**GROUNDWATER SOLUTIONS INTERNATIONAL**

115 Tasman Street, Mt Cook,

Wellington 6021

NEW ZEALAND

29 October 2014

NSW Government

Department of Planning & Environment

Dear Sir/Madam,

Reference Number: SSD 12-5581

**Title: Centennial Airly Pty Ltd Airly Mine Extension Project, Environmental Impact Statement (EIS)**

I am an Independent Contract Hydrogeologist operating as a sole trader under the name Groundwater Solutions International, New Zealand.

I have worked as a Hydrogeologist and Geologist in the environmental and mining sectors, both in government and private consultant practices, in New Zealand and Australia since 1989.

Since 2006 I have been contracted by NSW community groups as an Independent Reviewer of groundwater impacts of mining and CSG operations on the environment. I remain an active interested party with respect to any hydrogeological investigations, and other relevant scientific studies, undertaken in New South Wales, Australia.

Please find attached my submission for the Airly Mine Extension Project.

Yours sincerely

Andrea Broughton

Independent Hydrogeologist

Groundwater Solutions International

# Executive Summary

The purpose of this review is to highlight any concerns that have arisen from the groundwater technical documents that require further consideration. The concerns are as follows:

1. A Peer Review of the Hydrogeological Model has not been published in the Environmental Impact Statement, Groundwater Impact Assessment or the Hydrogeological Model Report. This is required in accordance with the Australian Groundwater Modelling Guidelines. As part of the Director General's Requirements the Peer Review is required for assessment by the Independent Expert Scientific Committee (IESC) under the federal *Environment Protection and Biodiversity Act 1999* (IESC, 2013).

2. The Groundwater Monitoring Network does not represent all the areas of interest in the Coal Mine project area. The nine bores used are not adequate to fulfill the data requirements for the Groundwater Model for the whole model domain. The proposed new monitoring bores for Authorisation 232 should have been completed and used as part of this Environmental Impact Assessment, including two years of monitoring data.

3. Overall the Environmental Impact Assessment was light on data supporting conclusions made by GHD.

4. Mine dewatering and subsidence may alter the hydraulic ability of the local groundwater system to transmit groundwater.

5. Reduced baseflow recharge to the Quaternary alluvium, and Creeks, directly overlying and recharging the shallow Shoalhaven and Devonian Formation aquifers is of great concern to groundwater users.

6. If Centennial Airly bought an 'Additional Entitlement' WAL 36565 for 120 ML/year from the Sydney North Basin from another catchment, then how can this be reconciled with the lack of water availability in the Capertee Catchment? The source for this allocation has not been published.

7. Once the mine reaches its peak requirements of 199 ML/year and is recycling 80% of this produced water there will be no need to have a 278 ML/year groundwater allocation.

***Given the above concerns the author does not consider the groundwater model is robust enough to provide data, assumptions and conclusions for surface water and subsidence modelling at this point.***

# 1.0 Introduction

The Centennial Airly Coal Mine is an existing underground coal mine located in the Central West of New South Wales, east of the Blue Mountains Dividing Range and approximately 40km north-west of Lithgow. The Centennial Airly Mine Extension Project covers an area defined by Mining Lease ML1331 (2,774 ha) and Authorisation A232 (3,096 ha) and is located in the Mugii Murum Ban State Conservation Area. The underground coal mine is currently operating under Airly Mountain with intentions to extend under Mt Genowlan, both mesas in the Capertee Valley.

The proposed mining area contains 10% of Australia's biodiversity including rare flora, fauna and geological features (e.g. platey pagodas). The mining area is adjacent to the Gardens of Stone National Park to the south. The Genowlan Creek flows through the Capertee Valley providing water to the Wollemi World Heritage Area to the north.

The Centennial Airly Coal Mine: Environmental Impact Assessment, prepared by Golders Pty Ltd, is supported by the following groundwater assessment reports:

- GHD (July 2014) Airly Mine Extension Project: Groundwater Impact Assessment, Centennial Airly Pty Limited (Golders Environmental Impact Assessment: Appendix E)

- GHD (July 2014) Airly Mine Extension Project Hydrogeological Model Report, Centennial Airly Pty Limited (GHD Groundwater Impact Assessment: Appendix B).

The purpose of this review is to highlight any concerns that have arisen from the groundwater technical documents that require further consideration.

# 2.0 Background

Centennial Airly have submitted an Environmental Impact Statement as part of obtaining approval for the extension of their Airly Mine into Authorisation A232 under Mt Genowlan. The Airly Mine Extension Project will continue to extract up to 1.8 Mtpa of ROM coal from the Lithgow seam underlying the Project Application Area, extend the life of mine by 25 years from the date of consent, extract coal using partial extraction methods with the mining lease (ML1331) and extend the mining area to the east of the existing workings into Authorisation 232 (A232) area.

Any activity which intercepts and potentially removes water from the recharge areas of the upper reaches of a surface water system will impact on the groundwater system, or potentially allows cross contamination of poor water quality from the coal seams, workings and rejected piles, should be scrutinised in light of these potential risks.

Any degradation of the Quaternary shallow alluvial/colluvial unconfined aquifer and the Devonian metamorphic fractured rock aquifer beds may result in significant consequences to these highly valuable water supplies.

# 3.0 Director Generals Requirements (DGRs)

The groundwater assessments are required to be prepared in accordance with the Director Generals Requirements (DGRs) and additionally in accordance with the following requirements and guidelines:

- NSW Office of Water (NOW) Environmental Assessment Requirements Airly Mine Extension Project (SSD 5581)
- Independent Expert Scientific Committee's *Information Guidelines for Proposals Relating to the Development of Coal Seam Gas and Large Coal Mines where there is a Significant Impact on Water Resources,* Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development, April 2014.

The Groundwater Impact Assessment was undertaken based on the requirements for assessment by the Independent Expert Scientific Committee (IESC) under the federal *Environment Protection and Biodiversity Act 1999* (IESC, 2013).

The following have not been supplied in the EIS documentation:

1. Detailed monitoring **bore completion logs and geological logs.**
2. A **Peer Review** of the Groundwater Model in accordance with the Australian Groundwater Modelling Guidelines.

# 4.0 Groundwater Monitoring Bore Network

Monitoring bores provide the critical data required to formulate conceptual hydrogeological models. They provide the opportunity to test individual aquifers to determine aquifer hydraulic properties and the inter-relationships between the hydrostratigraphic units.

Baseline monitoring data is required by NSW Office of Water to be collected for at least two years to enable Steady State Flow calibration. Five years of monitoring data is required to carry out a Transient State calibration so that long term predictions of aquifer drawdown by mine dewatering and aquifer interference effects can be made.

Centennial Airly started their monitoring bore network in 2012, although they have been operating with a license since 2009. In that time, they have drilled 9 monitoring bores and suggest the bores represent adequate coverage of the groundwater aquifer conditions in the mining lease area. The only data GHD present regarding monitoring bore details is given in Table 4.1 That is depth to geological formation e.g. Narrabeen Sandstone below ground level. GHD also mention approximate depths to groundwater at the time of bore installation.

The bore monitoring network is not considered to be representative of the mining lease extension area. There is not enough detail to form a conceptual hydrogeological model. There was not enough monitoring data (2 years) to calibrate the numerical groundwater model for Steady State Flow.

GHD presented groundwater hydrographs for seven Vibrating Wire Piezometers (VWP monitoring bores). These groundwater hydrographs show no response to rainfall recharge and were not useful in calibrating the transient groundwater model (see section 7). Given rainfall is the main aquifer recharge mechanism in the local groundwater system the author would expect to see at least a lag time effect from rainfall recharge events. The details of

monitoring bore construction cannot be verified as they have not been included in the groundwater reports. Important details omitted from the groundwater reports include:

- Detailed VWP monitoring bore geological logs.
- VWP monitoring bore completion logs detailing at what interval the Vibrating Wire Piezometers (VWP) are measuring; and whether they were installed as clustered, nested or multilevel VWPs; there is no information on the hydrostratigraphic unit being monitored for groundwater pressure fluctuations. Are the VWPs sufficiently separated using packers or bentonite plugs? At what interval?
- Hydraulic test data (packer and falling head test) collected during drilling.

In addition shallow alluvial monitoring bore information did not include height datum at the piezometer surface; drilling method used; detailed geological logs; screen interval within the alluvial/colluvial aquifer.

The monitoring bore network should also have included monitoring baseflow conditions in the upper catchment tributaries, for Genowlan Creek; and be used to characterise surface water and groundwater connectedness.

The author understands Centennial Airly is drilling an additional 5 monitoring bores to better cover the proposed extension into Authorisation 232. The EIS should have included these bores along with two years of monitoring data.

## 5.0 Conceptual Groundwater Model

GHD's conceptual hydrogeological model essentially consists of two groundwater systems effectively operating independently of each other – the local and regional groundwater systems, both of which are located within the Sydney Basin North groundwater source.

The local groundwater system is described as: 'predominantly within Quaternary alluvium associated with Gap Creek and Genowlan Creek, weathered and/or fractured sandstone and coal seams that occur within Mt Airly and Genowlan Mountain. They are classified as 'less productive' in accordance with the criteria specified in the NSW Aquifer Interference Policy' and are confined to 'the Project Application Area since their outcrop boundaries occur entirely within this area'.

Monitoring bore groundwater pressure and water level data indicate a downward hydraulic gradient in the local groundwater system. This suggests groundwater flows downwards and seeps out along joints and fractures or directly into the creeks, as observed.

This hydrogeological conceptual model of the local groundwater system does not allow for baseflow in the shallow colluvial deposits and highly weathered sandstone in the **upper reaches** of the Creeks, as seen at the Grotto. GHD acknowledge it occurs but it is not apparent in the building of their Conceptual Hydrogeological Model.

The regional groundwater system is described as: 'occurring within the Shoalhaven Group below the target coal seam, as well as within the underlying Devonian rocks, and extend beyond the Project Applicant Area' where it is considered there would be minimal inter-aquifer hydraulic connection between the Shoalhaven Group and lower Devonian metamorphic formations regional groundwater sources, based on differences in groundwater chemistry.

GHD's Model Boundary Conditions are logical and reasonable. The model assumptions and limitations are noted.

# 6.0 Numerical Groundwater Model – Steady State Flow

The *Environmental Impact Assessment (EIS)* relies on the outcomes of the *Groundwater Impact Assessment (GIA)*, which in turn relies on the outputs of the *Hydrogeological Model Report (HMR)*.

The Hydrogeological Model forms the basis from which critical decisions are made by Centennial Airly and the NSW Government in determining whether the Airly Coal Mine Extension will impact on the environment.

The outcomes of the Hydrogeological Model are based on the Conceptual and Numerical Hydrogeological Model and the inputs into these models.

Groundwater Model was calibrated for Steady State flow using two years of groundwater pressure and water table data from Centennial Airly's nine monitoring bores, and a sensitivity analysis undertaken. The results were comparable with observed groundwater level data, however, aquifer parameters required a bit of massaging to achieve the calibration targets.

The author does not consider the data obtained from the nine monitoring bores to be sufficiently representative of the proposed extension area in Authorisation 232. GHD have proposed five more monitoring bores will be drilled by the end of 2014, but these should have been included in this Environmental Impact Assessment Groundwater Model, along with two years of monitoring data collected.

GHD have used average rainfall data as input into the groundwater numerical model. The data is from daily rainfall data obtained as SILO Patched Point Data for Bureau of Meteorology (BOM) Ilford (Warragunyah) Station (No. 62031). This BOM station is located 29km north-west of Airly Mine. This station was chosen based on the length and quality of the data record and proximity to the site. Although the station clearly receives rainfall through most of the months, with summer months receiving predominantly more than winter months, the rainfall patterns at Ilford Station are not similar to Mt Airly and Genowlan Mountain. Rainfall in the upper tributaries of the Genowlan Creek is scarce for the majority of the year, punctuated by localised, intense rainfall. The use of Ilford Station rainfall data will impact on the Water Balance calculations and overestimate aquifer recharge. It will also impact on the salt load calculations in the surface water environment. Salt will be more concentrated in the talus 'break of slope' areas and remobilized in baseflow during rainfall in higher concentrations. Using average rainfall from Ilford Station may underestimate the salt load as it will be continually leached back into the surface water at lower concentrations.

# 7.0 Groundwater Model Predictions

The Steady State model was converted into a Transient State model using annual stress periods and actual rainfall data from 2009 to 2014. Calculated initial groundwater heads from the Steady State model was used. Storage parameters, hydraulic conductivity values and net recharge coefficient were varied to try and simulate groundwater levels in shallow alluvial bore APR05. The range of groundwater levels reported over time in APR05 were achieved, but not in the timeframe expected. There should have been a more rapid response in groundwater levels to rainfall. This indicated the alluvium should have a higher hydraulic conductivity. GHD may not have an appropriate conceptual model of the shallow groundwater system. GHD intend to refine the transient model. However the model was run using the lowest hydraulic conductivity value for the alluvium from the steady state flow calibration.

This is a conservative approach. The model predicted no groundwater flow into the mine workings over this period which GHD say was consistent with observations.

Potential changes in baseflow were assessed from 11 locations throughout the model domain to determine whether any baseflow reductions occurred at the model boundary and at the confluence of Gap and Genowlan Creeks. No assessment locations were used in the upper tributaries of the model domain. Predicted changes in baseflow and groundwater drawdown as a result of proposed mining operations is so sensitive to hydraulic conductivity values assigned to both the alluvium and Permian strata. However, there is little real data used to calibrate the transient model and to check on the model predictions.

## 8.0 Groundwater Model Peer Review

The groundwater numerical model was not independently Peer Reviewed in accordance with the Australian Groundwater Modelling Guidelines. I understand this was requested by Capertee Valley Alliance (CVA) at the Planning Assessment Commission (PAC) meeting on 30 September 2014. The independent Peer Review has not been exhibited on the Department of Planning & Infrastructure website and is not included in Centennial Airly's Environment Impact Assessment and supporting documents. Given the independent Peer Review is an important process for determining whether a Groundwater Model is realistic and working, this is a critical omission. The author would like the opportunity to address the independent Peer Review and be able to make further submissions in light of its contents, as a matter of procedural fairness.

## 9.0 Domestic, Stock and Irrigation Groundwater Users

Dewatering and subsidence, due to Airly Coal Mine operations, may alter the hydraulic ability of the local groundwater system to transmit groundwater to the talus slope colluvium flanking Mt Airly and Genowlan Mountain. This may result in reduced baseflow recharge to the Quaternary alluvium and to Gap Creek, Genowlan Creek and Emu Creeks. Reduced recharge to the Quaternary alluvium directly overlying and recharging the shallow aquifers in the Shoalhaven and Devonian Formation (Regional Aquifers), and the lack of baseflow recharging the creeks, is of great concern.

The regional aquifers are directly overlain by the Quaternary alluvial sediments along Gap Creek, Genowlan Creek and Emu Creek. If the hydraulic gradient is downwards, that is, if the overlying alluvial aquifers are able to locally recharge the underlying regional aquifer system, then there is a possibility the bores in the catchment may be affected.

GHD have not collected enough monitoring data and have not adequately set up the groundwater model to determine how realistic this scenario may be. This is a serious omission on GHDs behalf.

## 10.0 Centennial Airly Coal Mine Water Allocations

GHD state 'extraction and interception from the Sydney Basin North groundwater source over the life of The Project (proposed conditions) is predicted to peak at 199 ML/year (90$^{th}$ percentile)'.

Since the beginning of the *Water Sharing Plan* for the *Greater Metropolitan Region Groundwater Sources* in 2011 Centennial Airly have two groundwater licenses:

- Production Bore WAL 24386 for 158 ML/year at a maximum rate of 5 L/s. This allocation comes from the Sydney North Basin and is from the Shoalhaven aquifer system in the Airly Creek Catchment. It is used for mining operations.

- 'Additional Entitlement' WAL 36565 for 120 ML/year. This allocation comes from the Sydney North Basin following a 'controlled allocation order'. This author is not sure what this means, however, has been led to believe that this allocation has not come from buying a license in the Capertee Catchment. The source for this allocation has not been published. The use for this water is to cover any groundwater that is intercepted during coal mine workings.

If the 'additional entitlement' WAL 36565 was bought from another catchment how can that be reconciled with the lack of water availability in the Capertee Catchment? Given 80% of the mine water will be recycled then why would 278 ML be required each year? Surely once the mine reached its peak requirements from recycling 80% then the groundwater allocation from the Water Sharing Plan for the mine works could be ramped down?

## 11.0 Conclusions

Overall this Environmental Impact Assessment lacks quality data that spatially represents the Project Area. The lack of data, including bore logs, aquifer tests and bore completion logs, is a concern when calibrating the groundwater model for steady state flow.

The author is concerned the shallow groundwater system has not been effectively conceptualised and therefore not represented appropriately in the groundwater model.

Mine dewatering and subsidence may alter the hydraulic ability of the local groundwater system to transmit groundwater to the talus slope colluvium, as baseflow, flanking Mt Airly and Genowlan Mountain.

Reduced baseflow recharge to the Quaternary alluvium, and Creeks, directly overlying and recharging the shallow Shoalhaven and Devonian Formation aquifers is of great concern to groundwater users.

Furthermore since the Groundwater Model has not been independently Peer Reviewed by expert modelers, the author is wary of how sensitive this model is to hydraulic conductivity inputs.

The transient model is not 'fit for purpose' to predict baseflow reduction and groundwater drawdown over long periods of time due to groundwater dewatering from mine activities. There is not enough quality data to input to the transient model and the use of Ilford Station rainfall data may not be representative of the Project Area.

Could the Ilford Station rainfall data not be checked against local property rainfall records just to get some verification?

The proposed five groundwater monitoring bores should have been completed at the same time as the APR 01-APR09 to provide a complete data set to assess groundwater conditions in the extension area. The Environmental Impact Assessment should have included them, with two years of monitoring data. This was a great oversight.

Centennial Airly bought an 'Additional Entitlement' WAL 36565 for 120 ML/year from the Sydney North Basin following a 'controlled allocation order'. This author has been led to believe that this allocation has not come from buying a license in the Capertee Catchment. The source for this allocation has not been published.

If the 'additional entitlement' WAL 36565 was bought from another catchment how can that be reconciled with the lack of water availability in the Capertee Catchment?

Once the mine reaches its peak requirements of 199 ML/year and is recycling 80% of this produced water will NSW Office of Water seek to reduce this groundwater allocation?

*This submission has been prepared solely for the purpose of commenting on the following reports:*

*GHD (July 2014) Airly Mine Extension Project: Groundwater Impact Assessment, Centennial Airly Pty Limited (Appendix E of the Golders Pty Ltd Environmental Impact Assessment 2014); and*

*GHD (July 2014) Airly Mine Extension Project: Hydrogeological Model Report, Centennial Airly Pty Limited (Appendix B of GHD Groundwater Impact Assessment 2014).*

*Neither this report nor its contents may be referred to or quoted in any statement, study, report, application, prospectus, loan, other agreement or document, without the express approval of Andrea Broughton, Groundwater Solutions International.*

***Disclaimer***

The information contained in this desktop review is based on the contents of *Airly Mine Extension Project: Groundwater Impact Assessment (GHD, July 2014)* which forms Appendix E of the *Airly Mine Extension Project Environmental Impact Assessment (EIA), Golders Pty Ltd*; and *Airly Mine Extension Project: Hydrogeological Model Report (GHD, July 2014)* which forms Appendix B of the *Airly Mine Extension Project: Groundwater Impact Assessment (GHD, July 2014)* and my own professional experience. I accept no responsibility for the results of actions taken as a result of information contained herein and any damage or loss, howsoever caused, suffered by any individual or corporation.

The findings and opinions in this report are based on a desk top review undertaken by myself, Andrea Broughton, Independent Hydrogeologist, Groundwater Solutions International (BSc (Hons) Geology, MAppSci Hydrogeology and Groundwater Management).