Expert Response to the Land Court by Mark Stewart

1. Experts Details & Qualifications

1.1 Name

My name is Mark Stewart.

1.2 Address

My business address is:

Level 17, 240 Queen Street

Brisbane

Queensland, 4000

1.3 Qualifications

I hold the following qualifications:

(a) Bachelor of Science (Geology)

My curriculum vitae is included in my Expert Witness Report dated 30 May 2013.

2. Instructions

I have been instructed by Allens on behalf of Hancock Coal Pty Ltd to formulate a response to the issues raised in Dr Webb's Additional Statement (the affidavit of Sean Patrick Ryan dated 23 September 2013).

3. Facts and Assumptions

In producing this Response, I have relied on the following facts and assumptions:

(a) Contained with my Expert Report, dated 30 May 2013 and the reports referenced in that report;

(b) Included in my comments included in the Joint Experts Report, dated 02 August 2013; and

(c) Contained in the reports and documents referenced in the Joint Experts Report, dated 02 August 2013, including the latest version of the Predictive Groundwater Model constructed and calibrated for the Alpha Coal Mine, dated March 2012.

4. Opinion and Findings

Opinions of Dr Webb

In Dr Webb's Additional Statement he makes the following claims:

- Recharge rate is defined by the salinity of groundwater, and thus should be ~ 1% of Mean Annual Precipitation in the confined Permian aquifers;
- The URS groundwater model is calibrated using an assumed recharge;

- Calibrated hydraulic conductivity values can be increased to match proposed increased recharge based on aquifer test data; and
- That although the range of hydraulic conductivity parameters considered in the model are appropriate these values could be increased to match his recharge theory.

Summary

In response I have considered the following:

- Recharge rates used in the Alpha Coal Mine groundwater model were based on the geological factors (vertical infiltration potential and flow paths), hydrochemistry, and groundwater level hydrographs, not just salinity.
- The Alpha Coal Mine groundwater model calibration was conducted considering hydraulic conductivity and recharge simultaneously, with no predetermined recharge. The model calibration used automated parameter software that determines the model parameters based upon measured data. The calibration process included the following:
    - First, to simulate 'steady state' conditions (i.e. allow for a comparison of resultant groundwater heads (groundwater level) in the model to the groundwater levels measured on site);
    - The second phase called a 'transient model', is a revision to not only assess the match between the groundwater level variations in response to the Alpha Test Pit, but also assess the model's predicated total volume of groundwater removed compared to the actual amount removed by the Alpha Test Pit;
    - The third phase was an uncertainty analysis to assess the parameters where a range of data was observed for steady-state, transient and field measurements.
    - Calibration statistics were then considered, if the calibration statistics were beyond an acceptable range (5% of scaled Root Mean Square (RMS) error when comparing measured verses modelled groundwater heads), then these parameter values were deemed not to be reflective of field conditions. This RMS error is an acceptable industry standard to demonstrate that a groundwater model is appropriately calibrated.
- Rather than adopting only the highest or lowest hydraulic conductivity data in the calibration of the Alpha Coal Mine groundwater model, the Alpha groundwater model considers a range of aquifer test results and literature values, both low and high. This allows for the determination of the most spatially representative hydraulic conductivity data for the model layers, using steady-state and transient calibration and uncertainty analyses. This approach recognises that the confined Permian aquifers are heterogeneous based on the available data.
- In order to address Dr Webb's queries regarding recharge to the confined Permian aquifers and the possibility of higher hydraulic conductivity within these aquifers I undertook additional modelling.
- I modified the latest version of the groundwater model to include direct recharge to the confined Permian aquifers and increase the hydraulic conductivity to assess the viability of Dr Webb's conceptual model (i.e. whether the model could be calibrated using both the

higher recharge and higher hydraulic conductivity suggested by Dr Webb against the known data (e.g. steady-state groundwater levels and groundwater volumes extracted during the Alpha Test Pit dewatering) within the same calibrated margin of error used for the current Alpha groundwater model). Calibrating to groundwater flow provides the most accurate evaluation of aquifer parameters.

- When Dr Webb's suggested inputs were added to the model, both the steady-state and transient models could not be calibrated by increasing hydraulic conductivities of C-D, D-E, and sub-E sandstone units. The transient simulations did not match the actual data (groundwater level drawdown and groundwater volumes extracted) in the mine area. On the various scenarios assessed, the RMS error for Dr Webb's theory ranged between ~15% and ~10%, outside that of the Alpha groundwater model by a factor of about two to three times. The ~10% RMS error was based on adopting horizontal hydraulic conductivity values 10 to 20 times higher than those actually measured on site.
- The confined Permian aquifers can be heterogeneous in nature, as indicated by a wide range of field test values. The high end values of hydraulic conductivity for C-D and D-E sandstone units occur in discrete areas within the model domain due to heterogeneity and not representative if the entire unit. The Alpha groundwater model was calibrated to take into account the heterogeneous nature of the Permian aquifers. For the purposes of assessing a 'best case' scenario for Dr Webb's theory, the highest measured hydraulic conductivity was adopted for the entire model domain for the Permian units (i.e. it was assumed that Permian Aquifers had homogenously high hydraulic conductivity. The field data shows that this is not in fact the case). The model still did not calibrate.
- Given the heterogeneous aquifers the net recharge of 1% of mean annual precipitation is considered to be excessive. The additional model runs I have completed to test Dr Webb’s theory support this view.

I consider that the predictive modelling, refined over time, conducted for the Alpha Coal Mine allowed for an assessment of potential impacts of the mining based on representative aquifer parameters, which reflect actual site specific data. These parameters within the area to be mined allowed for the evaluation of potential extent of drawdown at the end of mining and in the long term, 300 years.

Findings

4.1 Recharge Considerations

In his additional statement, Dr Webb only considers the rate of recharge based on the chloride mass balance method using salinity data and the salinity of rainfall. No comment on the groundwater level hydrographs or alteration in chemistry (during deep drainage through the various overlying units) is provided.

I consider the groundwater associated with the deeper confined aquifers reflect the water associated with the fluvial deposits, trapped during the rock formation, and the inert nature of the quartz-rich host rock.

I consider that the chloride mass balance approach is a simplification based on the groundwater quality data and discussion, provided in the Groundwater Model Report (URS, 2012) and my Supplementary Expert Response Report, dated 20 August 2013.

These chemistry data indicate that the salinity is variable in each unit and that higher chloride concentrations occur near surface. I consider that the slow recharge rates, as calculated based on zones of low vertical permeability in the overlying units (presented for the Rewan Formation in paragraph 182 of the Joint Experts Report), would result in alteration in the groundwater quality during the infiltration through overlying units to the confined Permian (C-D, D-E, and sub-E sandstone units).

In order for the quality not to be altered during infiltration the recharge mechanism envisaged by Dr Webb would need to be rapid, so as not to alter the groundwater quality within the confined Permian units. I consider that the potential for faults or fractures to provide preferential flow paths are limited based on:

- The clay-rich nature of the units;
- The limited potential for extensional faults; and
- The infilling of fractures due to sediments introduced through surface water ingress.

In addition, the groundwater level data recorded over time also do not show, other than the Bandanna Formation units monitored in bore AVP-13, any marked response to rainfall even during the high rainfall events measured during 2009/10 and 2010/11. I consider that a groundwater pressure response in the confined aquifers, due to the calibrated low storage (specific capacity) values (see Table 2 below), would be marked if recharge entered the confined aquifers, i.e. a measurable response would be recorded even if only small volumes of water are added to the confined aquifer. No response to rapid recharge was recorded during or after these rainfall events.

Recharge rates need to be, and for the purposes of the Alpha groundwater model were considered based on hydrochemistry, groundwater level hydrographs, and aquifer parameters and not just salinity.

4.2 Calibration Approach

Dr Webb incorrectly assumes that URS calibrated their steady-state model, the hydraulic conductivity values, to match an assumed recharge value.

The model calibration was conducted considering hydraulic conductivity and recharge simultaneously using the automated parameter estimation software package PEST, which allows for the assessment of resultant groundwater heads using numerous combinations of parameters against measured data.

This allows for the identification of the basecase range of parameters, which when combined, provided the best simulated (model produced) water levels compared to the observed field measured water level data. The target of the steady-state calibration was to match the groundwater head data compiled for 31 points in various aquifers across both the Alpha and Kevin’s Corner mine lease areas. The parameter evaluation is conducted with the aim of reducing the scaled RMS error %, between measured and modelled groundwater heads, to a 5% RMS error target.

The parameters, hydraulic conductivity and recharge, were constrained within appropriate ranges based on site specific data and literature values. For recharge the constraints were 1% of Mean Annual Precipitation (MAP) based on the Great Artesian Basin intake bed recharge range of 3 to 10 mm/yr (JBT Consulting, 2010). The high values of hydraulic conductivity, as measured on site, were included as constraints to the hydraulic conductivity range. Table 1 provides the constraint range for the PEST input file, i.e. the control data set for the PEST automated parameter estimation.

Table 1 Parameter constraint range

Parameter	Layer	Minimum (m/day)	Maximum (m/day)
Horizontal hydraulic conductivity	1 GAB	0.1	8
	2 Tertiary Sediment	0.04	0.11
	3a Rewan	1×10^{-6}	0.001
	3b Tertiary laterite	5×10^{-4}	0.005
	4 Bandanna Fm	1×10^{-6}	0.05
	5 C seam	0.001	0.1
	6 C-D sandstone	0.06	0.83
	7 D seam	0.001	0.1
	8 D-E sandstone	0.05	1.56
	9 E seam	0.001	0.1
	10 Sub-E sandstone	0.05	1.56
	11 Joe Joe Fm	1×10^{-6}	0.001
Vertical hydraulic conductivity	1 GAB	0.01	0.8
	2 Tertiary Sediment	1×10^{-6}	0.001
	3a Rewan	1×10^{-6}	0.001
	3b Tertiary laterite	5×10^{-5}	0.005

	4 Bandanna Fm	1 x 10^{-5}	0.05
	5 C seam	1 x 10^{-6}	1 x 10^{-4}
	6 C-D sandstone	1 x 10^{-6}	0.83
	7 D seam	1 x 10^{-6}	1 x 10^{-4}
	8 D-E sandstone	5 x 10^{-6}	1.56
	9 E seam	1 x 10^{-6}	1 x 10^{-4}
	10 Sub-E sandstone	5 x 10^{-6}	1.56
	11 Joe Joe Fm	1 x 10^{-6}	0.001
Recharge (% of Mean Annual Recharge)		1 x 10^{-5} (0.001%)	0.01 (1%)

Transient calibration, based upon the Alpha Test Pit dewatering program, was conducted to further asses the model parameters, including recharge. This was followed by uncertainty analyses to assess the parameters where a range of data was observed for steady-state, transient and field measurements.

Calibration statistics were then considered, if the calibration statistics were beyond an acceptable range (5% of scaled RMS error when comparing measured verse modelled groundwater heads), then these parameter values were deemed not to be reflective of field conditions.

The model calibration approach was conducted considering hydraulic conductivity and recharge simultaneously and did not include a predetermined 0.1 % of Mean Annual Precipitation recharge value.

4.3 Calibration Range compared to Field Data

The range of field measurements for the confined Permian C-D and D-E sandstone units, considering the pumping tests and slug tests provided a range of values. These include:

- C-D sandstone 0.06 to 0.83 m/day for the horizontal hydraulic conductivity
- D-E sandstone 0.03 to 1.56 m/day for the horizontal hydraulic conductivity

As no field data measurements were available for the sub-E sandstone, the values adopted for the D-E sandstone were included for the sub-E sandstone unit in the URS modelling.

The calibrated parameters included in the final refined model (Table 11-4 of the Groundwater Model Report, URS, 2012) included a horizontal hydraulic conductivity value of 0.1 m/day for the C-D sandstone and 0.05 m/day for the D-E and sub-E sandstone units. I identified these values as the most representative for these units across the model domain based on available data sets.

I consider that the higher values are associated with zones of alteration (i.e. zones of increased permeability) within these units, where joints or fractures or weathering (i.e. secondary processes) have increased the groundwater potential of these units in discrete areas. I, therefore, do not consider the higher values as representative of the entire unit.

This view and conclusion is evident and supported by the results obtained from the Alpha Test Pit, where a large 300 m x 250 m pit was excavated into the Colinlea Sandstone units. The groundwater volumes extracted during pit dewatering provide a clear indication of the groundwater hydraulic conductivities over a large area as opposed to discrete zones of increased permeability.

A range of aquifer test results and literature values was considered, both low and high, allowing for the determination of the most representative hydraulic conductivity data for the model layers, using steady-state and transient calibration and uncertainty analyses.

4.4 Model Simulations

In order to address Dr Webb's concept that the study area could receive higher recharge (considered in model simulations to be 1% of MAP, some 5 mm per year, based on the range (0.6 to 1.25%) submitted in Dr Webb's Additional Statement) if higher aquifer hydraulic conductivity were included in the confined Permian units, I modified the model to simulate the following:

- Direct recharge introduced into the confined Permian C-D sandstone unit;
- Simulate a recharge zone of 400 km^2 (Figure 1 below). The recharge zone along the Great Dividing Range and size is as envisaged by Dr Webb in his expert's report;
- Increase the horizontal and vertical hydraulic conductivity of the C-D, D-E, and sub-E sandstone units to the maximum values measured on site; and
- The ratio of horizontal hydraulic conductivity to vertical conductivity is 1:1000 for the C-D, D-E, and sub-E sandstones units. This ratio was determined based on the transient calibration, matching groundwater level change in the different model layers over time in response to the Alpha Test Pit dewatering and the total groundwater volume extracted during the 91 day dewatering period. As part of this modelling, to facilitate the higher recharge, the ratio was changed to 1:100. I consider that a 1:100 ratio is plausible with sandstone units.

This approach allowed for the evaluation of model calibration with these assumptions so as to consider whether these higher parameters are reflective of field conditions.

The modified model was assessed to simulate steady-state conditions, i.e. allow for the comparison of resultant groundwater heads in the model to those measured on site. The revised hydraulic conductivity and recharge model parameters were then used in the (modified) transient model to simulate the Alpha Test Pit dewatering. The results were compared to the measured drawdown and groundwater extracted during the Alpha Test Pit dewatering.

The model parameters included in the revised model are presented in Table 2. The C-D sandstone horizontal hydraulic conductivity values were increased by a factor of 8 and the D-E sandstone values by a factor of 30. As the sub-E sandstone units adopt the D-E sandstone values in the modelling, the values for the sub-E sandstone were also increased by a factor of 30. It is noted that the vertical hydraulic conductivity were increased by 80 and 300 times for the C-D sandstone and the D-E and sub-E sandstone units, respectively (i.e. changing the ratio to 1:100 and then increasing as per the horizontal hydraulic conductivity values).

Steady-State Results

The simulated groundwater heads in the revised model were some 10 to 20 m higher than those measured on site in the various model layers (Table 3). The scaled RMS error, used to assess calibration, was 15.5%. This is outside the adopted calibration RMS error of 5% (Table 4).

Figure 1 Model recharge area (red area of 400 km^2)

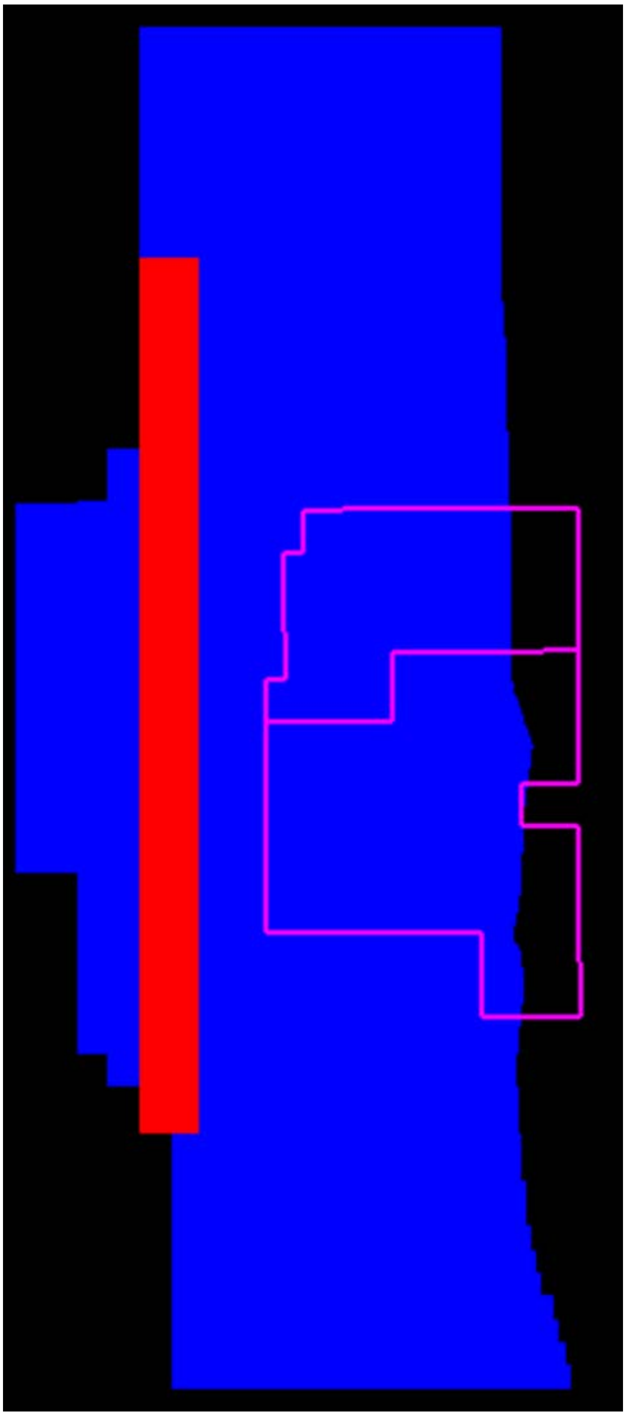


Table 2 Revised model parameters

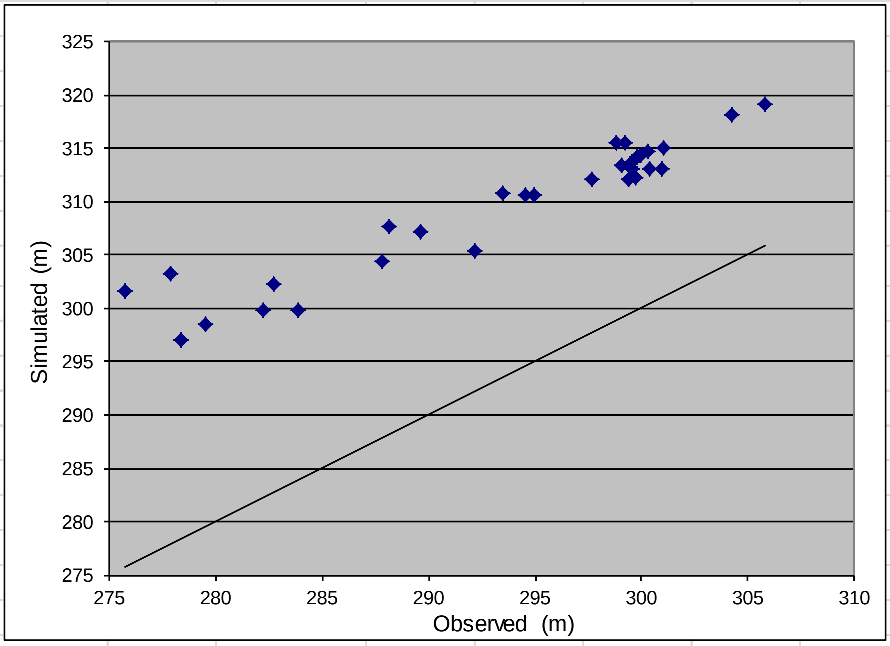
Model Layer	Unit	Hydraulic Conductivity (m/day)		Storage	
		Horizontal	Vertical	Specific Capacity	Specific Yield
1	GAB	5.60E+00	5.60E-01	6.00E-04	5.01E-02
2	Tertiary sediment	1.00E-01	1.00E-02	6.00E-04	5.01E-02
3	Rewan	1.00E-04	1.00E-05	4.56E-04	8.41E-03
3	Tertiary laterite	1.00E-03	1.00E-05	4.56E-04	8.41E-03
4	Bandanna Formation	1.76E-03	1.76E-04	4.56E-04	8.41E-03
5	C seam	1.00E-02	1.00E-05	9.77E-06	8.02E-03
6	C-D sandstone	0.83	8.30E-03	6.23E-06	8.03E-03
7	D seam	1.00E-02	1.00E-05	9.77E-06	8.02E-03
8	D-E sandstone	1.56	1.56E-02	4.56E-04	8.41E-03
9	E seam	1.00E-02	1.00E-05	9.77E-06	8.02E-03
10	Sub E sandstone	1.56	1.56E-02	4.56E-04	8.41E-03
11	Joe Joe Formation	1.00E-04	1.00E-05	4.56E-04	8.41E-03

Table 3 Measured and Simulated Water Levels (highest measured C-D and D-E sandstone data)

Well	Measured (m)	Modelled (m)	Difference	Model Layer
1228C	287.80	304.4424	-16.64	6 C-D sandstone
1228C	292.20	305.3617	-13.16	8 D-E sandstone
1234C	282.70	302.236	-19.54	6 C-D sandstone
1234C	277.90	303.1675	-25.27	8 D-E sandstone
1238C	275.70	301.6866	-25.99	8 D-E sandstone
1238C	278.40	297.0455	-18.65	6 C-D sandstone
1313C	279.50	298.4605	-18.96	8 D-E sandstone
1313C	282.21	299.7789	-17.57	6 C-D sandstone
1356C	283.86	299.813	-15.95	8 D-E sandstone
1356C	300.30	314.6953	-14.40	8 D-E sandstone
AMB-01	289.60	307.168	-17.57	6 C-D sandstone
AVP-01	288.10	307.7366	-19.64	8 D-E sandstone
AVP-01	293.50	310.8295	-17.33	8 D-E sandstone
AVP-03	298.80	315.4925	-16.69	6 C-D sandstone
AVP-04	299.20	315.537	-16.34	8 D-E sandstone
AVP-04	299.74	312.2141	-12.48	6 C-D sandstone
AVP-05	299.51	313.0664	-13.55	8 D-E sandstone
AVP-05	297.70	312.0508	-14.35	5 C seam
AVP-05	299.36	312.1303	-12.77	6 C-D sandstone
AVP-06	299.09	313.4436	-14.35	8 D-E sandstone
AVP-06	299.49	313.2328	-13.75	6 C-D sandstone
AVP-07	299.93	314.3688	-14.44	8 D-E sandstone
AVP-07	299.83	314.2715	-14.45	8 D-E sandstone
AVP-08	299.56	313.6605	-14.10	7 D seam
AVP-08	301.00	315.0266	-14.03	6 C-D sandstone
AVP-09	305.83	319.1487	-13.32	8 D-E sandstone
AVP-10	294.56	310.5846	-16.02	6 C-D sandstone
AVP-11	294.93	310.5868	-15.66	8 D-E sandstone
AVP-11	304.27	318.1198	-13.85	8 D-E sandstone
AVP-13	300.36	312.9798	-12.62	6 C-D sandstone
AVP-14	300.97	312.9934	-12.02	8 D-E sandstone

Table 4 Model revised to highest measured C-D and D-E sandstone data – statistics[1]

Mean Error	-15.98
RMSE	16.32
SD	3.35
Head range	105.00
Mean Error %	-15.22%
RMS Error %	15.5%
SD Error %	3.2%
R^2	0.91



Further model results

In order to further test whether Dr Webb's theory could be calibrated, allowing for the increase in recharge (1% of MAP), the hydraulic parameters (horizontal and vertical) were increased by a factor of 10 above the highest measured in the field (hydraulic conductivity for C-D sandstone to 8.3 m/day and D-E sandstone to 15.6 m/day) and by a factor of 20 above the highest measured for the project (hydraulic conductivity for C-D sandstone to 16.6 m/day and D-E sandstone to 31.2 m/day).

These hydraulic conductivity values are outside of any results measured on site and only conducted to emphasise that for higher recharge, higher hydraulic conductivity values would be required to reduce the modelled groundwater heads. The modelled groundwater heads, in both cases, were still some 10 m above the field measurements and the calibration statistics indicate the RMS error% of ~ 10%, outside the target 5% RMS error.

Table 5 presents the statistics for including hydraulic conductivity values in the C-D, D-E, and sub-E sandstone units that are ten (10) times the highest hydraulic conductivity recorded on site. Table 6 presents the statistics for the twenty (20) times the highest hydraulic conductivity values in the C-D, D-E, and sub-E sandstone units.

---

[1] RMSE –Root Mean Square Error

SD – Standard Deviation

R^2 – regression analysis

Table 5 Model revised to 10 x highest measured C-D and D-E sandstone data – statistics

Mean Error	-10.41
RMSE	11.11
SD	3.95
Head range	105.00
Mean Error %	-9.92%
RMS Error %	10.6%
SD Error %	3.8%
R^2	0.88

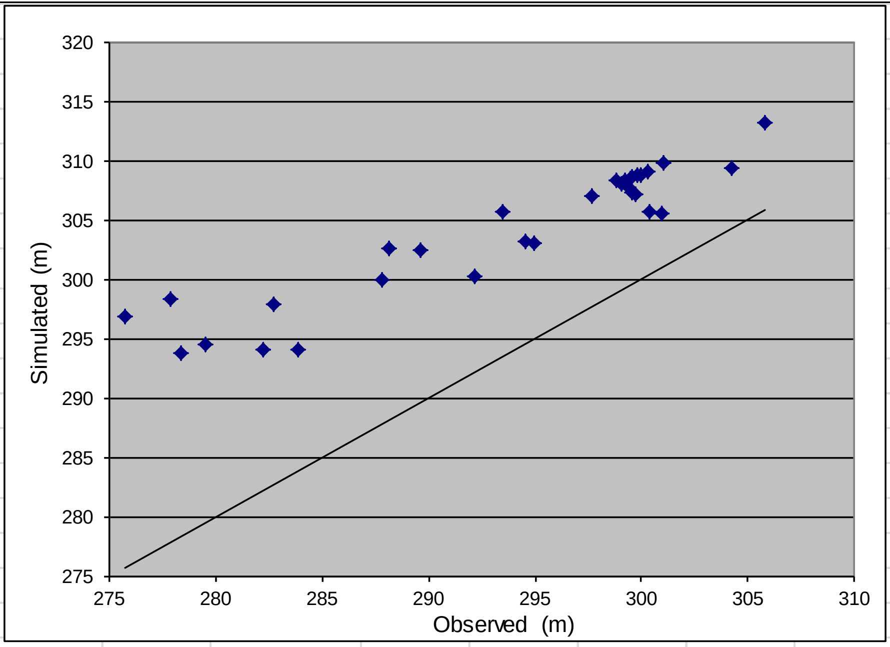
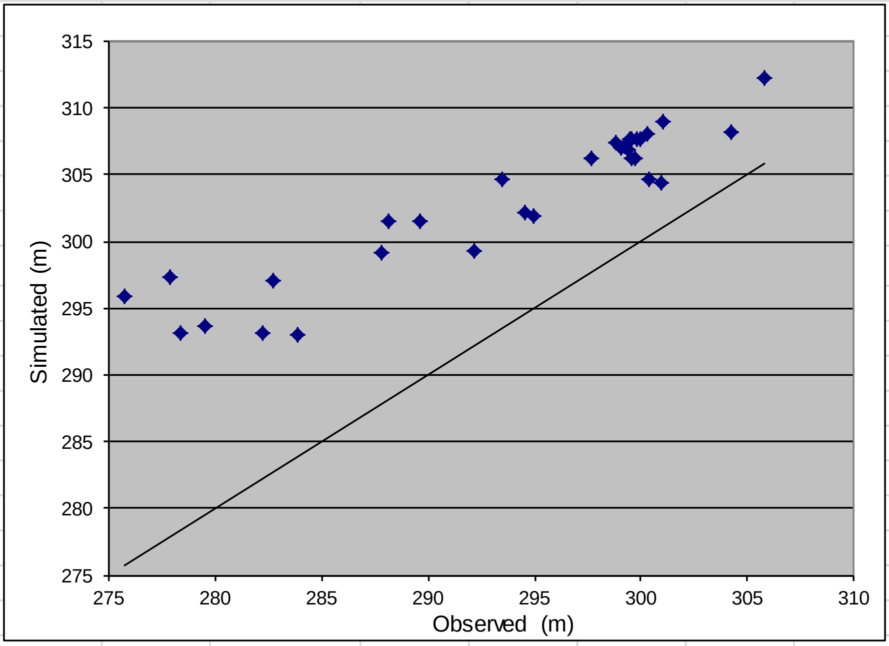


Table 6 Model revised to 20 x highest measured C-D and D-E sandstone data – statistics

Mean Error	-9.42
RMSE	10.21
SD	3.99
Head range	105.00
Mean Error %	-8.97%
RMS Error %	9.7%
SD Error %	3.8%
R^2	0.88



Transient Model Evaluation

The transient model was revised to include the highest measured hydraulic conductivity values for the C-D, D-E, and sub-E sandstone units using the measured head values. These groundwater values were used as the heads generated in the modified steady-state model, using 1% recharge, were not representative of site conditions.

The use of the modified transient model was to not only assess the match between groundwater level variations in response to the Alpha test Pit dewatering over time but also assess the total volume of groundwater removed compared to actual. This allows for the consideration of how representative the higher hydraulic conductivity values are to site conditions.

The layers and the model parameters for the revised transient model are included in Table 7.

Table 7 Revised Transient Model details

Model	Unit	Hydraulic conductivity (m/day)		Storage	
Layer		Horizontal	Vertical	Specific capacity	Specific yield
1	Tertiary sediment	0.1	0.01	1×10^{-3}	7×10^{-2}
2	Tertiary sediment	0.1	0.01	1×10^{-3}	7×10^{-2}
3	Tertiary laterite	0.0028	0.000028	2.16×10^{-4}	5×10^{-3}
4	Bandanna Formation	0.003	0.0003	2.16×10^{-4}	5×10^{-3}
5	C seam	0.002	1.46×10^{-6}	5×10^{-6}	1×10^{-3}
6	C-D sandstone	0.83	0.0083	2.43×10^{-5}	3.18×10^{-3}
7	D seam	0.002	1.46×10^{-6}	5×10^{-6}	1×10^{-3}
8	D-E sandstone	1.56	0.0156	3.93×10^{-4}	4.99×10^{-2}
9	E seam	0.002	1.46×10^{-6}	5×10^{-6}	1×10^{-3}
10	Sub E sandstone	1.56	0.0156	3.93×10^{-4}	4.99×10^{-2}
11	Joe Joe Formation	0.0001	0.000001	2.16×10^{-4}	5×10^{-3}

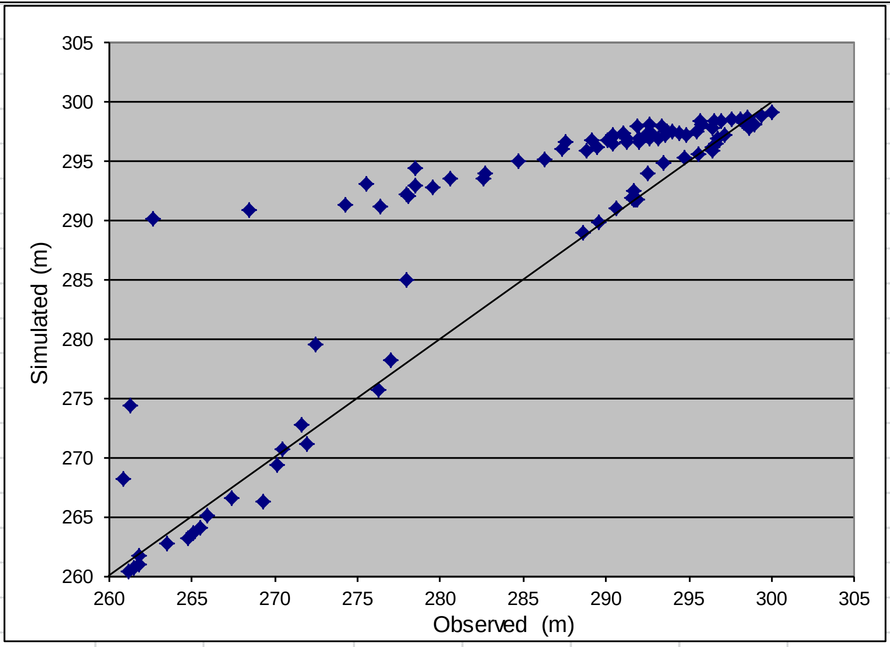
The model was then run to simulate the dewatering from the Alpha Test Pit as well as the resultant drawdown in the different bores and units, as recorded on site. The resultant drawdown graphs, showing observed and simulated, are attached (Appendix A).

The resultant calibration statistics for the transient model calibration indicates a RMS error of 14.1%, outside of the targeted 5% RMS error. The calibration results are included in Table 8.

The resultant water balance for the revised model indicates a total of 99 ML would be extracted due to the higher permeability values. This is double the 45 ML recorded during the actual Alpha Test Pit dewatering program. The higher hydraulic conductivity values, considering that the Alpha Test Pit allowed for a large 300 m x 250 m excavation, are not representative of site conditions.

Table 8 Transient model with highest measured C-D and D-E sandstone data – statistics

Mean Error =	-4.00
RMSE=	6.93
SD	5.68
Head range	49.15
Mean Error %	-8.13%
RMS Error %	14.1%
SD Error %	11.6%
R^2	0.79



The transient calibration, considering groundwater extraction, assisted in identifying reasonable ranges of hydraulic conductivity and is a different approach to the correlation of recharge and transmissivity (aquifer hydraulic conductivity multiplied by aquifer thickness) inherent to head-only calibration (i.e. steady-state). As demonstrated in the modified modelling results, the head-only calibration cannot be met with the suggested maximum field values of hydraulic conductivity. Even if the head-only calibration was met groundwater extracted from the test pit was more than double than the field measurement. This further demonstrates that maximum field values were not representative for the entire units. The high recharge and hydraulic conductivity values, envisaged by Dr Webb, are therefore not representative of site conditions.

The range of hydraulic conductivity, horizontal and vertical, for the various units determined during the transient calibration are representative of the area to be mined. These hydraulic conductivity values limit the volume of effective recharge into the mine area and determine the rate of flow across the site.

I conducted sensitivity analyses, evaluating the effect of change in model parameters on model results (compared to field measurements), on all model parameters during the modelling to assess the representativeness of these values. The sensitivity analyses included horizontal and vertical hydraulic conductivity, recharge, evapotranspiration, specific capacity, and specific yields, as presented in Figures 9-12 and 9-13 of the Groundwater Model Report (URS, 2012).

Comment

I consider that using the calibrated values presented in Table 11-4 of the Groundwater Model (URS, 2012) provide the most representative range of hydraulic conductivity and recharge, allowing for accurate match to measured groundwater levels (static and transient) and extraction volumes, thus the predictions generated using these values allows for valid assessment of potential drawdown extent as a result of mine dewatering.

5. Expert's Statement

I confirm the following:

(d) the factual matters stated in this report are, as far as I know, true;

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

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

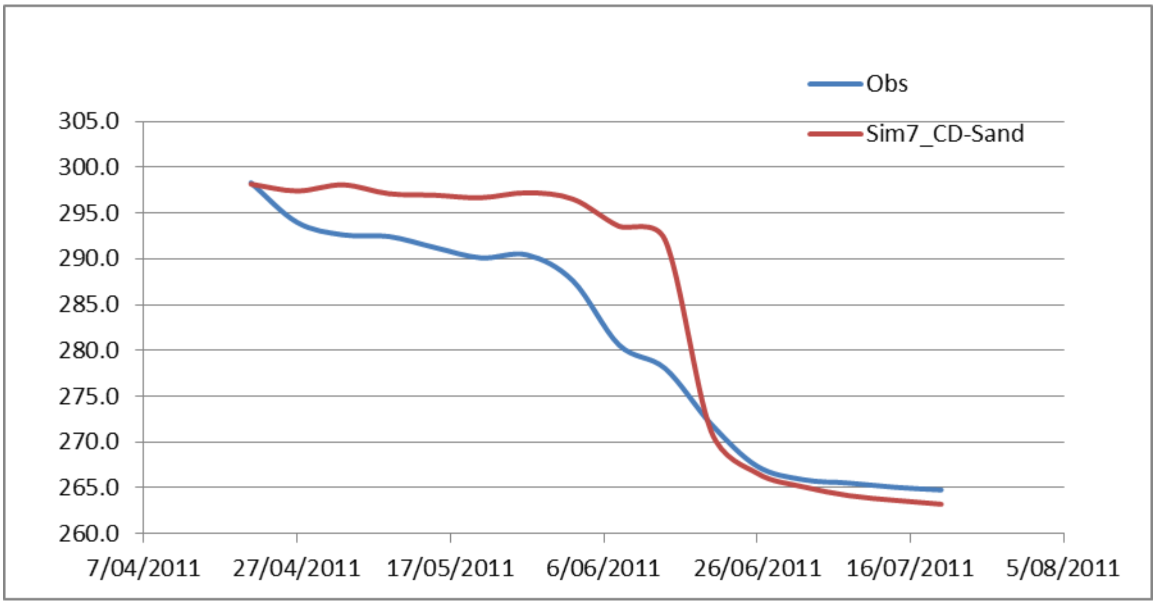
(g) the report contains reference to all matters I consider significant; and

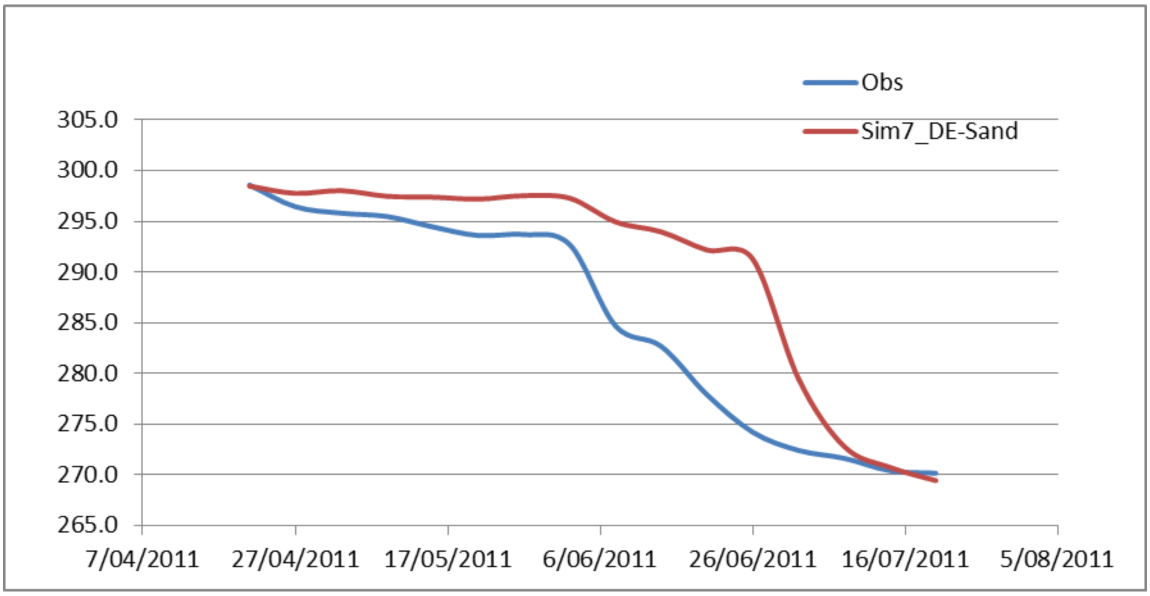
(h) I understand my duty to the court and have complied with the duty.

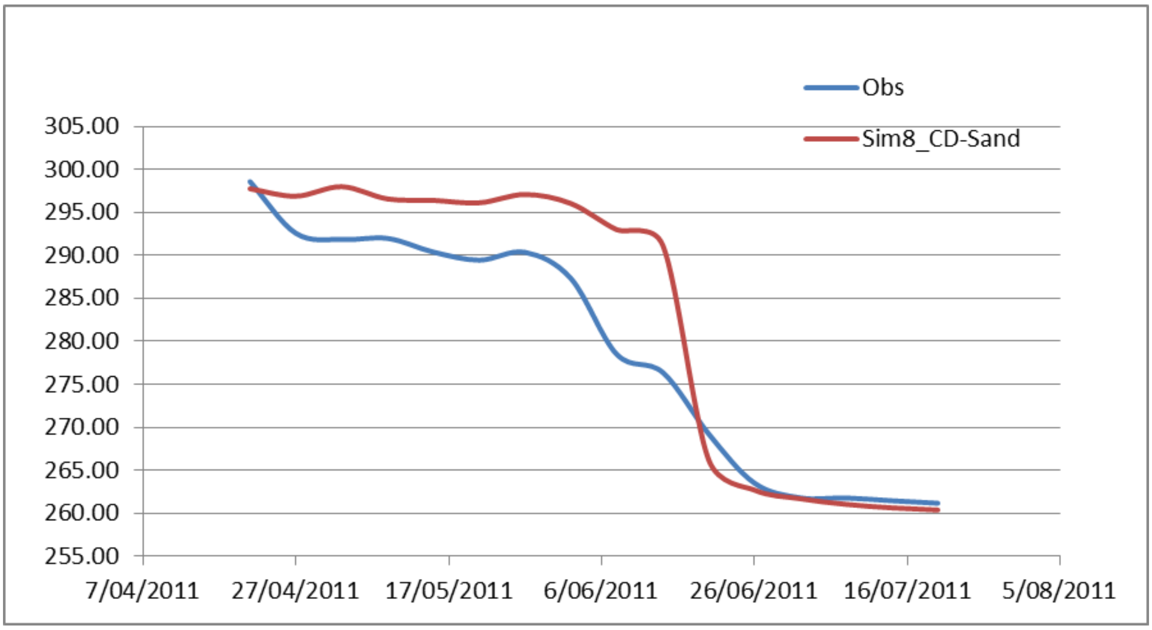
Mark Stewart

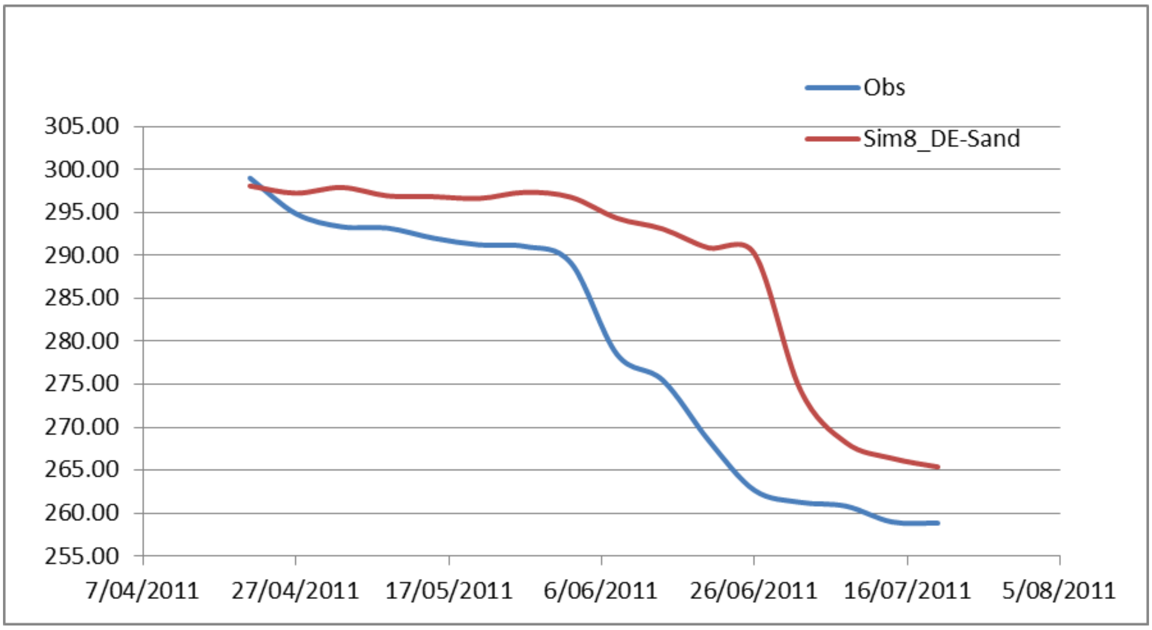
27 September 2013

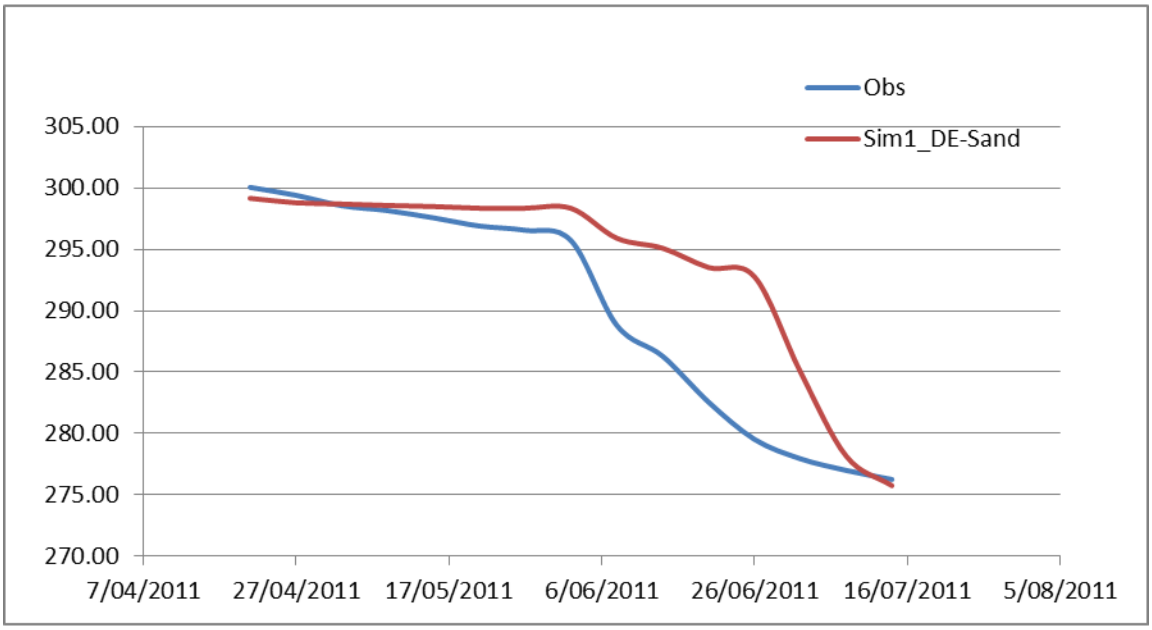
Appendix A – Transient Groundwater Plots

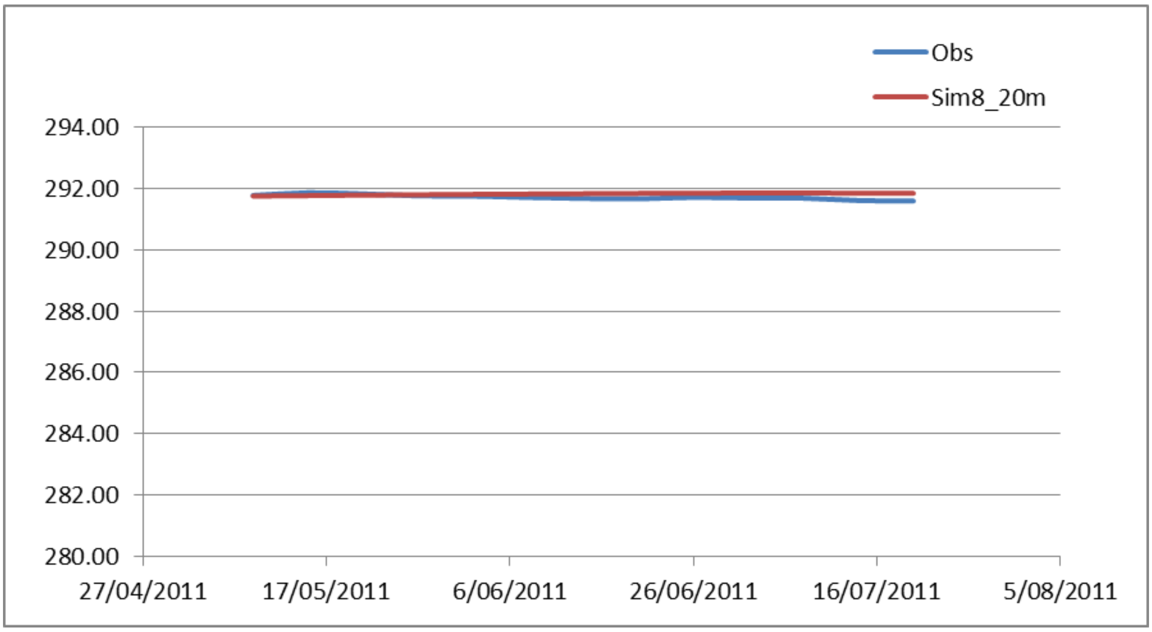


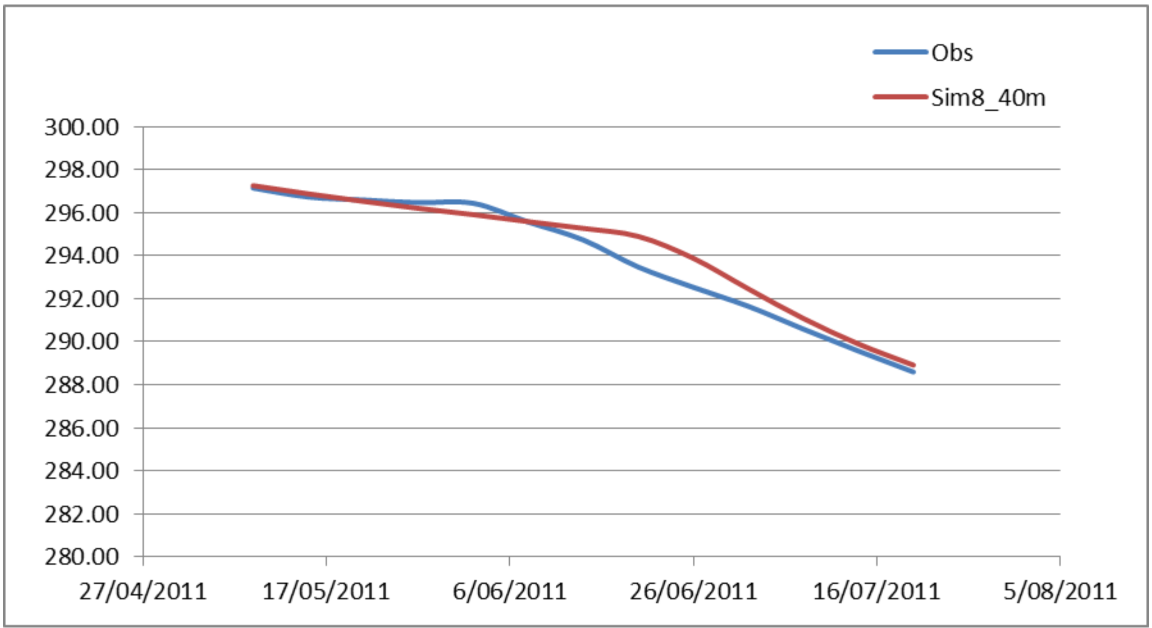



Obs
Sim8_CD-Sand
305.00
300.00
295.00
290.00
285.00
280.00
275.00
270.00
265.00
260.00
255.00
7/04/2011
27/04/2011
17/05/2011
6/06/2011
26/06/2011
16/07/2011
5/08/2011


Obs
Sim8_DE-Sand
305.00
300.00
295.00
290.00
285.00
280.00
275.00
270.00
265.00
260.00
255.00
7/04/2011
27/04/2011
17/05/2011
6/06/2011
26/06/2011
16/07/2011
5/08/2011


Obs
Sim1_DE-Sand
305.00
300.00
295.00
290.00
285.00
280.00
275.00
270.00
7/04/2011
27/04/2011
17/05/2011
6/06/2011
26/06/2011
16/07/2011
5/08/2011


Obs
Sim8_20m
294.00
292.00
290.00
288.00
286.00
284.00
282.00
280.00
27/04/2011
17/05/2011
6/06/2011
26/06/2011
16/07/2011
5/08/2011



Where:

Sim 7_CD-Sand is the results from monitoring bore AVP7, the vibrating wire piezometer in the C-D sandstone

Sim 7_DE-Sand is the results from monitoring bore AVP7, the vibrating wire piezometer in the D-E sandstone

Sim 8_CD-Sand is the results from monitoring bore AVP8, the vibrating wire piezometer in the C-D sandstone

Sim 8_DE-Sand is the results from monitoring bore AVP8, the vibrating wire piezometer in the D-E sandstone

Sim 1_DE-Sand is the results from monitoring bore AMB01, screened across the D-E sandstone

Sim 8_20m is the results from monitoring bore AVP8, the vibrating wire piezometer at 20 m from surface

Sim 8_40m is the results from monitoring bore AVP8, the vibrating wire piezometer at 40 m from surface