PROJECT CHINA STONE

Attachment C Responses to IESC Advice

PROJECT CHINA STONE

RESPONSE TO IESC SUBMISSION ON DRAFT EIS

for

MacMines Austasia Pty Ltd

67 IESC SUBMISSION

Context

The Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (the IESC) was requested by the Australian Government Department of the Environment and the Queensland Office of the Coordinator-General to provide advice on the MacMines Austasia's China Stone Coal project in Queensland.

This advice draws upon aspects of information in the draft Environmental Impact Statement (EIS) together with the expert deliberations of the IESC. The project documentation and information accessed by the IESC are listed in the source documentation at the end of this advice.

The China Stone Coal Project is a new open cut and underground coal mine, located in Central Queensland, approximately 270 km southwest of Townsville and 300 km west of Mackay, in the northern Galilee Basin. The project will target the A, B, C and D coal seams of the Permian Betts Creek Beds. The proposed project will cover an area of approximately 20,000 ha and extract up to 38 million tonnes per year of product (thermal) coal, over the 50-year life of the project. Associated proposed infrastructure includes: workshop/buildings; coal covered storage areas and access roads; dragline and equipment laydown areas; coal handling and preparation plants; tailings dam; waste and water management infrastructure, dams and treatment facilities; conveyors, rail loop and train-loading facilities; and a power station.

Key potential impacts

Key potential impacts include drawdown of groundwater and reduced pressure and flow within Great Artesian Basin (GAB) aquifers (i.e. the Clematis Sandstone), and subsequent reduced supply to the Doongmabulla Springs Complex and private bores. Potential subsidence impacts include alteration of surface features including development of ground surface depressions, enhancement of inter-aquifer connectivity, and cracking of the bed of the Northern Seasonal Wetland. Potential hydrological and ecological impacts may arise from mine water discharges. There is uncertainty regarding the potential impacts both from this mine and cumulatively from the adjacent Carmichael Coal Mine (CCM) project to groundwater dependent ecosystems (GDEs) including the Doongmabulla Springs Complex. The proposed project and the CCM project both require a large external water supply (up to approximately 12 GL/year each) however the potential impacts of sourcing this supply on surface water or groundwater resources have not been assessed.

The IESC recognises the proposed project is a greenfield site with a lack of representative spatial, temporal and hydrostratigraphic variation in data available for the area. This lack of data results in uncertainty in the hydrogeological conceptualisation and subsequent numerical groundwater modelling predictions. This uncertainty leads to low confidence in the potential impacts predicted by the proponent, and makes tenous any comment on the appropriateness of mitigation and management measures. The advice, therefore, necessarily identifies further information and data that is needed to address the questions raised.

Assessment against information guidelines

The IESC, consistent with its Information Guidelines (IESC, 2014), has considered whether the proposed project assessment has used the following:

Relevant data and information: key conclusions

The proponent's groundwater monitoring data was collected over a limited timeframe, does not provide a regional context for, and is inadequate to assess spatial and temporal variability of groundwater flows,. The data provided is insufficient to confirm the presence and hydrogeological influences of a posited fault in the proposed Northern underground mining area. Available data from shallow bores indicate that the majority of the Clematis Sandstone is dry or unsaturated in much of the project area, which limits prediction of impacts. Ecological attributes onsite and offsite were inadequately assessed, with survey locations only visited on one occasion, or surveys only being undertaken at the beginning and end of the dry season. Baseline surface water quality and quantity data is insufficient to establish environmental management objectives for the project.

Application of appropriate methodologies: key conclusions

The groundwater model is classified as Class 1 (Barnett, et al., 2012), which is inappropriate for an impact and assessment model at the project scale. There was no transient calibration, uncertainty analysis or peer review undertaken. Sensitivity analyses were undertaken on the numerical groundwater model to determine the influence of the fault and potential subsidence impacts. However, an uncertainty analysis was not undertaken on the numerical groundwater model predictions. Subsidence modelling used an acceptable empirical method. The fault was not considered as part of predicting subsidence impacts and no justification of the extent of connective cracking above the dual seam longwall mining area was provided. A simplistic cumulative impact assessment of the CCM project and China Stone project was undertaken by superimposing maximum predicted groundwater drawdown contours for each project on a map and not through appropriate calculations. Other reasonably foreseeable coal projects, such as Hyde Park Coal Project, were not considered. The full extent of potential cumulative impacts has not been considered, including to the Doongmabulla Springs Complex and to sources of water supply for the mines.

Reasonable values and parameters in calculations: key conclusions

Modelled hydrograph data presented provides consistently poor matches to observed head levels. For surface flows, the Australian Water Balance Model runoff modelling parameters were appropriately selected based on experience and a review of comparable mining operations in central Queensland and the Galilee Basin. Water quality guidelines (ANZECC & ARMCANZ, 2000) are incorrectly quoted as mg/L rather than µg/L (EIS Appendix G, Table D1), leading to incorrect conclusions about potential exceedences within the project site.

67.1 QUESTION 1

What are the key uncertainties, risks and potential impacts on water resources? Are there additional measures and commitments required to adequately mitigate, monitor and manage potential risks and impacts to water resources?

<u>IESC Response</u>

1. There are numerous uncertainties associated with this project due to insufficient hydrogeological, hydrological and ecological data presented both within and surrounding the project area. This lack of data results in uncertainty in the hydrogeological conceptualisation and subsequent numerical groundwater modelling predictions. This uncertainty leads to a lack of confidence in the potential impacts predicted by the proponent, and makes tenuous any comment on the appropriateness of mitigation and management measures.

The draft EIS presents a comprehensive assessment of the potential impacts on water resources. This assessment is based upon extensive bodies of hydrogeological, hydrological and ecological data. This data is presented in the draft EIS relevant studies draws upon exhaustive desk study and field investigations.

In addition, the draft EIS groundwater study specifically incorporated all relevant geological and groundwater information collected as part of the Carmichael Coal Project EIS, SEIS and AEIS groundwater studies. The compiled groundwater dataset is discussed in Section 6 of the draft EIS Groundwater Report (Appendix I). The draft EIS groundwater study therefore presents the most comprehensive groundwater dataset yet compiled in this part of the Galilee Basin.

This dataset represents a substantial body of data upon which to develop a conceptual understanding of the groundwater regime that captures the key behaviour and characteristics of the real-world groundwater regime. The submission does not provide any specific uncertainties or any details that would further the conceptual understanding of the groundwater regime developed from the available data.

This conceptual understanding was used to inform the numerical modelling approach. The groundwater modelling predictions presented in the draft EIS have been made following a rigorous calibration process. The numerical modelling predictions therefore provide a suitable basis for assessment of potential impacts associated with the project.

The proponent has also collected an additional 23 months of 6 hourly groundwater monitoring data from dataloggers installed at the project site. This additional data is presented in Attachment D – Additional Information on Groundwater. The proponent has therefore collected 37 months of groundwater monitoring data from the site over the period December 2012 and January 2016.

The additional groundwater monitoring data is consistent with the data presented in the draft EIS Groundwater Report (Appendix I), and therefore provides further support to the conceptual and numerical groundwater models presented in the draft EIS and validates the draft EIS groundwater impact assessment.

The extensive body of ecological and hydrological data available does not contribute to any material level of uncertainty in the groundwater modelling predictions.

2. The key uncertainties arise from the lack of monitoring data to provide any meaningful interpretation of baseline conditions. These impact on:
a. the appropriateness of the hydrogeological conceptualisation (including the fault and associated strata in the Northern underground mining area and the relationship between surface water and groundwater systems, such as the Doongmabulla Springs Complex and Lake Buchanan); and
b. the reliability of the numerical groundwater model and its predicted impacts.

Please refer to the response to IESC Response 1.

3. No environmental risk assessment was undertaken for water resources or water-related assets. The key uncertainties above lead to the risk that the potential impacts on water resources have not been identified. For example, there is the risk that cumulative depressurisation effects may extend to key water-related assets, such as the Doongmabulla Springs Complex.

A detailed environmental risk assessment was undertaken in relation to the potential environmental impacts of the project on water resources and water related assets. These are presented in the draft EIS as follows:

- Section 12.4 presents the assessment of groundwater resources and groundwater water-related assets;
- Section 13.6 presents the assessment of surface water resources and surface water-related assets; and
- Sections 9 and 10 present the assessment of terrestrial and aquatic ecological impacts related to water resources and water-related assets.

The draft EIS specifically considered the risks of cumulative groundwater depressurisation on all relevant water-related assets, including the Doongmabulla Springs Complex. The findings are presented in Section 12.4.11 of the draft EIS and Section 8.6 of the draft EIS Groundwater Report (Appendix I). The Doongmabulla Springs Complex lies 22 km from the project site and the project is not predicted to contribute to cumulative groundwater depressurisation or associated impacts at this location.

As discussed in the response to IESC Response 1, the additional groundwater monitoring data presented in Attachment D – Additional Information on Groundwater is consistent with the data presented in the draft EIS Groundwater Report (Appendix I), provides further support to the conceptual and numerical groundwater models presented in the draft EIS and validates the draft EIS groundwater impact assessment.

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The submission does not identify any other specific impacts that have not been comprehensively addressed in the draft EIS.

4. As a consequence a number of key potential impacts are identified but are not sufficiently quantified. These include: a. drawdown of groundwater and reduced pressure and flow within GAB aquifers (i.e. the Clematis Sandstone) and reduced supply to private bores; b. alteration of surface features including development of ground surface depressions, expansion of inter-aquifer connectivity, and cracking of the bed of the Northern Seasonal Wetland from subsidence; c. changes to the flow regime in Tomahawk Creek and North Creek catchments; d. mine water releases with contaminants potentially exceeding guidelines for the protection of aquatic ecosystems across large floodplain areas downstream of the project area; and e. potential cumulative impacts to the Belyando River catchment and GDEs including the Doongmabulla Springs Complex.

A complete assessment of the potential impacts has been presented in the draft EIS. In relation to the key potential impacts listed:

4a) The extent and magnitude of depressurisation of the relevant GAB aquifers (including the Clematis Sandstone) has been quantified using a numerical groundwater model. The results are presented in Section 8 of the draft EIS Groundwater Report (Appendix I). The potential for impacts to water supply bores due to groundwater drawdown are discussed in Section 8 of the draft EIS Groundwater Report (Appendix I) and quantified in Table 6 of the draft EIS Groundwater Report (Appendix I). The additional groundwater monitoring data presented in Attachment D – Additional Information on Groundwater validates this assessment.

4b) The potential impacts of subsidence including alteration of surface water features are addressed in Sections 10 and 13 of the draft EIS.

The potential effects of connective subsidence cracking have been accounted for in the groundwater modelling predictions presented in the draft EIS Groundwater Report (Appendix I).

Section 10 of the draft EIS addresses the potential impacts on the Northern Seasonal Wetland, including cracking of the bed of the wetland. Refer to the response to IESC Response 16b for additional discussion on this issue.

4c) Hydraulic modelling has been undertaken to quantify the effects of mining on the flow regime of North Creek and Tomahawk Creek during the operations phase and post mining. These results are presented in the draft EIS Open Cut Mine Drainage Report (Appendix J).

This modelling assessment considered the potential changes to drainage and flooding in these creeks during a range of flow events.

As discussed in Section 13.6.3 of the draft EIS, the modelling results show that with the application of erosion management measures the predicted changes in the flow regime are unlikely to result in significant flood or drainage impacts.

4d) The potential effects of mine-affected water discharge are discussed in Section 13 of the draft EIS. Refer to the response to IESC Response 10 which discusses the revised draft discharge conditions presented in Attachment E – Additional Information on Surface Water.

4e) The potential for cumulative effects on the Belyando River, the Doongmabulla Springs Complex and GDEs are addressed in Sections 13, 12 and 9 of the draft EIS, respectively.

Refer to the response to IESC Responses 78 and 79 for additional discussion on the Belyando River catchment.

Refer to the response to IESC Response 77 for additional discussion on the Doongmabulla Springs Complex.

5. Further baseline and time-series monitoring data needs to be collected from within and beyond the project area on surface water and groundwater quantity and quality, especially groundwater levels within the Clematis Sandstone and Moolayember Formation. Data should be collected to ensure that seasonal variability and the relationship between surface water and groundwater systems are captured. This data should be utilised to further assess potential impacts to water resources and water-related assets. An appropriate monitoring programme should be designed to reduce uncertainty associated with predictions and quantify potential impacts. This should be used to inform the design of a follow-up monitoring programme to assess impacts and the effectiveness of mitigation or management strategies during and after mining.

As discussed in Section 12.5.1 of the draft EIS, baseline groundwater level monitoring has been ongoing since December 2012 and will continue until the commencement of project construction in order to enable natural water fluctuations to be distinguished from the potential effects of mining.

As discussed in the response to IESC Response 1, a total of 37 months of baseline groundwater monitoring data has now been collected from the groundwater monitoring network installed by the proponent. Data collected between January 2013 and January 2016 has been recorded using dataloggers at 6 hour intervals. This available data therefore comprises a detailed time-series collected over an extended timeframe.

The data reinforces the draft EIS conclusions that the groundwater regime is relatively consistent and exhibits no significant seasonal response to recharge. The data also supports the calibrated groundwater levels presented in the draft EIS, including those in the Clematis Sandstone.

The Moolayember Formation subcrops 7 km west of the project site and the project will not directly impact this formation. Indirect depressurisation of the Moolayember Formation could potentially occur via the underlying Clematis Sandstone and underlying formations. The additional groundwater monitoring data collected from the project site is consistent with the data presented in the draft EIS. The groundwater modelling predictions presented in the draft EIS Groundwater Report (Appendix I) are therefore supported by the additional data. The baseline data therefore supports the draft EIS groundwater assessment of the Moolayember Formation.

Explanation

Groundwater

6. The Clematis Sandstone is reported as being unsaturated or dry in the project area based on the bore data presented. However, this same unit is considered to be the source aquifer for the Doongmabulla Springs Complex (e.g. Bradley, 2015).

The conceptual groundwater model and impact assessment presented in the draft EIS are entirely consistent with the content of this submission.

The draft EIS conceptual groundwater model shows that the Clematis Sandstone is typically located above the regional groundwater table where it forms the elevated western slopes of Darkies Range. The Clematis Sandstone is therefore dry and unsaturated in these elevated areas. This is supported by 37 months of baseline groundwater monitoring data collected from the project site and its surrounds which shows that bores targeting the Clematis Sandstone have been continuously dry, with the groundwater table in the vicinity of Darkies Range typically located in the underlying Rewan Formation. This collated data is presented in Attachment D – Additional Information on Groundwater.

The draft EIS conceptual groundwater model also shows that the Clematis Sandstone becomes saturated where the base of this formation extends below the elevation of the regional groundwater table. This is predicted to occur in areas where the Clematis Sandstone is located at depth (e.g. down-dip to the west of the project site) and in areas where the groundwater table and Clematis Sandstone are shallow (e.g. in topographically low lying areas such as the Doongmabulla Springs Complex).

The Doongmabulla Springs Complex is located in a low lying area of the Carmichael River floodplain 22 km south of the project site. The surface elevation at the Doongmabulla Springs Complex is approximately 245 m Australian Height Datum (AHD). This is up to 245 m lower than the surface elevation of Darkies Range within the project site. It is also lower than the base of the Clematis Sandstone within the project site.

Consistent with a range of sources (including Bradley, 2015 and the Carmichael Coal Mine EIS), the draft EIS shows that that the shallow Clematis Sandstone at this location is saturated and the groundwater table intersects the ground surface, creating artesian (spring) conditions.

The potential impacts of groundwater depressurisation on the Doongmabulla Springs Complex have been assessed in Section 8 of the draft EIS Groundwater Report (Appendix I).

7. Given the inconsistency between project site and other regional information, it is unclear how depressurisation from the proposed project would impact on the Clematis Sandstone.

Beyond the natural hydrogeological variation and supporting explanations presented in the draft EIS, this submission does not provide examples of any specific inconsistencies that would materially affect the modelling results or the conclusions of the draft EIS groundwater impact assessment.

Please refer to the response to IESC Response 1 which explains how all relevant site-specific and regional information has been incorporated into the draft EIS groundwater study and used to develop conceptual and numerical groundwater models that reflect the range of hydrogeological characteristics exhibited within the vicinity of the project site. On this basis, the draft EIS groundwater impact assessment is suitable for the purposes of the draft EIS.

The predicted depressurisation of the Clematis Sandstone due to the project is shown on Figures 29 and 37 of the draft EIS Groundwater Report (Appendix I). A clear assessment of the potential impacts of this depressurisation on groundwater users and other features (including the Doongmabulla Springs Complex) is provided in Section 8 of the draft EIS Groundwater Report (Appendix I).

Surface Water

8. Potential impacts to the surface water flow regime include:

a. Projected reductions in catchment area of Tomahawk and North creeks by approximately 2% and 7% over the life of the project (and reductions of 2% for both catchments post mining).

b. Subsidence impacts resulting in surface cracking, ponding, impacts to residual pools and subsequent loss of catchment yield.

c. Change in the inundation regime for floodplain habitat, ephemeral drainages and creeks downstream of the project area, and drainage corridors onsite.

These surface water drainage and flooding effects are addressed in Section 13 of the draft EIS.

9. Investigation and assessment into surface water flow regimes should be undertaken for creeks downstream of the project area, such as Pigeonhole Creek, North Creek and the "major waterway" identified (under the Department of Agriculture Forestry and Fisheries' mapping system) in the Tomahawk Creek catchment.

These surface water drainage and flooding effects are addressed in Section 13 of the draft EIS. The project is not predicted to result in significant changes to the drainage and flooding characteristics of these highly ephemeral drainage features.

10. The release of large volumes of mine-affected water from mining pits across a 64 km length of relatively flat ground with small drainage lines. Mine water releases can be expected to have increased turbidity, salinity, contaminants (e.g. metals) that are likely to exceed aquatic ecosystem protection limits. Subsidence may also increase erosion leading to water quality impacts in downstream areas.

As discussed in Section 13.6.5 of the draft EIS, any release of mine-affected water from the project site will be conducted in accordance with the Queensland Department of Environment and Heritage Protection (EHP) model Environmental Authority (EA) discharge conditions.

The model EA discharge conditions include limits on the volume and quality of discharged mine-affected water. These limits are specifically designed to protect downstream water quality and environmental values, including the protections of aquatic ecosystems.

The draft EA discharge conditions presented in Attachment 24-4 of the draft EIS have been revised in order to address submissions from the Queensland EHP. The revised draft discharge conditions have been provided in Attachment E – Additional Information on Surface Water, and include more stringent limits for mine-affected water release than presented in the draft EIS.

In addition, the proponent is required to develop and maintain a Receiving Environment Monitoring Program (REMP). The REMP is discussed in Attachment E – Additional Information on Surface Water.

Surface water-groundwater interaction

11. There is a lack of monitoring data to inform the understanding and assessment of potential impacts to sites with groundwater-surface water interaction, which include the Doongmabulla Springs Complex and Lake Buchanan and smaller scale GDEs on drainage lines or seasonal perched aquifers.

Please refer to the response to IESC Response 1.

12. A monitoring programme should be developed that allows for the assessment of groundwater-surface water systems. This programme could include an early warning methodology to ensure mine-induced depressurisation does not impact the Doongmabulla Springs Complex, Lake Buchanan and the Caukingburra Swamp

Refer to the response to IESC Response 47 which confirms that the groundwater monitoring network presented in the draft EIS Attachment 24-4 comprises 36 groundwater monitoring points located within the project site and 20 additional groundwater monitoring locations within the surrounding area, including in the vicinity of drainage features located east of the project site.

As discussed in Section 12.5 of the draft EIS the operations phase groundwater monitoring program that will be implemented to identify any unexpected departures from the draft EIS groundwater modelling predictions. All unexpected departures will be investigated in accordance with the Queensland EA to allow the early identification of any significant departures that could potentially result in impacts to groundwater users or other sensitive environmental features such as Lake Buchanan, Caukingburra Swamp and the Doongmabulla Springs Complex.

The proponent will implement any necessary changes to the groundwater monitoring network to ensure that it remains fit for purpose, in accordance with the Queensland EA requirements for groundwater monitoring. The commitments provided in the draft EIS therefore address the intent of this submission.

On this basis, no additional monitoring at Lake Buchanan, Caukingburra Swamp or the Doongmabulla Springs Complex is required to ensure that the project will not result in significant adverse impacts to the hydrology of these features.

Ecology

13. Ecological impacts are uncertain as there is no mapping of ecological attributes and no ecological survey effort outside the project boundary. Surveys are expected to extend to (at least) the predicted extent of groundwater drawdown (IESC, 2014).

Ecological field surveys and assessment of ecological attributes beyond the project site boundary are not typically undertaken as part of an EIS for a mining project in Queensland.

As discussed in Sections 12.4.5 and 12.4.7 of the draft EIS, the groundwater table is at least 15 m, and more typically at least 20 m, below the ground surface within the predicted extents of drawdown. Hence there is no potential for groundwater dependent ecosystems to present within the predicted extent of groundwater drawdown.

Further assessment of ecological attributes beyond the site boundary is not considered to be warranted.

14. Aquatic surveying was inadequate with locations visited on one occasion or only undertaken at the beginning and end of the dry season. For example, only one round of sampling for stygofauna was undertaken within the project area, with only two Tertiary bores sampled. Best practice guidelines (WA EPA, 2007) state that sampling should be done across the zone of impact and at least twice. Dr Grant Hose, the expert who examined the samples, mentioned the need for multiple sampling events in his letter attached to the EIS assessment documentation (EIS, Appendix E of Appendix G).

In accordance with the Terms of Reference (TOR) for the project, the draft EIS included a desktop assessment and pilot study field investigation to assess the potential for stygofauna to occur within the project site. The assessment and pilot study field investigation was conducted in accordance with best practice guidelines, being the *Guidance for the Assessment of Environmental Factors – Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia No*

54a (Western Australia EPA, 2007). These best practice guidelines state that in cases where a desktop assessment confirms there is little likelihood of subterranean fauna occurring in a project area but further evidence is required, a pilot study can be used "*to determine whether a project area has significant faunal values, which can be achieved with low sampling effort".* The guidelines further state that *"It is expected that 6 – 10 stygofauna samples or 10 - 15 troglofaunal samples will be collected in pilot studies".* The draft EIS pilot study included samples collected from 15 bores, which exceeds the expectations of a pilot study design, as described in the best practice guidelines. Samples were collected from bores within the key water-bearing units on the site (being the Tertiary Sediments and Clematis Sandstone), in addition to the Rewan Formation and Betts Creek Beds.

It is noted that Dr Grant Hose, the expert who examined the samples, mentioned the need for multiple sampling events in his letter attached to the draft EIS assessment documentation (draft EIS, Appendix E of Appendix G). However, multi-season sampling is not required for a pilot study, according to the best practice guidelines. In addition, Dr Grant Hose also noted he was unaware of the sampling location or setting and as such couldn't provide further comment on the results. He was therefore unaware of the results of the desktop assessment that concluded there is limited potential for significant stygofauna habitat or assemblages to occur within the project site.

Due to the nature of the groundwater setting and the results of the pilot study field investigation, there is little evidence to suggest the project site supports a significant stygofauna assemblage or habitat. On this basis, and in accordance with the best practice guidelines, further investigation of stygofauna values (including additional sampling) is not warranted.

15. The proponent considers there is no shallow groundwater onsite to support GDEs. Water levels in the Tertiary sediments below North Creek are 15-20 metres below ground level suggesting that potential GDEs should be considered in the assessment.

As discussed in Sections 12.4.5 and 12.4.7 of the draft EIS, the groundwater table is at least 15 m, and more typically at least 20 m, below the ground surface within the predicted extents of drawdown. Hence there is no potential for groundwater dependent ecosystems to present within the extent of groundwater drawdown.

16. The project area contains two seasonal wetlands, and a series of residual pools within the drainage lines which are generally considered of less value by the proponent due to the non-permanence of their water supply. The Southern Seasonal Wetland will be removed by open cut mining, and the Northern Seasonal Wetland will be undermined by longwall mining.

a. The proponent's claim that these wetlands do not provide important habitat for a number of waterbirds (including migratory species) due to their seasonal nature is not supported by sufficient evidence, due to the lack of survey effort.
b. The proponent considers the Northern Seasonal Wetland is not dependent on, nor interacts with, groundwater due to the large depth to groundwater in this area. The potential for dependence on the role of perched groundwater was not considered.

c. Subsidence may result in potential impacts to the Northern Seasonal Wetland including:
   i. a loss in storage capacity as perched groundwater and surface water are lost to the fracture zone, particularly if impacts occur during the period the wetland holds water;
   ii. ponding and increased areas of inundation; and
   iii. habitat disturbance during surface subsidence remediation activities.

16 a) The draft EIS does not *"claim that these wetlands do not provide important habitat for a number of waterbirds".* In fact, as shown in Figure 11-10 of the draft EIS, both the Northern Seasonal Wetland and Southern Seasonal Wetland have been assessed as potentially providing high value habitat for the Australian Painted Snipe, a threatened species under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The wetlands were both surveyed during the May 2012 field survey. They were inspected in the October/November 2012 survey but were found to be dry. A lack of water during the dry season confirms their seasonal nature and does not represent a "*lack of survey effort*" by the proponent.

16 b) The Northern Seasonal Wetland is located on the elevated Darkies Range plateau in the northern part of the project site. The regional groundwater table is located approximately 100 m below ground level in this location and is therefore disconnected from the Northern Seasonal Wetland.

In order to investigate the potential presence of shallow groundwater, a total of 11 bores were drilled on elevated Darkies Range plateau as part of the draft EIS groundwater study. This investigation included two bores (MB26 and MB27) in the immediate vicinity of the Northern Seasonal Wetland (as shown on Figure 12 of the draft EIS Groundwater Report [Appendix I]). As shown on the drilling logs presented in Appendix A of the draft EIS Groundwater Report (Appendix I), these bores remained dry during drilling and did not encounter perched water in the unsaturated zone above the regional water table. This site-specific data therefore indicates that a pervasive perched groundwater regime is extremely unlikely to be present below the Northern Seasonal Wetland.

This finding is consistent with the draft EIS surface water assessment which concludes the Northern Seasonal Wetland is an internally draining topographic feature that is supported by seasonal rainfall runoff.

The alternative conceptualisation proposed in the submission (i.e. the Northern Seasonal Wetland being supported by a highly localised, perched groundwater regime located 100 m above the regional groundwater table) is therefore poorly supported by the available information.

16 c) The potential impacts of subsidence on the Northern Season Wetland are discussed in the draft EIS Aquatic Ecology and Stygofauna Report (Appendix G). This section discusses the

various potential impacts listed in the IESC's advice, and describes any necessary management measures.

17. The proponent defined high value habitat for a number of threatened bird species (squatter pigeon and black throated finch) based on distance to permanent water sources. The loss of residual pools, riparian habitat, and the Southern Seasonal Wetland may decrease the suitability of surrounding habitat for species reliant on water. Many species records for the black throated finch are some distance from mapped permanent water sources, and not within high value habitat. The black throated finch may require a greater mosaic of habitat (see DECC NSW, 2007) than the high value habitat identified by the proponent.

The Black-throated Finch (BTF) habitat modelling for the project site has been revised in consultation with the Federal Department of the Environment and Energy (DoEE) and the Queensland EHP. An overview of the revised habitat modelling is provided in Attachment F - Additional Information on Ecology. The revised habitat modelling includes a greater mosaic of habitat, given that it includes habitat around non-permanent sources of water (as well as habitat around permanent water sources).

Water resources

18. The mine water management system is predicted to have a water deficit throughout the proposed operations. The annual external water requirement over the life of the mine is predicted to range from approximately 903 ML/year under wettest modelled conditions to 12,300 ML/year under driest modelled conditions.
    a. The proponent is considering options for sourcing external water supplies. However, insufficient information has been provided to enable assessment of the viability of supply and impacts to other water users.
    b. Potential impacts on the surface water and groundwater resources from where this water is sourced from should be assessed, particularly when considering the impact of the external water requirements for the adjacent CCM project.

The proponent is currently considering external water supply options including sourcing water from either a managed water supply scheme (operated by a water manager such as SunWater) or through the purchasing of existing water allocations through water trading.

The water supply schemes will be developed and operated by others and would be subject to separate environmental impact assessment and approvals.

Mitigation, monitoring and management

19. A groundwater monitoring programme should be developed to reduce uncertainty associated with the current conceptualisation and associated model predictions (see response to Question 8 below).

Refer to the response to IESC Responses 33 and 47.

20. Assessment of the potential impacts to surface water resources from the proposed project would be improved by:
a. Water quality objectives being established and justified for each relevant receiving water resource.
b. Contextual information about the surface water quality dataset, such as time, frequency and corresponding flow level, being provided to ensure that the data are representative of the existing condition and that the data set spans a suitable period of record, and relevant ANZECC & ARMCANZ (2000) guidelines are applied appropriately.
c. Installing monitoring stations immediately downstream of the project area (and the discharge point) to assess water quality changes to Pigeonhole Creek, North Creek, and downstream of the confluence of North Creek and the “major waterway” identified in the Tomahawk Creek catchment to detect any water quality change to the Belyando River.

The release of mine-affected water based on flows in North Creek and the strict application of the EHP model mine conditions will ensure that sufficient flushing flows occur in North Creek following any discharge events and that there are no adverse impacts on downstream environmental values in North Creek, including aquatic ecosystems.

20a) A baseline water quality and flow monitoring program will be implemented for North Creek. The baseline monitoring program will be undertaken in accordance with the Queensland Water Quality Guidelines, prior to the commencement of the project.

Baseline water quality and flow data collected as part of this monitoring program will also be used to establish locally relevant water quality objectives for North Creek in accordance with the Queensland Water Quality Guidelines.

20b) The details of the proposed baseline water quality and flow monitoring program are provided in Attachment E – Additional Information on Surface Water. Water quality and flow gauging will be undertaken on North Creek downstream of the proposed controlled release point and on the Belyando River.

Contextual information about the baseline surface water quality dataset including time, frequency and corresponding flow level will be collected to ensure that the water quality data are representative of the baseline conditions and that the dataset spans a suitable period of record for the establishment of a robust baseline and the development of locally relevant water quality objectives.

The baseline data will be collected and analysed in accordance with the Queensland Water Quality Guidelines, which are consistent with the ANZECC & ARMCANZ (2000) guidelines.

20c) The proposed baseline water quality and flow monitoring program described in Attachment E – Additional Information on Surface Water comprises ten baseline water quality monitoring sites including sites in the headwaters and lower reaches of North Creek, Eight Mile Creek and the Belyando River upstream and downstream of the confluence with North Creek. This specifically includes a dual purpose water quality and flow monitoring site immediately downstream of the project site (and the proposed release point RP1) and a monitoring site between the North Creek and Tomahawk Creek confluences with the Belyando River.

It is not proposed to discharge mine-affected water to the Tomahawk Creek catchment (including Pigeonhole Creek). No monitoring of Pigeonhole Creek or the 'major waterway' identified in the Tomahawk Creek catchment is therefore proposed.

21. The proponent notes a commitment to monitor ongoing health of flora and fauna retained in the project area, with details to be outlined in the biodiversity management plan which was not available in the assessment documentation, preventing assessment of the suitability of the proposed plan.

a. The provision of fauna watering points beyond the project area to mitigate for the loss of surface water sources should be considered.

b. Aquatic surveys were undertaken in May and October 2012 at 22 sites but not all sites could be resurveyed in October due to a lack of water. These sites should be re-surveyed to assess temporal variability particularly with regard to the wet and dry seasons.

c. Terrestrial surveys were generally undertaken at the beginning and end of the dry season, however it is important to conduct surveys during the wet season. If this is not possible, reasons should be stated and the precautionary principle applied.

d. Stygofauna surveys were limited to a single sampling occasion which is inadequate (see paragraph 13) and should be consistent with the best practice guidelines (WA EPA, 2007).

The Biodiversity Management Plan is an operational management plan and will therefore be developed prior to construction of the project. However, the principles have been outlined in Section 9.7.3 of the draft EIS.

21 a) Section 9.7.2 of the draft EIS includes a commitment to provide fauna watering points within areas of native vegetation beyond the footprint of the open cut mining area and the mine infrastructure. In addition, as discussed in Section 4.7 of the draft EIS Biodiversity Offset Strategy (Appendix H), the provision of fauna watering points within offset sites will be considered as part of the management of offset properties.

21 b) A lack of water during the dry season confirms the seasonal nature of waterways within the site and is considered to represent temporal variability for these aquatic ecosystems. The basis for re-surveying these sites is considered illogical as it fails to acknowledge the highly ephemeral nature of surface water at the project site and the fact that the temporal variability in the site waterbodies typically includes these waterbodies being completely dry in each dry season. It is

highly likely that any attempt to re-survey these waterways in the dry season would result in the same outcome as experienced in the field surveys for the draft EIS i.e. a lack of water.

21 c) Terrestrial field surveys included a survey conducted in May 2012, which was the earliest possible time the site was accessible following a substantial period of rainfall at the end of the wet season in 2012. This rainfall is considered likely to have prolonged the wet season in 2012 and as such, the site was considered likely to have contained more ephemeral water at that time than the site usually would after a normal wet season. Due to these site conditions, the May 2012 field survey is considered to be consistent with a post-wet season ecological survey.

21 d) In accordance with the TOR for the project, the draft EIS included a desktop assessment and pilot study field investigation to assess the potential for stygofauna to occur within the project site. The assessment and pilot study field investigation was conducted in accordance with best practice guidelines, being the *Guidance for the Assessment of Environmental Factors – Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia No 54a* (Western Australia EPA, 2007). This guideline does not require multiple sampling events for the purposes of a pilot study. Please refer to IESC Response 14 for more information.

67.2 QUESTION 2

Does the IESC agree with the proponent's assessment that there is no direct groundwater – surface water interconnection within the predicted extents of groundwater drawdown?

IESC Response

22. No. There are small areas within and outside the project area of potential and known groundwater-surface water interaction, including: seasonal perched aquifers along Bully Creek or drainage lines that support GDEs (e.g. River Red Gum), the Northern Seasonal Wetland, the Doongmabulla Springs Complex and Lake Buchanan.

Refer to the response to IESC Response 13 that addresses the potential for impacts to vegetation associated with drainage features.

Section 12 of the draft EIS provides an assessment of the potential impacts of groundwater depressurisation on environmental features including potential GDEs, drainage features, surface water features (including wetlands and Lake Buchanan) and the Doongmabulla Springs Complex.

The groundwater assessment concludes that depressurisation of the regional groundwater regime is not predicted to extend to any of these features and therefore groundwater-surface water interactions will not be affected.

The response to IESC Response 16 describes the potential impacts on the Northern Seasonal Wetland.

Explanation

23. Groundwater is reported as typically being at depths in excess of 15 m below ground throughout the project area, and locally in excess of 100 m. Local topography in the area is dominated by the Darkies Range which forms an area of groundwater recharge and groundwater flow generally follows the topography to the east and west of the recharge zone.

Section 12 of the draft EIS states that, where present within the project site, the water table is generally deep (25 to 55 m below ground level). Further east, the water table is typically 15 to 20 m below North Creek and 20 to 25 m below Tomahawk Creek. The remainder of the submission is factually correct.

24. Quaternary sediments (mud and gravel) can provide a water source supporting River Red Gum and Forest Red Gum along ephemeral drainage lines. Whilst the proponent found only thin (less than 1 m thick) patches of Quaternary sediments, there is insufficient evidence to confirm the broadscale absence of Quaternary sediments across the project area. As there is the potential for impacts to the water content of these sediments from subsidence or groundwater drawdown, their presence (or otherwise) and hydrology should be further investigated.

As discussed in Section 12.3.1 of the draft EIS, targeted groundwater drilling and stream geomorphology assessments found that extensive, deep alluvial deposits and associated shallow groundwater are absent from the project site and surrounding area. Fluvial sediments present in the vicinity of the project site are limited to thin (less than 1 m) patches of mud and gravel that dry quickly following flow events. As shown in Section 12 of the draft EIS, the regional groundwater table is greater than 25 m below ground level in these locations and is therefore disconnected from these sediments.

The potential presence of a perched groundwater table is not supported by the available information. In the event that a highly localised perched groundwater table is present within these sediments, this would be hydraulically disconnected from the underlying groundwater regime and any associated effects from the project. This would therefore preclude significant impacts on associated vegetation.

On this basis, additional surveys within the thin fluvial sediments would not yield information that would change the conclusions of the impact assessment, and consequently no further investigations are justified.

25. Lake Buchanan, listed on the Directory of Important Wetlands, has been inferred by the proponent as an indirect discharge zone for the Clematis Sandstone via the overlying Moolayember Formation due to the high saline water quality of the lake. There is insufficient groundwater monitoring data for the Clematis Sandstone, Rewan Formation or the underlying Permian Formation to the west of the project area. This limits understanding of Lake Buchanan groundwater-surface water dynamics and any potential future propagation of depressurisation towards Lake Buchanan. The 1 m drawdown contours provided by the proponent suggest that Lake Buchanan will not be impacted. However, it is important to note that given a steady state model has been used, some drawdown impact would be expected at the lake. Higher resolution model predictions, including a transient calibrated model and 0.2 m drawdown contours, would provide stronger evidence of potential drawdown impacts not reaching the lake.

The conceptualisation of Lake Buchanan as a groundwater discharge zone presented in the draft EIS is supported by:

- Groundwater levels within bores adjacent to Lake Buchanan (Figure B1 of Attachment D – Additional Information on Groundwater) which show that the groundwater table is typically located 2 to 11 m above the lake bed elevation to the west of the lake and within 2 to 5 m below the lake bed to the east of the lake. This data supports the EIS conceptualisation of Lake Buchanan.
- The elevation of the lake bed is approximately 290 m AHD and is at least 50 to 100 m below Darkies Range and the surrounding ridgelines. The Lake Buchanan is the lowest topographic feature within a radius of approximately 50 km. This elevation difference promotes groundwater connection.

- Historical imagery (Google Earth Engine, 2016) which indicates that water is present in the lake during prolonged dry periods and drought conditions when no surface water runoff occurs.
- The Bureau of Meteorology Groundwater Dependent Ecosystem (GDE) Atlas which indicates that:
  - Previous studies have confirmed that the western part of the lake contains ecosystems that are reliant on the surface expression of groundwater;
  - Ecosystems in the eastern part of the lake have a high potential for interaction with surface expression of groundwater; and
  - Ecosystems in the lake have a high potential for interaction with subsurface groundwater.
- Published studies including Lorimer (2005) and DIWA (undated) state that Lake Buchanan is a discharge zone.
- Published Queensland GDE mapping which indicates that ‘expert knowledge’ has concluded there is a high confidence in the prediction that ecosystems in 80 to 100% of Lake Buchanan have some degree of groundwater dependence.
- Published limnology (Timms, 1987) and aerial photography (1984 to present) which indicates that salts tend to accumulate at the surface (as is typical of groundwater discharge zones) rather than being flushed through the superficial materials to the underlying bedrock (as is typical of recharge zones).

The conceptualisation of Lake Buchanan as a likely groundwater discharge zone is therefore consistent with available desktop information and field data.

By adopting this conceptualisation any drawdown on the regional groundwater regime would result in impacts on Lake Buchanan. This conceptualisation therefore represents a conservative approach to impact assessment. Despite this conservative approach, the project is not predicted to result in any significant adverse impacts on Lake Buchanan.

Alternative conceptualisations would involve Lake Buchanan being perched above the regional groundwater table or functioning as a source of sustained groundwater recharge. These conceptualisations are poorly supported by the available information. In addition, these alternative conceptualisations would result in a less conservative impact assessment for the following reasons:

- A perched lake would be hydraulically disconnected from the underlying groundwater regime and any associated effects from the project.
- Modelling Lake Buchanan as a recharge zone would necessarily involve increasing the amount of recharge entering the model cells used to represent Lake Buchanan. This would have the effect of buffering any groundwater drawdown associated with the project in the vicinity of Lake Buchanan.

On this basis, adopting an alternative conceptualisation for Lake Buchanan would further reduce the potential for the project to impact Lake Buchanan. The information provided indicates with a high level of confidence that Lake Buchanan is a discharge zone (rather than an 'inferred discharge zone'). Section 5.3 – Editorial Corrections includes clarification that representing Lake Buchanan as a discharge zone in the groundwater model provides a conservative basis for the assessment of potential impacts on Lake Buchanan due to groundwater drawdown.

Refer to the response to IESC Response 85b which clarifies the limits of accuracy associated with groundwater modelling predictions.

26. The absence of shallow groundwater from the project area conflicts with the Bureau of Meteorology (BoM) GDE Atlas mapping and Queensland Wetland mapping tool. These show potential for groundwater interaction with terrestrial GDEs such as Eucalyptus species associated with the Regional Ecosystem in the north of the project area. Furthermore, the Bingeringo Aggregation (listed on the Directory of Important Wetlands), includes a section of Bully Creek that drains off the escarpment to the north of the project area and a section of Bully Creek is known to hold water at the height of drought (DIWA, undated-a), which indicates likely groundwater input.

The Qld Government's *"Groundwater Dependent Ecosystem Mapping and Classification Method"* ("GDE Guideline") does not indicate the presence of Acacia and/or Eucalyptus species as being sufficient to confirm that vegetation is a GDE. Rather, it uses the presence of Acacia and/or Eucalyptus species as examples of "decision rules to identify GDEs". A number of other decision rules are provided in this example and a GDE is considered to be present if all of the decision rules are met. Other decision rules quoted in the example include vegetation being located on alluvia "where the groundwater table is less than five meters from the surface". As detailed in the draft EIS Groundwater Report (Appendix I), the depth to groundwater is more than 50 m at its shallowest within the northern section of the project site.

The Bingeringo Aggregation is located within the Bully Creek catchment approximately 50 km downstream of the Tomahawk Creek-Bully Creek catchment boundary and 30 km east-north-east of the project site.

As shown on Figure 13-2 and discussed in Section 13.2 of the draft EIS, the project site is located at the head of the North Creek and Tomahawk Creek catchments. The Tomahawk Creek-Bully Creek catchment boundary is aligned with the northern boundary of the project site. The project site is not located in the Bully Creek catchment and the project is therefore unlikely to adversely affect flows in Bully Creek or the Bingeringo Aggregation.

The draft ES Groundwater Report (Appendix I) shows the predicted extent of depressurisation associated with the project. The Bingeringo Aggregation lies a significant distance beyond the predicted extent of groundwater depressurisation associated with the project and is therefore unlikely to be adversely impacted by groundwater depressurisation.

67.3 QUESTION 3

Has the existing conceptual groundwater regime been adequately characterised, including the hydrogeology of each stratigraphic unit? If not, what changes should be made to the conceptual groundwater model?

IESC Response

27. No. More hydrogeological data is needed to support the underpinning conceptualisation and parameterisation of the groundwater model, including: confirmation of the extent of saturation of the Clematis Sandstone, surface water-groundwater interaction at Lake Buchanan, groundwater flow to the north of the project area and the presence of the North-north-west South-south-east trending fault in the Northern underground mining area.

Refer to the response to IESC Response 36 and 62 which address the extent of saturation of the Clematis Sandstone.

Refer to the response to IESC Response 25 which addresses the potential groundwater interactions with surface water at Lake Buchanan.

Refer to the response to IESC Response 76a which addresses the groundwater flow regime to the north of the project site.

Refer to the response to IESC Response 28 which addresses the presence of the fault in the north of the project site.

IESC Explanation

28. The fault in the Northern underground mining area is assessed as penetrating through the Clematis Sandstone and Rewan Formation, being downthrown approximately 100 m to the east, and truncating the Clematis Sandstone against the Rewan Formation. Concerns about the presence and potential influence of this fault include:

a. Bore data provided in the assessment documentation was for groundwater monitoring data only and provides inconclusive evidence for the presence of the fault.

b. There is a lack of evidence on the characteristics of the fault (as it is presented as an isolated feature), or justification of why the fault stops at the northern edge of the project area and just north of the area of the southern open cut mining pit.

Section 12.4.2 of the draft EIS states that the groundwater model was based on the project geological model as well as all published lithological logs within the model extents, including drilling logs from the adjoining Carmichael Coal Mine Project and the Department of Natural Resources and Mines (DNRM) groundwater database.

The project geological model included detailed data from approximately 200 bores drilled as part of exploration programs undertaken at the project site and at adjacent sites, along with data from deep wells in the region outside the proposed mining area. Figure 12-8 of the draft EIS shows the geological cross-sections that are based upon this data. As shown in section C-C' the available geological data indicates approximately 100 m of vertical displacement in the Permo-triassic geology in the western part of the project site.

As shown in sections A-A' and B-B' the displacement does not extend into the central and southern parts of the project site. In addition, the geological data shows that the displacement does not extend north of the project site.

On the basis of the significant body of geological data, the most likely explanation for this displacement is the presence of a localised fault. Faulting is a relatively common occurrence at the margins of the Galilee Basin and lineaments typically indicative of faults and significant fractures are present in elevated areas in vicinity of Darkies Range and Lake Buchanan.

Folding is not mapped in the vicinity or observed in the project geology model and is therefore unlikely to explain the observed displacement. No other plausible explanations for the observed displacement (of approximately 100 m) in the geological data have been offered in the submission (as requested by the regulator in Question 3).

On the basis of the available geological information and previous mining experience in the same or equivalent formations in extensively faulted areas of the Bowen Basin, the fault is likely to restrict groundwater flow for the following reasons:

- Regionally, fractures associated with faults are typically sealed by mineralisation and precipitation.
- The high clay content of the Permo-Triassic formations means that there is a significant likelihood of clay smearing across the fault plane that is likely to reduce the fault permeability by several orders of magnitude compared to the un-faulted areas.
- The coal seams are thin and represent an extremely small proportion of the overall thickness of the Permo-Triassic sediments (i.e. less than 1%). There is therefore a greater than 99% probability that fault displacement has resulted in a coal seam being juxtaposed with less permeable Permian interburden or Rewan Formation sediments on the other side of the fault.
- Previous mining experience in the Bowen Basin indicates that coal seams are typically highly compartmentalised by faulting.

On this basis the conceptualisation, mapping and characterisation of the fault in the north of the project site is supported by the available information.

In addition, Section 12.4.2 of the draft EIS describes the sensitivity analysis was undertaken to test the influence of the geological fault on the modelling predictions. The sensitivity analysis considered the fault as a low permeability flow barrier and a high permeability flow conduit to capture extremes in the potential behaviour of the fault. The results presented in Section B3 of the draft EIS Groundwater Report (Appendix I) clearly show that the modelling predictions are relatively insensitive to the permeability of the fault.

29. To the west of the project area, there is limited monitoring of the Clematis Sandstone, Rewan Formation or the underlying Permian Formation (Betts Creek Beds and associated coal seams). This does not allow for adequate understanding of groundwater-surface water dynamics at Lake Buchanan.

Refer to the response to IESC Response 25 which clarifies the basis for conceptualisation of groundwater surface water interactions in the vicinity of Lake Buchanan and confirms the conservatism in the modelling approach and impact assessment presented in the draft EIS.

30. The Rewan Formation was accounted for using two model layers, but it is unclear why two layers were chosen, and what or when parameters differed between the two layers.

Section B1.2.3 of the draft EIS Groundwater Report (Appendix I) explains that the Rewan Formation was represented by two model layers to provide a better representation of the behaviour of the formation, specifically in response to subsurface subsidence cracking. Section B2.2 of the draft EIS Groundwater Report (Appendix I) describes the parameterisation of the Rewan Formation layers in relation to subsurface subsidence cracking.

31. The monitoring network does not provide sufficient information to conceptualise the groundwater regime in the project area. There is only one bore to the north and north east of the project area, which did not fully penetrate the Clematis Sandstone sequence in this location and did not intersect groundwater, limiting understanding of groundwater flows, groundwater-surface water interaction, and potential cumulative (i.e. with the proposed Hyde Park Coal Project) impacts in this area.

Refer to the response to IESC Response 33.

67.4 QUESTION 4

Are the groundwater conceptualisation, groundwater contours and flow direction representative of the aquifer systems based on information available?

<u>IESC Response</u>

32. No. The information available: a. does not support the conceptualisation of the fault in the Northern underground mining area; b. could reasonably be interpreted to produce alternate groundwater contour maps and flow directions; c. does not provide sufficient detail to support the groundwater contour maps and flow direction presented for the Permian and Rewan Formation; and d. does not provide a regional context for groundwater behaviour within the project area.

32a) Refer to the response to IESC Response 28 which clarifies the information and conceptual basis for the presence of a fault in the northern part of the project site.

32b) The groundwater contours and flow directions presented in the draft EIS Groundwater Report (Appendix I) are based upon a significant dataset and have been verified by calibrated groundwater modelling. On this basis, the groundwater contours and flow directions are considered to be robust. The claim that the data could reasonably be re-interpreted to produce alternative contours and flow directions is not technically supported.

32c) Refer to the response to IESC Response 34.

32d) Refer to the response to IESC Response 1 which explains how all relevant site-specific and regional information has been incorporated into the draft EIS groundwater study and used to develop conceptual and numerical groundwater models that reflect the range of hydrogeological characteristics exhibited within the vicinity of the project site. On this basis, the draft EIS groundwater impact assessment is suitable for the purposes of the draft EIS.

<u>IESC Explanation</u>

33. The monitoring network does not provide sufficient information to conceptualise the groundwater regime, groundwater contours and flow direction within the project area. Additional groundwater level/pressure data should be collected to confirm groundwater flow directions for the Tertiary sequence, Clematis Sandstone, Rewan Formation and the Permian sequence. A broader regional context should also be provided to understand local groundwater processes.

Section 5 of the draft EIS Groundwater Report (Appendix I) confirms that an extensive hydrogeological dataset was compiled from exhaustive desk study and field investigations.

In addition to the groundwater monitoring network installed for the project, the draft EIS groundwater study specifically incorporated all relevant geological and groundwater information collected as part of the Carmichael Coal Project EIS, SEIS and AEIS groundwater studies and data collected from the Queensland DNRM Groundwater Database.

Groundwater data has therefore been collected from an area of approximately 75 x 85 km and includes in excess of 100 bores. The draft EIS groundwater study therefore presents the most comprehensive groundwater dataset yet compiled in this part of the Galilee Basin.

This dataset represents a substantial body of data that captures the local and regional scale behaviour and characteristics of the groundwater regime, including the groundwater flow directions in the Tertiary sediments, Clematis Sandstone, Rewan Formation and the Permian coal measures.

Additional baseline groundwater monitoring data collected from this network is presented in Attachment D – Additional Information on Groundwater. This extensive dataset supports the conceptualisation of the groundwater regime presented in the draft EIS.

34. The groundwater contours for the Permian stratigraphy demonstrate that groundwater north of the project area flows in both a westerly and easterly direction. It is unclear how the proponent established the groundwater flow direction as there are no bores at this location.

The conceptual groundwater model presented in Section 12 of the draft EIS considers the elevated ridgelines located to the west of the project site represent groundwater recharge zones. Groundwater flow will follow hydraulic gradients from these recharge zones to discharge zones. Groundwater discharge zones are likely to form in low-lying areas that intersect the groundwater table, including rivers and other low lying areas.

It is acknowledged that the geological units dip to the west, however groundwater flow is ultimately from areas of high pressure to low pressure, and catchment properties therefore play a significant role in influencing groundwater pressures. This concept is consistent with Darcy's Law and the well-established pattern of regional groundwater flow (Toth, 1963). It is also consistent with the conceptualisation of groundwater flow presented in the Carmichael Coal Mine Project EIS, and the findings of the subsequent reviews conducted by URS (2013), Dr Noel Merrick (2014) and DNRM (2014) as part of the approval process for the Carmichael Coal Mine Project. These reviews specifically confirmed that:

- Elevated ridgelines west of the Carmichael Coal Mine Project site and the Project China Stone site are groundwater recharge zones that form a regional groundwater divide in the Colinlea Sandstone (equivalent to the Betts Creek Beds); and
- Groundwater levels in shallow bores and groundwater flow in the Clematis Sandstone are both strongly influenced by local topographical high and low points.

The submission refers specifically to the area north of the project site. Figure 12-1 of the draft EIS shows that several groundwater monitoring bores are located to the north of the project site and east and west of the elevated Darkies Range groundwater divide.

The draft EIS groundwater model produced calibrated groundwater heads for the shallow bedrock and deeper formations that are consistent with these measured levels (Figure B6 to B8 of the draft EIS Groundwater Report (Appendix I)). The data and modelled heads indicate that there is a hydraulic gradient in the shallow bedrock from the elevated Darkies Range ridgeline to the east and west. This is consistent with Merrick (2014) and DNRM (2014) which confirm that local groundwater flow reflects catchment boundaries and topography.

The groundwater flow directions to the north of the project site are therefore considered to be robust and justifiable based upon the best available data, and are supported by the robust model calibration results.

35. In the Rewan Formation there are no monitoring bores located to the north and south, or within the south east, of the project area, yet an overall easterly flow direction is inferred. It is unclear how data for the Rewan Formation flow direction was obtained. Based on the presented data from a single bore (MB 24), it is not possible to infer a flow direction at Lake Buchanan.

As shown in Appendix A1 of the draft EIS Groundwater Report (Appendix I) groundwater levels have been collected from the Rewan Formation at several locations in the project site and its surrounds, including 11 monitoring bores and 6 VWPs installed at the project site, two bores immediately south-east of the project site and several other bores within the regional setting.

Calibration results presented in Appendix B of the draft EIS Groundwater Report (Appendix I) show that the modelled groundwater contours and flow directions show good agreement with the monitoring data.

36. No groundwater flow contours were provided for the Clematis Sandstone, due to the Clematis Sandstone being unsaturated and possibly even dry (5 out of 6 monitoring bores were dry – the other bore has a slotted interval encompassing the base of the Clematis Sandstone and the top of the Rewan Formation). The proponent should provide more information on the Clematis Sandstone, including saturation of the formation and groundwater flows by increasing the number of monitoring bores to the south, east, and north and outside of the project area to reduce the level of uncertainty in regards to the level of saturation and consequent modelling predictions.

Section 6 of the draft EIS Groundwater Report (Appendix I) shows that the Clematis Sandstone is typically dry and unsaturated at the project site, with the groundwater table typically located in the underlying formations.

In addition to the five dry bores within the Clematis Sandstone at the project site, groundwater monitoring levels have been collected from the Clematis Sandstone at several locations in the project site and its surrounds, including monitoring bores to the north, south and west of the project site. These monitoring locations are listed in Appendix A1 of the draft EIS Groundwater Report (Appendix I).

Calibrated groundwater head and groundwater flow directions are presented in Appendix B of the draft EIS Groundwater Report (Appendix I). Saturated extents and saturated thickness of the Clematis Sandstone are shown in Figure 22 of the draft EIS Groundwater Report (Appendix I).

67.5 QUESTION 5

Is the numerical groundwater model adequate to identify and quantify potential impacts to groundwater resources? Is the sensitivity analysis conducted by the proponent sufficient to encompass the range of likely uncertainty in key parameters and variability in aquifer parameters? If not, what changes should be made to the numerical groundwater model?

IESC Response

37. No. There are significant uncertainties associated with the numerical groundwater model as the conceptualisation and parameterisation used is not supported by adequate information. The numerical groundwater model is classified as Class 1 (Barnett et al., 2012) as there has been no peer review and no transient calibration, with transient predictions made with steady state calibration.

Refer to the response to IESC Response 1 which addresses the adequacy of the groundwater data presented in the draft EIS.

Section 8 and Appendix B of the draft EIS Groundwater Report (Appendix I) explain that groundwater level responses are negligible and do not provide a meaningful basis for transient calibration. Additional monitoring data presented in Attachment D – Additional Information on Groundwater confirms this assessment. A transient verification of the model was undertaken. This indicates that the groundwater model achieves a suitable level of calibration and predictive reliability.

In order to further assess the impacts of the model conceptualisation and parameterisation, a robust sensitivity analysis was undertaken. The results of the sensitivity analysis are presented in Section B3 of the draft EIS Groundwater Report (Appendix I).

There is no requirement for a peer review of the groundwater model in the EIS TOR nor is it standard practice for mining EISs. The draft TOR for the project prepared by the OCG did not include a requirement for a groundwater model peer review. The draft TOR were publicly exhibited and EHP, DNRM and DoEE were provided an opportunity to comment on the draft TOR prior to its finalisation. EHP, DNRM and DoEE's submissions on the draft TOR did not request the need for a peer review of the groundwater model for the project. In addition, all specific submission issues that were raised in relation to the draft EIS groundwater model have been responded to as part of the preparation of the Supplement. This has included discussions with the key regulatory agencies, including EHP, DNRM and DoEE. It is not reasonable to now require a peer review of the groundwater model at this stage, given that it is not a requirement of the TOR, the groundwater study has addressed the project's TOR and all specific groundwater issues that were raised by regulatory agencies have been addressed, in consultation with the agencies.

On this basis, the groundwater model provides a suitable basis for the assessment of groundwater impacts.

38. No. Sensitivity analysis was undertaken using a range of suitable parameters for the steady state numerical groundwater model. Sensitivity analysis was also undertaken to test the influence of the fault acting as either a high permeability or low permeability layer. However, sensitivity analyses were not conducted on model boundaries and the results of the numerical groundwater model did not undergo an uncertainty analysis, which limits understanding of model behaviour and the reliability of the numerical groundwater model predictions.

The model boundaries have been located at significant distances from the predicted extent of depressurisation associated with the project. The interaction between the predicted depressurisation effects and the model boundaries is therefore negligible and has no material effect on the modelling results or impact assessment.

The sensitivity analysis considered scenarios that encompassed extreme ranges of key hydraulic parameters and conceptualisations. The results presented in Section B3 of the draft EIS Groundwater Report (Appendix I) confirm that the model is relatively insensitive to all but the most extreme changes. Furthermore, the maximum predicted extent of depressurisation associated with the sensitivity analysis scenarios does not extend to any springs, lakes or other groundwater dependent features. It can therefore be concluded with a high degree of confidence that changes in key hydraulic parameters and conceptualisations in the order of those assessed will not give rise to any significant impacts at these features.

39. More monitoring data is needed to calibrate the model and the groundwater model should undergo transient calibration. Boundary conditions should be justified and undergo sensitivity testing, and a robust programme for update and review of the groundwater model should be defined as additional data becomes available.

Refer to the response to IESC Response 1 which confirms that additional monitoring data supports the model conceptualisation, calibration method and results and predictions presented in the draft EIS. Specifically, these data do not show any significant changes in groundwater level due to hydraulic stresses (e.g. diffuse rainfall, runoff etc) and therefore a transient calibration to an effectively static groundwater system would not provide any material benefits. The model calibration presented in the draft EIS Groundwater Report (Appendix I) is therefore suitable for the purposes of the draft EIS.

Section B1.2.3 of the draft EIS Groundwater Report (Appendix I) provides justification for the boundary conditions and confirms that the boundary conditions have been selected to ensure that they have no significant bearing on the model outcomes.

IESC Explanation

40. The proponent suggests that the steady state calibration addresses the long-term groundwater behaviour. Whilst there was no transient calibration, transient verification was undertaken using transient water level records to verify that the model could replicate water levels measured in the monitoring bore network installed for the project. The 26 hydrographs are presented for model verification, but data was only collected for 6-12 months and shows little variability. This may not be representative of long-term groundwater behaviour.

Refer to the response to IESC Response 1 and 39.

41. Northern and southern boundaries of the model are parallel to interpreted groundwater flow directions, but it is unclear how the west and east boundaries were determined. Justification should be provided on the east and west boundaries and why the base of the model was set as a no-flow boundary.

The western boundary of the model was aligned to the western extent of the Lake Buchanan catchment. This catchment boundary is an inferred regional groundwater divide. Positioning the model boundary in this location allows for a robust assessment of the potential impacts on Lake Buchanan and the GAB sediments west of the project site.

The eastern model boundary extends to the eastern margin of the basement formations and includes the Belyando River floodplain. This allows for a robust assessment of any potential impacts on the Betts Creek Beds and the Belyando River alluvium.

The base of the model was set as a no flow boundary as this has no significant bearing on the model outcomes.

67.6 QUESTION 6

Are the hydraulic parameters used for the base case, as well as to simulate fracturing from underground longwall mining, considered appropriate?

IESC Response

42. The appropriateness of base case parameters cannot be determined, due to the lack of data available. The factors applied to simulate the effects of subsidence fracturing (in some cases, producing a free draining system) exceed other reasonable estimates (see Guo et al., 2007). There is a risk that this simulation of fracturing is unduly influencing drawdown predictions.

Baseline data and appropriateness of base case hydraulic parameters

Refer to the response to IESC Response 1 in relation to the available data.

An extensive dataset of hydraulic conductivity values was collected at the project site and Carmichael Coal Mine site. The collected dataset is described in Section 6.2 of the draft EIS Groundwater Report (Appendix I) and includes 154 rising/falling head and packer tests conducted at the project site and the Carmichael Coal Mine site. This provides a suitable body of data from which to determine appropriate hydraulic parameters.

Rationale for the Modelled Approach to Subsurface Subsidence Fracturing

As discussed in Section 12.4.2 of the draft EIS, the prediction of subsurface subsidence cracking effects on vertical hydraulic conductivity carries inherent uncertainties. In order to address this uncertainty, the groundwater model was designed to create a fully drainable fracture network within each of the predicted fractured zones.

Table B8 of the draft EIS Groundwater Report (Appendix I) provides an example of the undisturbed vertical hydraulic conductivity of each model layer, the fully drainable fractured vertical hydraulic permeability of that model layer and the ratio of these values (shown as a multiplication factor). Attachment D – Additional Information on Groundwater, illustrates this example. As shown in this example, the factor applied to each layer is determined by the undisturbed vertical hydraulic conductivity of each model layer. A large multiplication factor is applied to low permeability strata close to the goaf (i.e. interburden within the coal measures), while a smaller multiplication factor is applied to higher permeability strata and strata located in the upper fractured zone. The multiplication factors presented in Table B8 are therefore correct for each model layer in the example location provided.

This modelling approach creates a highly permeable fracture zone that does not unduly restrict drainage to the mine workings or the propagation of groundwater depressurisation. This provides a conservative basis for the assessment of the project's groundwater impacts.

In addition, the model has been designed to extend the fracture zone to include the full thickness of all model layers that are within the predicted height of subsidence cracking. This modelling approach is intended to ensure that the predicted groundwater depressurisation effects and groundwater impacts of the project are not reliant on the mitigating effects of either the aquitard properties of the Rewan Formation or the partial fracturing of an aquifer. This modelling approach provides an additional level of conservatism to the predicted groundwater depressurisation effects and groundwater impacts of the project.

A review of groundwater studies for other mining projects in the Galilee Basin and other coal mining regions was undertaken as part of the scoping phase of the draft EIS groundwater study. The review showed that subsidence effects on permeability changes are typically modelled by applying a uniform factor to all layers or a series of factors relating to the height of cracking above the goaf, for example:

- The Carmichael Coal Project EIS adopted a uniform factor of x50 permeability up to 75 m above the goaf and a uniform factor of x10 above this height.
- The China First Coal Project EIS adopted a uniform factor of x106 for a height of 2 m (i.e. the caved goaf) and a uniform factor of x10 above this height.

This approach provides a straightforward modelling approach but maintains the presence of low and high permeability layers within the fractured zone. The presence of low permeability layers may have the effect of impeding groundwater drainage from relatively high permeability formations to the mine workings. This can result in buffering of the drawdown effects of mining in the overlying formations.

In conclusion, the vertical hydraulic conductivity values and subsidence factors presented in Appendix B of the draft EIS Groundwater Report (Appendix I) are correct and the rationale for the modelled approach to subsurface subsidence cracking represents a suitably conservative scenario for the assessment of project impacts on groundwater, without unduly increasing drawdown predictions.

<u>IESC Explanation</u>

43. The hydraulic parameters for all major stratigraphic units were established through in-situ permeability testing (18 falling head and 68 in-situ packer tests) and data from permeability testing at the CCM project. There is a paucity of data available to support the base case hydraulic parameters used for the Quaternary sediments, Ronlow Formation and Moolayember Formation. Quaternary sediments and the weathered rock regolith modelled hydraulic parameters fall outside the range of available field data for both the proposed project and CCM project. For the proposed project no data was available for the Moolayember Formation and the Ronlow Formation.

As discussed in Section 6 of the draft EIS Groundwater Report (Appendix I) the hydraulic parameters were determined from 114 packer tests and 40 rising/falling head tests.

This dataset includes 6 rising/falling head tests in Quaternary sediments. Figure B9 of the draft EIS Groundwater Report (Appendix I) shows that the calibrated hydraulic conductivity of the Quaternary sediments (and regolith) was higher than the measured range of hydraulic conductivity. However, the calibrated hydraulic conductivity remained within realistic bounds for a highly permeable alluvium, and is therefore a conservative basis for assessment of project impacts. The calibrated hydraulic conductivity was also consistent with those adopted for the adjacent Carmichael Coal Mine Project EIS.

The Ronlow Formation and Moolayember Formation are not present on the project site and limited hydraulic data is available regionally for these formations. The hydraulic conductivity of these formations was determined through the calibration process. The modelled hydraulic conductivity values are consistent with the lithology of these formations.

The Quaternary alluvium, Ronlow Formation and Moolayember Formation are not present at the project site and are not directly impacted by mining. These formations are therefore not key formations in the calculation of groundwater depressurisation due to the project and the assessment of groundwater impacts.

44. In the numerical groundwater model, the hydraulic conductivity of shallow strata (Rewan Formation and Clematis Sandstone) in the Northern underground mining area was increased to reflect the predicted fracturing associated with subsidence. The high hydraulic conductivity values used to simulate subsidence-induced fracturing may limit the predicted extent of groundwater drawdown in the Betts Creek Beds Units. The proponent should run the model with lower modified hydraulic conductivities for the overlying units to determine the sensitivity of drawdown in the Betts Creek Beds Units to the modified hydraulic conductivity of the Clematis Sandstone and Rewan Formation.

Refer to the response to IESC Response 42 which confirms that the vertical hydraulic conductivity values and subsidence factors presented in Appendix B of the draft EIS Groundwater Report (Appendix I) are correct and the rationale for the modelled approach to subsurface subsidence cracking represents a suitably conservative scenario for the assessment of project impacts on groundwater, without unduly increasing drawdown predictions.

Nonetheless, as discussed in Section B3 of the draft EIS Groundwater Report (Appendix I), the sensitivity of the modelled drawdown predictions to changes in model parameters was investigated. The sensitivity analysis investigated the effect of changing both the horizontal and vertical hydraulic conductivities by +/-1 order of magnitude across all model layers. The purpose of these scenarios was to determine the model sensitivity of the predictions to changes in key parameters. The changes have been applied to all layers simultaneously in order to determine the sensitivity of the overall model to these parameters. The sensitivity analysis therefore included changes to the hydraulic conductivity.

45. Subsidence modelling was undertaken using empirical methods because it is a greenfield project and there is no measured data. Parameters for the subsidence model were reasonable, based on subsidence data from the Bowen Basin presented in the 2012 South Galilee EIS. Once subsidence data from longwall coal projects in the Galilee Basin becomes available, subsidence predictions should be updated.

Section 6 of the draft EIS describes the subsidence monitoring program that will be undertaken throughout longwall mining operations. Monitoring will be used to identify any departures from the subsidence predictions and any such departures will be investigated to determine the likelihood of significant adverse impacts. The merit of undertaking additional subsidence modelling would be considered as part of the investigation outcomes.

67.7 QUESTION 7

Does the groundwater model require a peer review?

IESC Response

46. Yes, a peer review of the groundwater model should be undertaken, as recommended in the IESC Information Guidelines (2014).

There is no requirement for a peer review of the groundwater model in the EIS TOR nor is it standard practice for mining EISs. The draft TOR for the project prepared by the OCG did not include a requirement for a groundwater peer review. The draft TOR were publicly exhibited and EHP, DNRM and DoEE were provided an opportunity to comment on the draft TOR prior to its finalisation. EHP, DNRM and DoEE's submissions on the draft TOR did not request the need for a peer review of the groundwater model for the project. In addition, all specific submission issues that were raised in relation to the draft EIS groundwater model have been responded to as part of the preparation of the Supplement. This has included discussions with the key regulatory agencies, including EHP, DNRM and DoEE. It is not reasonable to now require a peer review of the groundwater model at this stage, given that it is not a requirement of the TOR, the groundwater study has addressed the project's TOR and all specific groundwater issues that were raised by regulatory agencies have been addressed, in consultation with the agencies.

67.8 QUESTION 8

Is the proposed groundwater monitoring program adequate to determine baseline conditions, provide a continued understanding of the groundwater systems, and monitor impacts to groundwater resources as a result of the project such as changes in water levels, both on and off lease, over time from both a spatial and aquifer extent? If not, what changes should be made to the groundwater monitoring program?

IESC Response

47. No. At present the monitoring programme has insufficient spatial and stratigraphic coverage to adequately determine baseline conditions, characterise and enable appropriate assessment of, or monitor potential impacts to water resources.

Section 12.5.1 of the draft EIS describes the proposed baseline groundwater monitoring program. The baseline groundwater monitoring program includes monitoring bores targeting all key formations at the project site including the Tertiary sediments, the Clematis Sandstone, the Rewan Formation and the Betts Creek Beds. The baseline monitoring program therefore provides full stratigraphic coverage of the local groundwater regime.

Section 12.5.2 of the draft EIS describes the proposed operations phase groundwater monitoring program that will be used to monitor the potential impacts of the project. As shown in the draft EIS Attachment 24-4, the proponent has proposed a groundwater monitoring network that comprises 36 groundwater monitoring points located within the project site and 20 additional groundwater monitoring locations within the surrounding area.

This includes offsite groundwater monitoring locations to provide additional coverage of the GAB sediments to the north, south and west of the project site and the groundwater regime in the vicinity of the Carmichael Mine.

The proposed groundwater monitoring programs are therefore sufficient to characterise the local baseline conditions and address the full extent of potential project and cumulative impacts.

48. The groundwater monitoring programme should be focused on reducing the uncertainty in the groundwater model conceptualisation and parameterisation and informing quantification of impacts to identified environmental objectives and water-related assets. This will need a greater extent (beyond the project area, more hydrostratigraphic units) and increased resolution (temporal frequency and spatial density) of monitoring stations than is currently proposed by the proponent.

Refer to the response to IESC Response 47.

IESC Explanation

49. The pre-mining groundwater monitoring network consisted of 31 monitoring bores at 24 locations, although 13 monitoring bores have been reported as being dry, and should not be considered part of the ongoing monitoring network. Baseline monitoring results from December 2012 to August 2013 did not record any significant changes in groundwater levels from hydraulic stresses.

Refer to the response to IESC Response 47 in relation to the proposed baseline groundwater monitoring program.

For clarity, it is considered technically incorrect to suggest that bores recorded as dry do not provide useful data on the baseline groundwater conditions at the project site. The proponent is therefore committed to continued monitoring of baseline conditions across all bores within the proposed baseline monitoring program.

Refer to the response to IESC Response 1 which confirms that baseline data collected between December 2012 and January 2016 did not record any significant changes in groundwater levels from hydraulic stresses.

50. Specific issues relating to baseline monitoring include:

a. The distribution of bores does not adequately cover the south east of the project area.

b. There is insufficient monitoring of the Clematis Sandstone, Rewan Formation or the underlying Permian Formation (Betts Creek Beds and associated coal seams).

c. There is uncertainty regarding the screened formations for bores (i.e. 153583, 153582, 8 Mile bore) to the west of the project area.

d. There is only one bore to the north and north east of the project area, which did not intersect groundwater, limiting understanding of groundwater flows, potential groundwater-surface water interaction, and potential cumulative impacts in this area.

e. There is no baseline monitoring of potential shallow perched groundwater in the Northern Seasonal Wetland, which could be drained by cracking associated with subsidence.

f. While there is a model prediction for take from the GAB, there is no described monitoring-based methodology for determining and verifying baseline contribution of recharge to the GAB.

50a) Figure 12 of the draft EIS Groundwater Report (Appendix I) shows that there are currently four baseline monitoring bores located in the southern part of the project site. The geology at these locations is consistent with the geology to the east. These bores therefore provide sufficient understanding of the baseline in the south of the project site.

In addition, the proponent has committed to monitoring several monitoring bores located adjacent to the south and south-east of the project site as discussed in the draft EIS Attachment 24-4. The bores will provide sufficient cover to allow the groundwater regime in the south-east of the project site and the Carmichael Mine to be monitored.

50b) Refer to the response to IESC Response 47.

50c) Figure 12 and Appendix A1 of the draft EIS Groundwater Report (Appendix I) show the screened formations of monitoring bores based upon published bore logs and the geology model. The screened formations are therefore understood with the same degree of certainty.

It is noted that these three bores are not part of the baseline monitoring program and any concerns in relation to screened formations are not material to the quality of the baseline monitoring program.

50d) As discussed in the draft EIS Attachment 24-4, the proponent has proposed a groundwater monitoring network that comprises 36 groundwater monitoring points located within the project site and 20 additional groundwater monitoring locations within the surrounding area.

Contrary to the submission, the groundwater monitoring network specifically includes eight monitoring locations east of the project site in the Tertiary sediments.

In the north of the project site and offsite to the north, the Betts Creek Beds are located at significant depths below the Tertiary sediments (where present), the Rewan Formation and the Clematis Sandstone. Due to the significant depth of these strata and presence of a groundwater table in the overlying sediments there are currently no groundwater supply bores targeting the Betts Creek Beds or the target coal seams in these areas. Groundwater monitoring bores targeting these overlying formations are proposed at several locations in the north of the project site and offsite to the north. These bores will provide sufficient information on the groundwater regime in these areas and the potential impacts of the project.

Overall the groundwater monitoring program described in the draft EIS is considered adequate to monitor the impacts of the project and additional monitoring bores are not considered to be necessary.

50e) Refer to the response to IESC Response 16b in relation to the groundwater dependency of the Northern Seasonal Wetland.

50f) Recharge is not directly measurable and must be inferred from available data. Common methods of inference include modelling, water fluctuation method, and chloride mass balance.

The draft EIS groundwater assessment calculated recharge using the modelling approach as described in Section B1.2 of the draft EIS Groundwater Report (Appendix I). The diffuse (background) recharge rates have been calculated by applying the calibrated recharge percentage by the adjusted annual rainfall. The calculated diffuse recharge rate has been refined by the inclusion of enhanced recharge zones based on surface geology and topography.

This approach was used as it provides a robust calibration result that reflected the available monitoring data. The modelling approach is commonly used in groundwater studies for coal mining projects and has been used to calculate the rate of recharge in groundwater studies undertaken for previous Galilee Basin mining projects.

In order to provide a further level of confidence in the recharge rate, rainfall and groundwater monitoring data has been analysed to identify potential recharge events and calculate the rate of recharge.

Groundwater level data collected over the period of 37 months between December 2012 and January 2016 is presented in Attachment D – Additional Information on Groundwater. Rainfall data over this period has been analysed to identify potential recharge events. The rate of recharge over the monitoring period has been estimated using the water table fluctuation method. This method provides an estimate of recharge based upon detailed measurements of site-specific changes in the groundwater levels. In this instance, due to the high frequency of the groundwater monitoring data (i.e. 6 hourly intervals), this method is considered likely to provide a reasonably accurate estimate of recharge.

This data shows that, despite several significant rainfall events with the potential to generate recharge, groundwater levels remain relatively uniform with no significant seasonal recharge response. This data therefore provides supporting evidence for the low recharge rate conceptualised within the draft EIS groundwater assessment.

The monitoring based methodologies have therefore been used to determine and verify recharge rates adopted in the draft EIS groundwater assessment.

51. There is no justification of monitoring bore and screen locations during operations, with only one dedicated offsite monitoring bore proposed. The proposed network does not include monitoring of potential impacts associated with mine subsidence and associated fracturing/cracking, or potential impacts to Lake Buchanan, the Northern Seasonal Wetland and the Doongmabulla Springs Complex.

a. The proponent proposes that the current monitoring network will be maintained throughout the project, and that any monitoring bores removed during the mining process will be replaced where necessary. As well as removal, a number of the existing monitoring bores are dry or at risk of being damaged beyond use due to fracturing associated with subsidence. As most of the monitoring network may need to be replaced, a description should be provided of where replacement bores will be placed.

b. The proposed network does not have capacity to monitor potential water quality issues associated with mine storage waste facilities. Monitoring bores MB20 and MB32 are dry and were finished and screened in the Tertiary sediments above the water table (total bore depth 25 m), limiting their capacity to detect any potential groundwater contamination associated with the tailings dam, or waste storage facilities.

51) Refer to the response to IESC Response 47 which confirms that the groundwater monitoring network presented in the draft EIS Attachment 24-4 comprises 36 groundwater monitoring points located within the project site and 20 additional groundwater monitoring locations within the surrounding area.

As discussed in Section 12.5 of the draft EIS the operations phase groundwater monitoring program that will be implemented to identify any unexpected departures from the draft EIS groundwater modelling predictions. All unexpected departures will be investigated in accordance with the Queensland EA to allow the early identification of any significant departures that could potentially result in impacts to groundwater users or other sensitive environmental features such as Lake Buchanan, the Northern Seasonal Wetland and the Doongmabulla Springs Complex.

On this basis, no additional monitoring at Lake Buchanan, the Northern Seasonal Wetland or the Doongmabulla Springs Complex is required to ensure that the project will not result in significant adverse impacts to the hydrology of these features.

51a) As discussed in Section 12.5 of the draft EIS, data collected from the groundwater monitoring network will be reviewed on a quarterly basis. This review process will also identify any issues that may be affecting the optimal performance of the groundwater monitoring network. The proponent will implement any necessary changes to the groundwater monitoring network to ensure that it remains fit for purpose, in accordance with the Queensland EA requirements for groundwater monitoring.

Any replacement bores will be sited in consultation with the Queensland EHP.

51b) Monitoring bores MB20 and MB32 were primarily constructed to characterise the groundwater regime within low-lying areas of the project site and confirm the absence of shallow groundwater within the Tertiary and superficial sediments in the vicinity of the proposed mine waste storage facilities.

The proposed groundwater monitoring network includes bores surrounding the proposed mine waste storage facilities (Figure E1 of Attachment E – Additional Information on Groundwater). These bores are screened within the shallow unconfined groundwater regime that would receive any seepage from the proposed mine waste storage facilities. These bores are therefore suitable for monitoring the potential effects of seepage from the mine waste storage facilities.

In addition, as discussed in Section 8.7 of the draft EIS Groundwater Report (Appendix I), extensive geochemical testing shows that any leachate generated by the mine waste storage facilities is likely to be of better quality than the underlying groundwater regime. In the event of any seepage from the mine waste storage facilities reaching the underlying groundwater regime, degradation of the underlying groundwater quality is unlikely to occur.

52. The proponent indicates that impacts will be managed by investigating bores where the drawdown exceeds 90% of the maximum predicted drawdown and those which return water quality concentrations in excess of the 85th percentile of background data (triggers yet to be determined from data collected prior to mining).

a. Justification should be provided for the selection of the 85th percentile, given the standard use of the 80th percentile by ANZECC & ARMCANZ (2000).

b. While the proponent notes that they will propose groundwater triggers and limits in water management plans post approval, there are no indications of any potential limits or what would be done if a limit were to be exceeded.

52a) The adoption of a 85^{th} percentile was proposed to ensure consistency with the approved limits described in the EA for the adjacent Carmichael Coal Mine.

52b) The proposed groundwater triggers and limits will be developed in consultation with the EHP based upon baseline monitoring data. Triggers and limits will be designed to ensure a suitable level of protection for environmental values.

As discussed in Section 12.5 of the draft EIS, the operations phase groundwater monitoring program that will be implemented to identify any unexpected departures from the draft EIS groundwater modelling predictions and baseline conditions (as indicated by exceedances of established groundwater triggers and limits). All unexpected departures will be investigated in accordance with the Queensland EA to allow the early identification of any significant departures that could potentially result in impacts to groundwater users or other sensitive environmental features.

53. A monitoring programme should be developed that:

a. Provides justification of monitoring bores and screen locations and a methodology for quantifying impacts.

b. Determines hydrogeological impacts associated with subsidence, including a methodology for assessing impacts to groundwater systems and interactions with surface water.

c. Provides for the assessment of hydrology/hydrogeology of the Northern Seasonal Wetland and its potential contribution to Pigeonhole Creek and North Creek catchments.

d. Includes additional monitoring locations with multi-level wells screened/monitored in all potentially impacted strata to the north and west of the project area to determine potential impacts to Lake Buchanan, and to the west and south of the project area, to determine the proposed project's potential impacts on the Doongmabulla Springs Complex.

e. Provides understanding of the groundwater-surface water interactions at Lake Buchanan and developing an early warning methodology to ensure mine induced depressurisation does not impact on lake hydrology or the hydrology of Caukingburra Swamp.

f. Quantifies and verifies mine induced impacts to GAB recharge.

53a) As discussed in draft EIS Attachment 24-4, the proponent has proposed a groundwater monitoring network that comprises 36 groundwater monitoring points located within the project site and 20 additional groundwater monitoring locations within the surrounding area. The rationale for the distribution and target strata of monitoring points located within the project site is discussed in the draft EIS Groundwater Report (Appendix I). The offsite monitoring network includes all offsite bores that are predicted to be impacted by project drawdown.

Section 12.5 of the draft EIS describes the operations phase groundwater monitoring program that will be implemented to identify any unexpected departures from the draft EIS groundwater modelling predictions. All unexpected departures will be investigated in accordance with the Queensland EA to allow the early identification of any significant departures that could potentially result in impacts to groundwater users or other sensitive environmental features

The groundwater monitoring program described in Section 12 of the draft EIS is therefore considered adequate to monitor the impacts of the project

53b) The hydrogeological impacts associated with subsidence are fully considered within the draft EIS groundwater model. The proposed groundwater monitoring network is suitable for identification of any departure from these modelling predictions. A methodology for investigating and assessing any departure from these modelling predictions and the impacts assessed in the draft EIS (including impacts to groundwater systems and interactions with surface water) is discussed in Section 12.5 of the draft EIS.

53c) The hydrology/hydrogeology of the Northern Seasonal Wetland is fully assessed in the draft EIS. Additional information is provided in the response to IESC Response 16.

The groundwater monitoring network includes several bores in the vicinity of the Northern Seasonal Wetland which demonstrate that the groundwater table is located at significant depth.

53d) The groundwater monitoring network includes 56 monitoring locations in all potentially impacted strata. This includes several bores containing multi-level VWP sensor arrays within the project site.

The monitoring network includes several monitoring locations north and west of the project site (including two monitoring locations in the Clematis Sandstone in this area). These locations are suitable for monitoring changes to the groundwater regime between the project site and Lake Buchanan. The monitoring network also includes several monitoring locations south of the project site that are suitable for monitoring changes to the groundwater regime between the project site and the Doongmabulla Springs Complex.

As discussed in Section 12 of the draft EIS, the project is not predicted to result in significant adverse impacts on either Lake Buchanan or the Doongmabulla Springs Complex.

53e) The conceptual understanding of the groundwater-surface water interactions at Lake Buchanan are discussed in the response to IESC Response 25.

As discussed in the response to IESC Response 53d, the proposed groundwater monitoring network includes several monitoring locations north and west of the project site (including two monitoring locations in the Clematis Sandstone in this area). These locations are suitable for monitoring changes to the groundwater regime between the project site and Lake Buchanan/Caukingburra Swamp, so as to provide an early indication of any departure from the modelling predictions that would suggest potential for impacts to Lake Buchanan or Caukingburra Swamp.

The installation of additional bores within Lake Buchanan or Caukingburra Swamp to investigate the groundwater-surface water interactions is therefore not necessary or justified.

53f) The GAB recharge zone extends for several thousand kilometres and covers a significant area. The project will occupy a minor proportion of the GAB recharge zone and is predicted to result in localised depressurisation of the GAB sediments. On this basis, there is no evidence to support the conclusion that the project is likely to result in significant impacts on the GAB recharge zone.

54. Commitments for surface water and groundwater monitoring should be presented as part of a water monitoring plan and should be consistent with the National Water Quality Management Strategy.

Specific requirements for the groundwater and surface water monitoring programs will be specified in the Environmental Authority. Proposed Environmental Authority conditions related to groundwater and surface water monitoring are presented in Section 24 of the draft EIS and Attachment E – Additional Information on Surface Water.

67.9 QUESTION 9

Have impacts to the GAB and the Belyando River catchments, including the impacts of long-term water take, been adequately identified and quantified?

IESC Response

55. Impacts to the GAB and the Belyando River catchments have been identified but they have not been quantified consistently. For example:

a. Estimates for the peak take during mining operations and long-term take from the GAB are reliant on the current numerical groundwater modelling predictions, which are uncertain (refer to response to Question 5).

b. Uncertainty exists regarding the potential impacts to the Belyando River catchment as combined water quantity impacts (including loss of catchment area, subsidence, and external water supply) have not been quantified. Sources of water supply and potential cumulative impacts to the Belyando River catchment (given it may supply water to the CCM project), should be identified and assessed.

c. Impacts to surface water quality and downstream ecosystems as a result of mine-water discharges have not been adequately assessed and may be greater than predicted.

55a) Refer to the responses to IESC Response to Question 5.

55b) Refer to the response to IESC Response 74c, 78 and 79.

55c) Refer to the response to IESC Response 10.

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IESC Explanation

56. It is proposed that the surplus water from mine pits will be discharged through the Mine Water Dam to the Belyando River via a tributary drainage pathway in the North Creek catchment. The tributary drainage pathway from the Mine Water Dam to the Belyando River is approximately 64 km in length and comprises ephemeral drainage lines and creek lines within the North Creek catchment, upstream of the Belyando River. However:

a. A map of this discharge point and the tributary drainage pathway in the North Creek catchment was not provided, nor was detailed information about the water quality and flow conditions of the receiving waters, proposed discharge rate, duration and timing.

b. There is a lack of information to assess potential risks to the water resources and ecological communities from discharge within the tributary drainage and in the Belyando River Catchment.

c. Background surface water quality for aluminium, copper, and zinc exceeded ANZECC & ARMCANZ (2000) guideline values at several sites. Mine-affected water discharges could exceed aquatic ecological values for turbidity, salinity, nutrients, contaminants (e.g. metals).

56a) A figure showing the proposed release point and the drainage pathway is provided in Attachment E – Additional Information on Surface Water.

56b) Refer to the response to IESC Response 10 which clarifies that Attachment E – Additional Information on Surface Water provides revised draft discharge conditions that are designed to avoid adverse impacts on the receiving waters of North Creek downstream of the release point.

56c) Refer to the response to IESC Response 56b.

57. The loss of catchment area across the project area has been reported by the proponent although inconsistently. For example, the EIS states that total catchment loss during mining is predicted to peak at 4,226 ha at year 30 (EIS, P13-27), which is less than the sum of the combined maximum catchment impacts reported in the technical report (4,462 ha; Appendix K, P12).

Section 5.3 – Editorial Corrections provides clarification on the maximum contained catchment area.

58. There is no assessment of the impact that this loss of contributing catchment may have on surface flows. The loss of surface flows due to subsidence effects, such as surface cracking and ponding, has not been estimated. Whilst the proponent claims in the EIS “no loss in catchment yield” with the application of subsidence remediation (EIS, P13-29), a quantification of the potential impact on catchment should be provided to account for the risk that remediation is not effective.

Refer to the response to IESC Responses 78 and 79 on the potential effect of the project on catchment yield and surface water flows.

As discussed in Section 13 of the draft EIS, surface cracking is not predicted to result in any significant loss of surface water flows.

The installation of remedial drainage measures in subsided areas will also reinstate free drainage. This approach is well established in Queensland and is a proven technique for the effective management of ponding in subsidence depressions.

Ongoing monitoring of the remediated areas will be undertaken in accordance with the Subsidence Management Plan to ensure that the remedial drainage is effective.

67.10 QUESTION 10

What is the acceptable GAB take long term post mining? (Page 18 Appendix B summarises this)

IESC Response

59. The acceptability of water take is a matter for the regulator.

Noted.

67.11 QUESTION 11

Does the IESC agree with the proponent's assessment that Lake Buchanan is a discharge zone for the Moolayember Formation and the underlying Clematis Sandstone, and that the project will not impact groundwater levels in the Lake Buchanan area?

IESC Response

60. Evidence (Lorimer, 2005; DIWA, undated-b) suggests that Lake Buchanan is a groundwater discharge zone. Limited information was provided by the proponent to confirm the presence, or source, of this groundwater discharge and as such, potential impacts remain uncertain. Additional data, including monitoring to the west of the project area, would increase the understanding of this system and assist in identifying any potential impacts.

Refer to the response to IESC Response 25 which confirms the hydrogeology of Lake Buchanan.

Refer to the response to IESC Response 47 which confirms that the proposed monitoring network includes monitoring locations west of the project site and in the vicinity of Lake Buchanan.

61. Although the numerical groundwater model 1 m drawdown contours suggest that Lake Buchanan will not be impacted by a drawdown of this magnitude, higher resolution model predictions including drawdown contours at the 0.2 m scale would provide greater insight into any potential impacts to Lake Buchanan. However a transient calibrated model is required to quantify the level of impact as small changes may change the nature of the groundwater discharge into the lake.

Refer to the response to IESC Response 85b which clarifies the limits of accuracy associated with groundwater modelling predictions.

Refer to the response to IESC Response 37 which discusses transient calibration.

62. The proponent models some leakage from the Clematis Sandstone to underlying units. If the Clematis Sandstone is dry in parts of the project area, and the numerical groundwater model does not represent it as such, then the overall water balance is likely to be incorrect.

Section 12.3.3 of the draft EIS confirms that the Clematis Sandstone is generally dry within the project site.

In the north of the project site, a normal fault is present in this unit and the underlying strata. To the east of the fault, a thin wedge of Clematis Sandstone has been downthrown by approximately 100 m and is now truncated against the Rewan Formation on the west of the fault. In this area, the deeper Clematis Sandstone lies below the water table. The saturated thickness of this unit reaches 50 m close to the fault and gradually reduces to the east as the base of the unit rises above the water table.

These characteristics are fully captured in the groundwater model. The model water balance is discussed in Appendix B of the draft EIS Groundwater Report (Appendix I).

67.12 QUESTION 12

Is the proponent's subsidence impact assessment and modelling adequate to assess and quantify the potential impacts to water resources? Are the proposed measures to mitigate and manage the potential impacts of subsidence adequate? If not, are there additional measures available to mitigate and manage impacts to water related assets?

<u>IESC Response</u>

63. There is uncertainty regarding the subsidence impact assessment and low confidence in the modelling to quantify potential impacts as:

a. the parameters applied from the Bowen Basin may differ in the Galilee Basin and need to be verified as part of a monitoring programme;
b. fracture height selection was not justified;
c. the full range of potential vertical and horizontal hydraulic conductivities have not been explored;
d. potential connectivity of the subsurface fracture network has not been considered;
e. there is uncertainty in dual seam subsidence effects as the implications for the extraction sequencing in the proposed project are unclear; and
f. the role of the fault was not considered within the subsidence assessment (noting it was included within the groundwater assessment).

63a) Refer to the response to IESC Response 64 which confirms that the subsidence predictions are based on a large dataset of observed subsidence monitoring data from both Queensland and New South Wales, and are consistent with previous studies undertaken in the Galilee Basin.

Section 6 of the draft EIS describes the subsidence monitoring program that will be undertaken throughout longwall mining operations. Monitoring will be used to identify any departures from the subsidence predictions and any such departures will be investigated to determine the likelihood of significant adverse impacts. The merit of undertaking additional subsidence modelling would be considered as part of the investigation outcomes.

63b) Refer to the response to IESC Response 64.

63c) Refer to the response to IESC Response 42 which explains that an extensive dataset of hydraulic conductivity values was collected at the project site and Carmichael Coal Mine site. The collected dataset is described in Section 6.2 of the draft EIS Groundwater Report (Appendix I) and includes 154 rising/falling head and packer tests conducted at the project site and the Carmichael Coal Mine site. This provides a suitable body of data from which to determine appropriate hydraulic parameters.

A review of groundwater studies for other mining projects in the Galilee Basin and other coal mining regions was undertaken as part of the scoping phase of the draft EIS groundwater study and this confirmed that the parameters applied in the draft EIS groundwater model encompass an appropriate range of potential vertical and horizontal hydraulic conductivities.

In addition, sensitivity analysis presented in Appendix B of the draft EIS Groundwater Report (Appendix I) investigated the effect of changing the horizontal and vertical hydraulic conductivities by +/- 1 order of magnitude across all model layers. As discussed in Section B3 of the draft EIS Groundwater Report (Appendix I), as expected, each of these scenarios increased the overall model error and reduced the ability of the model to match measured groundwater levels showing that they are less appropriate than the range of values adopted in the model. Nonetheless, as discussed in Section B3 of the draft EIS Groundwater Report (Appendix I), the combined effect of each of these two extreme scenarios was marginal in terms of the model predictions.

63d) The connectivity and permeability of the subsurface cracking has been addressed in the draft EIS groundwater model. Refer to the response to IESC Response 42.

63e) Refer to the response to IESC Response 68 which confirms that in the dual seam mining areas in the Northern Underground, a more conservative height of 180 m for continuous cracking above the A Seam longwall has been adopted. This 50% increase from the initial predicted continuous cracking height should more than adequately account for the uncertainty associated with the continuous cracking height predictions and therefore provide a conservative basis for the purposes of assessing potential worst case groundwater impacts.

63f) The proposed mining areas do not intersect the fault and therefore the fault is unlikely to have a material effect on vertical subsidence or the height of subsurface subsidence cracking. On this basis the fault is unlikely to affect the potential subsidence effect on water resources.

The effects of the fault on groundwater movement have been fully considered in the draft EIS Groundwater Report (Appendix I).

64. Limited data is available in the Galilee Basin to reduce uncertainty in subsidence predictions. Confidence would be increased by consideration of the variation of impacts and the actual process over time (cracks may develop, then fill with sediment; fracture networks may be flooded, then drain).

The draft EIS Subsidence Report (Appendix A) predicts that connective cracking may occur up to 120 m above areas where single seam extraction is undertaken and 180 m above the upper A seam in areas of the Northern Underground where dual seam mining is proposed.

The subsidence predictions are based on a large dataset of observed subsidence monitoring data from both Queensland and New South Wales, and are consistent with previous studies undertaken in the Galilee Basin. In any areas of uncertainty, conservative assumptions have been applied. The draft EIS Subsidence Report (Appendix A) discusses the limitations of the model and notes that these limitations are considered unlikely to present a material difference to the potential subsidence effects or impacts predicted.

The subsidence predictions therefore provide a suitable basis for the assessment of the project impacts on water resources.

65. The Crack Subsidence Remediation Strategy may prove ineffective in some areas because it assumes that cracks can be remediated but this may not be the case for rocky drainage lines that are present in the area.

Whilst there is surface rock in some areas on Darkies Range the sandstone is highly weathered near the surface and can be excavated with civil earthmoving equipment. The proponent has installed access for exploration drilling in the Darkies Range area and can confirm that these areas can be excavated with an excavator and/or a small bulldozer.

Nonetheless, a monitoring program will be established for areas that have been disturbed as part of the subsidence crack rehabilitation program. The program will initiate crack rehabilitation maintenance work, where necessary, and ensure that the cracks have been successfully rehabilitated and any disturbed vegetation is regenerating.

66. Adaptive management measures such as Trigger Action Response Plans (TARPs) should be considered for management approaches to mitigating impacts to drainage lines and the Northern Seasonal Wetland. Further mitigation options may need to be considered, such as narrower longwalls, or mining methods with lower subsidence impacts. Importantly, the proponent should commit to a programme of periodically revised subsidence prediction following mining commencement.

As discussed in Sections 12 and 13 of the draft EIS, the project is not predicted to result in significant impacts on drainage lines. It is proposed to offset any significant residual Impacts to the Northern Seasonal Wetland based upon detailed mine planning. No TARPs or other management measures beyond those discussed in the draft EIS are therefore warranted.

Section 6 of the draft EIS describes the subsidence monitoring program that will be undertaken throughout longwall mining operations. Monitoring will be used to identify any departures from the subsidence predictions and any such departures will be investigated to determine the likelihood of significant adverse impacts. The merit of undertaking additional subsidence modelling would be considered as part of the investigation outcomes.

IESC Explanation

67. The Surface Deformation Prediction System (SDPS) was used for subsidence modelling, which relies on project data to calibrate the function. As no data is currently available for the proposed project, the accuracy of the outputs will be reduced (Commonwealth of Australia, 2015). This is an intrinsic problem given the lack of longwall mining to date in the Galilee Basin.

The subsidence predictions are based on a large dataset of observed subsidence monitoring data from both Queensland and New South Wales, and are consistent with previous studies undertaken in the Galilee Basin. In any areas of uncertainty, conservative assumptions have been applied. The draft EIS Subsidence Report (Appendix A) discusses the limitations of the model and notes that these limitations are considered unlikely to present a material difference to the potential subsidence effects or impacts predicted.

The subsidence predictions therefore provide a suitable basis for the assessment of the project impacts on water resources.

68. There is no evidence to suggest that the potential for increased subsidence impacts from settling of multiple goaf strata after longwall extraction has been taken into account. No justification of the length of connective cracking above the dual seam longwall mining area was provided, with only a 50% increase in height of continuous cracking above the A seam applied in dual mining areas. Further, the connective cracking value of 120 m for a single seam is not supported by evidence or methodology. Fracture height estimation should be based on available work (e.g. Ditton and Merrick (2014)).

The draft EIS Subsidence Report (Appendix A) provides a detailed assessment of the potential height of subsurface cracking associated with longwall mining. The subsidence assessment was undertaken by a subsidence expert with more than 20 years of longwall mining and subsidence expertise.

The draft EIS Subsidence Report (Appendix A) draws upon extensive longwall experience from the Australian and overseas coal mining industry including over 25 years of microseismic monitoring and groundwater inflow measurements collected from the Bowen Basin. This data has been verified against empirical models and numerical modelling undertaken at operating longwall mines in the Bowen Basin.

Based on experience in Australia and overseas, continuous subsurface subsidence cracking and resultant unrestricted inflow generally occurs to a height of about 120 m above the active longwall in single seam extraction areas, with inflow rates progressively reducing as the depth of cover increases above 120 m. As such, continuous cracking up to 120 m above the longwall panels extracted in virgin ground can be expected.

Recent physical modelling work by Ghabraie and Ren (2014) was reviewed to provide an understanding of the subsurface strata movement in a dual seam longwall. Published dual seam longwall experience from the Australian and overseas coal mining industry has also been referenced.

In the dual seam mining areas in the Northern Underground, a conservative continuous cracking height of 180 m above the A Seam longwall was adopted. This continuous cracking height more than adequately accounts for the uncertainty associated with the continuous cracking height predictions and therefore provides a conservative basis for the purposes of assessing potential worst case groundwater impacts.

The subsidence height assessment also considered all relevant subsidence cracking assessments presented in previous Galilee Basin EISs. The adopted cracking heights for the project are conservative when compared to these studies.

69. There is uncertainty regarding the hydrogeological conceptualisation of the Northern Seasonal Wetland and a lack of consideration of the potential impacts to this wetland and surrounding drainage lines. The proponent reports that this wetland will not be affected because water and sediment are expected to fill and seal the cracks. However:

a. No supporting evidence is provided to support this assumption.

b. The proponent describes that the project area drainage features include a network of gullies in the steeper topography associated with Darkies Range. These gullies are characterised by steep rocky sides confining narrow rocky channels.

c. There is no assessment of the base of the wetland or if the wetland is sustained by a perched water table, and the effects subsidence may have on the ability of the wetland to retain water.

d. If cracking and fractures do not reach the surface there is still the possibility that fracture networks exist relatively close to the surface which will lead to increased draining from the wetland and less water flowing down the streams into the tributaries.

e. The potential impacts to the ecology reliant on the wetland if the wetland is drained for one or more seasons, or if the wetland drains more rapidly, were not considered.

69a) The draft EIS does not suggest that filling and sealing cracks will prevent any impacts to the Northern Seasonal Wetland. The draft EIS shows that subsidence cracking is unlikely to extend to the Northern Seasonal Wetland due to the significant depth of mining in this area.

69b) The Northern Seasonal Wetland is located on the Darkies Range plateau. Drainage in this area is via overland sheet flow with no defined drainage features. Any surface tension cracking would be localised in extent and of limited depth and further reduced by the saturation of the highly laterised Tertiary clays and claybound Triassic sediments that comprise the geology in this area (as shown in Figure 6 of the draft EIS Groundwater Report, Appendix I).

The steeper topography that forms the slopes of Darkies Range is located beyond the catchment of the Northern Seasonal Wetland. Drainage in these areas are characterised by rocky drainage features.

69c) Refer to the response to IESC Response 16b which describes the characteristics of the wetland and explains why the wetland is not considered to be associated with perched groundwater.

69d) As discussed in Section 10 of the draft EIS, the wetland is a contained catchment on the plateau area of Darkies Range. The wetland catchment does not provide significant contributing flows to the highly ephemeral drainage network in the vicinity of Darkies Range.

The changes to the pond storage and catchment area of the wetland due to subsidence will result in changes to the ponding characteristics of the seasonal wetland. For a particular rainfall event, the water level of the seasonal wetland will be reduced following subsidence, compared to the wetland pre-subsidence. This will also mean that the wetland will dry out more rapidly and more frequently.

However, the hydrology of the wetland does not materially influence the local drainage features and any reduction in catchment of the wetland is therefore unlikely to result in significant reduction in nearby drainage features or associated environmental values.

The influence of potential cracking is addressed in the responses to IESC Responses 69a and 69b.

69e) The potential impacts to the ecology reliant on the wetland are assessed in Section 10 of the draft EIS. As discussed in the response to IESC Response 69, the hydrogeology and hydrology of the wetland is unlikely to be adversely affected by the project. However, monitoring and management measures are proposed and it is proposed to offset any significant, residual impacts on the wetland. The need for offsets will be determined prior to any subsidence of the wetland and based on detailed mine planning and subsidence predictions for the area. Detailed design supported by further exploration work is still to be undertaken and could significantly alter the predicted nature and extent of impacts on the wetland.

70. Further assessment of the Northern Seasonal Wetland, particularly with regard to the base of the wetland and quantitative surface flow modelling of the drainage surrounding the wetland should be undertaken.

Refer to the response to IESC Response 16b which describes the characteristics of the wetland.

Section 10.6.3 of the draft EIS provides a quantitative assessment of the change in the Northern Seasonal Wetland catchment area due to subsidence. The wetland pond catchment will also be potentially affected by subsidence and it is anticipated that the catchment will change in size from 2,711 ha pre-mining to 2,399 ha post-mining, resulting in a 12% reduction in the size of the catchment. The ponding area before mining is approximately 127 ha and it will increase to approximately 199 ha as a result of subsidence.

These changes to the pond storage and catchment area of the wetland will result in changes to the ponding characteristics of the seasonal wetland. For a particular rainfall event, the water level of the seasonal wetland will be reduced following subsidence, compared to the wetland pre-subsidence. This will also mean that the wetland will dry out more rapidly and more frequently.

It is proposed to offset any significant, residual impacts on the wetland. The need for offsets will be determined prior to any subsidence of the wetland and based on detailed mine planning and subsidence predictions for the area. Detailed design supported by further exploration work is still to be undertaken and could significantly alter the predicted nature and extent of impacts on the wetland. The value of any runoff modelling will be considered as part of the detailed design stage. This work will be described in the Subsidence Management Plan.

Runoff modelling based upon the conceptual mine plan presented in the draft EIS would not result in any change to the proposed management of these impacts and no further action is currently proposed.

71. Mitigation is proposed using the subsidence crack rehabilitation programme, whereby monitoring and remedial action will be undertaken if subsidence effects are observed. However, remediation strategies such as sealing fracture networks of exposed rock in creeks and tributaries have been found to be costly, risky and likely to have a limited lifespan (Commonwealth of Australia, 2014).

The response to IESC Response 65 describes the crack rehabilitation strategy for the project site, including the rocky drainage features and demonstrates that this will be suitable to manage any potential erosion associated with cracking in these drainage features.

72. Adaptive management measures such as Trigger Action Response Plans (TARPs) may be a suitable management approach to mitigating impacts to drainage lines and the Northern Seasonal Wetland. This could include having early warning trigger values, and clear, enforceable response measures capable of mitigating impacts.

As discussed in Sections 12 and 13 of the draft EIS, the project is not predicted to result in significant impacts on drainage lines. It is proposed to offset any significant residual Impacts to the Northern Seasonal Wetland based upon detailed mine planning. No TARPs or other management measures beyond those discussed in the draft EIS are therefore warranted.

73. Once subsidence data is available, subsidence predictions should be reviewed and further modelling should be undertaken, including calibration, verification and validation.

Section 6 of the draft EIS describes the subsidence monitoring program that will be undertaken throughout longwall mining operations. Monitoring will be used to identify any departures from the subsidence predictions and any such departures will be investigated to determine the likelihood of significant adverse impacts. The merit of undertaking additional subsidence modelling would be considered as part of the investigation outcomes.

67.13 QUESTION 13

Does the proponent's water resources assessment give adequate consideration to cumulative impacts between this project and the Carmichael Coal Mine and Rail Project (EPBC 2010/5736)?

a. If both projects operate concurrently have the cumulative groundwater impacts during both the operations phase and post mining phase been appropriately addressed in the EIS documents?

b. If not, what changes should be made to ensure the assessment represents a conservative and risk adverse approach?

c. Does the IESC have any concerns with the project's contribution to cumulative impacts upon the Great Artesian Basin and Belyando River catchment?

<u>IESC Response</u>

74. There has been no formal assessment of the likely magnitude and significance of cumulative impacts either during the operations phase or post mining. The proponent considers cumulative impacts to groundwater, however the full extent of potential direct, indirect, upstream, downstream, and consequential impacts, including to the Doongmabulla Springs Complex, surface water and downstream ecosystems have not been considered.

a. No. The cumulative groundwater impact assessment between the CCM project and China Stone projects was undertaken by superimposing maximum predicted groundwater drawdowns on a map during operations and post mining for each project. No appropriate calculations were undertaken. This is approach is inadequate to estimate the extent of cumulative groundwater drawdown impacts.

b. Appropriate monitoring and adaptive management should be put in place for potential cumulative impacts to Lake Buchanan and Doongmabulla Springs Complex, in conjunction with specific assessment of the risks to these specific assets.

c. There are concerns about potential cumulative impacts to the Belyando River catchment, due to water supply needs, water discharges and loss of contributing catchment. Cumulative impacts to the GAB are more likely to be significant at the local scale rather than the regional scale.

74. The potential for the project to contribute to cumulative impacts on water resources is fully assessed in Sections 12 and 13 of the draft EIS.

Additional clarification on the quantification of cumulative groundwater impacts is presented in the response to IESC Response 74a.

Refer to the response to IESC Response 77 which specifically addresses the potential for cumulative impacts on the Doongmabulla Springs Complex.

74a) Section 12.4 of the draft EIS explains the method of superimposition that has been used to determine the potential cumulative effects of groundwater depressurisation associated with the project and the adjacent Carmichael Coal Mine. This method is widely used to determine the cumulative effects of multiple coal mining activities. Within the Galilee Basin, the Galilee Coal Project SEIS states that the Coordinator General and DNRM endorsed this approach to cumulative impact assessment (although a lack of published drawdown contours from adjacent mines ultimately prevented its use). This method is therefore considered theoretically sound and suitable for the purposes of undertaking a cumulative impact assessment.

The depressurisation effects of the Carmichael Coal Mine were approved as part of the draft EIS assessment process for that project. There is insufficient publicly available information to accurately recreate the approved depressurisation effects of the Carmichael Coal Mine in the Project China Stone groundwater model. The proponent has therefore used approved maximum depressurisation contours presented in the Carmichael Coal Mine Project EIS as the basis for the cumulative groundwater impact assessment.

The draft EIS Groundwater Report (Appendix I) provides contour plans showing the maximum predicted depressurisation associated with the project and the adjacent Carmichael Coal Mine. The use of maximum predicted depressurisation for the project and the Carmichael Coal Mine represents a worst-case scenario. This ensures that the cumulative impact assessment is conservative.

Section 12.4 of the draft EIS explains that the magnitude of cumulative depressurisation at a given location corresponds to the sum of these contours. No additional calculations are therefore required to determine the magnitude of cumulative depressurisation.

74b) A cumulative impact assessment is presented in Section 12.4 of the draft EIS that specifically addresses potential impacts on Lake Buchanan located 17 km west of the project site and the Doongmabulla Springs Complex located 22 km south of the project site. The project is not predicted to contribute to cumulative impacts on either Lake Buchanan or the Doongmabulla Springs Complex.

Refer to the response to IESC Response 47 which confirms that the groundwater monitoring network presented in the draft EIS Attachment 24-4 comprises 36 groundwater monitoring points located within the project site and 20 additional groundwater monitoring locations within the surrounding area, including in the vicinity of drainage features located east of the project site.

As discussed in Section 12.5 of the draft EIS the operations phase groundwater monitoring program that will be implemented to identify any unexpected departures from the draft EIS groundwater modelling predictions. All unexpected departures will be investigated in accordance with the Queensland EA to allow the early identification of any significant departures that could potentially result in impacts to groundwater users or other sensitive environmental features such as Lake Buchanan, Caukingburra Swamp and the Doongmabulla Springs Complex.

The proponent will implement any necessary changes to the groundwater monitoring network to ensure that it remains fit for purpose, in accordance with the Queensland EA requirements for groundwater monitoring. The commitments provided in the draft EIS therefore address the intent of this submission.

On this basis, no additional monitoring at Lake Buchanan, Caukingburra Swamp or the Doongmabulla Springs Complex is required to ensure that the project will not result in significant adverse impacts to the hydrology of these features.

74c) The proponent is currently considering external water supply options including sourcing water from either a managed water supply scheme (operated by a water manager such as SunWater) or through the purchasing of existing water allocations through water trading. The water supply schemes will be operated by others and would be subject to separate environmental impact assessment and approvals.

Refer to the response to IESC Responses 78 and 79 which explains that the project is unlikely to result in significant adverse impacts on downstream surface waters due to discharges from the mine water management system, and that project is likely to have a negligible effect on the contributing catchment of the Belyando River.

The potential impacts on the GAB are discussed in Section 12 of the draft EIS.

IESC Explanation

75. Cumulative impacts were considered from the CCM project and Moray Power Project, but did not consider other 'reasonably foreseeable' coal projects such as the Hyde Park Coal Project.

According to the project's TOR, cumulative impacts are required to be considered for "*existing or proposed project(s) publicly known or advised by the office of the Coordinator-General to be in the region*". As the Hyde Park Coal Project has not yet commenced an EIS or submitted a Mining Lease application it is purely speculative to suggest at this stage that this project will proceed and therefore unreasonable to include such a project in the cumulative impact assessment. In addition, there is no information about the project that is currently publicly available that could be used to assess possible cumulative impacts with Project China Stone. The draft EIS cumulative impact assessment is therefore considered to have appropriately considered all reasonably foreseeable projects.

In addition, it is well established practice that if the Hyde Park Coal Project were to proceed in the future, the TOR for the Hyde Park Coal Project would include a requirement to assess the cumulative impacts of the project with other "*existing or proposed projects"* which would include Project China Stone.

76. The proponent presents maps of maximum cumulative groundwater depressurisation contours for the water table in the Tertiary, and A/B and D coal seams. The proponent has considered project stages to some extent—cumulative groundwater drawdowns have been considered for the coal seams at the end of and following mining. On the basis of the proponent's

assessment, the only area of concern for groundwater impacts is that between the CCM project and the China Stone project. However:

a. There is only one bore to the north of the project area, which did not record a groundwater, level limiting identification and quantification of potential cumulative impacts in this area.

b. The drawdown at the end of mining in the D seams appears to be much lower for the proposed project than for the CCM project.

c. The CCM project modelled depressurisation of up to 1 m in the Clematis Sandstone. The proponent states that there will be no cumulative impact on the Clematis Sandstone, but the IESC has low confidence in this statement given uncertainties in the proponent's modelling.

76a) The draft EIS groundwater model is based upon data collected from an extensive network of bores. These bores are listed in Appendix A1 of the draft EIS Groundwater Report (Appendix I), and shown on Figures 10, 11 and 12 of the draft EIS Groundwater Report (Appendix I). This network includes numerous bores located in the northern part of the project site and north of the project site. These bores were included in the model calibration that informed the groundwater depressurisation predictions for the project. The predicted groundwater depressurisation effects within and north of the project site are therefore based upon a significant body of data (i.e. not a single bore) and therefore provide a suitable basis for informing the groundwater impact assessment.

As shown on Figures 44 to 49 of the draft EIS Groundwater Report (Appendix I), publicly available information shows that the Carmichael Coal Mine Project is not anticipated to result in depressurisation in the northern part of the project site or further north. On this basis, there is no potential for cumulative depressurisation or associated cumulative impacts on groundwater users or any other features in this area.

Refer to the response to IESC Response 75 in relation to the Hyde Park Project.

76b) Noted. The proponent is unable to comment on the accuracy or reliability of groundwater depressurisation predictions presented in the Carmichael Coal Mine Project EIS.

The groundwater modelling predictions presented in the draft EIS Groundwater Report (Appendix I) are based upon a robust dataset that includes all relevant groundwater and geological data presented in the Carmichael Coal Mine Project EIS. Full justification for the groundwater modelling predictions is presented in Appendix B of the draft EIS Groundwater Report (Appendix I).

76c) As discussed in the response to IESC Response 76b, the groundwater modelling predictions presented in the draft EIS Groundwater Report (Appendix I) are based upon a robust dataset and are suitable for the purposes of impact assessment.

77. There is the potential for cumulative impacts as a result of groundwater depressurisation on Darkies Range and subsequent impacts to Doongmabulla Springs Complex and associated downstream ecosystems (e.g. Waxy Cabbage Palm). The proponent rules out cumulative

impacts to the springs as the project's predicted post-mining 1 m drawdown contour only extends half the 22 km to these springs. However, impacts remain uncertain as a thorough assessment of cumulative impacts on the springs has not been undertaken and the source of the springs is not certain (see Webb et al., 2015).

The predicted depressurisation of groundwater regime in the vicinity of Darkies Range is described in Section 12.4 of the draft EIS and shown from Figure 27 to 41 of the draft EIS Groundwater Report (Appendix I). The predicted propagation of depressurisation from Darkies Range to the surrounding groundwater regime is also shown on these figures.

As discussed in Section 12.4 of the draft EIS, the groundwater modelling results clearly show that the project is not predicted to result in significant depressurisation of any geological formations within 11 km of the Doongmabulla Springs Complex.

In order for the springs to experience a significant adverse impact due to the cumulative effects of the Carmichael Coal Mine Project and Project China Stone, it would be necessary for cumulative depressurisation from these activities to occur at the springs.

On this basis, the draft EIS has logically concluded that the lack of significant depressurisation at the Doongmabulla Springs Complex due to the project will therefore preclude any potential for cumulative impacts on the Doongmabulla Springs Complex and any downstream ecosystems. This logic is valid for all geological formations and irrespective of the source of the springs.

The suggestion that the assessment cumulative groundwater impact assessment presented in the draft EIS is not sufficiently detailed is therefore not justified.

Refer to the response to IESC Response 85b which addresses the use of a 1 m contour to define the limit of depressurisation.

78. The proponent rules out cumulative impacts to surface water as the mines and their associated discharges are in different sub-catchments, and discharges are subject to the conditioning of the Queensland Government. However:

a. Cumulative impacts to surface water due to water supply needs for the mines may be significant (up to 12.3 GL/year to be taken from the Belyando/Suttor or Cape River catchments for the proposed project and up to 12.5 GL/year from the Belyando River for the CCM project).

b. Cumulative impacts to the Belyando River from loss of contributing catchment (during mining and final landform, from open-cut pits/voids and subsidence) should also be quantified and assessed.

c. Discharges of mine-affected water during and after heavy rainfall events may be required, which may have adverse impacts on downstream water resources, including ecosystems and other water users. These impacts would be amplified with simultaneous discharges from nearby mines.

78a) As discussed in Section 13.5.5 of the draft EIS, the proponent is currently considering water supply options including sourcing water from either a managed water supply scheme (operated by a water manager such as SunWater) or through the purchasing of existing water allocations through water trading.

The water supply schemes will be operated by others and would be subject to separate environmental impact assessment and approvals.

78b) As discussed in Section 13.6.2 of the draft EIS, the post mining contained catchment corresponds to 0.09% of the Belyando River catchment and 0.03% of the Burdekin Falls Dam catchment. This represents a negligible proportion of the overall receiving catchment areas and hence the project will not have a significant impact on the Belyando River, either alone of cumulatively with other projects.

78c) As discussed in Section 13 of the draft EIS, water balance modelling results indicate that modelling of the proposed mine water management system indicates that there would be no uncontrolled discharges of mine-affected water for the 124 years of climate data assessed. This means that the probability that an uncontrolled discharge will occur is less than once in 124 years (i.e. the average recurrence interval of a discharge event is greater than 124 years).

However, during extended wet periods, significant runoff volumes will accumulate in the open cut pit. To ensure that the open cut mine can continue to operate following these extended wet periods, the ability to discharge mine-affected water under controlled conditions is required. The water management system has therefore been designed to allow for the controlled release of stored pit water from the Mine Water Dam to the Belyando River catchment.

Any controlled discharges from the Mine Water Dam would be conducted in accordance with the EHP's model mining conditions. These conditions are designed to prevent any adverse impacts on downstream environmental values and are required to consider potential cumulative impacts with discharges from other approved mines.

79. The project assessment documentation would benefit from identification of:
a. specific measures for monitoring cumulative impacts;
b. relevant programmes to assess or mitigate cumulative impacts, or the proponent's participation in these; and
c. modifications or alternatives to avoid, minimise or mitigate potential cumulative impacts, including opportunities to work with others.

Refer to the response to IESC Response 47 which describes the proposed groundwater monitoring program in relation to cumulative impacts.

Revised draft EA discharge conditions are presented in Attachment E – Additional Information on Surface Water. These conditions are designed to ensure there are no adverse impacts on the downstream receiving waters including cumulative impacts. These conditions also include monitoring that ensures the cumulative effect of controlled discharges does not result in significant adverse impacts on downstream surface water values or users.

In addition, a REMP will be implemented in accordance with the requirements for the Queensland EA. The REMP is described in Attachment E – Additional Information on Surface Water and includes surface water monitoring locations downstream of the project site and will monitor any potential cumulative effects on the receiving environment.

The project is not predicted to contribute to significant cumulative impacts on groundwater or surface water and therefore no additional cumulative management or mitigation measures are warranted.

80. Appropriate monitoring and adaptive management mechanisms should be developed in consultation with the owners of nearby mines and should be put in place for potential cumulative impacts to the Doongmabulla Springs Complex (similar to the Joint Industry Plan in the Surat Basin), and the Belyando River catchment.

As discussed in Section 12.4 of the draft EIS, the project is not predicted to impact the Doongmabulla Springs Complex.

Section 12.5 of the draft EIS describes the operations phase groundwater monitoring program that will be implemented to identify any unexpected departures from the draft EIS groundwater modelling predictions. All unexpected departures will be investigated in accordance with the Queensland EA to allow the early identification of any significant departures that could potentially result in impacts to groundwater users or other sensitive environmental features such as the Doongmabulla Springs Complex.

No additional monitoring or adaptive management measures are required in relation to the Doongmabulla Springs Complex.

Refer to the response to IESC Responses 78 and 79 in relation to potential cumulative impacts on the Belyando River catchment.

81. The Lake Eyre Basin bioregion, which includes the Galilee Basin subregion, has been identified as a Bioregional Assessment priority region. Data and relevant information from the proposed project should be made accessible to this Bioregional Assessment and related research projects.

The proponent will consider any specific requests for information on a case-by-case basis.

67.14 QUESTION 14

Does the IESC agree with the proponent's assessment that impacts on the Doongmabulla Spring Complex, 22km south of the proposed open cut pit, as a result of the project or as a result of cumulative impacts with the Carmichael Coal Mine and Rail Project are unlikely?

IESC Response

82. Given the proponent's approach to cumulative assessment (refer response to Question 13) and the alternative conceptualisations of the springs (Webb et al., 2015), there is uncertainty with the proponent's assessment that impacts to the Doongmabulla Springs Complex are unlikely.

Refer to the response to IESC Response 77.

83. To enable a rigorous assessment of potential impacts and the development of appropriate mitigation measures, further geochemical data to identify the source aquifer of the Doongmabulla Springs Complex, revision of the numerical groundwater model and further groundwater monitoring is needed. An adaptive management approach with limits and triggers, and a joint industry approach between the proponent and the CCM project should be developed. For example, a limit of 0.2 m of drawdown at the spring would address the uncertainty regarding the spring's source and potential cumulative impacts. This approach is similar to the conditions placed on approvals for coal seam gas projects to protect springs in the Surat Basin.

Refer to the response to IESC Response 77.

IESC Explanation

84. The Doongmabulla Springs Complex, which support an EPBC Act listed endangered ecological community, is located 22 km south of the proposed mining area. There is evidence to support the hypothesis that the Clematis Sandstone, sourced from Darkies Range, is the source aquifer for the Doongmabulla Springs Complex, e.g. Bradley (2015). More data is needed to gain an accurate understanding of the groundwater chemistry and flow directions in the Clematis Sandstone.

Refer to the response to IESC Response 77 which explains that the project is not predicted to result in significant depressurisation of any geological formations within 11 km of the Doongmabulla Springs Complex.

Groundwater levels and flow directions in the Clematis Sandstone are presented in Figure B7 of the draft EIS Groundwater Report (Appendix I). These flow directions are based upon an extensive body of data collected from in excess of 100 bores within the project site, the Carmichael Coal Mine site and the surrounding area, including more than 20 bores targeting the Clematis Sandstone. The groundwater flow directions in the Clematis Sandstone are therefore well understood and suitable for the purposes of informing the groundwater impact assessment.

The groundwater chemistry of the Clematis Sandstone is not material to the conclusions of this assessment.

No further actions are warranted in response to this submission.

85. Drawdown impacts were not predicted to the Doongambulla Springs Complex, however the sensitivity analysis predicts the 1 m contour for the maximum zone of depressurisation in the Clematis Sandstone will be less than 3 km from the Doongmabulla Springs Complex. There is considerable uncertainty with regard to the prediction that these springs will not be impacted given the:

a. uncertainty in the hydrogeological conceptualisation and the numerical groundwater modelling predictions; and

b. uncertainty around the cumulative impact assessment for the Clematis Sandstone presented in the EIS, including the lack of 0.2 m drawdown contours.

85a) It is not the purpose of sensitivity analysis to provide alternative depressurisation predictions upon which to base an impact assessment. The impact assessment presented in the draft EIS is based on conservative predictions derived from the best available data and robust modelling.

The purpose of the sensitivity analysis is to determine the model sensitivity to changes in key parameters. The sensitivity analysis considered several sensitivity scenarios including:

- The effect of changing both the horizontal and vertical hydraulic conductivities by +/- 1 order of magnitude across all model layers simultaneously; and
- The effect of changing the specific storage by +/-1 order of magnitude across all model layers simultaneously.

Crucially, these changes have been applied to all layers simultaneously in order to determine the sensitivity of the overall model to these parameters.

As discussed in Section B3 of the draft EIS Groundwater Report (Appendix I), as expected each of these scenarios increased the overall model error and reduced the ability of the model to match measured groundwater levels. This shows that the values adopted in the sensitivity analysis are unrealistic extreme values. These values are therefore less appropriate for impact assessment than the range of values adopted in the model for the predictions.

The effects of these sensitivity scenarios on the extent of depressurisation in the Clematis Sandstone is shown in Figures B16 and B18 of the draft EIS Groundwater Report (Appendix I). These figures show that despite the use of unrealistic extreme hydraulic parameters, the extent of depressurisation is unlikely to extend to the Doongmabulla Springs Complex. It can therefore be concluded with a high degree of confidence that the project will not affect these springs.

Refer to the response to IESC Response 77 in relation to the conceptualisation of the Clematis Sandstone and the Doongmabulla Springs Complex.

85b) As discussed in Section 12.4 of the draft EIS, the zone of depressurisation includes the area that is predicted to experience a 1 m or greater lowering of the potentiometric groundwater surface due to depressurisation. The 1 m depressurisation contour therefore represents the extent of the zone of depressurisation.

The 1 m depressurisation contour is typically adopted in defining the zone of depressurisation as this represents the reasonable limit of precision that can be inferred from groundwater modelling and is within the likely natural range of groundwater level fluctuations within any potentially impacted aquifers.

Predictions of groundwater depressurisation in the order of 20 centimetres over a distance of 22 km (i.e. the distance between the project site and the Doongmabulla Springs Complex) are there therefore beyond reasonable limit of precision that can be inferred from groundwater modelling. Regardless, the considerable distance between the predicted limit of depressurisation and the springs, defined by the 1 m drawdown contour, i.e. approximately 10 km, provides a high level of confidence that the project will not impact the springs.

Refer to the response to IESC Response 77 for further discussion of the assessment of cumulative impacts on the Doongmabulla Springs Complex.

67.15 QUESTION 15

Has the proponent adequately identified downstream environmental and public use values that could be impacted as a result of the project? Is the proposed monitoring program adequate to establish baseline values and identify and quantify potential impacts as a result of the project?

IESC Response

86. The proponent has identified some downstream recreational uses (Wilandspey, and Burdekin Falls Dam). However potential environmental and public use values on the 64 km length of floodplain to the Belyando River, which may be impacted by discharges were not identified.

As discussed in Section 13 of the draft EIS, the project site is located in the headwaters of North Creek. The North Creek catchment is characterised by cattle grazing use. No significant public use values are present in this area.

The controlled release of mine-affected water will be undertaken in accordance with model EA discharge conditions that are designed to prevent significant impacts to the environmental values of receiving waters. Attachment E – Additional Information on Surface Water provides information in relation to the model discharge conditions that are designed to avoid impacts to the environmental values of North Creek and its headwaters.

87. The proponent claims to have an indicative baseline dataset for surface waters, which is based on Queensland Department of Natural Resources and Mines gauges outside of the project area. At a regional scale, monitoring may be considered adequate but the proposed monitoring onsite is inadequate to establish baseline values and quantify potential impacts. Recommendations on how to improve the surface water monitoring programme have been included in response to Question 16.

The surface water monitoring data presented in the draft EIS was focussed upon the potential impacts to the Belyando River as the receiving waters for releases of mine-affected water from the project site. The draft EIS cited extensive water quality and flow data from which to derive a suitable baseline, locally relevant water quality objectives and EA discharge conditions.

In response to numerous submissions, the proponent has agreed to adopt North Creek as the receiving water for mine-affected water rather than the Belyando River. This change in discharge strategy was not anticipated and consequently the available water quality and flow data relating to North Creek is limited. In addition, the project site is remote and is located at the head of the North Creek catchment and experiences highly ephemeral, short duration, surface water flows which severely limits the ability for any regular sampling of surface water flows from North Creek.

The proponent is proposing to implement a baseline water quality and flow monitoring program for North Creek. The baseline monitoring program will be undertaken in accordance with the Queensland Water Quality Guidelines, prior to the commencement of the project.

Baseline water quality and flow data collected as part of this monitoring program will also be used to establish locally relevant water quality objectives for North Creek in accordance with the Queensland Water Quality Guidelines. The water quality objectives will be used in the development of site-specific EA conditions for the controlled release of mine-affected water to North Creek in accordance with the EHP model mining conditions.

The baseline water quality data (and derived water quality objectives) will also inform the REMP baseline and objectives. The REMP is described in detail in Attachment E – Additional Information on Surface Water.

The details of the proposed baseline water quality and flow monitoring programs are provided in Attachment E – Additional Information on Surface Water. Water quality and flow gauging will be undertaken on North Creek downstream of the proposed controlled release point and on the Belyando River.

67.16 QUESTION 16

Have the potential risks and impacts of contamination to water resources been adequately identified, assessed and quantified? If not, what additional measures could be implemented to adequately mitigate, manage and monitor potential risks and impacts?

IESC Response

88. Impacts to water resources from contamination have been assessed. Additional information on the geochemistry of the target coal seams, particularly to the northern area of the project area, would have been beneficial.

The geochemistry of the target coal seams is assessed in the draft EIS Geochemistry Report (Appendix D).

89. To monitor and manage potential risks, surface water and groundwater monitoring locations around waste storage facilities should be clearly identified and molybdenum, selenium, and aluminium be included in regular surface water quality sampling.

A REMP will be implemented in accordance with the requirements for the Queensland EA. The REMP is described in Attachment E – Additional Information on Surface Water and includes surface water monitoring locations downstream of the project site. Surface water monitoring undertaken in accordance with the REMP will include regular testing for molybdenum, selenium, and aluminium.

Section 12.5.2 of the draft EIS describes the proposed groundwater monitoring program. Details of the proposed groundwater monitoring bores are provided in Attachment 24-4 of the draft EIS. The monitoring program includes bores located in the vicinity of the tailings and power station waste storage facilities. The proposed groundwater monitoring program includes selenium, molybdenum and aluminium.

IESC Explanation

90. Potential impacts to water resources could result from surface runoff or seepage from: overburden emplacement areas; the Tailings Storage Facility and Power Station Waste Storage Facility; and raw coal stockpiles.

The potential groundwater quality impacts associated with the overburden emplacement areas; the Tailings Storage Facility and Power Station Waste Storage Facility are addressed in Section 12.4.9 of the draft EIS.

The water table in the vicinity of the coal stockpiles is relatively deep, and any leachate generated from the stockpiles will be of a similar quality to any groundwater that may be present in the underlying sediments. The coal stockpile bases will be constructed from compacted materials that will minimise leachate generation. However were seepage to occur, a degradation in groundwater quality is unlikely.

Section 13.4.1 of the draft EIS presents a site drainage plan that includes the management of runoff from overburden emplacement areas, the Tailings Storage Facility, the Power Station Waste Storage Facility and the raw coal stockpiles. As discussed in Section 13.4.1, drainage from these areas will be managed to ensure that there are no adverse effects on surface water quality.

91. Raw coal and coal reject material were sourced from the southern mining area only. Furthermore, some coal reject material was gathered from E, F and G seams which is not relevant, as these seams are not being targeted by the project.

A total of 81 coal and coal reject samples were included in the geochemical testing program. The coal reject sample materials were collected from representative geology within the project site.

The EHP model mining EA condition require the regular sampling and geochemical characterisation of coal reject material during the operation phase.

92. Geochemical testing on tailings material indicate that any leachate from the Tailings Storage Facility is likely to be of better quality than the tertiary groundwater so degradation of groundwater quality is improbable should any seepage from the Tailings Storage Facility occur. The proponent states the facility will be designed to minimise leachate generation, but no information was provided on how this will be achieved.

Section 7.4.3 of the draft EIS describes the construction and operation of the Tailings Storage Facility, including the installation of a seepage collection system to collect and contain any water seeping from the Tailings Storage Facility.

93. Based on the benign nature of the materials tested, no special management measures are proposed. The proponent commits to:

a. Quarterly monitoring of pH, EC, TSS, dissolved trace metals/metalloids and major ions for surface runoff and seepage from the overburden emplacement area, tailings storage, raw coal stockpile, feed coal stockpile and power station waste facility. In addition to the analytes proposed, monitoring of selenium, molybdenum, nickel and aluminium is essential where runoff or seepage from overburden or coal material is likely.

b. ‘Regular’ inspections of storage facilities. The frequency of ‘regular’ inspections of waste storage facilities should be clarified.

93a) Refer to the response to IESC Response 89 which describes the REMP that will be implemented to monitor receiving surface waters, and the groundwater monitoring program that will be undertaken during the operations phase.

Runoff from contained catchments (including mine wastes and stockpiles) will be captured within the mine water management system. A water management system monitoring program is described in Section 13.5.6 of the draft EIS. Releases from the mine water management system will be monitored in accordance with the potential contaminants listed in Table 7 of Attachment 24-4 of the draft EIS. This includes selenium, molybdenum, nickel and aluminium.

93b) The frequency of the proposed inspections will be determined as part of the detailed health, safety and environment procedures to be developed prior to commencement of the project. Indicatively, a tiered system of weekly, monthly and quarterly inspections may be undertaken. However, the frequency of the inspections will vary over the life of the mine in response to the progressive development of these structures.

67.17 QUESTION 17

Would backfilling the pits to a level to prevent excessive groundwater intrusion be an effective management option to ameliorate post mining flow rates to the final void (predicted at 0.5ML/day from GAB and 0.5 ML/day from non-GAB management units such as the Greater Western Artesian Area)?

<u>IESC Response</u>

94. Backfilling would be an effective management option to ameliorate flow rates to the final void by reducing excess evaporation and subsequent ongoing groundwater inflow.

In order to prevent post mining groundwater take it would be necessary to backfill the final void to a level that is above the pre-mining groundwater level (i.e. a backfilling depth of up to approximately 300 m).

On this basis, it is not economically feasible for this mine (or any other Galilee Basin open cut mine) to backfill the final void to the extent necessary to prevent post mining groundwater take, and a commitment of this nature would be unprecedented for a coal mining project in the Galilee Basin or elsewhere.

Furthermore, the post mining groundwater take of 183 ML/year represents a minor volume of groundwater within the context of the GAB aquifers and is not a significant proportion of the sustainable yield of the GAB. Post mining groundwater take is therefore not likely to result in any significant adverse effects on the GAB groundwater resource or significant impacts on sensitive environmental features. The proponent will be required to mitigate impacts on water or any associated bores as a condition of its associated water licence under the Queensland *Water Act 2000*.

In conclusion, the suggested additional commitment to backfilling the void in order to manage impact is inconsistent with existing regulations and unjustified. The suggestion is also not economically feasible.

<u>IESC Explanation</u>

95. Post mining, the final voids are predicted to act as a sink to groundwater flow. This will reduce the hydraulic gradient and magnitude of drawdown immediately surrounding the mined areas but also allow the zone of depressurisation to continue to expand as water from the surrounding groundwater systems (Moolayember Formation and Clematis Sandstone) flow into the voids. Considering the voids are positioned at the base of Darkies Range, further evidence should be provided to support the concept that the final voids will act as groundwater sinks, rather than groundwater through-flow systems.

For the purposes of clarity, Section 12.4.2 of the draft EIS states that the final void will fill with water post closure (due to the cessation of active dewatering of mined areas). The hydraulic gradient and magnitude of drawdown around the mined areas is predicted to reduce as this process occurs. The draft EIS does not state that this process is due to the voids acting as a groundwater sink, nor does it state that the Moolayember Formation and Clematis Sandstone are the surrounding groundwater systems from which water will flow towards the final voids.

Groundwater movement occurs from areas of high hydraulic head to areas of low hydraulic head along a hydraulic gradient. The difference in head between the final void lake and the local groundwater regime and will determine the direction and gradient of groundwater flow, and hence whether the final void will act as a groundwater sink or a flow through system. Conceptually, a groundwater sink will occur where the head in the final void lake is lower than the local groundwater regime (i.e. hydraulic gradient is towards the void). A flow through system may occur where the head in the final void is lower than the local groundwater regime in some areas and is equal to (or higher than) the local groundwater regime in other areas (i.e. hydraulic gradient is towards the void in areas and away from the void in other areas).

The conceptualisation of final void as a permanent groundwater sink is supported by a substantial body of evidence including:

- Final void water balance modelling undertaken to assess the likely final void water levels shows that the long-term final void lake water level is predicted to fluctuate in the range of 249 to 260 m AHD with an average elevation of 255 m AHD. The final void water balance modelling is described in the draft EIS Water Management System Modelling Report (Appendix K).
- Groundwater monitoring data presented in Section 6 of the draft EIS Groundwater Report (Appendix I) which shows that recorded groundwater levels within the Tertiary sediments, Rewan Formation and Permian coal measures are higher than the final void water level from all directions.
- Calibrated groundwater heads presented in Appendix B of the draft EIS Groundwater Report (Appendix I) which show that local groundwater heads are higher than the final void water level from all directions.
- Post mining numerical groundwater modelling predictions which show that the final voids will continue to act as a groundwater discharge zone for the local groundwater regime. On this basis, post mining groundwater modelling shows that the resulting hydraulic gradient will cause groundwater movement towards the final void.

The draft EIS therefore provides sufficient data to support the conceptualisation of the final void as a permanent groundwater sink (as discussed in Section 12.4.2 of the draft EIS). No additional evidence is therefore required to address this submission.

Furthermore, the evidence does not support the conceptualisation of flow through conditions in the vicinity of the final void and therefore further consideration of these conditions is not justified.

96. Further assessment taking into account seasonal and climatic variations (i.e. high rainfall and flooding) would be beneficial to assess final void water levels and the likelihood of the final voids discharging water into surface water and groundwater systems. Given that the final void is predicted to act as a groundwater sink, salt and other potentially harmful constituents will be expected to accumulate in the final voids and these should be modelled to inform adequate mitigation and management measures.

Section 13.6.6 of the draft EIS describes the modelling undertaken to determine water levels in the final voids. Direct rainfall and catchment runoff to the final void has been calculated from 124 years of daily climate data. This climate data includes all seasonal and climatic variations recorded over this period, including periods of high rainfall. On this basis, the draft EIS final void assessment fully accounts for the seasonal and climatic variations raised in this submission.

A final void water balance model was developed as part of the draft EIS to predict the final void water levels and assess the likelihood of overflow of water from the final void. The final void modelling results are discussed in Section 13.6.6 of the draft EIS and the final void water level is shown on Graph 13-3 of the draft EIS. Section 13.6.6 of the draft EIS shows that the long-term final void lake water level is predicted to fluctuate in the range of 249 to 260 m AHD with an average elevation of 255 m AHD. The average final void water level is 50 m below the final void spill point elevation of 305 m AHD. Overflow of water from the final void to downstream drainage is therefore extremely unlikely based upon the final void modelling results. No further assessment is required.

As discussed in Section 12.4.9 of the draft EIS, the final void water level is predicted to be lower than the pre-mining groundwater levels. Post mining groundwater modelling shows that the resulting hydraulic gradient will result in groundwater movement towards the final void. The final void will therefore act as a permanent groundwater sink. As a result of these hydraulic conditions, the surrounding groundwater quality and any associated other environmental values or features, are highly unlikely to be impacted post closure. On this basis, no mitigation or management measures are required to address water quality in the final void.

The assessment of final void impacts is based upon hydraulic conditions and is therefore independent of water quality in the final void. Modelling of water quality therefore amounts to a theoretical exercise that will not materially affect the conclusions of the final void assessment presented in the draft EIS. On this basis, no further assessment is warranted.

97. The management of the voids could be further strengthened by providing a Final Void Management Plan, to be developed prior to completion of mining in the first pit. This plan should consider aspects such as groundwater hydrology, surface water hydrology and include measures to minimise potential impacts associated with the final voids. In the Final Void Management Plan, the proponent should demonstrate that impacts to water resources are mitigated and managed in perpetuity and consider options for the post-mine use.

The requirement for a Final Void Management Plan is a standard EA condition for open cut mines.

67.18 QUESTION 18

Has the EIS definitively shown that groundwater impacts will not affect Caukingburra Swamp north east of Lake Buchanan (which extends for 2km with a northwest-southeast orientation and up to 1km wide located in the same closed drainage depression as Lake Buchanan). If not, what further work should be completed to satisfactorily demonstrate this?

IESC Response

98. The EIS does not assess potential impacts to Caukingburra Swamp. There is uncertainty as to whether the swamp is groundwater fed. However, based on the current modelling predictions due to the distance from the project area, there is a low likelihood of impacts as a result of the project, even if the swamp is a GDE.

Section 12.4 of the draft EIS provides an assessment of the potential impacts to the closest sensitive groundwater users and other relevant environmental features.

Caukingburra Swamp is located at the northern end of Lake Buchanan. Lake Buchanan is located 17 km west of the project site. As explained in Section 12.4.4 of the draft EIS, groundwater modelling shows that the maximum predicted extent of depressurisation associated with the project does not extend to Lake Buchanan. The project is therefore unlikely to result in any impacts on water levels in the lake.

Caukingburra Swamp is located approximately 1 km further from the project site than Lake Buchanan, at the closest point (i.e. the swamp is approximately 18 km from the project site). Hence, the maximum predicted extent of depressurisation associated with the project does not extend to Caukingburra Swamp and the project is unlikely to impact water levels in the swamp.

As noted in this submission, the degree to which Caukingburra Swamp may be groundwater dependent has no bearing on the outcome of this impact assessment.

99. Detailed surveys and monitoring should be undertaken on Lake Buchanan and Caukingburra Swamp to determine water requirements and sources to provide confidence in assessing any potential impacts.

For clarity, it has been assumed that the 'water requirements' discussed in the submission are referring to Lake Buchanan and Caukingburra Swamp. There is no means of directly measuring groundwater discharge into a lake or swamp. The rate of groundwater discharge in the vicinity of Lake Buchanan has therefore been determined by numerical modelling for the purposes of the draft EIS groundwater study. The modelled rate of groundwater recharge provides an optimal calibration result and is consistent with the wider groundwater regime. These results are therefore suitable for the purposes of the draft EIS and no further action is proposed at this time.

Conceptually, the potential sources of water for Lake Buchanan and Caukingburra Swamp could include:

- The regional groundwater table;
- A perched groundwater regime; and/or
- Surface water runoff.

The draft EIS presents a conceptualisation of Lake Buchanan as a likely discharge zone for the regional groundwater regime. Sections 5 to 7 of the draft EIS Groundwater Report (Appendix I) describe the extensive body of desktop information and field data that support this conceptualisation. A hydraulic connection was therefore modelled between water levels in Lake Buchanan and the regional groundwater table. This approach allowed for any potential effects of depressurisation on the regional groundwater regime at Lake Buchanan to affect groundwater discharge to Lake Buchanan. The potential impacts of groundwater depressurisation on the environmental values of the lake were therefore fully considered.

However, as discussed in Section 12.4 of the draft EIS, the project is not predicted to result in significant groundwater depressurisation within 6 km of Lake Buchanan or Caukingburra Swamp. Therefore, despite the modelled hydraulic connection, the project is not predicted to result in adverse impacts to the lake.

The potential alternative water sources (listed above) involve Lake Buchanan being perched above the regional groundwater table or functioning as a source of sustained groundwater recharge. These conceptualisations are not supported by the available information and would result in a less conservative impact assessment for the following reasons:

- A perched lake would be hydraulically disconnected from the underlying groundwater regime and any associated effects from the project.
- Modelling Lake Buchanan as a recharge zone would necessarily involve increasing the amount of recharge entering the model cells used to represent Lake Buchanan. This would have the effect of buffering any groundwater drawdown associated with the project in the vicinity of Lake Buchanan.

On this basis, additional surveys and monitoring of Lake Buchanan and Caukingburra Swamp would not result in a more conservative impact assessment or provide any additional confidence in the conclusions presented in the draft EIS, and consequently no further actions are currently proposed.

IESC Explanation

100. Caukingburra Swamp, listed on the Directory of Important Wetlands (DIWA, undated-c), is a seasonal freshwater swamp adjacent to the north east tip of Lake Buchanan. It is a terminal drainage depression and receives surface inflows from the north and off the Great Dividing Range (north of the project area). It is recognised as an important freshwater refuge in the landscape, including for migratory birds. It retains water for a longer period than similar habitats in the region and water may persist through the dry season (Lorimer, 2005), which indicates a potential groundwater contribution.

Refer to the response to IESC Response 98.

101. The Queensland Government WetlandMaps reports that the swamp is likely a closed alluvial system with fresh, intermittent groundwater connectivity and is a low confidence GDE.

Refer to the response to IESC Response 98.

102. Through increased monitoring, the proponent should improve understanding of the groundwater-surface water interactions at Lake Buchanan to ensure mine-induced depressurisation will not impact on the hydrology of Caukingburra Swamp.

The response to IESC Response 99 provides an overview of the understanding of groundwater interactions with Lake Buchanan that is presented in the draft EIS, and explains that this provides a conservative basis for the assessment of potential impacts on the hydrology of Lake Buchanan and Caukingburra Swamp.

Section 12.5 of the draft EIS describes the operations phase groundwater monitoring program that will be implemented to identify any unexpected departures from the draft EIS groundwater modelling predictions. All unexpected departures will be investigated in accordance with the Queensland EA to allow the early identification of any significant departures that could potentially result in impacts to groundwater users or other sensitive environmental features such as Lake Buchanan or Caukingburra Swamp.

On this basis, no additional monitoring at Lake Buchanan and Caukingburra Swamp is required to ensure that the project will not result in significant adverse impacts to the hydrology of these features.