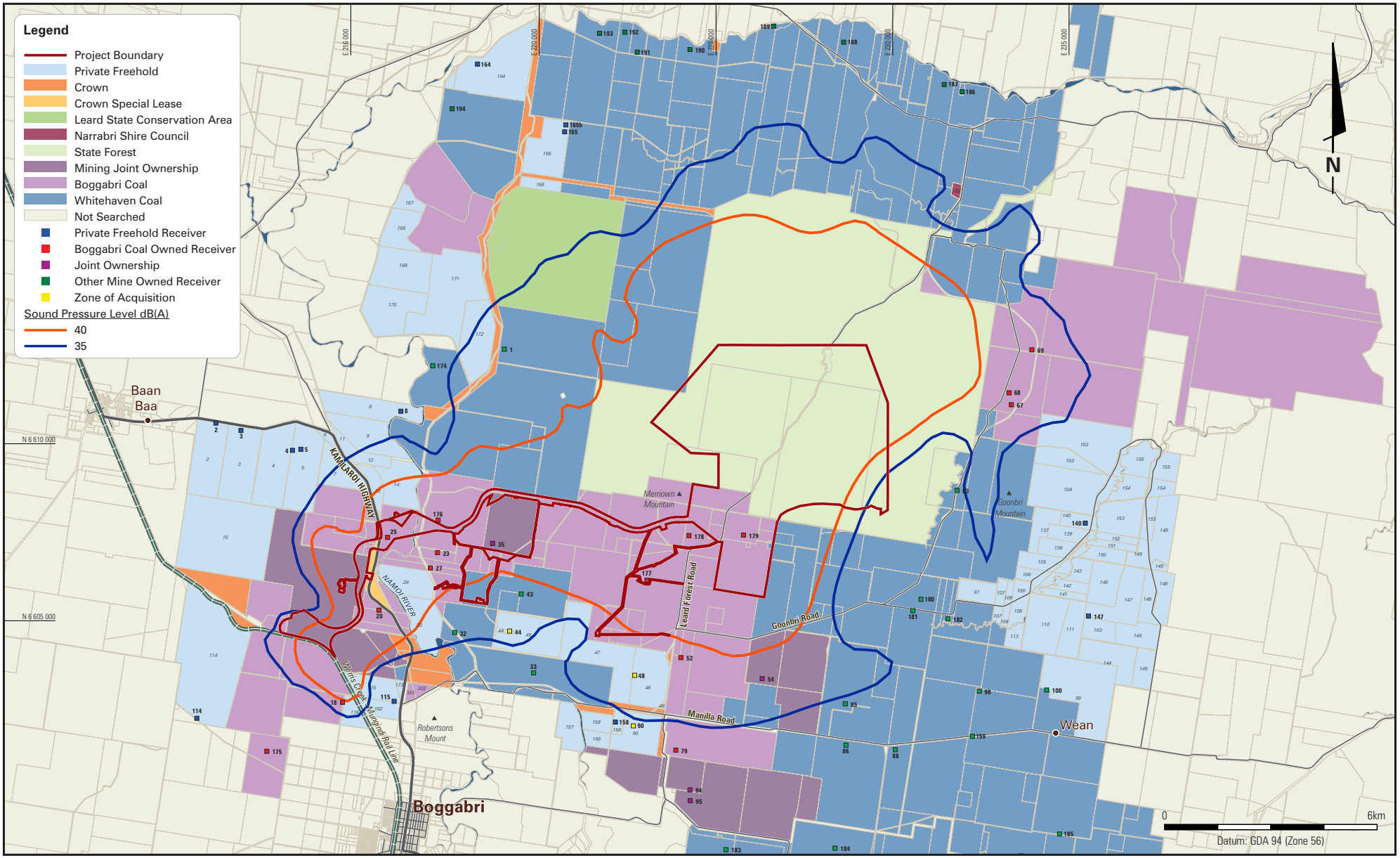

HB BOGGABRI MOD8 1824 F10 Indicative Noise Contours, 2029, Max Period (LAeq,15minute dB) 21 01 2021

BOGGABRI COAL MINE

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Indicative Noise Contours, 2029, Max all Periods (LAeq,15minute dB)

FIGURE 10

The VLAMP criteria were utilised to determine the significance of the predicted noise levels at private receivers, along with the existing noise criteria specified under SSD 09_0182.

Three receivers were predicted to experience a 1 dB exceedance of the relevant criteria during the night time period for the Year 2024 modelling scenario. Exceedances of 0-2 dB of the intrusive criteria are considered negligible in accordance with the VLAMP, as noise levels of this magnitude would not be discernible to the average listener and do not warrant receiver based treatments or controls. Further detail with respect to these predicted noise levels is outlined below.

Receiver 48 is currently subject to acquisition upon request under SSD 09_0182. The Year 2024 modelling scenario predicted noise levels at this receiver may be 1 dB greater than the maximum predicted noise level from the original NBIA. A 1 dB increase in noise levels at this receiver would not be discernible to the average listener and does not warrant any further mitigations or controls (beyond those already afforded to this receiver under SSD 09_0182).

Receivers 8 and 158 are predicted within the Year 2024 modelling scenario to experience noise levels which are 1 dB greater than the night period intrusive criteria. Receiver 8 which is located to the west of BCM (on the western side of the Namoi River) was not assessed in the original NBIA and is therefore not listed as a specific receiver within the noise criteria in SSD 09_0182. The predicted noise levels at this receiver are primarily due to the noise generated from train movements on the rail spur, which are not proposed to change as a result of MOD 8. Operational noise levels from BCM without the train travelling on the rail spur are predicted to remain well within the relevant criteria listed in SSD 09_0182.

Receiver 158 is located to the south of BCM on the southern side of Manilla Road. This residence was constructed after the original NBIA was prepared. Accordingly, the noise levels for this receiver are not currently listed within SSD 09_0182. The predicted noise levels at this receiver are generally consistent with the noise levels predicted over this property within the original NBIA (Bridges Acoustics, 2010).

Private Land Area Assessment

The VLAMP requires that proponents assess noise (and air quality) impacts over the area of privately owned land (whether a residence occurs on the land or not). The VLAMP states that voluntary land acquisition rights may apply where, even with the implementation of best practice management, the noise generated by the development would contribute to exceedances of the acceptable noise amenity levels plus 5 dB in Table 2.2 of the NPfI on more than 25% of any privately-owned land.

The outcome of this assessment was that no privately owned landholdings have more than 25% of the land area predicted to exceed VLAMP criteria in any time period, for either the Year 2024 or Year 2029 modelling scenarios. Therefore, no additional properties should be entitled to voluntary land acquisition rights due to predicted noise impacts of MOD 8 over more than 25% of the landholding area.

Sleep Disturbance

Potential sleep disturbance impacts were assessed for MOD 8 by predicting noise levels from plant items known to generate noise levels that at times, stand out above the general mining continuum. The assessment of sleep disturbance involved modelling each source, and then combining the highest prediction with the results for the remainder of operational plant to obtain an estimate of possible short term maximum noise emissions.

Sleep disturbance model predictions did not identify any privately owned receiver where short term maximum noise levels exceeded the relevant $L_{A1,1minute}$ criteria prescribed in SSD 09_0182. As such, there is no sleep disturbance impact is predicted for MOD 8.

Low Frequency Noise

The Year 2024 and Year 2029 modelling scenarios both indicate that noise levels will remain well below the NPfI thresholds for low frequency noise at all privately owned receivers. Accordingly, the low frequency noise modifying factor adjustment is not applicable to modelling predictions for MOD 8.

Fauna Crossing Construction Noise

A scenario was developed that represents a typical worst case configuration of the activities and equipment usage for the proposed construction of the fauna movement crossing.

This construction noise assessment scenario demonstrated that construction activities associated with the fauna movement crossing are not likely to increase noise over and above the noise generated by the open cut mining operations at BCM.

Noise generated from these activities are therefore predicted to remain well within the construction noise criteria prescribed in SSD 09_0182 (**Table 10**).

Cumulative Noise

A cumulative noise assessment was completed for MOD 8 which included the noise sources from activities at:

- Maules Creek Mine; and
- Tarrawonga Mine (including the activities associated with MOD 7, which has recently been approved).

Modelling predictions indicate that cumulative noise levels will remain well below the criteria prescribed in SSD 09_0182 (**Table 9**).

Road Traffic

Road traffic noise generated from the additional road traffic resulting from MOD 8 on the BCM Access Road are predicted to be below the relevant criteria specified within the RNP at the nearest privately owned receivers. Any changes in road traffic noise levels along the Access Road resulting from traffic increases due to MOD 8 will not be measurable or perceptible at the nearest privately owned receiver.

Blasting

No material changes are proposed to the approved blasting practices at BCM as a result of MOD 8. Blasting will remain within the currently approved Mine Disturbance Boundary, albeit at greater depths. Continued implementation of blast design, management and monitoring protocols outlined in the Blast Management Plan (BMP) will ensure BCM's blasting activities will maintain compliance with the approved blasting criteria.

7.1.4 Mitigation and Management

BCOPL currently manages its noise impacts in accordance with the reasonable and feasible measures described within the Noise Management Plan. BCOPL operates a comprehensive noise management system on site, as outlined in the Noise Management Plan. The noise management system uses a combination of predictive meteorological forecasting and real-time noise monitoring data to guide the day-to-day planning of mining operations, and the implementation of both proactive and reactive noise mitigation and management measures. This includes (at least) the following reasonable and feasible noise mitigation and management measures which have been applied to the noise modelling exercise:

- Directing the overburden haul truck fleet to higher, exposed emplacement areas during favourable weather conditions (generally during the day) and to lower, more shielded emplacement areas where possible during noise enhancing weather conditions (generally during the evening and night periods);
- Placing overburden in strategic locations to provide additional screening between noise sources at the BCM and nearby noise sensitive areas;
- Constructing noise bunds along the edge of any exposed ramps at exposed elevations on the OEA;
- Where possible, scheduling of noisier activities in the day time period (7 am to 6 pm);
- Substituting alternative, quieter operating methods or machines. This may include operating equipment at lower speeds and/or adopting new technologies to reduce potential noise emissions and even extend to ceasing operating equipment that is identified as the dominant noise source(s) until weather conditions are more favourable;
- Continuing to monitor noise levels following implementation of a change to mining activities to confirm the change has been effective;
- Limiting the speed of the track dozers in reverse;
- Predictive meteorological forecasting and real time noise monitoring to guide the day-to-day planning of mining operations; and
- Equipment found to have defects that lead to elevated noise emissions will not be returned to operations until repaired.

BCOPL will continue to manage its noise impacts in accordance with the Noise Management Plan which will be reviewed and updated for MOD 8 as required. Throughout the life of the mine, noise control and management strategies will continue to be implemented to ensure ongoing compliance with the approved noise criteria.

BCOPL has demonstrated BCM's ongoing compliance with the approved noise and blasting criteria prescribed in SSD 09_0182 for the last 5 years. Further to this, the NBIA for MOD 8 has demonstrated that the BCM will be able to continue to operate utilising existing equipment (operating with sound power levels greater than those assessed within the original NBIA), whilst generally maintaining compliance with approved noise and blasting criteria set out in SSD 09_0182. The only exception is to incorporate minor amendments to include the predicted noise levels for three privately owned receivers surrounding BCM, two of which were not assessed within the original NBIA.

The NBIA for MOD 8 demonstrates that there are no material changes to the noise impacts for BCM. Schedule 3, Conditions 9 and 10 of SSD 09_0182 are outdated and are no longer necessary to comply with the relevant noise criteria approved for BCM having regard to the success of existing reasonable and feasible noise mitigation and management measures.

7.2 AIR QUALITY

7.2.1 Background

An Air Quality and Greenhouse Gas (GHG) Assessment has been undertaken by the Jacobs Group (Australia) Pty Ltd (Jacobs) to determine the likely air quality impacts of MOD 8 and the total GHG emissions arising from MOD 8.

Appendix G provides a copy of the Air Quality and GHG Assessment and a summary is provided within the following sections.

7.2.2 Methodology

Approach to Assessment

The assessment of air quality impacts resulting from MOD 8 was undertaken using the procedures in accordance with the EPA's *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (the Approved Methods) (EPA, 2016).

The assessment entailed:

- Estimating emissions for all dust generating activities associated with the BCM, including the operational changes sought by MOD 8 (i.e. development of emissions inventories for representative years of the worst case operation of BCM, including MOD 8);
- Dispersion modelling using a regulatory approved dispersion model to predict ground level concentrations for key pollutants at surrounding sensitive receivers; and
- Assessment of cumulative impacts, considering the combined effect of existing baseline air quality conditions and other local mining projects.

The highest intensity operational years of MOD 8 (i.e. years in which air emissions are expected to peak) were determined to be in Years 2024, 2029 and 2032. All three mine plan years were identified to include the periods with maximum material handling quantities, maximum haulage distances, with varying proximities to neighbouring receivers, and the worst case combined interactions with neighbouring approved mining operations. Further detail on the methodologies utilised for the Air Quality and GHG Assessment is provided in **Appendix G**.

Impact Assessment Criteria

The Approved Methods specify the air quality impact assessment criteria relevant for assessing the air quality impacts of a development. These criteria are generally based on the total pollutant loads in the environment. As such, new sources of pollutants must be added to the existing background environmental levels for assessment purposes. **Appendix G** provides details as to how background environmental air quality levels have been determined for assessment purposes.

The Approved Methods also prescribe nuisance-based goals for dust deposition, which relate to amenity type impacts such as soiling of exposed surfaces. The impact assessment criteria from the Approved Methods for dust deposition, concentrations of particulate matter (Total Suspended Particulate (TSP), Particulate Matter less than 10 microns (PM_{10}) and Particulate Matter less than 2.5 microns ($PM_{2.5}$)) and Nitrogen Dioxide (NO_2) are summarised in **Table 13**, **Table 14** and **Table 15** respectively.

The impact assessment criteria are generally consistent with the criteria stipulated within the existing approval conditions (SSD 09_0182) for BCM. The exceptions are the reduced PM_{10} annual average criterion (reduced from 30 to 25 µg/m^3) and the inclusion of the $PM_{2.5}$ 24-hour average and annual average criteria which were incorporated within the amended Approved Methods in 2016.

Table 13
Impact Assessment Criteria for Dust Deposition

Pollutant	Maximum increase in Dust Deposition	Maximum Total Dust Deposition Level
Deposited Dust (as insoluble solids)	2 g/m^2/month	4 g/m^2/month

Source: EPA, 2016.

Table 14
Impact Assessment Criteria for Particulate Matter Concentrations

Pollutant	Criteria	Averaging Period
TSP	**90 µg/m3**	**Annual**
PM10	**50 µg/m3**	**24-hour**
	25 µg/m3	**Annual**
PM2.5	**25 µg/m3**	**24-hour**
	8 µg/m3	**Annual**

Source: EPA, 2016.

Table 15
Impact Assessment Criteria for Nitrogen Dioxide

Pollutant	Criteria	Averaging Period
NO2	246 µg/m3	1-hour
	62 µg/m3	Annual

Source: EPA, 2016.

The VLAMP (DPIE, 2018) describes the approach to address dust (and noise) impacts where modelling predictions exceed the relevant impact assessment criterion, despite the implementation of all reasonable and feasible avoidance or mitigation measures. The VLAMP criteria is generally consistent with the criteria within the Approved Methods. However, it also includes a supplementary impact criterion where more than 25% of a contiguous property has been predicted to exceed the relevant criteria.

Modelling Method

The air dispersion modelling conducted for this assessment utilised the CALPUFF modelling platform. This modelling platform is specifically listed in the Approved Methods and has been used to predict ground-level particulate matter concentrations and deposition levels due to the BCM (including the changes for MOD 8) and other sources.

Total dust emissions have been estimated for the selected operational scenarios using the material handling schedule, equipment listing and mine plans combined with emission factors from:

- Emission Estimation Technique Manual for Mining (NPI, 2012); and
- AP 42 (US EPA 1985 and updates).

Full details on the emission calculations, including assumptions, emission controls and allocation of emissions to modelled locations and model settings are provided in **Appendix G**.

Years 2024, 2029 and 2032 of MOD 8 were selected as reasonable worst case operational years for the purposes of modelling. The scenarios for Years 2024 and 2029 represent the periods of anticipated peaks in overburden and coal handing, maximum haul distances from pit to dumps and associated maximum numbers of mining equipment. The scenario for Year 2032 was modelled to address the year with the maximum quantity of materials handling (i.e. ROM coal and overburden) throughout the life of the mine with MOD 8. Predictions of particulate matter emissions were made across a model domain, including at sensitive receivers relevant to BCM. These predictions were then compared against the relevant regulatory air quality criteria.

Cumulative Impacts

Cumulative air quality impacts have been assessed as part of the Air Quality and GHG Assessment by combining the contribution from the proposed operations at BCM associated with MOD 8 with the existing ambient air quality environment.

The approach to cumulative assessment was to model the contribution from all existing and proposed local mining operations and to add a background for all other non-mining sources based on background air quality monitoring data. The cumulative model for MOD 8 also includes the following operations or proposed operations within the local region:

- BCM, including the proposed changes for MOD 8;
- Approved operations at Maules Creek Mine; and
- Approved operations for the Tarrawonga Mine, including the recent modification approved.

Further detail in relation to the methodology and assumptions used within the air quality modelling assessment is provided in **Appendix G**.

7.2.3 Impact Assessment

Deposited Dust

The predicted annual average deposited dust levels due to BCM show that the EPA's assessment criterion for incremental deposited dust (2 g/m^2/month) will not be exceeded at private receivers. Similarly, the predicted cumulative annual average deposited dust levels show that the EPA's assessment criterion for total deposited dust (4 g/m^2/month) will not be exceeded at private receivers.

Total Suspended Particulates

There were no predicted exceedances of the cumulative annual average TSP criteria of 90 µg/m³ at any private receiver surrounding BCM during any of the modelled years. Further modelling for MOD 8 identified that TSP emissions will generally remain within the impacts originally assessed within the Boggabri EA. The highest TSP annual average result at a private receiver is at Receiver 165 (and 165b) in 2024 being 47.9 µg/m³.

Maximum 24-hour Average PM_{10} and $PM_{2.5}$ Concentrations

The Approved Methods do not prescribe a Project only criteria for 24-hour average PM_{10} concentrations. However, the VLAMP refers to a Project only 24-hour average PM_{10} criteria of 50 µg/m^3 for the purposes of determining land acquisition and mitigation requirements.

The modelling determined that the Project only 24-hour average PM_{10} criteria criterion would not be exceeded at any private receiver because of BCM's operations alone. Further, the predicted extent of 24-hour average PM_{10} air quality emissions from BCM (including the changes sought by MOD 8) will continue to remain largely within the zone of impact identified within the predicted within the 2010 Air Quality Assessment for the BCM (PAE Holmes, 2010). The only exception is where it extends into crown land to the north east of the previously predicted zone of impact.

The modelling of cumulative 24-hour average PM_{10} concentrations is highly sensitive to the modelling assumptions, including the assumed background air quality concentrations and forecast weather conditions utilised within the modelling.

Three private receivers (Receivers 140, 147 and 165) have been predicted to experience an exceedance of the 24-hour average PM_{10} criteria of 50 µg/m³ for at least one day of the modelled year (with modelling results of 52 µg/m^3, 52 µg/m^3 and 54 µg/m^3 respectively).

A Level 2 assessment has been completed as outlined by the Approved Methods to examine the contemporaneous background and mining contributions for each day in the modelling year where these predicted exceedances were experienced.

Despite BCM contributing minor dust levels (3 µg/m^3) to total dust levels on these days, it was observed that the background air quality levels on these days were assumed to be already leading towards or exceeding the 24-hour average PM_{10} criterion.

There were no predicted exceedances of the MOD 8 alone and cumulative $PM_{2.5}$ 24-hour average criteria (i.e. 25 µg/m³), with the highest prediction for MOD 8 alone being 6.7 µg/m³ (at receiver 140).

Annual Average PM_{10} and $PM_{2.5}$ Concentrations

Figure 11 and **Figure 12** illustrate the predicted cumulative annual average PM_{10} and $PM_{2.5}$ concentrations for Years 2024 and 2029 respectively in relation to the neighbouring private receivers. Predicted PM_{10} and $PM_{2.5}$ emissions from BCM, including MOD 8 for Project Year 2032 remains well within the area of impact modelled for Years 2024 and 2029.

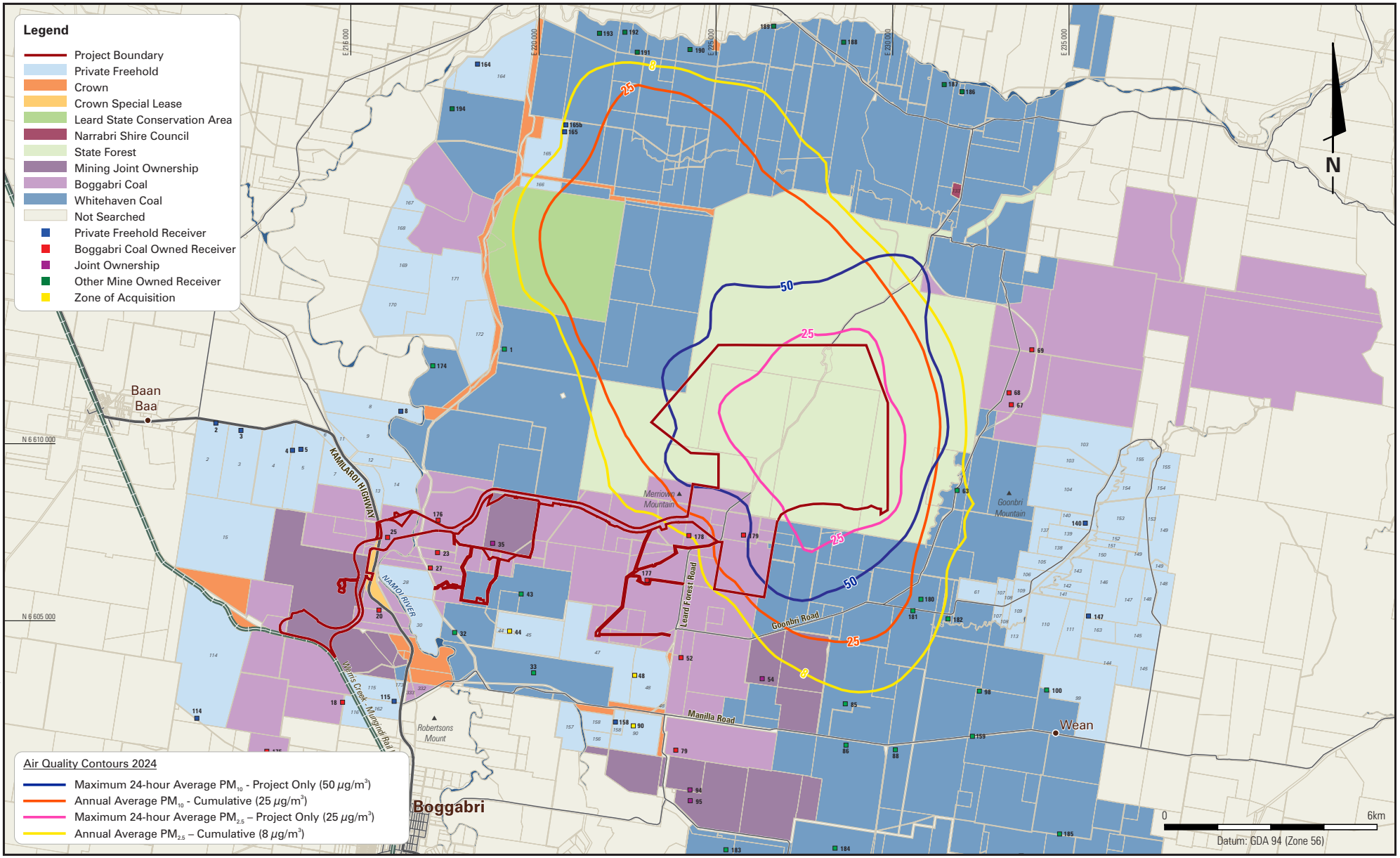
There are no predicted exceedances of the cumulative annual average PM_{10} criteria of 25 µg/m³ at any private receiver surrounding the BCM during any of the modelled worst case years. The predicted cumulative annual average PM_{10} concentrations are largely within the predicted air quality emissions originally identified within the 2010 Air Quality Assessment (PAE Holmes, 2010).

There were no predicted exceedances of the cumulative annual average $PM_{2.5}$ criteria of 8 µg/m³ at any private receiver surrounding BCM for any of the modelled worst case years. The modelling determined that BCM's operations would contribute less than 1 µg/m³ of $PM_{2.5}$ to the annual average $PM_{2.5}$ concentrations at the nearest private receivers (i.e. at receivers 165 and 165b).

Diesel Exhaust

Emissions from diesel exhaust associated with off-road vehicles and equipment at mine sites are often deemed a lower air quality impact risk than dust emissions from the material handling activities. This is because of the relatively few emission sources involved, for example when compared to a busy motorway, and the large distances between the sources and sensitive receptors. However, an assessment of diesel exhaust from the BCM, including changes sought by MOD 8 was completed to ensure diesel exhaust from operations will remain within EPA's guidelines as listed in **Table 15**.

Modelling results indicated that NO2 levels as a result of diesel exhaust will remain well within the EPA's maximum 1-hour average NO_2 criterion (246 µg/m^3) as well as the EPA's annual average NO_2 criterion (62 µg/m^3) for all private receivers.



HB BOGGABRI MOD8 1824 F11 Air Quality Contours 2024 29 03 2021

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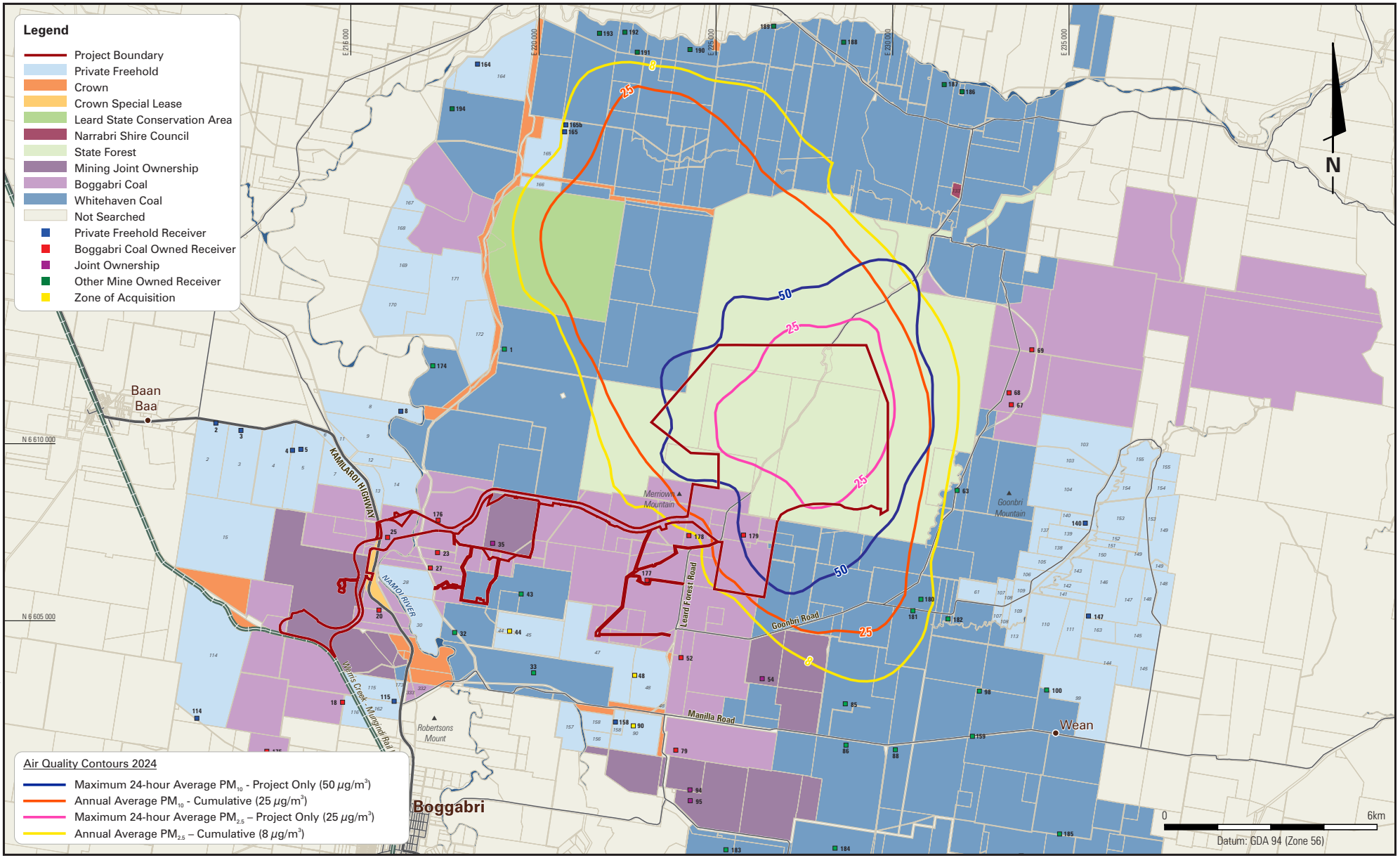
Indicative Air Quality Contours 2024

FIGURE 11



HB BOGGABRI MOD8 1824 F12 Air Quality Contours 2029 29 03 2021

BOGGABRI COAL MINE

Indicative Air Quality Contours 2029

FIGURE 12

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Post Blast Fume

An assessment of a worst-case blast with a rated 3 fume zone and under prevailing weather conditions was undertaken to determine any implications of an event occurring during operations. Modelling results indicated that the maximum 1- hour average NO_2 concentrations would not exceed the EPA criterion for NO_2 (246 µg/m^3) at any private receiver.

GHG Emissions

Over the lifetime of the BCM, including MOD 8 (i.e. between 2022 to 2039), Scope 1 and 2 emissions have been estimated to average 0.69 Mt CO_2-e per year. These annual emission rates are essentially equivalent to those generated from existing operations, although these emissions will continue in line with the continuation of mining operations at BCM for the further six years (i.e. from 2033 to 2039) as sought by MOD 8.

Appendix G provides a detailed breakdown of the estimated emissions for each activity. The estimated annual average Scope 1 and 2 emissions from BCM, including MOD 8 (0.69 Mt CO_2-e) represents approximately 0.13% of Australia's 2019 emissions.

The NSW Government's *Net Zero Plan Stage 1: 2020-2030* was released in March 2020 and sets out several initiatives to cut GHG emissions by 35% in 2030 compared with 2005 levels. This plan also states:

> "*Mining will continue to be an important part of the economy into the future and it is important that the State's action on climate change does not undermine those businesses and jobs and the communities they support*".

In accordance with statutory requirements, Scope 3 emissions have also been estimated for MOD 8 in **Appendix G**. However, the Scope 3 emissions for MOD 8 are not to be assessed as a portion of Australia's 2019 emissions, as these emissions are to be accounted as Scope 1 emissions by the end-user of the product coal against their respective country's GHG reporting system.

Fauna Crossing Construction

Appendix G considered the potential air quality impacts resulting from the construction of the fauna movement crossing. This assessment considered that the material handling quantities during these construction activities will be much lower than the materials handling during the operations phase and accordingly dust impacts will be lower than operations.

Disturbance areas will be stabilised as soon as practicable and dust suppression measures will be utilised during construction to minimise the generation of dust from these activities.

7.2.4 Mitigation and Management

BCOPL currently manages potential air quality impacts at BCM in accordance with the Air Quality and Greenhouse Gas Management Plan and the BTM Air Quality Management Strategy. The measures listed in these management plans/strategies will continue to be implemented as part of the ongoing operations at BCM, including MOD 8.

This includes measures such as:

- Optimising road haulage of overburden and coal;
- The use of water sprays;
- Watering of all active haul roads;
- Closed conveyor systems with automatically triggered dust suppression sprays;
- Progressive mine rehabilitation;
- Utilise the existing Trigger Action Response Plan (TARP) along with data obtained from the real-time air quality monitoring network to assist in proactively managing operations to minimise dust impacts.

The Air Quality and GHG Assessment modelling showed that the potential extent of impacts due to BCM (as modified) will largely be within the approved extent of impacts and that dust concentrations and deposition levels would not exceed relevant EPA assessment criteria at the nearest private receivers. Therefore, no additional dust emission mitigation and management measures are required beyond those currently implemented.

BCOPL is committed to the implementation of all reasonable and feasible measures to minimise GHG emissions from the site in accordance with the current requirements of SSD 09_0182. BCOPL will continue to implement the following GHG emission management measures:

- Improving efficiencies of the operations to minimise diesel usage and to limit its fugitive emissions, as far as practicable;
- Regular maintenance of plant and equipment to minimise fuel consumption and associated emissions;
- Continuing to select plant and equipment that are energy efficient; and
- Training all staff on continuous improvement strategies regarding efficient use of plant and equipment, including maintaining equipment to retain high levels of energy efficiency.

In support of the requirements specified within Schedule 3, Condition 24 of SSD 09_0182, BCOPL is committed to:

- Commission a GHG Emissions Minimisation Study which assess BCM's measures to minimise the release of GHG emissions from the site and determine whether there are any reasonable and feasible measures that can be implemented to further reduce Scope 1 and 2 GHG emissions from the site. The GHG Emissions Minimisation Study is proposed to be submitted within 2 years of the approval of MOD 8 to SSD 09_0182 and will then be undertaken on a three yearly basis; and
- Implement any reasonable and feasible measures identified within the GHG Emissions Minimisation Study in a timeframe determined in consultation with DPIE.

BCOPL will continue to report on the GHG emissions from its operations at BCM within the Annual Review and compare these GHG emissions with those estimated as part of the assessment completed for this Modification Report. Should this comparison identify any exceedances of the forecast scope 1 and scope 2 emissions (based on a 3 year rolling average), BCOPL will notify DPIE of the exceedance and offset the additional emissions.

BCOPL has established and is actively rehabilitating land as part of the BCM biodiversity offset strategy. BCOPL is also committed to, and has advanced, the establishment of woodland communities on its mine rehabilitation areas. These measures are aimed towards delivering a major proportion of a regional biodiversity corridor being established between the Pilliga State Forest to the west and the Nandewar Ranges to the east. BCOPL's work on its biodiversity offset strategy and mine rehabilitation areas will also create a future carbon sink (i.e. increasing the quantity of carbon being absorbed from the atmosphere).

IAR recognises the importance of identifying and implementing sustainable energy efficiency programs designed to deliver sustainable resource management for all its operations. IAR's corporate Energy Management Policy promotes these values with the corporate team actively engaged in developing improved GHG minimisation strategies for implementation across its coal operations.

BCOPL will review and update its Air Quality and GHG Management Plan to ensure that it includes the contemporary reasonable and feasible measures in place at BCM to minimise GHG emissions to the greatest extent practicable.

7.3 GROUNDWATER

7.3.1 Background

A Groundwater Impact Assessment (GIA) was undertaken for MOD 8 by Australasian Groundwater and Environmental Consultants (AGE). The GIA is provided in **Appendix H**.

The objectives of the GIA were to assess the incremental impact of the mine plan changes associated with MOD 8 on the regional groundwater regime and to address the requirements of NSW and Federal government legislation and policies. The GIA also assessed the potential cumulative impacts to the regional groundwater regime as a result of mining and other hydrological stresses within the region.

BTM Complex Numerical Model

Consistent with the other BTM Complex mines, SSD 09_0182 requires BCOPL to:

> "*[implement] a program to validate the groundwater model for the project, including an independent review of the model every 3 years, and comparison of monitoring results with modelled predictions (condition 38(c)); and*
>
> *co-ordinate modelling programs [with surrounding mines] for validation, re-calibration and re-running of the groundwater and surface water models using approved mine operation plans (condition 38(d)); and"*

Similarly, EPBC 2009/5256 requires BCOPL to conduct operations in accordance with surface water and groundwater management plans (approved by the Commonwealth Minister for the Environment) which are prepared in accordance with Condition 38 of SSD 09_0182. This requirement is also held for the other BTM Complex mines. In this regard, an agreement was reached between the BTM Complex mines to generate a cumulative numerical groundwater model using data from all three sites.

Further to this, the State planning approvals for each of the three BTM Complex mines required the installation of a groundwater monitoring network to monitor cumulative impacts surrounding these mining operations, with specific focus on the neighbouring alluvial floodplains which are not expected to be significantly affected by mining. The cumulative groundwater monitoring bore network was installed between November 2013 and January 2014.

At this time, the numerical groundwater model which was developed for the approvals process for the MCCM was updated with new information gained during the installation of the BTM monitoring network. The bore installation and associated updates to the MCCM model is reported within AGE (2014).

AGE (2018) describes the initial independent review and validation of the BTM Complex groundwater model on behalf of the BTM Complex mines as required in their respective planning approvals. AGE (2018) also describes the update of the numerical model with data collected from the BTM monitoring network between 2013 and 2016 and the restructure and update of the numerical model from MODFLOW-SURFACT to MODFLOW-USG.

The update to the MODFLOW-USG modelling code was described to provide a number of benefits to the modelling approach, such as the use of an unstructured mesh which can be used to more accurately reflect the geological structure and other features of hydrological sensitivity.

Since AGE (2018), there has been ongoing consultations with NSW Government departments to conduct further conceptualisations and updates to the BTM Complex numerical model. These latest revisions to the BTM Complex numerical model are described within the *Boggabri, Tarrawonga, Maules Creek Complex Groundwater Model Update* (AGE, 2020) which was provided to the Government departments in December 2020. Whilst further reporting updates are underway for the BTM Complex Groundwater Model Update (AGE, 2020), the latest version of the BTM Complex numerical model has been utilised for the purposes of the MOD 8 GIA.

MOD 8 Work Program

The MOD 8 GIA included the following work program:

- Summarise the existing background data and previous hydrogeological investigations;
- Incorporate the changes sought by MOD 8 within the pre-existing cumulative groundwater model for the BTM Complex (version dated September 2020), which has been progressively developed and updated since 2011 in consultation with the relevant NSW Government regulatory authorities;

- Assess the cumulative and BCM specific impacts as a result of MOD 8;
- Assess the potential impacts to GDEs as a result of the predicted changes to the regional groundwater system;
- Assess the potential third party impacts (i.e. privately owned bores) as a result of the predicted changes to the regional groundwater system;
- Assess predicted impacts of MOD 8 against the requirements of the AIP and the EPBC Act; and
- Provide recommendations for the management of groundwater impacts, including recommendations in relation to ongoing groundwater monitoring.

Groundwater Resources

There are four general hydrogeological systems across the BCM surrounding area:

- Two Quaternary alluvial groundwater systems, including:
    - Narrabri formation; and
    - Gunnedah formation;
- A Permian groundwater system of the Maules Creek Formation; and
- A late Carboniferous/early Permian groundwater system of the Boggabri Volcanics.

Rainfall is the principal means for recharge to the groundwater systems within the investigation area. The amount of water that will eventually reach underlying groundwater systems depends on the rate and duration of rainfall, soil/vegetation properties, depth of the water table and residual soil moisture.

As part of recent updates to the BTM Complex model (AGE, 2020), a number of recharge zones were defined based on data review and conceptual understandings of recharge. These included zones for the coal measures/volcanics, the alluvial flood plain, drainage features within the alluvium, and break of slope areas (including a specific break of slope zone for the Nandewar Ranges). The highest rates of recharge have been identified to occur in the break of slope zones.

Quaternary Alluvium

The Quaternary alluvial groundwater systems proximate to the BTM Complex include those adjacent to the Namoi River and its tributaries (such as Bollol Creek, Goonbri Creek, Maules Creek and Back Creek). The alluvial groundwater systems are divided into the:

- *Narrabri Formation* – Surface (or upper) alluvial cover, comprising extensive overbank clays, with lesser channel sands/gravels. Relative to the underlying Gunnedah Formation, the greater presence of clay results in water quality exhibiting higher salinity and lower yields; and

- *Gunnedah Formation* - Basal paleochannel alluvium, comprising sands/gravel with interbedded clay. Extremely high yields of fresh water can be extracted from bores within this strata and groundwater abstraction from these aquifers within the region is significant.

The alluvial aquifer system, particularly the Gunnedah Formation, is the main groundwater bearing unit within the vicinity of the BTM Complex. Accordingly, this is the main groundwater aquifer system utilised by groundwater users.

Coarser sediments of the Gunnedah Formation are much more permeable than the overlying Narrabri Formation (median horizontal hydraulic conductivity of 6.18 m/day compared to 0.09 m/day). Although less permeable, data suggests that the Narrabri Formation still has the potential to store and transmit appreciable volumes of groundwater.

Monitoring of alluvial groundwater show that level variations are generally consistent with the Cumulative Rainfall Departure (CRD), with no mining related declining levels evident to date.

Regionally, alluvial extraction for irrigation purposes is significant, particularly within the deeper higher yielding Gunnedah Formation. Groundwater monitoring of bores on the Namoi River floodplain clearly indicates this. Groundwater monitoring data demonstrate impacts associated with agricultural extraction, with large range pumping spikes becoming evident that lead to an overall falling trend.

Multi-level monitoring that extends through both the alluvium and the coal measures is limited within the investigation area. Vertical differences in groundwater levels at monitoring sites confirm a downwards hydraulic gradient from the alluvium to the underlying coal seams. Responses to rainfall are visible in the alluvium and within the upper coal seams, with the magnitude of this response reducing at depth.

Maules Creek Formation

The Maules Creek Formation exhibits water bearing strata within the coal seams, interburden and the weathered zone, with the coal seams being the primary water bearing lithology within these strata.

Coal seams of the Maules Creek Formation are of variable thickness, with a cumulative thickness greater than 35 m within the investigation area. The coal seams exhibit low to moderate permeability and the water quality is generally fresh to brackish close to the areas of mining.

The interburden is hydrogeologically ‘tight’ and very low yielding to essentially dry conglomerate/sandstone that comprises the majority of the Maules Creek Formation. The weathered zone is variable in thickness, with deeper weathering profiles found along fractures and potential fault zones within the investigation area. Whilst the weathered zone is interpreted to be more permeable than fresh rock, it is still considered to be hydrogeologically ‘tight’. There is limited information on the water quality within the weathered zone, as it is commonly above the regional water table.

Coal seam hydraulic conductivity is highly variable, with approximately four orders of magnitude separating the highest and lowest estimates (1 m/day to $1x10^{-4}$ m/day). There is currently insufficient data to provide confidence in an inverse relationship with depth as seen within other regions.

The hydraulic conductivity of the interburden is also variable with approximately three orders of magnitude separating the maximum and minimum (1 m/day to $1x10^{-3}$ m/day). There is a reasonably strong relationship between the hydraulic conductivity and depth, with lower values found in tests of the deeper strata. This relationship has been incorporated into the BTM complex groundwater model.

Pre-mining groundwater flow within the Maules Creek Formation generally mimics topography, with a dominant direction of flow to the west. Existing mining activities have led to localised areas of depressurisation around BCM and adjacent mines which results in the complex acting as a local groundwater sink.

Monitoring has indicated that levels within the Maules Creek Formation have fallen as the approved mining operations have expanded and removed materials below the water table, with the timing and rate of depressurisation related to the mining progression and the bore's location relative to these activities. Whilst this depressurisation has been observed at monitoring sites peripheral to mining, the zone of depressurisation has not extended out to the more distant monitoring sites to the east.

Boggabri Volcanics

The Boggabri Volcanics outcrop in only a small portion of the study area and generally forms the basement of the Maules Creek Sub-basin. The volcanics are of very low permeability/impermeable, particularly at depth. Where present, groundwater is likely stored in fractures and/or weathered material.

Limited testing of the permeability of the Boggabri Volcanics has been undertaken to date. Although available results indicate relatively impermeable rock (horizontal hydraulic conductivity values less than 10^{-4} m/day).

Groundwater flow within the Boggabri Volcanics is also consistent with topography (i.e. generally moving from east to west) (AGE, 2020).

Groundwater monitoring for locations within two kilometres of BCM shows that groundwater levels are either generally increasing or consistently stable. In monitoring bores further afield, the Boggabri Volcanics monitoring data shows that groundwater levels have generally remained stable. The stable levels recorded are considered a function of the relatively low hydraulic conductivity and poor interconnectivity of fracture network.

Water Quality and Beneficial Uses

Salinity has a significant influence on the beneficial use of groundwater and generally correlates to electrical conductivity (EC), which can be used to categorise groundwater quality (FAO, 2013).

A study completed for the Commonwealth Government's Bioregional Assessment by Pena-Arancibia et al. (2016) shows that the salinity of the investigation area is variable, with fresh groundwater generally limited to bores adjacent to the Namoi River, Barbers Lagoon, and Maules Creek. Groundwater salinity starts to shift to brackish or moderately saline further away from these surface drainage features.

Regionally, groundwater quality of the Namoi sub-region is typified by a median EC value of 1,013 µS/cm. A ten-year monitoring record for a bore located directly southwest of BCM demonstrates that the water quality has been brackish to moderately saline on average, with a median EC of approximately 2,000 µS/cm.

Collective monitoring data of the BTM Complex (AGE, 2020) shows that groundwater within coal seams and interburden of the Maules Creek Formation is generally brackish to moderately saline, with a median EC of approximately 1,000 µS/cm and 2,300 µS/cm, respectively. These salinity levels are generally fresher than, or consistent with concentrations found in alluvial monitoring bores.

Groundwater of the Boggabri Volcanics is also brackish to moderately saline, with a median EC of approximately 2,000 µS/cm.

The pH of each groundwater system within the investigation area generally falls between 7.0 and 7.5 and generally typifying neutral conditions.

Groundwater Bore Users

There are 1,049 registered bores on the NSW groundwater bores database within the investigation area. The records classify these bores as follows: 252 as monitoring bores, 202 as water supply bores, 196 as irrigation bores, 180 as stock and domestic bores, 11 as commercial and industrial bores, 11 as exploration bores and 197 bores with an unknown purpose.

Bores that are licensed to extract groundwater are located primarily within the alluvial aquifers, with the greatest recorded volumes being extracted from bores immediately adjacent to the Namoi River. These areas of high extraction generally coincide with identified irrigation areas on the Namoi River floodplain.

Groundwater Dependent Ecosystems

The GDE Atlas of Australia (BoM, 2021) illustrates potential aquatic/terrestrial GDEs proximate to the BTM Complex. Under the 2020 updates to the MDB Porous Rock WSP and the Namoi Groundwater WSP, these terrestrial GDEs are now considered high priority GDEs under the *Water Management Act 2000* and are therefore assessable against the AIP.

Further to these high priority GDEs, the threatened ecological communities listed under the EPBC Act that have the potential to be groundwater dependent have also been considered within the GIA. As requested by DAWE, the following ecological communities were considered:

- Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland;

- Poplar Box Grassy Woodland on Alluvial Plains; and
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

Other ecological communities which were identified to have potential to be dependent upon groundwater have also been considered.

A GDE specific assessment report has been prepared by WSP and is further discussed in **Section 7.10**.

7.3.2 Methodology

Model Methodology

The potential groundwater impacts associated with MOD 8 were assessed using the BTM Complex numerical model which has recently been updated (AGE, 2020). The BTM Complex numerical model is a 3D numerical simulation model developed over the investigation area. It covers an area of approximately 39 km from north to south and 25 km from east to west. The modelling code used for the model is known as MODFLOW-USG. The BTM Complex model has been subject to multiple phases of review by DPIE and other regulatory authorities.

The BTM Complex model has 34 layers representing the major hydrostratigraphic units, including the alluvium, weathered zone, interburden, major coal seams, and underlying basement volcanics. The model cells within each layer were active and each cell was assigned to a single hydrostratigraphic unit.

The BTM Complex model was calibrated to a pre-mining steady state water level dataset and then to transient water level records (2006 to 2019) as well as mine inflow datasets. The calibration was achieved by adjusting groundwater system parameters and stresses to produce the best match between the observed and simulated water levels and mine inflows (history matching). Manual testing, automated parameterisation software (PEST) (Doherty, 2010), and pilot points were used to guide the model towards a set of hydraulic parameters and recharge rates that provided the best calibration.

The match between the observed and simulated water levels was determined by calculating the Scaled Root Mean Square (SRMS) statistic. The SRMS was 4.41%, which is below the commonly accepted upper limit of 10%. The predicted mine inflow was also compared to provide a reasonable match to observed inflows at each mine within the BTM Complex.

Following calibration, the model was used to estimate potential changes in groundwater pressure (drawdown) for the various groundwater systems, as well as the volume of groundwater directly and indirectly intercepted by BCM. The impacts from MOD 8 were determined by calculating the difference between two model simulations, with the first model representing the base case and the second representing the base case with the changes sought by MOD 8.

The modelling assumed that all mining areas within the BTM Complex will be left open (i.e. no spoil backfill within the mining areas) until December 2039 (i.e. the end of mining at BCM for MOD 8) to allow for conservative predictions of cumulative impacts to be calculated. Mining-induced dewatering was represented in the model by drain boundary conditions, in which the drains were set at the floor of the deepest coal seam approved for mining to effectively dewater the open cut mining areas.

Residual impacts to the groundwater system after mine closure were assessed for a period of 1,000 years by continuing the simulations under long-term average climatic drivers. Spoil was represented in each of the mining areas immediately after mining, with the emplaced material existing between the base of mining and the adopted final landform. The final landform adopted for BCM was specific to MOD 8, while the voids for Maules Creek Mine and Tarrawonga Mine were respectively sourced from the original approval and Tarrawonga's MOD 7 application. A sensitivity analysis was undertaken to determine how changes to the model parameters influenced the final landform equilibrium water level and time to reach equilibrium.

A detailed discussion of the groundwater modelling methodology is provided in **Appendix H**.

Uncertainty Analysis

The uncertainty in the model parameters was assessed using a complex Monte Carlo style uncertainty analysis which enabled various model inputs to be changed at the same time to test the potential effects on the predicted groundwater impacts. The uncertainty analysis focussed on the possible uncertainty in cumulative (i.e. BTM Complex mines with MOD 8 scenario) groundwater drawdown and on predicted groundwater inflows at BCM.

Appendix H presents further information on the uncertainty analyses completed for the MOD 8 GIA.

Independent Peer Review

The BTM Complex model utilised for MOD 8 has been subjected to reviews and updates over the past decade since the initial development of the MCCM numerical model. The three yearly reviews aim to validate and update the BTM Complex model with the latest monitoring information and mining progressions.

The BTM Complex model (AGE, 2018) has been independently peer reviewed by Dr Noel Merrick of HydroSimulations in 2018. Dr Merrick is a groundwater modeller, hydrogeologist and geophysicist with more than 40 years' experience in groundwater modelling, management and policy development.

The latest revisions to the BTM Complex model (AGE, 2020) between 2019 and late 2020 have been undertaken on a staged basis and in close consultation with and review by technical personnel of DPIE, DPIE-Water and NRAR.

An independent peer review of the MOD 8 GIA and its application of the BTM Complex model to assess the impacts of MOD 8 was undertaken by Associate Professor Claire Côte of the University of Queensland's Centre for Water in the Minerals Industry. Commentary from the University of Queensland in relation to their independent peer review is provided in **Appendix I**.

7.3.3 Impact Assessment

Groundwater Inflows

MOD 8

Predicted annual groundwater inflows to the BCM mining areas for MOD 8 between Year 2022 and Year 2039 are variable ranging from 213 ML/year to 712 ML/year. These groundwater inflows to the mining area are directly from the Permian coal seam aquifers, which is not widely utilised for agricultural uses. The influence of MOD 8 is most apparent from 2025, which is the year that mining first steps down to the Templemore Seam. BCM's inflow is predicted to be at its highest levels between 2025 and 2030, when the deepest sections of the Templemore Seam are proposed to be mined towards the northeast corner of the mining area. Inflow rates then decrease as the already depressurised Templemore Seam continues to be mined at higher elevations until the end of 2036. The mining operations will then step back up to the Merriown Seam from 2037 until the end of 2039. The maximum groundwater inflows at BCM for MOD 8 are modelled to occur in 2027 with a total of 712 ML/year compared to the currently approved maximum 537 ML/year (to occur in Year 2021).

Cumulative

At a cumulative level across the BTM Complex, there is predicted to be a maximum annual groundwater inflow to the approved mining areas of 1,866 ML/year in Year 2024 under base case conditions. For the MOD 8 scenario, there will be a maximum cumulative annual inflow of 1,928 ML/year in 2027. The changes sought by MOD 8 generally leads to a decrease in the maximum inflow rates at the Maules Creek and Tarrawonga mines, with maximum reductions of 93 ML/year and 23 ML/year, respectively.

Drawdown and Depressurisation

MOD 8

Figure 13 shows the MOD 8 incremental drawdown within the alluvium to the south west of BCM in 2039.

Drawdown that can be directly attributed to MOD 8 is only predicted within a small portion of the alluvial tongue that is directly southwest of BCM on BCOPL owned land. This incremental drawdown as a result of MOD 8 alone reaches a maximum of 0.8 m.

HB BOGGABRI 1824 F13 MOD8 Groundwater Drawdown in the Alluvium - MOD8 Only 12 07 2021

BOGGABRI COAL MINE

Hansen Bailey
ENVIRONMENTAL CONSULTANTS

IDEMITSU
BOGGABRI COAL

Groundwater Drawdown in the Alluvium - MOD 8 Only

FIGURE 13

It is important to note that much of this area is occupied by the MIA, CHPP facilities and rail loop and associated facilities and this groundwater is therefore not used for agricultural or other beneficial uses.

MOD 8 is predicted to increase the drawdown in all coal seams, with the most pronounced increase occurring within the Templemore Seam. This is expected as MOD 8 proposes to increase mining down to this seam and would be the first mining activity to significantly extract from this seam. Conversely, coal seams down to the Tarrawonga Seam, which have already been mined to date, or are already approved for mining at neighbouring mines within the BTM Complex, are predicted to experience less incremental impacts as a result of MOD 8.

Depressurisation of the Boggabri Volcanics is predicted by both the approved mining and MOD 8 simulations. Predictions indicate that MOD 8 alone will generate up to 50 m of drawdown in the volcanics within the centre of the BTM Complex, with drawdown that exceeds 10 m generally limited to the Permian outcrop where mining takes place.

Cumulative

Cumulative drawdown within the alluvium is predicted to be generally less than 2 m for both the approved mining and MOD 8 simulations, with most of this drawdown occurring within the alluvium of Bollol Creek and Driggle Draggle Creek to the south of BCM. The predicted cumulative drawdown exceeds 2 m in a small portion of the alluvial tongue that is directly southwest of BCM on BCOPL owned land, where a maximum drawdown of approximately 5 m is predicted. Cumulative drawdown also exceeds 2 m to the immediate south eastern corner of the Tarrawonga Coal Mine, where the alluvium is assumed to be mined through.

The existing cumulative zone of drawdown within the coal seams is predicted to expand as mining continues and reaches the northern, eastern and southern model boundaries by 2039 for both the approved mining and MOD 8 simulations. The predicted extent of drawdown within the coal seams is considered to be a conservative overestimate, as widespread propagation to the east has not been observed in any coal seams through monitoring to date.

The cumulative drawdown predicted for both the Merriown Seam and the Nagero Seam is most significant within the footprints of the BTM Complex mines, with respective maximums of approximately 110 m and 300 m, generally corresponding with the mining depth of the coal seams in this area.

Further detail on the drawdown to the hydrological system as a result of MOD 8 and in conjunction with the cumulative impacts is provided within **Appendix H**.

Incidental Alluvial and Surface Water Takes

Alluvial Takes

Open cut mining at the BCM does not directly intercept water from the alluvial aquifers. However, there is predicted to be an indirect impact (or water take) from the alluvial aquifers as the Permian strata become depressurised and the volume of groundwater flowing from the Permian coal measures to the alluvium progressively reduces.

As discussed above, the direct takes from the porous rock aquifer are predicted to peak between 2025 and 2030, when the deepest sections of the Templemore Seam are proposed to be mined at the BCM. The indirect takes from the zone 4 alluvial (i.e. alluvials to south and south west of BCM) remains relatively stable after the initial spike in 2025. Indirect takes from zone 11 alluvium (i.e. Maules Creek alluvium to the north of BCM) generally increase over time as BCM continues mining and the zone of depressurisation extends beyond the footprint of operations. MOD 8 results in predicted water takes from the zone 4 alluvium to increase from a peak of 78 ML/year in year 2021 for the approved BCM mining operations to a peak of 109 ML/year in year 2036 for MOD 8.

Within the Zone 11 alluvium, MOD 8 results in water takes increasing (from a peak of 4 ML/year in 2033 for the approved BCM mining operations) to a peak of 13 ML/year in year 2036 for MOD 8.

Surface Water Takes

Water budgets for MOD 8 indicate that from 2020 onwards, cumulative mining activities within the BTM Complex result in a maximum reduction of baseflow to the Namoi River of approximately 7.5 ML/year, with an average loss of approximately 2 ML/year. This loss in baseflow is only significant during periods of no river flow, with average flows of the Namoi River being more than 700,000 ML/year. Any predicted changes in baseflow are not a direct take of water, but rather an indirect take of groundwater that would have flowed to the Namoi River without mining. MOD 8 is not expected to result in any further impacts on the baseflow to the Namoi River relative to the approved mining within the BTM Complex.

Potential impacts to surface water within Nagero Creek were also considered. Simulations indicate this drainage feature has no contributions from groundwater over the entire calibration/prediction period. This is consistent with the conceptualisation of this drainage feature being a ‘losing stream’ and as such surface flows in this creek recharge the underlying water table.

Water Licensing

A summary of maximum predicted water takes from the various water sources within and surrounding BCM in relation to BCOPL’s existing entitlements is provided in **Table 16**. This table demonstrates that BCOPL hold sufficient WALs to account for the predicted takes of water as a result of MOD 8.

Groundwater Users

Registered bores within the investigation area were identified from a search of the NSW Government database. The closest privately-owned registered bore (GW001799) is located approximately 6.67 km south east of the MOD 8 mining area.

Within the alluvium, there are no privately owned registered bores predicted to experience a decline of more than 2 m due to either approved mining or as a result of MOD 8. Drawdown at registered bores within the alluvium is generally predicted to be less than 0.5 m.

Table 16
Maximum Predicted Water Take in Relation to Existing Entitlements

WSP	Water Source	Year of Maximum Take	Maximum Predicted Annual Take (ML)	BCM Existing Annual Entitlement (ML)
NSW MDB Porous Rock Groundwater Sources	Gunnedah-Oxley Basin porous rock	2027	608	842
Upper and Lower Namoi Groundwater Sources	Zone 4 alluvium	2036	109	1,028
Upper and Lower Namoi Groundwater Sources	Zone 11 alluvium	2036	13	20
Upper and Lower Namoi Groundwater Sources	Zone 5 alluvium	n/a	0	0

There are 49 registered groundwater bores within the 'less productive' Gunnedah-Oxley Basin Porous Rock Water Source which are located within the 2 m drawdown contour for the Permian coal measures. Many of these bores are located on property owned by and/or within mining leases held for the BTM Complex mining operations and the neighbouring Rocglen mine. There is a single bore located on privately owned land to the east of BCM. There is limited construction/geological data available for this bore, although the reported shallow depth of installation (38.4 mbgl) suggests that it is likely installed into overburden material, which would not be depressurised at this location. BCOPL is seeking to arrange an in-field assessment / census of this bore to confirm its current use.

It is important to note the drawdown attributable to MOD 8 does not result in any new bores to be impacted beyond the 2 m threshold when compared to the impacts from the currently approved operations. Identified impacts are therefore not directly a result of MOD 8, with the predicted drawdown similar to predictions for approved mining.

Groundwater Dependent Ecosystems

The modelling results indicate the cumulative drawdown in the water table for the BTM Complex (including MOD 8) will occur beneath several areas which have been regionally mapped as high priority GDEs within the relevant WSPs. This includes:

- Cumulative drawdown of up to 0.5 m in the alluvium that underlies mapped terrestrial GDEs adjacent to parts of Goonbri Creek, Bollol Creek, and Driggle Draggle Creek;
- Up to 40 m of drawdown in the watertable that underlies terrestrial GDEs adjacent to Back Creek and its upper tributaries; and
- Up to 5 m of drawdown in the watertable that underlies terrestrial GDEs adjacent to the upper reaches of Goonbri Creek.

Using the assumption of seasonal water table fluctuations of 1 m, all areas listed above would exceed the AIP minimal impact threshold of less than or equal to 10% cumulative variation in the water table.

Previous assessments completed for mining operations within the BTM Complex have demonstrated that these potential GDEs are either unlikely to be present (Back Creek potential GDEs), or that potential impacts have already been taken into consideration as part of EAs for surrounding mining operations (Goonbri Creek, Bollol Creek, and Driggle Draggle Creek potential GDEs).

It is important to note that the identified impacts are not directly a result of MOD 8 and are also predicted to occur as part of approved mining. Predicted incremental impacts for MOD 8 alone within the highly productive alluvial aquifer are negligible (i.e. up to 0.8 m in the tongue of alluvium to the south west of BCM). Further predicted impacts for MOD 8 alone within the less productive Permian groundwater sources are fundamentally equivalent to the approved mining operations case (i.e. coal seams impacted in both scenarios).

Further assessment of the potential impacts to GDEs proximate to the BCM is provided in **Section 7.10**.

Post Mining Recovery

Simulated groundwater levels for all recovery scenarios successfully reached equilibrium within 300 years post mining. This is approximately 125 years slower than predictions of the original GIA (AGE, 2010), which is expected given the inclusion of neighbouring mines and their cumulative impacts within the model as well as the increased depth of mining proposed by MOD 8 will lead to increased storage within the spoil of the infilled mining areas. Predictions of the stabilised water table are generally consistent with the findings of the original GIA (AGE, 2010), where stabilised levels do not exceed the final landform elevation and no pit lake is present.

All modelling scenarios resulted in the water table equilibrating at approximately 285 mAHD with water levels being maintained due to the effects of evapotranspiration. This conclusion remains generally consistent with the predictions of the original GIA (AGE, 2010).

Throughout mining operations and during the years of recovery until equilibrium is reached, the BCM mining area serves as a groundwater sink. Once water levels within the final landform have equilibrated, the BCM mining area is predicted to act as a rainfall recharged groundwater source.

Predictions of recovered groundwater levels indicate that groundwater within the spoil of the BCM mining area largely reports to the final void lakes associated with the adjacent Maules Creek Mine and Tarrawonga Mine. A relatively minor volume of seepage potentially enters the adjacent alluvial tongue to the south west of BCM. Any flux of groundwater from spoil to nearby alluvial groundwater systems is expected to be insignificant relative to other sources of recharge to these systems. As such, it is inferred that a long-term change in the beneficial use of surrounding groundwater systems is unlikely, as are any increases in salinity to groundwater gaining surface water systems such as the Namoi River.

Given the conclusions of the geochemical analyses prepared for BCM to date, including RGS, 2009 and RGS, 2020 (as described within **Section 7.9**), the quality of any groundwater that migrates from the BCM mining area is expected to be of relatively good quality. No changes in the beneficial use or salinity of surrounding receptors are therefore anticipated.

Compliance with Aquifer Interference Policy

Predicted groundwater impacts associated with mining within the BTM Complex have been assessed in accordance with the provisions of the AIP. The AIP states that any assessment relating to aquifer interference activities must consider the relevant 'Minimal Impact Considerations' with respect to groundwater resources.

There are two levels of minimal impact considerations specified in the AIP. If the predicted impacts are less than the Level 1 minimal impact considerations, then these impacts will be considered as acceptable. Where the predicted impacts are greater than the Level 1 minimal impact considerations then the AIP requires additional studies to fully assess these predicted impacts. If this assessment shows that the predicted impacts do not prevent the long-term viability of the relevant water-dependent asset, then the impacts will be considered to be acceptable.

Based on the groundwater modelling, cumulative impacts that are associated with approved mining and MOD 8 generally meet the Level 1 minimal impact considerations under the AIP for the following Water Sources:

- The 'highly productive' Upper Namoi Alluvium (Management zones 11, 5, 4, and 2); and
- The 'less productive' Gunnedah-Oxley Basin Porous Rock.

Cumulative water table or water pressure declines of more than 2 m are not predicted at any privately owned water supply work within the 'highly productive' Upper Namoi Alluvium Water Sources.

Predicted water levels for the end of mining operations are predicted to exceed the Level 1 minimal impact consideration at 49 registered groundwater bores within the 'less productive' Gunnedah-Oxley Basin Porous Rock Water Source.

Make good provisions for these water supply works are unlikely to be required as:

- 33 of these bores are licenced as monitoring bores and the predicted depressurisation will therefore have no impact on their intended purpose;
- Licences for 15 of these bores are held by members of the BTM Complex/other mine operators. As such, make good works during mining are not required, nor is BCM predicted to contribute to depressurisation to these water supply works post mining; and
- The single remaining private bore is likely installed into overburden material, which would not be depressurised during mining (this is being verified by a bore census). Additionally, predictions for approved mining activities show that (if it is located within the coal seam), this bore is already impacted irrespective of MOD 8.

The cumulative end of mining water table drawdown beneath several high priority GDEs is predicted to exceed the 10% cumulative drawdown threshold. As discussed above, this threshold is predicted to occur beneath regionally mapped terrestrial GDEs. It should be noted that these impacts are not specific to MOD 8 and are also predicted to occur as part of approved mining.

Changes in groundwater quality are not predicted to lower the beneficial use in either of the Water Sources, nor are any long-term salinity increases expected in connected surface water bodies.

All direct and indirect groundwater takes can be accounted for with WALs held by BCOPL for each Water Source under the WM Act.

BCOPL will continue to regularly compare monitoring data against the predictions of the MOD 8 GIA in accordance with the provisions of the GMP. In the event that any observed impacts are identified to be greater than those predicted, the process for further investigations/potential mitigation works as outlined within Sections 6.1 and 6.2 of the GMP will be followed.

EPBC Act Considerations

As previously noted, DAWE determined that the aspects of MOD 8 were a controlled action under the EPBC Act on 28 May 2021. DAWE provided its assessment requirements to DPIE whom issued SEARs to BCOPL on 8 June 2021.

The SEARs relevant to the assessment of potential groundwater impacts have been addressed within the GIA. The GIA was undertaken in accordance with the requirements of the EPBC Act Significant Impact Guidelines (DoE, 2013) and the IESC Information Guidelines for Coal Seam Gas (CSG) and Large Coal Mining Development Proposals (CoA, 2018) and associated Explanatory Notes (Doody et al, 2019).

Groundwater modelling undertaken for MOD 8 indicates that the incremental impacts of MOD 8 relative to approved mining are minimal, while cumulative impacts are fundamentally equivalent to those for already approved mining activities.

Whilst MOD 8 results in some changes in flow regimes, recharge rates, aquifer pressure/water table level, groundwater-surface water interactions, river-floodplain connectivity, and inter-aquifer activity, these changes are not expected to be of a sufficient scale or intensity as to significantly reduce the quantity or quality of the water resources for third party users or the environment.

As per the Significant Impact Guidelines and in line with impact considerations discussed above, MOD 8 is not likely to have a significant impact on the hydrological characteristics of surrounding water sources.

7.3.4 Mitigation and Management

BCOPL manages impacts to groundwater resources in accordance with its Water Management Plan and associated Groundwater Management Plan.

BCOPL operates a groundwater monitoring network, with regular monitoring from bores that are installed into the adjacent alluvium, the Boggabri Volcanics, and coal seams (generally down to the Merriown Seam). This monitoring network is supplemented by cumulative groundwater monitoring network completed for the BTM Complex, which includes multi-level vibrating wire piezometers (VWPs) and monitoring bores down to the Templemore Seam.

The Water Management Plan will be reviewed and updated to accommodate MOD 8. Whilst the specific impacts to groundwater assets as a result of MOD 8 are predicted to be of negligible consequence when compared to approved mining, the following additional measures will be undertaken:

- An in-field assessment of the potentially impacted private registered bore (GW002523) will be undertaken to confirm its existence/suitability for use and to confirm its total depth.
- The existing monitoring network will be supplemented with additional monitoring bores in indicative site locations shown on **Figure 13**, including:
    - Site 1 - Three bores constructed within the tongue of alluvium to the southwest of BCM to monitor predicted drawdown within the alluvium;
    - Site 2 - Three monitoring bores located within key coal seams on the northern boundary of the approved Mine Disturbance Footprint to replace previous bores which have been consumed by mining activities; and
    - Site 3 - One multi-level VWP will be installed down to the base of the Templemore seam to the north-east of BCM to assist in monitoring the depressurisation of the key coal seams as mining operations progress.

7.4 SURFACE WATER

7.4.1 Background

A Surface Water Impact Assessment (SWIA) was undertaken for MOD 8 by Engeny Water Management (Engeny). The SWIA report is provided within **Appendix J** with a summary provided within the following sections.

Site Water Management System

The existing site water management system at BCM is operated in accordance with the Water Management Plan and supporting Surface Water Management Plan. The key objectives and functions of the site water management system include:

- Diversion of clean water around mining operations to minimise capture of upslope runoff and separate clean water runoff from mining activities;
- Segregating mine impacted water and runoff from undisturbed and revegetated areas with better water quality to minimise the volume of mine impacted water that requires reuse;
- Reuse of mine impacted water within the water management system to reduce reliance on raw/clean water;

- Minimising adverse effects on downstream waterways (i.e. hydraulic and water quality impacts); and
- Reducing the discharge of contaminants from the mine to the environment.

Clean water (i.e. runoff from undisturbed and/or fully rehabilitated areas) is diverted around mining operations to minimise impacts to surface flows wherever practically possible. Dirty water (i.e. runoff from disturbed areas outside the mining pit and infrastructure areas, such as OEAs (both active and under rehabilitation) is captured in sediment dams and is pumped to storages within the site water management system. Mine water (i.e. runoff from areas exposed to coal or water used in coal processing) is managed as part of the mine water management system. Mine affected water is separately contained within mine water storage dams for reuse on site.

Raw water is imported to the site from nearby groundwater and surface water sources for which WALs are held to assist in meeting the site water demands. BCOPL preferentially utilises the groundwater borefield ahead of surface water sources due to it longer term viability. BCOPL also discharges surplus water from the BCM in accordance with the conditions of EPL 12407.

Site Water Balance

The site water management system generally operates as a closed system and is designed to minimise the use of water from external sources (such as the borefield and Namoi River). Notwithstanding, water collected within the site water management system can be released to the downstream environment under certain circumstances.

Sources to the site water balance include:

- Direct rainfall and runoff from:
    - Clean catchments - which is minimised to greatest extent practical and captured within highwall dams and diversion structures upslope of the mining area;
    - Dirty water captured within sediment dams which collects runoff from disturbed areas; and
    - Mine water captured within mine water dams and entailing runoff from mining areas, coal stockpiles and other areas receiving contaminated water (other than water containing sediments);
- Groundwater inflows to the mining area which is pumped to mine water dams; and
- Licensed imported water from the Project borefield and/or from the Namoi River pump station.

The primary water demands within the site water balance include:

- Dust suppression on haul roads, conveyors and coal stockpiles;
- CHPP process water to process up to 4.2 Mtpa of ROM coal;

- MIA and potable water; and
- Evaporation from the various water storages.

Further to the above, water collected within clean water dams/structures can be diverted into the downstream environment. Treated water is released to the downstream environment once it reaches certain water quality parameters. Sediment laden water runoff overflows from the sediment dams to the downstream environment in periods of rainfall greater than the relevant design criteria. These releases of water are managed in accordance with EPL 12407.

Water Quality Monitoring

BCOPL conducts surface water monitoring in accordance with the surface water monitoring program outlined in the Surface Water Management Plan. The Surface Water Management Plan includes monitoring of the following elements of the site water management system and surrounding catchment areas:

- Surface water quality and flows in upstream and downstream watercourses;
- Geomorphology condition of Nagero Creek, upstream and downstream of the BCM;
- Stream and riparian health conditions in Nagero Creek and the Namoi River; and
- On-site water management, including water quality within dirty and mine water dams.

Historical monitoring indicates that Nagero Creek rarely experiences flow. Based on the limited monitoring data available, ambient water quality within Nagero Creek is generally good, with relatively low salinity (as EC) and suspended solids (as Total Suspended Solids (TSS)).

7.4.2 Methodology

Water Balance Modelling

The GoldSim site water balance model for the BCM was initially developed as part of the surface water impact assessment (PB, 2010) undertaken to support the Boggabri EA. SSD 09_0182 requires BCOPL to conduct an annual review of the water balance model to ensure it remains consistent with current operations. The last revision was undertaken by Engeny on behalf of BCOPL in 2020 and is the basis for site water balance modelling undertaken for MOD 8.

The water balance model was updated to simulate the mining and coal handling characteristics because of MOD 8. The model considers existing and future operations and is used to estimate the likely water surplus/deficits and requirements into the future.

The assessment of the potential impacts of MOD 8 on the predicted water balance is based on the outcomes of the GoldSim site water balance model. The model uses the climate data for the past 126 years of record. The potential impacts of MOD 8 were assessed using 126 possible climatic sequences and as such assesses the water balance for many rainfall possibilities.

A detailed discussion of the site water balance modelling methodology and assumptions is provided in **Appendix J**.

7.4.3 Impact Assessment

The proposed changes to the mine plan for MOD 8 will not result in an increase to the approved Mine Disturbance Boundary for BCM. Further the proposed disturbance for the western embankment of the fauna movement crossing will be designed to avoid impacts to surface catchments. Accordingly, MOD 8 will not result in appreciable changes to the following surface water impacts when compared to the approved operations at BCM:

- Surrounding catchment areas (including cumulative impacts) or the final landform;
- The potential for downstream flooding impacts and watercourse stability (including cumulative impacts); and
- The potential for changes in downstream flow regimes (including cumulative impacts), and therefore impacts to downstream water users and ecological conditions.

Further assessment of the above is provided within **Appendix J**.

Water Management System Changes

The conceptual water management system for MOD 8 includes an additional sediment dam, located within a trapped low point formed within the eastern edge of the OEA (see **Appendix J**). This sediment dam will be designed in accordance with the requirements of the Water Management Plan.

Pumps, pipes and drain infrastructure to support the management of existing and new water management dams/storages will also be relocated and/or constructed as part of the progression of mining operations associated with MOD 8.

Site Water Balance

A detailed site water balance has been completed with the aim of assessing future site water and water supply reliability for MOD 8 (refer to **Appendix J**).

The GoldSIM water balance model has been run for four staged mine plan years for MOD 8, including Years 2021, 2026, 2031 and 2039. A summary of the average results from the water balance modelling for these years is provided within **Table 17**.

The water balance modelling indicates total water inventory on site is primarily driven by groundwater inflows into the pit, and the imported make-up water from the groundwater borefield. During periods of low groundwater inflows to the mining area and when site water inventories drop below 1,000 ML, additional external water supplies may be required. This is consistent with the current water management procedures at BCM.

The water balance modelling indicates that, for average conditions, MOD 8 will not result in the need to purchase any additional WALs for extraction of water from the Namoi River.

The water balance modelling indicates that the volume of uncontrolled discharges (overflows) of sediment-laden water from sediment dams will reduce over time. This is expected as the OEA will be progressively rehabilitated and enable subsequent releases of water runoff from these areas to the downstream environment.

Table 17
Summary of MOD 8 Water Balance Modelling Results – Average Conditions

Water Management Element	Model Simulation Year (ML)			
	2021	2026	2031	2039
Inflows				
Direct rainfall and runoff:				
Clean water (highwall) dams	0	31	0	0
Dirty water (sediment) dams	680	333	330	334
Contaminated water dams, MWDs and Pit	1,429	1,272	1,266	1,616
Groundwater makes	173	517	401	202
Licensed imported water	470	644	486	565
Total Inflows	**2,751**	**2,797**	**2,483**	**2,716**
Outflows				
Dust suppression	639	1,643	895	720
CHPP	989	1,048	1,040	393
MIA and potable water	365	365	362	365
Evaporation:				
Clean water (highwall) dams	0	1	0	-
Dirty water (sediment) dams	133	109	99	102
Contaminated water dams, MWDs and Pit	406	367	384	510
Licenced discharges to Nagero Creek:				
Clean water (highwall) dam discharges	-	24	0	-
Dirty water (sediment) dam discharges	175	44	50	68
Overflows to Nagero Creek:				
Dirty water (sediment) dam overflows	133	12	14	16
Total Outflows	**2,841**	**3,613**	**2,844**	**2,173**
Change in storage	**-90**	**-815**	**-361**	**543**

Water Quality

As MOD 8 does not include changes to the approved water management system, the potential for changes to downstream water quality (including cumulative impacts) is considered minor, compared to the approved operations.

The Geochemical Impact Assessment undertaken for the strata underlying the Merriown coal seam (as described within **Section 7.9**) indicates that surface runoff and seepage from overburden materials is likely to fall within the 95th percentile species protection range for aquatic ecosystems and therefore unlikely to present a significant risk to surface water quality.

The water management system is designed to enable BCOPL to meet the conditions of EPL 12407, taking account of both historical and current water qualities in the surrounding watercourses, and current and future downstream water users. The risk of overflows during events that exceed the approved design criteria and potential impacts associated with overflows is currently managed by the Water Management Plan.

No changes to the design criteria for water management infrastructure are proposed. The Water Management Plan allows for the ongoing assessment of risk as mining operations progress, and the implementation of improvements and changes where required.

Flow Regimes

The Groundwater Impact Assessment for MOD 8 (see **Section 7.3.3**) indicates that the proposed mine plan changes results in small increases to groundwater inflows to the mining areas, negligible impacts to the alluvial aquifer systems and no measurable change baseflow loss from surface water systems. Therefore, the potential for impacts to streamflow regimes are negligible, compared to the approved operations.

Water Users

As no changes are proposed to the total extent of mining and no significant changes will occur to the approved water management system, the potential for changes in downstream flow regimes (including cumulative impacts), and therefore downstream water users, is considered minor, compared to the approved operations.

Water balance modelling indicates that the current WALs held by BCOPL will remain sufficient to cater for water demand at BCM, with the periodic purchase or sale of additional water to continue (in line with climatic conditions) as per current practice on site.

Final Void

As discussed within **Section 7.3.3**, groundwater modelling indicates that the long-term groundwater levels within the vicinity of the final void will be below the finished level of the floor of the partially infilled final void area.

Therefore, groundwater inflows into the final void will be minimal, and the void will likely provide additional groundwater recharge through the capture and infiltration of surface water.

Modelling of the final void indicates that surface water will accumulate within the void following periods of high rainfall intensity or extended wet weather. This intercepted water will be retained and lost to evaporation and infiltration. Therefore, no final pit lake is expected in accordance with the requirements of Schedule 3, Condition 69, Table 16 of SSD 09_0182.

7.4.4 Mitigation and Management

Surface water is managed at BCM in accordance with the Water Management Plan and associated Surface Water Management Plan.

These plans will be reviewed and updated to include the addition of a new sediment dam and associated infrastructure to the water management system and to account for the changes to the site water balance associated with MOD 8.

7.5 TRAFFIC AND TRANSPORT

7.5.1 Background

A Traffic and Transport Assessment (TTA) for MOD 8 has been undertaken by Cardno. A summary of this report is discussed below and is provided in full in **Appendix K**.

The purpose of the TTA was to assess the potential impacts of MOD 8 on the capacity, efficiency and safety of the local road network in the vicinity of BCM.

As noted in **Section 3.6**, the initial environmental assessments for BCM indicated the operations would be supported by up to 500 employees (indicative) at the peak production of 7 Mtpa of product coal. It should be noted that the 2010 Boggabri EA estimate of 500 FTE did not account for contractors employed for short term or shutdowns or persons accessing site for very short periods of time, which are now captured by contemporary industry reporting using the FTE value recording system. As of June 2020, the BCM has a workforce of approximately 750 FTE personnel (including employees and contract workers).

The proposed MOD 8 workforce will be an average of 620 FTEs from 2022 to 2039, with a peak number of 770 FTE. This forecast workforce peak is broadly equivalent to current peak operations and has been used for impact assessment purposes.

Whilst the proposed employment for MOD 8 is generally consistent with the current employment levels at BCM. However, the TTA has assessed the additional movements on the local road network for MOD 8 that were not accounted for in the Boggabri EA assessments. In addition, changes to deliveries and workforce resulting from the proposed increase in intensity of mining have also been accounted for within the TTA for MOD 8.

BCOPL advised that shift changeover periods have remained relatively consistent at BCM throughout the years since the Boggabri EA was prepared and hence for consistency, these shift changeovers have been applied to the MOD 8 scenario.

MOD 8 also proposes a temporary workforce associated with the construction of the fauna movement crossing. The TTA has conservatively assessed 25 FTE employees for approximately six months. However, it is noted that current planning indicates that only 15 FTE employees are likely to be required.

7.5.2 Methodology

<u>Desktop Review</u>

A desktop review was completed which included a review of the BCM locality, historical traffic data collection, review of other transport models completed within the area and the existing road safety conditions.

The TTA was prepared utilising the following information:

- Existing site condition review of the BCM and surrounding road network;
- Use of historical traffic data sources from on-site monitoring and surrounding development applications. It is noted that at the time of preparing this assessment, traffic volumes surrounding the BCM may have been impacted by the COVID-19 pandemic, having influenced peoples working arrangements, and recreational trips;
- Assessment of the parking requirements in consideration of NSC's Development Control Plan (DCP);
- Establishment of baseline traffic conditions without MOD 8 and assessment of the MOD 8 traffic generation impact based on site information and forecast assumptions. The traffic impact assessment also considers the cumulative impacts of on-site construction activities where it overlaps with the MOD 8 mining operations as well as other development applications surrounding the BCM;
- Review of road safety considerations (following a review of crash data provided by NSW Roads and Maritime Services (RMS)) and an assessment of the potential impacts of MOD 8 on road safety; and
- Review of existing mitigation and management measures and the identification of any further measures which may be required to appropriately control the potential additional traffic impacts as a result of MOD 8.

The incremental impacts of MOD 8 on the performance of key roads and intersections were assessed by comparing the projected traffic to existing traffic volumes.

Performance of the local road network was assessed using criteria contained within *Austroads Guide to Traffic Management Part 3: Traffic Studies and Analysis* (Austroads Guide). The midblock level of service (LoS) assessment criteria contained with the Austroads Guide provides a useful benchmark to assess changes as a result of development, particularly for road segments which have relatively low traffic volumes whereby intersection performance and delay is not necessarily the appropriate measure.

Background traffic volumes (including both mining and non-mining related traffic) were assumed to increase by up to 1% per annum. Increases in traffic volumes due to other mining proposals within the region were also included in background traffic volumes.

7.5.3 Impact Assessment

Operational

The identified peak 770 FTE is estimated to generate approximately 404 additional daily trips beyond that previously assessed within the Boggabri EA (500 employees).

The expected increase in deliveries will be proportional to the increase in fuel consumption, being estimated to increase by a factor of 1.71 from 2019 levels. Therefore, the increase in daily movements for deliveries of fuel is forecast to be a total of approximately 12 movements per day or an increase of 6 vehicles per day.

For other ancillary deliveries, the current operation generates approximately 31 movements per day to the workshop. Based on the forecast increase to the yearly consumption of fuel, being a factor of 1.71, the daily movements associated with other delivery types are forecast to increase from 31 to 53 per day. Accordingly, it is assumed that MOD 8 will result in an additional 27 movements per day for consumables and deliveries (14 in; 13 out).

The cumulative 2025 forecast volumes along the assessed roads are within an acceptable LoS A, indicating that the proposed traffic which has conservatively assumed to be generated by MOD 8 will have little to no impact on the road network performance, including when considering other projects in the region.

Further to this, the peak hour volume of traffic increase across the road network is unlikely to result in detrimental impacts to the intersection performance of Kamilaroi Highway / BCM Access Road (1 and 2) or Rangari Road / Leard Forest Road. The traffic volumes utilising these intersections has been assessed by Cardno to be sufficiently low such that intersection modelling is not justified.

The review of the history of crashes on the local road network did not highlight any particular crash causation factors on the key roadways. The additional traffic assessed for MOD 8 is unlikely to have a tangible nexus in detrimentally impacting the crash rates on the road network surrounding the BCM.

Fauna Crossing Construction

The construction workforce for the fauna movement crossing is anticipated to be relatively low in comparison to the operation of the BCM. It is estimated that up to 15 employees will be onsite at any one time in association with the fauna movement crossing.

The timing of the crossing construction works is not yet known. However, it was conservatively assumed to overlap with the peak Operation Workforce period, being Year 2025. The estimated construction workforce is predicted to generate some 38 trips during the day. This construction traffic in conjunction with the additional traffic assumed to be generated by MOD 8 were assessed to result in negligible impacts to the existing road network.

Conclusion

The TTA identified that the additional traffic generated by MOD 8 will have a negligible impact on the operation of the road network. There are no specific safety concerns with the existing road network due to MOD 8.

7.5.4 Mitigation and Management

BCM currently manages the impacts of its traffic on the local road network in accordance with the BCM Traffic Management Plan (TMP). The TMP includes the following:

- A code of conduct for the drivers of heavy vehicles;
- Nominated access routes for heavy vehicles;
- Measures to minimise traffic impacts to school bus routes;
- Measures to minimise the generation of dust on unsealed roads which are used to access to the BCM;
- Travelling speeds;
- Procedures to ensure that drivers to and from BCM adhere to designated over-dimensional and heavy vehicles routes;
- Procedures to ensure that drivers to and from BCM implement safe driving practices; and
- A detailed program to monitor and report on the effectiveness of these measures and the code of conduct.

Given that MOD 8 will result in the generation of additional heavy vehicles and employee vehicle movements, the controls currently described within the TMP for driver code of conduct and fatigue management will continue to be implemented for MOD 8.

BCOPL will prepare and implement a Construction Traffic Management Plan for the proposed fauna movement crossing to identify, mitigate and manage any potential traffic impacts during the construction program.

7.6 VISUAL

7.6.1 Background

A Visual Impact Assessment (VIA) was undertaken by Hansen Bailey to assess the visual impacts of MOD 8 within the contemporary landscape. A copy of this report is provided within **Appendix L**, with a summary in the following sections.

7.6.2 Methodology

The VIA for MOD 8 generally entailed the following:

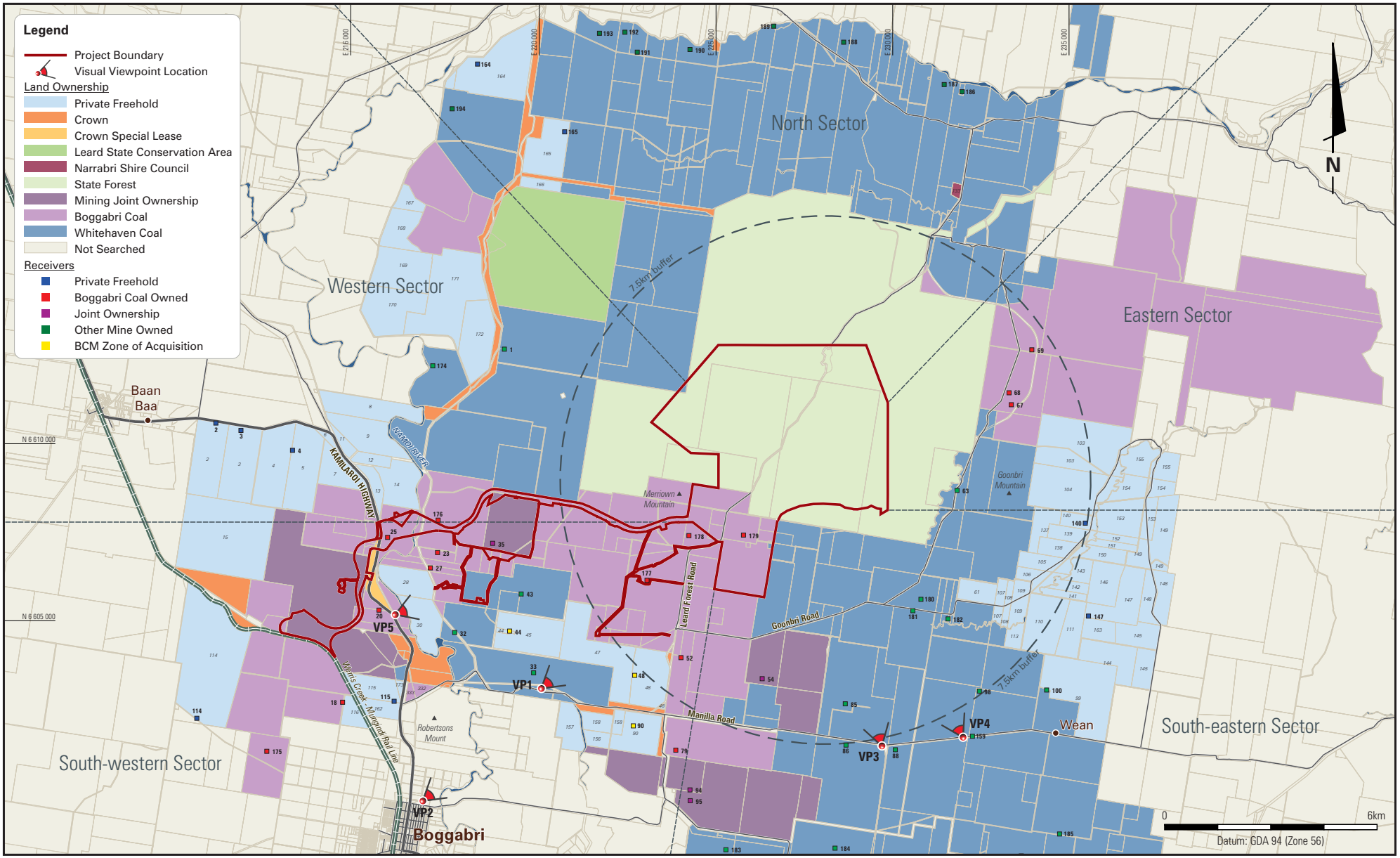
- Desktop literature review and consideration of previous assessments completed for the BCM (such as the Boggabri EA VIA (Integral, 2010)) and surrounding mines to determine the background visual character of the landscape;
- Review of the proposed changes to the BCM Conceptual Final Landform for MOD 8 to determine the primary visual catchment, view sectors and key viewing locations to visit during the field visit. The primary visual catchment, view sectors and view locations assessed for MOD 8 were consistent with those assessed within the Boggabri EA VIA (Integral, 2010) and are illustrated on **Figure 14**;

- Field visit to review the existing visual character, including any changes since the previous assessments and to take photographs from the key viewing locations to support the assessment of visual impacts from the mine plan changes sought by MOD 8;
- Determination of the visual effect and visual sensitivity of the proposed mine plan changes sought by MOD 8. The visual effect and visual sensitivity were assessed by considering the visual characteristics of the proposed mine plan changes in the context of the existing landscape within which these changes will be seen;
- Assessment of visual impacts by considering the interactions between the visual sensitivity of the key viewing locations and visual effect of the proposed mine plan changes (as viewed from the key viewing locations) as outlined in **Table 18**;
- Consideration of the potential impacts of MOD 8 on the contemporary visual character of the landscape; and
- Identification of any further mitigation and management measures required to minimise the potential visual impacts created by MOD 8.

Visual sensitivity is a measure of how critically a change to the existing landscape is viewed by people from different land use areas in the vicinity of a development. Assessing the visual impact of the proposed modifications to the landscape involves quantifying the change to the existing environment that the construction and operation of MOD 8 will have. The magnitude of the impact will depend on the visual effect of the proposed mine plan changes sought by MOD 8 (i.e. how much it contrasts with the existing environment) and the visual sensitivity of any viewers.

Table 18
Visual Impact Assessment Matrix

		Visual Effect		
Visual Sensitivity		**High**	**Moderate**	**Low**
	High	High	High/Moderate	Moderate/Low
	Mod	High/Moderate	Moderate	Moderate/Low
	Low	Moderate/Low	Moderate/Low	Low
	Very Low	Low	Very Low	Very Low



HB BOGGABRI MOD8 1824 F14 Indicative View Sectors 23 03 2021

BOGGABRI COAL MINE

Indicative View Sectors

FIGURE 14

Hansen Bailey
ENVIRONMENTAL CONSULTANTS

IDEMITSU
BOGGABRI COAL

7.6.3 Impact Assessment

The assessed visual impacts of the proposed mine plan changes sought for MOD 8 are summarised in **Table 19**.

The North, East and West Sectors will continue to not experience any visibility to BCM's activities, due to screening from the Willow Tree Range. Accordingly, no visual impacts are anticipated from MOD 8 to receivers located within these view sectors.

Within the South East Sector, VP3 and VP4 are anticipated to continue to have views towards the southern slopes and elevated parts of the developing OEA. Given that existing views of exposed overburden profiles are currently experienced by these receivers, the increase in landform heights by 5 m will result in moderate to low impacts. A higher visual impact may occur for representative private receivers in proximity to VP3 (which is 7 km from the highest point of the OEA from MOD 8). However, all landholdings inside this area are now mine owned properties which are therefore of lower sensitivity. The closest private receiver to VP4 is now Receiver 147, which is approximately 7 km away and is partially screened by the Willow Tree Range, has views towards the Tarrawonga Mine and limited background views of BCM's OEA. Therefore, a moderate to low impact from MOD 8 is predicted at this location, reducing to low after 2026 when rehabilitation of the exposed faces of the OEA is completed.

In the South West Sector, VP1 is anticipated to continue to experience distant views of the development of the OEA. The mine plan changes sought by MOD 8 to the OEA have been assessed to result in moderate to low impacts to VP1. VP2 and VP5, where limited views are available to the BCM from distant viewing locations (i.e. generally more than 10 km), visual impacts are predicted to continue to be low.

It is noted that the mine plan changes sought by MOD 8 have the potential to result in a high visual effect being experienced at VP1 (representative of private receivers within the south west sector) during the period within which the OEA is being developed and views of raw overburden materials are visible. However, this high visual effect is considered unlikely to occur due to the advancement of current rehabilitation activities at BCM, including the rehabilitation of the southern faces of the OEA which will form a large proportion of views of the BCM.

Table 19
Visual Impact Assessment Summary

Viewing Point	Visual Sensitivity	Visual Effect	Visual Impact
VP1	Moderate	High	Moderate to Low
VP2	Moderate	Low	Low
VP3	Low	Moderate	Moderate to Low
VP4	Low	Moderate	Moderate to Low
VP5	Low	Low	Low

Night Lighting

MOD 8 may result in changes to existing lighting emissions from BCM due to the proposed amendments to mining operations, including the advancing faces of the OEA. In addition, the reconfiguration of the mining fleet as proposed by MOD 8 may increase the volume of mobile vehicles which result in altered lighting effects.

However, given MOD 8 is not proposing to extend mining outside of the currently approved Mine Disturbance Boundary, instead only going deeper, the nature and scale of the night lighting at BCM is anticipated to be generally consistent with the existing night lighting at BCM.

The Siding Springs Observatory is located approximately 126 km south-west of BCM. As such, the BCM is within the Dark Sky Region, as defined in the *Dark Sky Planning Guideline* (DPIE, 2016). It is considered that MOD 8 would result in a negligible change to night lighting effects when compared to the currently approved operations at BCM.

Schedule 3, Condition 65 of SSD 09_0182 specifies operational measures to be applied to BCM's operations to minimise lighting and visual effects from its operations. This includes the requirement for all external lighting to comply with *Australian Standard (AS)4282 (INT) 1997 – Control of Obtrusive Effects of Outdoor Lighting* (or its latest version) and to ensure lighting is directed below the horizontal.

These requirements are consistent with the lighting design principles described within the Dark Sky Guidelines and will continue to be implemented for operations under MOD 8.

BCOPL has provided details of the proposed mine plan changes sought by MOD 8 along with the existing lighting management at BCM to the Siding Springs Observatory for their information.

7.6.4 Mitigation and Management

The changes to operations sought by MOD 8 will not result in any material additional impacts on the surrounding visual landscape at any private receiver. Operations at the BCM will continue to be managed in accordance with the relevant conditions of SSD 09_0182. No further mitigation or management measures beyond those previously outlined in the Boggabri EA and SSD 09_0182 are proposed.

Night lighting will continue to be managed in accordance with Condition 65, Schedule 3 of SSD 09_0182 and in consideration of the *Dark Sky Planning Guideline* (DPIE, 2016).

7.7 REHABILITATION AND FINAL LANDFORM

7.7.1 Background

Landloch was commissioned to undertake a review of the Conceptual Final Landform for MOD 8, consider the potential impacts of the proposed landform changes to its integration with adjoining Maules Creek and Tarrawonga Mines and to provide recommended mitigation and management measures to address any landform erosion stability risks.

The Evaluation of Proposed Changes to Final Landform report is provided in **Appendix M** with a summary provided within the following sections.

7.7.2 Methodology

The landform review entailed the comparison of:

- Drainage patterns between the approved Conceptual Final Landform and the MOD 8 Conceptual Final Landform,
- Simulated erosion rates for the OEA and mining areas for each landform design to identify areas of erosion risk; and
- Interaction of the MOD 8 Conceptual Final Landform design with neighbouring Tarrawonga and Maules Creek Mines.

Drainage comparisons were made by reviewing the outputs of the digital elevation models (DEMs) for each landform design and identifying drainage flow lines (with an assumed minimum catchment area of 0.25 ha).

Simulated erosion rates were derived utilising the SIBERIA landform evolution model (Willgoose *et al* 1989; 1991). The outputs of this modelling were utilised to identify areas of increased long-term erosion risk for the MOD 8 Conceptual Landform Design which will require attention in the final landform construction.

For the SIBERIA model, Landloch utilised output data from the Water Erosion Prediction Model (WEPP) runoff/erosion model which has previously been prepared for the BCM landforms (Landloch 2018). The WEPP outputs were then modified to consider the target vegetation for batter slopes (i.e. Woodland), with cover levels specified in the BCM MOP, including:

- 30% grass cover;
- 20% litter cover;
- Approximately 30% shrub canopy cover; and
- 30-65% tree canopy cover.

Various other parameters of the SIBERIA modelling were developed utilising conservative assumptions, including hydraulic conductivity of the landform, surface roughness and surface cover. The SIBERIA modelling was then run for 50, 100, 200 and 300 years following the establishment of the final landform. Outputs were reviewed to determine areas of potential erosion risk for ongoing management during the establishment of the final landform at BCM.

Further details on the SIBERIA modelling methodology are included within **Appendix M**.

7.7.3 Impact Assessment

Drainage Review

The key change to the BCM Conceptual Final landform proposed by MOD 8 is to increase the approved maximum height of the OEA by 5 m from 395 m AHD to 400 m AHD. This will allow the top of the landform to be redesigned to a more undulating surface to ensure the final landform blends with the surrounding natural landform, with most runoff being managed on the top of the landform.

Landloch identified that this will assist by reducing the potential for uncontrolled discharges of water runoff onto outer batter slopes of the landform. In turn, this will assist in the minimisation of erosion potential in the years that vegetation cover is established on the outer slopes of the landform.

It is noted that the review identified that much of the western and southern slopes of the OEA at BCM have already been established. Whilst MOD 8 seeks to increase the height of the OEA by 5 m, the OEA will also cover a larger footprint and advance further towards the northern and eastern parts of the BCM.

Erosion Modelling

Overall, the erosion rates for both approved and MOD 8 landforms are in the range of 5.3 to 6.9 tonnes per ha per year (t/ha/y). These erosion rates are within the range of the commonly applied “acceptable” rate of 5 t/ha/y (Landloch, 2020). A small area in the south of the landform shows a higher erosion rate. Considering the simulations included conservative assumptions the predicted erosion rate from the OEA for the MOD 8 Conceptual Final Landform is considered acceptable.

Overall, the simulations do not indicate large differences in erosion risk between the approved and proposed mining area final landforms.

Integration with Neighbouring Mines

Consideration of the proposed final landforms for the three mines within the BTM Complex did not identify any significant changes in landform integration as a result of the MOD 8 Final Landform Design.

The assessment identified some areas of potential erosion risk in the southern portion of the existing BCM OEA which is adjacent to the common boundary with the Tarrawonga Mine. This area is unaffected by MOD 8. BCOPL is proactively working with Tarrawonga Mine in relation to the integration of the landforms in the vicinity of the common lease boundary. These works are anticipated to assist in remediating the potential for erosion risk in this area.

7.7.4 Mitigation and Management

Rehabilitation activities at BCM are currently managed in accordance with the measures described within the Rehabilitation Management Plan (RMP) and MOP.

The evaluation of the MOD 8 Conceptual Final Landform identified a small area of material erosion potential. BCOPL will implement the following mitigation measures to reduce this potential erosion risk to a more acceptable level:

- Diversion of upslope catchments and surface runoff away from this area;
- Rock armouring of the short steeper section of land at the toe of the slope; and
- Continuing to proactively engage with Tarrawonga Mine in relation to the appropriate integration of the final landform along the common boundary.

Fauna Movement Crossing Rehabilitation

Land which is disturbed for the construction of the fauna movement crossing will be rehabilitated at the final stages of the construction program. The primary objectives of the proposed rehabilitation activities associated with the fauna movement crossing include:

- Establish a landform which is safe, stable and non-polluting;
- Landform is developed such that it integrates (or is consistent) with the adjacent natural and previously rehabilitated landforms; and
- Revegetated utilising local native plant species to create natural woodland and with the primary focus of restoring ecosystem function and habitat connectivity to encourage semi-mobile and sedentary fauna species to move between the Leard State Forest and the rehabilitated mining areas. The connection for these fauna species is currently limited with the separation of these woodland areas by the main haul road.

Rehabilitation activities for the fauna movement crossing will utilise the following measures to achieve the above objectives:

- Rehabilitation activities will utilise habitat resources/fauna furniture (i.e. fallen logs, bush rocks, stag trees, etc) recovered from clearing activities at BCM on the fauna movement crossing in a way to minimise potential predation effects;
- Rope bridges, glider poles and barrier fencing will be utilised to encourage fauna to utilise the crossing; and
- Lighting and noise mitigation measures will be applied to the fauna movement crossing to avoid potential deterrents for fauna to not utilise the crossing.

At the cessation of mining operations, it is anticipated that the fauna movement crossing, and associated infrastructure will be removed, and the area rehabilitated.

7.8 SOILS

7.8.1 Background

Landloch was commissioned to undertake the relevant assessment of the soils and landforms to be disturbed by MOD 8.

The Soils Assessment is included within **Appendix N**, with a summary of this assessment provided within the following sections.

7.8.2 Methodology

The assessments generally entailed a review of background data, a field inspection of the MOD 8 Survey Area to validate available soils information and development of mitigation and management recommendations.

Desktop Review

A desktop review was completed prior to fieldwork to understand the available information and establishing fieldwork plans to focus on areas requiring validation to existing information. This preliminary review enabled the construction of a baseline conceptual model of the soil and landscape characteristics of the MOD 8 Survey Area.

This review included:

- Assessment of available topographic, geological, vegetation, soil mapping and associated reports, relevant to the MOD 8 Survey Area;
- Reviewing of aerial imagery of the MOD 8 Survey Area; and
- Drafting the preliminary mapping units for validation during the fieldwork.

Field Inspection

A targeted survey of the MOD 8 Survey Area as illustrated on **Figure 15** was completed in June 2020 to verify the preliminary mapping units developed during the desktop review.

A previous field assessment completed for BCOPL by Landloch (Landloch, 2014) had largely covered the southern area of the MOD 8 Survey Area. Accordingly, the June 2020 field surveys focused on the northern portion of the MOD 8 Survey Area.

Four new sites were investigated in the field to supplement previous surveys for MOD 8. Data was collected from all ground observation sites in accordance with the *Australian Soil and Land Survey Field Handbook* (The National Committee on Soil and Terrain, 2009).

Brief mapping observations were undertaken to verify soil type, mapping boundaries, and distributions. No laboratory analysis was considered necessary for the field survey given the previous sampling effort for the soil types within the MOD 8 Survey Area.

The previous soils assessment (Landloch, 2014) entailed laboratory analysis for 19 full soil profiles and 13 partial soil profiles over the southern portion of the MOD 8 Survey Area (including the MOD 8 Disturbance Footprint).

The soil types at each of the four new sites investigated were classified using the Australian Soil Classification system (Isbell, 2002), generally to a suborder level (OEH & OASFS, 2013). Soil types were determined by similarity of morphological and physico-chemical properties as well as by parent material, representative landforms and geomorphological position in the landscape (McKenzie, et al., 2008).

Mapping was completed following the fieldwork and laboratory analysis, to refine and modify the preliminary mapping units and to develop 'soil mapping units' (see **Appendix N**).

7.8.3 Impact Assessment

Soil Mapping Units

Two distinct soil mapping units were identified within the MOD 8 Survey Area. The Blue Vale Footslopes soil mapping unit was identified to cover around 61 ha of the northern portion of the MOD 8 Survey Area. The remaining 48 ha within the southern portion of the MOD 8 Survey Area was assessed to comprise the Brentry soil mapping unit. The MOD 8 Disturbance Footprint is located at the transition zone between the two soils mapping units.

Topsoil Suitability and Availability

Table 20 provides a summary of the topsoil stripping depths and suitable growth media for the two soil mapping units assessed to occur within the MOD 8 Survey Area.

For materials rated as either marginal or poor suitability as growth media, the primary issues being low fertility, dispersive, alkalinity and salinity.

Table 20
Summary of Stripping Depths and Growth Media Suitability

Soil Mapping Unit	Layer	Depth (m)	Growth Media Suitability
Blue Vale Footslopes	TS	0 to 0.2	Good
	Upper Sub Soil (USS)	0.2 to 0.5	Marginal (low fertility, dispersive)
	Lower Sub Soil (LSS)	0.5 to 1.2	Marginal (low fertility, highly alkaline, highly dispersive)
Brentry	TS	0 to 0.15	Good
	USS	0.15 to 0.4	Marginal (highly dispersive)
	LSS	0.4 to 1.0	Marginal (highly dispersive, sometimes saline)

7.8.4 Mitigation and Management

BCOPL currently manages the impacts of BCM's activities on soil resources in accordance with the mitigation and management measures described within the BCM Soil Management Protocol, Surface Water Management Plan, RMP and MOP. The management strategies outlined within these documents are relevant to the additional disturbance area associated with the construction of the fauna movement crossing and can be readily implemented to manage the impacts.

Consistent with the current operations, the following mitigation and management strategies will be implemented during the construction activities for the fauna movement crossing:

- Erosion and sediment control measures will be planned and implemented prior to ground disturbance activities occurring to appropriately manage erosion risks;

- Prior to disturbance, soil resources will be identified and a plan for soil stripping and recovery will be developed to enable the salvage of suitable soil resources for reuse in the final rehabilitation activities at BCM (including those proposed for the fauna movement crossing);
- Soil materials will be stripped in a moist condition and placed directly onto shaped rehabilitation areas (where practicable) or temporarily stockpiled using methods to reduce impacts to soil structure and compaction for later reuse on rehabilitation areas; and
- Soil materials salvaged for clearing activities associated with the Fauna Movement Crossing will be recorded within the BCM soil inventory as detailed within the Soil Management Protocol.

7.9 GEOCHEMISTRY

7.9.1 Background

A geochemical assessment was undertaken by RGS Environmental to assess the interburden and potential coal reject material that would be encountered for the deeper strata during mining operations associated with MOD 8. A copy of this report is provided within **Appendix O**, with a summary provided in the following sections.

7.9.2 Methodology

The purpose of the assessment was to:

- Characterise the overburden, interburden and coal rejects (including coarse rejects and fine rejects) associated with open cut mining of the targeted coal seams for MOD 8; and
- Develop and recommend any necessary environmental management measures related to overburden, interburden and coal reject emplacement and BCM's rehabilitation program.

The characterisation of the overburden, interburden and coal rejects has enabled an understanding of the anticipated water quality associated with runoff and seepage from coal stockpile areas, backfilled open cut voids and OEAs. These findings have in turn been considered within the Surface Water Impact Assessment and the Groundwater Impact Assessment (see **Sections 7.4** and **7.3**).

An initial preliminary review of previous geochemical programs completed at BCM along with any other relevant site data was completed to facilitate the development of an appropriate sampling and geochemical program for obtaining representative samples of interburden and potential coal reject materials associated with MOD 8.

Three drill holes (BC2463, BC2464 and BC2466) were sampled by BCOPL personnel and drill core from the 2019 resource drilling program. These samples were provided to RGS for geochemical assessment.

A total of 92 samples were collected from the three drill holes provided (35 samples from BC2463, 27 samples from BC2464 and 30 samples from BC2466). The samples represented the interburden and potential coal reject materials expected to be encountered during future mining activities at BCM, from approximately 75 m to 450 m below surface.

The samples focussed on the stratigraphic profile from directly below the Merriown Seam to the basement of the coal measures (i.e. to the Boggabri Volcanics).

Samples were subjected to a series of geochemical tests at a commercial laboratory in Brisbane. A series of static and kinetic geochemical tests were completed on the collected BCM samples. This program was designed to assess the degree of risk from the presence and potential oxidation of sulfides, and generation and the presence/leaching of soluble metals/metalloids and salts. The assessment also included characterisation of standard soil parameters including salinity, sodicity, Cation Exchange Capacity (CEC), exchangeable sodium percentage (ESP), and major metal concentrations.

7.9.3 Impact Assessment

Coal Rejects and Coal

The results of the static geochemical tests demonstrate that the majority of the interburden and potential coal reject materials contain negligible sulfur, have excess Acid Neutralising Capacity (ANC), and are classified as Non Acid Forming (NAF). These samples represent materials with a very low risk of acid generation and a high factor of safety with respect to generating acidic drainage.

It is expected that the continuation of current practice by blending the potential coal reject materials with overburden materials will result in a bulk material that is classified as NAF. The majority of the materials represented by the samples tested have excess ANC and are likely to provide a significant source of buffering to any unexpected acidity generated from specific mining materials.

The ANC results for the current work was observed to be higher than the previous work completed for the approved operations on overburden, interburden and potential coal reject materials (i.e., from surface down to the Merriown Seam). This indicates an improved factor of safety at BCM with respect to any potential for Acid Mine Drainage (AMD) as operations advance deeper into the stratigraphic profile (i.e. below the Merriown Seam to the base of the Templemore Seam).

Seepage Water Quality

The risk of significant water quality impacts from NAF coal and mining waste material is low. Static and Kinetic Leach Column (KLC) geochemical test results have indicated that initial and ongoing surface runoff/seepage is likely to be slightly alkaline.

The major ion concentrations in leachate from interburden and potential coal reject materials are relatively low and dominated by sodium, chloride, sulfate and bicarbonate. The calcium and sulfate concentration in leachate from the interburden and potential coal reject materials is well below the required guideline criterion.

Trace metals/metalloids in seepage and runoff from coal reject and storage areas are likely to be low. The concentration of dissolved metals/ metalloids in surface runoff and seepage from these materials is likely to be low and below the applied water quality guideline criteria.

The interburden and potential coal reject materials are not expected to present any environmental issues associated with metal/metalloid concentrations for revegetation and rehabilitation.

Soil Characteristics

Dispersive materials can impact surface water environments through increasing the sediment load present in surface waters, increasing the turbidity of surface waters. Overall, the results of the geochemical tests indicate that the deeper interburden materials are strongly sodic and low in exchangeable calcium and consequently, may be susceptible to dispersion and erosion. This is generally consistent with the materials encountered during existing operations for which appropriate management measures have been established.

Low Total Organic Carbon (TOC) level of the conglomerate and sandstone interburden indicates that material represented by the samples tested may exhibit poor to average structural conditions and structural stability.

7.9.4 Mitigation and Management

The ongoing management of overburden will consider the geochemistry of these materials with respect to their potential risk to cause harm to the environment and their suitability for use in construction and revegetation. The following mitigation measures will be implemented for MOD as described within the approved Soil Management Protocol:

- Operational sampling and geochemical testing of mining waste, consistent with best practice, throughout the mine life; and
- The periodic addition of several metals into the water quality monitoring program to verify the dissolved concentration of these elements remains low.

7.10 ECOLOGY

7.10.1 Background

WSP was commissioned to prepare the relevant assessment of ecological values for MOD 8 in relation to the additional 1.21 ha of disturbance (within the MOD 8 Disturbance Footprint), outside of the currently approved disturbance area at BCM, required to construct the fauna movement crossing.

The BOS has been established under the BC Act to provide a framework to avoid, minimise and offset impacts on biodiversity from development and clearing.

The proponent for a development to which the BOS applies is required to prepare a Biodiversity Development Assessment Report (BDAR) in support of an application for approval to undertake that development.

The BDAR uses the Biodiversity Assessment Method (BAM) to provide a methodology for determining the number and type of biodiversity credits required to offset biodiversity impacts. The BOS applies where a proposal exceeds the following thresholds:

- Where the area of native vegetation being cleared exceeds the relevant threshold areas (based on lot sizes under the relevant LEP); or
- Whether the impacts occur within an area where significant biodiversity values have been identified on the Biodiversity Values Map published by the Minister of Environment; or
- Where the impacts are likely to result in a significant impact on any threatened species, populations or ecological communities.

The MOD 8 Disturbance Footprint is located on land zoned as RU3 (Forestry) under the Narrabri LEP. Lot Size Map Sheet LSZ_004 does not have a minimum lot size for areas of land zoned as RU3. Land surrounding the Leard State Forest is zoned as having a minimum lot size of 100 ha, including the southern extent of the MOD 8 Survey Area. A worst case vegetation clearing scenario of approximately 3.3 ha associated with MOD 8 (i.e. conservatively assuming the entire MOD 8 Disturbance Footprint will be disturbed) exceeds the BOS threshold. As such, the BAM was triggered and a BDAR has subsequently been prepared for MOD 8.

A summary of the BDAR prepared for MOD 8 is provided within the following sections, with the document included in **Appendix P**.

WSP was also commissioned to complete the relevant assessment of the potential impacts of changes sought by MOD 8 (primarily the impacts from increasing mining depth at BCM) on GDEs. A summary of the GDE assessment is provided within the following sections and a full copy of this report included in **Appendix Q**.

7.10.2 Methodology

The MOD 8 Survey Area, which was subject to the BDAR ecological field assessments, covers an area of 110 ha on the western side of the BCM approved Mine Disturbance Boundary. The MOD 8 Survey Area was identified as a conservative area which may accommodate infrastructure options considered to establish a fauna crossing.

The MOD 8 Disturbance Footprint was subsequently determined following the establishment of a conceptual understanding of the proposed fauna movement crossing over the existing haul road. As the detailed design of the fauna crossing will be undertaken post approval, the entire 3.3 ha of the MOD 8 Disturbance Footprint has been conservatively assessed to be disturbed within the BDAR prepared for MOD 8, albeit only up to 1.21 ha of this area is expected to be disturbed.

The BDAR has been prepared in accordance with the BAM (OEH, 2017) and supplementary BAM Operational Manuals – Stage 1 and Stage 2 (DPIE, 2019 and OEH, 2018).

The threatened species and ecological communities known or likely to occur within the MOD 8 Survey Area and the smaller MOD 8 Disturbance Footprint were identified through a systematic approach that comprised of relevant database searches, a review of recent literature and targeted field surveys.

Extensive biodiversity surveys and investigations have been undertaken across the BCM Project Boundary and surrounds associated with the approved operations. The results from these previous assessments have been considered in the preparation of the BDAR. A review of previous documents and reports relevant to the MOD 8 was undertaken. The information obtained was used to inform survey design and was also used to assist in the assessment of potentially occurring threatened and migratory species, endangered populations and Threatened Ecological Communities (TEC). Relevant documents included:

- Continuation of Boggabri Coal Mine – Biodiversity Impact Assessment (2010);
- Maules Creek Coal Mine Biodiversity Impact Assessment (2011);
- Tarrawonga Coal Project Environmental Assessment – Appendix E (Fauna Assessment) and Appendix F (Flora Assessment) (2011);
- Alternative Biodiversity Corridor Strategy (2016);
- Annual Biodiversity Monitoring of Leard State Forest (2006-2019);
- Annual Monitoring of Leard State Forest Biodiversity Corridor (2013-2019);
- BCM Tree Clearing Reports (2013-2020);
- Biodiversity surveys of Boggabri Coal Mine within Leard State Forest (2018-2020);
- PlantNet Database, assessed August 2020;
- BioNet Atlas of NSW Wildlife, assessed August 2020;
- EPBC Act Protected Matters Search Tool, assessed August 2020;
- Biodiversity Assessment Calculator (BAM-C), assessed August 2020; and
- Fisheries Spatial Data Portal, assessed August 2020.

An initial likelihood of occurrence assessment was undertaken using habitat profiles for each species from the *Threatened Biodiversity Data Collection* (TBDC) (DPIE, 2020) and the *Species Profile and Threats Database* (DAWE, 2020). The results of these database searches, literature reviews and the likelihood of occurrence assessment were used to design the survey requirements for species-credit species so that adequate targeted surveys were undertaken as part of the BDAR.

Various ecosystem credit species were identified and assessed for the MOD 8 Disturbance Footprint and the larger MOD 8 Survey Area using information about the:

- Site context,
- Mapped Plant Community Types (PCTs);
- Vegetation integrity attributes collected during the field surveys; and
- Data obtained from the TBDC.

Targeted surveys and transects for seasonal threatened fauna and flora species were conducted over a series of survey periods between Spring 2018 and Spring 2020. Further details on the survey efforts for the key flora and fauna are provided in **Appendix P**.

The vegetation of the MOD 8 Disturbance Footprint and extended MOD 8 Survey Area was surveyed using best-practice techniques to delineate vegetation communities across these areas. Field survey techniques included parallel field traverses, systematic surveys, active searches whilst completing BAM integrity plots, random meanders and opportunistic surveys to accurately sample the vegetation communities and potentially occurring threatened flora species within the additional disturbance area.

Fauna survey methods included a range of survey techniques including targeted searches (Regent Honeyeater, Swift Parrot and Koala), opportunistic sightings, diurnal bird surveys, Anabat Bat detection, spotlighting, call play-back, stag watches, hairtubes and remote cameras.

Following the completion of the field surveys, the Biodiversity Assessment Calculator (BAM-C) (NSW Government, 2020) was utilised to calculate the ecosystem and species credit species impacts for MOD 8.

GDE Assessment

The MOD 8 GDE Assessment was undertaken via desktop analysis utilising available knowledge of vegetation surrounding the BCM and the previous GDE assessments completed for the mines within the BTM Complex. Two study areas were established for which the MOD 8 GDE assessment was focussed:

- Regional Study Area – area within an approximate 10 km radius of the MOD 8 Survey Area to consider the potential cumulative impacts on regionally mapped high priority GDEs; and
- Nagero Creek Study Area – an area of alluvium to the south west of the BCM to focus on the vegetation which occurs in the area where incremental groundwater drawdown is predicted as a consequence of MOD 8.

Extensive vegetation mapping of the Project Boundary and within the nearby Biodiversity Offset properties which form part of the BCM Biodiversity Offset Strategy has been undertaken over the past decade. Where field verified vegetation mapping was not available proximate to the BCM, WSP relied on broad-scape vegetation mapping prepared for the NSW Government (OEH, 2016 & Eco Logical, 2013). Since field verified mapping was previously completed (some dating back to 2009), new vegetation communities have been listed as Threatened Ecological Communities under the BC Act and/or EPBC Act. For the purposes of the GDE assessment, it has been conservatively assumed that certain PCTs within the study areas conform to the listed vegetation communities under the BC Act and/or EPBC Act.

A literature review was undertaken to inform the assessment of the potential impacts of MOD 8 within the Nagero Creek and Regional Study Areas. These desktop reviews focussed on the assessment previously undertaken for the approved mines within the BTM Complex. The literature review also identified literature which discusses the rooting depths and likely reliance of vegetation on groundwater.

The GDE assessment also included an Assessment of Significance in accordance with the EPBC Act Significant Impact Guidelines 1.1 Matters of National Environmental Significance (DoE, 2013) for the key listed vegetation communities which have a potential to be impacted due to groundwater drawdown from MOD 8.

Further detail on the methods used for the GDE assessment is available in **Appendix Q**.

7.10.3 Impact Assessment

Vegetation Communities

Four native PCT and areas of disturbed land were recorded within the 110 ha MOD 8 Survey Area. Two of the PCTs recorded have been assessed to conform to the White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Box Gum Woodland) community which is listed as a CEEC under the BC Act and EPBC Act.

These PCTs include:

- PCT 599 Blakely's Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion; and
- PCT 1383 White Box grassy woodland of the Nandewar Bioregion and Brigalow Belt South Bioregion.

Table 21 lists the vegetation communities as PCTs within the MOD 8 Survey Area and the MOD 8 Disturbance Footprint. The distribution of the identified vegetation communities within the MOD 8 Survey Area is shown in **Figure 15**.

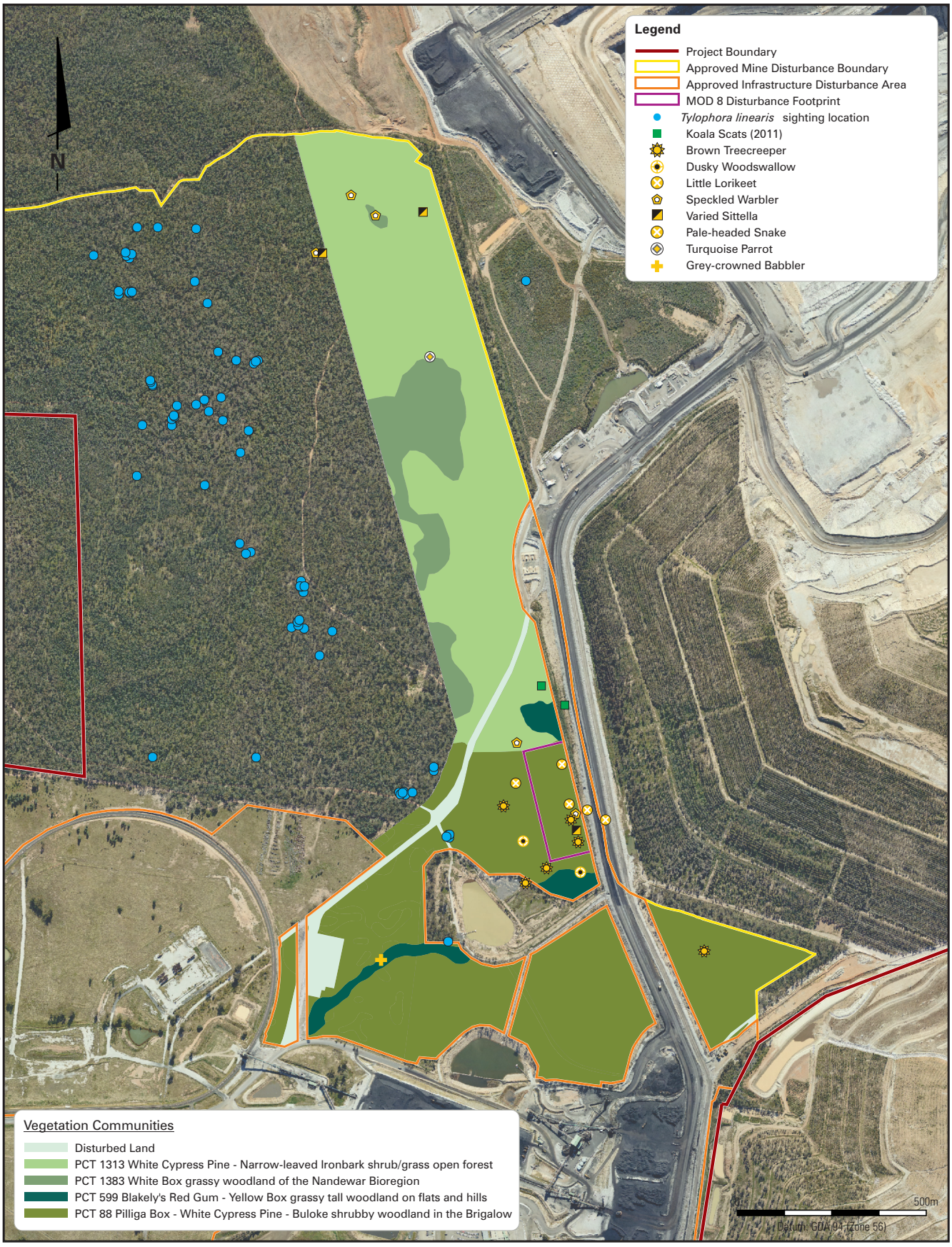
The 3.3 ha MOD 8 Disturbance Footprint, where up to 1.21 ha of disturbance is proposed for MOD 8 is made up wholly of PCT 88 Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion. This vegetation does not conform to any listed vegetation community under either the BC Act or the EPBC Act. Therefore, MOD 8 will not directly impact on any threatened ecological community.

The proposed disturbance was identified to potentially result in some impacts to vegetation providing habitat for the range of threatened flora and fauna species described below.

Table 21
Vegetation Communities within Survey Area and Disturbance Footprint

Vegetation Community	Condition	BC Act Status	EPBC Act Status	MOD 8 Survey Area (ha)	MOD 8 Disturbance Footprint (ha)
PCT 88 Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion	Intact	Not Listed	Not Listed	37.96	3.3
	Modified	Not Listed	Not Listed	1.83	-
	Shrubby Regrowth	Not Listed	Not Listed	2.90	-
	Derived Native Grasslands (DNG)	Not Listed	Not Listed	8.24	-
PCT 599 Blakely's Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion	Intact	CEEC	CEEC	3.21	-
PCT 1313 White Cypress Pine - Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion	Intact	Not Listed	Not Listed	41.68	-
PCT 1383 White Box grassy woodland of the Nandewar Bioregion and Brigalow Belt South Bioregion	Intact	CEEC	CEEC	8.99	-
Highly disturbed areas with no or limited native vegetation	N/A	Not Listed	Not Listed	4.35	
Total Native Vegetation (ha)				**104.81**	**3.3**
Total Disturbed Land (ha)				**4.35**	**-**

*Blue shading illustrates proposed species directly impacted by MOD 8.



HB BOGGABRI MOD8 EPBC Referral 1824 F6 Vegetation communities 28 01 2021

BOGGABRI COAL MINE

Vegetation Communities

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FIGURE 15