductivity	µS/cm			0
Total Dissolved Solids	mg/L			0
Major Ions				
Calcium (Ca)	mg/L			0
Magnesium (Mg)				0
Potassium (K)				0
Sodium (Na)				0
Chloride (Cl)				0
Sulphate (SO_4)				0
Fluoride (F)				0
Nutrients				
Ammonia (N)	mg/L			0
Nitrate (N)				0
Nitrite (N)				0
Total phosphorous (P)				0
TPH (C_6-C_{40})	ppb			0
BTEX				0
pH	pH units	6.5-8.5	± 1 pH unit from highest/lowest readings	

5.3 Proposed Upgrade of Baseline Monitoring Network

Based on a review of proposed mining activities, the current monitoring network and responses received from regulatory bodies, Adani will augment their current baseline groundwater network as summarised in Table 5-10. **Appendix A** presents the location of these bores.

Table 5-10 Additions to the current monitoring network

Bore location	Easting	Northing	Description	Landholder	Target aquifer/formation
AGWB-001_01	442467	7561194	Immediately North of Carmichael river	Moray downs	Monitoring bore in the Tertiary between Pit E and land holders on east side and north of Carmichael river
AGWB-001_02					Monitoring bore into the Early Permian between Pit E and land holders on east side and north of Carmichael river
AGWB-008_01	440152	7567059	North of Carmichael river	Moray downs	Monitoring bore in the Tertiary between Pit D and land holders on east side and north of Carmichael river
AGWB-008_02					Monitoring bore into the Early Permian between Pit D and land holders on east side and north of Carmichael river
AGWB-002_01	443642	7556541	Immediately South of Carmichael river	Moray downs	Monitoring bore in the Tertiary between Pit F and land holders east and south of Carmichael river
AGWB-002_02					Monitoring bore into the Early Permian between Pit F and land holders east and south of Carmichael river
AGWB-011_01	444256	7552781	South of Carmichael river	Moray downs	Monitoring bore in the Tertiary between Pits F and G and land holders to east and south of Carmichael river
AGWB-011_02					Monitoring bore into the Early Permian between Pits F and G and land holders to east and south of Carmichael river
AGWB-021_01	445182	7548569	South of Carmichael river	Lignum	Monitoring bore in the Tertiary east of Pit G and for land holders to east and south of Carmichael river
AGWB-021_02					Monitoring bore into the Early Permian East of Pit G and for land holders to east and south of Carmichael river
AGWB-003R_01	426391	7561598	West of 1690	On Moray downs and on the side of	Early warning bore in Clematis Sandstone, between UG mine and Doongmabulla springs in central mine

Bore location	Easting	Northing	Description	Landholder	Target aquifer/formation
				Doongmabulla road (near Air strip)	area
AGWB-003R_02					Early warning bore in Dunda beds, between UG mine and Doongmabulla springs in central mine area
AGWB-004_01	423759	7559744	West of AGWB3R, between mine and Doongmabulla springs	Doongmabulla road	Construct in Clematis Sandstone, background bore at spring, monitor the natural fluctuations and a reference bore
AGWB-004_02					Early warning bore in Dunda Beds adjacent to Doongmabulla springs
AGWB-010	448521	7533368	Northwest of Mellaluka	Bruce Cobb/ Mellaluka	Bore into Early Permian, bore to 150 m to assess spring source and monitor drawdown in between mine and land holders to the southeast
AGWB-012	445317	7536101	South of AGWB9	Lignum	Bore into Early Permian, bore to 150 m to assess spring source and monitor drawdown in between mine and land holders to the southeast
AGWB-014	440389	7533410	South of 1690 and west of 1080 in Mellaluka property	Bruce Cobb/ Mellaluka	Bore through Colinlea Sandstone to Early Permian, to assess coal seams, spring source, and monitor drawdown in between mine and land holders to the south
AGWB-009	44810	7541470	East of 1690 in 1080 in south side	Lignum	Bore into Early Permian, bore to 150 m to assess spring source and monitor drawdown in between mine and land holders to the southeast
AGWB-013	448600	7527457	EPC 1080, south of monitoring bore C180121	Bruce Cobb/ Mellaluka	Bore into Early Permian, to reach competent rock (~150 m), south side of Mellaluka bores
AGWB-019	444975	7558325	East of MLA70505	Carmichael River	Bore into alluvium, to monitor groundwater in alluvium south side of Carmichael River
AGWB-020	443585	7559330	East of MLA70505	Carmichael River	Bore into alluvium, to monitor groundwater in alluvium north side of Carmichael River
AGWB-017_01	429841	7550930	West of MLA70441	Opposite northern mining area	GAB monitoring bore in Clematis Sandstone, opposite northern mine area
AGWB-017_02					Early warning GAB bore in Dunda Beds, opposite northern mine area
AGWB-017_03					Early warning bore in Bandanna Formation, opposite northern mine area
AGWB-018_01	418124	7566791	West of MLA70441	Opposite central mining area	GAB monitoring bore in Clematis Sandstone, opposite central mine area
AGWB-018_02					Early warning GAB bore in Dunda

Bore location	Easting	Northing	Description	Landholder	Target aquifer/formation
					Beds, opposite central mine area
AGWB-018_03					Early warning bore in Bandanna Formation, opposite central mine area
AGWB-016_01	430030	7543903	West of MLA70441	Opposite southern mining area	GAB monitoring bore in Clematis Sandstone, opposite southern mine area
AGWB-016_02					Early warning GAB bore in Dunda Beds, opposite southern mine area

5.4 Baseline Landholder Bore Monitoring

In line with the make-good agreements to be concluded between Adani and the neighbouring landholders, the groundwater monitoring program includes the baseline assessments and annual monitoring of the landholder bores.

The baseline bore assessments, based on the following guidelines, will allow for capture of accurate pre-mining information, which will be used for comparison to monitoring during mining to assess potential impacts. The guidelines include:

- EM1088 Baseline Assessments (http://www.ehp.qld.gov.au/management/non-mining/documents/baseline-assessment-guideline.pdf);
- EM1178 Bore Assessment Guidelines (http://www.ehp.qld.gov.au/management/non-mining/documents/bore-assessment-guideline.pdf); and
- Make good obligations (http://www.agforceqld.org.au/file.php?id=1014&open=yes)

The baseline assessment will allow for the compilation of the following information about the landholder water supply bores:

- The groundwater level and quality of water in the bore;
- How the bore was constructed; and
- The type of infrastructure used to pump water from the bore.

Data to be compiled for each landholder bore identified in the make-good agreement will include:

- Registration number (where required);
- Location of the bore (co-ordinates);
- Bore construction details, including date of construction, casing, bore logs, and screen details;
- Pump equipment details, including power, yield, operational, any records;
- Water use, maximum extraction and peak periods, stock watering volumes, and domestic use;
- Static and dynamic water level readings; and
- Groundwater sample to assess water quality, laboratory tests to include:

- Physical parameters: pH, temperature, electrical conductivity, total dissolved solids
- Ions: calcium, chloride, fluoride, magnesium, potassium, sodium, sulphate
- Metals (dissolved and total): aluminium, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, uranium, vanadium, zinc
- Alkalinity and hardness
- Nutrients: ammonia, nitrate, nitrite, total phosphorous.

In order to obtain additional groundwater data and to establish an accurate background dataset Adani will undertake an assessment of the current bore yield for each of the make-good bores.

To determine the current bore yield, a suitable test will be determined based on the current pumping equipment and available data. These tests include:

- Variable head tests;
- Pumping tests or flow/pressure tests; or
- Measurements of flow rate (only where a pumping test is not possible e.g. because of fixed head works).

The GMP includes for the repeat of these bore yield tests at regular intervals, dependent on the mine plan, mine schedule, and distance from the mining activities. These details will be developed during the make-good agreements prior to the commencement of mining activities.

5.5 Proposed Construction GMP

A monitoring program specific to the construction phase will be compiled as different activities, compared to mining, will be involved. It is considered that this would include monitoring of the shallow groundwater units (Alluvium, Tertiary sediments, and Permian sub-crop) to ensure fuel, oil, and possibly chemical storage and handling will not impact negatively on site.

The existing baseline groundwater monitoring network will be enhanced to allow for the monitoring of groundwater level and quality and any departures from natural fluctuations (such as potential seepage adjacent (down gradient) of the proposed in- and out-of-pit tailings storage facilities. Shallow bores (to base of weathering) will be constructed adjacent to the water and waste storage facilities to allow for the compilation of baseline groundwater quality prior to use. These monitoring bores will also provide groundwater level data to assess any potential impacts of construction of these facilities on the recharge and shallow groundwater flow (i.e. ponding or compaction impacts).

The additional monitoring bores are to be constructed adjacent and down gradient of selected mine infrastructure (with the potential to alter groundwater resources) at least 6 months prior to construction. This will allow for the compilation of baseline data for comparison during and post construction.

5.6 Operational GMP

A preliminary validation monitoring program has been designed for inclusion in the GMP, for the first ten (10) years of mine life. This considers the EIS mine plan and predicted drawdown impacts. It is considered that this operational GMP network will alter with time (as mine activities extend to the west) so as to allow for the monitoring bore network to be augmented or replaced over time.

Predicted drawdown contours will be used at regular intervals (for example 10 years) to show the proposed monitoring locations and units over time. These data will be used to validate and update the predictive groundwater model as well as the operational monitoring bore network. It is noted that consideration of cumulative drawdown (with neighbouring projects) changes in groundwater flow direction over time will be given when locating additional operational monitoring points.

During operations the groundwater monitoring network will include for VWPs to be constructed along the CCP boundary to allow for the assessment of groundwater level decline over time, as envisaged in the predictive modelling.

Threshold levels, set based on predictive modelling, will provide early warning before groundwater levels decline within the unconfined aquifers, such that potential impact on the vegetation (sensitive and groundwater dependent ecosystems) could occur. The threshold values will, as part of the GDE management program, be determined and agreed with the regulatory agency once sufficient baseline (natural fluctuation) groundwater and ecological information is compiled.

In addition, threshold values may be developed for units which are utilised by neighbouring groundwater users. Groundwater levels in monitoring bores, located between the mine and existing bores will be compiled and assessed. Should groundwater levels within the various confined aquifer units (Rewan Group, Bandanna Formation, and Colinlea Sandstone) be recorded to vary by more than 5 m compared to natural fluctuation (baseline data) then an assessment of any adjacent “at-risk’ bores will be undertaken as per the make-good commitments and agreements. This will allow for the planning and provision of an alternative water source to replace water supply from the ‘at-risk’ bore, as required.

The reference bores selected for comparison and prediction evaluation are based on mine plans, schedules, groundwater dependent ecosystems, identified landholder bores and GAB units. The initial bores are included in Table 5-11.

Table 5-11 Preliminary operational monitoring network and frequency

Bore ID	Easting	Northing	Monitoring Location					Monitoring Required	
			Carmichael River	GAB Impacts	Doongmabulla Springs	Mellaluka Springs	Landholder Early Warning Bores + Model Validation	Water Level - Logger 12hrly	Water Quality – Quarterly (Q)/Biannual (B)
Alluvium									
C027P1	433643	7554818	✓		✓			✓	Q
C029P1	437691	7555082	✓					✓	Q
HD03B	427559	7556119			✓			✓	B
AGWB 20	443585	7559330	✓					✓	B
AGWB 19	444975	7558325	✓				✓	✓	B
Tertiary									
C012P2	430887	7569877					✓	✓	Q
C025P1	438016	7555846	✓					✓	Q
C025P2	438010	7555845	✓					✓	Q
C029P2	437688	7555081	✓					✓	Q
AGWB 1_01	442467	7561194					✓	✓	B
AGWB 8_01	440152	7567059					✓	✓	B
AGWB 2 _01	443641	7556541					✓	✓	B
AGWB 11_01	444256	7552781					✓	✓	B
AGWB 21_01	445182	7548569					✓	✓	B
C9180124SPR	448600	7536358				✓		✓	Q
C9180125SPR	447040	7531739				✓		✓	Q
C180123SP	448079	7529358				✓		✓	Q
Bandanna Formation									
C007P2	434726	7559864					✓	✓	Q
C014P2	430731	7563976					✓	✓	Q
C020P2	427846	7566932					✓	✓	Q
C032P2	439404	7544896					✓	✓	Q
C035P2	441402	7546828					✓	✓	Q
AGWB 18_03	418124	7566791					✓	✓	B
AGWB 17_03	429841	7550930					✓	✓	B
C056C_V2	424920	7569970					✓	✓	
C553P_V2	420993	7573965					✓	✓	
C555P_V2	432450	7557881	✓		✓			✓	
C9556P_V2	436544	7549883					✓	✓	
C968VWP_04	424874	7570989					✓	✓	

Bore ID	Easting	Northing	Monitoring Location					Monitoring Required	
			Carmichael River	GAB Impacts	Doongmabulla Springs	Mellaluka Springs	Landholder Early Warning Bores + Model Validation	Water Level - Logger 12hrly	Water Quality – Quarterly (Q)/Biannual (B)
C968VWP_05	424874	7570989					✓	✓	
Colinlea Sandstone									
C555P_V1	432450	7557881	✓		✓			✓	
C007P3	434728	7559862					✓	✓	Q
C024P3	428909	7571761					✓	✓	Q
C833SP	439559	7554779	✓					✓	Q
C848SP	442364	7543815					✓	✓	Q
C056C_V1	424920	7569970					✓	✓	
C553P_V1	420993	7573965					✓	✓	
C968VWP_02	424874	7570989					✓	✓	
C9556P_V1	436544	7549883					✓	✓	
C832SP	439570	7554788	✓					✓	Q
C9839SPR	439567	7552797	✓					✓	Q
C844SP	441392	7546840					✓	✓	Q
C847SP	442385	7543809					✓	✓	Q
Rewan Formation									
C035P1	441404	7546824		✓			✓	✓	Q
C555P1	432450	7557881		✓			✓	✓	Q
C056C_V3	424920	7569970		✓			✓	✓	
C555P_V3	432450	7557881	✓	✓	✓			✓	
C9556P_V3	436544	7549883		✓			✓	✓	
C9845SPR	439412	7544904		✓			✓	✓	Q
Dunda Beds									
C022P1	426813	7565962		✓			✓	✓	Q
C027P2	433648	7554819	✓	✓	✓			✓	Q
C9553P1R	421010	7573975		✓			✓	✓	Q
HD03A	427565	7556120		✓	✓			✓	B
C180116SP	439394	7540911		✓			✓	✓	B
C180117SP	435917	7547523		✓			✓	✓	B
C180118SP	423799	7568090		✓			✓	✓	B
AGWB 3R_02	426391	7561598		✓	✓			✓	B
AGWB 4_02	423759	7559744		✓	✓			✓	B
AGWB 18_02	418124	7566791		✓	✓			✓	B
AGWB 17_02	429841	7550930		✓	✓			✓	B

Bore ID	Easting	Northing	Monitoring Location					Monitoring Required	
			Carmichael River	GAB Impacts	Doongmabulla Springs	Mellaluka Springs	Landholder Early Warning Bores + Model Validation	Water Level - Logger 12hrly	Water Quality – Quarterly (Q)/Biannual (B)
AGWB 16_02	430030	7543903		✓	✓			✓	B
Clematis Sandstone									
HD02	423823	7557008		✓	✓			✓	B
AGWB 3R_01	426391	7561598		✓	✓			✓	B
AGWB 4_01	423759	7559744		✓	✓			✓	B
AGWB 18_01	418124	7566791		✓	✓			✓	B
AGWB 17_01	429841	7550930		✓	✓			✓	B
AGWB 16_01	430030	7543903		✓	✓			✓	B
Early Permian									
C834SP	439577	7554764	✓					✓	Q
C968VWP_01	424874	7570989					✓	✓	
C9849SPR	442357	7543819					✓	✓	Q
AGWB 1_02	442467	7561194					✓	✓	B
AGWB 8_02	440152	7567059					✓	✓	B
AGWB 2 _02	443642	7556541					✓	✓	B
AGWB 11_02	444256	7552781					✓	✓	B
AGWB 21_02	445182	7548569					✓	✓	B
AGWB-009	44810	7541470				✓	✓	✓	B
AGWB-010	448521	7533368				✓	✓	✓	B
AGWB-012	445317	7536101				✓	✓	✓	B
AGWB-013	448600	7527457				✓	✓	✓	B
AGWB-014	440389	7533410				✓	✓	✓	B

In addition to the bores detailed in Table 5-11 shallow monitoring bores (~ 10 m deep) will be located adjacent to the water and waste storage facilities to assess potential impacts on the more vulnerable shallow unconfined aquifers and allow for the assessment of possible seepage migration towards the surface water bodies and/or mine workings. Seepage predictions from tailings storage facilities will be used to locate optimum validation monitoring (seepage minimisation). Assumptions of seepage being captured in drawdown cones will be used.

5.7 Post Closure GMP

A reduced monitoring program is envisaged for groundwater rebound validation and post mining groundwater flow patterns and quality assessment. This will be included in this GMP, which will be modified over time to reflect ongoing monitoring.

Final voids, resulting in altered long term groundwater flow patterns, will be monitored to provide model validation, ensure poor quality groundwater migrates towards the final voids and not off site in the groundwater, and assist with assessing the effectiveness of closure activities.

6 COMMITMENTS

Adani will:

- Develop and implement a Groundwater Monitoring Program detailing the location and frequency of groundwater monitoring activities, as well as trigger levels and response actions;
- Expand the existing groundwater monitoring network over time to enable ongoing groundwater impact evaluations;
- Install groundwater monitoring bores a minimum six months prior to mining in an area;
- Undertake groundwater monitoring and sampling via a suitably qualified and experienced professional in accordance with recognised procedures and guidelines;
- Conduct an annual review of the monitoring data, using suitably qualified expert;
- Include in the review an assessment of groundwater level and water quality data, and the suitability of the monitoring network;
- Undertake groundwater modelling audits on a regular basis (intervals not exceeding five years) and provide the modelling results to the administering authority for review;
- Investigate all groundwater-based complaints, including the maintenance of a complaints register. The register will be made available to the regulating authority upon request; and
- Implement make-good agreements with land holders affected by groundwater drawdown.

General commitments regarding the groundwater monitoring include:

- Sampling will be undertaken in accordance with the current edition of the Department of Environment and Heritage Protection's Water Quality Sampling Manual, or subsequent updated versions;
- Groundwater level and groundwater quality results will be kept for a minimum of 5 years and annual data will be compiled in an annual monitoring report; and
- Notification to the regulating authority within one month of receiving water quality analysis results, should any parameters tested exceed agreed trigger levels.

6.1 Make-Good Commitments

The make-good agreements, mutually agreed between Adani and the neighbouring groundwater users, includes for the dissemination of groundwater monitoring information. The GMP allows for the compilation of these data. The groundwater data to be provided as part of the make-good agreements includes:

- Details regarding the baseline data compiled during the bore survey of groundwater use;
- Details from a groundwater data validation program to be undertaken once threshold levels are reached in the early warning monitoring bores;
- Annual groundwater quality monitoring data, trend analyses, and interpretation;
- Groundwater level data trends and comparison to model predictions;
- Details regarding the groundwater monitoring network, predictive groundwater modelling validation, and dewatering scheme(s); and

- The annual groundwater monitoring report compiled by suitably qualified independent experts.

6.2 Springs, Groundwater Dependent Ecosystems or Baseflow Commitments

The reporting will include any revised predictive modelling and comments regarding potential impacts on the sensitive ecosystems. All details of proposed aquifer management studies and implemented remediation schemes will be provided to the administering authority.

The GMP will closely link to the Groundwater Dependent Ecosystems Management Plan developed by Adani specifically the Doongmabulla, Mellaluka, Carmichael River and Waxy Cabbage Palm subplans. Data collected from the GMP will assist in the monitoring of the ecological health at these Groundwater Dependent Ecosystems and will allow for the identification of potential stress and consequently requirements for mitigation and management measures as outlined in the subplans.

6.3 Monitoring Program Updates

The groundwater monitoring program will evolve and respond to the various stages of the mining project, i.e. the groundwater monitoring program will be different depending on the different phases on mining including baseline, construction, operations, and closure.

In order to develop the optimum groundwater monitoring plan Adani proposes a phased approach, which will allow for the correct scientific development of the program and allow for variation over time to suit the site / mining phases.

The revised GMP, prior to the implementation of the next phase of mining, will be submitted for approval with the administering authority.

7 REFERENCES

- National Water Commission (NWC), 2012. Minimum Construction Requirements for Water Bores in Australia 3rd Edition, National Uniform Drillers Licensing Committee, 2011
- EM1088 Baseline Assessments: http://www.ehp.qld.gov.au/management/non-mining/documents/baseline-assessment-guideline.pdf
- EM1178 Bore Assessment Guidelines: http://www.ehp.qld.gov.au/management/non-mining/documents/bore-assessment-guideline.pdf
- Make good obligations http://www.agforceqld.org.au/file.php?id=1014&open=yes
- Great Artesian Basin Consultative Council (GABCC), 1998. Great Artesian Basin Resource Study, November 1998
- Department of Natural Resources and Mines (NRM), 2013a. Minimum standards for the construction and reconditioning of water bores that intersect the sediments of artesian basins in Queensland, State of Queensland, September 2013
- Department of Natural Resources and Mines (NRM), 2013b. Water bore driller's licensing handbook, State of Queensland, September 2013

8 LIMITATIONS

8.1 Geotechnical & Hydro Geological Report

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Adani Mining Pty Ltd and only those third parties who have been authorised in writing by URS to rely on the report.

It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the contract dated December 2013.

The methodology adopted and sources of information used by URS are outlined in this the Report.

Where this report indicates that information has been provided to URS by third parties, URS has made no independent verification of this information unless required as part of the agreed scope of work. URS assumes no liability for any inaccuracies in or omissions to that information.

This Report was prepared between December 2013 and January 2014.The information in this report is considered to be accurate at the date of issue and is in accordance with conditions at the site at the dates sampled. Opinions and recommendations presented herein apply to the site existing at the time of our investigation and cannot necessarily apply to site changes of which URS is not aware and has not had the opportunity to evaluate. This document and the information contained herein should only be regarded as validly representing the site conditions at the time of the investigation unless otherwise explicitly stated in a preceding section of this report. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

This report contains information obtained by inspection, sampling, testing or other means of investigation. This information is directly relevant only to the points in the ground where they were obtained at the time of the assessment. The borehole logs indicate the inferred ground conditions only at the specific locations tested. The precision with which conditions are indicated depends largely on the uniformity of conditions and on the frequency and method of sampling as constrained by the project budget limitations. The behaviour of groundwater and some aspects of contaminants in soil and groundwater are complex. Our conclusions are based upon the analytical data presented in this report and our experience. Future advances in regard to the understanding of chemicals and their behaviour, and changes in regulations affecting their management, could impact on our conclusions and recommendations regarding their potential presence on this site.

Where conditions encountered at the site are subsequently found to differ significantly from those anticipated in this report, URS must be notified of any such findings and be provided with an opportunity to review the recommendations of this report.

Whilst to the best of our knowledge information contained in this report is accurate at the date of issue, subsurface conditions, including groundwater levels can change in a limited time.

Therefore this document and the information contained herein should only be regarded as valid at the time of the investigation unless otherwise explicitly stated in this report.

Except as required by law, no third party may use or rely on, this Report unless otherwise agreed by URS in writing. Where such agreement is provided, URS will provide a letter of reliance to the agreed third party in the form required by URS.

To the extent permitted by law, URS expressly disclaims and excludes liability for any loss, damage, cost or expenses suffered by any third party relating to or resulting from the use of, or reliance on, any information contained in this Report. URS does not admit that any action, liability or claim may exist or be available to any third party.

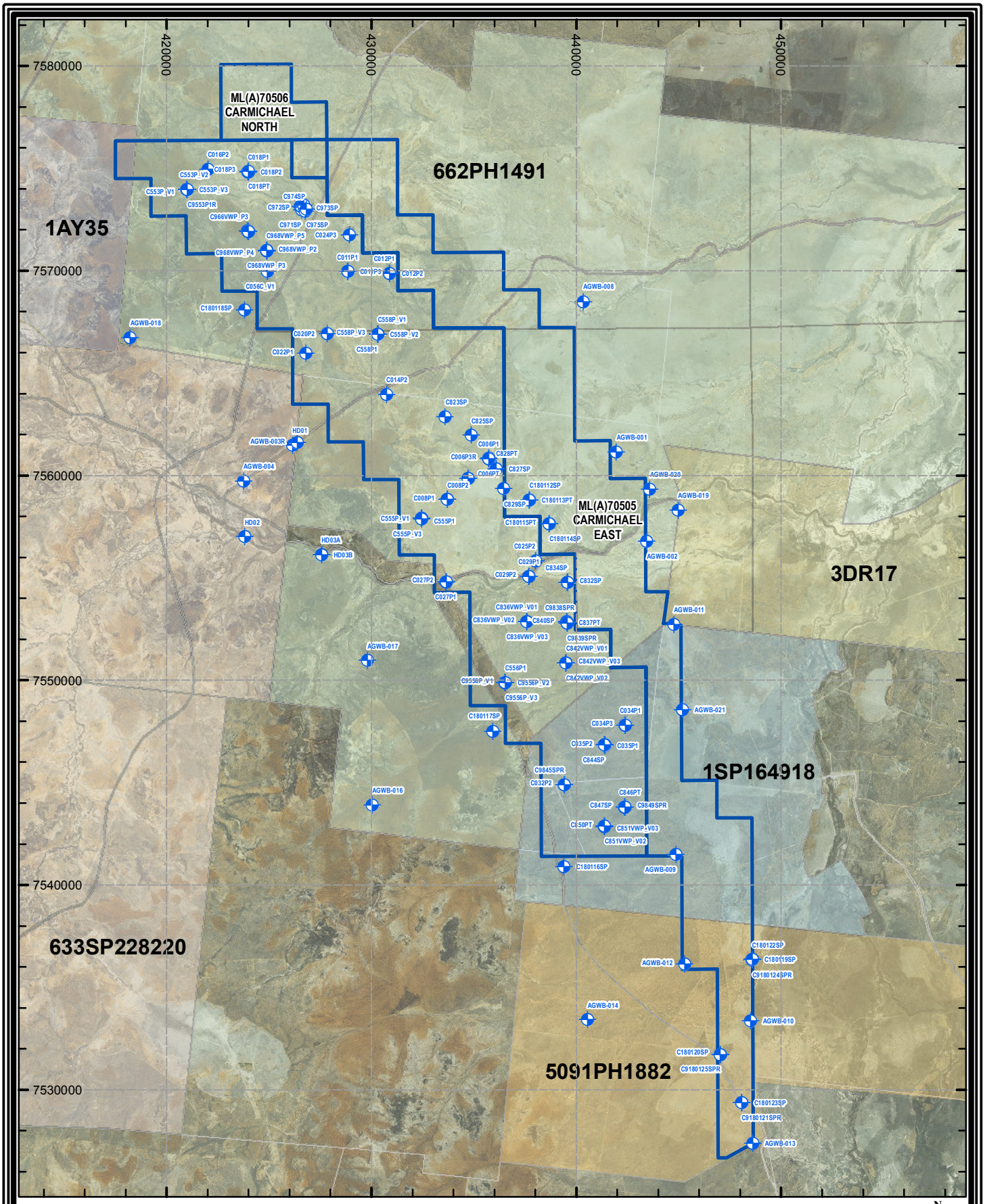
URS does not represent that this Report is suitable for use by any third party.

Except as specifically stated in this section, URS does not authorise the use of this Report by any third party.

It is the responsibility of third parties to independently make inquiries or seek advice in relation to their particular requirements and proposed use of the relevant property.

Any estimates of potential costs which have been provided are presented as estimates only as at the date of the Report. Any cost estimates that have been provided may therefore vary from actual costs at the time of expenditure.

APPENDIX A MAPS OF GROUNDWATER MONITORING BORES



Carmichael Mine Development

Project Approvals

Mining Lease (Application) Boundary
Road
Track
Major Drainage (1: 250k GA)
Minor Drainage (1: 250k GA)
Cadastral Boundary

adani™

Groundwater Monitoring Bores

Bores - All

Drawn By:	Chris Schlebusch
Checked by:	Srinivasa Yarlagadda
Date:	2014-03-03

Sheet No.
CCMP-ADERC-MAP-EN-0027 (B)

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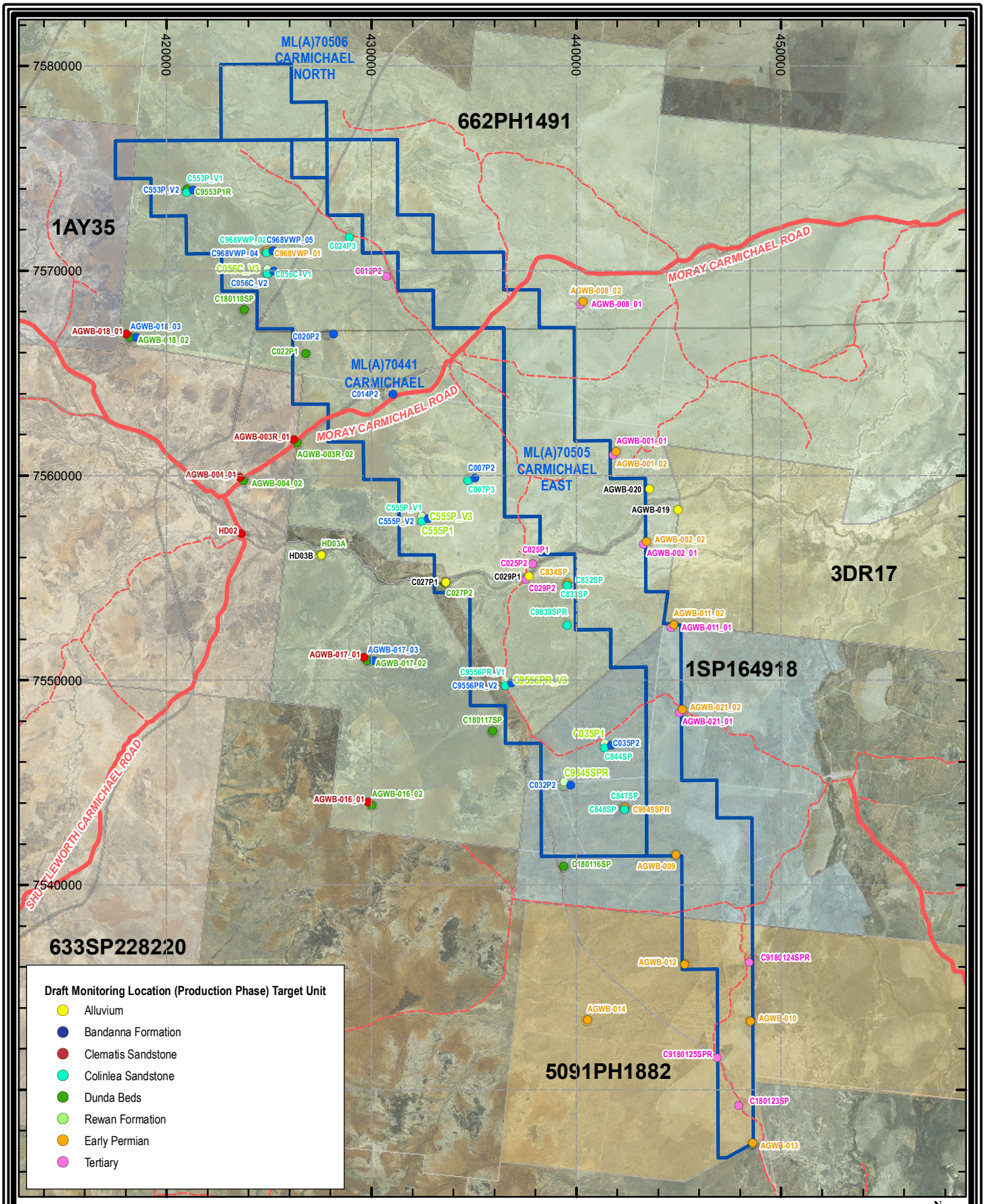

Carmichael Mine Development

Project Approvals

Mining Lease (Application) Boundary
Road
Track
Major Drainage (1: 250k GA)
Minor Drainage (1: 250k GA)
Cadastral Boundary

adani

Groundwater Monitoring Bores

Production Phase - Draft

Drawn By:	Chris Schlebusch
Checked by:	Srinivasa Yarlagadda
Date:	2014-03-03

Sheet No.
CCMP-ADERC-MAP-EN-0037(C)

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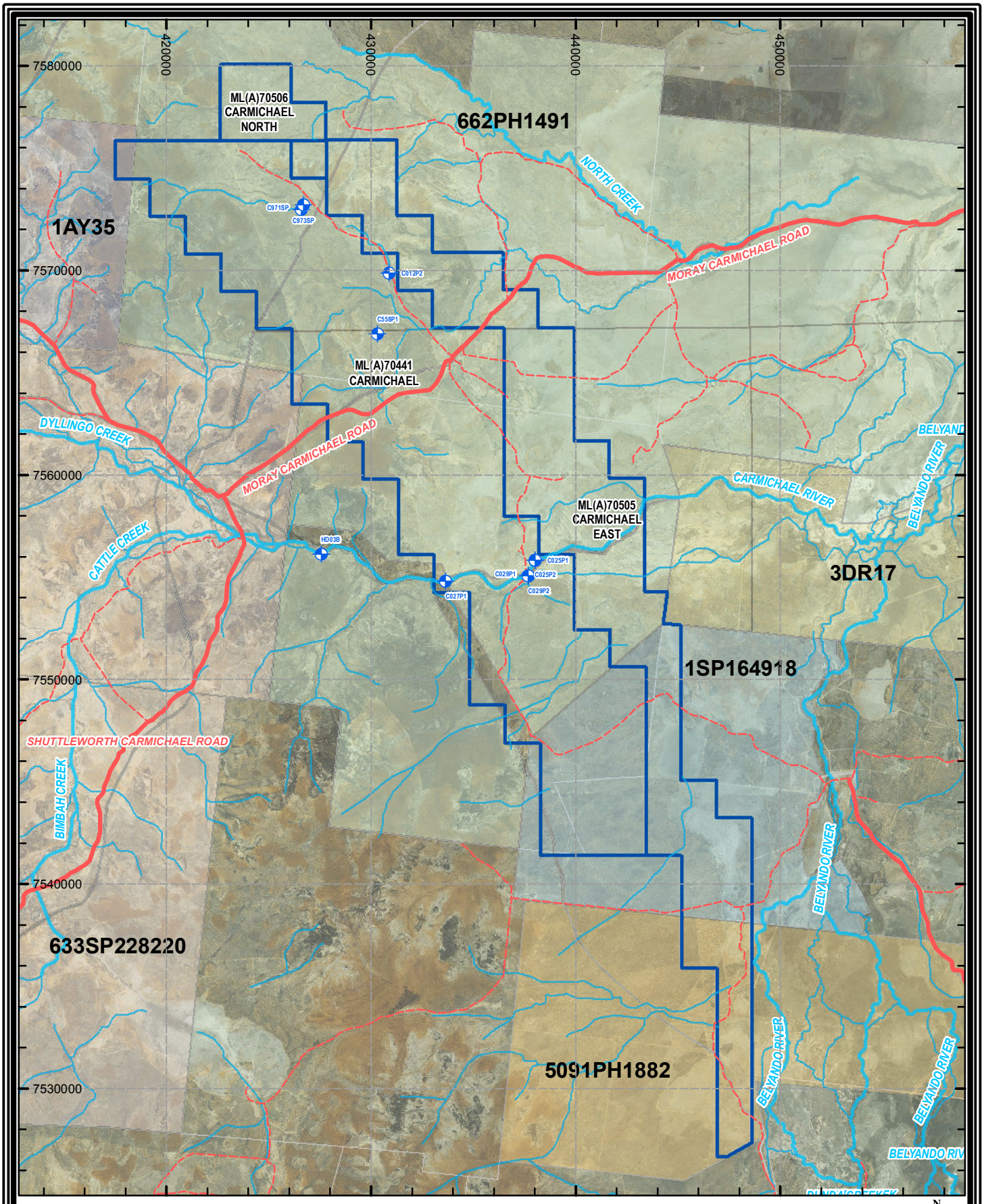

Carmichael Mine Development

Project Approvals

Mining Lease (Application) Boundary
Road
Track
Major Drainage (1: 250k GA)
Minor Drainage (1: 250k GA)
Cadastral Boundary
Monitoring Bore

adani™

Groundwater Monitoring Bores Alluvial and Tertiary Units

Drawn By:	Chris Schlebusch
Checked by:	Srinivasa Yarlagadda
Date:	2014-01-21
Sheet No.	CCMP-ADERC-MAP-EN-0020 (A)

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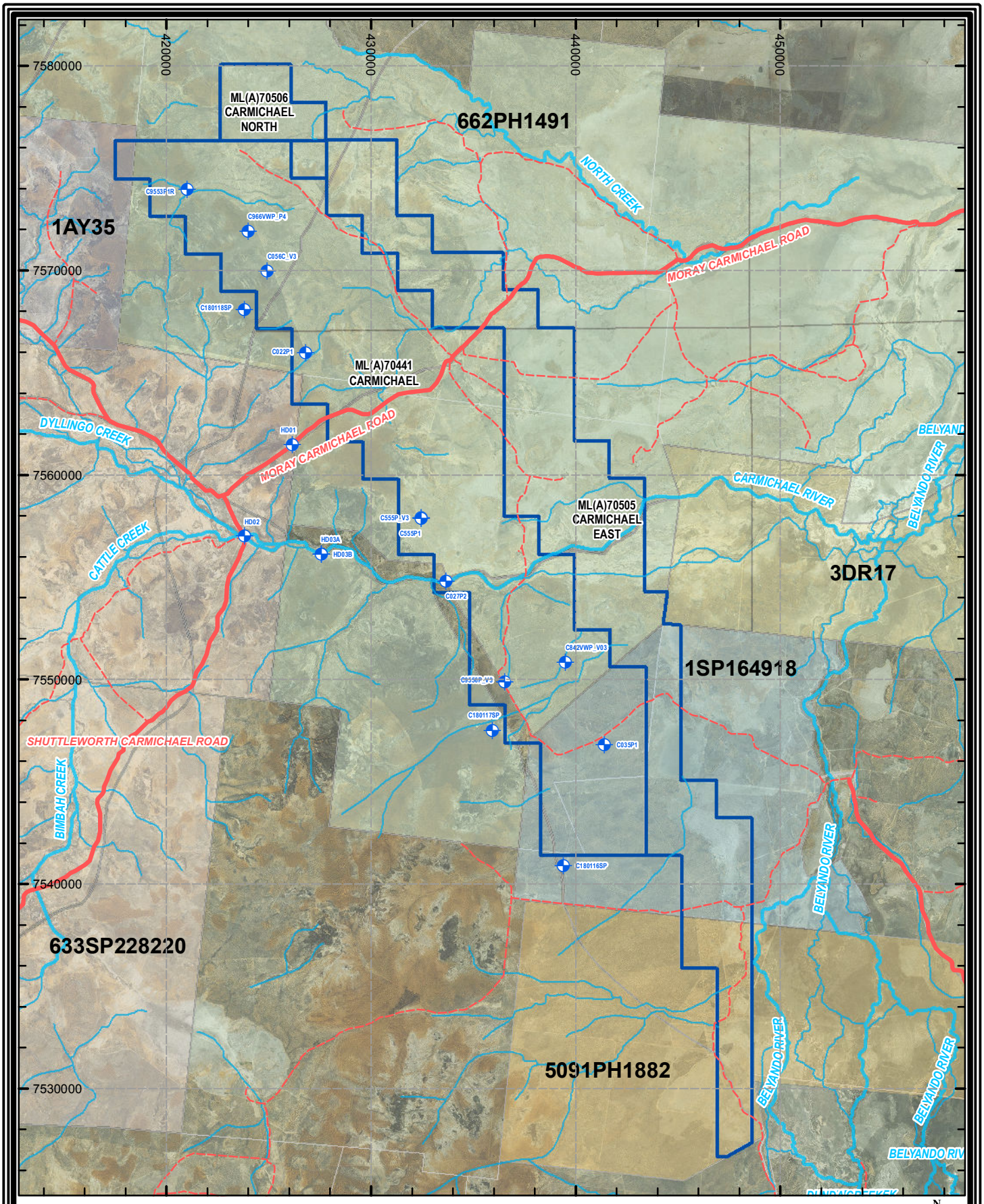

0 1 2 3 4 5
Kilometers

GDA94
MGA Zone 55

Carmichael Mine Development

Project Approvals

N
W E
S

Mining Lease (Application) Boundary
Road
Track
Major Drainage (1: 250k GA)
Minor Drainage (1: 250k GA)
Cadastral Boundary
Monitoring Bore

adani

Groundwater Monitoring Bores

GAB Units

Drawn By:	Chris Schlebusch
Checked by:	Srinivasa Yarlagadda
Date:	2014-01-21

Sheet No.
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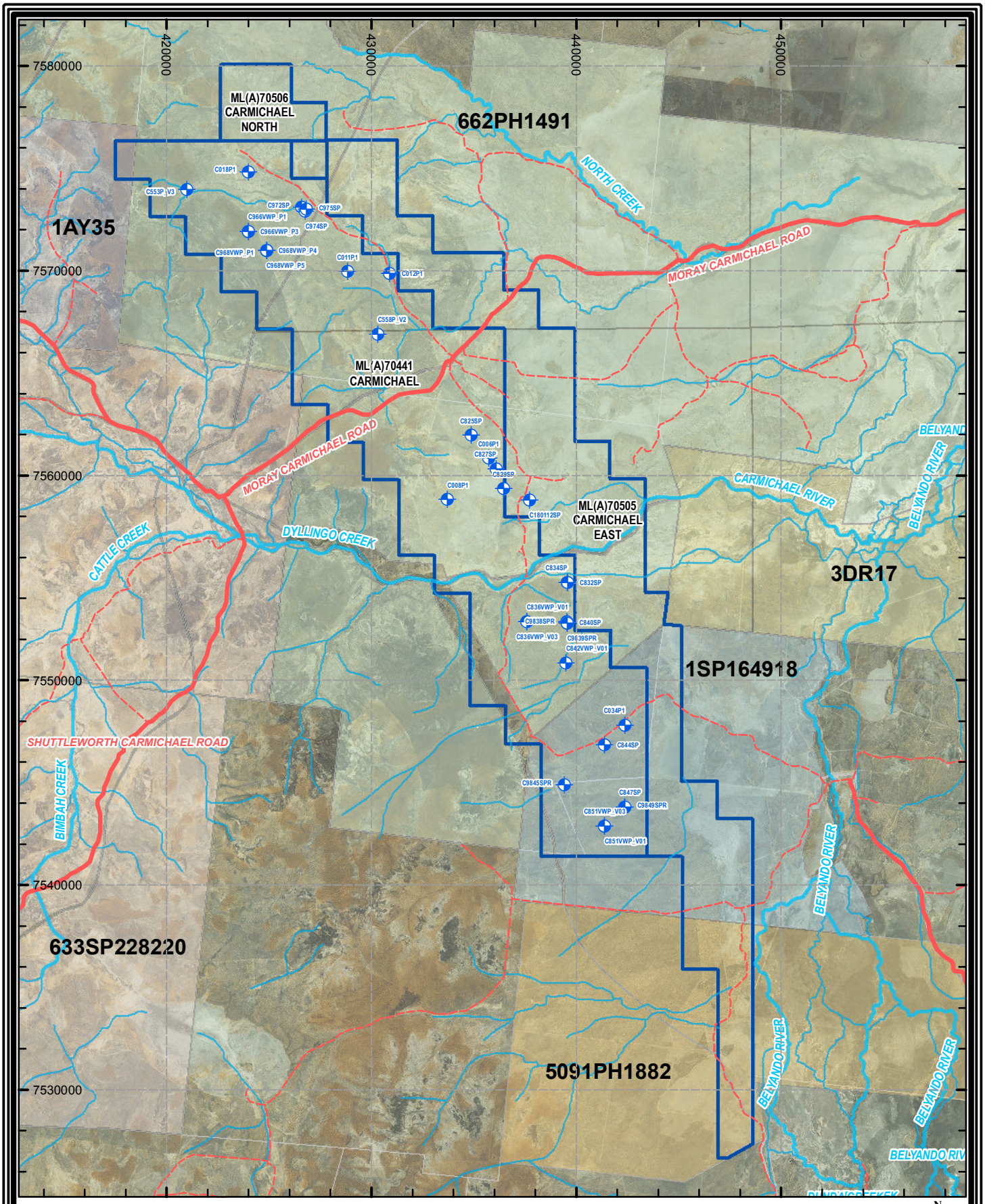

0 1 2 3 4 5
Kilometers

GDA94
MGA Zone 55

Carmichael Mine Development

Project Approvals

N
W E
S

- Mining Lease (Application) Boundary
- Road
- Track
- Major Drainage (1: 250k GA)
- Minor Drainage (1: 250k GA)
- Cadastral Boundary
- Monitoring Bore

adani™

Groundwater Monitoring Bores Bandana and Colinlea Sandstone

Drawn By:	Chris Schlebusch
Checked by:	Srinivasa Yarlagadda
Date:	2014-01-21

Sheet No.
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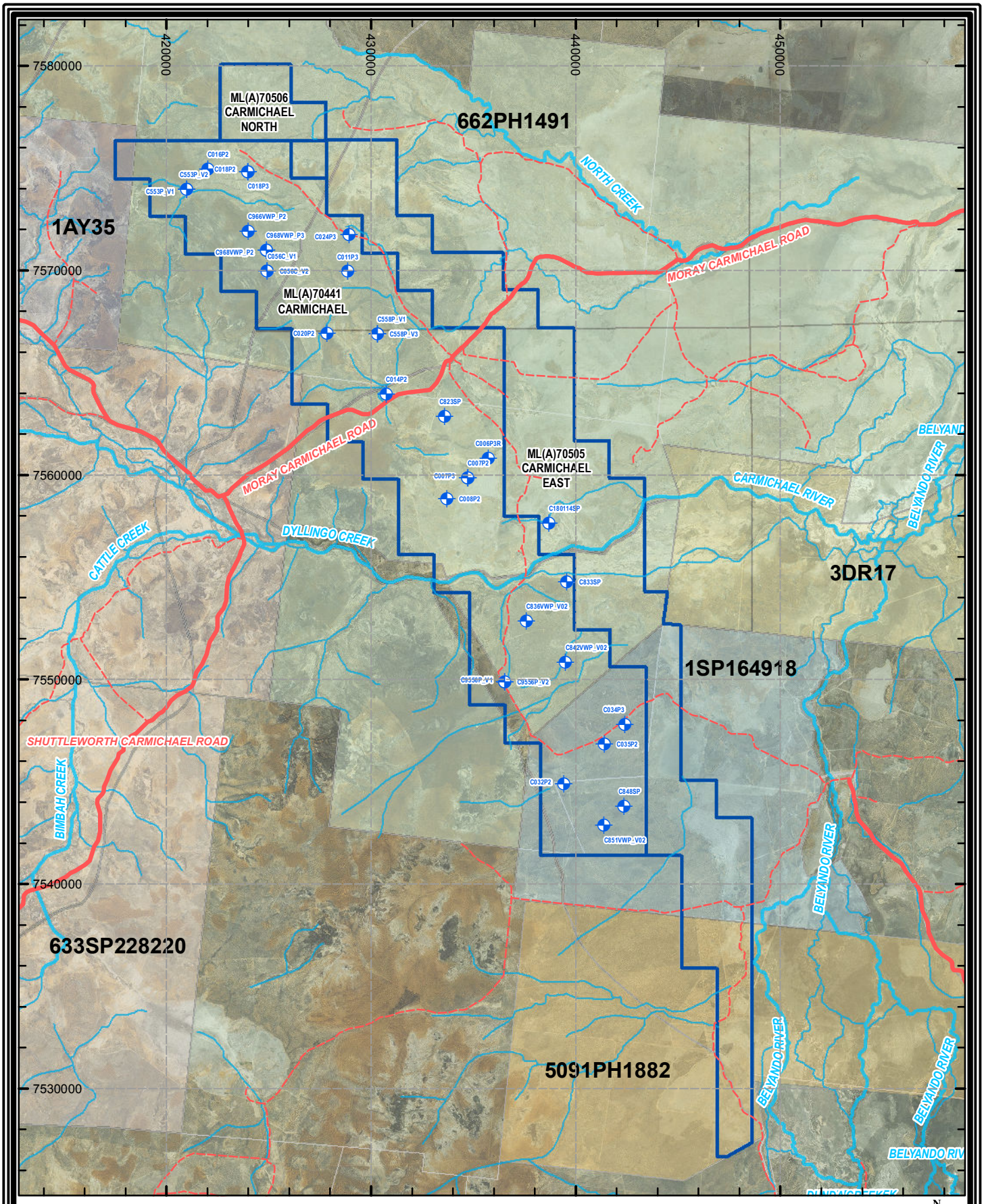

Carmichael Mine Development

Project Approvals

Mining Lease (Application) Boundary
Road
Track
Major Drainage (1: 250k GA)
Minor Drainage (1: 250k GA)
Cadastral Boundary
Monitoring Bore

adani

Groundwater Monitoring Bores

Coal Seams

Drawn By:	Chris Schlebusch
Checked by:	Srinivasa Yarlagadda
Date:	2014-01-21

Sheet No.
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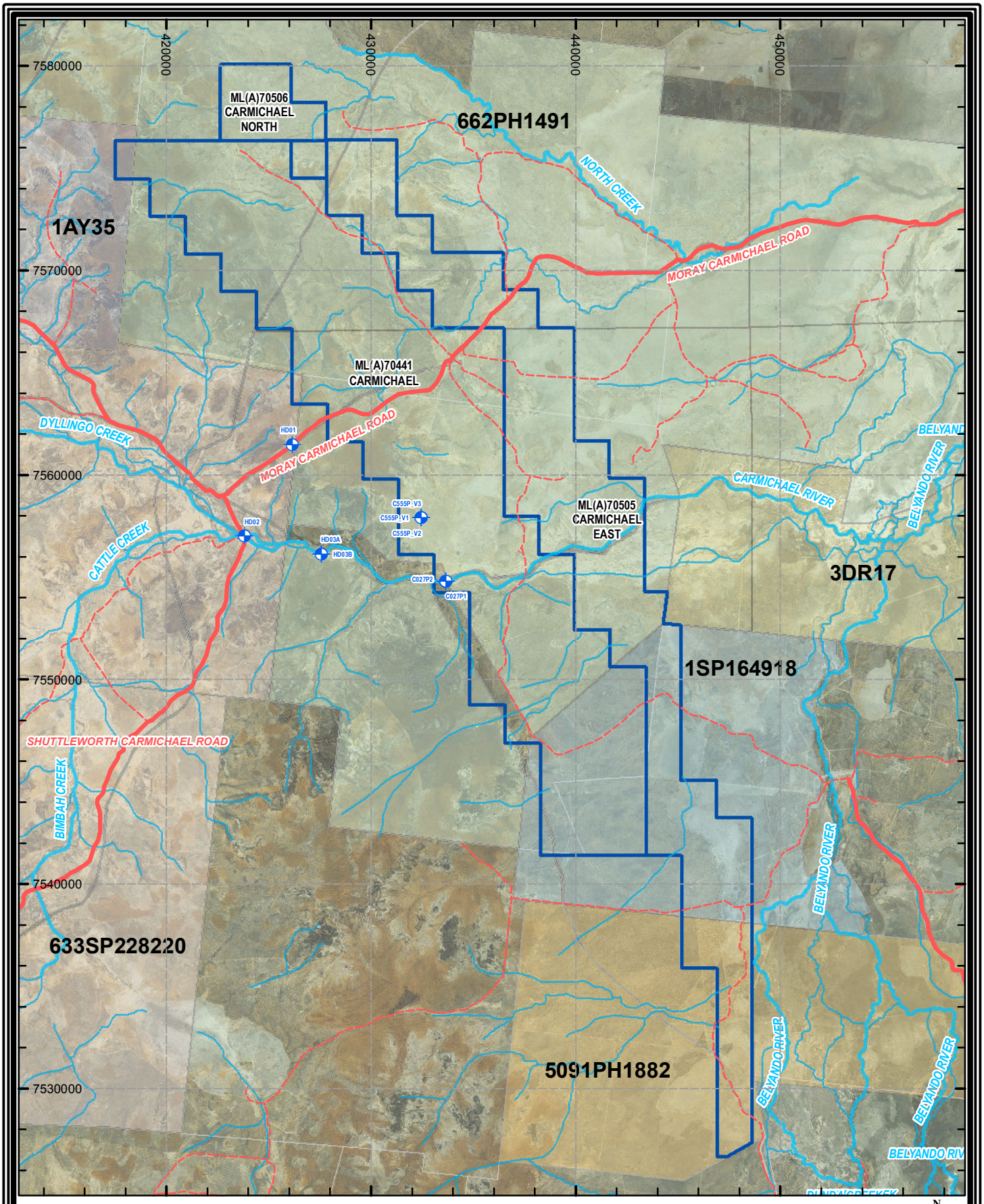

Carmichael Mine Development

Project Approvals

Mining Lease (Application) Boundary
Road
Track
Major Drainage (1: 250k GA)
Minor Drainage (1: 250k GA)
Cadastral Boundary
Monitoring Bore

adani™

Groundwater Monitoring Bores

Doongmabulla

Drawn By:	Chris Schlebusch
Checked by:	Srinivasa Yarlagadda
Date:	2014-01-21

Sheet No.
CCMP-ADERC-MAP-EN-0017 (A)

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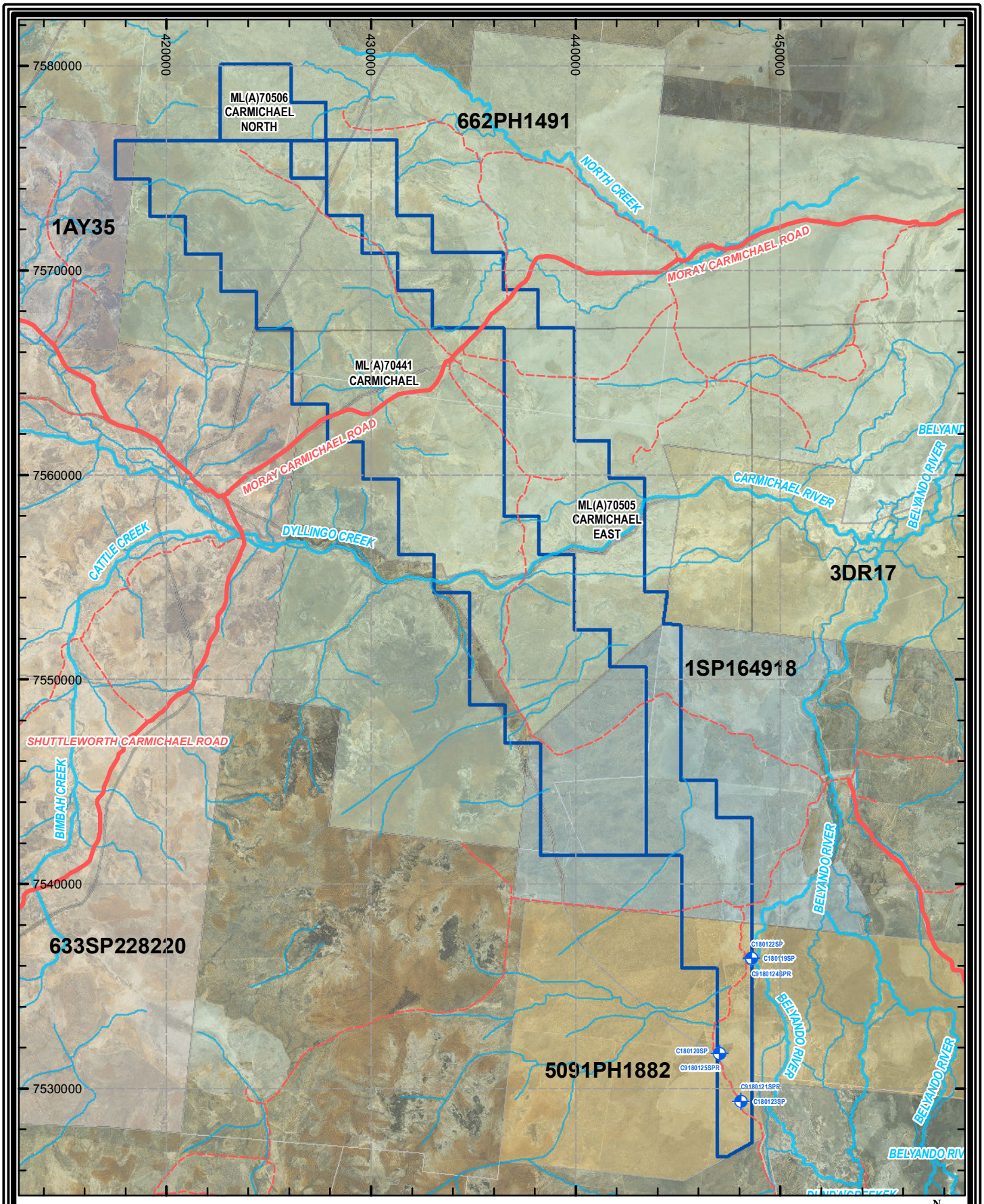

0 1 2 3 4 5
Kilometers

GDA94
MGA Zone 55

Carmichael Mine Development

Project Approvals

N
W E
S

Mining Lease (Application) Boundary
Road
Track
Major Drainage (1: 250k GA)
Minor Drainage (1: 250k GA)
Cadastral Boundary
Monitoring Bore

adani

Groundwater Monitoring Bores

Mellaluka

Drawn By:	Chris Schlebusch
Checked by:	Srinivasa Yarlagadda
Date:	2014-01-21

Sheet No.
CCMP-ADERC-MAP-EN-0018 (A)

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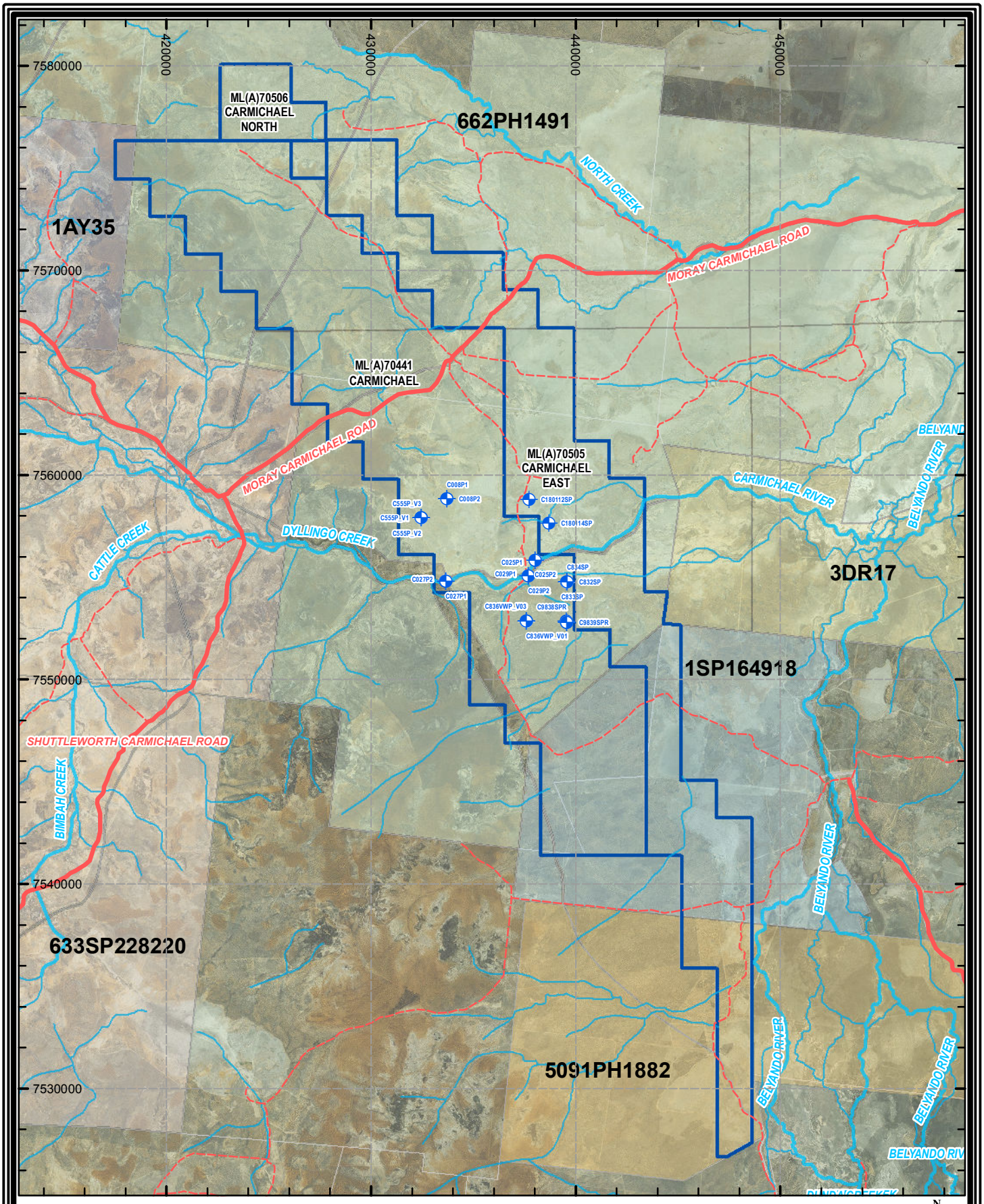

0 1 2 3 4 5
Kilometers

GDA94
MGA Zone 55

Carmichael Mine Development

Project Approvals

N
W E
S

Mining Lease (Application) Boundary
Road
Track
Major Drainage (1: 250k GA)
Minor Drainage (1: 250k GA)
Cadastral Boundary
Monitoring Bore

adani™

Groundwater Monitoring Bores

Carmichael River

Drawn By:	Chris Schlebusch
Checked by:	Srinivasa Yarlagadda
Date:	2014-01-21

Sheet No.
CCMP-ADERC-MAP-EN-0016 (A)

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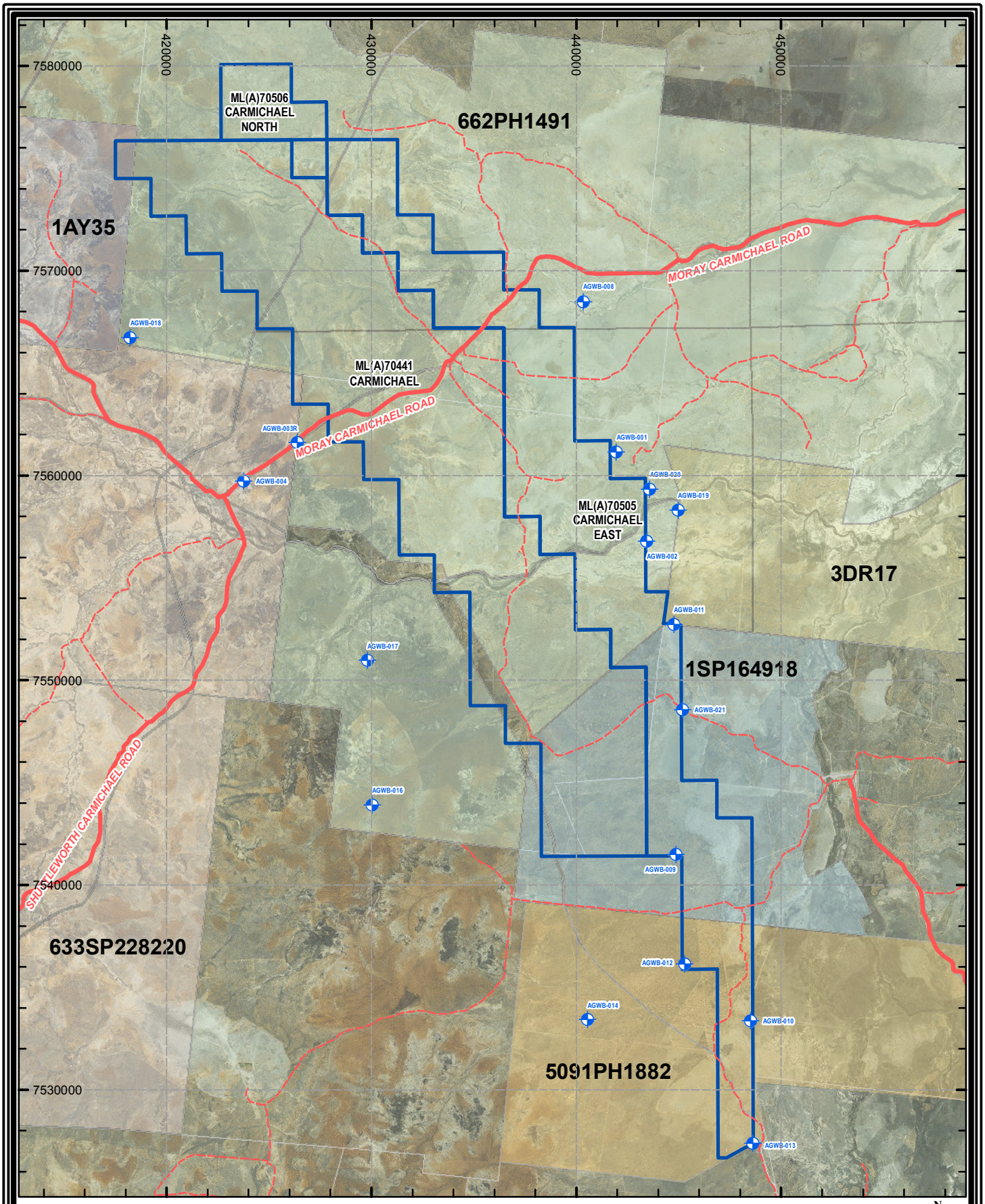

0 1 2 3 4 5
Kilometers

GDA94
MGA Zone 55

Carmichael Mine Development

Project Approvals

N
W E
S

- Mining Lease (Application) Boundary
- Road
- Track
- Major Drainage (1: 250k GA)
- Minor Drainage (1: 250k GA)
- Cadastral Boundary
- Monitoring Bore

adani™

Groundwater Monitoring Bores

Additional Bores

Drawn By:	Chris Schlebusch
Checked by:	Srinivasa Yarlagadda
Date:	2014-03-03

Sheet No.
CCMP-ADERC-MAP-EN-0026 (C)

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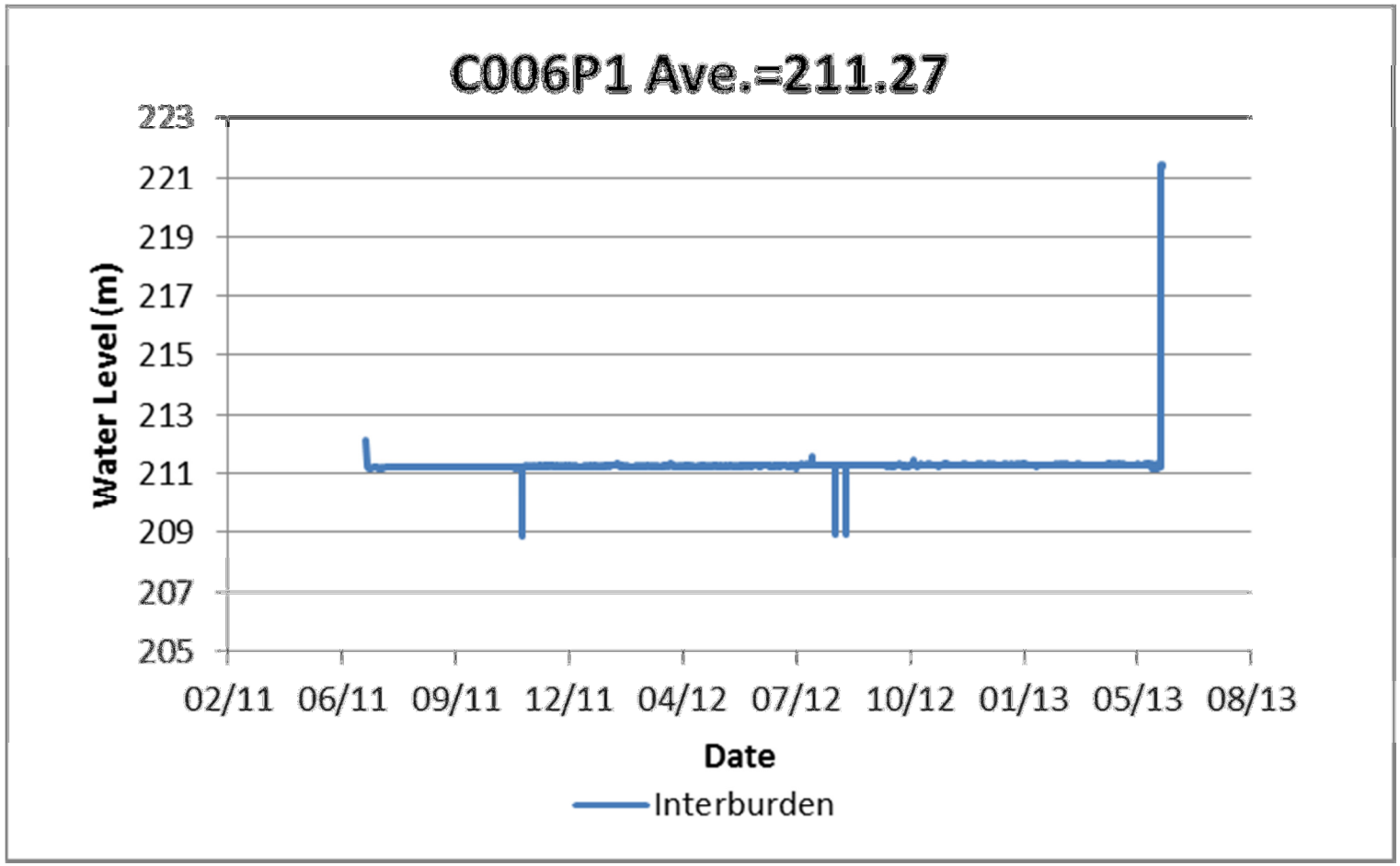
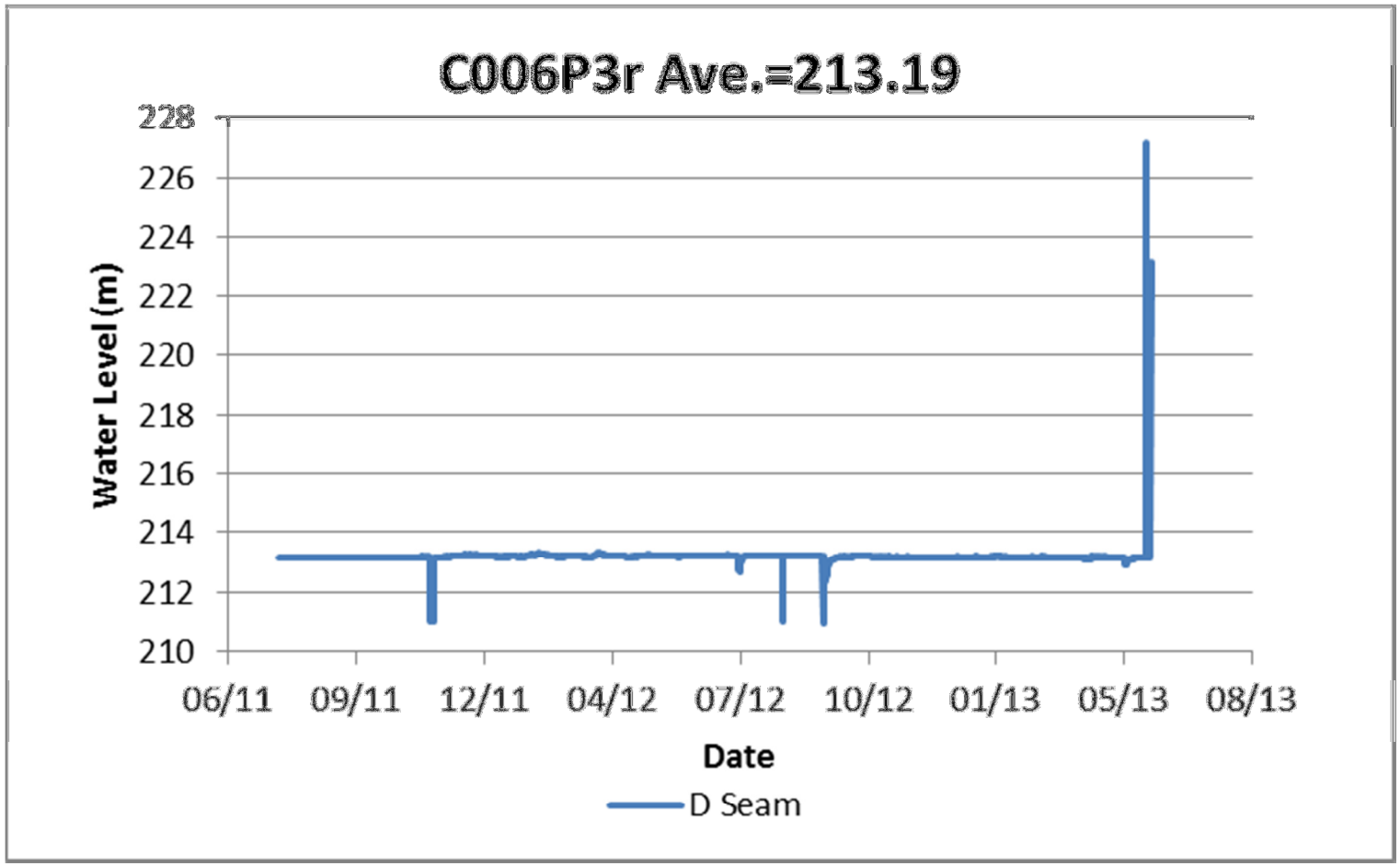
APPENDIX B GROUNDWATER LEVELS

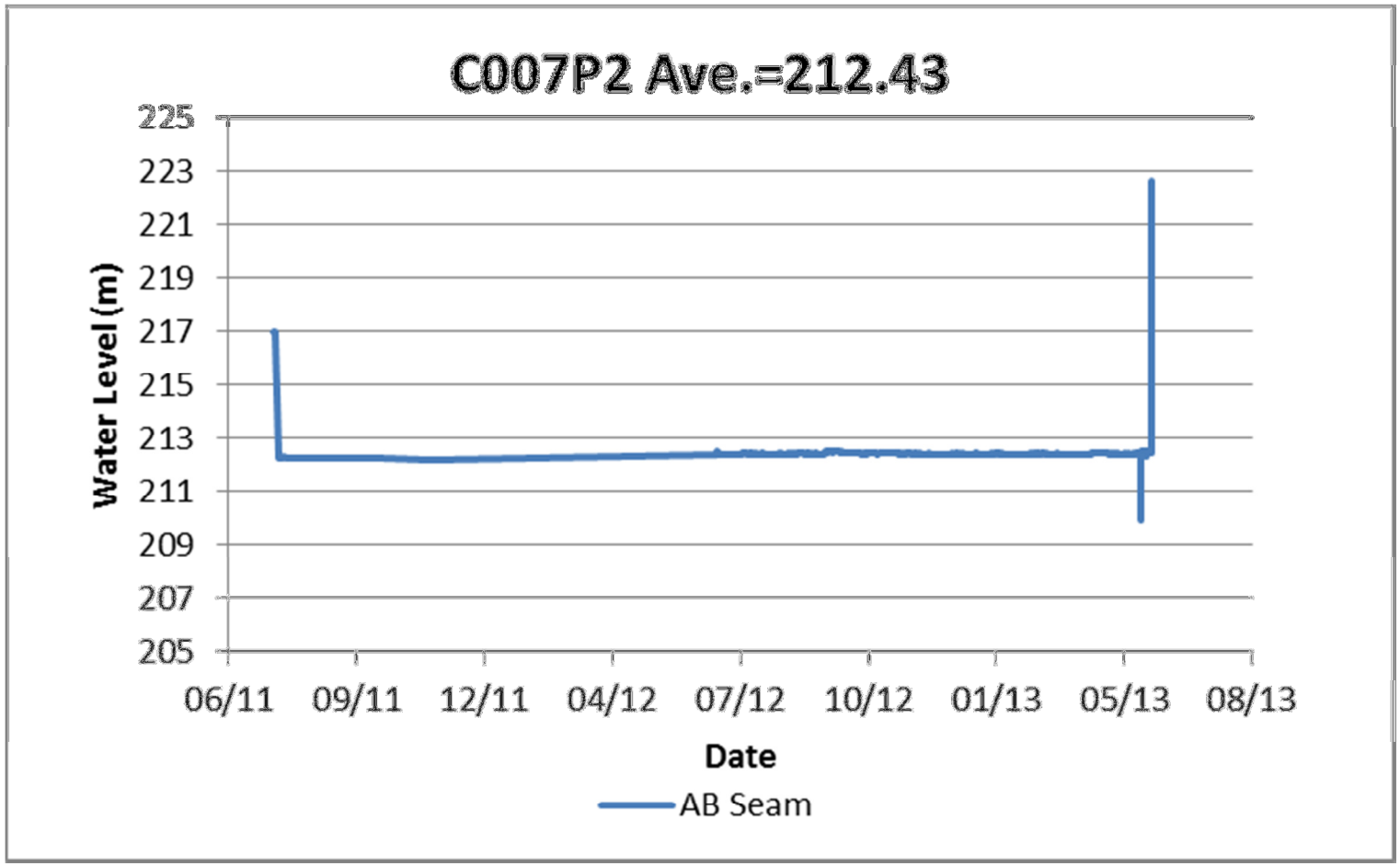
B.1 C006P1


C006P1 Ave.=211.27
223
221
219
217
215
213
211
209
207
205
Water Level (m)
02/11
06/11
09/11
12/11
04/12
07/12
10/12
01/13
05/13
08/13
Date
Interburden

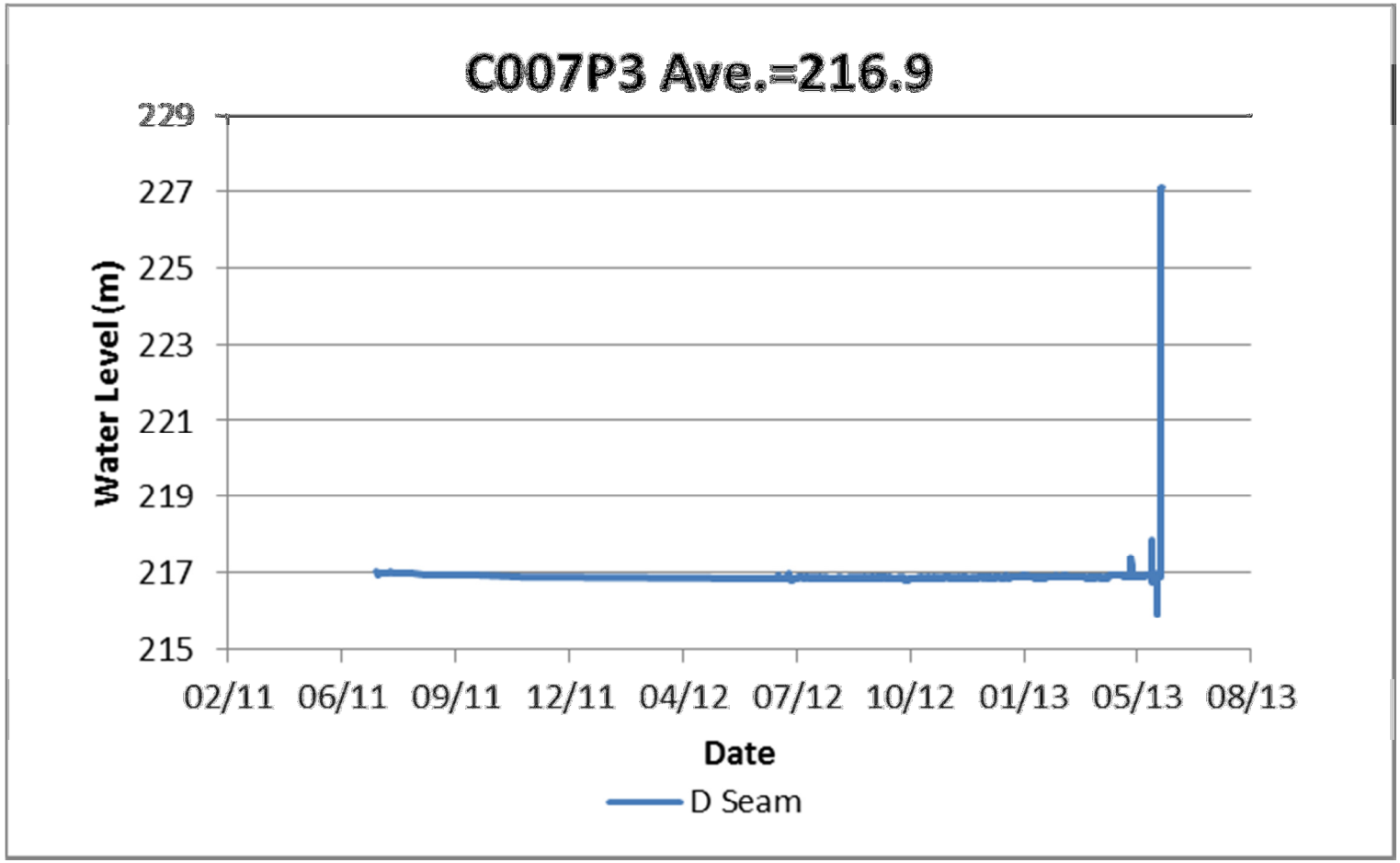
B.2 **C006P3r**


C006P3r Ave.=213.19
228
226
224
222
220
218
216
214
212
210
Water Level (m)
06/11
09/11
12/11
04/12
07/12
10/12
01/13
05/13
08/13
Date
D Seam

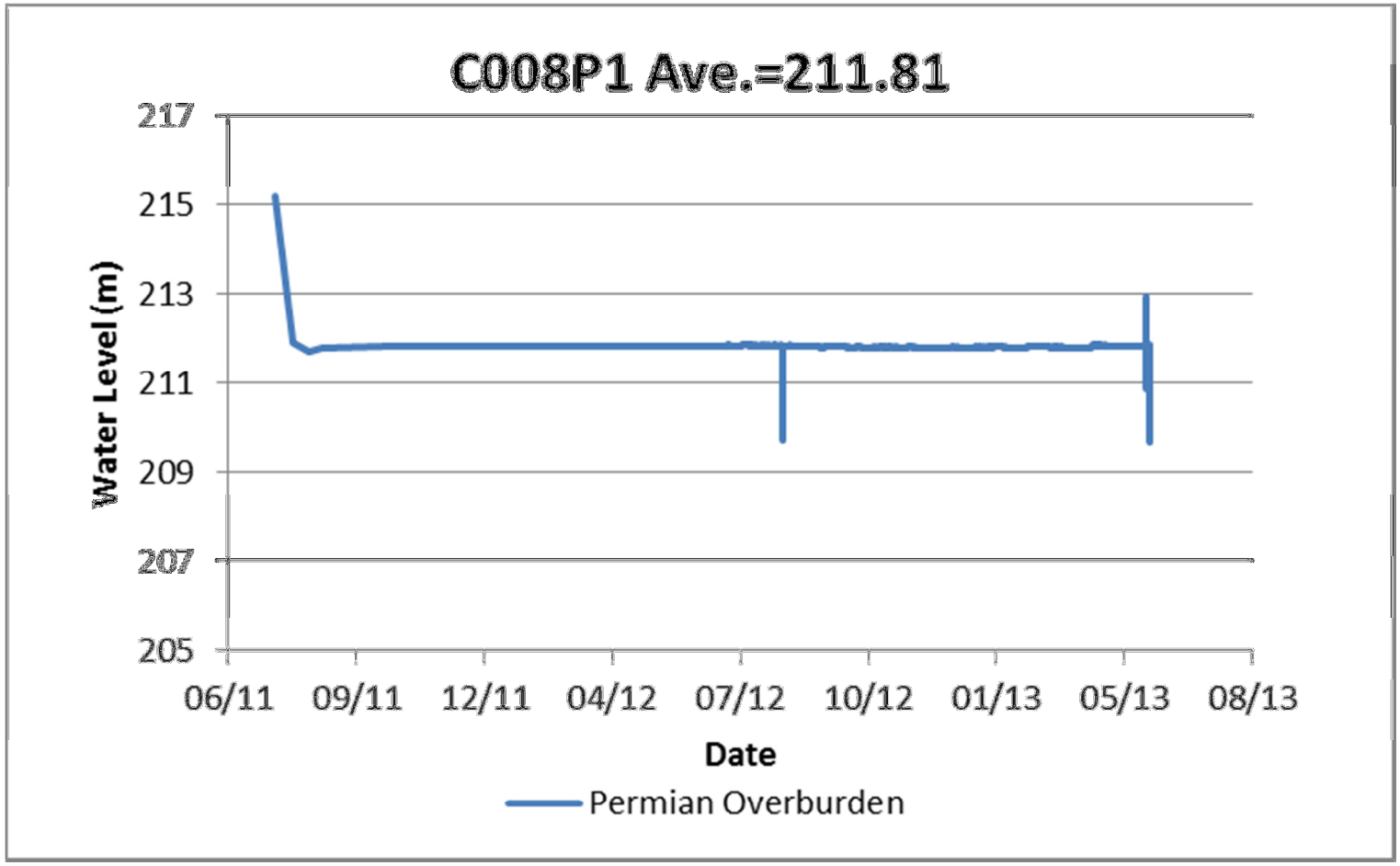
B.3 **C007P2**


C007P2 Ave.=212.43
225
223
221
219
217
215
213
211
209
207
205
Water Level (m)
06/11
09/11
12/11
04/12
07/12
10/12
01/13
05/13
08/13
Date
AB Seam

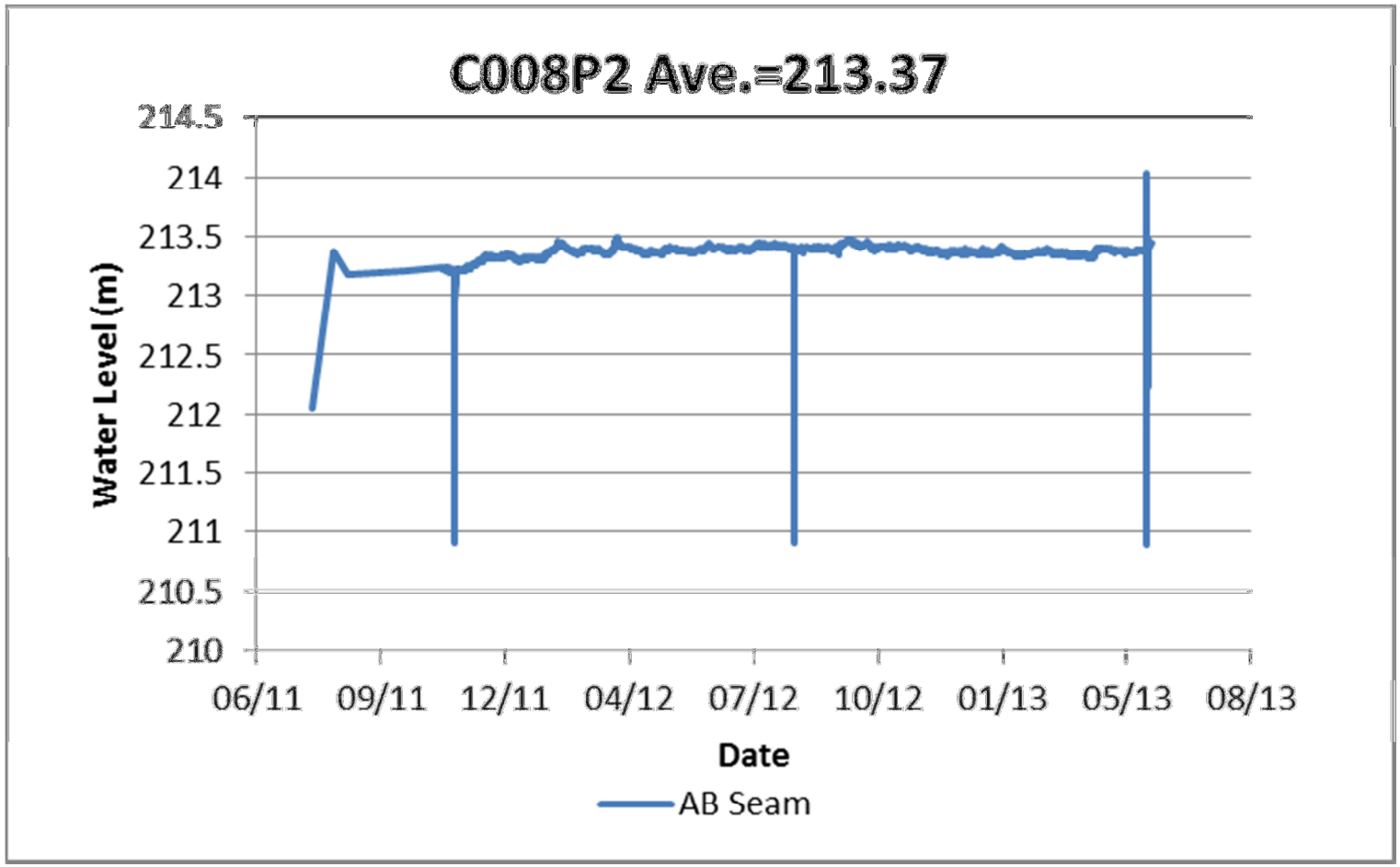
B.4 C007P3


C007P3 Ave.=216.9
229
227
225
223
221
219
217
215
Water Level (m)
02/11
06/11
09/11
12/11
04/12
07/12
10/12
01/13
05/13
08/13
Date
D Seam

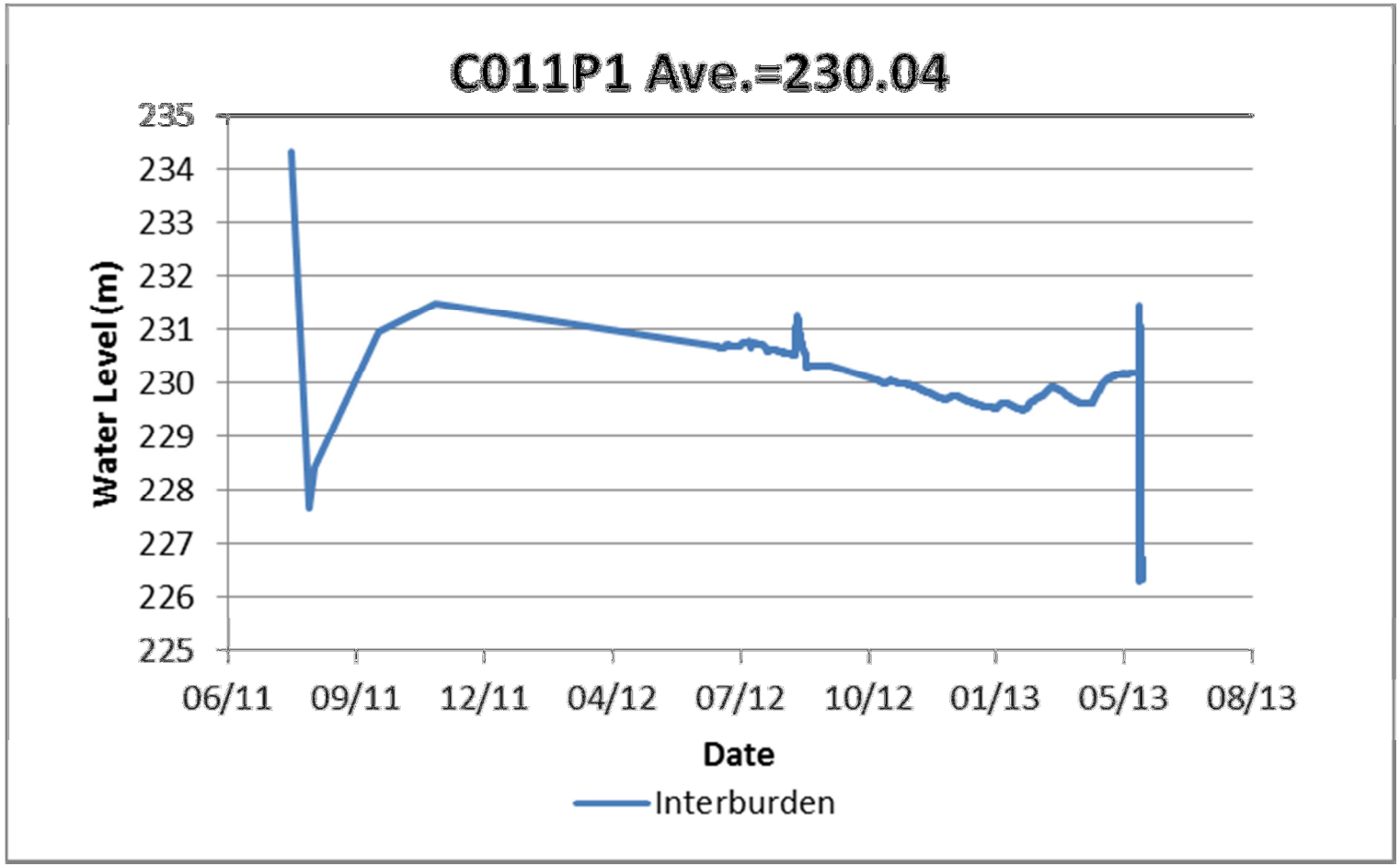
B.5 C008P1


C008P1 Ave.=211.81
217
215
213
211
209
207
205
Water Level (m)
06/11
09/11
12/11
04/12
07/12
10/12
01/13
05/13
08/13
Date
Permian Overburden

B.6 **C008P2**


C008P2 Ave.=213.37
214.5
214
213.5
213
212.5
212
211.5
211
210.5
210
Water Level (m)
06/11
09/11
12/11
04/12
07/12
10/12
01/13
05/13
08/13
Date
AB Seam

B.7 **C011P1**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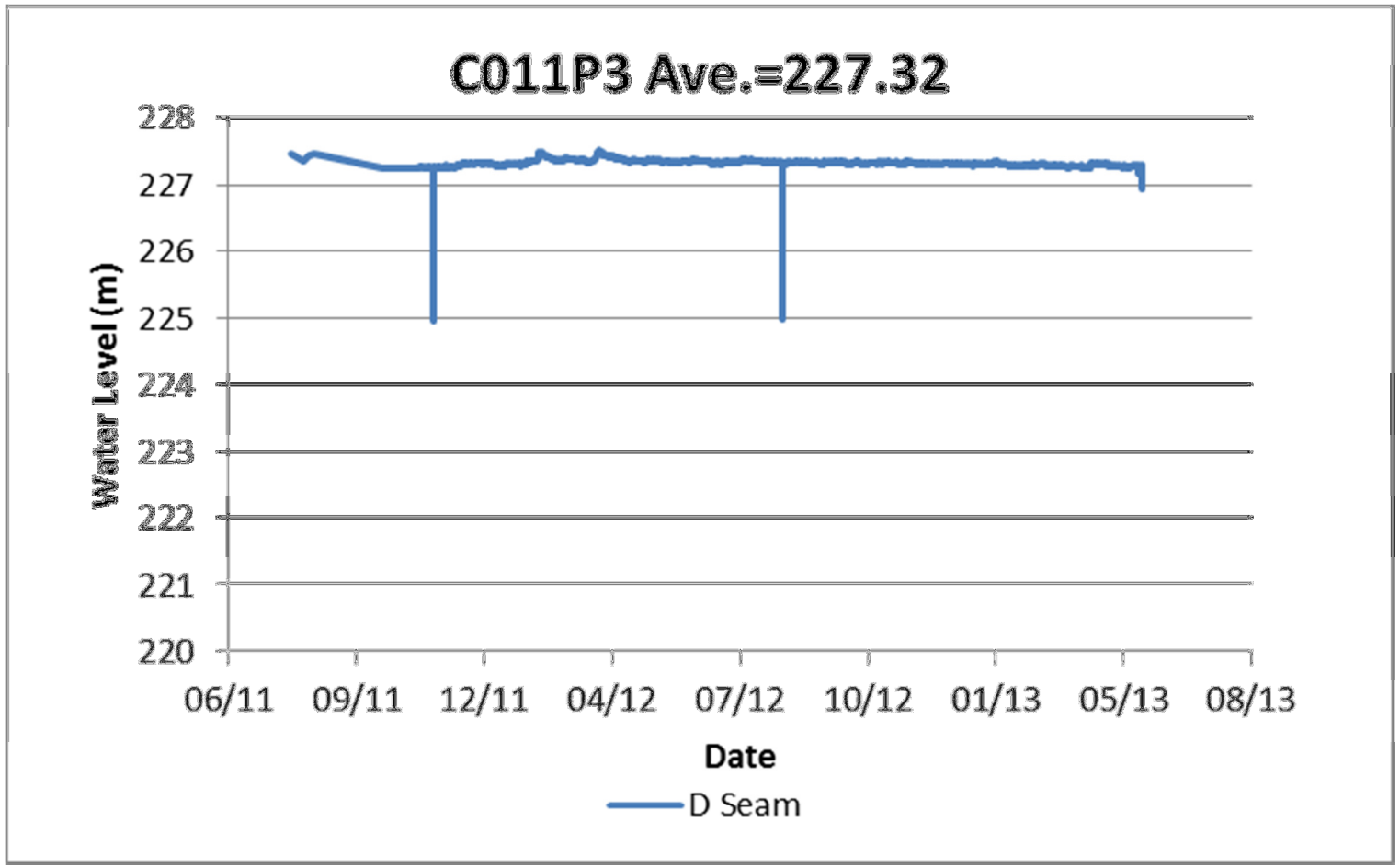
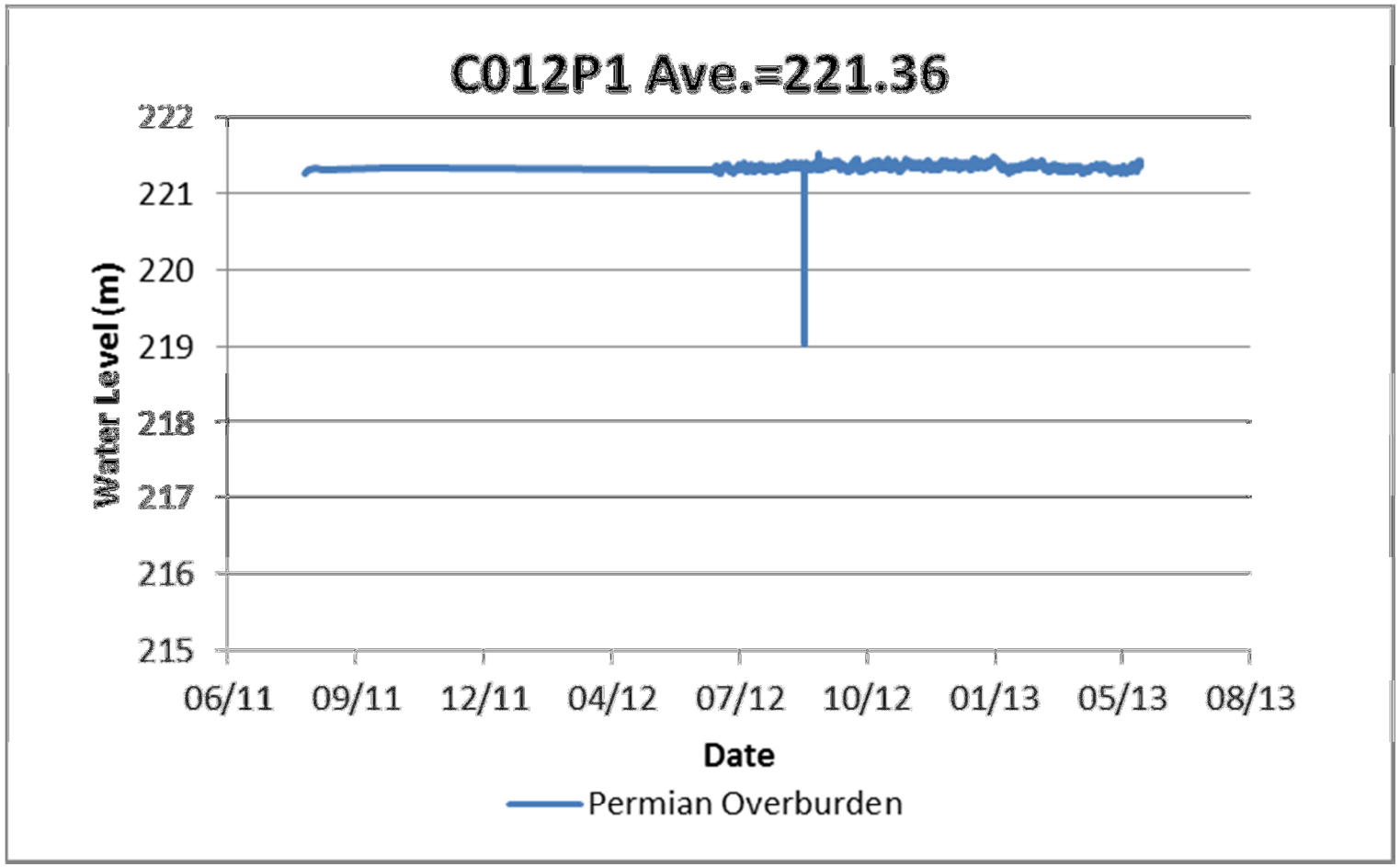
Water Level (m)
235
234
233
232
231
230
229
228
227
226
225
06/11
09/11
12/11
04/12
07/12
10/12
01/13
05/13
08/13
Date
Interburden

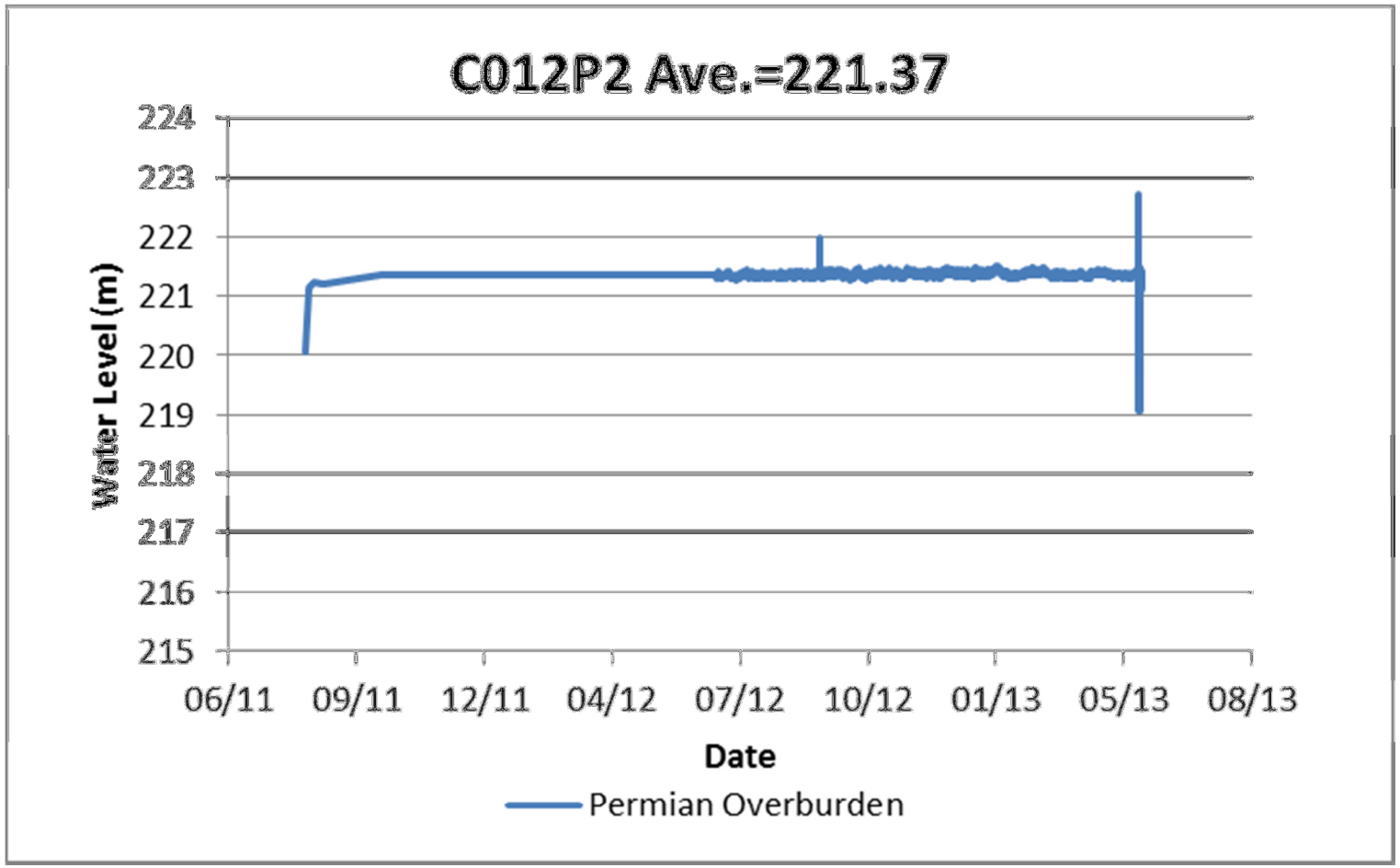
B.8 **C011P3**


C011P3 Ave.=227.32
228
227
226
225
224
223
222
221
220
Water Level (m)
06/11
09/11
12/11
04/12
07/12
10/12
01/13
05/13
08/13
Date
D Seam

B.9 C012P1


C012P1 Ave.=221.36
222
221
220
219
218
217
216
215
Water Level (m)
06/11
09/11
12/11
04/12
07/12
10/12
01/13
05/13
08/13
Date
Permian Overburden

B.10 C012P2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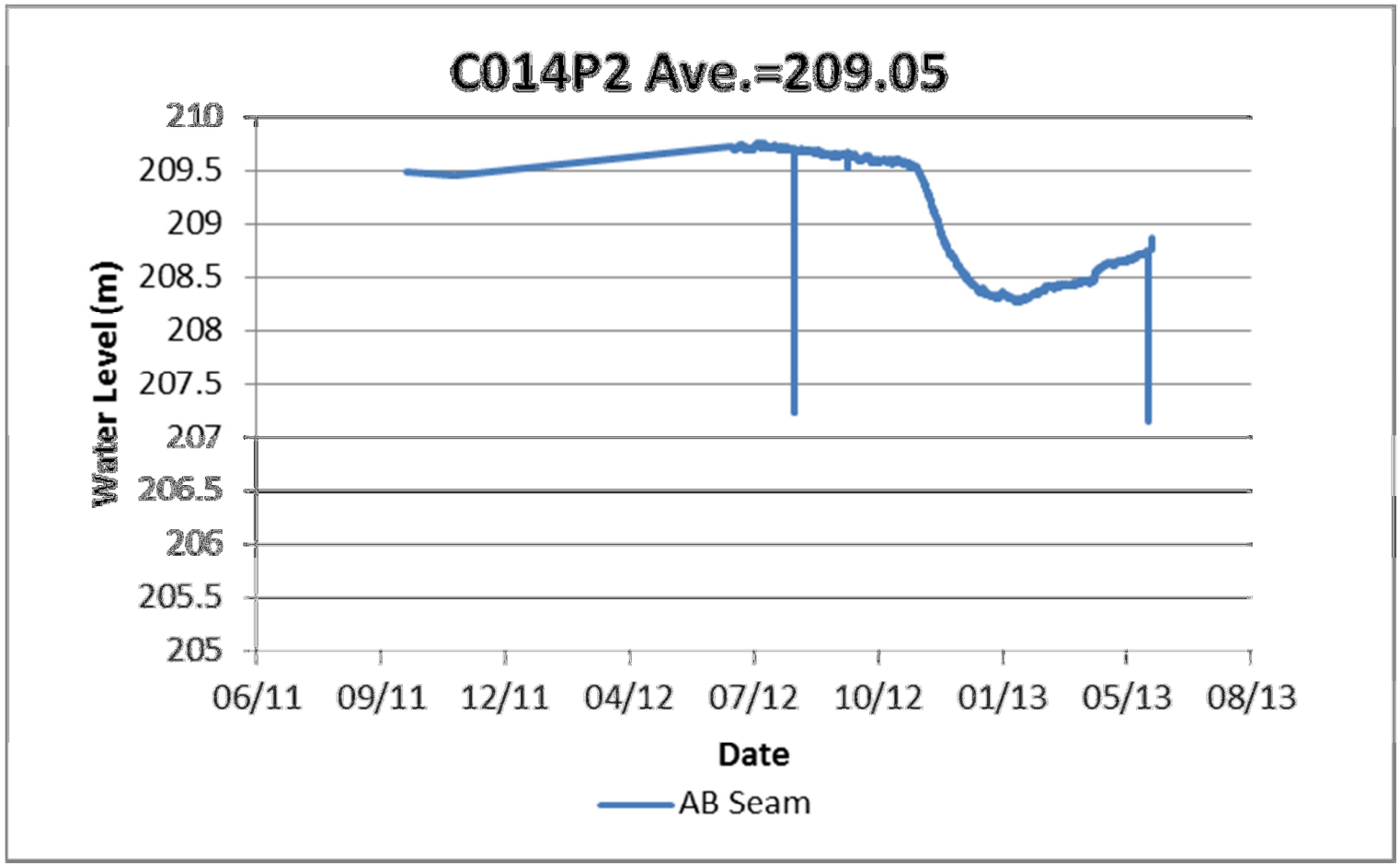
Water Level (m)
224
223
222
221
220
219
218
217
216
215
06/11
09/11
12/11
04/12
07/12
10/12
01/13
05/13
08/13
Date
Permian Overburden

B.11 **C014P2**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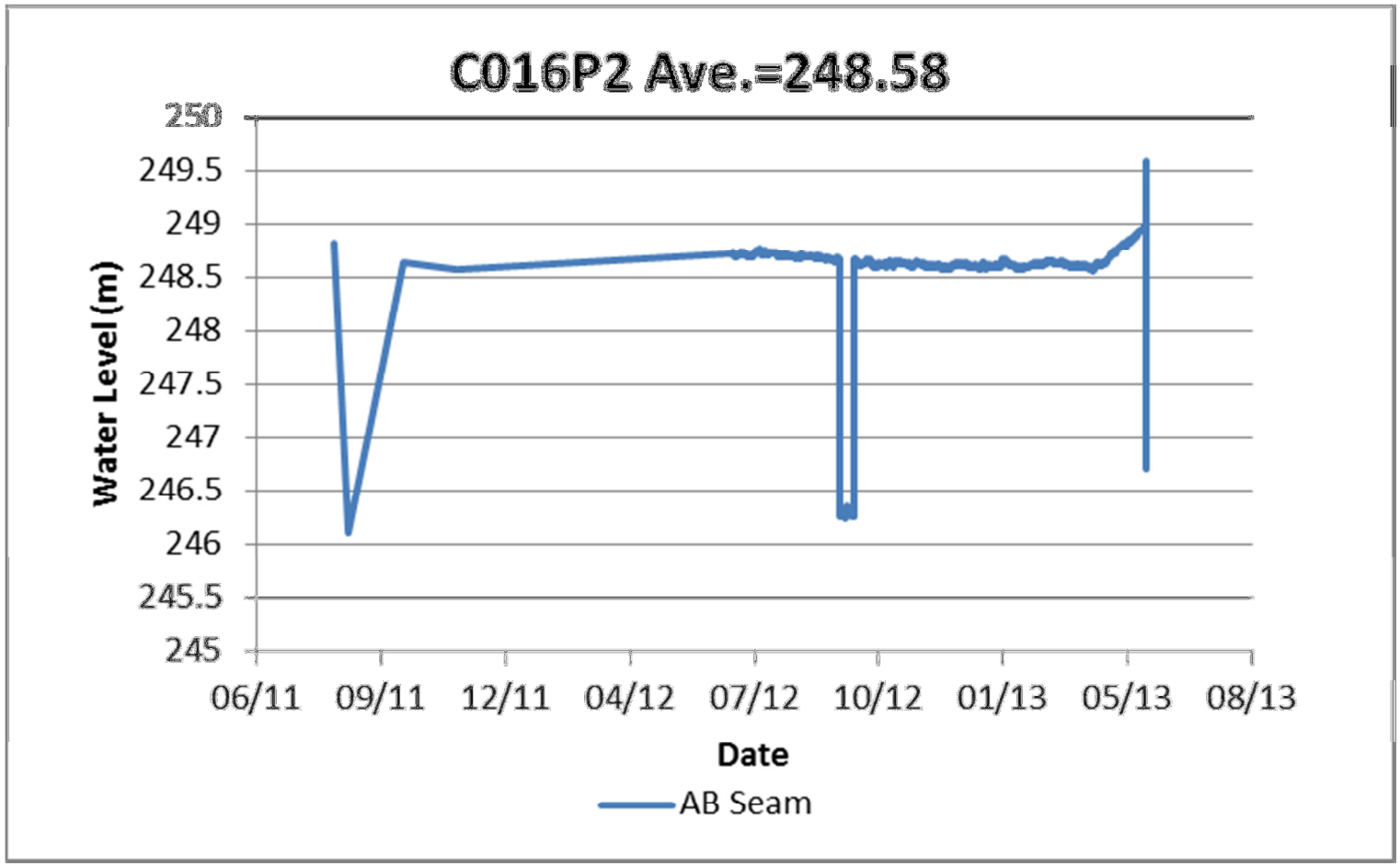
Water Level (m)
210
209.5
209
208.5
208
207.5
207
206.5
206
205.5
205
06/11
09/11
12/11
04/12
07/12
10/12
01/13
05/13
08/13
Date
AB Seam

B.12 **C016P2**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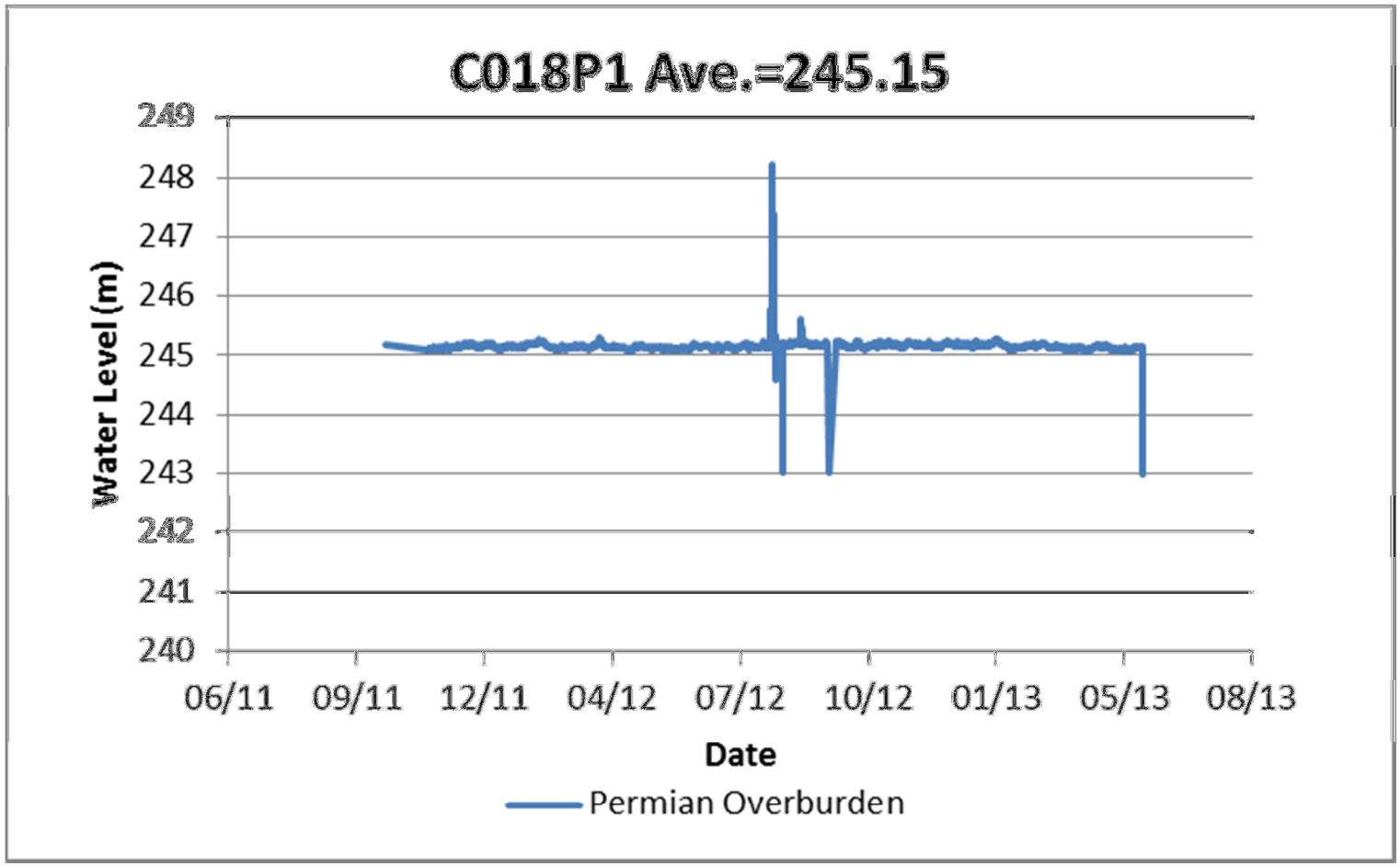
250
249.5
249
248.5
248
247.5
247
246.5
246
245.5
245
Water Level (m)
06/11
09/11
12/11
04/12
07/12
10/12
01/13
05/13
08/13
Date
AB Seam

B.13 C018P1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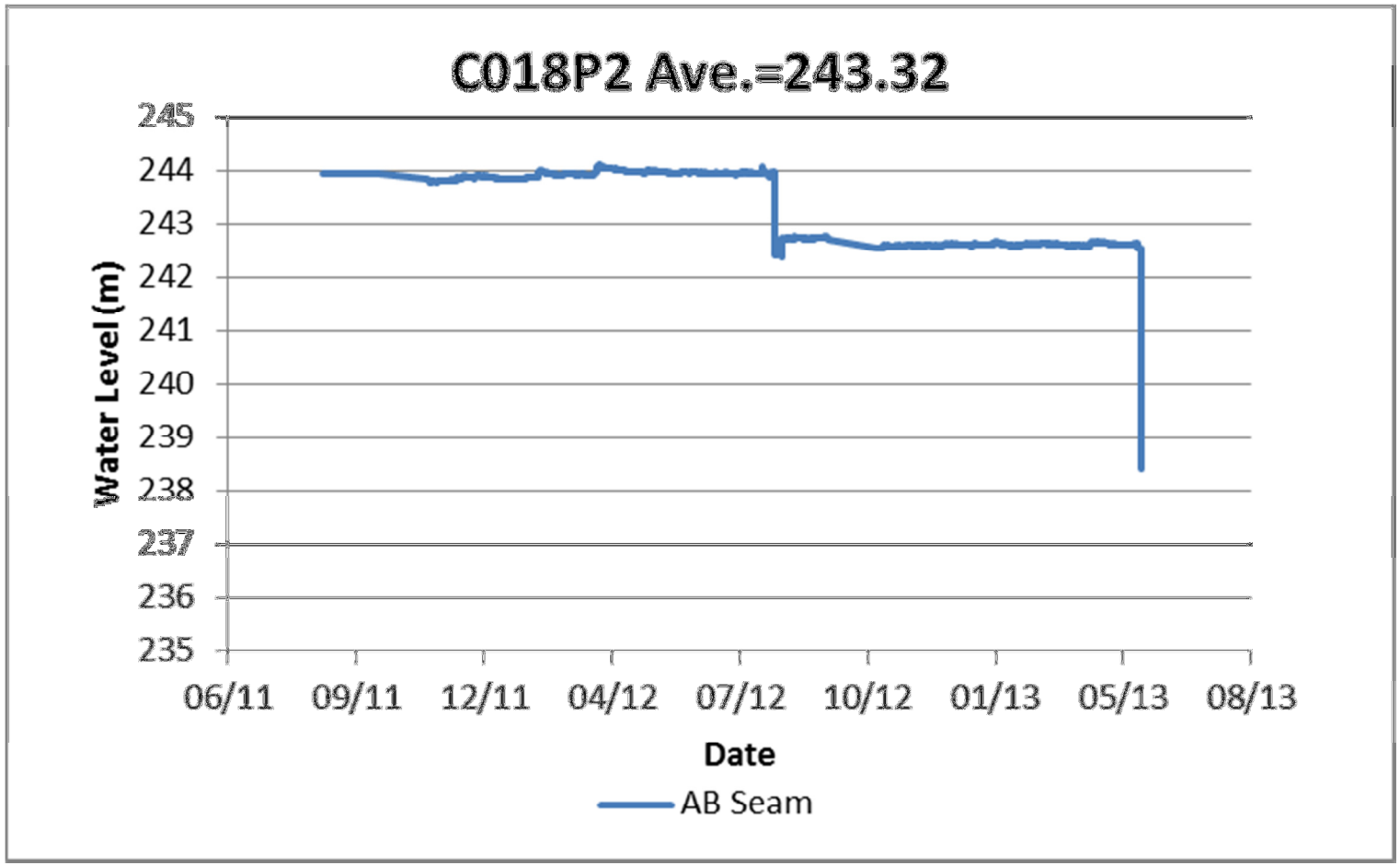
Water Level (m)
249
248
247
246
245
244
243
242
241
240
06/11
09/11
12/11
04/12
07/12
10/12
01/13
05/13
08/13
Date
Permian Overburden

B.14 **C018P2**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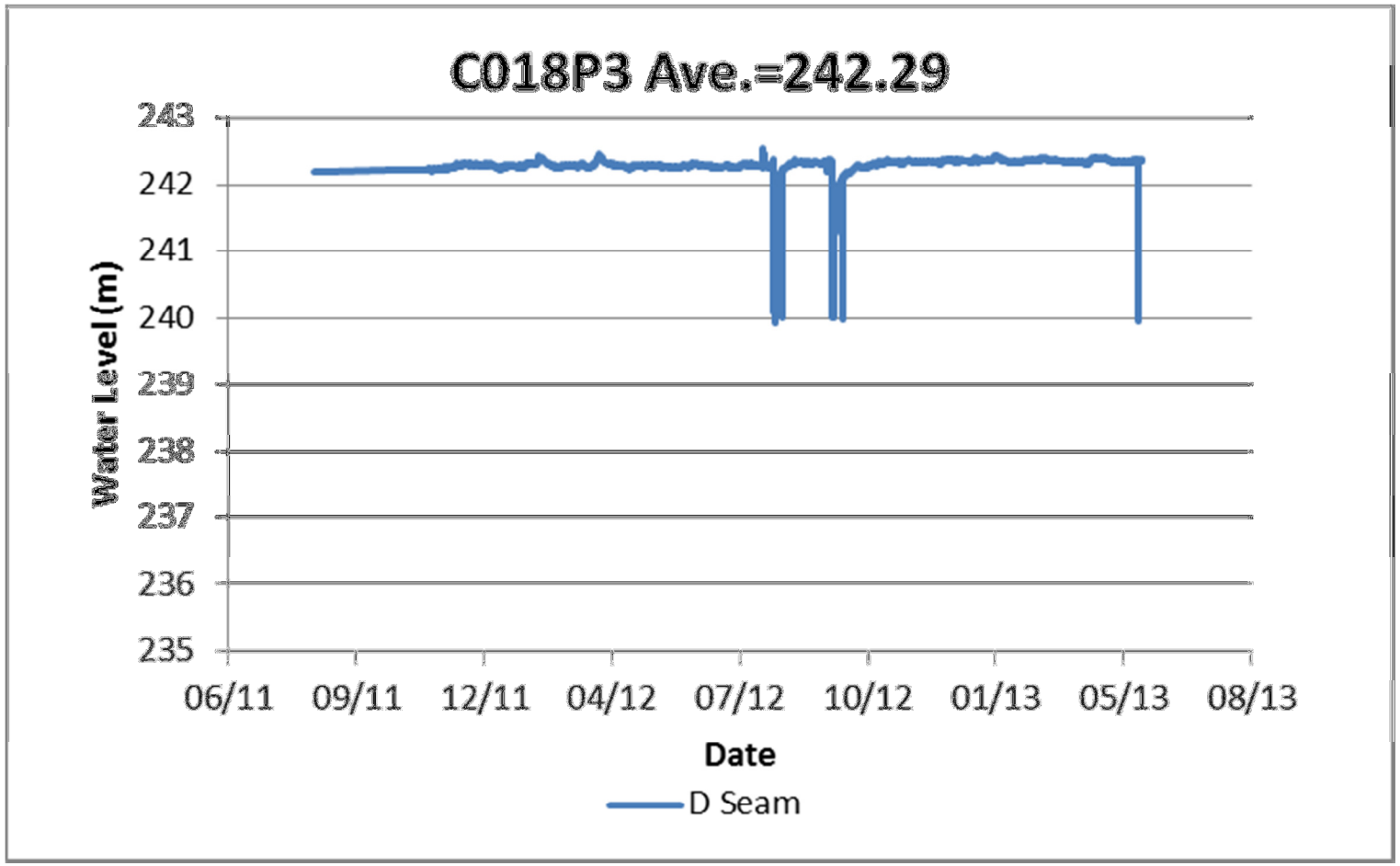
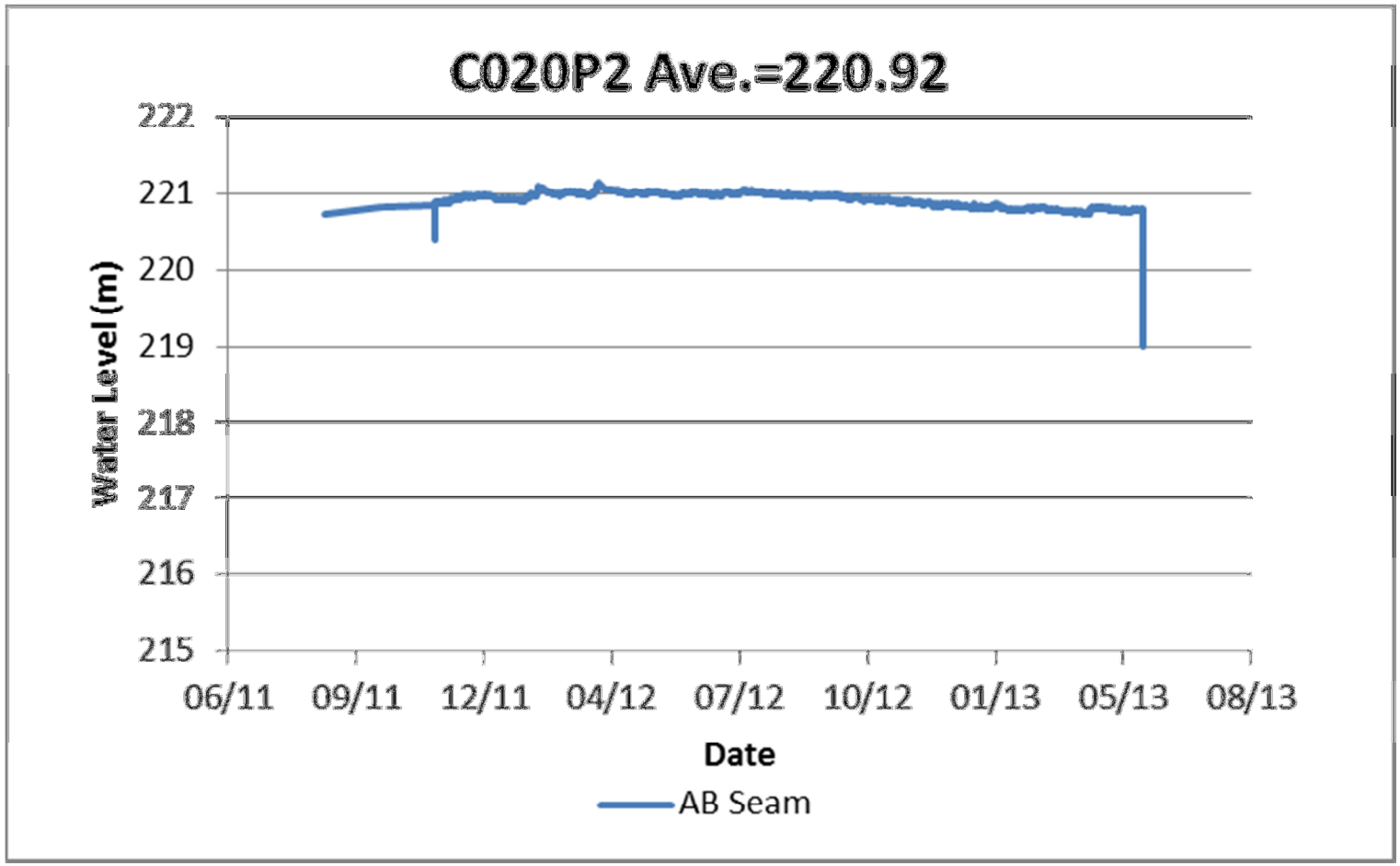
245
244
243
242
241
240
239
238
237
236
235
Water Level (m)
06/11
09/11
12/11
04/12
07/12
10/12
01/13
05/13
08/13
Date
AB Seam

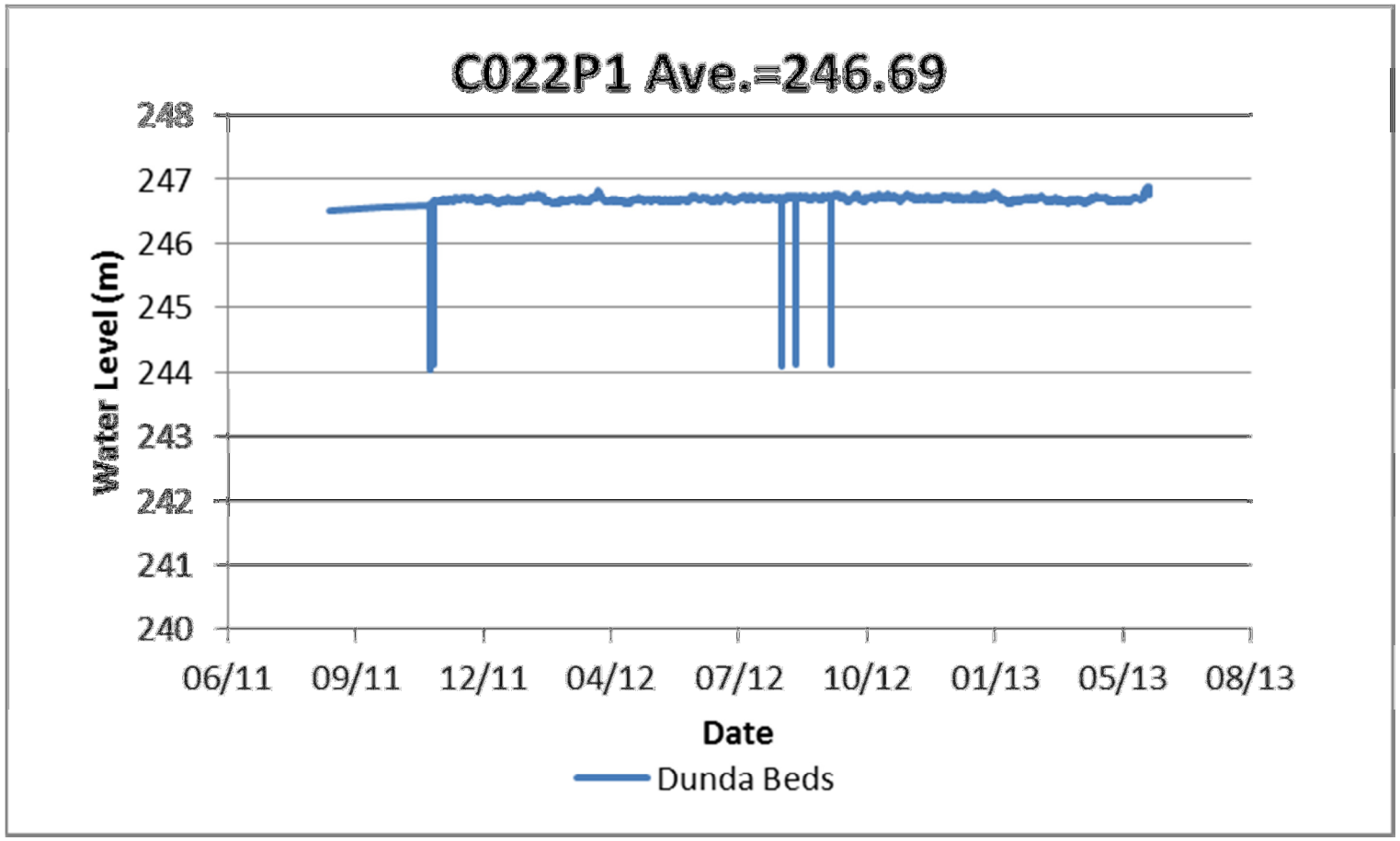
B.15 **C018P3**


C018P3 Ave.=242.29
Water Level (m)
243
242
241
240
239
238
237
236
235
06/11
09/11
12/11
04/12
07/12
10/12
01/13
05/13
08/13
Date
D Seam

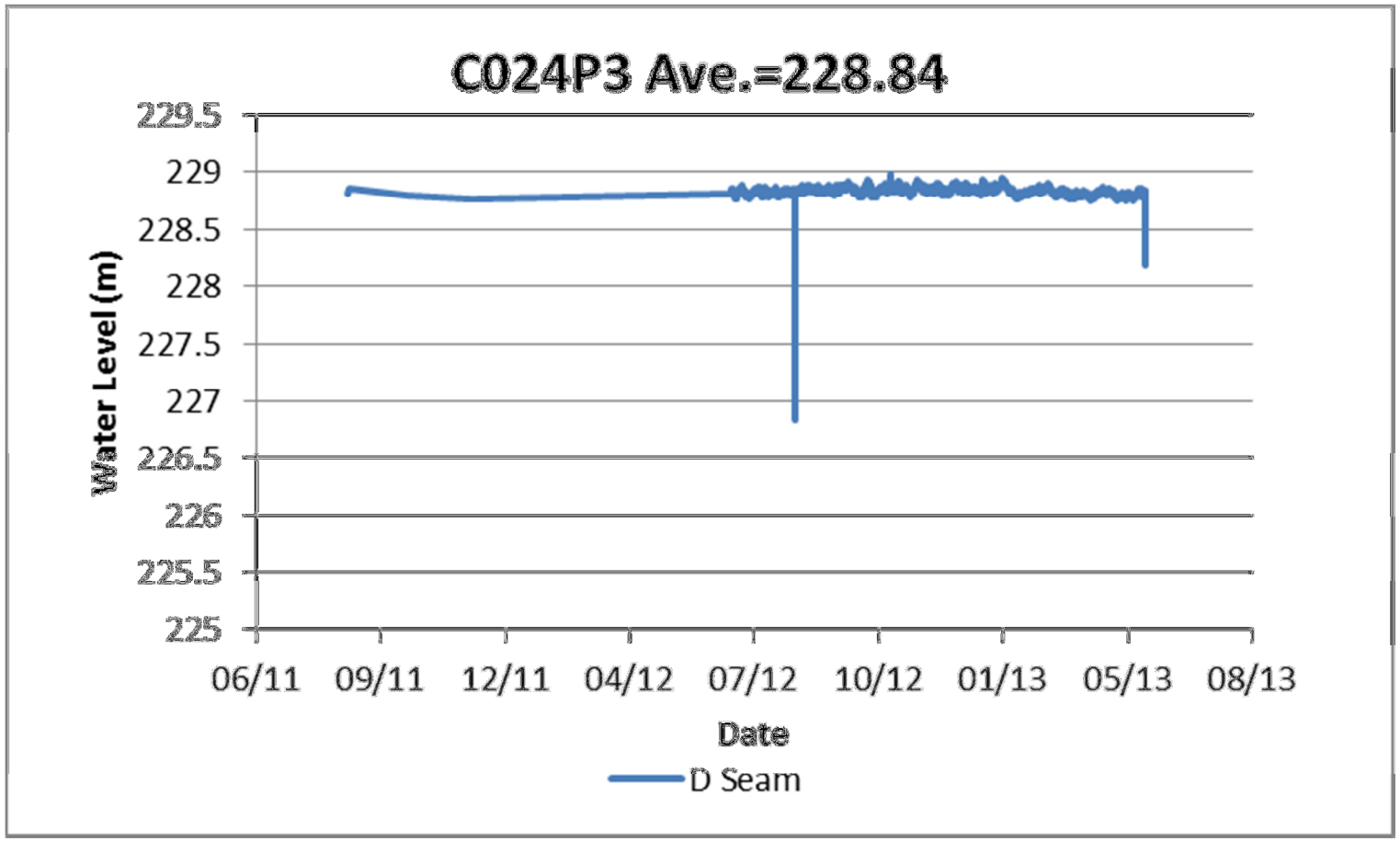
B.16 C020P2


C020P2 Ave.=220.92
222
221
220
219
218
217
216
215
Water Level (m)
06/11
09/11
12/11
04/12
07/12
10/12
01/13
05/13
08/13
Date
AB Seam

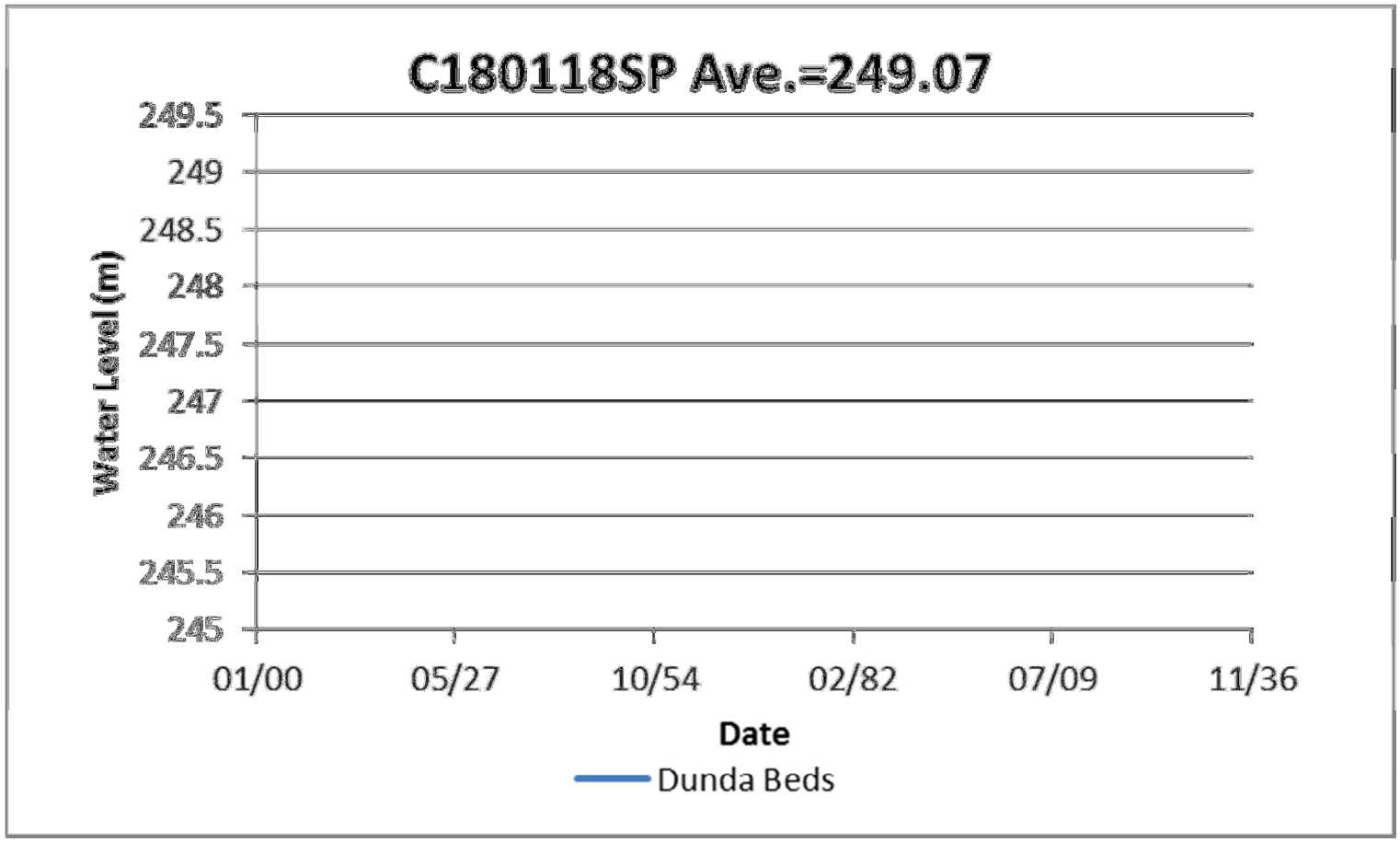
B.17 C022P1


C022P1 Ave.=246.69
248
247
246
245
244
243
242
241
240
Water Level (m)
06/11
09/11
12/11
04/12
07/12
10/12
01/13
05/13
08/13
Date
Dunda Beds

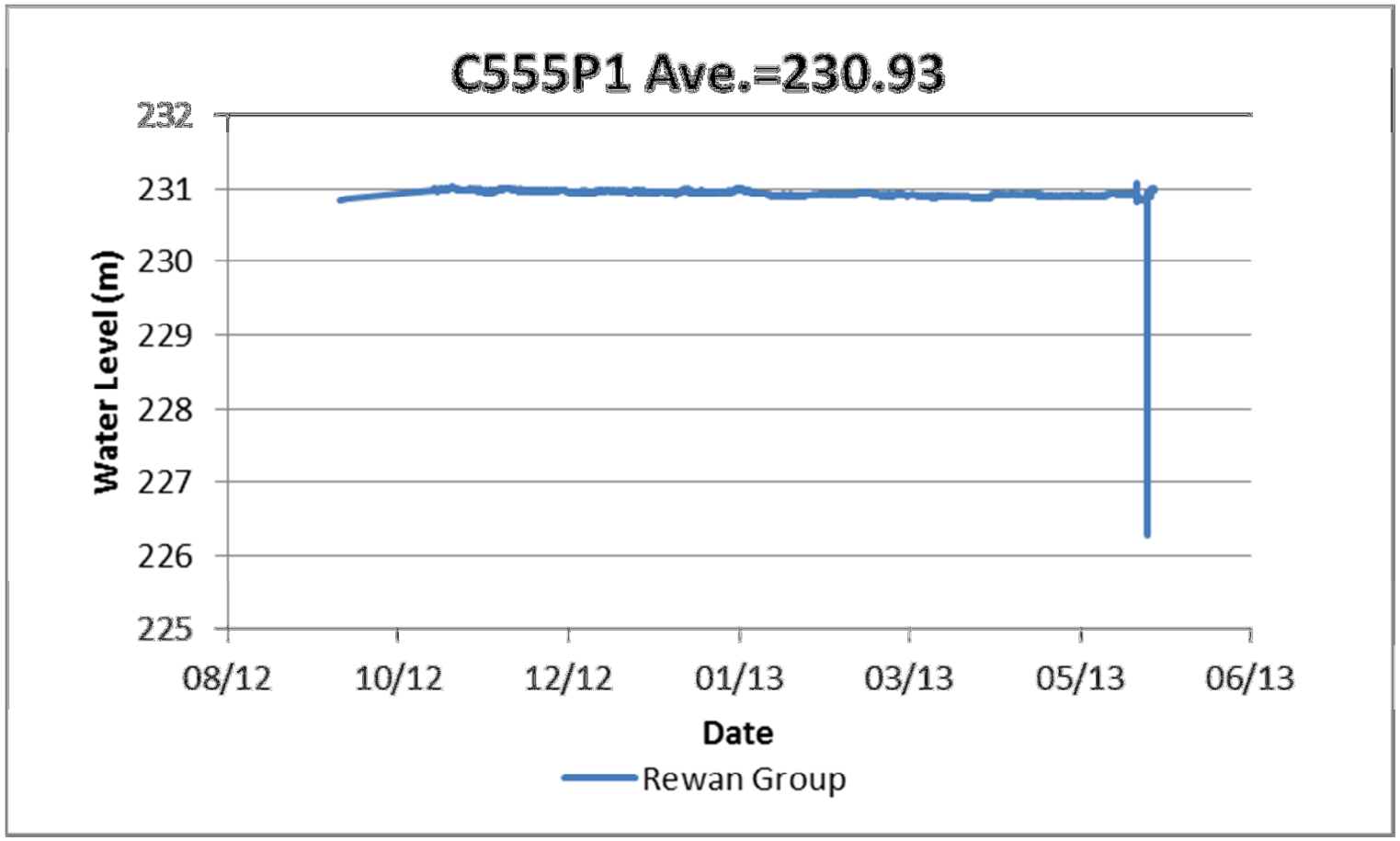
B.18 C024P3


C024P3 Ave.=228.84
229.5
229
228.5
228
227.5
227
226.5
226
225.5
225
Water Level (m)
06/11
09/11
12/11
04/12
07/12
10/12
01/13
05/13
08/13
Date
D Seam

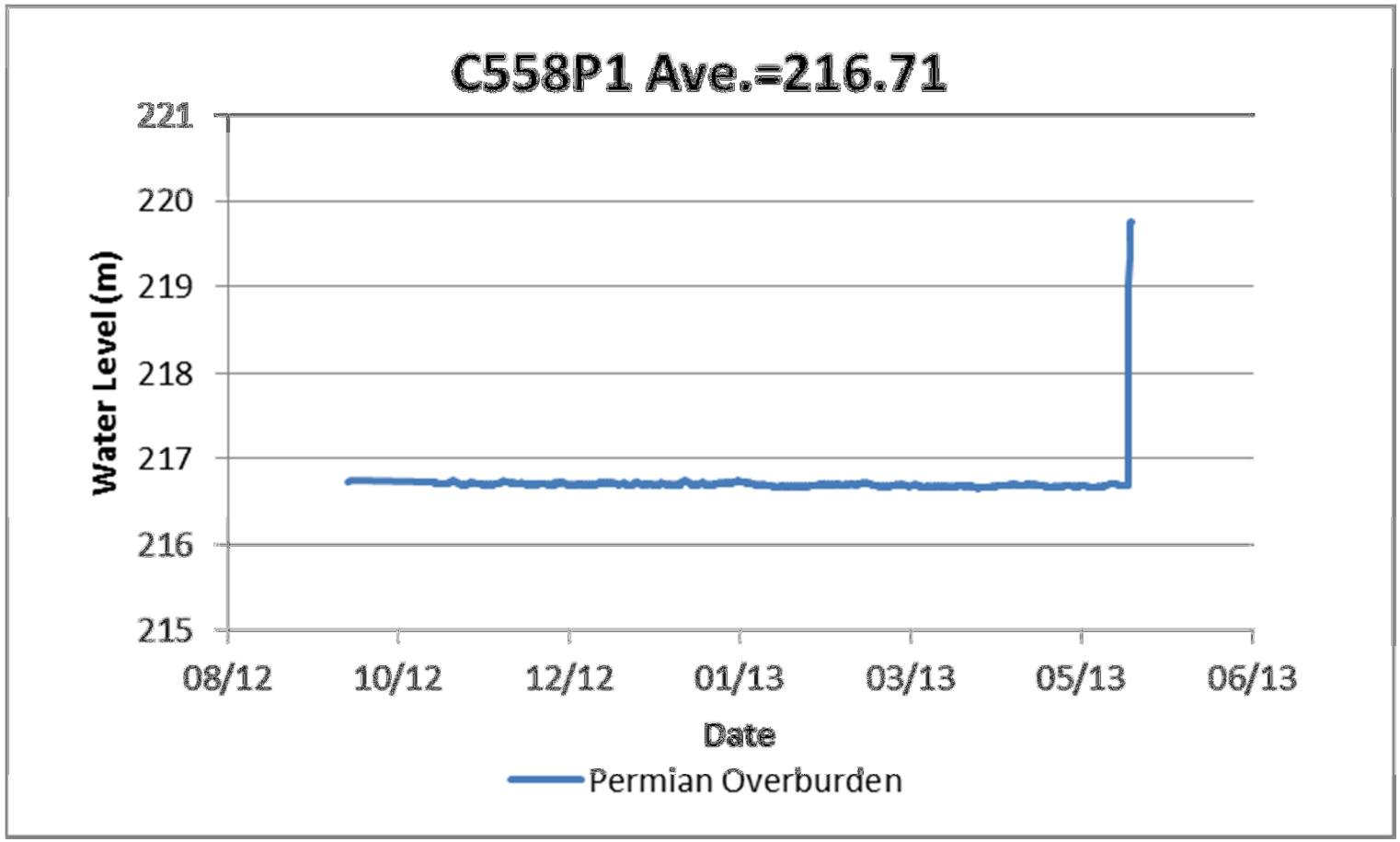
B.19 C180118SP



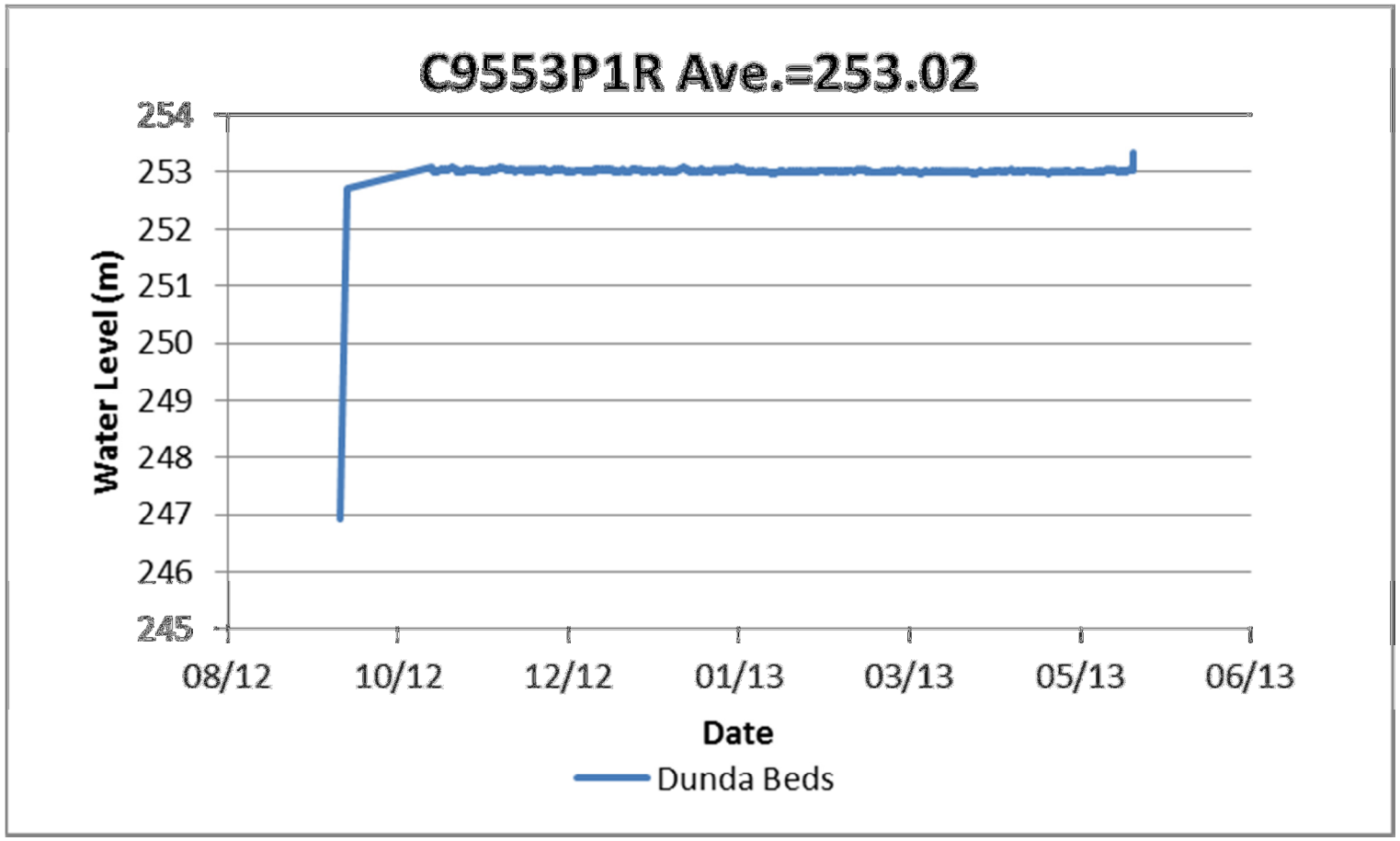
B.20 C555P1


C555P1 Ave.=230.93
232
231
230
229
228
227
226
225
Water Level (m)
08/12
10/12
12/12
01/13
03/13
05/13
06/13
Date
Rewan Group

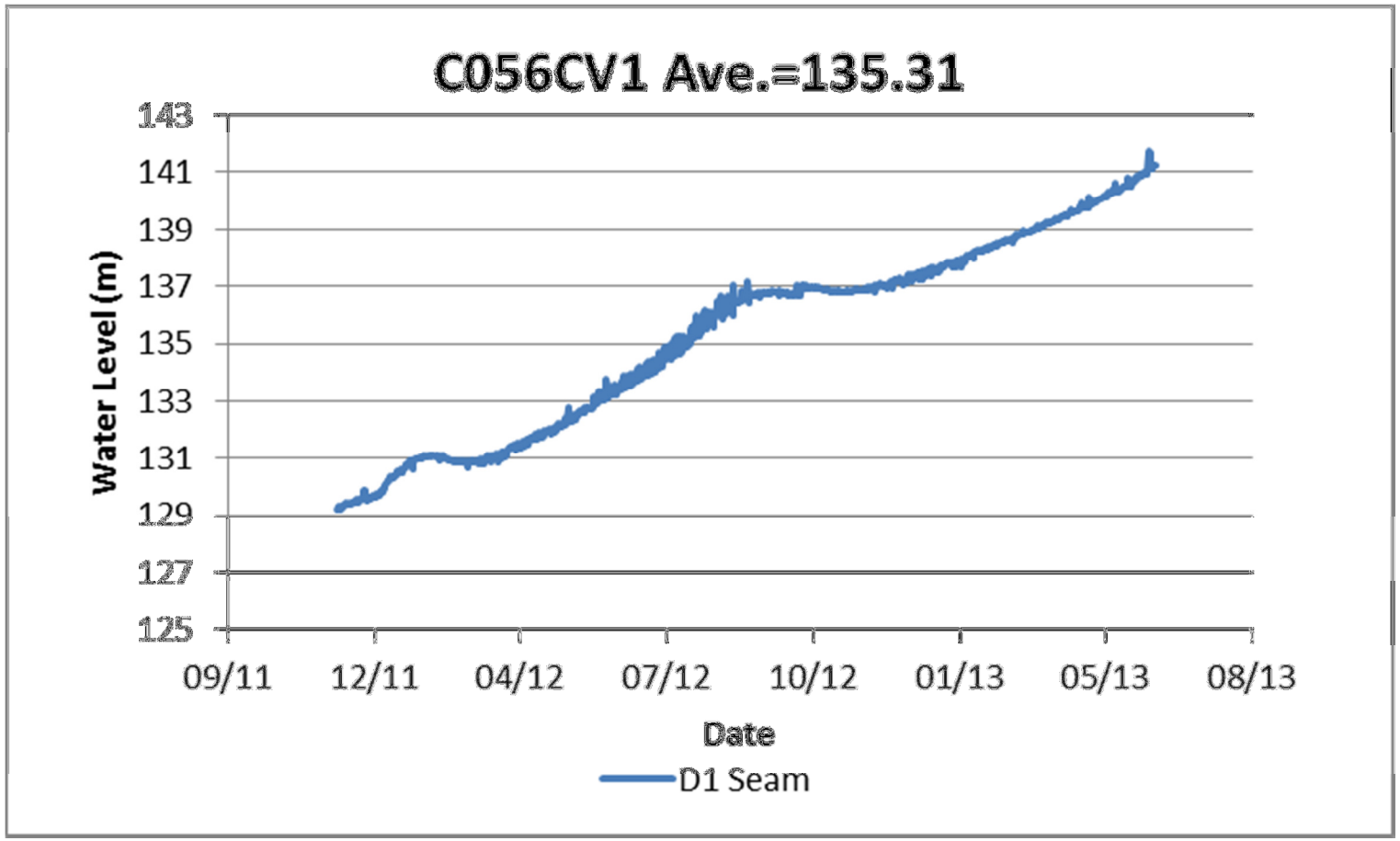
B.21 C558P1


C558P1 Ave.=216.71
221
220
219
218
217
216
215
Water Level (m)
08/12
10/12
12/12
01/13
03/13
05/13
06/13
Date
Permian Overburden

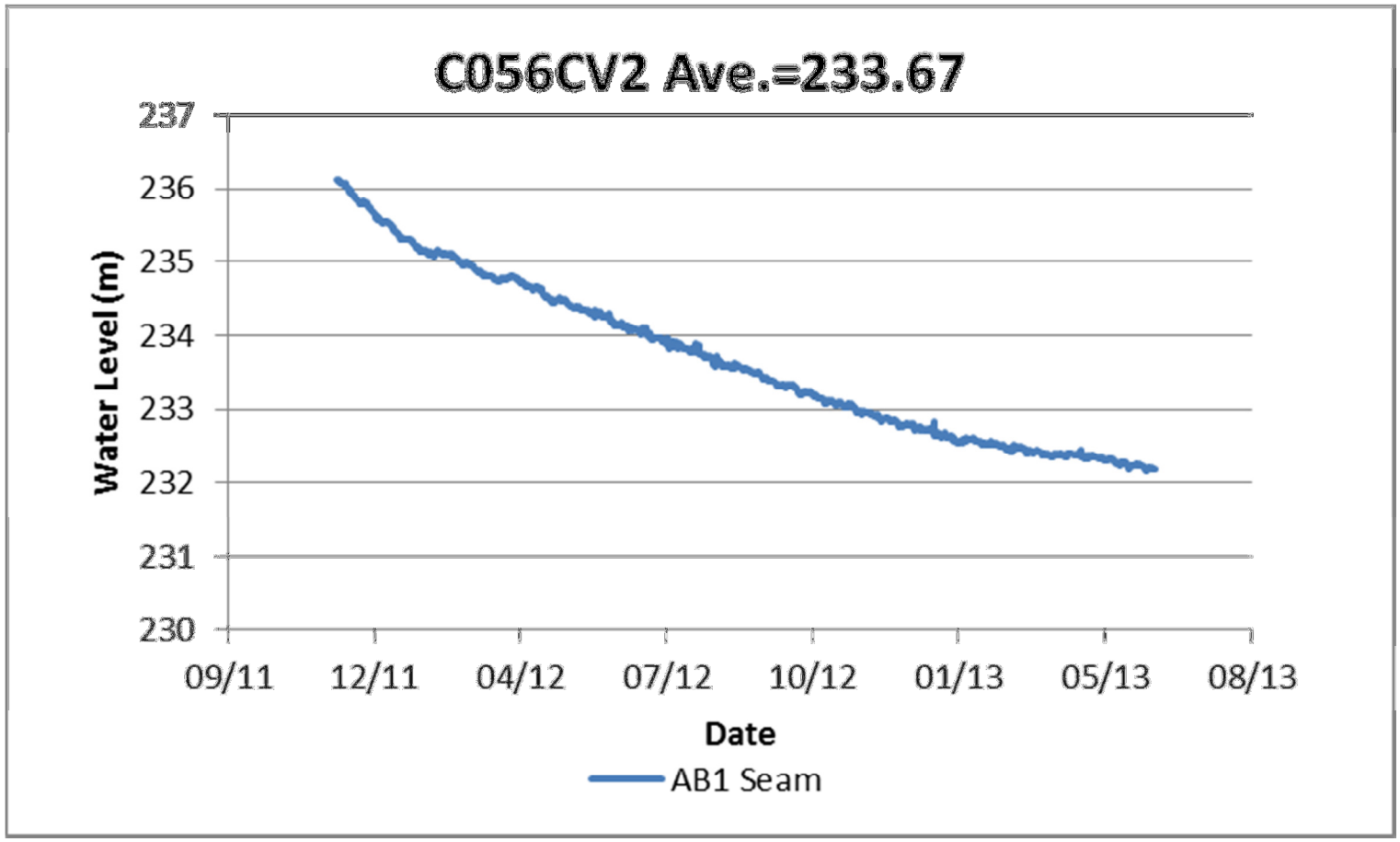
B.22 C9553P1R



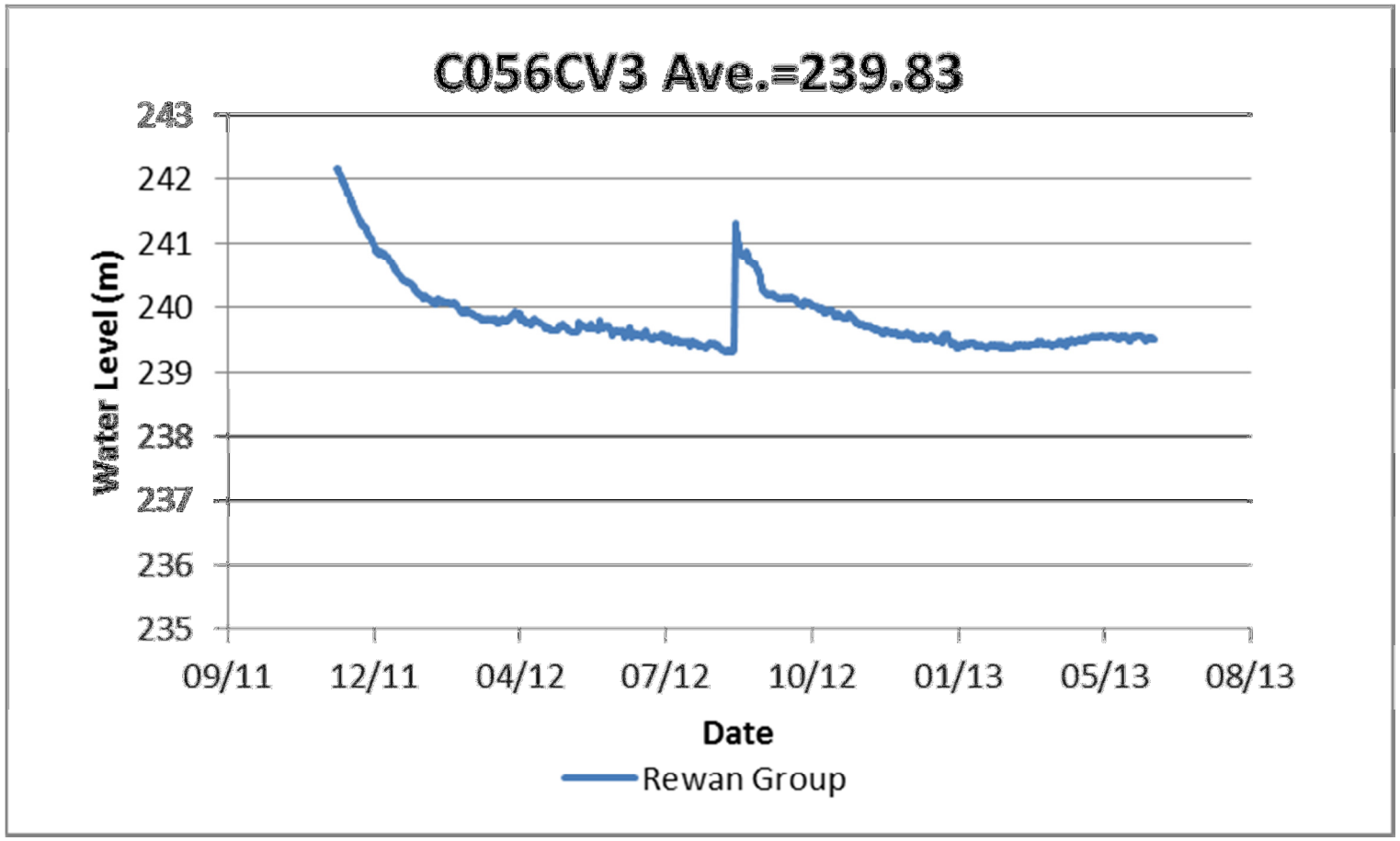
B.23 **C056CV1**


C056CV1 Ave.=135.31
143
141
139
137
135
133
131
129
127
125
Water Level (m)
09/11
12/11
04/12
07/12
10/12
01/13
05/13
08/13
Date
D1 Seam

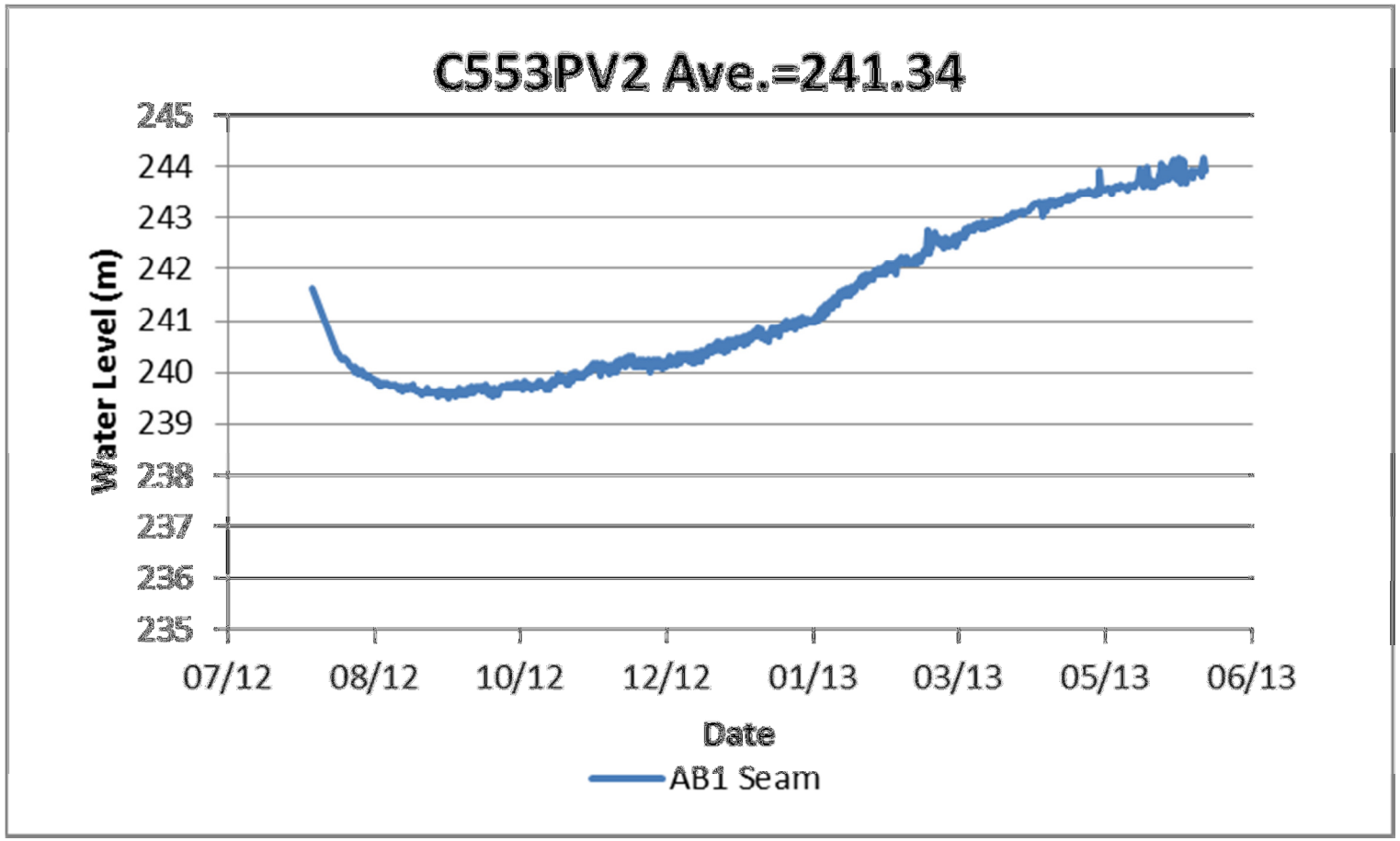
B.24 C056CV2


C056CV2 Ave.=233.67
237
236
235
234
233
232
231
230
Water Level (m)
09/11
12/11
04/12
07/12
10/12
01/13
05/13
08/13
Date
AB1 Seam

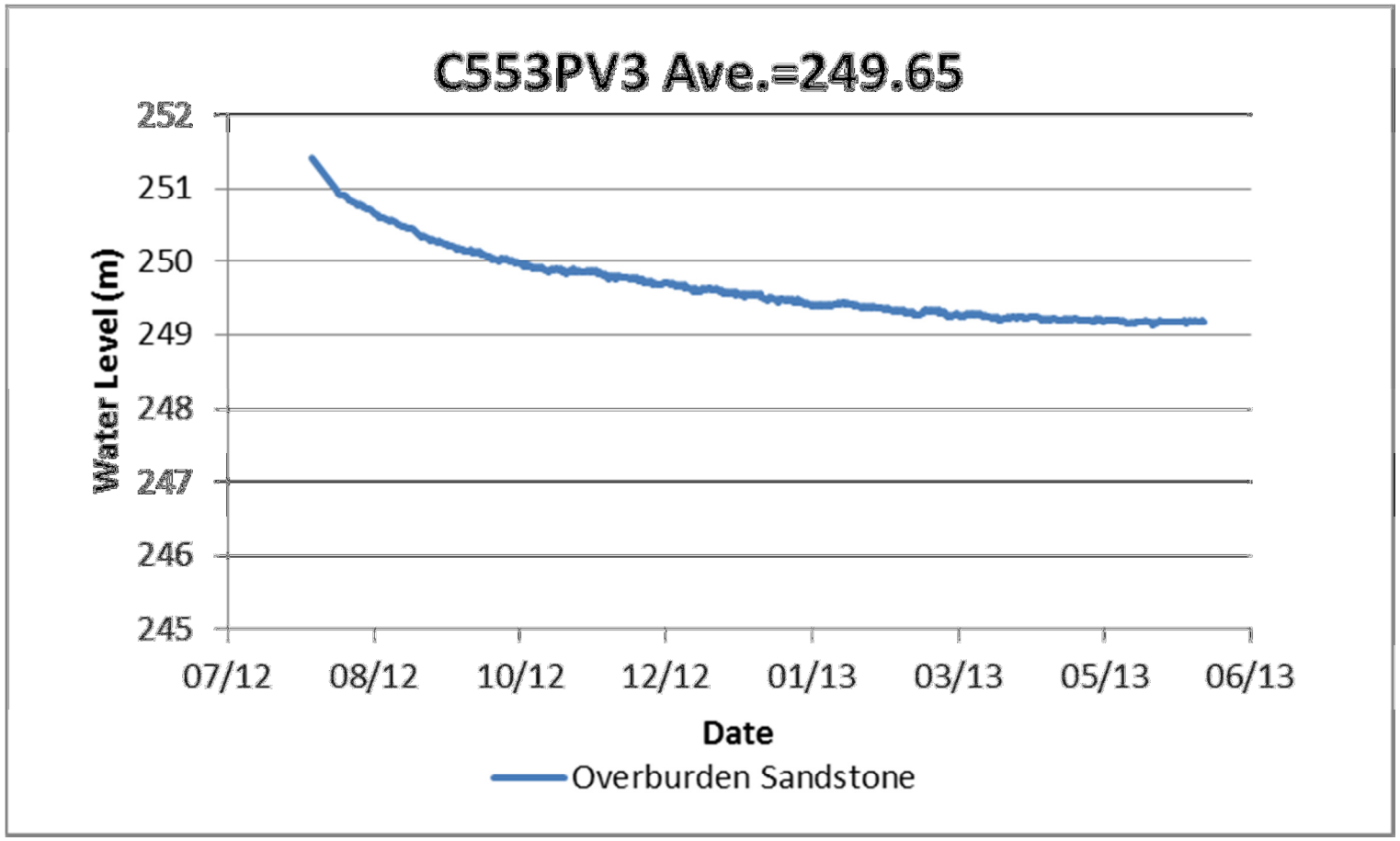
B.25 **C056CV3**


C056CV3 Ave.=239.83
243
242
241
240
239
238
237
236
235
Water Level (m)
09/11
12/11
04/12
07/12
10/12
01/13
05/13
08/13
Date
Rewan Group

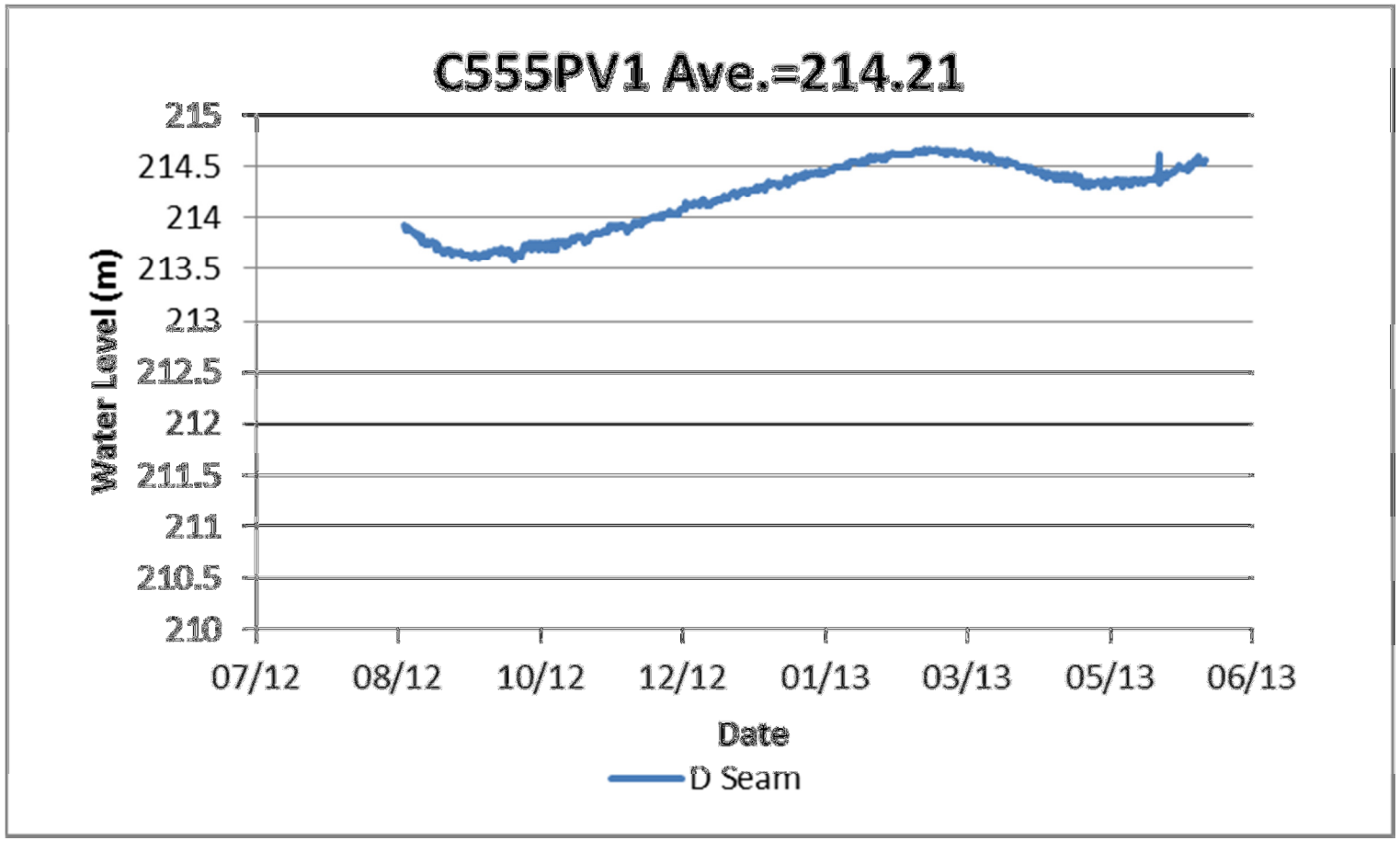
B.26 **C553PV2**


C553PV2 Ave.=241.34
Water Level (m)
245
244
243
242
241
240
239
238
237
236
235
07/12
08/12
10/12
12/12
01/13
03/13
05/13
06/13
Date
AB1 Seam

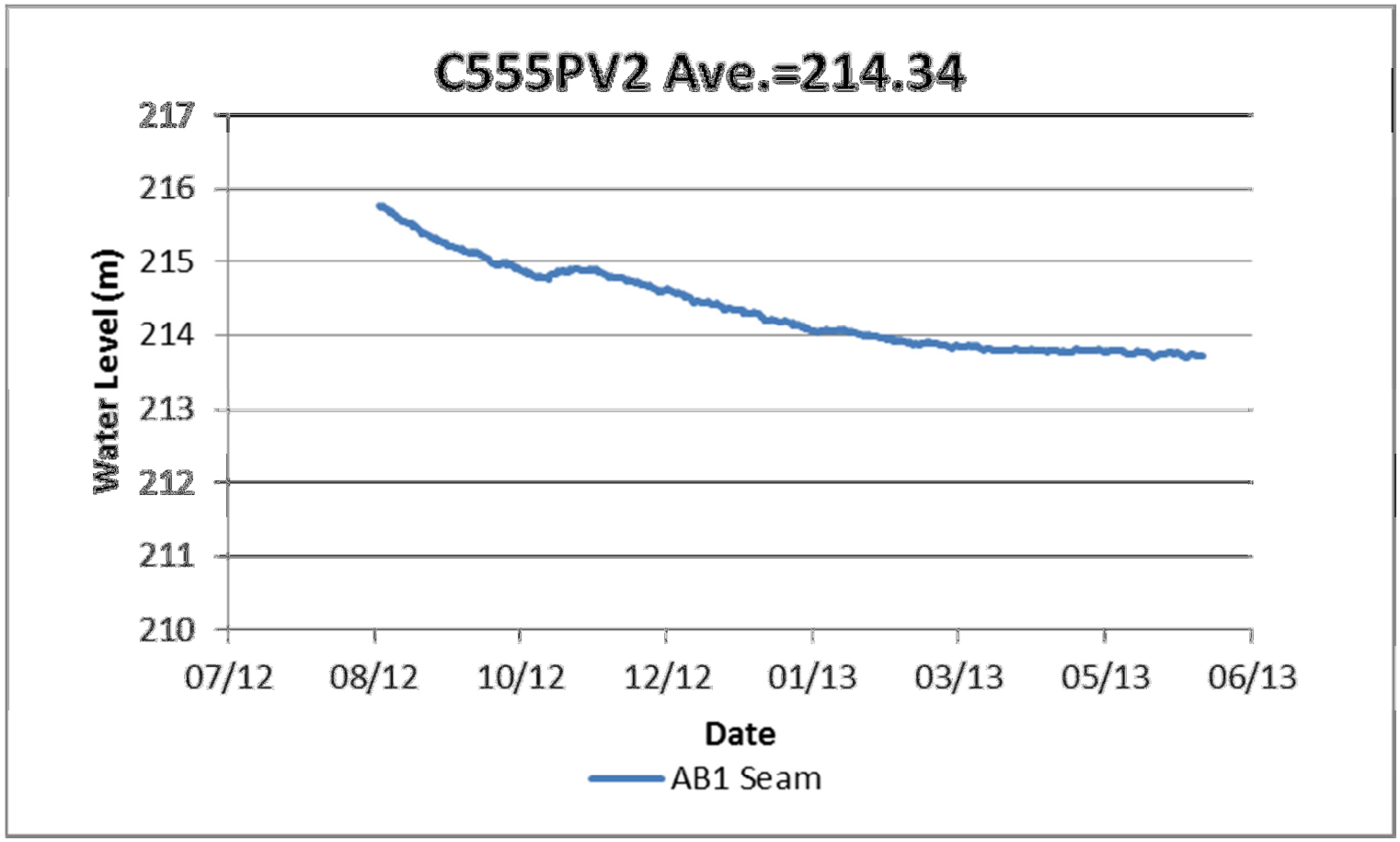
B.27 **C553PV3**


C553PV3 Ave.=249.65
252
251
250
249
248
247
246
245
Water Level (m)
07/12
08/12
10/12
12/12
01/13
03/13
05/13
06/13
Date
Overburden Sandstone

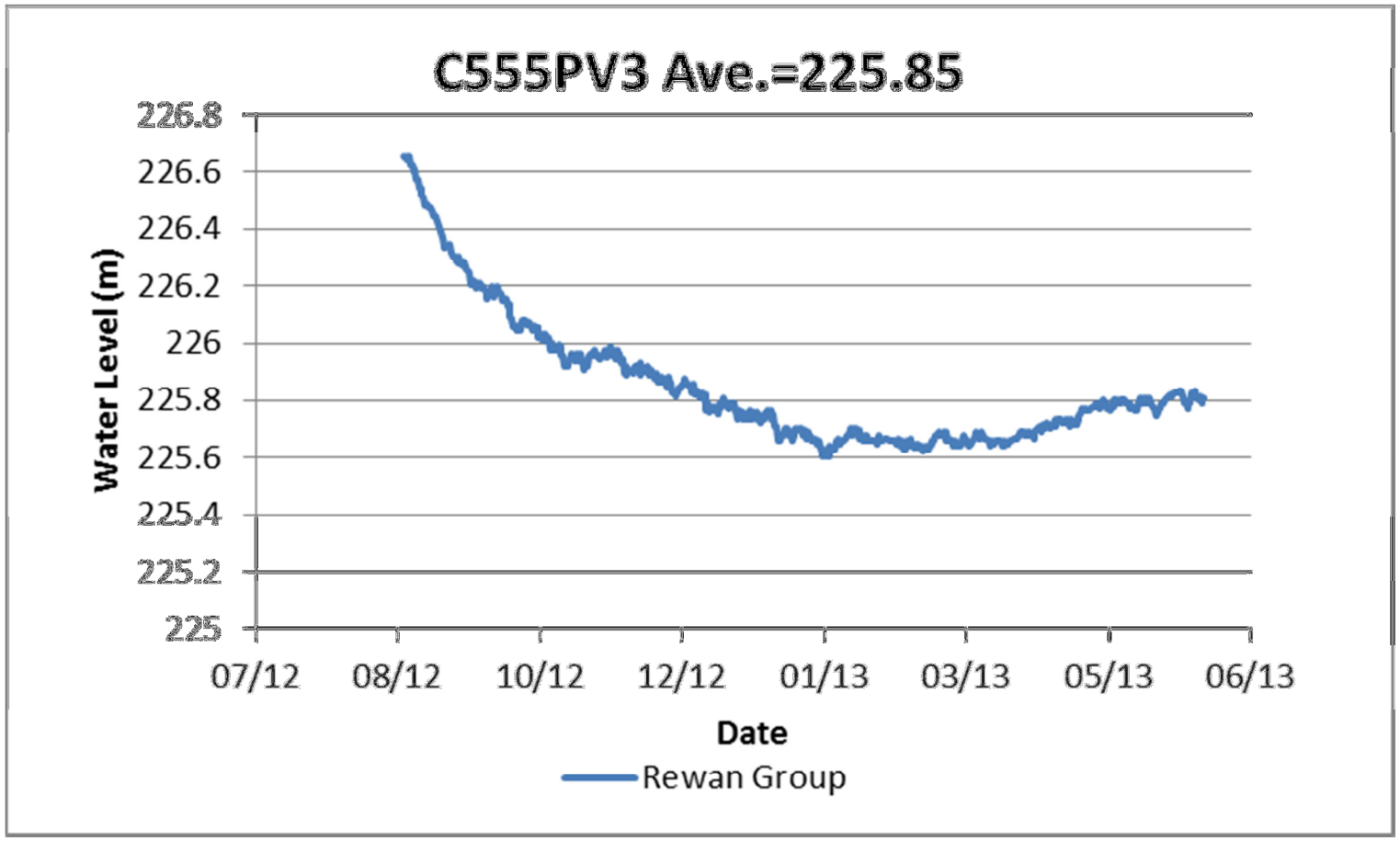
B.28 C555PV1


C555PV1 Ave.=214.21
215
214.5
214
213.5
213
212.5
212
211.5
211
210.5
210
Water Level (m)
07/12
08/12
10/12
12/12
01/13
03/13
05/13
06/13
Date
D Seam

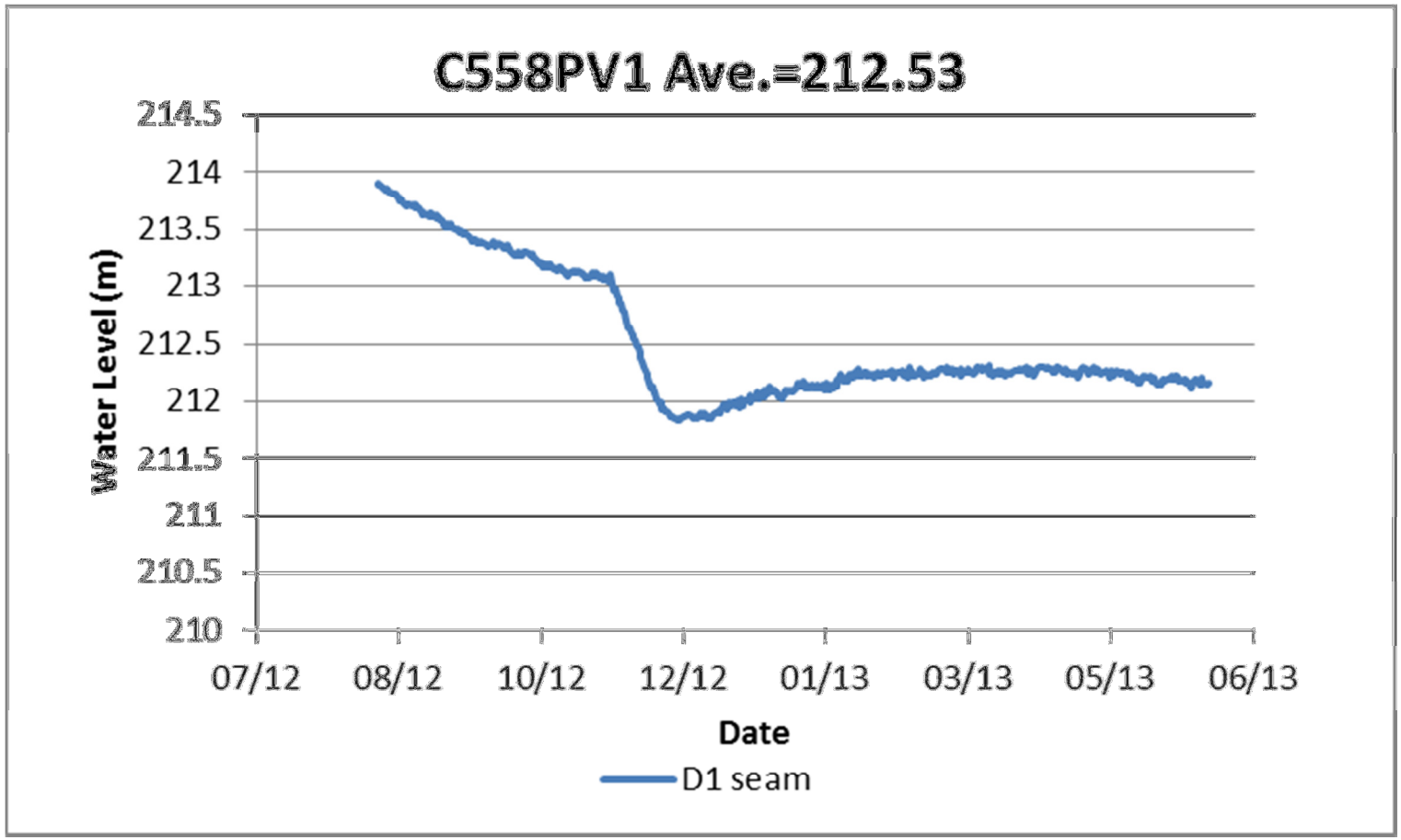
B.29 C555PV2


C555PV2 Ave.=214.34
Water Level (m)
217
216
215
214
213
212
211
210
07/12
08/12
10/12
12/12
01/13
03/13
05/13
06/13
Date
AB1 Seam

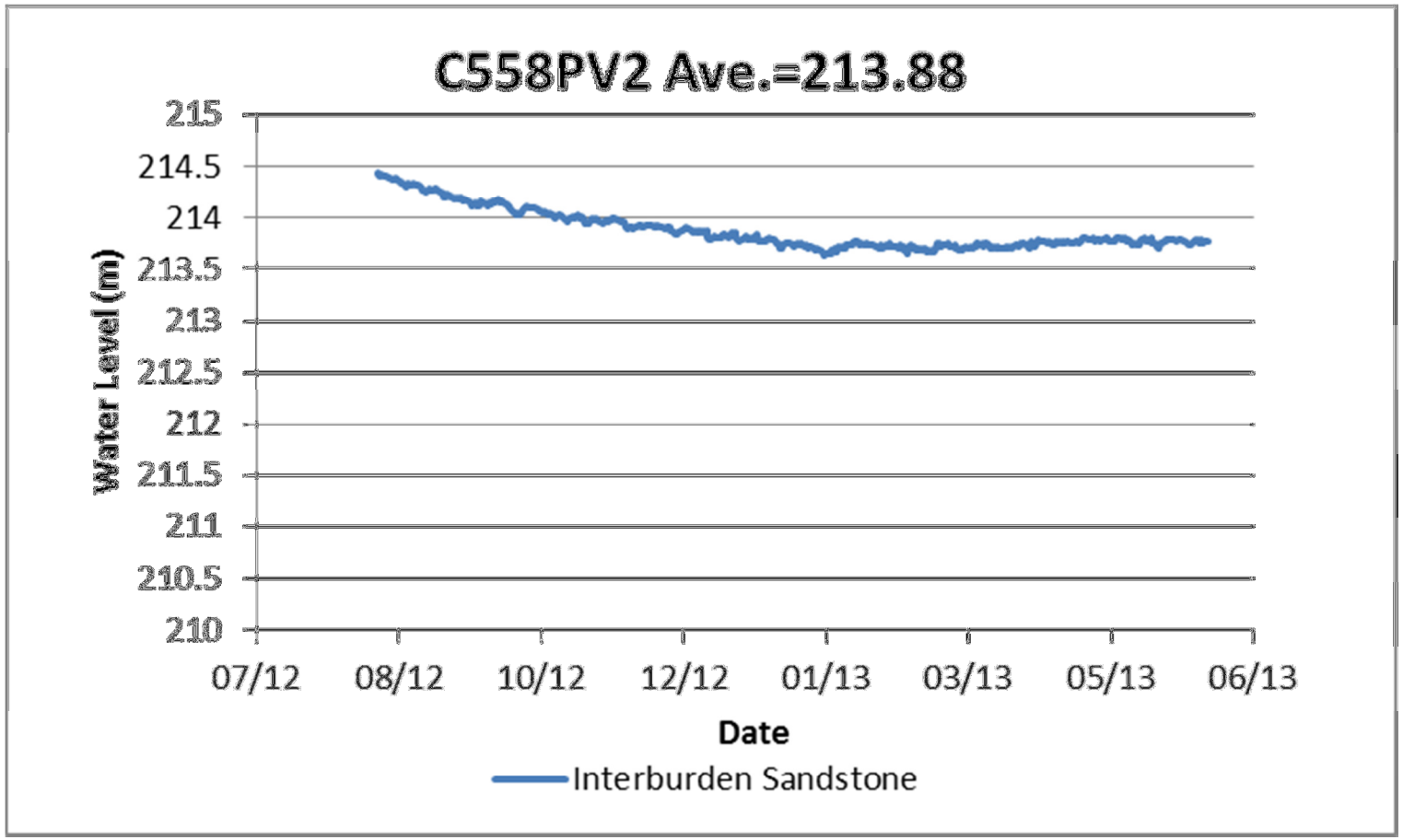
B.30 C555PV3


C555PV3 Ave.=225.85
Water Level (m)
226.8
226.6
226.4
226.2
226
225.8
225.6
225.4
225.2
225
07/12
08/12
10/12
12/12
01/13
03/13
05/13
06/13
Date
Rewan Group

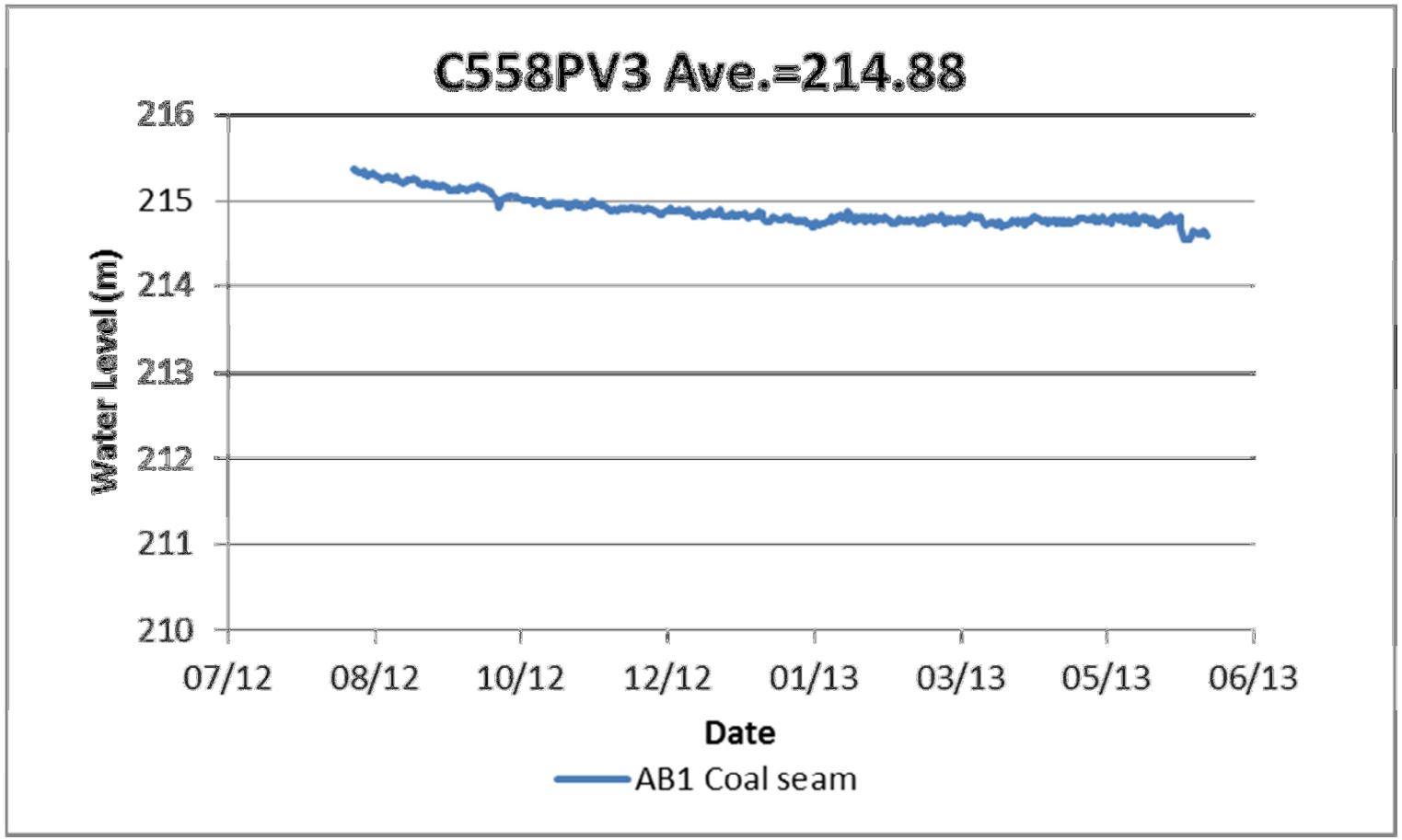
B.31 **C558PV1**


C558PV1 Ave.=212.53
214.5
214
213.5
213
212.5
212
211.5
211
210.5
210
Water Level (m)
07/12
08/12
10/12
12/12
01/13
03/13
05/13
06/13
Date
D1 seam

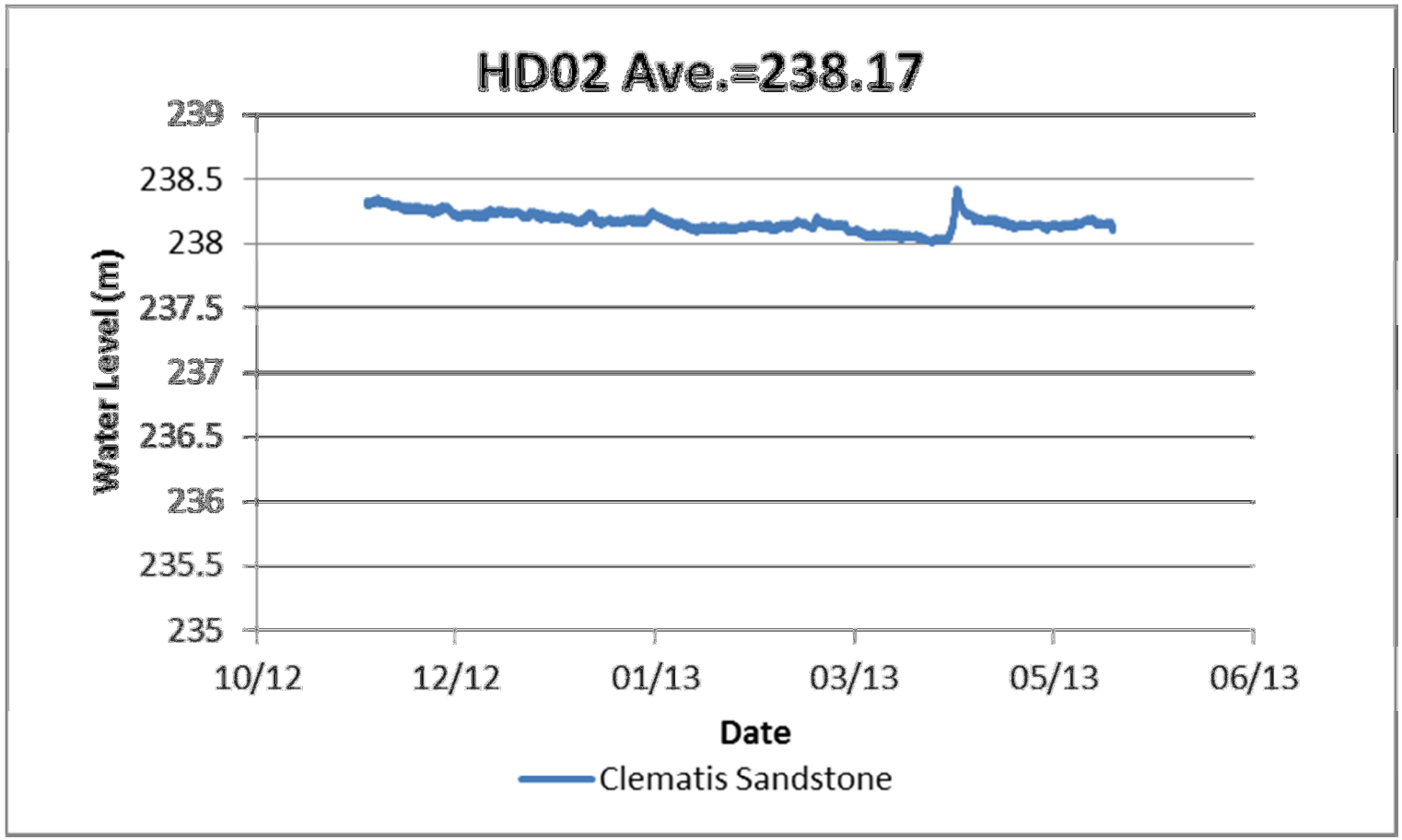
B.32 C558PV2


C558PV2 Ave.=213.88
Water Level (m)
215
214.5
214
213.5
213
212.5
212
211.5
211
210.5
210
07/12
08/12
10/12
12/12
01/13
03/13
05/13
06/13
Date
Interburden Sandstone

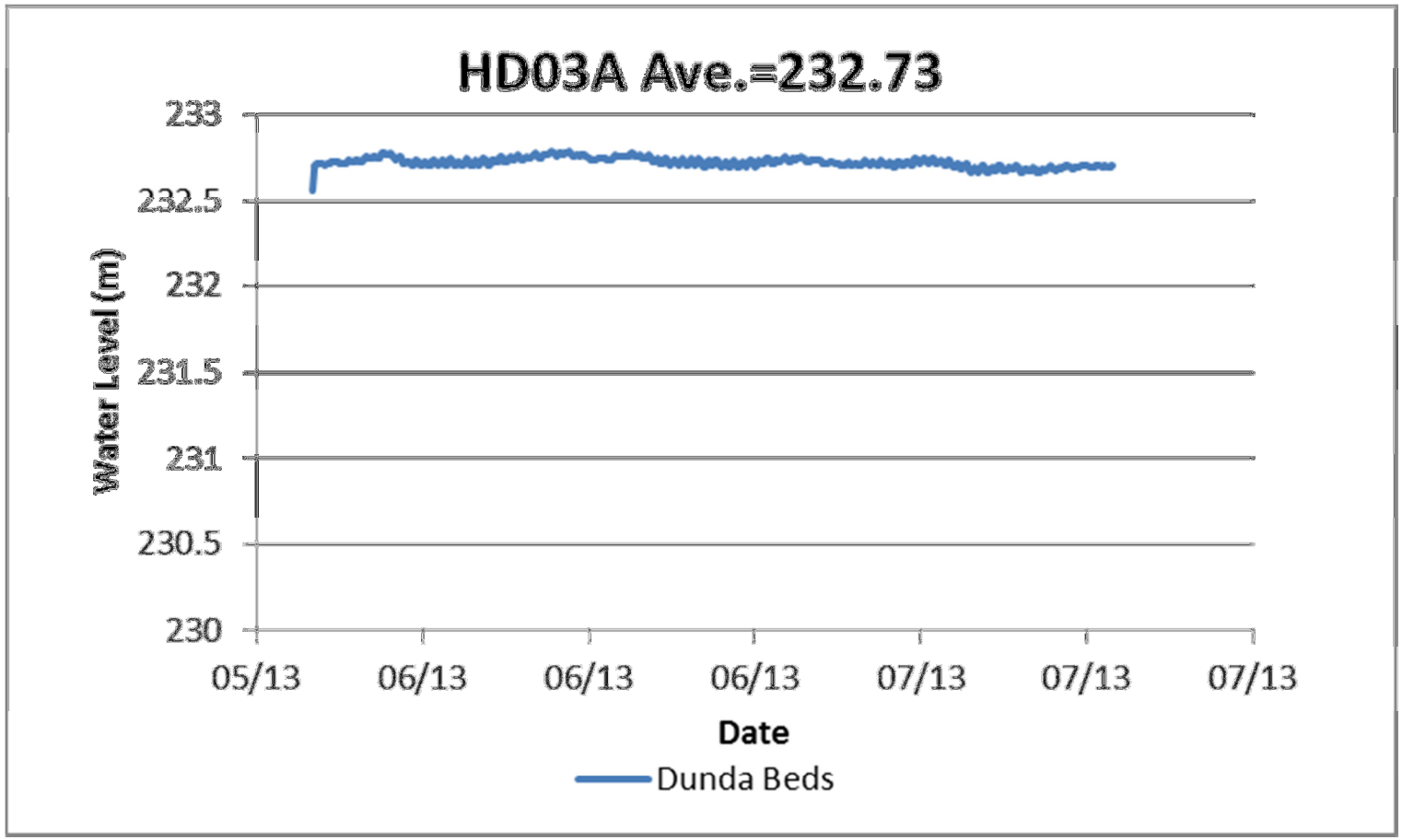
B.33 **C558PV3**


C558PV3 Ave.=214.88
216
215
214
213
212
211
210
Water Level (m)
07/12
08/12
10/12
12/12
01/13
03/13
05/13
06/13
Date
AB1 Coal seam

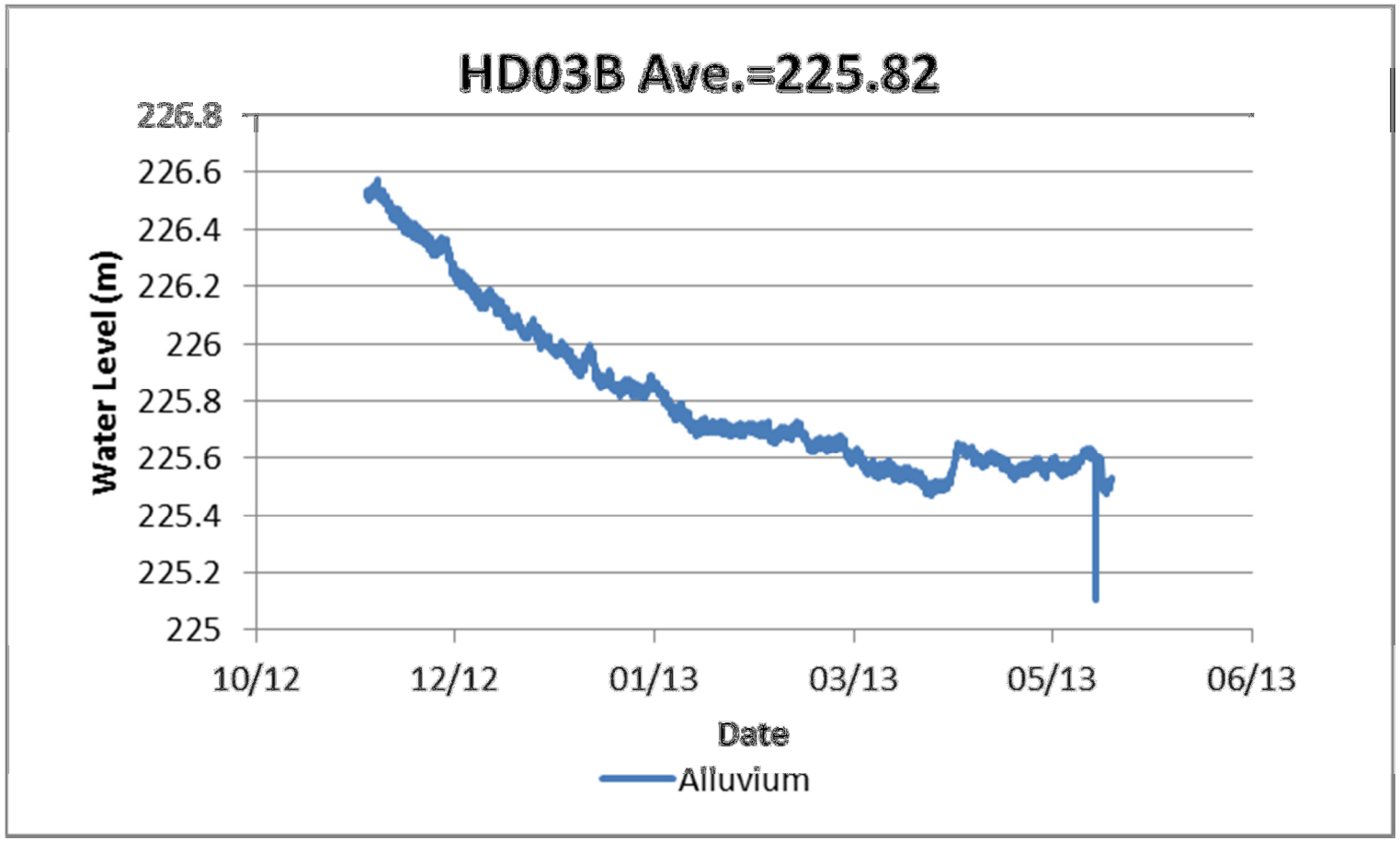
B.34 HD02


HD02 Ave.=238.17
239
238.5
238
237.5
237
236.5
236
235.5
235
Water Level (m)
10/12
12/12
01/13
03/13
05/13
06/13
Date
Clematis Sandstone

B.35 HD03A


HD03A Ave.=232.73
233
232.5
232
231.5
231
230.5
230
Water Level (m)
05/13
06/13
06/13
06/13
07/13
07/13
07/13
Date
Dunda Beds

B.36 **HD03B**


HD03B Ave.=225.82
226.8
226.6
226.4
226.2
226
225.8
225.6
225.4
225.2
225
Water Level (m)
10/12
12/12
01/13
03/13
05/13
06/13
Date
Alluvium

GOVERNMENT OIL & GAS INFRASTRUCTURE POWER INDUSTRIAL

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APPENDIX C GROUNDWATER CHEMISTRY

	No Samples			1	5	7	1	1	5	5	7	0	7	0	2	5	0	0	2	2	6	7	7	7	7	7	7	7	2	7	7	6	1	5	0	0			
	Min			0	0	0.15	0	0	0	0	0.53	0	0.157	0	0	0	0	0	0	0	0	0	839	608	2	2	16	178	192	141	0.4	0.14	0	0	0	0	0			
	Max			0.01	0.028	3.49	0.0006	0.004	0.007	0.006	29.3	0	4.81	0	0.006	0.076	0	0	0.15	0.02	0.019	29900	20100	87	368	229	6710	9520	686	1	1.35	0.05	0.02	0.39	0	0			
	85th Percentile			0.001	0.016	2.65	0.0002	4E-04	0.004	0.002	19	0	4.576	0	0.0015	0.021	0	0	0.06	0.011	0.015	28280	19290	71	363	182	6035	8539	604	0.9	0.97	0.02	0	0.228	0	0			
	99th percentile			0.0094	0.027	3.43	0.0006	0.004	0.007	0.006	28.6	0	4.794	0	0.0057	0.072	0	0	0.144	0.0194	0.019	29792	20046	86	368	226	6665	9455	681	1	1.32	0.05	0.02	0.3792	0	0			
	Units			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	uS/cm	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			

Overall _Unit Alluvium

Lab

LocCode	Sampled_Date	Sample_Type	MonitoringUnit	Values	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)	Electrical conductivity *(lab)	Total Dissolved Solids	Calcium (Filtered)	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Chloride	Sulphate	Fluoride	Ammonia as N	Nitrate (as N)	Nitrite (as N)	Phosphorus	C6-C40 Calculated	Calc
C027P1	**29/09/2011**	Normal	Alluvium		0.01	0.013	0.63		0	0	0	16	0	4.49	0	0	0	0	0	0	0.01	0.006	6260	3850	27	111	52	1070	1580		0.9	0.53	0.01	0.02	0.21	0	0
	8/11/2011	Normal	Alluvium		0	0.015	0.52	0	0.004	0.004	0.001	29.3	0	4.55	0	0	0.015	0	0	0	0	0.019	6590	4370	26	114	58	1080	1420	141	0.7	0.93	0.02	0	0	0	0
	25/05/2013	Normal	Alluvium		0	0.005	0.73	0	0	0.002	0.002	17.9	0	3.34	0	0	0.002	0	0	0	0	0.008	6910	4080	24	140	83	1180	1770		0.5	0.69	0.01	0	0.1	0	0
		Field_D	Alluvium		0	0.004	0.72	0.0006	0	0.003	0.002	17.5	0	3.27	0	0	0.003	0	0	0	0	0.013	6860	4030	24	143	82	1200	1780		0.5	0.72	0.01	0	0	0	0
C029P1	**29/09/2011**	Normal	Alluvium																																		
	7/11/2011	Normal	Alluvium		0	0.028	2.56	0	0	0.003	0.006	5.62	0	4.81	0	0.001	0.076	0	0	0.05	0.02	0.013	29900	20100	87	362	177	5960	8430	686	0.9	1.35	0.01	0	0.15	0	0
	24/05/2013	Normal	Alluvium		0	0	3.49	0	0	0.007	0	0.72	0	0.942	0	0.006	0.015	0	0	0.15	0	0	28100	19200	69	368	229	6710	9520		1	0.28	0.05	0	0.39	0	0
HD03B	**27/10/2012**	Normal	Alluvium																																		
	20/05/2013	Normal	Alluvium		0	0	0.15	0	0	0	0.001	0.53	0	0.157	0	0	0	0	0	0	0	0.015	839	608	2	2	16	178	192		0.4	0.14	0	0	0.21	0	0

			1	6	6	0	4	1	3	5	0	6	0	2	3	2	0	2	2	6	6	6	6	6	6	6	6	2	6	5	4	0	3	0					
			0	0.001	0.84	0	0	0	0	0.72	0	0.19	0	0	0	0	0	0	0	0.006	10900	6810	94	117	58	2180	3670	10	0.5	0.07	0	0	0	0					
			0.03	0.013	1.22	0	0.005	0.001	0.002	24.5	0	3.01	0	0.001	0.005	0.05	0	0.002	0.01	0.015	14700	8660	130	134	83	2780	4710	246	0.8	1.38	0.16	0	0.38	0					
			0.0075	0.01225	1.0625	0	0.00425	0.0004	0.00125	13.598	0	2.395	0	0.001	0.002	0.02	0	0.002	0.01	0.012	14175	8300	118	131	80	2720	4605	210.6	0.65	0.984	0.082	0	0.278	0					
			0.0285	0.01295	1.2095	0	0.00495	0.00096	0.00195	23.7732	0	2.969	0	0.001	0.0048	0.048	0	0.002	0.01	0.0148	14665	8636	129.2	133.8	82.8	2776	4703	243.64	0.79	1.3536	0.1548	0	0.3732	0					
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L					

Lab

Values

Sample_Type	MonitoringUnit_2	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)	Electrical conductivity (lab)	Total Dissolved Solids	Calcium (Filtered)	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Chloride	Sulphate	Fluoride	Ammonia as N	Nitrate (as N)	Nitrite (as N)	Phosphorus	C6-C40 Calculated	BTEX (Sum of Total) - Calc
Normal	Tertiary Overburden	0.03	0.012	1.01	0	0.005		0		0	1.16	0	0.001	0	0.05	0	0.002	0.01	0.006	14000	8180	107	134	79	2700	4570		0.8	0.63	0.03	0	0.38	0	18.5
Normal	Tertiary Overburden	0	0.013	1.01	0	0	0	0.002	24.5	0	2.19	0	0	0.001	0.01	0	0	0.01	0.006	14700	8660	130	130	74	2680	3670	10	0.6	1.38	0.16	0	0.12	0	8.5
Normal	Tertiary Overburden	0	0.002	1.22	0	0.004	0	0	4.11	0	3.01	0	0	0	0	0	0	0	0.006	12700	7780	114	117	79	2780	4710		0.5	0.72	0	0	0	0	0
Normal	Tertiary Overburden	0	0.006	0.92		0	0	0	1.74	0	0.448	0	0.001	0.001	0	0	0	0	0.006	11600	6960	100	118	58	2280	3950		0.6					0	0
Normal	Tertiary Overburden	0	0.008	0.84	0	0.002	0.001	0.001	6.33	0	0.655	0	0	0.005	0	0	0	0	0.011	12100	7780	95	122	75	2180	3740	246	0.6	0.42	0.01	0	0.21	0	0
Normal	Tertiary Overburden	0	0.001	0.94	0	0.001	0	0.001	0.72	0	0.19	0	0	0	0	0	0.002	0	0.015	10900	6810	94	122	83	2320	4060		0.5	0.07	0.01	0	0	0	0

	No Samples			0	1	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	1	1	0	0	1	0	0						
	Min			0	0.003	0.09	0	0	0	0	0.05	0	0.09	0	0	0	0	0	0	0	0.011	588	426	2	1	12	122	114	0	0.3	0.15	0	0	0.14	0	0						
	Max			0	0.003	0.09	0	0	0	0	0.05	0	0.09	0	0	0	0	0	0	0	0.011	588	426	2	1	12	122	114	0	0.3	0.15	0	0	0.14	0	0						
	85th Percentile			0	0.003	0.09	0	0	0	0	0.05	0	0.09	0	0	0	0	0	0	0	0.011	588	426	2	1	12	122	114	###	0.3	0.15	0	0	0.14	0	0						
	99th percentile			0	0.003	0.09	0	0	0	0	0.05	0	0.09	0	0	0	0	0	0	0	0.011	588	426	2	1	12	122	114	###	0.3	0.15	0	0	0.14	0	0						
				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	uS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L						

Overall _Unit Clematis

Lab

Values

LocCode	Sampled_Date	Sample_Type	MonitoringUnit_2	Aluminium (Filtered)	Arsenic (Filtered)	Boron (Filtered)	Cadmium (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)	Electrical Conductivity @ 25°C (lab)	Total Dissolved Solids	Calcium (Filtered)	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Chloride	Sulphate	Fluoride	Ammonia as N	Nitrate (as N)	Nitrite (as N)	Phosphorus	C6-C40 Calculated Calc	
HD02	**27/10/2012**	Normal	Clematis Sandstone																																
	20/05/2013	Normal	Clematis Sandstone	0	0.003	0.09	0	0	0	0.05	0	0.09	0	0	0	0	0	0	0	0.011	588	426	2	1	12	122	114		0.3	0.15	0	0	0.14	0	0		

Overall _Unit Dunda

Lab

Values

LocCode	Sampled_Date	Sample_Type	MonitoringUnit_2	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)	Electrical conductivity *(lab)	Total Dissolved Solids	Calcium (Filtered)	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Chloride	Sulphate	Fluoride	Ammonia as N	Nitrate (as N)	Nitrite (as N)	Phosphorus	C6-C40 Calculated	BTEX (Sum of Total) - Calc
	No Samples			10	7	10	0	2	7	4	9	0	10	0	1	9	0	0	0	0	10	8	8	9	9	9	8	8	3	9	9	8	0	7	0	
	Min			0.01	0	0.07	0	0	0	0	0	0	0.034	0	0	0	0	0	0	0	0.006	0	0	1	2	2	0	0	14	0.1	0.01	0	0	0	0	
	Max			0.63	0.019	0.23	0	0.002	0.024	0.01	24.9	0	1.78	0	0.001	0.01	0	0	0	0	0.092	992	949	41398	41617	16	175	213	18	0.8	1.71	0.2	0	0.96	0	
	85th Percentile			0.412	0.012	0.21	0	0.001	0.008	0.002	13.7	0	1.063	0	0	0.006	0	0	0	0	0.026	808.6	810	4	9.6	12	157	191	17	0.5	0.86	0.03	0	0.33	0	
	99th percentile			0.6192	0.018	0.23	0	0.002	0.023	0.009	24	0	1.724	0	9E-04	0.01	0	0	0	0	0.086	978.3	944	38086	38288	16	174	212	18	0.8	1.65	0.19	0	0.91	0	
				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/l	mg/L	mg/l	mg/L	mg/L	mg/l	mg/l	mg/l	mg/l	mg/L	mg/L	µS/cn	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
C022P1	**3/10/2011**	Normal	Dunda Beds	0.51	0	0.15	0	0	0.005	0	0.5	0	0.099	0	0	0.006	0	0	0	0	0.011	332	301	2	4	2	55	67		0.3	0.02	0.03	0	0.07	0	0
	6/10/2011	Normal	Dunda Beds																																	
	10/11/2011	Normal	Dunda Beds	0.63	0.001	0.11	0	0.002	0.007	0	0.76	0	0.083	0	0	0.006	0	0	0	0	0.014	395	209	2	4	3	57	77	16	0.3	0.05	0.02	0	0	0	0
	14/11/2011	Normal	Dunda Beds	0.23	0.002	0.07	0	0	0.009	0	2.67	0	0.2	0	0	0.006	0	0	0	0	0.028	357	233	3	4	3	56	70	18	0.3	0.04	0.03	0	0	0	0
	26/05/2013	Normal	Dunda Beds	0.08	0	0.13	0	0	0.024	0.01	0	0	0.034	0	0	0.005	0	0	0	0	0.023	275	183	1	3	2	47	65		0.1	0.01	0.2	0	0.36	0	0
C027P2	**29/09/2011**	Normal	Dunda Beds	0.09	0.019	0.22		0	0.007	0	24.9	0	1.78	0	0	0.004	0	0	0	0	0.009	0	0	41398	41617	10	0	0		0.5	0.97	0.01	0	0.19	0	0
		Field_D	Dunda Beds	0.16	0.011	0.23		0	0.005	0	15	0	1.16	0	0	0.004	0	0	0	0	0.006														0	0
	5/11/2011	Normal	Dunda Beds	0.14	0.012	0.16	0	0.002	0.002	0	11.3	0	0.883	0	0	0.01	0	0	0	0	0.01	992	949	3	10	12	175	199	14	0.4	0.42	0.02	0	0.02	0	19.5
	25/05/2013	Normal	Dunda Beds	0.01	0.004	0.2	0	0	0	0.002	2.08	0	0.234	0	0	0.002	0	0	0	0	0.018	821	488	1	5	9	160	213		0.2	0.09	0.03	0	0.09	0	0
C180116SP	**23/05/2013**	Normal	Dunda Beds																																	
C180117SP	**5/08/2013**	Normal	Dunda Beds																																	
C180118SP	**6/08/2013**	Normal	Dunda Beds																																	
C9553P1R	**2/10/2012**	Normal	Dunda Beds																																	
	21/05/2013	Normal	Dunda Beds	0.02	0.01	0.1	0	0	0	0.001	6.6	0	0.498	0	0.001	0.006	0	0	0	0	0.012	522	891	4	8	4	106	35		0.8	1.71	0	0	0.96	0	0
C9845SPR	**18/05/2013**	Normal	Dunda Beds																																	
HD03A	**27/10/2012**	Normal	Dunda Beds																																	
	27/05/2013	Normal	Dunda Beds	0.03	0	0.14	0	0	0	0.002	0.64	0	0.402	0	0	0	0	0	0	0	0.092	759	380	4	2	16	143	158		0.3	0.24	0.01	0	0.09	0	0

Overall _Unit Rewan

Lab

Values

LocCode	Sampled_Date	Sample_Type	MonitoringUnit_2	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)	Electrical conductivity *(lab)	Total Dissolved Solids	Calcium (Filtered)	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Chloride	Sulphate	Fluoride	Ammonia as N	Nitrate (as N)	Nitrite (as N)	Phosphorus	C6-C40 Calculated	BTEX (Sum of Total) - Calc
	No Samples			4	5	5	0	1	3	1	5	0	5	0	2	3	0	0	0	0	4	6	6	6	6	6	6	6	1	6	6	4	0	5	0	0
	Min			0	0.002	0.1	0	0	0	0	0.27	0	0.12	0	0	0	0	0	0	0	0	290	248	2	3	3	54	45	50	0.4	0.03	0	0	0	0	0
	Max			0.08	0.008	0.7	0	0.001	0.004	0.006	2.04	0	0.67	0	0.003	0.01	0	0	0	0	0.014	4280	2990	21	18	7	830	1100	50	0.8	0.19	0.06	0	1.99	0	0
	85th Percentile			0.074	0.006	0.66	0	4E-04	0.003	0.002	1.4	0	0.422	0	0.002	0.009	0	0	0	0	0.014	4265	2465	21	18	6	824	1078	50	0.7	0.14	0.05	0	0.61	0	0
	99th percentile			0.0796	0.008	0.7	0	1E-03	0.004	0.006	2	0	0.653	0	0.003	0.01	0	0	0	0	0.014	4279	2955	21	18	7	830	1099	50	0.8	0.19	0.06	0	1.9	0	0
				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/l	mg/L	mg/l	mg/L	mg/L	mg/l	mg/l	mg/l	mg/l	mg/L	mg/L	uS/cm	mg/l	mg/l	mg/l	mg/L	mg/L	mg/l	mg/L	mg/L	mg/L	mg/l	mg/L	ug/L	ug/L
C035P1	**5/10/2011**	Normal	Rewan Group	0.08	0.008	0.64	0	0	0	0	2.04	0	0.256	0	0	0	0	0	0	0	0	4260	2290	21	18	6	822	1070		0.7	0.1	0.05	0	0.15	0	0
		Field_D	Rewan Group																			4280	2260	21	18	6	820	1070		0.7	0.11	0.06	0	0.13	0	0
	6/11/2011	Normal	Rewan Group	0.03	0.005	0.54	0	0.001	0	0	0.68	0	0.218	0	0	0	0	0	0	0	0.006	4010	2990	20	18	6	744	909	50	0.6	0.12	0.02	0	1.99	0	0
	27/05/2013	Normal	Rewan Group	0	0.002	0.7	0	0	0.001	0	0.38	0	0.12	0	0	0.002	0	0	0	0	0.008	4030	2170	16	16	5	830	1100		0.7	0.07	0	0	0.09	0	0
C555P1	**30/09/2012**	Normal	Rewan Group																																	
	25/05/2013	Normal	Rewan Group	0.02	0.005	0.28	0	0	0.002	0	0.97	0	0.67	0	0.003	0.008	0	0	0	0	0.014	860	467	5	7	7	170	191		0.8	0.19	0	0	0.04	0	0
C556P1	**1/10/2012**	Normal	Rewan Group																																	
	26/05/2013	Normal	Rewan Group	0.07	0.002	0.1	0	0	0.004	0.006	0.27	0	0.211	0	0.001	0.01	0	0	0	0	0.014	290	248	2	3	3	54	45		0.4	0.03	0.02	0	0	0	0

				Aluminium (Filtered)	Arsenic (Filtered)	Boron (Filtered)	Cadmium (Filtered)	(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)	*(lab)	Total Dissolved Solids	Calcium (Filtered)	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Chloride	Sulphate	Fluoride	Ammonia as N	Nitrate (as N)	Nitrite (as N)	Phosphorus	C6-C40 Calculated	Calc
	No Samples			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Min			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Max			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	85th Percentile			#NUM!	##	##	###	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##
	99th percentile			#NUM!	##	##	###	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##
				mg/L	mg/l	mg/l	mg/L	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	S/cr	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	ug/L	ug/L

Overall _Unit	Early Permian

Lab

Values

LocCode	Sampled_Date	Sample_Type	MonitoringUnit_2
C180112SP	**23/05/2013**	Normal	Permian below D Seam
C825SP	**24/05/2013**	Normal	Permian below D Seam
C827SP	**25/05/2013**	Normal	Permian below D Seam
C834SP	**22/05/2013**	Normal	Permian below D Seam
C840SP	**19/05/2013**	Normal	Permian below D Seam
C9849SPR	**21/05/2013**	Normal	Permian below D Seam

				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)	Electrical conductivity *(lab)	Total Dissolved Solids	Calcium (Filtered)	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Chloride	Sulphate	Fluoride	Ammonia as N	Nitrate (as N)	Nitrite (as N)	Phosphorus	C6-C40 Calculated	BTEX (Sum of Total) - Calc
	No Samples			17	20	25	1	9	3	10	18	0	21	0	18	10	0	2	4	0	14	25	25	25	20	25	25	25	7	24	25	23	0	18	2	5
	Min			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0
	Max			15.8	0.013	0.61	0.0001	0.005	0.002	0.003	2.24	0	0.595	0	0.202	0.058	0	0.004	0.003	0	0.019	17100	10800	564	312	319	2740	5930	473	1	6.02	0.05	0	1.73	100.32	10.5
	85th Percentile			0.414	0.004	0.48	0	0.002	0	0.001	0.82	0	0.382	0	0.012	0.002	0	0	4E-04	0	0.01	16100	10225	461	242	65	2593	4570	313	0.8	3.75	0.03	0	0.29	0	5.9
	99th percentile			13.366	0.012	0.59	8E-05	0.005	0.002	0.003	2.03	0	0.594	0	0.156	0.045	0	0.004	0.003	0	0.018	16950	10775	563	312	286	2710	5918	472	1	5.75	0.05	0	1.48	75.245	10.1
				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	uS/cm	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

Overall _Unit Bandanna

Lab

Values

LocCode	Sampled_Date	Sample_Type	MonitoringUnit_2	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)	Electrical conductivity *(lab)	Total Dissolved Solids	Calcium (Filtered)	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Chloride	Sulphate	Fluoride	Ammonia as N	Nitrate (as N)	Nitrite (as N)	Phosphorus	C6-C40 Calculated	BTEX (Sum of Total) - Calc
C007P2	**4/10/2011**	Normal	AB Seam	0	0.003	0.41	0	0.001	0.001	0.002	0.24	0	0.445	0	0.008	0	0	0.004	0.003	0	0	17100	10300	558	234	52	2740	5460		0.4	3.07	0.03	0	1.73	0	0
	10/11/2011	Normal	AB Seam		0.003	0.51	0.0001				0.16		0.304		0.001			0.003			0.005	16500	10800	486	270		2620	5230	473		2.48	0.01		0.04	0.02	
		Field_D	AB Seam	0	0.002	0.49	0	0.002	0	0.001	0.1	0	0.285	0	0	0	0	0	0.002	0	0	16100	10700	453	267	66	2590	4350	465	0.4	2.43	0.01	0	0	0	0
	23/05/2013	Normal	AB Seam	0	0.002	0.51	0	0.002	0	0.001	0.76	0	0.592	0	0.001	0	0	0	0.001	0	0	16100	10300	547	312	60	2600	5880		0.3	3.67	0.01	0	0.06	0	0
		Field_D	AB Seam	0.01	0.002	0.48	0	0.002	0.001	0.002	0.74	0	0.595	0	0.002	0.001	0	0	0.001	0	0.01	16100	10200	564	311	60	2620	5930		0.3	4	0.01	0	0.08	0	0
C008P2	**3/10/2011**	Normal	AB Seam	0.02	0.004	0.3	0	0	0	0	0	0	0.263	0	0.005	0	0	0	0	0	0	3330	1920	35	19	20	732	755		0.8	0.9	0.02	0	0.18	0	0
	12/11/2011	Normal	AB Seam	0.06	0.008	0.3	0	0.001	0	0.001	0.06	0	0.361	0	0	0.002	0	0	0	0	0.019	3260	1920	38	21	20	577	683	31	0.9	0.85	0.01	0	0	0	9
	23/05/2013	Normal	AB Seam	0	0.003	0.27	0	0	0	0	0	0	0.102	0	0.002	0.001	0	0	0	0	0	3110	1710	27	18	19	596	742		0.8	1.52	0	0	0.13	0	0
C014P2	**4/10/2011**	Normal	AB Seam	0	0.004	0.3	0	0	0.002	0	0.38	0	0.084	0	0.009	0.003	0	0	0	0	0	2020	1110	20	6	25	415	398		1	0.82	0.02	0	0	0	0
	12/11/2011	Normal	AB Seam	0.42	0.004	0.24	0	0.001	0	0	0.18	0	0.002	0	0.012	0.002	0	0	0	0	0.007	2030	1340	3	3	33	374	406	0	1	0.98	0.02	0	0.28	0	0
	26/05/2013	Normal	AB Seam	15.8	0	0.1	0	0	0	0.003	0.12	0	0	0	0.202	0.058	0	0	0	0	0.009	5950	2390	28	0	319	702	442		0.4	2.21	0.01	0	0.22	100.32	0
C016P2	**2/10/2011**	Normal	AB Seam	0.08	0.004	0.31	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0.006	3000	1660	5	0	119	573	735		0.2	4.93	0.02	0	0.51	0	10.5
	6/10/2011	Normal	AB Seam																																	
	13/11/2011	Normal	AB Seam	0.02	0.003	0.23	0	0	0	0	0.05	0	0.001	0	0.013	0	0	0	0	0	0.005	3840	1840	4	0	182	520	659	21	0.3	4.32	0.02	0	0	0	5.5
	21/05/2013	Normal	AB Seam	2.23	0.001	0.27	0	0	0	0	0	0	0	0	0.008	0	0	0	0	0	0.005	2810	1440	56	0	64	499	661		0.2	6.02	0	0	0.02	0	0
C018P2	**2/10/2011**	Normal	AB Seam	0	0.001	0.61	0	0	0	0	1.13	0	0.051	0	0	0	0	0	0	0	0.007	2490	1420	45	43	18	359	578		0.4	0.03	0.02	0	0.3	0	0
	6/10/2011	Normal	AB Seam																																	
	9/11/2011	Normal	AB Seam	0	0	0	0	0.003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0.02	0	0	0	0
	20/05/2013	Normal	AB Seam	0	0	0.48	0	0	0	0.001	0.61	0	0.08	0	0	0.001	0	0	0	0	0.015	1550	1260	46	26	16	284	456		0.4	0.08	0	0	0.02	0	0
C020P2	**3/10/2011**	Normal	AB Seam	0.1	0.002	0.48	0	0	0	0	0.06	0	0.037	0	0.004	0	0	0	0	0	0	1780	1050	15	3	4	374	411		0.6	0.04	0.03	0	0.23	0	0
	6/10/2011	Normal	AB Seam																																	
	14/11/2011	Normal	AB Seam	0.04	0.001	0.41	0	0	0	0	0	0	0.041	0	0.002	0	0	0	0	0	0	1740	970	16	3	5	310	406	16	0.6	0.52	0.02	0	0	0	6.5
		Field_D	AB Seam	0.04	0.001	0.39	0	0	0	0	0	0	0.04	0	0.002	0	0	0	0	0	0	1760	978	16	3	5	310	411	17	0.6	0.53	0.02	0	0	0	7.5
C032P2	**5/10/2011**	Normal	AB Seam	0.02	0.005	0.3	0	0	0	0	0.33	0	0.264	0	0.018	0	0	0	0	0	0	1400	951	24	6	20	257	229		0.6	0.05	0.03	0	0.12	0	0
	7/11/2011	Normal	AB Seam	0.02	0.013	0.3	0	0.003	0	0	1.4	0	0.464	0	0.01	0.002	0	0	0	0	0.005	1580	1540	37	13	11	294	934	0	0.7	0.71	0.01	0	0.74	0	0
	27/05/2013	Normal	AB Seam	0.41	0.005	0.32	0	0	0	0	0	0	0	0	0.016	0.001	0	0	0	0	0.009	1590	798	1	0	50	319	232		0.9	0.64	0.02	0	0.03	0	0
C035P2	**5/10/2011**	Normal	AB Seam	0.35	0	0.24	0	0	0	0.002	1.01	0	0.136	0	0	0	0	0	0	0	0	1560	851	12	8	6	280	404		0.3	0.04	0.05	0	0.06	0	0
	6/11/2011	Normal	AB Seam	5.66	0	0.2	0	0.005	0	0.001	2.24	0	0.128	0	0	0.003	0	0	0	0	0.01	1550	1180	13	8	7	276	535	17	0.3	0.07	0.03	0	0	0	0
	27/05/2013	Normal	AB Seam	0.01	0	0.27	0	0	0	0.001	0.46	0	0.102	0	0	0	0	0	0	0	0.013	1610	782	11	8	6	293	441		0.3	0.06	0.02	0	0.05	0	0
C180119SP	**2/06/2013**	Normal	Overburden																																	
C180120SP	**1/06/2013**	Normal	Overburden																																	
C180122SP	**2/06/2013**	Normal	Overburden																																	
C180123SP	**1/06/2013**	Normal	Overburden																																	
C9180121SPR	**1/06/2013**	Normal	Overburden																																	
C9180124SPR	**2/06/2013**	Normal	Overburden																																	
C9180125SPR	**5/06/2013**	Normal	Overburden																																	

Overall _Unit Colinlea

Values

LocCode	Sampled_Date	Sample_Type	MonitoringUnit_2	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)	Electrical conductivity *(lab)	Total Dissolved Solids	Calcium (Filtered)	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Chloride	Sulphate	Fluoride	Ammonia as N	Nitrate (as N)	Nitrite (as N)	Phosphorus	C6-C40 Calculated	BTEX (Sum of Total) - Calc
	No Samples			15	26	29	0	9	10	7	26	0	29	0	17	14	0	0	8	0	16	30	29	29	30	30	29	30	7	30	28	22	0	19	0	2
	Min			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	881	0	0	3	4	0	40	0	0.3	0	0	0	0	0	0
	Max			0.32	0.02	1.71	0	0.004	0.005	0.004	30.1	0	0.891	0	0.029	0.009	0	0	0.014	0	0.044	19000	11900	337	454	41609	3270	6720	42278	2.6	1.19	0.08	0	0.57	0	7.5
	85th Percentile			0.085	0.005	0.75	0	0.002	0.001	0.001	3.55	0	0.238	0	0.007	0.004	0	0	0.003	0	0.017	4933	2849	59	41	17	854	1213	302.5	2.3	0.41	0.03	0	0.13	0	0
	99th percentile			0.29	0.017	1.59	0	0.004	0.005	0.003	25.5	0	0.83	0	0.026	0.009	0	0	0.014	0	0.039	18826	11900	329	447	29562	3215	6581	38100	2.6	1.19	0.07	0	0.47	0	7.2
				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	uS/cm	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
C006P1	**3/10/2011**	Normal	Permian Interburden	0	0.011	1.05	0	0.004	0	0	1.9	0	0.891	0	0.029	0.002	0	0	0.014	0	0.006	14100	8960	244	246	27	2560	4800		0.7	0.46	0.02	0	0.04	0	0
	10/11/2011	Normal	Permian Interburden	0	0.01	1.3	0	0.004	0.005	0.001	3.85	0	0.687	0	0.005	0.004	0	0	0.014	0	0.008	19000	11900	311	429	66	3080	6240	497	0.6	0.27	0.02	0	0	0	0
	23/05/2013	Normal	Permian Interburden	0	0	1.71	0	0	0	0	1.33	0	0.179	0	0.008	0	0	0	0.013	0	0.026	18400	11900	337	454	64	3270	6720		0.5	0.09	0.02	0	0	0	0
C006P3r	**3/10/2011**	Normal	D Seam	0.14	0.004	0.18	0	0	0	0	0.8	0	0.046	0	0.002	0	0	0	0	0	0	1000	587	9	4	4	246	58		2.2	0.34	0.02	0	0.08	0	0
	10/11/2011	Normal	D Seam	0.1	0.003	0.13	0	0.003	0	0	0.44	0	0.036	0	0.002	0	0	0	0	0	0	1030	568	9	3	5	197	56	0	2.2	0.33	0.02	0	0.02	0	0
	12/11/2011	Normal	D Seam	0.13	0.003	0.12	0	0.001	0	0	0.41	0	0.038	0	0.002	0.003	0	0	0	0	0.009	1020	620	9	3	5	209	59	0	2.4	0.31	0	0	0.21	0	0
	23/05/2013	Normal	D Seam	0	0.002	0.17	0	0	0	0.002	0.27	0	0.032	0	0.001	0.002	0	0	0	0	0.01	973	541	8	3	4	208	55		2.3	0.4	0.01	0	0.08	0	0
C007P3	**4/10/2011**	Normal	D Seam	0.32	0.004	0.22	0	0	0	0.004	0.18	0	0.052	0	0.019	0	0	0	0.002	0	0	1230	809	10	3	4	297	61		2.6	0.3	0.01	0	0.14	0	0
	10/11/2011	Normal	D Seam	0.22	0.003	0.22	0	0	0	0	0.12	0	0.042	0	0.019	0	0	0	0.002	0	0.01	1220	760	6	3	6	253	49	45	2.6	0.43	0.02	0	0.05	0	0
	23/05/2013	Normal	D Seam	0.02	0.002	0.23	0	0	0	0	0	0	0.054	0	0.005	0	0	0	0.001	0	0	1080	627	6	3	4	237	40		2.3	0.41	0.01	0	0.02	0	0
C011P1	**13/11/2011**	Normal	Permian Interburden	0.07	0.002	0.9	0	0.002	0.001	0	0	0	0.113	0	0.007	0.009	0	0	0.004	0	0.023	2980	1900	18	17	14	565	539	91	0.8	0.12	0.05	0	0	0	0
	19/05/2013	Normal	Permian Interburden	0.02	0.003	0.87	0	0	0	0.001	0	0	0.064	0	0.006	0.003	0	0	0.003	0	0.008	2810	1670	17	14	11	586	576		0.6	0.04	0	0	0	0	0
C011P3	**4/10/2011**	Normal	D Seam	0	0.004	0.41	0	0	0.002	0	2.59	0	0.218	0	0.002	0	0	0	0	0	0	1020	568	17	5	17	180	164		1.2	0.21	0.03	0	0.57	0	0
	13/11/2011	Normal	D Seam	0.02	0.002	0.35	0	0	0	0	0.88	0	0.09	0	0.002	0.001	0	0	0	0	0.01	1030	608	22	6	14	165	173	0	1.2	0.29	0.02	0	0	0	0
	28/11/2011	Normal	D Seam																																	
	20/05/2013	Normal	D Seam	0.01	0	0.38	0	0	0	0	0.2	0	0.05	0	0.001	0.001	0	0	0	0	0.013	881	598	22	4	8	161	155		1.1	0.29	0	0	0.03	0	0
C018P3	**2/10/2011**	Normal	D Seam	0.05	0.002	0.35	0	0	0.001	0	0.59	0	0.122	0	0.001	0	0	0	0	0	0	1050	651	22	6	9	189	213		1.2	0.32	0.03	0	0.09	0	0
	6/10/2011	Normal	D Seam																																	
	9/11/2011	Normal	D Seam	0	0.001	0	0	0.002	0	0	0	0	0	0	0	0	0	0	0	0	0	1040	0	0	6	41609	0	211	42278	1.2	0	0.02	0	0	0	0
	19/05/2013	Normal	D Seam	0	0.001	0.3	0	0	0.001	0	0.46	0	0.055	0	0	0	0	0	0	0	0	948	653	23	6	8	174	213		1.1	0.16	0	0	0.12	0	0
	20/05/2013	Normal	D Seam																																	
C024P3	**6/10/2011**	Normal	D Seam	0	0.007	0.3	0	0	0.001	0	14.8	0	0.261	0	0	0	0	0	0	0	0	1710	1150	27	51	17	270	351		0.4	0	0	0	0.07	0	7.5
	14/11/2011	Normal	D Seam	0	0.004	0.28	0	0.001	0	0.002	8.37	0	0.236	0	0	0.009	0	0	0	0	0.044	1720	1050	23	42	17	232	374	0	0.4	0.02	0	0	0	0	6.5
	20/05/2013	Normal	D Seam	0	0.001	0.28	0	0	0.004	0	7.94	0	0.239	0	0	0.005	0	0	0	0	0.016	1520	1110	18	38	10	234	388		0.6	1.19	0.01	0	0.18	0	0
		Field_D	D Seam	0.01	0.02	0.28	0	0	0.004	0	30.1	0	0.256	0	0	0.004	0	0	0	0	0	1500	1110	18	36	11	237	390		0.6	1.18	0.01	0	0.18	0	0
C034P1	**5/10/2011**	Normal	Permian Interburden	0.01	0.005	0.6	0	0	0.001	0	3.24	0	0.204	0	0	0	0	0	0	0	0	5180	2870	62	39	11	842	1220		0.7	0.06	0.06	0	0.05	0	0
	6/11/2011	Normal	Permian Interburden	0.01	0.003	0.51	0	0.001	0	0	1.3	0	0.141	0	0	0.001	0	0	0	0	0.01	4950	2810	59	38	12	862	1200	108	0.7	0.08	0.01	0	0	0	0
		Field_D	Permian Interburden	0	0.003	0.53	0	0	0	0	1.23	0	0.137	0	0	0.001	0	0	0	0	0	4900	2940	59	38	12	860	1060	107	0.7	0.11	0.01	0	0	0	0
	24/05/2013	Normal	Permian Interburden	0	0.002	0.63	0	0	0	0	0.73	0	0.116	0	0	0.001	0	0	0	0	0.014	4420	2320	54	34	11	810	1220		0.7	0.12	0	0	0	0	0
C034P3	**5/10/2011**	Normal	D Seam	0	0.002	0.26	0	0	0	0	1.2	0	0.23	0	0.006	0	0	0	0	0	0	2410	1260	32	14	15	424	601		0.5	0.14	0.08	0	0.07	0	0
		Field_D	D Seam	0.01	0.005	0.59	0	0	0.001	0	3.2	0	0.195	0	0	0	0	0	0	0	0															
	6/11/2011	Normal	D Seam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1770	1020	22	11	14	295	478	24	0.3	0.09	0.02	0	0	0	0
	24/05/2013	Normal	D Seam	0	0	0.24	0	0	0	0.001	1.4	0	0.184	0	0	0	0	0	0	0	0.019	1970	1010	26	11	14	338	563		0.3	0.17	0	0	0.05	0	0
		Field_D	D Seam	0	0	0.26	0	0.002	0	0.001	1.42	0	0.192	0	0	0	0	0	0	0	0.018	1980	1040	25	11	14	340	562		0.3	0.17	0.01	0	0.08	0	0
C180114SP	**23/05/2013**	Normal	D Seam																																	
C829SP	**25/05/2013**	Normal	Permian within D Seam																																	
C832SP	**22/05/2013**	Normal	Permian Interburden																																	
C833SP	**22/05/2013**	Normal	D Seam																																	
C844SP	**14/06/2013**	Normal	Permian Interburden																																	
C847SP	**21/05/2013**	Normal	Permian Interburden																																	
C848SP	**21/05/2013**	Normal	D Seam																																	
C9839SPR	**19/05/2013**	Normal	Permian Interburden																																	

APPENDIX D GROUNDWATER MANAGEMENT PROGRAM OBLIGATIONS

Groundwater Management Program Obligations

(To be finalised with exact conditions to be drafted for CCP)

A draft groundwater monitoring program has been compiled for discussion and comment from the administering authorities. The draft groundwater monitoring program has been compiled in response to the (assumed) approval conditions compiled in:

- The Coordinator-General's Evaluation Report for the Carmichael Coal Project;
- The draft Environmental Authority; and
- The *Environmental Protection and Biodiversity Act 1999* approval.

The draft groundwater monitoring program was compiled in order to respond to the following obligations as compiled in the approval conditions. The groundwater monitoring program was designed to allow for the assessment of possible alteration of groundwater resources due to the proposed Carmichael Coal Project mining activities and assess the effectiveness and efficiencies of the mitigation and management process and procedures to be utilised on site. In addition, the monitoring data will allow for the verification and validation of predictions and provide information required for decision making, assessment of potential for environmental harm, and the implementation of "make-good" commitments.

The approval conditions met or facilitated with regards to the groundwater monitoring program include:

1. Coordinator – General Conditions

A. Current Obligations (Section 5.7 of main text):

- Project design to ensure the minimum possible impacts on the groundwater resource;
- Mitigate any adverse effects that may occur such as changes to water quality in groundwater resources;
- Compliance with the terms of any water licence conditions issued by the Department of Environment and Heritage Protection (EHP);
- Establish a groundwater monitoring program;
- The determination and approval by EHP of water quality and trigger levels before the commencement of mine operations;
- The proponent will be required to undertake periodic audits of its groundwater model, and re-calibrate and re-predict future impacts during the mining phase of the project.

B. Appendix 1: Stated Conditions – Mine Environmental Authority:

Condition XXX: Groundwater

(a) A groundwater monitoring program must be developed and submitted to the administering authority for approval before the commencement of mining activities. The monitoring program must:

1. Allow for the compilation of representative groundwater samples from the aquifers identified as potentially affected by mining activities. The geological units monitored include

Quaternary alluvium, Bandanna Formation, Colinlea Sandstone, Clematis Sandstone, Rewan Formation, Dunda Beds, and Early Permian sediments.
2. Include at least twelve sampling events, no more than two months apart over a two year period, to determine background groundwater quality;
3. Obtain background groundwater quality in hydraulically isolated background bore(s), and
4. Allow for the identification of natural groundwater level trends, hydrochemical trigger levels, and contaminant limits.

(b) In addition to Condition XXX(a) groundwater quality and levels must be monitored at the locations and frequencies specified in Table XX: Groundwater monitoring network locations and frequency. Tables are listed in Section 5 of this Groundwater Monitoring Program.

(c) If groundwater monitoring results greater than the trigger levels (or outside the trigger levels range for pH) specified for the relevant aquifer in the Tables 5-2 to 5-9 of this document (inclusive) are recorded, then the following must be conducted:

1. The relevant monitoring point(s) will be re-sampled and the samples analysed for major cations and anions, and selected dissolved metals, including Al, As, B, Cd, Cr, Co, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, U, V, and Zn;
2. If elevated concentrations (above trigger) are recorded on two consecutive sampling events then an investigation into cause, optimum response, and the potential for environmental harm must be conducted; and
3. If elevated concentrations are recorded on two consecutive sampling events then the administering authority will be notified within 1 month of receiving the analysis results.

(d) If groundwater monitoring results greater than the contaminant limits (or outside the contaminant limits range for pH) specified for the relevant aquifer in Table 5-2 to Table 5-9 (inclusive) are recorded, then an investigation into cause, optimum response, and the potential for environmental harm must be conducted.

(e) Groundwater contaminant trigger levels for Table 5-2 to Table 5-9 (inclusive) must be finalised based on the Groundwater Monitoring Program approved under Condition XXX (a) and submitted to the administering authority 28 days prior to commencing coal extraction.

(f) Groundwater monitoring bores must be constructed in accordance with methods prescribed in the Minimum Construction Requirements for Water Bores in Australia – 3rd Edition (NWC, 2012), or equivalent.

(g) The monitored data must be reported to the administering authority, and must satisfy the following criteria:

1. Data collected under the monitoring program will be forwarded to the administering authority on a quarterly basis within 30 business days of the end of each quarter and compiled in an annual monitoring report in a format approved by the administering authority;
2. The proponent shall undertake an assessment of the impacts of mining on groundwater after the first 12 months of dewatering commencing and thereafter every subsequent calendar year;
3. The annual monitoring report will be forwarded to the relevant authority by the first of March each calendar year; and

4. The annual monitoring report will include an assessment of impacts, any mitigation strategies as wells as any recommendations for changes to the approved monitoring program.
5. If there is a requirement to submit a similar groundwater report as part of any condition issued under a water licence under the Water Act 2000 then the proponent and the relevant administering authorities may agree for the reports to be combined.

C. Appendix 2: Part B: Imposed Conditions - mine

Imposed Conditions to Address Cumulative Impacts:

Regional groundwater monitoring and reporting program (Condition 2):

To address the potential cumulative impacts on groundwater quality and availability in the Galilee basin, the Coordinator-General has imposed the following condition for the Carmichael Coal Project that will be similarly imposed for other projects in the basin. EHP is designated as the agency responsible for this condition.

(a) The proponent must:

1. Before commencing mining activities prepare to the satisfaction of the administering authority and implement a groundwater monitoring and reporting program for aquifers impacted by the project off the mining lease
2. Design the program to complement the environmental authority requirements and other groundwater management programs in the Galilee basin. The program should aim to enable a basin groundwater model to be developed to predict, verify and monitor groundwater impacts.
3. Make monitoring results from the program publicly available on the proponent's web site updated at least annually
4. Contribute to any basin wide collaborative project established by the administering authority to develop a basin groundwater model, including pro-rata funding
5. Contribute to development of a basin wide groundwater model for determining the capacity of aquifers and acceptable extraction rates, including pro-rata funding

Imposed condition 2, Part B, Appendix 2 would be complemented by EHP/NRM as the lead agencies for developing a coordinated basin wide monitoring and assessment program, to organise and collate basin wide monitoring programs, data and reports, and to ensure such outcomes influence the ongoing management of groundwater resources.

Recommendation 2. Groundwater Modelling

(a) The proponent must recalibrate the groundwater model referred to in the Groundwater Section of the EIS initially at a minimum of 5-yearly intervals, and subsequently with the approval of the administering authority for the *Water Act 2000*, at 10-yearly intervals throughout the mining phase of the project; and

(b) The proponent must provide a report on each recalibration to the administering authority for the *Water Act 2000* within 6 weeks of completion of the recalibration.

Recommendation 3. Monitoring

(a) The proponent must:

1. Monitor and record groundwater levels at representative monitoring bores agreed to by the administering authority for the *Water Act 2000*, at frequencies determined on the basis of the results of baseline monitoring and trigger values (monthly/quarterly/continuous);
2. Monitor and record groundwater inflows and dewatering volumes pumped (monthly/continuous);
3. Compare water level changes with model-predicted water level changes, to verify the reliability of model predictions, for input to Condition XXX;
4. Report annually to the administering authority for the *Water Act 2000*, the results of monitoring and comparison of observed impacts with predicted impacts.

E. Appendix 5 Proponent Commitments – Mine

GROUNDWATER

The proponent will:

- Develop and implement a Groundwater Monitoring Program detailing the location and frequency of groundwater monitoring activities, as well as trigger levels and response actions,
- Expand the existing groundwater monitoring network over time to enable ongoing groundwater impact evaluations,
- Install groundwater monitoring bores a minimum six months prior to mining in an area,
- Undertake groundwater monitoring and sampling via a suitably qualified and experienced professional in accordance with recognised procedures and guidelines,
- Conduct an annual review of the monitoring data, using suitably qualified expert,
- Include in the review an assessment of groundwater level and water quality data, and the suitability of the monitoring network,
- Undertake groundwater modelling audits on a regular basis (intervals not exceeding three years) and provide the modelling results to the administering authority for review,
- Investigate all groundwater-based complaints, including the maintenance of a complaints register. The register will be made available to the regulating authority upon request, and
- Implement make-good agreements with land holders affected by groundwater drawdown.

2. Draft Environmental Authority Conditions

CXA: Groundwater: A groundwater monitoring program must be developed and submitted to the administering authority for approval before the commencement of mining activities. The monitoring program must:

a) Allow for the compilation of representative groundwater samples from the aquifers identified as potentially affected by mining activities. The geological units monitoring include Quaternary alluvium, Bandanna Formation, Colinlea Sandstone, Clematis Sandstone, Rewan Formation, Dunda Beds, and Early Permian sediments;
b) Include at least 12 sampling events, no more than 2 months apart over a 2 year period, to determine background groundwater quality;
c) Obtain background groundwater quality in hydraulically isolated background bore(s), and
d) Allow for the identification of natural groundwater level trends, hydrochemcial trigger levels, and contaminant limits.

CXB: In addition to condition CXA groundwater quality and levels must be monitored at the locations and frequencies specified in Table 5-1: Groundwater monitoring network bores and frequency and **Appendix A** which includes the Groundwater Monitoring Locations.

CXC: If groundwater monitoring results in greater than the trigger levels (or outside the trigger levels range for pH) specified for the relevant aquifer in Table 5-2 to Table 5-9 (inclusive) are recorded, then the following must be conducted:

a) The relevant monitoring point(s) will be resampled and the samples analysed for major cations and anions, and selected dissolved metals including Al, As, B, Cd, Cr, Co, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, U, V, and Zn;
b) If elevated concentrations (above trigger) are recorded on two consecutive sampling events then an investigation into cause, optimum response, and the potential for environmental harm must be conducted; and
c) If elevated concentrations are recorded on two consecutive sampling events then the administering authority will be notified within 1 month of receiving the analysis results.

CXD: If groundwater monitoring results greater than the contaminant limits (or outside the contaminant limits range for pH) specified for the relevant aquifer in Table 5-2 to Table 5-9 (inclusive) are recorded, then an investigation into cause, optimum response, and the potential for environmental harm must be conducted.

CXE: Groundwater contaminant trigger levels for Table 5-2 to Table 5-9 (inclusive) must be finalise based on the Groundwater Monitoring Program approved under condition CXA and submitted to the administering authority 28 days prior to commencing coal extraction.

CXF: Groundwater monitoring bores must be constructed in accordance with methods prescribed in the Minimum Construction Requirements for Water Bores in Australia -3rd Edition (NWC, 2012), or equivalent.

CXG: The monitored data must be reported to the administering authority, and must satisfy the following criteria:

a) Data collected under the monitoring program will be forwarded to the administering authority on a quarterly basis within 30 business days of the end of each quarter and

compiled in an annual motioning report in a format approved by the administering authority;

b) The proponent shall undertake an assessment of the impacts of mining on groundwater after the first 12 months of dewatering commencing and thereafter every subsequent calendar year;
c) The annual monitoring report will be forwarded to the relevant authority by the fist of March each calendar year; and
d) The annual monitoring report will include an assessment of impacts, any mitigation strategies as well as any recommendations for changes to the approved monitoring program.
e) If there is a requirement to submit a similar groundwater report as part of any condition issued under a water license under the *Water Act 2000* then the proponent and the relevant administering authorities may agree for the reports to be combined.

Schedule F – Land

FXX: The Post Closure Management Plan must include the following elements:

a) Operation and maintenance of:
   - wastewater collection and reticulation systems;
   - wastewater treatment systems;
   - the groundwater monitoring network;
   - final cover systems of spoil dumps and
   - vegetative cover; and

b) monitoring of:
   - Surface water quality;
   - Groundwater quality;
   - Seepage rates;
   - Erosion rates;
   - Integrity and stability of all slopes, ramps, and voids; and
   - The health and resilience of native vegetation cover.

3. *Environmental Protection and Biodiversity Conservation Act 1999* Conditions

Water Quality

Condition 11 - Regional Water Plan:

The person taking the action must submit a Regional Water Plan to the Minister for approval. The plan must address the following requirements:

a) A regional surface water and a regional groundwater water monitoring program with reference to groundwater dependent habitat for listed threatened species and ecological communities, and listed migratory species:
b) The monitoring identified in condition XX must include identification of linkages between the formations, and likely movement of water into and out of the aquifers;
c) Address the potential for impacts to groundwater dependent habitat for listed species and ecological communities, and listed migratory species:
d) Include an ongoing monitoring program to be undertaken to:
   - Ensure no drawdown impacts result from mining operations on groundwater dependent communities in the Great Artesian Basin;
   - Measure the success of management measures and inform an adaptive management approach that must be implemented;
   - Report on milestones and compliance with this plan;
   - Identify measures of success; and
   - Identify thresholds for intervention, where rehabilitation and vegetation management measures are exceeded.

The person taking the action cannot commence construction activities until the Minister approves the Regional Water Plan in writing.

The approved Regional Water Plan must be implemented.

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