Review of baseline data collected for Carmichael Coal Mine project, and implications for Groundwater Dependent Ecosystems including the Doongmabulla Springs Complex

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Introduction

This report outlines my expert opinion regarding matters associated with the baseline groundwater data for Adani's Carmichael Coal Mine. I was requested to update this report by the Environmental Defenders Office Ltd, acting for WnJ Nagana Yarrbayn Cultural Custodians.

Relevant qualifications and expertise

I am an Associate Professor in the School of Engineering at RMIT University. I received my PhD from Monash University in 2011, in the field of hydrogeology & geochemistry. For the last ten years I have taught hydrogeology, geochemistry and groundwater modelling courses to hundreds of environmental and civil engineering students, and supervised Masters and PhD projects in applied hydrogeology research. I have been awarded more than $1 million in research funding as a chief investigator on more than 12 grants, supporting projects examining groundwater sustainability and contamination issues. I have published more than 50 peer-reviewed international journal articles, which have been cited more than 1900 times, and served on the editorial board of the *Hydrogeology Journal* (the journal of the International Association of Hydrogeologists) from 2014 to 2017. I have acted as an independent hydrogeology expert witness during the Victorian Parliamentary Inquiry into Unconventional Gas, proceedings in the Land Court of Queensland, and in submissions to the Independent Planning Commission of NSW on mining and gas development proposals.

My Opinion:

I have reviewed the baseline groundwater monitoring data that are relevant to the assessment of potential impacts from the Carmichael Mine on groundwater dependent ecosystems (particularly the Doongmabulla Springs Complex), which are contained in the approved Groundwater Monitoring and Management Plan (GMMP), Groundwater Dependent Ecosystem Management Plan (GDEMP) and other relevant documents. Both water quality and level data have been reviewed. The analysis below relates to the question of whether these data a) meet the requirements outlined under conditions of approval for the project and b) are fit for the purpose of providing a comprehensive baseline against which to assess potential impacts of the Carmichael mine on key GDEs in the area, particularly the

ecologically and culturally significant Doongmabulla Springs Complex. Due to time and resource constraints, this review is somewhat limited in detail and scope; however, I would be more than happy to meet and further expand upon the rationale and basis for the opinions. I also welcome any feedback on potential datasets or reports which may contain relevant information or data which I was not aware of at the time of completing this review.

My opinion:

1. The baseline groundwater quality monitoring for the Carmichael Mine required under condition 3 of the project's Environmental Authority do not entirely meet (to the best of my knowledge) the full requirements of this condition – namely to "Include at least 12 groundwater sampling events that are no more than 2 months apart over a 2 year period." In the GMMP (including the text on page 120-121 and the raw data tables attached to the GMMP), it is indicated that baseline sampling did not always take place within the required 2-month frequency – e.g.:

> **3.1.2 Baseline Monitoring Program**
>
> Between 2013 and 2014, the groundwater monitoring network was expanded to include 68 monitoring locations and a formal baseline groundwater monitoring program was developed to address EA Condition E3 (**Appendix A**).
>
> In order to satisfy EA Condition E3 (**Appendix A**), Adani developed and undertook a regular (~every two months) groundwater monitoring program where events were conducted, and data collected, in:
>
> - April, May, July, September, and November 2014
> - February, March, May, July, September, and November 2015
> - February, April, July, and November 2016
> - April 2017.
>
> The groundwater monitoring network was again expanded in 2014 and 2015 to allow for groundwater quality and level data from gaps identified.

2. Generally speaking, the sampling frequency outlined above would be expected to produce data of comparable value for the purpose of defining baseline groundwater conditions as the more frequent sampling outlined in the condition (i.e., always spaced less than 2 months apart), provided the sampling covered sufficient bores in each aquifer surrounding the mine site and any high value groundwater dependent ecosystems. Of significant concern (in my opinion) is the limited spatial coverage of the baseline data. As is clear from the map of bores sampled in the baseline program (presented in the GMMP), only a limited number of groundwater quality samples were collected close to the Doongmabulla Springs, with the majority clustered within the mining lease. Bores HD02, C14012SP, C14013SP and C14011SP are the only sites within the reported baseline program that are close to (within approximately 5 km) of the major springs in the complex, and all of these bores are within one aquifer (Clematis Sandstone). As such, the baseline data do not give a clear picture of the groundwater quality within and surrounding the springs complex, including in multiple aquifers below them. Multiple independent sources (e.g. Currell et al., 2017; Lewis et al., 2018; CSIRO and Geoscience Australia 2019; Werner et al., 2019) have highlighted that to date the source aquifer(s) providing water to the springs is yet to be conclusively resolved,

and as such data from aquifers other than the Clematis Sandstone (including deeper units) are potentially crucial to examining and explaining water quality changes that may be observed in the springs in future,in response to mining or other influences.

I note that some newer groundwater monitoring bores have subsequently been constructed closer to the springs; however, I do not believe there has been a sufficient period of time and sampling frequency prior to commencement of mine construction on the site, to characterise a comprehensive baseline.

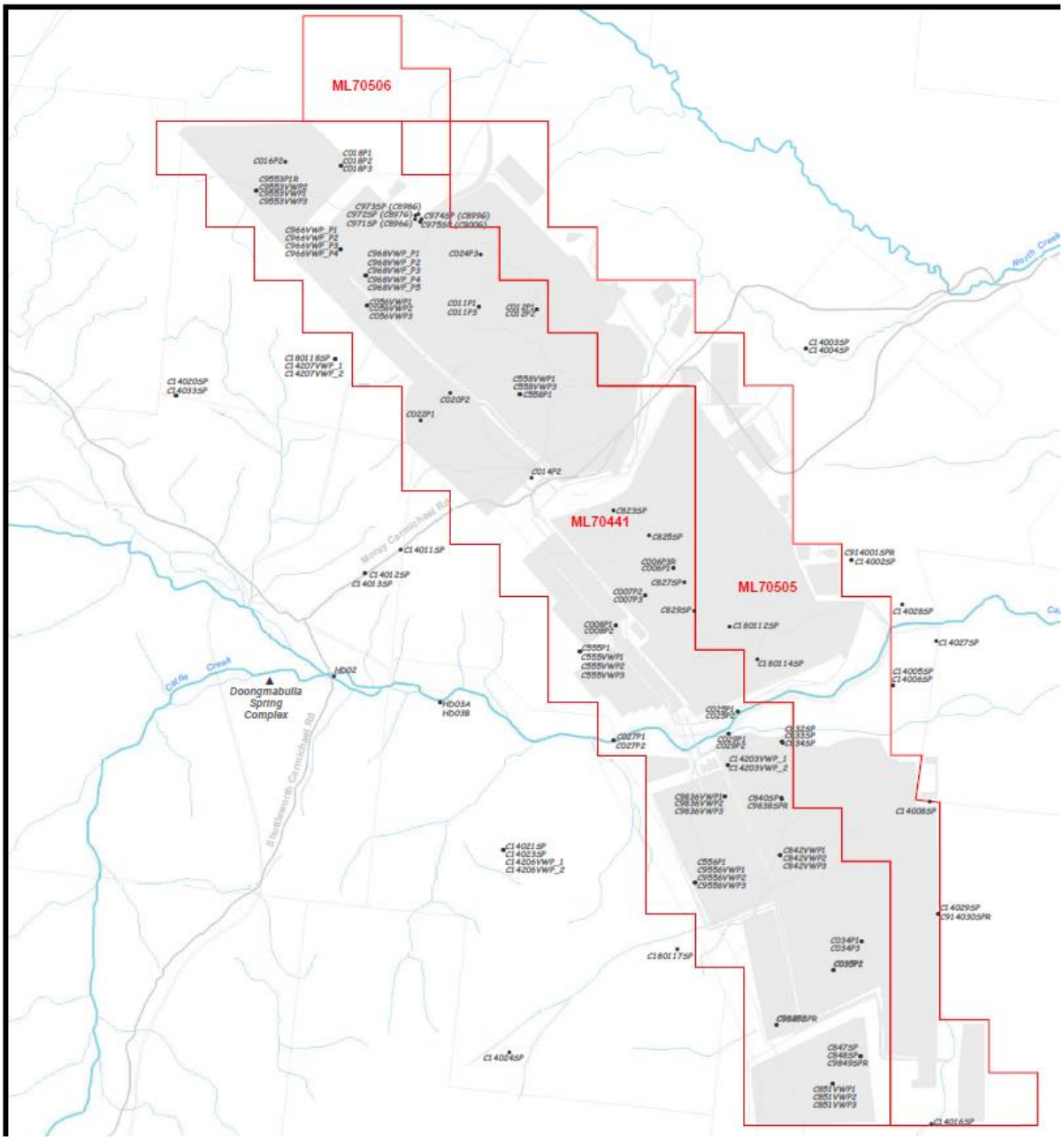

Fig 1 – Map of groundwater monitoring bores provided in Adani GMMP (AECOM, 2019).

2. Based on an analysis of groundwater level data reported by Adani/Bravus on their website (see Fig 2 and hydrographs in Appendix A), it appears substantial de-watering activity has been taking place at the mine site since late 2019 and continued throughout 2020 – as seen by

a significant drop in groundwater levels within coal-bearing aquifer units from this time onwards:

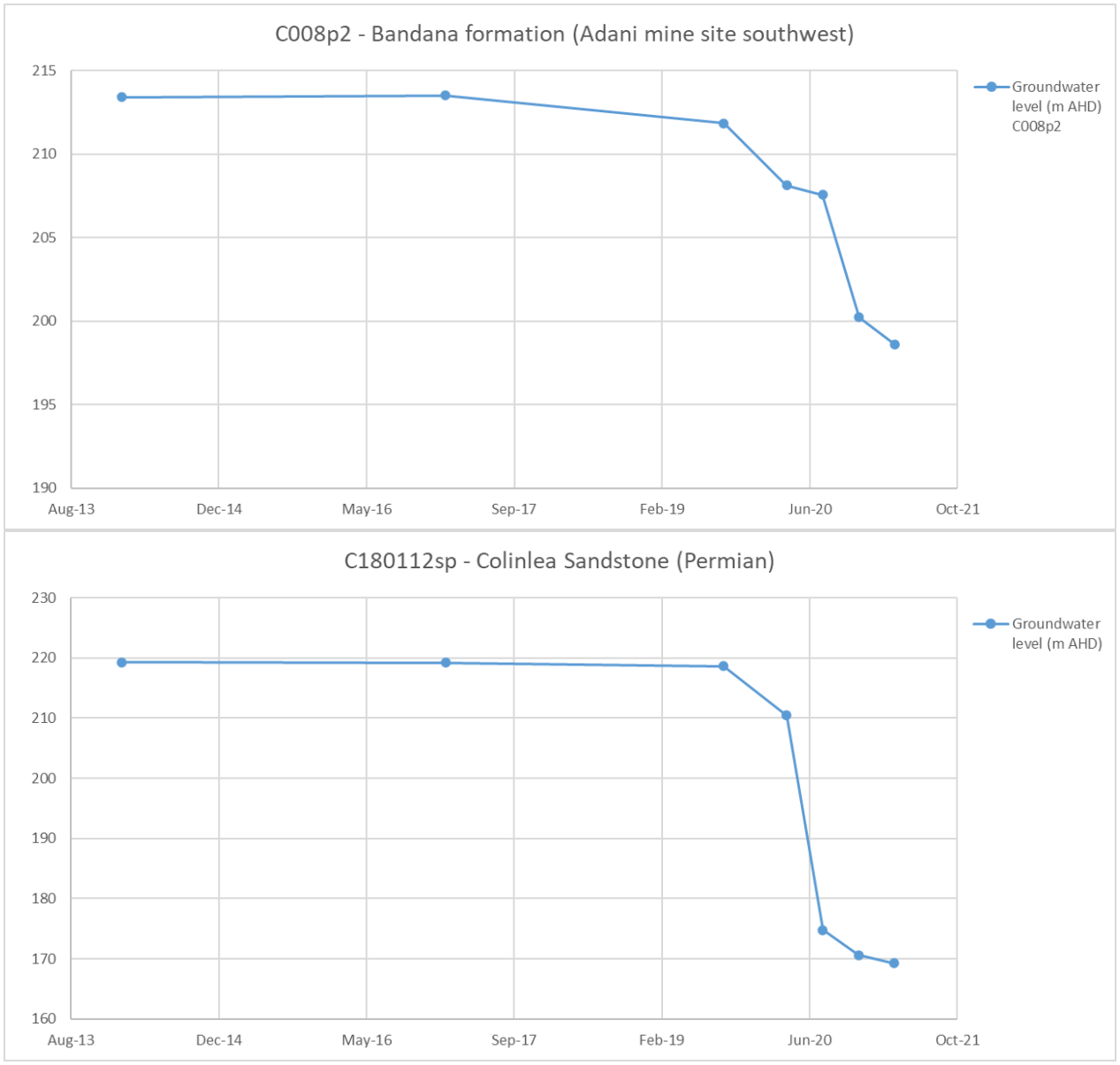

Fig 2 – Hydrographs from 2 selected bores showing substantial drop in water levels commencing in later 2019 or early 2020, indicative of de-watering of the coal-bearing aquifer unit(s) at the Carmichael mine site. Note there is a gap in reported groundwater level monitoring data between early 2017 and mid-2019 in all bores.

3. I have also reviewed the approved version of the Groundwater Dependent Ecosystems Management Plan, including stated requirements for the collection of baseline data outlined in Appendix A of the project's Environmental Authoridy, namely that for each GDE, the submitted GDEMP must include:

(1) A description and map of each GDE potentially or indirectly impacted by mining activities

(2) Detailed baseline monitoring (using QuickBird Imagery or similar) to be undertaken on the specific ecology of each GDE, groundwater level, groundwater and surface water quality, threatened species and ecosystem function.

(3) Detailed baseline research to establish:

a) The extent and ecological composition of each GDE, in accordance with the Wetland Monitoring Methodology for springs in the Great Artesian Basin (R. Fensham, 2009) where applicable

b) the source aquifer(s) for groundwater supply to the GDE

c) the natural variation of the groundwater level/pressure

d) GDE ecosystem pressure response to groundwater level/pressure fluctuation

4) How results of baseline research/annual monitoring are to be used to determine changes in GDE ecology attributable to mining activities

5) Description of the potential impact on each GDE from each project stage, including impacts from subsidence, mine dewatering of aquifers, water discharge, hydrological changes and weed and pest infestation

6) mitigation measures to be undertaken to avoid, mitigate, offset and manage impacts to GDE environmental values resulting from each stage of the project.

Based on my assessment of the publicly available groundwater data and reporting, my opinion is that many of these requirements – particularly those highlighted in **bold** in the above text – are not contained within the approved version of the GDEMP and to my knowledge these requirements have not been subsequently satisfied through additional data and analysis in other documentation. It is thus concerning to note evidence that substantial modification of the region's groundwater hydrology (e.g. large reductions in groundwater levels due to de-watering activity) has already occurred on the site (see Fig 2) before these baseline requirements have been fulfilled.

4. The potential consequences of commencing mining activity without having first completed the tasks above for the springs could be serious. In my opinion, the following must be determined under baseline conditions (i.e., before any development activity) to enable proper impact assessment and protection of springs:

a) The source aquifer(s) for the springs in the complex (in line with 3b above)

b) The relationship between groundwater levels/pressures in the source aquifer(s), the flux (discharge) rates occurring to spring wetlands at different water levels, and the area of the spring wetlands receiving groundwater discharge (in line with 2 above)

c) Eco-hydrological relationships, such as the water level and quality requirements of key wetland species, and their tolerance for changes in hydrological and water quality conditions (in line with 3a and 3d above)

The commencement of mining activity without having first established these key requirements potentially risks causing irreversible damage to the springs, which could have been avoided or mitigated with better hydrogeological knowledge and baseline data. Failing to fulfil these requirements will also make future impact assessment challenging – i.e., the

precise extent of damage or change in spring wetland health and hydrology may not be able to be determined, and the extent to which changes reflect mining as opposed to other potential influences may not be able to be determined.

5. It is my understanding that additional groundwater monitoring wells designed to further document groundwater levels in the vicinity of the springs within multiple aquifers (including the deeper Permian aquifer), were installed in late 2020 (e.g. bore codes 190229, 190276, 190277, 190278). The timing of construction and monitoring of these bores with respect to commencement of mining activity is not fully clear to me, however it is my understanding that a significant amount of mine construction activity (including, de-watering of groundwater) has commenced on the site, and as such these bores will not be able to provide substantive pre-impact baseline data and information to resolve the issues above.

6. CSIRO and Geoscience Australia published two reviews of Adani's groundwater model, GDEMP and GMMP in February and June, 2019. These reviews pointed out a number of knowledge and data gaps relevant to the issues discussed above. These include:

- Re-iterating that there was residual uncertainty as to the source aquifer(s) for the Doongmabulla Springs, noting that the Clematis Sandstone was considered (on the available evidence) to be a likely source aquifer, but not ruling out other potential source aquifers:

"It is not plausible and reasonable to state unequivocally that the Clematis Sandstone is *the sole* source aquifer for the DSC, as sufficient uncertainty surrounding hydrogeochemistry, inter-aquifer connectivity and groundwater flow exists." (CSIRO and Geoscience Australia, 2019a).

- Emphasising that additional geochemical data would be required to resolve this issue of the source aquifer:

"**Recommendation:** To constrain the source aquifer(s) of the DSC, a more sophisticated statistical analysis of hydrochemistry data is required. This includes assessing a wider variety of groundwater and surface water analytes, as well as appropriate use of isotope hydrochemistry analysis"

- Pointing out that due to errors in the groundwater model and questionable assumptions (including over-estimation of leakage rates from the Carmichael River to groundwater and the under and over-estimation of various hydraulic parameters in the modelling) drawdown in the Clematis aquifer at the springs was under-estimated in the mine SEIS groundwater model.

As yet, these issues, which are critical to understanding the possible impact of the mine on the Doongmabulla Springs, remain un-resolved. For example, there does not appear to be any publicly available data reporting the additional geochemical indicators in groundwater from the new (or existing) bores to resolve uncertainty regarding the springs' source aquifer. My view (as outlined above) is that this is a critical aspect of baseline or pre-impact groundwater assessment required to conduct proper management, mitigation and protection of the springs, prior to the commencement of any activity which may alter the hydrology of the system.

7. Similarly, there is no publicly available information showing how the correction of the errors in the modelling pointed out by CSIRO and GA affect predictions of drawdown in the Clematis Sandstone (and other potential spring source aquifers) and changes resulting in

predicted impacts on the Doongmabulla Springs. I can think of no justifiable reason why the public (including affected stakeholders with a high interest in maintaining the health and values of the Doongmabulla Springs) should not be provided with updated impact prediction modelling following correction of these simple modelling errors. This would allow for a more informed discussion regarding the likely impacts of the mine, and allow for a more pro-active approach to their monitoring and protection.

Declaration

I confirm that the factual matters stated in the report are, as far as I know, true; the opinions stated in the report are genuinely held by myself; the report contains reference to all matters I consider significant on the topic and I have not received or accepted instructions to adopt or reject a particular opinion.

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2nd June 2021

References

CSIRO and Geoscience Australia (2019a) Advice on Groundwater Management and Monitoring and Groundwater Dependent Ecosystem Management plans to the Department of the Environment and Energy. February 2019, 63pp. http://www.environment.gov.au/system/files/pages/cb8a9e41-eba5-47a4-8b72-154d0a5a6956/files/csiro-geoscience-australia-final-advice.pdf.

CSIRO and Geoscience Australia (2019b) Carmichael Coal Mine. Advice on Groundwater Dependent Ecosystem Management Plan v11b to the Queensland Department of Environment and Science. June 2019, 27pp.

Currell, M.J., Werner, A.D., McGrath, C., Webb, J.A., Berkman, M. 2017. Problems with the application of hydrogeological science to regulation of Australian mining projects: Carmichael Mine and Doongmabulla Springs. Journal of Hydrology 548: 674-682.

Lewis S, Evans T, Pavey C, Holland KL, Henderson BL, Kilgour P, Dehelean A, Karim F, Viney NR, Post DA, Schmidt RK, Sudholz C, Brandon C, Zhang YQ, Lymburner L, Dunn B, Mount R, Gonzalez D, Peeters LJM, O' Grady A, Dunne R, Ickowicz A, Hosack G, Hayes KR, Dambacher J and Barry S (2018) Impact and risk analysis for the Galilee subregion. Product 3-4 for the Galilee subregion from the Lake Eyre Basin Bioregional Assessment.

Department of the Environment and Energy, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia. http://data.bioregionalassessments.gov.au/product/LEB/GAL/3-4

Werner, A.D., Love, A.J., Irvine, D., Banks, E.W., Cartwright, I., Webb, J., Currell, M. 2019. Position paper by concerned scientists: Deficiencies in the scientific assessment of the Carmichael Mine impacts to the Doongmabulla Springs. http://doi.org/10.25957/5cf4adbc6f43c