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Monitoring Point[26]	Monitoring	Location		Surface RL (mAHD)[27]	Monitoring Frequency	Comments Regarding Triggers
		Easting (GDA94 – Zone 55K)	Northing (GDA94 – Zone 55K)			
Colinlea Sandstone (D Seam)						
C848SP	Water level and quality	442363.39	7543815.03	237.03	At least 2 to 3 monthly	Bore specific triggers – outlier bore
C034P3	Water level and quality	442388.72	7547813.99	227.38		Bore specific triggers – outlier bore
C833SP	Water level and quality	439559.68	7554777.43	223.30		Bore specific triggers – outlier bore
C024P3*	Water level and quality	428909.10	7571761.09	258.62		Bore specific triggers – outlier bore
C018P3	Water level and quality	423977.57	7574853.06	281.36		Unit specific triggers
C975SP*	Water level and quality	426824.24	7573002.03	266.81		
C011P3*	Water level and quality	428845.58	7569954.89	254.54		
C006P3R*	Water level and quality	435727.00	7560835.00	233.86		
C007P3*	Water level and quality	434726.28	7559864.39	237.99		
C180114SP	Water level and quality	438684.80	7557646.88	224.92		
C056VWP1	VWP – assessment of depressurisation trends only	424923.62	7569971.65	283.86		No quality triggers
C558VWP1		430311.51	7566903.01	250.05		
C968VWP_P2		424873.59	7570989.17	279.18		
Joe Joe Group						
C14003SP	Water level and quality	440350.80	7568518.85	217.967	At least 2 to 3 monthly	Bore specific triggers
C914001SPR	Water level and quality	441973.49	7561149.58	226.146		Bore specific triggers
C180119SP	Water level and quality	448587.45	7536355.38	223.13		Unit specific triggers

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Monitoring Point[26]	Monitoring	Location		Surface RL (mAHD)[27]	Monitoring Frequency	Comments Regarding Triggers
		Easting (GDA94 – Zone 55K)	Northing (GDA94 – Zone 55K)			
C180123SP	Water level and quality	448077.54	7529357.50	226.47		
C9180124SPR	Water level and quality	448600.00	7536357.00	223.19		
C9180125SPR	Water level and quality	447039.74	7531738.83	222.50		
C14016SP	Water level and quality	444852.34	7541471.06	221.75		
C914030SPR	Water level only	445072.27	7548821.00	216.96		
C14015SP	Water level and quality	445301.98	7536138.69	228.22		
C14004SP	Water level only	440355.93	7568513.34	217.969		
C14008SP	Water level and quality	444760.74	7552697.83	219.54		
C012P1	Water level and quality	430887.52	7569874.40	247.333		
C012P2	Water level and quality	430887.34	7569876.76	247.252		
C14002SP	Water level only	441977.77	7561157.53	226.23		
C14032SP	Water level only	448355.77	7533400.67	221.13		
C14006SP	Water level and quality	443446.61	7556785.07	218.98		Triggers for C14017SP and C14006SP
C14017SP	Water level and quality	447525.30	7526907.00	229.228		
Additional Monitoring Bores[28]						
Tertiary sediments / Joe Joe Group						
C180120SP	Water level only	447056.56	7531729.89	222.40	At least 2 to 3 monthly	No quality triggers for composite bores
C180122SP	Water level only	448579.21	7536348.70	222.95		
C14029SP	Water level only	445059.11	7548820.62	218.17		

[28] Although monitoring of composite bores and Moolayember Formation are not required in the EA, these bores will add value to the monitoring network allowing for additional assessment of potential groundwater impacts

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Monitoring Point[26]	Monitoring	Location		Surface RL (mAHD)[27]	Monitoring Frequency	Comments Regarding Triggers
		Easting (GDA94 – Zone 55K)	Northing (GDA94 – Zone 55K)			
Moolayember Formation						
C14020SP	Water level and quality	418230.28	7566782.35	296.55	At least 2 to 3 monthly	Triggers not required
C18003SP	Water level and quality	420944.04	7558963.70	248.22		
Composite Bore						
C14024SP	Water level only	430036.80	7543917.13	333.53	At least 2 to 3 monthly	No quality triggers for composite bores
C14031SP	Water level only	448331.34	7533407.27	222.14		
Seepage Bores						
C18004	Water level and quality	437013	7565647	TBA	At least 2 to 3 monthly	To be developed if perched or permanent groundwater is recorded in these seepage bores over the minimum 6 month baseline monitoring period prior to the commissioning of the mine affected water and waste storage facilities
C18005	Water level and quality	438966	7564569	TBA		
C18006	Water level and quality	439882	7562704	TBA		
C18007	Water level and quality	434334	756394	TBA		
C18008	Water level and quality	433753	7565451	TBA		
C18009	Water level and quality	436933	7567302	TBA		
Sub-E Bores						
CSSTMB1	Water level and quality	TBD	TBD	TBD	TBD	Triggers not required
CSSTMB2	Water level and quality	TBD	TBD	TBD		
Springs						
Joshua Spring	Water level and quality	421201.8	7559387.6	241.20	At least 2 to 3 monthly	Triggers not required
Mellaluka Spring	Water level and quality	446825.82	7531904.29	224.4		
C18010SP^	Water level and quality	421610.10	7556860.74	238.21		
C18011SP^	Water level and quality	422044.83	7556285.96	240.11		

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Monitoring Point[26]	Monitoring	Location		Surface RL (mAHD)[27]	Monitoring Frequency	Comments Regarding Triggers
		Easting (GDA94 – Zone 55K)	Northing (GDA94 – Zone 55K)			
C18012SP^	Water level and quality	420424.31	7557642.01	239.03		
C18013SP^	Water level and quality	420427.75	7557636.78	238.66		
C18014SP^	Water level and quality	424639.57	7557046.47	235.48		

Notes:
TBD – to be determined (these bores are scheduled to be installed prior to commencement of mining operations)
* Bores denoted with an * are recognised to be lost to mining in the future and will be replaced over time
^ Spearpoints into the DSC springs were only installed in September 2018 as such are not included in the baseline monitoring network, but will be part of the operational GMMP
VWP monitoring points (not standpipe bores) have an associated total pressure value at that point and will be used for monitoring groundwater pressure (head) trend analysis purposes only. These VWPs allow for assessing changes in pressure in overlying units or along strike or dip of the mining, which can aid in assessing depressurisation rates and extent. These monitoring points will not be used for monitoring groundwater levels or groundwater quality

NOTE: Groundwater level measurements in the remaining baseline bores (**Table 23**) will still be equipped with automated water level loggers, which will be downloaded at a maximum of every six months. These data will be used to assist with the regular model revisions and GMMP assessments

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6.3 Post Closure GMMP

A reduced monitoring program is envisaged for groundwater rebound validation and post mining groundwater flow patterns and quality assessment. This will be included in this GMMP, which will be modified over time to reflect ongoing monitoring.

Final voids, resulting in altered long term groundwater flow patterns, will be monitored to provide model validation, ensure poor quality groundwater migrates towards the final voids and not off site in the groundwater, and assist with assessing the effectiveness of closure activities.

7.0 Commitments

Adani will:

- Implement this GMMP, which details the location and frequency of groundwater monitoring activities, as well as trigger levels and response actions
- Augment the existing groundwater monitoring network over time to enable ongoing groundwater impact evaluations
- Maintain and decommission of bores, according to industry standards, to ensure the management of groundwater resources and obtaining representative groundwater monitoring data
- Utilise digital pressure gauges to obtain more accurate pressure readings at all of the artesian monitoring bores during every groundwater monitoring event
- Detail all automatic water level loggers (model, setting, and setting information), including the depth of installation within the artesian bore headworks
- Compile all automated water level logger data in a standard format for all monitoring bores, such that the data provided is easier to assess and interpret. The format is, in accordance to approval conditions, to be supplied in a format specified by the administrating authority. The information will include, as a minimum:
  - Manual and logger download data
  - Correction for barometric pressure (non-vented loggers)
  - Logger set-up details, depth of installation and measurements as depth-to-water
  - Logger reset or replacement details
  - Logger type and accuracy
  - Agreed column naming convention
- Monitor the recently installed shallow seepage groundwater monitoring bores, for a minimum six months prior to construction in areas to include mine affected water and waste storage facilities
- Install additional monitoring bores located up and down gradient of surface infrastructure considered potential sources of contamination (e.g. mine infrastructure, waste dumps, and tailings areas) before construction of such facilities
- Alluvium bore C025P1, regularly recognised to be dry, will be replaced with a new alluvium bore located within deeper alluvium adjacent to the Carmichael River. A bore specific groundwater level threshold will be derived for this bore over time, the groundwater level threshold for existing bore C025P1 will be used in the interim
- A new monitoring bore will be installed into clematis sandstone at current location of C180118SP as this bore is currently blocked
- Undertake groundwater monitoring and sampling via a suitably qualified and experienced professional in accordance with recognised procedures and guidelines
- Conduct a regular review of the monitoring data, using suitably qualified expert (update conceptualisations and refine modelling based on these data)
- Hydrochemistry results will be reviewed after each groundwater monitoring event to identify trends which may inform of potential impacts
- Include in the review an assessment of groundwater level and water quality data, and the suitability of the monitoring network
- The results of research plans, inclusive of the GAB Springs Research Plan and Rewan Formation Connectivity Research Plan, will be incorporated in to the next iterations of the numerical model review and GMMP (within two years of boxcut and every five years after that).
- Adani commits to incorporate the following in the groundwater model re-run:

   - Inclusion of locally appropriate and derived hydrogeological parameters, particularly for the Clematis Sandstone and Rewan Formation
   - Inclusion of updated and clearly defined bore reference levels. The review should also include how changes (if any) affect historical model calibration performance
   - Transient calibration of the groundwater model, incorporating available bore water level data and surface water flows for the Carmichael River
   - Review of evapotranspiration (ET) to assess its influence on model predictions relating to the DSC and the Carmichael River GDEs
   - Update of the groundwater model to incorporate additional information obtained since the SEIS, including update of the geological and hydrogeological conceptualisation based on drilling works since the SEIS
   - Updated sensitivity analysis
   - Uncertainty analysis based on recent literature (e.g. Middlemis and Petters, 2018, Uncertainty Analysis – Guidance for groundwater modelling within a risk management framework)."

  The modelling review will include:

   - an independent review and update of the groundwater conceptual model
   - an independent review of the numerical groundwater model
   - an independent review of the water balance calculations

  The recommendations of the reviews will be incorporated in the revised / updated GMMP document including a table of changes made in response to the independent reviews

- Initial review of the approved GMMP by an appropriately qualified person with a report provided on the outcome of the review to the administering authority by 1 July 2020. After the initial review, the review will be conducted by 1 July every five years following, the report provided to the administering authority
- Investigate all groundwater-based complaints and maintain a complaint register. The register will be made available to the regulating authority upon request
- Implement make-good agreements with land holders affected by groundwater drawdown
- Monitoring results will be publicly available on the Adani website (www.adaniaustralia.com.au) for the life of the CCP; the groundwater monitoring dashboard on the website will be operational within three months of approval of the GMMP.

General commitments regarding the groundwater monitoring include the following:

- Sampling will be undertaken in accordance with the current edition of DES's Water Quality Sampling Manual, or subsequent updated versions
- Groundwater level and groundwater quality results will be maintained for the life of the project and annual data will be compiled in an annual monitoring report
- Notification to the regulating authority within one month of receiving water quality analysis results, should any parameters tested exceed agreed trigger levels
- Should groundwater level monitoring indicate exceedance of any or all of the groundwater level thresholds then an investigation will be instigated within 14 days of detection and the investigation report will be made available within 28 days of the completion of the investigation
- Adani, in the event of an exceedance of a groundwater drawdown threshold level, will:
   - Update/revise the numerical groundwater model using the monitoring results
   - Review the mine plan, including the sequencing of mining
   - Update the model predictions and revise the threshold levels

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- Should any or all the groundwater level Impact thresholds be realised, through the assessment of groundwater monitoring data and comparison to model predictions, then an appropriately qualified person will complete an investigation into the potential for environmental harm (MSES and MNES) and will provide a written report to the regulator within 60 days of the exceedance. In the event of exceedances of threshold levels on MNES Adani will take the following actions:
  - Update/revise the numerical groundwater model with the monitoring results
  - Review of the mine plan including the sequencing of mining
  - Update the predictions using the revised model to check if the revised predicted drawdown within the DSC are within the approved limits of drawdown impacts (i.e. the interim thresholds)
- Conduct regular groundwater monitoring bore assessments and maintenance (where required) as well as ensuring dry or damaged bores (as a result of mining activities) are decommissioned according to the latest editions of the Minimum Construction Requirements for Water Bores in Australia, 3rd Edition (NWC, 2012) and the Minimum Standards for the Construction and Reconditioning of Water Bores that Intersect the Sediments of Artesian Basins in Queensland (DNRME, 2017)
- As the proposed threshold values are reliant on predictions from the numerical groundwater model, to be updated within two years of the box cut excavation then every five years subsequently, Adani will compare the actual measured groundwater level data to predicted drawdown to assess the rate of change. In the instance the drawdown rate of the actual data is steeper/ faster than the predicted rate, an investigation will be commenced into the cause of the drawdown rate change.

7.1.1 Springs, GDEs, and Baseflow Commitments

The reporting will include any revised predictive modelling and comments regarding potential impacts on the sensitive ecosystems. All details of proposed aquifer management studies and implemented remediation schemes will be provided to the administering authority.

The GMMP will closely interlink to the GDE Management Plan developed by Adani specifically the Doongmabulla Spring Complex, Mellaluka Spring Complex, Carmichael River baseflow and GDEs, and Waxy Cabbage Palm tree communities sub-plans.

Data collected from the GMMP will assist in the monitoring of the ecological health at these GDEs and will allow for the identification of potential stress and consequently requirements for mitigation and management measures as outlined in the sub-plans.

Monitoring of the Dunda Beds and Rewan Formation as potential contributors to the Doongmabulla Spring Complex (DSC) will be undertaken to enable spatially comparable data to be collected.

Additional bores will be installed at three locations co-located as far as practicable within 500 m of existing Clematis Sandstone monitoring points as follows: HD02, HD03A, and C14011SP.

These bores, once installed, will be added to the operational groundwater monitoring program and will allow for the collection of additional spatially comparable groundwater level and quality data between the Mining lease and DSC. The additional monitoring points will assist in further evaluation of the predicted groundwater impacts associated with the mining activities and will also assist in validating the predicted timing of impacts.

The additional groundwater (bore construction and monitoring) data will be used in the groundwater model rerun for the prediction of impacts, which will then be used to develop additional Early warning groundwater level and Impact thresholds for inclusion in the next GMMP.

Further, Adani will investigate drilling into deeper Permian age units for the purpose of acquiring data for monitoring purposes and to capture information if required under relevant research programs.

As discussed in **Section 2.2.8**, **Section 3.5.4**, **Section 5.6** the installation of these new bores will assist in various objectives to fill data gaps in the current hydrogeological conceptualisation and understanding, as well as contribute to the management and mitigation of potential impacts from the CCP. Further, Adani will consider drilling and installation of additional bores into deeper units for

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monitoring purposes if there is a need to do so identified in the relevant research programs (e.g. GAB Springs Research Plan, Rewan Formation Connectivity Research Plan, etc.).

Drilling and aquifer assessments conducted post model construction will, as included in **Section 2.2.6.3**, be included in the development of a more detailed conceptualisation of the geology and groundwater resources at the Mellaluka Springs Complex. These data, which forms part of the baseline assessment of the springs, will be included in future model refinement. The evaluation of artesian conditions, considered to be related to the Belyando River palaeochannels (recharge and hydraulic heads derived in the upper reaches of the river drainage system) will be conducted as part of research into the Mellaluka Springs Complex. Further research in this regard, in addition to discussions in **Section 2.2.6.3.1**, may include an assessment of the artesian well head control systems and potential contribution of the Belyando River palaeochannels via aquifer pump tests or similar. The proposed research initiatives will be reassessed after each model re-run to refine the research approach.

The GMMP and predictive groundwater model refinement, to be undertaken at regular intervals (within 2 years and then every 5 years), will allow for the revised predictions and trend analysis (quality and water levels) to be included in the update/ refinement of the GAB Springs Research Plan. Conversely information derived from the GAB Springs Research Plan, including possible assessment of the interim thresholds, will aid in the regular GMMP and predictive groundwater model refinement.

The GMMP and predictive groundwater model refinement, to be undertaken at regular intervals, will be conducted based on groundwater monitoring information including groundwater ingress volumes and groundwater level measurements (responses to dewatering). This will allow for the validation of the aquitard nature of the Rewan Formation. It is considered that these regular assessments, including the annual monitoring reports (factual and interpretative) will be used in refining the Rewan Formation Connectivity Research Plan. Conversely the aquitard assessment results, derived from the Rewan Formation Connectivity Research Plan, will be used in the regular GMMP (and predictive groundwater model) updates.

7.1.2 Monitoring Program Updates

The groundwater monitoring program (network, frequency of sampling, and analytes) will evolve and respond to the various stages of the mining project, i.e. the groundwater monitoring program will be different depending on the different phases on mining including baseline, construction, operations, and closure.

To develop the optimum groundwater monitoring plan Adani proposes a phased approach, which will allow for the correct scientific development of the program and allow for variation over time to suit the site / mining phases.

Any revised GMMP will be submitted for approval with the administering authority, prior to the implementation of the next phase of mining.

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9.0 Standard Limitation

9.1 Geotechnical & Hydro Geological Report

AECOM Services Pty Ltd (AECOM (formerly URS)) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Adani Mining Pty Ltd and only those third parties who have been authorised in writing by AECOM to rely on the report.

It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the contract dated December 2013.

The methodology adopted, and sources of information used by AECOM are outlined in this the Report.

Where this report indicates that information has been provided to AECOM by third parties, AECOM has made no independent verification of this information unless required as part of the agreed scope of work. AECOM assumes no liability for any inaccuracies in or omissions to that information.

This Report was prepared between December 2013 and November 2018.The information in this report is considered to be accurate at the date of issue and is in accordance with conditions at the site at the dates sampled. Opinions and recommendations presented herein apply to the site existing at the time of our investigation and cannot necessarily apply to site changes of which AECOM is not aware and has not had the opportunity to evaluate. This document and the information contained herein should only be regarded as validly representing the site conditions at the time of the investigation unless otherwise explicitly stated in a preceding section of this report. AECOM disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

This report contains information obtained by inspection, sampling, testing or other means of investigation. This information is directly relevant only to the points in the ground where they were obtained at the time of the assessment. The borehole logs indicate the inferred ground conditions only at the specific locations tested. The precision with which conditions are indicated depends largely on the uniformity of conditions and on the frequency and method of sampling as constrained by the project budget limitations. The behaviour of groundwater and some aspects of contaminants in soil and groundwater are complex. Our conclusions are based upon the analytical data presented in this report and our experience. Future advances in regard to the understanding of chemicals and their behaviour, and changes in regulations affecting their management, could impact on our conclusions and recommendations regarding their potential presence on this site.

Where conditions encountered at the site are subsequently found to differ significantly from those anticipated in this report, AECOM must be notified of any such findings and be provided with an opportunity to review the recommendations of this report.

Whilst to the best of our knowledge information contained in this report is accurate at the date of issue, subsurface conditions, including groundwater levels can change in a limited time.

Therefore, this document and the information contained herein should only be regarded as valid at the time of the investigation unless otherwise explicitly stated in this report.

Except as required by law, no third party may use or rely on, this Report unless otherwise agreed by AECOM in writing. Where such agreement is provided, AECOM will provide a letter of reliance to the agreed third party in the form required by AECOM.

To the extent permitted by law, AECOM expressly disclaims and excludes liability for any loss, damage, cost or expenses suffered by any third party relating to or resulting from the use of, or reliance on, any information contained in this Report. AECOM does not admit that any action, liability or claim may exist or be available to any third party.

AECOM does not represent that this Report is suitable for use by any third party.

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Except as specifically stated in this section, AECOM does not authorise the use of this Report by any third party.

It is the responsibility of third parties to independently make inquiries or seek advice in relation to their particular requirements and proposed use of the relevant property.

Any estimates of potential costs which have been provided are presented as estimates only as at the date of the Report. Any cost estimates that have been provided may therefore vary from actual costs at the time of expenditure.

FOI 190417
Document 14

From:	s22
To:	"james.johnson@ga.gov.au"; "jane.coram@csiro.au"
Cc:	"Stuart Minchin"; "Blewett Richard"; "McDonald, Warwick (L&W, Black Mountain)"; Gregory Manning; s22 ; Dean Knudson
Subject:	RE: Revised GDEMP [SEC=OFFICIAL]
Date:	Friday, 5 April 2019 1:04:45 PM
Attachments:	Attachment%20A%20-%20GDEMP%20Final_Part2.pdf image001.jpg

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Part 2 of the GDEMP

s22

T 02 s22 @environment.gov.au

W www.environment.gov.au

From: s22

Sent: Friday, 5 April 2019 1:04 PM

To: 'james.johnson@ga.gov.au' ; 'jane.coram@csiro.au'

Cc: 'Stuart Minchin' ; 'Blewett Richard' ; 'McDonald, Warwick (L&W, Black Mountain)' ; Gregory Manning ; s22 ; Dean Knudson

Subject: RE: Revised GMMP [SEC=OFFICIAL]

Hi everyone,

Part one of the GDEMP attached – parts 2 and 3 will follow

-s22

T 02 s22 @environment.gov.au

W www.environment.gov.au

From: s22

Sent: Friday, 5 April 2019 12:53 PM

To: 'james.johnson@ga.gov.au' <james.johnson@ga.gov.au>; 'jane.coram@csiro.au' <jane.coram@csiro.au>

Cc: Stuart Minchin <stuart.minchin@ga.gov.au>; Blewett Richard <Richard.Blewett@ga.gov.au>; 'McDonald, Warwick (L&W, Black Mountain)' <Warwick.Mcdonald@csiro.au>; Gregory Manning <Gregory.Manning@environment.gov.au>; s22 @environment.gov.au>; Dean Knudson <Dean.Knudson@environment.gov.au>

Subject: Revised GMMP [SEC=OFFICIAL]

Hi James and Jane,

Please find the revised GMMP attached.

The GDEMP will follow

s22

Acting Director | Post Approvals Strategies

Environment Standards Division

Department of the Environment and Energy

T 02 s22 @environment.gov.au

Reconciliation%20Email%20Footer

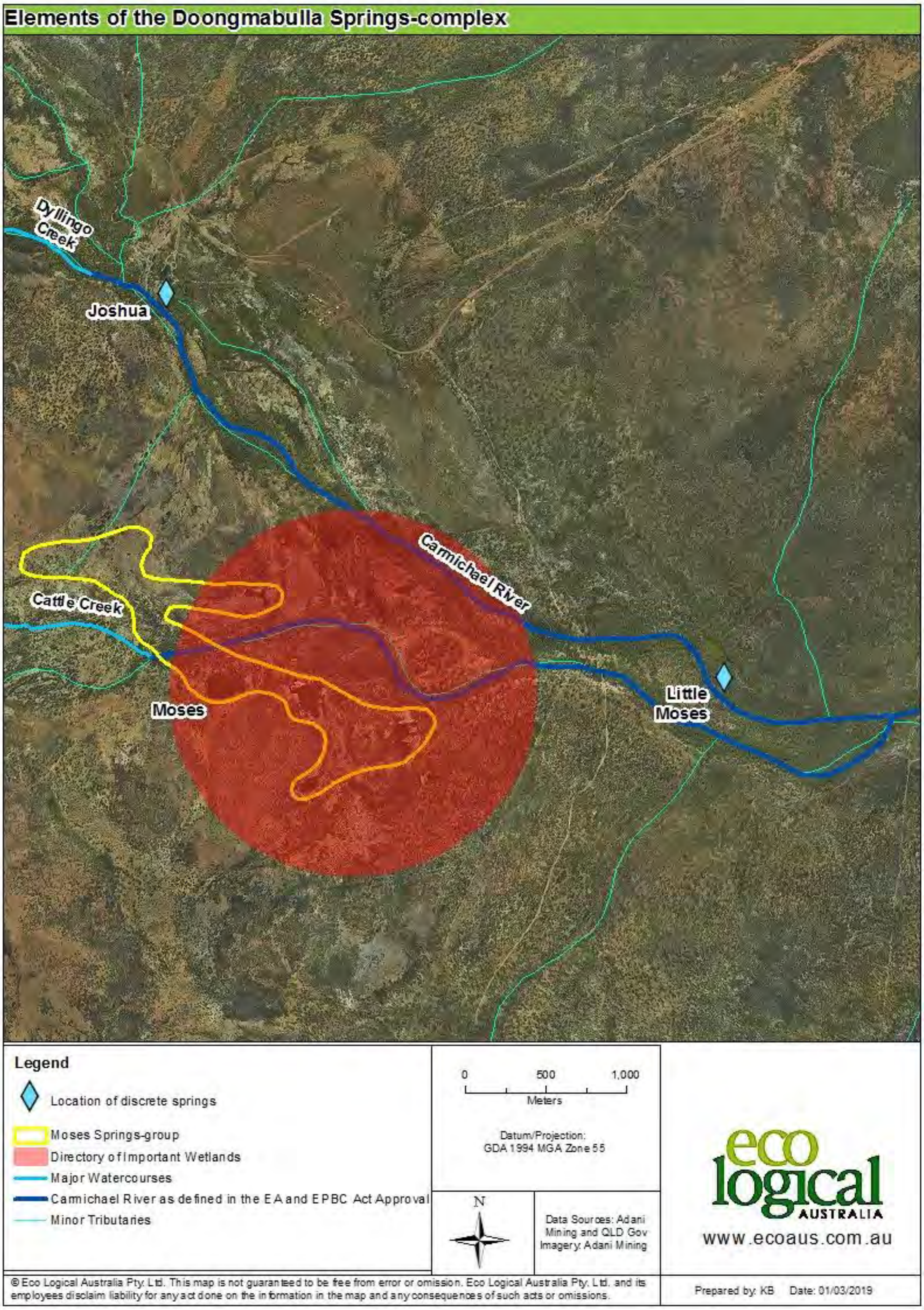


Figure 8-1 Location of the elements of the Doongmabulla Springs-complex

Recent studies of the Doongmabulla Springs-complex (Fensham et al. 2016) have also described the following features:

- A cluster of eight small to medium sized springs known as Home Springs are located within the Joshua Springs-group, approximately 580 m south-east of the Joshua spring. The outflow from the Joshua Spring and House Springs converge to form the main discharge feeding the Carmichael River for a distance of 20 km.
- Bonanza Springs-group – a small number of non-mounding springs, located on the southern banks of Dyllingo Creek, immediately north of the Mouldy Crumpet springs.
- Within the Moses Spring-group, the following springs have been identified
    - Mouldy Crumpet Springs-group – a cluster of numerous small mounded springs (82 vents), located on the scalded plain between Dyllingo Creek and Cattle Creek.
    - Camaldulensis Spring, Greschlechin Spring, and Bush Pig Trap Spring – non-mounding springs located on the eastern edge of the Moses Springs-group.
- Yukunna Kumoo Springs – one large recharging spring and vents on the edge of the wetland, located 1.8 km downstream of the Little Moses Springs-complex.
- Dusk springs – a small cluster of outcrop springs, located north of the Carmichael River, 2.3 km downstream of the Yukunna Kumoo Springs.
- Surprise Spring – an outcrop spring which has formed a short gully from an ill-defined sources in colluvial material on the edge of Surprise Creek which enters the Carmichael River.
- There are some scalded areas around House Springs and Camp Springs, but *Trianthema* sp. is the only scald endemic occurring in these areas

These features are discussed in further detail within the following sections.

8.1.1 Moses Springs-group

The Moses Springs-group consists of at least 65 springs spread over an area 2.5 km long by 1.3 km wide, located in the Doongmabulla Mound Springs Nature Refuge, approximately 9 km west of the Project area (**Figure 8-5** and **Figure 8-6**). The Moses Springs-group includes the Moses Springs, Keelback Springs, Geschlichen Spring, Mouldy Crumpet Springs and Camp Spring.

Most of the discharge areas in the Moses Springs-group are mound springs ranging in height from 20 - 50 cm, and often supporting central pools (GHD 2014). The highest mound is 1.5 m tall, which suggests that the existing pressure head is up to 1.5 m above ground level (GHD 2014). Seepage springs are also present. The size of the vents, in conjunction with the scalded areas, suggests groundwater is fed by artesian pressure through a vertical conduit, features characteristic of discharge springs elsewhere (Fensham et al. 2016).

All of the springs have a wetted area, with five springs supporting wetland areas larger than 0.5 ha. In four locations the mound springs have contributed water to broad shallow pools (often only a few centimetres deep), forming wetlands of approximately 3.5 ha in total area (GHD 2014). Elsewhere, mounds have occasionally formed localised shallow pools up to 20 m in diameter (GHD 2014) and aggregations of wetland vegetation <4 m in diameter. The large wetlands at the Moses Springs-group wetlands, together with the Keelback Springs flow into permanent open ponds and channels within the bed of Cattle Creek, however during periods of drought, evaporation reduces moisture in the regolith and these channels do not discharge into the Carmichael River (Fensham et al. 2016).

The condition of the Moses Springs-group is rated as 1a on a scale of 1-5 with 1 being the best condition, 4 being the poorest condition, and 5 being extinct (Fensham et al. 2010). However, Rod Fensham suggests that the Moses Springs-group would be unlikely to achieve the highest overall score if the ranking exercise were to be undertaken again, due to degradation, and the discovery of a formerly endemic plant species at another Springs-complex nearby (GHD 2012a).

Despite this, the Moses Springs-group does have exceptional biological value, with two fauna species found only within this springs-group, seven GAB spring endemic flora species including one that is only known from two springs-groups and of which six are listed as threatened under the EPBC Act and / or NC Act (**Section 8.2** and **Figure 8-3**).

The GAB endemic and threatened species associated with the wetland areas at Doongmabulla Springs-complex are all found in the Moses Springs-group. These species were generally present on or immediately adjacent to mounds, seeps or pools, with the majority of species located within the wetland areas fed by seepage from the springs. Most mounds (and associated wetlands) are generally heavily vegetated with a characteristic suite of species that identify them from a distance, in particular the grass *Sporobolus pamelae*, which only occurs in association with GAB mound springs (GHD 2014).

Scalded, pale soils, and extensive grasslands and sedgelands at the Moses Springs-group reflect altered soil chemistry, likely due to the high salinity content of GAB groundwater discharge, which has resulted in a specialised community of salt-tolerant and endemic flora (GHD 2012a). These soil and vegetation characteristics indicate the Moses Springs-group wetland community is mature and has probably been in place for a long time (GHD 2012a).

8.1.2 Little Moses Springs-group

The Little Moses Springs-group is immediately adjacent to Dyllingo Creek, approximately 7 km from the western edge of the Project area boundary (**Figure 8-7**).

The Little Moses Springs-group is a series of seepages (no mounds) from the side of a slope and one large pool (GHD 2012a). The spring is a tear-shaped sedgeland/wetland with an open pond in the centre. The spring is approximately 200 m long and 50 m wide.

Waxy Cabbage Palm has been recorded at the Little Moses Springs-group (GHD 2012a), although it occurs in non-wetland vegetation where the surface is not permanently wet. No GAB endemic flora or fauna species are known to occur at this spring.

Grasslands are absent from the Little Moses Springs-group and the soil is dark brown to black and of a heavier nature. These observations, combined with a lack of surface water and GAB springs flora and fauna endemics, have led to the postulation that Little Moses may be a very young springs-group (GHD 2014).

8.1.3 Joshua Springs-group

The Joshua Springs-group is located approximately 10 km directly west of the mine area boundary (**Figure 8-8**). The Joshua Springs-group consists of one spring mound (‘Joshua Spring’) that has been modified into an artificial turkey’s nest dam (GHD 2012a). It is a high flow spring with a strong pressure head, which rises at least 1 m above the surrounding plain (GHD 2014). The daily flow of Joshua Spring is approximately 4.32 to 8.64 ML (GHD 2014). The water flows out of the mound spring and into an adjacent shallow wetland of approximately 2 ha in area, and then drains to Dyllingo Creek, where it is believed to contribute a significant proportion of the Carmichael River’s base flow (GHD 2014).

The Joshua Spring is considered to be high value habitat for aquatic fauna (GHD 2012a). Given the depth and permanency of this spring, it is likely that fish, amphibian, turtle and aquatic invertebrate species use it, especially during the dry season (GHD 2012a). The wetland contains two threatened flora species:

- *Myriophyllum artesium* (listed as Endangered under the NC Act)
- *Sporobolus partimpatens* (listed as Near Threatened under the NC Act).

The Joshua Spring wetlands harbour a Category 3 restricted matter and WoNS Olive Hymenachne, with the outflow channel of the modified spring mound dam choked with this exotic grass.

Scalded earth was not observed at this site, and it is speculated that this spring may have been similar to the Little Moses spring seepages, prior to modification, only with a much larger flow (GHD 2012a).

8.2 Ecology

As well as being a GAB springs wetland TEC, the Doongmabulla Springs-complex and associated wetlands are listed as being of national significance in the Directory of Important Wetlands because: 1) they are a good example of a wetland type occurring within a biogeographic region in Australia, and 2) the wetlands are important habitat for animal species at vulnerable stages in their life cycles, or provide a refuge when adverse conditions such as drought prevail (DoE 2015).

8.2.1 Vegetation Communities

The open vegetation areas of the Doongmabulla Springs-complex wetlands include (**Figure 8-2**):

- bare scalded clay pans with sparse grass and herb cover, including the Near Threatened grass *Sporobolus partimpatens* and low chenopod shrubs.
- grasslands dominated by the Endangered *Sporobolus pamelae*, growing in or close to the saturated zone (within RE 10.3.31). This vegetation community is considered to be obligate groundwater dependent.
- mixed-species sedgelands in the wetter areas, dominated by *Cyperus laevigatus, C. polystachyos, C. difformis, Eleocharis cylindrostachys*, and *Fuirena umbellata*. Some of these sedgelands contain a small population of the Vulnerable Waxy Cabbage Palm.

These vegetation communities are all included in RE 10.3.31, which is an Of Concern RE that is part of the GAB springs wetland TEC ecological community.

Wooded vegetation communities within the Doongmabulla Springs-complex and wetland areas include *Eucalyptus coolabah* (Coolibah) / River Red Gum woodland and open woodland, Weeping Paperbark forest, *E. persistens* (Peppermint Box) open woodland, and Reid River Box woodland (GHD 2012a).

Sporobolus pamelae grassland

Mixed Sedglands

Weeping Paperbark forest

Peppermint Box open woodland

Figure 8-2 Vegetation communities

8.2.2 Flora of the Doongmabulla Springs-complex

The wetland areas and mound springs of the Doongmabulla Springs-complex are known to contain six threatened flora species (**Figure 8-3**, **Figure 8-4**):

- *Eryngium fontanum* (Blue Devil) – Endangered under the EPBC Act and NC Act, and is only known from two springs-groups
- *Eriocaulon carsonii* (Salt Pipewort)– Endangered under the EPBC Act NC Act
- *Hydrocotyle dipleura* – Vulnerable under the NC Act
- *Myriophyllum artesium* - Endangered under the NC Act
- *Sporobolus pamelae* – Endangered under the NC Act
- *Sporobolus partimpatens* - Near Threatened under the NC Act
- Waxy Cabbage Palm - Vulnerable under the NC Act and the EPBC Act

Habitat for these occurs at the wetlands of Moses, Keelback, Geshlichen, Camp, Stepphing Sone and Mouldy Crumpet Springs. *Sporobolus partimpatens* is a scald endemic found in scalded areas around the Moses and Mouldy Crumpet Springs (Fensham et al. 2016).

Six other spring endemic flora species have been recorded at the complex:

- *Isotoma* sp. (R.J. Fensham 3883)
- *Peplidium* sp. (R.J. Fensham 3880)
- *Chloris* sp. (Edgbaston R.J. Fensham 5694)
- *Panicum* sp. (Doongmabulla RJ Fensham 6555)
- *Utricularia fenshamii* (Fensham et al. 2016)
- *Fimbristylis blakei* (Fensham et al. 2016)

Salt Pipewort

Blue Devil

Hydrocotyle dipleura

Waxy Cabbage Palm

Myriophyllum artesium

Sporobolus pamelae

Figure 8-3 Threatened flora

8.2.3 Fauna of the Doongmabulla Springs-complex

Squatter Pigeon, which is listed as Vulnerable under the EPBC Act and NC Act, has been recorded in open woodlands associated with the Doongmabulla Springs-complex (GHD 2012a). *Denisonia maculata* (Ornamental Snake), *Egernia rugosa* (Yakka Skink), *Phascolarctos cinereus* (Koala), *Poephila cincta cincta* (Black-throated Finch) and the *Rostratula australis* (Australian Painted Snipe) are threatened vertebrates that are considered likely to occur within the Doongmabulla Springs-complex (GHD 2012a).

The Doongmabulla Springs-complex also contains two spring endemic fauna species:

- *Gabbia rotunda* (a mollusc)
- *Mamersella* sp. AMS KS 85341 (an invertebrate)

8.2.4 Habitat Values

The Doongmabulla Springs-complex and associated wetlands provide habitat for many non-threatened fauna, including nesting habitat for birds, permanent pools for fish and aquatic reptiles, sedgeland habitat for frogs, and aquatic habitat for invertebrates such as mussels, crayfish, freshwater crabs and insects. A total of 18 fish species are predicted to occur in the surface waters of the Doongmabulla Springs-complex, including rainbowfish and spangled perch (GHD 2012a).

The Doongmabulla wetland was also used for bird nesting. Mud nests were especially common, highlighting the importance of this site as a resource for nest building materials, particularly during dry periods when mud may be scarce. Stick nests were also frequently observed within the Doongmabulla wetland.

Hollows are plentiful on the periphery of the wetland and surrounds, so it is very likely that a number of arboreal species will be present at the wetland. Woody debris was typically abundant in forested areas, but was (as would be expected) absent from the grasslands and wetlands. Leaf litter was dense in much of the forested parts of the wetland, particularly under the stands of Weeping Paperbark. Logs, lifted or fallen bark and fallen timber was common, and was confirmed to provide habitat for skinks, geckos and dragons. The Doongmabulla Springs-complex is fringed by rocky rises, some with short but abrupt escarpments, populated by a grassy open woodland of peppermint gum with porcupine grass and soft spinifex. The rock mosaic and spinifex provide ideal habitat for reptiles. It is likely that this diverse habitat within the Doongmabulla wetland would support a diverse and abundant range of reptiles.

The Doongmabulla Springs-complex, and in particular the Moses Springs-group, provide abundant, suitable habitat for frogs in the region. The density of vegetation and abundance of perennial water makes the Doongmabulla Springs-complex and associated wetlands an important amphibian habitat in an otherwise arid environment.

While the springs themselves may provide a relatively small area of habitat for fish, the value of these springs is in providing surface flows which in some areas drained directly into the neighbouring waterways. Doongmabulla Springs-complex also provides a diverse range of habitat for aquatic invertebrates, including freshwater mussels, crayfish, freshwater crabs and various insects.

The diversity and abundance of aquatic invertebrates is largely determined by the habitat structure and type (for example clay substrates with root masses) and the availability of foraging material (for example leaf litter and other organic detritus). Suitable habitat was observed within the springs themselves, within the wetlands, and also in adjacent waterways. Substrates ranged from sand (suitable for freshwater mussels) to clays (preferred by many aquatic insects), and were mostly provided with abundant organic matter utilised by invertebrates for shelter and as a food source.

8.2.5 Disturbance

In general, the habitats present within the Doongmabulla Springs-complex are intact and in good ecological condition. The wetland is exposed to introduced wildlife and stock, with cattle trampling observed particularly at the Moses Springs-group (GHD 2012a). The Doongmabulla Springs-complex is currently (and was historically) used for watering livestock, which directly impacts the springs through trampling, pugging, fouling of water and compaction (GHD 2012a). The greatest damage to the wetlands was caused by Feral Pigs, with parts of some wetlands highly disturbed by pig wallowing and foraging (GHD 2012a).

Outside of the wetland, Rubber vine is present along Cattle Creek, which is a Category 3 restricted matter under the Queensland *Biosecurity Act 2014*, and is a Weed of National Significance (WoNS) under Commonwealth legislation. This weed was growing in very low densities, as scattered individuals. However, it is growing near mound springs within the Moses Springs-group and is a potential future threat. The overflow channel for the Joshua spring is infested with Olive Hymenachne, a Category 3 restricted matter under the Biosecurity Act 2014 and a WoNS species.

The Joshua Springs-group is the most impacted and is completely altered from its natural state. It now consists of an upper turkey's nest dam and a more recently constructed lower turkeys nest dam. Given the depth of the turkey's nest dam and the permanency and high flow rate of this spring, it is predicted that the Joshua Spring provides potential habitat for fish, amphibians, turtles and invertebrate species, especially during the dry season.

Maps of the key wetland areas are provided in **Figure 8-5** to **Figure 8-8**.

Figure 8-4 *Eriocaulon carsonii* and *Eryngium fontanum* records

Figure 8-5 Moses Springs-group wetland areas

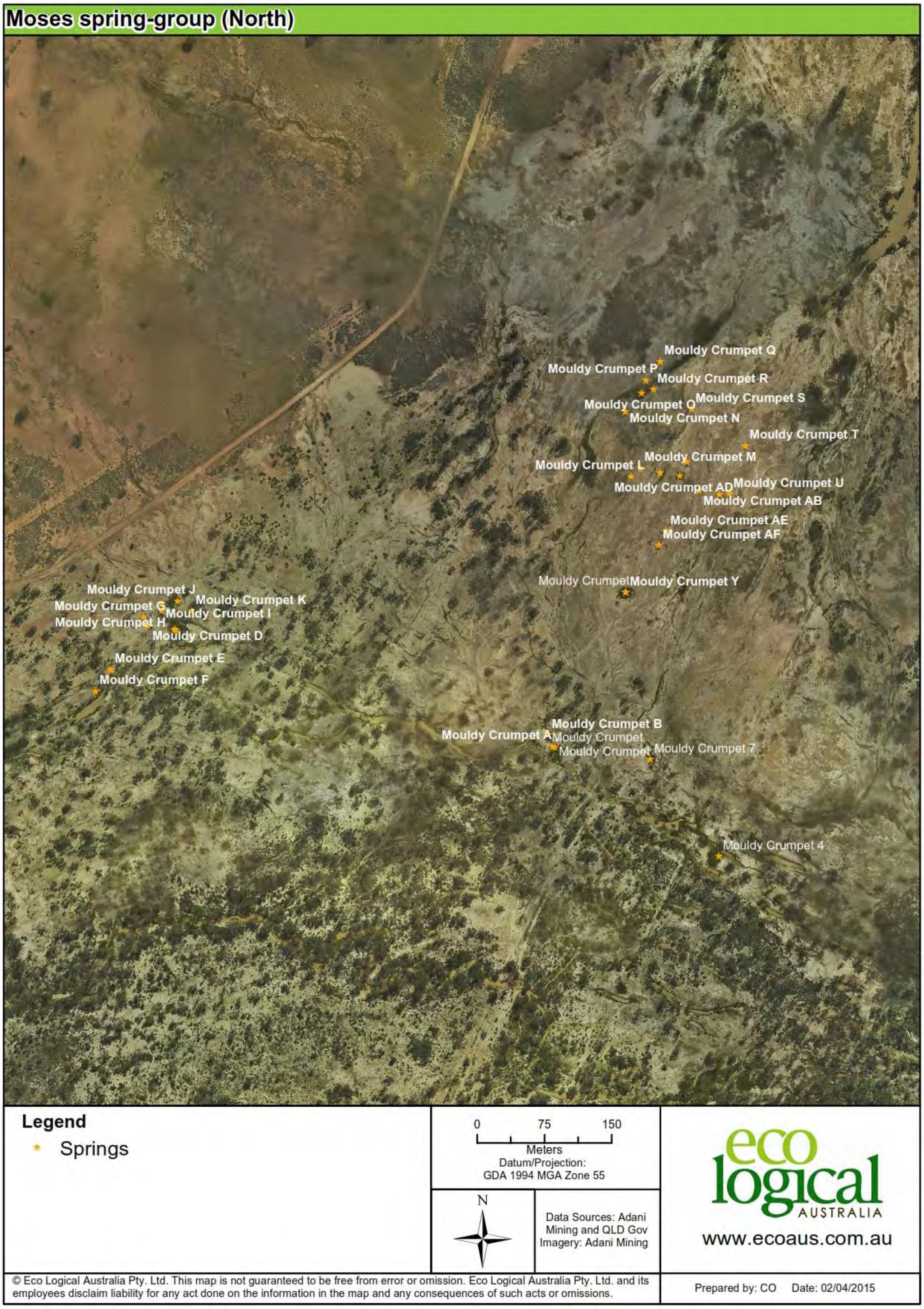


Figure 8-6 Moses Springs-group mound springs

Figure 8-7 Little Moses Springs-group

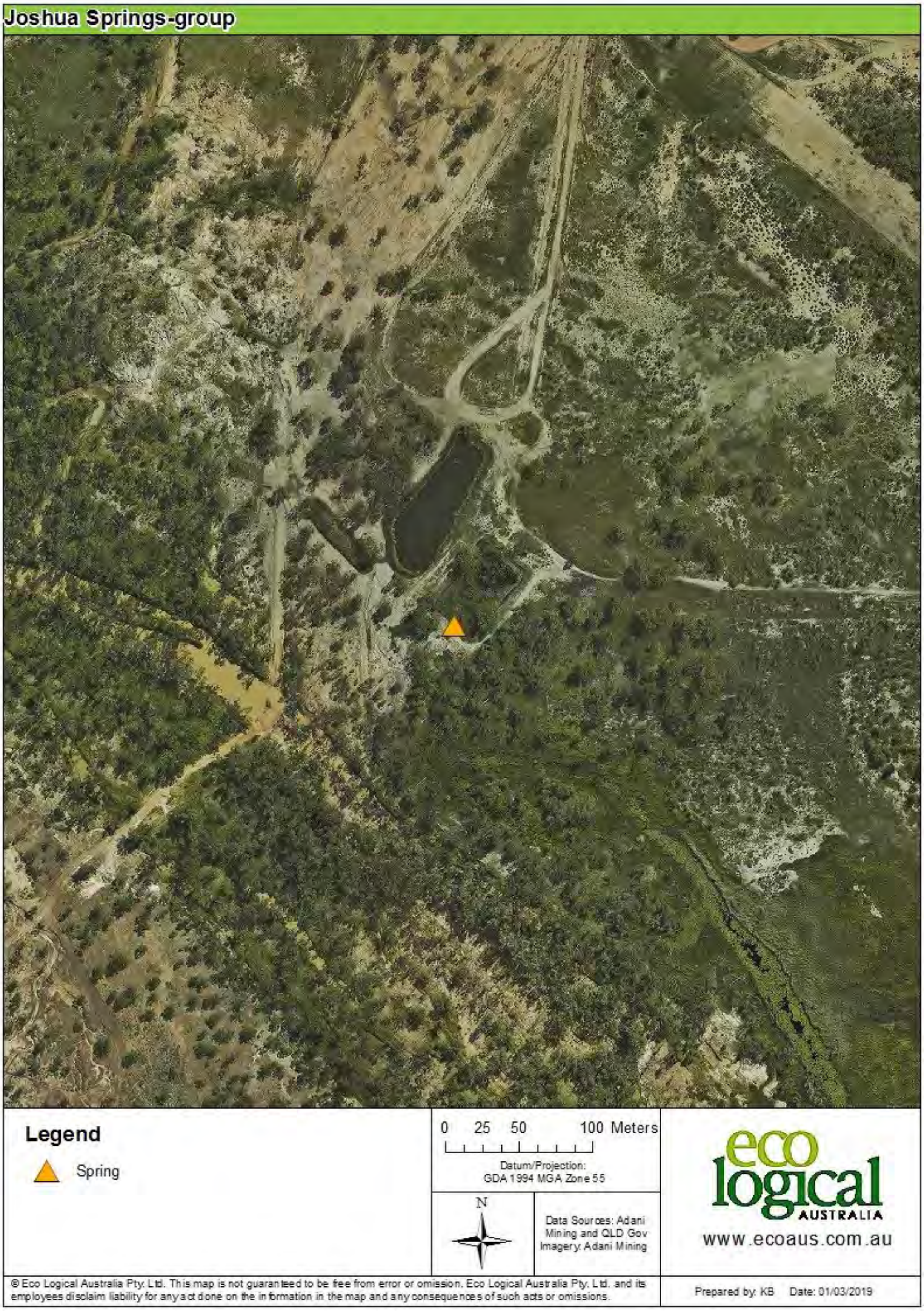


Figure 8-8 Joshua Springs-group

8.3 Supporting Groundwater resources

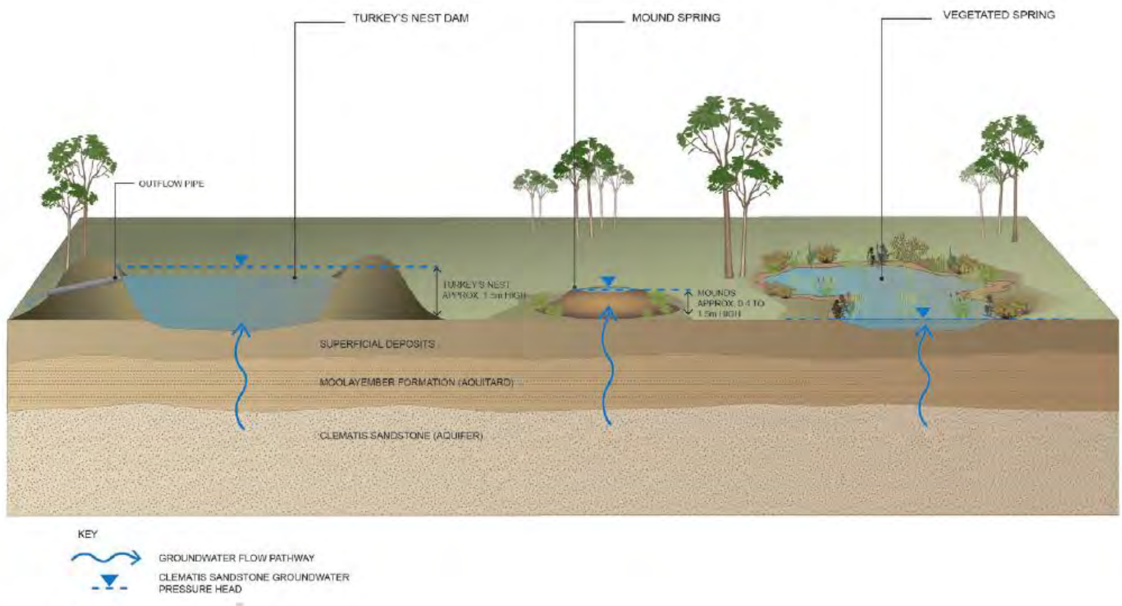
8.3.1 Conceptual groundwater model

The Doongmabulla Springs-complex comprises a series of mound (wetland) springs approximately 8 km to the west of the mine leases, as depicted in **Figure 8-1**.

Studies undertaken during and post EIS indicate that the source aquifer of the Doongmabulla Springs-complex is discharge from the artesian Clematis Sandstone through weathered Moolayember Formation.

A conceptual groundwater model (**Figure 8-9**), which formed the basis of the numerical groundwater model, was developed based on existing information and field data collected for the Carmichael Coal Mine EIS process. This original conceptual model has been refined over time with new information since completion of the EIS. This model was independently peer reviewed through the EIS process by Adani and by the Queensland Government, reviewed by the Independent Expert Scientific Committee (IESC), further developed and subsequently approved through the Queensland Coordinator General's Evaluation Report and the EPBC Approval. Subsequent work included the groundwater flow model review conducted as per conditions 22 and 23 of the EPBC Approval which was peer reviewed by an independent expert and the results of which further informed the conceptual groundwater model.

The current understanding of the site's hydrogeological regime is presented in detail in the GMMP, with relevant material from the GMMP also provided in this GDEMP. This refined conceptual model has also been utilised to inform augmentation of the groundwater monitoring network and program and identify data gaps (through various mechanisms such as the GABSRP and the RFCRP) which in turn, will be utilised to update the conceptual model. For further information, reference should be made to *Research Study Report - Source Aquifer to Doongmabulla Springs* (Adani 2018).



Source: GHD 2013b

Figure 8-9 Conceptual groundwater model for the Doongmabulla Springs-complex GDE

The groundwater conceptual model has been subsequently refined to include the results of continued investigations. It is considered the key elements of the groundwater system in the area include:

- Geometry of each unit

- Groundwater levels and influences on these levels (e.g. artesian conditions south of Carmichael River)
- Inter-aquifer connectivity
- Groundwater flow directions
- Recharge and discharge mechanisms.

The current understanding of these key elements has allowed for the development of pre- and post-mining conceptualisations presented in **Figure 8-10** and **Figure 8-11**. The groundwater contour impact mapping in **Section 8.5** is presented on the basis of this hydrogeological conceptual model.

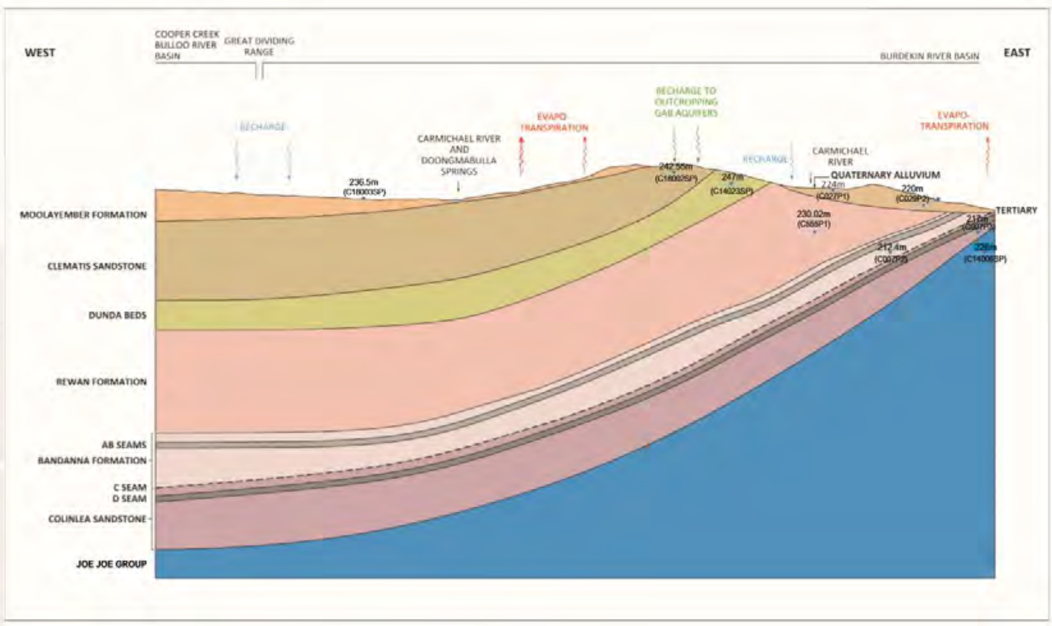


Figure 8-10 Hydrogeological conceptual model – pre-mining

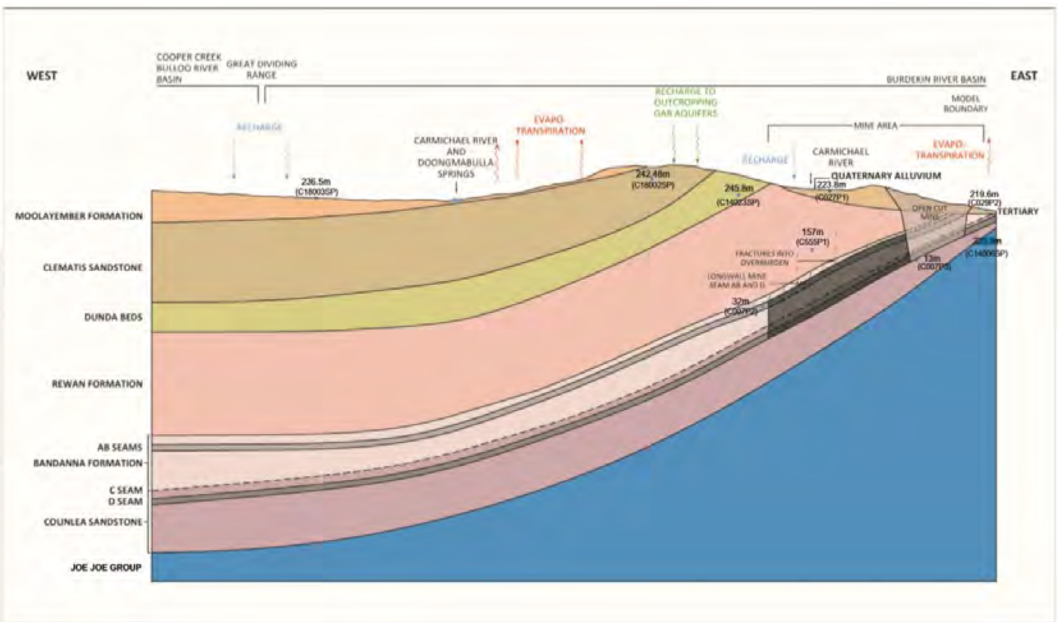


Figure 8-11 Hydrogeological conceptual model – post-mining

The groundwater model conceptualisation is supported through the following baseline studies, investigations and information, each of which is provided in further detail below, and additionally in the GMMP:

- Additional borehole Information
- Water Level data
- Water Quality data
- Regional geological interpretation
- The properties of the Rewan Formation

8.3.2 Additional Borehole Information

Project approvals are based on EIS (2012) and SEIS (2013) Groundwater modelling and Impact assessment studies. The hydrogeological conceptualisation generated by these studies is summarised below;

- The hydrogeological model has been developed based on the exploratory drilling within the ML area (from 2011 to 2014)
- The spatial extent of geological units within the Project area is extrapolated to areas outside the Project area for modelling purposes and cross checked with publicly available regional geological data
- The conceptualisation (based on mapped geology) determined that the Doongmabulla Springs-complex are likely fed by groundwater from the Clematis Sandstone aquifer through the overlying Moolayember Formation and/or Quaternary alluvium
- Three monitoring bores (HD02, HD03 A and HD03B) are installed between the Project area and the Doongmabulla Springs-complex in this conceptualisation
- It was identified through the approvals process that the collection of additional geological/hydrogeological information close to the Doongmabulla Springs-complex would be necessary.
- This need was also identified in the 'Lake Eyre Basin Springs Assessment Project: Hydrogeology, Cultural History and Biological Values of Springs in the Barcaldine, Springvale and Flinders River supergroups, Galilee Basin and Tertiary Springs of western Queensland' report (2016) which states on page 194:

"Drilling of new monitoring bores in the vicinity of the springs, …A high-resolution survey of spring elevations would also improve the accuracy of predictions relating to spring flows and the potentiometric surface of potential aquifers."

Further work has been undertaken by Adani since 2014 to address recommendations/requirements:

- Three (3) additional deep core bores were drilled and logged (outside the Project area and in between the Project area and the Doongmabulla Springs-complex), through the Rewan Formation and into the coal seams below the Rewan formation
- Field and Laboratory investigations were conducted to determine the hydraulic properties of the Rewan formation;

- Several additional monitoring bores were drilled outside the Project area and in between the Project area and the Doongmabulla Springs-complex into the aquifers conceptualised to be the source of the springs
    - 8 bores in the Clematis Sandstone
    - 2 bores in the Moolayember Formation
- Shallow spear point wells (5) were installed in close vicinity to mound springs and discharge springs within the Doongmabulla Springs-complex
- Monitoring of groundwater levels and chemistry in the new monitoring bores was completed, and measurement of vertical groundwater gradients in the different hydro-stratigraphic formations
- Accurate survey of the springs and spring mounds to measure groundwater levels for comparison with that of source aquifers
- An assessment of the drilling conditions in the west of the Project area whilst drilling through the Rewan Formation and associated laboratory testing of the physical properties of the Rewan Formation;

8.3.3 Water Level Data

Hydrostatic pressure was measured at various locations within the springs, and compared with groundwater levels from the network of monitoring bores installed into the same source aquifer of the springs to provide a means for testing and correlating the source aquifer (**Table 8-1**).

Table 8-1 Water level data

Bore ID	Easting	Northing	Ground Surface Elevation (mAHD)	Water Level (mAHD)	Comment
C14033SP	418230.3	7566782.4	296.47	250.52	
C180118SP	423796.8	7568090.9	306.63	250.17#	
C14011SP	426131.0	7561454.8	311.67	242.77	
C14012SP	424895.5	7560591.1	286.37	242.53	
C14013SP	424895.5	7560591.1	286.46	242.46	
C18002SP	420948.1	7558952.3	248.30	242.55	
Joshua Spring	421201.8	7559387.6	241.20	241.20 (243.26)	Floor of spring (Top of Turkey's nest) - From Survey data
C14021SP	429796.3	7550966.3	277.59	245.93	
C18001SP	416311.5	7553052.0	246.97	249.77	
DS4	421571.0	7556883.0	241 to 243	243*	Mound Springs
C 18010 SP**	421610.099	7556860.735	237.84	237.837	Moses Springs Group- Doongmabulla Springs-complex
C 18011 SP**	422044.827	7556285.962	240.11	239.908	Moses Group (Camaldulensis Spring)- Doongmabulla Springs-complex
C 18012 SP**	420424.313	7557642.007	239.03	239.03	Mouldy Crumpet Spring- Doongmabulla Springs-complex
C 18013 SP**	420427.749	7557636.776	238.66	238.663	Mouldy Crumpet Springs- Doongmabulla Springs-complex

Bore ID	Easting	Northing	Ground Surface Elevation (mAHD)	Water Level (mAHD)	Comment
C 18014 SP**	424639.569	7557046.462	235.48	235.475	Little Moses Spring – Doongmabulla Springs-complex

Note-*: As measured during 2013 SEIS studies
**: Installed in September 2018
#- Last reading before blocked (new bore will be installed)

Key findings from the review of water level data:

- The groundwater levels in the mound springs are generally in agreement with that of Clematis Sandstone in the vicinity of the springs;
- Groundwater level in C 18002 SP (screened into the Clematis Sandstone) is 243.67 (April 2018) m AHD and is considered to be the prevailing potentiometric hydrostatic heads in Clematis Sandstone in the vicinity of springs;
- It is observed that Joshua Spring (modified turkeys nest dam) top of mound level is 243.26 m AHD is matching to the groundwater level of C 18002 SP;
- Further assessment of groundwater levels of C 18002 SP and Joshua Spring is summarised below:
    - Bore C 18002 SP is screened in coarsest Clematis Sandstone at around 70m deep;
    - It is observed that the water level at the Joshua Spring turkeys nest dam is matching with that of bore C 18002 SP, and to support this observation there must exist a clear conduit or passage way for discharge of water at the Turkeys nest dam;
    - This observation is at odds with the other discharge springs/mound springs where the ground water potentiometric heads are found to be less than 240m AHD
    - With the above it is likely that Joshua Spring must be a very old uncontrolled water bore, having been converted into a turkeys nest dam to make use of the water head (albeit there is a drop in head at Joshua Spring by 0.40 m when compared to C 18002 SP bore, possibly be due to accumulation of sand, clay and vegetation around the bore over a period of time)
- Groundwater potentiometric heads within the mounds of Moses Springs-group (Moses Spring, Camaldulensis Spring and Mouldy Crumpet Spring) are within the range of 237 m to 239 m AHD;
- Comparing the hydro-stratigraphic potentiometric heads of the Clematis Sandstone aquifer as measured form C 18002 SP, with that of mound springs, it is observed that most of the pressure heads are lost in finding the way through to the surface through weak /thin unconfined Moolayember Formation. This validates the scenario discussed in the LEBSA Report 2016: *"Under this scenario sufficient artesian head in the Clematis Sandstone is required to provide discharge to the surface through a thin layer of the Moolayember Formation and/or surface alluvium thinned by erosion around the confluence of Carmichael Creek and Bimbah Creek"*
- The springs occur where the Moolayember Formation is of sufficient thickness and (low) permeability to act as a confining layer, yet sufficiently thin to facilitate discharge. This is evident from the surface outcrop adjacent to the mound springs comprises multi-coloured (white and

purple-rust) clay-rich weathered Moolayember Formation sediments; as presented in **Figure 8-12**.

Figure 8-12 Moolayember Formation outcrop

8.3.4 Water Quality Data

Water quality results from across the project area (**Table 8-2**) from EIS studies and data reported through the Environmental Authority and additionally presented in the GMMP demonstrates the following:

- Groundwater quality at Joshua Spring is fresh, recently recharged groundwater, where electrical conductivity (EC) is measured at 940 micro Siemens per centimetre (µS/cm), albeit this location is a pond/dam where water quality is influenced by evaporation/ evapotranspiration.
- Groundwater from the Clematis Sandstone outcrop (bores C14012SP and C14013SP) ranges from 410 to 490 µS/cm.
- Groundwater quality down dip of the outcrop increases slightly in salinity, where EC is measured at 630 to 720 µS/cm in Clematis Sandstone bores HD02 and HD03A.

Table 8-2: Electrical conductivity (µS/cm) in each hydrogeological unit

Hydrogeological Unit	85th Percentile of Electrical conductivity (µS/cm)
Alluvium	42,250 (east) / 900 (west)
Tertiary	14,000
Moolayember Formation	572
Clematis Sandstone	640
Dunda Beds	772
Rewan Formation	3,723
Bandanna Formation	1,896
Colinlea Sandstone	2,000
Joe Joe Group	15,900

8.3.5 Regional Geology Interpretation

Adani commissioned an investigation of the interaction of mine-scale faulting at the Carmichael Coal Project (as identified from field mapping, exploration drilling and a high resolution 2D seismic survey and interpretation undertaken in 2011), with regional trends identified from the eastern margin of the Galilee Basin.

The report briefly examined the relationship between regional structure of the eastern Galilee Basin and the local structure identified at the mine site, with reference to the effect of faulting on any aquifers present in the target sequence and the overlying strata.

There is no evidence in the geological data set of any faults with sufficient throw to bring the Clematis Sandstone into contact with the underlying Permian-age units on the other side of a faulted contact. Given that the Rewan Group is around 250 m thick at the western boundary of the proposed Mine Area, a throw of 40 m would still result in an effective aquitard thickness of 210 m.

Additionally, local field mapping, exploration drilling and 2D seismic surveying has, to date, only revealed normal faulting with throws to a maximum of forty (40) metres in the planned mine area.

Considering the current documented fault regime and based on independent geological opinion, it is not considered scientifically possible that aquifers within the coal measures (mostly coal seams) would impact on groundwater flow processes in aquifers identified in the overlying Triassic aged Dunda beds and Clematis Sandstone.

8.3.6 Properties of the Rewan Formation

Rewan Thickness

Adani has conducted extensive drilling investigations into the Rewan Formation as presented in **Table 8-3** and **Figure 8-13** which demonstrates a minimum thickness of 249m and a maximum thickness of 337.1 m and an average thickness of 277 m.

Furthermore, the Rewan Formation is found to be extending to the west of the mine leases consistently, which also separates the Permian target coal seams from the stratigraphically younger Dunda Beds and Clematis Sandstone (recognised GAB aquifer) to the west. Hence it can be concluded that the consistency of the Rewan Formation thickness to the west of the Project area up to the Doongmabulla Springs-complex further confirms the hydrogeological conceptualisation.

Table 8-3 Rewan thickness

Bore	Thickness (m)	Top of Formation (mAHD)	Bottom of Formation (mAHD)
C003	270	48	318
C010	290	89	379
C015	263	60	323
C022	268	84	352
C037	285	50.5	335.5
C037C	284	49	333
C039	273	46	319
C039CR	284	46	330
C044C	270	56	326

Bore	Thickness (m)	Top of Formation (mAHD)	Bottom of Formation (mAHD)
C047	284	176	460
C048	273	65	338
C053	269	130	399
C065	286	54	340
C065C	282	57	339
C14204VWP	306	127	433
C14205VWP	302	375	609
C14207 VWP	333	166	499
C860G	280	48	328
C861G	283	92	375
C864G	249	166	415
C865G	254	79	333
C866G	275	153	428
Shoemaker-1	279	246	526.8

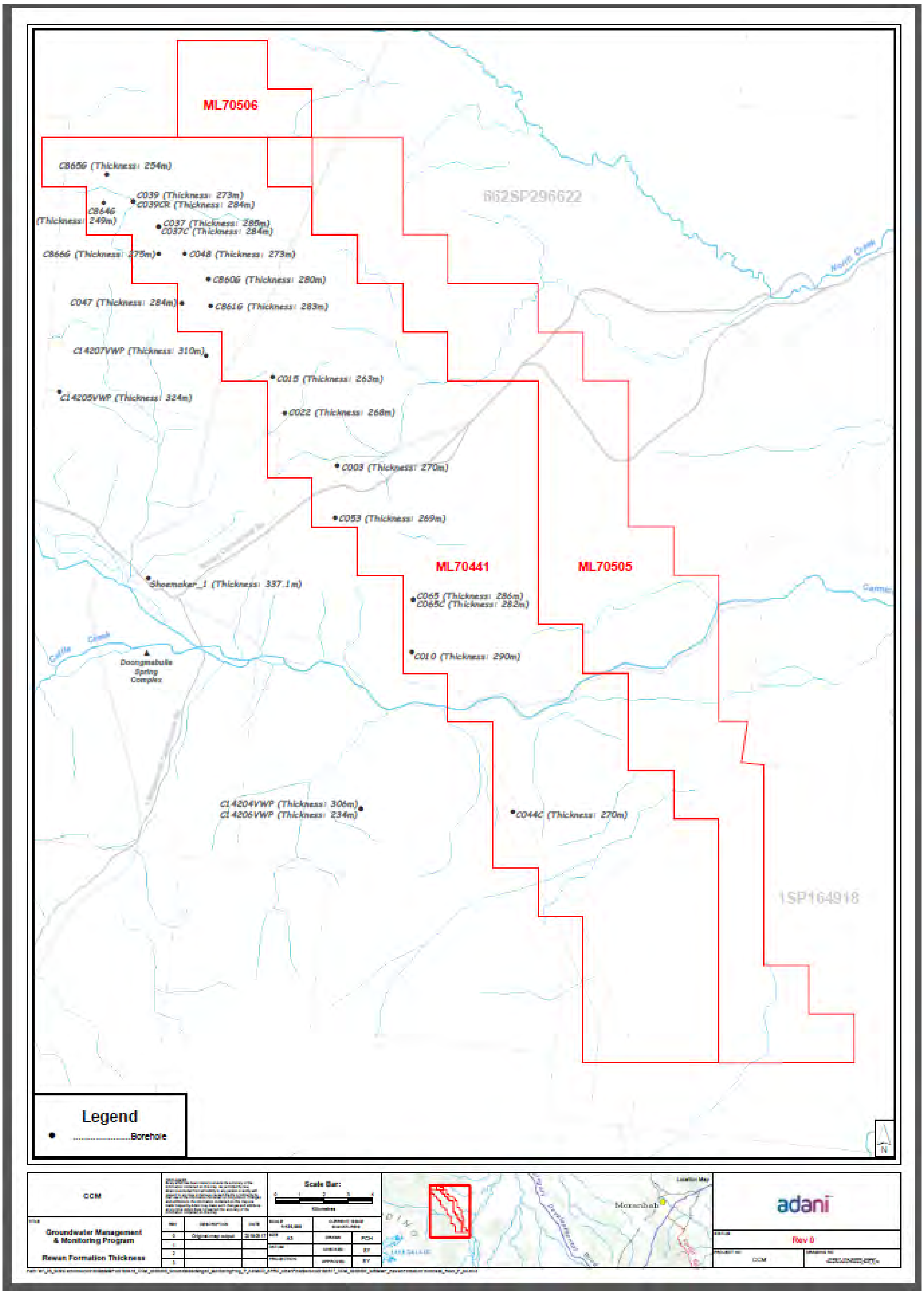


Figure 8-13 Rewan Formation boreholes

Rewan Formation Permeability

The primary permeability of the upper claystone sequence of the Rewan Formation was measured as consistently low, based on the laboratory analysis of sampled cores. In the predominant claystone strata, both vertical and horizontal hydraulic conductivity ranged from 10^{-6} to 10^{-5} m/day. In the interbedded siltstone strata, permeability was measured as low, but slightly more permeable than the surrounding claystone at 10^{-4} m/day.

The primary (formation) permeability of the lower siltstone sequence of the Rewan Formation measured as low to very low, but more variable than the upper sequence (10^{-7} to 10^{-4} m/day), likely as the result of the variance in grainsize within the predominant siltstone and the larger amount of defects.

Self-sealing Properties of Rewan Formation: Shale Gouge ratio (SGR)

To determine the SGR of interpreted faults a number of individual borehole logs extending from within the Project area towards the west (including the Shoemaker hole close to the Doongmabulla Springs-complex), were examined and the thickness of clay and shale dominated sequences within relevant logged units was quantified. Clay and shale sequences were determined from both core logging and geophysical logs for calculation of SGR for each of the relevant sequences based on anticipated fault displacements of 10 m (most frequent lower order displacement) and 50 m (maximum anticipated displacement of interpreted faults in the CCMP. Note that a SGR of 15% – 20%, is considered as the threshold above which the faults will selfheal.

- The highest SGR’s are calculated as expected in the Rewan (recognised aquitard) Formation, with the lowest SGR’s in the Clematis Sandstone
- For the Tertiary, Moolayember and Rewan Formations, calculated SGR’s are well in excess of the limiting threshold (20%), indicating that 10 m and 50 m displacement faults would consistently form an impermeable seal in these instances
- Calculated SGR’s for the Rewan Formation are consistently greater than 431% for 10 m displacement faults, and consistently greater than 86% for 50 m displacement faults. This is so far in excess of SGR of 20% derived from multiple international case study examples, that it is considered scientifically impossible for faults of this magnitude to provide connectivity through and within the interpreted Rewan Formation sequences.

8.3.7 Alternative Model Scenario

An alternative groundwater concept for the Doongmabulla Springs-complex is that the source of the mound springs is a result of the presence of faults, which facilitate groundwater flow from a deeper source aquifer below the Clematis Sandstone and the Rewan formation (**Figure 8-14**).

Consideration of drilling results, vertical groundwater gradients, and water quality data allowed for assessment of the suitability of this conceptualisation.

A key line of evidence to test this scenario was to compare the hydraulic head for all the aquifers considered to be source(s). Data from relevant bores in each hydro geological unit was used to examine the possibility of an alternate scenario.

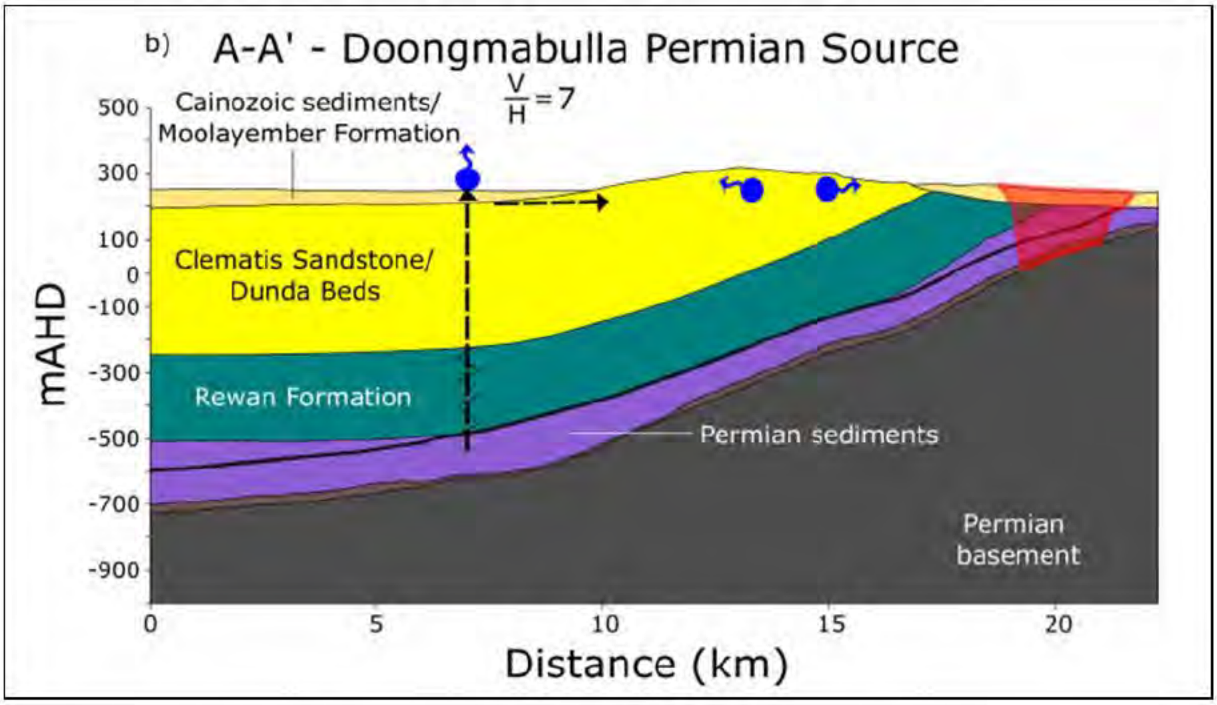


Figure 8-14 Alternative conceptual model representing the Permian Scenario (LEBSA 2016)

However groundwater levels indicate that the vertical groundwater gradients are upward above the Rewan Formation and downward below the Rewan Formation (see **Table 8-4** below which provides a summary based on groundwater contour data); this indicates the source of the Doongmabulla Springs-complex is above the Rewan Formation.

Table 8-4 Groundwater Level Elevation Data (North, Mid, and South across the CCP area)

Hydrostratigraphic Unit	North (mAHD)	Mid (mAHD)	South (mAHD)
Moolayember Formation	252.43	236.50	ND
Clematis Sandstone	250.75	243.67	247.22
Dunda Beds	246.73	227.18	250.94
Rewan Formation	252.26	211.83	239.47
Bandanna Formation	248.55	209.32	233.00
Colinlea Sandstone	242.43	213.31	231.94
Joe Joe Group	221.39	209.44	234.13

ND – Not determined

The findings from these considerations included:

- Drilling results, including the difficulties in construction of the standpipe groundwater monitoring bores within the Rewan Formation due to swelling clays, along with aquifer test results indicate that the potential for faults to occur and remain open within the approximately 250 m thick Rewan Formation are negligible.

- Surface outcrop adjacent to the mound springs comprises multi-coloured (white and purple-rust) clay-rich weathered Moolayember Formation sediments; no marked changes in elevation (fault throw) or outcrop is apparent in the springs area.
- Groundwater levels indicate that the vertical groundwater gradients are upward above the Rewan Formation and downward below the Rewan Formation this indicates the source of the Doongmabulla Springs-complex is above the Rewan Formation.
- Groundwater quality at Joshua Spring is fresh, recently recharged groundwater, where electrical conductivity (EC) is measured at 940 µS/cm, albeit this location is a pond/dam where water quality is influenced by evaporation/evapotranspiration. Groundwater from the Clematis Sandstone outcrop (bores C14012SP and C14013SP) ranges from 410 to 490 µS/cm. Groundwater quality down dip of the outcrop increases slightly in salinity, where EC is measured at 630 to 720 µS/cm in Clematis Sandstone bores HD02 and HD03A.

8.4 Summary of baseline monitoring findings

Baseline surveys of the Doongmabulla Springs-complex, described in **Section 8.2**, identified the following key features (GHD 2012a, 2014), summarised below.

- The Moses Springs-group is almost entirely intact, with the exception of impacts from cattle and pigs. It straddles Cattle Creek, comprises approximately 65 vents or springs, spread over 2.5 km, and forms a wetland of approximately 3.5 hectares (GHD, 2014).
- The Little Moses Springs-group is located to the east of the Moses Springs-group. Little Moses differs from the main Moses Springs-group in being much smaller (it has approximately two vents) and located within a woodland with different soils (GHD, 2014).
- The Joshua Springs-group was the most impacted, and is completely altered from its natural state. It now consists of a single turkey's nest dam and two associated scrapes. The overflow channel for the Joshua Spring (which carries a significant volume of water) is infested with the Grass Olive, a Category 3 restricted matter and WoNS (GHD, 2014).

The greatest habitat values of the Doongmabulla Springs-complex is the permanency of water, and the connectivity of the wetland to the nearby waterways, and the surrounding region. The reliable water supply provides an important resource for both flora and fauna during dry periods, but it is the habitat connectivity that provides the means for fauna to access the springs. Generally, the Doongmabulla Springs-complex and adjacent areas consisted of a diverse range of habitats. All strata of terrestrial vegetation were present, from native grasses and herbs through to mature trees.

The Doongmabulla Springs-complex contains a comparatively high number of flora species endemic to GAB spring wetlands, including:

- Salt Pipewort – listed as endangered under both the NC Act and the EPBC Act, observed at Moses Spring during the 2012 and 2013 field surveys.
- Blue Devil – listed as endangered under the NC Act and the EPBC Act, observed at Moses Spring during the 2012 and 2013 field surveys.
- *Hydrocotyle dipleura* – listed as vulnerable under the NC Act, observed confirmed at Moses Spring during the 2012 and 2013 field surveys.
- Waxy Cabbage Palm – listed as vulnerable under the NC Act and the EPBC Act, observed at Moses and Little Moses springs during the 2012 and 2013 field surveys.
- *Myriophyllum artesium* – listed as endangered under the NC Act, observed at Moses and Joshua springs during the 2012 and 2013 field surveys.

- *Sporobolus pamelae* – listed as endangered under the NC Act, observed at Moses Spring during the 2012 and 2013 field surveys.
- *Sporobolus partimpatens* – listed as near threatened under the NC Act, observed at Moses Spring during the 2012 and 2013 field surveys and Joshua Spring during the 2013 field survey.

A number of active searches were made during the 2012 and 2013 surveys in a variety of habitats during which only the Squatter Pigeon was observed.

8.5 Threats and impacts

Threats and potential direct / indirect project impacts that are required to be addressed as they apply to the Doongmabulla Springs-complex are:

- Direct and indirect project impacts outlined in the EIS (GHD 2012a; Adani 2012) Carmichael Coal Mine and Rail Project – Groundwater Dependent Ecosystems Management Plan (11 February 2014).
- Matters outlined in Condition 6(c) require details for impacts and threats MNES to be included in this plan.

The key threats and potential direct / indirect project impacts identified for Doongmabulla Springs-complex that are relevant to the Project are identified in **Table 8-5** and **Section 8.5**. It should be noted that the Doongmabulla Springs-complex is located a minimum of approximately 8 km from the Project's western boundary, and will therefore not be subject to direct impacts.

It should be noted that the Doongmabulla Springs-complex is on land not owned by Adani, and therefore potentially subject to impacts beyond Adani's control (e.g. grazing, clearing). Indirect impacts described in the following sections primarily relate to threats unrelated to Project activities. These potential third party impacts will be addressed by other Federal and state legislation managed between the landholder and the relevant government departments.

Table 8-5 Doongmabulla Springs-complex threats, potential direct / indirect project impacts and matters required to be addressed by conditions

#	Potential Threat or Impact	Potential indirect threat or impact identified in EIS (GHD, 2014)	EPBC Approval, condition 6	Environmental Authority condition I14 and Appendix 1, Definition of "GDEMP"	National Recovery Plan for the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin	Project Phase/s*	Earliest predicted potential impact	Table
1	Groundwater drawdown from mine dewatering	Yes	(c)(iii)	(5)	Yes	Operations Rehabilitation	Year 20	Table 8-10
2	Subsidence from underground mining	-	(c)(ii)	(5)	-	Operations Rehabilitation	Not applicable	
3	Changes to hydrology including: stream diversion and flood levees other alterations to surface water regime degradation of surface water quality	Yes	(c)(vii)	(5)	Yes	Operations	Year 1	
4	Weeds and pests through direct competition or habitat degradation	Yes	(c)(ix)	(5)	Yes	Construction Operations	Year 1	
5	Grazing pressures including browsing and trampling vegetation and disturbing hydrology	-	-		Yes	Not applicable	Not applicable	
6	Vegetation clearing / habitat loss	-	(c)(i)	-	Yes	Not applicable	Not applicable	
7	Earthworks	Yes	(c)(iv)	-	Yes	Construction	Year 1	
8	Noise and vibration	-	(c)(v)	-	-	Construction Operations	Year 1	
9	Emissions (including dust)	Yes	(c)(vi)	-	-	Construction Operations	Year 1	
10	Light spill and other visual impacts	-	(c)(vii)	-	-	Construction	Year 1	

* Please refer to Section 2.2 for details on GDEMP monitoring & implementation phase; baseline, pre-impact, impact

#1: Groundwater drawdown from mine dewatering

EPBC Approval 2010/5736, condition 6(c)(iii) requires details of potential impacts from groundwater drawdown of aquifers be addressed in this plan.

Environmental Authority condition I14 and Appendix 1, Definition of “GDEMP” (5) requires potential impacts from mine dewatering of aquifers to be addressed in this plan.

Aquifer drawdown is listed as a key threat in the Recovery plan for the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin (Queensland Government, 2010). Drilling of bores for the pastoral industry since the nineteenth century has created thousands of free-flowing artesian bores throughout the GAB. This has resulted in pressure head declines of up to 120 m, and spring flows in the discharge areas of the GAB have declined dramatically as a result of aquifer pressure decline from artificial extraction (Queensland Government, 2010).

EPBC Approval 2010/5736, condition 6(c)(iii) requires details of potential impacts from mine dewatering be addressed in this plan.

Groundwater modelling results indicate mine dewatering will influence groundwater pressure within the Doongmabulla Springs-complex during the operational and post-operational phases (GHD 2015). The maximum predicted reduction in pressure for each spring during these phases is presented in **Table 8-6** and

Table 8-7. Disturbance from local cattle grazing is a significant existing threat to the GAB springs wetland communities.

Table 8-6 Modelling predictions for aquifer springhead pressure reductions in springs-groups associated with the Doongmabulla Springs-complex – Operational Phase (GHD 2015)

Spring number and name	Spring system	Sub-system	Peak predicted drawdown in source aquifer (m) SEIS model
1031_Moses4*	Doongmabulla	Moses	<0.05
1032_Moses3*	Doongmabulla	Moses	<0.05
1033_Moses2*	Doongmabulla	Moses	0.08
1034_Littmose*	Doongmabulla	Little Moses	<0.05
1035_Moses1*	Doongmabulla	Moses	0.06
1036_75E*	Doongmabulla	Moses	0.09
1037_75A*	Doongmabulla	Moses	0.08
1038_75D*	Doongmabulla	Moses	0.07
1039_75B*	Doongmabulla	Moses	0.12
1040_75C*	Doongmabulla	Moses	0.12
1041_Doongma*	Doongmabulla	Joshua	0.19

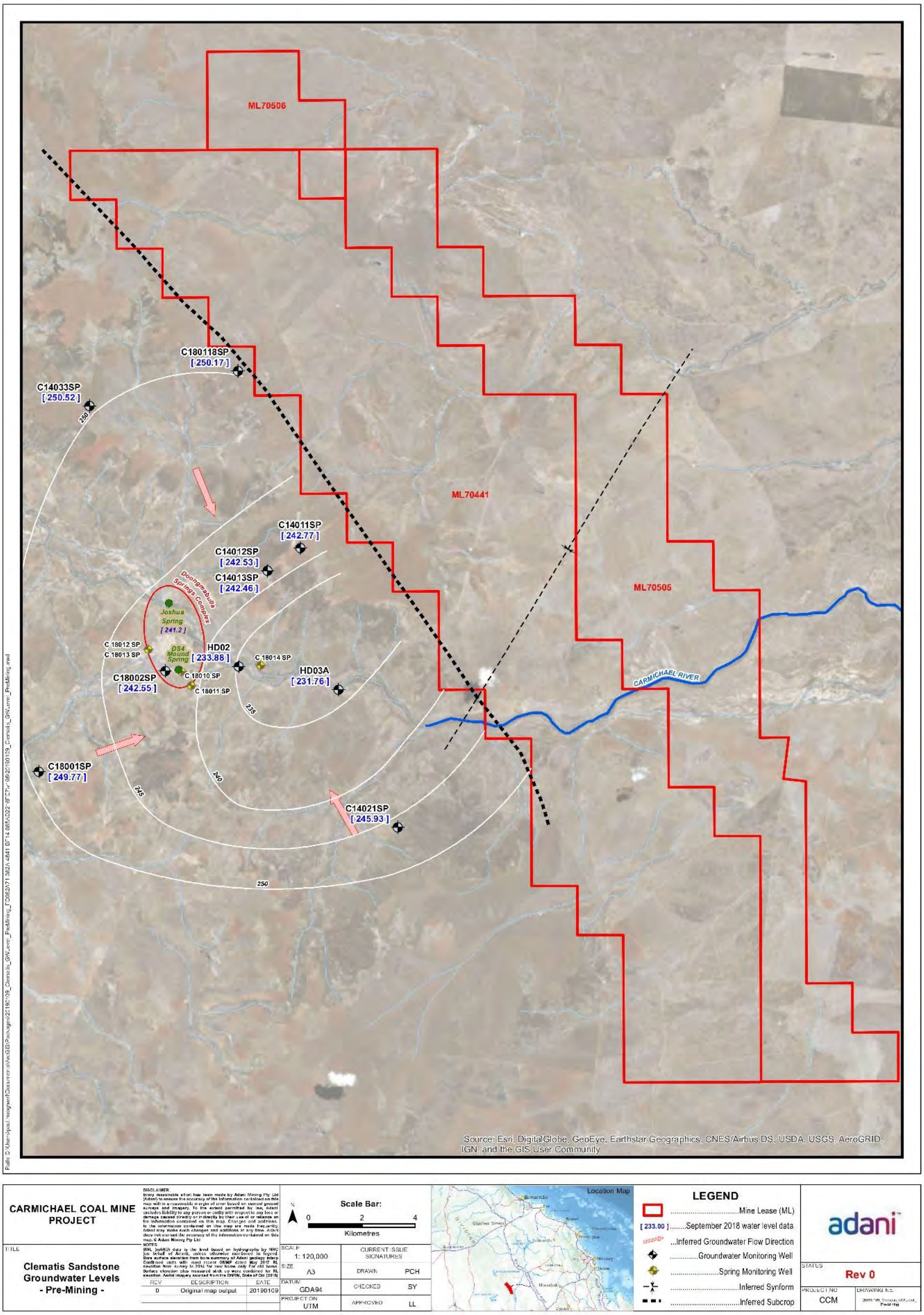
* predicted drawdown in the Clematis Sandstone

Table 8-7 Modelling predictions for aquifer springhead pressure reductions in springs-groups associated with the Doongmabulla Springs-complex – post-closure phase (GHD 2015)

Spring number and name	Spring system	Sub-system	Peak predicted drawdown in source aquifer (m) SEIS model
1031_Moses4*	Doongmabulla	Moses	<0.05
1032_Moses3*	Doongmabulla	Moses	0.05
1033_Moses2*	Doongmabulla	Moses	0.08
1034_Littmose*	Doongmabulla	Little Moses	<0.05
1035_Moses1*	Doongmabulla	Moses	0.06
1036_75E*	Doongmabulla	Moses	0.09
1037_75A*	Doongmabulla	Moses	0.07
1038_75D*	Doongmabulla	Moses	0.07
1039_75B*	Doongmabulla	Moses	0.11
1040_75C*	Doongmabulla	Moses	0.11
1041_Doongma*	Doongmabulla	Joshua	0.16

* predicted drawdown in the Clematis Sandstone

Groundwater contour maps representing the predicted drawdown from pre-mining to post-closure are presented in **Figure 8-15a-e**.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CHECKED SY
APPROVED LL
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Spring Monitoring Well
Inferred Synform
Inferred Subcrop
adani
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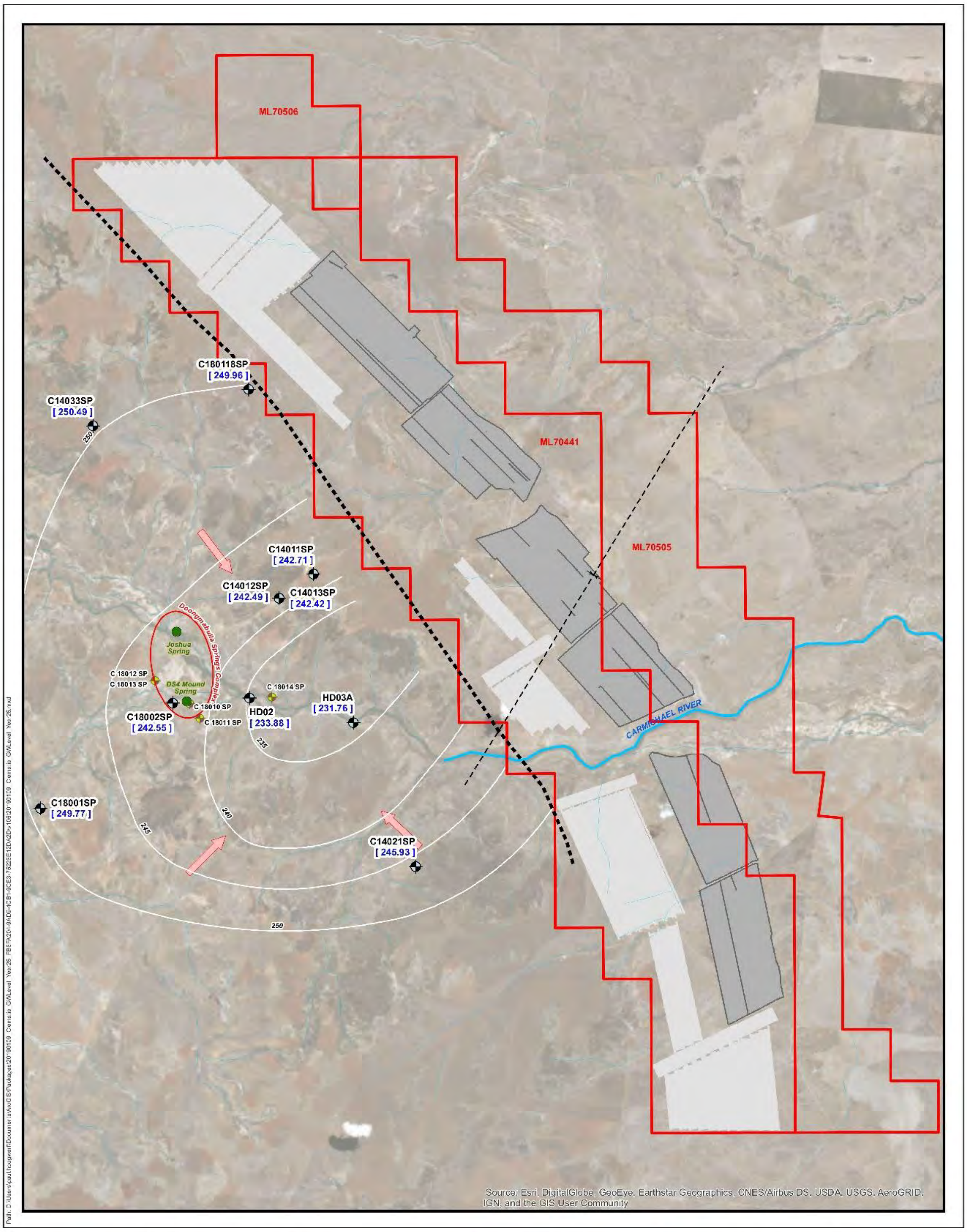

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				DATUM GDA94	CHECKED	SY
				PROJECTION UTM	APPROVED	LL

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- [233.00] Predicted Groundwater Elevation (mAHD)
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adani

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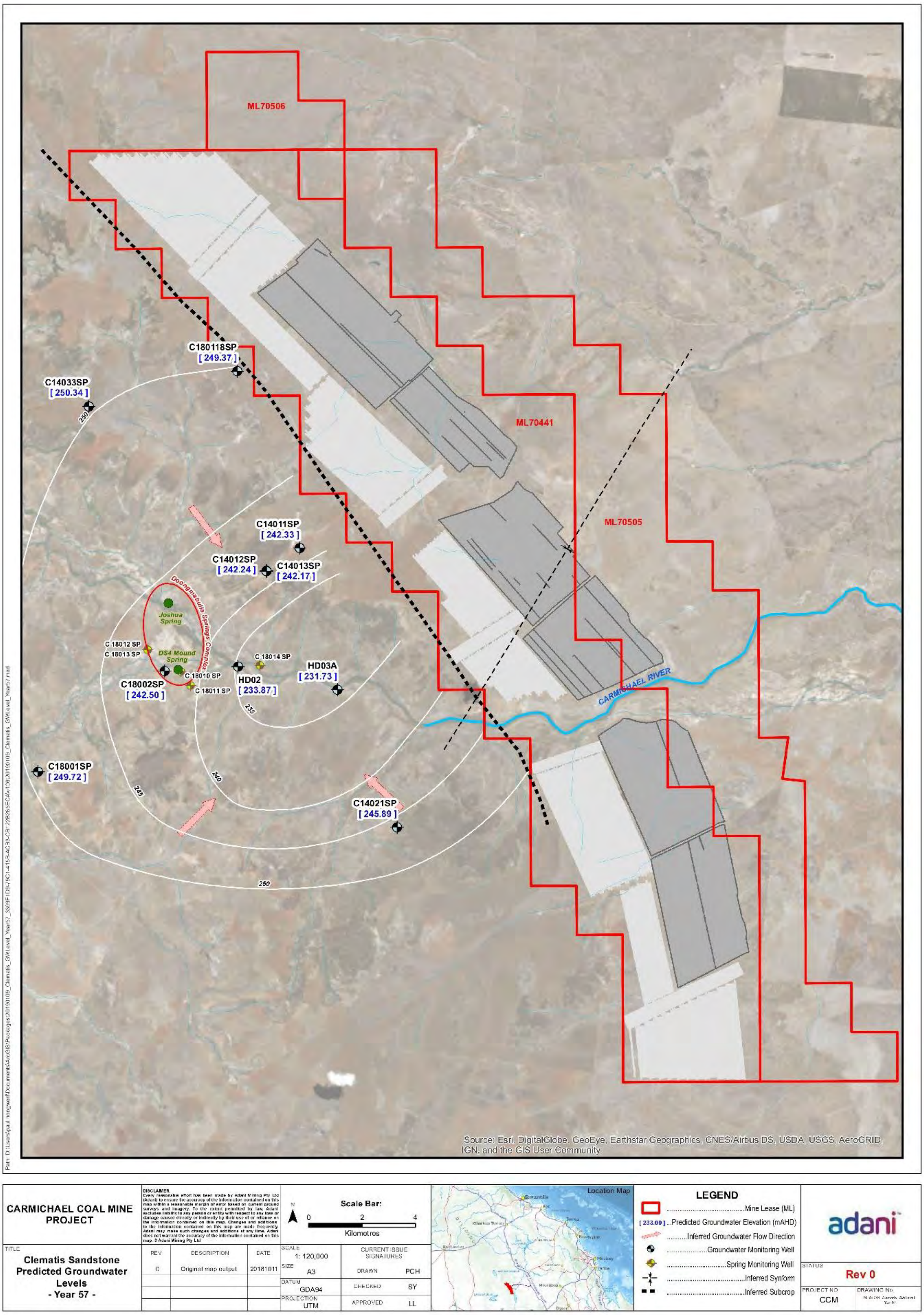

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Joshua Spring
DS4 Mound Spring
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CARMICHAEL COAL MINE PROJECT
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Spring Monitoring Well
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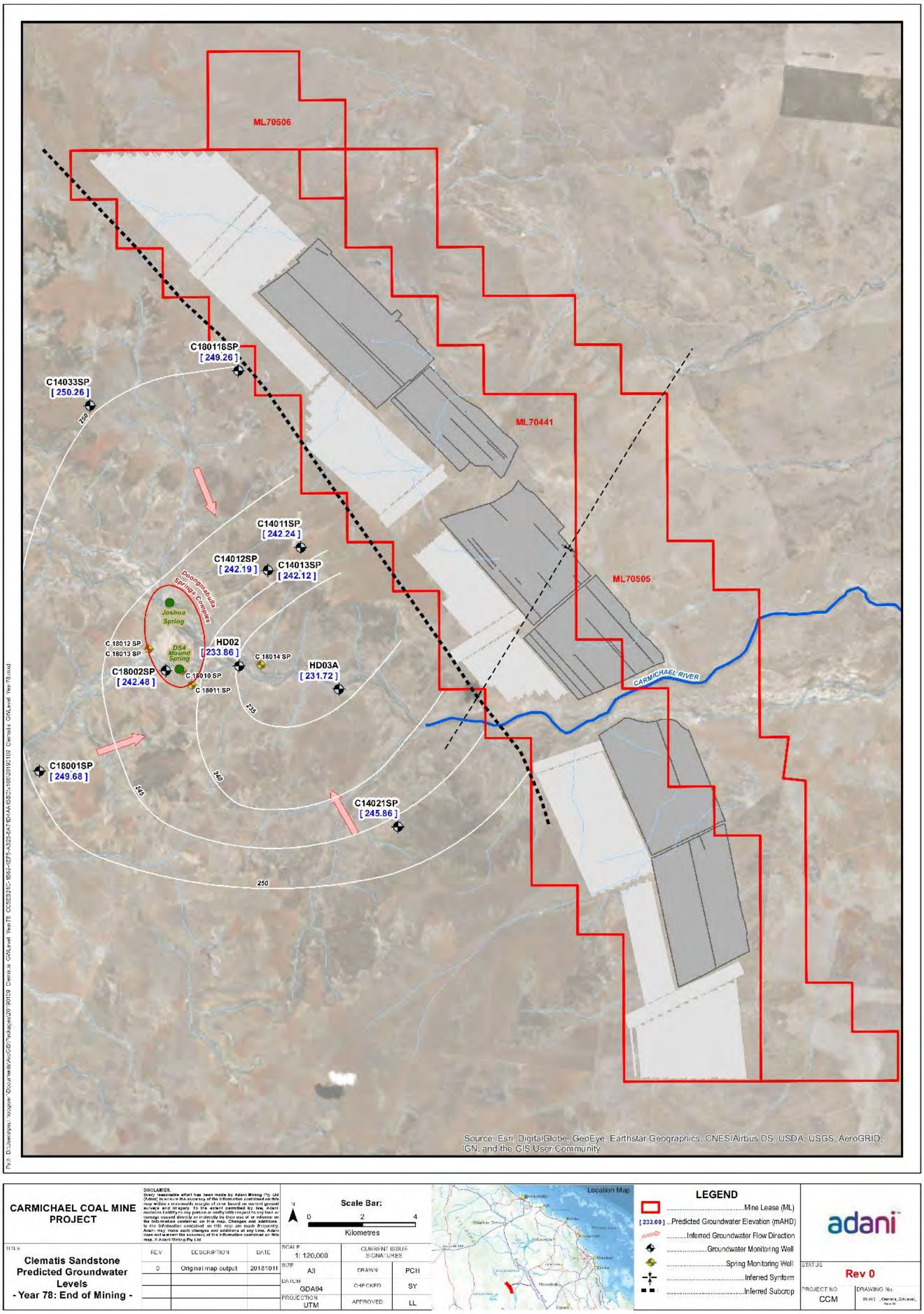
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CARMICHAEL RIVER
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245
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
CARMICHAEL COAL MINE PROJECT
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Every reasonable effort has been made by Adani Mining Pty Ltd (Adani) to ensure the accuracy of the information contained on this map within a reasonable margin of error based on current ground surveys and imagery. To the extent permitted by law, Adani excludes liability to any person or entity with respect to any loss or damage caused directly or indirectly by their use of or reliance on the information contained on this map. Changes and additions to the information contained on this map are made frequently. Adani may make such changes and additions at any time. Adani does not warrant the accuracy of the information contained on this map. © Adani Mining Pty Ltd
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Spring Monitoring Well
Inferred Synform
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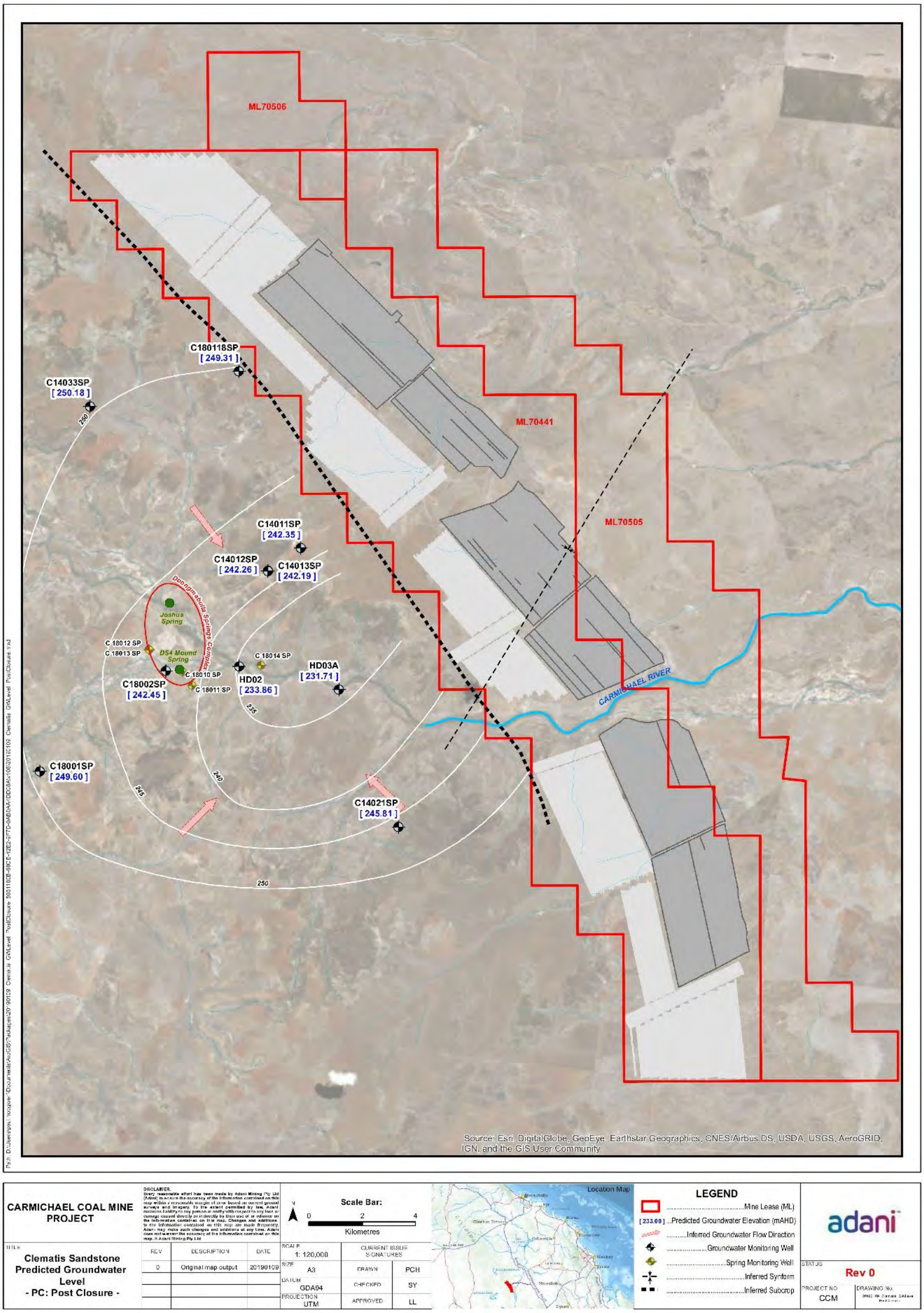


Figure 8-15a-e Groundwater impact contour maps for the Clematis aquifer

Twelve mounds at Moses Springs are less than 20 cm high, 24 mounds are 20 to 50 cm high, and 20 mounds are >50 cm high. The tallest mounds are approximately 1 to 1.5 m high (GHD 2014). The reduction in pressure at the Moses Springs-group is predicted to be between <0.05 and 0.11 m (**Table 8-6** and

Table 8-7), with the predicted reduction in pressure for the majority of the Moses spring heads being <0.08 m (GHD 2014). This predicted pressure drop falls within the natural range of seasonal fluctuations in spring flow to which the Moses Springs-group wetland communities are already adapted. Therefore, it is thought that the reduction in flow will be within a tolerable range (GHD 2014). The threatened species associated with the Moses Springs-group are generally present on or immediately adjacent to the mounds, seeps or pools. Most mounds are separated from other mounds by bare sections of plain. The majority of the population of endemic and/or threatened species at Moses Springs-group are located within wetland areas fed by seepage from the springs. These wetlands generally form sedgeland or grassland, rarely with trees (Weeping Paperbark clumps or individual Waxy Cabbage Palms).

The predicted reduction in pressure at the Little Moses Springs-group will be <0.05 m, which is predicted to result in a negligible impact on the spring wetland communities (GHD 2014).

Joshua Spring is a high flow spring that rises at least 1 m above the surrounding plain (GHD 2014). The predicted reduction in pressure of up to 0.19 m at Joshua Spring is expected be a minor impact, with no major impact on associated threatened flora (GHD 2014). The threatened species found at the Joshua Spring wetland, *Myriophyllum artesium* and *Sporobolus partimpatens*, are unlikely to be impacted, as the water supply to the wetland in which they occur is not likely to be reduced to an extent that will affect these species.

The reduction in pressure of the aquifers is expected after approximately 20 years from the commencement of mining operations (GHD 2014).

The levels of reductions (generally less than 5 percent at Moses Springs and within the range of natural seasonal fluctuations) are likely to have negligible adverse impacts at Moses Springs and, at most, negligible adverse impacts to Joshua and Little Moses Springs.

No significant impacts to the GAB discharge spring wetlands TEC will occur, as the Project (Mine) will not:

- Reduce the extent of, fragment, or increase fragmentation of the ecological community
- Adversely affect habitat critical to the survival of the ecological community, or destroy or modify factors necessary for the survival of the community
- Cause substantial changes or reductions in species compositions, quality or integrity.

Localised and direct threats to GAB springs wetland communities include excavation of springs, exotic plants, stock and feral animal disturbance, exotic aquatic animal invasion, tourist access, and impoundments (Fensham et al. 2010). Due to the location of the Doongmabulla Springs-complex being outside the mining footprint, and about 8 km from the Project boundary, mining activities are generally not expected to introduce or exacerbate direct threats to the integrity of the Doongmabulla Springs-complex wetlands TEC, such as excavation and impoundments.

A management objective under this plan is to manage the impacts of mine dewatering and limit impact of hydrological changes on the Doongmabulla Springs-complex from mine dewatering. **Table 8-10** describes how the management objectives will be met, including performance criteria, management actions, monitoring, triggers for adaptive management and corrective actions.

#2: Subsidence from underground mining

EPBC Approval 2010/5736, condition 6(c)(ii) requires details of potential impacts from subsidence be addressed in this plan.

Environmental Authority condition I14 and Appendix 1, Definition of "GDEMP" (5) requires potential impacts from mine dewatering of aquifers to be addressed in this plan.

No direct or indirect impacts associated with subsidence are predicted to occur within the vicinity of the Doongmabulla Springs-complex.

As no subsidence is predicted to occur, the management objective is to monitor to ensure there is no habitat alteration through subsidence. **Table 8-10** describes how the management objective will be met, including performance criteria, management actions, monitoring, triggers for adaptive management and corrective actions.

#3: Changes to hydrology

EPBC Approval 2010/5736, condition 6(c)(viii) requires details of potential impacts from stream diversions and flood levees, be addressed in this plan.

Environmental Authority condition I14 and Appendix 1, Definition of "GDEMP" (5) requires potential impacts from mine dewatering of aquifers to be addressed in this plan.

In addition, impoundments which may inundate GAB discharge springs are listed as a threat in the Recovery plan for the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin (Queensland Government, 2010).

The Doongmabulla Springs-complex is situated near the confluence of three third order creek systems (Cattle Creek, Dyllingo Creek and Carmichael Creek). These creeks join downstream to form the Carmichael River within the upper reaches of the Burdekin River catchment. The Springs-complex is located upstream of the Project area. There is no predicted significant impact to flooding conditions associated with the construction of levees on either side of the Carmichael River (**Figure 8-16**). **Figure 8-16** shows no increase to flooding at the western edge of the mining lease, noting that the Doongmabulla Springs-complex is upstream from this location. The focus for this threat is therefore to maintain existing surface water quality of the Doongmabulla Springs-complex.

A management objective under this plan is to maintain surface water level and quality. **Table 8-10** describes how the management objective will be met, including performance criteria, management actions, monitoring, triggers for adaptive management and corrective actions.

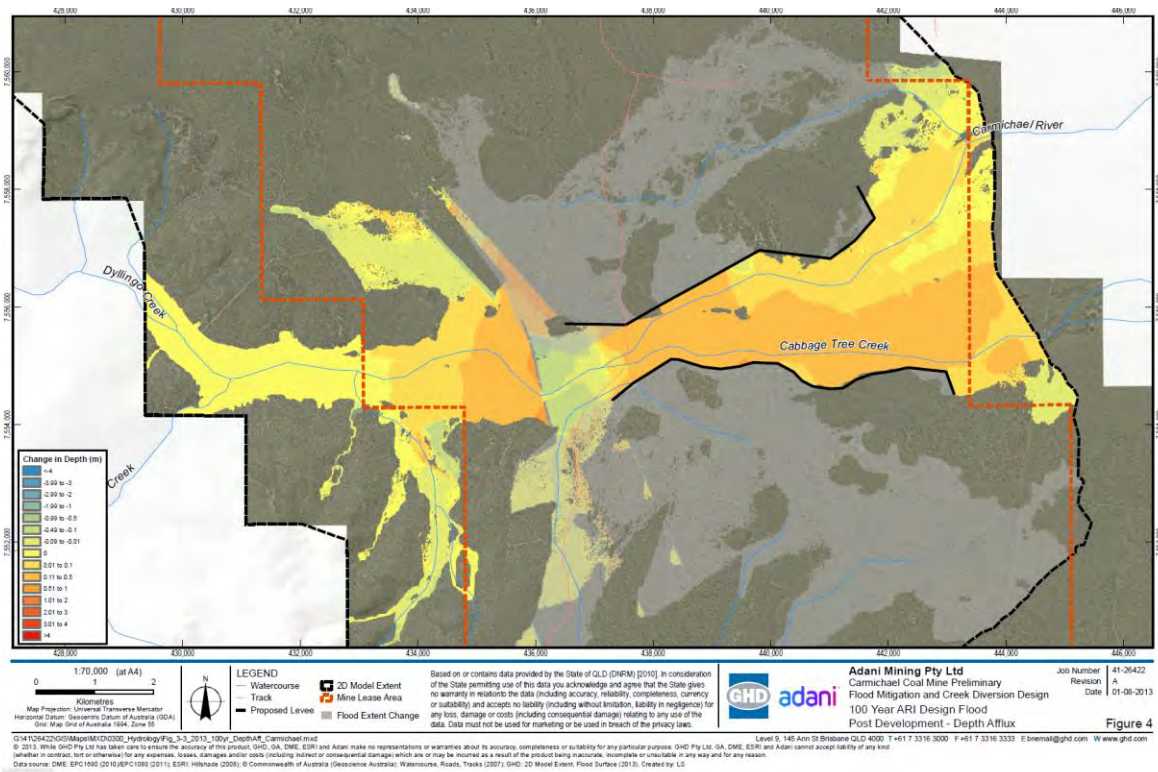


Figure 8-16 Predicted flood impacts on Carmichael River: 100-year ARI event (SEIS, Appendix K5)

#4: Weeds and pests through direct competition or habitat degradation

EPBC Approval 2010/5736, condition 6(c)(ix) requires details of potential impacts from weeds and pests, be addressed in this plan.

Environmental Authority condition I14 and Appendix 1, Definition of "GDEMP" (5) requires potential impacts from mine dewatering of aquifers to be addressed in this plan.

Weeds and pests are listed as an impact under the "National Recovery Plan for the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin".

Exotic plant incursion (e.g. ponded pasture species such as Grass Olive), and introduction of exotic animals (e.g. Mosquitofish and Cane Toads) are listed as threats in the Recovery plan for the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin (Queensland Government, 2010).

Project-related impacts on the Doongmabulla Springs-complex through drawdown may exacerbate existing impacts from weeds and pests, by reducing the resilience of the wetland communities and impacting sensitive native flora species. However, drawdown impacts have been modelled to be negligible (see #1) and no exacerbation of impacts from weeds and pests are predicted as a result of drawdown. The Doongmabulla Springs-complex currently experiences impacts in the form of pugging from cattle and pigs. Impacts from cattle grazing are not under the direct control of Adani, as the Doongmabulla Springs-complex is located on land not owned by Adani. However, Adani commits to engaging where possible with the landholder at the Doongmabulla property regarding weed and pest management practices. While there are potential impacts from increased human traffic to and from the Springs-complex for research and monitoring purposes, the risks and magnitude of such impacts are low.

A management objective under this plan is to reduce weed competition and habitat degradation from Project-related activities within the Doongmabulla Springs-complex. **Table 8-10** describes how the management objectives will be met, including performance criteria, management actions, monitoring, triggers for adaptive management and corrective actions. It should be noted that the Doongmabulla Springs-complex is located on land that is not owned by Adani.

#5: Grazing pressures

Stock and feral animal disturbance is listed as a threat in the Recovery plan for the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin (Queensland Government, 2010).

Domestic cattle grazing may lead to impacts on vegetation communities in that stock will browse leaves, trample seedlings and disturb the local hydrology. The grazing regime influences the composition and structure of the herbaceous layer of vegetation. Currently, the area surrounding the Doongmabulla Springs-complex is being predominantly used for cattle grazing. Grazing is managed by the landholder, not by Adani.

Particular cattle grazing regimes can also be used to manipulate the grass layer and manage fire by reducing fuel loads and therefore fire intensity. Grazing by cattle can be used strategically to reduce fuel loads in order to reduce the risk of hot extensive fires.

Sustainable grazing practices will be used in the Project Area on land managed by Adani as a management tool to manage threats to vegetation communities. However, Adani commits to engaging where possible with the landholder at the Doongmabulla property regarding grazing practices. For example, grazing will be used to decrease the abundance and presence of weeds, such as Buffel Grass and other exotic pasture grasses, and control fuel loads so as to reduce the risk of an uncontrolled fire.. This may have benefits for neighbouring areas adjacent to the Project area, such as the Doongmabulla Springs-complex, by reducing the dispersal and abundance of weeds in the region.

A management objective under this plan is to use strategic and sustainable grazing to manipulate the grass layer and manage fire by reducing fuel loads and therefore fire intensity, on land under the control of Adani. However, the objective is to also ensure grazing itself does not become a threat. **Table 8-10** describes how the management objectives will be met, including performance criteria, management actions, monitoring, triggers for adaptive management and corrective actions.

#6: Vegetation clearing / habitat loss

EPBC Approval 2010/5736, condition 6(c)(i) requires details of potential impacts from vegetation clearing be addressed in this plan.

Listed as an impact under the “National Recovery Plan for the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin”.

There is no direct or indirect clearing of vegetation at the Doongmabulla Springs-complex as a result of Project activities.

Management objectives about the threat and impacts include minimising habitat loss and habitat restoration of disturbed areas. **Table 8-10** describes how the management objectives will be met, including performance criteria, management actions, monitoring, triggers for adaptive management and corrective actions.

#7: Earthworks

EPBC Approval 2010/5736, condition 6(c)(iv) requires details of potential impacts from earthworks be addressed in this plan.

Earthworks/Excavations listed as an impact under the "National Recovery Plan for the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin".

Earthworks carried out as a part of mine construction and operations could lead to increased exposure to light, noise, dust, vehicles and people in areas adjacent to the Project area (Adani, 2012). The Project area is more than 8 km to the east, and there will be no direct incursion from Project vehicles or personnel beyond monitoring required as part of this plan.

Dust, noise, vibration and light spill are described in following sections.

A management objective under this plan is to minimise the risk of light vehicle and machinery strike during earthworks and operations. **Table 8-10** describes how the management objectives will be met, including performance criteria, management actions, monitoring, triggers for adaptive management and corrective actions.

#8: Noise and vibration

EPBC Approval 2010/5736, condition 6(c)(v) requires details of potential impacts from noise and vibration be addressed in this plan.

The project will use standard construction equipment, general trade equipment and specialised equipment as required. Some blasting will be required to prepare overburden for removal and also coal extraction (Adani 2012), however, it is not anticipated noise and vibration will likely impact the Doongmabulla Springs-complex due to the distance from the activities.

A management objective under this plan is to minimise habitat modification as a result of noise and vibration. **Table 8-10** describes how the management objectives will be met, including performance criteria, management actions, monitoring, triggers for adaptive management and corrective actions.

#9: Emissions (including dust)

EPBC Approval 2010/5736, condition 6(c)(vi) requires details of potential impacts from emissions, including dust, be addressed in this plan.

Dust deposition associated with construction and operational is not predicted to impact the Doongmabulla Springs-complex (Appendix L, SEIS; **Table 8-8**).

Table 8-8 Predicted incremental dust impacts (peak) – Table 17, Appendix L, SEIS

ID	Name	Predicted Incremental Deposited Dust (Annual average) (g/m^2/month)
1	Mellaluka	0.003
2	Bygana	0.002
6	Doongmabulla	0.043
17	Carmichael	0.015
18	Moray Downs	0.059
32	Lignum	0.003
V1	MWAV	0.172
A1	Airport Terminal	0.010

Note: Criterion = 2 g/m^2/month (Annual average)

A management objective under this plan is to minimise emissions, particularly dusts. **Table 8-10** describes how the management objectives will be met, including performance criteria, management actions, monitoring, triggers for adaptive management and corrective actions.

#10: Light spill and other visual impacts

EPBC Approval 2010/5736, condition 6(c)(vii) requires details of potential impacts from light spill, be addressed in this plan.

Development of the project will necessitate the installation of lighting for safety and security of operations as the proposed mine will operate 24 hours per day. Impacts from lighting will involve static floodlights associated with mine operations, lighting around the mine infrastructure area, workshops and ancillary buildings, vehicle lights moving around the site. Artificial night lighting levels are expected to be very low indeed, if present at all, and this is considered to be an impact of minor significance (Adani 2012).

It is not anticipated light spill will likely impact the Doongmabulla Springs-complex due to the distance from the activities.

A management objective under this plan is to minimise light spill and other visual impacts. **Table 8-10** describes how the management objectives will be met, including performance criteria, management actions, monitoring, triggers and corrective actions.

8.6 Mitigation and management measures

Required mitigation and management actions under the Recovery Plan for the GAB springs wetland communities ('Community of native species dependent on natural discharge of groundwater from the Great Artesian Basin' – Fensham et al. 2010) include the investigation of stock removal and fencing impacts, review of historic spring flows, monitoring of current spring flows, inventory of all endemic species in spring wetlands, monitoring of endemic species, investigating the ecology and biology of endemic species, study of the interactions between native and exotic spring fauna, better understanding of the habitat requirements of spring-dependent flora and fauna, better understanding of the impacts of fire and grazing regimes on species composition and abundance, and further investigation into the physical and chemical characteristics of springs (Fensham et al. 2010, DoE 2015).

The Moses and Little Moses Springs-groups are included in the Doongmabulla Mound Springs Nature Refuge and are subject to a Conservation Agreement that outlines the management responsibilities for the area. Landowner/s have specific obligations to manage the Nature Refuge, which is not under Adani's direct control. The Conservation Agreement requires the landholder to conserve the area's significant natural resources while permitting limited activities including:

- Low to moderate cattle grazing that does not utilise more than 50% (by weight) of the pasture standing at the end of the growing season.
- The area must be spelled during summer.
- Horses and working dogs are only allowed for the purposes of mustering cattle.
- Feral animal control (including the use of firearms).

Pre-impact groundwater monitoring will inform the updating of the numerical and conceptual groundwater model in order to confirm the source aquifer and predicted impacts. This will be completed before activities associated with predicted impacts occur. The GMMP and GDEMP will be updated once these reviews are complete and hence the mitigation and management measures presented below are based on the current conceptual groundwater model as approved through the EIS which notes that there is not likely to be significant groundwater losses at these springs leading to loss of ecological function.

Activities associated with aquifer drawdown are not expected to commence until approximately 2020, with the reduction in pressure of the aquifers expected after approximately 20 years (GHD 2014).

8.6.1 Adaptive Management

An adaptive management framework will be employed to mitigate impacts from the Project and will include a review of trigger levels for the Doongmabulla Springs-complex during the course of the Project and particularly in response to long term monitoring and studies undertaken during each assessment and monitoring stage.

When adaptive management and corrective actions are triggered, the first step is to investigate the cause of the trigger. Such investigations will involve a review of available data (including groundwater levels and groundwater quality), consideration of the potential influence of mining and non-mining activities or fluctuations in the area that may have contributed to the result, and the input of specialist advice. The specific details of the investigation will be tailored to identify the root cause or best available solution to the identified issue.

The effectiveness of management and mitigation measures will be reviewed and assessed at the completion of each assessment and monitoring stage as increased knowledge and data of the EWR and response to groundwater changes is developed during long term monitoring and research programs. If monitoring and / or greater understanding of the springs and species relationship with groundwater identifies that management measures are ineffective, the GDEMP will be updated with improved management measures.

In the event that groundwater level trigger levels for the Doongmabulla Springs-complex are exceeded, in accordance with Conditions E13 and E14 of the EA, the following process will be initiated:

- an investigation will be instigated within 14 days of detection to determine whether the fluctuations are the result of mining activities, pumping from licensed bores, seasonal variation or neighbouring land use
- if the investigation determines that the exceedance is caused by mining activities, the following tasks will be undertaken
    - determine whether impacts to the Doongmabulla Springs-complex (including threatened flora species) have occurred or are likely to occur
    - identify long-term mitigation and management measures to address the impact
    - identify corrective actions
    - notify the administering authority within 28 days of the detection
- undertake an assessment of the associated impacts to the Doongmabulla Springs-complex
- update the GDEMP if required

In accordance with Conditions I4 and I5 of the EA, if the investigation indicates that there is a risk of impacting the Doongmabulla Springs-complex beyond the current project approval, the BOS will be reviewed, and a report prepared within 3 months to identify the actual impact to the Doongmabulla Springs-complex from the mining activities. If the assessment finds that unapproved impacts to the Doongmabulla Springs-complex will occur, the BOS will be amended within 30 days and the amended offset delivered within 12 months. Potential offsets, if required, will include:

- rehabilitation of GAB springs wetland communities, in re-activated Springs-complexes within the Barcaldine Supergroup, to the same quality as baseline measures for the Doongmabulla Springs-complex wetland communities that become degraded due to groundwater drawdown
- translocation of threatened and Doongmabulla Springs-complex endemic flora and fauna species to rehabilitated and / or alternative spring habitats within the Barcaldine Supergroup
- incorporate information from the GAB Springs Research Plan into translocation and rehabilitation measures for offsetting the Doongmabulla Springs-complex wetland communities.

In the event that groundwater drawdown thresholds levels for the Doongmabulla Springs-complex are exceeded, an investigation into the cause will be undertaken and the administering authority notified within 28 days of the detection.

During this time mining activities will be limited to current activities (no expansion or mining of new areas), until the investigation determines the cause of the trigger level exceedance and also to ensure the drawdown impact interim threshold to 0.2m as per EPBC Act condition 3 (d) is not breached.

If the investigation identifies mining activities as the cause, an assessment into the known or likely impacts will be undertaken and mitigation measures identified. Adaptive management measures to be implemented include, but are not limited to:

- Limit mining activities to current activities, until monitoring indicates the trigger level(s) are no longer being exceeded, or at further risk of exceedance.
- Recharge springs using suitable quality groundwater in compliance with the EA.
- Implementation of prepared and approved BOS and Offset Management Plan.

8.7 Monitoring

8.7.1 Pre-impact survey and monitoring

Consistent with EA Conditions (E13, E14, I3, I4, I5, I8, I10 and I11), EPBC Approval Conditions (6f, 11b, 11g, 11j and 11o) and Project commitment M4.18, ecological and groundwater surveys and monitoring will be carried out at the Doongmabulla Springs-complex.

Pre-impact surveys will be undertaken at all four main wetland areas in the Moses Springs-group, the main wetland area in the Little Moses Springs-group, Joshua Spring and at least 10 mound springs in the Moses Springs-group (**Figure 8-17**). The mound springs in the Moses Springs-group have been selected from previous mounds visited and inventoried during the EIS and by the Queensland Herbarium in 2013 to represent different sizes, the presence of threatened flora (especially Salt Pipewort and Blue Devil) and to cover a geographic spread across the entire Moses Springs-group (**Figures 8-5** to **8-7** and **Figure 8-17**).

Monitoring sites will be selected on the first pre-impact survey, with the objective of selecting sites that are representative of the hydrological and ecological features that occur throughout the Doongmabulla Springs-complex. Of the 10 sites, a number will be identified to act as indicative early warning triggers and control sites..

A habitat features survey will be undertaken quarterly for two years, then nominally annually and will include:

Spring wetland extent

Mapping of the vegetated area perimeter and wetted area, as defined in the 'Wetland Monitoring Methodology for Springs in the Great Artesian Basin' (Fensham & Fairfax, 2009):

- >50% target perennial wetland cover
- Areas where >50% target perennial wetland cover would have been prior to disturbance by pigs or stock
- Areas of free water forming a spring pool contained within target perennial wetland vegetation
- Review and interpretation of remote sensing images if available, following 'A new approach to monitoring spatial distribution and dynamics of wetlands and associated flows of Australian Great Artesian Basin springs using QuickBird satellite imagery' (White & Lewis 2011)
- Produce a digital elevation model for the Doongmabulla Springs-complex
- Spring wetland extent will be monitored at Little Moses, Moses 1, Moses 3, Moses 4 and Geschlichen.

Indicator: spring wetland extent

Spring wetland water level

A baseline water level will be established at a reference location for the springs, and water levels will be measured using a reference marker. Surface water level will be measured against the marker during each survey.

This monitoring will complement the wetland area measurements, which provides a surrogate measure of flow via the Fatchen equation.

Spring wetland water level will be monitored at Little Moses, Moses 1, Moses 3, Moses 4 and Geschlichen.

Indicator: wetland pool depth

Mound springs

Surveys of 10 mound springs at the Moses Springs-group, to collect the following information:

- Mound diameter, height and perimeter
- Full floristic species composition and abundances
- Population surveys for spring endemic flora species
- Population surveys for EPBC and NC Act listed species
- Photographic references

These surveys will describe both the terrestrial (i.e. non-wetland) and spring wetland vegetation, as well as define the target perennial wetland species.

The mound springs to be monitored are Mouldy Crumpet 4, Mouldy Crumpet 6, Mouldy Crumpet B, Mouldy Crumpet C, Mouldy Crumpet G, Mouldy Crumpet L, Mouldy Crumpet N, Mouldy Crumpet AD, Moses 1A and Moses 1D.

Wetland vegetation monitoring

Monitoring will consist of vegetation surveys along transects and within sub plots. Vegetation transects will be located across the wetland area gradient, from the spring source to the boundary with non-wetland areas. The transects and subplots along the transects will be used to collect the following information:

- Identify wetland zones (pool, saturated, damp, dry) and their boundary locations
- Photographic references (photo point monitoring)
- Wetland vegetation species composition
- Wetland vegetation species abundances (1 m x 1 m subplots spaced 4 m apart, along the transect)

These surveys will describe both the terrestrial (i.e. non-wetland) and spring wetland vegetation.

Baseline vegetation composition surveys will be used to identify target non-endemic and non-threatened perennial wetland species for monitoring at each springs wetland. These species will be monitored using replicate 1 m x 1 m subplots.

Spring wetland vegetation will be monitored at Little Moses, Moses 1, Moses 3, Moses 4, and Geschlichen.

Indicators: wetland vegetation zone, native vegetation cover

Threatened and endemic flora populations

Targeted searches will be used to identify patches of endemic and threatened wetland flora for monitoring at each springs wetland.

The location, extent, and presence of all threatened and endemic flora will be surveyed and recorded using a differential GPS. The threatened and endemic species to be monitored include:

- Waxy Cabbage Palm *Livistona lanuginosa* (Vulnerable – Moses)
- Blue Devil *Eryngium fontanum* (Endangered - Moses)
- Salt pipewort *Eriocaulon carsonii* (Endangered – Moses)
- *Hydrocotyle dipleura* (Vulnerable - Moses)
- *Isotoma* sp. 'RJ Fensham 3883' (Endemic – Moses)
- *Myriophyllum artesium* (Endangered – Moses and Joshua)
- *Sporobolus pamelae* (Endangered – Moses)
- *Sporobolus partimpatens* (Near Threatened – Moses and Joshua)
- Any other flora identified during baseline surveys as endemic or threatened, and reliant on GAB spring wetlands for survival

Threatened and endemic flora will be surveyed at all spring heads in the Moses Springs-group and monitored at all springs where they occur.

Indicators: threatened and endemic species presence, condition and location.

Aquatic invertebrate communities

Aquatic invertebrate sampling (for endemic species) will be based on the methods used for GAB Springs monitoring in the Surat Basin. This includes sweeping an area of up to 5m^2 with a macroinvertebrate net for 5 minutes and transferring samples into a sterile jar (with a preservative) for subsequent laboratory identification to morpho-family level.

Macroinvertebrate assemblage structure will be compared with results obtained during EIS studies, and as well as published results from similar studies of springs in Queensland.

Aquatic invertebrates will be monitored at the Little Moses, Moses 1, Moses 3, Moses 4, Camp spring and Geschlichen wetland areas.

Indicators: Macroinvertebrate genera and species richness

Weed and pest surveys

Annual weed and pest surveys will be undertaken at the Doongmabulla Springs-complex to:

- identify the extent of weeds,
- identify areas of wetland habitat subject to damage from feral and domestic animals

Indicators: Presence of weed species, Extent of weed coverage, Presence of pest species, Extent of pest disturbance

Stygofauna

Stygofauna sampled from two bores within the western Mine Area were identified as belonging to three families that are common to all Australian states.

A round of stygofauna sampling will be undertaken at Doongmabulla (and Mellaluka) Springs-complexes, to determine the presence of stygofauna and to identify if endemicity in the stygofauna community exists within the aquifer.

<u>Indicators</u>: Stygofauna presence, stygofauna endemicity

Groundwater Monitoring

Groundwater monitoring to inform combined baseline and pre-impact dataset for input into model review prior to activities and impacts.

- 12 hourly for water levels and at least every two months for water quality as per GMMP

<u>Indicators</u>: groundwater level, groundwater quality

Surface Water Monitoring

Water quality will be assessed (monthly) at Joshua Spring, Little Moses, Mouldy Crumpet 4, Mouldy Crumpet 6, Mouldy Crumpet B, Mouldy Crumpet C, Mouldy Crumpet G, Mouldy Crumpet L, Mouldy Crumpet N, Mouldy Crumpet AD, Moses 1A, Moses 1D, Moses 1, Moses 3, Moses 4 and Geschlichen.

Measure flow rates at Joshua Spring and Dyllingo Creek adjacent to Joshua Spring

<u>Indicators</u>: surface water quality (analytes in **Appendix A**), flow rates

8.7.2 Baseline and pre-impact condition report

At the conclusion of pre-impact surveys an Ecological Condition report will be prepared for the springs. The report will present results from baseline studies (EIS), each of the pre-impact monitoring events, mapping and photo-points and discuss the seasonal and spatial variation in the results. Data from the GMMP monitoring program (or example springs flow/ water level and head pressure) will also be included. Recommendations for refining future ongoing monitoring methodology and frequency will also be made, in conjunction with a review of the relevant management and monitoring plans.

8.7.3 Impact surveys and monitoring

Impact surveys and photo monitoring at the Doongmabulla Springs-complex will be undertaken annually for the life of the mine. The full suite of the survey and monitoring program will be confirmed after the completion of the Ecological Condition Report, but include at a minimum, groundwater, wetland extent and level, spring flow, endemic species, annual habitat feature surveys, photo monitoring and weed and pest surveys.

Impact survey and monitoring will begin from excavation of the first box cut and afterwards for the life of the mine, and for at least five years after mining operations are completed.

Ongoing monitoring will also contribute to the continued understanding of the springs until groundwater drawdown impacts from the mine appear (at approximately 20 years after commencement). Monitoring will focus on the responses of the springs wetlands and mound springs as well as Salt Pipewort and Blue

Devil in response to changes in groundwater conditions. The effectiveness of management and mitigation measures with regard to Project related threats will also be monitored.

Events based monitoring will also occur during impact surveys if routine monitoring of groundwater and / or the Doongmabulla Springs-complex wetlands and mound springs identifies that trigger levels have been exceeded. This will consist of investigations, studies and additional monitoring to determine the cause and potential magnitude of impacts as well as identifying adaptive and corrective management measures.

Surface water monitoring will be undertaken monthly and will include:

- Water quality will be assessed at Joshua Spring, Little Moses, Mouldy Crumpet 4, Mouldy Crumpet 6, Mouldy Crumpet B, Mouldy Crumpet C, Mouldy Crumpet G, Mouldy Crumpet L, Mouldy Crumpet N, Mouldy Crumpet AD, Moses 1A, Moses 1D, Moses 1, Moses 3, Moses 4 and Geschlichen.

An annual report on the spring condition, including statistical comparison to baseline condition, will be provided to DoEE and DES, including reporting on any change from baseline conditions and planned actions.

Indicators: groundwater level, groundwater quality, wetland extent and level, spring flow, threatened and endemic species presence, condition and location, presence of weed species, extent of weed coverage, presence of pest species, extent of pest disturbance

Figure 8-17 Mound springs to be monitored

8.7.4 Groundwater Monitoring Program (GMMP)

Pre-impact monitoring of groundwater quality and levels at Doongmabulla Springs-complex will be undertaken every two months up to commencement of the relevant mining activities. Ongoing monitoring of groundwater quality at Doongmabulla Springs-complex will be undertaken every two months, as described in the GMMP. Monitoring programs will be implemented following approval of the GDEMP.

There are five spear wells installed into spring mounds to monitor groundwater levels near spring mounds:

- C18010SP
- C18011SP
- C18012SP
- C18013SP
- C18014SP

Specific groundwater monitoring bores (also shown on **Figure 8-15a-e**) for the Doongmabulla Springs-complex are:

- Moolayember Formation
    - C14020SP
    - C18003SP
- Clematis Sandstone
    - HD02
    - HD03A
    - C14011SP
    - C14012SP
    - C14013SP
    - C14021SP
    - C14033SP
    - C18001SP
    - C18002SP

Corresponding groundwater level and quality trigger levels for some of these bores, as well as additional bore monitoring being conducted in the first two-year program prior to the groundwater model rerun, are provided in **Appendix B**.

Monitoring will be a fundamental component of the management approach, with the objective of informing an adaptive management approach with respect to ecological values of the Doongmabulla Springs-complex and springs in the Galilee Basin (GHD 2014).

A refined conceptual model for the Doongmabulla Springs-complex will be developed following the completion of the pre-impact surveys. This will detail the predicted interactions and EWRs as well as responses to groundwater changes. This model will be revised whenever new information is available from monitoring.

Groundwater modelling will be re-run as new information becomes available as per EA and EPBC Act approval conditions (within 2 years of commencement of mining activities and every 5 years thereafter). All groundwater models will be independently peer-reviewed prior to submission. Post closure groundwater modelling will be undertaken at least two years prior to closure to confirm and / or validate predicted impacts on the Doongmabulla Springs-complex and inform ongoing mitigation and monitoring measures.

Additional studies to determine the interaction with groundwater and the EWR of the springs and threatened flora species will occur as part of the research program that Adani has committed to.

8.8 Triggers for adaptive management and corrective action

Trigger levels for impacts to the Doongmabulla Springs-complex have been developed based on current understanding (in particular the Clematis Sandstone is the source aquifer), available literature and similar studies for GAB spring wetland communities (e.g. OGIA 2015, DNRM 2016a, DNRM 2016b, Fensham et al. 2016). Low-risk trigger levels for biological and ecological indicators are based on statistically significant deviations from conditions determined during baseline surveys.

Triggers include thresholds related to groundwater, wetland area, vegetation composition, weed cover and water quality. Ecological trigger levels (described in **Section 5.3**) will be reviewed at the completion of pre-impact surveys, based on an improved understanding of natural variation in the wetland attributes and the aquifer water levels.

The Doongmabulla Springs-complex wetlands and mound springs will be monitored quarterly during baseline studies, with the results feeding into an adaptive management protocol. If trigger levels are exceeded, the response will be immediate corrective actions if appropriate, and a review of management and offset options.

As per the GMMP, a network of groundwater monitoring bores has been established including bores with the particular aim of monitoring groundwater level and quality in the vicinity of the springs, including the following designated early warning bores:

- HD03A (Clematis Formation)
- C14012SP (Clematis Sandstone)
- HD02 (Clematis Sandstone)
- C 18002 SP (Clematis Sandstone)
- C 18003 SP (Moolayember formation)
- C180116SP (Rewan Formation)
- C14023SP (Rewan Formation)
- C14024SP (Rewan Formation)
- C9553P1R (Rewan Formation)
- C555P1 (Rewan Formation)
- C556P1 (Rewan Formation)

The GMMP recommends the installation of additional bores, in order to evaluate the vertical gradients between hydrogeological units. These proposed additional monitoring bores will be completed in the

Rewan Formation / Dunda Beds and will also be designated as early warning bores for vertical migration of potential drawdown from the deeper coal measures. They will be co-located, or within 500m of existing Clematis sandstone monitoring locations.

Groundwater drawdown and quality trigger levels will be defined for these bores based on background groundwater monitoring data collected during the baseline monitoring and will be incorporated in the GMMP. The relevant early warning and threshold triggers for aquifers associated with this GDE are described in the GMMP, in **Section 4.3.1** and are also presented in **Appendix B**. The Doongmabulla Springs-complex and groundwater levels will be monitored with the results feeding into an adaptive management protocol.

Low-risk trigger levels for biological and ecological indicators are based on a statistically significant deviation from baseline for the following indicators:

- Wetland area (baseline conditions will be partly informed by desktop studies using historic satellite imagery and associated calculations of wetland area)
- Mound springs characteristics (maximum diameter, height, perimeter length, full floristics species composition and abundance, abundance of spring endemic flora species, abundance of threatened species) Cover and diversity of threatened and endemic flora species and native vegetation
- Wetland pool depth (measured from a specific site in each pool for consistency)
- Wetland vegetation zone margins (e.g. area of free-standing water, proportion of wetland that is saturated, damp or dry – measured using a soil moisture probe)
- Loss of a threatened and / or endemic flora population from a wetland area
- Reduction in the abundance of threatened and / or endemic fauna
- Change in aquatic invertebrate communities (utilising GAB Monitoring protocols)

If a trigger is exceeded, an investigation will be conducted to determine whether the detected result is caused by mining activities. The investigation should follow the broad approach outlined in Section 3.3 of the ANZECC (2000) Guidelines, and will involve:

- Development of a decision tree model for the possible effect of mining activities on the measured variable
- Site-specific investigations involving the collection and interpretation of additional data
- A review of relevant data related to potential non-mining causes of variability in environmental variables (e.g. climatic data)
- Developing a detailed model of relevant environmental variables
- Expert opinion on the potential for environmental harm

In the event that threatened flora or fauna species are discovered during monitoring activities, additional surveys will be required to determine the species dependency on the springs. The GDEMP and Mine Species Management Plan will be updated, and additional offsets may be required.

The approach to statistical analysis is summarised in **Table 8-9**.

Table 8-9 Statistical approach for Doongmabulla Springs-complex triggers and monitoring

GDE	Indicator	Relevant Triggers	Design (to be confirmed following pre-impact surveys)	Parameters	Statistical analysis
Doongmabulla Springs-complex	Groundwater level	Groundwater level drawdown thresholds as outlined in the GMMP, Appendix B and Table E3 in the EA.	Monitoring at the bores listed in Section 8.7.4. Monitored bi-monthly on an ongoing basis.	Groundwater level.	Univariate comparison between groundwater level at time of sampling and groundwater level threshold.
	Groundwater quality	Groundwater Quality Trigger levels as outlined in the GMMP and Table E2 in the EA.	Monitoring at the bores listed in Section 8.7.4. Monitored quarterly as per GMMP.	Water quality parameters as outlined in GMMP.	Descriptive comparison with defined trigger levels.
	Spring wetland extent	Statistically significant difference in spring wetland extent from Baseline & pre-impact conditions.	Surveys will be undertaken at Moses, Little Moses and Joshua springs. Pre-impact monitored seasonally (wet and dry season) for two years, then seasonally (wet and dry season) until baseline & pre-impact is established, annually thereafter.	Perennial wetland cover assessed both on site and via remote sensing. Identify wetland zones (pool, saturated, damp, dry) and their boundary locations. Photographic reference	Univariate f and t-tests to statistically compare variance and mean extent between time of sample and baseline & pre-impact conditions.
	Wetland vegetation	Statistically significant difference in wetland vegetation composition from Baseline & pre-impact conditions.	Surveys will be undertaken at Moses, Little Moses and Joshua springs. Pre-impact monitored seasonally (wet and dry season) for two years, then seasonally (wet and dry season) until Baseline & pre-impact is established, annually thereafter.	Wetland vegetation species composition Wetland vegetation Species abundances (1 m x 1 m subplots spaced 4 m apart, along the transect).	MDS graphs to show relative spread of plots based on vegetation composition (cover and species richness). Multivariate PERMANOVA test on parameters to detect significant differences between sampling time and baseline & pre-impact. Follow up SIMPER tests to detect the main indicators driving the patterns in the data.
	Threatened and endemic flora populations	Loss of a threatened species from any spring	Surveys will be undertaken at Moses, Little Moses and Joshua springs. Pre-impact	Location, extent and condition of	Univariate f and t-tests to statistically compare vegetation extent, condition and richness

GDE	Indicator	Relevant Triggers	Design (to be confirmed following pre-impact surveys)	Parameters	Statistical analysis
		Statistically significant difference in threatened species condition from Baseline & pre-impact conditions.	monitored seasonally (wet and dry season) for two years, then seasonally (wet and dry season) until Baseline & pre-impact is established, annually thereafter.	Waxy Cabbage Palm *Livistona lanuginosa* (Vulnerable – Moses) Blue Devil *Eryngium fontanum* (Endangered - Moses) Salt pipewort *Eriocaulon carsonii* subsp. *Orientale* (Endangered – Moses) *Hydrocotyle dipleura* (Vulnerable - Moses) *Isotoma* sp. 'RJ Fensham 3883' (Endemic – Moses) *Myriophyllum artesium* (Endangered – Moses and Joshua) *Sporobolus pamelae* (Endangered – Moses) *Sporobolus partimpatens* (Near Threatened – Moses and Joshua) Any other flora identified during baseline surveys as endemic or threatened, and reliant on GAB spring wetlands for survival.	between time of sample and baseline & pre-impact conditions. MDS graphs to show relative spread of plots based on vegetation composition (cover and species richness). Multivariate PERMANOVA test on parameters to detect significant differences between sampling time and Baseline & pre-impact. Follow up SIMPER tests to detect the main indicators driving the patterns in the data.

8.9 Environmental Offsets

The assessment of potential impacts to the Doongmabulla Springs-complex indicates that no offset is required (GHD 2014). In the event that future monitoring and modelling suggest that impacts will be significant and mitigation and management measures are not feasible, offsets will be considered as part of the Biodiversity Offset Plan.

8.10 Management, Mitigation, Monitoring and Corrective Actions

The threats to the Doongmabulla Springs-complex (including the listed flora species present at the spring) relevant to the Project and potential project impacts and actions minimising impacts to the Doongmabulla Springs-complex are summarised in **Table 8-10**. The table addresses the following:

- management objectives
- performance criteria
- management actions
- monitoring
- triggers for adaptive management and corrective actions
- specific, measurable and time-bound corrective actions.

The relevant statistical analyses outlined in section 5.4.3 support the specific performance criteria for the Doongmabulla Springs complex. Table 8-10 and Table 8-9 (Statistical approach for Doongmabulla Springs-complex triggers and monitoring) will be used to assess the success of management measures against goals, triggers, implementation of corrective actions if the criteria are not met within specified timeframes.

At the conclusion of pre-impact monitoring, the performance criteria, monitoring and triggers will be reviewed, and updated, as required, via the review and adaptive management process detailed in sections 10.2 (Pre-impact studies, reporting and updates), 10.3 (Annual and compliance reporting) and 10.4 (Reporting and monitoring of related management plans and programs).

The objectives apply for the life of the approvals, and the life of this plan, subject to updates via reviews and adaptive management process detailed in sections 10.2 to 10.4

Table 8-10 Management objectives, performance criteria, adaptive management triggers and corrective actions for the Doongmabulla Springs-complex

#	Potential indirect project impact	Management objective	Performance Criteria	Management Actions	Monitoring	Monitoring Indicators	Ecological trigger for adaptive management and corrective actions	Corrective actions
1	Groundwater drawdown from mine activities including dewatering	Minimise the impact of aquifer drawdown caused by mining activities on the Doongmabulla Springs-complex	No impact to Doongmabulla Springs-complex due to aquifer drawdown caused by mining activities other than that approved.	Implement groundwater monitoring and management program as per the GMMP and undertake review of conceptual model as per EA and EPBC Conditions to inform impact predictions. Incorporate research outcomes from the GABSRP and RFCRP in relation to GDEMP and GMMP implementation,	**Pre-impact and impact monitoring:** Groundwater Management and Monitoring Program Habitat Features Survey (initially quarterly, then annually) inclusive of indicators under Section 8.7.1 Aquatic Invertebrate Survey Stygofauna Survey (PI)	Groundwater quality Groundwater level Spring wetland extent Spring wetland water level Wetland pool depth Wetland vegetation zone Native vegetation cover Threatened and Endemic Flora presence and location Macroinvertebrate genera and species richness Stygofauna presence Stygofauna endemicity	Groundwater level drawdown thresholds as outlined in the GMMP, Appendix B and Table E3 in the EA are exceeded. Groundwater drawdown rates are exceeded The condition of Doongmabulla Springs-complex declines due to aquifer drawdown caused by mining activities including: • Decrease in wetland area • Wetland vegetation zone margins contract Loss of native wetland vegetation cover Increase in weed and / or non-wetland species	The appropriate corrective actions will be implemented and may include: • In the event that groundwater level or rate triggers are exceeded, the investigation, response and corrective actions process under the GMMP will be implemented • Limiting mining to current activities until trigger not exceeded and revision of mine planning or associated activities • Directing research priorities under the GABSRP and/or RFCRP in relation to mitigation strategies and offset requirements, • If impacts are predicted to be beyond those allowed in the project approvals, commence planning of further mitigation activities with regards to water availability at the springs. • Reviewing ecological trigger and groundwater trigger/threshold relationships and, if required, proposed new trigger mechanisms. Assessment and review to be completed within 4 weeks. • Implementing relevant operational constraints in relation to groundwater drawdown impacts, including revised mine planning or associated activities •
		Minimise the impact of aquifer drawdown caused by mining activities on the Doongmabulla Springs-complex	No impact to Doongmabulla Springs-complex due to degradation of groundwater quality caused by mining activities other than that approved.	No predicted groundwater quality impacts as a result of mining activities. Monitoring bores have been established in suitable locations associated with the Doongmabulla Springs-complex. Adani will undertake additional studies that inform the conceptual model relating to the source aquifer of the Doongmabulla Springs-complex. .	**Pre-impact and impact monitoring:** Groundwater Management and Monitoring Program Habitat Features Survey (initially quarterly, then annually) inclusive of indicators under Section 8.7.1 Aquatic Invertebrate Survey Stygofauna Survey (PI)	Groundwater quality Spring wetland extent Spring wetland water level Wetland pool depth Wetland vegetation zone Native vegetation cover Threatened and Endemic Flora presence and location Macroinvertebrate genera and species richness Stygofauna presence Stygofauna endemicity	Groundwater quality trigger levels as outlined in the GMMP and Table E2 in the EA are exceeded. The condition of Doongmabulla Springs-complex declines due to aquifer drawdown caused by mining activities including: • Decrease in wetland area • Wetland vegetation zone margins contract Loss of native wetland vegetation cover Increase in weed and / or non-wetland species	
2	Subsidence from underground mining	No habitat impacts related to subsidence	No subsidence impacts, such as ponding and cracking (not predicted for any GDE)	Implement the project Subsidence Management Plan as per the EA. Engagement with landholder at the Doongmabulla property regarding operational practices.	**Pre-impact and impact monitoring:** Subsidence Management Regular (at least monthly) site inspections in accordance with the Environmental Management Plan and System.	Early warning signs of subsidence, such as ponding, cracking, tilt, strain and displacement.	Measurable evidence of tilt in the vicinity of the Doongmabulla springs-complex attributable to Subsidence.	The appropriate corrective actions will be implemented and may include: • Repeating the Habitat Features Survey within 2 months to validate / test findings • Groundwater impact report to be developed within 2 months to inform on background/seasonal/mining related impacts • Reviewing subsidence related infrastructure and drainage within 2 months to identify causal factors and recommend changes to prevent ongoing impacts.

#	Potential indirect project impact	Management objective	Performance Criteria	Management Actions	Monitoring	Monitoring Indicators	Ecological trigger for adaptive management and corrective actions	Corrective actions
3	Changes to hydrology	Protection of surface water quality values within waterways of the receiving environment.	No Project related degradation (i.e. dust, coal and heavy metals) of surface water quality in Doongmabulla Springs-complex.	There are no predicted surface water degradation impacts likely to occur at the Doongmabulla Springs-complex. Activities carried out associated with monitoring under this plan must be undertaken to prevent surface water quality degradation. Standard mine operating procedures will include dust control of project areas in accordance with procedures under the Environmental Management Plan.	**Pre-impact and impact monitoring:** Monthly Surface water quality monitoring as per section 8.7.3	Surface water quality physical and chemical characteristics as per ANZECC guidelines including pH, DO, Temperature, EC SS, Total P & N	Water Quality trigger when 80th percentile of parameter met. Physical evidence of degradation to surface water quality.	The appropriate corrective actions will be implemented and may include: • Scheduling duplicate chemistry testing to confirm water quality against relevant standards, in the event that visual inspection of dust impacts fails within 2 weeks • Reviewing operational activities with respect to dust monitoring protocols and reporting • Engaging with landholder to understand potential impacts from agricultural activities • Reviewing relevant meteorological data • Reviewing adherence to control procedures to ensure compliance • Taking remedial action where compliance has not been adhered to in accordance with Project Dust Management Plan • Communicating with personnel involved and across all site team members (for example, via toolbox meetings) • Reporting to DES as per statutory and project requirements where incidents trigger reporting thresholds.
		Protection of surface water quality values within waterways of the receiving environment.	No degradation of surface water quality by effluent / contaminants / siltation associated with project related activities.	There are unlikely to be sediment or erosion impacts at the Doongmabulla Springs-complex as a result of monitoring and survey activities. Standard mine operating procedures will include ensuring vehicle access to not create a risk of erosion. Any sites used for chemical and fuel storage will be located a safe distance away from Doongmabulla Springs-complex, with bunding or other raised barrier, resistant to normal flood events, between chemicals and habitat. All vehicles and machinery will be cleaned and maintained to minimise the introduction of contaminants such as oil and fuel.	**Pre-impact and impact monitoring:** Monthly surface water quality monitoring as per section 8.7.3	Surface water quality physical and chemical characteristics as per ANZECC guidelines including pH, DO, Temperature, EC SS, Total P & N	Physical evidence of contamination to Doongmabulla Springs-complex. Water Quality trigger when 80th percentile of parameter met.	The appropriate corrective actions will be implemented and may include: • Immediately reviewing vehicle access arrangements to avoid reoccurrence and address actual cause prior to any subsequent site visits • Reviewing adherence to control procedures to ensure compliance • Engaging with landholder to understand potential impacts from agricultural activities • Reviewing relevant meteorological data • Taking remedial action where compliance has not been adhered to, such as installing erosion and sediment control, within 4 weeks. • Communicating with personnel involved and across all site team members (for example, via toolbox meetings). • Reporting to DES as per statutory and project requirements where incidents trigger reporting thresholds.

#	Potential indirect project impact	Management objective	Performance Criteria	Management Actions	Monitoring	Monitoring Indicators	Ecological trigger for adaptive management and corrective actions	Corrective actions
4	Weeds and pests through direct competition or habitat degradation	Reduce weed extent and competition	No introduction of pest plants, invasive understorey species in Doongmabulla Springs-complex associated with project related activities.	Weed hygiene controls, including the use of weed wash down stations, will be implemented in accordance with the PMP to prevent the introduction and spread of declared pest plants and other invasive weeds. Weed free areas within the Doongmabulla Springs-complex will be identified and mapped with strict weed control requirements for entering weed free areas. Adaptive management of weed controls to minimise threats to Doongmabulla Springs-complex. Engagement with landholder at the Doongmabulla property regarding operational practices.	**Pre-impact and impact monitoring:** Annual Weed and Pest Surveys Habitat Features Survey (conduct through pre-impact and impact quarterly, then annually)	Presence of weed species Extent of weed coverage	Results of weed surveys indicate a degradation of in Doongmabulla Springs-complex, due to a proliferation of weeds. A significant increase in the abundance of weeds, or pests or identification of new weeds or infestations.	The appropriate corrective actions will be implemented and may include: • Engaging with landholder to raise issues within 5 days of investigation • Engaging with landholder to understand potential impacts from agricultural activities • Eliminating potential sources or reasons that are have attributed to an increase in species richness and/or relative abundance of weeds • Amending weed hygiene restrictions for all subsequent access requirements • Providing additional educational awareness training for all staff and contractors to ensure weed hygiene restrictions are adhered to • Revising weed control methods in accordance with the *Biosecurity Act 2014* • Engage with the landholder to protect and restore in Doongmabulla Springs-complex values through implementation of site-specific measures such as weed control, fire management or grazing
	Feral animal impacts	Achieve reduced impacts to the Doongmabulla Springs-complex from feral animal impacts	No increase in spring disturbance due to feral animals associated with project related activities.	The landholder at Doongmabulla springs has an existing management requirement under the Nature Refuge agreement. Adani will support the landholder through information sharing practices and aligning related activities with the landholder land management practices. Engagement with landholder at the Doongmabulla property regarding operational practices.	**Pre-impact and impact monitoring:** Annual Weed and Pest Surveys Habitat Features Survey (conduct through pre-impact and impact quarterly, then annually)	Presence of pest species Extent of pest disturbance	Observed habitat degradation attributed to pest species New pest species observed.	The appropriate corrective actions will be implemented and may include: • Engaging with landholder to raise issues within 5 days of investigation. • Engaging with landholder to understand potential impacts from agricultural activities • Increasing the frequency and intensity of pest animal control, working in partnership with the landholder and relevant agencies • Reviewing actions and methods included in the project pest management plan
5	Grazing pressures	Achieve reduced impacts to the Doongmabulla Springs from grazing impacts	No increase in spring disturbance due to grazing pressure associated with project related activities.	The landholder at Doongmabulla springs has an existing agistment requirement under the Nature Refuge agreement. Details are provide in Section 8.6 Adani will support the landholder through information sharing practices and aligning related activities with the landholder land management practices.	Regular (at least monthly) site inspections in accordance with the Environmental Management Plan and System. Habitat Features Survey (conduct through pre-impact and impact quarterly, then annually)	As per requirements under the Nature Refuge Agreement (Section 8.6)	Observed habitat degradation attributed to grazing pressures as per requirements under the Nature Refuge Agreement (Section 8.6)	The appropriate corrective actions will be implemented and may include: • Engaging with landholder to raise issues within 5 days of investigation. • Engaging with landholder to understand potential impacts from agricultural activities and requirements under the Nature Refuge Agreement • Modifying monitoring and survey access and activities where required to support landholder actions (such as fencing, spelling) • Ensuring staff are following practices related to cattle exclusion such as protocols around gates.

#	Potential indirect project impact	Management objective	Performance Criteria	Management Actions	Monitoring	Monitoring Indicators	Ecological trigger for adaptive management and corrective actions	Corrective actions

6	Vegetation clearing / habitat loss	Prevent Doongmabulla Springs-complex habitat loss arising from Project activities
		(other than indirect drawdown as described above)
			No direct clearing of vegetation at Doongmabulla Springs-complex unless otherwise approved.	Prior to the commencement of any related site works / monitoring / bore hole drilling the limits of clearing and exclusion areas will be clearly marked. Temporary fencing, such as barricade webbing, wire fencing or similar, will be used to prevent clearing.
				No clearing to be undertaken associated with survey and monitoring activities in and around the Doongmabulla Springs-complex unless otherwise approved and managed in accordance with such approval.
				Vehicle access will be by existing tracks wherever possible and no new tracks created without the necessary approvals in place.
					Pre-impact and impact monitoring:
					Habitat Features Survey (quarterly, then annually)
					Regular (at least monthly) site inspections in accordance with the Environmental Management Plan and System.
						Native vegetation cover
						Threatened and Endemic Flora presence and location
							Evidence of clearing of habitat at the Doongmabulla Springs-complex.	The appropriate corrective actions will be implemented and may include:
								• Engaging with landholder to understand potential impacts from agricultural activities
								• If evidence of clearing outside approved clearing footprint, in no go zones or without a "Permit to Disturb" issued,
								  ○ Environment Manager ensure that all clearing activities cease immediately
								  ○ Area assessed by a suitably qualified ecologist/person within 15 business days of investigation
								  ○ additional barricading to be installed
								  ○ reviewing and modifying "Permit to Disturb" process and no-go zone identification and communication protocols.
								  ○ Remediation activities to be completed within 2 months of conclusion of ecological assessment.
								• Environmental offsets, if required, for unsuccessful habitat loss after remediation.

7	Earthworks	Minimise impacts on geomorphology	No project earthworks at Doongmabulla Springs-complex associated with project related activities.	There are no predicted or required earthworks impacts likely to occur at the Doongmabulla Springs-complex, as Project activities are limited to ongoing monitoring activities.	Regular (at least monthly) site inspections in accordance with the Environmental Management Plan and System.	Event monitoring for: pH Turbidity	Degradation or disturbance of Doongmabulla Springs-complex likely to have been caused by earthworks activities	The appropriate corrective actions will be implemented and may include: • Engaging with landholder to understand potential impacts from agricultural activities • Ceasing any earthworks related to project activities in the vicinity of the springs and remediate within 4 weeks of conclusion of investigation. • Reviewing and re design to avoid reoccurrence and address actual cause • Communicating with personnel involved where appropriate and across all site team members (for example, via toolbox meetings).
8	Noise and vibration	Minimise habitat modification	No disturbance of Doongmabulla Springs-complex from noise and vibration associated with project related activities.	There are no predicted mining related noise and vibration impacts likely to occur at the Doongmabulla Springs-complex Standard mine operating procedures will include noise and vibration management in accordance with procedures under the Environmental Management Plan.	Regular (at least monthly) site inspections in accordance with the Environmental Management Plan and System. Ongoing engagement with the landholder in accordance with the Environmental Management Plan and System.	Event monitoring for: dB(A) peak particle velocity (PPV)	Degradation of Doongmabulla Springs-complex likely to have been caused by noise or vibration.	The appropriate corrective actions will be implemented and may include: • Engaging with landholder to understand potential impacts from agricultural activities • Reviewing project noise and vibration monitoring program to determine if any exceedance's recorded or noted at the Doongmabulla homestead • Reviewing and re designing project activities to avoid reoccurrence and address actual cause, completion within 3 months of investigation. • Communicating with personnel involved where appropriate and across all site team members (for example, via toolbox meetings).

#	Potential indirect project impact	Management objective	Performance Criteria	Management Actions	Monitoring	Monitoring Indicators	Ecological trigger for adaptive management and corrective actions	Corrective actions
9	Emissions (including dust)	Minimise emissions (dusts)	No emissions (dust) on photosynthetic ability of flora in the Doongmabulla Springs-complex habitat associated with project related activities.	There are no predicted emissions / dust impacts likely to occur at the Doongmabulla Springs-complex Standard mine operating procedures will include dust control of project areas in accordance with procedures under the Environmental Management Plan.	Regular (at least monthly) site inspections in accordance with the Environmental Management Plan and System.	Event monitoring for: Total suspended particulate matter	Evidence of degradation of Doongmabulla Springs-complex thought to have been caused by dust or other emissions.	The appropriate corrective actions will be implemented and may include: • Engaging with landholder to understand potential impacts from agricultural activities • Reviewing relevant meteorological data • Reviewing project air quality monitoring program to determine if any exceedance's recorded or noted at the Doongmabulla homestead • mitigating source of dust as per Project Environmental Plan, re inspect within 2 months. • Reducing speed limits to access monitoring locations • Communicating with personnel involved and across all site team members (for example, via toolbox meetings). • Engaging with landowner with regards to related dust matters
10	Light spill and other visual impacts	Minimise light spill	No light disturbance at Doongmabulla Springs-complex associated with project related activities.	There are no activities likely to cause light spill at the Doongmabulla Springs-complex.	Regular (at least monthly) site inspections in accordance with the Environmental Management Plan and System.	Observations of amount of light falling on the Doongmabulla Springs-complex	Direct light spill onto the Doongmabulla Springs-complex.	The appropriate corrective actions will be implemented and may include: • Engaging with landholder to understand potential impacts from agricultural activities • Reviewing relevant meteorological data • Reviewing monitoring and survey activities to determine any association • Reviewing and re designing light controlling devices, or adjust location of light, to reduce light spill and lighting levels below trigger levels and implementation within 3 months. • Communicating with personnel involved and across all site team members (for example, via toolbox meetings).

9 Mellaluka Springs-complex

9.1 Status and description

The Mellaluka wetland is a relatively unknown Springs-complex, and although identified by the DES wetland mapping tool, it is not listed in the Directory of Important Wetlands. The Mellaluka Springs-complex aquifer is believed to be located in the Joe Joe group, although additional studies are required to confirm this because there is very little information available regarding this Springs-complex (GHD 2014).

The Mellaluka Springs-complex consists of three springs:

- Mellaluka Springs-group – a large mounding spring ('Mellaluka Spring') with several vents, and two non-mounding springs. Mellaluka Spring is the largest spring in the group, and it supports a wetland area and dam
- Stories Spring – a discrete non-mounding artesian spring
- Lignum Spring – a discrete non-mounding artesian spring

The Mellaluka Springs-complex contains both mound springs and non-mounding artesian springs (GHD 2014). Although this Springs-complex is not associated with the GAB, the environmental characteristics and formation process are similar to that described above for the Doongmabulla Springs-complex (**Section 8**).

9.2 Distribution

The Mellaluka Springs-complex occurs in an approximately north-south line, between 3 km and 11 km south of the southern boundary of the Project, on Mellaluka Station (GHD 2014) (**Figure 9-1**). The northernmost spring is Lignum Spring, which is 3.6 km north of Stories Spring, with Mellaluka Spring a further 2.3 km to the south (GHD 2014). Each spring is a discrete environment that is not located near any significant waterways (GHD 2014).

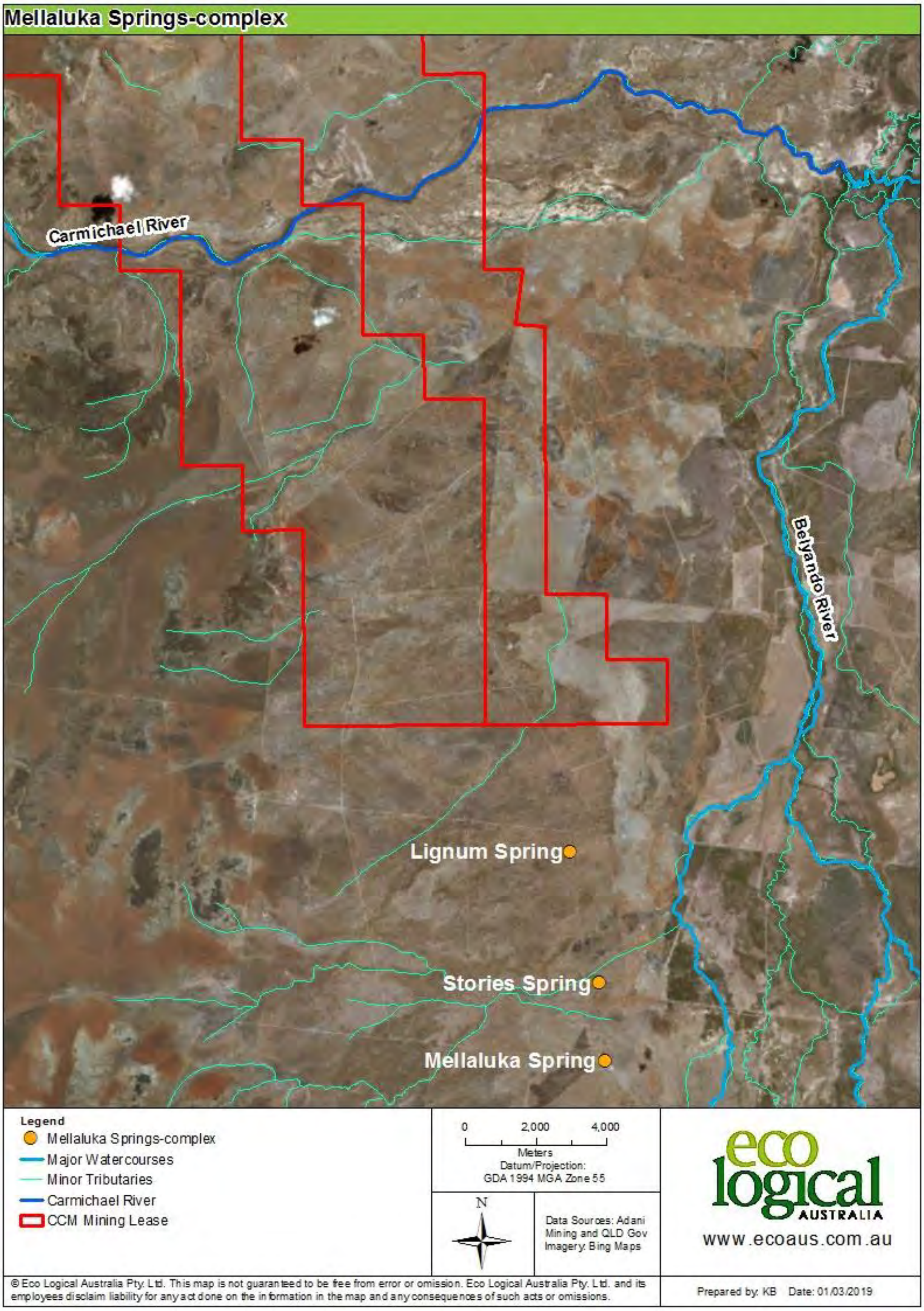


Figure 9-1: Location of Mellaluka Springs-complex

9.3 Ecology

The abundance of perennial water makes the Mellaluka Springs-complex and associated wetlands an important fauna habitat in an otherwise arid environment (GHD 2014). The aquatic fauna community at the Mellaluka Springs-complex is likely to consist of turtles, fish, freshwater shrimps, prawns, crabs and crayfish, microcrustaceans, and a range of aquatic insects and other invertebrates (GHD 2014). No threatened or endemic species are known from Mellaluka Springs; however, an Asteraceae (daisy) *Streptoglossa sp*., collected from the main Mellaluka Springs-group mound could not be matched to a known species by the Queensland Herbarium (GHD 2014). This species was also collected at the Doongmabulla Springs-complex (GHD 2014).

The Mellaluka Springs-complex is an important water source for livestock and domestic use (GHD 2014). There is a bore installed at each of the three springs-groups (GHD 2014). The spring wetlands are accessed by horses and cattle, and domestic pigs and Feral Pigs, which have degraded the water quality by stirring up sediment, and urinating and defecating in the water (GHD 2014). Cattle and pigs have caused the greatest damage to Lignum and Stories springs (GHD 2014), whereas Mellaluka Spring and its associated wetland is fenced off from cattle, although domestic pigs have access (GHD 2014). The Mellaluka Station homestead is adjacent to the Mellaluka Spring (GHD 2014).

9.3.1 Mellaluka Springs-group

The Mellaluka Springs-group (**Figure 9-2**) has formed a peat mound approximately 3 – 4 m taller than the surrounding plain, and about 100 m in diameter. Immediately adjacent to the south of this large mound, two further springs are located, both approximately 20 – 30 m diameter, but neither having formed a mound (GHD 2014). There are several vents on the mound, which feed a large pool about 1 m deep (GHD 2014). There are also several shallow overflow pools and associated wetlands at the foot of the mound (GHD 2014). Large, scalded areas surrounded parts of the base of the Mellaluka Spring mound, and the spring itself is characterised by a dense substrate of peat, topped by a sedgeland to 2 m tall (GHD 2014).

Mellaluka Spring is predominately covered in a tall sedgeland dominated by *Baumea rubiginosa* and *Schoenus falcatu*s, which contained small groves of low Weeping Paperbark trees (GHD 2014). *Phragmites australis*, *Typha domigensis* (cumbungi) and the fern *Cyclosorus interruptus* were also common in places (GHD 2014). Approximately ten tall River Red Gums occur on the apex of the mound, forming a small open-forest of approximately 0.5 ha (GHD 2014).

The groundcover at Mellaluka Spring is thick, and includes leaf litter, woody debris and grasses (GHD 2014). Tree hollows are common in the tall River Red Gums on the apex of the mound, but are sparse in the surrounding paddocks (GHD 2014). This spring provides abundant habitat for frogs, with a perennial water source and dense vegetative cover (GHD 2014).

The non-mounding springs in the Mellaluka Springs-group are located adjacent to the south of the main Mellaluka Spring, and are both approximately 20 – 30 m in diameter (GHD 2014). The saturated areas of these springs are characterised by *P. australis* grasslands with *Leersia hexandra* and *Fimbristylis ferruginosa*, or sedgeland dominated by an unknown tall *Cyperus sp*. (GHD 2014).

The Mellaluka Springs-group appears to have created its own small alluvial plain, exhibiting the same pale, very fine powdery sandy soil around the edges of the springs, as seen at Moses Spring (GHD 2014). These dry areas are characterised by *Sporobolus mitchellii* and *S. virginicus* (Saltwater couch) grasslands with shrubs such as *Chenopodium auricomum* and *Atriplex sp*. (GHD 2014). The woodlands surrounding the Mellaluka Springs-group are dominated by Gidgee (RE 11.4.6) (GHD 2014). Mellaluka Springs-group does not contribute surface water to any nearby waterways (GHD 2014).

Figure 9-2 Mellaluka mound spring (top left), runoff pool (top right), pool in peat (bottom left) and wetland (bottom right; GHD 2014)

9.3.2 Lignum and Stories springs

The northern two springs (**Figure 9-3**) are not permanent and have only one spring or outlet each, which seeps water into of a shallow pond approximately 0.5 – 1 m deep (GHD 2014). Both of these springs (inclusive of their wetlands) are small in size (Stories Spring is approximately 20 x 12 m and Lignum Spring is approximately 20 x 6 m), and both are situated within broad, level to gently undulating sand plains (GHD 2014). The Lignum and Stories springs are discrete outlets that do not flow or contribute surface water to nearby waterways (GHD 2014). They are both slightly modified from their natural state to facilitate access by cattle, with water at just below ground level (GHD 2014).

Stories and Lignum springs contain *Typha domigensis* (cumbungi) almost exclusively (GHD 2014). These springs are located in a large area of intact grassy woodlands dominated by Silver-leaved Ironbark and Reid River Box woodlands (GHD 2014). These woodlands have a high level of structural habitat complexity, although log piles and fallen timber are not common at the springs, and are very sparse at Lignum Spring (GHD 2014). Here, a sparse, light ground cover is provided by leaf litter (GHD 2014). Stories and Lignum springs are likely to provide ephemeral water sources for some threatened species that are likely to inhabitat the surrounding woodland, especially the Black-throated Finch and Squatter Pigeon. The Squatter Pigeon has been recorded adjacent to Lignum Spring (GHD 2013c).

Figure 9-3 Lignum Spring (top) and Stories Spring (bottom; GHD 2014)

9.4 Supporting Groundwater resources

The Colinlea Sandstone was initially considered to be the primary source aquifer for the Mellaluka Springs-complex. However, additional drilling (detailed in the GMMP) indicates complex artesian conditions associated with the Tertiary and Joe Joe Group sediments that provide discharge to the surface in the area of Mellaluka Springs-complex.

Further monitoring of these aquifers including the installation of additional groundwater monitoring bores has been recently undertaken and detailed in the GMMP. The location of these bores is provided in **Figure 9-4**, **Figure 9-5** and **Figure 9-6**.

Groundwater quality indicates mixing / blending of groundwater measured at Mellaluka Springs, when considering the salinity of Tertiary and Joe Joe Group data. It is further considered that, based on mapped palaeochannels, the area likely includes groundwater associated with the Belyando River which may provide, or contribute to, the artesian pressures.

Based on the site-specific geology, mapping of coal seam subcrop, and the available groundwater quality, it is considered that the groundwater associated with the Mellaluka Springs-complex is sourced from artesian Tertiary and Joe Joe sediments.

This conceptualisation, based on conditions within the area, will be refined overtime as additional groundwater data is compiled and the groundwater model is revised at regular intervals (initially after 2 years of mining and then every 5 years). The GMMP, and by association the GDEMP, will be revised, as required, in response to modelling refinement.

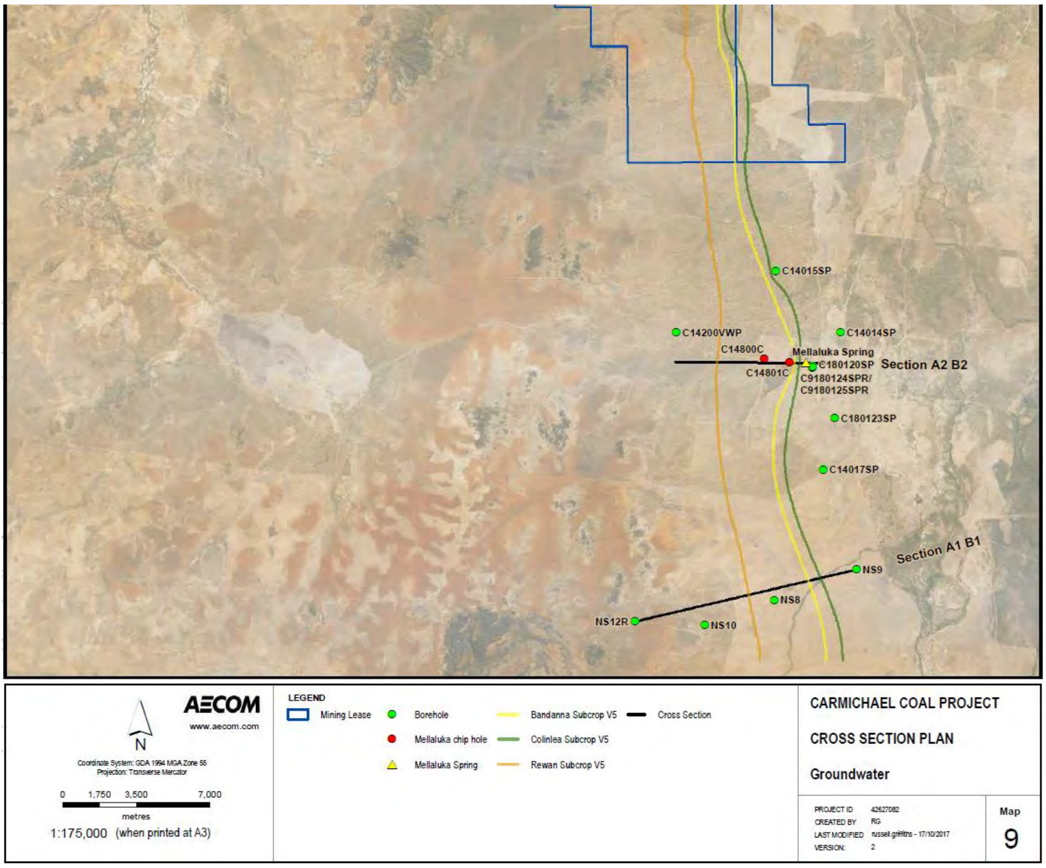


Figure 9-4 Groundwater bores associated with the Mellaluka Springs – bores shown are government exploration bores (Source: GMMP)

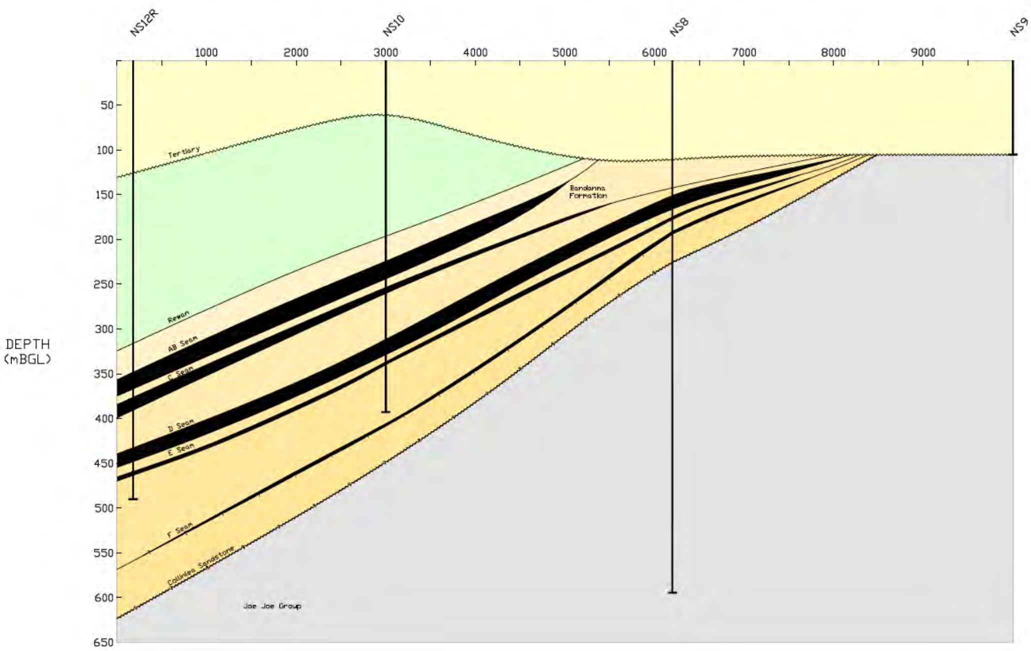


Figure 9-5 Cross section extract of bores associated with the Mellaluka Springs-complex. Water levels (Artesian) are: C9180125SPR 243.10 mAHD, C180120SP 243.48 mAHD, C14015SP 239.15 mAHD and C14014SP 239.32 mAHD. Remaining bores are government exploration bores (Source: GMMP)

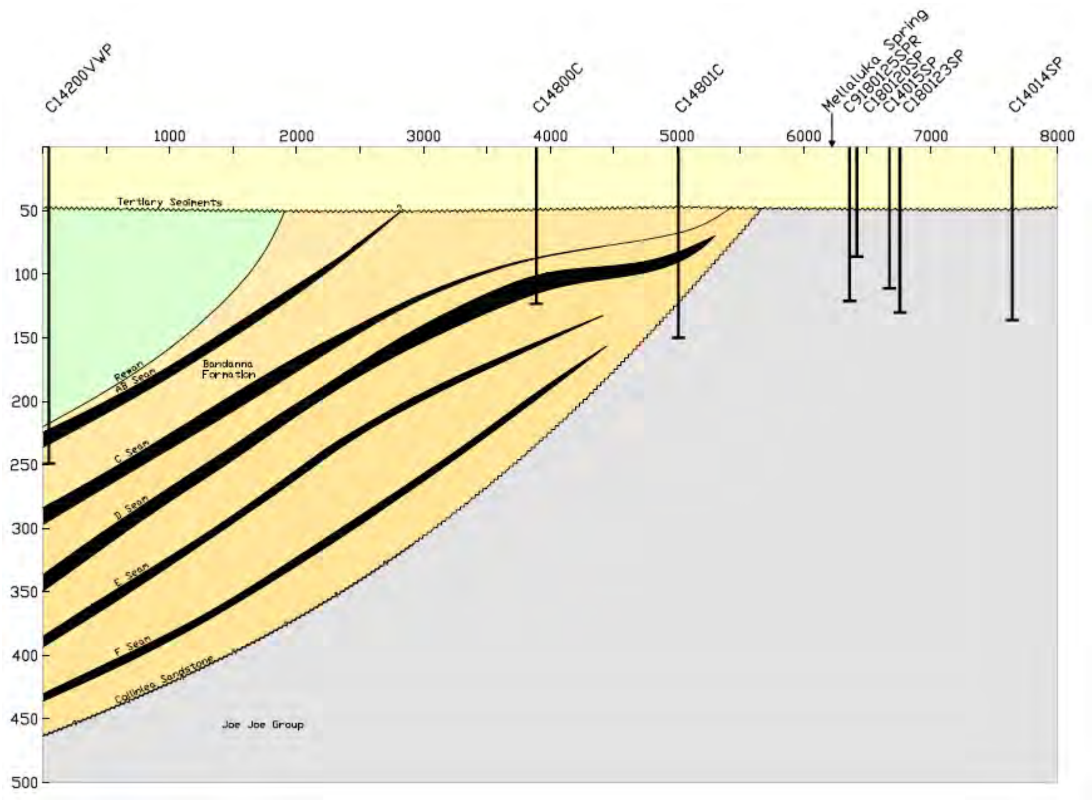


Figure 9-6 Cross section extract of bores associated with the Mellaluka Springs-complex (Source: GMMP)

9.5 Summary of baseline monitoring findings

9.5.1 Mellaluka Springs

Whilst mapped as non-remnant vegetation, there is approximately 3 – 4 ha of remnant vegetation associated with this spring that meets the description of the of concern RE 11.3.22, which is 'Springs, associated with recent alluvia', but also including those on ancient alluvia' (Queensland Herbarium, 2013).

There were three main vegetation communities recorded at this spring.

1. Tall sedgeland to 2 m tall dominated by *Baumea rubiginosa* (soft twig rush) and *Schoenus falcatus* with *Phragmites australis* (common reed), cumbungi and the fern *Cyclosorus interruptus* also common in places. Small groves of Weeping Paperbark were present in the sedgeland, all less than 5 m tall.
   On the apex of the mound, but in sandy soil, were approximately ten tall (to 20 m) river red gums, forming a small open forest of half a hectare.
   Saturated grasslands characterised by *P. australis, L. hexandra* and *Fimbristylis ferruginosa*, or sedgeland dominated by an unknown tall *Cyperus sp*.
2. Dry areas adjacent to pools were comprised of the fine, powdery sand that appears to be characteristic of developed springs. These areas were characterised by grassland of *Sporobolus mitchellii* and freshwater couch with shrubs such as *Chenopodium auricomum* and *Atriplex sp*.
3. The area surrounding Mellaluka Springs is dominated by Gidgee woodland on a clay plain, comprising the RE 11.4.6 (Queensland Herbarium, 2013).

An unidentified daisy, *Streptoglossa sp*., was collected on the main Mellaluka Spring mound. Further specimens are required to confirm whether it is in fact a new species.

With regards to providing habitat for flora and fauna species, the following findings are noted:

- While the Mellaluka Spring is relatively large, it is isolated from nearby grass and woodland, and habitat connectivity may be compromised for many species.
- The Mellaluka Spring contained the largest community of flora species which in turn created a broad range of habitats.
- The dam at the Mellaluka Spring provides a valuable habitat for turtles as the surface waters are perennial, and prey (frogs, fish, insects and crustaceans) are predicted to be abundant
- The aquatic invertebrate community is likely to consist of decapods (freshwater shrimps, prawns, crabs and crayfish). The Mellaluka Spring provided particularly abundant habitat for amphibians as it had a perennial water source and dense vegetative cover, microcrustaceans and a range of aquatic insects
- While there is little cover provided by submerged timber or floating macrophytes, the peat and clay substrate does provide an environment suitable for aquatic invertebrates.

With regards to threatening processes and disturbance, the following findings are noted:

- The wetlands are accessed by a number of domestic and feral animals which have resulted in moderate disturbances from horses, cattle and pigs.
- The proximity of Mellaluka Station to the Mellaluka Spring may also create some anthropogenic disturbances, for example, from noise and light, increased human activity, chemical spraying and the presence of domestic pigs (which were observed to utilise the wetland).
- A deterrent to mammals at the Mellaluka Spring (excluding the Stories and Lignum springs) are the presence of domestic dogs at the Mellaluka homestead.

Adani undertook further ecological survey of the Mellaluka Springs in 2015 and 2016, particularly in regards to the Coordinator General's Imposed Condition 1 (d)(i). As a result of those surveys, it was confirmed that the Mellaluka Springs-complex does not provide high value habitat for the Black-throated finch and therefore does not require further baseline research as per EPBC Act Condition 6 (k).

9.5.2 Stories and Lignum Springs

Stories and Lignum springs are much simpler springs than those at Mellaluka Springs and the main vegetation features recorded are:

- Both springs are dominated exclusively by cumbungi
- These springs are located in grassy woodland dominated either by Silver-leaved Ironbark (RE11.3.28) or Reid River Box (RE 10.3.6)

With regards to providing habitat for flora and fauna species, the following findings are noted:

- Both springs are unlikely to provide direct habitat for most mammal species, although some small mammals may seek refuge in the denser vegetation within the springs.
- Conversely, Stories and Lignum springs have value for mammals as a perennial source of water, particularly during dry periods.
- While both Stories and Lignum springs contained frogs, the smaller size of the springs and the associated disturbances to the springs make these vents less suitable for supporting large amphibian populations

- Stories and Lignum springs are both situated in woodland where terrestrial habitat connectivity is maintained

With regards to threatening processes and disturbance, the following findings are noted:

- Cattle and pigs have caused extensive damage to these two spring wetlands
- Water quality is degraded through the stirring up of sediment, and urinating and defecating by cattle

9.6 Threats and impacts

Threats and potential direct / indirect project impacts that are required to be addressed as they apply to the Mellaluka Springs-complex are:

- direct and indirect project impacts outlined in the EIS (GHD 2012a; Adani 2012) *Carmichael Coal Mine and Rail Project – Groundwater Dependent Ecosystems Management Plan (11 February 2014*)
- matters outlined in Condition 6(c) require details for impacts and threats to MNES to be included in this plan.

The key threats and potential direct / indirect project impacts identified for Mellaluka Springs-complex that are relevant to the Project are identified in the following sections and **Table 9-1**. It should be noted that the Mellaluka Springs-complex is located a minimum of approximately 3 km (Lignum Spring) from the Project's southern boundary, and will therefore not be subject to direct impacts.

Table 9-1 Mellaluka Springs-complex threats, potential direct / indirect project impacts and matters required to be addressed by conditions

#	Potential Threat or Impact	Potential indirect threat or impact identified in EIS (GHD, 2014)	EPBC Approval, condition 6	Environmental Authority condition I14 and Appendix 1, Definition of "GDEMP"	Project Phase/s*	Earliest predicted potential impact	Table
1	Groundwater drawdown from mine dewatering	Yes	(c)(iii)	(5)	Operations Rehabilitation	Year 20	Table 9-3
2	Subsidence from underground mining	-	(c)(ii)	(5)	Operations Rehabilitation	*Not applicable*	
3	Changes to hydrology and degradation of surface water quality	-	(c)(vii)	(5)	Construction Operations Rehabilitation	*Not applicable*	
4	Weeds and pests through direct competition or habitat degradation	Yes	(c)(ix)	(5)	Construction Operations Rehabilitation	Year 20	
5	Vegetation clearing / habitat loss	Yes	(c)(i)	-	Operations	Not applicable	
6	Earthworks	-	(c)(iv)	-	Construction	Not applicable	
7	Noise and vibration	-	(c)(v)	-	Construction Operations	Not applicable	
8	Emissions (including dust)	-	(c)(vi)	-	Construction Operations	Not applicable	
9	Light spill and other visual impacts	-	(c)(vii)	-	Construction Operations	Not applicable	

* Please refer to Section 2.2 for details on GDEMP monitoring & implementation phase; baseline, pre-impact, impact

#1: Groundwater drawdown from mine dewatering

EPBC Act Approval 2010/5736, condition 6(c)(iii) requires details of potential impacts from groundwater drawdown of aquifers be addressed in this plan.

Environmental Authority condition I14 and Appendix 1, Definition of "GDEMP" (5) requires potential impacts from mine dewatering of aquifers to be addressed in this plan.

A change in groundwater hydrology as a result of the operational phase of the Project (mine), specifically, a reduction in groundwater pressure is the primary potential impact on the Mellaluka Springs-complex (GHD 2014).

During operations, the maximum predicted reduction in groundwater pressure for the Mellaluka Springs-complex (in the Permian-age strata aquifer) is up to 1.16 m at the Mellaluka Spring, 2.35 m at Stories Spring, and 8.26 m at Lignum Spring (GHD 2015). Predictions suggest that these significant impacts will not occur until around 60 years into the proposed life of the mine (GHD 2014). Post-closure reductions in pressure are predicted to be up to 9.46 m at Mellaluka Spring, 13.81 m at Stories Spring, and 25.8 m at Lignum Spring.

The predicted post-closure reductions in pressure in the aquifers of the Mellaluka Springs-complex will have significant impacts on the ecological function for all the springs in the Mellaluka Springs-group, and their capacity to supply domestic and agricultural water, with the springs drying up at the surface (GHD 2014). The predicted draw-down pressure reductions are well below ground level and only the most deep-rooted trees associated with the springs will be able to access groundwater at this depth (GHD 2014). It is concluded that impacts to this spring group will be serious during operations for at least the Lignum and Stories Springs, and of significant magnitude post-closure for the entire Mellaluka Springs-group (GHD 2014).

Conceptually this is represented for the Mellaluka Spring in **Figure 9-7**.

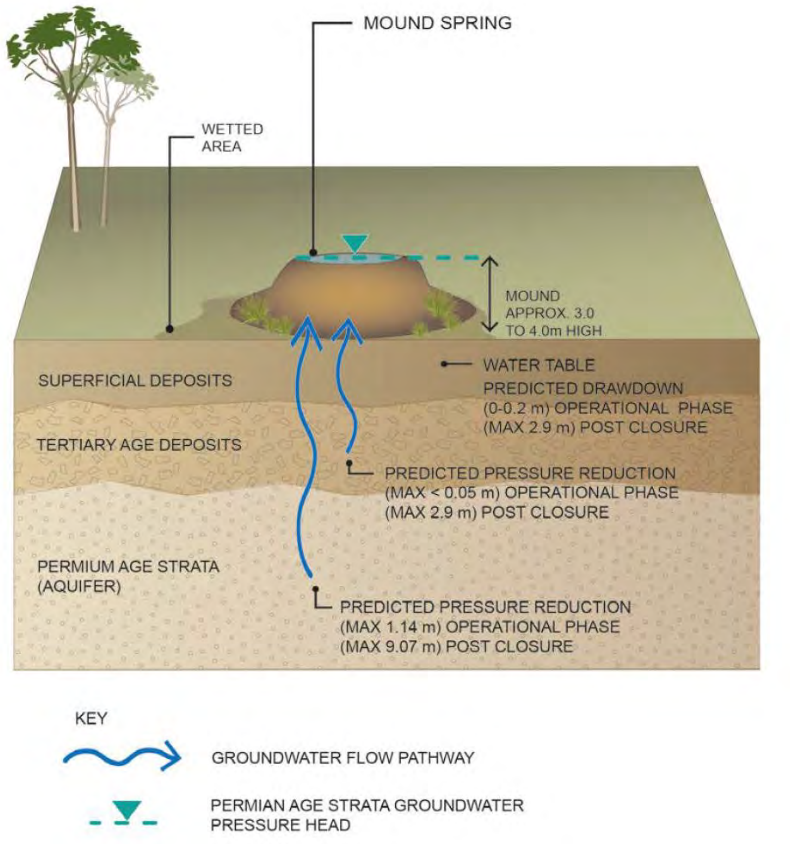
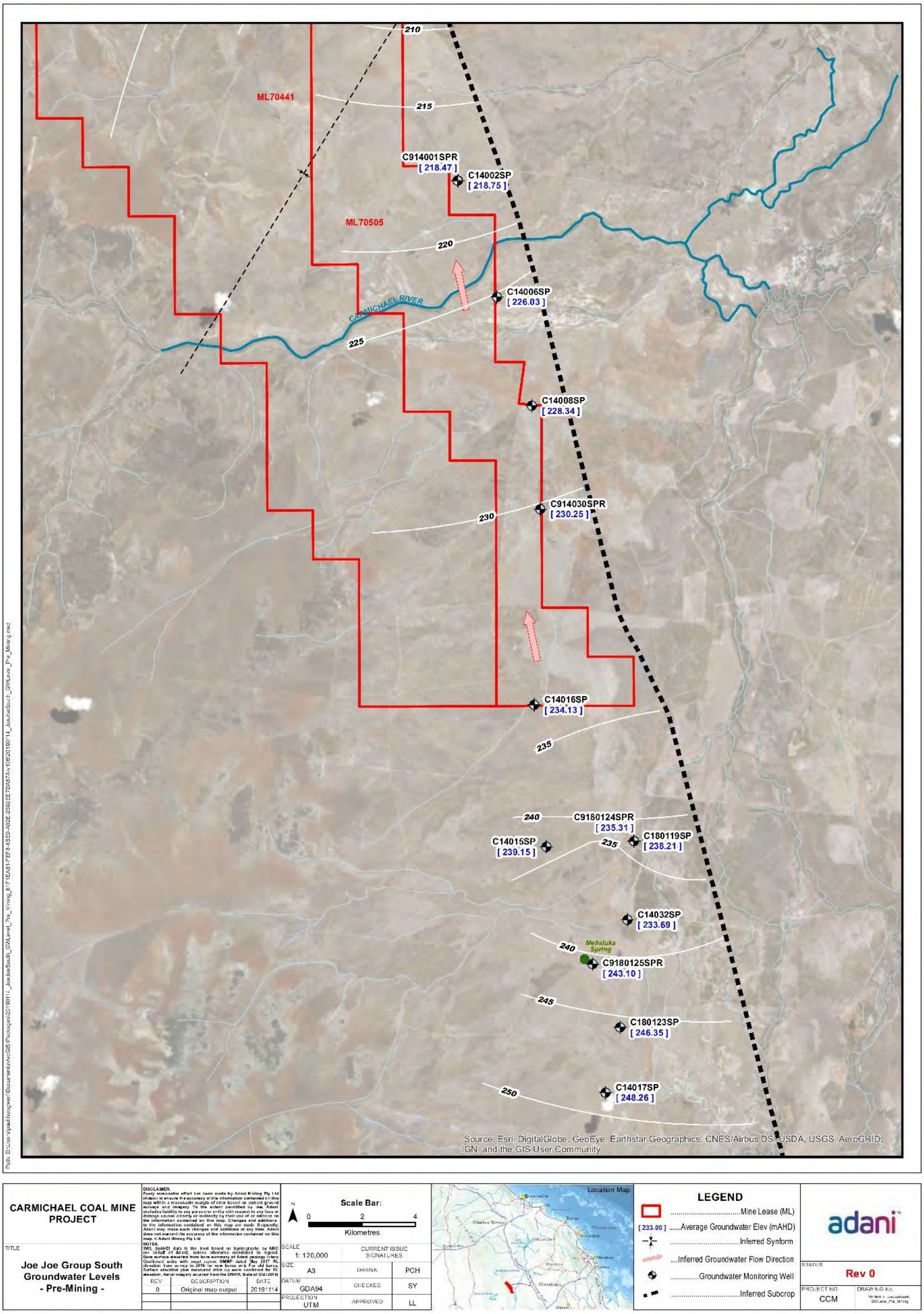


Figure 9-7 Conceptual model of groundwater impacts at the Mellaluka Springs-complex (GHD, 2013b)

However, noting more recent hydrogeological information obtained from recent drilling, it is considered that the groundwater associated with the Mellaluka Springs Complex is sourced from artesian Tertiary and Joe Joe sediments. This conceptualisation, based on conditions within the area, will be refined overtime as additional groundwater data is compiled and the groundwater model is revised at regular intervals (initially after 2 years of mining and then every 5 years). The GMMP, and also the GDEMP will be revised, as required, in response to modelling refinement.

Further, as predicted impacts to the Melluka Springs-complex are associated with mining activities south of the Carmichael River and these activities will not commence until Year 10, pre-impact groundwater and ecological monitoring will allow the refinement of this model prior to the commencement of mining activities and hence an updated prediction of impact, triggers and if required, offsets. Actual impacts to the Mellaluka Springs-complex are not predicted to occur for 20 to 25 years after Project commencement.

Figure 9-8a-g on the following pages provides progressive drawdown predictions for the Mellaluka Springs-complex for both the Joe Joe and the Tertiary. The locations of monitoring bores are included on these figures.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Melaluka Spring
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CARMICHAEL COAL MINE PROJECT
TITLE
Joe Joe Group South Groundwater Levels - Pre-Mining -
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NOTES.
SWL (mAHD) data is the level based on hydrographs by NRC (on behalf of Adani), unless otherwise mentioned in legend. Bore surface elevation from bore summary of Adani geology interp. Confirmed units with most recent GMMP dated May 2017. RL elevation from survey in 2014 for new bores only. For old bores, Surface elevation plus measured stick up were combined for RL elevation. Aerial imagery sourced from the DNRM, State of Qld (2018)
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Inferred Groundwater Flow Direction
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adani
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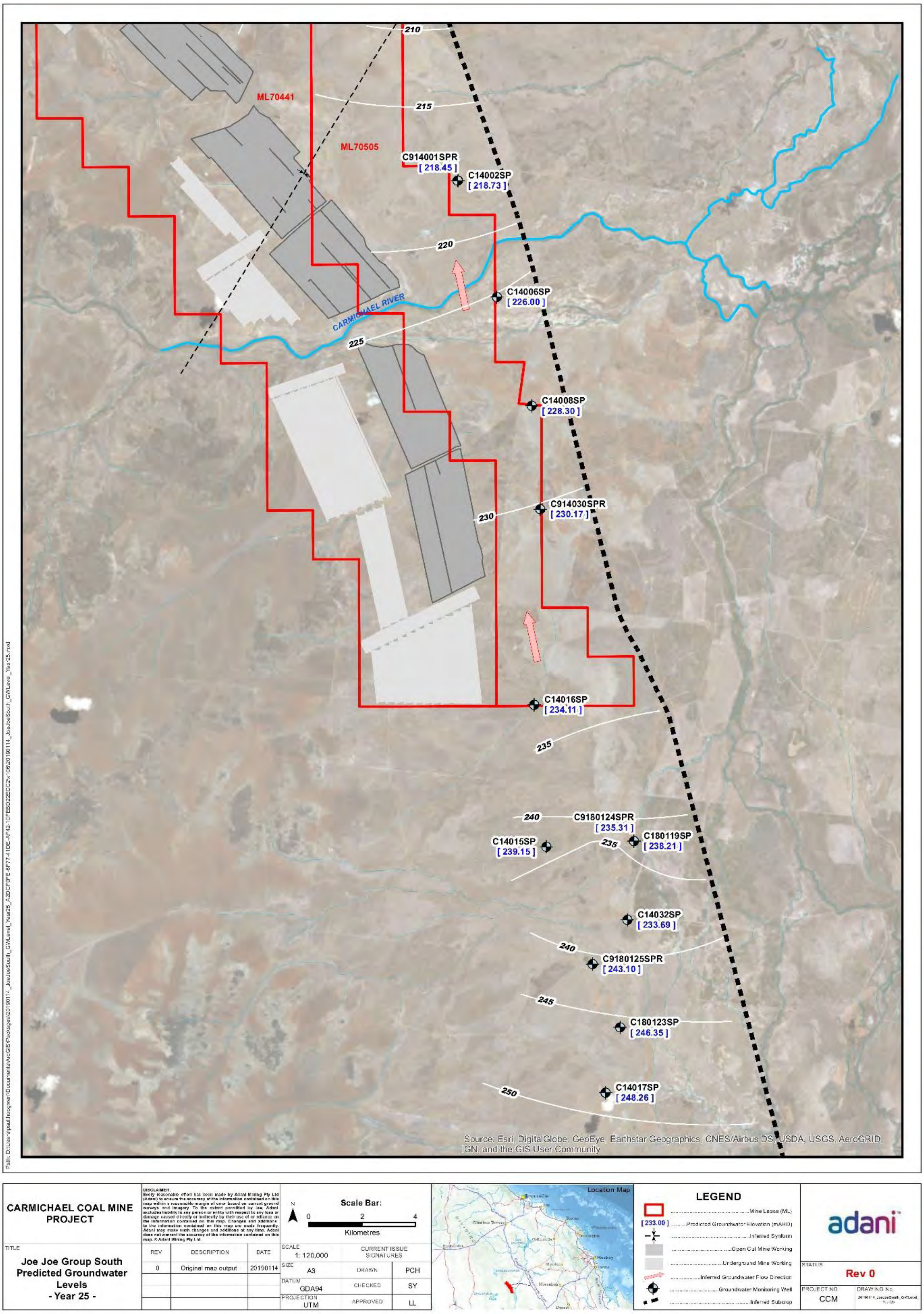
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CARMICHAEL RIVER
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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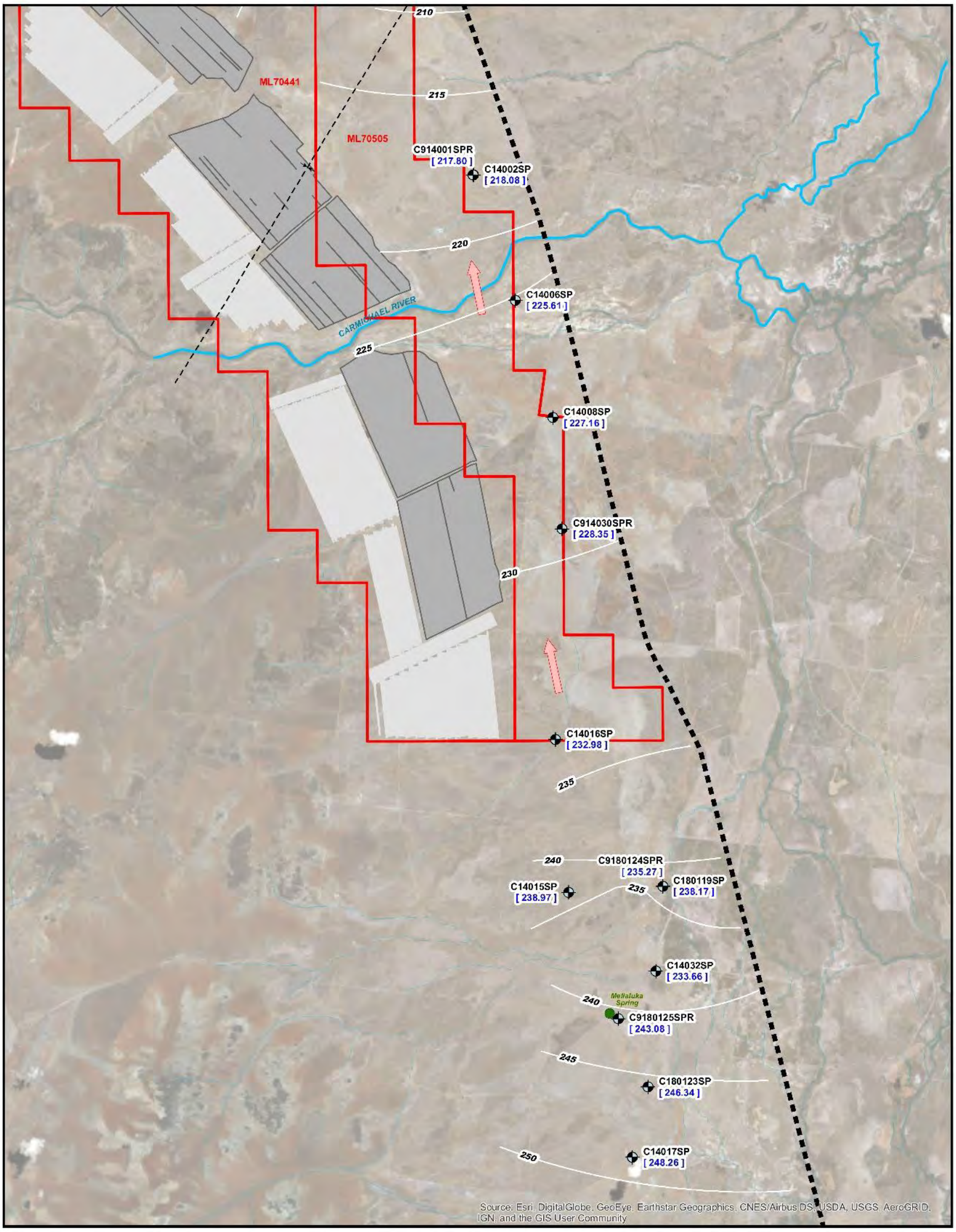

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PROJECTION UTM	APPROVED	LL

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- Inferred Synform
- Open Cut Mine Working
- Underground Mine Working
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- Inferred Subcrop

adani

STATUS: Rev 0

PROJECT NO: CCM

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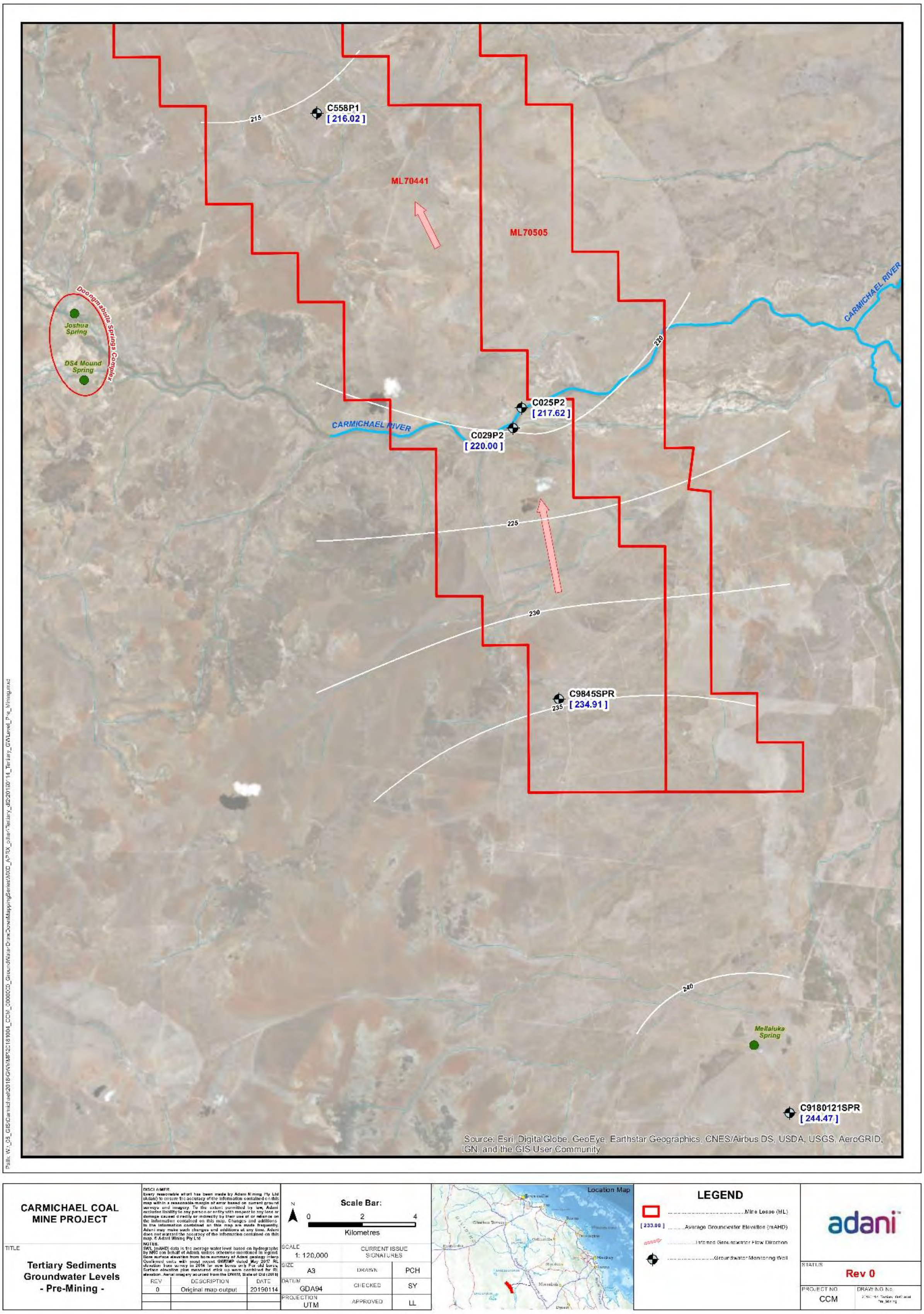
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CARMICHAEL COAL MINE PROJECT
TITLE
Tertiary Sediments Groundwater Levels - Pre-Mining -
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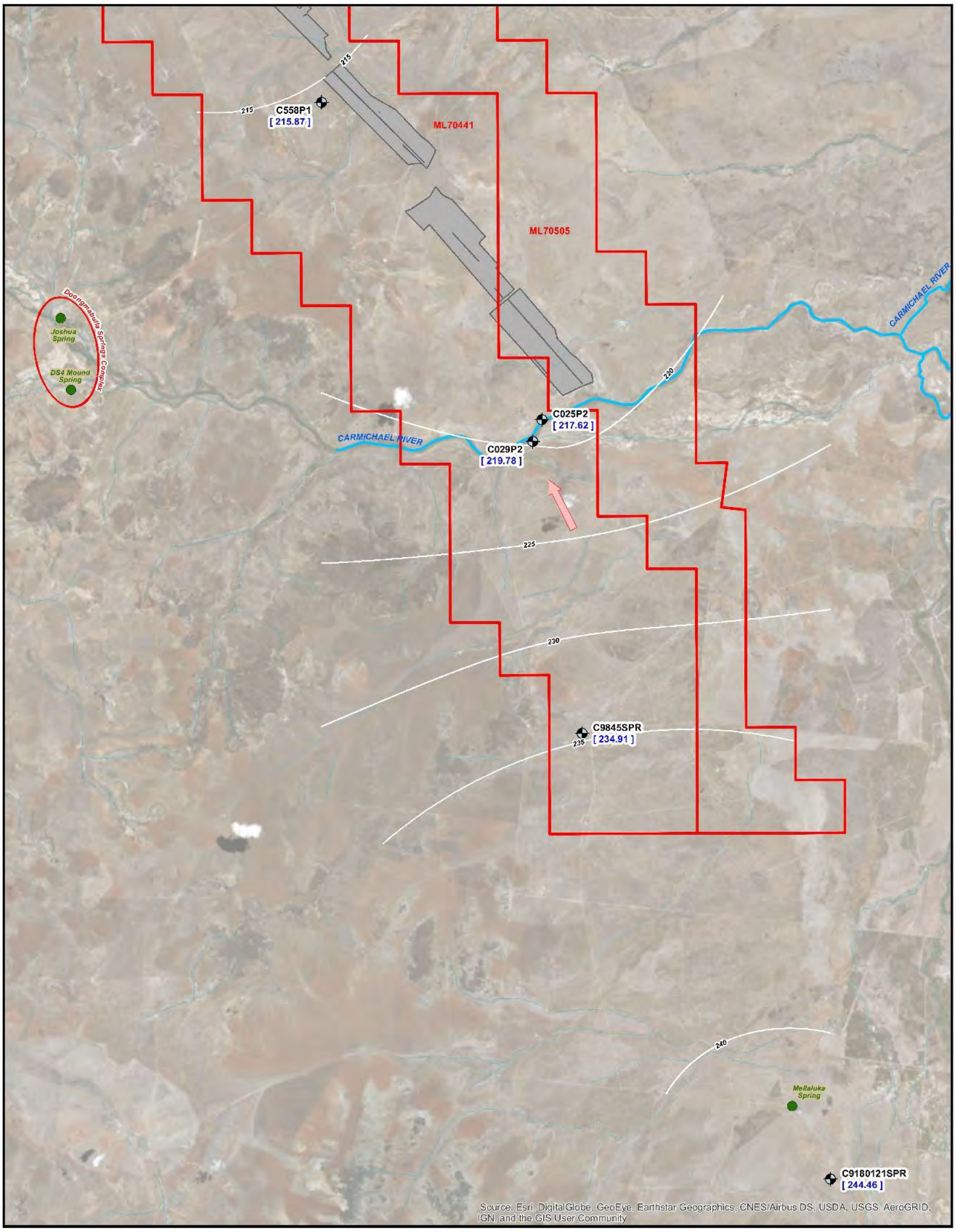

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TITLE
Tertiary Sediments Predicted Groundwater Levels - Year 5 -

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REV	DESCRIPTION	DATE
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PROJECTION UTM	APPROVED	LL

Location Map

LEGEND

- Mine Lease (ML)
- [233.00] Predicted Groundwater Elevation (mAHD)
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- Inferred Groundwater Flow Direction
- Groundwater Monitoring Well

adani

STATUS **Rev 0**

PROJECT NO. CCM

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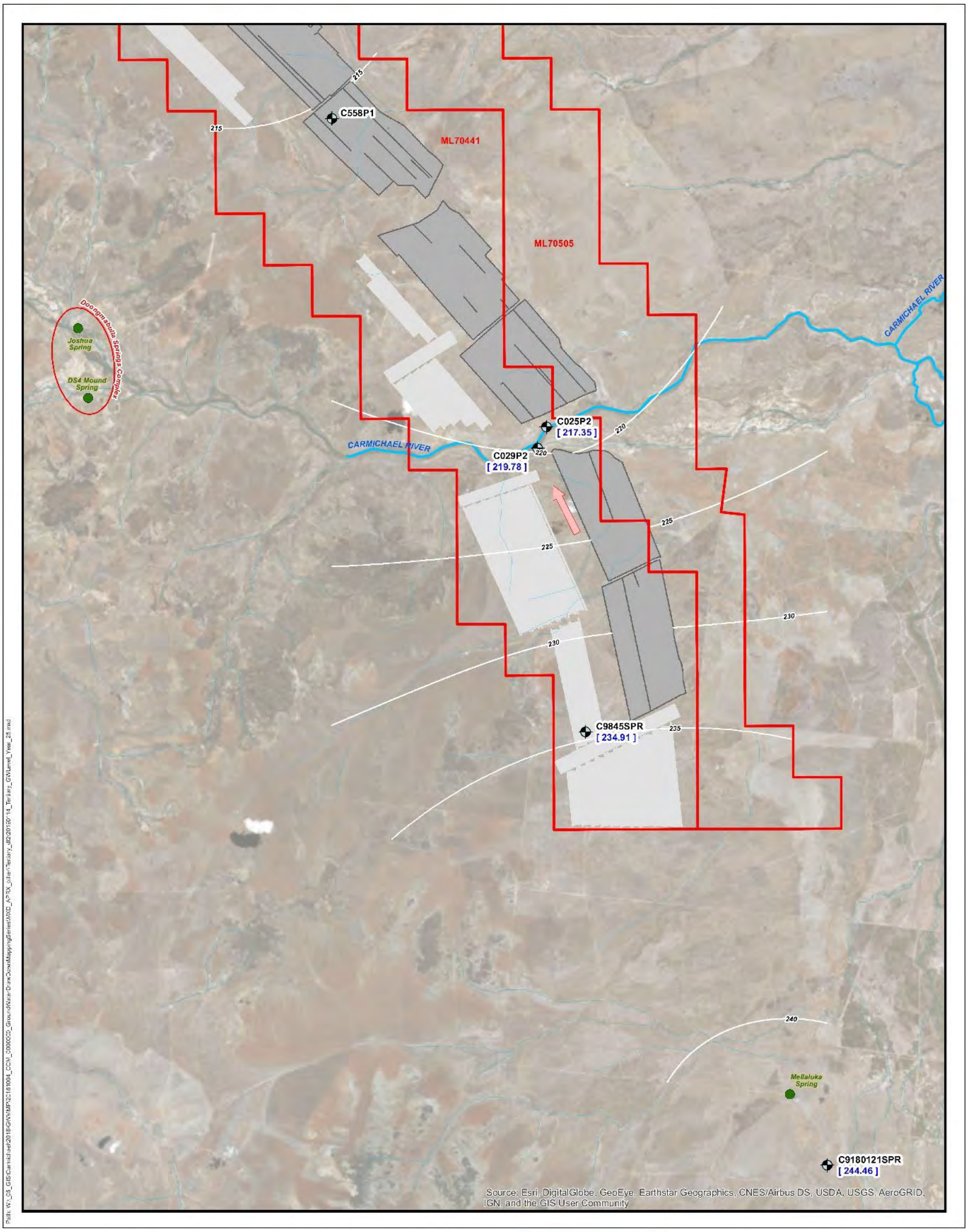

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TITLE
Tertiary Sediments Predicted Groundwater Levels - Year 25 -

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Location Map

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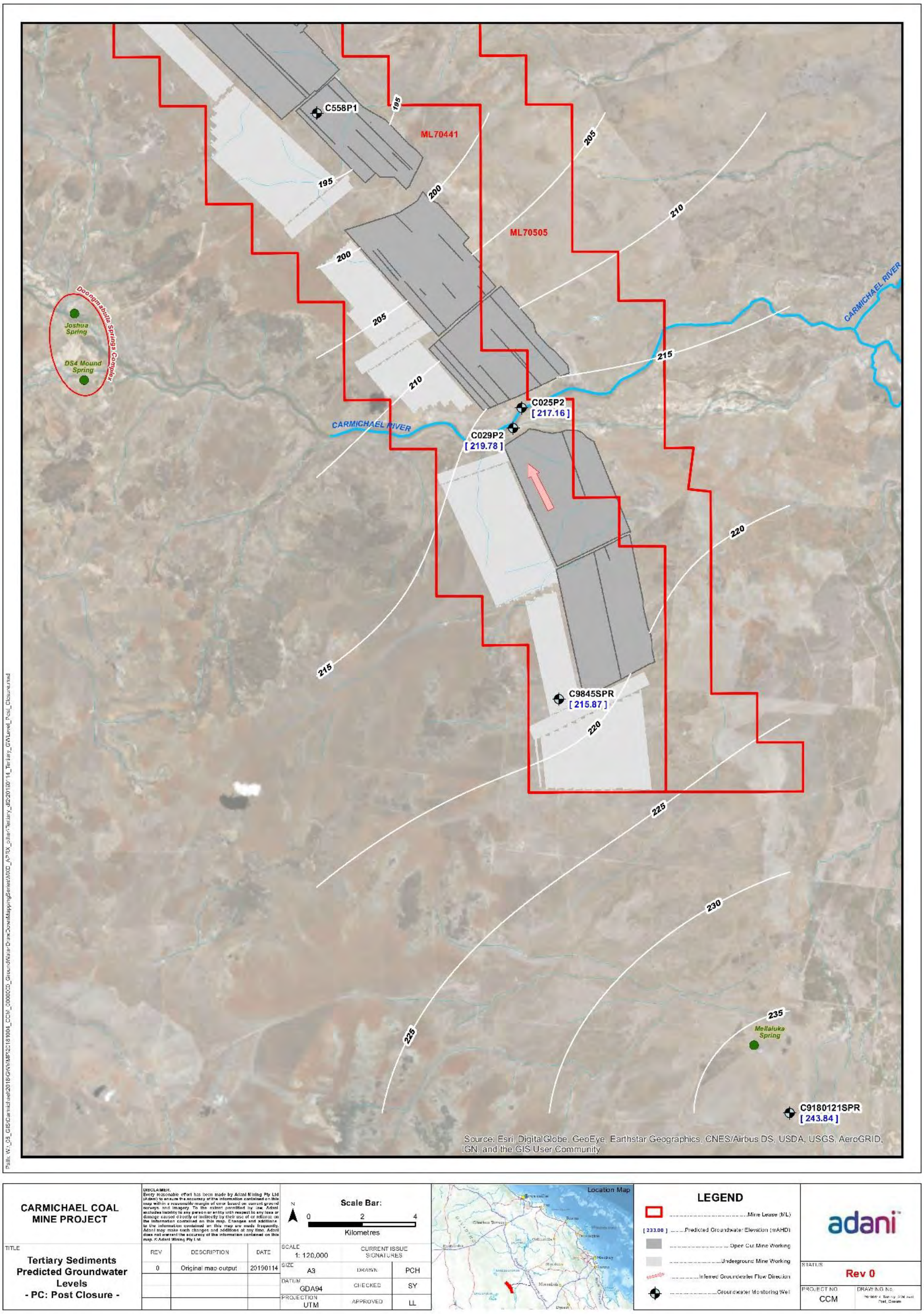

Figure 9-8a-g Predicted groundwater draw down associated with the Mellaluka springs-complex

A management objective under this plan is to manage the impacts of mine dewatering and limit impact of hydrological changes on the Mellaluka Springs-complex from mine dewatering. **Table 9-3** describes how the management objectives will be met, including performance criteria, management actions, monitoring, triggers for adaptive management and corrective actions.

#2: Subsidence from underground mining

EPBC Approval 2010/5736, condition 6(c)(ii) requires details of potential impacts from subsidence be addressed in this plan.

Environmental Authority condition I14 and Appendix 1, Definition of "GDEMP" (5) requires potential impacts from subsidence to be addressed in this plan.

No subsidence is predicted to occur within the vicinity of the Mellaluka Springs-complex, the nearest spring (Lignum Spring) being located a minimum of 3 km from the boundary of the Project Area.

As no subsidence is predicted to occur, the management objective is to monitor to ensure there is no habitat alteration through subsidence. **Table 9-3** describes how the management objective will be met, including performance criteria, management actions, monitoring, triggers for adaptive management and corrective actions.

#3: Changes to hydrology

EPBC Approval 2010/5736, condition 6(c)(viii) requires details of potential impacts from stream diversions and flood levees, be addressed in this plan.

Environmental Authority condition I14 and Appendix 1, Definition of "GDEMP" (5) requires potential impacts from water discharges and hydrological changes to be addressed in this plan.

Mellaluka Springs-complex does not contribute surface water to any nearby waterways, being located near the margin of extensive clay plains to the south west, sand plains to the north west, and a large alluvial plain to the east associated with the Belyando River, which is approximately 9 km away (GHD 2014). The focus for this threat is therefore to maintain existing surface water quantity (level) and quality of the Mellaluka Springs-complex, noting that there are existing impacts associated with weeds, feral animals and the impact of domestic animals.

A management objective under this plan is to maintain baseline surface water quantity (level) and quality. **Table 9-3** describes how the management objective will be met, including performance criteria, management actions, monitoring, triggers for adaptive management and corrective actions.

#4 Weeds and pests through direct competition or habitat degradation

EPBC Approval 2010/5736, condition 6(c)(ix) requires details of potential impacts from weeds and pests, be addressed in this plan.

Environmental Authority condition I14 and Appendix 1, Definition of "GDEMP" (5) requires potential impacts from weed and pest infestation to be addressed in this plan.

The ecology of the Mellaluka Springs-complex is currently threatened by pugging from cattle and pigs. This is unlikely to be exacerbated by mining activities and is under the management control of the landowner. All springs in this group are also characterised by the presence of weeds which overtime will further degrade wetland habitat quality, outcompete native vegetation, and potentially reduce the extent of open water available within the spring wetland areas.

Project-related impacts on the Mellaluka Springs-complex through drawdown may exacerbate existing impacts from weeds and pests, by reducing the resilience of the wetland communities and impacting sensitive native flora species. Visits to the Springs-complex to conduct monitoring also have the potential to introduce weeds and pests, if appropriate hygiene measures are not implemented. Impacts from cattle grazing are not under the direct control of Adani, as the Mellaluka Springs-group is located on land not owned by Adani, and grazing is managed by the landholder.

A management objective under this plan is to promote reduced weed competition and habitat degradation from Project-related activities within the Mellaluka Springs-complex, noting that responsibility for weed management at the site rests with the landholder. **Table 9-3** describes how the management objectives will be met, including performance criteria, management actions, monitoring, triggers for adaptive management and corrective actions. It should be noted that the Mellaluka Springs-complex is located on land that is not owned by Adani.

#5 Vegetation clearing / habitat loss

EPBC Approval 2010/5736, condition 6(c)(i) requires details of potential impacts from vegetation clearing be addressed in this plan.

There is no direct clearing of vegetation at the Mellaluka Springs-complex as a result of Project activities. However, habitat may be impacted by groundwater drawdown (addressed above).

Management objectives about the threat and impacts include minimising habitat loss and habitat restoration of disturbed areas, and if required environmental offsets. **Table 9-3** describes how the management objectives will be met, including performance criteria, management actions, monitoring, triggers for adaptive management and corrective actions.

#6: Earthworks

EPBC Approval 2010/5736, condition 6(c)(iv) requires details of potential impacts from earthworks be addressed in this plan.

Earthworks carried out as a part of mine construction and operations could lead to increased exposure to light, noise, dust, vehicles and people in areas adjacent to the Project area (Adani, 2012). The Project area is more than 3 km to the north, and there will be no direct incursion from Project vehicles or personnel beyond monitoring required as part of this plan.

Earthworks carried out as a part of mine construction and operations are unlikely to lead to increased risk and exposure of the Mellaluka Springs-complex to light, noise, dust, vehicles and people. Dust, noise, vibration and light spill are described in the following sections.

A management objective under this plan is to minimise risks during construction and operations. **Table 9-3** describes how the management objectives will be met, including performance criteria, management actions, monitoring, triggers for adaptive management and corrective actions.

#7: Noise and vibration

EPBC Approval 2010/5736, condition 6(c)(v) requires details of potential impacts from noise and vibration be addressed in this plan.

The project will use standard construction equipment, general trade equipment and specialised equipment as required. Some blasting will be required to prepare overburden for removal and also coal extraction (Adani 2012), however, it is not anticipated noise and vibration will likely impact the Mellaluka Springs-complex, due to its distance from project activities (a minimum of 3 km from the edge of the Project area to the closest spring - Lignum).

A management objective under this plan is to minimise habitat modification as a result of noise and vibration. **Table 9-3** describes how the management objectives will be met, including performance criteria, management actions, monitoring, triggers for adaptive management and corrective actions.

#8: Emissions (including dust)

EPBC Approval 2010/5736, condition 6(c)(vi) requires details of potential impacts from emissions, including dust, be addressed in this plan. Dust deposition associated with construction and operational is not predicted to impact the Mellaluka Springs-complex.

A management objective under this plan is to minimise emissions, particularly dusts. **Table 9-3** describes how the management objectives will be met, including performance criteria, management actions, monitoring, triggers for adaptive management and corrective actions.

#9: Light spill and other visual impacts

EPBC Approval 2010/5736, condition 6(c)(vii) requires details of potential impacts from light spill, be addressed in this plan.

Development of the project will necessitate the installation of lighting for safety and security of operations as the proposed mine will operate 24 hours per day. Impacts from lighting will involve static floodlights associated with mine operations, lighting around the mine infrastructure area, workshops and ancillary buildings, vehicle lights moving around the site. This is not expected to be an impact to the Mellaluka Springs-complex.

A management objective under this plan is to minimise light spill and other visual impacts. **Table 9-3** describes how the management objectives will be met, including performance criteria, management actions, monitoring, triggers for adaptive management and corrective actions.

9.7 Mitigation and management measures

Mitigation and management measures will focus on the impacts of groundwater drawdown.

Pre-impact groundwater monitoring will inform the updating of the numerical and conceptual groundwater model in order to confirm the source aquifer and predicted impacts. This will be completed before activities associated with predicted impacts occur. The GMMP and GDEMP will be updated once these reviews are complete and hence the mitigation and management measures presented below are based on the current conceptual groundwater model as approved through the EIS, which notes that there is likely to be significant groundwater lossses at these springs leading to a loss of ecological function.

Therefore, the key mitigation measure at Mellaluka Spring will be to supplement water supplies once operational drawdown impacts on the wetland begin to occur. These impacts will be mitigated through the installation of pumps to supplement surface water availability from alternative water sources (GHD 2014). In the event that this mitigation measure is not successful, then offsets will be implemented (**Section 9.7.2**).

9.7.1 Adaptive Management

When adaptive management and corrective actions are triggered, the first step is to investigate the cause of the trigger. Such investigations will involve a review of available data (including for example groundwater levels and groundwater quality, surface water quality), consideration of the potential influence of mining and non-mining activities or fluctuations in the area that may have contributed to the result, and the input of specialist advice. The specific details of the investigation will be tailored to identify the root cause or best available solution to the identified issue.

If ongoing declines in ecological values are detected an investigation into the cause will be undertaken and the administering authority notified within 28 days of the detection. If the investigation identifies mining activities as the cause, an assessment into the known or likely impacts will be undertaken and mitigation measures identified. If the investigation indicates that there is a risk of impacting the Mellaluka Springs-complex, then additional mitigation measures will be considered.

9.7.2 Environmental Offsets

The assessment of potential impacts to the Mellaluka Springs-complex indicated that no offset is required (GHD 2014; EPBC Act Approval Condition 10). Predicted impacts to the Mellaluka Springs-complex will be refined through the re-modelling to be undertaken within two years of commencement. This modelling will utilise additional geological and groundwater information to confirm the source aquifer for the Mellaluka Springs-complex and the predicted impacts.

Mitigation measures will be refined in response and offsets proposed, should there be significant residual impacts that cannot be mitigated, or as a corrective action should mitigation measures not be effective. EPBC Act conditions make reference to the potential to offset the ecological function of the Mellaluka spring–group, should the review of the conceptual and numerical impact model at the end of pre-impact monitoring demonstrate groundwater drawdowns consistent with the worst case predictions of the EIS conceptual groundwater model, as described above in **Section 9.6**. Adani will secure ecological offsets if pre-impact monitoring and groundwater model confirm likely complete loss of ecological function at each spring location.

9.8 Monitoring

This section describes the monitoring program of the Mellaluka Springs-complex.

9.8.1 Pre-impact survey and monitoring

Pre-impact monitoring will involve the following key tasks.

Habitat features survey

Bi-annual (wet and dry season) surveys will be completed for two years from commencement of this plan, then the frequency will be reviewed, and nominally revert to annually at each springs-complex: Lignum, Stories and Mellaluka. Surveys will be undertaken to establish the existing condition of the springs and seasonal fluctuations in size, surface water level and vegetation characteristics. The following variables will be measured:

- Survey and photo monitoring relating to existing conditions, including obtaining digital elevation data for each spring through remote sensing
- Wetland area (baseline conditions will be further informed by desktop studies using historic satellite imagery and associated calculations of wetland area)

- Review and interpretation of remote sensing images if available, following 'A new approach to monitoring spatial distribution and dynamics of wetlands and associated flows of Australian Great Artesian Basin springs using QuickBird satellite imagery' (White & Lewis 2011)
- Produce a digital elevation model for the Mellaluka Springs-complex
- Wetland pool depth (measured from a specific site in each pool for consistency)
- Wetland vegetation zone margins (e.g. area of free-standing water, proportion of wetland that is saturated, damp or dry - measured using a soil moisture probe)
- Native wetland vegetation cover
- Photographic reference

Pre-impact monitoring surveys will also include analysis of spring-head pressure via bores targeting the spring source aquifer, spring wetland characteristics including wetland area and physical condition, water quality, wetland vegetation and any threatened and endemic flora and fauna identified (including the *Streptoglossa* sp. collected from the main Mellaluka Springs-ground mound at Mellaluka Springs-complex and at the Doongmabulla Springs-complex).

All mapping will be undertaken with the assistance of QuickBird imagery or similar, and using Differential GPS equipment capable of sub-metre accuracy and real time correction. This will include the identification, photography, and mapping of wetland weeds and their extent. Monitoring results will be reported annually to DoEE and DES.

<u>Indicators</u>: spring wetland extent, wetland pool depth, wetland vegetation zone, native vegetation cover, photographic reference

Aquatic invertebrate communities

Aquatic invertebrate sampling (for endemic species) will be based on the methods used for GAB Springs monitoring in the Surat Basin and will be undertaken at the Mellaluka Spring. This includes sweeping an area of up to $5m^2$ with a macroinvertebrate net for 5 minutes, and transferring samples into a sterile jar (with a preservative) for subsequent laboratory identification to morpho-family level.

<u>Indicator</u>: Macroinvertebrate genera and species richness

Weed and pest surveys

Weed and pest surveys will be completed annually at each springs-complex: Lignum, Stories and Mellaluka in accordance with the Project pest management plan to:

- identify the extent of weeds,
- identify areas of wetland habitat subject to damage from feral and domestic animals

<u>Indicators</u>: Presence of weed species, Extent of weed coverage, Presence of pest species, Extent of pest disturbance

Stygofauna

A round of stygofauna sampling will be undertaken for the Mellaluka Springs-complex (at Bore C180120SP) to determine the presence of stygofauna and to identify if endemicity in the stygofauna community exists within the aquifer.

<u>Indicators</u>: Stygofauna presence, stygofauna endemicity

Groundwater monitoring

Groundwater level monitoring will be completed 12 hourly for water levels and at least quarterly for groundwater quality as per the GMMP. Groundwater monitoring will inform a combined baseline and pre-impact dataset for input into model review prior to activities and impacts.

Indicators: groundwater level, groundwater quality

Surface water monitoring

Surface water quality monitoring will be undertaken monthly at the Mellaluka Springs-complex.

Indicator: surface water quality (**Appendix A**)

Pre-impact condition report

At the conclusion of pre-impact surveys an Ecological Condition report will be prepared for the springs. The report will present results from baseline studies and the pre-impact monitoring events, mapping and photo-points and discuss the seasonal and spatial variation in the results. Recommendations for refining future ongoing monitoring methodology and frequency will also be made, in conjunction with a review of the relevant management and monitoring plans.

9.8.2 Impact survey and monitoring

The full suite of impact monitoring program attributes will be confirmed after the completion of the Ecological Condition Report, but will as a minimum include the following at the same locations as pre-impact monitoring:

- Wetland area (baseline conditions will be partly informed by desktop studies using historic satellite imagery and associated calculations of wetland area)
- Wetland pool depth (measured from a specific site in each pool for consistency)
- Wetland vegetation zone margins (e.g. area of free-standing water, proportion of wetland that is saturated, damp or dry - measured using a soil moisture probe)
- Native wetland vegetation cover
- Groundwater quality and level monitoring (as per GMMP)
- Surface water quality monitoring
- Weed and pests surveys

Ongoing monitoring will also contribute to a pre-impact baseline of the springs until groundwater drawdown impacts from the mine commence (at approximately 20 years after commencement). The approach to statistical analysis is summarised in **Table 9-2**.

9.8.3 Groundwater Monitoring Program

Pre-impact monitoring of groundwater quality and levels at Mellaluka Spring will be undertaken every two months for the period up until commencement of relevant mining activities.

Ongoing monitoring of wetland condition and groundwater levels at nearby bores will be undertaken during mine operations. Monitoring will be a fundamental component of the management approach, with a dual objective of informing an adaptive management approach to remediating the Mellaluka Spring wetland and to contribute to the understanding and protection of the ecological values of springs in the Galilee Basin (GHD 2014).

The key monitoring bores are:

- Tertiary
  - C180122SP
  - C9180121SPR
  - C14031SP
- Joe Joe
  - C180119SP
  - C180120SP
  - C180123SP
  - C9180124SPR
  - C9180125SPR
  - C14032SP
  - C14008SP
  - C14015SP
  - C14017SP

9.9 Trigger levels

Trigger levels (described in **Section 5.3**) will be reviewed at the completion of pre-impact surveys, based on an improved understanding of natural variation in the wetland attributes and the aquifer water levels. Low-risk trigger levels for biological and ecological indicators are based on a statistically significant deviation from the baseline/pre-impact for the following indicators:

- Wetland area (baseline/pre-impact conditions will be partly informed by desktop studies using historic satellite imagery and associated calculations of wetland area)
- Wetland pool depth (measured from a specific site in each pool for consistency)
- Wetland vegetation zone margins (e.g. area of free-standing water, proportion of wetland that is saturated, damp or dry – measured using a soil moisture probe)
- Native wetland vegetation cover

If a trigger is exceeded, an investigation will be conducted to determine whether the detected result is caused by mining activities. The investigation should follow the broad approach outlined in Section 3.3 of the ANZECC (2000) Guidelines, and will involve:

- Development of a decision tree model for the possible effect of mining activities on the measured variable
- Site-specific investigations involving the collection and interpretation of additional data
- A review of relevant data related to potential non-mining causes of variability in environmental variables (e.g. climatic data)
- Developing a detailed model of relevant environmental variables
- Expert opinion on the potential for environmental harm

The relevant Groundwater drawdown and groundwater quality triggers for aquifers associated with this GDE are described in the GMMP and are also presented in **Appendix B**.

Table 9-2 Statistical approach for Mellaluka springs triggers and monitoring

GDE	Indicator	Relevant Trigger	Design (to be confirmed following pre-impact surveys)	Parameters	Statistical analysis
Mellaluka Springs-complex	Groundwater level	Groundwater level drawdown thresholds as outlined in the GMMP, Appendix B and Table E3 in the EA and Appendix B.	Monitoring at the bores listed in Section 9.8.3. Monitored 12 hourly as per GMMP.	Groundwater level	Univariate comparison between groundwater level at time of sampling and groundwater level threshold.
	Groundwater quality	Groundwater Quality Trigger levels as outlined in the GMMP and Table E2 in the EA.	Monitoring at the bores listed in Section 9.8.3. Monitored quarterly as per GMMP.	Water quality parameters as outlined in GMMP.	Descriptive comparison with defined trigger levels.
	Spring wetland extent	Statistically significant difference in spring wetland extent from baseline & pre-impact conditions.	Surveys will be undertaken at Mellaluka, Stories and Lignum Springs seasonally for two years, then annually thereafter.	Perennial wetland cover assessed both on site and via remote sensing.	Univariate f and t-tests to statistically compare variance and mean extent between time of sample and baseline & pre-impact conditions.
	Wetland vegetation	Statistically significant difference in wetland vegetation composition from baseline & pre-impact conditions.	Surveys will be undertaken at Mellaluka, Stories and Lignum Springs seasonally for two years, then annually thereafter.	Identify wetland zones (pool, saturated, damp, dry) and their boundary locations. Photographic reference Wetland vegetation species composition Wetland vegetation Species abundances (1 m x 1 m subplots spaced 4 m apart, along the transect).	Descriptive comparison between wetland vegetation composition at time of sampling and baseline & pre-impact condition. Univariate f and t-tests to statistically compare variance and mean of wetland vegetation composition parameters between time of sample and baseline & pre-impact conditions. MDS graphs to show relative spread of plots based on vegetation composition (cover and species richness). Multivariate PERMANOVA test on parameters to detect significant differences between sampling time and baseline & pre-impact. Follow up SIMPER tests to detect the main indicators driving the patterns in the data.
	Threatened and endemic flora populations	Loss of a threatened species from any spring Statistically significant difference in threatened species condition from	Surveys will be undertaken at Mellaluka, Stories and Lignum Springs. Monitored	Any other flora identified during baseline & pre-impact surveys as endemic or threatened, and reliant	Descriptive comparison between vegetation extent, condition and richness at time of sampling and baseline & pre-impact condition. Univariate f and t-tests to statistically compare variance and mean of vegetation extent, condition and richness

GDE	Indicator	Relevant Trigger	Design (to be confirmed following pre-impact surveys)	Parameters	Statistical analysis
		baseline & pre-impact conditions.	seasonally for two years then annually thereafter.	on wetlands for survival.	between time of sample and baseline & pre-impact conditions. MDS graphs to show relative spread of plots based on vegetation composition (cover and species richness). Multivariate PERMANOVA test on parameters to detect significant differences between sampling time and baseline & pre-impact. Follow up SIMPER tests to detect the main indicators driving the patterns in the data.

9.10 Management objectives, performance criteria, adaptive management triggers and corrective actions

The threats to the Mellaluka Springs-complex relevant to the Project and potential project impacts and actions minimising impacts to the Mellaluka Springs-complex are summarised in **Table 9-3**. The table addresses the following:

- management objectives
- performance criteria
- management actions
- monitoring
- triggers for adaptive management and corrective actions
- specific, measurable and time-bound corrective actions.

The relevant statistical analyses outlined in section 5.4.3 support the specific performance criteria for the Mellaluka Springs-complex. Table 9-3 and Table 9-2 (Statistical approach for Mellaluka Springs-complex triggers and monitoring) will be used to assess the success of management measures against goals, triggers, implementation of corrective actions if the criteria are not met within specified timeframes.

At the conclusion of pre-impact monitoring, the performance criteria, monitoring and triggers will be reviewed, and updated, as required, via the review and adaptive management process detailed in sections 10.2 (Pre-impact studies, reporting and updates), 10.3 (Annual and compliance reporting) and 10.4 (Reporting and monitoring of related management plans and programs).

The objectives apply for the life of the approvals, and the life of this plan, subject to updates via reviews and adaptive management process detailed in sections 10.2 to 10.4

Table 9-3 Management objectives, performance criteria, adaptive management triggers and corrective actions for Mellaluka Springs-complex

#	Potential indirect project impact	Management objective	Performance Criteria	Management Actions	Monitoring	Monitoring Indicators	Ecological triggers for adaptive management and corrective actions	Corrective actions
1	Groundwater drawdown from mine dewatering	Minimise the impact of aquifer drawdown caused by mining activities on the Mellaluka Springs-complex	No greater impact to Mellaluka Springs-complex due to aquifer drawdown caused by mining activities other than that approved.	Implement groundwater monitoring and management program as per the GMMP and undertake review of conceptual model as per EA and EPBC Conditions to inform impact predictions. Incorporate information from the GAB Springs Research Plan into measures for managing and/or remediating the Mellaluka Springs-complex.	**Pre-impact and impact monitoring:** Groundwater Management and Monitoring Program Habitat Features Survey (initially bi-annually, then annually) Aquatic Invertebrate Survey Stygofauna Survey (PI)	Groundwater level Spring wetland extent Wetland pool depth Wetland vegetation zone Native vegetation cover Macroinvertebrate genera and species richness Stygofauna presence Stygofauna endemicity	Groundwater level drawdown thresholds as outlined in the GMMP, Appendix B and Table E3 in the EA are exceeded. The condition of Mellaluka Springs-complex declines due to aquifer drawdown caused by mining activities including: • Decrease in wetland area • Wetland vegetation zone margins contract • Loss of native wetland vegetation cover Increase in weed and / or non-wetland species	The appropriate corrective actions will be implemented and may include: • In the event that groundwater quality triggers are exceeded, the investigation, response and corrective actions process under the GMMP will be implemented • Repeating the Habitat Features Survey within 2 months to validate / test findings • Groundwater impact report to be developed within 2 months to inform on background/seasonal/mining related impacts • Increasing ongoing frequency of Habitat Features Survey and review of indicators over the following 12 months • Identifying and implement adaptive management measures and / or alternative rehabilitation strategies in consultation with the Mellaluka landholder • Reviewing and update the Wetland Remediation and Management Plan if necessary • Securing ecological offsets within specified approval timeframes if increased monitoring and groundwater model confirms likely complete loss of ecological function at each spring location.
		Minimise the impact of aquifer drawdown caused by mining activities on the Mellaluka Springs-complex	No impact to Mellaluka Springs-complex due to degradation of groundwater quality caused by mining activities other than that approved.	Implement groundwater monitoring and management program as per the GMMP and undertake review of conceptual model as per EA and EPBC Conditions to inform impact predictions. Incorporate information from the GAB Springs Research Plan into measures for managing and/or remediating the Mellaluka Springs-complex. Prepare a Wetland Remediation and Management Plan in consultation with the Mellaluka landholder.	**Pre-impact and impact monitoring:** Groundwater Management and Monitoring Program Habitat Features Survey (initially bi-annually, then annually) Aquatic Invertebrate Survey Stygofauna Survey (PI)	Groundwater quality Spring wetland extent Wetland pool depth Wetland vegetation zone Native vegetation cover Macroinvertebrate genera and species richness Stygofauna presence Stygofauna endemicity	Groundwater quality trigger levels as outlined in the GMMP and Table E2 in the EA are exceeded. The ground water quality of Mellaluka Springs-complex declines caused by mining activities Loss of native wetland vegetation cover Increase in weed and / or non-wetland species	The appropriate corrective actions will be implemented and may include: • In the event that groundwater quality triggers are exceeded, the investigation, response and corrective actions process under the GMMP will be implemented • Repeating the Habitat Features Survey within 2 months to validate / test findings • Groundwater impact report to be developed within 2 months to inform on background/seasonal/mining related impacts • Increasing ongoing frequency of Habitat Features Survey and review of indicators over the following 12 months. • Identifying and implementing adaptive management measures and / or alternative rehabilitation strategies in consultation with the Mellaluka landholder. • Reviewing and updating the Wetland Remediation and Management Plan • Securing ecological offsets within specified approval timeframes if increased monitoring and groundwater model confirms likely complete loss of ecological function at each spring location.

#	Potential indirect project impact	Management objective	Performance Criteria	Management Actions	Monitoring	Monitoring Indicators	Ecological triggers for adaptive management and corrective actions	Corrective actions
		Minimise alterations to surface water / groundwater connectivity from mining activities	No impact to surface water at Mellaluka Springs-complex due to aquifer drawdown caused by direct or indirect mining activities than that approved.	There are no predicted surface water degradation impacts likely to occur at the Mellaluka Springs-complex. Activities carried out associated with monitoring under this plan must be undertaken to prevent surface water quality degradation. Standard mine operating procedures will include dust control of project areas in accordance with procedures under the Environmental Management Plan	**Pre-impact and impact monitoring:** Groundwater Management and Monitoring Program (monthly) Surface water quality monitoring program (monthly)	Groundwater level and quality Surface water level and quality	Water Quality trigger when 80th percentile of parameter met. Groundwater level thresholds triggered as per Appendix B	The appropriate corrective actions will be implemented and may include: • Installing electric submersible pumps (as per relevant industry standards) for this purpose in response to drawdown. This will ensure the continuation of water to the Mellaluka Spring wetlands (and homestead) from an alternative source, providing a continuation of water for ecological services and domestic and agricultural purposes. • Reviewing groundwater trigger drawdown thresholds in relation to relevant ecological trigger exceedance and appropriate actions in accordance with GMMP. • Securing ecological offsets if pre-impact monitoring and groundwater model confirms likely complete loss of ecological function at each spring location
2	Subsidence from underground mining (not predicted to occur within Mellaluka Springs-complex)	Minimise habitat impacts related to subsidence	No impacts, such as ponding and cracking in subsidence areas (not predicted for any GDE)	Unlikely to occur Implement the project Subsidence Management Plan as per the EA Conditions. Engagement with landholder at the Mellaluka property regarding operational practices.	Regular (at least monthly) site inspections in accordance with the Environmental Management Plan and System.	Early warning signs of subsidence, such as ponding or cracking	Evidence of subsidence at Mellaluka Springs-complex	The appropriate corrective actions will be implemented and may include: • Repeating the Habitat Features Survey within 2 months to validate / test findings • Groundwater impact report to be developed within 2 months to inform on background/seasonal/mining related impacts • Reviewing subsidence related infrastructure and drainage within 2 months to identify causal factors and recommend changes to prevent ongoing impacts.
3	Changes to hydrology	Protection of environmental values within waterways of the receiving environment. Maintain baseline and pre-impact surface water quality Minimise siltation of water resources	No degradation of permanent water sources by effluent / contaminants / siltation as a result of mine operations or activities.	There are no predicted surface water degradation impacts likely to occur at the Mellaluka Springs-complex. Activities carried out associated with monitoring under this plan must be undertaken to prevent surface water quality degradation. Standard mine operating procedures will include dust control of project areas in accordance with procedures under the Environmental Management Plan No unapproved clearing associated with activities at the Mellaluka Springs-complex Any sites used for chemical and fuel storage will be located a safe distance away from Mellaluka Springs-complex, with bunding or other raised barrier, resistant to normal flood events, between chemicals and habitat. Engagement with landholder at the Mellaluka property regarding operational practices.	**Pre-impact and impact monitoring:** Surface water quality monitoring program (monthly)	Surface water quality physical and chemical characteristics as per ANZECC guidelines including pH, DO, Temperature, EC SS, Total P & N	Physical evidence of contamination to Mellaluka Springs-complex. Water Quality trigger when 80th percentile of parameter met.	The appropriate corrective actions will be implemented and may include: • More frequent chemistry testing to confirm water quality against relevant standards, in the event that visual inspection of dust impacts fails • Engaging with landholder to understand potential impacts from agricultural activities • Reviewing relevant meteorological data • Reviewing adherence to control procedures to ensure compliance • Taking remedial action where compliance has not been adhered to • Communicating with personnel involved and across all site team members (for example, via toolbox meetings). • Reporting to DES as per statutory and project requirements where incidents trigger reporting thresholds

#	Potential indirect project impact	Management objective	Performance Criteria	Management Actions	Monitoring	Monitoring Indicators	Ecological triggers for adaptive management and corrective actions	Corrective actions
4	Weeds and pests through habitat degradation	Reduce weed extent and competition	No introduction of pest plants, invasive understorey species in Mellaluka Springs-complex as a result of Project related activities.	Weed hygiene controls, including the use of weed wash down stations, will be implemented in accordance with the PMP to prevent the introduction and spread of declared pest plants and other invasive weeds. Weed free areas within the Mellaluka Springs-complex will be identified and mapped with strict weed control requirements for entering weed free areas. Adaptive management of weed controls to minimise threats to Mellaluka Springs-complex. Engagement with landholder at the Mellaluka property regarding operational practices.	**Pre-impact and impact monitoring:** Weed and Pest Surveys (annually) Habitat Features Survey (initially bi-annually, then annually)	Presence of weed species Extent of weed coverage	Results of weed monitoring indicate a degradation of in Mellaluka Springs-complex, due to a proliferation of weeds. A significant increase in the abundance of weeds, or pests or identification of new infestations.	The appropriate corrective actions will be implemented and may include: • Eliminating potential sources or reasons that are have attributed to an increase in species richness and/or relative abundance of weeds • Engaging with landholder to raise issues within 5 days of investigation. • Engaging with landholder to understand potential impacts from agricultural activities • Amending weed hygiene restrictions • Providing additional educational awareness training for all staff and contractors to ensure weed hygiene restrictions are adhered to • Revising weed control methods in accordance with the *Biosecurity Act 2014* • Engaging with the landholder to protect and restore in Mellaluka Springs-complex values through implementation of site-specific measures such as weed control, fire management or grazing
		Achieve reduced impacts to the Mellaluka Springs-complex from Feral animal impacts	No significant increase in spring disturbance due to feral animals as a result of Project related activities.	Adaptive management of pest controls in the Project area to minimise threats to Mellaluka Springs-complex (which lies on adjacent land and requires landholder action). A project pest management plan will be developed and implemented prior to construction and operations, including measures for controlling rabbits, goats, foxes and cats. The project pest management plan will be developed in conjunction with neighbouring land owners, and will focus on tracks, waterways and habitat edges. Engagement with landholder at the Mellaluka property regarding operational practices.	**Pre-impact and impact monitoring:** Weed and Pest Surveys (annually) Habitat Features Survey (initially bi-annually, then annually)	Presence of pest species Extent of pest disturbance	Observed habitat degradation attributed to threatening pest species	The appropriate corrective actions will be implemented and may include: • Engaging with landholder to raise issues within 5 days of investigation. • Engaging with landholder to understand potential impacts from agricultural activities • Increasing the frequency and intensity of pest animal control, working in partnership with the landholder • Revising methods of pest animal control in accordance with Queensland Department of Agriculture and Fisheries (DAF) guidelines, and coordinate with neighbouring land owners to ensure a consistent approach • Reviewing actions and methods included in the project pest management plan • Updating pest animal control methods in targeted pest animal control programs • Increasing feral herbivore management efforts, in conjunction with neighbouring land owners • Increasing invasive predator management efforts, in conjunction with neighbouring land owners.

#	Potential indirect project impact	Management objective	Performance Criteria	Management Actions	Monitoring	Monitoring Indicators	Ecological triggers for adaptive management and corrective actions	Corrective actions

5	Vegetation clearing / habitat loss	Prevent Mellaluka Springs-complex habitat loss arising from Project activities (other than indirect drawdown as described above)	No direct clearing of vegetation at Mellaluka Springs-complex unless otherwise approved.	Prior to the commencement of any related site works / monitoring / bore hole drilling the limits of clearing and exclusion areas will be clearly marked. Temporary fencing, such as barricade webbing, wire fencing or similar, will be used to prevent clearing.
				Engagement with landholder at the Mellaluka property regarding operational practices.
					Pre-impact and impact monitoring:
					Habitat Features Survey (initially bi-annually, then annually) regular (at least monthly) site inspections in accordance with the Environmental Management Plan and System.
						Native vegetation cover	Unapproved clearing of habitat at the Mellaluka Springs-complex.	The appropriate corrective actions will be implemented and may include:
								• Engaging with landholder to understand potential impacts from agricultural activities
								• When clearing outside approved clearing footprint, no go zones or without a "Permit to Disturb Permit" issued,
								  o Environment Manager ensure that all clearing activities cease immediately
								  o Area assessed by a suitably qualified ecologist/person within 15 business days of investigation
								  o additional barricading to be installed
								• Reviewing and modifying "Permit to Disturb" process and no-go zone identification and communication protocols.
								• Environmental offsets, if required, for habitat loss or habitat degradation.

6	Earthworks	Minimise the risk of light vehicle and machinery strike during earthworks and operations	No fauna strikes at Mellaluka Springs-complex Group due to project related vehicle movements. No project earthworks at Mellaluka Springs-complex associated with project related activities.	Vehicles and plant will drive on pre-determined roads only, and adhere to all speed limits, which will be clearly communicated. There are no predicted or required earthworks impacts likely to occur at Mellaluka Springs-complex, as Project activities are limited to ongoing monitoring activities.	Regular (at least monthly) site inspections in accordance with the Environmental Management Plan and System.	Observation of fauna strike	Vehicles observed /reported driving outside designated areas Fauna strike during monitoring or related activities Degradation or disturbance of Mellaluka Springs-complex likely to have been caused by earthworks activities	The appropriate corrective actions will be implemented and may include: • Engaging with landholder to understand potential impacts from agricultural activities • Restricting access / realigning access routes • Reviewing and re designing to avoid reoccurrence and address actual cause • Communicating with personnel involved and across all site team members (for example, via toolbox meetings).
7	Noise and vibration	Minimise habitat modification	No disturbance of Mellaluka Springs-complex from noise and vibration	There are no predicted noise and vibration impacts likely to occur at the Mellaluka Springs-complex Standard mine operating procedures will include noise and vibration management in accordance with procedures under the Environmental Management Plan.	Regular (at least monthly) site inspections in accordance with the Environmental Management Plan and System.	Event monitoring for: dB(A) peak particle velocity (PPV)	Degradation of Mellaluka Springs-complex likely to have been caused by noise or vibration.	The appropriate corrective actions will be implemented and may include: • Engaging with landholder to understand potential impacts from agricultural activities • Reviewing project noise and vibration monitoring program to determine if any exceedance's recorded or noted at the Mellaluka homestead • Reviewing and re designing to avoid reoccurrence and address actual cause • Communicating with personnel involved where appropriate and across all site team members (for example, via toolbox meetings).
8	Emissions (including dust)	Minimise emissions (dusts)	Emissions attributable to the Project (i.e. dust, coal and heavy metals) do not degrade water source quality in Mellaluka Springs-complex.	There are no predicted emissions / dust impacts likely to occur at the Mellaluka Springs-complex Standard mine operating procedures will include dust control of project areas in accordance with procedures under the Environmental Management Plan.	Regular (at least monthly) site inspections in accordance with the Environmental Management Plan and System.	Event monitoring for: Total suspended particulate matter	Degradation of Mellaluka Springs-complex likely to have been caused by dust or other emissions.	The appropriate corrective actions will be implemented and may include: • Engaging with landholder to understand potential impacts from agricultural activities • Reviewing of relevant meteorological data • Reviewing of project air quality monitoring program to determine if any exceedance's recorded or noted at the Mellaluka homestead • Where monitoring shows a reduction in habitat condition due to dust, mitigating source of dust • Communicating with personnel involved and across all site team members (for example, via toolbox meetings).

#	Potential indirect project impact	Management objective	Performance Criteria	Management Actions	Monitoring	Monitoring Indicators	Ecological triggers for adaptive management and corrective actions	Corrective actions
9	Light spill and other visual impacts	Minimise light spill	No light disturbance at Mellaluka Springs-complex.	There are no activities likely to cause light spill at the Mellaluka Springs-complex.	Regular (at least monthly) site inspections in accordance with the Environmental Management Plan and System.	Observations of amount of light falling on Mellaluka Springs-complex	Direct light spill onto Mellaluka Springs-complex	The appropriate corrective actions will be implemented and may include: • Engaging with landholder to understand potential impacts from agricultural activities • Reviewing of relevant meteorological data • Reviewing of monitoring and survey activities to determine any association • Reviewing and re designing light controlling devices, or adjust location of light, to reduce light spill and lighting levels below trigger levels • Communicating with personnel involved and across all site team members (for example, via toolbox meetings).

10 Plan updates, reporting and compliance

10.1 Plan updates

This management plan will be reviewed within two years of commencement of mining and from there on every five years. The plan will be amended as required, and in response to new information. This will include updates to the conceptual models of GDEs and trigger levels, changes in the status of listed species or the identification of listed species in the Project area that had not been previously recorded. The groundwater model will be reviewed within two years, as described in the GMMP, with the GDEMP updated accordingly.

In the event that new species or Threatened Ecological Communities are found, then DoEE and/or DES will be notified within five business days and Adani will outline how the conditions of this approval will still be met within 20 business days. Revised management and monitoring arrangements will be identified as part of the adaptive management approach. Updates to the management plan will be made in consultation with DoEE and DES, in accordance with Condition 33 of the EPBC Act approval and Section 143A of the EPBC Act.

If impact monitoring identifies an exceedance of trigger levels, Adani will notify the Department/s in writing within five business days. Within 28 business days, Adani will submit a report detailing the findings of investigations including the known or likely cause and potential magnitude of impacts, corrective actions, recommended mitigation and management measures. An updated GDEMP will then be prepared and submitted to the DoEE and DES for approval.

In all other circumstances, Adani will revise the management plan following the completion of pre-impact monitoring, and resubmit it to DoEE and DES for the Minister's written approval within 3 months of completion. Once approved, the revised management plan will be implemented. A summary of the timing of key project elements is provided in **Appendix C**.

10.2 Pre-impact studies, reporting and updates

Pre-impact studies will be undertaken for the Doongmabulla Springs-complex, Waxy Cabbage Palm, Carmichael River and Mellaluka Springs-complex GDEs (**Section 5.3**). These studies will build on existing baseline information collected during and post the EIS and evaluate the pre-impact conditions including seasonal variations and existing threats.

Following the completion of these pre-impact surveys, the frequency of monitoring will be reviewed and ongoing monitoring data will contribute towards the development of an extended baseline for each GDE to account for temporal variations. Trigger levels for groundwater drawdown and ecological impacts (discussed in **Sections 6-9**) will be reviewed, and if appropriate, refined. Adani will verify that pre-impact data are not influenced by mining activities. A pre-impact report containing proposed new recommended trigger levels (to be applied to the operational monitoring of each GDE) will be compiled and submitted for DoEE and DES approval prior to implementation.

This GDEMP will be updated upon approval of the revised trigger levels, which will replace the triggers (where appropriate). Groundwater drawdown triggers will also provide an 'early warning' that changes in the groundwater environment may have occurred and that investigations into potential ecological responses must be undertaken.

10.3 Annual and compliance reporting

Initially, an annual report on the findings of pre-impact monitoring will be prepared. This will include establishing a database for existing baseline and new pre-impact data. The report will identify any constraints for ongoing monitoring, and identify any changes required to the field sampling plan (on the basis of results from the first year of monitoring). Any changes to the monitoring program will be submitted to DoEE and DES for approval.

In accordance with Condition 31 of the EPBC Act approval, a report will be published on Adani's website within three months of every 12 month anniversary of the commencement of the project. The report will address compliance with each of the conditions of approval, including implementation of management plans (including this GDEMP). Evidence of the date of publication and non-compliance with any of the conditions of approval will be provided to DoEE at this time.

In accordance with Condition I14 of the EA, an annual report of the findings of this GDEMP, including all monitoring results and interpretations as well as a summary of the activities implemented in the previous 12 months, will be prepared and made available on request to the administering authority. The report will include:

- An assessment of background reference groundwater levels
- The condition of each GDE compared with previous monitoring results
- An assessment of long-term trends in the results
- Information on whether any triggers have been exceeded
- The suitability of current groundwater trigger thresholds
- Detail on the effectiveness of avoidance, mitigation and management actions in curtailing adverse impacts on GDE ecosystems
- A description of any adaptive management initiatives implemented
- Details of monitoring undertaken and proposed revisions to existing triggers
- Any offsets required for residual impacts.

The condition assessment of each GDE will include a statistical comparison to baseline conditions to ensure seasonal variations are accounted for and identify any change from the baseline and any planned actions.

Monitoring results and reports will be kept for the life of the project in accordance with Condition 30 of the EPBC Act approval. Adani will conduct periodic audits to monitor compliance with management plan commitments, in accordance with the Adani quality system. Non-compliances with the plan will be reported to the relevant Department (DoEE and DES) within five business days. Adani will integrate the management plan commitments with other aspects of the mine construction and operations, to avoid actions being overlooked.

This GDEMP will be available to all employees, contractors and subcontractors and will be published on Adani's website. Adani will amend the GDEMP in response to regular reviews, monitoring results and changes in legislation, in consultation with regulatory authorities. Amendments to the GDEMP will be updated on Adani's website within 30 business days.

Adani will notify the managing agencies (DoEE and DES) of mining stage closure and commencement.

10.4 Reporting and monitoring of related management plans and programs

Adani is required to develop and implement a number of associated management plans and programs to address the requirements of approval conditions under both Commonwealth and Queensland legislation. Linkages between this GDEMP and these associated management plans and programs are summarised in **Section 1.3**. These plans and programs will be subject to ongoing monitoring, review, and as required update and approval.

Key linkages across research program outcomes, modelling updates and management plan review, update and reporting are summarised in **Table 10-1**.

Table 10-1: Reporting requirements of other management plans with linkages to this GDEMP

Management Plan	Description	Internal Review Frequency	External Review Frequency	Reporting Frequency	Linkage to GDEMP and triggers/corrective actions
Groundwater Management and Monitoring Plan (GMMP) EPBC Approval Condition 3 EA Approval Conditions E4 and E5	The GMMP identifies monitoring, management and mitigation with respect to approved impacts to groundwater resources. The GMMP includes details of groundwater monitoring network for monitoring GAB aquifers, GDEs (Springs, Carmichael River) during all phases of the project including baseline, operations, and post-closure.	The GMMP will be reviewed by an appropriately qualified person by July 2020 and then at regular five-year intervals, as per EA Condition E5 and EPBC Act approval condition 3e In compliance with EA approval conditions (EA Condition E6; Appendix A), the numerical groundwater model is to be reviewed, using the GMMP data and measured mine dewatering volumes, within two years of the initial box cut excavation and then at least every five years afterwards. The review of the groundwater model will include expert review by a person/s of the Minister's / DES choosing.	EA Annual Compliance Report to be prepared by Third Party.	Annual – EPBC Compliance Reporting – Condition 31 Annual - EA Compliance Reporting – Condition A13 Every 5 years – after internal review process	The GMMP provides a framework for the management of groundwater impact, including defining groundwater trigger levels, and MNESMPs for other threatened species and ecological communities. The GMMP will facilitate the detection of any mining related impacts to groundwater (i.e., impacts from establishment and operation of the mine). Relevant triggers from the GMMP (those that are related to groundwater dependent ecosystems) have been included in this GDEMP each sub-plan. Should recommended trigger levels be refined as a result of pre-impact studies (see **Section 5.3**) this will require update of both this GDEMP (see **Section 10.1**) and the GMMP. Where outcomes of the groundwater model review to be conducted within 2 years of mining influence aspects of this plan (such as triggers, criteria, predicted impacts), this plan will be reviewed and updated accordingly. Additionally, should trigger levels in the GMMP (which are informed by groundwater modelling) require update as part of the GMMP review process every five years, the requirement to update trigger levels in this GDEMP will be reviewed.

Management Plan	Description	Internal Review Frequency	External Review Frequency	Reporting Frequency	Linkage to GDEMP and triggers/corrective actions
Receiving Environment Monitoring Program (REMP) EA Approval Conditions F23 to F25	The aim of the REMP is to monitor, identify and describe and provide early warning indicators for any adverse impacts to surface water environmental values, quality and flows due to the authorised mining activity. For the purposes of the REMP, the receiving environment is the waters of the Carmichael River and connected or surrounding waterways within 12 km downstream from the release point. This includes the Belyando River, which is immediately downstream of the confluence with the Carmichael River.	Annual monitoring and findings report to be prepared and provided.		Annual - EA Compliance Reporting – Condition A13 Annual implementation report - EA condition F25	Surface water monitoring results will be used in relation to monitoring and management for the Carmichael River GDE, within the context of approved mine discharges to the River and the impacts of mining activities on water quality and flow.
GAB Springs Research Plan (GABSRP) EPBC Approval Condition 25	The GABSRP investigates, identifies and evaluates methods to prevent, mitigate and remediate ecological impacts on the EPBC Act listed community of native species dependent on natural discharge of	Annually and as directed through the outcomes of discrete research packages. *Note: this plan requires separate approval and hence review frequency will be*		Annual – EPBC Compliance Reporting – Condition 31 Annual Implementation Report	The GABSRP informs ecological triggers, monitoring and management through adaptive processes. Both the GMMP and GDEMP will define groundwater and (related) ecological trigger levels and management and mitigation measures, which

Management Plan	Description	Internal Review Frequency	External Review Frequency	Reporting Frequency	Linkage to GDEMP and triggers/corrective actions
	groundwater from the Great Artesian Basin, including the Doongmabulla Springs-complex, in the Galilee Basin.	*determined and approved through that mechanism.*			will inform research programs undertaken under the GAB. This GDEMP will provide information to the GAB Springs Research Plan with the aim of supporting research and analysing the effectiveness of mitigation actions. Research outcomes will directly inform monitoring, management, prevention mitigation and remediation. Both the baseline springs survey and the specific species study (part of the GABSRP), will be undertaken as specified in this GDEMP.
Rewan Formation Connectivity Research Plan (RFCRP) EPBC Approval Conditions 27 and 28	The RFCRP characterises the Rewan Formation within the area impacted by the mine. The Rewan Formation has been identified as an area where further information needs to be collected and additional studies need to be conducted to negate uncertainties, especially with effect of faulting and potential subsidence induced.	Within 1 year of approval of the RFCRP Adani will provide a report on research outcomes, *Note: this plan requires separate approval and hence review frequency will be determined and approved through that mechanism.*		Annual – EPBC Compliance Reporting – Condition 31	The RFCRP informs groundwater triggers, monitoring and management through adaptive processes as described in the GMMP. Details have been included in the GMMP regarding how the Rewan Formation monitoring allows for: 1). The development of early warning monitoring points (with regards to potential impacts on the GAB units); 2). The establishment of groundwater level threshold levels (which if detected instigate investigation into the cause of potential environmental harm); 3). The interaction of the Rewan Research Plan (groundwater component) with the GAB Spring

Management Plan	Description	Internal Review Frequency	External Review Frequency	Reporting Frequency	Linkage to GDEMP and triggers/corrective actions
					Research Plan, offset, subsidence, and GDEMP; and 4). Links to the Geoscience Australia regional Galilee Basin numerical groundwater model
Biodiversity Offset Strategy (BOS); GAB Offset Strategy; Offset Area Management Plans (OAMP's) EPBC Approval Conditions 8 to 13 EA Approval Condition I1 to I5	The BOS describes required offsets for unavoidable residual impacts to MNES. The BOS details how the project's offset requirements will be fulfilled and to guide ongoing offset delivery. The BOS was approved in October 2016 In addition to the overarching BOS, OAMPs have been developed that guide the ongoing management and monitoring of MNES and MSES associated with offset delivery, and describes specific management actions for properties to be used as offsets under the BOS. T he GAB Offset Strategy addresses indirect impacts to GAB aquifers	The BOS will be reviewed and updated prior to the commencement of each offset delivery stage. Annual reports over the 5-year period of the GAB Offset program The OAMP will be reviewed after the first year of implementation, and thereafter every 3 years.	The updated and amended BOS will be provided to the Minister for approval prior to the commencement of each offset delivery stage	Annual – EPBC Compliance Reporting – Condition 31 Annual - EA Compliance Reporting – Condition A13 5 yearly BOS Compliance Report Annual OAMP Report, then 3 yearly	The BOS outlines offset requirements for MNES including relevant GDEs. As part of the review of the BOS, offset requirements will be reassessed, and additional offsets delivered, including in the event that groundwater fluctuations exceed the defined GDE groundwater drawdown trigger levels in the project's draft EA and the trigger exceedance is determined to be the result of mining activities and impacts on GDE cannot be feasibly mitigated. Additional offsets may be required under the BOS if impacts are greater than predicted in the EIS. The OAMP includes management of GDE offset areas. The OAMP will be updated to incorporate additional information obtained through research programs or plans (such as this GDEMP), as the results become available.

Management Plan	Description	Internal Review Frequency	External Review Frequency	Reporting Frequency	Linkage to GDEMP and triggers/corrective actions
	The OAMP for Moray Downs West acquits the project's offset liability for GDEs.				
MNES Species Management Plan EPBC Approval Conditions 5, 6 and 7	A Species Management Plan has been prepared and approved by DoEE (20 July 2016). The plan was developed to protect listed species of fauna, flora, ecological communities and the Outstanding Universal Value (OUV) of the Great Barrier Reef World Heritage Area (GBRWHA) from impacts associated with the mine (and offsite infrastructure) project.	The MNES Species Management Plans will be reviewed annually and updated as required. In all other circumstances, Adani will revise the MNES Species Management Plan following pre-clearance surveys and resubmit for DoEE ministerial approval within three months of the survey being completed.	Updates to the MNES Species Management Plan will be made in consultation with DoEE and DES and the Relevant Recovery Team as required. Independent Peer Review to revisions as per EA Condition I7	Annual – EPBC Compliance Reporting – Condition 31 Annual - EA Compliance Reporting – Condition A13 Adani will prepare an annual report on the implementation of the MNES Species Management Plans.	The MNES SMP ensures consistent monitoring, mitigation and management measures for common threats and impacts.

10.5 Qualifications

Persons implementing key tasks described in this GDEMP will have appropriate skills and qualifications. For GDE pre-impact surveys and monitoring, the lead ecologist will have >5 years of experience undertaking assessments of GDEs. Qualifications and experience requirements are summarised in **Table 10-2**. Field surveys will be led by ecologists or botanists with at least 5 years of experience on the Brigalow Belt and/or Desert Uplands Bioregions. A hydrogeologist with at least 5 years of experience will be involved in the analysis of data and reporting, to assist in the interpretation of ecological and hydrological data.

The Doongmabulla Springs-complex will be surveyed and monitored by suitably qualified ecologists / botanists with previous experience in springs and familiarity with their ecology, species and values. In particular the ecologists / botanists will be familiar with the threatened flora species associated with the springs. Macroinvertebrates will be sent to a laboratory for identification to morpho-family level.

Carmichael River surveys and monitoring will be undertaken by experienced terrestrial and aquatic ecologists (leader with >5 years of experience). CORVEG surveys will be led by ecologists / botanists with >5 years of experience in flora surveys in the the Brigalow Belt and/or Desert Uplands Bioregions.

Waxy Cabbage Palm surveys and monitoring will be undertaken by suitably qualified ecologists / botanists who are familiar with the species and experienced in undertaking systematic flora surveys.

Weed monitors will have weed monitoring experience and demonstrable identification skills for all potential terrestrial, wetland and riparian weeds in the Project area.

If the identification of a suspected threatened flora species or previously unrecorded species is not certain, a specimen will be collected and submitted to the Queensland Herbarium for confirmation of identification. If previously unrecorded species or suspected threatened fauna species are observed or collected, the Queensland Museum will be the first contact for identification confirmation (via photographs and / or specimens), followed by persons with demonstrable identifications skills for the suspected threatened species, as outlined in **Table 10-2**.

Persons undertaking ground and surface water monitoring will be trained or be able to demonstrate practical experience in the completion of water monitoring in accordance with relevant sampling manuals or standards.

Table 10-2: Qualification requirements for GDE monitoring and reporting

Component	Qualifications required	Experience required	Demonstrable specialist skills required
Ecological survey of: • Waxy Cabbage Palm • Carmichael River • Doongmabulla Springs-complex • Mellaluka Springs-complex	Ecologist / Botanist with tertiary degree in relevant field	Ecologist / Botanist with degree and >5 years' of experience in the Brigalow Belt and/or Desert Uplands Bioregions	Experience in the identification of: Waxy Cabbage Palm Threatened flora species associated with the Doongmabulla Springs-complex Weed identification Relevant threatened fauna species
Data analysis and reporting	Ecologist / Botanist with tertiary degree in relevant field Hydrogeologist with tertiary degree in relevant field	Ecologist / Botanist with degree and >5 years' of experience in the Brigalow Belt and/or Desert Uplands Bioregions Hydrologist with >5 years' experience	Interpretation and analysis of complex ecological data Interpretation of groundwater monitoring results in an ecological context

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Appendix A Receiving waters contaminant trigger levels and flow release regime

Refer to Table F3 and Table F5 of the Environmental Authority for further explanation.

Quality characteristic	Trigger level	Monitoring frequency
pH	6.5 - 9	Daily during the release. Table F5 of EA.
Electrical Conductivity (µS/cm)	270	
Turbidity (NTU)	660	
Sulphate (SO_4^{2-}) (mg/L)	250	
Sodium (mg/L)	180	
Aluminium (µg/L)	55	Commencement of release and thereafter weekly during release (first sample to be taken within 2 hours of commencement of release). Table F3 of EA.
Arsenic (µg/L)	13	
Cadmium (µg/L)	0.2	
Chromium (µg/L)	2	
Copper (µg/L)	4	
Iron (µg/L)	300	
Lead (µg/L)	4	
Mercury (µg/L)	0,2	
Nickel (µg/L)	11	
Zinc (µg/L)	30	
Boron (µg/L)	370	
Cobalt (µg/L)	90	
Manganese (µg/L)	1900	
Molybdenum (µg/L)	34	
Selenium (µg/L)	10	
Silver (µg/L)	1	
Uranium (µg/L)	1	
Vanadium (µg/L)	10	
Ammonia as N (µg/L)	900	
Nitrate as NO_3 (µg/L)	1100	
Total Nitrogen (µg/L)	590	
Total Phosphorus (µg/L)	200	
Petroleum hydrocarbons (C6-C9) (µg/L)	20	
Petroleum hydrocarbons (C10-C36) (µg/L)	100	
Fluoride (µg/L)	2000	
Sodium (µg/L)	180000	
Suspended Solids	106	
Sulphate (mg/L)	1000	

Refer to Table F4 of the Environmental Authority for further explanation.

Carmichael River Release Locations	**Flow Regime**	**Receiving Water Flow Rate**	**Permitted Release Rate**	**Electrical conductivity release limit (µS/cm)**
RP1 and RP2	Low Flow	<0.2 m^3/s for a period of 28 days after natural flow events that exceed 0.2 m^3/s	0.05 m^3/s	168
	Medium Flow	1-5 m^3/s	0.25 m^3/s	840
	Medium Flow	5-10 m^3/s	0.5 m^3/s	1,850
	High Flow	>10 m^3/s	0.5 m^3/s	3,500

Appendix B Groundwater drawdown and quality triggers

Early warning triggers

The aim of the Early Warning triggers is to provide early warning regarding the predicted induced flow from groundwater units associated with the Doongmabulla Springs-complex and the Carmichael River towards the dewatered / depressurised coal seams targeted during mining.

The Early warning triggers have been selected based on the possible change in groundwater levels beyond the recorded natural groundwater level fluctuations (Refer to Section 5.3 of the GMMP). The assessment of groundwater level data, compiled during mining operations, will allow for the evaluation of groundwater level trends.

Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Early Warning Level (criteria)	(High) Impact Threshold (criteria)	Total Change in Water Level (½NF + Model predictions)	Comment
Doongmabulla Springs - Clematis Sandstone							
HD02	0.03 m	90	0.46 m (44 months)	0.26 m (½NF + 90% of prediction)	0.26 m (Prediction plus ½NF)	0.26 m	Early warning triggers are suggested as 90% of the predicted drawdown and Impact thresholds are suggested as prediction plus half of the natural fluctuations (for comparison to the average groundwater level reference level over time).
HD03A	0.18 m	87	1.02 m (44 months)	0.67 m (½NF + 90% of prediction)	0.69 m (Prediction plus ½NF)	0.69 m	
C180118SP	2.61 m	80	0.23 m (245 months)	2.07 m (½NF + 75% of prediction)	2.46 m (½NF + 90% of prediction)	2.73 m	Clematis Sandstone sentinel bore, close to mining lease.

Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Early Warning Level (criteria)	(High) Impact Threshold (criteria)	Total Change in Water Level (½NF + Model predictions)	Comment
C14021SP	1.66 m	500	1.09 m (23 months)	1.37 m (½NF + 50% of prediction)	2.03 m (½NF + 90% of prediction)	2.20 m	Unconfined GAB Clematis Sandstone bore.
C14033SP	0.25 m	500	0.26 m (15 months)	0.32 m (½NF + 75% of prediction)	0.36 m (½NF + 90% of prediction)	0.38 m	Clematis Sandstone bore, west of mining lease.
C14011SP	0.62 m	81	0.23 m (22 months)	0.58 m (½NF + 75% of prediction)	0.67 m (½NF + 90% of prediction)	0.74 m	Clematis Sandstone bore, west of mining lease
C14012SP	0.38 m	83	0.23 m (23 months)	0.40 m (½NF + 75% of prediction)	0.46 m (½NF + 90% of prediction)	0.50 m	Clematis Sandstone bore, west of mining lease. 90% of predicted drawdown is less than the low threshold, suggests NF + 90% as high threshold value.
C14013SP	0.38 m	82	0.29 m (23 months)	0.43 m (½NF + 75% of prediction)	0.49 m (½NF + 90% of prediction)	0.53 m	Clematis Sandstone bore, west of mining lease.
Doongmabulla Springs - Dunda Beds							
C022P1	3.86 m	81	0.42 m (65 months)	3.10 m (½NF + 75% of prediction)	3.68 m (½NF + 90% of prediction)	4.07 m	Confined Dunda Beds monitoring bore.
C027P2	1.11 m	65	0.72 m (66 months)	1.19 m (½NF + 75% of prediction)	1.36 m (½NF + 90% of prediction)	1.47 m	Induced flow from GAB unit, Dunda Beds.
C14023SP	0.32 m	500	0.30 m (29 months)	0.39 m (½NF + 75% of prediction)	0.44 m (½NF + 90% of prediction)	0.47 m	Dunda Beds / Rewan Formation contact.

Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Early Warning Level (criteria)	(High) Impact Threshold (criteria)	Total Change in Water Level (½NF + Model predictions)	Comment
C180117SP	4.83 m	586	0.38 m (29 months)	3.81 m (½NF + 75% of prediction)	4.54 m (½NF + 90% of prediction)	5.02 m	Confined bore within GAB Dunda Beds
Carmichael River – all relevant aquifers							
HD03B	0.004 m	64	1.26 m (47 months)	0.63 m (½NF + 75% of Prediction)	0.63 m (Prediction plus ½NF)	0.634 m	Predicted drawdown, due to distance from mining and vertical hydraulic conductivity, is limited. The groundwater level threshold is suggested as the prediction plus half of the natural fluctuations (for comparison to the average groundwater level reference level over time). 225.47 mAHD average groundwater level
C027P2	1.11 m	65	0.72 m (66 months)	0.92 m (½NF + 50% of prediction)	1.19 m (½NF + 75% of prediction)	1.47 m	Induced flow from GAB unit, Dunda Beds, adjacent to river. 226.90 mAHD average groundwater level
C029P1	0.33 m	50	1.01 m (65 months)	0.59 m (½NF + 25% of prediction)	0.67 m (½NF + 50% of prediction)	0.835 m	Induced flow from GAB unit, Dunda Beds, adjacent to river impacting on alluvium. 214.77 mAHD average groundwater level
C029P2	0.42 m	58	0.47 m (35 months)	0.45 m (½NF + 50% of prediction)	0.55 m (½NF + 75% of prediction)	0.655 m	Induced flow from Tertiary sediments adjacent to river. 220.00 mAHD average groundwater level
~~C025P1~~	~~1.87 m~~	~~59~~	~~0.51 m (58 months)~~	~~0.72 m (½NF + 25% of prediction)~~	~~1.19 m (½NF + 50% of prediction)~~	~~2.13 m~~	~~The hydrograph for this bore indicates this bore is often dry. In addition, this bore is predicted to be~~

Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Early Warning Level (criteria)	(High) Impact Threshold (criteria)	Total Change in Water Level (½NF + Model predictions)	Comment
							~~impacted by induced flow from alluvium adjacent to river.~~ ~~The groundwater level threshold for this bore is considered to relate to the duration of dry measurements within the bore, such that if the bore is consistently dry for 6 continuous months (no response to wet season or show recovery) then an investigation will be triggered.~~ ~~An additional alluvium monitoring bore, installed in deeper saturated alluvium, will be constructed adjacent to C025P1 to assess the groundwater level threshold for this location.~~ ~~216.72 mAHD (average groundwater level)~~
C025P2	1.2 m	60	1.20 m (58 months)	1.20 m (½NF + 50% of prediction)	1.50 m (½NF + 75% of prediction)	1.80 m	Induced flow from Tertiary sediments adjacent to river. 217.62 mAHD average groundwater level
C14028SP	0.075 m	500	0.31 m (29 months)	0.21 m (½NF + 75% of Prediction)	0.23 m (Prediction plus ½NF)	0.23 m	Predicted drawdown, due to distance from mining and vertical hydraulic conductivity, is limited. Groundwater level thresholds are suggested for prediction plus half of the natural fluctuations (for comparison to the average groundwater level reference level over time).
C14027SP	0.018 m	500	0.22 m (25 months)	0.12 m (½NF + 75% of Prediction)	0.13 m (Prediction plus ½NF)	0.13 m	

Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Early Warning Level (criteria)	(High) Impact Threshold (criteria)	Total Change in Water Level (½NF + Model predictions)	Comment
C14006SP	0.42 m	500	0.94 m (10 months)	0.68 m (½NF + 50% of prediction)	0.79 m (½NF + 75% of prediction)	0.89 m	Induced flow from artesian Joe Joe Group unit adjacent to river 226.03 mAHD average groundwater level

Groundwater drawdown triggers

Table B-1 Groundwater drawdown triggers

Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Impact Threshold (criteria)	Total Change n Water Level (½NF + Model predictions[1])	Comment / Reference Level	Unit	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)
Carmichael River Location									

[1] The total change in groundwater level, relative to the average groundwater level (**Appendix E of GMMP**), comprises the maximum predicted drawdown plus half of the natural fluctuation.

Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Impact Threshold (criteria)	Total Change in Water Level (½NF + Model predictions[1])	Comment / Reference Level	Unit	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)
HD03B	0.004 m	64	1.26 m (47 months)	0.63 m (Prediction plus ½NF)	0.634 m	Predicted drawdown, due to distance from mining and vertical hydraulic conductivity, is limited. The groundwater level threshold is suggested as the prediction plus half of the natural fluctuations (for comparison to the average groundwater level reference level over time). 225.47 mAHD average groundwater level	Alluvium	427559.00	7556120.00
C027P2	1.11 m	65	0.72 m (66 months)	1.19 m (½NF + 75% of prediction)	1.47 m	Induced flow from GAB unit, Dunda Beds, adjacent to river. 226.90 mAHD average groundwater level	Dunda Beds	433648.21	7554818.54
C029P1	0.33 m	50	0.72 m (65 months)	0.53 m (½NF + 50% of prediction)	0.69 m	Induced flow from GAB unit, Dunda Beds, adjacent to river impacting on alluvium. 214.70 mAHD average groundwater level	Alluvium	437691.19	7555082.39
C029P2	0.42 m	58	0.47 m (35 months)	0.55 m (½NF + 75% of prediction)	0.655 m	Induced flow from Tertiary sediments adjacent to river. 220.00 mAHD average groundwater level	Tertiary	437687.63	7555080.91

Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Impact Threshold (criteria)	Total Change in Water Level (½NF + Model predictions[1])	Comment / Reference Level	Unit	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)
C025P1	1.87 m	59	0.51 m (58 months)	1.19 m (½NF + 50% of prediction)	2.13 m	The hydrograph for this bore indicates this bore is often dry. In addition, this bore is predicted to be impacted by induced flow from alluvium adjacent to river. The groundwater level threshold for this bore is considered to relate to the duration of dry measurements within the bore, such that if the bore is consistently dry for 6 continuous months (no response to wet season or show recovery) then an investigation will be triggered. An additional alluvium monitoring bore, installed in deeper saturated alluvium, will be constructed adjacent to C025P1 to assess the groundwater level threshold for this location. 216.72 mAHD (average groundwater level)	Alluvium	438015.54	7555845.80
C025P2	1.2 m	60	1.20 m (58 months)	1.50 m (½NF + 75% of prediction)	1.80 m	Induced flow from Tertiary sediments adjacent to river. 217.62 mAHD average groundwater level	Tertiary	438010.34	7555844.69
C14028SP	0.075 m	500	0.31 m (29 months)	0.23 m (Prediction plus ½NF)	0.23 m	Predicted drawdown, due to distance from mining and vertical hydraulic conductivity, is limited.	Alluvium	443775.64	7559581.18

Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Impact Threshold (criteria)	Total Change in Water Level (½NF + Model predictions[1])	Comment / Reference Level	Unit	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)
C14027SP	0.018 m	500	0.22 m (25 months)	0.13 m (Prediction plus ½NF)	0.13 m	Groundwater level thresholds are suggested for prediction plus half of the natural fluctuations (for comparison to the average groundwater level reference level over time).	Alluvium	444964.65	7558330.02
C14006SP	0.42 m	500	0.94 m (10 months)	0.79 m (½NF + 75% of prediction)	0.89 m	Induced flow from artesian Joe Joe Group unit adjacent to river 226.03 mAHD average groundwater level	Early Permian	443446.61	7556785.07
Great Artesian Basin to West of Mine Lease									
C180118SP	2.61 m	80	0.23 m (24 months)	2.07 m (½NF + 75% of prediction)	2.73 m	Clematis Sandstone sentinel bore, close to mining lease. 250.17 mAHD average groundwater level	Clematis	423796.76	7568090.93
C14033SP	0.25 m	500	0.26 m (15 months)	0.32 m (½NF + 75% of prediction)	0.38 m	Clematis Sandstone bore, west of mining lease. 250.62 mAHD average groundwater level	Clematis	418210.8	7566775.83
C14011SP	0.62 m	81	0.23 m (22 months)	0.58 m (½NF + 75% of prediction)	0.74 m	Clematis Sandstone bore, west of mining lease. 242.80 mAHD average groundwater level	Clematis	426130.96	7561454.81
C14012SP	0.38 m	83	0.23 m (23 months)	0.40 m (½NF + 75% of prediction)	0.50 m	Clematis Sandstone bore, west of mining lease. 242.62 mAHD average groundwater level	Clematis	424896.07	7560596.18

Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Impact Threshold (criteria)	Total Change in Water Level (½NF + Model predictions[1])	Comment / Reference Level	Unit	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)
C14013SP	0.38 m	82	0.29 m (23 months)	0.43 m (½NF + 75% of prediction)	0.53 m	Clematis Sandstone bore, west of mining lease. 242.49 mAHD average groundwater level	Clematis	424895.49	7560591.10
HD02	0.03 m	90	0.46 m (43 months)	0.26 m (Prediction plus ½NF)	0. 26 m	Predicted drawdown, due to distance from mining and vertical hydraulic conductivity, is limited. Groundwater level thresholds are suggested for prediction plus half of the natural fluctuations (for comparison to the average groundwater level reference level over time). HD02 – 234.28 mAHD HD03A – 232.03 mAHD	Clematis	423822.04	7557008.25
HD03A	0.18 m	87	1.02 m (44 months)	0.69 m (Prediction plus ½NF)	0.69 m		Clematis	427562.00	7556132.00
C14021SP	1.66 m	500	1.09 m (23 months)	1.37 m (½NF + 50% of prediction)	2.2 m	Unconfined GAB Clematis Sandstone bore. 246.54 mAHD (average manual groundwater level)	Clematis	429796.25	7550966.33
C022P1	3.86 m	81	0.42 m (65 months)	3.10 m (½NF + 75% of prediction)	4.07 m	Confined Dunda Beds monitoring bore. 246.66 mAHD average groundwater level	Dunda Beds	426812.52	7565961.84
C027P2	1.11 m	65	0.72 m (66 months)	1.19 m (½NF + 75% of prediction)	1.47 m	Induced flow from GAB unit, Dunda Beds. 226.90 mAHD average groundwater level	Dunda Beds	433648.21	7554818.54

FOI 190417
Document 15

From: s22
To: "james.johnson@ga.gov.au"; "jane.coram@csiro.au"
Cc: "Stuart Minchin"; "Blewett Richard"; "McDonald, Warwick (L&W, Black Mountain)"; Gregory Manning; s22 Dean Knudson
Subject: RE: Revised GDEMP [SEC=OFFICIAL]
Date: Friday, 5 April 2019 1:08:42 PM
Attachments: Attachment%20A%20-%20GDEMP%20Final_Part3.pdf
image001.jpg

Last one!
Part 3 of the GDEMP
This GDEMP includes its appendices, but the GMMP did not. I am happy to provide the appendices to the GMMP separately, but these largely are the same as previous revisions – the updates were to the body of the plan.
s22

T 02 s22 | **E** s22 @environment.gov.au
W www.environment.gov.au

From: s22
Sent: Friday, 5 April 2019 1:05 PM
To: 'james.johnson@ga.gov.au' ; 'jane.coram@csiro.au'
Cc: 'Stuart Minchin' ; 'Blewett Richard' ; 'McDonald, Warwick (L&W, Black Mountain)' ; Gregory Manning ; s22 ; Dean Knudson
Subject: RE: Revised GDEMP [SEC=OFFICIAL]
Part 2 of the GDEMP
Emily Turner
T 02 6275 9726 | **E** emily.turner@environment.gov.au
W www.environment.gov.au

From: s22
Sent: Friday, 5 April 2019 1:04 PM
To: 'james.johnson@ga.gov.au' <james.johnson@ga.gov.au>; 'jane.coram@csiro.au' <jane.coram@csiro.au>
Cc: 'Stuart Minchin' <stuart.minchin@ga.gov.au>; 'Blewett Richard' <Richard.Blewett@ga.gov.au>; 'McDonald, Warwick (L&W, Black Mountain)' <Warwick.Mcdonald@csiro.au>; Gregory Manning <Gregory.Manning@environment.gov.au>; s22 @environment.gov.au>; Dean Knudson <Dean.Knudson@environment.gov.au>
Subject: RE: Revised GMMP [SEC=OFFICIAL]
Hi everyone,
Part one of the GDEMP attached – parts 2 and 3 will follow
s22

T 02 s22 @environment.gov.au
W www.environment.gov.au

From: s22
Sent: Friday, 5 April 2019 12:53 PM
To: 'james.johnson@ga.gov.au' <james.johnson@ga.gov.au>; 'jane.coram@csiro.au' <jane.coram@csiro.au>
Cc: Stuart Minchin <stuart.minchin@ga.gov.au>; Blewett Richard <Richard.Blewett@ga.gov.au>; 'McDonald, Warwick (L&W, Black Mountain)' <Warwick.Mcdonald@csiro.au>; Gregory Manning <Gregory.Manning@environment.gov.au>; s22 @environment.gov.au>; Dean Knudson <Dean.Knudson@environment.gov.au>
Subject: Revised GMMP [SEC=OFFICIAL]

Hi James and Jane,

Please find the revised GMMP attached.

The GDEMP will follow

s22

[redacted]

Acting Director | Post Approvals Strategies

Environment Standards Division

Department of the Environment and Energy

T 02 s22 [redacted]@environment.gov.au

Reconciliation%20Email%20Footer

Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Impact Threshold (criteria)	Total Change n Water Level (½NF + Model predictions[1])	Comment / Reference Level	Unit	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)
C14023SP	0.32 m	500	0.30 m (29 months)	0.39 m (½NF + 75% of prediction)	0.47 m	Dunda Beds / Rewan Formation contact. 247.26 mAHD average groundwater level	Dunda Beds	429801.74	7550968.73
C180117SP	4.83 m	586	0.38 m (29 months)	3.81 m (½NF + 75% of prediction)	5.02 m	Confined bore within GAB Dunda Beds. 251.02 mAHD average groundwater level	Dunda Beds	435915.16	7547522.16
C9553P1R	4.5 m	586	0.15 m (35 months)	3.45 m (½NF + 75% of prediction)	4.58 m	Confined bore within Rewan Formation. 252.26 mAHD average groundwater level	Rewan	421010.11	7573974.87
C556P1	84.5 m	50	0.58 m (54 months)	76.34 m (½NF + 90% of prediction)	84.79 m	Induced flow from Rewan Formation to depressurised coal 234.84 mAHD average groundwater level	Rewan	436524.08	7549881.55
C555P1	73 m	90	0.35 m (35 months)	65.88 m (½NF + 90% of prediction)	73.18 m	Induced flow from Rewan Formation to depressurised coal 231.89 mAHD	Rewan	432461.38	7557892.99
Doongmabulla to West of Mine Lease									
HD02	0.03 m	90	0.46 m (44 months)	0.26 m (Prediction plus ½NF)	0.26 m	Groundwater level thresholds are suggested for prediction plus half of the natural fluctuations (for comparison to the average groundwater level reference level over time). HD02 – 234.28 mAHD HD03A – 232.03 mAHD	Clematis	423822.04	7557008.25
HD03A	0.18 m	87	1.02 m (44 months)	0.69 m (Prediction plus ½NF)	0.69 m		Clematis	427562.00	7556132.00

Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Impact Threshold (criteria)	Total Change in Water Level (½NF + Model predictions[1])	Comment / Reference Level	Unit	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)
C14013SP	0.38 m	82	0.29 m (23 months)	0.43 m (½NF + 75% of prediction)	0.53 m	Clematis Sandstone bore, west of mining lease. 242.49 mAHD average groundwater level	Clematis	424895.49	7560591.10
C022P1	3.86 m	81	0.42 m (65 months)	3.10 m (½NF + 75% of prediction)	4.07 m	Confined Dunda Beds monitoring bore. 246.66 mAHD average groundwater level	Dunda Beds	426812.52	7565961.84
C14012SP	0.38 m	83	0.23 m (23 months)	0.40 m (½NF + 75% of prediction)	0.50 m	Clematis Sandstone bore, west of mining lease. 242.62 mAHD average groundwater level	Clematis	424896.07	7560596.18
C14021SP	1.66 m	500	1.09 m (23 months)	1.37 m (½NF + 50% of prediction)	2.2 m	Unconfined GAB Clematis Sandstone bore. 246.54 mAHD (average manual groundwater level)	Clematis	429796.76	7550966.33
C14206VWP_1	36 m	84	-	32.4 m (90% of max drawdown predicted)	-	AB Seam. 224.00 mAHD	AB Seam	429783.15	7550956.80
C558VWP1	143.05 m	586	-	129 m (90% of max drawdown predicted)	-	D seam. 212.00 mAHD	D seam	430311.51	7566903.01

Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Impact Threshold (criteria)	Total Change n Water Level (½NF + Model predictions[1])	Comment / Reference Level	Unit	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)
C968VWP_P2	206.2 m	12	-	186 m (90% of max drawdown predicted)	-	D seam. 355.00 mAHD	D seam	424873.59	7570989.17
C968VWP_P5	170.72 m	15	-	154 m (90% of max drawdown predicted)	-	AB seam. 192.80 mAHD	AB seam	424873.59	7570989.17
C848SP	127.96 m	586	1.00 m (37 months)	115.70 m (½NF + 90% of prediction)	128.46 m	Bore within target D Seam, southern portion of lease. 231.91 mAHD average groundwater level	D seam	442363.39	7543815.03
Mellaluka Springs to the southeast of Mine Lease									
C851VWP2	136 m	586	-	122.40 m (90% of max drawdown predicted)	-	AB Seam target. 228.70 mAHD	AB Seam	441384.00	7542877.33
C180120SP	0.02 m	586	2.53 m (29 months)	1.29 m (Prediction plus ½NF)	1.29 m	Predicted drawdown, due to distance from mining and vertical hydraulic conductivity, is limited.	Tertiary / Early Permian	447056.56	7531729.89
C180122SP	0.045 m	586	0.75 m (29 months)	0.42 m (Prediction plus ½NF)	0.42 m	Groundwater level thresholds are suggested for prediction plus half of the natural fluctuations (for comparison to the	Tertiary / Early Permian	448579.21	7536348.70

Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Impact Threshold (criteria)	Total Change in Water Level (½NF + Model predictions[1])	Comment / Reference Level	Unit	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)
C180119SP	0.045 m	586	0.49 m (22 months)	0.29 m (Prediction plus ½NF)	0.29 m	average groundwater level reference level over time).	Early Permian	448587.45	7536355.38
C180123SP	0.007 m	586	0.67 m (28 months)	0.34 m (Prediction plus ½NF)	0.34 m		Early Permian	448077.54	7529357.50
C9180124SPR	0.045 m	586	0.55 m (24 months)	0.32 m (Prediction plus ½NF)	0.32 m		Early Permian	448600.00	7536357.00
C9180125SPR	0.02 m	586	1.07 m (25 months)	0.56 m (Prediction plus ½NF)	0.56 m		Early Permian	447039.74	7531738.83
Early Warning Bores									
C14016SP	27.23 m	37	2.13 m (21 months)	25.57 m (½NF + 90% of prediction)	28.30 m	Artesian bore in Joe Joe Group on southern lease boundary. 234.13 mAHD	Early Permian	444852.34	7541471.06
C9845SPR	21.49 m	586	0.28 m (29 months)	19.48 m (½NF + 90% of prediction)	21.63 m	Tertiary sediments bore, south west portion of lease. 234.91 mAHD average groundwater level	Tertiary	439410.87	7544903.28
C14029SP	1.90 m	500	0.47 m (20 months)	1.66 m (½NF + 75% of prediction)	2.14 m	Artesian bore across Tertiary sediments and Joe Joe Group, east of lease. 251.08 mAHD	Tertiary / Early Permian	445059.11	7548820.62

Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Impact Threshold (criteria)	Total Change n Water Level (½NF + Model predictions[1])	Comment / Reference Level	Unit	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)
C14003SP	0.09 m	500	0.27 m (32 months)	0.23 m (Prediction plus ½NF)	0.23 m	Joe Joe Group. Groundwater level threshold is suggested as prediction plus half of the natural fluctuations (for comparison to the average groundwater level reference level over time). 209.37 mAHD average groundwater level	Early Permian	440350.8	7568518.85
C14030SP / C914030SPR	1.90 m	500	1.29 m (20 months)	2.07 m (½NF + 75% of prediction)	2.55 m	Confined Joe Joe Group bore to the east of the lease. 230.25 mAHD average groundwater level	Early Permian	445072.27	7548821
C14015SP	6.65 m	500	0.55 m (9 months)	5.26 m (½NF + 75% of prediction)	6.93 m	Confined Joe Joe Group bore to the east of the lease near Lignum. 239.15 mAHD average groundwater level	Early Permian	445301.98	7536138.69
C016P2	159.64 m	14	0.19 m (486 months)	143.77 m (½NF + 90% of prediction)	159.83 m	AB seam north portion of lease. 248.46 mAHD average groundwater level	AB seam	422017.38	7574974.58
C14004SP	7.01 m	63	0.52 m (28 months)	5.52 m (½NF + 75% of prediction)	7.27 m	Confined Joe Joe Group bore to the east of the lease near Moray Carmichael road. 209.44 mAHD average groundwater level	Early Permian	440355.93	7568513.34
C14008SP	1.18 m	500	1.38 m (19 months)	1.58 m (½NF + 75% of prediction)	1.87 m	Joe Joe Group northeast of the mine lease. 228.34 mAHD average groundwater level	Early Permian	444760.74	7552697.83

Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Impact Threshold (criteria)	Total Change in Water Level (½NF + Model predictions[1])	Comment / Reference Level	Unit	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)
C180116SP	16.69 m	586	0.23 m (29 months)	15.14 m (½NF + 90% of prediction)	16.81 m	Confined Rewan Formation bore south / along strike of lease. 239.12 mAHD average groundwater level	Rewan	439392.91	7540908.81
C14024SP	2.44 m	500	0.18 m (24 months)	1.92 m (½NF + 75% of prediction)	2.53 m	Confined Clematis Sandstone / Rewan Group bore. 262.71 mAHD average groundwater level	Clematis / Rewan Group	430036.80	7543917.13
C14020SP	0.157 m	500	0.31 m (31 months)	0.27 m (½NF + 75% of prediction)	0.31 m	Confined Moolayember Formation bore. 252.43 mAHD average groundwater level	Moolayember	418230.28	7566782.35

Groundwater quality triggers

Proposed trigger levels have been assigned to each of the water quality parameters for formations. Proposed triggers have been compiled for each of the hydrostratigraphic units potentially (directly or indirectly) impacted by the proposed mining activities, as identified in the EA are presented in the tables below below and were derived for each of the groundwater units based on statistical evaluation of existing datasets, and following additional recommendations by the Queensland Department of Environment and Science.

Alluvium Triggers

The results of the groundwater quality assessment undertaken to ensure the monitoring bores for each unit are suitable to detect impacts from the approved mining operations has resulted in the proposed separation of the alluvial aquifer into eastern and western monitoring zones. The groundwater quality of the alluvial aquifer is spatially varied and considered the result of the Carmichael River across the project area, which is considered to be a losing river to the east and gaining in the west, where groundwater continuously discharges from the Joshua Spring.

This is demonstrated as groundwater quality in the eastern area contains high levels of chloride, electrical conductivity (EC) and total dissolved solids (TDS) concentrations an order of magnitude higher than the groundwater quality from the western CCP area, which is considered fresh to slightly brackish. This occurs because of “first-flush”, the mobilisation and addition of evaporitic salts in the non-perennial alluvium during the wet season.

Based on the variation in the alluvium, due to differing levels of saturation and parent material, bore specific triggers were developed for this unit.

Table B-23 Alluvium Proposed Trigger Levels

Parameter	Units	Eastern Area (C14028SP) Contaminant Trigger Levels (85th Percentiles)	Eastern Area (C029P1) Contaminant Trigger Levels (85th Percentiles)	Eastern Area (C027P1) Contaminant Trigger Levels (85th Percentiles)	Western Area (HD03A) Contaminant Trigger Levels (85th Percentiles)
Calcium	mg/L Ca	**800**	**68**	**27**	**2.1**
Magnesium	mg/L Mg	**1,000**	**360**	**140**	**2.7**
Potassium	mg/L K	**204**	**397**	**100**	**21**
Sodium	mg/L Na	**8,305**	6,583	**1,209**	**175**
Chloride	mg/L Cl	**16,000**	10,750	**2,000**	**191**
Sulphate	mg/L SO_4	**1,900**	**1,100**	450	**14**
Alkalinity	mg/L $CaCO_3$	**404**	**2,400**	**355**	**150**
Sulphide	mg/L S_2	NV	**1.5**	NV	NV

Parameter	Units	Eastern Area (C14028P) Contaminant Trigger Levels (85th Percentiles)	Eastern Area (C029P1) Contaminant Trigger Levels (85th Percentiles)	Eastern Area (C027P2) Contaminant Trigger Levels (85th Percentiles)	Western Area (HD03A) Contaminant Trigger Levels (85th Percentiles)
Fluoride	mg/L F	1.4	**1.6**	**0.6**	**0.49**
Aluminium	µg/L Al	**55**	**55**	**55**	**55**
Arsenic	µg/L As	**13**	**13**	**13**	**13**
Boron	µg/L B	**3,170**	5,275	**845**	**370**
Cadmium	µg/L Cd	**0.2**	**0.2**	**0.2**	*0.2*
Chromium	µg/L Cr	**1.0**	**1.0**	**1.0**	*1.0*
Cobalt	µg/L Co	**23**	**12**	**8**	1.4
Copper	µg/L Cu	**7**	69	**157**	*1.4*
Iron	µg/L Fe	**652**	954	16,095	**530**
Lead	µg/L Pb	**3.4**	**3.4**	**3.4**	*3.4*
Manganese	µg/L Mn	**8,670**	**1,900**	3,750	**2,080**
Molybdenum	µg/L Mo	35(5)	35(5)	34*	34*
Nickel	µg/L Ni	**11**	20	**17**	*11*
Selenium	µg/L Se	**11**	**11**	**11**	*11*
Silver	µg/L Ag	**0.05**	**0.05**	**0.05**	*0.05*
Uranium	µg/L U	**74**	**149**	0.5*	0.5
Vanadium	µg/L V	6*	**27**	6*	**6.0**
Zinc	µg/L Zn	**26**	**56**	48	*8.0*
Mercury	µg/L Hg	***0.06***	***0.06***	***0.06***	***0.06***
Ammonia	mg/L N	**0.9**	**0.9**	**0.9**	0.9
Nitrate	mg/L N	**0.7**	**0.7**	**0.7**	0.7
Nitrite	mg/L N	NV	NV	NV	NV
T. Phosphorous	mg/L P	0.1	**0.3**	**0.1**	**0.1**

Parameter	Units	Eastern Area (C14028SP) Contaminant Trigger Levels (85th Percentiles)	Eastern Area (C029P1) Contaminant Trigger Levels (85th Percentiles)	Eastern Area (C027P1) Contaminant Trigger Levels (85th Percentiles)	Western Area (HD03A) Contaminant Trigger Levels (85th Percentiles)
Total Recoverable Hydrocarbons	ppb ($C_6 - C_9$)	Detect above LOR	Detect above LOR	Detect above LOR	Detect above LOR
Total Recoverable Hydrocarbons	ppb ($C_6 - C_{10}$)	Detect above LOR	Detect above LOR	Detect above LOR	Detect above LOR
Total Recoverable Hydrocarbons	ppb ($C_{10} - C_{40}$)	Detect above LOR	Detect above LOR	Detect above LOR	Detect above LOR
BTEX	ppb	Detect above LOR	Detect above LOR	Detect above LOR	Detect above LOR
pH**	pH units	**6.0 – 9.0**	**6.0 – 9.0**	**6.0 – 9.0**	**6.0 - 9.0**
Electrical Conductivity	µS/cm	**44,000**	32,000	7,200	**900**
Total Dissolved Solids	mg/L	**26,000**	**20,000**	**4,400**	**580**

Notes:

Bold – at least eight (8) results from the baseline groundwater monitoring program were reported above LORs and utilised to calculate trigger and contaminant levels (85^{th} and 99^{th}).
Bold - 95% protection trigger levels for freshwater aquatic ecosystems from Table 3.4.1 in the ANZECC 2000 and ANZECC 2018 guidelines were applied where <8 results above LORs were available from the baseline groundwater monitoring program (XX) – calculated values
Not bold or **Bold** – ANZECC 95^{th} reliability (freshwater) trigger level or low reliability trigger level from Section 8.3.7 was adopted over baseline calculated value (85% baseline is less than ANZECC value).
'Detect above LOR' – no guideline values available, no results above LORs reported during baseline monitoring program.
NV - no published guideline value; however, there were results above LOR (less than 8).
* - trigger level adopted from Section 8.3.7 of the ANZECC 2000 guidelines (low reliability trigger levels) where there were no 95% protection trigger levels for freshwater aquatic ecosystems from Table 3.4.1 of the ANZECC 2000 guidelines and where <8 results above LORs were available.
** - pH trigger levels recommended by the Queensland Department of Environment and Science.
0.06 µg/L Hg adopted, which is the ANZECC 2000, 2018 guidelines 99% protection trigger levels for freshwater aquatic ecosystems.
Grey text denotes trigger levels refined by Queensland Department of Environment and Science

Tertiary Sediments

As a result of the extensive assessment and quality assurance of the baseline dataset, the trigger levels for Tertiary sediments monitoring bores have been identified as three groups, which include:

- C558P1 (bore specific / outlier bore)
- C025P2 and C029P2
- C9180121SPR and C9845SPR.

Table B-34 Tertiary Sediments Proposed Trigger Levels

Parameter	Units	Bore C558P1 Contaminant Trigger Levels (85th Percentiles)	Bores C025P2 and C029P2 Contaminant Trigger Levels (85th Percentiles)	All other Tertiary Bores Contaminant Trigger Levels (85th Percentiles)
Calcium	mg/L Ca	**80**	**120**	**35**
Magnesium	mg/L Mg	**215**	**120**	**50**
Potassium	mg/L K	**49**	**100**	**15**
Sodium	mg/L Na	**1,540**	**2,900**	**575**
Chloride	mg/L Cl	**2,900**	**4,500**	**1,100**
Sulphate	mg/L SO_4	240	**430**	**98**
Alkalinity	mg/L $CaCO_3$	**240**	**420**	**60**
Sulphide	mg/L S_2	NV	NV	NV
Fluoride	mg/L F	**0.4**	**0.6**	**0.3**
Aluminium	µg/L Al	55 (20)	**55**	**55**
Arsenic	µg/L As	**13**	**13**	**13**
Boron	µg/L B	**840**	**1,600**	307
Cadmium	µg/L Cd	**0.2**	**0.2**	**0.2**
Chromium	µg/L Cr	**1**	**1**	**2**
Cobalt	µg/L Co	**4**	1.4*	1.4*
Copper	µg/L Cu	405	**26**	**180**

Parameter	Units	Bore C558P1 Contaminant Trigger Levels (85th Percentiles)	Bores C025P2 and C029P2 Contaminant Trigger Levels (85th Percentiles)	All other Tertiary Bores Contaminant Trigger Levels (85th Percentiles)
Iron	µg/L Fe	430	2,750	350
Lead	µg/L Pb	3.4	3.4	3.4 (2)
Manganese	µg/L Mn	1,900 (265)	2,600	1,900 (19)
Molybdenum	µg/L Mo	34*	34 (2)	34*
Nickel	µg/L Ni	34	11 (7)	11 (4)
Selenium	µg/L Se	11	11	11 (5)
Silver	µg/L Ag	0.05	0.05	0.05
Uranium	µg/L U	2	1.1	0.5*
Vanadium	µg/L V	11	10	6*
Zinc	µg/L Zn	46	15	950
Mercury	µg/L Hg	*0.06*	*0.06*	*0.06*
Ammonia	mg/L N	0.9 (0.7)	0.9 (0.7)	0.9 (0.013)
Nitrate	mg/L N	0.7 (0.3)	0.7 (0.02)	0.7 (0.22)
Nitrite	mg/L N	NV	NV	NV
T. Phosphorous	mg/L P	0.03	0.19	0.09
Total Recoverable Hydrocarbons	ppb (C_6 – C_9)	Detect above LOR	Detect above LOR	Detect above LOR
Total Recoverable Hydrocarbons	ppb (C_6 – C_{10})	Detect above LOR	Detect above LOR	Detect above LOR
Total Recoverable Hydrocarbons	ppb (C_{10} – C_{40})	Detect above LOR	Detect above LOR	Detect above LOR
BTEX	ppb	Detect above LOR	Detect above LOR	Detect above LOR
pH**	pH units	6.0 – 9.0	6.0 – 9.0	6.0 – 9.0
Electrical Conductivity	µS/cm	9,360	14,000	3,700

Parameter	Units	Bore C558P1 Contaminant Trigger Levels (85th Percentiles)	Bores C025P2 and C029P2 Contaminant Trigger Levels (85th Percentiles)	All other Tertiary Bores Contaminant Trigger Levels (85th Percentiles)
Total Dissolved Solids	mg/L	**5,600**	**8,660**	**2,300**

Notes:

Bold – at least eight (8) results from the baseline groundwater monitoring program were reported above LORs and utilised to calculate trigger and contaminant levels (85th and 99th).

Bold - 95% protection trigger levels for freshwater aquatic ecosystems from Table 3.4.1 in the ANZECC 2000 guidelines were applied where <8 results above LORs were available from the baseline groundwater monitoring program (XX) – calculated values.

Not bold or **Bold** – ANZECC 95th reliability (freshwater) trigger level or low reliability trigger level from Section 8.3.7 was adopted over baseline calculated value (85% baseline is less than ANZECC value).

'Detect above LOR' – no guideline values available, no results above LORs reported during baseline monitoring program.

NV - no published guideline value; however, there were results above LOR (less than 8).

* trigger level adopted from Section 8.3.7 of the ANZECC 2000 guidelines (low reliability trigger levels) where there were no 95% protection trigger levels for freshwater aquatic ecosystems from Table 3.4.1 of the ANZECC 2000 guidelines and where <8 results above LORs were available.

** - pH trigger levels recommended by the Queensland Department of Environment and Science

0.06 µg/L Hg adopted, which is the ANZECC 2000, 2018 guidelines 99% protection trigger levels for freshwater aquatic ecosystems.

Grey text denotes trigger levels refined by Queensland Department of Environment and Science

Clematis Sandstone

Assessment of analytical concentrations for the Clematis Sandstone bores has resulted in subdivision of the hydrostratigraphic unit based on chemistry. There are two groups, as follows:

- HD03A and C14021SP
- All other Clematis Sandstone bores (C14011SP, C14012SP, C14013SP, C14033SP, C180118SP, HD02).

Proposed trigger levels have been assigned to each of the water quality parameters for formations. Proposed triggers have been compiled for each of the hydrostratigraphic units potentially (directly or indirectly) impacted by the proposed mining activities, as identified in the EA are presented in the tables below below and were derived for each of the groundwater units based on statistical evaluation of existing datasets, and following additional recommendations by the Queensland Department of Environment and Science.

Alluvium Triggers

The results of the groundwater quality assessment undertaken to ensure the monitoring bores for each unit are suitable to detect impacts from the approved mining operations has resulted in the proposed separation of the alluvial aquifer into eastern and western monitoring zones. The groundwater quality of the alluvial aquifer is spatially varied and considered the result of the Carmichael River across the project area, which is considered to be a losing river to the east and gaining in the west, where groundwater continuously discharges from the Joshua Spring.

This is demonstrated as groundwater quality in the eastern area contains high levels of chloride, electrical conductivity (EC) and total dissolved solids (TDS) concentrations an order of magnitude higher than the groundwater quality from the western CCP area, which is considered fresh to slightly brackish. This occurs because of “first-flush”, the mobilisation and addition of evaporitic salts in the non-perennial alluvium during the wet season.

Based on the variation in the alluvium, due to differing levels of saturation and parent material, bore specific triggers were developed for this unit.

Table B-23 Alluvium Proposed Trigger Levels

Parameter	Units	Eastern Area (C14028SP) **Contaminant** Trigger Levels (85th Percentiles)	Eastern Area (C029P1) **Contaminant** Trigger Levels (85th Percentiles)	Eastern Area (C027P1) **Contaminant** Trigger Levels (85th Percentiles)	Western Area (HD03A) Contaminant Trigger Levels (85th Percentiles)
Calcium	mg/L Ca	**800**	**68**	**27**	**2.1**
Magnesium	mg/L Mg	**1,000**	**360**	**140**	**2.7**
Potassium	mg/L K	**204**	**397**	**100**	**21**
Sodium	mg/L Na	**8,305**	6,583	**1,209**	**175**

Parameter	Units	Eastern Area (C14028SF) Contaminant Trigger Levels (85th Percentiles)	Eastern Area (C029P1) Contaminant Trigger levels (85th Percentiles)	Eastern Area (C027P1) Contaminant Trigger Levels (85th Percentiles)	Western Area (HD03A) Contaminant Trigger Levels (85th Percentiles)
Chloride	mg/L Cl	**16,000**	10,750	**2,000**	**191**
Sulphate	mg/L SO4	**1,900**	**1,100**	450	**14**
Alkalinity	mg/L CaCO3	**404**	**2,400**	**355**	**150**
Sulphide	mg/L S2	NV	**1.5**	NV	NV
Fluoride	mg/L F	1.4	**1.6**	**0.6**	**0.49**
Aluminium	µg/L Al	**55**	**55**	**55**	**55**
Arsenic	µg/L As	**13**	**13**	**13**	**13**
Boron	µg/L B	**3,170**	5,275	**845**	**370**
Cadmium	µg/L Cd	**0.2**	**0.2**	**0.2**	*0.2*
Chromium	µg/L Cr	**1.0**	**1.0**	**1.0**	*1.0*
Cobalt	µg/L Co	**23**	**12**	**8**	1.4
Copper	µg/L Cu	**7**	69	**157**	*1.4*
Iron	µg/L Fe	**652**	954	16,095	**530**
Lead	µg/L Pb	**3.4**	**3.4**	**3.4**	*3.4*
Manganese	µg/L Mn	**8,670**	**1,900**	3,750	**2,080**
Molybdenum	µg/L Mo	35(5)	35(5)	34*	34*
Nickel	µg/L Ni	**11**	20	**17**	*11*
Selenium	µg/L Se	**11**	**11**	**11**	*11*
Silver	µg/L Ag	**0.05**	**0.05**	**0.05**	*0.05*
Uranium	µg/L U	**74**	**149**	0.5*	0.5
Vanadium	µg/L V	6*	**27**	6*	**6.0**
Zinc	µg/L Zn	**26**	**56**	48	*8.0*
Mercury	µg/L Hg	***0.06***	***0.06***	***0.06***	***0.06***

Parameter	Units	Eastern Area (C14026SF) Contaminant Trigger Levels (85th Percentiles)	Eastern Area (C029P1) Contaminant Trigger Levels (85th Percentiles)	Eastern Area (C027P1) Contaminant Trigger Levels (85th Percentiles)	Western Area (HD03A) Contaminant Trigger Levels (85th Percentiles)
Ammonia	mg/L N	**0.9**	**0.9**	**0.9**	0.9
Nitrate	mg/L N	**0.7**	**0.7**	**0.7**	0.7
Nitrite	mg/L N	NV	NV	NV	NV
T. Phosphorous	mg/L P	0.1	**0.3**	**0.1**	**0.1**
Total Recoverable Hydrocarbons	ppb (C6 – C9)	Detect above LOR	Detect above LOR	Detect above LOR	Detect above LOR
Total Recoverable Hydrocarbons	ppb (C6 – C10)	Detect above LOR	Detect above LOR	Detect above LOR	Detect above LOR
Total Recoverable Hydrocarbons	ppb (C10 – C40)	Detect above LOR	Detect above LOR	Detect above LOR	Detect above LOR
BTEX	ppb	Detect above LOR	Detect above LOR	Detect above LOR	Detect above LOR
pH**	pH units	**6.0 – 9.0**	**6.0 – 9.0**	**6.0 – 9.0**	**6.0 - 9.0**
Electrical Conductivity	µS/cm	**44,000**	32,000	7,200	**900**
Total Dissolved Solids	mg/L	**26,000**	**20,000**	**4,400**	**580**

Notes:

Bold – at least eight (8) results from the baseline groundwater monitoring program were reported above LORs and utilised to calculate trigger and contaminant levels (85th and 99th).

Bold - 95% protection trigger levels for freshwater aquatic ecosystems from Table 3.4.1 in the ANZECC 2000 and ANZECC 2018 guidelines were applied where <8 results above LORs were available from the baseline groundwater monitoring program (XX) – calculated values

Not bold or **Bold** – ANZECC 95th reliability (freshwater) trigger level or low reliability trigger level from Section 8.3.7 was adopted over baseline calculated value (85% baseline is less than ANZECC value).

'Detect above LOR' – no guideline values available, no results above LORs reported during baseline monitoring program.

NV - no published guideline value; however, there were results above LOR (less than 8).

* - trigger level adopted from Section 8.3.7 of the ANZECC 2000 guidelines (low reliability trigger levels) where there were no 95% protection trigger levels for freshwater aquatic ecosystems from Table 3.4.1 of the ANZECC 2000 guidelines and where <8 results above LORs were available.

** - pH trigger levels recommended by the Queensland Department of Environment and Science.

0.06 µg/L Hg adopted, which is the ANZECC 2000, 2018 guidelines 99% protection trigger levels for freshwater aquatic ecosystems.

Grey text denotes trigger levels refined by Queensland Department of Environment and Science

Tertiary Sediments

As a result of the extensive assessment and quality assurance of the baseline dataset, the trigger levels for Tertiary sediments monitoring bores have been identified as three groups, which include:

- C558P1 (bore specific / outlier bore)
- C025P2 and C029P2
- C9180121SPR and C9845SPR.

Table B-34 Tertiary Sediments Proposed Trigger Levels

Parameter	Units	Bore C558P1 Contaminant Trigger Levels (85th Percentiles)	Bores C025P2 and C029P2 Contaminant Trigger Levels (85th Percentiles)	All other Tertiary Bores Contaminant Trigger Levels (85th Percentiles)
Calcium	mg/L Ca	**80**	**120**	**35**
Magnesium	mg/L Mg	**215**	**120**	**50**
Potassium	mg/L K	**49**	**100**	**15**
Sodium	mg/L Na	**1,540**	**2,900**	**575**
Chloride	mg/L Cl	**2,900**	**4,500**	**1,100**
Sulphate	mg/L SO4	240	**430**	**98**
Alkalinity	mg/L CaCO3	**240**	**420**	**60**
Sulphide	mg/L S2	NV	NV	NV
Fluoride	mg/L F	**0.4**	**0.6**	**0.3**
Aluminium	µg/L Al	55 (20)	**55**	**55**
Arsenic	µg/L As	**13**	**13**	**13**
Boron	µg/L B	**840**	**1,600**	307
Cadmium	µg/L Cd	**0.2**	**0.2**	**0.2**
Chromium	µg/L Cr	**1**	**1**	**2**
Cobalt	µg/L Co	**4**	1.4*	1.4*
Copper	µg/L Cu	405	**26**	**180**

Parameter	Units	Bore C555P1 Contaminant Trigger Levels (85th Percentiles)	Bores C025P2 and C029P2 Contaminant Trigger Levels (85th Percentiles)	All other Tertiary Bores Contaminant Trigger Levels (85th Percentiles)
Iron	µg/L Fe	**430**	2,750	**350**
Lead	µg/L Pb	**3.4**	**3.4**	**3.4** (2)
Manganese	µg/L Mn	**1,900** (265)	**2,600**	**1,900** (19)
Molybdenum	µg/L Mo	34*	34 (2)	34*
Nickel	µg/L Ni	**34**	**11** (7)	**11** (4)
Selenium	µg/L Se	**11**	**11**	**11** (5)
Silver	µg/L Ag	**0.05**	**0.05**	**0.05**
Uranium	µg/L U	**2**	**1.1**	0.5*
Vanadium	µg/L V	**11**	**10**	6*
Zinc	µg/L Zn	46	**15**	**950**
Mercury	µg/L Hg	***0.06***	***0.06***	***0.06***
Ammonia	mg/L N	**0.9** (0.7)	**0.9** (0.7)	**0.9** (0.013)
Nitrate	mg/L N	**0.7** (0.3)	0.7 (0.02)	**0.7** (0.22)
Nitrite	mg/L N	NV	NV	NV
T. Phosphorous	mg/L P	**0.03**	**0.19**	**0.09**
Total Recoverable Hydrocarbons	ppb (C6 – C9)	Detect above LOR	Detect above LOR	Detect above LOR
Total Recoverable Hydrocarbons	ppb (C6 – C10)	Detect above LOR	Detect above LOR	Detect above LOR
Total Recoverable Hydrocarbons	ppb (C10 – C40)	Detect above LOR	Detect above LOR	Detect above LOR
BTEX	ppb	Detect above LOR	Detect above LOR	Detect above LOR
pH**	pH units	**6.0 – 9.0**	**6.0 – 9.0**	**6.0 – 9.0**
Electrical Conductivity	µS/cm	**9,360**	**14,000**	3,700
Total Dissolved Solids	mg/L	**5,600**	**8,660**	**2,300**

Notes:

Bold – at least eight (8) results from the baseline groundwater monitoring program were reported above LORs and utilised to calculate trigger and contaminant levels (85th and 99th).

Bold - 95% protection trigger levels for freshwater aquatic ecosystems from Table 3.4.1 in the ANZECC 2000 guidelines were applied where <8 results above LORs were available from the baseline groundwater monitoring program (XX) – calculated values.

Not bold or **Bold** – ANZECC 95th reliability (freshwater) trigger level or low reliability trigger level from Section 8.3.7 was adopted over baseline calculated value (85% baseline is less than ANZECC value).

'Detect above LOR' – no guideline values available, no results above LORs reported during baseline monitoring program.

NV - no published guideline value; however, there were results above LOR (less than 8).

* trigger level adopted from Section 8.3.7 of the ANZECC 2000 guidelines (low reliability trigger levels) where there were no 95% protection trigger levels for freshwater aquatic ecosystems from Table 3.4.1 of the ANZECC 2000 guidelines and where <8 results above LORs were available.

** - pH trigger levels recommended by the Queensland Department of Environment and Science

0.06 µg/L Hg adopted, which is the ANZECC 2000, 2018 guidelines 99% protection trigger levels for freshwater aquatic ecosystems.

Grey text denotes trigger levels refined by Queensland Department of Environment and Science

-4 below presents the trigger levels for the Clematis Sandstone.

Table B-4 Clematis Sandstone Trigger Levels

Parameter	Units	Bores HD03A and C14021SP Contaminant Trigger Levels (85th Percentiles)	All other Clematis Bores Contaminant Trigger Levels (85th Percentiles)
Calcium	mg/L Ca	**5**	**3**
Magnesium	mg/L Mg	**11**	**9**
Potassium	mg/L K	**18**	**15**
Sodium	mg/L Na	**130**	**100**
Chloride	mg/L Cl	**150**	**110**
Sulphate	mg/L SO_4	**19**	**9**
Alkalinity	mg/L $CaCO_3$	**120**	**130**
Sulphide	mg/L S_2	NV	NV
Fluoride	mg/L F	**0.3**	**0.4**
Aluminium	µg/L Al	**55**	**55** (18)
Arsenic	µg/L As	**13**	**13** (8)
Boron	µg/L B	**370** (130)	**370** (110)
Cadmium	µg/L Cd	**0.2**	**0.2**
Chromium	µg/L Cr	**1.0**	**1.0**
Cobalt	µg/L Co	1.4*	**4**
Copper	µg/L Cu	**13**	**16**
Iron	µg/L Fe	**505**	**55**
Lead	µg/L Pb	**3.4**	**3.4**
Manganese	µg/L Mn	**1,900** (425)	**1,900** (120)
Molybdenum	µg/L Mo	34*	34*

Parameter	Units	Bores HD03A and C14021SP Contaminant Trigger Levels (85th Percentiles)	All other Clematis Bores Contaminant Trigger Levels (85th Percentiles)
Nickel	µg/L Ni	**11**	**11** (10)
Selenium	µg/L Se	**11**	**11**
Silver	µg/L Ag	**0.05**	**0.05**
Uranium	µg/L U	0.5*	0.5*
Vanadium	µg/L V	6*	6*
Zinc	µg/L Zn	33	**54**
Mercury	µg/L Hg	***0.06***	***0.06***
Ammonia	mg/L N	**0.9** (0.2)	**0.9** (0.15)
Nitrate	mg/L N	**0.7** (0.17)	**0.7** (0.67)
Nitrite	mg/L N	NV	NV
T. Phosphorous	mg/L P	**0.1**	**0.18**
Total Recoverable Hydrocarbons	ppb ($C_6 – C_9$)	Detect above LOR	Detect above LOR
Total Recoverable Hydrocarbons	ppb ($C_6 – C_{10}$)	Detect above LOR	Detect above LOR
Total Recoverable Hydrocarbons	ppb ($C_{10} – C_{40}$)	Detect above LOR	Detect above LOR
BTEX	ppb	Detect above LOR	Detect above LOR
pH**	pH units	**6.0 – 9.0**	**6.0 – 9.0**
Electrical Conductivity	µS/cm	**720**	607
Total Dissolved Solids	mg/L	**430**	**380**

Notes:

Bold – at least eight (8) results from the baseline groundwater monitoring program were reported above LORs and utilised to calculate trigger and contaminant levels (85th and 99th).

Bold - 95% protection trigger levels for freshwater aquatic ecosystems from Table 3.4.1 in the ANZECC 2000 guidelines were applied where <8 results above LORs were available from the baseline groundwater monitoring program (XX) – calculated values.

Not bold or **Bold** – ANZECC 95th reliability (freshwater) trigger level or low reliability trigger level from Section 8.3.7 was adopted over baseline calculated value (85% baseline is less than ANZECC value).

'Detect above LOR' – no guideline values available, no results above LORs reported during baseline monitoring program.

NV - no published guideline value; however, there were results above LOR (less than 8).

*- trigger level adopted from Section 8.3.7 of the ANZECC 2000 guidelines (low reliability trigger levels) where there were no 95% protection trigger levels for freshwater aquatic ecosystems from Table 3.4.1 of the ANZECC 2000 guidelines and where <8 results above LORs were available.

** - pH trigger levels recommended by the Queensland Department of Environment and Science.
0.06 μg/L Hg adopted, which is the ANZECC 2000, 2018 guidelines 99% protection trigger levels for freshwater aquatic ecosystems.

Grey text denotes trigger levels refined by Queensland Department of Environment and Science

Dunda Beds

Bore C027P2 was identified to have variable groundwater quality from the remaining bores in the unit and therefore, Adani have developed bore-specific triggers for this monitoring well.

Table B-55B-5 presents the trigger levels for the Dunda Beds.

Table B-55 Dunda Beds Trigger Levels

Parameter	Units	Bore C027P2 Contaminant Trigger Levels (85th Percentiles)	All other Dunda Beds Bores Contaminant Trigger Levels (85th Percentiles)
Calcium	mg/L Ca	**1.1**	**3.5**
Magnesium	mg/L Mg	4.2	**3.8**
Potassium	mg/L K	**10**	**3.8**
Sodium	mg/L Na	**160**	**57**
Chloride	mg/L Cl	**212**	**69**
Sulphate	mg/L SO_4	**24**	**16**
Alkalinity	mg/L $CaCO_3$	162	80
Sulphide	mg/L S_2	NV	NV
Fluoride	mg/L F	**0.3**	**0.7**
Aluminium	µg/L Al	**55**	**56**
Arsenic	µg/L As	**13** (7)	**13**
Boron	µg/L B	**370** (210)	**370** (126)
Cadmium	µg/L Cd	**0.2**	**0.2**
Chromium	µg/L Cr	**1.0**	**1.0**
Cobalt	µg/L Co	**3**	**53**
Copper	µg/L Cu	**3**	**100**
Iron	µg/L Fe	**1,325**	**790**
Lead	µg/L Pb	**3.4** (2)	**3.4**

Parameter	Units	Bore C027P2 Contaminant Trigger Levels (85th Percentiles)	All other Dunda Beds Bores Contaminant Trigger Levels (85th Percentiles)
Manganese	µg/L Mn	**1,900** (220)	**1,900** (28.8)
Molybdenum	µg/L Mo	34*	34*
Nickel	µg/L Ni	**11** (3.8)	12
Selenium	µg/L Se	**11**	**11**
Silver	µg/L Ag	**0.05**	**0.05**
Uranium	µg/L U	0.5*	0.5*
Vanadium	µg/L V	6*	6*
Zinc	µg/L Zn	**28**	**42**
Mercury	µg/L Hg	***0.06***	***0.06***
Ammonia	mg/L N	**0.9** (0.16)	**0.9** (0.25)
Nitrate	mg/L N	**0.7** (0.09)	**0.7** (0.22)
Nitrite	mg/L N	Detect above LOR	NV
T. Phosphorous	mg/L P	**0.03**	**0.06**
Total Recoverable Hydrocarbons	ppb (C_6 – C_9)	Detect above LOR	Detect above LOR
Total Recoverable Hydrocarbons	ppb (C_6 – C_{10})	Detect above LOR	Detect above LOR
Total Recoverable Hydrocarbons	ppb (C_{10} – C_{40})	Detect above LOR	Detect above LOR
BTEX	ppb	Detect above LOR	Detect above LOR
pH**	pH units	**6.0 – 9.0**	**6.0 – 9.0**
Electrical Conductivity	µS/cm	**850**	350
Total Dissolved Solids	mg/L	**523**	**220**

Notes:

Bold – at least eight (8) results from the baseline groundwater monitoring program were reported above LORs and utilised to calculate trigger and contaminant levels (85th and 99th).

Bold - 95% protection trigger levels for freshwater aquatic ecosystems from Table 3.4.1 in the ANZECC 2000 guidelines were applied where <8 results above LORs were available from the baseline groundwater monitoring program (XX) – calculated values.

Not bold or **Bold** – ANZECC 95th reliability (freshwater) trigger level or low reliability trigger level from Section 8.3.7 was adopted over baseline calculated value (85% baseline is less than ANZECC value).

'Detect above LOR' – no guideline values available, no results above LORs reported during baseline monitoring program.

NV - no published guideline value; however, there were results above LOR (less than 8).

*- trigger level adopted from Section 8.3.7 of the ANZECC 2000 guidelines (low reliability trigger levels) where there were no 95% protection trigger levels for freshwater aquatic ecosystems from Table 3.4.1 of the ANZECC 2000 guidelines and where <8 results above LORs were available.

** - pH trigger levels recommended by the Queensland Department of Environment and Science.
0.06 µg/L Hg adopted, which is the ANZECC 2000, 2018 guidelines 99% protection trigger levels for freshwater aquatic ecosystems.

Grey text denotes trigger levels refined by Queensland Department of Environment and Science

Rewan Formation

Assessment of analytical concentrations for the Rewan Formation bores has resulted in subdivision of the hydrostratigraphic unit into three components with trigger levels being applied to the groupings as follows:

- C008P1
- C035P1
- All other Rewan Formation bores (C555P1, C556P1, C9553P1R, C9838SPR).

Bore C008P1 was identified as an outlier bore within the Rewan Formation. The baseline groundwater quality data for this bore, due to its proximity to C555P1, was discontinued as a monitoring point in 2014. Analysis during the trigger assessment indicates this bore, drilled and screened within the Rewan Formation indicates a different groundwater type to the other Rewan Formation bores. As such, this bore has been reinstated as a groundwater quality monitoring point and will have bore-specific triggers developed.

Due to the paucity of groundwater chemistry data for C008P1, the concentrations included in **Table B-56B-5** for bore C008P1 are considered to be interim trigger levels for the first two years of the GMMP in lieu of sufficient data.

Table B-56 Rewan Formation Trigger Levels

Parameter	Units	Bore C008P1 Contaminant Trigger Levels (85th Percentiles)	Bore C035P1 Contaminant Trigger Levels (85th Percentiles)	All other Rewan Formation Bores Contaminant Trigger Levels (85th Percentiles)
Calcium	mg/L Ca	NV	**18.5**	**6**
Magnesium	mg/L Mg	NV	**17**	**8**
Potassium	mg/L K	NV	**7.6**	**8**
Sodium	mg/L Na	NV	**755**	**130**
Chloride	mg/L Cl	NV	**1,100**	**170**
Sulphate	mg/L SO_4	280	57	**50**
Alkalinity	mg/L $CaCO_3$	NV	**171**	**140**
Sulphide	mg/L S_2	NV	NV	NV
Fluoride	mg/L F	0.7	**0.7**	**0.7**

Parameter	Units	Bore C000P1 Contaminant Trigger Levels (85th Percentiles)	Bore C035P1 Contaminant Trigger Levels (85th Percentiles)	All other Rewan Formation Bores Contaminant Trigger Levels (85th Percentiles)
Aluminium	µg/L Al	**55**	**55**	54
Arsenic	µg/L As	**13**	**13** (4)	**13** (4)
Boron	µg/L B	**370**	**710**	**370** (240)
Cadmium	µg/L Cd	**0.2**	**0.2**	**0.2**
Chromium	µg/L Cr	**1**	**1.0**	**1.0**
Cobalt	µg/L Co	1.4*	1.4*	**4**
Copper	µg/L Cu	**1.4**	**1.4**	**23**
Iron	µg/L Fe	800	800	**1,635**
Lead	µg/L Pb	**3.4**	**3.4**	**3.4**
Manganese	µg/L Mn	**1,900**	**1,900** (171)	**1,900** (488)
Molybdenum	µg/L Mo	34*	34*	34*
Nickel	µg/L Ni	**11**	**11**	**11** (5)
Selenium	µg/L Se	**11**	**11**	**11**
Silver	µg/L Ag	**0.05**	**0.05**	**0.05**
Uranium	µg/L U	0.5*	0.5*	0.5*
Vanadium	µg/L V	6*	6*	6*
Zinc	µg/L Zn	**8**	**151**	**38**
Mercury	µg/L Hg	***0.06***	***0.06***	***0.06***
Ammonia	mg/L N	**0.9**	**0.9** (0.08)	**0.9** (0.4)
Nitrate	mg/L N	**0.7**	**0.7**	**0.7** (0.2)
Nitrite	mg/L N	NV	NV	NV
T. Phosphorous	mg/L P	0.14	**0.14**	**0.26**

Parameter	Units	Bore C008P1 Contaminant Trigger Levels (85th Percentiles)	Bore C035P1 Contaminant Trigger Levels (85th Percentiles)	All other Rewan Formation Bores Contaminant Trigger Levels (85th Percentiles)
Total Recoverable Hydrocarbons	ppb ($C_6 – C_9$)	Detect above LOR	Detect above LOR	Detect above LOR
Total Recoverable Hydrocarbons	ppb ($C_6 – C_{10}$)	Detect above LOR	Detect above LOR	Detect above LOR
Total Recoverable Hydrocarbons	ppb ($C_{10} – C_{40}$)	Detect above LOR	Detect above LOR	Detect above LOR
BTEX	ppb	Detect above LOR	Detect above LOR	Detect above LOR
pH**	pH units	**6.0-9.0**	**6.0 – 9.0**	**6.0 – 9.0**
Electrical Conductivity	µS/cm	21,140	**4,000**	800
Total Dissolved Solids	mg/L	NV	**2,465**	**490**

Notes:

Bold – at least eight (8) results from the baseline groundwater monitoring program were reported above LORs and utilised to calculate trigger and contaminant levels (85th and 99th).

Bold - 95% protection trigger levels for freshwater aquatic ecosystems from Table 3.4.1 in the ANZECC 2000 guidelines were applied where <8 results above LORs were available from the baseline groundwater monitoring program (XX) – calculated values.

Not bold or **Bold** – ANZECC 95th reliability (freshwater) trigger level or low reliability trigger level from Section 8.3.7 was adopted over baseline calculated value (85% baseline is less than ANZECC value).

'Detect above LOR' – no guideline values available, no results above LORs reported during baseline monitoring program.

NV - no published guideline value; however, there were results above LOR (less than 8).

*- trigger level adopted from Section 8.3.7 of the ANZECC 2000 guidelines (low reliability trigger levels) where there were no 95% protection trigger levels for freshwater aquatic ecosystems from Table 3.4.1 of the ANZECC 2000 guidelines and where <8 results above LORs were available.

** - pH trigger levels recommended by the Queensland Department of Environment and Science.

0.06 µg/L Hg adopted, which is the ANZECC 2000, 2018 guidelines 99% protection trigger levels for freshwater aquatic ecosystems.

Grey text denotes trigger levels refined by Queensland Department of Environment and Science

Bandanna Formation (AB Seam)

As with the Rewan Formation bore C008P1, bore C007P2 was to have a water type markedly different to the AB Seam baseline groundwater quality data.

Bore C007P2 was identified as an outlier bore within the AB Seam. The baseline groundwater quality data for this bore, due to its proximity to C008P2, was discontinued as a monitoring point in 2014. Analysis during the trigger assessment indicates this bore, drilled and screened within the AB Seam indicates a different groundwater type to the other AB Seam bores. As such, this bore has been reinstated as a groundwater quality monitoring point and will have bore-specific triggers developed.

Due to the paucity of groundwater chemistry data for C007P2, the concentrations included in **Table B-6B-6** for bore C007P2 are considered to be interim trigger levels for the first two years of the GMMP in lieu of sufficient data.

The remaining AB Seam bores include C008P2, C014P2, C016P2, C020P2, C032P2, and C035P2.

Table B-6B-6 below presents the trigger levels for the AB Seam.

Table B-6 Bandanna Formation (AB Seam) Trigger Levels

Parameter	Units	Bore C007P2 Contaminant Trigger Levels (85th Percentiles)	All other Bandanna Formation Bores Contaminant Trigger Levels (85th Percentiles)
Calcium	mg/L Ca	32	**32**
Magnesium	mg/L Mg	16	**16**
Potassium	mg/L K	49	**49**
Sodium	mg/L Na	570	**570**
Chloride	mg/L Cl	723	**723**
Sulphate	mg/L SO_4	74	**74**
Alkalinity	mg/L $CaCO_3$	NV	**480**
Sulphide	mg/L S_2	NV	**10**
Fluoride	mg/L F	1	**1**
Aluminium	µg/L Al	**55**	**400**
Arsenic	µg/L As	**13**	**13** (9)
Boron	µg/L B	**370**	**370**
Cadmium	µg/L Cd	**0.2**	**0.2** (0.2)

Parameter	Units	Bore C007P2 Contaminant Trigger Levels (95th Percentiles)	All other Bandanna Formation Bores Contaminant Trigger Levels (95th Percentiles)
Chromium	µg/L Cr	**1**	**1**
Cobalt	µg/L Co	1.4*	1.4*
Copper	µg/L Cu	**1.4**	**2**
Iron	µg/L Fe	138	**138**
Lead	µg/L Pb	**3.4**	**3.4**
Manganese	µg/L Mn	**1,900**	**1,900** (108)
Molybdenum	µg/L Mo	34*	**38**
Nickel	µg/L Ni	**11**	**15**
Selenium	µg/L Se	**11**	11
Silver	µg/L Ag	**0.05**	0.05
Uranium	µg/L U	0.5*	0.5*
Vanadium	µg/L V	6*	6*
Zinc	µg/L Zn	**8**	**15**
Mercury	µg/L Hg	***0.06***	**0.06**
Ammonia	mg/L N	**0.9**	**2.8**
Nitrate	mg/L N	**0.7**	**0.7** (0.03)
Nitrite	mg/L N	NV	NV
T. Phosphorous	mg/L P	0.13	**0.13**
Total Recoverable Hydrocarbons+	ppb ($C_6 – C_9$)	Detect above LOR	**61**
Total Recoverable Hydrocarbons+	ppb ($C_6 – C_{10}$)	Detect above LOR	**126**
Total Recoverable Hydrocarbons+	ppb ($C_{10} – C_{40}$)	Detect above LOR	Detect above LOR
BTEX	ppb	Detect above LOR	Detect above LOR
pH**	pH units	**6.0 – 9.0**	**7.0 – 11.5**

Parameter	Units	Bore C007P2 Contaminant Trigger Levels (85th Percentiles)	All other Bandanna Formation Bores Contaminant Trigger Levels (85th Percentiles)
Electrical Conductivity	µS/cm	NV	**3,000**
Total Dissolved Solids	mg/L	NV	**1,800**

Notes:

Bold – at least eight (8) results from the baseline groundwater monitoring program were reported above LORs and utilised to calculate trigger and contaminant levels (85th and 99th).

Bold - 95% protection trigger levels for freshwater aquatic ecosystems from Table 3.4.1 in the ANZECC 2000 guidelines were applied where <8 results above LORs were available from the baseline groundwater monitoring program (XX) – calculated values.

Not bold or **Bold** – ANZECC 95th reliability (freshwater) trigger level or low reliability trigger level from Section 8.3.7 was adopted over baseline calculated value (85% baseline is less than ANZECC value).

'Detect above LOR' – no guideline values available, no results above LORs reported during baseline monitoring program.

NV - no published guideline value; however, there were results above LOR (less than 8).

*- trigger level adopted from Section 8.3.7 of the ANZECC 2000 guidelines (low reliability trigger levels) where there were no 95% protection trigger levels for freshwater aquatic ecosystems from Table 3.4.1 of the ANZECC 2000 guidelines and where <8 results above LORs were available.

** - pH trigger levels recommended by the Queensland Department of Environment and Science.

0.06 µg/L Hg adopted, which is the ANZECC 2000, 2018 guidelines 99% protection trigger levels for freshwater aquatic ecosystems.

Grey text denotes trigger levels refined by Queensland Department of Environment and Science

Colinlea Sandstone (D Seam)

As a result of the extensive assessment and QA of the baseline dataset, bore specific triggers have been developed for:

- C833SP
- C848SP
- C034P3
- C024P3.

The remaining D Seam bores have remained in one group and include C006P3R, C007P3, C011P3, C018P3, C180114SP, and C9849SPR. These are considered to represent the unit specific triggers.

Trigger levels and contaminant limits for the D Seam bores are presented in **Table** B-7**B-7** below.

Table B-7 Colinlea Sandstone (D Seam) trigger levels

Parameter	Units	Bore C833SP Trigger Levels (85th Percentiles)	Bore C848SP Trigger Levels (85th Percentiles)	Bore C034P3 Trigger Levels (85th Percentiles)	Bore C024P3 Trigger Levels (85th Percentiles)	All other Colinlea Sandstone Bores Trigger Levels (85th Percentiles)
Calcium	mg/L Ca	**19**	**29**	**28**	25	**25**
Magnesium	mg/L Mg	**7**	**23**	**12**	6	**6**
Potassium	mg/L K	**55**	**27**	**16**	11	**11**
Sodium	mg/L Na	**270**	**540**	**355**	220	220
Chloride	mg/L Cl	**220**	**790**	**560**	200	**200**
Sulphate	mg/L SO_4	**37**	**20**	**30**	15	**15**
Alkalinity	mg/L $CaCO_3$	322	**240**	**115**	NV	**440**
Sulphide	mg/L S_2	**2**	NV	NV	NV	**1.3**
Fluoride	mg/L F	**1.9**	**0.4**	**0.3**	6.2	**6.2**
Aluminium	µg/L Al	**55**	**55**	**55**	**55**	**121**
Arsenic	µg/L As	**13**	**13**	**13**	**13**	**13** (4)
Boron	µg/L B	**370** (190)	**370** (190)	**370** (254)	**370** (300)	**410**

Parameter	Units	Bore C033SP Trigger Levels (95th Percentiles)	Bore C040SP Trigger Levels (95th Percentiles)	Bore C034P3 Trigger Levels (95th Percentiles)	Bore C024P3 Trigger Levels (95th Percentiles)	All other Colinlea Sandstone Bores Trigger Levels (95th Percentiles)
Cadmium	µg/L Cd	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**
Chromium	µg/L Cr	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**
Cobalt	µg/L Co	1.4*	1.4*	1.4*	1.4*	1.4*
Copper	µg/L Cu	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**
Iron	µg/L Fe	**46**	1,345	**2,030**	410	410
Lead	µg/L Pb	**3.4**	**3.4**	**3.4**	**3.4**	**3.4**
Manganese	µg/L Mn	**1,900** (126)	**1,900** (330)	**1,900** (245)	**1,900** (240)	**1,900** (55)
Molybdenum	µg/L Mo	**16**	34*	34*	34*	**2**
Nickel	µg/L Ni	**11**	**11**	**11**	**11**	**11** (5)
Selenium	µg/L Se	**11**	**11**	**11**	**11**	**11**
Silver	µg/L Ag	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**
Uranium	µg/L U	0.5*	0.5*	0.5*	0.5*	0.5*
Vanadium	µg/L V	6*	6*	6*	6*	6*
Zinc	µg/L Zn	**88**	24	**8**	**8**	25
Mercury	µg/L Hg	***0.06***	***0.06***	***0.06***	***0.06***	***0.06***
Ammonia	mg/L N	**1.0**	**0.9** (0.12)	**0.9** (0.12)	**0.9** (0.6)	**0.9** (0.3)
Nitrate	mg/L N	**0.7**	**0.7**	**0.7**	**0.7**	**0.7** (0.02)
Nitrite	mg/L N	NV	NV	NV	NV	NV
T. Phosphorous	mg/L P	**0.02**	**0.03**	**0.07**	0.08	**0.08**
Total Recoverable Hydrocarbons+	ppb ($C_6 – C_9$)	Detect above LOR	Detect above LOR	Detect above LOR	Detect above LOR	Detect above LOR
Total Recoverable Hydrocarbons+	ppb ($C_6 – C_{10}$)	Detect above LOR	Detect above LOR	Detect above LOR	Detect above LOR	Detect above LOR

Parameter	Units	Bore C833SP Trigger Levels (85th Percentiles)	Bore C848SP Trigger Levels (85th Percentiles)	Bore C034P3 Trigger Levels (85th Percentiles)	Bore C024P3 Trigger Levels (85th Percentiles)	All other Colinlea Sandstone Bores Trigger Levels (85th Percentiles)
Total Recoverable Hydrocarbons+	ppb (C_{10} – C_{40})	Detect above LOR	Detect above LOR	Detect above LOR	Detect above LOR	Detect above LOR
BTEX	ppb	Detect above LOR	Detect above LOR	Detect above LOR	Detect above LOR	Detect above LOR
pH**	pH units	6.0 – 9.0	**6.0 – 9.0**	**6.0 – 9.0**	**6.0 – 9.0**	**6.0 – 9.0**
Electrical Conductivity	µS/cm	1,210	**3,000**	1,935	1,030	1,030
Total Dissolved Solids	mg/L	**1,100**	**1,800**	**1,215**	639	639

Notes:

Bold – at least eight (8) results from the baseline groundwater monitoring program were reported above LORs and utilised to calculate trigger and contaminant levels (85th and 99th).

Bold - 95% protection trigger levels for freshwater aquatic ecosystems from Table 3.4.1 in the ANZECC 2000 guidelines were applied where <8 results above LORs were available from the baseline groundwater monitoring program (XX) – calculated values.

Not bold or **Bold** – ANZECC 95th reliability (freshwater) trigger level or low reliability trigger level from Section 8.3.7 was adopted over baseline calculated value (85% baseline is less than ANZECC value).

'Detect above LOR' – no guideline values available, no results above LORs reported during baseline monitoring program.

NV - no published guideline value; however, there were results above LOR (less than 8).

*- trigger level adopted from Section 8.3.7 of the ANZECC 2000 guidelines (low reliability trigger levels) where there were no 95% protection trigger levels for freshwater aquatic ecosystems from Table 3.4.1 of the ANZECC 2000 guidelines and where <8 results above LORs were available.

** - pH trigger levels recommended by the Queensland Department of Environment and Science.

0.06 µg/L Hg adopted, which is the ANZECC 2000, 2018 guidelines 99% protection trigger levels for freshwater aquatic ecosystems.

Grey text denotes trigger levels refined by Queensland Department of Environment and Science.

Joe Joe Group

Bores C14003SP and C914001SPR were identified to have variable groundwater quality from the remaining bores in the unit and therefore, Adani have developed bore-specific triggers for these locations. Bores C14017SP and C14006SP were also variable, but similar to each other, and have been grouped together.

The remaining bores have been grouped together for trigger levels and include C012P1, C012P2, C14008SP, C14014SP, C14015SP, C14016SP, C180119SP, C180123SP, C9180124SPR, and C9180125SPR. **Table B-87** presents the trigger levels for the Joe Joe Group bores.

Table B-87 Joe Joe Group Trigger Levels

Parameter	Units	Bore C14003SP Trigger Levels (85th Percentiles)	Bore C914001SPR Trigger Levels (85th Percentiles)	Bores C14017SP and C14006SP Trigger Levels (85th Percentiles)	All other Joe Joe Group Bores Trigger Levels (85th Percentiles)
Calcium	mg/L Ca	**2,620**	**880**	180	**76**
Magnesium	mg/L Mg	**1,600**	**435**	**84**	**28**
Potassium	mg/L K	**52**	**124**	**39**	**15**
Sodium	mg/L Na	**8,000**	3,800	**1,500**	**426**
Chloride	mg/L Cl	**21,000**	**7,070**	2,545	**630**
Sulphate	mg/L SO_4	2,710	**1,600**	206	**54**
Alkalinity	mg/L $CaCO_3$	48	210	240	**290**
Sulphide	mg/L S_2	NV	NV	NV	**1.4**
Fluoride	mg/L F	**0.2**	0.7	**1.0**	**0.7**
Aluminium	µg/L Al	**55**	**55**	**55**	**55** (39)
Arsenic	µg/L As	**13**	**13 (2)**	**13 (4)**	**13** (6)
Boron	µg/L B	**4,000**	**2,035**	**720**	**425**
Cadmium	µg/L Cd	**0.2**	**0.2**	**0.2**	**0.2**
Chromium	µg/L Cr	**1**	**1**	**1**	**4**
Cobalt	µg/L Co	**29**	1.4*	**3**	**6**
Copper	µg/L Cu	**670**	**1.4**	**1.4**	**19**

Parameter	Units	Bore C14003SP Trigger Levels (95th Percentiles)	Bore C9140016PR Trigger Levels (95th Percentiles)	Bores C14017SP and C14006SP Trigger Levels (95th Percentiles)	All other Joe Joe Group Bores Trigger Levels (95th Percentiles)
Iron	µg/L Fe	**1,300**	**9,445**	1,870	**765**
Lead	µg/L Pb	**3.4**	**3.4**	**3.4**	**7**
Manganese	µg/L Mn	**2,620**	**1,900** (994)	**1900** (1006)	**1,900** (407)
Molybdenum	µg/L Mo	34*	34*	**4**	**4**
Nickel	µg/L Ni	**33**	**11 (3.5)**	**11 (7)**	**11 (9.6)**
Selenium	µg/L Se	**11** (3.5)	**11**	**11**	**11**
Silver	µg/L Ag	**0.05**	**0.05**	**0.05**	**0.05**
Uranium	µg/L U	0.5*	3.4	0.5*	**1**
Vanadium	µg/L V	6*	6*	6*	6*
Zinc	µg/L Zn	**69**	60	**297**	**260**
Mercury	µg/L Hg	***0.06***	***0.06***	***0.06***	***0.06***
Ammonia	mg/L N	**0.9** (0.67)	**0.9** (0.47)	**0.9** (0.47)	**0.9** (0.18)
Nitrate	mg/L N	**0.7**	**0.7**	**0.7**	**0.7** (0.2)
Nitrite	mg/L N	NV	NV	NV	NV
T. Phosphorous	mg/L P	0.05	0.05	**0.03**	**0.05**
Total Recoverable Hydrocarbons	ppb ($C_6 – C_9$)	Detect above LOR	Detect above LOR	Detect above LOR	Detect above LOR
Total Recoverable Hydrocarbons	ppb ($C_6 – C_{10}$)	Detect above LOR	Detect above LOR	Detect above LOR	Detect above LOR
Total Recoverable Hydrocarbons	ppb ($C_{10} – C_{40}$)	Detect above LOR	Detect above LOR	Detect above LOR	Detect above LOR
BTEX	ppb	Detect above LOR	Detect above LOR	Detect above LOR	Detect above LOR
pH**	pH units	**6.0 – 9.0**	**6.0 – 9.0**	**6.0 – 9.0**	**6.0 – 9.0**
Electrical Conductivity	µS/cm	**53,000**	**21,000**	**8,600**	**2,600**

Parameter	Units	Bore C14003SP Trigger Levels (85th Percentiles)	Bore C914001SPR Trigger Levels (85th Percentiles)	Bores C14017SP and C14006SP Trigger Levels (85th Percentiles)	All other Joe Joe Group Bores Trigger Levels (85th Percentiles)
Total Dissolved Solids	mg/L	**32,000**	**13,000**	**5,100**	**1,600**

Notes:

Bold – at least eight (8) results from the baseline groundwater monitoring program were reported above LORs and utilised to calculate trigger and contaminant levels (85th and 99th).

Bold - 95% protection trigger levels for freshwater aquatic ecosystems from Table 3.4.1 in the ANZECC 2000 guidelines were applied where <8 results above LORs were available from the baseline groundwater monitoring program (XX) – calculated values.

Not bold or **Bold** – ANZECC 95th reliability (freshwater) trigger level or low reliability trigger level from Section 8.3.7 was adopted over baseline calculated value (85% baseline is less than ANZECC value).

'Detect above LOR' – no guideline values available, no results above LORs reported during baseline monitoring program.

NV - no published guideline value; however, there were results above LOR (less than 8).

*- trigger level adopted from Section 8.3.7 of the ANZECC 2000 guidelines (low reliability trigger levels) where there were no 95% protection trigger levels for freshwater aquatic ecosystems from Table 3.4.1 of the ANZECC 2000 guidelines and where <8 results above LORs were available.

** - pH trigger levels recommended by the Queensland Department of Environment and Science

0.06 µg/L Hg adopted, which is the ANZECC 2000, 2018 guidelines 99% protection trigger levels for freshwater aquatic ecosystems.

Appendix C Chart showing timing of key project element


Carmichael Coal Mine Project: Management Plan Deliverables (first 20 Years)
Pre Commencement
Commencement
Year 1
Year 2
Year 3
Year 4
Year 5
Year 6
Year 7
Year 8
Year 9
Year 10
Year 11
Year 12
Year 13
Year 14
Year 15
Year 16
Year 17
Year 18
Year 19
Year 20
GDEMP
Annual EPBC Compliance Reporting
Annual EA Compliance Reporting
Annual GDEMP Report
GMMP
Annual EPBC Compliance Reporting
Annual EA Compliance Reporting
First anniversary report
Five yearly reporting
Groundwater Model re run
Receiving Environment Management Plan
Annual Report
GAB Springs Research Plan
Program delivery
Annual Reporting
Rewan Formation Connectivity Research Plan
Program delivery
Annual Reporting
Project Activities, Impacts and Monitoring sequencing (first 20 Years) for GDE Management Plan
Doongmabulla Springs
Pre-Construction Activities
Management Plan Approval
Construction Activities
Operational Activities
Impacts commence - groundwater
Baseline Monitoring
Pre Impact Monitoring
Impact Monitoring
Carmichael River
Pre-Construction Activities
Management Plan Approval
Construction Activities
Operational Activities
Impacts commence - catchment area
Impacts commence - direct disturbance
Impacts commence - groundwater
Baseline Monitoring
Pre Impact Monitoring
Impact Monitoring
Waxy Cabbage Palm
Pre-Construction Activities
Management Plan Approval
Construction Activities
Operational Activities
Impacts commence - direct disturbance
Impacts commence - groundwater
Baseline Monitoring
Pre Impact Monitoring
Impact Monitoring
Mellaluka Springs
Pre-Construction Activities
Management Plan Approval
Construction Activities
Operational Activities
Impacts commence - groundwater
Baseline Monitoring
Pre Impact Monitoring
Impact Monitoring

Appendix D Compliance matrix

Approval & condition number	Description of Condition or Commitment	How Addressed	Section of GDE Management Plan
EPBC Act Approval, condition 5	At least three months prior to commencement of mining operations, the approval holder must submit to the Minister for approval Matters of National Environmental Significance plan/s for the management of direct and indirect impacts of mining operations on MNES.	MNESMP for the Carmichael mine and off-site infrastructure, were lodged and approved on 20 July 2016. Linked to these overarching plans, two further specific plans relating to MNES have been prepared. A Black-throated Finch Management Plan was lodged on 11 May 2017, and this Groundwater Dependent Ecosystems Management Plan (GDEMP) was lodged on 7 November 2016. Commencement of mining operations, in accordance with the approval condition, has not yet occurred. This plan addresses the management of direct and indirect impacts of mining construction and operations on GDEs. Management of impacts from mining construction and operations are contained in Table 6-9 Carmichael River, Table 7-6 Waxy Cabbage Palm, Table 8-10 Doongmabulla Springs-complex and Table 9-4 Mellaluka Springs-complex. Direct impacts have largely been avoided through project design (e.g. buffer along the Carmichael River), however construction of a bridge over the Carmichael River will require clearing of some riparian habitat, including five Waxy Cabbage Palm individuals. Indirect impacts predominantly relate to the potential for groundwater drawdown.	Sections 6.4, 7.4, 8.5 and 9.6 Tables 6-9, 7-6, 8-10 and 9-4
	Note: If the MNESMP does not address any specific future activities (e.g. possible additional seismic surveys or specific mining stages) it should be updated in accordance with Condition 33.	If this management plan does not address any specific future activities (e.g. possible additional seismic surveys or specific mining stages) it will be updated in accordance with condition 33 of the EPBC Act approval.	
EPBC Act Approval, condition 6	The MNESMP must incorporate the results of the groundwater flow model re-run (Condition 23) where relevant, and be consistent with relevant recovery plans, threat abatement plans and approved conservation advices and must include:	Section 4.3.2 and Section 6.6.1 describe how the groundwater model re-run has been included. There are numerous guideline documents that have informed the preparation of this GDEMP. These include relevant recovery plans, research findings and monitoring methodology for springs, and national water quality guidelines. These are summarised in Section 1.4. These include the National Recovery Plan for Great Artesian Basin discharge spring wetlands (Fensham et al. 2010) and Commonwealth Approved Conservation Advice for Waxy Cabbage Palm (*Livistona lanuginosa*) (DEWHA, 2008). Threats identified in the National Recovery Plan for Great Artesian Basin discharge spring wetlands are addressed specifically in Section 8.5 (Doongmabulla Springs-complex). Aquifer drawdown is listed as a key threat in the Recovery plan for the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin. Other threats include stock and feral animal disturbance, changes to hydrology, vegetation clearance, and incursion by weeds. Potential project impacts are discussed in Section 8.5. Monitoring and research activities of the GDEMP closely align with recovery objectives described in Section 4 of the National Recovery Plan for Great Artesian Basin discharge spring wetlands (e.g. ensure flows do not decrease lower than natural variability, engage custodians in responsible management of springs). Further details of these measures are provided in Section 8.10 of the GDEMP. Threats identified in the Conservation Advice for Waxy Cabbage Palm are addressed specifically in Section 7.4. The main threats to the species are fire, trampling and grazing by stock, clearing for agricultural development, changes in water levels and introduction of invasive weeds. Potential project impacts are discussed in Section 7.4. Monitoring and research activities of the GDEMP closely align with recovery and threat abatement actions described in the Conservation Advice for Waxy Cabbage Palm (e.g. monitor known populations, stock management plans, fire management, control of invasive weeds). Further details of these measures are provided in Section 7.6 of the GDEMP. There are no recovery plans, threat abatement plans and approved conservation advices for the Carmichael River. The SPRAT profile for the GAB springs community lists two relevant abatement plans: *Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads*, and, *Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs*. The GDEMP includes specific monitoring tasks (Section 8.7) to identify damage to springs caused by pigs, and to monitor the presence of pigs and cane toads, at the Doongmabulla Springs-complex. The GDEMP is therefore consistent with the threat abatement plans, which prioritise a science-based approach to the monitoring and control of these pest species.	Section 4.3.2 and Section 6.6.1 Sections 7.4 and 7.6, Sections 8.5 and 8.10 Section 8.7
	a) A description of environmental values for each of the Matters of National Environmental Significance addressed in the plan	A description of environmental values for the listed GDEs is provided in Section 6.1 Carmichael River, Section 7.1 Waxy Cabbage Palm, Section 8.2 Doongmabulla Springs-complex and Section 9.2 Mellaluka Springs-complex. The descriptions include the status under Commonwealth and State legislation, ecology and habitat values and distribution in the vicinity of the project area.	Sections 6.3, 7.3, 8.4 and 9.5
	b) Details of baseline and impact monitoring measures to be implemented for each of the Matters of National Environmental Significance including control and impact sites to be monitored throughout the life of the project. The monitoring must provide sufficient data to quantify likely impacts resulting from mining operations, including subsidence and changes in groundwater levels, to set habitat management goals (Conditions 6e) and 6f)).	A description of pre-impact and impact monitoring measures for GDEs is provided in Sections 6.6 and 6.7 Carmichael River, Section 7.6 Waxy Cabbage Palm, Section 8.7 Doongmabulla Springs-complex and Section 9.8 Mellaluka Springs-complex, of the GDEMP. The location of monitoring sites is provided on Figures 6-13, 7-8 and 8-17. The monitoring will quantify impacts resulting from mining activities and provide feedback on the effectiveness of mitigation measures. The monitoring will include consideration of the impacts from subsidence, and groundwater drawdown on GDE habitat values. Performance criteria and triggers for corrective actions are contained in Section 6.9 Carmichael River, Section 7.9 Waxy Cabbage Palm, Section 8.10 Doongmabulla Springs-complex and Section 9.9 Mellaluka Springs-complex. Initial ecological trigger levels are described in Section 5.3.	Sections 6.6 and 6.7, 7.6, 8.7 and 9.8 Figures 6-13, 7-8 and 8-17 Sections 6.9, 7.9, 8.10 and 9.9

Approval & condition number	Description of Condition or Commitment	How Addressed	Section of GDE Management Plan
	c) Details of potential impacts, including area of impact, on each of the Matters of National Environmental Significance from mining operations, including impacts from:	Details of potential impacts of the project on the GDEs are addressed in Sections 6 to 9 of the GDEMP. An area of impact (vegetation clearing), or estimate of level of groundwater drawdown is provided in relevant subsections of Sections 6 to 9, for potential impacts for which a quantitative estimate can be provided. For example, area of vegetation clearing for the Carmichael River in Section 6.4, area of Waxy Cabbage Palm habitat potentially impacted by groundwater drawdown in Section 7.4, estimate of levels of groundwater drawdown in mine operations at Doongmabulla Springs and Mellaluka Springs in Sections 8.5 and 9.6 respectively. Cross-references for specific impacts are provided below.	Sections 6.4, 7.4, 8.5 and 9.6
	(i) Vegetation clearing	Details of impacts from vegetation clearing are described in Section 6.4 Carmichael River and Section 7.4 (Waxy Cabbage Palm). No vegetation clearing for the Project will take place at either Doongmabulla Springs or Mellaluka Springs.	Section 6.4 and Section 7.4
	(ii) Subsidence from underground mining, including subsidence induced fracturing and any changes to groundwater or surface water flow	No subsidence is predicted to occur within Waxy Cabbage Palm habitat on the Carmichael River, as modelled in the EIS for the Project. No subsidence is predicted to occur in the vicinity of the Doongmabulla Springs or Mellaluka Springs-complexes (Section 8.5 and Section 9.6).	Section 6.4 Section 8.5 and Section 9.6
	(iii) Mine dewatering	Hydrogeology, groundwater resources and their relationship to GDEs are summarised in Section 4.3 (drawn from the Groundwater Management and Monitoring Plan (GMMP). Details of groundwater drawdown as a result of mine dewatering, specific to each GDE are described in Section 6.4 Carmichael River, Section 7.4 Waxy Cabbage Palm, Section 8.5 Doongmabulla Springs-complex and Section 9.6 Mellaluka Springs-complex.	Section 4.3 Sections 6.4, 7.4, 8.5 and 9.6
	(iv) Earthworks	A buffer of 500 m either side of the Carmichael River will be maintained in the Project. The only direct impact in this corridor will be construction of a haul road corridor across the Carmichael River, described in Section 6.4. Clearing of 5.47 ha Waxy Cabbage Palm habitat and the removal of five individuals for the construction of the haul road across the Carmichael River as the only direct impact of the project. This is described in Section 7.4. The Project area is over more than 8km to the east of Doongmabulla Springs and 3km to the north of Mellaluka Springs, and there will be no direct incursion from Project vehicles or personnel beyond monitoring required as part of this plan. There will be no direct impact from earthworks on these Springs-complexes and potential impacts from light, dust and noise are described separately (Section 8.5 and Section 9.6).	Section 6.4 and Section 7.4 Section 8.5 and Section 9.6
	(v) Noise and vibration	A description of anticipated noise and vibration impacts on the values of the Carmichael River, is provided in Section 6.4. Noise and vibration is not a perceivable impact on the Waxy Cabbage Palm. No impacts from noise and vibration are predicted in the vicinity of the Doongmabulla Springs or Mellaluka Springs-complexes, due to the distance from the Project area (Section 8.5 and Section 9.6).	Section 6.4 Section 8.5 and Section 9.6
	(vi) Emissions (including dust)	Details of impacts from emissions (including dust), specific to each GDE are described in Section 6.4 Carmichael River, Section 7.4 Waxy Cabbage Palm, Section 8.5 Doongmabulla Springs-complex and Section 9.6 Mellaluka Springs-complex.	Sections 6.4, 7.4, 8.5 and 9.6
	(vii) Light spill and other visual impacts	A description of anticipated light spill impacts on the values of the Carmichael River, is provided in Section 6.4. Light spill and visual impacts are not a perceivable impact on the Waxy Cabbage Palm. No impacts from light spill or other visual impacts are predicted in the vicinity of the Doongmabulla Springs or Mellaluka Springs-complexes, due to the distance from the Project area (Section 8.5 and Section 9.6).	Section 6.4 Section 8.5 and Section 9.6
	(viii) Stream diversion and flood levees	Impacts on the Carmichael River from flood levees, and changes in hydrology, are described in Section 6.4. Changes to the hydrology of the Project Area, during the construction and operational project phases, were identified in the EIS as an indirect impact on Waxy Cabbage Palm habitat and the Carmichael River. Changes to hydrology indirectly impacting Waxy Cabbage Palm and the Carmichael River may include potential stream diversions, flood levees and contamination of surface waters (Section 7.4). These activities are likely to commence from construction, in Year 1. There is no predicted significant impact to Doongmabulla Springs associated with the changes to the flooding conditions associated with the construction of levees on either side of the Carmichael River (Section 8.5). Mellaluka Springs-complex does not contribute surface water to any nearby waterways, being located near the margin of extensive clay plains to the south west, sand plains to the north west, and a large alluvial plain to the east associated with the Belyando River, which is approximately 9 km away (Section 9.6).	Section 6.4 and Section 7.4 Section 8.5 and Section 9.6
	(ix) Weeds and pests	Details of impacts from weeds and pests, specific to each GDE are described in Section 6.4 Carmichael River, Section 7.4 Waxy Cabbage Palm, Section 8.5 Doongmabulla Springs-complex and Section 9.6 Mellaluka Springs-complex. Doongmabulla Springs and Mellaluka Springs are located on land not owned by Adani, and the only Project activities will be visits to conduct monitoring associated with this GDEMP.	Sections 6.4, 7.4, 8.5 and 9.6

Approval & condition number	Description of Condition or Commitment	How Addressed	Section of GDE Management Plan
	d) Measures that will be undertaken to mitigate and manage impacts on Matters of National Environmental Significance resulting from mining operations. These measures must include but not be limited to:	A description of measures that will be undertaken to mitigate and manage impacts on the GDEs resulting from mining operations is provided in relevant subsections in Sections 6-9. Specific cross-references are provided in sub-sections below.	Sections 6 to 9
	(i) The use of fauna spotters prior to and during all vegetation clearing activities to ensure impacts on Matters of National Environmental Significance are minimised	Fauna spotters will be used prior to and during all vegetation clearing activities to ensure impacts on Matters of National Environmental Significance are minimised. Vegetation clearing is proposed for 5.7 ha of Waxy Cabbage Palm habitat in the Carmichael River, required for the haul road corridor across the Carmichael River. No vegetation clearing is proposed for the Doongmabulla Springs-complex or Mellaluka Springs-complex.	Sections 6.9 and 7.9
	(ii) Measures to avoid impacts on Matters of National Environmental Significance and their habitat located in the Project Area, but outside areas to be cleared, constructed upon and / or undermined, including adjacent to cleared areas	Management actions to avoid impacts on MNES outside of the Project footprint, are contained in Section 6.9 Carmichael River, Section 7.9 Waxy Cabbage Palm, Section 8.10 Doongmabulla Springs-complex and Section 9.9 Mellaluka Springs-complex. These include indirect impacts such as weeds and pests, changes in hydrology, impacts from groundwater drawdown and emissions. Doongmabulla Springs and Mellaluka Springs are located on land not owned by Adani, and the only Project activities will be visits to conduct monitoring associated with this GDEMP.	Sections 6.9, 7.9, 8.10 and 9.9
	(iii) Measures to rehabilitate all areas of Matters of National Environmental Significance habitat	Rehabilitation activities associated with the Project at the Carmichael River and for the Waxy Cabbage Palm arediscussed in Table 6-10 and Table 7-6. Doongmabulla Springs and Mellaluka Springs are located on land not owned by Adani, and the only Project activities will be visits to conduct monitoring associated with this GDEMP. No rehabilitation is required in these GDEs.	Table 6-10 and Table 7-6.
	(iv) Habitat management measures including but not limited to management of subsidence and groundwater impacts of the project	Management actions to avoid impacts on MNES outside of the Project footprint, are contained in Section 6.9 Carmichael River, Section 7.9 Waxy Cabbage Palm, Section 8.10 Doongmabulla Springs-complex and Section 9.9 Mellaluka Springs-complex. These include indirect impacts such as weeds and pests, changes in hydrology, impacts from groundwater drawdown and emissions. No subsidence is predicted to occur in the vicinity of the Doongmabulla Springs or Mellaluka Springs-complexes (Section 8.5 and Section 9.6). Details of groundwater drawdown as a result of mine dewatering, specific to each GDE are described in Section 6.4 Carmichael River, Section 7.4 Waxy Cabbage Palm, Section 8.5 Doongmabulla Springs-complex and Section 9.6 Mellaluka Springs-complex.	Sections 6.9, 7.9, 8.10 and 9.9 Sections 6.4, 7.4, 8.5 and 9.6
	e) Goals for habitat management for each relevant Matters of National Environmental Significance	Management objectives, performance criteria and triggers for corrective actions are contained in Section 6.9 Carmichael River, Section 7.9 Waxy Cabbage Palm, Section 8.10 Doongmabulla Springs-complex and Section 9.9 Mellaluka Springs-complex. Initial ecological trigger levels are described in Section 5.3. Management actions to achieve these outcomes are also described in these sections.	Sections 6.9, 7.9, 8.10 and 9.9
	f) A table of specific criteria for assessing the success of management measures against goals, and triggers for implementing corrective measures if criteria are not met within specified timeframes. This table must include but not be limited to measures relating to subsidence and groundwater impacts, including early warning triggers for impacts on groundwater at the Doongmabulla Springs Complex and the Carmichael River. Goals and triggers must be based on the baseline condition of the relevant Matters of National Environmental Significance as determined through baseline monitoring (see Conditions 3b) and 6b)). Corrective measures must include provision of offsets where it is determined that corrective management measures have not achieved goals within specified timeframes (see Conditions 11m) and 11o)).	Initial trigger levels are described in Section 5.3, and a summary of corrective actions provided in Section 5.6. A summary of existing baseline monitoring is provided in Section 6.3 Carmichael River, Section 7.3 Waxy Cabbage Palm, Section 8.4 Doongmabulla Springs-complex and Section 9.5 Mellaluka Springs-complex. This baseline monitoring has informed management objectives, performance criteria and triggers for corrective actions, which are contained in Section 6.9 Carmichael River, Section 7.9 Waxy Cabbage Palm, Section 8.10 Doongmabulla Springs-complex and Section 9.9 Mellaluka Springs-complex. Offset requirements will be reassessed and additional offsets delivered, in the event that groundwater fluctuations exceed the defined GDE groundwater drawdown trigger levels in the project's draft EA and the trigger exceedance is determined to be the result of mining activities and impacts on GDE cannot be feasibly mitigated. This will be subject to approval from government agencies.	Section 5.3 and 5.6 Sections 6.3, 7.3, 8.4 and 9.5 Sections 6.9, 7.9, 8.10 and 9.9

Approval & condition number	Description of Condition or Commitment	How Addressed	Section of GDE Management Plan
	g) An ongoing monitoring program to determine the success of mitigation and management measures against the stated criteria in Condition 6f), including monitoring locations, parameters and timing. Monitoring for water resource Matters of National Environmental Significance must include hydrogeological, hydrological and ecological parameters.	A summary of the monitoring approach is provided in Section 5.5, with Investigations and Corrective Actions described in Section 5.6. Details of the ongoing monitoring program specific to each GDE is provided in Section 6.6 and 6.7 Carmichael River, Section 7.6 Waxy Cabbage Palm, Section 8.7 Doongmabulla Springs-complex and Section 9.8 Mellaluka Springs-complex. Monitoring is described in terms of pre-impact and impact monitoring, and includes hydrogeological, hydrological and ecological parameters. A summary of existing baseline monitoring is provided in Section 6.3 Carmichael River, Section 7.3 Waxy Cabbage Palm, Section 8.4 Doongmabulla Springs-complex and Section 9.5 Mellaluka Springs-complex.	Section 5.5 Sections 6.6 and 6.7, 7.6, 8.7 and 9.8 Sections 6.3, 7.3, 8.4 and 9.5
	h) Details of how compliance will be reported	Annual and compliance monitoring is described in Section 10.3 of the GDEMP, including periodic reporting and audits to monitor compliance with management plan requirements. Reporting and monitoring of related plans is described in Section 10.4.	Section 10.3 and 10.4
	i) Details of how the MNESMP will be updated to incorporate and address outcomes from research undertaken for Matters of National Environmental Significance under this and any state approvals, including updating of goals, criteria and triggers (as required under Conditions 3c), 3d) 6e) and 6f)).	The relationship between the GDEMP and other management plans and programs is described in Section 1.3, and the relationship with research programs and guidelines is set out in Section 1.4. Adani is required to develop and implement a number of other management plans to address the full requirements of approval conditions under both Commonwealth and Queensland legislation. There will be some interaction among the plans during all phases of the Project, with respect to key linkages across research program outcomes, modelling updates and management plan review, update and reporting. An adaptive management approach will be taken and revisions to the GDEMP. Adaptive management is summarised in each GDE chapter (Section 6.8 Carmichael River, Section 7.8 Waxy Cabbage Palm, Section 8.6.1 Doongmabulla Springs-complex and Section 9.7.1 Mellaluka Springs-complex). Requirements for updating the GDEMP are summarised in Section 10.1, including scheduled updates and triggers for additional unscheduled updates. Annual and compliance reporting is set out in Section 10.3. Triggers will be updated where appropriate at the completion of pre-impact studies and monitoring and where relevant updates are made to the GMMP (Section 5.3). A revision of triggers will also occur where information from related management and research plans (as described in Section 10.4) informs this GDEMP.	Section 1.3 and 1.4, Section 5.3 Sections 6.8, 7.8, 8.6.1 and 9.7.1 Section 10.1 to 10.4
	j) Provisions to ensure that suitably qualified and experienced persons are responsible for undertaking monitoring, review and implementation of the MNESMP	Persons implementing key tasks described in this GDEMP will have appropriate skills and qualifications. Section 10.5 of the GDEMP outlines the qualifications of persons responsible for monitoring, reviewing and implementing the plan.	Section 10.5
	k) In the event that the future baseline research required by the Queensland Coordinator-General (Appendix 1, Section 3, Condition 1 of the Coordinator-General's Assessment Report) identifies that the Mellaluka Springs Complex provides high value habitat for the Black-throated finch, the approval holder must include management measures to address impacts resulting from drawdown at the Mellaluka Springs Complex in the MNESMP	Studies have determined that the Mellaluka Springs-complex does not provide BTF habitat. A letter from the Office of the Coordinator-General, dated 22 July 2016, has been received confirming the Commonwealth and Queensland government's acceptance of this finding.	Not applicable
	l) Details of how, where habitat for an EPBC Act listed threatened species or community not previously identified and reported to the Department is found in the Project Area, the approval holder will notify the Department in writing within five business days of finding this habitat, and within 20 business days of finding this habitat will outline in writing how the conditions of this approval will still be met (refer Condition 11j)).	This condition is addressed in the approved threatened species management plan for the Carmichael Mine. Section 5.1 of that plan says "In the event that new species or Threatened Ecological Communities are found, then DoEE and/or DES will be notified within five business days and Adani will outline how the conditions of this approval will still be met within 20 business days". This statement is also included in Section 10.1 of this GDEMP.	Sections 6 to 9
EPBC Act Approval, condition 7	Mining operations must not commence until the required MNESMP have been approved by the Minister in writing. The approved plan/s must be implemented. Note – Management plans such as the Black-throated Finch Management Plan and the Groundwater Dependent Ecosystems Management Plan may also be required under state approvals. Wherever possible a combined document should be prepared to address both state government and EPBC Act approval conditions. Note – Impacts of the action other than mining operations will be offset as required in accordance with Conditions 8 to 11, but will be otherwise managed in accordance with state approvals – this is of particular relevance when impacts may occur prior to approval of the MNESMP.	Mining operations will not commence until this plan has been approved. This plan addresses the combined requirements of the Commonwealth and Queensland governments in one document, as encouraged by the condition.	Section 3.2

Approval & condition number	Description of Condition or Commitment	How Addressed	Section of GDE Management Plan
EPBC Act Approval, condition 9	To compensate for authorised unavoidable impacts on Matters of National Environmental Significance, the approval holder must submit a Biodiversity Offset Strategy (BOS) and a GAB Offset Strategy to the Minister for approval at least three months prior to the commencement of mining operations.	A Biodiversity Offset Strategy (BOS) has been developed separately, and submitted for the Project. The strategy was approved in October 2016. This GDEMP is consistent with the BOS. The relationship between the GDEMP and the BOS is described in Section 1.3 and Section 10.4, as well as relationships to the Great Artesian Basin (GAB) Offset Strategy and Offset Area Management Plans (OAMPs).	Section 1.3 and Section 10.4.
EPBC Act Approval, condition 10	Offsets for authorised unavoidable impacts (defined in Table 1), and water resource impacts must be managed in accordance with the BOS and the GAB Offset Strategy.	As part of the review of the BOS, offset requirements will be reassessed and additional offsets delivered, including in the event that groundwater fluctuations exceed the defined GDE groundwater drawdown trigger levels in the project's draft EA and the trigger exceedance is determined to be the result of mining activities and impacts on GDE cannot be feasibly mitigated. The OAMP includes management of GDE offset areas. The OAMP will be updated to incorporate additional information obtained through research programs or plans (such as this GDEMP), as the results become available.	Section 1.3 and Section 10.4.
Environmental Authority, condition A5	Except where specified otherwise in another condition of this environmental authority, all monitoring records or reports required by this environmental authority must be kept for a period of not less than 5 years.	Monitoring results and reports will be kept for the life of the project in accordance with Condition 30 of the EPBC Act approval.	Section 10.3
Environmental Authority, condition H5	Self-sustaining vegetation and native ecosystem, as per Table H1 – Rehabilitation Acceptance Criteria (Appendix 2), must be consistent with the reference sites identified in Table H2 – Reference Sites and Figure H5: Reference Sites.	Rehabilitation activities associated with the Project at the Carmichael River and for Waxy Cabbage Palm are discussed in Table 6-10 and Table 7-6. Doongmabulla Springs and Mellaluka Springs are located on land not owned by Adani, and the only Project activities will be visits to conduct monitoring associated with this GDEMP. No rehabilitation is required in these GDEs. Any rehabilitation that takes place will be consistent with the Project Rehabilitation Plan.	Table 6-10 and Table 7-6.
Environmental Authority, condition I11	The proponent must develop and implement a Groundwater Dependent Ecosystems Management Plan (GDEMP) to detail the management of threats to defined environmental values and to report results and corrective actions for each GDE over the full period of mining activities and for a period of five years post mining rehabilitation.	This GDEMP was lodged on 7 November 2016. Mining operations will not commence until this plan has been approved. This management plan in whole addresses the requirement of this condition. This plan addresses the management of direct and indirect impacts of mining construction and operations on GDEs. Management of impacts from mining construction and operations are contained in Table 6-9 Carmichael River, Table 7-6 Waxy Cabbage Palm, Table 8-10 Doongmabulla Springs-complex and Table 9-4 Mellaluka Springs-complex.	Section 3.2 Tables 6-9, 7-6, 8-10 and 9-4
Environmental Authority, condition I12	This GDEMP must be approved by the administering authority in writing and this GDEMP published on a website before the commencement of Project Stage 2.	This GDEMP was lodged on 7 November 2016. Mining operations will not commence until this plan has been approved. This management plan in whole addresses the requirement of this condition. This GDEMP will be available to all employees, contractors and subcontractor and will be published on Adani's website. Adani will amend the GDEMP as necessary in response to regular reviews, monitoring results and changes in legislation, in consultation with regulatory authorities. Any changes to the GDEMP will be updated on Adani's website within 30 business days.	Section 10.3
Environmental Authority, condition I13	For the purposes of conditions I11 and I12, the GDEs include the affected Carmichael River riparian zone (ecosystems associated with the Carmichael River between Doongmabulla Springs and the Belyando River, including populations of Waxy Cabbage Palm), the Lignum, Stories and Mellaluka springs and the Doongmabulla Springs-complex.	This GDEMP as a whole addresses the requirement of this condition.	Sections 6 to 9
Environmental Authority, condition I14	A report of the findings of this GDEMP, including all monitoring results and interpretations, must be prepared annually and made available on request to the administering authority. The report must include:	Annual and compliance reporting is summarised in Section 10.3. An annual report of the findings of this GDEMP, including all monitoring results and interpretations as well as a summary of the activities implemented in the previous 12 months, will be prepared and made available on request to the administering authority.	Section 10.3
	a) An assessment of background reference groundwater levels (see condition E9).	A summary of the content of the report (including this sub-condition) is provided in Section 10.3.	Section 10.3
	b) The condition of each GDE compared with previous monitoring results.	A summary of the content of the report (including this sub-condition) is provided in Section 10.3.	Section 10.3
	c) The suitability of current groundwater trigger thresholds (as defined in condition E13).	A summary of the content of the report (including this sub-condition) is provided in Section 10.3.	Section 10.3
	d) Detail on the effectiveness of avoidance, mitigation and management actions in curtailing adverse impacts on GDE ecosystems.	A summary of the content of the report (including this sub-condition) is provided in Section 10.3.	Section 10.3
	e) A description of any adaptive management initiatives implemented.	A summary of the content of the report (including this sub-condition) is provided in Section 10.3.	Section 10.3
	f) Any offsets required for residual impacts.	A summary of the content of the report (including this sub-condition) is provided in Section 10.3.	Section 10.3

Approval & condition number	Description of Condition or Commitment	How Addressed	Section of GDE Management Plan
Environmental Authority, Appendix 1 Definitions	A GDEMP is a plan developed by a suitably qualified and experienced person that is consistent with any Bioregional Management Plan for the bioregion, the Water Resource (Great Artesian Basin) Plan and relevant threat abatement plans, conservation advice and project species management plans. The plan must include:	The GDEMP has been developed by a team of experienced scientists who are suitably qualified in the fields of terrestrial ecology, aquatic ecology and the management of groundwater dependent ecosystems. The authors have extensive tertiary qualifications relevant to the field, and decades of experience. Further details of the qualifications and experience of the authors, including CVs, can be provided to DoEE and DES upon request. Persons implementing key tasks described in this GDEMP will have appropriate skills and qualifications. Section 10.5 of the GDEMP outlines the qualifications of persons responsible for monitoring, reviewing and implementing the plan. There are numerous guideline documents that have informed the preparation of this GDEMP. These include relevant recovery plans, research findings and monitoring methodology for springs, and national water quality guidelines. These are summarised in Section 1.4.	Plan as a whole
	1) A description and map of each GDE potentially or indirectly impacted by mining activities	A description of environmental values for the listed GDEs is provided in Section 6.1 Carmichael River, Section 7.1 Waxy Cabbage Palm, Section 8.2 Doongmabulla Springs-complex and Section 9.2 Mellaluka Springs-complex. Maps of each GDE are provided in these sections.	Sections 6.1, 7.1, 8.2 and 9.2
	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	Pre-impact monitoring including photo monitoring and satellite imagery (e.g. QuickBird) will be carried out on each GDE (Section 6.6 Carmichael River, Section 7.6 Waxy Cabbage Palm, Section 8.7.1 Doongmabulla Springs-complex and Section 9.8.1 Mellaluka Springs-complex).	Sections 6.6, 7.1, 8.7.1 and 9.8.1
	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.	A description of environmental values for the listed GDEs, including existing baseline data, is provided in Section 6.1 Carmichael River, Section 7.1 Waxy Cabbage Palm, Section 8.2 Doongmabulla Springs-complex and Section 9.2 Mellaluka Springs-complex. Pre-impact surveys will supplement the existing baseline data and follow this methodology. This methodology is only applicable to the Doongmabulla and Mellaluka Springs-complexes.	Sections 6.1, 7.1, 8.2 and 9.2
	b) the source aquifer(s) for the groundwater supply to the GDE.	Details of the source aquifers are described in Section 8.3 Doongmabulla Springs-complex and Section 9.4 Mellaluka Springs-complex. Adani will further investigate the source aquifer for Mellaluka Springs-complex (Section 9.7), and will undertake additional studies that inform the conceptual model relating to the source aquifer of the Doongmabulla Springs-complex (Section 8.10).	Sections 8.3 and 9.4 Section 8.10 and Section 9.7
	c) the natural variation of the groundwater level/pressure.	The Groundwater Monitoring Program (undertaken separately to the GDEMP but informing the studies) is summarised in Sections 6.6 and 6.7 Carmichael River, Section 7.6 Waxy Cabbage Palm, Sections 8.3 and 8.7 Doongmabulla Springs-complex and Sections 9.4 and 9.6 Mellaluka Springs-complex. Triggers include thresholds related to groundwater, wetland area, vegetation composition, weed cover and water quality. Initial trigger levels (described in Section 5.3) will be reviewed at the completion of pre-impact surveys, based on an improved understanding of natural variation in the GDE attributes and the aquifer water levels.	Sections 6.6 and 6.7, 7.6, 8.3 and 8.7 and 9.4 and 9.6
	d) GDE ecosystem pressure response to groundwater level/pressure fluctuation.	The Groundwater Monitoring Program (undertaken separately to the GDEMP but informing the studies) is summarised in Sections 6.6 and 6.7 Carmichael River, Section 7.6 Waxy Cabbage Palm, Sections 8.3 and 8.7 Doongmabulla Springs-complex and Sections 9.4 and 9.6 Mellaluka Springs-complex. An adaptive management approach will be adopted to ensure impacts are within the approved limits, linking GDE values with the underpinning groundwater model and assessing interactions with groundwater, responses to changes and natural variations for GDEs in the Project area.	Sections 6.6 and 6.7, 7.6, 8.3 and 8.7 and 9.4 and 9.6
	4) A description of how the results of baseline research and annual monitoring are to be used to determine any changes in GDE ecology attributable to mining activities.	A summary of the monitoring approach is provided in Section 5.5, with Investigations and Corrective Actions described in Section 5.6. In each GDE subsection, the monitoring program specific to each GDE is described, including performance criteria and triggers for corrective actions (Section 6.7 Carmichael River, Section 7.6 Waxy Cabbage Palm, Section 8.7 Doongmabulla Springs-complex and Section 9.8 Mellaluka Springs-complex).	Sections 6.7, 7.7, 8.8 and 9.9
	5) A 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.	Potential impacts (with summary tables indicating Project stages) are provided in Section 6.4 Carmichael River, Section 7.4 Waxy Cabbage Palm, Section 8.5 Doongmabulla Springs-complex and Section 9.6 Mellaluka Springs-complex. Direct and indirect project impacts outlined in the EIS (GHD 2012a; Adani 2012) Carmichael Coal Mine and Rail Project – Groundwater Dependent Ecosystems Management Plan (11 February 2014), as well as matters outlined in EPBC approval or Environmental Authority conditions have details for impacts and threats included in this plan.	Sections 6.4, 7.4, 8.5 and 9.6
	6) Mitigation measures to be undertaken to avoid, mitigate, offset and manage impacts to GDE environmental values resulting from each stage of the project.	A description of measures that will be undertaken to mitigate and manage impacts on the GDEs resulting from mining operations is provided in relevant subsections in Sections 6-9.	Sections 6-9

Approval & condition number	Description of Condition or Commitment	How Addressed	Section of GDE Management Plan
Adani Commitment, M4.23	Impacts to the waxy cabbage palm will be managed and mitigated through:	-	-
	a) The supplementary introduction of surface water to the channel near the upstream Mine Area boundary through controlled discharges.	Corrective actions (if changes in Waxy Cabbage Palm habitat occur from groundwater drawdown impacts) will be implemented, which will include possible supplementary introduction of surface water near the upstream mine area boundary through controlled discharges.	Section 7.9
	b) Intensive monitoring of riparian condition, base flows and groundwater levels.	Surface Water Monitoring at the Carmichael River will be carried out monthly, in accordance with the Receiving Environment Management Plan. Flow data will be monitored daily and reported monthly prior to construction, during operation and post operation (Section 7.6.1). Riparian community health surveys will commence prior to any predicted impact. Permanent CORVEG survey sites will be located at regular intervals along the Carmichael River. A riparian community health survey will be carried out biannually (wet and dry season), for two years, and then the frequency will be reviewed (Section 7.6.1).	Section 7.6.1
	c) Removal of weeds and pest animals.	Weed and pest surveys will be undertaken yearly along the Carmichael River to identify the extent of weeds, especially Rubber Vine, identify areas of Waxy Cabbage Palm habitat subject to pig damage and identify areas for weed and pest management activities in accordance with the Pest Management Plan (Section 7.6). Doongmabulla Springs and Mellaluka Springs are located on land not owned by Adani, and the only Project activities will be visits to conduct monitoring associated with this GDEMP. Weed hygiene controls, including the use of weed wash down stations, will be implemented in accordance with the PMP to prevent the introduction and spread of declared pest plants and other invasive weeds.	Section 7.6
	d) Possible translocation of individual plants (if deemed viable), seed collection and planting programs.	Corrective actions (if changes in Waxy Cabbage Palm habitat occur from groundwater drawdown impacts) will be implemented, which will include possible translocation of plants and/or seed collection and planting programs.	Section 7.9
	e) Research and monitoring to understand distributional range, water dependency requirements and threatening process triggers.	Waxy Cabbage Palm condition surveys will be carried out in pre-impact monitoring. Additionally an Environmental Water Requirement Assessment will be undertaken which will review the requirements of the species, particularly relating to water use.	Section 7.6
Adani Commitment, M4.24	Flow and groundwater level monitoring, mapping and measurements of the perimeter of the main wetland areas and selected isolated mound springs to monitor changes to the springs.	Hydrological, hydrogeological and ecological monitoring of GDEs is provided in Sections 6-9.	Sections 6-9
Adani Commitment, M4.25	Ecological studies of aquatic invertebrates, blue devil, salt pipewort and stygofauna will be conducted in the springs with associated reporting of results.	Ecological studies of Doongmabulla Springs is provided in Section 8.7, and of Mellaluka Springs in Section 9.8. These sections address relevant environmental values stated in the commitment associated with these GDEs.	Section 8.7 and Section 9.8
Adani Commitment, M4.26	Pumping groundwater to the surface may act to offset the loss of some sections of the Mellaluka Spring wetland, and the proponent will install electric submersible pumps when drawdown commences for this purpose. Additional detail will be presented in the Draft GDE Management Plan.	Adani will prepare a Wetland Remediation and Management Plan in consultation with the Mellaluka landholder. This plan will include pumping groundwater to the surface to compensate for the loss of some sections of the Mellaluka Spring wetland. Adani will install electric submersible pumps for this purpose when drawdown commences. This will ensure the continuation of water to the Mellaluka Spring wetlands (and homestead).	Section 9.9
Adani Commitment, M4.27	Adani will provide a Draft Groundwater Dependant Ecosystem (GDE) Management Plan for approval prior to the commencement of construction. This plan will address impacts to the following GDE"s: • Doongmabulla Springs-complex • Mellaluka Springs-complex • Carmichael River, particularly the Waxy Cabbage Palm The Plan will include the following:	This GDEMP was lodged on 7 November 2016. This plan addresses the management of direct impacts of mining construction and operations on GDEs. Management of direct impacts from mining construction and operations are contained in Table 6-9 Carmichael River, Table 7-6 Waxy Cabbage Palm, Table 8-10 Doongmabulla Springs-complex and Table 9-4 Mellaluka Springs-complex. Direct impacts have largely been avoided through project design (e.g. buffer along the Carmichael River), however construction of a bridge over the Carmichael River will require clearing of some riparian habitat, including five Waxy Cabbage Palm individuals. This plan also addresses the management of indirect impacts of mining construction and operations on GDEs. Specifically management actions of indirect impacts are located in Table 6-9 Carmichael River, Table 7-6 Waxy Cabbage Palm, Table 8-10 Doongmabulla Springs-complex and Table 9-4 Mellaluka Springs-complex. Indirect impacts predominantly relate to the potential for groundwater drawdown.	Sections 6 to 9 (Tables 6-9, 7-6, 8-10 and 9-4)
	a) A management framework that aligns with the other project management plans.	The GDEMP is consistent with other management plans prepared for the Project. Linkages to other management plans, particularly the GMMP which informs this GDEMP, is provided in Section 1.3.	Section 1.3
	b) Clear statements regarding the intent, approval requirements, objectives and actions.	Management objectives, performance criteria, management measures and triggers for corrective actions are contained in Section 6.9 Carmichael River, Section 7.9 Waxy Cabbage Palm, Section 8.10 Doongmabulla Springs-complex and Section 9.9 Mellaluka Springs-complex. Approval requirements are addressed in Appendix D.	Sections 6.9, 7.9, 8.10 and 9.9 Appendix D

Approval & condition number	Description of Condition or Commitment	How Addressed	Section of GDE Management Plan
	c) Details of how the management plan will be applied across the project phases – pre construction / construction / operation / post operations, offset areas.	Potential impacts to GDEs have been described by Project phase (Section 6.4 Carmichael River, Section 7.4 Waxy Cabbage Palm, Section 8.5 Doongmabulla Springs-complex and Section 9.6 Mellaluka Springs-complex). The subsequent sections identifying management actions and monitoring programs specify timing of monitoring and management actions being carried out, by pre-impact and impact phases. Section 2.2 describes the relationship between project phases (including the corresponding GDE toolbox stage) and implementation.	Section 2.2 Sections 6.4, 7.4, 8.5 and 9.6
	d) Details of any proposed adaptive monitoring program to support the plan objectives.	Details of adaptive management are provided in each GDE chapter (Section 6.8 Carmichael River, Section 7.8 Waxy Cabbage Palm, Section 8.6.1 Doongmabulla Springs-complex and Section 9.7.1 Mellaluka Springs-complex).	Sections 6.8, 7.8, 8.6.1 and 9.7.1
	e) Details of how experts will be used in a review capacity to inform ongoing monitoring and management.	This management plan will be reviewed within two years of commencement of mining and from there on every five years. The plan will be amended as required, and in response to new information. Persons implementing key tasks described in this GDEMP will have appropriate skills and qualifications.	Section 10.1, Section 10.5
	f) Incorporates all proposed management and mitigation measures, including reference to relevant State and Federal Guidelines of relevance to these GDE"s.	Management objectives, performance criteria, management measures and triggers for corrective actions are contained in Section 6.9 Carmichael River, Section 7.9 Waxy Cabbage Palm, Section 8.10 Doongmabulla Springs-complex and Section 9.9 Mellaluka Springs-complex. There are numerous guideline documents that have informed the preparation of this GDEMP. These include relevant recovery plans, research findings and monitoring methodology for springs, and national water quality guidelines. These are summarised in Section 1.4.	Sections 6.9, 7.9, 8.10 and 9.9
	g) Specific performance targets and how these will be measured and reported.	Management objectives, performance criteria, management measures and triggers for corrective actions are contained in Section 6.9 Carmichael River, Section 7.9 Waxy Cabbage Palm, Section 8.10 Doongmabulla Springs-complex and Section 9.9 Mellaluka Springs-complex.	Sections 6.9, 7.9, 8.10 and 9.9

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FOI 190417
Document 16

From: EA.DeanKnudson
To: s22
Cc: s22
Subject: RE: Meeting Tuesday [SEC=OFFICIAL]
Date: Friday, 12 April 2019 2:30:33 PM
Attachments: image001.jpg

All done.

From: s22
Sent: Friday, 12 April 2019 12:11 PM
To: EA.DeanKnudson
Cc: s22
Subject: Meeting Tuesday [SEC=OFFICIAL]

Hi s22

Can you please send a meeting invite from Dean's diary?

Time: Tuesday 16 April from 8:30am to 11:30am

Subject: Technical discussion on Adani groundwater plans

Venue: Room 5017, 51 Allara Street, Canberra (call x. 9726 from foyer)

Attendees:

Department – Greg Manning, s22

DES – s22

Geoscience Australia – James Johnson, Richard Blewett, s22

CSIRO – Jane Coram, Warwick McDonald, s22

Noting that as discussed, we think James/Jane will forward onto technical staff to attend

Let me know if you have any questions

-s22

[redacted]

Acting Director | Post Approvals Strategies
Environment Standards Division
Department of the Environment and Energy
T 02 s22 @environment.gov.au

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FOI 190417
Document 17

From: Coram, Jane (L&W, Black Mountain)
To: s22 ; Mayfield, Peter (Executive, Newcastle)
Cc: s22 (CorpAffairs, Dutton Park); s22 (SI&P, North Ryde); Dean Knudson; s22 "james.johnson@ga.gov.au"
Subject: RE: Previous Geoscience Australia advice on Adani [SEC=OFFICIAL]
Date: Wednesday, 10 April 2019 12:06:59 PM
Attachments: image001.jpg

Thanks very much, s22 much appreciated.
With regards, Jane.

From: s22 @environment.gov.au]
Sent: Wednesday, 10 April 2019 10:35 AM
To: Mayfield, Peter (Executive, Newcastle) ; Coram, Jane (L&W, Black Mountain)
Cc: s22 (CorpAffairs, Dutton Park) ; s22 SI&P, North Ryde) ; Dean Knudson ; s22 ; 'james.johnson@ga.gov.au'
Subject: FW: Previous Geoscience Australia advice on Adani [SEC=OFFICIAL]

Hi s22 and Jane,
I can confirm that CSIRO had not previously provided advice on the project.
For your visibility, GA's previous advice is attached.
Please let me know if you have any questions
s22

T 02 s22 @environment.gov.au
W www.environment.gov.au

From: s22
Sent: Wednesday, 10 April 2019 8:51 AM
To: 'james.johnson@ga.gov.au' <james.johnson@ga.gov.au>
Cc: 'Stuart Minchin' <stuart.minchin@ga.gov.au>; 'Blewett Richard' <Richard.Blewett@ga.gov.au>; s22 @environment.gov.au>; Gregory Manning <Gregory.Manning@environment.gov.au>; James Tregurtha <James.Tregurtha@environment.gov.au>; Dean Knudson <Dean.Knudson@environment.gov.au>
Subject: Previous Geoscience Australia advice on Adani [SEC=OFFICIAL]

Hi James,
As promised, GA's advice at the time of approval is attached, as are copies of your advices from 2017.
s22

T 02 s22 @environment.gov.au
W www.environment.gov.au

From: s22
Sent: Wednesday, 10 April 2019 8:42 AM
To: 'peter.mayfield@csiro.au' <peter.mayfield@csiro.au>; 'jane.coram@csiro.au' <jane.coram@csiro.au>; s22 @csiro.au' s22 @csiro.au>; 'james.johnson@ga.gov.au' <james.johnson@ga.gov.au>; s22 @csiro.au' s22 @csiro.au>
Cc: Dean Knudson <Dean.Knudson@environment.gov.au>; James Tregurtha <James.Tregurtha@environment.gov.au>; Gregory Manning <Gregory.Manning@environment.gov.au>; s22 @environment.gov.au>
Subject: Adani media release [SEC=OFFICIAL]

Hi everyone,
Thanks for the phone call yesterday.
A link to the Minister's media release is here: http://environment.gov.au/minister/price/media-releases/mr20190409.html
James, I will send you GA's comments on the project at the time of approval, plus initial comments

from 2017 shortly.

s22 [redacted]

Acting Director | Post Approvals Strategies
Environment Standards Division
Department of the Environment and Energy
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Reconciliation%20Email%20Footer

FOI 190417
Document 18

From: s22
To: s22
Cc: s22
Subject: RE: Review to commence [SEC=UNCLASSIFIED]
Date: Thursday, 24 January 2019 1:06:31 PM

Hi s22
Thank you for the update, we will begin our review today – I'll update our timelines and provide you a copy shortly. Could we our meeting on Tuesday next week? I'll coordinate a short meeting for the morning of Tuesday 29 January.
Thanks

s22

From: s22
Sent: Thursday, 24 January 2019 1:02 PM
To: s22
Cc: s22
Subject: Review to commence
Hi s22
Just confirming the Department requests GA and CSIRO commence review today of the GDEMP and GMMP submitted in the past couple of days.
We understand that the bore water level data QA has been completed and will proceed as such.
Given the time that has elapsed, it might be nice to have a re-inception meeting tomorrow (understand you are on a RDO) or early next week.
Let me know what time might suit or if you have any questions.

s22
Sent from my iPhone

On 23 Jan 2019, at 11:21 am, s22 @ga.gov.au> wrote:

> Hi s22 ,
> I'll grab a copy and ensure the rest of the team is made aware.
> We'll eagerly await the whistle blow to start.
> Thanks
> s22
>
> ---
>
> **From:** s22 @environment.gov.au>
> **Sent:** Wednesday, 23 January 2019 11:04 AM
> **To:** s22 @ga.gov.au>; s22 @csiro.au>
> **Subject:** RE: EPBC 2010/5736: condition 5 - Updated Groundwater Dependent Ecosystem Management Plan (groundwater data) [SEC=UNCLASSIFIED]
> **Importance:** High
> Hi s22 ,
> I have just uploaded Rev 5 of the GMMP to Govdex. I'm yet to receive confirmation from DNRME that all water level data has been verified, but understand that the GMMP has been updated with the revised water level data, as per the GDEMP earlier this week.
> When we receive confirmation, your review can formally start
> s22

s22
T 02 s22 @environment.gov.au
W www.environment.gov.au

From: s22
Sent: Monday, 21 January 2019 3:54 PM
To: s22 @ga.gov.au>
Subject: Re: EPBC 2010/5736: condition 5 - Updated Groundwater Dependent Ecosystem Management Plan (groundwater data) [SEC=UNCLASSIFIED]

It will be after 5 - is that ok?

Sent from my iPhone

On 21 Jan 2019, at 3:00 pm, s22 @ga.gov.au> wrote:

> Hi s22 ,
> That would be helpful if you could stop in at Symonston and I can get eyes on it immediately.
> Thanks
>
> s22
>
> **From:** s22 @environment.gov.au]
> **Sent:** Monday, 21 January 2019 2:01 PM
> **To:** s22
> **Cc:** s22 ; Gregory Manning
> **Subject:** FW: EPBC 2010/5736: condition 5 - Updated Groundwater Dependent Ecosystem Management Plan (groundwater data) [SEC=UNCLASSIFIED]
> **Importance:** High
>
> Hi s22 and s22 ,
> I have uploaded a revised GDEMP (v10a) onto Govdex, for your review. The word version with tracked changes is too big for the site – I am happy to drop a USB to Symonston this afternoon if it would help.
> I will let you know as soon as we get a revised GMMP including DNRME agreement to the revised water level data and Adani's 'materiality' test for model revisions.
> Please let me know there are any questions
> s22
>
> **T** 02 s22 @environment.gov.au
> **W** www.environment.gov.au
>
> **From:** s47F @adani.com.au]
> **Sent:** Monday, 21 January 2019 11:26 AM
> **To:** Gregory Manning <Gregory.Manning@environment.gov.au>
> **Cc:** s22 @environment.gov.au>; s22 environment.gov.au>; s22 @environment.gov.au>; s22 @environment.gov.au>; s22 @environment.gov.au>; Post Approval <PostApproval@environment.gov.au>; Hamish Manzi

<Hamish.Manzi@adani.com.au>
Subject: EPBC 2010/5736: condition 5 - Updated Groundwater Dependent Ecosystem Management Plan (groundwater data)
Importance: High
COMMERCIAL IN CONFIDENCE
Good morning Greg
The purpose of this email is to advise that I will shortly transmit a copy of the *Groundwater Dependent Ecosystem Management Plan (Carmichael Coal Mine Project)* with updated groundwater level and quality data.
For your information, following figures and tables have been updated:

Figures

- Figure 4-2: Hydrogeological conceptual model – pre-mining
- Figure 4-3: Hydrogeological conceptual model – mining & post-mining
- Figure 6-9 a-d Predicted Alluvial aquifer impacts associated with the Carmichael River
- Figure 7-6 a to d: Predicted drawdown to Alluvium aquifer over the life of the project
- Figure 8-10 Hydrogeological conceptual model – pre-mining
- Figure 8-11 Hydrogeological conceptual model – post-mining
- Figure 8-15a-e Groundwater impact contour maps for the Clematis aquifer
- Figure 9-8a-f Predicted groundwater draw down associated with the Mellaluka springs-complex

Tables

- Table 6-7 Groundwater Monitoring locations (from the GMMP), column titled “Monitoring Bores (depth in m)”, last two monitoring levels
- Table 8-1 Water level data; columns titled “Ground Surface Elevation (mAHD)” and “Water Level (mAHD)”
- Appendix B - Groundwater drawdown and quality triggers, and all groundwater quality tables, including new information at the start of each table.

I will also transmit a track changed version, highlighting the location of the changes.
Could the department please advise when the documents are successfully retrieved?
Regards
s47F

Manager, Approvals
Off +s47F @adani.com.au | www.adaniaustralia.com
Level 25, 10 Eagle Street, Brisbane, QLD 4000 | GPO Box 2569, Brisbane, QLD, 4001

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Geoscience Australia Disclaimer: This e-mail (and files transmitted with it) is intended only for the person or entity to which it is addressed. If you are not the intended recipient, then you have received this e-mail by mistake and any use, dissemination, forwarding, printing or copying of this e-mail and its file attachments is prohibited. The security of emails transmitted cannot be guaranteed; by forwarding or replying to this email, you acknowledge and accept these risks.

From: Coram, Jane (L&W, Black Mountain)
To: s22 [redacted]
Cc: McDonald, Warwick (L&W, Black Mountain); Gregory Manning; s22 [redacted]
Subject: Re: How advice has been addressed [SEC=OFFICIAL]
Date: Friday, 5 April 2019 3:25:18 PM
Attachments: image001.jpg

Thanks s22 [redacted] fo your prompt response.

With regards, Jane.

On 5 Apr 2019, at 3:23 pm, s22 [redacted] @environment.gov.au> wrote:

Hi Jane,
As discussed:

<!--[if !supportLists]-->• <!--[endif]-->The advice recommended monitoring the Dunda Beds and Rewan Formation for the additional nested bores, as a minimum. Adani commits to this, as well as investigating deeper bores into the Permian sediments as part of the research program.
<!--[if !supportLists]-->• <!--[endif]-->Rate limits will be applied to all bores
<!--[if !supportLists]-->• <!--[endif]-->The administering authority will be notified for groundwater quality and/or groundwater level exceedances

Thanks
s22 [redacted]

T 02 s22 [redacted] @environment.gov.au
W www.environment.gov.au

From: s22 [redacted]
Sent: Friday, 5 April 2019 12:25 PM
To: 'jane.coram@csiro.au' <jane.coram@csiro.au>; s22 [redacted] (L&W, Black Mountain)' s22 [redacted] @csiro.au>
Cc: Gregory Manning <Gregory.Manning@environment.gov.au>; s22 [redacted] @environment.gov.au>
Subject: How advice has been addressed [SEC=OFFICIAL]

Hi Jane,
As discussed.
Plans to follow
s22 [redacted]
Acting Director | Post Approvals Strategies
Environment Standards Division
Department of the Environment and Energy
T 02 s22 [redacted] environment.gov.au

FOI 190417
Document 20

From: s22
To: s22
Cc: s22
Subject: RE: HPE CM: Call about groundwater data [SEC=UNCLASSIFIED]
Date: Tuesday, 5 February 2019 3:28:31 PM
Attachments: image001.png
image003.png
image004.png
image005.png
image006.png
image007.jpg

Dear s22

Thank you for your consideration of Geoscience Australia to review the proponent responses and corrections to QLD DNRME comments on water level data for the Carmichael Coal Project. While GA has the capability to conduct the review, we have concerns about reviewing only a portion of the water level data on behalf of DoEE and that our review would be done in parallel with Queensland's own processes. After conferring with our higher delegations, GA recommends allowing the Queensland government to resolve internal processes to provide clarity and continuity to the current situation.

Kind regards

s22
[redacted]**, PhD |** A/g Director
Groundwater Advice and Data **|** Environmental Geoscience Division
t +61 2s22 **|** www.ga.gov.au

16-9481 GA Email Signature_social media-04

From: s22
Sent: Wednesday, 30 January 2019 11:02 AM
To: s22
Subject: HPE CM: Call about groundwater data [SEC=UNCLASSIFIED]
Importance: High

Hi s22 ,

We'd like you to let us know if GA/CSIRO has capacity to review Adani/AECOM's edits as a result of DNRME's comments on outstanding bore data from 11 Jan. We think this is for up to about 30 bores, in the deeper (non-Clematis / alluvial) units.

If you could provide an estimate of time/$ that would be involved today, that would be great.

Have you got any time for a quick chat after lunch?

Thanks

s22
[redacted]
Assistant Director | Post Approvals Strategies
Environment Standards Division
Department of the Environment and Energy
T 02 s22 @environment.gov.au

Reconciliation%20Email%20Footer

From: Coram, Jane (L&W, Black Mountain)
To: s22
Cc: s22 (L&W, Black Mountain)
Subject: Re: Letter to Dean [SEC=OFFICIAL]
Date: Friday, 5 April 2019 4:22:51 PM
Attachments: image001.jpg

Just adding them in now, s22 and then we'll send it over.

Thank you for all your help!

With regards, Jane.

On 5 Apr 2019, at 4:10 pm, s22 @environment.gov.au> wrote:

> Hi Jane,
> If the letter hasn't been sent yet, can I request that it also gets cc'd to Finn Pratt and Greg Manning?
> Thanks
> s22
>
> Acting Director | Post Approvals Strategies
> Environment Standards Division
> **Department of the Environment and Energy**
> **T** 02 s22 @environment.gov.au

FOI 190417
Document 22

From: s22
To: s22
Subject: RE: Meeting Friday [SEC=UNCLASSIFIED]
Date: Tuesday, 19 March 2019 5:10:59 PM
Attachments: image001.jpg

Hi s22
It was meant to be an RDO but… work.
We received a courtesy request from DoEE on an ACF FoI and are seeking clearances from our end.
I'd say we include s22 and s22, as well as s22 and s22, I am on leave from 1-28 April and s22 will be A/g SL while I am away.
The timing is good as my CEO is after some feedback and outcome from our advice.
The GA crew is free between 0930-1000 or 1100-1200 on Friday 22
Speak soon
s22

From: s22
Sent: Tuesday, 19 March 2019 5:03 PM
To: s22
Subject: Meeting Friday [SEC=UNCLASSIFIED]
Hi s22,
We'd like half an hour or so to discuss a couple of final things on Adani – FOI, comments on the GDEMP + invoices, our decision making. I hope it's not an RDO?
Also who in CSIRO should we include? Is s22 still in Russia?
Thanks
s22
[redacted]

Assistant Director | Post Approvals Strategies
Environment Standards Division
Department of the Environment and Energy
T 02 s22 @environment.gov.au

Reconciliation%20Email%20Footer

From: s22
To: s22
Subject: RE: Meeting tomorrow morning [SEC=UNCLASSIFIED]
Date: Monday, 15 April 2019 4:36:45 PM
Attachments: image001.png
image002.png
image003.png
image004.png
image005.png

Thanks s22 I guess you're away from your desk again now!! I'll be glued to my desk for a bit so any chance you can give me a really quick call? Just interested in your perspective of the meeting so I can tell my BH. At this stage GA is treating it as pretty high level, so if it's a technical meeting s22 and s22 might be doing a lot of talking on their own! Also not a great look for GA to turn up with 7 staff…..!

From: s22
Sent: Monday, 15 April 2019 3:44 PM
To: s22
Subject: RE: Meeting tomorrow morning [SEC=UNCLASSIFIED]
Hi s22
Don't let the senior people scare you! I'm very much hoping that you, s22 and s22 can all come and that we can actually have a useful discussion.
Give me a ring if you'd like to chat, I'm back at my desk now!
s22

T 02 s22 @environment.gov.au
W www.environment.gov.au

From: s22 @ga.gov.au]
Sent: Monday, 15 April 2019 1:38 PM
To: s22 @environment.gov.au>
Subject: Meeting tomorrow morning [SEC=UNCLASSIFIED]
Hi s22 ,
Sorry to bother you, I'm sure you're flat out! We're just trying to get a sense of whether our presence is needed beyond s22 tomorrow morning for the discussions with QLD DES and others. We understand that the CEO etc will be there, so the likelihood of technical discussion is probably low? s22 and I are able to attend if you think it would be worthwhile having us there, however it does look like a large meeting of fairly senior people.
Thanks for any advice!
s22
| Hydrogeologist
Groundwater Branch | Environmental Geoscience Division
t +61 2 s22 www.ga.gov.au
16-9481 GA Email Signature_social media-04

From:	s22
To:	s22
Subject:	RE: Costs for WL data assessment based on information provide to date [SEC=UNCLASSIFIED]
Date:	Friday, 1 February 2019 11:17:46 AM
Attachments:	image001.png image002.png image003.png image004.png image005.png

---

Completely understand. Greg is talking to Dean today, so I thought I'd check. Nothing is needed until next week.

s22

T 02 s22 @environment.gov.au

W www.environment.gov.au

From: s22

Sent: Friday, 1 February 2019 10:42 AM

To: s22

Subject: RE: Costs for WL data assessment based on information provide to date [SEC=UNCLASSIFIED]

Hi s22 ,

Happy Friday!

Have you had a chance to check further up the line? Give me a call if you're able.

Thanks

s22

T 02 s22 @environment.gov.au

W www.environment.gov.au

From: s22

Sent: Wednesday, 30 January 2019 3:59 PM

To: s22 @ga.gov.au>

Cc: s22 @ga.gov.au>; s22 @environment.gov.au>

Subject: RE: Costs for WL data assessment based on information provide to date [SEC=UNCLASSIFIED]

Hi s22

Thanks for the rough estimate at this stage, it will help us consider options. Look forward to hearing more about GA's views and capacity when you get the chance.

-s22

From: s22 @ga.gov.au]

Sent: Wednesday, 30 January 2019 2:40 PM

To: s22 @environment.gov.au>; s22 @environment.gov.au>

Cc: s22 @ga.gov.au>

Subject: Costs for WL data assessment based on information provide to date [SEC=UNCLASSIFIED]

Hi s22 and s22 ,

Time wise, I anticipate approximately 10 work days of effort plus a day or two of internal clearance as a ballpark.

That brings us to ~$20K based on the GA cost model – This will need to be refined once we have

more detailed specs on upon a formal request.
Conferring with my Branch Head, our preference would be for the QLD State to address this matter of QA/QC to inform the QLD single point of truth water level database, and we highly recommend QLD OGIA as suitable assessors.
I will need to test the appetite for the work at higher delegations given the potential issues and risks we have discussed, not to mention our current availability and need to redirect resources.
Thanks

s22
, PhD | A/g Director
Groundwater Advice and Data **|** Environmental Geoscience Division
t +61 2 s22 **|** www.ga.gov.au
16-9481 GA Email Signature_social media-04

FOI 190417
Document 25

From: s22
To: s22
Cc: s22 @csiro.au
Subject: RE: DoEE Request: GA/CSIRO Carmichael [SEC=UNCLASSIFIED]
Date: Monday, 21 January 2019 10:11:11 AM
Attachments: image001.png
image002.png
image003.png
image004.png
image005.png

Hi s22 ,

Hope you're well. Not much to report. I'm happy to have a chat. Whenever you're free, give me a call

s22

[redacted]

T 02 s22 @environment.gov.au

W www.environment.gov.au

From: s22 @ga.gov.au]
Sent: Monday, 21 January 2019 9:19 AM
To: s22
Cc: s22 @csiro.au
Subject: DoEE Request: GA/CSIRO Carmichael [SEC=UNCLASSIFIED]

Hi s22

Wondering if you had any news/information to impart following your meeting last week.

Thanks

s22

[redacted] **, PhD |** A/g Director
Groundwater Advice and Data **|** Environmental Geoscience Division
t +61 2 6249 9621 **|** www.ga.gov.au

16-9481 GA Email Signature_social media-04

FOI 190417
Document 26

From: s22
To: "Mayfield, Peter (Executive, Newcastle)"
Cc: Dean Knudson
Subject: RE: Draft response re Adani [SEC=OFFICIAL]
Date: Thursday, 11 April 2019 11:47:48 AM

Thanks very much s22

s22
T 02 s22 @environment.gov.au
W www.environment.gov.au

From: Mayfield, Peter (Executive, Newcastle) [mailto:Peter.Mayfield@csiro.au]
Sent: Thursday, 11 April 2019 11:02 AM
To: s22
Subject: Draft response re Adani

Hi s22

As mentioned on the call,,this is the draft response we will be using for the enquiry. I will be talking with Karen shortly. If you could also let Dean know.

Thx

Peter

Karen Middleton, The Saturday Paper - **Have all the conditions been met in Adani's proposal?**

RESPONSE

In late 2018 and early 2019 CSIRO and Geoscience Australia wrote two reports for the federal government on specific questions on groundwater monitoring, management and modelling planned by Adani Pty Ltd for its Carmichael mine proposal in central Queensland.

This advice was limited to answering discrete inquiries on whether elements of Adani's proposed plans would be adequate to protect environmental assets.

CSIRO identified inadequacies in the plans and was later asked to review Adani's response to the recommendations CSIRO made to address the issues we raised.

CSIRO found that the commitments made to revise the groundwater modelling plans should satisfy our recommendations while also acknowledging that there are still some issues that need to be addressed in future approvals.

CSIRO has provided robust, peer-reviewed scientific advice on specific questions about the plan. It has not been asked to comment all conditions of groundwater monitoring, management and modelling planned for the proposal. CSIRO ~~does~~ will not play a role in approval processes around developments.

Regards,

Peter

Peter Mayfield
Executive Director, Environment, Energy and Resources
CSIRO
Phone: +61 2 4960 6046
peter.mayfield@csiro.au | www.csiro.au
Address: CSIRO PO Box 330, Newcastle NSW 2300

FOI 190417
Document 27

From: s22
To: s22
Cc: s22 (L&W, Waite Campus); s22 @csiro.au
Subject: RE: Call about groundwater data [SEC=UNCLASSIFIED]
Date: Wednesday, 30 January 2019 11:47:36 AM
Attachments: image001.jpg

Hi s22

Thanks for the query. Upfront question, is this to be done concurrently with the GMMP review? If yes, then I do not have available people within my Section, and the rest of the GW Branch is likewise limited at present. I'm happy to raise this issue to CoD or higher position if warranted to redirect resources. But first we should perhaps consider the following few questions -

1) Is there a sample of what might be involved so I can understand what's involved and cost appropriately?
   a. Does DNRME have a clear acceptance process applied to the other bores reviewed?
2) Noting we are not the data custodians or the authority for QLD data compliance, is that acceptable and appropriate that GA conducts this work in light of our independent review of the Plans?
   a. Could DNRME not contract this work out to independent reviewers themselves, allowing GA serve as advisors to DoEE and not decision makers for State Gov?
   b. If we proceed, should we have a clear arbitration process of acceptance or resolution should there be a disagreement between QLD/Proponent/GA&CSIRO on the efficacy of the proponent edits to DNRME's comments?

I'm available after 2pm today for phone discussion. Availability aside, whilst GA has the technical capability to assess the proponent edits to water level data, I think my above question 2 merits further consideration.

I'll book a time with you shortly to follow up. Apologies I can't simply say 'yes'!

Thanks

s22

From: s22
Sent: Wednesday, 30 January 2019 11:02 AM
To: s22
Subject: Call about groundwater data [SEC=UNCLASSIFIED]
Importance: High

Hi s22

We'd like you to let us know if GA/CSIRO has capacity to review Adani/AECOM's edits as a result of DNRME's comments on outstanding bore data from 11 Jan. We think this is for up to about 30 bores, in the deeper (non-Clematis / alluvial) units.

If you could provide an estimate of time/$ that would be involved today, that would be great.

Have you got any time for a quick chat after lunch?

Thanks

s22
[redacted]
Assistant Director | Post Approvals Strategies
Environment Standards Division
Department of the Environment and Energy
T 02 s22 @environment.gov.au

Reconciliation%20Email%20Footer

From: s22
To: s22
Cc: s22
Subject: RE: Carmichael - potential for perceived conflict of interest [SEC=UNCLASSIFIED]
Date: Tuesday, 15 January 2019 9:51:23 AM
Attachments: image001.png
image002.png
image003.png
image004.png
image005.png

Hi s22
Happy new year!
Thank you for raising this with us. I have no concerns, however I will flag it with the Executive here simply so that they are aware.
Regards
s22

From: s22 @ga.gov.au]
Sent: Tuesday, 15 January 2019 9:48 AM
To: s22
Cc: s22
Subject: Carmichael - potential for perceived conflict of interest [SEC=UNCLASSIFIED]

Hi s22 and s22
s22 and I have both noted that our linked'in profiles have actively been searched/viewed by Adani Australia recently which is, in a way, complimentary. I bring this up as my profile has details of my studies and a potential perceived conflict of interest.
I'd like to make you aware, if I haven't shared it previously, that one of my supervisors for my postgraduate studies in environmental engineering was Prof. Adrian Werner. Adrian was one of the experts representing the plaintiff, Land Services of Coast and Country Inc & Ors against Adani Australia in the Queensland Land Court case 48.
I've had limited contact with Adrian, the occasional social 'hello' email. Prior to that he's worked with several GA staff (including me) on the National Seawater Intrusion Vulnerability Project for the NWC.
Thought I would share this reminder in case a query/challenge comes from left field. I'm perhaps being paranoid.
Thanks

s22
[redacted], **PhD** | A/g Director
Groundwater Advice and Data | Environmental Geoscience Division
t +61 2 [redacted] s2 www.ga.gov.au
16-9481 GA Email Signature_social media-04

FOI 190417
Document 29

From: s22
To: "McDonald, Warwick (L&W, Black Mountain)"; s22 (L&W, Waite Campus)
Subject: RE: Carmichael media/issues + Ministerial briefing [SEC=OFFICIAL]
Date: Monday, 25 March 2019 3:35:45 PM

That would be great Warwick I will send you an invite.
-s22

T 02 s22 @environment.gov.au
W www.environment.gov.au

From: McDonald, Warwick (L&W, Black Mountain) [mailto:Warwick.Mcdonald@csiro.au]
Sent: Monday, 25 March 2019 3:30 PM
To: s22 (L&W, Waite Campus) ; s22
Subject: Re: Carmichael media/issues + Ministerial briefing
I will attend in person @ DoEE
Warwick
Warwick McDonald
Research Director | Water Resource Management
CSIRO Land and Water
T: +61 2 s22 | M: +61 s22 | E: ws22 @csiro.au

From: s22 @csiro.au>
Date: Monday, 25 March 2019 at 2:34 pm
To: "s22 (CorpAffairs, Black Mountain)" s22 @csiro.au>, "McDonald, Warwick (CLW, Black Mountain)" <Warwick.Mcdonald@csiro.au>, Jane Coram <Jane.Coram@csiro.au>, "s22 (CorpAffairs, Dutton Park)" s22 @csiro.au>
Cc: s22 @csiro.au>, s22 (CorpAffairs, Black Mountain)" s22 @csiro.au>, MPLO <MPLO@csiro.au>, "s22 (CorpAffairs, Adelaide K. Ave)" s22 s22 @csiro.au>
Subject: RE: Carmichael media/issues + Ministerial briefing
Hi s22
The briefing has now been scheduled for 8.45 tomorrow morning Brisbane time.
s22 .

From: s22 (CorpAffairs, Black Mountain)
Sent: Monday, 25 March 2019 12:38 PM
To: s22 (L&W, Waite Campus) s22 @csiro.au>; McDonald, Warwick (L&W, Black Mountain) <Warwick.Mcdonald@csiro.au>; Coram, Jane (L&W, Black Mountain) <Jane.Coram@csiro.au>; s22 (CorpAffairs, Dutton Park) s22 @csiro.au>
Cc: s22 (CorpAffairs, Dutton Park) s22 @csiro.au>; s22 (CorpAffairs, Black Mountain) s22 @csiro.au>; MPLO <MPLO@csiro.au>; s22 (CorpAffairs, Adelaide K. Ave) <s22 @csiro.au>
Subject: RE: Carmichael media/issues + Ministerial briefing
Hi all,
Thanks for looping us in to this.
Would be great if you could let me know once this meeting has been scheduled so that I can let our Minister's office know. We may be ask us to provide some talking points for our Minister about our (CSIRO's) role and scope of work, however at the moment our Minister's office have advised that they have the background information they need.
Cheers, s22

s22
Manager, Ministerial Liaison Office
CSIRO
E mplo@csiro.au
E s22 @csiro.au
T +61 2 s22
M s22
www.csiro.au
CSIRO acknowledges the Traditional Owners of the lands that we live and work on across Australia and pays its respect to Elders past and present.

From: s22 (L&W, Waite Campus)
Sent: Saturday, 23 March 2019 10:27 AM
To: McDonald, Warwick (L&W, Black Mountain) <Warwick.Mcdonald@csiro.au>; Coram, Jane (L&W, Black Mountain) <Jane.Coram@csiro.au>; s22 (CorpAffairs, Dutton Park) s22 @csiro.au>
Cc: s22 (CorpAffairs, Dutton Park) s22 @csiro.au>; s22 (CorpAffairs, Black Mountain) <Ls22 @csiro.au>; MPLO <MPLO@csiro.au>; s22 (CorpAffairs, Adelaide K. Ave) s22 @csiro.au>; s22 (CorpAffairs, Black Mountain) s22 @csiro.au>
Subject: RE: Carmichael media/issues + Ministerial briefing

I'll let you know as soon as I find out

From: McDonald, Warwick (L&W, Black Mountain)
Sent: Saturday, 23 March 2019 9:47 AM
To: s22 (L&W, Waite Campus) s22 @csiro.au>; Coram, Jane (L&W, Black Mountain) <Jane.Coram@csiro.au>; s22 (CorpAffairs, Dutton Park) s22 @csiro.au>
Cc: s22 (CorpAffairs, Dutton Park) s22 @csiro.au>; s22 (CorpAffairs, Black Mountain) s22 @csiro.au>; MPLO <MPLO@csiro.au>; s22 (CorpAffairs, Adelaide K. Ave) s22 @csiro.au>; s22 (CorpAffairs, Black Mountain) s22 @csiro.au>
Subject: Re: Carmichael media/issues + Ministerial briefing

Hi s22

Please provide briefing meeting details (where, when). My sense is that Jane and/or I should attend or at least be able to listen in (diary and other demands willing).

Regards
Warwick

Warwick McDonald
Research Director | Water Resource Management
CSIRO Land and Water
T: +61 2 6246 5926 | M: +61 477 379 266 | E: warwick.mcdonald@csiro.au

---

From: s22 @csiro.au>
Date: Saturday, 23 March 2019 at 10:05 am

To: "McDonald, Warwick (CLW, Black Mountain)" <Warwick.Mcdonald@csiro.au>, Jane Coram <Jane.Coram@csiro.au>, "s22 (CorpAffairs, Dutton Park)" <s22 @csiro.au>
Cc: s22 @csiro.au>, "s22 (CorpAffairs, Black Mountain)" s22 @csiro.au>, MPLO <MPLO@csiro.au>, "s22 (CorpAffairs, Adelaide K. Ave)" s22 @csiro.au>, "s22 (CorpAffairs, Black Mountain)" <s22 @csiro.au>
Subject: RE: Carmichael media/issues + Ministerial briefing

Looks like the briefing with the minister is now on Thursday via phone hook-up. Please see attached email for all that I know at the moment.

From: McDonald, Warwick (L&W, Black Mountain)
Sent: Friday, 22 March 2019 1:21 PM
To: Coram, Jane (L&W, Black Mountain) <Jane.Coram@csiro.au>; s22 (CorpAffairs, Dutton Park) s22 @csiro.au>; McDonald, Warwick (L&W, Black Mountain) <Warwick.Mcdonald@csiro.au>
Cc: s22 (CorpAffairs, Dutton Park) s22 @csiro.au>; s22 (CorpAffairs, Black Mountain) s22 @csiro.au>; MPLO <MPLO@csiro.au>; s22 (CorpAffairs, Adelaide K. Ave) s22 @csiro.au>; s22 (CorpAffairs, Black Mountain) s22 @csiro.au>; s22 (L&W, Waite Campus) s22 @csiro.au>
Subject: Re: Carmichael media/issues + Ministerial briefing

Hi s22

As discussed I think Jane should be the CSIRO spokesperson for many reasons including being the L&W Director…

As always happy to work this through to the point of having something 'near final' to put in front of Jane. My diary is challenging…. so may need to creative after hours.

Regards

Warwick

Warwick McDonald
Research Director | Water Resource Management
CSIRO Land and Water
T: +61 2 6246 5926 | M: +61 477 379 266 | E: warwick.mcdonald@csiro.au

---

From: Jane Coram <Jane.Coram@csiro.au>
Date: Friday, 22 March 2019 at 1:42 pm
To: "s22 (CorpAffairs, Dutton Park)" s22 @csiro.au>, "McDonald, Warwick (CLW, Black Mountain)" <Warwick.Mcdonald@csiro.au>
Cc: s22 @csiro.au>, s22 (CorpAffairs, Black Mountain)" s22 @csiro.au>, MPLO <MPLO@csiro.au>, "s22 (CorpAffairs, Adelaide K. Ave)" s22 @csiro.au>, s22 (CorpAffairs, Black Mountain)" s22 @csiro.au>, s22 <Russell.Crosbie@csiro.au>
Subject: RE: Carmichael media/issues + Ministerial briefing

Thank you all. This could blow sky high so please make sure we have the appropriate level of representation for the Ministerial briefing – Warwick if you're not available it should be me (and maybe should be anyway?).

With regards, Jane.

From: s22 (CorpAffairs, Dutton Park)

Sent: Friday, 22 March 2019 1:13 PM
To: McDonald, Warwick (L&W, Black Mountain) <Warwick.Mcdonald@csiro.au>
Cc: Coram, Jane (L&W, Black Mountain) <Jane.Coram@csiro.au>; s22 (CorpAffairs, Dutton Park) s22 s22 @csiro.au>; s22 (CorpAffairs, Black Mountain) s22 @csiro.au>; MPLO <MPLO@csiro.au>; s22 (CorpAffairs, Adelaide K. Ave) s22 @csiro.au>; s22 CorpAffairs, Black Mountain) s22 @csiro.au>; s22 (L&W, Waite Campus) s22 @csiro.au>
Subject: Carmichael media/issues + Ministerial briefing

Warwick

Good to talk this morning. Attached is the current version of the Carmichael media/issues plan including media protocol. Since speaking with you received a call from s22 I who has been invited to brief Minister Price on the (second) report findings next week. Given the sensitivities and interest suggested you might want to accompany him so expect a call on that front.

s22 – note above and wrt our minister and whether you are satisfied they are suitably briefed.

Also received a call from Tony Moore Fairfax wanting background, referred them to s22 DoEE corporate comms.

I'll make a time for you, s22 and I to catchup next week as I think we need to be prepared for every eventuality with this one.

Thanks

s22

FOI 190417
Document 30

From: McDonald, Warwick (L&W, Black Mountain)
To: s22 (L&W, Waite Campus) s22
Subject: Re: Carmichael media/issues + Ministerial briefing
Date: Monday, 25 March 2019 3:30:27 PM

I will attend in person @ DoEE
Warwick
Warwick McDonald
Research Director | Water Resource Management
CSIRO Land and Water
T: +61 2 6246 5926 | M: +61 477 379 266 | E: warwick.mcdonald@csiro.au

---

From: s22
Date: Monday, 25 March 2019 at 2:34 pm
To: s22 (CorpAffairs, Black Mountain)" , "McDonald, Warwick (CLW, Black Mountain)" , Jane Coram , "s22 (CorpAffairs, Dutton Park)"
Cc: s22 (CorpAffairs, Black Mountain)" , MPLO , "s22 (CorpAffairs, Adelaide K. Ave)"
Subject: RE: Carmichael media/issues + Ministerial briefing
Hi s22
The briefing has now been scheduled for 8.45 tomorrow morning Brisbane time.
s22 .

From: s22 (CorpAffairs, Black Mountain)
Sent: Monday, 25 March 2019 12:38 PM
To: s22 (L&W, Waite Campus) ; McDonald, Warwick (L&W, Black Mountain) ; Coram, Jane (L&W, Black Mountain) ; s22 (CorpAffairs, Dutton Park)
Cc: s22 (CorpAffairs, Dutton Park) ; s22 (CorpAffairs, Black Mountain) ; MPLO ; s22 (CorpAffairs, Adelaide K. Ave)
Subject: RE: Carmichael media/issues + Ministerial briefing
Hi all,
Thanks for looping us in to this.
Would be great if you could let me know once this meeting has been scheduled so that I can let our Minister's office know. We may be ask us to provide some talking points for our Minister about our (CSIRO's) role and scope of work, however at the moment our Minister's office have advised that they have the background information they need.
Cheers, s22
[redacted]
Manager, Ministerial Liaison Office
CSIRO
E mplo@csiro.au
E s22
[redacted]
www.csiro.au
CSIRO acknowledges the Traditional Owners of the lands that we live and work on across Australia and pays its respect to Elders past and present.

integrity of this communication has been maintained or that the communication is free of errors, virus, interception or interference.

Please consider the environment before printing this email.

From: s22 (L&W, Waite Campus)
Sent: Saturday, 23 March 2019 10:27 AM
To: McDonald, Warwick (L&W, Black Mountain) <Warwick.Mcdonald@csiro.au>; Coram, Jane (L&W, Black Mountain) <Jane.Coram@csiro.au>; s22 (CorpAffairs, Dutton Park) s22 @csiro.au>
Cc: s22 (CorpAffairs, Dutton Park) s22 @csiro.au>; s22 (CorpAffairs, Black Mountain) <s22 @csiro.au>; MPLO <MPLO@csiro.au>; s22 (CorpAffairs, Adelaide K. Ave) s22 @csiro.au>; s22 (CorpAffairs, Black Mountain) s22 @csiro.au>
Subject: RE: Carmichael media/issues + Ministerial briefing

I'll let you know as soon as I find out

From: McDonald, Warwick (L&W, Black Mountain)
Sent: Saturday, 23 March 2019 9:47 AM
To: s22 (L&W, Waite Campus) <s22 @csiro.au>; Coram, Jane (L&W, Black Mountain) <Jane.Coram@csiro.au>; s22 (CorpAffairs, Dutton Park) <s22 @csiro.au>
Cc: s22 (CorpAffairs, Dutton Park) <s22 @csiro.au>; s22 (CorpAffairs, Black Mountain) s22 @csiro.au>; MPLO <MPLO@csiro.au>; s22 (CorpAffairs, Adelaide K. Ave) s22 @csiro.au>; s22 (CorpAffairs, Black Mountain) s22 @csiro.au>
Subject: Re: Carmichael media/issues + Ministerial briefing

Hi s22
Please provide briefing meeting details (where, when). My sense is that Jane and/or I should attend or at least be able to listen in (diary and other demands willing).
Regards
Warwick
Warwick McDonald
Research Director | Water Resource Management
CSIRO Land and Water
T: +61 2 s22 @csiro.au

From: s22 @csiro.au>
Date: Saturday, 23 March 2019 at 10:05 am
To: "McDonald, Warwick (CLW, Black Mountain)" <Warwick.Mcdonald@csiro.au>, Jane Coram <Jane.Coram@csiro.au>, "s22 CorpAffairs, Dutton Park)" <s22 @csiro.au>
Cc: s22 @csiro.au>, "s22 (CorpAffairs, Black Mountain)" s22 @csiro.au>, MPLO <MPLO@csiro.au>, "s22 (CorpAffairs, Adelaide K. Ave)" s22 @csiro.au>, s22 (CorpAffairs, Black Mountain)" s22 @csiro.au>
Subject: RE: Carmichael media/issues + Ministerial briefing

Looks like the briefing with the minister is now on Thursday via phone hook-up. Please see attached email for all that I know at the moment.

From: McDonald, Warwick (L&W, Black Mountain)
Sent: Friday, 22 March 2019 1:21 PM

To: Coram, Jane (L&W, Black Mountain) <Jane.Coram@csiro.au>; s22 (CorpAffairs, Dutton Park) s22 @csiro.au>; McDonald, Warwick (L&W, Black Mountain) <Warwick.Mcdonald@csiro.au>
Cc: s22 (CorpAffairs, Dutton Park) s22 @csiro.au>; s22 (CorpAffairs, Black Mountain) s22 @csiro.au>; MPLO <MPLO@csiro.au>; s22 (CorpAffairs, Adelaide K. Ave) s22 @csiro.au>; s22 (CorpAffairs, Black Mountain) s22 @csiro.au>; s22 (L&W, Waite Campus) s22 @csiro.au>
Subject: Re: Carmichael media/issues + Ministerial briefing

Hi s22

As discussed I think Jane should be the CSIRO spokesperson for many reasons including being the L&W Director…

As always happy to work this through to the point of having something 'near final' to put in front of Jane. My diary is challenging…. so may need to creative after hours.

Regards

Warwick

Warwick McDonald
Research Director | Water Resource Management
CSIRO Land and Water
T: +61 2 6246 5926 | M: +61 477 379 266 | E: warwick.mcdonald@csiro.au

---

From: Jane Coram <Jane.Coram@csiro.au>
Date: Friday, 22 March 2019 at 1:42 pm
To: "s22 (CorpAffairs, Dutton Park)" s22 @csiro.au>, "McDonald, Warwick (CLW, Black Mountain)" <Warwick.Mcdonald@csiro.au>
Cc: s22 @csiro.au>, "s22 (CorpAffairs, Black Mountain)" s22 @csiro.au>, MPLO <MPLO@csiro.au>, "s22 (CorpAffairs, Adelaide K. Ave)" s22 @csiro.au>, "s22 CorpAffairs, Black Mountain)" s22 @csiro.au>, s22 @csiro.au>
Subject: RE: Carmichael media/issues + Ministerial briefing

Thank you all. This could blow sky high so please make sure we have the appropriate level of representation for the Ministerial briefing – Warwick if you're not available it should be me (and maybe should be anyway?).

With regards, Jane.

From: s22 CorpAffairs, Dutton Park)
Sent: Friday, 22 March 2019 1:13 PM
To: McDonald, Warwick (L&W, Black Mountain) <Warwick.Mcdonald@csiro.au>
Cc: Coram, Jane (L&W, Black Mountain) <Jane.Coram@csiro.au>; s22 (CorpAffairs, Dutton Park) <s22 @csiro.au>; s22 (CorpAffairs, Black Mountain) s22 @csiro.au>; MPLO <MPLO@csiro.au>; s22 (CorpAffairs, Adelaide K. Ave) s22 @csiro.au>; s22 (CorpAffairs, Black Mountain) s22 t@csiro.au>; s22 (L&W, Waite Campus) <s22 @csiro.au>
Subject: Carmichael media/issues + Ministerial briefing

Warwick

Good to talk this morning. Attached is the current version of the Carmichael media/issues plan including media protocol. Since speaking with you received a call from s22 who has been invited to brief Minister Price on the (second) report findings next week. Given the sensitivities and interest suggested you might want to accompany him so expect a call on that front.

s22 – note above and wrt our minister and whether you are satisfied they are suitably briefed.
Also received a call from Tony Moore Fairfax wanting background, referred them to Amanda Foreman DoEE corporate comms.
I'll make a time for you, s22 and I to catchup next week as I think we need to be prepared for every eventuality with this one.
Thanks
s22

FOI 190417
Document 31

From: s22
To: s22
Subject: RE: Assessment against CSIRO advice [SEC=UNCLASSIFIED]
Date: Tuesday, 19 March 2019 10:58:12 AM
Attachments: image001.jpg

Yes, it does.

s22

T 02 s22 @environment.gov.au
W www.environment.gov.au

From: s22
Sent: Tuesday, 19 March 2019 10:58 AM
To: s22
Subject: RE: Assessment against CSIRO advice [SEC=UNCLASSIFIED]

Goodo. Does this cover both GDEMP and GMMP? If so, we just inc. the same in each brief.

From: s22
Sent: Tuesday, 19 March 2019 10:19 AM
To: s22 @environment.gov.au>; s22 @environment.gov.au>
Subject: Assessment against CSIRO advice [SEC=UNCLASSIFIED]

Link:
http://spire.environment.gov.au/spire/855732/855004/103/2010-5736%20Carmichael%20Coal%20Mine%20and%20Rail%20Project/2010-5736-20190316-External%20advice-How%20addressed%20in%20revised%20plans.docx

s22

Assistant Director | Post Approvals Strategies
Environment Standards Division
Department of the Environment and Energy
T 02 s22 @environment.gov.au

Reconciliation%20Email%20Footer

FOI 190417
Document 32

From: s22
To: s22
Cc: Blewett Richard; s22
Subject: RE: Briefing [DLM=For-Official-Use-Only]
Date: Monday, 25 March 2019 3:08:33 PM
Attachments: image001.png
image002.png
image003.png
image004.png
image005.png

Thankyou all. I think we'll use Greg's office in his absence. His EA s22 or I , will meet you in the foyer.

s22
[redacted]
T 02 s22 @environment.gov.au
W www.environment.gov.au

From: s22 [mailto:Hashim.Carey@ga.gov.au]
Sent: Monday, 25 March 2019 2:59 PM
To: s22
Cc: Blewett Richard ; s22
Subject: Briefing [DLM=For-Official-Use-Only]

Hi s22 ,

My Branch Head, Richard Blewett, will join us tomorrow. From GA it will be s22 and me. We'll arrive at the foyer of 51 Allara Street Civic @ 0930 to allow sufficient time for a 0945 meeting.

Thanks

s22
[redacted] **PhD** | A/g Director
Groundwater Advice and Data | Environmental Geoscience Division
t +61 2 s22 | www.ga.gov.au

16-9481 GA Email Signature_social media-04

FOI 190417
Document 33

From: Coram, Jane (L&W, Black Mountain)
To: s22 ; s22 (L&W, Waite Campus); McDonald, Warwick (L&W, Black Mountain)
Subject: Queries around summary document
Date: Friday, 5 April 2019 3:23:03 PM

Hi s22

Further to our discussion just now, could you possibly confirm the details I was querying from the summary document:

1. That the deeper units now committed to being monitored will be the Dunda, Rewan and Permian Formations

4. That rate limits have been included in early warning triggers for the Carmichael River, the Doongmabulla Springs and every bore

5f. That the administering authority will be notified when an investigation is to be instigated for groundwater quality and/or levels.

Thank you! Jane.

From: s22
To: 's22 (L&W, Waite Campus)'; 's22
Subject: RE: Adani briefing [SEC=OFFICIAL]
Date: Monday, 25 March 2019 3:21:12 PM
Attachments: image001.jpg

Ok. I'll let you know when we know a number you can call

s22

T 02 s22 @environment.gov.au
W www.environment.gov.au

From: s22 (L&W, Waite Campus) [mailto s22 e@csiro.au]
Sent: Monday, 25 March 2019 2:29 PM
To: s22 '
Subject: RE: Adani briefing [SEC=OFFICIAL]

Hi s22

I'll stay in Adelaide and be on the end of the phone. CSIRO would also like someone more senior to listen in as this is likely to end up on the media at some point. This will probably be Jane Coram who is the Land & Water Director.

s22

From: s22 [mailto:Emily.Turner@environment.gov.au]
Sent: Monday, 25 March 2019 12:41 PM
To: s22 @ga.gov.au>; s22 L&W, Waite Campus) <s22 @csiro.au>
Subject: Adani briefing [SEC=OFFICIAL]

Hi s22

The briefing is 8:45am Brisbane time - or 9:45am our time tomorrow (Tues). Would you like to come here?

s22 will you join us too?

I can set up a telecom line

Thanks

s22

Assistant Director | Post Approvals Strategies
Environment Standards Division
Department of the Environment and Energy
T 02 s22 @environment.gov.au

Reconciliation%20Email%20Footer

FOI 190417
Document 35

From: s22
To: s22 (L&W, Black Mountain)"
Subject: RE: Advice on Groundwater Management Plans and Response [SEC=OFFICIAL]
Date: Friday, 5 April 2019 4:36:17 PM

Thanks s22
s22
T 02 s22 @environment.gov.au
W www.environment.gov.au

From: s22 (L&W, Black Mountain) [mailto:s22 @csiro.au]
Sent: Friday, 5 April 2019 4:36 PM
To: s22
Subject: FW: Advice on Groundwater Management Plans and Response
Dear s22
FYI.
Regards
s22

From: s22 (L&W, Black Mountain) **On Behalf Of** Coram, Jane (L&W, Black Mountain)
Sent: Friday, 5 April 2019 4:34 PM
To: 'dean.knudson@environment.gov.au' <dean.knudson@environment.gov.au>
Cc: 'Finn.Pratt@environment.gov.au' <Finn.Pratt@environment.gov.au>; 'gregory.manning@environment.gov.au' <gregory.manning@environment.gov.au>; s22 (Executive, Black Mountain) s22 @csiro.au>
Subject: Advice on Groundwater Management Plans and Response
Dear Mr Knudson
Please find attached a letter from Jane Coram regarding advice on groundwater management plans and response.
Regards
s22
[redacted]
Executive Assistant
CSIRO Land and Water
Research in land, water, ecosystems, cities, social and economic sciences, pollution, earth observation, and climate adaptation
E s22
http://www.csiro.au/en/Research/LWF
GPO Box 1700 Canberra ACT 2601
CSIRO Black Mountain Site
Clunies Ross St, Canberra ACT 2601

FOI 190417
Document 36

From: s22 CorpAffairs, Dutton Park)
To: s22
Subject: RE: As per our phone call [SEC=OFFICIAL]
Date: Thursday, 4 April 2019 5:13:36 PM
Attachments: image001.jpg
Further information- groundwater management and monitoring planning for the Carmichael Coal Project .msg

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Hi s22 , for your information I am attaching a copy of the short brief provided to our Minister's advisor today.
Regards s22

From: s22 @environment.gov.au]
Sent: Thursday, 4 April 2019 12:38 PM
To: s22 (CorpAffairs, Dutton Park)
Subject: As per our phone call [SEC=OFFICIAL]

Hi s22

I can confirm the FOI decision has not been made yet, but is due today. As I said, I expect the reviews won't become public unless the Minister agrees as such

-s22

Assistant Director | Post Approvals Strategies
Environment Standards Division
Department of the Environment and Energy
T 02 s22 @environment.gov.au

Reconciliation%20Email%20Footer

FOI 190417
Document 36a

From: s22 (CorpAffairs, Black Mountain)
To: s22
Cc: MPLO; s22 (Executive, Black Mountain)
Subject: Further information- groundwater management and monitoring planning for the Carmichael Coal Project

Hi s22

Further to our discussion today, here is some further information about the groundwater management and monitoring planning for the Carmichael Coal Project.

- CSIRO, in partnership with Geoscience Australia, delivered two confidential reports to the Department of the Environment and Energy (DoEE) in late 2018 and early 2019 related to groundwater management and monitoring planning for the Carmichael Coal Project, a proposed thermal coal mine in the north of the Galilee Basin in Central Queensland.
- The reports were requested by DoEE to advise on draft research and management plans submitted by Carmichael mine proponent, Adani Pty Ltd, and their suitability to ensure outcomes under Environment Protection and Biodiversity Conservation Act (1999) could be met. The scientific advice was provided in two reports, on November 29, 2018, and February 22, 2019.
- The first report was to advise on how plausible and reasonable is it that the Clematis Sandstone aquifer is the source aquifer for Doongmabulla Springs Complex, a nationally-important artesian springs complex. It also looked at how adequately the methods and techniques put forward in the research plans addressed uncertainties about the source of the springs, the capacity of the Rewan (geological) formation to prevent impacts on springs, and methods to prevent, mitigate and remediate ecological impacts to the springs.
- The second report provided advice on groundwater management and monitoring planning for the Carmichael project, and addressed questions on the coal project's proposed Groundwater Dependent Ecosystem Management Plan and the Groundwater Management and Monitoring Plan.
- The review found the modelling, which underpins the approaches in the management and monitoring plans, is not suitable to ensure the outcomes sought by the EPBC Act conditions are met. A number of limitations were also identified in the proposed monitoring and management approaches, indicating they are not sufficiently robust to monitor and minimise impacts to protected environments.
- It also makes a series of recommendations which, if implemented, will refine the proponent's conceptualisation and improve the robustness of the modelling, monitoring and management approaches to address the intended outcomes of the approval conditions.
- The report found that uncertainty still exists about whether the Clematis Sandstone is the sole source aquifer for the Doongmabulla Springs Complex, based on the information provided in both plans, as well as information that is in the public domain.
- A Freedom of Information request was received in January 2019 and was transferred to DoEE for action. A decision had not been made, as at April 4.

Please let me know if you have any questions.

Cheers, s22

Manager, Ministerial Liaison Office

CSIRO
E mplo@csiro.au
E s22
www.csiro.au

From: s22
To: s22 (L&W, Waite Campus); s22 @csiro.au; s22
Subject: Initial Tranche 2 timeline based on 4 weeks [DLM=For-Official-Use-Only]
Date: Thursday, 24 January 2019 3:26:40 PM
Attachments: Tranche2Revision7.docx

Hi All,

Please find attached,

I've aimed for a delivery of 22/02/19 which is 3 weeks of work + 1 week for organisational review/clearance.

To be discussed next Tuesday.

Thanks

s22

FOI 190417
Document 37a

Task Name	Duration	Start	
Carmichael Assessment - Tranche 2 - GMMP and GDEMP assessment - 4 weeks from approval to proceed	**21 days**	Fri 25/01/19	
Week 1 | initial assessment of GDEMPv10a and GMMPv5	**4 days**	Tue 29/01/19	Fri 1/02/19
CSIRO - GDEMPv10a and Numerical modelling in GMMPv5 - considerations to monitoring and management of GDE, representation of GDE systems in GDEMP and application of Research plans - addressing Q2a, Q2b and Q3	**4 days**	Tue 29/01/19	Fri 1/02/19
GA - integration of research plan hydrogeological conceptualisation (Q1a and Q1b) in GMMP, implementation of conceptualisation in numerical model, water levels issues	4 days	Tue 29/01/19	Fri 1/02/19
Team meeting to share and discuss issues	**0 days**	**Fri 1/02/19**	**Fri 1/02/19**
Decision point | 1) Are the issues identified in Tranche 1 still present? 2)Are there make or break issues for Q2a, Q2b or Q3 that warrant notifying DoEE?	0 days	Fri 1/02/19	Fri 1/02/19
Week 2 | Detailed assessment of GDEMPv10a vs GMMPv5 assessment, collation of response.	**5 days**	Mon 4/02/19	Fri 8/02/19
CSIRO - Focus on issues raised from T2W1 for GDEMPv10a, interact with GA on GMMPv5 conceptualisation and numerical implementation for Q2a, Q2b, and Q3	5 days	Mon 4/02/19	Fri 8/02/19
GA - interaction with CSIRO for GMMP and GDEMP interaction and numerical modelling/thresholds/limits/triggers, focus on monitoring and management Q3 rationale and methodologies. Resolve issues from Tranche 1 in research plans	5 days	Mon 4/02/19	Fri 8/02/19
Team meeting to share and discuss issues	**0 days**	**Fri 8/02/19**	**Fri 8/02/19**
Decision point | 1) are there detailed issues arising that warrant notifying DoEE? 2) Is the timeline still viable?	0 days	Fri 8/02/19	Fri 8/02/19
Week 3 | Finalisation and compilation	5 days	Mon 11/02/19	Fri 15/02/19
GA/CSIRO - continue and finalise T2W2 work - review interaction of GMMP and GDEMP with regards to triggers/limits and bore locations	4 days	Mon 11/02/19	Thu 14/02/19
Authors to finalise their assessments and submit to coordinator by CoB 07/12/18	1 day	Thu 14/02/19	Thu 14/02/19
Compilation of internal review draft	1 day	Fri 15/02/19	Fri 15/02/19
Week 4 | Internal review and clearance, delivery	**5 days**	**Mon 18/02/19**	**Fri 22/02/19**
Organisation review - GA (GW BH) and CSIRO (TBA) - concurrent	1 day	**Mon 18/02/19**	Mon 18/02/19
Amendments to internal review response - final amendments from authors reading of draft	1 day	Tue 19/02/19	Tue 19/02/19
Organisation review - GA (EGD CoD/CEO) and CSIRO (TBA) - concurrent	1 day	Wed 20/02/19	Wed 20/02/19
Amendments, final author review and submission compilation	1 day	Thu 21/02/19	Thu 21/02/19
Submission | DoEE PAS - Briefing meeting and submission - CoB 22/02/19	**1 day**	**Fri 22/02/19**	**Fri 22/02/19**

From: s22
To: s22
Cc: s22
Subject: points to raise [SEC=UNCLASSIFIED]
Date: Thursday, 7 February 2019 11:25:41 AM
Attachments: image001.png
image002.png
image003.png
image004.png
image005.png

Hi s22

Would you have time tomorrow to discuss a few items that have come up as part of our Tranche 2 assessment to date that we will be incorporating as part of our final response.

Thanks

s22
[redacted]**, PhD |** A/g Director
Groundwater Advice and Data **|** Environmental Geoscience Division
t +61 2 s22 **|** www.ga.gov.au

16-9481 GA Email Signature_social media-04

FOI 190417
Document 39

From: s22 [redacted]
To: "james.johnson@ga.gov.au"
Cc: "Stuart Minchin"; "Blewett Richard"; s22 [redacted]; Gregory Manning; James Tregurtha; Dean Knudson
Subject: Previous Geoscience Australia advice on Adani [SEC=OFFICIAL]
Date: Wednesday, 10 April 2019 8:51:04 AM
Attachments: image001.jpg
Industry and GA letter at approval.pdf
2017 GA final advice.pdf
2017 GA initial advice.pdf

Hi James,
As promised, GA's advice at the time of approval is attached, as are copies of your advices from 2017.
s22 [redacted]
[redacted]
T 02 s22 [redacted]@environment.gov.au
W www.environment.gov.au

From: s22 [redacted]
Sent: Wednesday, 10 April 2019 8:42 AM
To: 'peter.mayfield@csiro.au' ; 'jane.coram@csiro.au' ; s22 [redacted]@csiro.au' ; 'james.johnson@ga.gov.au' ; s22 [redacted]@csiro.au'
Cc: Dean Knudson ; James Tregurtha ; Gregory Manning ; s22 [redacted]
Subject: Adani media release [SEC=OFFICIAL]

Hi everyone,
Thanks for the phone call yesterday.
A link to the Minister's media release is here: http://environment.gov.au/minister/price/media-releases/mr20190409.html
James, I will send you GA's comments on the project at the time of approval, plus initial comments from 2017 shortly.
s22 [redacted]
[redacted]
Acting Director | Post Approvals Strategies
Environment Standards Division
Department of the Environment and Energy
T 02 s22 [redacted]@environment.gov.au
Reconciliation%20Email%20Footer

Australian Government

Department of Industry

Industry House, 10 Binara Street
CANBERRA CITY ACT 2601
GPO Box 9839
Canberra ACT 2601 Australia
Web: www.industry.gov.au
ABN: 74 599 608 295

Mr s22 [redacted]
Director
Queensland and Sea Dumping section
Environment Assessment and Compliance Division
Department of the Environment
GPO Box 787
CANBERRA ACT 2601

Dear Mr s22 [redacted]

RE: Invitation to comment on proposed approval decision EPBC2010/5736 – Carmichael Coal Mine and Rail Project, Queensland

Thank you for the opportunity to comment on *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) proposed approval decision EPBC2010/5736 regarding a proposal to develop an open cut and underground coal mine in the north Galilee Basin, Central Queensland, plus a 189 km rail link and associated infrastructure to export coal via the Port of Abbot Point and/or the Port of Hay Point.

The Department of Industry has consulted with Geoscience Australia (GA) and attached is a copy of the advice we received from GA for your consideration.

The Department notes the significant long term economic and employment benefits that would flow to the region, state and national economy from development of the Carmichael Coal Mine and Rail Project. If the Carmichael Coal Mine and Rail Project proceeds, it is expected to result in an investment of $7.1 billion and generate 2,575 jobs during construction and another 3,945 jobs during its approximately 60 years of operation.[1]

Coal mining and exports will not only bring economic benefits and employment in Australia, but will also bring a stable supply of coal into world markets, which plays an important role in improving living standards for people around the world. The coal industry is currently facing a number of challenges, including lower coal prices, a high Australian dollar and high input costs, and in responding to these challenging market conditions coal producers are focusing on improving productivity.

If you have any questions regarding this advice, please contact s22 [redacted]
or email s22 [redacted]@industry.gov.au

Yours sincerely

s22 [redacted]

s22 [redacted]
General Manager
Coal and Minerals Productivity Branch
Resources Division

3 July 2014

[1] Bureau of Resources and Energy Economics, 2014. *Resources and Energy Major Projects – April 2014 – Projects Listing* http://www.bree.gov.au/publications/resources-and-energy-major-projects

Australian Government

Geoscience Australia

Cnr Jerrabomberra Avenue
and Hindmarsh Drive,
Symonston ACT 2609

GPO Box 378,
Canberra, ACT 2601 Australia

Phone: +61 2 6249 9111
Facsimile: +61 2 6249 9999

Email: stuart.minchin@ga.gov.au
Web: www.ga.gov.au

ABN 80 091 799 039

Coal and Access Section

Coal and Minerals Productivity Branch

Resources Division

Department of Industry

Attn s22

02 July 2014

Re: Proposed EPBC Approval Notice: Carmichael Coal Mine and Rail Infrastructure Project Queensland (EPBC 2010/5736)

I refer to your request for comments, dated 19 June 2014, on the proposed approval notice and associated draft conditions for the *Carmichael Coal Mine and Rail Project* (the Project) for the proponent *Adani Mining Pty Ltd* (Adani). Geoscience Australia (GA) has reviewed the proposed approval conditions, with reference to other relevant information where time allowed. GA has focussed the review on proposed conditions 3-7, and 21-27.

Background

The Project is located approximately 175 km west of the town of Moranbah in the Galilee Basin, Queensland. It is within the Burdekin River basin, with the lease area straddling the Carmichael River, a non-perennial tributary to the Belyando River which flows to the Burdekin River via the Suttor River.

The Project involves the development and operation of a 60 million tonnes per annum (Mtpa) open-cut and underground coal mine and associated greenfields rail infrastructure. The thermal coal resource, hosted within the Permian age Bandanna Formation Coal Measures and Colinlea Sandstone, is estimated at approximately 460 million tonnes. The operating life of the mine would be approximately 60 years. In addition to mine infrastructure elements, a rail infrastructure of 189km in length is proposed to head east from the mine to access the existing Goonyella and Newlands rail infrastructure and export via Hay Point or Abbot Point.

The Minister for the Environment has proposed approval, with 35 conditions, under sections 130(1) and 133 of the *Environment Protection and Biodiversity Conservation Act, 1999* (the EPBC Act) for Adani to develop and operate a greenfield open-cut and underground coal mine and associated rail infrastructure.

Summary

The approval conditions appear to be considered and account for many potential sources and pathways for impacts to water resources arising from the proposed action. The following summarises the key comments relating to particular aspects of the conditions, with the remaining comments contained in the detailed comments attachment.

- *Condition 3.d* could be amended to allow the Proponent to identify significant knowledge gaps in the GMMP as well as outline a plan for how these knowledge gaps will be filled and how new information will be incorporated into the conceptual and numerical groundwater models.
- *Condition 3.d.i* could be expanded to incorporate a review and update of the monitoring network in order to assist the refinement of the numerical or conceptual model with new data over the operational life of the mine.

- The approval conditions for the Groundwater Flow Model Review (*Conditions 21-23*) are prescriptive without identifying the technical rationale for these conditions. In order to improve the transparency of *Conditions 21 – 23,* GA recommends additional general wording to better encapsulate the conditions as relating to informing and addressing outcomes in order to avoid the future limitations associated with an excessively prescriptive approach.
- Verify the bore name DH02 specified in *Condition 22.d* as GA could not find a bore with that reference, only the bore, HD02.
- The Rewan Formation Connectivity Research Plan (*Conditions 26.d*) should also specify appropriate geological, hydrogeological and hydrogeochemical methods as well as other possible future approaches.

Regards,

Stuart Minchin

Chief of Division,

Environmental Geoscience Division

Geoscience Australia

Attachment: Detailed Comments

Attachment – Detailed Comments.

Groundwater management and monitoring program (Conditions 3 – 4)

GA supports the requirements of the Groundwater Management and Monitoring Program (GMMP) as identified in *Conditions 3 and 4*, in particular the need to document and establish connectivity between aspects of the groundwater system. GA suggests additional clarity is required for *Condition 3.b* regarding the water balance, in particular, it is unclear whether *Condition 3.b* requires assessment of the regional water balance for cumulative impacts, a site/project water balance or both. GA recommends both scales of water balance to be assessed if possible

Condition 3.d requires that the GMMP must provide commitments for review of the conceptual and numerical groundwater model and the GMMP throughout the life of the mine. GA recommends that as part of this review, the Proponent is required to identify significant knowledge gaps in the GMMP as well as outline a plan for how these knowledge gaps will be filled and how new information will be incorporated into the conceptual and numerical groundwater models.

GA supports *Condition 3.d.i* for the regular review and update of both the groundwater conceptual model and the numerical groundwater model. GA suggests this condition could be expanded to incorporate a review and subsequent update of the monitoring network in order to assist the refinement of the numerical or conceptual groundwater model with new data over the operational life of the mine. This will ensure that monitoring is still adequate to detect propagation of predicted impacts and to provide early warning of impacts.

GA queries the rationale in explicitly citing the Office of Water Science in *Condition 3.e* given the operational life of the mine as 60 years and likely changes in government during that time.

Matters of National Environmental Significance Management Plan/s (Conditions 5 – 7)

GA supports *Condition 6.k* as the current knowledge on the source aquifer for the Mellaluka Springs Complex is unknown. GA recommends expanding (and linking *Condition 6* with *Condition 3*) the conditions to be more explicit that future work by the proponent on the Mellaluka Springs Complex should be incorporated as part of the GMMP updates. There is currently limited information regarding the hydrogeology of the southern extents of the lease and subsequently the conceptual and numerical groundwater models.

Groundwater Flow Model Review (Conditions 21 – 23)

GA supports *Condition 21* and *Condition 22*, however the addition of the underlying technical rationale would enhance the transparency of *Conditions 21 and 22*. GA recommends the wording of these Groundwater Flow Model Review conditions be revised to focus on the technical rationale and outcomes rather than specificity in order to allow the conditions to be more transparent for all audiences and avoid the future limitations associated with a prescriptive approach. For example:

- *Condition 22.a-c*: GA cautions that these conditions appear prescriptive and transparency could be emphasised with background technical rational. It would be of benefit to frame these conditions in the context of a rationale or outcome objective the condition is trying achieve. For example, *Condition 22.b* might be framed as *'to ascertain the impacts of the positioning of the western GHB boundary on model outcomes and explore the sensitivity of the model predictions to repositioning the GHB from the current location in all layers to the western edge of the model domain'* or words to that effect.
- *Condition 22.d*: could be revised to emphasise the requirement to use the suitably representative data as opposed to a specific bore- *'to use best available data, of suitable quality, as agreed by the Department in writing for the model re-runs. This includes using data from bore DH02[sic] and other suitably representative datasets as well as the approval holder's best elevation data for the subcrop of the Clematis Sandstone'* or words to that effect.

Condition 22.d: GA notes the condition specifies the bore **DH02**. In the review of available documentation, GA can only find reference to bore **HD02** and assumes this is the bore pertinent to *Condition 22.d.* GA advises to validate the identity of the bore specified in *Condition 22.d* and specify the correct bore name. GA notes the lack of available bore data to the west of HD02 and the lease area and advises the condition to not specify a particular bore, but rather to refer to representative data of suitable quality.

Condition 22.i: GA supports this condition and understands the lack of data to discriminate between local and regional flow systems. GA suggests the condition also encompass an outline of knowledge and data gaps, if they exist, in the justification for the topographically driven flow. GA suggests the following wording *'Provide adequate data (spatially and geologically representative) to justify the conceptualisation of topographically driven flow from south to north (and west to east) in both shallow and deeper aquifers.'*

Great Artesian Basin (GAB) springs research plan (Conditions 24 -25)

GA supports *Conditions 24 and 25* to be implemented in the approval as the impact of the operations on the Doongmabulla Spring Complex and the GAB will benefit from further research. GA suggests *Condition 24.g* should also include the methodology for assessing, defining and implementing baseline conditions for the Doongmabulla Spring Complex as this will be pertinent for the GMMP and the conceptual and numerical models.

Rewan Formation Connectivity Research Plan (Conditions 26 – 27)

GA supports the need for a better understanding of the potential hydrogeological connectivity between the Galilee Basin and the Great Artesian Basin particularly in the presence of an open-cut and underground coal mine operation. GA notes that the recent Great Artesian Basin Water Resources Assessment defines the Rewan Formation as an aquifer, or leaky aquitard[1]. This needs to be addressed in assessing the potential connectivity and propagation of groundwater impacts. GA advises that the requirements of *Condition 26.d* could be improved by clarifying the range of methods used in the research. GA recommends rewording this *Condition 26.d* to the following *'including, <u>but not limited to,</u> seismic surveys, and other appropriate geological, hydrogeological and hydrogeochemical methods'* to not limit the scope of approaches used to investigate the Rewan Formation. GA recommends that the words, *'as well as any fracturing induced by long wall mining subsidence'* are incorporated into *Condition 26.d*, as current wording can be interpreted to mean only naturally occurring fracturing.

Reporting of data and evidentiary standards (all conditions reviewed)

Evidentiary standards and their proper application ensure that consistent and reputable methodologies are applied to the assessment of impacts, and the tracking of performance against management objectives. GA recommends that the conditions include a requirement to describe the data and evidentiary standards used to derive baseline conditions, and the exceedance limits, and that data and evidentiary standards be included in regular reporting against various conditions. An example of the need to use evidentiary standards pertains to *Condition 22.i* where scientific justification is required to be provided.

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[1] Ransley, T. R. and Smerdon, B. D., Eds. (2012). Hydrostratigraphy, Hydrogeology and System Conceptualisation of the Great Artesian Basin. A Technical Report to the Australian Government from the Csiro Great Artesian Basin Water Resource Assessment. Australia, CSIRO Water for a Healthy Country Flagship.

Attachment A - GA Stage 2 : detailed technical commentary for the Carmichael Coal Mine and Rail Project Groundwater Management and Monitoring Program (EPBC 2010/5736)

Caveats and limitations of this review

GA's review was limited to assessing the GMMP (AECOM 2017) against EPBC 2010/5736 approval conditions 3a.i, 3a.ii, 3a.iii, 3b, 3c, and 3d.i. GA has considered the documentation supplied by DoEE as listed in the references section. GA was not made aware of any specific provisions or agreements made with Queensland State Government for this GMMP for the Queensland Environmental Authority; and so this review has been undertaken solely through consideration of the references provided.

In relation to Approval Conditions 3d.ii, 3e.iii, 3e.iv, 24, 25, 26, 27 and 28, the Great Artesian Basin Springs Research Plan (GABSRP) and the Rewan Formation Connectivity Research Plan (RFCRP) are integral to the hydrogeological conceptualisation underpinning the numerical groundwater flow model, determining trigger thresholds, monitoring site selection and GMMP implementation. However, the GABSRP and RFCRP were not available to GA at the time of this review. The GABSRP and RFCRP will inform future monitoring requirements, consequently the GMMP will require further review once they are available.

GA is aware of the Australian Government's Bioregional Assessment Programme which provides transparent scientific information to better understand the potential impacts of coal and coal seam gas developments on water and the environment. This Programme includes a detailed assessment of the Galilee Basin that is nearing completion and delivery, with many outcomes pertinent to the GMMP.

GA notes the GMMPs for the construction (Section 5.4), operational (Section 5.5) and post-closure (Section 5.6) phases are incomplete and not finalised.

GA emphasises that the examples provided in the detailed comments table highlights rather represents an exhaustive list of all specific issues with the GMMP.

It is possible that some information that is absent in the GMMP is included in other documents (e.g. the Carmichael Coal Project Environmental Impact Statement (EIS) and Supplementary Environmental Impact Statement (SEIS)). However, specific components of these documents are not referenced or cited in the GMMP. GA has been able to review aspects of the SEIS document (specifically Appendix D of GHD 2015) in the available timeframe for our Stage 2 review. However, GA considers that it is preferable for the GMMP to be a stand-alone document because it will be reviewed and revised as the project progresses.

General comment on science communication

The GMMP contains many typographical and grammatical errors, making interpretation ambiguous. Repetition and transcription errors reduce clarity and confidence in reporting. Some examples include (but are not limited to):

- Naming of monitoring bores is inconsistent at times throughout the document. For example, Table 21 refers to C056C_V3, however it is unclear if this is the same as bore C056VWP3 that is referenced in most of the other tables. While the differences are minor, it is an issue for accuracy and clarity.

- There is no consistency in the ordering of monitoring locations throughout the Plan. Listing monitoring bores (and relevant formations) in the same order in each table would be useful. Consistent ordering will improve readability of the plan and make it easier for both writers and reviewers to ensure all the necessary information is presented.
- The EPBC Approval conditions use the following terms:
    - control monitoring sites
    - baseline monitoring data
    - proposed trigger values for detecting impacts on groundwater levels (and a description of how and when they will be finalised)
    - groundwater level early warning triggers for the Doongmabulla Springs Complex, and
    - impact thresholds for the Doongmabulla Springs Complex.

  The EPBC Approval Conditions propose an 'Interim Threshold' (for groundwater level drawdown) of 0.2m at the Doongmabulla Springs Complex. The GMMP appears to use the term 'Interim Threshold' interchangeably with 'Threshold Levels', 'Threshold values' and 'Threshold Limits' (a term proposed in the GMMP to replace 'early warning trigger' – see Table 1 – Condition 3c). GA recommends that the proponent use the terminology from the approval conditions.

The large number of reporting errors within the GMMP reduces confidence that scientific rigour and review has been applied to water management and planning requirements which may have impacts on the ability to protect Matters of National Environmental Significance under the Commonwealth Environment Protection and Biodiversity Conservation Act.

Hydrogeological Conceptualisation

The conceptualisation of the hydrogeology of the project site and surrounds is not discussed in sufficient detail in the GMMP, nor has sufficient attention been given to the potential for alternative conceptualisations (see details in the GA Stage 1 report). For example, the GMMP indicates the Clematis Sandstone is the source aquifer for the Doongmabulla Springs, however expert analysis (Land Court of Queensland – LSCC & Ors vs Adani 2015 – First Joint Groundwater Experts Report, 9 January 2015) has recognised that the conceptualisation for the source of the Doongmabulla Springs is inconclusive and that there are two potential sources that need to be considered.

The proponent states the GMMP has been developed to:

"...characterise the baseline groundwater conditions (pre-mining) and provision of monitoring points to evaluate the potential impacts on: local groundwater resources, local landholder bores, aquifers of the Great Artesian Basin (GAB), groundwater dependent ecosystems (GDEs), overlying alluvium and Tertiary groundwater resources, and surface water resources (Carmichael River baseflow, Doongmabulla Springs, and Mellaluka Springs) which may result from the proposed project." AECOM 2017, p1

From this, and Section 2.2 *Environmental Values*, it is unclear if the GMMP accounts for alternative conceptualisations and subsequently addresses all water resources protected under the Commonwealth EPBC Act - Section 24D and 24E – *Protection of water resources from coal seam gas development and large coal mining development* with *water resources* defined by the Commonwealth Water Act 2007. It is unclear if the GMMP has subsequently addressed all water resources with the current monitoring network design.

GA sees the opportunity for the proponent to address the uncertainty and knowledge gaps in the current hydrogeological conceptualisation and explore alternative conceptualisations via the GABSRP, RFCRP and monitoring conducted as part of the GMMP. The first two documents have not been reviewed, however, the GMMP makes no mention of conceptual uncertainty, and the proposed monitoring program does not appear to have been designed to address it. GA considers that alternative conceptualisations cannot be adequately refuted by only seeking additional data to verify the current conceptualisation. In order to rule out alternative conceptualisations, additional data must be collected that provides refuting evidence.

Monitoring effectiveness - Bore water level data - issues/quality assurance – Implications for condition 3.a-d)

Accurate and precise determination of groundwater levels is crucial in determining baseline groundwater conditions, establishing how the groundwater system behaves and setting impact triggers and thresholds. Groundwater level data has not been adequately presented and interpreted in the GMMP, so GA cannot confidently assess the effectiveness of the monitoring program.

Groundwater levels can be determined manually or a pressure transducer logger can be installed in a monitoring bore to provide continuous measurement of pressure, which then needs to be converted to groundwater level. The GMMP does not explain the methodology used to calculate and correct groundwater levels from loggers, or how this data is calibrated to manual water level measurements. This lack of information, coupled with errors and inconsistencies in the groundwater monitoring data presented in Appendix C (AECOM 2017), is of major concern. It provides no certainty that the monitoring process will consistently and accurately determine groundwater levels from pressure readings to identify when triggers and thresholds may be approached.

GA has qualitatively compared the water level data supplied with the GMMP in Appendix C to the corresponding data supplied as part of the SEIS (Appendix D of GHD 2015). There are many notable inconsistencies between the water level monitoring data provided in the GMMP and the SEIS. These inconsistencies indicate significant flaws in data management and the reporting processes. If these issues are not addressed the ability of the proponent to monitor and report on groundwater conditions will be compromised.

Monitoring effectiveness - control sites and baseline – Condition 3.a.i) and 3.b)

GA assumes that control monitoring sites are those monitoring locations used to acquire uninterrupted data throughout the life of the project. As such, these control sites should be located where they will not be displaced by mining operations, in order to provide representative data on the conditions around the site.

GA notes the term 'Control Monitoring sites' is used twice in the GMMP, with both instances indicating these sites have been established. However, the GMMP does not provide any information regarding the location of hydrogeology of these Control Monitoring sites. GA is of the professional opinion that Condition 3.a.i) has not been adequately addressed.

Conceptualisation/monitoring- bore network, locations, placement – Conditions 3.a.i-iii and 3.d

In order to provide effective early warning/protection from potential mining impacts, monitoring points are required between the impact source and Matters of National Environmental Significance (MNES). Early warning information can also be provided by monitoring intervening formations between the formations to be mined and the formations supporting the MNES.

The GMMP identifies 36 unique monitoring bores that are assigned threshold limits (Table 11, AECOM 2017), 19 of which are classified as Early Warning Bores. However, Figure 1 shows only 8 of the 19 bores have the potential to provide monitoring data for the life of the mine in formations and locations that may provide early warning of impacts to MNES.

GA considers that these 8 early warning bores do not provide adequate early warning to protect MNES from potential impacts. The geographic coverage of the network is insufficient and the network design does not appear to address the uncertainty in the Doongmabulla spring source aquifer conceptualisation by monitoring the Rewan and underlying formations with life-of-mine monitoring bores.

Conceptualisation/trigger - mitigation measures for water resources - Conditions 3.d and 3.d.i)

The GMMP proposes an investigation approach for exceedances of 'impact threshold levels' for Great Artesian Basin (GAB) units only (specifically Dunda Beds, Clematis Sandstone and Rewan Formation). The Queensland Environmental Authority (EA) does not limit or exclude considering investigation or mitigation actions for other, potentially affected, hydrogeologic units. The only specific corrective action is to offset predicted take of GAB water for the life of the project as determined by the administering authority. No other water resources have corrective action and/or mitigation measures.

GA has concerns regarding the method used to determine Threshold Limits (trigger values). No information is provided to indicate that the 'Maximum Predicted Groundwater Level Drawdown' value (Table 11, AECOM 2017) from the groundwater model is a reasonable drawdown and subsequently of low environmental risk. No information is provided to show that model uncertainty has been quantified. It is not explained why model-predicted drawdown plus 10% is an appropriate Threshold Limit (p87). The Threshold Limit must be informed by the impact considered acceptable to a receptor. If the Threshold Limits are set so that no unacceptable drawdown is predicted at receptors, a more precautionary way to deal with model uncertainty would be to set the thresholds at model-predicted minus 10%. Model uncertainty must be quantified, and a detailed rationale provided for how the Threshold Limits were set.

Water quality - methodology/uncertainty/QLD EA – Condition 3.d.i)

The inadequate spatial coverage and lack of control sites identified for water level monitoring also apply to the network proposed to monitor groundwater quality, which utilizes many of the same bores. In addition to this concern, GA identified a wide range of problems with the groundwater quality components of the GMMP.

Groundwater quality data has not been suitably evaluated and no details are included on how it will be assessed in future. There are numerous inconsistencies in data used to derive trigger levels, and no demonstration of an assessment of the quality/ reliability of the data used. Groundwater quality triggers have been set through inappropriate handling of non-detect data and published water quality guidelines (e.g. ANZECC 2001), without consideration of spatiotemporal variability and biases in the dataset. This has resulted in some triggers far in excess of baseline concentrations, which will not provide adequate warning of mining-related impacts. Draft rather than final versions of national water quality guidelines have been referenced, and even some of these draft values have been incorrectly reproduced/ applied. Data prior to 2014 has not been considered when setting trigger values without reasonable justification.

Due to these concerns around the groundwater monitoring data, it is not possible to determine if the proposed monitoring network and methods are suitable. The investigation and response process to trigger exceedances is unclear, and there is no description of how groundwater quality data will be compared to proposed trigger levels. In summary, the groundwater quality components of the GMMP require thorough, detailed revision before they can be properly assessed for adequacy. Examples to support the above conclusions are included in the detailed review table (rows 22 to 36). It is emphasised that the detailed review table does not include an exhaustive list, rather a selection of issues to illustrate the range of problems identified.

Carmichael Coal Mine and Rail Project

GA Stage 2 Commentary: Detailed technical comments on Groundwater Management and Monitoring Program (GMMP; 1 August 2017) in relation to EPBC 2010/5736 approval conditions 3a.i, 3a.ii, 3a.iii, 3b, 3c, and 3d.i.

Reviewer: Geoscience Australia

	GMMP section	Comment	Relevant approval condition/topic
Monitoring effectiveness - Bore water level data - issues/quality assurance			
1	s3.2, s3.2.2, s3.2.3, Appendix C	Groundwater level data has not been adequately presented and interpreted in the GMMP. There are various issues with the groundwater level data which are not discussed in the GMMP. There is limited methodology detailing the processing, corrections and accuracy of the water level data. This makes it unclear if appropriate methodology or procedures have been followed to inform the hydrogeological conceptualisation, establish the well network, and evaluate baseline conditions. Examples include (but are not limited to): • Some manual measurements are substantially different to logger measurements. In C9180121SPR (p14 of 109) the maximum difference approaches 5 m (noting that this well is artesian). In HD03b (p8 of 109) the maximum difference approaches 10 m. • It appears that physical logger depths may have been altered in some wells but these adjustments not accounted for in conversion to AHD (e.g. a step is evident in the C018P2 logger levels that does not match manual measurements; p23 of 109). • C025P1 (p3 of 109) has been dry since May 2015 but there is no discussion on whether it will be replaced with a deeper well (or if its screen is above the base of the alluvium it monitors). • There are large ranges in salinity (e.g. Appendix D and p96 of the main text), but there is no discussion on whether water levels should be adjusted for specific gravity density. • There is no discussion if water levels are corrected for thermal density changes – or if thermal density corrections are unwarranted, there is no justification. • It is not clear where the barometers are located. There needs to be consideration of the number required per area to ensure groundwater levels reported have accounted for diurnal barometric changes. • Bore elevation/measure point elevation details could not be found. The GMMP does not include the bore construction details or reference where this might be found. The SEIS appendix B Table B1 (Appendix D GHD 2015), supplies some surveyed ground elevations and top of casing elevation information. Of concern is bore HD02 which appears to only have a basic GPS ground level elevation survey, with the top of casing elevation (the measure point for water levels) being derived from the GPS ground elevation. There is no discussion on the constraints of vertical accuracy for these water level measure points (particularly for HD02) and their subsequent implications to water level accuracy.	Water levels. Affects assessment of all approval conditions.

	GMMP section	Comment	Relevant approval condition/topic
2	s3.2 s3.2.2 s3.2.3 Appendix C	GA has compared Appendix C from GMMP 2017 (AECOM 2017) to Appendix C from the SEIS (as attached in Appendix D of GHD 2015). The hydrographs presented in the GMMP were frequently different to those in the SEIS for the same monitoring wells over the same time period. The following differences were observed repeatedly: • The GMMP hydrographs did not present the whole monitoring record for many of the monitoring points. o This was not discussed in the GMMP, and is of significance as the earlier data should be considered as part of the baseline dataset (unless there is a technical reason to not include the data), and will have an impact on the reference values calculated from the baseline dataset. • The groundwater levels on the hydrographs in the two documents are different for several of the monitoring points, for example there often appears a slight shift up or down. The differences in the hydrographs do not appear to be systematic or consistent. • The hydrographs in the GMMP appear to be upside down for several monitoring points compared to the SEIS, despite having the same vertical units (metres in AHD). • Monitoring points C008P1 and C012P1 are reported to be from different formations in the two documents. To illustrate the issues found between the data present in the GMMP and comparable data contained in the SEIS, the following figures highlight hydrographs for the same monitoring point in AECOM (2017) and GHD (2015). • Figure 2 – C011P1 • Figure 3 – C027P2 • Figure 4 – HD02 In the time available, GA has identified a number of examples of groundwater level data issues in Table 1, but this should not be considered an exhaustive list. These issues are examples of impact on confidence in the data and scientific process being applied. These issues need to be either fixed or justified. In its current form, the data presented in the GMMP is not an acceptable baseline dataset.	Water levels. Affects assessment of all approval conditions.

	GMMP section	Comment	Relevant approval condition/topic
3	s3.2.2, p62 Appendix C Table 11, p87-89	In order to compare groundwater levels across the site and over time, and the groundwater flow direction, the groundwater level measurements collected need to be referenced to a common datum, usually Australian Height Datum (AHD). This section implies that logger measurements of groundwater level are converted to elevations relative to AHD based on a single manual reading taken when the logger is installed. This is inappropriate, and may explain why manual measurements do not match logger levels in Appendix C. Manual measurements should be taken accurately using calibrated dip meters (noting that a different method may be required for artesian bores). Manual measurements are the primary observations against which logged water level measurements should be calibrated. Logger readings/accuracies are known to fluctuate over time due to factors such as instrument drift. Logger readings should therefore be adjusted to match manual measurements by distributing errors between manual measurement points, taking care to adjust logger measurements to reflect water density where required. As part of this process, it is important to establish over what timeframe instrument drift is linear so that manual measurements can be taken at an appropriate frequency. This process will also provide information on logger measurement uncertainty/accuracy (which should always be evaluated and reported). The data processing description above does not always match the data included in Appendix C (e.g. on p18 of 109, the first manual measurement taken in C008P2 is below the logger reading. HD03b on p8 of 109 in Appendix C is another clear example). Additional information is required on how vibrating wire piezometers were installed (e.g. fully grouted or with gravel packs), the accuracy to which installation depth is known, and the anticipated accuracy and resolution of the instruments. This is required to inform instrument suitability for measuring proposed drawdown thresholds in the GMMP Table 11 (AECOM 2017, p87-89). This suitability assessment should extend to all loggers, not only vibrating wire piezometers.	Water levels. Affects assessment of all approval conditions.
4	s4.2.2, p78	It is stated that hydrostatic pressure readings are taken from artesian bores 'manually (reading PSI gauges) and using automated pressure gauges'. A discussion is required on the accuracy of the 'PSI gauges' and what exactly the 'automated pressure gauges' are. Do these differ from the logger/vibrating wire piezometer – data logger instrumentation discussed in the subsequent paragraph? Note that if 'PSI gauges' are used for manual measurements against which to calibrate submerged logger readings (see comment on s3.2.2 above), this implies that the 'PSI gauges' have greater accuracy.	Water levels. Affects assessment of all approval conditions.
5	s3.6, p75	Is it unclear what 'composite bores' in Table 8 are (AECOM 2017), these could be nested or continuously slotted bores. There needs to be a discussion of what they represent and if they are fit for purpose.	Water levels.
Monitoring effectiveness - control sites and baseline – Condition 3.a.i) and 3.b)			
6	General	The GMMP does not explicitly identify control monitoring sites.	Condition 3.a.i)
7	s3.0	Hydrographs are not provided (Appendix C) for several of the monitoring bores listed as part of the Baseline Monitoring network (these are C971SP (C896G), C14032SP, C14024SP, C14015SP). This omission has not been explained.	3.b
8	s3.0	C14020SP (Moolayember Formation) has a hydrograph provided and is listed as part of the preliminary monitoring network, but not listed in the Baseline monitoring network. This has not been explained.	3.b
Conceptualisation/monitoring- bore network, locations, placement			

	GMMP section	Comment	Relevant approval condition/topic
9	s3.1, s5.2, Table 11	The monitoring points intended to monitor potential impacts on the GAB Aquifers are not specifically identified.	Condition 3.a.ii,
10	s3.0 Table 3	The monitoring network is not adequate to meet the EA conditions. E4 requires that the GMMP be used to confirm the groundwater numerical model predictions, but there is a lack of bores to the west in units deeper than the Clematis Sandstone	3.d.i
11	Table 11	As noted in the Stage 1 report, there are several unexplained repetitions of monitoring points in Table 11 (AECOM 2017), and inconsistencies in some threshold values presented.	3.a/ii
12	s3.0	At least two of the 19 Early Warning bores lie to the east of the mine, and so do not appear to be situated to provide early warning of impact to Doongmabulla Springs and GAB water resources Figure 1. It is not clear if these are monitoring other MNES.	3.d and 3.d.i
13	s3.0, s4.0	It is important that monitoring bores are available throughout the life of the mine, so that long term changes in the monitored parameters can be identified and used to improve the understanding of the hydrogeology of the area and identify any deviations from behaviour predicted in numerical models. Of the 19 Early Warning Bores, 5 appear likely to be mined through at some point in the mine operations. Table 3 (attached) lists the number of bores to be compromised by mining progression.	3.a.ii 3.a.iii
14	s3.0, s4.0	Early warning can also be provided by monitoring formations located between the target coal seams to be mined and the formations supporting the MNES. The Carmichael Mine will primarily target the AB seam in the Bandanna Formation and the D Seam in the Colinlea Sandstone. The potential source aquifers for the Doongmabulla Springs are either the Clematis Sandstone or a source below the Rewan Formation, both of which lie above the target coal seams. As such, formations underlying the target seams are unlikely to provide early warning of potential impacts, and so do not warrant the significant monitoring effort described in the Early Warning Monitoring Network (6 of the 19 Early Warning bores are monitoring the Joe Joe Formation, which underlies the target seams).	Condition 3.a.ii and Condition 3.d.i
Conceptualisation/trigger - mitigation measures for water resources			
15	s5.2.1	No discussion of investigation approaches that consider geological units other than Dunda Beds, Clematis Sandstone and Rewan Formation – noting there are no unit specific limitations imposed by either EPBC approval conditions or Queensland EA.	Condition 3.d and 3.d.i
16	s5.2.1	No discussion of corrective actions or mitigation measures that consider geological units other than Dunda Beds, Clematis Sandstone and Rewan Formation – noting there are no unit specific limitations imposed by either EPBC approval conditions or Queensland EA.	Condition 3.d and 3.d.i
17	s5.2	Groundwater level thresholds have been set at maximum model drawdown +10% and +20% for low and high thresholds respectively. There is insufficient justification for this approach. Threshold should be determined by unacceptable impacts to receptors.	Condition 3.c & Condition 3.d
18	s5.2	Stage 1 identified the need for clarity in describing the methodology for establishing trigger values and the decision making, mitigating actions and reporting process if early warning triggers and drawdown impact thresholds are reached – this would best be shown in a decision tree diagram for clarity of process	Condition 3.c & Condition 3.d
19	s5.0	Some monitoring points appear to be at the same location, targeting the same formation, and yet have different threshold values (for example see Table 2).	Condition 3.c & Condition 3.d
20	s5.0	The monitoring points intended to monitor potential impacts on the GAB Aquifers are not specifically identified.	Condition 3.d

	GMMP section	Comment	Relevant approval condition/topic
21	s5.0	The GMMP would benefit from providing a synopsis of simulated drawdown confidence or uncertainty, or alternatively guide the reader to previous reports with the appropriate information. Such a synopsis should consider the implications of model grid refinement around the bores to be utilised for developing trigger values, or for predicting drawdown around the springs. This would allow a more localised assessment of potential impacts. In the time available, GA has been unable to identify a figure which indicates the model grid and mesh refinements.	Condition 3.c & Condition 3.d

	GMMP section	Comment	Relevant approval condition/topic
Water quality - methodology/uncertainty/QLD EA – Condition 3.d.i)			
22	General comments on trigger level setting methodology, mostly pertaining to: s5.3.1, p94-110 Appendix D	The GMMP does not demonstrate that groundwater quality triggers have been set appropriately. These triggers are intended as threshold concentrations, where exceedances warn of potential mining-related impacts. The GMMP states that, where >50% of results are below laboratory detection limits, the trigger was set based on national water quality guidelines. Where <50% of values were non-detects, triggers were set at the 85th percentile of baseline concentration in each geological unit. National water quality guidelines are useful for assessing if environmental harm has been caused (e.g. to inform conditions E11 and E12), but they are not suitable triggers to warn of mining-related impacts. These water quality guidelines often substantially exceed baseline concentrations measured in groundwater. As an example, the Rewan Formation chromium (Cr) trigger is set at 27.4 ug/L (AECOM 2017, Table 17, p103) based on water quality guidelines, but the maximum groundwater concentration is only 2 ug/L (p9 of Appendix D). This allows Cr concentrations to exceed 13.7 times the current maximum concentration in Rewan Formation groundwater before a potential mining-related impact is identified. As a second example, the maximum concentration of sulphate in the Colinlea Sandstone D seam is reported as 51 mg/L (p8 of 75, Appendix D), but the trigger is set at a '*marine*' water quality guideline of 500 mg/L. This is a higher trigger than for other formations that show higher baseline sulphate concentrations than the Colinlea Sandstone D seam. It is important to note that the trigger is not the concentration at which environmental harm occurs; it is the concentration that signals potential mining-related impacts. Note that further issues with the selected Cr and sulphate water quality guidelines are outlined in comment 26 below. Where many values are non-detect, more sensitive laboratory analytical methods could be considered. If more sensitive methods are unavailable, a trigger could be justified at or close to the detection limit, but setting the trigger at a groundwater quality guideline that is higher than baseline is not appropriate. It is noted that the triggers for total recoverable hydrocarbons (TRH) and sulfide (S_2) were set at the detection limit in the GMMP, but no rationale is provided in s5.3.1, and other parameters were not treated in the same way without explanation. A single groundwater trigger is given for each analyte in each geological unit without taking into account spatial variability. Trigger levels can therefore be biased by a few anomalous bores (or measurements) towards high concentrations. One example is copper in the 'Tertiary' unit. The trigger is set at 0.225 mg/L at the 85th percentile of baseline data. However, there are six bores in the 'Tertiary', and only two have recorded concentrations >0.225 mg/L. The remaining four wells have recorded maximum concentrations of 0.063, 0.028, <0.001 and <0.001. Since there is considerable variability in quality within individual geological units, this potentially enables substantial, widespread increases in concentrations before a trigger is exceeded. Setting triggers for individual bores, or possibly sub-areas with similar chemistry, would be more suitable. No justification has been provided for setting them at the geological unit level. Consideration of spatial variability is required. The GMMP does not indicate how groundwater concentrations will be evaluated against the triggers. For example, if individual concentrations are compared to the trigger, this would result in automatic failure in wells that already exceed the 85th percentiles. Alternatively, will the 85th percentile be calculated for all bores in a geological unit and compared to the trigger for that unit? If so, will this be for all readings including baseline? Or will this be undertaken on a yearly/monitoring round basis? The comparison method will affect results/interpretations so it must be stated before the GMMP can be approved.	Groundwater quality – condition 3.d.i

	GMMP section	Comment	Relevant approval condition/topic
23	General comments on data analysis procedures in relation to trigger setting, mostly pertaining to: s5.3.1, p94-110 Appendix D	Groundwater chemistry data has not been adequately presented and interpreted in the GMMP, so GA cannot confidently assess what trigger levels are suitable. Only groundwater quality tables with summary statistics are included (Appendix D). This data should be analysed to better characterise/contrast hydrochemistry of different geological units. Among many options, useful assessments could include: • Considering the data spatially to understand variations in chemistry and assess if a single trigger value is suitable for each geological unit (discussed in comment 22 above; e.g. if all elevated concentrations are only in a small portion of the unit, they are not a conservative trigger level for other areas). Spatial assessment may also help to inform the hydrogeological conceptualisation. • Further classifying/interpreting the data using piper diagrams, multivariate statistics or other means (the SEIS (appendix D of GHD 2015) includes this style of analysis with earlier data). This would enable a detailed spatial assessment of chemical processes and potentially identify existing aquifer connectivity. • Chemistry results must be discussed and interpreted in the context of the conceptual model, but even this basic level of analysis is mostly lacking. One example is TRH identified above detection limits in several wells (e.g. sample C029P120140429, Appendix D (AECOM, 2017), p2 of 75). The potential TRH sources and causes of elevated concentrations are not discussed. These need to be understood before mining-related sources of TRH (e.g. fuels) are used on site. Methods exist (e.g. silica gel cleanup) to distinguish between petrogenic and other hydrocarbons, but these do not appear to have been considered. • Considering data temporally. No analysis is presented of how chemistry fluctuates in individual bores over time. This is important: it can indicate if results are anomalous (e.g. artefacts of poor sampling technique or residual drilling effects) and should therefore be excluded when developing trigger levels. One example is manganese in C008P2 (Figure 5a and b) which decreases over time in the graphs. If the elevated results are unrepresentative of baseline conditions, they should not be incorporated when developing trigger levels. Further examples include aluminium in well C014P2 (Figure 5c which includes the maximum concentration in the Bandanna Formation), and pH and ammonia in well C833SP (Figure 5d) in the D seam of the Colinlea Sandstone (this bore is of particular interest, because TRH and BTEX compounds are regularly identified above detection limits and the elevated pH values seem unusual). None of these chemistry variations are discussed in the GMMP, yet these results are included in the baseline data set to derive trigger values. • Results from each well should be carefully assessed to understand if they are representative of groundwater. One example is C971SP. This well is periodically dry. It has only been sampled once and had the lowest total dissolved solids (TDS) of all the 'Tertiary' wells. If it is representative of groundwater in this area, then only including one sample for this well in the database skews the 85^{th} percentile for TDS of this unit towards high values (fully explained in comment 26 below). Conversely, if it is unrepresentative of groundwater, it should not be included in deriving the trigger values. An explanation is required for why this well is not re-drilled, given the commitment in s6 (p117) to replace dry wells. • Fully assessing data quality to understand associated uncertainty and reliability. This has not been demonstrated in the GMMP and is discussed in detail under comment 24 below.	Groundwater quality – condition 3.d.i

	GMMP section	Comment	Relevant approval condition/topic
24	General comments on QA/QC, mostly pertaining to: s4.3.4, p81 and Appendix D	Quality assurance / quality control (QA/QC) procedures are inadequately dealt with in s4.3.4. A detailed QA/QC program is required to understand uncertainty in the data, evaluate its reliability, and enable GA to assess the suitability of proposed trigger values. Guidance is provided in a range of state and federal publications (e.g. Sundaram et al., 2009). There is also guidance contained in the '*EHP Water Quality Sampling Manual*' referred to on p80 of the GMMP, so it is unclear why this has not been incorporated. Examples of common QA/QC procedures that have not been discussed/included in the GMMP include (but are not limited to): • Section 4.3.4 indicates that intra-laboratory duplicate samples were taken for QA/QC and refers to Appendix D. Appendix D does not clearly indicate the duplicate samples. There is no discussion of whether these were blind duplicates (they should be), and there is no detailed discussion of results. It is standard practice to calculate relative percentage differences (RPD) between duplicate samples and assess them against nominated acceptance criteria. This has not been demonstrated. • It appears that duplicate samples may be labelled with a 'Q' in Appendix D. If so, it is unclear why they were not tested for all analytes (noting that in s4.3.4 p81 it states that they will be). Q4 (p9 of 75 in Appendix D), for example, omits all TRH fractions besides C6-C10, while Q1 (p11 of 75 on Appendix D) omits major cations. Further, only two samples labelled with a 'Q' were included in the tables. This does not match the stated 1 in 10 duplicate samples referred to in Section 4.3.4. If there are more duplicate samples, these must be clearly labelled. As per the discussion in comment 26 below, including duplicate samples in statistical assessments may affect results and must be discussed/considered. • Charge balances on major ions have not been reported. These are usually calculated, reported, and discussed relative to nominated acceptance criteria to provide confidence in the monitoring results. • Blanks, spikes and inter-laboratory duplicates are often considered for inclusion in groundwater sampling QA/QC programs in addition to intra-laboratory duplicates. • Detailed descriptions of sampling, handling and preservation procedures are required (see comment 27 below). • Field parameters (temperature, dissolved oxygen, pH, redox potential, electrical conductivity) should be reported, compared to previous results to identify sampling issues, and can be used to confirm that laboratory results are reliable (e.g. certain metals will only be soluble under particular Eh-pH conditions). • Laboratory electrical conductivity and TDS measurements can be compared to field electrical conductivity readings to identify analytical discrepancies. • Inclusion of chain of custody documentation confirming that samples have been appropriately handled and holding times have not been exceeded, or at least confirmation that this documentation is available upon request.	Groundwater quality – condition 3.d.i

	GMMP section	Comment	Relevant approval condition/topic
25	General comments on data quality affecting trigger levels in: Appendix D	In addition to a lack of QA/QC assessment, GA noted a range of problems with the groundwater chemistry data in Appendix D. It is crucial that this data is scrutinised and assessed for reliability because it forms the basis of the trigger levels derived to protect groundwater. Data scrutiny and assessment have not been demonstrated in the current GMMP and the chemistry results are not adequately discussed. The following examples of issues noted in Appendix D can help to inform that process in future (these are only a selection of the problems identified): • Sulphate has not been analysed for some samples without explanation. Charge balances cannot be calculated for these samples for QA/QC. Other analytes have also been omitted without explanation for some samples (e.g. nitrogen species, sulphide, fluoride, BTEX). • Most TPH fraction concentrations in alluvium (Appendix D, p2 of 75) are input as the same values. If this is the detection limit, it should be indicated with a '<' prefix as per other columns. The TPH C10-C36 fraction generally appears to be the sum of the three constituent fractions but this is not consistent. • The TRH non-detects are also internally inconsistent. Examples include: o '>C10-C40' should be the sum of the constituent fractions but it is not; for C027P1 (Appendix D, p2 of 75), for example, it is given as '<100', but should be '<300'. o It is incorrect to list '>C10-C40' as '120 ug/L' for C029P120140429. The sum of <100, 120 and <100 is not adequately represented as 120; <320 would be more suitable. o The <C10-C36 TRH sum has not been calculated for all samples without explanation. This applies to other TRH columns. o Total TRH should not be zero based on non-detects. It should be input as a < value. If calculated as the sum of all the measured fractions, this should be noted, and the heading for 'Total TRH' adjusted appropriately (e.g. TRHC6-C40). • Naphthalene is not reported in Appendix D. However, there is a '>C10-C16 minus Naphthalene' column that has been filled in, so naphthalene must have been analysed in some samples. There is no discussion of this omission. • A total value is given for BTEX. It would be informative to report the results separately for the constituent species (benzene, ethylbenzene, xylene, toluene). • It appears that the method detection limits are included in row 4 of the tables in Appendix D although this row is not labelled. If these are detection limits, some concentrations are input below the method detection limits without explanation. • Field parameters should be reported and can be compared to laboratory results as part of QA/QC. • There is no explanation of why TDS is calculated from EC rather than using gravimetric methods. If it is to be calculated using EC, some explanation of the conversion factor and how this was derived are required (it is likely to be quite uncertain). If TDS is to be calculated from EC, it is unclear why there are separate triggers proposed for TDS and EC in s5.3.1 (p84-110). • Some of the results seem unusual; e.g. the TDS and EC results for C9845SPR are exactly the same for eight out of nine samples. • Appendix D omits data prior to 2014 that was included in the SEIS without sufficient explanation. Section 3.2.1 (p48) notes that the previous sampling was irregular and did not include the full analytical suite of later baseline sampling. However, it is unclear why the results are not included in the baseline assessment where overlap of analytes occurs. This could affect trigger setting. One example is C008P2. BTEX compounds were reported in the 12/11/2011 sample from this well in the SEIS, but none are identified above detection limits in the current GMMP.	Groundwater quality – condition 3.d.i

	GMMP section	Comment	Relevant approval condition/topic
26	Additional issues relating to trigger setting, mostly relating to: s5.3.1, p94-110. Appendix D	Potential problems with basing groundwater quality triggers on national water quality guidelines are outlined in comment 22 above. Further issues were noted with the implementation/selection of triggers in the GMMP. Those relating to water quality guidelines will have relevance to future assessments of environmental harm: • Schedule B1 from a proposed amendment to the 1999 National Environment Protection (Assessment of Site Contamination) Measure (NEPM) marked 'Draft for Public Consultation' is included in Appendix D (p15-75). It contains many of the water quality guidelines referenced in the GMMP. A revised version of this amendment was finalised in 2013 so this is not the correct version to reference. • The applicability of all water quality guidelines proposed in the GMMP should be thoroughly reviewed and the values re-confirmed. Examples of errors identified with this aspect of the GMMP include: o The water quality guideline for chromium (Cr) is erroneously applied. Only total Cr has been analysed; speciation into CrIII and CrVI has not been undertaken. The proposed GMMP trigger of 27.4 ug/L is a value from the NEPM for protection of marine waters from CrIII. The CrVI value for the protection of freshwater is 1 ug/L in the NEPM. Selection of the higher trigger value is not conservative given that speciation testing has not occurred, and a marine trigger is less applicable in this environment. o It is unclear why the 'total xylenes' trigger is used for BTEX when individual water quality guidelines are provided in the NEPM for benzene, toluene, ethylbenzene and xylene. o The proposed trigger of 500 mg/L for sulphate in the Colinlea Sandstone D seam is referred to as a 'marine' trigger, but this is actually a drinking water guideline in the NEPM. o The water quality guideline for mercury is listed as 0.6 ug/L in the current GMMP, probably based on the value for inorganic mercury in the draft NEPM included in error as Appendix D. This value does not appear in the final version of the NEPM, where the only freshwater quality guideline for mercury is 0.06 ug/L (from the ANZECC Water Quality Guidelines (ANZECC 2001) for protection of freshwater species in slightly-moderately disturbed systems). • Groundwater quality varies substantially between bores in the same geological unit. Some bores have been sampled only once or twice (e.g. C971SP), while others have been sampled over ten times. The GMMP must consider the potential effects this may have on deriving trigger levels statistically from baseline values if this is undertaken on a geological unit basis. Further to this point, sampling was discontinued in several wells without explanation in Table 4, (AECOM 2017, p49-61 – e.g. C006P1, as the first table entry). Justification for the particular subset of wells selected for ongoing groundwater quality sampling is required, and consideration should be given to how this may affect derived trigger values. • The quality triggers for pH are input as the maximum and minimum laboratory analyses. This is problematic: o The EA stipulates they should be 85th percentiles, not maximum and minimum values. So the 85th percentiles could be calculated in ascending and descending order to get the required range. o The laboratory pH value is unlikely to be representative of site conditions. CO_2 will usually outgas from samples so laboratory pH values are typically higher than those measured in the field. Trigger values should rather be developed for field pH readings.	Groundwater quality – condition 3.d.i

	GMMP section	Comment	Relevant approval condition/topic
27	General comments on sampling methodology, mostly pertaining to: s4.3.2, p79-80	Insufficient details are provided on sampling methodology. A detailed methodology is required if GA is to assess whether representative samples are likely to be obtained. Similarly to QA/QC procedures, there are a number of state and federal publications that provide detailed guidance on sampling methodology. It is insufficient to state that sampling will be undertaken in line with certain guidelines because they cover a range of possibilities, so project-specific information is required. The methodology should include (but certainly not be limited to): • Confirmation that field instruments will be properly calibrated (it is noted that this is mentioned in s4.3.4, p81, but incorporation of all procedures into a single sampling plan will facilitate review and help the proponent and DoEE ensure correct procedures are being followed). • The type of low flow sampling pump and suitability for gathering sample types (e.g. certain methods will not provide representative samples for volatile hydrocarbons). • Confirmation of detailed low-flow sampling methodology (tolerated head drawdown, minimum purge times/volume, if packers will be used to isolate screens etc.). • Confirmation that 'dedicated low-flow systems' is intended to include that no part of the sampling system that contacts groundwater before sampling will be used in more than one well. If this is not the case, the proposed method for cleaning equipment between wells should be stipulated (along with proposed QA/QC measures e.g. rinsate blanks). • The type of sample containers to be used. • Sample handling and preservation details (the use of clean gloves, cleaning and rinsing of containers, cooling, freezing, acidification, filtering, reducing light exposure etc.). • Confirmation that spring samples will be representative of discharging water (e.g. precautions taken to prevent inclusion of oxygenated waters, colloids, nutrients etc.). • Confirmation that appropriately accredited laboratories (NATA) will be used to undertake analyses (this is only mentioned in reference to TRH/TPH in the table footnotes in s5.3.1, p95-110). • Confirmation that '*all determinations of groundwater quality, groundwater monitoring and biological monitoring must be performed by appropriately qualified person/s*' in line with the requirements of E2 of the EA. Again, this is mentioned in s6, p117, but it should form part of a detailed sampling methodology.	Groundwater quality – condition 3.d.i
28	s3.2.1, p48	Condition E3 of the Queensland EA clearly states that baseline monitoring events must be no more than 2 months apart. This monitoring frequency was not met according to the third bullet list on p48 and the sample dates in Appendix D.	Groundwater quality – condition 3.d.i
29	s3.2.1, Table 4, p49-61	Several issues were identified with Table 4 (AECOM 2017): • From Table 4, it appears that all samples in the Joe Joe Group are from the Jochmus Formation. If so, consistency is required between Table 4 (refers to the Jochmus Formation) and Appendix D (refers to the Joe Joe Group). • In Table 4, sampling was not continued in several wells without explanation (e.g. C006P1, as the first table entry). A rationale is required for the selection of wells for ongoing groundwater sampling. • It is unclear why some samples reported in Table 4 are not included in Appendix D e.g. no samples are included in Appendix D for C14005SP and C14006SP but they are listed as having been sampled on p58.	Groundwater quality – condition 3.d.i
30	s3.3.1, p65	It is not good practice to use glue for constructing wells that are used for monitoring groundwater quality because it can introduce a range of contaminants to water samples. The effects may be exacerbated in low yielding wells, and in this setting may be of concern where monitoring for chemical/waste storage impacts. This goes against the requirement of E16: '...ensures the integrity of the bores to obtain accurate monitoring...'	Groundwater quality – condition 3.d.i

	GMMP section	Comment	Relevant approval condition/topic
31	s3.3.4, p67 s5.4, p111	These sections propose additional monitoring wells for construction phase activities relating to fuel, oil, chemical, water and waste storage/handling. The adequacy of the proposed monitoring cannot be assessed without details of the activities, their locations, and groundwater flow directions. A rationale for the proposed well depths is required. It does not seem that the monitoring plan for the additional wells proposed in these sections will meet the EA requirements for baseline data prior to construction (E3). Where chemical and fuel storage are proposed, additional analytes may be required.	Groundwater quality – condition 3.d.i
32	s4.1, p77	The GMMP states that suitable indicators of mining impacts include those that are 'Commonly found in the environment'. This requires explanation. Indicators uncommonly found in the environment but introduced by mining would also be suitable parameters. In light of this fact, potential contaminants that may be introduced throughout all mining phases should be listed. Some of these may need to be added to the water quality monitoring suite in some bores to ensure that mining-related impacts will be identified. For example, 'chemical storage facilities' are referred to in s2.4.2, p39. Depending on what chemicals are to be stored or used on site, additional parameters may be locally required.	Groundwater quality – condition 3.d.i
33	s4.3.3, p81	A reduced parameter suite is referred to but not provided. Condition E9 and Table E1 make no reference to a reduced parameter suite. With the exceptions of including dissolved oxygen and temperature, the baseline monitoring parameter suite listed under s4.3.3 p80 matches Table E2, so it is unclear why reductions would be justified.	Groundwater quality – condition 3.d.i
34	s4.5.1, p82	Statistical tests to develop parameter limits in isolation from spatiotemporal analysis are not acceptable as outlined in comments 22 and 23 above.	Groundwater quality – condition 3.d.i
35	s4.5.1, p82-83. s4.5.2, p83	Both 'contaminant limits' and 'trigger levels' are set for groundwater quality. The EA does not make mention of 'contaminant limits' in relation to groundwater in condition E (they are only discussed in relation to water release to surface water in condition F), and only requires setting of trigger levels. A more detailed explanation of, and justification for, the 'contaminant limits' are required. Some basic information is included in s4.5.2, p83 (Investigation and Response Process) but the response process is unclear in this description: • A flow diagram of the response process including response times would help to improve clarity here. This response process must be clearly written and meet the time and reporting requirements stipulated in the EA. • It is unclear why re-testing of groundwater in this response process will not include all analytes. What if TPH, BTEX, pH, TDS, or electrical conductivity exceeds the trigger values? Why will they not be retested? Further to this point, it is noted that the footnotes to Tables 13-20 (AECOM 2017) state that if TRH or S_2 exceed the trigger values, they will be reanalysed and only if the second analysis exceeds the trigger will investigation into environmental harm be initiated. It is unclear why these two parameters are discussed separately in the table notes but not in the response process. It could be related to the fact that the triggers for these parameters are set at the method detection limit, but this is not discussed. As is the case for much of the GMMP, more information is required. • In s6, p117, the proponent commits to notifying the regulator within one month of receiving water quality results if a trigger is exceeded. If this is intended, it should be incorporated into the response procedure in s4.5.2. It should be made clear if this is proposed for all trigger exceedances for all analytes (e.g. see discussion on TRH and S_2 in the preceding bullet point). Consistency in the GMMP is required.	Groundwater quality – condition 3.d.i

	GMMP section	Comment	Relevant approval condition/topic
36	s5.3.1, p94	The GMMP proposes that monitoring wells in coal seams can be used to represent water quality in the Bandanna Formation and Colinlea Sandstone. The justification provided is: '*…as these units will be directly affected by mining operations and have large baseline datasets*'. These coal seams should be monitored, but further explanation is required as to why they are representative of the Bandanna Formation and Colinlea Sandstone. Water quality within the coal seams should be compared to water quality outside the coal seams when making this assessment, because different lithologies may well show differences in hydrochemistry.	Groundwater quality – condition 3.d.i
37	s2.4, p37	The GMMP refers to potentially contaminating land uses that would require specific monitoring and design details. Of particular concern, p37 refers to a general waste landfill, but there are no details provided of containment design and monitoring infrastructure. Landfills pose a large risk to groundwater quality, so a thorough assessment of design and proposed monitoring are required. An airport is also referred to in this section (and s2.3).	Groundwater quality – condition 3.d.i

Figures

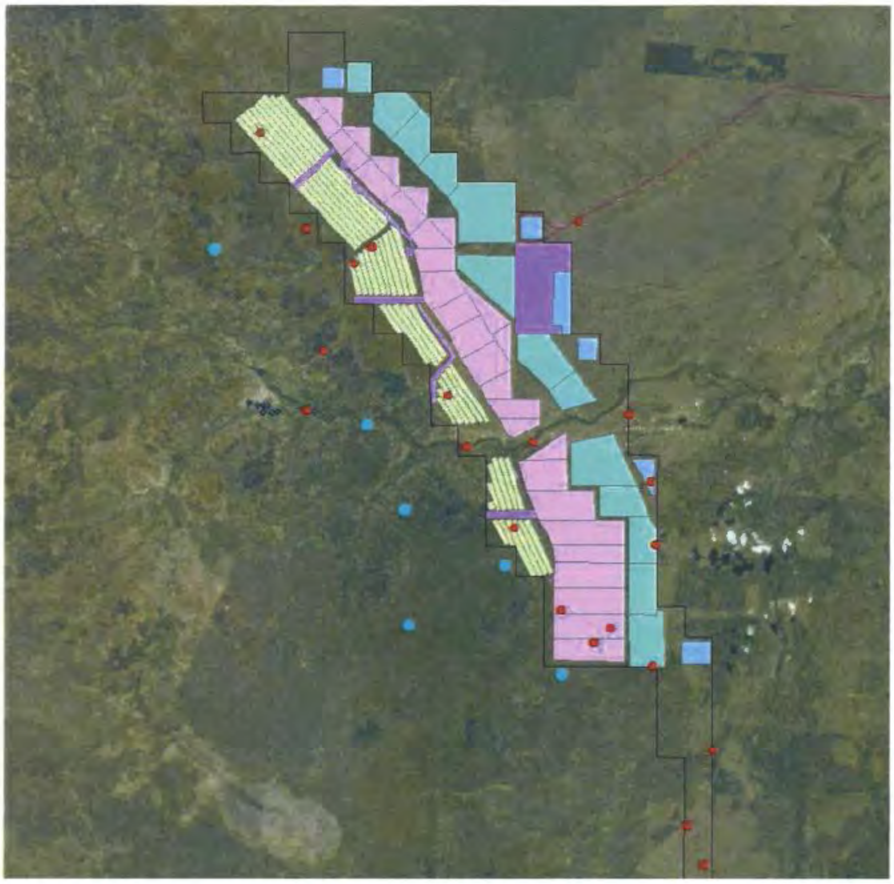


Figure 1: <u>Note: GA derived map</u> - Location of monitoring bores with threshold limits (both red and blue dots) and 8 suitable early warning bores (blue dots). It is noted that some bores are co-located so there appear to be fewer bores on the map than described. Yellow shaded areas are long wall panels, pink shaded areas are excavated pits, green shaded areas are waste rock/overburden and blue regions are water storage. Background image is Landsat world imagery

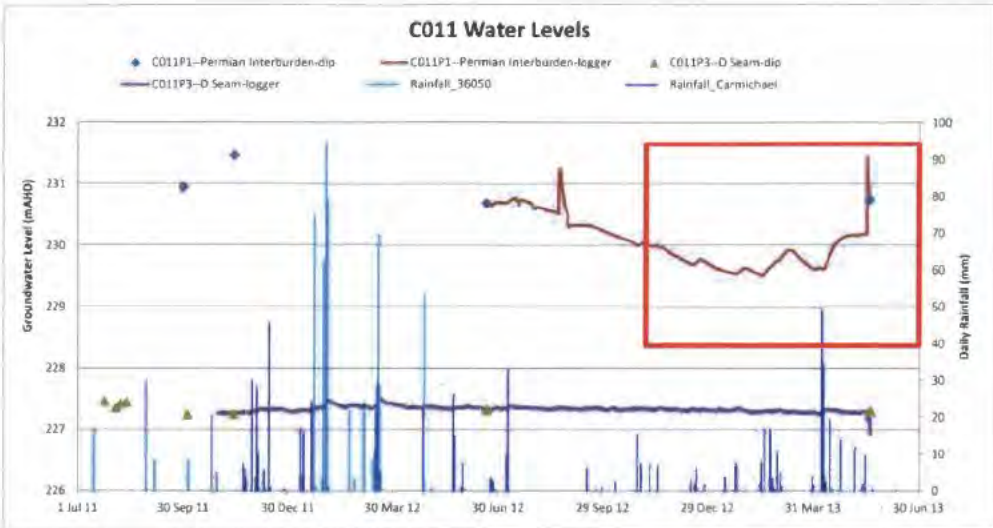
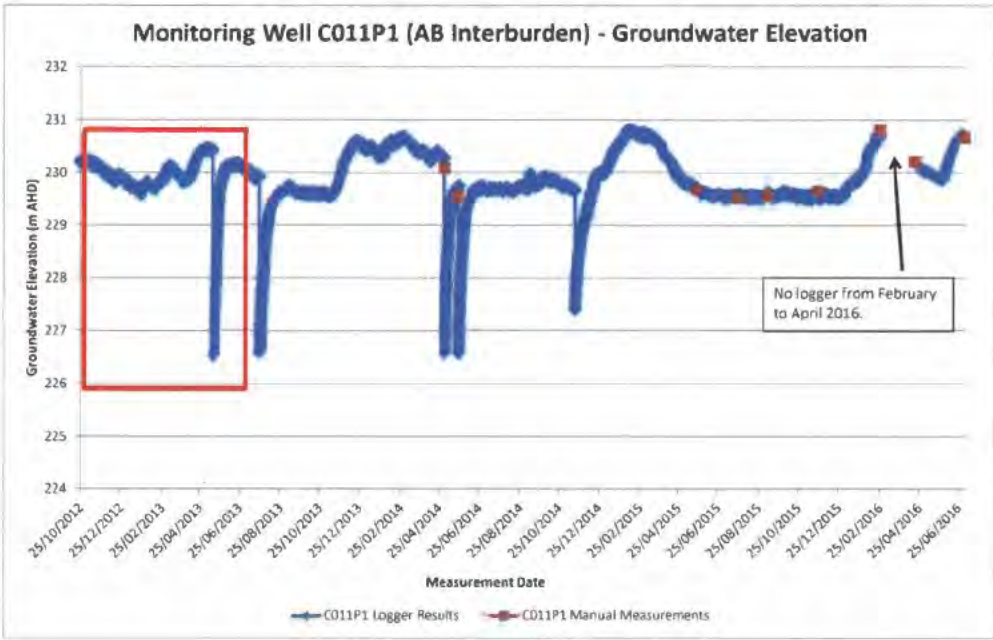
	a) hydrograph from Appendix D of Condition 23 Response (SEIS in GHD 2015)
	b) hydrograph from Appendix C of GMMP

Figure 2: Response in Bore C011P1 - a) The SEIS (Appendix D in GHD 2015) and b) Appendix C of the GMMP. The red outline in both graphs denotes approximately the same time period. Vertical scale for both graphs is in mAHD
The burgundy line in a) and the blue line in b) are the hydrograph for the same monitoring point. As can be seen b) ***does not include all of the early data*** *for the monitoring point, additionally for the period of overlap between the two plots (approximately 25/10/2012 to 30 June 2013) the* ***plots have a similar shape until the peak value, which appears to be reversed*** *in figure b). The values in the period of overlap also* ***appear to be shifted slightly higher*** *in b) (approximately 0.3m). No explanation is provided for any of these issues*

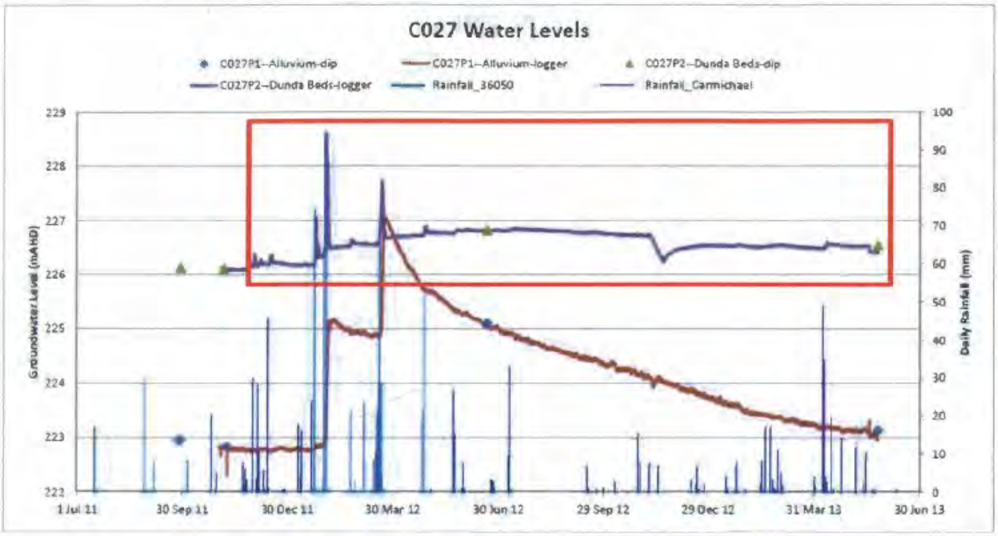
	a) Bore C027P2 (purple line) hydrograph from Appendix D of Condition 23 Response (SEIS in GHD 2015)
	b) Bore C027P2 hydrograph from Appendix C of GMMP

Figure 3: Response in Bore C027P2 - a) The SEIS (Appendix D in GHD 2015) and b) Appendix C of the GMMP. The red outline in both graphs denotes approximately the same time period. Vertical scale for both graphs is in mAHD
a) the SEIS hydrograph of C027P2 Dunda Beds (purple line) shows correlation to rainfall gauge 36050
b) the GMMP hydrograph of C027P2 Dunda Beds appears to be the vertical inverse of the same data for the same period as provided in the SEIS (Figure 3a).

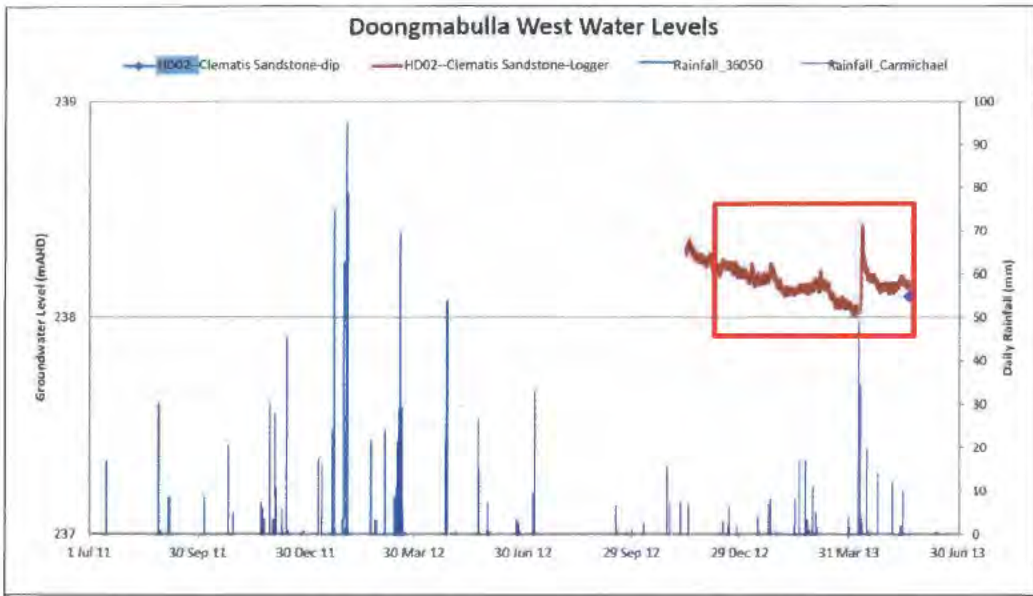
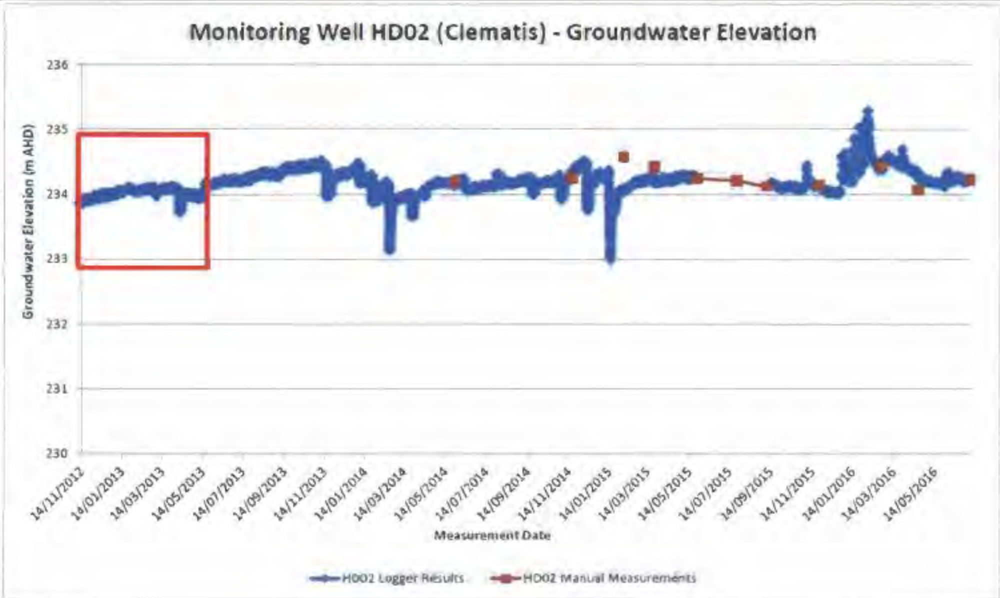
	a) hydrograph from Appendix D of Condition 23 Response (SEIS in GHD 2015)
	b) hydrograph from Appendix C of GMMP

Figure 4: Response in Bore HD02 - a) The SEIS (Appendix D in GHD 2015) and b) Appendix C of the GMMP. The red outline in both graphs denotes approximately the same time period. Vertical scale for both graphs is in mAHD
a) the SEIS hydrograph of HD02 Clematis Sandstone (brown line) shows correlation to rainfall gauge at Carmichael and a declining trend in water levels prior to the April 2013 rain event
b) the GMMP hydrograph of HD02 Clematis Sandstone appears to be the vertical inverse of the same data for the same period as provided in the SEIS (Figure 4a), resulting in a markedly different interpretation.

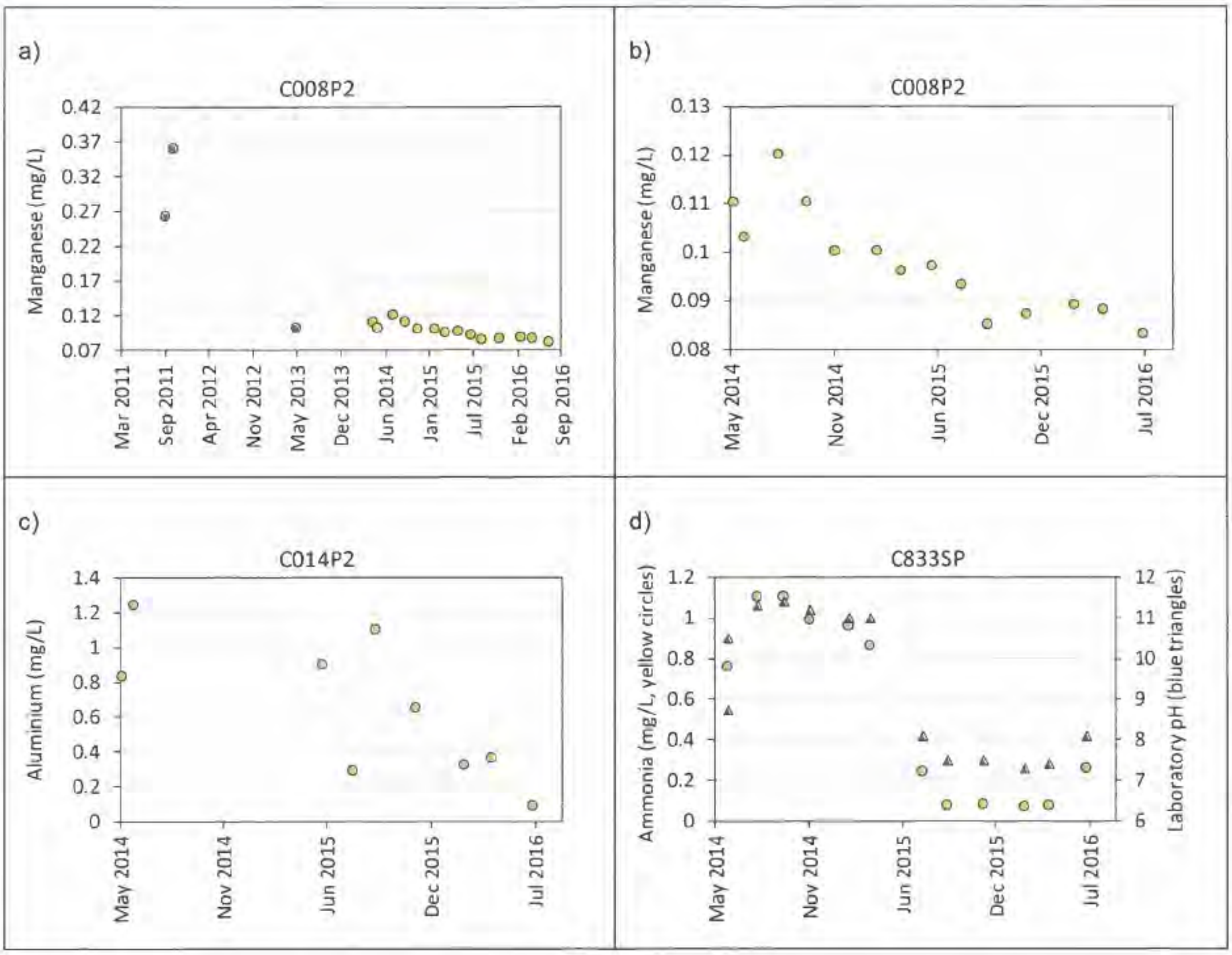


*Figure 5: **NOTE: these graphs were created by GA - no such analysis is included in the GMMP** - related to comment 23, Figure 5a) and b) manganese in C008P2 which decreases over time (green markers are from the SEIS, yellow are from the GMMP). If the elevated results are unrepresentative of baseline conditions, they should not be incorporated when developing trigger levels. Other examples include, Figure 5c) aluminium in well C014P2 (which includes the maximum concentration in the Bandanna Formation), and Figure 5d) pH and ammonia in well C833SP in the D seam of the Colinlea Sandstone (this bore is of particular interest, because TRH and BTEX compounds are regularly identified above detection limits and the elevated pH values seem unusual). None of these chemistry variations are discussed in the GMMP, yet these results are included in the baseline data set to derive trigger values.*

Tables

Table 1: Summary of bore water level data supplied with GMMP (Appendix C) and identified issues.

Bores with water level data issues	Appendix C (p##) from GMMP (AECOM 2017) and description of data issue as compared to data included in SEIS (Appendix D of GHD 2015)
C025P1	p3 – assume stand pipe, with terminal depth of 216.38mAHD why is there fluctuations of ~ 0.25m when well is supposedly dry - instrumentation issue? Pressure to SWL conversion issue?
C027P1	p4 – pre 01/03/2014 - available from SEIS, not included.
HD03B	p8 – Does not correlate to SEIS Appendix C data presented - Logger data not matching manual measurements, 15m offset in logger data not explained
C025P2	p10 – Does not correlate to data presented in SEIS Appendix C - WL trends in wrong direction
C029P2	p11 – Does not correlate with SEIS appendix C data - assumed conversion issue
C558P1	p12 – SEIS record shows SWL of 216 mAHD (p620 - modelling report) for same period, not 216.50 in Appendix C
C007P2	p17 – pre 01/03/2014 - available from SEIS, not included.
C008P2	p18 – pre 01/03/2014 - available from SEIS, not included.
C011P1	p19 – See Figure 2 – some parts appear inverted to SEIS data whilst other appear normal - missing logger data from SEIS
C014P2	p20 – Does not correlate with SEIS appendix C data - assumed conversion issue.
C016P2	p21 – pre 01/03/2014 - available from SEIS, not included.
C018P1	p22 – discrepancy in SEIS logger data (p 628 SWL >245mAHD for all periods) and GMMP (dips below 245 mAHD pre 22/09/2013). Pre 22/09/2012 - available from SEIS, not included.
C018P2	p23 – pre 25/10/2012 - available from SEIS, not included.
C020P2	p24 – values and trend for this well does not match that presented in SEIS (inverted)
C032P2	p25 – pre 01/03/2014 - available from SEIS, not included.
C035P2	p27 – pre 10/02/2015 - available from SEIS, not included.
C006P3r	p34 – difficult to ascertain but some of the 0.5 - 1.0 m drops in GMMP data have no equivalent in SEIS for same period (p621)
C011P3	p36 – pre 01/03/2014 - available from SEIS, not included.
C018P3	p37 – pre 01/03/2014 - available from SEIS, not included.
C034P3	p39 – Does not correlate to data presented in SEIS Appendix C.

Bores with water level data issues	Appendix C (p##) from GMMP (AECOM 2017) and description of data issue as compared to data included in SEIS (Appendix D of GHD 2015)
C035P1	p54 – pre 01/02/2014 - available from SEIS, not included
C555P1	p55 – discrepancy in WL – SEIS indicates sub 230.5mAHD WL. GMMP shows WL for same period to be 231mAHD
C556P1	p56 – discrepancy in WL - SEIS indicates consistently greater than 235 mAHD WL. For same period, GMMP WL shows less than 235mAHD
C9553P1R	p57 – discrepancy in WL - SEIS indicates consistent WL of ~253mAHD. GMMP indicates WL of 252.4 with seemingly greater level of fluctuation
C022P1	p61 – pre 01/03/2014 - available from SEIS, not included.
C027P2	p62 – See Figure 3
HD02	p72 – See Figure 4
C012P1	p75 – difficult to ascertain because of scale and presentation but there appears to be issues in the GMMP WLs compared against the SEIS WLs (see signal around the 21/02/2013 against SEIS - p625)
C555	p97 - nomenclature between SEIS and GMMP unclear for VWPs in bore C555. It appears there is a mix up in GMMP legend/labelling - VWP1 – AB Seam (GMMP) appears to refers to C555PV2-AB (SEIS) – however it does not match the value or the trends in response for the SEIS data (C555PV2), but does seemingly match the trends for C555PV1-D Seam Logger VWP2 – Rewan (GMMP) appears to refer to C555PV1 – D Seam Logger (SEIS) but response appears inverted and does not match values, but does seemingly match trends for C555PV2-AB-Seam logger but not exact values VWP3 – Rewan appear to refer to C555PV3-Rewan Group logger – responses appear similar but WL values appear incorrect
C558	p98 VWP1 – appears to correlate with PV1 in SEIS VWP2 – appears to correlate with PV2 in SEIS VWP3 – does **not** correlate with PV3 for WL values
C9556VWP	p104 SEIS (p619) shows data for PV2 (VWP2 in GMMP) why is this not included? - no explanation provided VWP1 – D Seam does **not** appear to correlate with SEIS C9556PV1 - D Seam logger in SEIS VWP3 – Rewan Formation appears to correlate with C9556PV3 Rewan group logger in SEIS

Table 2: Excerpt from Table 11 (AEMCOM 2017) showing inconsistencies in data (final 2 columns from Table 3 – AECOM 2017)

Monitoring Location	Unit	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)	Maximum Predicted Groundwater level Drawdown	(Low) Threshold Drawdown (mbgl)	(High) Threshold Drawdown (mbgl)	**Total Depth**	**Geology / Comment**
C555P1	Rewan	432461.38	7557892.99	73 m	80 m	88 m	75	Rewan 37 to 336m
C555VWP2	Rewan	432461.38	7557892.99	315 m	345 m	-	473.78	VWP at 260.5m
C555VWP3	Rewan	432461.38	7557892.99	72 m	79 m	87 m	473.78	VWP at 166m

Table 3: Analysis of monitoring points

Stratigraphic Column	No. of Monitoring Points	No. in Baseline Monitoring Network		No. in Preliminary Network		No. that have a threshold limit		No. of Early Warning Bores		No. of GDE Monitoring Bores		No. outside lease boundary	No. in mining/waste area
GMMP/reference	Table 3					Table 11		Table 11					ArcGIS
		Total	To be mined	Total	To be mined	Total	To be mined	Total	To be mined	Total	To be mined		
Alluvium	6	6	0	6	0	1		0	-	6	0	3	0
Tertiary Sediments	6	6	2	6	2	2	1	1	1	2	0	0	2
TRIASSIC													
Moolayember	1	0	0	1	0	1	0	1	0	1	0	1	0
Clematis Sandstone	8	8	0	8	0	7	0	3	0	7	0	7	0
Dunda Beds	4	4	1	4	1	4	1	3	1	2	0	1	1
Rewan Formation	22	22	16	8	7	7	5	2	0	0	-	5	16
PERMIAN													
Bandanna Formation													
AB Seam - Bandanna Formation	20	20	15	13	10	3	3	0	-	0	-	3	15
AB interburden	3	3	3	1	1	0	-	0	-	0	-	0	3

Stratigraphic Column	No. of Monitoring Points	No. in Baseline Monitoring Network		No. in Preliminary Network		No. that have a threshold limit		No. of Early Warning Bores		No. of GDE Monitoring Bores		No. outside lease boundary	No. in mining/waste area
GMMP/reference	Table 3					Table 11		Table 11					ArcGIS
		Total	To be mined	Total	To be mined	Total	To be mined	Total	To be mined	Total	To be mined		
B-C Sandstone	3	3	2	1	1	0	-	0	-	0	-	0	2
C Seam	3	3	3	1	1	0	-	0	-	0	-	0	3
C Seam interburden	4	4	3	2	2	0	-	0	-	0	-	0	3
Other Bandanna	2	2	1	0	-	0	-	0	-	0	-	0	1
Colinlea Sandstone													
(referred to in App C as D seam)													
C-D Sandstone	5	4	4	0	-	1		0	-	0	-	1	5
D Seam	16	16	13	8	8	2	2	1	1	0	-	0	13
D Seam interburden	2	2	1	0	-	0	-	0	-	0	-	0	1
D-E Sandstone	2	2	2	0	-	0	-	0	-	0	-	0	2
E-F Sandstone	1	1	0	0	-	0	-	0	-	0	-	0	0
Other Colinlea Sandstone	2	2	2	0	-	0	-	0	-	0	-	0	2
Joe Joe Group	18	17	4	15	3	11	2	6	2	9	1	12	4
Composite Points	7	0	-	1	0	4	0	2	0	3	0	4	1
Totals	**135**	**125**	**72**	**75**	**36**	**43**	**14**	**19**	**5**	**30**	**1**	**37**	**74**

Note that the monitoring points identified as 'to be mined' were identified by a visual inspection of data layers at GA, and numbers of impacted monitoring points may differ when more recent mine plans are analysed (this information was not discussed in the GMMP).

FOI 190417
Document 39c

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Post Approvals Section
Environmental Standards Division
Department of the Environment and Energy

8 September 2017

Attn s22 [redacted]

Re: Geoscience Australia's Stage 1 response to Department of the Environment and Energy's request for comment on Carmichael Coal Mine and Rail Project Groundwater Management and Monitoring Program (EPBC 2010/5736)

I refer to the re-issued request from the Department of the Environment and Energy (DoEE) to review the Carmichael Coal Mine and Rail Project Groundwater Management and Monitoring Program (GMMP) for EPBC 2010/5736, specifically the following approval conditions: 3a.i, 3a.ii, 3a.iii, 3b, 3c, and 3d.i (requested on 21/08/2017). DoEE has requested that Geoscience Australia (GA) provides a Stage 1: initial general feedback commentary for the GMMP to be delivered by Friday 8th of September, to facilitate expeditious feedback to the proponent for guidance as noted in GA reference: D2017-129248. GA will supply our detailed technical comments as part of the agreed Stage 2 commentary by Friday 13 October 2017. The attached advice represents GA's Stage 1 response only.

The Stage 1 comments are impacted by a short delivery schedule; GA has been constrained in the depth of review detail and broader consideration of material beyond the GMMP. The GA response has been unable to address the Queensland State Environmental Approvals in this Stage 1 response. GA cautions that our Stage 1 review has been unable to consider how the GMMP will incorporate and interact with the Great Artesian Basin Springs Research Plan (GABSRP) and the Rewan Formation Connectivity Research Plan (RFCRP) as these plans are currently unavailable for review. GA is aware of the Australian Governments Bioregional Assessment Programme which includes a detailed assessment of the Galilee Basin. The Programme is nearing completion and delivery, with many outcomes pertinent to this GMMP review. GA has attached specific caveats and limitations to accompany our initial general feedback commentary.

In summary, from the GA Stage 1 review, the GMMP does not present sufficient technical information, specifically detailed methodologies, interpretable data and discussion on limitations and knowledge gaps, to provide confidence that the EPBC approval conditions 3a.i, 3a.ii, 3a.iii, 3b, 3c, and 3d.i are adequately addressed. Attachment A provides GA's considerations of the GMMP against these conditions to support our assessment. Further information is required as is development and refinement of the GMMP.

If you have any queries on this, please contact s22 [redacted] or s22 [redacted] u

Kind regards

Dr. Stuart Minchin
Chief of Division
Environmental Geoscience Division
Geoscience Australia

Attachment A - GA Stage 1 Initial general feedback commentary

Caveats and limitations

GA's review was limited to assessing the GMMP against EPBC 2010/5736 approval conditions 3a.i, 3a.ii, 3a.iii, 3b, 3c, and 3d.i. Due to time constraints the GMMP was not reviewed in detail against Queensland Environmental Authority EPML01470513 Schedule E (DEHP, 2017). The limited time allocated for review has required a high level focus in this Stage 1 work component. Only major issues are discussed and much detail is omitted. A more thorough assessment with detailed technical commentary will be included in our Stage 2 response (due Friday 13 October 2017).

In Approval Conditions 3d.ii, 3e.iii and 3e.iv, 24, 25, 26, 27 and 28, the Great Artesian Basin Springs Research Plan (GABSRP) and the Rewan Formation Connectivity Research Plan (RFCRP) are integral to the hydrogeological conceptualisation underpinning the numerical groundwater flow model, trigger threshold assignment, monitoring site selection and GMMP implementation. However, the GABSRP and RFCRP were not available to GA for review. The GABSRP and RFCRP will inform future monitoring requirements, so the GMMP will require further review once they are available. GA is aware of the Australian Governments Bioregional Assessment Programme which includes a detailed assessment of the Galilee Basin. The Programme is nearing completion and delivery, with many outcomes of pertinence to this GMMP review.

It is possible that some information lacking in the GMMP is included in other documents (e.g. the Carmichael Coal Project Environmental Impact Statement (EIS) and Supplementary Environmental Impact Statement (SEIS)). However, these could not be reviewed within the Stage 1 timeframe and are not specifically referred to within the GMMP. Further, GA considers that it is preferable for the GMMP to be a stand-alone document because it will be reviewed and revised as the project progresses.

General comment on science communication

The GMMP contains many typographical and grammatical errors, making interpretation ambiguous. Repetition and transcription errors reduce clarity and confidence in reporting, e.g. tables contain erroneous duplication (e.g. Table 11, p88 - 'Doongmabulla to West of Mine Lease' bore - C14013SP). The report incorrectly references information contained in appendices in places (e.g. Section 4.5.1 'Hydrochemistry', paragraph 2, p82, refers to 99th percentile values as prescribed by QLD EA Condition E9 Table E2, however, the QLD EA Table E2 prescribes 85th percentile values).

The large number of reporting errors diminishes confidence that scientific rigour has been applied to protecting Matters of National Environmental Significance under the Commonwealth Environment Protection and Biodiversity Conservation Act.

General comment on GMMP implementation

GA understands that the GMMP, when approved, will be the central reference point for the regulation of groundwater impacts under the EPBC Act. Therefore, the GMMP needs to be detailed and specific regarding how the approval conditions will be implemented. The GMMP (AECOM, 2017) does not provide sufficient detail to enable an adequate assessment of either the proposed or utilised methodologies as currently written in the document.

In several sections of the GMMP, the proponent uses the phrase a 'living document'. Care should be taken with this concept, as the GMMP cannot be changed without approval from the Minister. The content of the plan should sufficiently describe and justify the monitoring and management of groundwater until the next version of the plan is approved. Likewise, the use of "Draft" terminology in a GMMP is of potential concern as it reduces the certainty the agreed values if this GMMP were approved.

In Section 6 p117, the proponent commits to retaining data for a minimum of 5 years. GA considers it imperative for the proponent to consider the level of adequacy for data and metadata collection, storage and retention in the iterative and adaptive management of the project for the life of the project, not just 5 years. Data provenance and quality control are important in assessing and verifying numeric model performance resulting from iterative advancements. GA recommends that the proponent commit to ongoing retention of all data and accompanying metadata for the purposes of an accountable, adaptive management processes and for scientific transparency, reproducibility and rigour.

Hydrogeological conceptualisation

The hydrogeological conceptual model for the project site and surrounds is critical for the appropriate implementation of the GMMP. The conceptual model and gaps in current understanding should be a focus for monitoring bore locations and screening depths. The conceptual model is also a reference keystone for the numerical groundwater flow model; any shortfalls in the conceptual understanding will have a direct impact on the predictive capacity of the numerical model.

Section 2.0 of the GMMP (AECOM, 2017 – p30) contains cursory descriptions of the hydrostratigraphy with limited hydrogeological parameterisation. There is no discussion on the limitations, uncertainty and knowledge gaps for the hydrogeological system or how the proponent is committed to investigating these gaps (via the GABSRP or the RFCRP) and refining the conceptual understanding.

In the supplied GMMP, there is insufficient information on the hydrogeological conceptualisation on and around the project site. GA is unable to determine the appropriateness and suitability of the monitoring scheme from the information provided in the document. GA surmises that the required details may be provided in the EIS, SEIS or subsequent reports, but no references to these documents are provided. Additionally, the GMMP has been delivered to address the EPBC approval conditions and so GA considers that a reader of the GMMP should not need to refer to other documents to gain a clear understanding of the system being monitored by the GMMP.

As the hydrogeological conceptualisation is refined over time, it is important that a self-contained understanding of the prevailing hydrogeological conceptual model is presented for each iteration of the GMMP. GA considers at a minimum the discussion on the conceptual model should include, but not be limited to, the following:

- cross-sections and surface outcrop diagrams of hydrogeology
- diagrams indicating the interpreted direction of groundwater flow,
- recharge/discharge processes and locations,
- inter-aquifer connectivity,
- potential preferential flow paths,
- locations, characteristics and impacts of geologic structure, and
- a summary water balance.

Other inclusions should be a discussion of the key elements of the groundwater system in the area and remaining data gaps for that iteration of the GMMP.

GA sees the opportunity for the proponent to address the uncertainty and knowledge gaps in the current hydrogeological conceptualisation and explore the potential for alternative conceptualisations via the GABSRP and the RFCRP and the monitoring conducted as part of the GMMP. GA considers that alternative conceptualisations cannot be adequately refuted by only seeking additional data to verify the current conceptualisation. In order to rule out alternative conceptualisations, additional data must be collected that provides refuting evidence.

Monitoring network design (Conditions 3.a.ii) and 3.a.iii))

The proponent has presented information on a large number of bores across several tables and maps. There is inconsistency in the datasets presented in Appendices B and C (with some bores listed in one appendix, but not appearing in the other) and it is not clearly communicated which bores are intended to be part of the ongoing monitoring network. To proceed with our assessment, GA has assumed the proponent intends for only those bores listed in Table 11 to be part of the long term groundwater monitoring network, and the following comments relate to these bores. This assumption requires confirmation from the proponent.

Insufficient information on the network design and rationale has been provided to determine if sufficient bores are included in the network. Information including, but not limited to, the following would be required:

- maps of geology extents, including mine scale mapping;
- geological cross-sections;
- maps showing assumed flow directions (noting that the contours indicated in Appendix C require greater consideration of alternative conceptualisations, or a discussion of where the concentrated flows to the east are going, if that is the preferred conceptualisation);
- gaps showing model predictions; and
- a summary conceptual model.

Additionally, no rationale is given for selecting the monitoring locations. It is stated that exploration bores were used for points inside the project area, hence their location was set by exploration aims, but there is no discussion about suitability as long-term monitoring locations. There is no rationale provided for site selection outside the project boundaries.

GA observes a demonstrable inadequacy of groundwater level data analysis and discussion for the existing monitoring data provided in Appendix C – Groundwater Levels. Further discussion is needed on:

- the mismatch between manual and pressure transducer water levels;
- the methodology used in conversion of measured pressure to density (temperature and specific gravity) and barometrically corrected water levels;
- the large number of instrument failures and instrument drift; and
- proposed approaches to manage these issues.

In addition to the inclusion of the above discussion points, the following specific data should be included to illustrate the suitability of the monitoring network:

- the screened intervals for monitoring bores, noting the reference on AECOM (2017) p41 to Appendix B for bore construction summary is insufficient;
- the surveying methodology and accuracy of the vertical reference point for water level monitoring bores;
- the accuracy to which the installation depths of vibrating wire piezometers are known; and
- the resolution of monitoring equipment (e.g. vibrating wire piezometers and other pressure transducers).

This information, along with appropriate data quality checking against manual measurements, is vital to ensure the monitoring network is able to provide the data resolution required.

Terminology

The EPBC Approval conditions use the following terms:

- control monitoring sites
- baseline monitoring data
- proposed trigger values for detecting impacts on groundwater levels (and a description of how and when they will be finalised)
- groundwater level early warning triggers for the Doongmabulla Springs Complex, and
- impact thresholds for the Doongmabulla Springs Complex.

GA notes the difficulty for the proponent in traversing the required terminology used between the QLD EA and the EPBC Approval Conditions. In this iteration of the GMMP, the proponent has created confusion within the document by changing the terminology for terms used in the conditions (s1.7 – first dot point). GA recommends that the proponent use the terminology from the approval conditions. If the proponent needs to change the terminology this should be done by formally altering the wording of the conditions in consultation with DoEE.

Control monitoring sites (Condition 3.a.i))

GA considers that control monitoring sites are those monitoring locations used to acquire uninterrupted data throughout the life of the project. As such these control sites should be located where they will not be displaced by mining operations, in order to provide representative data on the conditions around the site.

GA notes the term ‘Control Monitoring sites’ is used twice in the GMMP, and in both instances, the proponent writes that control monitoring points have been established. However, there is no indication in the GMMP as to which locations the proponent considers are Control Monitoring sites. GA is of the professional opinion that Condition 3.a.i) has not been adequately addressed.

Baseline monitoring data (Condition 3.b))

Baseline monitoring data is vital in the implementation of the approval conditions as these represent foundational reference values. Data acquired throughout the life of the project are then compared to the reference values to identify if drawdown levels exceed trigger or threshold values (for example a trigger value of 3m means a drop in water level, from the reference value, of 3m).

There is some confusion in the document regarding the baseline monitoring data. It is currently unclear if the baseline data provided is intended to be the ‘final’ dataset from which reference values will be determined, or if the collection of ‘baseline’ data will continue. GA recommends that the proponent defines the time period and data that will be used to determine reference values. A description of the data analysis techniques proposed for calculating reference values should be included. The proponent must specify the date when reference values will be determined and finalised.

GA notes there are errors and inconsistencies in the monitoring data presented in Appendix C that are not addressed in the text of the report. For example:

- Several of the hydrographs show a divergence of automatic logger and manual dip measurements; however, no explanation is given, nor clarification of which data points should be used as the baseline data (some hydrographs of concern include, but are not limited to, the following HD03B, C034P1, C823SP, C832SP, C833SP).
- The baseline data points on the contour maps in Appendix C appear to include incorrect data values (e.g. on Figure F2 the values labelled on C025P1 and C14028SP are not representative of the values on the hydrographs provided) and exclude some monitoring points without explanation

(e.g. on Figure F8 the monitoring point C9180121SPR is not included; however, the related hydrograph indicates that it is monitoring the relevant formation (Tertiary)).

GA is of the professional opinion that Condition 3b has not been adequately addressed.

GMMP informed by the results of the groundwater flow model re-run (condition 23)

GA notes that the GMMP (AECOM, 2017) has little to no discussion regarding the model re-run resulting from Approval Condition 23 as reviewed by Middlemis (2014) and accepted by DoEE (DoEE 2014b). At a minimum, there should be a high-level description of the model, including (but not limited to):

- a synopsis of the numerical model changes resulting from Approval Condition 23;
- an assessment of the current steady state calibration variance against existing monitoring data;
- the subsequent implications these conceptual changes have had to predicted drawdown and how these learnings have informed selection of bore locations as well as groundwater level triggers and thresholds; and
- how and which data will be set aside and utilised for numeric model verification vs incorporation as part of future transient numeric model calibration to satisfy Queensland Environmental Authority schedule E6.

It is essential to incorporate a discussion of numeric model predictive uncertainty as part of the discussion around the low (+10%) and high (+20%) threshold values and the corresponding risks for decision makers. This therefore also requires a discussion identifying the hydrogeologic conceptualisation knowledge gaps and conceptualisation uncertainty and how the GMMP and research plans aim to address this uncertainty, as raised earlier.

Early warning triggers and impact thresholds (Conditions 3.c) and 3.d))

The GMMP contains limited justification and methodological detail for the development of water level threshold values (trigger values) from the numerical model. Information is not provided on whether threshold values will protect MNES (e.g. there is no detailed discussion of predicted impacts to receptors in the event that these thresholds are realised). Consequently, GA cannot adequately assess the suitability of proposed thresholds.

Further to the comments on water level measurements under ‘monitoring network design’, the GMMP does not consider accuracy of water level measurements in relation to threshold values. The GMMP should consider whether the proposed monitoring instrumentation is sufficiently accurate to identify exceedances of nominated thresholds.

The Draft Groundwater Threshold Limits presented in Table 11 (AECOM, 2017 - p87) contain potential transcription errors and omit information. Further, GA cannot confirm many of the threshold values in Table 11 derived from the predictive modelling presented in Appendix E because the ‘*Modelled Drawdown by Bore*’ plot is cluttered and unclear for the 0-50m drawdown range. In addition to data presentation issues, GA notes an error for the drawdown threshold for Bore C029P2. This is listed as 0.05m in Table 11, but the modelled hydrograph in Appendix E indicates a predicted drawdown of approximately 0.45m.

The early warning trigger and impact threshold exceedance response procedures are unclear. A decision tree diagram with response timings would provide greater clarity and structure to this important GMMP component.

The above issues and errors with setting threshold values are of particular concern because these are the main early warning indicators of potential impacts to MNES. GA considers that the proponent should more clearly describe their methodology, justify their proposed thresholds, and demonstrate how these relate to numerical modelling predictions and existing monitoring. This will enable a detailed assessment of whether the proposed thresholds are adequate to meet the EPBC Approval Conditions.

Details of groundwater level early warning triggers and impact thresholds for the Doongmabulla Springs Complex (Condition 3.d.i))

The EPBC Approval Conditions propose an 'Interim Threshold' (for groundwater level drawdown) of 0.2m at the Doongmabulla Springs Complex. The GMMP appears to use the term 'Interim Threshold' interchangeably with 'Threshold Levels', 'Threshold values' and 'Threshold Limits' (a term proposed in the GMMP to replace 'early warning trigger' – see Table 1 – Condition 3c). Greater clarity is required in the GMMP to ensure the reader can discern the intent and usage of these terms in the document. Until these terms are further clarified, GA cannot make assumptions of what the low and high threshold values represent. The GMMP does not include details of potential remediation/mitigation actions should thresholds be exceeded.

Groundwater quality

Groundwater quality data has not been adequately evaluated and no details are included on how it will be assessed in the future. Groundwater quality triggers have been set on page 94 through inappropriate handling of non-detect data and published water quality guidelines without consideration of spatiotemporal variability. There are insufficient details to establish whether the proposed monitoring networks and methods are suitable, but from a preliminary review it appears that they are not.

Documents reviewed

AECOM (2017). *Groundwater Management and Monitoring Program: Carmichael Coal Project*, Prepared by AECOM Services Pty Ltd for Adani Mining Pty Ltd, Job No.: 42627082, Revision 1, 01 August 2017

Middlemis, H (2014). *Carmichael Coal Project Groundwater Flow Model Independent Review (re: Approval Conditions 22 & 23)*. Prepared by Hydrogeologic Pty Ltd for Adani Mining Pty Ltd. 28 November 2014

GHD (2014), *Carmichael coal Project Proposed Groundwater Boundary Revisions*, Memorandum prepared by James Dowdeswell, 27 October 2014 (28pp), GHD Reference 41/28057/462251

GHD (2015). *Carmichael Coal Project: Response to Federal Approval Conditions – Groundwater Flow Model, March 2016*, Prepared by GHD Pty Ltd for Adani Mining Pty Ltd GHD Reference: 41/28057

OWS (2014). *OWS Advice Note 13 October 2014 – Carmichael Coal Mine and Rail Infrastructure Project, Queensland (EPBC 2010/5736) – Condition 23 (Groundwater model re-run)*. Prepared by Peter Baker and Natasha Amerasinghe, 14 October 2014

DoEE (2014a). *Response – 2010-5736 post approval review comments on Carmichael proposed groundwater boundary revisions*. Prepared by Kelly Strike, Compliance & Enforcement Branch, 16 October 2014

DoEE (2014b). *Carmichael Coal Mine and Rail Infrastructure Project (EPBC 2010/5736) – Approval of the redefined General Head Boundary and Cell Elevations for Inclusion in the Groundwater Flow Model*. Prepared by Mr S. Gaddes, 3 November 2014

DEHP (2017), *Environmental Authority EPML01470513 – Carmichael Coal Mine*, Queensland Government Department of Environment and Heritage Protection, Permit number: EPML01470513, Effective date 5 June 2017

DSDIP (2014), *Carmichael Coal Mine and Rail Project: Coordinator-General's evaluation report on the environmental impact statement, May 2014*, Queensland Government Department of State Development, Infrastructure and Planning, Source record number: D14/58255

FOI 190417
Document 40

From: s22
To: "james.johnson@ga.gov.au"
Cc: "Stuart Minchin"; "Blewett Richard"
Subject: How GA/CSIRO advice has been addressed [SEC=OFFICIAL]
Date: Friday, 5 April 2019 1:35:52 PM
Attachments: Attachment E - Summary of CSIRO and GA advice.docx
image001.jpg

Hi James,

Please also find a summary of the advice and how it has been addressed – this formed the basis of our briefing this morning

s22

Acting Director | Post Approvals Strategies
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FOI 190417
Document 41

From: s22
To: s22
Cc: Gregory Manning
Subject: FW: Words on CSIRO [SEC=UNCLASSIFIED]
Date: Thursday, 21 March 2019 3:49:04 PM
Attachments: image002.jpg

For number 4

GMMP

The CSIRO and Geoscience Australia review found that the modelling that underpins the approaches in the GMMP is not suitable to ensure the outcomes sought by the EPBC Act conditions are met. A number of limitations were also identified in the proposed monitoring and management approaches indicating they are not sufficiently robust to monitor and minimise impacts to protected environments.

Recommendations from the review enable Adani to refine the conceptualisation and improve the robustness of the modelling, monitoring and management over time to address the intended outcomes of the approval conditions. Adani has addressed recommendations from the review, by committing to install additional groundwater and surface water monitoring and applying more conservative triggers before the modelling limitations are fully addressed at the next model review required under the Queensland EA within two years.

GDEMP

The CSIRO and Geoscience Australia review found that the GDEMP systematically addresses the management objectives, performance criteria, adaptive management triggers and corrective actions. Monitoring under the plan is based on the GDE Toolbox approach, and is considered adequate. However, the GDEMP relies heavily on the conceptualisations and modelling outlined in the GMMP and other research plans, and as such is subject to any limitations of these plans.

Recommendations from the review enable Adani to refine the conceptualisation and improve the robustness of the modelling, monitoring and management over time to address the intended outcomes of the approval conditions. Adani has addressed recommendations from the review, by committing to install additional groundwater and surface water monitoring and applying more conservative triggers before the modelling limitations are fully addressed at the next model review required under the Queensland EA within two years.

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Reconciliation%20Email%20Footer

FOI 190417
Document 42

From: s22
To: "jane.coram@csiro.au"; "McDonald, Warwick (L&W, Black Mountain)"
Cc: Gregory Manning; s22
Subject: How advice has been addressed [SEC=OFFICIAL]
Date: Friday, 5 April 2019 12:25:04 PM
Attachments: Attachment E - Summary of CSIRO and GA advice.docx
image001.jpg

Hi Jane,

As discussed.

Plans to follow

s22

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Summary of CSIRO and Geoscience Australia (GA) Advice on Groundwater Management Plans and Response

Advice on monitoring

1. CSIRO and GA recommended that Adani:

   a. Install more bores to monitor the deeper groundwater units in the central zone between the mine and the Doongmabulla springs. Installing these bores at existing points would remove any significant access issues, and would enable comparison to existing data.

      Action: The Department required that Adani install additional deeper bores at existing sites (condition 3aiii/6b) and collect suitable baseline data (condition 3b) at these sites.

      Response: Adani have committed (refer section 7 of the GMMP) to install deeper bores at, or within 500m of, three existing monitoring locations in the central zone. These bores will not monitor all of the deeper units. Adani will investigate drilling bores into deepest units where coal occur for monitoring and research purposes. These commitments have also been referenced in the GDEMP (see sections 4.3.2 and 8.8).

   b. Include stream flow gauging upstream and downstream of the mine area in their ongoing monitoring program, with updated height-discharge surveys

      Action: The Department required more precise gauging locations and commitments for future height-discharge surveys in the GDEMP (condition 6b).

      Response: Adani have committed in the GDEMP to install an additional 3 gauging locations, in addition to the two existing locations, and further surveys to determine height-discharge relationships (see section 6.6.1).

   c. include a more sophisticated statistical analysis of hydrochemistry data to constrain the source aquifer(s) of the Doongmabulla Springs. This includes assessing a wider variety of groundwater and surface water parameters.

      Action: The Department required clarity on these methods, which are a requirement of research under the *Great Artesian Basin Springs Research Plan* (GABSRP) at condition 25e and rely on installation of additional nested bores to the west of the site.

      Response: Adani will address this issue in revisions to the GABSRP.

Advice on management

2. The limitations of the numerical groundwater model mean that drawdown could be under-predicted, so the adopted thresholds and triggers will be reached sooner than anticipated and are not a suitable foundation for the proposed monitoring and management approaches.

   Action: The Department required that Adani adopt a more conservative approach to monitoring and management until the model is reviewed within two years of the first box cut (or first extraction of coal). For example, more conservative measures might include:

   - Monitoring additional parameters, e.g. spring flow / flux, in addition to groundwater level and pressure;
   - Committing to a particular mine plan or number of tonnes of coal; and/or
   - Applying rate-based triggers for more bores to verify model predictions and to other GDEs to ensure they are protected.

Response: Adani has:

- included monitoring of spring flow under the GDEMP (refer section 8.7).
- not committed to a scaled-down mine plan, but has included further details about the proposed mine plan for the first five years of operations in the GMMP (refer section 2.6 and Appendix B).
- committed to investigating any drawdown rates that are faster than predicted as per standard practices at model review and update (see section 5.3.5.2 of the GMMP).

3. The proposed monitoring and management approaches do not sufficiently address the uncertainty regarding potential alternative or additional source aquifers of Doongmabulla Springs. Recommendations to address this uncertainty include: the installation of monitoring bores between the mine and the Doongmabulla springs, streamflow gauging and a more sophisticated statistical analysis of hydrochemistry data as described under item 2 above.

Action: The Department required that Adani address the actions under item 2 and commit to apply triggers and limits for the additional nested bores to the west of the site. These triggers must be based on baseline condition (condition 6f).

Response: Adani has addressed the advice under item 2 and committed to apply triggers and limits to the additional nested bores in the GMMP (see section 7). The revised early warning triggers and impact thresholds will be submitted to the Department for approval as part of review of the GMMP. The Department will ensure that these triggers and limits are set to ensure the protection and long-term viability of the Doongmabulla Springs Complex.

4. CSIRO and GA advice on the design of water level thresholds and triggers included that:

a. All monitoring locations for which water level thresholds are defined should also have drawdown rate limits derived. Evaluation of drawdown rate limits should form part of routine monitoring data assessment and be included in the Impact Threshold Assessment approach.

Action: The Department required that rate limits are applied for both the Carmichael River and the Doongmabulla Springs in the GDEMP, based on the requirement for early-warning triggers at these GDEs (condition 6f), not all bores.

Response: Early warning triggers have been included in the GDEMP for both the Carmichael River and the Doongmabulla Springs (see Appendix B).

Action: To account for model limitations, and likely underpredictions, the Department required that Adani apply drawdown rate limits until the model is reviewed within two years of the first box cut.

Response: Adani has committed to investigating any drawdown rates that are faster than predicted as per standard practices at model review and update (see section 5.3.5.2 of the GMMP).

b. A bore in the alluvium, ‘C025P1’, has been dry during the baseline monitoring period and should not be used as a threshold monitoring point.

Action: The Department required that a trigger not be set at C025P1.

Response: Adani has committed in the GMMP (see section 7) that bore C025P1 will be replaced. In the interim, if bore C025P1 is dry, or has no water level readings longer than 6 months, the trigger will be exceeded (section 5.3.3.1). This trigger is cross-referenced in the GDEMP Appendix B.

5. CSIRO and GA provided advice to improve the investigation procedures. Recommendations included that the GMMP:

   a. Explicitly state that the Commonwealth regulator will be notified whenever a groundwater exceedance occurs

      Action: The Department required that Adani commit to notify the Department whenever a groundwater exceedance occurs

      Response: Section 4.7.2.2 of the GMMP now states: The administering authority will be notified when an investigation is to be instigated for both groundwater quality and levels.

   b. Commit to a maximum timeframe in which the investigation will be completed (for example three months).

      Action: The Department required that Adani specify a timeframe in which a groundwater exceedance investigation will be completed.

      Response: Section 4.7.2.2 of the GMMP now states: If the groundwater level thresholds exceedance is because of authorised mining activities, the investigation will be prioritised and, depending on the nature of the impact, completed within three months.

   c. Provide details of the process to remove non-mining influences will occur during investigation of threshold exceedances.

      Action: The Department required upfront details of these investigations so when there is an exceedance it can be assigned to the cause.

      Response: Adani has provided further details of the trend analysis that will be undertaken in the GMMP (section 4.7.2.2) , which will include assessing at least 12 months of groundwater data for the bore and comparing it to climate data, nearby bores, other local projects and assessing the potential for cumulative impact.

   d. Present mitigation actions in the GMMP itself

      Action: The Department required that mitigation actions be summarised within the GMMP to address condition 3d, rather than just references to mitigation in other plans.

      Response: The GMMP (section 4.7.2.2) uses examples of mitigation actions in response to an exceedance, including:

      - review of the mine plan (including sequencing of mining);
      - limiting thickness of extraction of coal seams and reviewing extraction of multiple coal seams for the underground longwall mining; and
      - freezing mine development at current levels until the completion of investigations and assessments which conclude that further development will not exceed approved impacts.

6. CSIRO and GA provided advice on the design of water quality thresholds and triggers

   Action: The Department notes that water quality triggers and limits are not a requirement of the EPBC conditions of approval. This advice will be provided to DES for their information.

   Response: Not applicable for the groundwater management plans under EPBC conditions.

Advice on modelling

7. The review found that the numerical groundwater model used by the GMMP is the most conservative of the model scenarios available. However CSIRO and GA do not consider the model fit-for-purpose for achieving the outcomes sought by the conditions of approval, and have provided recommendations, including:

    a. fixing identified errors in the bore heights used to calibrate the model, explaining how they have changed over time and how these changes affect model prediction and performance

    b. using locally-appropriate parameters (which dictate how water moves through the model layers) to represent the Carmichael River, Rewan Formation and Clematis Sandstone, and subsidence above longwall mining

    c. recalibrating the model using the revised information in (a) and (b), using the baseflow in the Carmichael River as a target to ensure it produces realistic values

    d. global sensitivity analysis and uncertainty analysis to determine the full range of likely impacts and the influence of each parameter and

    e. validating the model based on data from new bores drilled since approval of the mine.

    Action: The Department required that Adani commit in the GMMP and GDEMP to these updates as part of the model review required within two years of the first box cut under Queensland’s EA.

    Response: Adani have committed to address the limitations identified by the CSIRO and GA review in the groundwater model re-run - see section 7 of the GMMP and section 4.3.2 of the GDEMP.

FOI 190417
Document 43

From: s22
To: "peter.mayfield@csiro.au"; "jane.coram@csiro.au"
Cc: s22 @csiro.au"; s22 @csiro.au"; Dean Knudson; s22 "james.johnson@ga.gov.au"
Subject: FW: Previous Geoscience Australia advice on Adani [SEC=OFFICIAL]
Date: Wednesday, 10 April 2019 10:35:24 AM
Attachments: image001.jpg
Industry and GA letter at approval.pdf
2017 GA final advice.pdf
2017 GA initial advice.pdf

Hi Peter and Jane,
I can confirm that CSIRO had not previously provided advice on the project.
For your visibility, GA's previous advice is attached.
Please let me know if you have any questions
s22
[redacted]
T 02 s22 @environment.gov.au
W www.environment.gov.au

From: s22
Sent: Wednesday, 10 April 2019 8:51 AM
To: 'james.johnson@ga.gov.au'
Cc: 'Stuart Minchin' ; 'Blewett Richard' ; s22 ; Gregory Manning ; James Tregurtha ; Dean Knudson
Subject: Previous Geoscience Australia advice on Adani [SEC=OFFICIAL]
Hi James,
As promised, GA's advice at the time of approval is attached, as are copies of your advices from 2017.
s22
[redacted]
[redacted] | **E** s22 @environment.gov.au
W www.environment.gov.au

From: s22
Sent: Wednesday, 10 April 2019 8:42 AM
To: 'peter.mayfield@csiro.au' <peter.mayfield@csiro.au>; 'jane.coram@csiro.au' <jane.coram@csiro.au>; s22 @csiro.au' <s22 @csiro.au>; 'james.johnson@ga.gov.au' <james.johnson@ga.gov.au>; s22 @csiro.au' <s22 @csiro.au>
Cc: Dean Knudson <Dean.Knudson@environment.gov.au>; James Tregurtha <James.Tregurtha@environment.gov.au>; Gregory Manning <Gregory.Manning@environment.gov.au>; s22 @environment.gov.au>
Subject: Adani media release [SEC=OFFICIAL]
Hi everyone,
Thanks for the phone call yesterday.
A link to the Minister's media release is here: http://environment.gov.au/minister/price/media-releases/mr20190409.html
James, I will send you GA's comments on the project at the time of approval, plus initial comments from 2017 shortly.
s22
[redacted]
Acting Director | Post Approvals Strategies
Environment Standards Division
Department of the Environment and Energy
T 02 s22 @environment.gov.au

Reconciliation%20Email%20Footer

FOI 190417
Document 44

From: s22
To: s22 ; Blewett Richard; s22 s22 ; "McDonald, Warwick (L&W, Black Mountain)"
Subject: FW: Ring in to Adani briefing [SEC=OFFICIAL]

Hi s22 ,

The telecon details are below, but we may not need to use it. We'll try call you direct

Do you have a mobile number we can use to text/call if needed?

Toll Free dial in: 1800 701 826.

Guest/participant code: 51727747 #

s22

-----Original Appointment-----
From: s22
Sent: Monday, 25 March 2019 3:12 PM
To: s22 ; Blewett Richard; s22 ; 'McDonald, Warwick (L&W, Black Mountain)'
Subject: Ring in to Adani briefing [SEC=OFFICIAL]
When: Tuesday, 26 March 2019 8:45 AM-10:15 AM (UTC+10:00) Brisbane.
Where: Greg Manning's office, Level 6, 51 Allara St, Canberra

Hi,

As discussed, please call Greg's extension (x.1400) on arrival and we will collect you from the foyer

I have extended the time just in case

s22

Assistant Director | Post Approvals Strategies
Environment Standards Division
Department of the Environment and Energy
T 02 s22 environment.gov.au <mailto:emily.turner@environment.gov.au>

FOI 190417
Document 45

From: s22 (CorpAffairs, Dutton Park)
To: s22
Subject: FW: URGENT
Date: Thursday, 11 April 2019 12:44:16 PM

Dear s22 for your information below is an updated version of the CSIRO statement on the advice provided regarding the Carmichael project.

In late 2018 and early 2019 CSIRO and Geoscience Australia wrote two reports for the federal government on specific questions on groundwater monitoring, management and modelling planned by Adani Pty Ltd for its Carmichael mine proposal in central Queensland.

This advice was limited to answering discrete inquiries on whether elements of Adani's proposed plans would be adequate to protect nationally significant environmental assets.

CSIRO identified inadequacies in the plans and was subsequently asked to review Adani's response to the recommendations CSIRO made to address the issues we raised, as summarised by the Department of the Environment and Energy. Adani had committed to address the modelling limitations identified by the CSIRO and GA review in a groundwater model re-run to be undertaken within two years.

CSIRO considered that this commitment satisfied our recommendations, while also acknowledging that there are still some issues that need to be addressed in future approvals, particularly confirming the source of the ecologically-important Doongmabulla Springs.

CSIRO has provided robust, peer-reviewed science on specific groundwater modelling-related questions about the plans. CSIRO's role is to provide scientific advice to inform approval processes, but it does not have any role in making approval decisions.

Kind regards, s22

Communication Manager
CSIRO Land & Water
E s22 @csiro.au **P** s22
Ecosciences Precinct
41 Boggo Road Dutton Park QLD 4102
GPO Box 2583 Brisbane QLD 4001 Australia
www.csiro.au | Facebook | Twitter

From: Coram, Jane (L&W, Black Mountain)
Sent: Thursday, 11 April 2019 11:43 AM
To: s22 (CorpAffairs, Black Mountain) <s22 @csiro.au>; s22 (CorpAffairs, Dutton Park) s22 @csiro.au>; Mayfield, Peter (Executive, Newcastle) <Peter.Mayfield@csiro.au>; McDonald, Warwick (L&W, Black Mountain) s22 @csiro.au>
Cc: s22 (CorpAffairs, Dutton Park) s22 @csiro.au>; s22 (Executive, Black Mountain) s22 @csiro.au>; s22 (CorpAffairs, Adelaide K. Ave) s22 @csiro.au>
Subject: RE: URGENT

Further refinements (in blue).

Thank you; Jane.

From: Coram, Jane (L&W, Black Mountain)
Sent: Thursday, 11 April 2019 11:26 AM
To: s22 (CorpAffairs, Black Mountain) s22 g@csiro.au>; s22 (CorpAffairs, Dutton Park) s22 @csiro.au>; Mayfield, Peter (Executive, Newcastle) <Peter.Mayfield@csiro.au>; McDonald, Warwick (L&W, Black Mountain) <s22 @csiro.au>
Cc: s22 (CorpAffairs, Dutton Park) <s22 @csiro.au>; s22 (Executive, Black Mountain) s22 @csiro.au>; s22 (CorpAffairs, Adelaide K. Ave) s22 @csiro.au>
Subject: RE: URGENT

Hi all,

A few tweaks in green and also two points needing clarification in the last line:

(i) CSIRO has provided robust, peer-reviewed scientific advice on specific questions about the plan. While our advice was based on understanding developed through other peer-reviewed work, there was no external peer review process involved in the advice. Is this statement misleading and should we leave off the "peer-reviewed"?

(ii) CSIRO does will not play a role in approval processes around developments. Can we say this – we may be asked to provide further advice to inform the approvals of the subsequent research plan. Suggest alternate wording: CSIRO's role is to provide independent scientific advice to inform approvals processes, but it does not have any role in making approvals decisions. Or is this also too defensive?

With regards, Jane.

From: s22 (CorpAffairs, Black Mountain)
Sent: Thursday, 11 April 2019 10:46 AM
To: s22 (CorpAffairs, Dutton Park) s22 @csiro.au>; Mayfield, Peter (Executive, Newcastle) <Peter.Mayfield@csiro.au>; Coram, Jane (L&W, Black Mountain) <Jane.Coram@csiro.au>
Cc: s22 (CorpAffairs, Dutton Park) s22 @csiro.au>; s22 (Executive, Black Mountain) s22 @csiro.au>; s22 (CorpAffairs, Adelaide K. Ave) <s22 @csiro.au>
Subject: RE: URGENT

Looks good, just a couple of small suggestions to make it slightly less defensive..

s22 CSIRO
E s22 @csiro.au **T** 02 s22

From: s22 (CorpAffairs, Dutton Park)
Sent: Thursday, 11 April 2019 10:26 AM
To: Mayfield, Peter (Executive, Newcastle) <Peter.Mayfield@csiro.au>; Coram, Jane (L&W, Black Mountain) <Jane.Coram@csiro.au>
Cc: s22 (CorpAffairs, Dutton Park) s22 @csiro.au>; s22 (Executive, Black Mountain) s22 @csiro.au>; s22 (CorpAffairs, Adelaide K. Ave) <s22 @csiro.au>; s22 CorpAffairs, Black Mountain) s22 @csiro.au>
Subject: URGENT

s22 eter

Further to earlier email below is the written response for APPROVAL.

Deadline is tight at 12 noon. We will need to advise DoEE & GA of this development.

Thanks

s22

s22

Karen Middleton, The Saturday Paper - **Have all the conditions been met in Adani's proposal?**

RESPONSE

In late 2018 and early 2019 CSIRO and Geoscience Australia wrote two reports for the federal government on specific questions on groundwater monitoring, management and modelling planned by Adani Pty Ltd for its Carmichael mine proposal in central Queensland.

This advice was limited to answering discrete inquiries on whether elements of Adani's proposed plans would be adequate to protect nationally significant environmental assets.

CSIRO identified inadequacies in the plans and was ~~later~~subsequently asked to review Adani's response to the recommendations CSIRO made to address the issues we raised, whereby Adani committed to address the modelling limitations identified by the CSIRO and GA review in a groundwater model re-run to be undertaken within 2 years.

CSIRO considered that this ~~found that the~~ commitment~~s made to revise the groundwater modelling plans sh~~would satisfy our recommendations, whilst also acknowledging that there are still some issues that need to be addressed in future approvals~~, including confirming the source of the ecologically-important Doongmabulla Springs~~.

CSIRO has provided robust, peer-reviewed scientific advice on specific groundwater modelling-related questions about the plans. CSIRO does ~~will~~ not play a role in approval processes around developments.

From:	s22
To:	Gregory Manning; s22
Cc:	s22
Subject:	FW: Draft Geoscience Australia response to SMH [SEC=UNCLASSIFIED]
Date:	Friday, 12 April 2019 4:11:42 PM
Attachments:	image005.png image006.png image007.png image008.png image009.png image010.jpg image011.jpg image012.jpg image013.jpg

---

Please see email below from Geoscience Australia. FYI.

From: Media [mailto:Media@ga.gov.au]
Sent: Friday, 12 April 2019 3:59 PM
To: Media <Media@environment.gov.au>; Media <Media@ga.gov.au>
Subject: RE: Draft Geoscience Australia response to SMH [SEC=UNCLASSIFIED]

Hi s22

I'll send the below response shortly (taking on your edits).

Response:

The Department of the Environment and Energy is responsible for the process to approve management plans under the *Environmental Protection and Biodiversity Conversation Act 1999*. It is not the role of Geoscience Australia to make or suggest regulatory decisions to the Department of the Environment and Energy.

As part of a process overseen by the Department of the Environment and Energy, Geoscience Australia together with the CSIRO was asked to review Adani's groundwater management plans for the Carmichael Coal Mine and Rail Infrastructure project.

Specifically, the Department of the Environment and Energy sought technical advice relating to the Groundwater Dependent Ecosystem Management Plan, the Groundwater Management and Monitoring Plan, the Rewan Connectivity Research Plan and Great Artesian Springs Research Plan.

Geoscience Australia provided its technical advice for consideration to the Department of the Environment and Energy on Thursday 15 November 2018 for the research plans, and on Friday, 22 February 2019, for the managements plans. A copy of the advice is publicly available on the Department of Environment and Energy website:
http://www.environment.gov.au/protection/assessments/key-assessments

On Friday, 5 April, Geoscience Australia was extensively briefed by the Department of the Environment and Energy about changes made by Adani to its groundwater management plans following the technical advice provided on Friday, 22 February 2019. A summary of these changes is publically available on the Department of Environment and Energy website:
http://www.environment.gov.au/system/files/pages/cb8a9e41-eba5-47a4-8b72-154d0a5a6956/files/summary-csiro-ga-advice-response.pdf.

Based on this updated information provided by the Department of the Environment and Energy, Geoscience Australia was of the view that Adani had addressed the issues and concerns raised in the technical advice provided on Friday, 22 February 2019.

As the administering department, the Department of the Environment and Energy is the best point of contact for questions about Adani's groundwater management plans.

Kind regards,

s22
s22 | Media Adviser | Public Relations

Communications | Enabling Services
t +61 2 s22 **Media Hotline** 1800 882 035 www.ga.gov.au
cid:image006.png@01D239A5.39C6E990

Geoscience Australia acknowledges the Traditional Custodians of Country throughout Australia and recognises the continuing connection to lands, waters and communities. We pay our respects to Aboriginal and Torres Strait Islanders Cultures: and to elders past, present and emerging.

From: Media <Media@environment.gov.au>
Sent: Friday, 12 April 2019 3:36 PM
To: Media <Media@environment.gov.au>; Media <Media@ga.gov.au>
Subject: RE: Draft Geoscience Australia response to SMH [SEC=UNCLASSIFIED]

Just following on from that – these changes would be most appreciated
Regards
s22
Media Team
Communications and Engagement Branch
Department of the Environment and Energy
GPO Box 787, CANBERRA ACT 2601

From: Media
Sent: Friday, 12 April 2019 3:34 PM
To: 'Media' <Media@ga.gov.au>
Cc: Media <Media@environment.gov.au>
Subject: FW: Draft Geoscience Australia response to SMH [SEC=UNCLASSIFIED]

s22
s22
Apologies, we've just received some further changes
Please let us know if you've already gone back to Nicole
Regards
s22

From: Media <Media@ga.gov.au>
Sent: Friday, 12 April 2019 12:20 PM
To: Media <Media@ga.gov.au>
Cc: Media <Media@ga.gov.au>
Subject: Draft Geoscience Australia response to SMH [SEC=UNCLASSIFIED]

Hi s22
As discussed, below is the draft response we have put together to address Nicole's questions (attached).
This is tentatively approved – if you can provide some advice on the below response and what your approach is going to be, I can look at getting final approval on our end and then send this to the journalist.
Thanks,

s22

Draft response:

~~On behalf of the Australian Government,~~ The Department of the Environment and Energy is responsible for ~~oversees~~ the process to approve ~~all groundwater~~ managements plans under the *Environmental Protection and Biodiversity Conversation Act 1999*. It is not the role of Geoscience Australia to make or suggest regulatory decisions to the Department of the Environment and Energy.

As part of a process overseen by the Department of the Environment and Energy, Geoscience Australia together with the CSIRO was asked to review Adani's groundwater management plans for the Carmichael Coal Mine and Rail Infrastructure project.

Specifically, the Department of the Environment and Energy sought technical advice ~~on three questions~~ relating to the Groundwater Dependent Ecosystem Management Plan ~~(version 10a)~~, ~~and~~ the Groundwater Management and Monitoring Plan ~~(version 5)~~, the Rewan Connectivity Research Plan and Great Artesian Springs Research Plan.

Geoscience Australia provided its technical advice for consideration to the Department of the Environment and Energy on Friday, 22 February 2019. A copy of the advice~~, including the three questions,~~ is publicly available on the Department of Environment and Energy website: http://www.environment.gov.au/system/files/pages/cb8a9e41-eba5-47a4-8b72-154d0a5a6956/files/csiro-geoscience-australia-final-advice.pdf

On Friday, 5 April, Geoscience Australia was extensively briefed by the Department of the Environment and Energy about changes made by Adani to its groundwater management plans following the technical advice provided on Friday, 22 February 2019. A summary of these changes is publically available on the Department of Environment and Energy website: http://www.environment.gov.au/system/files/pages/cb8a9e41-eba5-47a4-8b72-154d0a5a6956/files/summary-csiro-ga-advice-response.pdf.

Based on this updated information provided by the Department of the Environment and Energy, Geoscience Australia was of the view that Adani had addressed the issues and concerns raised in the technical advice provided on Friday, 22 February 2019.

As the administering department, the Department of the Environment and Energy is the best point of contact for questions about Adani's groundwater management plans.

Kind regards,

s22
[redacted] | Media Adviser | Public Relations
Communications | Enabling Services
t +61 2 s22 **Media Hotline** 1800 882 035 www.ga.gov.au

cid:image006.png@01D239A5.39C6E990

Geoscience Australia acknowledges the Traditional Custodians of Country throughout Australia and recognises the continuing connection to lands, waters and communities. We pay our respects to Aboriginal and Torres Strait Islanders Cultures: and to elders past, present and emerging.

From:	s22
To:	s22 "
Subject:	FW: GA Comms gearing up for our submission to DoEE [SEC=UNCLASSIFIED]
Date:	Tuesday, 12 February 2019 4:20:42 PM
Attachments:	image001.png image002.png image003.png image004.png image005.png

---

Hi s22

Best to contact the Department's media team: media@environment.gov.au or (02) 6275 9880

s22 is the relevant director

-s22

[redacted]

T 02 s22 @environment.gov.au

W www.environment.gov.au

From: s22 @ga.gov.au]

Sent: Tuesday, 12 February 2019 3:32 PM

To: s22

Subject: GA Comms gearing up for our submission to DoEE [SEC=UNCLASSIFIED]

Hi s22

GA Comms are wanting to be on the front foot with and media enquiries we might receive as a result of Tranche 2 work.

We're guessing that GA says very little and directs all enquiries to DoEE. Is there a point of contact you would like us to pass on to GA comms?

We'll keep you in the loop on our discussions and run them by you.

Thanks

s22

[redacted] **PhD |** A/g Director

Groundwater Advice and Data **|** Environmental Geoscience Division

t +61 2 s22 **|** www.ga.gov.au

16-9481 GA Email Signature_social media-04

From: s22
To: s22 "
Cc: s22
Subject: FW: GMMP Update Register [SEC=UNCLASSIFIED]
Date: Saturday, 26 January 2019 11:06:11 AM
Attachments: image001.png
CSIRO_GA_ Adani comment response_26012019.docx

Hi,
See attached, which outlines the edits to the GMMP in the most recent version. I've uploaded to Goxdex too.
Looking forward to discussing this and more on Tuesday morning
s22

T 02 s22 @environment.gov.au
W www.environment.gov.au

From: s47F @adani.com.au]
Sent: Saturday, 26 January 2019 10:16 AM
To: s22 ; s22
Cc: Hamish Manzi
Subject: GMMP Update Register

H s22
Please find attached update register of amendments made to GMMP in response to comments.
Regards
s47F
Head of Mine – Carmichael Coal Mine Project
Adani Mining Pty. Ltd. | Level 8, 7 Tomlins Street, Townsville QLD 4810
Phone: +61 (07) 4430 6723 | Ext: 75723 | Mob: 0448 086 443
Llewellyn.Lezar@adani.com.au | www.adaniaustralia.com

FOI 190417
Document 48a

Adani comment response: Geoscience Australia (GA) and CSIRO comments on revised hydrographs provided in Appendices C and E of November 2018), Attachment A in report dated 6 December 2018

Comments/ actions specified by Srini to be addressed.

CSIRO Comment location in App A	CSIRO Comment	Adani Comment response	Location where CSIRO comment to be addressed in GMMP rev 5
Paragraph 1, Attachment A (Revised Hydrographs)	For bores C008P1 and C035P1, no data has been provided, however a geochemical trigger value is provided.	No data on Rewan formation is provided in Appendix D. However in GMMP report body, triggers for C008P1 are provided.	Section 5.4.3.4.5 of GMMP (Rev 5)
Paragraph 2, Attachment A (Revised Hydrographs)	A key point identified in this work is that Appendix C and E of GMMP revision 4 show differences between hydrographs for individual bores.	Appendix C has been revised to include only groundwater contours; Appendix E includes hydrographs	Refer to Appendix E of the revised GMMP (Rev 5)
Paragraph 2, Attachment A (Revised Hydrographs)	Groundwater contour figures: notes and legend between Clematis and all other maps are different. The "Notes" to the groundwater level maps appear to be based on a template, whereas the "Legend" is map-specific.	Groundwater contour figures have been updated per action specified in next column	The maps legend has been corrected. Please refer to maps in Appendix C.
Paragraph 3, Attachment A (Revised Hydrographs)	Inconsistencies between App C and App E	Hydrographs in App C have been removed and App E includes most recent hydrographs accepted by DNRME	Refer to Appendix E for hydrographs in revised GMMP
Paragraph 4 and subsequent dot points, Attachment A (Revised Hydrographs)	Revised HD02 hydrograph (accounting for DNRME comments) raises questions: 1. How does this effect the integrated interpretation of data near the springs given there is now a drop of ~0.6m in 4years in GMMP revision 4 as opposed to the 0.2m in the GMMP revision 1 graphs for HD02? 2. Should the trigger values consider this rate of decline (i.e. no increase in rate) as part of	1. The min GWL is 234.07 and max GWL is 234.58, The decline of 0.6m is not observed. The bore is also influenced by flooding of Carmichael River. 2. The rate of decline in HD02 which is a Clematis Sst bore is a naturally occurring	The hydrograph for HD02 has been reviewed, and all inconstancies have been addressed and explanation provided and signed off by DNRME. The hydrograph has been updated up to 2017.

CSIRO Comment location in App A	CSIRO Comment	Adani Comment response	Location where CSIRO comment to be addressed in GMMP rev 5
	the early warning assessment of the 0.2m limit? 3. Why was data only corrected up until 2016?	phenomena, as this bore is influenced by the flooding of Carmichael River. However mining related impacts are also monitored in units below Clematis by assigning triggers based on a rate of decline and which will occur prior to the impact reaching HD02.	
Paragraph 6 (Revised Hydrographs)	1. It is unclear why minimum and maximum water levels are calculated from automated logger data for some bores, and from manual water level readings for other bores. 2. Similarly, it is unclear why some bore records have been used to derive water level contours, as opposed to including all bore records available.	1. The GMMP details the dataset utilised to calculate average groundwater elevation for each bore and rationale 2. The GWL data collected by manual dipping and automated logger for each bore is assessed and as per assessment the most valid data is used for generating the hydrographs. For generating hydrographs, only data within the same horizon/aquifer is considered.	The GWL statistics has been derived by using the most accurate data. DNRME has agreed with the approach followed in selecting the data sets for deriving the GWL stats. See Section 3.4 of the revised GMMP.

CSIRO Comment location in App A	CSIRO Comment	Adani Comment response	Location where CSIRO comment to be addressed in GMMP rev 5
	3. A significant change between previous versions of the GMMP is the omission in revision 4 of vibrating wire piezometer data. Hydrographs do not report data for 2017 or 2018.	3. As per DNRME advice all VWP data was not considered for generating hydrographs	See Section 3.3 of GMMP
	4. As noted in reviews of previous revisions, as well as in peer reviews of the GMMP provided by the Proponent, groundwater contour maps must contain the subcrop or extents of hydrogeological units. For example, Figures F1 through F4 and F8a and 8b do not include mapped extents, whereas Figures F5 through F7 do.	4. Figures F1 and F2 are for alluvium and tertiary where extents exist throughout the area. Extents of Clematis SSt and Dunda Beds may be included in Figures F3 and F4 respectively.	The sub crop lines where identified from the geological model are now incorporated in the maps. For sub crops not identified in the geological model an indicative sub crop are included. Refer to updated maps in Appendix C.
	5. Another feature not present on all maps is the location of the interpreted groundwater synform. This feature appears for all units stratigraphically below the Clematis Sandstone, although the axis does not appear to match with the groundwater contours.	5. Synform does not extend through all hydrostratigraphic units	
Paragraph 1 (Issues relating to….. modelled impacts)	There are several issues with the model calibration which makes the drawdown predictions unreliable, including that the model was calibrated to incorrect bore heights; the parameterisation of the Rewan and Clematis are at the extremes of the expected range; and, the river flows were not part of the calibration.	Model review is outside scope/ objective of GMMP.	See Section 2.2.9
Paragraph 1 (Issues relating to….. modelled impacts)	…We cannot estimate the error in predicted drawdown due to the change in bore elevations without re-calibrating the model.	Model review is outside scope/ objective of GMMP.	See Section 2.2.9

CSIRO Comment location in App A	CSIRO Comment	Adani Comment response	Location where CSIRO comment to be addressed in GMMP rev 5
Paragraph 2 (Issues relating to..... modelled impacts)	The hydraulic conductivity of the Rewan formation is extremely low and this minimises the propagation of drawdown into the Clematis. The hydraulic conductivity of the Clematis is at the high end of the expected value which allows the model to draw more water in horizontally and thus minimising the drawdown to Doongmabulla Springs. The sensitivity analysis shows that if either of these parameters were changed to their expected values then the drawdown at the springs would be greater than 0.2m. If both were changed it would be greater again.	Model review is outside scope/ objective of GMMP	See Section 2.2.9
Hydrogeochemistry			
Paragraph 2	The Proponent describes the methodology they used to calculate trigger levels, however the results of this methodology are not presented in the GMMP. For example there are no box and whisker plots; there are no piper diagrams to identify why some bores are considered to have different water quality to other bores in the same hydrostratigraphic unit.	Further information has been detailed with respect to the adopted approach to finalise the trigger levels in consultation with DES	Section 5.4.3.2 and Section 5.4.3.3
Paragraph 2	No clear evidence is presented for why bore C0227P2 in the Dunda Beds has variable groundwater quality compared to other bores in the Dunda Beds. Time series graphs in Appendix D indicate this bore is not consistently different across a range of groundwater quality indicators from other bores in the Dunda Beds.	As the site is currently a greenfield site, the reported variability is considered to be a representation of the existing (baseline) environment. A conservative approach has been adopted for this bore by the development of bore-specific trigger levels.	Section 5.4.3.4.4

CSIRO Comment location in App A	CSIRO Comment	Adani Comment response	Location where CSIRO comment to be addressed in GMMP rev 5
Other issues associated with the proposed groundwater quality triggers include:	1. Some trigger levels are set far in excess of baseline concentrations. The trigger levels for boron, manganese and iron seem to be consistently higher than baseline data. The Proponent do not provide an explanation for why their proposed triggers differ from those recommended by Queensland Department of Environment and Science (DES).	Further information has been detailed with respect to the adopted approach to finalise the trigger levels in consultation with DES	Section 5.4.3.2 and Section 5.4.3.3
	2. Setting trigger levels does not account for trends in groundwater chemistry that may provide anearly indication of impact. Following the recommendation from DES (DES review August 2018), the Proponent state that two consecutive groundwater chemistry results above the trigger value will prompt an investigation. Some assessment of trends in the groundwater chemistry data following each monitoring event to identify if groundwater quality is changing over time should also form part of the monitoring strategy.		
	3. Few bores are classified as 'sentinel' bores have site-specific groundwater trigger levels set. The trigger levels for these bores defaults to hydrostratigraphic unit-wide trigger levels. Whilst this may be a suitable approach to investigate aquifer-wide changes to groundwater chemistry; the protection of specific receptors requires site-specific triggers to provide early	Assignment of site-specific triggers to provide early warning for 'specific receptors' is not related to GMMP, or the objective of GMMP as per EA as this will be for GDEMP to prescribe. But EPBC approval require GMMP to assign triggers for MNES. Therefore, the hydrostratigraphic unit which is the	

CSIRO Comment location in App A	CSIRO Comment	Adani Comment response	Location where CSIRO comment to be addressed in GMMP rev 5
	warning of potential impacts to the springs. Individual triggers need to be set for sentinel bores which are "a monitoring point where groundwater level and quality changes can be monitored before changes occur at a receptor (p.32)".	source of springs is MNES.	

CSIRO Table 1 – Compilation of specific comments relating to hydrographs presented in GMMP Rev 4 and Adani responses:

Bore ID	Initial Review comments	Contoured	Hydrochemistry	Adani response
Quaternary Alluvial Deposits				
C025P1	• Used in the contour plot, however has been reported dry since 2015. Since dry, they use a rounded value of terminal depth as the WL. This is not correct. This data point should be discounted and not used in the contour (or in model calibration). - its only value is to indicate maximum possible water level if checking modelled data over the historic period. • This bore is shown in the Tertiary formation in Figure 12	Yes	No	Adani will install a new bore at this location to slightly higher depths.
C027P1	Value used in contour plot is over 1 metre higher than	Yes	Yes	This bore is influenced by flow in Carmichael river

Bore ID	Initial Review comments	Contoured	Hydrochemistry	Adani response
	long term value and most recent reading on hydrograph. A rise of WL of this amount is inconsistent with long term trends.			which is a naturally occurring variation. A consistent approach has been taken to assign thresholds across all bores and formations. The periodic review process of GMMP will assess the revision of threshold levels with more transient data if required.
C029P1	Manual dips diverged from logger data for a few readings. (Logger not being reset at each dip)	Yes	Yes	Yes. The logger results were used to calculate natural fluctuation and commitments to improve the monitoring program have been included in Section 7.0.
HD03B	• RL has shifted >3m. Concern this shift will impact model calibration. • Logger and manual dips divergent, this not explained.	Yes	Yes	Model calibration outside scope and objective of GMMP. The hydrograph has been reassessed in this regard and included in Appendix E. Note: this bore is influenced by the Carmichael River which accounts for the groundwater level variation.
C14027SP	Contour plot uses long term minimum, instead of long term average	Yes	No	Contour map updated to reflect average gw elevation. See Appendix C.
C14028SP	The hydrograph is characterised by a peak	Yes	Yes	This hydrograph has been updated, see Appendix E.

Bore ID	Initial Review comments	Contoured	Hydrochemistry	Adani response
	(associated with flooding) in 2012. Then subsides to a significantly lower value that is fairly steady from 2014 to 2017. The average value uses data from the peak and so gives a long term average that is more than a metre higher than the apparent long term average value.			
Tertiary Age Sediments				
C025P2	• Outlying data point removed - approximately Jan 2015, no explanation. • Plot in Appendix C still inverted version.	Yes	Yes	The hydrograph has been updated- see Appendix E
C029P2	The early manual dip readings are no longer included (from 2011)	Yes	Yes	The hydrograph has been updated- see Appendix E
C558P1	• Step change in data values still present and not explained. Concern that model calibrated using GHD logger values, whereas long-term dataset is >0.5m higher. • Appears to be 3 manual dip readings between 2014 and early 2015 removed from data set without explanation.	Yes	Yes	The hydrograph has been updated- see Appendix E Model calibration is outside the scope and objectives of the GMMP

Bore ID	Initial Review comments	Contoured	Hydrochemistry	Adani response
C9180121SPR	No overlap between logger and manual dips, however logger used to calculate max, min and average values.	Yes	Yes	The hydrograph has been updated- see Appendix E
C9845SPR	Nil comment	Yes	Yes	-
C971SP (C896G)	No hydrograph presented	No	No	-
Triassic Age Units (GAB units)				
Moolayember Formation				
C14020SP	Nil comment (not contoured)	No	No	-
Clematis Sandstone				
HD02	• Values transposed down approximately 4m compared with SEIS hydrograph. This likely to impact validity of model calibration. • Parts of plot appear upside down. If so this would fix the divergence between manual dips and logger data. • Hydrograph does not include any data beyond mid 2016.	Yes	Yes	Model calibration is outside the scope and objectives of the GMMP. Adani, in conjunction with DNRME, have re-assessed and re-assigned reference levels. The hydrograph has been updated to include data to 2017, see Appendix E
HD03A	Manual dips not included on hydrograph	Yes	Yes	To be updated for next revision of GMMP
C180118SP	• Hydrograph indicates well is blocked from mid 2015, suggesting value should not be used on contour plot.	Yes	Yes	The bore is considered blocked from installation of a pump. The pressure transducer, and relative water level, is not

Bore ID	Initial Review comments	Contoured	Hydrochemistry	Adani response
				considered to be affected. This is further supported by the characteristics of the logger data which, prior to mid-2015, is consistent with manual measurements. No marked difference between the pre- and post- blocked well is apparent; therefore, this data is considered representative.
	• Value used on contour plot is >1m lower than last value on hydrograph, not clear if it is now unblocked, but if so value shows a dramatic drop from previously steady readings.			The contour map has been revised to include the correct average water level for this bore (see Appendix C).
C14021SP	• This point lies outside the formation boundary for the Clematis (likely Tertiary or Dunda Beds). Thus is used incorrectly on the Clematis contour plot. • Manual dip readings (in Appendix C) not provided on Appendix E hydrograph	Yes	Yes	Please see Appendix C for updated contour figure See Appendix E
C14033SP	Nil comment	Yes	Yes	-

Bore ID	Initial Review comments	Contoured	Hydrochemistry	Adani response
C14011SP	• Value on contour plot is approximately 1m higher than last value on hydrograph. Given the very steady long-term groundwater levels it is unprecedented for the hydrograph to rise sufficiently to make contour value likely. • Maximum water level on hydrograph appears to be calculated from manual dips, if so value is incorrect.	Yes	Yes	Contour figure (Appendix C) has been updated where the variation is 0.03m between the hydrograph and contour figure. This is a transcription error and will be updated for the next revision of the GMMP. The hydrograph (Appendix E) has been revised to include the maximum logger elevation.
C14012SP	Value on contour plot is approximately 1m higher than last value on hydrograph. Given the very steady long-term groundwater levels it is unprecedented for the hydrograph to rise sufficiently to make contour value likely	Yes	Yes	Contour figure (Appendix C) has been updated where the variation is 0.09m between the hydrograph and contour figure. This is a transcription error and will be updated for the next revision of the GMMP.
C14013SP	Value on contour plot is approximately 1m higher than last value on hydrograph. Given the very steady long-term groundwater levels it is unprecedented for the	Yes	Yes	Contour figure (Appendix C) has been updated where the variation is 0.03m between the hydrograph and contour figure. This is a transcription error and will be updated for the next revision of the

Bore ID	Initial Review comments	Contoured	Hydrochemistry	Adani response
	hydrograph to rise sufficiently to make contour value likely			GMMP.
C18001SP	New, artesian	Yes	No	None
C18002SP	New	Yes	No	None
C18010SP	New	Yes	No	None
C18011SP	New	Yes	No	None
C18012SP	New	Yes	No	None
C18013SP	New	Yes	No	None
C18014SP	New	Yes	No	None
Dunda Beds				
C022P1	Nil comment	Yes	Yes	None
C027P2	• Early manual dip readings appear to have been shifted up 1m in the Appendix E hydrograph Section of the plot is possibly inverted (ie rainfall response) • Manual dip readings in mid 2016 appear to have been omitted (are present in Appendix C data).	Yes	Yes	Adani, in conjunction with DNRME, have re-assessed and re-assigned reference levels. The hydrograph has been updated- see Appendix E
C14023SP	Nil comment	Yes	No	None
C180117SP	Early manual dip readings (March to November 2014) have not been included in Appendix E hydrograph	Yes	Yes	The hydrograph has been updated- see Appendix E
Rewan Formation				
C008P1	Manual dip readings in Appendix C and Appendix E	Yes	? Have trigger	Adani, in conjunction with DNRME, have re-assessed

Bore ID	Initial Review comments	Contoured	Hydrochemistry	Adani response
	do not match - possibly a time shift in the data, or several points omitted.			and re-assigned reference levels. The hydrograph has been updated- see Appendix E
C035P1	• Time scale on Appendix E plot has malfunctioned (mid 2013 to 4/2015 missing). • Data ends at 2/2016. • Appears that manual dip points are missing/Plots in appendices C and E very different.	Yes	? Have trigger	The hydrograph has been updated- see Appendix E- with data to 2017.
C555P1	• Approximately 1m jump in water levels in mid 2013 - not explained. • Logger data from approximately 9/2015 in Appendix E appears to be a plotting error (different to App C). • Calculated average water level is incorrect (appears to be 1m higher than correct value - typo?), the incorrect value is used in the contour plot.	Yes	No	The hydrograph has been updated- see Appendix E Logger malfunction from May to September 2015. Contour figure updated (see Appendix C)
C556P1	Outlying manual dip reading has been removed - but not mentioned/ discussed/explained.	Yes	No	The hydrograph has been updated- see Appendix E
C9553P1R	• Data ends 7/2016. • Early data (2012 to 7/2013)	Yes	No	Erroneous depth to water readings on 3/10/2012 and

Bore ID	Initial Review comments	Contoured	Hydrochemistry	Adani response
	has two logger plots that don't coincide. No explanation given as to why data is different. • Need to clarify which data was used for the model calibration.			21/05/2013 were used to establish/ program the logger which resulted in erroneous reference levels. The hydrograph has been updated- see Appendix E Model calibration is outside the scope and objectives of the GMMP.
C180116SP	Nil comment	Yes	No	-
C9838SPR	Logger and manual dips diverge from mid 2016 - not discussed/explained.	Yes	No	The hydrograph has been updated- see Appendix E
Permian Age Units				
B-C Sandstone (Bandanna Formation)				
C006P1	Nil comment	No	No	-
C018P1	Short period in early part of plot with 2 sets of logger data. Need to clarify which was used in the model calibration	No	No	The hydrograph has been updated- see Appendix E Model calibration is outside the scope and objectives of the GMMP.
C847SP	2 outlier manual dips from early 2015 removed in Appendix E without discussion.	No	No	The hydrograph has been updated- see Appendix E
A-B Seam				
C007P2	Nil comment	Yes	Yes	-

Bore ID	Initial Review comments	Contoured	Hydrochemistry	Adani response
C008P2	5/2016 outlier manual dip removed - no discussion.	Yes	Yes	The hydrograph has been updated- see Appendix E
C014P2	Nil comment	Yes	Yes	-
C016P2	Appears to be a small vertical shift (<0.5m) downward in data. Difficult to confirm due to variable scales.	Yes	Yes	The hydrograph has been updated- see Appendix E
C020P2	Nil comment	Yes	Yes	-
C032P2	Appears to be a small vertical shift upward of data in 2013/2014 (approximately 0.5m).	Yes	Yes	The hydrograph has been updated- see Appendix E
C034P1	• Single manual dip - significantly different to logger data - not discussed/ explained. • Logger appear to malfunction from 7/2016 - not discussed/explained.	No	No	The hydrograph has been updated- see Appendix E
C035P2	Nil comment	Yes	Yes	-
A-B Interburden				
C011P1	• It appears the elevation of the data has shifted by approximately 1m. This may impact model calibration. •Appendix C and Appendix E are inconsistent, and the issues identified in 2017 have not been addressed.	No	No	The hydrograph has been updated- see Appendix E

Bore ID	Initial Review comments	Contoured	Hydrochemistry	Adani response
C Seam				
C823SP	• Hydrograph behaviour strange (opera house) - either logger error (as indicated in Appendix E) or issues with gw sampling (as indicated in Appendix C) this issued should be clarified and resolved. Has been going since end of 2014. • Plots in Appendix C and E are different (logger coincides with manual dip in E, but not in C).	No	No	The hydrograph has been updated- see Appendix E
C832SP	Divergence of manual readings and logger data in later 2016 not explained	No	No	Commitments to improve the monitoring program have been included in Section 7.0.
C Seam Interburden				
C9839SPR	2 manual dip outliers (early 2015) removed in Appendix E without discussion	No	No	The hydrograph has been updated- see Appendix E
C844SP	Nil comment	No	No	-
Other Bandanna Formation				
C018P2	1.5 metre step down in data in approximately 8/2012. Not explained.	No	No	The hydrograph has been updated- see Appendix E
C034P1	• Single manual dip - significantly different to	No	No	Commitments to improve the monitoring program

Bore ID	Initial Review comments	Contoured	Hydrochemistry	Adani response
	logger data - not discussed/ explained. • Logger appears to malfunction from 7/2016 - not discussed/explained.			have been included in Section 7.0. The hydrograph has been updated- see Appendix E
Colinlea Sandstone				
C-D Sandstone				
C972SP (C897G)	Not included	No	No	-
C974SP (C899G)	Nil comment	No	No	-
D Seam				
C006P3R	•Two sets of logger data provided for early (10/11 to 5/13) part of plot. One plot has peaks in the data not present in the other. • The logger plot that continues as the long-term logger appears to be inverted (potential rainfall response falling instead of rising).	Yes	Yes	The hydrograph has been updated- see Appendix E
C007P3	Nil comment	Yes	Yes	-
C011P3	Nil comment	Yes	Yes	-
C018P3	Nil comment	Yes	Yes	-
C024P3	Nil comment	Yes	Yes	-
C034P3	• Logger appears to have failed in late 2015 - no comment/ explanation (however data appears not to be used in calculation of average).	No	Yes	The hydrograph has been updated- see Appendix E

Bore ID	Initial Review comments	Contoured	Hydrochemistry	Adani response
	• Manual dips shown in Appendix E do not appear to match those in Appendix C.			
C180114SP	Nil comment	Yes	Yes	-
C833SP	Logger and manual readings do not match throughout monitoring period. No discussion about why.	Maybe - with typo as C883?	Yes	The hydrograph has been updated- see Appendix E
C848SP	Nil comment	Yes	Yes	-
C9849SPR	Appendix C includes many more manual readings than Appendix E.	No	Yes	The hydrograph has been updated- see Appendix E
C975SP (C900G)	Nil comment	Yes	No	-
D Seam Interburden				
C829SP	Outlying manual dip included in Appendix C but not E - no explanation	No	No	The hydrograph has been updated- see Appendix E
D- E Sandstone				
C825SP	Nil comment	No	No	-
C840SP	Outlying manual dip included in Appendix C but not E - no explanation	No	No	The hydrograph has been updated- see Appendix E
E-F Sandstone				
C180112SP	Outlying manual dip included in Appendix C but not E - no explanation	No	No	The hydrograph has been updated- see Appendix E
Other Colinlea Sandstone				
C827SP	Nil comment	No	No	None
C834SP	• Appendix C includes manual dips, none are included in Appendix E.	No	No	The hydrograph has been updated- see Appendix E

Bore ID	Initial Review comments	Contoured	Hydrochemistry	Adani response
	• Dips diverge from logger data - no discussion/ explanation.			
Joe Joe Group				
C012P1	Nil comment	Yes	Yes	-
C012P2	Nil comment	Yes	Yes	-
C180119SP	Manual dips included in appendix C but not appendix E.	Yes	Yes	The hydrograph has been updated- see Appendix E
C9180124SPR	• Water levels in appendix C are approximately 3 metres lower than Appendix E values. • Appendix C includes manual dips, none are included in Appendix E. • Dips do not coincide with logger data - no discussion/explanation.	Yes	Yes	The hydrograph has been updated- see Appendix E
C9180125SPR	• Appendix C includes manual dips, none are included in Appendix E. • Dips do not coincide with logger data - no discussion/explanation.	Yes	Yes	The hydrograph has been updated- see Appendix E
C180123SP	Manual dips included in appendix C but appendix E.	Yes	Yes	The hydrograph has been updated- see Appendix E
C14002SP	Manual readings have shifted vertically from Appendix C to Appendix E.	Yes	No	The hydrograph has been updated- see Appendix E
C914001SSPR	Nil comment	Yes	Yes	-

Bore ID	Initial Review comments	Contoured	Hydrochemistry	Adani response
C14014SP	• Early manual dips in Appendix C and Appendix E do not correspond. • Notes indicate farmer using bore, consequently is the bore suitable as a monitoring point?	Yes	Yes	The hydrograph has been updated- see Appendix E
C14032SP	• No hydrograph provided in appendix C. • Step change in water levels in approximately October 2015 (3m down) - not explained/explored. Could it be a resurvey of the monitoring point? (water levels appears relatively steady before and after the step change)	Yes	No	The hydrograph has been updated- see Appendix E
C14008SP	Manual dips and logger data do not coincide - not discussed/explained	Yes	Yes	The hydrograph has been updated- see Appendix E
C14015SP	No manual dip data provided	Yes	Yes	-
C14017SP	Manual dips and logger data do not coincide - not discussed/explained	Yes	Yes	The hydrograph has been updated- see Appendix E
C14006SP	• Manual dip readings not presented in Appendix E. • Dips and logger do not coincide - not discussed/explained	Yes	Yes	The hydrograph has been updated- see Appendix E
C914030SPR	Manual dips and logger data	Yes	No	The hydrograph has been

Bore ID	Initial Review comments	Contoured	Hydrochemistry	Adani response
	do not coincide - not discussed/explained			updated- see Appendix E
C14004SP	Early outlier in Appendix C removed in Appendix E (probably reasonable, but not explained).	Yes	No	The hydrograph has been updated- see Appendix E
C14016SP	Nil comment	Yes	Yes	-
C14003SP	Outlying manual dips from Appendix C not in E.	Yes	Yes	The hydrograph has been updated- see Appendix E
Composite Sample Points				
C180122SP	• No manual dips included in appendix E. • Manual dips do not coincide with logger data - no explanation	No	No	Composite bores were not used for average gw elevation or contour development; however, they will aid with groundwater resource assessments, groundwater conceptualisations, and predictive groundwater modelling.
C180120SP	•No manual dips included in appendix E. • Manual dips diverge from logger data - no explanation	No	No	Composite bores were not used for average gw elevation or contour development; however, they will aid with groundwater resource assessments, groundwater conceptualisations, and predictive groundwater modelling.
C973SP (C898G)	Not included in Appendix C	No	No	Composite bores were not

Bore ID	Initial Review comments	Contoured	Hydrochemistry	Adani response
				used for average gw elevation or contour development; however, they will aid with groundwater resource assessments, groundwater conceptualisations, and predictive groundwater modelling.
C14031SP	No manual dips included in appendix E.	No	No	Composite bores were not used for average gw elevation or contour development; however, they will aid with groundwater resource assessments, groundwater conceptualisations, and predictive groundwater modelling.
C14024SP	Not included in Appendix C	No	No	Composite bores were not used for average gw elevation or contour development; however, they will aid with groundwater resource assessments, groundwater conceptualisations, and predictive groundwater modelling.
C14005SP	• Plots in Appendix C and Appendix E are very different: several data steps	No	No	Composite bores were not used for average gw elevation or contour

Bore ID	Initial Review comments	Contoured	Hydrochemistry	Adani response
	in Appendix C, none in Appendix E. • No manual dips in Appendix E. • Several small downward data spikes not explained. • Logger and manual readings divergent			development; however, they will aid with groundwater resource assessments, groundwater conceptualisations, and predictive groundwater modelling.
C14029SP	Not included in Appendix C	No	No	Composite bores were not used for average gw elevation or contour development; however, they will aid with groundwater resource assessments, groundwater conceptualisations, and predictive groundwater modelling.

From: s22 [redacted]
To: "McDonald, Warwick (L&W, Black Mountain)"
Subject: FW: Letter to the Secretary [DLM=Sensitive]
Date: Friday, 5 April 2019 2:20:31 PM
Attachments: image001.png
image002.png
image003.png
image004.png
image005.png
DoEE Letter 5 April 2019.pdf

Hi Warwick,

GA sent their letter (attached) to Finn. Dean said to Jane that the letter could go to him – up to you!

s22 [redacted]

T 02 s22 [redacted] @environment.gov.au
W www.environment.gov.au

From: s22 [redacted]
Sent: Friday, 5 April 2019 2:17 PM
To: s22 [redacted]
Subject: FW: Letter to the Secretary [DLM=Sensitive]

From: Dean Knudson
Sent: Friday, 5 April 2019 12:37 PM
To: s22 [redacted] @environment.gov.au>
Subject: FW: Letter to the Secretary [DLM=Sensitive]

From: Johnson James [mailto:James.Johnson@ga.gov.au]
Sent: Friday, 5 April 2019 11:23 AM
To: Finn Pratt <Finn.Pratt@environment.gov.au>
Cc: Dean Knudson <Dean.Knudson@environment.gov.au>
Subject: Letter to the Secretary [DLM=Sensitive]

Dear Finn,

I attach a letter relating to this morning's teleconference.

Kind regards,

James

Dr James Johnson | Chief Executive Officer

t +61 2 6249 9236 **m** +61 (0) 407 896 599 www.ga.gov.au

cid:image003.png@01D239B0.335017C0

Geoscience Australia acknowledges Traditional Custodians of Country throughout Australia and recognises the continuing connection to lands, waters and communities. We pay our respects to Aboriginal and Torres Strait Islanders' cultures and to elders past, present and emerging.

From: Gregory Manning
To: s22
Subject: FW: Advice on Groundwater Management Plans and Response [SEC=OFFICIAL]
Date: Friday, 5 April 2019 4:35:10 PM
Attachments: Letter to Dean Knudson re Advice on Groundwater Management Plans and Response dated 5 April 2019.pdf

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From: s22 (L&W, Black Mountain) [mailto:s22 @csiro.au] **On Behalf Of** Coram, Jane (L&W, Black Mountain)
Sent: Friday, 5 April 2019 4:34 PM
To: Dean Knudson
Cc: Finn Pratt ; Gregory Manning ;s22 (Executive, Black Mountain)
Subject: Advice on Groundwater Management Plans and Response

Dear Mr Knudson

Please find attached a letter from Jane Coram regarding advice on groundwater management plans and response.

Regards

s22

Executive Assistant
CSIRO Land and Water
Research in land, water, ecosystems, cities, social and economic sciences, pollution, earth observation, and climate adaptation
E s22
http://www.csiro.au/en/Research/LWF
GPO Box 1700 Canberra ACT 2601
CSIRO Black Mountain Site
Clunies Ross St, Canberra ACT 2601

LAND AND WATER
www.csiro.au

FOI 190417
Document 50a

Black Mountain Science and Innovation Park, Clunies Ross Street, Acton ACT 2601
GPO Box 1700, Canberra, ACT 2601, Australia
T (02) 6246 4383 • ABN 41 687 119 230

5 April 2019

Mr Dean Knudson
Deputy Secretary, Environmental Protection Group
Department of the Environment and Energy
GPO Box 787
CANBERRA ACT 2600
(dean.knudson@environment.gov.au)

Dear Mr Knudson

RE: Advice on Groundwater Management Plans and Response

Thank you for briefing me on the actions agreed to by Adani in their two groundwater-related management plans, following the advice that CSIRO and Geoscience Australia and CSIRO provided to you in late February 2019. CSIRO was responsible for the modelling component of this advice, and our comments here relate to that component of Adani's responses.

Our examination of Adani's actions is based on today's briefing and the summary information ("Summary of CSIRO and Geoscience Australia (GA) Advice on Groundwater Management Plans and Response") subsequently provided to CSIRO by your Department.

CSIRO is of the view that Adani's responses should satisfy the recommendation to update the groundwater models, and are directed to address the modelling related issues and concerns raised in our advice, noting that there are still components of that advice that will need to be addressed through the approval of the research plan.

Yours sincerely

JE Coram

Jane Coram
Director
CSIRO Land and Water

cc Finn Pratt, Secretary, Department of the Environment and Energy
Greg Manning, Assistant Secretary, Assessment & Post Approvals Branch, Department of the Environment and Energy

FOI 190417
Document 51

From: s22 L&W, Black Mountain)
To: s22
Subject: FW: Advice on Groundwater Management Plans and Response
Date: Friday, 5 April 2019 4:36:00 PM
Attachments: Letter to Dean Knudson re Advice on Groundwater Management Plans and Response dated 5 April 2019.pdf

---

Dear s22

FYI.

Regards

s22

From: s22 (L&W, Black Mountain) **On Behalf Of** Coram, Jane (L&W, Black Mountain)
Sent: Friday, 5 April 2019 4:34 PM
To: 'dean.knudson@environment.gov.au'
Cc: 'Finn.Pratt@environment.gov.au' ; 'gregory.manning@environment.gov.au' ; s22 (Executive, Black Mountain)
Subject: Advice on Groundwater Management Plans and Response

Dear Mr Knudson

Please find attached a letter from Jane Coram regarding advice on groundwater management plans and response.

Regards

s22

[redacted]

Executive Assistant

CSIRO Land and Water

Research in land, water, ecosystems, cities, social and economic sciences, pollution, earth observation, and climate adaptation

E s22

http://www.csiro.au/en/Research/LWF

GPO Box 1700 Canberra ACT 2601
CSIRO Black Mountain Site
Clunies Ross St, Canberra ACT 2601

FOI 190417
Document 52

From: s22
To: Gregory Manning; s22
Cc: s22 ; James Tregurtha
Subject: FW: Draft Geoscience Australia response to SMH [SEC=UNCLASSIFIED]
Date: Friday, 12 April 2019 2:32:13 PM
Attachments: image001.png
image002.png
image003.png
image004.png
image005.png
SMH inquiry Adani"s groundwater plans.msg
image006.jpg
image007.jpg
image008.jpg
image009.jpg

Dear Greg and s22

Here is the draft GA response on the Nicole Hasham query. We have undertaken to get back to them today if we have any concerns so that they can respond to Nicole.

s22 | **Public Affairs Officer**
External Engagement team, Communications, Innovation and Partnerships Branch
Policy Advice and Implementation Division
Department of the Environment and Energy
GPO Box 787, CANBERRA ACT 2601
T 02 s22
amanda.forman@environment.gov.au

Note to media: Unless otherwise agreed, the information contained in this email is for background only and is not for attribution.

From: Media <Media@ga.gov.au>
Sent: Friday, 12 April 2019 12:20 PM
To: Media <Media@ga.gov.au>
Cc: Media <Media@ga.gov.au>
Subject: Draft Geoscience Australia response to SMH [SEC=UNCLASSIFIED]

Hi s22

As discussed, below is the draft response we have put together to address s22 questions (attached).

This is tentatively approved – if you can provide some advice on the below response and what your approach is going to be, I can look at getting final approval on our end and then send this to the journalist.

Thanks,

s22

Draft response:

On behalf of the Australian Government, the Department of the Environment and Energy oversees the process to approve all groundwater managements plans under the *Environmental Protection and Biodiversity Conversation Act 1999*. It is not the role of Geoscience Australia to make or suggest regulatory decisions to the Department of the Environment and Energy.

As part of a process overseen by the Department of the Environment and Energy, Geoscience Australia together with the CSIRO was asked to review Adani's groundwater management plans for the Carmichael Coal Mine and Rail Infrastructure project.

Specifically, the Department of the Environment and Energy sought technical advice on three questions relating to the Groundwater Dependent Ecosystem Management Plan (version 10a) and the Groundwater Management and Monitoring Plan (version 5).
Geoscience Australia provided its technical advice for consideration to the Department of the Environment and Energy on Friday, 22 February 2019. A copy of the advice, including the three questions, is publicly available on the Department of Environment and Energy website:
http://www.environment.gov.au/system/files/pages/cb8a9e41-eba5-47a4-8b72-154d0a5a6956/files/csiro-geoscience-australia-final-advice.pdf
On Friday, 5 April, Geoscience Australia was extensively briefed by the Department of the Environment and Energy about changes made by Adani to its groundwater management plans following the technical advice provide on Friday, 22 February 2019. A summary of these changes is publically available on the Department of Environment and Energy website:
http://www.environment.gov.au/system/files/pages/cb8a9e41-eba5-47a4-8b72-154d0a5a6956/files/summary-csiro-ga-advice-response.pdf.
Based on this updated information provided by the Department of the Environment and Energy, Geoscience Australia was of the view that Adani had addressed the issues and concerns raised in the technical advice provided on Friday, 22 February 2019.
As the administering department, the Department of the Environment and Energy is the best point of contact for questions about Adani's groundwater management plans.
Kind regards,

s22 [redacted]
[redacted] | Media Adviser | Public Relations
Communications | Enabling Services
t +61 2 s22 [redacted] **Media Hotline** 1800 882 035 www.ga.gov.au

cid:image006.png@01D239A5.39C6E990

Geoscience Australia acknowledges the Traditional Custodians of Country throughout Australia and recognises the continuing connection to lands, waters and communities. We pay our respects to Aboriginal and Torres Strait Islanders Cultures: and to elders past, present and emerging.

FOI 190417
Document 52a

From: s22
To: Media
Subject: SMH inquiry: Adani"s groundwater plans
Date: Thursday, 11 April 2019 12:00:55 PM

Hello, please find questions below on Geoscience Australia's reviews of Adani's groundwater plans.

A response by 4.30pm today would be appreciated, thanks. However I understand the questions are detailed so if you need more time in order to fully answer the questions, please let me know. Can you please confirm receipt of this email?

1. The CSIRO/GSA report in February 2019 said of Adani’s groundwater management plan that “the modelling used is not suitable to ensure the outcomes sought by the EPBC conditions are met”? Was concern from the Department regarding the implications of this finding for Adani’s mine communicated to GSA by the department or anyone else at any stage?
2. Is GSA confident that Adani has identified the source aquifer for the Doongmabulla Springs?
3. Does GSA believe that questions central to the question of the Carmichael mine’s impact on groundwater that remain unaddressed?

4. Regarding the meeting on Friday April 5 between DOEE, CSIRO and GSA:
a) When was the meeting requested, who requested the meeting and who was present? What time did the meeting start and end?
b) What documents were provided to GSA prior to and at the meeting? What documents were provided to GSA after the meeting? At what time?
c) What was the process for considering these documents and assurances prior to the issue of GSA's letter to Dean Knudson? How long did this take?
d) Did the GSA authors of the initial advice have the opportunity to review Adani’s proposed responses?
What time elapsed between the end of the meeting and sending the letter?
e) What verbal or written assurances were GSA provided by DOEE about Adani’s responses to their comments? Was GSA satisfied by those assurances that all its concerns were answered?
5. Does GSA ordinarily provide scientific assessments/advice on the basis of a verbal briefing and a summary document? Would you agree with the characterisation of this assessment process as highly unusual?
6. What was communicated to the CSIRO regarding the necessity for such haste in finalising this assessment process?

Best regards,

Nicole Hasham
Environment and energy correspondent
Sydney Morning Herald and The Age
W (02) 6240 4033 M 0421 565 668
Twitter: @Nicole_Hasham

From: s22 [redacted]
To: s22 [redacted]"
Subject: FW: Adani Groundwater Data Review Project [DLM=For-Official-Use-Only]
Date: Wednesday, 30 January 2019 12:22:30 PM
Attachments: image001.png
image002.jpg
20190110 TERTIARY DNRME comments.pdf
20190111 REWAN FORMATION DNRME Comments.pdf
20190111 FINAL BANDANNA DNRME comments.pdf
20190111 FINAL COLINLEA SANDSTONE DNRME comments.pdf
20190111 Final JOE JOE DNRME comments.pdf

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s22 [redacted]

We'd be looking for you to review Adani's edits in response to the DNRME comments attached. Sending the responses is more difficult – hopefully you have some idea of the (variability in) scale of work from their issues identified attached.

s22 [redacted]

T 02 s22 [redacted]@environment.gov.au
W www.environment.gov.au

From: s22 [redacted]@des.qld.gov.au]
Sent: Wednesday, 30 January 2019 9:34 AM
To: s22 [redacted]
Subject: FW: Adani Groundwater Data Review Project

FYI

From: s22 [redacted]
Sent: Friday, 11 January 2019 4:22 PM
To: s22 [redacted]
Cc: s22 [redacted] s22 [redacted]
Subject: RE: Adani Groundwater Data Review Project

Hi s22 [redacted],

As per the email below, please find attached reports containing initial reviews of the remaining bores in the following aquifers:

- Tertiary;
- Rewan Formation;
- Bandanna Formation;
- Colinlea Standstone; and
- Joe Joe.

Kind regards,

s22 [redacted]

s22 [redacted]
Project Coordinator
Water Services | Central Region
Department of Natural Resources, Mines and Energy

P: s22 [redacted]

A: 22-30 Wood Street, Mackay Qld 4740
W: www.dnrme.qld.gov.au

From: s22
Sent: Friday, 21 December 2018 10:27 AM
To: s22
Cc: s22
Subject: Adani Groundwater Data Review Project

Hi s22

As discussed, please see our plan to move forward with the review of the Adani groundwater data review:

- DNRME will continue to review the groundwater bore data supplied, aiming to provide you with the review summary and any follow-up actions/ questions for Adani/ AECOM by the 11th January 2019.
- This does not include the review of any responses to queries already raised, of which DNRME are waiting for responses. This will occur after the 11th January 2019.
- Of the 81 bores to be reviewed, approximately 63 still need to be reviewed.
- **Of the 63 bores remaining, approximately 30 require further investigation and are likely to require clarification with Adani/ AECOM.**
- DNRME believes that the best result will be achieved if we continue reviewing the remaining data, and put specific clarification requests back to the client (via DES) for response.
- Correspondence going forward will be through Sam or myself, directly to you.

Please give me a call at any stage if you have any questions.

Kind regards,

s22

s22
Project Coordinator
Water Services | Central Region
Department of Natural Resources, Mines and Energy

P: s22
[redacted].au
A: 22-30 Wood Street, Mackay Qld 4740
W: www.dnrme.qld.gov.au

From: s22
To: "peter.mayfield@csiro.au"; "jane.coram@csiro.au"; "s22 @csiro.au"; "james.johnson@ga.gov.au"; s22 @csiro.au"
Cc: Dean Knudson; James Tregurtha; Gregory Manning; s22
Subject: Adani media release [SEC=OFFICIAL]
Date: Wednesday, 10 April 2019 8:42:20 AM
Attachments: image001.jpg

Hi everyone,

Thanks for the phone call yesterday.

A link to the Minister's media release is here: http://environment.gov.au/minister/price/media-releases/mr20190409.html

James, I will send you GA's comments on the project at the time of approval, plus initial comments from 2017 shortly.

-s22

Acting Director | Post Approvals Strategies
Environment Standards Division
Department of the Environment and Energy
T 02 s22 @environment.gov.au

Reconciliation%20Email%20Footer

ustralian Government
Geoscience Australia

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Symonston ACT 2609

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Australia

+61 2 6249 9111
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ABN 80 091 799 039

Friday 5 April 2019

Mr. Finn Pratt

Secretary

Department of the Environment and Energy

finn.pratt@environment.gov.au

cc: Mr Dean Knudson (dean.knudson@environment.gov.au)

Finn

Dear ~~Mr Pratt~~,

Thank you for the extensive briefing from Department of Environment and Energy regarding the actions agreed to by Adani in the revised Groundwater Management and Monitoring and Groundwater Dependent Ecosystem Management plans in response to advice provided your Department from Geoscience Australia and CSIRO on 22 February 2019. Based on this briefing Geoscience Australia is of the view that Adani have addressed the issues and concerns raised in our recommendations.

Sincerely,

Dr. James Johnson

Chief Executive Officer

FOI 190417
Document 56

From: s22
To: Dean Knudson
Cc: James Tregurtha; s22; s22; s22; s22; s22
Subject: For information: Lock the Gate GDEMP review [DLM=For-Official-Use-Only]
Date: Friday, 22 February 2019 10:49:58 AM
Attachments: image001.png
Review of Adani draft GDEMP V10 for Carmichael coal mine MCurrell.pdf
image002.png

Hi Dean

Qld DES have sent through a technical review of Adani's draft GDEMP commissioned by Lock the Gate – the review is dated 20 February 2019. Lock the Gate obtained a copy of the draft GDEMP under Queensland's right to information laws.

The review was undertaken by Dr Matthew Currell of RMIT University who has previously make comments about the Adani approval. Having just received the report we are yet to read it in detail, however it appears to areas of concern raised about the draft are aligned with the advice we've sought from CSIRO/GA on.

We will start preparing some points ahead of the review likely making an appearance in the media over the weekend.

Also, we've been in touch with CSIRO/GA to confirm we will receive their review report before COB today and have organised a meeting with them on Monday.

Cheers
s22

From: s22 [mailto:s22@des.qld.gov.au]
Sent: Friday, 22 February 2019 10:16 AM
To: s22@environment.gov.au>
Subject: re. GDEMP review

Hi Emily,

For your consideration.

Ciao for now

s22

s22
Manager
Business Centre Coal - Coal and Central Queensland Compliance
Department of Environment and Science

P 07 4987 9356 **M** 0436607932
99 Hospital Road, Emerald QLD 4720
PO Box 3028, Emerald QLD 4720

FOI 190417
Document
56a

Analysis draft Groundwater Dependent Ecosystem Management Plan (version 10): Carmichael Mine

Dr Matthew Currell
Associate Professor
School of Engineering
RMIT University
GPO Box 2476, Melbourne VIC 3000

20/02/19

Introduction

This report contains my analysis of the draft Groundwater Dependent Ecosystem Management Plan (GDEMP) prepared for the Carmichael Coal Mine Project by Ecological Australia (dated November 2018). The draft GDEMP report was provided to me by Carmel Flint from Lock the Gate, who requested I complete an independent review. I agreed to conduct the review on a pro-bono basis. The views below are my own independent views as an academic with expertise in the field of hydrogeology.

I have previously published articles examining the scientific basis for assumptions made regarding the impacts of the Carmichael Mine on groundwater dependent ecosystems, particularly the Doongmabulla Springs (Currell, 2016; Currell et al., 2017).

In these articles, it was highlighted that:

a) The evidence base for assuming the source aquifer to the Doongmabulla Springs was inadequate to make a conclusive determination on this matter, and at least one alternative scenario (that the springs could receive part or all of their flow from groundwater emanating from the deeper Permian sediments) could not be ruled out. This view was supported by the interrogation of hydrogeological evidence during the proceedings between LSCC vs. Adani Mining in the Land Court of Queensland in 2015 and subsequent work published in the Lake Eyre Basin Springs Assessment (Fensham et al., 2016).
b) Assumptions about the relationship between drawdown caused by mining and the resulting effects on spring flow rates and wetland area were questionable, and existing modelling did not adequately address this issue. Currell et al., 2017 and Currell, 2016 also argued that proposed monitoring and management strategies- focussed on drawdown in the shallow aquifers of the region - could run the risk of not detecting potential impacts on the springs until such time as it is too late to take effective mitigation action.

My analysis of the GDEMP here examines whether these issues have been resolved (for example through additional field investigations and/or modelling) as well as discussing other considerations with respect to the proposed monitoring and management program to protect the Doongmabulla Springs.

Summary of my opinion

The draft GDEMP provides data from some additional site investigation work carried out between the mine lease and the Doongmabulla Springs, which has some bearing on the two issues noted above. Shallow spear-point wells have been installed to examine water elevations at some spring wetlands, additional land elevation surveys have been conducted and 10 new groundwater monitoring bores were constructed, predominantly within the Clematis Sandstone, providing further water level readings from this aquifer. It is this aquifer which is assumed (in groundwater modelling conducted for Adani) to be the source aquifer for the Doongmabulla Springs.

However, deficiencies remain in the overall field data available from the site, preventing conclusive resolution of the question of the source aquifer(s) for the springs. Namely:

- There is no mapping of groundwater elevations and flow patterns in the deeper hydrostratigraphic units below the Clematis Sandstone, including the Permian layers (e.g. Colinlea Sandstone) in the vicinity of the springs.
- There is no analysis of vertical hydraulic gradients between the Permian and Triassic aquifers at different depths, using nested monitoring bores. Such gradients are critical to assessing the potential for discharge of groundwater to the surface form different units. Analysis of groundwater flow patterns (e.g. using contouring of water level data) is only presented in two dimensions, assuming flow in the Clematis aquifer is the only aspect of the groundwater flow system relevant to discharge to the springs. Analysis of the flow patterns in multiple aquifers/depths, and the vertical component of flow throughout the region is required to assess the source and mechanism of spring discharge (as well as recharge to potential source aquifers).
- There has been no detailed investigation of geological structures in the region – for example, informed by geophysical testing and detailed stratigraphic correlation of series of bore logs through the full geological sequence. This means that the possibility of faulting providing a conduit for deeper groundwater to flow to the surface at the springs (a plausible explanation for the occurrence of the springs) has yet to be properly investigated.

Without these additional data and analysis, the issue of the source aquifer for the springs remains un-resolved. There are also other short-comings in the data and analyses included in the GDEMP which contribute to ongoing uncertainty on the issue of how the Doongmabulla Springs might be impacted by mining (such as questions over the role of the Moolayember Formation as a confining layer).

While some additional modelling of the groundwater systems in the Galilee Basin has occurred recently as part of the Commonwealth's Bioregional Assessment program (e.g. Turvey et al., 2015; Lewis et al., 2018), this modelling has been conducted making essentially the same assumptions as the previous modelling carried out for Adani regarding the springs' source aquifer – i.e., that flow is derived from the Clematis Sandstone. The Bioregional assessment modelling notes that there is a significant probability of some level of drawdown impact in the Clematis Sandstone aquifer at the location of most of the spring wetlands associated with the Doongmabulla Springs. This should warrant a more detailed re-analysis of the potential impact of mining on the springs complex. The possible range of water level change from the recent cumulative impact modelling should be assessed in conjunction of a detailed analysis of the threshold elevation levels below which spring wetlands will be impacted or cease to receive discharge. The effect of mining in terms of a reduction in fluxes (flow volumes of water over time) as a result of water level changes, has also still not been assessed in detail either by Adani or the Bioregional Assessment modelling. As such, there remains significant uncertainty with respect to the impacts of mining on the springs.

The proposed monitoring program outlined in the GDEMP, which is designed to detect possible impacts of mining on GDEs in the region, is ill-equipped for the purpose of rapid and early detection of impacts which may affect the Doongmabulla Springs. Further understanding of the relationship between water levels and spring discharge (including flow rates) at the various wetlands within the springs complex is needed to more properly determine the key monitoring criteria and infrastructure needed to rapidly detect and mitigate any impacts. At present there is a substantial risk that should the proposed monitoring, trigger and corrective actions outlined in the draft plan be adopted, the springs may be vulnerable to irreversible impacts, without proper advance warning. This is particularly given the lack of groundwater monitoring bores proposed or installed within deep sediments below the Clematis Sandstone, from which mine-related drawdown will likely propagate (irrespective of their source aquifer).

Specific comments on the report

Section 8.3.1 Conceptual groundwater model

- The statement that "Studies undertaken during and post EIS indicate that the source aquifer of the Doongmabulla springs-complex is discharge from the artesian Clematis Sandstone through weathered Moolayember Formation" on page 169 is not substantiated. At the very least, the references on which the statement is based, and those outlining alternative conceptual models (e.g. Webb et al., 2015; Currell et al., 2017) should be included here. A more thorough discussion of different possible conceptual models that have been put forward is needed upfront.
- In the list of factors that are considered important to inform conceptual model of the springs (Page 170), there is no mention of geological structures (e.g. fractures and faults), which are frequently key controls on the location of springs in the landscape (e.g. Fetter, 2001; Moya et al, 2014).
- The conceptual model of the springs (shown in Figures 8-9, 8-10, 8-11) does not clearly show the mechanism by which groundwater discharges to the springs (although it is stated in the text that discharge is inferred to be from the Clematis Sandstone). There is no indication of the direction or magnitude of the hydraulic gradients – including in the vertical dimension - which control the discharge of groundwater to the surface at the springs. A proper assessment of these gradients requires detailed analysis of water levels both in the horizontal (e.g. within each aquifer unit) and vertical (between aquifers, by means of analysis of water levels in nested sites) dimensions.
- Recharge areas are only very generally marked on the conceptual cross section, without a detailed analysis of where recharge enters the aquifers in the region (e.g., shown on a map in conjunction with water levels and gradients). This is important in analysing the possibility of different aquifers providing flow to the springs, e.g. based on analysis of whether there is sufficient driving head to allow artesian flow at the springs. Recharge is inferred (in the proposed conceptual model) to occur through the Moolayember Formation, which is also proposed to also act as the confining layer through which artesian discharge takes place to the springs. This is a somewhat unusual conceptual model, and one which requires further interrogation by means of detailed field investigations - e.g. further characterisation of the thickness and hydraulic properties of the Moolayember Formation and vertical hydraulic gradients at the (proposed) recharge and discharge area(s).

Section 8.3.2 & 8.3.3 – Additional borehole and water level data

- The number of bores between the project area and the springs has increased since the previous modelling work. Ten additional monitoring bores have been drilled between the project area and the springs, in the Clematis Sandstone and Moolayember Formation (Table 8-1). These have been used to determine additional water level data from these units. Shallow spear-point wells have also been installed to gauge the water level at the surface in the vicinity of some spring wetlands. These data provide some additional indication of the potential for the Clematis Sandstone to be providing part or all of the groundwater flow to the Doongmabulla springs.
- However, the bore network is still insufficient to determine groundwater flow directions in all of the possible aquifers which might provide flow to the springs, or properly analyse the hydraulic gradients in both horizontal and vertical dimensions. This is because water level data from deeper bores in the vicinity of the springs have not been collected. Ground water levels in the deeper units (e.g. Colinlea Sandstone, Rewan Formation) are required to conduct a proper analysis of flow patterns - e.g. using groundwater flow-nets, which illustrate both the vertical and horizontal components of flow in the strata below the springs. A further short-coming is the lack of information regarding the depth of the screened interval for the new bores, to which the water level data apply. As such, only a basic two-dimensional understanding of groundwater levels can be conducted.

- As is noted on page 172-173, the groundwater elevations in the Clematis aquifer are generally similar to (or in some cases higher than) water levels recorded at the various spring wetlands at the land surface. While this is a pre-requisite for the Clematis aquifer providing flow to the springs, of itself it does not provide conclusive evidence that discharge from this aquifer provides the majority of flow to the various spring outlets. Assessment of the potential for groundwater discharge from the aquifer to the springs also requires detailed mapping of the groundwater elevations – from which flow gradients can be determined - along with topographic/surface water elevations at the wetlands for comparison (e.g. surfaces representing groundwater elevation and surface elevation).
- Most of the new bores in the Clematis Sandstone have groundwater elevation levels below ground level, indicating limited potential for artesian flow; however, there is one bore (C18001SP – see Table 8-1) which has a higher water level than the ground surface, indicating the possibility of artesian flow from the aquifer at this location. This bore is located to the west of the springs.
- Many of the groundwater elevations in the Clematis Sandstone aquifer in the new bores (table 8-1) are close to or higher than the water elevation recorded at Joshua Spring, which would be a pre-requisite for this spring receiving groundwater discharge from the Clematis unit. However, the location of the bores with respect to the spring outlet is critical. In order for discharge to occur the groundwater elevations must exceed land surface elevation, and there must be a gradient for groundwater flow towards the spring. On page 173 it is stated that the water level in bore C18002 SP matches the water level at the Spring turkeys nest dam. This is not clearly shown on a map. It appears (from the coordinates provided) that this bore, as well as the other bore with water level record similar to the spring (C14012SP) are still located more than 2 kilometres from the spring outlet. Groundwater elevation data from closer to the spring, along with high-accuracy elevation surveys of the region surrounding the spring, are needed to verify the relationship between water levels and spring outlet elevation. Similarly, without a proper analysis of the vertical component of groundwater flow (using nested monitoring bores), it cannot be verified whether these water level data are indeed consistent with discharge from the Clematis aquifer to Joshua Spring.
- The additional 'deep core bores' drilled into the Rewan Formation and underlying coal seams (mentioned on page 171 and discussed in section 8.3.6) appear not to have been constructed as groundwater monitoring bores to allow determination of groundwater elevations within these units to compare with the water levels in overlying aquifers, or take samples of groundwater at or near the location of the springs. They are thus of limited value in terms of assessing the alternative possibility that the springs receive flow from the deeper aquifer(s). Bores which are nested – e.g. constructed to monitor water levels and quality at multiple depths/lithologies at a single location, are required in order to properly assess the relationship between the springs and the underlying groundwater system. Such bores should intersect the full geological sequence, from Permian through to Cainozoic, with monitoring in each hydrostratigraphic unit. This would allow estimation of the possible direction and magnitude of vertical water fluxes between the hydrostratigraphic units in the vicinity of the springs.
- The Joshua Spring has a relatively high flow rate, and as such there must be a confining geological layer which restricts groundwater discharge in all but a small area where it is absent, allowing artesian flow at the surface. The GDEMP (and other hydrogeological work completed for Adani) proposes that the Moolayember formation acts as this confining layer (e.g. see page 174). However, there are potential problems with this conceptualisation. Under the conceptual model presented in the GDEMP, recharge of groundwater is proposed to occur through this same formation – the Moolayember (see Figure 8-10 and 8-11). For the same unit to act both as a confining layer for an underlying artesian aquifer, and to be the main layer through which recharge occurs would be unusual and is only be plausible if there was significant geological heterogeneity in the properties and thickness of the unit. As such, a far more detailed characterisation of the distribution of this unit throughout the region (e.g. detailed maps and cross sections of its thickness and extent), analysis of its hydraulic properties in different areas of the site, and

hydraulic gradients in the proposed recharge and discharge areas incorporating the Moolayember are needed in order to properly understand this issue.

- This speaks to a more general problem of a lack of proper identification (through detailed mapping) of proposed groundwater recharge areas, shown in relation to groundwater flow patterns (in multiple layers) at the site. This is important, as it is the groundwater elevation levels in areas of groundwater recharge for a given unit which provide the driving head for groundwater discharge at the other end of the groundwater flow system. Recharge areas will typically be in areas of elevated topography and/or outcrop of the relevant geological unit(s) and will be characterised by downward vertical hydraulic gradients (evident through monitoring groundwater elevations at nested sites). Groundwater residence time indicators (such as tritium) are also valuable in identifying areas of likely recharge. The only map of pre-mining groundwater flow patterns (Fig 8-15a) shows groundwater elevations in the Clematis aquifer only and shows no indication of where recharge is proposed to be taking place. The detail on this map and the water level data provided elsewhere are insufficient to give a proper picture of how groundwater recharge, flow and discharge (ultimately to the Doongmabulla Springs) occur in the region.

Section 8.3.5 Regional Geology Interpretation

- Further information regarding geological structures in the region does not appear to have been collected or analysed since the original hydrogeological study in the EIS. As discussed in the expert reports prepared in the Land Court case between LSCC and Adani (Webb et al., 2015) and in Currell et al., (2017), geological structures such as faults and fractures are often important controls on spring location. This is because such structures often result in localised breaching of confining layers which otherwise prevent upward discharge of pressurised water in deep confined aquifers. In order to conclusively determine the source aquifer(s) providing flow to the springs, geological structures in the area should be characterised. This should include both direct evidence from detailed logging and stratigraphic correlation of bores which intersect all of the potentially relevant units (including the Colinlea Sandstone) as well as non-invasive geophysical data, such as seismic surveys. No such data appear to have been collected in the vicinity of the springs, meaning the role of structures can't be properly assessed.

Section 8.3.6 Rewan Formation properties

- As is clear from Figure 8-13, the bores used to assess thickness and properties of the Rewan Formation are nearly all within or close to the mining lease area, and the only deep bore in relatively close proximity to the Doongmabulla Springs is the Shoemaker Bore (from which data have already been analysed in the Lake Eyre Basin Springs Assessment – Fensham et al., 2016). To characterise the Rewan unit's thickness and hydraulic properties (as well as the possibility of faulting/fracturing) a series of bores drilled through the unit into the underlying Permian sediments are needed. Given that the springs are restricted to a specific geographic area, it is in this area where it is most important that the geological characteristics and structure are characterised.
- While testing of corehole materials is one approach that can be used to assess hydraulic parameters such as hydraulic conductivity, it is generally understood in hydrogeology that such testing may not be a reliable indicator of the bulk hydrogeological properties for thick hydrostratigraphic layers. Pumping tests are a far more reliable means to estimate the bulk hydraulic conductivity of an aquifer or aquitard. Without such testing, it will be unclear how the unit will behave as a whole in response to stresses such as those caused by mine de-watering.

Section 8.3.7 Alternative model scenario

- An analysis of groundwater levels in multiple aquifers – including the deeper Permian sediments - is presented in Table 8-4 to assess the plausibility of a deeper source aquifer (the Permian sediments) providing flow to the springs. This table provides ‘averaged’ groundwater level data for different regions (North, Mid, South) in the study area. However, it is not clear where the location of the springs relates to these broad regions, nor how these average water levels translate to actual horizontal and vertical hydraulic gradients in the aquifers of the region. Mapping of actual water level elevations within the Permian sediments, and presentation of the water levels and vertical gradients at specific bore locations is required in order for these data to provide relevant information about the springs relationship to the water levels in the deeper layers.

- Some basic water quality data are provided, indicating some similarity in the water quality characteristics in the Joshua Spring and Clematis aquifer. However again, specific groundwater conductivity and other chemical parameters are not mapped to show their relationship to springs, and examine whether similar groundwater quality in the spring discharge water occurs in the various different aquifers which may be possible source(s) of spring flow.

Section 8.6 & 8.7 Mitigation, management measures and monitoring

- In terms of the proposed monitoring program, the current and proposed monitoring network will have limited ability to detect the propagation of drawdown both horizontally and vertically in all relevant geological units which may control discharge to the Doongmabulla Springs. This is particularly the case if groundwater flow from the Permian sediments is a source of water to the springs, but it is also more generally the case, even if the Springs’ flow is predominantly sourced from the Clematis Sandstone. Mining will cause groundwater levels to drop initially (and most rapidly) within the deeper, Permian layers that are targeted for coal extraction. Propagation of drawdown will then occur to a greater or lesser extent in adjoining layers, including the overlying aquifers. The recent Bioregional Assessment modelling in the basin indicates that there is highly likely to be some level of drawdown propagation into the Clematis Sandstone during mining (Turvey et al., 2015; Lewis et al., 2018) – warranting comparison with the predicted levels in the modelling completed for the EIS (on which the design of the monitoring/management strategy is based).
- The monitoring of drawdown propagation must include bores that record water levels at multiple depths, including the deep aquifer(s) in which the drawdown will first occur. If monitoring only focusses on the shallow units (e.g. Clematis Sandstone) in the region of the springs, as appears to be the case in the proposed program (see proposed monitoring bore list on page 203), then there is a risk that by the time drawdown begins to propagate into the aquifer from below, it may be too late to take effective remedial action. Analysis of changes in both horizontal and vertical flow gradients is a critical component of monitoring changes to groundwater systems as a result of mining. While this is acknowledged to some extent in the GDEMP, there appears to be limited or no proposal to incorporate monitoring of deep groundwater levels into the program. On page 204 the report states:

> “The GMMP recommends the installation of additional bores, in order to evaluate the vertical gradients between hydrogeological units. **This proposed additional monitoring bore** will be completed in the Clematis Sandstone / Dunda Beds and will also be designated as an early warning bore for vertical migration of potential drawdown from the deeper coal measures.” (emphasis added in bold)

One additional bore, installed within the Clematis Sandstone / Dunda Beds (as opposed to deeper, Permian sediments) will be unable to provide adequate characterisation of vertical gradients and will not detect possible vertical propagation of drawdown from below the Rewan Formation upwards into overlying aquifers. This creates a significant risk for the springs. Once drawdown has already propagated through the aquitard (ie, when it would first be detected under the monitoring regime), there is a significant possibility that action to prevent impacts to limit further upward propagation of drawdown may be ineffective.

- This underscores wider problems with adopting an ‘adaptive management’ approach to the protection of GDEs such as the Doongmabulla Springs. Because springs depend on water levels and flow above ‘threshold’ levels, a management approach which involves monitoring to ‘wait and see’ creates a risk that irreversible impacts could emerge without sufficient time to halt or mitigate these. This risk is heightened where the spatial coverage of the monitoring network (both laterally and with depth) is limited. The focus on drawdown within the upper aquifer(s), as the key criterion for assessing whether action needs to be taken to protect the springs, is also problematic for the following reasons:

  1. If monitored at or close to a spring itself, drawdown is a poor ‘early warning’ indicator that flow to a spring will be imminently affected by groundwater extraction. By the time drawdown arising from groundwater pumping in an aquifer has reached the point where groundwater naturally discharges to the surface, groundwater flow directions and/or gradients will have already changed, and there is a significant possibility this can result in loss of part or all of the groundwater discharge required to sustain them (Currell, 2016).

  2. Drawdown must always be assessed relative to a baseline water level, which requires long-term monitoring without any mining or other groundwater extraction, and an understanding of how other factors (such as climate) affect water levels through time. It is not clear whether an ample period of time to determine both the critical drawdown thresholds for the various wetlands, and the natural baseline variability of water levels over an appropriately wide geographical spread of sites will be available prior to the commencement of mining. Such monitoring would need to take place over a period covering the wide spectrum of climate variability and eco-hydrological behaviour that typically characterises arid and semi-arid regions such as central Queensland (ie, years).

  3. Groundwater systems are typically characterised by a significant degree of inertia, meaning there is often a substantial time-lag between taking an action in one part of an aquifer system (such as reducing groundwater extraction for mining at a site), and the effects of this manifesting elsewhere in the system - such as springs located a number of kilometres away (e.g. Rousseau-Guetin et al., 2013). Hence, halting de-watering (for example) at the mine site in response to monitoring data showing unexpected changes in water levels near the springs will by no means guarantee that the impact will stop or be reversed in time to protect them. Adani and others’ modelling of the Galilee Basin coal projects show that many impacts on groundwater take decades to fully emerge and will continue well beyond the life of the mines – indicating significant hydraulic inertia within the system.

8.10 Management, mitigation, monitoring & corrective actions

- There are areas of the proposed monitoring and corrective actions outlined in Table 8-10 which are problematic. In particular, because a conclusive relationship between water levels in particular aquifers and spring flow (flux) rates has never been determined or explicitly modelled – the impact on springs has only ever been assessed in terms of a drawdown within the assumed source aquifer (rather than a flux to springs over time) - decisions regarding whether or not mining is influencing the springs are likely to be subjective and possibly, inconclusive. In this context, the ‘triggers’ for corrective actions may not afford protection to the springs. For example, one of the proposed triggers for corrective actions is that:

  > “ The condition of Doongmabulla springs-complex declines **due to aquifer drawdown caused by mining** activities including: Decrease in wetland area; Wetland vegetation zone margins contract” (emphasis added)

- With the current level of knowledge and baseline monitoring data available for the system, it would be very difficult to rapidly establish conclusively whether observed changes in water level, and in turn decreases in wetland area can be attributed to mining, as distinct from other potential influences. The lack of spatial coverage of the current monitoring network (e.g. lack water level data in the deep Permian sediments, and areas within spring wetlands where there are no current monitoring records) and inadequacy in the availability of long-term baseline data would create difficulty in this regard.
- Likewise, with respect to corrective action, the action whereby

  > "investigation into the cause will be undertaken and the administering authority notified within 28 days of the detection. The investigation will include consideration of groundwater monitoring data and vegetation surveys against baseline distribution information. **If the investigation identifies mining activities as the cause**, an assessment into the known or likely impacts will be undertaken and mitigation measures identified." (emphasis added).

  Given the current uncertainties outlined in this report regarding the relationship between the springs and the underlying hydrogeological system, such assessments are again likely to be subjective, and possibly inconclusive, particularly within the tight timeframes required to initiate corrective actions which may be critical to the springs' survival. To commence mining while such uncertainty remains unresolved (regarding the source aquifer and effect of water level changes on spring function), risks leaving the springs little protection against potentially irreversible impacts. The question of where the onus of proof will lie in determining whether an impact relates to mining or not, and the appropriate spatial and temporal coverage required in baseline monitoring need to be carefully considered in this context.
- As discussed above, changes to the water balance (as distinct from drawdown) may also result in negative effects on springs, for example by reducing the flux/flow of groundwater to spring vents (such as the high-flowing Joshua Spring). This is related to, but not the same as, effects on springs that are caused by drawdown (e.g. reduction of water levels to below a geographic threshold elevation). As is demonstrated in Currell, (2016) it is possible for changes in flux/flow rate of water to the surface to occur with minimal drawdown being experienced at the point of impact (e.g. springs). There currently appears to be no practical mechanism to evaluate changes in spring flow rates and mitigate this through corrective actions (according to the criteria listed in Table 8-10). Spring flow rates should also be included as a monitoring criteria and subject to a significant period of baseline data collection, in order to develop flux-based measures important for spring health, in addition to those related to water level/drawdown (e.g. Werner et al., 2011).

<u>Relevant findings from other groundwater modelling in Galilee Basin</u>

- The current GDEMP relies on the drawdown predictions made in the original EIS model completed for Adani (GHD, 2013). A re-examination of these drawdown predictions should be conducted in light of new modelling looking at the potential cumulative impacts from the Carmichael project as well as other Galilee Basin mines. For example, more recent modelling conducted by HydroSimulations (2015) produced drawdown predictions which indicated a significantly larger area of the Clematis Sandstone being potentially impacted by drawdown (see below). The magnitude of drawdown also appears to be larger (e.g. between 1-2m) in the region of the Doongmabulla Springs (particularly under the sensitivity tested scenario), compared to those predicted in the original groundwater modelling conducted for Adani (see Figure 1).
- Similarly, Lewis et al., (2018) also recently conducted revised cumulative groundwater impact assessment of Galilee Basin mines, including looking at effects of these on the Doongmabulla Springs, as part of the Bioregional Assessment of the Galilee sub-region. This was carried out using analytic element modelling, with probabilistic predictions and consideration of all proposed/approved coal mining developments in the region. This modelling also considered that discharge from the Clematis Sandstone (and locally, Dunda Beds) is the most likely source of water to the springs, although it did not rule out a component of flow derived from deeper units (e.g. Colinlea Sandstone) – see page 144 of Lewis et al. On this issue the authors note:

> "Although the Assessment team considers that the available evidence supports the Clematis Group aquifer as the most likely groundwater source for the Doongmabulla Springs complex, there are some discrepancies with the available data in and around the zone of potential hydrological change (e.g. variability in the mapped extents of various geological units of the Galilee Basin (see Section 3.3)). In addition, the analysis undertaken for this BA has highlighted key geoscientific data and knowledge gaps, which are discussed further in Section 3.7, as well as in companion product 2.1-2.2 (Evans et al., 2018a) and companion product 2.3 (Evans et al., 2018b) for the Galilee subregion. Future targeted research to address these gaps would greatly assist with future management of the springs complex and better understanding its response to predicted levels of groundwater drawdown due to additional coal resource development"

- Based on revised drawdown modelling in the Clematis Sandstone, the authors conclude that the likely drawdown impacts at the Doongmabulla Springs may exceed the values predicted in the original model developed for the Carmichael Mine EIS. For example:

> "The median additional drawdown in excess of 0.2 m under this conceptualisation is also predicted to affect 181 springs in this complex. There is a 5% chance that 120 springs in this complex will experience drawdown in excess of 2 m in the Clematis Group aquifer, although there are no springs in the Doongmabulla Springs complex that are predicted to experience additional drawdown in excess of 5 m."

- The Bioregional Assessment model assessed two alternative conceptualisations of the springs' relationship to different hydrostratigraphic units, the latter of which results in lesser drawdown impacts than those outlined above. However, the possibility that the springs are fed by flow from the deeper Permian aquifer was not modelled. It is presumed (e.g. as outlined in Webb et al., 2015) that if the springs are fed by flow from the Permian layer(s), mining will cause much greater drawdowns which will cause irreversible loss of the springs.
- Re-assessment of the potential impacts on Doongmabulla Spring wetlands' areas and flow rates in light of this modelling should be conducted and incorporated into the proposed monitoring and management strategy. Evidence heard in the Land Court of Queensland in 2015 showed that even very small changes in groundwater levels (e.g. drawdowns less than 20cm) could potentially lead to groundwater discharge no longer reaching the surface at some of the spring wetlands (e.g. Little Moses). This was illustrated in an exchange between LSCC's barrister (Q), and Adani's groundwater expert witness, Dr Noel Merrick (A):

"Q: And given [Little Moses is] a seep, would you assume that to be pretty – not far above the ground surface?
A: Very close to ground level.
Q: By "very close", a matter of centimetres?
A: Centimetres for the geomorphic threshold.
Q: Yeah. So, in that case, again, the number that we need to figure out when Little Moses would stop – would stop, is the difference between that head [in] the Clematis, a few centimetres above ground level, and ground level?
A: Yes.
Q: Logically, that's a few centimetres?
A: It probably is.
Q: And just to be absolutely clear, that's the – that's one for one drawdown. So if drawdown is more than that few centimetres number, then Little Moses stops flowing?
A: Yes….

Q: In any event, if it just so happens that that number, the drawdown – five centimetres, 10 centimetres, 12 centimetres, whatever it is – if it so happens that that number is bigger than the few centimetres that would be needed to make Little Moses run dry, then Little Moses runs dry?
A: Yes. If the drawdown were to be of the order of five centimetres, then you would expect seeps would dry up.
Q: And that's on the basis of the outputs of this model in their current state, accepting them on face value?
A: Correct. That's, yes, for the base case model[1].

- A full analysis of the relationship between the range of possible drawdown levels and the 'threshold' water levels, below which groundwater discharge would cease to occur at the various spring wetlands throughout the Doongmabulla Springs Complex is needed in order to properly design a monitoring and mitigation program to protect the springs. While there is some work proposed to characterise water levels at and below a sub-set of the springs in addition to mapping of wetland area and vegetation characteristics (outlined in section 8.7 the GDEMP), this is selective and may leave many wetlands vulnerable to impact. Given the new cumulative impact modelling completed for the Bioregional Assessment, a detailed analysis of the 'threshold' levels at the various wetlands and possible range of drawdown levels predicted in the different models should be conducted and incorporated.
- This is not to say that the additional field investigations and analysis outlined above are not also required to address ongoing uncertainty regarding the springs source aquifer and relationship to hydraulic gradients and groundwater flow patterns. Should these additional field investigations result in the possibility of an alternative conceptual model of the springs, then evidently a full re-analysis of the possible effects of mining would be required as well.
- Additionally, as noted above, a limitation of the Bioregional Assessment modelling is that the analytic element method (like the original modelling done for Adani) used did not allow for any assessment of changes in the *flux* of water to the springs as a result of mining. While drawdown is one measure which is important in assessing whether springs are likely to be impacted by groundwater extraction, it is not the only consideration, and the flux/flow of water (which is often what is important for sustaining ecological communities) is not always readily relatable to a level of drawdown. A proper water-balance assessment, which looks at the flux of water to the springs before, during and after mining (including quantifying the capture of spring flow) is required in order to examine this issue.

[1] Land Court of Queensland, 2015

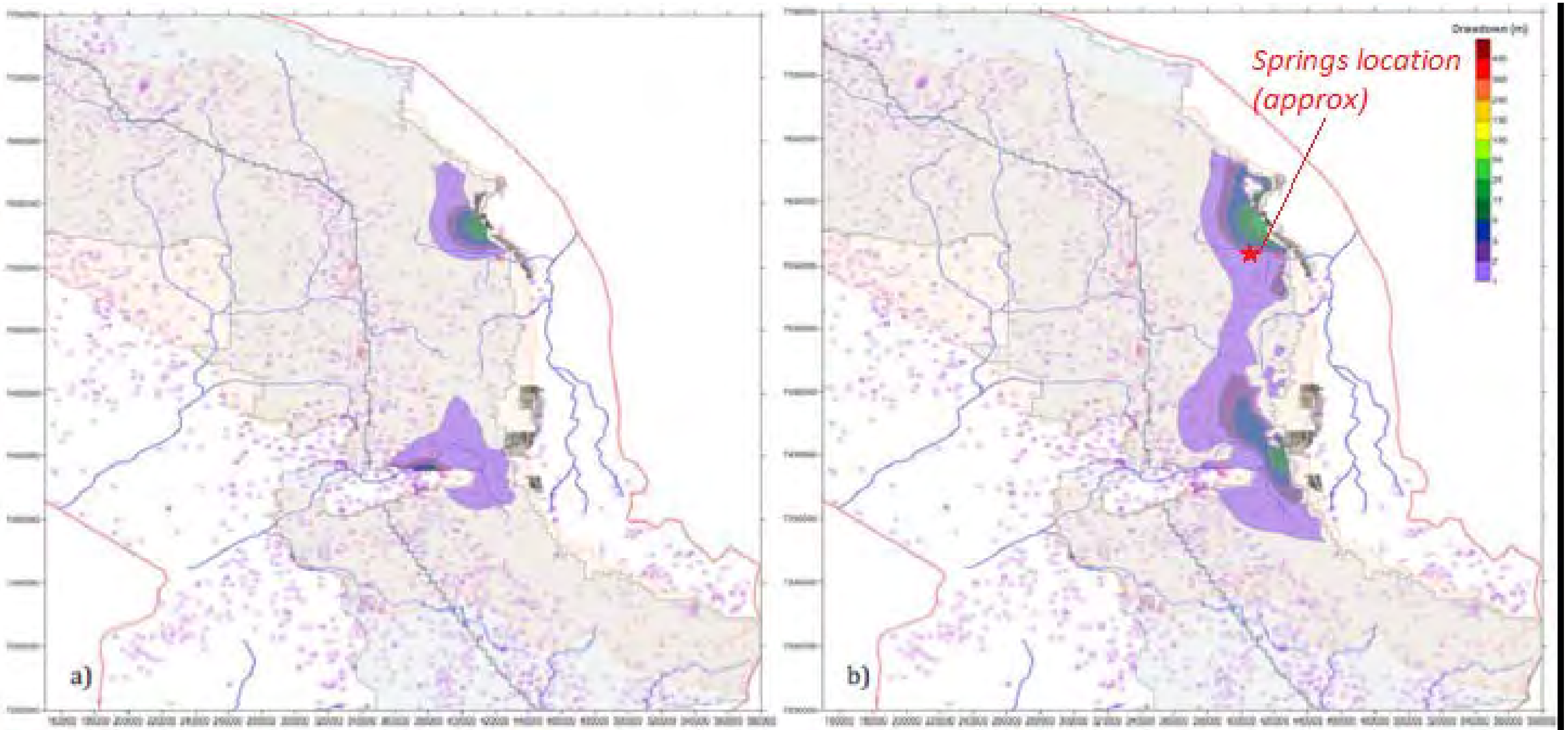

Figure 6-3 Maximum predicted drawdown in Layer 8 (Clematis Sandstone) for a) Base Case and Sensitivity #2 (no TVM) and b) Sensitivity#1 –increased K_z

Figure 1 - map from Hydrosimulations (2015) model showing predicted ‘base case’ and alternative ‘sensitivity’ scenario drawdown levels in Clematis Sandstone. Location of Doongmabulla Springs is shown on panel b). Under both scenarios, the springs appear to be within an area predicted to be impacted by 1-2m drawdown

Unresolved questions

There are further unresolved questions arise from the draft GDEMP, as well as the recent modelling conducted under the Bioregional Assessment. Full resolution of these questions should be a pre-requisite for finalising a GDE management plan for the project:

- Given that groundwater flow directions in the Colinlea Sandstone (deeper Permian aquifer) appear to converge on the area of the springs (Webb et al., 2015), a credible explanation is needed – e.g. how/why does groundwater converge on this area if there is no discharge point (such as the springs) for the water in this aquifer?
- Are there geological structures occurring in the vicinity of the springs which might convey deeper flow to the surface?
- What are the vertical hydraulic gradients across the full sequence of Permian and Triassic units in the vicinity of the springs, and thus what is the potential for inter-aquifer flow and/or discharge between the deeper layers and shallower aquifer(s)?
- Does water from multiple flow systems/depths converge and provide combined discharge to the springs? This seems plausible given the water level and topographic data, but it is impossible to verify without details of water levels in the deeper aquifers, details regarding geological structures and more information about specific unit thicknesses, lithologies and hydraulic properties in the area.
- Where is the proposed recharge area for the Clematis sandstone from which water flows towards the springs and which provides the required driving head to allow discharge at the springs (if indeed this aquifer is the only/primary source of flow)? If recharge to the aquifer is proposed to occur through the Moolayember Formation, then how can this formation also be the confining layer through which the artesian discharge takes place?
- What are the consequences on the flux (flow) of water from the predicted drawdown levels - noting that drawdown itself can't be used to estimate flux without additional information? What are the threshold groundwater elevations below which the various spring wetlands (apart from Joshua Spring) would no longer receive discharge of groundwater, and thus cease to exist?

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.

M Currell

……………………………..

20th February, 2019.

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Attachment F

Department of the Environment and Energy Assessment

EPBC Number	2010-5736
Project	Carmichael Coal Mine and Rail Infrastructure Project, Queensland
Approval Holder	Adani Mining Pty Ltd
Name of document under review	Groundwater Dependent Ecosystems Management Plan, Carmichael Coal Mine Project. Prepared for Adani Mining Pty Ltd Version 11 (final version) received 15 March 2019 Version 11b (revised final submission) received 19 March 2019
Date plan first received	4 November 2016
Date review completed	20 March 2019

#	Condition	How Addressed	GDEMP Reference
5	At least three months prior to commencement of mining operations, the approval holder must submit to the Minister for approval Matters of National Environmental Significance plan/s for the management of direct and indirect impacts of mining operations on MNES.	**Submission 3 months prior to commencement: Met** Matters of National Environmental Significance Management Plan/s (MNESMP) for the Carmichael mine and off-site infrastructure, were lodged and approved on 20 July 2016. Linked to these overarching plans, two further specific plans relating to MNES have been prepared. A Black-throated Finch Management Plan was initially lodged on 11 May 2017 and approved on 18 December 2018, and this Groundwater Dependent Ecosystems Management Plan (GDEMP) was initially lodged on 7 November 2016. Commencement of mining operations, in accordance with the approval condition, has not yet occurred.	N/A
	Note: If the MNESMP does not address any specific future activities (e.g. possible additional seismic surveys or specific mining stages) it should be updated in accordance with Condition 33.	**Update in accordance with condition 33: Met** Adani commit that "If this management plan does not address any specific future activities (e.g. possible additional seismic surveys or specific mining stages) it will be updated in accordance with condition 33 of the EPBC Act approval."	App D
6	The MNESMP must incorporate the results of the groundwater flow model re-run (Condition 23) where relevant, and be consistent with relevant recovery plans, threat abatement plans and approved conservation advices and must include:	**Model re-run: Met** Adani point to Section 4.3 to describe how the groundwater model re-run has been included, which states: *A peer review of the adequacy of the Groundwater Flow Model, along with the report on the re-run of the Groundwater Flow Model were approved by the Commonwealth Government in March 2016. As described in the GMMP, the results of the model re-run where similar to the SEIS model [the model used during the assessment process, from the Supplementary Environmental Impact Statement] and the SEIS model was the most conservative. As such, there were no results arising from the groundwater flow model re-run under condition 23 relevant to this GDEMP.* **Consistency with relevant recovery plans: Met** The only relevant recovery plan is the Recovery plan for the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin (Fensham et al. 2010).	Section 4.3

#	Condition	How Addressed	GDEMP Reference
		The overall objective of the recovery plan is to maintain or enhance groundwater supplies to GAB discharge spring wetlands, maintain or increase habitat area and health, and increase all populations of endemic organisms. The relevant goals for Doongmabulla Springs Complex from the GDEMP (minimise impacts of drawdown, reduce impacts from feral animals and grazing, prevent habitat loss; refer table 8.10) are consistent with these objectives.	Table 8.10
		The main threats identified in the recovery plan are: Aquifer drawdown, Excavation of springs, Exotic plants, Stock and feral animal disturbance, Exotic aquatic animals, Tourist access, and Impoundments. Threats identified in the Recovery Plan that are relevant for project impacts to the Doongmabulla Springs Complex are discussed in Section 8.5.	Section 8.5
		Most of the actions identified in the recovery plan to recover this community include on-ground actions that are not applicable, as Doongmabulla Springs Complex is not on Adani tenure. The actions include: • controlling flow from strategic bores [not applicable, managed through the approval via GAB offsets strategy]; • controlling new groundwater allocations [not applicable]; • protecting and managing Category 1 and 2 GAB discharge springs through perpetual agreements [not proposed, noting that Doongmabulla Springs is at least category 2, is not part of Adani's tenure and is partially covered by a nature refuge]; • fencing appropriate springs to exclude stock [not applicable]; • controlling feral animals [not applicable]; • preventing further spread of Gambusia and other exotic fauna [not applicable]; • implementing protocols to avoid transportation of organisms from one location to another [weed hygiene controls, table 8.10]; • re-establishing the natural values of reactivated springs [suggested as a potential offset, section 8.6]; • encouraging landholders to responsibly manage springs [engagement with landholders, table 8.10]; • increasing involvement of Indigenous custodians in spring management [not applicable]; • raising community awareness of the importance of GAB discharge springs [Adani commits to engage with landholders as above];	Table 8.10

#	Condition	How Addressed	GDEMP Reference
		• developing and implementing visitor management plans for selected sites [not applicable]; • convening a GAB springs forum [not applicable]; and • effectively coordinating and reporting on the recovery program [not applicable]. Monitoring and research actions within the GDEMP are consistent with the recovery plan. Actions in the recovery plan include: reviewing historic spring flows [existing data was collected as part of the assessment process]; monitoring current spring flows [see section 8.7 – flow at Joshua spring will be monitored]; studying the interactions between native and exotic fauna [indirectly through monitoring in section 8.7 and/or GAB springs research]; completing an inventory of endemic species in GAB springs [see monitoring section 8.7]; monitoring populations of endemic species [see monitoring section 8.7].	Section 8.7
		Consistency with relevant threat abatement plans: Met The SPRAT profile for GAB springs community lists two relevant abatement plans: *Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads*. Available from: http://www.environment.gov.au/resource/threat-abatement-plan-biological-effects-including-lethal-toxic-ingestion-caused-cane-toads. In effect under the EPBC Act from 06-Jul-2011. *Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (Sus scrofa) (2017)*. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/feral-pig-2017. In effect under the EPBC Act from 18-Mar-2017. The GDEMP includes specific monitoring tasks (Section 8.7) to identify damage to springs caused by pigs, and to monitor the presence of pigs and cane toads, at the Doongmabulla Springs-complex. The GDEMP is therefore consistent with the threat abatement plans, which prioritise a science-based approach to the monitoring and control of these pest species.	App D

#	Condition	How Addressed	GDEMP Reference
		Consistency with relevant conservation advices: Met There is one relevant advice: Approved Conservation Advice for Waxy Cabbage Palm (*Livistona lanuginosa*) (DEWHA, 2008) The main threats to the species identified in the advice are included in table 7-3 of the GDEMP: fire (4), trampling and grazing by stock (6), clearing for agricultural development (7/9); as well as potential threats: changes in water levels (1/3) and introduction of invasive weeds (5). Monitoring and research activities of the GDEMP closely align with the research priorities in the conservation advice, which include: Design and implement a monitoring program [see section 7.6], More precisely assess population size, distribution, ecological requirements and the relative impacts of threatening processes [see section 7.6], Undertake grazing exclusion experiments to conclusively determine livestock grazing effects. While Adani makes no commitment to grazing experiments, it will undertake vegetation assessments annually and commit to corrective actions including additional fencing or spelling of paddocks to control grazing in order to prevent impacts whilst maintaining biomass levels for fire management. This is not inconsistent with the conservation advice. The conservation advice includes the following priority actions in relation to hydrology: Manage any changes to hydrology that may result in changes to the water table levels, increased run-off, sedimentation or pollution; Manage any disruptions to water flows. The GDEMP includes management objectives to (i) limit and manage the impact of hydrological changes in Waxy Cabbage Palm habitat from mine dewatering beyond those approved and offset and (ii) maintain surface water flow and quality. These objectives will be managed through implementation of the Groundwater Management and Monitoring Plan (GMMP) and Receiving Environment Monitoring Program (REMP).	Section 7.4 Section 7.6 Section 7.4
6a)	A description of environmental values for each of the Matters of National Environmental Significance addressed in the plan	**Description of values: Met** A description of environmental values for each groundwater dependent ecosystem (GDE) defined as a MNES is provided in:	Section 6.1 Section 7.1

#	Condition	How Addressed	GDEMP Reference
		• Section 6.1 Carmichael River, • Section 7.1 Waxy Cabbage Palm, • Sections 8.1 and 8.2 Doongmabulla Springs-complex and • Sections 9.1 and 9.3 Mellaluka Springs-complex. The descriptions include the status under Commonwealth and State legislation, plus what is known about distribution, ecology and values in the vicinity of the project area. Where baseline understanding of these values is limited (e.g. location of refugial pools, losing/gaining nature along the length of the Carmichael River), the monitoring has been designed to collect further information to update the baseline understanding or conceptual models for these GDEs.	Sections 8.1 and 8.2 Sections 9.1 and 9.3
6b)	Details of baseline and impact monitoring measures to be implemented for each of the Matters of National Environmental Significance	**Baseline and impact monitoring: Met** For the purposes of the GDEMP, baseline monitoring measures include the baseline data already collected, plus further pre-impact monitoring. Description of pre-impact and impact monitoring measures for GDEs is provided in each chapter for surface water, groundwater and ecological parameters. Details about ecological monitoring are described in the GDEMP itself and are considered adequate. Details about groundwater monitoring measures are in the GMMP, which must be approved under EPBC conditions. Surface water monitoring plans are not required under EPBC conditions. These requirements are picked up under Queensland EA requirements, and are referenced accordingly in the GDEMP. Pre-impact monitoring sites for Doongmabulla Springs Complex will be determined based on an initial survey, to determine hydrologically and ecologically representative sites. Some of the 10 sites proposed will be identified to act as indicative early warning and control sites. Impact monitoring for Doongmabulla Springs Complex will be reviewed and refined on the basis of a baseline and pre-impact condition report. The full suite of the survey and monitoring program will be confirmed after the completion of the Ecological Condition Report, but include at a minimum, groundwater, wetland extent and level, spring flow, endemic species, annual habitat feature surveys, photo monitoring and weed and pest surveys.	Sections 6.6 and 6.7 Section 7.6 Section 8.7 Section 9.8

#	Condition	How Addressed	GDEMP Reference
	including control and impact sites to be monitored throughout the life of the project.	**Control sites: Met** Impact sites will be monitored for all GDEs throughout the life of the project. Control sites are available for the Carmichael River (upstream and downstream of the impacted area) and Waxy Cabbage Palm (including on the offset property at Moray Downs West). However, control sites are not applicable for the Doongmabulla Springs and Mellaluka Springs complexes because the springs are unique and cannot be replicated elsewhere. The Department considers that the intent of this condition in requiring both impact and control sites is to ensure that the monitoring program is capable of detecting and quantifying impacts as a result of mining. External review by CSIRO and Geoscience Australia recommended inclusion of a method to remove non-mining influences to achieve the same intent. Adani's monitoring methodology (see section 5.4) is designed to enable the measurement and separation of mining and non-mining influences on the monitoring indicators. Given the 'greenfield' nature of the project area, the Department considers that this method is adequate to remove non-mining influences on the Doongmabulla Springs and Mellaluka Springs.	Sections 6.6, 6.7 and 7.6 Section 8.7 and Section 9.8 Section 5.4
	The monitoring must provide sufficient data to quantify likely impacts resulting from mining operations, including subsidence and changes in groundwater levels, to set habitat management goals (Conditions 6e) and 6f)).	**Monitoring to quantify impacts and set goals: Met** Performance criteria (goals) and associated monitoring are contained in Section 6.9 Carmichael River, Section 7.9 Waxy Cabbage Palm, Section 8.10 Doongmabulla Springs-complex and Section 9.9 Mellaluka Springs-complex. The monitoring measures are suitable to quantify likely impacts and set goals (i.e. ensure impacts do not exceed those approved). Adani commits to installing additional surface water gauges upstream and downstream of the lease, as well as mid-lease, where the greatest drawdown impacts are predicted. The final gauging station locations will be determined based on factors such as ease of access, suitability characteristics and long term viability. Once determined, locations will be included in the updated versions of this plan. This is considered acceptable because future updates to the GDEMP must be approved and as such there is minimal risk that the locations will not provide sufficient data to quantify likely impacts.	Sections 6.9, 7.9, 8.10 and 9.9

#	Condition	How Addressed	GDEMP Reference
6c)	Details of potential impacts, including area of impact, on each of the Matters of National Environmental Significance from mining operations, including impacts from:	**Details of impacts:** Met Details of potential impacts of the project on the GDEs are addressed in Sections 6 to 9 of the GDEMP. An area of impact (vegetation clearing), or estimate of level of groundwater drawdown is provided in relevant subsections of Sections 6 to 9, for potential impacts for which a quantitative estimate can be provided. Cross-references for specific modes of impact are provided below.	Sections 6.4, 7.4, 8.5 and 9.6
	(i) Vegetation clearing	**Details of impacts:** Met Details of impacts from vegetation clearing are described in Section 6.4 Carmichael River and Section 7.4 (Waxy Cabbage Palm). No vegetation clearing for the Project will take place at either Doongmabulla Springs or Mellaluka Springs.	Section 6.4 and Section 7.4
	(ii) Subsidence from underground mining, including subsidence induced fracturing and any changes to groundwater or surface water flow	**Details of impacts:** Met No subsidence is predicted to occur within Waxy Cabbage Palm habitat or in the vicinity of the Carmichael River, Doongmabulla Springs or Mellaluka Springs as modelled in the EIS for the Project. Subsidence beneath the Carmichael River catchment area, which may impact groundwater and surface water flows, is dealt with under dewatering (#1) and hydrology (#3) impacts, respectively.	Sections 6.4, 7.4, 8.5 and 9.6
	(iii) Mine dewatering	**Details of impacts:** Met The key mode of impact for these GDEs is through dewatering. Hydrogeology, groundwater resources and their relationship to GDEs are summarised in Section 4.3 (drawn from the GMMP). Details of impacts, based on the SEIS model, as a result of mine dewatering specific to each GDE are described in Section 6.4 Carmichael River, Section 7.4 Waxy Cabbage Palm, Section 8.5 Doongmabulla Springs-complex and Section 9.6 Mellaluka Springs-complex. Consistent with the adaptive management approach, the limitations of the SEIS model will be addressed over the life of the mine as more information is available.	Section 4.3 Sections 6.4, 7.4, 8.5 and 9.6

#	Condition	How Addressed	GDEMP Reference
	(iv) Earthworks	**Details of impacts:** Met A buffer of 500 m either side of the Carmichael River will be maintained in the Project. Adani state that the only direct impact in this corridor will be construction of a haul road corridor across the Carmichael River, described in Section 6.4. Clearing of 5.47 ha Waxy Cabbage Palm habitat and the removal of five individuals for the construction of the haul road across the Carmichael River as the only direct impact of the project. This is described in Section 7.4. The Project area is over more than 8km to the east of Doongmabulla Springs and 3km to the north of Mellaluka Springs, and there will be no direct incursion from Project vehicles or personnel beyond monitoring required as part of this plan (Section 8.5 and Section 9.6).	Section 6.4 and Section 7.4 Section 8.5 and Section 9.6
	(v) Noise and vibration	**Details of impacts:** Met A description of anticipated noise and vibration impacts on the values of the Carmichael River, is provided in Section 6.4. Noise and vibration is not a perceivable impact on the Waxy Cabbage Palm. No impacts from noise and vibration are predicted in the vicinity of the Doongmabulla Springs or Mellaluka Springs-complexes, due to the distance from the Project area (Section 8.5 and Section 9.6).	Section 6.4 Section 7.4 Section 8.5 and Section 9.6
	(vi) Emissions (including dust)	**Details of impacts:** Met Details of impacts from emissions (including dust), specific to each GDE are described in Section 6.4 Carmichael River, Section 7.4 Waxy Cabbage Palm, Section 8.5 Doongmabulla Springs-complex and Section 9.6 Mellaluka Springs-complex. These impacts are expected to be minor.	Sections 6.4, 7.4, 8.5 and 9.6
	(vii) Light spill and other visual impacts	**Details of impacts:** Met A description of anticipated light spill impacts on the values of the Carmichael River, is provided in Section 6.4.	Section 6.4

#	Condition	How Addressed	GDEMP Reference
		Light spill and visual impacts are not a perceivable impact on the Waxy Cabbage Palm. No impacts from light spill or other visual impacts are predicted in the vicinity of the Doongmabulla Springs or Mellaluka Springs-complexes, due to the distance from the Project area (Section 8.5 and Section 9.6).	Section 7.4 Section 8.5 and Section 9.6
	(viii) Stream diversion and flood levees	**Details of impacts:** Met Changes to the hydrology of the Project Area, during the construction and operational project phases, were identified in the EIS as an indirect impact on Waxy Cabbage Palm habitat and the Carmichael River. Changes to hydrology indirectly impacting Waxy Cabbage Palm and the Carmichael River may include potential stream diversions, flood levees and contamination of surface waters (Section 7.4). There is no predicted significant impact to Doongmabulla Springs associated with the changes to the flooding conditions associated with the construction of levees on either side of the Carmichael River (Section 8.5). Mellaluka Springs-complex does not contribute surface water to any nearby waterways, being located near the margin of extensive clay plains to the south west, sand plains to the north west, and a large alluvial plain to the east associated with the Belyando River, which is approximately 9 km away (Section 9.6). No diversions or levees are proposed.	Section 6.4 and Section 7.4 Section 8.5 Section 9.6
	(ix) Weeds and pests	**Details of impacts:** Met Details of impacts from weeds and pests, specific to each GDE are described in Section 6.4 Carmichael River, Section 7.4 Waxy Cabbage Palm, Section 8.5 Doongmabulla Springs-complex and Section 9.6 Mellaluka Springs-complex. For the Carmichael River and Waxy Cabbage Palm, the EIS identified that there is the potential that the project could introduce or spread weeds and pests during all project phases. Increased weed levels reduce species diversity and ecosystem complexity, reducing the ability of the River to host a diverse range of species and life forms. Doongmabulla Springs and Mellaluka Springs are located on land not owned by Adani, and the only Project activities will be visits to conduct monitoring associated with this GDEMP.	Sections 6.4, 7.4, 8.5 and 9.6

#	Condition	How Addressed	GDEMP Reference
6d)	Measures that will be undertaken to mitigate and manage impacts on Matters of National Environmental Significance resulting from mining operations. These measures must include but not be limited to:	**Mitigation and management measures:** Met A description of measures that will be undertaken to mitigate and manage impacts on the GDEs resulting from mining operations is provided in relevant subsections in Sections 6-9. Specific cross-references are provided in sub-sections below.	Sections 6 to 9
	(i) The use of fauna spotters prior to and during all vegetation clearing activities to ensure impacts on Matters of National Environmental Significance are minimised	**Mitigation and management measures:** Met Fauna spotters will be used prior to and during all vegetation clearing activities to ensure impacts on MNES are minimised. Vegetation clearing is proposed for 5.7 ha of Waxy Cabbage Palm habitat in the Carmichael River, required for the haul road corridor across the Carmichael River. No vegetation clearing is proposed for the Doongmabulla Springs-complex or Mellaluka Springs-complex.	Sections 6.9 and 7.9
	(ii) Measures to avoid impacts on Matters of National Environmental Significance and their habitat located in the Project Area, but outside areas to be cleared, constructed upon and / or undermined, including adjacent to cleared areas	**Mitigation and management measures:** Met Management actions to avoid impacts on MNES outside of areas to be cleared/ constructed/ undermined, including adjacent to cleared areas, are included for the Waxy Cabbage Palm and Carmichael River, namely through the 500m riparian corridor. Doongmabulla Springs and Mellaluka Springs are located on land not owned by Adani, and the only Project activities will be visits to conduct monitoring associated with this GDEMP.	Sections 6.9 and 7.9
	(iii) Measures to rehabilitate all areas of Matters of National Environmental Significance habitat	**Mitigation and management measures:** Met Rehabilitation activities associated with the Project at the Carmichael River and for the Waxy Cabbage Palm (around the road crossing) are discussed in Table 6-10 and Table 7-6. No rehabilitation measures are provided for Doongmabulla Springs because the approval conditions require the protection and long-term viability of the complex. The rehabilitation of Mellaluka springs is described in Table 9-3 and includes a Wetland Remediation and Management Plan and / or alternative rehabilitation strategies in consultation with the Mellaluka landholder.	Table 6-10 and Table 7-6 Table 9-3

#	Condition	How Addressed	GDEMP Reference
	(iv) Habitat management measures including but not limited to management of subsidence and groundwater impacts of the project	**Mitigation and management measures: Met** Whilst the primary impact to GDEs is dewatering/hydrology, management actions in the mitigation and management section for each GDE chapter focus on impacts from weeds and pests, grazing and fire. The mitigation and management sections do not include management measures for dewatering or hydrology impacts. However, management tables in each chapter refer to implementation of the GMMP, REMP and subsidence monitoring program, as well as review of models and incorporation of research for groundwater as relevant mitigation or management measures.	Sections 6.5 and 6.9 Sections 7.5 and 7.9 Sections 8.6 and 8.10 Sections 9.7 and 9.9
6e)	Goals for habitat management for each relevant Matters of National Environmental Significance	**Goals: Met** Habitat management goals are referred to as Management objectives in the GDEMP, and discussed against each threat/impact, as well as in the management tables in Section 6.9 Carmichael River, Section 7.9 Waxy Cabbage Palm, Section 8.10 Doongmabulla Springs-complex and Section 9.9 Mellaluka Springs-complex. In general, goals are to ensure impacts do not exceed those approved.	Sections 6.9, 7.9, 8.10 and 9.9
6f)	A table of specific criteria for assessing the success of management measures against goals, and triggers for implementing corrective measures if criteria are not met within specified timeframes.	**Performance criteria and triggers for implementing corrective measures: Met** Specific criteria for assessing success of management measures against goals are defined as performance criteria in the GDEMP. These criteria are generally measurable. Most criteria refer to approved impacts, and as such the timeliness and appropriateness of triggers requires reference to other parts of the GDEMP and/or assessment documentation where those impacts are described. The 'corrective measures' in this condition are corrective actions in the GDEMP.	Sections 6.9, 7.9, 8.10 and 9.9

#	Condition	How Addressed	GDEMP Reference
		Adani has committed to updating the plan in line with future model review (see table 10-1). However, there is no trigger for the Doongmabulla Springs, Mellaluka Springs or Waxy Cabbage Palm to implement corrective measures if impacts are predicted that exceed those approved. This means that triggers are based on monitoring data alone (not modelling), and therefore there is less capacity to have an early intervention. The Department considers that this poses a residual risk to these GDEs, which can be managed through (i) a robust monitoring program and (ii) Department review and approval of future iterations of the GDEMP following model reviews. Corrective actions in the GDEMP include immediately limiting mining activities to current activities, until monitoring indicates the trigger level(s) are no longer being exceeded, or at further risk of being exceeded. References are made to further mitigation measures or actions, particularly around drawdown impacts to the Carmichael River, but these are not yet specified in the GDEMP.	
	This table must include but not be limited to measures relating to subsidence and groundwater impacts, including early warning triggers for impacts on groundwater at the Doongmabulla Springs Complex and the Carmichael River.	**Early warning triggers:** Met Subsidence impacts are not predicted to GDEs, however the management tables for Doongmabulla and Carmichael River include early warning triggers for subsidence based on tilts. Early-warning triggers for groundwater are shown in Appendix B. Early warning bores are listed in section 8.8 for Doongmabulla Springs Complex. Drawdown rate limits have also been defined in the GMMP and are referenced in table 8-10 for Doongmabulla Springs. These provide an early warning that impacts could exceed predictions. Drawdown rate limits have not been specifically applied for the Carmichael River, however Adani commits to reviewing the rate of drawdown impacts for all bores at regular model review and update. Further, the Carmichael River includes a trigger for corrective action based on revised groundwater modelling and drawdown predictions (i.e. improved predictions exceeding the impacts approved). This provides capacity for early intervention if impacts are ever predicted to exceed those approved.	Section 8.8

#	Condition	How Addressed	GDEMP Reference
		Note: The revised early warning triggers and impact thresholds will be submitted to the Department for approval as part of review of the GMMP after the model review within two years of the first box cut (or the first extraction of coal). This will include triggers and impact thresholds for the deeper nested bores at three locations between the mine and Doongmabulla springs. The Department will ensure that these triggers and limits are set to ensure the protection and long-term viability of the Doongmabulla Springs Complex.	
	Goals and triggers must be based on the baseline condition of the relevant Matters of National Environmental Significance as determined through baseline monitoring (see Conditions 3b) and 6b)).	**Goals and triggers based on baseline condition: Met** A summary of existing baseline monitoring is provided in Section 6.3 Carmichael River, Section 7.3 Waxy Cabbage Palm, Section 8.4 Doongmabulla Springs-complex and Section 9.5 Mellaluka Springs-complex. This baseline monitoring has informed management objectives, performance criteria and triggers for corrective actions, which are contained in Section 6.9 Carmichael River, Section 7.9 Waxy Cabbage Palm, Section 8.10 Doongmabulla Springs-complex and Section 9.9 Mellaluka Springs-complex. Baseline data is not yet available for multiple monitoring indicators, including many ecological parameters and surface water flow/level. There is also no baseline data for deeper groundwater bores yet to be installed between the mine and the Doongmabulla Springs. This data will be collected during the pre-impact monitoring phase and new triggers defined for additional parameters based on pre-impact condition. External review highlighted the need for a verification process to ensure pre-impact data is not influenced by mining operations. Adani have addressed this recommendation by stating in section 10.2 that Adani will verify that pre-impact data are not influenced by mining activities.	Sections 6.3, 7.3, 8.4 and 9.5
	Corrective measures must include provision of offsets where it is determined that corrective management measures have not achieved goals within specified timeframes (see Conditions 11m) and 11o)).	**Corrective actions: Met** The 'corrective management measures' in this condition are 'management measures' in the GDEMP. If the investigation finds that the actual impacts to the Carmichael River or WCP differ from those detailed in the approved Biodiversity Offset Strategy (BOS), the BOS will be amended within 30 days and the amended offset delivered within 12 months.	Sections 6.9, 7.9, 8.10 and 9.9

#	Condition	How Addressed	GDEMP Reference
		The BOS also includes a description of the potential additional offsets for Doongmabulla Springs Complex or Carmichael River. If the investigation finds that the actual impacts to the Doongmabulla Springs Complex are greater than predicted, Adani will commence planning of further mitigation activities with regards to water availability at the springs. This is based on Departmental advice that ecological impacts to Doongmabulla cannot be offset. Adani commits to securing ecological offsets for the Mellaluka springs within specified approval timeframes if pre-impact monitoring and groundwater model confirms likely complete loss of ecological function at each spring location.	
6g)	An ongoing monitoring program to determine the success of mitigation and management measures against the stated criteria in Condition 6f), including monitoring locations, parameters and timing. Monitoring for water resource Matters of National Environmental Significance must include hydrogeological, hydrological and ecological parameters.	**Monitoring for success:** Met A summary of the monitoring approach is provided in Section 5.5, with Investigations and Corrective Actions described in Section 5.6. Details of the ongoing monitoring program specific to each GDE is provided in Section 6.6 and 6.7 Carmichael River, Section 7.6 Waxy Cabbage Palm, Section 8.7 Doongmabulla Springs-complex and Section 9.8 Mellaluka Springs-complex. Impact monitoring locations, hydrogeological, hydrological and ecological parameters and timing are adequate to assess success of mitigation and management measures against performance criteria. Monitoring indicators are now defined for geomorphology, noise and vibration, emissions, light. Rehabilitation success parameters are defined based on the Queensland Environmental Authority.	Section 5.5 Sections 6.6 and 6.7, 7.6, 8.7 and 9.8
6h)	Details of how compliance will be reported	**Compliance reporting:** Met Annual and compliance monitoring is described in Section 10.3 of the GDEMP, including periodic reporting and audits to monitor compliance with management plan requirements. Reporting and monitoring of related plans is described in Section 10.4.	Section 10.3 and 10.4

#	Condition	How Addressed	GDEMP Reference
6i)	Details of how the MNESMP will be updated to incorporate and address outcomes from research undertaken for Matters of National Environmental Significance under this and any state approvals, including updating of goals, criteria and triggers (as required under Conditions 3c), 3d) 6e) and 6f)).	**Incorporation of research: Met** The relationship between the GDEMP and other management plans and programs is described in Section 1.3, and the relationship with research programs and guidelines is set out in Section 1.4. An adaptive management approach will be taken to the GDEMP. Adaptive management is summarised in each GDE chapter (Section 6.8 Carmichael River, Section 7.8 Waxy Cabbage Palm, Section 8.6.1 Doongmabulla Springs-complex and Section 9.7.1 Mellaluka Springs-complex). Requirements for updating the GDEMP are summarised in Section 10.1, including scheduled updates and triggers for additional unscheduled updates. Annual and compliance reporting is set out in Section 10.3. Triggers will be updated where appropriate at the completion of pre-impact studies and monitoring and where relevant updates are made to the GMMP (Section 5.3). A revision of triggers will also occur where information from related management and research plans (as described in Section 10.4) informs this GDEMP.	Section 1.3 and 1.4 Section 5.3 Sections 6.8, 7.8, 8.6.1 and 9.7.1 Section 10.1 to 10.4
6j)	Provisions to ensure that suitably qualified and experienced persons are responsible for undertaking monitoring, review and implementation of the MNESMP	**Personnel: Met** Persons implementing key tasks described in this GDEMP will have appropriate skills and qualifications. Section 10.5 of the GDEMP outlines the qualifications of persons responsible for monitoring, reviewing and implementing the plan.	Section 10.5

#	Condition	How Addressed	GDEMP Reference
6k)	In the event that the future baseline research required by the Queensland Coordinator-General (Appendix 1, Section 3, Condition 1 of the Coordinator-General's Assessment Report) identifies that the Mellaluka Springs Complex provides high value habitat for the Black-throated finch, the approval holder must include management measures to address impacts resulting from drawdown at the Mellaluka Springs Complex in the MNESMP	**Research into BTF at Mellaluka: Met** Studies have determined that the Mellaluka Springs-complex does not provide BTF habitat. A letter from the Office of the Coordinator-General, dated 22 July 2016, was written to Adani confirming the Department and Queensland government's acceptance of this finding. As such, there is no requirement to include additional measures to address drawdown impacts at Mellaluka.	Not applicable
6l)	Details of how, where habitat for an EPBC Act listed threatened species or community not previously identified and reported to the Department is found in the Project Area, the approval holder will notify the Department in writing within five business days of finding this habitat, and within 20 business days of finding this habitat will outline in writing how the conditions of this approval will still be met (refer Condition 11j)).	**New habitat: Met** Section 10.1 of the GDEMP states "In the event that new species or Threatened Ecological Communities are found, then DoEE and/or DES will be notified within five business days and Adani will outline how the conditions of this approval will still be met within 20 business days".	Section 10
7	Mining operations must not commence until the required MNESMP have been approved by the Minister in writing. The approved plan/s must be implemented.	**Mining commencement: Met** Mining operations will not commence until this plan has been approved.	Section 3.2

#	Condition	How Addressed	GDEMP Reference
	Note – Management plans such as the Black-throated Finch Management Plan and the Groundwater Dependent Ecosystems Management Plan may also be required under state approvals. Wherever possible a combined document should be prepared to address both state government and EPBC Act approval conditions.	This plan addresses the combined requirements of the Commonwealth and Queensland governments in one document, as encouraged by the condition. This means that some sections, e.g. Section 8.3 – about the source aquifer for Doongmabulla Springs Complex, are not required under our approval, but have been incorporated to meet the requirements of the Qld GDEMP definition.	
	Note – Impacts of the action other than mining operations will be offset as required in accordance with Conditions 8 to 11, but will be otherwise managed in accordance with state approvals – this is of particular relevance when impacts may occur prior to approval of the MNESMP.	No impacts are predicted to these MNES from activities other than those as part of mining operations.	

Attachment F

Department of the Environment and Energy Assessment

EPBC Number	2010-5736
Project	Carmichael Coal Mine and Rail Infrastructure Project, Queensland
Approval Holder	Adani Mining Pty Ltd
Name of document under review	Groundwater Management and Monitoring Program Carmichael Coal Mine Project. Prepared for Adani Mining Pty Ltd Version 7 (final version with track changes) received on 15 March 2019 Version 7 (final version, clean) 18 March 2019
Date plan first received	1 August 2017
Date review completed	19 March 2019

#	Condition	How addressed	GMMP Reference
3	At least three months prior to **commencing excavation of the first box cut**, the **approval holder** must submit to the **Minister** for approval a Groundwater Management and Monitoring Plan (GMMP).	**Met** The GMMP was first submitted on 1 August 2017. It is noted that the Queensland Environmental Authority (EA) Conditions refer to a Groundwater Management and Monitoring Program, which is considered to be the same as the EPBC Act approvals Groundwater Management and Monitoring Plan. The abbreviation GMMP throughout the document is considered to adhere to both approval requirements.	
	The GMMP must be informed by the results of the groundwater flow model re-run (condition 23) and contain the following:	**Met** Results of the model re-run are described in section 2.3, and compared to previous model scenarios. The model used in the Supplementary Environmental Impact Statement (SEIS model) predicts the highest magnitude of impacts and hence the results from the SEIS model have been used for all assessments and development of water quality triggers and water level thresholds included in the GMMP. The external review by CSIRO and Geoscience Australia found that the SEIS scenario was the most appropriate of those available to underpin the GMMP. In Section 1.8.1, Adani commits to address the recommendations of the groundwater model re-run and independent model peer review required under condition 23 in the first groundwater model refinement to be conducted within two years of the first box cut (or first coal extraction) as per the Queensland EA conditions of approval.	Section 1.8.1 Section 2.3
3a	Details of a groundwater monitoring network that includes: i. control monitoring sites	**Met** Details of the groundwater monitoring network are at Section 5.5. The Department considers that control bores are to be located outside the zone of potential impact and that the intent of this condition is to ensure that the groundwater monitoring network is capable of separating out non-project influences on water resources. The control monitoring bores in section 5.5 can be utilised during all phases of the mine where natural groundwater level and chemistry changes can be monitored (then compared to the mine monitoring bore network to aid in assessing if change is due to approved mining or natural fluctuations).	Section 5.5

#	Condition	How addressed	GMMP Reference
		To achieve the intent of this condition (i.e. separating out non-project influences on water resources), Adani states a trend assessment on water levels will be undertaken to separate other influences, e.g. landholder extraction. The Department agrees that non-project groundwater impacts are likely to be limited in extent and localised and therefore, identifiable via trend analysis. As such, the further details about separation methods in section 4.7.2.2 are considered suitable to identify and separate out other users' influences on groundwater levels.	
	ii. sufficient bores to monitor potential **impacts** on the Great Artesian Basin (GAB) aquifers (whether inside or outside the **Project Area**).	Met Groundwater monitoring bores are located adjacent (to the west) of the mine lease within the Great Artesian Basin (GAB) aquifers to allow for the assessment of potential induced drawdown impacts on GAB aquifers. Table 23 lists two bores in the Moolayember formation, 10 in the Clematis Sandstone, 5 in the Dunda Beds and 7 bores, with multiple vibrating wire piezometers installed in the Rewan Formation. Consistent with advice from CSIRO and Geoscience Australia, Adani commits in section 7, and elsewhere, to augment the network to install nested monitoring bores in the Dunda Beds and Rewan Formation at, or within 500m of, three existing Clematis Sandstone monitoring locations prior to the occurrence of predicted impacts associated with project activities. With these further nested bores outside of the mine screened in or below the aquifers of the GAB, the Department found that the bore network is sufficient to monitor potential impacts on GAB aquifers.	Section 3.1 Table 23 Section 7
	iii. a rationale for the design of the monitoring network with respect to the nature of potential **impacts** and the location and occurrence of **Matters of National Environmental Significance** (whether inside or outside the **Project Area**).	Met MNES defined in the approval include four groundwater dependent ecosystems (GDEs): the Carmichael River, Mellaluka Springs Complex, Doongmabulla Springs Complex and Waxy Cabbage Palm (which occurs along the Carmichael River and at Doongmabulla Springs Complex). The plan describes the rationale for the network (section 3.7) and describes the purpose of bores in Table 23, with reference to each relevant GDE: Carmichael River, Mellaluka Springs Complex, and Doongmabulla Springs Complex, which the Department considers adequate. Adani commits to augment the network to install nested monitoring bores at, or within 500m of, three existing Clematis Sandstone monitoring locations between the mine and the Doongmabulla springs.	Table 23 Section 3.7

#	Condition	How addressed	GMMP Reference
		Adani will also investigate for drilling into deeper Permian age units for the purpose of acquiring data for monitoring and to capture information if required under relevant research programs. These bores in the Permian units would be useful to rule out alternate sources of the springs (e.g. the Colinlea Sandstone). The Department will review the need for drilling into the Permian sediments as part of the review and approval of the research plans required under the conditions of approval. These plans must be approved before the commencement of the first box cut.	
3b	Baseline monitoring data	**Met** The plan describes the expansion of the monitoring network over time and the collation of baseline data. The 'final' baseline dataset is from September 2011 to April 2017, noting that a formal monitoring network with regular sampling events was not established until 2013. Most of the water level data gathered has been verified through the Queensland Department of Natural Resources, Mines and Energy (DNMRE), and hydrographs exist for over 80 bores. The baseline data is summarised by GDE location in table 38, to inform triggers at 3c, which is considered adequate. Adani commit to include any revised bore data after verification through DNRME is complete in the model re-run within 2 years, and include how any changes affect model performance. Water quality data has also been presented and used by DES to define interim water quality triggers. These triggers will be updated when further pre-impact data is available.	Various, including table 38
3c	Details of proposed trigger values for detecting **impacts** on groundwater levels and a description of how and when they will be finalised and subsequently reviewed in accordance with **state approvals**.	**Met** Groundwater trigger values for detecting impacts on groundwater levels are referred to as groundwater level thresholds in the GMMP (noting that State approval conditions refer to triggers for water quality). These triggers are described in section 5.3 in relation to MNES including: • Adjacent to the Carmichael River (Dunda Beds, Alluvium, Tertiary sediments, and Joe Joe Group) • To the west of the mine lease in and below the GAB units (Rewan Formation, Dunda Beds, and Clematis Sandstone) • Adjacent to the Mellaluka Springs Complex (Tertiary sediments and Joe Joe Group)	Section 5.3

#	Condition	How addressed	GMMP Reference
		• Adjacent to the Doongmabulla Springs Complex (as per GAB units plus D seam and AB seam) The triggers proposed for the Carmichael Coal Mine are as follows: • If groundwater levels vary by 50% of the predicted drawdown, above natural fluctuation, in unconfined aquifers • If groundwater levels / potentiometric levels vary by 75% of the predicted drawdown, above natural fluctuation, in the confined aquifers • For bores where groundwater levels are predicted to decline by >10 m, as a direct result of coal mining, the groundwater level thresholds are 90% of the predicted maximum drawdown levels plus half of the natural fluctuation • In cases where the predicted drawdown is lower than the natural fluctuation, the highest predicted drawdown plus half of natural fluctuation is taken as the groundwater level thresholds. These triggers are shown in Table 41 and will be finalised upon approval of the GMMP by Queensland DES. As the proposed triggers are reliant on predictions from the numerical groundwater model, to be updated within two years of the first box cut then every five years subsequently, Adani will compare the actual measured groundwater level data to predicted drawdown to assess the rate of change. In the instance the drawdown rate of the actual data is steeper/ faster than the predicted rate, an investigation will be commenced into the cause of the drawdown rate change (section 5.3.5.2). **Note:** Groundwater level triggers are only reported if exceeded on two events (which occur quarterly). This approach is not the most conservative and could allow for exceedances to occur for over six months before they are reported to the Department. The Department considers that this poses a low residual risk to MNES, as changes in groundwater level are expected to be relatively slow (i.e. years to decades).	

#	Condition	How addressed	GMMP Reference
3d	Details of groundwater level early warning triggers and impact thresholds for the Doongmabulla Springs Complex, informed by groundwater modelling and corrective actions and/or mitigation measures to be taken if the triggers are exceeded where caused by mining operations, to ensure that groundwater drawdown as a result of the project does not exceed an interim threshold of 0.2 meters at the Doongmabulla Springs Complex.	**Met** Details of early warning triggers and impact thresholds are set out in Section 5.3. This section includes details of how the proposed drawdown thresholds were derived, including Early warning triggers (referred to as low impact thresholds) and Impact thresholds (referred to as high impact thresholds). These triggers and thresholds are all based on groundwater modelling, which assumes that the source of the springs is the Clematis Sandstone and that the worst-case impacts are 0.19m at Joshua Spring. Advice from CSIRO and Geoscience Australia was that the major source of the Doongmabulla Springs is likely to be the Clematis Sandstone. This aquifer is separated from the coal seams (where impacts will occur) by the Rewan Formation, a thick aquitard. However, CSIRO and Geoscience Australia state that it is not plausible or reasonable that this is the only source of the springs. Additional sources may include the Dunda Beds (also above the Rewan Formation), or deeper units close to the coal seams. Early warning triggers are defined for bores in the Clematis Sandstone and Dunda Beds at 50%, 75% or 90% of the predicted drawdown, above natural fluctuation. Following review of the monitoring network by CSIRO and Geoscience Australia, Adani has committed to installing additional bores in the Dunda Beds and Rewan Formation in the vicinity of three existing Clematis Sandstone monitoring locations between the mine and the springs. Adani commits to defining early warning triggers at these bores once the model is reviewed and pre-impact data is collected. These triggers will provide an even earlier warning of potential impacts to the springs. If an early warning trigger is exceeded due to mining, Adani commits to undertaken additional monitoring in GAB and Permian aquifers and increase the monitoring of GDE health. The Impact thresholds are defined as: • 90% or 100% of the predicted maximum drawdown levels above natural fluctuation in the Clematis Sandstone and Dunda Beds bores, as per Table 45 • Timing of groundwater level drawdown, such that if groundwater levels start to decline before the predicted impacts in plate 14 to 22	Section 5.3

#	Condition	How addressed	GMMP Reference
		• The rate of groundwater level decline trigger in three bores in the Rewan Formation and Dunda Beds, as per table 44. The interim rate decline triggers defined in table 44 have an allowance of 10% for modelling errors when predicted drawdown is greater than 1m and 20% when predicted drawdown is less than 1m. The predicted drawdown rate for the first period are 0 m/year, so the modelling error allowance will have no effect before the first model review, which is a more appropriately conservative approach. The Department will review this allowance in the revised GMMP, and reconsider its application based on the limitations identified with the revised model. If an impact threshold is exceeded, Adani commits to refine the numerical model, increase monitoring, review the mine plan, review the GMMP and implement outcomes from the research into GAB springs for the management, prevention and remediation of impacts on Doongmabulla Springs Complex. If the investigation (refer 4.7.2.2) finds that impacts are predicted to be beyond those allowed in the project approvals, Adani will commence planning of further mitigation activities with regards to water availability at the springs which may include limiting thickness of extraction of coal seams and reviewing extraction of multiple coal seams for the underground longwall mining and freezing mine development at current levels until the completion of investigations and assessments which conclude that further development will not exceed approved impacts. **Note:** The revised early warning triggers and impact thresholds will be submitted to the Department for approval as part of review of the GMMP after the model review within two years of the first box cut. This will include triggers and impact thresholds for the deeper nested bores at three locations between the mine and Doongmabulla springs. The Department will ensure that these triggers and limits are set to ensure the protection and long-term viability of the Doongmabulla Springs Complex.	
	i. The early warning triggers and impact thresholds must be informed by groundwater modelling in accordance with Conditions3ei, 22, 23, and 24 and the relevant requirements of the environmental authority	**Met** The early warning triggers are informed by groundwater modelling in the SEIS. As per condition 3, the external review by CSIRO and Geoscience Australia found that the SEIS scenario was the most appropriate of those available to underpin the GMMP.	Section 5.4

#	Condition	How addressed	GMMP Reference
	held under the Environmental Protection Act (1994) Qld (in particular requirements arising in response to the conditions at Appendix 1, Section 1, Schedule E of the Coordinator-General's Assessment Report)	In section 1.10.1, Adani commit to review of the GMMP in accordance with the Queensland EA requirements, with a report to the Department, including a review of the adequacy of the groundwater monitoring locations, frequencies, and groundwater quality triggers in EPBC Act approval condition 3e.	
	ii. The interim drawdown threshold required under condition 3d) may be replaced with a new drawdown threshold, if the approval holder applies to the Minister for approval to change it, and submits further evidence supported by further groundwater modelling and other scientific investigations (such as those required in conditions 25 and 27), that a new drawdown thresholds will ensure the protection and long-term viability of the Doongmabulla Springs Complex.	**Not applicable** The approval holder has not requested this change, as modelling predictions are still less than the interim threshold.	n/a

#	Condition	How addressed	GMMP Reference
3e	Details of the timeframe for a regular review of the GMMP in accordance with the requirements of the environmental authority issued under the *Environmental Protection Act 1994* (Qld), and subsequent updates of the GMMP, including how each of the outcomes of the following will be incorporated:	**Met** Section 1.10.1 includes details of the GMMP review, intervals and details.	Section 1.10.1
	i. Independent review and update of the **groundwater conceptual model,** as well as the **numerical groundwater model** and water balance calculations as necessary, to incorporate monitoring data	**Met** **Section 1.10.1** includes details of the GMMP review process including these requirements. Adani commits that the update of the GMMP will include: • an independent review and update of the groundwater conceptual model • an independent review of the numerical groundwater model • an independent review of the water balance calculations and that the recommendations of the reviews will be incorporated in the revised / updated GMMP document including a table of changes made in response to the independent reviews.	Section 1.10

#	Condition	How addressed	GMMP Reference
	ii. Future baseline research required by the Queensland Coordinator-General into the **Mellaluka Springs Complex** (Appendix 1, Section 3, Condition 1 of the **Coordinator-General's Assessment Report**)	**Not applicable** This requirement relates to further research on the Black-throated Finch (BTF). Studies have determined that the Mellaluka Springs-complex does not provide BTF habitat. A letter from the Office of the Coordinator-General, dated 22 July 2016, was written to Adani confirming the Department and Queensland government's acceptance of this finding. As such, there is no requirement for further updates to the GMMP based on BTF research.	n/a
	iii. The GAB Springs Research Plan (Conditions 25 and 26)	**Met** Adani commits that the results of research plans, inclusive of the GAB Springs Research Plan, will be incorporated in to the next iterations of the numerical model review and GMMP (within two years of the first box cut and every five years after that).	Section 1.10.1
	iv. The Rewan Formation Connectivity Research Plan (Conditions 27 and 28)	**Met** Adani commits that the results of research plans, inclusive of the Rewan Formation Connectivity Research Plan, will be incorporated in to the next iterations of the numerical model review and GMMP (within two years of the first box cut and every five years after that).	Section 1.10.1

#	Condition	How addressed	GMMP Reference
3f	Provisions to make monitoring data available to **the Department** and Queensland Government authorities (if requested) on a six-monthly basis for inclusion in any cumulative impact assessment, regional water balance model, bioregional assessment or relevant research required by the **Bioregional Assessment of the Galilee Basin sub-region and the Lake Eyre Basin and any subsequent iterations**	**Met** Adani has committed to providing groundwater monitoring data on a regular basis to the administering authorities, as below: Interpreted data will be disseminated through the agreed (Queensland EA Condition E15 (Appendix A)) reporting requirements (Section 4.8). These data will be provided on a six-monthly basis, in line with the approval conditions. In Section 4.8, Adani note this requirement to provide data to the Department on a six monthly basis. They commit that the provision of this data, considering the requirements of the Queensland EA approval condition (Appendix A, Condition E15), will be provided in a format specified by the administrating authority.	Section 4.6.2 Section 4.8
3g	Provisions to make monitoring results publicly available on the **approval holder**'s website for the life of the project.	**Met** In section 4.6.2, Adani commit that verified (Quality Assurance / Quality Control) groundwater monitoring data will be made available to the public through the Adani website, these publicly available data will include: • All groundwater quality monitoring data • All groundwater level data • Figures showing the groundwater monitoring points • Site rainfall data. The data will be uploaded to the website within 4 weeks of the finalisation of the 6 monthly reports.	Section 4.6.2

#	Condition	How addressed	GMMP Reference
3h	A peer review by a **suitably qualified independent expert** approved by the Minister in writing, and a table of changes made in response to the peer review.	**Met** Adani, in agreement with the Department, appointed JBT Consulting to undertake an independent review of the draft GMMP. Comments and recommendations which resulted from the initial independent review of the draft are presented in Appendix F. A record of changes and modifications to this GMMP, in response to the independent review, are included in Appendix G.	Section 1.11 App F App G
4	The **approval holder** must not **commence excavation of the first box cut** until the GMMP has been approved by the **Minister** in writing. The approved GMMP must be implemented. *Note: Many elements of the GMMP are also required under the state approval for the project, Where possible a combined document should be prepared that addresses both state government and EPBC Act approval conditions.*	**Met** This draft GMMP document has been submitted for approval. The GMMP is a combined document prepared to address both state government and EPBC Act approval conditions.	n/a

FOI 190417
Document 59

Australian Government
Department of the Environment and Energy

Document Review / Comments

Approval Holder: Adani

Project: 2010/5736

Document: Groundwater Management and Monitoring Plan

EPBC conditions: 3

Document full title	Groundwater Management and Monitoring Program – Carmichael Coal Mine Project. Prepared for Adani Mining Pty Ltd Revision 5, 22 January 2019
Drafting officer	s22
Reviewing officer	s22
Date plan received	22 January 2019
Date issued to approval holder	27 February 2019
Background	The advice provided in this document is based on the Department's internal regulatory review of the revised plan in response to previous comments and an external expert scientific review provided to the Department on 22 February 2019.

Approval condition	Department Comments February 2019
General – Science Communication	Operational maps presented in Appendix B indicate the location of the year 5 mine footprint. Please clarify how this footprint relates to the location of the first box cut, and provide further information on the phasing of mine operations, including locations of dewatering bores. This information should be presented in Section 2.6 pg. 102 – CCP mine activities. There are still a number of areas where referencing of figures etc. still need to be checked and corrected. Please check and update pages 139 to 152 in Appendix A as content is not shown.
General – Hydrogeological Conceptualisation	As per the Departments' second round of comments, it is requested that Adani provide a copy of all reports listed in Section 2, pg. 34 for record, to enable future expert review when Plans are updated.
3. At least three months prior to commencing excavation of the first box cut, the approval holder must submit to the Minister for approval a Groundwater Management and Monitoring Plan (GMMP). The GMMP must be informed by the results of the groundwater flow model re-run (condition 23) and contain the following:	The SEIS model predictions are used by the GMMP as this model was found to be the most conservative of the scenarios available. As part of the adaptive management approach, the commitment to the future review of the model (e.g. 2 years from box cut) must include commitments to address the recommendations from the previous independent peer review of the groundwater model re-run (pg. 10) and the following: • Inclusion of locally appropriate and derived hydrogeological parameters, particularly for the Clematis Sandstone and Rewan Formation. • Inclusion of additional bore water level data. • Updated and clearly defined bore reference levels. The review should also include how changes (if any) affect model prediction and performance. • Re-calibration. Subsequent review of evapotranspiration (ET) is also needed to assess its influence on drawdown to the DSC and the Carmichael River GDEs. • Surface water flows for the Carmichael River as a calibration parameter. • Validation of the model based on new bores drilled since the SEIS. • Sensitivity analysis to assess cumulative sensitivity (i.e. cumulative effect on predictions of varying multiple parameters, where they change at the same time), including sensitivity of the model to parameters changes due to underground mining. • Uncertainty analysis based on recent literature (e.g. Middlemis and Peeters, 2018, *Uncertainty Analysis – Guidance for groundwater modelling within a risk management framework).*

Approval condition	Department Comments February 2019
a) details of a groundwater monitoring network that includes:	The current monitoring network does not adequately address potential contributions to the DSC from the Dunda Beds, Rewan Formation, or from deeper units to the west outside the mine lease. These potential spring contributions need to be considered and factored into the monitoring network. A commitment to monitoring of the Dunda Beds and the Rewan Formation is required. Ideally all units from outcrop to sub-Joe Joe coal (Jericho Formation) would also be monitored. Co-location with existing points (HD02, HD03A, C14012SP/C14013SP and C14011SP) is required. This will enable spatially comparable data to be collected and remove any access issues. . Further clarification is needed in relation to the construction and operational GMMPs referred to in Section 6. Please provide details on how (if at all) the groundwater monitoring locations presented in Table 56 vary to those presented earlier in the Plan.
(i) control monitoring sites	Bores located where there is little or no drawdown (beyond natural fluctuation), and those not directly impacted by approved mining activities would be suitable control monitoring sites (Section 5.5). The method required to meet condition 3c to separate other users' influences on groundwater levels could be applied to these bores, to inform impacts due to other groundwater extraction.
(ii) sufficient bores to monitor potential impacts on the Great Artesian Basin (GAB) aquifers (whether inside or outside the Project Area)	The installation of additional monitoring bores in the Dunda Beds and Rewan Formation (upper Rewan and lower Rewan) at existing monitoring points in the west of the central zone (nested bores) is needed. Co-location with existing points (HD02, HD03A, C14012SP/C14013SP and C14011SP) is recommended. This is to allow an assessment of any dewatering impact propagating through the Rewan Formation to the GAB. The nested sites will also serve to validate the current understanding of vertical groundwater gradients above and below the Rewan (Section 2.2.6.2 pg. 72).
(iii) a rationale for the design of the monitoring network with respect to the nature of potential impacts and the location and occurrence of Matters of National Environmental Significance (whether inside or outside the Project Area).	Maps presented in Appendix B and C show monitoring bore locations and groundwater contours. To support the rationale for the design of the monitoring network, maximum predicted drawdown extents need be provided for all units. Figure 16 (pg. 106) only shows the maximum predicted drawdown in the water table. To evaluate the effectiveness of the groundwater monitoring network with respect to the occurrence of MNES (inside or outside) the project, maximum drawdown extents for each unit need to be provided. Clarify the status and extent of surface water monitoring for impacts to MNES GDEs. Ongoing flow gauging upstream and downstream of the mine is needed.

Approval condition	Department Comments February 2019
b) baseline monitoring data	Commit to establish appropriate baseline (pre-impact) data at the additional bores (required at locations HD02, HD03A, C14012SP/C14013SP and C14011SP) within the Dunda Beds, Rewan Formation and deeper units prior to establishing associated trigger values for impact management. The drilling of bores and baseline assessments at these locations need to be detailed as a commitment in Section 7. The installation of an additional alluvium bore near C025P1 and associated baseline assessment also needs to be detailed in Section 7.
c) details of proposed trigger values for detecting impacts on groundwater levels and a description of how and when they will be finalised and subsequently reviewed in accordance with state approvals	The proposed trigger values approach relies heavily on predictions from the numerical groundwater model. The use of drawdown rate limits for selected bores within the Rewan Formation and Dunda Beds is a suitable adaptive management approach for an early warning of potential impacts in this instance. However, noting limitations and associated uncertainties with the model, a precautionary approach is needed to ensure actual impacts are not greater than predicted. On this basis, all monitoring locations for which water level trigger values are defined also need drawdown rate limits derived. C025P1 should not be used as a threshold monitoring point until a deeper replacement has been installed. The trigger value for the new bore should only be set after the acquisition of sufficient baseline data. In relation to the process for reporting (Section 4.7.2 pg. 162), commit to a defined investigation workflow including: notifying the Department whenever an exceedance occurs, what data will be used in the investigation, what process will be followed to remove non-mining influences, and a maximum timeframe in which the investigation will be completed. The GMMP needs to detail (i.e. a method specified) how non-mining influences on groundwater levels (such as other land uses or climatic variability) will be quantified and assessed during the investigation of threshold exceedances (Section 4.7.2.2 pg. 162).
d) details of groundwater level early warning triggers and impact thresholds for the Doongmabulla Springs Complex, informed by groundwater modelling and corrective actions and/or mitigation measures to be taken if the triggers are exceeded where caused by mining operations, to ensure that groundwater drawdown as a result of the project does not exceed an interim threshold of 0.2 metres at the Doongmabulla Springs Complex	Groundwater level Early warning triggers and impact thresholds for groundwater level within the Clematis Sandstone and Dunda Beds (Table 43, pg. 208) rely heavily on predictions from the numerical groundwater model. Please ensure the first rate limit is applicable for the period that the plan applies, until the model review within two years of the box cut. Also please ensure that rates are defined for the entire life of the plan (noting they can be updated every five years). In addition there is currently no groundwater monitoring at depth to inform potential for alternate source aquifers at this location and nearby. Additional triggers and thresholds for new nested bores (see 6aii) within the Dunda Beds, Rewan Formation and deeper units are needed.

Approval condition	Department Comments February 2019
(i) the early warning triggers and impact thresholds must be informed by groundwater modelling in accordance with Conditions 3e)i, 22, 23 and 24 and the relevant requirements of the environmental authority held under the Environmental Protection Act (1994) Qld (in particular requirements arising in response to the conditions at Appendix 1, Section 1, Schedule E of the Coordinator-General's Assessment Report) (ii) the interim drawdown threshold required under condition 3d) may be replaced with a new drawdown threshold, if the approval holder applies to the Minister for approval to change it, and submits further evidence supported by further groundwater modelling and other scientific investigations (such as those required in conditions 25 and 27), that a new drawdown threshold will ensure the protection and long-term viability of the Doongmabulla Springs Complex.	Groundwater quality The Department notes that the ANZECC guidelines have recently been updated and are now referred to as ANZG 2018. Australian and New Zealand guidelines for fresh and marine water quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available [online]: www.waterquality.gov.au/anz-guidelines. Relevant generic trigger values need to make reference to the updated Guidelines. Water quality triggers for the Dunda Beds need to be included at a minimum, until alternative conceptualisations for the source aquifer for the DSC has been resolved, as the Dunda Beds are likely to be a contributing water source. Also given the current conceptualisation of the Clematis Sandstone as the sole source aquifer for the DSC, contaminant limits for the Clematis Sandstone are also required. Setting static trigger levels does not account for trends in hydrochemistry that may provide an early indication of impact. An assessment of trends in the hydrochemistry data following each monitoring event is required to identify if groundwater quality is changing over time, which may provide an early warning of triggers being approached. Mitigation Mitigation actions are not adequately presented in the GMMP, although a number of references are made to actions presented in the GAB Spring Research Plan (GABSRP) or the Biodiversity Offset Strategy (BOS). It is a requirement of this condition that proposed mitigation measures to protect the DSC be incorporated into the GMMP.
e) details of the timeframe for a regular review of the GMMP in accordance with the requirements of the environmental authority issued under the Environmental Protection Act 1994 (Qld), and subsequent updates of the GMMP, including how each of the outcomes of the following will be incorporated:	The Department notes the timeframes for state review. Please ensure the commitments in Section 7 relate to the update of the groundwater model and the GMMP.
(i) independent review and update of the groundwater conceptual model, as well as the numerical groundwater model and water balance calculations as necessary, to incorporate monitoring data	There is inconsistency regarding the timing of the groundwater review – Section 2 states this review to be within two years. However there a number of sections where the review is stated to be after two years. Please ensure the timeframes are consistent within the Plan and the requirements of the state EA condition E6.

Approval condition	Department Comments February 2019
	As per the Department previous comments, please commit that the independent reviewer will not be appointed for any review until approved by the Department and DES for that review.
(ii) future baseline research required by the Queensland Coordinator-General into the Mellaluka Springs Complex (Appendix 1, Section 3, Condition 1 of the Coordinator-General's Assessment Report)	In relation to the Mellaluka Springs, there is a general statement that the conceptualisation and understanding of the groundwater resources will be refined over time for inclusion in the future iterations of the predictive groundwater model. Some work and data collection has already been undertaken (Section 2.2.6.3.1 pg. 80). Please specify what other research or data collection is proposed in order to confirm the source.
(iii) the GAB Springs Research Plan (Conditions 25 and 26) (iv) the Rewan Formation Connectivity Research Plan (Conditions 27 and 28).	Section 2 pg. 35 states that results of these studies will be incorporated into the next iterations of the GMMP and numerical model review and update. As per previous comment, please confirm timeframes for reporting, mechanisms for update (i.e. whether they will be submitted to the Department for approval, or not), and mechanisms for subsequent updating of plans.
f) provisions to make monitoring data available to the Department and Queensland Government authorities (if requested) on a six monthly basis for inclusion in any cumulative impact assessment, regional water balance model, bioregional assessment or relevant research required by the Bioregional Assessment of the Galilee Basin sub-region and the Lake Eyre Basin and any subsequent iterations	Please clarify if/when data will be provided in response to an investigation of an exceedance.
g) provisions to make monitoring results publicly available on the approval holder's website for the life of the project	The following data is noted to be publicly available – groundwater quality, groundwater level, figures showing monitoring points and site rainfall data. This commitment should explicitly state that <u>all</u> monitoring data is will be made available, including a commitment that this will be available for the life of the project as per requirements of condition 3g. This commitment should also be given in Section 4.8 reporting pg. 164 and Section 7. Please also state when this website will be operational.
h) a peer review by a suitably qualified independent expert and a table of changes made in response to the peer review.	Awaiting scope of review and the extent to which the conditions of approval have been addressed, as per Adani's comment.

Australian Government
Department of the Environment and Energy

Document Review / Comments

Approval Holder: Adani

Project: 2010/5736

Document: Groundwater Dependent Ecosystems Management Plan

EPBC conditions: 6

Document full title	Groundwater Dependent Ecosystem Management Plan – Carmichael Coal Mine Project. Prepared for Adani Mining Pty Ltd Version 10a, 21 January 2019
Drafting officer	s22
Reviewing officer	s22
Date plan received	21 January 2019
Date issued to approval holder	27 February 2019
Background	This advice should be read in conjunction with the Department's regulatory comments on v10, provided to Adani on 1 February 2019. The advice provided in this document is made in the context of an external expert scientific review provided to the Department on 22 February 2019, which largely focused on the GMMP. As the GDEMP relies heavily on the conceptualisations and modelling outlined in the GMMP, further edits to the GDEMP may be required as a result of addressing advice on the GMMP

Condition	Department comments on version 10a
General Comments	Where references to commitments are made in the document, or required below, please ensure that these commitments are specific and time-bound.
6. The MNESMP must incorporate the results of the groundwater flow model re-run (condition 23) where relevant, and be consistent with relevant recovery plans, threat abatement plans and approved conservation advices and must include:	<u>Groundwater model review</u> Ensure that commitments made in the plan to review the groundwater model within 2 years and update the GDEMP accordingly include commitments to address the specific modelling issues raised in the Department's comments on the GMMP.
a) a description of environmental values for each of the Matters of National Environmental Significance addressed in the plan	No further comments.
b) details of baseline and impact monitoring measures to be implemented for each of the Matters of National Environmental Significance including control and impact sites to be monitored throughout the life of the project. The monitoring must provide sufficient data to quantify likely impacts resulting from mining operations, including subsidence and changes in groundwater levels, to set habitat management goals (Conditions 6e) and 6f))	<u>Pre-impact monitoring</u> Please define a verification process to ensure pre-impact data is not impacted by mining operations if operations commence before this data is collected. <u>Carmichael River</u> Specify within the plan (in addition to references to the REMP) the exact locations for baseline, pre-impact and impact monitoring of streamflow in the Carmichael River to provide sufficient data to quantify likely impacts along its length. If sufficient locations (upstream and downstream of the mine site) do not yet exist, please commit to installing them. To ensure gauged data is accurate, include commitments to resurvey channel cross-sections at these stream gauging locations to maintain accurate height-flow-discharge relationships. <u>Doongmabulla Springs</u> Include commitments to nest additional bores at 2-5 existing sites to quantify likely impacts resulting from mining to source aquifers for the DSC other than the Clematis Sandstone. This requirement is based on advice that it is not plausible and reasonable to state unequivocally that the Clematis Sandstone is the sole source aquifer for the DSC, and to allow for that uncertainty. To be consistent with the GMMP, water quality triggers for the Dunda Beds and Clematis Sandstone are needed, until alternative conceptualisations for the source aquifer for the DSC has been resolved.

c) details of potential impacts, including area of impact, on each of the Matters of National Environmental Significance from mining operations, including impacts from: (i) vegetation clearing (ii) subsidence from underground mining, including subsidence induced fracturing and any changes to groundwater or surface water flow (iii) mine dewatering (iv) earthworks (v) noise and vibration (vi) emissions (including dust) (vii) light spill and other visual impacts (viii) stream diversion and flood levees (ix) weeds and pests.	No further comments.
d) measures that will be undertaken to mitigate and manage impacts on Matters of National Environmental Significance resulting from mining operations. These measures must include but not be limited to: (i) the use of fauna spotters prior to and during all vegetation clearing activities to ensure impacts on Matters of National Environmental Significance are minimised (ii) measures to avoid impacts on Matters of National Environmental Significance and their habitat located in the Project Area, but outside areas to be cleared, constructed upon and / or undermined, including adjacent to cleared areas	No further comments.

(iii) measures to rehabilitate all areas of Matters of National Environmental Significance habitat (iv) habitat management measures including but not limited to management of subsidence and groundwater impacts of the project.	
e) goals for habitat management for each relevant Matter of National Environmental Significance	No further comments.
f) a table of specific criteria for assessing the success of management measures against goals, and triggers for implementing corrective measures if criteria are not met within specified timeframes. This table must include but not be limited to measures relating to subsidence and groundwater impacts, including early warning triggers for impacts on groundwater at the Doongmabulla Springs Complex and the Carmichael River. Goals and triggers must be based on the baseline condition of the relevant Matters of National Environmental Significance as determined through baseline monitoring (see Conditions 3b) and 6b)). Corrective measures must include provision of offsets where it is determined that corrective management measures have not achieved goals within specified timeframes (see Conditions 11m) and 11o))	<u>Pre-impact monitoring</u> To address the requirement that triggers and limits are based on baseline condition, please include clear commitments about updating triggers and limits in the GDEMP based on pre-impact monitoring data. Updates to groundwater and surface water level/flow parameters should occur as soon as possible after the model review required within two years of the box cut. <u>Carmichael River</u> If sufficient streamflow locations do not yet exist (see comments against 6b), please include commitments to collect pre-impact data for these locations and define early-warning indicators and triggers as soon as sufficient baseline data is available. <u>Doongmabulla Springs</u> Include commitments to collect pre-impact data for other sources for the DSC at the additional nested bores at 2-5 existing sites to the west of the mine lease (see comments against 6b) and define early-warning indicators and triggers at these locations as soon as sufficient baseline data is available. This needs to include appropriate water quality data for the Clematis Sandstone and Dunda Beds, as a minimum. <u>Early-warning triggers</u> The GMMP includes rate limits to act as early warning triggers for impacts on groundwater at the Doongmabulla Springs Complex. Please ensure these are included in the GDEMP to meet this condition. Please ensure the first rate is applicable for the period that the plan applies, until the model review within two years of the box cut. Also please ensure that rates are defined for the life of the plan (noting they can be updated every five years).

	Please include similar rate limits in the GDEMP and GMMP to act as early-warning triggers for the Carmichael River.
g) an ongoing monitoring program to determine the success of mitigation and management measures against the stated criteria in Condition 6f), including monitoring locations, parameters and timing. Monitoring for water resource Matters of National Environmental Significance must include hydrogeological, hydrological and ecological parameters	No further comments.
h) details of how compliance will be reported	<u>Compliance with early-warning thresholds, triggers and limits</u> Commit to a defined investigation workflow including: notifying the Department whenever an exceedance occurs, what data will be used in the investigation, what process will be followed to remove non-mining influences (to ensure impacts are attributable to mining as per 6d/f), and a maximum timeframe in which the investigation will be completed.
i) details of how the MNESMP will be updated to incorporate and address outcomes from research undertaken for Matters of National Environmental Significance under this and any state approvals, including updating of goals, criteria and triggers (as required under Conditions 3c), 3d), 6e) and 6f))	No further comments.
j) details of qualifications and experience of persons responsible for undertaking monitoring, review, and implementation of the MNESMP	No further comments.
k) In the event that the future baseline research required by the Queensland Coordinator-General (Appendix 1, Section 3, Condition 1 of the Coordinator-General's Assessment Report) identifies that the Mellaluka Springs Complex provides high value habitat for the black throated finch, the approval holder must include management measures to address impacts resulting from drawdown at the Mellaluka Springs Complex in the MNESMP	No further comments.

l) details of how, where habitat for an EPBC Act listed threatened species or community not previously identified and reported to the Department is found in the Project Area, the approval holder will notify the Department in writing within five business days of finding this habitat, and within 20 business days of finding this habitat will outline in writing how the conditions of this approval will still be met (refer Condition 11j).	No further comments.

Document Review / Comments

Approval Holder: Adani

Project: 2010/5736

Document: Groundwater Dependent Ecosystems Management Plan

EPBC conditions: 5-7

Document full title	Groundwater Dependent Ecosystem Management Plan – Carmichael Coal Mine Project. Prepared for Adani Mining Pty Ltd Version 10, 19 November 2018
Drafting officer	s22 , s22
Reviewing officer	s22
Date plan received	19 November 2018
Date issued to approval holder	1 February 2019

This advice provided in this document:

- is based on an internal Departmental review and does not limit further comments that may be provided following the expert scientific review of the plan.
- does not include a review of any parts of the GDEMP (including Appendix B) that relate to the verification of water level data, Departmental review of the GMMP, and external scientific review of the GMMP as these have not been finalised.
- does not review V10a of the GDEMP that includes the updated water level data.

#	Condition	Department comments on version 9	Adani response Nov 2018	Department comments on version 10
	General Comments	<u>Inconsistencies / errors</u>	<u>Inconsistencies / errors</u>	<u>Inconsistencies / errors</u>
1 2 3 4 5 6		a). There are internal inconsistencies in the plan – for example Appendix D refers to triggers differently from how they are presented in Section 5.3.2, Table 7, Table 10, Table 15 and Table 17; section 7.5.1 discusses surveys of remnant pools in the Carmichael River and aquatic ecology survey of species in those pools. This has not been transcribed over into Table 11 – Monitoring program for the Carmichael River. b). **Please ensure consistency between, but ideally incorporate, information from appendices into the plan.** Tables of monitoring or mitigation / management within the plan, for example, should be complete and stand alone. c). There are still spelling / grammatical errors in the plan – Bio regional (one word), monitoring, GDE 2014, commencement, Carmichael Rivers, dependant, etc. **Please address.** d). **Please ensure the plan is updated based on recent changes to the project, e.g. references to 388km of new rail, particularly if these are likely to change mine staging or production rates.** <u>Ambiguity</u> a). Much text remains vague and/or ambiguous. Terms such as "corrective management measures" could be either a "management and mitigation measure" or "corrective action". b). In particular, most 'commitments' in Section 12 Table of Commitments p 163 are too incomplete or ambiguous to be considered 'commitments'. In what way do they relate to text in the plan? They need to be clear, specific, timebound, effective and complete. c). Another example is the determination of baseline (p 27). This remains quite ambiguous. There must be a clearly defined point in time when baseline monitoring ceases and subsequent monitoring can be compared to baseline. The baseline must be provided in the plan (condition 6.b)) and in any case before there are impacts (e.g. dewatering, reduction of watershed and overburden removal). **Please ensure commitments are consistent.** **Please use clear language. Avoid may, if possible, should, seek to, etc.** d). **Please provide a key to all abbreviations. For example, does "N/A" mean 'not available' or 'not applicable' or something else?** e). **Please use consistent terminology, as per the conditions.** f). The plan describes in multiple places incompletely detailed processes for investigating the causes of trigger levels being detected and the determination of appropriate corrective actions. These locations in the plan include section 5.3.3, Table 7, section 6.7.6, section 6.9.3, Table 10, section 7.5.3, section 7.7.3, Table 11, Table 15, section 8.6.3, section 8.8.3 and Table 16. It is unclear which process will be used and the complete details of the proposed process(es) are not provided.	a). Plan has been updated overall, with trigger levels bought in from GMMP and material from Appendix D now integrated into the plan and reviewed for consistency throughout. b). Appendix D has been integrated into the Plan. Appendices have now been used to support the plan material and stronger cross referencing introduced. c). Spelling and grammatical errors have been resolved, noting there was a document formatting error. d). The plan has been updated to be consistent with the latest project description. Section 2 of the GDEMP provides an overview of the Project. <u>Ambiguity</u> a). Terms have been revised throughout. Note the only use of the term "corrective management measures" refers to the cross-reference with conditions, where this term appeared in the EPBC approval condition wording. b). The section showing the table of commitments has been removed from v10 of the GDEMP. Commitments are captured separately in each section for each GDE. Commitments have sought to be clear in their terminology and timing, and used clear, commital language. c). Table 2 provides a summary of GDE monitoring and implementation phases (baseline, pre impact, post impact) and how these relate to project activities, and the appropriate stage of the GDE toolbox. d). An abbreviations section is provided up front in the GDEMP, otherwise abbreviations are spelt out in full at first use. e). There has been a revision throughout the document on the terminology used to add clarity – e.g.	a). There remain inconsistencies within the plan, particularly within the monitoring and management tables. Monitoring must be able to (i) measure performance criteria, (ii) determine if triggers are exceeded, as well as (iii) measure the success of any corrective actions. There are also inconsistencies between these two tables and indicators etc. described within in the text (e.g. section 5, as well as individual MNES chapters). Once tables are updated, please check they are consistent with all the other text. i). Revise description of Environmental Value's in Section 4.2 to align with approval conditions (i.e. Second dot point on page 14 – 'Carmichael River riparian zone as described in the EBPC Act approval and Environmental Authority' does not meet EPBC approval definition, which is accurately described on page 13). Section 6.1.1 description of the Carmichael River has not been updated and still states 'forms…, approximately 2 km upstream'. ii). Figure 4-1. Update figure. Legend - DSC is one complex comprising of groups. Mellaluka spring is part of the Mellaluka Spring Complex. Extent – blue line of Carmichael River should extend to DSC. Please update any other figures that have the same errors. iii). There are two 4.3.1 sections (4.3.1 A. Hydrogeological conceptual model, 4.3.1 B. Hydrogeological units and aquifers). Section 4.3.1 A. states that the current understanding of the hydrogeological regimes presented in 'subsections', but there is only one subsection. iv). Consistency in naming convention for flora in Section 8. (e.g. Salt pipewort, *Eriocaulon carsonii*, *Eriocaulon carsonii* subsp. *Orientale* (Table 8-9). Note this species endangered listingis *Eriocaulon carsonii*). c). There are still spelling / grammatical / formatting errors in the plan – base flow / baseflow; flood plain / floodplain; Spring complex / spring-complex / Spring-complex / complexes (incl. Figure 6-2); DoE / DoEE ; close brackets for MNES description under Section 3.2; lack of table number 6-10 in sub box for weed management p73; referencing (Figure 6-11 relates to GHD 2012 a or b?), (missing GHD 2016 or should it be 2015?), (DEWHA 2009 relevance? Can't find in list – suggest this is removed); approve should be approved P8; references to this plan being approved in 2018 and formatting in table 2-1; post-impact vs. impact; paragraph formatting P39; bullet points needed P47; repeated sentence P51; impacts to Carmichael at year 15 (6-2) or 20 (6-3); table 6-3 add 'increase' by 30-60% in last row; ground vs. groundwater P90; change Moses springs-complex to DSC or Moses group p111; Waxy Cabbage Palm (*Waxy Cabbage Palm*) P117; missing cross-reference end P117; headings need to be separated from indicators P136; blank row in table 8-5; delete third sentence P183; repeat sentence under 9.3.1; 'Mellauka' spelling P225; formatting and 'described' under section 9.8; incomplete description of RFCRP table 10-1. <u>Ambiguity</u> b) Please remove terms like "may", "ideally", "if possible" so that commitments are enforceable. c). Determination of baseline data - Section 5 - Monitoring process outlines that additional baseline data is to be collected during the pre-impact phase,

		g). **Clarity of the plan would be improved by providing a single detailed, timebound description of the investigation process (or, if more than one process is intended, detailing the required permutations, and, where relevant in the tables and sections related to specific project aspects, refering to the investigation process (or the specific permutation that will apply).**	baseline, pre impact etc, and how this relates to the stages of the GDE toolbox and project timing (e.g. addition of Table 2). f). the investigation process is introduced in section 5.6, and then within each chapter specific to each GDE g). Addition of completely revised Section 5 provides a description of the monitoring approach, by stage, and where triggers apply.	which includes construction activities. Suggest this wording is revised as baseline information is defined elsewhere (in Table 2-1) as being part of the pre-construction phase and used to establish trigger values.
		<u>Link to GMMP</u> a). The plan refers to the GMMP as providing relevant groundwater drawdown water triggers. The current version of the GMMP does not detail what conceptualisation of groundwater it assumes and how this is applied to determine triggers. It therefore provides no basis for accepting the triggers it proposes as being appropriate for the GDEMP. **Please provide a revised GDEMP that is stand-alone; or revised GDEMP and GMMP that can be considered for approval as a job lot, to address comments.**	<u>Link to GMMP</u> a). Appendix B provided for stronger cross connection to the GMMP whilst allowing for individual plan approval and review. Adani's position is that this approach is consistent with the wording and intent of respective conditions.	<u>Link to GMMP</u> b). Table 1-1 confirm text in fourth column, which suggests that the GMMP informs ecological triggers – how is this the case? c). Update any new and relevant information from the GMMP to Section 4 to inform the description of EVs for each MNES, including: i. Table 4-1 - substantiate description of alluvium to have continuous discharge from Joshua, including a stronger link to the GMMP. - add depths for bores in Rewan formation, and add text to description about the formation's role in preventing and being an early-warning for impacts to DSC. - add in C027P2. ii. Link the 4 alluvium bores to key WCP populations and to areas of 'gaining' and 'losing' to clearly detail control and impact monitoring sites, including outlining why there are no monitoring bores in the alluvium located along Carmichael River within ML70505. iii. Although there is a 500m buffer around the alluvium, the cross-section in figure 4-3 suggests the alluvium will be mined in the open-cut pit. You may wish to revise. iv. add water levels for the bores shown in figures 4-4 and 4-5 (repeated later in the document) to assist in the conceptualisation for Mellaluka springs. v. If the GDEMP and GMMP are submitted in parallel, we recommend the springs source report be an Appendix to the GMMP, which negates the need for sections 8.3.5-7. If these studies are described in either plan, they need to be properly referenced (rather than 'an investigation', 'the report' P175). vi. Wherever possible, please reference relevant sections of the GMMP in text for ease of cross-referencing.
		<u>Link to other plans</u> a). The plan refers to many other plans, e.g. REMP, WMP, SWMP, GMMP, not all of which are covered by Commonwealth conditions of approval. For this plan to be stand-alone, any such references must be explained.	<u>Link to other plans</u> a). Section 1.3 describes the relationship with other management plans, and Section 10.3 summarises the reporting requirements of these other plans and interactions with the GDEMP.	<u>Link to other plans</u> a). Please ensure consistency between, but ideally incorporate, information from related plans into this plan. Clear links, and relevant information, that is provided in other plans should also outlined in this plan, including initial description in Section 1.3. Please also ensure the references to these plans are consistent. For example,

				- The Rehabilitation Management Plan is part of Adani's commitment to meet Condition 6. D.) (iii) – measures to rehabilitate all areas of MNES habitat. - There is still key information not included in this Plan to be stand-alone (e.g. monitoring sites, flow rates and timeframes in the REMP). Please reference Appendix A in text where necessary to address this issue. Table 10-1 limits the linkage to the REMP to be in relation to discharges only – what about monitoring at other times, the definition of water quality triggers, the use of discharge as a corrective action? Are references to the surface water quality monitoring program referring to the REMP? (see P90)
		<u>Phasing/staging</u> a). **Please address previous action from V8.** The plan commits to various actions in relation to project 'phases'. References are made to construction, and recovery post construction (e.g. P36). Clearly, this does not apply to most MNES in question. The plan does not make clear the boundaries between these phases. Commitments must be clearly timebound and related to on-ground progress. The stages are based on predicted impacts occurring in 2030. All GDE toolbox stages must be completed before impact. **Please provide a table enabling clear comprehension of mine project stages, GDE toolbox stages, project 'phases' and key events nominated in the conditions (e.g. commencement, first box cut, start of drawdown impacts). Please justify the staged approach, including how GHD 2015 predictions are still based on the best available information.** b). Relationships need to be developed and triggers updated based on improved data <u>before</u> groundwater levels drop. However, Stage 3 of the GDE toolbox approach 'characterisation of ecological response to change' does not commence (and initial/interim triggers won't be updated) until predicted groundwater drawdowns occur (15 years after commencement). Further, the GDEs are impacted by activities other than dewatering causing drawdown, as specified in the plan. Triggers need to be confirmed (i.e. stage 3 complete) ahead of these likely impacts (e.g. construction of haul road, flood levees). **Please bring forward the timing of 'characterisation of ecological response to change' to be completed prior to potential drawdown to key features and/or other impacts.** c). The Department also notes that the draft GABSRP states that stage 1 of the toolbox approach is basically complete for Doongmabulla springs. **Please confirm whether stage 1 of the toolbox approach is complete and ensure consistency between documents.** <u>Updates</u> **Please address previous action from V8.** a). Some references to the plan update do not specify when they will occur, whether approval is required, by whom, and contain ambiguous statements like "(should changes be relevant)". For example, the text describing the determination of trigger values (p 27) suggests that many details in the plan will often require updating, making it	<u>Phasing/staging</u> a). Table 2 showing description of project timing adds clarity around project phases/stages, and how these relate to GDEMP monitoring and implementation and the GDE toolbox. Each individual GDE section contains details around timing of impacts, and specifies when management actions will take place. b). Plan updated to demonstrate the pre-imapct monitoring and actions that will be undertaken prior to groundwater imapcts. c). Stage 1 terminology removed, Pre-impact studies proposed for the Doongmabulla Springs. <u>Updates</u> a). Section 10.3 adds detail when revision of the plan is required, and whether approval is needed. b). Figure removed, replaced by table in section 10.3 to show relationships with other management plans and programs	<u>Phasing/staging</u> a). Ensure the plan is specific as to when additional pre-impact data and triggers for each parameter (or variable) will be determined, taking into consideration seasonal and temporal variability and alignment with timeframes outlined in other plans. Please ensure that baseline information and triggers are determined prior to relevant impacts, especially for parameters that could be impacted by construction activities (e.g. surface water flows / flooding within the first year, as outlined in Table 6.2). Revise language, and have commitment, to determine pre-impact information, and revise conceptual model and relevant triggers within a defined timeframe and before any impacts for each GDE. b). Clarify the duration of the pre-impact phase. Table 2-1 suggests this is only two years. Does this mean the triggers etc. will be updated for approval after two years and then impact monitoring will commence before impacts occur? c). Confirm the need for significant groundwater changes to occur to complete stage 3 of the GDE toolbox. If pre-impact monitoring is complete after two years (see above), could the natural variations from year 2-20 (approx.) be enough to determine the EWRs and ecological response to groundwater change required under stage 3 of the toolbox? This would allow for hydrological-ecological relationships to be developed before the impact phase, and therefore improve confidence in the monitoring and management framework. d) Clarify that construction impacts occur during the 'pre-impact' phase, and update text accordingly (e.g. table 6-2). e) Please clarify what the 'first phase' of construction and operations (P80) means. f). Use consistent terminology. E.g. pre-development - does that cover pre-impact monitoring which also involves construction activities, or just baseline? <u>Updates</u> As further information will be updated/included at various stages, include a stand-alone schedule in the plan of further data to be collected (to what standard/method), further studies to be completed and subsequent reviews or revisions of the plan. This schedule should include timing and purpose, as well as the need for approval of each revision. At a minimum, this schedule should include

		a very fluid document. Revisions of the approved plan should be a significant, considered event. There are inconsistencies as to whether the updates to the GDEMP subsequent to updates of the model / GMMP will need to be reviewed, approved (pp67, 107); or not approved (pp9, 31, 70). **Please define a schedule of clear revision points. The requirement for these updates to be approved, and by whom, should also be clear at each use within the text.** b). Figure 4 shows interactions between elements of the GDEMP and interaction with the GABSRP. This is overly simplistic. It is unclear what the arrows represent and there is no mention of Mellaluka springs or the RFCRP. The links between the studies in this plan to determine these ecologically-relevant triggers and the GMMP need to be clear, and clear commitments made for update and approval. **Update Figure 4 to include the RFCRP, GMMP, Mellaluka framework and explain what information is transferring between elements.** c). We understand that the model, GMMP and GDEMP will be updated after 2 years and every 5 years thereafter. Adani commits that this will include a peer review. **Please revise any commitments about the review of the groundwater model to include expert review by a person/s of the Minister's / DES choosing.** **Please clarify the statement on P160 about submission for the Minister's approval within 3 months** – is this supposing the Minister's approval will be within 3 months, or submission within 3 months of stage completion?	c). This is not a requirement of the relevant condition. Clarity added in statement in Section 10.1 confirming it is 3 months from completion of the stage.	1. the collation of pre-impact monitoring data for each GDE before impacts, including construction where relevant, occur. [Will this be all at once, or different time for each GDE?] 2. inclusion/update of conceptual models. Also please confirm where conceptual models[1] are currently presented (see p84, 248), and ecological features map. 3. the revisions to triggers / actions / impact monitoring once pre-impact monitoring is complete, and conceptual models revised for each GDE. 4. regular reviews in line with the groundwater model / GMMP. 5. incorporation of research outcomes from the GABSRP/ RFCRP / other relevant research.
7	5. At least three months prior to commencement of mining operations, the approval holder must submit to the Minister for approval Matters of National Environmental Significance plan/s for the management of direct and indirect impacts of mining operations on MNES (MNESMP). *Note: If the MNESMP does not address any specific future activities (e.g. possible additional seismic surveys or specific mining stages) it should be*	The first draft of the plan was submitted in November 2016. Mining operations have not yet commenced.	Noted	The first draft of the plan was submitted in November 2016. Mining operations have not yet commenced.

[1] For development of conceptual models, we recommend Andersen M, Barron O, Bond N, Burrows R, Eberhard S, Emelyanova I, Fensham R, Froend R, Kennard M, Marsh N, Pettit N, Rossini R, Rutlidge R, Valdez D & Ward D, (2016) *Research to inform the assessment of ecohydrological responses to coal seam gas extraction and coal mining*, Department of the Environment and Energy, Commonwealth of Australia.

	updated in accordance with Condition 33.			
8	6. The MNESMP must incorporate the results of the groundwater flow model re-run (condition 23) where relevant, and be consistent with relevant recovery plans, threat abatement plans and approved conservation advices and must include:	a). It is unclear how the groundwater flow model re-run (under condition 23) has informed this plan, although it is stated to be consistent (P9). On which model scenario is the plan based? Did any predictions change? The groundwater model re-run could impact the surface water modelling and, as a result, comparison to EIS predictions in the plan (e.g. Table 7, P54) may not be appropriate. **Please clarify specifically how the plan has addressed the findings of the groundwater model re-run and what changes have been made as a result.** b). References are made to consistency with the GAB springs recovery plan (e.g. P8), but no evidence or justification of how the plan is consistent is provided. **Please explain how the plan is consistent with relevant recovery plans, threat abatement plans and approved conservation advices. This could be provided in a table.**	a). The plan is absed on the model scenario that was presented through the EIS, independently peer reviewed through the EIS, and used for the groundwater model re-run. This is the approved model scenario. The groundwater model re-run outcomes have been directly captured through the GMMP and hence GMMP triggers have been incorporated into this GDEMP in relation to relevant ecological triggers. b). Tables added in Section 1.3 and Section 10.3. Links to research plans and guidance provided in Section 1.4. Additional detail under the DS Chapter with regards to relevant recovery plan threats and how they are to be addressed.	a). Please clarify response in the plan itself. We understand that the model scenario in the EIS/SEIS differs from the 3 scenarios in the model re-run. We believe the SEIS scenario was selected, but this needs to be specified in the plan itself, to meet the approval condition. b). Ensure the plan contains current reference to the approved conservation advice for the Waxy Cabbage Palm (currently listed in the plan as DSEWPaC 2013c). • Approved Conservation Advice for Livistona lanuginosa (Waxy Cabbage Palm). Canberra: Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/64581-conservation-advice.pdf. In effect under the EPBC Act from 03-Jul-2008
9	a) a description of environmental values for each of the Matters of National Environmental Significance addressed in the plan	<u>MNES</u> a). **Please be clear and consistent about the requirements under the EPBC Act. Some species, or GDEs are not themselves a MNES because they are groundwater dependent, the MNES is 'water resources', which includes dependent ecosystems. Please also describe these MNES on P21 as per the full definitions in the conditions of approval.** b). The definition of the Carmichael River on P75 is confusing. It says the Carmichael is only formed 2km upstream of the site, but then refers to baseflow peaking 7km upstream of the project boundary. For clarity, our view is that the definition of Carmichael River as per the conditions includes the Dylingo Creek from outflow of the Joshua Spring. **Confirm WCP includes along the reach of the defined Carmichael River, plus populations at relevant spring groups.** c). Page 24 refers to other non-GAB springs that occur at the Doongmabulla spring-complex. Thereafter DSC seems to be referenced as GAB spring wetlands. Is Adani is under the impression that only GAB-sourced springs are protected? **Please clarify what is meant by reference to GAB spring wetlands. Under the water trigger, the full complex is protected, regardless of the source. For the avoidance of doubt, please update all references to refer only to DSC (do not shorten to GAB springs).** **Please update figures 12 to 16 to consistently outline each spring location, cross-reference between the spring groups (i.e. provide insets on figure 12 and name the group on figure 16).** d). Multiple references are made to GDEs within the project area. Is this to intentionally exclude some GDEs?	a). MNES are described in Section 3.2 consistent with the specific approval conditions. b). Definition of the Carmichael River on P.75 has been revised to be consistent with the rest of the GDEMP. Section 6 Waxy Cabbage Palm refers to that population from the DS downstream to the ML. c). References to GAB Springs have been clarified. Figures have been updated as requested d). All GDE descriptions checed for clarity against relevant conditions and requirements. Figures updated. e). Descriptions of these GDE's updated in the relevant chapters.	<u>All MNES</u> Environmental values should include key ecohydrological features of each MNES, including those that could be impacted by construction activities (as pre-impact data will be subject to construction impacts). We have included comments on what is known about the baseline condition of each MNES in this section describing the environmental values (a), where these comments were largely under (b) previously. We do note there is a current commitment to have a pre-impact survey during construction. This can still act as a pre-clearance survey, but does not meet approval condition to have triggers *based on baseline condition* included in this plan. <u>Description of Carmichael River MNES (Section 6)</u> Does the plan provide all available information on hydrological characteristics of the river, especially seasonality of baseflows and how that impacts GW interaction? For example, can you specify the areas of 'gaining and losing' both spatially and temporally, and description of key instream habitats like refugial waterholes (location, depth, persistence times - especially location of these refugial waterholes in 'known' areas of losing water, direct impact to persistence times)? Include a more detailed description of the complexity of hydrological interactions, demonstrating an understanding of how natural conditions and / or mining operations could impact GW drawdown and reduction in flows (especially baseflow), and how these will be included in the monitoring program. Specific comments: a) Has there been any studies on determining groundwater interaction using isotope analysis (refer to Burrows et al (2018))?

		The level of protection, and robustness of the management approach should be applied consistently, regardless of whether or not a GDE is in the project area. e). Section 8.3 Ecological values (page 118) states “A large number of bores have been historically drilled in the bioregion, which has resulted in a lowering of hydrological pressure across the GAB aquifer and aquifer drawdown, threatening the Doongmabulla spring-complex (GHD 2014).” The statement neglects the contemporary context of the GABSI program which has reduced decline in hydrostatic artesian pressure and affected aquifer pressure recovery in some regions, which may include the Galilee Basin. **Please revise to present an accurate description of the current status of the GAB in relation to the Doongmabulla spring-complex.** **Please update the description of the Mellaluka springs in relation to the north-south alignment of the springs (P150). Please also update based on the finding that the springs do not support BTF habitat.**		b). Section 6.1.1. What is a typical ‘dry’ season and ‘wet’ season? (i.e. is the wet season typically from Dec to Feb?). c). Section 6.2. Confirm over what time period baseflow was modelled (e.g. Over 100 years). Is there any baseline monitoring data which can assist in determining actual, rather than modelled, baseflow? d). Section 6.3. If flow monitoring was undertaken until 2014, where is this data presented? Further baseline data would be particularly useful in regards to seasonality. The figure 6-5 is useful – can the period be extended / other time periods added? e). P44. Include a commitment to include any updates in the REMP into this plan to reflect the EVs of the river. f). Table 6-1. Where were WQ samples taken – upstream, impact zone, downstream to Belyando? Over how many years? Is it described in detail in another report? If the water is very turbid during the wet season (6.3.2), how does this correspond to what is presented in Table 6-1? It might be clearer if WQ attributes in Table 6-1 are separated out for wet and dry seasons – especially if MAW discharge will only occur during periods of flow. g). Section 6.3.2. Specify within text how often losing/gaining parts of the river cease to flow, any differences between dry or wet season. h). Sections 6.3.3 and 6.3.4. Describe what is known about all ecological communities dependent on this system. If these details are not yet known, update the monitoring program to address these attributes, including but not limited to: macroinvertebrates assemblages within surface water including % composition of functional groups that are not aerial dispersers, (i.e. group that would be impacted by drawdown, baseline assemblage structure based on 2 years of ‘wet’ and ‘dry’ season sampling); stygofauna within the hyporheic zone; fish guilds and their ecohydrological requirements that arelikely to be impacted by dewatering; characterisation and condition of riparian vegetation and habitat along the entire reach (noting hydrological requirements of floodplain riparian vegetation like River Red Gum). i) p53. Where is critical refugia within the Carmichael River from DSC to Belyando crossing, especially in relation to the 15km modelled to be impacted by dewatering? j) How deep is the alluvium? Is it consistent along the Carmichael River reach, from DSC to confluence with Belyando? k) P64. The riparian zone is defined as 10m either side of the river. The riparian zone is not limited to a specific distance under the approval and the entire zone should be considered a MNES. <u>Description of Waxy Cabbage Palm MNES (Section 7)</u> Can the key areas be shown on a map, particularly with reference to ‘gaining’ and ‘losing’ areas within the Carmichael River reach? Are you able to include any details of WCP downstream of the mining lease boundary (east of the operations)? Are you able to outline the extent of WCP habitat, similar to what is outlined for the offsets area (Figure 7-8), and extend this to cover all WCP records in relation to Regional Ecosystems listed in Table 7-2?

				Does the text on P119 mean that the source could not be the alluvium? What surveys will be done to confirm this? When? Specific comments: a). Section 7.2. Refer to comments on determining the baseline conditions to 'gaining' and 'losing' areas within the Carmichael River reach. Also, in this section, can you clarify what 'the water table is on average 0.5 m above the bed of the river channel' means in relation to surface water / groundwater? Does this mean that the surface water level, above the river bed, is typically 0.5m? Where is this true? Along the whole reach / year-round? Is it based on monitoring, or modelled data? b). P111. Paragraph on baseflow fluctuations is confusing and not substantiated by evidence. Which sections of the Carmichael River have periods of 'zero' baseflow? Do you have evidence from drought periods of no flows? Is this baseflow from the alluvium, or DSC? c). P111. Noting that population structure (life form stages) is a key indicator in monitoring, consider outlining that adult palms comprise of non-producing and reproducing adults. Also outline which of the 12% proportion of adults are reproducing across the entire southern population, and if this proportion is similar across each population (e.g. what is the proportion of adults is in the DSC)? d). P111. Is the habitat for the population upstream of the confluence of Carmichael River and Cabbage Tree Creek the same for other populations downstream of this confluence? e).Section 7.3. Is there a complete list, and locality, of WCP within this southern population provided in this Plan? f). Table 7.4. Could this include numbers, age class and locality of WCP in each key area, especially for areas with potential impact (Key areas 4-5)? This table is also missing details on WCP downstream of the mining lease boundary. g). Figures 7-5 a-d. We assume that these figures show all 'known' palms that were recorded before 2016. Do you assume that there will still be 831 palms in 2019, comprising of ~12% adults? <u>Description of Doongmabulla springs-complex MNES (Section 8)</u> Can you confirm when the last comprehensive survey of the springs, including targeted searches for endemic species, was undertaken? Did it include a survey that covered all 187 vents, which is mentioned under Section 8.1 (refer to Fensham et al 2016)? Please include all available baseline, including from other studies (bioregional assessments, Fensham et al 2016). For example, Fensham et al 2016 notes that some springs contain disjunct populations of plant species (e.g. *Cenchrus purpurascens* and *Utricularia caerulea* at Edgbaston and Doongmabulla, providing background on environmental values). Ensure that the description of the complex incorporates all 187 vents / describes that vents appear / disappear over time (see remote sensing for DSC in bioregional assessment for the Galilee, <u>product 3-4</u>, which maps wet/greenness over time – some mapped vents do not stay 'wet', whilst other unmapped areas appear to stay 'wet' for the ~30 year period). Description can also include 'known' springs and features:

					- Joshua Spring and House springs converge to start Carmichael River (as defined in conditions) - Bonanza, Keelback, Geschlichen (on a shallow side gully to the south), Bush Pig Trap and Camaldulensis springs - are not mounded, but also occur in flat areas remote from outcrop, and are also most certainly discharge springs with vertical conduits. The plan only refers to Geschlichen in monitoring (spring wetland water level), but is not described. - The eastern springs (Little Moses, Yukunna Kumoo, Dusk and Surprise Spring) have vents on the edge of wetlands at the base of gently sloping topography suggesting lateral discharge, a feature typical of outcrop springs. - There are some scalded areas around the House Springs and Camp Springs, but *Trianthema* sp. (Coorabulka R.W. Purdie 1404) is the only scald endemic occurring in these areas. - The flat topography, mounded vents and absence of outcrop at the western springs (House, Mouldy Crumpet, Stepping Stone) is strongly suggestive of a vertical conduit through a confining bed typical of discharge springs. The summary of hydrological baseline (Section 8.3) should link clearly to relevant sections of the GMMP where baseline for the springs hydrological characteristics is described. - Ensure that the GMMP includes all available groundwater level / spring flow / quality data. - Key findings (P173) are vague regarding water level data (i.e. 'generally', 'is likely'). All levels referred back to only one bore (C18002SP). - Water quality data (P174-5) needs explaining that table 8-2 is across site, not just DSC. Some interpretation about what potential source may be based on this data, and how reliable it is stand-alone (vs. use across multiple lines of evidence) could also be included. Why isn't Moolayember EC results included in Table 8.2 (listed as 572 in Nov 2018 report)? Has there been any readings after major rainfall (about 6 months later)? This would impact the EC results. Specific comments a). Expand the description for the 187 vents, including accurate description of groups (see examples above). i). Does Moses groups have exactly 65 mounds / non-mound springs? What are the relative % of these types across the group? ii). How many springs in the Little Moses group? iii). Remaining vents, like the large Yukunna Kumoo Spring, and then a cluster of small springs known as the Dusk Springs, is located in the northern part of the Carmichael and does not seem to have been described. In particular, the Yukanna Kumoo Spring supports WCP.

				b). Some springs are not described, but are included in monitoring. Figure 8-5 – Geschlichen is listed in the figure, but never mentioned in main body of plan. Is there a reason for this? c). Link endemic species associated with specific habitat conditions, such as spring water chemistry, water temp, spring –head. These conditions could be critical for their survival. d). Camaldulensis spring is listed in Table 8-1 (comments against Bore C 18011 SP), but not outlined in figures for water level data nor included in the monitoring program. Is there a reason for its exclusion? e). Section 8.2.2 Flora from DSC – Include all spring endemics that have been recorded at DSC, considering there hasn't been a flora survey since 2013 (as outlined on p180). (e.g. *Utricularia fenshamii* and *Fimbristylis blakei* recorded by Fensham et al (2016), but not mentioned in this plan). f). Section 8.2.2. What spring groups are Salt pipewort and Blue devil associated with? Is there a reason for not describing this? (see comments on Figure 8-4 below) g). Please clarify what is known about each of the identified 187 vents, including their vent elevation. Vent elevation is critical for determining how any dewatering impacts will translate into ecological changes. h). Section 8.2.4. Has there been any targeted surveys to confirm status and use of habitat values, especially aquatic fauna which could be impacted by dewatering (i.e. macroinvertebrates, fish, frogs)? i). Include relevant information on figure 8-4 that is similar to 8-5 and 8-6) (e.g. outlines / points for spring wetlands and vents), to show at which springs the species are located. For example, it looks like Blue devil specimens have been recorded around the Moses spring wetland, and Salt pipewort with Mouldy crumpet spring (when compared with other figures). Is there a reason for not describing this species as being associated with the Moses spring group? <u>Description of Mellaluka springs-complex MNES</u> The description of MSC is much less detailed than other MNES. Is there anything else known about the condition and extent of key ecological features for MSC? The summary of hydrological baseline (9.4) should link clearly to relevant sections of the GMMP where a baseline for the springs hydrological characteristics is described. Ensure that the GMMP includes <u>all</u> available groundwater level / spring flow / quality data. Are any studies planned in the near future to determine the source of the springs? Will this be determined before the review of the model at year two? How does the statement on P237 that no endemic flora are thought to occur at Mellaluka coincide with the unidentified daisy that has only been found and MSC and DSC?
10	b) details of baseline and impact monitoring measures to be implemented for each of the Matters of	<u>Baseline monitoring</u> a). Condition 6.b) requires that details of baseline be included in the plan. There are multiple references in the Plan to an intention to commence or	<u>Baseline monitoring</u> a). Text has been added to Section 5.1 on the general approach which	<u>Baseline monitoring (also referenced as *pre-impact* in the plan)</u> Provide all baseline data available (as per comments against description of environmental values above).

	National Environmental Significance including control and impact sites to be monitored throughout the life of the project. The monitoring must provide sufficient data to quantify likely impacts resulting from mining operations, including subsidence and changes in groundwater levels, to set habitat management goals (Conditions 6e) and 6f))	progress baseline studies after approval of the plan (i.e. throughout stage 1). The Plan is unclear as to when baselines will be determined. The adequacy of goals, triggers, management measures and corrective actions cannot be appropriately assessed without a complete baseline. **Please provide all available baseline studies and determinations in the plan. The pre-impact dataset must account for temporal variations. This is particularly relevant for DSC, which is noted in the plan to vary over years / decades, rather than seasons.** b). The plan then refers to stage 2 as building an 'extended' baseline. It is unclear what is meant by this term. Stage 1 either produces an appropriate baseline, or it does not. Results from baseline surveys will be used to update conceptual models for GDEs. **Please include the resulting conceptual models within the plan in its next revision.** A clear, shared understanding of these conceptual models is crucial to understanding the monitoring and management approaches outlined in the plan. For information in relation to conceptual modelling, we recommend this 2015 report[2] Impact monitoring a). Using WCP as an example: Monitoring measures (e.g. table 7) are included in "mitigation and management measures" and are not capable of detecting triggers. Text in 6.8 regarding monitoring is vague, confusing and inadequate. It confuses baseline determination (which must be provided in the plan to be approved) with monitoring. The boundaries between 'stages' are unclear. Few commitments are timebound or precise. Table 8 sets out a monitoring program for WCP. However, the triggers to which the monitoring in Table 8 relates are different and largely unrelated to the triggers in Table 7, which are linked to the corrective actions. **Please provide in Table 7 (or equivalent) a separate column for monitoring or otherwise reconcile Tables 7 and 8 (or equivalent) and ensure appropriate clear, timely monitoring capable of detecting each trigger in Table 7 are provided.** **Please provide details of how the proposed frequency and time-of-year of monitoring will be adequate to detect change, track the success of mitigation/management measures, enable triggers to be timely (e.g. to enable effective corrective actions) and document actual loss of protected matters.** **Please clearly identify in the plan (including in maps) the location of control and impact sites for each GDE where impacts will be monitored, to meet this condition. Where 'control' sites are not possible, e.g. for the springs, some the use of a reference spring may be appropriate.** **Please include monitoring measures to enable detection of triggers, and specify the details, timing and frequency of monitoring.**	explains the baseline work that has taken place to date. Table 2 in Section 2.2 also provides a summary of project staging. b). Stage 2, now called pre-impact will provide for the collection of pre-impact information) to supplement baseline information. Used to inform and if required revise interim trigger values, based on extensive additional data from pre-impact period. Impact monitoring a). Impact tables in GDE subsections have been restructured completely to provide management actions, triggers and corrective actions clearly linked to potential impacts. The request to include control sites for these impacted systems is not possible. There are no relevant control sites associated with these specific GDE's where impact from the project is not presented and all otehre variables are adequately controlled to provide a statistically reliable "control".	Also include text in the plan against the requirements for control/monitoring sites for pre-impact and impact monitoring, with justification if they are not provided for. a). Where a baseline is incomplete, provide details of how the proposed methods/standards, frequency and time-of-year of pre-impact monitoring will be adequate to complete a baseline dataset before impacts occur. b). Section 5.5.4 states that alternative pre-impact monitoring may be considered. Can you outline how and who will determine the discontinuing of the collection of these variables and the consideration of others? Also clarify when this will be undertaken? We assume it will be undertaken prior to construction. Please revise this text to include a commitment for review / approval if pre-impact monitoring changes once this GDEMP is approved. c). Section 5.5.2 links monitoring attributes to triggers listed under 5.3. Section 5 could be reordered so attributes are mentioned first and triggers are listed after, as they should be based on attributes. d). Suggest that details of REMP, GMMP (where referenced in monitoring/mgmt. tables) are described in section 5 so the plan can be read stand alone. e). Update Table 5-1. Ecological features map / monitoring transects / surveys are not attributes. Perhaps list the methods / programs to collect information on the attributes in a separate column? This could then also list the GMMP, REMP as per d) above. f). Section 5.5.4 – there is a commitment to collect information on all variables listed in the GDEMP during pre-impact monitoring. To ensure commitments are met, can you outline what these variables are? Do you mean the attributes in table 5-1? g). Section 5.5.4. What are the pre-impact studies and how are they different to studies to determine reliance on groundwater (assumedly also under this plan) and research in other plans? Are the pre-impact studies the same as those listed in section 10.1.1? Are they currently being done? Pre-impact studies should be completed before impact, which would mean pre-construction for some studies. h). Clarify, for both baseline and impact monitoring, what meteorological monitoring will be undertaken – parameters such as rainfall, evapotranspiration, will be important for determining water balance (and therefore groundwater use) by GDEs. i). Please clarify, for both baseline and impact monitoring, that surface water quantity means both flow (during flow periods in the river) and water level (during no flow periods in the river / standing water bodies like wetlands) and update throughout the document. j) In sections 6.6.1 and 6.6.2,and equivalents for other MNES like the management tables, please maintain each subsection to that described (e.g. P84 monitoring of riparian condition should just consider condition, other indicators such as groundwater level, which should be considered under groundwater levels and surface water flow). Please also make sure these

[2] 'Commonwealth of Australia 2015, Modelling water-related ecological responses to coal seam gas extraction and coal mining, prepared by Auricht Projects and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) for the Department of the Environment, Commonwealth of Australia'.

		The same approach needs to be completed for all four GDEs. b). Impact monitoring described on P157 focuses solely on ecological characteristics. **Groundwater and surface water monitoring should be included as important approaches (as per condition g, but also as these provide an early warning).** <u>Carmichael River</u> a). **Please discuss monitoring in section 5 for the triggers defined in sections 6-10, and specify how frequently they will be reviewed (5.3.4). Please ensure that baseline and impact monitoring for early-warning triggers is also included in the plan.** **Please ensure that baseline and impact monitoring extends along the full reach of the Carmichael as defined in the conditions of approval, as well as 'control' sites upstream and downstream.** **Please define the goals, triggers, mitigation/management and corrective actions for the Carmichael River and Mellaluka springs within the plan and consider the timing of impacts to allow for the application of offsets ahead of impacts occuring.** b). P28 explains stygofauna are present in the alluvial aquifer of the Carmichael River. **Please undertake and provide details of a baseline survey for stygofauna, particularly in the alluvium, to provide evidence to support or revise the assertions that stygofauna are not present / not likely to be impacted. Please also clarify where existing records were found in relation to the 800m reach where impacts are likely to be greatest.** c). P75 refers to streamflow being strongly seasonal, but then includes average baseflow at one point upstream in the same sentence. This does not seem to support the claim of seasonal variability. **Please provide within the plan, adequate baseline data for streamflow, gaining/losing nature, including baseflow contribution from groundwater and springs along the length of the river. This baseline data should incorporate seasonal and temporal variability and be used to set triggers.** d). The ecological features map (see P101) is needed upfront to assess the adequacy of baseline and impact monitoring. **Please include the ecological features map as part of the next revision to the plan.** e). Gaining/losing sections of the river will be identified by mini-piezometers (P102). **Please specify where these piezometers will be installed, when and for what period, how frequently data is collected, how accurate they are.** **Additional hydrological monitoring for the river could include outflow from Joshua spring, pool persistence, riffle habitat, baseflow index, and geomorphological indicators.**	<u>Carmichael River</u> a). Updating monitoring details provided including linkages to the REMP under the Environmental Authority. b). There are no Type 1 GDEs in the project areas, which are most conducive to the presence of stygofauna. While stygofauna may be present in the alluvial aquifer of the Carmichael River, the predicted groundwater drawdown along the Carmichael River is generally <0.2 m, except in two sections of the river closest to the mine approximately 800 m in length. A one off monitoring of stygofauna communities has been proposed to close off this matter. c). Stream flow information and impacts now included d). Baseline updated including ecological triggers. e). This is a GMMP activity included in the GDEMP for reference. Relevant aquifer trigegrs are included so this further details is not needed in the GDEMP.	indicators (with the same terminology) are reflected into table 6-9 (or equivalent). <u>Baseline and Impact monitoring</u> comments are made against each MNES. <u>Monitoring of Carmichael River MNES</u> a). Section 6.6 references multiple indicators of spring wetland extent, threatened/endemic populations, spring head pressure and wetland vegetation. Is the intent to monitor attributes of riparian wetlands? Or are these errors, related to DSC? b). Clarify on P80 that the surveys of permanent upstream waterholes are upstream of the Carmichael as defined under the EPBC approval (i.e. upstream of Dylingo creek). c). P78 states that a detailed ecological features map will be prepared. When is this? Will it be pre-impact, including pre-construction? d). How will the monitoring program target key ecohydrological features (see above), and relevant parameters for monitoring measures once the map is prepared? e). The bores in figure 6-9 don't seem to show much groundwater change. Consider additional bores in the alluvium within the indirect impact zone to the eastern half of the mine site. f). Clarify on P80 (and elsewhere as needed) that a complete surface water flow dataset will be collected prior to construction. Monitoring during the first phase could be subject to reductions in catchment area / clearing of catchment vegetation. g). Table 6-7 lists approx. 15 bores. Six are used for triggers on P84. Clarify why there are not groundwater triggers defined for the other bores listed. h). The text about review of the GMMP on P84 seems out of place in the impact monitoring section. i). What is meant by the rehabilitated riparian zone (p85)? Is this the zone that will be cleared for the haul road? If the buffer is so large, it seems unlikely. What rehabilitation will be undertaken? Where? When? These actions should be included in the management tables. j). Table 6-9 - Indicators should reflect those in previous sections (e.g. groundwater level and groundwater quality , not groundwater monitoring). - Clarify 'ideally' where groundwater sites will coincide with population monitoring. What factors could mean they don't? Who will be notified? - What does 'descriptive' comparison mean for each analysis? Where data is quantitative, there should be little reason for description. - Clarify that monitoring of surface water flow is daily (right column), not monthly (central column). - What is the justification for surface water flow trigger at the 80th percentile? - Add surface water quality.

		As per previous IESC advice, baseline and impact monitoring should allow for the identification of individual species' EWRs and tolerances to predicted changes in flow regimes <u>Waxy Cabbage Palm</u> a). Table 6 identifies dieback in overcanopy as an early warning of impact to the palms. **Please include regular monitoring of canopy condition in WCP habitat as a monitoring activity and signs of dieback as an early warning trigger.** **Please include triggers related to flooding/inundation greater than predicted.** **Please commit to monitor *Livistona* populations for condition, weeds and pests so that triggers and corrective actions can be implemented to increase resilience against drawdown impacts.** **Please consider monitoring *Livistona* populations at the same locations as monitoring bores so that correlation of condition and drawdown can be tested.**	<u>Waxy Cabbage Palm</u> a). Monitoring of condition of Waxy Cabbage Palm habitat is proposed in Section 6, including evidence of dieback. Weed and pest monitoring is proposed. Detail on flooding included.	<u>Monitoring of Waxy Cabbage Palm MNES</u> a). Can you provide indicative habitat quality monitoring points, similar to what has been outlined for the offsets area (Figure 7-8)? Is there any monitoring proposed downstream of the mine site? b). P133. Can you include a clear commitment to tag and monitor all sub-adults prior to construction, including a pre-clearance survey in the impact area? First sentence states 'The location of all mature individuals will be recorded using differential GPS, photographed and mapped'. Another sentence states 'During the pre-impact population survey, each individual within each transect will be marked using a differential GPS, and older life forms (sub-adult and older) will be permanently tagged'. c). One control site is planned at MDW (P133), where drawdown is "minimal". Explain what monitoring is in place to confirm that drawdown will not influence the control site. This monitoring should also consider any changes in flows in the River downstream of DSC (see comments regarding Figure 7-9). d). Update P134 where surface water monitoring will be carried out monthly. Is this water quality? Elsewhere you have stated that flow is monitored daily. e). Table 6-7 lists approx. 15 bores along the Carmichael River. P139 only lists 6 alluvium bores that will used for triggers. Yet only 4 alluvium bores outlined on Figure 7-9 as being used for monitoring. Clarify why there are not groundwater triggers defined for the other bores listed. Also changes to hydrology from stream diversions and flood levees have been identified as potential indirect impact for WCP. Is there a reason there are no surface watering monitoring sites outlined for WCP? f). Please revise the text on the bottom of P135 so it is clear that groundwater monitoring will (definitely) occur, and sites will be matched to population monitoring sites (if possible). g). Table 7-5 - Indicators should reflect those in previous sections (e.g. groundwater level and groundwater quality, not groundwater monitoring). - Clarify that monitoring of surface water flow is continuous (central column), not monthly (previous text). - What is the justification for surface water flow trigger at the 80th percentile? - Add surface water quality. - Align terminology of life stages for monitoring with Table 7-1. - Triggers for monitoring weeds should be outlined in the plan, especially for specific species, like WoNS. h). Figure 7-9. Consider use of the term 'Waxy Cabbage Palm' instead of Livistona lanuginosa (which is used in previous Figures). No monitoring bores near WCP downstream of lease, although C14027SP / C14028SP have been associated with WCP in Table 4-1 and triggers. Is there a reason for exclusion? What is the reason for inclusion of C029P2, which is associated with tertiary

		Springs 1. Remotely sensed data sourced from the available 30-year Landsat archive provided by Digital Earth Australia has been used to track "greenness" over time. **Please supplement the proposed quarterly photo monitoring with the use of satellite imagery. If remote sensing is used, it should be applicable across the landscape and therefore need not be limited to particular spring vents (see table 16).** These results showed that some mapped spring vents were not consistently 'wet', whilst there were unmapped features that were green/wet. **Please consider use of satellite imagery to identify and monitor previously unmapped vents.** 2. Monitoring of springs flow / hydraulic head, along with pressures in potential source aquifers would help to determine baseline relationships ahead of impact. **Please commit to ongoing monitoring of flow and/or hydraulic head of springs and publication of results.** **3. Please include reference sites for springs to be used as 'control' sites to meet the requirements of this condition.**	Springs 1). Updated with regards to use of satellite imagery. 2). More detail included, though note that the flow from springs particularly Joshua is highly impacted to the landholder and cannot be a reliable measure. 3). As per above, given the predicted model impacts to the DSC, it is not feaible or possible to co-located a control site for these GDE's. Adani submits that the condition wording applies across all MNES under the approval. Adani has included controls sites in MNESMP's where this is possible to do so, for example - identical habitat for threatened species. Due to the nature of predicted impacts on these GDE's, locating control sites would not be statistically or practically beneficial.	sediments for Mellaluka spring-complex in Table 4-1? Is this the potential alternative source for the WCP mentioned elsewhere? Springs Remote sensing is not described in the monitoring regime for wetland extent, or identifying unmapped vents.
11	*As above*	Doongmabulla a). **Please explain what baseline and impact monitoring will be undertaken to be able to assess performance criteria, early-warning triggers and triggers, to ensure the drawdown limit is not exceeded. These should include all possible sources for the springs until research is complete.** Baseline studies are proposed quarterly for one year. The text interchangeably includes or excludes Joshua spring in this baseline. **Please explain how one year of baseline data (4 times) is adequate for baseline, given the stated changes in GAB springs over years or decades.** **Please include all spring groups in this monitoring and justify the locations within these groups (are these the most responsive?) and link references to individual vents / wetlands within text to maps showing their location.** **Please include the baseline data in the plan and ensure consistency with the GABSRP, which states that most of the baseline studies for DSC are complete.** b). The plan links drawdown impacts to the GAB. This ignores the potential for heterogeneity in the DSC, including sources below the Rewan. **Please explain (or reference) what studies are underway to confirm the source of the springs as part of baseline monitoring, such as:**	Doongmabulla a). This has been addressed in the updated DSC chapter in regards to ecological triggers. Groundwater trigegrs are presented in Appendix B and linked to ecological triggers. Please note that GDEMP is not the plan to undertake GW monitoring and assess groundwater related triggers. b). These are issues required to be addressed through the GABSRP, not the GDEMP. Nevertheless, more content has been inserted in Sections 8.3 and 8.4. c). Figures 20a-c have been updated	Monitoring of Doongmabulla springs-complex MNES The complex includes 187 vents forming 160 separate wetlands. How is the proposed monitoring (4 wetlands and 10 mounds at Moses, 1 wetland at Little Moses, Joshua) appropriate to address each of these known vents, particularly variation (and new vents appearing) over time? Do you know / when will you assess the elevation of each spring vent? The explanation (P197) would be further supported by comparison of impacts at each of the vents, such that there was a distribution in likelihood of hydrological change / monitoring of vents with the least spring head pressure (and therefore most susceptible to impact). Wetland surveys – clarify what the following sentence means '*Pre-impact monitored seasonally for two years, then seasonally until Baseline & pre-impact is established, annually thereafter*.' Should it be baseline first, then pre-impact? What is seasonal (biannual or quarterly)? Wetland vegetation monitoring – consider including particular species as an indicator. Threatened and endemic flora populations – consider including the condition of the species as an indicator. Aquatic invertebrate sampling? How did you choose the subset of springs to sample? Also do these monitoring sites cover areas where *Gabbia rotunda* (a mollusc) and *Mamersella* sp. have previously been recorded?

		a. drilling of new monitoring bores in the vicinity of the springs **b. geophysical/ seismic surveys** **c. a high-resolution survey of spring elevations to also improve the accuracy of predictions relating to spring flows and the aquifer pressures (see row 10)** **d. geochemical / isotopic sampling.** c). Figures 20a-c are illegible. **Please update.** Mellaluka a). As Mellaluka Springs is protected under the EPBC Act and its source has not yet been determined, adequate investigation, monitoring and early warning triggers are required. **Please apply the full GDE Toolbox approach (p26).** **Please complete baseline studies (stage 1, 2 and 3) for the Mellaluka Springs complex and include details of the existing baseline. This should include similar approaches to the DSC (i.e. quarterly surveys, rather than seasonal) and discussion of what further studies will be undertaken for the unidentified daisy found here and at the DSC.** **Please remove any references within the plan to actions for 'selected' GDEs (i.e. excluding Mellaluka).** **Please provide details commensurate with the protection of Mellaluka Springs under the EPBC 'water trigger', specify triggers that will provide early warning and enable prevention of impacts of this and specify monitoring that will detect triggers, should they arise.** **Please define the goals, triggers, mitigation/management and corrective actions for the Carmichael River and Mellaluka springs within the plan and consider the timing of impacts to allow for the application of offsets ahead of impacts occuring.**	Mellaluka a). The groundwater source of Mellauka Springs is noted as a MNES. Ecological suveys have not determined that the Mellaluka Sprigns is ecologically significant with respect to MNES. Furtehr clarification provided in regards to pre-impact monitoring timing for MS noting that activities south of the Carmichael River (and hence activities that are predicted to impact MS) are not scheduled to commence until year 10 of operations. Groundwater triggers for MS aquifers are included. A commitment to the review and application of offsets is included and will be informed by pre-imapct monitoring, revised groundwater modelling and other studies well ebfore any relevant impacting activities commence.	Weed and pest surveys – where will they occur? At every vent? Surface water monitoring – what water quality parameters are being assessed and in situ only, or are they the parameters listed in Table 8-8? If you are measuring flow rates as well, include as an indicator. Remote sensing does not seem to feature in the monitoring design (e.g. 8.7.1). Update 8.7.4 with the monitoring program in GMMP, which must include early-warning in other units. Also monitoring frequency does not match what is outlined in 8.7.3 (every 12 hours for GW level or bi-monthly?). Clarify what monitoring will be done in the GMMP vs. GDEMP vs. GABSRP vs. RFCRP – reference to studies that 'may' occur (P203) are not adequate, or bores that the GMMP 'recommends' (P204). Mellaluka Springs On what page is this commitment to review mentioned in your response? It needs to be very clear to commit to survey, to ensure adequate pre-impact data is obtained, including confirming the source of the springs within a designated timeframe so as to inform adequate pre-impact monitoring. As such, it should further commit to revise sampling parameters after revising conceptual understanding of SW/GW interactions for the MSC. Do you know / when you will assess the elevation of each spring vent? Remote sensing does not seem to feature in the monitoring design. What pre-impact surface water monitoring is proposed at the complex (P238)? What parameters, in which locations? Given the uncertainty around the springs source, it would be beneficial to stipulate in the GDEMP which aquifers will be monitored under the GMMP as part of the pre-impact monitoring on P238 and analysis of spring-head pressure on P237.
12	c) details of potential impacts, including area of impact, on each of the Matters of National Environmental Significance from mining operations, including impacts from: (i) vegetation clearing (ii) subsidence from underground mining,	Dewatering impacts a). The extent and severity of predicted impacts is described in words but without accompanying mapping is ambiguous. **Please provide a map or maps showing the predicted extent and severity of drawdown to water resources most relevant to GDEs over time – particularly the river, alluvium and their vicinity, and ensure that features including the springs are located on the map(s).** b). P119 states that drawdown impacts do not commence until 2020. If this is true, it is unclear why consistent references are instead made to 2035 within the plan as the start of impacts.	Dewatering impacts a). Mapping provide under each GDE to show dewatering impacts b). Timing updated throughout	General comments on impacts: a). Quantify in the management tables, especially where the goal is to not exceed approved impacts, what the approved impacts are. This should include areas for defined direct/indirect impact zones, but also the extent and nature of impacts beyond these areas, so that any impacts beyond those approved can be addressed/offset. b). Ensure the years selected in the drawdown figures (6-9 (or equivalent) show pre-mining (baseline; yr. 0), start of impact (yr. 15-20), maximum impact, and post mining. Terminology on these figures also needs to be revised and in line with the rest of the plan – does pre-mining mean pre-impact or pre-construction or pre-operations?

	including subsidence induced fracturing and any changes to groundwater or surface water flow (iii) mine dewatering (iv) earthworks (v) noise and vibration (vi) emissions (including dust) (vii) light spill and other visual impacts (viii) stream diversion and flood levees (ix)weeds and pests.	**Please confirm this is true for all GDEs and rewrite the year based on # years after commencement. Please explain within text the difference between dewatering, drawdown and reduction in aquifer pressure, and the times for each, in relation to all possible source aquifers for each GDE.** This will also assist in phasing / staging the plan (see above). <u>Carmichael River</u> a). **Please specify and clearly map in the plan the combined effect of predicted impacts along the length of the River over time. This should include loss of baseflow from DSC, loss of baseflow to the river / alluvium, loss of catchment area, construction of the haul road, loss of runoff due to subsidence, discharges. Maps should clearly show the 800m reach most severely impacted, spring, gauging and proposed discharge locations, project boundaries and key confluences.** This is necessary to assess the adequacy of proposed monitoring locations. **Please clarify when construction of the haul road will occur.** b). P76 states that impacts will be 'minimal' in the western half of the project area and the riparian communities likely to tolerate predicted changes. **Please clarify what is meant by 'minimal', map this western half of the project area and provide justification for the communities' tolerance of these impacts.** c). Table 9 states various impacts, e.g. loss of up to 7% of baseline groundwater inputs to the River. **Please clarify how this relates to other impacts predicted in this table of predicted loss in baseflow** d). Table 9 also includes use of surface water for construction activities. Elsewhere, the lack of surface water extraction from the Carmichael is described as a mitigation measure. **Please clarify if any water will be extracted from the Carmichael River, at what time, what volume / rate / under which conditions and for what purpose.** **Please clarify the nature of each impact in table 9 and use specific terms to describe impacts (e.g. average, peak, along what reach of the river and what time period).**	<u>Carmichael River</u> a). Updated mapping included b). Updated baseline description based on approved project impacts and studies. c). Impacts across GW aquifers included in Section 6.4 d). There is no surface water extraction from the CR for construction or any other activity.	<u>Details of potential impacts of Carmichael River MNES</u> Which map shows the 800m reach? Impacts need to be clearly defined, ideally qualitatively, so that offsets can be provided if they are exceeded. Are you able to quantify what the changes to surface and groundwater flows into the Carmichael River are likely to be (a) under different seasonal conditions (low to no flow periods to flooding), (b) from pre-development conditions to impact to post-closure, and (c) upstream of mining operations, within mining operations footprint and downstream of mining operations (down to Belyando crossing)? If not now, is this something that can be updated before construction / after the model review at year 2 and can be committed to in this plan? E.g. will 27% reduction be for low flow conditions only (p51)? Will the reduction of baseflows be consistently up to 33% for the entire operational phase, within the mining footprint? Can you confirm that predicted impacts (0.19m) of drawdown at Joshua will not affect outflow, and therefore that no changes to baseflow from DSC are predicted? Are you able to clarify what the impact and potential loss of large trees (P80) within the Riparian zone means, including area of impact? This information also fits under #5 for habitat loss. Is this related to potential impact from GW drawdown or is the accidental removal during construction (p71)? How much, and where, will there be temporary loss of habitat if construction vehicles require access to the river? How will you manage access, and minimise impact, if required? Revise management table accordingly. Please use careful language when stating that vegetation will not be cleared within the buffer zone (P72, 73) given there are known areas over the haul road where vegetation will be cleared. Please also clarify those impacts already described - How close the 'vicinity' of the eastern mine boundary is for an increase in periods of no flows. - Specify what the difference for these no flow periods is within the CCM and upstream. - Outline where loss of 16,664 ha of the catchment (33% reduction in surface water discharged into the Carmichael River) will be. - As per (c) previously, what does the loss of groundwater flows into the river by up to 5% on P52 mean? When is this? Over what reach of the river? How does it relate to the predicted changes in flow/baseflow? - What does a reduction of 60% of the baseflow mean to the Carmichael River reach, downstream of the project? Has there been consideration of multiple hydrological changes (e.g. GW drawdown and reduction in overbank flows, in conjunction, which can

				increase likelihood and extent of impacts)? How will monitoring separate these impacts? The figures 6-9a-d do not seem to show the predicted 1-4m of drawdown. Where are the location of gauging stations on these figures? Suggest quick reference back to table 4.1. Better distinguish between #3 and #4 when discussing impacts – surface water (hydrology) changes seem to be confused with water quality changes (e.g. P70. The intro and first dot point under heading #4 seem to be related to hydraulics, not water quality). Section 6.4. Clarify under #2 (third para) that subsidence beneath catchment areas feeding into the Carmichael River is also addressed in #1 and #3. Section 6.4. Clarify under #3 what is meant by 'disconnection of the floodplain'. How will this occur? Where? What are the likely resultant impacts to floodplain flora and fauna? Section 6.4. Clarify under #3 what the quality and flow requirements of the river (P63) are. Assume these can be referenced to the REMP. Quality release limits are specified above, but not flow? What is continuous monitoring frequency for WQ (table 6-5) - every second, hour, day? Consider changing commitment to review turbidity release limits when sufficient monitoring data is available. Revise terminology on P53 that the loss of refugia will result in localised extinction of aquatic fauna, like fish, residing in these pools. Confirm these localised extinctions were articulated in the EIS/SEIS (and therefore 'approved' impacts).
		<u>Waxy Cabbage Palm (WCP)</u> a). Table 6 describes potential impacts to hydrology and water quality, which in turn are likely to impact WCP. The plan does not provide 'details of potential impacts, including area of impact' on WCP as required by the condition. Section 6.5 includes a prose description of predicted groundwater and river flow changes in relation to the distribution of WCP. This is difficult to interpret. **Please provide details of potential impacts, including area of impact, on WCP, as required by the condition.** **Please include a map of the predicted extent and severity of reduced drawdown and reduced flow mapped against the current distribution of WCP. In particular, show the location of the Moses springs complex in relation to this, as it is the location of the only known occurrence of a WCP-GAB spring wetland association.**	<u>Waxy Cabbage Palm</u> a). updated to include presence and impact mapping.	<u>Details of potential impacts of Waxy Cabbage Palm MNES</u> Are you able to outline where the direct removal of 5.47ha of WCP habitat, including 5 individuals, will be? It is expected that this information will be in a detailed map of the area, which would be used by the construction team to ensure only this area was cleared. Figure 7-7 is currently insufficient. Table 7-3. Suggest to update project phases to align with monitoring phases. #1 Drawdown i. P120 – 'Drawdown may impact dominant riparian species (River Red Gum and Paperbarks) and therefore result in loss of open forest canopy. Loss of open forest canopy may in turn impact Waxy Cabbage Palm'. Where are these areas and is this information included in Section 6? ii. P120 identifies a residual impact of 21.7ha in the indirect impact zone. When will this occur? Is this the same zone that was offset for the River? Does it extend downstream of the eastern boundary? What offsets are in place for impacts downstream of the site? iii. Like the Carmichael River, Figures 7-6 a-d do not seem to show the maximum changes in groundwater drawdown predicted #3 hydrology i. P127 should specify / quantify what the actual changes in are. Reference can be made to the relevant section of the Carmichael river chapter (see comments above) to avoid repeating information.

				ii. Is it possible to include detailed maps outlining areas where the range of drawdown will be (1-4m), changes in hydrology are predicted, and GW/SW monitoring locations are, in relation to key areas of WCP populations? #4 Fire – threat of ignition from vehicles has not been addressed yet, but mentioned in #10 Earthworks (Adani 2012). #5 Weeds / Pests – need commitment to resurvey before construction to confirm relevance of management techniques, especially as invasive weeds are a key threat to WCP (TSSC 2008), and rubber vine is throughout the project area. Suggest review of Table 7-6 to ensure this is captured. #6 Grazing Pressure – is listed under the Approved Conservation Listing as one of the main identified treats to WCP, yet this plan states ' Sustainable grazing practices will be used in the Project Area as a management tool to manage threats to the Waxy Cabbage Palm'. The use of stock to manage weeds, without exclusion zones and an appropriate monitoring program, is not an appropriate mitigation / management measure for this threat. #7 Vegetation clearing / habitat loss – this sentence is confusing '*However, there are other identified potential threats and indirect impacts such as avoiding trampling or unapproved clearing and habitat fragmentation is to be avoided, minimised and offset by protecting and improving the existing condition of offset areas'*.Trampling is the threat / indirect impact and avoiding is the management objective. Also, what is trampling associated with? Cattle grazing only? Grazing by other fauna? Grazing by all fauna? How does this threat differ from #9 Clearing? This section would benefit from inclusion of indirect impacts like threat of reduction of floods reducing species dispersal / viability east of the mine site.
		<u>Doongmabulla</u> a). Maximum drawdown impact at Doongmabulla predicted in the SEIS (P113, 119) is 0.19m. This should be reflected on p 113 of the GDEMP (which has 0.13m) or an explanation provided for the difference. **Please clarify which model scenario is used as the basis for predictions in all groundwater plans and use it consistently throughout.** **When discussing potential depressurisation impacts, include discussion of potential impacts for other sources of the springs, including in Table 14. Also provide further justification for the statements that the DSC is already adapted to predicted drawdowns, or that they are within a tolerable range, resulting in minimal or negligible impact given drawdown is in addition to natural fluctuation and is sustained over a much longer period.** **Please strengthen / clarify the statement that mining activities are "generally not expected to" introduce or exacerbate direct threats to the integrity of the DSC (P119).**	<u>Doongmabulla</u> a). Impact update, table 8-5	<u>Details of potential impacts of Doongmabulla springs-complex MNES</u> It remains unclear which model scenario has been selected in the plan – see comments against relevant condition above. Do you know the predicted impacts at each of the 187 vents? Or how will you relate hydrological changes to potential impacts at each vent, or unmapped vents (given variation over time)? Please describe the likely impacts at a range of springs at the east of Doongmabulla - Yukunna Kumoo, HD03A, Dusk and Surprise? Please link predicted drawdowns P183/190 to vent elevations to describe any likely change in spring flow (e.g. Merrick in the land court said some springs would stop flowing completely with a drop of 5cm, this should be described). These changes to flow / wetted area should be described under #3. #1 dewatering - As previous, justify the statements that the pressure reductions are within natural / tolerable ranges and the springs will adapt. What is the evidence for these statements? We understood that the purpose of the GDEMP, consistent with the GDE toolbox was to determine these relationships between hydrology and ecology. - P190 What does 'negligible adverse impacts' mean? If the reduction in pressure is an impact, it needs to be addressed. Also, is there evidence of natural seasonal fluctuation for comparison? - Why is there no description of 'known' mound heights under baseline conditions?

		Mellaluka a). **Please clarify what the best available information suggests likely impacts to Mellaluka are, including timing and nature of drawdown impacts and explicit reference to any uncertainties in the source. The model scenario that predicted these impacts should be clear and the process for any updates clearly identified.**	Melalluka a). The best available information is the modelling studies undertaken through the EIS process and subsequently approved by the Minister.	- Why is there no specific mention of Salt pipewort and Blue devil associated with predicted pressure drop for Moses? #1 subsidence - When describing potential impacts from subsidence, although not predicted to occur, please link to the RFCRP, which considers the impacts of subsidence on springs. # 4 weeds / pests – Isn't there a likelihood for the spread of weeds due to 'increased human traffic to and from the springs-complex for research and monitoring purposes'? Details of potential impacts of Mellaluka springs MNES It remains unclear which model scenario has been selected in the plan – see comments against relevant condition above. We agree the original impacts were approved by the Minister. However, the plan states that more recent data suggests the springs may have an alternate source, and therefore impacts will be less than those approved by the Minister. As previous, these impacts need to be quantified (timing and magnitude) within the plan. As a minimum, reference can be made to approved impacts, with a commitment to revise these if further studies / update of the model after 2 years show impacts are likely to be less than originally predicted. Please link predicted drawdowns to vent elevations to describe any likely change in spring flow – What does "essentially" drying up mean? Will they, or won't they? See general comment for all MNES above – the drawdown figures seem to show change in contours over time, without the water level in the individual bores changing. Please revise.
17	d) measures that will be undertaken to mitigate and manage impacts on Matters of National Environmental Significance resulting from mining operations. These measures must include but not be limited to: (i) the use of fauna spotters prior to and during all vegetation clearing activities to ensure impacts on Matters of National Environmental Significance are minimised (ii) measures to avoid impacts on Matters of National Environmental Significance and their	Management measures Using the Waxy Cabbage Palm as an example, Table 7 provides impact mitigation and management measures. However, these lack details including timing. Some mitigation and management measures are not such (e.g. "Ecological features to be incorporated into the Monitoring Program which will be during and following the first box cut excavation" and "development of the GMMP and the undertaking of baseline surveys" - Baseline details must be provided in the plan (see condition 6.b)). Some measures reference implementation of plans yet to be prepared and not requiring Commonwealth approval (e.g. Receiving Environment Management Plan and Bushfire Management Plan). It is noted that the plan limits mitigation and management actions to the areas under direct Adani management. It would be desirable, if possible, to propose measures to improve resilience in key WCP habitat on neighbouring leases. **Please revise Tables 7, 10, 15 and 17 to ensure that all criteria, mitigation and management measures and corrective actions are appropriate, specific, timebound and effective.** **Please also include a range of methods as per previous IESC advice that further mitigation options (including alternative mining methods) need to be considered, such as narrower longwalls, or mining methods with lower subsidence impacts.**	Management Measures All GDE chapters restructured as discussed with DoE to capture objectives, threates, management, monitoring and response activities.	Management measures i). Fauna spotters **Pre-clearance survey -** Where in the plan is there a commitment to have a pre-clearance survey, and to have suitably qualified people present, including a fauna spotter, during clearance? WCP - Will you have a pre-clearance survey to demarcate the 5.47 hectares of habitat, including the 5 individuals, to be cleared? Is there clear commitment to notify the Department if there are unexpected finds during pre-clearance and what are the steps for informing the Department if additional area of habitat and / or more individuals are required to be removed? ii). Measures to avoid impacts Have you considered using alternate mining methods as a management measure? **Weeds and pests -** Do you think that the key information in the Weeds and Pest Management Sub-Plan are included in this plan? Currently this plan does not detail current condition of weeds and pests, including the identification of species and extent, and reference to relevant guidelines, in this plan to ensure appropriate management actions are in the plan (e.g. Weeds of National Significance (WoNS))? Note: weeds / pests are a key threatening process for WCP and GDE springs.

	habitat located in the Project Area, but outside areas to be cleared, constructed upon and / or undermined, including adjacent to cleared areas (iii) measures to rehabilitate all areas of Matters of National Environmental Significance habitat (iv) habitat management measures including but not limited to management of subsidence and groundwater impacts of the project.	Rehabilitation measures The plan does not provide measures to rehabilitate all areas of MNES habitat. Commitments for rehabilitation address reinstatement of ground cover to stabilise creek banks at the Carmichael River crossing, areas of WCP habitat degraded by works in the riparian zone, and riparian vegetation to the edge of the haul road impacted by its construction. **Please provide commitments detailing measures to rehabilitate all areas of MNES habitat.** Mellaluka Further details are required about the proposed mitigation by means of a submersible pump to maintain water levels when drawdown occurs – including evidence where this has worked before, how it will be maintained (as the worst impacts are post operations), how it would be sited to avoid further impacts to the spring, and which vents would have a pump. Carmichael River The text discusses impacts due to loss of catchment area upstream, which will have a 33% impact (P78) on flows. Table 9 lists alterations to surface water regime as an impact, but the only mitigation/management in table 10 is that no water is directly sourced from the Carmichael River. **Please include tangible mitigation / management measures to minimise and reverse the loss of catchment area. Please commit to provide relevant offsets if these measures are not effective.** **Please address previous IESC advice, i.e.** **1. management measures to address the predicted dieback of riparian vegetation [river red gums and paperbark] and changes to spawning, feeding, and breeding to individual species.** **2. These management measures should take into consideration any uncertainties within the hydrological and flood modelling.** **3. Given that groundwater drawdown impacts are generally predicted to increase post closure, options for post-closure flow supplementation should also be taken into consideration.** Doongmabulla Springs **Please include explicit references to and describe the role of the GABSRP in determining appropriate mitigation / management measures. As table 15 notes, these could also be applied to Mellaluka.**	Rehabilitation Measures Specific actions are included in each GDE table where relevant, for example Table 6-2 for the Carmichael River. Note that there are no predicted significant surface disturbance activities apart from WCP which has been offset inclusive of the immediate riparian vegetation associated with those works. IESC advice Not sure what this is referring to. IESC advice was given during the EIS phase and responded to during that process. Relevant approval conditions have been used to develop this GDEMP. GABSRP Tables 1-1 and 10-1 provide detail on connectiosn with other plans and programs	- Parthenium - Pay close attention to property hygiene. - Weed seeds are spread very easily by vehicles, machinery, stock, grain and fodder. http://environment.gov.au/biodiversity/invasive/weeds/publications/guidelines/wons/p-hysterophorus.html - Rubber vine http://environment.gov.au/biodiversity/invasive/weeds/publications/guidelines/wons/c-grandiflora.html **Grazing / Fire** - Can you demonstrate how you will monitor the biomass levels of paddocks to ensure 'sustainable grazing' of WCP habitat? Do you have adequate management measures in place to detect breaches in over grazing of WCP habitat? **Earthworks –**(P73) – Should there be a mitigation measure to limit introduction of new pests (flora / fauna, aquatic / terrestrial) - Would earthworks possibly impact the river through indirectly spreading weeds? iii). Rehabilitation Measures There are some minor references to post mine activities in Section 6-9. Consider a commitment to post impact / rehabilitation monitoring in Section 2. **Mellaluka** – Please provide response to our previous comment about the effectiveness of the submersible pump, with reference to revised text in plan. Have you considered how to supplement flows post-closure?
19	e) goals for habitat management for each relevant Matter of National Environmental Significance	Goals are provided in Table 7, 10 and 15. Goals will need to be re-assessed by the Department when (a) baseline data is complete and included in the plan, (b) the need for upfront offsets has been addressed and (c) the series of changes required to the tables have been addressed.	Noted – impact tables restructured in the GDE sections	As per (f) below – the goal should match the impact. #3 (P70) refers to surface water quality as the objective. This should relate to hydrology and quality be discussed only under #4. #3 (P191) refers to surface water quality as the objective. This should relate to hydrology and quality be discussed only under #4. For dewatering at Mellaluka springs, given the scale of approved impact, and if no further updates to impacts are available based on alternate source, the goals may be better focused on rehabilitation/remediation, rather than minimising impacts?

20	f) a table of specific criteria for assessing the success of management measures against goals, and triggers for implementing corrective measures if criteria are not met within specified timeframes. This table must include but not be limited to measures relating to subsidence and groundwater impacts, including early warning triggers for impacts on groundwater at the Doongmabulla Springs Complex and the Carmichael River. Goals and triggers must be based on the baseline condition of the relevant Matters of National Environmental Significance as determined through baseline monitoring (see Conditions 3b) and 6b)). Corrective measures must include provision of offsets where it is determined that corrective management measures have not achieved goals within specified timeframes (see Conditions 11m) and 11o))	<u>General</u> a). **Please rewrite the document to use a consistent hierarchy of actions, i.e.** **Set goals and performance criteria** **Monitor against these criteria** **Apply mitigation / management measures to achieve performance criteria** **Monitor success of these measures and** **Define triggers for implementing corrective actions if measures above are ineffective.** b). Notes: Mitigation / management are to occur before corrective actions. Mitigation measures do not include modelling, baseline or impact monitoring or offsets. The performance criteria define what impacts are relevant, and need to have defined timeframes. After approval, the 'significance' (as defined under the Act) of impacts is no longer relevant. The EIS predictions are not relevant in determining a response (unless these are explicit in the plan). Investigations or reviews should not delay implementation of corrective actions. <u>Triggers</u> a). The plan states (p33) regardless of ecosystem condition classification that may apply to the GDE, trigger values for ecological parameters in this plan aim to detect statistically significant change ($p<0.05$) from baseline conditions of >10%...this approach recognises the conservation value of the ecosystems being monitored. **Please justify this (and multiple associated) statements that 10% change in baseline in any range of monitoring variables will conserve the ecosystems. This would suggest all variables (hydrogeological, hydrological, and ecological) are equally as important and sensitive / tolerant to change. One value across multiple variables seems unlikely to be valid. An approach (and adequate monitoring) to detect <u>any</u> statistically significant change from baseline conditions would be more defensible.** **Please provide triggers for all variables and ensure they are based on the baseline condition.** b). P33 also suggests that if hydrogeological triggers are met, ecological triggers will be reviewed and only if there has been ecological change will corrective actions be applied. This does not recognise the hydrogeological limits that are set for GDEs, i.e. the DSC. The absence of ecological response should be no reason to delay implementation of corrective actions. **Please update this text / approach.** c). Many triggers are not defined in the GDEMP, but reference is made to the GMMP. The GDEMP must be stand-alone. Whilst DoEE intends to process the plans as a job lot, we also must be consistent with DES and ensure a management approach that is clear and not contradictory. **As such,**	<u>General</u> a). Impact tables in GDE Sections have been restructured accordingly b). Monitoring, management measures and corrective actions have been restructured in tables in GDE sections <u>Triggers</u> a), b) and c). Ecological triggers updated and clarified throughout and linked to groundwater trigegrs where relevant	<u>General</u> a). Management tables are to have clear and definable management objectives that are relevant to the impact, to guide appropriate monitoring indicators and triggers (i.e. water quantity impacts are monitored using water quantity indicators). Refer to discussions on the Carmichael River and adopt similar approach for other MNES. Please remove any remaining references to investigations from the tables to section 5.6. Clarify in 5.6 the ability to develop the decision tree model before any investigation, to address the previous comment that 'Investigations or reviews should not delay implementation of corrective actions'. Clarify in text how activities will be limited during an investigation - See P197. b). Management tables to reflect information presented in the section (i.e. if geomorphological features have been identified to be impacted, then geomorphological features should be an indicator). Please ensure all text and tables are consistent. <u>Triggers</u> Please include clear commitments within section 7.7 (or equivalent) to update triggers when conceptual understanding (e.g. source) changes, pre-impact data is collected before the impact phase and once Environmental Water Requirements of GDES are known. Specify when these updates will occur and what review / approval will be needed. Use consistent terminology in relation to the trigger investigation process – triggers met, trigger exceedances (Carmichael River), trigger levels reached (contamination); trigger value(s) breached (Section 8 adaptive management), below trigger levels (light spill)? Should references ANZECC Guidelines (2000) be updated with latest revision of the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018)* http://waterquality.gov.au/anz-guidelines/about? Are there any other changes, regarding triggers, which therefore need to be considered in this plan?

		we recommend the relevant monitoring, triggers, measures and actions from the GMMP and included in the GDEMP so that this plan can meet the conditions of approval. <u>Corrective actions</u> a). Most 'corrective actions' are not such (e.g. "Management Plan and trigger levels to be updated following completion of studies", "A review of mitigation measures", "Implementation of additional monitoring"). Many corrective actions comprise investigation or further monitoring. Some corrective actions which include investigations do not include details of who will be responsible for the investigations, the timeframes within which these will be undertaken and completed, or how and by whom decisions will be made regarding the cause (mine or not). It would be preferable to set out in the text of the plan a clear investigation process applicable to such instances, and to only include as corrective actions the actual corrective action. In many instances the corrective action if the mine is determined to be the cause, is "the BOS will be amended" or "revision to the BOS will be proposed" implying, but not specifying, that a commensurate additional offset will be provided. b). **Please commit to undertake conceptual model development and root cause analyses routinely so that, should a trigger be reached, the latest information is immediately available.** **Please specify timebound corrective actions as required by the condition.** **Please provide a separate detailed description of the relevant investigation process(es) proposed to determine whether triggers are attributable to the mine (including timeframes, consultation and decision making) (see also comment above under 'General' regarding details of investigation processes). Please provide in Table 7 (or equivalent) the likely potential corrective actions. Please provide clear corrective actions regarding provision of additional offsets, possibly by reference to clear text outside Table 7 (or equivalent) regarding the process for determining and providing additional offsets.** <u>Offsets</u> a). The points at which offsets will be provided (as required under the condition) are unclear. **Please specify clear processes and timeframes for provision of offsets in relation to each relevant GDE. This should include the need to offset unavoidable impacts tbefore they occur and reflect that complete loss of flow to the DSC cannot be offset (noting that with only 5cm drawdown, Merrick said some vents could go dry).**	<u>Corrective actions</u> a). Corrective actions/monitoring sections have been restructured in each GDE plan section. b). Investigation processes clarified generally, section 5.6, and under each GDE chapter. <u>Offsets</u> a). Requirement for offsets specified in relevant GDE plan sections	<u>Corrective actions</u> Please clarify in text what limiting mining activities to current activities means – this assumedly means no mining of new seams / areas – is that correct? See P197 for example. Please clarify what implementation of prepared and approved BOS / offset management plan means in relation to DSC (p197). The BOS describes potential offsets for DSC, but as we understand it Adani does not intend to prepare an OMP relating to impacts at DSC. There could still be greater clarity about the investigation process upfront, so that there is consistency in process across all GDEs. <u>Offsets</u> Clarify within the plan what the offset provided for the Carmichael River under the BOS relates to. Is this for the 6.4ha indirect impact zone? Or the direct impacts (haul road)? Clarify what the area of disturbance in the BOS for the Carmichael River (P92) and each MNES is. Is area the appropriate parameter to use for GDEs? How was the 90 ha offset for WCP determined? Based on 5.4 ha (direct) or 21.7ha (indirect) or total both (direct / indirect)? Reviewing the BOS, there are no proposed offsets for stage 2 (when indirect impacts are likely to occur). There is, however, enough WCP available in stage 1 (up to 336.49 ha – Table 10 in BOS). When referencing the requirements for upfront offsets for Mellaluka, it would be more robust to quote conditions or reasons from regulators at the time of approval, rather than the GHD assessment (p237). Responses to these questions may inform the accuracy of the statement in 10-1 the MDW OAMP acquits offset requirements for GDEs.

		Waxy Cabbage Palm a). Table 7 nominates 'performance criteria', some of which are not performance criteria (e.g. "Avoid unnecessary clearing" and "Limit impact of hydrological changes in [WCP] habitat from mine dewatering") and some are unmeasurable (e.g. "Limit disconnection of groundwater with surface water in *Livistona lanuginose")*. Some performance criteria are poorly worded commitments (e.g. "Maintain and improve existing condition of retained population (i.e. areas outside of predicted impacts) from indirect impacts including emissions and weeds"). Table 7 also nominates triggers but does not describe what monitoring will be undertaken in order to detect most triggers, should they occur. Some significant performance criteria have no trigger specified. Some 'triggers' are not triggers (e.g. "Update to the *Livistona lanuginosa* distribution") and some are unmeasurable (e.g. "Decreases in water flows within the Carmichael River exceed those predicted from hydrological modelling during the EIS phase of the project" and "Ongoing declines in population health …"). The proposed trigger "Statistically significant change in the age class structure of *L lanuginosa* or riparian composition and health, when compared to baseline" is likely to defy detection. Some triggers are not based on the baseline condition, as required by the condition. Few specific timeframes within which performance criteria must be achieved or for implementing corrective actions are provided. It is noted that the plan limits corrective actions to the areas under direct Adani management. It may be appropriate, if possible, to propose measures in key WCP habitat on neighbouring leases. This may be particularly appropriate if additional offsets are required. The plan commits to establishing only one monitoring site located downstream of the predicted impact. **Please revise Table 7 to ensure that all performance criteria, mitigation and management measures and corrective actions are appropriate, specific, timebound and effective.** **Please include, in a separate column, monitoring measures to enable detection of triggers, and specify the details, timing and frequency of proposed monitoring.** **Please provide evidence that the baseline data available and the monitoring proposed is capable of detecting the trigger "**Statistically significant change in the age class structure of *L lanuginosa* or riparian composition and health, when compared to baseline", **or replace this with an appropriate trigger.** **Please consider implementing appropriate corrective actions on non-Adani land where key habitat occurs (e.g. fencing to exclude stock).**	Waxy Cabbage Palm Please refer to updated WCP chapter including sections 7.4 through 7.9	Tighten language around provision of offsets in future (e.g. P208, 237). The provision of additional offsets under the BOS if impacts under the GDEMP are greater than predicted should be specified as a linkage in table 10-1. Waxy Cabbage Palm Please refer to discussions on the management table for the Carmichael River. We are able to discuss the WCP accordingly, if requested.

		Carmichael River a). Table 10 confuses the use of performance criteria, mitigation and management measures, triggers and corrective actions. It contains multiple references to monitoring / baseline assessment that do match those in the next tables and that should be separated out as column/s for measuring performance criteria and success of management measures in this table. Performance criteria and triggers are not time-bound. Attempts to define time “following the completion of works” or state “to a satisfactory condition” need to be quantified. In many cases, project design or alternatives (whereby impacts have been avoided) are listed as mitigation. In some of these, corrective actions may make appropriate mitigation / management triggers instead, but the further corrective actions need to be defined if triggers are met. Language is vague and unquantified, there are many ‘minimise’ or ‘minimal level’, ‘regularly spaced intervals’. **Please revise Table 10 to ensure that all goals, performance criteria, mitigation and management triggers related These should address all potential impacts, including those to geomorphology, particularly from construction of levees.** **Please define early-warning triggers for Carmichael River.** **Please provide responses to early-warning triggers (is this the ‘enhanced’ mitigation mentioned earlier?)** **Please separate hydrological triggers from ecological** (see condition g). **Please include, in a separate column, monitoring measures for performance criteria and to enable detection of early-warning triggers and triggers, and specify the method, locations, timing and frequency of proposed monitoring.** **Please provide evidence that the baseline data available and the impact monitoring proposed is capable of detecting these triggers** b). Figure 11 does not seem to link to other content within this plan. Many terms don’t match, e.g. “Groundwater Monitoring Plan” “monitoring protocol” “Corrective measures”. Are these Qld terms? It does not separate between mitigation and management measures, and corrective actions (once triggers are exceeded). It does not include early-warning triggers or link to the DSC plan, despite receiving outflow from the springs. It is also unclear what the different coloured / dashed lines represent. **Please update this figure to address comments above and be consistent with the conditions of approval.** c). P104 states surface flow triggers will be developed during implementation of the surface water quality monitoring program and updated GMMP predictions. The intent of a water quality program is unlikely to focus on defining appropriate flow triggers for the River GDE, unless clearly specified; similar for the GMMP. **Clarify if this monitoring program is a Qld requirement and clearly define the scope, timing, review and approval process for these triggers. Our initial view is that the triggers need to be defined within this plan before it can be approved. Additional hydrological triggers could include outflow**	Carmichael River Please refer to updated CR chapter including sections 6.4 through 6.9	Carmichael River Refer to discussions via teleconference about table 6-10. Explain how the trigger will be based on reduction of baseflow (P90-91), if baseflow is not directly monitored. This also only addresses changes via groundwater level (mentioned previously in plan), not due to changes in flooding / runoff / levees, etc. Confirm the response actions for a trigger exceedance on P92, particularly that some sentences do not relate to the WCP instead. The review should consider both groundwater and surface water data, as direct impacts to the River are predicted from loss of catchment flows.

		from Joshua spring, pool persistence, riffle habitat, baseflow index, and geomorphological indicators. Doongmabulla Springs a). Table 15 focuses largely on impacts to the GAB and confuses the use of performance criteria, mitigation and management measures, triggers and corrective actions. It contains multiple references to monitoring / baseline assessment that do match those in the next tables and that should be separated out as column/s for measuring performance criteria and success of management measures in this table. Goals are unclear ("reduce the risk of threats…"). Performance criteria and triggers are not measurable or time-bound. Impacts that exceed "current estimates" are unclear. Specific, quantifiable language needs to be provided within the table without cross-referencing. Corrective actions should remain in place until it is proven that triggers are no longer at risk of being breached. **Please revise Table 15 to ensure that all goals, performance criteria, mitigation and management measures and corrective actions are appropriate, specific, timebound and effective.** **Please define criteria, measures, triggers and corrective actions for a sub-Rewan source for the springs, until research under the GABSRP proves the source.** **Please define early-warning triggers for the DSC.** **Please explain what limiting mining to "current strata" means in response to a trigger exceedance.** **Please include a trigger based on Joshua spring outflow.** **Please provide responses to early-warning triggers (is this the 'enhanced' mitigation mentioned earlier?)** **Please separate hydrological triggers from ecological** (see condition g). **Please include, in a separate column, monitoring measures for performance criteria and to enable detection of early-warning triggers and triggers, and specify the method, locations, timing and frequency of proposed monitoring.** **Please provide evidence that the baseline data available and the impact monitoring proposed is capable of detecting these triggers.** b). The interim trigger for impacts to Doongmabulla is specified as 0.19m drawdown at the springs, but this is practically the drawdown limit. References are also made in s. 8.6.3 to low-risk triggers. Some early warning bores are listed, including a bore in the Moolayember formation. It is unclear how this would provide an early warning of impact. **Please specify what other triggers will apply to provide an 'early-warning' in order to prevent impacts. Please specify the early warning triggers for bores (installed and yet to be installed) in all possible source aquifers, as well as in units between the coal measures and the source, to ensure this limit is not exceeded.** **Please include DoEE as well as DES in the adaptive management approach described in 8.8.3.**	Doongmabulla Springs Please refer to updated DS chapter including sections 6.5 through 8.10	Doongmabulla Springs Please refer to discussions on the management table for the Carmichael River. We are able to discuss the DSC accordingly, if requested. As for other MNES, our comments include the separation of different modes of impact, need to specify approved impacts, and removing investigation processes.

		Please note in the plan that offsets are only applicable for the partial loss of DSC. Complete loss is not offsetable. Please therefore include changes to the mine plan / ceasing mining as potential corrective action. c). Figure 18 does not seem to link to other content within this plan. Many terms don't match, e.g. "Groundwater Monitoring Plan" "monitoring protocol" "Corrective measures". Are these Qld terms? It does not separate between mitigation and management measures, and corrective actions (once triggers are exceeded). It does not specify the names of research plans or include early-warning triggers or link to the Carmichael River / WCP plan, despite WCP occurring at Moses and the springs providing baseflow to the river. It is also unclear what the different coloured / dashed lines represent. **Please update this figure to address comments above and be consistent with the conditions of approval.** <u>Mellaluka Springs</u> a). Table 17 does not provide measurable performance criteria. (what does "minimised" impact look like?). Monitoring and baseline survey is included as a management measure, which it is not. Links to the GMMP for monitoring and triggers have not been made. Timelines are unclear ("prior to water drawdown impacts beginning to occur"). Triggers are not specifically defined and corrective actions have not yet been identified / will be provided "if necessary". P33 suggested triggers will be based on desktop studies / satellite imagery. **Please revise Table 17 to ensure that all goals, performance criteria, mitigation and management measures and corrective actions are appropriate, specific, timebound and effective.** **Please separate hydrological triggers from ecological** (see condition g). **Please include, in a separate column, monitoring measures for performance criteria and to enable detection of triggers, and specify the method, locations, timing and frequency of proposed monitoring.** **Please provide evidence that the baseline data available and the impact monitoring proposed is capable of detecting these triggers** **Please ensure these triggers are based on baseline condition, which is defined as per the full GDE toolbox approach as per other GDEs.** b). P152 referenced GHD 2014 that no offset is required for Mellaluka springs. **Please refer to the Minister's statement of reasons and BOS requirements under the Commonwealth approval and update this statement.** **Please provide a similar diagram to that provided for other GDEs outlining interactions with research / groundwater plans, the BOS and other elements of the GDEMP.**	<u>Mellaluka Springs</u> Please refer to updated MS chapter including sections 9.6 through 9.10	<u>Mellaluka Springs</u> Please refer to discussions on the management table for the Carmichael River. We are able to discuss the MSC accordingly, if requested. As for other MNES, our comments include the separation of different modes of impact, need for corrective actions to be actions rather than further monitoring, need to specify timeframes, and to specify/quantify approved impacts. As significant impacts are predicted during mining operations at Lignum and Stories springs (P225), but for Mellaluka spring only post closure, please specify the timing of corrective actions. What will be put in place to manage further impacts post closure?

32	g) an ongoing monitoring program to determine the success of mitigation and management measures against the stated criteria in Condition 6f), including monitoring locations, parameters and timing. Monitoring for water resource Matters of National Environmental Significance must include hydrogeological, hydrological and ecological parameters	See comments on monitoring and mitigation/management measures above. The Department needs to be certain of the adequacy of both baseline and impact monitoring and mitigation measures before making comment on the adequacy of monitoring to detect the effectiveness of those measures. The monitoring program generally be separated into groundwater or ecological. Surface water triggers tend to be merged with ecological triggers. **Please ensure monitoring (and associated triggers) are clearly separated into hydrogeological, hydrological and ecological parameters**	GDE sections have been restructured accordingly, with separate tables for groundwater and ecology, and management measures/triggers/corrective actions/monitoring clearly defined	See comments on impact monitoring above. The Department needs to be certain of the adequacy of both baseline and impact monitoring and mitigation measures before making comment on the adequacy of monitoring to detect the effectiveness of those measures.
34	h) details of how compliance will be reported		No action required	
35	i) details of how the MNESMP will be updated to incorporate and address outcomes from research undertaken for Matters of National Environmental Significance under this and any state approvals, including updating of goals, criteria and triggers (as required under Conditions 3c), 3d), 6e) and 6f))	a). Links to research plans are described in section 1.4. The plan (P10) incorrectly refers to the GMMP as including early-warning for GAB units. **Please update this reference (and the GMMP) to include early-warning impacts to all potential sources of the DSC, not just the GAB. Please also note that this plan must include early-warning triggers for Carmichael River.** b). The plan (P10) incorrectly refers to a springs management plan. **Please update this reference. Is this the GABSRP?** c). None of the diagrams or detailed text show any relationship between this plan and the Rewan connectivity research required under the conditions of approval. The research will inform the GMMP, which then informs the GDEMP, so a reference should be included, particularly given the likely key role of the Rewan in mitigating impacts to the likely source aquifer for Doongmabulla springs. **Please explain in text and include in relevant diagrams the role of the Rewan connectivity research in informing the GDEMP, and vice versa.** **Please also consider consistency between diagrams about plan interactions between plans – compare Figure 1 and Figure 4 in this plan to similar figures in the GMMP.** d). The plan states research outcomes will directly inform monitoring, management, prevention, mitigation and remediation. **Please be specific about which research outcomes (from state and Commonwealth) and how they will inform the monitoring and management measures in this plan, and vice versa.** e). The interactions with the GABSRP on P26 are overly simplistic.	a). Section 1.4 updated. Section 5 contains details on early warning triggers. b). Updated to GABSRP c). Links to Rewan connectivity research discussed in Sections 1.3 and 10.3. d). Links to research discussed in Sections 1.3 and 10.3.	Section 1.4 includes reference to the LEBSA project. Please consider including reference to other bioregional assessment products now released for the Galilee subregion – see www.bioregionalassessments.gov.au Linkages to other plans – particularly the GABSRP are still not clear (see table 10-1). What information will flow from one plan to the other, and vice versa? How? When? Articulating these linkages in the review/update scheduled may assist.

		Please specify clear timeframes for reporting and triggers for update to inform the adaptive management approach, including how research under the GABSRP or RFCRP and ecological requirements developed for GDEs in this plan will update criteria, goals triggers/thresholds in this plan and the GMMP, the application of mitigation measures in this plan and the GABSRP and the application of offsets under the BOS. The requirement for these updates to be approved, and by whom, should also be clear at each use.	e). Requirements for updates to the GABSRP are described in Section 10.3	
36	j) details of qualifications and experience of persons responsible for undertaking monitoring, review, and implementation of the MNESMP	There is a noticeable lack of expertise in groundwater / hydrology and their interactions or statistics. **Table 18 and associated text should be updated to specify actual persons responsible and their individual qualifications.**	Section 10.4 updated.	
37	k) In the event that the future baseline research required by the Queensland Coordinator-General (Appendix 1, Section 3, Condition 1 of the Coordinator-General's Assessment Report) identifies that the Mellaluka Springs Complex provides high value habitat for the black throated finch, the approval holder must include management measures to address impacts resulting from drawdown at the Mellaluka Springs Complex in the MNESMP		No action required	
38	l) details of how, where habitat for an EPBC Act listed threatened species or community not previously identified and reported to the Department is found in the Project Area, the approval holder will notify the Department in writing within five business days of finding this habitat, and within 20 business days of finding this habitat will	For this plan, we consider the reference (e.g. P35) should be to any GDE not previously identified and reported. **Please update text accordingly.**	Text amended as requested	What is the probability of unexpected finds for endemic flora species, if only one targeted search was undertaken at DSC, for example? Can you point to in the plan where there is an unexpected finds policy for these endemic flora species?

	outline in writing how the conditions of this approval will still be met (refer Condition 11j).			