LAND COURT OF QUEENSLAND

REGISTRY: Brisbane
NUMBER: EPA495-15
MRA496-15
MRA497-15

Applicant: **New Acland Coal Pty Ltd ACN 081 022 380**

AND

Respondents: **Frank Ashman & Ors**

AND

Statutory Party: **Chief Executive, Department of Environment and Heritage Protection**

SUPPLEMENTARY STATEMENT OF EVIDENCE TO THE LAND COURT BY BRIAN GEORGE BARNETT

1. **Expert details and qualifications**

1.1 **Name**

My name is Brian George Barnett.

1.2 **Address**

My business address is Jacobs Group (Australia) Pty Ltd of Floor 11, 452 Flinders Street, Melbourne, in the State of Victoria.

1.3 **Qualifications**

(a) I am employed by Jacobs (formerly SKM) as a Senior Hydrogeologist / Geothermal Reservoir Engineer.

(b) I hold a bachelor of Engineering (Civil) (Honours), University of Auckland, 1979.

(c) Annexure A to my first Statement of Evidence dated 10 May 2016 contains a copy of my curriculum vitae.

2. **Instructions**

I have been requested by Clayton Utz to prepare a response to the Second Supplementary Statement of Evidence of Dr Matthew Currell and Professor Adrian Werner (**Second Supplementary Report**).

I have not been instructed to provide comments in relation to the conditions contained in Annexure A of the Second Supplementary Report.

3. **Structure of statement**

I have prepared a memorandum in response to the Second Supplementary Report. This memorandum is annexed as Annexure A.

4. **Expert's statement**

I confirm that:

(a) the factual matters included in this statement are, as far as I know, true;

(b) I have made all enquiries that I consider appropriate;

(c) the opinions stated in this statement are genuinely held by me;

(d) this statement contains reference to all matters I consider significant;

(e) I understand I have a duty to assist the court and that duty overrides any obligation I may have to any party to these proceedings or any person who is liable for my fees or expenses and I have complied with that duty;

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

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

B. S. Barnett.
....

Brian Barnett

27 June 2016

Annexure A - Memorandum in response to Second Supplementary Statement of Evidence of Dr Matthew Currell and Professor Adrian Werner

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Memorandum

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From Brian Barnett

Subject **Response to Second Supplementary Statement of Evidence**

Item 3 - Water level gradients as justification for the placement of faults in the groundwater model.

There is no new material presented in Item 3 of the Second Supplementary Statement of Evidence (**Second Supplementary Report**) of Professor Werner and Dr Currell. Professor Werner and Dr Currell argue that the groundwater gradients do not require the implementation of faults in a model. These opinions have been expressed previously in their supplementary expert reports and in their examinations as noted below. I disagree on the basis of my experience in trying to replicate the observed groundwater heads across the model domain. This has already been established through Individual Expert Witness Reports, Joint Expert Witness Reports, Supplementary Expert Witness Reports, the tabled evidence and through cross examination, as outlined below.

Item 3.1. Professor Werner and Dr Currell suggest that *"…faulting was relied on during the model calibration at the expense of (or in the absence of) other lines of field evidence - such as data on the degree of vertical hydraulic separation/connectivity of the different aquifers, groundwater extraction rates in different aquifers, and variable recharge around the site – factors which were given limited consideration at that stage".* Their views have previously been expressed in their Supplementary Individual Expert Reports[1] and in their examinations[2].

Model design and calibration in 2009 and 2013 included a detailed assessment and trials of numerous different physical processes and conceptualisations that could possibly explain the observed groundwater behaviour. The final calibrated models are the product of that process. They incorporate various aspects of the physical and hydrogeological environment that impact on groundwater behaviour. Any suggestions that consideration was given only to the inclusion and location of faults is incorrect.

Item 3.4. The issue of gradients has been considered previously[3], including gradients between the bores specifically identified in the Second Supplementary Report[4]. Professor Werner and Dr Currell claim that the head gradient between Bore #42234530 and Bore #42231395 is not particularly steep because it is similar to the difference in topography between these two locations. This is despite Dr Currell previously stating:

> "*I think it's about eight kilometres, according to the scale. So there may be a fairly steep hydraulic gradient across that distance.*"[5]

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[1] Supplementary Individual Expert Report of Dr Matthew Currell (Document ID: OCA.0069 Exhibit 824), Part 4, section 1.4 iii) and iv), Supplementary Individual Expert Report of Prof Adrian Werner (Document ID: OCA.0071 Exhibit 833) paragraph 22(c), 22(j).

[2] Examination-in-chief of Dr Currell Transcript 25-94 to 25-95, Examination-in-chief of Prof. Werner, at Transcript 27-42, line 3-6.

[3] Supplementary Individual Expert Report of Prof Adrian Werner (Document ID: OCA.0071 Exhibit 833) paragraphs 22(c), 22(j); Transcript 27-86 to 27-89 (Werner); Supplementary Individual Expert Report of Dr Matthew Currell (Document ID: OCA.0069 Exhibit 824), Part 4 section 1.4(iv); Transcript 25-95, Lines 31-37 & Transcript 25-107 - 25-108 (Currell).

[4] Transcript 25-95, Line 31-37 (Currell); Supplementary Individual Expert Report of Dr Matthew Currell (Document ID: OCA.0069 Exhibit 824), Part 4 section 1.4(iv).

[5] Transcript 25-95, line 32.

Professor Werner and Dr Currell now state that *"The difference in surface topography between the two bores in question (#42231395 and #42231530) is 32.4m, which indicates the water level difference of 35m represents a hydraulic gradient that is typical and consistent with the topographical gradient over the 8km distance."* [6] The inference that the head gradient can be explained by the difference in topography is not correct.

The fact that groundwater levels are a subdued reflection of the topographic surface is a well-established principle[7]. In this context the term *"a subdued reflection of topography"* implies that groundwater gradients are less steep than topographic gradients. Haitjema and Mitchell-Bruker, 2005[8] note that for relatively permeable aquifers (i.e., those that are able to support *"public or industrial water supplies"*), groundwater gradients are expected to be much lower than topographic gradients. Since the two bores identified by Professor Werner and Dr Currell are located in relatively permeable Basalt and alluvial aquifers, it is expected that groundwater gradients will be much lower than topographic gradients. This conclusion was reinforced by the model calibration work that I supervised in 2009.

Professor Werner and Dr Currell further claim that water levels in Bore #42231395 may be impacted by drawdown associated with nearby groundwater extraction including that from Bore #83211, being an extraction well used by the Oakey Abattoir.

The recorded groundwater heads in Bore #42231395 and Bore #42231530 are presented below in Figure 1. The measured water levels in Bore #42231395 show no obvious influence of drawdown from nearby pumping. There are long term fluctuations in head measured in this bore and the likely explanation for this is rainfall variability over the period of record.

Figure 1 also includes a plot of the cumulative deviation from mean rainfall (CDMR) as calculated from recorded rainfall between 1990 and 2016 at BOM station 41359, Oakey Aero. The CDMR is a useful tool for illustrating trends in rainfall with time. The CDMR rises during periods of above average rainfall and falls during periods of below average rainfall. A comparison between the CDMR and the measured levels in Bore #42231395 shows a direct correlation between the groundwater level measured in this bore and periods of higher than average and lower than average rainfall. In other words there is no clear evidence that would suggest that the groundwater levels in this bore have been influenced by groundwater extraction.

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[6] Second Supplementary Report of Professor Adrian Werner and Dr Matthew Currell, p 4.

[7] Desbarats, A. J., Logan, C. E., Hinton, M. J. and Sharpe, D. R (2001). On the kriging of water table elevations using collateral information from a digital elevation model. Volume 225, Issues 1-4, JOURNAL OF HYDROLOGY, 2001.

[8] Haitjema, H. M. and Mitchell-Bruker, S., 2005. Are Water Tables a Subdued Replica of Topography? GROUNDWATER, Vol. 43, No. 6, p781-786.

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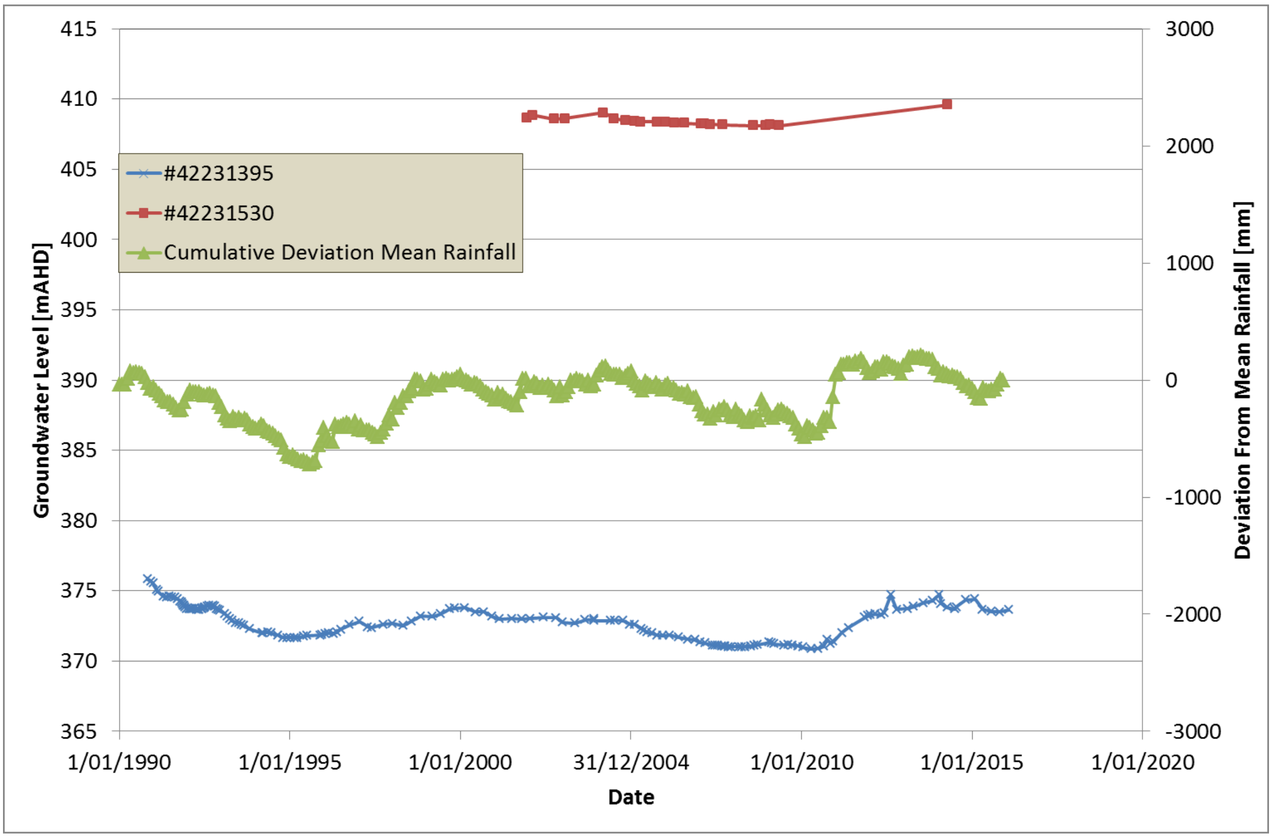
Figure 1 : Measured groundwater levels in Bore #42231395 and Bore #42231530



Item 4. Discussion about "level of calibration"

Discussion regarding the calibration has been addressed previously, both in the evidence of Dr Currell and Professor Werner, as well as during my examination, as outlined below.

The examination of Professor Werner by Mr Ambrose QC and Mr Holt QC included discussion of the "black box" concept[9]. The use of the term "black box" in evidence, including within the Second Supplementary Report, has been quite unhelpful. The term "black box model" is normally used to describe a model in which the underlying equations and assumptions are unclear or unknown thus giving rise to uncertainty as to whether the model is suitable or appropriate for the problem at hand. Professor Werner and Dr Currell appear to use this term in a different sense. They use the term black box to describe a model that is not based on established scientific laws and equations that describe physical processes irrespective of whether or not the underlying assumptions and equations are documented. The suggestion that a Modflow groundwater model can be considered as either "black box" or "physically based" is not correct. In reality the Modflow simulation code can only be used to produce a physically based model. Modflow is founded on well-established scientific principles such as mass and energy conservation and Darcy's Law. Furthermore, the inclusion of horizontal flow barriers in the model does not render that model as being a non-physically based model. Such an assertion is simply wrong.

In **Item 4.1**, Professor Werner and Dr Currell have tried to introduce a new vernacular in the use of terms *"measurement error"* and *"parameter mismatch"*. The term *"measurement error"* used by Professor Werner and Dr Currell is more usually described as *calibration error* (i.e., the difference between model predicted values of heads and fluxes and measured values of heads and fluxes), and the term *"parameter mismatch"* can simply be considered as whether or not the model is *consistent with the conceptualisation*. The process that they describe in **Items 4.1.5** and **4.1.6** has nothing to do with black box models, it simply describes normal model calibration procedure which I have already described in my evidence[10]. The text is reproduced as follows:

> *"Typically, calibration will involve the modeller making various assumptions about the hydraulic conductivity distribution in the aquifer to achieve an acceptable calibration. Indeed this approach is adopted whenever automated parameter estimation software is used to assist with calibration (including the widely used PEST software package). This approach is deemed appropriate provided the resulting model hydraulic conductivities are reasonable (i.e., they are within a range of values that are physically plausible for the aquifer in question) and are consistent with the hydrogeological conceptualisation of the groundwater system. In the event that the calibration result is at odds with the conceptual model, then a decision is required as to whether the calibration based evidence is sufficiently compelling to invoke changes in the conceptualisation."*

The issue of importance to the New Acland Coal Mine Model is whether or not the calibration evidence is sufficiently compelling to invoke a change in the conceptualisation (i.e., whether it was appropriate to introduce faults into the model). In **Item 4**, Professor Werner and Dr Currell appear to suggest that there was insufficient evidence to invoke a change in the conceptualisation. This is somewhat surprising given that both authors have acknowledged, under cross examination, that the use of faults in the New Acland Coal Mine model may well have been justified[11]. When shown steep groundwater gradients in the vicinity of the mine and asked whether this provides evidence for the existence of faults, Professor Werner states *"But I think my first estimate would be that those steep*

[9] Transcript 28-55, Lines 12-33; Transcript 28-78, Lines 22-42.

[10] Statement of Evidence of Brian Barnett (Document ID: NAC.0083, Exhibit 826), p 28.

[11] Transcript 25-108, Lines 34-40 and 27-87, Lines 36-44.

gradients are caused by something that is limiting the – limiting the flow, such as a fault."[12]. Similarly, Dr Currell, when asked to explain whether the steep gradients observed at the site may be explained by faults states *"So a combination of the factors that I've raised, plus some potential influence of faulting so the geology, the topography, some potential zones of enhanced recharge and the influence of faults, which we do know, to some degree, to have an influence on water level patterns."*[13]

The issues raised in **Item 4** by Professor Werner and Dr Currell simply boil down to the fact that, contrary to their statements outlined above, they now appear to claim that there is insufficient evidence to support the fact that groundwater flow is, in places, restricted by faulting. They suggest that *"If field knowledge of parameters is systematically violated, as Mr Barnett has appeared to have done, the model is no longer a physically based model.."*. I disagree with their opinion and firmly believe that there is sufficient evidence to support the inclusion of faults at this site. I argue that the *"parameter knowledge"* is that faults are present and that they do, in places, constrain the movement of groundwater. This is abundantly clear from:

a) the modelling that I have supervised[14];

b) the fault mapping that has been undertaken in and around the mine[15];

c) reports of observed groundwater conditions at the mine site[16] that repeatedly refer to the compartmental nature of the groundwater regime caused by the presence of faults (e.g., Section 6.1, page 10 and Section 9, page 14);

d) previous groundwater modelling of the mine site[17] that includes horizontal flow barriers to compartmentalise the Walloon Coal Measures;

e) interpretation of gravity data[18]; and

f) the steep groundwater gradients present at the mine site and elsewhere in the model domain[19].

I further suggest that none of the decisions that I have made in the modelling process have led to the situation that Professor Werner and Dr Currell describe as *"…the model is no longer a physically based model…"*. The flow of water across, along and around a fault in a Modflow model is calculated on the basis of well-founded and accepted equations that describe physical processes – it is a physically based model.

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[12] Transcript 27-87, Lines 36-44 (Werner).

[13] Transcript 25-108, Lines 34-40 (Currell).

[14] Statement of Evidence of Brian Barnett (Document ID: NAC.0083, Exhibit 826), p 6.

[15] Statement of Evidence of Brian Barnett (Document ID: NAC.0083, Exhibit 826), p 6 and attachments 2 and 3.

[16] Waste Solutions Australia, 2013. Stage 1 Groundwater Investigation at 81P and 82P, New Acland Coal Mine, Acland. Prepared for New Acland Coal Pty Ltd., RN13/W316-15/01. May 2013 (Document ID: OCA.0063 (Exhibit 817)).

[17] Waste Solutions Australia, 2006. New Acland Coal Mine Stage 2 Expansion Project. Environmental Impact Statement (Document ID: OCA.0063 (Exhibit 817)).

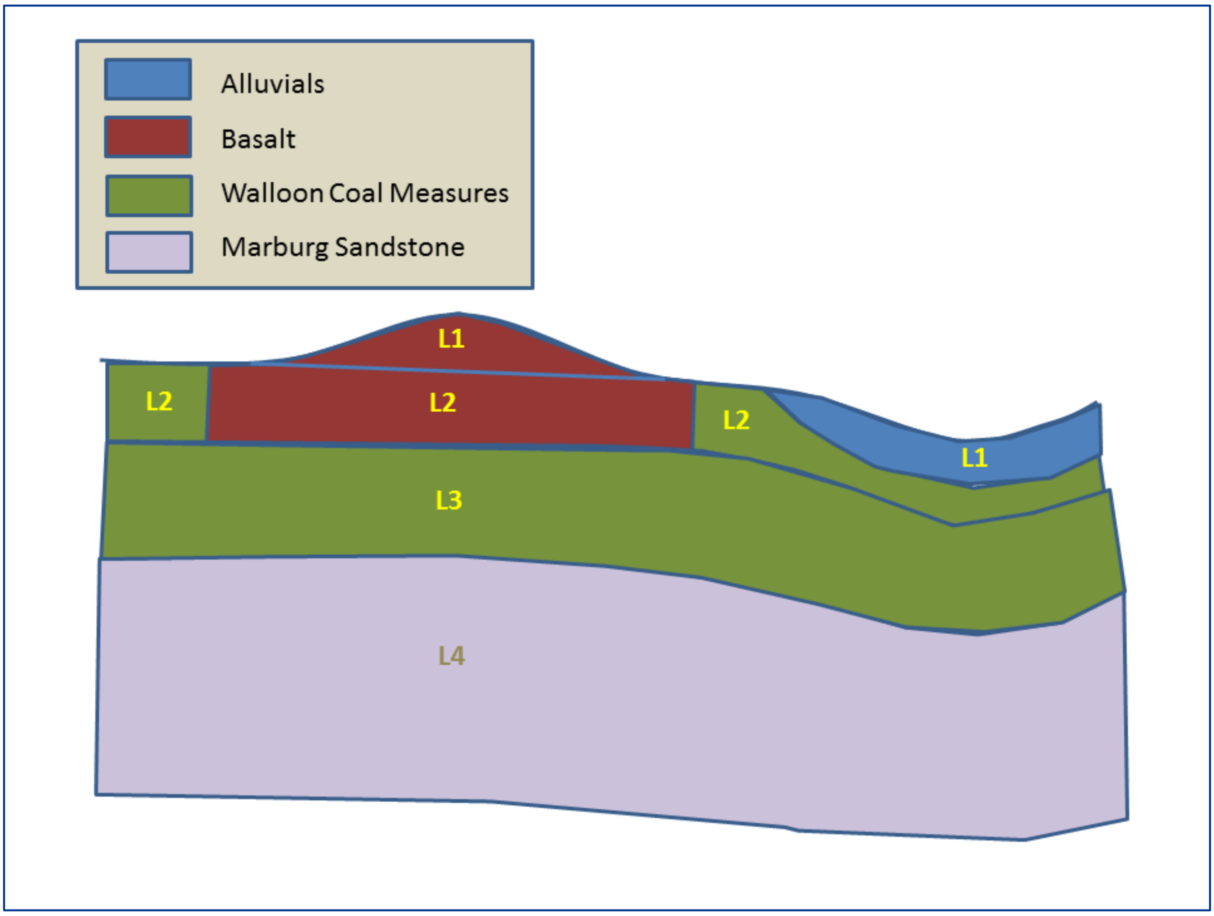
[18] Document ID: NAC.0087 (Exhibit 836).

[19] Document ID: NAC.0085 (Exhibit 834); See also: Statement of Evidence of Brian Barnett (Document ID: NAC.0083, Exhibit 826), Figure 2, p 27.

Item 5. Grouping of different aquifers within a single model layer

Professor Werner and Dr Currell provide a simplistic description of the model layer structure used in the 2009 version of the model, which has been dealt with previously in evidence[20]. They focus on the fact that the Walloon Coal Measures and Basalts are represented in a single model layer. They ignore the fact that there are, in fact, four model layers and that there is nowhere in the model where a model cell is required to represent two or more hydrogeological units. The model structure used in 2009 allows for an explicit and unambiguous representation of the hydrogeological units mapped at the site with a level of accuracy that is consistent with the available data. Figure 2 shows a schematic representation of the model layers in a vertical cross section through the model.

Figure 2 : Schematic representation of the model layers and hydrogeological units included in the 2009 model.



The misconception of the model structure appears to have been initiated by Dr Currell in his evidence[21]. I have addressed the issue previously in evidence[22].

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[20] See, for example, Supplementary Individual Expert Report of Prof Adrian Werner (Document ID: OCA.0071 Exhibit 833) page 61, row 33 and Transcript 25-94 Lines 31-95 (Currell).

[21] Transcript 25-94 to 25-95 (Currell).

[22] Transcript 29-31, Lines 17- 31 (Barnett).

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Item 6. Statements about the effect of faulting that are inconsistent with the model documentation

Item 6.1. Under cross examination by Mr Holt, I indicated that in the 2009 version of the model, the drawdown did not extend to most of the walls (horizontal flow barriers) included in the model[23]. This statement is mostly correct as shown in Figure 2 of the Second Supplementary Report (reproduced below as Figure 3). This figure illustrates predicted drawdown in 2042 at the completion of the planned mining operations.

There are two issues that require further explanation.

Firstly it is clear from Figure 3 that the 1 m drawdown contour extends to the locations of most of the faults. My response would have been more correct if I had qualified my statements by referring to drawdown in excess of 5 m was predicted not to reach most of the faults.

Secondly, Figure 3 suggests that small levels of drawdown (in the region of 1 to 2 m) are predicted to reach some of the fault locations by 2042. I understand that some confusion has arisen from the fact that the 2009 report[24] includes two versions of this drawdown map. One is presented as part of Figure 4-2[25] and the other as Figure 4-3[26] in that report. Figure 4-3 is shown below as Figure 3 and it also shown as Figure 2 in the Second Supplementary Report. It includes contours of drawdown that are less than 5 m. The other version of the prediction is presented as part of Figure 4-2 of SKM 2009 and is shown below as Figure 4. The results are presented with no contours between 1 m and 5 m of drawdown.

When discussing this matter under cross examination, I did not have these figures in front of me and I was relying on my memory. Had I been shown Figure 4-3, I would have been able to provide a more accurate response to the questions.

Both figures clearly demonstrate that the impact of the faults in this version of the model is much less pronounced than subsequent versions of the model including that used to support the AEIS.

[23] Transcript 29-14, Lines 38 – 43.

[24] SKM, 2009. New Acland Coal Mine Stage 3 Expansion Project Environmental Impact Statement. Appendix G.5 Numerical Groundwater Model. July 2009.

[25] SKM, 2009. New Acland Coal Mine Stage 3 Expansion Project 2009 Environmental Impact Statement. Appendix G.5 Numerical Groundwater Model. July 2009, page 4-4.

[26] SKM, 2009. New Acland Coal Mine Stage 3 Expansion Project 2009 Environmental Impact Statement. Appendix G.5 Numerical Groundwater Model. July 2009, page 4-5.

Figure 3 : Predicted drawdown in the Walloon Coal Measures in 2042 (as shown in Figure 4-3 of SKM, 2009[27]).

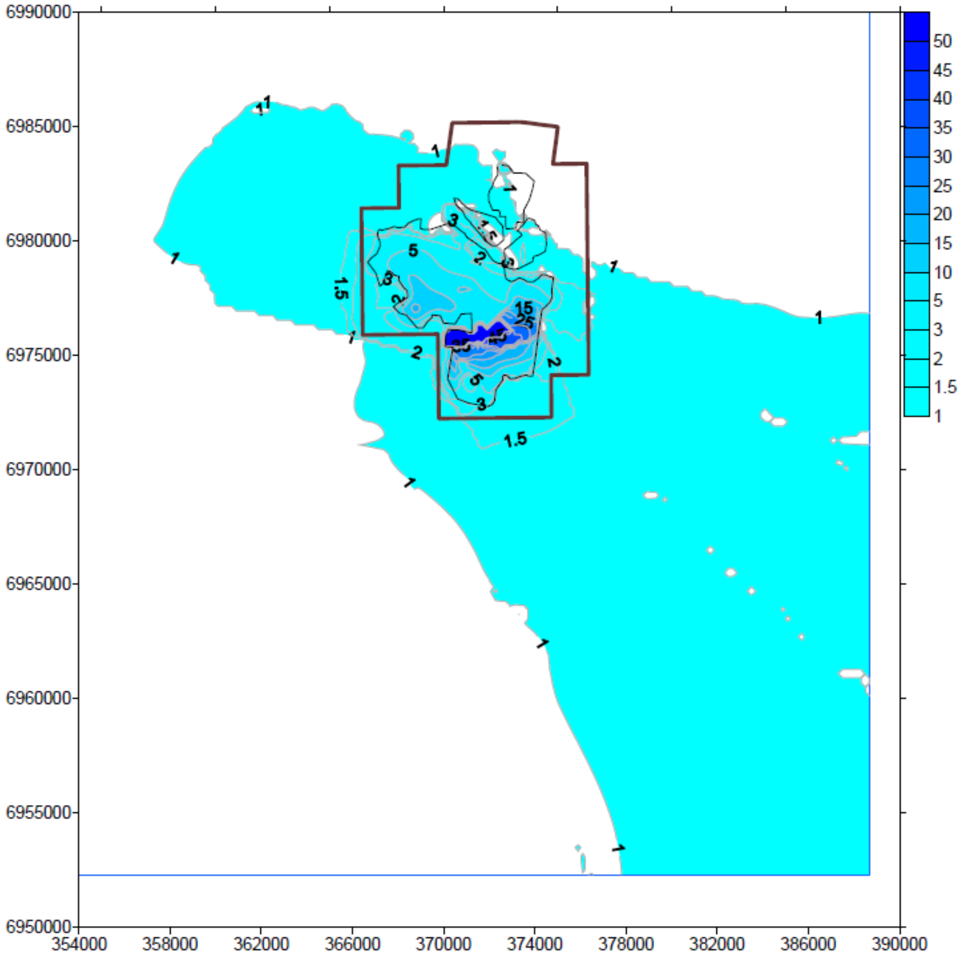
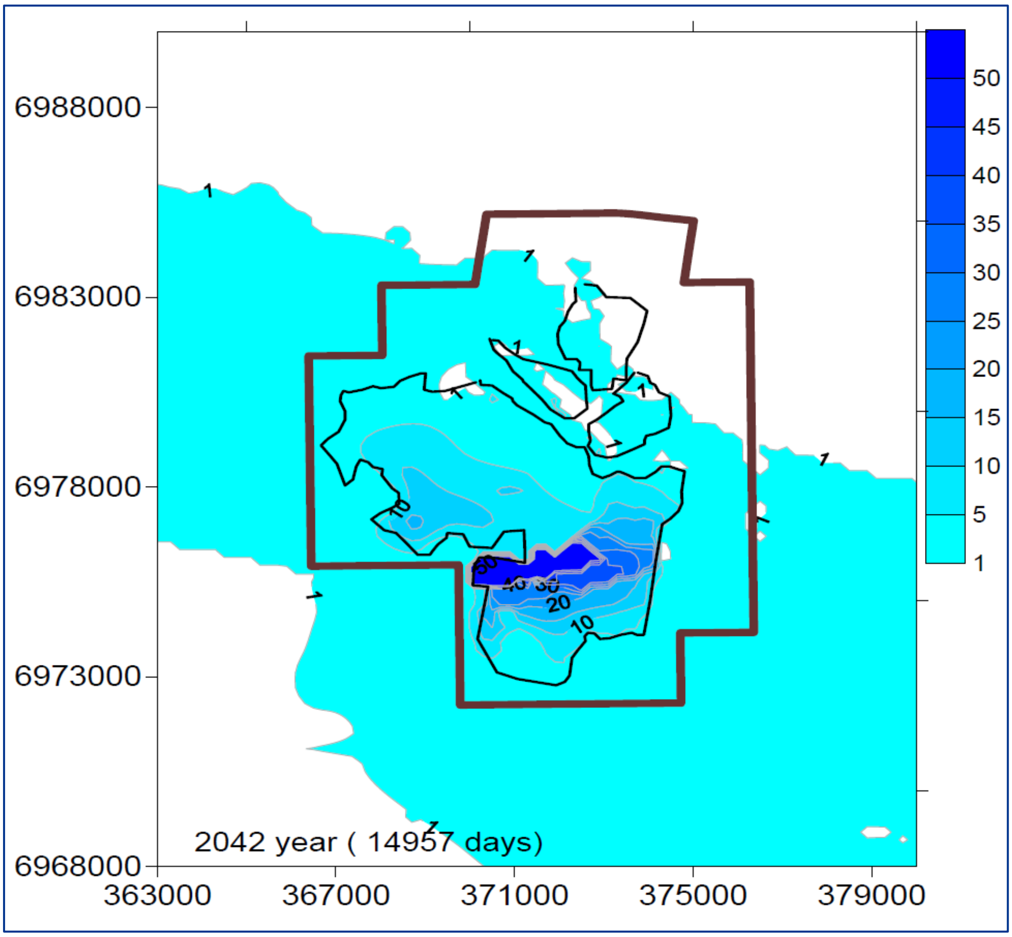


Figure 4-3 Drawdown [m] in Layer 2 and 3 (Walloon Coal Measures) in 2042 year

[27] SKM, 2009. New Acland Coal Mine Stage 3 Expansion Project 2009 Environmental Impact Statement. Appendix G.5 Numerical Groundwater Model. July 2009, Page 20

Figure 4 : Predicted drawdown in the Walloon Coal Measures in 2042 (as shown in Figure 4-2 of SKM, 2009[28].)



In **Item 6.2** Professor Werner and Dr Currell question the modelling that was undertaken in 2013 to help explain drawdown observed in bores 81P and 82P. Under cross examination, I indicated that I could not recall *"…whether it was modelled consistent with what we actually knew it was under the ground?"[29].* While I cannot recall the exact details of how the modelling was undertaken, I do recall that localised enhanced hydraulic conductivity was modelled and I do recall that we were unable to adequately replicate the drawdowns observed in 81P and 82P and the observed pit inflows.

In **Item 6.3**, Professor Werner and Dr Currell have misinterpreted my evidence of the 2013 recalibration process. Enhanced hydraulic conductivity on the alignment of the F5 fault was considered. This conceptualisation was rejected because it was unable to account for the observed drawdown in 81P and 82P and the observed pit inflow rates in combination. It is wrong to suggest that only extreme values of the hydraulic conductivity along the fault were considered.

[28] SKM, 2009. New Acland Coal Mine Stage 3 Expansion Project 2009 Environmental Impact Statement. Appendix G.5 Numerical Groundwater Model. July 2009, Page 21.

[29] Transcript 29-9, Lines 26-27 (Holt).

Item 7. Statements about modelling of groundwater pumping in steady state models

Under cross examination by Mr Holt, I indicated that groundwater extraction from bores was not included in the 2009 model because it is problematic to include groundwater pumping in a steady state model[30]. This is still my opinion. The inclusion of groundwater pumping in a steady state groundwater model is problematic. Most groundwater pumping from bores has a strong seasonal pattern and fluctuates from year to year. In this regard, the inclusion of groundwater pumping is likely to violate the basic underlying assumption of a steady state numerical model; namely that all groundwater stresses are constant with time. Contrary to Professor Werner and Dr Currell's assertions, groundwater extraction from pumping bores is not at all like water flowing into a mining pit. The magnitude and location of groundwater pumping is usually highly variable with time and is dependent on water demand which in turn is subject to land use changes, changes in allocation and climate variability. Flow into a mining pit after mine closure (as in the example provided by Professor Werner and Dr Currell) is dependent on factors that are relatively steady in time, such as, the pit shape, the pit lake area, groundwater inflows and evaporation. In my opinion, it is perfectly reasonable to model an abandoned mining pit in steady state but quite problematic to model groundwater extraction from bores in steady state.

Item 8. Discussion of gravity mapping

Criticisms of the model expressed by Professor Werner and Dr Currell include a lack of field justification for faults[31]. I have provided further "field based" evidence for the inclusion of Unmapped Fault #1 in the form of a basement topography map that has been interpreted from gravity surveys. Despite this, Professor Werner and Dr Currell do not consider this evidence to be sufficiently compelling for the inclusion of this fault in the model. Given the overwhelming scarcity of data that can be used to inform any groundwater model, I believe that the presented gravity data provides extremely valuable information that helps to corroborate the existence of a geological structure such as a fault in this location.

[30] Transcript 29-81, Lines 8-19 (Barnett).

[31] For example, Transcript 27-40, line 41 (Werner) and Transcript 25-94 Lines 37-46 (Currell).