APPENDIX F: ADDITIONAL INFORMATION

Refer to the Department's website:
http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=6367

F1 Forestry Corporation letter dated July 2016
F2 EPA letter dated August 2016
F3 RMS advice dated August 2016
F4 MSC letter dated August 2016
F5 KEPCO response to DPI Water request for clarification groundwater issues –Sep 2016
F6 KEPCO response to Forestry Corporation, October 2016
F7 OEH advice on Supplementary Response to Submissions, Nov 2016
F8 DPI advice on Supplementary Response to Submissions, Nov 2016
F9 KEPCO response to DPI Water, Nov 2016
F10 KEPCO response to MSC – road contributions, Dec 2016
F11 KEPCO response to MSC – road contributions, Feb 2017
F12 MSC letter dated Feb 2017

Forestry Corporation of NSW ABN 43 141 857 613

Western Region
Cnr Monash and Chelmsford Streets
Dubbo NSW 2830
(PO Box 865 Dubbo NSW 2830)

T: 02 6841 4205
E: jarod.dashwood@fcnsw.com.au

Stephen O'Donoghue
Team Leader – Resource Assessments
Department of Planning and Environment
GPO Box 39
SYDNEY NSW 2001

25 July 2016

Dear Stephen,

<u>RE: 160628 BYLONG COAL PROJECT FORESTRY NSW SUPPLEMENTARY RTS</u>

Forestry Corporation of NSW (FCNSW) has reviewed the tendered document and makes the following comments:

<u>Issue 1</u>

FCNSW acknowledges that KEPCO's intention is to allow FCNSW access to Bylong State Forest. What still remains unresolved is:

(a) where the "right of way" will be located;
(b) a time frame for the establishment of the "right of way";
(c) a commitment from KEPCO that the use of the "right of way" and subsequent occupation of Bylong State Forest will be unfettered; and
(d) what mechanism or instrument should be used to enforce this commitment.

<u>Issue 2</u>

FCNSW is seeking acknowledgement from KEPCO that they will accept commercial liability for unrepairable damage to FCNSW assets (i.e. land productivity, timber utilisation/devaluation etc). FCNSW are not asking KEPCO to quantify their impacts over the life of the project, only that KEPCO recognise that compensation due to FCNSW will be dealt with via a Compensation Agreement rather than operational plans that describe intentions for remediation, where KEPCO determines whether work is safe to perform or not.

<u>Issue 3</u>

KEPCO's noted response provides no reassurance that FCNSW will not be exposed to ongoing public safety or environmental liabilities as a result of KEPCO's activities. This arrangement is not acceptable to FCNSW.

If you have any further queries on this matter call 6841 4205

Yours Faithfully,

Jarod Dashwood
Forest Occupancy Supervisor
FCNSW WESTERN REGION

Your reference :
Our reference : EF15/16176; DOC16/193448-05
Contact : Ms Sheridan Ledger; (02) 6332 7608

Mr Matthew Riley
Senior Planning Officer
Department of Planning & Environment
GPO Box 39
SYDNEY NSW 2001

17 August 2016

Dear Mr Riley

PROPOSED BYLONG COAL PROJECT – FURTHER EPA COMMENT

RESPONSE TO SUBMISSIONS REPORT

I refer to your email of 14 July 2016 seeking comment from the Environment Protection Authority (EPA) to Kepco Bylong Australia (Kepco's) response to matters that were previously raised by the EPA in relation to the Response to Submissions Report (RTS) for the proposed Bylong Coal Project (the Project).

The EPA's comments are provided in Attachment 1. The EPA requests the opportunity to review the draft Director-General's Environmental Assessment report for the Project and to comment on any conditions of consent, should approval be recommended by the Department of Planning and Environment (DPE).

Should you have any further enquiries in relation to this matter please contact Ms Sheridan Ledger at the Central West (Bathurst) Office of the EPA by telephoning (02) 6332 7608.

Yours sincerely

DARRYL CLIFT
Head Central West Unit
Environment Protection Authority

PO Box 1388 Bathurst NSW 2795
Level 2, 203 – 209 Russell Street Bathurst NSW 2795
Tel: (02) 6332 7600 Fax: (02) 6332 7630
ABN 43 692 285 758
www.epa.nsw.gov.au

ATTACHMENT 1

Air Quality

From its review of the exhibited Environmental Impact Statement (EIS) and the RTS for the Project, the EPA advised that diesel particle emissions were not adequately quantified or assessed, with inadequate information being provided as to best practice measures for minimising emissions from diesel plant and equipment from the Project. This matter remains outstanding. While the assessment indicates there will be no exceedences of the impact criteria, EPA considers that all reasonable and feasible best practice measures to minimise air quality impacts from coal mines will be implemented, consistent with its current approach in relation to dust and diesel emissions from operational coal mines.

The following is provided to respond to Kepco's response to the EPA's comment on the RTS:

1. Impacts of diesel emissions on $PM_{2.5}$

    Information Provided

    Additional modelling has been undertaken using estimates of emissions from all diesel engines for years 3, 5, and 9. The predicted maximum concentrations for each day were then added to the existing modelling results for that day (project-only + background).

    EPA response

    The modelling approach is generally adequate, however modelled emissions have not been adequately justified. The assumed emission rate has not been justified on the basis of benchmarking all reasonable and feasible emission controls and management practices for diesel particles and oxides of nitrogen.

    Additionally, the assumptions underpinning the assumed emission rate have not been provided, including but not limited to composition of the proposed non-road diesel fleet, mine design and staging, activity rates, fuel consumption, engine capacity, load and emissions performance.

    Based on the above, it is not clear that the emission estimates are an accurate representation of proposed operational practice. Further information is needed to establish equipment performance, emissions, and utilisation.

2. Approaches to minimising diesel particle emissions

    Information Provided

    KEPCO re-assert they understand their obligations under section 128 of the *Protection of the Environment Operations Act 1997*. They then argue that as assessment found no exceedences of the impact assessment criteria it is unreasonable for the EPA to request best-practice measures.

    EPA Response

    Diesel exhaust is classified as a human carcinogen and health evidence indicates no safe level for exposure to fine particulate matter. The EPA is therefore seeking best practice measures for minimising emissions from diesel engines consistent with the objects of *Protection of the Environment Operations Act 1997*, particularly sections 3 (d) (ii) and 3 (d) (iv).

Noise

In response to the RTS, the EPA advised it does not support the use of the Broner low frequency noise (LFN) method utilised for the LFN assessment for the Project. In response, Kepco has provided a revised assessment of LFN utilising the United Kingdom's Department of Environment, Food and Rural Affairs (DEFRA) methodology.

The EPA considers the Project can be assessed using the DEFRA-based criteria, as this approach is consistent with current science.

Third-octave band assessment

The revised assessment did not identify any receivers as affected by low frequency noise. However, the assessment has limitations, as it:

- does not cover the whole frequency range of the criteria (it is limited in range)
- is based on octave band levels rather than third-octave bands (it is low resolution).

This means that there is a risk that low frequency noise impacts at some receivers may exceed criteria, even though the assessment did not identify them as affected by low frequency noise.

It is preferable for low frequency noise to be assessed in every third-octave band threshold level, rather than the two octave band levels provided. This would allow low frequency noise impacts to be identified earlier and dealt with in design of the Project. However, DPE may consider requiring a validation report be prepared by Kepco post commencement of operations to assess LFN in every third-octave band and to determine whether a LFN correction is required to be applied.

DEFRA-based criteria and corrections to measured noise levels

Any project approval, if issued, should adopt the noise levels predicted by KEPCO as limits, and require that a correction be applied to any measured noise level, before comparison to limits, where the $L_{Ceq} - L_{Aeq}$ exceeds 15 dB and:

- where any of the 1/3 octave noise levels in Table A are exceeded by up to 5dB, a 2 dBA positive adjustment to measured A weighted levels applies in the evening and night periods.
- where any of the 1/3 octave noise levels in Table A are exceeded by more than 5dB, a 5 dBA positive adjustment to measured A weighted levels applies for the evening and night periods, and a 2 dBA positive adjustment applies for the daytime period.

Table A: One-third octave low frequency noise thresholds

Centre frequency (Hz)	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
One-third octave $L_{Zeq(15min)}$ threshold level (dB)	92	89	86	77	69	61	54	50	50	48	48	46	44

Steve O'Donoghue

From: MCINTYRE Andrew R <Andrew.MCINTYRE@rms.nsw.gov.au>
Sent: Wednesday, 3 August 2016 5:02 PM
To: Steve O'Donoghue
Cc: Development Western
Subject: Bylong Coal Project

Dear Steve

Thank you for your time on the phone earlier. As discussed, I have reviewed the 'Response to RMS Submission' prepared by Hansen Bailey on 14 July 2016. The response provides commitments to manage driver fatigue and mine commuter safety.

In corresponding order, I provide the following comments in relation to each commitment.

Issue 2.

1. *Utilisation of the WAF provides a road safety mechanism in that it minimises the number of construction employees travelling to and from the site on a daily basis.*

RMS comment- Agreed. The WAF will reduce commute times however, the end of shift period commute still needs to be considered. RMS understands MWRC is not in favour of the WAF and should the WAF not be built, this commitment would be invalid.

2. *Commitment for a bus to and from the WAF throughout the construction phase*

RMS Comment: See earlier comment above.

3. *Commitment to investigate bussing of operational employees – subject to residential distribution of workers*

RMS Comment: Commitment 3 entails the proponent committing a bus service if workers are willing to use it, and, if the number of workers (not quantified) who reside at a particular location are sufficient to warrant a bus being provided. Further, the proponent commits to requiring contractors to encourage their staff accessing the mine to use a bus service, if available. These commitments do not provide a level of certainty for implementing and achieving measurable and successful management strategies to manage driver fatigue and mine commuter safety.

The Journey Management Plans for each employee is a good suggestion, however, more detail is required on what they actual mean, when a JMP is and is not approved, what are the measurables, what are the targets, what are the restrictions, how are they enforced? etc, etc.

4. *Project Fatigue Management policy to be implemented, including an education program in consultation with emergency service providers.*

RMS Comment: Supported. RMS requests involvement in the development of this Policy and its ongoing implementation and review, including, the training of supervisory staff.

5. *Provide detailed information to employees and their families about managing sleep cycles and the impact of fatigue on lifestyle and relationships.*

RMS Comment: Supported. RMS requests involvement in the development of information packages and involvement in toolbox talks.

6. *Identify and implement a program to encourage the operations phase workforce to car pool for the Project.*

RMS Comment: Further work and information is required for this program, such as incentives and requiring vehicles used in the car pooling program to be a minimum 4 – 5 AMCAP rated vehicle.

7. *Offer driver education training to workforce.*

RMS Comment: Supported in principle, however further detail required. If the training has value, RMS questions why this training cannot be mandatory?

8. *Encourage travel outside of school bus pick up and drop off periods.*

RMS Comment: Needs rewording. Commitment should be, shift changeover traffic generating activities will not coincide with school bus drop off/pick up times.

Issue 3

1. *Commute times within one hour are considered to be a safe commute time.*

RMS Comment: Who considers a 59 minute commute to be a safe commute time? In what conditions or after what period (ie after an earlier 59 minute commute and 12 hour shift).

Issue 4.

1. *Meeting with RMS Road User Safety Unit.*

RMS Comment: This has not occurred. The meeting on 23/6/16 was with RMS' Manager Land Use Assessment.

<u>Summary</u>

The strategies committed to by the proponent involving bussing staff, car pooling and the WAF are not certain. For example if the WAF isn't built, and employees are scattered across the region, these strategies that are not fully committed to by the proponent, will not occur. The policies and training proposed are good initiatives that require further development and planning work to ensure they are effective.

I would suggest the proponent needs to make solid and measurable commitments to manage driver fatigue and commuter safety. I'm happy to discuss this further with you and the proponent if required.

Regards,

Andrew McIntyre
Manager Land Use Assessment
Network & Safety Management
Western Region
T (02) 6861 1453 F (02) 6861 1414
www.rms.nsw.gov.au

Roads and Maritime Services
51-55 Currajong Street Parkes NSW 2870
PO Box 334 Parkes NSW 2870

Roads & Maritime

Transport
Roads & Maritime
Services

muswellbrook
shire council

Enquiries
Please ask for Steve McDonald
Direct 02 6549 3700
Our reference
Your reference

31 August 2016

Mr Stephen O'Donoghue
Team Leader, Planning Assessment
Dept of Planning & Environment
GPO Box 39
SYDNEY NSW 2001

Dear Mr O'Donoghue,

KEPCO Bylong Coal Project, Additional comment.

I refer to an application from KEPCO Bylong Australia ("the Proponent") for the Bylong Coal Project ("the Project") and make the following submission on behalf of Muswellbrook Shire Council ("Council") with respect to the Proponents Response to Submissions (RTS) dated 7th July 2016. Council appreciates the opportunity to comment on this document.

I understand you have been speaking to Scott Brooks, Council's Mining Liaison Contractor, regarding the KEPCO Bylong Project. In previous correspondence Council has requested a VPA to cover the costs of road maintenance resulting from this development. In this recent discussion you suggested Council should alternatively seek to have a road maintenance contribution placed in the draft consent conditions that will go in together with a similar request for inclusion by the Mid-Western Regional Council.

Council remains concerned on the implications this project may have on road safety of the Bylong Valley Way (BVW). The exact level of this risk is difficult to determine, as the project traffic predictions provided by the Proponent discount traffic volumes on the BVW to a lower level than Council believes will be the case. This is why Council is to undertake a Residential Traffic Study to get an independent opinion of the potential for traffic generation by this project.

Until this study is completed it is difficult for Council to estimate a maintenance value to include in the draft consent conditions. Further we suggest that should the project be approved, actual annual traffic assessments should be used to determine a contribution. However in the interim, Council has used the traffic volumes provided by the Proponent, together with known current maintenance costs of the BVW as a basis for contributions to Muswellbrook Shire Council.

Council have also undertaken a recent road safety audit of the BVW and this contained a number of recommendations for improvements. As the safety of the BVW is the primary concern of Council, we would request that there should be a one off payment to cover safety works proportional to the extra traffic predicted by the proponent and an ongoing annual maintenance cost.

Using the predicted traffic volumes provided by the proponent, Council requests that a one off fee of $95, 000 and a follow on annual fee of $60,000, payable to Council, be placed in the suggested road maintenance condition, with a review following the actual traffic use attributable to the proposed development if and when it commences.

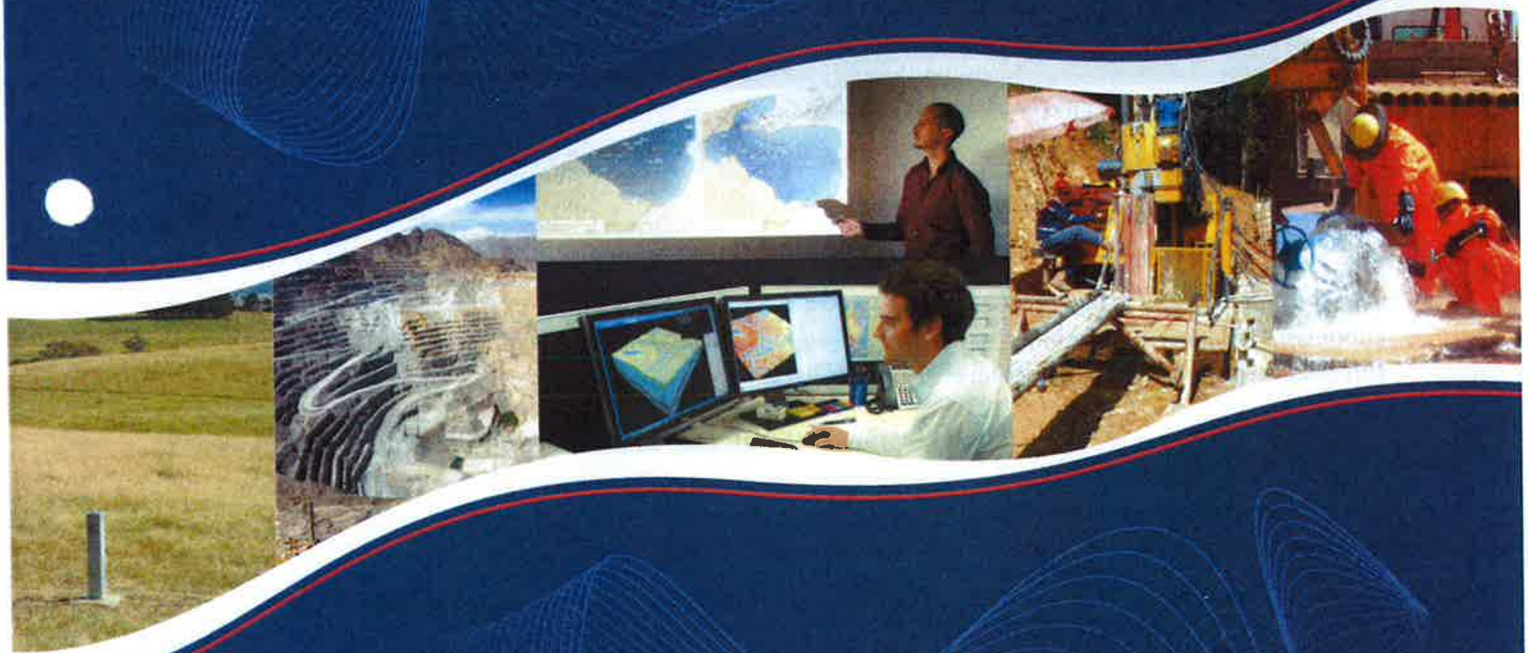
Whilst we plan to use our Residential Traffic Study as a basis for a further submission to the PAC, we ask if the road safety and maintenance works values provided here be used as a starting point in the draft consent conditions.

Council appreciates the opportunity to provide this additional comment and would be pleased to provide additional information if requested.

Yours faithfully

Steve McDonald
General Manager

Australasian
Groundwater
and Environmental
Consultants Pty Ltd
(AGE)



Report on

Bylong Coal Project

Response to Submissions on Groundwater

Prepared for
Hansen Bailey Pty Ltd

Project No. G1606 July 2016
www.ageconsultants.com.au ABN 64 080 238 642

Document details and history

Document details

Project number	G1606G
Document title	Bylong Coal Project – Response to Supplementary Submissions on Groundwater
Site address	Bylong, NSW
File name	G1606.Response_to_Submissions_Final.docx

Document status and review

Edition	Comments	Author	Authorised by	Date
v1	First draft issued to client	JST	JST	13/07/2016
v2	Second draft issued to client	JST	JST	15/07/2016
v3	Final issued to client	JST	JST	27/7/2016

Australasian Groundwater and Environmental Consultants Pty Ltd

AGE Head Office
Level 2 / 15 Mallon Street,
Bowen Hills, QLD 4006, Australia
T. +61 7 3257 2055
F. +61 7 3257 2088
brisbane@ageconsultants.com.au

AGE Newcastle Office
4 Hudson Street,
Hamilton, NSW 2303, Australia
T. +61 2 4962 2091
F. +61 2 4962 2096
newcastle@ageconsultants.com.au

Table of contents

Page No.

Table of contents
(continued)

Page No.

List of figures

Table of contents (continued)

Page No.

Table of contents
(continued)

Page No.

List of tables

List of appendices

Report on

Bylong Coal Project
Response to Submissions on Groundwater

1 Introduction and background

KEPCO Bylong Australia Pty Ltd (KEPCO) is planning to develop an open cut and underground coal mine in the Bylong Valley (the Project), which is located in Mid-Western Region of New South Wales (NSW). The Project has been subject to two levels of groundwater assessment, according to the NSW Regulatory Regime. The first was an initial groundwater assessment addressing the requirements of the NSW Gateway Certificate Assessment process. The second stage of work was a groundwater impact assessment prepared for the Environmental Impact Statement (EIS), which described the field investigations and impact assessment using numerical modelling. Major milestones for the EIS process have included:

- July-2015 EIS submitted to the NSW Government agencies;
- March 2016 Response to submissions (RTS) document submitted; and
- May 2016 Additional submissions from NSW Government agencies received.

This supplementary report provides additional information and analysis requested in submissions from the NSW Government agencies. It describes the results of further monitoring, field investigations and numerical modelling. For consistency with previous work, sections of this report refer to modelling work by AGE (2015) as the 'EIS' and AGE (2016) as the 'RTS', with the most recent updated modelling referred to as the 'RTS2'.

Hansen Bailey Environmental Consultants Pty Ltd (Hansen Bailey) engaged Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) to respond to the submissions on behalf of its client WorleyParsons Services Pty Ltd (WorleyParsons).

2 Objectives and scope of work

The Department of Primary Industries - Water (DPI Water) and the Department of Planning and Environment (DP&E) responded to the RTS submitted in March 2016 requesting additional information and investigation. The DPI Water requested further information and clarity on the:

- sustainability of extraction from the alluvial aquifer during drought conditions;
- impacts on neighbouring agricultural bores during drought conditions;
- the geology and hydrogeology datasets; and
- model calibration and water levels.

The DP&E commissioned Kalf and Associates (KA) to review the groundwater modelling on their behalf, with KA requesting further information:

- comparing outputs from the two numerical modelling codes used on the Project being MODFLOW SURFACT and MODFLOW USG;
- on the MODFLOW USG model mesh at the Goulburn River; and
- on the approach to modelling the surface water and groundwater interaction along the Bylong River and Lee Creek.

This report responds to the further requests from DP&E and DPI Water as follows:

- Section 3 presents a series of cross sections through the key stratigraphic units and proposed mining areas;
- Section 4 describes the pumping test program undertaken within the alluvial aquifer system;
- Section 5 presents additional information collected from the main groundwater systems including analysis of the pumping test data, recharge and saturated thickness;
- Section 6 describes further numerical modelling including calibration, predictions and uncertainty; and
- Section 7 discussed the results of the additional investigations and water management measures.

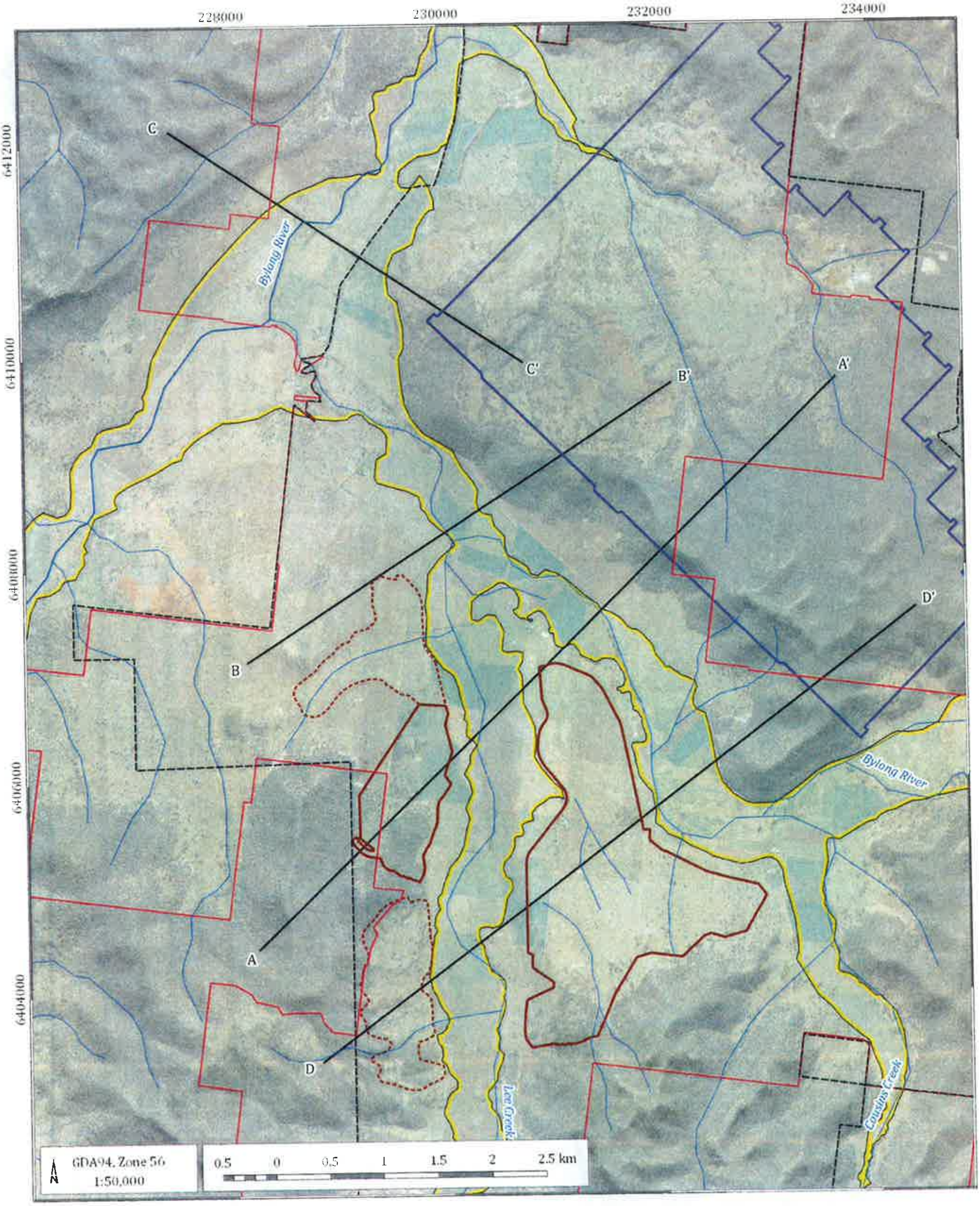
3 Geology

In response to previous requests the RTS document provided a series of geological cross sections. The first set of sections were developed through the alluvial aquifer and showed detailed lithological layers within the alluvial sediments (AGE 2016 - Section 4.2.1). The second set of cross sections were at a larger scale and developed from the sites geological model showing the key geological units (AGE 2016 - Appendix B).

In DPI Water's submission on the RTS it requested additional cross-sections to understand the 3D conceptual geology along the groundwater flow paths from recharge areas towards open-cut or underground mines or beneath coal spoil emplacement areas and towards other water users with detail on the dipping Permian beds.

To address this request the cross sections through the alluvium provided in the RTS were increased both laterally and vertically to incorporate the Permian strata, the catchment area contributing streams and the proposed mining and emplacement areas. A new cross section was also provided through the proposed open cut and underground mining areas further south and upstream.

Figure 3-1 shows the locations of the cross sections, whilst Figure 3-2 to Figure 3-5 shows the geological units along each cross section line. The cross sections are based on the groundwater model and therefore show the stratigraphic unit(s) each model layer represents. Adjacent monitoring bores are projected onto each cross section.

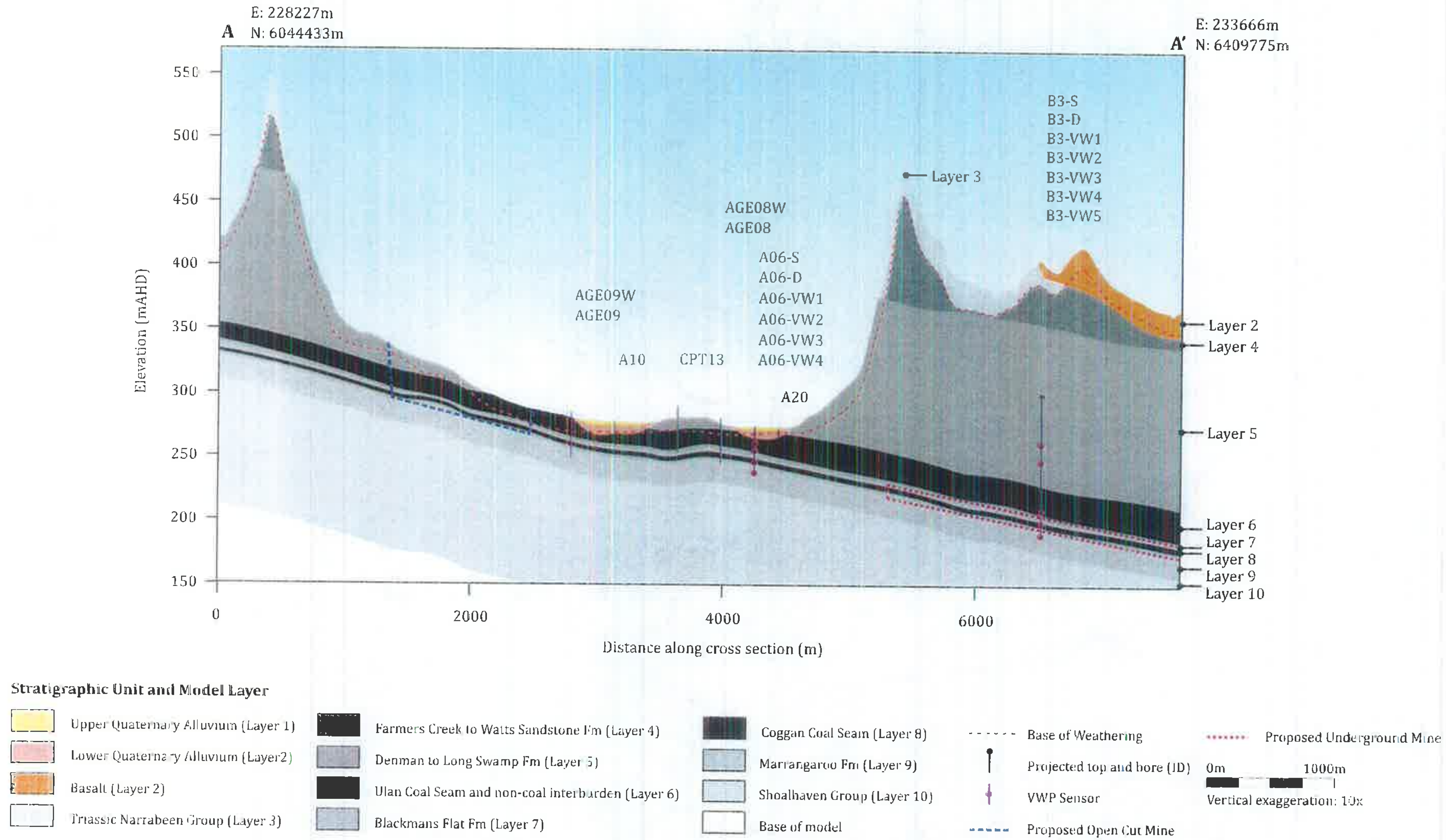


- Open Cut Mining Area
- Overburden Emplacement Area
- Underground Extraction Area
- Kepco owned land
- Project Boundary
- Quaternary alluvium
- Cross section line
- Major drainage
- Minor drainage

Bylong Coal Project (G1606G)

Location of cross sections through alluvium

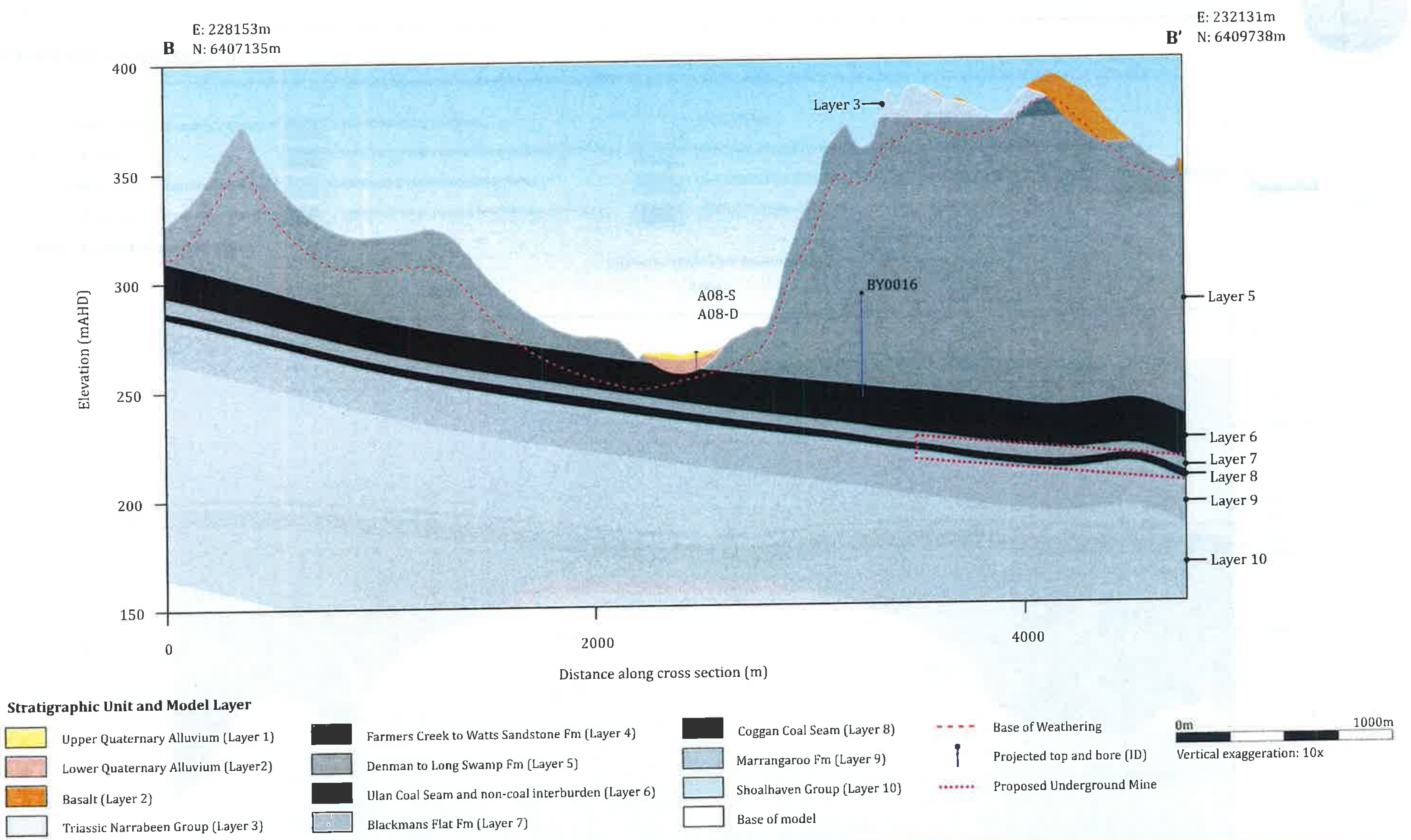
15/07/2016 **3-1**



Geological cross section A - A'

Figure 3-2

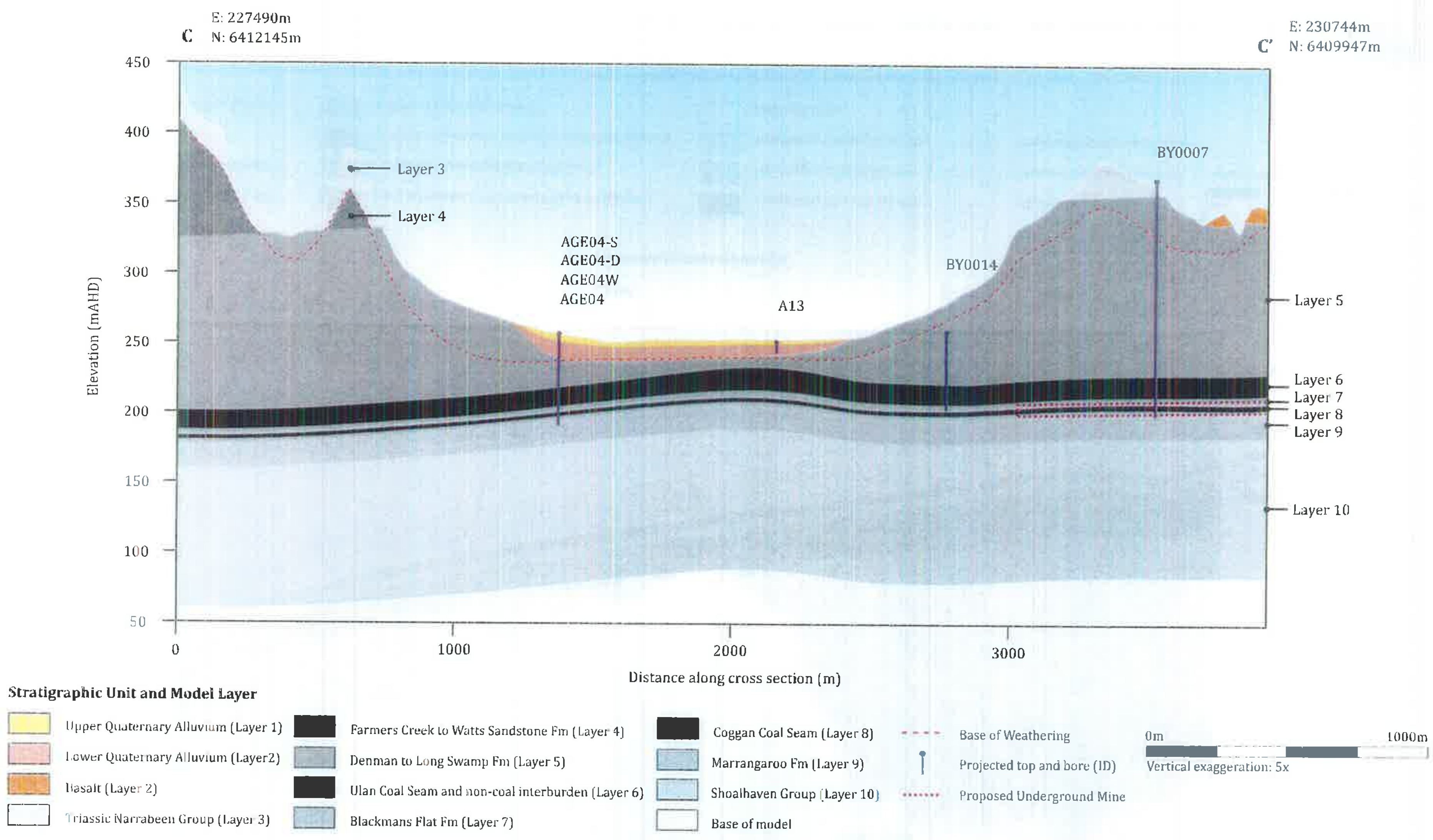
Bylong Coal Project (G1606G)



Geological cross section B - B'

Figure 3-3

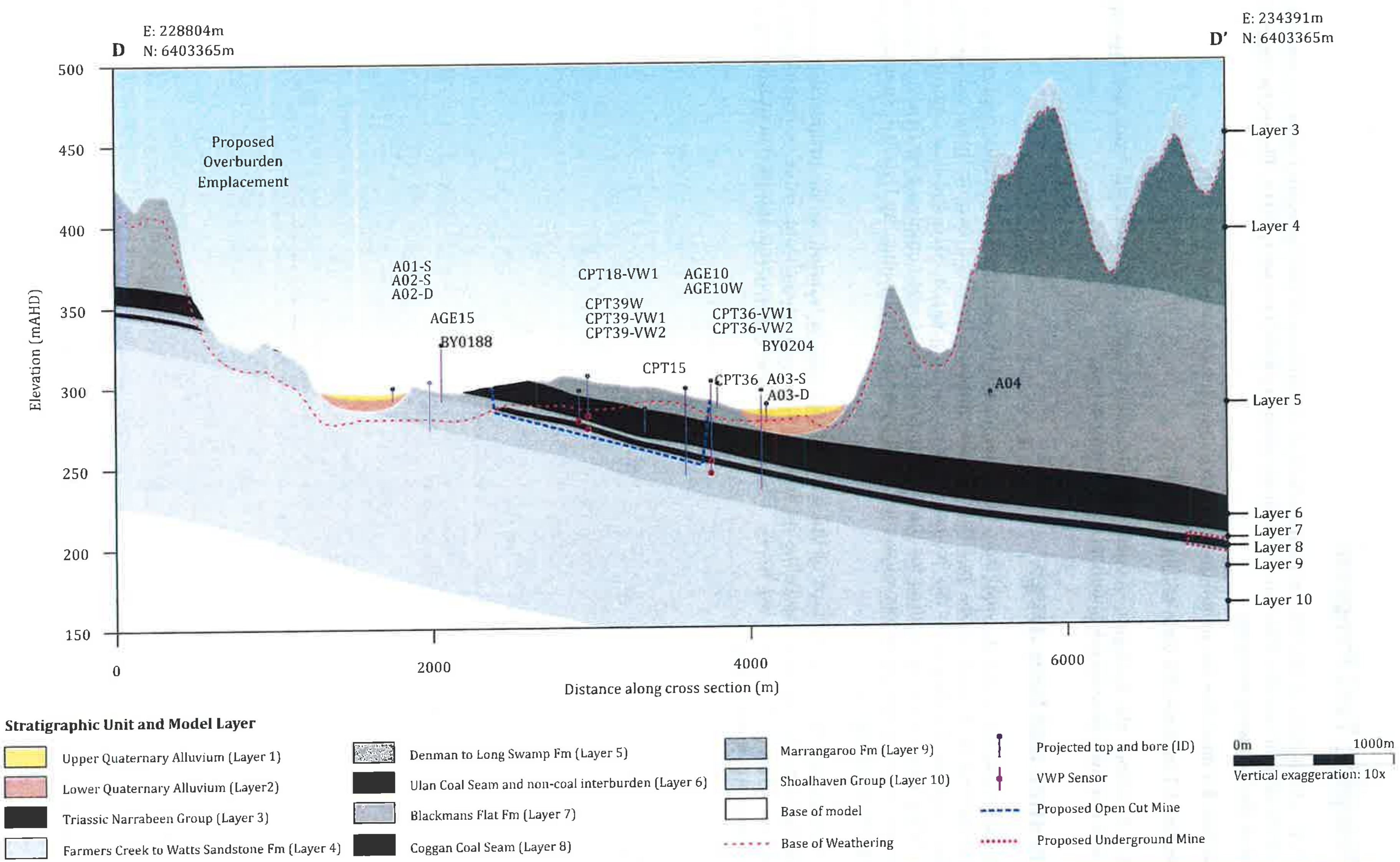
Bylong Coal Project (G1606G)



Geological cross section C - C'

Figure 3-4

Bylong Coal Project (G1606G)



Geological cross section D - D'

Figure 3-5

Bylong Coal Project (G1606G)

4 Pumping Test Program

A number of submissions on the EIS recommended the installation of trial pumping bores to measure the yield of the alluvial aquifer. This work was undertaken by KEPCO in early 2016. The work program is outlined in the following sections:

- Section 4.1 describes the installation of the trial pumping bores; and
- Section 4.2 outlines the yield testing program.

Section 5.1 describes the hydraulic properties and water quality data collected from the testing program and a revised description of alluvial aquifer properties.

4.1 Location and bore design

Four sites were selected to test the yield from the alluvium and to measure the hydraulic properties of the alluvial sediments. At each of the four trial sites, a pumping bore and two or three monitoring bores were installed. Fieldwork for the Project commenced mid-March 2016 and was completed in early May 2016. Large diameter drilling for the pumping test bores was completed by Gricks Drilling Pty Ltd, whilst monitoring bore works were completed by Hagstrom Drilling Pty Ltd. AGE supervised the drilling and pumping tests.

Figure 4-1 shows the locations of each of the trial testing sites in relation to the proposed mining areas, with Figure 4-2 to Figure 4-5 showing the detailed test layout at each site. Table 4-1 summarises the construction details for each of the bores. The geology and construction details (composite logs) are contained within Appendix A.

Open Cut Mining Area
Overburden Emplacement Area
Underground Extraction Area

Bore locations

- Monitoring bore
- Pumping bore
- Monitoring bore abandoned after testing
- Major drainage
- Minor drainage

Bylong Coal Project (1606G)

Pumping and monitoring bore locations

15/07/2016

4-1

Bore locations

- Monitoring bore
- Pumping bore
- Monitoring bore abandoned after testing
- Major drainage
- Minor drainage

Bylong Coal Project (1606G)

Pumping and monitoring bore locations - Site 1

15/07/2016 **4-2**

Open Cut Mining Area

Bore locations

- Monitoring bore
- Pumping bore
- Major drainage
- Minor drainage

Bylong Coal Project (1606G)

Pumping and monitoring bore locations - Site 2

15/07/2016

4-3

Bore locations

- Monitoring bore
- Pumping bore
- Major drainage
- Minor drainage

Bylong Coal Project ([illegible])

Pumping and monitoring bore locations - Site 3

15/07/2016

4-4

Bore locations

- Monitoring bore
- Pumping bore
- Major drainage
- Minor drainage

Bylong Coal Project (1606G)

Pumping and monitoring bore locations - Site 4

15/07/2016

4-5

Table 4-1 Summary of bore construction details

Well ID	Location	Bore type	Completion date	Easting (GDA94 Z56)	Northing (GDA94 Z56)	Collar - ground level (mAHD)	Collar - top of PVC / steel (mAHD)	Screen depth (mbgl)	Filter depth (mbgl)	Alluvium depth (mbgl)	SWL mTOC[1] / Date of measurement	Monitoring bore distance (metres from pumping bore)
AGE21P	Site 3	Pumping	19/03/2016	230399.86	6407017.74	275.42	276.32	8.6 - 10.6	3 - 16	11	7.615: 06/05/2016	-
AGE22M	Site 3	Monitoring	21/03/2016	230408.92	6406988.41	275.67	276.45	8 - 11	3 - 18	12	7.685: 06/05/2016	30.7
AGE23M	Site 3	Monitoring	23/03/2016	230404.43	6407002.98	275.5	276.25	8 - 11	3 - 18	12	7.492: 06/05/2016	15.45
AGE24P	Site 1	Pumping	23/03/2016	230335.86	6408250.32	267.07	267.77	9.46 - 11.46	3 - 11.5	13	3.44: 06/05/2016	-
AGE25M	Site 1	Monitoring	30/03/2016	230333.75	6408262.60	267.21	268.02	7 - 10[2]	N/A	N/A	-	5.5
AGE26M	Site 1	Monitoring	01/04/2016	230340.37	6408245.85	267.19	267.8	9 - 12	3 - 12	N/A	3.45: 06/05/2016	6.35
AGE27M	Site 1	Monitoring	02/04/2016	230344.68	6408241.39	267.34	268.06	9 - 12	3 - 12	N/A	3.69: 06/05/2016	12.55
AGE28P	Site 4	Pumping	02/04/2016	232022.00	6406184.64	283.91	284.42	13 - 15	3 - 20	15	1.88: 26/04/2016	-
AGE29M	Site 4	Monitoring	03/04/2016	232044.99	6406165.16	284.19	284.93	12 - 15	3 - 19	15	2.24: 05/05/2016	30.13
AGE30M	Site 4	Monitoring	05/04/2016	232033.68	6406174.91	284.03	284.88	12 - 15	3 - 19	15	2.197: 05/05/2016	15.2
AGE31M	Site 2	Monitoring	13/04/2016	231762.56	6406941.95	279.03	279.7	13 - 16	3 - 16.9	16	2.112: 04/04/2016	13.54
AGE32P	Site 2	Pumping	15/04/2016	231768.38	6406929.72	279.08	279.79	13 - 15	3 - 17.7	16	2.07: 04/04/2016	-
AGE33M	Site 2	Monitoring	16/04/2016	231774.97	6406915.71	279.14	279.85	13 - 16	3 - 18.6	16	2.082: 04/04/2016	29.03

Notes:

1. SWL mTOC = Standing water level metres below top of casing

2. Temporary screen for pumping test – bore abandoned after testing

4.1.1 Site 1 - Downstream at Bylong River - Lee Creek Confluence

Site 1 is located downstream of the open cut mine, about 300 m east of the Bylong River and 500 m downstream of the confluence of the Bylong River with Lee Creek. The site consisted of one pumping bore (AGE24P) and three monitoring bores (AGE25M, AGE26M, AGE27M). Figure 4-6 below shows installation of a bore at Site 1 looking to the north-west towards the Bylong River.

Figure 4-6 Drilling at Test Site 1

The pumping bore intersected relatively clean alluvial sands and gravels from 4 m to 13 m below surface during drilling. Tertiary basalt derived gravels occurred from 11 m to 13 m, creating difficult drilling conditions. This resulted in the hole collapsing from 11 m to 13 m, preventing the screen from being installed to the base of the alluvial aquifer.

The monitoring bore AGE25M encountered drill bit refusal due to igneous cobbles / boulders at a depth of 10 m. A temporary PVC casing was installed within this bore for monitoring during the pumping test and later abandoned. Monitoring bores AGE26M and AGE27M also encountered igneous gravels towards the base of the alluvial sequence and both bores were constructed at a depth of 12 m, where drilling chips suggested weathered rock had been intersected.

Groundwater levels at this site stabilised at about 3 m below ground surface indicating a saturated thickness of around 10 m to 11 m in this area.

4.1.2 Site 2 - East of proposed open cut mining area

Site 2 was located about 60 m to the east of the Bylong River approximately 2.3 km upstream of the Lee Creek confluence. The site consisted of one pumping bore (AGE32P) and two monitoring bores (AGE31M and AGE33M). The boreholes at this site intersected 16 m of alluvial sediments comprising clean sand and gravel, underlain by sandstone at about 16 m. Groundwater levels at this site were about 1 m below ground surface indicating a saturated thickness of around 15 m in this area. Figure 4-7 shows the location of a bore at Site 2 looking to the east.

Figure 4-7 Drilling Test Site 2 east of Bylong River

4.1.3 Site 3 – Lee Creek

Site 3 was located on the Lee Creek flood plain between the proposed Eastern and Western open cut mining areas. The site was within an area of pasture previously irrigated with a centre pivot, which is clearly visible within aerial photography. The site consisted of one pumping bore (AGE21P) and two monitoring bores (AGE22M and AGE23M). Figure 4-8 below shows drilling undertaken at Site 3 looking to the west.

Site 3 intersected sand and gravel to between 11 m and 12 m in depth. This was underlain by a dull black coal seam of about 1 m in thickness. Groundwater levels at this site were about 6 m to 7 m below ground surface indicating a more limited saturated thickness of around 4 m to 8 m in this area. The pumping bore AGE21P lifted slightly (~300 mm) as the surface casing was extracted, reducing slightly the installation depth. Subsequent hole development indicated the casing remained undamaged.

Figure 4-8 Drilling rigs setting up at Test Site 3 on Lee Creek flood plain

4.1.4 Site 4 – Upstream Bylong River

Site 4 was located on the Bylong River floodplain. The site again consisted of one pumping bore (AGE28P) and two monitoring bores (AGE29M and AGE30M). Figure 4-9 shows the site viewed from the west.

The boreholes at this site intersected 15 m of alluvial sediments comprising clean sand and gravel, with clay present within the drilling chips suggesting lenses of finer sediment. The alluvial sediments were underlain by a dull to bright banded, highly weathered coal seam of about 3 m in thickness. Groundwater levels at this site were about 1 m below ground surface indicating a saturated thickness of around 14 m in this area.

Figure 4-9 Drilling at Test Site 4 adjacent to Bylong River

4.2 Testing program

4.2.1 Test set-up

Pumping tests were undertaken at each site to assess the hydraulic properties of the alluvial aquifer and the long term yield from each bore. Each test consisted of an initial stage of equipment testing to determine pump flow rate at a given pressure. This was followed by a step draw down test which comprised of a series of steps with increasing flow rates over identical time periods. These measured flow rates and associated drawdown were used to determine a maximum flow rate for the 100 hour constant rate test. The constant rate tests were conducted on each site the day after the step drawdown test. After the test, the water level was recorded until the aquifer had fully recovered, which was usually within a day.

Data loggers were installed prior to the tests in the pumping bore and the two associated observation bores to record the water levels. The water levels were also manually checked in the pumping and monitoring bores and in any surrounding existing private wells and surface water features, where these were present. Table 4-2 summarises the dates the testing was undertaken.

Table 4-2 Summary of test dates

Site	Test dates		
	Step drawdown	Constant rate	Recovery
1	9 April 2016	12 - 16 April 2016	17 April 2016
2	4 May 2016	5 - 8 May2016	9 May 2016
3	18 April 2016	19 - 23 April 2016	24 April 2016
4	25 - 26 April 2016*	27 April - 1 May 2016	2 May 2016

Note: ** The pump capacity was insufficient to stress the aquifer and another test with three steps was conducted on 26th April with a higher capacity pump*

Two pumps were used for testing, depending on the yield of the bores as follows:

- lower yield bores – Lowara 16GS75, 4" submersible pump; and
- higher yield bores – Lowara Z646, 6" submersible pump (50Hz).

A mobile generator powered the pumps with water delivery through 4" diameter lay flat pipe. Flow rates were measured with an in-line impeller flow meter. Figure 4-10 shows the headworks and flow meter setup used for each pumping test.

Figure 4-10 Headworks and flow meter setup

Monitoring of bores on the Tinka Tong property was undertaken whilst pumping tests at Site 1 were in progress. No influence from the pumping test was evident at the two bores on this property. It is noted since completion of the pumping tests KEPCO has acquired this property.

4.2.2 Step tests

Table 4-3 summarises the pumping rate and duration for each of the steps undertaken during the step tests.

Table 4-3 Step test summary

Bore ID	Step	Rate (L/s)	Duration (min)
AGE21P	1	2.26	30
	2	2.93	45
	3	4.2	45
	4	5.1	45
	5	5.6	45
AGE24P	1	2.6	45
	2	4.3	45
	3	6.1	45
	4	7.3	45
AGE28P	1	2.16	45
	2	3.16	45
	3	4.16	45
	4	5	45
	5	6.16	45
	6	7.83	45
AGE28P*	1	8	45
	2	10	45
	3	11	45
AGE32P*	1	7.83	45
	2	10	45
	3	11.3	45
	4	12.83	45
	5	14	45

4.2.3 Constant rate test set-up

Table 4-4 below summarises the details of the constant rate test at each site.

Table 4-4 Constant rate test summary

Bore ID	Bore type	Distance from pumping well (m)	Standing Water Level (mbgl)	Maximum drawdown (m)	Site	Pumping rate (L/s)	Duration (hrs)
AGE21P	Pumping	-	6.64	1.81	3	4.6	100
AGE22M	Observation	30.7	6.95	0.18			
AGE23M	Observation	15.45	6.78	0.21			
AGE24P	Pumping	-	2.9	3.44	1	4.6	103
AGE26M	Observation	6.35	2.9	0.31			
AGE27M	Observation	12.55	2.99	0.24			
AGE28P	Pumping	-	1.41	8.28	4	8.3	100
AGE29M	Observation	30.13	1.65	0.23			
AGE30M	Observation	15.2	1.48	0.38			
AGE32P	Pumping	-	1.5	11.53	2	13.9	79
AGE31M	Observation	13.54	1.43	1.21			
AGE33M	Observation	29.03	1.43	0.84			
REG3005005	Observation	57.98	1.405	0.53			

The constant rate test for Site 2 was interrupted at 79 hours as a substantial rain event was forecast for the following evening. 15 mm of rainfall was measured on 10th May at the Bylong (Glenview) weather station (Number 62107), but given the limited rainfall and the fact it occurred after the test was completed indicates the testing program was not influenced by this event.

Section 5.1.1 describes the analysis of the data collected during the pumping test program.

5 Groundwater regime

The following sections provide further information on the groundwater regime as follows:

- Section 5.1 presents new information collected on the alluvial aquifers;
- Section 5.2 discusses the potential for the Tertiary basalt to form an aquifer; and
- Section 5.3 provides further information on the Permian weathered zone and coal seam connectivity with the alluvium.

5.1 Alluvial aquifer

5.1.1 Hydraulic properties

Drawdown and recovery data from pumping and monitoring bores provides an estimate of the hydraulic parameter of aquifer transmissivity and storage coefficient (Ss). The coefficient of hydraulic conductivity (K) is obtained by dividing the transmissivity by the aquifer thickness. The hydraulic properties of the alluvial aquifer system were estimated from the pumping test data using a variety of methods including a small numerical model and analytical equations.

A simple 'sand box' numerical model was constructed for the purposes of estimating the hydraulic properties of the alluvial aquifer. The model was constructed using the Groundwater Vistas 6 graphical user interface and MODFLOW and comprised:

- a single layer with 1 m x 1 m cells spanning 200 rows and 100 columns;
- a uniform thickness adjusted to match the thickness of the saturated aquifer at each pumping test site;
- constant head cells at rows 1 and 200 of the model with an elevation of 0.0 m and -0.001 m respectively to create a slight gradient across the model under non-pumped conditions;
- a single pumping well placed in the centre of the model grid, and the monitoring bores spaced accordingly; and
- two stress periods, the first for the 100 hour pumping tests and the second for the recovery period.

An automated parameter estimation program (PEST) was used to determine the optimal values of hydraulic conductivity and specific yield in the sand box model. Figure 5-1 shows the measured and modelled drawdowns and the optimised parameters for each monitoring bore site.

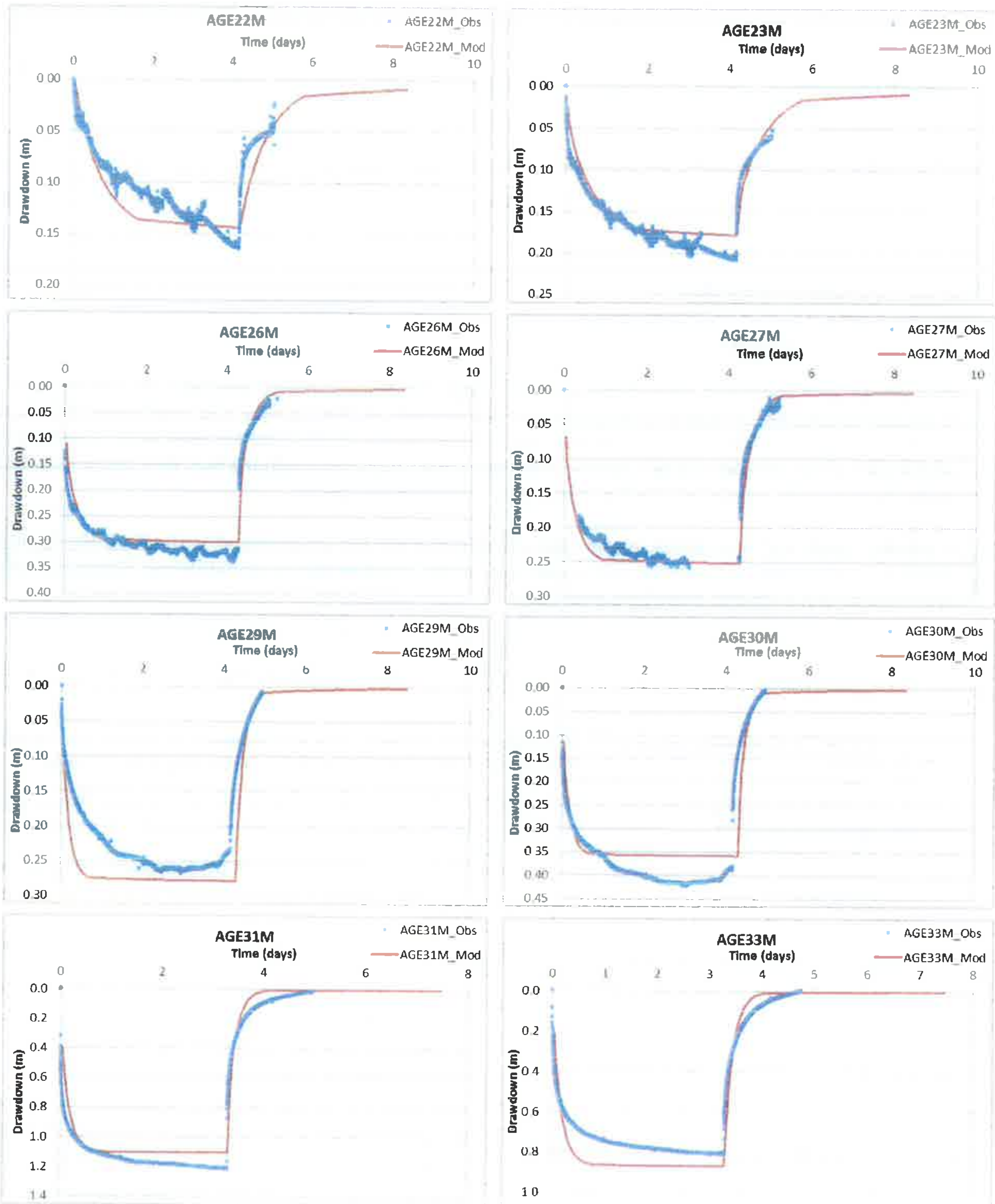


Figure 5-1 Simulated and measured groundwater levels from pumping and recovery tests

The data was also analysed using standard analytical methods (Theis, Cooper-Jacob and Neuman). The "Aquifer Test Version 2.0"[1] software package was used for this task. Table 5-1 summarises the hydraulic properties estimated from the analytical and numerical methods.

Table 5-1 Constant rate test results

Bore ID	Site	Theis		Cooper - Jacob		Neuman		Theis Recovery	Numerical model	
		k	Ss	k	Ss	k	Ss	k	k	Sy
AGE21P	3	106	-	165	-	85.6	-	230	235	19
AGE22M	3	153	19.2	191	12.9	192	9.9	374		
AGE23M	3	171	11.8	171	14.2	214	4.1	286		
AGE24P	1	78.6	-	102	-	70.7	-	110	97.4	5.5
AGE26M	1	1050	0.4	97.2	1.8	108	0.9	82.4		
AGE27M	1	-	0.001	139	0.3	236	0.001	76.9		
AGE28P	4	18.6	-	34.6	-	11.8	-	13.2	102.7	3.7
AGE29M	4	88.2	3.3	80.9	4.5	69.9	5.9	25.7		
AGE30M	4	78.7	1.1	88.2	0.7	73.5	1.5	24.3		
AGE31M	2	67.2	0.6	78.6	0.3	66.1	0.7	45.3		
AGE32P	2	19.2	-	64.9	-	19.9	-	47.9	38.8	2.0
AGE33M	2	65	0.2	78.8	0.05	65.1	2.7	41.1		

Notes: *k – hydraulic conductivity (m/day)*
Ss – storage coefficient (m^{-1} x 100)
Sy – specific yield (%)

[1] Waterloo Hydrogeologic, (1996), *"Aquifer Test Version 2.0"*

Figure 5-2 shows the optimised values compared with the ranges generated from analytical pumping test.

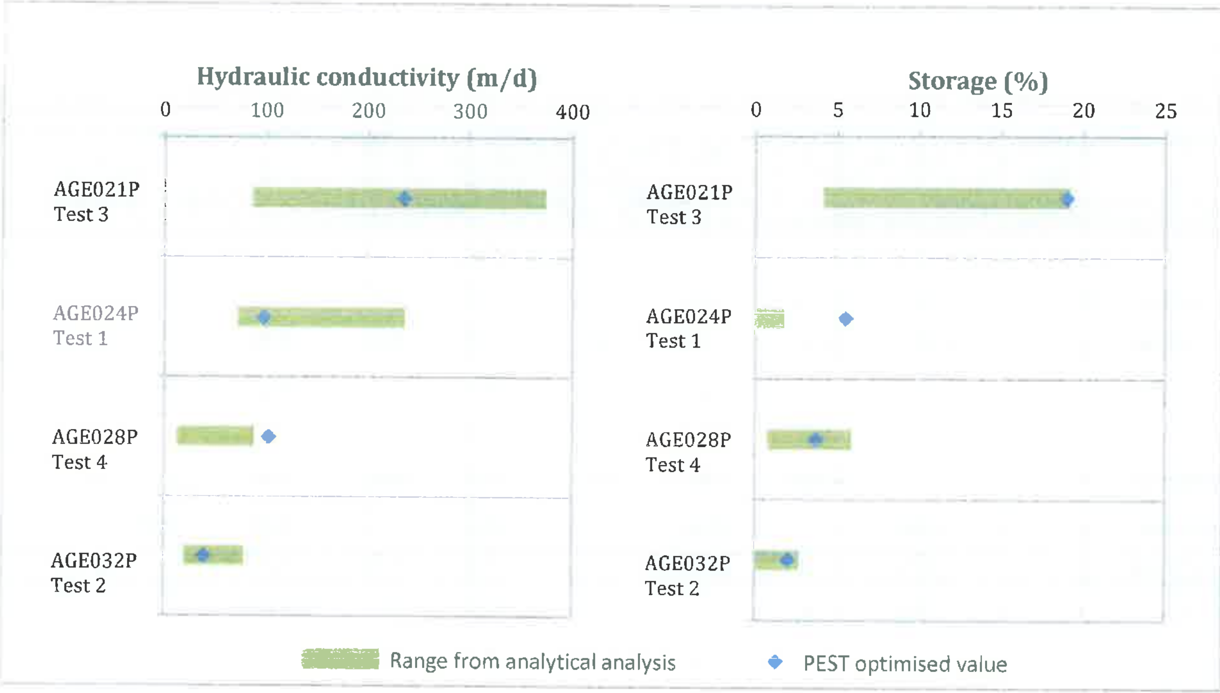


Figure 5-2 Aquifer properties estimated from analytical and numerical methods

The pumping test analyses indicate a high to very high hydraulic conductivity within the alluvial aquifer at each of the sites chosen for the pumping tests. The results are also higher than previous measurements of hydraulic conductivity obtained by conducting rising and falling head tests within the monitoring bores installed within the alluvial aquifer. Figure 5-3 shows graphically the range in hydraulic conductivity measured within each bore installed within the alluvial aquifer as well as the values adopted within the numerical modelling.

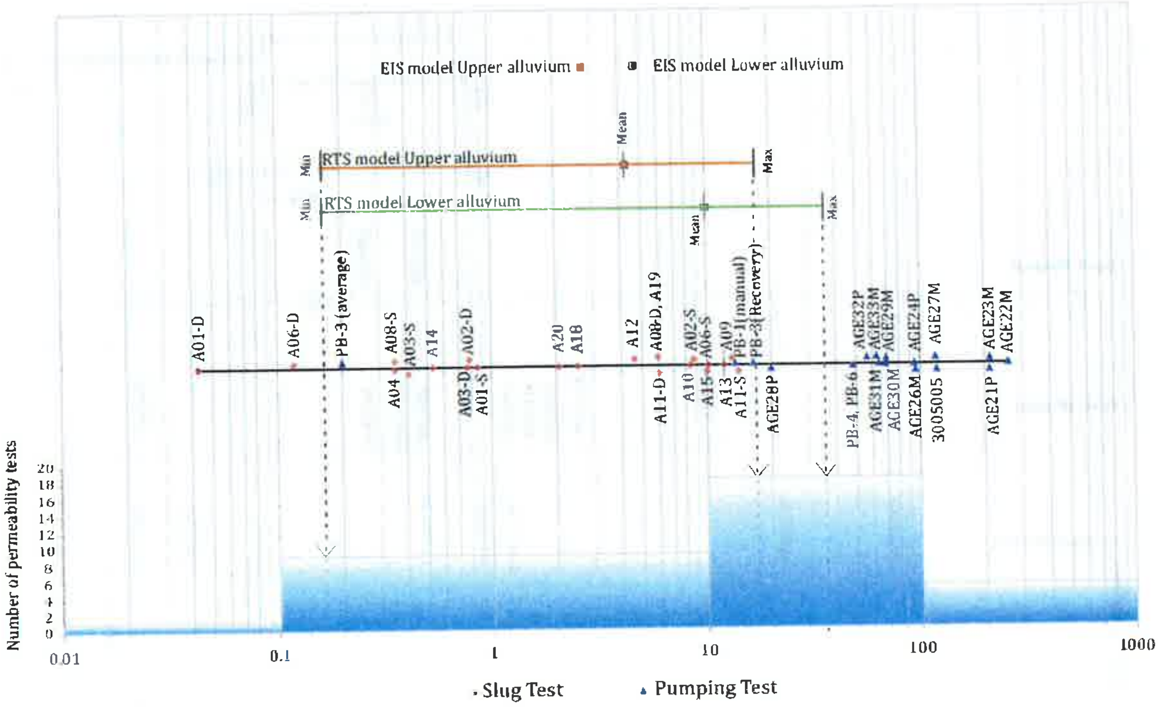


Figure 5-3 Range of hydraulic conductivity estimates within alluvium

The range within the data suggests either, a heterogeneous aquifer system, or the estimate of hydraulic conductivity depends on the testing method chosen. The pumping tests are considered more likely to have captured an appropriate estimate of hydraulic conductivity, as they are less likely to be subject to influences from 'skin effects' that may have retarded the flow of water from the formation during the rising and falling head tests.

Figure 5-3 shows the majority of hydraulic conductivity estimates fall within the range 10 m/day to 100 m/day. Figure 5-3 also shows the hydraulic conductivity range assumed for numerical models developed for the EIS and RTS and indicates the adopted values did not represent the upper end of the data range.

Figure 5-4 shows the range of storage estimates from the alluvial aquifer derived from the pumping test analysis. Like the hydraulic conductivity, the storage estimates show a relatively wide range. Storage is not estimated from the rising and falling head tests, and therefore the adopted methodology potentially does not explain the measured range, with heterogeneity in the aquifer being the only reason. Figure 5-4 also shows the storage range assumed for numerical models developed for the EIS and RTS and indicates, unlike hydraulic conductivity, the adopted values did likely consider an appropriate range based on available data.

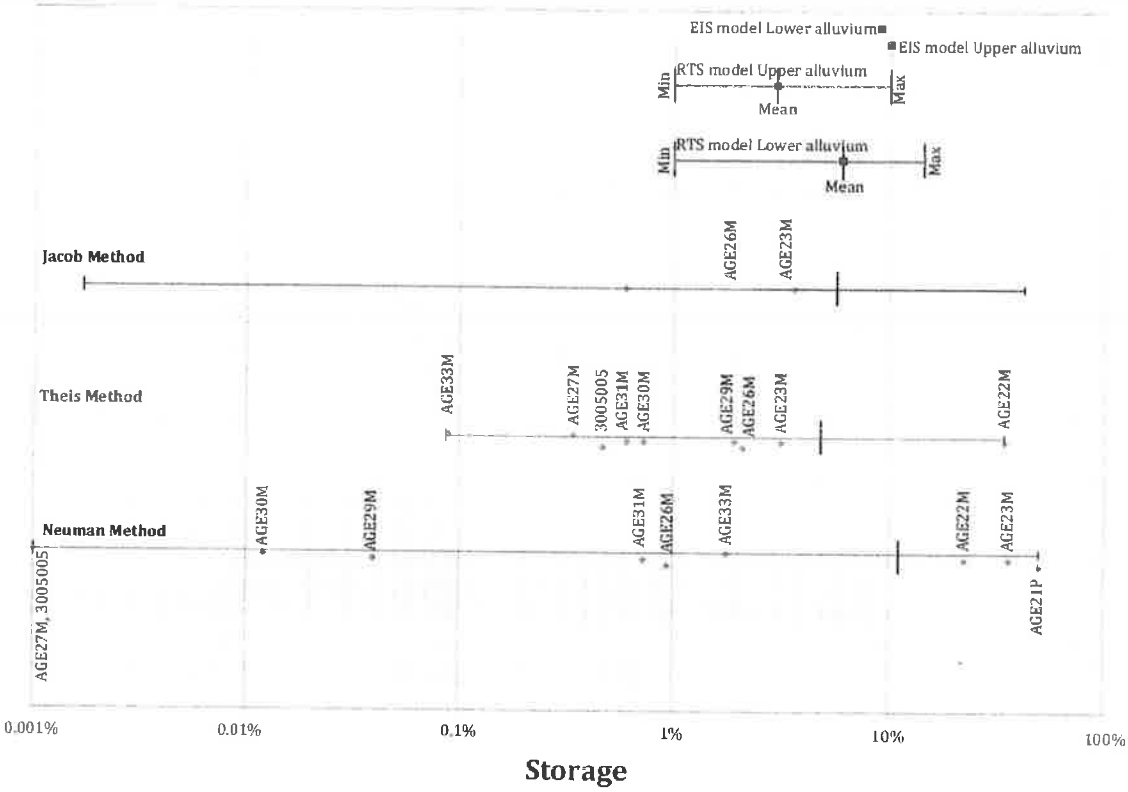
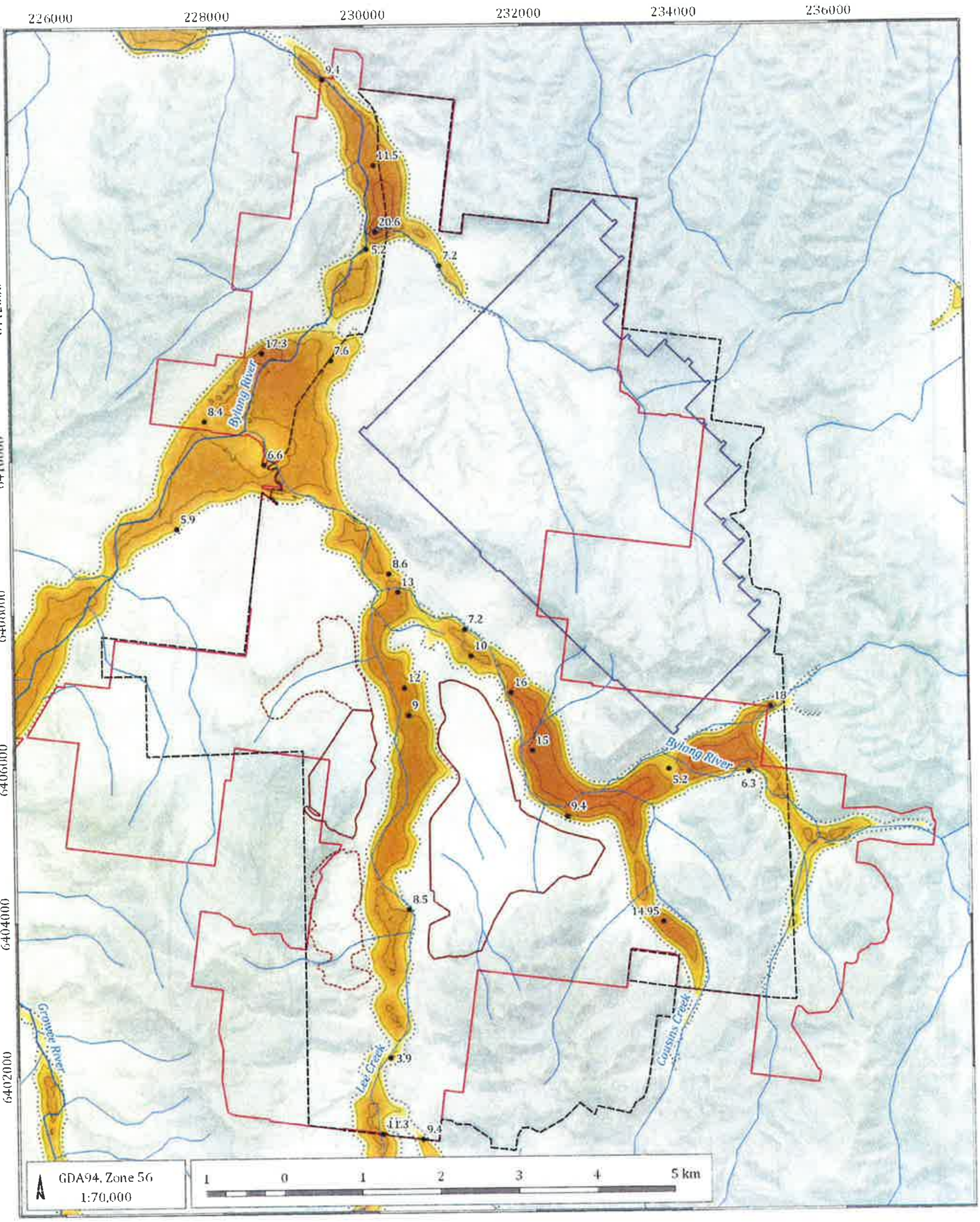


Figure 5-4 Range of storage estimates within alluvium

5.1.2 Alluvium thickness and water budget

As described above, the pumping test program provided further information on the properties of the alluvial aquifer surrounding the open cut mining area. This included estimates of hydraulic conductivity, storage and saturated thickness. The new geological data from drilling the new pumping and monitoring bores was used to update the mapping of the saturated thickness of the alluvial aquifer and to derive a simple water budget for the system.

During the EIS, the thickness of the alluvium was mapped using available borehole data and the limit of the alluvium was determined by Douglas Partners (refer AGE 2016 – Section 6.4). Control points were used where no data existed. The mapped thickness of the alluvium was updated using data from the newly installed pumping and monitoring bores. Figure 5-5 shows the mapped thickness of the alluvial sediments. The thickness of the saturated zone was determined by interpolating water levels measured in March 2016 and subtracting the depth to the water table from the total saturated thickness. A similar figure (Figure 7.1) was provided in the EIS based on information available at that time. The newer information indicates a larger thickness of alluvial sediment, in the Bylong River flood plain to the east of the Eastern open cut mining area. Figure 5-6 shows the mapped saturated thickness within the alluvial aquifer. It highlights the areas of most significant saturated thickness within the Bylong River alluvium occurs between the open cut and underground mining areas.



Open Cut Mining Area
Overburden Emplacement Area
Underground Extraction Area
Project Boundary
KEPCO owned land
Quaternary alluvium
Major drainage
Minor drainage

Interpolated thickness of alluvial sediments (m)

- 1
- 5
- 15
- 22

Interpolated thickness contour of alluvial sediments (m, 5m interval)

Drillholes used for interpolation of alluvial sediments thickness (m)

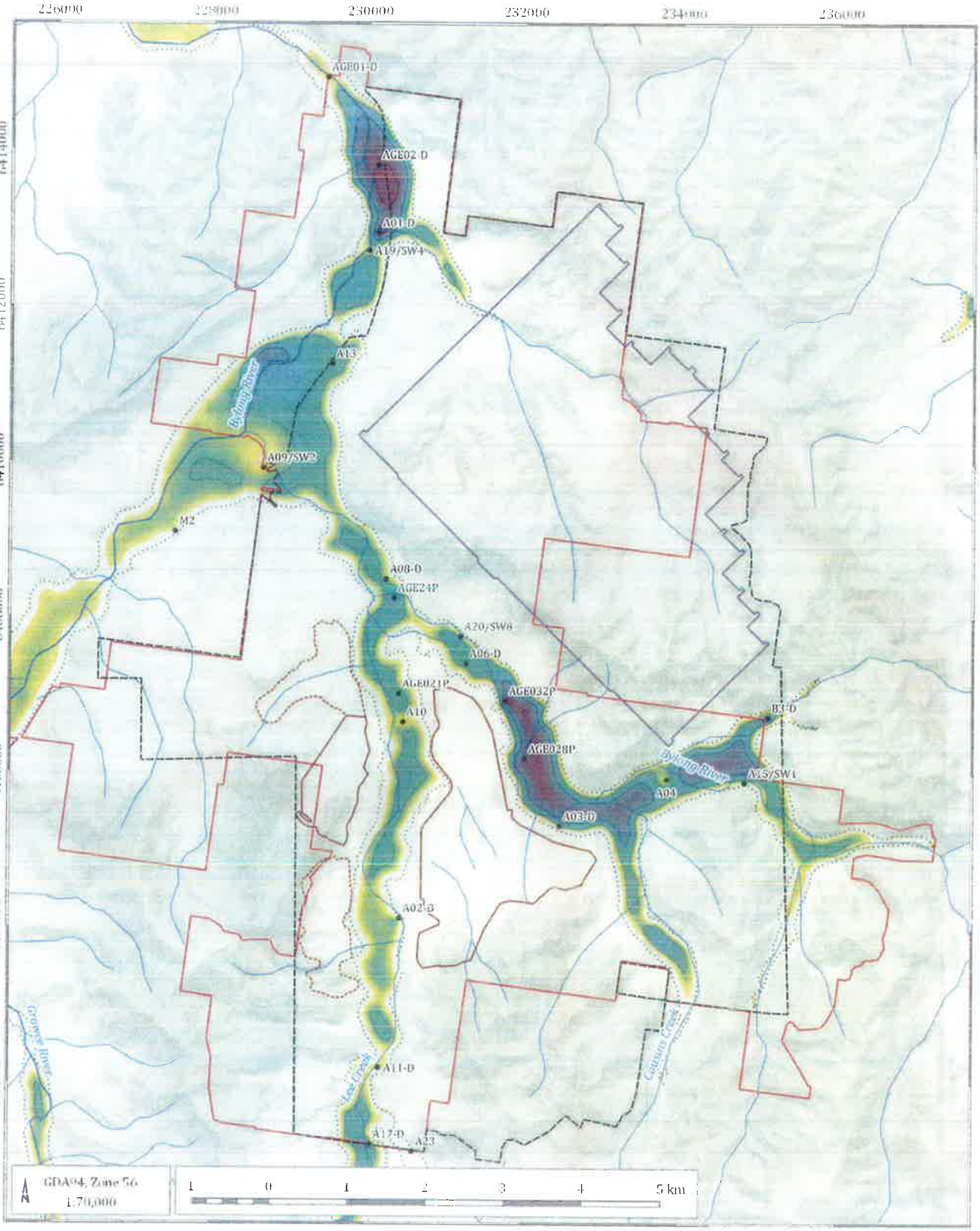
Bylong Coal Project (G1606G)

Revised interpolated thickness of alluvial sediments

AGE

15/07/2016

5-5



Open Cut Mining Area
Overburden Emplacement Area
Underground Extraction Area
Project Boundary
KEPCO owned land
Quaternary alluvium
Major drainage
Minor drainage

Interpolated thickness of saturated alluvial sediments (m)

- 1
- 5
- 10
- 15
- Interpolated thickness contour of saturated alluvial sediments (m, 5m interval)
- Drillholes used for interpolation of alluvial sediments water level

Bylong Coal Project (G1606G)

Revised interpolated saturated thickness of alluvial sediments

15/07/2016

5-6

As discussed, the figures show the maximum saturated thickness occurs within the Bylong River alluvium, particularly east of the open cut mining area, and also in a location downstream of the underground mine where the saturated thickness reaches a maximum of about 16 m. The maps suggest the areas of thicker alluvium are separated by rock bars that effectively create groundwater pools, separated by bedrock highs. The maps indicate that Lee Creek and the Growee River hold significantly less groundwater than the Bylong River with the saturated thickness, varying from around 2 m to 6 m and 2 m to 3 m respectively in each of these systems. This suggests the rock bars that hold back water and promote the collection of groundwater in the Bylong River alluvium, are less prominent in the bedrock underlying Lee Creek in the project area. Growee River is relatively distant from the project area and therefore there is less information on the bedrock morphology.

The mapped saturated thickness was used to estimate the volume of water in storage within the alluvium at March 2016. Rainfall recharge was also estimated using the surface area of the alluvial aquifer and proportions of average annual rainfall. Table 5-2 summarises the water budget for the alluvial aquifer system for March 2016.

Table 5-2 Alluvial aquifer water budget ~ March 2016

Alluvial aquifer	Saturated volume (m^3)	Surface area (m^2)	Estimated volume of water in storage (ML)		Estimated annual recharge (ML/year)	
			5%*	15%*	3%#	20%#
within Project boundary	95,232,427	11,280,780	4,762	14,285	73	1,467
within KEPCO land ownership^	126,741,570	14,808,926	6,337	19,011	96	1,925

Notes: ** assumed specific yield*

 # assumed % of annual rainfall that reaches the water table as recharge – average annual rainfall assumed to be 650 mm (refer AGE [2015] Figure 5.2 EIS)

^ area calculated prior to the acquisition of the Tinka Tong property

The assumed range for specific yield shown in Table 5-2 used to estimate the volume of water in storage was estimated from the results of the pumping test analysis. Table 5-2 shows the volume of groundwater in storage within the alluvial aquifer system within the project area is estimated to range from about 5,000 ML to 14,000 ML. The land owned by KEPCO extends beyond the Project Boundary, and when this increased area is considered the volume in storage within the alluvial aquifer increases to about 6,000 ML to 19,000 ML.

It should be noted that these estimates are based on groundwater levels measured largely in March 2016. Monitoring shows groundwater levels are historically relatively low and during periods of higher rainfall the water levels in storage can increase by 1.5 m to 3 m above the levels measured in March 2016 (AGE 2016). If groundwater levels were to rise by 1.5 m to 3 m the volumes of groundwater in storage would increase by about 20% to 50%.

Table 5-2 shows the potential range in groundwater recharge is wide depending on the proportion of annual rainfall adopted as entering the alluvial aquifer. This indicates rainfall recharge could vary between <100 ML/year and 1,500 ML/year within the Project Boundary, and up to 1,900 ML/year within KEPCOs land ownership.

Table 5-2 demonstrates that the volume of water required from the bore field to account for potential deficits in surface water could exceed the annual recharge rates. Where groundwater extraction exceeds recharge then groundwater is removed from aquifer storage and declines in groundwater levels will occur. However, when recharge rates are higher they are likely to exceed the demand from the bore field, then reduction in aquifer storage would not occur. It is also important to note there are other sources of groundwater recharge to the alluvial aquifers. These are seepage from flows in creeks and rivers, groundwater flow from upstream and flow from the underlying Permian bedrock into the alluvium, which all serve to recharge the alluvial aquifer.

5.1.3 Groundwater levels and recharge

The numerical modelling undertaken for the EIS and RTS utilised a simple soil moisture balance to estimate rainfall recharge rates to the shallow groundwater systems. The EIS utilised daily rainfall measurements from the rainfall gauge installed at the Project, along with data from the Wollar rainfall gauge (BOM station 62032), whilst the RTS used interpolated data from the SILO data source to estimate recharge.

Observations over the baseline monitoring period has indicated small high intensity storm events can move through the catchment resulting in significant variability in rainfall recorded in rain gauges across the catchment. To further estimate recharge, a combination of interpolated SILO data and measurements from the Project rain gauge were used. Figure 5-7 shows the daily rainfall and the periods the soil moisture budget indicates potential for the soil profile to become fully saturated, resulting in recharge to the water table of alluvial aquifer. It was assumed that 40 mm of rainfall excluding evaporation was required to accumulate in the profile for the soil to be fully saturated and promote deep drainage to the water table. Therefore rainfall must exceed evaporation to allow accumulation of water in the soil profile and accumulate over time to 40 mm in total.

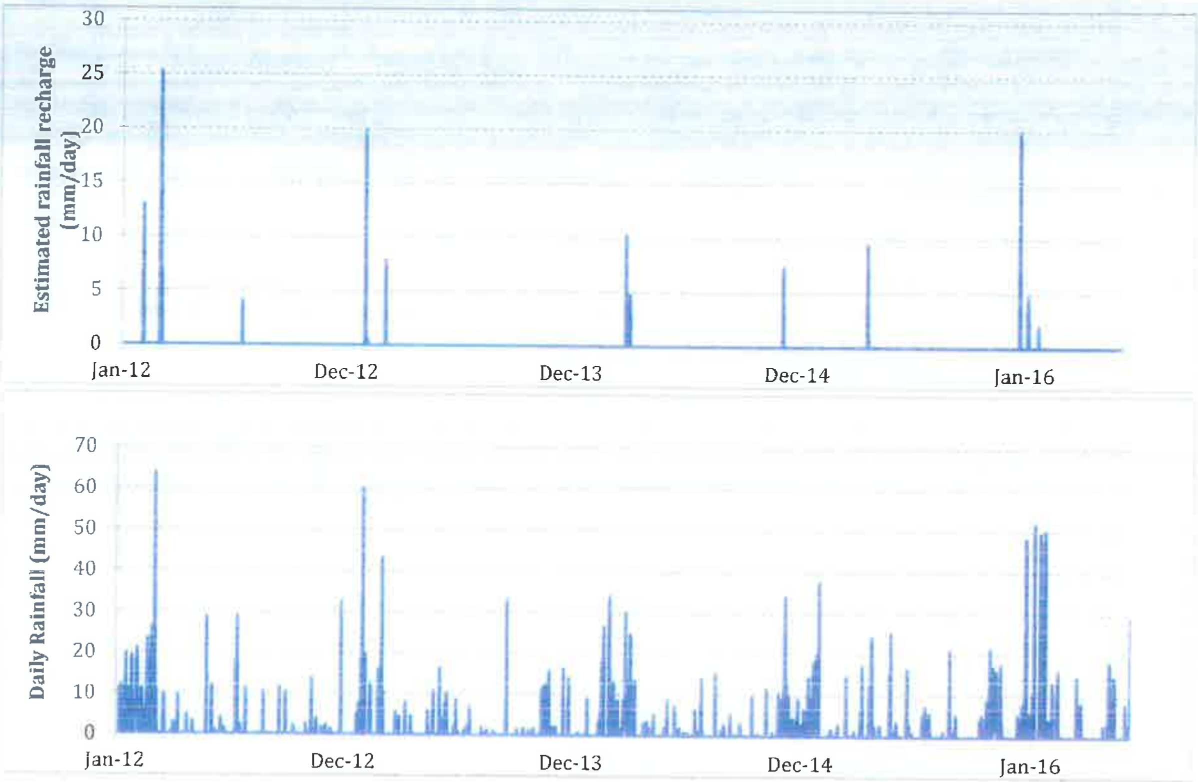


Figure 5-7 Daily rainfall and estimated rainfall recharge events

Figure 5-7 indicates over the baseline monitoring period significant recharge to the alluvial aquifer has generally occurred only during the summer months when rainfall has been sufficient to saturate the soil profile. The figure shows that a significant recharge event appears to have occurred during December 2015 and January 2016. The RTS document reviewed groundwater level data collected up to early December 2015, and therefore did not consider the influence of this recent recharge event. Review of the most recent groundwater monitoring data indicates there has been some recovery in groundwater levels within the alluvial aquifer due to rainfall events in late December 2015 and January 2016. Updated groundwater level hydrographs for bores within the monitoring network are included within Appendix B. Figure 5-8 to Figure 5-10 show groundwater levels recorded within the alluvial aquifer from selected bores over the baseline monitoring period. The RTS document includes a borehole location map (AGE 2016 - Figure 2).

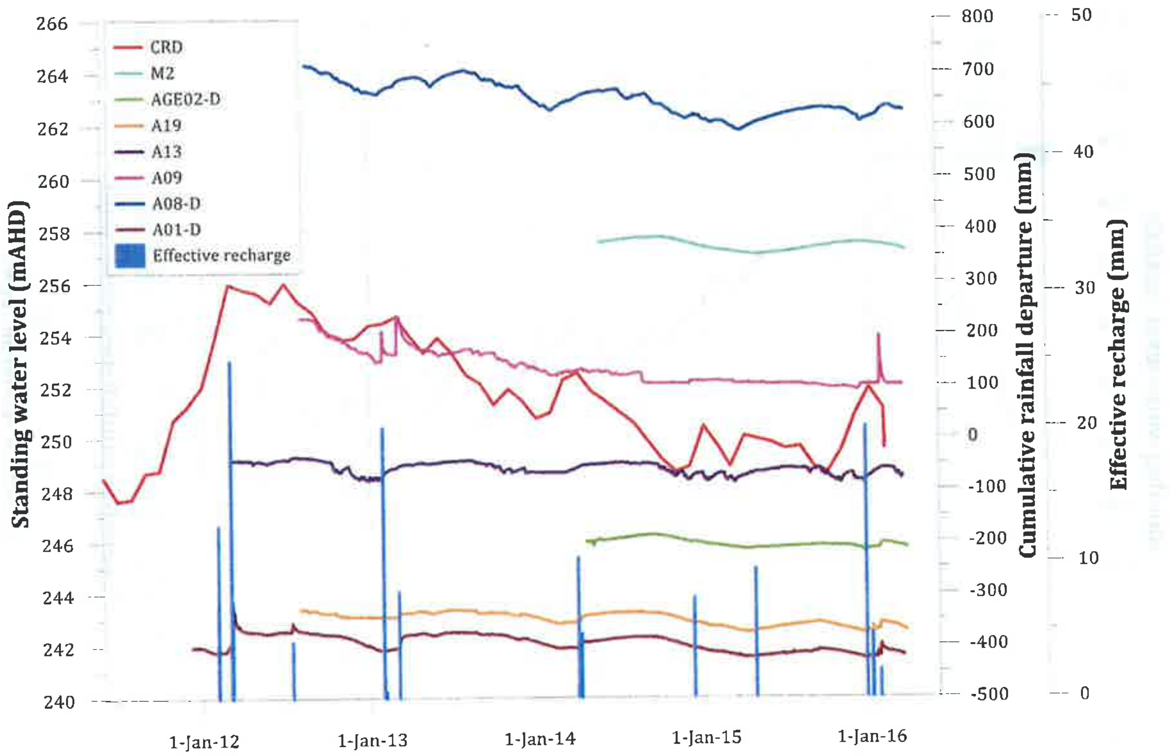


Figure 5-8 **Alluvial aquifer hydrographs – bore located down stream of proposed open cut mining area**

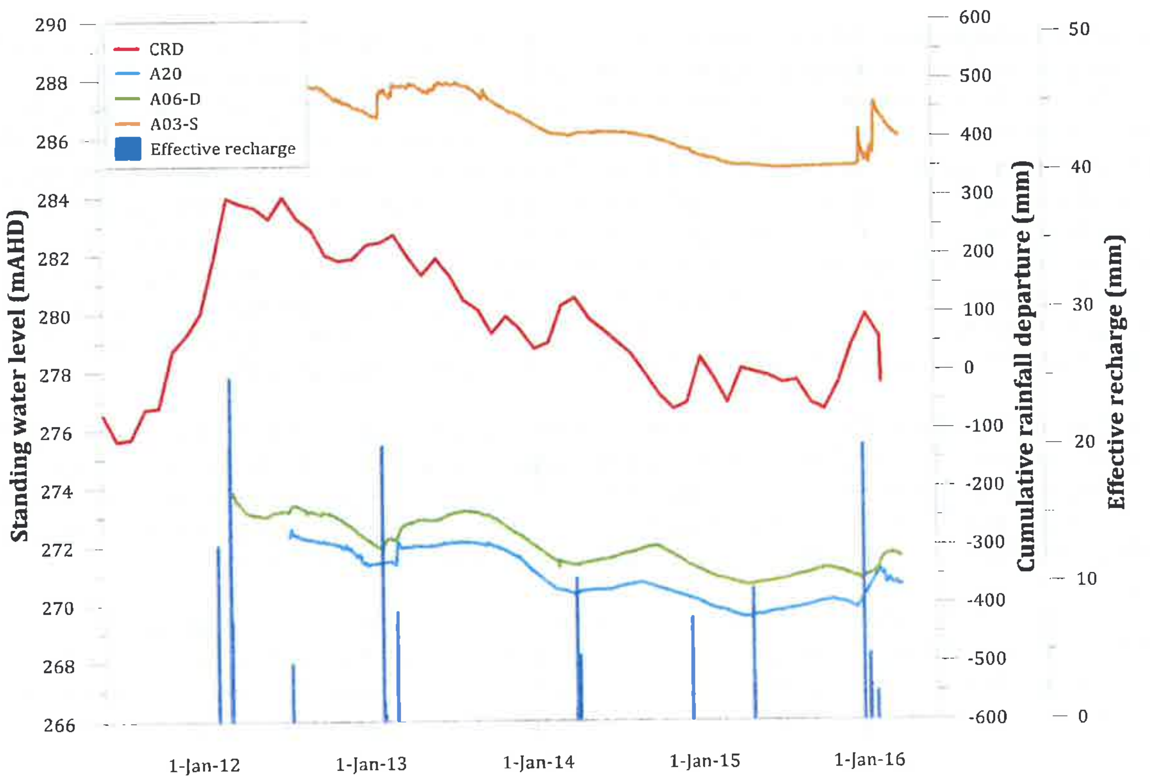


Figure 5-9 **Alluvial aquifer hydrographs – within Bylong River alluvium adjacent to proposed open cut mining area**

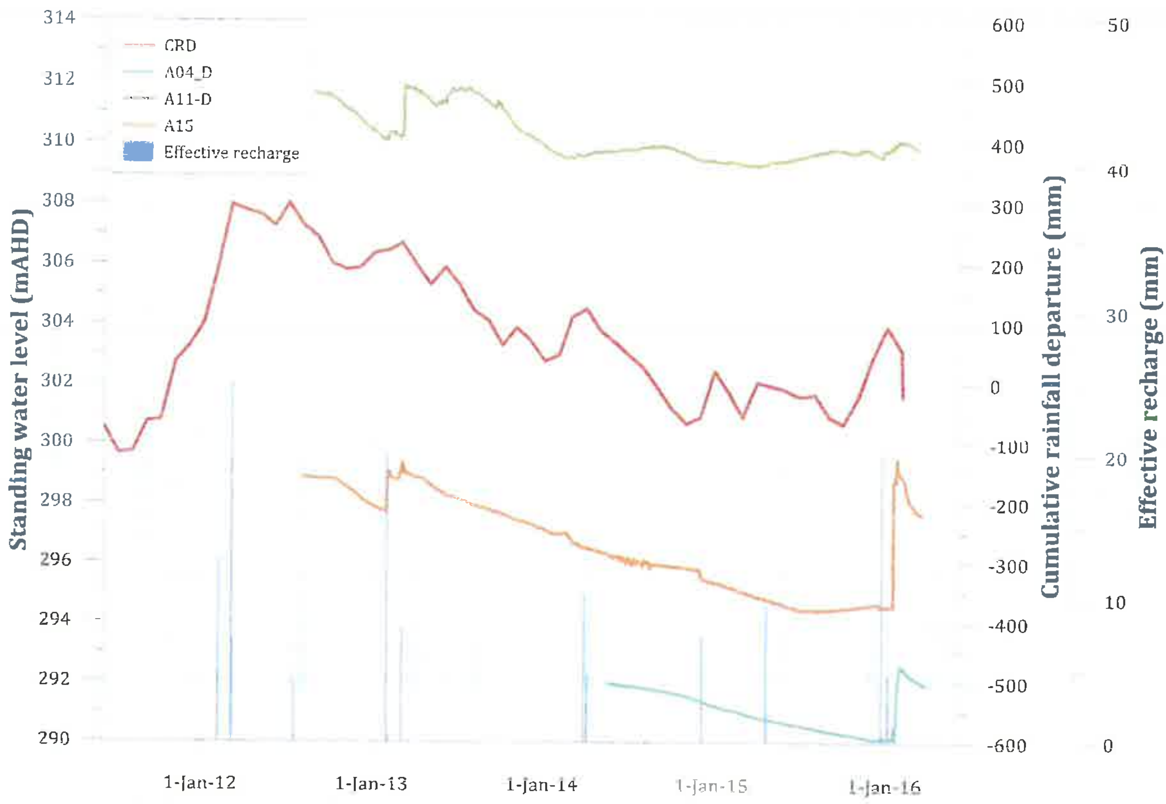


Figure 5-10 Alluvial aquifer hydrographs- up stream of proposed mining areas

The hydrographs generally show rising groundwater levels when rainfall recharge has been estimated, indicating estimates of recharge using the soil moisture spreadsheet are appropriate. The monitoring bores show a variety of responses to the rainfall event in December 2015 and January 2016. At some bores, water levels increased slowly over a period of about three weeks, where as in others water levels increased rapidly over a period of 24 hours. The most rapid response was recorded upstream of the proposed mining area in bores A15 that is located within relatively close proximity to the Bylong River which recorded a 4 m rise in water level on 15 January 2016. The rapid rise in water levels can only be explained by recharge to the alluvial aquifer due to seepage through the bed of the Bylong River. Interestingly other bores peaked about nine days later rising between 1 m and 2 m in a day (eg. A20, A09). These bores are located downstream of bore A15, suggesting runoff from the upstream catchments recharges the groundwater systems further downstream.

A much slower and gradual rise in groundwater levels was observed in other bores more distant from the rivers and creeks for example A08D and A04, suggesting rainfall recharge, or down valley flow as the primary recharge mechanisms. Using the assumptions for recharge presented previously in Table 5-2 and assuming an average water level rise of 1 m within the alluvial aquifer indicates the recharge observed in January 2016 would range from about 600 ML to 1,700 ML.

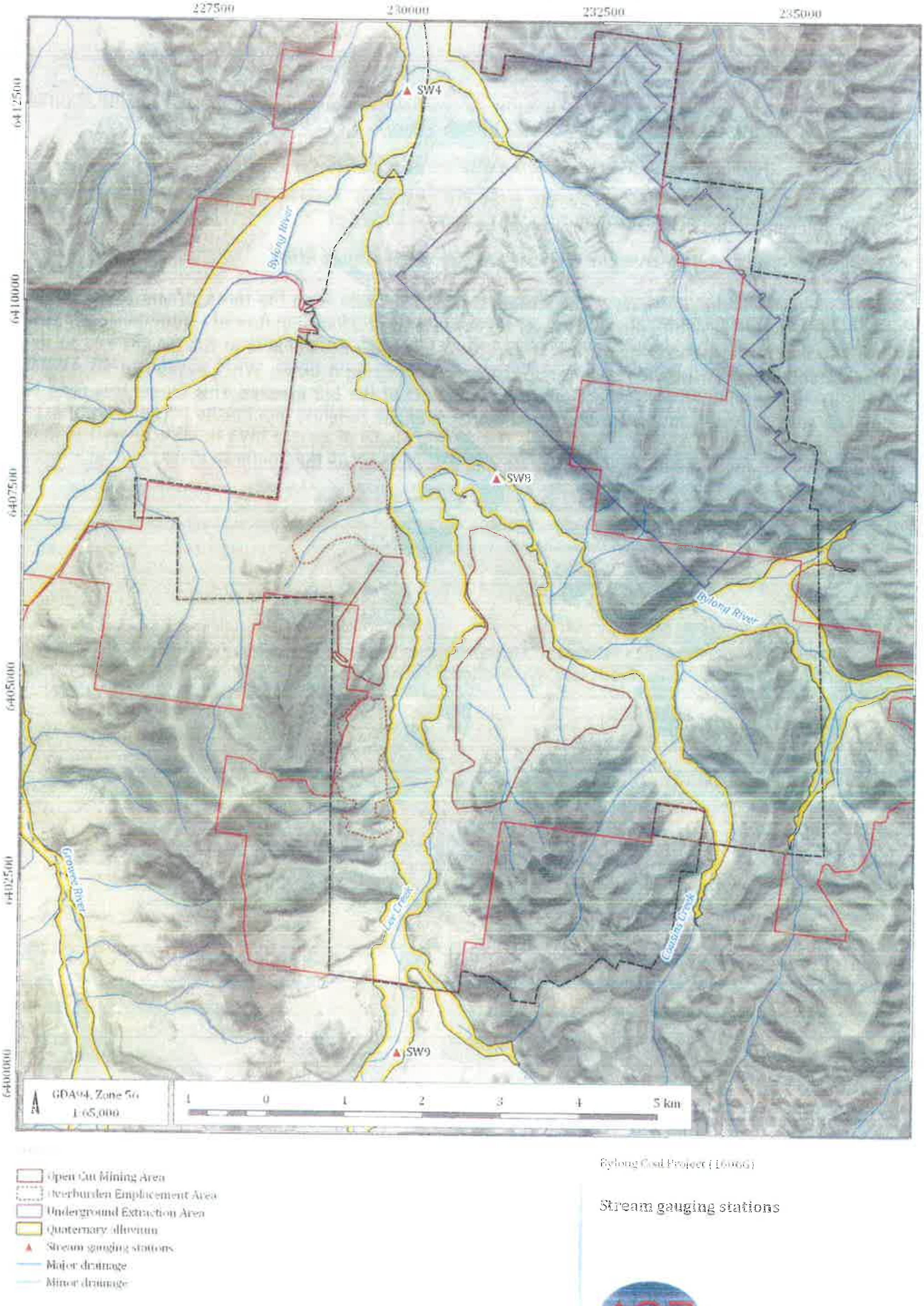
Section 6.3.2 describes how the rainfall recharges from the soil moisture spreadsheet were used to calibrate the groundwater model to the baseline data. Section 6.4.2 describes the assumptions used when determining rainfall recharge rates for the predictive model representing the proposed mining activities.

5.1.4 *Streamflow*

KEPCO have installed stream gauges to monitor stream flow levels, volumes and water quality at three sites within the Study Area. The gauges are located as follows:

- SW4 – Bylong River downstream of the confluence with Growee River;
- SW8 - Bylong River downstream from the proposed Eastern Open Cut Mining Area and adjacent to the proposed underground extraction area; and
- SW9 - Lee Creek upstream of the proposed Open Cut Mining Areas.

Figure 5-11 shows the locations of the stream gauges. The data from the three stream gauges show that the river systems within the Study Area are ephemeral, and have not flowed continuously over the baseline monitoring period. Measuring stream flow has been problematic at the gauges due to the intermittent flows. To provide a continuous estimate of stream flows, WRM developed an AWBM rainfall runoff model for the Project catchments as part of the EIS process. This model was used to simulate surface water flow within the catchments over the baseline monitoring period. Figure 5-12 shows the stream flow events simulated by the AWBM model at gauges SW4 to SW9, as well as flow recorded by the government stream gauge located downstream on the Goulburn River.



Bylong Coal Project (1606G)

Stream gauging stations

15/07/2016 **5-11**

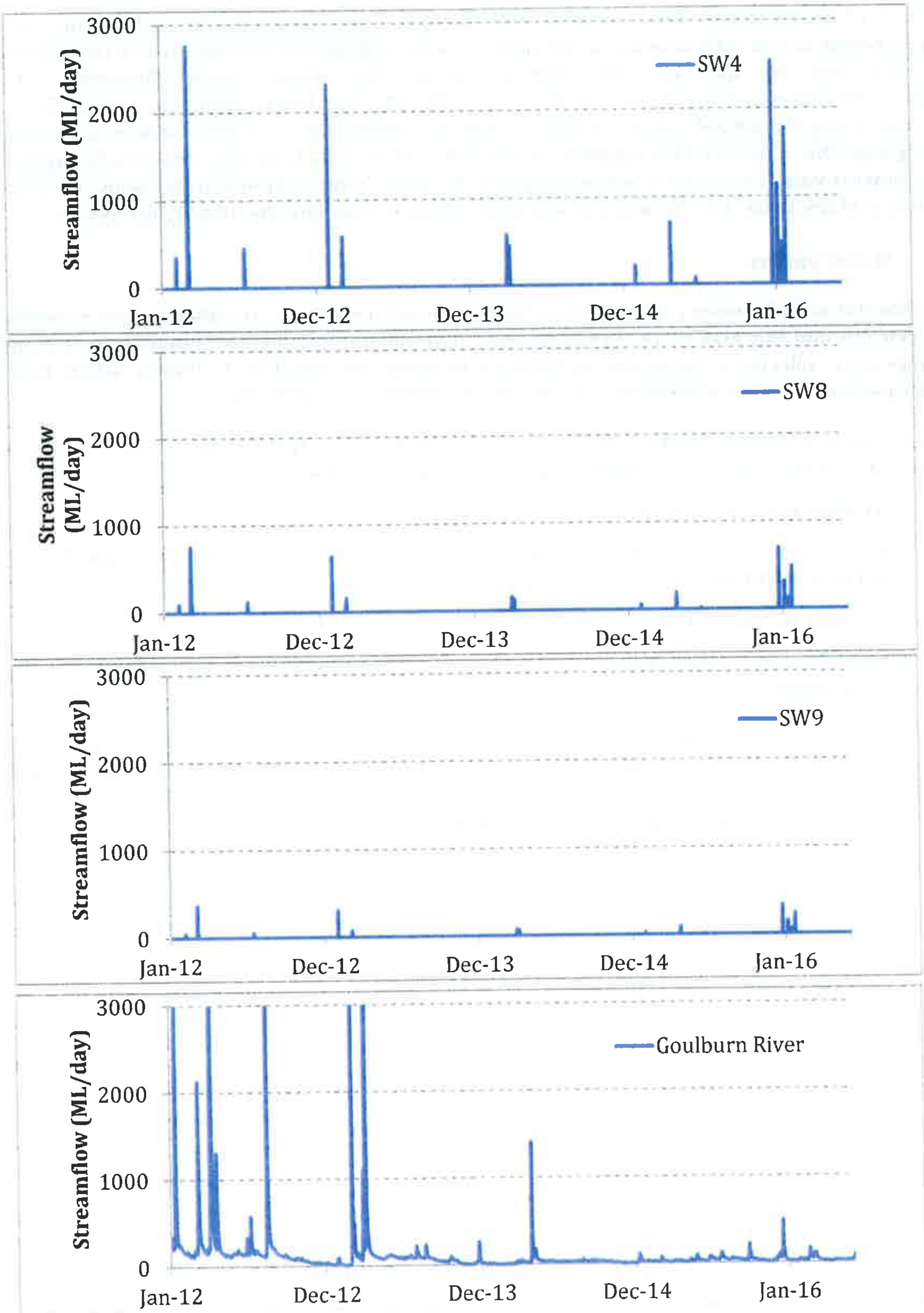


Figure 5-12 Stream flow hydrographs

Figure 5-12 shows stream flows increase with distance downstream as the contributing catchment area increases. At site SW8 adjacent to the open cut and underground mining areas stream flow events occur for only one day, with five separate stream flow events during December 2015 and January 2016, ranging from about 100 ML/day to 700 ML/day. Interestingly the stream flow events predicted using the AWBM model are higher than streamflow observed downstream at the Goulburn River gauge (No. 210006). This suggests streamflow is lost as recharge into the alluvial aquifers as it flows downstream. This is not unexpected given the water table is known to be below the bed of the streams in many areas, and therefore would allow water to flow into the underlying aquifer.

5.1.5 Water quality

Groundwater samples were collected from the eight monitoring bores installed for the pumping trials between 4th and 9th May 2016. Sampling was undertaken after the test pumping was completed. Samples were collected using an electro-submersible pump and low-flow technique, where field water quality parameters were allowed to stabilise before samples were collected.

Samples were analysed by Australian Laboratory Services in Sydney for a suite of parameters consistent with the baseline groundwater assessment and included:

- pH, electrical conductivity (EC) and turbidity;
- major cation / anions (calcium, magnesium, sodium, potassium, chloride, sulphate, alkalinity and ionic balance);
- nutrients (nitrate, nitrite, ammonia and total phosphorous); and
- dissolved metals (beryllium, barium, cadmium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, vanadium and zinc).

Table 5-3 presents the results of the laboratory analyses. The samples recorded neutral pH values ranging between 7.25 and 7.43. The EC measurements indicated relatively fresh water ranged from 395 µS/cm to 1670 µS/cm. The samples indicate the water is suitable for livestock, and potable in some locations, but with palatability issues at AGE26M and AGE27M.

Table 5-3 Groundwater analysis results

			Sample ID	AGE22M	AGE23M	AGE26M	AGE27M	AGE29M	AGE30M	AGE31M	AGE33M
			Sample date	09/05/2016	09/05/2016	09/05/2016	09/05/2016	05/05/2016	05/05/2016	04/05/2016	04/05/2016
Analyte	Units	LOR	ANZECC guidelines - livestock								
Physical properties											
pH Value	pH Unit	0.01		7.33	7.25	7.40	7.36	7.39	7.42	7.40	7.43
Electrical Conductivity @ 25°C	µS/cm	1		644	640	1370	1670	395	401	459	447
Cation / Anions											
Hydroxide Alkalinity as CaCO3	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	mg/L	1		172	164	319	324	132	135	157	149
Total Alkalinity as CaCO3	mg/L	1		172	164	319	324	132	135	157	149
Sulfate as SO4 - Turbidimetric	mg/L	1		59	60	62	107	9	9	10	11
Chloride	mg/L	1		58	58	234	308	38	38	42	42
Calcium	mg/L	1		46	47	81	101	21	21	26	25
Magnesium	mg/L	1		28	29	57	77	17	17	20	20
Sodium	mg/L	1		48	41	118	130	31	31	35	34
Potassium	mg/L	1		4	4	6	7	4	4	3	3
Ionic Balance	%	0.01		3.73	3.56	0.87	0.52	<0.01	0.76	0.13	0.65
Dissolved Metals											
Aluminium	mg/L	0.01	5	0.02	0.02	<0.01	<0.01	0.01	<0.01	0.01	0.02
Arsenic	mg/L	0.001	0.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

			Sample ID	AGE22M	AGE23M	AGE26M	AGE27M	AGE29M	AGE30M	AGE31M	AGE33M
			Sample date	09/05/2016	09/05/2016	09/05/2016	09/05/2016	05/05/2016	05/05/2016	04/05/2016	04/05/2016
Analyte	Units	LOR	ANZECC guidelines - livestock								
Beryllium	mg/L	0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	mg/L	0.001	-	0.120	0.101	0.076	0.088	0.021	0.027	0.035	0.030
Cadmium	mg/L	0.0001	0.01	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	mg/L	0.001	1	0.001	<0.001	0.001	0.001	<0.001	<0.001	0.002	0.001
Copper	mg/L	0.001	1	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	mg/L	0.001	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	-	0.177	0.025	0.096	0.133	0.105	0.092	0.281	0.211
Nickel	mg/L	0.001	1	0.002	0.005	0.002	0.002	0.002	0.002	0.002	0.002
Selenium	mg/L	0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	mg/L	0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.005	20	0.008	0.006	<0.005	<0.005	0.005	<0.005	<0.005	0.019
Iron	mg/L	0.05	-	0.24	<0.05	<0.05	<0.05	<0.05	0.07	0.18	0.13
Mercury	mg/L	0.0001	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nutrients											
Ammonia as N	mg/L	0.01	-	0.02	<0.01	<0.01	<0.01	0.01	0.02	0.04	0.04
Nitrite as N	mg/L	0.01	9.1	<0.01	<0.01	0.03	0.04	<0.01	<0.01	<0.01	<0.01
Nitrate as N	mg/L	0.01	90.3	0.91	1.50	0.42	0.87	0.04	0.04	0.03	0.03
Nitrite + Nitrate as N	mg/L	0.01	99.4	0.91	1.50	0.45	0.91	0.04	0.04	0.03	0.03
Total Phosphorus as P	mg/L	0.01	-	0.05	0.05	0.10	0.08	0.02	0.03	0.03	0.04

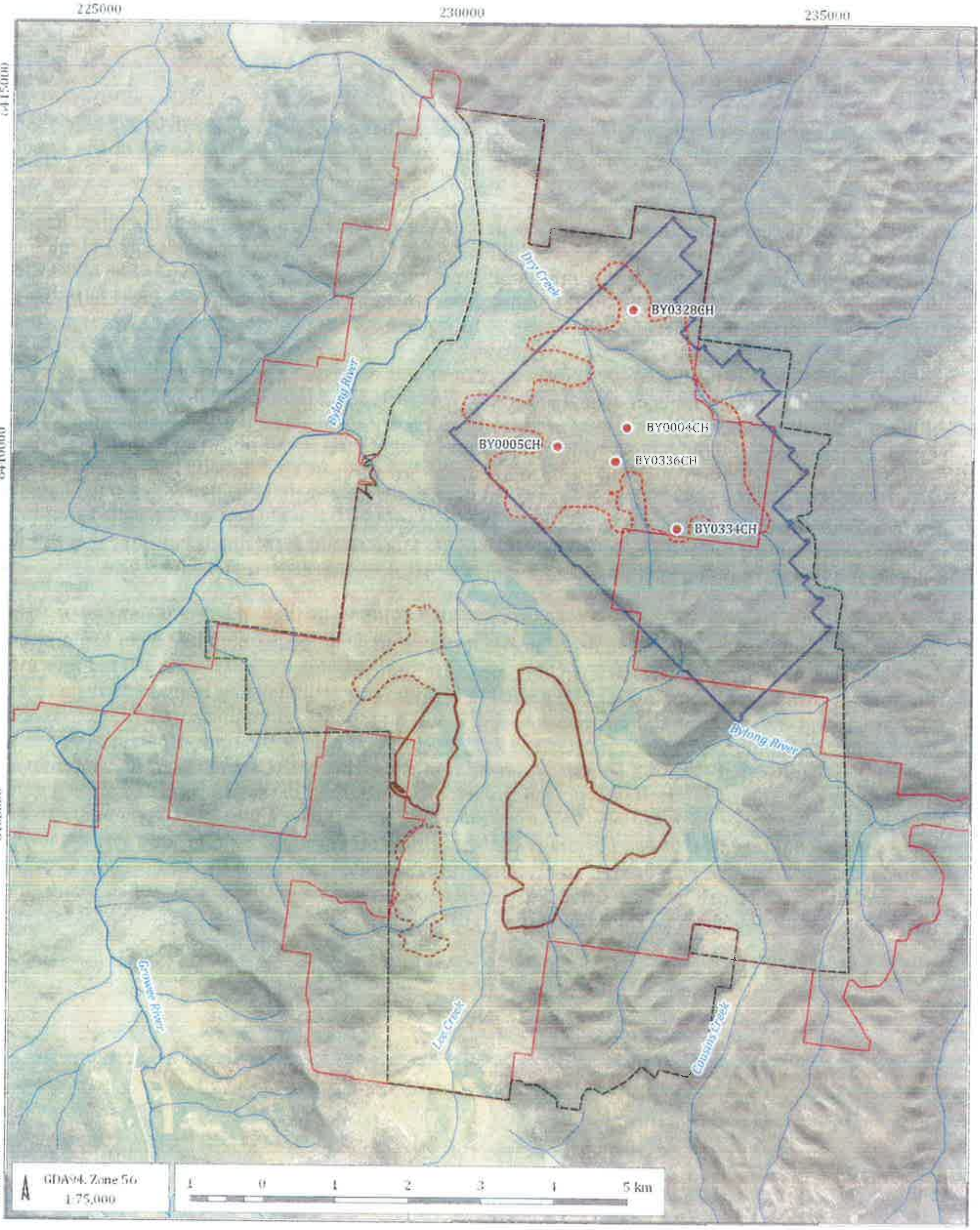
5.2 Tertiary basalt

Tertiary basalt flows occur as capping overlying Triassic sediments of the Narrabeen Group above the area where longwall mining is proposed. Exploration drilling indicates the thickness of the basalt averages 25 m.

KEPCOs geologists conducted field mapping as part of the exploration program and identified basalt outcrops occurring predominantly along creek lines on top of the plateau where underground mining is proposed and along Dry Creek. Colluvium comprising a proportion of basalt material often makes up the overburden lithological material in the valley areas. In some drill holes igneous rocks have been identified beneath weathered coal layers.

In the RTS, the potential for the basalt to form an aquifer was discussed using water level data collated across a vertical profile of units at a single location. This included a monitoring bore that is screened within the basalt (BY0091-B). This bore was found to be dry throughout the three year monitoring period. It is currently the only monitoring bore screened within the basalt unit. The RTS also referred to a deeper bore (BY0091-S) installed in the State Mine Formation, located directly beneath the basalt. Water level information from this bore, relative to the base of the basalt, indicated that the basalt was dry in the monitored area. The RTS concluded the basalt could potentially become partially saturated in areas where the base of the basalt is below 328 m RL. More recent assessment indicates that this is unlikely and that the basalt probably remains wholly unsaturated, as discussed below.

To further confirm the basalt does not form a permanent aquifer, the limited basalt groundwater data was augmented by reviewing and interpreting geophysical logging results obtained from exploration drill holes that penetrated the basalt. Five bore logs with sonic logging were assessed. These logs were run in open cored exploration holes. The principle of sonic (acoustic) logging requires that there be fluid present in the bore for the technique to work and a response to be measured. Therefore, the depth where the sonic log begins indicates the fluid level in that hole at the time. A potential problem with this method is that the fluid level may not be representative of the standing groundwater level due to the use of drilling muds. However, conservatism is introduced because a recorded drilling mud level would most likely be more elevated than the equilibrium water table level. It should also be noted that the fluid levels if at equilibrium with the groundwater systems represent an average levels controlled by the relative water levels in all water-bearing units intersected by the borehole because they are uncased. Each bore was drilled to between approximately 100 m and 200 m below the surface. A location plan for the exploration bores is presented as Figure 5-13.



Open Cut Mining Area
Overburden Emplacement Area
Underground Extraction Area
Project Boundary
Kepco owned land
Basalt extent
Exploration bore
Major drainage
Minor drainage

Bylong Coal Project (G1606G)

Location of exploration bores with sonic logs

15/07/2016 **5-13**

The water levels from the sonic logs were compared against the inferred groundwater levels and the base of the basalt to investigate the vertical relationship. In all cases, the base of the basalt was recorded as being above the fluid level, indicating the basalt is likely to be unsaturated. Table 5-4 presents the water level data. The smallest height difference between base basalt and fluid level is observed in bore BY0328CH. This is expected as the bore is located in a relative topographic low.

Table 5-4 Sonic-inferred fluid levels and logged basalt horizons

Bore ID	Sonic start (mbgl)	Top basalt (mbgl)	Bottom basalt (mbgl)	Top borehole elevation (mRL)	Sonic water level start (mRL)	Top basalt (mRL)	Bottom basalt (mRL)
BY0004CH	80.5	1	39.5	370.88	290.38	369.88	331.38
BY0005CH	92	1	23.8	356.00	264.00	355.00	332.20
BY0328CH	38	6	35	342.17	304.17	336.17	307.17
BY0334CH	116	1	10	404.41	288.41	403.41	394.41
BY0336CH	36	5	11	339.78	303.78	334.78	328.78

The RTS concluded that additional monitoring bores would be required to fully define the saturated and unsaturated characteristics of the basalt. These bores would target potentially deeper and thicker zones within the basalt where there is potential for groundwater to occur. The floor of the basalt appears to generally conform with the topography and therefore the highest potential for statured zones was considered likely to be in topographically lower lying areas.

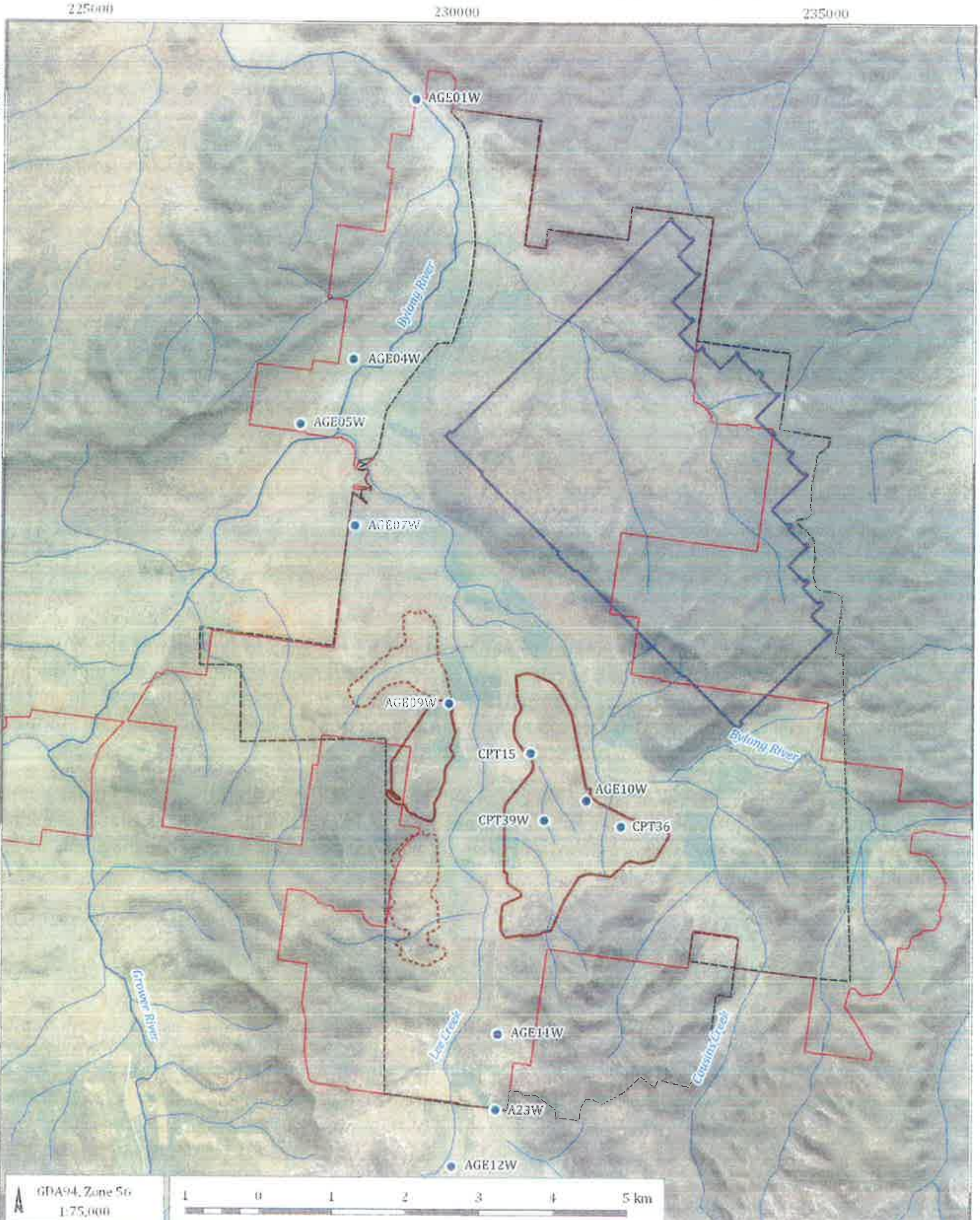
A methodology for installation of additional bores will be documented within the Water Management Plan. At this stage, however, the conceptual hydrogeological model for the basalt is that it remains unsaturated although may support short-term perching as part of normal recharge mechanisms as rainfall drains to deeper units.

5.3 Permian / Triassic

5.3.1 Weathered zone

The weathered zone and its hydraulic properties have been investigated and assessed largely due to its potential impact on groundwater ingress to the proposed open cut mine areas. The unit underlies the alluvium and will act as a pathway for flow from the alluvium to the proposed open cut mining areas in some parts. Section 4.4.1 of the RTS document presented further information on the weathered zone. The report provided thickness maps of the units and discussed the conservatism of assigned hydraulic properties used in the model. Subsequent stakeholder submissions requested further information regarding the aquifer properties of the weathered zone to increase the understanding of the potential for it to yield groundwater to the open-cut mining areas.

During the early stages of groundwater investigations for the Project, a network of monitoring bores were installed into the weathered zone. The bores with the prefix AGE, and suffix W (e.g. AGE01W) were located to measure hydraulic properties and monitor groundwater levels adjacent to potential open cut mining areas, and to understand the potential for the weathered zone to indirectly connect the mining areas with the alluvial aquifer. Figure 5-14 shows the location of AGE_W series and other bores installed within the weathered zone. The bores were relatively wide spread as other potential open cut mining areas were being considered at that time.



Open Cut Mining Area
Overburden Emplacement Area
Underground Extraction Area
Project Boundary
Kepco owned land
Monitoring bore
Major drainage
Minor drainage

Bylong Coal Project (G1606G)

Monitoring bores targeting weathered zone

15/07/2016 **5-14**

Douglas Partners (DP) supervised the drilling of the bores and carried out rising head tests to estimate hydraulic conductivity. Each rising head test was performed three times in each respective well to allow an average hydraulic conductivity to be assessed. Figure 5-15 presents the measured range in hydraulic conductivity obtained from this assessment as a box and whisker plot.

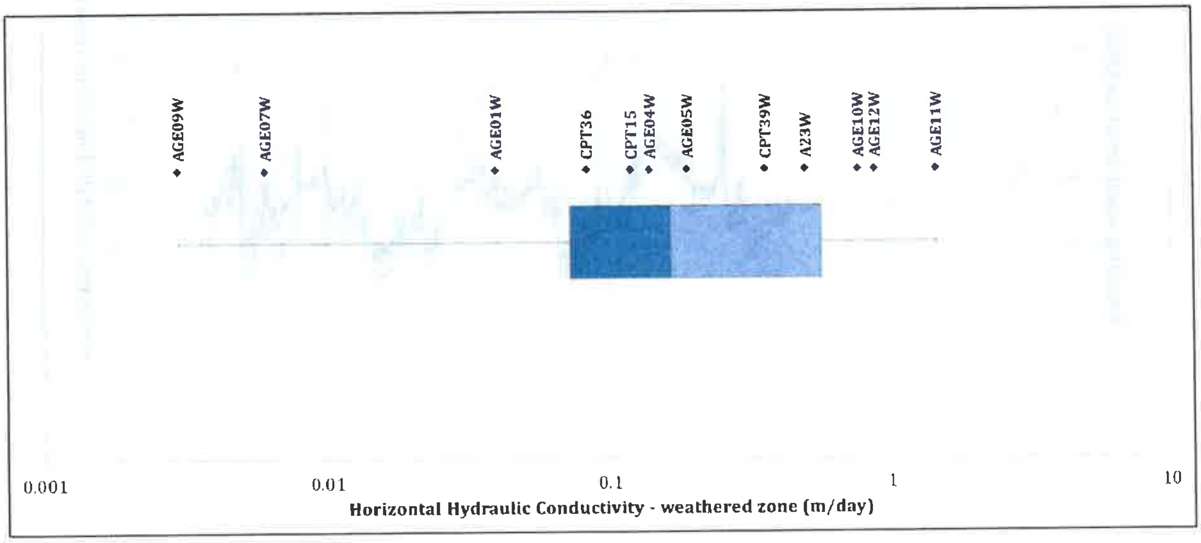


Figure 5-15 Weathered zone hydraulic conductivity range

The plot shows that values for hydraulic conductivity range over three orders of magnitude. This is to be expected given the heterogeneity of the weathered zone, related to the weathering and associated changes in mineralogy, particularly the formation of clays. The 0.003 m/day to 1.46 m/day range is characteristic of a silt to silty sand type lithology and is several orders of magnitude lower than that assessed for the alluvium. The majority of the test results fall within the 0.1 m/day to 1.0 m/day range (0.2 m/day was used for the unit in the numerical model). There is no clear geographic trend in the hydraulic conductivity estimates across the Project Boundary.

Figure 5-16, Figure 5-17 and Figure 5-18 below present groundwater level measurements from a subset of the weathered zone monitoring bores. Each figures presents groundwater levels from pairs of bores, where one bore is screened within the weathered zone, and the other within the overlying alluvial aquifer. These paired bores allow the water level fluctuations within weathered zone and alluvium to be compared.

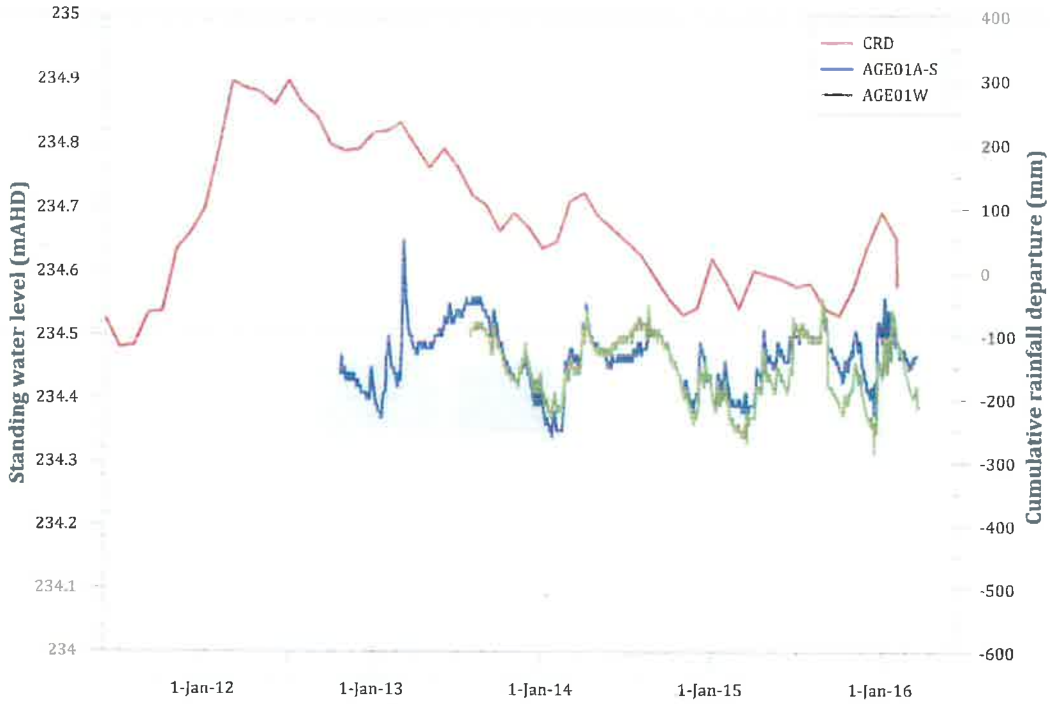


Figure 5-16 Groundwater levels – AGE01A-S and AGE01W

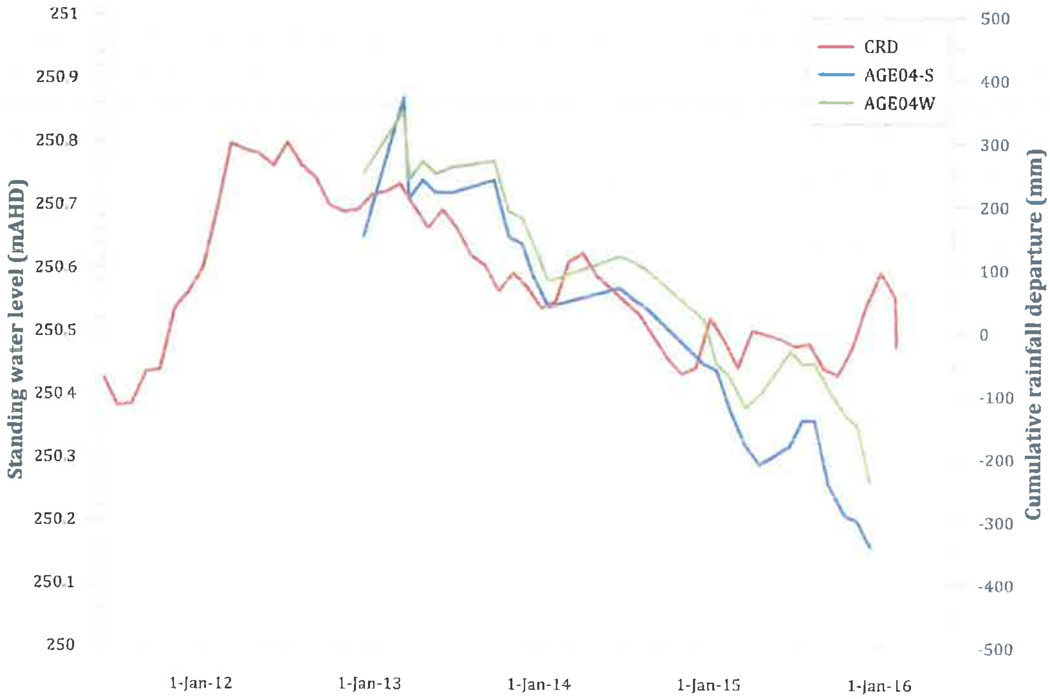


Figure 5-17 Groundwater levels – AGE04-S and AGE04W

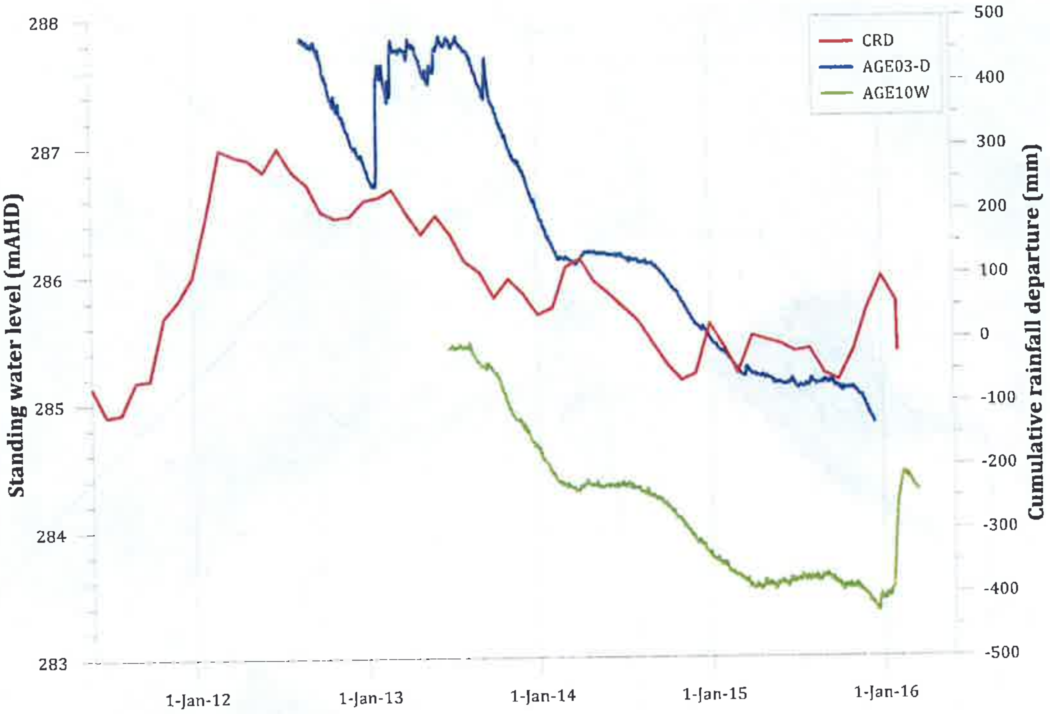


Figure 5-18 Groundwater levels – AGE03-D and AGE10W

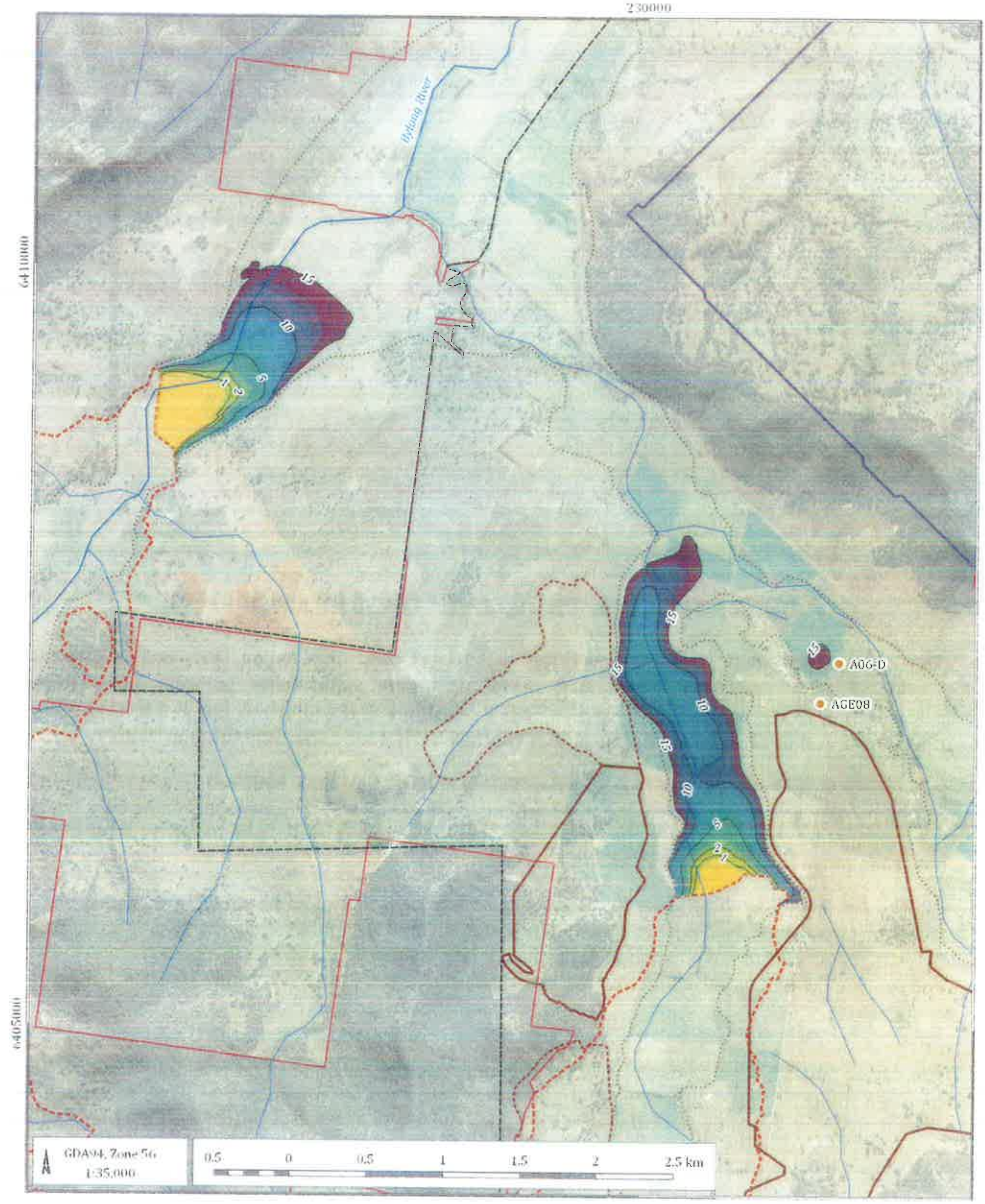
The hydrographs show similar water levels and trends over time within the alluvium and the weathered zone indicating a relatively direct hydraulic connectivity between these units. The exception is AGE10W which records similar fluctuations to the alluvium, but at a level of about 1 m below the alluvial water level. This bore is approximately 1 km away from the alluvial bore.

The results of the field investigations and monitoring indicate that the weathered zone is in hydraulic continuity with the alluvium and will yield groundwater seepage to the open cut mining area where the weathered zone extends into the water table. The water flux is likely to be locally variable due to the broad range in hydraulic conductivity.

Section 6.3 describes updates to the numerical model, with hydrographs showing modelled water levels included with Appendix C. Examination of simulated groundwater levels within monitoring bores installed within the weathered zone show a response in groundwater levels to climatic events and confirm the unit is well connected to the surficial alluvium within the groundwater model.

5.3.2 Coal seam connectivity with alluvium

DPI Water interpreted from maps presented within the RTS document that a hydraulic connection between the Quaternary alluvial aquifer and the Coggan Coal seam aquifer was likely to exist. It is agreed that the available data does indicate in some areas there is a direct or direct hydraulic connection between the alluvium and the coal seams proposed to be mined. Figure 5-19 shows where the Coggan Coal seam either subcrops below the alluvium, or outcrops close to the land surface. The areas where the coal seam subcrops directly beneath the alluvium, or is separated by a thin layer of weathered Permian sediments will be areas where the connectivity is enhanced. Figure 5-19 shows this occurs primarily in the area of the Lee Creek alluvium between the Eastern and Western open cut mining areas. Towards the south of this area the coal seams outcrop above the water table and therefore do not have any direct connection with the alluvial aquifer.



Bylong Coal Project (G1606G)

Coggan coal seam subcrop below water table and recharge area

15/07/2016 **5-19**

Figure 5-20 shows groundwater levels measured in alluvial monitoring bore A06-D and coal seam monitoring bore AGE08, which is about 15 m below the base of the alluvium. The groundwater levels fluctuate similarly indicating connectivity between these units.

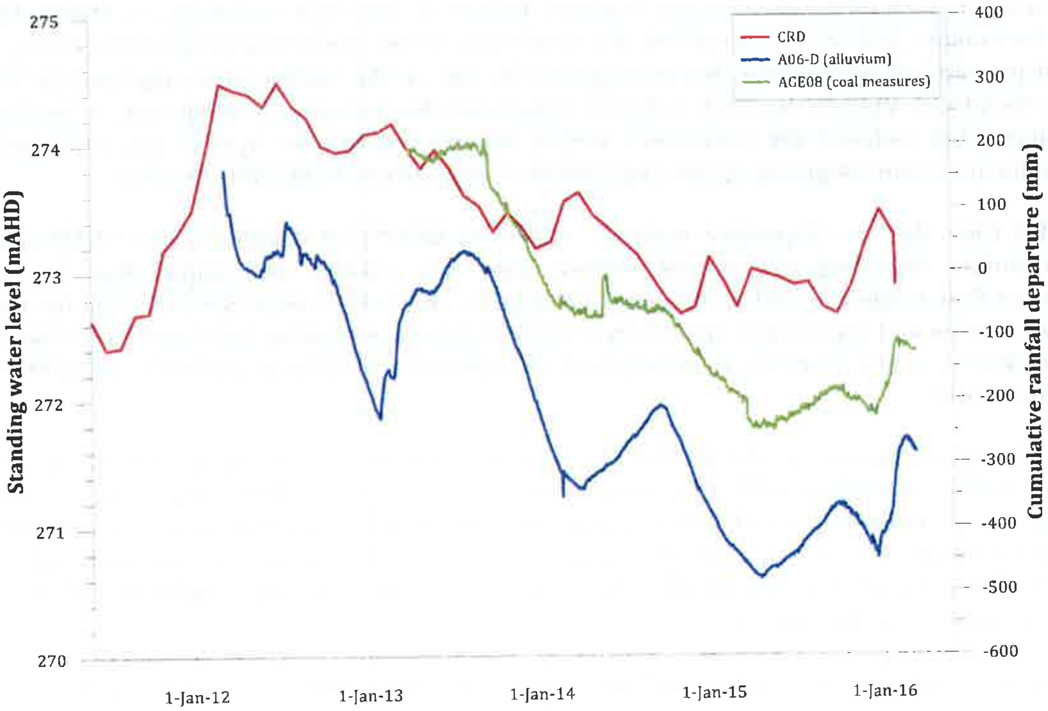


Figure 5-20 Groundwater levels – A06-D and AGE08

6 Numerical modelling

6.1 Background and history

Hansen Bailey commissioned AGE to commence developing the initial numerical modelling for the Bylong Coal Project in mid-2012, with the modelling presented in a report in late 2013. This report (AGE 2013) described the development of this early version of the model which formed part of a submission to the Gateway Panel. The numerical model was set up using MODFLOW SURFACT. MODFLOW SURFACT has two options to represent the recharge processes. These allow representing movement of water within the unsaturated vadose zone, or without these processes as a pseudo soil model. The vadose zone model approach uses the van Genuchten equations and requires values for air entry (α), desaturation rate (β) and residual saturation (Rs). These values are derived for soils but are not commonly available for rock profiles. Whilst these values were not available, a default set of values were used, that promoted rapid numerical convergence and allowed large complex regional models to be developed and calibrated.

In 2014 and 2015 a new version of the numerical model was developed for the Bylong Coal Project EIS. The purpose of the modelling was to address the Secretary's Environmental Assessment Requirements (SEARs) and the recommendations from the Gateway Panel. Whilst this modelling was being undertaken, third party peer reviewers of groundwater studies on other major mining projects began to question the use of the vadose zone approach for regional models. Their concern centred around the lack of data for the α, β and Rs in rock profiles.

To proactively address this concern, for the Project attempts were made to assess the sensitivity of the numerical modelling predictions to both the vadose zone and pseudo soil approaches. The EIS document (AGE 2015) describes the attempts to utilise the pseudo soil option within the MODFLOW SURFACT model developed for the EIS, and the eventual development of a new model in MODFLOW USG allowing the use of the pseudo soil function, known as upstream weighting in MODFLOW USG. The EIS document (AGE 2015) described the sensitivity of the modelling predictions to the vadose zone and pseudo soil approaches, but maintained the use of the vadose zone approach as the base case. The sensitivity analysis outlined in the EIS concluded that increased seepage rate to the proposed mining areas, but reduced the drawdown within the alluvial aquifer system are predicted when adopting the upstream weighting option (equivalent of pseudo soil in MODFLOW USG).

During this time, AGE corresponded with the author of MODFLOW SURFACT and MODFLOW USG, Dr Sorab Panday regarding use of the vadose zone and pseudo soil approaches for regional groundwater flow models. Based on this correspondence and further experience testing the influence of the vadose zone and pseudo soil approaches, whilst previous modelling was considered meaningful, it was decided to conduct further modelling with the upstream weighting approach using MODFLOW USG for the Project.

The numerical groundwater model for the Project was updated in response to submissions in early 2016, and utilised the MODFLOW USG model developed during the EIS along with the upstream weighting option. Modelling for the RTS is described by AGE (2016). The most current numerical modelling undertaken to incorporate the results of the pump testing program described in this document also adopted the MODFLOW USG model with the upstream weighting option as the 'basecase' to predict mining impacts.

The numerical modelling has undertaken an evolutionary path since it was commenced over four years ago in response to new data, requests from stakeholders and peer review experts. It is not considered this invalidates any previous work, rather that it shows that groundwater models have some inherent uncertainty, but this can be addressed by considering the potential range of outcomes and gradually refining models over time. The sections below describe the further improvements made to the numerical model with:

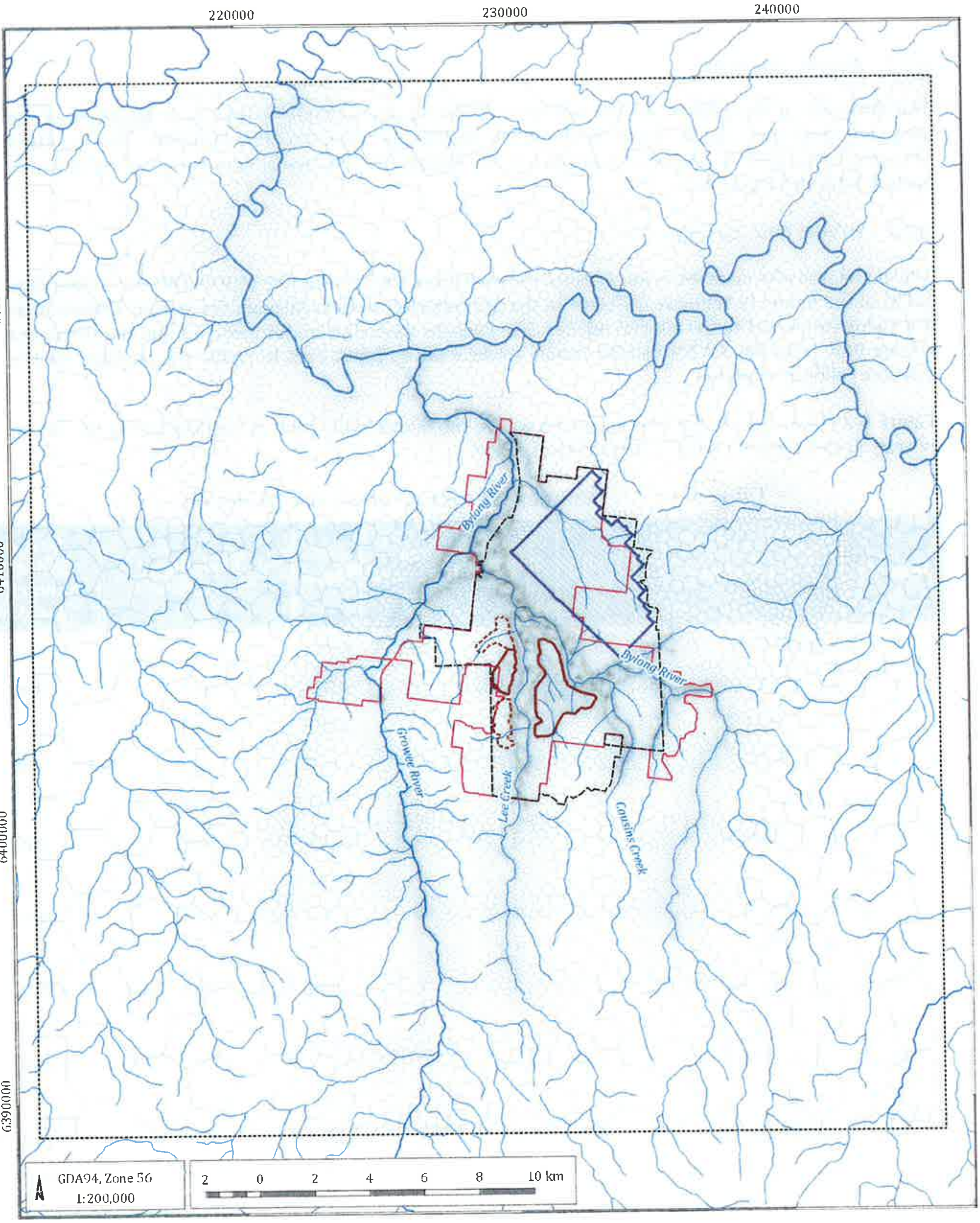
- Section 6.2 outlining the model updates;
- Section 6.3 presenting the updated calibration utilising pump test results; and
- Section 6.4 provides predictions of mining impacts using the updated and recalibrated model.

6.2 Model updates

As discussed, a series of updates were made to the numerical model to address queries raised by stakeholders, and to incorporate new data obtained from the pump testing program and monitoring data of recent rainfall recharge events. The sections below describe the refinements made to the model. The MODFLOW USG model with the upstream weighting option was used for the modelling. The reader should refer to the EIS and RTS reports for a detailed description of the setup of the MODFLOW USG model. The sections below outline the latest changes and refinements to the numerical model.

6.2.1 Mesh refinement

The model cells were refined around the key features including the Goulburn River and the alluvial aquifer to better represent these key features. The model mesh was also refined around the sites of the pumping bores to allow the cone of depression around each pumping bore to be more accurately replicated. Figure 6-1 shows the refined mesh for comparison with Figure 27 of the RTS report.



Open Cut Mining Area
Overburden Emplacement Area
Underground Extraction Area
Kepco owned land
Model extent
Project Boundary
Model mesh
Major drainage
Minor drainage

Bylong Coal Project (G1606G)

Refined MODFLOW USG model mesh

15/07/2016

6-1

6.2.2 Aquifer thickness

The thickness of the alluvial aquifer was also reviewed and updated to ensure it represented the saturated thickness of the alluvium identified during the pumping test program. The updated thickness of the alluvial aquifer was adjusted in the MODFLOW USG model based on the data shown in Section 5.1.2 and Figure 5-5.

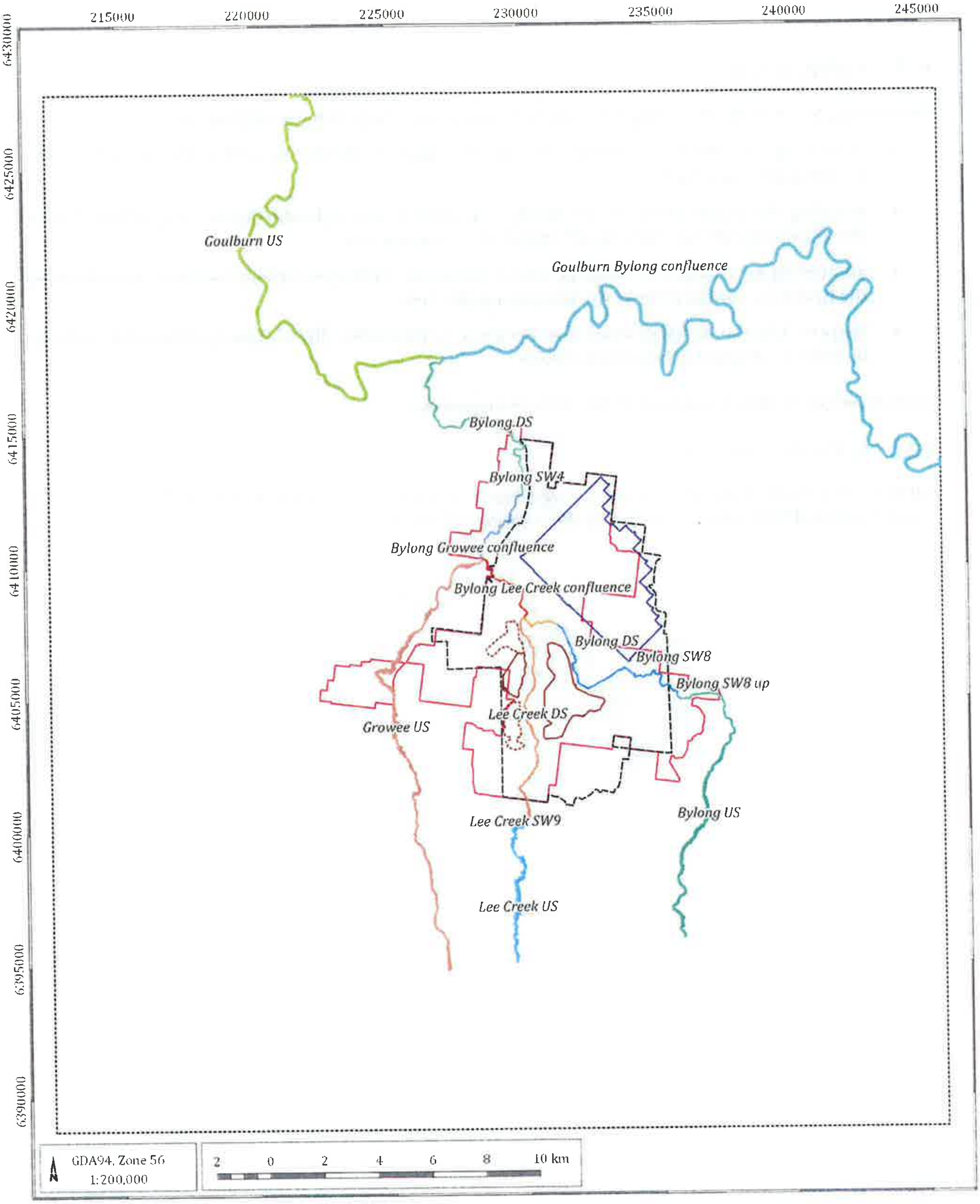
6.2.3 Stream flow package

The model was also updated to incorporate requests from KA to utilise the MODFLOW stream package (STR) in the model to simulate recharge to the groundwater system through the stream systems that are highly connected to the alluvial aquifer. The streams were divided into reaches and the simulated stream flow from the AWBM rainfall runoff model used as input data to create the package for the baseline calibration period.

Figure 6-2 shows the stream flow segments within the model, with Table 6-1 summarising the set-up of each stream segment within the numerical model.

Table 6-1 Summary of stream flow package set-up

Segment	Location	Width (m)	Depth (m)	Bed thickness (m)	Slope	Manning's Coefficient	Vertical hydraulic conductivity (m/day)
1	Lee Creek US	3	1	1.5	0.005	0.03	0.46
2	Lee Creek - SW9	3	1	1.5	0.005	0.03	0.06
3	Lee Creek DS	3	1	1.5	0.005	0.03	0.46
4	Growee US	3	1	1.5	0.005	0.03	0.30
5	Bylong US	5	2	2	0.004	0.03	0.51
6	Bylong SW8 up	5	2	2	0.004	0.03	0.01
7	Bylong DS	5	2	2	0.004	0.03	0.51
8	Bylong SW8	5	2	2	0.004	0.03	0.01
9	Bylong DS	5	2	2	0.004	0.03	0.51
10	Bylong Lee Creek	5	2	2	0.004	0.03	0.51
11	Bylong Growee	5	2	2	0.004	0.03	0.51
12	Bylong SW4	5	2	2	0.004	0.03	0.05
13	Bylong DS	5	2	2	0.004	0.03	0.51
14	Goulburn US	15	5	3	0.002	0.03	0.04
15	Goulburn Bylong	15	5	3	0.002	0.03	0.41



- Open Cut Mining Area
- Overburden Emplacement Area
- Underground Extraction Area
- Kepco owned land
- Project Boundary
- Model extent
- Model mesh

Stream flow segments

- 1 - Lee Creek US
- 2 - Lee Creek SW9
- 3 - Lee Creek DS
- 4 - Growee US
- 5 - Bylong US
- 6 - Bylong SW8 up
- 7 - Bylong DS
- 8 - Bylong SW8
- 9 - Bylong DS
- 10 - Bylong Lee Creek confluence
- 11 - Bylong Growee confluence
- 12 - Bylong SW4
- 13 - Bylong DS
- 14 - Goulburn US
- 15 - Goulburn Bylong confluence

Bylong Coal Project (1606G)

Stream flow segments

AGE

15/07/2016

6-2

6.3 Calibration

The revised MODFLOW USG model from the RTS was recalibrated with the objective of:

- increasing the hydraulic conductivity of the alluvial aquifer to reflect the results of the pumping testing program;
- ensuring the model does not uniformly over-predict groundwater levels, particularly within the alluvial aquifer as noted by DPI Water in its submission;
- accounting for changes in recharge rates induced by adding the stream recharge and changing the hydraulic conductivity of the alluvial aquifer; and
- representing the recharge event that occurred in December 2015 / January 2016 that resulted in some recovery in groundwater levels.

Sections below outline the results of the calibration process.

6.3.1 Hydraulic properties

Table 6-2 below presents the hydraulic properties in previous models developed for the EIS and RTS and the updated hydraulic properties in the recalibrated model.

Table 6-2 Calibrated aquifer parameters

Unit	Horizontal hydraulic conductivity (m/day)			Vertical hydraulic conductivity (m/day)				Specific yield (%)			Specific storage (m^{-1})		
	EIS	RTS	RTS2	EIS	RTS	RTS2	Kh/Kv	EIS	RTS	RTS2	EIS	RTS	RTS2
Alluvium upper (L1)	2.7	4.2	60	1.06	1.65	23.52	3	10	3	3	5E-3	1E-3	1E-3
Alluvium lower (L2)	4.72	10.1	100	1.66	3.55	35.1	3	9	6	6	1E-3	5E-3	5E-3
Colluvium (L3)	4.6E-1	4.6E-1	4.6E-1	8.62E-4	4.6E-2	1.9E-2	10	8	2	2	2E-5	1E-3	1E-3
Weathered Permian (L3)	2.41E-1	2.41E-1	2.41E-1	1.21E-1	1.21E-1	1.21E-1	2	10	10	10	2E-4	2E-4	2E-4
Tertiary basalts (L5)	1.10	1.10	1.10	1.92E-2	1.92E-2	1.92E-2	57	5	5	5	1.5E-5	1.5E-5	1.5E-5
Wallerawang Subgroup (L4)	1.5E-3	1.5E-3	2E-3	1.5E-4	1.5E-4	1.5E-4	10	2	2	2.2	1.6E-5	1.6E-5	1.6E-5
Charbon Subgroup (L5)	3.64E-4	3.64E-4	3.64E-4	4.32E-7	4.32E-7	4.32E-7	84	3	3	3	2.3E-6	2.3E-6	2.3E-6
Ulan Coal Seam (L6)	1E-5 - 0.05	1E-5 - 0.05	8.6E-6 - 0.05	1E-6 - 0.03	1E-6 - 0.03	4.3E-6 - 0.03	2	2	2	1.6	2.3E-5	2.3E-5	2.3E-5
Interburden (L7)	1.5E-3	1.5E-3	2E-3	1.5E-4	1.5E-4	1.5E-4	10	1	1	1	7.6E-5	7.6E-5	7.6E-5
Coggan Coal Seam (L8)	1E-5 - 0.13	1E-5 - 0.13	8.6E-6 - 0.13	1E-6 - 0.03	1E-6 - 0.03	9.9E-7 - 0.015	9	2	2	2	2E-4	2E-5	2E-5
Marrangaroo Fm (L9)	1.63E-3	1.63E-3	2E-3	3.15E-6	3.15E-6	3.2E-5	52	1	1	1	1.3E-5	1.3E-5	1.3E-5
Shoalhaven Group (L10)	1.87E-4	1.87E-4	1.87E-4	1.87E-5	1.87E-5	1.87E-5	10	1	1	1	7.1E-6	7.1E-6	7.1E-6
Triassic intrusions (L11)	1.49E-3	1.49E-3	1.49E-3	7.47E-4	1.49E-3	1.49E-3	2	1	1	1	1.6E-5	1.6E-5	1.6E-5

Table 6-2 shows the key changes to the hydraulic properties including increasing the horizontal and vertical hydraulic conductivity within the alluvial aquifer layers, and reducing the contrast between the horizontal and vertical hydraulic conductivity in selected bedrock layers. Figure 6-3 below illustrates the horizontal hydraulic conductivity values adopted for the EIS, RTS and RTS2 graphically. It shows the most significant change to the model has been the increase in horizontal hydraulic conductivity within the alluvial layers in the RTS2 version of the model.

Figure 6-3 Horizontal hydraulic conductivity in numerical models

The large range in the hydraulic conductivity within the coal seams shown in the above figure is due to the function that represents these layers as becoming less permeable with depth below the surface. The model reduced the hydraulic conductivity of the coal seams exponentially with depth to represent the effects of mechanical loading from overburden and sealing of cleats. Table 6-3 shows the relationship between coal seam depth and hydraulic conductivity in the groundwater model.

Table 6-3 Horizontal hydraulic conductivity of coal seam layers

Coal seam depth below land surface (m)	Horizontal hydraulic conductivity (m/day)	
	Ulan seam plys and interburden (Layer 6)	Coggan seam (Layer 8)
10	0.049	0.13
25	0.029	0.077
50	0.017	0.045
100	0.0055	0.015
200	0.0006	0.002

Comments from DPI Water suggested that the hydraulic conductivity of the coal seam aquifer was too low and the numerical model should be set-up in a manner that allows the connectivity between the coal seams and the alluvial aquifer. Table 6-3 shows that the hydraulic conductivity of the coal seams is relatively high where they are shallow and subcrop under the alluvium. The RTS2 model also pinches out the overlying non-coal layers where they do not occur and this directly connects the alluvial aquifer cells with the coal along the subcrop where appropriate in the numerical model.

6.3.2 *Rainfall recharge*

Increasing the hydraulic conductivity within the numerical model necessitated an increase in the recharge rate to maintain groundwater levels within the alluvial aquifer consistent with what had been measured in the field. The rainfall recharge rate estimated using the soil moisture balance (Section 5.1.3) was adjusted manually to achieve the best match between measured and simulated groundwater levels. The match was achieved by increasing the recharge rate on the alluvium to 2.5 times the rate estimated with the soil moisture balance. The total rainfall over the calibration period from January 2012 to June 2016 was 2,596 mm, with the model calibrating best with 439 mm of rainfall recharge, which is equivalent to 17% of the total rainfall over the baseline period. A factor of 0.1 times the rates within the soil moisture balance was used for rainfall recharge over the remainder of the model where alluvium was not present at bedrock outcrops. In the areas of bedrock outcrop this was equivalent to 17.56 mm of rainfall recharge, which is equivalent to 0.7% of the total rainfall over the baseline period. The total recharge to the model area averaged 20.62 ML/day as outlined below.

6.3.3 *Water budget*

Table 6-4 below summarises the average water fluxes simulated by the updated numerical model, with Figure 6-4 showing the transient water budgets for the baseline calibration period graphically.

Table 6-4 Water balance - averages for calibration period (ML/day)

Parameter	EIS		RTS		RTS2	
	Input	Output	Input	Output	Input	Output
Rainfall recharge	14.9		11.5	-	20.62	-
Streams	-	-	-	-	2.95	11.3
Rivers	34.7	43.3	58	3.1	0	3.98
Evapotranspiration		21.5	-	64.9	0	11.28
General head		0.1	0.0	0.0	0	0
Wells		6.2	0.0	6.5	0	6.05
Storage	36.4	15.2	18	13	31.08	22.22
Totals	**86**	**86.3**	**87.5**	**87.5**	**54.65**	**54.65**

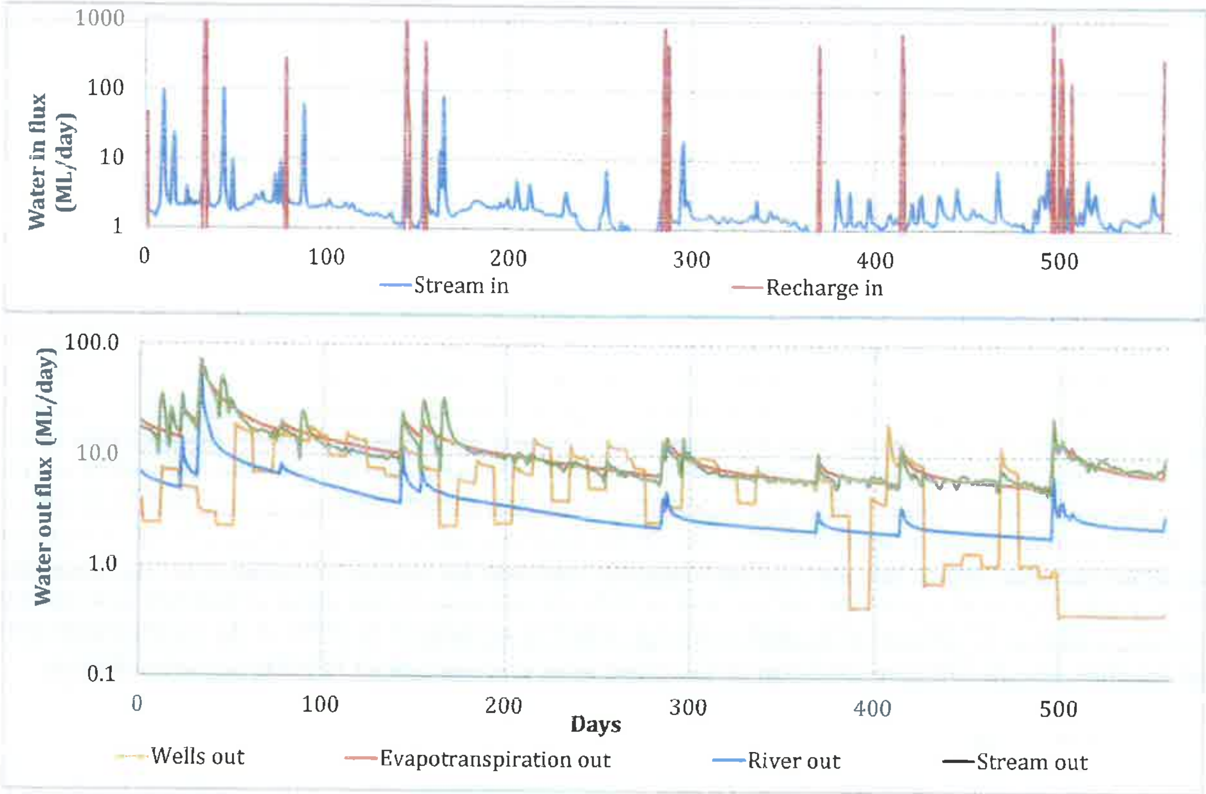


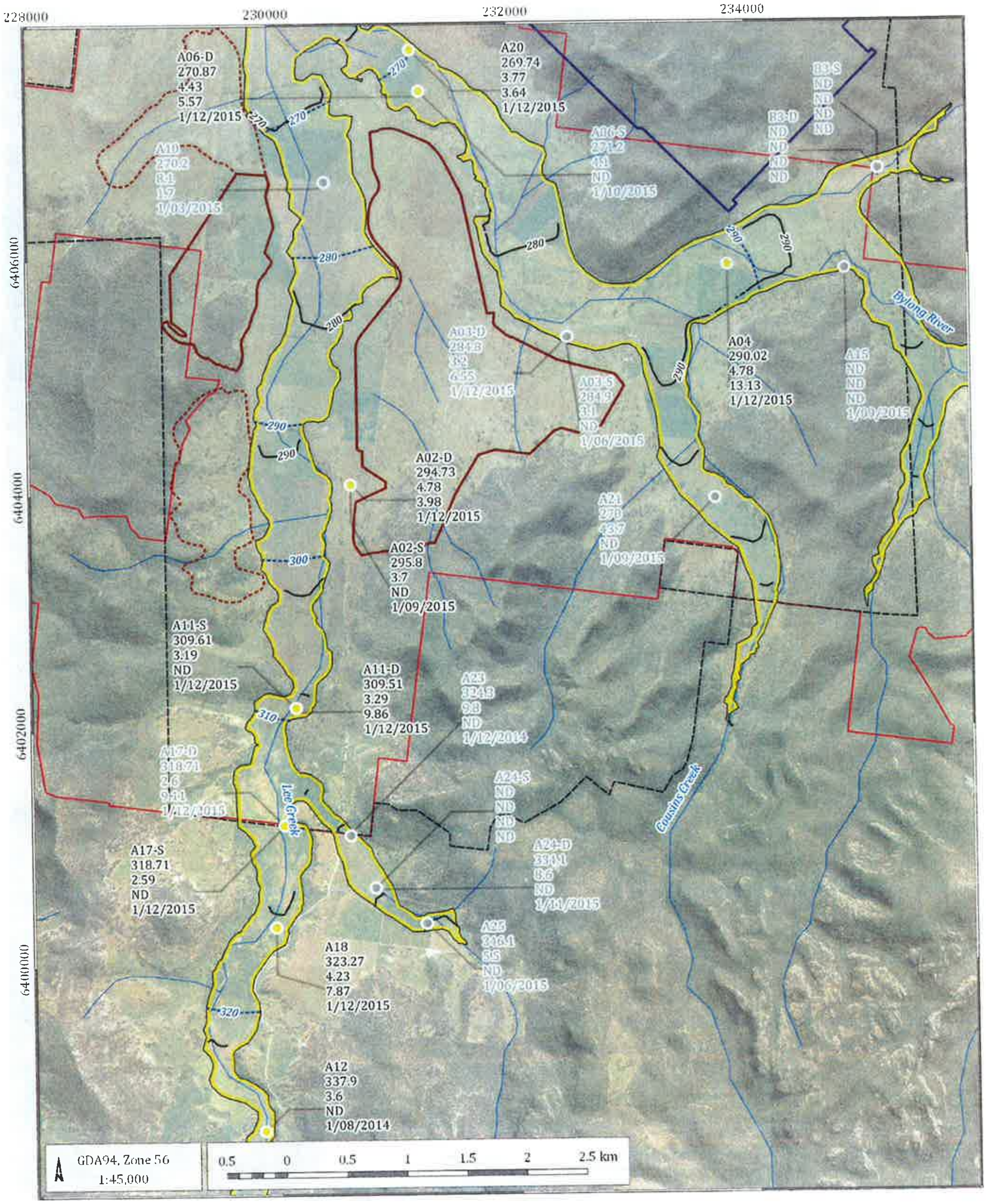
Figure 6-4 Calibration period transient water balance

Table 6-4 shows whilst the diffuse rainfall recharge rate was increased within the groundwater model, the total volume of water moving through the model was reduced. This was due to the more refined cells along the Goulburn River representing the bed elevation more accurately. This reduced the 'short circuiting' movement of water between adjacent river cells along the Goulburn River.

The net increase in rainfall recharge during the baseline calibration was a necessary increase required to maintain groundwater levels due to the increased hydraulic conductivity that promotes drainage of the aquifer. The increased recharge was also required to improve the ability of the model to replicate the rainfall recharge events that have occurred generally annually during the summer months over the baseline monitoring period.

6.3.4 Simulated groundwater levels

Figure 6-5 compares the observed groundwater levels with the levels simulated by the recalibrated model. Appendix C contains the hydrographs for each bore showing the match between the measured and model simulated groundwater levels.



LEGEND

- Monitoring locations used for water table contours
- Monitoring locations not used for water table contours
- Groundwater level contour (mRL)
- Simulated groundwater level contour (mRL)
- Project Boundary
- Open Cut Mining Area
- Overburden Emplacement Area
- Underground Extraction Area
- Kepco owned land
- Quaternary alluvium
- Major drainage
- Minor drainage

Bore Label:

1. Bore ID
2. Standing water level (mRL)
3. Depth to water
4. Saturated thickness
5. Date of measurement

ND = no data

Bylong Coal Project (G1606G)

Simulated and observed groundwater levels south - alluvium (layer 2) - December 2015

AGE

DATE 15/07/2016 FIGURE No. 6-7

- Monitoring locations used for water table contours
- Monitoring locations not used for water table contours
- Coggan coal seam sub-crop
- Simulated groundwater level contour (mRL)
- Project Boundary
- Open Cut Mining Area
- Overburden Emplacement Area
- Underground Extraction Area
- Kepco owned land
- Major drainage
- Minor drainage

Bore Label:

1. Bore ID
2. Standing water level (mRL)
3. Depth to water
4. Date of measurement

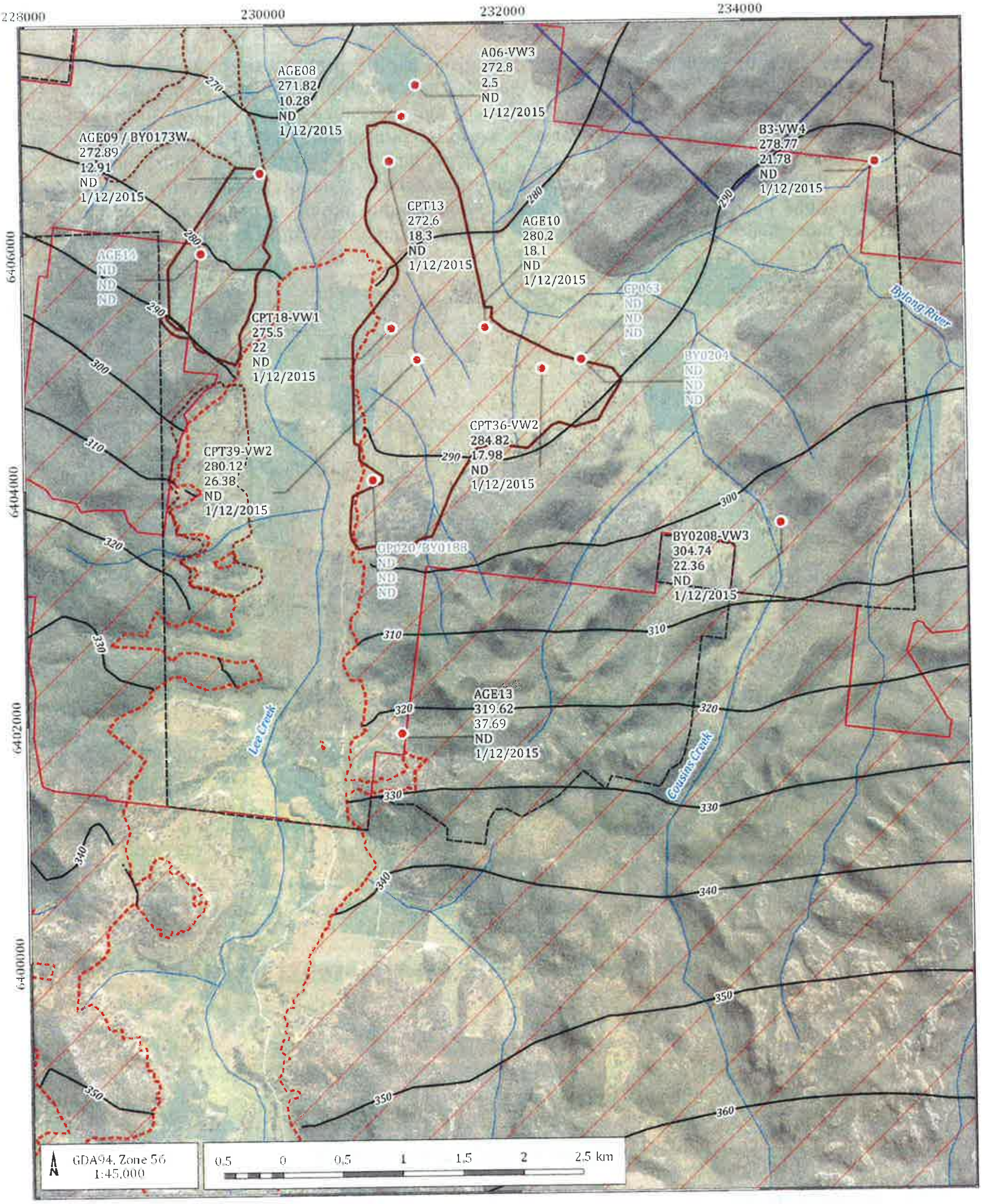
ND = no data

Bylong Coal Project (G1606G)

Simulated and observed groundwater levels north (layer 8) - Coggan Coal Seam - December 2015

15/07/2016

6-8



Legend

- Monitoring locations used for water table contours
- Monitoring locations not used for water table contours
- Simulated groundwater level contour (mRL)
- Coggan coal seam sub-crop
- Project Boundary
- Open Cut Mining Area
- Overburden Emplacement Area
- Underground Extraction Area
- Kepco owned land
- Major drainage
- Minor drainage

Bore Label:

1. Bore ID
2. Standing water level (mRL)
3. Depth to water
4. Date of measurement

ND = no data

Bylong Coal Project (G1606G)

Simulated and observed groundwater levels south - Coggan Coal Seam (layer 8) - December 2015

AGE

Date: 15/07/2016

Figure No: **6-9**

There are significantly fewer monitoring locations for measuring groundwater levels in the overlying Permian and Triassic non coal sediments, and therefore groundwater level maps are not presented for these layers. Instead Figure 6-10 shows graphically the match between simulated and measured groundwater levels in the Triassic and Permian overburden layers for each VWP sensor. This figure demonstrates the challenge in closely matching pressure data from VWP sensors. Whilst the match is not perfect, the model does generally replicate the trend of lower groundwater pressures occurring at lower elevations under the plateau area where underground mining is proposed. This indicates downward movement of groundwater from the surface through the profile in both the data and the model.

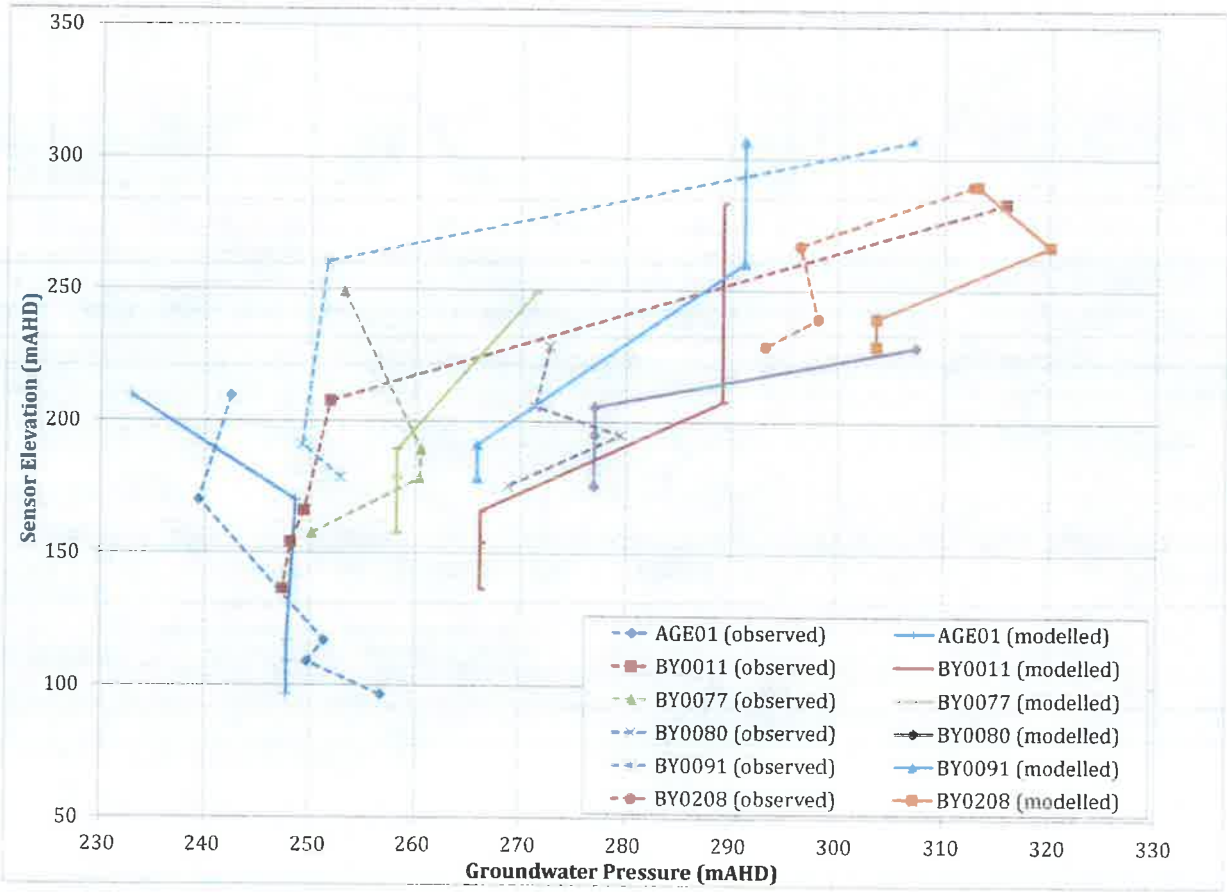


Figure 6-10 Simulated and observed pressures at VWPs

6.4 Predictions

The recalibrated and amended USG model was used to predict the impact of the open cut and underground mining on the groundwater regime. The sections below describe the changes made to the setup of the predictive model, the simulation results and uncertainty.

6.4.1 Borefield layout

As discussed in the EIS and RTS, there is potentially a need to supplement surface water collected in storages by pumping from a borefield installed within the alluvial aquifer to ensure adequate water available for the Project. The volume of 'make up water' required from the borefield depends on the volumes of groundwater that can be recovered and used from the open cut and underground mining areas and climatic conditions that control water held in surface storages.

Previous versions of the numerical model included a borefield to provide additional water in the event of a water deficit. The borefield comprised bores spaced evenly throughout the alluvial aquifer, and located at sufficient distances from constraints such as other private bores, government bores, water courses and property boundaries. Since this time, the pumping test program has provided additional information on the yield of bores installed within the alluvial aquifer and the zone of drawdown generated around each bore whilst pumping. The sites for the pumping bores were therefore revised giving consideration to the new data.

The locations of the pumping bores were adjusted manually to maximise the yield from the borefield, whilst minimising the drawdown impacts at the private bores. Unlike previous versions of the model presented within the EIS and RTS, the sites of the pumping bores were also constrained so as to be offset from potential GDEs. The pumping bores were located according to the rules of the Hunter Unregulated and Alluvial Water Sources Water Sharing Plan as follows:

- 400 m from access license bores on private property;
- 200 m from basic landholder rights bores;
- 50 m from a boundary with an adjacent landholder;
- 400 m from departmental monitoring bores; and
- 200 m from groundwater dependent ecosystems.

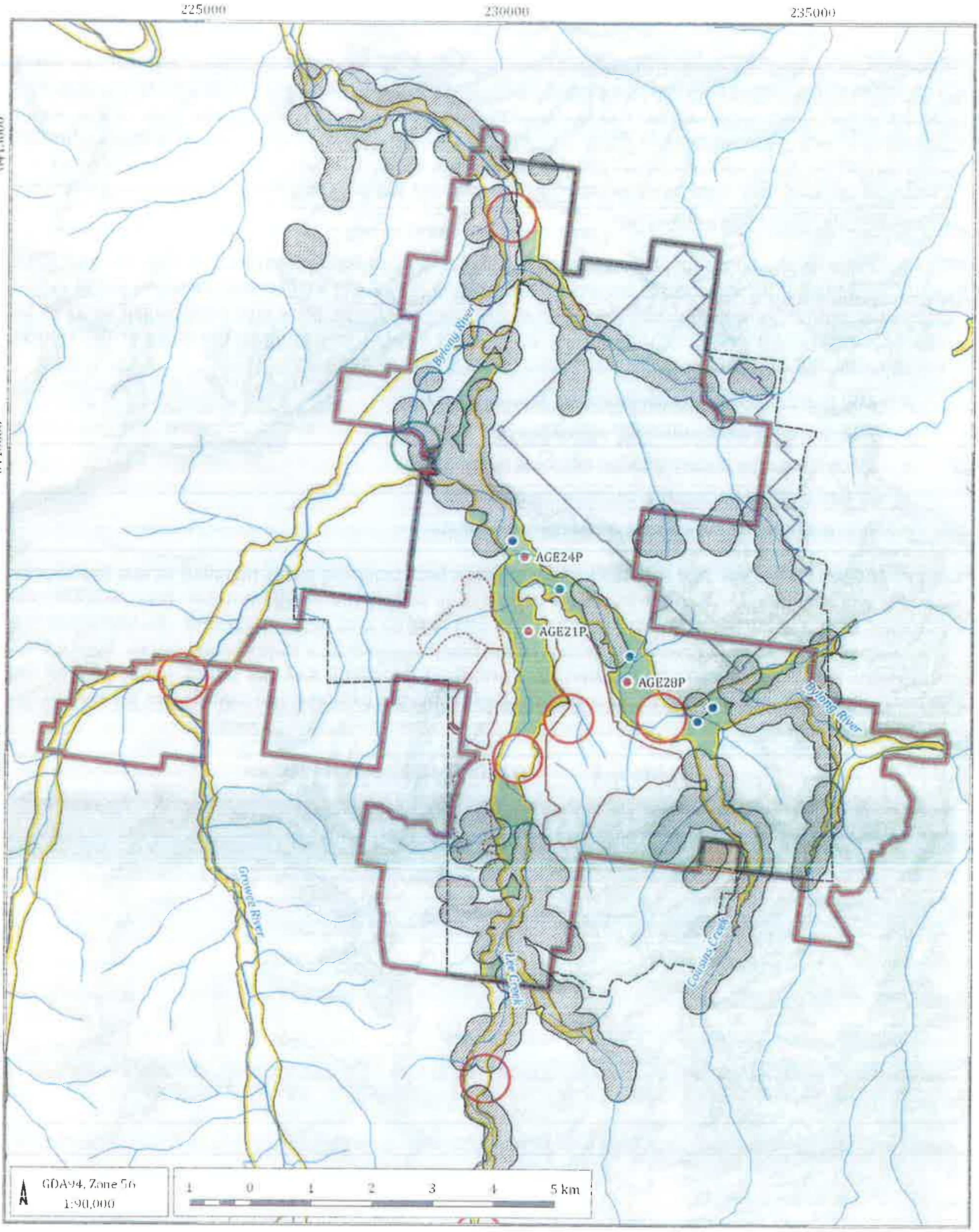
Three (AGE21P, AGE24P and AGE28P) of the existing four pumping bores installed to test the alluvial aquifer were included within the borefield proposed to supply the make up water. Bore AGE32P was excluded from the borefield as it is located within 200 m of an area of potential GDE. An additional five pumping bores were added, with the proposed borefield comprising a total of eight bores. Figure 6-11 shows the locations of each bore within the proposed borefield, and the buffer zones around the sensitive features where bores could not be located. Table 6-5 provides the coordinates for each of the proposed bore sites.

Table 6-5 Optimised borefield sites

Bore ID	Status	Easting	Northing	Ground elevation (mAHD)
AGE21P	Existing	230403	6407018	275.6
AGE24P	Existing	230335.7	6408249.8	267.3
AGE28P	Existing	232022.9	6406186.7	284.0
AGE34P	Proposed	230130	6408513	259.8
AGE35P	Proposed	230910	6407716	267.2
AGE36P	Proposed	232059	6406605	271.3
AGE37P	Proposed	233416	6405768	282.0
AGE38P	Proposed	233168	6405531	280.3

Note: *Coordinate system - GDA94 Z56*

The construction of the proposed bores will mirror the existing trial bores, comprising 219mm steel casing and stainless steel wire wound screens.



- Suitable bore location
- Unsuitable bore location
- GDE 200m buffer
- Project Boundary
- Goverment bore 400m buffer
- Entitlement bore 400m buffer
- Private property 50m buffer
- Kepco boundary 50m buffer
- Open Cut Mining Area
- Overburden Emplacement Area
- Underground Extraction Area
- Kepco owned land
- Quaternary alluvium
- Installed pumping bore
- Proposed pumping bore
- Major drainage
- Minor drainage

Bylong Coal Project (G1606G)

Optimised borefield layout

15/07/2016

6-11

6.4.2 Rainfall Recharge

As described in the RTS (AGE 2016), groundwater recharge was calculated for the predictive model by using rainfall records from 2000 to 2013 that encompassed a period of drought, followed by a number of years where the drought was broken by above average rainfall. This period included part of the 'Millennium drought' that occurred between 1995 and 2007, and was followed by a number of years of above average rainfall. Figure 6-12 shows the Southern Oscillation Index and the El Niño and La Niña climate cycles that occurred over this period that represent below average and above average rainfall and therefore variability groundwater recharge.

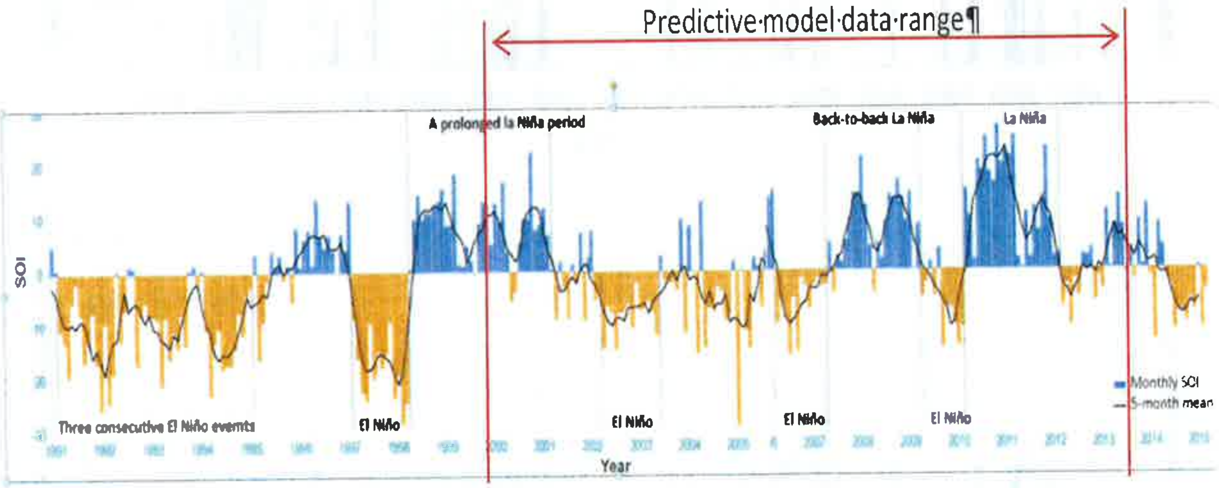


Figure 6-12 Southern oscillation index between 1991 and mid-2015[2]

Daily rainfall records from 2000 to 2013 generated by SILO for within the Project Boundary were used to estimate recharge rates using the soil moisture spreadsheet described in Section 5.1.3. This allowed the model to represent a drought from 2001 to 2007 followed by years of generally above average rainfall from 2008 to 2013. This cycle of recharge was then repeated for the proposed 23 years of mining for the Project.

The total rainfall over the period January 2000 to September 2013 was 8,452 mm. This is equivalent to an average of about 620mm per year and similar to the long term average recorded at Wollar (062032) of 593mm. The recharge over the period 2000 to 2013 is estimated at 898 mm, which is equivalent to 10% of annual rainfall reaching the water table. Figure 6-13 shows the rainfall and recharge rates used in the predictive model graphically.

[2] http://www.bom.gov.au/climate/about/australian-climate-influences.shtml?bookmark=enso

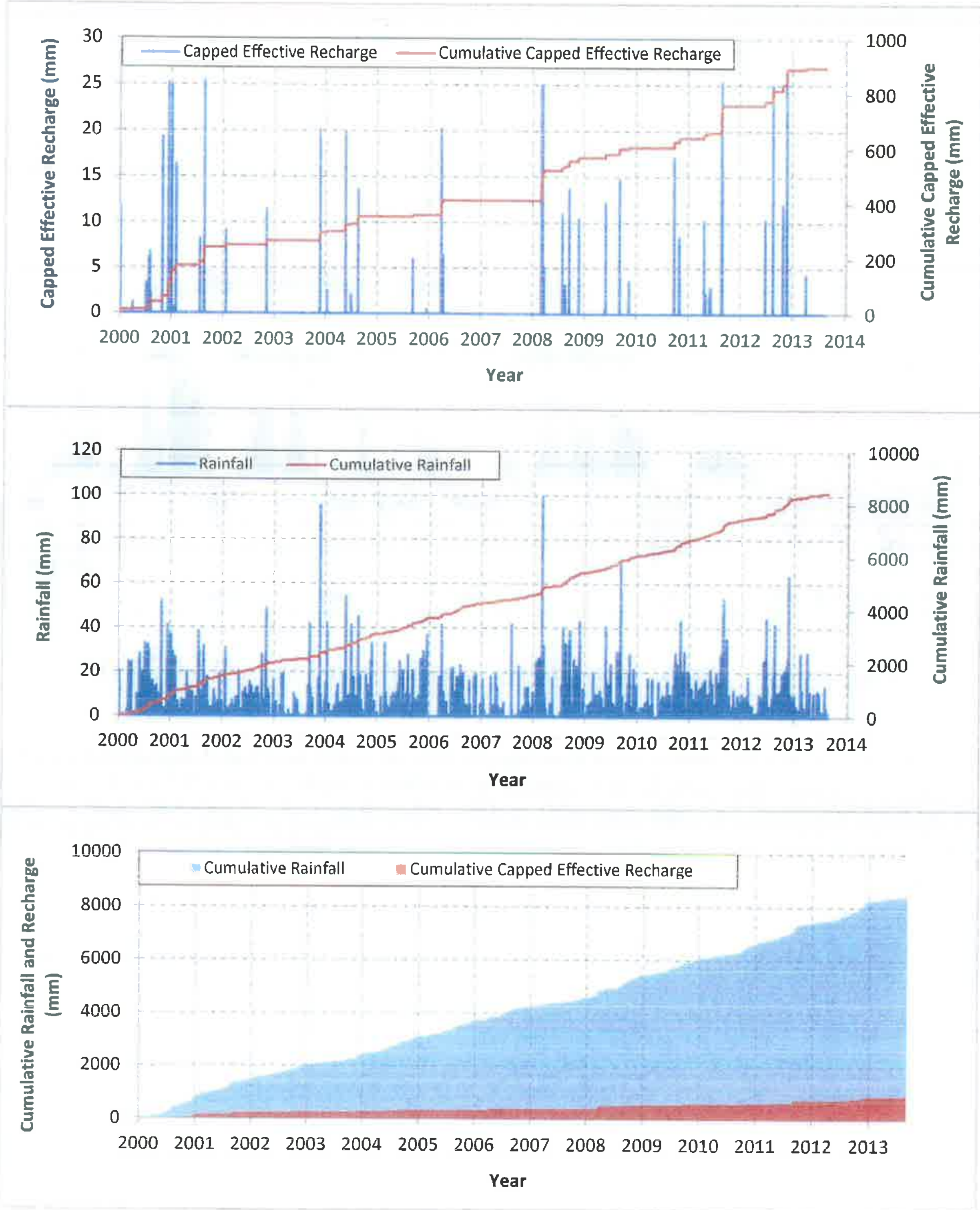


Figure 6-13 Recharge rates for predictive model (one cycle of data)

6.4.3 *Subsidence induced fracturing*

The model represented the fractured zone above the longwall panels by increasing the vertical hydraulic conductivity of the overlying layers. The EIS and RTS models represented the fracturing above the longwall mine by running the model in short time "slices" of three months. The mining was subdivided into 100 stress periods, each three months in length. At the beginning of each stress period changes in aquifer parameters resulting from the effects of the subsidence of material into the mined panel and the formation of a goaf above the panel were applied.

The updated model utilised the Time Variant Materials (TVM) package developed by HydroAlgorithmics Pty Ltd for MODFLOW USG. This package removed the need for time slices with changes to the hydraulic properties made during a single predictive model run.

6.4.4 *Predictions and uncertainty*

The sections below present predictions for mine inflow and drawdown from the updated groundwater model. The uncertainty in the model predictions is also presented.

The uncertainty analysis was conducted using a non-linear methodology described by Watermark Numerical Computing (2015). This is a more rigorous method than the linear uncertainty conducted for the RTS document. This is because the linear method assumes the range of impacts can be determined by projecting the predictions linearly either side of the base case according to a standard deviation. In some cases this can lead to unrealistic predictions at the lower bounds resulting in negative mine inflow or drawdown. The non-linear uncertainty analysis represents skewness better and prevents this issue. The linear method was undertaken for the RTS as it is suitable as a 'first pass' screening method that can indicate the range of uncertainty and the potential for non-linear processes.

The range in the parameters explored within the linear uncertainty analysis was based upon the expected upper and lower bounds from field testing data where available, and previous experience / judgement where data is sparse. Table 6-6 summaries the bounds on the non-linear uncertainty analysis, with Figure 6-14 showing the parameter ranges graphically.

Table 6-6 Non-linear uncertainty analysis parameter ranges

Parameter	Parameter number	Description	RTS			RTS2		
			Lower bound	Mean	Upper bound	Lower bound	Mean	Upper bound
Horizontal hydraulic conductivity (m/day)	hc01	Upper Alluvium parameters	0.152	4.2	17.7	10	60	120
	hc02	Lower Alluvium parameters	0.152	10.1	35.4	30	100	250
	hc03	Colluvium parameters	0.046	0.46	4.6	0.046	0.46	4.6
	hc04	Weathered parameters	0.024	0.24	2.4	0.01	0.24	1
Vertical hydraulic conductivity (m/day)	vhc01	Upper Alluvium parameters	0.001	0.392	0.7	0.0784	0.392	0.784
	vhc02	Lower Alluvium parameters	0.001	0.351	0.5	0.0702	0.351	0.702
	vhc03	Colluvium parameters	0.001	0.1	0.5	0.02	0.1	0.5
	vhc04	Weathered parameters	0.001	0.5	0.5	0.1	0.5	0.75
	vhc06	Interburden (layer 4) parameters	0.001	0.1	0.5	0.02	0.1	0.2
Specific yield (m^{-1})	sy01	Upper Alluvium parameters	0.01	0.03	0.1	0.01	0.03	0.25
	sy02	Lower Alluvium parameters	0.01	0.06	0.15	0.01	0.06	0.25
	sy03	Colluvium parameters	0.002	0.02	0.2	0.01	0.02	0.1
	sy04	Weathered parameters	0.01	0.1	0.1	0.01	0.1	0.2
Specific storage (m^{-1})	ss01	Upper Alluvium parameters	0.001	0.001	0.0125	0.0002	0.001	0.005
	ss02	Lower Alluvium parameters	0.005	0.005	0.01875	0.001	0.005	0.025
	ss03	Colluvium parameters	0.0001	0.001	0.01	0.0005	0.001	0.002
	ss04	Weathered parameters	0.00002	0.0002	0.002	0.0001	0.0002	0.0004
Rainfall recharge (proportion of recharge rate estimated from soil moisture spreadsheet)	rch01	% of rainfall on alluvium	1	14	18	1	14	18
	rch02	% of rainfall on colluvium	0.5	2.79	10	0.5	2.79	10
	rch04	% of rainfall on regolith	0.001	0.1	1	0.001	0.1	1

Parameter	Parameter number	Description	RTS			RTS2		
			Lower bound	Mean	Upper bound	Lower bound	Mean	Upper bound
	rch01tr	% of rainfall on alluvium	30	100	150	30	100	150
	rch02tr	% of rainfall on colluvium	0.5	5	10	0.5	5	10
	rch04tr	% of rainfall on regolith	0.001	1	1	0.001	1	1
Irrigation return (proportion of volume of water pumped by irrigators)	irrig	% of rainfall from irrigation	0.01	0.05	0.1	0.01	0.05	0.1

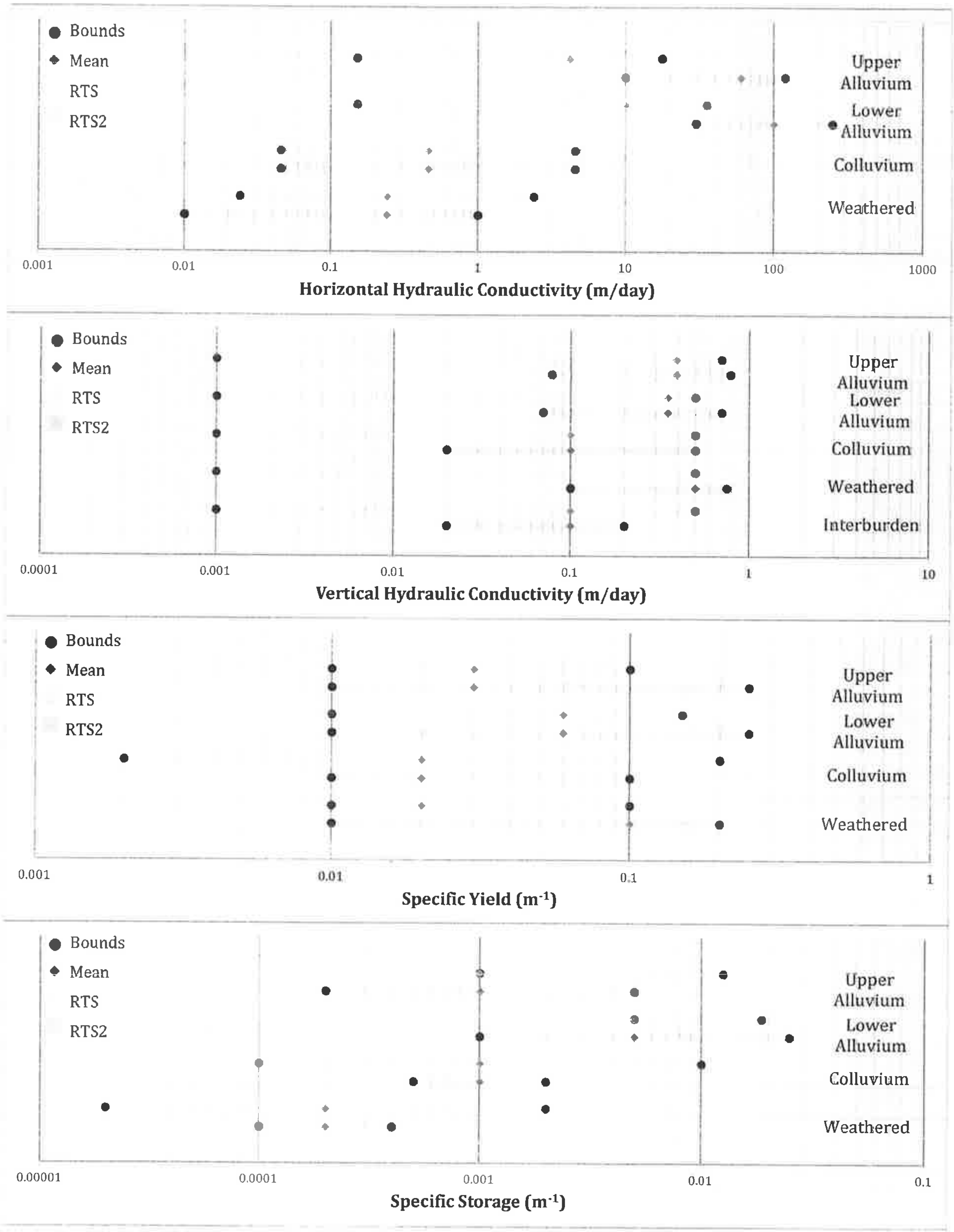


Figure 6-14 Non-linear uncertainty analysis parameter ranges

6.4.5 Water levels and drawdown

The updated numerical model was used to simulate the drawdown within the alluvial aquifer and the Coggan Coal seam during mining. Figure 6-15 and Figure 6-16 display the maximum drawdown predicted within the Quaternary alluvium (layer 2) and the Coggan coal seam (layer 8) respectively during the mine life. The figures also show the maximum drawdown within the mine life predicted by previous versions of the model presented within the EIS and RTS. A version of the RTS2 with the vadose zone van Genuchten option is also provided to assess the influence of this option on model predictions.

When comparing these models, it is important to note that the models are not the same. They each have differing underlying model code, parameters, stresses and layering. As described previously, the model has evolved from the EIS to the RTS2 with the key changes including:

- increasing the thickness, hydraulic conductivity, storage and recharge within the alluvial aquifer;
- moving from average rainfall recharge conditions in the EIS to representing a varying climate with El Niño drought periods and La Niña periods when rainfall is typically above average in the RTS; and
- moving from representing the unsaturated zone processes in the EIS to adopting the upstream weighting function for the base case within the RTS and RTS2.

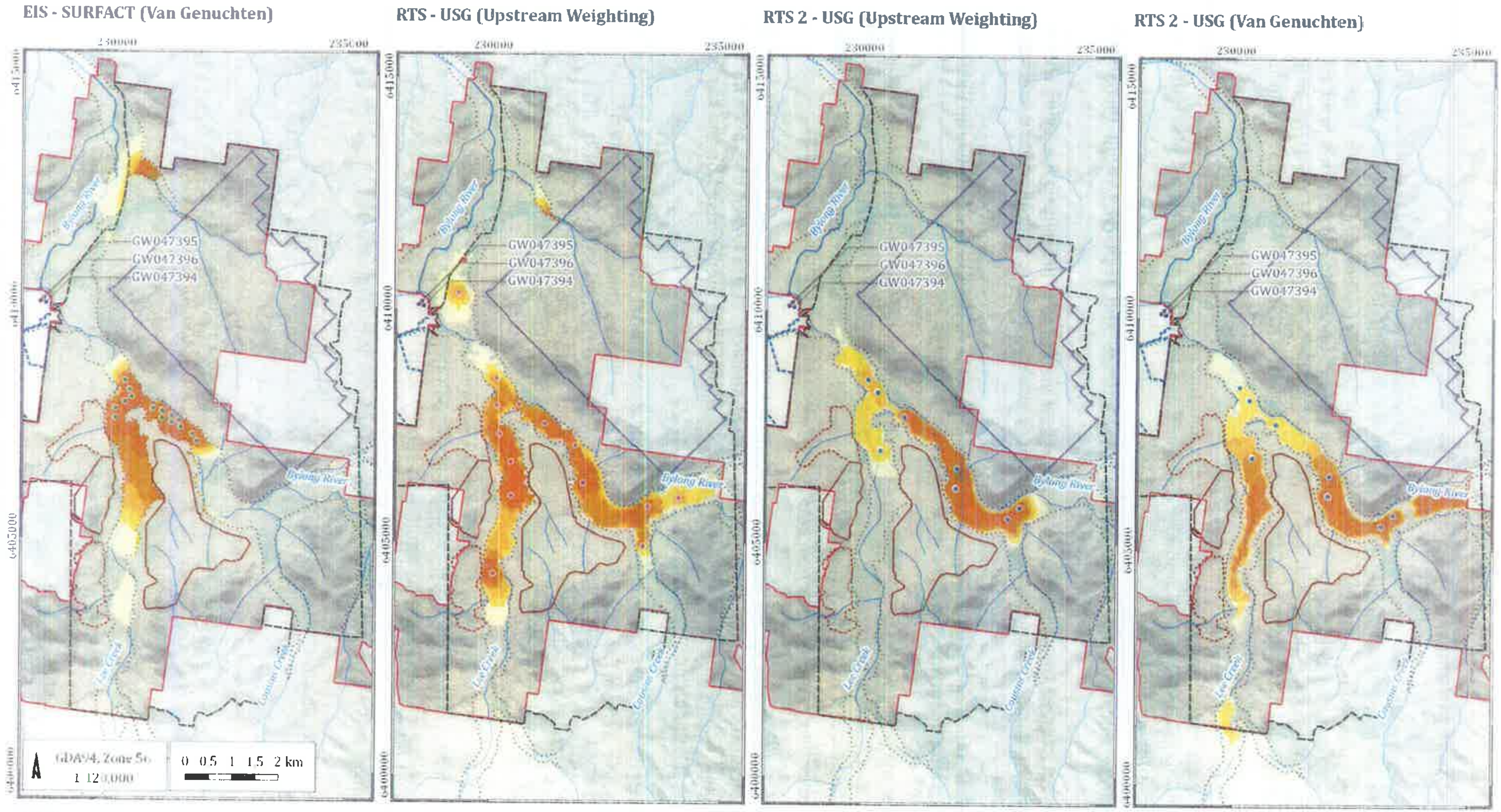
For these reasons, the predictions are not expected to be the same, but represent the gradual evolution of the numerical model based on feedback from stakeholders and as more data has become available to improve the predictive capacity. Despite these changes, the predicted impacts are generally comparable and provide a range of outcomes for consideration of environmental impacts.

Figure 6-17 and Figure 6-18 show the drawdown within the alluvium and Coggan coal seam, and the 0.1th and 99.9th percentile drawdown from the uncertainty analysis. These percentiles are effectively the lower and upper bounds of impacts for the current version of the model based on the parameter ranges selected for the uncertainty analysis.

Figure 6-15 shows how the sites selected for the pumping bores within the borefield have evolved and the maximum drawdown from the EIS, RTS and the RTS2. The figures show how the drawdown within the alluvium occurs mainly clustered around the pumping bores in each scenario. This is not unexpected given abstraction is directly from the borefield, as opposed to the mining areas that are not directly connected with the alluvium, and therefore only influence the alluvium through lower permeability bedrock.

Figure 6-15 shows the magnitude of drawdown within the alluvium is generally less with the current RTS2 version of the model (both upstream weighting and van Genuchten) than previous versions due to the improved capacity of the alluvial aquifer to supply water. The figure also shows the closest private licensed water bores on the "Eagle Hill" property are outside the zone of influence in all model scenarios, including the 99th percentile from the uncertainty analysis (Figure 6-17).

Figure 6-16 shows the maximum drawdown predicted within the Coggan coal seam for the various scenarios. The drawdown is of a similar extent at the regional scale in the EIS, RTS and RTS2. Figure 6-18 shows the drawdown becomes less extensive within the Coggan coal seam at the 1st percentile and more extensive at the 99th percentile upper bound. The drawdown within the coal seam is of no direct environmental consequence, as the coal seams dips to the east becoming deeper and more remote from surface water features. There are also no users of water abstracting directly from the coal seam aquifer within the predicted zone of depressurisation.



Open Cut Mining Area
Overburden Emplacement Area
Underground Extraction Area
Quaternary alluvium
Major drainage
Minor drainage
KEPCO owned land
Project Boundary
Eagle Hill property
- EIS proposed bores
- RTS proposed bores
- RTS 2 existing and proposed bores
- Private bores on Jarvet PTY LTD property

Drawdown (m)

1-2
2-3
3-4
4-5
5-10
10-15

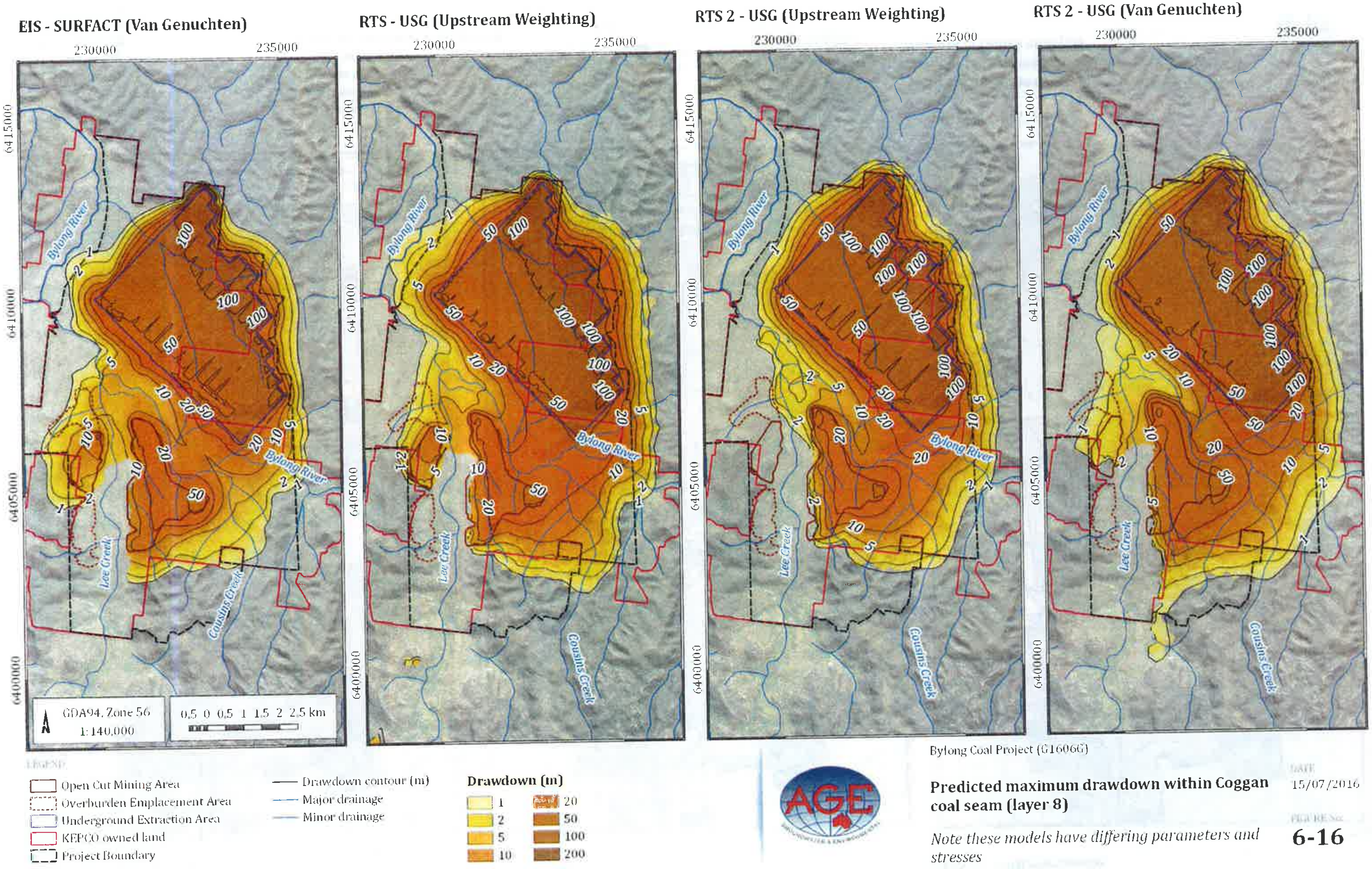
Bylong Coal Project (G1606G)

Predicted maximum drawdown within alluvium (layer 2)

Note these models have differing parameters and stresses

27/07/2016

6-15



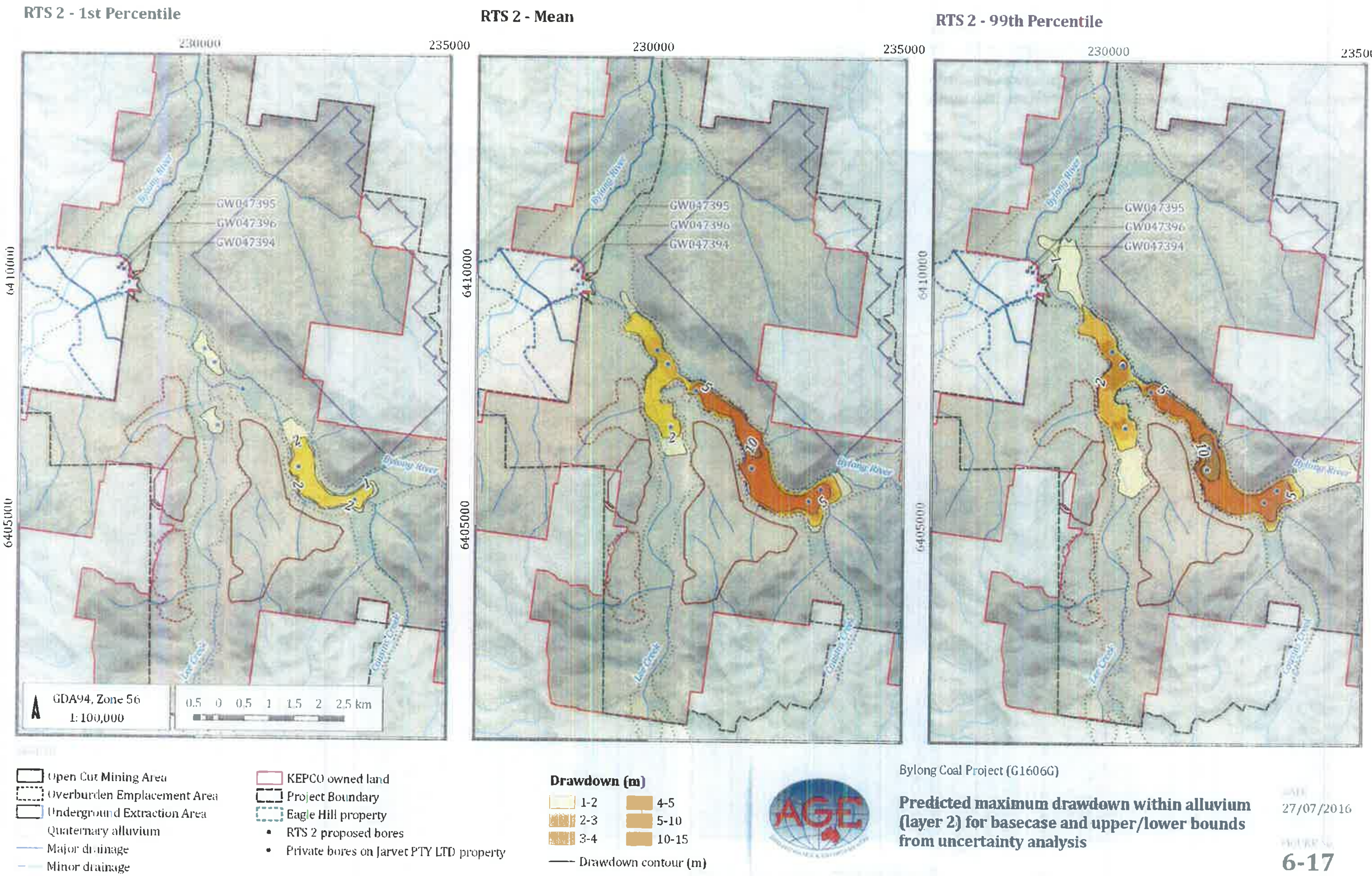
Bylong Coal Project (G1606G)

Predicted maximum drawdown within Coggan coal seam (layer 8)

Note these models have differing parameters and stresses

DATE 15/07/2016

FIGURE No. **6-16**

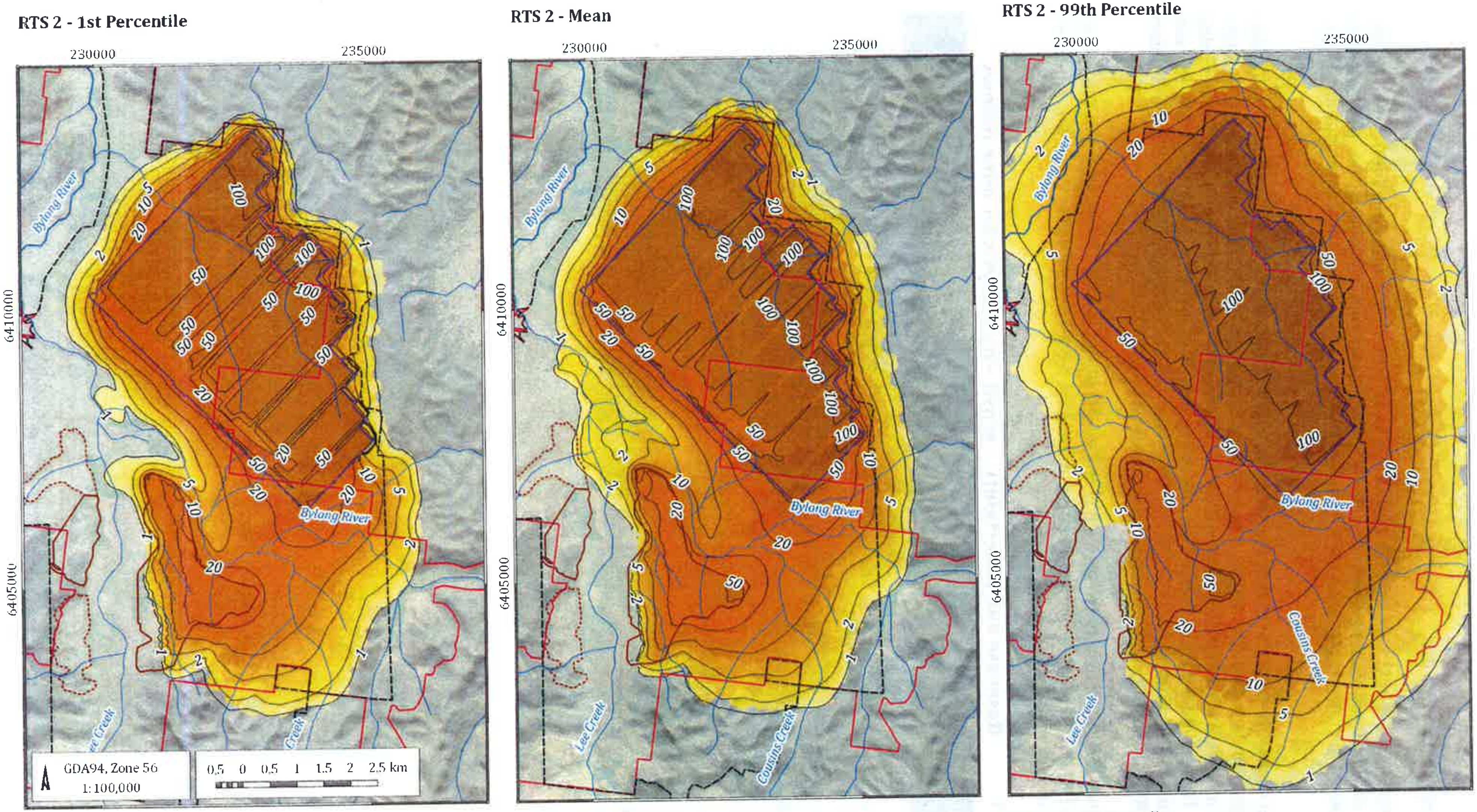


Bylong Coal Project (G1606G)

Predicted maximum drawdown within alluvium (layer 2) for basecase and upper/lower bounds from uncertainty analysis

27/07/2016

6-17



Open Cut Mining Area
Overburden Emplacement Area
Underground Extraction Area
KEPCO owned land
Project Boundary

Drawdown contour (m)
Major drainage
Minor drainage

Drawdown (m)

1, 2, 5, 10, 20, 50, 100, 200

Bylong Coal Project (G1606G)

Predicted maximum drawdown within Coggan coal seam (layer 8) for basecase and upper/lower bounds from uncertainty analysis

15/07/2016

6-18

6.4.6 Mine inflow

The updated numerical model was used to estimate the volume of groundwater intercepted by the open cut and underground mining areas. The recalibrated model was considered the basecase, and used as the basis of the uncertainty analysis to provide 1st percentile and 99th percentile bounds to the predictions.

Two additional scenarios were run to test the sensitivity of key model assumptions. Firstly, a run was undertaken using the basecase USG model where the drain cells remained active for the entire mine life to prevent any recovery of groundwater within the open cut or underground mining areas during the mine life. The second sensitivity was also run using the basecase USG model, but with the van Genuchten option for the unsaturated zone active. The results from the original EIS model that utilised MODFLOW SURFACT and the van Genuchten option are also presented.

Table 6-7 outlines the differences between each of the model runs. Figure 6-19 presents the volume of water predicted to be intercepted by the proposed mining on a logarithmic scale. Table 6-8 tabulates the data on an annual basis.

Table 6-7 Basecase and uncertainty / sensitivity analysis for mine inflows

Model	Version of MODFLOW	Unsaturated zone	Calibration	Drain setting	Notes
RTS2	USG	upstream weighting	Recalibrated using pumping tests	turn off after each longwall panel	Used for basecase and uncertainty analysis (1st and 99th percentile)
RTS2	USG	van Genuchten	Recalibrated using pumping tests	turn off after each longwall panel	
RTS2	USG	upstream weighting	Recalibrated using pumping tests	remain active for life of mine	
EIS	SURFACT	van Genuchten	EIS Calibration	turn off after each longwall panel	

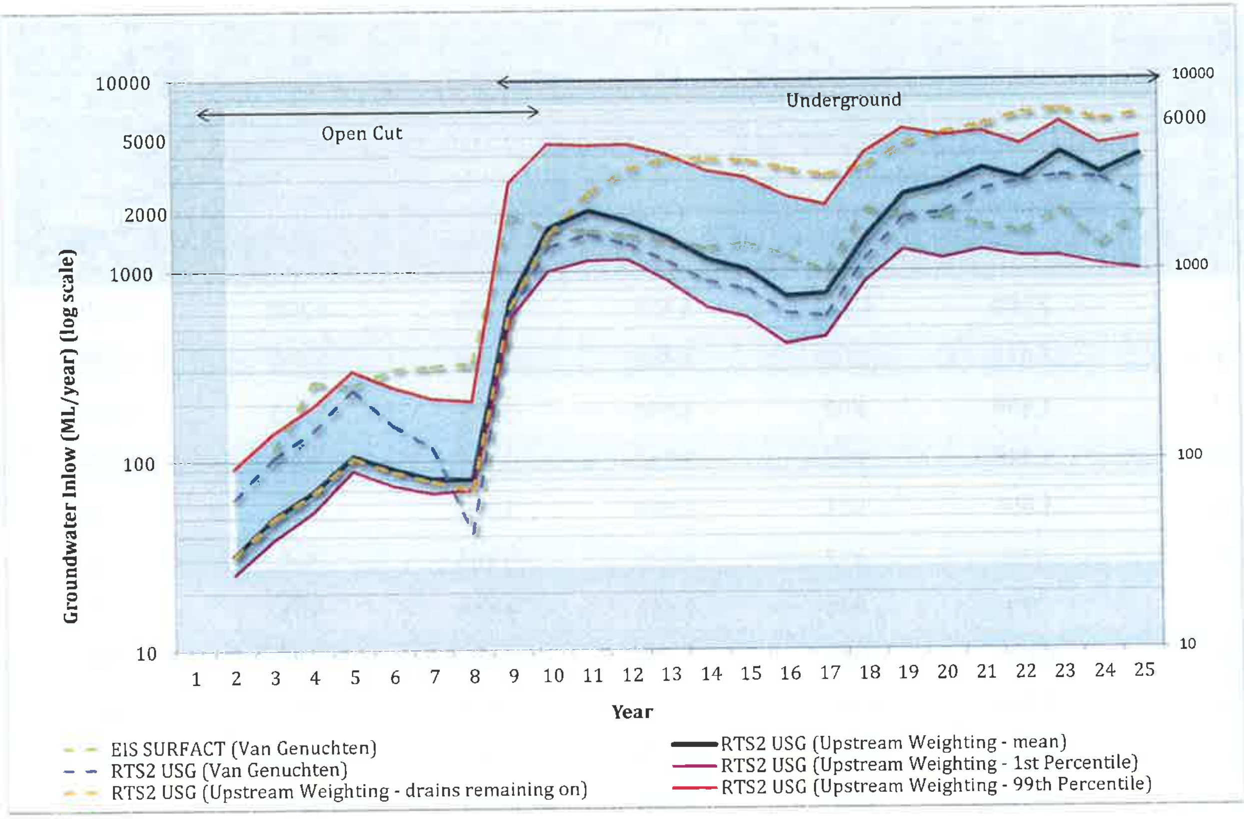


Figure 6-19 Predicted seepage to open cut and underground mining areas (semi log scale)

Table 6-8 Predicted seepage to mining areas

Year	RTS2 MODFLOW USG					EIS SURFACT
	upstream Weighting - basecase	upstream Weighting - 1st %ile	upstream weighting - 99th%ile	upstream weighting - drains remaining on	van Genuchten	van Genuchten
1	0	0	0	0	0	0
2	32	25	93	32	63	0
3	51	39	142	50	104	116
4	69	54	195	68	144	262
5	106	89	300	104	238	249
6	90	75	247	88	155	306
7	80	68	215	78	118	316
8	80	71	208	70	42	327
9	702	567	2937	641	596	1,968
10	1,675	1,004	4,659	1,553	1,334	1,667

Year	RTS2 MODFLOW USG					EIS SURFACT
	upstream Weighting - basecase	upstream Weighting - 1st %ile	upstream weighting - 99th%ile	upstream weighting - drains remaining on	van Genuchten	van Genuchten
11	2,065	1,139	4,577	2,555	1,560	1,629
12	1,812	1,152	4,618	3,402	1,382	1,538
13	1,498	892	4,090	3,868	1,123	1,405
14	1,148	645	3,347	3,867	880	1,324
15	1,006	571	3,084	3,780	799	1,385
16	725	413	2,459	3,408	597	1,207
17	751	450	2,206	3,157	573	975
18	1,471	870	4,129	3,516	1,141	2,093
19	2,492	1,283	5,514	4,570	1,892	1,921
20	2,776	1,150	5,078	5,262	2,005	1,940
21	3,387	1,277	5,298	5,755	2,637	1,720
22	2,999	1,181	4,550	6,602	2,907	1,584
23	4,099	1,176	5,923	6,917	3,099	2,053
24	3,202	1,063	4,551	6,069	2,997	1,331
25	3,952	1,000	4,892	6,542	2,438	2,005
TOTAL	**36,267**	**16,253**	**73,313**	**71,952**	**28,824**	**29,323**
AVERAGE	**1,451**	**650**	**2,933**	**2,878**	**1,153**	**1,173**

The recalibrated version of the numerical model predicts lesser groundwater inflow to the open cut mine, but increased volumes to the underground mining area when compared with the EIS. The changes are a function of approach to the unsaturated zone, changes in alluvial and bedrock parameters, differing recharge stresses and layering.

The 1st and 99th percentile indicate the uncertainty in the total inflow and also demonstrate the non-linear nature of the inflow with the basecase being skewed towards the lower end of the inflow range during the open cut mining, but moving close to the upper bound towards the end of the mine life.

6.4.7 *Water take and licensing*

The proposed mining will directly intercept groundwater in the open cut and underground mining areas. Some of this water will be lost to evaporation, or bound with spoils and coal, and therefore will not require pumping from the mining areas. For the purposes of water licensing, it has been assumed all the water predicted to be intercepted by the model drain cells is from the Permian or Triassic strata. Therefore, this water should be accounted for with water access licenses under the North Coast Porous and Fractured Rock Water Sharing Plan.

KEPCO has previously applied for a Water Access License under the *Water Act 1912* for the Project to extract groundwater from the Permian strata. It is understood that DPI Water will grant licenses applied for under the *Water Act 1912* within two years prior to the commencement of the North Coast Porous and Fractured Rock Water Sharing Plan which commenced on 1 July 2016. A water access license allowing extraction of up to 4,100ML/year will account for the peak annual water take in the base case.

The Aquifer Interference Policy also requires the assessment of the volume of groundwater indirectly influenced by the mining activities. This includes the volume of water pumped from the alluvial aquifers for make-up water and the reduction in Permian flow to the alluvial groundwater system. This water needs to be accounted for with water access licences from the Hunter Unregulated and Alluvial Water Sources Water Sharing Plan. Figure 6-20 presents the volume of water directly intercepted from the alluvial groundwater by pumping from bores and indirectly due to reduced flow of Permian groundwater to the alluvium due to depressurisation induced by mining.

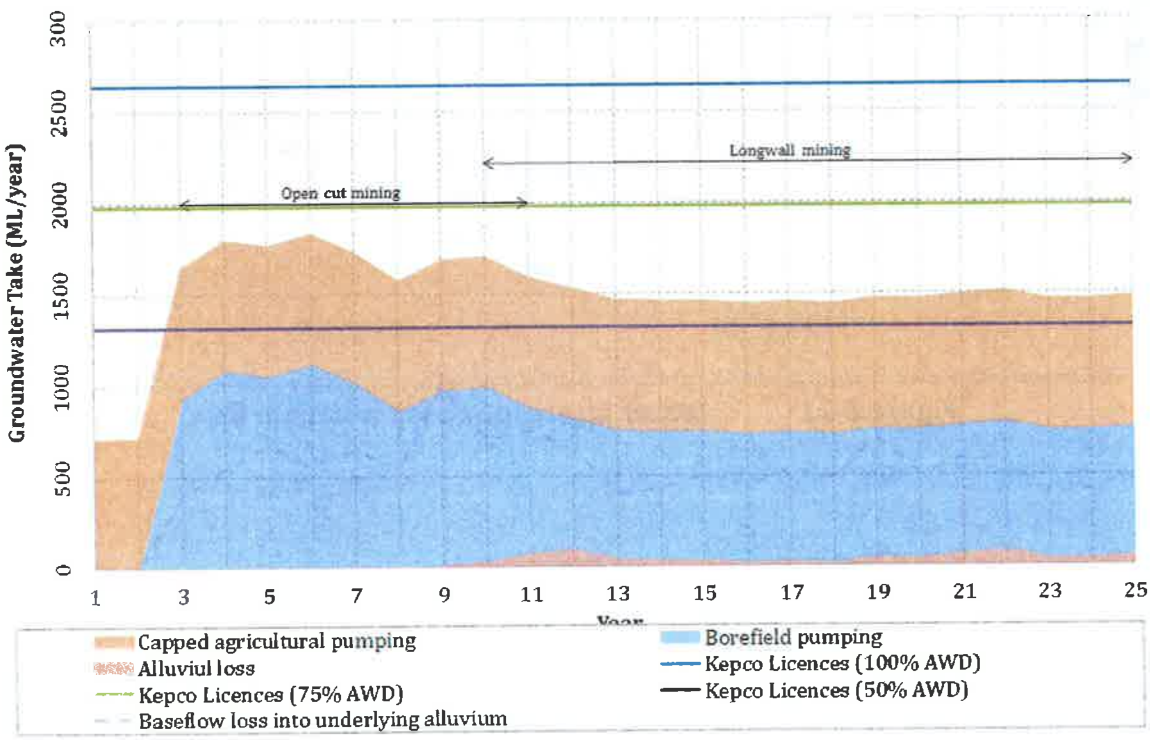


Figure 6-20 Water take from alluvium (mining interception + borefield + agriculture)

In the model, the pumping from the alluvial aquifer induces a flow of water from the surface water systems due to the lower head in the underlying aquifer. The induced flow from the surface water system is presented separately in Figure 6-21. As the change in surface water is part of the alluvial water budget, the surface water must enter the alluvium to flow to the borefield and therefore is accounted for in the well extraction and is excluded from the water licensing figure to avoid double accounting. Table 6-9 summarises the water budgets from the updated numerical model and the volumes of water required to account for water taken under the Hunter Unregulated and Alluvial Water Sources WSP and the North Coast Porous and Fractured Rock WSP. Table 6-9 demonstrates that KEPCO holds sufficient licenses to account for the water take from the alluvium. KEPCO will seek a variation to the *Water Act 1912* licence application to allow for the change to the base case modelling for extraction from the Permian strata.

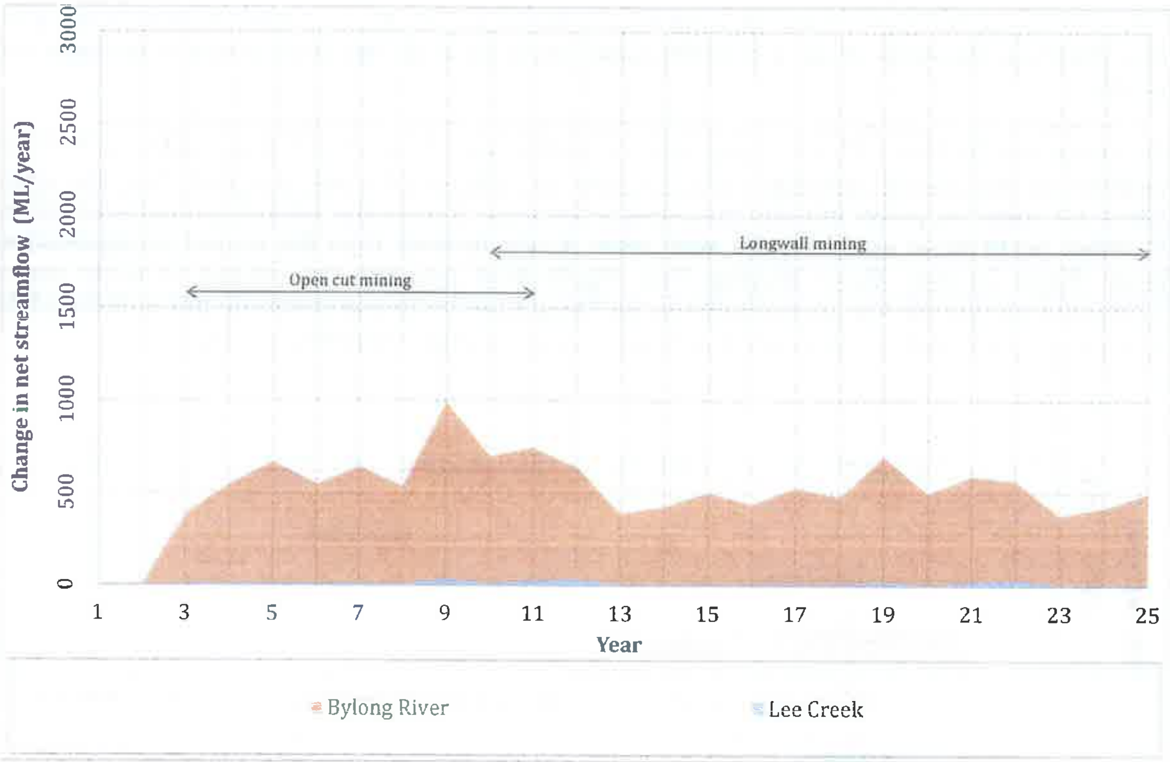


Figure 6-21 Water interception from stream flow

Table 6-9 Model water budgets and water licensing for the project

Year	Numerical model water budget item (ML/year)					Water licensing (ML/year)					
						Hunter Unregulated WSP			North Coast WSP		
	(a) Permian to alluvium flow change	(b) borefield pumping	(c) agricultural pumping (capped)	(d) stream flow change	(e) mine inflow	Surface water take (=d)	Ground water take (=a+b+c-d)	Total water take (=f+g)	Ground water take (=e)	Surface water take (=0)	Total water take (=e+0)
1	0	0	714	0	0	0	714	714	0	0	0
2	2	0	714	0	32	0	716	716	32	0	32
3	-65	1,000	714	390	51	390	1,259	1,649	51	0	51
4	-62	1,150	714	548	69	548	1,254	1,802	69	0	69
5	-46	1,100	714	670	106	670	1,098	1,768	106	0	106
6	-68	1,189	714	548	90	548	1,287	1,835	90	0	90
7	-56	1,071	714	639	80	639	1,090	1,729	80	0	80
8	-47	901	714	535	80	535	1,033	1,568	80	0	80
9	76	960	714	994	702	994	756	1,750	702	0	702
10	32	960	714	700	1675	700	1,006	1,706	1,675	0	1,675
11	74	800	714	746	2065	746	842	1,588	2,065	0	2,065
12	94	720	714	640	1812	640	888	1,528	1,812	0	1,812
13	43	710	714	390	1498	390	1,077	1,467	1,498	0	1,498
14	36	710	714	429	1148	429	1032	1,460	1,148	0	1,148
15	36	710	714	503	1006	503	957	1,460	1,006	0	1,006
16	21	710	714	441	725	441	1,004	1,445	725	0	725
17	29	710	714	528	751	528	925	1,453	751	0	751
18	18	710	714	477	1471	477	965	1,442	1,471	0	1,471

Year	Numerical model water budget item (ML/year)					Water licensing (ML/year)					
						Hunter Unregulated WSP			North Coast WSP		
	(a) Permian to alluvium flow change	(b) borefield pumping	(c) agricultural pumping (capped)	(d) stream flow change	(e) mine inflow	Surface water take (=d)	Ground water take (=a+b+c-d)	Total water take (=f+g)	Ground water take (=e)	Surface water take (=0)	Total water take (=e+0)
19	46	710	714	700	2,492	700	770	1,470	2,492	0	2,492
20	43	710	714	500	2,776	500	967	1,467	2,776	0	2,776
21	65	710	714	590	3,387	590	899	1,489	3,387	0	3,387
22	85	710	714	564	2,999	564	944	1,509	2,999	0	2,999
23	37	710	714	380	4,099	380	1,082	1,461	4,099	0	4,099
24	45	710	714	423	3,202	423	1,046	1,469	3,202	0	3,202
25	45	710	714	499	3,952	499	970	1,469	3,952	0	3,952

6.4.8 Borefield yield

The uncertainty analysis comprised 140 separate model runs with parameters varying randomly between the ranges outlined within Section 6.4.4. The yield from the proposed borefield was extracted for each model run to determine the potential to meet the estimated demand for makeup water. The data from the 140 model runs was used to calculate the proportion of the 140 model runs that failed to meet the upper makeup water demand presented within the RTS. Figure 6-22 shows the estimated makeup water demand presented within the EIS and RTS as well as the percentage of model runs that fell below the make up water demand.

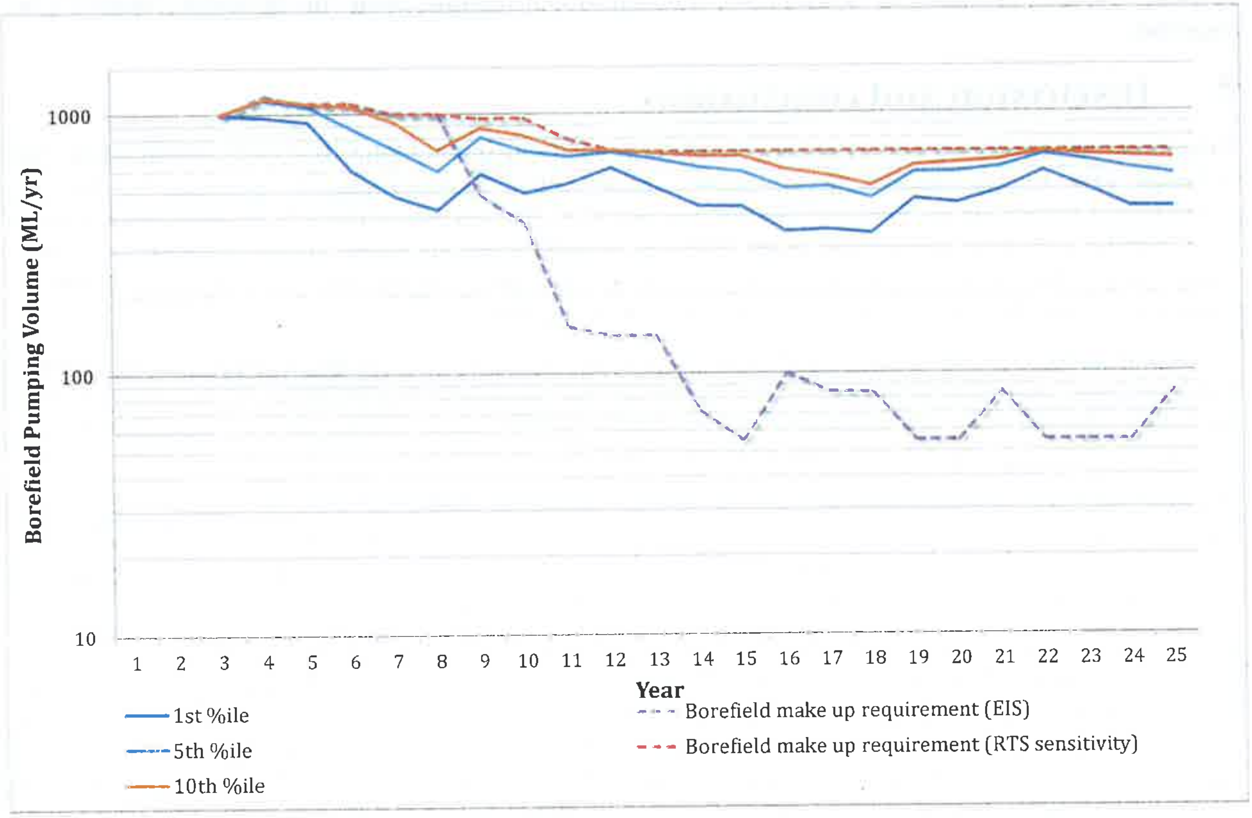


Figure 6-22 Uncertainty in borefield yield

Figure 6-22 indicates the borefield in the majority of the model runs was capable of supplying the make up water estimated within the RTS as a sensitivity. The figure shows the 1st and 5th percentiles for borefield pumping fall slightly below the RTS sensitivity make up water demand, with the 10th percentile falling below the demand intermittently.

Figure 6-22 indicates when the model is recalibrated to account for the higher hydraulic conductivity and storage determined from the pumping test program, the potential for the borefield to supply the make up water increases significantly. The basecase model can supply the make up water along with the majority of the models developed for the uncertainty analysis. This was achieved with a reduced borefield of eight bores installed within the alluvials throughout the Project Boundary. In the unlikely scenario that the borefield cannot meet the demand for make up water, there remains sufficient area to augment the borefield with additional bores. It should be noted that the scenarios where the borefield does not supply the entire makeup water demand are the extremes in both the groundwater and surface water models. Therefore, this outcome is improbable. However as noted in the RTS, should climatic conditions limit yield from the borefield, there will be appropriate contingency measures to implement.

As outlined in Section 6.4.6 the updated basecase model predicts reduced inflow to the open cut mine, but periods of increase in inflow during underground mining. WRM (2016) considered how this change in the mine inflow could influence the need to supplement the mine water circuit with additional water from the borefield. WRM (2016) concluded *"the annual bore water requirements will reduce to zero from PY12, as high groundwater inflows to the underground operations are predicted."* Between Project Years one to 12, the water balance model indicated additional water required from the borefield could increase from 79ML/yr to 304ML/yr for the 1st percentile scenario. This volume of water is expected to be available by augmenting the proposed borefield with an additional one or two bores within the most productive zones of the Bylong River alluvial aquifer. Adequate water access licenses are also available to account for this additional demand from the borefield should it be required.

7 Discussion and conclusions

The additional field work and numerical modelling has indicated a higher hydraulic conductivity and recharge rate to the alluvial groundwater system than that previously assumed within the groundwater modelling presented in the EIS and the RTS. The impact of this is to improve the capacity for a smaller borefield comprising eight bores to supply make up water during periods of surface water deficit. In the unlikely scenario that the borefield fails to supply the makeup water, it can be augmented with additional bore sites within the alluvial aquifer.

The pumping bore locations were selected to be more than 200 m from the vegetation communities that have been identified as potentially GDEs. Whilst the vegetation communities are not listed within the Water Sharing Plan and therefore do not require buffer zones, a conservative approach for the placement of these pumping bores has been was adopted.

The predicted take of water from the alluvial aquifer via the borefield and from the indirect impacts of mining on the alluvial water source remains less than the total volume of entitlements held by KEPCO for all scenarios modelled to date. The Project will therefore not impact upon water security under the Hunter Unregulated and Alluvial Water Sources Water Sharing Plan.

KEPCO has also applied for a water license under the *Water Act 1912* for the predicted water takes from the Permian. KEPCO understands DPI Water has assessed its earlier application under the *Water Act 1912* and will transfer the relevant license to the North Coast Porous and Fractured Rock Water Sharing Plan and will be issued based on the revised numerical modelling estimates of inflow to the mine. A water access license allowing extraction of up to 4,100 ML/year will account for the peak annual water take in the base case. There is no other known licenced usage of water from the North Coast Porous and Fractured Rock Water Sharing Plan in the vicinity of the Project, and therefore this access license is not expected to affect water security within the region.

As groundwater will be extracted directly from the borefield and the mining areas, as well as indirectly via mining depressurisation, measurement of groundwater volumes will be important. The Water Management Plan will outline a program to install flow meters and level loggers on selected agricultural bores operated by KEPCO and the borefield utilised for the Project. KEPCO have also installed water level loggers on selected surrounding agricultural properties and will continue to undertake this upon request. Monitoring of the volume of water pumped into and out of the open cut and underground mines will also be required to estimate the volume of groundwater entering the mining areas.

The closest private bores within the alluvium in proximity to the Project are located on the Eagle Hill property (receiver 60). The modelling has indicated that for all modelling scenarios, impacts will be less than 1 m for these three private bores, with a maximum drawdown of 0.1 m on the Eagle Hill property for the base case Therefore the statement within the EIS that *'there are no bores on privately held land where the drawdown is predicted by the numerical model to be greater than 0.1 m at any time'* remains unchanged for the updated base case version of the model. The Water Management Plan will outline a program for monitoring water levels within the alluvial aquifer between the private property and the borefield to monitor changes over time and to ensure that the private landholder is not impacted.

8 References

Australasian Groundwater and Environmental Consultants Pty Ltd (2013), "Bylong Coal Project Bylong Coal Project Gateway Groundwater Study", prepared for Hansen Bailey Pty Ltd, Project No. G1606, December 2013.

Australasian Groundwater and Environmental Consultants Pty Ltd (2015), "*Bylong Coal Project Groundwater Impact Assessment*", prepared for Hansen Bailey Pty Ltd, Project No. G1606, June 2015.

Australasian Groundwater and Environmental Consultants Pty Ltd (2016), "*Bylong Coal Project Response to Submissions on Groundwater*", prepared for Hansen Bailey Pty Ltd, Project No. G1606E, March 2016.

Doherty, John. (2015) "*Watermark Numerical Computing, Calibration and Uncertainty Analysis for Complex Environmental Models*".

WRM (2016) Memorandum - Bylong Coal Project – Water Balance Modelling for Revised Groundwater Inflows (Base Case), 14 July 2016

Appendix A Borehole logs and construction details

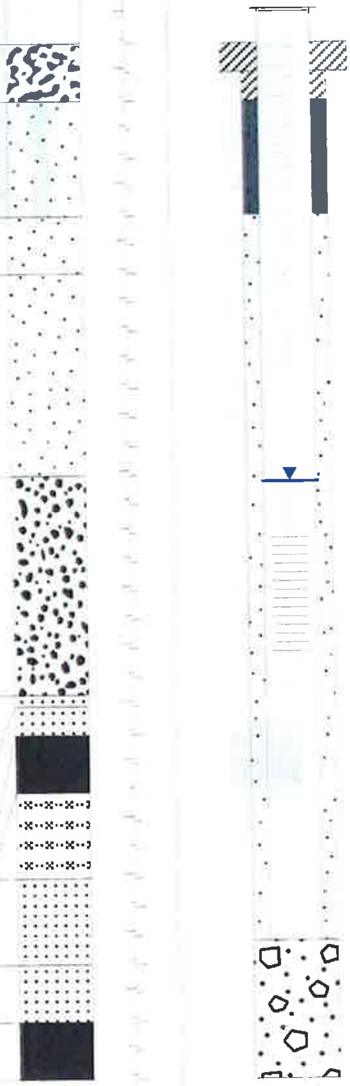
Australasian Groundwater & Environmental Consultants Pty Ltd

BOREHOLE LOG

AGE21P

G1606F	Gricks Drilling	230402.8 mE
Bylong borefield installation	S. Gricks	6407017.53 mN
19.03.2016	Mud Rotary	MGA94 (z56)
T.Walters (AGE)	Gardner Denver 1500W	275.42 mAHD
		18 mBGL

Pumping bore.



Bore development: 3.5 hr; EC: 655 µS/cm; pH:

Australasian Groundwater & Environmental Consultants Pty Ltd

BOREHOLE LOG

AGE22M

G1606F
Bylong borefield installation
21.03.2016
B.McKay (AGE)
Alluvial monitoring bore.

Hagstrom Drilling
S. Mortimer
Mud Rotary
Hydrapower scout

230405.74 mE
6407002.82 mN
MGA94 (z56)
275.67 mAHD
18 mBGL

Australasian Groundwater & Environmental Consultants Pty Ltd

BOREHOLE LOG

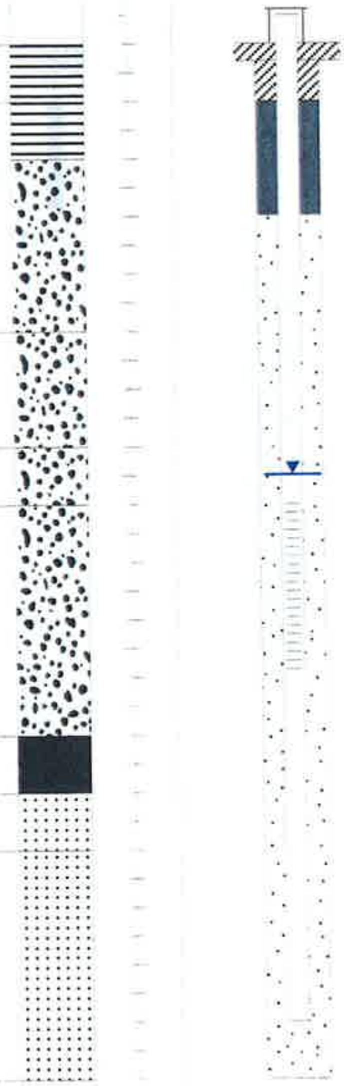
AGE23M

G1606F
Bylong borefield installation
23.03.2016
B.McKay (AGE)

Hagstrom Drilling
S. Mortimer
Mud Rotary
Hydrapower scout

230408.72 mE
6406988.01 mN
MGA94 (z56)
275.5 mAHD
18 mBGL

Alluvial monitoring bore.

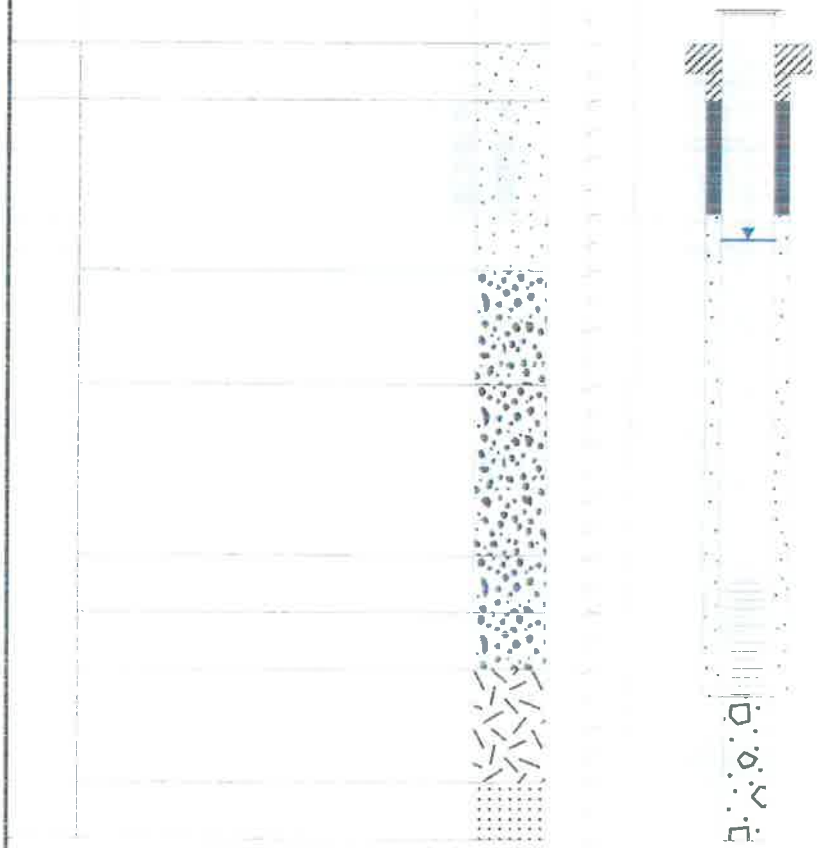


Australasian Groundwater & Environmental Consultants Pty Ltd

BOREHOLE LOG

AGE24P

G1606F	Gricks Drilling	230335.7 mE
Bylong borefield installation	S. Gricks	6408249.8 mN
20.03.2016	Mud Rotary	MGA94 (z56)
B.McKay (AGE)	Gardner Denver 1500W	267.07 mAHD
Alluvial pumping bore.		14 mBGL



Bore development: 1.4 hr; EC: 1669 μS/cm; pH:

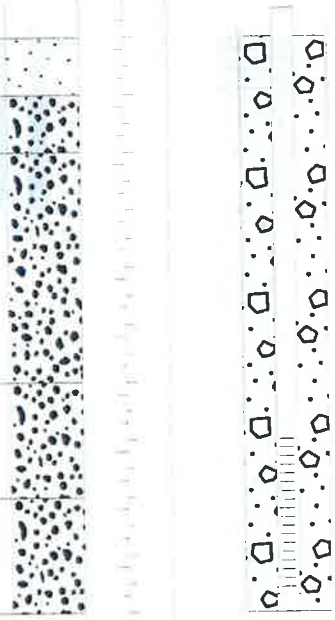
Australasian Groundwater & Environmental Consultants Pty Ltd

BOREHOLE LOG

AGE25M

G1606F	Hagstrom Drilling	230333.2 mE
Bylong borefield installation	S. Mortimer	6408259.1 mN
01.04.2016	Mud Rotary	MGA94 (z56)
B.McKay (AGE)	Hydrapower scout	267.21 mAHD
		10 mBGL

PVC used to prevent collapsing hole. Failed hole, bit refusal at 10m.

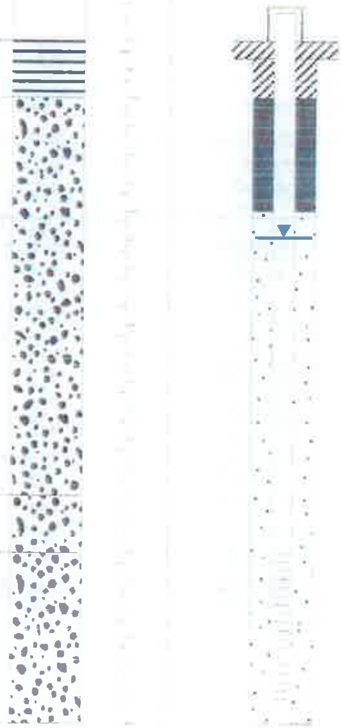


Australasian Groundwater & Environmental Consultants Pty Ltd

BOREHOLE LOG

AGE26M

G1606F	Hagstrom Drilling	230338.9 mE
Bylong borefield installation	S. Mortimer	6408244.7 mN
01.04.2016	Mud Rotary	MGA94 (z56)
B.McKay (AGE)	Hydrapower scout	267.19 mAHD
Alluvial monitoring bore.		12 mBGL



Australasian Groundwater & Environmental Consultants Pty Ltd

BOREHOLE LOG

AGE27M

G1606F	Hagstrom Drilling	230343.2 mE
Bylong borefield installation	S. Mortimer	6408240.9 mN
01.04.2016	Mud Rotary	MGA94 (z56)
B.McKay (AGE)	Hydrapower scout	267.34 mAHD
		12 mBGL

Alluvial monitoring bore.

Australasian Groundwater & Environmental Consultants Pty Ltd

BOREHOLE LOG

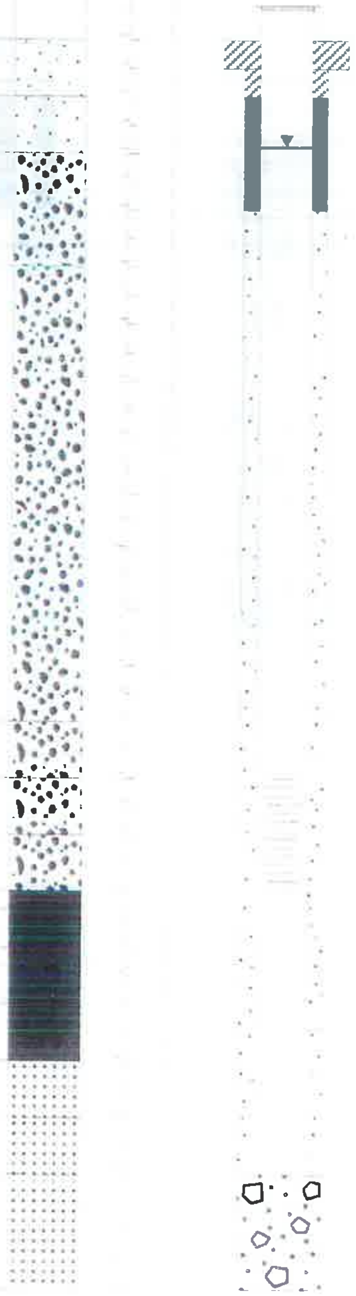
AGE28P

G1606F
Bylong borefield installation
04.04.2016
B.McKay (AGE)

Gricks Drilling
S. Gricks
Mud Rotary
Gardner Denver 1500W

232022.9 mE
6406186.7 mN
MGA94 (z56)
283.91 mAHD
22 mBGL

Alluvial pumping bore southern Tarwyn Park.



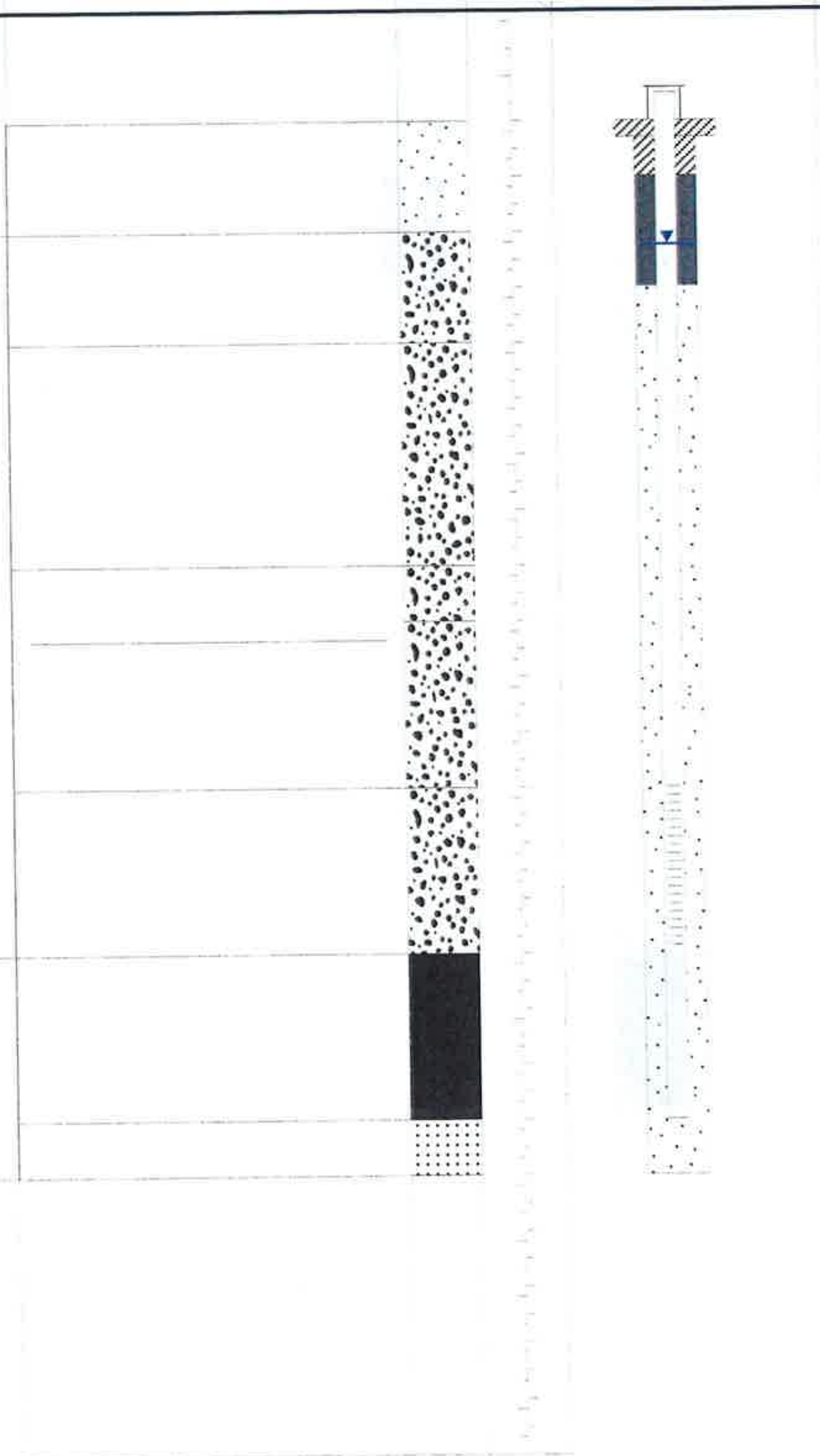
Bore development: 1.1 hr; EC: 407 μS/cm; pH:

Australasian Groundwater & Environmental Consultants Pty Ltd

BOREHOLE LOG

AGE29M

G1606F	Hagstrom Drilling	232047.4 mE
Bylong borefield installation	S. Mortimer	6406165.6 mN
04.04.2016	Mud Rotary	MGA94 (z56)
B.McKay (AGE)	Hydrapower scout	284.19 mAHD
Alluvial monitoring bore southern Tarwyn Park.		19 mBGL

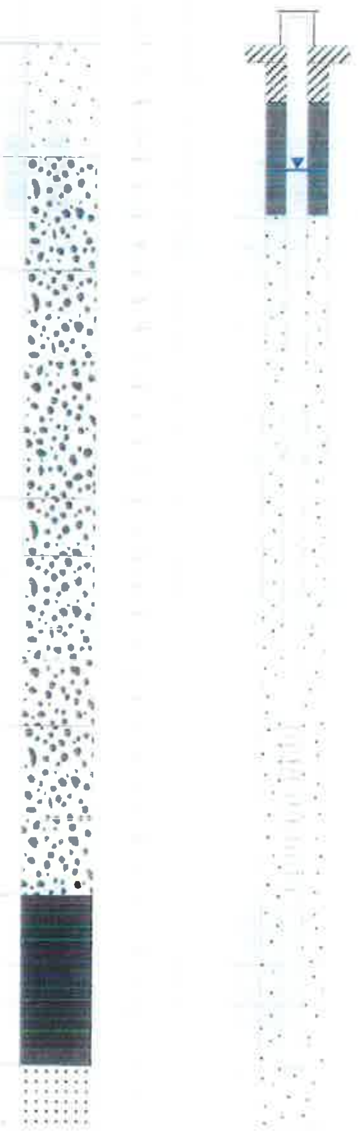


Australasian Groundwater & Environmental Consultants Pty Ltd

BOREHOLE LOG

AGE30M

G1606F	Hagstrom Drilling	232035.4 mE
Bylong borefield installation	S. Mortimer	6406175.6 mN
04.04.2016	Mud Rotary	MGA94 (z56)
B.McKay (AGE)	Hydrapower scout	284.03 mAHD
Alluvial monitoring bore southern Tarwyn Park.		19 mBGL



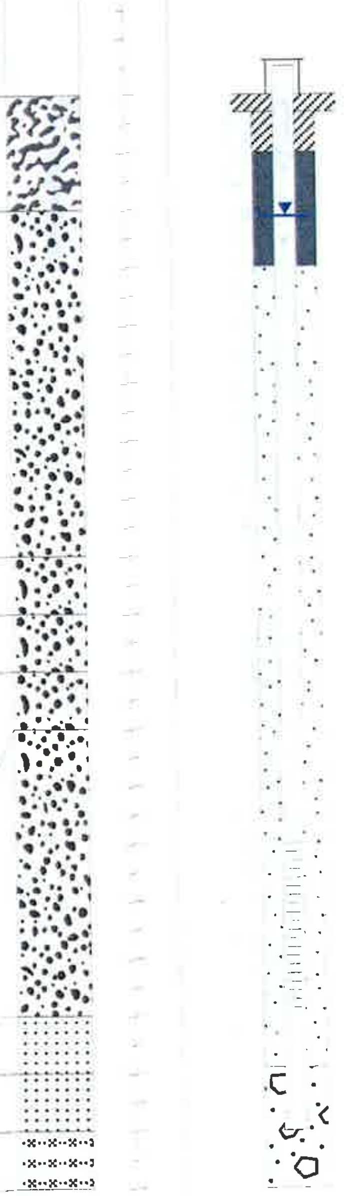
Australasian Groundwater & Environmental Consultants Pty Ltd

BOREHOLE LOG

AGE31M

G1606F	Hagstrom Drilling	231762.56 mE
Bylong borefield installation	S. Mortimer	6406941.95 mN
14.04.2016	Mud Rotary	MGA94 (z56)
T.Walters (AGE)	Hydrapower scout	279.03 mAHD
		19 mBGL

Alluvial monitoring bore on Tarwyn Park.

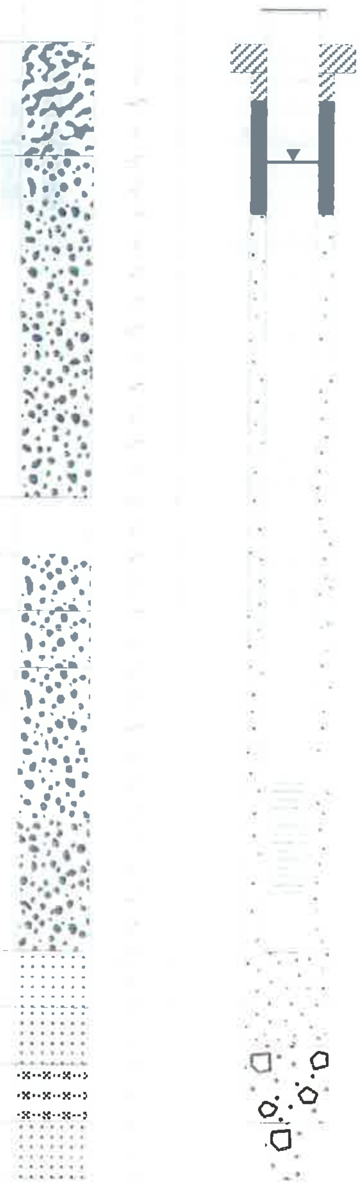


Australasian Groundwater & Environmental Consultants Pty Ltd

BOREHOLE LOG

AGE32P

G1606F	Gricks Drilling	231768.38 mE
Bylong borefield installation	S. Gricks	6406929.72 mN
16.04.2016	Mud Rotary	MGA94 (z56)
T.Walters (AGE)	Gardner Denver 1500W	279.08 mAHD
Alluvial pumping bore on Tarwyn Park.		20 mBGL



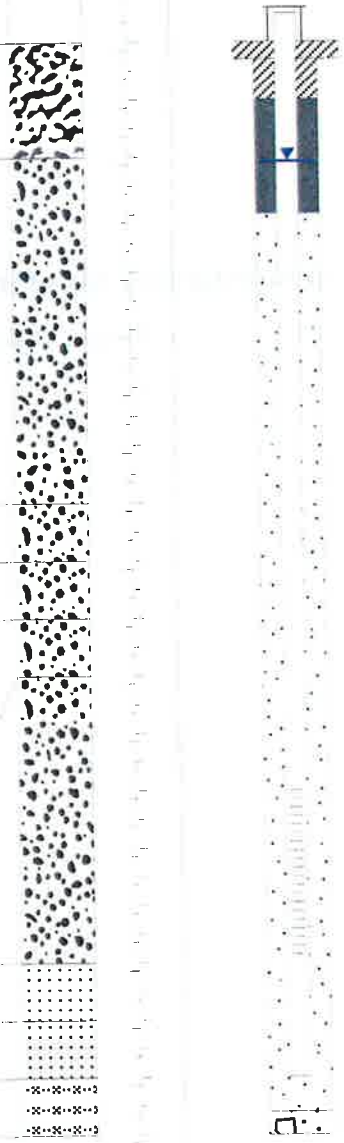
Bore development: 4 hr; EC: 460 µS/cm; pH: 7.11

Australasian Groundwater & Environmental Consultants Pty Ltd

BOREHOLE LOG

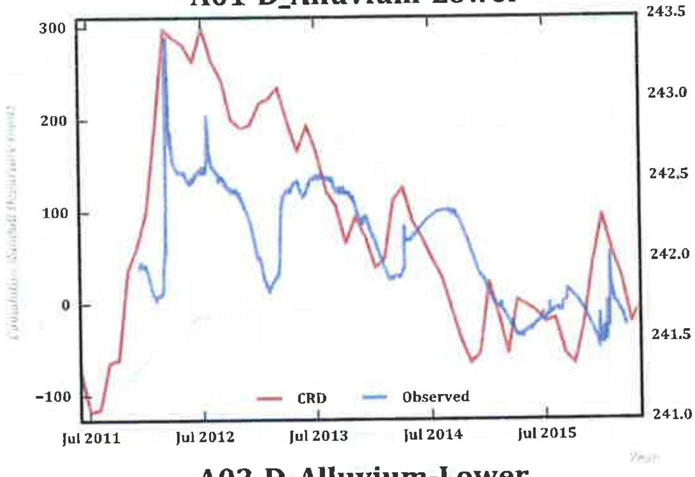
AGE33M

G1606F	Hagstrom Drilling	231774.97 mE
Bylong borefield installation	S. Mortimer	6406915.71 mN
16.04.2016	Mud Rotary	MGA94 (z56)
T.Walters (AGE)	Hydrapower scout	279.14 mAHD
Alluvial monitoring bore on Tarwyn Park.		19 mBGL

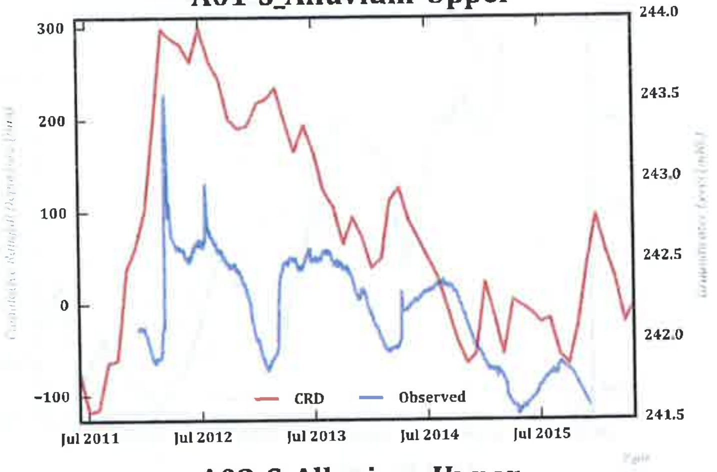


Appendix B Groundwater level monitoring data

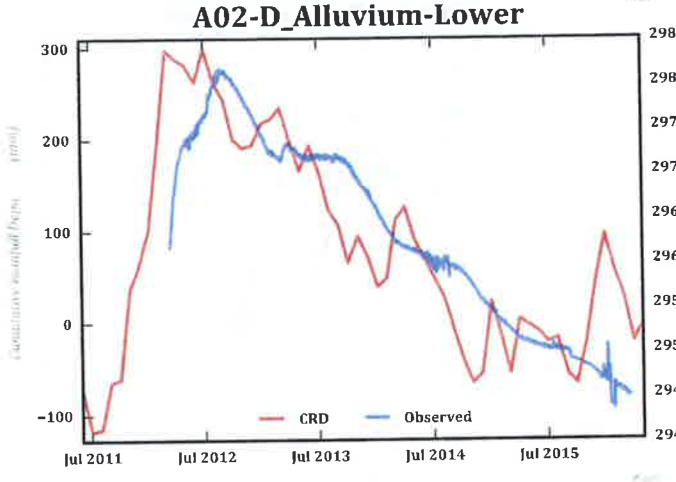
A01-D_Alluvium-Lower



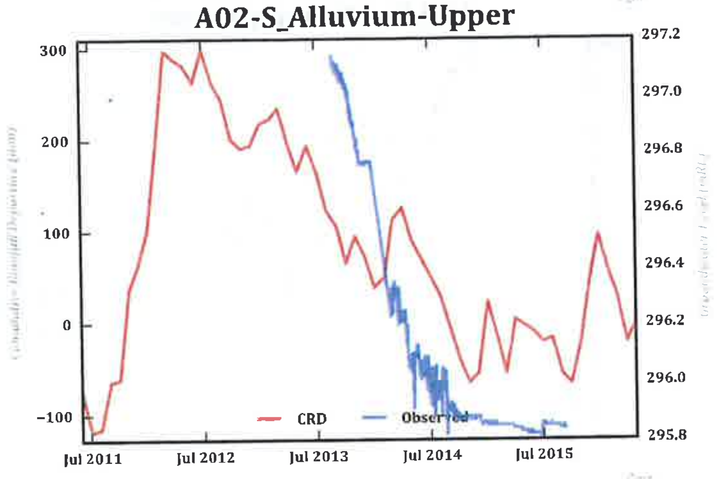
A01-S_Alluvium-Upper



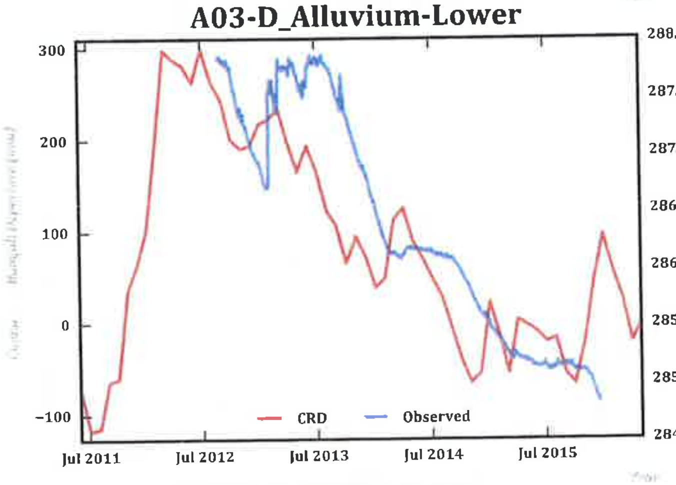
A02-D_Alluvium-Lower



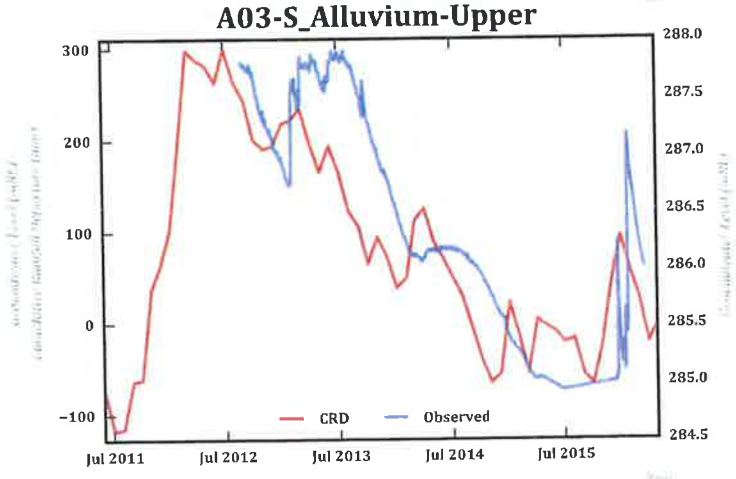
A02-S_Alluvium-Upper



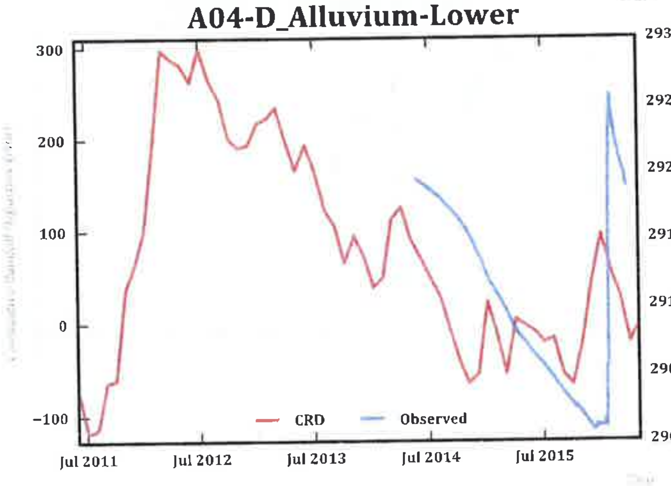
A03-D_Alluvium-Lower



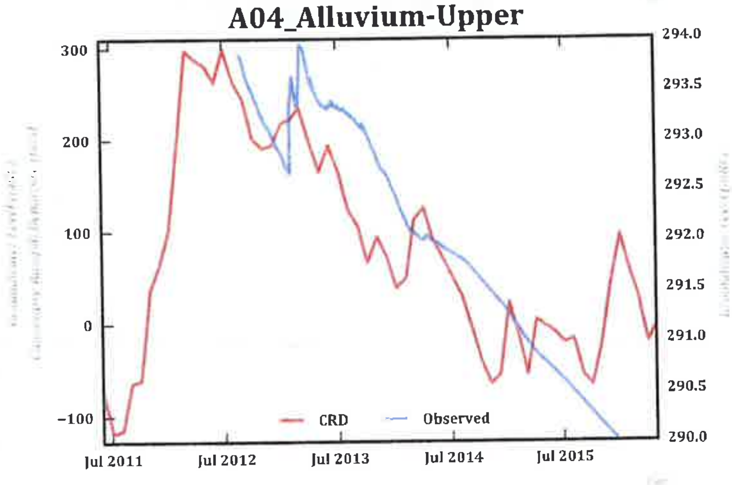
A03-S_Alluvium-Upper



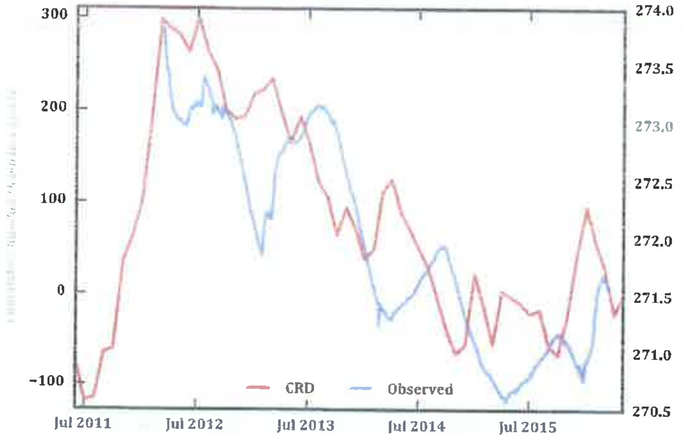
A04-D_Alluvium-Lower



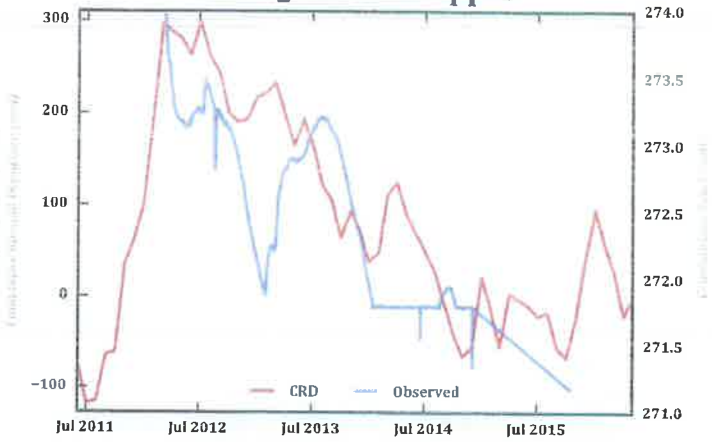
A04_Alluvium-Upper



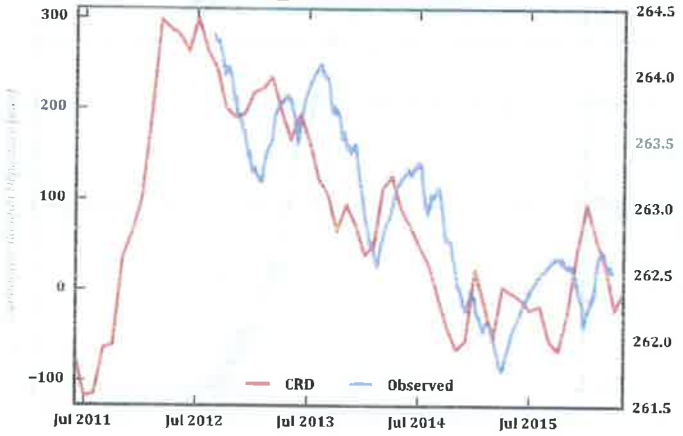
A06-D_Alluvium-Lower



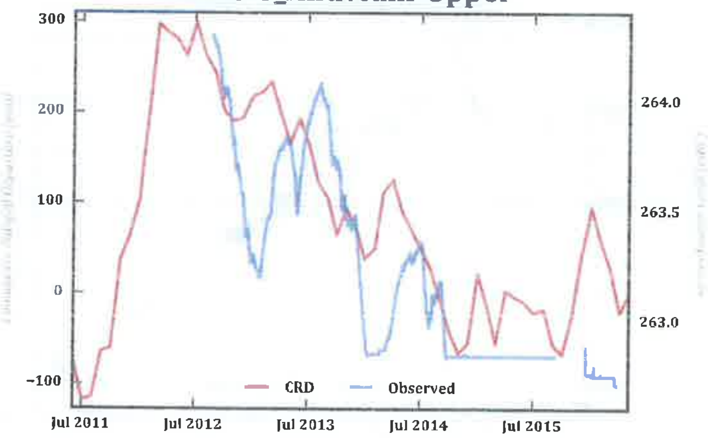
A06-S_Alluvium-Upper



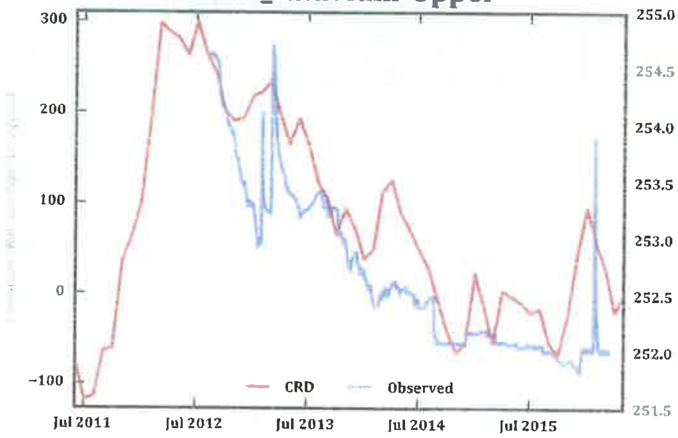
A08-D_Alluvium-Lower



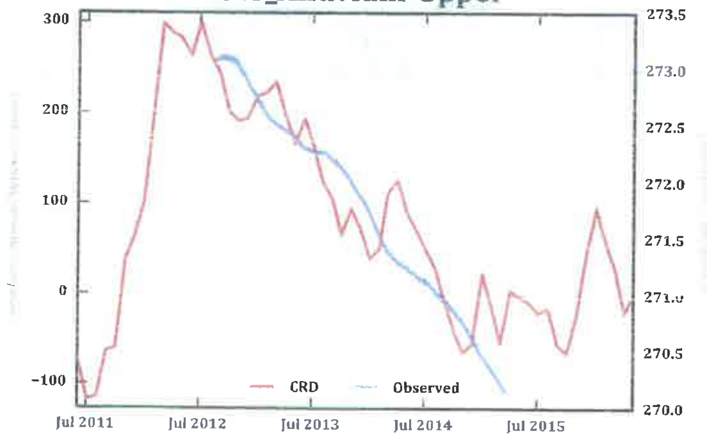
A08-S_Alluvium-Upper



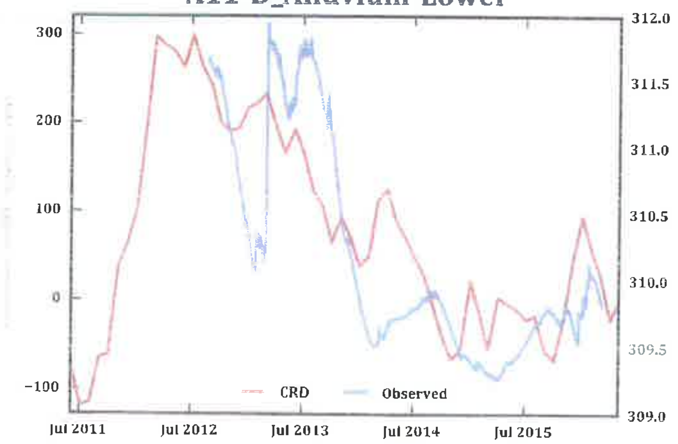
A09_Alluvium-Upper



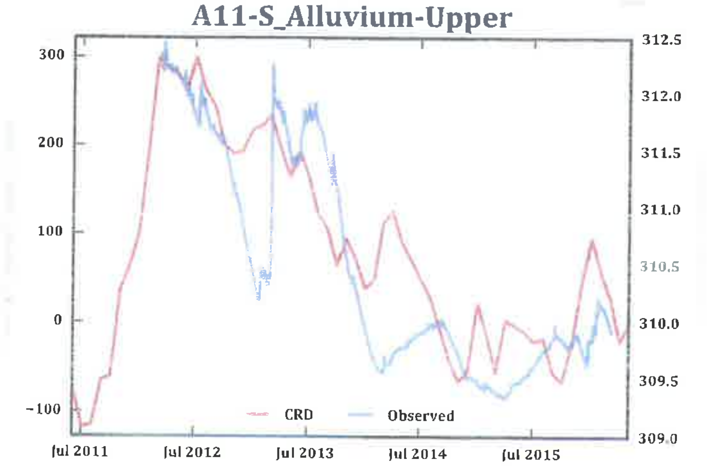
A10_Alluvium-Upper



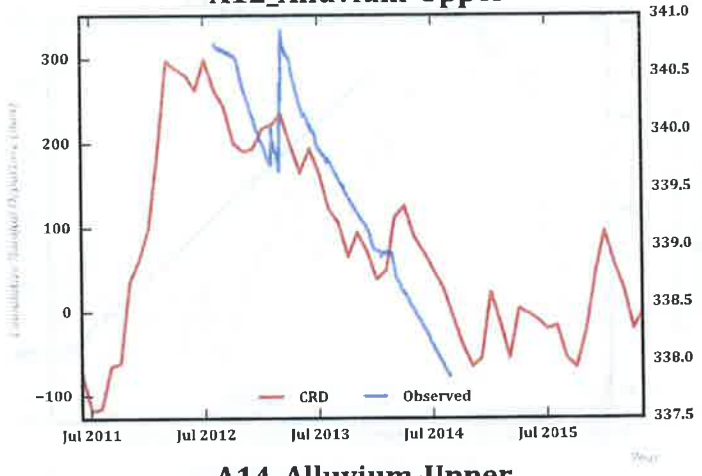
A11-D_Alluvium-Lower



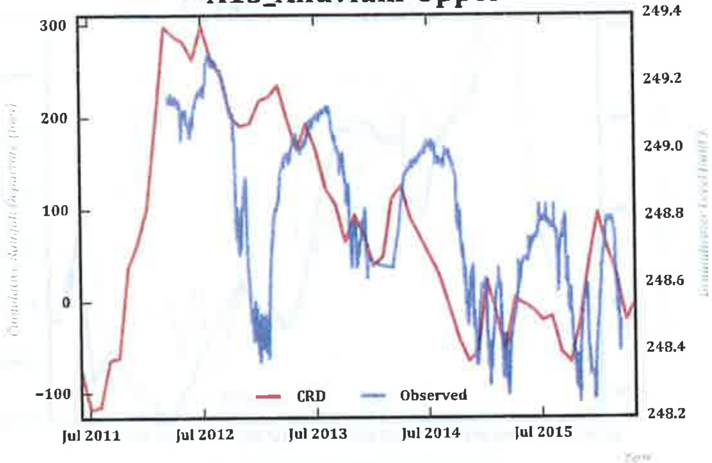
A11-S_Alluvium-Upper



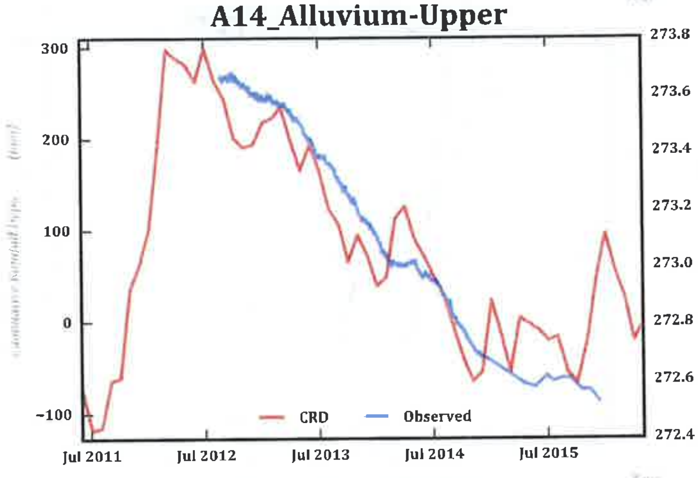
A12_Alluvium-Upper



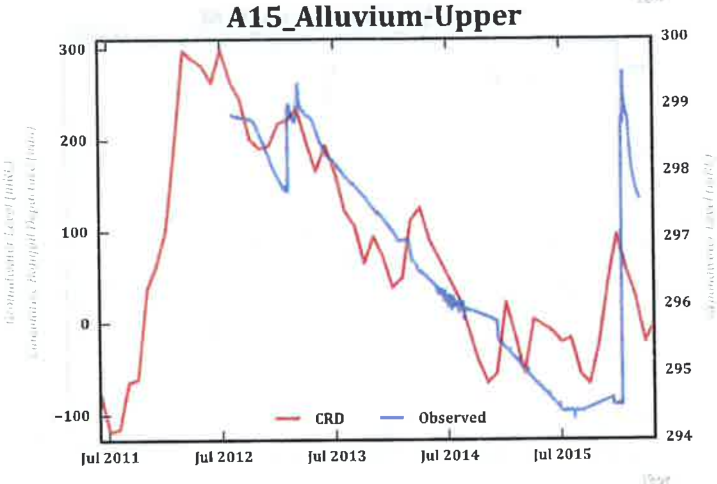
A13_Alluvium-Upper



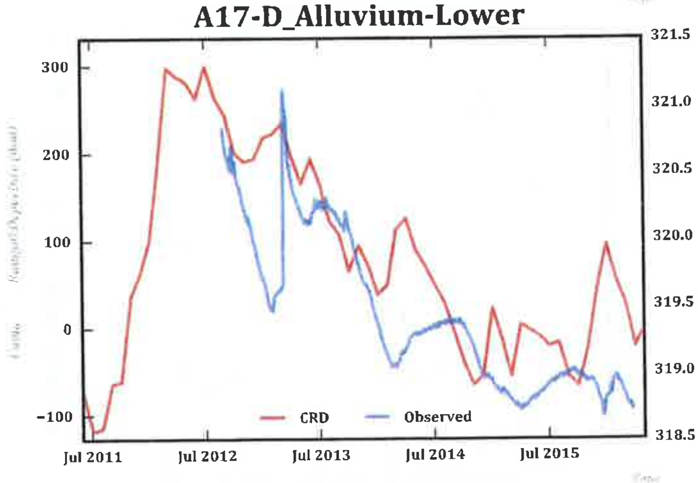
A14_Alluvium-Upper



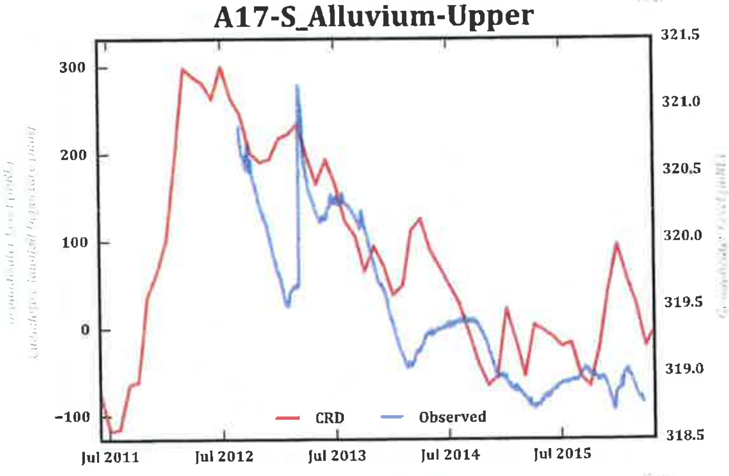
A15_Alluvium-Upper



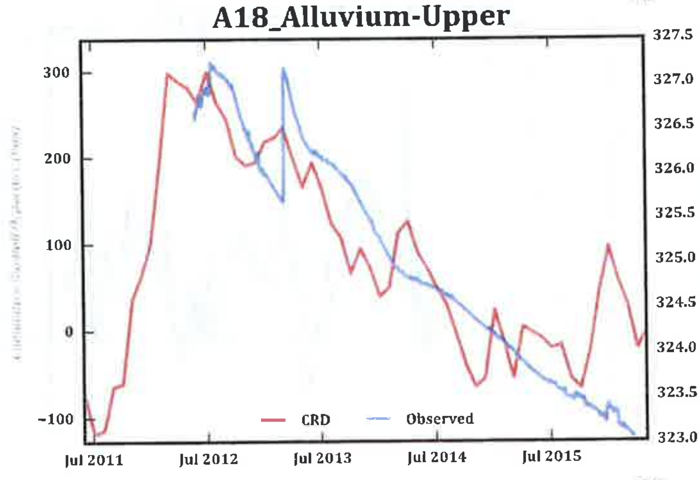
A17-D_Alluvium-Lower



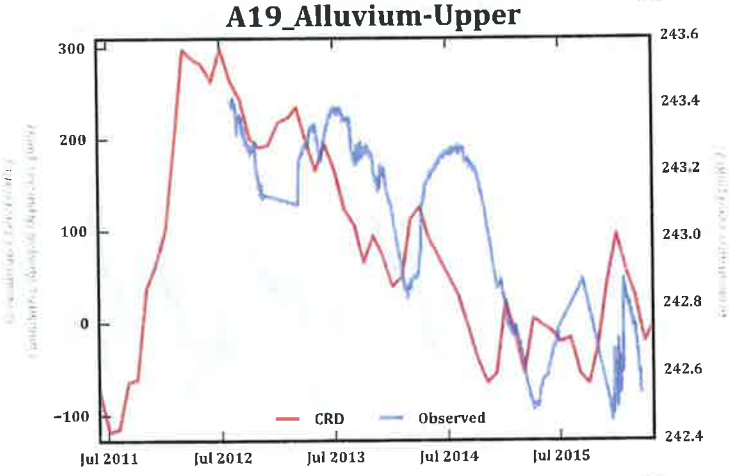
A17-S_Alluvium-Upper



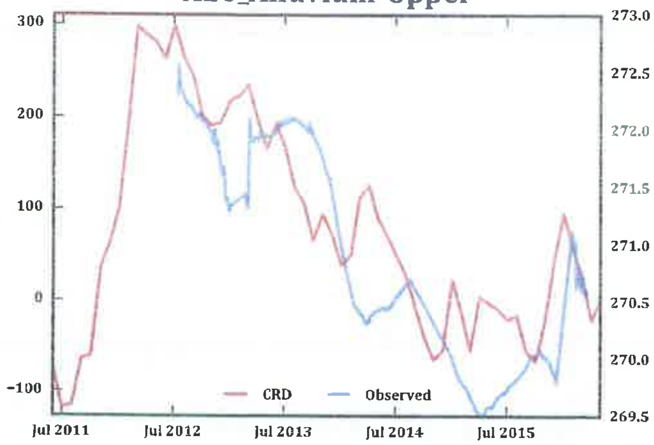
A18_Alluvium-Upper



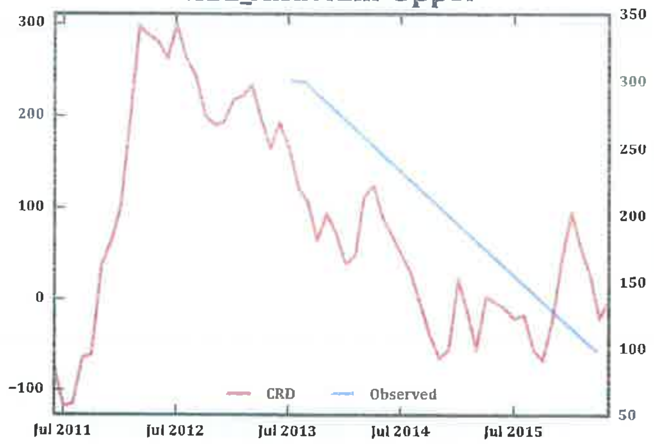
A19_Alluvium-Upper



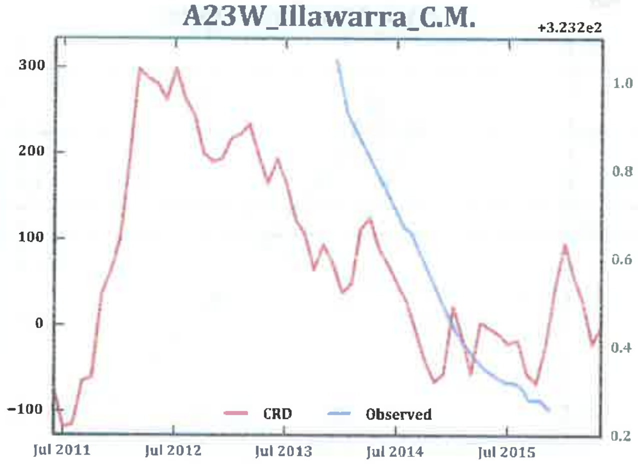
A20_Alluvium-Upper



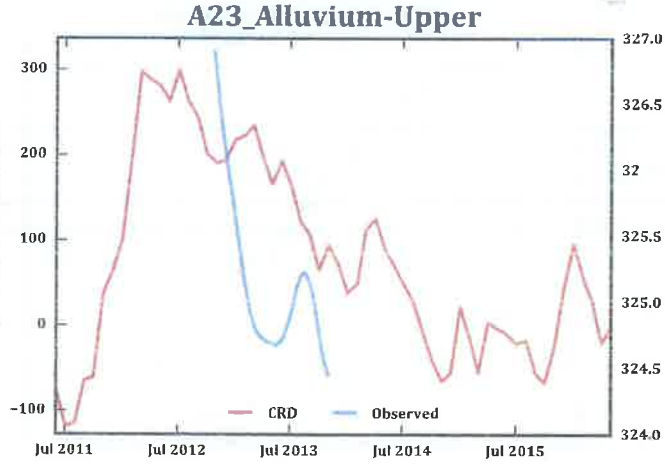
A21_Alluvium-Upper



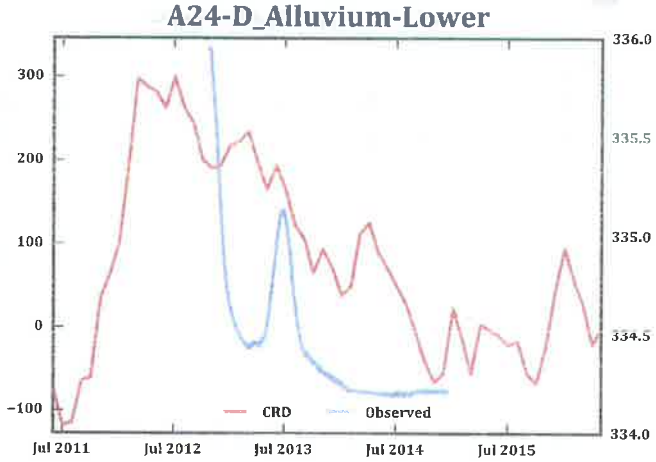
A23W_Illawarra_C.M.



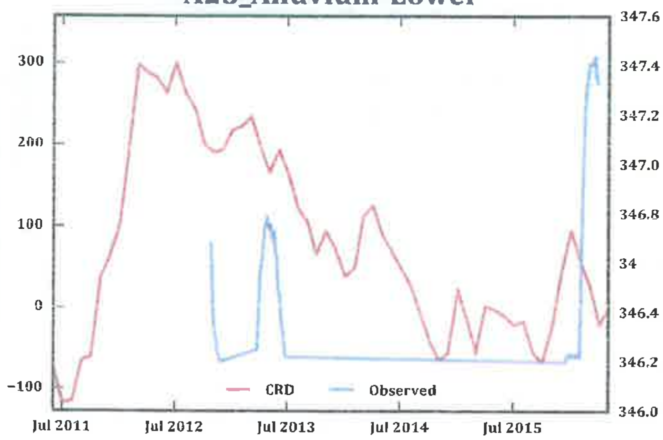
A23_Alluvium-Upper



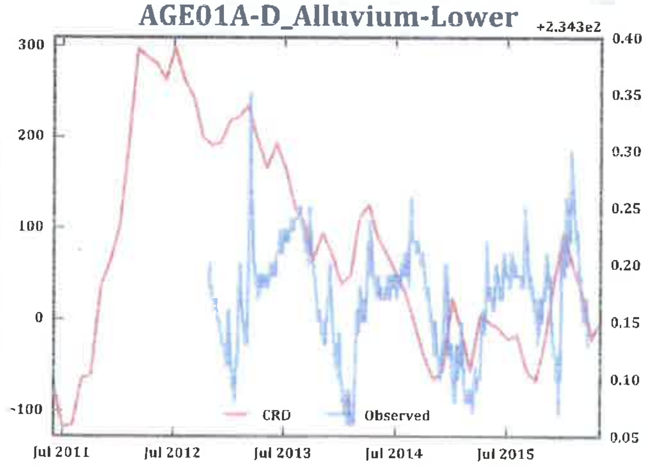
A24-D_Alluvium-Lower



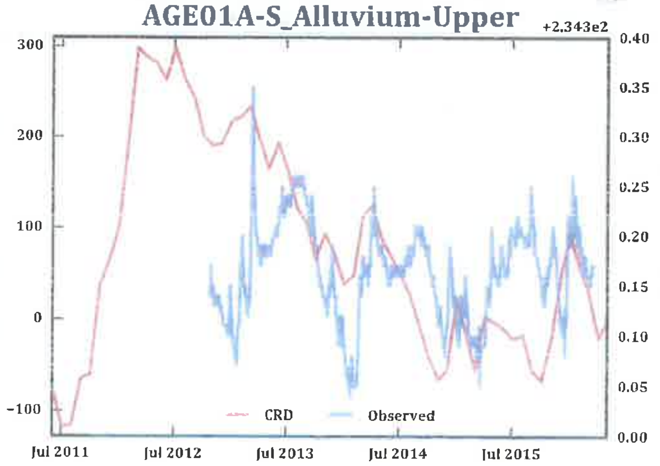
A25_Alluvium-Lower

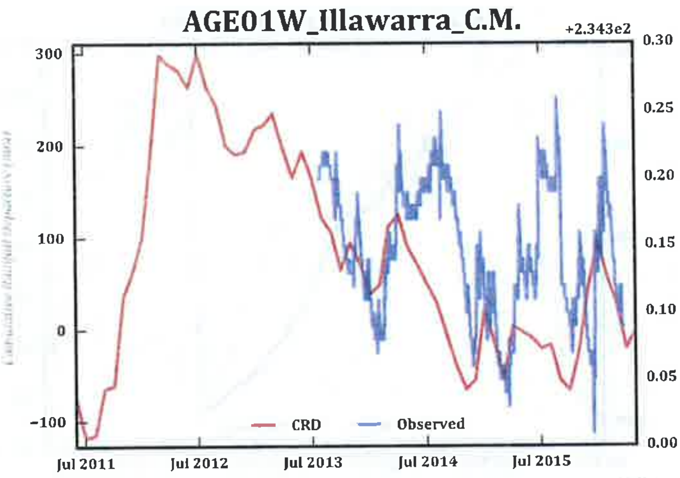


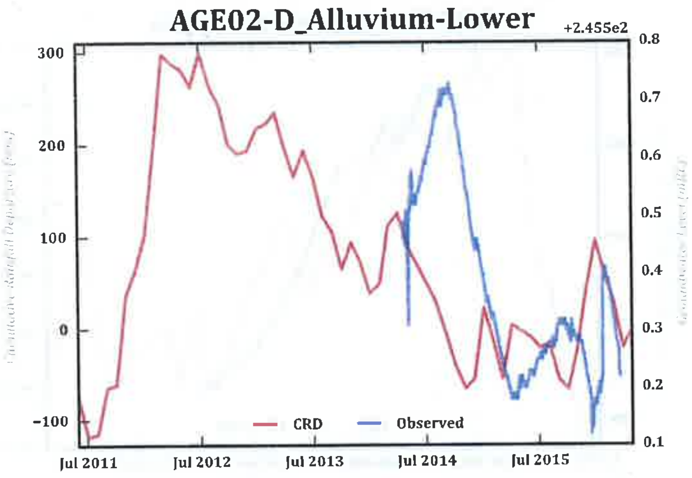
AGE01A-D_Alluvium-Lower

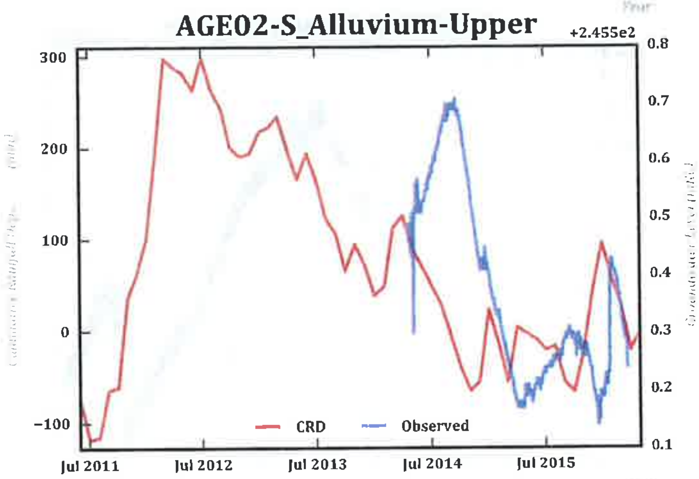


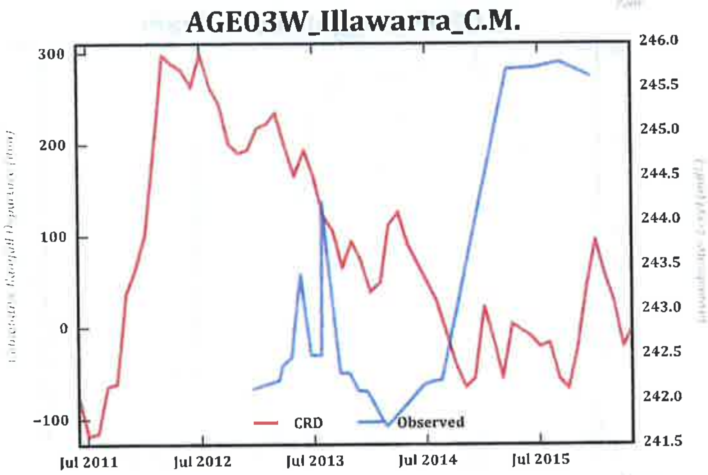
AGE01A-S_Alluvium-Upper

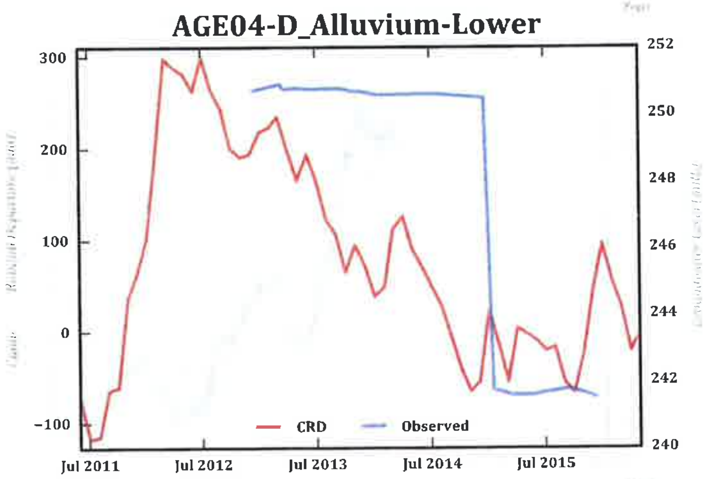


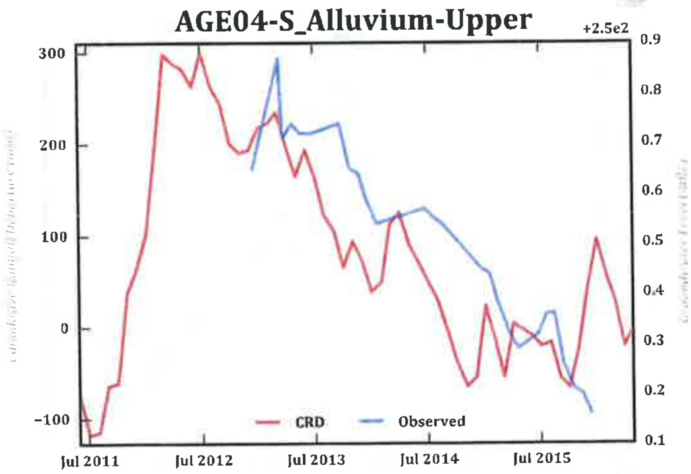

AGE01W_Illawarra_C.M.
+2.343e2
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015

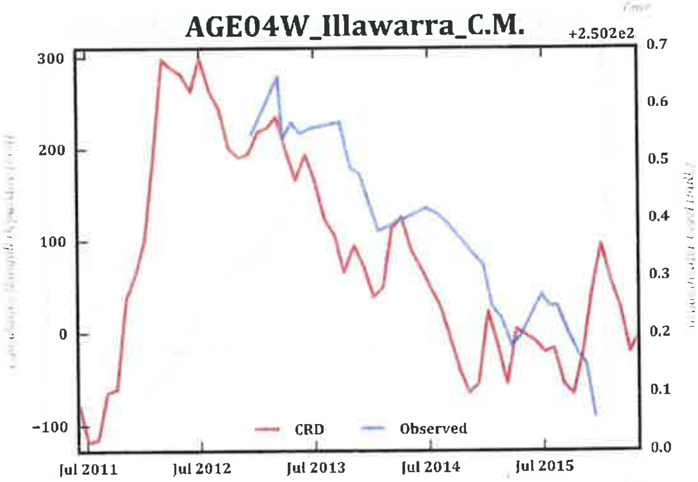

AGE02-D_Alluvium-Lower
+2.455e2
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015

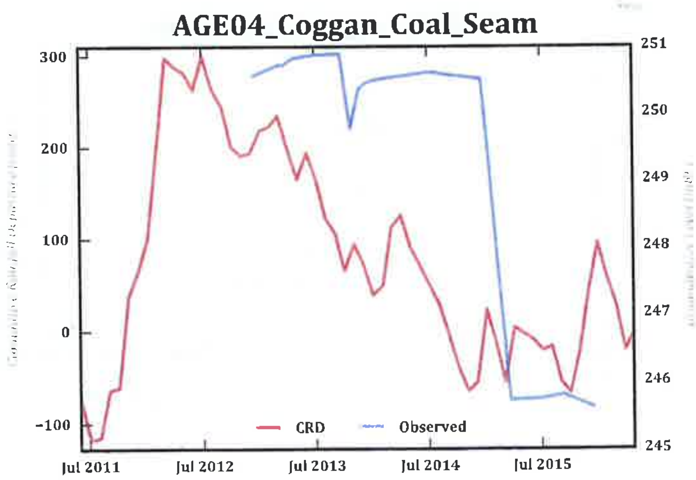

AGE02-S_Alluvium-Upper
+2.455e2
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015


AGE03W_Illawarra_C.M.
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015

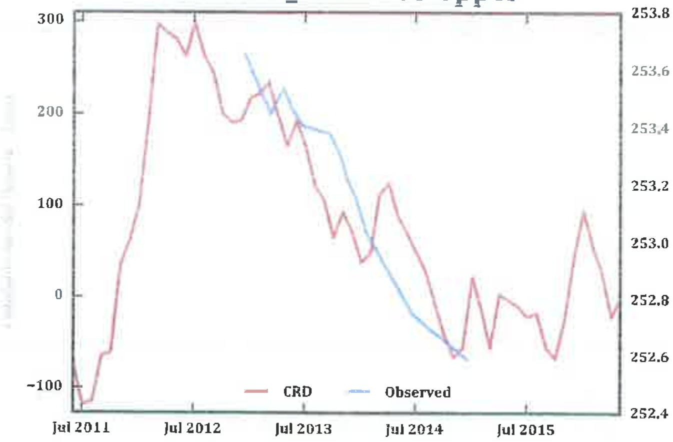

AGE04-D_Alluvium-Lower
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015


AGE04-S_Alluvium-Upper
+2.5e2
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015

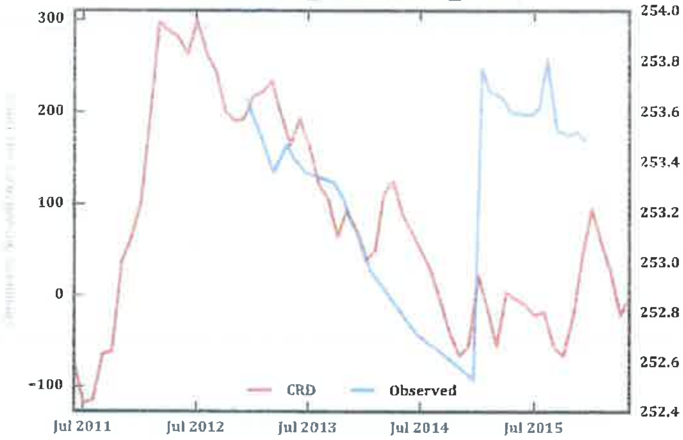

AGE04W_Illawarra_C.M.
+2.502e2
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015


AGE04_Coggan_Coal_Seam
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015

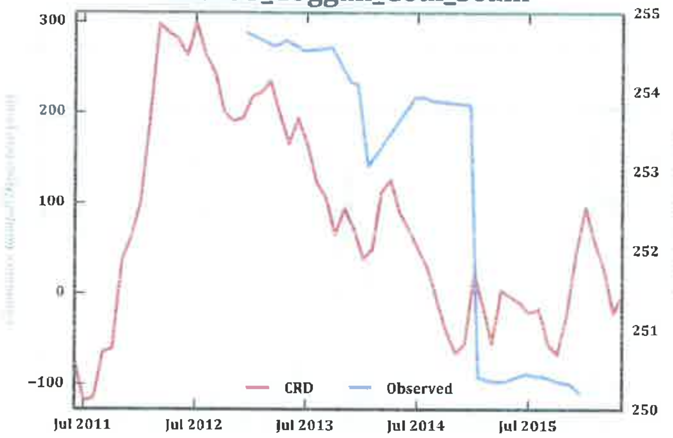
AGE05A_Alluvium-Upper



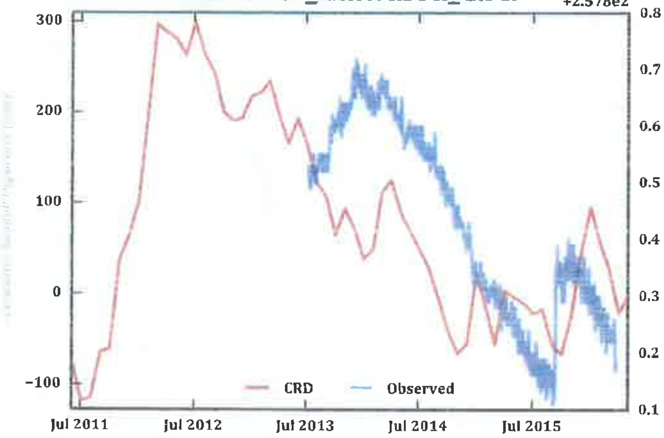
AGE05W_Illawarra_C.M.



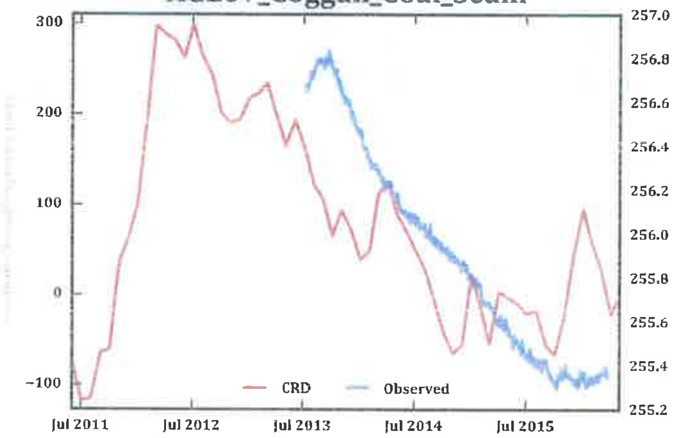
AGE05_Coggan_Coal_Seam



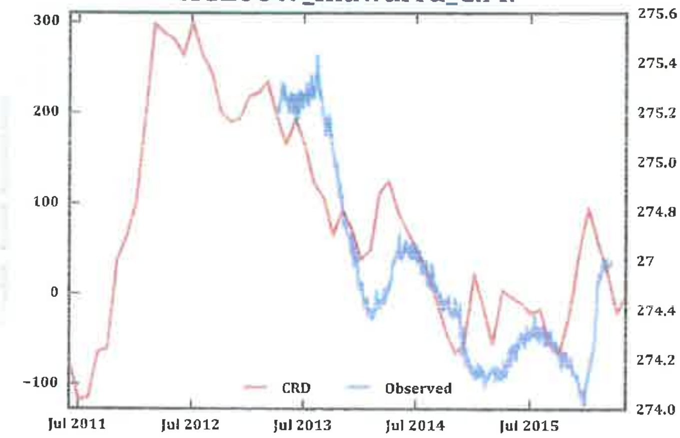
AGE07W_Illawarra_C.M.



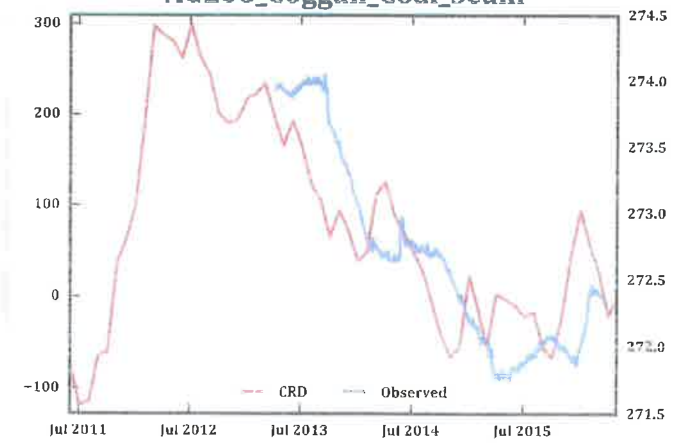
AGE07_Coggan_Coal_Seam



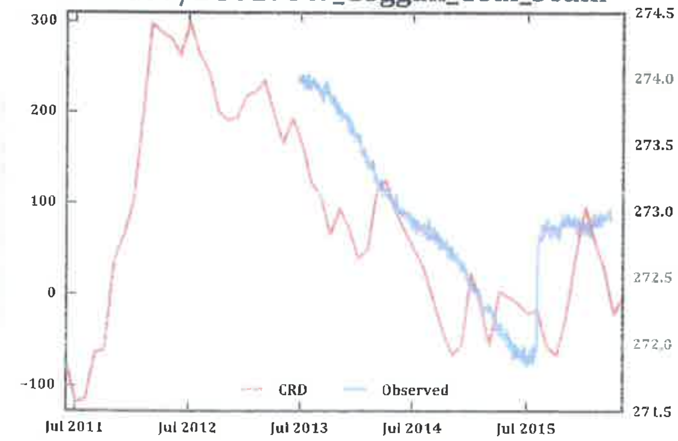
AGE08W_Illawarra_C.M.

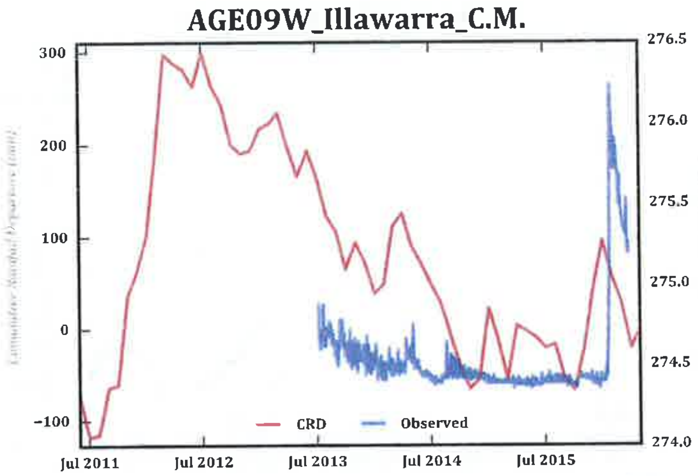


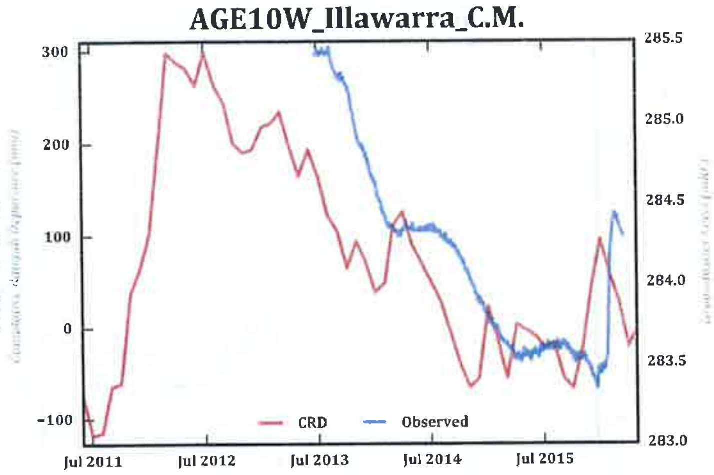
AGE08_Coggan_Coal_Seam

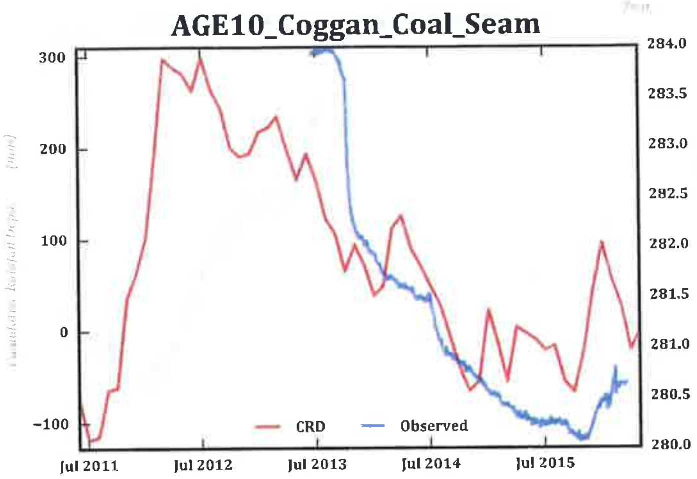


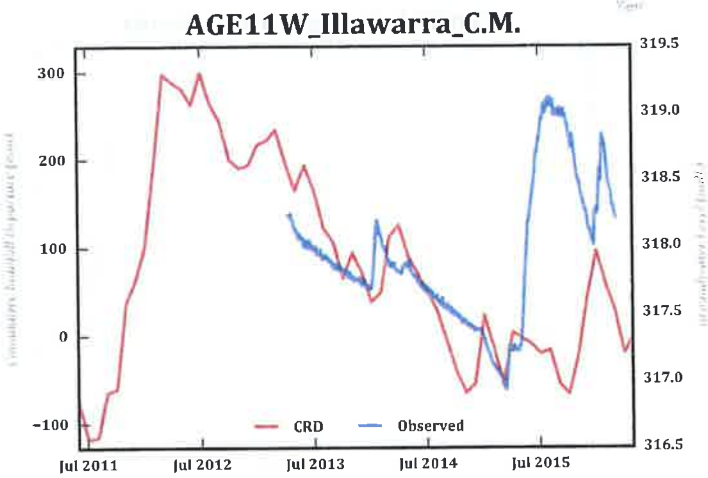
AGE09/BY0173W_Coggan_Coal_Seam

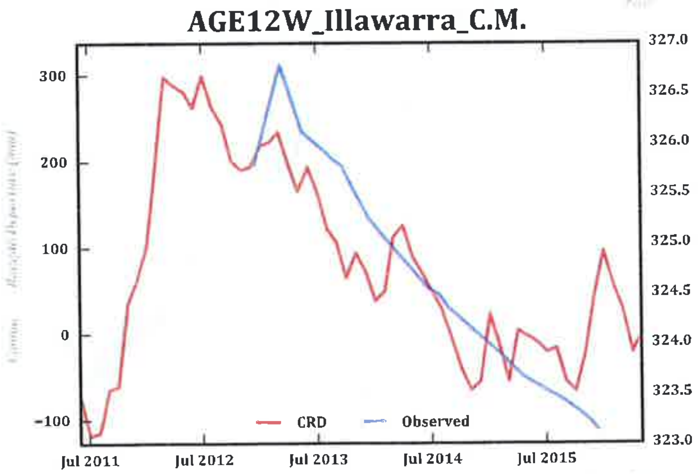


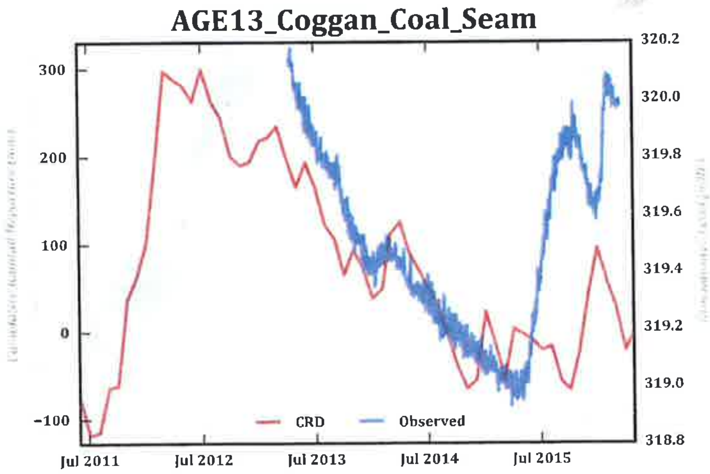

AGE09W_Illawarra_C.M.
300
200
100
0
-100
276.5
276.0
275.5
275.0
274.5
274.0
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015

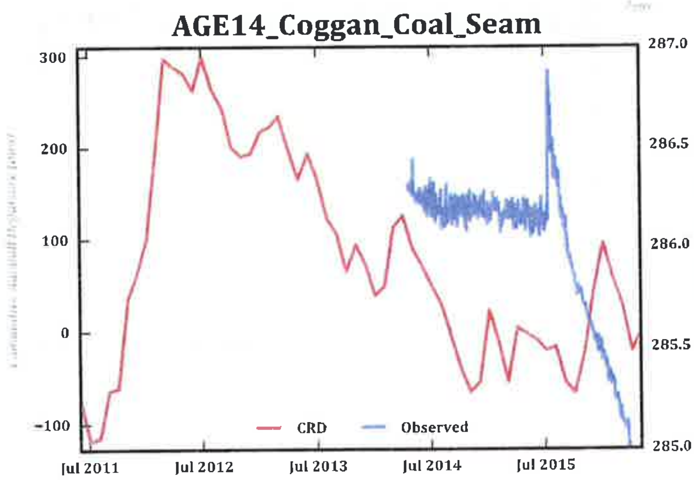

AGE10W_Illawarra_C.M.
300
200
100
0
-100
285.5
285.0
284.5
284.0
283.5
283.0
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015

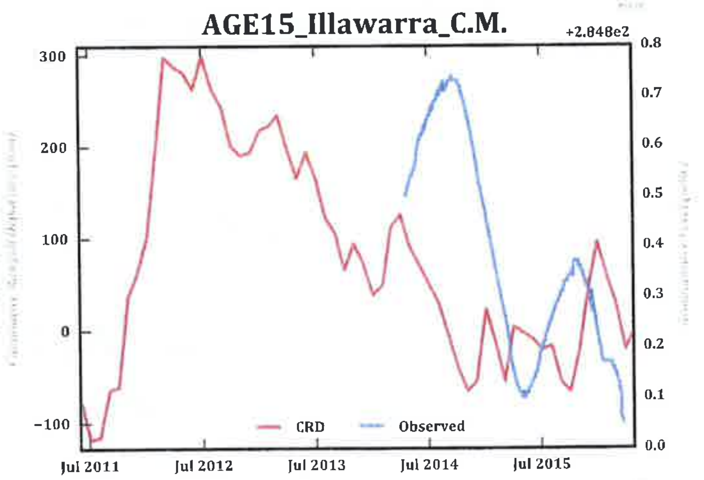

AGE10_Coggan_Coal_Seam
300
200
100
0
-100
284.0
283.5
283.0
282.5
282.0
281.5
281.0
280.5
280.0
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015


AGE11W_Illawarra_C.M.
300
200
100
0
-100
319.5
319.0
318.5
318.0
317.5
317.0
316.5
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015

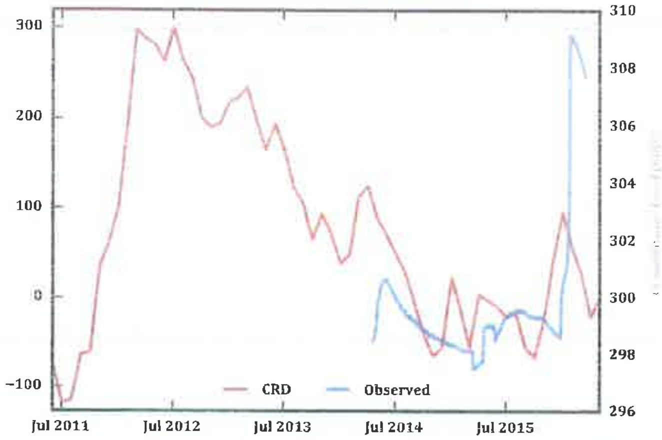

AGE12W_Illawarra_C.M.
300
200
100
0
-100
327.0
326.5
326.0
325.5
325.0
324.5
324.0
323.5
323.0
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015


AGE13_Coggan_Coal_Seam
300
200
100
0
-100
320.2
320.0
319.8
319.6
319.4
319.2
319.0
318.8
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015

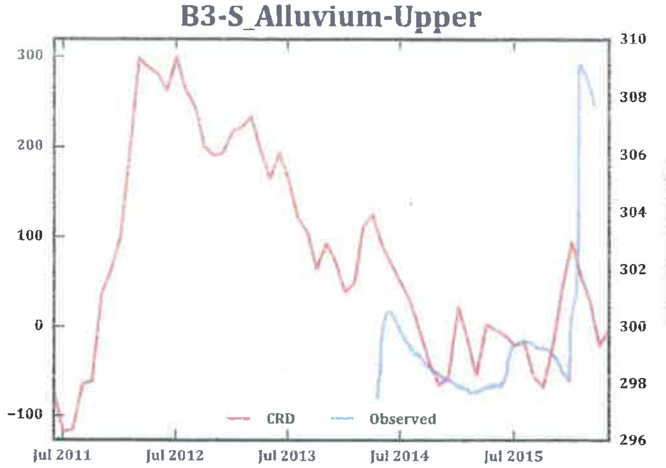

AGE14_Coggan_Coal_Seam
300
200
100
0
-100
287.0
286.5
286.0
285.5
285.0
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015


AGE15_Illawarra_C.M.
+2.848e2
300
200
100
0
-100
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015

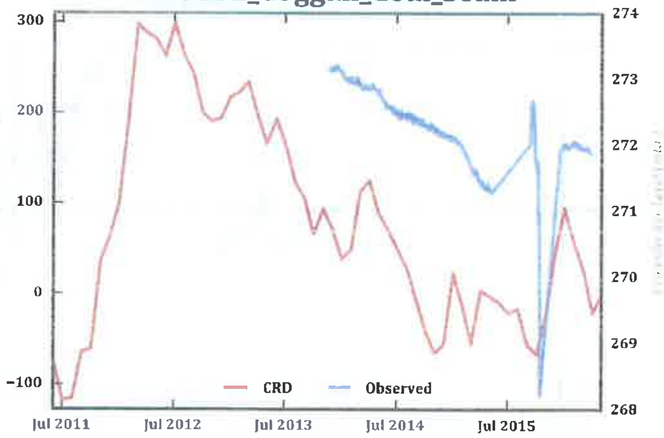
B3-D_Alluvium-Lower



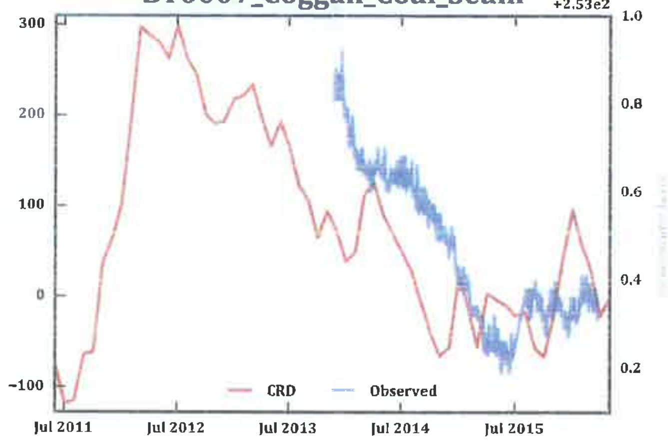
B3-S_Alluvium-Upper



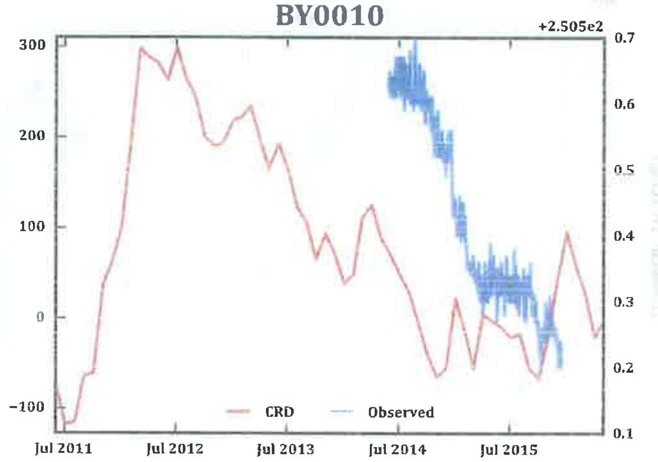
BY0001_Coggan_Coal_Seam



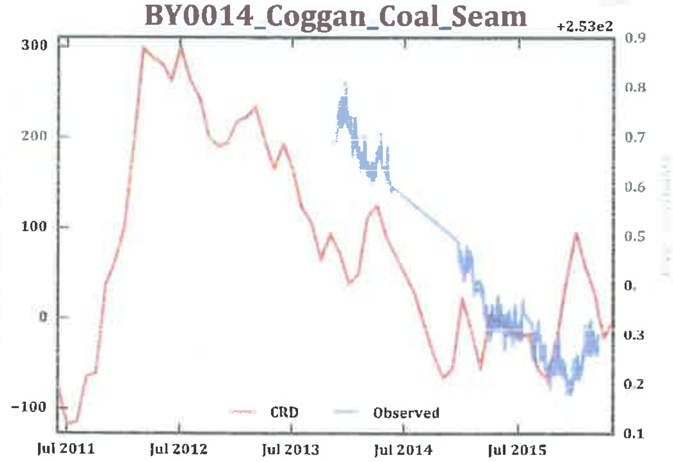
BY0007_Coggan_Coal_Seam



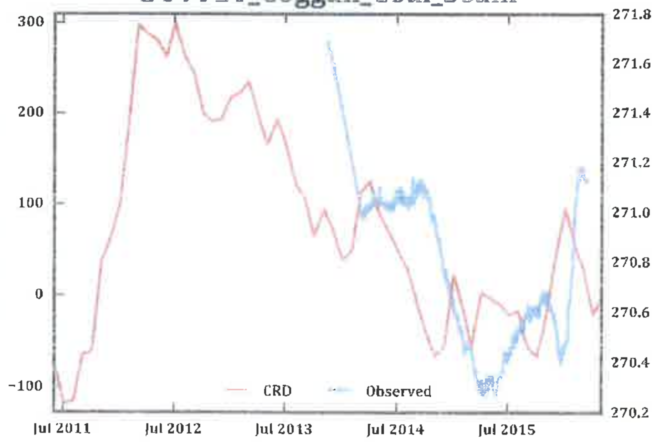
BY0010



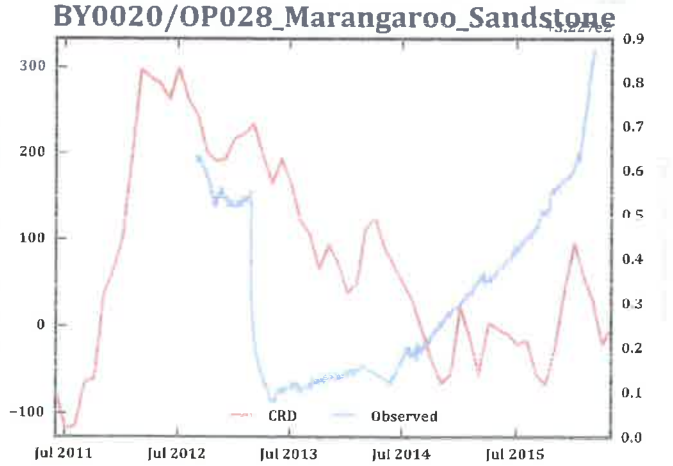
BY0014_Coggan_Coal_Seam



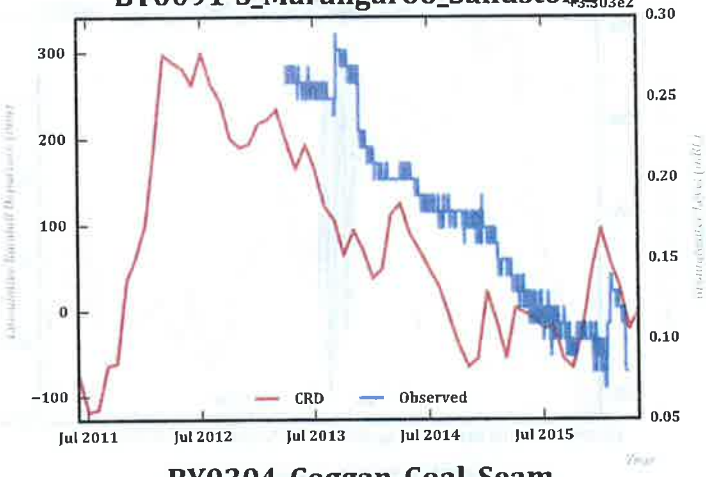
BY0016_Coggan_Coal_Seam



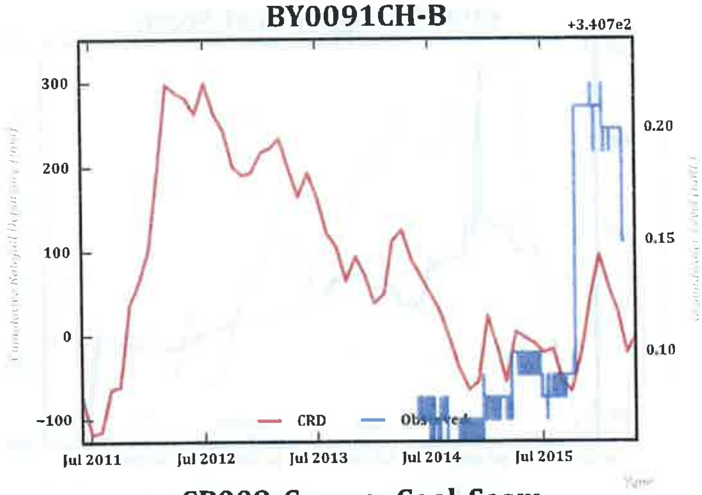
BY0020/OP028_Marangaroo_Sandstone



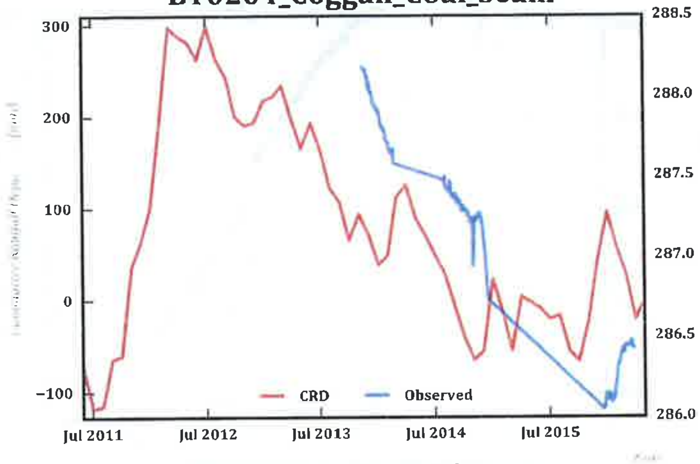
BY0091-S_Marangaroo_Sandstone



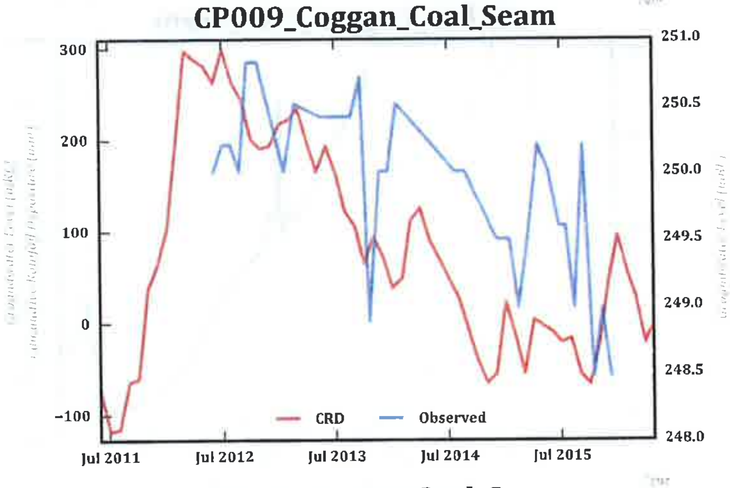
BY0091CH-B



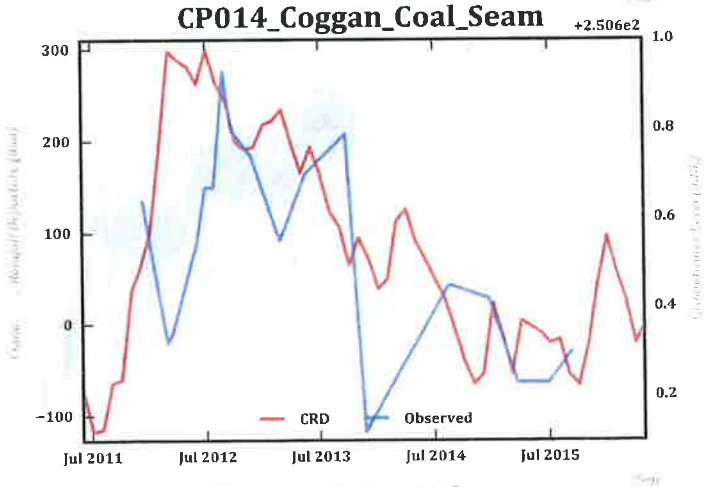
BY0204_Coggan_Coal_Seam



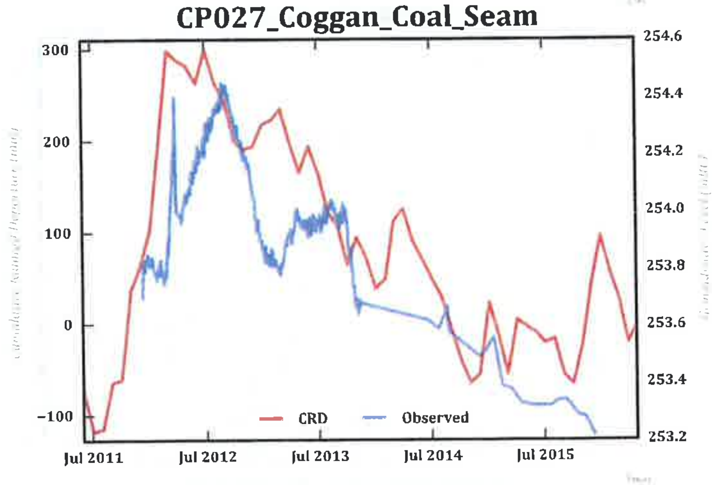
CP009_Coggan_Coal_Seam



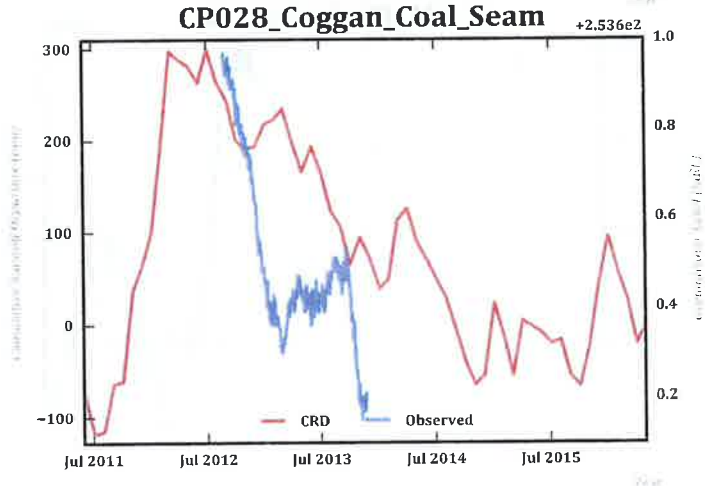
CP014_Coggan_Coal_Seam



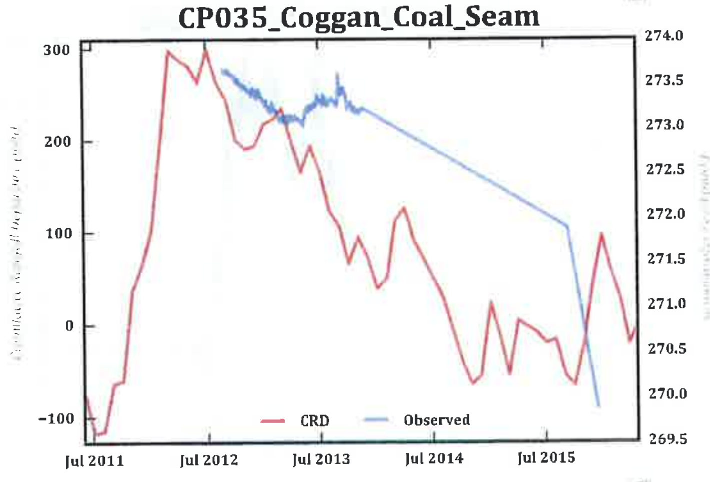
CP027_Coggan_Coal_Seam

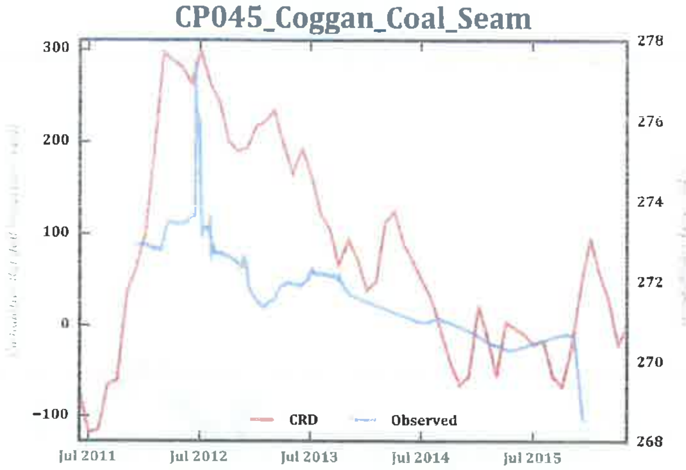


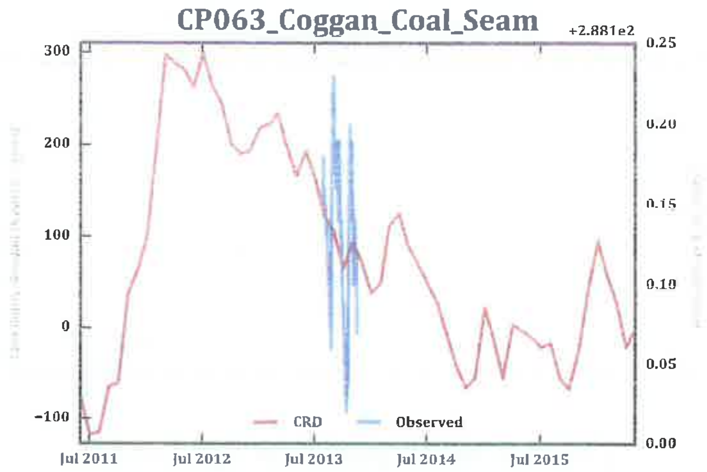
CP028_Coggan_Coal_Seam

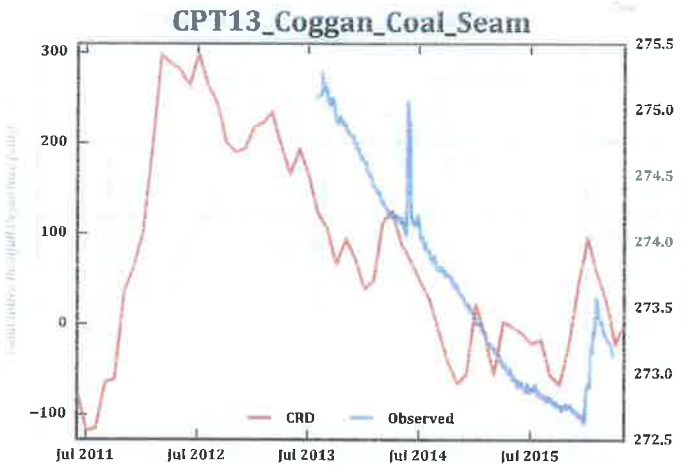


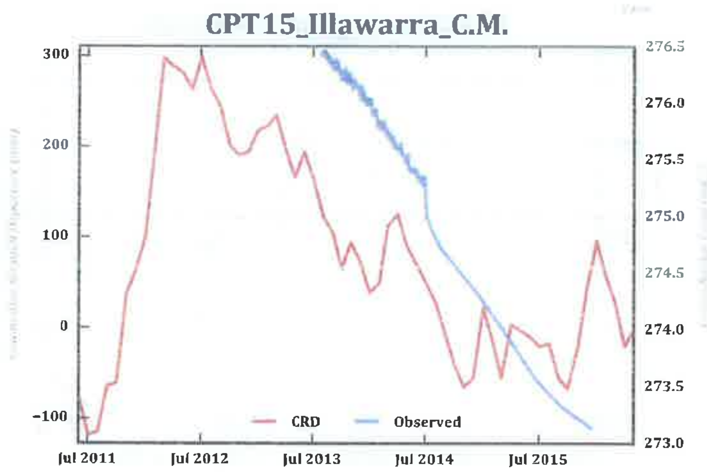
CP035_Coggan_Coal_Seam

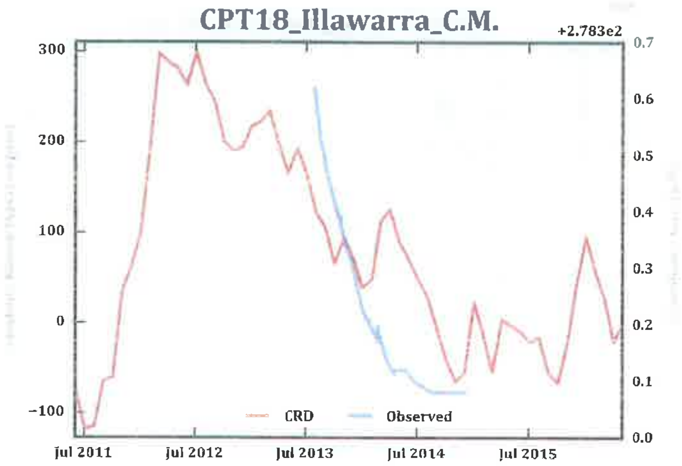


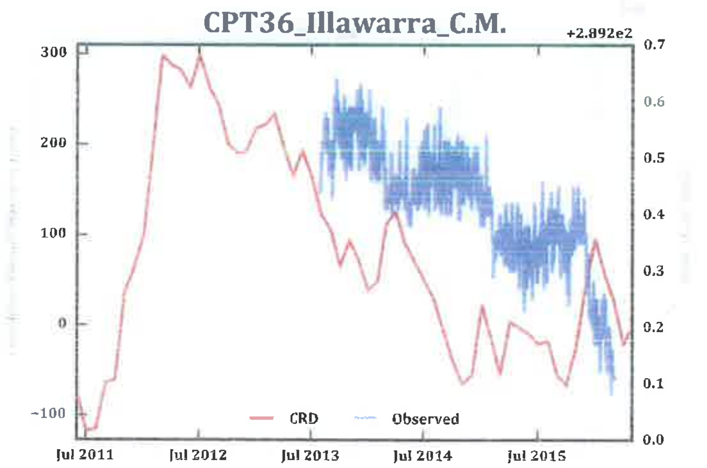

CP045_Coggan_Coal_Seam
300
200
100
0
−100
278
276
274
272
270
268
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015

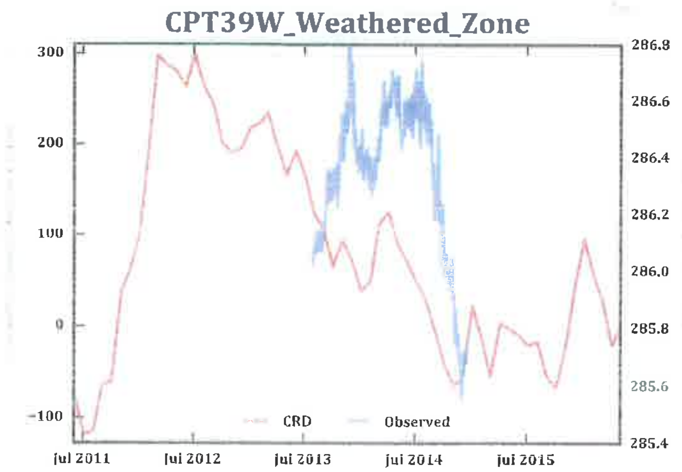

CP063_Coggan_Coal_Seam
+2.881e2
300
200
100
0
−100
0.25
0.20
0.15
0.10
0.05
0.00
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015

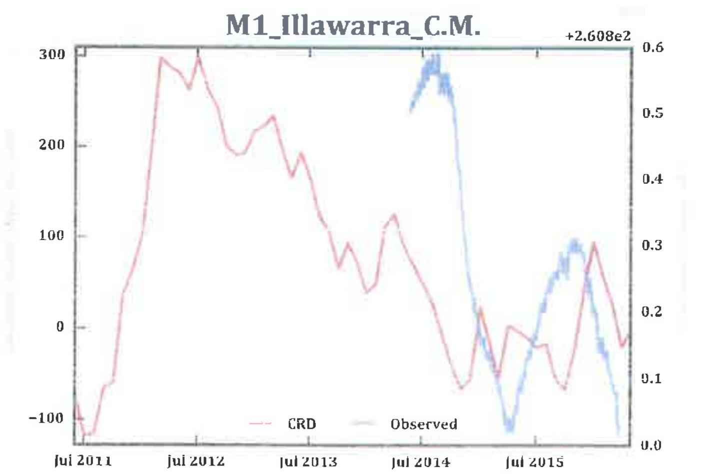

CPT13_Coggan_Coal_Seam
300
200
100
0
−100
275.5
275.0
274.5
274.0
273.5
273.0
272.5
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015

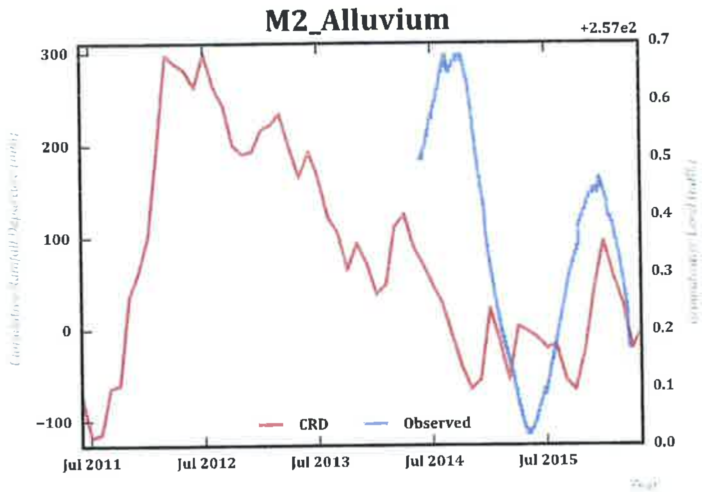

CPT15_Illawarra_C.M.
300
200
100
0
−100
276.5
276.0
275.5
275.0
274.5
274.0
273.5
273.0
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015


CPT18_Illawarra_C.M.
+2.783e2
300
200
100
0
−100
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015

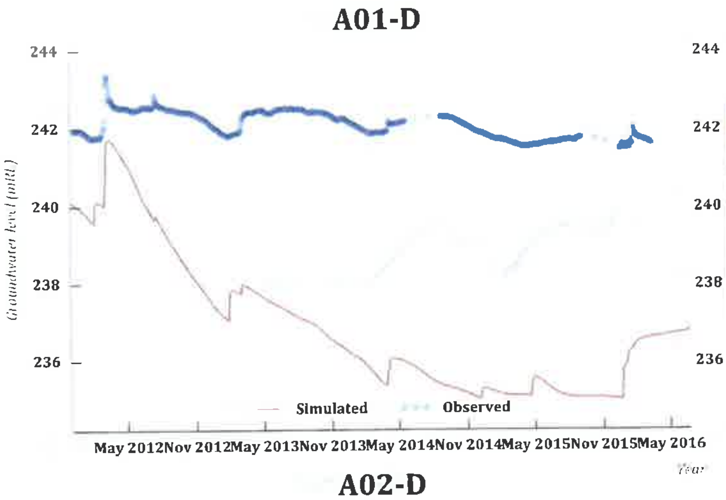

CPT36_Illawarra_C.M.
+2.892e2
300
200
100
0
−100
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015

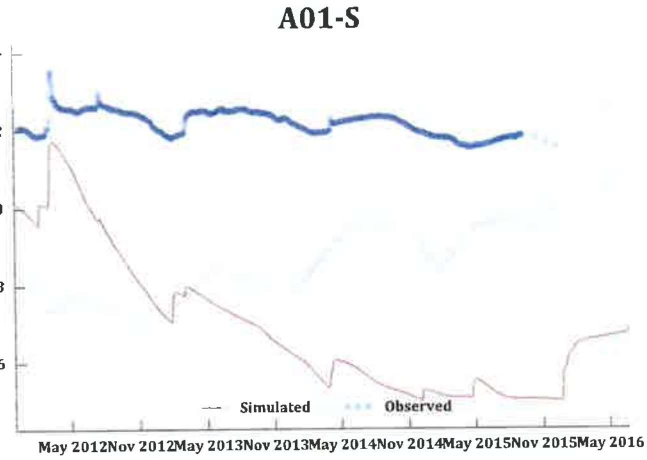

CPT39W_Weathered_Zone
300
200
100
0
−100
286.8
286.6
286.4
286.2
286.0
285.8
285.6
285.4
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015

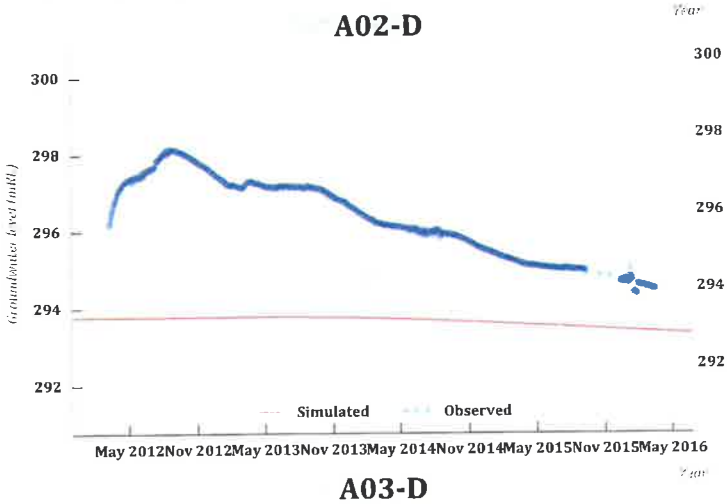

M1_Illawarra_C.M.
+2.608e2
300
200
100
0
−100
0.6
0.5
0.4
0.3
0.2
0.1
0.0
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015

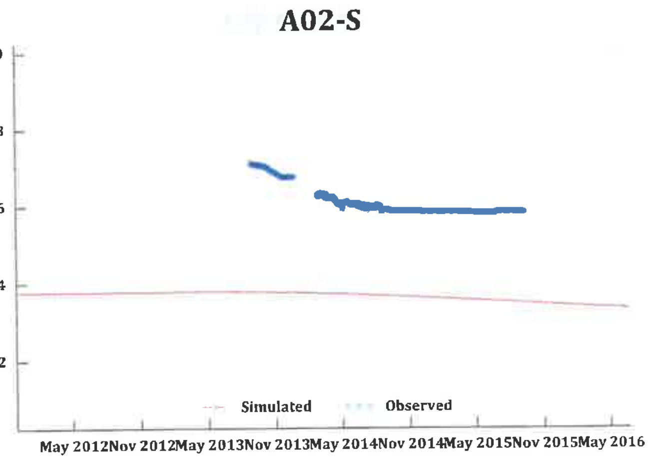

M2_Alluvium
+2.57e2
300
200
100
0
−100
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
CRD
Observed
Jul 2011
Jul 2012
Jul 2013
Jul 2014
Jul 2015

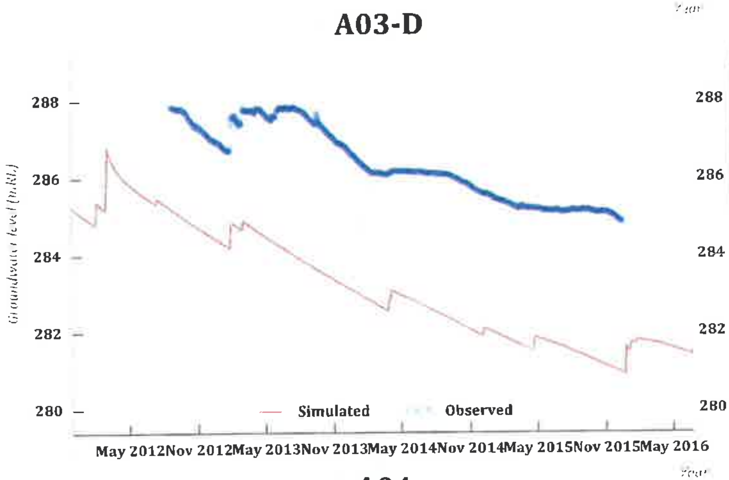
Appendix C **Transient calibration hydrographs**

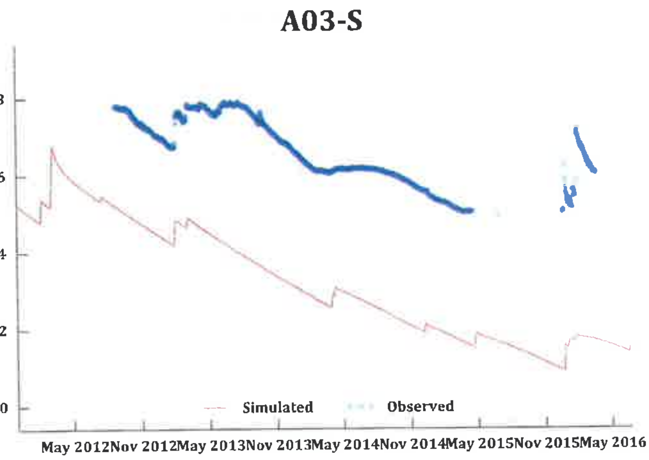

A01-D
244
242
240
238
236
Groundwater level (mRL)
Simulated
Observed
May 2012
Nov 2012
May 2013
Nov 2013
May 2014
Nov 2014
May 2015
Nov 2015
May 2016
Year

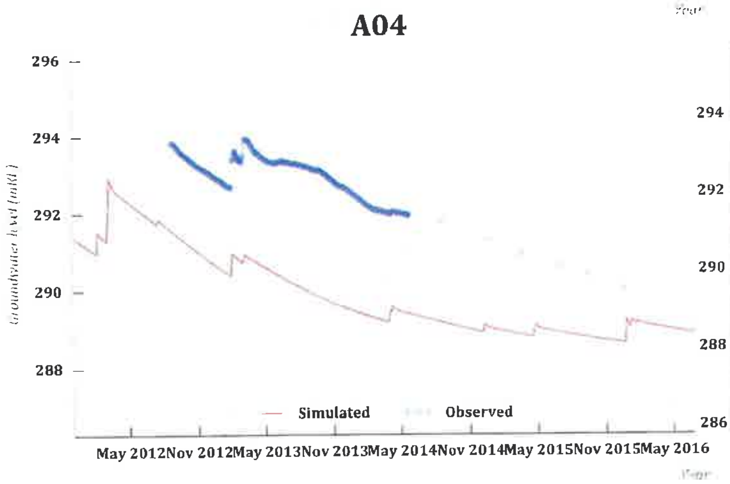

A01-S
244
242
240
238
236
Simulated
Observed
May 2012
Nov 2012
May 2013
Nov 2013
May 2014
Nov 2014
May 2015
Nov 2015
May 2016

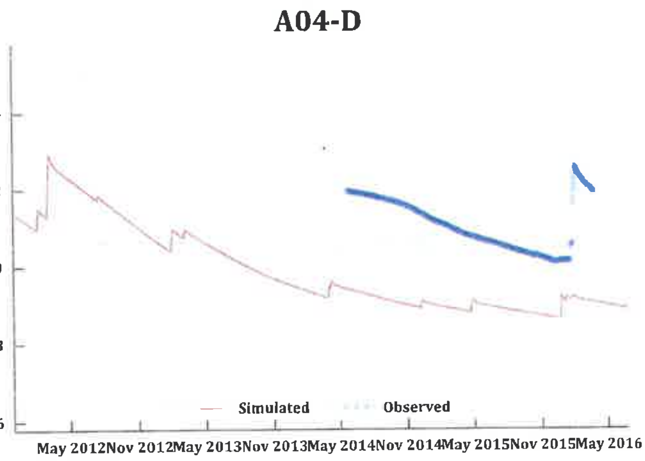

A02-D
300
298
296
294
292
Groundwater level (mRL)
Simulated
Observed
May 2012
Nov 2012
May 2013
Nov 2013
May 2014
Nov 2014
May 2015
Nov 2015
May 2016
Year

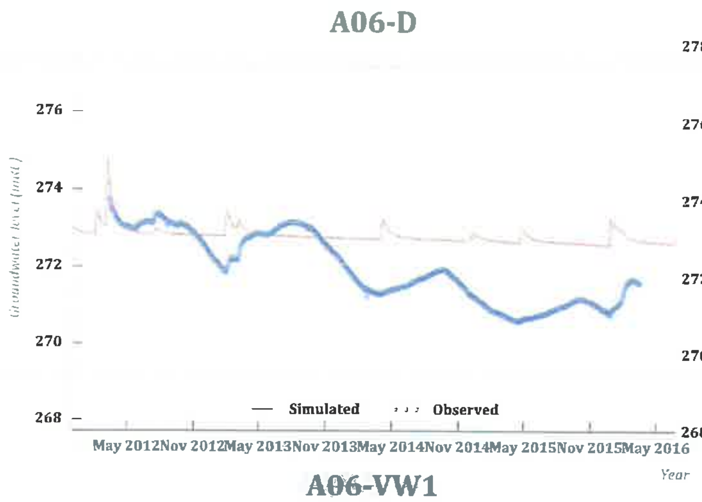

A02-S
300
298
296
294
292
Simulated
Observed
May 2012
Nov 2012
May 2013
Nov 2013
May 2014
Nov 2014
May 2015
Nov 2015
May 2016


A03-D
288
286
284
282
280
Groundwater level (mRL)
Simulated
Observed
May 2012
Nov 2012
May 2013
Nov 2013
May 2014
Nov 2014
May 2015
Nov 2015
May 2016
Year

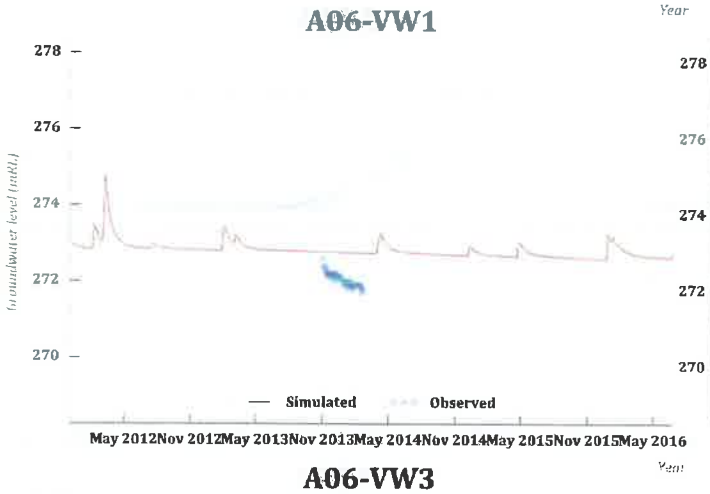

A03-S
288
286
284
282
280
Simulated
Observed
May 2012
Nov 2012
May 2013
Nov 2013
May 2014
Nov 2014
May 2015
Nov 2015
May 2016

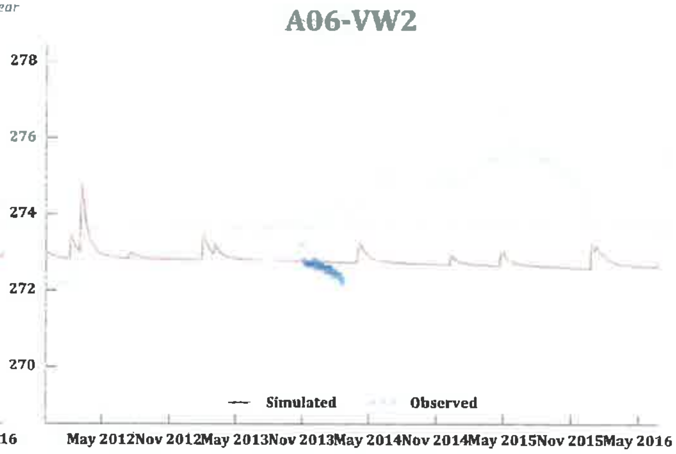

A04
296
294
292
290
288
Groundwater level (mRL)
Simulated
Observed
May 2012
Nov 2012
May 2013
Nov 2013
May 2014
Nov 2014
May 2015
Nov 2015
May 2016
Year

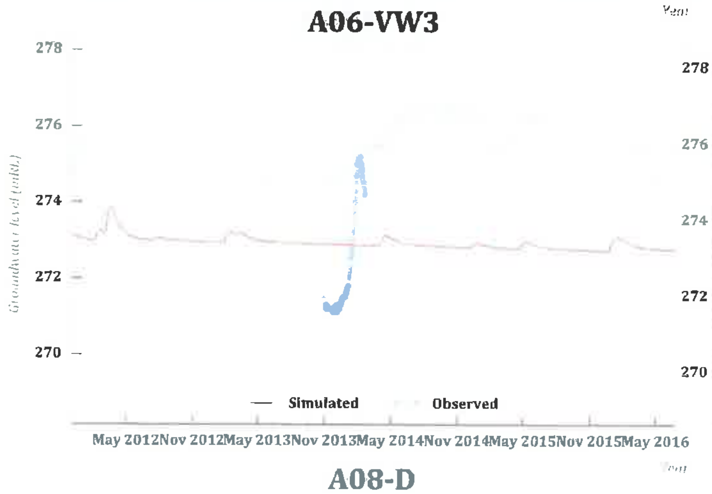

A04-D
294
292
290
288
286
Simulated
Observed
May 2012
Nov 2012
May 2013
Nov 2013
May 2014
Nov 2014
May 2015
Nov 2015
May 2016

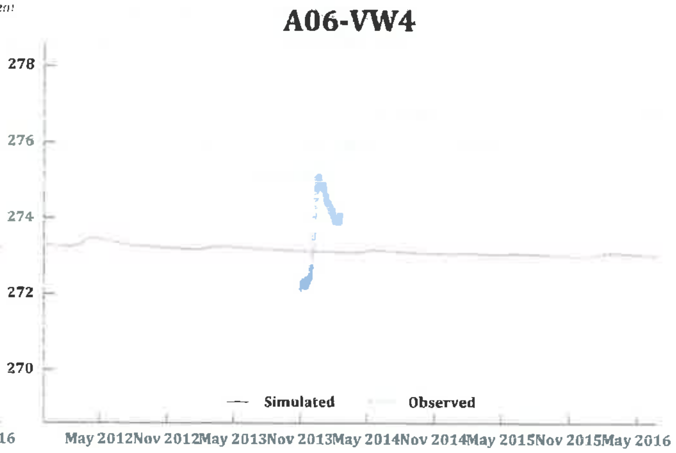

A06-D
276
274
272
270
268
Groundwater level (mRL)
Simulated
Observed
May 2012
Nov 2012
May 2013
Nov 2013
May 2014
Nov 2014
May 2015
Nov 2015
May 2016
Year

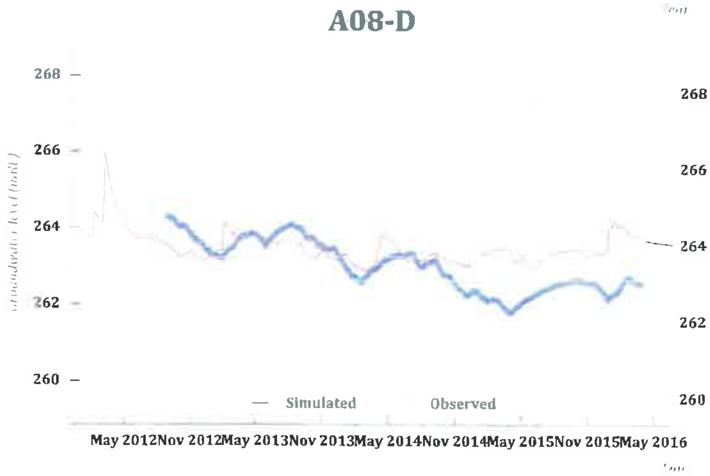

A06-S
278
276
274
272
270
268
Simulated
Observed
May 2012
Nov 2012
May 2013
Nov 2013
May 2014
Nov 2014
May 2015
Nov 2015
May 2016

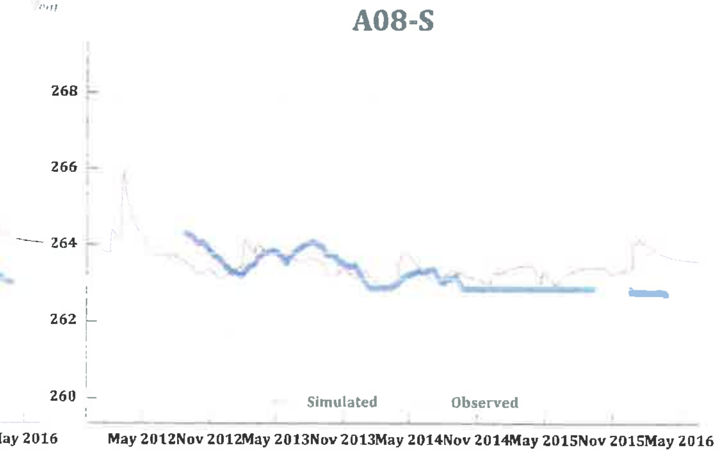

A06-VW1
278
276
274
272
270
Groundwater level (mRL)
Simulated
Observed
May 2012
Nov 2012
May 2013
Nov 2013
May 2014
Nov 2014
May 2015
Nov 2015
May 2016
Year


A06-VW2
278
276
274
272
270
Simulated
Observed
May 2012
Nov 2012
May 2013
Nov 2013
May 2014
Nov 2014
May 2015
Nov 2015
May 2016

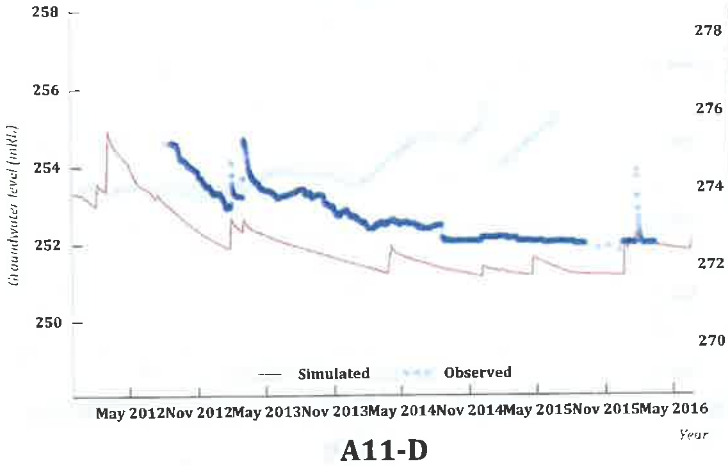

A06-VW3
278
276
274
272
270
Groundwater level (mRL)
Simulated
Observed
May 2012
Nov 2012
May 2013
Nov 2013
May 2014
Nov 2014
May 2015
Nov 2015
May 2016


A06-VW4
278
276
274
272
270
Simulated
Observed
May 2012
Nov 2012
May 2013
Nov 2013
May 2014
Nov 2014
May 2015
Nov 2015
May 2016

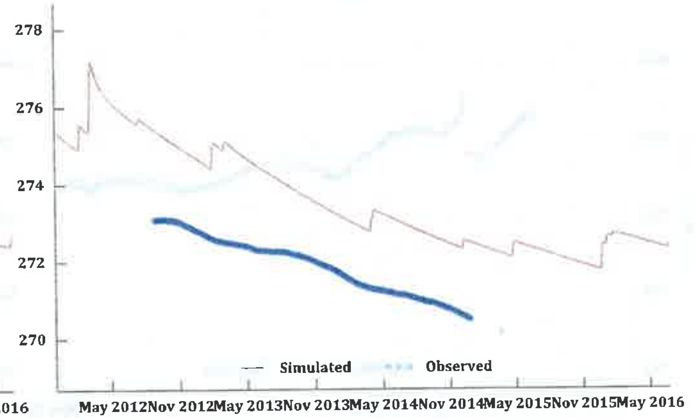

A08-D
268
266
264
262
260
Groundwater level (mRL)
Simulated
Observed
May 2012
Nov 2012
May 2013
Nov 2013
May 2014
Nov 2014
May 2015
Nov 2015
May 2016


A08-S
268
266
264
262
260
Simulated
Observed
May 2012
Nov 2012
May 2013
Nov 2013
May 2014
Nov 2014
May 2015
Nov 2015
May 2016

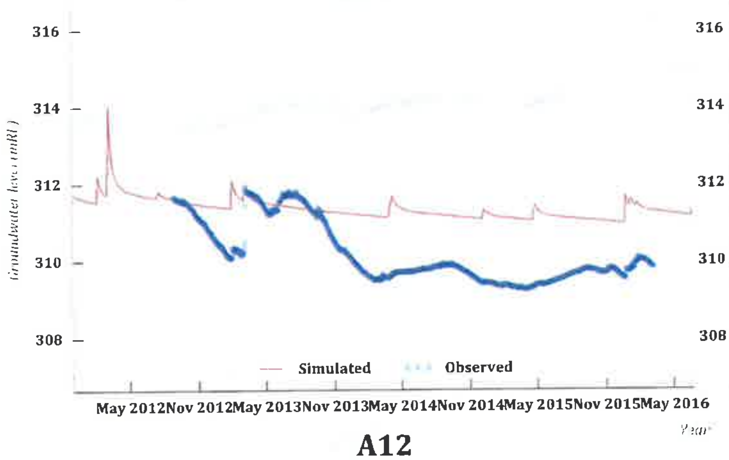
A09



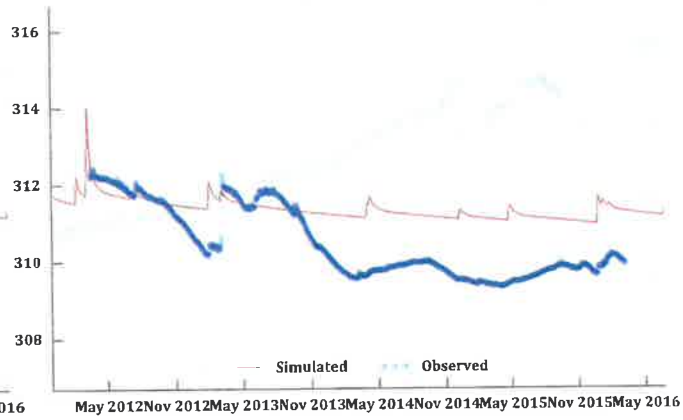
A10



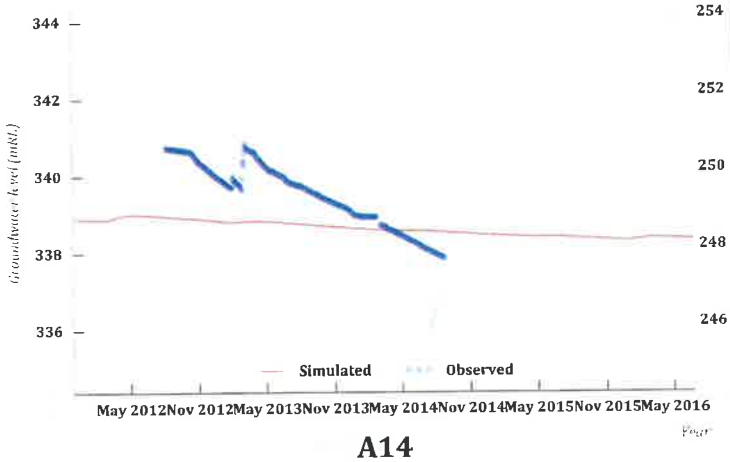
A11-D



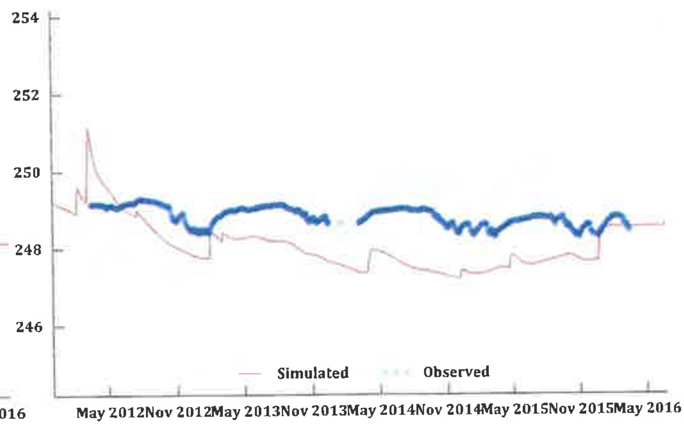
A11-S



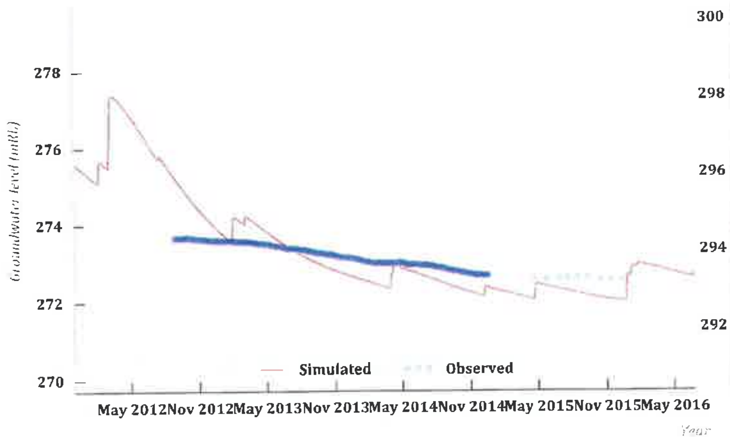
A12



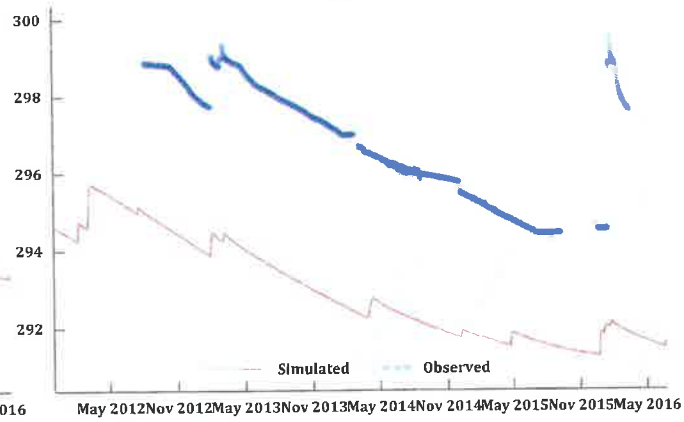
A13



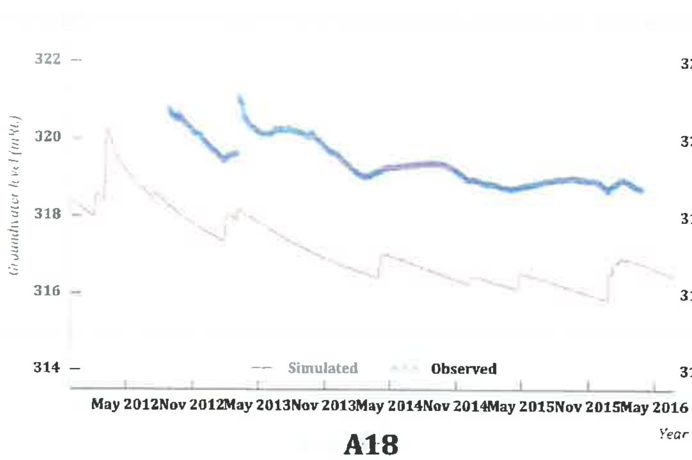
A14



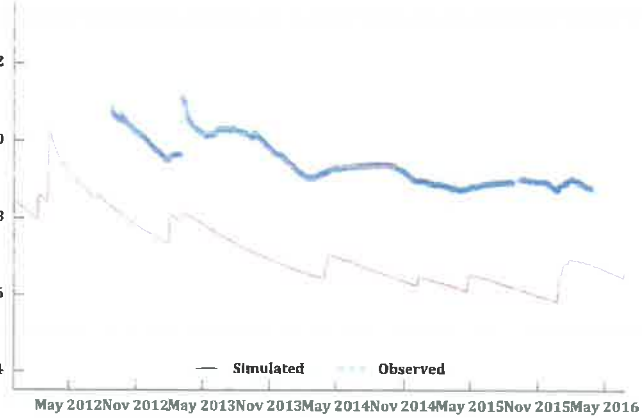
A15



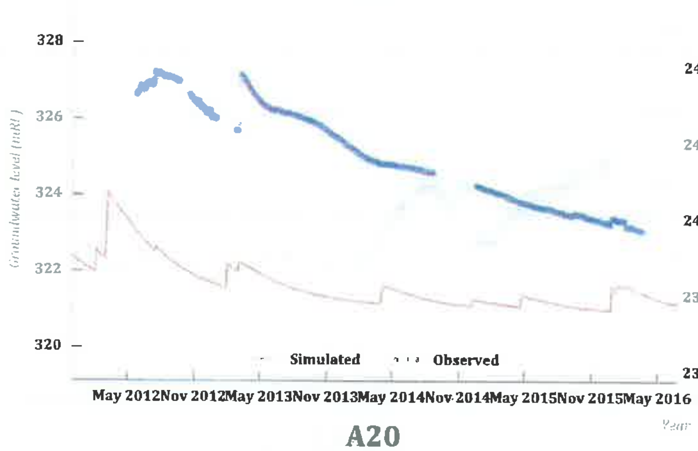
A17-D



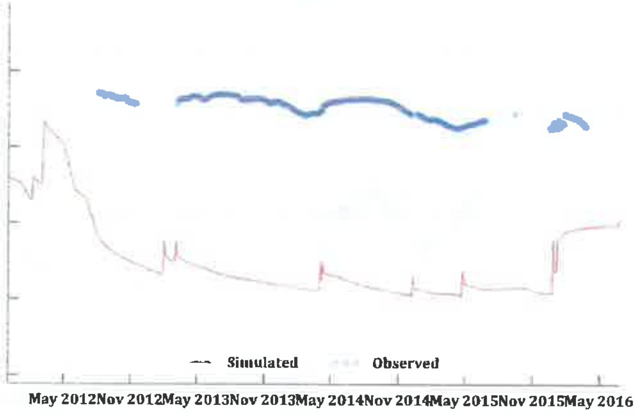
A17-S



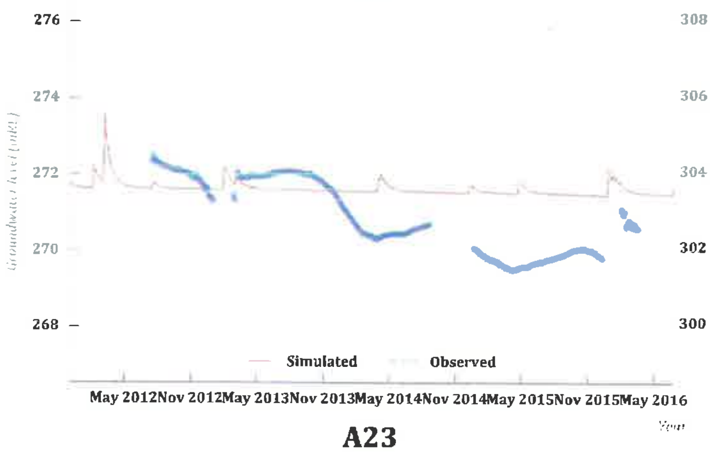
A18



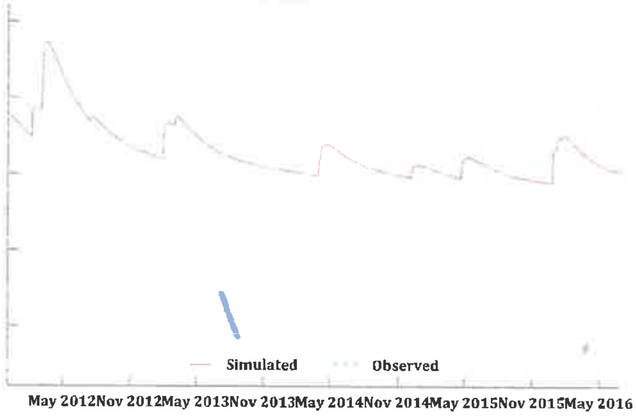
A19



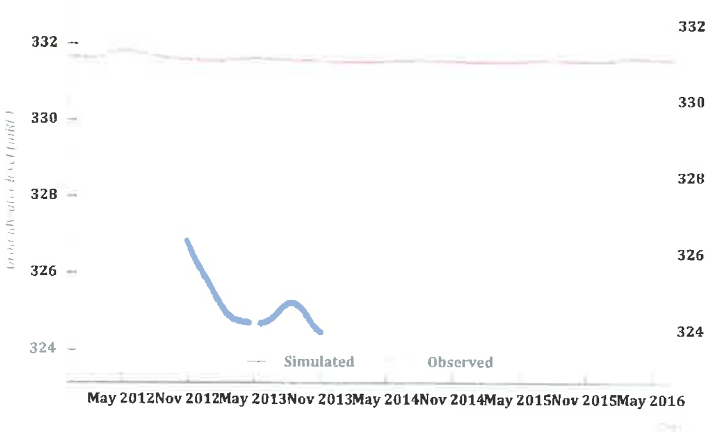
A20



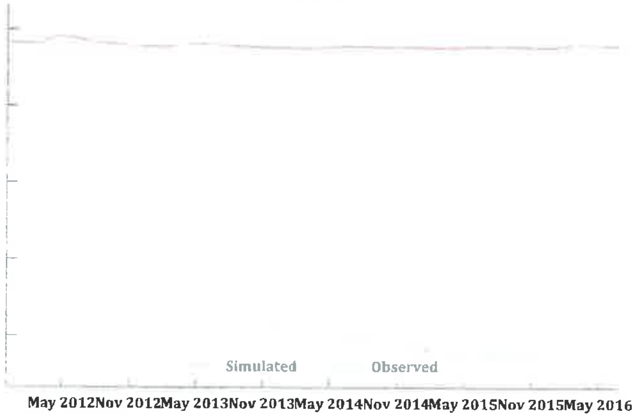
A21



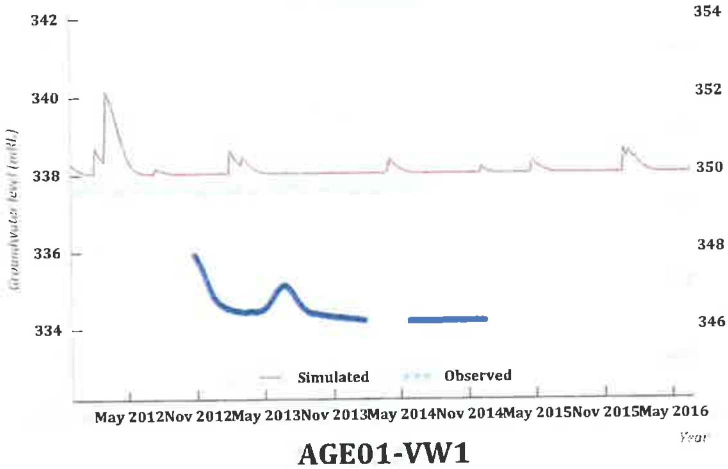
A23



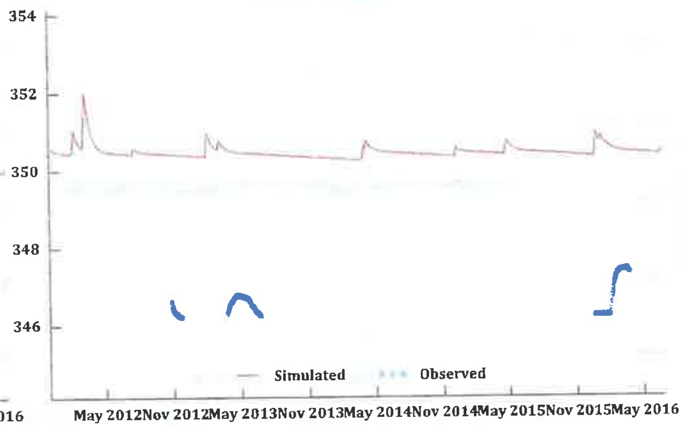
A23W



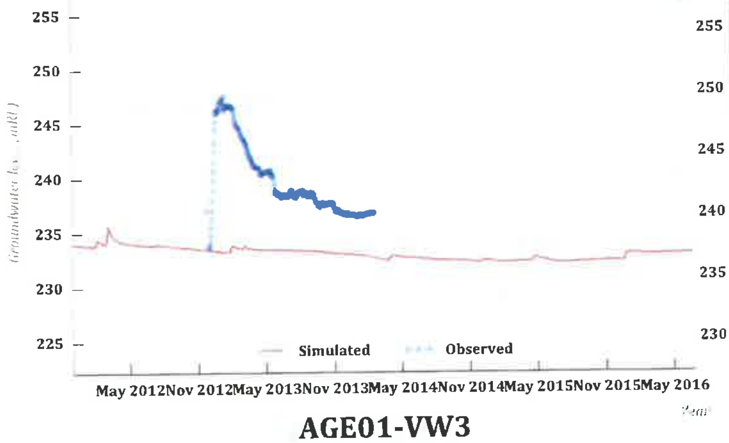
A24-D



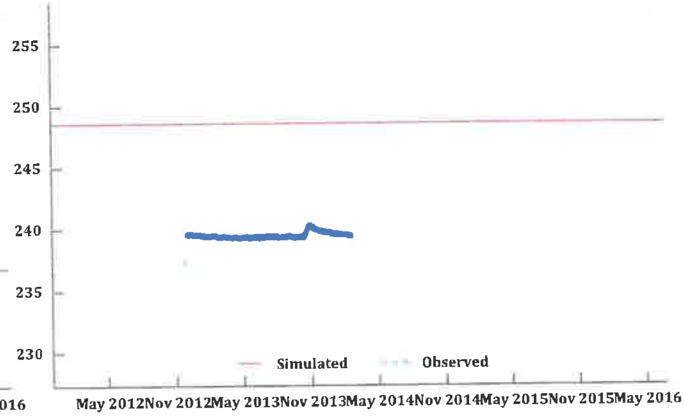
A25



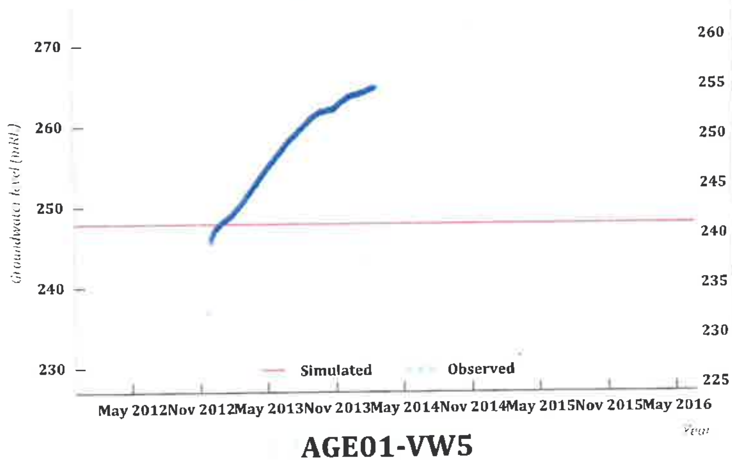
AGE01-VW1



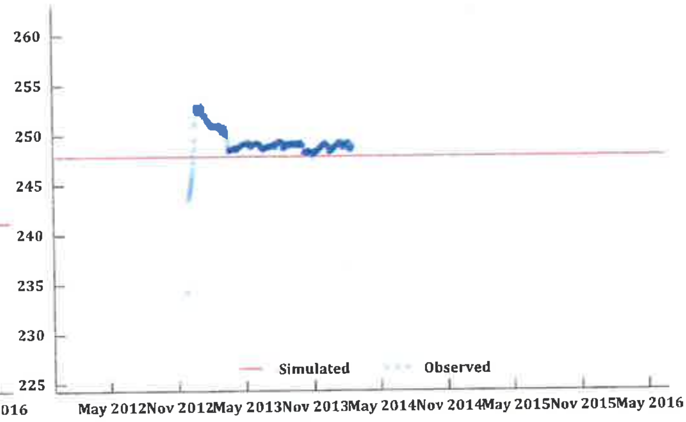
AGE01-VW2



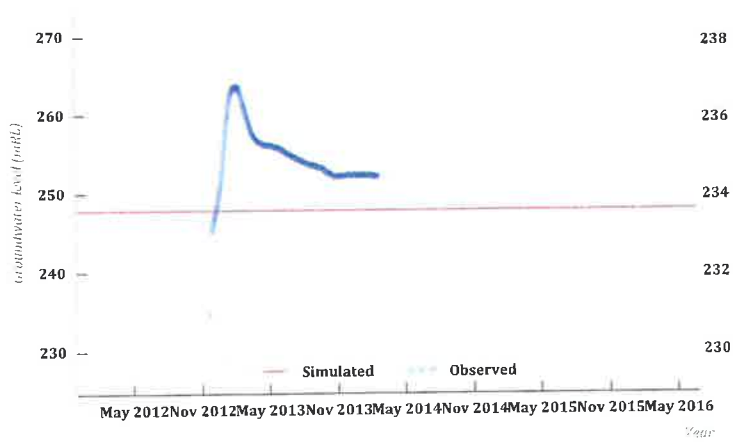
AGE01-VW3



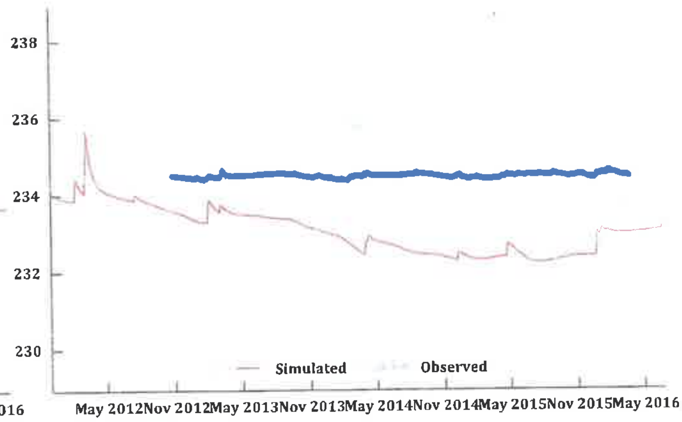
AGE01-VW4

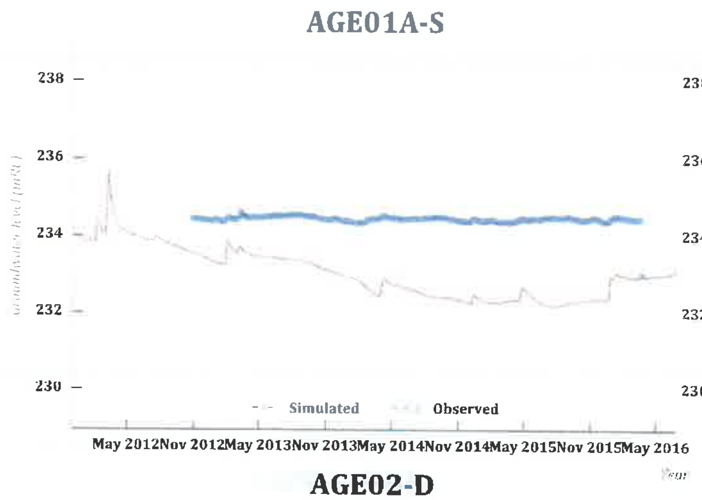


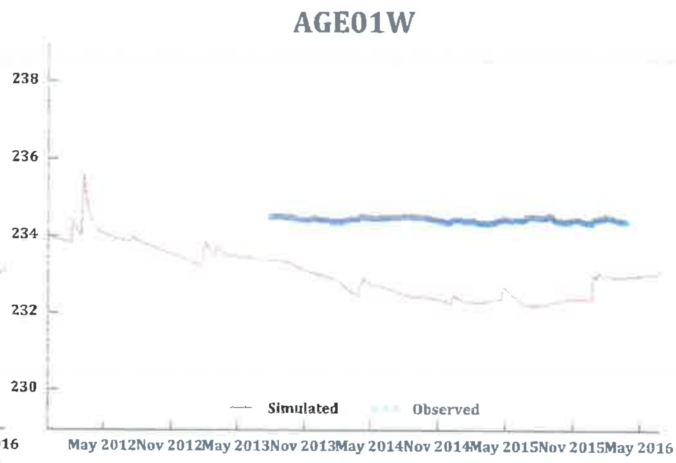
AGE01-VW5



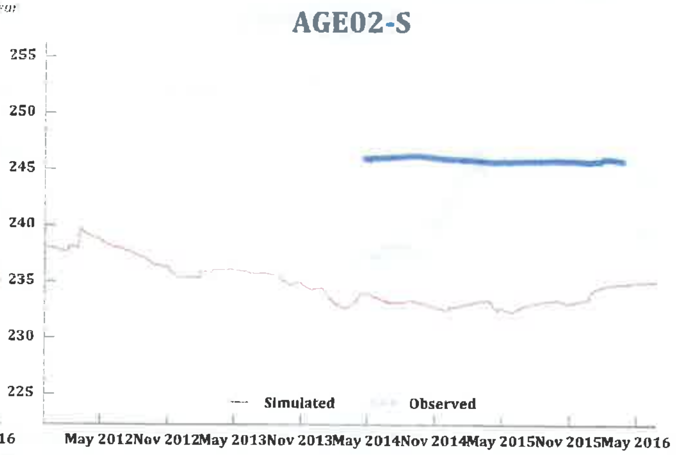
AGE01A-D

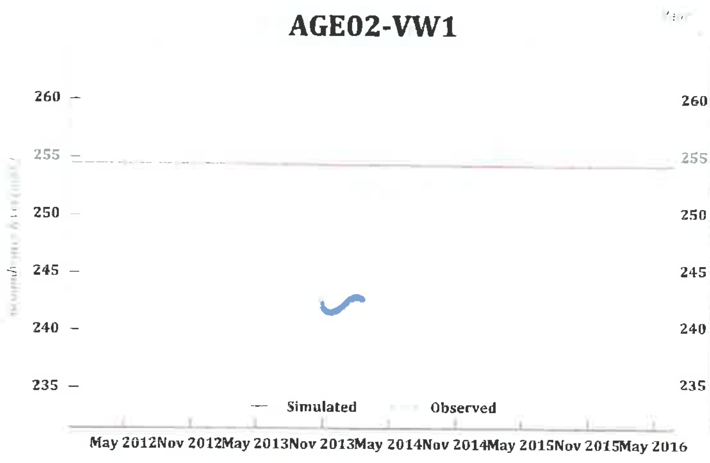



AGE01A-S
238
236
234
232
230
Simulated
Observed
May 2012Nov 2012May 2013Nov 2013May 2014Nov 2014May 2015Nov 2015May 2016

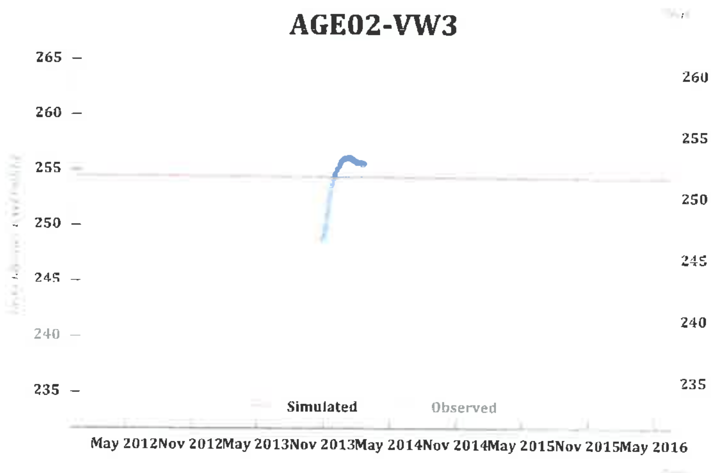

AGE01W
238
236
234
232
230
Simulated
Observed
May 2012Nov 2012May 2013Nov 2013May 2014Nov 2014May 2015Nov 2015May 2016

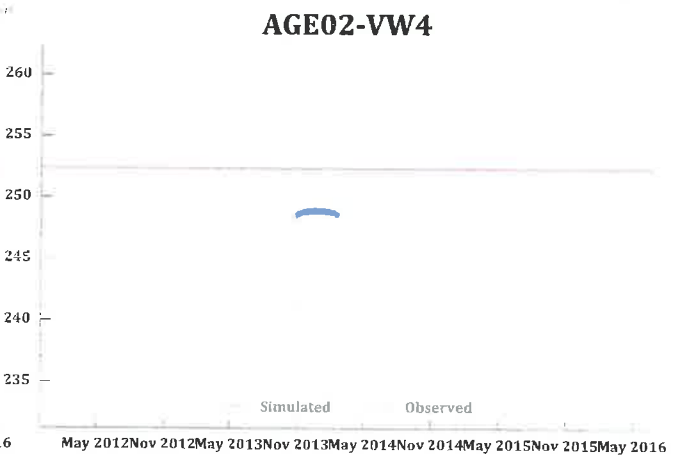

AGE02-D
255
250
245
240
235
230
225
Simulated
Observed
May 2012Nov 2012May 2013Nov 2013May 2014Nov 2014May 2015Nov 2015May 2016


AGE02-S
255
250
245
240
235
230
225
Simulated
Observed
May 2012Nov 2012May 2013Nov 2013May 2014Nov 2014May 2015Nov 2015May 2016

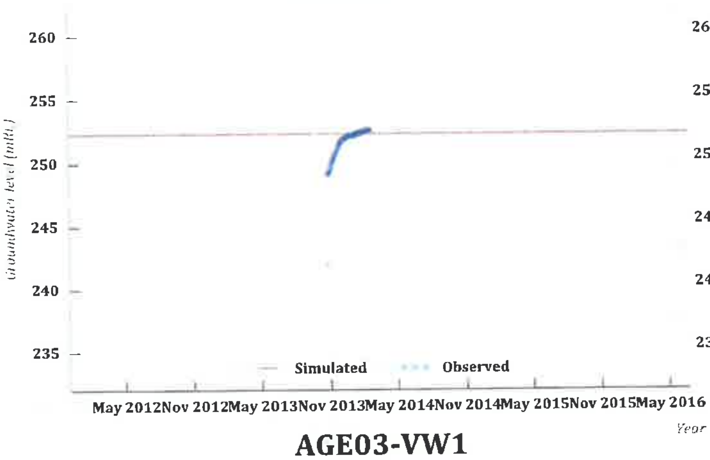

AGE02-VW1
260
255
250
245
240
235
Simulated
Observed
May 2012Nov 2012May 2013Nov 2013May 2014Nov 2014May 2015Nov 2015May 2016


AGE02-VW2
260
255
250
245
240
235
Simulated
Observed
May 2012Nov 2012May 2013Nov 2013May 2014Nov 2014May 2015Nov 2015May 2016

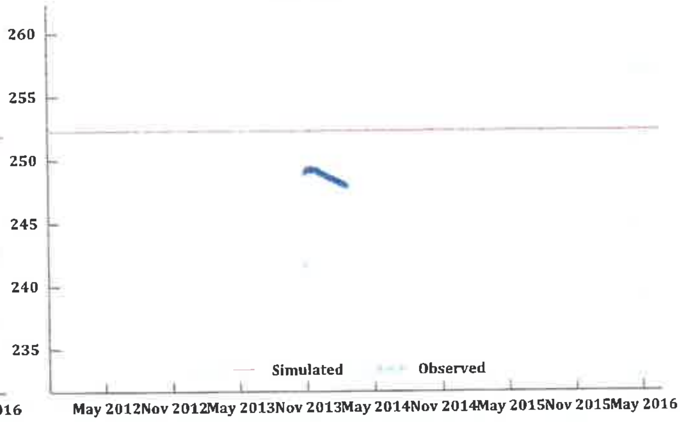

AGE02-VW3
265
260
255
250
245
240
235
Simulated
Observed
May 2012Nov 2012May 2013Nov 2013May 2014Nov 2014May 2015Nov 2015May 2016


AGE02-VW4
260
255
250
245
240
235
Simulated
Observed
May 2012Nov 2012May 2013Nov 2013May 2014Nov 2014May 2015Nov 2015May 2016

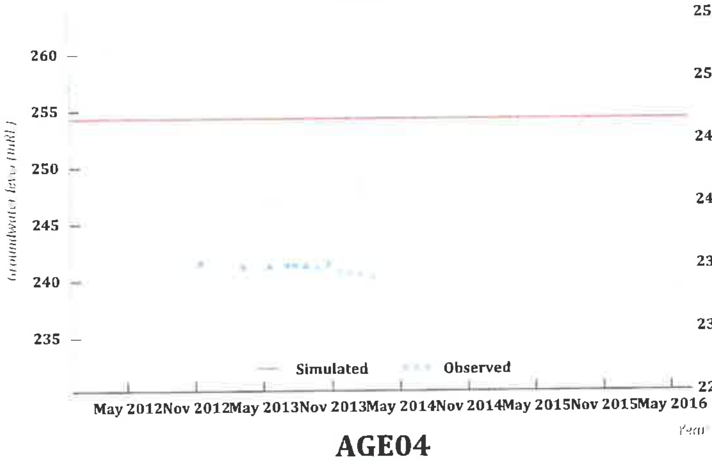
AGE02-VW5



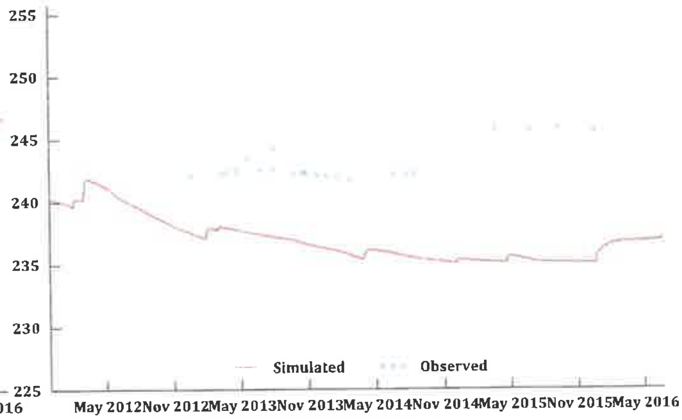
AGE02-VW6



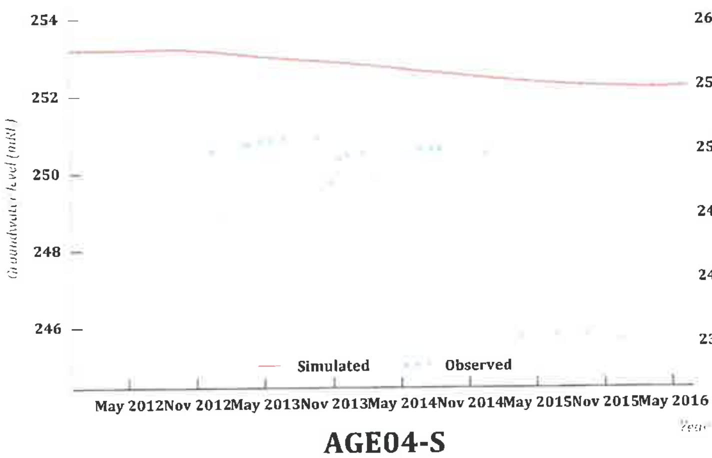
AGE03-VW1



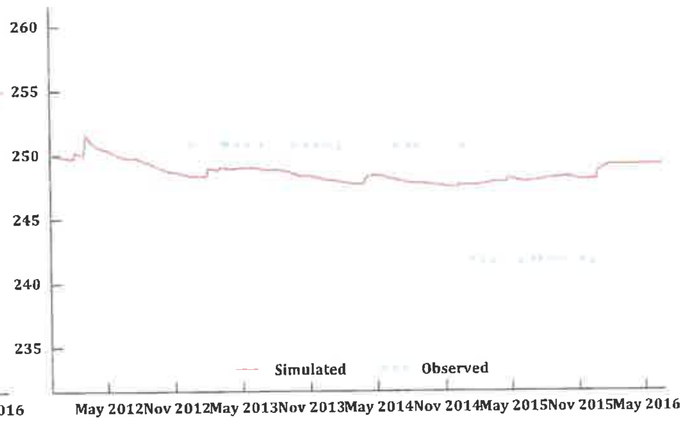
AGE03W



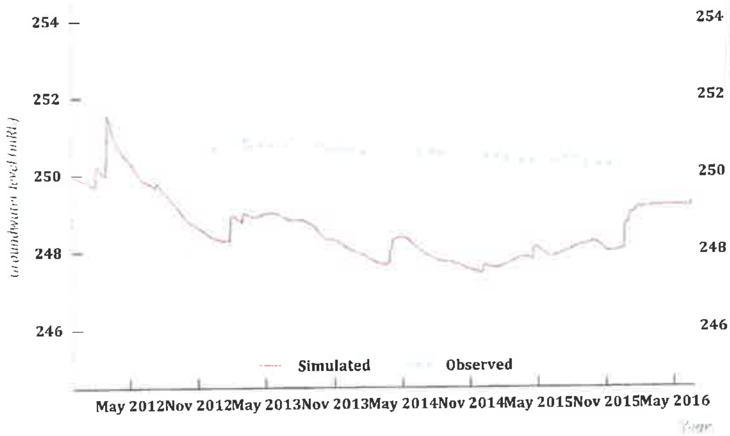
AGE04



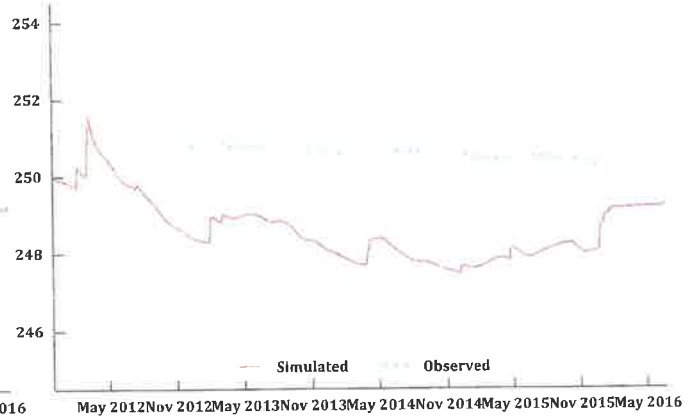
AGE04-D



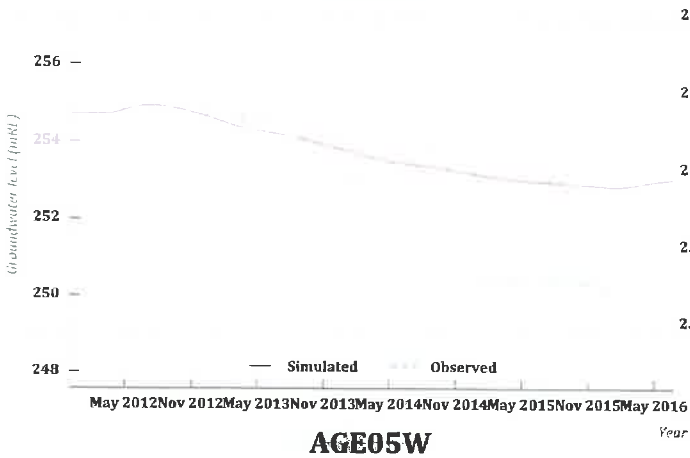
AGE04-S



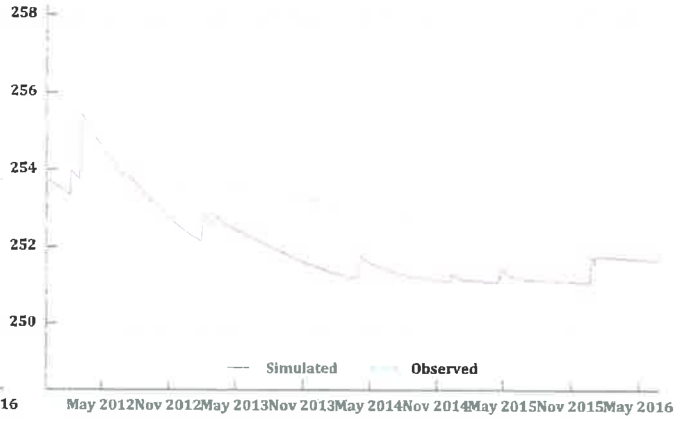
AGE04W



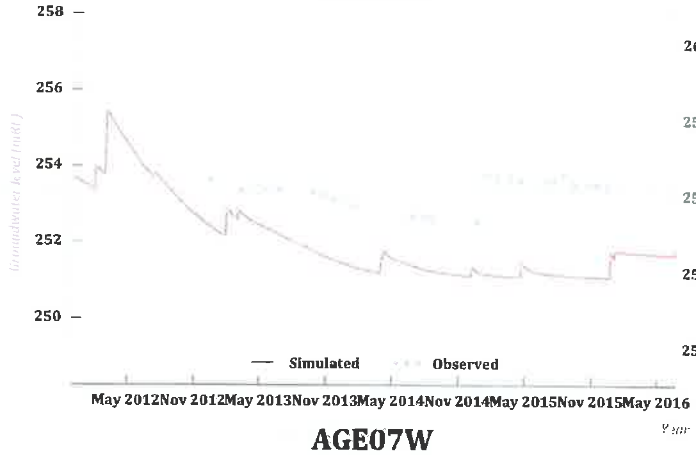
AGE05



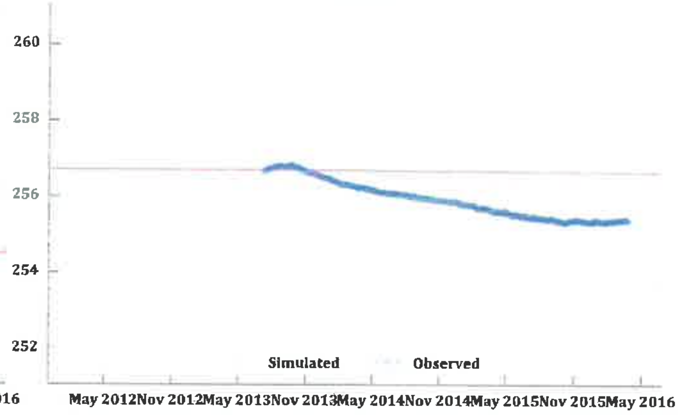
AGE05A



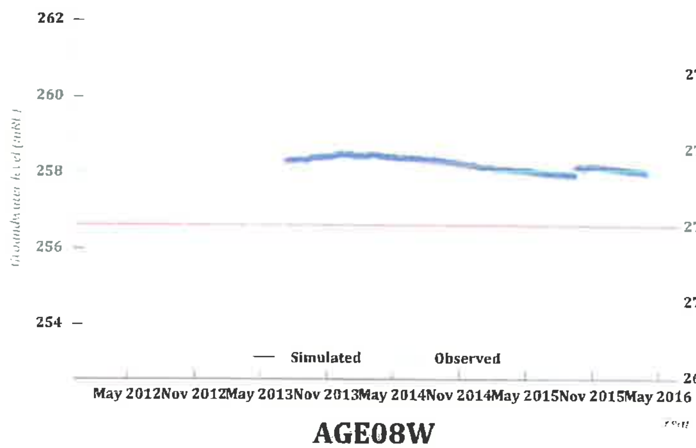
AGE05W



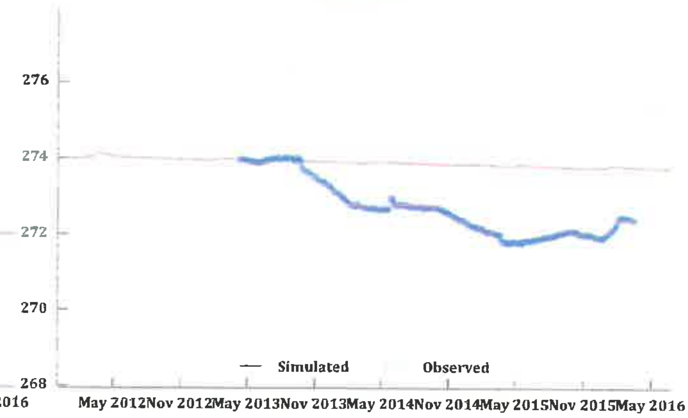
AGE07



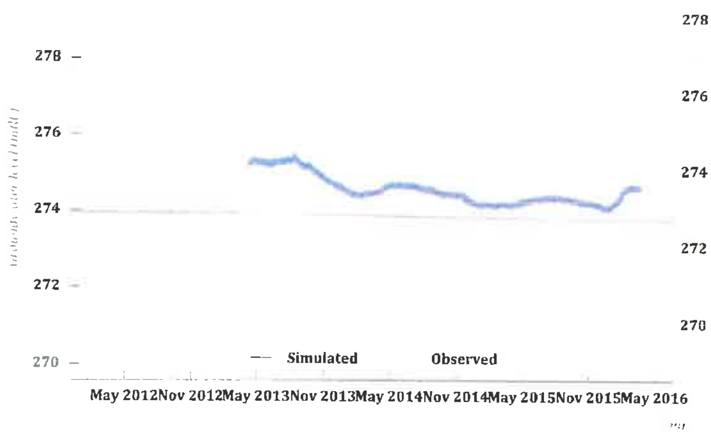
AGE07W



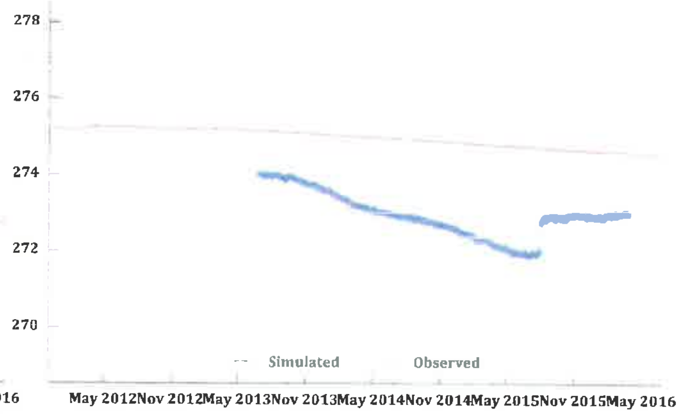
AGE08



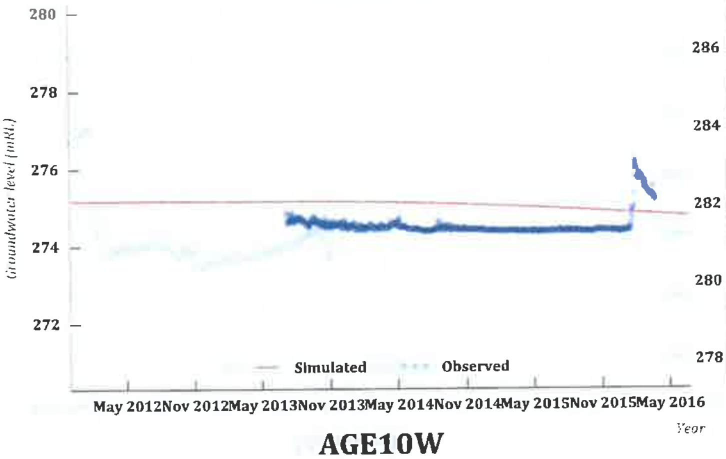
AGE08W



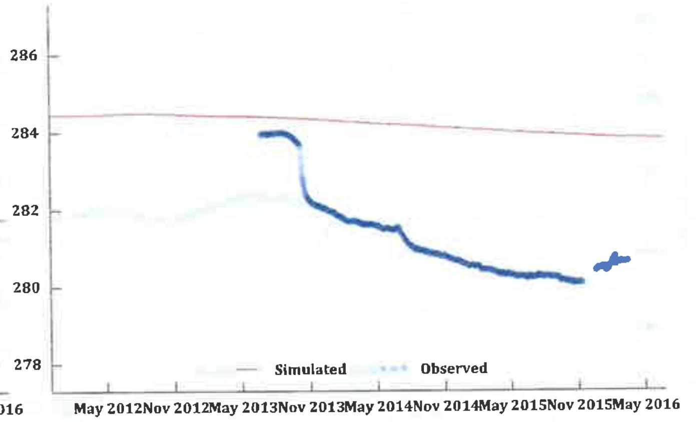
AGE09



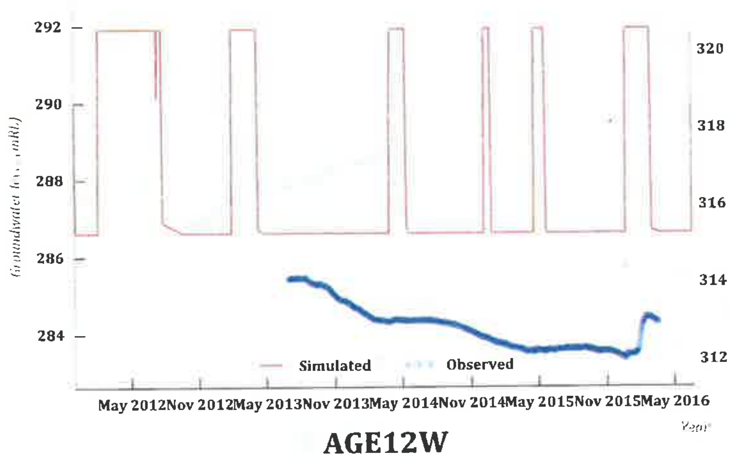
AGE09W



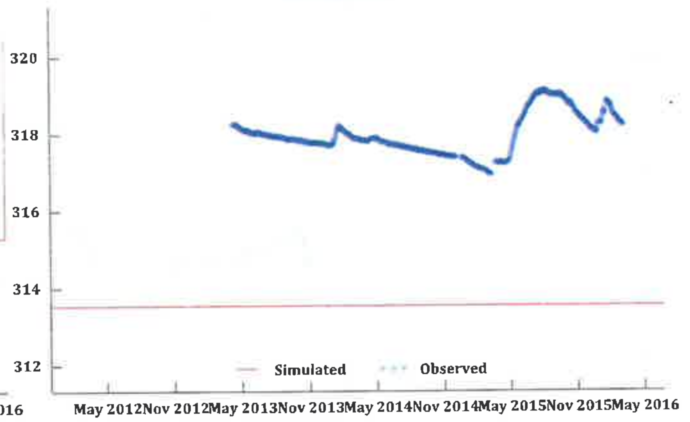
AGE10



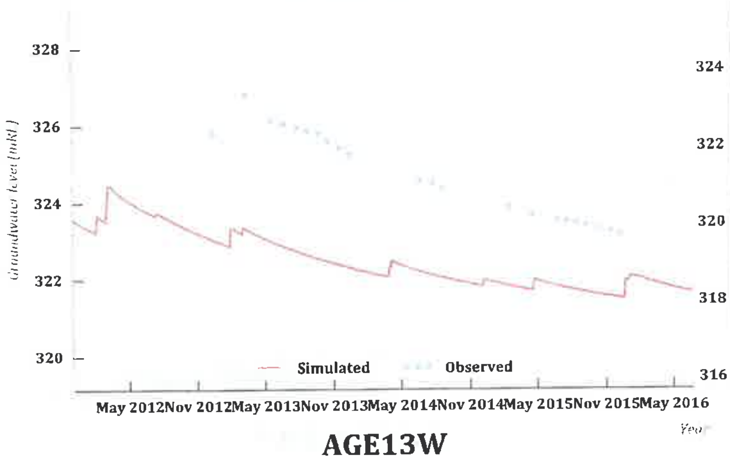
AGE10W



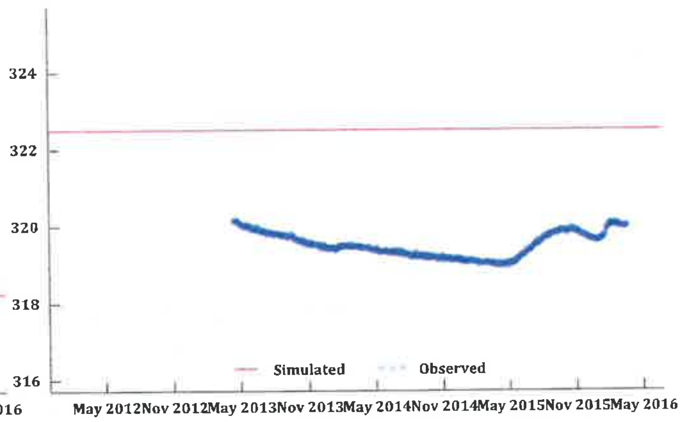
AGE11W



AGE12W

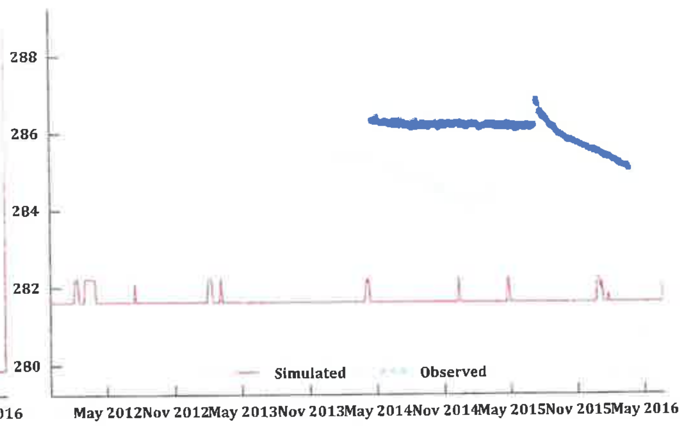


AGE13

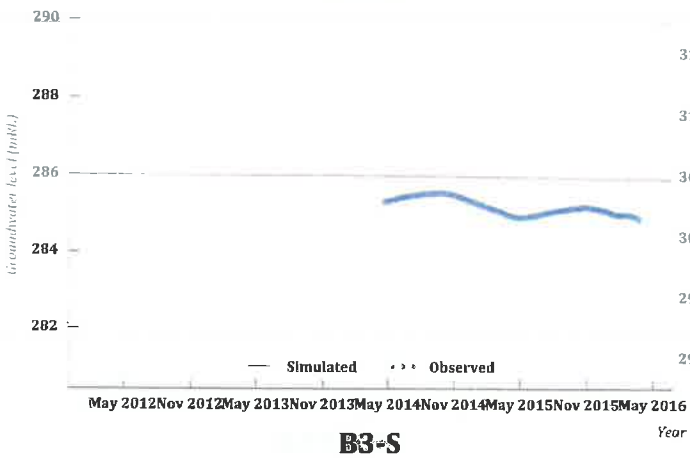


AGE13W

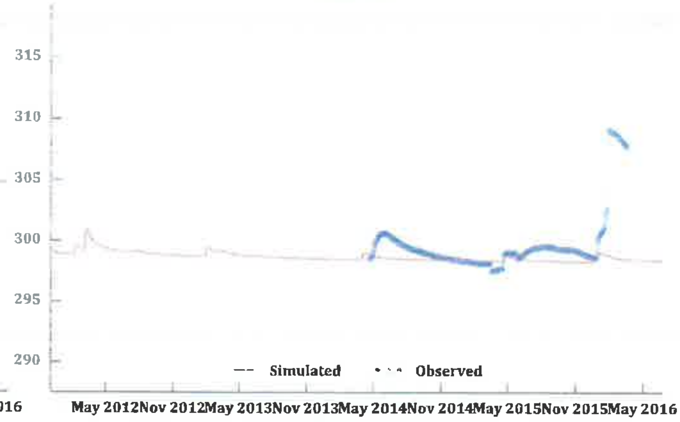
AGE14



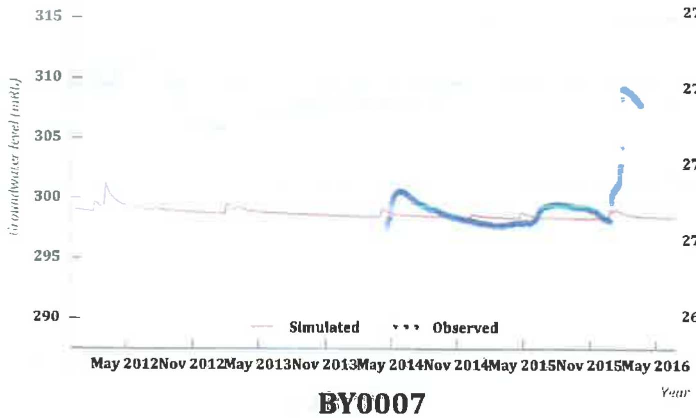
AGE15



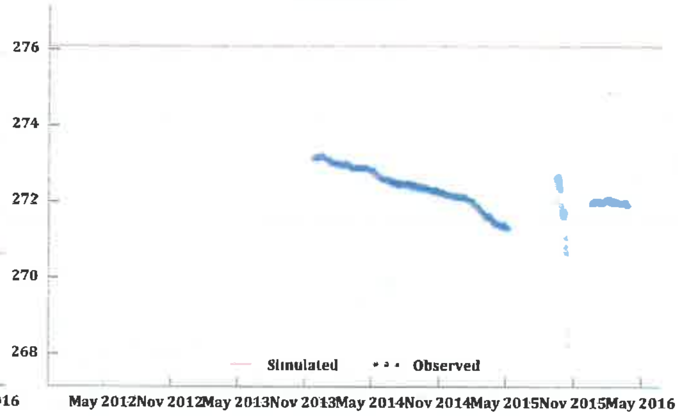
B3-D



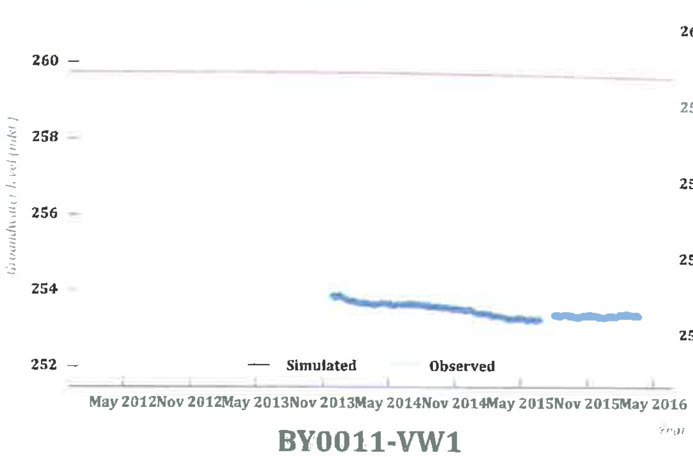
B3-S



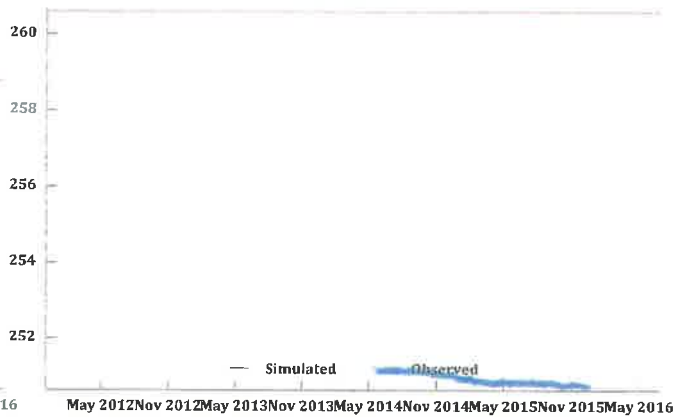
BY0001



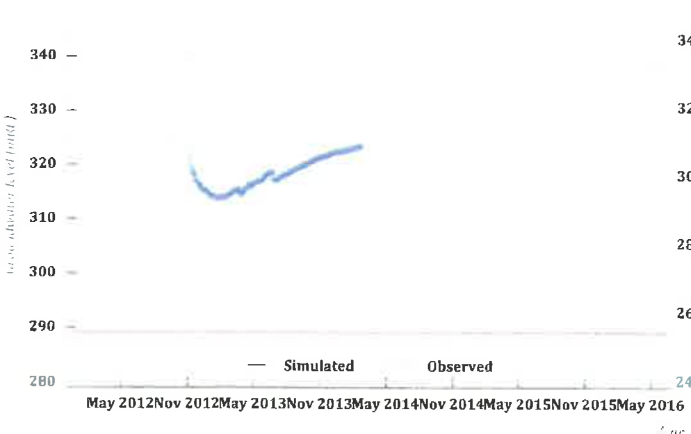
BY0007



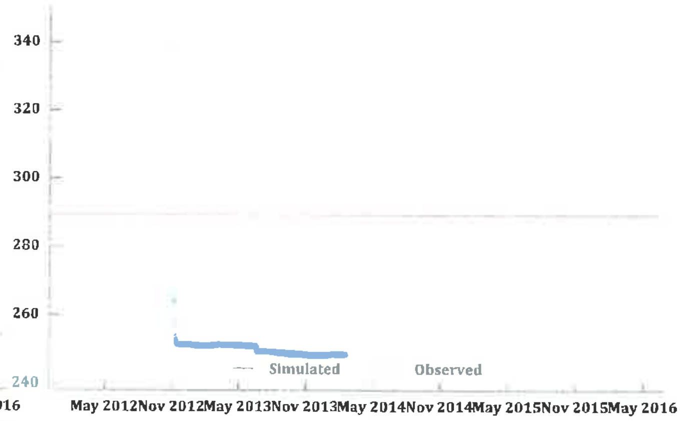
BY0010



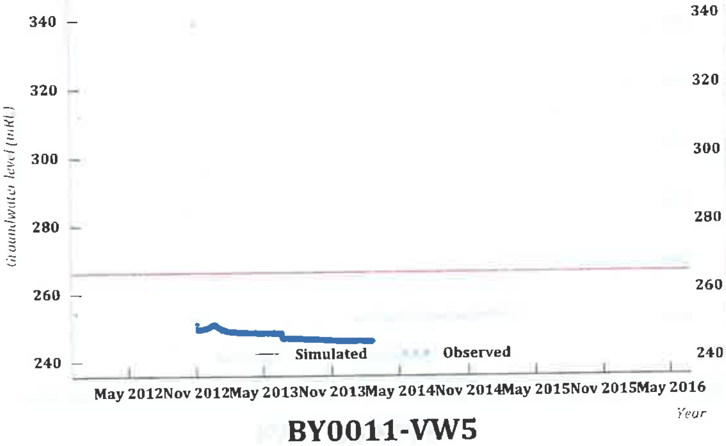
BY0011-VW1



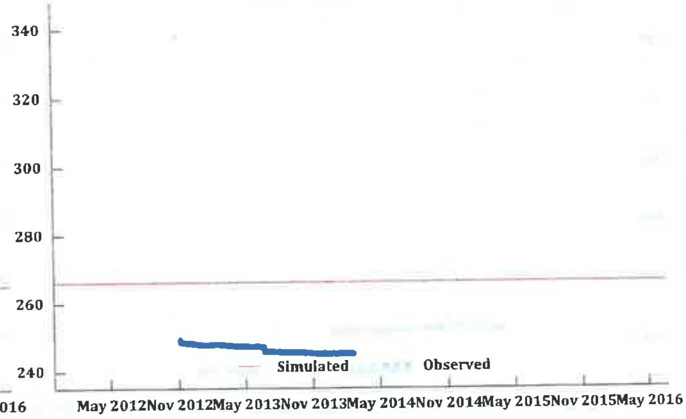
BY0011-VW2



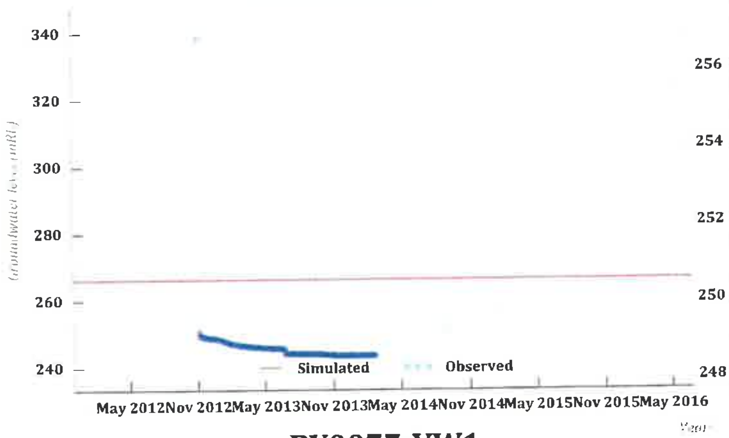
BY0011-VW3



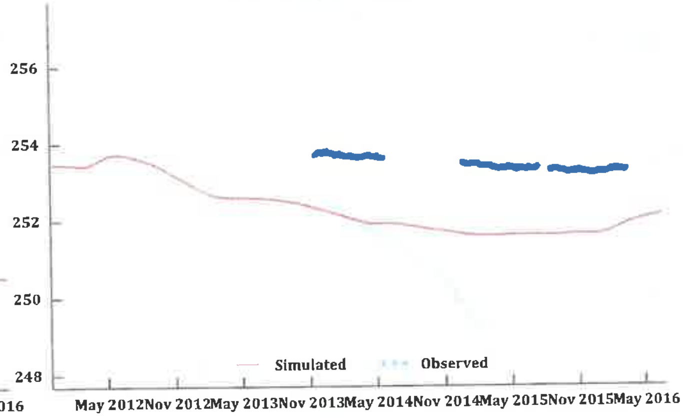
BY0011-VW4



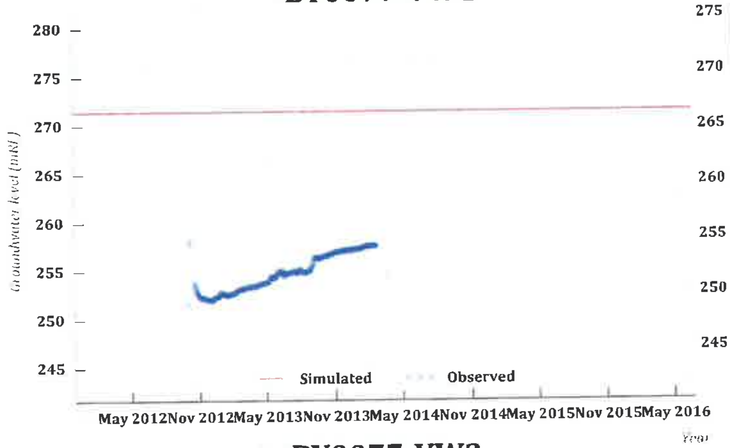
BY0011-VW5



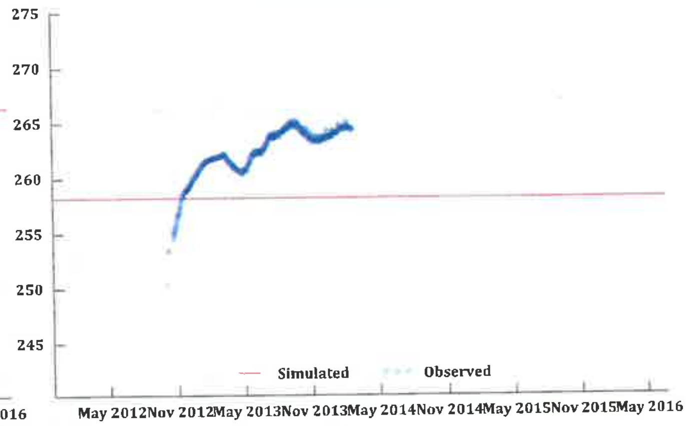
BY0014



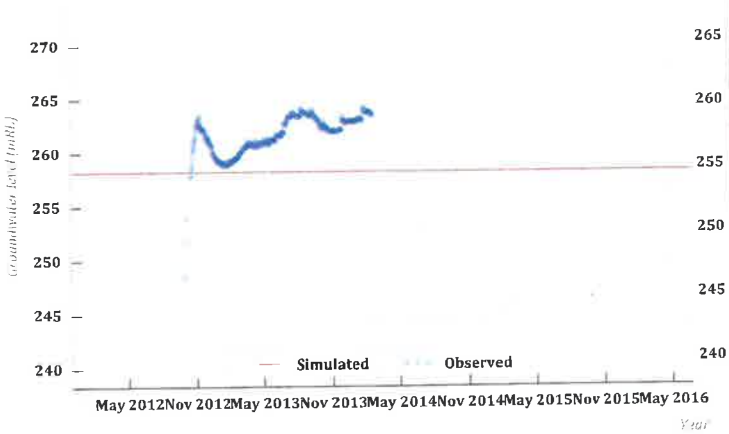
BY0077-VW1



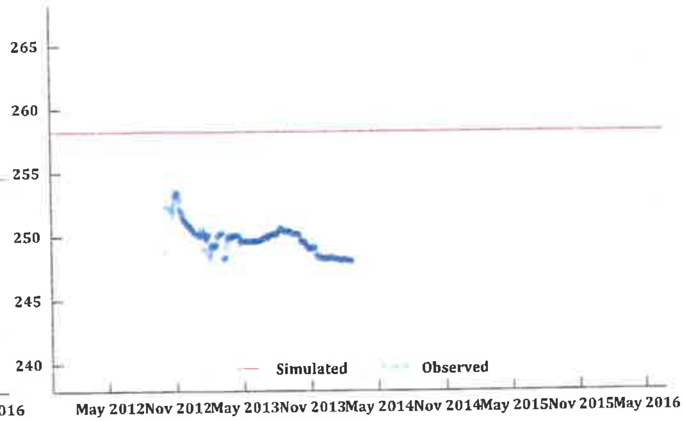
BY0077-VW2



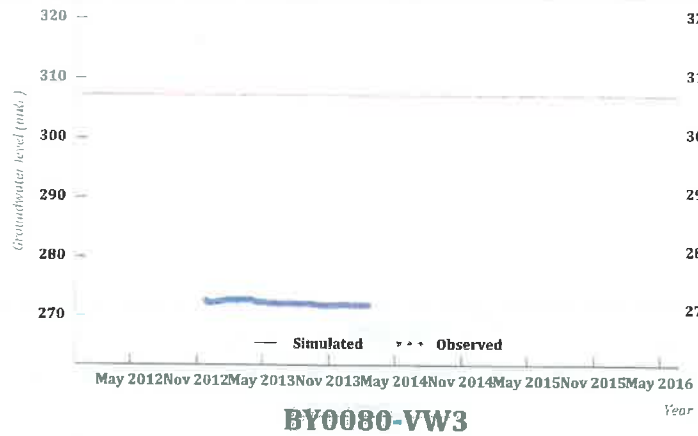
BY0077-VW3



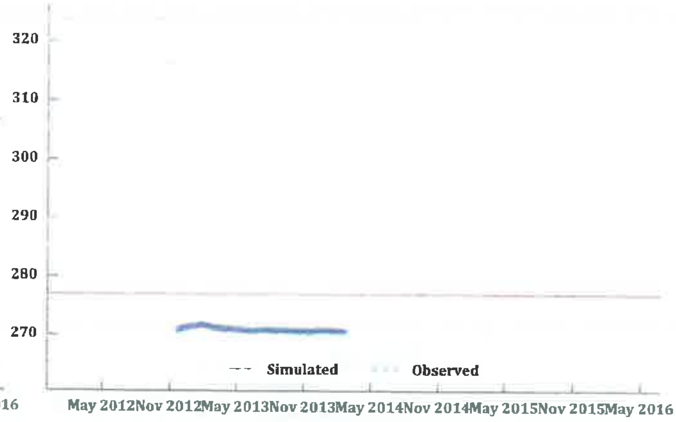
BY0077-VW4



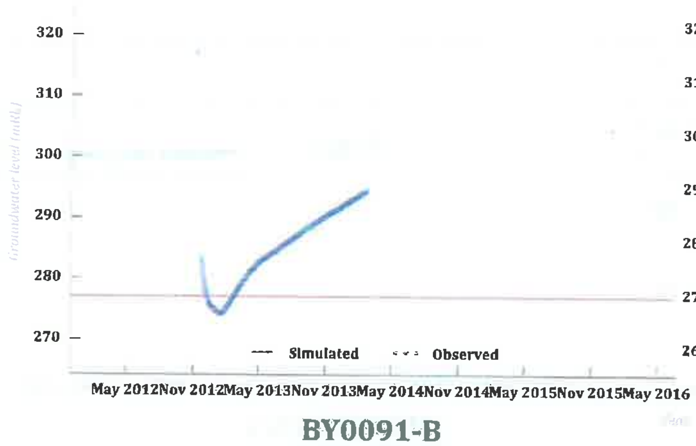
BY0080-VW1



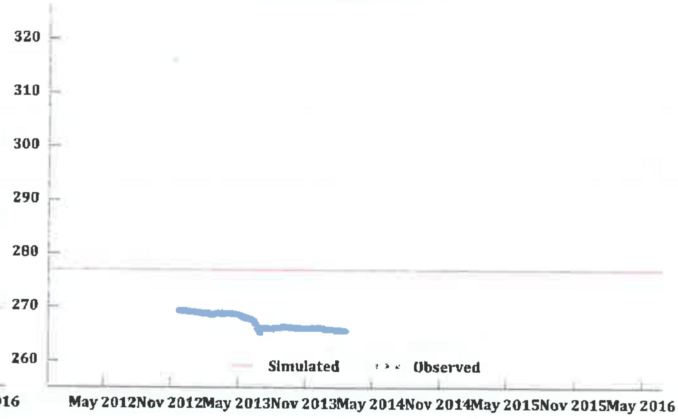
BY0080-VW2



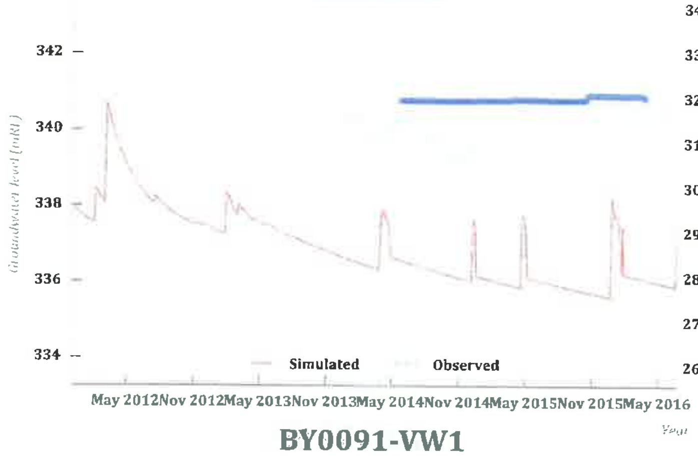
BY0080-VW3



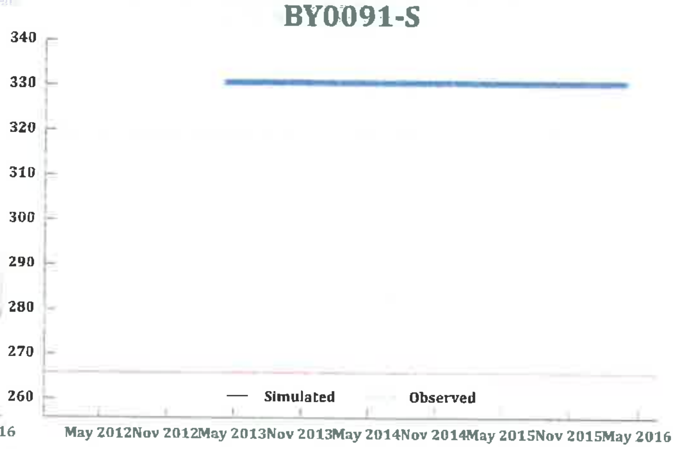
BY0080-VW4



BY0091-B



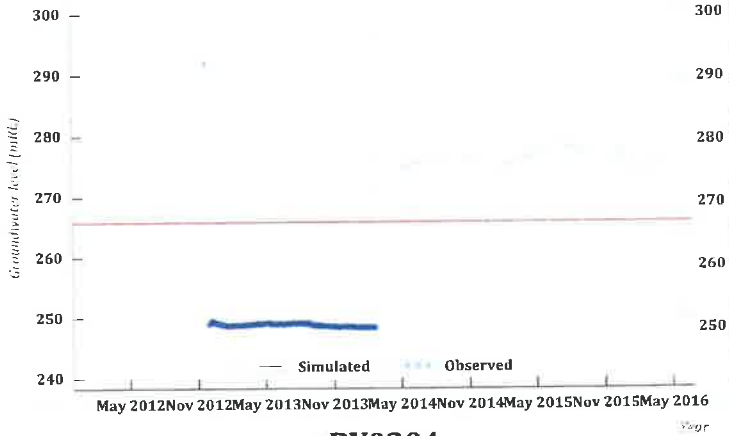
BY0091-S



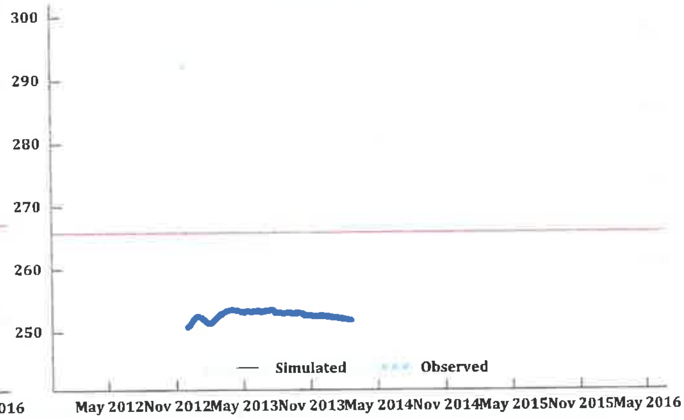
BY0091-VW1

BY0091-VW2

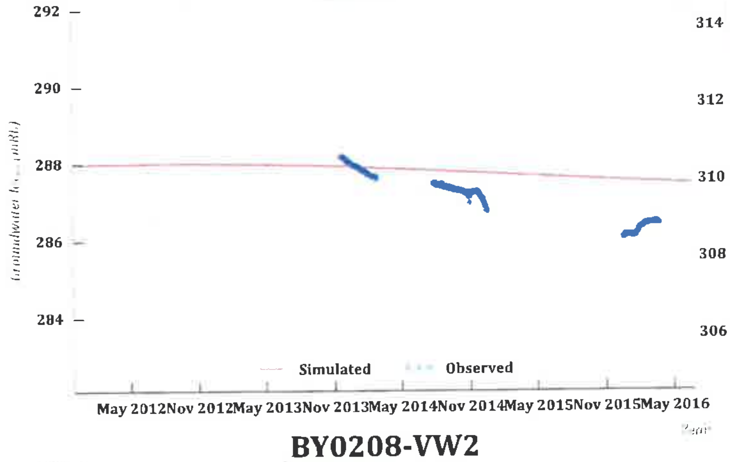
BY0091-VW3



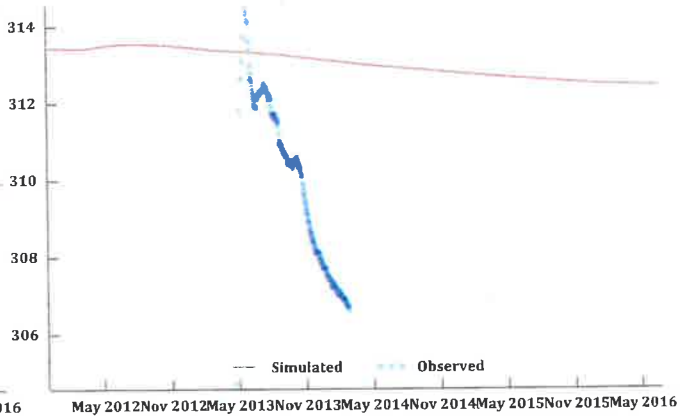
BY0091-VW4



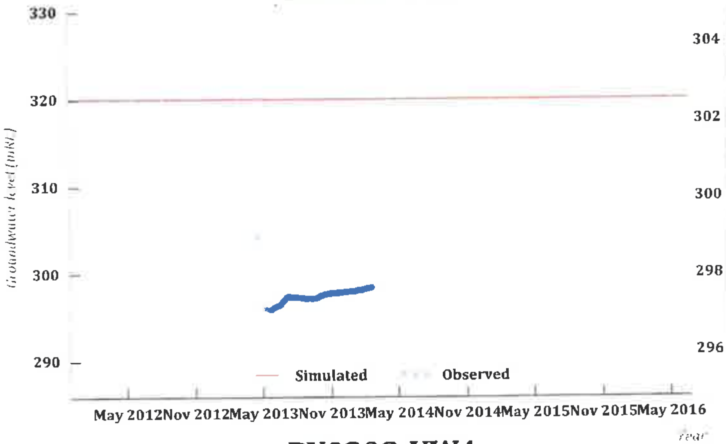
BY0204



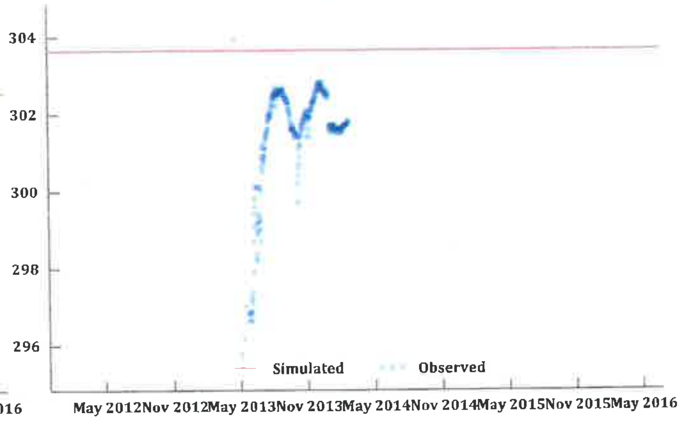
BY0208-VW1



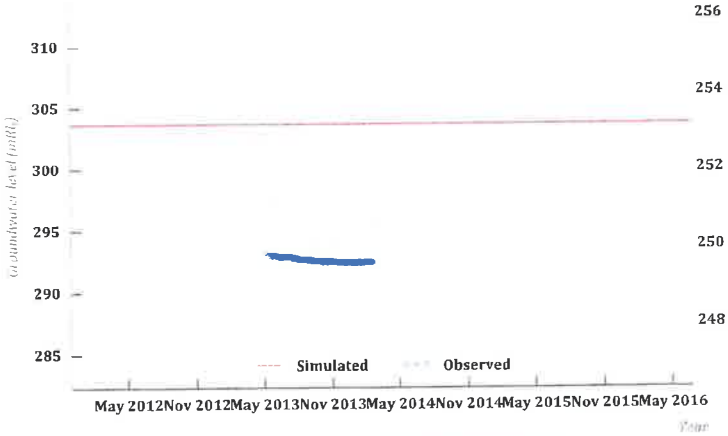
BY0208-VW2



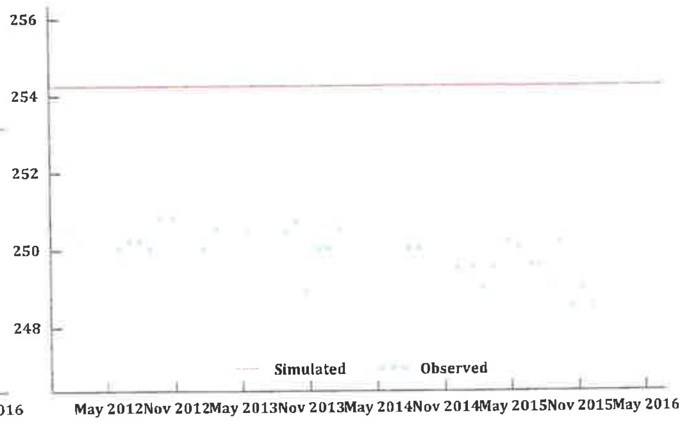
BY0208-VW3

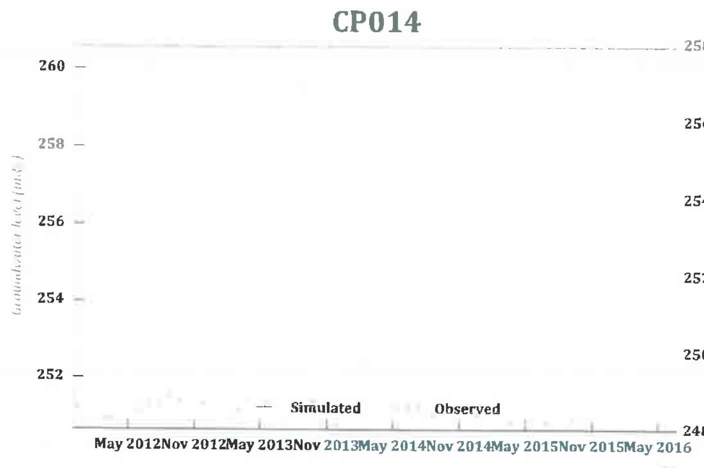


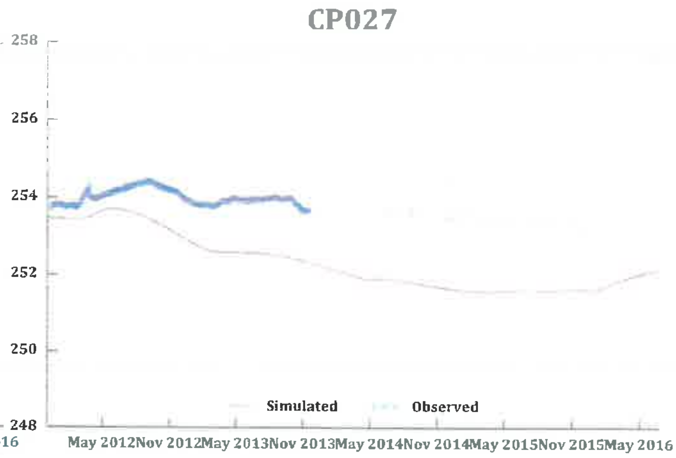
BY0208-VW4

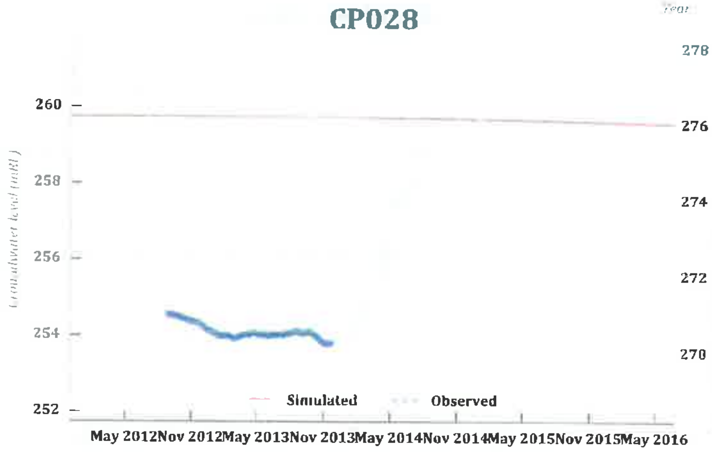


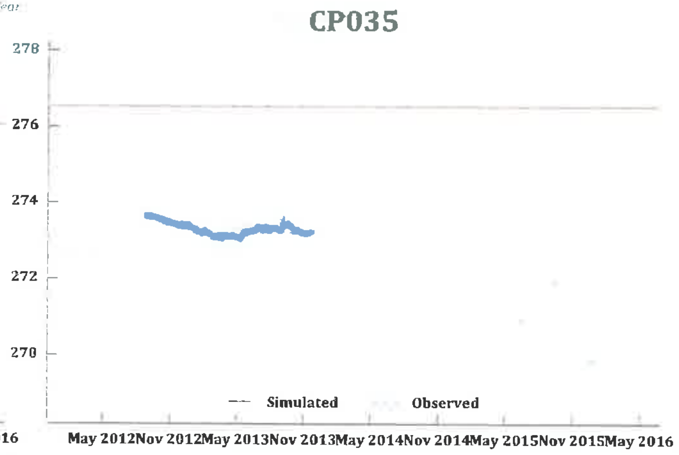
CP009

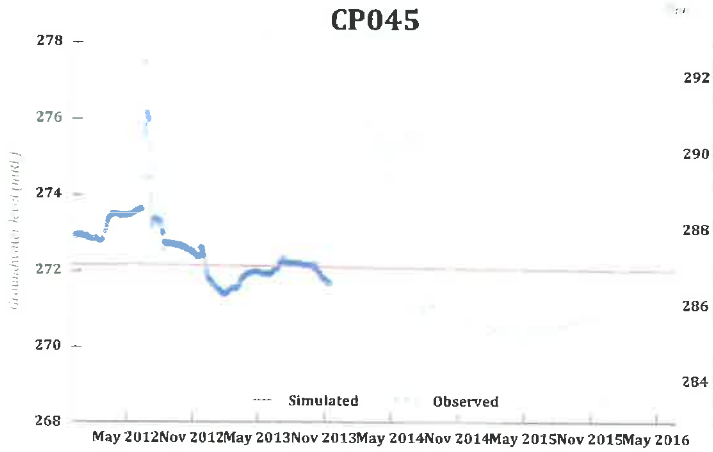


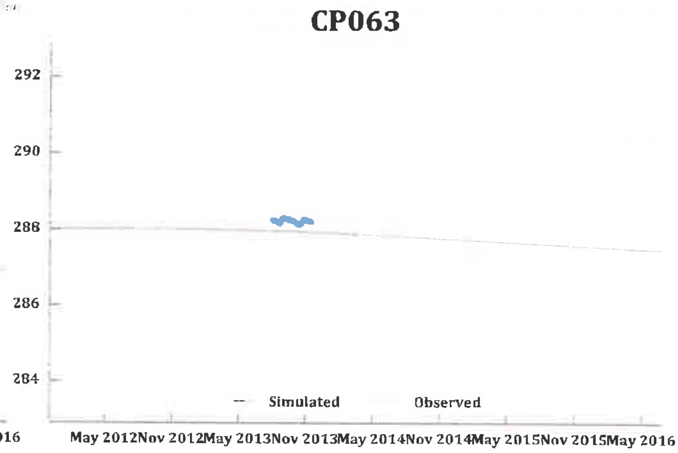

CP014
260
258
256
254
252
Simulated
Observed
May 2012Nov 2012May 2013Nov 2013May 2014Nov 2014May 2015Nov 2015May 2016

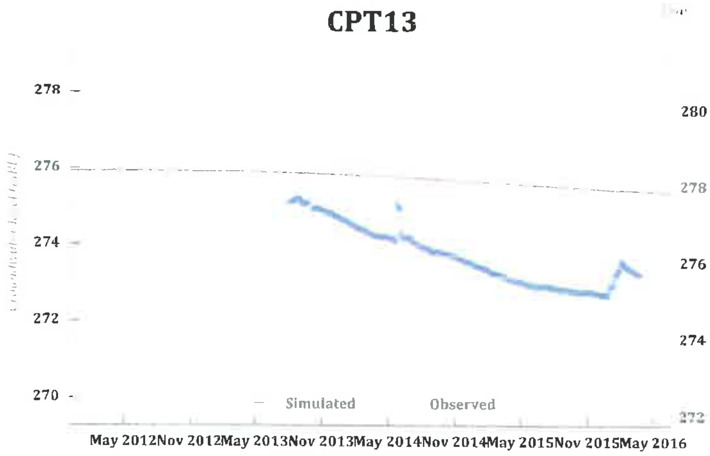

CP027
258
256
254
252
250
248
Simulated
Observed
May 2012Nov 2012May 2013Nov 2013May 2014Nov 2014May 2015Nov 2015May 2016

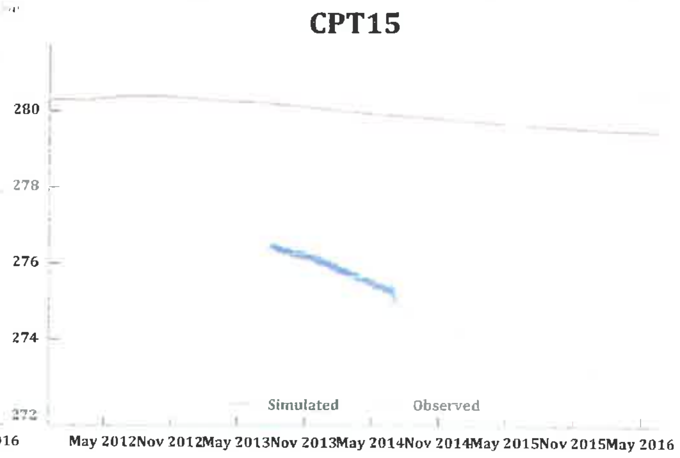

CP028
260
258
256
254
252
Simulated
Observed
May 2012Nov 2012May 2013Nov 2013May 2014Nov 2014May 2015Nov 2015May 2016


CP035
278
276
274
272
270
Simulated
Observed
May 2012Nov 2012May 2013Nov 2013May 2014Nov 2014May 2015Nov 2015May 2016

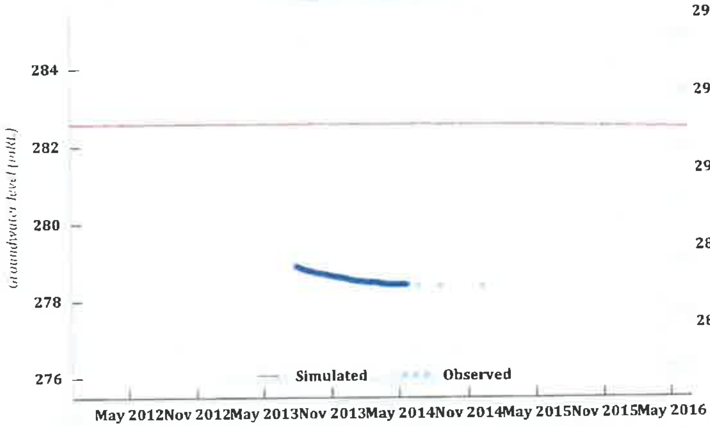

CP045
278
276
274
272
270
268
Simulated
Observed
May 2012Nov 2012May 2013Nov 2013May 2014Nov 2014May 2015Nov 2015May 2016


CP063
292
290
288
286
284
Simulated
Observed
May 2012Nov 2012May 2013Nov 2013May 2014Nov 2014May 2015Nov 2015May 2016

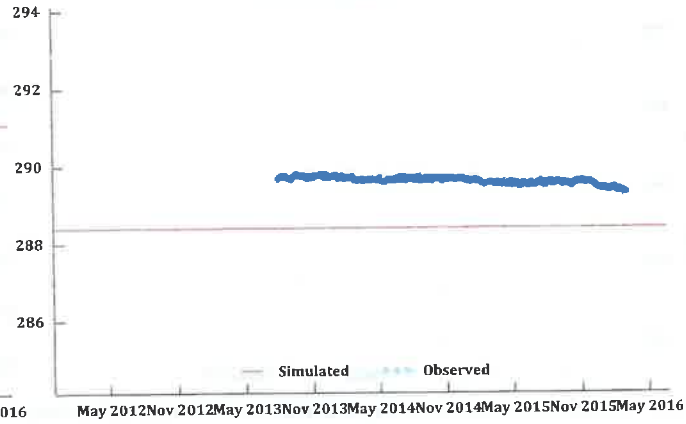

CPT13
278
276
274
272
270
Simulated
Observed
May 2012Nov 2012May 2013Nov 2013May 2014Nov 2014May 2015Nov 2015May 2016


CPT15
280
278
276
274
272
Simulated
Observed
May 2012Nov 2012May 2013Nov 2013May 2014Nov 2014May 2015Nov 2015May 2016

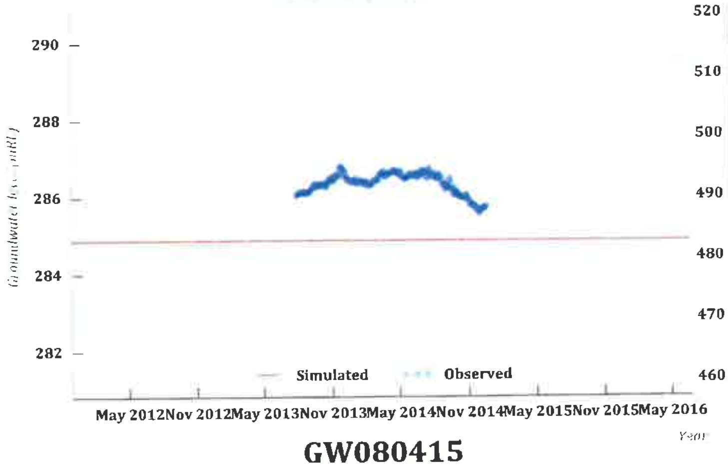
CPT18-VW1



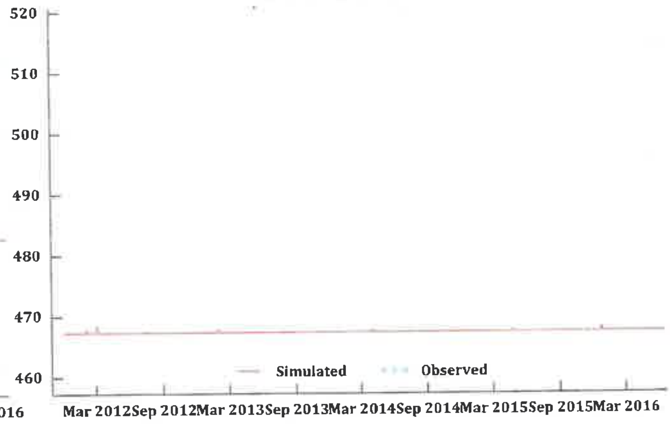
CPT36



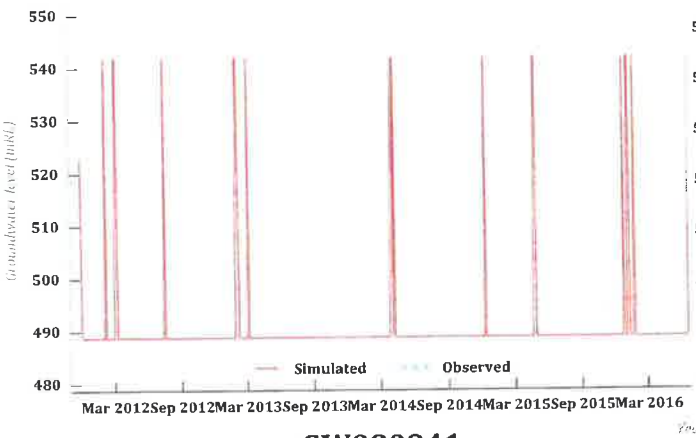
CPT39W



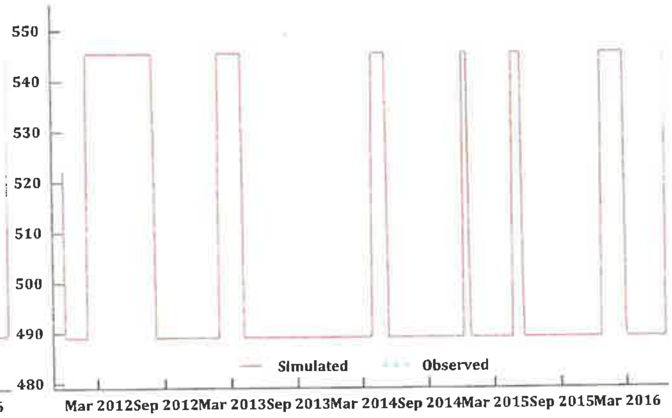
GW080414



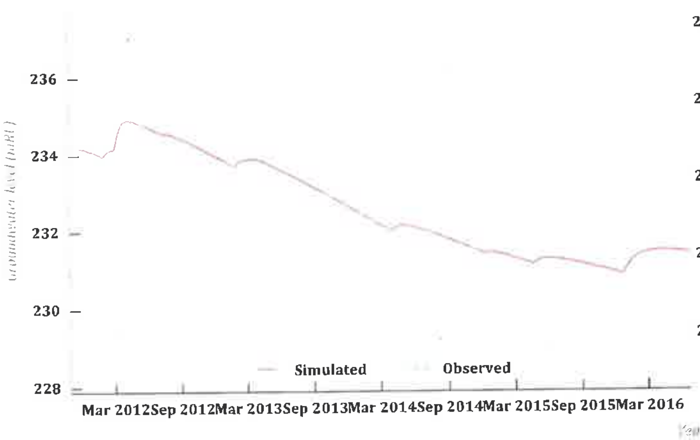
GW080415



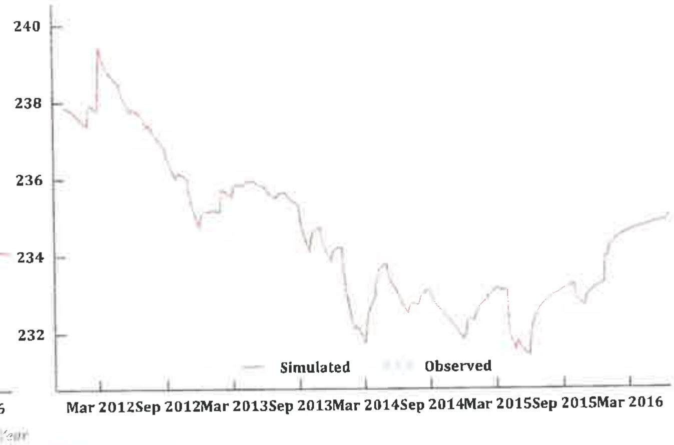
GW080416



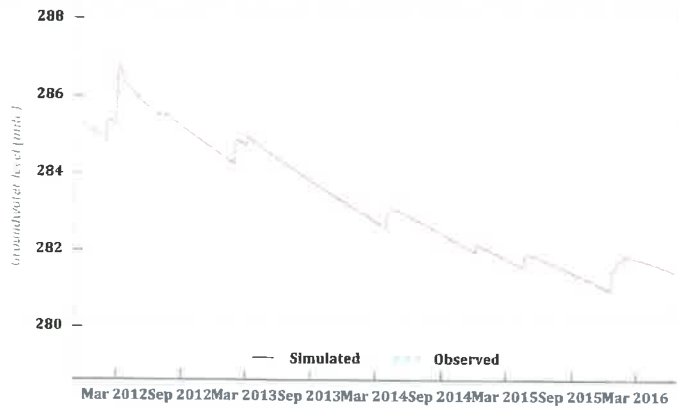
GW080941



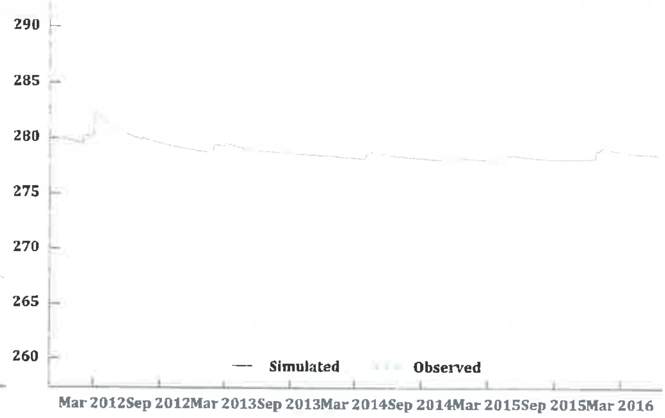
GW271002



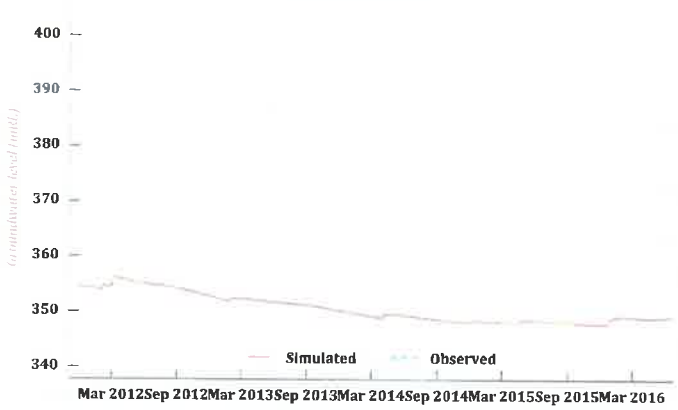
GW271003



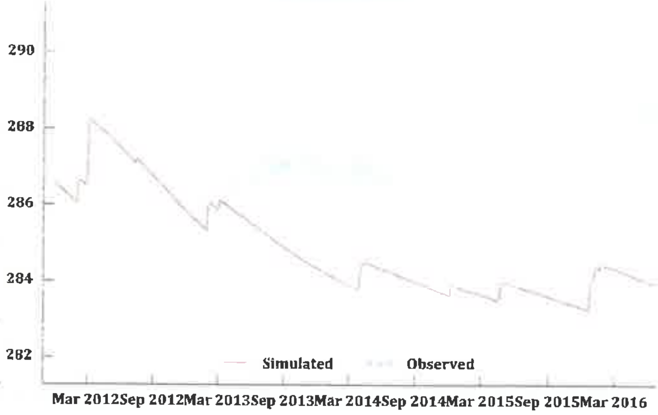
GW271004



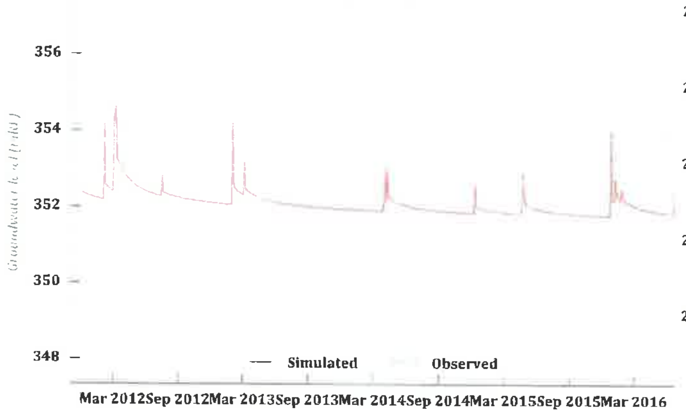
GW271006



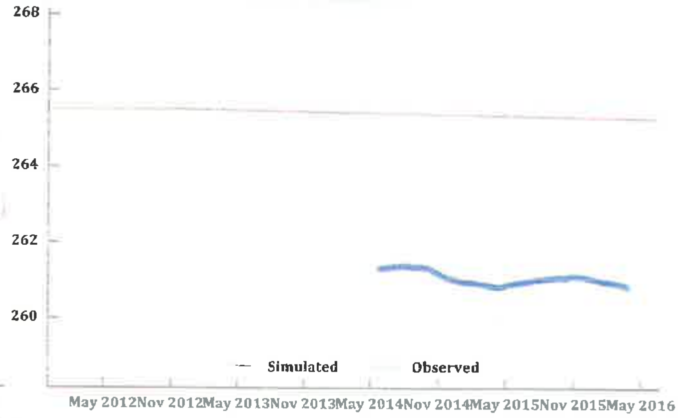
GW271037



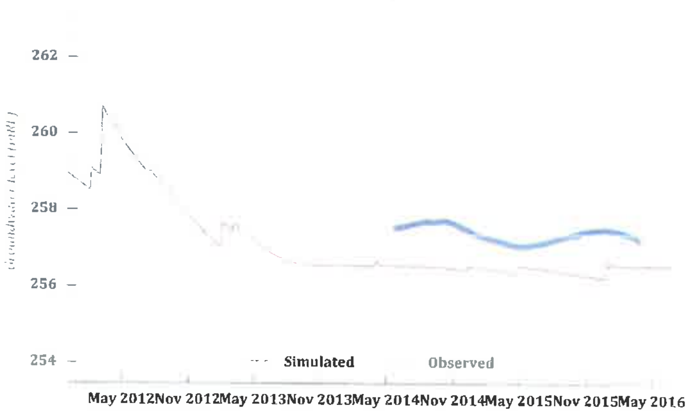
GW271038



M1



M2



Hansen Bailey

ENVIRONMENTAL CONSULTANTS

21 October 2016

Team Leader
Planning Assessment
22-33 Bridge Street
SYDNEY NSW 2000

Attention: Mr Stephen O'Donoghue

Dear Steve,

Bylong Coal Project
Response to Forestry Corporation of NSW Submission, Dated 25 July 2016

1. INTRODUCTION

The '*Bylong Coal Project Environmental Impact Statement*' (EIS) which supported Development Application (SSD) 14_6367 for the Bylong Coal Project (the Project) was placed on public exhibition between 23 September and 6 November 2015.

Hansen Bailey prepared the document '*Bylong Coal Project Response to Submissions*' (RTS) dated 23 March 2016 to address comments received from agencies and other stakeholders during the exhibition of the EIS. The RTS included responses to the Forestry Corporation of NSW (FCNSW) submission dated 3 November 2015 which was generally in relation to access and potential impacts due to subsidence.

FCNSW provided a further letter dated 30 May 2016 to the Department of Planning and Environment (DP&E) over various matters addressed in previous correspondence. A letter was prepared to respond to the FCNSW letter and was submitted to DP&E on 28 June 2016 and appended to the Supplementary Response to Submissions (Supplementary RTS) on 19 August 2016.

FCNSW has provided another submission dated 25 July 2016 which requested resolution over residual issues regarding access to the Bylong State Forest and liabilities. This letter has been prepared to address these issues.

Hansen Bailey Pty Ltd (ABN 17 093 597 810)

BRISBANE
Phone: (07) 3226 0900 **Fax:** (07) 3226 0901
Address: Level 15, 215 Adelaide Street Brisbane Qld 4000 **Postal:** GPO Box 3285 Brisbane Qld 4001

HUNTER VALLEY
Phone: (02) 6575 2000 **Fax:** (02) 6575 2001
Address: 6/127-129 John Street Singleton NSW 2330 **Postal:** PO Box 473 Singleton NSW

2. RESPONSE TO FCNSW SUBMISSION

Issue 1

Forestry Corporation of NSW (FCNSW) has reviewed the tendered document and makes the following comments:

FCNSW acknowledges that KEPCO's intention is to allow FCNSW access to Bylong State Forest. What still remains unresolved is:

(a) where the "right of way" will be located;

(b) a time frame for the establishment of the "right of way";

(c) a commitment from KEPCO that the use of the "right of way" and subsequent occupation of Bylong State Forest will be unfettered; and

(d) what mechanism or instrument should be used to enforce this commitment.

Response

As explained in Section 4.9.1 of the RTS, access to the Bylong State Forest is understood to have typically been via existing farm tracks on the "Bylong Station" property, in the absence of an established "right of way". This property is now owned by KEPCO.

As previously committed and listed in Table 41 (Revised Project Management and Monitoring Measures) of the RTS (ref 5), KEPCO will consult with the FCNSW to provide access arrangements for the public to Bylong State Forest via KEPCO owned land or on alternative land. KEPCO will work with FCNSW and the relevant parties in the process of establishing an approved "right of way" to the Bylong State Forest. The location and alignment of the "right of way" will be determined following discussions between the relevant parties (including FCNSW, DP&E, neighbouring landholders and KEPCO).Until the appropriate "right of way" easement is established, KEPCO upholds its previous its commitment to maintain the existing access to the Bylong State Forest via the "Bylong Station" property.

It should be noted that KEPCO's land is not the only land from which access can be gained to the Bylong State Forest. There are three other land owners adjoining the Bylong State Forest who should be involved in determining the appropriate location of the "right of way" or to achieve the establishment of this mechanism by a certain timeframe. However, KEPCO is committed to work closely with FCNSW and the other relevant parties with best endeavours to establish an acceptable "right of way" access prior to the commencement of the underground component of the Project.

The general intent of the "right of way" being implemented is to establish an unrestricted access to the Bylong State Forest for members of the public and FCNSW. The establishment of the "right of way" does not necessitate the requirement for KEPCO to develop the road structure.

As mentioned above, the RTS clearly explained KEPCO's commitment to working with FCNSW and the relevant parties to establish the required "right of way" access. It is a standard SSD Development Consent condition to require the proponent to operate in general accordance with that explained within the EIS and supporting documentation (which would include the RTS). In this regard, this commitment will be appropriately enforced under the conditions of any Development Consent for the Project.

A right of way registered on title would be the appropriate instrument to secure the access.

Issue 2

> *FCNSW is seeking acknowledgement from KEPCO that they will accept commercial liability for unrepairable damage to FCNSW assets (i.e. land productivity, timber utilisation/devaluation etc). FCNSW are not asking KEPCO to quantify their impacts over the life of the project, only that KEPCO recognise that compensation due to FCNSW will be dealt with via a Compensation Agreement rather than operational plans that describe intentions for remediation, where KEPCO determines whether work is safe to perform or not.*

Response

KEPCO acknowledges that a Compensation Agreement is the appropriate mechanism to outline the terms of compensation for commercial liability. KEPCO will continue to liaise with FCNSW to agree on the appropriate methodology to be utilised to determine the quantifiable losses suffered by FCNSW in relation to any unrepairable damage to the productivity of the Bylong State Forest. This damage will be determined through an appropriate understanding of the baseline condition and the relevant monitoring programs developed in consultation with FCNSW as part of the Extraction Plan process. Assessment of loss of land productivity, timber utilisation/devaluation etc should be determined by an independent expert.

Underground mining is scheduled to commence in Project Year 7. The terms of the Compensation Agreement will be agreed with FCNSW prior to impacts to the Bylong State Forest.

Issue 3

KEPCO's noted response provides no reassurance that FCNSW will not be exposed to ongoing public safety or environmental liabilities as a result of KEPCO's activities. This arrangement is not acceptable to FCNSW.

Response

Contemporary Development Consents for underground mining projects are subject to conditions requiring submission and approval of an Extraction Plan (EP) which describes how subsidence impacts will be managed. Approved EPs must then be implemented by the proponent as a requirement of both the Development Consent and Mining Lease. The EP is assessed by relevant agencies that provide advice to the DP&E prior to the approval of these management documents.

As outlined in Section 4.9.1 of the RTS, a component of the EP is the preparation of a Property Subsidence Management Plan (PSMP). A PSMP will be prepared specifically for the Bylong State Forest. The PSMP will include the following:

- An inspection of the existing condition of key features and commercial activities (as agreed with FCNSW) within the Bylong State Forest prior to mining;
- Review subsidence monitoring data gathered during the initial longwall mining operations and refinement of the subsidence model to more accurately predict the likely impacts;
- Consideration of potential subsidence impacts on Bylong State Forest, including impacts to access tracks and commercial activities undertaken by FCNSW, prior to the influence of the proposed longwalls and implementation of appropriate control measures, if required and as agreed with FCNSW;
- Notification protocols with FCNSW in relation to the timing and location of the mining beneath the Bylong State Forest;
- Monitoring of key FCNSW assets and access tracks during critical periods of active subsidence, with repair crews on hand to maintain the integrity of the access tracks; and
- Timely repairs of surface cracks and other deformations, as required.

The EP will contain agreed detailed performance indicators and describe the measures that would be implemented to ensure compliance with the performance indicators and manage or remediate subsidence impacts and/or environmental consequences within the Bylong State Forest. A Trigger Action Response Plan (TARP), or equivalent, to address potential subsidence impacts and environmental consequences that may result from mining subsidence will be developed for inclusion within the EP. The EP will be revised for each new proposed longwall panel to incorporate the findings of the actual subsidence impacts recorded from the completed longwall panels.

Public safety will be addressed as a component of the EP. KEPCO will implement a number of management measures to prevent, mitigate and promptly stabilise any identified safety hazards associated with the subsidence impacts. As outlined in the RTS, the Project will take reasonable steps to ensure (to the extent it can) the Bylong State Forest is accessible to the public and that any public safety risks are appropriately managed to enable safe access to these areas, including:

- Appropriate notifications and consultation with the community;
- Erecting warning signs during active subsidence; and
- Undertaking repairs where required and as soon as practicable.

In addition to and consistent with the required management activities of subsidence impacts, KEPCO will be required to liaise with FCNSW in relation to the appropriate occupation permit and compensation agreement for the Project. It is envisaged that these agreements will be consistent with the regulatory requirements which will be specified under the Development Consent approval.

3. CONCLUSION

We trust this response addresses the issues raised in the FCNSW latest correspondence.

Should you have any queries in relation to this letter, please contact us on 6575 2000.

Yours faithfully

HANSEN BAILEY

Nathan Cooper	James Bailey
Principal	*Director*

NSW GOVERNMENT

Office of Environment & Heritage

3 November 2016
DOC16/367592
SSD 14_6367

Mr Stephen O'Donoghue
Team Leader - Planning Services, Resources Assessments
Department of Planning & Environment
stephen.o'donoghue@planning.nsw.gov.au

Dear Steve

Bylong Coal Project - OEH response to KEPCO letter of 8 July 2016

I refer to your email of 13 July 2016 inviting the Office of Environment and Heritage (OEH) to comment on further advice from KEPCO regarding biodiversity and Aboriginal cultural heritage aspects of the Bylong Coal Project. This advice is as a result of matters discussed during the meeting between OEH, the Department of Planning and Environment (DP&E) and KEPCO representatives in Dubbo on 16 June 2016.

OEH is pleased to inform you that all substantial biodiversity and Aboriginal cultural heritage matters which required resolution prior to DP&E finalising assessment have now been resolved.

OEH's recommendations are provided in **Attachment A** and our detailed comments are provided in **Attachment B**. If you have any questions regarding this matter please contact Steven Cox on 02 6883 5382 or email steven.cox@environment.nsw.gov.au.

Yours sincerely

PETER CHRISTIE
Regional Manager North West
Regional Operations

Attachment A: OEH Review - Recommendations - Bylong Coal Project

Attachment B: OEH Review –Detailed Comments- Bylong Coal Project

PO Box A290 Sydney South NSW 1232
59-61 Goulburn St Sydney NSW 2000
Tel: (02) 9995 5000 Fax: (02) 9995 5999
TTY (02) 9211 4723
ABN 30 841 387 271
www.environment.nsw.gov.au

ATTACHMENT A

OEH Review - Recommendations

Bylong Coal Project

Recommendations

1. DP&E accept the BOS as suitable to offset the impacts of the project (with the addition of the Fuzzy Box Woodland offset area as per recommendation 3.1).
2. KEPCO collect the full set of plot/transect data required for each Plant Community Type to satisfy the requirements of the BOS under the FBA, post approval.
3. DP&E note that OEH does not require additional offsetting or other measures for any of the matters identified as requiring further consideration in the SEARs.
4. DP&E include the Fuzzy Box Woodland offset area within the offset package in the project consent conditions.
5. DP&E note that OEH is satisfied that the proposed offset package now contains sufficient species credits for the Regent Honeyeater.
6. DP&E incorporate the avoidance of impacts on cliff C5 into the project's approval conditions.
7. DP&E includes a consent condition that searches of potential roost sites and monitoring of cave-dwelling microbats are incorporated into the BMP.
8. DP&E note the updated mapping of the EPBC Act Box Gum Woodland and derived native grassland community.
9. DP&E include a consent condition that requires the regional rock art study and the assessments of select Biodiversity Offset Areas to be undertaken, in consultation with OEH and the RAPs, as a component of the Aboriginal Archaeology and Cultural Heritage Management Plan.

ATTACHMENT B

OEH Review – Detailed Comments

Bylong Coal Project

Acronyms

ACH	Aboriginal Cultural Heritage
BAR	Biodiversity Assessment Report
BBCC	BioBanking Credit Calculator
BMP	Biodiversity Management Plan
BOS	Biodiversity Offsets Strategy
DP&E	Department of Planning and Environment
EPBC	*Environment Protection and Biodiversity Conservation Act 1999*
FBA	Framework for Biodiversity Assessment
IBRA	Interim Biogeographic Regionalisation of Australia
KEPCO	Korea Electric Power Corporation
OEH	Office of Environment and Heritage
RAPs	Registered Aboriginal Parties

Offset Area 5

OEH provided advice to DP&E on 26 October 2016 specifically relating to the applicability of a BioBanking Agreement for Offset Area 5.

Data Required for Offset Sites

As discussed during the meeting of 16 June 2016, OEH acknowledges that the full set of data for offset sites (not all plot/transect data has been collected) is not required prior to a decision on consent. It will be required to finalise ecosystem and species credits for the BOS but this can be completed post approval. The BOS as it currently stands has sufficient excess credits that any changes in the number of credits available caused by new data are considered unlikely to result in a credit deficit.

Recommendations

1. DP&E accept the BOS as suitable to offset the impacts of the project (with the addition of the Fuzzy Box Woodland offset area as per recommendation 3.1).

2. KEPCO collect the full set of plot/transect data required for each Plant Community Type to satisfy the requirements of the BOS under the FBA, post approval.

Matters for Further Consideration

In a letter dated 2 March 2015, OEH supplied KEPCO with a list of species, populations and ecological communities which required further consideration if impacted by the Bylong Coal Project. The BAR identified encroachment on the riparian buffer along the Bylong River, Box Gum Woodland and derived native grassland, and the Regent Honeyeater as matters requiring further consideration by the consent authority under the FBA. OEH also indicated that the Brush-tailed Rock Wallaby was potentially a matter for further consideration.

OEH is satisfied that the small encroachment on the riparian buffer of the Bylong River is sufficiently dealt with within the BBCC. OEH is also satisfied that the Bylong Coal Project will not cause Box Gum Woodland and derived native grassland, the Regent Honeyeater or the Brush-tailed Rock Wallaby to become extinct or have its viability significantly reduced in the IBRA subregion.

Recommendation

3. DP&E note that OEH does not require additional offsetting or other measures for any of the matters identified as requiring further consideration in the SEARs.

Variation to Offset Rules – Ecosystem Credits

The BAR identified a shortfall of ecosystem credits for the Fuzzy Box Woodland community. OEH is pleased to note that KEPCO have identified a potential offset area on KEPCO owned land which has sufficient ecosystem credits to cover this shortfall. Consequently a variation to offset rules is no longer required.

Recommendation

4. DP&E include the Fuzzy Box Woodland offset area within the offset package in the project consent conditions.

Variation to Offset Rules – Species Credits

The BAR identified a shortfall of species credits for the Regent Honeyeater. OEH subsequently advised KEPCO that the description of habitat for the Regent Honeyeater within the OEH Threatened Species Profile Database had been updated. These new definitions of species habitat along with an analysis of plot data (to confirm the relevant canopy species are present within the plant community types) indicate that the offset package now has sufficient species credits for the Regent Honeyeater. Consequently a variation to offset rules is no longer required.

OEH calculations of the area of Regent Honeyeater habitat and species credits generated within the project disturbance boundary and at the offset sites differ slightly to that of KEPCO, but the difference is negligible (OEH – 1,615 excess credits, KEPCO - 1,620 excess credits).

Recommendation

5. DP&E note that OEH is satisfied that the proposed offset package now contains sufficient species credits for the Regent Honeyeater.

Cliffs

OEH welcomes the strengthened commitment from KEPCO that any material adverse impacts to cliff C5 will be avoided in the same way as for cliffs C1-C4. OEH understands that the underground mining stand-off from cliff C5 to avoid impact of far-field horizontal movements will be determined by monitoring of the initial five longwalls.

Recommendation

6. DP&E incorporate the avoidance of impacts on cliff C5 into the project's approval conditions.

Bat Monitoring

OEH welcomes the commitment by KEPCO to include within the BMP:

- searches of potential roost sites at prominent cliffs within and adjacent to the Subsidence Study Area; and
- monitoring of cave dwelling microbats prior to, and following, the underground mining component of the project.

Recommendation

7. DP&E includes a consent condition that searches of potential roost sites and monitoring of cave-dwelling microbats are incorporated into the BMP.

Category 2 and Category 3 Grassland Mapping

OEH accepts the revised mapping of the EPBC Act Box Gum Woodland and derived native grassland community. Further information regarding the derivation of EPBC Act Box Gum Woodland and derived native grassland is contained in OEH's Bilateral Assessment supplied to DP&E.

Recommendation

8. DP&E note the updated mapping of the EPBC Act Box Gum Woodland and derived native grassland community.

Aboriginal Cultural Heritage

OEH have considered the final KEPCO responses to the Aboriginal cultural heritage issues regarding the Bylong Coal Project. OEH notes KEPCO's responses, specifically their acceptance of the OEH recommendations for ACH assessments of biodiversity offset areas and a regional rock art study. OEH remains willing to assist in both endeavours by the provision of technical information and advice on methodology if required.

Recommendation

9. DP&E include a consent condition that requires the regional rock art study and the assessments of select Biodiversity Offset Areas to be undertaken, in consultation with OEH and the RAPs, as a component of the Aboriginal Archaeology and Cultural Heritage Management Plan.

Department of Primary Industries

OUT16/41422

Mr Stephen O'Donoghue
Resource Assessments
NSW Department of Planning and Environment
GPO Box 39
SYDNEY NSW 2001

Stephen.ODonoghue@planning.nsw.gov.au

Dear Mr O'Donoghue

Bylong Coal Project (SSD 6367)
Comment on the supplementary Response to Submissions

I refer to your email of 21 August 2016 to the Department of Primary Industries (DPI) in respect to the above matter. Comment has been sought from relevant divisions of DPI. Views were also sought from NSW Department of Industry - Lands that are now a division of the broader Department and no longer within NSW DPI.
Any further referrals to DPI can be sent by email to landuse.enquiries@dpi.nsw.gov.au.

DPI has reviewed all information for the project provided supplementary to the Response to Submissions and provides the following recommendations with further detail at **Attachment A**:

- The current prediction for groundwater take requirements from the Sydney Basin-North Coast Groundwater Source is 4100 ML. As the proponent currently holds Water Access Licenses (WALs) for 411 shares and has a valid application equivalent to 2093ML the proponent may need to purchase 1596 shares from the market to make up the shortfall.

- The proponent may not have correctly apportioned relevant take from each water source resulting from inflows to the mine, and may have underestimated the shares required in the Bylong River Water Source. The proponent holds 2535 shares in the Bylong River Water Source. It is understood that these shares will contribute to accounting for take of water from the bore field and take of water for agricultural purposes. However these shares will also need to account for passive take of water via alluvial loss and reduction in baseflow. For example the additional information received indicates that peak baseflow loss will occur in year 9 at 2.7 ML/day or 986 ML/year in the 99th percentile scenario. As such in that year this volume of water may not be actively extracted from the Bylong River Water Source and this should be reflected in the site water balance.

- The proponent should investigate alternative sources of water supply for the scenario whereby insufficient shares in the Bylong River Water Source are held or alluvial aquifer depressurisation decreases the yield of the water supply from the bore field. This should be considered to ensure security of water for agricultural purposes and also to source water should make-good provisions be triggered.

- The proponent should consider use of an alternative coupled surface water-groundwater modelling code for subsequent modelling work that partitions rainfall into recharge, overland flow and evapotranspiration using physics-based equations. The modelling is to utilise data obtained from the recommended additional fieldwork and to also include a complete and appropriate input data set as required for this task. This should be part of the Mining Operations Plan process and will increase the understanding of water take requirements from each water source.

- Aquifer pump testing should be undertaken in the Permian and Triassic aquifers and the results provided to DPI Water to verify the hydraulic conductivity values adopted in the model.

- The proponent should implement agreed setback distances from the alluvial boundary and perform ongoing monitoring of the setback during project construction to ensure the setback is maintained.

- All works on waterfront land should be conducted in accordance with DPI Water's *Guidelines for Controlled Activities on Waterfront Land*, as amended from time to time.

- Any determination for the project should contain the following condition of approval:
    - "The Applicant must ensure that it has sufficient water for all stages of the development, and if necessary, adjust the scale of operations on site to match its available water supply".

- The Water Management Plan for the project should be developed in consultation with DPI Water. This plan should at least include the following:

    - Additional assessment of impact of alluvial aquifer depressurisation on flow in the Bylong River should be undertaken. This should include consideration of the ecological impacts and the impacts on basic landholder rights extraction.

    - Make good commitments for private water users in the Bylong River Water Source whereby a reduction in water level produces an inability to take water for licensed purposes or basic landholder rights. The make-good provisions must occur prior to an investigation regarding the cause in the reduction of water levels. Specific consultation must occur to establish contingency water supply provisions for the "Budden" and "Eagle Hill" properties.

    - Monitoring of flows, riparian land, bank stability, erosion, scour, water quality and salt load in the Bylong River and surrounding tributaries. This monitoring program should relate to a prescriptive TARP, which includes mitigation and rehabilitation measures.

    - Expansion of the groundwater monitoring network prior to commencement of mining to monitor water level in areas of maximum predicted drawdown and identified groundwater dependent ecosystems. DPI Water should be consulted regarding the proposed expansion of the monitoring network to provide advice on location and target aquifer screening. Additional monitoring bore locations must be included between the:

        - Bore field and other water users
        - Alluvial aquifer and proximal coal seams
        - Alluvial aquifer and underground mine
        - Alluvial aquifer and open cut mine

- The proponent should provide further clarified information to the public regarding buffers for adjoining BSAL. The proponent should clarify that a 50 metre buffer has been applied, why a 50 metre buffer has been selected and how it will be managed.

- During the life of the project the proponent should manage any lands used for irrigated agriculture to retain this potential post project.

Yours sincerely

Mitchell Isaacs
Director, Planning Policy & Assessment Advice
7 November 2016

DPI appreciates your help to improve our advice to you. Please complete this three minute survey about the advice we have provided to you, here:
https://goo.gl/o8TXWz

Attachment A

Bylong Coal Project (SSD 6367)
Comment on the Response to Submissions Report
Detailed comments – DPI Water

The proponent has provided information about multiple, distinct Bylong regional groundwater models that were constructed using two mathematically different, separate modelling codes. These models have differences in the mesh design, input parameters, unsaturated zone equations, conceptual model and mathematical settings. The predicted levels of impacts varied between the models however all seven model scenarios resulted in a minimum drawdown of 2 m in the Bylong alluvium, which then effects surface flow in the Bylong River. It is considered that the likely scenario based on the model results provided is the 99th percentile or 'worst case'.

It is accepted that the Independent Model Review classed the model as fit for purpose however there are numerous elements which result in a lack of certainty regarding the impacts of the proposed project. Hence the recommendation for an alternative modelling code to be used as part of the Mining Operations Plan process. The reasons for this recommendation are as follows.

- Conductivity values used for the coal seams were not representative of the higher conductivity values from the packer testing results. These high conductivity values were also not used in the uncertainty analysis.
- Lack of pumped aquifer testing information from the Permian and Triassic aquifers to inform appropriate hydraulic conductivity values.
- Assumptions used to generate estimates on the volumes of WAL requirements may underestimate the quantity of required shares in the Bylong River. For example section 6.4.7 of the additional RTS states "*For the purposes of water licensing, it has been assumed all the water predicted to be intercepted by the model drain cells is from the Permian or Triassic strata. Therefore, this water should be accounted for with water access licences under the North Coast Porous and Fractured Rock Water Sharing Plan.*"
- The three dimensional models identified no aquiclude between the coal seam and alluvium. It is expected that alluvial aquifer water leakage will be induced to flow into the sub-cropping Permian aquifers that will be exposed in the open cut and underground mine void. This will result in water originating from the alluvial aquifer to also be taken in the open cut and the underground mine void.

End Attachment A

Hansen Bailey

ENVIRONMENTAL CONSULTANTS

22 November 2016

Team Leader
Planning Assessment
22-33 Bridge Street
SYDNEY NSW 2000

Attention: Mr Stephen O'Donoghue

Dear Steve,

Bylong Coal Project EIS
Response to Department of Primary Industries Submission, Dated 7 November 2016

1. INTRODUCTION

The '*Bylong Coal Project Environmental Impact Statement*' (EIS) which supported the State Significant Development Application (SSD) 14_6367 for the Bylong Coal Project (the Project) was placed on public exhibition between 23 September and 6 November 2015.

Hansen Bailey prepared the document '*Bylong Coal Project Response to Submissions*' (RTS) dated 23 March 2016 to address comments received from agencies and other stakeholders during the exhibition of the EIS. The RTS included responses to the NSW Department of Primary Industries (DPI) submission dated 11 November 2015 which consolidates submissions from DPI-Water, DPI-Agriculture, DPI-Lands and DPI-Fisheries.

A further submission was received from the DPI dated 12 May 2016 making comment on the information presented within the RTS. KEPCO prepared a response to the DPI-Water and DPI-Agriculture submission in two separate letters dated 17 August 2016 for the Department of Planning and Environment's (DP&E) consideration. These responses were provided as Appendices J and K of the Supplementary RTS report, respectively.

DPI-Water requested further detailed information on the groundwater modelling in an email to Nathan Cooper on 13 September 2016. KEPCO provided DPI-Water with the additional requested information from the groundwater modelling on 30 September 2016.

DP&E has provided to the proponent a further submission from DPI dated 7 November 2016 outlining final comments on the Project. This letter report addresses the comments in DPI's letter for DP&E's consideration.

2. RESPONSE TO NSW DPI SUBMISSION

2.1 GROUNDWATER IMPACT ASSESSMENT

Issue 1

The current prediction for groundwater take requirements from the Sydney Basin-North Coast Groundwater Source is 4100 ML. As the proponent currently holds Water Access Licenses (WALs) for 411 shares and has a valid application equivalent to 2093ML the proponent may need to purchase 1596 shares from the market to make up the shortfall.

Response

KEPCO is disappointed that DPI-Water is not able to amend the current application (not yet determined) for a water licence under the former *Water Act 1912* (Water Act) based on the predictions which have arisen from the latest groundwater modelling. The current water licence application has applied for up to 2,093 Mega Litres (ML) of water take from the Permian and Triassic strata, consistent with the groundwater modelling undertaken for the EIS. The latest groundwater modelling for the Project which has been undertaken in response to queries from various stakeholders (including DPI-Water) has determined that up to 4,099 ML per annum may be affected from this strata.

The introduction of the *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016* (North Coast WSP) in July 2016 has brought the management of this water source under the *Water Management Act 2000* (WM Act). The Sydney Basin-North Coast Groundwater Source (within which the Project is located) under the North Coast WSP has a long term average annual extraction limit of 90,000 ML per annum. As at 1 July 2016, there were 3,453 ML per annum of unassigned water allocation entitlements. None of groundwater modelling scenarios undertaken for the Project to date have identified impacts to any neighbouring registered non-mine owned bores within the fractured and porous rock aquifers. Further, due to the relatively low permeability and general brackish quality of the groundwater within this strata in the vicinity of the Project, it is unlikely that there will be many registered non-mine owned bores which may potentially be impacted. Mine dewatering impacts resulting from open cut and underground mining operations are likely to be a dominant use of this water throughout the Sydney Basin-North Coast Groundwater Source. The closest operating mine to the Project is the Wilpinjong Mine which is more than 24 km to the north west of the Project. The groundwater modelling for the Project has shown that there is unlikely to be any cumulative impacts on groundwater.

Based on the above information, DPI-Water has the information available to amend KEPCO's current water licence application to ensure that sufficient groundwater allocations for the Project are held according to the latest groundwater modelling predictions.

In the case that DPI-Water is unable to amend the current water licence application, it is noted that the current application (i.e. 2,093 ML) will cater the Project's predicted demands based on the base case scenario (RTS2 USG (Upstream weighting – mean)) until Project Year 19.

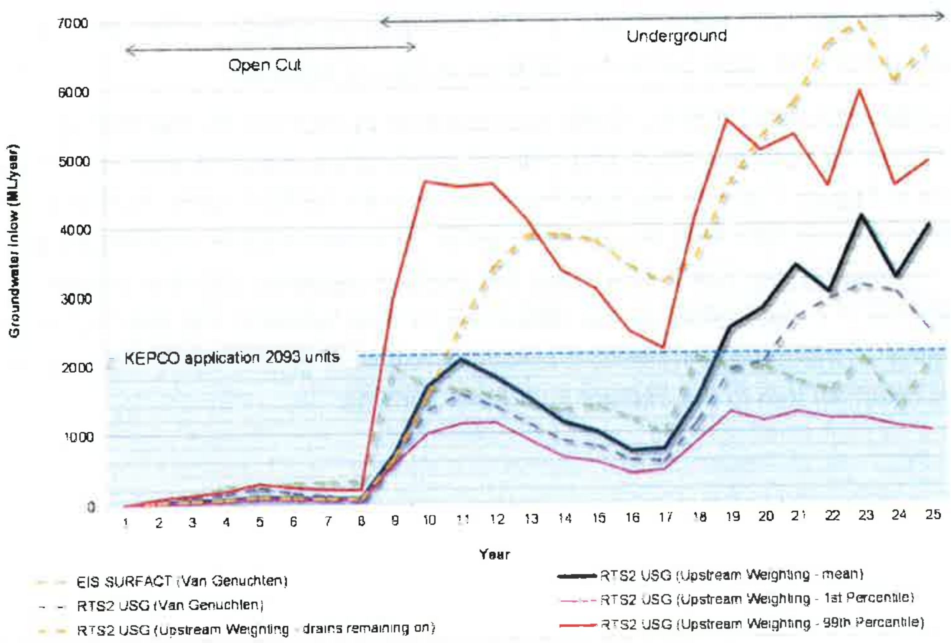
Therefore, it is likely that the additional water shares (up to the 4,099 ML of groundwater inflow predicted for Project Year 23) may be able to be secured from other users within the water source prior to these impacts occurring.

Figure 1 shows the various scenarios predicted by the numerical model in relation to the water licence application for 2,093 ML. It highlights for the base case (RTS2 USG (Upstream weighting – mean)), the mine can operate until Project Year 19 without needing to obtain additional water license units. It is also noted that the groundwater model predictions will be able to be further validated and refined with real data throughout the initial years of mining operations. This process will improve the predictions for the later years of mining within the underground mining area and assist in confirming the maximum water access licence requirements under the North Coast WSP.

Issue 2

> *The proponent may not have correctly apportioned relevant take from each water source resulting from inflows to the mine, and may have underestimated the shares required in the Bylong River Water Source. The proponent holds 2535 shares in the Bylong River Water Source. It is understood that these shares will contribute to accounting for take of water from the bore field and take of water for agricultural purposes. However these shares will also need to account for passive take of water via alluvial loss and reduction in baseflow. For example the additional information received indicates that peak baseflow loss will occur in year 9 at 2.7 ML/day or 986 ML/year in the 99th percentile scenario. As such in that year this volume of water may not be actively extracted from the Bylong River Water Source and this should be reflected in the site water balance.*

Figure 1
Predicted Groundwater Inflow/Seepage into Mining Areas



Response

KEPCO finalised the acquisition of the Tinka Tong property in June 2016. This purchase included the relevant water entitlements held for this property under the Bylong River Water Source of the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009* (Hunter Unregulated WSP). When these additional entitlements are considered, KEPCO currently holds 2,644 units of water entitlements for the Bylong River Water Source.

KEPCO is well aware that these water licences are required to account for the water utilised by its agricultural business, the alluvial borefield and water taken indirectly (or 'passively') from the alluvial areas that are not directly excavated for mining.

The groundwater modelling which has been undertaken for the Project has used a consistent and conservative approach to estimate both the direct and indirect take of water from the various water sources throughout the life of the Project. The modelling approach was first developed and reported as part of the Gateway Certificate application. This approach remained consistent throughout the subsequent versions of the groundwater model developed to respond to regulator feedback for the EIS, RTS and Supplementary RTS.

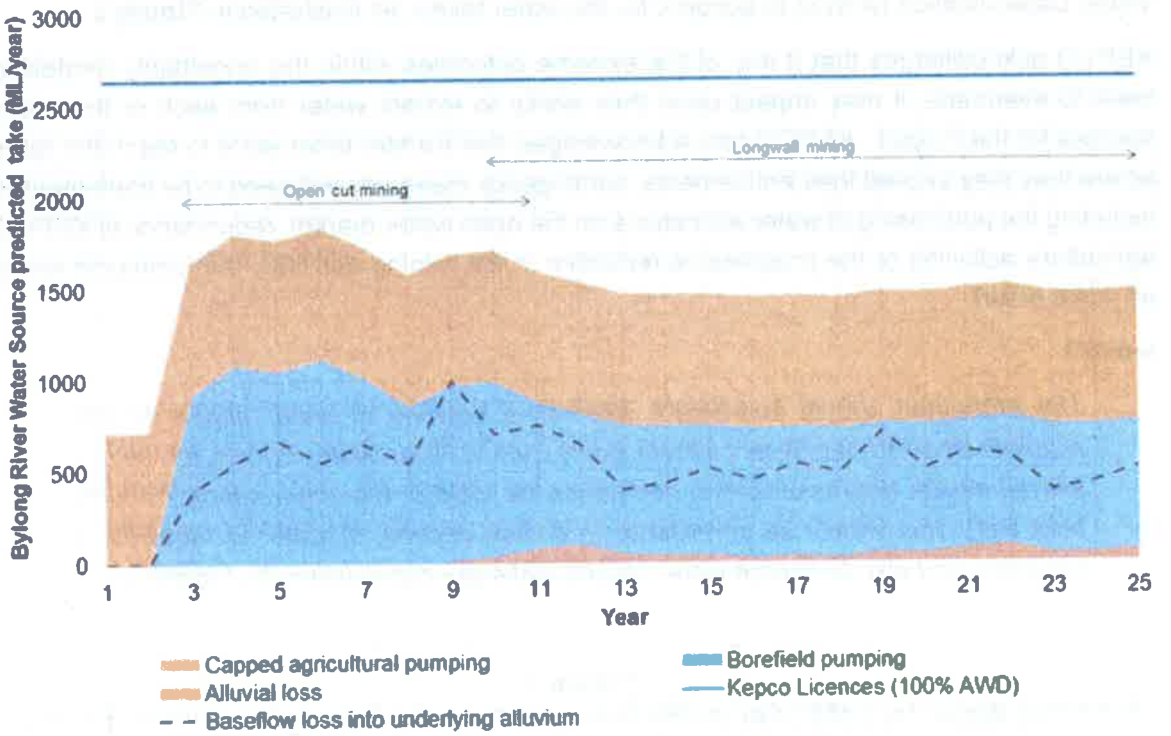
To estimate the indirect take of water from the Bylong River Water Source, two versions of the model were run: one with the proposed mining active; and the second without the proposed mining. The water budgets for the Bylong River Water Source from the two models were then compared to determine the change in flows to the alluvium and the streams due to the proposed mining alone.

Figure 2, which is modified from the Supplementary RTS groundwater report (Appendix J of the Supplementary RTS), shows the direct and indirect water takes from the Bylong River Water Source compared to the water licences held by KEPCO. **Figure 2** illustrates the:

- Direct take of groundwater from the alluvium, due to both the abstraction from the Project borefield and KEPCO's agricultural pumping activities ; and
- Indirect losses from the alluvium due to the depressurisation of the Permian bedrock resulting from the open cut and underground mining activities.

Figure 2 clearly illustrates that the water licences held by KEPCO for the Bylong River Water Source account for both the direct and indirect water takes resulting from the Project. The dashed line in **Figure 2** shows the baseflow loss from the surface water systems induced by the indirect and direct take from the alluvial aquifer. It is important to understand that this line does not necessarily represent flow from the surface systems into the underlying alluvial aquifer. Rather it is calculated as the difference in flow between the two models with and without mining. It therefore represents a reduction in flow of groundwater discharging into the streams as baseflow due to the indirect and direct impacts.

Figure 2
Predicted Base Case Water Take from the Bylong River Water Source



The reduction in flux of groundwater as baseflow into the surface water systems is already accounted for as this water is intercepted by the direct pumping, or the indirect effects of depressurisation on the alluvium. In simple terms, the groundwater that would have left the system as baseflow, now reports to the borefield pumps or the underlying bedrock. For this reason, the change in surface water flux is not included within the licensing required to account for the Project's impacts. This approach prevents the double accounting of water takes from the Bylong River Water Source where the groundwater and surface water are part of the one water source and are highly connected. A step by step calculation of the licenced volume requirements is included in Table 6-9 of the Supplementary RTS groundwater report.

Of course, it is important to acknowledge the inherent uncertainty in groundwater models, and to quantify this uncertainty as much as practicable. The models developed for the EIS, the RTS and the Supplementary RTS have acknowledged this inherent uncertainty and included an analysis with predictions for the more extreme outcomes as represented by the 95th and 99th percentile results.

It is considered inappropriate to use these extremes as the appropriate basis of water licensing, and inconsistent with DPI Water's approach for other mining related projects where 'base case' estimates are used. The amount of water units required to account for water take estimated to be induced by the proposed mining has always been based on the most probable outcome, not the most extreme. KEPCO holds a large entitlement from the Bylong River Water Source.

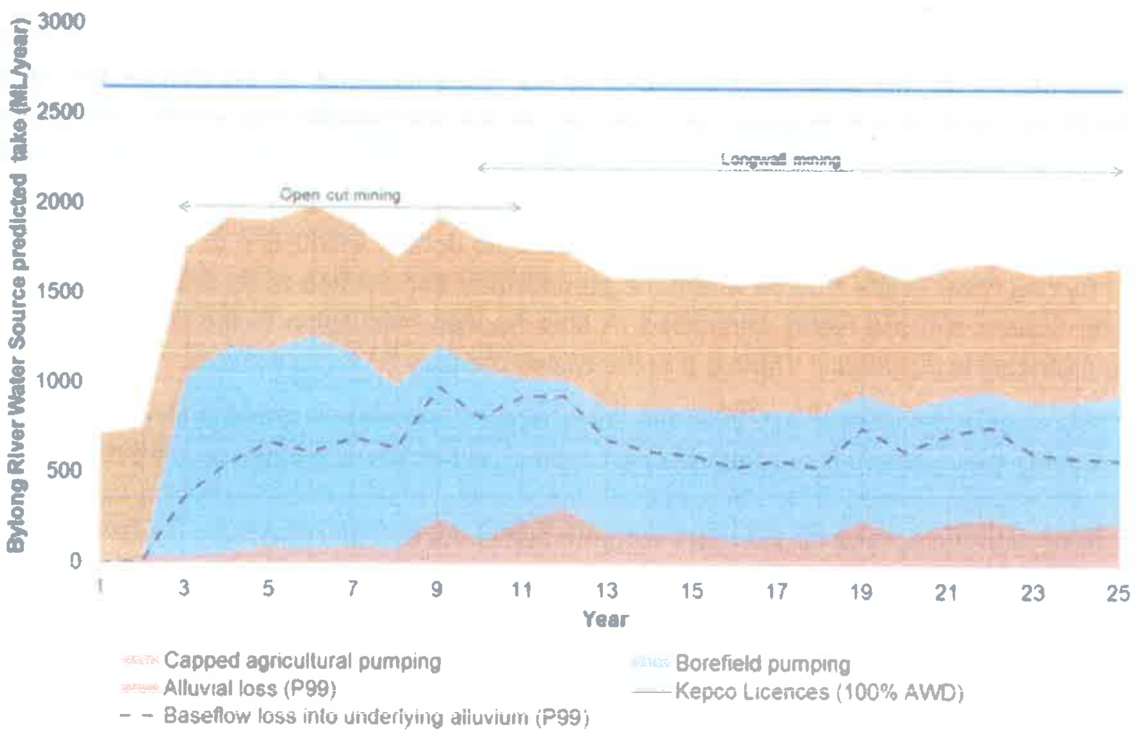
Therefore, even if the predicted 99th percentile baseflow and alluvial losses were included within the water accounting, the Project would still have enough entitlement (at 100% Available Water Determination (AWD)) to account for the water taken, as illustrated in **Figure 3**.

KEPCO acknowledges that if any of the extreme outcomes within the uncertainty modelling were to eventuate, it may impact upon their ability to extract water from each of the water sources for the Project. KEPCO has acknowledged that if water takes were to reach the rates where they may exceed their entitlements, contingency measures will need to be implemented including the purchasing of water allocations on the open water market, redundancy of KEPCO agriculture activities or the progressive reduction in the mining activities that consume water as a last resort.

Issue 3

> *The proponent should investigate alternative sources of water supply for the scenario whereby insufficient shares in the Bylong River Water Source are held or alluvial aquifer depressurisation decreases the yield of the water supply from the bore field. This should be considered to ensure security of water for agricultural purposes and also to source water should make-good provisions be triggered.*

Figure 3
Predicted Water Take (99th Percentile Scenario) from the Bylong River Water Source



Response

The Water Management Plan will outline a program to investigate potential alternative water supplies should these be required. It is important to note that (as explained within Section 2.1 of the response to DPI-Water submission included as part of the Supplementary RTS), the closest private bores within the alluvium in proximity to the Project are located on the Eagle Hill property.

It is important to note that this non-mine owned property is predicted to experience significant noise impacts as a result of the Project and is therefore likely to be afforded the right to acquisition upon request in any Development Consent for the Project. The groundwater modelling has indicated that for all scenarios, impacts will be less than 1 m for these three private bores, with a maximum drawdown of 0.1 m on the Eagle Hill property for the base case. Accordingly, there is no need for 'make good' provisions to be negotiated with this property owner, or any other property owner for all the wide range of scenarios investigated during the approvals process. In the improbable event that impacts were detected, then make good provisions would not be limited to providing an alternative water supply, but would including new or deeper bores or financial compensation. These options will be outlined in the Water Management Plan.

KEPCO has installed a significant groundwater monitoring network in the vicinity of the Project which will be augmented with new bores during the mining phase. The new bores will include sites between the active mining areas and the private bores on Eagle Hill and other private owned bores.

As noted above, KEPCO acknowledges that if any of the extreme outcomes from the uncertainty modelling were to eventuate and impact upon their ability to extract water from each of the water sources, they would need to implement the relevant contingency measures to ensure their entitlements are not exceeded. These contingency measures will be further described within the Water Management Plan and may include the purchasing of water allocations on the water market, scale back KEPCO's agriculture activities or progressively reduce mining activities that consume water as a last resort.

It is noted that water security varies at all mines, and ensuring the 100% security of water for all climatic scenarios is simply not practicable. Under these circumstances, it is appropriate for the risk of particular scenarios to be appropriately managed in accordance with the measures outlined within a Water Management Plan.

Issue 4

> *The proponent should consider use of an alternative coupled surface water - groundwater modelling code for subsequent modelling work that partitions rainfall into recharge, overland flow and evapotranspiration using physics-based equations. The modelling is to utilise data obtained from the recommended additional fieldwork and to also include a complete and appropriate input data set as required for this task. This should be part of the Mining Operations Plan process and will increase the understanding of water take requirements from each water source.*

Response

Variants of the MODFLOW modelling code were used to simulate the impact of mining on the regional groundwater regime for the Gateway, EIS, RTS and Supplementary RTS for the Project. The modelling code and associated modelling methodology was refined throughout this process to ensure consistency with contemporary modelling undertaken to address the requests of independent peer reviewers for other mining related projects. Consultation with DPI-Water, other regulators and independent groundwater peer reviewers throughout the groundwater modelling process did not reveal any comments that the chosen codes were inappropriate and there was no request to change the model code.

The MODFLOW packages utilised for the Project modelling represent recharge and evapotranspiration processes, but do not represent the process of surface overland flow. Overland flow is a relatively rapid process which is not well suited to being represented in groundwater models which are aimed at representing the much slower processes which occur over longer timeframes.

Therefore, overland flow that results in surface water flow in the creeks and rivers has been represented in the Project groundwater models using results from a separate AWBM model. In addition, a separate soil moisture balance was used to estimate periods and volumes of recharge for use in the numerical model. This soil moisture balance also estimates runoff and evapotranspiration, however these estimates were not required for the model. Whilst the rainfall runoff processes were not coupled directly within the numerical model, and were also a simplified representation of complex natural processes, this does not necessarily mean they provide a less valid approximation of impacts from mining.

On the contrary, it is considered more appropriate that natural processes be represented in an appropriate but simplified manner and over-elaborate complexity is avoided, to reduce the potential for error. This approach is supported by the Australian Groundwater Modelling Guidelines (Barnett *et al*, 2012) that recommend *"a conceptual model involving surface water–groundwater interaction should be developed to achieve a balance between real-world complexity and simplicity, such that the model includes all those features essential to the representation of the system, and enable predictions to meet objectives. Those features that are unlikely to affect model predictions should be left out".*

Whilst overland flow was not explicitly represented within the numerical model, a wide range of recharge was explored within the uncertainty analysis and accounts for this component. This included extreme scenarios where the surface water system was not allowed to leak any water into the underlying aquifer, but only remove water from the groundwater system, meaning overland flow was not represented. A numerical model coupling groundwater and surface water systems dynamically would not have represented these extremes which were considered necessary to explore to develop a robust groundwater impact assessment.

The numerical modelling for the Project has undertaken an evolutionary path since it commenced over four years ago in response to new data gathered and to address specific requests from stakeholders and peer review experts.

This model update process will continue during mining with validation modelling undertaken, which will utilise the newly collected data and the most appropriate model code and information available at the time. The model code to be utilised will be at the discretion of the technical groundwater consultants involved in the model validation at the time.

Issue 5

> *Aquifer pump testing should be undertaken in the Permian and Triassic aquifers and the results provided to DPI Water to verify the hydraulic conductivity values adopted in the model.*

Response

It is agreed that aquifer pump testing may be the optimal method to collect information on the properties of aquifers. This is because the results of the tests can be used to estimate both hydraulic conductivity and storage around the test sites. In contrast, other field methods such as packer testing or falling/rising head tests only provide an estimate of hydraulic conductivity, not aquifer volumetric storage. However, aquifer pump testing is only effective for aquifers which can yield sufficient quantities of groundwater to sustain a pump and induce a water level decline in surrounding monitoring bores whilst pumping.

In reality, much of the Triassic and Permian sequence in the vicinity of the Project is closer to an aquitard than an aquifer in terms of permeability. This means that the rate at which water is able to be pumped from boreholes within these formations is very low, or nil. This is evidenced by the distinct lack of private water supply bores within the Triassic and Permian formations within the region.

In low permeability formations with limited groundwater yields, alternative methods such as packer testing are more appropriate. Packer testing can collect multiple estimates of hydraulic conductivity within a single borehole by sealing the test device within different geological zones of uniform properties. This method has been adopted for the collection of baseline data for the Project along with falling/rising head tests to provide estimates of hydraulic conductivity within the bedrock strata. Future work for the operations phase will consider the most appropriate and practical methods, which will be documented within the Water Management Plan. Given the above discussion on the general unsuitability of pump testing on the Permian and Triassic strata, packer testing is likely to be the favoured approach for gaining further hydraulic information.

Issue 6

> *The proponent should implement agreed setback distances from the alluvial boundary and perform ongoing monitoring of the setback during project construction to ensure the setback is maintained.*

Response

The groundwater reports for the Gateway process, the EIS, the RTS and the Supplementary RTS all provided information on the buffer zone to remain between the proposed mining pit limits and the limit of the alluvial sediments.

The methodology used to define the limit of the alluvial sediments was also described. During construction appropriate survey controls will be put in place to ensure the mining pit limits as assessed in the EIS remains at least 150 m back from the identified extent of alluvial sediments.

Issue 7

All works on waterfront land should be conducted in accordance with DPI Water's Guidelines for Controlled Activities on Waterfront Land, as amended from time to time.

Response

Noted, as per Section 2.5 of KEPCO's letter dated 17 August 2016 responding to DPI-Water submission.

Issue 8

Any determination for the project should contain the following condition of approval:

o "The Applicant must ensure that it has sufficient water for all stages of the development, and if necessary, adjust the scale of operations on site to match its available water supply".

Response

Noted.

2.2 WATER MANAGEMENT PLAN

The Water Management Plan for the project should be developed in consultation with DPI Water. This plan should at least include the following:

Item 1

o Additional assessment of impact of alluvial aquifer depressurisation on flow in the Bylong River should be undertaken. This should include consideration of the ecological impacts and the impacts on basic landholder rights extraction.

Response

The Water Management Plan will outline the validation modelling to be undertaken routinely during mining operations. It is considered that further modelling prior to mining is considered to be of limited value. The Water Management Plan will outline further investment in the baseline monitoring network and field characterisation of aquifer properties which will benefit future validation modelling during mining.

The modelling undertaken to date for the Project has focused on quantifying the impacts of drawdown on other water users, including ecological communities and neighbouring non-mine landholder bores.

The latest round of modelling work has demonstrated that the risks to basic landholder rights were low, with the closest private bores within the alluvium in proximity to the Project located on the Eagle Hill property (refer to Figure 6-17 of the Supplementary RTS groundwater report).

The modelling has indicated that for all modelling scenarios, impacts will be less than 1 m for these three private bores, with a maximum drawdown of 0.1 m on the Eagle Hill property for the base case. Therefore, there is no need for 'make good provisions' with this property owner, or any other property owner for all the wide range of scenarios investigated during the approvals process.

The flood plain along the Bylong River Water Source has been largely cleared for agricultural purposes. Some small isolated stands of riparian vegetation remain intact adjacent to the Bylong River, which have been identified to potentially partially rely on groundwater. These stands of vegetation are within proximity of the proposed mining areas. As explained in Section 4.11.7 of the RTS, KEPCO proposes to carry out monitoring programs prior to and during the life of the Project to monitor water levels and vegetation condition to confirm any adverse impacts on these potential GDEs.

Item 2

> *o Make good commitments for private water users in the Bylong River Water Source whereby a reduction in water level produces an inability to take water for licensed purposes or basic landholder rights. The make-good provisions must occur prior to an investigation regarding the cause in the reduction of water levels. Specific consultation must occur to establish contingency water supply provisions for the "Budden" and "Eagle Hill" properties.*

Response

Make good agreements are appropriate where the approvals process has identified the potential for an impact to occur at a non-mine owned water supply bore. The most recent modelling for the Supplementary RTS did not identify any impacts at the "Budden" and "Eagle Hill" properties more than the 2 m trigger as stipulated within the Aquifer Interference Policy. Despite this, the "Eagle Hill" property is the closest potential private receptor and the Water Management Plan will outline the expansion of the groundwater monitoring program to include additional bores between the mining areas and this property to ensure there is an early warning of any unforeseen impacts. At this time make good agreements would be appropriate.

As explained in Section 5.9.5 of the RTS, the "Budden" property is located to the west of the proposed mining area significantly upstream within the Growee River catchment. No modelling scenarios undertaken to date for the Project have indicated impacts encroaching on this property. This is because the geology and topography serve to isolate the "Budden" property from the area proposed for mining. Despite this very low risk, KEPCO has previously agreed to undertake monitoring on this property, although the property owners have since declined the offer. A make good agreement is not considered to be appropriate given the location of this property in relation to the Project and the findings of the consistent findings of the groundwater studies that there is no potential for impact in this area.

Item 3

o Monitoring of flows, riparian land, bank stability, erosion, scour, water quality and salt load in the Bylong River and surrounding tributaries. This monitoring program should relate to a prescriptive TARP, which includes mitigation and rehabilitation measures.

Response

Noted.

Item 4

o Expansion of the groundwater monitoring network prior to commencement of mining to monitor water level in areas of maximum predicted drawdown and identified groundwater dependent ecosystems. DPI Water should be consulted regarding the proposed expansion of the monitoring network to provide advice on location and target aquifer screening. Additional monitoring bore locations must be included between the:

- *Bore field and other water users*
- *Alluvial aquifer and proximal coal seams*
- *Alluvial aquifer and underground mine*
- *Alluvial aquifer and open cut mine*

Response

KEPCO will consult with DPI Water during the preparation of the Water Management Plan, including selecting sites for any additional monitoring locations.

Whilst it is agreed the sites nominated by DPI Water would provide some benefit, it will be necessary to first consider the existing monitoring bore network and where this adequately monitors the impacts of the proposed mining on the groundwater systems. Additional monitoring can then be integrated with the existing network to efficiently meet the monitoring objectives to be outlined within the Water Management Plan.

2.3 AGRICULTURAL ASSESSMENT

Issue 1

The proponent should provide further clarified information to the public regarding buffers for adjoining BSAL. The proponent should clarify that a 50 metre buffer has been applied, why a 50 metre buffer has been selected and how it will be managed.

Response

Section 4.4.2.5 of the RTS stated that "*since the Gateway Application process, the Project Disturbance Boundary was modified and included an additional standoff from the proposed disturbance. This buffer was included within the EIS in response to the Gateway Panel's recommendations.*"

The buffer is the area between the Project Disturbance Boundary from the indicative locations of the open cut mining areas, overburden emplacement areas and associated infrastructure. The buffer applied to the disturbance areas is demonstrated in the Project Layout Figure (Figure 18 of the EIS). It is noted that the assessments and appropriate mitigation measures for the EIS have considered the impacts from the disturbance within the Project Disturbance Boundary.

Issue 2

During the life of the project the proponent should manage any lands used for irrigated agriculture to retain this potential post project.

Response

As explained in Section 2.2 of the letter dated 17 August 2016 in response to DPI-Agriculture's submission dated 12 May 2016, it is not reasonable for KEPCO to make a binding undertaking to keep a certain area under irrigated agriculture due to the time frame of the Project (25 years) and the potential for changes in agricultural economics and technology during this period.

Notwithstanding this, KEPCO undertakes to retain its non-mine agricultural land in productive agriculture. The areas of land which have been specifically excluded from the Project's Biodiversity Offset Strategy will continue to be managed for agricultural activities.

2.4 ATTACHMENT A

Issue 1

The proponent has provided information about multiple, distinct Bylong regional groundwater models that were constructed using two mathematically different, separate modelling codes. These models have differences in the mesh design, input parameters, unsaturated zone equations, conceptual model and mathematical settings. The predicted levels of impacts varied between the models however all seven model scenarios resulted in a minimum drawdown of 2 m in the Bylong alluvium, which then effects surface flow in the Bylong River. It is considered that the likely scenario based on the model results provided is the 99th percentile or 'worst case'.

Response

As described within the RTS and Supplementary RTS groundwater reports, the numerical modelling for the Project has undertaken an evolutionary path since it was commenced over four years ago. In this regard, the numerical modelling has been continually updated in response to new data, requests from stakeholders and peer review experts. It is not considered that this process invalidates any previous work, rather that it shows that groundwater models have some inherent uncertainty.

This inherent uncertainty can be addressed by considering the potential range of outcomes and gradually refining models over time.

As noted by DPI Water, the models have consistently predicted the potential for drawdown within the alluvium adjacent to the proposed mining areas to exceed 2 m, although no non-mine owned bores will be within this predicted drawdown extent. However, it appears that DPI Water have concluded that the most extreme drawdown impacts predicted by the modelling as represented by the 99th percentile results are likely to be the most probable. It is unclear how this conclusion has been reached, particularly in the absence of any modelling undertaken by DPI Water. However despite this difference, it does indicate that DPI Water have concluded the impacts of the Project have been identified within the uncertainty analysis. This is considered positive as KEPCO have planned to operate the mine in a manner that will ensure water extraction and drawdown do not exceed licenced limits should extreme scenarios occur.

This will be managed by advanced monitoring and if necessary implementing measures including the purchasing water on the water market, redundancy of KEPCO agriculture activities to progressive reduction in the mining activities that consume water as a last resort.

Issue 2

> *It is accepted that the Independent Model Review classed the model as fit for purpose however there are numerous elements which result in a lack of certainty regarding the impacts of the proposed project. Hence the recommendation for an alternative modelling code to be used as part of the Mining Operations Plan process. The reasons for this recommendation are as follows.*
>
> *Conductivity values used for the coal seams were not representative of the higher conductivity values from the packer testing results. These high conductivity values were also not used in the uncertainty analysis.*
>
> *Lack of pumped aquifer testing information from the Permian and Triassic aquifers to inform appropriate hydraulic conductivity values.*
>
> *Assumptions used to generate estimates on the volumes of WAL requirements may underestimate the quantity of required shares in the Bylong River. For example section 6.4.7 of the additional RTS states "For the purposes of water licensing, it has been assumed all the water predicted to be intercepted by the model drain cells is from the Permian or Triassic strata. Therefore, this water should be accounted for with water access licences under the North Coast Porous and Fractured Rock Water Sharing Plan."*
>
> *The three dimensional models identified no aquiclude between the coal seam and alluvium. It is expected that alluvial aquifer water leakage will be induced to flow into the sub-cropping Permian aquifers that will be exposed in the open cut and underground mine void. This will result in water originating from the alluvial aquifer to also be taken in the open cut and the underground mine void.*

Response

The modelling code is not considered the primary source of uncertainty in relation to the predicted impacts of the Project on the groundwater regime. It is the conceptual understanding of how the groundwater regime operates and the most appropriate way to represent this within a numerical model that creates uncertainty in predictions from models. The four reasons DPI Water provide to base their recommendation upon do not justify changing the model code. The four reasons are simply a request for more information on aquifer properties and adjustments to the physical setup of the model.

The field investigation programs conducted for the Project show (what is typical for most hydrogeological studies) that the aquifer properties vary widely spatially, along with the hydrologic processes of recharge and discharge. These widely varying properties and processes must be simplified to be represented within a computer based model. However representing the natural processes with more complexity in numerical models does not necessarily result in models that produce more certain predictions. On the contrary, it is considered more appropriate that processes be represented in numerical model in an appropriate but simplified manner and over-elaborate complexity is avoided, to reduce the potential for error. This is supported by the Australian Groundwater Modelling Guidelines that recommend *"the modeller should find a balance between simplicity (parsimony) and complexity (highly parameterised spatial distribution of some properties)."*

As acknowledged by DPI Water, the third party reviews of the modelling conducted by Independent Peer Reviewer (HydroSimulations) and also by DP&E's Peer Reviewer (Kalf & Associates) did not conclude the modelling code was inappropriate and did not recommend any future changes to the code utilised. The MODFLOW USG code (utilised for the EIS, RTS and Supplementary RTS) is considered to remain superior to other codes in this geological environment as it allows layers represented by coal seams to be terminated where they subcrop and connect with the alluvial aquifer. Other finite element codes such as FEFLOW do not support this pinching out of layers.

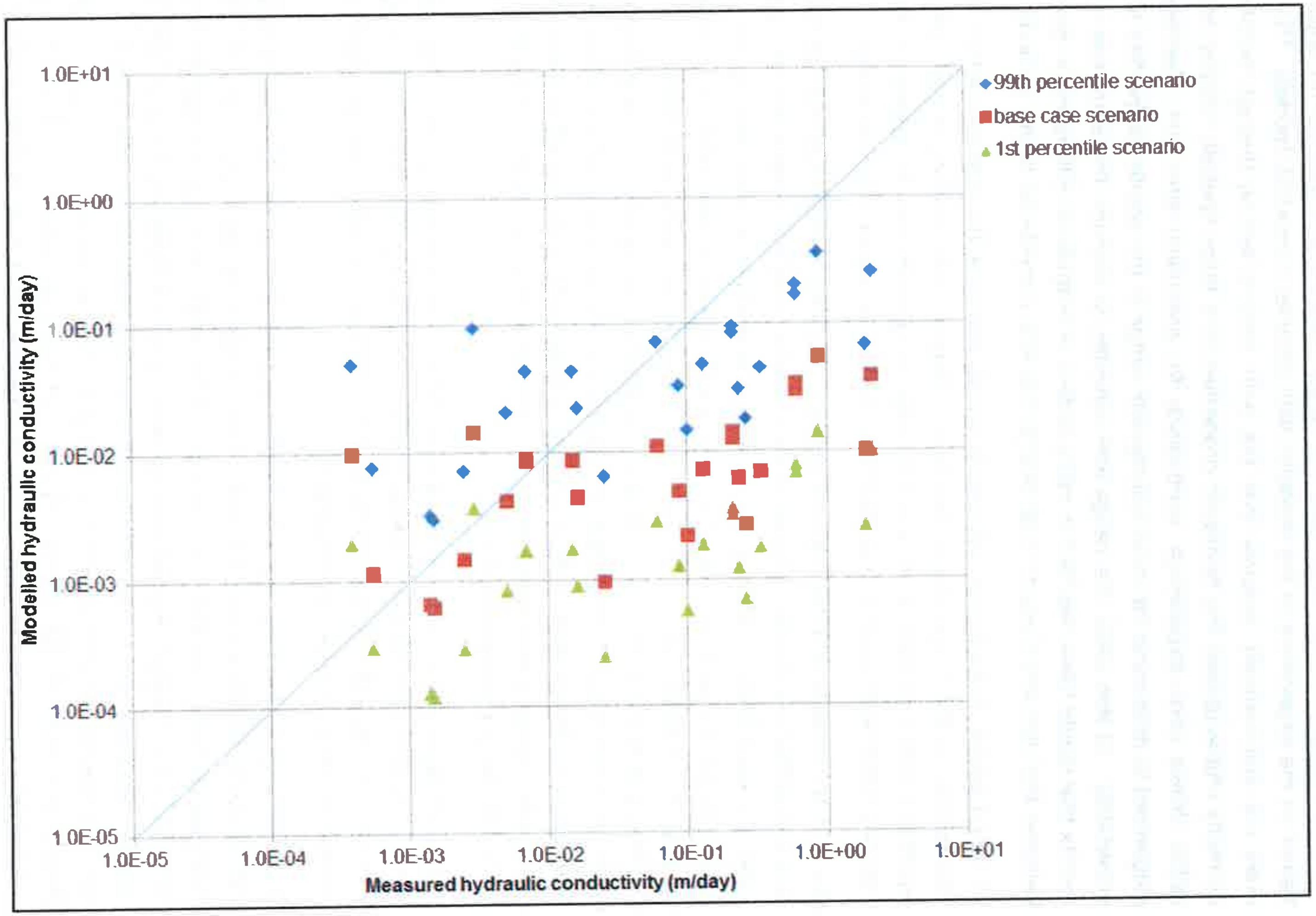
In response to the four comments provided as reasons to justify changing the model code, the following response is provided:

- The uncertainty analysis tested the influence of varying hydraulic conductivity values within the coal seams on the predicted impacts. **Table 1** presents the value of hydraulic conductivity measured using packer tests and the values adopted within the model in the uncertainty analysis for the various scenarios. The data is also presented graphically in **Figure 4**.

Table 1 Predicted Water Take (99th Percentile Scenario) from the Bylong River Water Source

Test Bore	Coal seam tested	Depth (m)	Hydraulic Conductivity (m/day)			
			Measured	Modelled 99th percentile	Modelled base case	Modelled 1st percentile
CP035	Coggan	100	6.0E-02	7.4E-02	1.1E-02	2.9E-03
CP028	Coggan	164	2.6E-01	1.8E-02	2.7E-03	7.0E-04
CP014	Coggan	136	8.6E-02	3.4E-02	5.0E-03	1.3E-03
BY0011CH	Coggan	202.395	5.5E-04	7.8E-03	1.2E-03	3.0E-04
CP027	Coggan	53.2	6.0E-01	2.1E-01	3.1E-02	8.1E-03
CP009	Coggan	93	2.1E-01	8.7E-02	1.3E-02	3.4E-03
CP045	Coggan	42.8	2.1E+00	2.6E-01	3.9E-02	1.0E-02
BY0077CH	Coggan	118.84	1.3E-01	4.9E-02	7.3E-03	1.9E-03
BY0080CH	Coggan	210.68	2.5E-02	6.5E-03	9.7E-04	2.5E-04
BY0091CH	Coggan	172.52	1.0E-01	1.5E-02	2.2E-03	5.8E-04
A06	Coggan Seam	26.705	8.6E-01	3.7E-01	5.6E-02	1.4E-02
BY0207CH	Coggan Seam	88.295	2.1E-01	9.6E-02	1.4E-02	3.7E-03
AGE02	Coggan Seam	103.53	1.9E+00	6.9E-02	1.0E-02	2.7E-03
BY0208CH	Coggan Seam	87.705	2.9E-03	9.7E-02	1.5E-02	3.8E-03
B3	Coggan Seam	121.275	3.3E-01	4.6E-02	6.9E-03	1.8E-03
BY0011CH	Ulan	196.395	1.4E-03	3.3E-03	6.6E-04	1.3E-04
BY0077CH	Ulan	112.33	5.0E-03	2.1E-02	4.2E-03	8.4E-04
BY0080CH	Ulan	200	1.5E-03	3.1E-03	6.1E-04	1.2E-04
BY0091CH	Ulan	160.195	2.5E-03	7.4E-03	1.5E-03	2.9E-04
BY0208CH	Ulan Seam	79.225	6.9E-03	4.4E-02	8.8E-03	1.8E-03
B3	Ulan Seam	109.375	1.6E-02	2.3E-02	4.5E-03	9.0E-04
BY0207CH	Ulan Seam	78.785	1.5E-02	4.4E-02	8.8E-03	1.8E-03
A06	Ulan Seam/Tuff	16.725	6.0E-01	1.7E-01	3.5E-02	6.9E-03
AGE02	Ulan Seam/Tuff	94.525	2.3E-01	3.1E-02	6.2E-03	1.2E-03
BY0207CH	Ulan Upper	73.285	3.9E-04	5.0E-02	1.0E-02	2.0E-03

Figure 4
Scatter Plot of Hydraulic Conductivity Measured Versus Modelled



- **Table 1** and **Figure 4** show the range of hydraulic conductivity adopted within the uncertainty analysis covers the median hydraulic conductivity, but not the extremes of the field measurements. Ultimately the range adopted and considered appropriate is based on the experience of the modeller with complex numerical models. The modeller does not automatically assume that the point source testing through boreholes has correctly characterised the hydraulic properties of a large spatially varying region, but rather draws upon experience, particularly for greenfield sites and exercises some judgement to determine the most appropriate range in the aquifer properties to quantify uncertainty. In this case, the range was selected to exclude the extremes in the test results that would have resulted in many orders of magnitude difference in permeability between the Ulan and Coggan coal seams that was considered highly unlikely.
- As noted earlier, it is agreed that aquifer pump testing is the optimal method to collect information on the properties of aquifers. However this method is only effective for aquifers which can yield sufficient quantities of groundwater to sustain a pump and induce a water level decline in surrounding monitoring bores whilst pumping.

  Much of the Triassic and Permian sequence in the area proposed for mining is closer to an aquitard than an aquifer in terms of permeability, and this means that the volumes of water pumped from boreholes within these formations is very low, or nil. This is evidenced by the distinct lack of private water supply bores within the Triassic and Permian formations within the region. In low permeability formations with limited borehole yields alternative methods such as packer testing are more appropriate under these circumstances. Packer testing was part of the testing program which has been undertaken for the Project. Future work for the operations phase will consider the most appropriate and practical methods for any additional testing, which will be documented within the Water Management Plan.
- A detailed description of the methodology utilised for estimating the water take from water sources is provided in **Section 2.1** Issue 2 above. This method is conservative and has been considered appropriate by DPI Water earlier within the approvals process and also on other mining related projects.
- Direct connection between the coal seams and the alluvial aquifer occurs only where erosion along the stream bed has cut into the underlying coal seam. This is a thin and limited zone known as the subcrop line. This direct physical connection has been identified within the groundwater assessments since the Gateway process and has been represented within the numerical models that have been developed for the Project to date. Elsewhere, the overlying less permeable sedimentary rocks do form an aquiclude between the base of the alluvial aquifer and the coal seam, retarding the hydraulic connectivity between these units. Again, this physical architecture of the geological units has been represented in the various numerical models for the Project.

The Supplementary RTS groundwater report (Appendix J of the Supplementary RTS) discussed this connectivity and provides a map (see Figure 5-19) showing where the coal encroaches closer to the base of the alluvium. Since the numerical models represented the connectivity created by the geological units (particularly in the case of the MODFLOW USG model which allows the pinching out of layers) the alluvial aquifer water is allowed to leak into the areas of sub-cropping Permian aquifers which are connected to the exposed faces within the open cut and underground mine areas.

The modelling results have therefore appropriately captured the impacts of this process and the results provided encompass this impact. The reason the alluvial groundwater system is not predicted to be completely drained by the proposed mining is that the recharge processes including stream leakage, diffuse rainfall and lateral through flow from upstream within the alluvium serve to replenish the water lost from the alluvial aquifer due to mining.

3. CONCLUSION

We trust this response addresses the issues raised in the latest NSW DPI correspondence and that DP&E is able to appropriate address these items within its Assessment Report.

Should you have any queries in relation to this letter, please contact us on 6575 2000.

Yours faithfully

HANSEN BAILEY

Nathan Cooper
Principal

James Bailey
Director

KEPCO BYLONG AUSTRALIA
Suite 1301, 141 Walker Street North Sydney NSW 2060
Phone: 02 8904 9508

9 December 2016

Mr Stephen McDonald
General Manager
Muswellbrook Shire Council
Via email:

Dear Mr McDonald,

BYLONG COAL PROJECT – ROAD SAFETY CONTRIBUTION

KEPCO Bylong Australia (KEPCO) has held a number of discussions with Muswellbrook Shire Council (MSC) regarding the Bylong Coal Project (Project). Meetings were held on 1 July 2014, 15 September 2015, 26 May 2016 and 5 October 2016. At these meetings, MSC expressed that they were concerned about potential Project-related road safety impacts on the 40 km section of Bylong Valley Way between the Golden Highway and the western boundary of the MSC Local Government Area.

The Environmental Impact Statement (EIS) for the Project was placed on public exhibition by Department of Planning and Environment (DP&E) between 23 September 2015 and 6 November 2015. No submission had been received from the MSC at the closing date for submissions (6 November 2015). A late submission was received by DP&E from MSC on 15 March 2016, some four months after the required closing date and shortly before the lodgement of KEPCO's Response to Submission report (23 March 2016).

KEPCO responded to MSC's submission following a meeting on 26 May 2016 in letter dated 7 July 2016. At the meeting held on 26 May 2016, MSC indicated that due to the low proportion of Project related traffic which is predicted to utilise the Bylong Valley Way to the east, and the commitment made within the Project EIS to avoid the use of oversize vehicles on this section of road, MSC would not be seeking an annual contribution from KEPCO for road maintenance. However, MSC stated that due to the existing road safety issues present on this section of road, MSC would seek a one off payment contribution from KEPCO to assist in facilitating the rehabilitation of road safety issues identified on Bylong Valley Way.

Further correspondence dated 9 August 2016 was received from MSC addressing road and other matters in relation to KEPCO's letter dated 7 July 2016. KEPCO received a letter from MSC dated 31 August 2016 indicating MSC's expectations for payments in relation to road safety and maintenance. Following the receipt of this letter, KEPCO sought clarification through DP&E as to how the requested contributions by MSC were derived. This information was subsequently received from DP&E on the 12 September 2016.

A meeting was held with representatives from MSC on 5 October 2016, where the basis of the numbers used in MSC's calculations of Project-related road impacts was discussed. It was evident at this meeting that the information used within the calculations was from the EIS. As was noted in the letter to DP&E dated 7 July 2016 (and discussed during the meeting on 26 May 2016), the EIS Traffic and Transport Impact Assessment was superseded by the revised Traffic and Transport Impact Assessment provided as an appendix to the Response to Submissions (RTS) report in response to other stakeholder comments. At the meeting on 5 October 2016, KEPCO undertook to provide information from the RTS from which MSC could review and rework their calculations. The reworked calculations were received directly from MSC on 9 November 2016.

It is evident from these calculations that MSC has used the predicted traffic volumes for Project Year 2 which represents the peak construction phase for the Project and has applied these for the life of the

Suite 1301, 141 Walker Street North Sydney NSW 2060
Phone: 02 8904 9508

mine. This results in a significant over estimate of predicted traffic volumes for the Project. KEPCO has now applied the predicted Project traffic volumes as determined by the RTS as distributed across the 25 year mine life as is indicated in what follows.

Following further discussions with DP&E, it was considered that by limiting heavy vehicle specifications on that section of the Bylong Valley Way that is under the control of MSC, a contribution should only be required by KEPCO for road safety and not road maintenance (as was the original position of MSC at the meeting held on 26 May 2016).

KEPCO have undertaken in the EIS to exclude overmass and oversized vehicles from this section of the Bylong Valley Way. In addition KEPCO will not allow Project related articulated semi-trailer type vehicles to use this section of road. KEPCO will require flatbed and pantech trucks that undertake delivery of stores items to utilise that section of road. This will be limited to the category Medium Rigid which includes trucks with a GVM of more than eight tonnes and two axles but in the case of Bylong Valley Way limited to ten tonnes. Any towed trailer must not weigh more than nine tonnes GVM.

On this basis, KEPCO provides the following calculations to determine the appropriate level of contribution to safety upgrades. In doing so, KEPCO has utilised the expenditure that MSC has nominated for safety upgrades to the nominated section of Bylong Valley Way i.e. $920,000, as a basis for the calculation.

Safety Improvement Works

The forecast traffic for Project Years 2, 9 and 13 in accordance with the Revised Traffic and Transport Impact Assessment (Parsons Brinckerhoff, 2016) in the RTS for the section of Bylong Valley Way between Wollar Road and Sandy Hollow is as shown in table below:

Forecast Traffic		PY2 with WAF		PY9 No WAF		PY13 No WAF	
		Mine Traffic	Non-Mine Traffic	Mine Traffic	Non-Mine Traffic	Mine Traffic	Non-Mine Traffic
Bylong Valley Way (Wollar Road to Sandy Hollow)	vpd	36	365	28	408	9	440
	%	9.0%	91.0%	6.4%	93.6%	2.0%	98.0%

The average proportion of mine versus non-mine traffic for the 25 years of the Project equals to 4.3% of the total vehicle traffic if we:

- apply the traffic forecast for Year 2 to Year 1 and 2
- apply the traffic forecast for Year 9 to Year 3 to 12 (conservative)
- apply the traffic forecast for Year 13 for Year 13 onwards.

Vehicles/day	Mine Traffic	Non-Mine Traffic
Bylong Valley Way (Wollar Road to Sandy Hollow)	4.3%	95.7%

Therefore, the $920,000 x 4.3% = $39,560

KEPCO BYLONG AUSTRALIA

Suite 1301, 141 Walker Street North Sydney NSW 2060
Phone: 02 8904 9508

On this basis KEPCO believes that a front end, one off contribution to road safety upgrades of $40,000 represents a fair apportionment based on the expected road usage by vehicles attributed to the Bylong Coal Project. This payment would be made when KEPCO commits to construction of the mine.

Please do not hesitate to contact me on 02 89049508 if you wish to discuss this matter further.

Yours sincerely,

Bill Vatovec
Chief Operating Officer
KEPCO Bylong Australia Pty Ltd

CC: Mr David Kitto - Department of Planning & Environment
Mr Stephen O'Donoghue - Department of Planning & Environment

muswellbrook
shire council

Enquiries
Please ask for Steve McDonald
Direct 02 6549 3700
Our reference
Your reference

19 January 2017

Mr Bill Vatovec
Chief Operating Officer
KEPCO Bylong Australia Pty Ltd
141 Walker St
NORTH SYDNEY NSW 2060

Dear Mr Vatovec,

KEPCO Bylong Coal Project, Bylong Valley Way, Road Safety Contribution and Other Matters.

Thank you for your letter dated 9th December 2016 offering a road safety contribution for the Bylong Valley Way (BVW), should your application for the Bylong Coal Project be approved.

Whilst any contribution for road safety works would be welcome by Muswellbrook Council, this contribution alone does not address the concerns Council has with safety issues on the BVW and ongoing maintenance expenses raised in previous correspondence between yourselves, DP&E and Council. These residual concerns are as follows:

1. The once off up front road safety contribution offered was based on traffic studies provided as a part of the project assessment. Council remain of the opinion that the use of the BVW by mine traffic, should the project be approved, is understated, and therefore the upfront safety contribution is inadequate. No offer was made for additional funding should ongoing traffic assessments indicate higher traffic numbers than predicted. Council continue to request that annual traffic counts are undertaken to assess the projects contribution to the total traffic using the road and adjust annual contributions accordingly.
2. Council considers that limiting mine related traffic over ten tonnes GVM would be an impossible proposition to sustain. Should KEPCO include conditions for its contractors and suppliers to limit the use of the BVW, it would be difficult to monitor and enforce for the duration of the proposed project. Council is of the opinion that it is almost certain that any contractors and suppliers to the mine based in Sydney, Newcastle and Muswellbrook would use the BVW instead of the longer route of the Golden Highway, Ulan and Wollar roads. Heavy rigid trucks and semitrailers are currently allowed to use this road and this is planned to continue. Should mine trucks of similar specifications use the road contrary to what is offered in your letter, there would be no way to tell if the truck was associated with the proposed project or not. This would make enforcement of a condition difficult, should it be included in a project consent.

3. Heavy vehicle traffic contributes to the majority of the maintenance requirements of Council roads. However the smaller trucks and light vehicles still contribute to the need for road maintenance. The offer for a once off payment for safety works does not acknowledge this need for ongoing funding.

Council are concerned that there were some statements in your letter dated 9th December that differ from our understandings of the meeting dated 26th May 2016. This is supported by the record of the minutes taken by Worley Parsons. Council did state that given the low traffic numbers provided in the EIS, and subsequent studies, that should a contribution for traffic use be required, the value would be small. This was then immediately followed up with discussions advising that Council believe that the traffic use by mine vehicles, should the project be approved, have been understated. This is why Council have commissioned a population demographic study to provide an independent estimate of probable traffic numbers. At the conclusion of the May meeting we did agree that a payment for safety works would be required, as road safety remains Council primary concern with the KEPCO Bylong proposal. We observed reluctance on the part of KEPCO to enter into a road maintenance compensation offer at the time. We did not request payment for ongoing maintenance works at the meeting as we firstly wanted to see what the final RTS contained regarding addressing the safety issues, and if any compensation was subsequently offered for additional traffic use. Council never at any time stated that they would not be seeking compensation for additional mine related traffic resulting from the proposal.

Council appreciates the opportunity to provide this additional comment and welcome further discussions to arrive at a mutually agreeable outcome.

Yours faithfully

Steve McDonald
General Manager

CC: Steve O'Donoghue – Department of Planning & Environment