FOI 190418
Document 1

From: Hamish Manzi
To: s22
Cc: s22, s47F
Subject: RE: GMMP
Date: Monday, 18 March 2019 2:13:58 PM

Good afternoon s22,

This link provides a clean copy of the GMMP sent through last Friday:
https://adaniau.sharefile.com/d-s22841add88f44ca9

Any questions, please let me know.

Kind regards,

Hamish

Hamish Manzi
Head - Environment & Sustainability
E Hamish.Manzi@adani.com.au
P office: +61 7 3223 4800 | direct: +61 7 3223 4837
A Level 25, 10 Eagle Street, Brisbane, QLD, 4000
P GPO Box 2569, Brisbane, QLD, 4001
W adaniaustralia.com

From: Hamish Manzi
Sent: Friday, 15 March 2019 3:33 PM
To: s22
Cc: s22, s47F
Subject: GMMP

Good afternoon s22

Please see attached the GMMP with a number of edits following our discussion this morning.

Edits have been made to sections 3.5.4, 5.3.5.1, 6.2, 7 and Table 45.

We are in the process of completing a full pdf version and will send through once completed.

Kind regards,

Hamish

Hamish Manzi
Head - Environment & Sustainability
E Hamish.Manzi@adani.com.au
P office: +61 7 3223 4800 | direct: +61 7 3223 4837
A Level 25, 10 Eagle Street, Brisbane, QLD, 4000
P GPO Box 2569, Brisbane, QLD, 4001
W adaniaustralia.com

From: s22
To: "Hamish Manzi"
Cc: Dean Knudson; James Tregurtha; "Lucas Dow"; 's47F Gregory Manning
Subject: Departmental advice on Adani groundwater research plans [DLM=For-Official-Use-Only]
Date: Monday, 4 March 2019 6:04:06 PM
Attachments: 2010-5736-20190304-GABSRP-Department comments.docx
2010-5736-20190304-RFCRP-RevJ-Dept comments.docx

Hi Hamish,

Please find attached the Department's feedback on Adani's draft Great Artesian Basin Springs Research Plan (v2) and Rewan Connectivity Research Plan (Revision J).

This feedback draws on finalised external scientific review of the plans, as well as our own regulatory feedback on the plans.

Please let us know if and when you would like to discuss the feedback advice in detail.

To expedite the Department's consideration of any revised plans in response to this advice, we would appreciate that updates that have been made are clearly identified through the use of tracked changes or highlighted test in the plans, as well as a separate written response to our comments.

Please let me know if you have any questions or concerns.

regards

s22
s22

Director
Post Approvals Section
Environmental Standards Division
Ph: (02) s22 @environment.gov.au
GPO Box 787 | CANBERRA ACT 2601 | AUSTRALIA
www.environment.gov.au/epbc

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	<u>Groundwater level</u> 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.	<u>Groundwater quality</u> 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. <u>Mitigation</u> 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 <u>and</u> 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 <u>within</u> two years. However there a number of sections where the review is stated to be <u>after</u> 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)	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.
(iv) the Rewan Formation Connectivity Research Plan (Conditions 27 and 28).	
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 all 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.

FOI 190418
Document 2b

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.

FOI 190418
Document 3

From:	s47F
To:	Gregory Manning
Cc:	Post Approval; Hamish Manzi; s22 ; s47F s22
Subject:	EPBC 2010/5736 Groundwater Dependent Ecosystem Management Plan
Date:	Wednesday, 6 March 2019 6:33:37 PM
Attachments:	Letter resubmission GDEMP 6March19 CWLTH.PDF FINAL 2010-5736 GDEMP-v10-DoEE Adani responses 6March19.pdf
Importance:	High

Commercial in Confidence

Dear Greg

Please find attached correspondence from Hamish Manzi, Head – Environment and Sustainability about the Groundwater Dependent Ecosystem Management Plan under controlled action approval EPBC 2010/5736. Also attached is a spreadsheet with the comments provided by your department in February 2019, and Adani's responses.

I will also send a separate email that includes a link to our "sharefile" system, where you can download version 11 of the *Groundwater Dependent Ecosystem Management Plan (March 2019)*, and a document showing differences between version 10 from November 2018 and this version.

Could your team please acknowledge receipt via return email?

Regards

s47F
s47F
Manager - Approvals
E s47F @adani.com.au
P s47F
A Level 25, 10 Eagle Street, Brisbane, QLD, 4000
P GPO Box 2569, Brisbane, QLD, 4001
W adaniaustralia.com

6 March 2019

Mr Gregory Manning
Assistant Secretary, Compliance & Enforcement Branch
Environment Assessment & Compliance Division

Via email: Gregory.manning@environment.gov.au
post.approvals@enviornment.gov.au

Carmichael Coal Mine and Rail Infrastructure Project – Groundwater Dependent Ecosystem Management Plan

Dear Mr Manning,

The Commonwealth Minister for the *Environment Protection and Biodiversity Conservation Act 1999* granted approval (EPBC approval) on 14 October 2015 for Adani Mining Pty Ltd's (Adani) Carmichael Coal Mine and Rail Project (the Project), subject to 36 conditions. The EPBC approval requires Adani to deliver a management plan for groundwater dependent ecosystems under conditions 5 to 7.

The attached is submitted for your assessment: *Groundwater Dependent Ecosystem Management Plan – Carmichael Coal Mine and Offsite Infrastructure (March 2019)*. To assist you with your assessment, also attached are:

- A document showing the difference between version 10 (submitted November 2018), and current version 11; and
- A spreadsheet with your department's 250 comments about version 10 provided on the 1st and 27th February 2019, and Adani's responses.

Adani Mining Pty Ltd
Level 25
10 Eagle Street, Brisbane, QLD 4000
GPO Box 2569, Brisbane, QLD 4001
Australia

Tel +61 7 3223 4800
Fax +61 7 3223 4850
www.adaniaustralia.com

Registered Office: Level 25, 10 Eagle Street, Brisbane, QLD 4000, Australia
ABN: 27 145 455 205

If you have any questions, please do not hesitate to contact me on (07) 32234800 or via email at Hamish.Manzi@adani.com.au.

Yours sincerely

Hamish Manzi
Head - Environment and Sustainability

Attachment 1 – Groundwater Dependent Ecosystem Management Plan – Carmichael Coal Mine and Offsite Infrastructure (March 2019)

Attachment 2 – Groundwater Dependent Ecosystem Management Plan – differences between previous and current versions

Attachment 3 – Spreadsheet of feedback and responses

#	Department comments on version 10	Changes made?	Response	Report reference
	Inconsistencies / errors			
1	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.	Yes	Management tables for Waxy Cabbage Palm (WCP), Doongmabulla Springs (DS) and Mellaluka Springs (MS) updated to reflect Department comments from Carmichael River. Thorough read through undertaken prior to resubmission.	Throughout document
2	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'.	Yes	Addressed and clarified the Carmichael River descriptions based on the approval	Section 4.2, Section 6.1.1
3	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.	Yes	All figures have been checked.	Figure 4-1 groundwater dependent ecosystems in project area, all figures.
4	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.	Yes	Sections are now labelled correctly as 4.3.1 and 4.3.2. Sentence has been changed to remove "subsections" and plural wording.	Sections 4.3.1 and 4.3.2
5	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 listings *Eriocaulon carsonii*).	Yes	Changed all so the convention is *Scientific name* (Common Name) and then Common Name used thereafter. Sentences with multiple species of the same genus will be shortened after first mention within the same sentence, e.g. Eucalyptus crebra, E. melanophloia. Updated weed legislation mentioned. Checked scientific spelling	All of section 8, and throughout document.
6	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.	Yes	Changed all to base flow/s. Changed all to floodplain. Changed all to Springs-complex or Springs-complexes as the plural. Still Springs-group as a separate item.	Throughout document (changes tracked).
	Ambiguity			
7	b) Please remove terms like "may", "ideally", "if possible" so that commitments are enforceable.	Yes	May' replaced in relation to commitments and when otherwise suitable. Many instances of use are appropriate. All reference to 'ideally' and 'if possible' removed.	Throughout (changes tracked)
8	c). Determination of baseline data - Section 5 - Monitoring process outlines that additional baseline data is to be collected during the pre-impact phase, 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.	Yes	Addressed	5.2 environmental baseline
	Link to GMMP			
9	b). Table 1-1 confirm text in fourth column, which suggests that the GMMP informs ecological triggers – how is this the case?	Yes	Added 'informs interpretation of ecological triggers'. That is, if an ecological trigger is exceeded, the results of the GMMP will assist in determining if drawdown is a cause.	Table 1-1

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10	c). Update any new and relevant information from the GMMP to Section 4 to inform the description of EVs for each MNES, including:	See below	See below	
11	i. Table 4-1 - substantiate description of alluvium to have continuous discharge from Joshua, including a stronger link to the GMMP.	Yes	Table 4-1 - amended table and references to GMMP	Table 4-1
12	- 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.	Yes	Bore depth of 71 m added to Table 4-1	Table 4-1
13	- add in C027P2.	Yes	Bore C027P2 added to Table 4-1 under Dunda beds.	Table 4-1
14	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.	Yes	Monitoring of Waxy Cabbage Palm - pre impact monitoring section updated, and reference also in the impact monitoring section. Described the overall monitoring approach, that is, monitoring alluvium bores, flow monitoring stations in the Carmichael River, which provides an understanding for the Waxy Cabbage Palms.	Sections 7.6.1 and 7.6.2
15	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.	Addressed - no changes made	The figure is conceptual only.	Figure 4-3
16	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.	Yes	The maps are updated to include this information. Bores shown in Figure 4-4 are government exploration bores, and no water level is available. Five of the bores shown in Figure 4-5 are groundwater monitoring bores for which water levels are available. These figures have been updated in the caption to reflect this information.	Figures 4-4 and 4-5
17	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).	Yes	The springs source report is a Queensland Government (Department of Environment and Science) requirement. The report will be made available however and referenced in the GDEMP. Section 8.3.5-7 retained so plan is stand alone.	Section 8.3.5-7
18	vi. Wherever possible, please reference relevant sections of the GMMP in text for ease of cross-referencing.	No	At the last revision, large amounts of material from the GMMP was included in the GDEMP so it would be stand alone. Cross referencing of material between the documents has been included throughout.	Throughout document
	Link to other plans			
19	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,	Yes	Information from other plans has been incorporated to the level of detail necessary for a groundwater management plan. Specific comments below.	Section 1.3, Table 1-1
19a	- The Rehabilitation Management Plan is part of Adani's commitment to meet Condition 6. D.) (iii) – measures to rehabilitate all areas of MNES habitat.	Yes	Additional text added to address this point.	Table 1-1
20	- 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)	Yes	References to Appendix A added (water quality parameters and triggers). Additional text added to Table 10-1 to clarify that not solely related to discharges. Further details are provided in the REMP and additional text has been inserted in Section 6.3.1 and Section 6.4 to address comment.	Section 6.3.1, Section 6.4, Table 10-1.
	Phasing/staging			
21	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).	Yes	Gantt Chart has been included in the Appendices	Section 10.1 & Appendix
22	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.	Yes	Wording to clarify pre-construction = baseline and pre-impact. Added defined timeframe sentence to Table 2-1. This information is included in Section 5.5.4. Additional commitment added to update conceptual model to this section.	Throughout document, Table 2-1

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23	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?	Yes	Clarifications added to Table 2-1 and Section 2.2. Timeframe varies per GDE.	Section 2.2
24	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.	No	For most GDEs the pre-impact phase is much longer than 2 years. Where the EWRs and ecological response to natural variation in groundwater can be determined, they will be. This is implied in existing content. The role of pre-impact monitoring in Stage 3 assessments of GDE toolbox is stated in Section 5.8.3	Section 5.8.3
25	d) Clarify that construction impacts occur during the 'pre-impact' phase, and update text accordingly (e.g. table 6-2).	Yes	Have made this clearer with sentences in section 2.2. Table 2-1 also clearly shows pre-impact period may include construction (see right hand column).	Section 2.2, Table 2-1
26	e) Please clarify what the 'first phase' of construction and operations (P80) means.	Yes	Text revised to provide clarity.	Section 6.6.1
27	f). Use consistent terminology. E.g. pre-development - does that cover pre-impact monitoring which also involves construction activities, or just baseline?	Yes	All references to pre-development removed to provide consistency.	Throughout document
	Updates			
28	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.	Yes	New schedule prepared and inserted as an Appendix (Gantt chart)	See new Appendix
	At a minimum, this schedule should include			
29	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?]	Yes	Included in the annual review process and Appendix with Gantt chart	Section 10.2
30	2. inclusion/update of conceptual models. Also please confirm where conceptual models[1] are currently presented (see p84, 248), and ecological features map.	Yes		
31	3. the revisions to triggers / actions / impact monitoring once pre-impact monitoring is complete, and conceptual models revised for each GDE.	Yes		
32	4. regular reviews in line with the groundwater model / GMMP.	Yes		
33	5. incorporation of research outcomes from the GABSRP/ RFCRP / other relevant research.	Yes		
34	The first draft of the plan was submitted in November 2016. Mining operations have not yet commenced.	Yes	Noted	
35	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.	Yes	GDEMP specifies the EIS/SEIS model has been used.	For example, Sections 4.3.1 and 8.3.2.
36	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).	Yes	Updated the reference throughout the document to DEWHA 2008, and removed TSSC 2008 and DSEWPaC 2013c	Throughout document
37	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	Yes	Updated the reference throughout the document to DEWHA 2008, and removed TSSC 2008 and DSEWPaC 2013c	Throughout document
	All MNES			
38	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.	Yes	Triggers are based on baseline condition (EIS, SEIS etc) and this has been clarified.	Sections 5.3, 5.5 and each MNES chapter.
	Description of Carmichael River MNES (Section 6)			
39	Does the plan provide all available information on hydrological characteristics of the river, especially seasonality of baseflows and how that impacts GW interaction?	Yes	Additional information provided	Section 6
40	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)?	No	Detail is provided in the conceptual diagrams of gaining and losing sections of river and associated text, Chapter 6.	Section 6

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41	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.	Addressed - no changes made	GDEMP describes that mining and natural/seasonal conditions may affect groundwater levels. Significant information was added in the last revision.	Section 6
	Specific comments:			
42	a) Has there been any studies on determining groundwater interaction using isotope analysis (refer to Burrows et al (2018))?	No	There have not been any studies.	
43	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?).	Yes	Have added clarity around wet and dry seasonal months in Section 4.1	Section 4.1 Environmental setting
44	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?	No	The baseflow was modelled over many years in the EIS. The baseline monitoring data referenced in the GDEMP is all the data available	Section 6.2
45	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?	Yes	Relevant data are presented in the EIS technical reports. The GDEMP has been updated to include additional information.	Section 6.3
46	e). P44. Include a commitment to include any updates in the REMP into this plan to reflect the EVs of the river.	Yes	Added a commitment	Section 6.3.1 before table 6-1 key water objectives
47	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.	Yes	The REMP provides more detail, however, significant additional text has been included.	Section 6.3.1
48	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.	No	The losing and gaining aspects of the river are described.	Section 6.3.2
49	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 are likely 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).	No	The purpose of these sections is to provide an overview to the reader on environmental values. Relevant indicators have been carried forward into the monitoring program and are specified in the plan.	
50	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?	No	This information is not available.	
51	j) How deep is the alluvium? Is it consistent along the Carmichael River reach, from DSC to confluence with Belyando?	No	This information is not available.	
52	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.	Yes	Riparian zone varies depending on topography. The riparian zone is not defined as 10 m either side of the river.	Section 6.1.1 and 6.4 # 3
	Description of Waxy Cabbage Palm MNES (Section 7)			
53	Can the key areas be shown on a map, particularly with reference to 'gaining' and 'losing' areas within the Carmichael River reach?	Addressed - no changes made	This is part of the "Carmichael River features map" to be produced following pre-impact monitoring. Maps are provided in the section describing the locations of this MNES, and gaining and losing areas are described.	Section 7
54	Are you able to include any details of WCP downstream of the mining lease boundary (east of the operations)?	No	The maps provided in the GDEMP are the current information available.	Section 8
55	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?	Addressed - no changes made	Locations of this MNES and habitat are described.	Section 7
56	Does the text on P119 mean that the source could not be the alluvium? What surveys will be done to confirm this? When?	Yes	Text amended to confirm that the source is the alluvium.	
	Specific comments:			

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57	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?	Addressed - no changes made	The table shows the results of modelling of the water table during the EIS. It means that the river is generally 0.5 m deep as a minimum, without considering water inputs from upstream. It is a generalised description for the management plan. Further details are provided in the EIS.	Section 7.2
58	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?	Yes	Amended to describe the river is highly variable and has no flow 30% of the time.	Section 7.2
59	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)?	Yes	Sentence added to specify that the 12% adults comprise of both non-reproducing and reproducing. Information about the proportion of adults reproducing is not available.	Section 7.3
60	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?	No	Information not available.	
61	e).Section 7.3. Is there a complete list, and locality, of WCP within this southern population provided in this Plan?	No	All information available has been presented in summary form in the GDEMP.	Section 7.3
62	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.	No	The table is about drawdown, not WCP numbers. That information is available elsewhere in the plan. The earliest drawdown is Year 20 and the plan will be updated on the basis of the WCP survey during pre-impact monitoring.	Table 7-4
63	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?	Yes	Pre-impact surveys will provide additional information on current status of the species.	Section 7.3
	Description of Doongmabulla springs-complex MNES (Section 8)			
64	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)?	Addressed - no changes made	Previous surveys have been described in the GDEMP, and the study by Fensham et al (2016) have now been included.	Section 8
65	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).	Yes	Additional information from Fensham et al. 2016 has been summarised	Section 8
66	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, product 3-4, 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:	Yes	Additional information from Fensham et al. 2016 has been summarised. Reference made to 187 vents.	Section 8
67	- Joshua Spring and House springs converge to start Carmichael River (as defined in conditions)	Yes	Added	Section 8.1
68	- 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.	Yes	Additional information from Fensham et al. 2016 has been summarised. Reference made to 187 vents.	Section 8
69	- 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.	Yes	Additional information from Fensham et al. 2016 has been summarised. Reference made to 187 vents.	Section 8
70	- 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.	Yes	Added to Section 8.1	Section 8.1
71	- 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.	Yes	Additional text added around geography and vertical conduit in section 8.1.1	Section 8.1.1
72	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.	No	Complex links to GMMP are no included as a large quantity of information has been duplicated to the GDEMP to date, and now the document is stand alone.	
73	- Ensure that the GMMP includes all available groundwater level / spring flow / quality data.	No	Comment for the GMMP	

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74	- Key findings (P173) are vague regarding water level data (i.e. 'generally', 'is likely'). All levels referred back to only one bore (C18002SP).	Yes	The wording is has been selected to reflect the situation. All levels refer to one bore because this is the bore from the relevant groundwater unit.	
75	- 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.	Yes	Clarification added to Section 8.3.4. Potential sources of GDEs is discussed in plan. EC value has been checked and updated.	Section 8.3.4
	Specific comments			
76	a). Expand the description for the 187 vents, including accurate description of groups (see examples above).	No	Previous surveys have been described in the GDEMP, and the study by Fensham et al (2016) have now been included.	
77	i). Does Moses groups have exactly 65 mounds / non-mound springs? What are the relative % of these types across the group?	No	Previous surveys have been described in the GDEMP, and the study by Fensham et al (2016) have now been included.	
78	ii). How many springs in the Little Moses group?	No	Previous surveys have been described in the GDEMP, and the study by Fensham et al (2016) have now been included.	
79	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.	No	Previous surveys have been described in the GDEMP, and the study by Fensham et al (2016) have now been included.	
80	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?	No	Previous surveys have been described in the GDEMP, and the study by Fensham et al (2016) have now been included.	
81	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.	No	Previous surveys have been described in the GDEMP, and the study by Fensham et al (2016) have now been included.	
82	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?	No	Intent is to summarise existing information rather than present all detail, consistent with use as a management plan.	
83	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).	Yes	Added to Section 8.2.2	Section 8.2.2
84	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)	Yes	Additional text added to Section 8.2.2.	Section 8.2.2.
85	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.	No	Previous surveys have been described in the GDEMP, and the study by Fensham et al (2016) have now been included.	
86	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)?	No	Refer to EIS and summary presented in GDEMP. Some of these variables will be monitored in pre-impact monitoring.	
87	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?	Yes	The figures show different things. Figure 8-4 records of species. Figures 8-5 and 8-6 locations of springs. Additional text has been added to Section 8.2.2 to discuss locations.	Section 8.2.2
	Description of Mellaluka springs-complex MNES			
88	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?	Addressed - no changes made	The environmental values of MSC are less than DSC. The information presented is what is available. The MSC is degraded and modified.	
89	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.	No	Relevant information has been brought across into GDEMP at last revision, so the plan is stand alone.	Section 9.4
90	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?	No	Information provided in the GMMP.	GMMP
91	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?	Yes	The daisy has not been identified so there is no evidence that it is an endemic species.	Section 9.3
	Baseline monitoring (also referenced as <u>*pre-impact*</u> <u>in the plan)</u>			
92	Provide all baseline data available (as per comments against description of environmental values above).	No	A summary of existing values has been provided. Refer to EIS.	

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93	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.	Yes	Additional text added to Section 5.5.4 to address comment.	Section 5.5.4
94	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.	Yes	Additional text added to Section 5.5.4 to address comment.	Section 5.5.4
95	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.	Yes	Additional text added to Section 5.5.4 to address comment.	Section 5.5.4
96	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.	Yes	Ecological triggers section has been moved back to be after the monitoring approach.	Section 5
97	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.	Addressed - no changes made	These are described in Section 1.3, Table 1-1.	Section 1.3, Table 1-1
98	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.	Yes	Updated table to make clearer, and used text from each monitoring section to connect, with References to the sections in column 1.	Table 5-1 key ecological monitoring attributes
99	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?	Yes	Have added reference to the sections with monitoring variables	Section 5.5.4 pre-impact monitoring
100	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.	Yes	The pre-impact studies are monitoring of the environmental condition of GDE's prior to any groundwater drawdown. When combined with baseline monitoring, this provides a long-term data set from which future impacts can be determined. Pre-impact monitoring is different to groundwater reliance studies. This is explained in the plan.	Several places, see for example Table 2-1.
101	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.	Yes	References made to rain gauges at the Carmichael mine site.	
102	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.	Yes	Updated throughout as suggested.	Throughout report
103	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 indicators (with the same terminology) are reflected into table 6-9 (or equivalent).	Yes	Chapters reviewed in light of comment.	Throughout document
	Baseline and Impact monitoring comments are made against each MNES.			
	Monitoring of Carmichael River MNES			
104	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?	Yes	These are inaccuracies copied from another section. Deleted.	Section 6.6
105	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).	Yes	Clarification added as suggested.	Section 6.6.1
106	c). P78 states that a detailed ecological features map will be prepared. When is this? Will it be pre-impact, including pre-construction?	Yes	It will be developed within 3 months of completing the first wet and dry surveys of the Carmichael River (see Section 7.6.1). Additional text also added for clarity.	
107	d). How will the monitoring program target key ecohydrological features (see above), and relevant parameters for monitoring measures once the map is prepared?	Addressed - no changes made	This is inherent in the adaptive management approach and updating of the plan as new information becomes available. If new features are identified then these will be monitored in the future.	
108	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.	Yes	These are impact levels. There is no value in having more downstream bores.	

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109	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.	Yes	The pre-construction baseline is established as per the EIS and REMP. Further information from the REMP will be included.	Section 6.9
110	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.	Yes	The alluvium bores are the relevant groundwater units for assigning trigger values for the Carmichael River. Clematis bores are used in the setting of triggers for Doongmabulla Springs.	
111	h). The text about review of the GMMP on P84 seems out of place in the impact monitoring section.	Yes	Agreed. Paragraph relocated to Section 1.3 where the GMMP is first introduced.	Section 1.3, Table 1-1
112	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.	Yes	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. Also included in management table.	Section 6.4
	j). Table 6-9			
113	- Indicators should reflect those in previous sections (e.g. groundwater level and groundwater quality , not groundwater monitoring).	Yes	Table updated as suggested	Table 6-9
114	- Clarify 'ideally' where groundwater sites will coincide with population monitoring. What factors could mean they don't? Who will be notified?	Yes	The word has been deleted.	Table 6-9
115	- What does 'descriptive' comparison mean for each analysis? Where data is quantitative, there should be little reason for description.	Yes	The term 'descriptive' is added to 'comparison' to indicate that rather than just comparing two means, there will be relevant discussion regarding the comparison, such as statistical power, replication, hypothesis etc.	Table 6-9
116	- Clarify that monitoring of surface water flow is daily (right column), not monthly (central column).	Yes	Clarified in table. Data will be collected continuously (daily) and analysed monthly.	Table 6-9
117	- What is the justification for surface water flow trigger at the 80th percentile?	Yes	Agreed. Changed to 20th percentile. This is a common approach in the ANZECC Guidelines, where the median (impact) is compared with the 20th/80th percentile of baseline data. For variables where high is bad (toxicants) - use 80th percentile. For flow reductions, 20th percentile is appropriate.	Table 6-9
118	- Add surface water quality.	Yes	Added as suggested	Table 6-9
	Monitoring of Waxy Cabbage Palm MNES			
119	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?	Addressed - no changes made	The plan outlines the proposed monitoring for this MNES including locations and extent.	
120	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'.	Yes	Additional text added to Section 7.6.1	Section 7.6.1
121	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).	Addressed - no changes made	Monitoring sites will be co-located with bores which will confirm the minimal drawdown. Alluvium Control Bore to assign is C027P1, this bore is not predicted to be impacted from water table drawdown.	Section 7.6.1
122	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.	Yes	Text updated to clarify situation.	Section 7.6.1
123	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?	Yes	Two additional alluvium bores added to Figure 7-9. This is the groundwater unit relevant to this GDE. There is no requirement for individual monitoring locations for the WCP. There is a monitoring program under the REMP.	
124	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).	Yes	Addressed	Section 7.6.1 pre-impact

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	g). Table 7-5			
125	- Indicators should reflect those in previous sections (e.g. groundwater level and groundwater quality, not groundwater monitoring).	Yes	Updated	Table 7-5
126	- Clarify that monitoring of surface water flow is continuous (central column), not monthly (previous text).	Yes	Updated	Table 7-5
127	- What is the justification for surface water flow trigger at the 80th percentile?	Yes	Changed to 20th percentile. A common approach in ANZECC is trigger of 80th or 20th percentile	Table 7-5
128	- Add surface water quality.	Yes	Updated	Table 7-5
129	- Align terminology of life stages for monitoring with Table 7-1.	Yes	Terms are consistent Established to Reproducing adult	Table 7-5
130	- Triggers for monitoring weeds should be outlined in the plan, especially for specific species, like WoNS.	Yes	Triggers for weeds are outlined in the plan. Added reference to WoNS	Table 7-5
131	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 sediments for Mellaluka spring-complex in Table 4-1? Is this the potential alternative source for the WCP mentioned elsewhere?	Yes	WCP term updated instead of scientific name. Figure 7-9 updated to show other alluvium bores. Bore C029P2 removed from the Tertiary Sediments / Mellaluka Springs row and added in new row near Alluvium above. Not sure what you are referring to regarding alternative sources for the WCP.	Figure 7-9 waxy cabbage palm monitoring locations
	Springs			
132	Remote sensing is not described in the monitoring regime for wetland extent, or identifying unmapped vents.	Yes	This information is included in Section 8.7.1, Table 8-9. Text also added to Section 9.8.1	Section 9.8.1
	Monitoring of Doongmabulla springs-complex MNES			
133	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?	No	Monitoring a representative selection of sites across an area of interest is a valid scientific approach. The sites will be selected during pre-impact monitoring.	
134	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).	Yes	The monitoring proposed is outlined. Pre-impact surveys of mount height will occur.	Section 8.7
135	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)?	Yes	Seasonal is twice a year (wet season and dry season). Clarifications added. It means that seasonal monitoring will occur for a minimum of two years, but will also go beyond two years if pre-impact data set is still being established.	Section 8.8
136	Wetland vegetation monitoring – consider including particular species as an indicator.	Yes	These are included - see Section 8.7.1 wetland species composition. Threatened and endemic species are listed below.	Section 8.7.1
137	Threatened and endemic flora populations – consider including the condition of the species as an indicator.	Yes	Condition added as indicator.	Section 8.7.1
138	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?	Yes	Representative selection of sites with good habitat values. Camp spring added to include site where Marmersella sp has been found. Gabbia rotunda has been found at Moses 1.	Section 8.7.1
139	Weed and pest surveys – where will they occur? At every vent?	No	Monitoring of representative sites across an area is a common and valid scientific approach. The sites will be selected during pre-impact monitoring.	Not applicable.
140	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.	Yes	Analytes in Appendix A (reference added). Flow rates added	Section 8.7.1
141	Remote sensing does not seem to feature in the monitoring design (e.g. 8.7.1).	Addressed - no changes made	Mentioned in Section 8.7.1 and 8.8.1.	Section 8.7.1 and 8.8.1
142	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?).	Yes	Every 12 hours for GW level and every two months for GW quality.	Section 8.7.4
143	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).	Yes	Changed "may" to "will".	Pages 203 & 204
	Mellaluka Springs			
144	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.	Addressed - no changes made	Section 9.7.2 has the commitment. Section 10.1 cover the other points.	Section 9.7.2 and Section 10.1

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145	Do you know / when you will assess the elevation of each spring vent?	Yes	Commitment added to carry out LiDAR or similar to determine the elevation.	
146	Remote sensing does not seem to feature in the monitoring design.	Addressed - no changes made	Mentioned in Table 9-2. Added to Section 9.8.1 for clarity.	Section 9.8.1 and Table 9-2
147	What pre-impact surface water monitoring is proposed at the complex (P238)? What parameters, in which locations?	Yes	Parameters in Appendix A (added to text). Locations to be determined during pre-impact monitoring.	Section 9.8.1 and Table 9-2
148	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.	Yes	Removed Bore C029P2 from the list on page 238. No other changes made - the aquifers are listed.	
	General comments on impacts:			
149	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.	No	Approved impacts are included in the plan.	
150	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?	Yes	No changes to sequences. A new Appendix has been included to resolve confusion about terminology.	
	Details of potential impacts of Carmichael River MNES			
151	Which map shows the 800m reach? Impacts need to be clearly defined, ideally qualitatively, so that offsets can be provided if they are exceeded.	Yes	Shown in Figure 6-8.	
152	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?	No	This information may be available in the future, in which case, will be included in future revisions.	
153	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?	No	This information may be available in the future, in which case, will be included in future revisions.	
154	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)?	Yes	It carries on from the previous paragraph about erosion of the banks. The plan is just describing potential indirect impacts in this section, and large trees hold sediment together.	
155	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.	Addressed - no changes made	Refer to direct impact area in Figure 6-8	
156	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.	Addressed - no changes made	Included in Section 6.4 #5.	
	Please also clarify those impacts already described			
157	- How close the 'vicinity' of the eastern mine boundary is for an increase in periods of no flows.	No	This additional detail is described in the EIS.	
158	- Specify what the difference for these no flow periods is within the CCM and upstream.	No	This additional detail is described in the EIS.	
159	- Outline where loss of 16,664 ha of the catchment (33% reduction in surface water discharged into the Carmichael River) will be.	Yes	Additional wording has been included to state that the extent of the impact will be 33%, as per the EIS	
160	- 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?	No	This is a zero flow condition loss. Not groundwater flow loss.	
161	- What does a reduction of 60% of the baseflow mean to the Carmichael River reach, downstream of the project?	Yes	There is not a 60% reduction in baseflow. There is a 30-60% change of no flow periods.	
162	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?	No	The management plan describes the impacts as they were assessed and approved.	
163	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.	No	The 1-4 m drawdown relates to the level of the water table, not a particular aquifer.	

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164	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).	Yes	Text reorganised into appropriate sections (quantity and quality)	Section 6.4
165	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.	Yes	Text added as suggested.	Section 6.4
166	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?	Yes	Some additional text added. Refer to EIS for further detail.	Section 6.4
167	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.	Yes	Reference to Appendix A and REMP added. Flow limits are in Appendix A. Continuous refers to several times per day (varies per instrument). Release limits will be reviewed by DES based on REMP reports	Section 6.4
168	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).	No	The word "extinction" was not used, but the paragraph refers to localised impacts as a part of how ephemeral or semi-ephemeral streams work.	
	Details of potential impacts of Waxy Cabbage Palm MNES			
169	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.	Addressed - no changes made	Shown in Figure 7-7. This is also covered in the permit to disturb process.	
170	Table 7-3. Suggest to update project phases to align with monitoring phases.	Yes	Addressed in previous comments	
	#1 Drawdown			
171	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?	Yes	Figures 7-7 and 6-8.	Figures 7-7 and 6-8.
172	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?	Addressed - no changes made	It is the same zone that was offset for the river. Impacts are described in the plan.	
173	iii. Like the Carmichael River, Figures 7-6 a-d do not seem to show the maximum changes in groundwater drawdown predicted	Yes	The 1-4 m drawdown relates to the level of the water table, not a particular aquifer.	
	#3 hydrology			
174	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.	Yes	Reference added to Section 6.4 as suggested	Section 6.4
175	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?	No	Existing maps show these features.	
176	#4 Fire – threat of ignition from vehicles has not been addressed yet, but mentioned in #10 Earthworks (Adani 2012).	Yes	The threat is therefore covered in the current plan. Its not necessary to go into all of the potential sources of ignition in the fire section.	
177	#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.	Yes	Added.	
178	#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.	Yes	Wording amended to reflect that the use of stock is not the only management tool. The effectiveness of stock at reducing weed biomass will be monitored.	
179	#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.	Yes	Agree sentence is confusing. Reworded for clarity. Suggestion about reduced dispersal from floods added to text.	Section 7.4

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	Details of potential impacts of Doongmabulla springs-complex MNES			
180	It remains unclear which model scenario has been selected in the plan – see comments against relevant condition above.	No	The model is identified and described in the EIS.	
181	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)?	Yes	Previous surveys have been described in the GDEMP, and the study by Fensham et al (2016) have now been included.	
182	Please describe the likely impacts at a range of springs at the east of Doongmabulla - Yukunna Kumoo, HD03A, Dusk and Surprise?	No	The impacts have been described. Refer to EIS and SEIS for further details.	
183	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.	Yes	Previous surveys have been described in the GDEMP, and the study by Fensham et al (2016) have now been included.	
184	#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.	No	Not required by condition.	
185	- 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?	Yes	It means that the extent of adverse impacts were assessed to be negligible. Refer to EIS.	
186	- Why is there no description of 'known' mound heights under baseline conditions?	Yes	Commitment added to carry out LiDAR or similar to determine the elevation.	
187	- Why is there no specific mention of Salt pipewort and Blue devil associated with predicted pressure drop for Moses?	Yes	There is. See Section 8.7.1. Additional text added to Section 8.4 for clarity.	
188	#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.	No	The Rewan studies in relation to subsidence must be done in a way that does not cause impacts to Matters of National Environmental Significance.	
189	# 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'?	Yes	This statement has been relocated from #1 to #4 to address comment.	Section 8.5
	Details of potential impacts of Mellaluka springs MNES			
190	It remains unclear which model scenario has been selected in the plan – see comments against relevant condition above.	No	Model used in the EIS/SEIS process.	
191	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.	No	Approved impacts are included in the plan.	
192	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?	Yes	The word "essentially" has been deleted. Refer to EIS for further detail.	
193	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.	Yes	These are the predicted water levels. The first is a reference level.	
	Management measures			
	i). Fauna spotters			
194	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?	Yes	See existing text in Section 7.6.1 under the heading of Pre-clearance survey. Table 7-6 states that suitably qualified spotter catcher will be present for clearing.	Section 7.6.1 and Table 7-6
195	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?	Yes	Yes. Please refer to Section 7.6.1 which explains this in existing text. See new text on notifying the department in Sections 5.7 and 10.1.	Section 7.6.1, 5.7 and 10.1
	ii). Measures to avoid impacts			
196	Have you considered using alternate mining methods as a management measure?	Yes	Alternative methods are not available. Also addressed in the EIS.	

#	Department comments on version 10	Changes made?	Response	Report reference
197	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.	No	Not required in the GDEMP, but will be included in the weed and pest management plan. Weeds and pests will be regularly surveyed, with results likely to change over time.	Not applicable.
198	- 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	Addressed - no changes made	See table 9-3 and Section 9.6	Not applicable.
199	- Rubber vine http://environment.gov.au/biodiversity/invasive/weeds/publications/guidelines/wons/c-grandiflora.html	Addressed - no changes made	See table 9-3 and Section 9.6	Not applicable.
200	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?	Addressed - no changes made	Habitat assessment method is provided.	Not applicable.
201	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?	No	Limiting the introduction of new pests is an objective, rather than a mitigation measure.	Page 73
202	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.	Yes	Commitment included.	Section 6-9
203	Mellaluka – Please provide response to our previous comment about the effectiveness of the submersible pump, with reference to revised text in plan.	Yes	Submersible pumps are used by the landholder for maintaining the house pad and cattle, and can be used for ecological purposes. If this does not work, then offsets will be triggered.	
204	Have you considered how to supplement flows post-closure?	No	This will be determined by approval limits and offset requirements.	Not applicable.
205	As per (f) below – the goal should match the impact.	Yes	Addressed throughout	Throughout the document
206	#3 (P70) refers to surface water quality as the objective. This should relate to hydrology and quality be discussed only under #4.	Yes	Updated in management objective green rectangle.	Section 6.4
207	#3 (P191) refers to surface water quality as the objective. This should relate to hydrology and quality be discussed only under #4.	Yes	Updated in management objective green rectangle.	Section 8.5
208	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?	Addressed - no changes made	Mitigation is preferred over rehabilitation in hierarchy.	Not applicable.
	General			
209	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.	Yes	Management tables for WCP, DS and MS updated to reflect Department comments from Carmichael River.	
210	Please remove any remaining references to investigations from the tables to section 5.6.	Yes	Management tables updated in accordance with DoEE comments.	Throughout document
211	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'.	Yes	New text added to Section 5.6 to clarify model comes before investigation and that investigation process should not delay corrective actions.	Section 5.6
212	Clarify in text how activities will be limited during an investigation - See P197.	Yes	Typo in paragraph 2 addressed. Note limited to currently approved activities.	
213	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).	Yes	Management tables for WCP, DS and MS updated to reflect Department comments from Carmichael River.	
214	Please ensure all text and tables are consistent.	Yes	Updated all tables including typing out image tables. Text and tables now appear consistent	Throughout document
	Triggers			
215	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.	Yes	These commitments have been added to Section 5.5 Ecological triggers. New appendix also added showing timing.	Section 5.5

#	Department comments on version 10	Changes made?	Response	Report reference
216	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)?	Yes	Changed all trigger value(s) to trigger level(s). Referenced the words below, detected and exceeded. Removed breach(ed) except in one instance, and removed reached	Throughout document
217	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?	Yes	The old ANZECC 2000 guidelines describe the approach, while a few minor changes to guideline values occurred in 2018. References reviewed and updated.	Throughout document
	Corrective actions			
218	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.	Yes	Correct. Clarified in text.	
219	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.	Yes	This means the application of offset requirements through the pathways in the approvals. No offset is predicted to be required as there are no predicted significant residual impacts.	
220	There could still be greater clarity about the investigation process upfront, so that there is consistency in process across all GDEs.	No	The process can be different, per GDE, so these have been left as separate	
	Offsets			
221	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)?	No	Offsets have been agreed and approved. Details are in the BOS. Offsets are adequately explained for the purpose of a groundwater management plan.	
222	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?	Yes	Offsets have been agreed and approved. Details are in the BOS. Offsets are adequately explained for the purpose of a groundwater management plan.	
223	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).	No	Offsets were determined via the EIS and approvals process, and the Biodiversity Offset Strategy approval in October 2016. Offset calculators were used to determine the requirements.	
224	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).	Yes	Amendments have been included to reference the appropriate condition. Predicted impacts to the MSC will be refined through the re-modelling to be undertaken within 2 years of commencement. This modelling will utilise additional geological and groundwater information to confirm the sources aquifer for the MS 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	Page 237
225	Responses to these questions may inform the accuracy of the statement in 10-1 the MDW OAMP acquits offset requirements for GDEs.	No	The Moray Downs West Offset Area Management Plan offset current requirements.	
226	Tighten language around provision of offsets in future (e.g. P208, 237).	Yes	Language tightened by use of 'will' rather than 'may'	
227	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.	Yes	Additional wording included. It is also covered in existing text in the table "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"	Table 10-1
	Waxy Cabbage Palm			
228	Please refer to discussions on the management table for the Carmichael River. We are able to discuss the WCP accordingly, if requested.	Yes	Management tables for WCP, DS and MS updated to reflect Department comments from Carmichael River.	
	Carmichael River			
229	Refer to discussions via teleconference about table 6-10.	Yes	Table 6-10 updated according to Department feedback in teleconference and subsequent track changes version.	Table 6-10
230	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.	Yes	More information regarding triggers for Carmichael River about baseflow trigger will be included. Output from springs, alluvial bores and flow rates. This information will also be updated after 2 year review and remodelling process.	

#	Department comments on version 10	Changes made?	Response	Report reference
231	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.	Yes	Revised text inserted to remove focus on WCP and include surface water flow and quality	Section 6.8
	Doongmabulla Springs			
232	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.	Yes	Management tables for WCP, DS and MS updated to reflect Department comments from Carmichael River.	
	Mellaluka Springs			
233	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.	Yes	Management tables for WCP, DS and MS updated to reflect Department comments from Carmichael River.	
234	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?	Yes	Corrective actions are in relation to triggers, not significant impacts, and timing is driven by that process. Post-closure impacts will be resolved through the modelling process and appropriate measures in place prior to closure (including offsets if required).	
235	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.	No	This comment has been addressed by the revisions and clarifications described above.	
236	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	Yes	Reference to new products added as suggested.	Section 1.4
237	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.	No	Linkages are clearly outlined. This plan is stand alone, as requested by the Department.	Not applicable.
238	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?	Yes	It is not possible to predict the probability of this event. New text added to Section 5.7 and 10.1 to cover this situation, including new listed species or endemic species.	Section 5.7 and 10.1
	Comments arising from GeoSciences Australia and CSIRO review			
	Groundwater model review			
239	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.	Yes	The groundwater model re-run within 2 years is covered in the GMMP. Updated reference included.	
	Pre-impact monitoring			
240	Please define a verification process to ensure pre-impact data is not impacted by mining operations if operations commence before this data is collected.	Yes	Commitment added to Section 10.2 that the Department will be notified at mining Stage closure and commencement.	Section 10.2
	Carmichael River			
241	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.	Yes	Baseline flow monitoring has been completed at the locations specified in Table 6-8. Two new gauging stations will be established – 1) upstream of the Mining lease/downstream of the Carmichael & Dylingo Creek confluence and 2) downstream of the Mining lease before the confluence with the Belyando River. Text revised in Section 6.6.1	Section 6.6.1
242	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.	Yes	Commitments included.	Section 6.6.1
	Doongmabulla Springs			
243	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.	Yes	Commitment made in GMMP and see new text in section 4.3.2 of this GDEMP.	Section 4.3.2.
244	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.	Addressed - no changes made	These have been included. Refer to Appendix B.	

#	Department comments on version 10	Changes made?	Response	Report reference
	Pre-impact monitoring			
245	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.	Addressed - no changes made	Clear commitment in Section 9.9. See also Section 10.1 which says the plan will be reviewed within 2 years of commencement.	Section 9.9 and 10.1
	Carmichael River			
246	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.	Yes	Streamflow triggers will be developed through the re-run of the groundwater model that is required within 2 years of the commencement of mining operations. See also response to Comment 241. See new text in section 6.6.1	Section 6.6.1
	Doongmabulla Springs			
247	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.	Yes	Commitment made in GMMP and see new text in section 4.3.2 of this GDEMP.	Section 4.3.2.
	Early-warning triggers			
248	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).	Yes	Rate limit material from GMMP has been incorporated into GDEMP, as agreed with DoEE.	
249	Please include similar rate limits in the GDEMP and GMMP to act as early-warning triggers for the Carmichael River.	Yes	Rate limit material from GMMP has been incorporated into GDEMP, as agreed with DoEE.	
	Compliance with early-warning thresholds, triggers and limits			
250	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.	Yes	Additional detail added to Section 5.6 to address comment. Difficult to assign timeframe as exceedances may be very simple or complex.	

FOI 190418
Document 4

From: Hamish Manzi
To: s22
Cc: s22 s47F ; s47F
Subject: GMMP Peer Review
Date: Wednesday, 20 March 2019 12:01:53 PM
Attachments: JBT01-055-004-GWMP Review.pdf

Good morning s22,

Please see attached correspondence from the approved peer reviewer of the GMMP as recently requested.

Kind regards,

Hamish

Hamish Manzi
Head - Environment & Sustainability
E Hamish.Manzi@adani.com.au
P office: +61 7 3223 4800 | direct: +61 7 3223 4837
A Level 25, 10 Eagle Street, Brisbane, QLD, 4000
P GPO Box 2569, Brisbane, QLD, 4001
W adaniaustralia.com

FOI 190418
Document 4a

JBT Consulting Pty Ltd
ABN 46 134 273 224
PO Box 1164
CARINDALE, QLD, 4152
Phone +61 7 3395 4552
Mobile +61 409 266 469

Our reference: JBT01-055-004

19 March 2019

s47F
Manager, Hydrogeology & Approvals
Adani Mining Pty Ltd
GPO Box 2569, Brisbane, QLD 4001, Australia

Review of Groundwater Management and Monitoring Program – Carmichael Coal Project

John Bradley of JBT Consulting Pty Ltd (JBT) has conducted an independent 3rd party review of a number of draft versions of the Groundwater Management and Monitoring Program (GWMMP) for the Carmichael Coal Project that have been prepared by AECOM Australia Pty Ltd (AECOM) . An independent 3rd party review of the GWMMP is a requirement of Condition 39(h) of the EPBC approval for the Carmichael Coal Project (the Project).

It is our understanding that Adani Mining Pty Ltd (Adani) have submitted the final draft[1] of the GWMMP to the regulator for review. It is our conclusion that draft report incorporates the changes and modifications that have been recommended by JBT and discussed with Adani and AECOM and that the 3rd party review process of the GWMMP has been completed.

Please contact the undersigned should you have any further queries.

Yours Faithfully,

John Bradley
Director/ Principal
JBT Consulting Pty Ltd

[1] Carmichael Coal Project – Groundwater Management and Monitoring Program, Draft 5, 22 January 2019. Report prepared for Adani Mining Pty Ltd by AECOM Services Pty Ltd.

FOI 190418
Document 5

From:	s22
To:	s47F "; Gregory Manning
Cc:	s22 ; s22 ; s22 ; s22 ; Post Approval; Hamish Manzi
Subject:	RE: EPBC 2010/5736: condition 5 - Updated Groundwater Dependent Ecosystem Management Plan (groundwater data) [DLM=For-Official-Use-Only]
Date:	Monday, 21 January 2019 2:08:57 PM
Attachments:	image002.png

HI s47F ,

I have successfully downloaded the PDF and word version with tracked changes. I have provided the PDF to GA and CSIRO and will get the word version to them later today.

s22
s22
s22 | E s22
W www.environment.gov.au

From: s47F [mailto s47F @adani.com.au]
Sent: Monday, 21 January 2019 11:26 AM
To: Gregory Manning
Cc: s22 ; s22 ; s22 ; s22 ; s22 ; Post Approval ; Hamish Manzi
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
s47F
Manager, Approvals
s47F @adani.com.au | www.adaniaustralia.com
Level 25, 10 Eagle Street, Brisbane, QLD 4000 | GPO Box 2569, Brisbane, QLD, 4001

FOI 190418
Document 6

From: s47F
To: s22
Cc: Post Approval; Hamish Manzi; s22
Subject: RE: EPBC 2010/5736 Groundwater Dependent Ecosystem Management Plan
Date: Friday, 15 March 2019 4:47:23 PM

COMMERCIAL IN CONFIDENCE

Good afternoon s22

Further to my email below, Adani has made some minor amendments to improve clarity, and rectify some clerical errors, in the Groundwater Dependent Ecosystem Management Plan.

I will also send a separate email that includes a link to our “sharefile” system, where you can download version 11a of the *Groundwater Dependent Ecosystem Management Plan (March 2019)*, and a document showing differences between version 11 of 6 March 2019 to this version.

Regards

s47F
s47F
Manager - Approvals
E s47F@adani.com.au
P s47F
A Level 25, 10 Eagle Street, Brisbane, QLD, 4000
P GPO Box 2569, Brisbane, QLD, 4001
W adaniaustralia.com

From: s47F
Sent: Wednesday, 6 March 2019 5:33 PM
To: 'Gregory Manning'
Cc: 'post.approvals@environment.gov.au' ; Hamish Manzi ; s22 @environment.gov.au' ; s47F ; s22
Subject: EPBC 2010/5736 Groundwater Dependent Ecosystem Management Plan
Importance: High

Commercial in Confidence

Dear Greg

Please find attached correspondence from Hamish Manzi, Head – Environment and Sustainability about the Groundwater Dependent Ecosystem Management Plan under controlled action approval EPBC 2010/5736. Also attached is a spreadsheet with the comments provided by your department in February 2019, and Adani’s responses.

I will also send a separate email that includes a link to our “sharefile” system, where you can download version 11 of the *Groundwater Dependent Ecosystem Management Plan (March 2019)*, and a document showing differences between version 10 from November 2018 and this version.

Could your team please acknowledge receipt via return email?

Regards

s47F

s47F
Manager - Approvals
E s47F @adani.com.au
P s47F
A Level 25, 10 Eagle Street, Brisbane, QLD, 4000
P GPO Box 2569, Brisbane, QLD, 4001
W adaniaustralia.com

FOI 190418
Document 7

From: s22
To: s47F
Cc: s22
Subject: RE: Meeting about groundwater late last year [SEC=UNCLASSIFIED]
Date: Monday, 7 January 2019 11:39:39 AM

Hi s47F

Attendees were as follows:

- Greg Manning (DoEE)
- s22 (DoEE)
- s22 (DoEE)
- s22 (DoEE)
- s22 (CSIRO)
- s22 (CSIRO)
- s22 (Geoscience Australia)
- s22 (Geoscience Australia)
- s22 (Geoscience Australia)

Cheers

s22

From: s47F [mailto s47F @adani.com.au]
Sent: Monday, 7 January 2019 9:28 AM
To: s22
Subject: Meeting about groundwater late last year

Hello s22

Are you able to please provide a list of attendees from the Commonwealth / Geoscience Australia / CSIRO at the video conference we had about groundwater late last year?

Regards

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

FOI 190418
Document 8

From: s22
To: "Hamish Manzi"
Cc: Lucas Dow; Dean Knudson; Gregory Manning; s22; James Tregurtha
Subject: RE: Revised Pathways document [SEC=UNCLASSIFIED]
Date: Thursday, 24 January 2019 3:55:59 PM

Hi Hamish

Thank you for your email and the attached information.

We now asked the CSIRO and Geoscience Australia to restart their review, now that we have updated groundwater management plans (GDEMP and GMMP) that are based on the updated data following the groundwater level quality assurance review. I note that Queensland agencies have not yet provided formal confirmation of the data, however on the basis of what you've provided below along with the updated plans we will move forward with the review.

The review has commenced as of today and it take four weeks. Please also note that we will be meeting with the CSIRO and Geoscience Australia to discuss revised timeframes and will let you know if there is a change to timing. Should Queensland formally advise that there remain groundwater bore data issues we will discuss with you prior to considering any decisions about the review.

As we've discussed, the Department has commenced its regulatory review of these plans. Following our conversations last week we will provide written feedback on the GDEMP in the coming days. Once we've done that we'll look at finalising our regulatory feedback on the GMMP.

Please let me know if you have any questions or concerns.

Regards

s22
s22

Director
Post Approvals Section
Environmental Standards Division
s22 @environment.gov.au
GPO Box 787 | CANBERRA ACT 2601 | AUSTRALIA
www.environment.gov.au/epbc

From: Hamish Manzi [mailto:Hamish.Manzi@adani.com.au]
Sent: Wednesday, 23 January 2019 9:21 PM
To: s22
Cc: Lucas Dow ; Dean Knudson ; Gregory Manning ; s22 ; James Tregurtha
Subject: RE: Revised Pathways document [SEC=UNCLASSIFIED]

Dear s22

I am writing to confirm that the Groundwater level quality assurance review is now complete. Our understanding is that you were seeking this confirmation in order to continue your review of these plans.

Broadly, the process that has been followed was:

1. Adani and our consultants have reviewed the groundwater level data sets and proposed a revised "measured" groundwater level for a number of bores
2. This material was provided to the QLD Department of Natural Resources, Mines and Energy for their review
3. DNRME responded to this with a request for further clarification or detail, specifically by bore if

required

4. Adani has responded to all those requests
5. Adani has subsequently incorporated that material into the GDEMP and GMMP

Adani have updated both the GDEMP and GMPP and transmitted those revised versions to the Department on the 21st and 22nd January respectively.

The attached memo provides further details of the quality assurance and materiality review that was conducted.

We look forward to now receiving the Department's comments on these plans.

Regards

Hamish

Hamish Manzi
Head of Environment & Sustainability
Off +61 7 3223 4800 | hamish.manzi@adani.com.au | www.adaniaustralia.com
Level 25, 10 Eagle Street, Brisbane, QLD 4000 | GPO Box 2569, Brisbane, QLD, 4001

From: s22 @environment.gov.au]
Sent: Friday, 4 January 2019 11:34 AM
To: Hamish Manzi <Hamish.Manzi@adani.com.au>
Cc: Lucas Dow <Lucas.Dow@adani.com.au>; Dean Knudson <Dean.Knudson@environment.gov.au>; Gregory Manning <Gregory.Manning@environment.gov.au>; s22 <s22 @environment.gov.au>; James Tregurtha <James.Tregurtha@environment.gov.au>
Subject: RE: Revised Pathways document [SEC=UNCLASSIFIED]

Hi Hamish

Thank you for confirming Adani's preferred pathway. Please note that when we received your email we spoke with the CSIRO and Geoscience Australia to let them know and indicated that they should continue reviewing aspects of the plans they can while the data issues are being resolved.

We are currently working through our 'regulatory review' of the GDEMP and will be in touch mid-next week before we send our feedback through.

Apologies for the delay in responding.

Kind regards

s22

Director
Post Approvals Section
Environmental Standards Division
s22 @environment.gov.au
GPO Box 787 | CANBERRA ACT 2601 | AUSTRALIA
www.environment.gov.au/epbc

From: Hamish Manzi [mailto:Hamish.Manzi@adani.com.au]
Sent: Friday, 21 December 2018 2:58 PM
To: James Tregurtha <James.Tregurtha@environment.gov.au>
Cc: Lucas Dow <Lucas.Dow@adani.com.au>; Dean Knudson <Dean.Knudson@environment.gov.au>; Gregory Manning <Gregory.Manning@environment.gov.au>; s22 @environment.gov.au>; s22 @environment.gov.au>

Subject: RE: Revised Pathways document [SEC=UNCLASSIFIED]

Good afternoon James,

Adani's preference is to continue on Pathway 1 as expeditiously as possible.

I understand from DES that DNRME have assigned additional resources to completed the quality assurance review, I was advised this morning that this will be completed on the 11th January. (DNRME have noted potential need for clarification from that review).

From that process, Adani will classify the significance of any groundwater reference level changes, as follows:

- Bores that were not used for the EIS Modelling process will be excluded as these have been QA checked separately and triggers can be developed from that check.
- A significance test for agreed (DNRM) changes to groundwater reference levels in the context of modelled impacts that would influence trigger levels in the GMMP
  (I have discussed this with John today, please note we are confirming this test with our hydrogeologist and will revert with details)
- If required, additional verification (we will also revert on these processes)

Adani will prepare and submit a revision of the GEDMP and GMMP which clearly shows any changes in relation to this groundwater reference level review.

I have also received interim feedback on the GMMP and GDEMP from DES today.

Regards,

Hamish

Hamish Manzi
Head of Environment & Sustainability
Off +61 7 3223 4800 | hamish.manzi@adani.com.au | www.adaniaustralia.com
Level 25, 10 Eagle Street, Brisbane, QLD 4000 | GPO Box 2569, Brisbane, QLD, 4001

From: James Tregurtha [mailto:James.Tregurtha@environment.gov.au]
Sent: Wednesday, 19 December 2018 1:37 PM
To: Hamish Manzi <Hamish.Manzi@adani.com.au>; Lucas Dow <Lucas.Dow@adani.com.au>
Cc: Dean Knudson <Dean.Knudson@environment.gov.au>; Gregory Manning <Gregory.Manning@environment.gov.au>; s22 [redacted]@environment.gov.au>; s22 [redacted]@environment.gov.au>
Subject: Revised Pathways document [SEC=UNCLASSIFIED]

Hi Lucas and Hamish,

As discussed with Hamish just now, here is a revised version of the pathways document that incorporates confirmation of our prior approval of Adani's groundwater model, and a couple of additional clarifying points from Geoscience Australia in the "Expected Characteristics" section of Pathway Two.

Regards

James

James Tregurtha
First Assistant Secretary - Environment Standards Division
Department of the Environment and Energy
Tel: 6274 1077 | Mob: 0434 567 487

FOI 190418
Document 9

From: Hamish Manzi
To: s22
Cc: Lucas Dow; Dean Knudson; Gregory Manning; s22 ; James Tregurtha
Subject: RE: Revised Pathways document [SEC=UNCLASSIFIED]
Date: Wednesday, 23 January 2019 9:21:36 PM
Attachments: Carmichael Coal Mine Groundwater level review Note 230119.pdf

---

Dear s22

I am writing to confirm that the Groundwater level quality assurance review is now complete. Our understanding is that you were seeking this confirmation in order to continue your review of these plans.

Broadly, the process that has been followed was:

1. Adani and our consultants have reviewed the groundwater level data sets and proposed a revised "measured" groundwater level for a number of bores
2. This material was provided to the QLD Department of Natural Resources, Mines and Energy for their review
3. DNRME responded to this with a request for further clarification or detail, specifically by bore if required
4. Adani has responded to all those requests
5. Adani has subsequently incorporated that material into the GDEMP and GMMP

Adani have updated both the GDEMP and GMPP and transmitted those revised versions to the Department on the 21st and 22nd January respectively.

The attached memo provides further details of the quality assurance and materiality review that was conducted.

We look forward to now receiving the Department's comments on these plans.

Regards

Hamish

Hamish Manzi
Head of Environment & Sustainability
Off +61 7 3223 4800 | hamish.manzi@adani.com.au | www.adaniaustralia.com
Level 25, 10 Eagle Street, Brisbane, QLD 4000 | GPO Box 2569, Brisbane, QLD, 4001

From: s22 @environment.gov.au]
Sent: Friday, 4 January 2019 11:34 AM
To: Hamish Manzi
Cc: Lucas Dow ; Dean Knudson ; Gregory Manning ; s22 ; James Tregurtha
Subject: RE: Revised Pathways document [SEC=UNCLASSIFIED]

Hi Hamish

Thank you for confirming Adani's preferred pathway. Please note that when we received your email we spoke with the CSIRO and Geoscience Australia to let them know and indicated that they should continue reviewing aspects of the plans they can while the data issues are being resolved.

We are currently working through our 'regulatory review' of the GDEMP and will be in touch mid-next week before we send our feedback through.

Apologies for the delay in responding.

Kind regards

s22

Director
Post Approvals Section
Environmental Standards Division
s22 @environment.gov.au

GPO Box 787 | CANBERRA ACT 2601 | AUSTRALIA
www.environment.gov.au/epbc

From: Hamish Manzi [mailto:Hamish.Manzi@adani.com.au]
Sent: Friday, 21 December 2018 2:58 PM
To: James Tregurtha <James.Tregurtha@environment.gov.au>
Cc: Lucas Dow <Lucas.Dow@adani.com.au>; Dean Knudson <Dean.Knudson@environment.gov.au>; Gregory Manning <Gregory.Manning@environment.gov.au>; s22 [redacted] @environment.gov.au>; s22 [redacted] @environment.gov.au>
Subject: RE: Revised Pathways document [SEC=UNCLASSIFIED]

Good afternoon James,

Adani's preference is to continue on Pathway 1 as expeditiously as possible.

I understand from DES that DNRME have assigned additional resources to completed the quality assurance review, I was advised this morning that this will be completed on the 11th January. (DNRME have noted potential need for clarification from that review).

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  (I have discussed this with John today, please note we are confirming this test with our hydrogeologist and will revert with details)
- If required, additional verification (we will also revert on these processes)

Adani will prepare and submit a revision of the GEDMP and GMMP which clearly shows any changes in relation to this groundwater reference level review.

I have also received interim feedback on the GMMP and GDEMP from DES today.

Regards,

Hamish

Hamish Manzi
Head of Environment & Sustainability
Off +61 7 3223 4800 | hamish.manzi@adani.com.au | www.adaniaustralia.com
Level 25, 10 Eagle Street, Brisbane, QLD 4000 | GPO Box 2569, Brisbane, QLD, 4001
Please consider the environment before printing this email

From: James Tregurtha [mailto:James.Tregurtha@environment.gov.au]
Sent: Wednesday, 19 December 2018 1:37 PM
To: Hamish Manzi <Hamish.Manzi@adani.com.au>; Lucas Dow <Lucas.Dow@adani.com.au>
Cc: Dean Knudson <Dean.Knudson@environment.gov.au>; Gregory Manning <Gregory.Manning@environment.gov.au>; s22 [redacted] @environment.gov.au>; s22 [redacted] @environment.gov.au>
Subject: Revised Pathways document [SEC=UNCLASSIFIED]

Hi Lucas and Hamish,

As discussed with Hamish just now, here is a revised version of the pathways document that incorporates confirmation of our prior approval of Adani's groundwater model, and a couple of additional clarifying points from Geoscience Australia in the "Expected Characteristics" section of Pathway Two.

Regards
James
James Tregurtha
First Assistant Secretary - Environment Standards Division
Department of the Environment and Energy
Tel: 6274 1077 | Mob: 0434 567 487

FOI 190418
Document 10

Carmichael Coal Mine – Groundwater level review

- Adani and our consultants have reviewed the 2011 to 2017 data sets with respect to groundwater reference levels for bores (41 of the 52 installed by Adani) that have been used for calibrating groundwater numerical model for the SEIS. The review was done to compare the groundwater level data used for SEIS calibration (period 2012-14) with more recent groundwater level data (period 2012-2017).
- Newer bores not used in the SEIS model were excluded from this review
- A report was submitted to DNRME for the bores in each hydrostratigraphic unit, with a justification for changes (if any) between the two data sets and a recommended (surveyed accurate) reference level
- DNRME have then reviewed this material, and where required have engaged with Adani before settling and agreeing on the data sets.
- DNRME will use this data in their public data set
- Adani will update the GDEMP and GMMP with this revised data set.
- Additionally, Adani have completed a materiality review of the revised groundwater levels which is presented below.

In undertaking the materiality review, consideration has been given to individual reference level adjustments as they pertain to the overarching objective and requirement of the GDEMP and GMMP plans. That is to say that a variation of the individual reference level may be significant as it relates to that individual bore, however it does not follow that such significance extends beyond that individual bore or mean that it is material in consideration of the entirety of the GDEMP and GMMP.

The purpose of this exercise was to review individually and collectively whether there was any significance associated with these reference level changes with respect to predicted groundwater drawdown and the groundwater model calibration.

The accuracy of model calibration, conducted during the SEIS based on the initial groundwater level data set, is best quantified by the RMS (root-mean-square) statistic as identified in the National Water Commission (2012) Australian modelling guidelines. This considers the totality of observations. Consequently, overall calibration performance cannot be judged on the basis of any one bore.

What is important for a single bore is not its reference level, or measured water level, but the residual of a simulated water level from the measured value. An indication of "significant variation" can be given by the RMS value for bores which was +/- 6.8 m at the time of the SEIS and is now +/- 7.6 m after corrections for modified bore reference levels. For this exercise, a significant variation was defined as +/- 7m. A residual of this magnitude at a given site would indicate that calibration is marginal at that site and not as good as other sites.

A total of 41 bores on the Adani mining lease have been examined for the difference between the reported SEIS measured water level, and the median of measured water levels from 2012 to 2017 (corrected where necessary for bore reference levels). The median difference was found to be 0.01 m. However, four (4) bores were found to have differences in excess of 2 m, due to bore re-surveying / elevation corrections.

The tables below provide a summary of the RMS for the bores installed by Adani for the SEIS and 2018 reviewed groundwater level data sets. The changes in calibration statistics are not material from a modelling perspective.

Table 1 Calibration statistics

	SEIS GWL data	2018 Reviewed GWL Data				
		Min	Max	Ave	Median	95%tile
Scaled RMS all bores	7.20%	7.33%	7.34%	7.33%	7.33%	7.33%
Scaled RMS- Adani Bores	12.20%	12.69%	12.96%	12.84%	12.85%	12.92%

Table 2 Individual bore level review results (metres)

Bore ID	Formation	GWL survey corrected and reported to DNRME	DNRME Review Process completed	SEIS - Measured	SEIS-Modelled	SEIS Variance between Modelled and Measured	Variance between SEIS Modelled and DNRME Reported	Difference between SEIS Variance and DNRME Reported Variance
C027P1	Alluvium	223.84	YES	224.79	222.11	-2.69	-1.74	0.95
C029P1	Alluvium	214.70	YES	214.63	219.18	4.55	4.48	-0.07
C025P1	Alluvium	216.72	YES	216.60	219.04	2.44	2.32	-0.12
C025P2	Tertiary	217.45	YES	217.92	219.04	1.12	1.59	0.47
C029P2	Tertiary	220.01	YES	220.20	218.18	-2.02	-1.83	0.19
C9845SPR	Tertiary	234.91	YES	234.21	233.01	-1.20	-1.90	-0.70
HD02	Clematis	234.36	YES	238.20	236.98	-1.22	2.62	3.84
C022P1	Dunda beds	246.66	YES	246.68	243.14	-3.54	-3.52	0.02
C027P2	Dunda beds	226.90	YES	226.59	224.83	-1.76	-2.07	-0.31
C180116SP	Rewan	239.46	*	238.07	240.87	2.80	1.41	-1.39
C035P1	Rewan	231.89	YES	232.19	228.31	-3.88	-3.58	0.30

Bore ID	Formation	GWL survey corrected and reported to DNRME	DNRME Review Process completed	SEIS - Measured	SEIS- Modelled	SEIS Variance between Modelled and Measured	Variance between SEIS Modelled and DNRME Reported	Difference between SEIS Variance and DNRME Reported Variance
C9838SPR	Rewan	228.74	YES	228.19	218.60	-9.59	-10.14	-0.55
C008P1	Bandanna/ Rewan	211.80	YES	211.82	221.58	9.76	9.78	0.02
C018P1	Bandanna	244.89	YES	245.14	254.30	9.16	9.41	0.25
C832SP	Bandanna	229.20	YES	223.34	219.99	-3.35	-9.21	-5.86
C847SP	Bandanna	232.59	YES	231.98	228.84	-3.14	-3.75	-0.61
C007P2	Bandanna	212.53	YES	212.39	221.51	9.12	8.98	-0.14
C008P2	Bandanna	213.40	YES	213.36	221.58	8.22	8.18	-0.04
C014P2	Bandanna	209.15	YES	209.69	226.32	16.63	17.17	0.54
C016P2	Bandanna	248.46	*	248.70	255.02	6.32	6.56	0.24
C018P2	Bandanna	242.45	YES	243.94	254.27	10.33	11.82	1.49
C020P2	Bandanna	220.66	*	220.99	233.21	12.22	12.55	0.33
C032P2	Bandanna	233.14	YES	233.08	228.88	-4.20	-4.26	-0.06
C035P2	Bandanna	232.84	YES	233.09	227.94	-5.15	-4.90	0.25
C011P1	Bandanna	230.03	YES	230.65	233.44	2.79	3.41	0.62
C034P1	Bandanna	230.96	*	231.92	224.56	-7.36	-6.40	0.96
C844SP	Bandanna	231.06	YES	231.25	227.76	-3.49	-3.30	0.19
C9839SPR	Bandanna	228.13	YES	227.20	218.61	-8.59	-9.52	-0.93
C006P3r	Colinlea	213.28	YES	213.19	221.44	8.25	8.16	-0.09
C007P3	Colinlea	216.93	YES	216.85	221.51	4.66	4.58	-0.08
C011P3	Colinlea	227.31	YES	227.34	233.18	5.84	5.87	0.03
C018P3	Colinlea	242.43	YES	242.28	253.50	11.22	11.07	-0.15
C024P3	Colinlea	228.88	YES	228.83	237.95	9.12	9.07	-0.05
C034P3	Colinlea	231.07	YES	231.40	224.59	-6.81	-6.48	0.33
C833SP	Colinlea	228.28	*	223.26	218.06	-5.20	-10.22	-5.02

Bore ID	Formation	GWL survey corrected and reported to DNRME	DNRME Review Process completed	SEIS - Measured	SEIS-Modelled	SEIS Variance between Modelled and Measured	Variance between SEIS Modelled and DNRME Reported	Difference between SEIS Variance and DNRME Reported Variance
C848SP	Colinlea	231.91	YES	231.45	228.66	-2.79	-3.25	-0.46
C834SP	Colinlea	227.60	*	223.19	219.34	-3.85	-8.26	-4.41
C840SP	Colinlea	228.01	YES	228.21	220.66	-7.55	-7.35	0.20
C9849SPR	Colinlea	231.88	YES	231.54	226.94	-4.60	-4.94	-0.34
C012P1	Joe-Joe	221.38	YES	221.34	233.16	11.82	11.78	-0.04
C012P2	Joe-Joe	221.35	YES	221.35	233.02	11.67	11.67	0.00

Note: For Bores marked * in the table above, Adani has responded to DNRME to address matters raised in the review process, and whilst awaiting a response from DNRME, is confident that all matters raised are addressed in full.

In order to determine whether the marginal variation in the calibration statistics (groundwater model accuracy) as a result of the longer and revised groundwater level data set at these sites will have a material impact on the predicted outcomes of the model the likely influence on the model needs to be considered.

The four bores found to have differences more than 2 m, due to bore re-surveying, include:

1. HD02 [Screened 26-32 m in Clematis Sandstone]
2. C832SP [Screened 90-99 m in Bandanna Formation]
3. C833SP [Screened 127-133m in Colinlea Sandstone]
4. C834SP [Screened 141-150m in Colinlea Sandstone]

The bore locations are highlighted in Figure 1.

Calibration results:

- The residual at HD02 has moved from -1.2 m (underestimate) to +2.8 m (overestimate). As this is well within the 7 m bandwidth, calibration has not been compromised by the HD02 correction.
- The residual at C832SP has moved from -5.3 m (underestimate) to -11.2 m (underestimate). As this is NOT within the 7 m bandwidth, calibration (at the bore within the larger scale model domain) has been compromised by the survey correction.
- The residual at C833SP has moved from -5.2 m (underestimate) to -11.3 m (underestimate). As this is NOT within the 7 m bandwidth, calibration (at the bore within the larger scale model domain) has been compromised by the survey correction.
- The residual at C834SP has moved from -3.8 m (underestimate) to -9.2 m (underestimate). As this is NOT within the 7 m bandwidth, calibration (at the bore within the larger scale model domain) has been compromised by the survey correction.

The scatter plots before and after survey correction are shown in Figure 2 and Figure 3 respectively. This shows how HD02 is still well calibrated but the other three bores have drifted out to the edge of the 7 m bandwidth limit.

Figure 4 indicates that calibration is very good in the Doongmabulla Spring Complex (DSC) area where HD02 is located. Therefore, the model calibration remains valid and the effect of re-surveying bore HD02 has no material consequence.

The other three bores are in close proximity to each other near the junction of ML70441 and ML70505, about 2 km south of the Carmichael River, the nearest feature of interest. They behave very similarly in the groundwater model; that is to say, the model reports similar calibrated groundwater levels (respectively 218.0, 218.1, 219.4 mAHD). As they are about 35 km to the east of the DSC, there can be no material impact on model predictions for the DSC springs.

The three bores are all deep (more than 100 m depth) and are screened at depths from 90 m to 150 m. Given their depth, they can have no material impact on any predicted baseflow impacts on Groundwater Dependent Ecosystems including the Waxy Cabbage Palm and the Carmichael River nor on any downstream riparian habitat.

Overall, the re-surveying of bores C832SP, C833SP and C834SP is unlikely to have any material consequence.

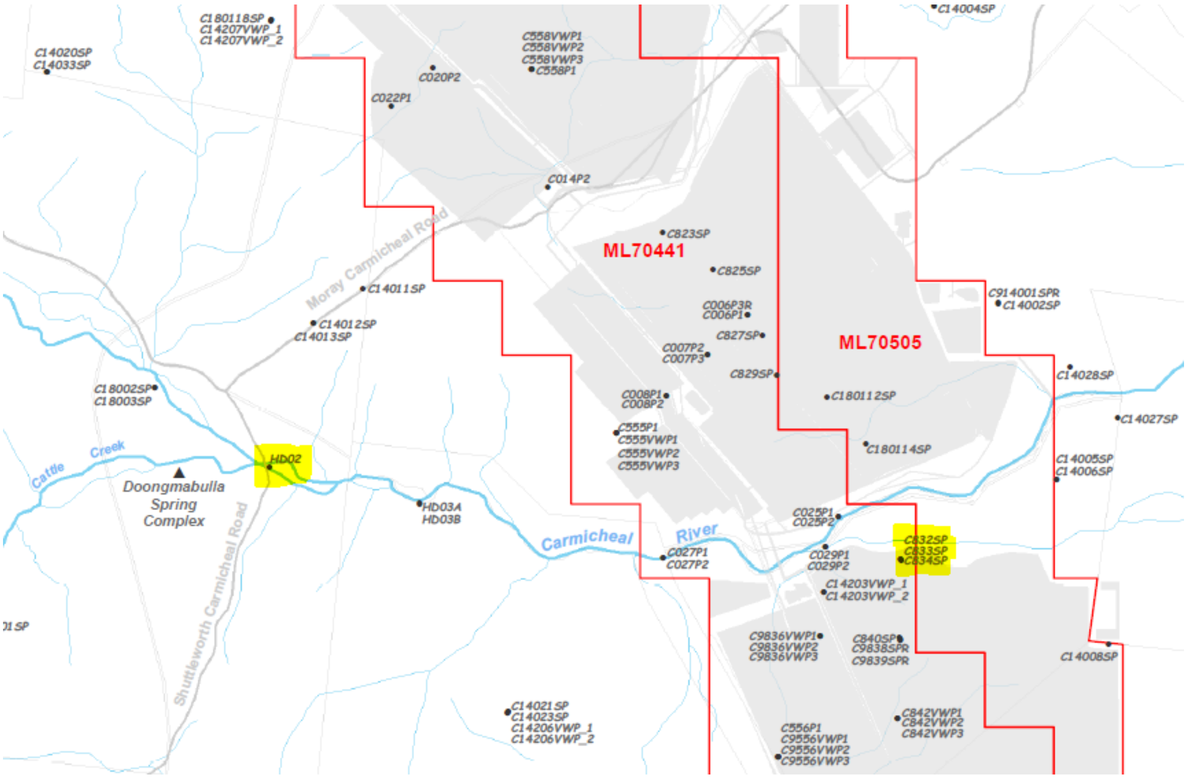


Figure 1. Groundwater monitoring bores

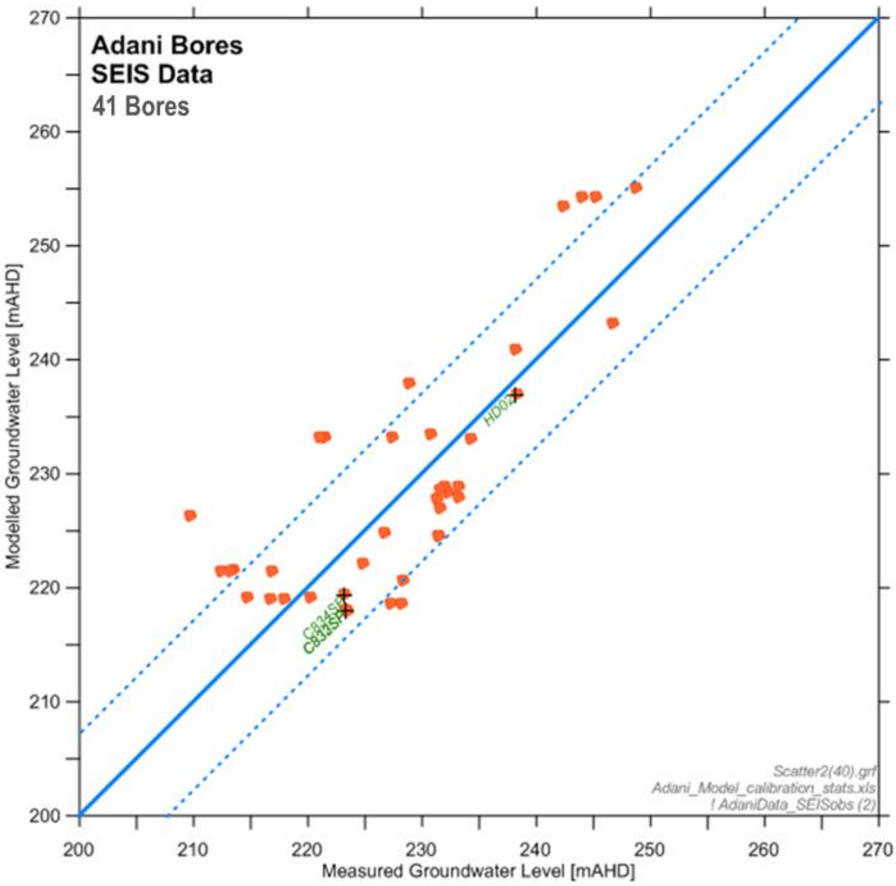


Figure 2. Calibration scatter plot at the time of the SEIS (before bore re-surveys) [±7m bandwidth]

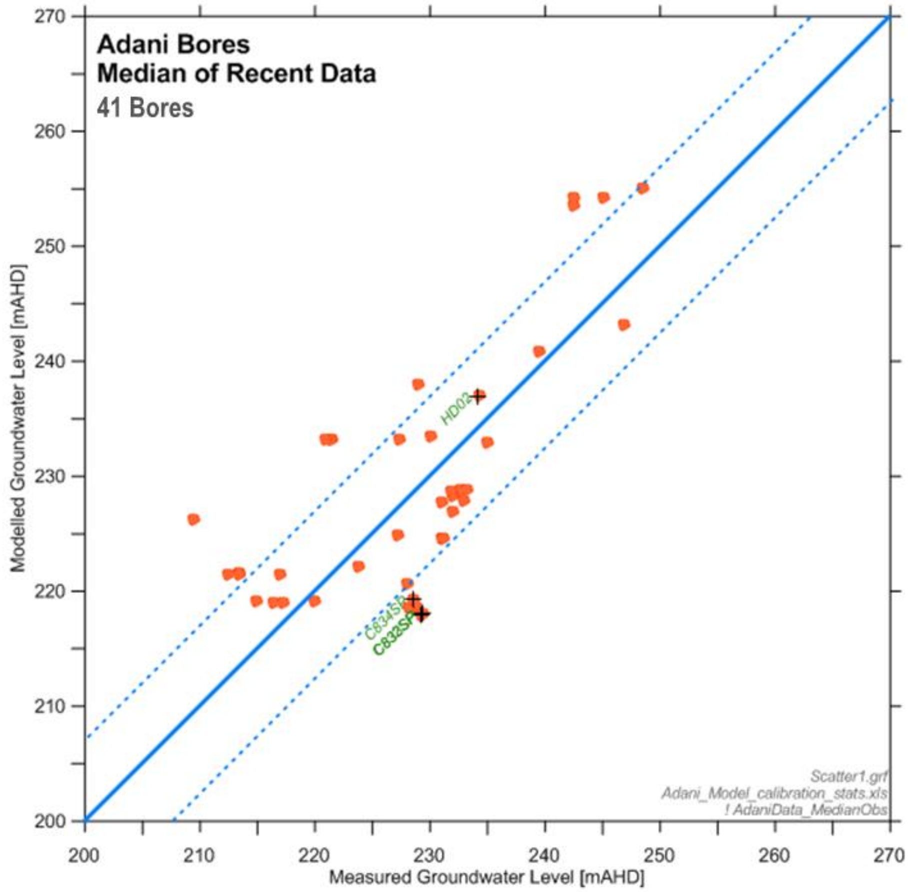


Figure 3. Calibration scatter plot of median 2014-2018 water level measurements after bore re-surveys [±7m bandwidth]

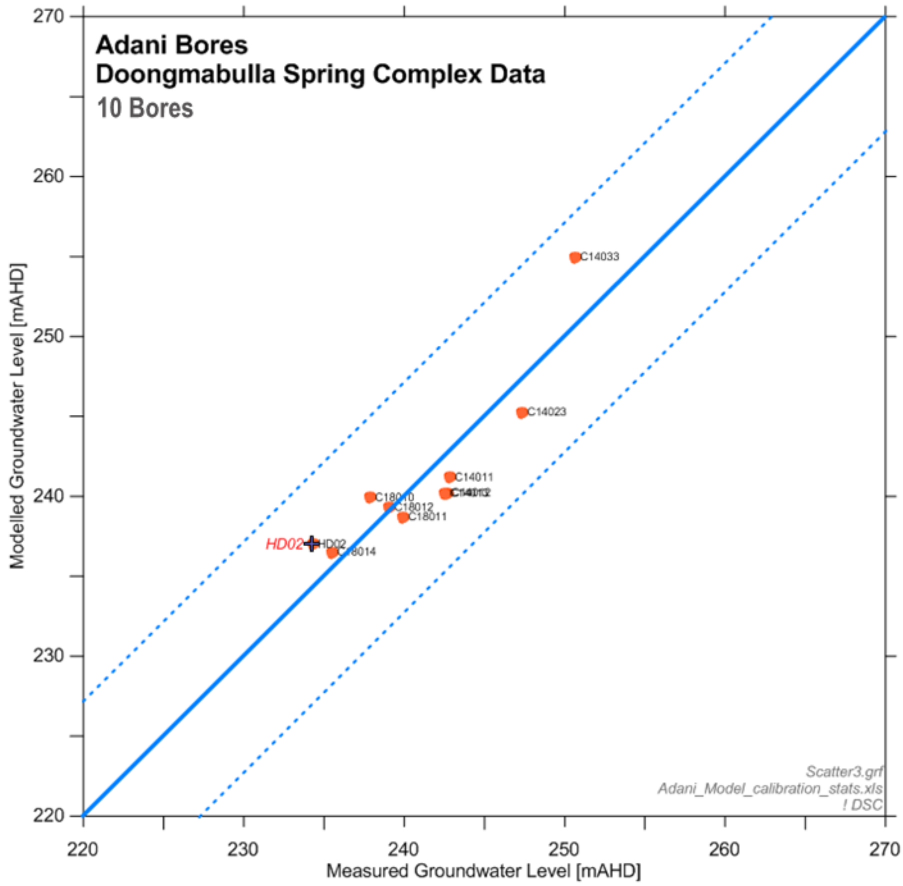


Figure 4. Calibration scatter plot for Doongmabulla Spring Complex bores for median 2014-2018 water level measurements after bore re- surveys [±7m bandwidth]

From: s22
To: "Hamish Manzi"
Cc: s47F "; s47F "
Subject: RE: GMMP [SEC=UNCLASSIFIED]
Date: Monday, 18 March 2019 3:34:11 PM

Hi Hamish
I can confirm receipt of the plan.
Cheers
s22

From: Hamish Manzi [mailto:Hamish.Manzi@adani.com.au]
Sent: Monday, 18 March 2019 2:14 PM
To: s22
Cc: s47F
Subject: RE: GMMP

Good afternoon s22
This link provides a clean copy of the GMMP sent through last Friday:
https://adaniau.sharefile.com/d-s22841add88f44ca9
Any questions, please let me know.
Kind regards,
Hamish

Hamish Manzi
Head - Environment & Sustainability
E Hamish.Manzi@adani.com.au
P office: +61 7 3223 4800 | direct: +61 7 3223 4837
A Level 25, 10 Eagle Street, Brisbane, QLD, 4000
P GPO Box 2569, Brisbane, QLD, 4001
W adaniaustralia.com

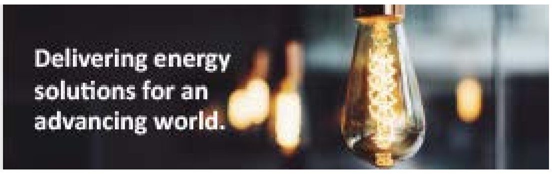
From: Hamish Manzi
Sent: Friday, 15 March 2019 3:33 PM
To: s22 @environment.gov.au>
Cc: s47F @adani.com.au>
Subject: GMMP

Good afternoon John,
Please see attached the GMMP with a number of edits following our discussion this morning.
Edits have been made to sections 3.5.4, 5.3.5.1, 6.2, 7 and Table 45.
We are in the process of completing a full pdf version and will send through once completed.
Kind regards,
Hamish

Hamish Manzi
Head - Environment & Sustainability
E Hamish.Manzi@adani.com.au

P office: +61 7 3223 4800|direct: +61 7 3223 4837
A Level 25, 10 Eagle Street, Brisbane, QLD, 4000
P GPO Box 2569, Brisbane, QLD, 4001
W adaniaustralia.com

adani Australia



FOI 190418
Document 12

From: s22
To: Gregory Manning
Cc: s22 ; s22 ; s22 s22 ; s22 ; Post Approval; Hamish Manzi
Subject: EPBC 2010/5736: condition 5 - Updated Groundwater Dependent Ecosystem Management Plan (groundwater data)
Date: Monday, 21 January 2019 11:26:04 AM
Attachments: image003.png
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
s47F
Manager, Approvals
s47F @adani.com.au | www.adaniaustralia.com
Level 25, 10 Eagle Street, Brisbane, QLD 4000 | GPO Box 2569, Brisbane, QLD, 4001

From: s47F
To: s22 s22 ; s22
Subject: FW: Confidential - table of feedback and responses - Groundwater Dependent Ecosystem Management Plan
Date: Thursday, 24 January 2019 1:08:12 PM
Attachments: image001.png
GDEMP-v9-DES comments_Adani_response Jan2019.pdf

For your information

From: s47F
Sent: Thursday, 24 January 2019 12:07 PM
To: s22
Cc: s22 ; Hamish Manzi
Subject: Confidential - table of feedback and responses - Groundwater Dependent Ecosystem Management Plan

COMMERCIAL IN CONFIDENCE

Good afternoon

Please find attached Adani's responses to the DES table of feedback provided about the Groundwater Dependent Ecosystem Management Plan.

Regards

s47F
s22, s47F
Manager, Approvals
s47F @adani.com.au | www.adaniaustralia.com
Level 25, 10 Eagle Street, Brisbane, QLD 4000 | GPO Box 2569, Brisbane, QLD, 4001

Regulatory Assessment

EA Condition requirement	How addressed in GDEMP	DES recommendation on v9 of GDEMP	Adani response Nov 2018
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.	For Waxy Cabbage Palm, **section 6.5** details the threats and impacts, while section 6.6 details the mitigation and management measures to be implemented to mitigate and manage the impacts. For the Carmichael River, **section 7.3** details the threats and impacts, while **section 7.4** details the mitigation and management measures to be implemented to mitigate and manage the impacts. For Doongmabulla Spring co-9mplex, **section 8.4** details the threats and impacts, while **section 8.5** details the mitigation and management measures to be implemented to mitigate and manage the impacts. For Mellaluka Spring complex, **section 9.3** details the threats and impacts, while **section 9.4** details the mitigation and management measures to be implemented to mitigate and manage the impacts.	The threats are adequately detailed, however the management of the threats and corrective actions need more detail (see below comments).	Noted – addressed in specific comments below Revised chapters now presented for each GDE across threats, management, mitigation and monitoring activities.
I12 The GDEMP must be approved by the administering authority in writing and the GDEMP published on a website before the commencement of Project Stage 2.	-	-	Noted
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 Spring Complex.	**Section 6** details status and description, ecology, known locations within the Project area, threats and impacts, mitigation and management measures and monitoring program for Waxy Cabbage Palm population – Livistona lanuginosa **Section 7** details location, ecological characteristics, threats and impacts, mitigation and management measures and monitoring program for the Carmichael River. **Section 8** details the GAB Spring Wetlands, Doongmabulla Spring Complex, ecological values, threats and impacts, mitigation and management measures and monitoring program for the Doongmabulla Springs Complex. **Section 9** details the ecology and distribution, known locations within the Project area, threats and impacts, mitigation and management measures, monitoring and trigger levels for Mellaluka Springs Complex.	The GDEMP addresses the relevant groundwater dependent ecosystems as required by condition I13.	Noted – no action required
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.	In the document tracking section it is stated that the GDEMP was prepared by Katrina Cousins, Rebecca McCue, Melissa Bruton, Chays Ogston, Brad Dreis, Miles Yeates and Mark Southwell. There are no details provided as to the suitability and experience of each of these people. **Section 1.3 – Relationship with other management plans and programs** details there is consistency if the GDEMP with the Adani GMMP, SWMP, REMP, GAB Springs Research Plan, and BOS. **Section 3.3 – Related policies and documents** details a list of documents that are relevant to the GDEMP including:-	a). Provide details of the qualifications and experience of the people that prepared the GDEMP. b). Provide details of which goals, mitigation and management measures and corrective actions are consistent with relevant threat abatement plans, conservation advice and project management plans in **Table 7 – Mitigation and management measures for *Livistona lanuginosa*, Table10 – Mitigation and management measures for Carmichael River and Table 15 – Mitigation and management measures for GAB springs wetland**	a). Details of persons that prepared the GDEMP can be provided in separate correspondence, including qualifications and experience, as was the case for the BTFMP b). Each GDE chapter has been updated to include these details, for example see Table 6-2 for the Carmichael River.

EA Condition requirement	How addressed in GDEMP	DES recommendation on v9 of GDEMP	Adani response Nov 2018
	the LEBSA project, EPP Water, and Wetland Monitoring Methodology. There is no mention of Water Resource Plan or Bioregional Management Plan or the Galilee bioregional assessment in the GDEMP. There are no details of how GDEMP interacts with the Regional groundwater and surface water monitoring and assessment program. **Section 6.6 Mitigation and management measures** (for *Livistona lanuginosa*) states that all relevant mitigation and management measures for *Livistona lanuginosa* are consistent with conservation advice but provides not detail as to how it is consistent with the advice. **Section 7.4 Mitigation and management measures** (for Carmichael River) states that the mitigation and management measures are consistent with conservation advice but provides not detail as to how it is consistent with the advice. **Section 8.5 Mitigation and management measures** (for Doongmabulla Springs complex) details the actions to mitigate and manage impacts on GAB springs under the National Recovery Plan for GAB spring wetland communities. This sections states that all relevant mitigation and management measures for Doongmabulla Springs Complex are consistent the recovery plan.	**communities in the Relevant condition, project commitment or management column.**	
1. must include a description and map of each GDE potentially or indirectly impacted by mining activities	Provided. In **sections 6.1 to 6.4** a description of *Livistona lanuginosa*, distribution of the species, ecology, known locations within the Project area are provided. **Figure 5** maps all known populations of *Livistona lanuginosa*, **Figure 6a, 6b, 6c and 6d** are maps of known populations of *Livistona lanuginosa* in the Project area. In **sections 7.1 and 7.2** the location of the Carmichael River and its ecological characteristics are detailed. **Figure 10** shows the Carmichael River catchment. The Carmichael River GDE as defined by the CG evaluation report is section of Carmichael River between Doongmabulla Springs Complex and the Belyando River – a 20km stretch of river. There are no monitoring points presented along the whole length for this GDE. In **sections 8.1** GAB Springs Wetlands, **8.1.2** GAB Springs Structure, **8.1.3** GAB Springs Wetlands, **8.1.4** GAB Springs Wetlands Ecology, **8.2** Doongmabulla Springs Complex, **8.2.1** Moses Spring Group, **8.2.2** Little Moses Spring-Group, **8.2.3** Joshua Spring Group, **8.3** Ecological Values descriptions of the Doongmabulla Springs complex is provided. **Figure 12** – Location of Doongmabulla springs complex, **Figure 13** – Moses spring group wetland areas, **Figure 14** – Moses Spring group mound springs, **Figure 15** – Little Moses Spring group, **Figure 16** – Joshua Spring group, **Figure 17** – *Eriocaulon carsonii* and *Eryngium fontanum* records –	Provide a map of the extent of the Carmichael River that is considered a GDE for this plan and the extent of the Carmichael River that will be impacted by the mining project and monitoring locations downstream of the mine on the Carmichael river before it intersects with the Belyando River. Provide a clear map of the three springs that make up the Mellaluka Springs complex.	Maps showing the GDE extent of the Carmichael River have been included in Section 6 and the Mellaluka Springs complex in Section 9

EA Condition requirement	How addressed in GDEMP	DES recommendation on v9 of GDEMP	Adani response Nov 2018
	provide adequate descriptions and maps of each GDE in the Doongmabulla springs complex. **Section 9.1** – Ecology and distribution (Mellaluka Spring complex, **Section 9.1.1** Mellaluka Springs group, **Section 9.1.2** Lignum and Stories Springs, **9.2** Known locations within the Project Area provide adequate descriptions of the Mellaluka Springs complex. **Figure 21** – Location of Mellaluka Springs complex is a map of the three springs location but is not specific.		
2. Must include detailed baseline monitoring (using QuickBird imagery or similar) **<u>to be undertaken</u>** on the specific ecology of each GDE, groundwater level, groundwater and surface water quality, threatened species and ecosystem function	The CG evaluation report states '*I consider it necessary for the proponent to establish a comprehensive baseline dataset on the current condition of the springs prior to the commencement of mining activities and an ongoing monitoring and reporting program.'* *Baseline monitoring of springs will be conducted before mining (at least one year of surveys prior to the commencement of mining operations), and monitoring against the established baseline will continue during mining operations on a quarterly basis and after mining commences.* The intent in the OCG report is clear that the baseline groundwater and ecological condition of each Groundwater Dependent Ecosystem is established prior to the commencement of mining activities. In the GDEMP, a staged approach to baseline monitoring is presented rather than the data from a baseline dataset. The GDEMP only provides details of the proposed baseline monitoring to be undertaken.	a). While the groundwater level, groundwater and surface water quality have been provided in the GMMP, this information must be provided in the GDEMP. Noting that any comments that may apply to this data are in the DES comments on the GMMP. There has been no baseline monitoring completed or provided on the specific ecology of each GDE, the threatened species and ecosystem function. This baseline monitoring of each GDE for its specific ecology, groundwater level, groundwater and surface water quality, threatened species and ecosystem function must be undertaken upfront and provided in the GDEMP. b). Stage 3 must be undertaken prior to impact.	Relevant information has been provided in the general approach (Section 5) and GDE plans (Sections 6-9) including water quality and quantity data and drawdown impact maps. Appendix B contains detailed information on groundwater level and quality triggers from the GMMP As discussed with the Department and agreed, existing EIS studies and work to date is included as baseline information. Pre-impact monitoring will commence for a two year period, longer for some GDE's at which point ecological triggers will be revised. Impact monitoring will commence from this point onwards.
3. Must include 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	In the CG evaluation report page 109 it states that the revised GDEMP should include additional information as follows: *'In addition to establishing the natural variation of spring flow and consistent with National Recovery Plan recommendations regarding spring flow monitoring, the proponent must establish as part of the GDEMP, the extent and composition of Doongmabulla Spring complex, in accordance with Fensham's Wetland Monitoring Methodology in the Great Artesian Basin (2009). This work must be completed prior to the commencement of activities that impact groundwater level or quality.'* The submitted draft GDEMP details the general proposed approach and rational in **section 5.3** – Monitoring approach and rationale, for Waxy Cabbage Palm in **section 6.10**, for the Carmichael River in **section 7.8**, for Doongmabulla Spring complex in **section 8.9** and for Mellaluka Spring complex in **section 9.5**	While detail of the baseline research proposed to establish the extent and ecological composition of each GDE is proposed and presented, this works needs to be undertaken and provided for approval of the GDEMP. Provide the detailed baseline research that establishes the extent and ecological composition of each GDE.	Baseline research (carried out prior to, during and post-EIS) is provided in the GDE plans. 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. The GDEMP provides detail of habitat features surveys and methodologies in accordance with the nominated Wetland Monitoring Methodology.
3 b) must include detailed baseline research to establish the source aquifer(s) for groundwater supply to the GDE	Not provided	Detailed baseline research that establishes the source aquifer for the groundwater supply to each GDE must be completed and presented for approval of GDEMP.	Baseline research (carried out prior to, during and post-EIS) is provided in the GDE plans. Section 8.3 provide details of source aquifer research undertaken that supports the conceptual model presented and approved through the EIS process.

EA Condition requirement	How addressed in GDEMP	DES recommendation on v9 of GDEMP	Adani response Nov 2018
3 c) must include detailed baseline research to establish the natural variation of the groundwater level/pressure	Provided via GMMP but not provided in this GDEMP.	The detailed baseline research that has been undertaken to establish the natural variation of the groundwater level/pressures for each aquifer that supports each GDE must be presented in the GDEMP.	Baseline research is presented in Section 8.3 and groundwater level triggers presented in Appendix B and within each GDE chapter which is based upon baseline groundwater monitoring inclusive of natural variation throughout that monitoring program.
3 d) must include detailed baseline research to establish the GDE ecosystem pressure response to groundwater level/pressure fluctuation	Not provided. It is understood that this will be determined in Stage 3 studies – Characterisation of ecological response to change. This must occur before the impacts occur.	The baseline research to establish the GDE ecosystem pressure response to groundwater level/pressure fluctuation must be presented in the GDEMP.	Baseline research is presented in Section 8.3 and groundwater level triggers are presented in Appendix B and within each GDE chapter, which is based upon baseline groundwater monitoring inclusive of natural variation throughout that monitoring program. Ecological triggers have been established in response to relevant groundwater triggers and are presented in Section 5.3.
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	**Section 5 – General Approach** details a management and monitoring framework and actions that address the potential threats from the Project. Management measures and monitoring, some completed, and some yet to commence have been identified for all stages of the Project (pre-construction, construction, operation and closure) and include: • comprehensive baseline surveys for GAB spring wetlands, Carmichael River and *Livistona lanuginosa* to determine the existing conditions, populations and values • development and implementation of a monitoring program to identify any changes in condition and physical characteristics as well as ecological responses from impacts to GDEs • identifying triggers that provide an early warning for potential impacts and warrant further investigation, monitoring and adaptive management measures • detailing specific management measures to minimise potential impacts and threatening processes from mining activities for each GDE **Section 6.7.6** details Trigger levels for impacts to *Livistona lanuginosa* and include thresholds related to groundwater levels, population health and population dynamics. These triggers will be reviewed following the completion of Stage 1 baseline studies, and then again following completion of groundwater model re-run (within 2 years of commencement of mining operations and every five years thereafter) and conceptualisation including Carmichael River baseline flow impacts on groundwater, undertaken during Stage 2. **Table 7 – Mitigation and management measures for *Livistona lanuginosa*** details the mitigation and management measures that will be implemented to minimise the impact of aquifer drawdown caused by mining.	a). Ecological triggers need to be revised based on the DES feedback above. b). Doongmabulla groundwater monitoring bores i.e. level thresholds should be also used for Carmichael river and *Livistona lanuginosa* if the source aquifer is the same for the baseflow of the River. c). Provide a description of how the results of baseline research and annual monitoring that will be used to determine changes in GDE ecology attributable to mining. d). In Table 17 - Confirmation of the Mellaluka source aquifer, while a necessary step to mitigation and management measures, is not a mitigation and management measure.	Each GDE Chapter is now structured to present: - Baseline conditions of the GDE - Threats to the GDE from project activities and relevant to conservation advices/recovery plans etc.. - Monitoring to assess ecological responses It is important to note that "changes in GDE ecology attributable to mining activities" as noted in this definition, can only occur concurrent to those activities. Hence the GDEMP now describes impact monitoring in more detail for each GDE. Relevant groundwater aquifers and bores have been presented for each GDE.

EA Condition requirement	How addressed in GDEMP	DES recommendation on v9 of GDEMP	Adani response Nov 2018
	Section 7.5.3 details that the GMMP will identify drawdown level thresholds for monitoring impacts to the Carmichael River based on updated ground and surface water modelling. Biological and ecological triggers for the Carmichael River GDE have been established and will be reviewed following the completion of the baseline surveys. Triggers identified include: changes in groundwater level, riparian community health indicators deviation more than 10%, remnant riparian habitat fauna use reduction by greater than 10%, id of new weeds, water quality, surface water flows and riparian zone rehabilitation **Table 10 – Mitigation and management measures for Carmichael river** details the mitigation and management measures that will be implemented to minimise the impact of aquifer drawdown caused by mining. **Section 8.6.3** details Triggers for Doongmabulla Springs complex that will be reviewed following baseline surveys and statistical analysis of the data. Trigger levels will be reviewed based on knowledge of natural baseline variation in the attributes monitored. Monitoring information will be supplemented with regional groundwater monitoring bores and baseline surveys conducted to find the causes and ecological responses of natural variation in flows. Using this information, changes to the wetlands that breach triggers will be able to be attributable to mining activity, natural variation or other activities impacting on the GAB. Low-risk trigger values 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. **Table 15 – Mitigation and management measures for GAB springs wetland communities** details the mitigation and management measures that will be implemented to minimise the impact of aquifer drawdown caused by mining. **Section 9.6** details low-risk trigger values for Mellaluka Springs complex – based on 10% deviation from baseline mean – wetland area, wetland pool depth, wetland vegetation zone margins and native wetland vegetation cover. **Table 17 – Mitigation and management measures for Mellaluka Springs complex** details the mitigation and management measures that will be implemented to minimise the impact of aquifer drawdown caused by mining. **Table 16 – Monitoring program for Doongmabulla spring complex** details baseline spring survey and photo monitoring		

EA Condition requirement	How addressed in GDEMP	DES recommendation on v9 of GDEMP	Adani response Nov 2018
	will occur quarterly for one year prior to mining activities. This is now – has this survey work been carried out? If so, it is recommended that the survey findings are presented in the GDEMP. No results of baseline research or annual monitoring have been presented to determine changes in GDE ecology attributable to mining. Tables 7, 10, 15 and 17 do not provide adequate monitoring to determine whether a trigger is met or adequately describe the corrective action. Further, the follow is required: 1. detail a mitigation and management measure under the Mitigation and Management Measure column, 2. must detail monitoring method and frequency to determine whether or not a trigger is reached. 3. the corrective actions must detail a timeframe for implementation.		
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	**Section 6.5 Threats and impacts** (*Livistona lanuginosa*) details the key threats and impacts from all stages of the project and **Table 6 – Potential impacts to *Livistona lanuginosa* from the Project** details the Potential impacts to *Livistona lanuginosa* from the project. **Section 7.3 Threats and impacts (Carmichael River)** and **Table 9 – Potential impacts on Carmichael River associated with the project** details the key threats and impacts from all stages of the project on the Carmichael River. **Section 8.4 Threats and impacts** (Doongmabulla Springs complex) and **Table 14 – Potential impacts from the Project on GAB springs wetland communities** detail all the key threats and impacts from all stages of the project on the Doongmabulla Springs complex. **Section 9.3 Threats and impacts** (Mellaluka Springs complex) and **Table 17 – Mitigation and management measures for the Mellaluka Springs complex** detail all the key threats and impacts from all stages of the project on the Mellaluka springs complex.	a). Include map of release points for mine affected water. b). An adequate description of the potential impacts to each GDE from each project stage including impacts from subsidence, mine dewatering of aquifers, water discharge, hydrological changes and weed and pest infestations is provided in the sections and tables detailed in previous row.	a). Map of release points is included as Figure 6-2 b). Restructured GDE sections (Sections 6-9) contain a summary of potential impacts, with project timing, in tables and discussed within section of impacts
6. Mitigation measures to be undertaken to avoid, mitigate, offset and manage impacts to GDE environmental values resulting from each stage of the project	**Section 6.6 Mitigation and management measures** (*Livistona lanuginosa*) and **Table 7 – Mitigation and management measures for *Livistona lanuginosa*** details all relevant mitigation and management measures for *Livistona lanuginosa* to be undertaken to avoid, mitigate, offset and manage impacts to WCP for each stage of the project. **Section 7.4 Mitigation and management measures** (Carmichael River) and **Table 10 – Mitigation and management measures for Carmichael River** detail all relevant mitigation and management measures for the Carmichael River to be undertaken to avoid, mitigate, offset and manage impacts to the Carmichael River for each stage of the project. **Section 8.5 Mitigation and management measures** (GAB springs wetlands communities) and **Table 15 – Mitigation**	a). The mitigation measures to be undertaken to avoid, mitigate, offset and manage impact to each GDEs environmental values resulting from each stage of the project have not been adequately detailed in the relevant sections and tables of the GDEMP. b). Provide detail of how the monitoring proposed in **Table 8** will directly address the impacts, identify the triggers, and instigate the mitigation and management measures detailed in **Tables 7, 10, 15 and 17.** c). The Mitigation measures specified must have the following: 1. Mitigation and management measures that addresses the actual impact.	a). Restructured GDE sections (Sections 6-9) describe mitigation and management measures, specific to potential impacts, with monitoring, trigger levels and corrective actions also described b). Restructured GDE sections (Sections 6-9) describe mitigation and management measures, specific to potential impacts, with monitoring, trigger levels and corrective actions also described c). Restructured GDE sections (Sections 6-9) describe mitigation and management measures, specific to potential impacts, with monitoring, trigger levels and corrective actions also described

EA Condition requirement	How addressed in GDEMP	DES recommendation on v9 of GDEMP	Adani response Nov 2018
	and management measures for GAB springs wetlands communities detail all relevant mitigation and management measures for the Doongmabulla Springs Complex. The mitigation and management measures detailed in the above sections do not provide adequate linkage to the monitoring and corrective actions. **Section 9.4 Mitigation and management measures** (Mellaluka Springs Complex) and **Table 17 – Mitigation and management measures for the Mellaluka Springs complex** detail all relevant mitigation and management measures for the Mellaluka Spring complex. The mitigation and management measures detailed in the above sections do not provide adequate linkage to the monitoring and corrective actions.	2. Relevant monitoring to establish whether a trigger value has been reach with defined frequency monitoring occurrence and 3. Corrective actions that actually counterbalance/address the impact. d). For example – **Table 7** – Mitigation and management measures for *Livistona lanuginosa* must provide the location of the gauging stations – the current base flow and the modelled loss of base flow and when this is likely to occur. e). For example – **Table 10** – where are the gauging stations going to be locate to monitor flow rates and when are they going to be installed and how regularly will the flow data be collected and analysed. Detail what the current base flow is and what is the predicted flow rate during and post mining and when will the flow rate be reduced. f). For example – **Table 15 - Mitigation and management measures for GAB spring wetland communities** –The measurement should be about any reduction of their measured extent, ecological values of springs with increase of groundwater drawdown in the relevant aquifer. g). The baseline monitoring should demonstrate the correlation of extent and ecology of GDE springs with groundwater natural variation. The trigger should be when a significant deviation from the natural variation of extent and groundwater level in the relevant aquifer. h). Monitoring of early warning bores should determine if the model predicted drawdown is accurate, the timing of drawdown and the extent of likely drawdown to determine if mining will impact on these springs and by how much. If groundwater drawdown at the early monitoring bore is greater than predicted at the predicted time of drawdown, then DOE and DES must be notified of the inaccuracy of the predictions and management measures should be implemented to ensure no unauthorised impacts to the springs occur. i). For example – **Table 17** – Detail the trigger values for groundwater drawdown. Including, how the baseline mean triggers for wetland area, wetland pool depth, wetland vegetation zone margins and native wetland vegetation cover are correlated with natural groundwater variation. Also, the corrective actions that will be implemented and when.	d). Baseflow impacts presented for WCP in section 7.4 e). Surface water flow monitoring will be carried out as per the REMP, detailed in Section 6.6 f). Revised ecological triggers for monitoring outlined in Section 8.7 g). Groundwater deviations are relevant to the GMMP as per relevant EA conditions h). Groundwater monitoring is required in the GMMP as per relevant EA conditions i). Groundwater monitoring is required in the GMMP as per relevant EA conditions. Triggers included in Appendix B

Additional Information about source aquifer for Doongmabulla Springs Complex submitted on 4 October 2018

Statement	DES Recommendation	Adani response Nov 2018
1. Adani has drilled six additional water monitoring bores outside the project area as well as two additional monitoring bores to the west of the Springs	It is recommended that the location and data attained from these bores be provided to the department to confirm the verification of the conceptual model by reference to comparisons of the relevant heads of groundwater in these bores and the springs.	Please refer to relevant GW Monitoring and modelling conditions in the EA. Adani will provide monitoring data to DES and DNRM as required.
2. Adani has drilled a further 3 bores through the Rewan Formation outside the project area and in between the project area and the Springs.	It is recommended that the location and data and the analysis of the core samples and geophysical logs from these bores be provided to the department to verify the thickness and uniformity of the Rewan formation to the west of the project area up to the springs	Adani has provided the Source Aquifer Research report in response to this request.
3. Adani has conducted laboratory tests on the above core samples to confirm the properties of the Rewan Formation.	It is recommended that laboratory tests of the core samples to confirm the properties of the Rewan Formation is provided to the department (as applied in the conceptual groundwater model and verifying the sensitivity analysis applied was adequate).	Adani has provided the Source Aquifer Research report in response to this request.
4. Adani has laboratory tested the properties of the strata above Permian coal measures (Rewan Formation) to investigate the inability or potential for faults to remain open and form an open hydraulic conduit.	It is recommended that laboratory test results for the properties of the strata above the Permian coal measures are provided to the department to confirm the absence of an open hydraulic conduit.	Adani has provided the Source Aquifer Research report in response to this request.
5. Adani has installed shallow spear point wells and surveyed the springs and associated spring mound to measure groundwater potentiometric levels and confirmed that heads match the corresponding heads in the Clematis and therefore confirmed that the Clematis is the source aquifer.	It is recommended that potentiometric levels of the spring survey and corresponding heads in the Clematis are provided to the department to confirm that the Clematis is the source aquifer.	Adani has provided the Source Aquifer Research report in response to this request.
6. Adani has re-assessed the regional geology for presence of faults or any other form of structural phenomenon and conclude that there is no evidence of existence of a significant geological structure which is likely to contribute to the flow of groundwater from lower Permian aquifers to upper Triassic aquifers through the Rewan Formation.	It is recommended that the results of the regional geology assessment are provided to the department to confirm the absence of significant geological structure which is likely to contribute to the flow of groundwater from lower Permian aquifers to upper Triassic aquifers through the Rewan Formation.	Adani has provided the Source Aquifer Research report in response to this request.
7. Adani has reviewed groundwater levels in all hydro-stratigraphic units (Triassic and Permian aged formations) to investigate the extent of movement of water vertically between different units. Groundwater levels indicate that the vertical groundwater gradients are upward above the Rewan Formation and downward below the Rewan Formation – inferring that the groundwater head in the Permian aquifer is insufficient to rise through the Rewan Formation to discharge to the Springs.	It is recommended that the review of the groundwater levels in all hydro-stratigraphic units (Triassic and Permian aged formation) to investigate the extent of movement of water vertically between different units is provided to the department.	Adani has provided the Source Aquifer Research report in response to this request.
The additional information provided in the letter dated 4 October 2018	It is recommended that the additional information provided in the letter to the department be included in the GDEMP. This must also include the additional results as requested above to justify the findings.	Adani has provided additional information in section 8.3 to support the requirements for the GDEMP.

Technical Assessment

Number	Section	Issue	Recommendation	Adani response Nov 2018
1	Section 8 – Doongmabulla Springs Complex and Section and 9 – Mellaluka Springs Complex	Further detail is required regarding the research undertaken to determine and/or verify the source aquifers of the Mellaluka Springs complex and the research undertaken to determine and/or verify the source aquifer for Doongmabulla Springs Complex. Additionally, more detail is required as to how the results of the baseline research and annual monitoring are to be used to determine any changes in GDE ecology attributable to mining activities.	Provide more detail on the proposed research to determine the source aquifer for Mellaluka Springs Complex and the research undertaken to determine the source aquifer for Doongmabulla Springs Complex. Provide detail on how results of the baseline research and annual monitoring will be used to determine changes in GDE ecology attributable to mining activities. Stage 1 and Stage 2 surveys and monitoring are omitted for Mellaluka Springs Complex – these need to be included.	Adani has provided additional information in section 8.3 and section 9.4 to support the requirements for the GDEMP. Each GDE chapter provides details of ecological triggers derived from baseline monitoring and the process by which these will be reviewed and revised after pre-impact monitoring concludes, prior to the commencement of impacting activities and concurrent monitoring.
2	Appendix D	Appendix D includes which indicators that a power analysis will be undertaken on to determine whether the number of sites is sufficient. However, there is no discussion of whether the frequency of baseline monitoring is sufficient to determine change. Also in Appendix D it states that multivariate ordination analysis will be used to assess change in biological communities, however, this is not reflected in the trigger values presented in the main part of the GDEMP.	Determine the frequency of monitoring that is required to determine change. The GDEMP needs to contain accurate and consistent information with respect to the statistical analysis that will be applied to each indicator and trigger.	Each GDE chapter has been updated to include this relevant material, see sections 6.7, 7.7, 8.8, 9.9.
3	Table D2 – Summary of hypothesis, trigger and statistical analysis for each monitoring parameter	Table D2 in Appendix D provides the hypothesis, trigger values and statistical analysis proposed for the GDEMP. This is not reflected in the main part of the GDEMP. Current triggers are not included in Section 5.3.2 or the relevant table or are referred to differently between Sections, Mitigation and Management table and Appendix D.	Consistency is required between **Section 5.3.2**, Mitigation and Management tables for each GDE (**Table 7, Table 10, Table 15** and **Table 17**) and Appendix D. It is recommended that **Table D2** be incorporated into the main part of the GDEMP.	Appendix D has now been incorporated into each GDE chapter
4	General	The GDEMP refers to groundwater quality and quantity trigger values that are derived in the Groundwater Monitoring and Management Plan (GMMP).	The GDEMP cannot be finalised until the groundwater quality and quantity trigger values in the GMMP are finalised and inserted in the GDEMP.	Refer to Appendix B
5	Section 4.2 Ecological values of groundwater dependent ecosystems	The last sentence states 'The Carmichael River also supports a large population of *Livistona lanuginosa* and provides habitat for numerous threatened fauna species, especially the Black-throated Finch and Koala'. While Koalas have been located along the Carmichael river, there is not sightings of black-throated finch in the vicinity of the river and therefore it is inaccurate to state that it provides habitat for BTF.	Revise to be accurate.	Revised
6	Section 5.1.1	P29 states 'Stage 1 studies will be commenced prior to the construction phase of the mine.' Does this mean this will be undertaken now?	Provide a clear timeframe for the occurrence of each stage of the GDEMP. Provide a timeframe of when Stage 1 and each Stage of 2 and 3 baseline studies will be completed.	Timing and staging clarified, see Table 2-1
7	Section 5.3.1 – Baseline monitoring	Baseline monitoring states that '*Baseline studies will be undertaken for the Doongmabulla Spring complex, Livistona lanuginosa and Carmichael river GDEs*'. However, triggers of the Mellaluka Spring Complex are provided in Section 5.3.2 based on a 10% change from baseline conditions.	Therefore, baseline studies are required to be undertaken for the Mellaluka Spring Complex and should be added to the statement in **Section 5.3.2**, 1st dot point in **Section 10.1** and **Section 10.2**.	Clarification provided with regards to baseline work that has been completed and the triggers established on that baseline work (Section 5.3). 10% change removed and replaced with "statistically significant change" throughout the GDEMP.

Number	Section	Issue	Recommendation	Adani response Nov 2018
8	Section 5.3.2 Triggers	Ecological triggers for the Carmichael River do not include an aquatic ecology trigger. Ecological triggers for *Livistona lanuginosa* No 4. Deviation of >10% from baseline conditions of riparian community health (CORVEG surveys). This is reflective of the riparian health not the *Livistona* populations health. It was suggested that in order to assess change in biological communities, <u>it is more appropriate to use a multivariate analysis which determines whether there has been a statistically significant change in species composition or conditions rather than an arbitrary 10% change from baseline conditions.</u> All triggers identified in **Section 5.3.2** should be included in the Mitigation and Management tables for each GDE (**Table7, Table 10, Table 15**, and **Table 17**). Currently triggers are not included in **Section 5.3.2** or the relevant Table or are referred to differently between Sections and Tables.	It is recommended that an aquatic ecology trigger based on the baseline survey in **Section 7.5.1** be included. Also recommend adding stream flow as an ecological trigger for Carmichael River. It is mentioned further in the specific section on Carmichael river (s7) but not here. For the ecological triggers for *Livistona lanuginosa* - It is recommended that ecological trigger 4 be the condition of the *Livistona lanuginosa* community health not riparian community health. It is recommended that the ecological trigger are when there is statistically significant change detected rather than 10% change from baseline conditions. It is recommended adding spring flow as an ecological trigger for Doongmabulla springs. It is mentioned in the specific section on Doongmabulla (s8) but not here.	Clarification provided with regards to baseline work that has been completed and the triggers established on that baseline work (Section 5.3). 10% change removed and replaced with "statistically significant change" throughout the GDEMP. Spring flow considered and will be monitored but is unreliable as a trigger due to the considerable influence landholder activities have on spring flow, particularly from the Joshua Spring.
9	5.5 Overview of method	The management of weeds and pests is outside of Adani's control on land owned by others. The ecological condition of the GDEs and resilience to groundwater drawdown impacts associated with mining activities can be improved by minimising additional impacts from weeds, feral animals and grazing. Adani should consider how management activities could be negotiated with landholders to enhance the GDEs condition on land outside Adani's control and this could be a positive mitigation and management measure for the GDE values.	Provide consideration to landholder negotiation to achieve better ecological condition of GDEs to increase their resilience to groundwater drawdown impacts – such implementing weed control, feral animal control and grazing control around GDEs.	Consideration provided and detailed in Tables 6-10, 7-6, 8-10, 9-3.
10	Section 6.5 Threats and impacts – *Livistona lanuginosa* – Table 6 – Changes in hydrology	Potential impacts associated with the project – residual impact of 21.7ha of habitat – no map to show where this potential impact may occur.	Provide map depicting area of potential residual impact of 21.7ha of *Livistona lanuginosa* habitat	Map has been provided in Section 7.4
11	Section 6.6 Mitigation and management measures – Table 7 Mitigation and management measures for *Livistona lanuginosa*	For the performance criteria – Limit impact of hydrological changes in *Livistona lanuginosa* habitat from mine dewatering. Please provide details of the bores that will be used to monitor the alluvium and groundwater level threshold limits and groundwater quality trigger values. Under the mitigation and management measures, triggers and corrective actions consider a negotiated outcome for weed and pest control with adjacent landholders to increase the resilience of the *Livistona lanuginosa* populations to groundwater drawdown impacts.	Identify the relevant groundwater bores and update the table to include approved groundwater level threshold limits and groundwater quality trigger values as per approved GMMP when approved. Include weed and pest management mitigation measures for all GDEs to increase resilience to groundwater drawdown impacts. Include information from Joshua Spring seasonal flow monitoring and provide detail as to how this affects base flow in the Carmichael River. Provide implementation and corrective actions within specified timeframes.	Refer to Appendix B for full details and also Table 4-1. See note above regarding Joshua spring flow monitoring. See Table 7-6 for timing of actions.

Number	Section	Issue	Recommendation	Adani response Nov 2018
		The flow monitoring at Joshua Spring may used to monitor base river flow and determine natural seasonal variation in base river flow.		
12	Section 6.10 Monitoring program Table 8 – Monitoring Program for *Livistona lanuginosa*	Groundwater monitoring – detailed groundwater drawdown triggers not included. Weed and pest surveys in Stage 2 are detailed to occur only once in every two years and not listed at all for Stage 3. Consider monitoring *Livistona lanuginosa* populations outside Adani land for weed and pest infestations	Identify the relevant groundwater bores and provide approved groundwater level threshold limits and groundwater quality trigger values as per approved GMMP and when approved. Must include annual monitoring for weeds and pest species in all stages. Consider monitoring all *Livistona* populations for condition, weeds and pest in order to ensure greater resilience to groundwater drawdown impacts.	Refer to Appendix B for full details and also Table 4-1. See sections 7.4/7.5/7.6 and Table 7-6 regarding weed and pest impacts and monitoring.
13	Section 6.7 Baseline *Livistona lanuginosa* population survey	At least five monitoring sites will be located within three key zones: upstream of predicted impact (control site), in the area of predicted groundwater impact area and downstream from the predicted groundwater impact (**Figure 8**). If possible, monitoring sites will be co-located with existing groundwater monitoring bores such as C027P1, C029P1, HD03 B, C14027, C14028 and C025P1.	It is recommended that the *Livistona lanuginosa* population and condition surveys be done at the same locations as the groundwater monitoring bores so that a comparison between the changes in *Livistona lanuginosa* and groundwater levels can be determined.	Refer to Figure 7-9 for monitoring locations which have been collocated where possible.
14	Section 7.3 Threats and impacts (to Carmichael River)	The 800m stretch of the Carmichael River expected to experience larger impacts is undefined.	Provide a map showing the '800m stretch' of the Carmichael River that is expected to experience larger impacts.	Not clear what this referring to. Details of impacts to Carmichael River presented in Section 6.4
15	Section 7.4 Mitigation and management measures (for Carmichael River) – Table 10 – Mitigation and management measures for Carmichael river	Under the Goal – Minimise the impacts of water drawdown on the Carmichael River – groundwater drawdown thresholds and groundwater quality trigger values are not provided. No detail is provided with respect to groundwater base flows. No locations of gauging stations are provided at which surface flow rates will be monitored. While surface water monitoring is presented in Table 11 and surface water monitoring for releases in Table 10 there is no surface water monitoring triggers presented for the Carmichael River for changes in baseflow. The Pest Management Plan specifies the removal of Rubber Vine infestation in the bed of the Carmichael River only.	Identify the relevant groundwater bores and provide approved groundwater level threshold limits and groundwater quality trigger values as per approved GMMP when approved. Provide details of the groundwater base flow and surface water monitoring of changes in base flow. Provide map showing the locations of gauging stations at which surface flow rates will be monitored. The Pest Management Plan should include the removal of all Rubber Vine infestations on the bend and banks of the Carmichael River between Doongmabulla Springs complex and the confluence of the Carmichael River with the Belyando River. The GDE extent of the Carmichael River that needs to be monitored is from 8 km upstream of the western boundary upstream of the mining lease to the confluence of the Belyando River.	Refer to Appendix B for full details and also Table 4-1. Refer to sections 6.4 through 6.9 for updated material on threats, impacts and management and monitoring for this GDE.
16	Section 7.5	Carmichael River groundwater level monitoring will be undertaken continuously and surface water flow monitoring will be undertaken upstream, downstream and within the Project area.	It is recommended that the Carmichael River groundwater and surface water quality monitoring be designed to complement each other and determine the potential interactions between the groundwater and surface water.	These are separate conditions in the EA and should not be compromised through the GDEMP process. The collation and use of groundwater and surface water information relevant to this GDE has been included though, see sections 6.5 through 6.9.
17	Section 7.5.1 Baseline surveys (Carmichael River)	Some of the proposed actions need to be carried over into other parts of the report: e.g. **Section 7.5.1** discusses surveys of remnant pools in the Carmichael River and aquatic ecology survey of species in those	Ensure all sections are consistent	Completed.

Number	Section	Issue	Recommendation	Adani response Nov 2018
		pools. This has not been transcribed over into Table 11 – Monitoring program for the Carmichael River.		
18	Section 7.8 Monitoring Program for Carmichael River Table 11 – Monitoring Program for the Carmichael River	Groundwater monitoring – drawdown triggers not provided. States that weed and pest surveys will be undertaken along the Carmichael River in the Project area and in sections of the river corridor under the control of Adani, however, upstream infestations will travel downstream and re-infested areas controlled by Adani.	Identify the relevant groundwater bores and provide approved groundwater level threshold limits and groundwater quality trigger values as per approved GMMP when approved. It is recommended that collaboration with upstream neighbours is proposed and that weed and pest surveys occur upstream of Moray Downs to ensure no infestations travel downstream and re-infest areas Adani controls.	Refer to Appendix B for full details and also Table 4-1. Refer to Section 6.9 for updated management and mitigation measures.
19	Section 8 – Doongmabulla Spring Complex	There is no detail of the baseline research to establish the source aquifer(s) for groundwater supply to Doongmabulla Springs complex.	Provide a full section that details of all baseline research/investigations that Adani has completed to establish the source aquifer for groundwater supply to Doongmabulla Springs complex. It is recommended that this include as many lines of evidence as available such as flow maps and geochemistry, hydraulic properties of relevant units, and a robust conceptual model.	Please refer to sections 8.1 through 8.5.
20	Section 8.4 Threats and impacts page 119	States – 'These aquifer drawdown impacts are not expected to commence until approximately 2020, with the reduction in pressure of the aquifers expected by approximately 2035 (GHD 2014). No detail is provided as to what the flow rate towards the pit is from the aquifer and what the time lag for impacts at Doongmabulla Springs Complex is expected.	Provide information of how and when the aquifer drawdown impacts at Doongmabulla Springs Complex and each GDE is expected to occur.	Provided in section 8.5.
21	Table 12 – Modelling predictions for aquifer springhead pressure reductions in spring groups associated with Doongmabulla Spring Complex – Operational phase and Table 13 – Modelling predictions for aquifer springhead pressure reductions in spring groups associated with the Doongmabulla spring complex	There is no explanation in the GDEMP regarding with difference between the predicted drawdown in the source aquifer between the Option 1 and Option 2 models presented in Tables 12 and 13. The option used to predict the impacts must be identified.	Provide an explanation of why there are differences in the predicted drawdown in the source aquifer between Option 1 and Option 2 models. It is unclear which option/model scenario has been used as the basis for predictions in the GDEMP and GMMP.	Has been updated throughout Section 8.
22	Table 15 – Mitigation and management	There is no mention or discussion with respect to groundwater drawdown early warning thresholds, which	Provide more detail of early warning drawdown thresholds at bores between the mine and the springs	Provided in section 8.5, 8.6 and 8.7

Number	Section	Issue	Recommendation	Adani response Nov 2018
	measures for GAB springs wetlands communities	are vital to the management of possible groundwater drawdown impacts to the springs.	and how these will be used to measure and mitigate impacts.	
23	Table 16 – Monitoring Program for Doongmabulla springs complex	Flow should be measured at one of the other springs as well as Joshua Spring. Early warning groundwater thresholds and groundwater quality need to be provided for each stage. Groundwater monitoring and modelling – the description is too vague.	Identify the relevant groundwater bore and provide approved groundwater level threshold limits and groundwater quality trigger values as per approved GMMP when approved. Provide details as to which bores will be monitored and why.	Provided in section 8.5, 8.6 and 8.7 Also refer to Appendix B
24	Figure 20a – Groundwater monitoring bores Figure 20b – Groundwater monitoring bores Figure 20c – Groundwater monitoring bores	These figures are fuzzy and unclear to read.	Provide figures that are clear and easy to read. It is recommended that the bore locations be provided with direction of flow and maximum drawdown extent contours also shown on the relevant figures.	All figures revised and updated.
25	Section 9 – Mellaluka Spring Complex	'*The Mellaluka spring-complex aquifer is believed to be located in the Permian strata, although additional studies are required to confirm this because there is very little information available regarding this springs-complex (GHD 2014).*' This is a very limited description of the source aquifer for these springs.	Further detail is required regarding the research proposed to determine the source aquifer(s) of the Mellaluka Spring Complex. The groundwater drawdown and decrease in pressure and flow has been predicted for the Carmichael river, Doongmabulla Springs Complex and Mellaluka Springs Complex. These predictions are based on the source aquifer, therefore, the predicted impact of the Mellaluka Spring Complex may not be accurate based on the assumed source aquifer. Provide a full section that details of all baseline research/investigations that Adani has completed to establish the source aquifer for groundwater supply to Mellaluka Springs complex.	Please see section 9.4 for additional details. This is based on work from the EIS modelling which has been approved.
26	Figure 21 – Location of Mellaluka springs complex	The figure does not show the actual location of Mellaluka springs	Provide a figure that shows the actual location of the Mellaluka springs.	See sections 9.1 and 9.2
27	Section 11 – Reporting and Compliance	Any revision of the GDEMP must be approved by DES as well as the DoE.	Amend to include amendment approval by DES.	See updated section 10.2

Overall comments

Comment	Adani response Nov 2018
1. The GDEMP does not identify the source aquifer of the Doongmabulla springs complex but refers in section 9.4 to ongoing monitoring (GMMP) to update groundwater model and to confirm the source aquifer of the Mellaluka Complex.	Noted – further text from the GMMP has been bought into the GDEMP
2. For all indicators measured in the GDEMP, the number of samples that would be needed to calculate the test statistic and determine natural variability and potential impacts needs to be determined and included in the GDEMP.	Not all triggers are quantitative and the inclusion of an investigation trigger of "statistically significant deviation" has been included. Therefore the number of samples needed is not a useful measure of each trigger.

3. The information provided in Table D2 in Appendix D is crucial information for the GDEMP and should be incorporated in a better manner into the main part of the GDEMP document. However, the statistical analysis provided in the table is unclear. The statistical analysis is described for a number of triggers to be a descriptive comparison (see below examples). It is unclear what is meant by this. Provide information about whether this is related to the control charts approach described in Appendix D.	All information from Appendix D has now been integrated throughout the GDEMP.
4. For a number of triggers the statistical analysis provided is not appropriate. See the example below. Details how a SIMPER provide a measure of deviation of >10% in baseline condition. A SIMPER analysis provides a breakdown of the contribution of each species (or other variable, condition metric) to the observed similarity (or dissimilarity) between samples. It allows the identification of the condition metric that are most important in creating the observed pattern of similarity not whether there has been a 10% change from baseline condition	Triggers have been revised and no longer refer to a 10% deviation from baseline conditions.

FOI 190418
Document 14

From: Hamish Manzi
To: s22
Cc: s47F
Subject: GMMP
Date: Friday, 15 March 2019 4:34:58 PM
Attachments: GMMP_CCP_07032019_V7_Master_final_edits.pdf

Good afternoon s22,

Please see attached the GMMP with a number of edits following our discussion this morning.

Edits have been made to sections 3.5.4, 5.3.5.1, 6.2, 7 and Table 45.

We are in the process of completing a full pdf version and will send through once completed.

Kind regards,

Hamish

Hamish Manzi
Head - Environment & Sustainability
E Hamish.Manzi@adani.com.au
P office: +61 7 3223 4800 | direct: +61 7 3223 4837
A Level 25, 10 Eagle Street, Brisbane, QLD, 4000
P GPO Box 2569, Brisbane, QLD, 4001
W adaniaustralia.com

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Adani Mining Pty Ltd
15-Mar-2019

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Groundwater Management and Monitoring Program

Carmichael Coal Project

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Groundwater Management and Monitoring Program

Carmichael Coal Project

Client: Adani Mining Pty Ltd

ABN: 27 145 455 205

Prepared by

AECOM Services Pty Ltd
Level 8, 540 Wickham Street, PO Box 1307, Fortitude Valley QLD 4006, Australia
T +61 7 3553 2000 F +61 7 3553 2050 www.aecom.com
ABN 46 000 691 690
~~ABN 46 000 691 690~~

15-Mar-2019

Job No.: 60451774

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Quality Information

Document	Groundwater Management and Monitoring Program
Ref	60451774
Date	15-Mar-2019
Prepared by	Krystle L. Nichols
Reviewed by	Mark Stewart

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
0	28-Jul-2017	For Issue	Mark Stewart Associate Director - Environment	
1	08-May-2018	Address regulator comments / data requests	Mark Stewart Technical Director - Hydrogeology	
2	26-Jul-2018	Triggers and Thresholds	Mark Stewart Technical Director - Hydrogeology	
3	08-Aug-2018	Draft for Submission	Mark Stewart Technical Director - Hydrogeology	
4	28-Nov-2018	Draft for Review	Mark Stewart Technical Director - Hydrogeology	
5	22-Jan-2019	Draft	Mark Stewart Technical Director - Hydrogeology	
6	07-Mar-2019	Draft for Review	Mark Stewart Technical Director - Hydrogeology	
7	15-Mar-2019	Draft DoEE Comments	Mark Stewart Technical Director - Hydrogeology	

~~Prepared for – Adani Mining Pty Ltd – ABN: 27 145 455 205~~

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Table of Contents

~~Prepared for – Adani Mining Pty Ltd – ABN: 27 145 455 205~~

D R A F T

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List of Plates

List of Figures

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List of Tables

D R A F T

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Abbreviations

Abbreviation	Description
Adani	Adani Mining Pty Ltd
AECOM	AECOM Services Pty Ltd (formerly URS Australia Pty Ltd)
AEIS	Addendum to the SEIS
AWL	Associated water licence
BTEX	Benzene, toluene, ethylbenzene, xylene
CCP	Carmichael Coal Project
CG's Report	The Coordinator-General's evaluation report
DERM	Department of Environment and Resources Management
DEHP	Department of Environment and Heritage Protection
DES	Department of Environment and Science
DNRM	Department of Natural Resources and Mines
DNRME	Department of Natural Resources, Mines and Energy
DO	Dissolved oxygen
DoE	Department of the Environment
DoEE	Department of the Environment and Energy
DotE	Department of the Environment
EA	Environmental Authority
EC	Electrical conductivity
EIS	Environmental Impact Statement
EHP	Department of Environment and Heritage Protection (now DES)
EMP	Environmental Management Plan
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPC	Exploration permit for coal
EPP (Water)	Environmental Protection (Water) Policy 2009
EVs	Environmental Values
Fm	Formation
GAB	Great Artesian Basin
GABSRP	GAB Springs Research Plan
GDEs	Groundwater Dependent Ecosystems
GDEMP	Groundwater Dependent Ecosystems Management Plan
GHBs	General head boundaries
GME	Groundwater monitoring event
GMMP	Groundwater Management and Monitoring Program / Plan
LOR	Limit of reporting
L/s	Litre per second

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Abbreviation	Description
m/day or m/d	metres per day
3332m³/day	metres cubed per day
µS/cm	microSiemens per centimetre
mg/L	milligrams per litres
mAHD	meters Australian Height Datum
MAW	Mine affected water storage dams
MIA	Mine infrastructure area
MLs	Mine Leases
MNES	Matters of National Environmental Significance
MSES	Matters of State Environmental Significance
Mtpa	Million tonnes per annum
NF	Natural fluctuation
NRM	Department of Natural Resources and Mines
RFCRP	Rewan Formation Connectivity Research Plan
RL	Reference Level (in mAHD)
SDWPO Act	State Development and Public Works Organisation Act 1971
SEIS	Supplemental Environmental Impact Statement
TDS	Total dissolved solids
TPH	Total petroleum hydrocarbons
UG	Underground mine
UWMP	Underground Water Monitoring Program
VWPs	Vibrating wire piezometers
WQIP	Water Quality Improvement Plan 2016
WQGs	Water quality guidelines

~~Prepared for – Adani Mining Pty Ltd – ABN: 27 145 455 205~~

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1.0 Introduction

1.1 Overview

Adani Mining Pty Ltd (Adani) propose to develop a 60 million tonne (product) per annum (Mtpa) thermal coal mine in the geological Galilee Basin, approximately 160 kilometres (km) north-west of Clermont, Central Queensland, Australia as presented in Figure 1~~Figure 1~~~~Figure 1~~Error! Reference source not found. below.

The Carmichael Coal Project (CCP), the mining component of the overall Carmichael Coal Mine and Rail project (the Project), includes a greenfield coal mine within mining leases (MLs) 70441, 70505, and 70506. The CCP proposes to comprise both open cut and underground mining methods, mine infrastructure and associated mine processing facilities, and ancillary mine infrastructure including a worker's accommodation village and associated facilities, a permanent airport, a mine industrial area, and water supply infrastructure.

The Queensland's Coordinator-General approved the overall Project subject to an extensive set of environmental and social conditions. These approval conditions include the development and approval of a Groundwater Management and Monitoring Program (GMMP) for the CCP component of the Project; the GMMP-specific conditions are included in the approvals as follows:

- Coordinator-General's evaluation report on the environmental impact statement (EIS) for the Carmichael Coal Mine and Rail project, dated May 2014 (CG's Report), and includes a stated condition of approval to develop a suitable Groundwater Management and Monitoring Program (Stated Condition E4)
- Environmental Authority (EA), issued by the Department of Environment and Heritage Protection (DEHP), on 5 June 2017 (now the Department of Environment and Science [DES]) requires a GMMP to be developed to address all phases of mining operations approved under the EA inclusive of the pre-mining or baseline phase
- Baseline (pre-mining) groundwater monitoring program must result in a groundwater dataset provided to the administering authority at least 30 days prior to commencement of any mining activities associated with box cut excavation
- Approval condition for the CCP issued by the Australian Government Department of the Environment (DotE), on 14 October 2015, with respect to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) requires the submission of a suitable Groundwater Management and Monitoring Plan[1] three months prior to the commencement of the first box cut excavation.

This document, the GMMP, has been prepared for the CCP to address both the Commonwealth and Queensland State environmental approval conditions, inclusive of proposed groundwater quality triggers (chemistry) and groundwater level thresholds. The GMMP has been compiled by Mark Stewart, Technical Director – Groundwater at AECOM Australia Pty Ltd and reviewed by John Bradley of JBT Consulting. Both are appropriately qualified persons (hydrogeologists) as required in the approvals.

This GMMP has been developed to characterise the baseline groundwater conditions (pre-mining) and to provide groundwater monitoring locations for all approved phases of mining operations, consistent with Project approval condition requirements to inform long term monitoring of groundwater resources. Further, the groundwater monitoring network presented herein is considered suitable to evaluate potential impacts which may result from the proposed CCP on: local groundwater resources, local landholder bores, aquifers of the Great Artesian Basin (GAB), groundwater dependent ecosystems (GDEs), overlying alluvium and Tertiary sediments groundwater resources, and surface water resources (Carmichael River baseflow, Doongmabulla Springs Complex, and Mellaluka Springs Complex).

[1] Based on the nature of the approval conditions it is noted that the required Groundwater Management and Monitoring Program (EA Condition E4) and the Groundwater Management and Monitoring Plan (EPBC Act condition) are the same document, abbreviated as GMMP in this document.

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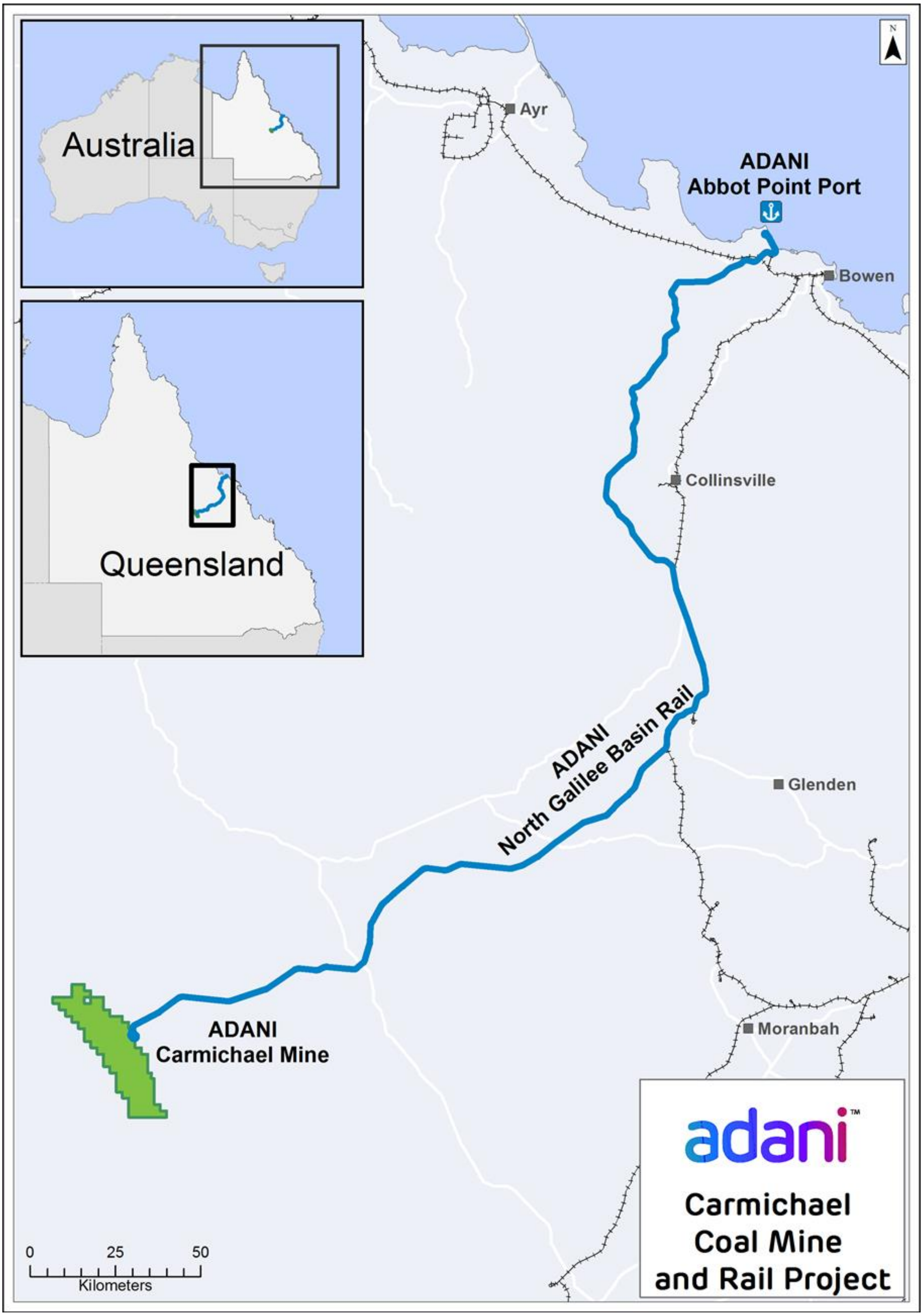

Figure 1 Location of the overall Project and CCP tenements

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1.2 Groundwater Management Framework

To ensure this GMMP is suitable to inform long term groundwater monitoring, and identification of potential impacts on groundwater resources, an adaptive management framework for performance assessment has been adopted.

Adaptive management is a structured, iterative process of robust decision-making with a focus on reducing uncertainty over time via systems monitoring and continuous improvement to achieve the desired environmental and operational outcomes of the project.

There are five primary principles to the adaptive management and continuous improvement process: Plan, Develop, Evaluate, Implement, and Monitor. These principles are centred around a continuous feedback loop (the improvement cycle) and presented in Error! Reference source not found..

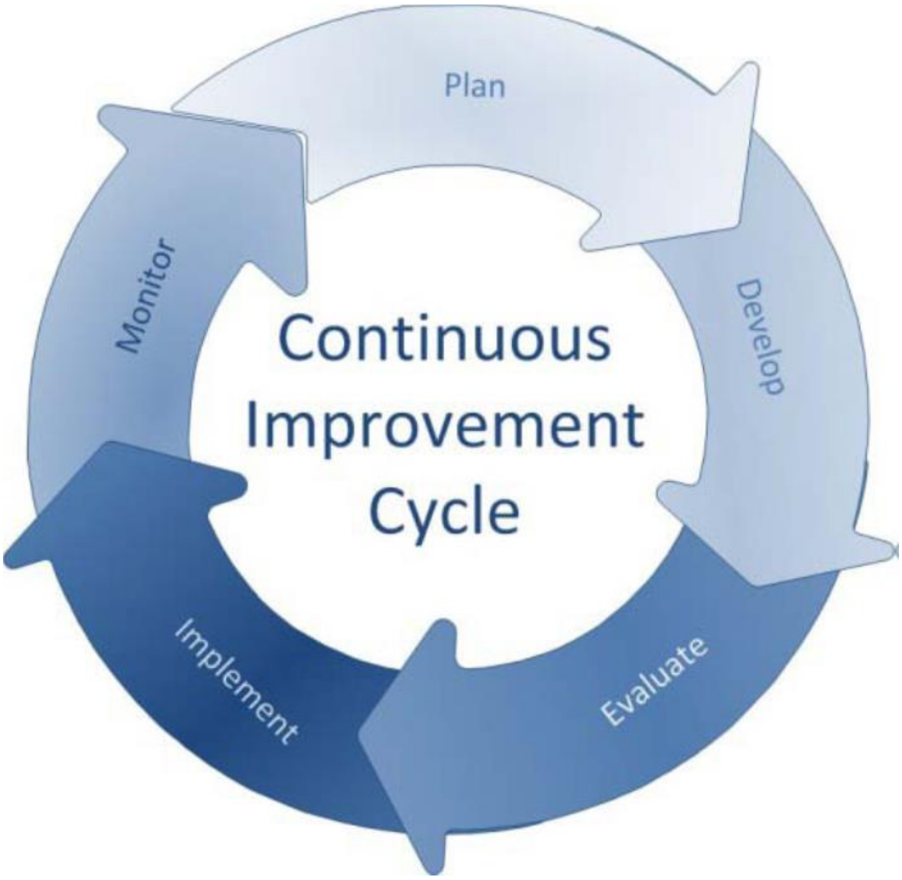

Figure 2 Adaptive management framework and continuous improvement process

Monitoring, evaluation, and reporting are required to ensure operational and environmental outcomes are being achieved for the CCP. If not, a feedback loop into management actions addresses the issues which prevent the desired outcomes. The elements associated with the adaptive management framework for the CCP are detailed in **Table 1**~~Table 1~~~~Table 1~~ below.

Adaptive management principles allow for adjustments in outcomes, indicators and limits, as well as associated monitoring and reporting approaches to improve the long-term management outcomes.

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Table 1 Elements of the Adaptive Management Framework for the CCP

Element	Description
Outcomes	The environmental state to be achieved. Outcomes reflect project requirements, regulatory requirements, and societal values and perceptions. Outcomes are pragmatic, realistic and measurable (using relevant indicators).
Parameter	A measured variable or state of resource condition used to verify that established outcomes are being achieved.
Trigger (contaminant trigger or water level threshold)	A desired condition or range for a given parameter to be maintained below, above, or within. The value(s) selected consider natural variability and ambient (background) conditions for an aquifer with respect to both quality and quantity.
Limit	A value not to be exceeded, such that the aquifer's health and associated resources may be maintained. That is, significant exceedance of the established natural variability at a given location or an agreed-upon published criterion can impact on the aquifer's condition.
Receptor	A natural discharge point (spring / watercourse) or user (landholder) of an environment or health value which is interconnected to the groundwater system and influenced by changes to aquifer's physical and / or chemical characteristics.

The adaptive management approach allows for inclusion of new groundwater quality and quantity data into models as it is collected and promotes adaptation of water management decisions. The groundwater levels and quality data collected for the EIS assessments, after EIS assessments (as a part of baseline data collection required for EA condition E3), and further data collected to date has been used for development of the GMMP, water quality triggers, and groundwater level drawdown thresholds. In addition to the monitoring bores installed for the EIS additional monitoring bores have been installed to collect data adjacent to identified GDEs and within the GAB hydrostratigraphic units. Further details of data collected and how it has been utilised is furnished in **Section 3.0**.

Development of groundwater quality triggers and groundwater level thresholds, used to instigate investigation into groundwater resource impacts, is discussed further in **Section 5.0**.

In compliance with the Coordinator-General's stated condition E6 of the EA this GMMP is to be reviewed within two years of commencement of mining activities and at least every five (5) years thereafter, and a report prepared which presents the outcomes of the GMMP review and provided to the administering authority for approval.

1.3 Groundwater Management and Monitoring Program – Baseline (Pre-Mining Phase) Monitoring

Adani has prepared this GMMP to address the CCP regulatory approval conditions specific to address all phases of mining, inclusive of the pre-mining (baseline) phase. The baseline monitoring program developed and presented in this GMMP includes the following:

- Details of the baseline groundwater monitoring program which comprises a bore network of monitoring points designed and constructed to collect representative ambient (background) data from each hydrostratigraphic unit (aquifer or aquitard) identified to potentially be impacted by the approved mining activities of the CCP. The identified hydrostratigraphic units with potential to be impacted are:
  - Quaternary aged alluvium
  - Tertiary sediments
  - Triassic aged Clematis Sandstone
  - Triassic aged Dunda Beds
  - Triassic aged Rewan Formation

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- Permian aged Bandanna Formation
- Permian aged Colinlea Sandstone
- Early Permian aged Joe Joe Group.

- The groundwater monitoring bore network, designed and constructed to provide sufficient spatial distribution across the MLs of the individual hydrostratigraphic units (listed above), allows for compilation of representative background groundwater quality and water level data
- Baseline groundwater quality and water level data from at least twelve (12) monitoring events
- Identification of natural groundwater level trends
- Calculated groundwater quality trigger levels (85th percentiles)
- Proposed groundwater level thresholds to allow for verification of predictions and assessment of potential impacts on groundwater resources.

1.4 Groundwater Management and Monitoring Program – Objectives

This inaugural version of the GMMP was developed to meet the objectives below:

- Ensure compilation of adequate groundwater monitoring data to allow for validation of the predictive groundwater numerical model, including boundary and recharge conditions, and assessment of the accuracy of groundwater impact predictions
- Ensure compilation of spatial and transient groundwater monitoring data to allow for refinement of the groundwater numerical model, as required, for accurate groundwater impact predictions
- Allow for a suitable groundwater monitoring bore network which promotes accurate groundwater level monitoring in all identified hydrostratigraphic units that may potentially be impacted by the approved mining activities
- Ensure collection of groundwater level data to confirm groundwater flow patterns for all identified hydrostratigraphic units that may potentially be impacted by the approved mining activities and to refine the conceptual models regarding recharge, groundwater flow, and discharge
- Allow for a suitable groundwater monitoring bore network which promotes monitoring of potential groundwater level drawdown impacts in all identified geological units that may potentially be impacted by the approved mining activities (this was the main rationale for developing the groundwater monitoring bore network across and adjacent to the CCP MLs)
- Utilisation of the existing predictive groundwater model(s) to develop proposed groundwater level thresholds and allow for assessment of possible impacts from the approved mining activities on identified GDEs, inclusive of spring complexes and the Carmichael River alluvium
- Ensure a groundwater monitoring bore network and program are established to suitably monitor the hydrostratigraphic units associated with the Mellaluka Springs Complex, located southeast of the MLs
- Ensure a suitable groundwater monitoring bore network and program are established so that representative groundwater monitoring data can be collected to facilitate refinement of the potential impact predictions on groundwater levels within hydrostratigraphic units of the Great Artesian Basin (GAB), inclusive of the Clematis Sandstone and Dunda Beds units
- Ensure compilation of groundwater level data to refine current estimations, using the existing numerical groundwater model, of groundwater ingress into mine workings and assessment of potential surface water ingress to mine workings because of flood events
- Allow for a suitable groundwater monitoring bore network and program to monitor possible source aquifers with potential to be utilised for alternative water supplies relevant to any approval issued under the *Water Act 2000* for the CCP
- The GMMP must allow for monitoring of hydrostratigraphic units throughout all phases of the CCP mine life, inclusive of the period post-closure (refer to Appendix 1, Section 1, Attachment B:

Rehabilitation Requirements of the Coordinator- General's Assessment Report [Appendix A~~Appendix AAppendix A~~])

- Ensure the identification of groundwater monitoring bores which may require replacement over time due to the proposed mining activities
- Ensure a suitable groundwater monitoring bore network and program to identify all potential impacts on groundwater from mine dewatering activities and mine water and waste storage facilities (artificial recharge) are established and allow for potential mitigation measures to be monitored.

In addition to these objectives, the GMMP includes groundwater quality monitoring objectives, which:

- Ensure a suitable groundwater monitoring bore network that:
  - allows for the collection of representative and repeatable groundwater quality data
  - facilitates the monitoring of potential groundwater quality impacts in all identified hydrostratigraphic units that may potentially be impacted by the approved mining activities.
- Ensure a suitable groundwater monitoring bore network to assess possible artificial recharge at mine water and waste storage facilities and evaluate any corrective actions (if required).

1.5 Groundwater Management and Monitoring Program – EA Approval Conditions

Preparation of the GMMP included consideration of the applicable groundwater-related EA Conditions (Appendix A~~Appendix AAppendix A~~). The groundwater-related EA Conditions include the following:

- Groundwater quality and water level monitoring to be performed by appropriately qualified person(s)
- The provision of groundwater management and monitoring records to facilitate the regular GMMP review, which is to include:
  - an assessment of the groundwater management and monitoring program against the objectives (**Section 1.4** and EA Condition E4 Appendix A~~Appendix AAppendix A~~)
  - a review of the adequacy of the groundwater monitoring locations, monitoring program frequencies, groundwater level thresholds (EA Condition Table E3 [**Section 5.3** of this GMMP] and the adopted groundwater quality triggers (EA Condition Tables E1 and E2 [Appendix A~~Appendix AAppendix A~~] [**Section 5.4** of this GMMP])
  - a review of the validity of the GMMP against the regular model predictions.
- The GMMP will facilitate the collection and compilation of accurate and representative groundwater monitoring data across all the identified geological units within and adjacent to the mine, which in conjunction with measured mine dewatering volumes, will be utilised to undertake regular reviews of the groundwater model
- The development of a suitable groundwater monitoring bore network and program to ensure the detection of potential impacts of the mine operations on groundwater quality
- The development of a suitable groundwater monitoring bore network capable of detecting:
  - groundwater level and pressure drawdown caused by the mining operation (and for comparison to the prediction in the numerical model)
  - the potential impacts of mine related groundwater alteration on State significant biodiversity values.
- Details of the groundwater monitoring program, approved by the administering authority, and groundwater quality and water level monitoring frequencies at the approved monitoring locations (Appendix A~~Appendix AAppendix A~~, EA Condition Table E1 [Table 35~~Table 35Table 35~~ of this GMMP])

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- The compilation of baseline groundwater quality data, allowing for the (statistical) calculation of contaminant trigger levels (Appendix A~~Appendix A~~~~Appendix A~~, EA Conditions E8 and E9 Table E2)
- If groundwater quality monitoring results reach any of the trigger levels stated in EA Condition Table E2 – Groundwater quality trigger levels, an investigation must be undertaken to determine if the exceedance is because of:
  - authorised mining activities
  - natural variation or
  - neighbouring land use resulting in groundwater impacts.
- Propose groundwater level thresholds for detecting impacts on groundwater levels (Appendix A~~Appendix A~~~~Appendix A~~, EA Conditions E8 and E13 Table)
- If groundwater monitoring results reach any of the groundwater level thresholds stated in EA Conditions E8 and E13 Table E3 – Groundwater level thresholds, an investigation must be undertaken to determine if the fluctuations are as a result of:
  - authorised mining activities
  - pumping from licensed bores
  - seasonal variation or
  - neighbouring land use resulting in groundwater impacts.
- The provision of the groundwater monitoring data collected in compliance with the EA Conditions and submitted to the administering authority in the format and at the frequency specified by the administering authority
- Construct, maintain, and manage the groundwater monitoring bores in a manner that prevents or minimises impacts to the environment and ensures the integrity of the bores to obtain accurate groundwater monitoring results.

1.6 Groundwater Management and Monitoring Program – *EPBC Act* Approval Conditions

Preparation of the GMMP included consideration of EPBC 2010/5736 Conditions dated 14 October 2015, (Appendix A~~Appendix A~~~~Appendix A~~). Specifically, the GMMP-related Approval Conditions, which include:

a. Details of a groundwater monitoring network that includes:
   - control monitoring sites
   - sufficient bores to monitor potential impacts on the GAB aquifers (whether inside or outside the Project Area)
   - 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 (MNES) (whether inside or outside the CCP mine lease) [**Section 3.8**].

b. Baseline monitoring data

c. Details of proposed trigger values for detecting impacts on groundwater levels and a description of how and when these values will be finalised and subsequently reviewed in accordance with state approvals

d. Details of groundwater level Early warning triggers and Impact thresholds for the Doongmabulla Springs Complex (GMMP **Section 5.3**), 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 drawdown threshold of 0.2 metres at the Doongmabulla Springs Complex:

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i. The Early warning triggers and Impact thresholds (GMMP **Section 5.3**) 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)* OLD (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 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.

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 update of the GMMP, including how each of the outcomes of the following will be incorporated:

- 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
- 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)
- the GAB Springs Research Plan (Conditions 25 and 26)
- the Rewan Formation Connectivity Research Plan (Conditions 27 and 28).

f. Provisions to make monitoring data available to the Department and Queensland Government authorities (if required) 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

g. Provisions to make monitoring results publicly available on the approval holder's website for the life of the project

h. A peer review by a suitably qualified independent expert and a table of changes made in response to the peer review.

1.7 Groundwater Management and Monitoring Program – Additional Approval Conditions

In addition, to further achieve compliance with the stated, recommended, and imposed EA conditions (Appendix A~~Appendix A~~Appendix A), this GMMP was developed to assist with the following:

- Development of a Groundwater Dependent Ecosystems Management Plan (GDEMP), to manage potentially affected GDEs, to include the monitoring of groundwater level fluctuations in proximity to GDEs
- Identification of groundwater level thresholds, ensuring the capture of groundwater level monitoring data across and adjacent to the mine site to allow for the comparison to groundwater level thresholds, assessment of mine dewatering impacts on groundwater dependent ecosystems (GDEs) and implementation of corrective measures for each GDE and/or the provision of offsets
- Provision of groundwater quality data for inclusion in the Subsidence Management Plan and allow for monitoring of potential impacts on groundwater due to longwall mining-induced subsidence
- Provision of site specific data for inclusion in the Rewan Formation Connectivity Research Plan (RFCRP) and GAB Spring Research Plan

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- Monitor and evaluate potential for groundwater take from the GAB to ensure compliance with the CCP Associated Water Licence (ref. 617264, dated 29 March 2017 [Appendix A~~Appendix A~~~~Appendix A~~])
- Collection of data that identifies natural groundwater level trends, as per EA Conditions E3 and E4 (Appendix A~~Appendix A~~~~Appendix A~~), which will facilitate the assessment of groundwater level impacts on authorised groundwater users (land holders) and the compilation of a report to each potentially unduly affected authorised groundwater user and the administering authority
- Development of groundwater quality objectives and model water conditions for coal mines and coal seam gas projects in the Galilee Basin and any other related decisions the administering authority under the *Environmental Protection Act 1994* may be required to make in relation to cumulative impacts on water quality
- Development of an ongoing regional groundwater monitoring and assessment program with reference to existing water users and maintenance of environmental values
- The GMMP will assist in addressing imposed conditions, under section 54B of the *State Development and Public Works Organisation Act 1971* (SDWPO Act), which includes:
  - a groundwater and surface water monitoring and reporting program that takes into account requirements of any regional groundwater and surface water monitoring and assessment program developed in accordance with Recommendation 3, Appendix 1, Section 2, Part B (CG's Report)
  - provision of the monitoring results in the format and at intervals specified in the protocol for co-ordination of regional groundwater and surface water monitoring data to the lead agency for the surface water monitoring and assessment program (Recommendation 3, Appendix 1, Section 2 (CG's Report))
  - a contribution to the on-going operation of the regional groundwater and surface water monitoring and assessment program in Recommendation 3, Appendix 1, Section 2, Part B (CG's Report).

1.8 Considerations included in the GMMP

Consideration of discussions with the administering authority, during the compilation of the EA Conditions, was given such that the GMMP allows for:

- Identification of potential groundwater impacts from the approved mining activities with sufficient time to implement management (i.e. make-good agreements) and/or mitigation measures
- Detection of long-term groundwater trends and potential cumulative effects from the mine and other future coal mining operations in the eastern Galilee Basin
- Recording of dewatering volume(s) data to assist in numerical/ predictive modelling revisions and water balance assessments
- Assistance in assessment of source aquifers which could be utilised for alternative water supplies
- Ensuring the capture of groundwater level data across and adjacent to the mine site to compile pre-mining groundwater flow patterns (including the groundwater “low” located to the north of Carmichael River)
- Assisting in the assessment of geological structures and their influence on groundwater flow patterns and mine dewatering predictions
- Monitoring of hydrostatic pressures in artesian bores to assess possible mine dewatering impacts.

1.8.1 EPBC Recommendations Included in Compilation of the GMMP

- Federal approval conditions regarding the CCP (EPBC 2010/5736) include requirements for an independent peer review, revision, and re-run of the numerical groundwater model (Carmichael

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Coal Project Groundwater Flow Model Independent Review (RE: Approval Conditions 22 and 23). These requirements have been completed and resulted in several recommendations

- Recommendations because of the independent peer review and revised numerical groundwater model reports, relevant to the groundwater monitoring program and network, were considered for the GMMP. The relevant recommendations include the following:
  - separate the D-seam from the underlying Joe Joe Group basement (as included in the conceptualisation, based on site-specific data, in **Section 2.2** of this GMMP)
  - investigate aquifer connectivity at Mellaluka Springs via data from monitoring bores in the area
  - application of recent groundwater monitoring data for the model validation process and to investigate episodic recharge processes
  - assess Rewan Formation aquitard parameters.

The recommendations of the groundwater model re-run and groundwater water model peer review will be addressed in the first groundwater model refinement to be conducted after two years as per EA conditions.

It is noted that, in line with these recommendations, the GMMP includes information from the preliminary assessment of the Mellaluka Springs, using geological and groundwater data compiled post-EIS and SEIS. The ongoing compilation and assessment of data will be used in future refinement of the groundwater modelling (refinement of conceptualisation) and iterations of the GMMP.

1.8.2 Carmichael Coal Project Response to Federal Approval Conditions – Groundwater Flow Model (GHD, 2015)

GHD conducted the required modelling revisions and re-run and considered that while the groundwater model is considered appropriate for the current stage of the project, the model should be updated in the future as the hydrogeological understanding of the Project and surrounding area continues to evolve.

GHD compiled recommendations as a guide for future investigations and modelling studies. These include:

- Update calibration targets based upon subsequent groundwater level data collected over the model domain, particularly within the GAB units to the west of the mine
- Re-calibrate the model, inclusive of transient calibration, with operational and regional monitoring data
- Incorporation of the weathered zone into the model
- Review of recharge parameters, particularly in the GAB units.

1.8.3 GMMP Considerations

This GMMP allows for the collection of transient groundwater level data across the current groundwater model domain, both spatially and with depth. These data will allow for the re-calibration and revised predictions of the current groundwater model.

Additional geological information will be available, from the detailed geological data collected during drilling and construction of monitoring bores on and adjacent to the mine lease since the model was constructed, for the next model refinement event.

The new bores (post-EIS) have allowed for the preliminary evaluation of geology and groundwater resources in the Doongmabulla and Mellaluka Springs areas. Additional data collection and assessment will be used to validate the existing conceptualisation, and will be used in future refinement of the predictive groundwater model. The refined groundwater model will aid in assessing and updating the GMMP. This approach is in line with the approval conditions, which include:

- The GMMP must be reviewed by an appropriately qualified person at least every 5 years with a report provided on the outcome of the review to the administering authority by 2nd February 2021 and then no later than 1 July every 5 years following (EA Condition E5)

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- The EPBC Act approval conditions for regular reviews of the GMMP and subsequent updates to the GMMP.

Groundwater and geological data collected and compiled under the GMMP and other groundwater related data collected for GDEs under the GDEMP and other research plans will be considered and included in future iterations of the GMMP, where appropriate. A Flow Chart **(**Error! Reference source not found.) has been compiled indicating the interaction between the research plans and the GMMP.

The interaction flow chart (Error! Reference source not found.) represents the implementation of the adaptive framework approach. The GMMP's primary function is the collecting of groundwater data through monitoring and updating impact predictions based on periodical model reviews. Any new information that has been collected via the research plans will assist in updating and refining the predictive groundwater model, allowing for addressing model uncertainties. These data will also be used to update the GMMP, including revising the monitoring regime, update the triggers, and formulating optimum mitigation measures. This will ultimately result in better management of GDEs that exist within the mining impacted zone.

It is also to be noted that the other management plans required under approval conditions such as the GDEMP, Rewan Formation Research Plan, and the GAB Spring Research Plan will also be informed from the results of the groundwater modelling, concepts and predictions as presented in the GMMP and also from any updates made to GMMP in future revisions

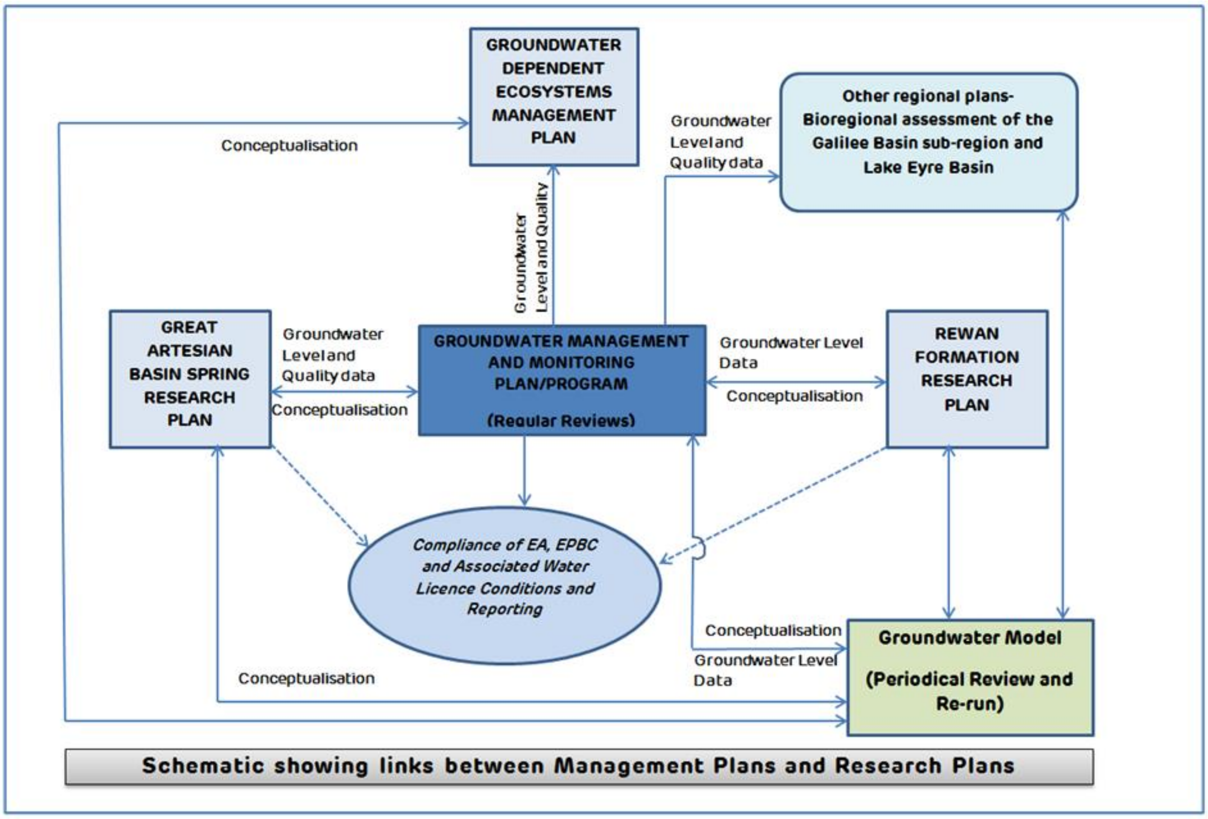

Figure 3 Interaction flow chart between Management Plans and Research Plans

Adani are 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 (Table 2~~Table 2Table 2~~). 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 (Table 3~~Table 3Table 3~~).

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Table 2 Description of other management plans and linkages with this GMMP

Management Plan	Description	Link to legislation or approval	Link with GMMMP
Groundwater Dependent Ecosystem 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.	EPBC Approval Conditions 5-6 EA Approval Condition I11- I14	Informs ecological triggers, monitoring and management through adaptive processes
Great Artesian Basin Springs Research Plan (GABSRP)	Investigates, identifies and evaluates methods to prevent, mitigate and remediate ecological impacts on the Doongmabulla Springs-complex	EPBC Approval Conditions 25-26	Informs ecological triggers, monitoring and management through adaptive processes
Receiving Environment Monitoring Program (REMP)	Monitors, identifies and describes adverse impacts to surface water environmental values, quality and flows associated with authorised mining activities	EA Approval Condition F23	Mine approved discharges are to the Carmichael River, a GDE under this plan
Rewan Formation Connectivity Research Plan (RFCRP)	Characterises the Rewan Formation within the area impacted by the mine	EPBC Approval Conditions 27-28	Informs groundwater triggers, monitoring and management through adaptive processes such as the GMMP
Biodiversity Offset Strategy (BOS) GAB Offset Strategy Offset Area Management Plans (OAMPs)	Describes required offsets for unavoidable residual impacts to MNES Describes required offsets for indirect impact to Great Artesian Basin (GAB) aquifers Describes specific management actions for properties to be used as offsets under the BOS	EPBC Approval Conditions 8-13 EA Approval Condition I1	The BOS outlines offset requirements for MNES including relevant GDEs The GAB Offset Strategy addresses indirect impacts to GAB aquifers The OAMP includes management of GDE offset areas
MNES management plans (other than GDEs)	Specific management plans for MNES listed in the EPBC Approval	EPBC Approval Conditions 5-7	Ensure consistent monitoring, mitigation and management measures for common threats and impacts
Project Management Plans	Plans to be used for day to day management of generic project matters including:	Not linked to specific conditions	Specific measures from relevant project management plans have been incorporated into

Management Plan	Description	Link to legislation or approval	Link with GMMMP
	• Sediment and erosion and control management plan • Pest management plan • Water quality management plan • Dust management plan • Waste management plan • Fire management plan • Rehabilitation management plan		this GDEMP to ensure consistency across areas of commonality

This GMMP has been developed to ensure consistency with the latest groundwater impact predictions as required under Condition 23 of EPBC Act Approval (groundwater flow model revisions, including revision to the GAB conceptualisation). The GMMP will facilitate the detection of any mining related impacts to groundwater (i.e., impacts from establishment and operation of the mine). Triggers from the GMMP, which are related to groundwater dependent ecosystems will be included in GDEMP.

Outcomes of implementing this GMMP will inform GDEMP, Rewan formation connectivity Research Plan and GAB Springs Research Plan with the aim of supporting research and analysing the effectiveness of mitigation actions. Conversely, research outcomes will directly inform monitoring, management, prevention mitigation and remediation measures presented in this GMMP

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Table 3 Reporting requirements of other management plans with linkages to this GMMP

Management Plan	Description	Internal Review Frequency	External Review Frequency	Reporting Frequency	Linkage to GMMP and triggers/corrective actions
Groundwater Dependent Ecosystem Management Plan (GDEMP)EPBC Approval Condition 5-6 EA Approval Conditions I11-I14	The GDEMP identifies monitoring, management and mitigation with respect to approved impacts to MNES The GDEMP includes details of for monitoring GAB aquifers, GDEs (Springs, Carmichael River and Waxy Cabbage Palms) during all phases of the project including baseline, operations, and post-closure.	In compliance with EA approval conditions (EA Condition I11-14 (Appendix A)),	EA Annual Compliance Report to be prepared by Third Party.	Annual – EPBC Compliance Reporting – Condition 31 Annual - EA Compliance Reporting – Condition A13	The GDEMP provides a framework for the management of groundwater impacts, including defining trigger levels, and MNESMPs for other threatened species and ecological communities. Relevant triggers from the GMMP (those that are related to groundwater dependent ecosystems) will be included in GDEMP.
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	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.

Management Plan	Description	Internal Review Frequency	External Review Frequency	Reporting Frequency	Linkage to GMMP and triggers/corrective actions
	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.				
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 groundwater from the Great Artesian Basin, including the Doongmabulla Springs-complex, in the Galilee Basin.	Annually and as directed through the outcomes of discrete research packages. *Note: this plan requires separate approval and hence review frequency will be determined and approved through that mechanism.*		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 will inform research programs undertaken under the GAB. GMMP 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 GMMP.

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Management Plan	Description	Internal Review Frequency	External Review Frequency	Reporting Frequency	Linkage to GMMP and triggers/corrective actions
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 reached instigate investigation into the cause of potential environmental harm); 3). The interaction of the Rewan Research Plan (groundwater component) with the GAB Spring Research Plan, offset, subsidence, and GDEMP; and 4). Links to the Geoscience Australia regional Galilee Basin numerical groundwater model

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1.9 Compliance with Approval Conditions – Groundwater

A summary of the groundwater approval condition requirements and cross-reference to the location of the details within the GMMP is presented in **Table 4~~Table 4Table 4~~** below. The table aims to ensure Adani's GMMP is compliant with all the state government and EPBC Act groundwater-related approval conditions.

~~Prepared for – Adani Mining Pty Ltd – ABN: 27 145 455 205~~

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Table 4 Conditions for Approval – Reference Table

Ref	Condition	Condition Requirement	Plan Reference	Demonstration / Commitments Plan Addresses Requirements
1	A5	Monitoring records or reports must be kept for a period of no less than 5 years.	Section 1.5 Section 4.6 Section 4.8	The compilation of groundwater monitoring reports will provide validation of environmental protection performance; long term trends will be established using historic datasets and used for comparison to assess potential impacts.
1	E1	The EA holder must not release contaminants to groundwater.	Section 1.13 Section 4.0 Section 5.0	The GMMP aims at assessing groundwater quality overtime and validating management / mitigation measures employed to ensure contaminants are not released offsite within the groundwater.
1	E2	All determination of groundwater quality, groundwater monitoring and biological monitoring must be performed by appropriately qualified person/s.	Section 7.0 Appendix A~~Appendix~~ A~~Appendix A~~ (AECOM Letter)	Adani employs specialist groundwater monitoring contractors and consultants to develop and maintain their groundwater monitoring network including the collection of representative groundwater monitoring data.
1	E3	A baseline groundwater monitoring program must be developed and certified by an appropriate qualified person and implemented by the EA holder no later than the 2nd June 2016.	Appendix A~~Appendix~~ A~~Appendix~~ A(AECOM Letter)	AECOM (formerly URS Australia Pty Ltd) provided a review and assessment of the baseline groundwater monitoring, including confirmation of implementation prior to 2 June 2016. Included in **Appendix A~~Appendix~~ A~~Appendix A~~**.
		The baseline groundwater monitoring program must result in the holder of this EA finalising a groundwater dataset that must be provided to the administering authority at least 30 days prior to commencing any mining activities associated with box cut excavation.	Section 1.3 Section 1.13 Section 3.1 Appendix C~~Appendix~~ C~~Appendix C~~ Appendix D~~Appendix~~ D~~Appendix D~~ Appendix	This GMMP includes the baseline groundwater data, compiled to meet the criteria under EA Condition E3, prior to any mining activities associated with box cut excavation.

Ref	Condition	Condition Requirement	Plan Reference	Demonstration / Commitments Plan Addresses Requirements
			EAppendix ~~EAppendix E~~	
		The groundwater dataset must: Contain representative groundwater quality samples from the geological units identified as potentially affected by mining activities including Quaternary age alluvium, Tertiary sediments, Bandanna Formation, Colinlea Sandstone, Clematis Sandstone, Rewan Formation, Dunda Beds, and Early Permian sediments.	Section 3.0 Appendix D~~Appendix D~~~~Appendix D~~	Representative baseline groundwater data has been compiled for all the units included in the EA condition, E3.
		The groundwater dataset must: Include at least 12 sampling events that are no more than 2 months apart over a 2-year period, to determine background quality.	Section 3.1 Appendix D~~Appendix D~~~~Appendix D~~ Section 5.4	Baseline data, included in the GMMP, consists of data that has been compiled since the EIS / SEIS phase from 2011-2014, data obtained from baseline monitoring carried out from 2014-2016 as per EA Condition E3, and data obtained from further monitoring carried out until April 2017. All the available data from September 2011 through April 2017 has been compiled to form the 'final' baseline monitoring dataset.
		The groundwater dataset must: Include background groundwater quality in hydraulically isolated background bore(s).	Section 3.1 Figure 19~~Figure 19~~~~Figure 19~~ Table 23~~Table 23~~~~Table 23~~ Section 5.4 Appendix B~~Appendix B~~~~Appendix B~~ Appendix D~~Appendix D~~~~Appendix D~~	Baseline data, included in the GMMP, consists of data that has been compiled since the EIS / SEIS phase from 2011-2014, data obtained from baseline monitoring carried out from 2014-2016 as per EA Condition E3, and data obtained from further monitoring carried out until 2017. All the available data from September 2011 through April 2017 has been compiled to form the 'final' baseline monitoring dataset. Maps included in **Appendix B~~Appendix B~~~~Appendix B~~** indicate the baseline groundwater monitoring bore network to collect background water quality, as no mining has occurred on or adjacent to the CCP. All bores are constructed according to the applicable standards and currently (pre-mining) provide representative ambient groundwater monitoring data for all hydrostratigraphic units included in EA Condition E3.

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Ref	Condition	Condition Requirement	Plan Reference	Demonstration / Commitments Plan Addresses Requirements
		The groundwater dataset must: Allow for the identification of natural groundwater level trends and groundwater contaminant trigger levels.	Section 3.1 Figure 19 Table 23~~Table 23Table 23~~ Section 5.0 Section 5.3 Section 5.4 Appendix C and E Appendix D	Groundwater levels have been compiled from manual water level measurements, automated water level loggers. These datasets have been assessed to determine natural fluctuation and seasonal trends. Groundwater quality trigger levels have been determined and included in the GMMP (as per EA Condition E9 Table E2).
1	E4	A Groundwater Management and Monitoring Program must be developed and certified by an appropriately qualified person which addresses all phases of mining operation approved under this EA.	Section 1.1 Appendix F Appendix G	Mark Stewart, Technical Director – Groundwater at AECOM, has compiled the GMMP. The GMMP has been reviewed and revised after a review by John Bradley of JBT Consulting. Both are appropriately qualified persons (hydrogeologists). The GMMP includes for the baseline, construction, operational, and post-closure phases of mining.
		The GMMP must be provided to the administering authority for approval with the baseline monitoring program in condition E3.	This document	Data and details required for the baseline monitoring program, as detailed above, is included in this draft GMMP for approval.
		GMMP objectives: Validation of groundwater numerical model to refine and confirm accuracy of groundwater impacts predicted.	Section 1.2 Section 1.4 Section 1.8.3 Section 1.10.1 Section 2.4 Section 2.7.4 Section 4.7.1 Section 5.3.5.3	Using adaptive management, as new groundwater quality and quantity knowledge is generated, models will be updated and water management decisions adapted accordingly; the compilation of groundwater monitoring data to allow for the validation and refinement of the groundwater numerical model (including boundary and recharge conditions) and assess accuracy of predicted groundwater impacts; the GMMP also allows for the recording of dewatering volume(s) data to assist in the modelling revisions. The numerical model re-run works and subsequent changes to the predicted impacts on groundwater have been included.

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Ref	Condition	Condition Requirement	Plan Reference	Demonstration / Commitments Plan Addresses Requirements
			Section 6.2	
		GMMP objectives: Groundwater level monitoring in all identified geological units present across and adjacent to the mine site to confirm existing groundwater flow patterns and monitor drawdown impacts.	Section 1.4 Section 1.5 Section 1.7 Section 1.8 Section 0 Section 2.2.3 Section 2.2.5 Section 2.2.8 Section 2.2.10 Section 2.3.6 Section 5.2 Section 5.3.3.1 Section 5.3.5 Appendix C	Representative baseline groundwater data has been compiled for all the units included in the EA condition, E3. Groundwater contours are included in Appendix C~~Appendix C~~~~Appendix C~~. Conceptualisation of groundwater flow is included in **Section 2.2**.
		GMMP objectives: Identification of groundwater drawdown level thresholds for monitoring the impacts to GDEs (including spring complexes and Carmichael River alluvium).	Section 1.4 Section 1.6 Section 0 Section 1.13 Section 2.2.5 Section 2.2.6 Section 2.3.3 Section 2.3.6 Section 2.7.2 Section 2.7.4	Groundwater drawdown predictions, from the predictive model, were used to develop groundwater level thresholds in locations included in EA Table E3 to assess model predictions, evaluate drawdown impacts, instigate investigations, and implement mitigation measures (as required). Details of the GDE monitoring bores are included in Table 57~~Table 57~~~~Table 57~~.

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Ref	Condition	Condition Requirement	Plan Reference	Demonstration / Commitments Plan Addresses Requirements
			Section 3.4 Section 5.3 Section 5.6 Section 6.2	
		GMMP objectives: Monitoring of aquifers in the area to the south of the mining lease that may affect the Mellaluka springs.	Section 1.4 Section 1.8.1 Section 1.8.3 Section 2.1.3 Section 2.2.5.8 Section 2.2.6.3 Section 2.7.4.2 Section 5.3 Section 5.3.4 Section 5.4 Section 5.5 Section 7.1.1	Details of the GDE monitoring bores are included in Table 57~~Table 57Table 57~~, including units intersected in the Mellaluka Springs area.
		GMMP objectives: Identify and refine potential impacts on groundwater levels in the GAB Clematis Sandstone and Dunda Beds geological units.	Section 1.4 Section 1.7 Section 0 Section 2.1.3 Section 2.7 Section 2.2.10.1 Section 3.0 Section 5.3 Section 6.2	Groundwater drawdown predictions, from the predictive modelling, were used to develop groundwater level thresholds to monitor potential impacts in the GAB Clematis Sandstone and Dunda Beds geological units. GAB monitoring bores are presented in Table 23~~Table 23Table 23~~.

~~Prepared for – Adani Mining Pty Ltd – ABN: 27 145 455 205~~

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Ref	Condition	Condition Requirement	Plan Reference	Demonstration / Commitments Plan Addresses Requirements
		GMMP objectives: Estimation of groundwater inflow to mine workings and surface water ingress to groundwater from flooding events using the groundwater model.	Section 1.4 Section 1.10.1 Section 2.2.7 Section 2.2.7.1 Section 2.3.6	Model refinement will occur using groundwater monitoring data compiled using the monitoring program included in the GMMP. The numerical groundwater model will be reviewed, using the GMMP data plus measured mine dewatering volumes, within two (2) years of the box cut excavation, and then at least every 5 years afterwards. In addition to measured mine dewatering volumes, other methods may be utilised (inclusive but not limited to): compilation of rainfall and evaporation data, records of water extracted from the pit, and estimates of catchment (runoff) capture, and conditions included in AWL (Appendix A~~Appendix A~~~~Appendix A~~) for the CCP. These data will aid with the water balance model, where the compilation of groundwater level data from units above and below the target coal seams will facilitate the revision of model water budgets and allow for the estimates of groundwater ingress from surrounding units. Surface water – groundwater interaction is included in the model and will be refined overtime, based on groundwater and surface water monitoring data.
		GMMP objectives: Monitoring in any identified source aquifers for alternative water supplies, relevant to any approval issued under the *Water Act 2000* for the project.	Section 1.4 Section 1.8 Section 2.1.3 Section 3.5.3 Section 4.5 Section 6.2	All geological units identified as potentially affected by mining activities including Quaternary aged alluvium, Tertiary sediments, Bandanna Formation, Colinlea Sandstone, Clematis Sandstone, Rewan Formation, Dunda Beds, and Early Permian sediments, are included in the GMMP. Additional bores are planned to facilitate the model refinement and to better assess the sub-E sediments. These bores will provide information regarding the groundwater potential within the sub-E coal seam sediments, which could be used as Make-Good groundwater supplies.
		GMMP objectives: Monitoring of geological units throughout all phases of project life including for the period post-closure in accordance with EA Approval Conditions Appendix 1.	Section 5.0 Section 6.1 Section 6.2 Section 6.3	Monitoring recommendations and commitments have been compiled for all phases of mine life, including baseline, construction, operations, and post-closure (inclusive of project stage 1 and project stage 2, as per Appendix 1 of the EA conditions).

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Ref	Condition	Condition Requirement	Plan Reference	Demonstration / Commitments Plan Addresses Requirements
		GMMP objectives: Identifying monitoring bores that will be replaced due to mining activities.	Section 3.5 Section 6.1 Section 6.2 Table 55	The GMMP includes the commitment to augment and alter the groundwater monitoring bore network in line with the mine plan and activities. Bores identified in the GMMP for Operational Phase are based on the first five years of mining, after the review and refinement of modelling at this approval condition timeframe, the Operational Monitoring network will be revised (if required). It is noted that not all bores lost during mining will be replaced based on the nature of the open cut and underground mining. Alternative monitoring bores, within the same target geological units, will be included based on the objectives of the GMMP.
		GMMP objectives: To ensure all potential groundwater impacts from mine dewatering and mine water and waste storage facilities are identified, mitigated and monitored.	Section 1.13 Section 2.2.7 Section 2.7.9 Section 3.5 Section 5.4.1 Section 6.1 Section 6.2 Section 7.0	The GMMP allows for the compilation of sufficient, spatially and geological unit-wise, groundwater monitoring data to adequately assess potential impacts from mine-dewatering and mine water and waste storage facilities are identified, mitigated, and monitored.
1	E5	The GMMP must be reviewed by an appropriately qualified person at least every 5 years with a report provided on the outcome of the review to the administering authority by 2nd February 2021 and then no later than 1 July every 5 years following.	Section 1.5 Section 1.6 Section 1.8.3 Section 1.10.1 Section 2.3.6 Table 35 Section 4.7.2 Section 5.3.5.3 Section 7.0	The GMMP includes for a review of the current GMMP and future versions, every 5 years. The commitment includes the details of the review requirements included under EA condition E5.

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Ref	Condition	Condition Requirement	Plan Reference	Demonstration / Commitments Plan Addresses Requirements
			Appendix F Appendix G	
1	E6	Groundwater Model Review.	Section 1.8.3 Section 2.2.6.2 Section 2.2.6.4 Section 2.2.9	The GMMP includes a summary of the predictive model review and re-run, as per approval conditions. The compilation of groundwater monitoring data, under the GMMP, will allow for the validation and refinement of the groundwater numerical model (including boundary and recharge conditions) and assess accuracy of groundwater impacts predictions.
1	E7	Groundwater Model Review Report.	Appendix A	The Carmichael Coal Project numerical groundwater flow model developed by GHD (as described in **Section 2.3**) was independently peer reviewed by Hugh Middlemis. The report is attached in **Appendix A~~Appendix A~~~~Appendix A~~**. To be conducted in the future based on GMMP input.
1	E8	Based on monitoring data collected in Condition E3 the EA holder must provide the following: • A proposed groundwater monitoring network for detecting potential impacts of the mine operations on groundwater quality.	Section 3.8 Section 4.0 Section 5.0 Section 6.0	Details regarding groundwater monitoring locations and sampling frequency (EA Condition Table E1) and groundwater quality trigger levels (EA Condition Table E2) are included in baseline groundwater monitoring tables, presented in this GMMP.
		Based on monitoring data collected in Condition E3 the EA holder must provide the following: • A groundwater monitoring network for detecting if: - Drawdown caused by the mining operation may exceed predictions in the numerical model referred to in condition E6.	Section 5.3	Groundwater level thresholds have been developed for assessing excess drawdown (compared to model predictions) and impacts on MSES (and MNES), as detailed in EA Condition Table E3. The groundwater monitoring network for detecting if drawdown caused by the mining operation may exceed predictions and MNES may be impacted is included in **Table 46~~Table 46~~~~Table 46~~** and **Table 57~~Table 57~~~~Table 57~~**.

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Ref	Condition	Condition Requirement	Plan Reference	Demonstration / Commitments Plan Addresses Requirements
		- Matters of State Environmental Significance may be impacted (Table E3).		
1	E9	Groundwater quality and level monitoring.	Section 3.0 Section 4.0 Appendix C Appendix D	Groundwater monitoring locations and frequency as required under EA Condition E9 has been developed and included in this GMMP. See GMMP Table 46~~Table 46Table 46~~ which represents EA Condition E9 Table E1 providing monitoring bore details, location and elevation data.
1	E10 E11 E12	Groundwater quality trigger level investigation.	Section 1.5 Section 1.10 Section 1.12 Section 1.13 Section 4.7 Section 5.4 Section 6.0	The investigation and response processes to be adopted in case of trigger levels being exceeded are detailed in **Section 4.7.2** in compliance with EA conditions E10, E11, and E12.
1	E13 E14	Groundwater (water levels).	Section 1.5 Section 1.14.1 Section 3.4 Section 4.7 Section 5.3 Section 6.1 Section 6.2	The investigation and response processes to be adopted in case of groundwater thresholds being exceeded are detailed in GMMP **Section 4.7.2.2, Section 5.3.3.1,** and **Section 5.3.5.1** in compliance with EA conditions E13 and E14.
1	E15	Monitoring data submission.	Section 4.6.2 Section 4.8	Data reporting details are included in the GMMP in **Section 4.8**, which considers all State and Federal reporting / data requests, committed to be compiled and submitted annually.

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Ref	Condition	Condition Requirement	Plan Reference	Demonstration / Commitments Plan Addresses Requirements
1	E16	Bore construction, maintenance and decommissioning of groundwater bores.	Section 3.4.6 Section 7.0	**Section 3.5.1** and **Section 3.5.2** of this GMMP includes details of bore designs and drilling for bores to be constructed to augment the existing bore network. Adani is committed to maintaining and the decommission of bores, according to industry standards, to ensure the management of groundwater resources and obtaining representative groundwater monitoring data.
2	EPBC Act Condition 3a	Groundwater management and monitoring plan. 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).	This document	As per EA Condition E4 above, data and details required for the baseline monitoring program, as detailed above, is included in the GMMP for approval. The GMMP includes all requirements of the EPBC conditioned Groundwater Management and Monitoring Plan. It is noted that the 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 contain the following: *Control monitoring sites.*	Section 1.6 Section 0 Section 1.14.1 Section 3.1.3 Table 22 Section 5.3 Section 5.5 Table 56	Control monitoring points have been located (within and adjacent to the mine lease) and constructed as hydraulically isolated background bores to obtain representative groundwater data within each hydrostratigraphic unit that could be impacted by the proposed mining activities. The selected control monitoring bores are included in **Section 5.4.4** are located in areas which allow these bores to be utilised during all phases of the mine allowing for monitoring and comparison to the proposed quality triggers and groundwater level thresholds (it is noted that these bores were included in the bores utilised to develop the thresholds and quality triggers).

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Ref	Condition	Condition Requirement	Plan Reference	Demonstration / Commitments Plan Addresses Requirements
		The GMMP must contain the following: *Sufficient bores to monitor potential impacts on the GAB aquifers (whether inside or outside the Project Area).*	Section 1.4 Section 1.6 Section 0 Section 1.12 Section 2.0 Section 3.1 Table 22 Section 3.5 Section 3.7 Section 5.3 Section 5.6 Section 6.2	Groundwater monitoring bores are located adjacent (to the west) of the CCP within the GAB aquifers to allow for the assessment of potential induced drawdown impacts on GAB aquifers. Bores identified in EA Condition E9 (groundwater quality monitoring within hydrostratigraphic units including the GAB aquifers) and EA Condition E13 (groundwater level thresholds in GAB units to the west of mine lease) address both approval requirements. Groundwater drawdown predictions, from the predictive modelling, were used to develop groundwater level thresholds to monitor potential impacts in the GAB Clematis Sandstone and Dunda Beds geological units. GAB monitoring bores are presented in **Table 23~~Table 23Table 23~~**.
		The GMMP must contain the following: *A rationale for the design of the monitoring network with respect to the nature of potential impacts and the location and occurrence of MNES (whether inside or outside the Project Area).*	Section 1.6 Section 1.12 Section 3.7 Section 5.0 Table 22 Table 33 Table 56	This document provides the details of the existing baseline groundwater monitoring program and rationale for the design and implementation for groundwater monitoring, for all approved phases of mining operations, in line with the EPBC approval condition requirements. Groundwater monitoring bores are located adjacent to the Carmichael River, spring complexes, and within the GAB aquifers to allow for the assessment of potential impacts on groundwater related MNES.
2	3b	The GMMP must contain the following: *Baseline monitoring data.*	Section 1.3 Section 1.6 Section 1.10 Section 3.1 Table 23~~Table 23Table 23~~	Baseline groundwater monitoring data for all groundwater monitoring events, between the EIS studies in 2011 and April 2017 are included in the GMMP.

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Ref	Condition	Condition Requirement	Plan Reference	Demonstration / Commitments Plan Addresses Requirements
			Section 3.7 Table 35 Section 4.4.3.1 Section 4.6.1 Section 5.0 Table 46 Section 6.0 Appendix B Appendix C Appendix D Appendix E	
2	3c	The GMMP must contain the following: *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.*	Section 5.3 Section 5.3.5 Section 5.3.5.3	Groundwater trigger values are referred to as groundwater level thresholds in the GMMP (noting that State approval conditions refer to triggers for water quality). These are discussed in compliance with State approvals in the GMMP, see EA Condition E13. **Section 5.3** includes details of how the proposed groundwater level thresholds were derived and have been submitted to DES for approval / comment.
2	3d	The GMMP must contain: *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*	Section 5.3 Section 5.3.5 Section 5.3.5.1	Groundwater level thresholds have been derived based on predictive modelling and an assessment of natural fluctuation, this approach has been compiled for the GAB units underlying the Doongmabulla Springs Complex. Selected bores between the MLs and the springs have low (Early warning triggers) and high (Impact thresholds) groundwater level drawdown thresholds as agreed with State regulators to meet the AWL conditions. **Section 5.3** includes details of how the proposed drawdown thresholds were derived, including Early warning triggers and Impact thresholds for the GAB units.

Ref	Condition	Condition Requirement	Plan Reference	Demonstration / Commitments Plan Addresses Requirements
		Complex. *i. The early warning triggers and impact thresholds must be informed by groundwater modelling in accordance with Conditions3e)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 thresholds will ensure the protection and long-term viability of the Doongmabulla Springs Complex.*		
	3e	The GMMP must contain the following: *Details of the timeframe for a regular review of the GMMP in accordance with the*	Section 1.5 Section 1.6 Section 1.8.3	GMMP is a document which will aim at continual improvement subject to refinement based on adaptive management, **Section 1.10.1** includes details of the GMMP review, intervals and details.

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Ref	Condition	Condition Requirement	Plan Reference	Demonstration / Commitments Plan Addresses Requirements
		requirements of the EA.	Section 1.10.1 Section 2.3.6 Table 35 Section 4.7.2 Section 5.3.5.3 Section 7.0 Appendix F Appendix G	
		In subsequent updates of the GMMP, how each of the outcomes of the following will be incorporated: *Independent review and update of the groundwater conceptual model, as well as the numerical groundwater model and water balance calculations.*	Section 1.8.1 Section 1.10 Section 1.11 Section 2.2.9 Section 2.3 Section 2.4 Section 7.0	**Section 1.10.1** includes details of the GMMP review process including these requirements. Details regarding the independent peer review and revision of the numerical groundwater model are included in **Section 1.8.1.**
		In subsequent updates of the GMMP, how each of the outcomes of the following will be incorporated: *Future baseline research required by the Queensland Coordinator-General into the Mellaluka Springs Complex.*	Section 1.4 Section 1.8.1 Section 1.8.3 Section 2.1.3 Section 2.2.5.8 Figure 3 Section 2.2.6.3 Section 2.7.4.2 Table 33 Section 5.3.4	Details regarding how the GMMP data compilation and assessment will aid with the various research programs are included. Extensive drilling and groundwater data collection, conducted during 2014 and 2015, around the Mellaluka Springs are included in the GMMP. Drilling and aquifer assessments post model construction have, as included in **Section 2.2.6.3**, resulted in a more detailed conceptualisation, which will be included in future model refinement.

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Ref	Condition	Condition Requirement	Plan Reference	Demonstration / Commitments Plan Addresses Requirements
			Section 7.1.1	
		In subsequent updates of the GMMP, how each of the outcomes of the following will be incorporated: *The GAB Springs Research Plan.*	Section 1.7 Section 1.8.3 Figure 3 Section 1.10.2 Section 2.0 Section 2.2 Section 2.2.6 Section 2.3 Section 7.1.1	Details regarding how the GMMP data compilation and assessment will aid with the various research programs are included. Extensive drilling and groundwater data collection, conducted during 2014, 2015, and 2018 to the west of the CCP mine lease. Re-run of the model (**Section 2.3**) in line with approval conditions, allowed for the further assessment of potential impacts on the GAB springs because of approved mining.
		In subsequent updates of the GMMP, how each of the outcomes of the following will be incorporated: *The Rewan Formation Connectivity Research Plan.*	Section 1.7 Section 1.8.3 Figure 3 Section 1.10.2 Section 2.0 Section 2.2 Section 2.2.9 Section 7.1.1	Details regarding how the GMMP data compilation and assessment will aid with the various research programs are included. Extensive drilling, core sample analysis, and groundwater data collection, conducted during 2014 and 2015, to the west of the CCP mine lease.
2	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 of relevant research required by the Bioregional Assessment.	Section 1.6 Section 4.6.2 Section 4.8 Section 7.0	Adani has committed to providing groundwater monitoring data on a regular basis to the administering authorities. **Section 4.8** provides details of the groundwater monitoring data dissemination and frequency.

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Ref	Condition	Condition Requirement	Plan Reference	Demonstration / Commitments Plan Addresses Requirements
2	3g	Provisions to make monitoring results publicly available on the approval holder's website for the life of the project.	Section 4.6.2 Section 4.8	Adani will make the groundwater data, collected throughout the monitoring life, available for the public through posting data on a webpage dedicated to sharing monitoring information in its website.
2	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.	Section 1.11 Section 2.3.5 Section 2.4 Appendix F Appendix G	**Section 1.11** includes the details of the independent peer review process, **Appendix F~~Appendix F~~~~Appendix F~~** includes the review details and **Appendix G~~Appendix G~~~~Appendix G~~** includes the table of changes.
2	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.	n/a	This draft GMMP document will be submitted for approval. The GMMP is a combined document prepared to address both state government and EPBC Act approval conditions.

NOTE:
Section 1.5 (EA Approvals), **Section 1.6** (EPBC Act Approvals), and **Section 1.7** (additional approval conditions) include details of how the GMMP will aid in addressing the various groundwater related conditions and achieve compliance with stated, recommended and imposed approval conditions.

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Table 2 References:

- Approval Carmichael Coal Mine and Rail Infrastructure Project, Queensland (EPBC 2010/5736), dated 10 October 2015
- Environmental Authority EPML01470513 – Carmichael Coal Mine dated 5 June 2017
- Department of Natural Resources and Mines (now DNRME) Associated Water Licence Reference 617264, dated 29 March 2017
- Carmichael Coal and Rail Project (project number 2010/5736) Department of Environment and Energy (DoEE) comments Groundwater Management and Monitoring Plan (informed by Geoscience Australia, and the Department of Agriculture and Water) dated 18 October 2017
- EHP (now DES) response to the GMMP for the Carmichael Coal Mine Project, email dated 8 November 2017, minutes of the clarification meeting with DES on 22 November 2017, and EHP comments on GMMP baseline dataset, email dated 8 December 2017
- DoEE comments sent 6 November 2018 based on Teleconference 12 September 2018 (conceptualisation), Workshop on 16 October 2018, and Teleconference 24 October 2018
- DES comments on draft GMMP submitted on 10 August 2018

1.10 GMMP Development

Establishment and implementation of the groundwater monitoring program promotes adaptive management principles, presented in **Section 1.2**, to allow for evolution and response to the various stages of the mining project (i.e. the groundwater monitoring program will adapt to the different phases of mining including baseline, construction, operations, and post closure).

To develop an optimal GMMP, Adani have adopted a phased approach to allow for the correct scientific development of the GMMP and allow for variation over time to suit the different mining stages.

The GMMP includes procedures and processes to assess the baseline hydrogeological regime(s), allowing for the development of groundwater quality triggers and groundwater level thresholds. The baseline data, derived from hydraulically isolated monitoring bores, will be used for comparison purposes to aid in assessing potential groundwater impacts of approved mining operations and to inform investigations and mitigation measures consistent with the EA Conditions (Appendix A~~Appendix A~~Appendix A). The majority of these hydraulically isolated control monitoring bores, located outside the mine footprint, have been recognised as control points (**Section 5.4.4**).

Compilation and compliance with approval conditions of the GMMP involved:

- Development of a groundwater management and monitoring program / plan (GMMP), EA Condition E4 and EPBC Act approval condition 3 (Appendix A~~Appendix A~~Appendix A)
- Obtaining approval of this GMMP from the administering authorities, which included development of a baseline monitoring program (EA Condition E3) and control monitoring sites (EPBC Act approval condition 3) (Appendix A~~Appendix A~~Appendix A)
- Independent peer review of this GMMP (EA Condition E7 and EPBC Act approval condition 3h) (Appendix A~~Appendix A~~Appendix A)
- Compilation of representative groundwater quality samples from each hydrostratigraphic unit identified with potential to be impacted (directly and/or indirectly) by the approved mining activities (EA Condition E9 and EPBC Act approval condition 3b)(Appendix A~~Appendix A~~Appendix A)
- Compilation of a representative baseline groundwater level dataset prior to mine activities, identification of trends and natural fluctuation, including groundwater flow patterns (EA Condition E13 and EPBC Act approval condition 3b) **(**Appendix A~~Appendix A~~Appendix A)
- Determination of groundwater quality triggers prior to commencement of coal mining activities ((EA Condition E9 and EPBC Act approval condition 3b)(Appendix A~~Appendix A~~Appendix A)

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- Development of groundwater monitoring network, in specific representative hydrostratigraphic units, which will act to detect water quality triggers (prior to reaching the predicted impacts of groundwater quantity) and drawdown thresholds , which when exceeded has a potential to result in environmental harm to GDEs (including spring complexes and the Carmichael River alluvium) and/or groundwater supply reduction in neighbouring landholder bores and GAB (Clematis Sandstone and Dunda Beds) units (EA Conditions E13 and E14 and EPBC Act approval condition 3a (ii), 3c, and 3d [Appendix A~~Appendix A~~Appendix A]).

The GMMP includes recommendations and considerations for remaining phases of mining to be implemented through revision of the GMMP and approval from the administering authority over time.

1.10.1 GMMP Review

The GMMP must be reviewed by an appropriately qualified person at the first instance before July 2020 and thereafter at regular five-year intervals, per EA Condition E5 and EPBC Act approval condition 3e (Appendix A~~Appendix A~~Appendix A). A report summarising the outcome of the review will be submitted to the administering authorities, which will include:

- An assessment of the GMMP to satisfy the objectives in EA Condition E5 (as presented in **Section 1.4** above)
- A review of the adequacy of the groundwater monitoring locations, frequencies, and groundwater quality triggers specified in **Table E1**, **E2**, and **E3** (Appendix A~~Appendix A~~Appendix A and **Section 5.4** in the GMMP) and in EPBC Act approval condition 3e
- A review of the validity of the groundwater monitoring program against the regular model predictions (EPBC Act approval condition 3e(i) and EA Condition E6) (EPBC Act approval condition 3e(i) and EA Condition E6) (Appendix A~~Appendix A~~Appendix A).

Upon evaluation of the five-year GMMP review report and included results, the administering authority may consider an amendment of the required review timeframe from at least five-year intervals to at least ten-year intervals, per Note under EA Condition E5 (Appendix A~~Appendix A~~Appendix A**)**

Preparation of the GMMP considered the required regular reviews will allow for the:

- Update of the groundwater conceptual model with (post-EIS) bore logs, groundwater level data (vertical gradients, interaction, and hydraulic connectivity), and groundwater chemistry data (recharge, discharge, and hydraulic connection) (EPBC Act approval condition 3e(i) and EA Condition E6(a, d, and f) (Appendix A~~Appendix A~~Appendix A)
- Verification and validation of the predictive numerical groundwater model with transient groundwater level data and mine dewatering data (volumes) (EPBC Act approval condition 3e(i) and EA Condition E6(b, e, and h) (Appendix A~~Appendix A~~Appendix A)
- Indirect assistance with the water balance model, where compilation of groundwater level data from units above and below the target coal seams will facilitate the revision of model water budgets (estimates of groundwater ingress from surrounding units) (EPBC Act approval condition 3e(i) and EA Condition E6(c) (Appendix A~~Appendix A~~Appendix A)

In compliance with EA approval conditions (EA Condition E6 (Appendix A~~Appendix A~~Appendix A)), the numerical groundwater model is to be reviewed, using the GMMP data and measured mine dewatering volumes, within two (2) years of the initial box cut excavation and then at least every five years afterwards. This is in line with the EPBC Act approval condition (3e), which requires a regular review of the GMMP, including the numerical groundwater model.

1.10.2 GMMP and Research

The GMMP bore network (spatial and with depth) was designed for compilation of extensive baseline groundwater levels and hydrochemistry data over time in all the hydraulically isolated geological formation that exist within and adjacent to the mine lease area. These data will allow for the assessment of potential impacts on groundwater resources and reassessment of groundwater alteration, due to stress (mine dewatering), over prolonged periods of mining.

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Such data, inclusive of the envisaged change in groundwater levels, induced groundwater movement towards the dewatered and depressurised target coal seams, and groundwater chemistry (mixing) changes, will be captured in the groundwater monitoring.

The groundwater monitoring data will, through accurate evaluation and assessment, allow for input into:

- Evaluation of compliance with groundwater quality triggers
- Evaluation of groundwater level thresholds (including EPBC Act specific approval condition Early warning triggers and Impact thresholds for the Doongmabulla Springs Complex)
- Development of the GDEMP (EA Approval Condition I11)
- The Carmichael Coal Project Biodiversity Offset Strategy
- The GAB Springs Research Plan (EPBC Act approval condition 3e(iii))
- The RFCRP (EPBC Act approval condition 3e(iv))
- Regional cumulative impact assessment(s) (EPBC Act approval condition 3f)
- Regional water balance model (EPBC Act approval condition 3f)
- Bioregional assessment and research for the Bioregional Assessment of the Galilee Basin sub-region and the Lake Eyre Basin (EPBC Act approval condition 3f).

All relevant data collected for the various research plans mentioned above (e.g. the GABSRP) will be considered in the subsequent iterations of the GMMP and groundwater model re-run(s).

In addition to groundwater level and quality data, augmentation of the GMMP bore network in response to mining allows for the provision of additional site specific geological data and aquifer hydraulic parameter estimations (modelling and aquifer testing) for the various research programs.

The dewatering volume records (to be maintained as per Associated Water Licence conditions), groundwater level changes (in response to mine dewatering), and hydrochemistry data will be available for consideration in the CCP Subsidence Management Plan (EA approval condition J2). These data will facilitate assessment of potential impacts and management processes associated with longwall mining impacts, such as subsidence.

Section 1.8.1 includes details of the GMMP – Research plan interaction.

1.11 GMMP Peer Review

For the GMMP to comply with EPBC Act approval conditions, a peer review of the GMMP is required (EPBC Act approval condition 3h).

Adani, in agreement with the DotE, appointed JBT Consulting (an independent specialist hydrogeological consultancy) 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**~~**Appendix F**~~~~**Appendix F**~~. A record of changes and modifications to this GMMP, in response to the independent review, are included in **Appendix G**~~**Appendix G**~~~~**Appendix G**~~.

The initial GMMP was then reviewed by DES and DotE, leading to this revision of the GMMP. The current version of the GMMP has been updated to address the regulator comments and recommendations.

1.12 Current Groundwater Monitoring Network

Adani developed and constructed a baseline groundwater monitoring network, detailed in **Section 3.0** which provided ambient groundwater level and quality data from all identified hydrostratigraphic units within, and adjacent to, the mine leases as per EA Condition E3(a).

Groundwater monitoring locations, on and off the mine leases, were initially drilled and constructed as a component of the EIS process, utilising existing larger diameter core / exploration bores. The EIS

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groundwater monitoring network was augmented post-EIS; both efforts were developed in consultation with the Queensland Department of Natural Resources, Mines and Energy (DNRME).

The resultant groundwater monitoring network, presented in **Appendix B**~~**Appendix B**~~~~**Appendix B**~~, is considered suitable to monitor potential impacts on groundwater resources as a result of the approved mining operations. The current groundwater monitoring network (monitoring rationale as requested in EPBC Act approval condition 3a(iii)) included the following:

- Installation of monitoring points along strike and down dip using existing exploration bores, specifically designed and constructed groundwater monitoring bores in the GAB units off lease, vibrating wire piezometers, and correctly designed (bore construction and wellheads) artesian bores. The bores all monitor hydraulically isolated units to provide groundwater level and groundwater quality data for each of the hydrostratigraphic units on and adjacent to the mine leases. The bores are located spatially across the mine footprint, providing data from subcrop to down-dip, as well as off lease adjacent to MNES, sensitive water resources, neighbouring groundwater users, and GDEs
- Collection of regular (~ 2-month intervals) baseline monitoring data (groundwater levels and quality) from all hydrostratigraphic units (potentially directly or indirectly impacted by mining), as described in this GMMP
- Identification of natural (seasonal) or anthropogenic fluctuations of groundwater levels and chemistry prior to mining (particularly the alluvium aquifers which are artificially recharged in the west due to discharge from the Joshua Spring / uncontrolled artesian flow and are non-perennial downstream, which results in changes in groundwater chemistry (no first flush changes in the west compared to the east)
- Identification of groundwater chemistry changes down-dip within hydrostratigraphic units (to assess differences based on recharge at subcrop and natural alteration down dip)
- Development of representative (site-specific) groundwater quality triggers and groundwater level thresholds.

Groundwater level data is recorded at 12-hour intervals via automated water level loggers. The groundwater level data, upon commencement of mining operations, will be compared to groundwater level thresholds derived from model predictions and assessment of natural fluctuation (**Section 5.3**).

1.13 Monitoring Performance Indicators

The adaptive management framework allows for, and promotes, assessment of management and mitigation measures for potential impacts on groundwater resources because of approved mining operations. To assess the effectiveness of such measures, to be employed by Adani during the life of mine (as compiled in the CCP Environmental Management Plan), performance criteria (to be assessed using this GMMP) has been developed such that:

- There will be no migration of mine-related poor quality seepage, within groundwater, into the surface water bodies
- There is compliance with groundwater quality triggers, and groundwater level thresholds (including the groundwater level Early warning triggers and Impact thresholds specific to the Doongmabulla Springs Complex) and the validation of corrective actions and/or mitigation measures to be taken if the triggers or thresholds are exceeded
- All landholder concerns over impacts on their groundwater supplies are to be addressed in a timely and prompt manner
- The compilation of annual groundwater monitoring reports, annually by 1 July (EA Condition E15), will provide validation of environmental protection performance
- Rehabilitated final voids to remain after mining will be managed and maintained appropriately.

The robust baseline groundwater dataset will be utilised for comparison during the life of mine and post-closure, to allow for assessment of mining operations on groundwater resources.

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All monitoring data, compiled during the different phases of mine life (baseline, construction, operation, and post-closure) will be maintained for the life of the project.

1.14 Clarifications

Approval conditions include for a Groundwater Management and Monitoring Program (EA Condition E4), a Groundwater Management and Monitoring Plan (EPBC Act condition), and an Underground Water management Program (UWMP) under the AWL conditions (*Water Act 2000*). The different approvals, Commonwealth and State, have similar requirements to be included in the GMMP, which leads to some confusion when compiling a single GMMP.

A glossary of terms has been included to allow for clarification regarding terms which mean different meanings depending on the source of the approval condition, i.e. triggers for the State approvals relates to groundwater chemistry, whereas triggers for the Commonwealth approvals relate to groundwater levels. The glossary provides details of the terms and their meanings as included in this GMMP.

1.14.1 Glossary

- Trigger values – a groundwater quality value, which if exceeded will lead to an assessment of the water quality parameter and possibly lead to (trigger) an investigation into potential for environmental harm

  Note: the groundwater level trigger values included in the EPBC Act approvals are referred to as groundwater level thresholds in this GMMP.

- Early warning bores – the use of the term early warning bores, in the initial iterations of the GMMP, has been recognised to cause confusion. The term was used to describe groundwater monitoring bores located between the mine activities and an identified receptor (GDE, landholder bore, etc.), providing a monitoring point where groundwater level and quality changes can be monitored before changes would occur at the receptor.

  Confusion was recognised as regulators / GMMP reviewers related early warning to be time related rather than spatial. To avoid this confusion the bores are now referred to as sentinel bores in this GMMP.

- Early warning triggers – the EPBC Act approvals includes for the details of groundwater level Early warning triggers and Impact thresholds for the Doongmabulla Spring Complex. These investigation triggers have developed to ensure that groundwater drawdown as a result of approved mining activities does not result in groundwater level decline by 0.2 m (the approval condition interim drawdown threshold for the Doongmabulla Spring Complex.

  The Early warning triggers in the GMMP are the same as the EA approval condition for groundwater level thresholds, a level of decline in water level which:

  - allows for the assessment of drawdown so it does not exceed the maximum predicted drawdown in the selected monitoring bore and hydrostratigraphic unit
  - validates predictive modelling
  - provides an early warning regarding the changes to groundwater levels if different (drawdown extent and/or rate of drawdown) to the predicted changes
  - instigates an investigation

- Interim threshold – EPBC Act approval condition 3(d) includes for Early warning triggers and Impact thresholds to be detailed in the GMMP so as to ensure that the groundwater drawdown as a result of the approved mining activities does not exceed 0.2 m, an interim drawdown threshold at the Doongmabulla Spring Complex.

  The interim drawdown threshold (0.2 m) may be replaced with a new drawdown threshold if further evidence can be provided which proves that a new drawdown threshold will ensure the protection and long-term viability of the Doongmabulla Spring Complex.

D R A F T

- Impact threshold – the EPBC Act approvals includes for the details of groundwater level Early warning triggers and Impact thresholds for the Doongmabulla Spring Complex. This drawdown threshold limit, selected to be less than the maximum predicted drawdown, ensures an investigation into groundwater drawdown, a revision of the predictive modelling, and the determination of mitigation measures to ensure that drawdown does not exceed 0.2 m, the interim drawdown threshold at the Doongmabulla Spring Complex.

  These impact threshold (drawdown limits for the DSC) are not the same as the States' groundwater level thresholds.

- High and low impact threshold levels - the Adani Associated Water Licence (AWL) condition 57 required the recommendations for low impact and high impact threshold levels in the Dunda Beds and Clematis Sandstone aquifers. The low impact and high impact threshold levels, derived for the AWL conditions, are the same as the Early warning triggers and Impact thresholds required for the Doongmabulla Springs Complex to meet the requirements of EPBC approval condition 3(d).

  To avoid confusion regarding groundwater level thresholds, the following is noted:

  - Early warning triggers (EPBC 2010/5736 Approval) are equivalent to the low impact threshold levels (AWL Condition 57) and groundwater level thresholds.
  - Impact thresholds (EPBC 2010/5736) are equivalent to the high impact threshold levels (AWL Condition 57).

- Control bores - control monitoring sites are a subset of the baseline hydraulically isolated groundwater monitoring bores. These monitoring bores are located adjacent to the mine lease and are constructed as hydraulically isolated background bores.

  The DotE considers that control bores are to be located outside the zone of potential impact. For groundwater this is impractical as the groundwater monitoring bores would have to be located outside the mine lease (due to the extent of drawdown extending beyond the mine lease boundaries) and long-term access cannot be assured. Discussions with Geoscience Australia indicated that the control bores can be where uninterrupted data can be provided during and after the life of the mine.

  Where possible Adani has identified control bores within areas where Adani has written approval for access these bores, and where little or no drawdown is predicted (beyond natural fluctuation). Although these bores, to the west of the mine lease, are not predicted to be impacted by mine related dewatering these bores are located on other landholders properties and as such there is no guarantee that these bores will not be impacted by groundwater extraction in the future.

  It is noted that Adani also has a series of sentinel bores between the mine lease and sensitive receptors (such as the Doongmabulla Spring Complex and neighbouring landholder bores). These bores will not be directly impacted by approved mining activities and as such will provide uninterrupted data can be provided during and after the life of the mine.

- Reference bores – control bores are technically reference bores, 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) .

2.0 Hydrogeological Regime

Understanding the site's hydrogeological system was essential to identify groundwater resources with potential to be impacted by the approved mining operations, including their magnitude and significance. To develop a fundamental comprehension of these systems at the CCP, several studies have been undertaken by Adani; the results of which have informed this GMMP.

The approvals process for the CCP allowed for compilation of geologic and hydrogeologic information from literature reviews, drilling and construction of groundwater monitoring wells, and groundwater assessments (groundwater quality and levels) conducted across and adjacent to the MLs. These datasets were utilised to develop initial groundwater, conceptual and numerical, models for the Environmental Impact Statement (EIS) (GHD, 2010), refinement in the Supplemental Environmental Impact Statement (SEIS) Mine Hydrogeology Report (GHD, 2013), and Addendum to the SEIS (AEIS) (GHD, 2013a).

This report was prepared to be read as a standalone document; however, should additional information regarding project geology and/or hydrogeology be required, reference should be made to the SEIS and AEIS reports referenced above.

To comprehensively understand the groundwater regime, review and assessment of the conceptual and numerical groundwater models were undertaken to identify potential data gaps. Continuous refinement of the models with new data as it becomes available ensures they are robust and defensible for use to accurately predict potential impacts because of the CCP. The groundwater model reviews, investigations undertaken, and requirements of future studies incorporated into this GMMP include:

- Carmichael Coal Mine and Rail Project SEIS Report for Mine Hydrogeology Report (GHD, 2013)
- Carmichael Coal Project Numerical Groundwater Model Peer Review (URS, 2013)
- Carmichael Coal Mine and Rail Project SEIS Mine Hydrogeology Report Addendum (GHD, 2013a)
- Carmichael Coal Project Groundwater Model Peer Review Final Comments (GHD, 2013b)
- Carmichael Coal Mine and Rail Project: Coordinator-General's evaluation report on the environmental impact statement (State of Queensland, 2014)
- Carmichael Coal Project Response to IESC Advise (GHD, 2014)
- Transient model verification memo (GHD, 2014a)
- Carmichael Coal Project Groundwater Model Independent Review (Hydrogeologic, 2014)
- Joint Groundwater Experts Report prepared for the Land Court of Queensland (Webb, et al., 2015)
- Adani - Carmichael Coal Project: Assessment of Potential Reduction in Spring Flow (Hydrosimulations, 2015)
- Land Court of Queensland judgement - Adani Mining Pty Ltd v Land Services of Coast and Country Inc. & Ors [2015] QLC 48
- Approval, Carmichael Coal Mine and Rail Infrastructure Project, Queensland (EPBC 2010/5736) (DotE, 2015)
- Response to Federal Approval Conditions - Groundwater Flow Model (GHD, 2015)
- Carmichael Coal Mine 2015 Hydrogeological Pumping Tests: Factual Report (AECOM, 2016)
- Environmental Authority Permit – Carmichael Coal Mine (EHP, 2016)
- Geological and Groundwater Assessment of the Rewan Formation (URS, 2016)
- Associated Water Licence 617264 Department of Natural Resources and Mines March 2017.

D R A F T

The numerical groundwater modelling in the SEIS and AEIS reports will be reviewed to incorporate groundwater monitoring data and measured mine dewatering volumes (from this GMMP) per EA Condition E6 (groundwater model review) within two years of commencement of any mining activities associated with box cut excavation and at least every five years after that. An accurate understanding of the impacts of approved mining operations on the groundwater regime(s) at the CCP is critical for appropriate refinement of this GMMP.

The subsections below present the current understanding of the groundwater regime(s), limitations, identified data gaps, studies undertaken to address known data gaps, and how future studies can incorporate remaining and/or future identified gaps in the groundwater conceptual understanding. It is recognised that at least one study has been planned to characterise the Rewan Formation within and adjacent to the mine leases, which will aid in finalising the current groundwater conceptual model.

Studies have been designed to satisfy the purposes of the RFCRP and GAB Springs Research Plan (GABSRP) and are currently in the planning stage. Objectives of the studies include further drilling and monitoring well installation to inform the source aquifer(s) for the Doongmabulla Spring Complex, located west of the CCP area. Results of these studies will be incorporated into the next iterations of the GMMP and numerical model review and update.

The current hydrogeological understanding has been used to inform this GMMP and the groundwater monitoring bore network, throughout the various stages of mining, spatially and temporarily.

2.1 Geology

2.1.1 Regional Geology

The CCP is situated along the eastern edge of the northern Galilee Basin, an intracratonic sedimentary basin comprised of Late Carboniferous to Middle Triassic sedimentary strata of predominantly fluvial depositional origin. The central Galilee Basin overlies the Devonian Adavale Basin, the Late Devonian-Early Carboniferous Drummond Basin, and Early Palaeozoic basement (Moya, et al., 2014). The Galilee Basin itself is overlain by the Jurassic-Cretaceous Eromanga Basin, a component of the GAB.

The principal tectonic elements of the Galilee Basin include the east-west trending Barcaldine Ridge which subdivides the basin into northern and southern components. The northern component of the basin is subdivided by the Maneroo Platform and the Beryl Ridge, which resulted in the development of the western depression termed the Lovelle Depression and the eastern depression termed the Koburra Trough; the CCP area occupies a position on the eastern margin of the Koburra Trough which corresponds with the basin margin, as depicted on **Plate 1**~~Plate 1Plate 1~~ below.

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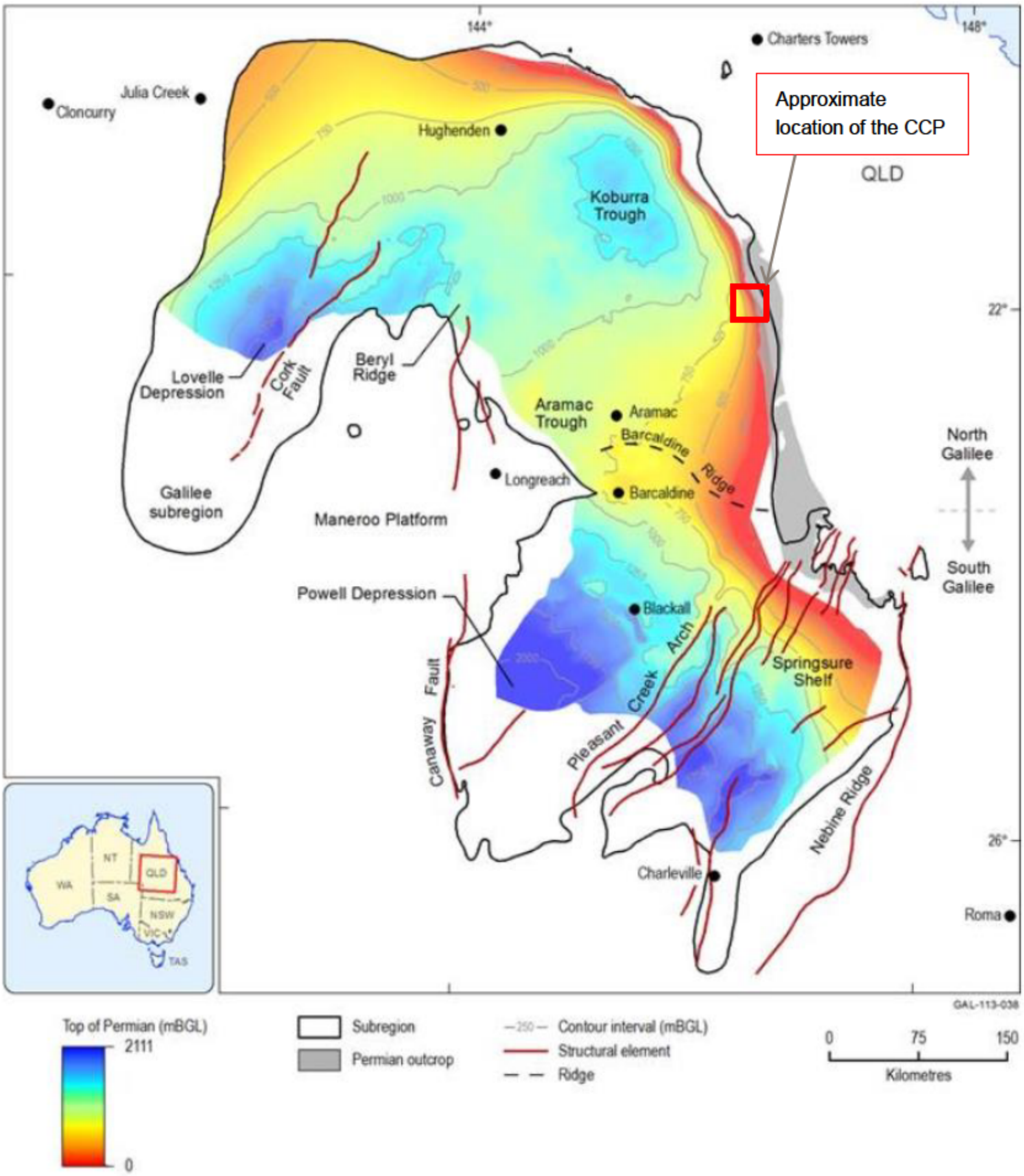

Plate 1 **Structures of the Galilee Basin (after Bradshaw et al., 2009)**

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Mineable coal seam targets occur in the Bandanna Formation (A and B seam) and the Colinlea Sandstone (C and D seams). The coal seams vary in thickness from 1 to 13 m across the mine leases and converge and diverge or split to distances that vary between 5 to 70 m. Together, these Late Permian coal measures are referred to as the Betts Creek Beds, which unconformably overlay the Early Permian Aramac Coal measures and Joe Joe Group. The Aramac Coal Measures do not occur in the CCP area; however, the Early Permian aged Joe Joe Group unconformably underlies the Colinlea Sandstone in the CCP area and is considered the basal unit of the Galilee Basin. Plate 2~~Plate 2~~Plate 2 below presents the Galilee Basin stratigraphy by proximity to major structural feature and relationship to the adjacent Eromanga and Drummond basins. Plate 3~~Plate 3~~Plate 3 depicts the relationship to the adjacent Eromanga Basin along the eastern margin of the Galilee Basin.

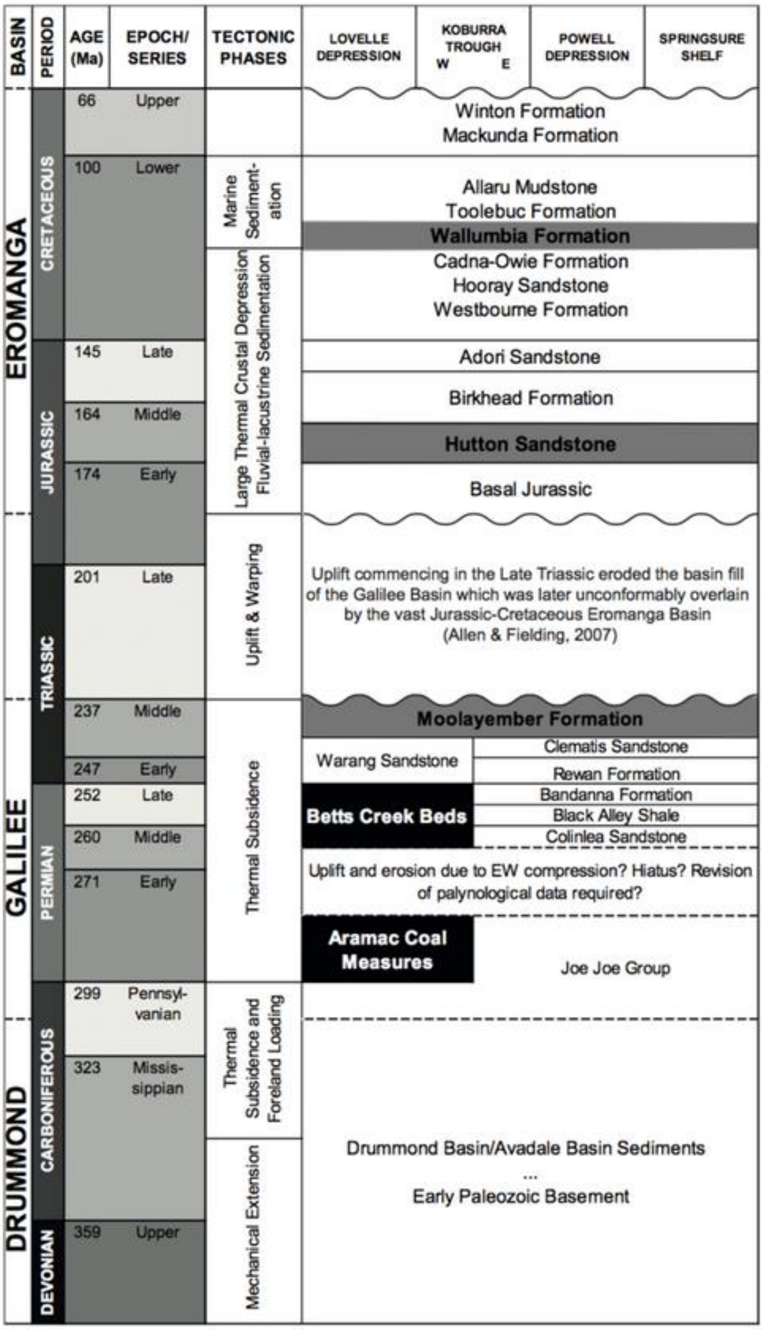

Plate 2 **Galilee Basin Stratigraphy and Relationship to adjacent basins (Modified from Scott et al. [1995] and van Heeswijck [2010])**

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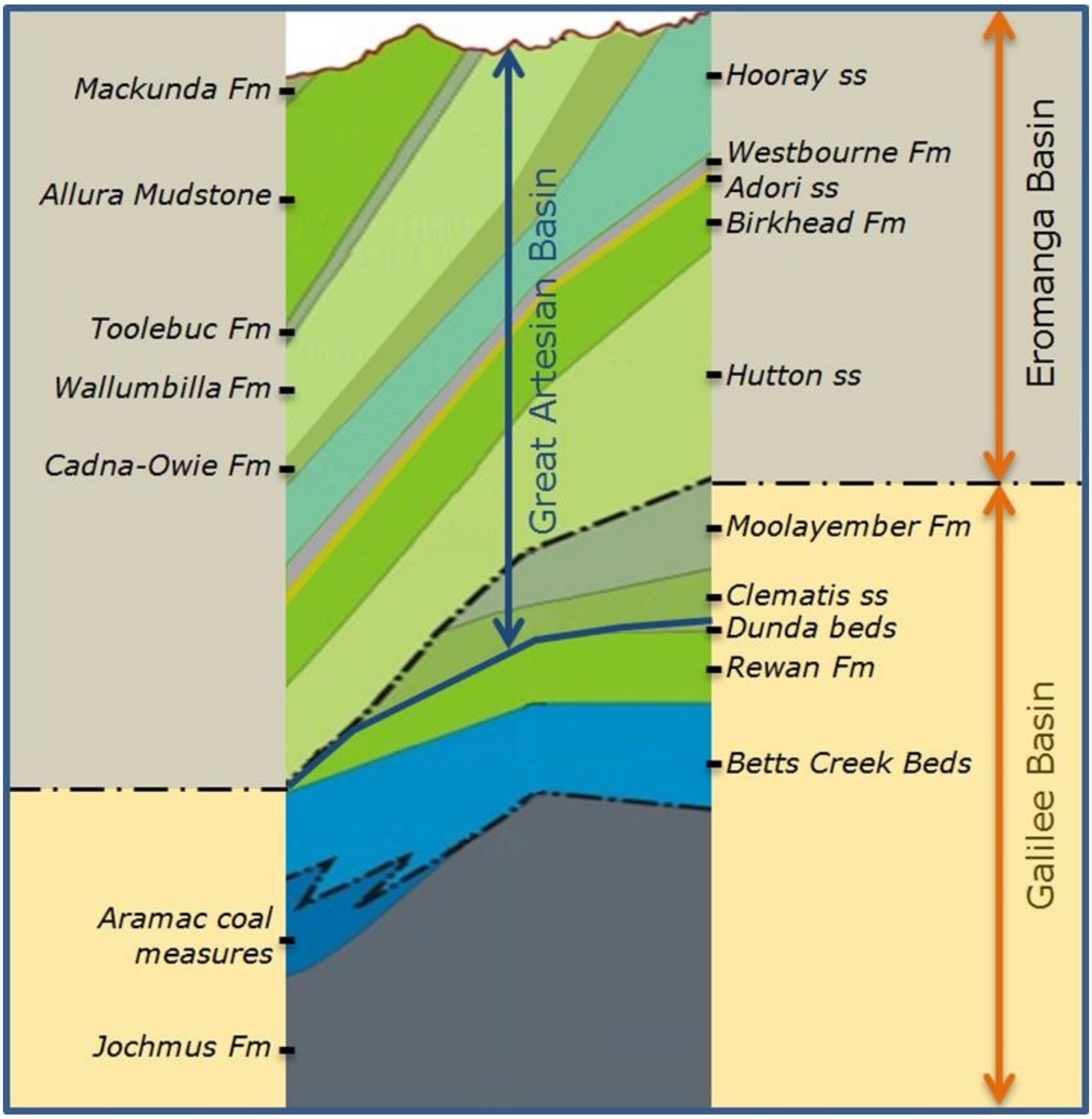

Plate 3 Galilee Basin – Eromanga Basin geology (source: Galilee Basin Operators Forum)

The stratigraphy of the CCP area is characterised by the Jochmus Formation of the Early Permian aged Joe Joe Group, the vertical extent of exploration, and overlying strata. Above the Jochmus Formation consists of the coal-bearing Colinlea Sandstone and Bandanna Formation, which are divided roughly by northwest-southeast trending geological outcrops, located west of the CCP area, comprised of the Moolayember Formation, Clematis Sandstone, and Dunda Beds. Error! Reference source not found. below depicts the CCP tenements and surface geology which presents the location and proximity of these outcrops. The Rewan Formation subcrops in this area and is underlain by the Late Permian to Triassic-aged coal-bearing units which overlie the Joe Joe Group.

East of the outcrop alignment, the depth to the Early Permian Joe Joe Group (Jochmus Formation) is limited and an unconformable and variable veneer of Tertiary sediments and Quaternary aged alluvium overlies the Early Permian aged sediments. The Joe Joe Group (Jochmus Formation) is considered the geological basement within the eastern portion of the CCP area and indicates the edge of the geological Galilee Basin.

Plate 4~~Plate 4Plate 4~~ below depicts the stratigraphy of the coal measures in the CCP area (modified from Allen & Fielding, 2007).

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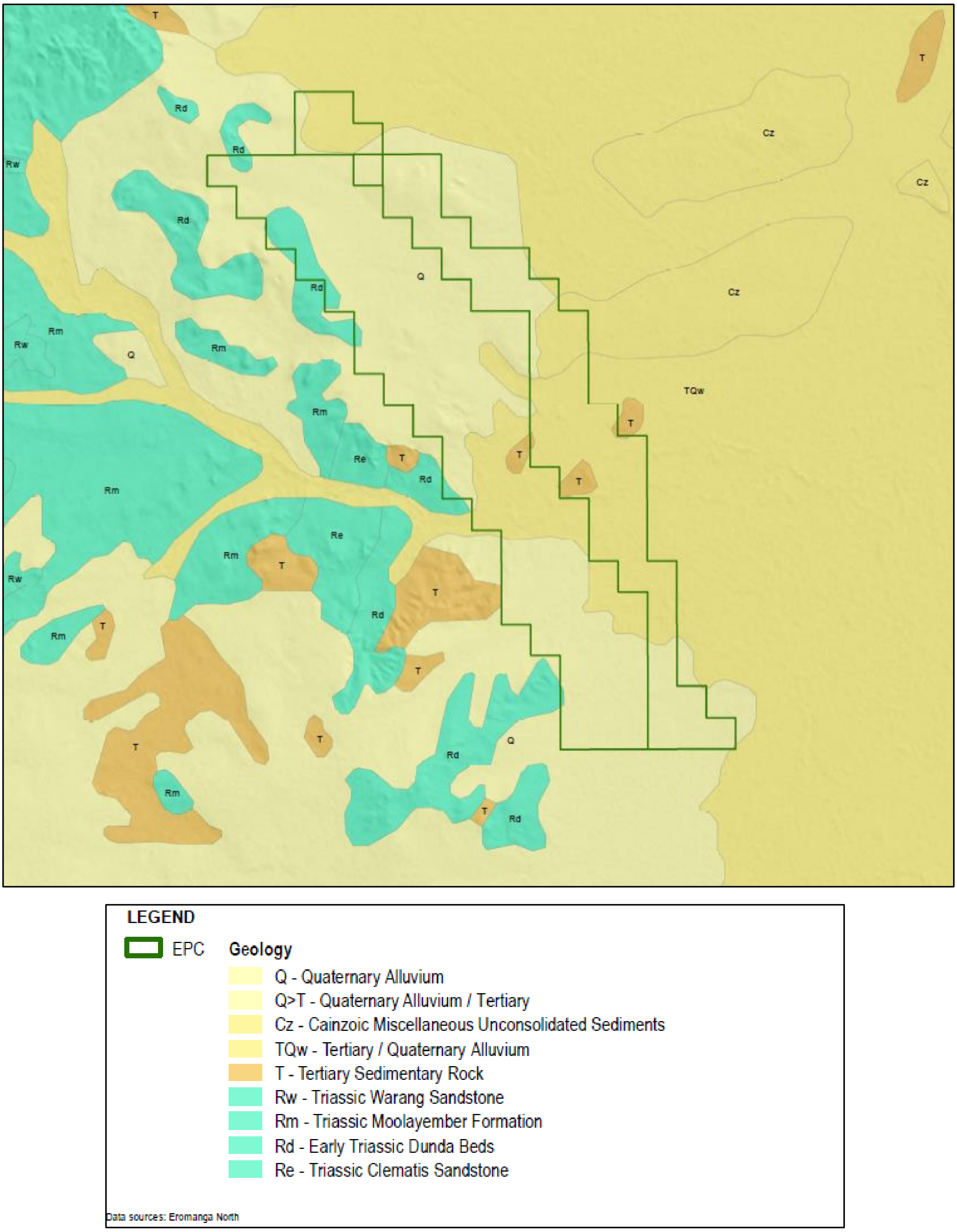

Figure 4 Regional Surface Geology and CCP Mine leases

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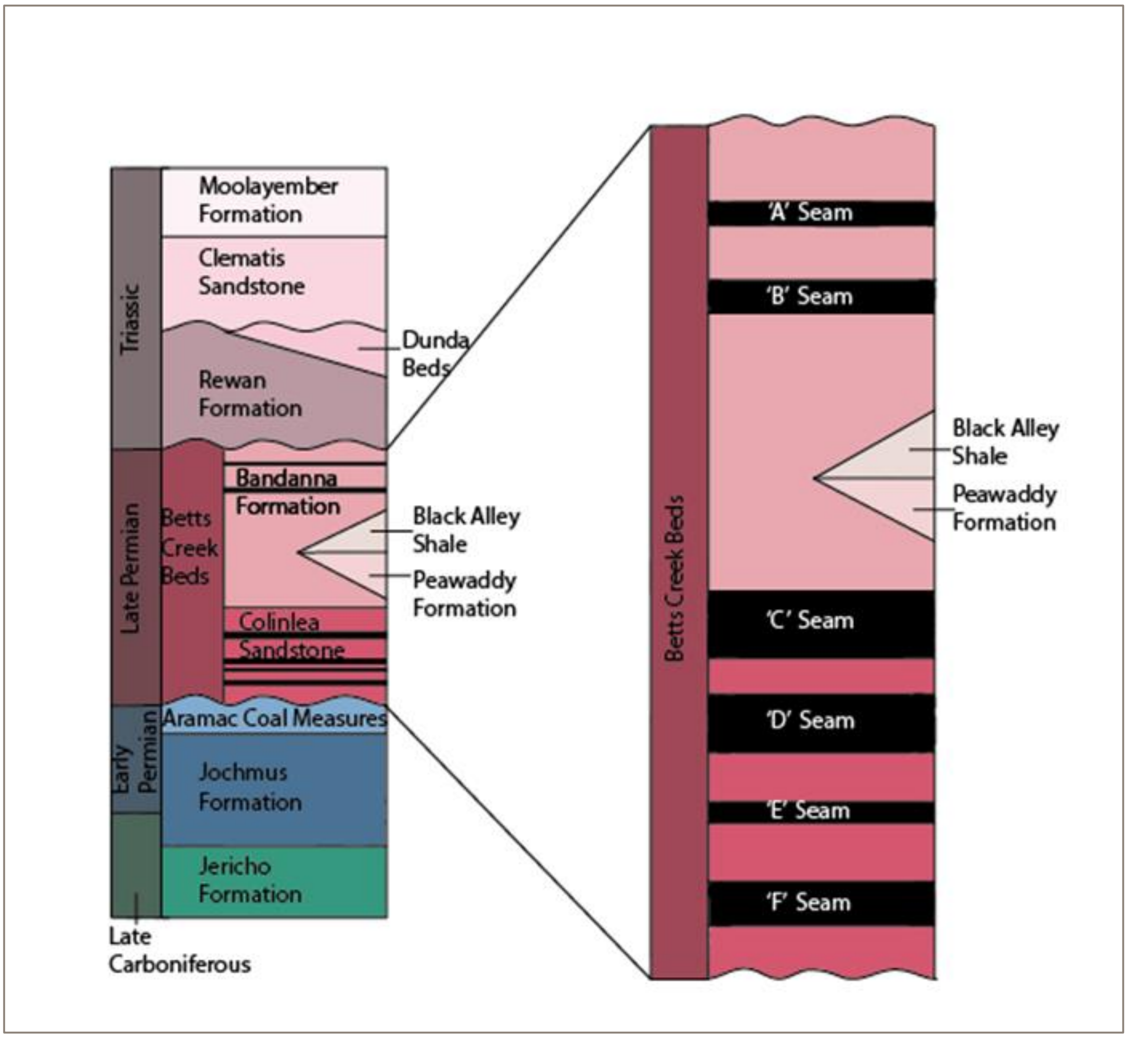

Plate 4 Galilee Basin Coal Stratigraphy

Cainozoic Cover

A sequence of sand, fine gravel and minor clay horizons (Tertiary sediments) covers the CCP mine lease areas. With an average thickness of 40 m, the Tertiary sediments are thickest in the eastern and central regions (~ 60 m thick) and thins towards the elevated areas in the west (< 5 m thick). Lateritic horizons (laterisation process of Permian aged sediments during the Tertiary period) are recorded along with mottled clay paleosols.

Floodplain alluvium sediments comprised of generally sands, silts, gravels, and clays are located along the Carmichael River and much of the Belyando River system east of the CCP area. The Tertiary sediments are overlain by alluvium in these areas. The alluvium sediments are laterally and vertically limited to the major surface water features.

The Cainozoic sediments unconformably overlie the Triassic aged Rewan Group (Dunda Beds and Rewan Formation), the Permian aged Bandanna Formation and Colinlea Sandstone, and the Early Permian aged Joe Joe Group units on the mine leases.

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Moolayember Formation

West of the CCP area, the Middle Triassic Moolayember Formation outcrops and predominantly comprises sandstone and siltstone. The Moolayember Formation is a recognised aquitard of the hydrogeological GAB and is the uppermost unit of the Galilee Basin, which is unconformably overlain by the sediments of the Eromanga Basin west of the Mine Leases (see **Plate 2**~~Plate 2Plate 2~~ above). In proximity to the CCP, this unit dips to the west and is not present within the Mine Lease; unconfined at areas of outcrop the Moolayember Formation becomes confined westwards where the Eromanga Basin overlies the Galilee Basin.

It is noted that the Moolayember Formation, west of the CCP leases, is absent south of the Carmichael River and becomes thicker to the north. The Moolayember Formation, weathered to clay, outcrops across the Doongmabulla Springs Complex area.

Clematis Sandstone

The Clematis Sandstone, a recognised major GAB aquifer, is observed at outcrop west of the CCP mine lease boundary. Comprised of quartz-rich coarse-grained sandstone, minor siltstone, and mudstone this unit is located along the western boundary of the CCP area. Considered unconfined at outcrop, the Clematis Sandstone dips westwards and becomes confined where it underlies the Moolayember Formation west of the CCP leases.

Drilling to the west of the CCP mine leases indicates artesian conditions exist within the Clematis Sandstone within the low-lying flood plains of the Carmichael River, where overlain by clay-rich Moolayember Formation sediments.

The Clematis Sandstone outcrop west of the CCP area is recognised as the recharge zone of the larger GAB.

Rewan Group

The Rewan Group sediments include the Dunda Beds and underlying Rewan Formation and comprise a massive sequence (~300 m thick) of multi-coloured argillaceous sediments which are regionally extensive.

The Dunda Beds, predominantly sandstone, form an angular unconformity with the overlying Tertiary aged strata and outcrop along the western margins of the mine leases.

The Rewan Formation underlies the Dunda Beds and comprises typical green to brownish purple siltstone and minor fine-grained sandstone which form a thick sequence of very low permeability strata (i.e. a regional aquitard) that separates recognised aquifers of the GAB from underlying Galilee Basin sediments, inclusive of the Permian coal-bearing sequences of the Bandanna Formation and Colinlea Sandstone. The base of the Rewan Formation is located some 30 to 50 m above the uppermost Bandanna Formation A seam coal ply.

Within the mining leases, the Rewan Formation is dominated by thick (~ 250 m) clays and mudstones with some interbedded sandstone strata. Drilling through the entire Rewan Group profile, to the west of the mine leases, intersected swelling clay resulted in difficult drilling conditions and abandonment of monitoring well construction. The Rewan Formation aquitard effectively separates the CCP coal resource within the underlying Permian-age strata from the stratigraphically younger Dunda Beds and Clematis Sandstone to the west.

Permian Sediments

Permian sedimentary deposits at site, which underlie the Rewan Group, comprise the Bandanna Formation and underlying Colinlea Sandstone, collectively known as the Betts Creek Beds. These Permian units contain both economic and sub-economic coal seams. The coal seams are named alphabetically A through to F, where the A seam is the uppermost unit.

Geologically, the boundary between the Bandanna Formation and Colinlea Sandstone is, in the absence of the Black Alley Shale and Peawaddy formations in the CCP area, an interval below the C coal seam where the sedimentation grades from argillaceous to increasingly arenaceous sediments. Thus, the Bandanna Formation hosts the A and B coal seams (and C where present) in clay-rich sediments, while the Colinlea Sandstone hosts the target D coal seam and coal seams E and F (where present) in more coarse-grained sandstone beds.

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A layer of tuff has been observed below the CCP area within the interburden between the C3 and D1 coal seams.

Bandanna Formation

The Bandanna Formation comprises calcareous, lithic sandstone, siltstone and a number of low rank sub-bituminous and sub-hydrous coal seams. This sequence represents fluvial deposition with sandy braided channel and flood plain deposits associated with mire (marsh) and coal seam development.

Three coal seams, namely seams A, B, and C, are laterally continuous and correlated regionally.

Colinlea Sandstone

The Colinlea Sandstone, an arenaceous sequence, comprises primarily quartz sandstone and conglomerate with minor shale and a number of low rank sub-bituminous and sub-hydrous coal seams. The sequence represents fluvial deposition with sandy braided channel and flood plain deposits associated with coal seam development. Three coal seams, namely seams D, E, and F are laterally persistent and correlated regionally.

Joe Joe Group

The Colinlea Sandstone is unconformably underlain by sediments of the late Carboniferous to Early Permian aged Joe Joe Group, comprised of four formations within the Galilee Basin. From oldest to youngest the Lake Galilee Sandstone, Jericho Formation, Jochmus Formation, and the Aramac Coal Measures; the Aramac Coal Measures are absent within the CCP area and the Lake Galilee Sandstone is restricted to the Trough axis. Thus, the upper Jochmus Formation is identified as the bottom confining unit of the Colinlea Sandstone aquifers and vertical extent of investigation for the CCP.

The Joe Joe Group in the project area consists of entirely non-marine sediments inclusive of mudstone, labile sandstone, siltstone, shale.

2.1.2 Site Geology

Tertiary sediments (sandstone, mudstone, laterite, and conglomerate) are mapped at outcrop over much of the CCP area and typically range from 20 to 60 m thick. Along the Carmichael River and over much of the Belyando River system to the east of MLs, these strata are mapped to be overlain by Quaternary aged alluvium (i.e. sands, silts, gravels, and clays).

Beneath the mine leases, an unconformity defines the boundary between the Tertiary sediments and the underlying Late Permian-age coal bearing strata (a sequence of siltstone, mudstone, sandstone, shale, and coal of the Bandanna Formation and Colinlea Sandstone).

The Late Permian-age strata typically dip at approximately 2 to 4 degrees to the west, which steepen slightly in the southern half of the lease. Monitoring well drilling indicates a synform within the MLs, which corresponds to the groundwater level lows monitored onsite (**Section 2.2.5**).

Along the western margins of the CCP area, a sequence of Triassic-age strata forms an angular unconformity with the overlying Tertiary sediments and is mapped at outcrop as the Dunda Beds (predominantly fine grained feldspathic sandstone). The Rewan Formation (mudstone and minor sandstone) underlies the Dunda Beds and overlies the Late Permian age coal bearing strata.

The lithostratigraphy along the eastern margin of the Galilee Basin is presented in **Table 5**~~Table 5~~~~Table 5~~ below.

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Table 5 Lithostratigraphy of the Eastern Limb of the Galilee Basin (source: CCP drilling and Alpha Bulk Sample Pit)

<table>
<tr><th>Age</th><th colspan="2">Geological unit</th><th>Lithology</th><th>Thickness</th><th>Comment</th></tr>
<tr><td>Quaternary</td><td colspan="2"></td><td>Alluvium</td><td>< 20 m</td><td>Unconfined aquifer along rivers</td></tr>
<tr><td>Tertiary</td><td colspan="2"></td><td>Argillaceous saprolite, laterite, and clay sediments</td><td>20 to 60 m</td><td>Unconfined aquifer, altered Permian units during the Tertiary period</td></tr>
<tr><td rowspan="4">Triassic</td><td colspan="2">Moolayember Formation</td><td>Moolayember Formation (sandstone and siltstone)</td><td>25 to 50 m near Doongmabulla Springs Complex; and >100 m further west</td><td>Outcrops to the west of CCP</td></tr>
<tr><td colspan="2">Clematis Sandstone</td><td>Quartz sandstone, minor siltstone and mudstone</td><td>~100 m near Doongmabulla Springs Complex; and >100 m further west</td><td>Unconfined at outcrop and confined to the west of the site, major GAB aquifer</td></tr>
<tr><td rowspan="2">Rewan Group</td><td>Dunda Beds</td><td>Sandstone, siltstone, mudstone</td><td>Up to 100 m on CCP</td><td rowspan="2">Confining unit, basal unit of the GAB, Rewan Formation grades into Dunda Beds</td></tr>
<tr><td>Rewan Formation</td><td>Grey-green mudstone, siltstone, and sandstone</td><td>~ 250 m on CCP</td></tr>
<tr><td rowspan="14">Late Permian (Betts Creek Beds)</td><td colspan="2" rowspan="6">Bandanna Formation</td><td>Sandstone</td><td></td><td>Permian 90 to 180 m to base of target coals</td></tr>
<tr><td>Coal - AB Seam</td><td>12 – 18 m</td><td>Resource target</td></tr>
<tr><td>Sandstone / siltstone</td><td>10 m</td><td>Aquitard</td></tr>
<tr><td>Coal – B splits</td><td>1 – 2 m</td><td>Coal</td></tr>
<tr><td>Siltstone / mudstone</td><td>60 – 70 m</td><td>Aquitard</td></tr>
<tr><td>Coal – C Seam</td><td>3 – 4 m</td><td>Carbonaceous</td></tr>
<tr><td colspan="2" rowspan="8">Colinlea Sandstone</td><td>Siltstone / sandstone</td><td>2 – 20 m</td><td></td></tr>
<tr><td>Coal – D1 Seam</td><td>4 – 6 m</td><td>Resource target</td></tr>
<tr><td>Sandstone</td><td>5 – 30 m</td><td></td></tr>
<tr><td>Coal – D2/D3 Seam</td><td>8 – 10 m</td><td>Resource seam</td></tr>
<tr><td>Siltstone / mudstone</td><td>10 – 20 m</td><td></td></tr>
<tr><td>Coal – E Seam</td><td>1 – 3 m</td><td>Resource seam</td></tr>
<tr><td>Sandstone / siltstone</td><td>5 – 10 m</td><td></td></tr>
<tr><td>Coal – F Seam</td><td>1 – 5 m</td><td>Resource seam</td></tr>
</table>

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Age	Geological unit	Lithology	Thickness	Comment
Early Permian	Joe Joe Group (Jochmus Formation)	Bedrock Mudstone, labile sandstone, siltstone, shale and thin carbonaceous beds		Low permeable unit

2.1.3 Site Hydrogeology

Based on the current understanding of the geology for the mine site the hydrogeological units considered of relevance to CCP include the:

- Quaternary aged unconsolidated alluvium associated with the Carmichael River and other local water courses
- Tertiary aged clay-rich saprolite and laterite (altered Permian units during the Tertiary period)
- Triassic aged units which form part of the GAB including the Moolayember Formation, Clematis Sandstone, Dunda Beds, and Rewan Formation
- Permian aged siltstone, mudstone, sandstone and coal seams of the Bandanna Formation and the Colinlea Sandstone which form the target of the proposed mining operations (not mapped at outcrop), also known as the Betts Creek Beds when these two units are combined together
- Early Permian aged Joe Joe Group (Jochmus Formation) weathered and fresh bedrock: mudstone, labile sandstone, siltstone, shale.

Alluvium

Unconsolidated alluvium typically forms the uppermost hydrogeological unit within and adjacent to the CCP leases. Along the Carmichael River these strata include sand, gravel and clay-dominated layers of variable thickness and limited lateral extent. These sediments form an unconfined aquifer, indicated to be approximately 20 m thick with variable saturation (seasonal) and from west to east where the Carmichael River is gaining (in the west because of continuous artesian discharge from Joshua Spring) to become a losing stream further east (downstream).

The permeability of these units is governed primarily by the proportion of sand and gravels and the connectivity of the strata, which vary both laterally and vertically. Bore yields recorded on site are < 1 L/s.

Tertiary Sediments

Clay, sandstone, and siltstone of Tertiary age are mapped on surface and underlie the younger unconsolidated deposits over much of the CCP tenures. Lithological logging of bores within the Tertiary sediments suggest a typical profile which includes around 16 m of clay that overlies a maximum thickness of 60 m of sandstone and often highly weathered siltstone (saprolite) and includes significant clay-dominated material. This saprolite is considered to be Permian-age strata weathered during the Tertiary period.

Variable (falling) head test results from the Tertiary sediments suggest hydraulic conductivity values as low as 2.1×10^{-4} m/day for the Tertiary age clay-rich strata. The Tertiary sediments are not considered to represent a locally important groundwater resource.

This unit does form an aquitard, a confining layer, that separates the alluvium and underlying Early Permian aged Joe Joe Group in the eastern area of the CCP are, in the area containing the Mellaluka Springs. Here the palaeochannel deposits within the Tertiary sediments and underlying Joe Joe Group are under artesian conditions.

Triassic GAB units

Triassic-age GAB units comprise the Rewan Formation, Dunda Beds, Clematis Sandstone, and Moolayember Formation, which lie within and to the west of CCP. The Rewan Group (Rewan Formation and Dunda Beds) is recognised as the regional basal confining unit (aquitard) of the GAB. Within the CCP area, the Rewan Formation is logged to be dominated by claystone and mudstone

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(which form swelling clays due to the presence of the expansive smectite clay) with some inter-beds of sand.

Analysis of core drilling samples across all bores drilled from north to south, west of the CCP mine leases, indicate the Rewan Formation comprises an aquitard. The triaxial permeability tests performed on the Rewan Formation core samples indicate permeability values that range from 1.1 x 10^{-03} to 7 x 10^{-05} m/day (bore C14025VWP) and 2.0 x 10^{-04} to 7.0 x 10^{-04} m/day (bore C14204VWP hole).

The Rewan Formation (a regional aquitard) is recognised to be continuous (~250 m thick) across and adjacent to the MLs. Table 6~~Table 6Table 6~~ below presents the measured thickness of the Rewan Formation from bore logs, which have top and bottom contact depth data for the Rewan Formation.

Table 6 Thickness of Rewan Formation

Bore	Thickness (m)	Top (mAHD)	Bottom (mAHD)
C14204VWP	294	165	459
Shoemaker-1[2]	337.1	199.7	536.8
C14205VWP	234	375	609
C865G	254	79	333
C864G	249	166	415
C039	273	46	319
C039CR	284	46	330
C037	285	50.5	335.5
C037C	284	49	333
C866G	275	153	428
C048	273	65	338
C860G	280	48	328
C047	284	176	460
C861G	283	92	375
C015	263	60	323
C022	268	84	352
C003	270	48	318
C053	269	130	399
C065	286	54	340
C065C	282	57	339
C010	290	89	379
C044C	270	56	326

The locations of these bores are presented on Error! Reference source not found. below.

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[2] Shoemaker-1 coal seam gas well drilled on Comet Ridge ATP744P (Comet Ridge, 2010)

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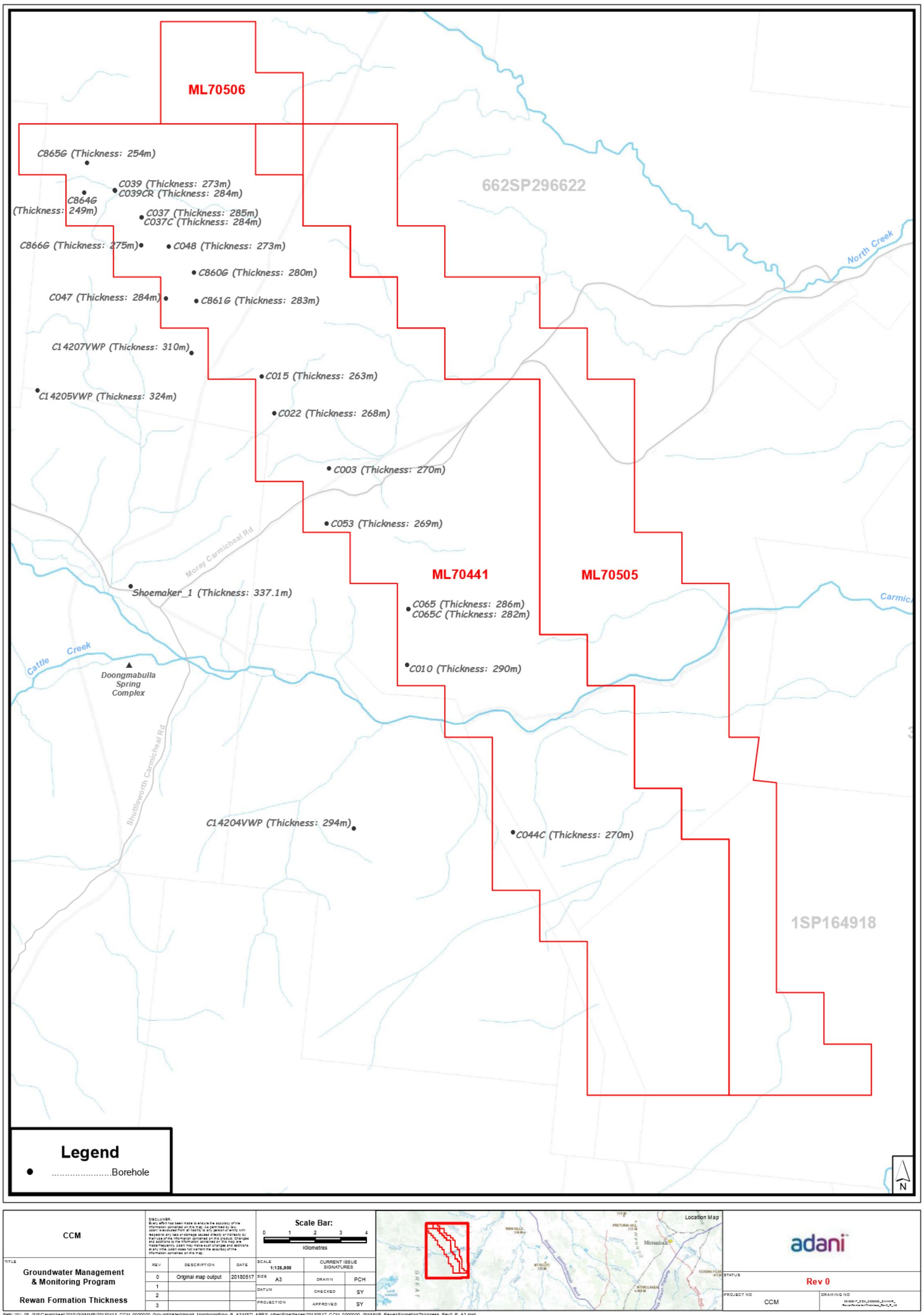

Figure 5 Rewan Formation Bores (with top and bottom Rewan Formation contacts recorded)

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The Rewan Formation, continuous in all bores to the west of the mine leases, separates the Permian target coal seams from the stratigraphically younger Dunda Beds and Clematis Sandstone (recognised GAB aquifer) to the west.
Near the CCP area, generally along the western boundary of the mine, permeability of the Dunda Beds sandstone unit is variable and dependent on the degree of weathering, cementing, and/or grain sizes. Available drilling records indicate the variability in permeability as available well yield data indicate a range from as low as 0.1 L/s to as high as 4 L/s

Permian Coal Measures

The target coal seams lie within the Late Permian age Bandanna Formation and Colinlea Sandstone units which dip from east to west across the CCP tenure. Thus, the coal seams subcrop directly beneath the Tertiary sediments in the eastern portion of the CCP area. Conversely, the Triassic-age sandstone and mudstone of the Rewan Group overlie the coal seams in the west. Both the Triassic and Permian age strata typically dip with a shallow gradient (2 to 4°) towards the west across the mine lease and are unconformably overlain by Tertiary sediments and Quaternary aged alluvium. An assessment of the geology and groundwater (potentiometric heads) levels, resulting in flow patterns towards the centre of the lease, indicate a local scale synform (**Section 2.2**).

From a groundwater perspective, major hydrostratigraphic boundaries occur within the CCP area at the base of weathering, beyond which groundwater is encountered under confined conditions in the A-B, B-C, and C-D sandstones and AB and D coal seams. Adani intend to drill and construct additional groundwater monitoring bores, south of the MLs, within the strata below the E seam (Sub-E) to assess and monitor potential alternative source aquifer supplies. These additional Sub-E bores are proposed to be drilled and constructed to the south of the MLs to inform potential aquifer suitability.

The Bandanna Formation typically comprises a varied sequence of sandstone, siltstone, mudstone, and coal. Primary porosity and permeability are typically low and, hence, yields are generally governed by the degree to which secondary porosity and permeability have developed. Experience at locations within the Galilee Basin suggests that coal seams within the Bandanna Formation argillaceous sediments are often the highest yielding and most permeable part of the sequence. This likely reflects the relatively low strength and high fracture potential of the coal seams in comparison to other units present.

Yield estimates from short period airlift tests (1 to 2 hours in length) conducted across CCP, from groundwater monitoring bores installed in the coal seams, ranged from <0.1 to 1.0 L/s (with a mean of 0.2 L/s and median of 0.12 L/s) which suggests low sustainable yields.

The Colinlea Sandstone comprises predominantly arenaceous sandstone between the coal seams. These sandstone units, becoming more coarse-grained with depth, are recognised to have good groundwater potential. Drilling results indicate yields in the coal of ~ 1 L/s and within the sandstone of 3 to 10 L/s. The Sub-E sandstone has been identified as possible sources of make-good groundwater supplies along the eastern margin of the Galilee Basin.

Joe Joe Group

The Jochmus Formation of the Joe Joe Group is identified to be low permeable strata and the bottom confining unit of the Colinlea Sandstone aquifers and geological basement in the CCP area. A heterogenic clay-rich unit, the Joe Joe Group sediments are understood to be variable but generally considered to have limited groundwater potential.

Drilling undertaken within the Joe Joe Group in the southern area of the CCP and south of the Mine Lease (near Mellaluka Spring Complex) indicate three distinct artesian zones:

- The contact between the Tertiary sediments and Joe Joe Group
- A more permeable sand-rich weathered layer within the Joe Joe Group
- The base of weathering in the Joe Joe Group.

Results of aquifer tests performed from groundwater monitoring wells, inclusive of high potentiometric pressures (artesian conditions), identified variable yield ranges (0.5 to 3.0 L/s) and indicate there is a low permeability hydraulic connection between the three artesian zones within the Joe Joe Group. It is conceptualised, based on location, drilling results, and chemistry (see **Section 2.2.6.3**), that the

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artesian conditions exist locally and are considered associated with the Belyando River palaeochannels. . The aquifer tests indicate that, with yields of up to 3 l/s, that the Joe Joe Group may be considered as alternate water supply source (in instances of make-good).

Further the first groundwater model revision (to be conducted within 2 years of the box cut excavation) will include Joe Joe Group site specific data as well as the revision of the model layers below the D seam and to the east (as conceptualised in **Section 2.2.6.3**). The refined model will be used to assist in evaluating the suitability of aquifers within the weathered Joe-Joe Group for providing alternative water supplies, relevant to any approval issued under the *Water Act 2000*.

2.2 Hydrogeological Conceptual Model

A conceptual groundwater model is a representation of the behaviour of the groundwater system and its interactions with surface water within the catchment. Development of a conceptual model requires the compilation of detailed information on the geology, water quality, recharge/discharge mechanisms, rivers, springs, water levels, hydraulic parameters, and groundwater usage. The key elements in a conceptual model are:

- The definition of the extent and hydraulic properties of the aquifers and aquitards
- An understanding of the groundwater recharge and discharge processes
- An understanding the groundwater flow directions.

A conceptual groundwater model, which formed the basis of the numerical groundwater model, was developed based on existing information and field data collected for the CCP and surrounding area. These data were utilised as the basis to develop the groundwater monitoring network for the project which has been and will continue to be augmented over time via the adaptive management framework presented in **Section 1.2**.

The original conceptual model has been refined over time with new information. The current understanding of the site’s hydrogeological regime is presented in the subsections below which are the result of incorporation of data gathered and assessed since the original model was developed for the EIS/SEIS. This refined conceptual model has 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 understanding for the CCP.

Refinement of the groundwater conceptual model indicates the groundwater regime of the Galilee Basin is complex and varied, particularly along the eastern margin, where the CCP area is located.

2.2.1 Geometry and Structures

Structural features of the Galilee Basin are located primarily along the eastern and western boundaries of the Basin. The Mingobar Monocline and Koburra Trough are in the north-eastern area of the Basin and a series of faults, monoclines, and ridges where the Galilee and Drummond basins intersect.

Geometry of the geological Betts Creek Beds (Triassic aged Bandanna Formation and Colinlea Sandstone) is understood to reflect a series of monoclines and synforms at the basin’s western and eastern boundaries. The westernmost extent of these units ends at the Maneroo Platform (metamorphic basement and granitic intrusions) and are pinched out between the contact of the Drummond Basin and the GAB, below the Hulton-Rand Monocline.

On the eastern margin of the basin, where the CCP is located, the stratigraphic units outcrop and subcrop within and adjacent to the MLs. The Dunda Beds and Clematis Sandstone outcrop along the western boundary of the CCP area. The Rewan Formation, Bandanna Formation, Colinlea Sandstone, and Joe Joe Group subcrop within the CCP area. The geometry of the subcrops and outcrops reflect a synform, as depicted in **Plate 5**~~**Plate 5Plate 5**~~.

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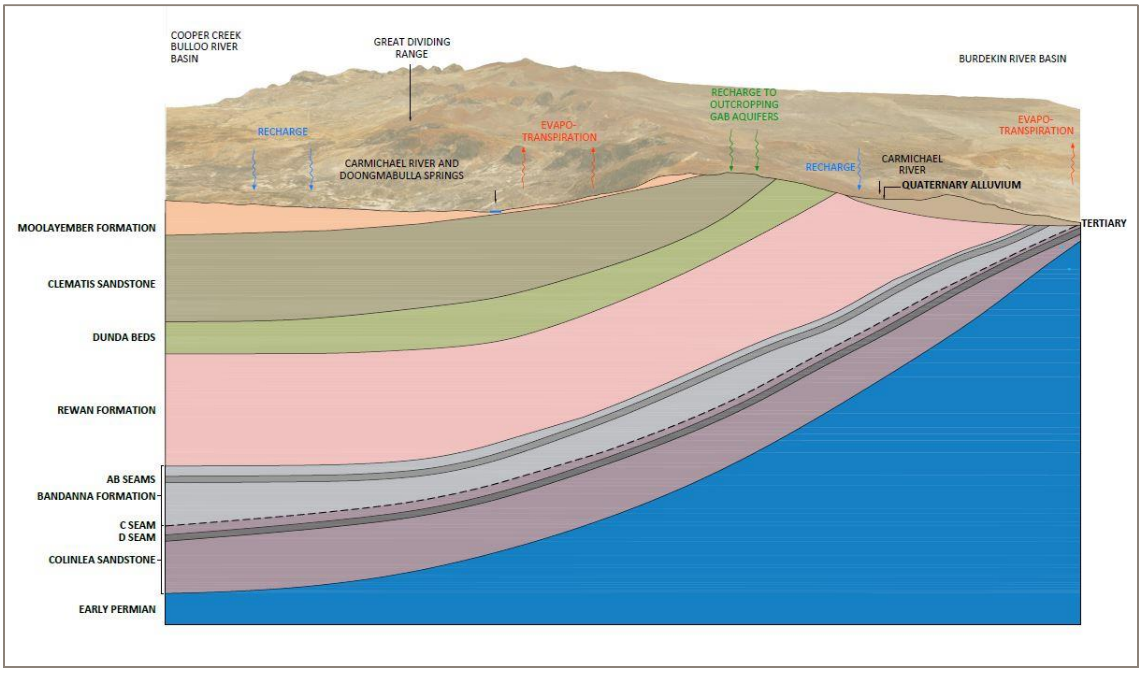

Plate 5 Conceptual Cross-section of the CCP area (Note: Early Permian aged sediments are the Joe Joe Group)

Structurally, there is a general absence of any significant regional faults in the area (Biggs, 2014). There are only four minor faults interpreted within the coal strata, with vertical throws between 20 and 40 m, which trend in a general east-west direction across the CCP area. The four minor faults were recognised because of exploration from a 2-D seismic investigation in 2011 and additional drilling works in 2013 across the project area. These minor faults were limited to the coal strata and not mapped to impact on the overlying units or act as a preferential pathway or compartmentalise the groundwater regime within the CCP area.

An assessment of available groundwater monitoring bore logs and screen depths indicates folding within the CCP footprint where a synform is recognised. The groundwater elevations associated with the deepest installed screens within the different hydrostratigraphic units monitored on site indicate a groundwater 'low' in the centre of the CCP area (as depicted in the groundwater contour figures in Appendix C~~Appendix C~~Appendix C). The axial plane of the synform, based on bore locations, screen depths, and associated groundwater level data, has a northeast to southwest strike. Due to this geometry, the units which overlie the Betts Creeks Beds are similarly influenced, inclusive of the Rewan Group units (Rewan Formation and Dunda Beds) but not the younger Clematis Sandstone (where no similar groundwater low is present). This groundwater 'low' can be observed on the groundwater contour maps (Appendix C~~Appendix C~~Appendix C); groundwater flow direction across the CCP site is observed to flow south/southeast north of the Carmichael River and flow towards the northwest from areas south of the Carmichael River.

While the geometry of the CCP area is considered to influence groundwater elevations onsite, the regional (basin-wide groundwater flow direction for these units) is understood to mirror the dip of the strata from northeast to southwest (except for the Clematis Sandstone), as depicted in the groundwater modelling (GHD, March 2015).

Overall, the hydrostratigraphic heads of each unit influence the groundwater flow direction within the CCP tenements where flow is towards the lowest hydraulic point associated with the deepest portion of the unit (groundwater elevation low observed onsite).

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2.2.2 Groundwater Recharge and Discharge

Each geologic unit's inferred recharge and discharge mechanisms are presented in Table 7~~Table 7~~Table 7 below.

Table 7 Groundwater Recharge and Discharge Mechanisms

Stratigraphic Unit	Primary Recharge Mechanism	Primary Discharge Mechanism	Comment
Alluvium	• Surface water infiltration, particularly from the Carmichael River • Direct rainfall infiltration • Vertical leakage (upward) from underlying units	• Baseflow to surface water features (i.e. Carmichael River) • Vertical leakage into underlying units • Evapotranspiration	Alluvium, along the Carmichael River, is recognised to be artificially recharged through continuous discharge from the Joshua Spring (artesian flow from the Clematis Sandstone), which is discharged into the Dyllingo Creek, which flows into the Carmichael River.
Tertiary sediments	• Surface water infiltration, particularly along the eastern portion of the site • Rainfall infiltration in outcrop areas • Vertical leakage from overlying alluvium	• Vertical leakage to overlying alluvium • Evapotranspiration • Poorly constructed bores resulting in uncontrolled discharge, forming springs	The Tertiary sediments, particularly overlying the Joe Joe Group, are considered to thicken in the eastern area of the site which results in artesian conditions. Complex multi-storey artesian conditions occur in the Tertiary sediments and Joe Joe Group due to interbedded high and low permeable units.
Moolayember Formation	• Rainfall recharge in outcrop areas (west of the CCP area) • Vertical leakage from the underlying units	• Vertical leakage into overlying Cainozoic sediments and underlying Clematis Sandstone • Recharge reject due to low permeability and storage • Evapotranspiration	Deep weathering and erosional features around the Doongmabulla Springs Complex indicates limited recharge and high runoff across the Moolayember Formation outcrop.
Clematis Sandstone	• Rainfall recharge in outcrop areas (along western boundary of the CCP area)	• Vertical leakage to underlying Dunda Beds and overlying Moolayember Formation (where present) • Evapotranspiration in outcrop areas • Vertical leakage forming the Doongmabulla Spring Complex • Loss through poorly constructed artesian bores	The Clematis Sandstone may be hydraulically connected to Cattle Creek and Dyllingo Creek, which drain across the outcrop.

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Stratigraphic Unit	Primary Recharge Mechanism	Primary Discharge Mechanism	Comment
Dunda Beds	• Rainfall recharge in outcrop areas (along western boundary of the CCP area) • Vertical leakage from the overlying units.	• Vertical leakage to underlying and overlying units • Evapotranspiration in the outcrop areas	An alternative conceptualisation is that the Dunda Beds may be a groundwater source of Doongmabulla Spring Complex. This is presented in **Section 2.2.6.2**.
Rewan Formation	• Minor recharge at outcrop	• Minor through flow due to low permeability	The Rewan Formation is, based on site specific data collected, an aquitard where the vertical groundwater gradient above and below the Rewan Formation are upwards above the unit and downwards below the unit (**Section 2.1.3**).
Bandanna Formation (AB Seam)	• Vertical leakage from the underlying units	• Vertical leakage to the more permeable underlying units	The coal seams are the most permeable units within the clay-rich Bandanna Formation.
Colinlea Sandstone (D Seam)	• Vertical leakage from the underlying and overlying units	• Vertical leakage to the more permeable underlying units • Vertical leakage to the overlying units in subcrop areas • Vertical leakage to the Mellaluka Spring Complex	The Colinlea Sandstone was initially considered to be the primary source aquifer for the Mellaluka Spring Complex ; however, additional drilling indicates complex artesian conditions associated with the Tertiary sediments and Joe Joe Group provide discharge to surface around the Mellaluka Spring Complex.
Joe Joe Group	• Vertical leakage from the overlying units, particularly in subcrop areas	• Vertical leakage to the overlying units	Information collected from additional groundwater monitoring bores installed within the Joe Joe Group to the south of Carmichael River suggests a possible hydraulic connection with the Belyando River (palaeochannels). Artesian pressures observed south of the Carmichael River occur where the Tertiary sediments are thicker become sub-artesian north of the river.

Note: The Bandanna Formation and Colinlea Sandstone are referenced as to include the AB Seam (Bandanna Formation) and D Seam (Colinlea Sandstone), the two target coal seams for mining. These coal seams are to be mined and as such will be the most altered (mined and dewatered) during mining, and as such are used as units to assess the potential groundwater impacts of these two Permian aged coal bearing hydrostratigraphic units in the GMMP.

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2.2.3 Regional Groundwater Flow

Subcrops of the Joe Joe Group (Jochmus Formation) and Colinlea Sandstone (in the higher elevation outcrops south of the town of Alpha), along the eastern margin of the Galilee Basin are recognised on a regional scale to result in the regional groundwater flow direction as northwards.

Figure 6~~Figure 6Figure 6~~ depicts the groundwater flow patterns within the Colinlea Sandstone of the eastern edge of the Galilee Basin.

2.2.4 Aquifer Hydraulic Properties

Multiple groundwater investigations have been undertaken within and near the CCP area from 2011 through 2018 to characterise the hydraulic regime of the site. Outcomes of each investigation were utilised to inform the augmentation of the groundwater monitoring network.

Hydraulic parameters were estimated from various investigations onsite via packer tests, aquifer pump tests, and falling head tests, in addition to air lift yields during new monitoring bore development. The results of these investigations were compiled to assist in estimating site-specific hydraulic properties, which are applied in the numerical groundwater model. The aquifer hydraulic conductivity data plus summary of studies are presented in Table 8~~Table 8Table 8~~ below.

Comments on the original model were considered and resulted in expansion of the numerical model domain towards the west of the hydraulic divide (Plate 12~~Plate 12Plate 12~~, **Section 2.3**), to incorporate a portion of the Lake Galilee catchment; the model was then re-run to understand any potential impacts on the GAB units from the CCP. Details of the revised model are included in the AEIS (GHD, 2013a), and the Response to Federal Approval Conditions - Groundwater Flow Model (GHD, 2015). While summarised in this GMMP (**Section 2.3**), it is recommended to review the reports referenced above for further information in this regard.

The model re-run (GHD, 2015) adopted the hydraulic values from those included in the SEIS and AEIS apart from the expanded model domain, west of the CCP area to incorporate a portion of the Lake Galilee catchment. Further information in regard to the model re-run works is presented in **Section 2.3** below.

Aquifer hydraulic tests were undertaken by AECOM in 2015 to gain an understanding of the potential for groundwater sources for construction purposes within the Tertiary sediments and underlying Early Permian aged Joe Joe Group to the east and south of the CCP. Results of the aquifer hydraulic tests indicate limited hydraulic connectivity between the Tertiary sediments and underlying Joe Joe Group. It is noted that to the south of the Carmichael River artesian conditions are observed.

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Figure 6 Regional Groundwater Flow Patterns in the Colinlea Sandstone, Eastern Limb of Galilee Basin (source: Alpha Land Court Joint Experts Report, 2015)

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Table 8 Estimates of Hydraulic Properties of Aquifers within the CCP Area

Hydrostratigraphic Unit	Monitoring Point	Lithology description	Investigation type and period	Estimated horizontal hydraulic conductivity (m/day)	Comments
Alluvium	C027P1	Alluvium (sand with gravel)	SEIS	2.5×10^{-02}	Slug test result
	C029P1	Alluvium (sand and clayey sand)	SEIS	1.4×10^{-01}	Slug test result
	HD03B	Alluvium (clay)	SEIS	1.1 x 10	Slug test result
	Layer 1	Quaternary	AEIS	$2.0 \times 10^{+01}$	Calibrated value for numerical model (result from sensitivity analysis)
Tertiary sediments	C025P2	Tertiary sediments (leached, fine grained rock)	SEIS	1.7×10^{-01}	Slug test result
	C029P2	Tertiary sediments (ferricrete / laterite)	SEIS	5.3×10^{-02}	Slug test result
	C558P1	Tertiary sediments and Permian aged overburden (sandy clay)	SEIS	2.1×10^{-04}	Slug test result
	Layer 2	Tertiary sediments	AEIS	1.0×10^{-02}	Calibrated value for numerical model (result from sensitivity analysis)
	Layer 2	Tertiary aged deposits and older Quaternary aged deposits	Model re-run	1×10^{-02}	Western model region (Lake Galilee catchment expansion to numerical model)
Moolayember Formation	Layer 3	Moolayember Formation	Model re-run	5.18×10^{-02}	Western model region (Lake Galilee catchment expansion to numerical model)
	Layer 3	Moolayember Formation	AEIS	5.18×10^{-02}	Calibrated value for numerical model (result from sensitivity analysis)

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Hydrostratigraphic Unit		Monitoring Point	Lithology description	Investigation type and period	Estimated horizontal hydraulic conductivity (m/day)	Comments
Clematis Sandstone		HD02	Clematis Sandstone	SEIS	$1.5 \times 10^{+01}$	Slug test result
		Layer 4	Clematis Sandstone	AEIS	1.6×10^{0}	Calibrated value for numerical model (result from sensitivity analysis)
		Layer 4	Clematis Sandstone	Model re-run	1.55×10^{0}	Western model region (Lake Galilee catchment expansion to numerical model)
		C14201VWP	Clematis Sandstone	Groundwater monitoring network expansion 2014	1.0×10^{-02}	Packer test result (median value)
		C14205VWP	Clematis Sandstone	Groundwater monitoring network expansion 2014	1.0×10^{-02}	Packer test result
Rewan Group	Dunda Beds	C022P1	Dunda Beds (weathered sandstone)	SEIS	3.0×10^{0}	Slug test result
	Dunda Beds	C027P2	Dunda Beds (ferricrete)	SEIS	2.5×10^{-01}	Slug test result
	Dunda Beds	C9553P1R	Dunda Beds (clayey sand)	SEIS	2.2×10^{-03}	Slug test result
	Dunda Beds	Layer 5	Dunda Beds	Model re-run	7.9×10^{-02}	Western model region (Lake Galilee catchment expansion to numerical model)
	Dunda Beds	Layer 5	Dunda Beds	AEIS	7.9×10^{-2}	Calibrated value for numerical model (result from sensitivity analysis)
	Rewan Group	C035P1	Rewan Group (weathered sandstone)	SEIS	2.3×10^{-02}	Slug test result

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Hydrostratigraphic Unit		Monitoring Point	Lithology description	Investigation type and period	Estimated horizontal hydraulic conductivity (m/day)	Comments
	Rewan Group	C555P1	Rewan Group (sandy clay)	SEIS	1.0×10^{-01}	Slug test result
	Rewan Group	C556P1	Rewan Group (sandy clay)	AEIS	2.9×10^{-01}	Slug test result
	Rewan Group	Layers 6/7	Rewan Group	AEIS	7.4×10^{-05}	Calibrated value for numerical model (result from sensitivity analysis)
	Rewan Group	C008P1	Rewan Group (weathered siltstone)	SEIS	2.3×10^{-03}	Slug test result
	Rewan Group	C842VWP	Rewan Group - interbedded siltstone and sandstone	Packer test 2013	9.50×10^{-5}	Packer test result
	Rewan Group	C836VWP	Rewan Group - Siltstone/ mudstone below base of weathering	Packer test 2013	3.72×10^{-4}	Packer test result
	Rewan Group	C836VWP	Rewan Group - siltstone (below base of weathering- no sandstone)	Packer test 2013	2.42×10^{-4}	Packer test result
	Rewan Group	C056 Test 9	Base of Rewan Group (siltstone, fractured)	SEIS	1.7×10^{-04}	Packer test result
	Rewan Group	C9556PR Test 6	Rewan Group (sandstone and siltstone)	SEIS	2.3×10^{-04}	Packer test result
	Rewan Group	C842VWP Test 5	Rewan Group (sandstone and siltstone)	SEIS	9.5×10^{-05}	Packer test result
	Rewan Group	C836VWP Test 5	Rewan Group (siltstone and mudstone)	SEIS	3.7×10^{-04}	Packer test result
	Rewan Group	C836VWP Test 6	Rewan Group (siltstone and mudstone)	SEIS	2.4×10^{-04}	Packer test result

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Hydrostratigraphic Unit		Monitoring Point	Lithology description	Investigation type and period	Estimated horizontal hydraulic conductivity (m/day)	Comments
	Rewan Fm	C14202VWP (Site 17 Rewan #3)	Rewan Formation	Groundwater monitoring network expansion 2014	4.0×10^{-04}	Packer test result (median value from 16 3-minute tests)
	Rewan Fm	C14202VWP (Site 17 Rewan #2)	Rewan Formation	Groundwater monitoring network expansion 2014	2.0×10^{-04}	Packer test result (median value from 18 3-minute tests)
	Rewan Fm	C14202VWP (Site 17 Rewan #1)	Rewan Formation	Groundwater monitoring network expansion 2014	2.0×10^{-04}	Packer test result (median value from 18 3-minute tests)
	Rewan Fm	C14201VWP (Site 18 Rewan #1)	Rewan Formation	Groundwater monitoring network expansion 2014	1.0×10^{-03}	Packer test result (median value from 26 2-minute tests)
	Rewan Fm	C14201VWP (Site 18 Rewan #2)	Rewan Formation	Groundwater monitoring network expansion 2014	3.0×10^{-04}	Packer test result (median value from 18 3-minute tests)
	Rewan Fm	C14201VWP (Site 18 Rewan #3)	Rewan Formation	Groundwater monitoring network expansion 2014	7.0×10^{-05}	Packer test result (median value from 17 3-minute tests)
	Rewan Fm	C14201VWP (Site 18 Rewan #4)	Rewan Formation	Groundwater monitoring network expansion 2014	2.0×10^{-04}	Packer test result (median value from 20 3-minute tests)

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Hydrostratigraphic Unit		Monitoring Point	Lithology description	Investigation type and period	Estimated horizontal hydraulic conductivity (m/day)	Comments
	Rewan Fm	C14201VWP (Site 18 Rewan #5)	Rewan Formation	Groundwater monitoring network expansion 2014	2.0×10^{-04}	Packer test result (median value from 18 3-minute tests)
	Rewan Fm	C14205VWP (Site 18)	Rewan Formation – claystone and minor siltstone (top of Rewan Formation)	Groundwater monitoring network expansion 2014	1.1×10^{-03}	Packer test result
	Rewan Fm	C14205VWP (Site 18)	Rewan Formation – interbedded fine-grained sandstone and claystone (upper section of Rewan Formation)	Groundwater monitoring network expansion 2014	3.0×10^{-04}	Packer test result
	Rewan Fm	C14205VWP (Site 18)	Rewan Formation –claystone (middle section of Rewan Formation)	Groundwater monitoring network expansion 2014	7.0×10^{-05}	Packer test result
	Rewan Fm	C14205VWP (Site 18)	Rewan Formation – siltstone with minor claystone (lower section of Rewan Formation)	Groundwater monitoring network expansion 2014	2.0×10^{-04}	Packer test result
	Rewan Fm	C14204VWP (Site 17)	Rewan Formation – interbedded siltstone and claystone (top section of Rewan Formation)	Groundwater monitoring network expansion 2014	2.0×10^{-04}	Packer test result
	Rewan Fm	C14204VWP (Site 17)	Rewan Formation – claystone with minor siltstone (top section of Rewan Formation)	Groundwater monitoring network expansion 2014	2.0×10^{-04}	Packer test result

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Hydrostratigraphic Unit		Monitoring Point	Lithology description	Investigation type and period	Estimated horizontal hydraulic conductivity (m/day)	Comments
	Rewan Fm	C14204VWP (Site 17)	Rewan Formation –siltstone (middle section of Rewan Formation)	Groundwater monitoring network expansion 2014	4.0×10^{-04}	Packer test result
	Rewan Fm	C14204VWP (Site 17)	Rewan Formation –siltstone (top section of Rewan Formation)	Groundwater monitoring network expansion 2014	7.0×10^{-04}	Packer test result
	Rewan Fm	Lake Galilee catchment	Rewan Formation	Model re-run	7.38×10^{-5}	-
Betts Creek Beds	Bandanna Fm (AB Seam)	C007P2	AB Seam	SEIS	5.6×10^{-02}	Slug test result
		C016P2	AB Seam (coal and carbonaceous siltstone)	SEIS	4.0×10^{-03}	Slug test result
		C056 Test 1	AB1/AB2 coal seams	SEIS	1.7×10^{-02}	Packer test result
		C056 Test 2	AB3 coal seam	SEIS	1.2×10^{-02}	Packer test result
		C039 Test 1	AB3 seam lower split (coal)	SEIS	5.4×10^{-04}	Packer test result
		C039 Test 2	AB3 seam upper split (coal)	SEIS	1.4×10^{-04}	Packer test result
		C558P Test 6	AB2/AB3 seams (coal)	SEIS	1.4×10^{-02}	Packer test result
		C555P Test 4	AB Seam (coal)	SEIS	1.2×10^{-03}	Packer test result
		C9556PR Test 4	AB Seam (coal)	SEIS	1.5×10^{-04}	Packer test result
		C842VWP Test 2	AB1 to AB3 (coal)	SEIS	2.8×10^{-03}	Packer test result
		C836VWP Test 3	AB2/AB3 (coal)	SEIS	4.8×10^{-02}	Packer test result
		C035[1]	AB Seam	SEIS	3.5 x 10	Slug test results

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Hydrostratigraphic Unit		Monitoring Point	Lithology description	Investigation type and period	Estimated horizontal hydraulic conductivity (m/day)	Comments
		Layer 9	AB coal seam	AEIS	1.9×10^{-03}	Calibrated value for numerical model (result from sensitivity analysis)
		Layer 9	AB Seam coal	Model re-run	1.0×10^{-04}	Western model region (Lake Galilee catchment expansion to numerical model)
	Colinlea Sandstone (D Seam)	C558P Test 2	D Seam (coal)	SEIS	1.6×10^{-02}	Packer test result
		C558P Test 3	D Seam and below D Seam (coal and sandstone)	SEIS	8.7×10^{-03}	Packer test result
		C007P3	D Seam (coal with siltstone)	SEIS	6.9×10^{-02}	Slug test result
		C056 Test 4	D Seam and interburden (coal, siltstone, sandstone)	SEIS	5.6×10^{-03}	Packer test result
		C555P Test 2	D1/D2 seams (coal and siltstone)	SEIS	2.8×10^{-03}	Packer test result
		C9556PR Test 2	D Seam (coal)	SEIS	1.3×10^{-04}	Packer test result
		C9556PR Test 3	Interburden to below D Seam (sandstone and coal)	SEIS	1.3×10^{-03}	Packer test result
		C851VWP Test 4	D Seam (coal)	SEIS	9.5×10^{-03}	Packer test result
		C006[2]	D Seam	SEIS	2.0×10^{-01}	Pump test results
		C018[3]	D Seam	SEIS	1.0×10^{-01}	Pump test results
		Layer 11	D Coal Seams	AEIS	3.1×10^{-03}	Calibrated value for numerical model (result from sensitivity analysis)
		Layer 11	D Seam coal and interburden	Model re-run	1.0×10^{-04}	Western model region (Lake Galilee catchment expansion to numerical model)

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Hydrostratigraphic Unit		Monitoring Point	Lithology description	Investigation type and period	Estimated horizontal hydraulic conductivity (m/day)	Comments
Joe Joe Group	Jochmus Fm	C012P1	Joe Joe Group (weathered sandstone and siltstone)	SEIS	4.1×10^{-01}	Slug test result
		C012P2	Joe Joe Group (weathered sandstone)	SEIS	2.5×10^{-03}	Slug test result
		C9556PR Test 5	Permian overburden (sandstone)	SEIS	2.3×10^{-04}	Packer test result
		C842VWP Test 3	Permian overburden (sandstone and siltstone)	SEIS	3.5×10^{-03}	Packer test result
		C842VWP Test 4	Permian overburden (sandstone)	SEIS	4.8×10^{-04}	Packer test result
		C836VWP Test 4	Permian overburden (sandstone)	SEIS	9.5×10^{-04}	Packer test result
		Layer 12	Older Permian units	AEIS	3.6×10^{-04}	Calibrated value for numerical model (result from sensitivity analysis)

Notes:

[1] The estimated storativity for C035 is 0.005 and transmissivity is 60 m^2/day

[2] The estimated storativity for C006 is 0.005 and transmissivity is 12 m^2/day

[3] The estimated storativity for C018 is 0.001 and transmissivity is 9 m^2/day

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2.2.5 Local (site-specific) Groundwater Flow Patterns

The groundwater monitoring results indicate complex groundwater flow patterns within the different hydrostratigraphic units across and adjacent to the CCP MLs. The groundwater flow patterns have been interpreted, as discussed above (see **Section 2.2.1**), to include a groundwater low, corresponding with the deepest portions of the hydrostratigraphic units of the CCP area, where the synform axial plane trends from northeast to southwest across the CCP footprint. The units observed to be influenced by the synform observed in the groundwater flow patterns include Dunda Beds, Rewan Formation, Permian sediments of the Colinlea Sandstone (D Seam), and the Early Permian aged Joe Joe Group. The younger Clematis Sandstone does not indicate the same fold influence on groundwater flow in this unit. No monitoring bore intersecting the Bandanna Formation AB seam is located within the synform.

In addition to the localised (CCP scale) groundwater flow in line with the synform, groundwater flow direction is also considered to:

- Either flow to the southwest (down dip) mimicking the regional basin-scale flow from subcrop in the northeast down dip to the southwest, or
- Discharge into overlying / underlying units (depending on vertical gradients) and discharge to the northeast, as is possible when considering the regional and local Colinlea Sandstone contours in **Figure 6**~~**Figure 6Figure 6**~~.

It is noted that additional flow trend analysis off lease is required to assess larger basin scale flow.

The local pre-mining inferred groundwater flow directions are depicted by unit on Figures F1 through F8 (**Appendix C**~~**Appendix CAppendix C**~~) and discussed below.

NOTES:

The groundwater contours generated utilised groundwater levels measured within the stand pipe monitoring bores only. No vibrating wire piezometer (VWP) data was used as the VWP sensors provide total pressure (formation, water, and [possible] gas) at a single point (sensor point) within the selected unit. VWP data is used for assessing predicted groundwater level (drawdown) trends as discussed in **Section 5.3** (thresholds).

The AB Seam and the D Seam units of the Bandanna Formation and Colinlea Sandstone, respectively have been selected to represent these Permian aged coal bearing units. This is done as the target coals have a good spatial spread of groundwater monitoring bores (along strike and down dip) and as target coal seams will be directly impacted by mining (allowing for assessment in the compilation of the GMMP).

Groundwater contours were created by Adani using krigging and edited by AECOM based on geological extent and subcrops.

2.2.5.1 Alluvium

Average groundwater level data (**Table 9**~~**Table 9Table 9**~~) were used to generate the groundwater contours within the alluvium. Groundwater flow in this surficial unit mimics topography and surface water and flows from west to east across CCP (**Figure F1** **Appendix C**~~**Appendix CAppendix C**~~).

Table 9 Average Alluvium Groundwater Levels

Bore ID	Average groundwater level (mAHD)
C025P1	216.72
C027P1	223.84
C029P1	214.77
C14027SP	203.58
C14028SP	205.46
HD03B	225.47

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2.2.5.2 Tertiary Sediments

Groundwater flow within the Tertiary sediments across the CCP is from south to north (**Figure F2** Appendix C~~Appendix C~~~~Appendix C~~), based on the average groundwater level data included in Table 10~~Table 10~~~~Table 10~~.

Table 10 Average Groundwater Levels in the Tertiary Sediments

Bore	Average Groundwater Level (mAHD)
C025P2	217.62
C029P2	220.00
C558P1	216.02
C9845SPR	234.91
C9180121SPR	244.47

2.2.5.3 Clematis Sandstone

The groundwater flow pattern, using groundwater level data from the new (September 2018) monitoring bores in the Clematis Sandstone around the Doongmabulla Spring Complex, indicates complex groundwater flow (**Figure F3** Appendix C~~Appendix C~~~~Appendix C~~).

Table 11~~Table 11~~~~Table 11~~ includes the groundwater levels measured in September 2018 after several additional groundwater monitoring bores had been constructed around the Doongmabulla Spring Complex.

The groundwater flow patterns are towards HD02, which indicates discharge at the springs and as baseflow in this area.

Table 11 Clematis Sandstone Groundwater Levels (September 2018)[3]

Bore ID	Water Level (mAHD)	Comment
C14033SP	250.52	
C180118SP	250.17	Note: last reading measured before blocked bore
C14011SP	242.77	
C14012SP	242.53	
C14013SP	242.46	
C18002SP	242.55	
Joshua Spring	241.20 (243.26)	Floor of spring (top of turkey's nest)
C14021SP	245.93	
C18001SP	249.77	
DS4 Mound Spring	241 (EIS survey)	Elevation of specific spring DS4
HD02	233.88	Average groundwater level is 234.28 mAHD
HD03A	231.76	Artesian average potentiometric level is 232.03 mAHD

[3] Only one groundwater level reading is available for all the new 2018 monitoring bores, such that average groundwater levels were not used for Clematis Sandstone

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2.2.5.4 Dunda Beds

Groundwater flow within the Dunda Beds, on and adjacent to the CCP mine leases, is considered to be influenced by the synform. Groundwater flow is from south to north and north to south towards C027P2, located within the synform (**Figure F4** Appendix C~~Appendix C~~~~Appendix C~~).

Average groundwater levels for the Dunda Beds, obtained from hydrographs in Appendix E~~Appendix E~~~~Appendix E~~, are included in Table 12~~Table 12~~~~Table 12~~.

Table 12 Average Groundwater Levels for the Dunda Beds

Bore	Average Groundwater Levels (mAHD)
C022P1	246.66
C027P2	226.90
C14023SP	247.26
C180117SP	251.02

2.2.5.5 Rewan Formation

Average groundwater level data, Table 13~~Table 13~~~~Table 13~~, was used to generate groundwater contours for the Rewan Formation across the CCP. Groundwater flow in this unit is influenced by the synform, where groundwater flow from north to south and south to north occurs towards C008P1 (**Figure F5** Appendix C~~Appendix C~~~~Appendix C~~).

Table 13 Average Groundwater Levels for the Rewan Formation

Bore	Average Groundwater Levels (mAHD)
C008P1	211.80
C035P1	231.89
C555P1	230.02
C556P1	234.84
C9553P1R	252.26
C9838SPR	228.74
C180116SP	239.12

It is noted that bore C035P1 has a slightly lower than expected average groundwater level when considering the other bores in the southern area of CCP. Groundwater level data, since 2013, is recognised to have declined overtime (resulting in the lower than envisaged average groundwater level). This declining trend has influenced groundwater levels in this area. It is currently considered that this trend is related to local groundwater abstraction (south of Carmichael River on the Lignum property) or as a result of groundwater sampling (extraction) over time with little or no recharge in the low permeable Rewan Formation. It is noted that this bore is located in the southern portion of the mine lease and away from the synform recognised to the north of the Carmichael River, which is recognised to influence groundwater levels and flow patterns.

Data from monitoring bore C555P1 is considered based on the resultant hydrograph to be inconsistent with the groundwater flow pattern. This is considered to occur due to erratic logger data recorded since July 2016 (Appendix E~~Appendix E~~~~Appendix E~~). The logger will be replaced as per the approval conditions (EA Condition E16), which relates to the maintenance of the groundwater monitoring network.

It is noted that Adani is committed to maintaining and the decommission of bores, according to industry standards, to ensure the management of groundwater resources and obtaining representative groundwater monitoring data.

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2.2.5.6 Bandanna Formation (AB Seam)

Average groundwater level data, as compiled in Appendix E~~Appendix E~~Appendix E hydrographs, were used to generate average groundwater flow patterns of the target AB Seam within the CCP mine leases. **Figure F6** (Appendix C~~Appendix C~~Appendix C) presents the result groundwater contours for the data included in **Table 14~~Table 14~~Table 14**.

Table 14 Bandanna Formation AB Seam Average Groundwater Levels

Bore ID	Average groundwater level (mAHD)
C007P2	212.38
C008P2	213.40
C014P2	209.21
C016P2	248.50
C020P2	220.92
C032P2	233.27
C035P2	232.68

The lowest measured groundwater level within the Bandanna Formation AB seam is located at C014P2, where groundwater flow is from the south and from the north towards the groundwater low. It is noted that bore C014P2 is not within the recognised synform included on **Figure F6** (**Appendix C~~Appendix C~~Appendix C**), this may be as a result of undulating coal seams within the Bandanna Formation and the absence of an AB seam groundwater monitoring bore along the synform axis.

2.2.5.7 Colinlea Sandstone (D Seam)

Groundwater level contours within the target D Seam across the CCP are influenced by the recognised synform, where groundwater flow is towards monitoring bore C006P3R. Groundwater monitoring bore C006P3R intersects a hydraulic low within the D Seam (**Figure F7** **Appendix C~~Appendix C~~Appendix C**).

Average groundwater levels, used to contour the groundwater flow patterns with the Colinlea Sandstone D Seam, are included in **Table 15~~Table 15~~Table 15**.

Table 15 Colinlea Sandstone D Seam Average Groundwater Levels

Bore ID	Average Groundwater Level (mAHD)
C006P3R	213.28
C007P3	216.93
C011P3	227.32
C018P3	242.43
C024P3	228.88
C833SP	228.28
C848SP	231.91
C975SP	240.99
C9849SPR	231.88
C180114SP	223.00

Groundwater flow, from north and south with the CCP MLs, is recognised as per the regional flow patterns in **Figure 6~~Figure 6~~Figure 6**. It is noted that the synform, influencing the local groundwater flow does not coincide with the Doongmabulla Springs Complex, which indicates that Permian

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sediments are not readily recognisable as a source of flow to the springs based on groundwater flow patterns.

2.2.5.8 Joe Joe Group

Groundwater flow contours across the CCP mine leases were generated using the average groundwater levels from the monitoring bores included in **Table 16~~Table 16Table 16~~**.

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Table 16 Average Groundwater Levels for the Joe Joe Group at CCP

Bore	Average Groundwater Levels (mAHD)
C012P1	221.33
C012P2	221.32
C14002SP	218.75
C14003SP	209.37
C14004SP	209.44
C14006SP	226.03
C14008SP	228.34
C14016SP	234.13
C914001SPR	218.47

Groundwater flow is recognised to be influenced by the synform across the CCP footprint, where groundwater within the Joe Joe Group flows towards monitoring bores C14003SP and C14004SP, as depicted in **Figure F8a** (Appendix C~~Appendix C~~Appendix ~~C~~).

Additional assessment of artesian groundwater potentiometric levels was conducted, where several groundwater monitoring bores were installed around the Mellaluka Springs Complex. The average groundwater levels within this area are included in Table 17~~Table 17~~Table ~~17~~ below and presented along with corresponding monitoring locations on **Figure F8b** (Appendix C~~Appendix C~~Appendix ~~C~~).

Table 17 Average Groundwater Levels for the Joe Joe Group at Mellaluka Springs Complex

Bore	Average Groundwater Levels (mAHD)
C14014SP	”239.32” – landholder is utilising this monitoring bore
C14015SP	239.15
C14017SP	248.26
C14032SP	233.69
C914030SPR	230.25
C180119SP	238.21
C180123SP	246.35
C9180124SPR	235.31
C9180125SPR	243.10
Mellaluka Spring	228 (surface elevation)

Groundwater flow within the Joe Joe Group is from south to north along the eastern edge of the Galilee Basin, the flow is recognised in **Figure F8b (**Appendix C~~Appendix C~~Appendix ~~C~~**)**, except for the local change in flow pattern because of discharge at the Mellaluka Spring.

Continuous discharge at the Mellaluka Spring plus extraction at the Mellaluka homestead (**Section 3.5.4**) is recognised to have influenced regional south to north flow at the Mellaluka Spring.

2.2.5.9 Observations and Discussion

In the area east of the mine leases and to the south of the Carmichael River, where the Tertiary sediments thicken above the Joe Joe Group, a multi-storey artesian aquifer system is inferred. In this area, the Tertiary sediments increase in thickness and directly overlie the Joe Joe Group.

This artesian system, based on measured piezometeric pressures and interbedded aquifers and aquitards, is considered to dictate the vertical groundwater flow direction within these units, as

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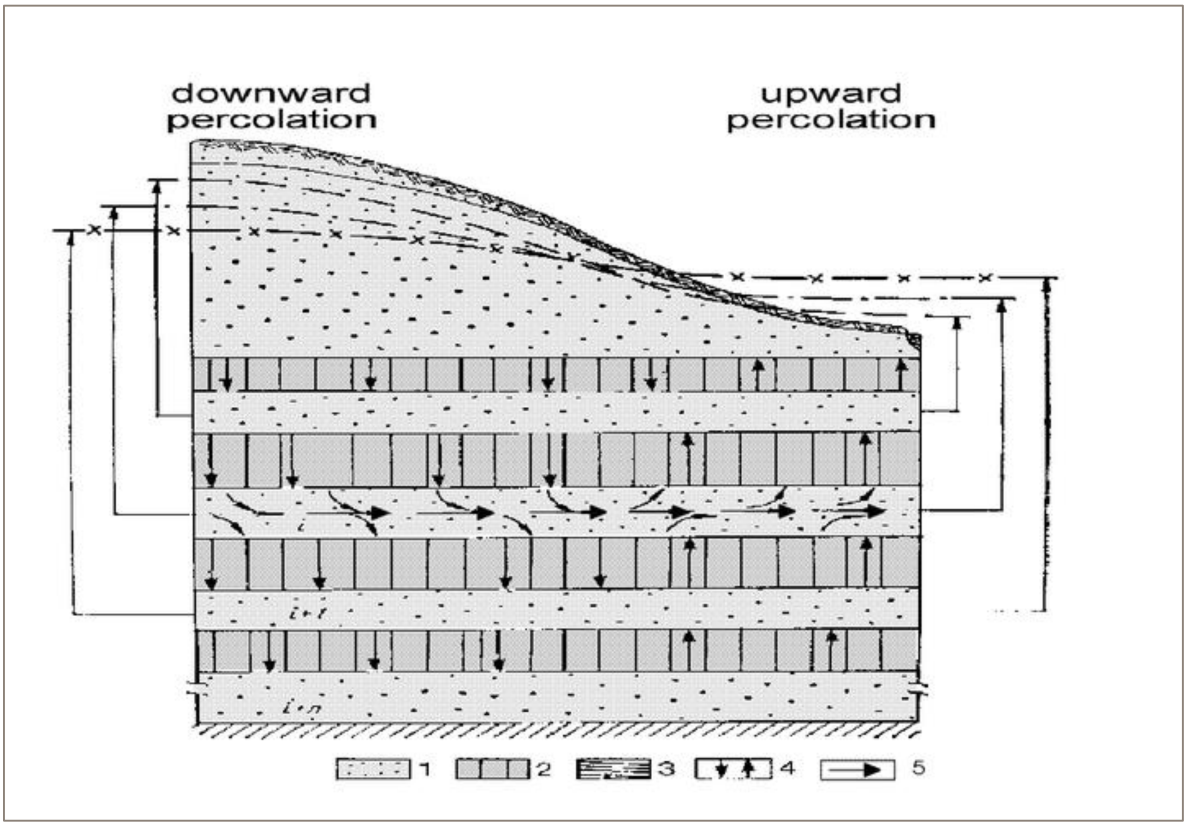
depicted in Plate 6~~Plate 6Plate 6~~ below (i.e. in the various nested monitoring bores constructed around the Mellaluka Spring vertical gradients are recognised as both upward and downward in this area).



Key:
1 = aquifers
2 = confining bed
3 = potentiometric levels of the aquifers
4 = directions of transverse groundwater flow
5 = directions of lateral flow

Plate 6 Example of multi-storey artesian aquifer system and resultant flow patterns (from Shestopalov, 1989)

It is noted that artesian conditions only occur south of the Carmichael River in the Tertiary sediments and Joe Joe Group, as sub-artesian conditions have been measured north of the Carmichael River. The extent of connectivity between the Tertiary sediments, Joe Joe Group, and the Belyando River are not yet fully understood.

The groundwater within Quaternary aged alluvium across the CCP area is observed to flow from west to east (seasonally dependent), along the Carmichael River. The continuous discharge from Joshua Spring into the Dyllingo Creek, which flows into the Carmichael River, results in flow from west to east. Flow in the Carmichael River is non-perennial with distance from the spring source, as surface water discharges to groundwater. Groundwater levels (and chemistry) are more seasonally varied to the east.

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2.2.6 Springs

Two recognised spring complexes are located within proximity to the CCP MLs; details of each are presented in the subsections below.

2.2.6.1 Doongmabulla Spring Complex

The Doongmabulla Springs Complex (DSC) comprises a series of mound (wetland) springs approximately eight (8) km to the west of the mine leases, as depicted in Error! Reference source not found. below. Drilling results and Clematis Sandstone groundwater level contours (**Figure F3**, Appendix C~~Appendix C~~~~Appendix C~~) indicate the source of the mound springs is discharge from the artesian Clematis Sandstone through weathered Moolayember Formation.

Table 11~~Table 11~~~~Table 11~~ **(Section 2.2.5.3)** above provides a summary of Clematis Sandstone monitoring bores and groundwater level data used to develop the conceptualisation.

Groundwater levels in the Clematis Sandstone groundwater monitoring bores HD02 and HD03A are considered to be influenced by Clematis Sandstone baseflow into the Carmichael River and discharge from the springs (i.e. these bores are down gradient of the springs (**Figure F3** Appendix C~~Appendix C~~~~Appendix C~~)).

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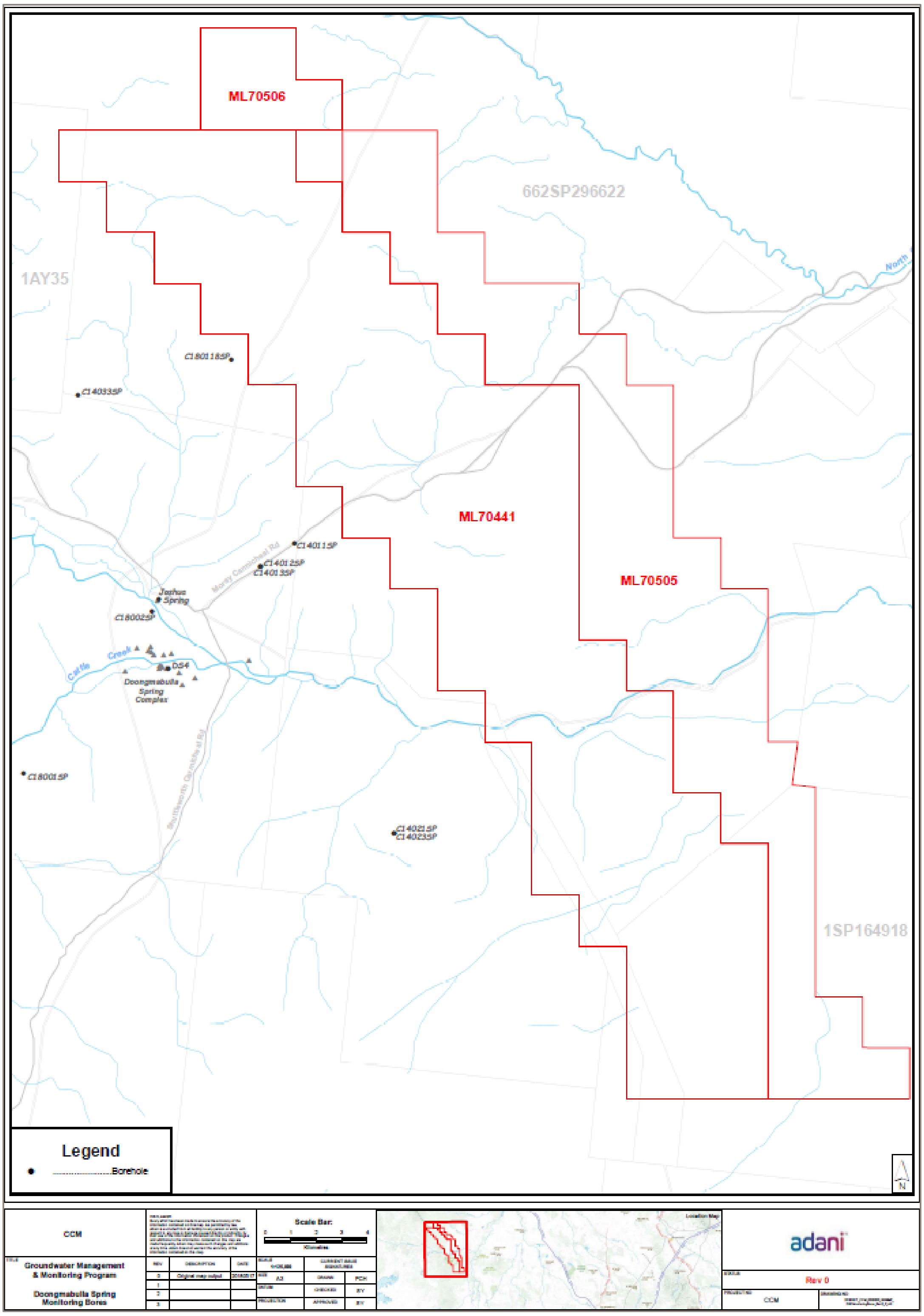

Figure 7 Doongmabulla Springs Complex in proximity to the CCP

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The data Table 11~~Table 11Table 11~~ **(Section 2.2.5.3)** indicates groundwater levels in the Clematis Sandstone, measured adjacent (west) of the MLs, are consistently above 243 mAHD away from the Carmichael River. Where weathered (thinning and more porous) Moolayember Formation cover is present at elevations lower than 243 mAHD, the spring discharges are observed.

Figure 8 Error! Reference source not found. presents the conceptualisation of the Doongmabulla Springs Complex, like the wetlands springs of the Surat Basin. In this conceptualisation, the Moolayember Formation is represented by the confining layer and the Clematis Sandstone is represented by the sandstone aquifer in Error! Reference source not found..

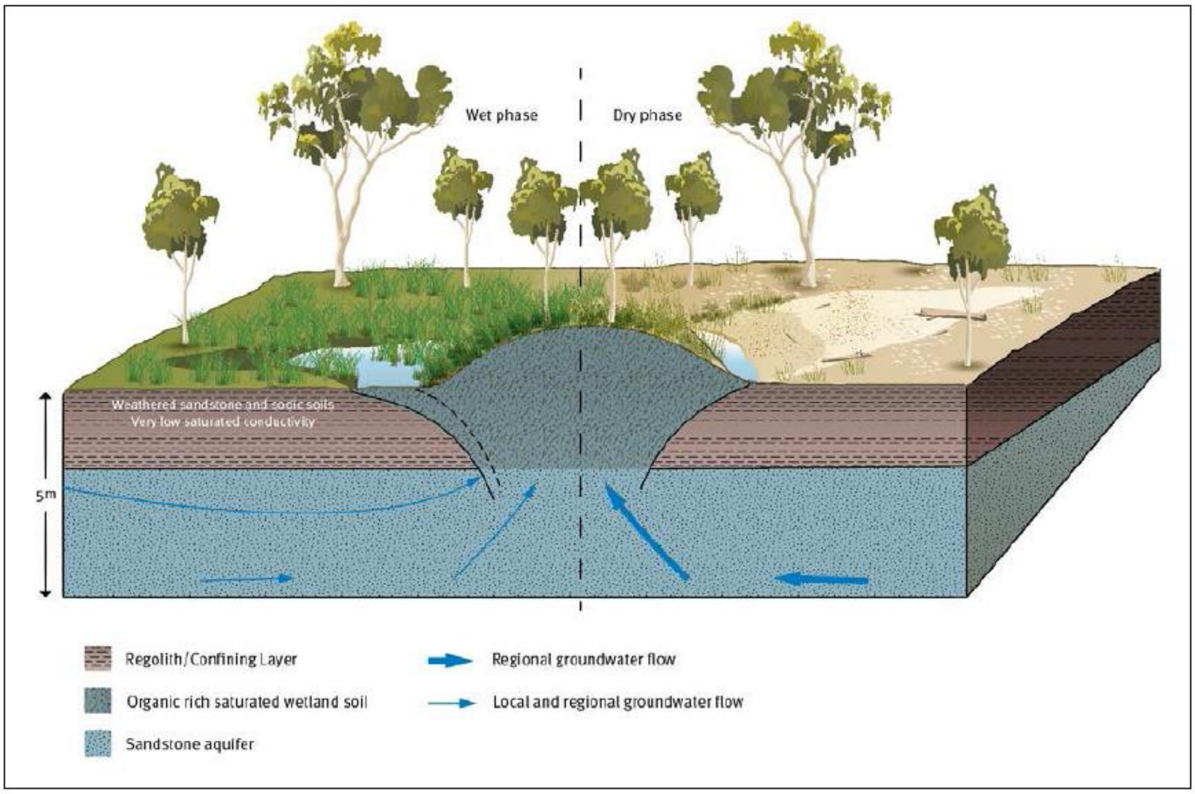

Figure 8 Conceptualisation of the Doongmabulla Springs Complex (source: DNRM Springs of the Surat CMA, 2016)

It is noted that, from drilling in 2014 along a south to north traverse parallel to the CCP MLs western boundary, the Moolayember Formation is absent to the south of the springs. The unit increases in thickness with distance to the north (refer to Section 1 on Error! Reference source not found. below), where:

- C14204SP does not intersect Moolayember Formation (intersecting Dunda Beds close to surface surface)
- Former location C14024VWP (now C14206VWP) intersects a thin veneer of Clematis Sandstone (~ 47 m)
- Schoemaker-1 exploration bore intersects 78 m of Moolayember Formation and 119 m of Clematis Sandstone
- C14025VWP (collapsed)[4] intersected 142 m of Moolayember Formation and 218 m of Clematis Sandstone.

The springs occur where the Moolayember Formation is sufficient thick and (low) permeable to act as a confining layer yet sufficiently thin to facilitate discharge. The absence to the south and thickness to the north result in reducing the extent or development of the Doongmabulla Springs Complex springs.

[4] See Section 2.1.1 for detail on swelling clays.

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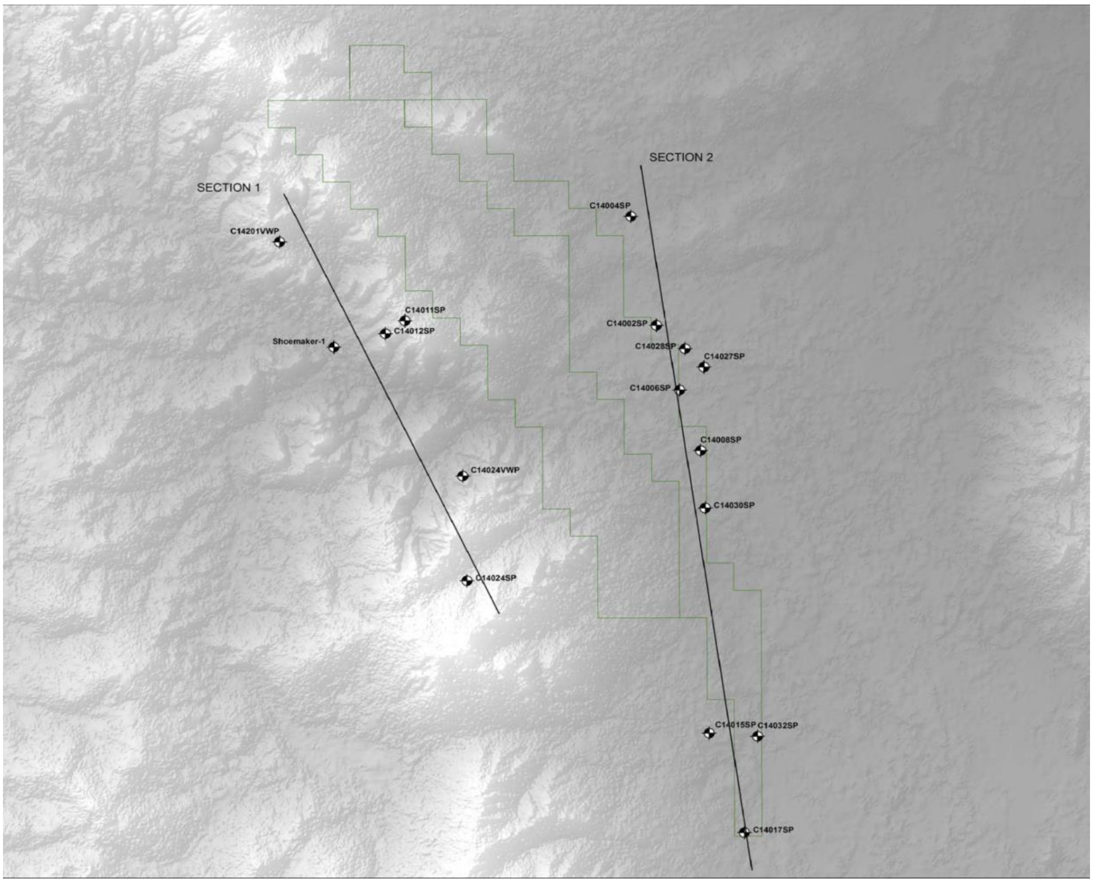

Plate 7 Geological traverse (bores drilled in 2014)

2.2.6.2 Alternative Conceptualisation for the Doongmabulla Spring Complex

The source aquifer for the DSC is, based on groundwater quality (salinity), geology (confining layers), and groundwater level data, was identified as the Clematis Sandstone. This has been included in the EIS documents, predictive modelling, and validated during the Land Court proceedings (independent model reviews). However, alternative sources for the springs have been offered, including:

- Alternative water source aquifers for the DSC, discussed in the Land Court of Queensland was “either the Clematis or the Colinlea may be the source”.
- The Lake Eyre Basin Springs Assessment (LEBSA) Project (The Department of Science, Information Technology and Innovation, 2016), has considered an alternative source aquifer for DSC being the Permian sediments. This alternative scenario was suggested by Dr John Webb during the land court proceedings that groundwater from the Permian provides discharge, via a fault or fracture through the Rewan Formation and Dunda Beds, as springs on surface.

Consideration of drilling results, vertical groundwater gradients, and water quality data allowed for assessment of the alternative source (Permian age) conceptualisation.

Considerations included:

- Drilling results, including the difficulties in construction of the standpipe groundwater monitoring bores within the Rewan Formation due to swelling clays (smectite), along with aquifer test results (**Table 8~~Table 8~~~~Table 8~~** above), 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, as presented in **Plate 8~~Plate 8~~~~Plate 8~~** below.

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- Groundwater levels indicate that the vertical groundwater gradients are upward above the Rewan Formation and downward below the Rewan Formation (see Table 18~~Table 18Table 18~~ below which provides a summary based on groundwater contour data); this indicates the source of the Doongmabulla Springs Complex is above the Rewan Formation.

Plate 8 Weathered Moolayember Formation outcrop near the Doongmabulla mound springs

Table 18 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	242	247.22
Dunda Beds	246.73	247	250.94
Rewan Formation	252.26	230	239.47
Bandanna Formation (AB Seam)	248.55	212	233.00
Colinlea Sandstone (D Seam)	242.43	217	231.94
Joe Joe Group	221.39	226	234.13

Notes:
ND – Not determined

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- Groundwater quality at Joshua Spring is fresh, recently recharged groundwater, where electrical conductivity (EC) is measured at 558 microSiemens per centimetre (µS/cm) in September 2018, albeit this location is a pond/dam where water quality is influenced by rainfall, evaporation, and evapotranspiration.

  Spearpoints installed in September adjacent to several DSC springs (see **Section 6.2**) indicate EC values between 532 and 681 µS/cm.

  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. The 85th percentiles for EC for the other hydrostratigraphic units at CCP are presented in **Table 19~~Table 19Table 19~~** below.

Table 19 Groundwater Salinity Data Summary (Electrical Conductivity in µS/cm)

Hydrostratigraphic Unit	85th Percentiles
Alluvium	42,250 (east) / 900 (west)
Tertiary sediments	14,000
Moolayember Formation[5]	572
Clematis Sandstone	640
Dunda Beds	772
Rewan Formation	3,723
Bandanna Formation (AB Seam)	1,896
Colinlea Sandstone (D Seam)	2,000
Joe Joe Group	15,900

Spring Chemistry

Major anion and cation concentrations obtained from the Joshua Spring water samples, have been used for comparison to the major anion and cation data for all the samples from the groundwater monitoring bores installed into the Permian aged Bandanna Formation (AB Seam) and the Colinlea Sandstone (D Seam). The composition (water types) for the Joshua Spring and the Bandanna Formation (AB Seam) and the Colinlea Sandstone (D Seam) are markedly different (**Plate 9~~Plate 9Plate 9~~**).

For comparison the Joshua Spring major anion and cation concentrations are compared to all the major anion and cation results derived from the groundwater bores in the Clematis Sandstone (**Plate 10~~Plate 10Plate 10~~**).

Conclusions

Conclusions with respect to consideration of the alternative conceptualisation for the Doongmabulla Spring Complex include:

- The available site-specific information negates the concept that a groundwater source, below the Rewan Formation, discharges at the Doongmabulla Springs Complex.
- Groundwater discharge from units below the Clematis Sandstone is considered unlikely based on quality data and vertical groundwater gradients. In addition, the clay-rich Dunda Beds sediments (interbedded claystone, mudstone and sandstone with minor siltstone) reduce the potential for this unit to provide continuous recently recharged groundwater at the springs.

[5] C18003SP was sampled in September 2018

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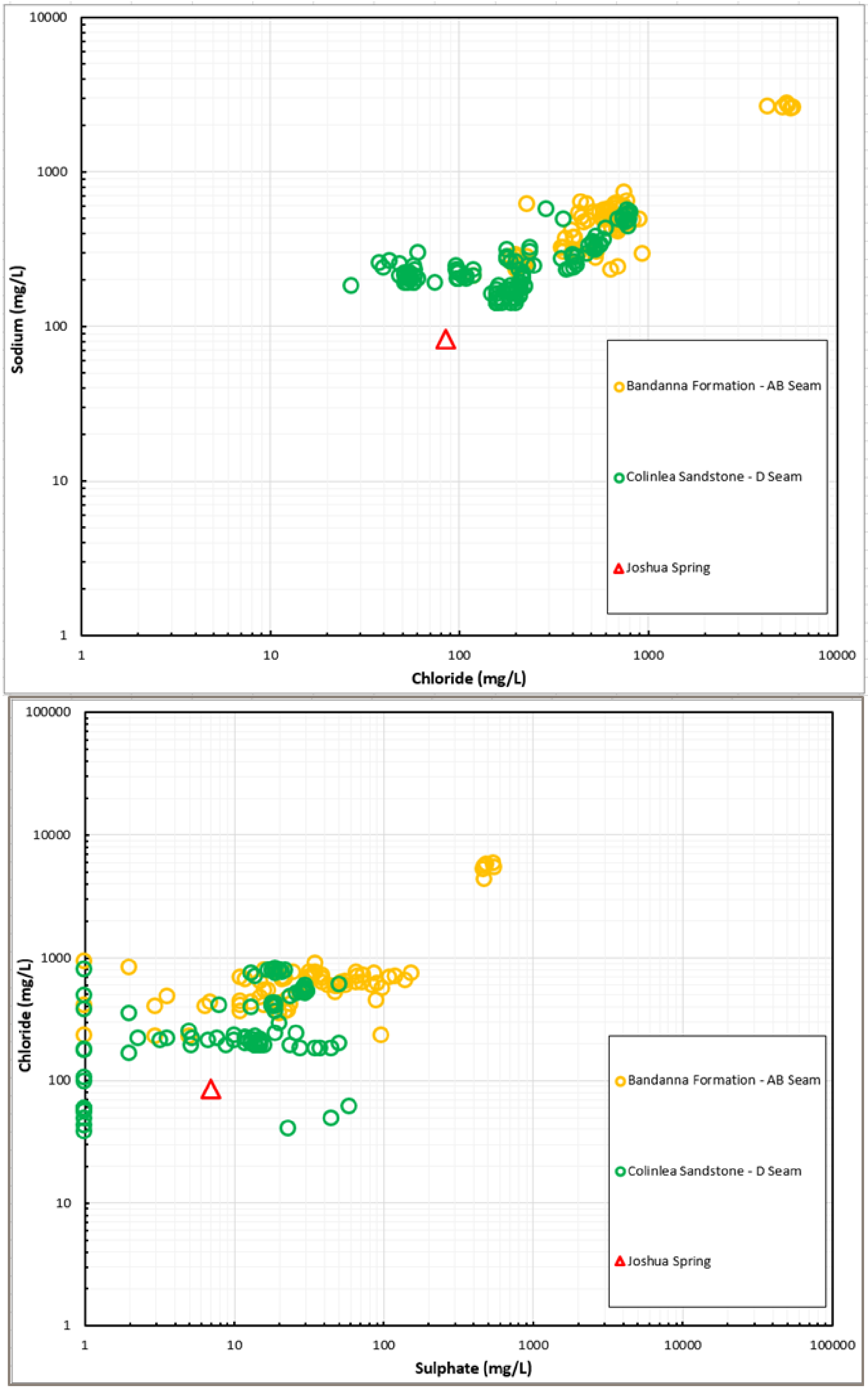

Plate 9 Major anion and cation concentrations comparison Joshua Spring and Betts Creek Beds

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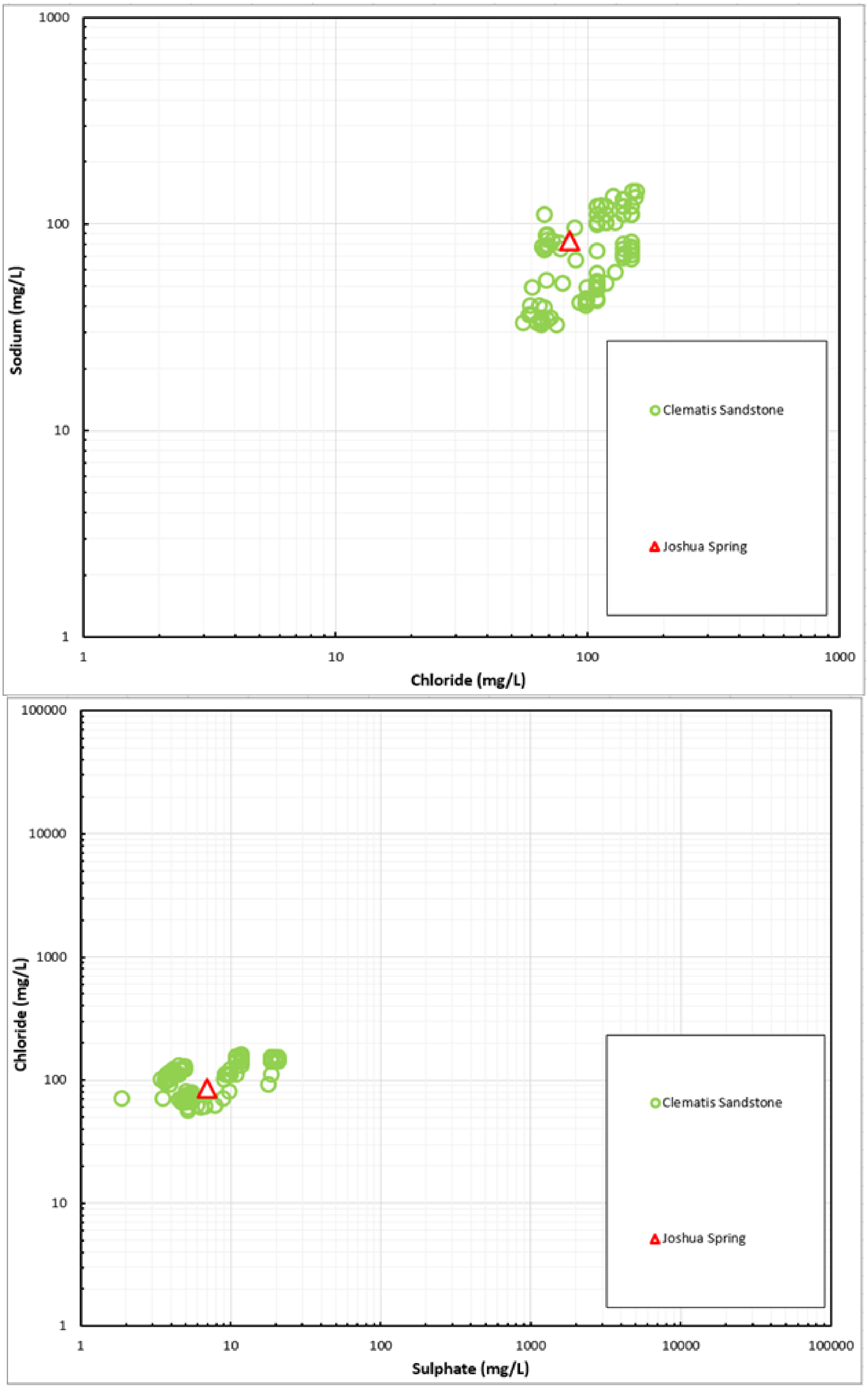

Plate 10 Major anion and cation concentrations comparison Joshua Spring and Clematis Sandstone

- Groundwater flow patterns (**Section 2.2.3** and **Section 2.2.5.7**), influenced by a synform, do not correspond with the springs such that discharge at the springs are not the reason for the complex Permian units flow patterns on CCP.

The groundwater heads in the DSC correlate well with monitoring data collected from the Clematis Sandstone monitoring bores, which confirms the conceptualisation of DSC used in impact assessment studies. Further additional field investigations into Rewan Formation confirms thickness and extent of Rewan Formation that separates source aquifers of DSC from the coal bearing Betts Creek Beds. Hence the groundwater drawdown thresholds (including Early warning thresholds and Impact thresholds) developed using the groundwater level data collected to date will meet the requirements and objectives of the approvals.

NOTE: The compilation of groundwater monitoring data during mining operations plus the results of research plans (EPBC Act approval conditions as detailed in **Section 1.6**) will allow for the refinement of the groundwater conceptualisation over time. This includes the current conceptualisation for the Doongmabulla Springs Complex.

The refinement of predictive modelling will allow for the reassessment of the potential impacts on groundwater levels, across all hydrostratigraphic units, and the revision of groundwater level Early warning and Impact thresholds for the DSC (as detailed in **Section 5.3**) as well as the interim threshold of 0.2 m at the DSC springs..

2.2.6.3 Mellaluka Springs Complex

Additional geological / exploration bores and monitoring bores were constructed to assess groundwater resources, associated with the Tertiary sediments and the Joe Joe Group's Jochmus Formation, for mine construction purposes. The drilling also allowed for a preliminary assessment of underlying geological and hydrogeological regimes around the Mellaluka Springs Complex. The locations of these bores are presented in Error! Reference source not found. below.

As discussed in **Section 2.2.5** (and depicted in Plate 6~~Plate 6Plate 6~~) the drilling in this area indicates a complex (multi-storey) groundwater system within the Tertiary sediments and Joe Joe Group in this area.

The conceptualisation and understanding of the groundwater resources will be refined over time for inclusion in the future iterations of the predictive groundwater model and the GMMP, in line with the approval conditions EA Conditions E4, E5, and E6 and EPBC Act condition 3e .

Cross-sections through Sections A1 - B1 and A2 - B2, as indicated in Error! Reference source not found. below, allowed for the assessment of the contact between the Colinlea Sandstone and the Joe Joe Group. This contact is depicted in Error! Reference source not found. and Error! Reference source not found. below.

The Mellaluka Springs Complex is located immediately adjacent to groundwater monitoring bore C9180124SPR, logged to be underlain by Tertiary sediments and Joe Joe Group.

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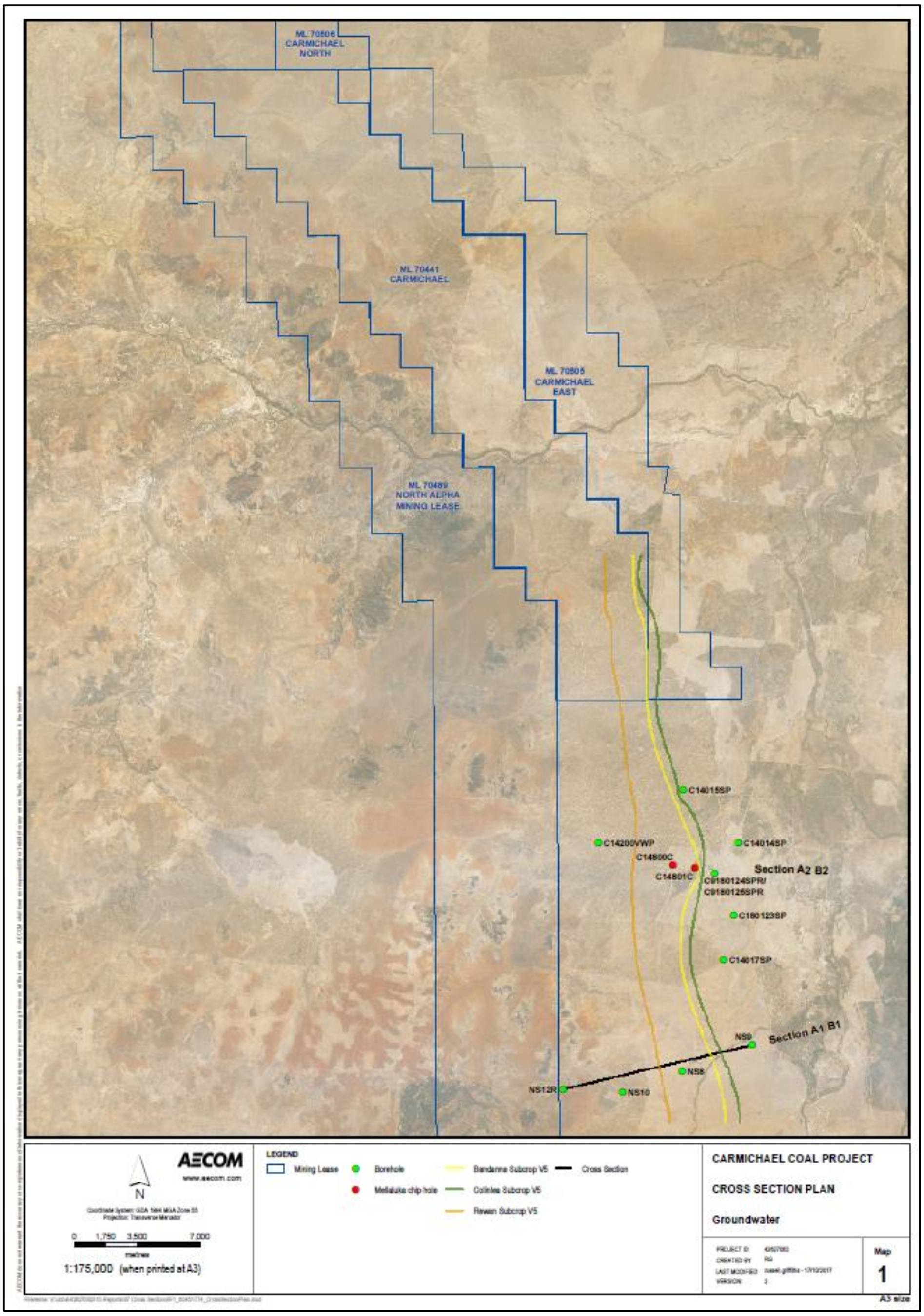

Figure 9 Bores located within the Mellaluka Springs Complex area

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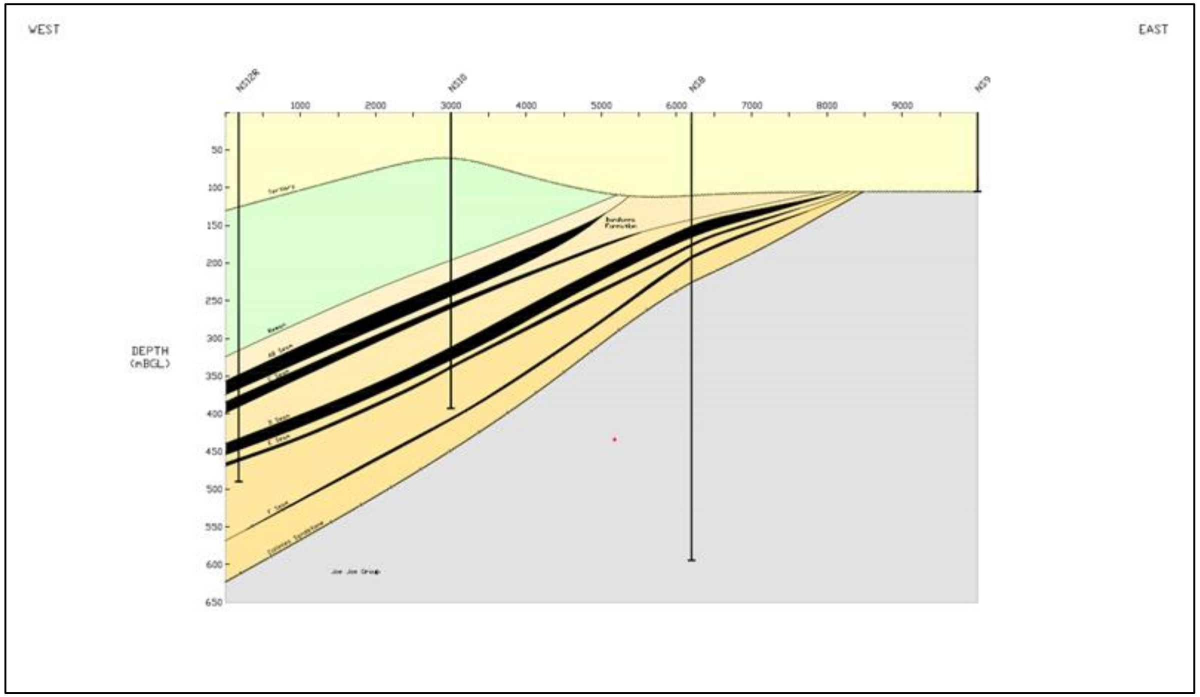

Figure 10 Cross-section A1 - B1

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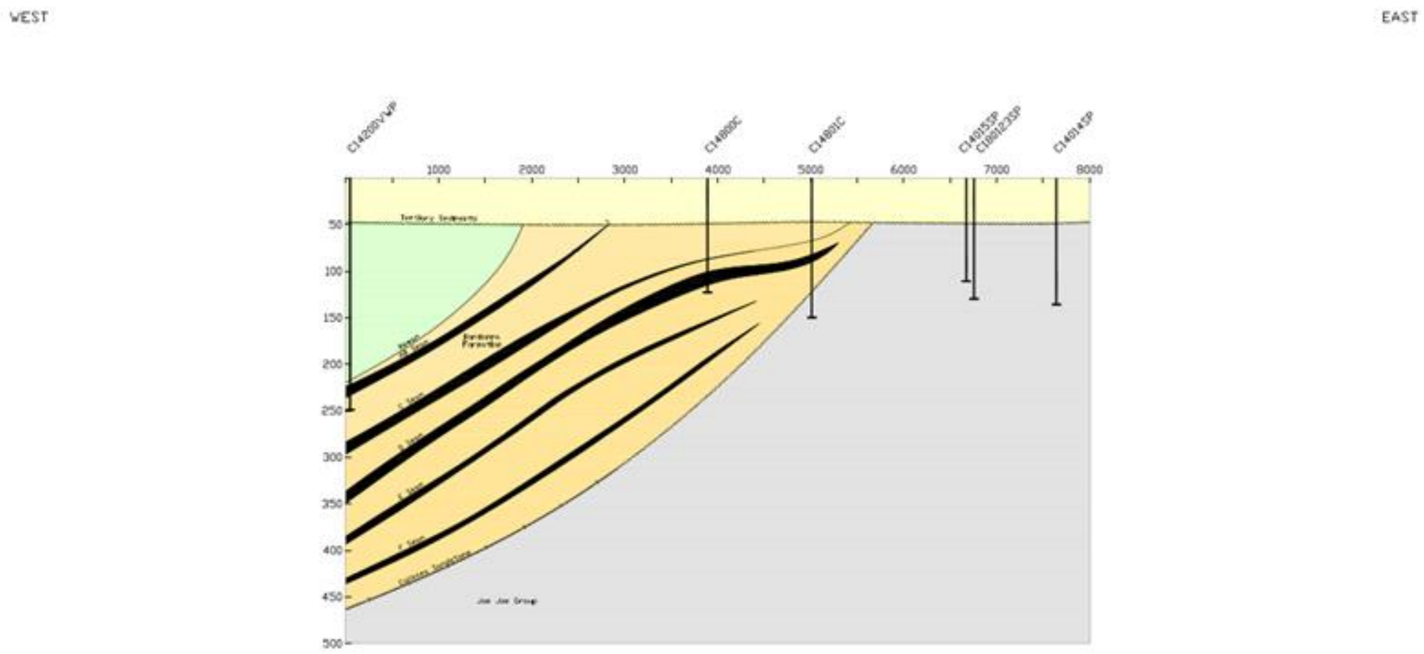

Figure 11 Cross-section A2 - B2

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2.2.6.3.1 Preliminary Assessment of Mellaluka Springs

The groundwater quality within the Mellaluka Springs Complex area includes the following:

- Mellaluka Spring salinity ranges from 800 to 3,200 µS/cm
- Bore C180123SP salinity ranges from 790 to 830 µS/cm (Joe Joe Group), C9180124SPR salinity ranges from 420 to 460 µS/cm (Joe Joe Group), C14014SP salinity ranges from 490 to 520 µS/cm (Joe Joe Group), and C180123SP salinity ranges from 790 to 830 µS/cm (Joe Joe Group)
- Tertiary sediments groundwater salinity, bore C9180121SPR, ranges from 3,600 to 3,700 µS/cm
- Blended groundwater quality from bores screened across both the Tertiary sediments and Joe Joe Group, such as bore C180120SP (6,500 to 8,700 µS/cm) and bore C180122SP (6,800 to 7,600 µS/cm).

Groundwater quality indicates mixing / blending of groundwater measured at Mellaluka Springs, when considering the salinity of Tertiary sediments 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. Plate 11~~Plate 11Plate 11~~ below depicts the mapped Belyando River, drainage pattern within a wide flood plain, and location of the Mellaluka Springs Complex.

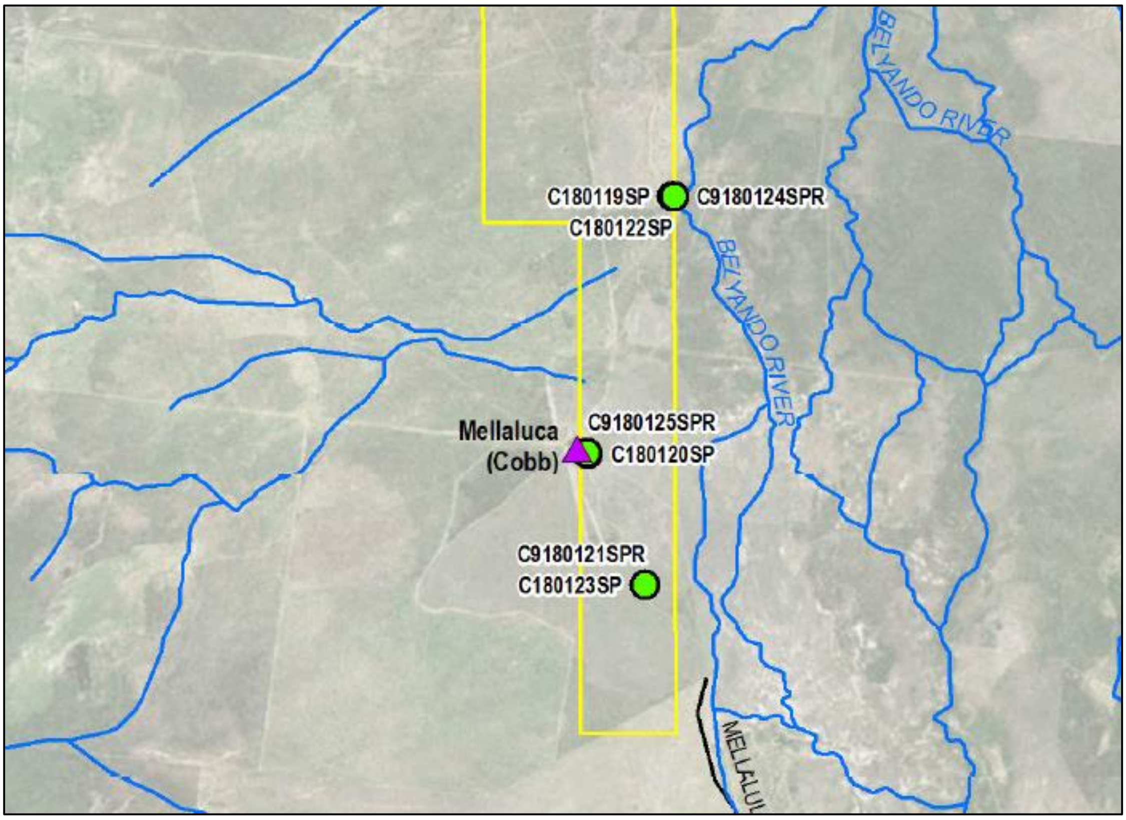

Plate 11 Belyando River proximity to Mellaluka Springs Complex

2.2.6.4 Considerations regarding Mellaluka Springs Complex

Based on the drilling results (re-assessment of site-specific geology) , mapping of coal seam subcrop, and the available groundwater quality, the groundwater associated with the Mellaluka Springs Complex is sourced from artesian Tertiary sediments and Joe Joe Group. The predicted groundwater level impacts, considering the alternate conceptualisation that Tertiary sediments and Joe Joe Group are the source of the Mellaluka springs, will be markedly less than those predicted for the Colinlea Sandstone source, as predicted in SEIS studies.

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It is noted that the groundwater level drawdown thresholds for the Mellaluka Springs area are based on the conservative SEIS model approach, which assumes the Colinlea Sandstone is the source of the springs, i.e. the bottom model layer is the coal bearing Colinlea Sandstone. Thus, the groundwater level drawdown thresholds for the Mellaluka Springs are developed based on worst case impacts considering the Mellaluka springs are sourced from Colinlea Sandstone (which is directly impacted by mine dewatering). The alternate conceptualisation will be tested during the first model review which is scheduled to be conducted within two years of commencement of any mining activities associated with box cut excavation.

This conceptualisation, based on conditions within the area, will be refined overtime as additional groundwater data is compiled and the groundwater model is revised. The model revision will include the inclusion of the Joe Joe Group and calibration of the model to the artesian conditions in the Joe Joe Group based on the additional drilling (which was conducted to assess groundwater potential for construction purposes to the east of the MLs). Further results of groundwater testing carried out to estimate aquifer parameters will be included in the model to aid in the refinement of the model construction and layer properties.

It is to be noted that predictions of drawdown are not considered to increase because of the revised conceptualisation in model refinement. The GMMP will be revised, as required, in response to modelling refinement.

2.2.7 Model Water Balance

The numerical groundwater model has been refined over time as additional information has become available. As a result, the calibrated steady state pre-development water balance has been updated; the most current balance is presented in Table 20~~Table 20Table 20~~ below. As can be observed, this table compares the model water balance with the SEIS model completed in 2013, both undertaken by GHD.

The groundwater model was revised and re-run in 2014 to review potential impacts on the GAB groundwater resources, as per the EPBC Act approval condition (Condition 23). The model re-run aimed to address the additional information requirements from the Commonwealth.

The model revision incorporated the required updates for the revised General Head Boundary (GHB) arrangements and included:

- The best fit GHB elevation of 275 m (Option 1)
- An 'alternative conceptualisation' GHB elevation of 250 m (Option 2).

As a primary driver of the model revision was to review potential impacts on the GAB units, the best fit elevation was reduced by 25 m to maximise the westerly flow of groundwater into the GAB units (Option 1 did not result in a high groundwater flow or a net westerly flow across the western GHB within the central region of the model).

Further information in regard to the model re-run is included in **Section 2.3** below.

Table 20 Model Water Balance (Source: GHD, 2015)

Component	SEIS model			Option 1 (275m) GHB model			Option 2 (250m) GHB model		
	Flow IN (m^3/d)	Flow OUT (m^3/d)	IN – OUT (m^3/d)	Flow IN (m^3/d)	Flow OUT (m^3/d)	IN – OUT (m^3/d)	Flow IN (m^3/d)	Flow OUT (m^3/d)	IN – OUT (m^3/d)
Recharge	2,533	0	2,533	2,940	0	2,940	2,941	0	2,941
Evapotranspiration	0	4,001	-4,001	0	4,060	-4,060	0	3,961	-3,961
Discharge from/to Adjoining Areas	44,680	41,466	3,214	84,933	77,758	7,175	80,272	76,917	3,355
Groundwater Extraction	0	152	-152	0	153	-153	0	151	-151
Carmichael River Leakage	6,662	7,084	-421	6,549	9,648	-3,099	6,889	7,931	-1,041
Discharge to Other Water Courses	0	1,200	-1,200	0	2,826	-2,826	0	1,162	-1,162
TOTAL	53,876	53,904	-28 (-0.05%)	94,422	94,446	-24 (-0.03%)	90,102	90,122	-20 (-0.02%)

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The model water balance, as presented in Table 20~~Table 20~~~~Table 20~~, indicates:

- Minor uniform groundwater recharge, due to clay-rich over burden (Tertiary sediments) across the model domain
- Evapotranspiration (EVT) is double the recharge across the model domain
- Groundwater through-flow into the CCP area is higher than outflow, due to loss to surface water bodies as evident in the Carmichael River where the river is a gaining river to the west
- Surface water losses are included in the water balance, where rivers and creeks are losing systems, such as Carmichael River to the east
- Minor local groundwater extraction is included in the model
- Influx and Outflow in the model, for all scenarios, are well balanced.

All future revisions of groundwater model will compare the initial and refined model water balance(s) with the actual measurements obtained through operational monitoring (i.e., actual dewatering volumes). The methods used for estimation of recharge and evapotranspiration will be updated based on annual rainfall measurements. The actual measured pit inflows and dewatering volumes will be used to compare the predicted dewatering volumes and update the groundwater flow model periodically.

2.2.7.1 EA Condition E4 f

The EA Approval Condition E4 f) Estimation of groundwater inflow to mine workings and surface water ingress to groundwater from flooding events using the groundwater model, was discussed with the regulators during a meeting held on 7 November 2018.

It was discussed that the groundwater model only includes for groundwater inflows into pits and through rainfall directly falling onto the active mining areas but not surface water flood inundation, as the mine includes for levees along the Carmichael River. The levees will be built to provide immunity from a 1 : 1000 year ARI design flood event on either sides of the Carmichael River.

It was agreed that the surface water ingress to groundwater from flooding events would not be required from the groundwater modelling based on the flood immunity.

The regularly updated groundwater model, initially after 2 years and then every 5 years, will be used to provide estimations of groundwater inflow and will include the model water balance (with the components as included in Table 21~~Table 21~~~~Table 21~~).

2.2.8 Surface water – Groundwater Interaction

The surface water – groundwater interaction within the surficial sediments (alluvium and Tertiary sediments) is complex across the CCP footprint. Spring discharge from Joshua Spring (into the Dyllingo Creek) and the DSC springs (into Cattle Creek) are recognised to facilitate perennial surface water within the Carmichael River to the west and within the western portion of the mine lease.

The Dyllingo Creek is non-perennial upstream of Joshua Spring, and then flowing as a result of continuous discharge from the turkey's nest dam constructed around Joshua Spring. The groundwater level, on average, within the alluvium monitoring bore HD03B is some 5 m below surface (225.47 mAHD). Surface water levels are considered to be at a similar elevation, exposed within the deeper river channel.

The groundwater level remains close to surface at alluvium monitoring bore C027P1 (223.8 mAHD, ~ 4 m below surface) near the water pool on the Carmichael River within the western boundary of the mine lease. Here the river channel is deeper and wider corresponding with the a change in topography.

Downstream of the permanent pool the groundwater levels start to decline markedly, corresponding to the Carmichael River being non-perennial as it drains eastwards. The groundwater discharges as throughflow in the alluvium, mimicking surface water flow, due to the limited effective storage of the more coarse-grained permeable alluvium.

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Two surface water flow monitoring stations located upstream (CAR04) and downstream (CAR01) locations to gauge flow of the Carmichael River will be serviced to make them operational. A third location, CAR02, is located centrally and is adjacent to alluvium monitoring bore C025P1. These surface water monitoring locations will allow for identification of impacts on the Carmichael River and associated riparian MNES / GDEs. A flow meter has been installed at Joshua Spring to monitoring possible impacts of flow from the spring into the Dyllingo and Carmichael rivers .

Groundwater levels in the alluvium, to the east of the mine lease, at monitoring bore C14028SP is some 15 m below surface (204 mAHD).

Groundwater level data for the underlying (up to 60 m thick) low permeable clay-rich Tertiary sediments directly below the alluvium is limited. The two monitoring bores (C029P2 and C025P2) along the Carmichael River within the mine lease indicate potentiometric groundwater levels of 220 mAHD. This groundwater level is contoured to occur below the Carmichael River (see **Figure F2**, **Appendix C**~~**Appendix C**~~~~**Appendix C**~~).

A review of the vertical groundwater level gradients, between the alluvium and the Tertiary sediments, indicates the gradient is downward where spring recharge (perennial conditions) occurs and upward to the east. Thus, groundwater is more readily discharged as throughflow than vertical downward flow in the eastern portion of the Carmichael River. It is noted that the confined hydrostratigraphic units, overlain by the Tertiary sediments (220 mAHD) and alluvium (225.5 to 204 mAHD) in the Carmichael River area, have the following average groundwater levels:

- Moolayember Formation, 236.50 mAHD (C18003SP)
- Clematis Sandstone, 242.55 mAHD (C18002SP)
- Dunda Beds, 247.26 mAHD (C14023SP)
- Rewan Formation, 230.029 (C555P1)
- Bandanna Formation (AB seam), 212.4 mAHD (bore C007P2)
- Colinlea Sandstone (D seam), 217 mAHD (bore C007P3)
- Joe Joe Group, 226.03 mAHD (C14006SP).

The groundwater gradients above the Rewan Formation (as discussed in **Section 2.2.6.2**) are upwards, restricting vertical groundwater loss from the alluvium in the areas where the alluvium overlie these units.

Figure 12~~**Figure 12**~~~~**Figure 12**~~ shows the conceptual model along the Carmichael River, illustrating geology, groundwater levels and recharge/discharge mechanisms with the alluvium, as well as the potentiometric level associated with the Tertiary sediments.

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Figure 12 Surface water – groundwater interaction conceptual model

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Flow impacts

The predictive modelling indicates the estimated average baseflow (upstream where perennial flow is measured in the Carmichael River) to be approximately 4,500 m^3/day. Model predictions indicate a possible decrease to 4,300 m^3/day at the end of mining; a possible reduction of 200 m^3/day (~4.4% of daily flow).

This "losing" of surface water to groundwater indicates that groundwater levels would need to reduce sufficiently to allow for a steeper vertical gradient between the alluvium and the target coal seam Permian age units so as to increase vertical groundwater flow (rather than horizontal throughflow).

The model predicts a decrease in the potentiometric level at the Joshua Spring of 0.19 m (**Section 2.7.4.1**), which is insufficient to alter the artesian conditions (the discharge from the turkey's nest occurs at some 2 m above the base of the dam) but could reduce the flow rate from the turkey's nest dam into the Dyllingo Creek.

No other change in DSC spring flow into the perennial portion of the Carmichael River is predicted.

2.2.9 Refinement of the Current Groundwater Conceptual Model

After reassessment of the data collected since commencement of investigations across and adjacent to the CCP, the revised groundwater conceptual model has addressed the data gaps identified in previous iterations. However, additional data gaps have been identified and include:

- Identification of artesian conditions evident between the Tertiary sediments and Joe Joe Group in the Mellaluka Springs Complex area
- The assessment of the changing artesian conditions within the Tertiary sediments and Joe Joe Group (south and north of the Carmichael River) including consideration of the Belyando River palaeochannels influence on potentiometric pressures (only mapped to the south of the Carmichael River)
- Moolayember Formation groundwater quality
- Verification / validation of the aquitard nature of the Rewan Formation
- Further explore hydraulic connectivity of the units
- Further explore groundwater flow directions
- Refine estimate of baseflow from the Carmichael River.

Adani propose to address the data gaps above to refine the current conceptual understanding of the groundwater regime and ensure the predictive capacity of the numerical model is robust. This GMMP includes for the collection of additional groundwater data to aid in refining conceptualisations for future iterations of the GMMP and numerical model updates.

Additional investigation(s) within and adjacent to the CCP area will be undertaken through the project's EPBC conditioned requirements to undertake a RFCRP and a GABSRP. Alternative conceptualisations may be developed and explored as the data from the studies required above are assessed and compiled.

The results of these studies, with respect to the groundwater conceptual understanding, are proposed to inform EA condition E6 numerical modelling review and updates (after two years then every five years). This approach promotes continued and increased accuracy of the groundwater numerical model simulations to predict potential impacts on the groundwater resources of the site over the life of mine. The model reviews, updates, and revised predictions will be provided to both the State and Commonwealth regulators for review, as well as an independent auditor (see **Section 7.0**).

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2.2.10 Hydrogeological Conceptual Model Summary

The groundwater conceptual model(s) has been refined to include the results of continued investigations onsite. It is considered the key elements of the groundwater system in the CCP 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 13~~Figure 13Figure 13~~ and Figure 14~~Figure 14Figure 14~~ below.

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Figure 13 Pre-mining Hydrogeological Conceptualisation for the CCP area

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Figure 14 Post-mining Hydrogeological Conceptualisation for the CCP area

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2.2.10.1 Predicted Changes in Groundwater Levels

Groundwater levels included in the conceptualisations are included in Table 21~~Table 21Table 21~~, which provide an indication of groundwater levels per hydrostratigraphic unit before and at the end of mining within the middle of the MLs.

Table 21 Groundwater Level Data for Conceptual Models

Hydrostratigraphic Unit	Average Groundwater Level (middle of CCP) [mAHD]	Projected Groundwater Level (middle of CCP) [mAHD]
Alluvium	224	224
Tertiary Sediments	220	219.6
Moolayember Formation	236.5	236.5
Clematis Sandstone	243	242.5
Dunda Beds	247	245.8
Rewan Formation	230	157
Bandanna Formation (AB Seam)	212	32
Colinlea Sandstone (D Seam)	217	13
Early Permian aged Joe Joe Group	226	225.6

The predicted groundwater level changes, because of approved mining operations, indicates limited potential for induced flow based on hydraulic properties of the hydrostratigraphic units.

Groundwater level change, per hydrostratigraphic unit, using the SEIS predictive groundwater model allowed for the compilation of groundwater level drawdown at the end of mining. These contours are included in Appendix C~~Appendix CAppendix C~~, and allow for evaluation of groundwater flow pattern changes (pre-mining and end of mining (78 years).

2.2.10.2 Final Void Influence

The post-mining hydrogeological conceptualisation is an important consideration for the development and augmentation of this GMMP. The long-term groundwater regime(s) are altered, post-mining, due to:

- Open cut mining, where backfill increases groundwater recharge
- Long wall mining (goaf), which results in increased vertical hydraulic conductivity and secondary permeability
- Final void(s), where groundwater rebound occurs within the underground workings to the base of the final voids.

The final voids will act as groundwater “sinks” in perpetuity, where the pseudo-steady state water levels within the final voids will be governed by:

- Direct rainfall
- Increased recharge through the backfill
- Evaporation (decreasing with depth and shade)
- Groundwater ingress
- Surface water runoff (directed into the voids until rehabilitation facilitates suitable water quality for discharge off site).

It is predicted that the final voids will result in long term alteration to localised groundwater flow patterns within the hydrostratigraphic units directly impacted by the open cut workings (i.e. the units intersected within the final voids), where groundwater flow will be into the final voids. This flow pattern

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will be considered when developing long term groundwater monitoring programs (bore network and sampling requirements).

The groundwater levels will reach a pseudo-steady state (these will be below current pre-mining groundwater levels), governed by permeability, such that groundwater drawdown cones facilitate flow towards the final voids, within the mine leases (and extend to the radius of influence as discussed in **Section 2.7.3**). This resultant groundwater flow directions into the final voids prevents contaminants within groundwater from migrating off-site.

Groundwater monitoring will be required to validate final void flow patterns and pseudo-steady state groundwater levels, and to verify groundwater quality into and off the MLs.

2.3 Model Re-Run

As part of the environmental approvals process for the CCP, the project was assessed to be a controlled action under sections 75 and 87 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Commonwealth approval of the project was issued subject to a series of conditions, documented within *Approval Carmichael Coal Mine and Rail Infrastructure Project, Queensland (EPBC 2010/5736)* (**Appendix A**~~Appendix A~~Appendix A). The EPBC Act Condition 23 required a re-run of the groundwater flow model, based on the independent expert review as per EPBC Act Condition 22.

Condition 23 includes:

The model revisions and re-runs must incorporate the following parameters in the scenarios and address the following additional information requirements:

a. *Re-define the current General Head Boundary (GHB) arrangement, as agreed by the Department in writing including the following:*
    i. *Remove the GHB from its current location in all layers to the western edge of the model domain*
    ii. *Review and justify the GHB conductance values used in the model to reflect the differences between aquifers and aquitards and also between aquifers (e.g. Clematis and Colinlea Sandstones), and modify if required;*
    iii. *GHB cell elevations to be re-set using data as agreed by the Department in writing*
    iv. *Report on the impacts on groundwater levels and net flows between the model domain for the revised GHB boundaries and compare with previous modelling results.*
b. *Review and justify the recharge parameters for the Clematis Sandstone to represent the flux into the recharge beds of the Great Artesian Basin, and modify if required;*
c. *Document outflow mechanisms used in the model for the Doongmabulla Springs Complex and individual model layers, using maps to show the spatial distribution of model discharges*
d. *Document and incorporate known licensed groundwater extractions within the model domain*
e. *Document and justify any other charges made as part of the model re-runs that are not outlined above*
f. *As per the IESC information guidelines provide an assessment of the quality of, and risks and uncertainty inherent in, the data used in the background data and modelling, particularly with respect to predicted model scenarios*
g. *Provide adequate data (spatially and geographically representative) to justify the conceptualisation of topographically driven flow from south to north (and west to east) in both shallow and deep aquifers.*

As a result of Condition 23, GHD undertook the model re-run which is documented in detail in the report *Carmichael Coal Project Response to Federal Approval Conditions- Groundwater Flow Model* (GHD, 2015) which should be read in conjunction with the SEIS (GHD, 2013) to enable a

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comprehensive understanding of the hydrogeology of the mine and surrounding area. The model re-run was completed based on the data within the SEIS report.

A technical memorandum, prepared in accordance with Condition 23 a)(iii) was submitted to the Department of the Environment (DotE) which outlined the approach to address conditions 23 a) (i)-(iii); Adani received notification from the Department on 3 November 2014 which confirmed that these conditions have been met.

It is noted that the Commonwealth Approval Condition 3 and Condition 24, related to the Groundwater management and monitoring plan, includes the provision that the GMMP must be informed by the results of the groundwater flow model re-run. The details of the groundwater network with respect to MNES and *EPBC Act* approvals, using the results of the predictive groundwater modelling, are included in **Section 3.0** of this GMMP.

2.3.1 Changes to the Numerical Model

Requirements of Condition 23 included the extension of the model domain westwards. The western boundary in the SEIS model was defined as the surface water divide associated with the Belyando River (including the Diamond Creek, Dyllingo Creek, Dunda Creek catchments). To satisfy Condition 23 (a) the western model boundary was moved to the western extent of the model domain, which resulted in a portion of the Lake Galilee catchment being included within the active extent of the model, as depicted in **Plate 12**~~**Plate 12Plate 12**~~.

The extension of the western model boundary involved modification of several boundary conditions associated with the SEIS model, which included:

- All general head boundaries (GHBs) were removed from the western extent of the SEIS model
- The no-flow cells in the western region of the model (Lake Galilee area) were activated
- A new series of GHBs were assigned along the revised western model boundary to allow for shallow groundwater discharge in the Lake Galilee area and deep through flow to the west
- A small section of GHBs were removed from the north-western corner of the model as the revised western GHB locations and elevations encouraged westerly flow in this region, with head contours orthogonal to the northern model boundary
- River boundaries were applied within the expanded western area of the model
- The GHB conductance values were revised for all GHB cells (previously these were set to 1000 m^2/d for all GHB cells)
- All other boundary conditions remain unchanged from the SEIS model.

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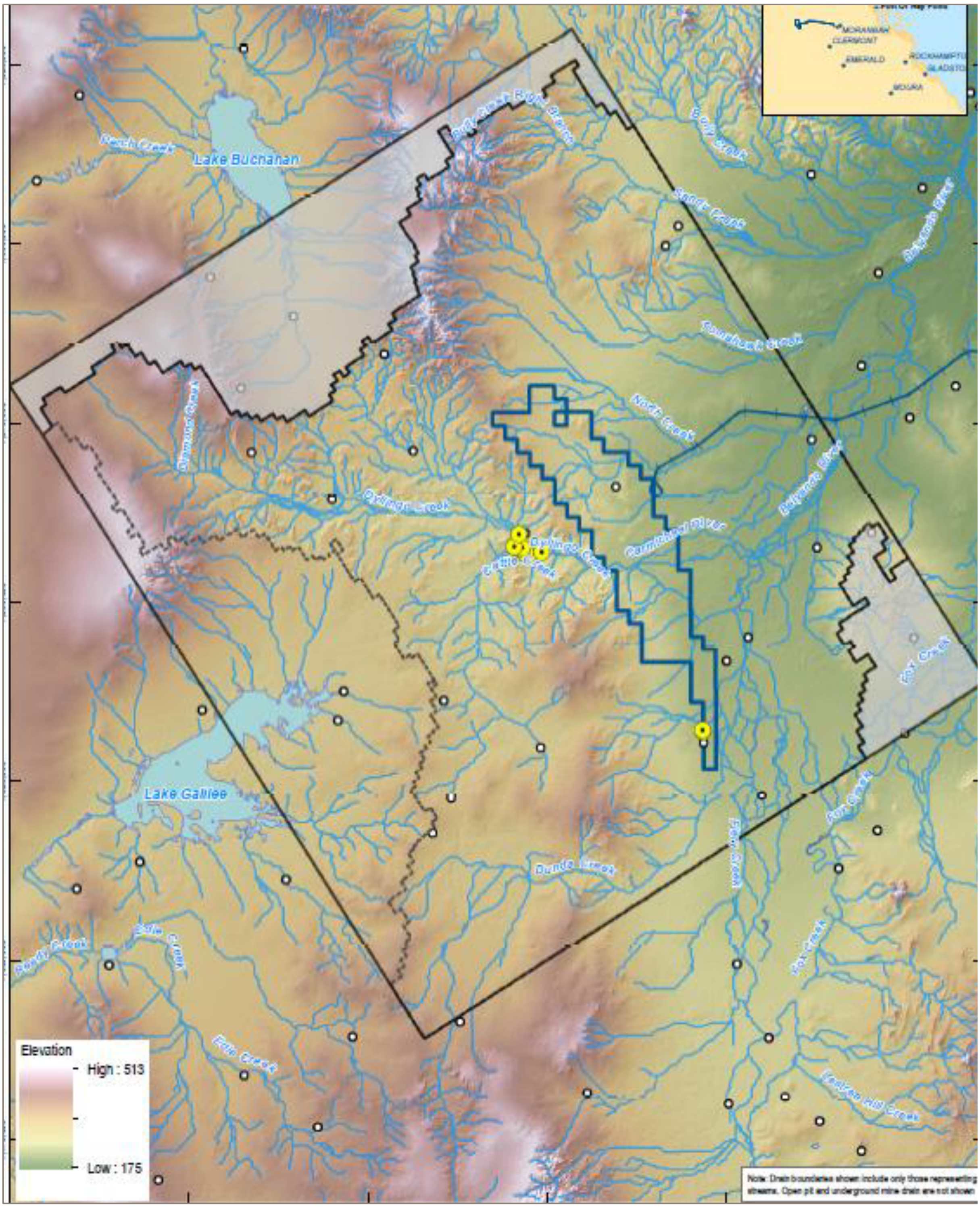

Plate 12 Model boundaries (Portion of Figure 4 from GHD 2015)

During preliminary model runs, it was noted that limited westerly groundwater flow was achieved through the western model boundary. To promote additional westerly flow, a second GHB configuration ("Option 2 [250m]") was adopted throughout this assessment, which utilised lower GHB elevations along the western boundary. The adoption of the Option 2 (250m) model was, therefore, included to further assess the model sensitivity and reduce the uncertainty in model predictions.

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2.3.2 Re-Run Model Input into GMMP

The model changes, through discussions and agreement with DotE, and reassessment of model parameters (head values, conductance, etc.) addressed the EPBC Act Condition 23 requirements.

The resultant re-run model predictions and uncertainty analyses were used to aid in compiling this GMMP, particularly the selection of the operational monitoring bore network, groundwater level thresholds, and assessment of potential impacts on MNES.

The re-run of the model allowed for:

- Configuration of model boundaries and justification for each model layer
- Assignment of conductance based on calibrated hydraulic conductivity values and cell geometry (thickness and width)
- Inclusion of licensed groundwater abstraction, approximately 73 ML/year within the revised model domain for nineteen (19) licensed stock bores and six (6) licensed irrigation bores
- Rainfall recharge assessment which indicates that the recharge used in the model are appropriate, supported by literature, verified by site specific data, and were derived during model calibration. Sensitivity analysis indicate that recharge has a low impact on model predictions
- An assessment of model layer hydraulic parameters, hydraulic conductivity, and storage are consistent for the model re-run (compared to the SEIS model), based on model calibration
- Calibration statistics for the SEIS model and the re-run model (both GHB options [250 m and 275 m]), are all acceptable calibration statistics and indicate little change in the scaled root-mean-square values
- Evaluation of outflow at the western model boundary
- Evaluation of the model water balance for the SEIS and re-run model options, which considered:
  - modelled recharge is higher in the re-run models due to increased model domain
  - evapotranspiration is relatively constant across all models
  - groundwater discharge from/to adjoining areas increases in the re-run models due to differences in the western boundary (hydraulic divide in SEIS model)
  - groundwater discharge to rivers is highest in re-run model option1 (275 m) due to higher heads in the upper reaches of the Carmichael River tributaries.
- Water level validation using additional measured groundwater levels in the expanded model domain.

On examining the impact predictions from the SEIS predictive groundwater model and re-run model scenarios (differing model boundaries) at important receptors it is evident that the impacts are similar but higher in case of SEIS model. The GMMP compilation include a review of the available models and a conservative approach was taken to use the SEIS model (i.e. base the GMMP on the highest predicted impacts). The 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 GMMP.

2.3.3 Model Predictions – Operational Phase

The predictive modelling allowed for an assessment of operational phase impacts on the groundwater resources, which were considered when compiling this GMMP.

2.3.3.1 Water Table Impacts

Maximum predicted water table impacts due to the approved open cut and underground mining have been predicted for the SEIS and re-run models. The model outputs allowed for identification of the maximum predicted drawdown irrespective of model layer and timing due to transient mining operations which resulted in maximum drawdown in different units at different times.

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Groundwater drawdown is deepest in the coal measures within the mine leases, approximately 300 m below surface. Drawdown outside the mine leases reach 20 to 50 m, related to depressurisation of the coal down-dip of mining (Error! Reference source not found.). It is noted that this depressurisation, estimated to be 500 m and greater than 8 km away from the GAB Doongmabulla Springs Complex reduce the potential for induced flow impacts on neighbouring groundwater resources, including the springs.

Comparison of maximum drawdown predictions for the different models is similar with limited differences in the extent of the maximum drawdown contours (smaller in the larger model domain models).

The 0.2 m drawdown contour, in both re-run model options, does not extent as far west as the SEIS model predictions, which is estimated to extend some 1 km closer than the re-run models.

The groundwater level predictions, using hydrographs from the predictive modelling, were used to develop groundwater level thresholds (**Section 5.3**), which allow for the instigation of further assessment to ensure management and mitigation of potential impacts on MNES and neighbouring bores (as required in EA approval Condition E13 (Table E3) and EPBC Act Condition 3d).

2.3.3.2 Spring Impacts

The assessment of potential impacts on the springs is included in **Section 2.7.3.1**, where model prediction hydrographs at the Doongmabulla and Mellaluka spring complexes have been assessed.

These hydrographs plus the model predictions for bores between the mine leases and the springs have been used to determine groundwater level thresholds, as detailed in **Section 5.3**.

2.3.3.3 Neighbouring Bores

Little or no impact is predicted, in all three models, at the 20 bore locations within the SEIS model domain. Maximum predicted drawdown includes:

- 0.05 m in 10 of the 20 bore locations
- < 0.2 m in a further 9 bores
- 0.8 m drawdown in RN90255 (despite being near the northern MLs boundary).

Predicted maximum groundwater level impacts at 15 registered groundwater within ten (10) km of the CCP are less than 1 m. Registered bores within the mine footprint are to be decommissioned (lost) due to mining operations.

Despite the model predictions indicating little or no groundwater level decline in the registered bores, sentinel bores have been included in the GMMP between the mine leases and the neighbouring bores to allow for the validation of model predictions, as detailed in **Section 5.3**.

2.3.3.4 Carmichael River

Reduction of groundwater baseflow and discharge from the Doongmabulla Springs Complex were considered in the modelling. Pre-mining steady-state modelling estimates average baseflow (upstream where perennial flow is measured in the Carmichael River) to be approximately 4,500 m^3/day. Model predictions indicate a possible decrease to 4,300 m^3/day at the end of mining; a possible reduction of 200 m^3/day.

In the area where the Carmichael River is a losing system (non-perennial flow) within the mine lease, pre-mining groundwater flow from surface water to groundwater is estimated to be 1,000 m^3/day. Predictive modelling estimates this contribution will increase to around 1,800 m^3/day at the end of mining.

Groundwater monitoring bores (Table 57~~Table 57Table 57~~**, Section 5.3**), along the Carmichael River (as included in EA approval condition E13 [**Table E3**]), have been identified and groundwater level thresholds have been developed for these bores to allow for the validation of groundwater level changes (considered to be associated in part to increased surface water losses).

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2.3.3.5 GAB Impacts

Pre-mining steady-state modelling estimates around 100 m^3/day of net vertical leakage from the lowest GAB unit (the Rewan Formation) to the underlying Permian units (conceptualisation and assessment of vertical gradients indicates this could occur, **Section 2.2.6.1**).

It is noted that this 100 m^3/day over the entire Rewan Formation model layer within the 10,044 km^2 model domain (re-run model), is a very low flow rate as associated with an aquitard.

Model predictions, at the end of mining, estimate vertical leakage to increase to 2,200 m^3/day due to mine dewatering /depressurisation of coal which facilitates induced flow.

The groundwater level predictions, using hydrographs from the predictive modelling for all available bores to the west of the mine leases, were used to develop groundwater level thresholds (GMMP **Section 5.3**), which allow for the instigation of further assessment to ensure management and mitigation of potential impacts on GAB units (as required in EA approval Condition E13 (Table E3) and EPBC Act Condition 3d).

2.3.4 Model Predictions – Post-Closure

The predictive modelling also allowed for an assessment of post-mining impacts on the groundwater resources. It is noted that, in compliance with approval conditions, these potential impacts will be assessed and revised as additional monitoring and refinement of modelling takes place during mining operations. These predictions were, however, considered when compiling the GMMP (i.e. if marked changes between operational impacts and post-mining impacts were identified the GMMP bore network was assessed to determine suitability for long-term groundwater impact monitoring).

2.3.4.1 Long-term Water Table Impacts

Long term 0.2 m drawdown contours are predicted to extend to west over time, south of the Carmichael River.

The 0.2 m drawdown, for all three models, is not predicted to extend into the Doongmabulla Springs Complex area.

2.3.4.2 Long-term Springs Impacts

The long-term impacts on the Doongmabulla Springs Complex are predicted to be less than or equivalent to the operational impacts. Maximum post-closure drawdown is predicted at 0.09 m (Option 1) and 0.13 m (Option 2) compared to the operational phase drawdown predictions 0.11 m (Option 1) and 0.13 m (Option 2).

For the Mellaluka Springs Complex, based on the conservative conceptualisation that the sub-D Permian sediments underlie the springs (see **Section 2.7.3.1**), the model predictions are considered to increase over time.

Refined modelling, using additional geological data, will be conducted as per the approval conditions. This refinement will allow for the more accurate assessment of drawdown in the Mellaluka Springs area.

2.3.4.3 Long-term Neighbouring Bore Impacts

Long term predictions are considered unlikely to materially affect neighbouring bores, i.e. groundwater levels are not predicted to exceed 5 m in confined aquifers.

2.3.4.4 Post-closure Baseflow Impacts

Pre-mining steady-state modelling estimates baseflow (upstream where perennial flow is measured in the Carmichael River) at:

- A maximum flow of 4,479 m^3/day, which will reduce to 4,189 m^3/day in the long-term (SEIS model)
- A maximum flow of 7,103 m^3/day, which will reduce to 6,850 m^3/day in the long-term (re-run Option 1 275 m) model)
- A maximum flow of 5,105 m^3/day, which will reduce to 4,752 m^3/day in the long-term (re-run Option 2 250 m) model).

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Long-term modelling predicts a 4 to 7% reduction in groundwater contribution to baseflow in the Carmichael River, compared to the 4.4% during mining operations.

In the area where the Carmichael River is a losing system (non-perennial flow) within the mine lease, pre-mining groundwater flow from surface water to groundwater is estimated at 1,000 m^3/day. Post-closure predictions suggest that this flow (loss) from surface water would increase to 1,650 m^3/day (less than the 1,800 m^3/day predicted at the end of mining).

2.3.4.5 Post-Closure GAB Impacts

Long term groundwater flow from the GAB was simulated in the model, considering flow within the model. Long-term flow indicates a range from 104 to 229 m^3/day, markedly less than the end-of-mining flow predictions.

2.3.5 Numerical Model Confidence

The groundwater model re-run was undertaken in accordance with Australian modelling guidelines, published by the National Water Commission (Barnett et all, 2012) and with reference to the Murray Darling Basin Commission (Middlemis et al, 2001). These guidelines provided a mechanism for characterising model objectives and confidence.

To provide sufficient confidence in model predictions, conservative, long-term steady state post-closure predictions were incorporated and flow data from the Carmichael River was used to benchmark groundwater/surface water interactions. Modelled results at receptors beyond the mine leases typically predict low levels of impact, which provides additional confidence in the level of stress observed at receptors versus calibration data (GHD, 2015).

A detailed sensitivity analysis has also been completed, which enabled the impact of uncertainty in the model inputs to be characterised.

According to the Australian modelling guidelines, the current groundwater model is a confidence level: Class 1–-2, based on the data utilised to date (for modelling). The level of confidence in the model is expected to increase once mining starts and model validation can be undertaken.

This is to say, steady-state calibration is acceptable for mine dewatering predictions as there is no additional data available. However, model validation can be undertaken to assist prediction once additional observations are available after the start of mining. Regular modelling updates are to be undertaken, as per approval conditions, including after 2 years of mining, which will be the first review of the model and the GMMP.

An independent review (see **Section 2.4** below) of the groundwater model has been conducted. The peer review process identified that the model design, software, extent, layers, cell size and boundaries described in detail in various reports are consistent with best practice.

2.3.5.1 Summary

The three models, using different boundary conditions, conductance, and conceptualisations, allow for a suitable range of predictions which can be used for developing the GMMP.

2.3.6 Predictive Modelling and Groundwater Level Thresholds

The GMMP includes a groundwater monitoring network that can detect drawdown caused by the approved mining operations and allow for the comparison of actual drawdown to the predicted drawdown of groundwater levels. The monitoring bore network also allows for the assessment of drawdown prior to reaching the maximum drawdowns (irrespective of model layer and timing due to transient mining operations).

While the GMMP is primarily developed to manage and monitor groundwater resources to meet all groundwater related approval conditions, the ongoing management of water during mine operations will be done through the water management plan. The important features of the water management plan will be to promote water conservation, water recycling, water reuse, and also to meet water quality objectives of the intended purpose of use or discharge. The water management plan also have management actions to measure quantity of water leaving a particular application or destination to ensure it is appropriate for the next application or destination, including, for example, release into the environment . The volume of water taken by carrying out the authorised activity under the mining lease

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(i.e., the water entering the pits or groundwater pumped out in advance from mining areas) will be measured and reported as required under section 334ZP of the Mineral Resources Act 1989 and sections 31A and 31B of the Mineral Resources Regulation 2013.

The compilation of groundwater ingress volume records during mining, based on mine dewatering schemes (pump flow meters), allows for addressing model uncertainty and model refinement (i.e. using actual dewatering results and changes in monitoring bore water levels to recalibrate the model) at regular intervals as per the EA conditions.

To undertake this assessment during mining operations groundwater level thresholds have been developed, in line with EA approval condition E13, to detect if drawdown caused by the mine operations may exceed predictions in the numerical model and sensitive ecosystems may be impacted. Apart from setting out and monitoring to detect for exceedances of groundwater level drawdown thresholds, it is noted that there are other monitoring and reporting mechanisms required under other project approval conditions. These details were discussed in monitoring and reporting in **Section 4.0**.

Section 5.3 provides details of the groundwater level thresholds, including the EPBC Act (EPBC 2010/5736) approval condition which includes for the details of groundwater level Early warning triggers and Impact thresholds for the Doongmabulla Springs Complex.

The selection of groundwater level thresholds was based on predictive model groundwater level projections, which allowed for the prediction of groundwater level change over time in different units across and adjacent to the MLs. It is noted that, to allow for model uncertainty (which will be improved with transient groundwater level and ingress / dewatering records during mining), that the groundwater drawdown thresholds include the following:

- Allow for the assessment of drawdown so it does not exceed the maximum predicted drawdown
- Validate predictive modelling
- Allow for the assessment of decline trends through the compilation of groundwater level hydrographs, to be updated after each groundwater monitoring event. This will allow for the evaluation of the rate of groundwater level decline as well as the actual drawdown
- Implementation of a rate of groundwater level decline trigger, as well as the groundwater level Early warning triggers and Impact thresholds for the Doongmabulla Springs Complex. This is to ensure the drawdown does not exceed the interim drawdown threshold of 0.2 m at the Doongmabulla Springs Complex.

The groundwater level thresholds (and groundwater level Early warning triggers for the Doongmabulla Springs Complex) 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 impact threshold levels are 90% of the predicted maximum drawdown levels
- In cases where the predicted drawdown is markedly lower than the natural fluctuation, the predicted drawdown plus natural fluctuation is taken as the impact threshold.

Should groundwater level monitoring indicate variations in groundwater levels by more than 50% (unconfined) or 75% (confined) groundwater level fluctuations or > 90% of the predicted maximum drawdown levels (in bores where drawdown is predicted to > 10 m) on two consecutive groundwater monitoring events (quarterly) then the following will occur:

- An investigation must be instigated within 14 days of detection
- Notify the regulator within 30 days as per condition 59 of the Associated Water Licence
- Assess the cause of the groundwater level fluctuation considering:

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- dry / drought conditions
- groundwater extraction from neighbouring user(s)
- groundwater level trends in multiple bores within the same unit
- long term recharge / discharge trends
- mining operations and dewatering volumes.

A report into the investigation will be made available to the State and Commonwealth regulators on request with findings and recommendations.

Impact thresholds for the Doongmabulla Springs Complex have been compiled to assess potential mining impacts on MNES. The Impact thresholds are defined as the following:

- 90% of the predicted maximum drawdown levels:
  - **NOTE:** For bore C14033SP, were the drawdown is predicted to be close to the natural fluctuations, the natural fluctuation variation (i.e. 90% of natural fluctuation in the reference data set) is the impact threshold
  - **NOTE:** For bores where the 90% of the predicted maximum drawdown levels is less than the selected groundwater level thresholds (determined based on natural fluctuation), the impact thresholds are determined using Natural Fluctuation plus 90% of predicted drawdown.
- Timing of groundwater level drawdown, such that if groundwater levels start to decline before the predicted impacts (as predicted in model hydrographs (**Section 5.3**))
- Rate of groundwater level decline change which exceeds the rate of groundwater level decline trigger in key hydrostratigraphic units (included in **Section 5.3.5**).

Should any or all these Impact threshold levels be realised, through the assessment of groundwater monitoring data and comparison to model predictions, then an appropriately qualified person will complete an investigation and will provide a written report to the State and Commonwealth regulators within 60 days.

The investigation will also perform refinement and re-run of predictive model if required along with increased monitoring through additional bores and evaluation of induced flow due to mining impacts. If the investigation concludes that the exceedance of Impact thresholds is a result of mining activities, then the following will occur:

- Review of the latest numerical groundwater model, comparing with the monitoring results and revising as required
- Update the predictions using the revised numerical model to check if the revised predictions exceed the interim threshold or not
- Review of mine plan including sequencing of mining
- Review of Underground Water Monitoring program
- Investigate and implement potential mitigation activities including those identified from the GAB Spring Research Plan.

2.4 Groundwater Model Independent Review

As per the requirements of the Conditions 22 and 23 of the EPBC Approval (EPBC 2010/5736) the Carmichael Coal Project numerical groundwater flow model developed by GHD (as described in **Section 2.3** above) was independently peer reviewed by Hugh Middlemis.

The peer review process identified that the model design, software, extent, layers, cell size, and boundaries described in detail in various reports are consistent with best practice. In fact, the investigation of an alternative conceptualisation is not common practice and should be considered a leading practice method of addressing the key area of conceptual model uncertainty. The report is attached in **Appendix A**~~**Appendix A**~~~~**Appendix A**~~.

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The summary of the peer review is set out below:

> *The review process did not identify any material weaknesses in the model design, boundary conditions, parameter values or calibration performance. The exploration of model uncertainty in conceptual and parameter value terms is commendable and the results indicate low sensitivity/uncertainty. It is my professional opinion that the model revisions have been undertaken competently, consistent with Condition 23, and the revised model design and performance is consistent with guidelines and suitable as is for impact assessment purposes, with future model refinements dependent on monitoring to obtain data for validation.*

2.5 Environmental Values

2.5.1 Environmental Protection (Water) Policy 2009

The Environmental Protection (Water) Policy 2009 (EPP [Water]) applies to all waters within Queensland which include rivers, streams, wetlands, lakes, estuaries, coastal areas, and groundwater aquifers. Based on the intent of the Environmental Protection Act 1994 (EP Act), groundwater quality is an EV with intrinsic value that is to be protected, with the groundwater quality maintained within the range of natural quality variations established through baseline characterisation to ensure that no adverse effect on groundwater quality occurs from the operation of the activity. The EPP (Water) achieves the objectives of the EP Act with a framework that includes identification of environmental values (EVs) which define the uses of the water by aquatic ecosystems and for human use (e.g. drinking water, irrigation, aquaculture, and recreation). Water quality objectives (WQOs) define objectives for the physical, chemical, and biological characteristics of the water (e.g. dissolved oxygen, turbidity, toxicants, fish); WQOs are being progressively determined for areas of Queensland to enhance or protect the environmental values identified for waters (DES, 2018).

The CCP is located within the Belyando Catchment of the Burdekin River Basin, where draft EVs and WQOs have been established and are included in the Water Quality Improvement Plan 2016 (WQIP) for the Burdekin Dry Tropics Natural Resource Management (NRM) region (NQ Dry Tropics, 2016).

For aquatic EVs, ecosystems are typically subdivided into three levels of protection related to their current condition, which include High Ecological Value, Slightly to Moderately Disturbed and Highly Disturbed ecosystems.

The Belyando Catchment is further divided into seven sub-catchments; the CCP is located within the Carmichael River sub-catchment. EVs considered applicable to the CCP to be particularly enhanced or protected under the EPP (Water), indicated as draft EVs in the WQIP for the Carmichael River sub-catchment, include (both surface and groundwaters):

- Biological integrity of an aquatic ecosystem (including the Waxy Cabbage Palm tree communities)
- Primary industries (water for farm use [fruit packing or milking shed] and stock watering)
- Primary recreation (swimming)
- The cultural and spiritual values of the water
- Drinking water (groundwater).

2.5.2 *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)

The EPBC Act focuses on Australian Government interests on the protection of mattes of national environmental significance (MNES), separate from the states and territories which have responsibility for matters of state and local significance. The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places which define the MNES.

In 2013, the EPBC Act was amended to include a 'Water Trigger' to include water resources as a MNES, in relation to coal seam gas and large coal mining developments (DoEE, 2013). Such developments likely to have a significant impact on water resources are required to be referred under the EPBC Act.

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The EVs considered applicable to the CCP to be particularly enhanced or protected under the EPBC Act include:

- The Great Artesian Basin spring system close to Doongmabulla around eight kilometres west of the mine lease western boundary
- The (non-GAB) springs mapped adjacent to Mellaluka around 10 km south-southeast of the approved mining
- Groundwater dependent ecology along Carmichael River, as identified in the GDE Management Plan
- Existing extraction bores and registered bores within the mine-related drawdown extent predicted adjacent to the CCP
- Recharge zones of the Clematis Sandstone (a major aquifer within the GAB).

2.5.3 Burdekin, Don, and Haughton River Basins

The CCP is located within the Burdekin Basin. Draft environmental values and water quality objectives (WQOs) have been compiled in a draft report for consultation to include for groundwaters of the Burdekin, Don, and Haughton River Basins (State of Queensland, 2017). The mine site is, based on the draft report, located within "Earlier sedimentary basins underlying the GAB", which comprise Clematis Sandstone, Dunda Beds, Rewan Group, and Moolayember Formation. The Permian coal bearing units are not included and the Joe Joe Group is considered within a Palaeozoic sedimentary basin.

The Environmental Values of the Earlier sedimentary basins underlying the GAB include:

- Aquatic ecosystems (waterways and waterholes)
- Stock watering
- Visual recreation
- Drinking water supply
- Cultural, spiritual and ceremonial values.

Water Quality Objectives have been drafted for groundwater zones within the Burdekin Basin, based on available DNRME water quality databases. The CCP is recognised to be located within the following groundwater (chemistry) zones:

- Suttor Alluvium Zone
- Saline Tertiary sediments
- Central Galilee Clematis
- Western Galilee Clematis.

It is noted that these groundwater zones are based on chemistry and differ from the geological descriptions / zones (Earlier sedimentary basins underlying the GAB) used to assess Environmental Values. These zones, once finalised and updated with additional data (currently only represent mid-range levels), are used to identify outlying sites and sudden or rapid changes. The draft WQO are included in **Table 23**~~**Table 23Table 23**~~.

It is considered that Adani has a more robust and site-specific (greenfield data) hydrochemistry dataset, which can be used to inform the draft report. These data have been used (**Section 5.4**) to identify outlying data and allow for chemical trend analysis to identify sudden or rapid changes.

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Table 22 Draft water quality objectives for groundwaters of Burdekin, Don and Haughton River Basins

Zone [1, 2]	Percentile	Na		Ca		Mg		HCO_3		Cl		SO_4		NO_3		EC	Hard	pH	Alk	SiO_2	F	Fe	Mn	Zn	Cu	SAR	RAH	eH
		mgL-1	%	mgL-1	%	mgL-1	%	mgL-1	%	mgL-1	%	mgL-1	%	mgL-1	%	µScm-1	mgL-1		mgL-1	mgL-1	mgL-1	mgL-1	mgL-1	mgL-1	mgL-1	meqL-1	meqL-1	mV
3 - Suttor	Samples	68	68	68	68	67	67	65	64	67	67	65	64	57	56	154	68	71	65	49	68	24	20	10	9	67	65	0
	10th	102	63	6	2	3	4	26	0	44	17	11	2	0.0	0.0	639	28	6.8	25.0	17.0	0.0	0.0	0.0	0.0	0.0	4.7	-106.6	0.0
	20th	141	65	11	4	6	5	46	1	95	33	21	3	0.0	0.0	823	46	7.0	40.0	19.6	0.1	0.0	0.0	0.0	0.0	8.1	-50.3	0.0
	50th	800	72	44	12	71	16	134	7	1150	86	92	6	0.5	0.0	6500	436	7.5	125.0	34.0	0.4	0.0	0.1	0.1	0.0	14.6	-2.6	0.0
	80th	3156	90	437	17	410	19	399	55	6318	93	622	9	1.6	0.2	21140	2612	8.1	349.0	49.4	0.8	0.8	0.6	0.5	0.3	29.6	3.7	0.0
	90th	5203	94	824	19	845	21	554	72	10996	94	850	11	6.4	0.7	31000	5505	8.3	540.0	59.2	2.6	2.7	2.4	0.7	0.6	33.2	4.9	0.0
6 - Saline Tertiary Sediments	Samples	156	156	155	155	155	155	143	143	156	156	151	151	107	107	245	156	173	156	76	141	85	77	34	35	154	141	0
	10th	147	57	6	2	5	3	55	2	142	56	0	0	0.0	0.0	580	32	6.8	6.1	14.1	0.0	0.0	0.0	0.0	0.0	6.4	-38.2	0.0
	20th	253	65	11	3	10	6	130	4	321	64	7	1	0.0	0.0	1015	80	7.1	55.7	15.0	0.1	0.0	0.0	0.0	0.0	7.8	-24.4	0.0
	50th	685	78	54	7	68	14	285	10	975	85	51	4	0.4	0.0	3613	455	7.8	223.0	26.5	0.3	0.0	0.0	0.0	0.0	15.6	-2.4	0.0
	80th	1804	91	203	13	220	23	494	34	3667	92	191	7	2.4	0.1	12330	1456	8.2	405.0	56.0	0.6	0.2	0.1	0.0	0.0	28.4	2.4	0.0
	90th	2897	94	367	18	312	30	686	43	5556	94	528	9	5.0	0.5	16100	2066	8.3	553.8	77.5	0.9	0.5	0.3	0.1	0.0	33.9	5.8	0.0
1 - Central Galilee Coal Measures	Samples	51	51	51	51	50	50	49	49	50	50	51	50	42	41	75	51	54	48	23	43	25	18	7	5	50	48	0
	10th	58	45	4	3	3	2	39	2	73	31	6	2	0.0	0.0	400	27	6.5	35.3	9.8	0.1	0.0	0.0	0.0	0.0	2.3	-23.6	0.0
	20th	87	65	16	4	5	6	69	4	110	38	18	2	0.0	0.0	725	67	7.1	69.6	13.0	0.2	0.0	0.0	0.0	0.0	4.4	-10.4	0.0
	50th	293	76	38	10	30	11	205	19	327	69	90	7	0.0	0.0	1530	236	7.7	178.5	18.0	0.3	0.0	0.1	0.0	0.0	10.7	-1.0	0.0
	80th	1179	87	127	18	112	22	413	40	1938	86	255	16	3.0	0.4	4460	769	8.1	339.5	25.9	1.0	0.3	0.2	0.4	0.0	22.4	1.9	0.0
	90th	2060	90	166	28	180	26	687	58	3595	89	452	27	6.3	0.6	9030	1448	8.2	566.4	47.4	1.4	0.5	0.7	2.6	0.0	34.8	4.3	0.0
3 - Western	Samples	27	27	26	26	26	26	27	27	27	27	27	27	21	21	42	26	36	26	17	25	19	18	4	1	26	26	0
Galilee Clematis	10th	35	73	1	1	2	2	18	4	52	64	0	0	0.0	0.0	204	10	6.6	20.6	10.0	0.1	0.0	0.0	0.0		3.7	-14.7	0.0
	20th	52	78	1	1	3	2	31	9	58	68	1	0	0.2	0.0	283	14	7.0	30.0	10.9	0.1	0.0	0.0	0.0		4.6	-4.7	0.0
	50th	239	88	7	3	6	9	116	15	275	80	4	2	0.8	0.1	1244	44	7.5	98.5	15.0	0.3	0.1	0.0	0.0		14.8	0.2	0.0
	80th	630	95	55	8	36	16	157	28	1110	88	57	7	1.3	0.4	3752	395	7.9	131.6	22.4	1.2	0.5	0.0	0.1		20.2	1.3	0.0
	90th	979	97	147	14	137	17	219	33	1429	92	132	8	2.6	0.7	5301	870	8.1	183.5	46.0	2.4	0.8	0.3	0.2		21.9	2.3	0.0

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2.6 CCP Mine Activities

The proposed CCP mine comprises a greenfield coal mine over Mine Lease areas, ML 70441, ML 70505, and ML 70506, for both open cut and underground mine operations. The approved mine plan includes for six open cut pits and five multi-seam underground mines to produce up to 74 Mtpa of raw coal, which equates to approximately 60 Mtpa of thermal coal over the 60 year mine life.

The mine footprint is over 200 km^2 and includes mine infrastructure, associated mine processing facilities, and offsite infrastructure (a worker's accommodation village and associated facilities, a permanent airport site, a mine industrial area and water supply and storage infrastructure). The mine layout is presented in Error! Reference source not found. below.

The geological characteristics of the CCP mine define the location of open cut and underground mining operations. This in turn determines the optimal location of mine infrastructure and associated interdependencies which include site access, services, and other infrastructure required to access offsite infrastructure and third-party service providers. The layout of the infrastructure has subsequently been designed and located to minimise the likelihood of resource sterilisation.

The main infrastructure area is located east of the target coal subcrops. The out-of-pit dumps are located to minimise handling of material and to avoid the sterilisation of coal resources.

The approved mining and associated mine infrastructure was reviewed to allow for identification of mine infrastructure which may potentially impact on groundwater, these include:

- Mine areas
- Fuel supply and storage
- Mine water supply and management
- Mine waste management
- Waste disposal facilities.

Mine phasing for the first five years (initial development phase) has been prepared and the location of the Year 5 mine footprint is included on the operational groundwater monitoring bore network figures (**Appendix B**). The Year 5 mine footprint inclusive of box cut works, and associated mine infrastructure re depicted on the operational bore network maps in **Appendix B**.

The nature of activities to be undertaken within the first five years of operations include:

- Water truck filling stations
- Power reticulation
- Telecommunications
- Warehouse
- Light vehicle workshop
- Administration facilities and bathhouses
- Carparking for light, medium and delivery vehicles
- Fire Services
- Rail loop
- Airstrip
- Accommodation village
- Explosive storage
- Heavy Workshop areas including:
  - Repair bays
  - Tyre changing facility

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  - Washdown bays
  - Services areas
  - Fuel and lubrication storage and refuelling facilities
  - Battery and gas storage area
  - Crib rooms and offices
- Open cut operations
- Mine services and infrastructure
- Potable water treatment plant and storage
- Sewerage treatment plant and storage
- Raw water, mine affected water and sediment water storages
- Process water storage
- Water management infrastructure including levees and creek diversions, and
- Coal handling and processing plant.

From Year 5 onwards, mining will progress to other pits north and south of the initial development.

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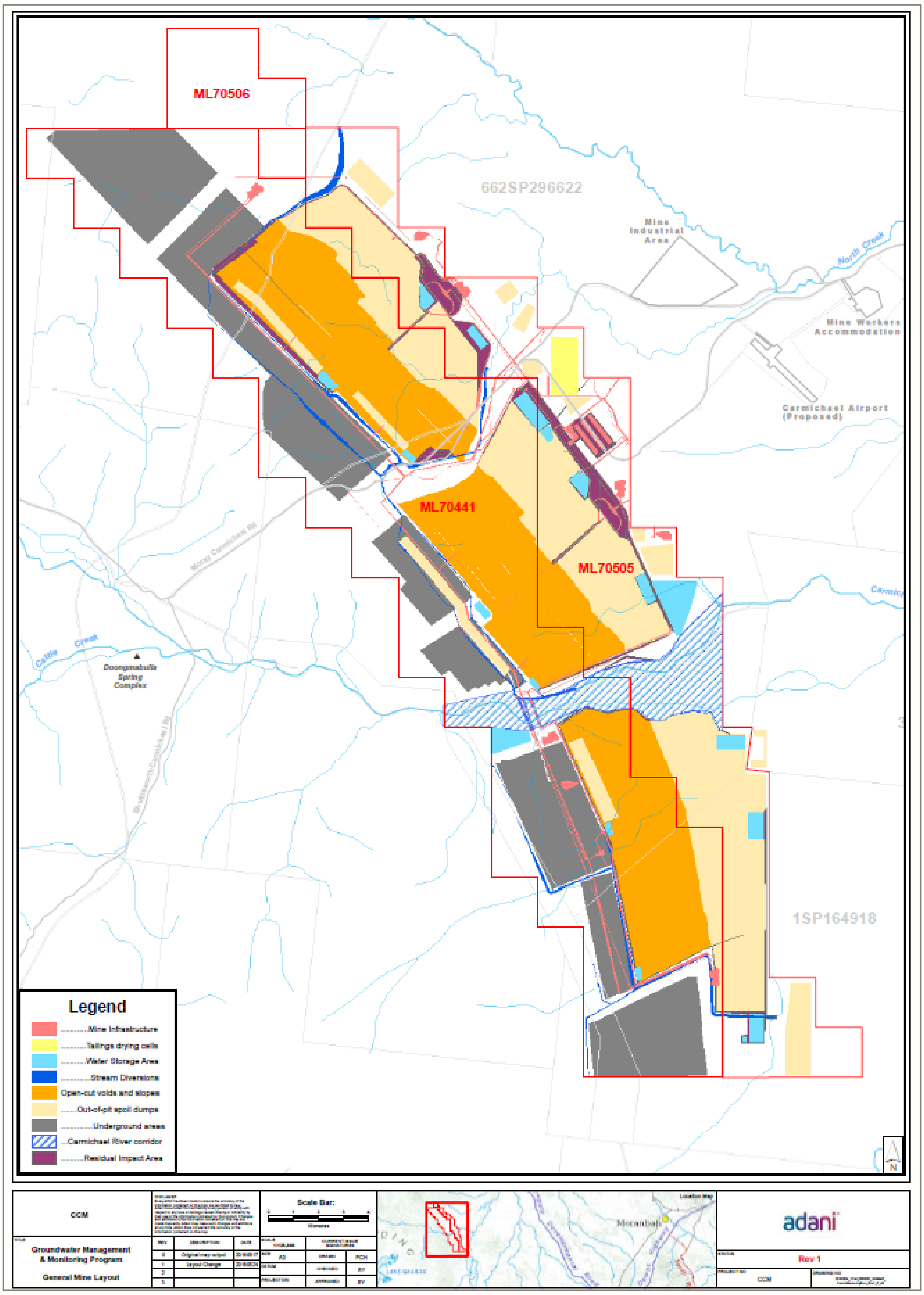

Figure 15 Proposed Mine Layout and Associated Infrastructure

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2.7 Potential Impacts on the Hydrogeological Regime

A summary of potential impacts of mining activities on the groundwater resources has been compiled and are based on the EIS and post-EIS groundwater studies, summarised below.

2.7.1 Construction

The principal activities during the construction phase of the mine, which may impact groundwater resources, are:

- Possible temporary dewatering of foundations for proposed infrastructure
- Degradation of groundwater quality due to spills and leaks of hazardous materials such as oil and diesel or mismanagement of wastewater.

Dewatering

Temporary dewatering is unlikely to be required for construction of foundations for infrastructure (including the village and airport) or for the construction of a general waste landfill, given that depth to groundwater is at least 20 m below ground surface away from the Carmichael River (i.e. near the Mine Infrastructure Area (MIA) where the majority of construction is proposed).

Temporary dewatering is also considered unlikely to be required for construction of minor creek crossings, given that the minor surface watercourses in the mine area are ephemeral and located in areas where groundwater is anticipated to be at least 20 m below ground surface.

Spills

Construction vehicles and equipment will use diesel and oil, which will be stored at the MIA and off-site infrastructure area. Other potentially environmentally hazardous materials include waste oils and sewage.

As the depth to groundwater in these areas is typically greater than 20 m below the clayey Tertiary sediments encountered across the site, the nature of these clays is considered to provide significant attenuation of any contaminants from leaks and spills before they reach the groundwater table.

2.7.2 Operations

The principal activities during the operational phase of the mine, which may impact groundwater resources, include:

- Dewatering of open cut pits and underground mine workings
- Spoil and tailings disposal to pits, out-of-pit spoil dumps, and/or tailings cells
- Mine affected water (MAW) storage dams
- Operation of processing and storage facilities and plant
- The diversion of minor ephemeral creeks along the western boundary of the mine lease area
- Longwall mining of the underground workings.

Mine Dewatering

Dewatering will be required to lower groundwater levels to the base of the proposed workings for safe and efficient operation of the open cut and the underground mines. As a result, groundwater levels will be drawn down during the operational phase.

The sandstone unit directly below the D coal seam and above the E coal seam (D-E sandstone), the overlying sandstone (AB-D sandstone interburden layers), and the AB and D coal seams will require to be locally dewatered for safe mining to occur.

Dewatering has the potential to reduce groundwater levels in existing groundwater bores that fall within the cone of influence of the proposed mine and hence has the potential to impact on existing groundwater supplies.

Predictive groundwater modelling was conducted as presented in the SEIS (GHD, 2013a) and reassessed, considering different model boundaries, in the Carmichael Coal Project Response to

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Federal Approval Conditions- Groundwater Flow Model report (GHD, 2015). This predictive modelling, using conservative geological model layers (such as the Colinlea Sandstone extending to the east) and a conservative hydraulic conductivity of 10^{-5} m/day for the Rewan Formation (which can be as low as 10^{-7} m/day), is used to allow for the evaluation of potential impacts on groundwater levels.

Error! Reference source not found. is the model output figure of maximum predicted groundwater drawdown (using the SEIS model), which indicates the predicted extent of drawdown (the 0.2 m below initial groundwater level). These drawdown predictions were used to evaluate possible impacts on groundwater resources and associated environmental values, as detailed below. The SEIS model-predicted drawdown for each unit except Rewan and Dunda Beds , at various times throughout the life of mine, have been included in Appendix C and are part of the SEIS assessments included in the report *Appendix K6 Mine Hydrogeology Report Addendum*.

The dewatering impacts, outside the mine lease, have been considered (**Appendix E**~~Appendix E~~~~Appendix E~~ hydrographs and **Section 5.0**). The GMMP includes for the validation and assessment of model predictions based on mine dewatering over time. The use of sentinel bores and groundwater level thresholds (in bores between the mine and sensitive groundwater reliant systems), on the mine lease boundaries, allows for assessment of dewatering and the instigation of investigations (into potential for environmental harm and/or make-good).

2.7.3 Indirect Impacts

No direct impacts on groundwater resources associated with the GAB Clematis Sandstone aquifer will occur because of approved mining. Longwall mining will, as a result of goaf, result in alteration of the overlying (above the target coal seams) Rewan Formation, the basal GAB aquitard.

Groundwater modelling results suggest the potential for indirect dewatering impacts via induced flow. Induced flow can occur due to the dewatering and depressurisation of the target coal seams, such that:

- Drawdown in the near-surface Tertiary sediments and Quaternary-age alluvium which are present throughout much of the modelled area can occur
- Induced flow from the overlying GAB Clematis Sandstone aquifer through the Rewan Group (Dunda Beds and Rewan Formation) to the depressurised target coal seams.

It is noted that the greatest potential for induced flow is where the coal is most dewatered / depressurised and induced flow would be vertically from over and underlying hydrostratigraphic units (extent dependent on vertical permeability, thickness of aquitards, and proximity to the target coal). The effects of depressurisation down dip of the mined coal will reduce exponentially such that the change in head (some 8 km from the mine lease) would be limited below the DSC. This possible depressurisation (if measurable) would have limited potential for induced flow (particularly through the Rewan Formation (the regional aquitard) and Bandanna Formation). As the coal seams are some 600 m below the DSC there is little or no potential for induced flow as indicated in the predictive modelling.

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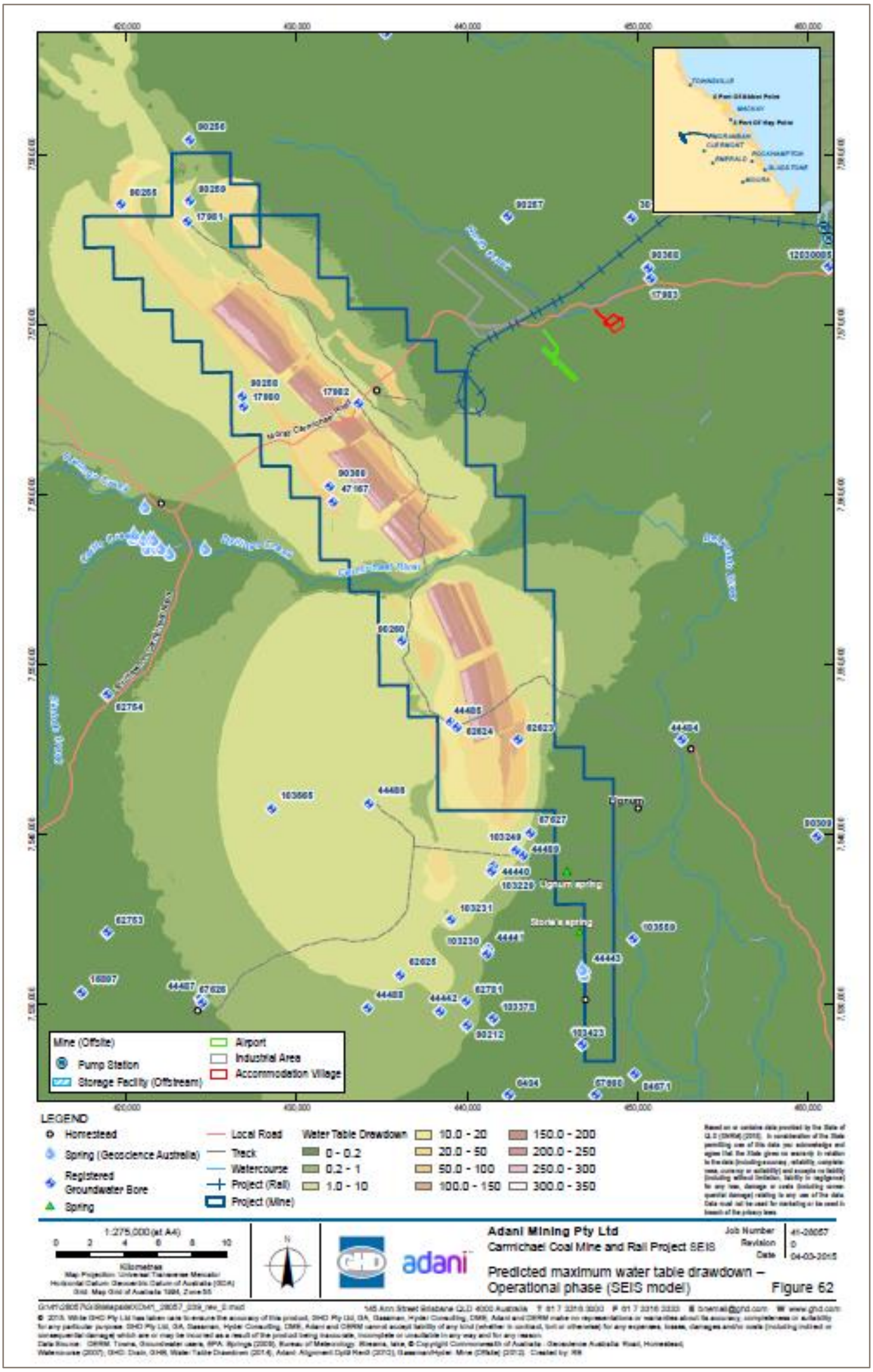

Figure 16 Predicted maximum water table drawdown (SEIS model, GHD, 2015)

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2.7.3.1 Cross-section along strike

The potential for induced flow from the GAB units is based on the change in head (increase in vertical gradient) between the depressurised target coal seams and the overlying hydrostratigraphic units as well as the hydraulic conductivity of the hydrostratigraphic units.

The dewatering and coal depressurisation will be greatest at the mine workings (dewatering required to allow for safe mining conditions) decreasing exponentially down dip away from the mine workings (Plate 11~~Plate 11Plate 11~~)

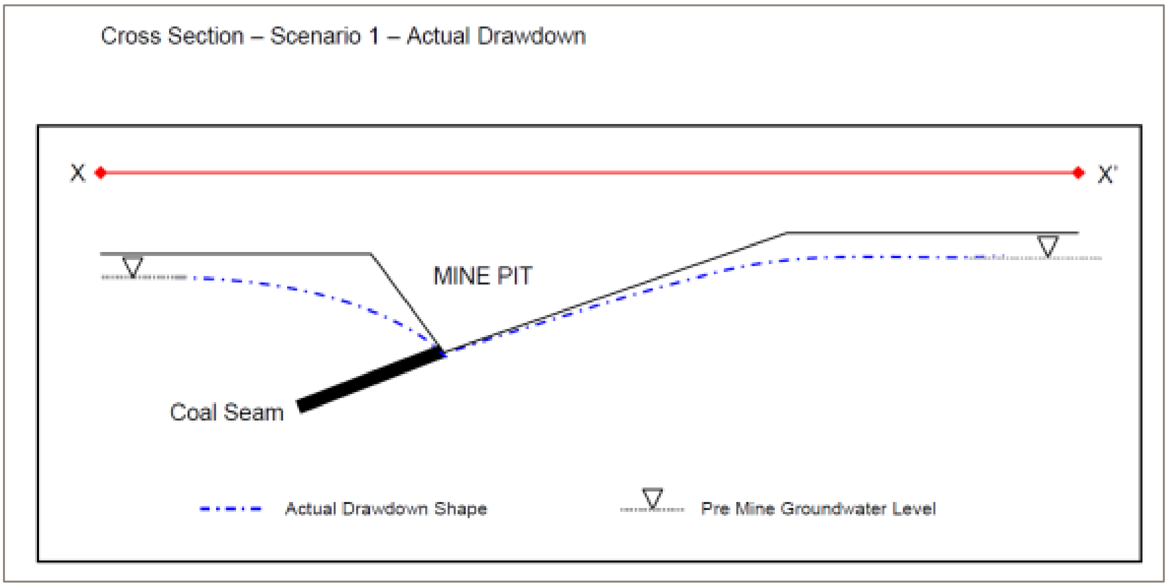

Plate 13 Mine dewatering drawdown curves

The zone of influence due to mine dewatering is the distance to negligible drawdown, as recognised in the Thiem-Dupuit stead-state equation (equation 1), such that the influence of dewatering (the depressurisation of the coal seams) reduces to zero with distance.

Equation 1

$$Q = \frac{\pi k (h_o^2 - h_w^2)}{\ln(R / r_e)}$$

Where:

Q = inflow (m^3/day),

k = hydraulic conductivity (m/day)

h_o = head at distance R from centre of pit (m),

h_w = head at distance re (m) at pit face (seepage face)

R = radius of “influence” or distance to negligible drawdown (m)

r_e = radius of “well” (m)

(Kruseman & de Ridder 1991[6])

A cross-section (Figure 17~~Figure 17Figure 17~~) has been compiled along geological strike along the western boundary of the mine lease. This cross-section allows for the illustration of the underlying geology, initial pre-mining groundwater levels (heads) and the predicted groundwater levels (post-mining heads), which indicates the predicted influence of direct mine dewatering on the coal seams and Rewan Formation as well as the predicted induced flow from the Dunda Beds and Clematis Sandstone above the Rewan Formation aquitard.

[6] Kruseman G.P. and N.A. de Ridder. 1991. Analysis and Evaluation of Pumping Test Data. 2nd Edition. International Institute For Land Reclamation and Improvement. Wageningen. The Netherlands.

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NOTE: The pre- and post-mining groundwater levels, derived from the hydrographs and predicted drawdown contours over time (Appendix E~~Appendix E~~~~Appendix E~~), have been included on the strike cross-section, as requested by the regulators. These groundwater levels are included in Appendix C~~Appendix C~~~~Appendix C~~.

The following conclusions have been compiled based on the predicted groundwater levels, along the western boundary of the MLs:

- Induced flow from the alluvium will result in centimetre alteration in the alluvium monitoring bores, on the cross-section bore C027P1 is predicted to vary from 223.84 mAHD to 223.82 mAHD (0.02 m) post closure
- The potentiometric levels across the Tertiary Sediments , where groundwater flow is from south to north pre-mining, indicate little or no change to groundwater flow patterns (south to north) at the end of mining
- Unsaturated Clematis Sandstone is only mapped in the northwest corner of the MLs so not included on the cross-section. Appendix C~~Appendix C~~~~Appendix C~~ drawdown contours over time indicate minor (< 0.2 m) drawdown predictions at the end of mining across the DSC area
- Groundwater flow in the Dunda Beds remains towards the synform, around C027P2 throughout the life of mine
- Rewan Formation groundwater flow patterns are towards C008P1, at the synform, before and at the end of mining
- Groundwater flow patterns, towards the synform at C008P2 and C007P2, remains over the life of mine within the target AB seam
- Groundwater flow patterns, towards the synform at C007P3 and C006P3R, remains over the life of mine within the target D seam
- Groundwater flow in the Joe Joe Group is always towards the synform at bores C14004SP and C14003SP
- Transient mining across a large (~ 45 km strike) over a long period results in groundwater level fluctuation (dewatering, depressurisation, and rebound) resulting in the difference in groundwater levels within the same hydrostratigraphic units during mining and post-mining
- Marked drawdown as a result of direct mine dewatering does not result in marked changes in groundwater levels in overlying hydrostratigraphic units (via induced flow) due to the aquitard (poor groundwater potential) of the sediments within the CCP.

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Figure 17 Cross-section along strike

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2.7.4 Spring Impacts

The spring water balance (Error! Reference source not found.) requires alteration to impact on springs. Based on the location of the mine operations, away from the identified springs adjacent to CCP, no alteration of surface water flow, precipitation, or evapotranspiration will occur because of the mining activities. The only possible alteration is the reduction in groundwater flux.

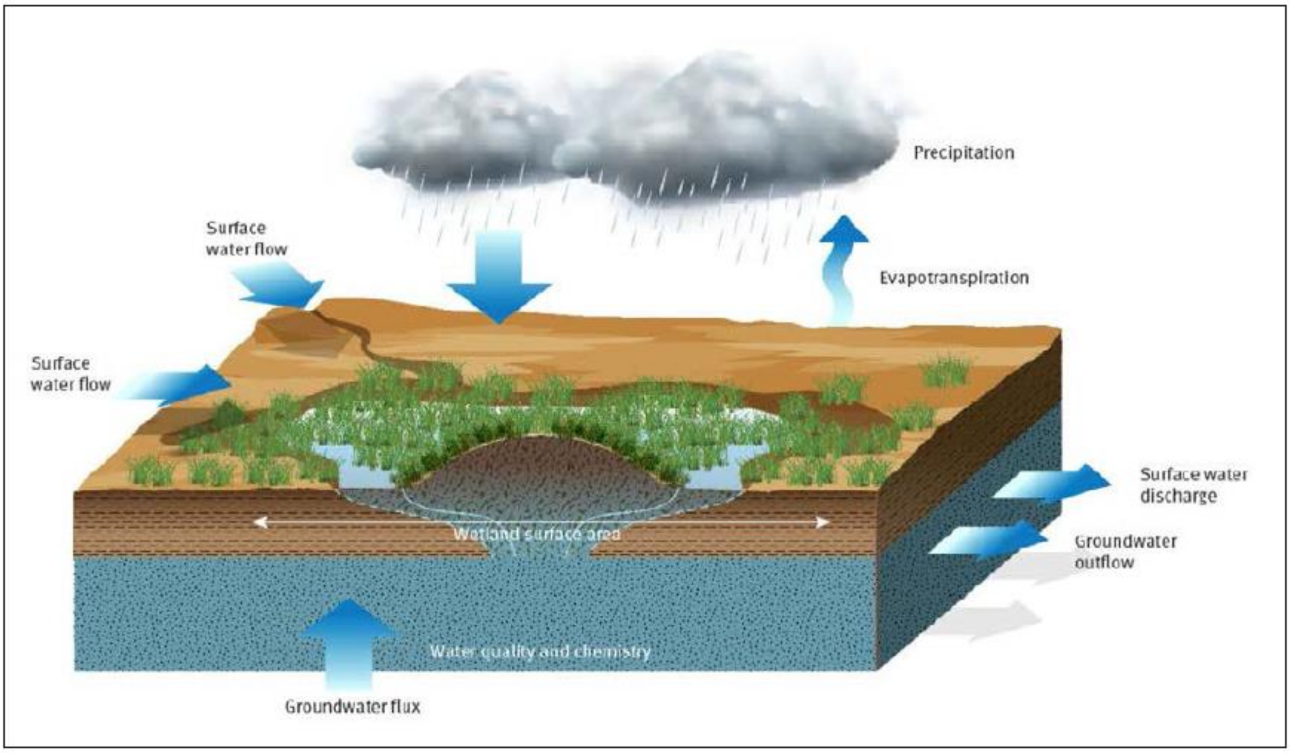

Figure 18 Spring Water Balance (Source: DNRM Springs of the Surat CMA, 2016)

2.7.4.1 Doongmabulla Springs Complex

In the EIS, the source aquifer for the Doongmabulla Spring Complex was identified as the Clematis Sandstone. Post-EIS drilling and groundwater monitoring indicates that recharge to the Clematis Sandstone discharges through the overlying Moolayember Formation (confining layer) to form the required artesian head for the spring to discharge, only where the Moolayember Formation is sufficiently thick to cause artesian conditions but thin/permeable enough to facilitate discharge as springs.

The SEIS predictive model (Error! Reference source not found.) indicate limited predicted drawdown impacts on groundwater levels within the Clematis Sandstone to the west of the mine site in the area containing the Doongmabulla Springs Complex (GHD, 2015).

Model predictions compiled during the SEIS and EPBC Act approval condition modelling (GHD, 2015) indicates:

- Drawdown of 0.2 m extending to Doongmabulla homestead (Predicted maximum water table drawdown – Operation phase SEIS model)
- Drawdown of 0.2 m does not extend to Doongmabulla homestead (Predicted maximum water table drawdown – Operation phase Option 2 (250 m) re-run model)
- Drawdown of 0.2 m does not extend to Doongmabulla homestead (Predicted maximum water table drawdown – Operation phase Option 1 (275 m) re-run model).

The largest predicted drawdown within the Doongmabulla Springs Complex area is at Joshua Spring, where the maximum predicted drawdown includes:

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- SEIS model drawdown of 0.19 m in mine year 95
- Option 1 (275 m) model drawdown of 0.11 m in mine year 85
- Option 2 (250 m) model drawdown of 0.13 m in mine year 91.

Groundwater monitoring between the Doongmabulla Spring Complex and the mine operations, will allow for the validation of the predictions and the reassessment of the potential for induced flow (from the GAB units to the depressurised coal seams).

2.7.4.2 Mellaluka Springs Complex

Predictive groundwater modelling conducted for the Mellaluka Springs Complex is based on a conservative conceptualisation by GHD, due to limited understanding / drilling in the area around the Mellaluka Springs Complex. The predictive groundwater model, constructed and calibrated for the SEIS and approval re-runs, considers the Colinlea Sandstone extends to the east; that is, no Early Permian Joe Joe Group contact or sediments are included in the model. Thus, the predictive modelling considers the springs to be sourced from sub-D coal seam Colinlea Sandstone sediments.

Drilling and aquifer assessments post model construction have, as included in **Section 2.2.6** above, resulted in a more detailed conceptualisation, which will be included in future model refinement.

Approval of mining operations was provided based on a possible worst-case scenario, where these springs are sourced from Colinlea Sandstone, directly impacted by mining operations. Model predictions[7] of groundwater level drawdown include:

- 8.2 m at Lignum Spring
- 2.3 m at Stories' Spring
- 1.1 m at Mellaluka Spring.

2.7.5 River Impacts

Mine dewatering is predicted to result in drawdown of the coal seam potentiometric surface, extending beneath the Carmichael River. Given that groundwater discharge to the Carmichael River upstream of the site maintains flow in the river during dry periods (discharge from Joshua Spring); surface water flows in the river may decline because of possible induced flow from the surface water to the groundwater, in response to the reduction in groundwater levels along the river.

Groundwater modelling results suggest that groundwater discharges to the Carmichael River upstream of the mine site, could be reduced by up to 200 m^3/day or 5 per cent of pre-development discharge during the operational phase.

This assessment, considering additional drilling, assessment of vertical groundwater gradients (particularly the nature of flow above and below the Rewan Formation) (**Section 2.2.5**), and the collection of mine dewatering data, will be updated and refined based on information compiled using the GMMP.

No groundwater drawdown, and thus potential from induced flow impacts, is predicted under the North Creek, as shown in Error! Reference source not found.. The existing groundwater monitoring bore network and program, during operations, allows for the validation of model predictions within the Tertiary sediments, alluvium, and Joe Joe Group to the east of the mine lease.

2.7.6 Riparian Impacts

Direct groundwater discharge to the Quaternary aged alluvium underlying the river and discharge from the Joshua Spring is conceptualised to provide water to the stands of the mature River Red Gum, Paper Bark and Waxy Cabbage Palm tree communities along the river, particularly during dry periods.

Any marked reduction in groundwater levels and/or surface water flows in the Carmichael River during dry periods have the potential to impact the ecological health of these communities.

It is considered this GMMP will provide data for input into the GDE Management Plan to aid with assessment of the project on GDEs.

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[7] All modelling provide the same predictions as no refinement of the model in this area has been done

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2.7.7 Other impacts

The construction and operation of the mine also require establishment of associated infrastructure such as tailings dams, water storage facilities, and mine-affected water (MAW) storage areas. As described in Section 2.5 the groundwater quality is an intrinsic environmental value, which highlights the need to identify those EVs specific to each environment in order to provide the appropriate levels of protection. Therefore adequate groundwater monitoring points have to be identified for baseline characterisation so as to maintain the groundwater quality within the range of natural quality variations and that no adverse effect on groundwater quality occurs from the operation of the above mentioned facilities. The proposed monitoring arrangements to track the likelihood of groundwater contamination are described in **Section 6**. Below is the summary of potential impacts due to these facilities.

2.7.7.1 Tailings

Mining activities generate waste during processing and washing of coal. This waste (tailings) will be stored temporarily in tailings drying cells before disposal. There is a potential for the seepage from the drying cells into the ground and could impact shallow groundwater resources.

Mine waste will be managed through a combination of in-pit disposal (overburden, interburden, coarse reject, tailings, and slimes) and out-of-pit disposal (overburden, interburden, and coarse reject).

The seepage from these out-of-pit or in-pit waste disposal facilities can potentially impact on shallow groundwater resources.

2.7.7.2 Waste Storage Facilities

If disposal of tailings and spoil are not managed effectively at the operational stage there is potential for these wastes to be sources of long term contamination of groundwater post closure of the mine, both within and down gradient of the mine lease.

Similarly if other waste generated from equipment maintenance, such as used oils, tyres and metallurgical waste, has the potential to contaminate shallow groundwater resources in the vicinity of these storage facilities.

2.7.7.3 MAW Storage Facilities

Water pumped out from the pits and underground dewatering operations will be treated as mine affected water. Mine affected water will be stored in (MAW) dams exclusively constructed for the purpose to re-use and recycling. Where the re-use will be used to meet mine dust suppression and process water requirements.

There is potential for seepage of mine affected water to seep and contaminate the shallow groundwater resources.

3.0 Groundwater Monitoring Bore Network

The long-term objective of the groundwater monitoring bore network is to monitor potential effects of the approved mining operations on the groundwater resources within the CCP area, as recognised in **Section 2.0**, such that informed and adaptive management decisions can be made.

The baseline groundwater monitoring bore network considers the hydrogeological regimes and groundwater resources, to collect representative ambient (pre-mining) data. The existing groundwater monitoring bore network provides lateral and vertical coverage such that potentially impacted groundwater resources can be assessed during mining (operational monitoring bore network).

The monitoring network also includes bores located strategically to allow for early warning of potential impacts on groundwater resources, where groundwater level decline differs from predicted drawdown, so that timely intervention can be implemented to ensure water security to landholders and reduce potential environmental harm.

In the instance groundwater monitoring in a bore indicates an alteration in water quality (using triggers), sample validation (re-sampling) and sampling of additional monitoring bores in other hydrostratigraphic units located in the vicinity of the bore will be undertaken. This will allow for an assessment of possible causes of the water quality changes and the extent of change. This is done as groundwater quality can alter due to blending, which can happen when induced flow from over- and under-lying hydrostratigraphic unit occurs.

3.1 Baseline Monitoring Bores

The baseline (pre-mining) groundwater monitoring bore network was designed to collect representative ambient (background) groundwater level and quality data from all hydrostratigraphic units within the CCP area prior to commencement of mining activities. Locations of each bore within baseline groundwater monitoring network were identified after consideration of the following:

- Exploration boreholes that allowed access to all potentially impacted units within the CCP area
- GAB units outside of the CCP tenure
- Discussions with DES (formerly DEHP)
- Predicted groundwater impacts from the EIS, SEIS, and AEIS
- Identified environmentally sensitive areas (spring complexes and the Carmichael River corridor)
- Existing landholder bores (groundwater extraction).

A summary of the baseline groundwater monitoring network is presented, per monitoring unit, in Table 23~~Table 23~~Table 23 below. Figure 19~~Figure 19~~Figure 19 below presents the comprehensive baseline groundwater monitoring bore network while Appendix B~~Appendix B~~Appendix B provides locality figures depicting all baseline bore locations with respect to the MLs for each of the hydrostratigraphic units.

3.1.1 Initial Monitoring Network

Groundwater monitoring commenced in late 2011 as a component of the EIS process for the collection of representative groundwater monitoring data from all potentially affected hydrostratigraphic units within and adjacent to the CCP mine leases. As there are currently no coal mining activities on or adjacent to the CCP, many of the monitoring locations are located within the CCP tenements and were exploration-phase bores converted to groundwater monitoring bores fit for purpose.

Hydrochemistry and water levels were collected from the initial monitoring network to characterise the groundwater regime below the CCP area. While not performed on a regular basis, a total of five monitoring events were completed during the EIS, SEIS, AEIS programs, as follows:

- September 2011
- October / November 2011

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- May / June 2012
- September / October 2012
- May / June 2013.

The initial monitoring network consisted of thirty-seven (37) locations which were assessed during this period and included bores from the following hydrostratigraphic units:

- Alluvium
- Tertiary Sediments
- Dunda Beds
- Rewan Formation
- AB Seam (Bandanna Formation)
- Bandanna Formation inter- and over-burden
- D Seam (Colinlea Sandstone)
- Colinlea Sandstone inter- and over-burden
- Joe Joe Group.

In addition, composite monitoring points have been included to aid with groundwater resource assessments, groundwater conceptualisations, and predictive groundwater modelling.

These bores were surveyed upon verification of suitability (screened interval, geology) to ensure accurate groundwater level data was procured. The Wilson Survey Group completed the survey of the initial monitoring network and reported the following data for each location:

- Easting / Northing (GDA94 – Zone 55)
- Ground level elevation (mAHD)
- Top of casing (Reference Level [RL]) elevation (mAHD).

The monitoring event in May/ June 2012 also included collection of field physio-chemical measurements from the Doongmabulla Springs Complex, Cattle Creek, and Dyllingo Creek. Six locations within the Mellaluka Springs Complex were sampled and analysed in April 2013 for cations/anions, metals and alkalinity. These data are the initial data for characterisation of water quality from the spring complexes within the CCP area.

At this time, a formal program of analytes was not established which resulted in groundwater quality data gaps with inconsistent monitoring across the events.

3.1.2 Baseline Monitoring Program

Between 2013 and 2014, the groundwater monitoring network was expanded to include 68 monitoring locations and a formal baseline groundwater monitoring program was developed to address EA Condition E3 (Appendix A~~Appendix A~~~~Appendix A~~).

In order to satisfy EA Condition E3 (Appendix A~~Appendix A~~~~Appendix A~~), Adani developed and undertook a regular (~every two months) groundwater monitoring program where events were conducted, and data collected, in:

- April, May, July, September, and November 2014
- February, March, May, July, September, and November 2015
- February, April, July, and November 2016
- April 2017.

The groundwater monitoring network was again expanded in 2014 and 2015 to allow for groundwater quality and level data from gaps identified.

The additional bores installed during this timeframe were surveyed upon completion. The Gassman Development Perspectives survey company completed the survey of the expanded network and reported the following data for each location:

- Easting / Northing (GDA94 – Zone 55)
- Ground level elevation (mAHD)
- Top of casing (RL elevation as mAHD).

The groundwater monitoring data collected from September 2011 through April 2017 was utilised to establish background groundwater quality, to identify natural groundwater level trends, and draft groundwater contaminant trigger levels and groundwater thresholds for the groundwater resources.

The baseline groundwater level and chemistry data are included in the following appendices:

- Appendix C~~Appendix C~~~~Appendix C~~ - Groundwater level contour figures
- Appendix D~~Appendix D~~~~Appendix D~~ - Groundwater quality
- Appendix E~~Appendix E~~~~Appendix E~~ - Water level information (hydrographs generated from automated data loggers and manual readings, and vibrating wire piezometers [VWPs]) and groundwater level threshold hydrographs.

For the purposes of developing reference groundwater data for the project, all the available data from September 2011 through April 2017 has been compiled to form the 'final' baseline monitoring dataset.

3.1.3 Summary of Bore Network and Groundwater Data included in GMMP

For clarity regarding the data points (monitoring bores), groundwater assessments, and data assessed for the compilation of the GMMP, the following sequence of events is presented (as requested by the Commonwealth regulators):

- All bores with the prefix C0 (such as C025P1 in Table 23~~Table 23~~~~Table 23~~) are exploration bores which were converted to groundwater monitoring bores during the compilation of the EIS and SEIS (circa 2011)
- The bores with the prefix HD were installed as groundwater monitoring bores during the compilation of the EIS and SEIS (circa 2011)
- The bores starting with C180, were installed as groundwater monitoring bores during the compilation of the EIS and SEIS (2011-2013)
- The bores C971SP (C896G), C972SP (C897G), C974SP (C899G), and C975SP (C900G) were geotechnical bores which were converted to groundwater monitoring bores within the box cut area in 2013
- The bores starting with C140 were drilled during 2014 for the collection and assessment of geology and groundwater data to the east (additional assessment of the Mellaluka Springs and Tertiary sediments) and west (Rewan Formation and Clematis Sandstone)
- Bores C18001SP to C18003SP were installed in 2018 as monitoring bores immediately adjacent to the DSC
- Bores C18001 to C18009 are shallow seepage monitoring bores adjacent to the mine water and waste storage facilities.

Note bores starting with C9 are redrills, i.e. C9180124SPR is a redrill of C180124SP, where the original bores could not readily be converted to groundwater monitoring bores.

The groundwater bores installed for the EIS and SEIS, associated aquifer testing, and groundwater level datasets, were used to undertake the predictive groundwater modelling. These model predictions were used to inform this GMMP.

Post EIS and SEIS drilling and bore construction, undertaken to assess groundwater resources and augment the groundwater monitoring network, were used (with the EIS and SEIS bore data) to describe the baseline groundwater conditions, develop groundwater quality triggers and groundwater drawdown thresholds.

Drilling from 2013 onwards, was used to assess and update groundwater conceptualisations at the Doongmabulla and Mellaluka spring complexes. Alternative conceptualisations were also considered

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using the entire geological and groundwater datasets. All available groundwater monitoring bores were considered when developing the baseline, construction, operational, control, and sentinel bore networks.

~~Prepared for – Adani Mining Pty Ltd – ABN: 27 145 455 205~~

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Figure 19 Baseline groundwater monitoring bore network

~~Prepared for – Adani Mining Pty Ltd – ABN: 27 145 455 205~~

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Table 23 Baseline Groundwater Monitoring Bore Network

Bore ID	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)	Screened Interval (mbgl)	Total Depth	Geology / Comment	Purpose
Quaternary aged Alluvium						
C025P1	438015.54	7555845.80	7 to 11	11.00	Sandy clay	Assess Carmichael River and GDEs Control bore
C027P1	433643.08	7554818.39	6 to 12	13.00	Mostly clay	Assess Carmichael River and GDEs
C029P1	437691.19	7555082.39	8 to 13	13.40	Fine and medium grained sand	Assess Carmichael River and GDEs Control bore
HD03B	427559.00	7556120.00	6 to 11	11.37	Pale grey clay	Assess perennially saturated alluvium Control bore
C14027SP	444964.65	7558330.02	9 to 21	21.00	Gravelly sand and clay	Assess alluvium downstream of MLs Control bore
C14028SP	443775.64	7559581.18	12 to 18	20.00	Clayey sand, very salty water	Assess alluvium downstream of MLs Control bore
Tertiary Sediments						
C025P2	438010.34	7555844.69	31 to 41	41.00	Clay	Assess induced flow within MLs, possible impacts on river and GDEs
C029P2	437687.63	7555080.91	37.8 to 41	46.00	Ferricrete and sand	Assess induced flow within MLs, possible impacts on river and GDEs
C558P1	430311.55	7566903.06	29 to 41.4	41.40	Tertiary sediments to 42.96 m	Baseline description of Tertiary sediments within planned open cut
C9180121SPR	448085.12	7529363.93	36 to 45	45.00	Tertiary sediments to 52 m	Baseline description of Tertiary sediments south of mine
C9845SPR	439410.87	7544903.28	36 to 45	45.00	Tertiary sediments to 58 m	Baseline description of Tertiary sediments within planned open cut Sentinel bore for long term monitoring on southwestern portion of MLs

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Bore ID	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)	Screened Interval (mbgl)	Total Depth	Geology / Comment	Purpose
C971SP (C896G)[8]	426590.06	7572994.56	14 to 20	86.97	Tertiary sediments to 34 m	Groundwater ingress assessment bore for box cut
Triassic Age Units (GAB Units)						
Moolayember Formation						
C14020SP	418230.28	7566782.35	105 to 117	136.00	Moolayember Formation to 140 m	Control bore at DSC Sentinel bore
C18003SP	420944.04	7558963.70	12 to 18	20.00	Moolayember Formation subcrop	Control bore at DSC
Clematis Sandstone						
HD02	423822.04	7557008.25	26 to 32	32.00	Sand, micaceous conglomerate	Control bore at DSC
HD03A	427562.00	7556132.00	29 to 37	37.00	Sand, artesian	Control bore at DSC
C180118SP	423796.76	7568090.93	117 to 123	126.00		Assess recharge in Clematis Sandstone subcrop outside western MLs boundary
C14021SP	429796.76	7550966.33	33 to 39	46.00	Coarse sandstone 32 – 39m	Assess Clematis Sandstone outside western MLs boundary
C14033SP	418210.22	7566775.83	188 to 200	200.00		Control bore at DSC
C14011SP	426130.96	7561454.81	90 to 96	144.00		Clematis Sandstone bores between MLs and DSC
C14012SP	424896.07	7560596.18	156 to 168	168.00	Sampled below base of weathering	
C14013SP	424895.49	7560591.10	57 to 69	72.00		
C18001SP	416311.5	7553052	176 – 188	197.00	Artesian bore	Control bore at DSC
C18002SP	420948	7558952	82 – 94	215.00	Backfilled to 100 m	Control bore at DSC

[8] Bore at box cut is dry and not used as a monitoring bore

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Bore ID	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)	Screened Interval (mbgl)	Total Depth	Geology / Comment	Purpose
Dunda Beds						
HD01[9]	426146.04	7561467.86	48 to 59	59.00	Silty clay	Drilled dry – geology only
C022P1	426812.52	7565961.84	61 to 67	67.00	Med to fine sandstone	Dunda Beds subcrop on western MLs boundary
C027P2	433648.21	7554818.54	28 to 32	32.80	Fine sandstone	Assessment of Dunda Beds below Tertiary sediments on river
C14023SP	429801.74	7550968.73	124 to 130	165.60	Dunda Beds / Rewan Fm gradational contact	Control bore, assess possible induced flow through Rewan Formation
C180117SP	435915.16	7547522.16	73 to 79	81.00	Dunda Beds to 79 m	Assessment of Dunda Beds on western MLs boundary, verify induced flow through Rewan Formation Sentinel bore
Rewan Formation						
C008P1	433712.50	7558833.75	47 to 57.50	57.50	Rewan Formation to 253 m	Groundwater quality assessment bore
C035P1	441403.59	7546823.81	52 to 62	62.00	Base at 91 m	Assess Rewan Formation within open pit area south of Carmichael River
C555P1	432461.38	7557892.99	65 to 75	75.00	Rewan Formation from 37 to 336 m	Monitoring bores in upper Rewan Formation at edge of mining, to assess possible induced flow through thick Rewan Formation above target coal
C556P1	436524.08	7549881.55	70 to 82	83.30	Rewan Formation from 47 to 348 m	
C9553P1R	421010.11	7573974.87	54 to 66	66.00	Clayey sand	
C180116SP	439392.91	7540908.81	40 to 51	71.00	Tertiary sediments to 39.71 m	Sentinel bore south of MLs
C9838SPR	439557.91	7552811.73	85 to 96	98.00	Base of Rewan Formation	Assess Rewan Formation within open pit area south of Carmichael River

[9] HD01 was drilled dry and not used as a monitoring point

DRAFT

Bore ID	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)	Screened Interval (mbgl)	Total Depth	Geology / Comment	Purpose
C056VWP3	424923.62	7569971.65	240	486.07		VWPs to aid with assessing vertical groundwater gradients and modelling
C9553VWP3	420992.73	7573965.33	265.4	485.00		
C555VWP2	432461.38	7557892.99	260.5	473.78		
C555VWP3	432461.38	7557892.99	166	473.78		
C9556VWP3	436542.64	7549884.87	216	444.00	Rewan Formation base 261.2	
C842VWP3	439505.09	7550840.30	130	247.65	Rewan Formation base 160.88m	
C851VWP3	441384.00	7542877.33	103.7	261.00	Rewan Formation base 136.06m	
C9836VWP3	437562.93	7552868.05	130	299.39	Rewan Formation base 216.66m	
C966VWP_P3	423982.89	7571921.15	260	286.00	Rewan Formation base 264.80m	
C966VWP_P4	423982.89	7571921.15	240	286.00	Rewan Formation base 264.80m	
C14200VWP_2	440547.49	7533418.60	199	249.00	Rewan Formation base 219m	
C14200VWP_3	440547.49	7533418.60	101	249.00	Rewan Formation base 219m	
C14203VWP_2	437658.90	7553984.34	77	273.00	Rewan Formation base 181m	
C14206VWP_2	429783.15	7550956.80	355	477.46	Rewan Formation base 458m	
C14207VWP_2	423806.63	7568105.26	400	525.36	Rewan Formation base 498m	
Permian Age Units						
Bandanna Formation						
B-C Sandstone						
C006P1	435726.23	7560833.15	36 to 42	47.30	Interburden above C seam	Assessment of interburden between B and C coal seams in Bandanna Formation, aided in model construction
C018P1	423981.83	7574849.86	44 to 52	53.00	Weathered Permian between the AB and C seams	

DRAFT

Bore ID	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)	Screened Interval (mbgl)	Total Depth	Geology / Comment	Purpose
C847SP	442354.86	7543817.19	78 to 87	87.00	Weathered Permian interburden between AB and C seams	
AB Seam						
C007P2	434728.01	7559861.98	163 to 173	179.50	AB1 and AB2 seams	Assessment of baseline data for target coal seams
C008P2	433710.27	7558830.28	260 to 271.50	271.38	AB1, AB2 and AB3 seams	
C014P2	430731.00	7563976.07	194 to 205	205.00	AB1 and AB2 seams	
C016P2	422017.38	7574974.58	218 to 227	233.00	AB1, AB2 and AB3 seams	Sentinel bore in northwest corner of MLs
C020P2	427845.47	7566931.73	255 to 262	267.00	AB1 and AB2 seams	Assessment of baseline data for target coal seams
C032P2	439404.36	7544896.02	250 to 262	263.00	AB1, AB2 and AB3 seams	
C035P2	441401.68	7546827.75	98 to 110	110.00	AB1, AB2 and AB3 seams	
C056VWP2	424923.62	7569971.65	312	468.07	AB3 seam	VWPs to aid with groundwater modelling
C9553VWP2	420992.73	7573965.33	348	485.00	AB1 seam	
C555VWP1	432461.38	7557892.99	346	473.78	AB1 seam	
C9556VWP2	436542.64	7549884.87	316	444.00	AB1 seam	
C558VWP3	430311.51	7566903.01	73	222.00	AB1 seam	
C842VWP2	439505.09	7550840.30	177.5	247.65	AB3 seam	
C851VWP2	441384.00	7542877.33	145.7	261.00	AB3 seam	
C9836VWP2	437562.93	7552868.05	237	299.39	AB3 seam	
C966VWP_P2	423982.89	7571921.15	268	286.00	AB1 seam	
C968VWP_P5	424873.59	7570989.17	244	375.00	AB1 seam	
C14200VWP_1	440547.49	7533418.60	224	249.00	AB1 seam	

DRAFT

Bore ID	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)	Screened Interval (mbgl)	Total Depth	Geology / Comment	Purpose
C14206VWP_1	429783.15	7550956.80	464	477.46	AB1 seam	
C14207VWP_1	423806.63	7568105.26	504	525.36	AB1_2 seam	
AB Interburden						
C011P1	428842.59	7569952.89	48 to 54	55.00	Weathered interburden between the AB3_3 and AB3_4 seams	Assessment of Bandanna Formation interburden between A and B seams, included in modelling
C966VWP_P1	423982.89	7571921.15	278	286.00	Interburden between the AB3_3 and AB3_4	
C968VWP_P4	424873.59	7570989.17	258	375.00	Interburden between the AB3_3 and AB3_4	
C Seam						
C823SP	433605.00	7562864.00	103 to 111	111.00	C1, C2 and C3 seams	Geological information for Bandanna Formation and Colinlea Sandstone contact (bottom of C seam)
C832SP	439569.61	7554787.07	89 to 100	102.00	C1_2 and C2 seams	
C968VWP_P3	424873.59	7570989.17	302.5	375.00	C1 seam	
C Seam Interburden						
C9839SPR	439565.48	7552795.94	162 to 168	173.00	Interburden between C2 and C3 seams	Geological and groundwater level data for Bandanna Formation in modelling
C844SP	441389.94	7546839.28	172 to 179	179.00	Interburden between C2 and C3 seams	
C558VWP2	430311.51	7566903.01	120	222.00	Interburden between the C0 and C1 seams	
C842VWP1	439505.09	7550840.30	235	247.65	Interburden between the C2 and C3 seams	
Other Bandanna Formation						
C018P2	423988.18	7574849.11	81 to 89	90.00	AB3_5, C0, C1_1 seams	Geological and groundwater level data

DRAFT

Bore ID	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)	Screened Interval (mbgl)	Total Depth	Geology / Comment	Purpose
C034P1	442385.59	7547815.69	59 to 67	67.00	Weathered Permian between AB and D, No C seam	for Bandanna Formation in modelling
Colinlea Sandstone						
C-D Sandstone						
C851VWP1	441384.00	7542877.33	209.7	261.00	Interburden between C and D seams	Assessment of interburden above the target D seam
C9836VWP1	437562.93	7552868.05	296	299.39	Interburden between C and D seams	
C972SP (C897G)[10]	426601.16	7573122.06	57 to 63	86.10	Interburden above D seam	
C974SP (C899G)	426765.59	7572907.73	48 to 60	86.47	Interburden above the D1 seam	
C14203VWP_1	437658.90	7553984.34	247	273	D seam overburden	
D Seam						
C006P3R	435727.00	7560835.00	108 to 118	118	D seam	Geological thickness and extent for model construction, aquifer hydraulic properties for baseline description
C007P3	434726.28	7559864.39	252 to 259	259.20	D2 and D3 seams	
C011P3	428845.58	7569954.89	94 to 104	105.00	D1 seam	
C018P3	423977.57	7574853.06	139 to 145	161.00	D2_5, D3_1 and D3_2 seams	
C024P3	428909.10	7571761.09	44 to 49	49.00	D3 seam	
C034P3	442388.72	7547813.99	94 to 107	113.00	D2 and D3 seams with 6 m of Permian underlying D3 seam	
C180114SP	438684.80	7557646.88	62 to 71	120.00	D1, D2 and D3 seams	
C833SP	439559.68	7554777.43	120 to 132	134.00	D1, D2 and D3 seams	

[10] Bore C972SP, due its close proximity to C974SP, was discontinued as a monitoring point

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DRAFT

Bore ID	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)	Screened Interval (mbgl)	Total Depth	Geology / Comment	Purpose
C848SP	442363.39	7543815.03	129 to 140	140.00	D0 and D1 seams	
C9849SPR	442383.73	7543808.29	157 to 169	170.00	D3_1 seam and interburden between the D3_1 and D3_2 seams	
C056VWP1	424923.62	7569971.65	412	468.07	D2 seam	
C9553VWP1	420992.73	7573965.33	467	485.00	D1 seam	
C9556VWP1	436542.64	7549884.87	410	444.00	D3 seam	
C558VWP1	430311.51	7566903.01	178	222.00	D3 seam	
C968VWP_P2	424873.59	7570989.17	348.5	375.00	D1 seam	
C975SP (C900G)	426824.24	7573002.03	48 to 60	86.73	Highly weathered D1 and D2 seams	
D Seam interburden						
C829SP	436459.73	7559355.44	137 to 147	147.00	Interburden between the D1_2 and D1_3 seams	Additional geological information for modelling
C968VWP_P1	424873.59	7570989.17	355	375.00	Interburden between the D2_1 and D2_2 seams	
D-E Sandstone						
C825SP	434867.57	7561957.63	125 to 132	134.00	Interburden between D3 and E seams	Assessment of sub-D sandstone
C840SP	439545.55	7552837.74	205 to 210	212.00	Interburden between D3 and E seams	
E-F Sandstone						
C180112SP	437712.17	7558819.50	92 to 97	120.00	Between E and F seams	Assessment of sub-D sandstone
Other Colinlea Sandstone						
C827SP	436100.74	7560332.12	130 to 138	138.00	D-E Sandstone, E seam, E-F Sandstone	Assessment of sub-D sandstone
C834SP	439575.77	7554763.53	140 to 150	151.00	E seam and interburden to F1 seam	

DRAFT

Bore ID	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)	Screened Interval (mbgl)	Total Depth	Geology / Comment	Purpose
Joe Joe Group						
C012P1	430887.52	7569874.40	35 to 40	40.00	Jochmus Formation	Assessment of Joe Joe Group subcrop on lease
C012P2	430887.34	7569876.76	52 to 58	59.00	Jochmus Formation	
C180119SP	448587.45	7536355.38	58 to 61	85.00	Weathered Jochmus Formation (JoeJoe)	Control bore in Mellaluka Springs area
C9180124SPR	448600.00	7536357.00	74 to 86	86.00	Weathered Jochmus Formation (JoeJoe)	Control monitoring bore at Mellaluka Springs area
C9180125SPR	447039.74	7531738.83	90 to 100	121.00	Jochmus Formation	Control monitoring bore at Mellaluka Springs area
C180123SP	448077.54	7529357.50	102 to 112	130.00	Weathered Jochmus Formation (JoeJoe)	Control monitoring bore at Mellaluka Springs area
C14002SP	441977.77	7561157.53	96 to 108	113.80	Jochmus Formation	Assess groundwater potential off lease
C914001SPR	441973.49	7561149.58	50 to 56	57.00	Tertiary sediments to 44.77m	
C14014SP	448343.76	7533407.48	108 to 120	136.00	Weathered Jochmus Formation (JoeJoe)	Assessment of groundwater resources adjacent to Mellaluka Spring
C14032SP	448355.77	7533400.67	78 to 89	90.00	Tertiary sediments to 50m	
C14008SP	444760.74	7552697.83	93 to 105	120.00	Weathered Jochmus Formation (JoeJoe)	Sentinel bore east of the MLs
C14015SP	445301.98	7536138.69	110 to 122	144.00	Weathered Jochmus Formation (JoeJoe)	Sentinel bore between MLs and Mellaluka Springs
C14017SP	447525.30	7526907.00	78 to 84	111.00	Weathered Jochmus Formation (JoeJoe)	Southern most monitoring bore (before MLs relinquishment)
C14006SP	443446.61	7556785.07	96 to 108	115.40	Weathered Jochmus Formation (JoeJoe)	Assess groundwater potential off lease
C914030SPR / C14030SP	445072.27	7548821.00	95 to 107	114.00	Weathered Jochmus Formation (JoeJoe)	Sentinel bore east of MLs
C14004SP	440355.93	7568513.34	91 to 103	103.00	Weathered Jochmus Formation (JoeJoe)	Sentinel bore east of MLs

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DRAFT

Bore ID	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)	Screened Interval (mbgl)	Total Depth	Geology / Comment	Purpose
C14016SP	444852.34	7541471.06	114 to 126	129.00	Weathered Jochmus Formation (JoeJoe)	Sentinel bore on southern MLs boundary
C14003SP	440350.80	7568518.85	54 to 66	70.00	Tertiary sediments to 39.23m	Sentinel bore east of MLs
Composite Sample Points						
C180122SP (Tertiary / Jochmus Fm)	448579.21	7536348.70	33 to 47	47.00	Laterite and weathered Jochmus Formation	Control monitoring bore at Mellaluka Springs area
C180120SP (Tertiary / Jochmus Fm)	447056.56	7531729.89	38 to 48	86.00	Tertiary sediments and weathered Joe Joe Group	Control monitoring bore at Mellaluka Springs area
C973SP (C898G) (Tertiary / Colinlea Sandstone)	426707.25	7573188.29	31 to 37	86.97	Tertiary sediments and highly weathered D1 and D2 seams	Groundwater assessment at box cut
C14031SP (Tertiary / Jochmus Fm)	448331.34	7533407.27	40 to 52	54.00	Tertiary sediments to 47.64 m	Groundwater assessment at Mellaluka Spring area
C14005SP (Tertiary / Jochmus Fm)	443452.50	7556775.91	40 to 60	67.00	Tertiary sediments to 52 m	Assess groundwater potential off lease
C14029SP (Tertiary / Jochmus Fm)	445059.11	7548820.621	44 to 56	56.00	Tertiary sediments to 49.44 m	Sentinel bore to east of MLs
C14024SP (Clematis Sandstone / Dunda Beds)	430036.80	7543917.13	140 to 152	162.00	Weathered Clematis Sandstone and Dunda Beds	Sentinel bore in Clematis Sandstone subcrop

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3.2 Static Water Level Data – Automated Pressure Transducers

Groundwater level measurements were and continue to be collected both manually (during each sample event) and automatically from monitoring wells located across the site. Manual readings are procured during each monitoring event (prior to any sampling); automated readings via dedicated water level loggers are downloaded from all baseline monitoring bores each monitoring event. These loggers are programmed to collect a static water level (SWL) measurement in the form of a pressure reading at least every 12 hours. At the commencement of the Baseline Monitoring Program, loggers were included in these bores only; however, all groundwater monitoring bores are now equipped with automated water level loggers.

The automatic groundwater level loggers measure the total pressure acting on a transducer at their zero point/sensor. The total pressure is a combination of the column of water lying above the logger pressure sensor (i.e. height of water column) and the atmospheric (barometric) pressure acting on the water surface. The groundwater level logger data is barometrically, and temperature compensated to obtain true height of water column measurements. All groundwater level logger data is converted to groundwater elevations in mAHD, utilising the measured depth of deployment of the logger, the recorded water column level and the (manual) measured depth to water below well casing.

Each automated level logger dataset is converted from a pressure reading to a water level by correlation to the manual measurements collected during installation. The logger readings are correlated to the manual reading nearest to the installation date of the logger to capture the longest timeframe of readings available. The loggers are then corrected for barometric pressure from the closest of three (3) dedicated barometric loggers across the site (north, central, and southern portions of the CCP footprint); the barometric pressure logger and groundwater level logger are corrected via software from the logger manufacturer.

The loggers are downloaded regularly (not more than 6 months apart) to ensure data collection and identify any faulty loggers. Faulty loggers are replaced as part of the groundwater monitoring program. Loggers where downloads are difficult / faulty loggers are sent to the manufacturers to try and retrieve missing data (where possible).

3.3 Vibrating Wire Piezometers

The groundwater monitoring bore network includes 17 vibrating wire piezometers (VWPs) fully grouted into fourteen (14) bores in separate locations (Appendix B~~Appendix B~~~~Appendix B~~ figures). The VWPs, installed on steel cable and measured tremmie pipes, are laid out on surface to collect calibration data and ensure sensors are grouted into the identified hydrostratigraphic units.

The total pressure readings (formation, water, and [possibly] gas), recorded at least at 12-hour intervals to a data logger, are downloaded every six months. The total pressure readings are converted to a relative water level (in mAHD) using calibration data. Each VWP sensor has its own calibration values, at surface readings (collected during installation), and calibration factors (supplier specific), which are used to convert the downhole (fully grouted) pressure readings.

Typically, there are multiple sensors installed in one bore, which allows for the collection of data from serval separate hydrostratigraphic units at one location on site versus standpipe monitoring bores which allow only one hydrostratigraphic unit to be monitored per bore.

The data collected at the VWP sites provides relative groundwater level measurements over time, which is used to assess groundwater level trends within the hydrostratigraphic units. The total pressure readings are noted to vary over time with curing of cement grout but in some cases do not stabilise and cannot be used for comparison or trend analysis during and post-mining. This can occur if air bubbles form between the VWP sensor and the grout, which does not readily allow the transfer of (accurate) pressure from the hydrostratigraphic unit to the sensor.

NOTE: Currently, quality of the VWP data is unproven but may prove useful for trend analysis in the future.

The VWP sensor depths, units, and (possible) suitability for use for trend analysis are included in **Table 24~~Table 24~~~~Table 24~~**. The relative water level hydrographs are included in **Appendix E~~Appendix E~~~~Appendix E~~**.

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Table 24 Summary of VWP Data

VWP ID	Unit	Sensor Depth (mbgl / mAHD)	Relative groundwater level (mAHD)	Trend	Monitoring Period	Comment
C966VWP_P1	AB Seam interburden	355 / -66.3	215	Flat	01/2014 to 02/2016	Can be used for assessing depressurisation due to mine dewatering
C966VWP_P2	AB Seam	348.5 / -59.8	222	Flat with time		
C966VWP_P3	Rewan Formation	302.5 / -13.8	258.5	Flat with time		
C966VWP_P4	Rewan Formation	258 / 30.7	251	Flat with time		
C056VWP1	D Seam	408 / -124.14	154	Stabilisation of pore pressure readings with time	10/2012 to 02/2017	Can be used for assessing depressurisation due to mine dewatering
C056VWP2	AB Seam	312 / -28.14	227			
C056VWP3	Rewan Formation	240 / 43.86	239			
C555VWP1	***AB Seam***	***346 / -104.85***	***Unstable***	***Unstable***	***09/2012 to 11/2016***	***Failed read-out unit*** ***Unstable readings – unsuitable for trend analysis***
C555VWP2	***Rewan***	***260.5 / -19.35***				
C555VWP3	***Rewan Formation***	***166 / 75.15***				
C558VWP1	D Seam	178 / 72.05	212	Flat with time	09/2012 to 04/2017	Can be used for assessing depressurisation due to mine dewatering
C558VWP2	C Seam interburden	120 / 130.05	214	Flat with time		
C558VWP3	***AB Seam***	**73 / 177.05**	**168.5**	***Failed***		***Unsuitable***
C842VWP1	C Seam interburden	235 / 3.84	**Unstable**	**Unstable**	07/2013 to 04/2017	Currently unsuitable but may stabilise going forward
C842VWP2	AB Seam	177.5 / 61.39				
C842VWP3	Rewan Formation	130 / 108.89				
C851VWP1	C-D Sandstone	209.7 / 34.97	226	Flat with time	06/2013 to 04/2017	Can be used for assessing depressurisation due to mine dewatering
C851VWP2	AB Seam	145.7 / 98.97	228.7	Flat with time		
C851VWP3	Rewan Formation	103.7 / 140.97	229.5	Flat with time		

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VWP ID	Unit	Sensor Depth (mbgl / mAHD)	Relative groundwater level (mAHD)	Trend	Monitoring Period	Comment
C968VWP_P1	D Seam interburden	355 / -75.82	380 (above ground)	Flat	01/2014 to 04/2017	Can be used for assessing depressurisation due to mine dewatering
C968VWP_P2	D Seam	348.5 / -69.32	355 (above ground)	Flat		
C968VWP_P3	C Seam	302.5 / -23.32	**275**	Flat		Possible issue – VWP3 water level should be 215 to 220 mAHD, VWP4 and VWP5 are lower than surrounds Flat trend – can be used for assessing depressurisation
C968VWP_P4	AB Interburden	258 / 21.28	**201**	Flat		
C968VWP_P5	AB Seam	244 / 35.18	**192.8**	Flat		
C9553VWP1	D Seam	467.43 / -172.87	**Unstable**	**Unstable**	08/2012 to 02/2016	Currently unsuitable but may stabilise going forward
C9553VWP2	AB Seam	348.43 / -53.87	**Unstable**	**Unstable**		
C9553VWP3	Rewan	265.43 / 29.13	219.7	Flat with time		Can be used for assessing depressurisation due to mine dewatering
C9556VWP1	***D Seam***	***410 / -149.6***	***Failed***	***Failed***	***10/2012 to 04/2017***	***Unstable readings – unsuitable for trend analysis***
C9556VWP2	***AB Seam***	***316 / -55.6***	***Failed***	***Failed***		
C9556VWP3	***Rewan Formation***	***216 / 44.4***	***Unstable***	***Unstable***		
C9836VWP1	C-D Sandstone	296 / NA	220	Flat with time	07/2013 to 04/2017	Can be used for assessing depressurisation due to mine dewatering
C9836VWP2	AB Seam	237 / NA	214	Flat with time		
C9836VWP3	Rewan Formation	130 / NA	223	Flat with time		

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DRAFT

VWP ID	Unit	Sensor Depth (mbgl / mAHD)	Relative groundwater level (mAHD)	Trend	Monitoring Period	Comment
C14200VWP_1	AB Seam	224 / 23.08	235	Flat with time	11/2014 to 04/2017	Failed read-out unit Suitable for trend analysis
C14200VWP_2	Rewan Formation	199 / 48.08	234	Flat with time		
C14200VWP_3	Rewan Formation	101 / 146.08	245	Flat with time		
C14203VWP_1	C-D Seam	247 / -16.45	225	Flat	10/2014 to 04/2017	Failed read-out unit Suitable for trend analysis
C14203VWP_2	***Rewan Formation***	***77 / 153.55***	***Unstable***	***Unstable***		***Unsuitable***
C14206VWP_1	AB Seam	464 / -186.85	224	Flat with time	03/2015 to 04/2017	Can be used for assessing depressurisation due to mine dewatering
C14206VWP_2	Rewan Formation	355 / -77.85	237	Flat with time		
C14207VWP_1	***AB Seam***	***504 / -198.83***	***Unstable***	***Unstable***	***03/2015 to 04/2017***	***Unsuitable***
C14207VWP_2	***Rewan Formation***	***400 / -94.83***	***Unstable***	***Unstable***		

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3.4 Hydrographs

The transient groundwater level data collected by automated water level loggers, manual readings, and artesian pressure measurements for each bore was compiled and further reviewed and assessed by DNRME. The DNRME review has resulted in identification of most accurate and valid data sets for development of hydrographs and to derive groundwater level statistics. For example, in some bores the more consistent manual data was selected as there are issues with logger-generated data due to failures, logger drift, tangling of loggers inside bores, etc. In some cases the more accurate logger data was used. Further, for hydrograph generation, only data within the same horizon/aquifer was considered. The hydrographs are included in Appendix E~~Appendix E~~~~Appendix E~~.

An assessment of these hydrographs, used for conceptualising groundwater flow patterns and proposing thresholds, was conducted to allow for the selection of the most suitable / representative data to be used in the GMMP.

As detailed in **Section 3.3**, a review of the suitability of VWP data was conducted, allowing for the selection of VWP sensors and units which can be utilised for verifying / validating dewatering trends. VWP data was not utilised for the development of groundwater flow patterns, as detailed in **Section 2.2.5** but several have been included in the proposed thresholds and monitoring. These VWPs allow for an assessment of drawdown predictions (**Section 5.3**).

All VWP hydrographs have been included in Appendix E~~Appendix E~~~~Appendix E~~ for completeness.

3.4.1 Alluvium

Six baseline groundwater monitoring bores are installed into the alluvium across and adjacent to the CCP MLs. The bores, average groundwater levels, and comments on transient data are included in Table 25~~Table 25~~~~Table 25~~.

Table 25 Alluvium Hydrograph Data

Bore	Average Groundwater Level (mAHD)	Duration of Hydrograph	Comments
C025P1	216.72	4 years 10 months	Dry well for most of the monitoring period
C027P1	223.84	5 years 5 months	High water levels after 2011 floods
C029P1	214.77	5 years 5 months	Faulty logger replaced, logger data more reliable than manual readings
C14027SP	203.58	2 years 1 month	Fault logger replaced, logger and manual readings good match
C14028SP	205.46	2 years 5 months	Logger and manual readings good match
HD03B	225.47	3 years 11 months (manual only)	No correlation between initial logger results, correlation between logger and manual readings poor becoming better since 04/16 Influenced by discharge from springs and runoff

3.4.2 Tertiary Sediments

Five of the six Tertiary monitoring bores have transient groundwater level data; bore C971 (located around the proposed box cut) is dry. Table 26~~Table 26~~~~Table 26~~ provides details of the Tertiary sediments hydrographs.

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Table 26 Tertiary Sediments Hydrograph Data

Bore	Average Groundwater level (mAHD)	Duration of Hydrograph	Comments
C025P2	217.62	4 years 10 months	Good correlation between loggers and manual readings
C029P2	220.00	5 years 8 months (manual)	Spikes in logger data due to sampling Consistent manual data used as logger data gaps
C558P1	216.02	4 years 6 months	Good correlation between loggers and manual readings Issue with set-up elevation of initial logger
C9845SPR	234.91	2 years 5 months	Good correlation between loggers and manual readings
C9180121SPR (artesian)	244.46	2 years 5 months	Conversion of manual pressure gauge readings inaccurate, logger provides consistent data

3.4.3 Moolayember Formation

A single hydrograph has been compiled for monitoring bore C14020SP, constructed in 2014.

The average groundwater level is 252.43 mAHD, where logger and manual readings correlate well over 31 months.

3.4.4 Clematis Sandstone

Eight groundwater monitoring bores constructed in the Clematis Sandstone have transient groundwater level data. Table 27~~Table 27Table 27~~ provides details of the Clematis Sandstone hydrographs.

Table 27 Clematis Sandstone Hydrograph Data

Bore	Average Groundwater level (mAHD)	Duration of Hydrograph	Comments
C14011SP	242.80	22 months	Good correlation between loggers and manual readings
C14012SP	242.62	23 months	Good correlation between loggers and manual readings
C14013SP	242.49	23 months	Good correlation between loggers and manual readings
C14021SP	246.54	23 months	Conservative approach – use manual readings only in the unconfined Clematis Sandstone outcrop
C14033SP	250.62	15 months	Good correlation between loggers and manual readings
C180118SP	250.17	2 years	Good correlation between loggers and manual readings Blocked – needs replacing
HD02	234.28	3 years 7 months	Good correlation between loggers Good correlation between manual readings and unconfined fluctuations in logger readings
HD03A (artesian)	233.03	3 years 8 months	Logger readings only in confined Clematis Sandstone below alluvium

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3.4.5 Dunda Beds

Four of the five Dunda Beds monitoring bores have transient groundwater level data; bore HD01 has always been dry. Table 28~~Table 28Table 28~~ provides details of the Dunda Beds hydrographs.

Table 28 Dunda Beds Hydrograph Data

Bore	Average Groundwater level (mAHD)	Duration of Hydrograph	Comments
C022P1	246.66	5 years 5 months	Good correlation between loggers and manual readings
C027P2	226.90	5 years 6 months	Good correlation between loggers and manual readings after initial logger issues
C14023SP	247.26	2 years 5 months	Good correlation between loggers and manual readings
C180117SP	251.02	2 years 5 months	Good correlation between loggers and manual readings

3.4.6 Rewan Formation

Hydrographs have been compiled for all seven Rewan Formation groundwater monitoring bores with transient groundwater level data, as presented in Table 29~~Table 29Table 29~~.

Table 29 Rewan Formation Hydrograph Data

Bore	Average Groundwater level (mAHD)	Duration of Hydrograph	Comments
C008P1	211.80	4 years 8 months (manual)	Water level / logger response issues after sampling in 2015 Used consistent manual readings
C035P1	231.89	5 years 6 months	Logger and manual readings declining since 2013, possibly due to extraction at Lignum property Not used in contouring or thresholds
C555P1	230.02	35 months (manual)	Logger data issues since 2015 Initial GHD logger offset possibly due to reference level error Not included in contours
C556P1	234.84	4 year 6 months	Good correlation between loggers and manual readings after initial logger issues
C9553P1R	252.26	2 years 11 months (manual)	Good correlation between loggers and manual readings after correcting logger install issues Logger reinstallation issues, after sampling events, noted Initial GHD logger offset possibly due to reference level error

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Bore	Average Groundwater level (mAHD)	Duration of Hydrograph	Comments
C9838SPR	228.74	3 years 1 month (manual)	Logger reinstallation in July 2016 different to previous reference level Used consistent manual data for contours
C180116SP	239.12	2 years 5 months	Good correlation between loggers and manual readings

Based on a review of the hydrographs several of the Rewan Formation monitoring bores will have replacement / faulty loggers repaired, as per EA Condition E16 which requires the maintenance of the groundwater monitoring network (including monitoring equipment) to ensure the compilation of representative groundwater monitoring data.

3.4.7 Bandanna Formation

Seventeen (17) groundwater level monitoring bores are installed in the Bandanna Formation across the CCP MLs (Table 23~~Table 23Table 23~~). These bores, located in various sediments included in the Bandanna Formation (as included in Table 30~~Table 30Table 30~~), are equipped with automated water level loggers which will remain and downloaded at least every 6 months to aid with model updates and refinement (as detailed in **Section 6.2** Operational GMMP).

Table 30 Bandanna Formation Hydrograph Data

Bore	Average Groundwater level (mAHD)	Duration of Hydrograph	Comments
AB Seam			
C016P2	248.50	3 years 1 month	Logger issues in 2012 / 2013; consistent manual readings from March 2014 to April 2017 applied
C020P2	220.92	5 years 5 months	Good correlation between loggers and manual readings
C014P2	209.21	4 years 5 months	Good correlation between loggers Good correlation between manual readings Logger to be reinstalled to correct depth
C007P2	212.38	years 10 months	Good correlation between loggers and manual readings
C008P2	213.40	5 years 8 months	Good correlation between loggers and manual readings
C035P2	232.68	3 years 11 months	Gap in logger data; manual dataset utilised. The average groundwater elevation calculation excludes erroneous measurement from November 2016
C032P2	233.27	20 months	Good correlation between loggers and manual readings after logger issues
AB Interburden			
C011P1	229.72	4 years 10 months	High variation, logger possibly affected by sampling
C Seam			
C823SP	209.30	36 months (manual)	Manual readings used as logger influenced by sampling / low recovery

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Bore	Average Groundwater level (mAHD)	Duration of Hydrograph	Comments
C832SP (artesian)	229.20	2 years 6 months	Conversion of manual pressure gauge readings inaccurate, logger provides consistent data
B-C Sandstone			
C006P1	211.25	5 years 5 months	Good correlation between loggers and manual readings
C018P1	244.98	5 years 5 months	Good correlation between loggers and manual readings after initial logger issues
C847SP	232.43	3 years 1 month	Good correlation between loggers and manual readings Manual measurement dataset used for calculation of average groundwater elevation due to longer monitoring period (more data points)
C Seam Interburden			
C844SP	231.00	37 months	Good correlation between loggers and manual readings
C9839SPR	228.13	37 months	Good correlation between loggers and manual readings
Other Bandanna Formation			
C018P2	242.47	54 months	AB3_5, C0, C1_1 seams Good correlation between loggers and manual readings after logger issues
C034P1 (artesian)	230.95	2 years 11 months	Weathered Permian between AB and D, No C seam Logger data only, faulty logger needs replacing

The AB Seam was selected for use for developing groundwater quality triggers, groundwater level thresholds, and groundwater contours for the Bandanna Formation. This was done as the AB Seam is a target coal seam for mining and is the most impacted unit (by approved mining operations) of the Bandanna Formation.

3.4.8 Colinlea Sandstone

Eighteen (18) groundwater level monitoring bores are installed in the Colinlea Sandstone across the CCP MLs (Table 23~~Table 23Table 23~~). These bores, located in various sediments included in the Colinlea Sandstone (as included in Table 31~~Table 31Table 31~~), are equipped with automated water level loggers which will remain and downloaded at least every six-months to aid with model updates and refinement (as detailed in **Section 6.2** Operational GMMP).

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Table 31 Colinlea Sandstone Hydrograph Data

Bore	Average Groundwater level (mAHD)	Duration of Hydrograph	Comments
C-D Sandstone			
C974SP	240.96	37 months	Good correlation between loggers and manual readings
C972SP	-	-	No logger, removed from monitoring program
D Seam			
C018P3	242.43	5 years 5 months	Good correlation between logger and manual readings
C975SP	240.99	3 years 1 month	Good correlation between logger and manual readings
C024P3	228.88	5 years 8 months	Good correlation between logger and manual readings
C011P3	227.32	5 years 9 months	Good correlation between logger and manual readings
C006P3R	213.28	5 years 9 months	Good correlation between logger and manual readings, logger influenced by sampling / low recovery
C007P3	216.93	5 years 8 months	Logger malfunction after November 2014 GME; logger replaced in September 2015.
C180114SP	223.00	2 years 5 months	Good correlation between logger and manual readings
C833SP (artesian)	228.28	2 years 5 months	Conversion of manual pressure gauge readings inaccurate, logger provides consistent data
C848SP	231.91	3 years 1 month	Good correlation between logger and manual readings
C9849SPR	231.88	3 years 1 month	Logger data only
C034P3 (artesian)	231.07	2 years 5 months	Erratic data from logger, not used in contours
D Seam Interburden			
C829SP	214.56	3 years 1 month	Good correlation between logger and manual readings
D-E Sandstone			
C825SP	211.82	2 years 5 months	Good correlation between logger and manual readings
C840SP	228.01	2 years 5 months	Good correlation between logger and manual readings
E-F Sandstone			
C180112SP	219.20	37 months	Good correlation between logger and manual readings
Other Colinlea Sandstone			
C827SP	212.86	2 years 4 months	D-E Sandstone, E seam, E-F Sandstone Good correlation between logger and manual readings
C834SP (artesian)	227.50	2 years 5 months	E seam and interburden to F1 seam Logger data only

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The D Seam was selected for use for developing groundwater quality triggers, groundwater level thresholds, and groundwater contours for the Colinlea Sandstone. This was done as the D Seam is a target coal seam for mining and is the most impacted unit (by approved mining operations) of the Colinlea Sandstone.

3.4.9 Joe Joe Group

All eighteen (18) groundwater monitoring bores within the Joe Joe Group sediments have transient groundwater level data. The summary of the resultant hydrographs is included in Table 32~~Table 32Table 32~~.

Table 32 Joe Joe Group Hydrograph Data

Bore	Average Groundwater level (mAHD)	Duration of Hydrograph	Comments
C012P1	221.33	4 years 10 months	Good correlation between logger and manual readings
C012P2	221.32	4 years 10 months	Good correlation between logger and manual readings
C14003SP	209.37	2 years 8 months	Good correlation between logger and manual readings
C14004SP	209.44	2 years 4 months	Good correlation between logger and manual readings
C914001SPR	218.47	2 years 5 months	Good correlation between logger and manual readings
C14002SP	218.75	2 years 5 months	Good correlation between logger and manual readings
C14006SP (artesian)	226.03	10 months	Logger readings stable since 09/2015
C14008SP (artesian)	228.34	1 year 7 months	Conversion of manual pressure gauge readings inaccurate, logger provides consistent data
C14016SP (artesian)	234.13	1 year 9 months	Good correlation between logger and pressure gauge readings
C14015SP (artesian)	239.15	9 months	Erratic logger data after April 2016; data used to calculate average groundwater elevation is from July 2015 to April 2016
C180119SP (artesian)	238.21	1 year 10 months	Consistent logger data since mid-April 2015
C9180124SPR (artesian)	235.31	2 years	Consistent logger data since April 2015
C14032SP (artesian)	233.69	1 year 5 months	Pressure gauge readings only, to be equipped with logger and digital pressure gauge
C9180125SPR	243.10	2 years 1 month	Consistent logger data since December 2014
C180123SP	246.35	2 years 4 months	Consistent logger data
C14017SP	248.26	1 year 7 months	Consistent logger data
C14014SP (artesian)	239.32	-	Not used for contours as landholder utilises bore for water supply
C914030SPR (artesian)	230.25	1 year 8 months	Consistent logger data

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3.4.10 Composite Bores

Seven (7) standpipe groundwater monitoring bores have been installed where the screened intervals, after construction, have been identified as intersecting two hydrostratigraphic units. These bores occur predominantly where the sediments are similar (initial logging records changed only after an assessment of down-hole geophysics) and/or where difficult drilling conditions (high potentiometric pressures and multiple artesian zones) were encountered.

Hydrographs of the groundwater level data from these bores will be compiled for future use for dewatering trend analysis (mine dewatering) and were not used to generate groundwater contours or thresholds.

3.5 Augmentations to the Groundwater Monitoring Network

The groundwater monitoring network has been augmented since 2011 to ensure the following:

- Collection of additional baseline groundwater levels across all the hydrogeological units that are likely to be impacted by approved mining operations
- The determination of groundwater level responses to mine activities. The comparison of water level decline to selected thresholds (**Section 5.3**) will allow for the identification of groundwater resources which may be unduly affected by mine dewatering, where unduly affected is where drawdown is projected to be greater than the groundwater level thresholds
- The extent and magnitude of drawdown in each aquifer is adequately monitored for comparison to modelled projections over time, which considers the envisaged alteration of the geological units above the coal seam units in response to longwall mining, particularly the intervening aquitards (Rewan Formation) which control projected drawdown (induced flow) from the Clematis Sandstone
- The identification and management of any potential impacts on surface water – groundwater interaction.

Examples of augmentations made to the network and baseline groundwater monitoring program include:

- Expansion of the groundwater monitoring network within and outside the MLs to include GAB units for the baseline groundwater monitoring program (quality and water levels) and for use as long term sentinel monitoring sites
- Identification of additional areas with artesian pressures and information on gradients between different strata south of the Carmichael River
- Collection of data from the vicinity of the Mellaluka Spring Complex
- Collection of aquifer hydraulic data through completion of packer tests, pump out tests, slug-in (falling head) tests and groundwater yield estimations from standpipe piezometer development within and outside the MLs
- Collection of hydraulic data from the Rewan Group, Joe Joe Group, and Tertiary sediments
- Collection of data from the Doongmabulla Springs Complex.

The groundwater monitoring bore network will, during operations, act as an early warning system should actual drawdown differ from predicted drawdown and to allow for the instigation of investigation in to changes in groundwater quality should chemistry triggers be exceeded.

These potential impacts could impact current groundwater use or have potential environmental harm. Therefore, the groundwater monitoring network will be modified as mining extends to the west (down dip) and south of the Carmichael River over time. The monitoring network augmentation will ensure the replacement of monitoring points that are lost during mining, and the groundwater monitoring program will be modified in response to mine activities change (i.e. operations or closure).

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Additional monitoring bores (post-EIS) have been constructed in optimum locations considering the proposed mine activities, groundwater resources, MNES, and local landholder groundwater extraction. These new monitoring points between the mine and the existing landholder extraction allow for an assessment of the groundwater resource(s) away from pumping effects.

Further monitoring bores have been constructed on neighbouring properties near the Doongmabulla Springs Complex. These nested bores, comprising standpipe bores about ten metres apart, are constructed within the Clematis Sandstone and overlying confining Moolayember Formation adjacent to the Doongmabulla Springs Complex.

Adani has also installed six additional shallow (installed into the clay-rich base of weathering within the Tertiary sediments) seepage monitoring bores adjacent to the mine affected water and waste storage facilities. These seepage monitoring bores were installed as per Adani's commitment that these bores would be installed at least six months prior to utilisation of these mine facilities.

The shallow seepage bores will be sampled every two months during the construction phase to establish the baseline water quality and levels (if any). Groundwater levels and water quality (if water is encountered) data will be compiled prior to operations for comparison purposes. These six bores are also included in the operational monitoring program. Groundwater level thresholds and water quality triggers will be established for these bores prior to commissioning of the mine affected water and waste storage facilities.

The monitoring bores installed within and outside the existing monitoring bores since 2013 are tabulated in Table 33~~Table 33Table 33~~ below and Error! Reference source not found..

Table 33 Summary of Augmentation Monitoring Bores

Bore ID	Easting	Northing	Formation	Comments
C971SP (C896G)	426590	7572995	Tertiary sediments	Drilled in 2013 for the assessment of possible groundwater ingress into the box cut
C972SP (C897G)	426601	7573122	Colinlea Sandstone	Drilled in 2013 for the assessment of possible groundwater ingress into the box cut from overburden above D seam
C974SP (C899G)	426766	7572908	Colinlea Sandstone	Drilled in 2013 for the assessment of possible groundwater ingress into the box cut from overburden above D seam
C975SP (C900G)	426824	7573002	Colinlea Sandstone	Drilled in 2013 for the assessment of possible groundwater ingress into the box cut from weathered D seam
C14003SP	440351	7569519	Joe Joe Group	Drilled in 2014 to assess groundwater potential of the Tertiary sediments east of the mine lease (north of Carmichael River)
C14004SP	440361	7568516	Joe Joe Group	
C914001SPR	441974	7561154	Joe Joe Group	
C14002SP	441973	7561154	Joe Joe Group	
C14028SP	443780	7559582	Alluvium	Drilled in 2014 augmentation to baseline monitoring network to include bores downstream of the mine lease on each side of the Carmichael River
C14027SP	444968	7558335	Alluvium	
C14005SP	443452	7556779	Tertiary sediments / Joe Joe Group	Drilled in 2014 to assess groundwater potential of the Tertiary sediments east of the mine lease (south of Carmichael River)
C14006SP	443440	7556788	Joe Joe Group	
C14008SP	444762	7552705	Joe Joe Group	
C914030SPR	445072	7548821	Joe Joe Group	

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Bore ID	Easting	Northing	Formation	Comments
C14029SP	445059	7548820	Tertiary sediments / Joe Joe Group	
C14016SP	444852	7541471	Joe Joe Group	Drilled in 2014 augmentation to baseline monitoring network on southern mine lease boundary, assessing geology to determine Colinlea Sandstone / Joe Joe Group contact
C14015SP	445301	7536138	Joe Joe Group	Drilled in 2014 augmentation to baseline monitoring network around Mellaluka Spring and assess underlying geology Colinlea Sandstone or Joe Joe Group Assess artesian conditions in the Tertiary sediments and Joe Joe Group
C14014SP	448344	7533410	Joe Joe Group	
C14031SP	448331	7533407	Composite Bore	
C14032SP	448355	7533400	Joe Joe Group	
C14200VWP	440547	7533419	VWP1 – AB Seam (224 mbgl) VWP2 – Rewan Fm (199 mbgl) VWP3 – Rewan Fm (101 mbgl)	Drilled in 2014 to assess geology west of Mellaluka Spring, augment baseline monitoring network and provide monitoring along strike of mining
C14017SP	447525	7526905	Joe Joe Group	Drilled in 2014 to augment the baseline monitoring network on southern mine lease boundary, which has now been relinquished
C14011SP	426140	7561447	Clematis Sandstone	Drilled in 2014 in a north – south transverse between the mine lease and the DSC, to assess GAB units, depth of cover to Permian coal seams Assess Rewan Formation, Moolayember Formation thickness leading to confining of Clematis Sandstone Assessment of aquifer hydraulic properties Increase groundwater monitoring network
C14012SP	424891	7560589	Clematis Sandstone	
C14013SP	424897	7560590	Clematis Sandstone	
C14024SP	430033	7543915	Clematis Sandstone/ Rewan Group	
C14020SP	418233	7566780	Moolayember Formation	
C14023SP	429803	7550970	Dunda Beds	
C14033SP	418210.	7566775	Clematis Sandstone	
C14021SP	429801	7550972	Clematis Sandstone	
C14203VWP	437658	7553983	VWP1 – D Seam overburden (247 mbgl) VWP2 – Rewan Fm (77 mbgl)	Drilled in 2014 adjacent to a pump test well, used as an observation bore when assessing groundwater resources in the mine pit area to the south of Carmichael River
C18001SP	416311	7553052	Clematis Sandstone	Installed in 2018 to augment the existing groundwater monitoring network, control bores at the DSC
C18002SP	420948	7558952	Clematis Sandstone	
C18003SP	420944	7558964	Moolayember Formation	
C18004	437013	7565647	Weathered Tertiary sediments	Seepage monitoring bores installed in 2018
C18005	438966	7564569	Weathered Tertiary sediments	

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Bore ID	Easting	Northing	Formation	Comments
C18006	439882	7562704	Weathered Tertiary sediments	
C18007	434334	7563940	Weathered Tertiary sediments	
C18008	433753	7565451	Weathered Tertiary sediments	
C18009	436933	7567302	Weathered Tertiary sediments	

Notes:
mbgl - metres below ground level

NOTE: **Section 3.1.3** includes a timeline of which bores were installed and for what purpose. The section includes comments on what data was used for the different groundwater inputs into the GMMP, such as modelling baseline descriptions, and monitoring networks.

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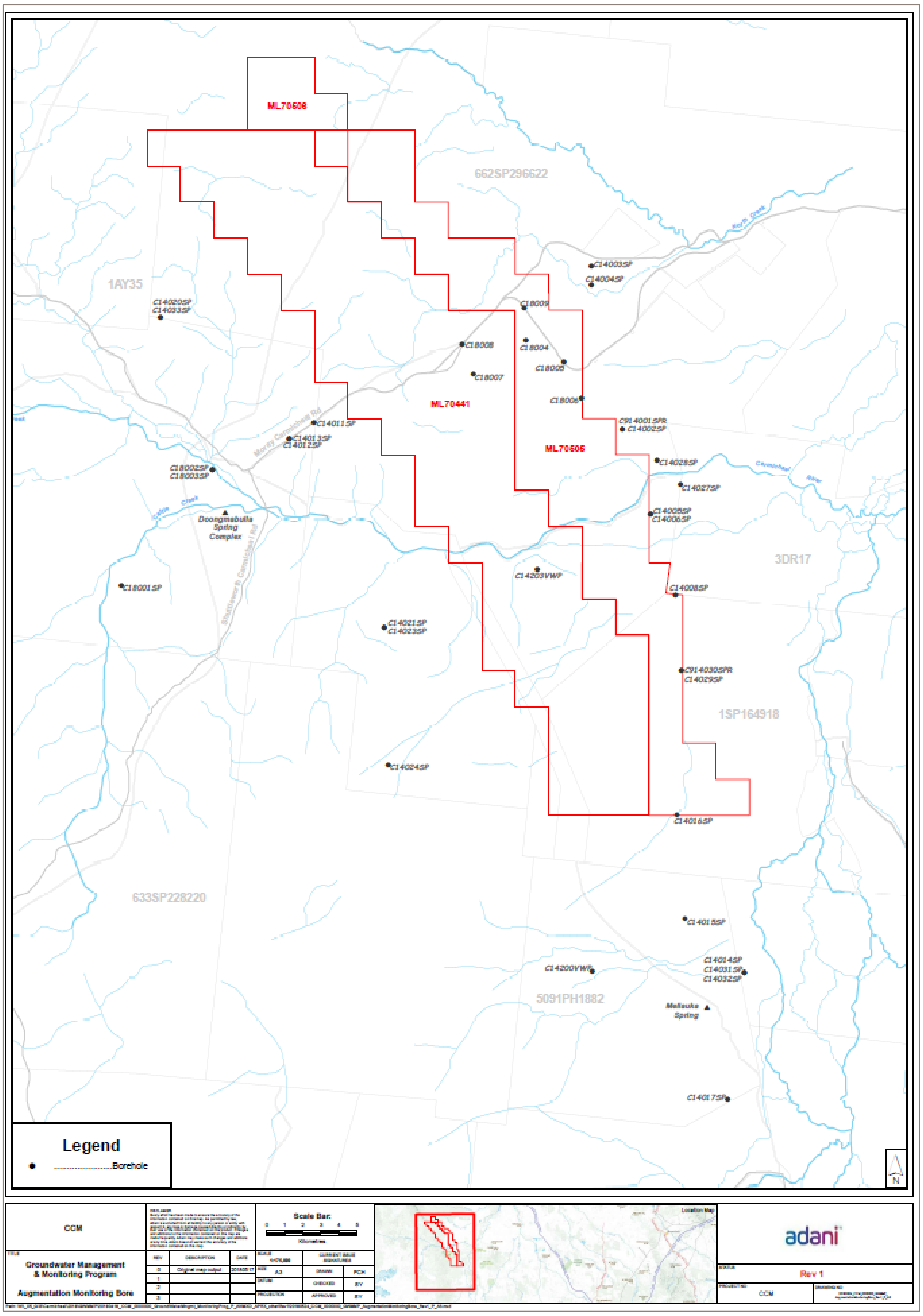

Figure 20 Augmentation Bores

3.5.1 Bore Design Drilling

All monitoring bores were drilled using a water bore drilling rig, using mud-rotary or air-percussion techniques. VWPs and bores which intersect the Rewan Formation were constructed with a core rig to facilitate sample recovery. The groundwater standpipe monitoring bores have been designed in accordance with 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 (NRM, 2013a). All future groundwater monitoring bores will adopt the water bore regulations (noting that these have or may be updated in the future).

Consideration was given to casing and annular seal requirements to ensure that no pathway is provided for the movement of water between aquifers.

Each standpipe monitoring bore was installed with 50 mm diameter uPVC casing, machine slotted screen and fitted with a lockable monument cover. The bore annulus of the screened interval was filled with washed two mm diameter silica sand, sealed with a bentonite plug and grouted to surface with a cement-bentonite grout mix. Each bore was developed by airlifting.

Each group of VWPs was installed on steel cable (sensor and wiring attached using cable ties through the cable) and grouted into place using dedicated tremmie pipes with bentonite-cement grout.

3.5.2 Artesian Bores

In areas with potential artesian conditions, the bore design, drilling, and construction were and need to be conducted in accordance with the requirements for artesian bores, inclusive of the requirement to use a Class 3 driller, as detailed in the following guidelines:

- Minimum standards for the construction and reconditioning of the water bores that intersect the sediments of artesian basins in Queensland (NRM, 2013a)
- Minimum Construction Requirements for Water Bores in Australia, 3rd Edition (DNRM, 2012)
- Water bore driller's licensing handbook (NRM, 2013b).

It is noted that updated versions of the guidelines have been released since the artesian bores were installed (Version 1.02 dated 2017). In the instance further bores are to be constructed in areas with potential for artesian conditions, the most recent version of applicable guidelines will be utilised.

The artesian bores include pressure gauges to allow for the measurement of the shut-in pressure. The pressure, typically measured in pounds per square inch (psi), is then converted to equivalent hydrostatic head in meters where 1 psi (6.9 kPa) of pressure measured has an equivalent water rise of 0.7 m above the gauge. In addition to pressure gauges, automated groundwater level loggers installed in the artesian bores provide additional water level data to the manual pressure readings.

An example of potentiometric level estimates for artesian bores, where the pressure readings were measured as pressure (either with an automated water level logger or manually read off a pressure gauge), where:

- pressure in psi or kPa was converted to meters of water column
- 1 mH_2O = 9,806.65 Pa
- 1 psi = 6,894.76 Pa
- mH_2O value x 9,806.65 Pa = psi value x 6,894.74 Pa
- mH_2O value = psi value x 0.70307
- e.g. 20 psi = 14.0614 m.

The hydrostatic head data, taking into consideration the height of the gauge above ground level, allow for the assessment of potential mine dewatering impacts on the springs.

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NOTE: Several comparisons between automated water level logger results and manual pressure readings (and conversion) show marked differences. It is considered the automated water level loggers provide more accurate data compared to the manual readings off the available pressure gauges, as is observed on hydrographs generated for groundwater level assessment (Appendix E~~Appendix E~~Appendix E).

This approach and design requirements were adopted for the artesian groundwater monitoring bores constructed adjacent to the Mellaluka Springs Complex and within the Tertiary sediments to the east of the mine leases (Appendix B~~Appendix B~~Appendix B). Error! Reference source not found. below shows the current artesian bore headworks constructed on site, adjacent to the Mellaluka Springs Complex (within the Tertiary sediments and Joe Joe Group), comprising two gate valves and an access bolt (for the collection of water level readings, groundwater samples when hydrostratigraphic pressures are below headworks, and a pressure gauge.

Figure 21 Artesian Monitoring Bore Headworks

3.5.3 Sub-E Permian Bores

Adani, after discussions with the administering authorities and in compliance with their EA conditions, will be refining the current predictive groundwater model on a regular basis (after two years and then at five-year intervals). The refined model is to include additional model layers and parameters for the sub-E sediments of the Colinlea Sandstone unit (consistent with the drilling results around the Mellaluka Springs Complex, **Section 2.2.6.3**). This is also consistent with the recommendations of DNRME during the EIS assessment to include additional modelling layer below D seam.

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To facilitate the model refinement and to better assess the unconformable contact between the Tertiary sediments, the Joe Joe Group (as recognised in the Mellaluka Springs Complex area), and the Colinlea Sandstone, additional groundwater monitoring bores are to be constructed prior to mine operations. These proposed sub-E bores are indicated on Error! Reference source not found., denoted as CSSTMB1 and CSSTMB2. These locations have been approved by DNRME as a part of the associated water licence Condition 47.

The data from these sub-E bores will be used to refine the groundwater model by adding additional model layers within and below the Colinlea Sandstone. The revision of model with additional layers will also provide impact predictions on sub-E aquifers due to the approved mining. It is expected that impacts due to mining on sub-E aquifers will be not significant as mining operations will be carried out above this aquifer, and this supports a suggestion that these aquifers could serve the purpose of providing alternative water supplies, relevant to any approval issued under the *Water Act 2000*, especially for other water resource users in the impacted area. Further these bores will be used to monitor the possible impacts on sub-E aquifers due to mining, which provides a pathway for assessing the suitability of these aquifers in terms of quality and quantity to provide alternate water supply sources.

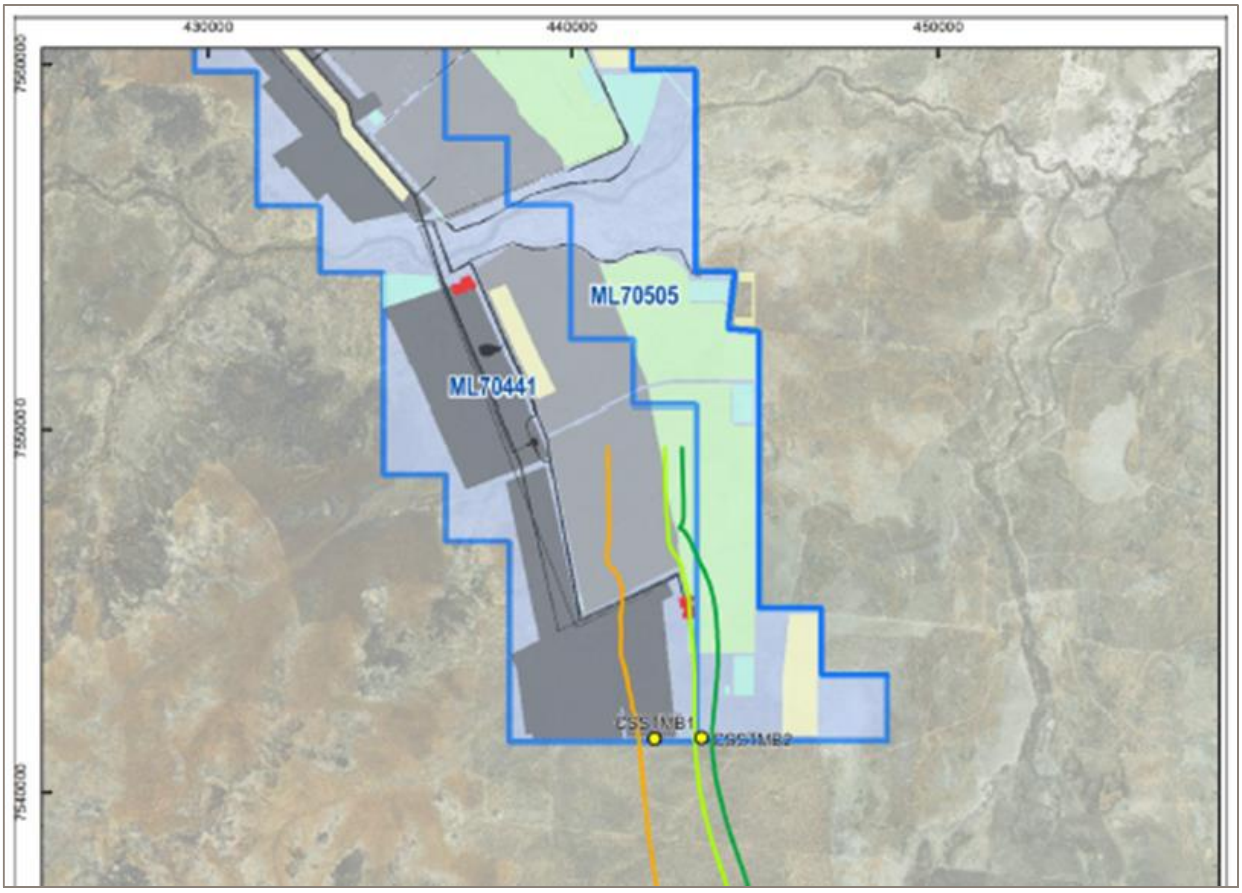

Figure 22 Proposed locations of Sub-E Permian Bores

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3.5.4 Doongmabulla Spring Complex

To augment the monitoring network Adani commits to installing additional monitoring bores into the Dunda Beds and the Rewan Formation to the west of Mining lease in between the Mining lease and DSC and is included in section 7.0 As far as practicable, these additional bores will be co-located with the existing bores, HD02, HD03A, and C14011SP, as nested monitoring bores in consultation with DNRME of Queensland.

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.

These bores once installed will be added to the operational groundwater monitoring program and will enable to collect spatially comparable groundwater level and quality data in between the Mining lease and DSC for the purpose of additional data collection prior to the occurrence of predicted impacts associated with project activities and timing (see Section 2.6). 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 (as compiled in Section 5.3) for inclusion in the next GMMP.

~~These bores once installed will be added to the operational groundwater monitoring program and will enable to collect spatially comparable groundwater level and quality data in between the Mining lease and DSC for the purpose of baseline (pre-impact) while box cut and construction are progressing. ed as impacts are not anticipated for several years. These construction activities, some 10 – 15 km to the east, will not impact on water levels adjacent to the DSC for several years.~~

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

~~Further, Adani will consider drilling into deeper Permian age units for monitoring purposes if there is a need to do so based on the outcomes of the relevant research programs.~~

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Figure 23 Landholder Bores

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Table 34 Landholder Bore Summary

Property name	Bore name	Number	Type / Use	Easting	Northing	Depth (m)	Aquifer
Lignum	Lake bore	158001	Stock & Domestic	446122	7549419	93	Unconsolidated alluvium / Tertiary sediments
	Hut Bore		Stock & Domestic	449869	7550061	TBD	Unconsolidated alluvium / Tertiary sediments
	Tap gate bore		Stock & Domestic	448517	7544827	85	Unconsolidated alluvium / Tertiary sediments
	Home bore	158471	Stock & Domestic	449378	7541377	93	Unconsolidated alluvium / Tertiary sediments
	Dexter bore	67627	Stock & Domestic	4456773	7540047	104	Tertiary sediments / Permian aged Sandstone
	New Bore	103249	Stock & Domestic	442972	7538727	46	Tertiary sediments /Permian aged Sandstone
	Shed Bore		Stock & Domestic	446876	7547938	TBD	Unconsolidated alluvium / Tertiary sediments
Albinia	Starlight bore	158649	Stock & Domestic	448149	7554152	90	Unconsolidated alluvium / Tertiary sediments
	Gold Lotto bore		Stock & Domestic	446002	7556100	TBD	Unconsolidated alluvium / Tertiary sediments
Bimbah East	Desert Bore	44486	Stock & Domestic	434344	7542064	91	Dunda Beds
	Clayholes Bore	103565	Stock & Domestic	424733	7536432	88	Clematis Sandstone (to be verified)
	Bimbah House Bore	44487	Stock & Domestic	424155	7529828	47	Clematis Sandstone
	Bimbah Irrigation Bore	67626	Irrigation	424155	7529828	137	Clematis Sandstone
	Glens Bore		Stock & Domestic	429833	7532978	~100	Dunda Beds (to be verified)
	Cockatoo Bore	44488	Stock & Domestic	432768	7533696	25	Dunda Beds
	Soak Bore	62625	Stock & Domestic	435979	7534079	85	Dunda beds
Mellaluka	Gidgea Bore	132959	Stock & Domestic	446731	7528369	97	Interburden in Joe Joe Group
	Gidgea Bore-1	103423	Stock & Domestic	446731	7528369	100	Interburden in Joe Joe Group
	Gidgea Bore-2	132960	Stock & Domestic	446731	7528369	140	Interburden in Joe Joe Group
	Iron Bark Bore	103378	Stock & Domestic	441486	7528898	96	Interburden in Joe Joe Group
	3 Mile Bore	103230	Stock & Domestic	441722	7532437	88	Interburden in Joe Joe Group
	Desert Bore	103229	Stock & Domestic	442930	7538681	47.85	Interburden in Joe Joe Group

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Property name	Bore name	Number	Type / Use	Easting	Northing	Depth (m)	Aquifer
	Middle Bore	132961	Stock & Domestic	442929	7534861	140	Interburden in Joe Joe Group
	Poison Bore	103231	Stock & Domestic	438212	7535068	97.4	Interburden in Joe Joe Group
	Stories Bore	103559	Stock & Domestic	446437	7534364	73.15	Tertiary sediments / Joe Joe Group
	Shellys bore	90212	Stock & Domestic	439949	7529980	84	Interburden in early Permian
	House Bore	44443	Stock & Domestic	446729	7532074	42	Tertiary sediments / Joe Joe Group
Bygana	River Bore	158678	Stock & Domestic	458554	7545051	168	Mount Hall Formation (Drummond Basin)
East Top	Artesian Bore	158631	Stock & Domestic	451402	7541297	100	Tertiary sediments / Joe Joe Group
Moray Downs	15 Mile Bore	90256	Stock & Domestic	423671	7580878	117	Tertiary sediments / Joe Joe Group
	8 Mile Bore	90368	Stock & Domestic	451221	7572005	100	Tertiary sediments / Joe Joe Group
Carmichael East	Carmichael House Bore		Stock & Domestic	406312	7570944	48.8	Moolayember Formation or Warang sandstone
	Kade's Bore		Stock & Domestic	406128	7571872	70.8	Moolayember Formation or Warang sandstone
	Cow Paddock Bore		Stock & Domestic	409855	7570961	57.6	Moolayember Formation or Dunda beds
	Crazy Bore		Stock & Domestic	414230	7576676	160	Base of Dunda beds
	Wild Bore		Stock & Domestic	415707	7574934	100	Dunda Beds
	Mosquito Bore	96545	Stock & Domestic	400432	7571736	234	Moolayember Formation or Warang sandstone
Doongmabulla	Caseys bore	16896	Stock & Domestic	407919	7557603	123.44	Moolayember Formation
	Junction hole bore		Stock & Domestic	415716	7552192	TBD	Clematis Sandstone
	Rocky bore	62750	Stock & Domestic	410986	7545753	168	Clematis Sandstone
	Fourmile bore	62751	Stock & Domestic	408065	7540229	221	Clematis Sandstone
	Nankeroo Bore	16895	Stock & Domestic	407851	7549824	97.5	Moolayember Formation
	Nine Mile bore	62754	Stock & Domestic	419215	7548049	91.4	Clematis Sandstone
	Bimbah Bore	165169	Stock & Domestic	416514	7541230	TBD	Dunda Beds
	Fiery Bore	62753	Stock & Domestic	418153	7535046	161	Dunda Beds

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Property name	Bore name	Number	Type / Use	Easting	Northing	Depth (m)	Aquifer
	Gricks Bore	16897	Stock & Domestic	416510	7531718	231	Clematis Sandstone
	Shuttleworth bore	62752	Stock & Domestic	409061	7534843	250	Clematis Sandstone

Notes:

TBD – To be determined

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3.7 Landholder Bores

During the compilation of the EIS several landholder bores, located on and adjacent to the CCP tenements, have been identified (Error! Reference source not found.) and a summary of the data compiled is included in Error! Reference source not found..

These bores are currently subject to bore assessments and discussions regarding make-good agreements. To assist with the assessment of potential impacts of approved mining activities on groundwater resources outside of the mine area and potentially on current groundwater users, sentinel bores have been identified between the mine and the local groundwater users, as discussed in **Section 5.3.1** (which includes groundwater level thresholds for the bores between the mine and the landholder bores).

Groundwater levels will be monitored in these sentinel monitoring bores, including in **Table 39~~Table 39~~~~Table 39~~**.

Groundwater levels will be compared to model predictions and the proposed groundwater level thresholds (**Section 5.3**).

3.8 Groundwater Monitoring Network Rationale

Groundwater monitoring bores were constructed within large diameter exploration bores across the CCP during the compilation of the EIS. The selection of exploration bores, along strike and down-dip, allowed for the construction of monitoring bores within the major hydrostratigraphic units intersected within the CCP mine leases.

Bore construction, including an assessment of lithology and down-hole geophysics, allowed for screened section of the bores (and installation of VWPs), which provided groundwater data for over-, inter-, and under-burden as well as the coal seams. Groundwater monitoring, quality and levels, allowed for the compilation and assessment of groundwater resources, groundwater flow and gradients, plus ambient hydrochemistry.

Discussions with the then DNRM (now DNRME) allowed for the compilation of baseline geological and groundwater data, which was used in the EIS / SEIS to:

- Describe the groundwater resources of the coal seams and surrounding aquifers
- Detail the ambient hydrochemistry
- Detail the geology / lithostratigraphy
- Assess aquifer types and groundwater levels and flow patterns
- Aquifer hydraulic parameter assessments
- Assessment of groundwater environmental values
- Conceptual groundwater model(s), including assessment of recharge / discharge mechanisms and surface water – groundwater interaction
- GAB resource evaluation and inter-aquifer connectivity
- Construct and calibrate a numerical groundwater model (and undertake impact assessments).

Additional drilling and monitoring bore network augmentation occurred post SEIS to aid with further understanding of groundwater regimes, providing baseline data, and assessing groundwater resource potential in the hydrostratigraphic units east and west (off lease) of the CCP mine leases.

The areas of additional assessment (geology and groundwater) through the drilling, down-hole geophysics, bore construction, and aquifer assessment (quantity and quality) included:

- The proposed box cut (monitoring bores and VWPs) in the AB Seam subcrop
- Bores installed and tested in the Tertiary sediments and Joe Joe Group to the east and southeast of the MLs, including an assessment of the Mellaluka Springs area

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- Deep drilling some 5 km west of the MLs to allow for an assessment of the Clematis Sandstone (dip, groundwater resources, and monitoring network augmentation), the Dunda Beds and Rewan Formation (aquitard evaluation), Bandanna Formation and Colinlea Sandstone VWPs
- Moolayember Formation and Clematis Sandstone bores adjacent and to the west of the Doongmabulla Springs.

The development of the large, > 100 bores, groundwater monitoring network allowed for the compilation of representative (and repeatable) groundwater monitoring data which allowed for the compilation of the GMMP and addressing approval conditions, such as groundwater quality triggers and groundwater impact levels.

The phased approach, allowing for the scientific development of the groundwater assessment, allowed for the development of a network of groundwater monitoring bores, which satisfactorily monitor groundwater resources (before, during and after mining) and obtain accurate groundwater information.

Error! Reference source not found. in **Section 3.5** provides the rationale / reasons for the bores installed since 2013.

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4.0 Monitoring Requirements

This section describes the groundwater monitoring that, at a minimum, is undertaken and will be conducted before, during, and after the approved mining activities. In accordance with the adaptive management approach, these monitoring requirements will be modified on an on-going basis to ensure optimal understanding of the groundwater regimes and assessment of the predicted mining impacts.

4.1 Parameters

Optimum parameter selection allows for the measure of the cause and effect relationship between mining activities and the environmental response to those activities. Suitable indicators include those:

- Commonly found in the environment
- Relatively easy to measure
- Sensitive to environmental change
- Specific to disturbance impacts.

The selected parameters, as included in the EA Condition E9 (Appendix A~~Appendix A~~~~Appendix A~~), allow for the description of the groundwater resource, the physical, chemical and biological aspects of the groundwater system. The parameters also allow for assessment of possible alteration of groundwater related to anthropogenic activities.

The groundwater monitoring program allows for the evaluation of both groundwater quantity (levels) and quality parameters.

4.2 Dewatering Volumes

The monitoring of groundwater volumes extracted during mining is an additional groundwater monitoring requirements to be met under the Associated Water Licence (AWL) issued for the project. Under the AWL conditions the volume of associated water taken, under the authority of the AWL licence, must be measured and reported in accordance with requirements prescribed in section 334ZP of the *Mineral Resources Act 1989* and sections 31A and 31B of the Mineral Resources Regulation 2013.

In addition to measurement of water quantities there is a requirement to provide an annual monitoring report. Further details are provided in **Section 4.7**.

4.3 Groundwater Level Monitoring

Groundwater level monitoring is the key parameter for assessing changes to the groundwater regime, particularly as the 'make-good' agreements with the landholders is predicated on a water level change.

4.3.1 Frequency and Duration

Groundwater level monitoring is ongoing to allow for characterisation and identification of natural fluctuation (seasonal variation) prior to commencement of mining activities.

Based on approval conditions (**Section 4.3**) groundwater levels within the baseline groundwater monitoring network are to be reviewed at least every six months. All groundwater monitoring locations have dedicated automated groundwater level loggers. The loggers compile water level data at a minimum 12-hour interval, with the data being downloaded (at a frequency of not more than six months) and assessed on a regular basis as per reporting requirements.

Groundwater level monitoring will continue through construction, operations, and post-closure at selected representative groundwater monitoring points to provide representative assessment of groundwater level changes in the various groundwater units and adjacent to MNES, Carmichael River GDEs, and neighbouring groundwater use.

During post-closure it is envisaged that the groundwater level data will provide recovery data (long-term pseudo-steady groundwater levels), which will be compared to long-term model predictions.

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Details of groundwater level monitoring frequency for each of the mine phases are included in Table 35~~Table 35Table 35~~.

Table 35 Mining Phases and Monitoring Details

Mining Phase	Groundwater Level	Frequency	Groundwater Quality	Frequency	Monitoring points
Baseline	Automated loggers	12-hour intervals	Every 2 months	For a minimum of 24 months	As per GMMP Table 46~~Table 46Table 46~~
Construction	Automated loggers	12-hour intervals	Every 2 months	During construction	As per GMMP Table 46~~Table 46Table 46~~, plus shallow bores adjacent to mine water and waste facilities six months prior to construction.
Operations	Automated loggers	12-hour intervals Life of Mine	Every 2 or 3 months[11] (subject to regulatory confirmation)	Life of Mine (possible revision of frequency after 10 years depending on chemistry trends)	As per GMMP **Section 6.2**
Post closure	Automated loggers	12-hour intervals Post-closure duration to be determined in closure plan	Every 3 months	Samples every 3 months for a minimum of 5 years[12] - frequency to be determined in the long term, depending on chemistry trends	Post closure monitoring points to be determined at least five years prior to cessation of mining operations.

4.3.2 Instrumentation and Control

Groundwater levels are measured manually with an electronic water level meter each time a bore is visited. The probe is decontaminated between bores.

Hydrostatic pressure readings are and will be collected from the artesian bores, both manually (reading PSI gauges) and from automated pressure loggers (Error! Reference source not found., **Section 3.5.2**).

Permanent automated water level measuring devices have been installed in all monitoring bores (**Section 5.0**), comprised of a pressure transducer or vibrating wire piezometer for water level measurement, and data loggers for recording the measurements.

Barometric pressure loggers are included across the large mine lease and are in each geographic region of the CCP tenements, three barometric loggers are located within the north, central, and southern sections of the MLs. The barometric pressure loggers are downloaded, and the data

[11] To be confirmed by DES during the GMMP approval process
[12] Adani will appoint a suitably qualified hydrogeologist to assess post-mining groundwater monitoring to assess long term trends.

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collected each sampling event to allow for barometric correction of water level data recorded over time.

4.3.3 Groundwater Level Indicators

Changes in quantity of groundwater (or availability of groundwater), flow volumes in aquifers, and interaction between groundwater and surface water features are primarily determined based on groundwater level/pressure levels and related changes to these levels.

Natural fluctuation in groundwater levels occur (dependant on aquifer type, depth, etc.) in response to daily, seasonal, and long-term climate cycles. The duration of these fluctuations can range from short-term (for example, shallow monitoring bores in unconfined aquifers responding to individual precipitation events) to long-term (multi-year variations in climate and basin water balance).

Mining-induced changes in groundwater levels can be caused by removal of groundwater from an aquifer, changes in groundwater balances (due to land cover changes including construction of ponds, dumps, etc.) and pressure effects due to depressurisation of aquifers.

Localised effects on groundwater levels can occur in the form of artificial recharge because of leakage from mine waste or mine water storage facilities which result in an increase of groundwater level(s).

The primary indicator for groundwater quantity is, therefore, defined as the temporal change to groundwater level (hydrostratigraphic pressure) in a defined aquifer interval at an established monitoring location.

As a result, groundwater levels at established locations are and will continue to be monitored to compare and assess future trends. Characterisation of expected natural fluctuations in groundwater elevation in each monitored hydrostratigraphic unit has been compiled to establish baseline conditions and variability. The identified baseline conditions and natural fluctuation (variability) were utilised to assess and categorize groundwater level thresholds and will be used to assess for mine-related influences on groundwater levels going forward.

4.4 Groundwater Quality Monitoring

Groundwater samples have and will be obtained from representative groundwater monitoring bores within each monitored hydrostratigraphic unit. The baseline groundwater quality monitoring undertaken to date was used to establish representative groundwater chemistry trigger levels, as required in EA Condition E9 (**Appendix A**~~Appendix A~~~~Appendix A~~).

The hydrostratigraphic units monitored on site, based on the potential for mine activities to impact on groundwater resources, include:

- Unconfined alluvium sediments
- Tertiary sediments
- Clematis Sandstone
- Dunda Beds
- Rewan Formation
- Bandanna Formation (AB Seam)
- Colinlea Sandstone (D Seam)
- Joe Joe Group.

4.4.1 Groundwater Quality Indicators

Ambient groundwater quality data for each hydrostratigraphic unit was collected as a component of the baseline monitoring program. This included analyses of a wide range of parameters to gain an understanding of specific hydrochemistry and variation within each unit.

Review of these baseline data resulted in identification of representative chemistry parameters for each unit. The established representative data allow for identification of conditions outside of the range of natural variability / baseline conditions and potential impacts on groundwater quality.

It is noted that baseline parameters (i.e. large suite of analytes) were collected until sufficient measurements were available to statistically demonstrate the range of natural variability within the each hydrostratigraphic unit.

The baseline hydrochemistry datasets will be used for comparison to future groundwater quality samples.

4.4.2 Methods

Groundwater quality sampling techniques were selected to minimise purge water volumes to be managed that ensure groundwater samples collected are representative and repeatable for the hydrostratigraphic unit.

Quality samples are collected via low-flow methods with dedicated tubing for each monitoring bore. Groundwater is purged until aquifer field parameters, measured via flowthrough cell, have stabilised per Table 36~~Table 36Table 36~~ below. Groundwater quality samples are then collected after confirmation of aquifer parameter stabilisation.

Table 36 Field Parameter Stabilisation Criteria Prior to Sample Collection

Measurement	Variability	Recording
pH	± 0.1 pH unit	Continuous readings until stabilised, i.e. three to five consecutive readings within the variability range.
Temperature	± 0.2°C	
Electrical Conductivity	± 3%	
Dissolved oxygen	± 0.3 mg/L	
Redox potential (Eh)	± 5%	

4.4.2.1 Groundwater Sampling

Groundwater monitoring and sample collection is undertaken in accordance with the most recent edition of the EHP (DES) Water Quality Sampling Manual, which outlines guidelines and approaches for the collection of repeatable and representative groundwater data.

4.4.2.2 Springs Sampling

For sample procurement purposes all springs sampled are treated similarly to a bore, except for two differences. Firstly, as the spring flows are continuous no purging is required. The second difference relates to quality: special care is made to not allow contamination of the representative flowing water with standing water during sampling (especially where cattle have access to spring discharge).

Adani's approach to reduce contamination is to obtain grab samples from the flowing water as close to the spring outlet as possible (where identifiable). Field parameters are measured and recorded, and after rinsing the sample bottles samples are collected as for a bore. Electrode measurements are made from little pools close to the spring outflow where the water velocity is not too great to cause distortion of the electrode readings.

In addition to the grab samples collected from the DSC springs, the samples to be collected at the Joshua Spring are obtained from the discharge pipe installed within the turkey's nest dam wall. This flowing water allows for the collection of a representative grab sample of the Joshua Spring.

The Mellaluka Springs Complex comprises a wetland and dam, with no readily discernible spring discharge point(s). Sampling from the wetland inundation requires additional consideration to ensure representative water samples.

Adani has, after discussions with the landholder, installed a spearpoint within an accessible portion of the permanently saturated section of the Mellaluka Springs Complex to facilitate the sample collection. These sample points were selected and constructed so to ensure the limitation of damage to sensitive ecosystems (groundwater dependent ecosystems, vegetation communities) that are associated with springs which could be damaged by long-term / ongoing sampling (walking to and working around springs can cause damage).

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Spearpoints

In September 2018 Adani installed five (5) spearpoints into springs within the Doongmabulla Spring Complex, to facilitate sampling. The spearpoints are included in the operational groundwater monitoring network (**Section 6.2**) to allow for the collection and assessment of groundwater data within the DSC.

A summary of the wellpoints is included in Table 37~~Table 37Table 37~~.

Table 37 Spearpoints at DSC

Spearpoint	Easting	Northing	Depth (mbgl)	Screen (mbgl)	Water level (mbgl)
C18010SP	421610.10	7556860.74	2.82	1.27 – 2.67	Blocked[13]
C18011SP	422044.83	7556285.96	0.56	0.08 – 0.51	0.22
C18012SP	420424.31	7557642.01	2.40	0.40 – 2.40	At surface
C18013SP	420427.75	7557636.78	2.52	0.50 – 2.52	0.18
C18014SP	424639.57	7557046.47	4.10	2.50 – 3.95	3.22

4.4.3 Parameters

4.4.3.1 Baseline Monitoring

The pre-mining groundwater quality monitoring, required to determine ambient hydrochemistry, includes the following:

- Field parameters: dissolved oxygen (DO), pH, temperature, and electrical conductivity (EC) - calculated total dissolved solids (TDS)
- Major cations and ions: calcium, magnesium, potassium, sodium, chloride, sulphate, alkalinity (carbonate and bi-carbonate), sulphide, and fluoride
- Dissolved[14] Metals/metalloids: aluminium, arsenic, boron, cadmium, chromium[15], cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, silver, uranium, vanadium, zinc, and mercury
- Nutrients: Ammonia (as N), nitrate (as N), nitrite (as N), and total phosphorous (as P)
- Total Petroleum Hydrocarbons[16] (TPH) (C_6 –C_{40}) and BTEX (benzene, toluene, xylene, ethylbenzene).

These parameters were selected to obtain a large encompassing suite of analyses to ensure accurate evaluation of ambient hydrochemistry, allowing for comparison with groundwater quality data compiled during mining.

NOTE: The baseline groundwater parameter suite, as included in EA Condition E9 (developed to allow for the determining baseline groundwater quality), will be adopted during the current ongoing monitoring (between GMMP draft and construction), during construction, and during the initial operational phases of mining. This list will then be assessed in future iterations of the GMMP and discussed with the regulators to develop a more site specific (indicator) list, as discussed in **Section 4.4.1**.

[13] Screen clogged with clay, to be developed
[14] Dissolved concentrations will be analysed as this is representative of the water that flows through the aquifer, rather than analysis of total concentrations which may be affected by bore conditions.
[15] Total chromium and not hexavalent chrome is included in the suite. Should elevated chromium results be recorded then speciation of chrome will be investigated.
[16] It is noted and has been discussed with DES that since the amendment of the NEPM NATA accredited laboratories provide their TPH concentrations at Total Recoverable Hydrocarbons, allowing for more definitive reporting. Adani will provide the most accurate hydrocarbon concentration results, i.e. the TRH results understanding that this addresses this EA approval requirement

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4.4.3.2 EA Condition Monitoring

The baseline monitoring suite detailed in **Section 4.4.3.1** has been adopted in EA Condition E9 Table E1 (Appendix A~~Appendix A~~Appendix A). These data will allow for comparison during and post-mining, should queries arise.

It is noted this baseline suite will continue to be collected during construction and initially when mining operations start. It is considered this parameter list may be reduced in the long term through discussions with regulators.

4.4.4 Quality Assurance / Quality Control Sampling

Field monitoring equipment, such as electrical conductivity and pH meters, are to be calibrated daily during groundwater monitoring events (GMEs) using appropriately ranged and preserved calibration solutions.

Quality assurance/quality control laboratory samples are collected at a rate of one duplicate sample for every ten groundwater samples collected, or if less than ten samples in a sampling event, one duplicate sample per batch. The duplicate sample is sent to the primary analytical laboratory.

NOTE: the duplicate results were included in the ambient groundwater quality dataset which was utilised to develop groundwater quality triggers (**Section 5.4**).

Duplicate groundwater samples are analysed for the full suite of parameters as the primary sample.

Collected samples are transported under chilled conditions to the laboratory without compromising the sample hold time limits.

4.5 Monitoring Requirements under the AWL

The AWL obtained for the project require development of Underground Water Monitoring Program (UWMP) with the following objectives-

(a) to assess the effects of the take of underground water authorised under this licence, including:
- *(i) to provide for the monitoring of impacts on springs and watercourses dependent on underground water flow (Doongmabulla Spring Complex, Mellaluka Spring Complex and Carmichael River alluvium and baseflow);*
- *(ii) to provide for the monitoring of impacts on other underground water users;*
- *(iii) to provide for underground water level monitoring in all identified geological units across and adjacent to the mine site;*
- *(iv) to monitor impacts on the Dunda Beds and Clematis Sandstone aquifers;*
- *(v) to monitor source aquifers identified as potential alternative water supplies for owners of bores with predicted impaired capacity;*
- *(vi) to estimate underground water inflow to, and take from mine workings;*

(b) to provide for the refinement and validation of the numerical underground water model used to assess impacts; and

(c) to take into account requirements of any regional underground water monitoring and assessment program developed to address potential cumulative impacts.

Note: the requirements of the Underground Water Monitoring Program may be incorporated within monitoring programs as required under Federal or State Government approvals

It is to be noted that the GMMP meets above required objectives of the UWMP, as the above objectives are consistent with that of mentioned under EA and EPBC approval conditions.

4.6 Data Management

4.6.1 Data Collation

All groundwater hydrochemistry data, compiled during the baseline project phase, is currently stored in a CCP-specific Excel workbook and in an ESdat database, which is directly updated using laboratory Certificates of Analysis (COA) reports.

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It is planned that all groundwater data (chemistry and water levels), collected and compiled as part of this GMMP, will be stored and managed in a CCP-specific groundwater database. This database is planned to include:

- Bore location details, aquifer and equipment details (including pumping infrastructure and instrumentation)
- Groundwater level and chemistry data
- Projected groundwater level variations based on predictive groundwater modelling
- Geological logs
- Bore construction details.

4.6.2 Data Dissemination

Reports

Interpreted data will be disseminated through the agreed (EA Condition E15 (Appendix A~~Appendix A~~~~Appendix A~~)) reporting requirements (**Section 4.8**). These data will be provided on a six-monthly basis, in line with the approval conditions.

Geological logs and construction details of monitoring bores constructed on site (existing and in future) will be provided for inclusion in the groundwater database and provided in reporting as required (Appendix A~~Appendix A~~~~Appendix A~~ - EA Condition E15).

Website Information

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 will be uploaded to the website within 4 weeks of the finalisation of the 6 monthly reports.

4.7 Data Analysis

4.7.1 Data Analysis Process

Adani has, in discussion with DES, proposed groundwater quality triggers and groundwater level thresholds.

The groundwater quality triggers (EA Condition E9 Table E2 (Appendix A~~Appendix A~~~~Appendix A~~)), are based on statistics, against which future monitoring data is to be assessed. Different methods exist for the assessment of groundwater monitoring data, one of which is the use of statistical tests for the development of indicator parameter limits. It is recognised that alternative methods exist, however, statistics honour natural data variability and facilitate tracking of quality and quantity trends.

The groundwater level thresholds (EA Condition E13 Table E3 (Appendix A~~Appendix A~~~~Appendix A~~)), including low and high impact threshold levels for the Dunda Beds and Clematis Sandstone (Recommended Condition 5 Great Artesian Basin aquifer threshold levels and condition 57 Associated Water License Ref 617264), and Early warning triggers and Impact thresholds in accordance with EPBC Act conditions 3e)i, 22, 23, and 24, have been proposed in **Section 5.3**. These thresholds, in response to the conditions at Appendix 1, Section 1, Schedule E of the CG's Report, have been based on predictive groundwater modelling.

4.7.1.1 Hydrochemistry Data

A sufficient (statistical) groundwater dataset is available (a minimum of 12 sample events over a two-year period) to assess and identify representative hydrochemistry data for each hydrostratigraphic unit being monitored (GMMP **Section 5.4**).

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The sufficient groundwater quality data (from a statistical perspective) has allowed for the proposition of groundwater quality trigger levels. These trigger levels are based on the conditioned 85th percentile values for each measured parameter (in EA Condition E9 Table E2) in each hydrostratigraphic unit, possibly impacted by mine operations, as detailed in EA Condition E9 Table E1 (Appendix A~~Appendix A~~~~Appendix A~~).

Trends can be identified, and follow-up investigations initiated (when trigger levels are exceeded) per the established approach outlined in **Section 4.7.2**. The intent of the investigative follow-up is to identify natural exceptions to established trigger levels and facilitate revision of the triggers as per the adaptive management approach (i.e. an assessment of potential for environmental harm will be conducted and if it is found that the trigger levels are exceeded due to natural conditions (not mine related) then the limits are to be re-evaluated).

4.7.1.2 Groundwater Level Data

It is recognised that drawdown, because of mine dewatering and/or depressurisation, can materially impact on groundwater yields (e.g. reduced available drawdown) and potentially cause environmental harm (e.g. water table decline below root depths).

To identify potential drawdown impacts before they can impact on sensitive receptors (springs, river, neighbouring bores, etc.), the groundwater monitoring at CCP allows for several of the monitoring points to act as early warning and model prediction validation points, when assessing mine dewatering drawdown.

Groundwater level thresholds in units between the mine and the sensitive ecosystems (GDEs, spring complexes, and riparian vegetation) and landholder supply bores have been proposed based on predictive modelling (GMMP **Section 5.3**).

Once monitoring indicates that these groundwater level thresholds (including Early warning triggers and Impact thresholds) have been reached then investigations and response processes will be instigated, as detailed in GMMP **Section 4.7.2**.

The proposed groundwater level thresholds have been adopted for monitoring points in areas as defined in EA Condition E13 Table E3 (Appendix A~~Appendix A~~~~Appendix A~~), and include:

- Adjacent to the Carmichael River
- To the west of the mine lease in and below the GAB units and adjacent to the Doongmabulla Springs Complex
- Adjacent to the Mellaluka Springs Complex to the southeast of the mine leases.

These monitoring points on the mine lease boundary and outside the mine lease, between the mine operations and current groundwater users, are sentinel bores which allow for the validation of groundwater level and chemistry change before these possible groundwater impacts occur at the sensitive receptors .

It is noted that the groundwater level thresholds will be revised over time, based on model refinement conducted using site specific monitoring data (every two years for first ten years and then every five years).

4.7.2 Investigation and Response Processes

4.7.2.1 Hydrochemistry

First Step

In compliance with EA Condition E10, should any groundwater quality triggers (as detailed in EA Condition E9 Table E2) be exceeded in two consecutive monitoring events, an investigation will be undertaken within 14 days of detection (after chemistry results are received from the second groundwater monitoring event) to determine if the exceedance is a result of:

- Mining activities authorised under this environmental authority, or
- Natural variation, or

Neighbouring land use resulting in groundwater impacts.

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Second Step

If the investigation determines that the exceedance was the result of the approved mining operations, then investigations will be undertaken to establish whether environmental harm has occurred or may occur (EA Condition E11).

Third Step

In compliance with EA Condition E12, if the investigation determines that environmental harm has or may occur, then the following will occur:

- Implement immediate measures to reduce the potential for environmental harm
- Develop long-term mitigation measures to address any existing groundwater contamination and prevent recurrence of contamination.

Fourth Step

Adani will provide details of the measures implemented to reduce the potential for environmental harm as well as the long-term mitigation measures to the administering authority within 28 days after completing the investigation.

NOTE: This stepped approach will be implemented for trigger exceedances, which allows for investigation and implementation of mitigation measures prior to reaching any groundwater quality limits. **Section 5.4.4** includes recommended Contaminant Limits, derived by DES, for consideration when assessing potential for environmental harm.

4.7.2.2 Groundwater Levels

If groundwater levels fluctuate more than the groundwater level thresholds (Early warning and low impact thresholds), defined through predictive modelling, an investigation will be instigated within fourteen (14) days of detection.

The investigation will aim at determining if the fluctuations in groundwater levels are a result of CCP activities or outside influences. Potential sources of impact may include:

- Mining activities authorised under this environmental authority
- Pumping from licensed bores
- Seasonal variation / climatic events such as prolonged drought
- Neighbouring land use resulting in groundwater impacts; or
- Nearby projects.

To identify if the fluctuation in groundwater level(s) are resultant from non-CCP activities, Adani will undertake investigation as follows:

- Investigate equipment condition / placement (e.g. water level logger malfunction, logger replaced in a different location – stuck on side of bore, animal disturbance, etc.)
- Review and assess at least the most recent twelve (12) months of groundwater level data (hydrographs) to identify and assess trends
- Compare the hydrograph to climate data (rainfall and evaporation rates) over the same timeframe
- Review hydrographs for nearby bores to identify the scale of fluctuation and area of influence (local vs regional)
- Compare the location of other local projects (e.g. projects not related to CCP such as road / rail improvements where groundwater is sourced for construction activities)
- Assess the potential for the fluctuation to be a cumulative impact (extreme drought coupled with local landholder's groundwater extraction rates/frequency increased due to extreme drought).

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

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months. Adani will notify the administering authority within 28 days of the completion of the investigation and provide the following:

- Details of whether actual environmental harm has occurred or is likely to occur
- Any proposed long-term mitigation measures required to address the affected groundwater resource
- An assessment into the known or likely impacts will be undertaken and mitigation measures identified
- A review of mitigation measures and the implementation of additional or more effective controls
- Implementation of additional monitoring to assess the effectiveness of mitigation measures and corrective actions
- Prescribe actions that prevent the occurrence of impacts beyond those that are approved
- Proposed actions to reduce the potential for environmental harm (as dictated per the GAB Spring Research Plan).

In addition, Adani will undertake an assessment of the associated impacts to matters of state environmental significance (MSES) and MNES values as per conditions i3, i4, and i5 of the EA (Appendix A~~Appendix A~~Appendix A). The investigation reports must be prepared within 3 months (of the completion of the investigation) by an appropriately qualified person. The investigation will include consideration of:

- Notification of relevant managing agencies and a revision to the Biodiversity Offset Strategy (BOS) will be proposed if an increased impact cannot be avoided
- Update/revise the numerical groundwater model with the monitoring results
- Implementation of relevant operational constraints in relation to groundwater drawdown impacts such as review of the mine plan (including sequencing of mining)
- Update the model predictions using the refined model and evaluation of the interim threshold level
- 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 which may include
    - limiting thickness of extraction of coal seams and reviewing extraction of multiple coal seams for the underground longwall mining.

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 administering authority will be notified when an investigation is to be instigated for both groundwater quality and levels.

4.8 Data Reporting

EA Condition E15 Requirements

Monitoring results, both groundwater levels and groundwater quality, are verified and stored in a CCP-specific monitoring database. Review of these data will be undertaken on a regular basis and will be reported to the relevant regulator on an agreed-upon basis (i.e. annual environmental returns), as per EA Condition E15.

EPBC Act Requirements

The approval conditions for the CCP under the EPBC Act (EPBC 2010/5736 dated 14 October 2015) include for the provision to make monitoring data available to the Department of the Environment (DotE) (and Queensland Government authorities if requested) on a six-monthly basis. The provision of this data, considering the requirements of the EA approval condition (Appendix A~~Appendix A~~Appendix A**,** Condition E15), will be provided in a format specified by the administrating authority.

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Reports will be prepared and provided at least every six months, as required. It is envisaged that, subject to agreement with the administering authority, the 6-monthly monitoring data packages/reports for the DotE will include:

- Details regarding any changes to the existing monitoring network from the previous report (for example, new monitoring bores coming online)
- The most recent monitoring results in comparison with groundwater quality triggers and groundwater level thresholds
- Histories of complaints regarding groundwater level drawdown or groundwater chemistry in private water bores
- The results of any investigation(s) into potential environmental harm, details of mitigation and / or rehabilitation plans, and results (if applicable)
- The most recent monitoring results in comparison with groundwater quality triggers and groundwater level thresholds
- Groundwater level hydrographs, and trend analysis, will be updated and included in the reports
- Long term trends in the groundwater quality data will also be assessed and included in the report.

<u>AWL Condition 51 Requirements</u>

Under condition 53 of AWL , Adani will provide the Annual Monitoring Report within three months after the end of the relevant water year which includes:

a) the underground water levels in the monitoring bores of the approved UWMP

b) any changes in water quality (Table 3 of AWL Condition 45) in the monitoring bores

c) quarterly monitoring information relating to springs and watercourses dependent on underground water flow by application of Tables 1 and 2 listed in Condition 45 of AWL

d) an estimate of spring flows for each of the spring groups including details of the method used to estimate the spring flows

e) maps showing the actual water level drawdown contours caused by the take of associated water for each aquifer

f) details of any review undertaken of the numerical underground water model since the previous Annual Monitoring Report, as required under AWL conditions 55 or 56

g) an assessment of any differences between the actual water level impact and the impact predicted for the same period in the most current numerical underground water model

h) details of any bores which are predicted by the most current numerical underground water model to be located in the affected area; and

i) raw data provided in a format as requested by the chief executive.

<u>Reporting</u>

Commitments in regard to groundwater monitoring data submission includes the following:

- Data collected under the groundwater monitoring program will be sent to the administering authority on a 6-monthly basis within 30 business days of the end of each six-monthly period and compiled in a motioning report in a format approved by the administering authority
- Adani will undertake an assessment of the impacts of approved mining operations on groundwater after the first 12 months of dewatering commencing and thereafter every subsequent calendar year
- The monitoring reports will include an assessment of impacts, any mitigation strategies as well as any recommendations for changes to the approved monitoring program.

Adani will submit the six-monthly groundwater data in compliance with the EPBC Act Conditions and provide an annual report (EA Condition E15). Groundwater level data and groundwater quality data,

D R A F T

detailed in the Associated Water Licence (AWL) (**Appendix A**~~**Appendix A**~~~~**Appendix A**~~), will be provided with the following timeframes:

- For water level data, within 10 business days from the measurements
- For water quality data, within 40 business days from measurement.

Adani will also make the groundwater data, collected throughout the monitoring life, available for the public through posting data on a webpage dedicated to sharing monitoring information on its website (www.adaniaustralia.com.au) as per AWL Condition 51.

All groundwater monitoring data, factual and interpretative reports will be kept in the Adani database (beyond the minimum five-year EA requirements) for comparison and identification of trends.

For completeness the groundwater monitoring data, factual and interpretative reports (including any possible investigations as a result of triggers / thresholds) will be provided to the Commonwealth regulators as well as the State regulators.

As detailed in **Section 4.6.2** the groundwater monitoring data will be made available to the public through the Adani website, which will be uploaded to the website within 4 weeks of the finalisation of the 6 monthly reports. The groundwater monitoring data dashboard on the website will be operational within three months of approval of the GMMP. Commonwealth-conditioned monitoring results will be publicly available on Adani's website for the life of the CCP.

~~Prepared for – Adani Mining Pty Ltd – ABN: 27 145 455 205~~

5.0 Monitoring Data Presentation and Compliance with Approval Conditions

The baseline data, compiled and presented in the previous sections, have been assessed and interrogated to allow for the compilation of approval conditions, for inclusion in the GMMP. These post approval assessments, to comply with regulatory requirements of the GMMP, include:

- Proposed groundwater level thresholds, which instigate investigations and validation of model predictions with regards to groundwater level changes over time
- Groundwater quality triggers, based on the large baseline groundwater monitoring data set for each hydrostratigraphic unit, which allows for the instigation of investigations into groundwater quality changes over time.

The site-specific GMMP includes detailed procedures which were undertaken to develop a robust baseline groundwater dataset. The baseline monitoring was and continues to be compiled before the commencement of mining activities to ensure representative data (from geologically isolated bores) is collected for comparison during the later stages of mine activities.

The monitoring data presented in this GMMP used to characterise the groundwater resources includes the groundwater monitoring period discussed in **Section 3.0**. Adani continue to collect ambient groundwater, at regular intervals to capture wet and dry season conditions (to provide continuity of data), until mining activities start.

5.1 Overview

The current GMMP allowed for the compilation of baseline data for identified hydrostratigraphic units (as stated above) that may be directly or indirectly impacted by the approved mining activities. The compilation of sufficient (from a statistical and approval perspective) hydrochemistry and water level baseline data allowed for the assessment of natural fluctuations (seasonal variation) of hydrostatic pressures and ambient groundwater quality, which will be used for comparative and assessment purposes over the life of mine and post-mining.

5.2 Groundwater Level Contours

Average groundwater levels using the hydrographs compiled for all available groundwater level data (Appendix E~~Appendix EAppendix E~~) have been contoured to provide an indication of baseline groundwater flow patterns, in each hydrostratigraphic unit, and gradients prior to mining.

The groundwater level contours and flow patterns are included in Appendix C~~Appendix CAppendix C~~.

5.3 Proposed Threshold Limits

5.3.1 Groundwater Level Data

The groundwater monitoring bores network for the monitoring locations, as included in the EA Condition E13, allowed for the collection of background / reference groundwater level data both north, central, and south across the mining lease area. A summary of these bores is presented in Table 38~~Table 38Table 38~~ below and their locations in relation to the mine leases are present in Appendix B~~Appendix BAppendix B~~ (Figures).

The bores selected for assignment of groundwater level thresholds, as required in Table E3 of EA Condition E13, included the following:

- Carmichael River Location - bores adjacent to the Carmichael River, west, within, and east of the Mining Lease, were selected to allow for the assessment of potential environmental harm to Groundwater Dependent Ecosystems (GDEs) associated with the river. Bores intersecting shallow groundwater resources within the surficial geology (Dunda Beds, Alluvium, Tertiary sediments, and Joe Joe Group) were selected for groundwater level thresholds monitoring

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- Great Artesian Basin to West of Mining Lease - Bores constructed within the Rewan Formation, Dunda Beds, and Clematis Sandstone were selected as required in Table E3. The bores were selected, from north to south, to the west of the mining lease for groundwater level thresholds and will also serve as control bores, which will remain for the life of the project and post-closure
- Doongmabulla West of Mining Lease – In addition to the bores identified for the Great Artesian Basin to West of Mining Lease above, the EA Condition E13 included the requirement to compile groundwater level thresholds for the target coal seams D seam and AB seam. It is noted that these units are > 600 m below the Doongmabulla Springs Complex to the west of the MLs and thus, in the absence of very deep coal seam standpipe monitoring bores, selected VWPs have been included to assess potential drawdown between the MLs and the western Doongmabulla Springs Complex area

  In addition, groundwater level thresholds have been proposed for bores within the Rewan Group sediments, the confining aquitard, between the target coal seams and the overlying GAB units
- Mellaluka Springs Complex south of the MLs – Bores to the southeast of the mine lease within the Tertiary sediments and Joe Joe Group were selected to assess potential impacts on groundwater levels adjacent to the Mellaluka Springs Complex. Two bores were included for groundwater level thresholds monitoring in the area in the Permian sediments which pinch out adjacent to the springs. The evaluation of groundwater levels in this area will allow for the assessment of possible induced flow and hydraulic connection within the Tertiary sediments
- Sentinel Bores – In addition to the bores selected above, additional bores that intersect the Joe Joe Groups within and outside the MLs were selected as sentinel bores. These bores are located between the mine and the neighbouring landholder bores and will remain for the life of the project and post-closure:
  - additional sentinel bores, not intersecting the Joe Joe Group, were included to provide long term monitoring bores between the mine lease and the areas of interest, including the Carmichael River, Doongmabulla and Mellaluka Spring complexes, and the neighbouring land holder bores.

The transient groundwater level data was collected using both manual methods (water level dip meter) and using automated water level loggers (In-situ level trolls with accuracy of ±0.1% of full scale, i.e. ± 0.34 m at full scale of 340 m). It is noted that groundwater levels are predicted to decline by up to 200 m (see **Plate 11**~~**Plate 11Plate 11**~~ to **Plate 19**~~**Plate 19Plate 19**~~ in **Section 5.3.2**), such that the accuracy of the level loggers will be adequate (within the full scale range of the loggers) to measure the change in groundwater levels.

As barometric pressure changes can effect groundwater level data the data from the non-vented loggers are corrected (compensated) for barometric pressure (**Section 3.2**).

The groundwater level measurements allowed for the identification of natural fluctuations within these units, as included in **Table 38**~~**Table 38Table 38**~~. The groundwater level hydrographs are included in **Appendix E**~~**Appendix EAppendix E**~~. The hydrographs allowed for the identification of natural fluctuation over the total monitoring period from installation to April 2017.

NOTE: Groundwater level measurements have been conducted prior to any mining activities. The fluctuation of groundwater levels is assumed to be representative of pre-mining conditions, however, existing extraction at neighbouring pastoral bores and/or regular sampling may result in groundwater level variation. Alteration associated with sampling has been edited where evident. The groundwater level data is referred to as natural fluctuation (NF) within this section.

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Table 38 Groundwater Level Data Summary

Bore ID	Maximum (mAHD)	Average (mAHD)	Minimum (mAHD)	Natural Fluctuation (monitoring period)	Trend / Comments
Carmichael River Location					
HD03B	226.28	225.47	225.02	1.26 m (47 months)	High variability in unconfined alluvium.
C027P2	227.35	226.90	226.64	0.72 m (66 months)	Stable water level within confined Dunda Beds after initial logger issues, no influence of wet/dry seasons or recharge / discharge evident.
C029P1	215.38	214.77	214.37	1.01 m (65 months)	Seasonal variation within unconfined alluvium.
C029P2	220.23	220.00	219.75	0.47 m (68 months)	Initial logger data issues, confined limited response in Tertiary sediments.
C025P1	217.05	216.72	216.54 (dry)	0.51 m (58 months)	Often dry downstream alluvium.
C025P2	218.56	217.62	217.36	1.20 m (58 months)	Unconfined to semi-confined Tertiary sediments.
C14028SP	205.60	205.46	205.29	0.31 m (29 months)	Minor fluctuations in response to seasonal changes.
C14027SP	203.72	203.58	203.50	0.22 m (25 months)	Initial logger data issues, confined limited response in alluvium.
C14006SP (Artesian)	226.61	226.03	225.67	0.94 m (10 months)	Stable logger data after 09/2015. Average potentiometric level some 6 m above surface.
Great Artesian Basin to West of Mine Lease					
C180118SP	250.28	250.17	250.05	0.23 m (24 years)	BLOCKED to be repaired. Stable water level within confined Clematis Sandstone, no influence of wet/dry seasons or recharge / discharge evident.
C14033SP	250.75	250.62	250.49	0.26 m (15 months)	Minor fluctuations in response in Clematis Sandstone to seasonal changes.
C14011SP	242.92	242.80	242.69	0.23 m (22 months)	
C14012SP	242.73	242.62	242.50	0.23 m (23 months)	
C14013SP	242.62	242.49	242.33	0.29 m (23 months)	

DRAFT

Bore ID	Maximum (mAHD)	Average (mAHD)	Minimum (mAHD)	Natural Fluctuation (monitoring period)	Trend / Comments
HD02	234.58	234.28	234.12	0.46 m (43 months)	Unconfined Clematis Sandstone bore, slight variations due to dry / wet seasons (highest water levels in February).
HD03A (Artesian)	232.50	232.03	231.48	1.02 m (44 months)	Average potentiometric level in Clematis Sandstone artesian bore, ~ 3 m above surface.
C14021SP	247.30	246.54	246.21	1.09 m (23 months)	Manual readings within unconfined Clematis Sandstone bore indicate variability. difference in manual readings from logger readings due to unconfined conditions.
C022P1	246.88	246.66	246.46	0.42 m (65 months)	Stable water level within confined Dunda Beds, no influence of wet/dry seasons or recharge / discharge evident.
C027P2	227.35	226.90	226.64	0.72 m (66 months)	Stable water level within confined Dunda Beds after initial logger issues, no influence of wet/dry seasons or recharge / discharge evident.
C14023SP	247.47	247.26	247.16	0.30 m (29 months)	Stable water level within confined Dunda Beds, no influence of wet/dry seasons or recharge / discharge evident.
C180117SP	251.16	251.02	250.78	0.38 m (29 months)	Stable water level within confined Dunda Beds, no influence of wet/dry seasons or recharge / discharge evident.
C9553P1R	252.35	252.26	252.20	0.15 m (35 months)	Minor fluctuations within confined Rewan Formation.
C556P1	235.10	234.84	234.52	0.58 m (54 months)	Logger data matching manual data since 05/2014, slight decline in confined water level trend in Rewan Formation.
C555P1	230.14	230.02	229.79	0.35 m (35 months)	Logger issues, manual readings indicate slight response to wet/dry seasons. GHD data datum incorrect.
Doongmabulla to West of Mine Lease					
HD02	234.58	234.28	234.12	0.46 m (43 months)	Unconfined Clematis Sandstone bore, slight variations due to dry / wet seasons (highest water levels in February).
HD03A (Artesian)	232.50	232.03	231.48	1.02 m (44 months)	Average potentiometric level in Clematis Sandstone artesian bore, ~ 3 m above surface.

DRAFT

Bore ID	Maximum (mAHD)	Average (mAHD)	Minimum (mAHD)	Natural Fluctuation (monitoring period)	Trend / Comments
C14013SP	242.62	242.49	242.33	0.29 m (23 months)	Stable water level within confined Clematis Sandstone, no influence of wet/dry seasons or recharge / discharge evident.
C022P1	246.88	246.66	246.46	0.42 (65 months)	Stable water level within confined Dunda Beds, no influence of wet/dry seasons or recharge / discharge evident.
C14012SP	242.73	242.62	242.50	0.23 m (23 months)	Stable water level within confined Clematis Sandstone, no influence of wet/dry seasons or recharge / discharge evident.
C14021SP	247.30	246.54	246.21	1.09 m (13 months)	Manual readings within unconfined Clematis Sandstone bore indicates variability, difference in manual readings from logger readings due to unconfined conditions.
C14206VWP_1	-	237.3	-	Stable since 11/2016	Hydrostatic plus pore pressure stable within AB seam VWP sensor used to assess dewatering / depressurisation trends.
C558VWP1	-	211.6	-	Stable since install 2012	Hydrostatic plus pore pressure stable within D seam VWP sensor used to assess dewatering / depressurisation trends.
C968VWP_P2	-	355	-	Stable since install 2014	Hydrostatic plus pore pressure stable within D seam VWP sensor used to assess dewatering / depressurisation trends.
C968VWP_P5	-	192.8	-	Stable since install 2014	Hydrostatic plus pore pressure stable within AB seam VWP sensor used to assess dewatering / depressurisation trends.
C848SP	232.52	231.91	231.52	1.00 m (37 months)	D Seam coal seam fluctuations.
Mellaluka Springs to the southeast of Mine Lease					
C180120SP (Artesian)	244.15	243.48	241.62	2.53 m (29 months)	Average potentiometric level in artesian bore, ~ 18.5 m above reference level. Composite Tertiary sediments / Joe Joe Group potentiometric pressure Possible sampling influence on potentiometric level.

DRAFT

Bore ID	Maximum (mAHD)	Average (mAHD)	Minimum (mAHD)	Natural Fluctuation (monitoring period)	Trend / Comments
C180122SP (Artesian)	236.66	236.46	235.91	0.75 m (29 months)	Average potentiometric level in artesian bore, ~ 11.5 m above reference level. Composite Tertiary sediments / Joe Joe Group potentiometric pressure Possible sampling influence on potentiometric level.
C851VWP2	-	229	-	Stable since 12/2014	Hydrostatic plus pore pressure stable within AB seam. VWP sensor used to assess dewatering / depressurisation trends.
C180119SP (Artesian)	238.43	238.21	237.94	0.49 m (22 months)	Initially aquifer undergoing stabilisation after drilling and monitoring well installation. Average potentiometric level in artesian bore since 04/2015, ~ 14 m above reference level.
C180123SP (Artesian)	246.52	246.35	245.85	0.67 m (28 months)	Average potentiometric level in artesian bore since 11/2014, ~ 18.5 m above reference level.
C9180124SPR (Artesian)	235.54	235.31	234.99	0.55 m (24 months)	Initially aquifer undergoing stabilisation after drilling and monitoring well installation. Average potentiometric level in artesian bore since 04/2015, ~ 11 m above reference level.
C9180125SPR (Artesian)	243.42	243.10	242.35	1.07 m (25 months)	Initially aquifer undergoing stabilisation after drilling and monitoring well installation. Average potentiometric level in artesian bore since February 2015, ~ 19 m above reference level.
Sentinel Bores					
C14016SP (Artesian)	235.52	234.13	233.39	2.13 m (21 months)	Logger installed 07/2015, average potentiometric level measured on logger is ~11.5 m above surface.
C9845SPR	235.02	234.91	234.74	0.28 m (29 months)	Confined Tertiary sediments.
C14029SP (Artesian)	251.22	251.07	250.75	0.47 m (20 months)	Average potentiometric level in artesian bore, ~ 12 m above reference level. Composite Tertiary sediments / Joe Joe Group potentiometric pressure.
C14003SP	209.52	209.37	209.25	0.27 m (32 months)	Confined Joe Joe Group

DRAFT

Bore ID	Maximum (mAHD)	Average (mAHD)	Minimum (mAHD)	Natural Fluctuation (monitoring period)	Trend / Comments
C14030SP (Artesian)	230.86	230.25	229.58	1.29 m (20 months)	Confined Joe Joe Group Average potentiometric level is approximately 12 m above the reference elevation. Alternate bore name: C914030SPR.
C14015SP (Artesian)	239.26	239.15	238.70	0.55 m (9 months)	Average potentiometric level is approximately 10 m above the reference elevation.
C016P2	248.56	248.46	248.37	0.19 m (66 months)	Relatively stable manual water levels since 02/2014.
C14004SP	209.65	209.44	209.13	0.52 m (28 months)	Confined Joe Joe Group
C14008SP (Artesian)	228.73	228.34	227.35	1.38 m (19 months)	Logger data used, average potentiometric level some 7.6 m above reference level. Manual readings erratic due to pressure gauge inaccuracies.
C180116SP	239.24	239.12	239.01	0.23 m (29 months)	Confined Rewan Formation sediments.
C14024SP	262.80	262.71	262.62	0.18 m (24 months)	Confined groundwater level for bore screened in Clematis Sandstone / Rewan Group.
C14020SP	252.62	252.43	252.31	0.31 m (31 months)	Confined Moolayember Formation sediments.

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5.3.2 Projected Groundwater Levels

During the pre- and post-approval process the groundwater flow model has been subjected to several revisions. On examining the impact prediction results of SEIS model (GHD, 2013) and re-run modelling (GHD, 2015) at sensitive receptors it is learnt that the impacts are similar but higher in case of SEIS model. For the GMMP a review has been made on all the available model predictions and a conservative approach has been taken to use the model which predicts the highest Impacts. The 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 and water level thresholds included in the GMMP.

Predictive groundwater modelling, compiled during the approval process and in response to approval conditions, allowed for the projection of groundwater levels within the bores included in Table 23~~Table 23Table 23~~ and Table 38~~Table 38Table 38~~ above. These projected drawdown levels within these bores are based on the approved mining operations. To better represent when and by how much each hydrostratigraphic unit may be altered (by mine dewatering) and the resultant changes in groundwater flow patterns a series of maps have been developed to depict groundwater flow patterns pre-mining and for different stages of mining (including post closure) have been compiled. The map series are provided in (Appendix C~~Appendix CAppendix C~~).

The projected changes in groundwater levels within the groundwater monitoring bores are included in Plate 14~~Plate 14Plate 14~~ through Plate 22~~Plate 22Plate 22~~ below, which present projected groundwater level hydrographs from the predictive groundwater modelling. The groundwater level change, within bores on and adjacent to the mine lease, are presented in semi-log scale. This is due to the large scale difference in the impacts (direct or indirect) of the mine dewatering. As discussed in **Section 2.7.3.1**, the scale of drawdown is dependent on the distance from the mine and the hydraulic conductivity properties of the hydrostratigraphic units. The bores, hydrostratigraphic units, locations, and predicted drawdown for the bores included in Plate 12~~Plate 12Plate 12~~ to Plate 19~~Plate 19Plate 19~~ are summarised and discussed in Table 40~~Table 40Table 40~~.

Table 39 Summary of predicted drawdown

Bore	Units	Location	Maximum Predicted Drawdown (m)	Mine year	Comment
Carmichael River Location					
HD03B	Alluvium	West of MLs	0.004	64	Shallow intersection of coal (drawdown in C832SP is predicted to be 21 m in the C seam and 37 m in C833SP the D seam) plus the thick low permeable clay-rich Tertiary sands overlying the target coal seams reduces the extent of induced drawdown within the area where the Carmichael River cross the mine lease
C029P1	Alluvium	Centre of MLs	0.33	50	
C025P1	Alluvium	Centre of MLs	1.87	59	
C14028SP	Alluvium	East of MLs	0.075	500	
C14027SP	Alluvium	East of MLs	0.018	500	
C029P2	Tertiary sediments	Centre of MLs	0.42	58	
C025P2	Tertiary sediments	Centre of MLs	1.20	60	
C027P2	Dunda Beds	Western boundary of MLs	1.11	65	
C14006SP	Joe Joe Group	Eastern boundary of MLs	0.42	500	
Great Artesian Basin to West of Mine Lease					
HD02	Clematis	West of MLs	0.03	90	Drawdown > 70 m within

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Bore	Units	Location	Maximum Predicted Drawdown (m)	Mine year	Comment
	Sandstone				the Rewan Formation, within the mine lease, is predicted to result in induced flow from the overlying Dunda Beds by < 5 m (one order of magnitude less), and drawdown in the Clematis Sandstone of ~ 0.5 m some 5 km from the mine lease (a further order of magnitude less), indicating the depressurisation impacts are reduced to the west with distance, thickness, and permeability of overlying units
HD03A	Clematis Sandstone	West of MLs	0.18	87	
C14021SP	Clematis Sandstone	West of MLs	1.66	500	
C14011SP	Clematis Sandstone	West of MLs	0.62	81	
C14012SP	Clematis Sandstone	West of MLs	0.38	83	
C14013SP	Clematis Sandstone	West of MLs	0.38	82	
C14033SP	Clematis Sandstone	West of MLs	0.25	500	
C180118SP	Clematis Sandstone	On western boundary of MLs	2.61	80	
C022P1	Dunda Beds	On western boundary of MLs	3.86	81	
C027P2	Dunda Beds	Western boundary of MLs	1.11	65	
C14023SP	Dunda Beds	West of MLs	0.32	500	
C180117SP	Dunda Beds	On western boundary of MLs	4.83	586	
C9553P1R	Rewan Formation	Northwest corner of MLs	4.5	586	
C556P1	Rewan Formation	West portion of MLs	84.5	50	
C555P1	Rewan Formation	West portion of MLs	73	90	
Doongmabulla to West of Mine Lease					
HD02	Clematis Sandstone	West of MLs	0.03	90	Similar to the GAB units above, drawdown within the D seam on site is predicted to be >120 m, whereas the drawdown within the monitoring bore HD02 some 1 km from the DSC (between the springs and the mine) is predicted to only vary by up to 0.03 m. The low permeable interbeds, above the AB
HD03A	Clematis Sandstone	West of MLs	0.18	87	
C14013SP	Clematis Sandstone	West of MLs	0.38	82	
C14012SP	Clematis Sandstone	West of MLs	0.38	83	
C14021SP	Clematis Sandstone	West of MLs	1.66	500	

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Bore	Units	Location	Maximum Predicted Drawdown (m)	Mine year	Comment
C022P1	Dunda Beds	On western boundary of MLs	3.86	81	seams in the Bandanna Formation, the Rewan Formation, and the Dunda Beds reduce the impacts on the Clematis Sandstone groundwater levels
C848SP	D Seam	Within MLs	128	586	
Mellaluka Springs to the southeast of Mine Lease					
C180120SP	Tertiary sediments and Joe Joe Group	At the Mellaluka Spring	0.02	586	Groundwater drawdown in the Tertiary and Joe Joe Group sediments are not predicted to result in the loss of artesian pressures (> 10 m) in the Mellaluka Springs area
C180122SP	Tertiary sediments and Joe Joe Group	North of Mellaluka Spring	0.05	586	
C180119SP	Joe Joe Group	North of Mellaluka Spring	0.04	586	
C180123SP	Joe Joe Group	South of Mellaluka Spring	0.007	586	
C9180124SPR	Joe Joe Group	North of Mellaluka Spring	0.045	586	
C9180125SPR	Joe Joe Group	At the Mellaluka Spring	0.02	586	

These projected groundwater level hydrographs were used to assist in developing groundwater level thresholds, as per the approval requirements detailed in EA Condition E13, Condition 5 of the CG's Report, and condition 58 of Associated Water Licence.

In addition, Early warning and Impact threshold levels are required for the Dunda Beds and Clematis Sandstone (GAB) aquifers (EPBC Approvals).

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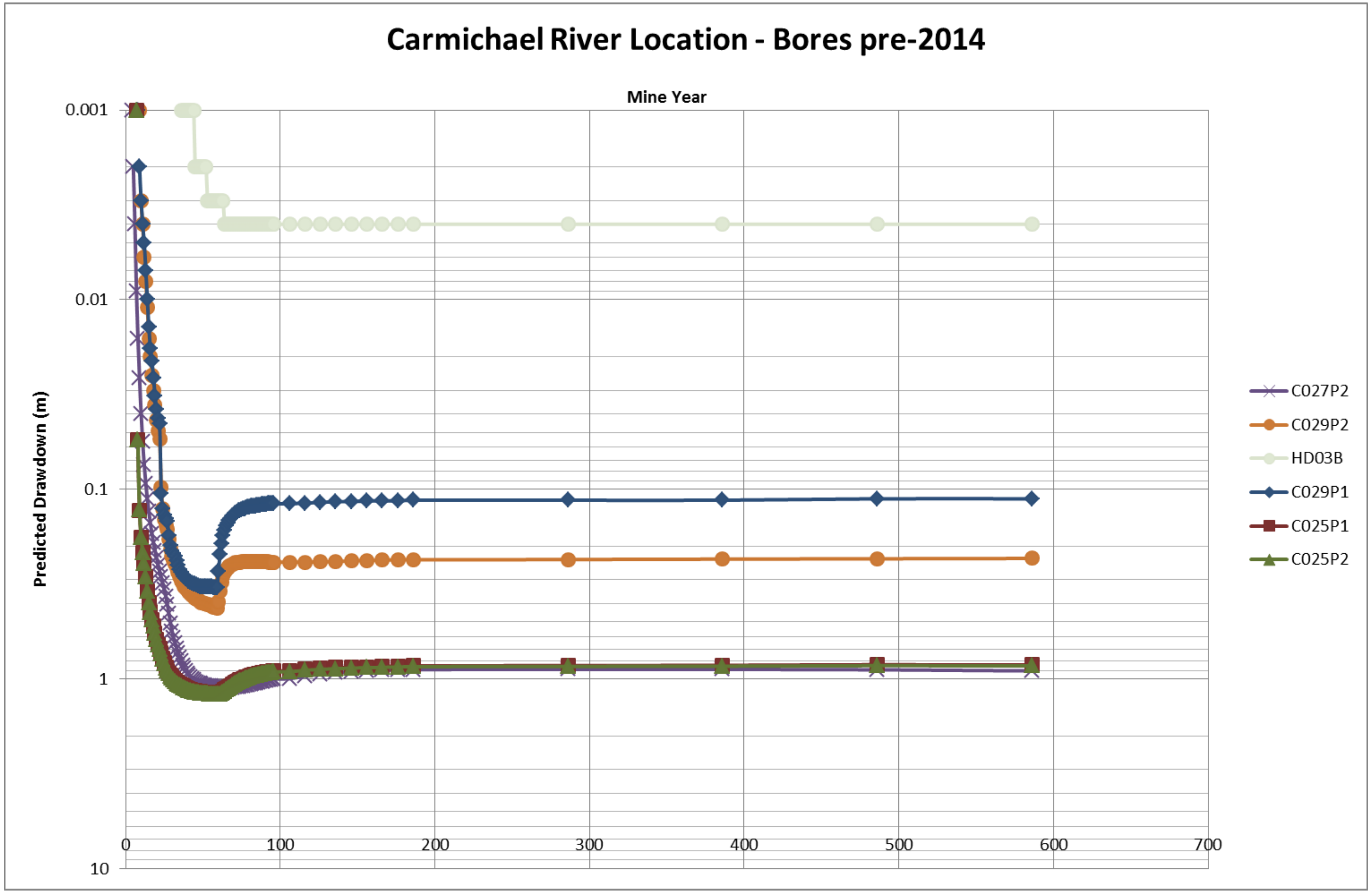

Plate 14 Carmichael River Location (modelled drawdown)

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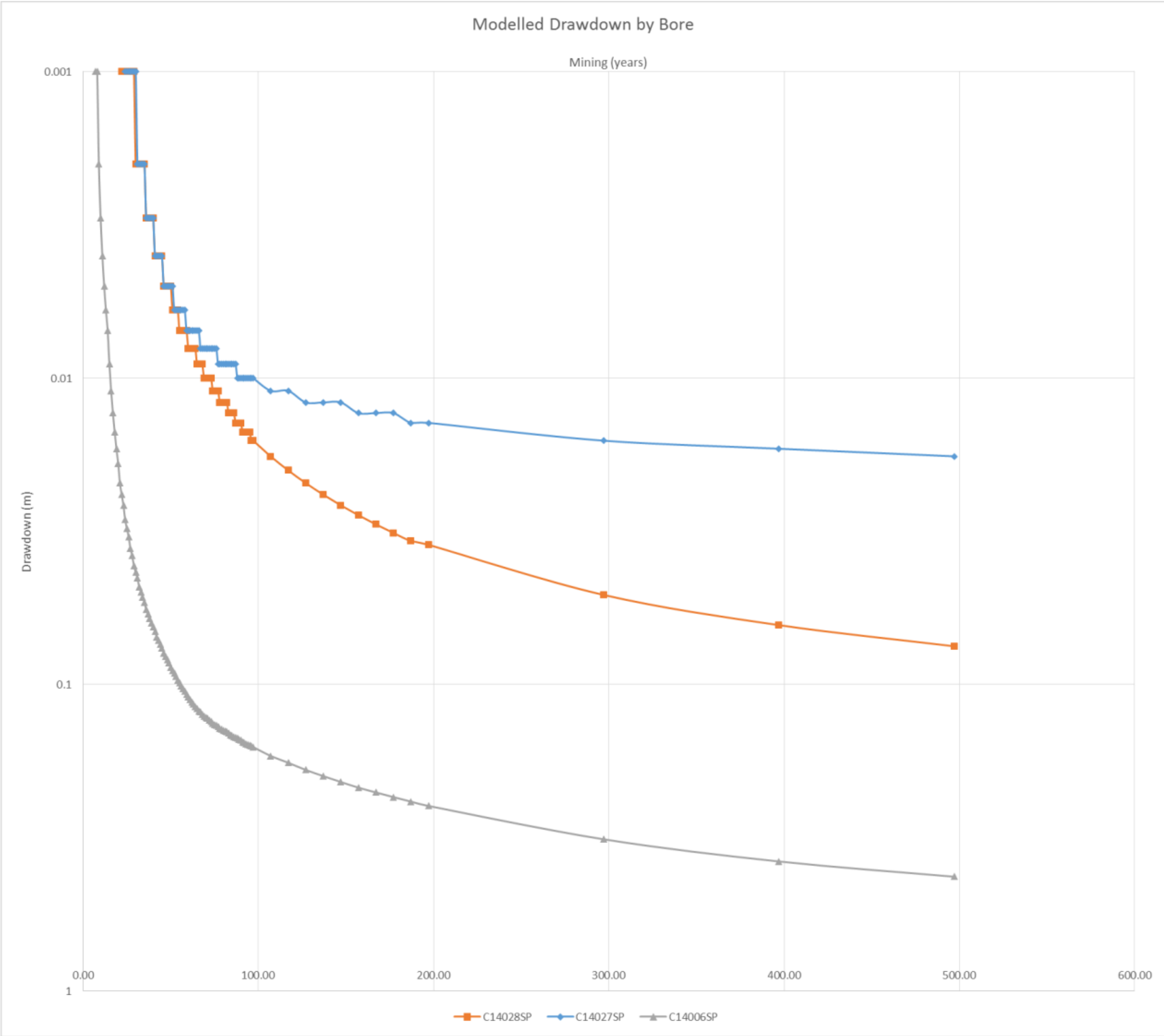

Plate 15 Carmichael River Area (2014 bores)

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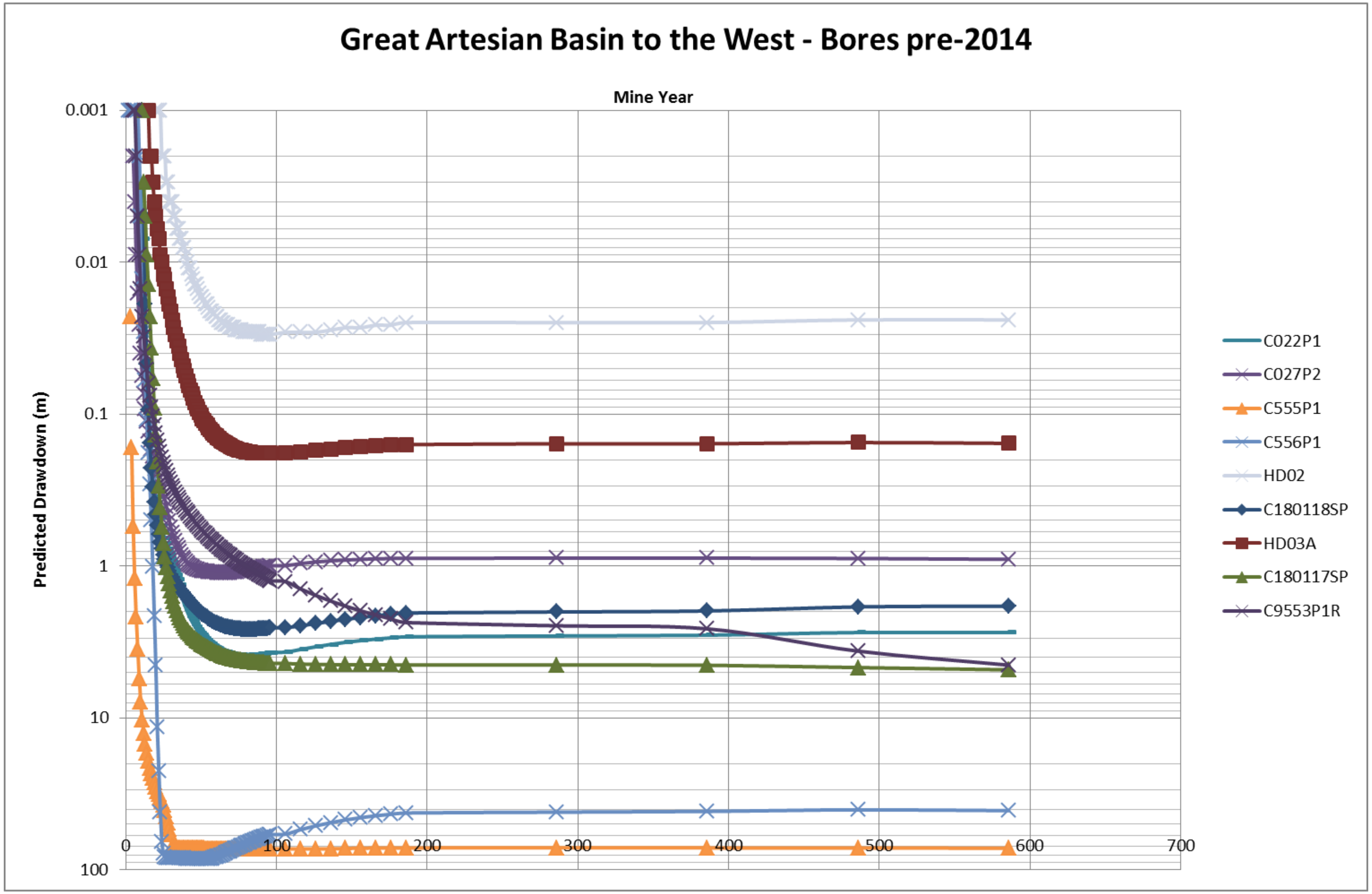

Plate 16 **Great Artesian Basin west of the Mine Leases**

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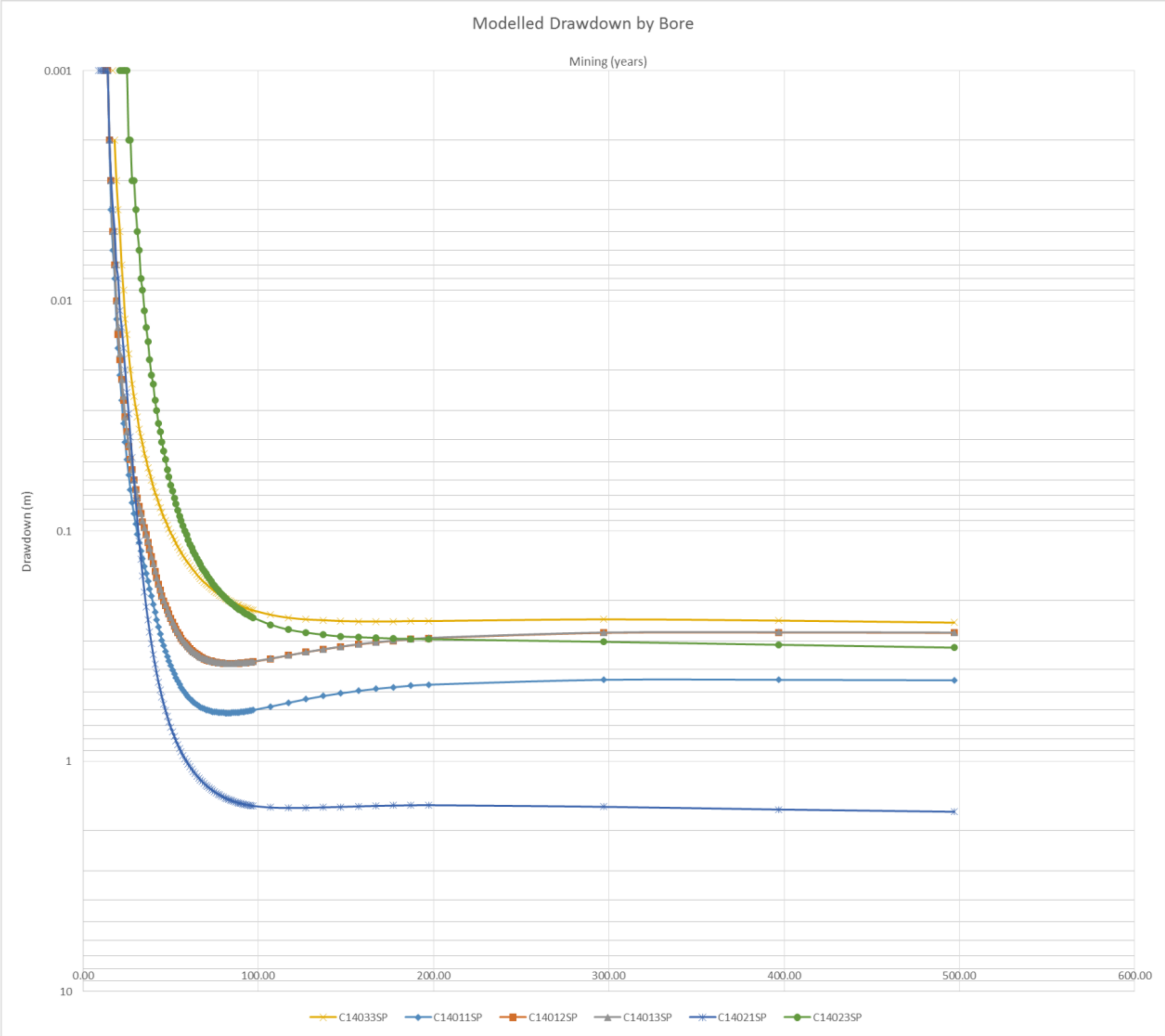

Plate 17 Great Artesian Basin west of the Mine Leases (2014 bores)

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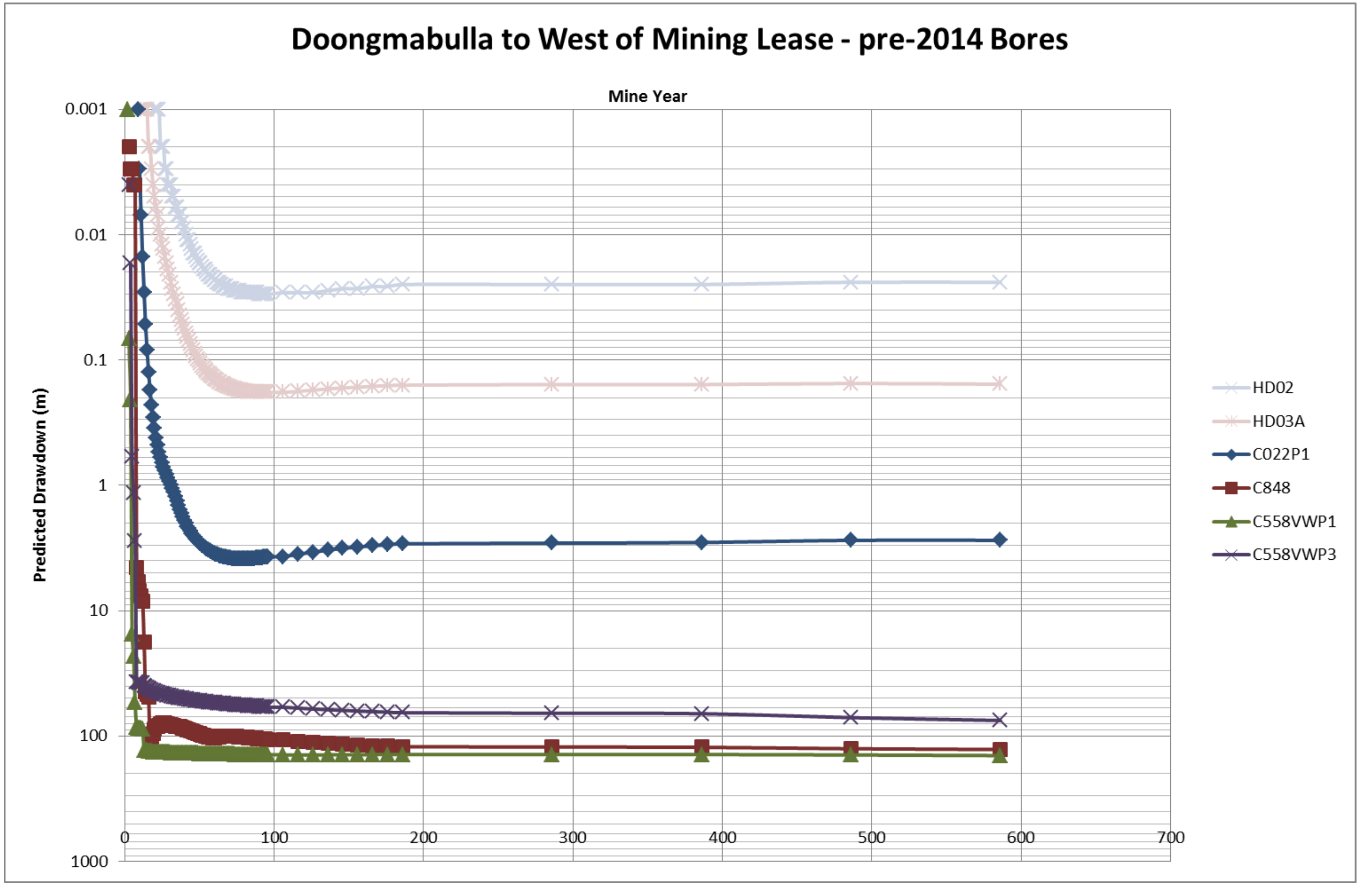

Plate 18 **Doongmabulla Spring Complex west of the Mine Leases**

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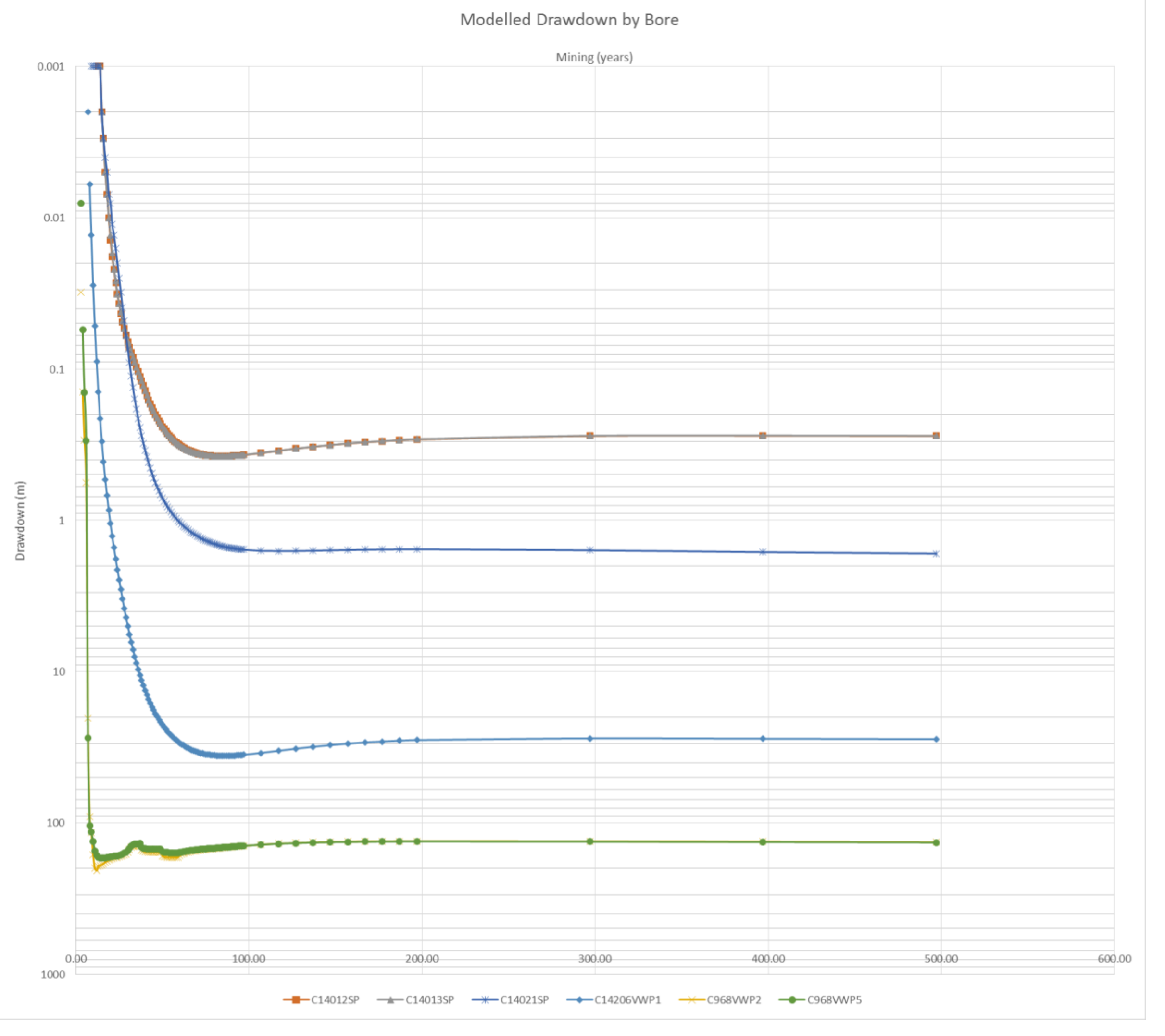

Plate 19 Doongmabulla Spring Complex west of the Mine Leases (2014 bores)

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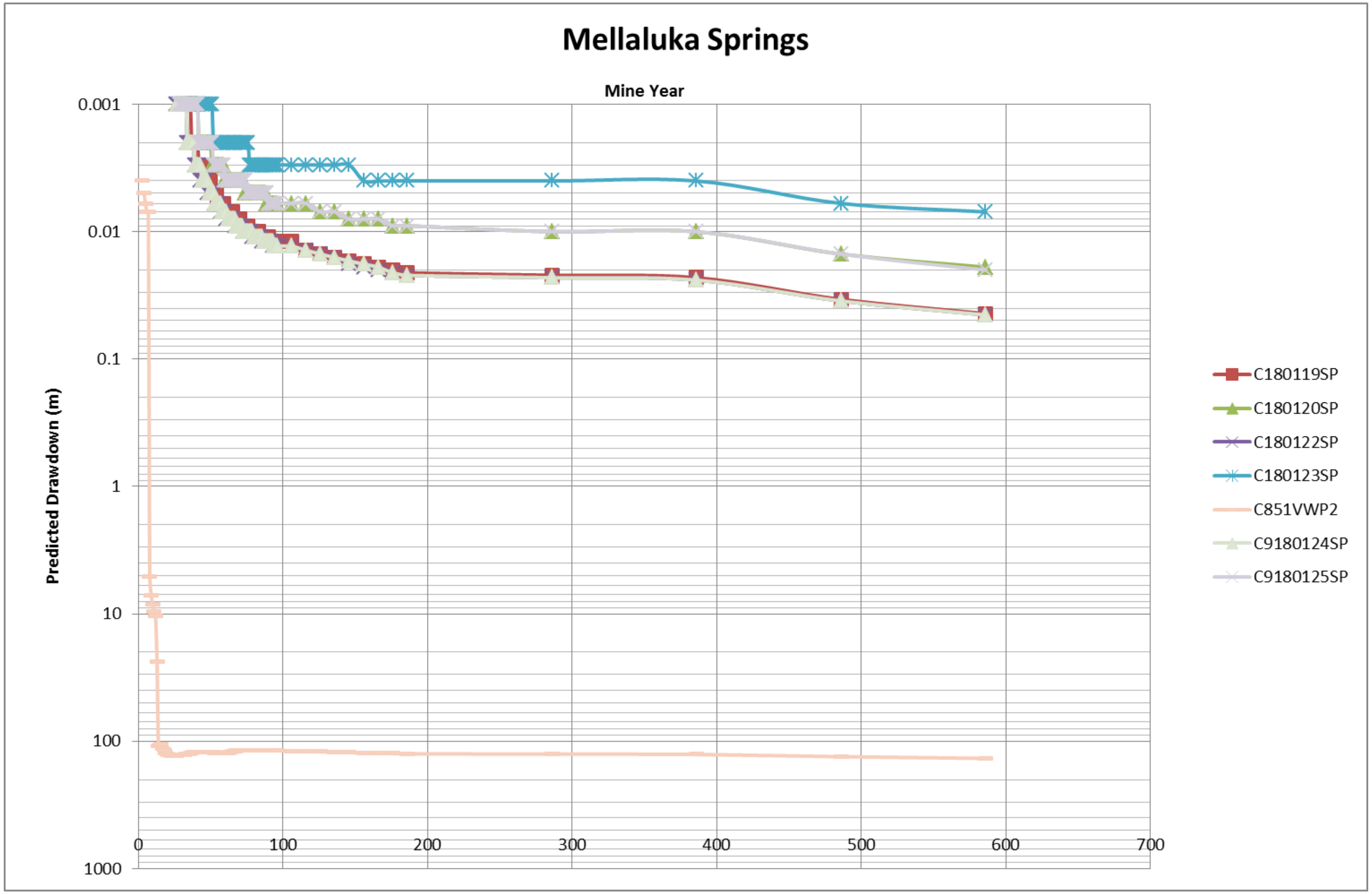

Plate 20 **Mellaluka Springs Complex (southeast of the MLs)**

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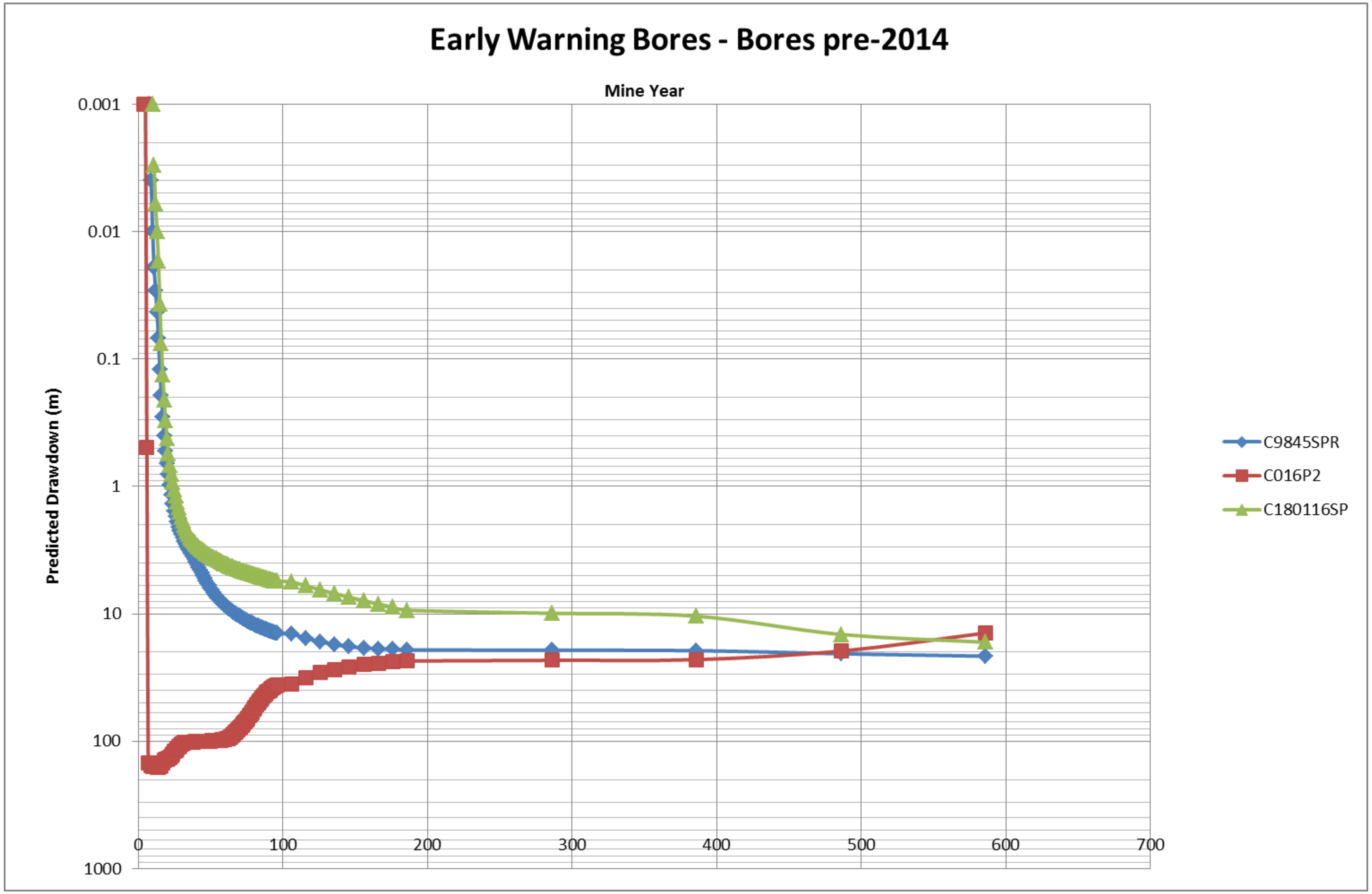

Plate 21 Sentinel Bores

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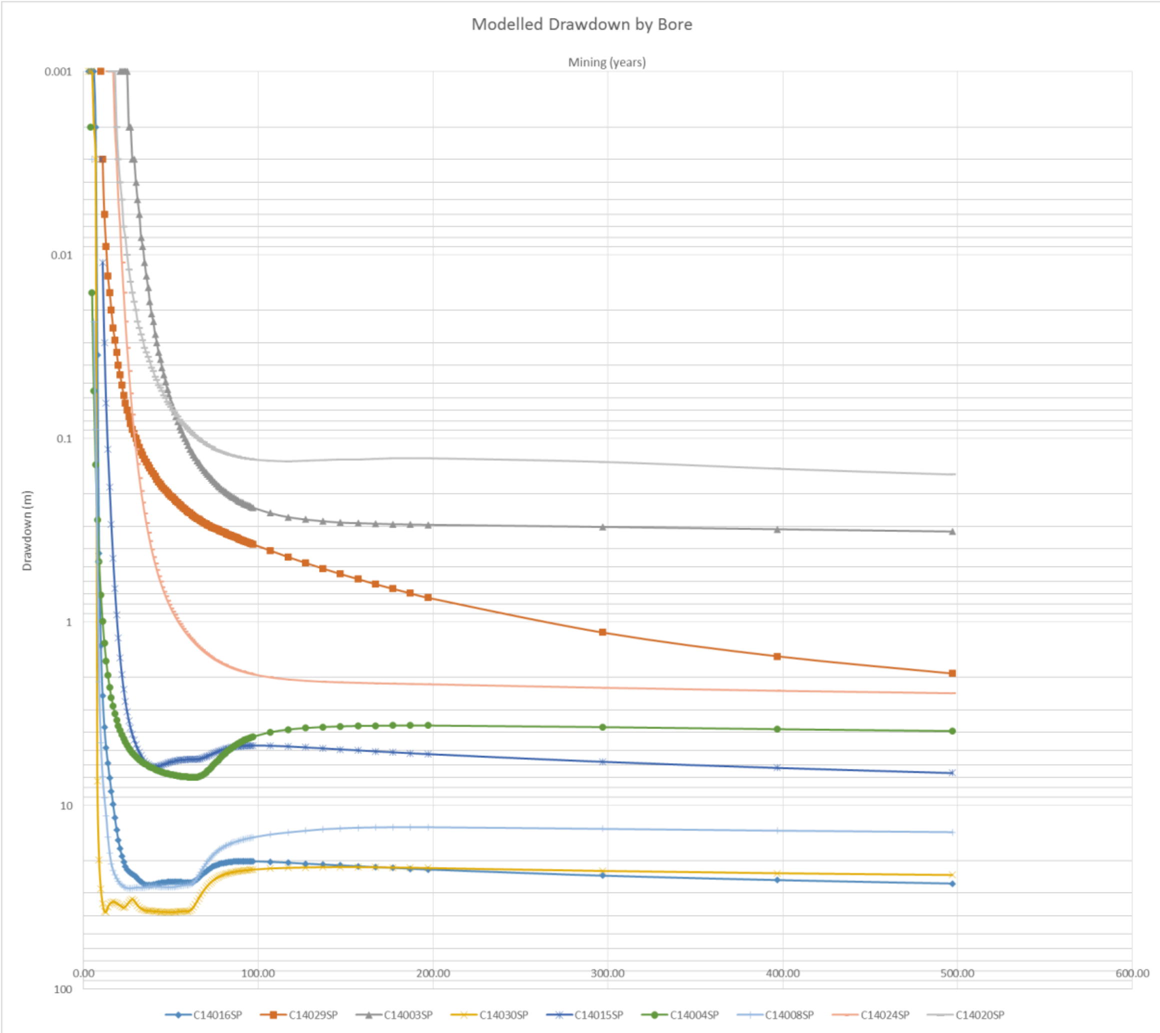

Plate 22 Sentinel Bores (2014 bores)

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The predicted drawdown (below modelled steady-state water level) and timing is summarised in Table 40~~Table 40Table 40~~.

Table 40 Drawdown Predictions

Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur[17]	Natural fluctuation (monitoring period)	Comments
Carmichael River Location				
HD03B	0.004 m	64	1.26 m (47 months)	Not predicted to drawdown more than natural fluctuation
C027P2	1.11 m	65	0.72 m (66 months)	Groundwater level predicted to recover and reach a post-mining level
C029P1	0.33 m	50	1.01 m (65 months)	Recovery to a post-mining level
C029P2	0.42 m	58	0.47 m (68 months)	Drawdown predicted to reach deepest drawdown at end of model simulation
C025P1	1.87 m	59	0.51 m (58 months)	Recovery to a post-mining level
C025P2	1.20 m	60	1.20 m (58 months)	Recovery to a post-mining level
C14028SP	0.075 m	500	0.31 m (29 months)	Drawdown predicted to reach deepest drawdown at end of model simulation
C14027SP	0.018 m	500	0.22 m (25 months)	Drawdown predicted to reach deepest drawdown at end of model simulation
C14006SP	0.42 m	500	0.94 m (10 months)	Drawdown predicted to reach deepest drawdown at end of model simulation
Great Artesian Basin to West of Mine Lease				
C180118SP	2.61 m	80	0.23 m (24 months)	Groundwater level predicted to recover over time
C14033SP	0.25 m	500	0.26 m (15 months)	Drawdown predicted to reach deepest drawdown at end of model simulation
C14011SP	0.62 m	81	0.23 m (22 months)	Recovery to a post-mining level

[17] Time since the commencement of mining in years

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Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur[17]	Natural fluctuation (monitoring period)	Comments
C14012SP	0.38 m	83	0.23 m (23 months)	Recovery to a post-mining level
C14013SP	0.38 m	82	0.29 m (23 months)	Recovery to a post-mining level
HD02	0.03 m	90	0.46 m (43 months)	Not predicted to drawdown more than natural fluctuation
HD03A	0.18 m	87	1.02 m (44 months)	Recovery to a post-mining level
C14021SP	1.66 m	500	1.09 m (23 months)	Drawdown predicted to reach deepest drawdown at end of model simulation
C022P1	3.86 m	81	0.42 m (65 months)	Groundwater level predicted to recover and reach a post-mining level
C027P2	1.11 m	65	0.72 m (66 months)	Groundwater level predicted to recover and reach a post-mining level
C14023SP	0.32 m	500	0.30 m (29 months)	Drawdown predicted to reach deepest drawdown at end of model simulation
C180117SP	4.83 m	586	0.38 m (29 months)	Drawdown predicted to reach deepest drawdown at end of model simulation
C9553P1R	4.5 m	586	0.15 m (35 months)	Drawdown predicted to reach deepest drawdown at end of model simulation
C556P1	84.5 m	50	0.58 m (54 months)	Groundwater level predicted to recover and reach a post-mining level
C555P1	73 m	90	0.35 m (35 months)	Groundwater level not predicted to recover
Doongmabulla to West of Mine Lease				
HD02	0.03 m	90	0.49 m (43 months)	Not predicted to drawdown more than natural fluctuation
HD03A	0.18 m	87	1.02 m (44 months)	Recovery to a post-mining level
C14013SP	0.38 m	82	0.29 m (23 months)	Groundwater level predicted to recover over time

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Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur[17]	Natural fluctuation (monitoring period)	Comments
C022P1	3.86 m	79	0.42 m (65 months)	Groundwater level predicted to recover and reach a post-mining level
C14012SP	0.38 m	83	0.23 m (23 months)	Recovery to a post-mining level
C14021SP	1.66 m	500	1.09 m (23 months)	Drawdown predicted to reach deepest drawdown at end of model simulation
C14206VWP_1	36 m	84	Stable at 237.3 since 11/2016	Recovery to a post-mining level
C558VWP1	143 m	586	Stable since 2012	Drawdown predicted to reach deepest drawdown at end of model simulation
C968VWP_P2	206 m	12	Stable since 2014	Recovery to a post-mining level
C968VWP_P5	171 m	15	Stable since 2014	Recovery to a post-mining level
C848SP	128	586	1.00 m (37 months)	Drawdown predicted to reach deepest drawdown at end of model simulation
Mellaluka Springs to the southeast of Mine Lease				
C180120SP	0.02 m	586	2.53 m (29 months)	Not predicted to drawdown more than natural fluctuation
C180122SP	0.05 m	586	0.75 m (29 months)	Not predicted to drawdown more than natural fluctuation
C851VWP2	136 m	586	Stable since 2014	VWP for trend analysis
C180119SP	0.04 m	586	0.49 m (22 months)	Not predicted to drawdown more than natural fluctuation
C180123SP	0.007 m	586	0.67 m (28 months)	Not predicted to drawdown more than natural fluctuation
C9180124SPR	0.045 m	586	0.55 m (24 months)	Not predicted to drawdown more than natural fluctuation
C9180125SPR	0.02 m	586	1.07 m (25 months)	Not predicted to drawdown more than natural fluctuation

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Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur[17]	Natural fluctuation (monitoring period)	Comments
Sentinel Bores				
C14016SP (Artesian)	27 m	37	2.13 m (21 months)	Groundwater level predicted to recover and reach a post-mining level
C9845SPR	21.5 m	586	0.28 m (29 months)	Groundwater level declining over entire prediction period
C14029SP (Artesian)	1.90 m	500	0.47 m (20 months)	Groundwater level declining over entire prediction period
C14003SP	0.09 m	500	0.27 m (32 months)	Groundwater level declining over entire prediction period
C14030SP (Artesian)	1.90 m	500	1.29 m (20 months)	Not predicted to drawdown more than natural fluctuation
C14015SP (Artesian)	6.65 m	500	0.55 m (9 months)	Groundwater recovery followed by decline predicted
C016P2	160 m	14	0.19 m (48 months)	Groundwater level predicted to recover and reach a post-mining level
C14004SP	7 m	63	0.52 m (28 months)	Groundwater level predicted to recover and reach a post-mining level
C14008SP	1.18 m	500	1.38 m (19 months)	Groundwater level declining over entire prediction period
C180116SP	17 m	586	0.23 m (29 months)	Groundwater level declining over entire prediction period
C14024SP	2.44 m	500	0.18 m (24 months)	Groundwater level declining over entire prediction period
C14020SP	0.16 m	500	0.31 m (31 months)	Groundwater recovery followed by decline predicted

5.3.3 Development of Groundwater Level Thresholds

Based on the assessment of natural fluctuations in groundwater levels, both unconfined and confined aquifers, and the model predictions, groundwater level thresholds have been compiled for the bores in the areas included in EA Condition E13.

The aim of the groundwater level thresholds is to provide an alert regarding possible deviation from the predicted dewatered / depressurisation impacts during mining.

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The groundwater level thresholds also aim to validate induced flow predictions, confirming water take from the GAB units (where present), and validating predicted groundwater level drawdown.

NOTE: It is noted that, due to distance from the approved mining and thick low vertical hydraulic conductivity sediments (Rewan Group and Bandanna Formation) between the target coal and overlying units, several bores are predicted to have limited drawdown because of possible induced flow (i.e. groundwater flow from the overlying units to the depressurised coal seams). These predicted induced flow impacts are recognised to be below the natural fluctuation, resulting in the need to develop several different approaches to setting groundwater level thresholds, as detailed below.

5.3.3.1 Groundwater Level Thresholds

The groundwater level threshold levels (referred to as low impact thresholds (for AWL) and Early warning (EPBC Act)), as required in the EA Condition E13, have been selected based on the possible change in groundwater levels as included in **Table 40**~~**Table 40Table 40**~~. The assessment of groundwater level data, compiled during mining operations, will allow for the compilation of groundwater level hydrographs (up dated after every groundwater monitoring event) allowing for the evaluation of groundwater level trends.

The groundwater level thresholds proposed for the Carmichael Coal Mine are as follows:

- If groundwater levels vary by 50% of the predicted drawdown, above natural fluctuation[18], 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 (for comparison to the average groundwater level as a reference level)
- 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
- Water level readings in C025P1 indicating continuous prolonged dry / no water level readings longer than 6 months (or 1.19 m in a newly constructed alluvium bore).

Should groundwater level monitoring indicate variations in groundwater levels by more than 50% (unconfined) or 75% (confined) groundwater level fluctuations or > 90% of the predicted maximum drawdown levels (in bores where drawdown is predicted to > 10 m) on two consecutive groundwater monitoring events (quarterly) then the following will occur[19]:

- An investigation must be instigated within 14 days of detection.
- The investigation is to determine the cause of the groundwater level fluctuation considering:
  - mining activities authorised under the EA
  - pumping from licensed bores
  - seasonal variation
  - neighbouring land use resulting in groundwater impacts.

A report into the investigation will be made available to the regulator, via WaTERS, within 28 days of completing the investigation. **Plate 23**~~**Plate 23Plate 23**~~ provides a decision tree in the event an investigation is instigated due to exceedance of groundwater level thresholds.

Table 41~~**Table 41Table 41**~~ presents a summary of the proposed groundwater level thresholds for the selected monitoring bores plus a summary of the selection criteria.

[18] Using the average groundwater levels from the hydrographs, the groundwater levels can vary by half the natural fluctuation before mining operations are considered to influence the groundwater level
[19] Prolonged dry conditions in C025P1 (alluvium bore) will trigger these investigations

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Table 41~~Table 41Table 41~~ includes a reference datum, the average groundwater level data from the baseline monitoring, to allow for the evaluation of groundwater change to the groundwater level thresholds. In doing so the groundwater level thresholds include for half of the natural fluctuation (i.e. the average groundwater can vary up and down by half the recognised natural fluctuation before the potential impacts of approved mining is recognised).

The predicted groundwater level hydrographs and associated groundwater level thresholds are included in Appendix E~~Appendix EAppendix E~~.

Groundwater level thresholds Summary – Decision Tree

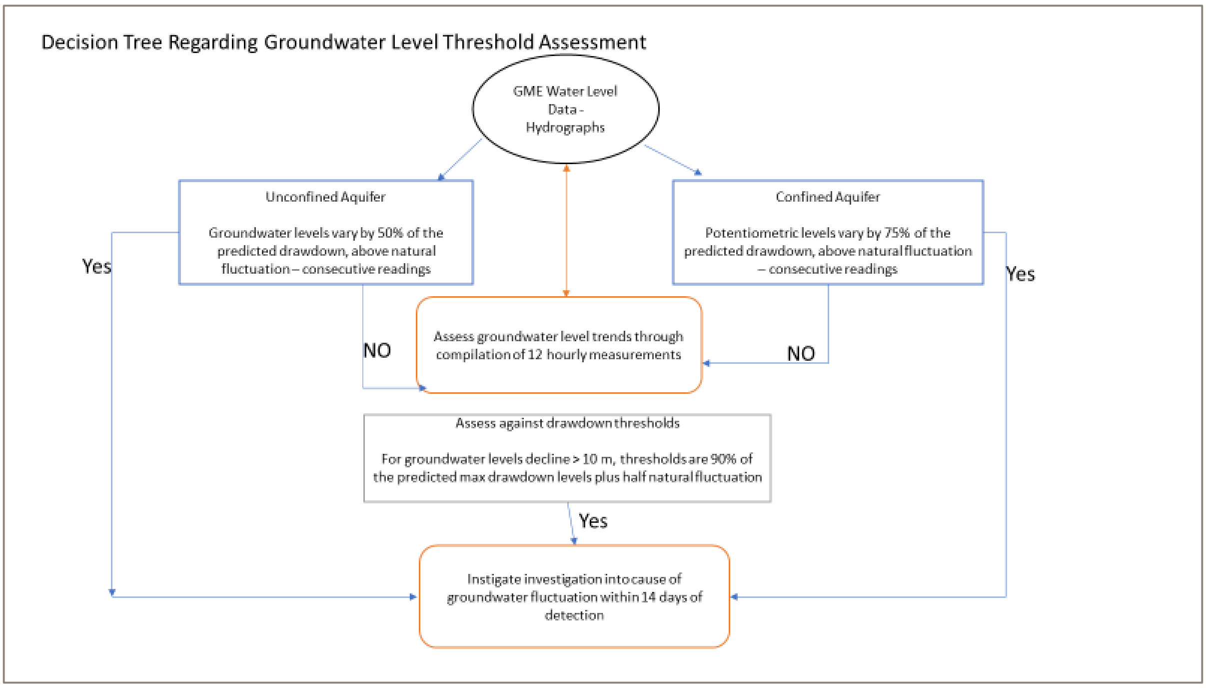

Plate 23 Groundwater level drawdown threshold decision tree

Note: The use of the groundwater level thresholds, including for alluvium along the Carmichael River, included in Table 43~~Table 43Table 43~~ addresses the EPBC Act approval condition 3 c) for detecting impacts on groundwater levels, which will be finalised and reviewed as per the EA Condition E13 approvals.

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Table 41 Groundwater Level Thresholds Summary

Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Groundwater Level Threshold (criteria)	Total Change in Water Level (½NF + Model predictions[20])	Comment / Reference Level
Carmichael River Location						
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
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
C029P1	0.33 m	50	1.01 m (65 months)	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)	0.55 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)	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.

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

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Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Groundwater Level Threshold (criteria)	Total Change in Water Level (½NF + Model predictions[20])	Comment / Reference Level
						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)	1.50 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)	0.23 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)	0.13 m (Prediction plus ½NF)	0.13 m	
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
Great Artesian Basin to West of Mine Lease						
C180118SP	2.61 m	80	0.23 m (24 months)	2.07 m (½NF + 75% of	2.73 m	Clematis Sandstone sentinel bore, close to mining lease.

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Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Groundwater Level Threshold (criteria)	Total Change in Water Level (½NF + Model predictions[20])	Comment / Reference Level
				prediction)		250.17 mAHD average groundwater level
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
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
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
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
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
HD03A	0.18 m	87	1.02 m (44 months)	0.69 m (Prediction plus ½NF)	0.69 m	
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)
C022P1	3.86 m	81	0.42 m (65 months)	3.10 m (½NF + 75% of	4.07 m	Confined Dunda Beds monitoring bore. 246.66 mAHD average groundwater level

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Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Groundwater Level Threshold (criteria)	Total Change in Water Level (½NF + Model predictions[20])	Comment / Reference Level
				prediction)		
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
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
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
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
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
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
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
HD03A	0.18 m	87	1.02 m (44 months)	0.69 m (Prediction plus ½NF)	0.69 m	

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Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Groundwater Level Threshold (criteria)	Total Change in Water Level (½NF + Model predictions[20])	Comment / Reference Level
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
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
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
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)
C14206VWP_1	36 m	84	-	32.4 m (90% of max drawdown predicted)	-	AB Seam. 224.00 mAHD
C558VWP1	143.05 m	586	-	129 m (90% of max drawdown predicted)	-	D seam. 212.00 mAHD
C968VWP_P2	206.2 m	12	-	186 m (90% of max drawdown predicted)	-	D seam. 355.00 mAHD
C968VWP_P5	170.72 m	15	-	154 m (90% of max drawdown predicted)	-	AB seam. 192.80 mAHD
C848SP	127.96 m	586	1.00 m (37 months)	115.70 m (½NF + 90% of	128.46 m	Bore within target D Seam, southern portion of lease.

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Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Groundwater Level Threshold (criteria)	Total Change in Water Level (½NF + Model predictions[20])	Comment / Reference Level
				prediction)		231.91 mAHD average groundwater level
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
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. Groundwater level thresholds are suggested for prediction plus half of the natural fluctuations (for comparison to the average groundwater level reference level over time).
C180122SP	0.045 m	586	0.75 m (29 months)	0.42 m (Prediction plus ½NF)	0.42 m	
C180119SP	0.045 m	586	0.49 m (22 months)	0.29 m (Prediction plus ½NF)	0.29 m	
C180123SP	0.007 m	586	0.67 m (28 months)	0.34 m (Prediction plus ½NF)	0.34 m	
C9180124SPR	0.045 m	586	0.55 m (24 months)	0.32 m (Prediction plus ½NF)	0.32 m	
C9180125SPR	0.02 m	586	1.07 m (25 months)	0.56 m (Prediction plus ½NF)	0.56 m	
Sentinel 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
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
C14029SP	1.90 m	500	0.47 m	1.66 m	2.14 m	Artesian bore across Tertiary sediments and

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Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Groundwater Level Threshold (criteria)	Total Change in Water Level (½NF + Model predictions[20])	Comment / Reference Level
			(20 months)	(½NF + 75% of prediction)		Joe Joe Group, east of lease. 251.08 mAHD
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
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
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
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
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
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
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

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Bore ID	Deepest Predicted Drawdown	Time when Deepest Drawdown will occur (years)	Natural fluctuation (NF) (monitoring period)	Groundwater Level Threshold (criteria)	Total Change in Water Level (½NF + Model predictions[20])	Comment / Reference Level
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
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

Notes:
NF – natural fluctuation

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A summary of the groundwater level thresholds (drawdown), for inclusion in EA Condition E13, is compiled in Table 42~~Table 42Table 42~~.

Table 42 Groundwater Level Thresholds - Drawdown (EA Condition E13)

Monitoring Location	Unit	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)	Groundwater Level Threshold Drawdown (m)
Carmichael River Location				
HD03B	Alluvium	427559.00	7556120.00	0.63
C027P2	Dunda Beds	433648.21	7554818.54	1.19
C029P1	Alluvium	437691.19	7555082.39	0.67
C029P2	Tertiary sediments	437687.63	7555080.91	0.55
C025P1	Alluvium	438015.54	7555845.80	6 months dry / no water level readings 1.19 (in a new bore to be installed, in deep alluvium, adjacent to C025P1)
C025P2	Tertiary sediments	438010.34	7555844.69	1.50
C14028SP	Alluvium	443775.64	7559581.18	0.23
C14027SP	Alluvium	444964.65	7558330.02	0.13
C14006SP	Joe Joe Group	443446.61	7556785.07	0.79
Great Artesian Basin to West of Mine Lease				
C180118SP	Clematis Sandstone	423796.76	7568090.93	2.07
C14033SP	Clematis Sandstone	418210.8	7566775.83	0.32
C14011SP	Clematis Sandstone	426130.96	7561454.81	0.58
C14012SP	Clematis Sandstone	424896.07	7560596.18	0.40
C14013SP	Clematis Sandstone	424895.49	7560591.10	0.43
HD02	Clematis Sandstone	423822.04	7557008.25	0.26
HD03A	Clematis Sandstone	427562.00	7556132.00	0.69
C14021SP	Clematis Sandstone	429796.25	7550966.33	1.37
C022P1	Dunda Beds	426812.52	7565961.84	3.10
C027P2	Dunda Beds	433648.21	7554818.54	1.19
C14023SP	Dunda Beds	429801.74	7550968.73	0.39
C180117SP	Dunda Beds	435915.16	7547522.16	3.81
C9553P1R	Rewan Formation	421010.11	7573974.87	3.45
C556P1	Rewan Formation	436524.08	7549881.55	76.34
C555P1	Rewan Formation	432461.38	7557892.99	65.88
Doongmabulla to West of Mine Lease				
HD02	Clematis Sandstone	423822.04	7557008.25	0.26
HD03A	Clematis Sandstone	427562.00	7556132.00	0.69

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Monitoring Location	Unit	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)	Groundwater Level Threshold Drawdown (m)
C14013SP	Clematis Sandstone	424895.49	7560591.10	0.43
C022P1	Dunda Beds	426812.52	7565961.84	3.10
C14012SP	Clematis Sandstone	424896.07	7560596.18	0.40
C14021SP	Clematis Sandstone	429796.76	7550966.33	1.37
C14206VWP_1	AB seam	429783.15	7550956.80	32.4[21]
C558VWP1	D seam	430311.51	7566903.01	129
C968VWP_P2	D seam	424873.59	7570989.17	186
C968VWP_P5	AB seam	424873.59	7570989.17	154
C848SP	D seam	442363.39	7543815.03	115.7
Mellaluka Springs to the southeast of Mine Lease				
C851VWP2	AB Seam	441384.00	7542877.33	122.4
C180120SP	Tertiary sediments / Joe Joe Group	447056.56	7531729.89	1.29
C180122SP	Tertiary sediments / Joe Joe Group	448579.21	7536348.70	0.42
C180119SP	Joe Joe Group	448587.45	7536355.38	0.29
C180123SP	Joe Joe Group	448077.54	7529357.50	0.34
C9180124SPR	Joe Joe Group	448600.00	7536357.00	0.32
C9180125SPR	Joe Joe Group	447039.74	7531738.83	0.56
Sentinel Bores				
C14016SP	Joe Joe Group	444852.34	7541471.06	25.57
C9845SPR	Tertiary sediments	439410.87	7544903.28	19.48
C14029SP	Tertiary sediments / Joe Joe Group	445059.11	7548820.62	1.66
C14003SP	Joe Joe Group	440350.8	7568518.85	0.23
C14030SP	Joe Joe Group	445072.27	7548821	2.07
C14015SP	Joe Joe Group	445301.98	7536138.69	5.26
C016P2	AB seam	422017.38	7574974.58	143.77
C14004SP	Joe Joe Group	440355.93	7568513.34	5.52
C14008SP	Joe Joe Group	444760.74	7552697.83	1.58
C180116SP	Rewan Formation	439392.91	7540908.81	15.14
C14024SP	Clematis Sandstone / Rewan Group	430036.80	7543917.13	1.92
C14020SP	Moolayember	418230.28	7566782.35	0.27

[21] Due to the discrepancies between the total pressure readings, converted to relative groundwater levels, and actual static water level readings in stand pipe monitoring bores in the same unit, an assessment of predicted pressure changes in the VWP have been assessed in key (and suitable) VWPs so as to allow for model validation and dewatering / depressurisation trends. The red VWP triggers are for assessing depressurisation impacts due to mine dewatering only.

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Monitoring Location	Unit	Easting (GDA94 – Zone 55)	Northing (GDA94 – Zone 55)	Groundwater Level Threshold Drawdown (m)
	Formation			

5.3.4 Mellaluka Springs Thresholds

Groundwater drawdown predictions in the Mellaluka Springs area, as detailed above, indicate that should the source of the Mellaluka Springs be the Permian aged Colinlea Sandstone (which contains the target coal seams) then the water levels could decrease by 1 to 8 m (depending on the spring). This approach, due to paucity of data during the EIS /SEIS modelling, is considered a "worst-case" scenario.

The latest drilling and conceptualisation of the geology and groundwater resources in the Mellaluka Springs area, detailed in **Section 2.2.6.3**, indicates that the source of the springs in the Mellaluka Springs area are the Tertiary sediments and Joe Joe Group. The drawdown within these footwall units, to the east of the mining, would be markedly less than the target coal seam bearing Colinlea Sandstone. This will be assessed in the next refinement of the groundwater model and as part of the baseline research into the Mellaluka Springs Complex.

The groundwater monitoring bores, with long-term baseline hydrostatic / potentiometric level data, are included in Table 43~~Table 43Table 43~~, which also includes the source aquifer and the proposed triggers.

Table 43 Mellaluka Springs area monitoring bores and thresholds

Bore	Unit	Easting	Northing	Average artesian potentiometric level (m above ground level)	Natural Fluctuation (m)	Threshold (m)
C180119SP	Joe Joe Group	448587.45	7536355.38	~14	0.49	0.29
C180123SP	Joe Joe Group	448077.54	7529357.50	~18.5	0.67	0.34
C9180124SPR	Joe Joe Group	448600.00	7536357.00	~11	0.55	0.32
C9180125SPR	Joe Joe Group	447039.74	7531738.83	`19	1.07	0.56
Non-artesian sentinel monitoring bores between the MLs and the Mellaluka Springs Complex**						
C180116SP	Rewan Formation	439392.91	7540908.81	239.12 mAHD	0.23	15.14
C14015SP	Joe Joe Group	445301.98	7536138.69	239.15 mAHD	0.55	5.26

** - These bores indicate the predicted drawdown within the sediments in sentinel bores, which will provide assessment of drawdown predictions before the drawdown extends to the Mellaluka Springs Complex.

Section 3.4 discusses the hydrographs for the groundwater monitoring bores included for threshold assessments, as depicted on Appendix B~~Appendix BAppendix B~~ figures. The groundwater level data for these bores, as included in Table 38~~Table 38Table 38~~, **Section 5.3.1**, indicates all these bores are artesian, with groundwater levels in excess of 10 m above ground.

It is, therefore, considered that the thresholds (~ 1 m) in these bores would mean that the bores will remain artesian, which reduces the risk of discontinuous flow at the springs occurring, i.e. the thresholds are looking at changes in the potentiometric pressure which will remain artesian.

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These thresholds are considered suitable even for the model predictions, which indicate groundwater level decrease up to 8 m. Based on the artesian groundwater data a decline of 8 m would still allow for the bores to be artesian, such that flow at surface would continue to occur.

5.3.5 Early Warning Triggers and Impact Thresholds for Doongmabulla Springs Complex

With regards to the DoEE Approval (EPBC 2010/5736, dated 14/10/2015), it is noted that the approval includes for the details of groundwater level Early warning triggers and Impact thresholds for the Doongmabulla Springs Complex, based on groundwater modelling, plus the details of corrective actions and/or mitigation measured to be taken if the triggers are because of mining operations.

The Early warning triggers and Impact thresholds are aimed at ensuring that groundwater drawdown because of the project does not exceed the interim drawdown threshold of 0.2 m at the Doongmabulla Springs Complex.

In addition, the Adani AWL condition 57 required the recommendations for low impact and high impact threshold levels in the Dunda Beds and Clematis Sandstone aquifers, where the Licensee must:

a. provide recommendations for low impact and high impact threshold levels for the Dunda Beds and Clematis Sandstone aquifers
b. include an assessment of natural seasonal variation in the Dunda Beds and Clematis Sandstone aquifers
c. outline the investigation protocol when low impact and high impact threshold levels are exceeded:
   i. including any requirements for additional modelling or monitoring required
   ii. including how impacts attributed to the mining operations will be determined.

The low impact and high impact threshold levels, derived for the AWL conditions, are the same as the Early warning triggers and Impact thresholds required for the Doongmabulla Springs Complex to meet the requirements of EPBC approval condition 3(d). These early warning / low impact groundwater trigger levels allow for the assessment of drawdown during mining before the predicted groundwater drawdown is reached.

To avoid confusion regarding groundwater level thresholds, the following is noted:

- Early warning triggers (EPBC 2010/5736 Approval) are equivalent to the low impact threshold levels (AWL Condition 57) and groundwater level thresholds (included in **Table 41**~~**Table 41**~~**Table 41**) as discussed above
- Impact thresholds (EPBC 2010/5736) are equivalent to the high impact threshold levels (AWL Condition 57).

The low and high impact thresholds for monitoring bores within the GAB units containing the Doongmabulla Springs Complex (Dunda Beds and Clematis Sandstone) have been selected based on the groundwater model predictions, which have been used to assess potential mining impacts during the approvals process.

Compliance with Approvals

It is noted that the groundwater level variations to be monitored as verification / assessment of potential impact to groundwater resources adjacent to the mine lease have been assessed and thresholds compiled in line with the relevant requirements of the environmental authority under the *Environmental Protection Act 1994 Queensland* in particular the requirements included in Appendix 1, Section 1, Schedule E of the Coordinator-General's Assessment Report.

5.3.5.1 Early Warning Triggers and Impact Thresholds

Based on the assessment of natural fluctuations in groundwater levels, both unconfined and confined aquifers, and the model predictions, Early warning triggers and Impact thresholds have been compiled for the Clematis Sandstone and Dunda Beds.

The aim of the Early Warning triggers and Impact thresholds is to provide early warning regarding the predicted induced flow from the GAB units, the Clematis Sandstone and the Dunda Beds, towards the dewatered / depressurised coal seams targeted during mining.

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The Early warning triggers and Impact thresholds also aim at validating induce flow predictions, confirming water take from the GAB units, validating predicted groundwater level drawdown, and ensuring drawdown does not exceed 0.2 m (interim drawdown threshold) at the Doongmabulla Springs Complex.

~~**NOTE:** Due to distance from the approved mining and thick low vertical hydraulic conductivity sediments between the target coal and the Clematis Sandstone, bores HD02 and HD03A are predicted to have limited drawdown because of induced flow (i.e. groundwater flow from the Clematis Sandstone to the depressurised coal seams approximately 600 m below HD02 and HD03A).~~

The predicted induced flow impacts are recognised to be below the natural fluctuation, resulting in these bores having Early warning triggers (Groundwater Level thresholds in Table 41~~Table 41~~Table 4~~1~~) proposed to be the maximum predicted drawdown (plus half of the natural fluctuation to allow for the assessment of groundwater levels over time against the reference average groundwater level). Thus, the groundwater level thresholds for these bores are the same as the Early warning triggers.

Early Warning Triggers

The Early warning triggers have been selected based on the possible change in groundwater levels beyond the recorded natural groundwater level fluctuations (as included in Table 45~~Table 45~~~~Table 45~~ below). The assessment of groundwater level data, compiled during mining operations, will allow for the evaluation of groundwater level trends. The Early warning triggers proposed for the CCP are as follows:

- If groundwater levels vary by 50% than those recorded for the natural fluctuation in the unconfined Clematis Sandstone bore, C14021SP[22]
- If groundwater levels / potentiometric levels vary by 75% than those recorded for the natural fluctuation in the confined Clematis Sandstone and Dunda Beds bores[23]

Should groundwater level monitoring indicate variations in groundwater levels by more than 50% (unconfined) or 75% (confined) groundwater level fluctuations on two consecutive groundwater monitoring events then the following will occur:

- Notify the regulator within 30 days as per condition 59 of the Associated Water Licence
- Assess the cause of the groundwater level fluctuation considering:
  - dry / drought conditions
  - groundwater extraction from neighbouring user(s)
  - groundwater level trends in multiple bores within the same unit
  - long term recharge / discharge trends
  - mining operations and dewatering volumes.

A report into the investigation will be made available to the regulator on request with findings and recommendations.

Commitments

If the investigation identifies the cause of an exceedance of the Early warning trigger(s) is due to approved mining operations, Adani will (in addition to the commitments included in **Section 4.7.2.2**):

- Install additional monitoring bores in GAB aquifers and Permian aquifers
- Undertake more frequent monitoring of health of GDEs.

[22] Where groundwater level fluctuations are measured to be in excess of the reference natural fluctuations by 50% or more in the unconfined aquifers

[23] Where groundwater level fluctuations are measured to be in excess of the reference natural fluctuations by 75% or more in the confined aquifers

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Impact Thresholds

The Impact thresholds have been selected based on the groundwater model predictions, which have been used to assess potential mining impacts during the approvals process. The use of Impact thresholds will:

- Allow for the assessment of drawdown so it does not exceed the maximum predicted drawdown
- Validate predictive modelling
- Allow for the assessment of decline trends through the compilation of groundwater level hydrographs, to be updated after each groundwater monitoring event. This will allow for the evaluation of the rate of groundwater level decline as well as the actual drawdown
- Implementation of a rate of groundwater level decline trigger, as well as the groundwater level Early warning triggers and Impact thresholds for the Doongmabulla Springs Complex. This is to ensure the drawdown does not exceed the interim drawdown threshold of 0.2 m at the Doongmabulla Springs Complex.

The Impact thresholds are defined as the following:

- 90% of the predicted maximum drawdown levels, as included in **Table 45~~Table 45Table 45~~**
- Timing of groundwater level drawdown, such that if groundwater levels start to decline before the predicted impacts (as shown in **Plate 14~~Plate 14Plate 14~~** to **Plate 22~~Plate 22Plate 22~~**)
- An investigation will be instigated if the rate of groundwater level decline change exceeds the rate of groundwater level decline trigger in key hydrostratigraphic units (**Section 5.3.5.2**).

5.3.5.2 Rate of Groundwater Level Decline

The large mine footprint, long life of mine, and transient nature of the mine plan it is recognised that potential indirect impacts on groundwater resources above the target coal seams, particularly the GAB units, are predicted to be less than natural fluctuation and will only occur after a considerable period of time. This reduced indirect impact is related to the nature of the aquitards between the target coal seams and the GAB units.

In order to allow for a regular assessment of groundwater level decline compared to predictions plus the validation of the aquitard nature of the Rewan Formation between the target coal seams and the GAB units, a rate of groundwater level decline trigger is recommended. This trigger will allow for the evaluation of the aquitard nature and regular assessment of the potential for induced flow.

The rate of decline will be assessed against bores in the Rewan Formation and Dunda Beds, where drawdown is measurable (above natural fluctuation) and is predicted to occur in the early part of mining. The bores are located between the mine workings and the DSC. The selected bores in the Rewan Formation and the Dunda Beds are compared to the Clematis Sandstone bore (C180118SP) which is located adjacent to the western boundary of the MLs. ~~Error! Reference source not found.~~**Figure 24** and ~~Error! Reference source not found.~~**Figure 25** shows the groundwater level hydrograph of the selected decline rate assessment bores.

Note: the hydrograph indicates the maximum predicted drawdown will occur within 100 years and then groundwater level recovery or a pseudo-steady post mining groundwater level will be reached.

To allow for regular assessment of the groundwater level change in the Rewan Formation and Dunda Beds bores, it is planned that the groundwater level hydrographs (updated after every groundwater monitoring event) will be compared to the predicted drawdown from the modelling. The assessment will coincide with the review of the GMMP and groundwater model, that is within 2 years after the box cut excavation and then every 5 years. The predicted change in groundwater levels at these intervals and the proposed interim decline rate triggers are included in **Table 45~~Table 45Table 45~~**.

Allowing for uncertainty in the model and possible water level measurement errors, the drawdown at the regular review periods is not to exceed 20% of the drawdown when predicted drawdown is less than 1m, and not to exceed 10% when predicted drawdown is greater than 1 m.

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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 (see **Section 4.7.2.2**).

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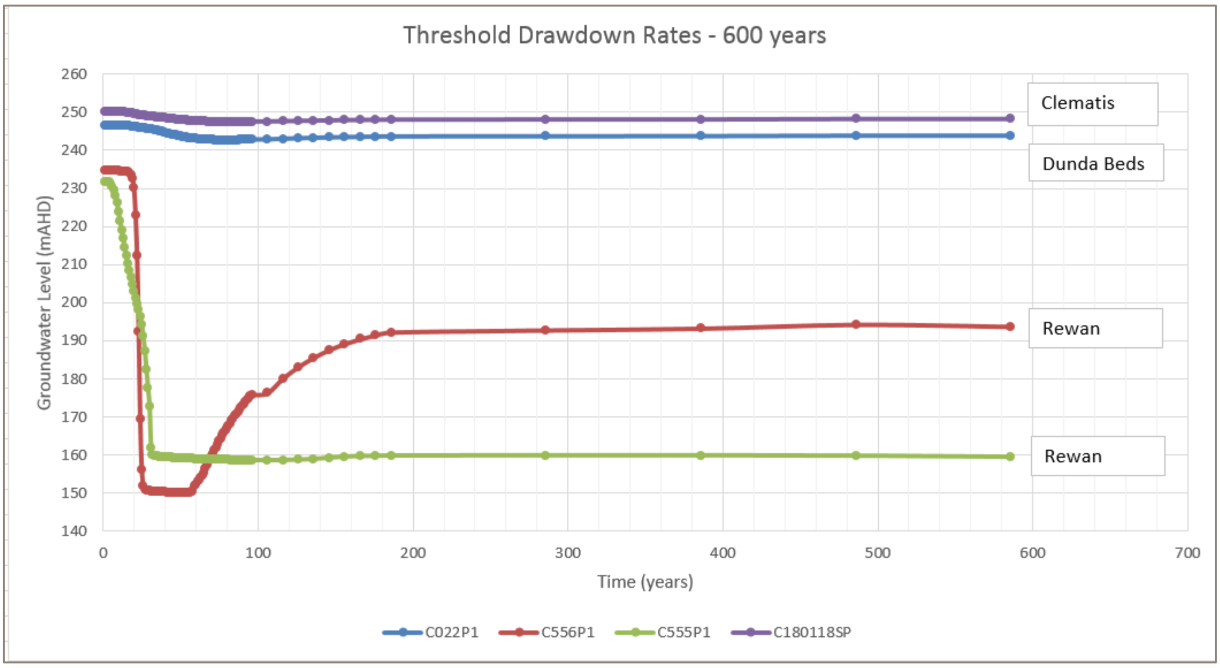

Figure 24 Selected bores for decline rate assessment

The rate of change predicted in the model, for the first 20 years, is included in ~~Error! Reference source not found.~~Error! Reference source not found..

Figure 25 Selected bores for decline rate assessment – 20 years

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Table 44 Interim drawdown rate triggers

Mine Years / Period of Drawdown	Hydrostratigraphic unit	Predicted drawdown (m below average groundwater level)	Drawdown rate trigger (m below average groundwater level)
C022P1			
0 - 2	Dunda Beds	0	0
3 - 7		0	0.01 (0.002 m/year)
8 - 12		0.015	0.018 (0.004 m/year)
13 -17		0.18	0.22 (0.044 m/year)
18 - 22		0.48	0.58 (0.12 m/year)
C555P1			
0 - 2	Rewan Formation	0	0
3 - 7		2.17	2.4 (0.48 m/year)
8 - 12		12.75	14 (2.8 m/year)
13 -17		23.31	26 (5 m/year)
18 - 22		32.11	35 (7 m/year)
C556P1			
0 - 2	Rewan Formation	0	0
3 - 7		0	0.01 (0.002 m/year)
8 - 12		0.03	0.04 (0.008 m/year)
13 -17		0.5	0.6 (0.12 m/year)
18 - 22		22.33	24.6 (5 m/year)

It is considered that the drawdown rate trigger can be assessed after 22 years to determine ongoing assessment criteria for the rate of decline. It is noted that the model will be revised / refined over time and that groundwater level drawdown predictions will be projected during the regular model updates.

5.3.5.3 Impact Thresholds and Exceedance

Should any or all the proposed Impact thresholds be realised and attributed to CCP activities, through the assessment of groundwater monitoring data and comparison to model predictions, then an appropriately qualified person will complete an investigation and will provide a written report to the regulator within 60 days.

The investigation will also perform refinement and re-run of predictive model if required along with increased monitoring through additional bores and evaluation of induced flow due to mining impacts. If the investigation concludes that the exceedance of Impact thresholds is a result of mining activities, then the following will occur (Plate 24~~Plate 24Plate 24~~ provides a decision tree in the event an investigation is instigated due to exceedance of Impact thresholds):

- Review of the latest numerical groundwater model and estimate the predicted take of water from the Dunda Beds and/or the Clematis Sandstone hydrostratigraphic units for the balance term of the project. The take is to consider for the approved level of impact, which currently (interim) limits the drawdown to 0.2 m at the Doongmabulla Spring Complex
- Review of the mine plan including sequencing of mining

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- Review of the GMMP (outside of the regulated frequency as required)[24]
- Implement of recommendations /outcomes of the GABSRP for the management, prevention and remediation of impacts on Doongmabulla Springs Complex.

Table 45~~Table 45Table 45~~ presents a summary of the selected Early warning triggers and Impact thresholds for the selected GAB monitoring bores in the Doongmabulla Springs Complex area, plus a summary of the selection criteria.

The reference levels for assessing the thresholds are included in Table 41~~Table 41Table 41~~. Appendix E~~Appendix EAppendix E~~ includes the individual hydrographs with the projected changes in groundwater levels, as predicted in the groundwater modelling, plus the Early warning triggers and Impact thresholds.

Impact thresholds Summary – Decision Tree

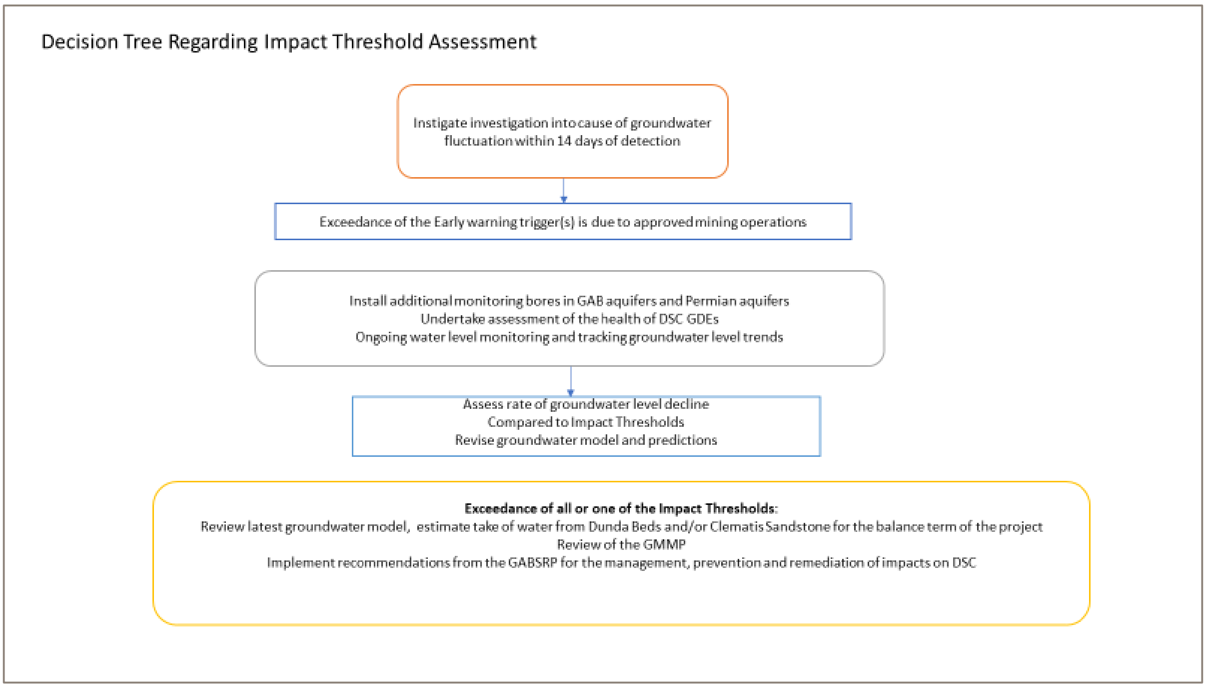

Plate 24 Impact thresholds exceedance decision tree

[24] It is noted that the AWL requires a review of the Underground Water Monitoring Program, which is recognised to be equivalent to the GMMP

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Table 45 Early warning triggers and Impact thresholds for the Doongmabulla Springs Complex

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
Clematis Sandstone							
HD02	0.03 m	90	0.46 m (44 months)	0.2~~6~~5 m (90% Prediction plus ½NF)~~[25]~~	0.26 m (Prediction plus ½NF)	0.26 m	Early warning triggers ~~and Impact thresholds~~ are suggested as 90% of predicted drawdown~~ion~~ 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)	0.6~~9~~7 m (90% Prediction plus ½NF) ~~[21]~~	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.
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

~~[25] Due to the limited predicted drawdown within bores HD02 and HD03A, the thresholds are set at the maximum predicted drawdown plus half the natural fluctuation. This results in the Early warning levels and Impact thresholds having the same drawdown values.~~

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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
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.
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.
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

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5.4 Development of Quality Triggers

5.4.1 Conceptualisation Regarding Groundwater Quality Alteration

During mining operations, groundwater quality within aquifers surrounding the site is not expected to change from pre-mining conditions. This would be a result of all CCP water and waste storage facilities infrastructure being designed, constructed, and managed to ensure little or no potential of seepage.

If groundwater contamination did occur contaminant migration off site in the groundwater will not occur. Any potential contaminant plumes would not leave site in the groundwater as during mining operations, groundwater will be continually extracted from bores or sumps in the underground workings to ensure a safe working environment. This abstraction of groundwater will create a depression in the potentiometric surface around the workings such that the net movement of groundwater is towards the workings during mine operation. This drawdown and alteration in groundwater flow effectively limits the potential for contaminant plumes to migrate off site via groundwater. However in case of mine-affected water storage dams, tailings storage facilities, and overburden storage areas there is a potential for the contaminants to migrate off site through seepage via shallow alluvium / Tertiary formations. Adani will install additional monitoring bores located up and down gradient of potential sources of contamination (e.g. mine infrastructure, waste dumps, and tailings facilities) to monitor for seepage from these surficial storage areas.

Upon finalisation of the footprints for these surficial storage areas, the seepage monitoring bores will be installed six months before construction of the infrastructure and monitored for groundwater quality (when there is sufficient water in the bores). In the instance quality data can be procured, it will be used to identify potential impacts in the form of seepage to groundwater by comparison of monitoring data from construction and operation stages to the pre-construction data.

Groundwater quality away from the influence of the mine dewatering will not deteriorate as these resources will continue to receive recharge via the same processes that occurred pre-mining.

Groundwater quality data (with respect to major anions and cations and dissolved metals) indicate that groundwater in the Clematis Sandstone, Dunda Beds, and Rewan Formation similar or better quality when compared to the Permian coal seam aquifers. Hence, any inadvertent mixing of groundwater during and post mining by induced downward movement from the upper to lower aquifers is unlikely to result in a deterioration of groundwater quality in the Permian aquifers.

The Tertiary sediments are recognised to have elevated dissolved solids, compared to the coal seams. Induced flow in areas where Tertiary sediments directly overlies the coal seams can result in marked water quality changes within the mine.

Groundwater monitoring (see **Section 6.2** Operational GMMP) network and triggers, allow for the assessment of the possible blending / alteration of groundwater due to dewatering.

5.4.2 Quality Triggers

The groundwater monitoring program (monitoring points and hydrostratigraphic units) compiled for collecting data prior to being disturbed by mining activities is included in **Table 46~~Table 46Table 46~~** below. The bores in **Table 46~~Table 46Table 46~~** were selected for the compilation of groundwater quality, in hydraulically isolated groundwater monitoring bores, which (after review of hydrochemical data (**Section 5.4.3.2**) allowed for the development of groundwater quality triggers.

Table 46~~Table 46Table 46~~ is recognised to be compliant with the requirements of EA Condition E9 Table E1 (**Appendix A~~Appendix AAppendix A~~**). **Appendix B~~Appendix BAppendix B~~** presents the location of these bores.

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Table 46 Baseline Groundwater Monitoring Network Bores

Monitoring Point	Location		Surface Elevation (mAHD)
	Easting (GDA94-Zone 55)	Nothing (GDA94-Zone 55)	
Alluvium			
C027P1	433643.08	7554818.39	226.95
C029P1	437691.19	7555082.39	225.438
HD03B	427559.00	7556120.00	229.41
C14028SP	443775.64	7559581.18	218.86
Tertiary Sediments			
C025P2	438010.34	7555844.69	227.48
C029P2	437687.63	7555080.91	225.37
C558P1	430311.55	7566903.06	250.07
C9180121SPR	448085.12	7529363.93	226.46
C9845SPR	439410.87	7544903.28	255.41
Clematis Sandstone			
C180118SP[26]	423796.76	7568090.93	306.63
C14021SP	429796.76	7550966.33	277.59
C14033SP	418210.22	7566775.83	296.47
C14011SP	426130.96	7561454.81	311.66
C14012SP	424896.07	7560596.18	286.37
C14013SP	424895.49	7560591.10	286.46
HD02	423822.04	7557008.25	236.353
HD03A	427562.00	7556132.00	229.41
Dunda Beds			
C022P1	426812.52	7565961.84	273.76
C027P2	433648.21	7554818.54	227.58
C180117SP	435915.16	7547522.16	279.59
Rewan Formation			
C008P1	433712.50	7558833.75	238.14
C035P1	441403.59	7546823.81	236.31
C555P1	432461.38	7557892.99	241.15
C556P1	436524.08	7549881.55	260.63
C9553P1R	421010.11	7573974.87	294.114
C9838SPR	439557.91	7552811.73	228.81
Bandanna Formation (AB Seam)			
C007P2	434728.01	7559861.98	238.11
C008P2	433710.27	7558830.28	238.12

[26] Blocked bore to be replaced

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Monitoring Point	Location		Surface Elevation (mAHD)
	Easting (GDA94-Zone 55)	Nothing (GDA94-Zone 55)	
C014P2	430731.00	7563976.07	255.99
C016P2	422017.38	7574974.58	294.45
C020P2	427845.47	7566931.73	263.06
C032P2	439404.36	7544896.02	256.32
C035P2	441401.68	7546827.75	236.24
Colinlea Sandstone (D Seam)			
C006P3r	435727.00	7560835.00	233.86
C007P3	434726.28	7559864.39	237.99
C011P3	428845.58	7569954.89	254.54
C018P3	423977.57	7574853.06	281.36
C024P3	428909.10	7571761.09	258.62
C034P3	442388.72	7547813.99	227.38
C180114SP	438684.80	7557646.88	224.92
C833SP	439559.68	7554777.43	223.30
C848SP	442363.39	7543815.03	237.03
C9849SPR	442383.73	7543808.29	236.69
Joe Joe Group			
C012P1	430887.52	7569874.40	247.333
C012P2	430887.34	7569876.76	247.252
C180119SP	448587.45	7536355.38	223.13
C9180124SPR	448600.00	7536357.00	223.19
C9180125SPR	447039.74	7531738.83	222.50
C180123SP	448077.54	7529357.50	226.47
C914001SPR	441973.49	7561149.58	226.146
C14014SP	448343.76	7533407.48	221.05
C14008SP	444760.74	7552697.83	219.54
C14017SP	447525.30	7526907.00	229.228
C14006SP	443446.61	7556785.07	218.98
C14016SP	444852.34	7541471.06	221.75
C14003SP	440350.80	7568518.85	217.967
C14015SP	445301.98	7536138.69	228.22

Notes: * - Reference Levels are the top of casing / measurement point for each monitoring point.

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5.4.3 Baseline Trigger Levels

Groundwater quality trigger levels have been proposed based on a statistical analysis of the baseline data (Appendix D~~Appendix D~~~~Appendix D~~), as per the requirements of EA Condition E9 Table E2 (Appendix A~~Appendix A~~~~Appendix A~~). The trigger levels are based on the 85th percentile of the background data.

As per Condition E8 of the EA, Adani must establish a groundwater monitoring network for detecting potential impacts of the mine operations on groundwater quality.

5.4.3.1 Approach

Adani has been undertaking groundwater monitoring during various stages in the Project's approvals process. The compiled dataset used for assigning the trigger values includes groundwater monitoring data, collected by multiple entities, from the following timeframes and project stages:

1. September and October 2011 (GHD): for the purposes of the EIS and associated numerical predictive groundwater model
2. May 2013 (GHD): for the purposes of the SEIS and update assessments based on the revised Mine Plan
3. April and May 2014 (4T Consultants Pty Ltd): for the purposes of baseline groundwater monitoring, under Condition E3 of EA
4. June 2014 – April 2017 (NRC): for the purposes of baseline groundwater monitoring under Condition E3 of EA.

It is recognised that not all monitoring bores were utilised to collect groundwater (hydrochemistry) analyses. Bores were selected for groundwater quality monitoring, per unit, based on the spatial distribution (along strike and down-dip) of the bores across the CCP. That is, a number of bores per hydrostratigraphic unit were identified for groundwater quality analyses, and subsequent trigger level development, to represent the hydrostratigraphic units (EA conditions, as included in **Section 5.4.3.2**) across the MLs.

5.4.3.2 Trigger Level Methodology

In order to populate Table E2, EA Condition E9, the baseline data was interrogated and assessed through an iterative process and correspondence with the Queensland Department of Environment and Science (DES) regarding the proposed trigger levels for the Carmichael Coal Project (CCP) Groundwater Management and Monitoring Program (GMMP) as detailed in documents included in Appendix A~~Appendix A~~~~Appendix A~~.

The assessment of hydrochemistry allowed for the development of groundwater quality triggers (trigger levels) for the hydrostratigraphic units included in the EA conditions, including:

- Alluvium
- Tertiary Sediments
- Clematis Sandstone
- Dunda Beds
- Rewan Formation
- Bandanna Formation (AB Seam)
- Colinlea Sandstone (D Seam)
- Joe Joe Group.

AECOM developed a methodology for assessing groundwater quality data (suitability for use) and to assign trigger levels for the different groundwater quality parameters in each hydrostratigraphic unit with consideration to comments from DES (formerly DEHP).

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5.4.3.2.1 Summary of Methodology

The methodology adopted for assigning the initial proposed trigger levels, following extensive consultation and agreement between Adani and DES is outlined in Table 47~~Table 47Table 47~~ below. The methodology represents the development of several approaches aimed at identifying triggers that will reduce the potential impact to groundwater quality. The approach is outlined below.

Table 47 Proposed Trigger Level Methodology

Step	Aim	Approach
1	Establish baseline groundwater information.	Baseline monitoring program (2014-2016)
		Historic and continuing monitoring (2011-present)
2	Assign groundwater to hydrostratigraphic units and / or subdivide into bore-specific baseline groundwater.	Compare time series plots of all analytes to look for similarities/variations in groundwater from bores in each hydrostratigraphic unit.
		Compare bore groundwater major ions to determine groundwater types (e.g,. Piper plots) and identify key differences within hydrostratigraphic units (if present). Bores assessed to potentially represent different water types within a hydrostratigraphic unit are separated and bore-specific triggers are calculated for these.
3	Identify and remove outliers.	Plot groundwater data as time series for all analytes in each hydrostratigraphic unit and visually compare outputs, noting obvious outliers.
		Refer data entries to field notes and laboratory Certificates of Analysis (CoA) to provide information on whether visual outliers represent true outliers or natural variations.
		Use major ion and total dissolved solids (TDS) box and whisker plots for each hydrostratigraphic unit and/or bore-specific units to identify data outliers
		Remove values that are beyond the mean + 4xSD for each analyte in each hydrostratigraphic unit/bore specific groundwater.
4	Calculate trigger values.	Calculate 85th percentiles for all hydrostratigraphic (and/or bore-specific) units with at least eight (8) results greater than the laboratory limit of report (LOR).
		Where there are less than eight results per analyte per hydrostratigraphic (and/or bore-specific) unit greater than the LOR, the ANZG 2018 guidelines (formerly ANZECC & ARMCANZ 2000 [ANZECC 2000] guidelines 95th protection (freshwater) trigger value from Table 3.4.1) of the guideline should be adopted.
		Where there is no 95th protection (freshwater) trigger value, and less than eight results above LOR, the low reliability (freshwater) trigger values from Section 8.3.7 of the ANZG 2018 guidelines (formerly ANZECC & ARMCANZ 2000 guidelines [ANZECC, 2000]) should be adopted.
		All trigger levels derived from the baseline monitoring program (at least eight results greater than LOR) are compared to the ANZG 2018 guidelines (formerly ANZECC & ARMCANZ 2000 guidelines [ANZECC, 2000]) guideline values per analyte (95th protection and low reliability). In instances where the ANZG 2018 guideline value is higher, this ANZG value should be adopted as the proposed trigger level.
5	Additional data quality steps.	Certain trigger values have been revised, based on agreement between DES and Adani, to provide additional levels of conservatism and the potential for a greater level of environmental protection. This has involved additional passes to remove potential individual analyte outliers.

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Step	Aim	Approach
		A 'consecutive exceedances' approach has been taken to validate the groundwater quality monitoring results. This approach requires two consecutive groundwater quality analytical results to be reported above a given parameter trigger value prior to the commencement of any investigations into the exceedance; a single trigger exceedance will not be cause for investigations into groundwater quality results.
		Consecutive sampling relates to two consecutive groundwater monitoring events, some two or three months apart.
		There remain some parameters, with no published guideline value, with reported concentrations above LOR, but less than eight. Where appropriate, a value has been be derived from all relevant data, which may include WQOs from the Burdekin, Don and Haughton River Basins (DEHP, 2017).

5.4.3.2.2 Initial Proposed Trigger Levels

Trigger levels were proposed for each hydrostratigraphic unit as required in the Environmental Approval (EA) dated 5 June 2017. Initially, trigger levels were calculated from the baseline groundwater quality dataset, which included monitoring from 2014 through to 2016. The approach adopted for management and application of analyte concentrations not detected above the laboratory's limit of reporting (LOR) was to apply an industry-standard approach for analytes with which was to apply half of the LOR value (e.g., where the resultant concentration for an analyte was <50 µg/L, a value of 25 µg/L was applied in the trigger level calculation.

After review and assessment of the results, it was decided that it would be more accurate and representative of site conditions to calculate the 85th percentile trigger levels for analytes with at least 50% of the results were reported above the LOR. For analytes with less than 50% of resultant concentrations reported above the LOR for analytes, the National Environment Protection Council (NEPC) National Environment Protection Measure (NEPM) groundwater investigation levels (GILs) for freshwater were adopted, where available. The NEPM guideline values were considered appropriate to supplement site-specific trigger levels as the objective of the NEPM is to provide adequate protection of human health and the environment where site contamination has occurred.

This approach was based on Adani's understanding that the objective of the trigger levels is to protect human health and the environment from contamination because of the approved mining activities; therefore, application of the NEPM was adopted to supplement site –specific trigger levels.

Where a freshwater GIL was not provided in the guideline, the more conservative drinking water GILs and/or marine water GILs were adopted, depending on the water quality of the hydrostratigraphic unit (salinity concentrations). The proposed trigger levels resultant of this methodology were included in the draft GMMP and submitted to DES for approval.

5.4.3.2.3 Associated Water Licence (AWL) and Resultant Augmentation of the Dataset

As a component of the AWL data request by the Department of Natural Resources and Mines (now the Department of Natural Resources, Mines, and Environment [DNRME]), the comprehensive groundwater quality dataset was provided which included data from the EIS and post-EIS monitoring (from 2011 - 2016).

Adani had been undertaking additional groundwater monitoring (events in 2016 - 2017) since the completion of the formal baseline groundwater monitoring program (12 events over two years, 2014 - 2016); DNRME then requested this additional data be incorporated into the baseline groundwater dataset (now incorporates all groundwater quality data from 2011 through April 2017).

This expanded dataset was utilised to recalculate the proposed 85th percentile trigger levels (for analytes with 50% of results above the LOR).

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5.4.3.2.4 Further Development of Trigger Levels and Groundwater Chemistry

Trigger Levels

As a development of the above approach, and following the draft GMMP review, it was advised that trigger levels for each analyte (per hydrostratigraphic unit) should be calculated when at least eight (8) concentrations were reported above the LOR and that eight results is considered sufficient and statistically representative of the groundwater quality regardless of the total number of samples analysed, as outlined in the Department of Science, Information Technology and Innovation (DSITI) groundwater guideline *Using monitoring data to assess groundwater quality and potential environmental impacts* (2017), to calculate site-specific limits (DES, November / December 2017 review of the draft GMMP).

In addition, it was recommended that the 85th percentile trigger levels should be compared to the ANZG 2018 guidelines (formerly ANZECC & ARMCANZ 2000 aquatic ecosystem guideline) values and the least stringent of the two values be applied. In instances where less than eight results were above the LOR in the baseline groundwater dataset, the ANZG 2018 aquatic ecosystem guideline values and the low reliability freshwater trigger levels should be applied (DES, November 2017).

Groundwater Chemistry

To take into account potential variations in concentrations and proposed trigger levels (85th percentiles) between bores within the hydrostratigraphic units, it was advised that 'a characterisation of the water quality within each bore should be undertaken to determine if groundwater bores can be grouped together' (DES, November 2017). This involved preparation of piper plots of the groundwater chemistry to classify and compare water quality types based on the ionic composition of different groundwater samples. Additionally, box plots for each bore within an aquifer group for each parameter were assessed to provide a visualisation of differences in water quality between bores.

The methodology to calculate trigger levels for each hydrostratigraphic unit specified in the EA, inclusive of non-detected concentrations, implemented by Adani was a staged approach, as outlined below.

1. Compiled all like analytes in the comprehensive dataset (2011 - 2017) for aquifer monitoring suitability analysis (carbonate, fluoride, etc.)
2. Prepared piper (trilinear) diagrams per hydrostratigraphic unit
3. Assessment of trilinear diagrams to identify potential data outliers and/or monitoring well outliers (from the overall hydrostratigraphic unit)
4. Prepared box and whisker plots per hydrostratigraphic unit to assess major ions and total dissolved solids (TDS) as a representative analyte to identify data outliers:
    a. Median and mean values per well per unit were identified

       NOTE: The box plots summarise the data distribution, displaying the median, interquartile range (IQR), skewness, and potential outlier values. Box plots were constructed as follows: a box is drawn from the 25th percentile (Q1) to the 75th percentile (Q3). The distance between the upper Q3 and lower Q1 lines of the box is equal to the IQR (Q3-Q1). The median (Q2) of the data falls between Q1 and Q3 and is depicted as a line within the interior of the box. The average or mean value were determined and included. The error bars (called whiskers) represents data points farthest from the box but within the maximum or minimum point within that range. Potential outliers (depicted as 'closed circle' symbol) are those that are three (3) times the IQR from Q1 or Q3.

    b. Outliers were then identified using the box and whisker plots (3 x IQR or more below the first quartile or above the third quartile) to be removed from dataset, per **Plate 25**~~**Plate 25Plate 25**~~ below:

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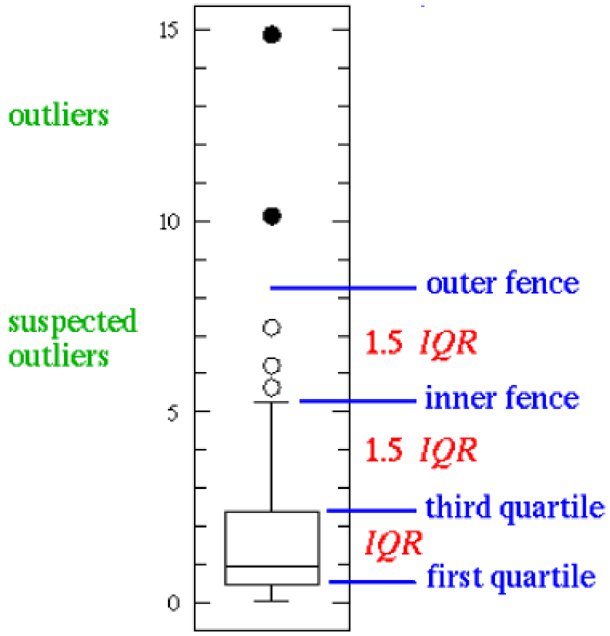

Plate 25 Outlier Identification Methodology

5. Outliers (bores or single sample results) identified were removed per monitoring well per unit
6. The trigger levels were then recalculated after the assessment and removal of identified outliers and resubmitted to DES on 26 March 2018.

Further comments from DES were received in May 2018 which included additional quality assurance (QA) measures for the baseline dataset, namely:

5.4.3.2.5 Additional Quality Assurance Measures

Additional quality assurance (QA) measures for the baseline dataset have been implemented (DES review, May 2018), including:

- Compilation of time-series graphs of all analytes per hydrostratigraphic unit over time to allow for visual identification of possible outliers (i.e. results markedly higher than the rest of the hydrographs)
- Assessment of potential outlier by review of all laboratory reports and field notes/ sheets to ensure the “outlier” was not a transcription error
- Assessing samples that fall outside of the mean and four(4) times the standard deviation (SD).
  - The DSITI (2017) guideline suggests that extreme values in a data set may be represented by measurements that lie outside the mean + 4*SD. However, a visual identification of outliers is also important. USEPA (2009) recommends the use of visual methods of assessment as the starting point for outlier assessment and the human eye remains singularly efficient at observing non-normal distributed data, trends and outliers.
  - The mean + 4*SD was calculated for each bore group (geological unit) and parameter. If outliers were identified that were less than the ANZG 2018 trigger level for 95% protection level for freshwater aquatic ecosystems they were not removed from the dataset. Values greater than mean + 4*SD were removed and the percentiles recalculated. Additional outliers

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were also identified which were considered an extreme value in the data set using a visual assessment, even if they were less than the mean + 4*SD.

- In addition, some 'outlier' bores were recommended to have bore-specific trigger levels.

Adani considered these recommendations and have undertaken the additional QA measures to allow for a robust dataset prior to trigger level calculation. An example of the time-series graphs prepared is presented in Plate 26~~Plate 26Plate 26~~ where the zinc concentrations, after removal of data outliers from Piper and Box and Whisker plots, for the Rewan Formation are detailed.

The visually identified "outlier" results were then checked against the laboratory reports and all field sheets prior to removal to determine if the "outlier" was a possible transcript or unit error.

In the instance the elevated concentration, after review of laboratory and field reports, is an outlier, the data was removed from the set. Where the laboratory and field reports did not indicate any errors, the data point remained in the set for further quality assurance assessment (e.g. to confirm the data point is in exceedance of four (4) times the standard deviation of the complete dataset.

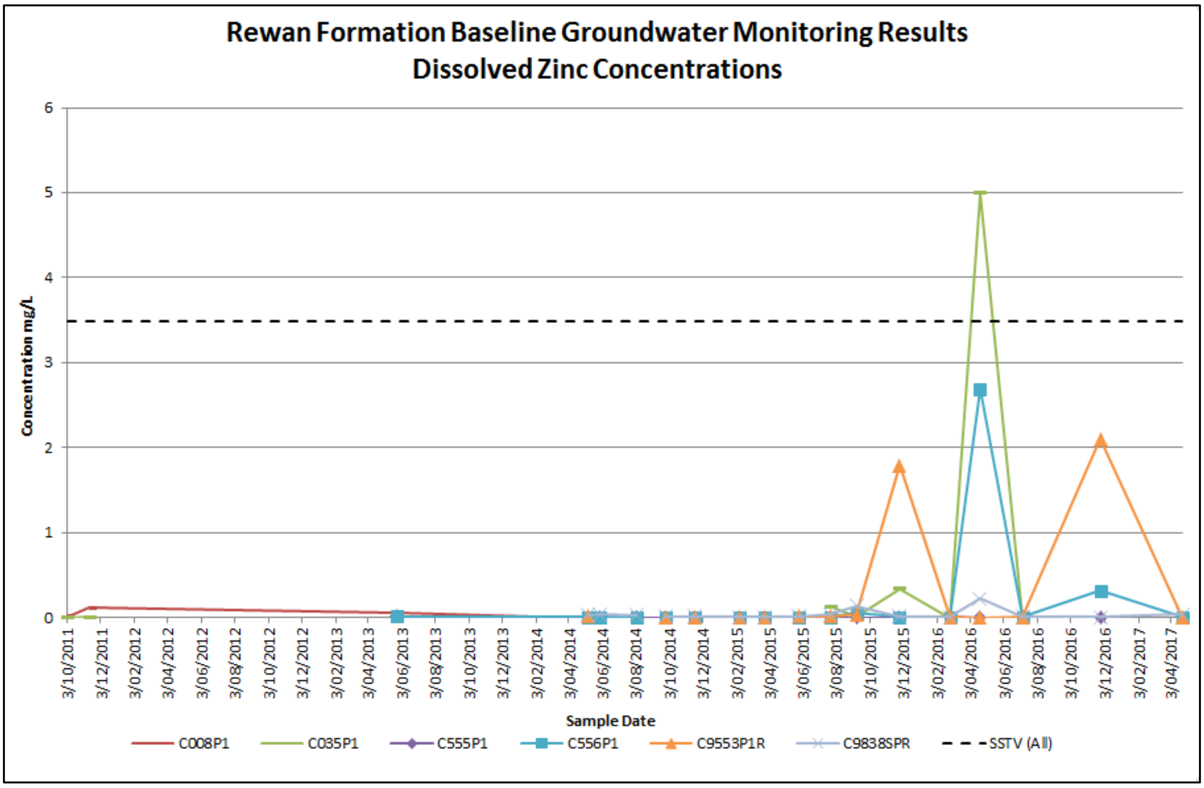

Plate 26 Example of time-series graph for baseline dataset QA

Site-Specific Trigger Values

Site-specific trigger values were determined following removal of outlier data (outside the mean + 4*SD) and calculation of the 85th percentiles of the resultant datasets.

Adani further examined these statistical outliers by referring to and review of the field sampling records. In the case of the example for zinc (Plate 26~~Plate 26Plate 26~~), the field notes revealed that there was a sulphurous odour observed at the time of sampling (see Plate 27~~Plate 27Plate 27~~ below).

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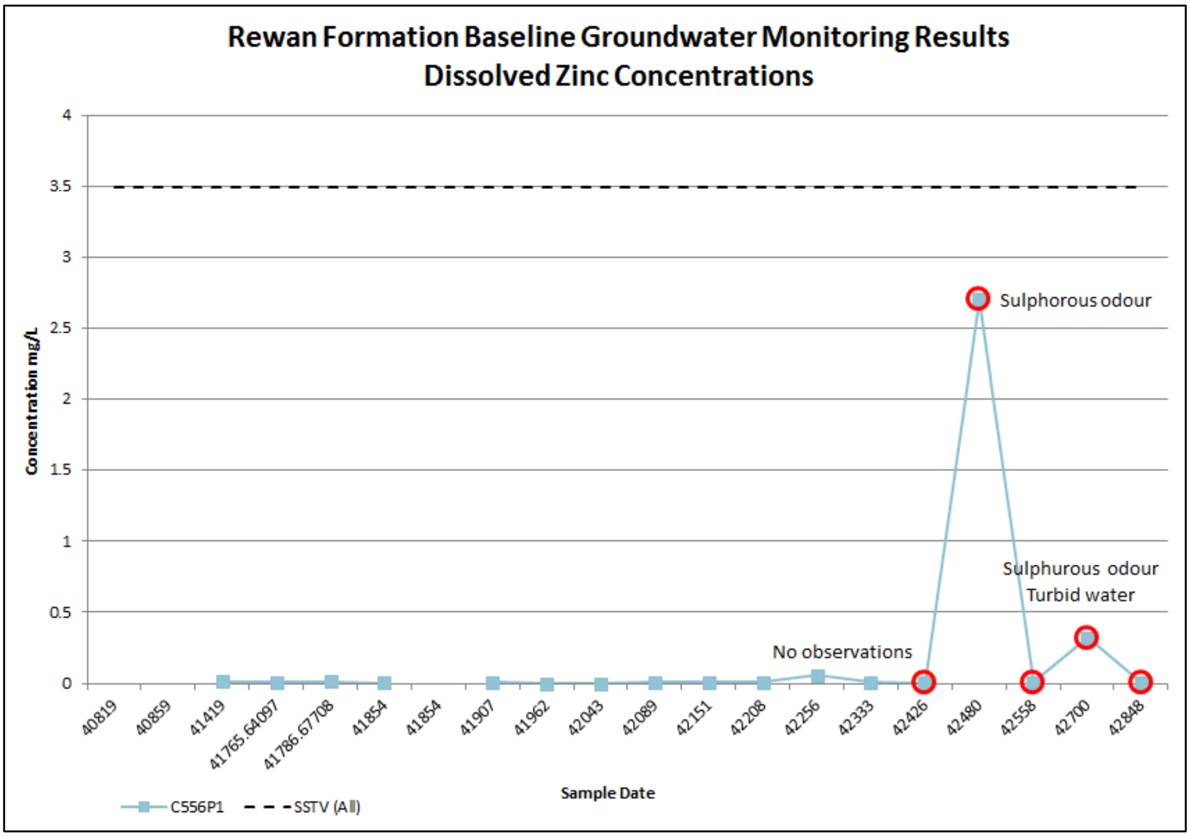

Plate 27 Field Observation correlation

In addition, the laboratory certificates of analysis (COA) were reviewed for any analysis issues, for example reported laboratory quality control outliers; none were noted, with analysis of lab blanks consistently reporting values below limits of detection.

As well as field observations, the time-series output has been compared to BOM rainfall records (collected at Bulliwallah station). Although the correlation is by no means definitive, there does appear to be some agreement between periods of recorded high rainfall and (in this case) increases in zinc concentration, as is depicted in Plate 28~~Plate 28Plate 28~~ below.

This suggests that “outliers” may result from a ‘flush’ in the hydrostratigraphic unit, as there are corresponding increases in concentrations of iron, lead (possibly), copper, etc. in 2016 (although not necessarily in the same bores and again the correlation is not definitive). It is therefore considered that the ‘spikes’ may be natural and would benefit from being monitored further. Nevertheless, it was recommended that these ‘spikes’ were removed to provide additional levels of conservatism following further review rounds (see below).

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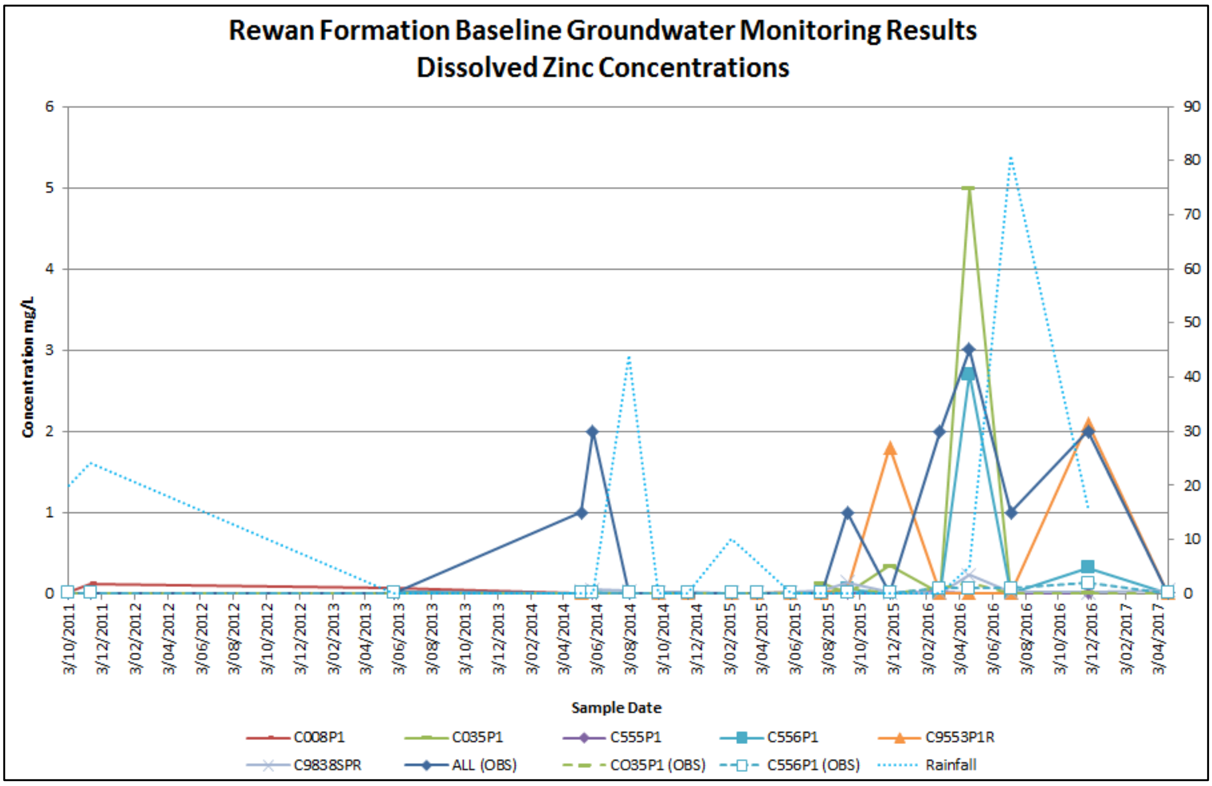

Plate 28 Rainfall vs Dissolved Zinc concentrations - Rewan Formation

Upon completion of the extensive QA assessment of the baseline dataset, and outlier assessment and removal, the trigger levels were calculated as follows:

1. 85th percentiles were then calculated for all hydrostratigraphic units with at least eight (8) results greater than the laboratory limit of report (LOR)
2. Where there were less than eight results per analyte per hydrostratigraphic unit greater than the LOR, the ANZECC & ARMCANZ 2000 guidelines 95th protection (freshwater) trigger value was adopted from Table 3.4.1 of the guideline (ANZECC, 2000)
3. Where there was no 95th protection (freshwater) trigger value (dot point above), and less than eight results above LOR, the low reliability (freshwater) trigger values were adopted from Section 8.3.7 of the ANZECC & ARMCANZ 2000 guidelines (ANZECC, 2000)
4. All trigger levels derived from the baseline monitoring program (at least eight results greater than LOR) were compared to the ANZECC & ARMCANZ 2000 guideline values per analyte (95th protection and low reliability). In instances where the ANZECC & ARMCANZ 2000 guideline value was higher, this ANZECC value was adopted as the proposed trigger level(DES review, November 2017)
5. There remain some parameters, with no published guideline value, with reported concentrations above LOR, but less than eight. These analytes (per unit) are to be considered for further discussion with respect to the appropriateness of the analyte in context of the Project for removal from compliance monitoring.

There remain some analytes which do not have established guideline values and variable LOR concentrations, namely total recoverable hydrocarbons (TRH C_6-C_{40}) and monocyclic aromatic hydrocarbons inclusive of benzene, toluene, ethylbenzene, and xylene isomers, collectively known as BTEX. There have been limited reported concentrations above LOR for some of the units; however, typically less than eight results above LOR.

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It is noted the ANZECC 2000 guidelines have been replaced with the Australian and New Zealand guidelines for fresh and marine water quality (ANZG 2018) during finalisation of this plan. The ANZG 2018 guidelines will be applied going forward until which time these are superseded.

It is considered the TRH fractions C_6-C_9 and >C_{10}-C_{40} (sum) are to be monitored and assessed as separate triggers due to limitations of analyses and reporting by laboratories which report TRH fractions in this manner (no total TRH concentration [C_6-C_{40}] reporting is available).

5.4.3.3 Reviews August - December 2018

Following additional review rounds and workshops, it was agreed to increase a greater degree of conservatism into the trigger values, with the aim of increasing EV protection. These include:

1. Adopting additional conservatism in the proposed values, which may offer a greater level of environmental protection.
2. Application of a 'consecutive exceedances' approach to validate the groundwater quality monitoring results. This approach requires two consecutive groundwater quality analytical results to be reported above a given parameter trigger value prior to the commencement of any investigations into the exceedance; a single trigger exceedance will not be cause for investigations into groundwater quality results. The consecutive sampling relates to two consecutive groundwater monitoring events, some two or three months apart.
3. The 'consecutive exceedances' approach has been adopted for the trigger values (**Section 5.4.3.4**) with the following exceptions:
    - High variability in the water quality from the Alluvium East subset of the alluvium trigger values makes assigning trigger values problematic. It was therefore agreed to calculate trigger values based on the bore-specific water qualities of each of the three Alluvium East bores, at least initially, to avoid erroneous triggers.
    - The ANZECC (2000) freshwater 99% species protection value of 5 µg/L was recommended as the trigger value for selenium (Tertiary sediments). It was noted, however, that the analytical laboratory's limits of reporting (LOR) for selenium concentrations were typically above this value. This means a typical analytical laboratory is incapable of identifying and reporting selenium at such a low concentration with a level of confidence. It is, thus, suggested that the ANZECC (2000) freshwater 95% species protection value, 11 µg/L Se, be adopted.
4. After the review and discussions the following were agreed:
    - On acceptance of the proposed trigger values, these values will be interim levels for two years
    - The table of trigger levels resulting from a meeting with DES (November, 2018) will replace Table E2 under Condition E9 of the Environmental Authority (EA)
    - A table of the groundwater monitoring locations of the bores utilise to develop the trigger levels will replace Table E1 of the EA (Condition 9).
5. Additional reviews in December 2018 have recommended minor adjustments to the proposed trigger levels (based on statistical analysis and comparisons between hydrostatic units), and are designed to provided additional levels of protection (DES review, December 2018).
    - For bore-specific triggers, a number of parameters may be represented below 8 recorded values. To provide values that may be included in the EA, these 'NV' (no value) entries have been compared to the hydrostratigraphic data as a whole, and values have been revised to provide appropriate representation (DES review, December 2018).

5.4.3.4 Proposed Triggers

Based on the methodology above, proposed trigger levels have been assigned to each of the water quality parameters for all the formations mentioned above. Proposed triggers, as discussed with DES, 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 Table 48~~Table 48Table 48~~

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to **Table 55~~Table 55Table 55~~** below and were derived for each of the groundwater units based on statistical evaluation of existing datasets, and following additional recommendations by DES.

5.4.3.4.1 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 CCP 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 (**Section 2.1.3**).

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.

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Table 48 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
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*

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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)
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**
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 (85th and 99th).

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- **Bold** - 95% protection trigger levels for freshwater aquatic ecosystems from Table 3.4.1 in the ANZECC & ARMCANZ 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 value 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 & ARMCANZ 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 & ARMCANZ 2000 guidelines and where <8 results above LORs were available.
- ** - pH trigger levels recommended by DES.
- *0.06* µg/L Hg adopted, which is the ANZECC & ARMCANZ 2000 guidelines 99% protection trigger levels for freshwater aquatic ecosystems.
- *Grey* text denotes trigger values refined by DES

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5.4.3.4.2 Tertiary Sediments

As a result of the extensive assessment and QA 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.

Notes for **Table 49~~Table 49Table 49~~** below include:

- **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 & ARMCANZ 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 value 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 & ARMCANZ 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 & ARMCANZ 2000 guidelines and where <8 results above LORs were available
- ** - pH trigger levels recommended by DES
- *0.06* µg/L Hg adopted, which is the ANZECC & ARMCANZ 2000 guidelines 99% protection trigger levels for freshwater aquatic ecosystems
- *Grey* text denotes trigger values refined by DES.

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Table 49 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
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*

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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)
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
Total Dissolved Solids	mg/L	**5,600**	**8,660**	**2,300**

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5.4.3.4.3 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).

Table 50~~Table 50Table 50~~ below presents the trigger levels for the Clematis Sandstone.

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Table 50 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*
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*

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Parameter	Units	Bores HD03A and C14021SP Contaminant Trigger Levels (85th Percentiles)	All other Clematis Bores Contaminant Trigger Levels (85th Percentiles)
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 & ARMCANZ 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 value 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 & ARMCANZ 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 & ARMCANZ 2000 guidelines and where <8 results above LORs were available.
- ** - pH trigger levels recommended by DES.
- *0.06* µg/L Hg adopted, which is the ANZECC & ARMCANZ 2000 guidelines 99% protection trigger levels for freshwater aquatic ecosystems.
- *Grey* text denotes trigger values refined by DES

5.4.3.4.4 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 51~~Table 51Table 51~~ presents the trigger levels for the Dunda Beds.

Notes for Table 51~~Table 51Table 51~~ include:

- **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 & ARMCANZ 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 value 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 & ARMCANZ 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 & ARMCANZ 2000 guidelines and where <8 results above LORs were available
- ** - pH trigger levels recommended by DES
- *0.06* µg/L Hg adopted, which is the ANZECC & ARMCANZ 2000 guidelines 99% protection trigger levels for freshwater aquatic ecosystems
- *Grey* text denotes trigger values refined by DES.

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Table 51 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**
Manganese	µg/L Mn	**1,900** (220)	**1,900** (28.8)
Molybdenum	µg/L Mo	34*	34*

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Parameter	Units	Bore C027P2 Contaminant Trigger Levels (85th Percentiles)	All other Dunda Beds Bores Contaminant Trigger Levels (85th Percentiles)
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**

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5.4.3.4.5 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 52~~Table 52Table 52~~** for bore C008P1 are considered to be interim trigger levels for the first two years of the GMMP in lieu of sufficient data.

Notes for **Table 52~~Table 52Table 52~~** include:

- **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 & ARMCANZ 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 value 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 & ARMCANZ 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 & ARMCANZ 2000 guidelines and where <8 results above LORs were available
- ** - pH trigger levels recommended by DES
- *0.06* µg/L Hg adopted, which is the ANZECC & ARMCANZ 2000 guidelines 99% protection trigger levels for freshwater aquatic ecosystems
- *Grey* text denotes trigger values refined by DES.

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Table 52 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**
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**

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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)
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**
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**

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5.4.3.4.6 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 53~~Table 53Table 53~~** 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 53~~Table 53Table 53~~ below presents the trigger levels for the AB Seam; notes for **Table 53~~Table 53Table 53~~** include:

- **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 & ARMCANZ 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 value 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 & ARMCANZ 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 & ARMCANZ 2000 guidelines and where <8 results above LORs were available
- ** - pH trigger levels recommended by DES
- *0.06* µg/L Hg adopted, which is the ANZECC & ARMCANZ 2000 guidelines 99% protection trigger levels for freshwater aquatic ecosystems
- *Grey* text denotes trigger values refined by DES.

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Table 53 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)
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**

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

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5.4.3.4.7 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 54~~Table 54Table 54~~** below; notes for the table include:

- **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 & ARMCANZ 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 value 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 & ARMCANZ 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 & ARMCANZ 2000 guidelines and where <8 results above LORs were available
- ** - pH trigger levels recommended by DES
- *0.06* µg/L Hg adopted, which is the ANZECC & ARMCANZ 2000 guidelines 99% protection trigger levels for freshwater aquatic ecosystems
- *Grey* text denotes trigger values refined by DES.

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Table 54 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**
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**

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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)
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
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

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5.4.3.4.8 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 55~~Table 55Table 55~~** presents the trigger levels for the Joe Joe Group bores; notes for **Table 55~~Table 55Table 55~~** include:

- **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 & ARMCANZ 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 value 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 & ARMCANZ 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 & ARMCANZ 2000 guidelines and where <8 results above LORs were available
- ** - pH trigger levels recommended by DES
- *0.06* µg/L Hg adopted, which is the ANZECC & ARMCANZ 2000 guidelines 99% protection trigger levels for freshwater aquatic ecosystems
- *Grey* text denotes trigger values refined by DES.

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Table 55 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**
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**

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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)
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**
Total Dissolved Solids	mg/L	**32,000**	**13,000**	**5,100**	**1,600**

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5.4.4 Groundwater Quality Trigger Assessment

As detailed in **Section 4.7.2,** a stepped approach will be implemented for trigger exceedances. These steps are summarised in the Trigger Assessment decision tree in **Plate 29~~Plate 29Plate 29~~**.

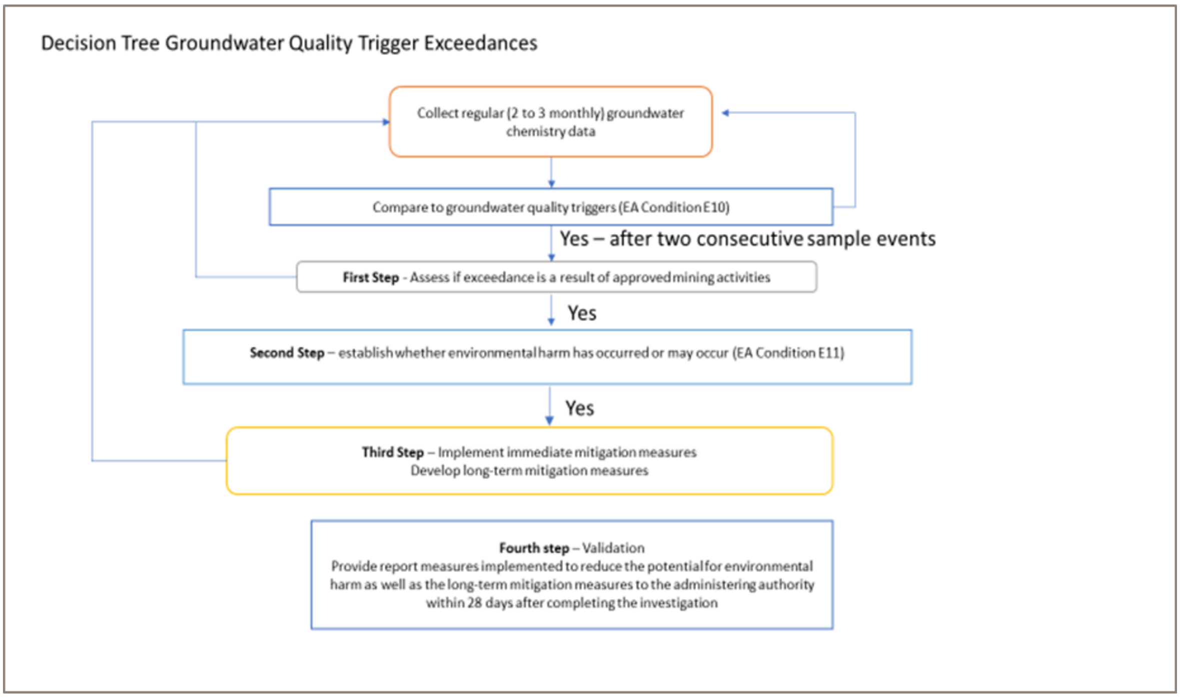

Plate 29 Trigger exceedance decision tree

This stepped approach will be implemented for trigger exceedances.

5.4.5 Contaminant Limits

EA Approval Condition E9 Table E2 (5 June 2017 version) includes for contaminant trigger levels based on the statistical assessment as detailed above. DES have recommended that contaminant limits be considered when assessing for potential for environmental.

The suggested contaminant limits, compiled by AECOM using the baseline chemistry dataset, available guidelines, and outlier identification, and then reviewed and edited by DES, are included in **Appendix D~~Appendix DAppendix D~~**.

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5.5 Control Monitoring Bores

As detailed in **Section 1.6**, the EPBC Act approval Condition 3a(i) include the requirement to include details of the control monitoring sites, which form part of the groundwater monitoring network.

The Commonwealth regulators considers that control bores are to be located outside the zone of potential impact. For groundwater this is not always possible as the groundwater monitoring bores would have to be located outside the mine lease (due to the extent of drawdown extending beyond the mine lease boundaries) and long-term access cannot be assured.

Where possible Adani has identified control bores within areas where Adani has written approval for access these bores, and where little or no drawdown is predicted (beyond natural fluctuation). Although these bores, to the west of the mine lease, are not predicted to be impacted by mine related dewatering these bores are located on other landholders properties and as such there is no guarantee that these bores will not be impacted by groundwater extraction in the future.

The selected control monitoring bores are in areas which allow these bores to 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).

It is noted that Adani also has a series of sentinel bores (**Section 5.3**) between the mine lease and sensitive receptors (such as the Doongmabulla Spring Complex and neighbouring landholder bores). These bores will not be directly impacted by approved mining activities and as such will provide uninterrupted data can be provided during and after the life of the mine.

To inform impacts on control and sentinel monitoring bores, due to non-CCP works (e.g. landholder extraction of groundwater, in most cases from shallow aquifer units), a trend assessment on water levels will be undertaken. Non-CCP groundwater impacts are likely to be limited in extent and localised and therefore, identifiable via trend analysis. As such, this method is considered suitable to identify and separate out other users' influences on groundwater levels.

Control monitoring bores are presented in Error! Reference source not found. below and in **Table 56**~~**Table 56Table 56**~~ below, by hydrostratigraphic unit. **NOTE**: Bores with a maximum predicted drawdown below natural fluctuation are considered suitable for control bores.

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Table 56 Control Monitoring Bores

Bore ID	Unit Monitoring	Monitoring Target	Predicted Drawdown (m)	Objectives
C025P1	Alluvium	Carmichael River alluvium and associated GDEs	Dry	Allows for monitoring of naturally occurring dry period in the alluvium within the Mine Lease Monitoring of natural change in alluvium required for comparison to other alluvium bores
C029P1	Alluvium		0.33 m	Allows for monitoring of natural fluctuation of groundwater within the alluvium within the mine lease, monitor for changes in vertical groundwater gradients, recharge and discharge in the middle of the mine lease Predicted drawdown is below natural fluctuation of 1.01 m
HD03B	Alluvium		0.004 m	Provides assessment of perennially saturated alluvium, due to spring discharge. Observation of natural fluctuation in the upstream portion of the alluvium
C14027SP	Alluvium		0.018 m	Allows for monitoring of natural fluctuation of groundwater within the alluvium downstream of the mine lease, monitor recharge and discharge in the alluvium. Predicted drawdown is below natural fluctuation of 0.22 m
C14028SP	Alluvium		0.075 m	Allows for monitoring of natural fluctuation of groundwater within the alluvium downstream the mine lease. Monitor recharge and discharge in the alluvium. Predicted drawdown is below natural fluctuation of 0.31 m
HD02	Clematis Sandstone	Doongmabulla Springs Complex (interim threshold of 0.2 m drawdown in spring water table)	0.03 m	Monitor unconfined Clematis Sandstone aquifer down gradient of the DSC discharge Natural fluctuation is 0.46 m

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Bore ID	Unit Monitoring	Monitoring Target	Predicted Drawdown (m)	Objectives
HD03A	Clematis Sandstone		0.18 m	Monitor confined Clematis Sandstone aquifer down gradient of the DSC discharge Natural fluctuation is 1.02 m
C14033SP	Clematis Sandstone		0.25 m	Monitor Clematis Sandstone confined by Moolayember Formation, recharge and discharge Natural fluctuation is 0.26 m
C14020SP	Moolayember Formation		0.16 m	Monitor recharge, vertical groundwater gradients with Clematis Sandstone (C14033SP) Natural fluctuation is 0.31 m
C18001SP	Clematis Sandstone		0	Control bores outside the predicted impact of approved mining activities Provide groundwater flow patterns from west of DSC
C18002SP	Clematis Sandstone		0	
C18003SP	Moolayember Formation		0	
C14023SP	Dunda Beds	Dunda Beds – responses to potential induced flow west of the mine lease	0.32 m	Monitor groundwater levels at Dunda Beds / Rewan Formation contact, evaluate induced flow potential also recharge Natural fluctuation is 0.30 m
C180119SP	Joe Joe Group	Mellaluka Springs Complex – associated GDEs and artesian conditions	0.04 m	All bores to be used to assess groundwater recharge, flow patterns, artesian conditions, and vertical gradients in the MSC area Natural fluctuation is 0.49 m
C180120SP	Tertiary sediments and Joe Joe Group		0.02 m	Natural fluctuation is 2.53 m
C180122SP	Tertiary sediments and Joe Joe Group		0.05 m	Natural fluctuation is 0.75 m

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Bore ID	Unit Monitoring	Monitoring Target	Predicted Drawdown (m)	Objectives
C180123SP	Joe Joe Group		0.007 m	Natural fluctuation is 0.67 m
C9180124SPR	Joe Joe Group		0.045 m	Natural fluctuation is 0.55 m
C9180125SPR	Joe Joe Group		0.02 m	Natural fluctuation is 1.07 m

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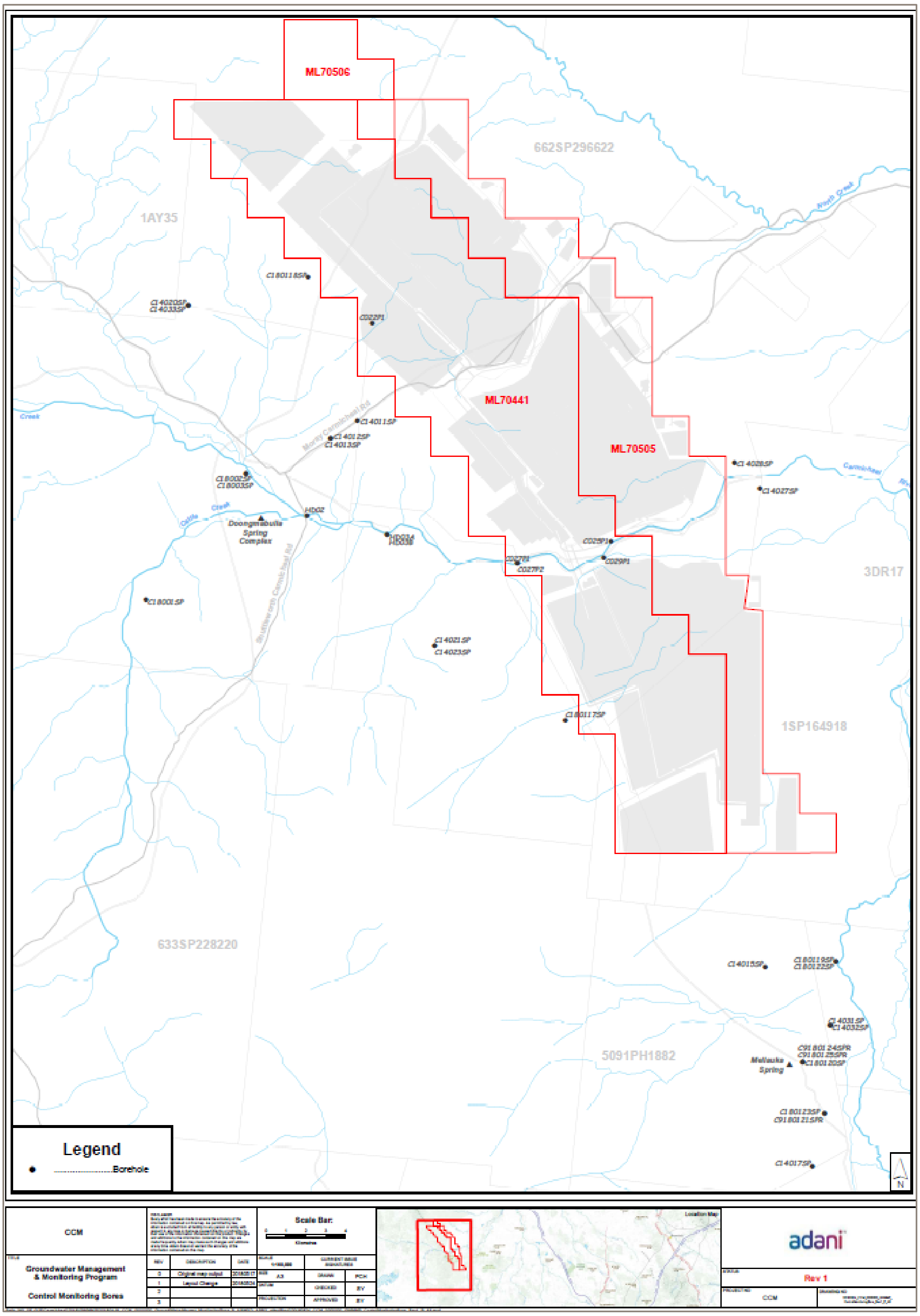

Figure 26 Control Monitoring Bores

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5.6 Monitoring Program for Sensitive Ecosystems

In compliance with EA Conditions E4 and E8 plus EPBC Act condition 3a, a number of groundwater monitoring bores have been installed across and adjacent to the CCP MLs to ensure the potential impacts of approved mining are assessed adjacent to the identified groundwater related MNES and state significant biodiversity values (as detailed in **Section 2.5**).

Groundwater monitoring bores, installed to monitor potential impacts on groundwater reliant and sensitive ecosystems, allow for the monitoring of groundwater level response in the following areas:

- The Doongmabulla Spring Complex
- Carmichael River GDEs (such as the Waxy Cabbage Palm tree communities)
- The Great Artesian Basin units and possible induced flow from these units to the mine workings
- The non-GAB Mellaluka Springs Complex.

It is noted that other groundwater environmental values, such as stock watering, are included in the monitoring program for the sentinel bores (**Section 2.5** Error! Reference source not found.).

Table 57~~Table 57Table 57~~ provides a summary of the GDE monitoring points and Error! Reference source not found.provides the location of these bores across and adjacent to the MLs.

Table 57 Summary of GDE Monitoring Points

Bore ID	Monitoring Unit	Area	Objective
C027P1	Alluvium	Carmichael River bank	Asses impacts on river and GDEs
C027P2	Dunda Beds	Carmichael River	Verify modelled induced flow, reduction in groundwater levels and influence on river and GDEs
C029P1	Alluvium	Carmichael River bank	Asses impacts on river and GDEs Control bore
C029P2	Tertiary sediments	Carmichael River	Verify predicted induced flow < 0.5 m, evaluate influence on river and GDEs
C180119SP	Joe Joe Group	Mellaluka North	Assess possible induced flow from Joe Joe Group between MLs and Mellaluka Spring GDEs Control bore
C180120SP	Tertiary sediments and Joe Joe Group	Mellaluka Middle	Assess possible induced flow at Mellaluka Spring GDEs Control bore
C180122SP	Tertiary sediments and Joe Joe Group	Mellaluka North	Assess possible induced flow from Joe Joe Group between MLs and Mellaluka Spring GDEs Control bore
C180123SP	Joe Joe Group	Mellaluka South	Control monitoring bore at Mellaluka Springs area

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Bore ID	Monitoring Unit	Area	Objective
C9180121SPR	Tertiary sediments	Mellaluka South	Assess groundwater flow from south within Tertiary sediments upgradient of Mellaluka Spring GDEs
C9180124SPR	Joe Joe Group	Mellaluka North	Assess possible induced flow from Joe Joe Group between MLs and Mellaluka Spring GDEs Control bore
C9180125SPR	Joe Joe Group	Mellaluka Middle	Control monitoring bore at Mellaluka Springs area
HD02	Clematis Sandstone	Doongmabulla Springs Complex /Carmichael River	Control bore
HD03A	Clematis Sandstone	Doongmabulla Springs Complex /Carmichael River	Control bore
HD03B	Alluvium	Carmichael River bank	Control bore
Mellaluka Spring	Tertiary sediments / Joe Joe Group	Mellaluka	Monitoring point for GDEs
Joshua Spring	Clematis Sandstone	Doongmabulla Springs Complex	Monitoring point for GDEs
C14028SP	Alluvium	Carmichael River bank	Assess alluvium GDEs downstream of MLs Control bore
C14027SP	Alluvium	Carmichael River bank	Assess alluvium GDEs downstream of MLs Control bore
C14031SP	Tertiary sediments and Joe Joe Group	Mellaluka	Assess possible induced flow from Joe Joe Group between MLs and Mellaluka Spring GDEs
C14032SP	Joe Joe Group	Mellaluka	
C14008SP	Joe Joe Group	Mellaluka	Sentinel bore
C14015SP	Joe Joe Group	Mellaluka	Sentinel bore
C14017SP	Joe Joe Group	Mellaluka	Assess groundwater flow from south within Tertiary sediments upgradient of Mellaluka Spring GDEs
C14033SP	Clematis Sandstone	Doongmabulla Springs Complex	Control bore
C14020SP	Moolayember Formation	Doongmabulla Springs Complex	Control bore
C14011SP	Clematis Sandstone	Doongmabulla Springs Complex	Assess groundwater level changes between MLs and DSC in Clematis Sandstone, early warning
C14012SP	Clematis Sandstone	Doongmabulla Springs Complex	

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Bore ID	Monitoring Unit	Area	Objective
C14013SP	Clematis Sandstone	Doongmabulla Springs Complex	for GDEs
C025P1	Alluvium	Carmichael River bank	Control bore
C14021SP	Clematis Sandstone	Doongmabulla Springs Complex	Assess groundwater level changes between MLs and DSC in Clematis Sandstone, early warning for GDEs
C14023SP	Dunda Beds	Doongmabulla Springs Complex	Control bore
C18001SP	Clematis Sandstone	Doongmabulla Springs Complex	Control bore
C18002SP	Clematis Sandstone	Doongmabulla Springs Complex	Control bore
C18003SP	Moolayember Formation	Doongmabulla Springs Complex	Control bore

In addition to these bores, Adani will install new wells west of the mine lease, to be co-located as far as practicable within 500 m of existing locations HD02, C14011SP, and HD03A. These bores will be installed to monitor the Dunda Beds and Rewan Formation to assess for any dewatering impact propagation through the Rewan Formation to the GAB. Further, these bores will inform the current understanding of the vertical groundwater gradients above and within the Rewan Formation. Adani will also consider drilling into deeper Permian age units for monitoring purposes if there is a need to do so identified in the relevant research programs.

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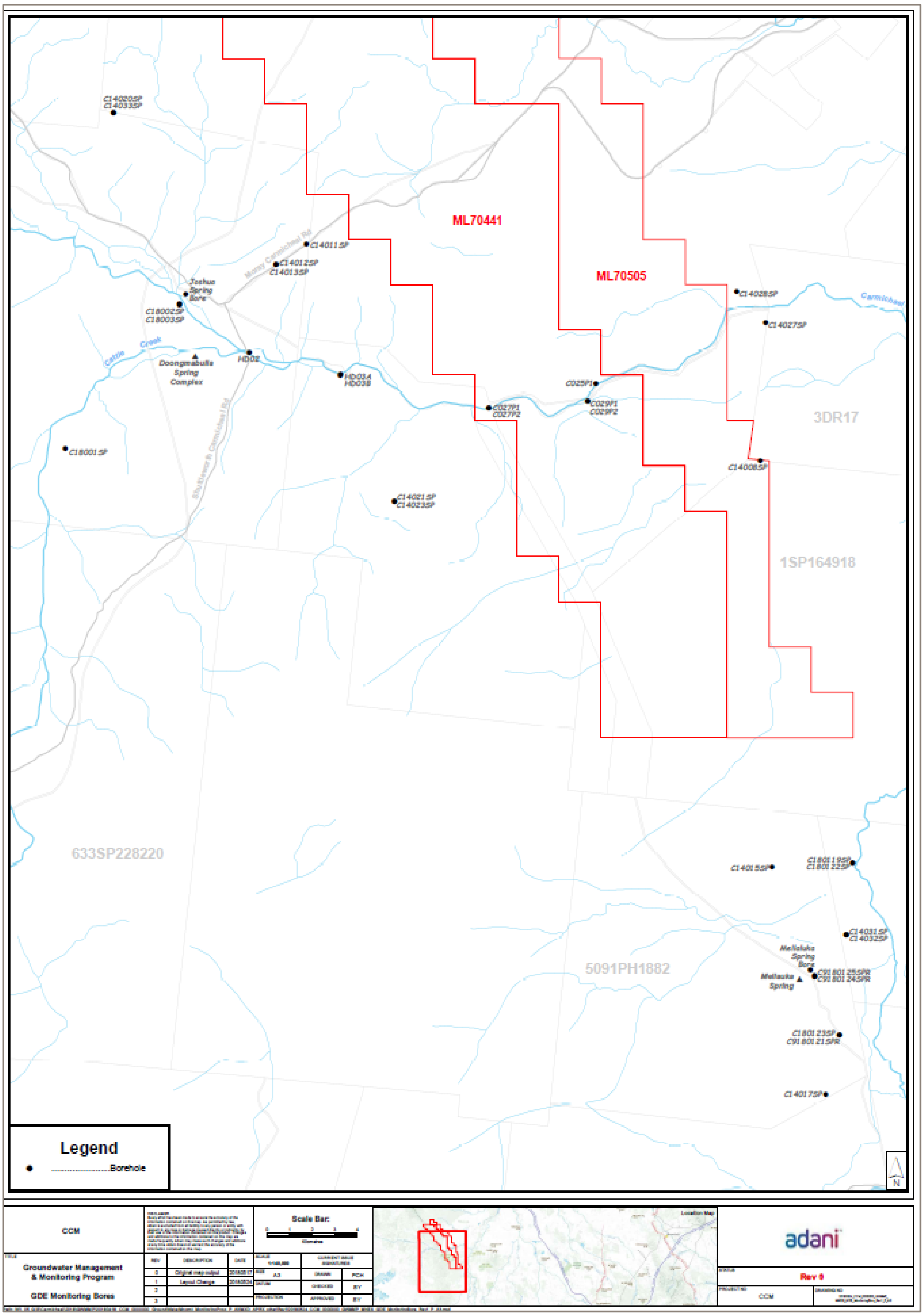

Figure 27 GDE Bores

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6.0 Development of Approval Groundwater Monitoring Programs

6.1 Construction GMMP

A groundwater monitoring program specific to the construction phase has been compiled as different activities, compared to mining, will be involved. This includes monitoring of the shallow groundwater units (Alluvium, Tertiary sediments, and Permian aged subcrop) to ensure fuel, oil, and possibly chemical storage and handling will not impact negatively on site.

The existing baseline groundwater monitoring network has been augmented to allow for the monitoring of groundwater level and quality and any departures from natural fluctuations, such as potential seepage adjacent (down gradient) of the mine affected water and waste storage facilities.

Shallow bores (within the weathered Tertiary sediments) have been constructed so that at least six (6) months of baseline data can be compiled prior to construction of the mine affected water and waste storage facilities. This will allow for the compilation of baseline groundwater quality prior to use, should perched or permanent groundwater is intersected in these bores over at least six months.

These shallow (seepage) monitoring bores provide indication of possible groundwater (saturated or unsaturated conditions prior to construction and use of possible sources of seepage) levels. Where shallow groundwater is intersected, groundwater level data will be compiled for comparison during operations to assess any potential impacts of these facilities on the recharge and shallow groundwater flow (i.e. ponding or compaction impacts) as well as possible artificial recharge (seepage).

The six (6) shallow bores installed adjacent to the mine affected water and waste storage facilities are to be sampled every two months during the construction phase, and are located in proximity to the storage facilities as depicted on Error! Reference source not found..

Groundwater levels and water quality data (the same set of parameters as included in **Section 4.4.3**) will be compiled prior to operations for comparison purposes. The water quality and water levels, if monitored over at least a six month period, will be used to develop groundwater level (rising) thresholds and water quality triggers.

The GMMP will be updated to include the location of additional seepage monitoring bores that will be installed at least six months prior to construction of other possible sources of artificial recharge, including MAW water storage dams, tailings storage/ drying cells, and out-of-pit spoil dumps where tailings will be co disposed. These bores cannot yet be included in the GMMP as they need to be located once the final footprint of these mine water and waste storage facilities has been finalised, i.e. the location of the seepage monitoring bore network can only be finalised after the footprints of these facilities has been finalised and surveyed on site.

Thus the construction monitoring network is the baseline groundwater monitoring network plus the additional seepage monitoring bores.

~~Prepared for – Adani Mining Pty Ltd – ABN: 27 145 455 205~~

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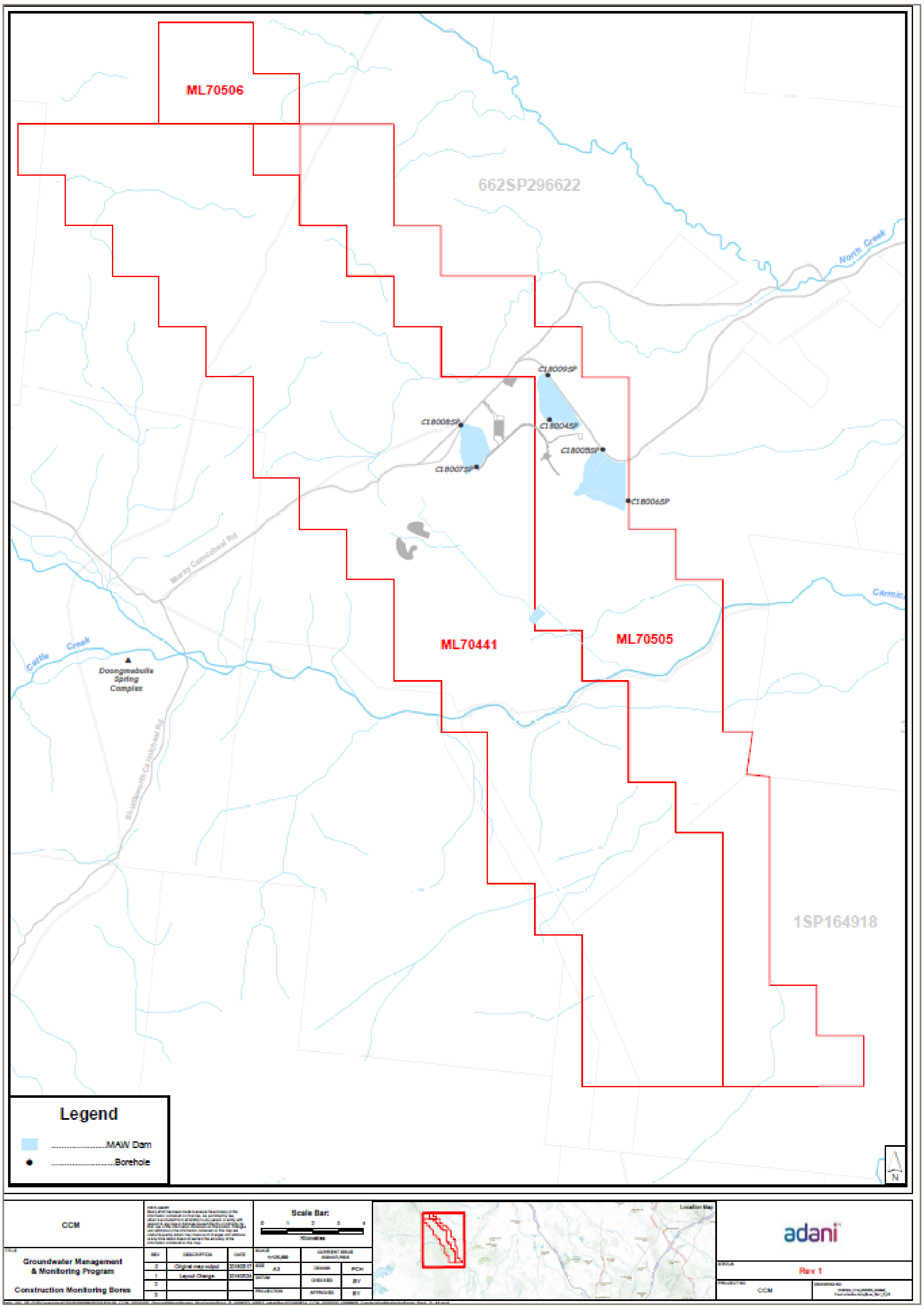

Figure 28 Seepage Bore locations and proximity to mine water infrastructure facilities

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6.2 Operational GMMP

A preliminary validation monitoring program has been designed for inclusion in this initial GMMP, for the first five (5) years of mine life (after which the GMMP is to be reviewed and modified as per the Approval Conditions). This initial Operation GMMP considers the SEIS mine plan and predicted drawdown impacts (model re-run). It is considered this initial operational GMMP groundwater monitoring network will alter with time as mine activities extend to the west and to the south to allow for the monitoring bore network to be augmented (bore replacement) over time.

During the GMMP review process the adequacy of the monitoring bore network, with regard to the active mining areas, will be assessed to ensure the impacts due to mining will be monitored and assessed. The review process also allows for the identification of when and which of the monitoring bores will be lost to mining and will require replacing (using the short term mine plans). The bores identified to be replaced will be drilled in alternate locations which will be representative of bores (i.e. same hydrostratigraphic units) that are being replaced. It is to be noted that identification of replacement bores will depend on progress of mining areas and mining schedules.

The Operational GMMP bores, selected for comparison and prediction evaluation, are based on the 5 year mine plan and schedule (the short term mine plan is considered the most accurate based on the most detailed mine planning). The Operational GMMP bores are included in **Table 58~~Table 58~~Table 58** below and presented on **Figure 29~~Figure 29~~Figure 29** below. These bores allow for the monitoring of potential groundwater impacts at or adjacent to GDEs, identified landholder bores, and GAB units. The Operational bore network was selected to address and ensure compliance with all approval conditions.

Additional bores will be installed to monitor potential seepage from tailing drying cells, water storage areas, and out-of-pit spoil dumps which are located to the east of mining areas. These monitoring bores will be installed around the perimeter of the tailings cells, water storage areas, and out-of-pit spoil dumps. Facilities will be monitored for surface seepage expressions following standard management practices. The current and operational monitoring bore network does not include the monitoring bores required for the above mentioned purpose but will be installed once the location of these facilities is finalised. The location and timing for installation of these bores will be done before construction and utilisation of these facilities and will be dictated by the mine planning process and progress of mining activities.

To augment the monitoring network Adani commits to installing additional monitoring bores into the Dunda Beds and the Rewan Formation to the west of Mining lease in between the Mining lease and DSC and is included in **Section 7.0** As far as practicable, these additional bores will be co-located with the existing bores, HD02, HD03A, and C14011SP, as nested monitoring bores in consultation with DNRME of Queensland.

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.

These bores once installed will be added to the operational groundwater monitoring program and will enable to collect spatially comparable groundwater level and quality data in between the Mining lease and DSC for the purpose of additional data collection prior to the occurrence of predicted impacts associated with project activities and timing (see Section 2.6). 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 (as compiled in Section 5.3) for inclusion in the next GMMP.

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

Construction and box cut activities will be progressed during this time, along the eastern boundary of the mine lease, as water level impacts west of the mine lease near the DSC are not anticipated for several years.

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Predicted drawdown contours will be used at regular intervals (five years) to show the groundwater monitoring locations and units over time. These data will be used to validate and update the predictive groundwater model as well as the operational monitoring bore network. It is noted that consideration of cumulative drawdown (with neighbouring projects) changes in groundwater flow direction over time will be given when locating additional operational monitoring points.

During operations the groundwater monitoring network, which includes VWPs to west of the mine leases, allows for the assessment of groundwater level decline over time, as predicted by the SEIS groundwater model.

Groundwater level drawdown thresholds proposed based on predictive modelling, will provide early warning before groundwater levels decline within the hydrostratigraphic units, such that potential impact on the vegetation (sensitive and groundwater dependent ecosystems) can be assessed.

In addition, groundwater level thresholds are proposed for units which are utilised by neighbouring groundwater users (within sentinel monitoring bores [**Section 5.3.5**]). Groundwater levels in these monitoring bores, located between the mine and existing bores will be compiled and assessed. Should groundwater levels within the various confined hydrostratigraphic units (Rewan Group, Bandanna Formation AB seam, and Colinlea Sandstone D seam) be recorded to vary by more than the groundwater level thresholds and natural fluctuation (baseline data) then an assessment of any adjacent "at-risk' bores will be undertaken as per the make-good commitments and agreements. This will allow for the planning and provision of an alternative water source to replace water supply from the 'at-risk' bore, as required.

Operational groundwater monitoring bores are to be sampled for parameters included in **Section 4.4.3** at the frequency included in **Table 58~~Table 58~~Table 58** (as per approval conditions). Groundwater level measurements will be collected with automated water level loggers, VWPs, and manually during GMEs. Quality assurance and quality control (QA / QC) procedures, as detailed in **Section 4.4.4**, will be adopted.

All of the monitoring bores in the current baseline monitoring bore network (**Table 23~~Table 23~~Table 23**) are equipped with automated water level loggers. These loggers will be downloaded every 6 months to allow for assistance with groundwater impact assessment and model refinement (particularly the over-and inter-burden layers). The purpose of the bores are detailed in **Table 23~~Table 23~~Table 23**. The bores included in the Operational GMMP were selected, from these baseline monitoring network, to validate predictive groundwater modelling and ensuring groundwater alteration is measured and monitored (for comparison to groundwater quality triggers and groundwater drawdown level thresholds) in the hydrostratigraphic units predicted to be impacted by mining. The spatial extent of the Operational bore network across and adjacent to the mine leases is indicated in **Figure 29~~Figure 29~~Figure 29**.

Appendix B includes a series of maps which depict the operational monitoring network by unit to be monitored and in relation to the Year 5 mine plan.

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Figure 29 Operational bore network

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Table 58 Groundwater monitoring locations and frequency for the Operational GMMP

Monitoring Point[27]	Monitoring	Location		Surface RL (mAHD)[28]	Monitoring Frequency	Comments Regarding Triggers
		Easting (GDA94 – Zone 55K)	Northing (GDA94 – Zone 55K)			
Alluvium						
HD03B	Water level and quality	427559.00	7556120.00	229.41	At least 2 to 3 monthly	Triggers for west – always saturated alluvium due to spring discharge into creek
C029P1	Water level and quality	437691.19	7555082.39	225.438		Bore specific triggers for non-perennial bores to the east
C025P1 (and new bore adjacent to C025P1)	Water level only	438015.54	7555845.80	227.54		
C14028SP	Water level and quality	443775.64	7559581.18	218.86		
C14027SP	Water level only	444964.65	7558330.02	217.56		
C027P1	Water level and quality	433643.08	7554818.39	226.95		
Tertiary Sediments						
C029P2	Water level and quality	437687.63	7555080.91	225.37	At least 2 to 3 monthly	Triggers for C029P2 +C025P2 (same water type)
C025P2	Water level and quality	438010.34	7555844.69	227.48		
C558P1*	Water level and quality	430311.55	7566903.06	250.07		Bore specific triggers
C9180121SPR	Water level and quality	448085.12	7529363.93	226.46		Unit specific triggers
C9845SPR	Water level and quality	439410.87	7544903.28	255.41		

[27] Monitoring is not required where a bore has been removed as a direct result of the mining activity.
[28] Locations, monitoring frequency and surface RL to be finalised based on information provided to the administering authority under condition E8 (a)

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Monitoring Point[27]	Monitoring	Location		Surface RL (mAHD)[28]	Monitoring Frequency	Comments Regarding Triggers
		Easting (GDA94 – Zone 55K)	Northing (GDA94 – Zone 55K)			
Clematis Sandstone						
C180118SP	Water level and quality	423796.76	7568090.93	306.63	At least 2 to 3 monthly Bore C180118SP is reported to be blocked; this bore is to be replaced	Unit specific triggers
C14033SP	Water level and quality	418210.80	7566775.83	296.47		
C14011SP	Water level and quality	426130.96	7561454.81	311.66		
C14012SP	Water level and quality	424896.07	7560596.18	286.37		
C14013SP	Water level and quality	424895.49	7560591.10	286.46		
HD02	Water level and quality	423822.04	7557008.25	236.35		
C18001SP (new bore no dataset yet)	Water level and quality	416311.50	7553052.04	246.97		
C18002SP (new bore no dataset yet)	Water level and quality	420948.12	7558952.34	248.30		
HD03A	Water level and quality	427562.00	7556132.00	229.41		Triggers for HD03A and C14021SP – based on Cl and geology, Moolayember Formation cover thin or non-existing
C14021SP	Water level and quality	429796.25	7550966.33	277.59		
Dunda Beds						
C027P2	Water level and quality	433648.21	7554818.54	227.58	At least 2 to 3 monthly	Bore specific triggers – outlier bore
C022P1	Water level and quality	426812.52	7565961.84	273.76		Unit specific triggers
C14023SP	Water level only	429801.74	7550968.73	277.67		
C180117SP	Water level and quality	435915.16	7547522.16	279.59		

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Monitoring Point[27]	Monitoring	Location		Surface RL (mAHD)[28]	Monitoring Frequency	Comments Regarding Triggers
		Easting (GDA94 – Zone 55K)	Northing (GDA94 – Zone 55K)			
Rewan Formation						
C556P1	Water level and quality	436524.08	7549881.55	260.63	At least 2 to 3 monthly	Unit specific triggers
C555P1	Water level and quality	432461.38	7557892.99	241.15		
C180116SP	Water level only	439392.91	7540908.81	260.82		
C9838SPR	Water level and quality	439557.91	7552811.73	228.81		
C9553P1R	Water level and quality	421010.11	7573974.87	294.114		
C035P1	Water level and quality	441403.59	7546823.81	236.31		Bore specific triggers – outlier bore
C008P1	Water level and quality	433712.50	7558833.75	238.14		Bore specific triggers – outlier bore Bore C008P1 was not included in baseline monitoring program due to proximity to C555P1 – reinstated for operational monitoring due to difference to other bores in Rewan Formation

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Monitoring Point[27]	Monitoring	Location		Surface RL (mAHD)[28]	Monitoring Frequency	Comments Regarding Triggers
		Easting (GDA94 – Zone 55K)	Northing (GDA94 – Zone 55K)			
Bandanna Formation (AB Seam)						
C007P2*	Water level and quality	434728.01	7559861.98	238.11	At least 2 to 3 monthly	Bore specific triggers – outlier bore Bore C007P2 was not included in baseline monitoring program (2014 – 2016) due to proximity to C008P2 – reinstated for operational monitoring due to difference to other bores in AB Seam bores
C14206VWP_1	VWP – assessment of depressurisation trends only	429783.15	7550956.80	227.15		No quality triggers
C14207VWP1		423806.63	7568105.26	305.17		
C14200VWP1		440547.49	7533418.60	247.08		
C968VWP_P5*		424873.59	7570989.17	279.18		
C851VWP1*		441384.00	7542877.33	244.67		
C851VWP2*		441384.00	7542877.33	244.75		
C016P2	Water level and quality	422017.38	7574974.58	294.45		Unit specific triggers
C032P2*	Water level and quality	439404.36	7544896.02	256.32		
C008P2*	Water level and quality	433710.27	7558830.28	238.12		
C014P2*	Water level and quality	430731.00	7563976.07	255.99		
C020P2*	Water level and quality	427845.47	7566931.73	263.06		
C035P2*	Water level and quality	441401.68	7546827.75	236.24		

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Monitoring Point[27]	Monitoring	Location		Surface RL (mAHD)[28]	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[27]	Monitoring	Location		Surface RL (mAHD)[28]	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[29]						
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		

[29] 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[27]	Monitoring	Location		Surface RL (mAHD)[28]	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[27]	Monitoring	Location		Surface RL (mAHD)[28]	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~~Table 23Table 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.

DRAFT

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

D R A F T

- 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.

These bores once installed will be added to the operational groundwater monitoring program and will enable to collect spatially comparable groundwater level and quality data in between the Mining lease and DSC for the purpose of additional data collection prior to the occurrence of predicted impacts associated with project activities and timing.

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.

D R A F T

Further, Adani will investigate ~~for~~ drilling into deeper Permian age units for the purpose of acquiring data for monitoring purposes and to capture ~~required~~ 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 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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8.0 References

- AECOM (2014), CCP Response to IESC Advice letter, AECOM 07 February 2014
- AECOM (2016), Carmichael Coal Mine 2015 Hydrogeological Pumping Tests: Factual Report (DRAFT)
- Allan, Jonathan P. and Fielding, Christopher R. (2007), "Sedimentology and Stratigraphic Architecture of the Late Permian Betts Creek Beds, Queensland, Australia. *Papers in the Earth and Atmospheric Sciences. 278.*
- Barnett et al, (2012), Australian groundwater modelling guidelines, Waterlines report, National Water Commission, Canberra
- Biggs, M (2014), A Short Review of Regional Structure in the Region of the Carmichael Coal Deposit, Central Queensland, ROM Resources for Adani Mining Pty Ltd
- Bureau of Mineral Resources, Geology and Geophysics (1969), Australia 1: 250,000 Geological Series Maps, Buchanan Sheet SF 55-06
- Bureau of Mineral Resources, Geology and Geophysics (1972), Australia 1: 250,000 Geological Series Maps, Galilee Sheet SF 55-10
- Bradshaw BE, Spencer LK, Lahtinen AC, Khinder K, Ryand DJ, Colwell JB, Chirinos A and Bradshaw J (2009), Queensland Carbon Dioxide Geological Storage Atlas. Department of Employment, Economic Development and Innovation, Queensland Government
- Comet Ridge (2010), 2010 Drilling Programme Shoemaker 1 Well Completion Report, ATP744P Galilee Basin Central Queensland
- DES (2018), https://www.ehp.qld.gov.au/water/policy/burdekin-basin.html
- DSITI (2017), Using monitoring data to assess groundwater quality and potential environmental impacts, Department of Science, Information Technology and Innovation, March 2017
- DNRM (2016), Springs of the Surat Cumulative Management Area
- DotE (2015), Approval, Carmichael Coal Mine and Rail Infrastructure Project, Queensland (EPBC 2010/5736)
- EHP (2016), Environmental Authority Permit – Carmichael Coal Mine Permit number EPML01470513
- Galilee Basin Operators Forum, https://www.rlms.com.au/galilee-basin-operators-forum/
- GHD (2012), Report for Carmichael Coal Mine and Rail project: Mine Technical Report, Hydrogeology Report 25215-D-RP-0026, Revision 2. 15 November 2012.
- GHD (2013), Carmichael Coal Mine and Rail Project SEIS Report for Mine Hydrogeology Report, 13 November 2013.
- GHD (2013a), Carmichael Coal Mine and Rail Project SEIS Mine Hydrogeology Report Addendum
- GHD (2013b), Carmichael Coal Project Groundwater Model Peer Review Final Comments, 18 October 2013
- GHD (2014), Carmichael Coal Project Response to IESC Advise, 7 February 2014
- GHD (2014a), Transient model verification memo, 17 December 2014
- GHD (2015), Carmichael Coal Project Response to Federal Approval Conditions- Groundwater Flow Model
- Heeswijck, Aldo Van (2006), The structure, sedimentology, sequence stratigraphy and tectonics of the Northern Drummond and Galilee basins. Central Queensland, Australia, Volume II. Thesis for Department of Earth Sciences, James Cook University of North Queensland
- Hydrogeologic (2014), Carmichael Coal Project Groundwater Model Independent Review (Re:

Approval Conditions 22 & 23), 28 November 2014

- HydroSimulations (2015), Adani-Carmichael Coal Project: Assessment of Potential Reduction in Spring Flow, 3 February 2015
- McKellar JL and Henderson RA (2013), Galilee Basin. Geology of Queensland. Geological Survey of Queensland, pages 196-202
- Middlemis et al (2001), Groundwater Flow Modelling Guideline, for Murray Darling Basin Commission, January 2001
- Moya C.E., et al (2014), Three-dimensional geological modelling of the Galilee and central Eromanga basins, Australia: New insights into aquifer/aquitard geometry and potential influence of faults on inter-connectivity, Journal of Hydrology: Regional Studies, Vol 2 November 2014 pages 119 – 139
- NQ Dry Tropics (2016), Burdekin Region Water Quality Improvement Plan 2016, NQ Dry Tropics, Townsville
- NRM (2014), Minimum Standards for the Construction and Reconditioning of Water Bores that Intersect the Sediments of Artesian Basins in Queensland, June 2014
- NWC (2012), Minimum Construction Requirements for Water Bores in Australia, 3rd Edition
- State of Queensland (2014), Carmichael Coal Mine and Rail Project: Coordinator-General's evaluation report on the environmental impact statement, May 2014
- State of Queensland (2017), Environmental values and water quality objectives for groundwaters of Burdekin, Don and Haughton River Basins, Draft for Consultation, September 2017
- URS (2013), Adani Carmichael Coal Project Numerical Groundwater Model Peer Review, 14 October 2013
- URS (2016), Geological and Groundwater Assessment of the Rewan Formation, 20 January 2016
- Webb, et al. (2015), Joint Groundwater Experts Report prepared for the Land Court of Queensland

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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.

D R A F T

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.

~~Prepared for – Adani Mining Pty Ltd – ABN: 27 145 455 205~~

Appendix A

EA Conditions

Appendix B

Bore Network Maps

DRAFT

Appendix C

Groundwater Level Contour Maps

Appendix D

Groundwater Chemistry

DRAFT

Appendix E

Groundwater Level Thresholds and Hydrographs

Appendix F

JBT Review

Appendix G

Record of Changes

From: Hamish Manzi
To: s22
Cc: s47F
Subject: Groundwater Plans engagement
Date: Friday, 1 March 2019 2:25:01 PM
Importance: High

Hi s22

As discussed, I would like to schedule in the following engagement please

- Tuesday 5th March - GDEMP – Meeting (in Canberra) (suggest 2 hours anytime from 12pm to 3pm)
- Tuesday 5th March – GMMP – Teleconference (suggest an hour from 3-4pm) –

Can you please advise whether this will work.

Thanks

Hamish

Hamish Manzi
Head - Environment & Sustainability
E Hamish.Manzi@adani.com.au
P office: +61 7 3223 4800 | direct: +61 7 3223 4837 | mobile: +61 407340125
A Level 25, 10 Eagle Street, Brisbane, QLD, 4000
P GPO Box 2569, Brisbane, QLD, 4001
W adaniaustralia.com

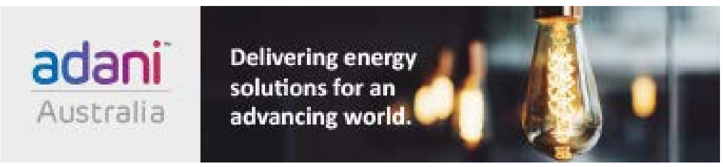
FOI 190418
Document 16

From: s22
To: s47F
Cc: Post Approval; Hamish Manzi; s22
Subject: RE: EPBC 2010/5736 Groundwater Dependent Ecosystem Management Plan [SEC=UNCLASSIFIED]
Date: Friday, 15 March 2019 5:17:08 PM

Hi s47F
I can confirm this has been received.
Cheers
s22
s22 **Foster**

Director
Post Approvals Section
Environmental Standards Division
s22 ô e: s22 @environment.gov.au
GPO Box 787 | CANBERRA ACT 2601 | AUSTRALIA
www.environment.gov.au/epbc

From: s47F @adani.com.au]
Sent: Friday, 15 March 2019 4:47 PM
To: s22
Cc: Post Approval ; Hamish Manzi ; s22
Subject: RE: EPBC 2010/5736 Groundwater Dependent Ecosystem Management Plan
COMMERCIAL IN CONFIDENCE
Good afternoon s22
Further to my email below, Adani has made some minor amendments to improve clarity, and rectify some clerical errors, in the Groundwater Dependent Ecosystem Management Plan.
I will also send a separate email that includes a link to our "sharefile" system, where you can download version 11a of the *Groundwater Dependent Ecosystem Management Plan (March 2019)*, and a document showing differences between version 11 of 6 March 2019 to this version.
Regards
s47F
s47F
Manager - Approvals
E s47F @adani.com.au
P s47F
A Level 25, 10 Eagle Street, Brisbane, QLD, 4000
P GPO Box 2569, Brisbane, QLD, 4001
W adaniaustralia.com



From: s47F
Sent: Wednesday, 6 March 2019 5:33 PM
To: 'Gregory Manning' <Gregory.Manning@environment.gov.au>
Cc: 'post.approvals@environment.gov.au' <post.approvals@environment.gov.au>; Hamish Manzi <Hamish.Manzi@adani.com.au>; s22 @environment.gov.au' s22 @environment.gov.au>; s47F @adani.com.au>; s22 @environment.gov.au>
Subject: EPBC 2010/5736 Groundwater Dependent Ecosystem Management Plan
Importance: High

Commercial in Confidence

Dear Greg

Please find attached correspondence from Hamish Manzi, Head – Environment and Sustainability about the Groundwater Dependent Ecosystem Management Plan under controlled action approval EPBC 2010/5736. Also attached is a spreadsheet with the comments provided by your department in February 2019, and Adani's responses.

I will also send a separate email that includes a link to our "sharefile" system, where you can download version 11 of the *Groundwater Dependent Ecosystem Management Plan (March 2019)*, and a document showing differences between version 10 from November 2018 and this version.

Could your team please acknowledge receipt via return email?

Regards

s47F
s47F
Manager - Approvals
E s47F @adani.com.au
P s47F
A Level 25, 10 Eagle Street, Brisbane, QLD, 4000
P GPO Box 2569, Brisbane, QLD, 4001
W adaniaustralia.com

FOI 190418
Document 17

From: s22
To: "Hamish Manzi"
Cc: s47F ; s22
Subject: RE: Groundwater Plans engagement [SEC=UNCLASSIFIED]
Date: Friday, 1 March 2019 2:29:31 PM

Hi Hamish
That will work at our end. We'll shortly send through meeting requests.
Cheers
s22

From: Hamish Manzi [mailto:Hamish.Manzi@adani.com.au]
Sent: Friday, 1 March 2019 2:25 PM
To s22
Cc: s47F
Subject: Groundwater Plans engagement
Importance: High

Hi John
As discussed, I would like to schedule in the following engagement please

- Tuesday 5th March - GDEMP – Meeting (in Canberra) (suggest 2 hours anytime from 12pm to 3pm)
- Tuesday 5th March – GMMP – Teleconference (suggest an hour from 3-4pm) –

Can you please advise whether this will work.
Thanks
Hamish

Hamish Manzi
Head - Environment & Sustainability
E Hamish.Manzi@adani.com.au
P office: +61 7 3223 4800 | direct: +61 7 3223 4837 | mobile: +61 407340125
A Level 25, 10 Eagle Street, Brisbane, QLD, 4000
P GPO Box 2569, Brisbane, QLD, 4001
W adaniaustralia.com

FOI 190418
Document 18

From: s22
To: "Hamish Manzi"
Cc: Lucas Dow; Dean Knudson; Gregory Manning; s22 ; James Tregurtha
Subject: RE: Revised Pathways document [SEC=UNCLASSIFIED]
Date: Friday, 4 January 2019 12:34:02 PM

Hi Hamish

Thank you for confirming Adani's preferred pathway. Please note that when we received your email we spoke with the CSIRO and Geoscience Australia to let them know and indicated that they should continue reviewing aspects of the plans they can while the data issues are being resolved.

We are currently working through our 'regulatory review' of the GDEMP and will be in touch mid-next week before we send our feedback through.

Apologies for the delay in responding.

Kind regards

s22
s22

Director
Post Approvals Section
Environmental Standards Division
s22 @environment.gov.au
GPO Box 787 | CANBERRA ACT 2601 | AUSTRALIA
www.environment.gov.au/epbc

From: Hamish Manzi [mailto:Hamish.Manzi@adani.com.au]
Sent: Friday, 21 December 2018 2:58 PM
To: James Tregurtha
Cc: Lucas Dow ; Dean Knudson ; Gregory Manning ; s22
Subject: RE: Revised Pathways document [SEC=UNCLASSIFIED]

Good afternoon James,

Adani's preference is to continue on Pathway 1 as expeditiously as possible.

I understand from DES that DNRME have assigned additional resources to completed the quality assurance review, I was advised this morning that this will be completed on the 11th January. (DNRME have noted potential need for clarification from that review).

From that process, Adani will classify the significance of any groundwater reference level changes, as follows:

- Bores that were not used for the EIS Modelling process will be excluded as these have been QA checked separately and triggers can be developed from that check.
- A significance test for agreed (DNRM) changes to groundwater reference levels in the context of modelled impacts that would influence trigger levels in the GMMP
  (I have discussed this with John today, please note we are confirming this test with our hydrogeologist and will revert with details)
- If required, additional verification (we will also revert on these processes)

Adani will prepare and submit a revision of the GEDMP and GMMP which clearly shows any changes in relation to this groundwater reference level review.

I have also received interim feedback on the GMMP and GDEMP from DES today.

Regards,
Hamish

Hamish Manzi
Head of Environment & Sustainability
Off +61 7 3223 4800 | hamish.manzi@adani.com.au | www.adaniaustralia.com
Level 25, 10 Eagle Street, Brisbane, QLD 4000 | GPO Box 2569, Brisbane, QLD, 4001

From: James Tregurtha [mailto:James.Tregurtha@environment.gov.au]
Sent: Wednesday, 19 December 2018 1:37 PM
To: Hamish Manzi <Hamish.Manzi@adani.com.au>; Lucas Dow <Lucas.Dow@adani.com.au>
Cc: Dean Knudson <Dean.Knudson@environment.gov.au>; Gregory Manning <Gregory.Manning@environment.gov.au>; s22 @environment.gov.au>; s22 @environment.gov.au>
Subject: Revised Pathways document [SEC=UNCLASSIFIED]

Hi Lucas and Hamish,

As discussed with Hamish just now, here is a revised version of the pathways document that incorporates confirmation of our prior approval of Adani's groundwater model, and a couple of additional clarifying points from Geoscience Australia in the "Expected Characteristics" section of Pathway Two.

Regards
James

James Tregurtha
First Assistant Secretary - Environment Standards Division
Department of the Environment and Energy
Tel: 6274 1077 | Mob: 0434 567 487

FOI 190418
Document 19

From: s22
To: "Hamish Manzi"
Cc: Lucas Dow; Dean Knudson; Gregory Manning; s22 ; James Tregurtha
Subject: RE: Revised Pathways document [SEC=UNCLASSIFIED]
Date: Thursday, 10 January 2019 6:36:30 PM

Hi Hamish

Thank you for your email. As discussed yesterday, I appreciate you raising these concerns with us.

The Department of the Environment and Energy (the Department) has contractual arrangements with the CSIRO that contains confidentiality clauses and claims intellectual property rights over the advice being provided to us. As such, in the first instance the active provision of that advice to another party is a matter for the Department.

I mentioned on Monday that we are working with the Queensland Department of Environment and Science (DES) as the state co-regulator and we have previously agreed to share the CSIRO and Geoscience Australia advice with DES. We expect that sharing the advice with DES will help decisions made by both the Commonwealth and the state to be aligned, robust, based on the best available science, and ensure efficient regulation. Provision of the advice to DES would be done on the basis for which the advice was commissioned (i.e. to inform regulatory decisions) and we would ask that the advice not be shared with other parties.

Much of the Department's work is considered discoverable through requests under the *Freedom of Information 1982* (the *FOI Act*) and that includes expert advice we commission. Queensland agencies would be bound by similar legislation. It is possible a request under the *FOI Act* would arise at some point. Should this occur, the Department would respond to request in accordance with the *FOI Act* noting that review rights are available to relevant parties in certain circumstances.

As discussed, the Department will continue to keep Adani informed of progress of both the CSIRO review of the groundwater plans and our feedback on the plans.

Regards

s22

From: Hamish Manzi [mailto:Hamish.Manzi@adani.com.au]
Sent: Wednesday, 9 January 2019 5:50 PM
To: s22
Cc: Lucas Dow ; Dean Knudson ; Gregory Manning ; s22 ; James Tregurtha
Subject: RE: Revised Pathways document [SEC=UNCLASSIFIED]

Good afternoon s22 ,

It is our understanding that the Department has commissioned the agencies CSIRO and Geoscience Australia to provide you directly with advice regarding a number of the management plans and programs required under Adani's EBC Act approval (2010/5736).

We also understand that the information provided by the CSIRO and Geoscience Australia to you will in turn be assessed within your Department in order to make a determination as to what is then communicated to Adani. Accordingly we understand that your Department will subsequently advise Adani of any required amendments to the submitted plans and programs as a result of the advice you received from those agencies.

We understand as part of this process we will not be provided with information directly from CSIRO and Geosciences Australia. We support the Department's approach in this regard to only forward to Adani Australia what the Department deems is necessary to complete the finalisation of the management plans and programs for approval. To do otherwise risks creating unnecessary confusion and dilution of the review process.

To this end we have concerns that the advice provided directly from the CSIRO and Geosciences Australia to you, may be misrepresented should it be used by third parties or read out of context with its primary purpose – that being to advise the Department. Specifically our concerns relate to the furnishing of the CSIRO and Geosciences Australia information to third parties. Therefore we respectfully ask that the Department does not release the advice to third parties. In requesting this

there is no inference that there exists any intention to do so.
This request is made in order to ensure there is no prejudice or harm to the process being followed in finalising these deliverables. Accordingly by controlling the distribution of such advice it prevents third parties using this information for purposes that undermine or intentionally harm the completion of the process as per the EPBC Act.

Separately, the DNRME review of groundwater level reference data will be completed on the 11th January, after which we will be able to revert to you on the next steps with regards to updating the GDEMP and GMMP.
Kind regards,
Hamish

Hamish Manzi
Head of Environment & Sustainability
Off +61 7 3223 4800 | hamish.manzi@adani.com.au | www.adaniaustralia.com
Level 25, 10 Eagle Street, Brisbane, QLD 4000 | GPO Box 2569, Brisbane, QLD, 4001
Please consider the environment before printing this email

From: s22 @environment.gov.au]
Sent: Friday, 4 January 2019 11:34 AM
To: Hamish Manzi <Hamish.Manzi@adani.com.au>
Cc: Lucas Dow <Lucas.Dow@adani.com.au>; Dean Knudson <Dean.Knudson@environment.gov.au>; Gregory Manning <Gregory.Manning@environment s22 @environment.gov.au>; James Tregurtha <James.Tregurtha@environment.gov.au>
Subject: RE: Revised Pathways document [SEC=UNCLASSIFIED]

Hi Hamish
Thank you for confirming Adani's preferred pathway. Please note that when we received your email we spoke with the CSIRO and Geoscience Australia to let them know and indicated that they should continue reviewing aspects of the plans they can while the data issues are being resolved.
We are currently working through our 'regulatory review' of the GDEMP and will be in touch mid-next week before we send our feedback through.
Apologies for the delay in responding.
Kind regards
s22
s22

Director
Post Approvals Section
Environmental Standards Division
s22 @environment.gov.au
GPO Box 787 | CANBERRA ACT 2601 | AUSTRALIA
www.environment.gov.au/epbc

From: Hamish Manzi [mailto:Hamish.Manzi@adani.com.au]
Sent: Friday, 21 December 2018 2:58 PM
To: James Tregurtha <James.Tregurtha@environment.gov.au>
Cc: Lucas Dow <Lucas.Dow@adani.com.au>; Dean Knudson <Dean.Knudson@environment.gov.au>; Gregory Manning <Gregory.Manning@environment.gov.au>; s22 @environment.gov.au>; s22 @environment.gov.au>

Subject: RE: Revised Pathways document [SEC=UNCLASSIFIED]

Good afternoon James,

Adani's preference is to continue on Pathway 1 as expeditiously as possible.

I understand from DES that DNRME have assigned additional resources to completed the quality assurance review, I was advised this morning that this will be completed on the 11th January. (DNRME have noted potential need for clarification from that review).

From that process, Adani will classify the significance of any groundwater reference level changes, as follows:

- Bores that were not used for the EIS Modelling process will be excluded as these have been QA checked separately and triggers can be developed from that check.
- A significance test for agreed (DNRM) changes to groundwater reference levels in the context of modelled impacts that would influence trigger levels in the GMMP
  (I have discussed this with John today, please note we are confirming this test with our hydrogeologist and will revert with details)
- If required, additional verification (we will also revert on these processes)

Adani will prepare and submit a revision of the GEDMP and GMMP which clearly shows any changes in relation to this groundwater reference level review.

I have also received interim feedback on the GMMP and GDEMP from DES today.

Regards,

Hamish

Hamish Manzi
Head of Environment & Sustainability
Off +61 7 3223 4800 | hamish.manzi@adani.com.au | www.adaniaustralia.com
Level 25, 10 Eagle Street, Brisbane, QLD 4000 | GPO Box 2569, Brisbane, QLD, 4001

From: James Tregurtha [mailto:James.Tregurtha@environment.gov.au]
Sent: Wednesday, 19 December 2018 1:37 PM
To: Hamish Manzi <Hamish.Manzi@adani.com.au>; Lucas Dow <Lucas.Dow@adani.com.au>
Cc: Dean Knudson <Dean.Knudson@environment.gov.au>; Gregory Manning <Gregory.Manning@environment.gov.au>; s22 @environment.gov.au>; s22 @environment.gov.au>
Subject: Revised Pathways document [SEC=UNCLASSIFIED]

Hi Lucas and Hamish,

As discussed with Hamish just now, here is a revised version of the pathways document that incorporates confirmation of our prior approval of Adani's groundwater model, and a couple of additional clarifying points from Geoscience Australia in the "Expected Characteristics" section of Pathway Two.

Regards

James

James Tregurtha
First Assistant Secretary - Environment Standards Division
Department of the Environment and Energy
Tel: 6274 1077 | Mob: 0434 567 487

FOI 190418
Document 20

From:	s47F
To:	s22
Cc:	Hamish Manzi; s47F
Subject:	Response table - Groundwater dependent ecosystem management plan
Date:	Monday, 21 January 2019 1:17:54 PM
Attachments:	2010-5736-20181025-GDEMP-v9-DoEE comments_Adani_response.pdf
Importance:	High

Good afternoon

Please find attached a table outlining how Adani has responded to your feedback about the Groundwater Dependent Ecosystem Management Plan.

Regards
s47F

Your message is ready to be sent with the following file or link attachments:

2010-5736-20181025-GDEMP-v9-DoEE comments_Adani_response

Note: To protect against computer viruses, e-mail programs may prevent sending or receiving certain types of file attachments. Check your e-mail security settings to determine how attachments are handled.

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: 5-7

Document full title	Groundwater Dependent Ecosystem Management Plan – Carmichael Coal Mine Project. Prepared for Adani Mining Pty Ltd Version 9, 5 July 2018
Drafting officer	s22
Reviewing officer	s22
Date plan received	13 July 2018
Date issued to approval holder	Teleconference 12 September 2018 – conceptualisation Workshop 16 October 2018 Teleconference 24 October 2018 Email 26 October 2018

Condition	DOEE comments on Version 8: Provided 27 November 2017	Adani response Dec 2017	Department comments on version 9	Adani response Nov 2018
General Comments	Further inaccuracies detected: 1.4 refers to the Plan as a 'report'. Table 7, p.55 the following trigger is defined: "Groundwater drawdown trigger level threshold exceeded." This is a meaningless tautology. Table 7 p.57 "water quality parameters outlined Sub catchment management plan for the Belyando-Suttor Basin" should read "meeting the water quality parameters specified in the sub-catchment plan for the Belyando-Suttor Basin". Please note that under EPBC approval condition 30 the approval holder must maintain accurate records substantiating all activities for the life of the approval. **Please correct 11.2 which states that "Monitoring results and reports will be kept for at least 5 years."**	Changed from report to management plan Text replaced with "Exceedance of the trigger levels for groundwater drawdown outlined in the GMMP." Change made in Table 7 as suggested and also Section 7.5.1. Section 11.2 amended as suggested.	Inconsistencies / errors 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. d). Please address. 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. Ambiguity 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	Inconsistencies / errors 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. Ambiguity 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. 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. Link to GMMP

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			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. 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). Link to GMMP 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. Link to other plans 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.	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. Link to other plans 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.
	While the language of commitments has been improved, there remain many commitments which remain vague. For many core requirements (for example the establishment of baseline and, as a consequence, triggers), it is not possible to determine from the plan precisely when this will occur. It is important to establish baseline and triggers prior to impacts occurring. **Action:** **Please ensure that the plan is specific as to when baseline and triggers for each parameter will be determined. Please ensure that the baseline and triggers are to be determined prior to impacts.**	Additional text added to Section 5.1 to clarify that baseline monitoring and the derivation of specific trigger levels will occur prior to the first box cut, and that such triggers will need to be approved by the Department. This approach is consistent across all monitoring variables, so best to specify this in the overview, rather than be repetitive in the tables in the following chapters. Section 6.7.6 amended with new text as requested, with reference to Condition 33 of the EPBC Act approval.	Phasing/staging 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 before groundwater levels drop.	Phasing/staging 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-impact monitoring and actions that will be undertaken prior to groundwater impacts. c). Stage 1 terminology removed. Pre-impact studies proposed for the Doongmabulla Springs. Updates a). Section 10.3 adds detail when revision of the plan is required, and whether approval is needed.

Condition	DOEE comments on Version 8: Provided 27 November 2017	Adani response Dec 2017	Department comments on version 9	Adani response Nov 2018
	Examples: The plan make numerous references to 'updating' it as new information becomes available. Please note that conditions 33 – 33D and section 143A of the EPBC Act govern the process by which the approved plan can be revised. **Action: Where updates of the plan or values in the plan are referred to, please reference the manner in which the approved plan can be changed, perhaps by including "see 11.1".**	Section 11.1 updated with condition and legislation details and cross reference to this section added to Section 6.7.6.	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 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.	b). Figure removed, replaced by table in section 10.3 to show relationships with other management plans and programs 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.

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			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?	
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 updated in accordance with Condition 33.*			The first draft of the plan was submitted in November 2016. Mining operations have not yet commenced.	Noted
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 based 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.

Condition	DOEE comments on Version 8: Provided 27 November 2017	Adani response Dec 2017	Department comments on version 9	Adani response Nov 2018
a) a description of environmental values for each of the Matters of National Environmental Significance addressed in the plan			MNES 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? 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.	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 checked for clarity against relevant conditions and requirements. Figures updated. e). Descriptions of these GDE's updated in the relevant chapters.

Condition	DOEE comments on Version 8: Provided 27 November 2017	Adani response Dec 2017	Department comments on version 9	Adani response Nov 2018
			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) 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))	As the GDEMP relies on commitments in the GMMP and OAMP, which are not yet approved, please include a commitment that ""Adani will not commence the first box cut until the Minister has approved a revised version of this plan which contains confirmed details in place of those which, in this version, refer to the as yet unapproved GMMP and/or OAMP." Table 7 (p.57) Trigger Baseline groundwater quality monitoring is not completed prior to first box cut excavation" should read "prior to commencement of mine activities" if it is to respond to the Mitigation and Management Measure: "Develop groundwater quality parameters for each groundwater unit incorporating information from all groundwater quality sampling for the development of the EIS and subsequent monitoring prior to the commencement of mine activities." The Corrective Actions proposed in Table 7 (p. 56-7) if water quality parameters exceed parameters in Tables F3 and F5 of the EA comprise investigation and providing a report in the next annual return. No actual corrective action is proposed in this instance. **Please propose actual corrective actions to be implemented.** Table 8 (pp.69, 70) Tasks 'baseline survey' and 'extended baseline' include	Text inserted at the end of Section 1.3 as requested. Table 7 amended as requested. Additional text added to corrective action column to outline that action will be taken to address the cause of the exceedance following the investigation, if there is potential for environmental harm. This will include modifying releases of mine affected water to achieve compliance. The baseline monitoring and establishment of triggers will be completed before the first box cut and any potential impact. This has been clarified through a revision to Section 6.7.6.	<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 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[1] <u>Impact monitoring</u> 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.	<u>Baseline monitoring</u> a). Text has been added to Section 5.1 on the general approach which 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. <u>Impact monitoring</u> 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 other variables are adequately controlled to provide a statistically reliable "control". <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 is included. <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

[1] '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'.

Condition	DOEE comments on Version 8: Provided 27 November 2017	Adani response Dec 2017	Department comments on version 9	Adani response Nov 2018
	as a trigger 'Population … deviates … from baseline". **As it will not be possible to implement such a trigger until a baseline has been defined, please either define an interim baseline or propose an effective trigger.**		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. 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>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>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.	length.Further discussions are being held with the department. 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 triggers are included so this further details is not needed in the GDEMP. <u>Springs</u> 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 due to activities of the landholder and cannot be a reliable measure. 3). As per above, given the predicted model impacts to the DSC, it is not feasible or possible to co-locate 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.

Condition	DOEE comments on Version 8: Provided 27 November 2017	Adani response Dec 2017	Department comments on version 9	Adani response Nov 2018
			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. 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>Springs</u> 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.	

Condition	DOEE comments on Version 8: Provided 27 November 2017	Adani response Dec 2017	Department comments on version 9	Adani response Nov 2018
			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.	
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: 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	Doongmabulla a). This has been addressed in the updated DSC chapter in regards to ecological triggers. Groundwater triggers 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 Mellaluka a). The groundwater source of Mellauka Springs is noted as a MNES. Ecological surveys have not determined that the Mellaluka Springs is ecologically significant with respect to MNES. Further 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-impact monitoring, revised groundwater modelling and other studies well before any relevant impacting activities commence.

Condition	DOEE comments on Version 8: Provided 27 November 2017	Adani response Dec 2017	Department comments on version 9	Adani response Nov 2018
			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.	
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	The plan characterises the requirements of the EPBC conditions in respect of GDE as (3.2) "development of management plans for the MNES dependent on groundwater considered most likely to be affected by the project". Condition 5 requires plans for the management of direct or direct impacts of mining operations on MNES. "A water resource" is a MNES. The *Significant impact guidelines 1.3 Coal seam gas and large coal mining developments* includes "the ecosystem components, processes and benefits or services that characterise the water resource, including support for the biological diversity or species composition of the water resource" (p16). The modelled drawdown will be significant in sections	As agreed at the teleconference on 14 December 2017, no changes will be made to the stygofauna sections (no monitoring commitments) in this version of the GDEMP. Adani will review the need to conduct stygofauna monitoring following approval of the GMMP and OAMP, and update the GDEMP as necessary at this time.	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. 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	Dewatering impacts a). Mapping provided under each GDE to show dewatering impacts b). Timing updated throughout Waxy Cabbage Palm a). updated to include presence and impact mapping. Doongmabulla a). Impact updated, Table 8-5 Carmichael River a). Updated mapping included b). Updated baseline description based on approved project impacts and studies.

Condition	DOEE comments on Version 8: Provided 27 November 2017	Adani response Dec 2017	Department comments on version 9	Adani response Nov 2018
(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.	of the River close to and downstream of the mine. The Department considers that it is therefore appropriate that biota that could be affected by changes to the water resource need to be monitored. **Action: Please review the range of GDE to which the plan applies in view of the *Significant impact guidelines 1.3 Coal seam gas and large coal mining developments.* Please cite these guidelines in 3.3.** The modelled impacts to groundwater are considered significant for the Carmichael River water resources (e.g. as summarised in 6.4) rather than minor as characterised in the Adani response (at left). **Action: Please revise the plan in consideration of the *Significant impact guidelines 1.3***		to all possible source aquifers for each GDE. This will also assist in phasing / staging the plan (see above). <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>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>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	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>Melalluka</u> a). The best available information is the modelling studies undertaken through the EIS process and subsequently approved by the Minister.

Condition	DOEE comments on Version 8: Provided 27 November 2017	Adani response Dec 2017	Department comments on version 9	Adani response Nov 2018
			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>Mellaluka</u> 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.	
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	See comments in rows 10 and 12 above. 6.7.6 (p.65) describes points at which nominated triggers will be reviewed and may be revised. It notes that "The GDEMP and GMMP will be updated following any revisions to trigger levels". **Action: Please specify the need for triggers to be approved by the Minister as part of proposed revisions of respective plans.** Please note that the reliability of data from groundwater monitoring bore HD03 B has been questioned by	Section 6.7.6 amended with new text as requested, with reference to Condition 33 of the EPBC Act approval.	<u>Management measures</u> 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	<u>Management Measures</u> All GDE chapters restructured as discussed with DoE to capture objectives, threats, management, monitoring and response activities. <u>Rehabilitation Measures</u> 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. <u>IESC advice</u>

Condition	DOEE comments on Version 8: Provided 27 November 2017	Adani response Dec 2017	Department comments on version 9	Adani response Nov 2018
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 (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.	Geoscience Australia in its review of the GMMP. **Please consider whether a replacement for bore HD03 B should be proposed for detecting trigger levels for *Livistona lanuginosa*.**	Next text added to Section 6.7.6 as requested.	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. <u>Rehabilitation measures</u> 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. <u>Mellaluka</u> 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. <u>Carmichael River</u> 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.	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. <u>GABSRP</u> Tables 1-1 and 10-1 provide detail on connection with other plans and programs

Condition	DOEE comments on Version 8: Provided 27 November 2017	Adani response Dec 2017	Department comments on version 9	Adani response Nov 2018
			<u>Doongmabulla Springs</u> 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.	
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
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))	**See comments in row 10 above**	**Comments in row 10 addressed as noted above.**	<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>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.

Condition	DOEE comments on Version 8: Provided 27 November 2017	Adani response Dec 2017	Department comments on version 9	Adani response Nov 2018
As per previous			Triggers 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 any 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, 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.	Triggers a), b) and c). Ecological triggers updated and clarified throughout and linked to groundwater triggers where relevant
As per previous			Corrective actions 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	Corrective actions 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.

Condition	DOEE comments on Version 8: Provided 27 November 2017	Adani response Dec 2017	Department comments on version 9	Adani response Nov 2018
			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.	
As per previous			<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>Offsets</u> a). Requirement for offsets specified in relevant GDE chapter sections
As per previous			<u>Carmichael River</u> 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	<u>Carmichael River</u> Please refer to updated CR chapter including sections 6.4 through 6.9

Condition	DOEE comments on Version 8: Provided 27 November 2017	Adani response Dec 2017	Department comments on version 9	Adani response Nov 2018
			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 from Joshua spring, pool persistence, riffle habitat, baseflow index, and geomorphological indicators.	

Condition	DOEE comments on Version 8: Provided 27 November 2017	Adani response Dec 2017	Department comments on version 9	Adani response Nov 2018
As per previous			<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
As per previous			<u>Doongmabulla Springs</u> 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	<u>Doongmabulla Springs</u> Please refer to updated DS chapter including sections 6.5 through 8.10

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			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. 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.	

Condition	DOEE comments on Version 8: Provided 27 November 2017	Adani response Dec 2017	Department comments on version 9	Adani response Nov 2018
			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.	
As per previous	Table 7 specifies triggers which rely on comparison with baseline values but apply before baseline has been established. E.g. No interim triggers are identified. Table 7 (p 53) proposes the following trigger: 'Decreases in Carmichael River flow exceed current flood modelling predictions.' Please clarify what this means. In Table 7 (p54, p55) please correct the trigger 'Evidence of dieback and impacts to Livistona lanuginosa' to read 'Evidence of dieback or impacts to Livistona lanuginosa'. In Table 7 (p55, p59) a trigger of 'Increase in weed cover (>10%) from baseline conditions'. As the management goal is to reduce weed abundance, reoccurrence of the baseline should be a trigger that the weed control plan is failing. Table 8 specifies triggers to apply during Stages 1 and 2 which rely on comparison with baseline values. No interim triggers are identified. **Action: Please specify the need for triggers to be approved by the Minister**	The baseline monitoring and establishment of triggers will be completed before the first box cut and any potential impact. This has been clarified through a revision to Section 6.7.6. Text amended as requested in Table 7. Amended in Table 7 and elsewhere throughout document. Management goal revised to reflect aim of maintaining weed and pest populations at or below those of baseline conditions. This is consistent with other performance criteria or management goals e.g. 'maintain or improve existing condition of retained population…' Baseline monitoring will be completed prior to the first	<u>Waxy Cabbage Palm</u> 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.	<u>Waxy Cabbage Palm</u> Please refer to updated WCP chapter including sections 7.4 through 7.9

Condition	DOEE comments on Version 8: Provided 27 November 2017	Adani response Dec 2017	Department comments on version 9	Adani response Nov 2018
	as part of proposed revisions of the respective plans. **Please clarify when Stage 2 ends and Stage 2 commences.**	box cut and potential impacts, allowing the development and implementation of triggers during Stage 1. Stages 1 and 2 comprise a period of approximately 15 years (extensive baseline data will be available for development of triggers). Need for DoE approval for new triggers has been specified. Section 5.1.2 provides start and finish times for Stage 2 (first box cut to ~15 years). Additional text has been added to clarify start timing.	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).	
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
h) details of how compliance will be reported				No action required
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			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?	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. e). Requirements for updates to the GABSRP are described in Section 10.3

Condition	DOEE comments on Version 8: Provided 27 November 2017	Adani response Dec 2017	Department comments on version 9	Adani response Nov 2018
Conditions 3c), 3d), 6e) and 6f))			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. 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.	
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.
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	Not applicable.			No action required

Condition	DOEE comments on Version 8: Provided 27 November 2017	Adani response Dec 2017	Department comments on version 9	Adani response Nov 2018
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				
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).	Addressed. No further action needed.		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

FOI 190418
Document 21

From: s47F
To: Hamish Manzi; s47F; s47F; s47F; s47F; Gregory Manning; s22; s22; s22; s22; s22; s22; s47F; s22; s22; s22; s22; s22; s22
Subject: RE: Adani Projects Update Meeting
Date: Monday, 14 January 2019 4:17:58 PM
Attachments: Outstanding Issues Report January 2019.pdf
Agenda Adani Projects Update 15Jan19.pdf

Good afternoon

Please find attached the agenda and outstanding issues report for the meeting tomorrow.

If you are teleconferencing into the meeting, please call s22 [redacted]

Regards
s47F

-----Original Appointment-----
From: s47F
Sent: Wednesday, 9 January 2019 1:19 PM
To: s47F; Hamish Manzi; s47F; s47F; s47F; s47F; s47F; Manning, Gregory; s22; s22; s22; [redacted] ;s22; s22; s22; s22; s22; s22; s22; s22; s22; s22
Cc: s47F
Subject: Adani Projects Update Meeting
When: Tuesday, 15 January 2019 12:00 PM-1:00 PM (UTC+10:00) Brisbane.
Where: 51 Allara Street, Canberra

Hello
The intent is for this meeting to be held at 12 noon Brisbane time; 1 pm Canberra time.
The teleconference details are below.
Draft agenda to be shortly distributed.
Regards
s47F

-- Do not delete or change any of the following text. --

s47F
[redacted]

s47F [redacted]

[redacted]

[Global call-in numbers]

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IMPORTANT NOTICE: Please note that this Webex service allows audio and other information sent during the session to be recorded, which may be discoverable in a legal matter. By joining this session, you automatically consent to such recordings. If you do not consent to being recorded, discuss your concerns with the host or do not join the session.

adani™

ADANI PROJECTS – OUTSTANDING ISSUES

January 2019

1.1 Groundwater Management and Monitoring Plan / Groundwater Management and Monitoring Program, Condition 3 (EPBC 2010/5736) and condition E3 of Environmental Authority (EPML 01470513)

Lodgement date and version number:	8 August (Commonwealth Government) and 9 August (Queensland Government) 2018 Version 2
Adani lead:	s47F
Commonwealth Government lead:	s22
Queensland Government lead:	s22
Approval sought by:	As soon as possible
Current status:	Finalisation of groundwater level review data

Issues –

- Adani are finalizing a review of groundwater level reference data with the Queensland Department of Natural Resources, Mines and Energy
- This material will be provided in a revised GMMP for agency review.

Who to resolve and when – Adani to provide updated information regarding groundwater reference level data.

s22

s22

s22

1.6 Groundwater Dependent Ecosystem Management Plan - Conditions 5, 6 and 7 (EPBC 2010/5736) and Conditions I11, I12, I13 and I14 of Environmental Authority (EPML 01470513)

Lodgment date and version number:	13 July 2018, Version 9 (updated) Extract provided 9 November 2018 19 November 2018, Version 10
Adani lead:	Hamish Manzi
Commonwealth Government lead:	Greg Manning, s22 [redacted], s22 [redacted]
Queensland Government lead:	s22 [redacted]
Approval sought by:	14 December 2018
Current status:	Finalisation of groundwater level review data

Issues –

- Commonwealth review of document for providing to Geosciences Australia and CSIRO.
- Finalisation of groundwater level review data exercise and then subsequent amendments to the plan for resubmission.
- Queensland Government provided draft feedback early January, further feedback to come.

Who to resolve and when – Commonwealth and Queensland Governments to provide updates.

s22

FOI 190418
Document 22

From: s22
To: s47F ; Gregory Manning
Cc: s22 ; s22 ; s22 ; s22 ; Post Approval; Hamish Manzi
Subject: RE: EPBC 2010/5736: condition 5 - Updated Groundwater Dependent Ecosystem Management Plan (groundwater data) [DLM=For-Official-Use-Only]
Date: Monday, 21 January 2019 2:08:57 PM
Attachments: image002.png

HI s47F ,

I have successfully downloaded the PDF and word version with tracked changes. I have provided the PDF to GA and CSIRO and will get the word version to them later today.

s22

s22
T s22 | **E** s47F @environment.gov.au
W www.environment.gov.au

From: s47F [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

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

From: s47F [redacted]
To: Hamish Manzi; s47F [redacted]; s47F [redacted]; s47F [redacted]; s47F [redacted]; s47F [redacted]; Gregory Manning; s22 [redacted]; s22 [redacted]; s22 [redacted]; s22 [redacted]; s22 [redacted]; s22 [redacted]; s22 [redacted]; s22 [redacted]; s22 [redacted]; s22 [redacted]; s22 [redacted]; s22 [redacted]
Subject: RE: Adani Projects Update Meeting
Date: Thursday, 24 January 2019 6:26:08 PM
Attachments: Carmichael-PostApprovals-Project Update Meeting Notes 15Jan2019.pdf

---

Good afternoon

Please find attached the final notes for our meeting on 15 January 2019.

Regards
s47F [redacted]

-----Original Appointment-----
From: s47F [redacted]
Sent: Wednesday, 9 January 2019 1:19 PM
To: s47F [redacted]; Hamish Manzi; s47F [redacted]; s47F [redacted]; s47F [redacted]; [redacted]
Subject: Adani Projects Update Meeting
When: Tuesday, 15 January 2019 12:00 PM-1:00 PM (UTC+10:00) Brisbane.
Where: 51 Allara Street, Canberra

Hello
The intent is for this meeting to be held at 12 noon Brisbane time; 1 pm Canberra time.
The teleconference details are below.
Draft agenda to be shortly distributed.
Regards
s47F [redacted]

-- Do not delete or change any of the following text. --

s22 [redacted]

[redacted]

[redacted]

s22

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Adani Projects Update Meeting
15 January 2019

Time:	12 noon to 1 pm (Brisbane time), 1 to 2 pm (Canberra time)
Location:	Teleconference
Teleconference:	s47F [redacted]
Attendees:	Commonwealth Government – Department of the Environment and Energy (DEE) **Post approvals:** s22 [redacted]
	Compliance: *(Note – the Compliance Team were unable to provide feedback about these meeting notes within the timeframe)* s22 [redacted] s22 [redacted] *via teleconference*
	Queensland Office of the Coordinator-General s22 [redacted] *via teleconference*
	Queensland Government – Department of Environment and Science (DES) s22 [redacted] *via teleconference* s22 [redacted] *via teleconference*
	Adani Hamish Manzi [HM] s47F [redacted] s47F [redacted] s47F [redacted] *via teleconference*
Apologies	s22 [redacted]; s22 [redacted]; s47F [redacted]
Purpose:	To share information about Adani projects, including mine, rail, port and renewable energy.

Agenda

#	Item	Start (Bris)	Time	Lead
1	Actions arising	1 pm	5 mins	s47F [redacted]
2	Project Update	1:05 pm	10 mins	HM
3	Critical delivery items	1:15 pm	30 mins	All
4	Other business	1:45 pm	10 mins	s47F [redacted]
5	Summary of agreed actions	1:55 pm	5 mins	s47F [redacted]
6	Close	2 pm		

Actions arising

Note – completed actions from previous meetings have been removed from table.

#	Action	Who	When	Status
114	s22 [redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	HM	By 18 January 2019	
116	Find out more information about the status of the bores and aquifer data and send an email update	HM	27 November 2018	*Complete*
117	Adani to schedule meeting to discuss the GA / CSIRO advice and s22 [redacted]	HM	14 December 2018	
118	s22 [redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	HM / s47F [redacted]	25 January 2019	
124	Adani will develop a table of responses to the Commonwealth feedback about the Groundwater Monitoring and Management Plan and Rewan Formation Connectivity Research Plan and send back	s47F [redacted]	25 January 2019	
125	s22 [redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	s47F [redacted]	16 January 2019	*Complete*

#	Action	Who	When	Status
129	Adani and Commonwealth Government to discuss Commonwealth Government feedback about the Groundwater Dependent Ecosystem Management Plan	MB / s22	By 25 January 2019	

Meeting Notes

#	Item	Start (Bris)	Time	Lead
2	Project Update	1:05 pm	10 mins	HM

s22 [redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- s22 [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

#	Item	Start (Bris)	Time	Lead
3	Critical delivery items	1:15 pm	30 mins	All

Groundwater Management and Monitoring Plan

HM provided an update –

- working through a groundwater level data quality assurance process with the Queensland Department of Natural Resources, Mines and Energy [DNRME]
- material submitted in December, response received last Friday. Adani believes it can respond quickly to those further queries.
- figures impacted by the review will be updated and included in all management plans shortly
- process also involved review of new data against the modelled data. Also looking at levels of significance in changes, however, generally there are no material differences that will influence the model.

s22 [redacted] asked if Adani could please develop response to Commonwealth feedback for the GMMP. **ACTION** – Adani will develop a response document to the Commonwealth feedback about the Groundwater Monitoring and Management Plan and send back.

s22 [redacted] advised that Srinivasa Yarlagadda sent a response about DNRME feedback. **ACTION** - KB to provide the data to DNRME and confirm all issues have been closed out.

s22 [redacted]

s22 [redacted] s22 [redacted]

s22 [redacted].

Groundwater Dependent Ecosystem Management Plan
HM advised that Adani will update the GDEMP based on changes to the figures as a result of the groundwater data review.

ACTION – s47F [redacted] to meet with s22 [redacted] and team to discuss Commonwealth Government feedback about the Groundwater Dependent Ecosystem Management Plan.

s22 [redacted] advised that DES are not sending any further feedback.

s22

From: s22
To: Hamish Manzi
Cc: s22 ; Gregory Manning
Subject: Scope for CSIRO and GA review of groundwater plans [SEC=UNCLASSIFIED]
Date: Friday, 25 January 2019 4:47:53 PM
Attachments: 2010-5736-20190125-GW-Questions for external review.docx

---

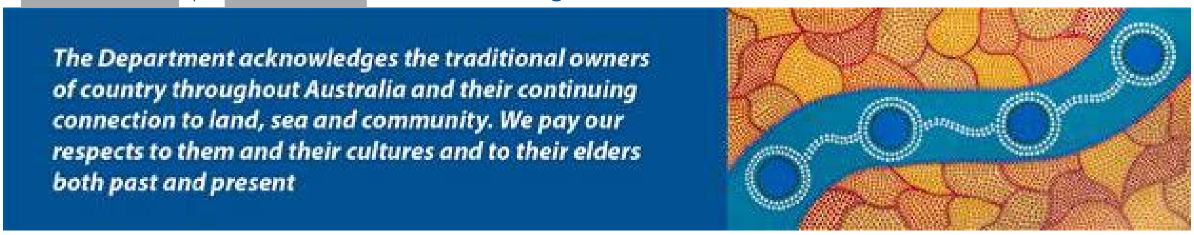
Hi Hamish,

As requested, please find a copy of the questions posed by the Department to CSIRO and Geoscience Australia in relation to Adani's groundwater plans attached.

Question 1 was addressed in their tranche 1 advice (complete), 2 and 3 will be addressed in tranche 2 advice now that we have the revised GDEMP and GMMP.

s22

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



FOI 190418
Document 24a

Questions

Scientific conceptualisation

The Department is seeking advice on the approval holder's ecohydrogeological conceptualisation, to ensure that is reasonable to use as a basis for the Groundwater Dependent Ecosystems Management Plan (GDEMP), Groundwater Management and Monitoring Plan (GMMP), Rewan Formation Connectivity Research Plan (RFCRP) and Great Artesian Basin Springs Research Plan (GABSRP) required under the conditions of approval. In particular:

1a. Based on the information currently available, how plausible and reasonable is it that the Clematis sandstone is the source aquifer for Doongmabulla Springs Complex?

1b. How adequately do the methods and techniques put forward in the research plans address any residual uncertainties about:

- the source of the springs
- the capacity of the Rewan Formation to prevent impacts to the springs and
- methods to prevent, mitigate and remediate ecological impacts to the springs?

Note: This assessment should be based on the four draft plans, the statement of claims about the springs source and additional information about the conceptualisation, including studies since the time of approval.

2a. How appropriate is the numerical model scenario selected by the approval holder to inform the GMMP and RFCRP and for incorporation into the GDEMP as required by the conditions of approval?

2b. Are there any other model scenarios put forward by the approval holder that are more appropriate to ensure the outcomes sought by the conditions of approval are met?

The relevant outcomes sought by the conditions are to:

- monitor and minimise impacts to water resources of the Great Artesian Basin;
- ensure groundwater drawdown at Doongmabulla Springs Complex does not exceed 0.2m and that there is no ecological impact at the springs; and
- monitor and minimise impacts to other groundwater-dependent ecosystems.

Note: The conditions require that results of the groundwater flow model re-run inform the GMMP and RFCRP and be incorporated into the GDEMP. The focus of question 2 is on the selection of a numerical modelling scenario from those available, i.e. the options around the general head boundary considered as part of the groundwater model re-run, and previous scenarios, i.e. the SEIS and EIS models.

Approaches to monitoring and management – Advice on revised GDEMP and GMMP

3. Are the monitoring and management approaches proposed in the GMMP and GDEMP consistent with the most plausible conceptualisation and sufficiently robust to ensure the outcomes above are met?

FOI 190418
Document 25

From:	Hamish Manzi
To:	Declan O"Connor-Cox
Cc:	Dean Knudson; James Barker; Gregory Manning
Subject:	RE: Subject: Review of Groundwater Dependent Ecosystem Management Plan (GDEMP) & Groundwater Monitoring and Management Plan (GMMP) [SEC=UNCLASSIFIED]
Date:	Wednesday, 30 January 2019 12:28:52 PM

Good Morning Declan,

Thanks for responding regarding the timing, there were no issues associated with the timing request, just an impetus to complete our understanding.

Kind regards,

Hamish

Hamish Manzi
Head of Environment & Sustainability
Off +61 7 3223 4800 | hamish.manzi@adani.com.au | www.adaniaustralia.com
Level 25, 10 Eagle Street, Brisbane, QLD 4000 | GPO Box 2569, Brisbane, QLD, 4001

From: Declan O'Connor-Cox [mailto:Declan.O'connor-Cox@environment.gov.au]
Sent: Tuesday, 29 January 2019 3:09 PM
To: Hamish Manzi <Hamish.Manzi@adani.com.au>
Cc: Dean Knudson <Dean.Knudson@environment.gov.au>; James Barker <James.Barker@environment.gov.au>; Gregory Manning <Gregory.Manning@environment.gov.au>
Subject: Re: Subject: Review of Groundwater Dependent Ecosystem Management Plan (GDEMP) & Groundwater Monitoring and Management Plan (GMMP) [SEC=UNCLASSIFIED]

Dear Hamish,

Please note that Dean is away ill today and may not be back at work tomorrow. I am acting in Greg Manning's position while Greg is in meetings in Perth this week.

We are currently considering your request. You request will require consultation and while we are not certain how long this will take it is may be next week before we can get back to you. You requested the list by 5pm tomorrow, could you please let me know if there are issues we need to be aware of that make this request that urgent?

Kind regards,
Declan

Declan O'Connor-Cox
Acting Assistant Secretary
Assessments (WA, SA, NT) and Post Approvals Branch
Department of the Environment and Energy
t: 02 6274 1400
m: s22
GPO Box 787 Canberra ACT 2601
Email: declan.oconnorcox@environment.gov.au

From: Hamish Manzi <Hamish.Manzi@adani.com.au>
Date: 25 January 2019 at 4:09:00 pm AEDT
To: "'dean.knudson@environment.gov.au'" <dean.knudson@environment.gov.au>
Subject: Review of Groundwater Dependent Ecosystem Management Plan (GDEMP) & Groundwater Monitoring and Management Plan (GMMP)

Dear Dean,

I refer to the decision of the Department of the Environment and Energy (DoEE) to refer Adani Mining Pty Ltd's (Adani) GDEMP and GMMP for review by the CSIRO and Geoscience Australia.

You may be aware of recent press coverage regarding an anti-coal and/or anti-Adani bias potentially held by experts reviewing other Adani government approvals. Those media reports have caused great concern for Adani. As a result of those reports, Adani wants to ensure that it is being treated fairly and, in a manner, consistent with other industry participants.

To ensure this is the case, Adani requests a list of each person from the CSIRO and Geoscience Australia involved in the review of the GDEMP and GMMP. For the avoidance of doubt, Adani is not suggesting any bias in relation to these organisations and Adani confirms that it will not contact the individual personnel. Adani simply wants to know who is involved in the review to provide it with peace of mind that it is being treated fairly and that the review will not be hijacked by activists with a political, as opposed to scientific, agenda.

Would you please ensure that this information is provided to Adani by no later than 5pm on Wednesday 30 January 2019. Should you need to discuss this matter please do not hesitate to contact me.

Kind regards,

Hamish

Hamish Manzi
Head of Environment & Sustainability
Off +61 7 3223 4800 | hamish.manzi@adani.com.au | www.adaniaustralia.com
Level 25, 10 Eagle Street, Brisbane, QLD 4000 | GPO Box 2569, Brisbane, QLD, 4001

From: s22
To: s47F ; Hamish Manzi
Cc: s22 ; s22 ; s22 ; s22 ; Gregory Manning
Subject: EPBC 2010/5736 Groundwater Dependent Ecosystem Management Plan V10 - DoEE comments [SEC=UNCLASSIFIED]
Date: Friday, 1 February 2019 5:14:37 PM
Attachments: 2010-5736-20190201-GDEMP-v10-DoEE comments.docx

Hi s47F and Hamish,

Please find attached the Department's regulatory comments on v10 of the GDEMP. Note that these comments do not include technical review of groundwater data, methods or triggers.

Please let us know if you would like to discuss, particularly on revisions to the management tables

s22

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

From: s47F @adani.com.au]
Sent: Monday, 19 November 2018 7:10 PM
To: Gregory Manning <Gregory.Manning@environment.gov.au>
Cc: Post Approval <PostApproval@environment.gov.au>; Hamish Manzi <Hamish.Manzi@adani.com.au>; s22 @environment.gov.au>; s47F @environment.gov.au>; s47F @adani.com.au>
Subject: EPBC 2010/5736 Groundwater Dependent Ecosystem Management Plan

Commercial in Confidence

Dear Greg

Please find attached correspondence from Hamish Manzi, Head – Environment and Sustainability about the Groundwater Dependent Ecosystem Management Plan under the controlled action approval EPBC 2010/5736.

I have also sent a separate email that includes a link to our "sharefile" system, where you can download the plan.

Could your team please acknowledge receipt via return email?

Regards
s47F

s47F
Manager, Approvals

| Direct s47F |
| 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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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: 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
 1 2 3 4 5 6	**General Comments**	<u>Inconsistencies / errors</u> 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.	<u>Inconsistencies / errors</u> 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.	<u>Inconsistencies / errors</u> 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.
		Link to GMMP 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.**	Link to GMMP 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.	Link to GMMP 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.
		Link to other plans 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.	Link to other plans 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.	Link to other plans 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, product 3-4, 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] <u>Impact monitoring</u> 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. <u>Impact monitoring</u> 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 Aurict 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 Waxy Cabbage Palm 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.**	Waxy Cabbage Palm 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.	Monitoring of Waxy Cabbage Palm MNES 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.** <u>Mellaluka</u> 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.**	<u>Mellaluka</u> 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). <u>Mellaluka Springs</u> 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,	<u>Dewatering impacts</u> 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.	<u>Dewatering impacts</u> a). Mapping provide under each GDE to show dewatering impacts b). Timing updated throughout	<u>General comments on impacts:</u> 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

		Waxy Cabbage Palm (WCP) 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.**	Waxy Cabbage Palm a). updated to include presence and impact mapping.	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). Details of potential impacts of Waxy Cabbage Palm MNES 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?

				- 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'?
		<u>Mellaluka</u> 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.**	<u>Melalluka</u> a). The best available information is the modelling studies undertaken through the EIS process and subsequently approved by the Minister.	<u>Details of potential impacts of Mellaluka springs MNES</u> 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	<u>Management measures</u> 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.**	<u>Management Measures</u> All GDE chapters restructured as discussed with DoE to capture objectives, threates, management, monitoring and response activities.	<u>Management measures</u> 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. Corrective actions 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.** Offsets 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).**	Corrective actions 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. Offsets a). Requirement for offsets specified in relevant GDE plan sections	Corrective actions 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. Offsets 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.

		<u>Carmichael River</u> 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**	<u>Carmichael River</u> Please refer to updated CR chapter including sections 6.4 through 6.9	<u>Carmichael River</u> 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).			

From: s47F
To: Gregory Manning; John Foster; s22; s22; s22; s22; s22; s22 s47F; s22; s22; s22; s22; s47F
Cc: Hamish Manzi
Subject: RE: Adani Projects Update Meeting
Date: Tuesday, 12 February 2019 11:24:51 AM
Attachments: FINAL Adani Project Update Meeting 13Feb2019.pdf
FINAL Outstanding Issues Report 13Feb2019.pdf

Good morning

CONFIDENTIAL

Good morning

Please find attached the final agenda and outstanding issues report for our meeting tomorrow.

Regards
s47F

-----Original Appointment-----
From: s47F
Sent: Friday, 18 January 2019 11:59 AM
To: s47F; Hamish Manzi; Manning, Gregory; s22; s22; s22; s22; s22; s22; s22; s47F; s22; s22; s22; s22; s22; s22; s47F
Subject: Adani Projects Update Meeting
When: Wednesday, 13 February 2019 1:00 PM-2:00 PM (UTC+10:00) Brisbane.
Where: 51 Allara Street Canberra / teleconference (details below)

Hello

The intention is for this meeting is to be held from 2 to 3 pm (Canberra time) / 1 to 2 pm (Brisbane time).

For those dialling into the meeting, please call s22.

Draft agenda will be sent out a week prior for comment.

Regards
s47F

-- Do not delete or change any of the following text. --

s22 [redacted]

[redacted]

[redacted]

Global call-in numbers

Can't join the meeting?

If you are a host, go here to view host information.

Adani Projects Update Meeting
13 February 2019

Time:	1 to 2 pm (Brisbane time), 2 to 3 pm (Canberra time)
Location:	51 Allara Street Canberra
Teleconference:	s47F
Attendees:	Commonwealth Government – Department of the Environment and Energy (DEE) **Post approvals:** s22
	Compliance: s22
	Queensland Office of the Coordinator-General (*via teleconference*) s22
	Queensland Government – Department of Environment and Science (DES) (*via teleconference*) s22
	Adani Hamish Manzi [HM] s47F *via teleconference* s47F *via teleconference*
Apologies	
Purpose:	To share information about Adani projects, including mine, rail, port and renewable energy.

Agenda

#	Item	Start	Time	Lead
1	Actions arising	2 pm	5 mins	s47F
2	Project update	2:05 pm	10 mins	HM
3	Critical delivery items	2:15 pm	30 mins	All
4	Other business	2:45 pm	10 mins	s47F
5	Summary of agreed actions	2:55 pm	5 mins	s47F
6	Close	3 pm		

Actions arising

Note – completed actions from previous meetings have been removed from table.

#	Action	Who	When	Status
114	s22 [redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	HM	By 18 January 2019	
117	Adani to schedule meeting to discuss the GA / CSIRO advice and s22 [redacted]	HM	14 December 2018	
118	s22 [redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	HM / s47F	25 January 2019	
124	Adani will develop a table of responses to the Commonwealth feedback about the Groundwater Monitoring and Management Plan and Rewan Formation Connectivity Research Plan and send back	s47F [redacted]	25 January 2019	
125	Queensland Department of Environment and Science to provide the data to the Department of Natural Resources, Mines and Energy and confirm all issues have been closed out	s47F [redacted]	25 January 2019	
126	Provide a table of responses to the GAB Springs Research Plan and Groundwater Dependent Ecosystems Management Plan feedback and forward to the Commonwealth	HM / s47F	25 January 2019	*Complete*
127	s22 [redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	s47F	16 January 2019	*Complete*

#	Action	Who	When	Status
129	Adani and Commonwealth Government to discuss Commonwealth Government feedback about the Groundwater Dependent Ecosystem Management Plan	s47F / s22	By 25 January 2019	*Complete*

ADANI PROJECTS – OUTSTANDING ISSUES

February 2019

1 Groundwater Management and Monitoring Plan / Groundwater Management and Monitoring Program, Condition 3 (EPBC 2010/5736) and condition E3 of Environmental Authority (EPML 01470513)

Lodgement date and version number:	8 August (Commonwealth Government) and 9 August (Queensland Government) 2018 Version 2
Adani lead:	s47F
Commonwealth Government lead:	s22
Queensland Government lead:	s22
Approval sought by:	As soon as possible
Current status:	Awaiting review of GMMP outcomes from Geoscience Australia and CSIRO

Issues –

Adani provided material arising from a review of groundwater level reference data with the Queensland Department of Natural Resources, Mines and Energy and the Commonwealth.

Who to resolve and when – Awaiting review of GMMP outcomes from Geoscience Australia and CSIRO.

s22

s22

5 s22 [redacted]

[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

s22 [redacted]

6 Groundwater Dependent Ecosystem Management Plan - Conditions 5, 6 and 7 (EPBC 2010/5736) and Conditions I11, I12, I13 and I14 of Environmental Authority (EPML 01470513)

Lodgment date and version number:	13 July 2018, Version 9 (updated) Extract provided 9 November 2018 19 November 2018, Version 10 21 January 2019, Version 10a
Adani lead:	Hamish Manzi
Commonwealth Government lead:	s22 [redacted]
Queensland Government lead:	s22 [redacted], s22 [redacted]
Approval sought by:	As soon as possible
Current status:	Adani updating the plan based on Commonwealth Government feedback. Geosciences Australia and CSIRO submission due 21 February; Adani to respond and resubmit as soon as possible afterwards.

adani

Issues –

- Groundwater level review data exercise and then subsequent amendments to the plan made and version 10a provided to Commonwealth and Queensland Governments on 21 January 2019.
- Adani provided table of responses to Commonwealth Government feedback of 2018 on 21 January 2019.
- Adani provided table of and responses to Queensland Government feedback of 2018 on 24 January 2019.
- Teleconferences between s47F [redacted], s22 [redacted] and s47F [redacted] held 17 and 18 January. Written feedback provided 1 February 2019. Adani now updating the GDEMP based on this feedback.
- Geosciences Australia and CSIRO submission due 21 February.

Who to resolve and when – Adani updating the plan based on Commonwealth Government feedback. Geosciences Australia and CSIRO submission due 21 February; Adani to respond and resubmit as soon as possible afterwards.

7 s22 [redacted]

[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

s22 [redacted]

- [redacted]
- [redacted]
- [redacted]

[redacted].

s22

From: s47F
To: Hamish Manzi; Gregory Manning; s22 ; s22 ; s22 ; s22 ; s22 ; s22 ; s22 s47F ; s22 ; s22 ; s22 ; s47F ; s22 @coordinatorgeneral.qld.gov.au; s22
Subject: RE: Adani Projects Update Meeting
Date: Monday, 18 February 2019 6:11:11 PM
Attachments: DRAFT Notes Adani Project Update Meeting 13Feb2019.docx

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Good afternoon

Please find attached the draft notes from our meeting last week.

If you would please provide any suggested changes using the Track Changes function, by this Friday 22 February, that would be appreciated.

Regards
s47F

-----Original Appointment-----
From: s47F
Sent: Friday, 18 January 2019 11:59 AM
To: s47F ; Hamish Manzi; Manning, Gregory; s22 ; s22 ; s22 ; s22 ; s22 ; s22 ; s22 s47F ; s22 ; s22 ; s22 ; s22 ; s22 ; s22 ; s47F
Subject: Adani Projects Update Meeting
When: Wednesday, 13 February 2019 1:00 PM-2:00 PM (UTC+10:00) Brisbane.
Where: 51 Allara Street Canberra / teleconference (details below)

Hello

The intention is for this meeting is to be held from 2 to 3 pm (Canberra time) / 1 to 2 pm (Brisbane time).

For those dialling into the meeting, please call 02 9037 0069; and use access code 573 834 829.

Draft agenda will be sent out a week prior for comment.

Regards
s47F

-- Do not delete or change any of the following text. --

Join Webex meeting

Meeting number (access code): 573 834 829

s22 [redacted]

[redacted]

Global call-in numbers

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Adani Projects Update Meeting
13 February 2019

Time:	1 to 2 pm (Brisbane time), 2 to 3 pm (Canberra time)
Location:	51 Allara Street Canberra
Teleconference:	s47F [redacted]
Attendees:	Commonwealth Government – Department of the Environment and Energy (DEE) **Post approvals:** s22 [redacted]
	Compliance: s22 [redacted]
	Queensland Office of the Coordinator-General (*via teleconference*) s22 [redacted]
	Queensland Government – Department of Environment and Science (DES) (*via teleconference*) s22 [redacted]
	Adani Hamish Manzi [HM] s47F [redacted] *via teleconference* s47F [redacted] *via teleconference*
Apologies	s22 [redacted] (DOEE), s22 [redacted] (DES)
Purpose:	To share information about Adani projects, including mine, rail, port and renewable energy.

Agenda

#	Item	Start	Time	Lead
1	Actions arising	2 pm	5 mins	s47F [redacted]
2	Project update	2:05 pm	10 mins	HM
3	Critical delivery items	2:15 pm	30 mins	All
4	Other business	2:45 pm	10 mins	s47F [redacted]
5	Summary of agreed actions	2:55 pm	5 mins	s47F [redacted]
6	Close	3 pm		

Actions arising

Note – completed actions from previous meetings have been removed from table.

#	Action	Who	When	Status
114	s22 [redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	HM	By 18 January 2019	HM replied to JF on 17 January. No further information required. *Complete*
117	Adani to schedule meeting to discuss the GA / CSIRO advice and s22 [redacted]	HM	14 December 2018	*Complete*
118	s22 [redacted]	HM	At next meeting	*Complete*
121	s22 [redacted]	HM / s47F [redacted]	25 January 2019	*Complete* for Matters of National Environmental Significance. Matters of MSES to be data checked. New action – by Monday will have an update on residual state offset to DES.
124	Adani will develop a table of responses to the Commonwealth feedback about the Groundwater Monitoring and Management Plan and Rewan Formation Connectivity Research Plan and send back	s47F [redacted]	25 January 2019	s22 [redacted] provided a copy electronically on 6 November 2018. Adani to follow up internally.

#	Action	Who	When	Status
125	Queensland Department of Environment and Science to provide the data to the Department of Natural Resources, Mines and Energy and confirm all issues have been closed out	s47F [redacted] and s47F [redacted]	25 January 2019	Data provided to DRMNE. DNRME are not going to close out the process due to resourcing. 13 January 2019 – responses provided by Adani to DRNME. Adani in discussions with DES and DNRME to resolve any outstanding issues.
130	Adani will review the GMMP feedback provided on 6 November 2018 and provide a table of responses to the Commonwealth.	s47F [redacted] / HM	22 February 2019	
131	s22 [redacted]	s47F [redacted] / HM	22 February 2019	
132	s22 [redacted]	HM	From now until end of March 2019	

Draft Meeting Notes

#	Item	Start	Time	Lead
2	Project update	2:05 pm	10 mins	HM

s22 [redacted]

s22 [redacted]

[redacted]	Item	Start	Time	Lead
3	Critical delivery items	2:15 pm	30 mins	All

Groundwater Management and Monitoring Plan (GMMP)

HM provided an update. GMMP is in review process but Adani needs to respond to table of comments provided on 6 November 2018. **ACTION** – Adani will review the GMMP feedback provided on 6 November 2018 and provide a table of responses to the Commonwealth.

s22 [redacted] advised that the review of GMMP outcomes from Geoscience Australia and CSIRO is due 22 February 2019. JF stated that a final report on that date. DOEE will review before passing material to Adani, the following week (week commencing 25 February).

s22 [redacted]

s22 [redacted]

Groundwater Dependent Ecosystem Management Plan (GDEMP)

s47F [redacted] provided an update:

- Adani provided table of responses to Commonwealth Government feedback of 2018 on 21 January 2019. Adani provided table of responses to Queensland Government feedback of 2018 on 24 January 2019.
- Teleconferences were held in January between Adani and the Commonwealth. Written feedback provided 1 February 2019 by the Commonwealth and Adani is updating the GDEMP based on this feedback.
- After Geosciences Australia and CSIRO review is complete, Adani will provide a consolidated version responding to all feedback.

s22 [redacted] advised on CSIRO and GA review process consistent with that noted above for the GMMP.

HM provided an update about the baseline surveys which are underway, to conduct detailed survey work. Adani has engaged a JV with an indigenous business partner, and the survey includes 10 positions for indigenous field technicians who are working with the scientists to train them up over time.

s22 [redacted]

s22

FOI 190418
Document 29

From: s47F
To: Hamish Manzi; Gregory Manning; s22 s22 ; s22 ; s22 ; s22 ; s22 ; s22 ; s47F ; s22 ; s22 ; s22 ; s47F ; s22 @coordinatorgeneral.qld.gov.au
Subject: RE: Adani Projects Update Meeting - 13 February 2019
Date: Monday, 25 February 2019 3:42:40 PM
Attachments: FINAL Notes Adani Project Update Meeting 13Feb2019.pdf

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Good afternoon

Please find attached the final notes from our meeting of Wednesday 13 February 2019.

The next meeting will be Thursday 14 March.

Regards
s47F

s47F
Manager - Approvals

E s47F @adani.com.au
P office s47F | direct s47F |
mobile: s47F
A Level 25, 10 Eagle Street, Brisbane, QLD, 4000
P GPO Box 2569, Brisbane, QLD, 4001
W adaniaustralia.com

s47F
Manager - Approvals
E s47F @adani.com.au
P s47F | s47F | mobile: s47F
A Level 25, 10 Eagle Street, Brisbane, QLD, 4000
P GPO Box 2569, Brisbane, QLD, 4001
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Apologies	s22 DOEE), s22 (DES)
Purpose:	To share information about Adani projects, including mine, rail, port and renewable energy.

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126	Provide a table of responses to the GAB Springs Research Plan and GDEMP feedback and forward to the Commonwealth	HM / s47F [redacted]	25 January 2019	Table not provided for GAB Springs Research Plan.
130	Adani will review the GMMP feedback provided on 6 November 2018 and provide a table of responses to the Commonwealth.	s47F [redacted] / HM	22 February 2019	
131	s22 [redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	HM	From now until end of March 2019	

Meeting Notes

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s22 [redacted]

[redacted]

5. s22 [redacted]

[redacted]

[redacted]	Item	Start	Time	Lead
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s22 [redacted] advised that the report on the technical review of the groundwater management plans by Geoscience Australia and CSIRO is due 22 February 2019. DOEE will consider the review before passing onto Adani, the following week (week commencing 25 February).

s22 [redacted]

[redacted]

[redacted]

s22 s22 [redacted]

Groundwater Dependent Ecosystem Management Plan (GDEMP)

s22 [redacted] provided an update:

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s22 [redacted]

s22