LAND COURT OF QUEENSLAND

REGISTRY: BRISBANE
NUMBER: MRA428-14, EPA429-14
MRA430-14, EPA431-14
MRA432-14, EPA433-14

Applicant:	ADANI MINING PTY LTD
	AND
First Respondent:	LAND SERVICES OF COAST AND COUNTRY INC.
	AND
Second Respondent:	CONSERVATION ACTION TRUST
	AND
Statutory Party:	CHIEF EXECUTIVE, DEPARTMENT OF ENVIRONMENT AND HERITAGE PROTECTION

AFFIDAVIT OF JOHN WILLIAM BRADLEY

I, John William Bradley, Principal Hydrogeologist, JBT Consulting, in the State of Queensland, affirm as follows:

1 I am the Principal Hydrogeologist at JBT Consulting and have been since 2009.

2 I am a geologist and hydrogeologist with over 23 years' experience in groundwater assessment and management.

3 I have been engaged by McCullough Robertson, on behalf of the Applicant, to appear as an expert witness in these proceedings in relation to issues raised in the objections to the Applicant's mining lease applications and environmental authority applications for the Carmichael Coal Mine project (**Objections**).

Deponent

GRitchie
Taken by:
Solicitor / ~~Justice of the Peace~~

Affidavit
Filed on behalf of the Applicants
Form 46 R.431

McCullough Robertson Lawyers
Level 11 Central Plaza Two 66 Eagle Street
BRISBANE QLD 4000
Phone: (07) 3233 8888 Fax: (07) 3229 9949
GPO Box 1855, BRISBANE QLD 4001
Ref: GMR:PWS:TMH:159359-00022

4 My curriculum vitae is attached to the individual expert report referred to below. I refer to my curriculum vitae and say that I have provided expert evidence to a number of matters of dispute relating to groundwater management issues and policies, and groundwater geophysics. These include:

(a) expert evidence on behalf of Endocoal Limited in relation to the Meteror Downs South (*Endocoal Limited v Glencore Coal Queensland Pty Ltd and Department of Environment and Heritage Protection* [2014] QLC 54); and

(b) expert evidence on behalf of Monto Coal 2 Pty Ltd in relation to the Monto Coal Project in the Land and Resources Tribunal (*Monto Coal 2 Pty Ltd & Ors v Dredge & Ors, Re* [2003] QLRT 27 (17 March 2003)).

5 I have previously prepared a joint report with John Webb, Adrian Werner, and John Bradley in relation to groundwater issues relating to the Carmichael Coal Project (**Groundwater Joint Report**).

6 I have been further asked to prepare an individual report in relation to whether, from a hydrogeology and groundwater assessment and management perspective, good reason exists to favourably recommend the Application for this mining lease, and to address any issues raised within my area of expertise by points of difference between experts. Exhibited to my Affidavit and marked '**JWB-1**' is a true copy of my report dated 6 February 2015 (**Individual Report**).

7 Pursuant to rule 428(3) *Uniform Civil Procedure Rules 1999* (Qld), I confirm that:

(a) the factual matters stated by me in the Joint Report and my Individual Report are, as far as I know, true;

(b) I have made all enquiries considered appropriate;

Deponent

GRitchie
Taken by:
Solicitor / ~~Justice of the Peace~~

(c) I genuinely hold the opinions stated by me in the Joint Report and in my Individual Report;

(d) my Individual Report contains reference to all matters that I considered significant; and

(e) I understand my duty to the court and I have complied with this duty.

8 All the facts and circumstances deposed to in this affidavit are within my own knowledge except those stated to be on information and belief. I have, as required, set out the basis and source of my knowledge or information and belief.

Affirmed by John William Bradley
at Brisbane
this 6th day of February 2015

Before me:

JBy

GRitchie

~~A Justice of the Peace/~~Solicitor

LAND COURT OF QUEENSLAND

REGISTRY:	BRISBANE
NUMBER:	MRA428-14, EPA429-14 MRA430-14, EPA431-14 MRA432-14, EPA433-14

Applicant:	ADANI MINING PTY LTD
	AND
First Respondent:	LAND SERVICES OF COAST AND COUNTRY INC.
	AND
Second Respondent:	CONSERVATION ACTION TRUST
	AND
Statutory Party:	CHIEF EXECUTIVE, DEPARTMENT OF ENVIRONMENT AND HERITAGE PROTECTION

CERTIFICATE OF EXHIBIT

Exhibit '**JWB-1**' to the affidavit of John William Bradley affirmed 6 February 2015.

Signed:
Deponent

GRitchie
Taken by:
Solicitor ~~/ Justice of the Peace~~ /
~~Commissioner for Declarations~~

JBT Consulting Pty Ltd
ABN 46 134 273 224
PO Box 1350
SRINGWOOD, QLD, 4127
Phone +61 7 3388 7604
Fax +61 7 3388 7604

Our reference: JBT01-049-001-Further Statement of Evidence.docx

6 February 2014

The Land Court of Queensland, Australia
GPO Box 5266
BRISBANE QLD 4001

Adani Mining Pty Ltd v Land Services of Coast and Country Inc & Ors
– Further Statement of Evidence – Geology and Hydrogeology (Groundwater Conceptualisation)

1. Experts Details & Qualifications

1.1. Name

My name is John William Bradley

1.2. Address

My business address is:

Director/Principal Hydrogeologist
JBT Consulting Pty Ltd
PO Box 1350
SPRINGWOOD QLD 4127

1.3. Qualifications and Expertise

My area of expertise relates to hydrogeology and groundwater assessment and management.

I have sufficient expertise to prepare this report because I have 23 years' experience as a hydrogeologist. The first 4 years of my career were spent in groundwater management (with the Rural Water Corporation, Victoria), with the following 19 years working as a consultant, predominantly within the Queensland coal mining industry.

My experience relates to:

- Integration of groundwater investigations with other investigations, such as surface water and geotechnical studies;
- Design and management of field investigations;
- Establishment of mine dewatering and aquifer depressurization requirements;
- Design and management of water supply/ dewatering borefields;
- Design and management of groundwater and environmental monitoring networks;
- Assessment of the impacts of operations on the environment, including civil water supplies;
- Preparation of conceptual and numerical groundwater models; and,
- Assessment of data and preparation of technical reports.

Annexure A to this report is my curriculum vitae, which sets out my professional qualifications.

2. Instructions

I have been instructed by McCullough Robertson Lawyers, acting on behalf of Adani Mining Pty Ltd (Adani), to formulate a report within the scope of the Brief provided to me, and within the scope of my skills and expertise. My instructions are attached as Annexure B.

3. Information Relied on for this Report

Information relied on for this report includes:

(i) Comet Ridge (2010) Shoemaker 1 Well Completion Report, ATP744P Galilee Basin Central Queensland. QDEX Report Reference 64041.

(ii) DNRM (2014) DNRM advice on groundwater flow direction. Appendix 3 of Coordinator General's evaluation report on the environmental impact statement.

(iii) EPASA (2010) Wastewater Guidelines – Wastewater Lagoons. Environment Protection Authority of South Australia document no. EPA 509/10. Draft for consultation.

(iv) GHD (2012) Report for Carmichael Coal Mine and Rail Project: Mine Technical Report. Hydrogeology Report 25215-D-RP-0026 Revision 2, 15 November 2012

(v) GHD (2013a) Carmichael Coal Mine and Rail Project SEIS – Report for Doongmabulla and Mellaluka Springs. 23 July 2013

(vi) GHD (2013b) Carmichael Coal Mine and Rail Project SEIS – Mine Hydrogeology Report Addendum. 24 October 2013

(vii) GHD (2013c) Carmichael Coal Mine and Rail Project SEIS – Report for Mine Hydrogeology Report. 13 November 2013

(viii) GHD (2014a) Carmichael Coal Project – Response to IESC Advice. Letter to Adani Mining of 7 February 2014. GHD (2014b) Carmichael Coal Project: Response to Federal Approval Conditions - Groundwater Flow Model. Report for Mine Hydrogeology Report. Report for Adani Mining Pty Ltd, November 2014

(ix) Habermehl & Lau (1997) Hydrogeology of the Great Artesian Basin, Australia (map at scale 1:2,500,000). Australian Geological Survey Organisation, Canberra.

(x) Hydrosimulations (2014) CPD-1-2014: A review of the Carmichael Coal Mine and Rail Project Water Hydrogeology Report. Appendix 4 (Independent Peer Review) of Coordinator General's evaluation report on the environmental impact statement.

(xi) IESC (2013) Advice to decision maker on coal mining project. Proposed action: Carmichael Coal Mine and Rail Project, Queensland (EPC 2010/5736) – New Development. 16 December 2013

(xii) URS (2014) Draft Groundwater Monitoring Program – Carmichael Coal Project Groundwater Monitoring Program. 3 March 2014

(xiii) Van Heeswijck, A (2006) The Structure, Sedimentology, Sequence Stratigraphy and Tectonics of the Northern Drummond and Galilee Basins, Central Queensland, Australia. Thesis submitted for the degree of Doctor of Philosophy in the Department of Earth Sciences, James Cook University of North Queensland.

(xiv) Vine et al. (1969) Buchanan 1:250,000 Scale Geology, Sheet SF55-6. Bureau of Mineral Resources, Geology and Geophysics.

(xv) Discussions held with project geological personnel during and subsequent to a site visit of 8-9 December 2014. The discussions relied on for this report specifically relate to the behaviour of the Rewan Formation during drilling and observations from core and chip samples. Specific discussions relating to the "healing" of the Rewan Formation during drilling were with M Stewart (URS).

(xvi) Adani (2015a) Carmichael Coal Project – Mellaluka Springs Stratigraphy. Included as Annexure F to this report.

(xvii) Adani (2015b) Spreadsheet containing hydraulic conductivity calculations from packer testing undertaken on bore C14201VWP.

4. Objections and Areas of Agreement/ Disagreement

Table 4-1 contains a summary of the original LSCII objections, the corresponding areas of agreement and disagreement from the Joint Groundwater Experts Report of 9 January 2015, and the sections of this Individual Expert Report that respond to specific objections or items of disagreement.

The Joint Groundwater Experts Report was prepared by the following experts and the abbreviations for each expert are used in Table 4-1:

(i) Dr John Webb (**JW**) acting on behalf of LSCII (groundwater conceptualisation and geology);
(ii) Mr John Bradley (**JB**) acting on behalf of Adani (groundwater conceptualisation and geology);
(iii) Dr Adrian Werner (**AW**) acting on behalf of LSCII (numerical groundwater modelling); and,
(iv) Dr Noel Merrick (**NM**) acting on behalf of Adani (numerical groundwater modelling).

The original objections raised by LSCII and the areas of disagreement in the Joint Expert Report that are addressed by this report are limited to groundwater conceptualisation and geology and do not consider matters relating to numerical groundwater modelling.

Specific responses to the LSCII objections and the areas of disagreement from the Joint Groundwater Expert Report are contained in Section 5 of this report.

Table 4-1: Summary of Objections, Areas of Disagreement and Responses

Original LSCII Issues (from Preliminary Notification of Issues)		Areas of Agreement/ Disagreement from Joint Groundwater Experts Report	Section of Further Statement of Evidence that Refers
Applicant's Conceptual Hydrogeological Model			
1	The modelling in the SEIS is based on a misconceptualisation of the geology and hydrogeology around the mine.	Refer discussion below under items 1(c) to 1(f) of the Preliminary Notification of Issues.	Sections 5.1, 5.2, 5.3
1(a)	All conceptual geological cross sections of the mine area indicate that the Triassic and Late Permian-age strata dip approximately 2-4º to the west, but the groundwater in these units has a general west to east gradient for much of the area, i.e. the groundwater flows up-dip. This is the opposite direction of flow that occurs in the GAB; the formations in this basin dip from east to west and groundwater flow is also from east to west, i.e. down-dip.		Sections 5.1, 5.2, 5.3
1(b)	Existing groundwater flow conceptualisations do not provide an adequate explanation for this direction of groundwater flow in and around the area of the proposed mine.	*Areas of Agreement* Paragraphs 2 to 5 of Joint Groundwater Experts Report discuss areas of agreement with respect to groundwater flow directions. *Areas of Disagreement* Paragraph 24 of Joint Groundwater Experts Report notes that there is no disagreement over groundwater flow directions.	Sections 5.1, 5.2, 5.3, 5.5
1(c)	A reinterpretation of the geology based on remote sensed data (radiometric, aeromagnetic, Landsat and Google Earth images) shows that:	*Areas of Agreement* Paragraph 1 notes that there are no areas of agreement in respect to regional geology. Paragraph 6 notes that the experts agree that the conceptual cross sections (e.g. Figures 9 and 10 of GHD (2013)[1]) are simplistic and that they do not accurately represent the probable flow conditions *Areas of Disagreement* 21. The experts disagree on the need to reconsider the published regional geology. 22. **JB** takes the view that the regional groundwater flow patterns and spring occurrence can be conceptualised without a need to reconsider the published geology and the Project geology.	Sections 5.1, 5.2, 5.3
1(c)(i)	there are several broad, open folds across the area;		Sections 5.1, 5.2, 5.3
1(c)(ii)	Lake Buchanan lies in the axis of a syncline;		Sections 5.1, 5.2, 5.3
1(c)(iii)	the drainage divide to the west of the proposed mine site coincides with an anticline axis;		Sections 5.1, 5.2, 5.3
1(c)(iv)	a substantial outcrop of the Rewan Formation is exposed in the headwaters of the Carmichael River;		Sections 5.1, 5.2, 5.3
1(c)(v)	there are extensive outcrops of Dunda Beds in the hills west of the proposed mine site;		Sections 5.1, 5.2, 5.3

<table>
<tr><th colspan="2">Original LSCII Issues (from Preliminary Notification of Issues)</th><th>Areas of Agreement/ Disagreement from Joint Groundwater Experts Report</th><th>Section of Further Statement of Evidence that Refers</th></tr>
<tr><td>1(c)(vi)</td><td>outcrops of the Clematis Sandstone are restricted to the crest of the range north of the proposed mine; and</td><td rowspan="5">23. JW takes the view that the regional geology needs to be revised in order to present a coherent conceptualisation of groundwater flow and spring hydrology.

25. The experts disagree on the need for exactitude in schematic conceptual model diagrams. NM and JB regard such diagrams as merely indicative of major water sources and sinks and regional flow directions. AW prefers to see detailed flow directions that honour the refraction caused by aquitards; flow lines are drawn crossing the Rewan Formation to create flow in an easterly direction – this violates the basic premise of this formation being an aquitard.

26. The experts disagree on the need to invoke faults as a major feature in the conceptual model. JB and NM consider that the Principle of Parsimony should be applied (consistent with groundwater modelling guidelines) when there is no definitive evidence of faults affecting the groundwater system. The Principle of Parsimony is also known as Occam's Razor - "Entia non sunt multiplicanda sine necessitate". This may be translated literally as "The number of entities should not be increased without good reason", or loosely as "It is vain to do with more what can be done with fewer" (Constable et al., 1987[1]). AW's view is that the analysis of faults (and other preferential pathways such as abandoned wells) is inadequate to predict with reasonable certainty the competence of the aquitards as barriers to flow. JW believes that because faulting may be feeding Doongmabulla Springs (para 28), it could be a major feature of the conceptual in places.</td><td>Sections 5.1, 5.2, 5.3</td></tr>
<tr><td>1(c)(vii)</td><td>outcrops of the Moolayember Formation are absent in this area.</td><td>Sections 5.1, 5.2, 5.3</td></tr>
<tr><td>1(d)</td><td>The reinterpretation of the geology suggests that the Colinlea Sandstone rises to a sufficient height in the axis of the anticline to the west that it can drive the up-dip groundwater flow to the east.</td><td>Sections 5.1, 5.2, 5.3</td></tr>
<tr><td>1(e)</td><td>The reinterpretation of the geology also suggests that the Triassic strata unconformably overlie the Permian strata in the area of the proposed mine.</td><td>Sections 5.1, 5.2, 5.3</td></tr>
<tr><td>1(f)</td><td>The reinterpretation of the geology also shows that the Doongmabulla Springs are located in outcrops of Dunda Beds rather than Clematis Sandstone.</td><td>Sections 5.1, 5.2, 5.3</td></tr>
<tr><td colspan="2">Doongmabulla Springs Complex</td><td></td><td></td></tr>
</table>

[1] Constable. S. C., Parker, R. L. and Constable, C. G. (1987) Occam's inversion: A practical algorithm for generating smooth models from electromagnetic sounding data. *Geophysics* **52**, 289-300.

<table>
<tr><th colspan="2">Original LSCII Issues (from Preliminary Notification of Issues)</th><th>Areas of Agreement/ Disagreement from Joint Groundwater Experts Report</th><th>Section of Further Statement of Evidence that Refers</th></tr>
<tr><td>5</td><td>The Doongmabulla Springs Complex comprises a group of several large, permanent springs that supply baseflow to the upper Carmichael River, which flows permanently in this area. The Doongmabulla Springs lie only ~8 km west of the proposed mine.</td><td rowspan="6">Areas of Agreement
7. We agree that the source of the Doongmabulla Springs is inconclusive and that there are two potential sources that need to be considered; one a source below the Rewan Formation, the other a source from above the Rewan Formation. Methods such as isotope sampling, in conjunction with analysis of existing data (water chemistry, water level, geology) would potentially assist in resolving the question.
Areas of Disagreement
28. Whilst it is agreed (refer point number 7) that the source aquifer for the Doongmabulla Springs Complex is inconclusive and that two potential sources need to be considered (one being a source above the Rewan Formation and the other being a source from below the Rewan Formation), we disagree on the extent to which a source from below the Rewan Formation is probable. JW's view is that the potential for upward flow through the Rewan Formation via a permeable fault or fracture is a viable option. JB's view is that there are sufficient zones of low-permeability clay material within the Rewan Formation to “heal” any existing faults or fractures and that the probability of a continuously permeable fault/fracture through the entire thickness of Rewan Formation is low. JB therefore favours a source aquifer for the Doongmabulla Springs complex that is above the Rewan Formation.</td><td>Sections 5.1, 5.2, 5.3</td></tr>
<tr><td>6</td><td>Dewatering for the proposed mine is modelled in the SEIS to have only a minor impact on the Doongmabulla Springs, because they issue from a sandstone unit that is separated from the coal-bearing Colinlea Sandstone by a regional aquitard, the clay-rich Rewan Formation.</td><td>Sections 5.1, 5.2, 5.3</td></tr>
<tr><td>7</td><td>There is considerable uncertainty about the likely impact of the proposed mine on the hydrogeology relevant to the Doongmabulla Springs Complex.</td><td>Sections 5.1, 5.2, 5.3</td></tr>
<tr><td>7(a)</td><td>It is likely that the Doongmabulla Springs are supplied by groundwater from the Colinlea Sandstone rather than the sandstone overlying the Rewan Formation. Evidence for this includes:</td><td>Sections 5.1, 5.2, 5.3</td></tr>
<tr><td>7(a)(i)</td><td>the hydraulic head in the sandstone at the Doongmabulla Springs site, as shown by bore HD02, is several meters below ground level, whereas the hydraulic head for the aquifer supplying the springs is at least 3 m above ground level (Note there are no measurements of the existing hydraulic head at the Doongmabulla Springs, rather, the average head pressures are assumed based on the maximum height of the water level in the dam fed by the springs);</td><td>Sections 5.1, 5.2, 5.3</td></tr>
<tr><td>7(a)(ii)</td><td>the Doongmabulla Springs are most likely fed by flow along a fracture/fault, as is the case for the Mellaluka Springs, which receive groundwater from the Colinlea Sandstone;</td><td>Sections 5.1, 5.2, 5.3</td></tr>
</table>

Original LSCII Issues (from Preliminary Notification of Issues)		Areas of Agreement/ Disagreement from Joint Groundwater Experts Report	Section of Further Statement of Evidence that Refers
7(a)(iii)	the Rewan Formation generally has a very low permeability, but measurements on this unit around the proposed Alpha Coal Mine to the south show that it contains zones of high permeability that are likely to be fractures;	*Area of Disagreement* 27. The experts disagree on the suitability of adopted hydraulic conductivities for the Rewan Formation aquitard. **JB** and **NM** consider that the adopted hydraulic conductivities are appropriate and sufficiently justified. AW notes that the Rewan hydraulic conductivity values are at the lower end of field-based values, and therefore, the calibrated groundwater model may under-predict leakage through the Rewan. **JW** points out that a small percentage of Rewan hydraulic conductivity values are quite high and would allow substantial groundwater flow; this has been entirely neglected in the model.	Sections 5.1, 5.2, 5.3
7(a)(iv)	groundwater with a similar salinity to the Doongmabulla Springs occurs in the Colinlea Sandstone to the east of the Doongmabulla Springs;	No specific reference	Section 5.6
7(a)(v)	there is a marked trough in the potentiometric surface of the Permian units to the east of the Doongmabulla Springs, which suggests the influence of a fault; and	No specific reference, though paragraphs 21 to 26 (items of disagreement) refer.	Sections 5.1, 5.2, 5.3
7(a)(vi)	the potentiometric surface of the Permian units is sufficiently elevated within part of the proposed mine area to drive groundwater flow to the Doongmabulla Springs.		Sections 5.1, 5.2, 5.3
7(b)	The Applicant's predictive numerical modelling does not account for a major fault/fracture system feeding the springs, which would require model cells to be defined with the appropriate locations, dimensions and hydrogeological properties for groundwater flow along this fracture system.	Refer paragraph 26 (item of disagreement) of Joint Groundwater Experts Report (reproduced above)	Sections 5.1, 5.2, 5.3
7(c)	If the Doongmabulla Springs are fed by groundwater flow from the Colinlea Sandstone, then the impact of mine dewatering on spring flow will be similar to that at Mellaluka Springs, i.e. the springs will be likely to permanently dry up.	No specific reference	Sections 5.1, 5.2, 5.3
Carmichael River			

Original LSCII Issues (from Preliminary Notification of Issues)		Areas of Agreement/ Disagreement from Joint Groundwater Experts Report	Section of Further Statement of Evidence that Refers
8	In turn, this will remove baseflow from the Carmichael River, which will no longer flow permanently in this area.	No specific reference	Section 5.4
9	There can be no confidence in the analysis of river hydrology and river-groundwater interaction analyses in the SEIS.		Section 5.4
Mellaluka Springs			
10	The Mellaluka Springs Complex to the southeast comprises three separate springs that lie along a straight line. The Mellaluka Springs Complex is supplied by groundwater flow from the Colinlea Sandstone.	*Areas of Agreement* 8. The experts agree that the source for the Mellaluka Springs is beneath the coal-bearing sequence of the Colinlea Sandstone. **JB** believes that it is likely to be a permeable layer at the top of the Joe Joe Formation and not the Colinlea Sandstone as currently conceptualised (**JW** accepts that this is likely, but notes that it is also possible that the source is the sub-E sandstone in the Colinlea Sandstone). We agree that if the source is the Joe Joe Formation, it means that the drawdown impact on this spring may be somewhat less than modelled but is likely to be still substantial. The model currently does not have a layer for the Joe Joe Formation; we agree that addition of an additional model layer is not necessary for modelling spring impacts at this stage but should be included in future model updates. *Areas of Disagreement* 29. **JW** contends that the source could be the sub-E sandstone in the Colinlea Sandstone, as well as **JB**'s preferred option of a permeable layer at the top of the Joe Joe Formation.	Section 5.3
11	Dewatering for the proposed mine will severely impact these springs, which are likely to disappear.		Section 5.3

5. Opinion and Findings

5.1. Conceptual Groundwater Model

5.1.1. Regional Geology and Hydrogeology

1. The LSCII preliminary notification of issues (issue 1) states that the modelling in the SEIS is based on a misconceptualisation of the geology and hydrogeology around the mine. Issues 1(a) to 1(f) then contend that the geology and hydrogeology as presented in the SEIS does not explain regional groundwater flow directions. An extensive re-interpretation of the regional geology is then proposed as a means of explaining both regional groundwater flow and the hydrogeology of the Doongmabulla Spring Complex.
2. The Joint Groundwater Expert Report notes that there are no areas of agreement between the experts on regional geology. Therefore it is anticipated that **JW** will prepare an Individual Expert Report that seeks to explain his re-interpretation of the regional geology and hydrogeology, whilst I (**JB**) present a conceptualisation below that is consistent with the regional geology of previous workers (e.g. Vine et. al 1969, Habermehl & Lau 1997, Comet Ridge 2010, EIS and SEIS documents) and presents a viable conceptualisation of the Doongmabulla Springs Complex (note that the Doongmabulla Springs Complex are also discussed separately in Section 5.2 of this report).
3. A number of figures have been prepared that will be referred to in this discussion. These include:
   (i) Figure 1, which shows detail from published 1:250,000 topographic maps;
   (ii) Figure 2, which shows detail from published 1:250,000 scale geological maps;
   (iii) Figure 3, which shows the solid geology[2] of the area. The solid geology shown in Figure 3 is a combination of:
      a. Digital subcrop boundaries for GAB intake beds, derived from Habermehl & Lau (1997). It is noted that these units appear to have been derived in part from digitizing of existing 1:250,000 geological mapping; however due to the scale of the GAB Hydrogeological Map (1:2,500,000 scale) the boundaries may be somewhat simplified compared to the 1:250,000 scale geology;
      b. Outcrop geology from published 1:250,000 geological mapping. The GAB intake bed mapping (as described above) does not include units below the GAB intake beds (including the Rewan Formation, which is regarded as the hydraulic basement to the GAB, as well as older Galilee Basin sediments). The boundaries of these units have been digitized by **JB** to produce the boundaries shown on Figure 3. Where these boundaries have been digitized from 1:250,000 scale geological maps, the unit boundaries have been simplified. The boundaries are also extensions of subcrop boundaries provided to **JB** by Adani (Adani 2015b, Annexure F, a copy of which has been provided to **JW**). To the north of the MLA area the subcrop boundaries are interpreted entirely by **JB**;
      c. Interpretation by **JB**, based on review of selected geological logs and professional judgement

      Where the solid geology has been obtained from interpretation of data (rather than from published geology) the boundaries have been marked with question marks.

   (iv) Figure 4, which shows a conceptual hydrogeological cross section that is orientated approximately along an inferred groundwater flow line from the recharge area (Darkies Range) to the discharge area (Doongmabulla Springs). The location of the section line is shown on Figure 3.
4. Reference to the above figures is made throughout the text where necessary to show the location of specific features and to aid in the explanation of specific concepts.

[2] Solid geology maps are constructed by removing the unconsolidated Tertiary/Quaternary cover, revealing the relationships between the underlying older rocks.

5. The geological units referred to in this report are summarised in the EIS and SEIS documentation (e.g. Table 4-1 of GHD (2012); Table 4-1 of GHD (2012) is included as Annexure C of this report)
6. In addition to the significant body of geological data and knowledge from drilling and interpretation for the Carmichael Project, the geology at depth in the vicinity of the Doongmabulla Springs Complex is available from a coal seam gas (CSG) exploration well, Shoemaker 1, which was drilled in January 2010 by Comet Ridge. The stratigraphy and lithology of the well is summarised as shown below in Table 5-1; information in Table 5-1 is based on information provided in the well completion report for Shoemaker 1 (Comet Ridge 2010). The drilling log for Shoemaker 1 is included as Annexure D to this report.

Table 5-1: Summary Information for Shoemaker 1

Unit	Depth Interval (mbgl)	Thickness (m)	Comment
Moolayember Formation	0 to 77.6	77.6	Logged as interbedded sandstone and siltstone. The drilling log (Attachment A) records the unit as being predominantly sandstone and the gamma ray (GR) log is consistent with an interpretation of sandstone with minor siltstone bands.
Clematis Sandstone	77.6 to 196.5	118.9	Logged as comprising sandstone with minor interbeds of siltstone and claystone. The drilling log (Attachment A) records the unit as being predominantly sandstone and the GR log is consistent with multiple depositional sequences of sandstone fining upwards to siltstone and claystone.
Dunda beds	196.5 to 246.8	50.3	Logged as an interbedded sequence of claystone, mudstone and sandstone with minor siltstone.
Rewan Formation	246.8 to 526.0	279.2	Logged as comprising three distinct sequences, these being Rewan R3 (246.8 to 389.0 metres below ground level (mbgl), siltstone, minor sandstone increasing toward base, minor mudstone), Rewan R2 (389.0 mbgl to 436.8 mbgl, siltstone) and Rewan R1 (436.8 to 526.0 mbgl, interbedded siltstone and sandstone, minor mudstone and claystone).
Betts Creek beds	526.0 to 649.0	123	Logged as comprising interbedded sandstone, siltstone, mudstone, claystone and coal, with minor tuff.
Colinlea Sandstone	649.0 to 667.4	18.4	Logged as comprising sandstone with rare carbonaceous siltstone. It is noted that the Colinlea Sandstone is generally taken to be contained within the Betts Creek beds (which comprises the Bandanna Formation and Colinlea Sandstone); however the Colinlea Sandstone has been differentiated for the purpose of the Shoemaker 1 well log.
Jochmus Formation	667.4 to 694.95 (TD)	27.55+	Within Jochmus Formation at total depth (TD) of hole. Logged as interbedded and laminated siltstone and fine sandstone with rare thin claystone bands.

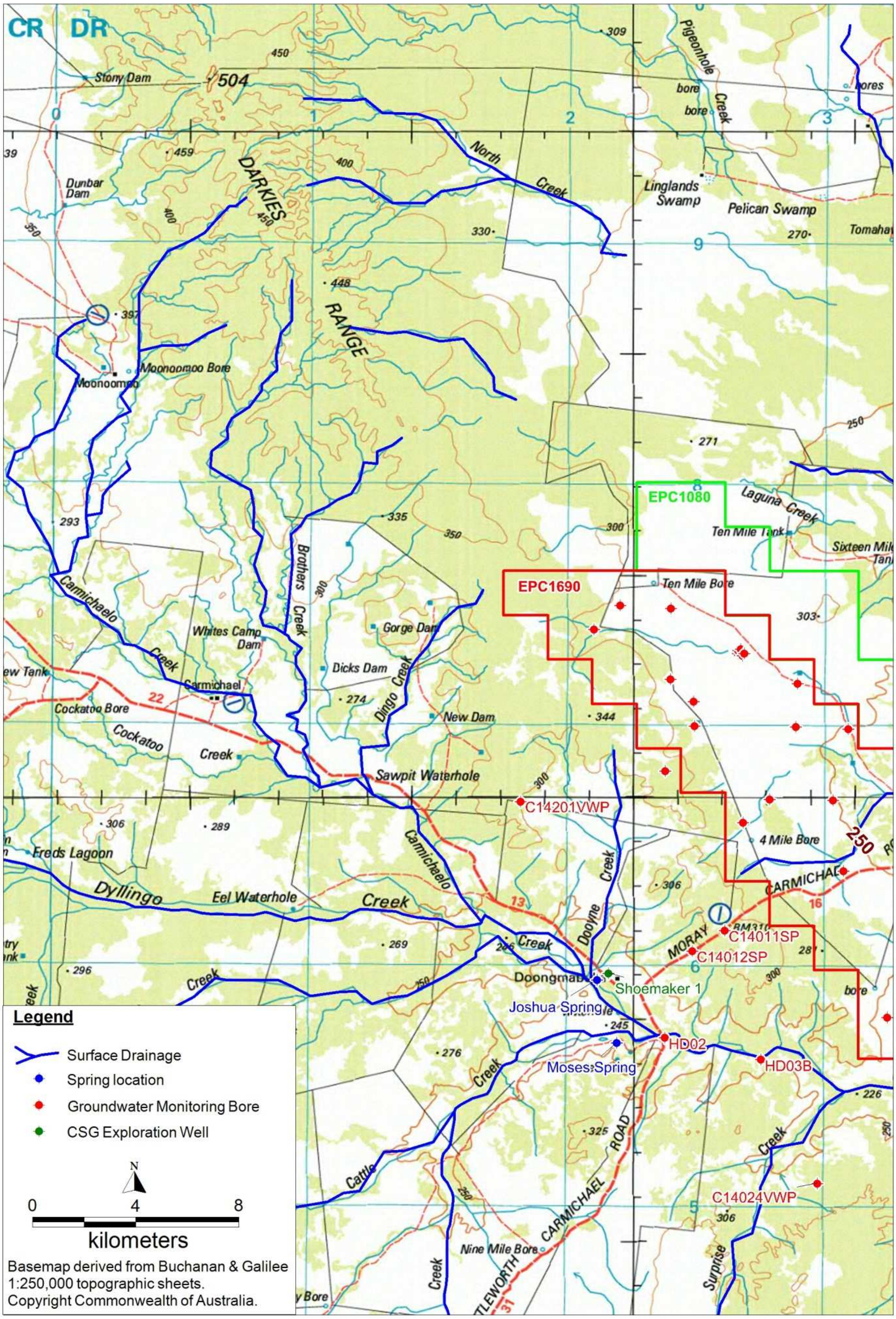


Figure 1: Topography and Surface Features in the Vicinity of the Joshua Spring Complex

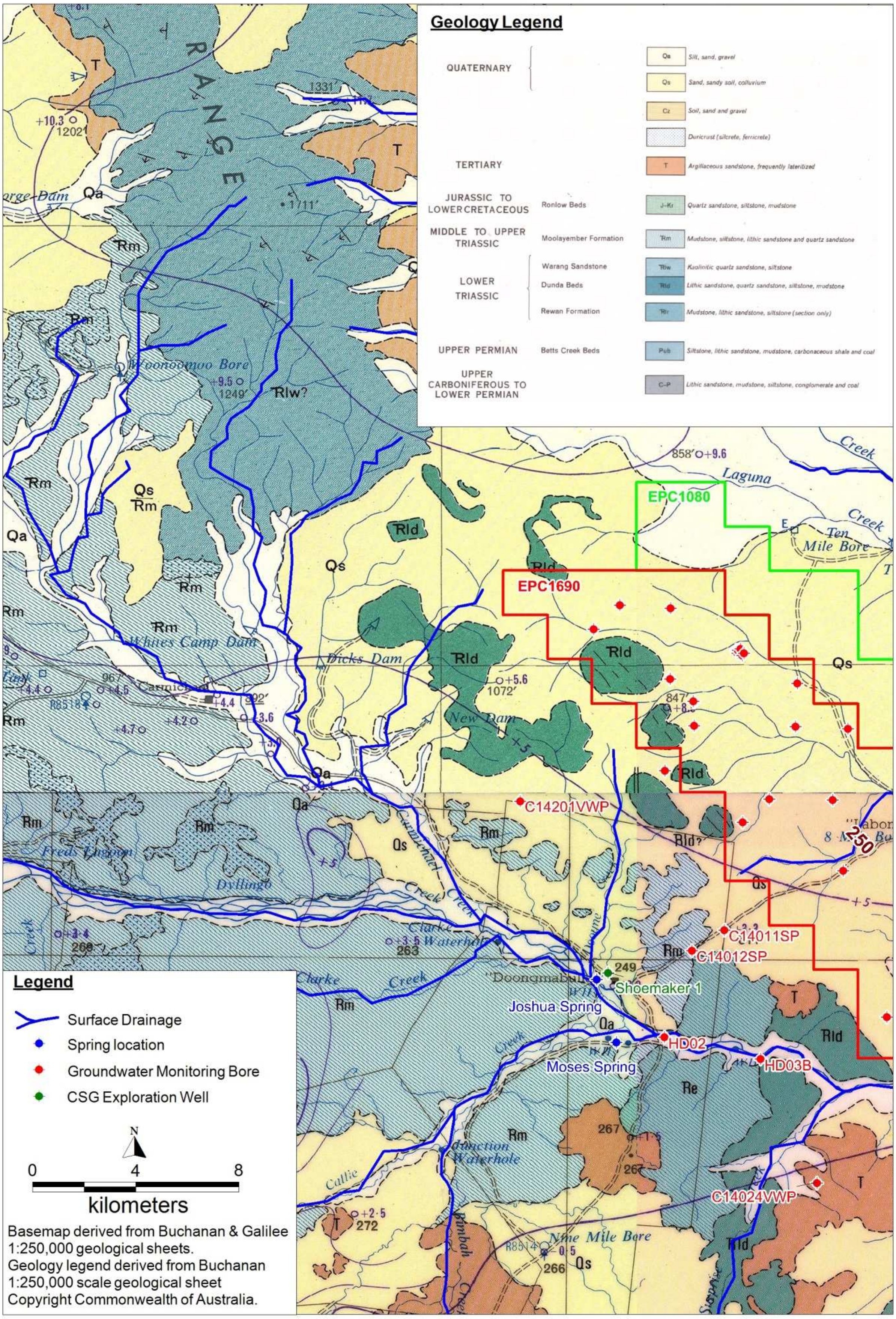


Figure 2: Surface Geology in the Vicinity of the Joshua Spring Complex

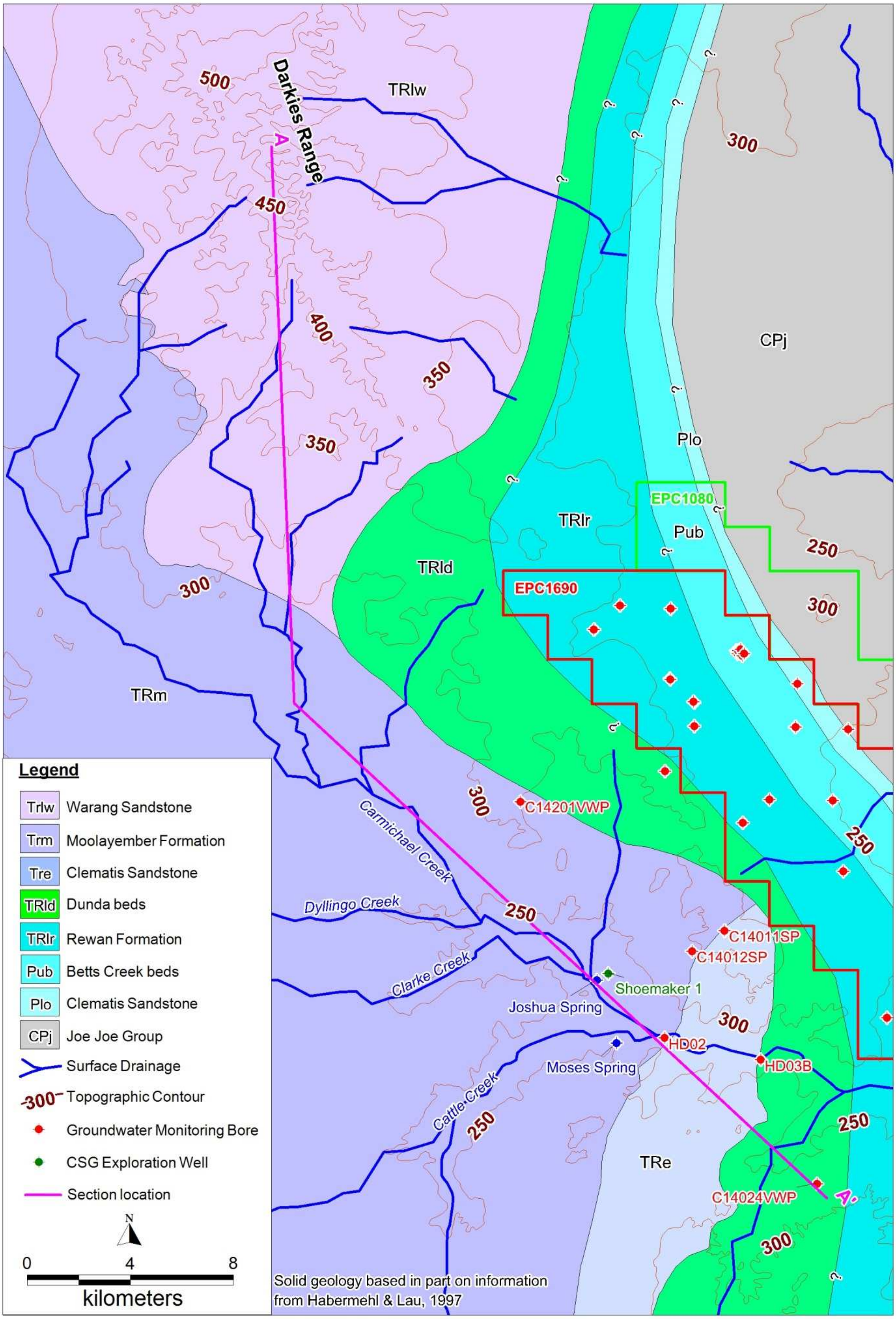


Figure 3: Interpreted Solid Geology in the Vicinity of the Joshua Spring Complex

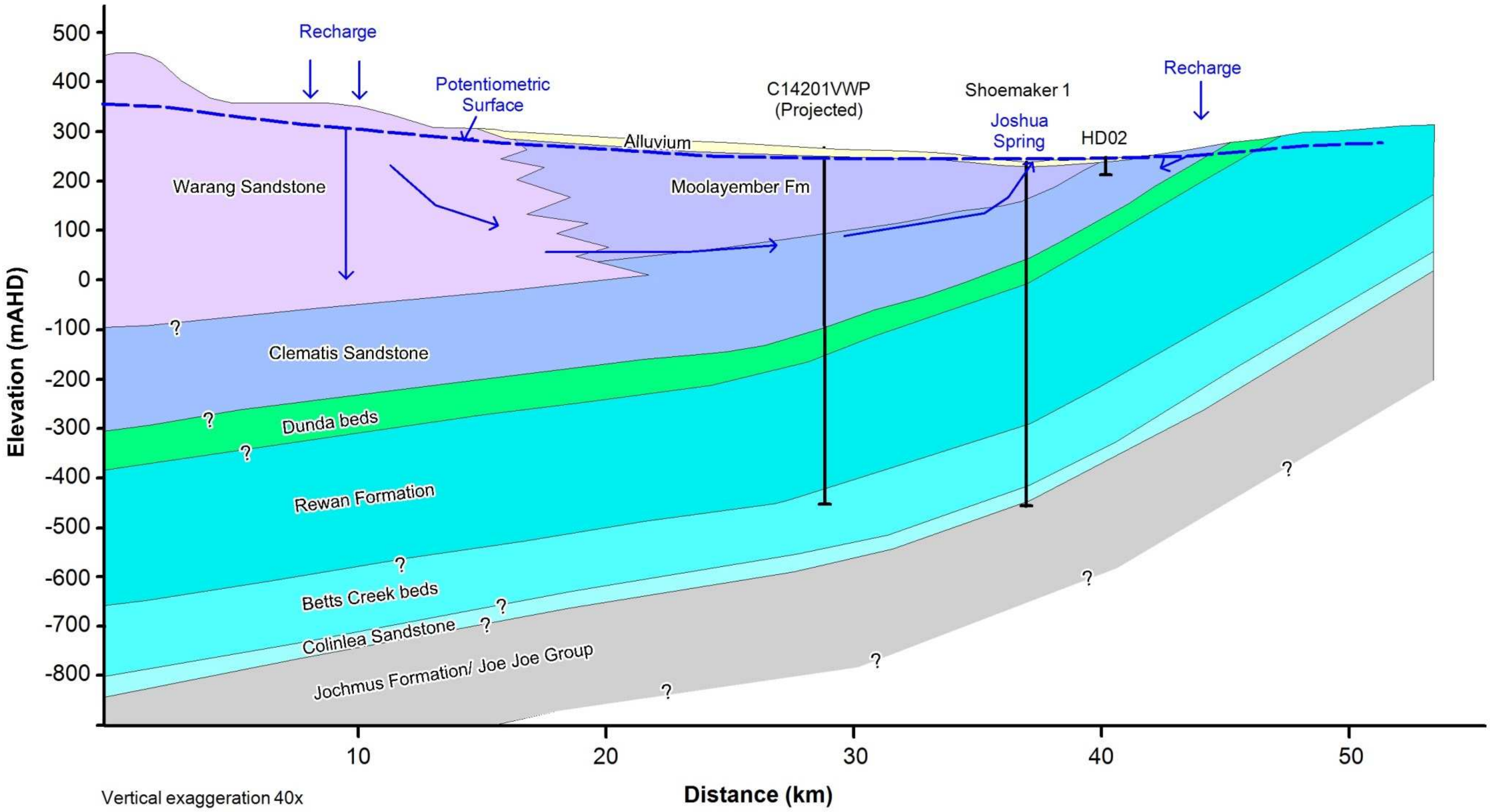


Figure 4: Conceptual Hydrogeological Cross Section

5.1.2. Rewan Formation

5.1.2.1. Introduction

7. The properties of the Rewan Formation are discussed specifically in this report due to the importance of the unit to the discussion that follows;
8. The Rewan Formation is a low permeability unit, up to 250 m thick at the western limit of the lease (GHD 2012) and approximately 279 m thick in the area of the Joshua Spring (based on data from Shoemaker 1, refer Table 5-1). The Rewan Formation is predominantly comprised of low permeability sediments (siltstone, mudstone, claystone) with isolated bands of higher permeability sediments (sandstone and sandy siltstone). In Shoemaker 1 the Rewan Formation is summarised as follows:
   (i) The Rewan Formation is 279.2 m thick;
   (ii) Three distinct sandy units are logged within the Rewan Formation, these being:
      a. A 9 m thick interval from 384 to 393 m below ground level (mbgl) comprising 95% medium sandstone and 5% siltstone;
      b. A 10 m thick interval from 441 to 451 mbgl comprising 50% fine to very fine-grained sandstone and 50% siltstone; and,
      c. A 10 m thick interval from 489 to 499 mbgl comprising 80% fine to very fine grained sandstone and 20% siltstone.
   (iii) The remainder of the Rewan Formation (250.2 m thickness out of 279.2 m total thickness, or 90% of the total thickness) comprises fine-grained sediment such as siltstone or claystone.

5.1.2.2. Hydraulic Properties

9. Hydraulic properties of the Rewan Formation (specifically permeability/ hydraulic conductivity data) are available as follows:
   (i) Rising/falling head slug tests – 12 tests at 3 sites (GHD 2013c)
   (ii) Packer tests – 10 tests at 5 sites (GHD 2013c, Adani 2015a)
10. Available hydraulic conductivity data for the Rewan Formation is summarised below in Table 5-2. In summary:
   (i) Data from packer testing (which occurred predominantly within fine-grained sediments such as siltstone and claystone) shows:
      a. A range from 7.00E-05[3] to 1.40E-03 m/day (8.10E-10 to 1.62E-08 m/sec)
      b. A mean value of 3.28E-04 m/day (3.79E-09 m/sec)
      c. A median value of 2.15E-04 m/day (2.78E-09 m/sec)
   (ii) Data from slug testing (which occurred predominantly within coarser-grained sediments such as weathered sandstone and sandy clay) shows:
      a. A range from 2.30E-02 to 2.90E-01 m/day (2.66E-07 to 3.36E-06 m/sec)
      b. A mean value of 1.38E-01 m/day (1.59E-06 m/sec)
      c. A median value of 1.00E-01 m/day (1.16E-06 m/sec)
11. To place the above data into context, the Environment Protection Authority South Australia (EPASA) requires placement of a 0.3 m thick compacted clay liner with a permeability[4] of less than 1E-09 m/s for construction of wastewater lagoons (EPASA 2010). The median hydraulic conductivity of 2.78E-09 m/sec for low-permeability sediments of the Rewan Formation is therefore not dissimilar to the

[3] Scientific notation is used throughout this report, i.e. 7.00E-05 m/sec is the same as 7.00 x 10^{-5} m/sec.

[4] Permeability is a measure of the capacity of a porous material to transmit water. Hydraulic conductivity is similar to permeability with the exception that hydraulic conductivity calculations also take into account the properties of the fluid (density, viscosity etc.). In groundwater systems where the water is relatively fresh (as is the case in the Carmichael Project area) permeability and hydraulic conductivity values could be expected to be so similar that the terms could be used interchangeably. Therefore for the purpose of this report, permeability and hydraulic conductivity are taken to be the same thing and the terms are used interchangeably.

permeability of a compacted clay liner and when it is taken into account that the continuous thickness of low-permeability material within the Rewan Formation can be in excess of 100 m, the Rewan Formation should be regarded as a low-permeability barrier of significant thickness;

Table 5-2: Summary of Hydraulic Conductivity Data – Rewan Formation

Site ID	Test ID	From (mbgl)	To (mbgl)	Test interval (m)	Hydraulic Conductivity		Lithology of test interval
					m/day	m/sec	
Packer Tests							
C14201VWP	Rewan 1	385	390.5	5.5	1.40E-03	1.62E-08	Very fine-grained sandstone
C14201VWP	Rewan 2	444.83	449.6	4.77	3.00E-04	3.47E-09	interbedded fine-grained sandstone and claystone
C14201VWP	Rewan 3	492.83	498.5	5.67	7.00E-05	8.10E-10	Claystone, rare siltstone
C14201VWP	Rewan 4	564.73	570.5	5.77	2.00E-04	2.31E-09	Siltstone, minor claystone
C14201VWP	Rewan 5	615.23	621.5	6.27	2.00E-04	2.31E-09	Siltstone, minor claystone
C056	Test 9	268	276.5	8.5	1.70E-04	1.97E-09	Siltstone, fractured
C9556PR	Test 6	243.1	249.1	6	2.30E-04	2.66E-09	Sandstone/ siltstone
C842VWP	Test 5	131.7	136.7	5	9.50E-05	1.10E-09	Siltstone and sandstone
C836VWP	Test 5	132.8	137.8	5	3.70E-04	4.28E-09	Siltstone/ mudstone
C836VWP	Test 6	105.8	110.8	5	2.40E-04	2.78E-09	Siltstone
Mean					*3.28E-04*	*3.79E-09*	
Median					*2.15E-04*	*2.78E-09*	
Slug Tests							
C035P1					2.30E-02	2.66E-07	Weathered sandstone
C555P1					1.00E-01	1.16E-06	Sandy clay
C556P1					2.90E-01	3.36E-06	Sandy clay
Mean					*1.38E-01*	*1.59E-06*	
Median					*1.00E-01*	*1.16E-06*	

12. Available drilling and hydraulic conductivity testing data indicates that the Rewan Formation contains a number of isolated and discrete intervals of sandy sediments that have a higher permeability than the surrounding fine-grained strata (comprising siltstone, claystone and mudstone). The data available from the CSG test well Shoemaker 1 (the closest available bore to the Joshua Spring) indicates that these sandy units make up approximately 10% of the total thickness of Rewan Formation sediments;
13. The fine-grained sediments of the Rewan Formation comprise approximately 90% of the total thickness of the Rewan Formation (based on data from Shoemaker 1) and it is the permeability of these sediments that will dominate the movement of water within the Rewan Formation. This is especially true for the vertical movement of water, where the passage of water must occur through a significant thickness of fine-grained material (in the case of Shoemaker 1 the maximum thickness of fine-grained material between sandstone bands is 134 m) where the vertical hydraulic conductivity could be expected to be one to several orders of magnitude lower than the horizontal hydraulic conductivity (the hydraulic conductivity data shown in Table 5-2 is horizontal hydraulic conductivity (Kh), therefore if the median Kh of fine-grained sediments from packer testing is 2.15E-04 m/day (2.78E-09 m/sec) then a one-order of magnitude lower vertical hydraulic conductivity (Kz) would be in the order of 2.14E-05 m/day (2.78E-10 m/sec);

14. Therefore the presence of higher permeability sandy intervals within the Rewan Formation must be viewed in the context of their relative thinness compared to the overall unit thickness and the thickness of low-permeability material that occurs in-between the sandy intervals;
15. The above assessment is consistent with available data within the MLA area, i.e. the Rewan Formation comprises predominantly fine-grained sediments (siltstone, claystone, mudstone) with relatively minor and isolated intervals of coarser-grained (i.e. sandy) sediments;
16. With respect to the significance of Rewan Formation hydraulic properties to groundwater modelling my opinion is as follows:
    (i) It is my experience (based on 23 years of preparing groundwater models and reviewing actual groundwater level data post-modelling) that groundwater models tend to over-predict drawdown. In a groundwater model (which assumes a continuous porous medium) drawdown will always tend to occur through a low-permeability material, with the timing and extent of drawdown dependent on the hydraulic conductivity (Kh and Kz), the thickness of the unit and the head difference between adjacent units. In fine-grained sediments and in fractured rock aquifers the porous medium is often not continuous (for example water may occur within fractures which are compartmentalised and hydraulically disconnected, or the pore spaces within the sediment may be isolated (i.e. low effective porosity) to an extent that vertical transfer of water ceases, or occurs at a slower rate than predicted by modelling due to the tortuosity of the flow paths);
    (ii) The point above is not intended as a criticism of groundwater models or the modelling process; rather it is an observation based on experience that groundwater models tend towards being conservative and that, for situations where the hydraulic parameters used in the model are an accurate reflection of the formation parameters, actual drawdown may still occur much later than predicted by modelling, or to a lesser extent than predicted by modelling, or even not at all.

5.1.2.3. Impacts of Faulting

17. It is contended that the modelling is deficient (issue 7b of Preliminary Notification of Issues) because it does not account for a major fault/fracture system feeding the springs
18. It is my opinion that, if the presence of faults with a continuous hydraulic connection has not been established (e.g. via drilling, geophysics, geochemistry etc.) then the inclusion of faults should not form part of the conceptualisation and modelling of water level impacts due to faulting should not be attempted;
19. It is also my opinion (refer following Section 5.2) that a viable explanation exists for water source to the Doongmabulla Spring Complex that is above the Rewan Formation. Therefore it is not necessary to invoke faulting as it is my opinion that faulting is not necessary for the spring complex to exist;
20. Discussions with site geological personnel indicate that the Rewan Formation is generally a difficult formation to drill. This is because open boreholes tend to close within the Rewan Formation within 1 to 2 drilling shifts due to the presence of swelling clays that can completely close the borehole. This attests to the properties of clays within the Rewan Formation that would tend to “heal” any faults, rather than allowing the presence of hydraulically continuous faults through the entire thickness of the formation;
21. Therefore the presence of fault traces within the Rewan Formation (as determined by geophysics etc.) would not necessarily indicate the presence of hydraulically continuous zones that would allow the vertical transfer of water;
22. It is my assessment that, due to the thickness of the low-permeability sediments and the field observations that swelling clays tend to “heal” boreholes within 1 to 2 drilling shifts, the probability that hydraulically continuous faults occur through the Rewan Formation is extremely low. This being said, the Commonwealth Approval Conditions specify a requirement to undertake a study that specifically

focusses on the issue of connectivity of the Rewan Formation; this will allow this hypothesis to be tested and remedial actions to be developed as appropriate.

5.1.2.4. Summary – Rewan Formation

23. The objectors premise is that a source aquifer for the Doongmabulla Springs Complex that is below the Rewan Formation (i.e. from the Colinlea Sandstone) is likely (Preliminary Notification of Issues, issue 7(a)) via a fracture/fault through the Rewan Formation. The objectors also contend that high permeability zones exist in the Rewan Formation to the south (around the proposed Alpha Coal Mine) that are likely to be fractures (Preliminary Notification of Issues, issue 7(a)(iii).
24. I have demonstrated above in Sections 5.1.2.2 and 5.1.2.3 that:
    (i) A continuously permeable fracture/fault through the entire thickness of Rewan Formation is unlikely due to:
        a. the occurrence of swelling clays that tend to “heal” open boreholes (and would therefore tend to “heal” faults);
        b. The thickness of low-permeability sediments, which would make the occurrence of a continuously-connected high permeability zone unlikely; and,
        c. The high-permeability zones to the south of the project which are discussed by the objector can be alternatively explained by the presence of sandy intervals within the Rewan Formation. However these units are isolated, make up a relatively small portion of the overall thickness of the Rewan Formation (e.g. 10% of the overall thickness is the case of Shoemaker 1) and significant thickness of low permeability sediment occurs between the higher-permeability zones (> 100 m thickness in the case of Shoemaker 1)
25. The evidence against a source aquifer for the Doongmabulla Spring Complex that is below the Rewan Formation is further discussed in Section 5.2.3.

5.2. Doongmabulla Springs Complex

5.2.1. Introduction

26. The Doongmabulla Springs complex comprises three distinct spring groups, these being Joshua, Moses and Little Moses. The Moses Spring Group comprises at least 65 individual spring groups which contribute surface water to a series of adjacent wetlands (GHD, 2013a).
27. The artesian water level[5] at the springs is unknown, however the head[6] can be inferred from review of the Joshua Spring, which has been dammed by means of constructing a turkey’s nest dam[7] around the spring vent. Based on visual inspection the water level in the dam is assessed to be approximately 3 m. The dam has been constructed with an overflow pipe therefore the height of water in the dam does not represent the artesian head at this location; however based on the height of water in the dam it can at least be said that the spring is artesian by approximately 3 m at this location.
28. Joshua Spring, Moses Spring and Little Moses Spring all occur within surface drainage areas, close to the confluence of Carmichael Creek, Cattle Creek and Dyllingo Creek (Figure 1). Therefore the spring complex is preferentially developed at a topographically low point in the landscape where the potentiometric surface of the source aquifer is marginally above ground level (in the order of 3 m

---

[5] Artesian water level is defined in the *Water Act 2000* as “the level to which the water would, if it were tapped by a water bore and the water were contained vertically above the surface of the land, rise naturally above the surface of the land”.

[6] Head – in groundwater terms head can be simply defined as the height above a standard datum of the surface of a column of water. In Australia the standard datum is taken to be Australian Height Datum (AHD) which is analogous to mean sea level.

[7] Turkey’s nest dam – a dam which has been constructed by mounding impermeable material (clay etc.) around the edges of the dam to create a basin in the middle where water is stored. This type of dam has no catchment and receives water only via direct rainfall, pumping, or upward seepage (e.g. as is the case with Joshua Spring). This is an Australian term, with the dam so named due to its resemblance to the mounded nest of a brush turkey.

above ground level as outlined in the paragraph above) and conditions exist with the confining cover strata to allow water to discharge to the ground surface;

29. In the Joint Groundwater Experts Report (paragraph 7) it was a point of agreement at the time of writing of the report that the source of the Doongmabulla Springs were inconclusive and that there were two potential sources that need to be considered; one a source below the Rewan Formation, the other a source from above the Rewan Formation. However a point of disagreement (paragraph 28) also exists as to the extent to which a source from below the Rewan Formation is probable. My view (as expressed in paragraph 28) is that there are sufficient zones of low-permeability clay material within the Rewan Formation to "heal" any existing faults/fractures and that the probability of a continuously permeable fault/fracture through the entire thickness of Rewan Formation is low (discussed above in Sections 5.1.2.2 and 5.1.2.3). For this reason, and following further review of the geology and hydrogeology in the vicinity of the spring complex for this report, I favour a source aquifer for the Doongmabulla Springs complex that is above the Rewan Formation.
30. The following sections present my summary of the relative potential for a source aquifer above or below the Rewan Formation to be the source of water to the Doongmabulla Springs Complex.

5.2.2. Source Aquifer above the Rewan Formation

31. It is my opinion that a source aquifer above the Rewan Formation is the most likely explanation for the Doongmabulla Springs complex, for example with recharge and artesian head derived from a mountain range to the north of the springs (Darkies Range) in outcrop areas of the Warang Sandstone and discharge occurring in topographically low areas where preferential pathways for upward groundwater flow are developed within sandy "windows" of the Clematis Sandstone and overlying Moolayember Formation. The following observations are made in this regard:
    (i) The Darkies Range occurs to the north-northwest of the Doongmabulla Springs complex (Figure 1), where a maximum elevation of 504 mAHD is recorded relative to a ground surface elevation of the Doongmabulla Springs below 250 mAHD.
    (ii) The exact elevation of the ground surface at the Joshua Spring and Moses Spring is not known, however the following observations are made with respect to ground elevation in the area of the springs:
        a. The Joshua Spring, Moses Spring, Little Moses Spring, Shoemaker 1 CSG bore and HD02 (Adani groundwater observation bore screened within the Clematis Sandstone) all occur below the 250 m AHD contour (Figure 1)
        b. The ground elevation at Shoemaker 1 is given as 248 mAHD (Comet Ridge 2010). Shoemaker 1 is located adjacent to a roadway which is topographically elevated above the area where the Joshua Spring occurs (based on field observation, aerial photo interpretation, and interpretation of published topographic data). It is therefore concluded that the ground elevation at Joshua Spring must be below 248 mAHD;
        c. A spot height of 245 mAHD is shown on the 1:250,000 topographic map for the area of flood plain between Cattle Creek and Carmichael Creek.
        d. The ground elevation at HD02 is given as 240 mAHD (based on elevation from a hand-held GPS, the accuracy of which is uncertain) and the bore has a measured casing stick-up of 1.02 m. Recent water level monitoring (September 2014) records a depth to water of 3 m below top of casing (mTOC) at this site, therefore the recorded water level is approximately 2 m below surface (i.e. approximate water level of 238 mAHD). It has been noted that, based on the probable ground elevations at the Doongmabulla Springs, and on the interpreted artesian head (at least 3 m above ground level) it may be expected that the water level would be above the top of HD02 (i.e. that the bore would be artesian). However the bore is potentially in a groundwater recharge area (where artesian heads would not occur).

e. A recently-drilled groundwater monitoring bore within the Clematis Sandstone (C14012SP – refer Figures 1, 2 and 3) is located to the east of the Joshua Spring on the Moray-Carmichael Road. The ground elevation at this site is given as 293 mAHD (understood to be GPS-derived); allowing for a casing stick-up of 1.0 m the elevation of the top of casing is taken to be 294 mAHD. Recent monitoring (September 2014) recorded a depth to water at this site of 44.43 mTOC (say 44.5 mTOC) giving an approximate water elevation in the Clematis Sandstone at this site of approximately 249.5 mAHD. If this elevation were to be projected to the location of the Joshua Spring (assuming a ground elevation of approximately 246 mAHD, as per the spot height from the topographic map) the water level in the Clematis sandstone may be several metres above ground level at the location of Joshua Spring;

f. Based on review of available data it is my opinion that the Doongmabulla Spring Complex is artesian by approximately 3 m but less than 5 m. This opinion is based on:
   i. Field observation of water height in the turkey's nest dam at Joshua Spring relative to the surrounding ground level;
   ii. The occurrence of a spot elevation height of 245 mAHD in the flood plain adjacent to Moses Spring (Figure 1); and,
   iii. The observation that springs within the Doongmabulla Spring Complex occur below the 250 mAHD contour.

(iii) Surface water flow occurs to the east, west and south of the Darkies Range, with runoff from the south and southwest of the range flowing to the southeast along Carmichael Creek, which is the creek in which Joshua Spring occurs;

(iv) The 1:250,000 geological map (Figure 2) shows the Doongmabulla Springs complex (specifically, Joshua Spring and Moses Spring) as being located within outcrop of the Moolayember Formation, close to the contact between the Moolayember Formation and the Clematis Sandstone;

(v) The Darkies Range is developed predominantly within outcrop of the Warang Sandstone. The Warang Sandstone is a recognised GAB intake bed and is described as comprising kaolonitic quartz sandstone and siltstone (Vine et al. 1969);

(vi) Stratigraphically, the Warang Sandstone is described as being correlative with the upper Clematis Sandstone and the lower Moolayember Formation (Van Heeswijck 2006, Gray 1977). Habermehl and Lau (1997) regard the Warang Sandstone as being a lateral aquifer equivalent of the Moolayember Formation, which is regarded as a confining bed. The relationship proposed by Van Heeswijck (2006) and Gray (1997) is shown schematically in Figure 4. This relationship is not inconsistent with the relationship proposed by Habermehl and Lau as for all interpretations mentioned above the Warang Sandstone is in direct contact with the Clematis Sandstone;

(vii) In the area of the Joshua Spring (i.e. based on the log of Shoemaker 1, Table 5-1) the Moolayember Formation and the underlying Clematis Sandstone both comprise interbedded sandstone and siltstone, but are logged as comprising predominantly sandstone. Photos 1 and 2 show outcrop of the Moolayember Formation, comprising interbeds of fine sandstone and siltstone, in an area adjacent to the Moses Spring.

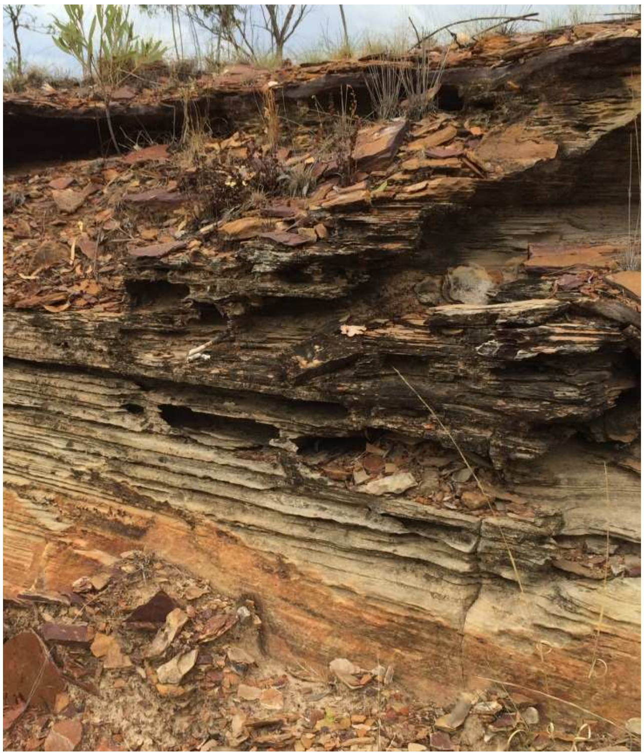


Photo 1 – Moolayember Formation Outcrop **Photo 2 – Moolayember Formation Outcrop**

32. Based on information described above a mechanism for the existence of the Doongmabulla Springs complex is proposed as follows (refer Figure 4):
    (i) Groundwater recharge occurs in the topographically elevated region of Darkies Range with downward flow occurring through the Warang Sandstone to the underlying Clematis Sandstone;
    (ii) Groundwater flow also occurs from the recharge area and laterally through the basal Moolayember Formation, which is interpreted to be relatively sandy at this location (based on the drilling and geophysical logs for Shoemaker 1 as well as inspection of Moolayember Formation outcrop adjacent to Moses Spring (Photos 1, 2);
    (iii) Groundwater flow direction is topographically controlled, with groundwater flow lines occurring from the recharge area of Darkies Range towards surface drainage features that drain to the south-east (e.g. Carmichael Creek);
    (iv) The potentiometric surface of the Clematis Sandstone/ Moolayember Formation units comes above the ground surface just below the 250 mAHD contour line, i.e. in the area of the confluence of a number of creeks and where a spot height of 245 mAHD is recorded (Figure 1);
    (v) Upward discharge of groundwater occurs to the Doongmabulla Spring Complex in areas where groundwater pressure is able to exploit weaknesses in the rock strata, creating vents that allow groundwater discharge to the ground surface.
33. It is understood that **JW** proposes to present an alternative explanation for a source aquifer for the Doongmabulla Springs that is above the Rewan Formation, with his source aquifer potentially being the Dunda beds. If it is agreed that the most viable source aquifer for the Doongmabulla Springs Complex is from above the Rewan Formation then arguments as to the impact on the proposed mining operations on the springs largely become moot for the following reasons:

(i) The groundwater model makes prediction of the water level drawdown impact on the model layer that is located above the Rewan Formation;

(ii) Whether the source aquifer for the Doongmabulla Spring Complex is the Clematis Sandstone/ Moolayember Formation as conceptualised for the current groundwater model (as well as for this report), or an alternative groundwater unit above the Rewan Formation (e.g. Dunda beds) that may be proposed by **JW,** the current model is still predicting drawdown within the groundwater unit above the Rewan Formation; therefore the model results therefore remain valid.

5.2.3. Source Aquifer below the Rewan Formation

34. The Preliminary Notification of Issues proposes (issues 7(a) to 7(c)) that water to the Doongmabulla Spring Complex is sourced from the Colinlea Sandstone via a fault developed through the Rewan Formation;

35. It is my assessment that a source aquifer below the Rewan Formation is unlikely for the following reasons:

    (i) There is no direct evidence for a hydraulically continuous fault through the Rewan Formation from drilling or other investigations undertaken to date for the Project

    (ii) An hydraulically continuous fault through the entire thickness of the Rewan Formation is assessed to have a low probability of occurring (refer Section 5.1.2.2, paragraphs 9 to 17 as well as Section 5.1.2.3, paragraphs 18 to 23 of this report);

    (iii) A viable explanation exists for a source aquifer that is above the Rewan Formation (refer Section 5.2.2, paragraphs 32 to 34 of this report);

5.2.4. Summary – Doongmabulla Springs Complex – Source Aquifer

36. The principle of parsimony/ Occam's Razor, demands that, where alternative hypothesis exist to explain a particular phenomenon, the hypothesis with the least assumptions must be accepted (alternatively translated, *it is vain to do with more what can be done with fewer*).

37. As a viable explanation for a source aquifer above the Rewan Formation, based on existing geology/hydrogeology, is presented in this report, this explanation should be preferred over:

    (i) an explanation that requires either a hydraulically continuous fault through more than 200 m of low-permeability sediments (for which no evidence exists – i.e. a source aquifer below the Rewan Formation); and/or,

    (ii) an explanation which relies on extensive re-interpretation of the regional geology, which requires all other studies undertaken in the region to be wrong, and which I assess to be ultimately unnecessary

38. Whether the source aquifer for the Doongmabulla Spring Complex is the Clematis Sandstone/ Moolayember Formation as conceptualised for the current groundwater model (as well as for this report), or an alternative groundwater unit above the Rewan Formation (e.g. Dunda beds) that may be proposed by **JW,** the current model is still predicting drawdown within the groundwater unit above the Rewan Formation; therefore the model results therefore remain valid.

5.3. Mellaluka Springs Complex

39. The source aquifer for the Mellaluka Springs Complex is the subject of minor disagreement, with **JB** favouring a source aquifer from the Jochmus Formation (underlying the Colinlea Sandstone) and **JW** accepting that this is likely, while contending that the source may also be from a basal unit of the Colinlea Sandstone (sub-E sandstone).

40. Information from recent drilling by Adani shows that the area where the Mellaluka Spring Complex is located lies within the Jochmus Formation, with the subcrop of the Colinlea Sandstone located to the west of the springs. The available data is summarized on a figure which was provided by Adani; the figure is included as Annexure E.

41. Therefore it is my opinion that the source aquifer for the Mellaluka Springs Complex is the Jochmus Formation.

5.4. Carmichael River

42. The Joint Groundwater Expert Report did not note any areas of specific agreement or disagreement with respect to baseflow to the Carmichael River, though the Preliminary Notification of Issues (issues 8 and 9 – refer Table 4-1) contends that mining will remove baseflow from the Carmichael River and that as a result the river will no longer flow permanently in this area;
43. I am of the opinion, based on information provided in earlier sections of this report, that the source aquifer for the Doongmabulla Springs Complex is above the Rewan Formation. This interpretation is consistent with groundwater modelling undertaken for the Project, therefore I conclude that baseflow losses to the Carmichael River will be consistent with those modelled by GHD (GHD 2013c, GHD 2014b).

5.5. Groundwater Flow Directions

44. The Joint Groundwater Expert Report did not note any areas of disagreement with respect to groundwater flow direction (refer paragraph 24 of Joint Groundwater Experts Report), but did note areas of agreement (paragraphs 2 to 5). This included agreement that the modelled groundwater level contours for the Clematis Sandstone as shown in the latest GHD groundwater modelling report (GHD 2014b) are reasonably consistent with Figure 1 of the Joint Groundwater Expert Report, which is a reproduction of groundwater contours and flow directions for the Colinlea Sandstone from Hydrosimulations (2014). The experts have agreed (paragraph 2 of Joint Groundwater Experts Report) that the contours are a reasonable best estimate of groundwater flow at depth.
45. The groundwater flow direction proposed in this report for the Clematis Sandstone (Section 5.2.1.1, paragraph 30) is consistent with the modelled groundwater contours shown in GHD (2014b);
46. The modelled groundwater flow contours for the Clematis Sandstone as shown in GHD (2014b) also indicate flow lines from the west and southwest of the Doongmabulla Springs Complex. This figure is not inconsistent with the interpretation discussed in this report and in my opinion the most likely source aquifer for the Doongmabulla Spring Complex is above the Rewan Formation.

5.6. Groundwater Chemistry

47. There are no areas of agreement or disagreement from the Joint Groundwater Expert Report that relate to groundwater chemistry;
48. However, issue 7(a)(iv) of the Preliminary Notification of Issues states that “groundwater with a similar salinity to the Doongmabulla Springs occurs in the Colinlea Sandstone to the east of the Doongmabulla Springs”. This is presented as supporting evidence for the theory that groundwater to the Doongmabulla Springs is sourced from the Colinlea Sandstone;
49. I have conducted a review of available groundwater salinity and major ion data (to December 2014) with respect to water salinity and water type analysis (Piper ternary diagrams). It is my conclusion that the available data is inconclusive with respect to source aquifer.

6. Additional Information Required

I am satisfied that I have had access to all the information I need to reach a reliable conclusion.

7. Expert’s Statement

I confirm the following:

(i) the factual matters stated in this report are, as far as I am aware, true;

(ii) I have made all enquiries which I consider are appropriate for the purposed of providing the opinions which I have expressed;

(iii) the opinions stated in this report are genuinely held by me;

(iv) the report contains reference to all matters I consider significant in reaching the conclusions which I have expressed;

(v) I understand my duty to the court and have complied with that duty;

(vi) I have read and understood the rules contained in Part 5 of the Land Court Rules 2000 (Qld) as far as they apply to me; and,

(vii) I have not received or accepted instructions to adopt or reject a particular opinion in relation to an issue in dispute in the proceedings.

Yours Faithfully,

John Bradley
Director/ Principal Hydrogeologist
JBT Consulting Pty Ltd

ANNEXURE A

CURRICULUM VITAE OF JOHN BRADLEY

John Bradley
Telephone ***(+61) 07 3388 7604***
Mobile ***(+61) 0409 266 469***
Email ***jbradley@jbtconsultingcom.au***
Web ***www.jbtconsulting.com.au***

John Bradley	Principal Hydrogeologist
Year's Experience	23
Education	Bachelor of Applied Science (Geology Honours), Ballarat University College; Master of Science (Hydrogeology and Groundwater Management) University of Technology, Sydney
Affiliations	International Association of Hydrogeologists: Member International Mine Water Association: Member International Water Resources Association: Member National Groundwater Association (USA): Member

Experience
2009 - current
JBT Consulting Pty Ltd **Brisbane, Queensland**
Principal Hydrogeologist/ Director

2007-2008
Geoaxiom Pty Ltd **Brisbane, Queensland**
Principal Hydrogeologist/ Director

2003 to 2007
Golder Associates Pty Ltd **Brisbane, Queensland**
Senior Hydrogeologist
As detailed below.

2001 – 2003
Parsons Brinckerhoff, formerly PPK Environment & Infrastructure
Senior, then Principal Hydrogeologist
Responsible for surface and groundwater investigations, including water supply projects, mine dewatering investigations, assessment of impact of groundwater extraction and mine inflow on groundwater regime, undertaking groundwater modelling, community liaison, management and training of staff.

1998 – 2001
Geo-Eng Australia Pty Ltd, Brisbane
Senior Hydrogeologist
Managed Queensland office, undertook groundwater contamination assessments and modelling, water supply investigations, water management projects.

1995 – 1998
Geo-Eng Australia Pty Ltd, Morwell
Hydrogeologist
Managed aquifer depressurisation program on behalf of Loy Yang coal mine. Duties included:

- supervision of field investigations, including drilling, water sampling, aquifer testing;
- Interpretation of geophysical and geological data;
- scheduling of aquifer depressurisation activities to match requirements of mine development schedule;
- Plan aquifer investigation requirements for whole of mine life program;
- Develop groundwater models as required to assess aquifer depressurisation options and strategies.

- Management of operations and capital budgets; and
- Supervision of technical and professional staff

1992 – 1995 **Hydro Technology (formerly Rural Water Corporation), Melbourne**
Hydrogeologist
Undertook field supervision of drilling programs and aquifer testing programs. Undertook data analysis and preparation of technical reports, assessed impacts of proposed groundwater extraction bores on the groundwater regime and other groundwater users for the purpose of bore licensing.

EXAMPLE PROJECTS – AUSTRALIA

Expert Witness Roles **Queensland**

Acted as expert witness in the following cases:
- Endocoal Limited v Glencore Coal Queensland Pty Ltd and Department of Environment and Heritage Protection. Land Court of Queensland, 2014.
- Monto Coal 2 Pty Ltd & Ors v Dredge & Ors. Queensland Land and Resources Tribunal, 2003

Alpha and Kevin's Corner Projects, Hancock Prospecting **Alpha, Queensland**
Provide input to EIS and BFS studies for both projects, including:
- Installation of a groundwater monitoring bore network for both operations (vibrating wire piezometer bores and standpipe piezometer bores);
- Installation of pumping test bores, and undertaking of pumping tests to determine aquifer hydraulic properties;
- Develop a conceptual groundwater model to cover both sites as well as the regional groundwater system
- Undertake 2-D slice modelling (using Seep/W) to provide estimates of pit inflow volumes, and to provide input to geotechnical (slope stability) modelling;
- Undertake numerical groundwater modelling (via specialist sub-contractor) for prediction of inflow volumes to the open cut and underground mine voids, and for prediction of impacts on regional groundwater levels; and,
- Prepare technical reports for EIS and BFS studies.

Meandu Mine, Stanwell Corporation **Nanango, Queensland**
Provide ongoing groundwater support to the project including:
- Design of groundwater monitoring bore network for monitoring of in-pit ash disposal
- Specification of groundwater monitoring parameters
- Preparation of annual compliance reports for submission to regulators, describing variations in groundwater levels as well as interpretation of water quality data

Dingo West Coal Project, Macarthur Coal **Dingo, Queensland**
Undertake feasibility-level water supply options study (surface water and groundwater supply) for construction water supply and whole-of-life water supply

Carbon Energy **Bloodwood Creek UCG Project, Queensland**
Design of groundwater pressure monitoring network, interpretation of groundwater pressure and groundwater chemistry data for the periods prior to and during the trial reactor burn, preparation of baseline reporting.

Anglo Coal Australia **Moranbah North Open Cut, Queensland**
Design of groundwater monitoring network, design and undertake groundwater studies to satisfy regulatory requirements.

Anglo Coal Australia **Foxleigh Plains Project, Queensland**
Undertake groundwater studies in support of the EIS, including data review, development of conceptual groundwater model, prediction of groundwater inflow rates to the underground workings, prediction of impacts of mine on regional groundwater levels.

Anglo Coal Australia **Grosvenor Coal Project, Queensland**
Undertake groundwater studies in support of the EIS, including data review, development of conceptual groundwater model, monitoring bore installation, pumping test design and analysis, prediction of groundwater inflow rates to the underground workings, prediction of impacts of mine on regional groundwater levels.

Rio Tinto Coal Australia **Clermont Coal Project, Queensland**
Specification of requirements for advance dewatering of the box-cut, and design of the life-of-mine dewatering and water supply network for the Clermont Coal Project. Responsibilities include conceptual borefield design, design of the field testing program, final design and construction supervision of the advance dewatering borefield network and monitoring bore network. Ongoing responsibilities include monitoring and compliance reporting (landholder reports, DERM compliance reports, internal network performance), regional groundwater modeling.

ANZ Bank **Comet Ridge, Queensland**
Due Diligence review of Comet Ridge CBM Project expansion, including assessment of groundwater impacts, groundwater disposal issues.

Wandoan Coal Project, MIM **Wandoan, Queensland**
Project management of Pre-Feasibility Water Supply Options report. Technical input to report included review of groundwater supply options from regional aquifers and coal-bed methane wells, as well as groundwater licensing issues.

Curragh Queensland Mining Ltd **Queensland**
- Determined construction water requirements and identified water sources to meet construction scheduling for a Curragh North coal mine, Queensland.
- Planned and managed drilling investigations and hydraulic testing requirements to determine the necessity for a groundwater cutoff wall beneath a proposed 11km long levee.
- Assessment of drilling information, aerial photography, Landsat-7 imagery to determine the location of prior channels of a river system. Location of prior channels required as input to design for levee banks, which are to be constructed to prevent flooding of mine by the river.

Monto Coal Project, Macarthur Coal **Monto, Queensland**
- Assessed groundwater issues for environmental licensing purposes, including assessment of groundwater inflows to mine, and impact on adjacent alluvial aquifer and groundwater users. Project involved liaison with Department of Natural Resources and Mines and Environmental Protection Agency over environmental licence conditions. Carried out groundwater modelling

using MODFLOW to determine impact of proposed water-supply bore on groundwater resource and existing groundwater users, as support for Water Licence application.

- Design, licensing, contract preparation and tender appraisal for 700m-deep artesian water supply bore to be constructed using inert fiberglass reinforced plastic (FRP) casing. The Bore was designed to satisfy the requirements of WRC (1990) Specification for Construction, Reconditioning or Plugging of Bores Tapping Recognised Aquifers of the Great Artesian Basin in Queensland, and ARMCANZ (1997) Minimum Construction Requirements for Water Bores in Australia, and the project included liaison with DNR&M to obtain approval for the bore design.
- Acted as expert witness on groundwater issues relating to Mining Lease Application (MLA) and Environmental Authority (EA) applications at Land and Resources Tribunal. Mining Lease and EA granted with no changes to groundwater conditions.

Monto Town Water Supply, Monto Shire Council **Monto, Queensland**

Project management of Monto Town Water Supply Project, seeking SCAP funding for drilling of a Precipice Sandstone water supply bore. Project included design of a 700m deep artesian bore, with the design conforming to WRC (1990) *Specification for Construction, Reconditioning or Plugging of Bores Tapping Recognised Aquifers of the Great Artesian Basin in Queensland*, and ARMCANZ (1997) *Minimum Construction Requirements for Water Bores in Australia.*

Underground Coal Gasification (UCG) Project, CS Energy **Chinchilla, Queensland**

Assessed environmental and groundwater issues to be addressed following closure of burned void.

Acland Coal Project, New Hope Coal **Acland, Queensland**

Carried out groundwater modelling using MODFLOW to assess impacts of proposed Hutton Sandstone aquifer bores on resource and existing groundwater users, as support for Water Licence application. Project included liaison with Department of Natural Resources and Mines and Environmental Protection Agency in relation to development of the conceptual and numerical groundwater model.

Ash Disposal Assessment, Tarong Energy/Tarong Coal **Meandu Mine, Queensland**

Assessed impacts of ash disposal on groundwater, design of field testing program to assess impacts of ash disposal to groundwater system, including specification of lysimeter monitoring to assess leachate development in the ash, and transport of leachate through the unsaturated zone to the watertable.

Commodore Coal Mine, Roche Mining. **Millmerran, Queensland**

Specification for monitoring of ash dumps using lysimeters, in accordance with requirements of Plan of Operations.

Murarrie Power Station Assessment **Murarrie, Queensland, Enertrade**

Investigated extent of contamination at former coal-fired power station site. Project included review and analysis of historical data, planning and undertaking field investigations, analysis of data, reporting, and liaising with client and Environmental Protection Agency.

Loy Yang Mine, Loy Yang Power **Latrobe Valley, Victoria**

- Aquifer Depressurisation Program, Latrobe Valley, Victoria, Loy Yang Power. Designed and implemented groundwater investigations on local and regional scale. Responsibilities included:

- Investigation of multiple-aquifer artesian system beneath Loy Yang Mine to determine aquifer thickness, hydraulic properties, and groundwater pressures;
- Determination of aquifer pressure level targets, which were set according to a geotechnical requirement to control water levels to prevent floor heave and batter instability.
- Design of aquifer depressurisation and monitoring program, including design of wellfields for dewatering muliple aquifer artesian system, as well as design of local and regional scale monitoring network.
- Scheduling of drilling activities, taking into account aquifer target levels, and the requirement to depressurise aquifers in advance of planned mining operations;
- assessment of operating costs of aquifer depressurisation systems, and review of alternative aquifer depressurisation methods.
- Undertaking analytical modeling as well as numerical groundwater flow modeling using MODFLOW, to predict performance of aquifer depressurisation system and to plan scheduling of drilling operations;

- Planned, designed and managed mine aquifer depressurisation system, and controlled operations and capital drilling budgets. Projects included:
- Assessment of technical and economic considerations of employing groundwater re-injection via bores, as a method of limiting land subsidence due to aquifer depressurisation.

Collie Basin 3-D Groundwater Flow Model — Stages I & II, Water and Rivers Commission, WA Perth, Western Australia

- Project managed stage I of three-dimensional Groundwater Flow Model of Collie Basin. This involved data collation, literature review, and processing data to establish data sets for definition of aquifer geometry and aquifer hydraulic properties. First stage of investigation also required establishment of conceptual approach to modelling, production of detailed data sets in digital format, and reporting.
- Project managed stage II of three-dimensional Groundwater Flow Model of Collie Basin, including representation of existing open cut coal mines, and pre-existing underground coal mines. This involved development of conceptual model, supervision of model construction, calibration and verification, and reporting.

Matrix Metals **Cloncurry, Queensland**

Project management of hydrogeological and hydrological investigations, which are being undertaken as input to a Bankable Feasibility Study for the project. The aim of the study is to establish a sustainable surface water/groundwater supply, as well as determine dewatering requirements for the open pits. Groundwater work includes assessment of existing geological data from exploration boreholes and surface mapping, management of logistics for establishing access to the remote site, siting of groundwater investigation bores, planning and analysis of pumping tests, groundwater modelling, liaison with landholders and government agencies.

Twin Hills Gold Project **Queensland**

Undertook investigation into groundwater supply prospects for the mine, provided input to identification of groundwater and surface water issues for Environmental Management Overview Strategy (EMOS). Provided advice on siting of production bores and monitoring bores, designed and undertook pumping tests (step drawdown tests and 100 hour constant discharge tests) to establish long-term yield of bores.

Dewatering Borefield Engineering Review, Pasminco Century Mine **Queensland**

Project management of dewatering borefield engineering review, which included assessment of borefield design, assessment of hydraulic performance of pipeline, and recommendations for system improvement.

Underground Coal Gasification (UCG) Project, CS Energy **Chinchilla, Queensland**
Assessed environmental and groundwater issues to be addressed following closure of burned void.

Redcliffe City Council **Queensland.**
Assessment of feasibility of storage and recovery of excess waste water to coastal aquifers.

Bundaberg Irrigation Area Groundwater Investigation, Department of Natural Resources **Bundaberg, Queensland**
Project included design of drilling program, drilling supervision, interpretation of data, synthesis of drilling data with geophysics data, and preparation of final report.

Design of Aquifer Depressurisation System, LaTrobe Shire **Moe, Victoria**
Designed aquifer depressurisation system to alleviate discharge of artesian groundwater to a residential street. Project included design of system and supervision of system's installation.

Regional Water Supply Investigations, Ballarat Water Board **Western Victoria**
Assessed water-supply augmentation options and undertook groundwater investigations at Skipton, Lexton, and Wallace, Victoria.

Ballarat 1:250,000 Hydrogeological Map, Murray–Darling Basin Commission **Ballarat, Victoria**
Principal author of Ballarat 1:250,000-scale hydrogeological map. Project included data review, analysis, compilation and data file preparation for transfer to map printers.

Groundwater Assessments, Rural Water Corporation **Various Locations, Victoria**
Assessed impact of proposed bores on existing groundwater users and on environment, and determined groundwater occurrence, quality, depth and potential yield for potential groundwater users.

Tioxide Groundwater Investigation, Tioxide Australia **Burnie, Tasmania**
Supervised drilling (down-hole hammer drilling in bedrock) and construction of nested piezometers to measure groundwater heads and to facilitate sampling for chemical testing. Undertook hydraulic (slug) testing of bores.

Investigation Drilling **Warrnambool, City of Warrnambool**
Investigated nutrient contamination from septic tanks in coastal area, near Warrnambool. Responsibilities included supervising drilling of groundwater-monitoring bores, design of groundwater-sampling program, and planning and analysis of hydraulic (slug) tests.

Ballarat Groundwater Investigation, Department of Conservation and Natural Resources **Ballarat, Victoria**
Evaluated groundwater resources in Ballarat area. Supervised drilling and construction of network of 20 groundwater observation bores in fractured rock and sedimentary aquifers, using down-hole hammer and conventional mud-rotary drilling.

Lake Buffalo Embankment Testing, Rural Water Corporation **Victoria**

Supervised drilling, sampling and testing of embankment at Lake Buffalo Water Storage, using hollow-flight auger drilling. Drilling and sampling included standard penetration tests and undisturbed samples, with final placement of standpipe piezometers in embankment and toe of dams.

Lake Taylor Embankment Testing, Water Corporation **Victoria**

Supervised drilling, sampling and testing of embankment at Lake Taylor Water Storage, using hollow-flight auger drilling. Drilling and sampling included standard penetration tests and undisturbed samples, with final placement of standpipe piezometers in embankment and toe of dams.

Werribee Delta Groundwater Investigation, Southern Rural Water **Werribee, Victoria**

- Supervised drilling and construction of bores to monitor intrusion of sea water on Werribee Delta, using conventional mud-rotary drilling in coastal sediments. Undertook assessment of sustainable yield of unconfined aquifer, which underlies Werribee Delta.
- Determined siting and supervised drilling of network of observation bores to determine changes in position of salt water/fresh water interface beneath Werribee Delta irrigation area.
- Determined sustainable yield for Werribee Delta aquifer, including calculation of through flow from aquifer and assessment of position of saltwater/freshwater interface.

Drilling of Bores for Investigation of Kaolin Deposits, English China Clays
Pittong, Victoria

Responsibilities included operation of Gemco 110A solid-flight auger drilling rig, logging of samples, and preparation of drilling reports.

SA/VIC Border Groundwater Review Committee **South Australia/Victoria**

Member of technical review committee that performed 1991–1995 five-year review on SA/VIC Border Groundwater Agreement. Review included assessment of:

- groundwater occurrence, aquifer properties, soil properties and aquifer recharge rates in SA/VIC border zone designated area;
- permissible annual volumes of groundwater extraction for the individual zones of designated area;
- permissible rate of lowering of potentiometric surface; and
- permissible levels of groundwater salinity (if any) for individual zones of designated area.

Campaspe Salinity Risk Study **Campaspe Valley, Victoria,**

Assessed groundwater data and prepared salinity risk map for input to State groundwater management plan.

Groundwater Education, Murray–Darling Basin Commission **Murray Basin, Victoria**

Project included:

- organisation of seminars on relationship between groundwater and salinity at Mildura, Berri, Murray Bridge, Griffith, Wagga Wagga, Shepparton, Horsham, Lake Boga, Sydney and Adelaide;
- preparation of materials explaining hydrogeology and salinity issues to general public and schools; and
- speaking engagements on groundwater issues to schools, community groups and government agencies across Murray Basin.

Groundwater Support on Numerous Salinity Projects, Rural Water Corporation,
Various Locations, Victoria

Projects involved interpretation of groundwater levels, trends, groundwater flow direction and velocity; assessment of interaction between surface water and groundwater (groundwater interaction with lakes and rivers/streams); public education on salinity issues at numerous farm field days; and other public forums.

Acid Sulfate Soils Investigation, Pt Halloran **Queensland, Sabdoen Developments**
Designed acid sulfate soils investigation for proposed residential development, including desk-top study, design of field investigation program, field sampling and testing, analysis of results, preparation of environmental management plan for site works, and preparation of report to Council.

Acid Sulfate Soil Management, Whyte Island **Queensland, Basic Constructions**
Reviewed environmental reports and documentation; prepared environmental management plan (EMP) for construction phase, involving disturbance of potential and actual acid sulfate soils; trained site staff in soil and water testing procedures; audited data collection procedures; and reported site investigations and compliance with EMP on completion of construction phase.

Regional Landfill Siting, Bundaberg **Queensland, Burnett Shire Council**
Assessed sites for regional landfill, based on analysis of environmental and cultural criteria, geological and groundwater considerations, and transport issues.

Environmental Impact of Landfills, Bundaberg **Queensland, Burnett Shire Council**
Conducted analysis of landfill sites to determine environmental impact, based on geological and hydrogeological assessment of conditions at each site

Site Assessment and Drilling Supervision, Biloela **Queensland, McConaghy Holdings**
Conducted site assessment, design, and drilling supervision of extraction bores to enable remediation of total petroleum hydrocarbon (TPH) contaminated groundwater of former service station for Biloela shopping centre development.

John Bradley
Telephone (+61) 07 3388 7604
Mobile (+61) 0409 266 469
Email jbradley@jbtconsultingcom.au
Web www.jbtconsulting.com.au

EXAMPLE PROJECTS – OUTSIDE AUSTRALIA

Tonkolili Iron Ore Mine, African Minerals Limited **Tonkolili, Sierra Leone**

- Undertook independent third-party review of groundwater program and groundwater conceptualization. Project involved in-country site visit and post-visit analysis and reporting.

Tutupan Coal Mine **Kalimantan, Indonesia**

- Design of aquifer depressurisation system to depressurise the artesian aquifer system beneath the mine.
- Supervision of bore installation and aquifer testing program, review and analysis of results, and provision of recommendations for future programs
- Design of air-lift test wells to reduce artesian groundwater pressure to assist geotechnical stability. Undertook field supervision of well installation, design of aquifer testing and monitoring program, and analysis of monitoring results

Mehdiabad Zinc Project, Aker Kvaerner **Mehdiabad, Iran**

Undertook water supply components of a Bankable Feasibility Study for a proposed open-cut lead-zinc mine near Mehdiabad, central Iran. Project involved in-country review of potential water sources (groundwater, surface water, treated waste-water etc.) to establish the sustainability and economic feasibility of the project water supply.

Rapu Rapu Gold Mine, Lafayette Mining **Albay Province, Philippines**

Design of groundwater testing program to determine inflows to pit, and leakage beneath tailings dam. Training of personnel on site to undertake pumping tests, airlift tests, to determine aquifer hydraulic properties. Used aquifer properties in SEEP/W seepage model to determine pit inflows. Sited and designed surface water weirs to measure site catchment flows. Provision of input to hydrology report to satisfy Due Diligence review requirements.

Lefa Gold Mine, Macquarie Bank **Guinea, West Africa**

Due diligence review of a Bankable Feasibility Study for proposed expansion and deepening of the existing Lefa open-cut gold mine. Issues reviewed on-site included pit dewatering requirements, capital and operating costs of borefield, surface water diversions, and site hydrology.

PUBLICATIONS

Principal author, 'Groundwater Management in Coal Bed Methane Projects — 'Turning a Waste into a Resource' Presented at Water in Mining Conference Brisbane, QLD, 13 - 15 October 2003.

Principal author, 'Bundaberg Irrigation Area Groundwater Investigation Project, Bundaberg Australia'. Paper presented at Water 99 Joint Congress — 25th Hydrology & Water Resources Symposium, 2nd International Conference on Water Resources & Environmental Research, Brisbane, 6–8 July 1999.

Principal Author, *Ballarat Hydrogeological Map* (1:250,000 scale), Murray Basin Hydrogeological Map Series, Australian Geological Survey Organisation, Canberra 1994.

Coauthor, 'Management of Major Aquifer Systems for Productive Mine Development in the Latrobe Valley'. Paper presented at Mine Water Management, IIR Conference, Brisbane, 15–16 June 1998.

Coauthor - Calibration of a Groundwater Model based on a Pattern Search Method: A Case Study, in *Proceedings of the IAH International Groundwater Conference — Groundwater: Sustainable Solutions*, eds. T. R. Weaver and C. R. Lawrence, Melbourne, 8–13 February 1998.

Coauthor, 'Five Year Technical Review 1991–1995', MC/44057.050, SA–VIC Border Groundwater Review Committee, 1995.

ANNEXURE B

INSTRUCTIONS

Partner Peter Stokes
Writer Siobhan Moloney
Direct line 07 3233 8694
Email smoloney@mccullough.com.au
Our reference SEM:PWS:159359-00022

3 February 2015

Mr J Bradley
JBT Consulting

Email jbradley@jbtconsulting.com.au

Dear Mr Bradley

Adani Mining Pty Ltd v Land Services of Coast & Country Inc. & Anor
Land Court objections hearing
Land Court of Queensland Proceedings no. MRA428-14, EPA429-14, MRA430-14, EPA431-14, MRA432-14 and EPA433-01

We refer to:

1 Mining Lease Applications (**MLAs**) 70441, 70505 and 70506 made by Adani Mining Pty Ltd (**Adani**);

2 the associated environmental authority application, as re-made on 14 April 2014;

3 the Environmental Impact Statement (**EIS**), Supplementary EIS (**SEIS**) and Additional Information to the EIS (**AEIS**) prepared for Adani and made publicly available under the *State Development and Public Works Organisation Act 1971* (Qld);

4 the draft Environmental Authority (**EA**) issued by the Statutory Party on 28 August 2011;

5 the Objection of Land Services of Coast and Country Inc (**LSCCI**) to the MLAs dated 16 June 2014;

6 the Objection of LSCCI to the EA made 10 September 2014;

7 the submission (dated 17 June 2014) and objection (dated 25 September 2014) about the EA made by Debi Goenka of the Conservation Action Trust (**CAT**);

8 the Preliminary List of Issues for the LSCCI dated 2 December 2014;

9 your joint report, with John Webb, Adrian Werner and Noel Merrick dated 9 January 2015 (**Joint Report**); and

10 our letter of instruction to you dated 6 November 2014.

Instructions

11 We require you to provide a further statement of evidence under the *Land Court Rules 2000* (Qld) (**Rules**).

12 In accordance with orders made by the Court, your further statement of evidence is required by **Friday, 6 February 2015**.

Format of report

13 When preparing the further statement of evidence, and responding to the questions dealt with in Section E below, please deal with the following:

SECTION A - Qualifications and Curriculum Vitae

14 Please attach your curriculum vitae to the report.

SECTION B - Material relied on in preparing the statement

15 Lists are sufficient for the statement, however, it would be useful to ensure that you (and we) have a copy of all the listed material when finalising your report. In particular, you should list:

(a) all material facts, written or oral, on which the statement of evidence is based; and

(b) reference to any literature or other material relied on by you to prepare the statement.

16 It may also be necessary to review the Joint Report to ensure your lists include sources that may not be specifically identified in that report.

17 You do not need to list material you have **not** relied on.

18 Any inspection, examination or experiment conducted, initiated or relied on by you to prepare the statement must also be described.

SECTION C – Background to Report

19 Please set out the extent of your previous involvement in the Mine. Specifically, we would like you to:

(a) indicate whether you were involved in the preparation of any material in support of the proposed Mine and, if so, provide details of that work;

(b) confirm that you have since been engaged by McCullough Robertson, on behalf of Adani, to provide an expert report in the Land Court proceedings;

(c) confirm that you have read this letter of instruction (and attach a copy of this letter of instruction to your report), and confirm that you understand your duties to the Land Court as an expert witness;

(d) confirm that, notwithstanding your previous relationship with the Mine (if any), you consider you are able to provide an informed, independent opinion about the matters contained within your Report.

SECTION D – Opinion on objections

Instructions for your report

20 Please review the objections and respond to any issues within your field of expertise which concern the MLAs and EAs.

21 You should not respond to matters raised by Messrs Werner, Webb, and Merrick that are outside your field of expertise (except to state that you will not be responding, unless you have already indicated this in the Joint Report).

22 In your further statement of evidence, the Rules also require that where:

(a) there is a range of opinion on matters dealt with, a summary of the range of opinion and the reasons why you have adopted a particular opinion be provided; and

(b) access to any **readily ascertainable** additional facts would assist you in reaching a more reliable conclusion, a statement to that effect be included.

23 We request that you specifically identify, in your further report, those areas of disagreement in the Joint Report where your counterparts have made assertions for which you have not been provided a factual basis or material to rely upon.

24 For each such assertion, please make your own enquiries or seek further instructions from us to ascertain whether a factual basis or material is available. If no factual basis or material exists for a particular assertion, please further identify this in your individual report.

25 In dealing with the points of disagreement in your Joint Report, and responding to the relevant Facts and Circumstances and grounds of the objections, please also specifically identify any relevant conditions of the draft EA and express your opinion as to the appropriateness of the draft condition or its relevance to the grounds of the objections.

26 We think it is essential you explain your expertise as distinct from Dr Noel Merrick and identify the matters upon which you express an opinion and those that you do not – leaving it to the expert opinion of Dr Merrick. It is necessary then that the court can identify with whom of the objectors experts your opinion differs.

Restrictions on your report

27 Your further statement of evidence should also refer to, and expand upon, matters of disagreement in your joint expert report which require further explanation.

28 Please note that, pursuant to the Rules, your further statement may not:

(a) contradict, depart from or qualify an opinion in relation to an issue the subject of agreement in the Joint Report; or

(b) raise a new matter not already mentioned in the Joint Report.

Key questions

29 In preparing your statement of evidence, please have reference to the following matters in the LSCCI Objection (as set out on page 3 of the Joint Report) and express an opinion on each to the extent it within your expertise:

(a) *if the mine proceeds, it will cause severe adverse environmental impacts to groundwater (paragraph 11);*

(b) *if the mine proceeds, it will impact groundwater dependent springs including the Doongmabulla Springs Complex and Mellaluka Springs Complex (paragraph 12);*

(c) *that the full extent of such impacts cannot be stated due to inadequate information having been provided in the applications, EIS and SEIS (paragraph 13); and*

(d) *it has not been demonstrated adequately that the mine will not have unacceptable adverse impacts on groundwater, particularly in terms of quality and quantity (paragraph 14(a)).*

General questions

30 Some key terms are used in the joint report. It would assist the Court if you could explain the following key terms:

(a) 'Clematis sandstone';

(b) 'Colinlea sandstone';

(c) 'Rewan Formation';

(d) Permian Strata;

(e) Dunda Beds

(f) 'Joe Joe Formation';

(g) 'aquifer'; and

(h) 'aquitard'.

Specific questions

31 We also ask that you address the following specific questions (either separately, or as part of the responses to the issues in the objections). All paragraph references are references to the Joint Report.

Groundwater flow directions (agreed)

32 Paragraphs 2 to 5 discuss groundwater flow directions. Please explain the significance of the groundwater flow directions. For example:

(a) why is it important or relevant (if at all) that the head contours for the Colinlea sandstone suggest a groundwater divide that is offset to the west from the Doongmabulla Springs (paragraph 3)?

(b) why is it important or relevant (if at all) that the flow directions as shown in Figure 1 are known (paragraph 4)?

(c) why is it important or relevant (if at all) that the experts are uncertain about flow at and beyond the western boundary of the model (paragraph 5)?

33 If the flow rate directions are important, but are unresolved:

(a) how and when will they be resolved?

(b) why is it important to resolve the issue?

(c) is the issue mitigated by the EA conditions?

34 To assist with clarity, could you please explain the term 'head contours' (paragraph 3).

Conceptual model (agreed)

35 Paragraph 6 states that the conceptual cross-sections are simplistic and do not accurately represent the probably flow conditions. Please explain:

(a) what this means;

(b) the significance (if any) of this;

(c) whether there are more reliable cross-sections available. If more reliable cross sections are available, why have these not been used? If they could be used, what are they likely to show, or not show?

(d) whether it is necessary to find more reliable cross sections; and

(e) if more reliable cross sections are not available, how and when this issue could be resolved.

Conceptual model (not agreed)

36 Paragraph 25 relates to the exactitude in the schematic conceptual model diagrams. Please explain what this paragraph means and its significance.

37 The paragraph states that you regard diagrams as merely indicative of major water sources, sinks, and flow directions. Please explain:

(a) the reasons for this view;

(b) whether your view complies with standard methodology and practices in this area of expertise;

38 The paragraph also states that Adrian Werner prefers to see detailed flow directions. Please explain:

(a) if possible, your understanding of the reasons for Mr Werner's view

(b) why you do not agree with this view;

(c) whether detailed flow directions go beyond what is typically required for this type of exercise? I.e. would it be undertaking a task over and above what is normally done?

39 The paragraph also states flow lines are drawn crossing the Rewan Formation to create flow in an easterly direction, which '*violates the basic premise of this formation being an aquitard'*. It is not clear which expert held this view; could you please clarify this and, if possible, explain what this means and its significance (especially if it is you who holds this view). If necessary, please include a map or diagram in your report to explain this.

40 To assist with clarity, please explain the terms:

(a) 'sink';

(b) 'refraction';

(c) 'aquitard'; and

(d) 'flow lines'.

41 Paragraph 26 relates to the need to invoke faults as a major feature of the conceptual model.

42 It is your view that there is no need to invoke faults; please explain:

(a) why this is your view;

(b) whether your view complies with standard methodology and practices in this area of expertise;

(c) why Adrian Werner's view that faults should be invoked is, in your view, incorrect;

(d) whether invoking faults is going beyond what is typically required for this type of exercise. I.e. would it be undertaking a task over and above what is normally done?

43 To assist with clarity, please explain the terms:

(a) 'faults';

(b) 'preferential pathways'; and

(c) 'abandoned wells' (for example, are these natural wells, or manmade wells?).

44 Paragraph 27 relates to the suitability of adopted hydraulic conductivities for the Rewan Formation aquitard. Please explain:

(a) why you consider that the adopted hydraulic conductivities are appropriate;

(b) why you consider that Mr Werner's view about the conductivities are incorrect;

(c) the significance of the disagreement between the experts; and

(d) in your view, what the answer to this issue is.

45 To assist with clarity, please explain the terms:

(a) 'hydraulic conductivities'; and

(b) 'field-based values'.

Source aquifer for Doongmabulla Springs Complex (agreed)

46 Paragraph 7 lists various methods that may assist in determining the source of the Doongmabulla Springs Complex. If it is intended that the question of the source be resolved, when is this likely to happen.

Source aquifer for Doongmabulla Springs Complex (not agreed)

47 Paragraph 28 discusses the source aquifer for the Doongmabulla Springs Complex.

48 Please explain the significance (if any) of determining the source of the Doongmabulla Springs.

49 Please explain what the consequences are if the source is:

(a) above the Rewan Formation; and

(b) below the Rewan Formation.

50 If there is a risk that the Doongmabulla Springs will be adversely affected because of the location of the source, please explain the likelihood of this risk. For example, is the risk real, or is it so small as to be negligible? If there is a real risk of adverse impacts, what is the scale of those impacts? For example, are they significant, or are they minor?

51 Are there any mitigation methods that relate to this issue? Is the issue mitigated by the EA conditions?

52 Please comment, to the extent it is within your field of expertise, on the accuracy of the numerical modelling you have reviewed particularly with respect to the Doongmabulla Springs and whether it is likely to be the same as the drawdown predicted under the numerical modelling, having regard to the permeability assumptions included within the modelling, for example:

(a) as predicted;

(b) higher; or

(c) lower or nil.

53 Please also provide your opinion as to the state of evidence that groundwater with a similar salinity to the Doongmabulla Springs occurs in the Colinlea Sandstone to the east of the springs, and how this affects your opinion (if at all) regarding the source aquifer for the Doongmabulla Springs.

Source aquifer for Mellaluka Springs Complex (not agreed)

54 Paragraph 29 describes a minor disagreement about the source of the Mellaluka Springs Complex. Please explain the significance (if any) of this disagreement.

55 For clarity, please explain the term 'sub-E sandstone'.

Figures 1 and 2

56 Please explain what Figures 1 and 2 show. For example, what do the arrows on Figure 1 indicate? What do the contoured lines on Figure 1 indicate? What do the thin white lines on Figure 2 indicate?

57 Please explain the significance of Figures 1 and 2. For example, why is Figure 1 important? What does it establish? How does it relate to the other sections of the Joint Report?

Regional geology (not agreed)

58 In paragraph 22, you take the view that regional flow patterns and spring occurrence can be conceptualised without a need to reconsider the published geology and the Project geology.

59 Please explain:

(a) the reasons for your views;

(b) whether your view complies with standard methodology and practices in this area of expertise;

(c) why you disagree with John Webb on this point;

(d) the significance of the disagreement;

(e) if John Webb's view (in paragraph 23) is correct, is there any reason that the regional geology has not been revised? Is there a reason it does **not** need to be done?

(f) whether revising the regional geology is going beyond what is typically required for this type of exercise? I.e. would it be undertaking a task over and above what is normally done?

(g) if the regional geology were to be revised, how long would it take?

SECTION E – Summary of conclusions

60 The Rules require your further statement to provide a summary of the conclusions you have reached. In our view, this is often best presented in a separate, concluding section (or at the start of the statement).

61 If there are no issues raised in the CAT submission relevant to your field of expertise, please indicate that in your summary of conclusions.

SECTION F – Expert's confirmation

62 It is important that the report you prepare be an independent report prepared bearing in mind an expert witness' overriding duty to the court. The overriding duty encompasses the following points:

(a) You have an overriding duty to assist the Court on matters relevant to your area of expertise;

(b) You are not an advocate for a party, even when giving testimony that is necessarily evaluative rather than inferential; and

(c) Your paramount duty is to the Court and not to the person retaining you.

63 An example of the type of thing that might be said in this section is as follows:

(a) *I have read and understood relevant extracts of the Land Court Rules 2010 (Qld) and the Uniform Civil Procedure Rules 1999 (Qld). I acknowledge that I have an overriding duty to assist the Court and state that I have discharged that duty.*

(b) *I have provided within my report:*

(i) *details of my relevant qualifications;*

(ii) *details of material that I relied on in arriving at my opinions; and*

(iii) *other things as required by the Land Court Rules.*

(c) *I confirm that:*

(i) *the factual matters included in the statement are, to the best of my knowledge, true;*

(ii) *I have made all enquiries I consider appropriate for the purpose of preparing this statement;*

(iii) *the opinions included in this statement are genuinely held by me;*

(iv) *this statement contains reference to all matters I consider significant for its purpose;*

(v) *I have not received or accepted any instructions to adopt or reject a particular opinion in relation to an issue in dispute in the proceeding.*

(d) *If I become aware of any error or any data which impact significantly upon the accuracy of my report, or the evidence that I give, prior to the legal dispute being finally resolved, I shall use my best endeavours to notify those who commissioned my report or called me to give evidence.*

(e) *I shall use my best endeavours in giving evidence to ensure that my opinions and the data upon which they are based are not misunderstood or misinterpreted by the Land Court.*

(f) *I have not entered into any arrangement which makes the fees to which I am entitled dependent upon the views I express or the outcome of the case in which my report is used or in which I give evidence.*

Confidentiality

64 Any report generated by you should remain in draft until such time as we are in a position to discuss the contents of the report with you. We ask that the report be kept strictly confidential as it is to be used for the purpose of obtaining legal advice or for use in legal proceedings. You are not authorised to provide these instructions or your report to any other person or party.

If you would like any further material, or have any questions, please contact us.

Yours sincerely

Peter Stokes
Partner

ANNEXURE C

TABLE 4-1, GHD (2012)

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

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

[1] Within EPC 1690 lease area

ANNEXURE D

DRILLING LOG, WELL SHOEMAKER 1

Drilling Log

Well: Shoemaker-1 **Permit:** ATP 744P

Comet Ridge

SURFACE LOCATION

Latitude :	22° 03' 57.36" S
Longitude :	146° 14' 26.03" E
Easting :	421 645 mE
Northing :	7 559 680 mN
RT Elevation:	251.2 m
GL Elevation:	248.0 m
Datum:	GDA94, MGA Z55

HOLE SIZE

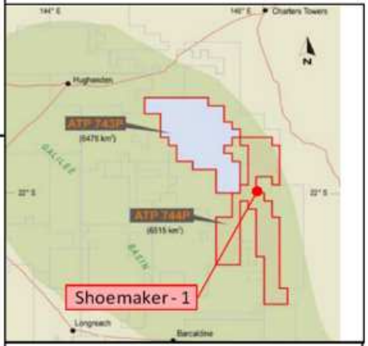
Diameter	Depth MD
8.500 in.	207.5
6.125 in.	536.8
3.780 in.	697.6

CASING

Diameter	Depth MD
7 in.	205.3 m
4.500 in.	536.8 m

SHOW SYMBOLS

	Oil	Gas
Good		
Fair		
Poor		
Trace		



DST SUMMARY

DST#1 Betts Creek 589.09-595.30mDF
IF/ISI/FF/FSI: 5/30/20/240 minutes
Water Cushion: 180m
FSI pressure: 838psi @ 590mDF

DST#2 Betts Creek 620.18-625.59mDF
IS/ISI/FF/FSI: 5/60/20/240 minutes
Water Cushion: 294m
FSI Pressure: 878psi @ 624.09mDF

LEGEND

- Test Interval
- MFT Depth
- Casing Shoe
- Sidewall Core
- Core

LITHOLOGY LEGEND

CONGLOMERATE	LIMESTONE
VERY COARSE SANDSTONE	DOLOMITE
SANDSTONE	SHALE
VERY FINE SANDSTONE	WEATHERED VOLCANIC
SILTSTONE	VOLCANIC
CLAYSTONE	BASALT
MUDSTONE	SHALY SANDSTONE
COAL	CARB. SILTSTONE
TUFF	CLAYEY SANDSTONE

Services

Engineer: M.Troughton
Geologist: J.Hulse
Wireline: Weatherford Wireline
Core Handling: Weatherford Labs
Operations Supervisor: G.Smith

DATES

Spud :	0700hrs 15/1/2010
Reached TD :	1130hrs 29/1/2010
Rig Release :	1700hrs 30/01/2010

WIRELINE

Run #1: MCG-CLDC-MPD-MDN-MDL-MSS

Rm @ 25°C	: 0.20
Rmf @ 25°C	: n/a
Rmc @ 25°C	: n/a
Rm @ 45°C BHT:	0.14

SUMMARY

Operator:	Comet Ridge Limited
Country:	Australia
State:	Queensland
Rig Name:	Atlas #1
TD Logger:	698.2 m
TD Driller:	697.6 m

WELL REMARKS

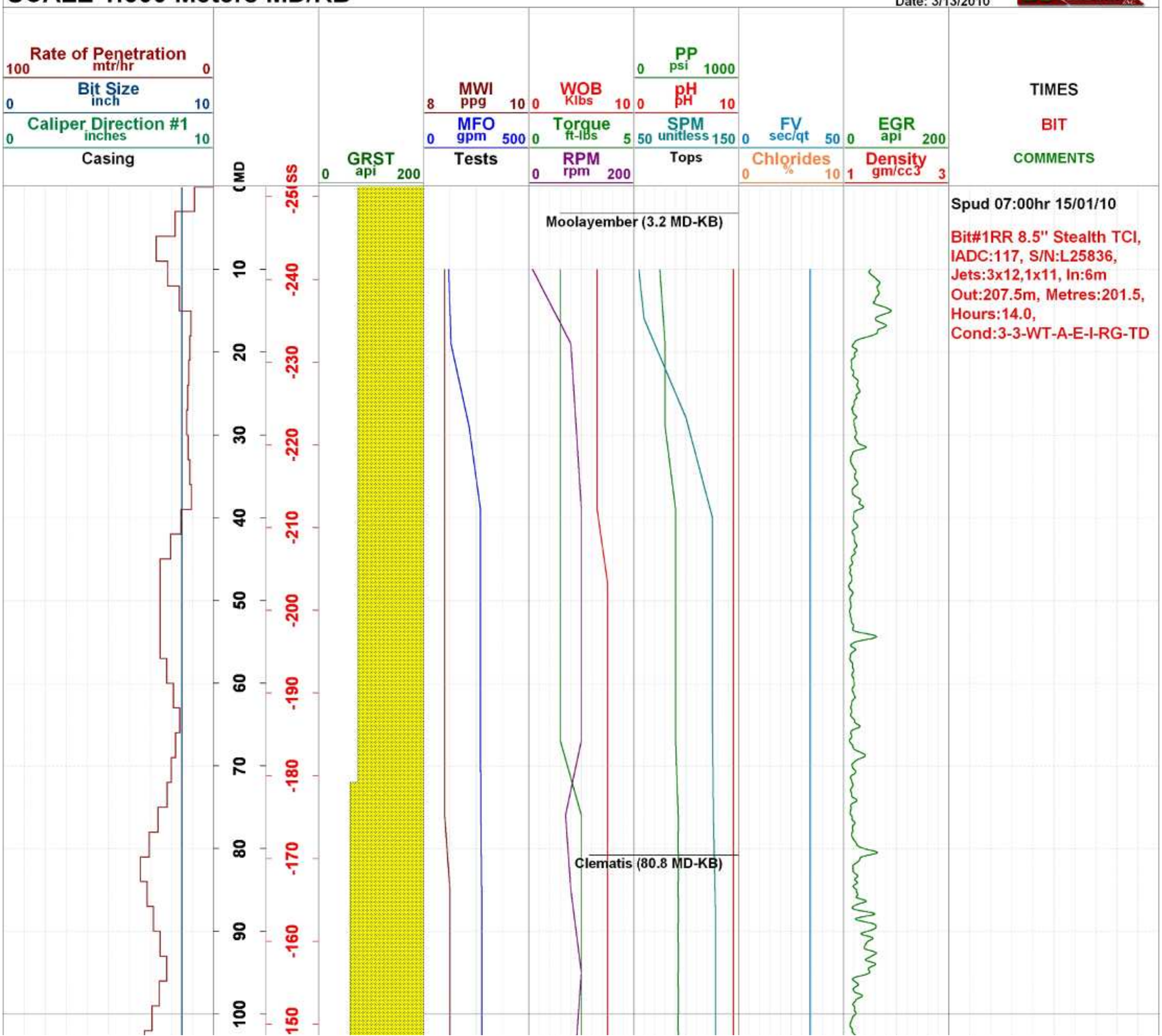
Shoemaker-1 was Plugged and Abandoned as programmed after successfully achieving all evaluation objectives.

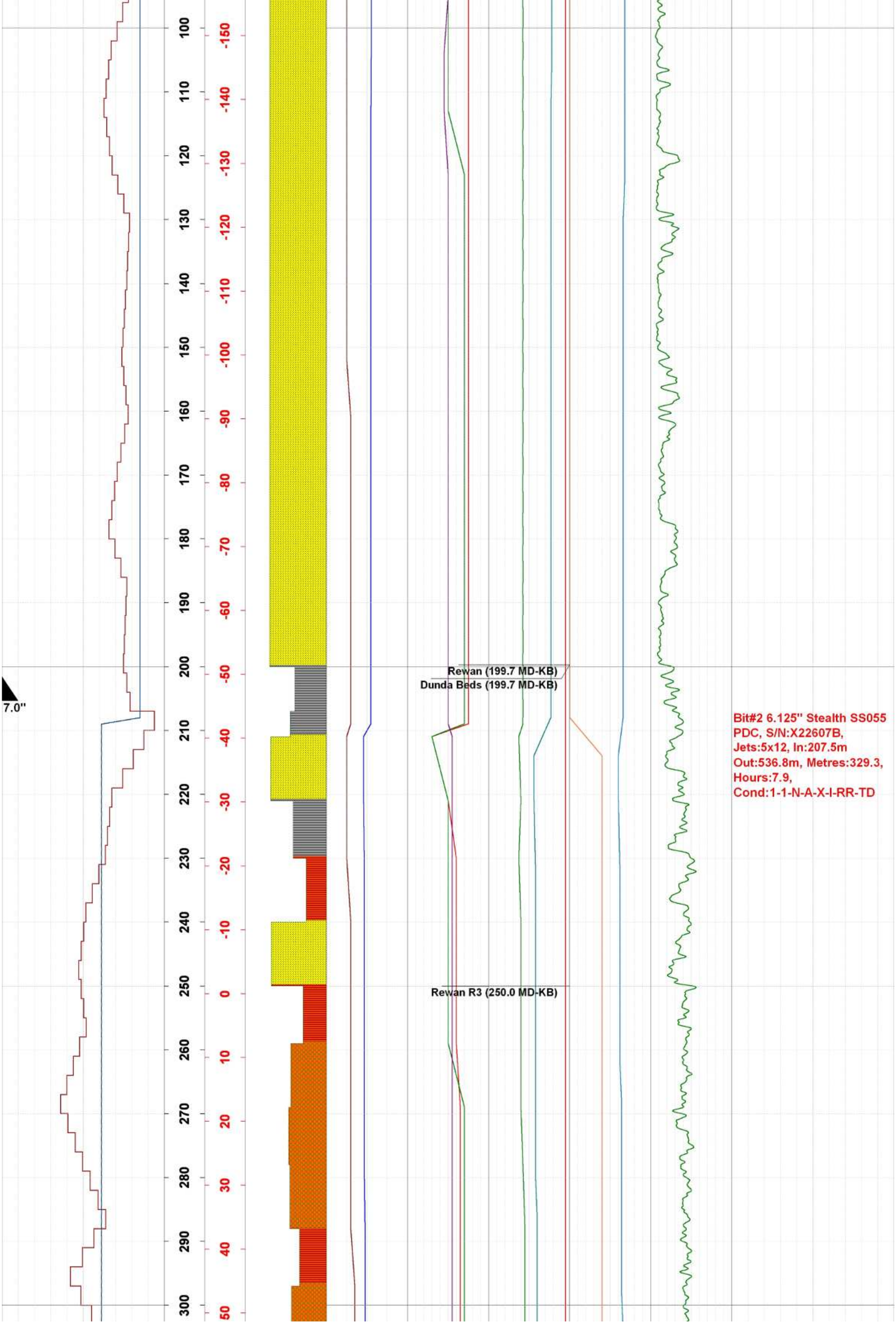
Note: Desorption Intervals have been depth shifted -0.5m to match wireline log depths.

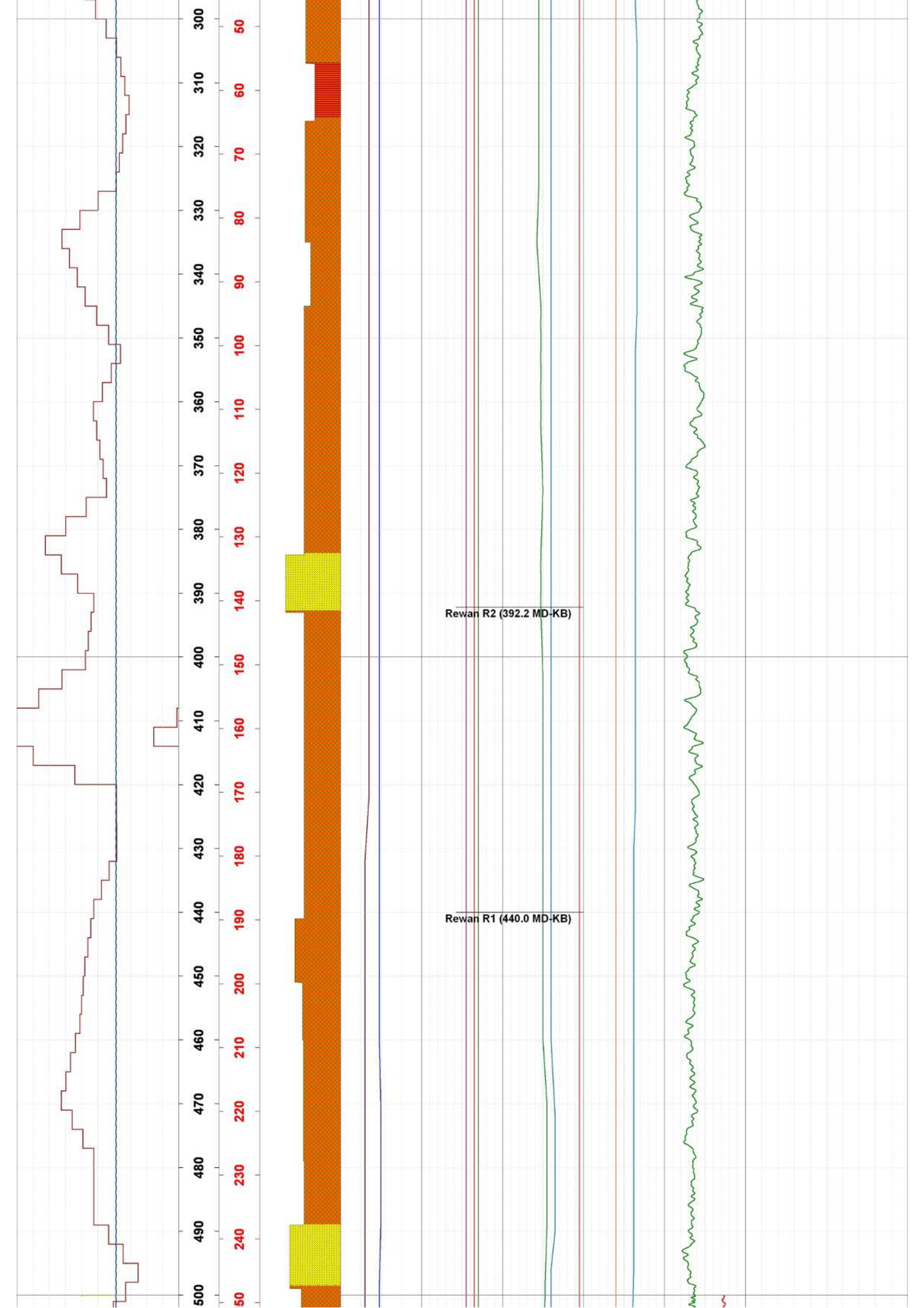
SCALE 1:500 Meters MD/KB

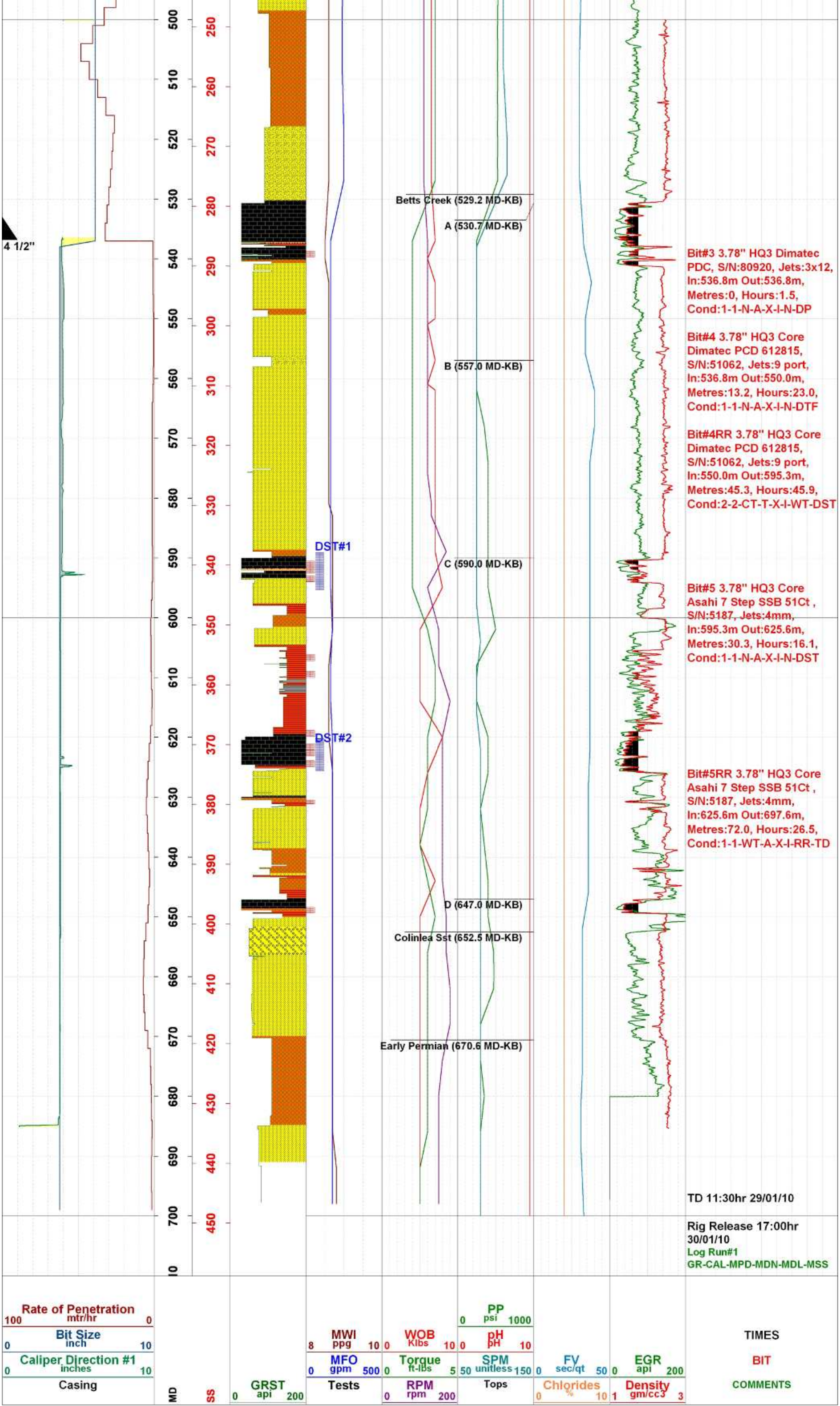
Date: 3/13/2010

GS SOFTWARE



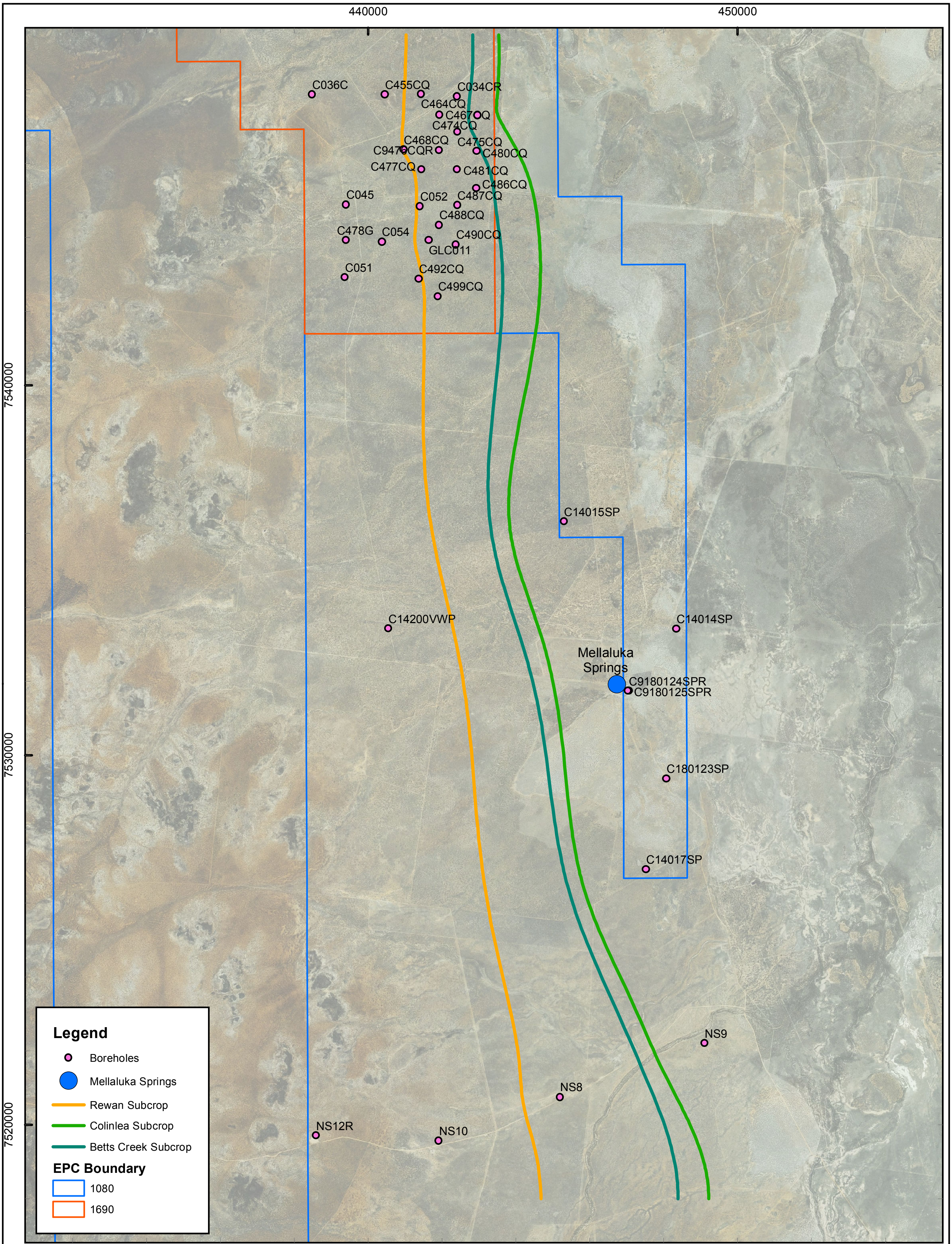

Rewan (199.7 MD-KB)
Dunda Beds (199.7 MD-KB)
Rewan R3 (250.0 MD-KB)
7.0''
Bit#2 6.125'' Stealth SS055
PDC, S/N:X22607B,
Jets:5x12, In:207.5m
Out:536.8m, Metres:329.3,
Hours:7.9,
Cond:1-1-N-A-X-I-RR-TD


Rewan R2 (392.2 MD-KB)
Rewan R1 (440.0 MD-KB)
300 310 320 330 340 350 360 370 380 390 400 410 420 430 440 450 460 470 480 490 500
50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250


4 1/2"
Betts Creek (529.2 MD-KB)
A (530.7 MD-KB)
B (557.0 MD-KB)
C (590.0 MD-KB)
D (647.0 MD-KB)
Colinlea Sst (652.5 MD-KB)
Early Permian (670.6 MD-KB)
DST#1
DST#2
Bit#3 3.78" HQ3 Dimatec PDC, S/N:80920, Jets:3x12, In:536.8m Out:536.8m, Metres:0, Hours:1.5, Cond:1-1-N-A-X-I-N-DP
Bit#4 3.78" HQ3 Core Dimatec PCD 612815, S/N:51062, Jets:9 port, In:536.8m Out:550.0m, Metres:13.2, Hours:23.0, Cond:1-1-N-A-X-I-N-DTF
Bit#4RR 3.78" HQ3 Core Dimatec PCD 612815, S/N:51062, Jets:9 port, In:550.0m Out:595.3m, Metres:45.3, Hours:45.9, Cond:2-2-CT-T-X-I-WT-DST
Bit#5 3.78" HQ3 Core Asahi 7 Step SSB 51Ct , S/N:5187, Jets:4mm, In:595.3m Out:625.6m, Metres:30.3, Hours:16.1, Cond:1-1-N-A-X-I-N-DST
Bit#5RR 3.78" HQ3 Core Asahi 7 Step SSB 51Ct , S/N:5187, Jets:4mm, In:625.6m Out:697.6m, Metres:72.0, Hours:26.5, Cond:1-1-WT-A-X-I-RR-TD
TD 11:30hr 29/01/10
Rig Release 17:00hr 30/01/10
Log Run#1
GR-CAL-MPD-MDN-MDL-MSS
MD 500 510 520 530 540 550 560 570 580 590 600 610 620 630 640 650 660 670 680 690 700
SS 250 260 270 280 290 300 310 320 330 340 350 360 370 380 390 400 410 420 430 440 450
Rate of Penetration mtr/hr 100 0
Bit Size inch 0 10
Caliper Direction #1 inches 0 10
Casing
MD
SS
GRST api 0 200
MWI ppg 8 10
MFO gpm 0 500
Tests
WOB Klbs 0 10
Torque ft-lbs 0 5
RPM rpm 0 200
PP psi 0 1000
pH pH 0 10
SPM unitless 50 150
Tops
FV sec/qt 0 50
Chlorides % 0 10
EGR api 0 200
Density gm/cc3 1 3
TIMES
BIT
COMMENTS

ANNEXURE E

CARMICHAEL COAL PROJECT – MELLALUKA SPRINGS STRATIGRAPHY



Data Source: Geoscience Australia, Queensland Department of Environment and Resource Management

Carmichael Coal Project
Mellaluka Springs - Stratigraphy

0 1,200 2,400 4,800 Meters

1:127,595 at A4 size

N W E S

adani

GDA94 MGA Zone 55

Sheet No. 2014-12-04_002

Mellaluke Springs Region

Drawn by: Mike Jacobson

Checked by:

Date: 2014-12-05